LINAC2024 - 32nd Linear Accelerator Conference

Sunday 25 August 2024 - Friday 30 August 2024

Hilton Chicago

Book of Abstracts

Contents

Main Session MOZ / 2

State-of-the-art photocathodes for bright-beam and spin-polarized-beam generation

Author: Oksana Chubenko[1]

[1] *Northern Illinois University*

Corresponding Author: chubenko@niu.edu

Talk will cover state-of-the-art photocathodes for bright-beam and spin-polarized-beam generation.

Footnotes:

Funding Agency:

Main Session TUX / 6

Status of the Spallation Neutron Source Proton Power Upgrade

Author: Sang-Ho Kim[1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: kimsh@ornl.gov

The Proton Power Upgrade (PPU) Project at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory will upgrade or replace accelerator components for beam power capability from 1.4 to 2.8 MW and upgrade the first target station for 2-MW beam at 1.3 GeV and at 60 pulses per second. The remaining beam power will be available for the future second target station. PPU scope is optimized between built-in upgrade provisions from the original SNS project, cost effectiveness and technical aspects based on SNS experiences. PPU is taking a phased approach for beam power ramp-up as new equipment are installed. This paper summarizes the status of PPU project, commissioning, progresses of beam power ramp-up and operation plan in the future.

Footnotes:

Funding Agency:

Main Session TUX / 8

First two years of FRIB operation

Author: Peter Ostroumov[1]

Co-author: Jie Wei [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: ostroumov@frib.msu.edu

The Facility for Rare Isotope Beams (FRIB), a major nuclear physics facility for research with fast, stopped, and reaccelerated rare isotope beams, was successfully commissioned and has been in operation for the past two years. Various ion beam species have been accelerated up to 300 MeV/u and delivered to the target. FRIB routinely provided 10 kW primary beams on target over the past year, a factor of 10 above used at the beginning of user operation. Recently, a record-high 10.4 kW of uranium beam, the most challenging for accelerator systems, was delivered to the target, and three new isotopes were discovered during a short 24-hour run. In July 2024, we plan to develop a 20-kW Se-82 beam and provide it for the first observation of neutron-rich rare isotopes of calcium. Every incremental step in energy and power of primary beams allows us to gain valuable experience in the facility's safe operation and provides directions for further improvements. Several accelerator improvement projects are being pursued for further power ramp-up, improving the accelerator availability, delivering more time for science, and preparing for the ultimate 400 kW beam on target.

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the FRIB Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

Footnotes:

Funding Agency:

Main Session MOZ / 9

Beam shaping using an ultra-high vacuum multileaf collimator and emittance exchange beamline

Author: Nathan Majernik[1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: majernik@slac.stanford.edu

A multileaf collimator comprising many individually controlled blades has been used to impose predefined transverse beam shapes to an electron beam. Afterwards transverse-to-longitudinal mapping transforms this shape into a longitudinal one. This technique opens a wide field of applications using individually tailored longitudinal beam profiles.

Footnotes:

Funding Agency:

Main Session WEX / 16

Status of the iBNCT accelerator

Author: Masaharu Sato[1]

Co-authors: Akira Takagi [1]; Chikashi Kubota [1]; Fujio Naito [1]; Hidetomo Oguri [2]; Hiroaki Kumada [3]; Hitoshi Kobayashi [1]; K. Nanmo [1]; Kenta Futatsukawa [1]; Kiyoshi Ikegami [1]; Nobuaki Nagura [4]; S. Tanaka [3]; Taichi Miura [1]; Takashi Obina [1]; Takashi Sugimura [1]; Tatsunobu Shibata [1]; Toshikazu Kurihara [1]; Toshikazu Toyoshima [5]; Toshiyuki Ohba [4]; Yoshitaka Matsumoto [3]; Yuji Fukui [1]; Zhigao Fang [1]

[1] *High Energy Accelerator Research Organization*

[2] *Japan Proton Accelerator Research Complex (J-PARC)*

[3] *Tsukuba University*

[4] *Nippon Advanced Technology Co., Ltd.*

[5] *ATOX*

Corresponding Author: masaharu.sato@kek.jp

Present status and future prospects of the iBNCT accelerator will be discussed. Several accelerator-based neutron sources for Boron Neutron Capture Therapy (BNCT) have been developed in the world. The iBNCT (Ibaraki, BNCT) is a linac-based BNCT facility which is operated by University of Tsukuba and KEK in close collaboration with the local government, Ibaraki prefecture. The accelerator is based on the design and experiences of the J-PARC linac, and consists of an ion source, 3-MeV RFQ, 8-MeV DTL and a Beryllium target with modulators.

The project aims to realize a compact and low activation BNCT accelerator of several mA proton beam with high duty factor to obtain the thermal neutron flux required for BNCT, but with high stability as a medical accelerator.

Originally the cavities were designed with the minimum amount of cooling water, and their resonance frequencies were maintained by dynamical control of the water temperature according to the RF power input. However, after the interlock due to RFQ discharge, the resonance frequency was shifted frequently. By improving and enhancing the cooling water and vacuum, stable operation at an average current of 2 mA has been achieved. We are performing the pre-clinical testing in FY2022, and prepare to start clinical trials in FY2023. This reports the present status of the iBNCT accelerator and its future prospects.

Footnotes:

Funding Agency:

Main Session THX / 31

Wide dynamic range diagnostics system for primary and secondary beams at FRIB

Author: Steven Lidia[1]

Co-authors: Aubrey Lokey [1]; Marco Cortesi [1]; Salvatore Di Carlo [2]; Scott Cogan [1]; Thomas Larter [1]; Douglas McNanney [1]; Igor Nesterenko [1]; Sergio Rodriguez Esparza [1]; Shen Zhao [3]; K. Saini [3]; M. Smith [3]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *European Organization for Nuclear Research*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: lidia@frib.msu.edu

The FRIB diagnostics system covers an extensive range of primary and secondary beam intensities of 14 orders of magnitude and requires continuous improvements. The linac diagnostic system has provided straightforward linac commissioning and supports the development of many primary heavy ion beam species for producing rare isotopes. The diagnostics system for the secondary beam has a unique feature of detecting and measuring low-intensity rare isotope beams. This talk will report on the performance of the FRIB diagnostics system and ongoing improvements.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy Office of Science under Cooperative Agreement DE-SC0023633, the State of Michigan, and Michigan State University.

Main Session MOY / 38

Coherent nanophotonic electron accelerator

Author: Julian Litzel[None]

Corresponding Author: julian.litzel@fau.de

The acceleration of electrons with the help of laser light inside a photonic nanostructure represents a microscopic alternative to microwave-driven accelerators. The main advantage is that the much higher driving facilitates damage thresholds of dielectric materials reaching 10 GV/m. This means that acceleration gradients far in excess of 1 GeV/m should be attainable. Furthermore, the structure size of the optical accelerators lies in the nanometer range, meaning that nanofabrication methods can be employed to build the accelerator structures. In pursuit of these goals, we demonstrated a scalable nanophotonic linear electron accelerator that coherently combines particle acceleration and transverse beam confinement utilizing an alternating phase focusing (APF) scheme. It accelerates and guides electrons over a considerable distance of 500 μm in a channel just 225 nm wide. The highest energy gain observed was 43%, from 28.4 keV to 40.7 keV. We expect this work to pave the way for nanophotonic accelerators. These on-chip particle accelerators might enable transformative applications in medicine, industry, materials research and science. In this talk, we will give a status update of nanophotonics accelerators.

Footnotes:

Chlouba, T., Shiloh, R., Kraus, S. et al. Coherent nanophotonic electron accelerator. Nature 622, 476–480 (2023). https://doi.org/10.1038/s41586-023-06602-7

Funding Agency:

Main Session MOY / 42

Current status of LWFA development towards robust table-top XUV-FEL

Author: Zhan Jin[1]

Co-authors: Yan-Jun GU [1]; Kai HUANG [2]; Nobuhiko NAKANII [2]; Zhenzhe LEI [1]; Shingo SATO [1]; Masaki Kando [2]; Tomonao Hosokai [1]

[1] *Osaka University*

[2] *National Institutes for Quantum Science and Technology*

Corresponding Author: jin@sanken.osaka-u.ac.jp

In order to develop a stable LWFA based accelerator and demonstrate FEL generation, the unique LWFA platform was constructed in the RIKEN SPring-8 center and systematic experiments have being conducted financially supported by ImPACT (2013-2018) and JST MIRAI (2018-) programs. Although undulator radiation in an XUV spectral range driven by LWFA electron beams was successfully demonstrated on the platform in 2019, the sufficient reproducibility was not obtained due to the poor electron pointing stability and large energy fluctuations. In order to solve the above problems, the accelerated electron beam quality has been improved by developing the Shock injection scheme enabling a precise injection control and a stable plasma condition. This development has dramatically improved the reproducibility and stability of the LWFA electron beam. The preliminary proof-of-concept experiment has recently demonstrated the clear amplification of the undulator radiation and the possibility of LWFA based FEL in XUV range. The talk will be presenting the outline of the LWFA platform, the setup of a proof-of-concept experiment focusing on key improvements and obtained results.

Footnotes:

Funding Agency:

Main Session WEX / 50

Sub-femtosecond time-resolved measurements of electron and photon beams

Author: Eduard Prat[1]

Co-author: Paolo Craievich [1]

[1] *Paul Scherrer Institut*

Corresponding Author: eduard.prat@psi.ch

Time-resolved diagnostics are fundamental for x-ray free-electron lasers (FELs). Radio-frequency (RF) transverse deflector structures (TDSs) are typically employed to characterize the temporal properties of the electron beams driving FELs. In this contribution, we present time-resolved measurements with a resolution below one femtosecond using a C-band and X-band RF TDS at SwissFEL. Measurements with a sub-femtosecond resolution are of crucial importance for ultra-fast x-ray FEL applications.

Footnotes:

Funding Agency:

Main Session MOY / 58

Breaking through 100 mA H- ion source output current at SNS

Author: Baoxi Han[1]

Co-authors: Chip Piller [1]; Chris Stinson [1]; Gregory Terszakowec [1]; Robert Welton [1]; Sang-Ho Kim [1]; Vic Andzulis [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: hanb@ornl.gov

The performance of the SNS H- ion source has been improved over many years with a primary emphasis on extending its operational lifetime and enhancing its reliability. Recent research and development efforts have resulted in a significant boost in the output beam current, increasing from the existing capability of ˜60 mA to more than 100 mA. This talk will discuss the advancements in design and diagnostics that have contributed to the performance elevation of the SNS H- ion source.

Footnotes:

Funding Agency:

Main Session FRX / 67

Operational experience and reliability of the new CERN Linac4

Author: Edgar Sargsyan[1]

Co-authors: Alessandra Lombardi [1]; Giulia Bellodi [1]; Jean-Baptiste Lallement [1]; Piotr Skowronski [1]; Rolf Wegner [1]

[1] *European Organization for Nuclear Research*

Corresponding Author: edgar.sargsyan@cern.ch

Since its completion in 2017, Linac4, the new 160 MeV proton injector for the CERN accelerator complex, has undergone some tests to assess and improve reliability, until being connected to the Proton Synchrotron Booster (PSB) during the 2018-2020 Long Shutdown 2 (LS2). The performance requirements for the LHC high-luminosity upgrade have been successfully met, and during its first three complete years of operation the linac has shown high reliability figures. Recent improvements of the H- ion source enable the increase of the beam current from the nominal 35 mA to 50 mA, opening the possibility for increasing the intensity of the Booster beams, for the benefit of the experimental programmes. This paper presents the operational experience and reliability of Linac4 in its first three years of operation.

Footnotes:

Funding Agency:

Main Session WEX / 75

Advances in fs synchronization

Author: Marie Kristin Czwalinna[1]

Co-authors: Björn Lautenschlager [1]; Frank Ludwig [1]; Holger Schlarb [1]; Julien Branlard [1]; Sebastian Schulz [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: marie.kristin.czwalinna@desy.de

Linear accelerators for FELs have very high requirements for the accuracy of synchronization. The long and short term stability is influenced by various sources of interference. In this paper it will be shown which methods of stabilization exist and how synchronization accuracies up to the fs-level can be achieved.

Footnotes:

Funding Agency:

Main Session MOY / 76

Operation of FLASH above 1.3 GeV and below 4 nm

Author: Lucas Schaper[1]

Co-authors: Katja Honkavaara [1]; Mathias Vogt [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: lucas.schaper@desy.de

FLASH is undergoing major modifications in the framework of the FLASH2020+ project.
During the last upgrade phase in 2021/22 alterations to the superconducting linac have been the main priorty. Among other changes two accelerating modules were replaced by modern high gradient versions. This allows to operate FLASH routinely with electron beam energies exceeding 1.3 GeV and thus extends the photon wavelength range to below 4 nm in the fundamental. This presentation summarises the major facility modifications during the 2021/22 shutdown and will give an overview and outlook about the operation since then.

Footnotes:

Funding Agency:

Main Session THY / 81

Design of ultrafast electron microscopy with superconducting rf gun

Author: Jinfeng Yang[1]

[1] *Osaka University*

Corresponding Author: yang@sanken.osaka-u.ac.jp

Observation of ultrafast structural dynamics is very important for elucidating functions and creating new materials. We have been promoting research and development of ultrafast electron microscopes by generating relativistic femtosecond electron beam pulses using radio frequency (RF) accelerator technology. So far, we have fabricated the world's first ultrafast electron microscope using a normal-conducting S-band RF electron gun and demonstrated its feasibility in demonstration experiments. However, the normal-conducting RF electron gun uses high-power RF pulses, which causes limitations of low beam repetition rate and pulse-by-pulse energy stability. In this study, we have devised an L-band Nb3Sn superconducting RF electron gun that breaks through these limitations and are aiming to develop an ultrafast electron microscope using this gun. We will report the design of the Nb3Sn superconducting RF electron gun, beam simulation results, and conceptual design of an ultrafast electron microscope using the gun.

Footnotes:

Funding Agency:

Main Session THX / 104

Automatic retuning of superconducting linacs using LightWin

Author: Adrien Plaçais[1]

Co-authors: Angie Orduz [2]; Bruce Yee-Rendon [3]; Emmanuel Froidefond [1]; Frédéric Bouly [1]; Guillaume Normand [2]; Jarno Van De Walle [4]; Jean-Michel Lagniel [2]; Lennert De Keukeleere [4]

[1] *Laboratoire de Physique Subatomique et de Cosmologie*

[2] *Grand Accélérateur Nat. d'Ions Lourds*

[3] *Japan Atomic Energy Agency*

[4] *Belgian Nuclear Research Centre in Mol*

Corresponding Author: placais@lpsc.in2p3.fr

Reliability is an important feature for high power particle accelerators. This is particularly true for Accelerator-Driven Systems (ADS), for that every beam interruption can strongly affect the availability of the nuclear reactor.

Many of these outages come from the loss of accelerating cavities or of their associated systems. Cavity failures can be compensated for by retuning other cavities of the linac. Finding the ideal compensation settings is however a difficult challenge that involves beam dynamics and multi-objective optimisation, and which raises very different issues according to the linac under study. For instance in the SPIRAL2 linac, a lot of cavities are mobilized for the compensation and the search space has a very high number of dimensions. Plus, it has quite low margins on the longitudinal acceptance. Linacs for ADS (such as the Japan Atomic Energy Agency ADS or MYRRHA) have a specific fault-tolerance design which facilitate the optimisation, but cavities have to be retuned in a few seconds.

Hence we developed LightWin, a tool to automatically and systematically find compensation settings for every cavity failure of any given linac. In this study, we will present LightWin's latest developments as well as the compensation strategies that we developed for SPIRAL2 and ADS linacs, both from a beam dynamics and a mathematical point of view.

Footnotes:

Funding Agency:

Main Session TUZ / 106

Fabrication and beam testing of a 180 GHz colinear wakefield accelerator

Author: Branko Popovic[1]

[1] *Argonne National Laboratory*

Corresponding Author: bpopovic@anl.gov

Corrugated waveguide based colinear wakefield accelerator development at Argonne National Laboratory has been ongoing, achieving significant progress in fabrication and testing of most principal components of the accelerator module. A few 30 cm long corrugated waveguides with a 2 mm ID and short transition sections which provide fundamental mode power extraction and beam offset diagnostics via the wakefield induced dipole mode have been fabricated. Several high field gradient quadrupoles envisioned for beam guidance and suppression of a beam breakup instability have been fabricated as well. The structures have been tested at mmWave frequencies and the quadrupoles were characterized via magnetic measurements. Electron beam testing was conducted at Brookhaven National Lab's Accelerator Test Facility. The fundamental and dipole mode's frequency and signal levels were measured and a good agreement with design parameters has been demonstrated.

Footnotes:

Funding Agency:

Main Session TUZ / 116

The progress of CiADS linac and first beam acceleration

Author: Zhijun Wang[1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: wangzj@impcas.ac.cn

CiADS is the world's first Accelerator Driven System under construction with a Mega-watt beam power. The linac of CiADS is designed to accelerate a 500 MeV and 5 mA proton beam with five-family superconducting resonators. The facility was lunched from mid 2021 and the hardware has finished the development of the prototype. In this presentation, we will present the physical design of the superconducting linac, progress of key hardware and the first beam acceleration from normal conducting fronted.

Footnotes:

Funding Agency:

Main Session FRX / 117

Status of HIAF iLinac SC cavity system at IMP

Authors: Mengxin Xu[1]; Yuan He[1]

Co-authors: Chunlong Li [1]; Hao Guo [1]; Hongwei Zhao [1]; Jiancheng Yang [1]; Jiyu Wang [1]; Lubei Liu [1]; Pingran Xiong [1]; Qitong Huang [2]; Shenghu Zhang [1]; Shengxue Zhang [1]; Shichun Huang [1]; Teng Tan [1]; Tiancai Jiang [1]; Yue Tao [1]; Zhijun Wang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *Advanced Energy Science and Technology Guangdong Laboratory*

Corresponding Author: xumx@impcas.ac.cn

HIAF is a heavy ion accelerator facility in China for nuclear physics research. The superconducting LINAC was used to accelerating beam energy up to 17MeV/u, then injecting to a Booster Ring. The linac are under construction since 2021, which includes 30 quarter-wave resonator (QWR) and 66 half-wave resonator (HWR). The first-batch production of cavity system have been completed. And the cavity's auxiliaries, such as coupler and tuner are ready too for first two cryomodules. This paper will present the current status of the HIAF SC cavity system.

Footnotes:

Funding Agency:

This work is supported by the Large Research Infrastructures "High Intensity heavy-ion Accelerator Facility"(Grant No. 2017-000052-73-01-002107).

Main Session WEX / 127

Full automatic clean assembly of HWR cavity

Author: Hao Guo[1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: guohao@impcas.ac.cn

Cleanroom processing and assembly are critical for ensuring optimal performance of SRF (Superconducting Radio Frequency) cavities. Human activities are a significant source of particle emissions in cleanrooms, posing a risk of cavity contamination. To mitigate this risk and reduce labor costs, the implementation of robotics in cleanroom environments has garnered increasing attention in recent years.
In the pursuit of automated HWR (Half-Wave Resonator) cavity assembly, several key processes have been identified and segmented from the traditional cleanroom assembly workflow. These processes include cavity transportation and automated handling, nut placement, and fastening, among others. This report will provide an overview of these decomposed processes, along with the results of their implementation.

Footnotes:

Funding Agency:

Main Session THY / 149

High charge, 10-GeV electron bunches from a 10-cm long, nanoparticle assisted, laser wakefield accelerator: our next steps

Author: Stephen Milton[1]

Co-author: Bjorn Hegelich [2]

[1] *TAU Systems, Inc.*

[2] *The University of Texas at Austin*

Corresponding Author: stephen.milton@tausystems.com

We recently demonstrated generation of very high charge (1+ nC), very high energy (10 GeV) electron bunches from a nanoparticle-assisted laser wakefield accelerator [1]. While the experiment did yield record breaking results, the statistics were quite poor due to the very slow repetition rate of the Texas Petawatt Laser system. We are currently on a campaign to repeat and improve upon these results. Here we will report on our improved understanding of the nanoparticle-assist effect as well as the planned experimental program we have laid out.

[1] C. Aniculaesei et al. "The Acceleration of a High-Charge Electron Bunch to 10 GeV in a 10-cm Nanoparticle-Assisted Wakefield Accelerator", Matter Radiat. Extremes 9, 014001 (2024) https://doi.org/10.1063/5.0161

Footnotes:

Funding Agency:

Main Session MOZ / 153

High average gradient in a laser-gated multistage plasma wakefield accelerator

Author: Alexander Knetsch[1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: knetsch@slac.stanford.edu

Plasma wakefield accelerators driven by particle beams are one promising method of advanced acceleration, with capable of providing accelerating gradient much larger than RF technology. One of the biggest remaining issues is coupling beams from one stage to another. This novel concept optimizes inter-plasma distances in a staged beam-driven plasma accelerator by drive-beam coupling in the temporal domain and gating the accelerator via a low-power, ultrashort pulse laser.

Footnotes:

Funding Agency:

Main Session FRY / 167

The quest for high gradient and high Q in SRF cavities

Author: Akira Miyazaki[1]

[1] *Université Paris-Saclay, CNRS/IN2P3, IJCLab*

Corresponding Author: akira.miyazaki@cern.ch

The SRF world has made considerable advances in the last 15 years on the performance of bulk niobium cavities. Processing recipes like N-doping and 120C baking are now being accepted as standard and consistently delivered by industry. New treatments like mid-T baking are now being incorporated into some project processing recipes as well. Thin film research is advancing with the mission to pave the way to performance beyond bulk niobium. This talk should give a summary of present performance with a glimpse towards the fundamental processes at play in the treatments of today and some thoughts towards future directions.

Footnotes:

Funding Agency:

Main Session WEX / 170

Crabbing cavity system development for International Linear Collider

Author: Subashini De Silva[1]

[1] *Old Dominion University*

Corresponding Author: sdesilva@jlab.org

The International Liner Collider requires a crabbing system to increase the luminosity of the colliding electron bunches. The ILC has a large crossing angle that requires compensation in order to meet the luminosity requirements. There are several frequency options proposed for the crabbing cavity design. Two crab cavity designs were selected to be prototyped in the pre-lab phase, following the Down Selection Review on Crab Cavity Design held in April 2023. The two rf designs selected are the 1.3 GHz rf-dipole cavity and the 2.6 GHz QMiR cavity. We will be presenting the electromagnetic and mechanical design details of the two compact crabbing cavity designs.

Footnotes:

Funding Agency:

Main Session WEX / 173

Adaptive machine learning with hard physics constraints and generative diffusion for 6D phase space diagnostics

Author: Alexander Scheinker[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: ascheink@lanl.gov

Machine learning (ML) tools have been growing in popularity for accelerator applications, but still struggle with time varying systems, for which they require lengthy brute-force re-training. LANL has developed generative machine learning (ML)-based tools, that utilize adaptive model independent feedback control theory together with hard physics constraints, to make the tools much more robust to distribution shift. These adaptive ML tools are able to extrapolate much further beyond the span of the training data and are thus much more robust for time-varying systems. This talk will give a broad overview of the challenges of various time-varying accelerator systems at various accelerator facilities (known as systems with distribution shift in the ML community) and will present adaptive ML tools for 6D phase space diagnostics of intense charged particle beams. The talk will give a general overview of diffusion-based generative models and also adaptive latent space tuning, which is the novel method we have developed for adaptive ML, and how we are strictly enforcing hard physics constraints in our ML tools, which traditional ML tools lack. We demonstrate our general methods for various accelerators: the 5-meter long ultra-fast electron diffraction (UED) HiRES compact accelerator at LBNL, the ˜kilometer long plasma wakefield accelerator FACET-II at SLAC, and the LANL ion accelerator LANSCE.

Footnotes:

Funding Agency:

Main Session WEY / 182

Results from CXLS commissioning

Author: William Graves[1]

Co-authors: Alan Dupre [1]; Alex Gardeck [1]; Alexandra Ros [1]; Anastasia Martinez [1]; Antonella Semaan [1]; Arvinder Sandhu [2]; B. Liebich [1]; Brandon Cook [1]; Christina Bell [1]; Dean Smith [1]; Elena Ros [1]; Eric Everett [1]; Gregory Babic [1]; Henrik Loos [3]; Hyung Seo Lee [1]; Jade Stanton [1]; Jasmin Falconer [1]; Joseph Tinlin [4]; Juan Vela [1]; Kevin Eckrosh [1]; Lucas Malin [1]; Mark Holl [1]; Mukhtar Hussain [1]; P. Jiang [1]; Paul Brown [5]; Petra Fromme [1]; Rachel Larsen [1]; Rejul Jaswal [1]; Richard Kirian [1]; Robert Kaindl [1]; Roy Rednour [1]; Sabine Botha [1]; Sami Tantawi [3]; Samuel Teitelbaum [1]; Sean Tilton [1]; Shreya Tripathi [1]; Stephen Jachim [1]; Taryn Brown [1]; Trixia Dela Rosa [1]; Valery Dolgashev [3]; Xinyi Ma [1]

[1] *Arizona State University*

[2] *University of Arizona*

[3] *SLAC National Accelerator Laboratory*

[4] *Los Alamos National Laboratory*

[5] *Communications & Power Industries, Inc.*

Corresponding Author: wsg@asu.edu

The Compact X-ray Light Source (CXLS) is a compact source of femtosecond pulses of x-rays that is now commissioning in the hard x-ray energy range 6-20 keV. It collides the electron beam from recently developed X-band distributed-coupling, room-temperature, standing-wave linacs and photoinjectors operating at 1 kHz repetition rates and 9300 MHz RF frequency with a Yb:YAG 1030 nm laser beam operating at high peak and average power at 1 kHz repetition rate with pulse energy up to 200 mJ. We present the performance of the CXLS accelerator, laser, and timing systems, and initial x-ray results.

Footnotes:

Funding Agency:

NSF awards 2153503 and 1935994

Main Session WEY / 183

Distributed coupling linacs: a paradigm shift in linear accelerator design

Author: Sami Tantawi[1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: tantawi@slac.stanford.edu

Distributed coupling linear accelerators (DCLs) represent a revolutionary approach to accelerator design, offering significant advantages over traditional standing-wave and traveling-wave linacs. DCLs achieve record-breaking efficiency and gradient while remaining highly reliable, even under extreme operating conditions. These advancements make them ideal for a wide range of applications, including: Novel FELs, C3 collider concepts, medical radiotherapy, and Inspection and imaging technologies. This presentation delves into the theoretical underpinnings of DCLs and their latest development. We will explore how the technology has evolved from its initial pi-mode configuration to the even more efficient 3 pi/4-mode structure.

Footnotes:

Funding Agency:

DoE, DHS, DARPA

Main Session MOX / 185

Recent advances in normal conducting radiofrequency linac structures

Author: Xueying Lu[1]

[1] *Northern Illinois University*

Corresponding Author: xylu@niu.edu

Normal conducting radiofrequency (NCRF) technology plays a crucial role in the development of more compact and cost-effective linear accelerators with increased energy reach and intensity. Over

the past few years, NCRF structures have seen remarkable progress in accelerating gradient, RF-to-beam efficiency and overall performance that could lead to compact linacs for a multitude of applications. These advances are driven by new understanding of RF breakdown physics, innovative structure topologies and coupling schemes, advanced materials and fabrication techniques, and new operating regimes including operation at cryogenic temperatures, at various frequencies, and with nanosecond-scale RF pulses. In this talk, I will review some recent progress in NCRF structures and discuss their synergies with advanced accelerator concepts towards future colliders and compact light sources.

Footnotes:

Funding Agency:

Main Session THZ / 189

Commissioning of LCLS-II

Author: Axel Brachmann[1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: brachman@slac.stanford.edu

We will present the results of the commissioning program to establish x-ray lasing and operation of the LCLS-II facility, based on the 4 GeV superconducting accelerator. The commissioning scope included the cryogenic systems, SRF and cryomodules, beam transport and two undulator beamlines serving the hard and soft x-ray programs. The talk will include a discussion of achieved beam performance, both for electron and photon beam and our plans to ramp up to the final objectives. A report of operational issues will be included as well. Finally a brief summary of the status of LCLS-II-HE will be provided.

Footnotes:

Funding Agency:

Main Session THX / 190

Machine-learning-assisted beam tuning at FRIB

Author: Kilean Hwang[1]

Co-authors: Alexander Plastun [2]; Kei Fukushima [2]; Peter Ostroumov [2]; Qiang Zhao [3]; Tomofumi Maruta [2]; Tong Zhang [2]

[1] *Facility for Rare Isotope Beams*

[2] *Facility for Rare Isotope Beams, Michigan State University*

[3] *Michigan State University*

Corresponding Author: hwang@frib.msu.edu

Facility for Rare Isotope Beams (FRIB) requires diverse primary ion species beams to produce rare isotopes. The beam tuning time can be reduced by employing Machine Learning (ML) techniques. In this presentation, we aim to explore practical perspectives on shortening beam tuning time. Specifically, we discuss customization of Bayesian Optimization for maximum beam time utilization, and virtual diagnostics that are currently under development.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Award Number DE-SC0024707 and used resources of the FRIB Operations, which is a DOE Office of Scien

Main Session TUX / 191

CSNS linac energy upgrade

Author: Huachang Liu[1]

[1] *Dongguan Neutron Science Center*

Corresponding Author: liuhc@ihep.ac.cn

The CSNS power upgrade project (CSNS-II) has been launched. It will increase the proton beam power from 100 kW to 500 kW, along with the new construction of 9 neutron instruments. CSNS-II will utilize superconducting accelerator structures to raise the linac energy from 80 MeV to 300 MeV. The pre-research on key technologies has been completed. The newly developed RF ion source is already operational. Prototypes of the dual-spoke and 6-cell elliptical superconducting cavities and their corresponding cryomodules have been developed.

Footnotes:

Funding Agency:

Main Session WEY / 193

PIP-II: an international endeavor to enable neutrino science

Author: Pantaleo Raimondi[None]

Corresponding Author: praimond@fnal.gov

This talk will provide an overview of the PIP-II project, how the international contributions are being arranged, the major systems, current status, and outlook. It will also discuss how the accelerator complex will be evolved to take advantage of PIP-II beams to meet the needs of the neutrino program, including some of the accelerator physics challenges.

Footnotes:

Funding Agency:

Main Session FRX / 194

SRF coaxial resonators for hadron acceleration

Author: Philipp Kolb[1]

[1] *TRIUMF*

Corresponding Author: kolb@triumf.ca

SRF technology using niobium accelerating cavities enables high performance and efficient acceleration for modern accelerator projects. While electron linacs accelerate particles with common structures designed for relativistic acceleration hadron linacs require acceleration over a broad velocity range. SRF technology is now being adopted at hadron energies in some cases starting from the RFQ exit but with top end energies such that a velocity range of a factor of ten has to be considered in the linac configuration and cavity design. Different structures in the TEM mode (coaxial) class (QWR, HWR, SSR, DSR) are employed with customized rf frequency, design beta and cavity structure. The coaxial cavities are now operating at very high performance rivaling the achievements in the 1.3GHz elliptical cavities. The talk should give an overview of the state of the art in the field.

Footnotes:

Funding Agency:

Main Session MOX / 195

The future of the Fermilab Accelerator Complex with the new PIP-II linac

Author: Donato Passarelli[1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: donato@fnal.gov

In this opening plenary talk, the speaker will discuss advances in SRF technologies are enabling PIP-II, the new proton driver for the Fermilab Accelerator Complex currently under construction. This includes advanced cavity processing methods such as nitrogen doping and the mid-T bake and innovations in cryomodule design. He will present an overview of plans to evolve Complex in the PIP-II era to take advantage of the higher power beams from PIP-II to support the LBNF/DUNE neutrino program. Finally, he will discuss a vision for the future, including a proposed extension of the PIP-II linac, and how this can eventually enable a muon collider at Fermilab.

Footnotes:

Funding Agency:

Main Session FRX / 199

Machine learning-based fault classification in superconducting cavities at Chinese ADS front-end demo SRF linac

Author: Feng Qiu[1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: qiufeng@impcas.ac.cn

In 2021, the Chinese ADS Front-end demo superconducting radio-frequency (SRF) linac, known as CAFe, successfully conducted a commissioning of a 10 mA, 200 kW continuous wave proton

beam. During this commissioning, it was observed that the SRF cavity fault played a predominant role, contributing to approximately 70% of total beam trips. Upon the detection of fault signals, an acquisition process recorded 8 RF waveforms using digital low-level radio-frequency systems. A meticulous study of the cavity fault mechanisms was undertaken, leading to the identification and generalization of several fault patterns through the analysis of collected time-series data. The findings revealed that the dominant causes of SRF trips were field emission-triggered cavity faults and thermal quenches. We optimized the feature extraction methods for fault signals and developed a machine learning-based fault classification model. Comparative analysis with expert identification results demonstrated an accuracy rate of over 90% for the model. This research marks a significant stride towards enhancing the availability and reliability of operational beams for the future China Initiative Accelerator-Driven System project.

Footnotes:

Funding Agency:

Main Session THZ / 200

Various applications of SRF linear accelerators in KEK

Author: Hiroshi Sakai[1]

[1] *High Energy Accelerator Research Organization*

Corresponding Author: hiroshi.sakai.phys@kek.jp

As an introduction, we will talk about the merit of the superconducting cavity and we about our applied research based on Compact ERL (cERL) in KEK, which uses the Nb superconducting cavity and can make energy recovery operation. The cERL's characteristic using the high-current beam has a variety of applications; industrial applications using high-intensity terahertz light and mid-infrared FEL (free-electron laser). In addition, high current CW-beam irradiation was conducted for basic research on domestic production of nuclear medicine, strengthening of asphalt, and the highly efficient production of nanocellulose from wood in cERL. After talking about these applications of cERL, we will discuss "Future plan for applied research using superconducting accelerators". One is the EUV-FEL light source development for EUV-lithography and the other is the development of compact superconducting RF accelerator based on Nb3Sn for high-power beam irradiation.

Footnotes:

Funding Agency:

Tuesday Poster Session / 202

Dominance of particle resonances over parametric instabilities in high-intensity linacs

Author: Dong-O Jeon[1]

Co-author: Ji-Ho Jang [1]

[1] *Institute for Basic Science*

Corresponding Author: jeond@ibs.re.kr

For high-intensity linear accelerators, space-charge halo mechanisms are largely classified into two families: particle resonances and parametric instabilities. The dominance between the fourth-order

particle resonance and the envelope instability has been argued and studied. Our studies and previous literature indicate the dominance of particle resonances over parametric instabilities in high-intensity linear accelerators. Any counter evidence has not been found yet. Furthermore studies indicate that parametric instabilities except the envelope instability are unlikely to be observed in actual linear accelerators unless waterbag or KV distributions are generated. We propose a way to overcome the previous design rule to avoid the zero-current phase advance > 90° for the high-intensity linac. The interplay is presented of the envelope instability and the fourth-order parametric instability.

Footnotes:

Funding Agency:

Monday Poster Session / **203**

Development of test bench for 324 MHz superconducting cavity power couplers

Author: MengXu Fan[1]

[1] *Institute of High Energy Physics*

Corresponding Author: fanmx@ihep.ac.cn

The power coupler is one of the most important components for superconducting cavities. Different from the normal conducting cavity, the superconducting cavity has to keep an ultra-high cleanliness environment for operation. As the vacuum barrier, power couplers are welded by many different materials and maybe the gas source since they are installed to the cavities after vertical test, therefore, they should be high power conditioned before operation. Generally speaking, test bench equipment with two power couplers is often designed to improve the high conditioning efficiency. In this paper, different types of test benches are compared according to simulation and the cylindrical quarter-wavelength cavity is chosen. Besides, the detailed electromagnetic and mechanical design of the test bench is presented; to verify machining accuracy, two test pieces are also designed to measure the transmission of the test bench. In addition, to meet the high power conditioning of different power couplers, the test bench is optimized to have a capacity of 300 kW CW forward power. Finally, limited by the output power of klystron, the test bench with a pair of couplers is high power conditioned to a standing power level of 500 kW with a repetition rate of 25 Hz and a pulse width of 1.2 ms.

Footnotes:

Funding Agency:

Monday Poster Session / **204**

Fundamental power couplers development at CSNS campus

Author: MengXu Fan[1]

[1] *Institute of High Energy Physics*

Corresponding Author: fanmx@ihep.ac.cn

The China Spallation Neutron Source (CSNS) project is now operating stably at the CSNS campus and the upgrade work (CSNS-Ⅱ) has already started in 2023, meanwhile, the preliminary research work on the south advance photon source (SAPS) project is in progress. More than six types of accelerator

cavities: radio frequency quadrupole (RFQ), drift tube linac (DTL), double spoke superconducting cavities, elliptical superconducting cavities, Debuncher and C band traveling wave structure, and so on in these projects, requiring corresponding different fundamental power couplers (FPCs). These FPCs are divided into waveguide and coaxial types. Different coaxial FPCs are chosen for the superconducting cavities and RFQ, while waveguide FPCs are chosen for the DTL, Debuncher, and traveling wave structure as they need a high peak power. In this paper, we will review the FPCs development at the CSNS campus. The basis for selection, design considerations, operating or testing results, etc. will be all described in this paper.

Footnotes:

Funding Agency:

Monday Poster Session / 205

Development of an online adjustable waveguide coupler for CSNS-II debuncher cavity

Author: MengXu Fan[1]

Co-authors: Huachang Liu [2]; Pei Hua Qu [1]; Ahong Li [1]

[1] *Institute of High Energy Physics*

[2] *Dongguan Neutron Science Center*

Corresponding Author: fanmx@ihep.ac.cn

The China Spallation Neutron Source Upgrade Project (CSNS-II) will use two debuncher cavities to supplement the beam energy at the end of the linear accelerator. The PI mode structure operating at room temperature is chosen, and each debuncher cavity is equipped with an online adjustable waveguide coupler. The main body of the coupler is the WR1500 waveguide, and a hole on the narrow wall of the waveguide is opened to achieve the coupling between the cavity and the waveguide. Meanwhile, every coupler contains a removable waveguide window. In this paper, we will detail describe the electromagnetic, cooling and mechanical design of the coupler. Finally, the coupler is high-power conditioned to 1 MW with a duty factor of 2.25%, and the coupler factor of it can be online adjusted between 0.6~3 without arc event.

Footnotes:

Funding Agency:

Tuesday Poster Session / 206

Physics applications for RAON linac commissioning

Author: Dong-O Jeon[1]

[1] *Institute for Basic Science*

Corresponding Author: jeond@ibs.re.kr

Physics applications have been developed and applied to the linac commissioning of the RAON injector and superconducting linac. Beam parameters obtained from the physics applications have been checked and validated during the beam commissioning using various ion beams.

Footnotes:

Funding Agency:

Thursday Poster Session / 208

ISIS injector linac emittance measurement and phase-space tomography

Author: Alan Letchford[1]

Co-authors: Sasan Ahmadiannamin [1]; Robert Williamson [1]; Billy Kyle [1]

[1] *Science and Technology Facilities Council*

Corresponding Author: alan.letchford@stfc.ac.uk

Accurate beam emittance measurement and characterizing beam parameters are essential steps in the performance improvement and better physics studies of high-intensity proton beam accelerators. While various procedures exist for measuring beam parameters, they often come with limitations and provide only a linear space charge approximation of the phase space ellipse. To achieve better characterization, it is crucial to obtain a comprehensive view of the phase space distribution and investigate nonlinearities. The ISIS neutron spallation source, one of the world's oldest machines, boasts a 70 MeV injector linac and 800 MeV RCS with plans for operation for the next twenty years. Future upgrades aim to increase beam intensity to 300 microamps while minimizing beam loss. Machine physics cycles are actively pursued to achieve these targets. Beam parameters at the output of the injector profoundly impact maximum transmission and high-quality beam matching to the Rapid Cycling Synchrotron of the ISIS machine. This paper presents the results of phase space tomographic reconstruction and quadrupole scan results for emittance measurement at the end of the ISIS 70 MeV injector. The findings demonstrate a strong correlation between tomographic measurement and simulation results, indicating the efficacy of the proposed method in accurately characterizing beam properties.

Footnotes:

Funding Agency:

Tuesday Poster Session / 209

Beam transient studies for the JAEA-ADS LEBT

Author: Bruce Yee-Rendon[1]

Co-authors: Yasuhiro Kondo [1]; Jun Tamura [1]; Shin-ichiro Meigo [2]; Fujio Maekawa [2]

[1] *Japan Atomic Energy Agency*

[2] *Japan Proton Accelerator Research Complex (J-PARC)*

Corresponding Author: byee@post.j-parc.jp

The Japan Atomic Energy Agency (JAEA) is designing a 30-MW CW proton linear accelerator (linac) for nuclear waste transmutation. Space-charge is the primary challenge in achieving low losses and high beam quality for high-power accelerators, especially at low energy levels where space-charge forces are greater. To counteract the space-charge effects, the low-energy beam transport (LEBT) uses a magnetostatic design to enable the neutralization of the beam charge, the so-called space charge compensation. The neutralization is an accumulation process that reaches a charge balance

between the main beam and the opposite ionized particles. However, this equilibrium is destroyed by the chopper system used during beam ramping. During those transient regimes, the beam optics conditions are not optimal for the beam, producing considerable degradation that can end in serious damage to the accelerator. Thus, analysis of beam behavior at these periods is essential to develop a robust design and an efficient operation of the JAEA-ADS linac. This study presents the beam dynamics of neutralization build-up and chopper operation for the JAEA-ADS LEBT.

Footnotes:

Funding Agency:

Tuesday Poster Session / 210

The LINACs simulation framework

Author: Bruce Yee-Rendon[1]

Co-authors: Robert Jameson [2]; Masahiro Okamura [3]; Chao Li [4]; Peiyong Jiang [5]; Johannes Maus [6]

[1] *Japan Atomic Energy Agency*

[2] *Goethe Universität Frankfurt*

[3] *Brookhaven National Laboratory*

[4] *Deutsches Elektronen-Synchrotron*

[5] *Institute of Modern Physics, Chinese Academy of Sciences*

[6] *NTG Neue Technologien GmbH & Co KG*

Corresponding Author: byee@post.j-parc.jp

LINACs is a simulation framework for designing optics and beam dynamics of charged particles in particle accelerators. LINACs is an open-source software that enables the user complete control over all design and simulation parameters of RFQs. This includes beam-driven design, fully 3D simulation using precise quadrupolar symmetry, and rigorous Poisson solution for external and space charge fields. The code can handle simultaneous particle beams with analytical input distributions and allows input beam scans. The software offers a relatively short running time and provides extensive analysis techniques. This work provides a historical overview of the code, presents results from RFQ models, and discusses future developments.

Footnotes:

Funding Agency:

Monday Poster Session / 211

Overview of accelerating structure research activities at IHEP

Author: Jingru Zhang[1]

Co-authors: Cai Meng [1]; Hua Shi [2]; Nan Gan [2]; Ouzheng Xiao [2]; Xiaoping Li [1]; Xiang He [1]; Xinpeng Ma [3]; Jindong Liu [1]; Zusheng Zhou [2]; Yuhui Li [1]; Jie Gao [1]; Da-Yong He [1]; Jingyi Li [2]

[1] *Chinese Academy of Sciences*

[2] *Institute of High Energy Physics*

[3] *Key Laboratory of Particle Acceleration Physics and Technology*

Corresponding Author: zhangjr@ihep.ac.cn

In electron linear accelerators, the improvement of the acceleration gradient of the acceleration structure has been a continuous research topic for scientists, which can reduce the construction cost of the entire accelerator by increasing the accelerating gradient. For the CEPC and HEPS projects at IHEP, S-band 3 meters long and C-band 1.8 meters long accelerating structure has been developed. The operating frequencies are 2860 MHz, 2998.8 MHz and 5720MHz respectively. CEPC linac is 30 GeV with S & C-band structures in the TDR phase. The high-power test gradient of S-band accelerating structure reach the 33MV/m. The C-band structures also designed and waiting for high power test. HEPS is 500 MeV linac in-jector and already conditioning for one year. The maxi-mum gradient achieved with the beam during commis-sioning was approximately 26 MV/m with a beam current of 7 nC. During actual operation, it has been functioning at around 20 MV/m. The electron beam has remained stable up to the present time.

Footnotes:

Funding Agency:

Tuesday Poster Session / **212**

The acceleration of high intensity heavy ion beams at IMP

Author: Yao Yang[1]

Co-authors: bo2 zhang [1]; Yu Tang [1]; Yuhan Zhai [1]; Zehua Jia [1]; Liangting Sun [1]; Hongwei Zhao [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: yangyao@impcas.ac.cn

The production of low energy high intensity heavy ion beams is challenging for the community. Several high intensity heavy ion beam accelerators for versatile purposes have been developed at IMP, such as LEAF, which is a low energy high intensity heavy ion accelerator complex for multi-discipline researches that features a superconducting ECR source, and a heavy ion beam linac. The major acceleration structure of LEAF is a 4-vane RFQ, which accelerates heavy ions with M/q from 2 to 7 to 0.5 MeV/u. With the support of the energy modulation system based on a DTL and two bunchers, this facility features high intensity heavy ion beam acceleration up to 1 emA, fine tuning of ion beam energy within 0.3 to 1.0 MeV/u with an energy spread of <0.25% (FWHM) that is favored by high precision experimental investigations such as C-C burning study in nuclear astrophysics. A 4-rod RFQ, which was fabricated 15 years ago, has been recently modified and adopted a laser ion beam source as primary ion beam injector to accelerate high intensity pulsed heavy ion beams, especially for refractory metal ions. In addition, a very compact IH RFQ with frequency of 81.25 MHz has been developed to accelerate H2+ ions with currents of several mA. The cavity outer diameter is only 266 mm, which makes it possible that the RFQ could be embedded into a cyclotron and acts as the axial injector of high intensity ion beams. This report will present the latest progress and challenges of the aforementioned work.

Footnotes:

Funding Agency:

Thursday Poster Session / **213**

Calibration of the analog beam-signal hardware for the credited engineered beam power limit system at the Proton Power Upgrade Project at the Spallation Neutron Source

Author: Craig Deibele[1]

Co-authors: Trent Allison [2]; Charlotte Barbier [3]; Miljko Bobrek [1]; Patrick Bong [4]; Kay-Uwe Kasemir [1]; Kelly Mahoney [1]; Chrysostomos Michaelides [1]; Yugang Tan [1]; Walter Willis [1]

[1] *Oak Ridge National Laboratory*

[2] *Thomas Jefferson National Accelerator Facility*

[3] *ITER Organization*

[4] *Lawrence Berkeley National Laboratory*

Corresponding Author: deibele@ornl.gov

A programmable signal processor-based credited safety control that calculates pulsed beam power based on beam kinetic energy and charge was designed as part of the Proton Power Upgrade (PPU) project at the Spallation Neutron Source (SNS). The system must reliably shut off the beam if the average power exceeds 2.145 MW averaging over 60 seconds. System calibration requires pedigree in measurements, calibration setup, and calculations. This paper discusses the calibration of the analog beam signal components up to and including the Analog Digital Convertors (ADCs) for implementation into the Safety Programmable Logic Controllers (PLCs) and Field Programmable Gate Arrays (FPGAs).

Footnotes:

Funding Agency:

This manuscript has been authored by UT-Battelle, LLC, under contract DE-AC05-00OR22725 with the US Department of Energy (DOE).

Main Session THX / 214

An overview of plasma processing of SRF cavities at JLAB

Author: Tom Powers[1]

Co-authors: Iresha Senevirathne [1]; Nabin Raut [1]; Tiffany Ganey [2]

[1] *Thomas Jefferson National Accelerator Facility*

[2] *Jefferson Lab*

Corresponding Author: powers@jlab.org

Plasma processing is a common technique where the free oxygen produced in a low-pressure RF plasma breaks down and removes hydrocarbons from surfaces. This increases the work function and reduces the secondary emission coefficient of the treated surfaces. Jefferson Lab has an ongoing R&D program in plasma processing. The experimental program investigated processing using argon/oxygen and helium/oxygen gas mixtures. The initial focus of the effort was processing C100 cavities by injecting RF power into the HOM coupler ports. We also developed the methods for establishing a plasma C75 cavities where the RF power is injected via the fundamental power-coupler. As part of the process development we processed, three C100 cryomodules in our off-line cryomodule test facility. In May 2023 we processed four C100 cryomodules in-situ in the CEBAF accelerator with the cryomodules returning to an operational status in Sept. 2023. The improvement in field emission free operation, as measured on a cavity by cavity basis, was 59 MeV or 24%. At the time that this abstract was written, the plans are to process an additional 5 to 7 cryomodules in the CEBAF accelerator in the summer of 2024. Methods systems and results from processing cryomodules and individual cavities in the vertical test will be presented. Current status and future plans will also be presented.
Funding provided by SC Nuclear Physics Program through DOE SC Lab funding announcement DE-FOA-0002670.

Footnotes:

Funding Agency:

Tuesday Poster Session / 217

Progress of the spoke cavity prototyping for the JAEA-ADS linac

Author: Jun Tamura[1]

Co-authors: Bruce Yee-Rendon [1]; Eiji Kako [2]; Fujio Maekawa [3]; Hiroshi Sakai [2]; Kensei Umemori [2]; Shin-ichiro Meigo [3]; Takeshi Dohmae [2]; Yasuhiro Kondo [1]

[1] *Japan Atomic Energy Agency*

[2] *High Energy Accelerator Research Organization*

[3] *Japan Proton Accelerator Research Complex (J-PARC)*

Corresponding Authors: jtamura@post.j-parc.jp, byee@post.j-parc.jp

The Japan Atomic Energy Agency (JAEA) has been proposing an accelerator-driven nuclear transmutation system (ADS) as a future nuclear system. In preparation for the actual design of the CW proton linac for the JAEA-ADS, we are now prototyping a low-beta (around 0.2) single-spoke cavity. The cavity fabrication started in 2020. Most of the cavity parts were shaped in fiscal year 2020 by press-forming and machining. In 2021, we started welding the shaped cavity parts together. By preliminarily investigating the optimum welding conditions using mock-up test pieces, each cavity part was joined together with smooth welding beads. So far, we have fabricated the body section and the two end-plate sections. By measuring the resonant frequency of the temporarily assembled cavity, it was confirmed that there were no significant problems with the cavity fabrication.

Footnotes:

Funding Agency:

Main Session TUZ / 218

Status and plans for the high-energy linear e+e- collider projects: ILC, CLIC and C3

Author: Philip Burrows[1]

[1] *John Adams Institute*

Corresponding Author: p.burrows@physics.ox.ac.uk

The International Linear Collider (ILC), Compact Linear Collider (CLIC) and C3 are proposed designs for a next-generation high-energy electron-positron linear collider for exploring the Higgs-boson, top-quark and beyond-Standard Model sectors.
An overview and status of each collider project will be given, including the design, key technologies, accelerator systems, energy-staging strategies, and cost and power estimates, including sustainability considerations. An overview of the ongoing development strategy for each project over the next few years will also be given.

Footnotes:

Funding Agency:

Monday Poster Session / 219

Design of a beam transport line for external injection of plasma wakefield acceleration experiments based on BEPCII

Author: Xueyan Shi[1]

Co-authors: Yiwei Wang [1]; Haisheng Xu [2]; Dazhang Li [1]; Ande Ma [1]

[1] *Chinese Academy of Sciences*

[2] *Institute of High Energy Physics*

Corresponding Author: shixueyan@ihep.ac.cn

Laser wakefield accelerator (LWFA) and plasma wakefield acceleration (PWFA) have attracted a wealth of research interests since they can provide an accelerating gradient of ˜100 GV/m. Recently, a series of LWFA/PWFA external injection experiments are foreseen to be carried out based on the linear accelerator (LINAC) of Beijing Electron-Positron Collider II (BEPCII). We hereby present a design of the beam transport line from the BEPCII LINAC to the LWFA/PWFA experimental chamber. The constraint of the existing building and beamline of the BEPCII was considered carefully in the design. The performance of the transport line is evaluated using the particle tracking simulations, demonstrating that the bunch length of the electrons with energy of 2 GeV and charge of 2 nC can be compressed from 10 ps to 1 ps (RMS), and the beam spot size is focused from about 850 μm to 116 μm (RMS).

Footnotes:

Funding Agency:

Tuesday Poster Session / 220

Design and test of C-band linac prototypes for electron flash radiotherapy

Author: Lucia Giuliano[1]

Co-authors: David Alesini [2]; Fabio Cardelli [2]; Martina Carillo [1]; Enrica Chiadroni [1]; Massimiliano Coppola [1]; Giacomo Cuttone [2]; Alessandro Curcio [2]; Angelica De Gregorio [1]; Roberto Di Raddo [2]; Luigi Faillace [2]; Luca Ficcadenti [1]; Daniele Francescone [1]; Gaia Franciosini [1]; Giovanni Franzini [2]; Alessandro Gallo [2]; Marco Magi [1]; Giorgio Mauro [2]; Mauro Migliorati [3]; Andrea Mostacci [1]; Vincenzo Patera [1]; Luca Piersanti [2]; Alessio Sarti [1]; Gino Sorbello [4]; Bruno Spataro [2]; Giuseppe Torrisi [2]; Alessandro Vannozzi [2]; Luigi Palumbo [1]; E. Anelli [1]; F. Perondi [1]; R. Remetti [1]; Massimo Di Francesco [5]; Giuseppe Felici [5]; S. Farina [1]

[1] *Sapienza University of Rome*

[2] *Istituto Nazionale di Fisica Nucleare*

[3] *Istituto Nazionale di Fisica Nucleare - Sez. Roma 1*

[4] *University of Catania*

[5] *Sordina IORT Technologies*

Corresponding Author: lucia.giuliano@uniroma1.it

FLASH Therapy, a novel cancer treatment technique, aims to control the tumor-grown sparing the healthy tissue from radiation damage, increasing the therapeutic index. Translating FLASH therapy

into clinical practice, especially for treating deep-seated tumors, necessitates achieving Very High Electron Energy (VHEE) levels within the 50-150 MeV range [2]. In the framework of the SAFEST project [3–7], Sapienza University, in collaboration with INFN, is actively developing a compact C-band linac demonstrator at the energy of 24 MeV (loaded) with a 100 mA peak current. This paper provides insights into the design strategy and electromagnetic characteristics, focusing on prototype testing and tuning conducted at the Sapienza Accelerator Laboratory.
The progress of this innovative linac represents a step toward realizing an advanced FLASH VHEE source in cancer treatment.

Footnotes:

Funding Agency:

Thursday Poster Session / **221**

The status of ARIEL e-linac RF system

Author: Yanyun Ma[1]

Co-authors: Ken Fong [1]; Konstantin Piletskiy [1]; Philipp Kolb [1]; Ramona Leewe [1]; Robert Laxdal [1]; Vladimir Zvyagintsev [1]

[1] *TRIUMF*

Corresponding Author: mayanyun@triumf.ca

Now the stage of the 30 MeV portion of ARIEL (The Advanced Rare Isotope Laboratory) e-Linac (1.3 GHz, SRF) is under commissioning which includes an injector cryomodule (ICM) with a single nine-cell cavity and the 1st accelerator cryomodule (ACM1) with two cavities inside. This paper is focused on the recent advances towards high power operation which includes ICM MRO and Egun RF upgade with new tuner and PID loop with test results.

Footnotes:

Funding Agency:

Monday Poster Session / **222**

Single bunch and multi bunch operation with single klystron using a programmable SLED system

Author: Anton Tropp[1]

Co-authors: Pengda Gu [1]; Chris Christou [2]

[1] *Diamond Light Source Ltd*

[2] *Deutsches Elektronen-Synchrotron*

Corresponding Author: anton.tropp@diamond.ac.uk

The Linac for Diamond Light Source has been running with two 3 GHz klystrons, powering two 5.2m-long accelerating structures to deliver 100 MeV electron beam since the start of operation. By introducing a SLED pulse compressor system to generate a pulse capable to power both structures from one klystron, redundancy and reliability will be improved. With a 5 μs total pulse, it is possible to charge the SLED cavities for 4 μs and generate a high peak pulse for the last 1 μs able to power both structures. An arbitrary waveform generator function was implemented in digital low-level RF

to generate a flat top pulse, which can be utilized for both single bunch and multi bunch operation. Details of the waveguide network, low-level RF design and high-power operation will be described. Results from full energy operation will also be shown.

Footnotes:

Funding Agency:

Monday Oral Posters / 223

Thin gold layers on niobium for SRF cavities

Author: Sadie Seddon-Stettler[1]

Co-authors: Matthias Liepe [1]; Nathan Sitaraman [2]; Thomas Oseroff [1]; Helena Lew-Kiedrowska [3]; Chi Wang [4]; Van Do [3]; Steven Sibener [3]

[1] *Cornell University (CLASSE)*

[2] *Cornell University*

[3] *The University of Chicago*

[4] *National Cheng Kung University*

Corresponding Author: sgs238@cornell.edu

New materials beyond the standard bulk niobium have the potential to greatly improve the performance of Superconducting Radio Frequency (SRF) cavities. Specifically, thin coatings of normal conductors such as gold have the potential to improve the key RF performance metric of quality factor. We present progress on depositing thin gold layers onto 2.6 GHz SRF cavities and testing their RF performance.

Footnotes:

Funding Agency:

U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams; U.S. Department of Energy under Award DE-SC0024137.

Thursday Poster Session / 224

Development of 10 MeV electron linear accelerator for space environment simulation

Author: Yunlong Chi[1]

[1] *Institute of High Energy Physics*

Corresponding Author: chiyl@ihep.ac.cn

A compact 10 MeV S-band irradiation electron linear accelerator has been developed to simulate electronic radiation in outer space and carry out electron irradiation effect tests on spacecraft materials and devices. According to the requirements of space environment simulation, the electron beam energy is adjustable in the range of 3.5 MeV to 10 MeV, and the average current is adjustable in the range of 0.1 mA to 1 mA. The Linac should be capable of providing beam irradiation over a large area of 1 m2 with a uniformity of larger than 90% and a scanning rate of 100 Hz. A novel method

has been applied to achieve such a high beam scanning rate, utilizing a combination of a kicker and a scanning magnet.

Footnotes:

Funding Agency:

Monday Poster Session / **229**

The four beam destinations for the commissioning of the ESS Normal Conducting Linac

Author: Elena Donegani[1]

Co-authors: Anders Olsson [1]; Carlos Neto [1]; Ibon Bustinduy [2]; Laurence Page [1]; Marcos Ruelas [3]; Tara Hodgetts [3]; Thomas Shea [1]; Viatcheslav Grishin [1]; Vincent Bertrand [4]

[1] *European Spallation Source ERIC*

[2] *ESS Bilbao Consortium*

[3] *RadiaBeam*

[4] *PANTECHNIK*

Corresponding Author: elena.donegani@esss.se

The commissioning of the Normal Conducting Linac (NCL) of the European Spallation Source (ESS) in Lund (Sweden), started in September 2018 and was completed in July 2023.
The four NCL commissioning phases required the design, procurement, test, installation and operation of four distinct beam destinations in order to safely dump the proton beam and measure the current of protons with energy up to 0.075 MeV in the LEBT, up to 3.6 MeV in the MEBT, up to 21 MeV in the DTL1, and finally 74 MeV in the DTL4.

Each beam destination was operated under UHV, and designed to be as compact as possible while withstanding the Fast Tuning mode (62.5 mA, 5 μs, 14 Hz), and the Slow Tuning mode (62.5 mA, 50 μs, 1 Hz). The EPICS-based control system was fundamental for five main reasons: (1) the control of the motion in and out of the beam line, (2) the high voltage control in the [0, -1000 V] range, (3) the monitoring of the water cooling systems, (4) the proton current measurements and (5) the timing synchronization with the overall ESS NCL. Key milestones and measurements results are described to demonstrate the proton transport at the nominal current of 62.5 mA during each of the four commissioning phases.

Footnotes:

Funding Agency:

Tuesday Poster Session / **230**

Design and improvement of normal conducting heavy ion linac in China

Author: Xuejun Yin[1]

Co-authors: Changchun Li [1]; Cheng Qian [1]; Daqing Gao [1]; Fu Ma [1]; Haoning Wang [1]; Heng Du [1]; Hongwei Zhao [1]; Jia Wen Xia [1]; Jiancheng Yang [1]; Junxia Wu [1]; Liangting Sun [1]; Lijun Mao [1]; Long Jing [1]; Peng Jin [1]; Wang Lu [1]; Weiqing Yang [1]; Xiaojun Liu [1]; Xiaoni Li [1]; Xiaowei Xu [1]; Xueqing Yan [2]; Yan Cong [1]; Yaqing Yang [1]; Youjin Yuan [3]; Yuan He [1]; Yuanrong Lu [2]; Zhe Xu [1]; Zhongshan Li [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *Peking University*

[3] *University of Chinese Academy of Sciences*

Corresponding Author: yinxj@impcas.ac.cn

The research on heavy ion linac was began more than ten years ago initially to improve the HIRFL operation at IMP. In China, the first continuous wave (CW) heavy ion linac, SSC Linac, working at 53.667 MHz was developed as the SSC injector. The ion particle can be accelerated to 1.48 MeV/u with the designed A/q=5.17. At present stage, this CW linac has been put into operation and the Uranium has been accelerated to 1.48 MeV/u successfully. To satisfy the continue requirements, a compact 162.5 MHz heavy ion linac operating in pulse mode was developed. The "KONUS"beam dynamics design was adopted and the heavy ions can be accelerated to 4MeV/u with A/q≤3. The SESRI linac was another pulse machine which was built at Harbin. In this linac, both of the heavy ions and proton beam can be accelerated by this linac to 2 MeV/u and 5.6 MeV, respectively. In this paper, the status of these three heavy ion linacs and their beam commissioning results will be presented.

Footnotes:

Funding Agency:

Thursday Poster Session / 231

Halo formation based on 2D and 3D particle-core model

Author: Xinmiao Wan[1]

Co-author: Zhihui Li [1]

[1] *Sichuan University*

Corresponding Author: 419591863@qq.com

Using 2D and 3D particle-core models, we thoroughly studied potential resonance interactions between particles and core in matched beams within complete periodic and double periodic channels. By keeping consistent geometrical structures and phase advances, we compared the Poincaré sections obtained from both models. The findings show that the differences between the models are negligible. This implies that the predicted resonance orders remain consistent, and the size of the resonance island shows only minor discrepancies.
We conducted in-depth studies on resonance behavior in matched beams within periodic structures with varying zero-current phase advances (σ0) using a 3D particle-core model. Our research discovered that a 4:1 resonance phenomenon is triggered when σ0 surpasses 90°. Particularly, in beams influenced by space charge effects, particles within the 4:1 resonance island have the potential to transform into halo particles, a transformation not observed in beams governed by emittance. When σ0 is less than 90° and space charge effects are substantial, 6:1 resonance may emerge. Contrary to the conventional belief that 2:1 resonance caused by mismatch in uniform focusing channels drives particles towards higher amplitude regions, our study revealed that not 2:1 resonance results in particle migration to larger amplitudes. Our research employed TraceWin to confirm these insights, offering valuable contributions to the comprehension of beam dynamics in SCLs.

Footnotes:

Funding Agency:

Thursday Poster Session / 232

Intrabeam scattering simulation with a novel hybrid-kinetic Monte Carlo method for linear accelerators

Author: Paula Desire Valdor[1]

Co-authors: Alexander Gerbershagen [2]; Andrea Latina [1]

[1] *European Organization for Nuclear Research*

[2] *Particle Therapy Research Center*

Corresponding Author: paula.desire.valdor@cern.ch

Recent studies have identified intra-beam scattering (IBS) as one of the processes that can have a significant impact on the beam dynamics of linacs with high-density and low-energy beams, such as in free electron sources (FELs), where IBS appears to be one of the effects that most limits their performance. Most existing simulation codes have been developed for circular lattices or assume Gaussian beams and thus cannot accurately simulate the desired scenario. Motivated by this problem, this work presents the implementation of IBS in RF-Track, a tracking code developed for linear accelerators. The numerical simulation follows a novel methodology based on a hybrid-kinetic Monte Carlo approach. The method has proven to be stable using different input parameters and has shown emittance and a Sliced-Energy-Spread (SES) growth in different scenarios, demonstrating the accuracy of the tool and making it a promising solution to understand SES growth in FELs.

Footnotes:

Funding Agency:

Monday Poster Session / **233**

An alternative design scheme for CSNS-II MEBT dynamics

Author: Qi Yu Kong[1]

Co-authors: Huachang Liu [1]; Jun Peng [2]

[1] *Dongguan Neutron Science Center*

[2] *Institute of High Energy Physics*

Corresponding Author: kongqy@ihep.ac.cn

The China Spallation Neutron Source (CSNS) has been operating at a stable beam power of 160 kW since March 2024, marking a significant 60% increase from its original design capacity. The ongoing CSNS upgrading project, known as CSNS-II. As part of this upgrade, a versatile Medium Energy Beam Transport (MEBT) system has been meticulously studied and redesigned to meet the stringent requirements for beam control in the presence of strong space charge effects. The MEBT system boasts several key functions and features, including beam chopping for optimizing beam structure, scrapers for confining and removing beam halo particles. Detailed studies on beam performance, in conjunction with the main linac, have been carried out and are presented in this article.

Footnotes:

Funding Agency:

Monday Poster Session / **234**

Simulation and experiment study of proton generated by residual gas stripping in CSNS

Author: Qi Yu Kong[1]

Co-authors: Huachang Liu [1]; Jun Peng [2]

[1] *Dongguan Neutron Science Center*

[2] *Institute of High Energy Physics*

Corresponding Author: kongqy@ihep.ac.cn

The CSNS consists of an H- linac as injector, the interaction of the residual gas with H- particles will strip the electrons to produce associated protons within the LEBT, which follow the H- into the subsequent accelerating structure. In order to avoid the adverse effects of proton loss on the device, the feasibility of employing a bump for associated proton separation at the MEBT was investigated firstly using multiparticle tracking simulations. Beam experiment was carried out in the existing CSNS MEBT device, in which the transverse profile signals of the associated protons were observed. Intensity of the associated proton with and without the bump separation are compared downstream the DTL, which proves bump separation is an effective method for the removal of associated protons. The simulation and experimental results can provide scheme references for solving the associated proton problem faced in CSNS-II.

Footnotes:

Funding Agency:

Monday Oral Posters / 235

Mitigation of longitudinal beam losses in the FRIB linac

Author: Alec Gonzalez[1]

Co-authors: Alexander Plastun [1]; Peter Ostroumov [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: gonza603@msu.edu

The linear accelerator at the Facility for Rare Isotope Beams (FRIB) at Michigan State University uses a thin liquid Lithium film for charge stripping of high-intensity heavy ion beams. Energy straggling of the beam in the non-uniform Lithium film affects the energy distribution in the beam. This can lead to non-linear "tails"in the longitudinal phase-space beam distribution after bunching at the two 161 MHz Multi-Gap Bunchers (MGBs) between the stripper and the next accelerating segment. Some particles in these "tails"are lost in the downstream accelerator cryomodules. To mitigate these losses, we have designed a room-temperature IH-type buncher cavity with a resonant frequency of 322 MHz. The new harmonic cavities will be installed next to each MGB, linearizing the waveform of the effective bunching voltage and eliminating the formation of non-linear "tails."The increase in the energy acceptance of the post-stripper part of the accelerator reached over 50% according to our simulations. We present the electromagnetic design of this cavity along with beam dynamics simulations that demonstrate how the losses are mitigated. The construction and installation of the cavity are being pursued as an accelerator improvement project.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, High Energy Physics under Cooperative Agreement award number DE-SC0018362 and Michigan State University.

Monday Poster Session / 238

Low-level RF system development for a C-Band LINAC

Author: Jonathan Edelen[1]

Co-authors: Amirari Diego [2]; Joshua Einstein-Curtis [1]; Jure Krasna [3]; Maksim Kravchenko [2]; Robert Berry [4]

[1] *RadiaSoft LLC*

[2] *RadiaBeam*

[3] *Cosylab*

[4] *RadiaBeam Technologies*

Corresponding Author: jedelen@radiasoft.net

RadiaSoft and RadiaBeam are partnering on the development of a low level RF control system to support a 100MeV C-Band LINAC. Our system utilizes a Keysight data acquisition system and arbitrary waveform generator to drive the LINAC. The controllers are fully integrated with EPICS and are actively being commissioned. In this presentation we will provide an overview of the design architecture, discuss details of the epics integration, and show initial results controlling a photoinjector.

Footnotes:

Funding Agency:

Main Session WEY / 239

The Deep Electron FLASH Therapy facility

Author: Carlo Rossi[1]

Co-authors: Alexander Malyzhenkov [1]; Alexej Grudiev [1]; Andrea Latina [1]; Benjamin Frisch [1]; Eduardo Granados [1]; Igor Syratchev [1]; Jean Bourhis [2]; Jean-François Germond [2]; Jean-Marc Cravero [1]; Jeremie Bauche [1]; Maria Elena Angoletta [1]; Nick WALTER [2]; Olivier Brunner [1]; Ping Wang [1]; Raphaël Moeckli [2]; Roberto Corsini [1]; Steffen Doebert [1]; Sébastien Curtoni [3]; Terence Garvey [2]; Thibault Dufour [3]; Till Boehlen [2]; Vera Korchevnyuk [4]; Walter Wuensch [1]; philippe liger [3]

[1] *European Organization for Nuclear Research*

[2] *Lausanne University Hospital*

[3] *THERYQ*

[4] *Ecole Polytechnique Fédérale de Lausanne*

Corresponding Author: carlo.rossi@cern.ch

The "FLASH"effect is currently a topic of considerable interest in radio-oncology. We present the design of a novel VHEE linac, to be built and installed at CHUV (Lausanne), capable of producing electron beams which deliver radiation at dose rates and time scales consistent with the FLASH effect. The design is based on X-band radio-frequency technology, developed at CERN for the CLIC study. The e-beam properties correspond to a CHUV specification and would allow large, deep seated, tumors to be treated. Construction of DEFT (DEEP Electron FLASH Therapy) will be assured by the company THERYQ in the context of a CHUV-CERN-THERYQ collaboration.

Footnotes:

Funding Agency:

Main Session THX / 240

Matched transport of intense and coasting beams through quadrupole channels

Author: Chen Xiao[1]

Co-author: Lars Groening [1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

Corresponding Author: c.xiao@gsi.de

For the time being, determining the cell-to-cell periodic solution for transporting intense beams has been limited to the spatial envelope. Recently, a numerical method for provision of full 4d-periodicity of all 10 beam moments of an intense 4d-coupled beam has been developed and benchmarked with tracking simulations. For instance, it will pave the path towards exploring the potential of beam spinning for beam quality improvement as proposed by Y.-L. Cheon et al.

Footnotes:

Funding Agency:

Main Session FRX / 242

Using an electron linac to improve the sustainability of diamond mining

Author: Benjamin Bromberger[1]

[1] *RI Research Instruments GmbH*

Corresponding Author: benjamin.bromberger@research-instruments.de

We report on the successful test for locating diamonds in ore by using an electron linac to create the 11C isotope atoms via the (gamma,n) reaction which has a large cross-section (8mb) at the Giant Dipole Resonance. The 11C atoms can be detected consequently using the Positron Emission Tomography (PET).

The technology is presently being scaled up for deployment in a mine with the goal of discovery diamonds in the kimberlite ore grade. The typical run-of-mine throughput of several hundred tons per hour requires a high-power electron linac paired with high rate-capacity PET detectors system. 100% concentrate can be achieved followed by an intelligent diamond recovery process. Besides reducing breakage, the technology is waterless and greener. The mine lifetime will be extended, and marginal mines become viable.

The design of the linac has converged to Ee = 45MeV at 200 kW in the beam. Ruggedness in the mining environment dictates a warm Cu, S-band machine. The system can produce the required PET activity of 2 kBq/cm3 measured after a 30 min decay out of a FIFO storage to leave 11C as the dominant PET isotope. The technology is termed MinPET and is currently under study. This contribution details the linac design component of the project.

Footnotes:

Funding Agency:

Main Session MOX / 243

Welcome

Author: John Byrd[1]

Co-author: Sam Posen [2]

[1] *Argonne National Laboratory*

[2] *Fermi National Accelerator Laboratory*

Corresponding Authors: jbyrd@anl.gov, sposen@fnal.gov

Footnotes:

Funding Agency:

Main Session FRY / 244

High power hadron linacs; the Spallation Neutron Source Proton Power Upgrade and a look to the future

Author: Stephen Streiffer[1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: streiffersk@ornl.gov

Footnotes:

Funding Agency:

Monday Oral Posters / 245

High Q and high gradient performance of the first medium-temperature baking 1.3 GHz cryomodule

Author: Jiyuan Zhai[1]

Co-authors: B. Liu [1]; Feisi He [1]; Haiying Lin [1]; L. Sun [1]; M. Li [1]; M. Sang [1]; Peng Sha [1]; Qunyao Wang [1]; Rui Ge [1]; Ruixiong Han [1]; Song Jin [1]; T. Zhao [1]; Weimin Pan [2]; X. Yang [1]; Z. Zhang [1]; Zheng Mi [2]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

Corresponding Author: zhaijy@ihep.ac.cn

The world's first 1.3 GHz cryomodule containing eight 9-cell superconducting radio-frequency (RF) cavities treated by medium-temperature furnace baking (mid-T bake) was developed, assembled and tested at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences for the Dalian Advanced Light Source (DALS). The 9-cell cavities in the cryomodule achieved an unprecedented high average intrinsic quality factor (Q0) of 3.8E10 at 16 MV/m and 3.6E10 at 21 MV/m in the horizontal test. The cryomodule can operate stably up to a total continuous wave (CW) RF voltage greater than 191 MV, with an average cavity usable accelerating gradient of more than 23 MV/m. The results significantly exceed the specifications of DALS and the other high repetition rate free electron laser facilities (LCLS-II, LCLS-II-HE, SHINE, S3FEL etc.). This paper reviews the cryomodule performance and discusses some important issues in cryomodule assembly and testing.

Footnotes:

Funding Agency:

Tuesday Poster Session / 246

Reaching design electron energy at FLASH after linac upgrade

Author: Valeri Ayvazyan[1]

Co-authors: Julien Branlard [1]; Chris Christou [1]; Katja Honkavaara [1]; Valery Katalev [1]; Denis Kostin [1]; Juliane Roensch-Schulenburg [1]; Lucas Schaper [1]; Christian Schmidt [1]; Siegfried Schreiber [1]; Mateusz Wiencek [1]; Burcu Yildirim [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: valeri.ayvazyan@desy.de

The FLASH 2020+ project at DESY includes, among other modernizations, an upgrade of the electron beam energy. Two accelerator modules were replaced and the RF distribution of the other modules was optimized. The limiting factors such as cavity quenching and field emissions are identified and measured at acceleration modules. At a later stage, based on those measurements, a high-power distribution adjustment scheme was proposed and the optimal operating point was demonstrated to achieve the design energy of 1.35 GeV with the nominal RF pulse length at FEL lasing conditions. After proper optimization and tuning of the low-level RF parameters, the linac successfully operated at maximum energy and delivered SASE-FEL radiation in the wavelength range below 3.2 nm. The measurement results as well as the achieved cavity gradients with energy gains are presented.

Footnotes:

Funding Agency:

Monday Poster Session / 247

Commissioning and performance of a C-band LLRF system at RadiaBeam

Author: Jonathan Edelen[1]

Co-authors: Amirari Diego [2]; Joshua Einstein-Curtis [1]; Jure Krasna [3]; Maksim Kravchenko [2]; Robert Berry [4]

[1] *RadiaSoft LLC*

[2] *RadiaBeam*

[3] *Cosylab*

[4] *RadiaBeam Technologies*

Corresponding Author: jedelen@radiasoft.net

RadiaBeam and RadiaSoft have been developing a LLRF system for a 100MeV C-band LINAC. The system is based on a Keysight PXIE arbitrary waveform generator and ADCs. We are in the process of commissioning our system and validating its performance. In this presentation, we will provide details on amplitude and phase calibration, improvements to signal conditioning, comparisons between measurements and simulations, and performance of our pulse to pulse feedback scheme.

Footnotes:

Funding Agency:

Monday Poster Session / **248**

Successful international validation test shipment of the PIP-II HB650 cryomodule transportation system

Author: Jeremiah Holzbauer[1]

Co-authors: Adam Wixson [1]; Joseph Ozelis [1]; Josh Helsper [1]; Mitchell Kane [2]

[1] *Fermi National Accelerator Laboratory*

[2] *Science and Technology Facilities Council*

Corresponding Author: jeremiah@fnal.gov

The PIP-II Project will receive fully assembled cryomodules from CEA and STFC-UKRI as in-kind contributions. Damage to these cryomodules during transport is understood to be a significant risk to the project, so an extensive testing and validation program has been executed to mitigate this risk. The centerpiece of this effort was the successful shipment, from FNAL to STFC-UKRI and back, of a prototype HB650 cryomodule with cold testing before and after shipment to verify no functionality changes from shipment. Building on an escalating test transport program, the prototype cryomodule was shipped to the UK and back using realistic logistics, handling, instrumentation, and planning. The process of executing this shipment, lessons learned, and plan moving forward will be presented here.

Footnotes:

Funding Agency:

Work supported by Fermi Research Alliance, LLC under Contract No. DeAC02-07CH11359 with the United States Department of Energy.

Monday Poster Session / **249**

Direct injection extraction system into a high frequency radiofrequency quadrupole for medical applications

Author: Aristeidis Mamaras[1]

Co-authors: Alessandra Lombardi [1]; Dimitrios Sampsonidis [2]; Eleonora Pasino [1]; Francesco Di Lorenzo [1]; Jean-Baptiste Lallement [1]; Marten Koopmans [1]

[1] *European Organization for Nuclear Research*

[2] *Aristotle University of Thessaloniki*

Corresponding Author: aristeidis.mamaras@cern.ch

As part of CERN's medical application research, a compact electrode system (< 30 cm) has been designed to facilitate low-current, multiparticle beam extraction and matching to a high-frequency RFQ. This study explores the innovative extraction system design and evaluates its simulation performance. Superfish (SF) and CST Studio Suite were employed to export the 2D and 3D electric field maps of the extraction system for beam dynamics simulations. Beam dynamics simula-tions using the Travel code have confirmed the sys-tem's ability to deliver a high-quality, low-current par-ticle beam fully matched to a 750 MHz RFQ, capable of accelerating particles with a □/□ ratio of ½ to 1. This paper provides an overview of the key design considerations, geometry layout, and beam dynamics results.

Footnotes:

Funding Agency:

Monday Oral Posters / 250

Accelerator design choices for a compact, electron-driven, pulsed neutron source

Author: Laurence Wroe[1]

Co-authors: Andrea Latina [1]; Francois Plewinski [2]; George Kharashvili [3]; Javier Olivares Herrador [1]; Steinar Stapnes [1]; Walter Wuensch [1]

[1] *European Organization for Nuclear Research*

[2] *European Spallation Source ERIC*

[3] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: laurence.wroe@cern.ch

Neutron scattering is an indispensable technique in material science research for providing solutions to important engineering challenges, including the ever-growing demand for more efficient batteries and fuel-cells. There are, however, limitations in the access and availability to the necessary neutron beams and this is worsening as nuclear research reactors continue to shut down. As a result, there appears to be market demand for an affordable, medium-flux, compact, accelerator-driven neutron source optimised for deployment in an industrial setting. In this paper, we present an overview of the beam specification and the high-level design choices for an electron linear accelerator that is optimised to drive such a facility.

Footnotes:

Funding Agency:

Monday Poster Session / 251

Analysis of the Panofsky-Wenzel Theorem in pillbox cavities with a beam pipe

Author: Laurence Wroe[1]

Co-authors: Andrea Latina [1]; Matthew Southerby [2]; Robert Apsimon [2]; Steinar Stapnes [1]; Walter Wuensch [1]

[1] *European Organization for Nuclear Research*

[2] *Cockcroft Institute*

Corresponding Author: laurence.wroe@cern.ch

In this paper, we derive the multipolar form of the change in transverse and longitudinal momenta of an ultra-relativistic charged particle that traverses a harmonic TM_{mn0} mode in a pillbox cavity with a beam pipe. The relevant equations are first formalised before presenting results from the numerical integration of RF cavity field maps. In particular, we show that the radial dependence of the change in transverse and longitudinal momenta through a TM_{mn0} mode has polynomial, and not Bessel, dependence.

Footnotes:

Funding Agency:

Thursday Poster Session / **252**

A compact, ultrafast high-voltage pulser for tranverse electromagnetic kickers

Author: Thi Le[1]

Co-author: Anatoly Krasnykh [1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: thile@slac.stanford.edu

A compact, high-voltage (HV) pulser in the nanosecond regime for transverse electromagnetic (TEM) kickers is presented. TEM kickers are electromagnetic deflectors used in particle accelerators to redirect bunches of particles out of their original trajectory into a new path, such as alternate beam paths, detectors, or other instrumentation devices. The circuit proposed in this design consists of two main portions: a gate driver and a HV switch. The gate driver consists of an isolated and high-speed gate driver, powered by an isolated DC/DC converter with dual output voltages. The HV switch portion was simulated in Ansys HFSS and is composed of a SiC MOSFET, LC resonance components, and specialized diodes. When switched, the MOSFET is used to pump a high voltage into the LC circuit and diode stack, and the ultrafast diode turnoff delivers the final HV pulse to the resistor load. Careful layout techniques were implemented for the MOSFET driver to reduce pulse to pulse instability. A 1 MHz repetition rate was the target of our design.

Footnotes:

Funding Agency:

Department of Energy contract DE-AC02-76SF00515

Monday Poster Session / **253**

Progress in the development of the cryomodules for CSNS-II superconducting linac

Author: Miaofu Xu[1]

Co-authors: Rui Ge [1]; Zhengze Chang [1]; Wenzhong Zhou [1]; Zheng Mi [2]; Feisi He [1]; Zhenqiang He [1]; Mei Li [1]; Jianrong Zhou [1]; Keyu Zhu [1]; Ye Han [2]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

Corresponding Author: xumf@ihep.ac.cn

The China Spallation Neutron Source (CSNS) is designed and constructed by physicists at the Institute of High Energy Physics (IHEP). It is the first pulsed neutron source facility in developing countries, which locates at Dalang Town of Dongguan city, the heart of the Guangdong-Hong Kong-Macao greater bay area. CSNS beam power reached design goal of 100 kW in 2020. The pre-research of CSNS Phase-II (CSNS-II) project started in 2021.
The target beam energy at exit of linac of CSNS-II is more than 300 MeV by building a superconducting linac. The superconducting section of the linac accelerates the beam from 80 MeV to 300 MeV. It is composed of one string of Spoke cavity cryomodules and one string of elliptical cavity cryomodules. There are ten sets of Spoke cavity cryomodules, each cryomodule contain two Spoke Niobium cavities operating at 2 K and at a frequency of 324 MHz. The prototype of Spoke cavity cryomodule is designed and under horizontal cryogenic test at Platform of Advanced Photon Source Technology R&D (PAPS), which is located in Beijing city. The test result shows that the cryomodule can operate stably at 2 K and the total heat load of Spoke cavity cryomodule is less than 20 Watt @2K.

Footnotes:

Funding Agency:

Thursday Poster Session / 255

Longitudinal Beam Dynamics Optimization for Infrared Terahertz FEL LINAC

Author: Yimin Yang[1]

Co-authors: Guangyao Feng [1]; Shancai Zhang [1]; Zhigang He [1]

[1] *University of Science and Technology of China*

Corresponding Author: yangyimin@mail.ustc.edu.cn

The high-repetition-rate infrared terahertz free-electron laser (IR-THz FEL) facility are progressing in the preliminary research stage, which can achieve the demand for a tunable, high-power-light source in the long wavelength spectrum and form a complementary structure of advantages with the Hefei Advanced Light Facility (HALF). In this paper, we present the design of a bunch compressor which can compress the bunch length to reach the peak current of 118 A. We also present an approach to optimize the RF parameters for the accelerating modules, which makes it feasible to generate a high-quality beam bunch that can reach the requirements for future FEL applications.

Footnotes:

Funding Agency:

Monday Poster Session / 258

Performance evaluation and enhancement in kW level SSAs

Author: Manjiri Pande[1]

Co-authors: A SHIJU [1]; Ankit Maheshwari [2]; D. Balakrishna [2]; Gopal Joshi [1]; Gourabattuni Poornima [2]; Jitendra Mishra [1]; Niranjan Patel [1]; Rama Rao Thalluri [2]; Sameer Dubey [2]; Sandip Shrotriya [1]; Shyam Jena [1]; Snigdha Singh [1]; Venkata Bala [1]; Venumohan Gollapalli [2]

[1] *Bhabha Atomic Research Centre*

[2] *Electronics Corporation of India Limited*

Corresponding Author: manjiri@barc.gov.in

The Bhabha Atomic Research Centre (BARC) of Department of Atomic Energy (DAE) has indigenously designed, developed and tested high efficiency compact 7 kW and 20 kW solid state amplifier (SSA) systems at 325 MHz. These SSAs will be used for both Indian accelerators and Proton Improvement Plan II (PIP-II) project of Fermilab, USA. The PIP-II accelerator requires two levels of RF power at 325 MHz for its single spoke resonator (SSR) section with 7 kW SSA for SSR1 with β of 0.22 and 20 kW SSA for SSR2with β of 0.47. Based on BARC design, eight 7 kW SSA systems were produced by Electronic Corporation of India (ECIL), DAE and deployed at PIP II injector test (PIP2IT) facility of Fermilab for beam acceleration. Performance evaluation of the 7 and 20 kW SSAs included, a detailed measurement survey of non-ionizing radiation at 325 MHz around SSA, validation of graceful degradation, measurement of mean time to replace etc. Enhancement accomplished in the SSA sub systems comprises of incorporation of inbuilt directional coupler in each 1 kW power amplifier (PA) module, a balanced input power divider, a 100W driver amplifier with heat pipe-heatsink and arrangement of three PA modules on single water cooled aluminum heat sink etc. This paper discusses all these performance evaluations and performance enhancements in detail for both 7 and 20 kW SSAs, which will be highly beneficial for reliable accelerator operation.

Footnotes:

Funding Agency:

Monday Oral Posters / 259

Performance of the Fermilab linac injector

Author: Daniel Jones[1]

Co-authors: Dan Bollinger [1]; Valery Kapin [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: dcjones@fnal.gov

The Fermilab linac injection line consists of a 35 keV magnetron-type H- ion source, two-solenoid Low Energy Beam Transport (LEBT), 201 MHz 4-rod 750 keV Radio Frequency Quadrupole (RFQ), and a Medium Energy Transport (MEBT) containing 4 quadrupoles and a bunching cavity. The injector delivers 25 mA, 48 μs pulses to drift-tube linac at a repetition rate of 15Hz. The transmission efficiency has been lower than expected since commissioning. Recent beam current measurements suggest that the beam is primarily lost upstream of the RFQ exit. Numerical simulations indicate that ions passing through the non-linear field region of the solenoids could produce a beam with an increased emittance resulting in up to 50 % of the LEBT beam current failing to meet the RFQ acceptance. An aperture restriction was installed upstream of the first solenoid to remove these ions. This report describes the results of measurements and simulations as well as the LEBT tuning.

Footnotes:

Funding Agency:

Tuesday Poster Session / 260

A significant step towards robust table-top XUV-FEL

Author: Zhan Jin[1]

Co-authors: Yan-Jun GU [1]; Kai HUANG [2]; Nobuhiko NAKANII [2]; Shingo SATO [1]; Zhenzhe LEI [1]; Masaki Kando [2]; Tomonao Hosokai [1]

[1] *Osaka University*

[2] *National Institutes for Quantum Science and Technology*

Corresponding Author: jin@sanken.osaka-u.ac.jp

Our recent experiments achieved EUV range undulator radiation amplification based on the stable electron beam obtained from laser wakefield accelerator (LWFA). The experiments were conducted on the LWFA platform in RIKEN Spring-8 center supported by ImPACT and JST MIRAI project. By optimizing the driving laser system and gas target, the reproducibility of the acceleration process has been significantly improved. The electron beam with central energy of 380 MeV can be steadily generated with an energy spread less than 1% and a pointing instability less than 0.5 mrad in RMS. The typical electron beams with an average charge of 15 pC were focused by three permanent magnetic quadrupoles and four electromagnetic quadrupoles to the undulators located 6.5 meters downstream to the target. The amplified undulator radiation centered at 45 nm has been detected and the maximum gain of the radiation power is approximately 14-fold. Such the demonstration is not only the first time in Japan but also one of the world leading results. Based on our current achievements, we anticipate a navigable road from EUV to X-ray wavelengths.

Footnotes:

Funding Agency:

Tuesday Poster Session / 261

Development of an integrated monitor system for real-time relative phase measurement between the cavity-RF and beam

Author: Ersin Cicek[1]

Co-authors: Zhigao Fang [1]; Yuji Fukui [1]; Kenta Futatsukawa [1]; Tomoaki Miyao [1]; Satoshi Mizobata [1]; Junichiro Kamiya [2]; Katsuhiro Moriya [3]; Shinichi Shinozaki [2]; Yoshikatsu Sato [2]

[1] *High Energy Accelerator Research Organization*

[2] *Japan Atomic Energy Agency*

[3] *Japan Proton Accelerator Research Complex (J-PARC)*

Corresponding Author: ecicek@post.kek.jp

In a linear accelerator, phase drift in upstream cavities can adversely affect downstream cavity synchronization, leading to beam degradation and potential loss. J-PARC LINAC employs different phase reference signals for beam monitoring and RF systems, hindering direct comparison. Recent observations revealed susceptibility of reference signals to environmental effects in the Klystron Gallery. Hence, a thorough observation of the relative phase between cavity-RF and beam is imperative. Addressing this, we took advantage of the newly developed MicroTCA.4-based monitor digitizers to meticulously analyze RF signals from cavity pick-up and beam signals from existing fast

current transformers dedicated to measuring beam phase. Initial results show enhanced long-term stability in the relative phase with a shared RF reference. A beam study was also conducted wherein deliberate alterations were made to the cavity-RF phase settings via the LLRF system to detect their impact on the phase drift of downstream cavities. The system recorded downstream beam oscillations prompted by phase drift in upstream cavities. Our work elucidates a real-time monitoring strategy for relative phase detection.

Footnotes:

Funding Agency:

Thursday Poster Session / **262**

White Rabbit based picosecond timing system for scientific facilities

Author: Pilar Gil[1]

Co-authors: Juan Fernández [1]; Javier Benavides [1]

[1] *Safran Electronics & Defense Spain S.L.*

Corresponding Author: pilar.gil@nav-timing.safrangroup.com

The timing system is a critical element in scientific facilities such as particle accelerator or laser ignition installations.
The different subsystems that integrate these scientific facilities need to have a common notion of time. This common time reference is provided by the timing system. Thank to that, it is possible to operate the machine in a time coherent manner and to properly track the different events that occur during the operation of the machine. The timing system also provides the discrete triggering events and periodic signals requested for the different subsystems. Furthermore, it can be used also for radiofrequency distribution across the facility.
In this work it is presented the timing system architecture, based on the White Rabbit technology and currently under development by Safran Electronic & Defense Spain SLU, for the distribution of synchronized triggers. The hardware, based on FPGA, will be detailed.
The timing system allows total triggering configuration in terms of direction, number of pulses, pulse rate, pulse period and delay offering a resolution in the order of 5ps. The White Rabbit technology provide sub-nanosecond accuracy and picosecond precision in addition to important characteristics as the automatic link calibration. The performance achieved will be shown in this work.

Footnotes:

Funding Agency:

Thursday Poster Session / **263**

Status of the development of the new digital LLRF for ALBA Synchrotron Light facility

Author: Pilar Gil[1]

Co-authors: Francis Perez [2]; Javier Benavides [1]; Juan Fernández [1]; Pol Solans [2]

[1] *Safran Electronics & Defense Spain S.L.*

[2] *ALBA-CELLS Synchrotron*

Corresponding Author: pilar.gil@nav-timing.safrangroup.com

One of the crucial control systems of any synchrotron is the Low-Level Radio Frequency (LLRF). The main purpose of an LLRF is to generate and maintain a stable electric field within the accelerator cavities by controlling its amplitude and phase.
SAFRAN Electronic & Defense Spain S.L.U. is currently developing the new digital LLRF to update the system in the ALBA Synchrotron Light facility located in Barcelona. The design, implementation and tests are based on ALBA technical specifications. It is expected that the system will be tested on site, in its 500 MHz version, by summer 2024 while the 1.5 GHz (third harmonic version) will be tested on site by the first quarter of 2025.
The architecture, design, and development as well as the performance of the LLRF system will be presented in this work.

Footnotes:

Funding Agency:

NextGenerationEU
Plan de Recuperación, Transformación y Resilencia. Gobierno de España

Monday Oral Posters / 265

Standing wave Dielectric Disk Accelerating structure design and fabrication

Author: Sarah Weatherly[1]

Co-authors: Ben Freemire [2]; Chunguang Jing [3]; Eric Wisniewski [1]; John Power [3]; Scott Doran [3]; Tetsuo Abe [4]

[1] *Illinois Institute of Technology*

[2] *Euclid Beamlabs LLC*

[3] *Argonne National Laboratory*

[4] *High Energy Accelerator Research Organization*

Corresponding Author: sweatherly@hawk.iit.edu

A Dielectric Disk Accelerator (DDA) is a metallic accelerating structure loaded with dielectric disks to increase coupling between cells, thus high group velocity, while still maintaining a high shunt impedance. This is crucial for achieving high efficiency high gradient acceleration in the short rf pulse acceleration regime. Research of these structures has produced traveling wave structures that are powered by very short (˜9 ns), very high power (400 MW) RF pulses using two beam acceleration to produce these pulses. In testing, these structures have withstood more than 320 MW of power and produced accelerating gradients of over 100 MV/m. The next step of testing these structures will use a more conventional, klystron power source. A new standing wave DDA structure is being fabricated for testing on the Nextef2 test stand at KEK. Simulation results of this structure show that at 50 MW of input power, the DDA produces a 457 MV/m gradient. It also has a large shunt impedance of 160 MΩ/m and an r/Q of 21.6 kΩ/m. Cold testing of this structure will be conducted July 2024 with high power testing to be done in August.

Footnotes:

Funding Agency:

Monday Poster Session / 266

Integrated approach for ESS personnel safety systems

Author: Jessica Lastow[1]

Co-authors: Afshin Farshidfar [1]; Ahmed Abujame [1]; Annika Nordt [1]; Anton Andersson [1]; Artem Petrushenko [1]; Charles Webber [1]; Dmitrii Plotnikov [1]; Donya Daryadel [1]; Johannes Gustafsson [1]; Julia Grönvall [1]; Luiz Nunes [1]; Marcin Zmuda [1]; Martin Carroll [1]; Mattias Eriksson [1]; Morteza Mansouri [1]; Nerusha Naicker [1]; Peter Holgersson [1]; Reza Foroozan [1]; Vincent Harahap [1]; Yaser Takzare [1]

[1] *European Spallation Source ERIC*

Corresponding Author: jessica.lastow@ess.eu

The European Spallation Source (ESS) is a state-of-the-art research facility currently under construction in Lund, Sweden. Upon project delivery, ESS will host the most powerful linear proton accelerator and a spallation target capable of producing the brightest neutron source in the world. In order to enable safe commissioning and operation of these potent systems, each system has a dedicated personnel safety system (PSS). Together they make up the ESS PSS, an integrated system of several PSS across the facility. These systems communicate with each other through a centralised interlink system, and together determine if the facility is ready for proton beam generation in the Accelerator and consequently neutron production at the Target Station. This paper provides a summary of the inner workings, along with a discussion on the approach and proposed strategies for overcoming the identified challenges.

Footnotes:

Funding Agency:

Tuesday Poster Session / 268

Superconducting β=0.40 half-wave cavity design for CiADS

Authors: Zehua Liang[1]; Mengxin Xu[1]; Shengxue Zhang[1]; Lubei Liu[1]; Jiyu Wang[1]; Yimeng Chu[1]

Co-authors: Hao Guo [1]; Tiancai Jiang [1]; Shichun Huang [1]; Chunlong Li [1]; Pingan Xiang [2]; Qitong Huang [2]; Pingran Xiong [1]; Shuhui Liu [1]; Teng Tan [1]; Zhijun Wang [1]; Fengfeng Wang [1]; Yuan He [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *Advanced Energy Science and Technology Guangdong Laboratory*

Corresponding Author: liangzehua@impcas.ac.cn

A 325 MHz, optimal beta = 0.40 niobium half-wave resonator (HWR) called HWR040 for the superconducting driver linac of the China initiative Accelerator-Driven subcritical System (CiADS) has been designed and analysed at the Institute of Modern Physics, Chinese Academy of Sciences (IMP, CAS). The linac requires 60 HWR040s to accelerate protons from 45 MeV to 175 MeV. This paper mainly presents the multi-physics studies of the HWR040, include electromagnetic optimization, mechanical structure design and heat transfer simulation of the cavity, to predict the behaviour of the cavity under practical operating process.

Footnotes:

Funding Agency:

Chinese Academy of Sciences "The Development of High Stability Cryomodule [E129812YR0]", and the Large Research Infrastructures "China initiative Accelerator Driven System [2017-000052-75-01-000590]".

Tuesday Oral Posters / 269

Development of wet nitrogen doping to improve the performance of half-wave resonators

Author: Yuting Wu[1]

Co-authors: Andrei Ganshyn [1]; Chris Compton [1]; Ethan Metzgar [1]; Kenji Saito [2]; Kyle Elliott [1]; Laura Popielarski [1]; Sang-Hoon Kim [1]; Spencer Combs [2]; Taro Konomi [2]; Ting Xu [2]; Walter Hartung [1]; Wei Chang [1]; Yoo Lim Cheon [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Facility for Rare Isotope Beams*

Corresponding Author: wuyu@frib.msu.edu

FRIB is developing a new N-doping method with a simplified recipe. This recipe is called wet nitrogen doping, by adding nitric acid to the conventional EP acid. Nitrogen doping introduces impurities to the SRF surface, and reduces the BCS resistance by shortening the mean free path, which leads to a higher Qo. Conventional nitrogen doping, developed at FNAL and Jlab, requires a high-temperature treatment (900 °C), and an additional light EP to remove the over-contaminated layer. This recipe produces a decreasing Qo at extremely low fields but successfully achieves high Qo performance up to 25 MV/m. The wet doping method does not require additional high-temperature baking and light EP afterwards, therefore it is superior in terms of processing steps. This method produced a high Qo of 8x10ˆ10 at a low field of 0.5MV/m without the decreasing trend on FRIB beta=0.53 HWR. In this presentation, we will show the related R&D results generated from the FRIB 0.53 HWRs.

Footnotes:

Funding Agency:

the U.S. Department of Energy, Office of Science,DOE Office of Science User Facility under Award Number RC114424

Thursday Poster Session / 270

Beam dynamics design for a proton Linac for a compact accelerator based neutron source

Author: Mina Abbaslou[1]

Co-authors: Marco Marchetto [1]; Philipp Kolb [1]; Robert Laxdal [1]; Tobias Junginger [1]

[1] *TRIUMF*

Corresponding Author: mabbaslou@triumf.ca

A prototype Canadian compact accelerator-driven neutron source (PC-CANS) is proposed for installation at the University of Windsor. The source is based on a high-intensity compact proton RF accelerator that delivers an average current of 10 mA of protons at 10 MeV to the target. This study can serve as a basis for the design of an initial stage of a new high-intensity compact accelerator-driven neutron source (CANS). The accelerator consists of a short radio frequency quadrupole (RFQ), followed by an efficient drift tube linac (DTL) structure. Different variants of DTL were investigated for our studies. APF, KONUS, CH-DTL, and Alvarez DTL as normal conducting cavities with a frequency of 352.2 MHz and a superconducting cavity with a lower frequency of 176.1 MHz were considered in our Linac design. Details of the beam dynamics of the RFQ and different types of DTL are presented in this paper.

Footnotes:

Funding Agency:

Monday Oral Posters / **271**

Simultaneous acceleration of proton and H-minus beams in RFQ

Author: Sergey Kurennoy[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: kurennoy@lanl.gov

The Los Alamos Neutron Science Center (LANSCE) accelerator complex delivers both protons (p) and negative hydrogen ions (H-) and provides various beam patterns simultaneously to multiple users. The LANSCE linac front end is still based on Cockcroft-Walton voltage generators that bring proton and H- beams to 750 keV. An upgrade of the front end to a modern, RFQ-based version is now under consideration. The most promising upgrade option is based on acceleration of two continuous beams, p and H-, injected simultaneously into a single RFQ, which has never been done before. We use an existing CST model of a proton RFQ to model simultaneous acceleration of proton and H- beams as a proof of principle for such an RFQ operation.

Footnotes:

Funding Agency:

Thursday Poster Session / **272**

Laser assist scattering with thermal electron in elliptical and circular polarized laser field

Author: Saddam Dhobi[1]

Co-authors: Buddha Shah [2]; Jeevan Nakarmi [1]; Kishori Yadav [1]; Saddam Dhobi [1]; Suresh Gupta [1]

[1] *Tribhuvan University*

[2] *Nepal Academy of Science and Technology*

Corresponding Author: saddamdhobe@gmail.com

The objective of this research work is to design and develop laser-assisted thermal electron and hydrogen scattering, using theoretical model for elliptical and circular polarized laser. To develop the model, Volkov wave function for thermal case in elliptical and circular polarized laser field was designed and designed wave function is used to obtain S-matrix using Kroll-Watson approximation and born first approximation, with the help of S-matrix, T-matrix was obtained to study the DCS for elliptical and circular polarized laser. The obtained T-matrix was used to compute nature of DCS for linear and elliptical polarized laser field using MATLAB with computing parameters value for laser photon energy (1 eV to 3 eV), incidence thermal electron energy (0.511 MeV to 4 MeV) and temperature (280 K to 300 K). The DCS nature found decrease with increasing in incidence energy of thermal electron with constructive and distractive interference as well as superposition also take palce. In addition, the DCS with thermal electron found higher than non-thermal electron in presence of laser field with scattering angle and incidence energy of the electron.

Footnotes:

Funding Agency:

No

Thursday Poster Session / **273**

Particle measurement on all-metal gate valve for CEBAF beamline via laser-based particle counter

Author: Mingqi Ge[1]

Co-authors: Anne-Marie Valente-Feliciano [1]; Roger Ruber [1]; Rong-Li Geng [1]; Shreyas Balachandran [2]; Tom Powers [1]

[1] *Thomas Jefferson National Accelerator Facility*

[2] *Florida State University*

Corresponding Author: mingqi@jlab.org

The Viton gate valves installed in the CEBAF beamline have significantly degraded after long-term operation in a radiation environment, generating numerous particles that cause heavy contamination and strong field emission. As a replacement, all-metal gate valves have been proposed for installation in the CEBAF beamline. In this paper, we present thorough comparison tests between the Viton gate valves and the all-metal gate valves, including evaluations of particle levels, aging tests of the gate valves, and analysis of the particle material.

Footnotes:

Funding Agency:

Thursday Poster Session / **274**

Recent progress on HF-free surface treatment by bipolar pulsed electropolishing for SRF Nb cavities

Author: Mingqi Ge[1]

Co-authors: Anne-Marie Valente-Feliciano [1]; Ernest Stallworth [2]; Hui Tian [1]; John Musson [1]; Mark Lester [1]; Natalie Brock [1]

[1] *Thomas Jefferson National Accelerator Facility*

[2] *Jefferson Lab*

Corresponding Author: mingqi@jlab.org

The bipolar pulsed electropolishing (BPEP), due to its HF-free feature, can offer much safer, more environmentally friendly, and lower-cost operation compared to the conventional electropolishing, using concentrated HF and H2SO4 as electrolyte. Jefferson Lab has developed the BPEP system using diluted H2SO4 only for implementing final surface processing of niobium SRF cavities, including single cells, 7-cell CEBAF C100 cavity, and 9-cell TESLA-style cavities. The BPEP-treated cavity, followed by 120℃ baking, has achieved an accelerating gradient (Eacc) of 37 MV/m with a quality factor (Q0) above 1e10 at 2K, which demonstrated the success of the system's development. The

detailed BPEP parameter optimization and study of the surface engineering by BPEP will also be presented.

Footnotes:

Funding Agency:

Thursday Poster Session / **275**

Progress update on the RF system refurbishment at the APS linac

Author: Yawei Yang[1]

Co-authors: Ali Nassiri [1]; David Meyer [1]; Gregory Fystro [1]; Nicholas DiMonte [1]; Suyin Wang [1]; Terry Smith [1]; Yine Sun [1]

[1] *Argonne National Laboratory*

Corresponding Author: yaweiyang@anl.gov

A new storage ring based on a multi-bend achromat (MBA) lattice has been built at the Advanced Photon Source. Currently, the commissioning process is underway to bring beamlines back into operation. The APS linac consists of two S-band thermoionic cathode guns at the front end and thirteen S-band traveling-wave RF structures, all powered by five klystrons. A major upgrade is in progress to enhance the RF system in the APS linac. Specifically, the high power undulators and klystrons will be replaced with a newly designed solid-state switching modulator systems. Additionally, the RF control and diagnostic systems are being replaced by brand-new digital LLRF systems. As of now, one RF station has been successfully upgraded, commissioned, and it has been operating for half a year. Notably, the RF stability at this station shows significant improvement compared to other stations.

Footnotes:

Funding Agency:

Tuesday Poster Session / **276**

Analysis of redundancy design and reliability estimation of 60 kW CW RF HPA for ALS-U project at LBNL

Author: Shree Subhasish Basak[1]

Co-authors: Benjamin Flugstad [1]; David Nett [1]; Kazuhiro Hirano [2]; Kenneth Baptiste [1]; Reichiro Kobana [2]; S. Hihara [2]; T. Sueishi [2]

[1] *Lawrence Berkeley National Laboratory*

[2] *R&K Company Limited.*

Corresponding Author: subhashish.707@gmail.com

The 60 kW CW AR RF HPA is critical major equipment in new RF system for ALS-U project at LBNL and so it has been designed & built with a modular redundant topology having large array of 96 RF final PA modules (each delivering ˜ 700 W RF output) that are combined in parallel, and large 30 DC PS modules (each ˜ 5 kW DC power) operating in parallel for achieving very high reliability (MTBF

˜ 135,000 hours) & availability (˜ 99.997 %) of RF HPA which is essential for continuous 24/7 beam operations. The redundancy design to modules failures is such that in the event upto 10% failures of RF PA modules and simultaneously upto 15 % failures of DC PS modules the HPA still can generate minimum 48 kW CW RF output that is needed for full beam power and so RF power headroom of 12 kW is built in. The operating power levels & temperatures of all components in HPA are well below to their maximum ratings for high reliability. The MBTF values of subsystems in HPA has been estimated based on components with high failures rates. The reliability probabilities having exponential distribution parameterized on failure rate were determined and the binomial distribution used for modules having redundancy. This paper presents such redundancy design analysis of HPA to such modules failures to achieve such minimum output power. Also the Availability (˜99.997%) and the Reliability (MTBF ˜ 135,000 hours) Estimation analysis of the overall HPA with such redundancy to modules failures is presented.

Footnotes:

Funding Agency:

Monday Oral Posters / **277**

High pulsed power measurements of superheating fields for SRF materials

Author: Nicole Verboncoeur[1]

Co-authors: Adam Holic [1]; Matthias Liepe [1]; Ryan Porter [1]; Thomas Oseroff [1]; Liana Shpani [1]; James Sears [1]

[1] *Cornell University (CLASSE)*

Corresponding Author: nmv39@cornell.edu

The Cornell High Pulsed Power Sample Host Cavity (CHPPSHC) is a new system designed to measure the superheating field of candidate superconducting RF (SRF) materials, giving insight into their operational limits. This system is designed to reach peak magnetic fields of up to 0.5 T in only a few microseconds, allowing us to achieve a pure magnetic field quench on the sample. We present an overview of the CHPPSHC system and proof of principle data from a niobium sample.

Footnotes:

Funding Agency:

Thursday Poster Session / **278**

Plan for terahertz-wave source of superimposed coherent transition radiation using ring-type resonator at LEBRA

Author: Norihiro Sei[1]

Co-authors: Hiroshi Ogawa [1]; Ken Hayakawa [2]; Takeshi Sakai [2]; Toshiharu Takahashi [3]; Toshinari Tanaka [2]; Yasushi Hayakawa [2]; Yumiko Takahashi [2]

[1] *National Institute of Advanced Industrial Science and Technology*

[2] *Nihon University*

[3] *Kyoto University*

Corresponding Authors: sei.n@aist.go.jp, sakai.takeshi@nihon-u.ac.jp

We have studied high-power terahertz-wave sources using a normal-conducting S-band linac at the Laboratory for Electron Beam Research and Application (LEBRA) at Nihon University [1, 2]. The developed coherent transition radiation (CTR) had a high energy of 1 mJ per macropulse [3]. However, the peak power of the CTR was approximately 100 kW and did not reach 1 MW, i.e., the level at which nonlinear optical phenomena are evident in the terahertz region. Therefore, we planned to generate high peak-power terahertz pulses by confining CTR micropulses in a ring-type resonator and superimposing them with CTR micropulses generated late within the resonator. By inserting a substrate with low absorption in the terahertz region into the resonator as an output coupler, it is possible to extract CTR pulses with high peak power while suppressing a cavity loss. In the presentation, we will report on this development plan based on the CTR pulse superimposition with the ring-type resonator at the LEBRA.

Footnotes:

1. N. Sei et al., J. Phys. D: Appl. Phys. 46 (2013) 045104.
2. N. Sei et al., Sci Rep. 11 (2021) 3433.
3. N. Sei et al., Jpn. J. Appl. Phys. 56 (2017) 032401.

Funding Agency:

Japan Society for the Promotion of Science KAKENHI
The Visiting Researcher's Program of the Kyoto University Institute for Integrated Radiation and Nuclear Science

Tuesday Poster Session / **279**

RF reference phase control system in the SuperKEKB injector LINAC

Author: Takako Miura[1]

Co-authors: Hiroaki Katagiri [1]; Tetsuya Kobayashi [1]; Toshihiro Matsumoto [1]

[1] *High Energy Accelerator Research Organization*

Corresponding Author: takako.miura@kek.jp

The RF reference phase in the SuperKEKB injector LINAC has been specially controlled for the stable beam injection to the main rings (HER/LER). The phase control system consists of three parts: MOFB, MOPS and SECT35PS. MOFB is the phase feedback system for drift compensation between the LINAC master oscillator (LMO) of 571.2 MHz and ring MO (RMO) of 508.9 MHz which has frequency ratio of 49/55 to the LMO. MOPS is the MO phase shifter. The LMO phase needs to be shifted smoothly depending on the injection phase for HER or LER rings in the repetition rate of 50 Hz. The laser system of the photocathode RF gun for HER beam, however, does not accept such fast phase changes. The MOPS module, therefore, has been developed to satisfy the requirement of the laser system and injection phase adjustment. SECT35PS is the phase shifter of 2856 MHz RF reference for downstream side of positron damping ring (DR) located in the middle of the LINAC. DR is operated with the same frequency as the main rings, 508.9 MHz. To increase the synchronization probability for the bucket selection of LER ring, the LINAC reference phase at the downstream of DR is changed pulse-to-pulse by the bucket selection system. This paper describes the RF reference phase control system.

Footnotes:

Funding Agency:

Thursday Poster Session / 280

Performance of the super-conducting RIKEN heavy-ion Linac at the RIKEN Radioactive Isotope Beam Factory

Author: Naruhiko Sakamoto[1]

Co-authors: Akito Uchiyama [1]; Kazunari Yamada [1]; Kazutaka Ozeki [1]; Kenji Suda [1]; Osamu Kamigaito [1]; Takahiro Nishi [2]; Takashi Nagatomo [1]; Yoshihide Higurashi [1]

[1] *RIKEN Nishina Center*

[2] *Nishina Center for for Accelerator-Based Science*

Corresponding Author: nsakamot@ribf.riken.jp

The RIKEN superconducting heavy-ion linear accelerator (SRILAC) has been steadily supplying beams for super-heavy element synthesis experiments since its commission in January 2020 by addressing relevant issues. The over- all availability of the accelerator during beam supply periods, excluding regular maintenance and downtime due to major malfunctions, is approximately 90%, with the availability exceeding 99% for SRILAC alone. The decrease in the available acceleration voltage due to the increase in X- rays i.e. field emission (FE) from superconducting (SC) cavities has been a major issue. However, this issue has been mitigated via high-RF power processing (HPP). This presentation reports on the current performance of SRILAC and its prospects.

Footnotes:

Funding Agency:

Tuesday Poster Session / 281

High performance megawatt uranium beams at GSI UNILAC

Author: Winfried Barth[1]

Co-authors: Florian Dziuba [2]; Hartmut Vormann [1]; Julian List [2]; Maksym Miski-Oglu [1]; Markus Vossberg [1]; Simon Lauber [2]; Stepan Yaramyshev [1]; Uwe Scheeler [1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[2] *Helmholtz Institut Mainz*

Corresponding Author: w.barth@gsi.de

The 50 years old GSI-UNILAC (Universal Linear Accelerator) as well as the heavy ion synchrotron SIS18 will serve as a high current heavy ion injector for the FAIR (Facility for Antiproton and Ion Research) synchrotron SIS100. The UNILAC together will provide for short and intense pulses. This contribution presents the results of the full performance high current uranium beam machine experiment campaign at UNILAC, conducted in the last three years. In order to determine the behavior of uranium beams, the transverse beam emittance at five selected measurement positions along the complete UNILAC have been measured for the first time in several machine investigation runs. A significant improvement in beam brilliance was achieved by using the pulsed hydrogen stripper at 1.4 MeV/u. It could be shown that extremely low horizontal emittances, i.e. very high brilliances, are achieved along the complete UNILAC up to the SIS injection. Besides high intense uranium beam with charge state 28+ also multi charge beam, comprising 27+, 28+, 29+ uranium ions, commonly recharged primarily to charge state 73+ using a carbon foil, were investigated and a record current of 3.6 emA has been achieved.

Footnotes:

Funding Agency:

Tuesday Poster Session / **282**

Development of new pulse driver for high power pulsed magnet

Author: Takuya Natsui[1]

[1] *High Energy Accelerator Research Organization*

Corresponding Author: takuya.natsui@kek.jp

The KEK injector linac injects high-charge electron and positron beams into the high-energy-ring and low-energy-ring of SuperKEKB respectively.
The linac also injects electron beams to the two light source rings, PF ring and PF-AR. We operate simultaneous top-up injections into the four rings by using many pulsed magnets. We have been upgrading the linac to attain the higher-quality beam injections for the SuperKEKB rings.
In the summer of 2023, large-aperture quadrupole pulsed magnets have been newly installed upstream of the linac and driven by new large-current pulse driver.
The power of the new pulse driver is 600 A 400 V and is energy recovery type. We achieve high efficiency with simple pulse width control. I would like to introduce this high-power, high-efficiency pulse driver.

Footnotes:

Funding Agency:

Monday Poster Session / **285**

High-voltage feed design for electrostatic potential depression in an RF accelerator

Author: Maria Sanchez Barrueta[1]

Co-author: Haoran Xu [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: msb@lanl.gov

Space-borne accelerator technologies suffer from significant electron beam loss during beam acceleration and excessive energy spread of the output beam. LANL is proposing a deployable and compact solution using electrostatic potential depression (EPD) to achieve higher bunching, lower beam loss, and smaller energy spread. This buncher system involves the use of three EPD sections, each electrically insulated from the bunching cavities and with a separate high voltage power supply, whose leads will have to reach through vacuum and the insulator to bias the specific section of the buncher. This presents considerable challenges due to the triple junction problem and the presence of parasitic radio frequency fields leaking through the insulating material.

Footnotes:

Funding Agency:

LDRD

Monday Poster Session / 286

Automation of sample alignment for neutron scattering experiments

Author: Breeana Pritchard[1]

Co-authors: Jonathan Edelen [1]; Morgan Henderson [1]

[1] *RadiaSoft LLC*

Corresponding Author: breeana@radiasoft.net

Sample alignment in neutron scattering experiments is critical to ensuring high quality data for the users. This process typically involves a skilled operator or beamline scientist. Machine learning has been demonstrated as an effective tool for a wide range of automation tasks. RadiaSoft in particular has been developing ML tools for a range of accelerator applications including beamline automation. In this poster we will present recent developments for selecting and aligning multiple samples at the HB-2A powder diffractometer at HFIR.

Footnotes:

Funding Agency:

This work is supported by DOE Office of Science Office of Basic Energy Science award number DE-SC0021555.

Monday Poster Session / 287

Advancements in Nb_3Sn growth for SRF technology

Author: Liana Shpani[1]

Co-authors: Chi Wang [2]; Helena Lew-Kiedrowska [3]; Matthias Liepe [1]; Steven Sibener [3]; Van Do [3]

[1] *Cornell University (CLASSE)*

[2] *National Cheng Kung University*

[3] *The University of Chicago*

Corresponding Author: ls936@cornell.edu

Nb_3Sn is the most promising alternative material for the future of superconducting radio-frequency (SRF) technology, steadily advancing towards practical applications. Having a critical temperature twice that of niobium, Nb_3Sn offers the potential for developing smaller, more powerful, and more efficient accelerators. We have designed a comprehensive study to synthesize and characterize substrate treatments at nucleation temperatures following the thermal vapor diffusion growth process to improve the uniformity of Nb_3Sn coatings, pushing its performance closer to fundamental limits.

Footnotes:

Funding Agency:

Work supported by the National Science Foundation under Grant No. PHY-1549132, the Center for Bright Beams and U.S. DOE grant No. DE-SC0008431.

Tuesday Poster Session / 288

High current machine campaign with various ion species at GSI UNILAC

Author: Hartmut Vormann[1]

Co-authors: Florian Dziuba [2]; Julian List [2]; Maksym Miski-Oglu [1]; Markus Vossberg [1]; Simon Lauber [2]; Stepan Yaramyshev [1]; Uwe Scheeler [1]; Winfried Barth [1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[2] *Helmholtz Institut Mainz*

Corresponding Author: h.vormann@gsi.de

After dedicated machine upgrade measures at the GSI UNILAC, a high current beam campaign has been performed recently. The presented results were accomplished - among other things - with newly installed electrodes for the superlens (short RFQ-type matching section), working completely fault free.
Beam experiments have been conducted with high intensity proton beam (1.2 mA), carbon (1 mA 12C6+) and nitrogen beam (5.4 mA 14N7+) dedicated for pion production. A record argon beam intensity of 28 mA (40Ar11) has been obtained at gas stripper section. A sufficiently high stripping efficiency of 35% applying a pulsed N2 gas stripper target could be realized. By achieving high-current performance for medium-heavy ions, a further step has been taken towards fulfilling the FAIR requirements for high-current operation. In this contribution the results of machine experiments are summarized, in particular the performance enhancement at the High Current Injector section (HSI).

Footnotes:

Funding Agency:

Monday Oral Posters / 289

Low energy multi-beam dynamics in novel LANSCE front end

Author: Yuri Batygin[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: batygin@lanl.gov

The proposed novel 100 MeV injector for the LANSCE Accelerator Facility* is designed to replace the existing 750-keV Cockcroft-Walton-columns-based injector. The new Front End includes two independent low-energy transports for H+ and H- beams merging at the entrance of a single RFQ, with the subsequent acceleration of particles in the new Drift Tube Linac. The challenge of the design is associated with the necessity of simultaneous acceleration of protons and H- ions with different beam currents, beam charges per bunch, beam emittances, and space charge depression, in a single RFQ and DTL, while injection beam energy is reduced from 750 keV to 100 keV. Acceleration of various beams in a single RFQ provides less flexibility for optimal adjustment of acceleration and

focusing parameters concerning the existing LANSCE setup. The paper discusses details of self-consistent multi-beam dynamics in the proposed injector.

Footnotes:

*Y. K. Batygin et al., "Advancement of LANSCE Front End Accelerator Facility", in Proc. IPAC'21, Campinas, Brazil, May 2021, p.1894 (2021).

Funding Agency:

The research presented in this paper was supported by the Laboratory Directed Research and Development program of Los Alamos National Laboratory under project number 20240177ER.

Thursday Poster Session / 290

Development of plasma processing of 1.3 GHz superconducting radiofrequency cavities at TRIUMF

Author: Daniel Hedji[1]

Co-authors: Philipp Kolb [1]; Robert Laxdal [1]; Tobias Junginger [1]; Vladimir Zvyagintsev [1]; Zhongyuan Yao [1]

[1] *TRIUMF*

Corresponding Author: dhedji@triumf.ca

Superconducting RadioFrequency (SRF) technology is a key component in many particle accelerators operating in a continuous wave, or high duty cycle, mode. The on-line performance of SRF cavities can be negatively impacted by the gradual reduction in the accelerating gradient that can be attained within a reasonable field emission level. Conventional cleaning procedures are both time- and resource-exhaustive as they are done *ex-situ*. As such, *in-situ* techniques are quite attractive. Plasma processing is an emerging *in-situ* method of cleaning which utilizes a mixture of oxygen and an inert gas to chemically remove hydrocarbon-based field emitters through plasma. At TRIUMF's Advanced Rare IsotopE Laboratory (ARIEL), an R&D program is in place to develop plasma processing procedures using fundamental power couplers on 1.3 GHz ARIEL 9-cell cavities. Single cell and multi-cell processing has been performed off-line. The studies involve varying the input parameters and testing the effectiveness of the treatment through RGA analysis. The progress on the developments will be reported.

Footnotes:

Funding Agency:

Monday Oral Posters / 292

Beam optics design of a prototype 20 kW conduction-cooled SRF accelerator for medical sterilization

Authors: Arun Saini[1]; Christopher Edwards[1]; Ivan Gonin[1]; Nikolay Solyak[1]; Thomas Kroc[1]; Vyacheslav Yakovlev[1]; Yichen Ji[1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: asaini@fnal.gov

Superconducting technology has significantly advanced the capabilities of particle accelerators, facilitating higher beam-power operations for fundamental research at a comparatively lower cost. However, the conventional implementation of superconducting technology introduces complexities in the form of cryogenic plants, cryogenic distribution systems and substantial construction and operational cost. In response to these challenges, recent research efforts at Fermilab have been dedicated to the development of a cryogen-free, conduction-cooled Nb3Sn-based superconducting technology. This paper outlines the beam optics design of a 20-kW conduction-cooled compact superconducting accelerator for medical sterilization. The paper reviews both the physics and practical constraints associated with high beam-power operation within the context of industrial applications. The focus is on providing insights into the potential of this innovative technology to overcome existing challenges and pave the way for more accessible and efficient industrial particle accelerators.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics

Monday Poster Session / 293

Compensation of quadrupole component of RF field in solenoidal focusing channel

Author: Arun Saini[1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: asaini@fnal.gov

High-intensity Superconducting Radio Frequency (SRF) ion/proton linear accelerators (linacs) typically utilize Half Wave Resonators (HWR) and Single Spoke Resonators (SSR) for beam acceleration in the low-energy section of the linac. Because of lack of azimuthal symmetry, HWR and SSR geometries result in a quadrupole field component of operating mode accelerating field. This, in turn, results in a quadrupole-like RF kick to the beam leading asymmetric growth in the transverse beam sizes. It becomes difficult to control the beam sizes in presence of non-linear space charge forces in a regular solenoidal focusing channel that provides uniform focusing in both transverse planes. Subsequently, if not compensated appropriately, the kick imposes severe implications on dynamics including emittance dilution. This paper delves into the effects of quadrupole RF kick in the low energy section of a SRF linac and presents a novel concept to compensate this kick locally using solenoidal focusing.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics

Tuesday Poster Session / 294

Development of the superconducting HWR cavities for NICA project

Authors: Zehua Liang[1]; Mengxin Xu[1]; Jiyu Wang[1]

Co-authors: Chunlong Li [1]; Qitong Huang [2]; Teng Tan [1]; Lubei Liu [1]; Pingan Xiang [2]; Shengxue Zhang [1]; Hao Guo [1]; Pingran Xiong [1]; Yuan He [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *Advanced Energy Science and Technology Guangdong Laboratory*

Corresponding Author: liangzehua@impcas.ac.cn

Nuclotron-based Ion Collider fAcility (NICA) is an accelerator complex under construction in JINR, in which superconducting linac-injector can accelerate protons up to 20 MeV and light ions to 7.5 MeV/u. To achieve this design target, a 325 MHz, beta = 0.21 niobium half-wave resonator (HWR) called HWR1 was developed jointly by IMP and JINR. This paper optimizes the electromagnetic design of NICA cavity, designs the mechanical structure (including helium jacket) and gives the results of multi-physical studies. Simulation results show that Epk/Eacc = 6.29, the coefficients of df/dp and LFD are 4.96 Hz/mbar and -1.28 Hz/(MV/m)ˆ2, respectively. In addition, the niobium cavity has been fabricated and vertically tested, the magnetic shield and helium jacket are in the process of electron beam welding, and the cryomodule will be assembled in the next 1˜2 months.

Footnotes:

Funding Agency:

Chinese Academy of Sciences "The Development of High Stability Cryomodule [E129812YR0]", National Key R&D "Next generation heavy ion accelerator key components cooperation development [E01O591KJ0]".

Tuesday Poster Session / 295

A novel test cavity setup for surface conductivity measurements of additive manufacturing samples

Author: Hendrik Hähnel[1]

Co-authors: Guenther Dollinger [2]; Julian Sonpar [1]; Michael Mayerhofer [2]; Ricardo Helm [2]

[1] *Goethe Universität Frankfurt*

[2] *Universitaet der Bundeswehr Muenchen*

Corresponding Author: haehnel@iap.uni-frankfurt.de

Additive Manufacturing (AM) has the potential to increase the performance of radio frequency (rf) cavity resonators while cutting manufacturing costs. To leverage this potential, AM processes and potentially post-processing techniques must be tailored to cavity requirements. Additionally, conventional manufacturing's quality assurance methods must adapt to the AM case requiring numerous studies on additively manufactured test bodies.
We introduce a compact rf cavity design, enabling cost-effective and precise studies of the surface conductivity of test bodies. The test body is mounted on a dielectric holder inside a cylindrical rf cavity made of aluminum. The geometry of the test body corresponds to a rod which allows simple and cost-effective production, post-processing and evaluation. The test body's surface conductivity is extracted from a measurement of the quality factor (Q0) of the cavity.
Depending on the geometry of the test body, Q0 values of over 10,000 can be achieved for copper test bodies. Thereby, the test body is responsible for up to two thirds of the total cavity loss. Studies will be presented demonstrating the precision of surface conductivity determination via Q-measurement and the impact of uncertainties in test body position and geometry.

Footnotes:

Funding Agency:

Monday Poster Session / **296**

LLRF and pulse-to-pulse correction for a compact linac

Author: Joshua Einstein-Curtis[1]

Co-authors: Amirari Diego [2]; Bo Hong [3]; Chao Liu [3]; Emilio Nanni [3]; F. Zuo [3]; Jonathan Edelen [1]; Julian Merrick [3]; Larry Ruckman [3]; Matthew Kilpatrick [1]; Robert Berry [4]; Ronald Agustsson [2]; Sami Tantawi [3]; Seiji Thielk [2]; Zenghai Li [3]

[1] *RadiaSoft LLC*

[2] *RadiaBeam*

[3] *SLAC National Accelerator Laboratory*

[4] *RadiaBeam Technologies*

Corresponding Author: joshec@radiasoft.net

The advent of c-band and x-band technology has made it possible to reduce the footprint of linear accelerators. Additionally, for industrial systems a more compact linac is enabling technology for burgeoning applications in security and defense. A key aspect to operating these machines in an industrial environments is stabilization of the amplitude and phase signals for the cavities. In this poster we present the design and recent results for a LLRF and pulse-to-pulse correction scheme utilizing an RFSoC based FPGA system.

Footnotes:

Funding Agency:

Monday Poster Session / **297**

An RF simulator for control system development

Author: Morgan Henderson[1]

Co-authors: Amirari Diego [2]; Dan Abell [1]; David Bruhwiler [1]; Jonathan Edelen [1]; Joshua Einstein-Curtis [1]; Ronald Agustsson [2]

[1] *RadiaSoft LLC*

[2] *RadiaBeam*

Corresponding Authors: mhenderson@radiasoft.net, jedelen@radiasoft.net

Simulation tools are critical to the prototype and validation of control algorithms prior-to and during commissioning of LLRF systems. Moreover for industrial systems, diagnostics that are available on test systems and in laboratory accelerators are not always available in the field. RadiaSoft has been developing an RF simulator suite that allows for rapid prototyping of control algorithms in a fully integrated epics environment. As part of this process we have performed extensive testing and bench-marking using a novel C-band test cavity with a range of diagnostics. This poster provides an overview of the simulator, comparison of model output with measurements, and signal reconstruction results for cavity control.

Footnotes:

Funding Agency:

Monday Oral Posters / 298

Automation of RF tuning for medical accelerators

Author: Finn O'Shea[1]

Co-authors: Auralee Edelen [1]; Jonathan Edelen [2]; Jorge Diaz Cruz [3]; Morgan Henderson [2]

[1] *SLAC National Accelerator Laboratory*

[2] *RadiaSoft LLC*

[3] *University of New Mexico*

Corresponding Author: foshea@slac.stanford.edu

RadiaSoft is developing machine learning methods to improve the operation and control of industrial accelerators. Because industrial systems typically suffer from a lack of instrumentation and a noisier environment, advancements in control methods are critical for optimizing their performance. In particular, our recent work has focused on the development of pulse-to-pulse feedback algorithms for use in dose optimization for FLASH radiotherapy. The PHASER (pluridirectional high-energy agile scanning electronic radiotherapy) system is of particular interest due to the need to synchronize 16 different accelerators all with their own noise characteristics. This presentation will provide an overview of the challenges associated with RF tuning for a PHASER-like system, a description of the model used to evaluate different control schema, and our initial results using conventional methods and machine learning methods.

Footnotes:

Funding Agency:

This work is supported by the DOE Office of Science Office of Accelerator Research Development and Production award number DE-SC0023641.

Tuesday Oral Posters / 299

2D material integration with cathodes for accelerators

Author: Hisato Yamaguchi[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: hyamaguchi@lanl.gov

The studies commissioned by the U.S. Department of Energy have repeatedly identified electron sources as critical risk area for development of future accelerators including LINAC. To address this challenge, we initiated an effort of integrating 2D materials with cathodes in 2013. The aim was to protect environmentally susceptible but high performing alkali antimonide semiconductor photocathodes with atomically thin two-dimensional (2D) materials such as graphene. The concept behind the effort was to decouple the competing mechanisms of high quantum efficiency and long lifetime. Our team succeeded in demonstration of the concept on metal photocathodes in 2017, won R&D 100 Award in 2019 and recently succeeded in demonstrating graphene encapsulated potassium caesium antimonide photocathodes to remain active in 3 orders of magnitude higher pressure compared to non-protected counterpart. The breadth of possibilities of 2D material integration with cathodes for accelerators will also be covered based on our findings during past decade such as graphene as

reusable substrates for alkali antimonide photocathodes, prevention of alloying between substrate material and alkali antimonide photocathode by graphene coating, demonstration of no detectable emittance increase on metal single crystal photocathodes by graphene coating, and work function lowering of thermionic- and photo-cathodes by monolayer hexagonal boron nitride coating.

Footnotes:

Funding Agency:

Thursday Poster Session / 300

Designing kicker magnet power supplies (MPS) for HX-SX simultaneous operation at PAL-XFEL

Author: Min-Jae Kim[1]

Co-authors: Garam Hahn [1]; Dong Eon Kim [1]; YoungGyu Jung [1]; Beom Jun Kim [1]; Woul Woo Lee [1]; Seong-Hun Jeong [1]; Hoon Heo [1]; Heung-Sik Kang [1]; Sukho Ahn [1]; Gyujin Kim [1]; DongCheol Shin [1]

[1] *Pohang Accelerator Laboratory*

Corresponding Author: kimminjae@postech.ac.kr

The PAL-XFEL accelerator is operating simultaneous operation of HX (10 GeV) and SX (3 GeV). To facilitate simultaneous operation, kicker MPS is necessary, requiring both AC mode and DC operation mode. AC mode operates with a square waveform at a repetition rate of 60 Hz. It operates as a bipolar type with an output voltage of 200 V and an output current of 45 A. The MPS is implemented using digital signal processing technology, employing DSP, FPGA, ADC, and others. The peak current stability of the kicker MPS showed approximately 50 ppm at a 45 A peak current. The long-term stability at 45 A in DC mode was measured to be 20 ppm peak-to-peak. These test results of kicker MPS indicate that it is sufficient for the stable simultaneous operation of PAL-XFEL.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 301

Beam emittance and Twiss parameters from pepper-pot images using physically informed neural nets

Author: Ian Knight[1]

Co-author: Brahim Mustapha [2]

[1] *Georgia Institute of Technology*

[2] *Argonne National Laboratory*

Corresponding Author: ianknight@gatech.edu

In the field of accelerator physics, the quality of a particle beam is a multifaceted concept, encompassing characteristics like energy, current, profile, and pulse duration. Among these, the emittance and Twiss parameters—defining the size, shape, and orientation of the beam in phase space—serve as important indicators of beam quality. Prior studies have shown that carefully calibrated statistical methods can extract emittance and Twiss parameters from pepper-pot emittance meter images. Our

research aimed to retrieve these parameters with machine learning (ML) from a transverse image of the beam after its propagation through a pepper-pot grid and subsequent contact with a scintillating plate. We applied a Convolutional Neural Network (CNN) to extract the x and y emittances and Twiss parameters (α and β), producing a six-dimensional output by simply looking at the image without calibration information. The extraction of divergence-dependent parameters, such as α and emittance, from a single image presented a challenge, resulting in a large Symmetric Mean Absolute Percentage Error (SMAPE) of 30%. To mitigate this issue, our novel method that incorporated image data from two points along the particles' propagation path yielded promising results. β prediction achieved a low SMAPE of 3%, while α and emittance predictions were realized with a 15% SMAPE. Our findings suggest the potential for improvement in ML beam quality assessment through multi-point image data analysis.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, under Contract No. DE-AC02-06CH11357. This research used the ATLAS facility, which is a DOE Office of Nuclear Physics User Facility.

Thursday Poster Session / 302

Extension of reference tracking method to reduce RF amplitude drift in particle accelerators

Author: Jinyul Hu[1]

Co-authors: Chang-Ki Min [1]; Hoon Heo [1]; Yong Jung Park [1]

[1] *Pohang Accelerator Laboratory*

Corresponding Author: hjy@postech.ac.kr

RF long-term stability (drift) is as important as RF short-term stability for the stable operation of particle accelerators including PAL-XFEL. Increasing the performance of LLRF itself becomes an important factor in maintaining the long and short-term stability of the RF field. The reference tracking method applied to LLRF is effectively used as a method of reducing the drift of the RF phase. However, this drift improvement method was not applied to the RF amplitude. This time, the method of reference tracking was newly expanded to improve the RF amplitude drift. As a result of applying this new function to PAL-XFEL LLRF, it is showing some effect in improving the RF amplitude drift. We would like to share the progress so far.

Footnotes:

Funding Agency:

Tuesday Poster Session / 303

Recent progress of Nb3Sn cavity development at KEK

Author: Hayato Ito[1]

Co-authors: Hiroshi Sakai [1]; Kensei Umemori [1]; Sohei Kasama [2]; Tomohiro Yamada [1]

[1] *High Energy Accelerator Research Organization*

[2] *Tohoku University*

Corresponding Author: hayato.ito@kek.jp

Nb3Sn is one of the most promising materials for the next generation of superconducting RF (SRF) cavities. One reason is that Nb3Sn cavities can achieve high Q-values at 4 K, whereas conventional Nb cavities need to be cooled down to 2 K. This allows for the operation of SRF cavities with conduction cooling, eliminating the need for liquid helium, unlike conventional SRF cavities which require immersion cooling. KEK started Nb3Sn deposition tests on the single-cell cavity based on the Sn vapor diffusion method around 2019 and has steadily improved the cavity performance. In addition, a small deposition furnace for the sample study was constructed last year to investigate the relationship between Nb3Sn film quality and deposition parameters and to improve the throughput of the deposition study. We will report the results of deposition tests on samples and RF measurements of single-cell Nb3Sn cavities.

Footnotes:

Funding Agency:

This work was supported by 【MEXT Development of key element technologies to improve the performance of future accelerators Program】 Japan Grant Number JPMXP1423812204.

Tuesday Poster Session / 304

Decrease of H- ion beam emittance with increased frequency in RF discharge

Author: Vadim Dudnikov[1]

[1] *Muons, Inc*

Corresponding Author: dvg43@yahoo.com

In recent years significant progress in increase intensity of H- beam in RF surface plasma sources. H- beam intensity in RF SPS of J-Parc was increased up to 145 mA.Intensity of H- in RF SPS of SNS was increased up to 110 mA, which is enough for European spallation source storage ring. Reduction of beamlet divergence in RF negative ion source for NBI is one of high-priority targets to be solved. Minimum beamlet 1/e divergence in RF H- ion sources with low RF frequency (2-4 MHz), much higher than in ion sources with DC discharge.
- min. q div(FA) ≤ 5 mrad (obtained at NIFS and QST with DC discharge)
- min. q div(RF) ≤ 12 mrad (obtained at IPP and RFX RF ion sources)
- max. q div(ITER NB) < 7 mrad.In RF H- ion sources
In H- ion sources with low RF frequency (2-4 MHz) is observed significant modulation of beam intensity at first and second harmonic. This should lead for vibration of the meniscus shape and increase angle spread. Work with higher RF frequency (13,56 MHz) should decrease intensity modulation and decrease emittance to two times. RF SPS with a frequency 13.56 MHz could be a good solution for a European spallation source with a storage ring.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 305

Preliminary measurement of 4D beam phase space distribution using a slit emittance meter system

Author: Seunghyun Lee[1]

Co-authors: Seok Ho Moon [1]; Dong-Hwan Kim [1]; Han-Sung Kim [2]; Hyeok-Jung Kwon [1]

[1] *Korea Multi-purpose Accelerator Complex*

[2] *Korea Atomic Energy Research Institute*

Corresponding Author: shl@kaeri.re.kr

Conventional beam diagnostics only measure 2D projections of the phase space in x-x', y-y' and z-z'. To estimate a 6D beam phase space distribution for simulations, these 2D projections are multiplied without any correlations between them. It is true only if their degrees of freedom are independent. Recent studies show that there exists correlation across conjugate pairs. This correlation can affect beam dynamics and cause beam loss. In our study, we sought to measure 4D beam phase space distribution with possible correlations across conjugate pairs. For this purpose, we used a direct method of measuring the 4D phase space distribution using slits. A set of 4 slits is used to slice the beam into a specific volume of the 4D phase space, and the charge inside each volume is measured. KOMAC has a test bench called BTS (Beam Test Stand) which consists of a microwave ion source, LEBT, a 200 MHz RFQ and two beamlines. At one of the beamlines, we have just installed slit emittance meter system to measure 4D beam phase space distribution. This paper presents design and fabrication of a slit emittance meter system and shows preliminary experimental results thereof.

Footnotes:

Funding Agency:

This work has been supported though KOMAC (Korea Multipurpose Accelerator Complex) operation fund of KAERI by Ministry of Sciencec and ICT, Korean Govt. (KAERI ID no. 524320-24).

Monday Poster Session / 306

RF power challenge for the linac of the U4 single pass RF driver for energy from inertial confinement fusion

Author: Robert Burke[1]

Co-author: Alexander Burke [2]

[1] *Arcata Systems*

[2] *Raytheon Missiles & Defense*

Corresponding Author: rjustburke@gmail.com

The U4 single pass rf driver (SPRFD) concept as developed overwhelms heavy ion beam requirements for pellet ignition to meet the need to be investment grade, commercial IFE, to justify building the first-of-a-kind, HIF IFE regional energy and water supply facility, with co-located heavy energy-use industries, from a coordinated set of computer models supported by empirical data including project-driven data acquisition. U4 uses the high gain cylindrical pellet approach with ion ranges up to ˜10g/cmˆ2 and fast ignition in 100g/cc DT*and extends charge balanced neutrality** to the multiple ion species. With no storage rings, all U4's 20 species can focus to the required 50μm. This paper characterizes the RF power challenge, specifically in the last highest frequency section, where an isotope's current from 64, 200mA sources [Staples et al., RF accel. for HEDP, 2006] is in a single beam (12.8A) due to zippering. 20 parallel linacs (˜100km total) accelerate ˜40MJ in ˜5 μsec: 8TW. 5e-5 duty factor at 10Hz. U4's challenges are in the linac; beam manipulations are aggressive but simple [Burkes, The U4 SPRFD, Accel.Apps. 2024]. (+) and (-) ion sources, telescoping ˜25-40GeV isotopes: Cd114, Ba136, Nd145, Gd155, Er166, Hf178, Ir190, Hg203, Th232. ˜10A per beam, 100MW/m to beam at 10MV/m. A concept under study integrates the final amplifier stage and the RF cavity

to 1) deliver the RF power, and 2) be mass-producible RF power and linac cavity LRUs to achieve a target cost of 50k$/m.

Footnotes:

*Basko M. et al., Prospects of heavy ion fusion in cylindrical geometry. Laser and particle beams. 2003.**Koshkarev DG, Charge-symmetric driver for heavy-ion fusion. Il Nuovo Cimento A. 1993.

Funding Agency:

Tuesday Poster Session / 307

Development of an X-band LLRF prototype for the EuPRAXIA@SPARC_LAB LINAC

Author: Phani Deep Meruga[1]

Co-authors: Andrea Mostacci [2]; Beatrice Serenellini [3]; Borut Baricevic [1]; Luca Piersanti [3]; Manuel Cargnelutti [1]; Marco Bellaveglia [3]

[1] *Instrumentation Technologies*

[2] *Sapienza University of Rome*

[3] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: phanideep.meruga@i-tech.si

EuPRAXIA stands for "European Plasma Research Accelerator with eXcellence In Applications". It's a next generation free-electron laser (FEL) aimed at developing a compact, cost-effective particle accelerator based on novel wake-field accelerator technology. Traditionally, high-energy physics requires higher acceleration voltages, so developing an X-band acceleration technology, enables the possibility to achieve high gradients with very compact structures. EuPRAXIA@SPARC_LAB LINAC injector features 1 S-band RF gun, 4 S-band and 16 X-band structures, achieving a max beam energy of 1 GeV. Low-Level Radio Frequency (LLRF) systems are crucial for RF station synchronization and machine stability at femtosecond precision. Currently, there are no commercially available X-band LLRF solutions, especially for pulse processing and control in the 100ns range. This project aims to develop an X-band LLRF prototype, in collaboration with INFN, tailored to meet EuPRAXIA@SPARC_LAB LINAC's demands. Once confirmed on a real testbench, the prototype will be used as a starting point for industrialization into a commercial instrument. This paper presents the prototype's architecture and preliminary results.

Footnotes:

Funding Agency:

Tuesday Poster Session / 308

Update on the intense heavy ion DTL project Alvarez 2.0 at GSI

Author: Lars Groening[1]

Co-authors: Manuel Heilmann [1]; Michael Kaiser [1]; Sascha Mickat [1]; Tanja Dettinger [1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

Corresponding Author: la.groening@gsi.de

The Alvarez-type post-stripper DTL at GSI accelerates intense ion beams with A/q <= 8.5 from 1.4 to 11.4 MeV/u. After more than 45 years of operation it suffers from aging and its design does not meet the requirements of the upcoming FAIR project. Prototyping of a new 108 MHz Alvarez-type DTL has been completed and series components for the 55 m DTL are under production and have been delivered partially. This report summarizes the actual status of Alvarez 2.0 at GSI and sketches the future path to completion.

Footnotes:

Funding Agency:

Tuesday Poster Session / 309

Development status of solid-state switches for thyratron replacement

Author: Sung Roc Jang[1]

Co-authors: Chan-Hun Yu [1]; Chang-Hyun Kwon [1]; Hyoung-Suk Kim [1]; Seong-Ho Son [1]; Sukho Ahn [2]; Yun-Sang Yu [1]

[1] *Korea Electrotechnology Research Institute*

[2] *Pohang Accelerator Laboratory*

Corresponding Author: scion10@keri.re.kr

This paper describes the development status of solid-state switches for thyratron replacement. A 50 kV, 10 kA solid-state switch has been developed based on IGBT series stacking technologies, including voltage balancing and synchronous driving. The proposed stacking structure minimizes internal inductance and provides a fast current rising time of up to 7 kA/us. Additionally, the developed switch has achieved low jitter of less than 1 ns. Owing to the modular structure of developed switch, it was implemented with various specifications for different applications. By implementing a 15 kV, 10 kA, 10 Hz switch, the solid-state kicker modulator was developed and successfully demonstrated in at Pohang Accelerator Laboratory(PAL). Furthermore, a 20 kV, 2 kA, 250 Hz switch has also been implemented and is currently used to operate a 6-MeV C-band electron linear accelerator (LINAC) at the Dongnam Institute of Radiological & Medical Sciences (DIRAMS). Additionally, a 50 kV, 10 kA switch is now ready for the klystron modulator. By sharing the development status of solid-state switches in Korea, it is hopefully expected to share our developed switch and technology and have the chance to discover its shortcomings together, so that we can work on improving them collaboratively.

Footnotes:

Funding Agency:

Tuesday Poster Session / 310

Fast chopper line for DONES

Author: Marco D'Andrea[1]

Co-authors: Andrea Pisent [1]; Antonio Palmieri [1]; Francesco Grespan [1]; Luca Bellan [1]; Luigi Ferrari [1]; Marco Di Giacomo [2]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *Grand Accélérateur Nat. d'Ions Lourds*

Corresponding Author: marco.dandrea@lnl.infn.it

The International Fusion Materials Irradiation Facility –DEMO-Oriented Neutron Early Source (IFMIF-DONES) will provide a deuteron beam of unprecedented intensity for irradiation and characterization of materials to be used in fusion reactors. In recent years, the possibility to use a small fraction of this beam for other applications in parasitic mode was discussed. This not only has the potential to enlarge the user community without perturbing the main operation, but also allows characterization measurements for beam quality management purposes. Considering various requirements and constraints, the most promising option for the extraction towards such a parasitic line involves the use of a meander-line travelling-pulse beam deflector at the start of the High Energy Beam Transfer (HEBT) line. This paper describes preliminary studies aiming at a first definition of the structure, materials and geometrical parameters of the meander-line deflector.

Footnotes:

Funding Agency:

Tuesday Poster Session / **311**

Considerations and findings on beam vorticity dynamics

Author: Lars Groening[1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

Corresponding Author: la.groening@gsi.de

Rotation of beams is usually quantified through its angular momentum rather than through its vorticity. However, the difference of the two transverse eigen-emittance is linked more strongly to vorticity as to angular momentum. It has been found that the dynamics of vorticity has remarkable similarity to the dynamics of the beam envelope along channels of solenoids and quadrupole triplets. Transport matrices of vorticity, corresponding phase advances and Twiss parameters look very similar and are partially even identical to their counterparts concerning envelopes. Corresponding to emittance, the quantity of vortissance, being a constant of motion, is defined. Unlike emittance, for vorticity-dominated beams, it may take imaginary values causing imaginary Twiss parameters and negative or zero phase advances along a finite beam line section.

Footnotes:

Funding Agency:

Tuesday Poster Session / **312**

Design and optimization of a compact electron linac for iIndustrial applications using Bayesian optimization

Author: Chong Shik Park[1]

[1] *Korea University Sejong Campus*

Corresponding Author: kuphy@korea.ac.kr

This work presents the design and optimization of a compact electron linear accelerator capable of achieving an energy less than 5 MeV, specifically tailored for industrial applications. The innovative design incorporates a Superconducting RF photoinjector. A significant focus has been placed on optimizing the geometry of the SRF photoinjector cavity to accelerate high-charge and small-emittance electron beams. Utilizing Bayesian optimization, the linac configuration has been refined to enhance both the geometry and performance of the photoinjector, leading to improved beam quality and energy efficiency. Our findings demonstrate that the optimized linac meets the stringent requirements of industrial applications and significantly enhances beam dynamics and operational stability.

Footnotes:

Funding Agency:

Thursday Poster Session / 313

Effective thermal load mitigation in cERL injector coupler through warm section modification

Author: Pragya Nama[1]

Co-authors: Ashish Kumar [2]; Dai Arakawa [2]; Eiji Kako [2]; Hiroshi Sakai [2]; Kensei Umemori [2]; Takako Miura [2]

[1] *Sokendai, the Graduate University for Advanced Studies*

[2] *High Energy Accelerator Research Organization*

Corresponding Author: pragya@post.kek.jp

Fundamental power couplers are utilized in SRF accelerators to transfer RF power from a source to the accelerating cavities. However, the issue of thermal heat load during high-power transmission in continuous wave (CW) mode operation poses a significant challenge for power couplers. To address this concern critical modifications have been implemented within the warm sections of the cERL injector prototype coupler which was previously tested for 30kW power level in CW mode operation. The modification includes implementation of active water cooling in the warm section of the coupler and material change from copper coated stainless steel to oxygen free copper for the inner conductor.
As a result, the thermal load at the inner and outer conductor was effectively mitigated during high power transmission in CW mode. Prior to the modifications, the inner conductor of the warm section reached a maximum temperature of 183℃ at 27 kW power in CW mode. However, with the modified inner conductor with water cooling, the temperature was a mere 25℃. Additionally, the overall coupler temperature of the modified coupler was significantly reduced due to the conduction cooling effect applied to other components. These results underscore the effectiveness of the implemented modifications and represent a highly effective approach for mitigating thermal load in critical coupler components.

Footnotes:

Funding Agency:

Thursday Poster Session / 316

Numerical study of 5 MeV SRF electron linac for wastewater purification

Author: Anjali Kavar[1]

Co-authors: Shigeru Kashiwagi [2]; Toshiya Muto [1]; abiko hayato [1]; Fujio Hinode [1]; Ikurou Nagasawa [1]; Ken-ichi Nanbu [1]; Kotaro Shibata [1]; Ken Takahashi [1]; Kodai Kudo [1]; Hiroki Yamada [1]; Hiroyuki Hama [1]

[1] *Tohoku University*

[2] *Research Center for Accelerator and Radioisotope Science*

Corresponding Author: anjalikavar5454@gmail.com

Superconducting Radio Frequency (SRF) technology is a proven solution for generating high-power electron beams (EB), suitable for tasks like purifying wastewater from challenging impurities such as PFAS. This study elaborates on effectiveness of EB treatment and outlines design considerations for a 1.3 GHz SRF linac operating at 5 MeV with an average beam current of 10 mA. Nu-merical analyses for the accelerator system, ensuring that the beam reaches 5 MeV with the desired characteristics, lead to a compact beamline structure. This structure includes a 100 kV thermionic gridded electron gun, a 1.3 GHz 3-cell low beta buncher cavity, and three 2-cell 1.3 GHz accelerator cavities, along with necessary focusing solenoids, all fitting within 3 meter. Given the need for high beam current, achieving a high bunch repetition rate is important. We therefore will employ the RF gating to the grid of the electron gun. The results of the numerical studies will be presented at this conference.

Footnotes:

Funding Agency:

Tuesday Poster Session / 317

Advanced algorithms for linear accelerator design and operation

Author: Ysabella Kassandra Ong[1]

Co-authors: Luca Bellan [1]; Andrea Pisent [1]; Michele Comunian [1]; Enrico Fagotti [1]; Damiano Bortolato [1]; Maurizio Montis [1]; Mauro Giacchini [1]; Osvaldo Carletto [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: ysaong@lnl.infn.it

In this paper, we investigate the usage of advanced algorithms adapted for optimizing the design and operation of different linear accelerators (LINACs), notably the superconducting linac ALPI at INFN-LNL and the ANTHEM BNCT facility to be constructed at Caserta, Italy. Utilizing various intelligent algorithms and machine learning techniques such as Bayesian optimization, genetic algorithms, particle swarm optimization, and surrogate modeling with artificial neural networks, we aim to enhance the design efficiency, operational reliability and adaptability of linear accelerators. Through simulations and case studies, we demonstrate the effectiveness and practical implications of these algorithms for optimizing LINAC performances across diverse applications.

Footnotes:

Funding Agency:

Thursday Poster Session / 318

Completion of Phase B+ beam commissioning of Linear IFMIF Prototype Accelerator (LIPAc)

Author: Tomoya Akagi[1]

Co-authors: Florian Benedetti [2]; Yann Carin [3]; Janic Chambrillon [4]; Fabio Cismondi [2]; Andrea De Franco [1]; Hervé Dzitko [3]; Takashi Ebisawa [1]; Dominique Gex [3]; Kazuo Hasegawa [1]; Kouki Hirosawa [1]; Jibong Hyun [1]; Tomonobu Itagaki [1]; David Jimenez-Rey [5]; Naomi Kaneko [1]; Atsushi Kasugai [1]; Keitaro Kondo [1]; Kohki Kumagai [1]; Saerom Kwon [1]; Kai Masuda [2]; Akihiko Mizuno [6]; Iván Moya [3]; Francesco Scantamburlo [2]; Masayoshi Sugimoto [7]

[1] *National Institutes for Quantum Science and Technology*

[2] *IFMIF/EVEDA Project Team*

[3] *Fusion For Energy*

[4] *Fusion for Energy*

[5] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[6] *Japan Synchrotron Radiation Research Institute*

[7] *Nippon Advanced Technology Co., Ltd.*

Corresponding Author: akagi.tomoya@qst.go.jp

The Engineering Validation and Engineering Design Activities for the International Fusion Materials Irradiation Facility (IFMIF/EVEDA) are being pursued under the Broader Approach agreement between EURATOM and the Japanese government. The Linear IFMIF Prototype Accelerator (LIPAc) is under commissioning in Rokkasho, Japan to demonstrate the feasibility of the high duty (CW) and high current (125mA) deuteron beam operation. Currently, the LIPAc beamline is in its final configuration, except for the SRF linac currently replaced by a temporary beam transport line, and is undergoing a high duty cycle RFQ operation up to 5 MeV, which is called Phase B+ and is planned to be completed by the end of June 2024. The major goals of this phase are to validate the RFQ, MEBT and Beam Dump performances at high duty cycle and to characterize the beam properties in preparation to the final configuration with the SRF linac. As of the end of April 2024, a beam current of about 115 mA, a pulse length of up to 3 ms and duty cycle of up to about 4% have been successfully achieved. After the completion of the Phase B+, the SRF will be delivered to the accelerator room and installed in the beamline. This paper will present the results of the Phase B+.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 319

Beam commissioning of the first HELIAC cryomodule

Author: Julian List[1]

Co-authors: Christoph Burandt [1]; Hartmut Vormann [2]; Florian Dziuba [1]; Holger Podlech [3]; Maksym Miski-Oglu [2]; Robin Kalleicher [1]; Simon Lauber [1]; Stepan Yaramyshev [2]; Thorsten Kuerzeder [2]; Viktor Gettmann [2]; Winfried Barth [2]; Uwe Scheeler [2]

[1] *Helmholtz Institut Mainz*

[2] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[3] *Goethe Universität Frankfurt*

Corresponding Author: j.list@gsi.de

The superconducting heavy ion HELmholtz LInear ACcelerator (HELIAC) is designed to meet the needs of the Super Heavy Element (SHE) research and material science user programs at GSI in Darmstadt. The beam energy can be varied smoothly between 3.5 and 7.3 MeV/u, with an average current of up to 1 emA and a duty cycle of 100 %.

Recently, the first cryomodule CM1, was fully commissioned and tested. CM1 comprises three Crossbar H-mode (CH)-type accelerator cavities, a CH-rebuncher, and two superconducting solenoid lenses. Following the commissioning of the cryogenic supply- and RF-systems, a successful beam test was conducted at the end of 2023. A helium ion beam was successfully accelerated to the design energy of 2.7 MeV/u. The beam energy could be varied continuously between 1.3 and 3.1 MeV/u without any significant particle losses being measured in the cryomodule. This contribution covers the construction and commissioning of the first HELIAC cryomodule and the results of the beam test campaign.

Footnotes:

Funding Agency:

Tuesday Poster Session / **320**

Progress and status of the FAIR proton linac

Co-authors: Alexander Schnase [1]; Anja Seibel [1]; Carl Kleffner [1]; Carsten Muehle [1]; Christina Will [1]; Gerald Schreiber [1]; Hendrik Hähnel [2]; Klaus Knie [1]; Maria Rodionova [1]; Markus Vossberg [1]; Maximilian Schuett [1]; Peter Forck [1]; Rudolf Hettinger [1]; Serban Udrea [1]; Sven Puetz [3]; Thomas Sieber [1]; Ulrich Ratzinger [2]; Vaishnavi Srinivasan [1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[2] *Goethe Universität Frankfurt*

[3] *European Organization for Nuclear Research*

Corresponding Author: c.kleffner@gsi.de

The progress and status of the high intensity short pulse 325 MHz proton linac driver for the FAIR facility in Darmstadt is described. The proton linac is designed to deliver a beam current of 70 mA at an energy of 68 MeV. The design of the normal conductiong CCH cavities was carried out in collaboration with our partners at the IAP Frankfurt and industrial partners. First bead pull measurements have been successfully performed on the CCH prototype. This prototype cavity is intended for later final production and copper plating. The construction of the ladder RFQ has been completed together with first rf measurements at levels up to 400 W. The RFQ has been delivered to FAIR and high power rf tests are expected to be performed on site during the next year. The proton driver, along with the antiproton chain of the FAIR project, has been postponed due to a re-prioritisation of the project and is now in a frozen state. All delivered components need to be brought to a state that is consistent with the project objectives. This will allow a smooth re-launch in the future. The status of this process is described in this paper.

Footnotes:

Funding Agency:

Tuesday Poster Session / **321**

Development of Bi-Alkali antimonide photocathodes for a 1.3 GHz superconducting rf photo-injector

Author: Ziye Yin[1]

Co-authors: John Lewellen [2]; John Smedley [3]; Sang-Hoon Kim [1]; Taro Konomi [4]; Ting Xu [4]; Walter Hartung [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Los Alamos National Laboratory*

[3] *SLAC National Accelerator Laboratory*

[4] *Facility for Rare Isotope Beams*

Corresponding Author: yin@frib.msu.edu

Superconducting Radio Frequency (SRF) photo-injectors offer the possibility of producing low-emittance electron beams in continuous wave operation. Among the various photo-emissive materials, bi-alkali antimonide is favored for its high quantum efficiency (QE) at visible light wavelengths. A development effort at FRIB is oriented toward the integration of advanced photocathodes into an SRF photo-injector. This paper describes improvements to the cathode preparation chamber, first cathode depositions, and characterization trials. A K2CsSb film was produced with a notably extended dark lifetime, albeit with a modest QE of approximately 5% at 530nm. Extensive spectral response analyses of the layer were conducted, along with thorough assessments of measurement procedures and hardware. This presentation offers insights into the factors contributing to the measured QE and describes plans for improving the cathode preparation chamber and the experimental procedures.

Footnotes:

Funding Agency:

Work funded by Michigan State University
yin@frib.msu.edu

Monday Poster Session / 322

Online diagnostics and dosimetry of electron beam irradiation with a minimally invasive screens and beam charge monitors

Author: Alexander Malyzhenkov[1]

Co-authors: Andrea Latina [1]; Antonio Gilardi [2]; Pierre Korysko [3]; Roberto Corsini [1]; Vilde Rieker [1]; Wilfrid Farabolini [1]

[1] *European Organization for Nuclear Research*

[2] *University of Napoli Federico II*

[3] *Oxford University*

Corresponding Author: alexander.malyzhenkov@cern.ch

In 2019, the annual number of cancer cases exceeded 100 million, resulting in 10 million deaths worldwide. Radiation therapy stands out as one of the most effective methods for cancer treatment. Electron beams in the 100-MeV range can reach even deep-seated tumors without the need for surgical intervention. Thanks to novel high-gradient acceleration technologies, clinical facilities for high-energy electron-based irradiation are actively under development. However, the online dosimetry of the delivered dose remains a challenge. In this work, we present a simple and effective solution. We demonstrate that thin YAG screen(s) permanently integrated into the layout of the beamline can be used to characterize the transverse beam distribution shot-to-shot during irradiation. When combined with a beam charge monitor(s), it allows for the prediction of the dose delivered to the target. We benchmark this method using the standard dosimetry routine based on the irradiation of radiochromic films calibrated with an ion chamber.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 323

Status of the L-band gun development at PITZ

Author: Anne Oppelt[1]

Co-authors: Andreas Hoffmann [1]; Christopher Richard [1]; Cornelius Martens [2]; Dmytro Dmytriiev [1]; Dmitry Bazyl [2]; Felix Riemer [1]; Frank Brinker [2]; Frank Stephan [1]; Frieder Mueller [1]; Grygorii Vashchenko [2]; James Good [1]; Lutz Jachmann [1]; Matthias Gross [1]; Mikhail Krasilnikov [1]; Namra Aftab [1]; Prach Boonpornprasert [1]; Sebastian Philipp [1]; Sumaira Zeeshan [1]; Winfried Koehler [1]; Xiangkun Li [1]; Xiao-Yang Zhang [3]; Zahra Lotfi [1]; Davit Kalantaryan [1]; Lucas Schaper [2]; Zohrab Amirkhanyan [1]; Anna Grebinyk [4]; Dirk Lipka [2]; Silke Vilcins [2]; Michael Bousonville [2]; Alexey Ermakov [2]; Arno Jeromin [5]

[1] *Deutsches Elektronen-Synchrotron DESY at Zeuthen*

[2] *Deutsches Elektronen-Synchrotron*

[3] *Tsinghua University in Beijing*

[4] *Technische Hochschule Wildau*

[5] *DESY Nanolab*

Corresponding Author: anne.oppelt@desy.de

Gun5, the new generation of high-gradient normal conducting 1.3 GHz RF guns for linac driven free-electron lasers like FLASH and European XFEL is under development at the Photo Injector Test facility at DESY in Zeuthen (PITZ). Its improved cell geometry and cooling concept allow for RF pulse durations of up to 1 ms at 10 Hz repetition rate, at gradients of ˜60 MV/m at the cathode. Gun5 is also equipped with an RF probe for measurements of the RF field inside the gun.
The first gun of this type, Gun5.1, is in operation at PITZ since April 2022. Gun5.2 will be commissioned at the FALCO conditioning facility at DESY in Hamburg, starting in June 2024. This gun is equipped with a balanced (symmetric) RF waveguide feed to the coaxial power coupler to prevent a coupler kick and thus improve the beam quality delivered by the electron source.
Further guns are currently in the manufacturing process. In parallel, studies towards a more reliable cathode spring design are ongoing, in order to overcome observed issues during the high duty cycle operation of Gun5.1. This article will give an overview on all those developments.

Footnotes:

Funding Agency:

Monday Poster Session / 324

Variable polarization self-locked streaking of electrons in time with a pair of corrugated structures

Author: Alexander Malyzhenkov[1]

Co-authors: Andrea Latina [1]; Antonio Gilardi [2]; Avni Aksoy [1]; Pierre Korysko [3]; Roberto Corsini [1]; Wilfrid Farabolini [1]

[1] *European Organization for Nuclear Research*

[2] *University of Napoli Federico II*

[3] *Oxford University*

Corresponding Author: alexander.malyzhenkov@cern.ch

Corrugated structures have recently been utilized for the time-resolved diagnostics of electron bunches and free-electron-laser (FEL) pulses across several FEL facilities: SwissFEL at PSI and European XFEL at DESY. This approach is simple and cost-effective, based on the self-streaking of electrons with a transverse wakefield enhanced in such structures.

In this work, we optimize the design of a corrugated streaker for the wide range of beam parameters of the CERN Linear Electron Accelerator for Research (CLEAR) at CERN. We report on the fabrication of corrugated plates with various corrugation parameters and their initial installation for in-air measurement at CLEAR.
Variable polarization streaking can be achieved either by mechanically rotating the plates or by utilizing two pairs of corrugated streakers. Additionally, we emphasize that when streaking in the vertical (or horizontal) direction with one structure, the undesired quadrupole wakefield can be compensated by the second orthogonally oriented streaker. This allows for a significant improvement in the resolution of the method.

Footnotes:

Funding Agency:

Thursday Poster Session / **325**

Operational improvements and upgrades of the CLEAR user facility

Author: Pierre Korysko[1]

Co-authors: Alexander Malyzhenkov [2]; Antonio Gilardi [3]; Avni Aksoy [2]; C. Robertson [4]; Eduardo Granados [2]; I. Najmudin [4]; Laurence Wroe [2]; Miguel Martinez-Calderon [2]; Roberto Corsini [2]; Vilde Rieker [2]; Wilfrid Farabolini [2]

[1] *Oxford University*

[2] *European Organization for Nuclear Research*

[3] *University of Napoli Federico II*

[4] *University of Oxford*

Corresponding Author: pierre.korysko@physics.ox.ac.uk

The CERN Linear Accelerator for Research (CLEAR) at CERN is a user facility providing a 200 MeV electron beam for accelerator R&D and irradiation studies, including medical applications. In this paper we will outline the most recent improvements in CLEAR operation and beam control and delivery, and describe the upgrades under way, giving an update of their current status. These upgrades include a new front-end for the laser system which will enable an highly flexible time structure, better stability and higher repetition rates, and the implementation of a second beam line which will provide additional testing capability and whose optics has been designed to match user requirements. Finally, we will discuss the proposed future experimental programme of the facility, particularly in view of the novel capabilities provided by the upgrades.

Footnotes:

Funding Agency:

Thursday Poster Session / **326**

Medical activities in CLEAR: studies towards radiotherapy using Very High Energy Electrons (VHEE) in the FLASH regime

Author: Roberto Corsini[1]

Co-authors: Alexander Malyzhenkov [1]; Antonio Gilardi [2]; Avni Aksoy [1]; Cameron Robertson [3]; Joseph Bateman [3]; Manjit Dosanjh [1]; Pierre Korysko [4]; Vilde Rieker [1]; Wilfrid Farabolini [1]

[1] *European Organization for Nuclear Research*

[2] *University of Napoli Federico II*

[3] *John Adams Institute*

[4] *Oxford University*

Corresponding Author: roberto.corsini@cern.ch

Given the present availability of high-gradient accelerator technology for compact and cost-effective electron linacs in the 100-200 MeV energy range, the interest for Very High Energy Electron (VHEE) radiotherapy (RT) for cancer treatment recently reached an all-time high. Particular significance is assumed by the Ultra-High Dose Rate (UHDR) regime where the so-called FLASH biological effect takes place, in which cancer cells are damaged while healthy tissue is largely spared. VHEE beams from linacs are especially well adapted for FLASH RT, given their penetration depth and the high beam current needed to treat large deep-seated tumours. In recent years, several multidisciplinary user groups carried out a number of studies on VHEE and FLASH RT issues using the CERN Linear Accelerator for Research (CLEAR) user facility, in close collaboration with the local operation team. In this paper we give an overview of such activities and describe the main results of chemical and biological tests aimed at clarifying the damage mechanisms at the root of the FLASH effect and the relevant beam parameters needed to achieve it. We also describe the dedicated systems and methods developed and used in CLEAR for these activities, focusing on recent advances in the crucial aspects of uniform beam delivery and high dose rate real-time dosimetry.

Footnotes:

Funding Agency:

Tuesday Poster Session / **327**

Feasibility study for dual higher-order-modes for plasma processing of FRIB superconducting coaxial resonators

Author: Patrick Tutt[1]

Co-authors: Kyle Elliott [1]; Paolo Berrutti [2]; Sang-Hoon Kim [1]; Ting Xu [3]; Walter Hartung [1]; Wei Chang [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Brookhaven National Laboratory (BNL)*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: tutt@frib.msu.edu

In-situ plasma processing is a promising technique to reduce field emission in superconducting radio-frequency cavities and thus maintain maximum accelerator performance for long-term operation. Continuous-wave accelerators such as FRIB are more challenging than pulsed accelerators due to relatively weak coupling (Qext = 2E6 to 1E7 for FRIB) via the fundamental power coupler (FPC). This results in an unfavorable mismatch at room temperature and makes fundamental-mode plasma processing difficult. Hence we have investigated the use of higher-order-modes (HOMs) with less FPC mismatch. Several HOMs are promising for lower-mismatch plasma generation. However, HOMs often present a less favorable plasma distribution. To improve the plasma distribution, we are studying techniques to drive the plasma with two HOMs simultaneously. Plasma development results will be presented for FRIB beta = 0.085 quarter wave resonators, including ignition threshold measurements and plasma distribution assessments.

Footnotes:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

Funding Agency:

Project supported by Department of Energy (DOE) Office of Science User Facility under Award number DE-SC0023633.

Thursday Poster Session / **328**

Impact of coherent synchrotron radiation effect on generalized longitudinal strong focusing insertion unit

Author: Jihong Bian[1]

Co-authors: Chuanxiang Tang [1]; Wenhui Huang [1]; Xiujie Deng [1]; Zizheng Li [1]

[1] *Tsinghua University in Beijing*

Corresponding Author: bianjh21@mails.tsinghua.edu.cn

The generalized longitudinal strong focusing (GLSF) scheme is a potential approach for a steady-state mi-crobunching (SSMB) storage ring, leveraging the ultra-low vertical emittance in the storage ring. It achieves active vertical-longitudinal coupling through an inser-tion unit, further compressing bunch length from the hundreds of nanometers scale in the main ring to the nanometers scale, thus emitting radiation. Due to the extremely short bunch length, coherent synchrotron radi-ation (CSR) effect may significantly impact beam dynam-ics. We developed a particle tracking program based on one-dimensional CSR model to preliminarily evaluate the influence of CSR effect in the GLSF scheme under current design parameters. Our work contributes to the future optimization of the GLSF scheme.

Footnotes:

Funding Agency:

Monday Poster Session / **329**

Conceptual design of a 325 MHz Inductive Output Tube (IOT)

Author: Sultan Shaik[1]

Co-authors: Lalit kumar [1]; Prasant Pattnaik [1]; Manjiri Pande [2]; Sandip Shrotriya [2]; Aviraj jadav [3]; Kapil gavali [1]; Harish Dixit [1]

[1] *Birla Institute of Technology and Science,*

[2] *Bhabha Atomic Research Centre*

[3] *Precision Power Products (i) Private Limited*

Corresponding Author: ahmadali403@gmail.com

Abstract: Inductive Output Tube (IOT) is a vacuum electronic device used for generation of radio frequency power.. IOT based RF amplifiers are used in accelerator systems, industrial heating systems among other applications. It is compact in size and provides linear operation over its entire operating range with efficiency varying from60 to 70 percent. This paper proposes the conceptual design of an IOT operating at 325 MHz with an RF power of 100 kW at an efficiency of approximately 70%. The design of all the sub components of the IOT viz. the gridded electron gun, the input and output cavities, magnetic circuit, collector are discussed in this paper. The input cavity is a TM01

mode coaxial cavity while the output cavity is a TM01 mode re-entrant cavity. The magnetic circuit is designed to provide a brillouin focusing to the electron beam. Tthe simulation of the integrated model of IOT and studies of effect of the output gap and the R/Q of the output cavity on the efficiency and output power level are discussed and will be presented.

Keywords: Accelerators, Amplifiers, Brillouin focusing, gridded electron gun, the input cavity, IOT, output cavity, R/Q

Footnotes:

Funding Agency:

BRNS, MUMBAI and BITS PILANI Hyderabad campus

Monday Poster Session / **330**

Update on ESS-Bilbao RFQ linac

Author: Juan Munoz[1]

Co-authors: Aitor Zugazaga [1]; Alexander Conde [1]; Arash Kaftoosian [1]; David Fernandez-Cañoto [1]; Ibon Bustinduy [1]; Javier Martin [2]; Nagore Garmendia [1]; Pedro Gonzalez [1]

[1] *ESS Bilbao Consortium*

[2] *ESS Bilbao*

Corresponding Author: jlmunoz@essbilbao.org

The ESS-Bilbao RFQ fabrication is completed. The RFQ will operate at 352.2 MHz and will accelerate a 45 mA proton beam from 45 keV up to 3.0 MeV. The RFQ is build up of 4 copper segments, for a total length of 3.2 m. Each segment is composed of 4 subparts, 2 major and 2 minor vanes, that are assembled together by using bolts, vacuum and RF gaskets, with no brazing used in the procedure. This approach enables possible corrections in the assembly. The machining of all the segments has now finished. The RFQ structure has been assembled and the several tests have been carried out on it. In this paper we present aspects of the mechanical fabrication of the RFQ, the results of the vacuum tests of the whole structure, with all the tuners and couplers inserted. The low power RF measurements, frequency spectrum, quality factor and tuning operations by bead pull technique. Fabrication and testing of the components (tuners, couplers, pickups) are also presented. The operation of the RFQ is initially planed for low duty cycle, simplifying water cooling engineering and couplers design. The tests at low duty cycle will enable to define the required facilities for the use of the RFQ at its nominal power for future steps.

Footnotes:

Funding Agency:

Tuesday Poster Session / **331**

Modeling beam dynamics in the HELIAC Advanced Demonstrator

Author: Simon Lauber[1]

Co-authors: Christoph Burandt [1]; Florian Dziuba [1]; Hartmut Vormann [2]; Julian List [1]; Maksym Miski-Oglu [2]; Robin Kalleicher [1]; Stepan Yaramyshev [2]; Thorsten Kuerzeder [2]; Uwe Scheeler [2]; Winfried Barth [2]

[1] *Helmholtz Institut Mainz*

[2] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

Corresponding Author: s.lauber@gsi.de

A crucial milestone towards the final expansion stage of the HELIAC (Helmholtz linear accelerator at HIM & GSI) is the commissioning of the first fully equipped cryomodule, the so-called Advanced Demonstrator. The cryomodule comprises three accelerating superconducting crossbar H-mode cavities, a buncher and two superconducting solenoids. For modelling the beam dynamics of the Advanced Demonstrator test setup, the actual 3D electromagnetic field distributions of the cavities and solenoids are used. The digital model was paired with beam-based measurements of the longitudinal and transverse beam density distribution to calculate the realistic beam propagation along the 20 m setup. The beam dynamics insights gained during the cryomodule commissioning are presented.

Footnotes:

Funding Agency:

Tuesday Poster Session / 332

Preliminary results of electromagnetic simulation for optimizing an SRF gun cavity to maximize the beam brightness

Author: Gowrishankar Hallilingaiah[1]

[1] *Helmholtz-Zentrum Dresden-Rossendorf*

Corresponding Author: g.hallilingaiah@hzdr.de

A high beam brightness is a crucial requirement for an electron linear accelerator, with the electron source setting the lower limit for the achievable brightness. A superconducting radio-frequency photoelectron injector (SRF gun) stands out as an advanced electron source capable of delivering beams with superior properties compared to other continuous-wave injectors. Currently, SRF guns are being reliably operated at various accelerators. However, the gun cavities are operated below its design gradient due to the field emission. This lower gradient reduces particle energy gain per cell and adversely affects beam quality by deviating from theoretical optima.
To overcome these limitations, a new cavity design is being explored, with the peak surface electric field restricted to 30 MV/m, corresponding to the fields that have typically been achieved so far. This contribution will begin by examining the similarities between accelerator and injector cavity designs, followed by an examination of the specific requirements unique to the injector cavity. Subsequently, the design methodology being followed will be described. A mesh convergence study is then presented in a later section. Various alternative cavity shapes to the TESLA design have been proposed, and the figure of merits (FOM) achieved using these full-cell shapes in conjunction with the existing HZDR injector first cell will be presented. The future plans are outlined in the final section.

Footnotes:

Funding Agency:

Thursday Poster Session / 333

Drift Tube Linac (DTL) steering magnets replacement design at SNS

Author: Haitao Ren[1]

Co-authors: George Toby [1]; John Moss [1]; Sang-Ho Kim [1]; Sung-Woo Lee [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: renh@ornl.gov

The SNS Drift Tube Linac (DTL) operates at 402.5 MHz and consists of 6 RF tanks, DTL1 to DTL6, which can accelerate the H- beam from 2.5 MeV to 87 MeV before entering the Coupled Cavity Linac (CCL). Each DTL tank assembly has 2 sets of horizontal and vertical electromagnetic steering magnets (24 in total) required for transverse beam steering. The coils of these steering magnets were routed to specific shapes with water-cooled copper tubing to fit the limited space inside the drift tube bodies. After operating over 20 years, some steering coils start having water leaks. Spare drift tubes including the steering ones are under development at SNS. To simplify the steering coil routing and avoid water leaking issues, a non-water-cooled steering magnet design has been developed for the replacement of existing magnets. With the existing yoke, the new coils are designed to produce the same magnetic field with a low electric power. According to the CST simulations, the maximum temperature of the coils is below 50 C with no water cooling. A prototype development is in progress and will be used for thermal test and magnetic field verification. Details of the steering magnet design and calculation results are presented in this paper.

Footnotes:

Funding Agency:

ORNL is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy. This research was supported by the DOE Office of Science, Basic Energy Science, Scientific User

Thursday Poster Session / 335

Studies on high repetition rate operation of SACLA with X-band normal conducting accelerator

Author: Takahiro Inagaki[1]

Co-authors: Kenji Yasutome [1]; Hirokazu Maesaka [1]; Eito Iwai [2]; Takashi Ohshima [2]; Chikara Kondo [2]; Takato Tomai [2]; Toru Hara [1]; Hitoshi Tanaka [1]

[1] *RIKEN SPring-8 Center*

[2] *Japan Synchrotron Radiation Research Institute*

Corresponding Author: inagaki@spring8.or.jp

The X-ray free-electron laser facility SACLA generates X-ray SASE up to 20 keV in a compact 700 m long machine using a low-emittance thermal cathode electron gun, a high-field C-band normal-conducting 8 GeV linac and short-period in-vacuum undulators. The next upgrade plan for SACLA is to increase the repetition rate of the accelerator, which is currently 60 Hz, by one order of magnitude to 1 kHz maintaining the performance of the current SASE and electricity usage. Challenge is how to achieve high repetition operation without increasing the electric power consumption, which allows to reuse the same accelerator building, electrical plant, and cooling water system. To improve the power efficiency, we choose X-band as the radio frequency of the main accelerator instead of current C-band. A basic design and optimization of the accelerator are undergoing. As a testbed, we plan to introduce an X-band transverse deflector cavity to measure the temporal distribution of the electron beam downstream of the undulator. The development of equipment such as RF sources, pulse compressors, dummy loads, low-level RF control, which are common to the systems for high repetition, has also begun. We will report the design and the status of developments.

Footnotes:

Funding Agency:

Thursday Poster Session / **337**

Completion of the Proton Power Upgrade project at the Spallation Neutron Source

Author: Mark Champion[1]

Co-authors: Glen Johns [1]; Gregory Stephens [1]; John Galambos [1]; John Moss [1]; Karen White [1]; Mark Connell [1]; Matthew Howell [1]; Nicholas Evans [1]; Sang-Ho Kim [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: championms@ornl.gov

The Proton Power Upgrade (PPU) project at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) has completed the installation and testing of all project scope required to meet threshold key performance parameters (KPPs), supported beam commissioning in June 2024, and transitioned to operations in July 2024. Increasing the beam energy from 1.0 to 1.3 GeV required the installation of seven additional cryomodules in the SNS Linac along with supporting RF systems. The accumulator ring injection and extraction regions were upgraded, a 2 MW mercury target was developed, and ancillary target systems were upgraded to support high-flow gas injection, mercury off-gas treatment, and ortho-para fraction control in the cryogenic moderator hydrogen loop. Three of four threshold KPPs have been demonstrated, and the project is planning for its final review in early 2025. Beam power on the first target station (FTS) will be ramped up to 2 MW over the next two years. Completion of the PPU project supports increased scientific capability at the FTS and will support operation of the second target station (STS) upon its completion. Lessons learned will be documented and a project closeout report will be written prior to the final closeout of the project.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under contract number DE-AC05-00OR22725.

Monday Poster Session / **338**

Accelerating structures for the FCC-ee pre-injector complex: RF design, optimization, and performance analysis

Author: Adnan Kurtulus[1]

Co-authors: Alexej Grudiev [1]; Andrea Latina [1]; Jean-Yves Raguin [2]; Paolo Craievich [2]; Simona Bettoni [2]

[1] *European Organization for Nuclear Research*

[2] *Paul Scherrer Institut*

Corresponding Author: adnan.kurtulus@cern.ch

The Future Circular Collider electron-positron (FCC-ee) pre-injector complex demands high-performance RF accelerating structures to achieve reliable and efficient acceleration of beams up to 20 GeV. In this study, we describe an analytical approach to RF design for the traveling-wave (TW) structures including a pulse compression system to meet the rigorous specifications of the FCC-ee pre-injector

complex. The fundamental mode at 2.8 GHz and Higher Order Mode (HOM) characteristics were determined through the utilization of lookup tables and analytical formulas, enabling efficient exploration of extensive parameter ranges. Optimization of the structure geometry and in particular the iris parameters was performed to address key challenges including maximizing effective shunt impedance, minimizing surface fields, and effectively damping long-range wakes through HOM detuning. Moreover, we investigated the impact of beam-loading effects on the bunch-to-bunch energy spread. Comprehensive thermal and mechanical analyses were carried out to evaluate the impact on the accelerating structure performance during operation at a repetition frequency of 100 Hz.

Footnotes:

Funding Agency:

Monday Poster Session / **339**

ALBA injector reliability improvement with an 80 MeV Linac beam

Author: Raquel Muñoz Horta[1]

Co-authors: Davide Lanaia [1]; Francis Perez [1]

[1] *ALBA-CELLS Synchrotron*

Corresponding Author: rmunoz@cells.es

The ALBA injector consists of a 110 MeV Linac, a Linac-to-Booster Transfer Line and a full energy Booster that further accelerates the electrons up to 3 GeV. The Linac consists of two pre-bunchers, a buncher and two accelerating structures and it is powered by two pulsed 37 MW klystrons at 3 GHz. To overcome an eventual klystron failure the injector has been adapted to keep operative at lower Linac beam energy. In 2014 the injection into the Booster was optimized for a Linac beam of 67 MeV, the energy achieved using only one klystron. However, the procedure of switching the injector from a Linac beam of 110 MeV to a 67 MeV one is not straightforward and it requires to be periodically updated. After a recent waveguide modification the RF power sent to the first accelerating structure is equally distributed between both accelerating structures. As a result, a Linac beam of 80 MeV is achieved using only one klystron. At this energy the injection into the the Booster is more efficient. Then, setting the nominal Linac beam energy at 80 MeV the injector operation is ensured by the hot-spare klystron in case of klystron failure.

Footnotes:

Funding Agency:

Tuesday Poster Session / **340**

Status of the INFN LASA in-kind contribution to PIP-II project

Author: Rocco Paparella[1]

Co-authors: Carlo Pagani [2]; Angelo Bosotti [1]; Michele Bertucci [1]; Elisa Del Core [1]; Fabrizio Fiorina [1]; Daniele Sertore [1]; Laura Monaco [1]; HyeKyoung Park [3]; Genfa Wu [3]; Joseph Ozelis [3]; Paolo Spruzzola [1]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *Università degli Studi di Milano & INFN*

[3] *Fermi National Accelerator Laboratory*

Corresponding Author: rocco.paparella@mi.infn.it

The status of INFN LASA in-kind contribution to the PIP-II project at Fermilab is reported in this paper. The effort for the series production of the 38 INFN LASA designed, 5-cell cavities with beta 0.61 for the LB650 section of the linac commenced and the status of ongoing activities and major procurements is here conveyed. At the same time, preliminary tests on INFN LB650 cavity prototypes are progressing in order to optimize the complete preparation and qualification cycle.
All cavities will be produced, and surface treated in industry to reach the unprecedented performances required, qualified through vertical cold test at state-of-the art infrastructures and delivered as installation ready at the string assembly site.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 341

On forced RF generation of CW magnetrons for superconducting accelerators

Author: Gregory Kazakevich[1]

Co-authors: Gennady Romanov [2]; Rolland Johnson [3]; Timergali Khabiboulline [2]; Vyacheslav Yakovlev [2]; Yaroslav Derbenev [4]

[1] *Muons, Inc*

[2] *Fermi National Accelerator Laboratory*

[3] *MuPlus, Inc.*

[4] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: gkazakevitch@yahoo.com

CW magnetrons, initially developed for industrial RF heaters, were suggested to power RF cavities of superconducting accelerators due to their higher efficiency and lower cost than traditionally used klystrons, IOTs or solid-state amplifiers. RF amplifiers driven by a master oscillator serve as coherent RF sources. CW magnetrons are regenerative RF generators with a huge regenerative gain. This causes regenerative instability with a large noise when a magnetron operates with the anode voltage above the threshold of self-excitation. Traditionally for stabilization of magnetrons is used injection locking by a quite small signal. Then the magnetron except the injection locked oscillations may generate noise. This may preclude use of standard CW magnetrons in some SRF accelerators. Recently we developed briefly described below a mode for forced RF generation of CW magnetrons when the magnetron startup is provided by the injected forcing signal and the regenerative noise is suppressed. The mode is most suitable for powering high Q-factor SRF cavities.

Footnotes:

Funding Agency:

Tuesday Poster Session / 342

On the life expectance of high-power CW magnetrons for SRF accelerators

Author: Gregory Kazakevich[1]

Co-authors: Rolland Johnson [2]; Timergali Khabiboulline [3]; Vyacheslav Yakovlev [3]; Yury Eidelman [4]

[1] *Muons, Inc*

[2] *MuPlus, Inc.*

[3] *Fermi National Accelerator Laboratory*

[4] *Eidelman's Scientific Consulting*

Corresponding Author: gkazakevitch@yahoo.com

Modern CW or pulsed Superconducting RF (SRF) accelerators require efficient RF sources controllable in phase and power with a reduced cost. Therefore, utilization of the high-power CW magnetrons as RF sources in SRF accelerator projects was proposed in a number of works. But typically, the CW magnetrons are designed as RF sources for industrial heating, and the lifetime of the tubes is not the first priority as it is required for high-energy accelerators. The high-power industrial CW magnetrons use the cathodes made of pure tungsten. The emission properties of the tungsten cathodes are not deteriorated much by electron and ion bombardments, but the latter causes sputtering of the cathode in the magnetron crossed fields. The sputtered cathode material covers the magnetron interior. That lead to sparks and discharges limiting magnetrons lifetime. We considered an analysis of magnetron failure modes vs. output power, developed a model of ionization of the residual gas in the magnetrons interaction space and simulated the spattering of the cathode in 100 kW CW magnetrons to estimate the life expectancy. Basing on results we proposed ways to increase the CW magnetrons longevity for SRF accelerators.

Footnotes:

Funding Agency:

Thursday Poster Session / 343

Efficient 6-dimensional phase space reconstructions from experimental measurements using generative machine learning

Author: Ryan Roussel[1]

Co-authors: Auralee Edelen [1]; Juan Pablo Gonzalez-Aguilera [2]; Young-Kee Kim [2]; Eric Wisniewski [3]; Alexander Ody [4]; Wanming Liu [4]; John Power [4]

[1] *SLAC National Accelerator Laboratory*

[2] *University of Chicago*

[3] *Illinois Institute of Technology*

[4] *Argonne National Laboratory*

Corresponding Author: rroussel@slac.stanford.edu

Next-generation accelerator concepts, which hinge on the precise shaping of beam distributions, demand equally precise diagnostic methods capable of reconstructing beam distributions within 6-dimensional position-momentum spaces. However, the characterization of intricate features within 6-dimensional beam distributions using current diagnostic techniques necessitates a substantial number of measurements, using many hours of valuable beam time. Novel phase space reconstruction techniques are needed to reduce the number of measurements required to reconstruct detailed, high-dimensional beam features in order to resolve complex beam phenomena, and as feedback in precision beam shaping applications. In this study, we present a novel approach to reconstructing detailed 6-dimensional phase space distributions from experimental measurements using generative machine learning and differentiable beam dynamics simulations. We demonstrate that this approach can be used to resolve 6-dimensional phase space distributions from scratch, using basic beam manipulations and as few as 20 2-dimensional measurements of the beam profile. We also demonstrate an

application of the reconstruction method in an experimental setting at the Argonne Wakefield Accelerator, where it is able to reconstruct the beam distribution and accurately predict previously unseen measurements 75x faster than previous methods.

Footnotes:

Funding Agency:

This work is supported by the U.S. Department of Energy, Office of Science under Contract No. DE-AC02-76SF00515 and the Center for Bright Beams, NSF award PHY-1549132.

Monday Poster Session / 344

Linac module phase scan in HPSim

Author: Martin Kay[1]

Co-authors: Anthony Braido [1]; En-Chuan Huang [1]; Jonathan Quemuel [1]; Lawrence Rybarcyk [1]; Petr Anisimov [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: mkay@lanl.gov

The side-coupled cavity linac (CCL) at the Los Alamos Neutron Science Center (LANSCE) is tuned by matching a single-particle model to the RF phase signature of the modules. In the future, the High-Performance Simulator (HPSim), a GPU-powered, 6-D particle tracking code, will be used to reveal additional information that will assist with tuning. In this proceeding, the status of the HPSim-based Phase Scan Signature Matching (PSSM) routine is presented, along with the outlook for its future implementation.

Footnotes:

Funding Agency:

Los Alamos National Laboratory's Laboratory Directed Research and Development (LDRD) program

Tuesday Poster Session / 345

Surface finishing of additive manufacturing parts for particle accelerators

Author: Hendrik Hähnel[1]

Co-authors: Andris Ratkus [2]; Benjamin Dedic [1]; Cristian Pira [3]; Eduard Chyhyrynets [4]; Matteo Pozzi [5]; Maurizio Vedani [6]; Maurizio Vretenar [7]; Natalie Kunkel [8]; Roberta Caforio [3]; Tobia Romano [2]; Toms Torims [7]

[1] *Goethe Universität Frankfurt*

[2] *Riga Technical University*

[3] *Istituto Nazionale di Fisica Nucleare*

[4] *Università degli Studi di Padova*

[5] *Rosler Italian*

[6] *Politecnico di Milano*

[7] *European Organization for Nuclear Research*

[8] *Technische Hochschule Mittelhessen*

Corresponding Author: haehnel@iap.uni-frankfurt.de

Significant progress towards the suitability of Additive Manufacturing (AM) metal parts for the production of linear accelerator components has been made in recent years. One significant factor for the suitability of AM parts to produce linac rf structures is the surface quality of the parts. Due to the inherently higher surface roughness of AM metal parts, post-processing is necessary to reach surfaces suitable for rf operation. We present most recent results of surface post-processing trials with AM parts from stainless steel.

Footnotes:

Funding Agency:

EU Horizon 2020 Research and Innovation programme: agreement No 101004730.
Development of PEP technology: PNRR MUR project PE0000023-NQSTI.
German BMBF grant number 05P21RFRB2.

Thursday Poster Session / 346

Microscopic understanding of the effects of impurities in low RRR SRF cavities

Author: Katrina Howard[1]

Co-authors: Daniel Bafia [2]; Zu-Hawn Sung [2]; Wieslawa Dziedzic-Misiewicz [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: khoward99@uchicago.edu

The SRF community has shown that introducing certain impurities into high-purity niobium can improve quality factors and accelerating gradients. We question why some impurities improve RF performance while others hinder it. The purpose of this study is to characterize the impurities of niobium coupons with a low residual resistance ratio (RRR) and correlate these impurities with the RF performance of low RRR cavities so that the mechanism of impurity-based improvements can be better understood and improved upon. The combination of RF testing, temperature mapping, frequency vs temperature analysis, and materials studies reveals a microscopic picture of why low RRR cavities experience low BCS resistance behavior more prominently than their high RRR counterparts. We evaluate how differences in the mean free path, grain structure, and impurity profile affect RF performance. The results of this study have the potential to unlock a new understanding on SRF materials and enable the next generation of high Q/high gradient surface treatments.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Thursday Poster Session / 348

Beam position monitors (BPMs), using their charge information at SLAC

Author: Franz-Josef Decker[1]

Co-authors: Bryce Jacobson [1]; Sonya Hoobler [1]; Tyler Kabana [1]; William Colocho [1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: decker@slac.stanford.edu

BPMs have been used for decades since their easy-to-use absolute transverse position capability. Left signal minus right signal divided by the sum times the radius gives the beam position. The charge is "just"a relative measurement and has to be calibrated (or ironed) against a toroid signal. Even when the incoming charge variation is high (like 3% rms for the superconducting LCLS2), the relative variations are only 0.1%. This opens up quite some uses. Besides even small charge losses at beam restrictions like collimators or septum magnets it has been found that this signal is very useful in quantifying the charge loss during a wire scan since losses of around 2% are observed. By taking the difference of a few BPMs before and after the wire scanners signal-to-noise levels of up to 5000 are observed, making this method compatible to the typical scintillator plus photomultiplier setup. This is especially helpful where the first beam loss is hundreds of meters downstream since most of the scattered electron make it down the relatively wide bore of the superconducting cavities. An SVD method to analyze the data independent by human judgement is discussed.

Footnotes:

Funding Agency:

Main Session FRX / 349

High power tests of an additive manufacturing IH-type cavity

Author: Hendrik Hähnel[1]

Co-authors: Adem Ates [1]; Benjamin Dedic [1]; Christopher Wagner [1]; Jan Kaiser [1]; Ulrich Ratzinger [1]

[1] *Goethe Universität Frankfurt*

Corresponding Author: haehnel@iap.uni-frankfurt.de

Additive manufacturing (AM) has become a powerful tool for rapid prototyping and manufacturing of complex geometries. A 433 MHz IH-DTL cavity has been constructed to act as a proof of concept for direct additive manufacturing of linac components. In this case, the internal drift tube structure has been produced from 1.4404 stainless steel, as well as pure copper using AM. We present the most recent results from high power tests with the AM IH-type structure.

Footnotes:

Funding Agency:

This research was funded by the German Federal Ministry of Education and Research (BMBF), grant number 05P21RFRB2.

Tuesday Poster Session / 351

RF and multipacting analysis of the high-power couplers of IFMIF/EVEDA RFQ and ESS DTL

Author: Francesco Grespan[1]

Co-authors: Andrea De Franco [2]; Andrea Pisent [1]; Antonio Palmieri [1]; Carlo Baltador [1]; Carlo Roncolato [1]; Domenic Nicosia [3]; Enrico Fagotti [1]; Fabio Cismondi [4]; Francesco Scantamburlo [4]; Hitoshi Kobayashi [5]; Laurence Page [3]; Lingyun Gong [3]; Luca Bellan [1]; Luigi Ferrari [1]; Matteo Campostrini [1]; Michele Comunian [1]; Rihua Zeng [3]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *National Institutes for Quantum Science and Technology*

[3] *European Spallation Source ERIC*

[4] *IFMIF/EVEDA Project Team*

[5] *High Energy Accelerator Research Organization*

Corresponding Author: francesco.grespan@lnl.infn.it

The performances and failure cases of the power couplers of the IFMIF/EVEDA RFQ and ESS DTLs have been analyzed with dedicated high-power test campaigns and multipacting simulation methods. The paper presents test and simulation methodology, results, and inputs for the next activities.

Footnotes:

Funding Agency:

Tuesday Poster Session / **352**

ESS DTL: final installation and first commissioning results up to 74 MeV

Author: Francesco Grespan[1]

Co-authors: Andrea Pisent [1]; Antonio Palmieri [1]; Bryan Jones [2]; Carlo Baltador [1]; Carlo Mingioni [1]; Ciprian Plostinar [2]; Edoardo Nicoletti [1]; Laurence Page [2]; Luca Bellan [1]; Marco Nenni [1]; Maurizio Montis [1]; Michele Comunian [1]; Natalia Milas [2]; Paolo Mereu [1]; Rihua Zeng [2]; Ryoichi Miyamoto [2]; Tina Bencivenga [1]; Yngve Levinsen [2]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *European Spallation Source ERIC*

Corresponding Author: francesco.grespan@lnl.infn.it

The Drift Tube Linac (DTL) for the European Spallation Source (ESS ERIC) will accelerate proton beam up to 62.5mA peak current from 3.62 to 90 MeV. The 5 cavities are now fully installed and tested in the linac tunnel. Moreover, in 2023 DTL1 to DTL4 have been RF conditioned to full power and beam commissioned with max peak current at short pulses. Relevant results of these activities are presented in this paper.

Footnotes:

Funding Agency:

Thursday Poster Session / **353**

Status of the test bench for the PIP-II LB650 cryomodules at CEA

Author: Hassen Jenhani[1]

Co-authors: Christian Arcambal [2]; Claire Simon [2]; Guillaume Devanz [2]; Luc Maurice [2]; Nicolas Bazin [2]; Olivier Piquet [2]; Patrick Sahuquet [2]; Philippe Bredy [3]; Quentin Bertrand [1]

[1] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

[2] *Commissariat à l'Energie Atomique*

[3] *Commission à l'Energie Atomique*

Corresponding Author: hassen.jenhani@cea.fr

The Proton Improvement Plan II (PIP-II) project at Fermilab is the first U.S. accelerator project that will have significant in-kind contributions (IKC) from international partners. As a part of the French IKC to this project, CEA will provide ten 650 MHz low-beta cryomodules (LB650) equipped with cavities from INFN-LASA (Italy), Fermilab (USA), and DAE-VECC (India), and power couplers and RF tuning systems from Fermilab. CEA is in charge of the design, manufacturing, assembly, and testing of these cryomodules. This paper presents the progress of the future implementation of the test stand dedicated to the cryogenic and RF power testing of the LB650 cryomodules.

Footnotes:

Funding Agency:

Tuesday Poster Session / 354

Simulations of field emitters and multipacting in PIP-II Single Spoke Resonator Type-2

Author: Jacob Brown[1]

Co-authors: Alexander Sukhanov [2]; Donato Passarelli [2]; Gennady Romanov [2]; Ting Xu [3]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Fermi National Accelerator Laboratory*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: brownjac@frib.msu.edu

It has been found in benchmark tests that some Single Spoke Resonator Type-2 (SSR2) cavities have early field emission onset as well as strong multipacting barriers. A longstanding hypothesis is that field-emitted electrons in the high electric field accelerating gap can migrate and ignite multipacting bands in the low electric field regions of the cavity periphery. In this study, we use simulation techniques to examine multipacting behavior in SSR2 cavities from electrons seeded in common field emitter locations. Additionally, we investigated seed locations for areas in SSR2 cavities which may have poor coverage during high pressure water rinsing and compared the multipacting behavior.

Footnotes:

This material is based upon work supported by the U.S Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

Funding Agency:

U.S Department of Energy, DOE Office of Science User Facility, under Award Number DE-SC0023633

Monday Poster Session / 357

Collimations systems studies at LANSCE

Author: Clara-Marie Alvinerie[1]

Co-authors: En-Chuan Huang [1]; Salvador Sosa Guitron [1]; Charles Taylor [1]; Janardan Upadhyay [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: calvinerie@lanl.gov

At the Los Alamos Neutron Science Center (LANSCE), an upgrade of the Proton Storage Ring (PSR) is potentially possible under the LANSCE Modernization Project (LAMP). For the PSR, reducing or at least controlling the beam losses could maximize the beam current delivered to the users and extend the run cycle via shortening the maintenance period. One of the approaches would be to install collimation systems that are not present at LANSCE. We will present preliminary results to evaluate various possibilities of collimation systems along the high energy beam transport and/or inside the ring.

Footnotes:

Funding Agency:

Tuesday Poster Session / 358

RF pulse conditioning to reduce field emission in FRIB SRF cryomodules

Author: Yoo Lim Cheon[1]

Co-authors: Sang-Hoon Kim [1]; Walter Hartung [1]; Wei Chang [1]; Ting Xu [2]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Facility for Rare Isotope Beams*

Corresponding Author: cheon@frib.msu.edu

Field emission (FE) is a major contributor to degradation in the high-field performance of Superconducting Radio Frequency (SRF) cavities. The driver linac for the Facility for Rare Isotope Beams (FRIB) has been operating for user experiments since May 2022, using 104 quarter-wave resonators and 220 half-wave resonators in 46 cryomodules. We have used pulsed RF conditioning to mitigate the FE X-rays and maintain the cavities'performance. During conditioning, we observe "electrical breakdown," a rapid (<1us) collapse of the field. We have found that the FE X-rays may be greatly reduced after a single to several electrical breakdown events, which are accompanied by a local discharge in the vacuum and burning out of the emitter on the cavity surface. On the other hand, when a slow (˜ms) thermal breakdown (known as quench) is seen, it limits the field and hampers further FE conditioning. We have also investigated the field enhancement factor and the effective area of FE emitter, inferred by Fowler-Nordheim fitting of FE X-ray dose rate vs accelerating gradient. In this paper, we will present RF pulse conditioning results and analysis thereof for about 50 cavities in FRIB cryomodules.

Footnotes:

Funding Agency:

This material is supported by U.S. Department of Energy (DOE), Office of Science, Office of Nuclear Physics, and DOE Office of Science User Facility under Award Number DE-SC0023633.

Tuesday Oral Posters / 359

Cryomodule operation experience for the FRIB continuous-wave superconducting linac

Author: Wei Chang[1]

Co-authors: Danlu Zhang [1]; Hai Nguyen [1]; Kenji Saito [2]; Sang-Hoon Kim [1]; Shen Zhao [2]; Shriraj Kunjir [1]; Taro Konomi [1]; Ting Xu [2]; Walter Hartung [1]; Xiaoji Du [1]; Yoo Lim Cheon [1]; Yoonhyuck Choi [2]; Yuting Wu [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Facility for Rare Isotope Beams*

Corresponding Author: chang@frib.msu.edu

The superconducting (SC) driver linac for the Facility for Rare Isotope Beams (FRIB) includes 46 cryomodules for acceleration of heavy ions to 200 MeV per nucleon. FRIB cryomodules have been supporting sustainable and reliable delivery of high-power heavy ion beams, including 10 kW uranium beam, to the target for production of rare isotope beams to nuclear physics user experiments. The linac operates in continuous-wave mode for maximum utilization of beam from the ion source. A total of 104 quarter-wave resonators (QWRs; β=0.041 and 0.085; 80.5 MHz) equipped with stepper-motor frequency tuners and frictional mechanical dampers are operated at 4 K. A total of 220 half-wave resonators (HWRs; β=0.29 and 0.53; 322 MHz) equipped with pneumatic frequency tuners are operated at 2 K. We will present resonance control and phase stability performance as well as experience with tuner systems in linac operation. FRIB cavities are designed to be operated at a peak surface electric field of approximately 30 MV/m. We will present cavity field emission performance over the years of linac operation and discuss field emission reduction measures such as pulsed RF conditioning (presently in use) and plasma processing (in development). Automation of SC devices is a key aspect of efficient delivery of beams to users. We will present our experience with automation of SC devices such as start-up, shut-down, and fast recovery from an RF trip as well as performance tracking of linac SC devices.

Footnotes:

Funding Agency:

Supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, award number DE-SC0023633.

Thursday Poster Session / 360

CW copper injector for SRF industrial cryomodules

Author: Roman Kostin[1]

Co-authors: Christopher Edwards [2]; Chunguang Jing [3]; Ivan Gonin [2]; Jayakar Thangaraj [2]; Nikolay Solyak [2]; Timergali Khabiboulline [2]; Vyacheslav Yakovlev [2]

[1] *Euclid TechLabs, LLC*

[2] *Fermi National Accelerator Laboratory*

[3] *Euclid Beamlabs LLC*

Corresponding Author: r.kostin@euclidtechlabs.com

Compact SRF industrial linacs can provide unique parameters of the beam (>1 MW and >1-10 MeV) hardly achievable by normal conducting linacs within limited space. SRF technology was prohibitively expensive until the development of conduction cooling which opened the way for compact stand alone SRF systems suitable for industrial and research applications. Limited cooling capacity puts strict requirements on the beam parameters with zero losses of the beam on the SRF cavity walls. This implies strict requirements on the beam energy to be accepted by the cryomodule and most importantly the beam bunching with zero particles in between.
We designed a CW normal conducting RF injector which consists of a gridded RF gun integrated with a first cell of a copper booster cavity to satisfy these requirements. Here we present a complete design of a booster cavity including beam dynamics, RF, thermomechanical and engineering design.

Footnotes:

Funding Agency:

Monday Poster Session / **361**

DTL studies for the LANSCE future front-end upgrade at LANL

Author: Dmitry Gorelov[1]

Co-authors: Dimitre Dimitrov [1]; Enrique Henestroza [1]; Leanne Duffy [1]; Salvador Sosa Guitron [1]; Sergey Kurennoy [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: gorelov@lanl.gov

LANSCE accelerator complex was successfully supporting nuclear science research at LANL for more then 50 years. However, the need of the upgrade of the linear accelerator becomes immanent due to development of the modern accelerator technology, and due to inevitable aging of the existing equipment. The first stage of the planned upgrade of the linear accelerator at LANSCE includes the replacement of the outdated proton and H- Cockroft-Walton sources with the modern RFQ accelerator, and development of the new DTL. The proposed DTL is designed to accelerate protons and H- ions simultaneously, just as the existing accelerator, from 3 MeV –the output energy of the RFQ, to 100 MeV, that will allow us to keep existing Coupled Cavities Linac (CCL) intact. Presently existing megawatt-class RF power amplifiers will be used in the proposed new DTL. The details of the proposed design of the DTL will be given in the present paper. The details will include the main linear accelerator parameters, like synchrotron and betatron oscillations frequencies, as well as the developed techniques for the design studies.

Footnotes:

Funding Agency:

This work benefited from the use of the LANSCE accelerator facility. Work was performed under the auspices of the US Department of Energy by Triad National Security under contract 89233218CNA000001.

Thursday Poster Session / **362**

Development of high-power 4K Nb3Sn superconducting RF electron linac for medical radioisotope production

Author: Shigeru Kashiwagi[1]

Co-authors: Akihiro Kikuchi [2]; Anjali Kavar [3]; Fujio Hinode [3]; H. Abiko [1]; Hayato Ito [4]; Hiroki Yamada [3]; Hiroshi Sakai [4]; Hiroyuki Hama [3]; Ikurou Nagasawa [3]; K. Kudo [1]; Ken Takahashi [3]; Ken-ichi Nanbu [3]; Kensei Umemori [4]; Kotaro Shibata [3]; Minoru TACHIKI [2]; Safwan Shanab [4]; Shunichi ARISAWA [2]; Shuuichi Ooi [2]; Tomohiro Yamada [4]; Toshiya Muto [3]

[1] *Research Center for Accelerator and Radioisotope Science*

[2] *National Institute for Materials Science*

[3] *Tohoku University*

[4] *High Energy Accelerator Research Organization*

Corresponding Author: kashiwagi@raris.tohoku.ac.jp

Various types of radioisotopes (RIs) are used in the field of nuclear medicine for diagnosis, such as PET and SPECT. In recent years, RIs are applied to therapy of cancer and the Ac-225 has been confirmed to be effective in the treatment of advanced cancer. One of the promising RI production methods for medical application is the use of high-intensity beam in accelerators. In the case of an electron accelerator, a photonuclear reaction is used in the RI production process. We have started research and development of a 4K niobium-tin (Nb3Sn) superconducting RF (SRF) electron accelerator system for RI production, which can be operated with a compact conduction cooling system and does not require a large-scale cooling system. As a first step, we plan to develop a single-cell Nb3Sn superconducting cavity and a cryomodule, and to demonstrate its performance by beam acceleration experiments. In this presentation, we report the basic design of the SRF electron linac and R&D project of the 35 MeV SRF linac for the medical RI production.

Footnotes:

Funding Agency:

Monday Poster Session / 363

Studies of single and multi-bunch instabilities in linacs using RF-Track

Author: Andrea Latina[1]

[1] *European Organization for Nuclear Research*

Corresponding Author: andrea.latina@cern.ch

In high-intensity linacs, bunch-to-bunch effects due to the excitation of short and long-range wakefields can lead to beam instabilities and beam breakup. Wakefields can be due to resistive or geometric effects excited in the RF structures or in the beam pipe. From version 2.3.0 onwards, the particle tracking code RF-Track has been modified to implement a multi-bunch beam model that simplifies and optimises the calculation of single and multi-bunch effects. The effect of wakefields on the beam is assessed by computing the action amplification due to incoming jitter. The jitter amplification due to multi-bunch effects is evaluated on the Super-KEK linac and found to be in agreement with experimental measurements.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 364

Evaluation of wakefield mitigation for upgrading the ATF final focus beamline

Author: Yuki Abe[1]

Co-authors: Kiyoshi Kubo [1]; Nobuhiro Terunuma [1]; Toshiyuki Okugi [1]

[1] *High Energy Accelerator Research Organization*

Corresponding Author: abeyuki@post.kek.jp

The KEK-ATF (Accelerator Test Facility) is an R&D facility for the final focus system to develop the nanometer beam technology required for the International Linear Collider. ATF is the best research environment for the study of wakefield effects on the nanometer small beam. The vertical beam size growth as a function of the bunch intensity was observed at the virtual interaction point (IP), which is mainly caused by wakefield. The evaluation results of wakefield effects show that wakefield sources installed in the high beta function section of the ATF final focus (FF) beamline, such as cavity BPM and vacuum flange, have strong effects on the small beam. We will upgrade the ATF-FF beamline to mitigate wakefield effects on the small beam. To confirm mitigation effects, internal shield parts were inserted into the vacuum flange, which is one of the strong wakefield source. The mitigation effect is evaluated based on the orbit response and IP vertical beam size. This report shows the evaluation results of the mitigation of the wakefild effects and the progress and current status of the work to upgrade the beamlines to reduce the effects of the wakefield.

Footnotes:

Funding Agency:

Monday Poster Session / 365

Design and test of double spoke superconducting cavity tuner for CSNS-II

Author: Zheng Mi[1]

Co-authors: Wenzhong Zhou [2]; Rui Ge [2]; Feisi He [2]; Jiyuan Zhai [2]; Miaofu Xu [2]; Weimin Pan [1]; Cong Zhang [2]; M. Liu [2]

[1] *Chinese Academy of Sciences*

[2] *Institute of High Energy Physics*

Corresponding Author: mizh@ihep.ac.cn

A new type tuner is designed for the double spoke superconducting cavity of the Spallation neutron Source Phase II project in China. The tuner is mounted on the side of the cavity, and each module contains two tuner systems. In this paper, the structure and working principle of the tuner are designed and analyzed, also the testing results of the tuner with the superconducting cavity system as a whole is introduced.

Footnotes:

Funding Agency:

Spallation neutron Source Phase II project（CSNS-II）;Chinese Academy of Sciences Youth Innovation Promotion Association;The Key Laboratory of Particle Accelerator Physics and Technology, Chinese Academ

Tuesday Poster Session / 366

Simulation and measurement studies of longitudinal acceptance based on the CAFe superconducting linac

Author: tingyue li[1]

Co-authors: Shuhui Liu [1]; Zhijun Wang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Authors: wangzj@impcas.ac.cn, litingyue@impcas.ac.cn

The accurate measurement of longitudinal beam parameters is paramount for controlling beam losses in high-power superconducting linac accelerators, particularly for low-energy beams which are significantly affected by the compensative challenges of nonlinear effects and pronounced space charge effects. In this context, systematic simulation and experimental studies of longitudinal acceptance have been performed based on the CAFe linac, employing techniques of phase and energy scanning. This paper provides a detailed description of the principles of the longitudinal acceptance measurement and presents an analysis of preliminary experimental results obtained from the CAFe linac. It was observed that the experimental longitudinal acceptance of the accelerator was reduced compared to the simulation predictions. Key factors such as transverse orbit deviations and RF phase errors are examined, and a thorough analysis of these discrepancies is discussed in the paper.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 367

First beam commissioning and beam quality optimization of the CiADS Front end

Author: Duanyang Jia[1]

Co-authors: Zhijun Wang [1]; Weilong Chen [1]; Yuan He [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: jiaduanyang@impcas.ac.cn

The China Initiative Accelerator Driven System (CiADS), a multi-purpose facility driven by a 500 MeV superconducting RF linac, is currently under construction in Huizhou, Guangdong. In order to ensure the stable operation of the superconducting linac, we conducted optimization research on the beam quality in the front-end section of CiADS. By using the point scraping method, part of the beam halo particles are removed in advance at the entrance of the LEBT, avoiding the generation of beam halo particles. On the other hand, since the beam extracted from the ECRIS contains a portion of H^{2+} and H^{3+}particles, impurity particles may lead to a decrease in the transmission efficiency of downstream accelerators. By separating the mixed beam, it is possible to measure the proportion and phase space distribution of the mixed beam at the exit of the ion source, thereby achieving accurate measurement of the proton beam. This paper mainly outlines the first beam commissioning of CiADS Front end. Additionally, the effectiveness of the point scraping method has been verified through transverse emittance measurement, and the proportion and phase space distribution of the mixed beam was measured. Furthermore, the stability of the ion source was tested, and the centroid shift of the ion source extracted beam was measured.

Footnotes:

Funding Agency:

Tuesday Poster Session / **368**

Reinforcement learning-based beam tuning for CiADS room temperature front-end prototype

Author: Chunguang Su[1]

Co-authors: Xiaolong Chen [1]; Zhijun Wang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: suchunguang@impcas.ac.cn

Achieving high-quality proton beams for accelerators hinges on effective beam tuning. However, the conventional "Monkey Jump" method, widely used for tuning, proves labor-intensive and inefficient. Through harnessing Reinforcement Learning (RL), a novel beam tuning strategy can swiftly emerge, making informed decisions based on the prevailing system status and control demands, offering a promising alternative for accelerator systems.
We explore novel techniques RL-based beam tuning and applying it to the beam tuning process of the CiADS Front End accelerator currently, with the aim of significantly enhancing the efficiency of the tuning process. To achieve this, we will first establish an RL-compatible environment based on dynamic simulation software. Subsequently, the policy is trained under different initial conditions. Finally, the strategy successfully trained in the simulation environment will be tested on real accelerator to verify its effectiveness.

Footnotes:

Funding Agency:

Thursday Poster Session / **369**

High-response PLC-based machine protection system development and performance for SRILAC

Author: Akito Uchiyama[1]

Co-authors: Misaki Komiyama [2]; Masaki Fujimaki [2]; Takahiro Nishi [3]; Keiko Kumagai [1]; Hiromoto Yamauchi [4]; Kenta Kaneko [4]

[1] *RIKEN Nishina Center*

[2] *The Institute of Physical and Chemical Research*

[3] *Nishina Center for for Accelerator-Based Science*

[4] *SHI Accelerator Service Ltd.*

Corresponding Author: a-uchi@riken.jp

The RIKEN Linear Accelerator (RILAC), one of the injectors at RIBF was upgraded by installing a superconducting RILAC (SRILAC) to search for superheavy elements with element number 119 and above. Before the SRILAC upgrade, the machine protection system in the RILAC was constructed using simple relay circuits. On the other hand, most of the accelerators at RIBF other than RILAC have been equipped with machine protection systems using Mitsubishi MELSEC-Q Programmable

Logic Controllers (PLCs) since 2006. They have a mechanism that triggers an anomaly signal to drive the beam chopper to stop the beam and are called beam interlock systems (BIS). Machine protection was needed in the SRILAC project to prevent vacuum deterioration of the superconducting cavity due to changes in the beam orbit. We have developed an FA-M3 PLC-based system to realize a BIS with high response performance at a lower cost than conventional systems. This system is characterized by implementing relatively slow response and I/O requiring high response performance. For example, in the case triggered by an anomaly signal of the electromagnet power supply, simulation of the beam orbit shows that the response performance is relatively slow, a few milliseconds being sufficient. In this conference, the performance results of the constructed BIS will be reported based on the types of anomaly signals in actual SRILAC operation.

Footnotes:

Funding Agency:

Thursday Poster Session / **370**

Measurement of CSR-affected beams using generative phase space reconstruction

Author: Juan Pablo Gonzalez-Aguilera[1]

Co-authors: Ryan Roussel [2]; Auralee Edelen [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *SLAC National Accelerator Laboratory*

Corresponding Author: jpga@uchicago.edu

Linear accelerators with dispersive elements experience projected emittance growth due to coherent synchrotron radiation (CSR) effects which become relevant for highly compressed beams. Even though this is a widely known effect, conventional measurement techniques are not precise enough to resolve the multi-dimensional effects in detail, namely the different rotations of transverse phase space slices throughout the longitudinal coordinate of the bunch. In this work, we apply our generative-model-based six-dimensional phase space reconstruction method in the detailed measurement of CSR effects at the Argonne Wakefield Accelerator Facility in simulations. Additionally, we study the current resolution limitations of the phase space reconstruction method and perform an analysis of its accuracy and precision in simulated cases.

Footnotes:

Funding Agency:

This work was supported by the U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams.

Monday Poster Session / **371**

Transverse Beam dynamics simulations benchmarked with ESS Bilbao injector measurements for ISOLDE ISRS project

Author: David Fernandez-Cañoto[1]

Co-authors: Ibon Bustinduy [1]; Juan Munoz [1]; Konrad Altenmüller [1]; Rosalba Miracoli [1]; Seadat Varnasseri [1]; Sergio Masa [1]

[1] *ESS Bilbao Consortium*

Corresponding Author: dfernandez@essbilbao.org

A multi-harmonic buncher cavity, MHB, is being designed by ESS Bilbao for HIE-ISOLDE ISRS project at CERN, to bunch beam pulses with 5 keV/u input energy. The MHB will be tested with ESS Bilbao light-ion injector. Transverse beam dynamics simulations were carried out to analyse preliminary measurements from hydrogen beams produced at 5 and 10 kV. Results have demonstrated that ESS Bilbao injector can produce H+ and H2+ beams with 5 keV/u, for an optimum characterization of MHB cavity.

Footnotes:

Funding Agency:

Project funded by Spain Government under grant agreement Experiment ISRS-ISOLDE (BOE-A-2023-16885), the Recovery, Transformation, and Resilience Plan, and the European Union program NextGenerationEU

Tuesday Poster Session / **372**

Design of 200 mA superconducting linear electron accelerator

Author: Yimeng Chu[1]

Co-author: Zhijun Wang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Authors: chuyimeng21@mails.ucas.ac.cn, wangzj@impcas.ac.cn

Electron accelerators utilized for radiation processing demand high beam currents and power outputs to maximize processing rate. Compared to conventional room-temperature accelerators, superconducting linear accelerators offer the capability to accelerate high-intensity continuous-wave (CW) electron beams. Therefore, the Design of a compact, 200mA, 2-5MeV CW superconducting linear accelerator holds promising potential for broad industrial applications. The Institute of Modern Physics (IMP) has recently completed operational testing on a conduction-cooled 5-cell-βopt=0.82 Nb3Sn superconducting cavity, thereby demonstrating the technical feasibility of miniaturizing superconducting accelerators. However, beam losses within the superconducting cavity, caused by factors such as mismatch between the inlet beam velocity and the cavity's optimal beta value, are impermissible. This paper addresses these challenges by methodically optimizing the beam line, ensuring 100% transmission within the superconducting cavity while maintaining compactness. The detailed beam dynamic design and the multi-particle simulation results were presented in this paper.

Footnotes:

Funding Agency:

Thursday Poster Session / **373**

The 648 MHz klystron power source system of CSNS-II Linac superconducting ellipsoid cavity

Author: Zhencheng Mu[1]

Co-authors: Bo Wang [1]; Hexin Wang [1]; Hui Zhang [2]; Lin Rong [3]; Ma Wan [1]; Zhe Xie [1]

[1] *Institute of High Energy Physics*

[2] *Dongguan Neutron Science Center*

[3] *Chinese Academy of Sciences*

Corresponding Author: muzc@ihep.ac.cn

The CSNS-II superconducting Linac accelerator includes 20 sets of 324 MHz superconducting spoke cavities and 24 sets of 648 MHz superconducting Ellipsoidal cavities. The beam energy at the end of the superconducting Linac accelerator reaches 300 MeV. The 324 MHz solid-state power source supplies RF power to superconducting Spoke cavity, while the 648 MHz klystron power source supplies RF power to superconducting Ellipsoid cavity. The RF pulse width of the 648 MHz klystron is 1.2 ms, the repetitive frequency is 50 Hz, and the peak power is 800 kW. The 1.5 ms long pulse solid-state modulator provides high voltage pulse for the klystron, and each modulator is equipped with four klystrons.

Footnotes:

Funding Agency:

Monday Poster Session / **374**

C-band RF system for the SAPS test bench

Author: Hui Zhang[1]

Co-authors: Bo Wang [2]; Hexin Wang [2]; Lin Rong [3]; Ma Wan [2]; Shimin Jiang [2]; Zhe Xie [2]; Zhencheng Mu [2]

[1] *Dongguan Neutron Science Center*

[2] *Institute of High Energy Physics*

[3] *Chinese Academy of Sciences*

Corresponding Author: zhanghui@ihep.ac.cn

This work describes a C-band RF system for the SAPS (Southern Advanced Photon Source of China) test bench linear accelerator.SAPS' RF testing system comprises of a photocathode electron gun and a 2-metre-long equal gradient acceleration device.The klystron power source delivers energy to the photocathode electron gun and the travelling wave acceleration structure,respectively.Test the photocathode electron gun first,followed by the travelling wave acceleration structure.We investigated a short-pulse C-band spherical pulse compressor.The photocathode electron gun's preliminary high-power testing is now complete.

Footnotes:

Funding Agency:

Monday Poster Session / **375**

Design of a helium ion linear accelerator for injection in a particle therapy synchrotron and parallel production of radioisotopes

Author: Lazar Nikitovic[1]

Co-authors: Maurizio Vretenar [1]; Toms Torims [1]

[1] *European Organization for Nuclear Research*

Corresponding Author: lazar.nikitovic@cern.ch

Interest in helium ions for cancer therapy is growing, motivated by their superior conformability as compared to protons or carbon. Clinical trials are starting, using beams produced by large carbon synchrotrons. To exploit the potential of this new ion, a compact synchrotron is being designed to accelerate helium and protons at treatment energies, for about half the size of a carbon machine. The helium LINAC is designed to operate at higher duty cycle than required for synchrotron injection. Beam pulses can be sent to a target producing radioisotopes, in particular alpha emitters to be used for targeted alpha therapy of cancer. The 352 MHz LINAC is made of 3 sections. To increase the efficiency with respect to a standard Drift Tube LINAC (DTL), the first section from 1 to 5 MeV/u is made of a Quasi-Alvarez DTL, a structure combining high efficiency and smooth beam optics. Only this section is powered when injecting helium ions into the synchrotron. The second and third sections of DTL type have energies of 7 MeV/u, the threshold for production of 211At, the most widely used alpha emitter, and 10 MeV/u, for injection of protons and production of other radioisotopes.

Footnotes:

Funding Agency:

Tuesday Poster Session / **377**

Multipacting with space charge: stability and saturation of a non linear dynamic system

Author: Andrea Pisent[1]

Co-author: Francesco Grespan [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: pisent@lnl.infn.it

The phenomenon of multipacting happens when in an RF cavity or wave guide electrons, randomly generated on the surfaces mainly by secondary emission and accelerated by the RF field, find e periodic and stable condition able to sustain the discharge. It is particularly detrimental for long pulse operation as in high intensity hadron linacs. An original view point for the associated dynamical system is here developed, with focus on the definition of stability conditions and on the role of space charge in the saturation of the discharge intensity. Moreover in the case of a resonant cavity the electron “beam loading” effect is analyzed.

Footnotes:

Funding Agency:

Main Session TUX / **378**

SPIRAL2 operations and future plans

Author: Angie Orduz[1]

Co-authors: Adrien Plaçais [2]; Alexandre Leduc [2]; Frédéric Bouly [2]; Guillaume Normand [1]; Jean-Michel Lagniel [1]; Marco Di Giacomo [1]

[1] *Grand Accélérateur Nat. d'Ions Lourds*

[2] *Laboratoire de Physique Subatomique et de Cosmologie*

Corresponding Author: angie.orduz@ganil.fr

GANIL (Grand Accélérateur National d'Ions Lourds) started the operation of the SPIRAL2 superconducting linac in 2022. Experiments in the Neutron For Science (NFS) room, specific beam dynamics studies and different technical improvements are carried out during its operation in the second half of each year, after the run of the cyclotrons in the first half of the year. Up to now, accelerated particles are mainly D+ and 4He2+ beams with energies between 7 and 20 MeV/A. First linac tunings with 18□6+ and 40□□14+ ion beams at energies between 7 and 14.5 MeV/A were also carried out to prepare the Super Separator Spectrometer (□3) experimental area commissioning. The paper presents a summary of the beam time distribution during the second year of operation, preliminary results of specific studies on cavity failure recovery and on pressure variation in the warm linac sections induced by beam losses.

Footnotes:

Funding Agency:

Tuesday Oral Posters / 379

Anthem project, construction of a RFQ driven BNCT neutron source

Authors: Andrea Pisent[1]; Francesco Grespan[1]

Co-authors: Andrea Passarelli [1]; Anna Selva [1]; Antonio Palmieri [1]; Carlo Baltador [1]; Carlo Mingioni [1]; Edoardo Nicoletti [1]; Enrico Fagotti [1]; Juan Esposito [1]; Luca Bellan [1]; Luigi Ferrari [1]; Marco Nenni [1]; Maria Rosaria Masullo [1]; Maurizio Montis [1]; Michele Comunian [1]; Paolo Mereu [1]; Silva Bortolussi [1]; Valeria Conte [1]; Valerio Vercesi [1]; Ysabella Kassandra Ong [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: pisent@lnl.infn.it

The project Anthem, funded within the Next Generation EU initiatives, foresees the realization of an innovative accelerator based BNCT (Boron Neutron Capture Therapy) facility at Caserta, Italy. The INFN (LNL, Pavia, Napoli, Torino) has in charge the design and construction of the epithermal neutron source, that will assure a flux of 10^9 n/(s cm2) with characteristics suited for deep tumors treatment. The driver is a cw RFQ, able to produce proton beam of 30 mA 5 mA. impinging on a beryllium target. Specific challenges are related to the medical application of the device. In the paper an overview of the project will be given.

Footnotes:

Funding Agency:

Tuesday Poster Session / 380

Development of phase locked oscillator FEL for high repetition mid-infrared frequency combs

Author: Yoske Sumitomo[1]

Co-authors: Tsukino Kubota [1]; Kazuki Harada [1]; Leo Soga [1]; Takeshi Sakai [1]; Yasushi Hayakawa [1]

[1] *Nihon University*

Corresponding Author: sumitomo.yoske@nihon-u.ac.jp

The mid-Infrared region (2-5 um) is currently a frontier of laser science with short durations, where many molecular absorbing spectrums exist. The oscillator free electron lasers have advantages against solid-state laser systems, that include the fundamental generations of high-intensity mid-IR pulses with femto-seconds scale short duration, continuous variations of the central wavelength, and the high-repetitions of pulses due to RF accelerations of electron bunches. Especially, the coexistence of high-intensities and high-repetitions at GHz scales is important for the development of mid-IR frequency combs that may open up a new direction of molecule nonlinear reactions. In this presentation, we report on the importance of phase-locking between FEL pulses that grow up independently due to shot noises for the mid-IR frequency combs, and the states of development of a test phase-locking system, and introduce possible applications of the mid-IR frequency combs.

Footnotes:

Funding Agency:

Startup Funding at Research Institute of Science and Technology, Nihon University (2023)

Thursday Poster Session / 381

Status of the CEA contribution to the PIP-II linear accelerator

Author: Nicolas Bazin[1]

Co-authors: Claire Simon [1]; Guillaume Devanz [1]; Hassen Jenhani [2]; Robin Cubizolles [1]; Stéphane Berry [1]

[1] *Commissariat à l'Energie Atomique*

[2] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

Corresponding Author: nicolas.bazin@cea.fr

The Proton Improvement Plan II (PIP-II) project at Fermilab is the first U.S. accelerator project that will have significant in-kind contributions (IKC) from international partners. CEA joined the international collaboration in 2018 and will deliver 10 low-beta cryomodules as IKC to the PIP-II project, with cavities supplied by INFN-LASA (Italy) and DAE-VECC (India), and power couplers and tuning systems supplied by Fermilab. An important milestone was reached in April 2023 with the Final Design Review of the cryomodule, launching the pre-production phase. This paper presents the status of the CEA activities on the construction of the LB650 pre-production cryomodule and the upgrade of the existing assembly and test infrastructures to the PIP-II requirements.

Footnotes:

Funding Agency:

Monday Poster Session / 382

Recent results of the high gradient S-band accelerating module for FERMI energy upgrade

Author: Mauro Trovo[1]

Co-authors: Andrea Milocco [1]; Federico Gelmetti [1]; Massimo Milloch [1]; Nuaman Shafqat [1]; Reto Fortunati [2]; Riccardo Zennaro [2]

[1] *Elettra-Sincrotrone Trieste S.C.p.A.*

[2] *Paul Scherrer Institut*

Corresponding Author: mauro.trovo@elettra.eu

FERMI is the seeded free electron laser (FEL) user facility at Elettra laboratory in Trieste, operating in the VUV - soft X-ray spectral range. In order to extend the FEL radiation to shorter wavelengths, an energy increase from 1.5 GeV to 2.0 GeV is required in the linear accelerator (linac). This result is achievable by replacing the present old sections with the newly designed accelerating sections that can work at high gradient with lower transverse wakefields. A new high-gradient (HG) module was build and installed at the FERMI linac. We report here the recent experience on the conditioning and the results on the e-beam energy gain in operation.

Footnotes:

Funding Agency:

Tuesday Poster Session / 383

New 3-MeV RFQ design and fabrication for KOMAC

Author: Han-Sung Kim[1]

Co-authors: Dong-Hwan Kim [2]; Hyeok-Jung Kwon [2]; Seok Ho Moon [2]; Seunghyun Lee [2]

[1] *Korea Atomic Energy Research Institute*

[2] *Korea Multi-purpose Accelerator Complex*

Corresponding Author: kimhs@kaeri.re.kr

Since the second half of 2013, Korea Multi-purpose Accelerator Complex (KOMAC) has been supporting user beam service by using a 100-MeV proton linac. As the operation period of the proton accelerator exceeds 10 years and the cumulative operating time surpasses 33,000 hours, we judge that it is an opportune time to establish a long-term plan to prepare for the aging of the accelerator. To replace the currently operating RFQ, which shows degradation in performance (especially the reduced beam transmission), we designed a new RFQ with some modifications. We removed a resonant coupling structure, located in the middle of the old RFQ, for simple design and easy tuning. In addition, we increased the length of RFQ from 3,266 mm to 3,537 mm for better beam transmission efficiency in high current mode. Error study on the new structure showed that the design is robust to the various error sources. The details of the RFQ design along with fabrication status will be given in this presentation.

Footnotes:

Funding Agency:

This work has been supported through the KOMAC operation fund of KAERI by MSIT (Ministry of Science and ICT of Korean government, KAERI-524320-24).

Thursday Poster Session / 384

PIP-II linac cryogenic distribution system design challenges

Author: Tomasz Banaszkiewicz[1]

Co-authors: Alex Martinez [2]; Maciej Chorowski [1]; Michal Stanclik [1]; Pawel Duda [1]; Ram Dhuley [2]; William Soyars [2]

[1] *Wroclaw University of Science and Technology*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: tomasz.banaszkiewicz@pwr.edu.pl

The PIP-II linac cryogenic distribution system (CDS) is characterized by extremally small heat inflows and robust mechanical design. It consists of a distribution valve box (DVB), intermediate transfer line, tunnel transfer line comprising 25 bayonet cans, and ends with a turnaround can. Multiple helium streams, each characterized by distinct helium parameters, flow through each of these elements. The CDS geometry allows maintaining an acceptable pressure drop for each helium stream, considering the planned flows and helium parameters in different operation modes. This is particularly crucial for the return line of helium vapors, which return from the CDS to the cold compressors and thus have very restrictive pressure drop requirements. On both sides of the DVB there are fixed supports for process pipes. One of the design challenges was to route the process pipes in such a way that their shape provided sufficient compensation for thermal shrinkage. This ensures that the forces resulting from thermal shrinkage acting on the cryogenic valves remain at a level acceptable to the manufacturer. The required thermal budget of the CDS was achieved by thermo-mechanical optimization of its components, like process pipes fixed supports in bayonet cans.

Footnotes:

Funding Agency:

Tuesday Poster Session / 385

Influence of environmental parameters on calibration drift in superconducting RF cavities

Author: Yue Sun[1]

Co-authors: Andrea Bellandi [1]; Julien Branlard [1]; Bozo Richter [1]; Christian Schmidt [1]; Annika Eichler [1]; Holger Schlarb [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: yue.sun@desy.de

Precisely calibrating RF superconducting radio-frequency linear accelerators is crucial for accurately assessing cavity bandwidth and detuning, which provides valuable insights into cavity performance, facilitates optimal accelerator operation, and enables effective fault detection and diagnosis. In practice, however, calibration of RF signals can present several challenges, with calibration drift being a significant issue, especially in settings prone to humidity and temperature fluctuations. In this paper, we delve into the effect of environmental factors on the calibration drift of superconducting RF cavities. Specifically, we examine long-term calibration drifts and explore how environmental variables such as humidity, temperature, and environmental noise affect this phenomenon. The results show that environmental factors, particularly relative humidity, significantly influence calibration drifts. Moreover, we observe and analyze the lag in their influence. By analyzing these correlations, appropriate compensation algorithms can be designed to mitigate and eliminate these effects, thus optimizing calibration accuracy and stability.

Footnotes:

Funding Agency:

Thursday Poster Session / **386**

Physical design of the injector for XiPAF-upgrading

Author: Canbin Yue[1]

Co-authors: Pengfei Ma [1]; Qingzi Xing [1]; Baichuan Wang [2]; Changtong Du [1]; Shu-xin Zheng [1]; Xialing Guan [3]; Mingtong Zhao [2]; Wolong Liu [2]; Minwen Wang [1]; Wei Lv [2]; Zhongming Wang [2]; Xuewu Wang [1]

[1] *Tsinghua University in Beijing*

[2] *State Key Laboratory of Intense Pulsed Radiation Simulation and Effect*

[3] *Tsinghua University*

Corresponding Author: ycb19@mails.tsinghua.edu.cn

This paper describes the physical design of one linac injector for the proton/heavy ion synchrotron, which is under construction for Xi'an 200 MeV Proton Application Facility(XiPAF) heavy ion upgrading project. A heavy ion linac injector will be constructed close to the existing proton linac injector. The heavy ion injector consists of one electron cyclotron resonance(ECR) source, one low energy beam transport(LEBT) section, one radio frequency quadrupole(RFQ) accelerator, one interdigital H-type drift tube linac(IH-DTL), and one linac to ring beam transport(LRBT) section. Heavy ion beams will be accelerated to 2 MeV/u. The unnormalized 99%-particles emittances at the injection point of proton and heavy ion are optimized to be lower than 10 and 16 □ mm·mrad, respectively. Besides, low dispersion at the injection point is obtained to minimize the beam offset caused by the dispersion mismatch in the synchrotron. Three scrapers are installed in the LRBT to meet the requirment of emittance and dispersion.

Footnotes:

Funding Agency:

Thursday Oral Posters / **387**

Research and development of coherent terahertz sources at LEBRA linac, Nihon University

Author: Takeshi Sakai[1]

Co-authors: Ken Hayakawa [1]; Kyoko Nogami [1]; Norihiro Sei [2]; Toshinari Tanaka [1]; Yasushi Hayakawa [1]; Yoske Sumitomo [1]; Yumiko Takahashi [1]

[1] *Nihon University*

[2] *National Institute of Advanced Industrial Science and Technology*

Corresponding Author: sakai.takeshi@nihon-u.ac.jp

The Laboratory for Electron Beam Research and Application (LEBRA) at Nihon University has been developing free electron laser (FEL), parametric X-ray radiation (PXR), and terahertz (THz) wave sources in collaboration with KEK and the National Institute of Advanced Industrial Science and Technology (AIST) using a 100 MeV electron linac. Each of these light sources is used for both internal and external collaborations. We are developing THz coherent edge radiation (CER), coherent

transition radiation (CTR) and plane-wave coherent Cherenkov radiation (CCR) sources in the THz band for the FEL and PXR beamlines, respectively. In particular, we are developing THz wave sources using an artificial quartz hollow conical tube for the CCR source and a thin aluminum plate with a helical target surface for the THz-CTR optical vortex source. So far, we have performed parameter measurements, including beam profile and spectrum measurements, for the THz-CCR and the THz-CTR vortex beams. In this paper, we describe the development and characteristics of each THz wave source.

Footnotes:

Funding Agency:

This work was supported by JSPS KAKENHI Grant Numbers JP19H04406, 21K12539, 23K28360, and JKA through its promotion funds from KEIRIN RACE.

Tuesday Poster Session / **388**

Injector status in NICA project

Author: Konstantin Levterov[1]

Co-authors: Andrey Butenko [1]; Boris Golovenskiy [1]; Evgeny Syresin [1]; Vladimir Mialkovskiy [1]

[1] *Joint Institute for Nuclear Research*

Corresponding Author: levterov@jinr.ru

Nuclotron based Ion Collider fAcility (NICA) project is being realized in JINR, Dubna.The main goal of new collider facility is investigations of the heavy ions collisions with center-of-mass energy up to 11 GeV/u.Two injectors will provide the beams as for colliding and for extracted beam experiments.One of them is Heavy Ions Linear Accelerator (HILAC) intended to inject heavy ions produced with the ESIS ion source into accumulating synchrotron Booster following by Nuclotron. Another one is Light Ions Linear accelerator has to inject light polarized ions produced by source of polarized ions SPI directly to Nuclotron. Status of both injectors and accelerating runs are presented.

Footnotes:

Funding Agency:

Tuesday Poster Session / **389**

Smith-Purcell radiation studies towards a compact high-resolution longitudinal diagnostic

Author: Blae Stacey[1]

Co-authors: Thomas Vinatier [1]; Willi Kuropka [1]; Wolfgang Hillert [2]

[1] *Deutsches Elektronen-Synchrotron*

[2] *University of Hamburg*

Corresponding Author: blae.stacey@desy.de

A new longitudinal diagnostic has been proposed, the SPACEChip (Smith-Purcell ACcElerator Chip-based) diagnostic, which can infer information about the temporal profile of a particle bunch from

the Smith-Purcell radiation spectrum generated when the bunch passes close to a dielectric grating. This is done using the bunch form factor after retrieving the phase. A simulated dielectric grating has been excited by Floquet modes to investigate the angular distribution of the Smith-Purcell radiation. Progress on the SPACEChip experimental campaign at the ARES linac at DESY will be reported, along with the expected photon yield from the structure with the ARES operational parameters.

Footnotes:

Funding Agency:

Thursday Poster Session / **391**

Smartcell X-band normal conducting accelerator structure prototype fabrication

Author: Pedro Morales Sanchez[1]

Co-authors: Alexandre Gerardin [1]; Alice Moros [1]; Ana Teresa Perez Fontenla [1]; Anastasiya Magazinik [2]; E. Rodriquez Castro [1]; Nuria Catalan-Lasheras [1]; Sergio Gonzalez Anton [1]

[1] *European Organization for Nuclear Research*

[2] *CEGELEC SA (Actemium Geneve)*

Corresponding Author: pedro.morales.sanchez@cern.ch

This presentation details the design and fabrication process of a prototype of a normal-conducting X-band accelerator structure, which we denominate Smartcell. These structures, achieved through brazing/bonding techniques, are crucial components for future linear colliders.
We will cover the brazing/bonding geometry, materials selection and their implications, variations in heat cycles, and atmospheres employed during brazing/bonding. Additionally, the impact of copper quality and annealing procedures implemented before, during, and after machining will be discussed specifically within the context of normal-conducting structures. This includes exploring how variations in copper quality and the timing and/or temperature of annealing treatments can influence the machinability, microstructure, and ultimately the performance of the final component.
The presentation will showcase the behavior of five mock-ups, including the results and conclusions obtained through optical examination, metrology, and SEM analysis. We will also discuss silicon carbide RF properties and characterization throughout the fabrication process.

Footnotes:

Funding Agency:

Thursday Poster Session / **392**

Inverse inference of initial beam profile and key parameters based on automatic differentiation method

Authors: Zheng Sun[1]; Tianmu Xin[1]

Co-authors: Xiaoping Li [2]; Ouzheng Xiao [1]; Cai Meng [2]; Zhongtian Liu [1]; Zhi Song [3]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

[3] *Tsinghua University in Beijing*

Corresponding Author: sunzheng@ihep.ac.cn

For experiments requiring the longitudinal shaping of the beam at the exit of an electron linear accelerators, it is crucial to infer the initial beam profile at the entrance of the linear accelerator and key parameters. After passing through the dispersion section of beam bunch compressor, and the high-frequency system, the electron beam will undergo modulation on the longitudinal density. Based on the longitudinal dynamic process, this paper proposes to use automatic differentiation to provide the design of beam initial conditions and key parameters corresponding to a specific longitudinal profile of the beam at the exit of the linear accelerator. Finally, we implemented this method on a section of linear accelerator consisting of two L-band accelerating cavities, one S-band accelerating cavity, and a bunch compressor.

Footnotes:

Funding Agency:

Monday Poster Session / **393**

Planned future upgrades of Linear IFMIF Prototype Accelerator (LIPAc)

Author: Fabio Cismondi[1]

Co-authors: Antti Jokinen [2]; Daniel Duglue [2]; Dominique Gex [2]; Francesco Scantamburlo [1]; Hervé Dzitko [2]; Iván Moya [2]; Kai Masuda [1]; Kazuo Hasegawa [3]; Keitaro Kondo [3]; Kohki Kumagai [3]; Kouki Hirosawa [3]; Masayoshi Sugimoto [4]; Pau Gonzalez-Caminal [5]; Tomoya Akagi [3]; Yann Carin [2]

[1] *IFMIF/EVEDA Project Team*

[2] *Fusion For Energy*

[3] *National Institutes for Quantum Science and Technology*

[4] *Nippon Advanced Technology Co., Ltd.*

[5] *Deutsches Elektronen-Synchrotron*

Corresponding Author: fabio.cismondi@f4e.europa.eu

Under the Broader Approach (BA) agreement the Accelerator Facility validation activities aim at demonstrating the acceleration of 125 mA D+ beam up to 9 MeV. This is the main goal of the Linear IFMIF Prototype Accelerator (LIPAc) under installation, commissioning and operation in Rokkasho. LIPAc is currently operating in its Phase B+ configuration, which consists of all the beamline except the SRF Linac (high duty cycle operation results up to 5 MeV are reported by T. Akagi in this conference). Installation and commissioning activities of the SRF Linac will then follow to complete Phase C and D operations.
In parallel, a number of upgrades for several systems are being designed and procured taking into account the lessons learned so far during commissioning and operation and will be the main object of this paper. These systems are: a new injector encompassing a new design of beam production and extraction system and of the LEBT; a new RF system based on SSPA technology for the RF-RFQ, whose full scale prototype is being manufactured and validated in 2024; a new set of RF-RFQ power couplers with improved design to overcome the limitations suffered by the couplers currently installed in LIPAc; a new set of SRF-RF power couplers and HWR; a new MPS based on centralized design and COTS.

Footnotes:

Funding Agency:

Tuesday Poster Session / 394

INFN LASA in-kind contribution to ESS ERIC project

Author: Daniele Sertore[1]

Co-authors: Angelo Bosotti [1]; Carlo Pagani [2]; Elisa Del Core [1]; Fabrizio Fiorina [1]; Laura Monaco [1]; Michele Bertucci [1]; Paolo Spruzzola [1]; Rocco Paparella [1]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *Università degli Studi di Milano & INFN*

Corresponding Author: daniele.sertore@mi.infn.it

INFN Milano - LASA recently concluded its in-kind contribution to European Spallation Source Eric, providing the 36 Superconducting Medium Beta cavities that will allow boosting the proton beam energy from 216 Mev to 571 Mev. The performances of the last four cavities, treated with Electro-Polishing as main removal step, are presented and compared with the results obtained on the remaining cavities treated with Buffered Chemical Polishing. The overall performance of the 36 cavities and lessons learned during the cavities production stages are also discussed.

Footnotes:

Funding Agency:

Tuesday Poster Session / 395

Phase setting issues for the SPIRAL2 LINAC

Author: Marco Di Giacomo[1]

Co-authors: Angie Orduz [1]; Christophe Jamet [1]; Jean-François Leyge [1]; Pierre Salou [1]

[1] *Grand Accélérateur Nat. d'Ions Lourds*

Corresponding Author: digiacomo@ganil.fr

The SPIRAL2 superconducting LINAC accelerates beams of different species, in a large energy range. During operation, the beam requested by the physics can change quite often and it is mandatory that beams that have been already tuned can be obtained again by simple application of the machine parameters already used. This reduces the accelerator retuning time and increases the machine availability for the physics experiences.
Voltages and more particularly phases of all the cavities are among the crucial parameters for a quick retuning. Proper beam tuning is monitored via the Beam Position Monitors.
This paper focuses on the phase issues, reminds the way the reference frequency distribution, the LLRF and the BPM works and are used in the tuning procedures, and summarizes the upgrade foreseen to improve the cavity phase setting reliability

Footnotes:

Funding Agency:

Thursday Poster Session / 396

Extremely stable operation of self-seeding FEL at PAL

Author: Chang-Ki Min[1]

Co-authors: Heung-Sik Kang [1]; Hoon Heo [1]; Inhyuk Nam [1]; Jinyul Hu [1]

[1] *Pohang Accelerator Laboratory*

Corresponding Author: minck@postech.ac.kr

The operation of hard X-ray FEL in a self-seeded mode requires much more precise control of electron phase space distribution compared to a SASE mode. In PAL-XFEL, we developed a unique RF feedback control based on high precision e-beam characterization (combined with ˜1 fs RF timing distribution) to maintain the optimized self-seeded FEL without drift during the user run.

Footnotes:

Funding Agency:

Tuesday Poster Session / **397**

R&D on SRF at INFN LASA

Author: Laura Monaco[1]

Co-authors: Angelo Bosotti [1]; Carlo Pagani [2]; Daniele Sertore [1]; Elisa Del Core [1]; Fabrizio Fiorina [1]; Michele Bertucci [1]; Paolo Spruzzola [1]; Rocco Paparella [1]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *Università degli Studi di Milano & INFN*

Corresponding Author: laura.monaco@mi.infn.it

Sustainability and cost reduction are key factors for the development of future large particle accelerators. This motivated INFN LASA to initiate an INFN-funded R&D program dedicated to improve the performance of SRF Nb cavities in terms of quality factor (High-Q) and accelerating gradient (High-G). The R&D program will start by exploiting state-of-the-art surface treatments on 1.3 GHz single-cell prototypes, in view of a possible industrialization process for large-scale productions.
Integrating part of this program is the upgrade of our vertical test facility to enable qualification of such high-performance cavities. Ongoing activities include the construction of a new dedicated cryostat, which minimizes Liquid Helium consumption, reduces the impact of trapped magnetic flux and provides a wide range of diagnostics for quench, field emission, and magnetic flux expulsion studies.

Footnotes:

Funding Agency:

Monday Poster Session / **398**

Design of BPMs for a 750 MHz hadrontherapy Linac

Author: Ángel Rodríguez Páramo[1]

Co-authors: Concepcion Oliver [1]; Gabriela Moreno [1]; José Miguel Carmona [2]; Pedro Calvo [1]; Daniel Gavela [1]; Jose Perez Morales [1]; Jone Etxebarria [1]; M. Leon [1]; A. Tato [2]

[1] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[2] *Added Value Solutions*

Corresponding Author: angel.rodriguez@ciemat.es

This works presents the design of Beam Position Monitors for a 750 MHz linac for hadrontherapy studies.
BPMs will be installed in different sections of the Linac, operating at different energies, from the RFQ exit at 5 MeV/u to the end of the line after IH cavities at 10 MeV/u. The BPMs will allow measurement of the beam position, phase and time of flight (tof) studies. Therefore, being fundamental for commissioning and operation of the protype hadrontherapy linac.
In the analysis we compare the expected signal from stripline and button BPMs using analytical and CST models. studying the BPMs size and response at different energies, and BPMs sensitivity for position, phase and tof measurements.

Footnotes:

Funding Agency:

Monday Poster Session / **399**

Emittance measurements with wire scanners in the Fermilab side-coupled linac

Author: Erin Chen[1]

Co-authors: Alexander Shemyakin [1]; John Stanton [1]; Ralitsa Sharankova [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: erinchen@fnal.gov

The Fermilab Side-Coupled Linac accelerates H- beam from 116 MeV to 400 MeV through seven 805 MHz modules. Twelve wire scanners are present in the Side Coupled Linac and four are present in the transfer line between the Linac and the Booster synchrotron ring. These wire scanners act as important diagnostic instruments to directly collect information on the beam's transverse distribution. The manipulation of the conditions of wire scanner data collection enables further characterization of the beam-line, such as calculating emittance and the Twiss parameters of the beam at select regions, which we present here.

Footnotes:

Funding Agency:

Tuesday Poster Session / **400**

Energy upgrade options of KOMAC 100 MeV linac

Author: Hyeok-Jung Kwon[1]

Co-authors: Dong-Hwan Kim [1]; Han-Sung Kim [2]; Sang-Pil Yun [1]; Seok Ho Moon [1]; Seunghyun Lee [1]; Young-Gi Song [1]

[1] *Korea Multi-purpose Accelerator Complex*

[2] *Korea Atomic Energy Research Institute*

Corresponding Author: hjkwon@kaeri.re.kr

An energy upgrade of the existing 100 MeV proton linear accelerator is considered at Korea Multi-purpose Accelerator Complex (KOMAC). 1 GeV proton linac for spallation neutron source is planned through 200 MeV linac upgrade as a near term project. Two options are considered for 200 MeV linac structure, one is a superconducting linac based on the half-wave resonator (HWR) and the other is a normal conducting linac based on separate drift tube linac (SDTL). In this paper, two options are presented and compared.

Footnotes:

Funding Agency:

This work was supported through the KOMAC operation fund of KAERI by Korean Government (MSIT, KAERI ID: 524320-24)

Monday Poster Session / 401

RF-Track simulations of Linac4

Author: Andrea Latina[1]

Co-authors: Alessandra Lombardi [1]; Giulia Bellodi [1]; Jean-Baptiste Lallement [1]

[1] *European Organization for Nuclear Research*

Corresponding Author: andrea.latina@cern.ch

A series of detailed Linac4 end-to-end simulations were conducted using RF-Track and benchmarked against PATH for validation. The simulations were performed from the RFQ entrance to the Linac4 end. In RF-Track, all the accelerating structures are described with calculated 3d field maps while the calculation time remains within minutes for half a million particles. Despite the inherent differences between the two codes, excellent agreement was found, almost particle by particle, in the case without space-charge effects. When space-charge effects were considered, the different algorithms implemented gave results that could not be compared particle-by-particle but were compatible in terms of emittance growth, beam size, bunch length, and energy spread. Particular care was put into handling space-charge effects in the transition between continuous and bunched beams, and the RF-Track's space-charge model was extended accordingly. As a result, we now have two complementary codes that accurately describe the dynamics of LINAC4. The results of this study are presented in this paper.

Footnotes:

Funding Agency:

Monday Poster Session / 403

High pressure rinse simulations for PIP-II SRF cavities

Author: Mattia Parise[1]

Co-authors: Donato Passarelli [1]; Tommaso Aiazzi [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: mparise@fnal.gov

The implementation of High Pressure Rinse (HPR) not only ensures thorough cleaning of the inner high purity niobium surface of Superconducting Radio Frequency (SRF) cavities but also unlocks their full potential for achieving peak performance. By effectively removing contaminants and impurities, HPR sets the stage for enhanced superconducting properties, improved energy efficiency, and superior operational stability. A simulation tool has been developed, facilitating the accurate prediction of both the quality and effectiveness of the rinsing process before its execution in the cleanroom. This tool, the focus of this paper, stands as a pivotal advancement in optimizing Superconducting Radio Frequency (SRF) cavity preparation. Furthermore, our paper will also present correlations with cavity cold testing results, demonstrating the practical applicability and reliability of the simulation predictions in real-world scenarios.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics

Thursday Poster Session / 405

Design and simulation of Virtual Pepper-Pot method for low energy proton beam

Author: Emre Cosgun[1]

Co-authors: Seok Ho Moon [2]; Dong-Hwan Kim [2]; Moses Chung [3]; Min Sup Hur [1]

[1] *Ulsan National Institute of Science and Technology*

[2] *Korea Multi-purpose Accelerator Complex*

[3] *Pohang University of Science and Technology*

Corresponding Author: e-cosgun@hotmail.com

The Virtual Pepper Pot (VPP) is a 4D transverse phase space measurement technique based on pepper-pot-like patterns that are generated by crossing each measured horizontal slit-based beamlet with all measured vertical slit-based beamlets. The VPP beam phase space distribution reconstruction and simulation are performed using the Beam Delivery Simulation (BDSIM) code, which is a Geant4 toolkit. The configuration includes a VPP 3D model slit, a scintillator screen, and a user-defined 1 MeV energy and 10 mA current proton beam distribution, characteristic of the KOMAC RFQ beam test stand. Besides VPP, pepper pot mask simulation is carried out, and the intensity and emittance differences are observed. The input beam distribution is generated from a TraceWin output file for comparison of results. The comparison between the VPP analysis results and the TraceWin input shows satisfactory results, ensuring accurate estimation of the emittance.

Footnotes:

Funding Agency:

Tuesday Poster Session / 406

Maximum entropy phase space tomography under nonlinear beam transport

Author: Liwen Liu[1]

Co-authors: Zhijun Wang [1]; Chun Yan Jonathan Wong [1]; Yu Du [1]; Chunguang Su [1]; Man Yi [1]; Lingyun Gong [2]; tingyue li [1]; Tielong Wang [3]; Yimeng Chu [1]; Haoyu Zhou [3]; Binghui Ma [1]; Tao Zhang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *European Spallation Source ERIC*

[3] *Institute of Modern physics, Chinese Academy of Science*

Corresponding Author: liuliwen@impcas.ac.cn

Obtaining the complete distribution of a beam in high-dimensional phase space is crucial for predicting and controlling beam evolution. Previous studies on tomographic phase space reconstruction often required linear beam optics in the relevant transport section. In this paper, we show that the method of maximum entropy tomography can be generalized to incorporate nonlinear transformations, thereby widening its scope to the case of nonlinear beam transport. The improved method is verified using simulation results and potential applications are discussed.

Footnotes:

Funding Agency:

Tuesday Poster Session / **407**

A comparison of RMS moments and statistical divergences as ways to quantify the difference between beam phase space distributions

Author: Yu Du[1]

Co-authors: Zhijun Wang [1]; Chun Yan Jonathan Wong [1]; Liwen Liu [1]; Chunguang Su [1]; Man Yi [1]; Lingyun Gong [2]; Tao Zhang [1]; Haoyu Zhou [3]; Binghui Ma [1]; Yimeng Chu [1]; Tingyue Li [1]; Tielong Wang [3]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

[2] *European Spallation Source ERIC*

[3] *Institute of Modern physics, Chinese Academy of Science*

Corresponding Author: duyu@impcas.ac.cn

Accurately assessing the difference between two beam distributions in high-dimensional phase space is crucial for interpreting experimental or simulation results. In this paper, we compare the common method of RMS moments and mismatch factors, and the method of statistical divergences that give the total contribution of differences at all points. We first show that, in the case of commonly used initial distributions, there is a one-to-one correspondence between mismatch factors and statistical divergences. This enables us to show how the values of several popular divergences vary with the mismatch factors, independent of the orientation of the phase space ellipsoid. We utilize these results to propose evaluation standards for these popular divergences, which will help interpret their values in the context of beam phase space distributions.

Footnotes:

Funding Agency:

Monday Poster Session / **408**

Studies of transverse emittance growth in CSNS Linac DTL

Author: Jun Peng[1]

Co-authors: Huachang Liu [2]; Ming-Yang Huang [1]; Sheng Wang [3]; Shinian Fu [1]; Xinyuan Feng [1]; Yanliang Han [1]; Yong Li [2]; Yue Yuan [1]; Zhiping Li [2]

[1] *Institute of High Energy Physics*

[2] *Dongguan Neutron Science Center*

[3] *Institute of High Energy Physics, CAS*

Corresponding Author: pengjun@ihep.ac.cn

The transverse emittance at the exit of the China Spallation Neutron Source (CSNS) DTL is measured regularly every year. However, recently, the measured transverse emittance growth became larger than the his-torical data. It is also bigger than the simulated emittance. The process of measurement, data analysis and matching methods used are almost the same. Several factors con-tributed to the transverse emittance growth are analysed and presented in this paper. Compared to other factors, longitudinal mismatch contributes the most growth.

Footnotes:

Funding Agency:

Thursday Poster Session / 409

Compact field emission electron gun driven by THz wave

Author: Wentao Yu[1]

Co-authors: Chuangye Song [1]; Kai Peng [1]; Longding Wang [2]; Sijie Fan [1]; Wenhui Huang [1]; Yixiao Fu [2]

[1] *Tsinghua University in Beijing*

[2] *Tsinghua University*

Corresponding Author: ywt15@tsinghua.org.cn

Accelerator-based light sources require high brightness electron bunches to improve performance in exploring structure of matter. Higher acceleration gradient is the key to generate high brightness electron bunches and is more feasible with higher frequency and shorter pulse length electromagnetic wave according to previous empirical formulas. A tapered rectangle waveguide structure driven by terahertz wave is designed as a compact electron gun. A nanotip is fabricated by focused ion beam (FIB) in the center to enhance the field and to emit electrons. The average emission charge per pulse is measured by Pico ammeter, and the peak value reaches 10fC. The max electron energy beyond 4keV is measured from the signal of channel electron multiplier behind a -4kV metal girds, revealing that maximum acceleration gradient is beyond 100MeV/m. These results indicate promising performance of compact terahertz electron gun in high brightness electron injection. Further research will be done in the future.

Footnotes:

Funding Agency:

Thursday Poster Session / 410

IHEP C band klystron development

Author: Zusheng Zhou[1]

[1] *Institute of High Energy Physics*

Corresponding Author: zhouzs@ihep.ac.cn

After the discovery of Higgs boson at LHC, Chinese scientists have planned to build a "Great Collider", that is a next-generation multinational particle accelerator research facility proposed as a circular electron positron collider (CEPC) and a super proton–proton collider (SPPC). The main component of the CEPC accelerator complex is the Collider ring, which has a circumference of 100 kilometers and the CEPC Booster and Collider rings will be located on the inner side of the tunnel. The Linac is built on the ground level. It raises the electron and positron beam energy up to 30 GeV. The CEPC Linac is a type of linear accelerator that uses normal conducting RF technology and operates at two different frequencies, S-band (2860 MHz) and C-band (5720 MHz). To achieve compactness in the Linac, the baseline design also uses klystrons operating at the C-band frequency (5720 MHz). A 80 MW pulsed-power RF source is required to power four accelerating structures. Institute of High Energy Physics (IHEP) is developing high power pulsed klystron of frequency 5720 MHz having output power of 80 MW. The design of 5720 MHz (80 MW) klystron for CEPC Linac is completed and manufacture is also started.

Footnotes:

Funding Agency:

Thursday Poster Session / **411**

Transfer of EP and doping technology for PIP-II HB650 cavities from Fermilab to industry

Author: Vijay Chouhan[1]

Co-authors: Alexandr Netepenko [1]; Ambra Gresele [2]; Andrii Tsymbaliuk [2]; Anna Shabalina [3]; Damon Bice [1]; Donato Passarelli [1]; Genfa Wu [1]; Grigory Eremeev [1]; HyeKyoung Park [1]; Joseph Ozelis [1]; Paolo Barbero [2]; Saravan Kumar Chandrasekaran [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Zanon Research & Innovation*

[3] *Science and Technology Facilities Council*

Corresponding Author: vchouhan@fnal.gov

Fermilab has optimized the surface processing conditions for PIP-II high beta 650 MHz cavities. This encompasses conditions for bulk electropolishing, heat treatment, nitrogen doping, post-doping final electropolishing, and post-processing surface rinsing. The technology has been effectively transitioned to industry. This paper highlights the efforts made to fine-tune the process and to smoothly share them with the partner labs and an associated vendor.

Footnotes:

Funding Agency:

Monday Poster Session / **412**

RF tuning analysis of a 750 MHz carbon RFQ for medical applications

Author: Gabriela Moreno[1]

Co-authors: Jorge Giner Navarro [2]; Concepcion Oliver [1]; Daniel Gavela [1]; Pedro Calvo [1]; Miguel Lopez [1]; Ángel Rodríguez Páramo [1]; Jone Etxebarria [1]; Jose Perez Morales [1]; Alessandra Lombardi [3]; Unai Etxebeste Rodríguez [4]; José Miguel Carmona [5]; Maria Alvarado Martin [5]

[1] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[2] *Instituto Universitario de Ciencia de los Materiales*

[3] *European Organization for Nuclear Research*

[4] *Egile Mechanics S.L.*

[5] *Added Value Solutions*

Corresponding Author: gabriela.moreno@ciemat.es

This work is part of the development study of a linac injector for hadron therapy with carbon ion beams. The initial cavities of the future injector consist of two 750 MHz Radio Frequency Quadrupoles (RFQ), which are based on the compact CERN High-Frequency RFQ. These RFQs are designed to accelerate the ions from 15 KeV/u to 5 MeV/u. Each RFQ, with a length of more of 2 meters, comprises four individual modules and 32 tuners, 8 per module.

Certain design choices, manufacturing imperfections, and misalignments lead to local variations in the frequency and field distribution within the RFQs. The tuning procedure corrects these perturbations in the TE210 operating mode using a bead pull system and movable tuners.

The aim of this article is to determine the maximum field correction achieved through this tuning without affecting the beam dynamics. For this purpose, a set of electromagnetic deviations that introduces significant dipole components to the cavity is simulated, using CST Studio. Using the tuning algorithm, this EM deviation is corrected in a realistic way.

Footnotes:

Funding Agency:

Tuesday Poster Session / 413

Anomalous frequency shifts near Tc of fundamental and higher-order modes in medium-velocity 644 MHz superconducting elliptical cavities

Author: Sean Moskaitis[1]

Co-authors: Peter Ostroumov [1]; Sang-Hoon Kim [1]; Yoo Lim Cheon [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: moskaiti@frib.msu.edu

Recent studies indicate the magnitude of an anomalous decrease in the resonant frequency, so-called frequency dip, near critical temperature of superconducting niobium cavities, Tc, correlates to the cavity quality factor, Q0, and impurities introduced into the superconducting niobium surfaces, such as nitrogen or oxygen. We measured frequency dips in both 644 MHz fundamental mode (FM) and 1.45 GHz higher-order mode (HOM) of single-cell elliptical cavities for FRIB energy upgrade (FRIB400) R&D. These measurements were performed in cavities with the following surface treatments: 1) electropolished (EP) only, 2) nitrogen-doped (N-doping), 3) medium-temperature (mid-T) baked and then hydrofluoric (HF) acid rinsed. We will present measured frequency dips and compare them to cavity Q0 performance in the FM. Frequency-dependent behavior of frequency dips with various surface treatments will also be discussed as our experimental setup has a unique feature compared to previous studies, which allows for measurement of frequency dips in different modes within the same cavity, in other word, on the same surfaces.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy using resources of the Facility for Rare Isotope Beams, a DOE Office of Science User Facility, under Award Number DE-SC0023633.

Monday Poster Session / **414**

Successful cleanroom installation of PIP-II SSR2 coupler using robotic arm

Author: Colin Narug[1]

Co-authors: Caleb Denton [2]; Damon Bice [1]; Donato Passarelli [1]; Genfa Wu [1]; Josh Helsper [1]; Mattia Parise [1]; Tommaso Aiazzi [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Northern Illinois University*

Corresponding Author: cnarug@fnal.gov

To minimize the contamination of SRF cavities, remote installation techniques are needed during the installation of components. Recent work at Fermilab has been performed to begin the process of developing techniques for assembling cavities using robotics. Multiple alignment methods were prototyped including alignment and computer vision methods. Using a remotely controlled robotic arm, the alignment and installation of couplers have been successfully performed on prototype PIP-II SSR2 cavities in a cleanroom. The installation process will be shown to show to demonstrate the potential of future installations on other cavities and cavity ancillaries.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Monday Poster Session / **415**

Standardization of ancillary installation tooling for SRF cavities at Fermilab

Author: Colin Narug[1]

Co-authors: Mattia Parise [1]; Iman Salehinia [2]; Leonardo Ristori [1]; HyeKyoung Park [1]; Vincent Roger [1]; Josh Helsper [1]; Caleb Denton [2]; Donato Passarelli [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Northern Illinois University*

Corresponding Author: cnarug@fnal.gov

For assemblies of cavities in cleanrooms, single-use tooling systems are made for the alignment and installation of ancillary components such as couplers and bellows. To try and minimize the amount

of tooling sets used, a design has been created to standardize alignment features to allow for assembly of different components with one set of tooling. A prototype set of tooling has been developed to with the required degrees of freedom for multiple assemblies while minimizing deformation during the assembly process. Prototype designs have been created for PIP-II SSR2 and 650 Cavities and for AUP Crab Cavities. Using 3D printing, this tooling can be quickly adjusted to allow for different ancillary components. The development process and status of the design will be discussed.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Thursday Poster Session / **416**

Study of mechanical grinding effects on niobium surface

Author: Vijay Chouhan[1]

Co-authors: Davida Smith [1]; Genfa Wu [1]; Tim Ring [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: vchouhan@fnal.gov

Mechanical grinding is commonly employed to eliminate surface defects such as scratches and pits from niobium cavity surfaces or sheets before cavity fabrication. Subsequently, chemically buffered polishing or electropolishing is often utilized to completely remove residues of the polishing media and any defects induced by mechanical grinding, ensuring a pristine surface. In this study, we conducted a systematic investigation to assess the influence of mechanical grinding using silicon carbide and aluminum oxide polishing media on niobium surfaces. Additionally, the study examines the effects of post-mechanical grinding chemical treatments on surface quality.

Footnotes:

Funding Agency:

Monday Poster Session / **417**

Study of manufacturing errors in 750 MHz RFQ using electromagnetic simulations

Author: Gabriela Moreno[1]

Co-authors: Jorge Giner Navarro [2]; Concepcion Oliver [1]; Daniel Gavela [1]; Pedro Calvo [1]; Miguel Lopez [1]; Ángel Rodríguez Páramo [1]; Jone Etxebarria [1]; Jose Perez Morales [1]; Alessandra Lombardi [3]; Unai Etxebeste Rodríguez [4]; José Miguel Carmona [5]; Maria Alvarado Martin [5]

[1] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[2] *Instituto Universitario de Ciencia de los Materiales*

[3] *European Organization for Nuclear Research*

[4] *Egile Mechanics S.L.*

[5] *Added Value Solutions*

Corresponding Author: gabriela.moreno@ciemat.es

As an initial part of a future linac for hadron therapy, two 750 MHz Radio Frequency Quadrupoles (RFQs) have been preliminarly designed by CERN, based on the compact HF-RFQ model. These RFQs aim to accelerate carbon ions from 15 KeV/u to 5 MeV/u. Each RFQ is composed of four individual modules.

Manufacturing imperfections and misalignments can result in local variations in the frequency and electromagnetic field distribution within the RFQs. In this study, we focus on analyzing the electromagnetic sensitivity to possible modifications in the structure of a single RFQ module. Additionally, we evaluate how the combination of these irregularities can generate significant dipole errors, even when they remain within the specified dimensional tolerances. For this purpose, electromagnetic simulations are conducted using CST Studio.

Footnotes:

Funding Agency:

Tuesday Poster Session / **418**

Design and optimization of a C-band RF Pulse Compressor for a VHEE LINAC for FLASH Radiotherapy

Author: Giuseppe Torrisi[1]

Co-authors: Giorgio Mauro [1]; Gino Sorbello [2]; Alessandro Curcio [1]; Luigi Faillace [1]; Bruno Spataro [1]; Lucia Giuliano [3]; Mauro Migliorati [4]; Andrea Mostacci [3]; Luigi Palumbo [3]

[1] *Istituto Nazionale di Fisica Nucleare*

[2] *University of Catania*

[3] *Sapienza University of Rome*

[4] *Istituto Nazionale di Fisica Nucleare - Sez. Roma 1*

Corresponding Author: peppetorrisi@lns.infn.it

In this paper, the design of a compact C-band SLED RF Pulse Compressor for a Very High Electron Energy (VHEE) FLASH machine is presented. A spherical cavity RF pulse compressor - selected because of its compactness and relative ease of fabrication - is adopted to compress the 5 μs RF pulse, down to 1 μs obtaining a peak power gain greater than 5. Both the RF and thermo-mechanical design have been carried out, including a sensitivity study to evaluate the mechanical tolerances, possible tuning methods, and the cooling system. The main parameters of the full RF design (spherical storage cavity + mode converter/polarizer) and the final mechanical design of the structure are presented.

Footnotes:

Funding Agency:

Thursday Poster Session / **419**

Excellent performance of 650 MHz single-cell niobium cavity after electropolishing

Author: Vijay Chouhan[1]

Co-authors: Alexandr Netepenko [1]; Andrew Cravatta [1]; Berardino Guilfoyle [2]; Damon Bice [1]; Genfa Wu [1]; Oleksandr Melnychuk [1]; Thomas Reid [2]; Timergali Khabiboulline [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Argonne National Laboratory*

Corresponding Author: vchouhan@fnal.gov

The electropolishing process and cathodes have undergone modification and optimization for both low- and high-beta 650 MHz five-cell niobium cavities. Cavities treated with these novel electropolishing conditions exhibited superb surface quality and performance in baseline tests. Nonetheless, due to administrative constraints on project cavities, maximum gradient performance testing was not conducted. This paper presents a study conducted on a single-cell 650 MHz cavity utilizing the optimized electropolishing conditions, highlighting the maximum performance attained for this specific cavity.

Footnotes:

Funding Agency:

Thursday Poster Session / 420

The UK XFEL conceptual design and options analysis project

Author: David Dunning[1]

Co-authors: Barry Fell [1]; Boris Militsyn [1]; David Walsh [1]; Deepa Angal-Kalinin [1]; Edward Snedden [1]; James Clarke [1]; James Green [1]; John Collier [1]; Jonathan Marangos [2]; Mark Roper [1]; Matthew Wilson [3]; Neil Thompson [4]; Paul Aden [1]; Peter Williams [4]; Storm Mathisen [1]

[1] *Science and Technology Facilities Council*

[2] *Imperial College of Science and Technology*

[3] *Science & Technology Facilities Council*

[4] *Cockcroft Institute*

Corresponding Author: david.dunning@stfc.ac.uk

The UK is conducting a multi-stage project to analyse the case for major investment into XFELs, through either developing its own facility or by investing at existing machines. The project's 2020 Science Case identified a clear need for 'next-generation'XFEL capabilities including near-transform limited x-ray pulses across a wide range of photon energies and pulse durations; evenly spaced high-repetition rate pulses; and a high-efficiency facility with a step-change in the simultaneous operation of multiple end stations. The project is developing a conceptual design to meet these requirements, significantly aided by collaboration with international XFELs. It is also guided by an extensive ongoing user engagement programme of Townhall meetings and other activities. Both the science requirements and the emerging conceptual design are expected to be of general interest to the community.

Footnotes:

Funding Agency:

Monday Poster Session / **421**

Extracting critical beamline element misalignments from data using a beam simulation model

Author: Adwaith Ravichandran[1]

Co-author: Brahim Mustapha [1]

[1] *Argonne National Laboratory*

Corresponding Author: aravichandran@anl.gov

Successful implementation of AI/ML models for online tuning of accelerators highlights the need for accurate simulation of beamline elements. Deployment of such models requires the inclusion of realistic element misalignments during the simulation process. This paper presents an original method to determine misalignments across entire beamlines and apply them to the previously developed TRACK simulation model. Validation and sensitivity analysis has been performed in this study for a newly commissioned section of ATLAS called the Argonne Material Irradiation Station (AMIS) using experimental data. A preliminary study shows the average difference in beam transmission between experiment and simulation for 28 tuning cases has dropped from ˜46% without steering to ˜17% after applying steering and further down to ˜8% after accounting for 4 quadrupole misalignments in the simulation. Given these values and the well-established accuracy of the TRACK model, major deviations in element positions could be narrowed down enabling engineers to perform the necessary alignment corrections, and possibly eliminating the need for some steering elements. Predictability of the TRACK code has been shown to significantly improve after applying realistic alignment and steering corrections

Footnotes:

Funding Agency:

U.S. Department of Energy, Contract No. DE-AC02-06CH11357

Monday Poster Session / **422**

Performance of PIP-II high-beta 650 cryomodule after transatlantic shipping

Author: Joseph Ozelis[1]

Co-authors: Alexander Sukhanov [1]; Crispin Contreras-Martinez [1]; Darren Crawford [1]; David Peterson [1]; Dominika Porwisiak [1]; Jacopo Bernardini [1]; Jeewan Subedi [1]; Jeremiah Holzbauer [1]; Jerry Makara [1]; Jim Steimel [1]; Jun Dong [1]; Liujin Pei [1]; Maria Barba [1]; Michael White [1]; Nikolay Solyak [1]; Niral Patel [1]; Philip Varghese [1]; Pierrick Hanlet [1]; Sajini Wijethunga [1]; Sergey Kazakov [1]; Shreya Ranpariya [1]; Sungwoon Yoon [2]; Timergali Khabiboulline [1]; Timothy Wallace [1]; Victor Grzelak [1]; Vrushank Patel [1]; Yi Jia [3]; Yi Xie [1]; Yuriy Pischalnikov [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Institute for Basic Science*

[3] *Linde BOC Process Plants LLC*

Corresponding Author: ozelis@fnal.gov

After shipment to the Daresbury Lab and return to Fermilab, the prototype HB650 cryomodule underwent another phase of 2K RF testing to ascertain any performance issues that may have arisen from the transport of the cryomodule. While measurements taken at room temperature after the conclusion of shipment indicated that there were no negative impacts on cavity alignment, beamline vacuum, or cavity frequency, testing at 2K was required to validate other aspects such as tuner

operation, cavity coupling, cryogenic system integrity, and cavity performance. Results of this latest round of limited 2K testing will be presented.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Thursday Poster Session / **423**

Decoupling of nitrogen and oxygen impurities in doped SRF cavities

Author: Hannah Hu[1]

Co-authors: Daniel Bafia [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: hannahhu@uchicago.edu

The performance of superconducting radiofrequency (SRF) cavities is critical to enabling the next generation of efficient high-energy particle accelerators. Recent developments have focused on altering the surface impurity profile through in-situ baking, furnace baking, and doping to introduce and diffuse beneficial impurities such as nitrogen, oxygen, and carbon. However, the precise role and properties of each impurity are not well understood. In this work, we attempt to disentangle the role of nitrogen and oxygen impurities through time-of-flight secondary ion mass spectrometry of niobium samples baked at temperatures varying from 75-800 C with and without nitrogen injection. From these results, we developed treatments recipe that decouple the effects of oxygen and nitrogen in doping treatments. Understanding how these impurities and their underlying mechanisms drive further optimization in the tailoring of impurity profiles for high-performance SRF cavities.

Footnotes:

Funding Agency:

Work supported by the Fermi National Accelerator Laboratory, managed and operated by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy.

Thursday Poster Session / **424**

Fabrication status of production SSR1 jacketed cavities for PIP-II at Fermilab

Author: Tommaso Aiazzi[1]

Co-authors: Donato Passarelli [1]; Laura Grassellino [1]; Mattia Parise [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: taiazzi@fnal.gov

This paper provides an overview of the current fabrication status of superconducting SSR1 spoke cavities intended for integration into the PIP-II SRF linac at Fermilab. It explores the ongoing development and fabrication processes of the jacketed SSR1 cavity, highlighting key modifications made in the mechanical design to enhance structural integrity.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Monday Poster Session / **425**

Beam loading compensation in charge-varying scenarios with RF-Track

Author: Javier Olivares Herrador[1]

Co-authors: Andrea Latina [1]; Nuria Fuster-Martinez [2]; Benito Gimeno-Martinez [3]; Daniel Esperante [2]

[1] *European Organization for Nuclear Research*

[2] *Instituto de Física Corpuscular*

[3] *Val Space Consortium*

Corresponding Authors: javier.olivares.herrador@cern.ch, andrea.latina@cern.ch

High intensity linacs based on compact accelerating RF structures suffer from beam loading effects, which result into a bunch-to-bunch energy loss as a consequence of the beam-induced excitation of the fundamental accelerating mode. To track charged particles under this effect, the code RF-Track implemented a beam loading module in version 2.2.2. For ultrarelativistic scenarios in travelling-wave structures, the simulation tool was limited to trains of bunches with equal charge per bunch. In this work, we present the latest update of the beam loading module in version 2.3.0, extending its capabilities to account for this effect in trains with different charges per bunch and allowing the performance of beam loading compensation studies in these scenarios.

Footnotes:

Funding Agency:

Thursday Poster Session / **426**

1.6 MW, 144 MHz solid state power amplifier for ELSA electron linac

Author: Anne-Sophie Chauchat[1]

Co-authors: Martin Collet [1]; Vincent Le Flanchec [1]; Bodo Fritsche [2]; Michael Leukert [3]

[1] *Commissariat à l'Energie Atomique*

[2] *Ampegon AG*

[3] *Ampegon Power Electronics AG*

Corresponding Author: anne-sophie.chauchat@cea.fr

The 19 MeV electron linear accelerator ELSA at CEA DAM has been in operation for 30 years. A renovation of the RF system was necessary to improve the reliability of the linac. The second part of the renovation deals with the 144 MHz RF amplifier, supplying power to the photo-injector.
The former tetrode based amplifier has been replaced by a 1.6 MW Solid State Power Amplifier delivered by Ampegon company. One of the challenges was to design a compact amplifier to keep the same footprint.
This paper presents the amplifier, the tests and the commissioning.

Footnotes:

Funding Agency:

Tuesday Poster Session / 428

Tomography Development at ATLAS

Author: Anthony Tran[1]

Co-authors: Brahim Mustapha [2]; Yue Hao [3]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Argonne National Laboratory*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: tranant2@msu.edu

Beam tomography is a method for reconstructing the higher-dimensional beam from its lower-dimensional projections. This provides an understanding of the beam's transverse phase space, enabling better modeling and predicting downstream beam loss. We will show methods of extrapolating confidence intervals of our reconstructed beam and explore a new beam tomography algorithms using Markov Chain Monte Carlo (MCMC).
\end{abstract}

Footnotes:

Funding Agency:

Tuesday Poster Session / 429

Current status of beam commissioning at the Frankfurt Neutron Source

Author: Hendrik Hähnel[1]

Co-authors: Adem Ates [1]; Benjamin Dedic [1]; Christopher Wagner [1]; Chuan Zhang [2]; Holger Podlech [1]; Klaus Kümpel [1]; Leonie Bauer [1]; Ulrich Ratzinger [1]

[1] *Goethe Universität Frankfurt*

[2] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

Corresponding Author: haehnel@iap.uni-frankfurt.de

The Frankfurt Neutron Source FRANZ will be a compact accelerator driven neutron source utilizing the 7Li(p,n)7Be reaction with a 2 MeV proton beam. Follwoing successful beam commissioning of the 700 keV proton RFQ, further beam experiments including emittance measurements are currently ongoing. Preparations for conditioning and commissioning of the IH-DTL are running in parallel to the current beam measurement campaign. We report on the current status of commissioning towards a 2 MeV proton beam.

Footnotes:

Funding Agency:

Monday Poster Session / **430**

Beam envelope matching for the LANSCE Modernization Project

Author: Leanne Duffy[1]

Co-authors: Dimitre Dimitrov [1]; Dmitry Gorelov [1]; Enrique Henestroza [1]; Kip Bishofberger [1]; Lawrence Rybarcyk [1]; Salvador Sosa Guitron [1]; Sergey Kurennoy [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: ldd@lanl.gov

The Los Alamos Neutron Science Center (LANSCE) accelerator celebrated fifty years of operation in 2023. The LANSCE Modernization Project (LAMP) aims to ensure the future, by upgrading the aging hardware with a new replacement front end. This includes plans to replace the Cockcroft-Walton generators with a Radio-Frequency Quadrupole (RFQ), the low and medium energy transport (LEBT and MEBT respectively) sections, and drift tube linac (DTL). In this work, we detail the matching for the LAMP MEBT and DTL.

Footnotes:

Funding Agency:

Work was performed under the auspices of the US Department of Energy by Triad National Security under contract 89233218CNA000001.

Thursday Oral Posters / **431**

A laser plasma wakefield electron accelerator for the Advanced Photon Source and Low-Energy Accelerator Facility

Author: Kent Wootton[1]

Co-authors: Alex Lumpkin [1]; Charles Kozlowski [1]; Emmanuel Aneke [2]; Frank Westferro [1]; Jeffrey Dooling [1]; Joseph Calvey [1]; Mike Edelen [1]; Sergey Chemerisov [1]; Vadim Sajaev [1]; Victor Guarino [1]; William Berg [1]

[1] *Argonne National Laboratory*

[2] *Northwestern University*

Corresponding Author: kwootton@anl.gov

Recent developments in laser wakefield accelerators (LWFAs) lead us to consider employing this technology to accelerate electrons at the Advanced Photon Source (APS) facility. Previous experiments using LWFAs were performed at Argonne using the Terawatt Ultrafast High Field Facility. The injector complex serving the APS begins with an electron linac, producing beam energies on the order of 450 MeV. We consider that the infrastructure developed at the Linac Extension Area (LEA) could be usefully employed to develop a new LWFA injector for the APS linac. In the present work, we outline the proposed parameters of an LWFA using approximately a 100-TW-peak laser pulse focussed into a few-mm in extent pulsed gas jet. We are targeting electron beam energies in the range 300–500 MeV. Initially, we would use the LEA quads, diagnostics and electron spectrometer to demonstrate performance and characterize the LWFA beam, before moving the LWFA to inject into the Particle Accumulator Ring (PAR).

Footnotes:

Funding Agency:

This research used resources of the Advanced Photon Source, operated for the U.S. Department of Energy Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357.

Thursday Poster Session / 435

Autonomous beam alignment through quadrupole triplets using Bayesian Algorithm Execution

Author: Ryan Roussel[1]

Co-authors: Dylan Kennedy [1]; Eric Wisniewski [2]; Alexander Ody [3]; Auralee Edelen [1]

[1] *SLAC National Accelerator Laboratory*

[2] *Illinois Institute of Technology*

[3] *Argonne National Laboratory*

Corresponding Author: rroussel@slac.stanford.edu

A common challenge in online accelerator operations is aligning beams through a series of quadrupole magnets, especially when in situ beam position monitors are not present. Accelerator operators generally use a trial-and-error approach to solve this problem by sequentially measuring the centroid deflection of the beam as a function of quadrupole strengths. This is a challenging process that necessitates dedicated effort by operational experts, requiring significant beam time and personnel resources to configure basic accelerator operations. In this work, we use Bayesian Algorithm Execution (BAX) with virtual objectives to autonomously control steering magnets at the Argonne Wakefield Accelerator to center the beam through a quadrupole triplet. This technique uses virtual objectives to reduce the number of measurements needed to converge to an optimal solution, resulting in a turn-key algorithm for finding the optimal steering configuration for a set of accelerator magnets from scratch.

Footnotes:

Funding Agency:

This work was funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-76SF00515.

Thursday Poster Session / 436

Updates to Xopt for online accelerator optimization and control

Author: Ryan Roussel[1]

Co-authors: Dylan Kennedy [1]; Tobias Boltz [1]; Kathryn Baker [2]; Christopher Mayes [1]; Auralee Edelen [1]

[1] *SLAC National Accelerator Laboratory*

[2] *Science and Technology Facilities Council*

Corresponding Author: rroussel@slac.stanford.edu

The recent development of advanced black box optimization algorithms has promised order of magnitude improvements in optimization speed when solving accelerator physics problems. These algorithms have been implemented in the python package Xopt, which has been used to solve online and offline accelerator optimization problems at a wide number of facilities, including at SLAC, Argonne, BNL, DESY, ESRF, and others. In this work, we describe updates to the Xopt framework that expand its capabilities and improves optimization performance in solving online optimization problems. We also discuss how Xopt has been incorporated into the Badger graphical user interface that allows easy access to these advanced control algorithms in the accelerator control room.

Footnotes:

Funding Agency:

U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-76SF00515

Thursday Oral Posters / 437

Progress and challenges in traveling-wave (TW) SRF cavity

Author: Fumio Furuta[1]

Co-authors: K. McGhee [1]; Pavel Avrakhov [2]; Roman Kostin [2]; Sergey Kazakov [1]; Timergali Khabiboulline [1]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Euclid TechLabs, LLC*

Corresponding Author: ffuruta@fnal.gov

Traveling-wave (TW) technology can push the accelerator field gradient of niobium SRF cavity to 70MV/m or higher beyond the limit of 50˜60MV/m in Standing-wave (SW) technology. The early stages of TW SRF cavity developments had been funded by several SBIR grants to Euclid Techlabs and completed in collaboration with Fermilab through a 1-cell prototype and a proof-of-principle 3-cell TW cavity. The TW resonance excitation in the 3-cell TW cavity at 2K was demonstrated through the low power RF test in early 2024. A high-power test of the 3-cell in TW mode being prepared. To advance a design and technology to fabricate a novel high gradient TW SRF cavity, FNAL proposed a half-meter TW RF design and R&Ds to realize that are in progress. Here we will report the recent progress in the 3-cell TW cavity and the challenges towards a half-meter scale TW cavity.

Footnotes:

Funding Agency:

Thursday Poster Session / 438

Validation of high efficiency klystron technology

Author: Paz Alonso Arias[1]

Co-authors: Alan Chauchet [1]; Chiara Marrelli [2]; Igor Syratchev [1]; Maggie Webber [1]; Março Boronat [1]; Matthew Jones [3]; Nuria Catalan-Lasheras [1]; Sergio González-Antón [1]; Un Nisa Zaib [4]

[1] *European Organization for Nuclear Research*

[2] *European Spallation Source ERIC*

[3] *Science and Technology Facilities Council*

[4] *Chinese Academy of Sciences*

Corresponding Author: paz.alonso.arias@cern.ch

The delivery of high RF power—from hundreds of kW to MW—by klystrons, is linked with a high overall energy consumption. A research programme led by CERN in collaboration with the industry is being conducted to understand what limits klystron efficiency and how to develop high-efficiency klystrons. As a result of this program, two first prototypes of X-band (11.994 GHz) high-efficiency klystrons have been successfully designed and manufactured in collaboration with Canon Electron Tubes and Devices. The first results look promising, revealing a remarkable ˜60% efficiency, and validating the proposed HE klystron technology. A comprehensive characterisation campaign has been conducted at CERN to verify and demonstrate these results. The methodology for the HEK tubes characterisation is based in two independent measurements: a RF power measurement, and a calorimetric methodology —less subject to calibration inaccuracies. We describe the setups, principle of the calorimetry methodology, and we discuss the feasibility and precision of the results.

Footnotes:

Funding Agency:

Monday Poster Session / 440

Online multi-particle model for LANSCE physics tune-up with HPSim

Author: En-Chuan Huang[1]

Co-authors: Anthony Braido [1]; Jonathan Quemuel [1]; Lawrence Rybarcyk [1]; Martin Kay [1]; Petr Anisimov [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: en-chuan@lanl.gov

At the Los Alamos Neutron Science Center (LANSCE), the accelerator operation is loss-dominated, and the losses are primarily minimized via operators' intuition. The physics tune-up procedures for the linac, including the Drift Tube Linac (DTL) and the Side-Coupled Cavity Linac (CCL), does not take the bunch distribution into consideration. For the DTL, only statistical quantities like the full width half maximum are considered but not the whole phase scan distributions. For the CCL, a single particle model is used. In this work, we demonstrate an improved tuning tool to incorporate the simulated bunch distribution via the multi-particle High-Performance Simulator (HPSim) for the physicists to monitor the bunch distribution and losses during the tune-up process.

Footnotes:

Funding Agency:

Monday Poster Session / **441**

Strategies for mitigating residual magnetic field effect on pre-production PIP-II SSR2 cryomodule performance

Author: Jacopo Bernardini[1]

Co-authors: Donato Passarelli [1]; Gennady Romanov [1]; Mattia Parise [1]; Vincent Roger [1]; Yi Xie [1]; Fred Lewis [1]; Alexander Hogberg [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: jbernard@fnal.gov

This paper outlines the strategy aimed at mitigating the adverse effects of residual magnetic fields on the performance of pre-production SSR2 superconducting cavities within the context of the PIP-II project at Fermilab. Residual magnetic fields can significantly impact cavity performance, leading to reduced quality factor. To address this challenge, our strategy integrates various approaches including magnetic shielding, careful selection of materials, quality controls aimed at measuring magnetic permeability, magnetic hygiene to reduce residual magnetic field at the installation phase. Additionally, experimental studies are being planned to analyze the behavior of the cavities under different magnetic field conditions, and the effectiveness of advanced demagnetization procedures.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Monday Poster Session / **443**

Integration of computer vision system to track the alignment SRF cavities into the test cryostat for PIP-II at Fermilab

Author: Jacopo Bernardini[1]

Co-authors: Ambre Gonzalez-Moreau [2]; David Dillman [1]; Donato Passarelli [1]; Fred Lewis [1]; Mattia Parise [1]; Nayan Kumar [3]; Silvia Zorzetti [1]; Vincent Roger [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

[3] *Science and Technology Facilities Council*

Corresponding Author: jbernard@fnal.gov

PIP-II cryomodules use a computer vision system (H-BCAMs system) to monitor the alignment of SRF cavities and focusing lenses during assembly, testing, and operation. This contribution details the integration of the H-BCAMs into the Spoke Test Cryostat (STC) at Fermilab, which is utilized for cold testing SRF cavities prior to their integration into the string assembly. Thermal and structural finite element analyses were employed to estimate the cavities'deformations, to be validated during cold testing in the STC using H-BCAMs. Notably, this marks the first instance of H-BCAMs integration into a cryostat and operation within a cryogenic environment.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Tuesday Poster Session / 444

Tuning of ESS DTLs

Author: Carlo Baltador[1]

Co-authors: Antonio Palmieri [1]; Andrea Pisent [1]; Francesco Grespan [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: carlo.baltador@lnl.infn.it

The normal conducting part of ESS LINAC in Lund (Sweden) uses 5 DTL cavities, provided by INFN LNL as in-kind partner, to accelerate 60 mA proton beam from 3.9 MeV to 90 MeV. DTL1 have been tuned, installed in the accelerator tunnel and RF conditioned in 2021, DTL2, 3 and 4 in 2022, while DTL5 has been tuned and installed in summer 2023, but not yet conditoned. All the DTLs were equiped with tuning elements like tuners and post couplers, but the challenges experienced during the tuning of the first DTL has resulted in a change of tuning strategy, which effectively reduced the timeframe to tune the other cavities from months to days. The aim of this paper is to give an overview of the the achieved results and tuning procedure performed on the DTLs.

Footnotes:

Funding Agency:

Monday Poster Session / 445

A cryogenic dielectric pulse compressor

Author: Sergey Kuzikov[1]

[1] *Euclid TechLabs, LLC*

Corresponding Author: sergeykuzikov@gmail.com

Efforts aimed at developing klystron parameters have made significant progress in recent years. However, the ultimate parameter list of connected pulse compressors (PCs) has been given insufficient attention. We propose to develop a new high efficiency, high power gain pulse compressor based on the use of a dielectric storage resonator (100% dielectric filling factor) that is operated at a cryogenic temperature (77K). It is well known that, at cryogenic temperatures, a copper cavity can gain a much higher Q factor. However, at cryogenic temperatures, the RF loss tangent of some dielectric materials also decreases substantially (tan☒10-9 for Sapphire at 10 K). This inspires our effort to develop dielectric resonators for PCs with an intrinsic quality factor, Q0, that is several orders of magnitude higher than the Q0 for all metallic resonators at room temperature, and at least twice as high as for cryogenic copper cavities. In addition, the dielectric storage cavity can make the PC system more compact and lower their cost. The concern for multipactor occurring on the dielectric surfaces can be successfully addressed by special RF design and coatings like the DLC (diamond-like carbon) coating. We anticipate improving the parameters of the well-known SLED and SLED-II PCs. We consider both a passive PC (switched with a fast change of the klystron's phase) as well as an active PC (which requires a fast RF switch).

Footnotes:

Funding Agency:

Thursday Poster Session / **446**

Nb3Sn Technology for Low-beta linacs

Author: Troy Petersen[1]

Co-authors: Brad Tennis [2]; Edward Spranza [3]; Grigory Eremeev [2]; Ronald Agustsson [4]; Sam Posen [2]; Sergey Kutsaev [4]

[1] *Argonne National Laboratory*

[2] *Fermi National Accelerator Laboratory*

[3] *RadiaBeam Technologies*

[4] *RadiaBeam*

Corresponding Author: tpetersen@anl.gov

Nb3Sn is the most advanced potential successor for niobium in superconducting RF accelerator cavities. Nb3Sn has a significantly higher critical temperature (18.3 K) compared to that of niobium (9.2 K). This has a large effect on the BCS surface resistance, and therefore, on the dynamic RF losses at 4.5 K. The higher critical temperature allows two important changes for cavity and cryomodule design. First, the lower BCS losses allow the designer to use a higher frequency, translating to physically smaller cavities and cryomodules. Second, the low dynamic losses allow the use of stand-alone cryocoolers instead of complex helium refrigerators and distribution systems. Fabrication of a prototype 218 MHz cavity, test results, and continuing challenges are discussed.

Footnotes:

Funding Agency:

Monday Poster Session / **447**

High-Q0 treatment development in 800 MHz 5-cell elliptical cavities

Author: Kellen McGee[1]

Co-authors: Alexandr Netepenko [1]; Franck Peauger [2]; Frank Gerigk [2]; Oleksandr Melnychuk [1]; Sam Posen [1]; Sergey Belomestnykh [1]; Shahnam Gorgi Zadeh [2]; Timergali Khabiboulline [1]

[1] *Fermi National Accelerator Laboratory*

[2] *European Organization for Nuclear Research*

Corresponding Author: kem11235@fnal.gov

High-efficiency sub-GHz elliptical superconducting RF cavity are a critical enabling technology for multiple upcoming accelerator development projects such as for the Powerful Energy Recovery Linac for Experiments (PEARLE), the Future Circular Collider (FCC) FCC Booster, and for a certain realization of the FCC Collider ring. The ambitious quality factor and gradient requirements of these projects require strong R&D programs applying advanced surface processing techniques such as mid-T baking to 800 MHz cavities. We report the current achievements of our current high-Q development program including the first mid-T baking of an 800 MHz 5-cell elliptical niobium cavity compatible with PEARLE and FCC applications.

Footnotes:

Funding Agency:

Monday Poster Session / **448**

Neutralizer-based longitudinal bunch profile measurement design

Author: Charles Taylor[1]

Co-authors: Charles Rohde [1]; En-Chuan Huang [1]; Heather Andrews [1]; John Lewellen [1]; Remington Thornton [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: cetaylor@lanl.gov

The Los Alamos Neutron Science Center (LANSCE) provides an 800-MeV H- ion beam to four of its five user facilities. Two new methods for studying the beam profile are being installed in the south transport lines to the Lujan Spallation Neutron Center and the Weapons Neutron Science (WNR) Facility. The Laser Profile Monitor (LPM) studies the longitudinal beam profile by neutralizing the H- ions. The Neutralization Beam Energy Measurement (NBEM) system uses the excited neutrals from stripping to measure the beam's momentum using doppler-shifted decay photons. Here presents the simulated results we expect from the system and how their data can be correlated.

Footnotes:

Funding Agency:

Laboratory Directed Research and Devlopment (LDRD) at Los Almost National Laboratory

Monday Poster Session / **449**

Design of a multi-purpose LEBT for the LANSCE Front End Upgrade

Author: Enrique Henestroza[1]

Co-authors: Salvador Sosa Guitron [1]; Sergey Kurennoy [1]; Dimitre Dimitrov [1]; Janardan Upadhyay [1]

[1] *Los Alamos National Laboratory*

Corresponding Authors: upadhyay@lanl.gov, henestroza@lanl.gov

The Los Alamos Neutron Science center (LANSCE) facility at LANL is considering an upgrade of its front end, from the source to the end of a 100 MeV DTL. One of the main features of LANSCE is that it delivers several types of bunching systems to 5 users (Lujan Neutron Scattering Center, Proton Radiography Facility, Ultra Cold Neutron Center, Isotope Production Facility and the Weapons Neutron Research Facility WNR). The first four users accept bunch trains modulated at 201.25 MHz produced from essentially DC beams. The WNR facility requires the delivery of sub-nanosecond bunches every 1.8 microseconds. At present the bunching system for the WNR beam is prepared in a 750 keV LEBT. The proposed upgrade will need to manipulate short bunches for WNR at an energy of 100 keV to be injected into a 3 MeV RFQ. The long (DC) beams can be charge-compensated by the ionization of background gas, which cannot be done for the short bunches of WNR. At such low energy, the uncompensated space charge of the bunch will require a special LEBT design that will

work simultaneously for all types of beams to be delivered by the LANSCE upgrade. We will describe a new LEBT layout for the LANSCE Front End Upgrade that will be able to deliver the required beam bunches to all facilities.

Footnotes:

Funding Agency:

This work benefited from the use of the LANSCE accelerator facility. Work was performed under the auspices of the US Department of Energy by Triad National Security under contract 89233218CNA000001.

Monday Poster Session / **450**

Cold test results of pre-production PIP-II SSR2 cavities with high-power couplers in the Fermilab Spoke Test Cryostat

Author: Alexander Sukhanov[1]

Co-authors: Crispin Contreras-Martinez [1]; Chuck Grimm [1]; Bruce Hanna [1]; Benjamin Hansen [1]; Sergey Kazakov [1]; Timergali Khabiboulline [1]; Mattia Parise [1]; Donato Passarelli [1]; Yuriy Pischalnikov [1]; Dominika Porwisiak [1]; Vincent Roger [1]; Jeewan Subedi [1]; Ahmed Syed [1]; Philip Varghese [1]; Sajini Wijethunga [1]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: ais@fnal.gov

As part of the PIP-II project at Fermilab, a pre-production cryomodule featuring 325 MHz Single Spoke Resonator type 2 (SSR2) superconducting RF cavities is under construction. These SSR2 cavities are fabricated by industry partners and undergo initial cold testing at our collaborating institution, IJCLab in France, utilizing low-power coupler. Subsequently, the cavities are subjected to final qualification at Fermilab, complete with tuner and high-power coupler assemblies. This paper provides an overview of the ongoing efforts dedicated to high-power testing of jacketed SSR2 cavities in the Spoke Test Cryostat (STC) at Fermilab. Performance parameters obtained from these tests are presented, offering valuable insights into the cavities'operational characteristics and readiness for integration into the PIP-II cryomodule.

Footnotes:

Funding Agency:

Tuesday Poster Session / **451**

Machine learning-based non-destructive measurement of bunch length at FRIB

Authors: Jinyu Wan[1]; Alexander Plastun[2]; Peter Ostroumov[2]

[1] *Facility for Rare Isotope Beams*

[2] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Authors: ostroumov@frib.msu.edu, plastun@frib.msu.edu, wan@frib.msu.edu

A machine learning-based virtual diagnostic method for measuring the longitudinal phase space is proposed. Utilizing multiple measurements of bunch length from the Facility for Rare Isotope Beams

(FRIB) accelerator, beam parameters are fitted with a concrete simulation model. A neural network model is trained to learn the correlations between the signals from beam position monitors (BPMs) and the bunch length. This model enables the rapid prediction of bunch length at BPM locations without compromising beam quality.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy using resources of the Facility for Rare Isotope Beams, a DOE Office of Science User Facility, under Award Number DE-SC0023633.

Thursday Poster Session / **452**

Optimization of static heat loads of the PIP-II cryomodules based on prototype HB650 cryomodule test results

Author: Vincent Roger[1]

Co-authors: Alex Martinez [1]; Benjamin Hansen [1]; Dominika Porwisiak [1]; Donato Passarelli [1]; Jacopo Bernardini [1]; Jeewan Subedi [1]; Jeremiah Holzbauer [1]; Jerry Makara [1]; Joseph Ozelis [1]; Michael White [1]; Sungwoon YOON [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Authors: vroger@fnal.gov, mjwhite@fnal.gov, donato@fnal.gov, jeremiah@fnal.gov, jbernard@fnal.gov, sungwoon@fnal.gov, ozelis@fnal.gov, martinez@fnal.gov, bhansen@fnal.gov, dporwisi@fnal.gov, makara@fnal.gov, jsubedi@fnal.gov

During the first cool down of the prototype HB650 cryomodule (pHB650 CM), high static heat loads have been measured compared to the estimation. Several analysis and calculations have been performed to explain this difference which led to cool down this cryomodule two additional times. Before each cool down, repairs and upgrades have been done, and instrumentations were added to identify the issues and quantify their impact on the heat loads. Based on these findings, the production cryomodule design and assembly process have been updated to align the future heat loads measurements with the estimations.

Footnotes:

Funding Agency:

Work supported by Fermi Research Alliance, LLC under Contract No. DE AC02 07 CH11359 with the United States Department of Energy

Thursday Oral Posters / **453**

Progress towards halo modeling at the SNS Beam Test Facility

Author: Kiersten Ruisard[1]

Co-authors: Alexander Aleksandrov [1]; Alexander Zhukov [1]; Austin Hoover [1]; Trent Thompson [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: ruisardkj@ornl.gov

The SNS beam test facility is a model of the SNS front end (source through medium-energy transport). On-going work at the BTF focuses on accurate modeling of the beam distribution to enable the prediction of halo losses (>100 parts per million). This presentation will discuss the latest progress towards this goal, including recent results after a reconfiguration of the test beamline. Good agreement within the 90% beam core is shown for a 30 mA beam at 2.5 MeV.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of High Energy Physics. This work has been authored by UT-Battelle, LLC under Contract No. DE-AC0

Thursday Oral Posters / 454

Development of additively manufactured 750 MHz RFQ

Author: Toms Torims[1]

Co-authors: Ahmed Cherif [1]; Andris Ratkus [2]; Cedric Garion [1]; Guntis Pikurs [2]; Hendrik Kos [1]; Matteo Pozzi [3]; Maurizio Vedani [4]; Maurizio Vretenar [1]; Nicolas Delerue [5]; Philipp Wagenblast [6]; Samira Gruber [7]; Tobia Romano [2]; Victoria Bjelland [1]; Walter Wuensch [1]

[1] *European Organization for Nuclear Research*

[2] *Riga Technical University*

[3] *Rosler Italian*

[4] *Politecnico di Milano*

[5] *Université Paris-Saclay, CNRS/IN2P3, IJCLab*

[6] *TRUMPF Laser- und Systemtechnik GmbH*

[7] *Fraunhofer IWS*

Corresponding Authors: maurizio.vretenar@cern.ch, t.torims@cern.ch

Additive manufacturing technologies, especially powder bed fusion, are rapidly taking their place in the technological arsenal of the accelerator community. A wide range of critical accelerator components are today being manufactured additively. However, there is still much of scepticism whether additive manufacturing can address the stringent requirements set to complete accelerator components. Therefore, as an advanced proof-of-principle, a full-size, pure-copper RFQ prototype was developed and additively manufactured in the frame of the I.FAST EU project. RFQ prototypes and accompanying samples of the additively manufactured pure-copper parts were submitted to a series of standard tests at CERN to prove that this novel technology and suitable post-processing can deliver the required geometrical precision, surface roughness, voltage holding, vacuum tightness, and other relevant parameters. The results obtained are very promising and could be of great benefit to the linac community at large. The paper will discuss in detail the technological development and RFQ design improvement process along with the obtained results and future endeavours.

Footnotes:

Funding Agency:

EU Horizon 2020 Research and Innovation programme: agreement No 101004730

Monday Poster Session / 455

LANSCE accelerator instrumentation and control technology choices

Author: Martin Pieck[1]

Co-authors: Christopher Hatch [1]; Heath Watkins [1]; Eric Westbrook [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: pieck@lanl.gov

From being the first computer-controlled accelerator, through its 52-year long operational history, today the LANSCE Instrumentation and Control System (LICS) shows little resemblance of its early days. Over the past 5 decades, generations of control system engineers were faced with the challenge of maintaining the LICS. However, its maintainability depends on the ability that a failed component or system can be restored or repaired. Complicating this task is the undeniable fact that technology has significantly evolved over the last decades and that older component and systems, while still performing their function, have become obsolete and unmaintainable. When a technology migration path isn't viable to ensure LICS maintainability, the only alternative and opportunity is to upgrade to a new technology platform. Consideration needs to be given that the new technology platform needs to seamlessly integrate with the existing LICS infrastructure while allowing for technological progress. Given LICS's technology complexity multiple dependencies make the migration and upgrade paths a challenging one. In this paper, we discuss technology choices and compromises made, technology migration and upgrade challenges still faced, and LICS vision for the future. All this under the budgetary and schedule constraints of an operating accelerator facility with an enduring mission.

Footnotes:

LA-UR-24-24808

Funding Agency:

U.S. Department of Energy through the Los Alamos National Laboratory which is operated by Triad National Security, LLC, for DOE's National Nuclear Security Administration, Cont. No. 89233218CNA000001

Thursday Oral Posters / 456

Development for beam injector using laser-driven ion acceleration

Authors: Akari Okano[1]; Haruya Matsumoto[2]; Hironao Sakaki[3]; Hiroshi Tsutsui[4]; Hiroyoshi Kuroki[5]; Kiminori Kondo[3]; Kiyotaka Ohtomo[6]; Kunikazu Ishii[1]; Masaharu Nishikino[3]; Norihiro Inoue[5]; Sadaoki Kojima[3]; Sayaka Oishi[1]; Tatsuhiko Miyatake[2]; Thanh-Hung Dinh[3]; Toshiyuki Shirai[7]; masayasu Hata[3]

[1] *Nara Women's-Univ.*

[2] *Kyushu University*

[3] *National Institutes for Quantum Science and Technology*

[4] *Sumitomo Heavy Industies, Ltd.*

[5] *Hitachi Zosen*

[6] *The Institute of Physical and Chemical Research*

[7] *National Institutes for Quantum Science and Technology, Accelerator and Medical Physics*

Corresponding Authors: inoue_no@hitachizosen.co.jp, okano.akari@qst.go.jp, dinh.thanhhung@qst.go.jp, kondo.kiminori@qst.go.j
kuroki_h@hitachizosen.co.jp, nishikino.masaharu@qst.go.jp, kojima.sadaoki@qst.go.jp, sakaki.hironao@qst.go.jp,
miyatake.tatsuhiko.640@s.kyushu-u.ac.jp, ohtomo@postman.riken.go.jp, shirai.toshiyuki@qst.go.jp, hata, ishii@cc.nara-
wu.ac.jp, oishi.sayaka@qst.go.jp, hiroshi.tsutsui@shi-g.com, matsumoto.haruya.876@s.kyushu-u.ac.jp

The development of a few MeV/n carbon ion injector using laser-driven ion acceleration by Target-Normal Sheath Acceleration (TNSA) is carrying out. And the prototype injector has been completed at QST-Kansai in Japan. The beam commissioning is underway and first data on beam characteristics obtained from them will be presented.

Footnotes:

Funding Agency:

Thursday Oral Posters / 457

First results from two Nb3Sn cavities assembled in a CEBAF quarter cryomodule

Author: Grigory Eremeev[1]

Co-authors: Anthony Reilly [2]; Brad Tennis [1]; Gianluigi Ciovati [2]; John Fischer [2]; Kurt Macha [2]; Matthew Weaks [3]; Michael Drury [2]; Michael McCaughan [2]; Robert Rimmer [2]; Sam Posen [1]; Sergey Cheban [1]; Uttar Pudasaini [2]

[1] *Fermi National Accelerator Laboratory*

[2] *Thomas Jefferson National Accelerator Facility*

[3] *Jefferson Lab*

Corresponding Authors: uttar@jlab.org, grigory@fnal.gov

Two 1.5 GHz CEBAF C75-shape 5-cell accelerator cavities were coated with Nb3Sn film using the vapor diffusion technique at Fermilab and Jefferson Lab coating facilities. Both cavities were measured at 4 K and 2 K in the vertical dewar test in each lab, then assembled into a CEBAF quarter cryomodule at Jefferson Lab. The cryomodule was tested in 4 K and 2 K in the CryoModule Test Facility at Jefferson Lab. RF test results for both cavities in the cryomodule are similar to those of the qualification test in VTS, with one cavity reaching Eacc = 7.5 MV/m and the other - 13 MV/m at 4 K. In this contribution we discuss the progress with assembling Nb3Sn cavities in a cryomodule and the first results from cryomodule testing.

Footnotes:

We would like to thank Alex Netepenko and Alex Melnychuk for help with cavity measurements, Damon Bice for cavity treatment coordination, Anna Grassellino, Alex Romanenko, Sergey Belomestnykh for their support. We also want to thank Danny Forehand, Chris Dreyfuss, Ashley Mitchell, Justin Kent, Peter Owen, and JLab technical staff for their help with preparing, assembling, and testing the cavities, and thank Rongli Geng and Anne-Marie Valente Feliciano for their support.

Funding Agency:

DOE/ SC/ NP under contract DE-AC05-06OR23177 with Jefferson Science Associates, LC., DOE ECA to G. Eremeev, Fermi Research Alliance, LLC, under Contract No. DE-AC02-07CH11359 with the DOE/ SC/ HEP.

Tuesday Poster Session / 459

Compact CW 1-15 MeV 10-100 kW Electron Accelerators

Author: Milorad Popovic[1]

Co-authors: Grigory Kazakevich [1]; Jerry Wessel [2]; Mary Anne Cummings [1]; Michael Neubauer [1]; Robert Abrams [1]; Rolland Johnson [3]; Stephen Kahn [1]; Thomas Blassick [2]; Vadim Dudnikov [1]

[1] *Muons, Inc*

[2] *Richardson Electronics Ltd*

[3] *MuPlus, Inc.*

Corresponding Author: popovic@muonsinc.com

Muons, Inc is developing Compact Electron Linacs to meet the increasing demand for modern solutions to address diverse applications including Co60 replacement, isotope production, industrial uses, and sterilization of medical devices, food and water. The designs employ the Muons, Inc. – Richardson Electronics Limited 1497 MHz magnetrons that were designed, built, and being tested to replace the klystrons at the Jefferson Lab CEBAF superconducting RF recirculating Linac. The key features of the new designs are a single Linac that is powered by a high efficiency magnetron and permanent magnet systems that recirculate the beam through the Linac to enable compactness and efficiency. Future directions include integrating Nb3Sn-based superconducting cavities with cryocoolers for higher beam energies and scalability. We believe that these Compact Electron Linacs offer a cost-effective, versatile solution to revolutionize electron beam applications across industries.

Footnotes:

Funding Agency:

Tuesday Poster Session / 460

Engineering design of 402 MHz normal conducting coaxial window

Author: Seiji Thielk[1]

Co-authors: Alexey Pronikov [2]; Ronald Agustsson [1]; Sergey Kutsaev [1]

[1] *RadiaBeam*

[2] *RadiaBeam Technologies*

Corresponding Author: sthielk@radiabeam.com

RadiaBeam is fabricating a novel RF vacuum window for use with the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL). The window features a coaxial ceramic window between two waveguides, brazed as a single assembly. Unlike traditional pillbox window designs, this approach allows the outer diameter of the ceramic to decrease and the added benefit of water cooling the inner diameter of the ceramic. This paper covers the engineering design including details of key features, the impact of the unique RF design on manufacturability, and mechanical simulations. A status update on the fabrication is also provided with emphasis on the ceramic TiN coating and brazing process.

Footnotes:

Funding Agency:

DOE DE-SC0021552

Monday Poster Session / **461**

Update on the status of Los Alamos Neutron Science Center accelerator modernization

Author: Steven Russell[1]

Co-authors: Bruce Carlsten [1]; Eric Brown [1]; Gregory Dale [1]; John Lyles [1]; John Tapia [1]; Joseph Bradley III [1]; Mark Gulley [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: srussell@lanl.gov

The Los Alamos Neutron Science Center (LANSCE) accelerator is MW-class H-/H+ 800 MeV linear accelerator that serves five distinct user facilities that support Los Alamos National Laboratory (LANL) national security missions, commercial applications, and the Department of Energy's Office of Science medical isotope production program. Now into it's sixth decade of continuous operation, major accelerator systems are showing their age with decreased reliability and diminished vendor support due to equipment obsolescence. With plans to continue LANSCE operations for several more decades, LANL is exploring different avenues to modernize large portions of the accelerator. We will present the current status of those plans and an overview of supporting R&D.

Footnotes:

Funding Agency:

National Nuclear Security Agency

Monday Poster Session / **463**

Status Update on the Multi-User Upgrade of the ATLAS Linac at Argonne

Author: Brahim Mustapha[1]

Co-authors: Albert Barcikowski [1]; Alexander Grabenhofer [1]; Clayton Dickerson [1]; Guy Savard [1]

[1] *Argonne National Laboratory*

Corresponding Author: brahim@anl.gov

The ongoing multi-user upgrade of the superconducting ion linac, ATLAS at Argonne, will enable simultaneous acceleration and delivery of two different ion beams to different experimental areas. In the initial phase, one stable, nearly continuous wave, beam from the ECR ion source and one pulsed radioactive beam from the EBIS charge breeder of the Californium Rare Isotope Beam Upgrade (CARIBU-EBIS) will be interleaved in time via an electrostatic deflector at injection, and accelerated through the first two sections of the linac. At that point, one of the beams is deflected via a pulsed switching magnet to a lower energy experimental area while the other is sent for further acceleration in the third section of the linac and delivered to a higher energy experimental area. Significant progress has been made over the past couple of years; construction of the new pulsed injection beamline is almost complete, and the design of the extraction beamline including the kicker magnet and a new chicane has been finalized. Details of the final design and the ongoing installation work will be presented. In addition to enhancing the nuclear physics program at ATLAS, this upgrade will also increase the availability of beam time for some applications.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy under Contract No. DE-AC02-06CH11357. This research used resources of ANL's ATLAS facility, which is a DOE Office of Nuclear Physics Facility.

Monday Poster Session / 464

LANSCE 805 MHz klystron design and performance

Author: Aditya Waghmare[1]

Co-author: Jesus Valladares [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: aditya@lanl.gov

The 805 MHz RF power plant at Los Alamos Neutron Science Center (LANSCE) is powered by 44 86kV 1.25 MW klystrons which generate the required RF to produce 800MeV proton beam. These 805 MHz klystrons are of the modulated-anode type and are specially engineered for a long pulse duration of 1.475 ms pulse and 120 Hz repetition rate with a 15% duty factor. In this paper we will talk about the original design of these klystrons, provide calculations and simulation results for the original design parameters, and then talk about the changes that need to be incorporated in this style of tubes to convert them into the newer style hard pulsed diode type of design. The proposed gun design will be discussed and how the design change pertains to the 805 MHz system performance improvement for the LANSCE SCCL.

Footnotes:

Funding Agency:

Los Alamos National Laboratory

Thursday Poster Session / 465

Design of a high-current LEBT

Author: Baichuan Wang[1]

Co-authors: Canbin Yue [2]; Minwen Wang [2]; Mingtong Zhao [1]; Wei Lv [1]; Yi-Hua Yan [1]; Di Wang [3]; Maocheng Wang [1]; Wolong Liu [1]; Xiaodong Zhang [3]; Zhongming Wang [1]; Liang Sheng [1]

[1] *State Key Laboratory of Intense Pulsed Radiation Simulation and Effect*

[2] *Tsinghua University in Beijing*

[3] *Northwest Institute of Nuclear Technology*

Corresponding Author: baichuannn@qq.com

We have designed a 4-solenoid LEBT, aiming at trans-porting high-current high-repetition short-pulse proton beam to RFQ acceptance. In this paper, we present the designs of the key parameters for the LEBT dynamics and the conical scraper. The influence of the solenoid magnetic fields and drift spaces were discussed. The performance of the scraper with different dimensions were compared. The designed LEBT and scraper can significantly remove the unwanted particles and reduce the beam loss in subsequent RFQ while maintaining a relatively high transmission efficiency.

Footnotes:

Funding Agency:

Thursday Oral Posters / **466**

Dust contamination in the TRIUMF e-Linac

Author: Aveen Mahon[1]

Co-authors: Devon Lang [1]; James Keir [1]; Philipp Kolb [1]; Thomas Planche [1]; Tobias Junginger [1]

[1] *TRIUMF*

Corresponding Author: amahon@triumf.ca

Dust particulates are always present to some degree inside the vacuum space of particle accelerators, causing a variety of issues. At the LHC, beam loss events have been linked to the interaction of charged dust with the proton beams. In superconducting rf cavities, dust contamination leads to field emission, limiting the accelerating gradient and causing damage to external beamline components. Facilities such as the SLAC LCLS-II and TRIUMF electron linear accelerator see progressive onsets in field emission that cannot simply be explained by vacuum events. The environment of a particle accelerator provides an ideal opportunity for dust to gain charge, which is one of the main drivers of dust grain dynamics in vacuum. However, fundamental parameters such as the dust composition and charge to mass ratio of these grains are unique to each accelerator environment and remain largely unknown. We will present an analysis of dust samples taken from TRIUMF linear accelerators, detailing their size, composition and potential sources. Preliminary results from experimental studies on the charging, detachment and migration mechanisms acting on micron sized particulates will also be presented.

Footnotes:

Funding Agency:

Tuesday Poster Session / **467**

Evaluating beam neutralization and transport dynamics in laser-driven ion accelerators

Author: Haruya Matsumoto[1]

Co-authors: Hironao Sakaki [2]; Keisuke Nagashima [2]; masayasu Hata [2]; Tomoyuki Endo [2]; Yukinobu Watanabe [1]; Kiminori Kondo [2]

[1] *Kyushu University*

[2] *National Institutes for Quantum Science and Technology*

Corresponding Author: matsumoto.haruya.876@s.kyushu-u.ac.jp

We are developing a laser-driven ion accelerator aimed at downsizing heavy ion therapy devices. The ion beam produced by this accelerator exhibits low emittance(transverse emittance is approximately 10-3 π mm-mrad and longitudinal emittance is approximately 10-5 eV・s), with a very short pulse width (about picoseconds). As a result, the peak current reaches the kA level. However, explosive beam divergence is mitigated by co-moving electrons that neutralize the beam's space charge in the high-density region immediately following acceleration. This study involved acceleration calculations and transport calculations of proton beams over 40 cm (up to just before the

quadrupole magnet) using the Par-ticle-in-Cell (PIC) simulation code to assess the ion beam's space charge neutralization characteristics. This presentation will show the results of our simulations using the PIC code, which analyzed the degree of neutralization by co-moving electrons. The results suggest the potential for optimizing target thickness when utilizing of specific energy ions produced by laser-driven ion acceleration. The results suggest confirmation of the space charge neutralization phenomenon in the laser-accelerated ion beam.

Footnotes:

Funding Agency:

Thursday Poster Session / **468**

Design of a compact RFQ

Author: Baichuan Wang[1]

Co-author: Canbin Yue [2]

[1] *State Key Laboratory of Intense Pulsed Radiation Simulation and Effect*

[2] *Tsinghua University in Beijing*

Corresponding Author: baichuannn@qq.com

We have designed a compact RFQ to accelerate proton beam to 1 MeV. In this paper, we present the analyses and designs of the key parameters including frequency, vane voltage, aperture, modulation, etc. Simulations show the RFQ has good performance in transmission rate, power consumption and size.

Footnotes:

Funding Agency:

Monday Poster Session / **469**

New concepts for a high power 805 MHz RF amplifier for LANSCE using Gallium Nitride semiconductors

Author: John Lyles[1]

Co-authors: Aditya Waghmare [1]; Brandon Comiskey [1]; Eric Brown [1]; Jesus Valladares [1]; Jose Castellano [1]; Joseph Bradley III [1]; Juan Alvarez Prieto [1]; Manuelita Rodriguez [1]; Maria Sanchez Barrueta [1]; Mark Prokop [1]; Michael Brown [1]; Paula Van Rooy [1]; Scott Baily [1]; Stephanie Rocha [1]; Steven Russell [1]; Sungil Kwon [1]; Wesley Hall [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: jtml@lanl.gov

Los Alamos Neutron Science Center uses a coupled-cavity linac (CCL) to accelerate H- beam from 100 to 800 MeV. This was the first CCL put into operation (1972) and is powered by forty-four 1.25 MW 805 MHz klystrons developed in the same era. A new initiative is underway to develop a replacement RF amplifier that fits in place of one klystron with HV modulator tank, and is functionally equivalent or better in RF performance. Conventional LDMOS transistors based on silicon have reduced power above 500 MHz, and are also limited in peak power by the maximum drain voltage (50-65 volts). Changing wireless infrastructure is causing leading manufacturers to introduce and

discontinue products within a decade. Long term operation of LANSCE requires continuity of product availability. We have chosen leading-edge high voltage Gallium Nitride (GaN) on Silicon Carbide transistors to be able to reduce the number of active devices and the complexity of power combing. GaN has inherent higher temperature and voltage capability. We are testing devices for 3.6 kW of saturated power at 100 volts, and improvements are underway. Combining technology is also under study as part of the overall system.

Footnotes:

Funding Agency:

US Department of Energy by Triad National Security, LLC, under contract 89233218CNA000001

Tuesday Poster Session / **470**

Machine learning enabled model predictive control for the resonance frequency of the FRIB RFQ

Author: Jinyu Wan[1]

Co-authors: Shen Zhao [1]; Yue Hao [1]; Wei Chang [2]; Hiroyuki Ao [2]

[1] *Facility for Rare Isotope Beams*

[2] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: wan@frib.msu.edu

Efficient control of frequency detuning for the radio-frequency quadrupole (RFQ) at the Facility for Rare Isotope Beams (FRIB) is still challenging. The transport delay and the complicated heat transfer process in the cooling water control system convolute the control problem. In this work, a long-short term memory (LSTM)-based Koopman model is proposed to deal with this time-delayed control problem. By learning the time-delayed correlations hidden in the historical data, this model can predict the behavior of RFQ frequency detuning with given control actions. With this model, a model predictive control (MPC) strategy is developed to pursue better control performance.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy Office of Science under Cooperative Agreement DE-SC0023633, the State of Michigan, and Michigan State University.

Thursday Oral Posters / **471**

The SARAF-LINAC project July 2024 status

Author: Nicolas Pichoff[1]

Co-authors: Amichay Perry [2]; Antoine Chance [1]; Arik Kreisel [2]; Damien Simon [3]; Didier Uriot [1]; Eyal Reinfeld [2]; Franck Senee [3]; Francoise Gougnaud [1]; Guillaume Ferrand [1]; Ilan Shmuely [2]; Jonathan Dumas [3]; Joseph Luner [2]; Leonid Weissman [2]; Thomas Plaisant [1]

[1] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

[2] *Soreq Nuclear Research Center*

[3] *Commissariat à l'Energie Atomique*

Corresponding Authors: nicolas.pichoff@cea.fr, arikk40@gmail.com

SNRC and CEA collaborate to the upgrade of the SARAF accelerator to 5 mA CW 40 MeV deuteron and proton beams (Phase 2). CEA is in charge of the design, construction and commissioning of the linac downstream the existing RFQ (SARAF-LINAC Project).
The MEBT is now installed at SNRC and has been commissioned with both proton (cw) and deuteron (pulsed) beams. Transverse and longitudinal emittances have been measured and beam transport has been com-pared with TraceWin simulations.
Cryomodules have been assembled and tested at Saclay. CM1 has been delivered to SNRC and is being integrated at SNRC.
This paper presents the results of the qualification of the cryomodules at Saclay and the commissioning at Soreq.

Footnotes:

Funding Agency:

Monday Poster Session / **472**

Testing of the SSR2 SRF cavity tuner for PIP-II at 2 K

Author: Crispin Contreras-Martinez[1]

Co-authors: Alexander Sukhanov [1]; Donato Passarelli [1]; Jeremiah Holzbauer [1]; Mattia Parise [1]; Philip Varghese [1]; Vincent Roger [1]; Yuriy Pischalnikov [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: ccontrer@fnal.gov

The PIP-II linac will include thirty-five 325 MHz Single Spoke Resonators Type 2 (SSR2) cavities. Each cavity will be equipped with a tuner for resonance control. The tuner consists of mechanical frame with a motor for coarse frequency tuning and a piezoelectric actuator for fine frequency tuning. The tuner was tested for the first time at Fermilab on an SSR2 cavity. This dressed cavity-tuner system was tested at the single spoke testing cryo-stat (STC) in Fermilab at 2 K. The tuner performance was evaluated and is presented. Lastly, cavity-tuner mechanical modes were measured via the piezos.

Footnotes:

Funding Agency:

Thursday Oral Posters / **473**

Application of a novel high brightness photogun for MeV ultrafast electron diffraction

Author: Thomas Lucas[1]

Co-author: Eduard Prat [2]

[1] *Paul Scherrer Institute*

[2] *Paul Scherrer Institut*

Corresponding Authors: thomas.lucas@psi.ch, eduard.prat@psi.ch

MeV ultrafast electron diffraction has become a new frontier for the study of molecular dynamics. With the temporal resolution of MeV-UED being limited by the electron bunch length at the target, electron sources used for this technique are becoming ever more intricate in the the push for shorter bunches length. However, moving to these complex setups makes them less feasible in a small-scale setting, such as universities, where keV-UED setups have become common place. In this paper, we use a novel traveling-wave rf photogun without any additional bunch compressor to generate ultra-short electron pulses whose lengths rival that of the most intricate magnetic or ballistic compression schemes. The broadband nature of the TW device allows for unique operation schemes that combines significant acceleration and compression all within the TW photogun. Such a device, when combined with state-of-the-art synchronization systems and lasers will be demonstrated to cross the so-called ‘50-fs time-resolution barrier’and push towards the femtosecond regime.

Footnotes:

Funding Agency:

Main Session THZ / **474**

RF-based energy savings at the FLASH and European XFEL linacs

Author: Julien Branlard[1]

Co-authors: Andrea Bellandi [1]; Chris Christou [1]; Christian Schmidt [1]; Holger Schlarb [1]; Marco Diomede [1]; Mathias Vogt [1]; Nicholas Walker [1]; Sebastian Göller [1]; Thomas Froelich [1]; Valeri Ayvazyan [1]; Vladimir Vogel (Fogel) [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: julien.branlard@desy.de

Several measures were developed and deployed at the pulsed linacs FLASH and European XFEL operated at DESY in order to reduce the energy consumption of the RF systems. A staged implementation of several techniques allowed energy savings up to 25% for both facilities, at the cost of reducing the RF overhead and increasing the complexity of the low-level radio frequency (LLRF) system. However, through tool development and automation, the energy saving linac configuration could be implemented without compromising the RF stability, maximum beam energy, accelerator availability and with minimal impact on the setup time.

Footnotes:

Funding Agency:

This work was funded in the context of the R&D program of the European XFEL.

Thursday Oral Posters / **475**

THz-driven acceleration of sub-relativistic electrons in tapered rectangular dielectric-lined waveguides

Author: Laurence Nix[1]

Co-authors: Joe Bradbury [1]; Christopher Shaw [1]; Robert Appleby [1]; Graeme Burt [2]; Rosa Letizia [2]; Darren Graham [3]; Morgan Hibberd [3]; Steven Jamison [2]

[1] *Cockcroft Institute*

[2] *Lancaster University*

[3] *The University of Manchester*

Corresponding Author: l.nix@lancaster.ac.uk

We have designed a tapered dielectric-lined waveguide for the acceleration of sub-relativistic electron bunches with THz-frequency electromagnetic pulses. We consider an example design based on a commercial 100keV electron gun and a THz generation scheme driven by a mJ-level regenerative amplifier laser system. With a 12μJ THz pulse we simulated acceleration of a 100keV electron bunch to 162keV with very low energy spread. A second example design shows energy doubling from 100keV to 205keV using a 22.5μJ pulse. The former of these two designs has been assembled for experimental testing. We also discuss methods to improve the efficiency of the design process using 1D particle tracking to provide better estimates of the initial geometry before optimization.

Footnotes:

Funding Agency:

Monday Poster Session / **476**

Gridded RF gun design for SRF linac applications

Author: Ivan Gonin[1]

Co-authors: Arun Saini [1]; Christopher Edwards [1]; Jayakar Thangaraj [1]; K. Gunther [2]; M. Curtis [2]; Nikolay Solyak [1]; Sergey Kazakov [1]; Thomas Nicol [1]; Timergali Khabiboulline [1]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Heatwave Labs*

Corresponding Author: gonin@fnal.gov

The concept of a compact linear accelerator for industrial application suggested in reference* is based on the use of SRF cavities. The design of a thermionic electron source which can either be directly connected to a superconducting cavity or be part of a normal conducted injector cavity is described. The direct connection option is applied in a prototype 1½ cell 650 MHz SRF cavity capable of delivering a 12.5 mA average beam current with a beam power of 20 kW which is currently being developed at Fermilab. As an external option we present the development of a CW normal conducting 1.3 GHz RF injector which consists of a gridded RF gun integrated with the first cell of a copper booster cavity.
The electron source concept is presented including the cathode-grid assembly and the gun resonator design. For the first case we considered thermal insulation of the cathode from the cavity, the cavity thermal load caused by the gun, including the static heat load, black body radiation, backward electron heating, etc.
For both projects we present the results of beam dynamics optimization, RF, thermomechanical, and engineering designs.

Footnotes:

*R.D. Kephart et al, "SRF, Compact Accelerators for Industry and Society,"17th International Conference on RF Superconductivity, Whistler, September 13-18, 2015, FRBA03

Funding Agency:

Thursday Poster Session / **479**

RF design of a C-band distributed cavity for Southern Advanced Photon Source

Author: Yun Wang[1]

Co-author: Xingguang Liu [2]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

Corresponding Author: wangyun@ihep.ac.cn

As one of the options for the injector of the Southern Advanced Photon Source, the C-band parallel feeding accelerating cavity has advantages such as the ability to operate under conditions of low pulse width (<1μs), high repetition rate, and high accelerating gradient. This paper will detail the electromagnetic design of the cavity, including the optimization of the electromagnetic parameters of the accelerating units and the design of the parallel feeding network. Specifically, we introduce a design with magnetic coupling holes to counteract the electrical coupling strength at the beam port. This approach can be applied to future large-aperture beam port designs to reduce the impact of the wakefields on the beam.

Footnotes:

Funding Agency:

Main Session TUX / 481

ESS installation progresses

Author: Henry Przybilski[1]

[1] *European Spallation Source ERIC*

Corresponding Author: henry.przybilski@ess.eu

The installation of the superconducting part of the ESS Linac is progressing towards the first operation at 870 MeV on the beam dump after summer 2024. A pilot installation of 1 Spoke and 1 elliptical cryomodules was conducted in the superconducting (SCL) part of the ESS tunnel in spring 2023, to practice the installation sequence as well as to complete the cryogenic distribution system (CDS) commissioning. Currently a total of 13 spoke and 14 elliptical cryomodules (9MB + 5HB) are being installed to allow 2 MW capabilities for the first phase of the project. Overall, 30 elliptical cryomodules will be delivered to extend the energy reach to 5MW. At the time of the conference the linac will be cold and in the technical commissioning phase.

Footnotes:

Funding Agency:

Thursday Poster Session / 482

Beam dynamics and tolerance studies of the C3 main linac

Author: Wei Hou Tan[1]

Co-authors: Glen White [1]; Zenghai Li [1]; Emilio Nanni [1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: whtan@slac.stanford.edu

The Cool Copper Collider (C3) is an advanced accelerator concept for a e+ e- linear collider that utilizes a cryogenically-cooled copper accelerator technology. The C3 linac is envisioned to accelerate e+ and e- beams from 10 GeV to 125 GeV for a 250 GeV center of mass collisions. To reach the target luminosity, emittance has to be preserved through the whole main linac, taking into account alignment and vibration errors. Here we present the beam dynamics analysis for the C3 main linac. We show the beam dynamics of the main linac and results of the tolerance studies.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy Contract No. DE-AC02-76SF00515 with SLAC National Accelerator Laboratory.

Thursday Poster Session / 483

Progress update of the X-band Test Area beamline for upcoming experiments

Author: Wei Hou Tan[1]

Co-authors: Annika Gabriel [1]; Sara Kandil [1]; Carlos Peqeuno [1]; Ankur Dhar [1]; Mohamed Othman [1]; Emma Snively [1]; Emilio Nanni [1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: whtan@slac.stanford.edu

The X-band Test Area (XTA) is a test accelerator beamline consisting of a 5.5 cell X-band electron gun followed by a 1-m long X-band linac. It delivers an 85 MeV electron beam up to hundreds of pC. Here we report the beam dynamics studies of XTA to prepare it for THz streaking and silicon carbide irradiation experiments. This paper talks about the requirement and the simulation studies to prepare XTA for both experiments.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy Contract No. DE-AC02-76SF00515 with SLAC National Accelerator Laboratory.

Monday Poster Session / 484

High order modes spectra measurements in 1.3 GHz cavities for LCLS-II

Author: Andrei Lunin[1]

Co-authors: Alexander Sukhanov [1]; Timergali Khabiboulline [1]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: lunin@fnal.gov

Fermilab recently completed production and testing of 1.3 GHz cryomodules for the LCLS-II project. Each cryomodule consists of eight TESLA-shaped superconducting elliptical cavities equipped with two High Order Mode (HOM) coupler ports. Measurement of the HOM spectrum is part of the incoming quality control of cavities at room temperature and the final qualification cold test of cryomodules at the Cryomodule Test Facility (CMTF). In this paper we describe the procedure for measuring the HOM spectrum along with further data processing. Finally, we present accumulated statistics of individual HOM frequencies and quality factors related to various cavity vendors and discuss the possible contribution of HOMs to heat loads and beam dynamics.

Footnotes:

Funding Agency:

Work supported by the Fermi National Accelerator Laboratory; managed by Fermi Research Alliance, LLC under Contract No. DEAC02-07CH11359 with the U.S. Department of Energy

Main Session THX / 486

Utilization of corrugated dechirper at the PAL-XFEL: femtoseconds HXFEL generation via fresh-slice technique and longitudinal phase space measurement as a passive deflector

Author: Chang-Kyu Sung[1]

Co-authors: Chi Hyun Shim [1]; Haeryong Yang [1]; Inhyuk Nam [1]; Kookjin Moon [1]; MyungHoon Cho [1]; Seongyeol Kim [1]

[1] *Pohang Accelerator Laboratory*

Corresponding Author: csung@postech.ac.kr

Many years ago, the use of a corrugated dechirper for energy-chirp control in a relativistic electron beam was experimentally demonstrated at the Pohang Accelerator Laboratory (PAL). Since then, a lot of efforts have been made at the PAL-XFEL to utilize the dechirper for the electron beam diagnostics and the short pulse generation as well as the removal of energy correlation. Currently, the PAL-XFEL operates the two undulator sections: one for the hard x-ray (HX) and the other for the soft x-ray (SX), both of which employ the corrugated dechirper (vertical streaking at HX while horizontal streaking at SX). Using these dechirpers, we have conducted experiments to generate the short-pulse FEL down to a few femtoseconds via the fresh-slice technique at the hard x-ray regime and to measure the longitudinal phase space (LPS) of electron beam at the soft x-ray line of PAL-XFEL. The results of these experiments using the dechirper will be presented.

Footnotes:

Funding Agency:

Tuesday Poster Session / 487

Analysis of beam characteristic variations in the 14.5 GHz ECR ion source at RAON

Author: Jeongil Heo[1]

[1] *Institute for Basic Science*

Corresponding Author: jiheo@ibs.re.kr

RAON (Rare isotope Accelerator complex for ON-line experiments) is a heavy ion accelerator under construction in Daejeon, South Korea. RAON plans to operate a 28 GHz Electron Cyclotron Resonance Ion Source (ECRIS) with a fully superconducting magnet and is currently operating a 14.5 GHz ECR ion source with a fully permanent magnet. The 14.5 GHz ECRIS was manufactured by PANTECHNIK and installed in our beamline in September 2020. The initial beam conditioning of RAON was conducted using the 14.5 GHz ECR ion source with 40Ar9+ and 40Ar8+ beams. Additionally, beam tests were performed with protons, 4He2+, and oxygen. During these experiments, an unusual phenomenon was observed: the characteristics of the beam changed despite no variations in the parameters. This was consistently noted during some of the beam tests. We hypothesized several potential causes for this phenomenon and analyzed them through experiments. In this paper, we discuss the results of these analyses.

Footnotes:

Funding Agency:

Thursday Poster Session / 488

RF and mechanical design of a 915 MHz SRF cavity for conduction-cooled cryomodules

Author: Gianluigi Ciovati[1]

Co-authors: Alejandro Castilla [1]; Gary Cheng [1]; James Henry [1]; John Rathke [2]; John Vennekate [1]; Keith Harding [1]; Tom Schultheiss [3]; Jacob Lewis [4]

[1] *Thomas Jefferson National Accelerator Facility*

[2] *Advanced Energy Systems*

[3] *TJS Technologies*

[4] *Old Dominion University*

Corresponding Author: gciovati@jlab.org

Conduction-cooled SRF niobium cavities are being developed for use in compact, continuous-wave electron linear accelerators for a variety of industrial applications. A 915 MHz two-cell cavity has been designed to achieve an energy gain of 3.5 MeV. The design of the cell shape aims at minimizing the peak surface magnetic field. Field flatness is achieved by adjusting the length of the outer end half-cells. The higher-order mode analysis shows that absorbers are not required for a moderate beam current of 5 mA. One of the beam tubes has two side-ports for insertion of coaxial fundamental power couplers. The mechanical design and analysis were done to maintain a stress near or less than 15.5 MPa for all anticipated loading conditions. This is half the measured yield strength and is to provide relief from creep when the cavity is evacuated and stored with outside atmospheric pressure.

Footnotes:

Funding Agency:

Funding provided by DOE, Nuclear Physics and Accelerator R&D and Production under contract DE-AC05-06OR23177

Monday Poster Session / **489**

High dose pass-rate sealed ion chamber

Author: Zhiquan Zhang[1]

[1] *Elekta Beijing Medical Systems Co.Ltd.*

Corresponding Author: zzq261261@gmail.com

With the development of radiotherapy,the need for high doses became strong.However, existing ion chambers are either more absorbent of X-rays in terms of material or are non-sealed, that subject to environmental influences and have a short lifecycle. Now we designed a new ion chamber, which have high dose pass-rate, sealed and long lifecycle under radiation environments. The dose pass-rate improves a lot than the latest one, keeps ultra high vacuum as very low leakage rate and 10 years lifecycle. Another important point is this kind of ion chamber have very simple assembly process and low cost. After our beam test, it performed very well with various test environments as Reproducibility of the dose response, Proportionality of the dose response, Stability of the dose response and so on.

Footnotes:

Funding Agency:

Tuesday Poster Session / **490**

Status and performance of 150 kW RF solid state power amplifiers for the RFQ cavity

Author: Ki Taek Son[1]

Co-authors: Kyungtae Seol [1]; Sangyoon Bae [1]; Do Yoon Lee [1]; Hyung Jin Kim [1]

[1] *Institute for Basic Science*

Corresponding Author: skt1385@ibs.re.kr

The RAON facility, under the Institute for Basic Science (IBS) in Daejeon, is an advanced accelerator complex designed for research involving rare isotopes. RAON uses different types of cavities to accelerate various ions. The 81.25 MHz RF superconducting Radio Frequency Quadrupole (RFQ) cavity plays a key role in the initial acceleration of the ion beam. Supplying RF power efficiently to this RFQ cavity requires a total of 150 kW of RF power from Solid State Power Amplifiers (SSPAs). To fulfill this requirement, the RF group initially developed a 20 kW SSPA. The developed 20 kW SSPA showed good performance in frequency stability, power amplification efficiency, and thermal management. Based on these good performance results, several 20 kW SSPAs were combined to make two 80 kW SSPAs, meeting the RF power requirements for the RFQ cavity.
In this paper, we present the development process and performance results of the 80 kW RF SSPAs.

Footnotes:

Funding Agency:

This work was supported by the National Research Foundation of Korea(NRF) funded by Ministry of Science and ICT(2013M7A1A1075764)

Tuesday Poster Session / 491

Calibration of button-type beam position monitor based on low beta beam at RAON

Author: Jangwon Kwon[1]

[1] *Institute for Basic Science*

Corresponding Author: jwkwon@ibs.re.kr

RAON is a multi-purpose accelerator facility that can accelerate various heavy ion beams and rare isotope beams. The maximum energy of the uranium beam is 200 MeV/u. Sixty button beam position monitors were fabricated for use in SCL3, which accelerates the beam from 0.5 MeV/u to 18.5 MeV/u in a uranium case. BPM Electronics has developed position measurement using the IQ method for the 1st, 2nd, and 3rd harmonic frequencies of 81.25 MHz. Calibration factors for each frequency of the BPM were obtained on a wire test bench for the three frequency harmonic components. The position calibration factor obtained from the CST simulation had a beta dependence and differed from the measurements from the wire test bench. To measure the calibration factor using a beam, a moving stage equipped with a micrometer was prepared on the one-dimensional plane of the MEBT cross-section. We present the results of a beam-based calibration test of a button-type BPM for a low-beta heavy ion beam.

Footnotes:

Funding Agency:

Tuesday Poster Session / 492

Preliminary design of transverse deflecting structure systems for Shenzhen Superconducting Soft-X-ray Free Electron Laser

Author: Zongbin Li[1]

Co-authors: Jiahang Shao [1]; Huang Qizhang [1]; Jia Yang [2]; Weiqing Zhang [1]

[1] *Institute of Advanced Science Facilities*

[2] *Dalian Institute of Chemical Physics*

Corresponding Author: lizongbin@mail.iasf.ac.cn

Transverse Deflecting Structures (TDS) are commonly used in Free Electron Laser (FEL) facilities for the measurement of longitudinal information of electron beam, including bunch length, temporal distribution, slice emittance, etc. Shenzhen Superconducting Soft-X-ray Free Electron Laser (S3FEL) is a high-repetition-rate FEL recently proposed for scientific research and applications. In S3FEL, TDSs that work at S-band (2997.222 MHz) and X-band (11988.889 MHz) will be utilized for the diagnosis and analysis of longitudinal phase space of electron bunches along the beamline. In this manuscript, we present the preliminary design of both S-band and X-band TDS systems of S3FEL, including system layout, deflecting structures, pulse compressors, RF distribution networks, etc. Additionally, we introduce a new parallel-coupled TDS cavity with variable polarization for multi-dimensional phase space diagnostics.

Footnotes:

Funding Agency:

Tuesday Poster Session / **494**

Photocathode study in SRF Gun-II at HZDR

Author: Rong Xiang[1]

Co-authors: Andre Arnold [1]; Anton Ryzhov [1]; Gowrishankar Hallilingaiah [1]; Jochen Teichert [1]; Petr Murcek [1]; Raffael Niemczyk [1]; Stefan Gatzmaga [1]; Adrian Hoffmann [1]

[1] *Helmholtz-Zentrum Dresden-Rossendorf*

Corresponding Author: r.xiang@hzdr.de

HZDR's SRF Gun-II is an excellent demonstration of SRF technology application in the field of electron sources operating in continuous wave mode. As well known, quality of the photocathode is crucial for op-erational stability and reliability of an SRF gun. In this contribution, various studies on Cs2Te cathodes, in-cluding cleaning, preparation, transport/insertion, RF and beam operation will be summariesed. We will look back at the achievements and open issues, and discuss possible improvements and further development.

Footnotes:

Funding Agency:

Thursday Poster Session / **495**

Cobotisation for SRF cryomodules at CEA: focus on ESS and future prospects

Author: Stéphane Berry[1]

Co-authors: Adrien Bouygues [1]; Julien Drant [1]; Ambre Gonzalez-Moreau [2]; Christophe Servouin [1]; Catherine Madec [1]; Arnaud Madur [2]

[1] *Commissariat à l'Energie Atomique*

[2] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

Corresponding Author: stephane.berry@cea.fr

The assembly of cavity string in the clean room is a tedious work that has noisy and painful steps such as cleaning the taped holes of a part. CEA together with the company INGELIANCE has developed a cobot: a collaborative robot operated by an technician one time and repeating the action without the operator. The cobot can work anytime without any operators: therefore it is working at night reducing the assembly duration by some hours. The cobot consists of a FANUC CRX10 a 6-axis arm on an Arvis cart. At CEA, the cobot is used to blow the flange holes of the cavities and bellows. This allows to reduce the noisy steps that the technicians are exposed to. The process is also more reproducible since the cobot does always the same steps. The cobot is used on ESS cavity string to clean the coupler and cavity flanges. Our activities, results and technical choices for next development will be presented in this poster.

Footnotes:

Funding Agency:

Monday Poster Session / **497**

An overview of microphonics in CEBAF and current moderation techniques

Author: Peter Owen[1]

Co-author: Tom Powers [1]

[1] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: powen@jlab.org

Superconducting RF (SRF) structures are susceptible to frequency detuning from external vibrations and modal mechanical resonances in the structure. These small disturbances, known as microphonics, require additional RF power in CW accelerating structures since the frequency is constantly shifting. In the Jefferson Lab CEBAF accelerator, time and frequency data of this frequency shift have been recorded for many years, allowing a retrospective analysis of different microphonics-mitigation techniques. Some of these techniques are specific to the design of each CEBAF cryomodule, for example implementing BNNT damping material on the cavity string. Other techniques are universal such as affixing vacuum lines and reinforcing waveguide structures.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics under contract DE-AC05-06OR23177.

Thursday Poster Session / 498

Beam dynamics simulations for the ERDC project: industrial SRF linac

Authors: Arun Saini[1]; Nikolay Solyak[1]

Co-authors: Christopher Edwards [1]; Ivan Gonin [1]; Jayakar Thangaraj [1]; Roman Kostin [2]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Euclid TechLabs, LLC*

Corresponding Author: solyak@fnal.gov

Compact conductively cooled SRF industrial linacs can provide unique parameters of the electron beam for industrial applications. (up to 10MeV, 1MW). For ERDC project we designed normal conducting RF injector with thermal RF gridded gun integrated in first cell of multi-cell cavities. For design of the RF gun we used MICHELL software to simulate and optimize parameters of the beam. Output file was converted to ASTRA format and most beam dynamic simulations in multi-cell normal conduction cavity and cryomodule were performed by using ASTRA software. For cross-checking we compare results of MICHELL and ASTRA in first few cells. At the end of injector beam reach ˜250keV energy which allow to trap bunch in acceleration regime without losses in TESLA like cavity. Short solenoid at the end of injector will allow to regulate transverse beam size in cryomodule to match beam to extraction system.

Footnotes:

Funding Agency:

Tuesday Poster Session / 499

Design update of the power couplers for the single-spoke resonators in Institute for Rare Isotope Science

Author: Junyoung Yoon[1]

Co-authors: Daeboo Cha [2]; Dongkeun Lee [2]; Yong Woo Jo [1]; Yoochul Jung [1]; Youngkwon Kim [1]

[1] *Institute for Basic Science*

[2] *VITZRO Nextech CO., LTD.*

Corresponding Author: foryjy12@ibs.re.kr

A heavy-ion accelerator facility was constructed for the Rare Isotope Science Project (RISP) at the Institute for Rare Isotope Science (IRIS) in Daejeon, Korea. A cryomodule with quarter-wave resonators (QWRs) and half-wave resonators (HWRs) was installed in the SCL (Superconducting Linac) 3 tunnel,and the initial beam commissioning using argon beams has been completed. Additionally, a cryomodule with single-spoke resonators (SSRs), power couplers,and tuners is currently under development for the SCL2 project. The geometry of the power couplers for the SSRs is a coaxial capacitive type based on a conventional 3-1/8 inch Electronic Industries Alliance (EIA) coaxial transmission line with a single ceramic window. A multi-physics analysis, incorporating electromagnetic, thermal, and mechanical aspects, was conducted to evaluate the design of the power coupler for the SSRs. This paper presents the results of the multi-physics analysis and the current design status of the power coupler for the SSRs.

Footnotes:

Funding Agency:

Tuesday Poster Session / 500

Development of 81.25 MHz and 162.5 MHz LDMOS-based solid-state power amplifiers for the heavy ion accelerator

Author: Sangyoon Bae[1]

Co-authors: Do Yoon Lee [1]; Hyung Jin Kim [1]; Ki Taek Son [1]; Kyungtae Seol [1]

[1] *Institute for Basic Science*

Corresponding Author: sybae83@ibs.re.kr

Construction of a heavy ion accelerator facility to support various scientific studies is underway. The heavy ion accelerator facility is largely comprised of SCL3 for low-energy acceleration and SCL2 for high-energy acceleration. SCL3 consists of 22 quarter wave resonators (QWR) with a superconducting acceleration cavity frequency of 81.25 MHz and 102 half wave resonators (HWR) with a frequency of 162.5 MHz, and SCL3 consists of 213 single spoke resonators (SSR) with a frequency of 325 MHz. A low-energy superconducting linear accelerator consisting of an injector, QWR, and HWR was successfully commissioned. SCL3 superconducting accelerator tube can supply up to 4kW of RF power to the acceleration cavity using a solid-state power amplifier (SSPA) based on LDMOS (Lateral Double-Diffused Metal Oxide Semiconductor). The basic principle of the solid-state power amplifier applied to the acceleration cavity of 81.25 MHz and 162.5 MHz is the same, with differences in the location and quantity of components such as circulator and RF combiner. The main components of SSPA are the main transistor, a bidirectional coupler for RF input power monitoring, an attenuator, a limiter to prevent over-input, an ultra-short MMIC, a driving amplifier, a 4-way input power divider, a 4-way output power combiner, a circulator, and a dummy load.

Footnotes:

Funding Agency:

This work was supported by the National Research Foundation of Korea(NRF) funded by Ministry of Science and ICT(2013M7A1A1075764)

Monday Poster Session / 502

Design of a quadripartite wakefield structure for free electron laser applications

Author: Jiahang Shao[1]

Co-authors: Congrui Lei [1]; Hongfei Wang [1]; J. Wei [1]; Jia Yang [2]; Jitao Sun [2]; L. He [1]; Wei Wang [2]; Wei Wei [1]; Weiqing Zhang [1]; Xueming Yang [2]; Yong Yu [2]; Yu Ji [1]; Zongbin Li [1]

[1] *Institute of Advanced Science Facilities*

[2] *Dalian Institute of Chemical Physics*

Corresponding Author: shaojiahang@mail.iasf.ac.cn

Wakefield structures are broadly employed in free electron laser (FEL) facilities for beam manipulation. Compared with cylindrical geometries, planar structures are typically preferred due to their increased flexibility, allowing for tunable wakefield strength through gap adjustment. However, these planar configurations can induce time-dependent quadrupole wakefields, which require careful compensation in various applications. To address this issue, we propose a novel structure design incorporating four identical corrugated elements which are independently controllable. By adjusting the gaps between orthogonal pairs, the quadrupole wakefield can be either fully compensated to avoid emittance growth or significantly amplified to enhance beam mismatch for slice lasing control. This manuscript presents both the physical and mechanical design of the proposed structure, as well as the planned proof-of-principle experiment.

Footnotes:

Funding Agency:

Tuesday Poster Session / 504

A new RFQ for the carbon therapy injector at HIT Heidelberg

Author: Ulrich Ratzinger[1]

Co-authors: Andreas Peters [2]; Chuan Zhang [3]; Hendrik Hähnel [1]; Holger Hoeltermann [4]; Holger Podlech [1]; Maximilian Schuett [3]; Rainer Cee [2]; Seval Altürk [4]; Thomas Haberer [2]

[1] *Goethe Universität Frankfurt*

[2] *Heidelberg Ionenstrahl-Therapie Centrum*

[3] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[4] *BEVATECH*

Corresponding Author: u.ratzinger@iap.uni-frankfurt.de

The tumor therapy facility HIT, Heidelberg, Germany is in operation with light ion beams up to carbon since 2009. The 7 A MeV, 216.8 MHz synchrotron injector linac with a total length of 5 m is designed for the ion C^(4+) from an ECR ion source. The RFQ accelerates the beam from 8 A keV

up to 400 A keV and is at present a bottleneck in beam transmission. After a careful analysis of the beam quality along the RFQ it was decided by HIT to order a new RFQ from Bevatech with higher beam acceptance and with tight mechanical tolerances. Other features are optimized entrance and exit gaps by including longitudinal field components, which are characteristic for 4-Rod-RFQs. A complete dipole field compensation along the mini-vane electrodes is another improvement. This RFQ is scheduled to replace the old one in 2026.

Footnotes:

Funding Agency:

Monday Poster Session / **505**

Transverse electric modes in a resonant cavity and the resultant kick to an 800 MeV proton beam

Author: Jesus Valladares[1]

Co-authors: Aditya Waghmare [1]; Jose Castellano [1]; Joseph Bradley III [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: chuy@lanl.gov

Resonant cavities used in accelerating structures have been studied and used in excited modes other than the fundamental frequency TM accelerating mode. These cavities can also be overmoded to accomplish specific beam quality or bunch structures. A TE mode properly phased can be used to induce a transverse kick to an 800 MeV proton beam, such as the beam produced by the Los Alamos Neutron Science Center Side Coupled Cavity LINAC. The exited overmoded cavity as a beam kicker can be advantageous compared to a conventional parallel plate kicker, in that it can be fine-tuned by modern the RF drivers in real time. This paper presents an EM simulation for the cavity in TE mode for kicking, and the required constraints in stored energy and RF phase to generate the required deflection angle.

Footnotes:

Funding Agency:

Tuesday Poster Session / **506**

Limitations of the EuXFEL 3rd harmonic cryomodule in high duty cycle operation

Author: Bozo Richter[1]

Co-authors: Andrea Bellandi [1]; Julien Branlard [1]; Artur Heck [1]; Max Herrmann [1]; Karol Kasprzak [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: bozo.richter@desy.de

Future High Duty Cycle (HDC) operation scenarios of the European X-ray Free Electron Laser (EuXFEL) promise increased bunch repetition rate and photon delivery, at the cost of changing system requirements and moving away from the current mode of Short Pulse (SP) operation. To assess whether the third harmonic cryomodule design is also suitable for Long Pulse (LP) and Continuous

Wave (CW) operation, key parameters of the spare module are examined at the Accelerator Module Test Facility (AMTF). For Radio-Frequency (RF) related energy efficiency, the cavity resonance tuning precision and the loaded quality factor tuning range are investigated. As performance indicators, limitations on attainable cavity gradient and RF stability are quantified. The results show that the module in its current design is insufficient for LP at high duty cycles and CW at the required operating points. The installed 3-stub tuners only yield maximum loaded quality factors between 5.3e6 and 1.9e7, and the mechanical cavity tuner prohibits tuning precision within the intended cavity half bandwidth. Also, some higher order mode couplers do not allow CW operation at required gradients. Nevertheless, closed-loop RF stability measured in single cavity control is comparable to that of the third harmonic system of EuXFEL.

Footnotes:

Funding Agency:

This work was funded in the context of the R&D program of the European XFEL.

Thursday Poster Session / 507

nuCARIBU commissioning at ATLAS

Author: Clayton Dickerson[1]

Co-author: Guy Savard [1]

[1] *Argonne National Laboratory*

Corresponding Author: cdickerson@anl.gov

fragments will be thermalized in an existing gas catcher and formed into beams for stopped and reaccelerated experiments. A 6 MeV, 0.5 mA proton cyclotron will bombard a 7Li target to generate the needed neutrons. This configuration will replace the current source of radioactive ions, a thin plating of spontaneously fissioning 252Cf. nuCARIBU is expected to increase the overall intensity of n-rich ions, and improve the consistency and reliability of radioactive ion beam production. This paper will present the results of the recent installation and commissioning of the cyclotron and initial proton beam delivery.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357 and used resources of ANL's ATLAS facility, an Office of Science User Facility

Monday Poster Session / 508

Application of survey and alignment techniques for beamline installation

Author: Alexander Grabenhofer[1]

[1] *Argonne National Laboratory*

Corresponding Author: agrabenhofer@anl.gov

The installation and alignment of new beamlines and beamline components is necessary at any accelerator facility. The equipment and methods used to perform these precision driven tasks must be accurate, reliable and above all, easily repeatable. Using coordinate measuring machines (CMM), laser trackers, combined with Spatial Analyzer, Autodesk Inventor and other custom tools, it is possible to rapidly and accurately take an idea from model to reality, as shown through the construction of the ATLAS Multi-User beamline.

Footnotes:

Funding Agency:

U.S. Department of Energy Office of Science, Office of Nuclear Physics, under contract number DE-AC02-06CH11357 and used resources of ANL's ATLAS Facility, which is DOE Office of Science User Facility

Monday Poster Session / 509

Construction status of the IFMIF-DONES 5 MW linac

Author: Ivan Podadera[1]

Co-authors: Alvaro Marchena [2]; Anderson Sabogal [3]; Andrea Pisent [4]; Andreas Jansson [5]; Angel Ibarra [2]; Antonio Moreno [3]; Antonio Palmieri [4]; Arnaud Madur [6]; Benoit Bolzon [7]; Cayetano Prieto [8]; Claudio Torregrosa [1]; Concepcion Oliver [2]; Cristina de la Morena [2]; Daniel Sánchez-Herranz [3]; David Jimenez-Rey [2]; David Regidor [2]; Davide Bernardi [9]; Dragan Poljak [10]; Fabio Cismondi [11]; Fernando Arranz [2]; Florian Benedetti [11]; Francesco Nitti [9]; Gioacchino Micciché [9]; Guillaume Devanz [7]; Hervé Dzitko [12]; Jacques Marroncle [7]; Javier Gutiérrez [8]; John Weisend [5]; Jorge Herranz [1]; Jorge Maestre [1]; José Aguilar [3]; Juan Carlos Morales Vega [1]; Juan Rueda [1]; Juliette Plouin [7]; Laura Segui [6]; Llorenç Macià [13]; Luca Bellan [4]; Lucas Maindive [3]; Luis Gonzalez Gallego Sanchez Camacho [1]; Mamad Eshraqi [5]; Manel Sanmarti [13]; Manuel Vázquez [3]; Marcelo Juni Ferreira [5]; Maria Luque [14]; Mario García [2]; Mario Ruiz [1]; Marta Ternero Gutierrez [3]; Maurizio Montis [4]; Mauro Giacchini [4]; Michele Comunian [4]; Moisés Weber [2]; Nicolas Bazin [7]; Nicolas Chauvin [6]; Pablo Araya Carmona [1]; Philippe Cara [15]; Philippe Legou [7]; Purificación Méndez [2]; Ruben Lorenzo Ortega [1]; Ruth Maldonado [1]; Santiago Becerril-Jarque [1]; Stéphane Chel [16]; Thomas Papaevangelou [7]; Tonci Tadic [17]; Victor Gutiérrez [2]; Volker Hauer [18]; Víctor Villamayor [2]; Wojciech Królas [19]; Yuefeng Qiu [18]

[1] *Consorcio IFMIF-DONES España*

[2] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[3] *Universidad de Granada*

[4] *Istituto Nazionale di Fisica Nucleare*

[5] *European Spallation Source ERIC*

[6] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

[7] *Commissariat à l'Energie Atomique*

[8] *Empresarios Agrupados*

[9] *ENEA Brasimone*

[10] *University of Split*

[11] *IFMIF/EVEDA Project Team*

[12] *Fusion For Energy*

[13] *Catalonia Institute for Energy Research*

[14] *European Organization for Nuclear Research*

[15] *Fusion for Energy*

[16] *Université Paris-Saclay, CEA*

[17] *Ruder Boskovic Institute*

[18] *Karlsruhe Institute of Technology*

[19] *Institute of Nuclear Physics Polish Academy of Sciences*

Corresponding Author: ivan.podadera@ifmif-dones.es

IFMIF-DONES (International Fusion Materials Irradiation Facility - DEMO-Oriented NEutron Source) is a facility under construction as part of the European fusion roadmap. The facility, located in Granada (Spain), is a powerful neutron irradiation facility for validation and qualification of materials to be used in fusion reactors. The construction of the facility under the framework of the DONES Programme started in March 2023, following the first DONES Steering Committee.
Currently, the design is being transferred to the DONES Programme, and the first bunch of in-kind contributions are being agreed, including the ones for the construction of the 5 MW deuteron superconducting linear accelerator. The design has been consolidated during the last years through the LIPAc (Linear IFMIF Prototype Accelerator), but also to other prototypes of critical parts of the accelerator among different frameworks. These include high-power solid-state amplifiers, superconducting cavities and beam diagnostics. Most of them are already validated, while a few are still undergoing validation.
In this contribution, the status of the design and manufacturing of the 5 MW linear accelerator will be reviewed, including the prototypes and validation activities being carried out under several projects.

Footnotes:

Funding Agency:

EURATOM partly through EUROfusion Consortium (Grant Agreement No 101052200) and DONES-ConP1 Consortium (Grant Agreement No 101145952).
Junta de Andalucía through project TECHAC (id ProyExcel_00989).

Thursday Poster Session / 510

Fast linac optics measurement with machine learning methods

Author: Nikita Kuklev[1]

[1] *Argonne National Laboratory*

Corresponding Author: nkuklev@anl.gov

Optics measurement is a common tuning and troubleshooting task which takes up a large amount of APS linac machine study time. It is of interest to explore more efficient methods to increase its'speed and data quality. We previously tested Bayesian inference for determining linac magnet parameters, and in this work extend the method to directly measure linear optics and nonlinear deviations. We rely on differentiable simulations to define a loss that describes the disagreement of the model and experimental data, which can then be minimized using standard ML methods. Alternatively, MCMC approaches can be used for direct sampling. We demonstrate the usefulness of our method by estimating Twiss parameters and detecting misconfigured magnets using significantly fewer measurements than standard tools. We also show how this analysis can be performed parasitically to user operation, which we hope can be used for a live optics model diagnostic and subsequent anomaly detection, improving injector reliability.

Footnotes:

Funding Agency:

The work is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357.

Thursday Poster Session / 511

Development of adaptive feedback methods for the APS linac

Author: Nikita Kuklev[1]

Co-author: Yine Sun [1]

[1] *Argonne National Laboratory*

Corresponding Author: nkuklev@anl.gov

Maintaining beam transport efficiency in the APS linac requires several feedback mechanisms to control orbit, phase, and other parameters. Presently, we apply pre-computed matrices to sets of deviations from fixed setpoints, corresponding to proportional linear feedback. This approach works most of the time but is slow and can become unstable at low charge levels. We explore two alternative machine learning (ML) methods - adaptive Bayesian optimization (ABO, developed previously) and reinforcement learning (RL). To pre-train ML methods we use a differentiable linac simulation to generate a custom kernel and policy, respectively. All 3 methods are experimentally tested using a set of simulated disturbances, and performance in terms of charge stability and recovery speed analyzed. We find that both ABO and RL techniques are more flexible than standard feedback but behave quite differently if beam degradation is large. Overall, RL appears to be the more robust long-term method for rough correction, while ABO is best for fine tuning on recent history. Based on the above results we implemented a novel hybrid scheme that dynamically combines algorithm outputs using historical and expected performance. It also restricts parameter space to the most relevant region. Preliminary results show this to be both more stable and more accurate than the standard approach. We are now exploring strategies for dynamic retraining and other advanced capabilities.

Footnotes:

Funding Agency:

The work is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357.

Thursday Poster Session / 512

GEANT4-BASED ANALYSIS OF FARADAY CUP PERFORMANCE FOR PIP-II LASER WIRE SCANNER SYSTEM

Author: Sajini Wijethunga[1]

Co-authors: Randy Thurman-Keup [1]; Victor Scarpine [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: swijethu@fnal.gov

The Proton Improvement Plan-II (PIP-II) accelerator upgrade at Fermilab marks a significant advancement in high-energy physics research. This initiative aims to enhance Fermilab's accelerator complex by replacing the existing linear accelerator with a warm front end (WFE) capable of accelerating H^- beams to 2.1 MeV. These beams are then further accelerated to 800 MeV using a superconducting linac (SCL). To accurately measure the transverse beam profile, traditional wire scanners will be utilized in the WFE section, while Laser wire scanners will be implemented along the SCL. The Faraday cup for the Laser wire scanner has been designed using the GEANT4 simulation toolkit. This paper presents a detailed analysis of its performance, focusing on electron absorption, secondary electron emission, and backscattering along the SCL.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Tuesday Poster Session / 514

Beam dynamics design of the superconducting section of a 100 mA superconducting linac

Author: Man Yi[1]

Co-author: Zhijun Wang [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Authors: wangzj@impcas.ac.cn, yiman@impcas.ac.cn

A high-power superconducting linac with an energy of 30 MeV and a beam current of 100 mA has been proposed and designed. The primary challenge lies in beam loss control and a robust lattice structure to ensure stable operation. This paper discusses the physics design study, design principles, and simulation results considering machine errors. Extensive multiparticle simulations (a cumulative statistic of 1×10ˆ5 macroparticles) demonstrated that this linac operating at 100 mA could maintain beam losses lower than 1 W/m in error scenarios.

Footnotes:

Funding Agency:

Monday Poster Session / 515

Generalization ability of convolutional neural networks trained for coherent synchrotron radiation computations

Author: Christopher Leon[1]

Co-authors: Alexander Scheinker [1]; Nikolai Yampolsky [1]; Petr Anisimov [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: cleon@lanl.gov

Coherent synchrotron radiation has a significant impact on electron storage rings and bunch compressors, inducing energy spread and emittance growth in a bunch. Calculating the effects are computationally expensive, severally limiting the use of simulations. Here, we explore utilizing neural networks (NNs) to model the 3D wakefields of electrons in circular orbit in the steady state condition. NN models were trained on both Gaussian and more general bunch distributions, which evaluate much faster than physics-based simulations. Here, we explore how well the models generalize, by testing their ability to 1) extrapolate to Gaussians with smaller/larger widths 2) predict on distributions never encountered before (out of distribution generalization) using smoothed uniform cubes. We see the models are able to generalize, which makes them potentially useful in the design and optimization of accelerator apparatuses by enabling rapid searches through parameter space.

Footnotes:

Funding Agency:

Work was supported by the Los Alamos National Laboratory Laboratory Directed Research and Development (LDRD) DR project 20220074DR

Main Session THY / 516

Commissioning of the RAON Superconducting Linac

Author: Ji-Ho Jang[1]

Co-authors: Dong-O Jeon [1]; Hyunchang Jin [1]; Hyung Jin Kim [1]

[1] *Institute for Basic Science*

Corresponding Author: jhjang@ibs.re.kr

The linear accelerator RAON consists of an injector and a superconducting linac. The injector contains two ECR ion sources and an RFQ. These ion sources produce various ions from protons (A/Q=1) to uranium (A/Q=7.2), with an energy of 10 keV/u. The RFQ accelerates these ions to an energy of 500 keV/u. The superconducting accelerator consists of two types of superconducting cavities (QWR and HWR). The linac is designed to accelerate uranium beams to 18.5 MeV/u. The beam commissioning of the injector system started in August 2021 with various ions (argon, oxygen, neon, helium, proton). The beam commissioning of the superconducting linac started in October 2022 with argon beams. This work summarizes the current status of the beam commissioning of the RAON linac.

Footnotes:

Funding Agency:

Thursday Poster Session / 517

Advancements in backwards differentiable beam dynamics simulations for accelerator design, model calibration, and machine learning

Author: Ryan Roussel[1]

Co-authors: Auralee Edelen [1]; Juan Pablo Gonzalez-Aguilera [2]; Remi Lehe [3]; Axel Huebl [3]; Jan Kaiser [4]; Andrea Santamaria Garcia [5]; Chenran Xu [5]; Annika Eichler [4]; Grégoire Charleux [3]

[1] *SLAC National Accelerator Laboratory*

[2] *University of Chicago*

[3] *Lawrence Berkeley National Laboratory*

[4] *Deutsches Elektronen-Synchrotron*

[5] *Karlsruhe Institute of Technology*

Corresponding Author: rroussel@slac.stanford.edu

Many accelerator physics problems such as beamline design, beam dynamics model calibration or interpreting experimental measurements rely on solving an optimization problem that use a simulation of beam dynamics. However, it is difficult to solve high dimensional optimization problems

using current beam dynamics simulations because calculating gradients of simulated objectives with respect to input parameters is computationally expensive in high dimensions. To address this problem, backwards differentiable beam dynamics simulations have been developed that enable computationally inexpensive calculations of objective gradients that are independent of the number of input parameters. In this work, we highlight current and future applications of differentiable beam dynamics simulations in accelerator physics, such as improving accelerator design, model calibration, and machine learning. We also describe current collaborative efforts between SLAC, DESY, KIT, and LBNL to implement fast, backwards differentiable beam dynamics simulations in Python. These tools will enable unprecedented improvements in optimization efficiency and speed when using beam dynamics simulations, leading to enhanced control and detailed understanding of physical accelerator systems.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, under DOE Contract No. DE-AC02-76SF00515, the Office of Science, Office of Basic Energy Sciences.

Thursday Poster Session / 518

Chromatic index to find a working point for a 4th generation synchrotron light source

Author: Edgar Sanchez[1]

Co-authors: Jorge Hernandez [1]; Armando Antillón [1]; Alain Flores [2]; Matías Moreno [1]

[1] *Universidad Nacional Autónoma de México*

[2] *Tec de Monterrey*

Corresponding Authors: armando@fis.unam.mx, edgarandres@fisica.unam.mx, jorge@icf.unam.mx, matias@fisica.unam.mx, alain.flores@tec.mx

The design and tuning of a storage ring for a fourth-generation synchrotron light source is very demanding. Recently, some research groups have considered techniques based on quasi-invariants of motion to address this task. This contribution presents tools, based on a quasi-invariant of motion method, for the description and optimisation of the electron dynamics in a storage ring. An overview of this quasi-invariant formalism in the context of electron dynamics in storage rings for synchrotron light sources is presented. Quasi-invariant surface techniques to study and optimise the dynamics of a particular model are shown in detail. The relevance of the distorted chromatic index for cell tuning and for determining a working point of a machine is highlighted. These techniques are implemented to optimise the horizontal electron dynamics generated by a ring model based on a 7BA cell, with 20 cells, 81 pm rad emittance and approximately 490 m circumference, and the results are presented.

Footnotes:

Funding Agency:

This work was supported by UNAM-PAPIIT IN108522. Proyecto apoyado por el "CONACYT"en el año 2023, con número CF-2023-I-119. E.S. is grateful to CONAHCYT for funding a postdoctoral fellowship.

Monday Poster Session / 519

Latent evolution model for time-inversion of spatiotemporal beam dynamics

Author: Mahindra Rautela[1]

Co-authors: Alan Williams [1]; Alexander Scheinker [1]

[1] *Los Alamos National Laboratory*

Corresponding Author: mrautela@lanl.gov

Charged particle dynamics under the influence of electromagnetic fields is a challenging spatiotemporal problem. Current physics-based simulators for beam diagnostics are computationally expensive, limiting their utility for solving inverse problems in real time. The problem of estimating upstream six-dimensional phase space given downstream measurements of charged particles is an inverse problem of growing interest. In this work, we propose a latent evolution model to invert the forward spatiotemporal beam dynamics. In this two-step unsupervised deep learning framework, we first use a variational autoencoder (VAE) to transform 6D phase space projections of a charged particle beam into a lower-dimensional latent distribution. We then autoregressively learn the inverse temporal dynamics in the latent space using a long-short-term memory (LSTM) network. The coupled VAE-LSTM framework can predict 6D phase space projections in upstream accelerating sections given downstream phase space projections as inputs.

Footnotes:

Funding Agency:

This work was supported by the LANL LDRD Program Directed Research (DR) project 20220074DR.

Monday Poster Session / **520**

Elliptical undulator in a resistive elliptical waveguide

Author: Michael Ivanyan[1]

Co-authors: Armen Grigoryan [1]; Ashot Vardanyan [2]; Bagrat Grigoryan [1]; Hrachya Babujyan [2]; Lusine Aslyan [1]; Vardan Avagyan [2]

[1] *CANDLE Synchrotron Research Institute*

[2] *Center for the Advancement of Natural Discoveries using Light Emission*

Corresponding Author: ivanian@asls.candle.am

The wakefield of a charged particle moving along an elliptical spiral-shaped trajectory in an infinite elliptical waveguide with resistive walls is calculated. A limiting transition to a flat trajectory located in one of the symmetry planes of the elliptic cylinder is carried out.

Footnotes:

Funding Agency:

The work was supported by the Science Committee of RA, in the frames of the research projects № 21T-1C239 and № 23SC-CNR-1C006.

Monday Poster Session / **521**

Geometric resonance of the wakefield of a metal-dielectric waveguide

Author: Michael Ivanyan[1]

Co-authors: Armen Grigoryan [1]; Ashot Vardanyan [2]; Bagrat Grigoryan [1]; Hrachya Babujyan [2]; Lusine Aslyan [1]; Vardan Avagyan [2]

[1] *CANDLE Synchrotron Research Institute*

[2] *Center for the Advancement of Natural Discoveries using Light Emission*

Corresponding Author: ivanian@asls.candle.am

The patterns of occurrence of geometric resonances of the wakefield in a two-layer metal-dielectric cylindrical waveguide are determined. It is shown that the sequences of their resonant frequencies are determined by the thickness of the dielectric layer and the dielectric constant of the material filling it, and do not depend on the radius of the waveguide and on the serial number of the term of the multipole expansion of the frequency distribution of the radiation field.

Footnotes:

Funding Agency:

The work was supported by the Science Committee of RA, in the frames of the research projects № 21T-1C239 and № 23SC-CNR-1C006.

Tuesday Poster Session / 523

Development of a compact RF coupler utilizing additive manufacturing

Author: Jan Kaiser[1]

Co-authors: Adem Ates [1]; Hendrik Hähnel [1]

[1] *Goethe Universität Frankfurt*

Corresponding Author: kaiser@iap.uni-frankfurt.de

Additive manufacturing (AM) has established itself as a powerful tool for rapid prototyping and the production of complex geometries. For use in a 433 MHz IH-DTL cavity, a CF-40 coupler is being developed that is manufactured from pure copper using a 3D printing process and has a water cooling concept that cannot be realized using conventional methods. The coupler consists of a ceramic window cooled on both sides, an outer conductor with spiral cooling channels and a cooled inner conductor. Thanks to its modular design, the individual components can be easily replaced. The ideal transmission is frequency-dependent and was adjusted by fine-tuning the inner conductor structure in CST-Simulations. A prototype made of aluminum was built for verification purposes.

Footnotes:

Funding Agency:

This research was funded by the German Federal Ministry of Education and Research (BMBF), grant number 05P21RFRB2

Tuesday Poster Session / 524

Circular modes for linacs

Author: Onur Gilanliogullari[1]

Co-authors: Brahim Mustapha [2]; Pavel Snopok [1]

[1] *Illinois Institute of Technology*

[2] *Argonne National Laboratory*

Corresponding Author: ogilanliogullari@anl.gov

Circular mode beams are beams with non-zero angular momentum and strong inter-plane plane coupling. This coupling can be achieved in linear accelerators (linacs) through magnetization of electrons or ions at the source. Depending on the magnetization strength, the intrinsic eigenmode emittance ratio can be large, which produces intrinsic flatness. This flatness can either be converted to real plane flatness or can be maintained as round coupled beam through the system. In this paper, we discuss rotation invariant designs that allow circular modes to be transported through the lattice while accelerating and maintaining its circularity. We demonstrate that with rotation invariant designs the circularity of the mode can be preserved as round beam while maintaining intrinsic flatness to be converted to flat beam later or injected into a ring.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

Thursday Poster Session / 525

Integration of HKL single crystal computations into EPICS using PyDevice

Author: Alexander Baekey[1]

Co-author: Kazimierz Gofron [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: alexanderbaekey@gmail.com

In this work, we integrate and extend an HKL computation package*into EPICSthrough a PyDevice*** IOC. This provides EPICS users a generalized approach to mapping real motor rotation space to HKL reflections for a wide range of diffractometers (4-circle, 6-circle, kappa geometries). Utilizing PyDevice for EPICS IOC development allows us to bind core calculations written in C to Python, simultaneously taking advantage of the efficiency of C and readability of Python. The EPICS IOC provides an interface between beamline hardware and users through an intuitive Phoebus CSS GUI, Extensions are being developed to the original HKL package to handle inelastic scattering in addition to the original elastic scattering case for neutron and X-ray diffraction.

Footnotes:

*https://repo.or.cz/hkl.git**https://epics-controls.org/***https://github.com/klemenv/PyDevice/

Funding Agency:

UT-Battelle, LLC, under contract DE-AC05-00OR22725 with the US Department of Energy (DOE)
Oak Ridge National Laboratory GEM Fellowship Internship Program

Monday Poster Session / **526**

Beam loss mechanisms in the PIP-II linac and beam transfer line at Fermilab

Author: Abhishek Pathak[1]

Co-author: Olivier Napoly [2]

[1] *Fermi National Accelerator Laboratory*

[2] *Commissariat à l'Energie Atomique*

Corresponding Author: abhishek@fnal.gov

Beam loss in high-intensity H- linacs, such as the PIP-II linac at Fermilab, is a critical challenge that requires comprehensive study and understanding to ensure efficient and safe operation. This study explores the various beam loss mechanisms encountered in the PIP-II linac and its beam transfer line, drawing parallels from other high-intensity H- linacs. Key loss mechanisms include residual gas stripping, where H- ions interact with residual gas molecules leading to electron detachment; field stripping, caused by the interaction of H- ions with magnetic fields; and intra-beam stripping, resulting from interactions within the beam itself. Beam halo formation, particularly due to Twiss function mismatch, is another significant source of beam loss, which can be exacerbated by Landau damping mechanisms. Adhering to the 1 W/m loss criterion is essential to maintain hands-on maintenance capability and ensure the longevity of the accelerator components. By understanding these mechanisms and implementing targeted mitigation strategies, the PIP-II linac can achieve its design goals while maintaining safe and efficient operations.

Footnotes:

Funding Agency:

Thursday Poster Session / **527**

Using TimePix3 detector for neutron and X-ray studies

Author: Kazimierz Gofron[1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: gofronkj@ornl.gov

The 65k pixel TimePix3 chip with ToA of 1.5625 [ns] nominal time resolution, allows timing and imaging studies using X-ray, neutron, and electron spectroscopies. The EPICS*ADTimePix3areaDetector***driver enables control and integration into the beamline acquisition system. This presentation will discuss the recent development of the beamline integration of the detector into neutron beamlines and selected results**.

Footnotes:

*https://epics-controls.orghttps://github.com/areaDetector/ADTimePix3***https://github.com/areaDetector****F. Funama et al., "Scintillator-based Timepix3 detector for neutron spin-echo techniques using intensity modulation", Rev. Sci. Instr. 95, 033304 (2024), https://doi.org/10.1063/5.0189920

Funding Agency:

This manuscript has been authored by UT-Battelle, LLC, under contract DE-AC05-00OR22725 with the US Department of Energy (DOE). The US government retains and the publisher, by accepting the article fo

Monday Poster Session / 528

Photocathode drive laser upgrade for the Advanced Photon Source linac

Author: Jeffrey Dooling[1]

Co-authors: Alex Lumpkin [1]; Alexander Zholents [1]; Kent Wootton [1]; Philippe Piot [2]; William Berg [1]; Yine Sun [1]

[1] *Argonne National Laboratory*

[2] *Northern Illinois University*

Corresponding Author: dooling@anl.gov

A Ytterbium-based photocathode gun drive laser is proposed for the Advanced Photon Source linac to replace the existing antiquated Nd:Glass laser. The proposed laser will readily operate at 30 Hz providing 0.3 mJ of 257-nm UV radiation per pulse yielding 1 nC from our copper cathode, s-band gun in support of user operations. In addition, the laser allows generation of lower-charge, low-emittance electron beams for high-brightness experiments in the APS Linac Extension Area. An advantage of updating the PC Gun drive-laser is that the configuration includes a downstream 3-m-long accelerating structure; this provides an additional 35-40 MeV of energy at the linac output over what is presently available from either of the two thermionic-cathode guns. Higher linac output energy will enhance stability for high-charge operation of the new storage-ring. We outline the laser physics requirements for our LCLS-I-style PC gun and summarize the expected beam performance.

Footnotes:

Funding Agency:

This work is supported by the U.S. D.O.E.,Office of Science, Office of Basic Energy Sciences, under contract number DE-AC02- 06CH11357.

Thursday Poster Session / 529

Simulated performance of a compact water-window FEL driven by a structure wakefield accelerator

Author: Rachel Margraf-O'Neal[1]

Co-authors: John Power [1]; Joseph Xu [1]; Philippe Piot [2]

[1] *Argonne National Laboratory*

[2] *Northern Illinois University*

Corresponding Author: rmargraf@stanford.edu

Free-electron lasers (FELs) send an accelerated electron beam through a magnetic undulator to provide a source of continuously tunable, short (10s of fs), high-peak power (GW-scale) radiation. FELs have found many applications, particularly in the infrared, extreme ultraviolet (EUV) and X-ray

regimes. However, current EUV and X-ray FELs are large (100s of m) and expensive facilities, limiting the accessibility of these sources. In this work, we present FEL simulations driven by a compact accelerator combining high-gradient short pulse two-beam wakefield accelerators [1] and short-period superconducting undulators [2]. An FEL demo based on a GeV-scale accelerator is discussed as a driver for a water-window (2.3-4.4 nm) FEL with a ≈ 50 m length. Such a proof-of-principle integrated facility would serve the dual purpose of supporting user-based research in the water-window regime, and providing a proving ground for these new technologies to later be applied to shorter wavelength FELs. Here, we present early design and simulation efforts with a focus on FEL-process modeling.

Footnotes:

[1]W. H. Tan et al., "Demonstration of sub-GV/m accelerating field in a photoemission electron gun powered by nanosecond x-band radio-frequency pulses,"Phys. Rev. Accel. Beams, vol. 25, no. 8, p. 083402, Aug. 2022, doi: 10.1103/PhysRevAccelBeams.25.083402.
[2]I. Kesgin et al., "Quench Behavior of 18-mm-Period, 1.1-m-Long Nb3Sn Undulator Magnets,"IEEE Transactions on Applied Superconductivity, vol. 34, no. 5, pp. 1–10, Aug. 2024, doi: 10.1109/TASC.2024.3350606.

Funding Agency:

Funded by Laboratory Directed Research and Development (LDRD) at Argonne National Laboratory, provided by the Director, Office of Science, of the U.S. DOE under Contract No. DE-AC02-06CH11357.

Tuesday Poster Session / 530

S-band RF pulse compressor for high-gradient carbon therapy linac

Author: Aurora Cecilia Araujo Martinez[1]

Co-authors: Alexander Smirnov [2]; Ronald Agustsson [2]; Seiji Thielk [2]; Sergey Kutsaev [2]; Valery Dolgashev [3]

[1] *RadiaBeam Technologies*

[2] *RadiaBeam*

[3] *SLAC National Accelerator Laboratory*

Corresponding Author: araujo@radiabeam.com

Novel hadron radiotherapy accelerator-based systems require a fast-imaging capability, synchronized with the hadron beam, to allow positioning and treating the tumor practically at the same time. Such systems must operate at high repetition rates (˜1,000 pulses per second) to provide reasonable treatment times. Currently, Argonne and RadiaBeam are collaborating on a high-gradient carbon therapy linac project, ACCIL, based on 40 MV/m S-band accelerating structures. In order to operate at repetition rates, the structures must be powered by the 5 MW klystrons. However, high gradient operation requires quadruple of this power. Therefore, we developed a compact S-band RF pulse compressor based on an E-plane polarizer and a spherical cavity operating at 2856 MHz. It incorporates features such as a cut-off circular port opposite to the circular waveguide to facilitate vacuum pumping, along with cooling channels distributed around the cavity and polarizer to manage the thermal loads. The RF pulse compressor is expected to generate a flat 18 MW 300 ns flat-top RF pulse with a 62% efficiency. We will present the mechanical design and fabrication status of the device.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, Office of High Energy Physics, under STTR grant DE-SC0015717 and Accelerator Stewardship Grant, Proposal No.0000219678.

Tuesday Poster Session / 531

Test results of an improved multi-dimensional Bunch Shape Monitor

Author: Aurora Cecilia Araujo Martinez[1]

Co-authors: Adam Moro [1]; Alexander Aleksandrov [2]; Alexander Smirnov [3]; Ronald Agustsson [3]; Sergey Kutsaev [3]

[1] *RadiaBeam Technologies*

[2] *Oak Ridge National Laboratory*

[3] *RadiaBeam*

Corresponding Author: araujo@radiabeam.com

RadiaBeam has developed and built a Bunch Shape Monitor (BSM) prototype for measuring the longitudinal bunch distribution in hadron linear accelerators. The device has been designed to operate at 402.5 MHz and it incorporates three main innovations to improve its performance: a focusing field between the target wire and the entrance slit for better collection efficiency, a novel design of the RF deflector to enhance beam linearity, and a moving mechanism that allows shifting both the wire and deflector cavity to enable transverse profile measurements. The BSM prototype has been installed at the Beam Test Facility at the Spallation Neutron Source and is currently under testing for characterization. In this paper, we will present the design, fabrication, and first test results of the BSM prototype.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, Office of Basic Energy Sciences, under contract DE-SC0020590.

Tuesday Poster Session / 532

Design of a 25 kW fundamental power coupler for conduction cooled Nb3Sn industrial linac

Author: Seiji Thielk[1]

Co-authors: Ronald Agustsson [1]; Sergey Kutsaev [1]; Alexey Pronikov [2]; Aurora Cecilia Araujo Martinez [2]; John Vennekate [3]; Gianluigi Ciovati [3]; Robert Rimmer [3]

[1] *RadiaBeam*

[2] *RadiaBeam Technologies*

[3] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: sthielk@radiabeam.com

RadiaBeam is designing a 915 MHz, 25 kW CW Fundamental Power Coupler (FPC) to power a Nb3Sn coated superconducting radio-frequency (SRF) cavity. Unlike traditional FPCs for SRF cavities, the device relies only on conductive cooling by cryocoolers. The baseline design was adapted from the liquid helium cooled 805 MHz SNS FPC with the notable addition of an intermediate 50 K thermal

intercept and associated RF shield. Engineering design details to address the thermomechanical, manufacturability, and structural challenges will be presented. Particular emphasis will be placed on static and dynamic heat load management along with finite element analysis to validate mechanical stability. Additionally, initial manufacturing studies of the coaxial window brazing will be discussed along with full device manufacturing and integration plans.

Footnotes:

Funding Agency:

This work has been supported by the ACCELERATE grant and an ARDAP Stewardship by the DOE through Jefferson Lab.

Tuesday Poster Session / **533**

CEBAF operations, performance, and future plans

Author: Eduard Pozdeyev[1]

[1] *Jefferson Lab*

Corresponding Author: pozdeyev@jlab.org

CEBAF has been providing electron beams for nuclear physics experiments for almost 30 years. Ten years ago, it went through a major upgrade to increase the beam energy from 6 to 12 GeV. This paper summarizes the status of the CEBAF 12 GeV operations. We discuss the performance of the machine, limitations, and performance enhancements. Also, the paper discusses future upgrade plans.

Footnotes:

Funding Agency:

Monday Poster Session / **534**

Machine learning tools to support heavy-ion linac operations

Author: Brahim Mustapha[1]

[1] *Argonne National Laboratory*

Corresponding Author: brahim@anl.gov

At a heavy ion linac facility, such as ATLAS at Argonne National Laboratory, a new ion beam is tuned once or twice a week. The use of machine learning can be leveraged to streamline the tuning process, reducing the time needed to tune a given beam and allowing more beam time for the experimental program. After establishing automatic data collection and two-way communication with the control system, we have developed and deployed machine learning models to tune and control the machine. We have successfully trained online different Bayesian Optimization (BO)-based models for different sections of the linac, including the commissioning of a new beamline. We have demonstrated transfer learning from one ion beam to another allowing fast switching between different ion beams. We have also demonstrated transfer learning from a simulation-based model to an online machine model and used Neural Networks as prior-mean for BO optimization. More recently, we have succeeded in training a Reinforcement Learning (RL) model online for one beam and deployed

it for the tuning of another beam. These models are being generalized to other sections of the ATLAS linac and can, in principle, be adapted to control other ion linacs and accelerators with modern control systems.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, under Contract No. DE-AC02-06CH11357. This research used the ATLAS facility, which is a DOE Office of Nuclear Physics User Facility.

Thursday Poster Session / **535**

LCLS-II longitudinal beam diagnostics based on a short S-band deflector

Author: Valery Dolgashev[1]

Co-authors: Axel Brachmann [1]; Ernest Williams [1]; Eugene Kraft [1]; Kathleen Ratcliffe [1]; Michael Kosovsky [1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: dolgash@slac.stanford.edu

We designed, built and commissioned a beam diagnostic system based on a short S-band defector and a commercial klystron transmitter. A two feet long transverse-horizontally deflecting S-band rf structure (STCAV2) is installed the LCLS-II post-laser-heater diagnostic beamline at 100 MeV electron beam energy to measure the absolute electron bunch length and to allow time-resolved beam quality measurements such as vertical slide emittance and slice energy spread. The deflector is designed to produce 0.48 MeV peak kick at 300 kW of input power. The klystron transmitter, which uses a commercial solid-state modulator, is installed in the klystron gallery at the grade level. The low-level RF system is based on ATCA and developed in-house. We will report on the overall performance of the project, which was successfully completed, on May 31, 2024.

Footnotes:

Funding Agency:

Tuesday Poster Session / **536**

First-principle beam-dynamics simulations of alpha magnets for bunch compression of bright beams

Author: Afnan Al Marzouk[1]

Co-author: Philippe Piot [1]

[1] *Northern Illinois University*

Corresponding Author: aalmarzouk@niu.edu

Producing bright electron beams is crucial for coherent light sources, where increasing the peak current is typically accomplished through bunch compression in magnetic chicanes. Alpha magnets, with their unique phase-space manipulation capabilities, have emerged as an attractive choice for

compressing sub-10 MeV electron beams generated by radio frequency photoinjectors. This paper presents detailed numerical modeling of the beam dynamics of high-charge, bright bunches undergoing compression within an alpha magnet. The model incorporates space-charge effects and coherent synchrotron radiation, providing a comprehensive understanding of the complex interactions and behaviors of the electron beams during the compression process.

Footnotes:

Funding Agency:

Thursday Poster Session / 537

LLM integration into EPICS

Author: Ethan Adams[1]

Co-author: Bayan Sobhani [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: eradams02@comcast.net

The utilization of large language models (LLMs) such as ChatGPT has seen a remarkable increase in various fields over the past few years. These models have demonstrated their versatility and capability in understanding and generating human-like text, making them invaluable tools in numerous applications. In this project, we explore the integration of a LLM into the Experimental Physics and Industrial Control System (EPICS). The primary focus of this integration is to employ the LLM for advanced image processing and spatial analysis on images obtained from the beamlines. By leveraging the capabilities of the LLM, we aim to enhance the accuracy and efficiency of image interpretation, enabling more precise data analysis and decision-making within the EPICS framework. This integration not only showcases the potential of LLMs in scientific and industrial applications but also sets the stage for future advancements in automated control systems.

Footnotes:

Funding Agency:

Thursday Poster Session / 538

Design of photonic band gap superconducting cavity working at 3.9 GHz

Author: Zixuan Du[1]

Co-author: Zhenchao Liu [1]

[1] *Xi'an Jiaotong University*

Corresponding Author: 2196113776@stu.xjtu.edu.cn

RF superconducting cavities have been widely used in accelerators. The higher order modes caused by the wakefield radiation will lead to the beam instability, which is very harmful. So, it is necessary to depress the higher order modes. The photonic band gap (PBG) structure can effectively absorb higher order modes and suppress wakefield radiation. In addition, PBG cavities based on PBG structures have the advantage of adding waveguide ports directly to the cavity wall. Therefore, the PBG cavity can be used directly as a coupler, instead of the coupler attached to the end cell. So far, the

PBG cavities have been tested and validated. On this basis, a PBG cavity working at 3.9 GHz was designed, and a couple of waveguide couplers are added to the cavity to ensure that all dangerous higher order modes in the cavity can be exported. After that, we used the CST microwave studio to calculate the electromagnetic parameters of the cavity. Accordingly, Q0=11488, Qe=1.149×1011, Eacc = 8.159×107, and Epeak/Eacc = 2.317.

Footnotes:

Funding Agency:

Main Session TUY / 539

Accelerator science and technology at the U.S. Department of Energy Office of Science

Author: Camille Ginsburg[1]

[1] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: camille.ginsburg@science.doe.gov

In 2014, U.S. Congress recognized accelerator science and technology (AS&T) as a critically important cross-cutting topic within the U.S. Department of Energy (DOE) Office of Science (SC), leading to the creation of the Accelerator Stewardship program. Congress further clarified and broadened SC's role in 2022 with the Chips and Science Act* to (1) advance accelerator science and technology relevant to DOE, other federal agencies, and U.S. industry; (2) foster partnerships to develop, demonstrate, and enable the commercial application of accelerator technologies; (3) support the development of a skilled, diverse, and inclusive accelerator workforce; and (4) provide access to accelerator design and engineering resources. An overview of current programs in support of our congressional mandate is provided.

Footnotes:

*https://www.congress.gov/bill/117th-congress/house-bill/4346

Funding Agency:

Thursday Poster Session / 540

Proposed investigations of electron-beam microbunching in the Advanced Photon Source linac

Author: Alex Lumpkin[1]

Co-authors: Jeffrey Dooling [1]; Kent Wootton [1]; William Berg [1]; Yine Sun [1]

[1] *Argonne National Laboratory*

Corresponding Author: lumpkin@anl.gov

We propose further investigations on the longitudinal-space-charge-impedance mechanism for inducing microbunching of relativistic electron beams within the Advanced Photon Source S-band linac. The microbunched content is evaluated by observing the coherent enhancements of optical transition radiation (COTR) generated as the beam transits a metal-vacuum interface. The facility also uniquely includes both thermionic cathode and photocathode rf guns as electron sources for comparisons of effects. Previously, we addressed mitigation of the COTR's deleterious effects in

the 2-D visible-light beam images at 325 MeV. *By extending our wavelength coverage into the NIR, we will access the much stronger enhancements predicted (>100)** and elucidate their spectral content. We will use an existing optical transport line for visible to NIR COTR (0.4 to 3.0 microns) from the diagnostics cube in the tunnel to an enclosed, external optics table. The inexpensive addition of a NIR-sensitive photodiode and integrating circuit with an existing digital oscilloscope in the optical setup would provide immediate extension of the detectors'wavelength coverage and would enable the testing of the current model predictions for the microbunching instability into the NIR.

Footnotes:

*A.H. Lumpkin et al., Phys. Rev. ST Accel. and Beams, Vol. 12, p. 080702 (2009).
** E.L. Saldin, E.A Schneidmiller, M.V. Yurkov, NIM Phys. Res. A, vol. 490, pp1-8, (2002).

Funding Agency:

This research used resources of the Advanced Photon Source, operated for the U.S. Department of Energy Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357.

Thursday Poster Session / 541

The PIP-II dedicated Radio Frequency Protection Interlock system full scale prototype design and integration

Author: Wojciech Cichalewski[1]

Co-authors: Bartosz Pekoslawski [1]; Grzegorz Jablonski [1]; Jeremiah Holzbauer [2]; Kacper Klys [1]; Niral Patel [2]; Pawel Marciniak [1]; Philip Varghese [2]; Piotr Amrozik [1]; Rafal Kielbik [1]; Rafal Kotas [1]; Wojciech Jalmuzna [1]; Wojciech Tylman [1]

[1] *Technical University of Lodz*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: wcichal@dmcs.pl

The Radio Frequency Protection Interlock (RFPI) system watches over fifty signals near the superconducting cavities cryomodule. Its major role is to recognize faulty situations instantly and drop permits for the Low-Level Radio Frequency control system (LLRF) and Solid State Amplifier (SSA) operation.

The full-scale prototype RFPI is a recent version of the PIP-II dedicated system capable of fulfilling the requirements of this newly constructed Linac project. Its hardware structure is compact but still modular. It provides enough capability to protect four superconducting resonators and their close environment at the same time.

This work summarizes the production phase and integration process of this designed RFPI system. The work introduces also the hardware and software structures of this system. Moreover, we also summarize the on-the-bench testing experiences from the individual hardware module verification and integrated RFPI studies.

Footnotes:

Funding Agency:

Thursday Poster Session / 542

A laser plasma wakefield electron accelerator for the Advanced Photon Source and Low-Energy Accelerator Facility

Author: Kent Wootton[1]

Co-authors: Alex Lumpkin [1]; Charles Kozlowski [1]; Emmanuel Aneke [2]; Frank Westferro [1]; Jeffrey Dooling [1]; Joseph Calvey [1]; Mike Edelen [1]; Sergey Chemerisov [1]; Vadim Sajaev [1]; Victor Guarino [1]; William Berg [1]

[1] *Argonne National Laboratory*

[2] *Northwestern University*

Corresponding Author: kwootton@anl.gov

Recent developments in laser wakefield accelerators (LWFAs) lead us to consider employing this technology to accelerate electrons at the Advanced Photon Source (APS) facility. Previous experiments using LWFAs were performed at Argonne using the Terawatt Ultrafast High Field Facility. The injector complex serving the APS begins with an electron linac, producing beam energies on the order of 450 MeV. We consider that the infrastructure developed at the Linac Extension Area (LEA) could be usefully employed to develop a new LWFA injector for the APS linac. In the present work, we outline the proposed parameters of an LWFA using approximately a 100-TW-peak laser pulse focussed into a few-mm in extent pulsed gas jet. We are targeting electron beam energies in the range 300–500 MeV. Initially, we would use the LEA quads, diagnostics and electron spectrometer to demonstrate performance and characterize the LWFA beam, before moving the LWFA to inject into the Particle Accumulator Ring (PAR).

Footnotes:

Funding Agency:

This research used resources of the Advanced Photon Source, operated for the U.S. Department of Energy Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357.

Monday Poster Session / 543

Thin Au layers on niobium for SRF cavities

Author: Sadie Seddon-Stettler[1]

Co-authors: Matthias Liepe [1]; Nathan Sitaraman [2]; Thomas Oseroff [1]; Van Do [3]; Helena Lew-Kiedrowska [3]; Chi Wang [4]; Steven Sibener [3]

[1] *Cornell University (CLASSE)*

[2] *Cornell University*

[3] *The University of Chicago*

[4] *National Cheng Kung University*

Corresponding Author: sgs238@cornell.edu

New materials beyond the standard bulk niobium have the potential to greatly improve the performance of Superconducting Radio Frequency (SRF) cavities. Specifically, thin coatings of normal conductors such as gold have the potential to improve the key RF performance metric of quality factor. We present progress on depositing thin gold layers onto 2.6 GHz SRF cavities and testing their RF performance.

Footnotes:

Funding Agency:

U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams; U.S. Department of Energy under Award DE-SC0024137.

Monday Poster Session / 544

Mitigation of longitudinal beam losses in the FRIB linac

Author: Alec Gonzalez[1]

Co-authors: Alexander Plastun [1]; Peter Ostroumov [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: gonza603@msu.edu

The linear accelerator at the Facility for Rare Isotope Beams (FRIB) at Michigan State University uses a thin liquid Lithium film for charge stripping of high-intensity heavy ion beams. Energy straggling of the beam in the non-uniform Lithium film affects the energy distribution in the beam. This can lead to non-linear "tails"in the longitudinal phase-space beam distribution after bunching at the two 161 MHz Multi-Gap Bunchers (MGBs) between the stripper and the next accelerating segment. Some particles in these "tails"are lost in the downstream accelerator cryomodules. To mitigate these losses, we have designed a room-temperature IH-type buncher cavity with a resonant frequency of 322 MHz. The new harmonic cavities will be installed next to each MGB, linearizing the waveform of the effective bunching voltage and eliminating the formation of non-linear "tails."The increase in the energy acceptance of the post-stripper part of the accelerator reached over 50% according to our simulations. We present the electromagnetic design of this cavity along with beam dynamics simulations that demonstrate how the losses are mitigated. The construction and installation of the cavity are being pursued as an accelerator improvement project.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, High Energy Physics under Cooperative Agreement award number DE-SC0018362 and Michigan State University.

Monday Poster Session / 545

High Q and high gradient performance of the first medium-temperature baking 1.3 GHz cryomodule

Author: Jiyuan Zhai[1]

Co-authors: Feisi He [1]; Haiying Lin [1]; Peng Sha [1]; Qunyao Wang [1]; Rui Ge [1]; Ruixiong Han [1]; Song Jin [1]; Weimin Pan [2]; Zheng Mi [2]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

Corresponding Author: zhaijy@ihep.ac.cn

The world's first 1.3 GHz cryomodule containing eight 9-cell superconducting radio-frequency (RF) cavities treated by medium-temperature furnace baking (mid-T bake) was developed, assembled and tested at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences for the Dalian

Advanced Light Source (DALS). The 9-cell cavities in the cryomodule achieved an unprecedented high average intrinsic quality factor (Q0) of 3.8E10 at 16 MV/m and 3.6E10 at 21 MV/m in the horizontal test. The cryomodule can operate stably up to a total continuous wave (CW) RF voltage greater than 191 MV, with an average cavity usable accelerating gradient of more than 23 MV/m. The results significantly exceed the specifications of DALS and the other high repetition rate free electron laser facilities (LCLS-II, LCLS-II-HE, SHINE, S3FEL etc.). This paper reviews the cryomodule performance and discusses some important issues in cryomodule assembly and testing.

Footnotes:

Funding Agency:

Monday Poster Session / **546**

Accelerator design choices for a compact, electron-driven, pulsed neutron source

Author: Laurence Wroe[1]

Co-authors: Andrea Latina [1]; Francois Plewinski [2]; George Kharashvili [3]; Javier Olivares Herrador [1]; Roberto Corsini [1]; Steinar Stapnes [1]; Walter Wuensch [1]

[1] *European Organization for Nuclear Research*

[2] *European Spallation Source ERIC*

[3] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: laurence.wroe@cern.ch

Neutron scattering is an indispensable technique in material science research for providing solutions to important engineering challenges, including the ever-growing demand for more efficient batteries and fuel-cells. There are, however, limitations in the access and availability to the necessary neutron beams and this is worsening as nuclear research reactors continue to shut down. As a result, there appears to be market demand for an affordable, medium-flux, compact, accelerator-driven neutron source optimised for deployment in an industrial setting. In this paper, we present an overview of the beam specification and the high-level design choices for an electron linear accelerator that is optimised to drive such a facility.

Footnotes:

Funding Agency:

Monday Poster Session / **547**

Performance of the Fermilab linac injector

Author: Daniel Jones[1]

Co-authors: Dan Bollinger [1]; Valery Kapin [1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: dcjones@fnal.gov

The Fermilab linac injection line consists of a 35 keV magnetron-type H- ion source, two-solenoid Low Energy Beam Transport (LEBT), 201 MHz 4-rod 750 keV Radio Frequency Quadrupole (RFQ),

and a Medium Energy Transport (MEBT) containing 4 quadrupoles and a bunching cavity. The injector delivers 25 mA, 48 μs pulses to drift-tube linac at a repetition rate of 15Hz. The transmission efficiency has been lower than expected since commissioning. Recent beam current measurements suggest that the beam is primarily lost upstream of the RFQ exit. Numerical simulations indicate that ions passing through the non-linear field region of the solenoids could produce a beam with an increased emittance resulting in up to 50 % of the LEBT beam current failing to meet the RFQ acceptance. An aperture restriction was installed upstream of the first solenoid to remove these ions. This report describes the results of measurements and simulations as well as the LEBT tuning.

Footnotes:

Funding Agency:

Monday Poster Session / **548**

Standing wave Dielectric Disk Accelerating structure design and cold test results

Author: Sarah Weatherly[1]

Co-authors: Ben Freemire [2]; Chunguang Jing [3]; Eric Wisniewski [1]; John Power [3]; Scott Doran [3]

[1] *Illinois Institute of Technology*

[2] *Euclid Beamlabs LLC*

[3] *Argonne National Laboratory*

Corresponding Author: sweatherly@hawk.iit.edu

A Dielectric Disk Accelerator (DDA) is a metallic accelerating structure loaded with dielectric disks to increase coupling between cells, thus high group velocity, while still maintaining a high shunt impedance. This is crucial for achieving high efficiency high gradient acceleration in the short rf pulse acceleration regime. Research of these structures has produced traveling wave structures that are powered by very short (˜9 ns), very high power (400 MW) RF pulses using two beam acceleration to produce these pulses. In testing, these structures have withstood more than 320 MW of power and produced accelerating gradients of over 100 MV/m. The next step of testing these structures will use a more conventional, klystron power source. A new standing wave DDA structure is being fabricated for testing on the Nextef2 test stand at KEK. Simulation results of this structure show that at 50 MW of input power, the DDA produces a 457 MV/m gradient. It also has a large shunt impedance of 160 MΩ/m and an r/Q of 21.6 kΩ/m. Cold testing of this structure will be conducted July 2024 with high power testing to be done in August.

Footnotes:

Funding Agency:

Monday Poster Session / **549**

Simultaneous acceleration of proton and H-minus beams in RFQ

Author: Sergey Kurennoy[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: kurennoy@lanl.gov

The Los Alamos Neutron Science Center (LANSCE) accelerator complex delivers both protons (p) and negative hydrogen ions (H-) and provides various beam patterns simultaneously to multiple users. The LANSCE linac front end is still based on Cockcroft-Walton voltage generators that bring proton and H- beams to 750 keV. An upgrade of the front end to a modern, RFQ-based version is now under consideration. The most promising upgrade option is based on acceleration of two continuous beams, p and H-, injected simultaneously into a single RFQ, which has never been done before. We use an existing CST model of a proton RFQ to model simultaneous acceleration of proton and H- beams as a proof of principle for such an RFQ operation.

Footnotes:

Funding Agency:

Monday Poster Session / **550**

High pulsed power measurements of superheating fields for SRF materials

Author: Nicole Verboncoeur[1]

Co-authors: Adam Holic [1]; Matthias Liepe [1]; Ryan Porter [1]; Thomas Oseroff [1]; Liana Shpani [1]; James Sears [1]

[1] *Cornell University (CLASSE)*

Corresponding Author: nmv39@cornell.edu

The Cornell High Pulsed Power Sample Host Cavity (CHPPSHC) is a new system designed to measure the superheating field of candidate superconducting RF (SRF) materials, giving insight into their operational limits. This system is designed to reach peak magnetic fields of up to 0.5 T in only a few microseconds, allowing us to achieve a pure magnetic field quench on the sample. We present an overview of the CHPPSHC system and proof of principle data from a niobium sample.

Footnotes:

Funding Agency:

Supported by U.S. Department of Energy Grant No DE-SC0008431

Monday Poster Session / **552**

Low energy multi-beam dynamics in novel LANSCE front end

Author: Yuri Batygin[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: batygin@lanl.gov

The proposed novel 100 MeV injector for the LANSCE Accelerator Facility* is designed to replace the existing 750-keV Cockcroft-Walton-columns-based injector. The new Front End includes two independent low-energy transports for H+ and H- beams merging at the entrance of a single RFQ, with the subsequent acceleration of particles in the new Drift Tube Linac. The challenge of the design

is associated with the necessity of simultaneous acceleration of protons and H- ions with different beam currents, beam charges per bunch, beam emittances, and space charge depression, in a single RFQ and DTL, while injection beam energy is reduced from 750 keV to 100 keV. Acceleration of various beams in a single RFQ provides less flexibility for optimal adjustment of acceleration and focusing parameters concerning the existing LANSCE setup. The paper discusses details of self-consistent multi-beam dynamics in the proposed injector.

Footnotes:

*Y. K. Batygin et al., "Advancement of LANSCE Front End Accelerator Facility", in Proc. IPAC'21, Campinas, Brazil, May 2021, p.1894 (2021).

Funding Agency:

The research presented in this paper was supported by the Laboratory Directed Research and Development program of Los Alamos National Laboratory under project number 20240177ER.

Monday Poster Session / 553

Beam optics design of a prototype 20 kW conduction-cooled SRF accelerator for medical sterilization

Author: Arun Saini[1]

[1] *Fermi National Accelerator Laboratory*

Corresponding Author: asaini@fnal.gov

Superconducting technology has significantly advanced the capabilities of particle accelerators, facilitating higher beam-power operations for fundamental research at a comparatively lower cost. However, the conventional implementation of superconducting technology introduces complexities in the form of cryogenic plants, cryogenic distribution systems and substantial construction and operational cost. In response to these challenges, recent research efforts at Fermilab have been dedicated to the development of a cryogen-free, conduction-cooled Nb3Sn-based superconducting technology. This paper outlines the beam optics design of a 20-kW conduction-cooled compact superconducting accelerator for medical sterilization. The paper reviews both the physics and practical constraints associated with high beam-power operation within the context of industrial applications. The focus is on providing insights into the potential of this innovative technology to overcome existing challenges and pave the way for more accessible and efficient industrial particle accelerators.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics

Monday Poster Session / 554

Automation of RF tuning for medical accelerators

Author: Finn O'Shea[1]

Co-authors: Auralee Edelen [1]; Jonathan Edelen [2]; Jorge Diaz Cruz [3]; Morgan Henderson [2]

[1] *SLAC National Accelerator Laboratory*

[2] *RadiaSoft LLC*

[3] *University of New Mexico*

Corresponding Author: foshea@slac.stanford.edu

RadiaSoft is developing machine learning methods to improve the operation and control of industrial accelerators. Because industrial systems typically suffer from a lack of instrumentation and a noisier environment, advancements in control methods are critical for optimizing their performance. In particular, our recent work has focused on the development of pulse-to-pulse feedback algorithms for use in dose optimization for FLASH radiotherapy. The PHASER (pluridirectional high-energy agile scanning electronic radiotherapy) system is of particular interest due to the need to synchronize 16 different accelerators all with their own noise characteristics. This presentation will provide an overview of the challenges associated with RF tuning for a PHASER-like system, a description of the model used to evaluate different control schema, and our initial results using conventional methods and machine learning methods.

Footnotes:

Funding Agency:

This work is supported by the DOE Office of Science Office of Accelerator Research Development and Production award number DE-SC0023641.

Tuesday Poster Session / 555

2D material integration with cathodes for accelerators

Author: Hisato Yamaguchi[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: hyamaguchi@lanl.gov

The studies commissioned by the U.S. Department of Energy have repeatedly identified electron sources as critical risk area for development of future accelerators including LINAC. To address this challenge, we initiated an effort of integrating 2D materials with cathodes in 2013. The aim was to protect environmentally susceptible but high performing alkali antimonide semiconductor photocathodes with atomically thin two-dimensional (2D) materials such as graphene. The concept behind the effort was to decouple the competing mechanisms of high quantum efficiency and long lifetime. Our team succeeded in demonstration of the concept on metal photocathodes in 2017, won R&D 100 Award in 2019 and recently succeeded in demonstrating graphene encapsulated potassium caesium antimonide photocathodes to remain active in 3 orders of magnitude higher pressure compared to non-protected counterpart. The breadth of possibilities of 2D material integration with cathodes for accelerators will also be covered based on our findings during past decade such as graphene as reusable substrates for alkali antimonide photocathodes, prevention of alloying between substrate material and alkali antimonide photocathode by graphene coating, demonstration of no detectable emittance increase on metal single crystal photocathodes by graphene coating, and work function lowering of thermionic- and photo-cathodes by monolayer hexagonal boron nitride coating.

Footnotes:

Funding Agency:

Tuesday Poster Session / 556

Development of wet nitrogen doping to enhance Q performance of β=0.53 half-wave resonators

Author: Yuting Wu[1]

Co-authors: Andrei Ganshyn [1]; Chris Compton [1]; Ethan Metzgar [1]; Kenji Saito [2]; Kyle Elliott [1]; Laura Popielarski [1]; Sang-Hoon Kim [1]; Spencer Combs [2]; Taro Konomi [2]; Ting Xu [2]; Walter Hartung [1]; Wei Chang [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Facility for Rare Isotope Beams*

Corresponding Author: wuyu@frib.msu.edu

FRIB is developing a new N-doping method with a simplified recipe. This recipe is called wet nitrogen doping, by adding nitric acid to the conventional EP acid. Nitrogen doping introduces impurities to the SRF surface, and reduces the BCS resistance by shortening the mean free path, which leads to a higher Qo. Conventional nitrogen doping, developed at FNAL and Jlab, requires a high-temperature treatment (900 °C), and an additional light EP to remove the over-contaminated layer. This recipe produces a decreasing Qo at extremely low fields but successfully achieves high Qo performance up to 25 MV/m. The wet doping method does not require additional high-temperature baking and light EP afterwards, therefore it is superior in terms of processing steps. This method produced a high Qo of 8x10ˆ10 at a low field of 0.5MV/m without the decreasing trend on FRIB beta=0.53 HWR. In this presentation, we will show the related R&D results generated from the FRIB 0.53 HWRs.

Footnotes:

Funding Agency:

the U.S. Department of Energy, Office of Science,DOE Office of Science User Facility under Award Number RC114424

Tuesday Poster Session / 557

Anthem project, construction of a RFQ driven BNCT neutron source

Author: Andrea Pisent[1]

Co-authors: Andrea Passarelli [1]; Anna Selva [1]; Antonio Palmieri [1]; Carlo Baltador [1]; Carlo Mingioni [1]; Edoardo Nicoletti [1]; Enrico Fagotti [1]; Francesco Grespan [1]; Juan Esposito [1]; Luca Bellan [1]; Luigi Ferrari [1]; Marco Nenni [1]; Maria Rosaria Masullo [1]; Maurizio Montis [1]; Michele Comunian [1]; Paolo Mereu [1]; Silva Bortolussi [1]; Valeria Conte [1]; Valerio Vercesi [1]; Ysabella Kassandra Ong [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Authors: pisent@lnl.infn.it, francesco.grespan@lnl.infn.it

The project Anthem, funded within the Next Generation EU initiatives, foresees the realization of an innovative accelerator based BNCT (Boron Neutron Capture Therapy) facility at Caserta, Italy. The INFN (LNL, Pavia, Napoli, Torino) has in charge the design and construction of the epithermal neutron source, that will assure a flux of 10ˆ9 n/(s cm2) with characteristics suited for deep tumors treatment. The driver is a cw RFQ, able to produce proton beam of 30 mA 5 mA. impinging on a beryllium target. Specific challenges are related to the medical application of the device. In the paper an overview of the project will be given.

Footnotes:

Funding Agency:

Tuesday Poster Session / 558

Beam commissioning of the first HELIAC cryomodule

Author: Julian List[1]

Co-authors: Christoph Burandt [1]; Hartmut Vormann [2]; Florian Dziuba [1]; Holger Podlech [3]; Maksym Miski-Oglu [2]; Robin Kalleicher [1]; Simon Lauber [1]; Stepan Yaramyshev [2]; Thorsten Kuerzeder [2]; Viktor Gettmann [2]; Winfried Barth [2]; Uwe Scheeler [2]

[1] *Helmholtz Institut Mainz*

[2] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[3] *Goethe Universität Frankfurt*

Corresponding Author: j.list@gsi.de

The superconducting heavy ion HELmholtz LInear ACcelerator (HELIAC) is designed to meet the needs of the Super Heavy Element (SHE) research and material science user programs at GSI in Darmstadt. The beam energy can be varied smoothly between 3.5 and 7.3 MeV/u, with an average current of up to 1 emA and a duty cycle of 100 %.
Recently, the first cryomodule CM1, was fully commissioned and tested. CM1 comprises three Crossbar H-mode (CH)-type accelerator cavities, a CH-rebuncher, and two superconducting solenoid lenses. Following the commissioning of the cryogenic supply- and RF-systems, a successful beam test was conducted at the end of 2023. A helium ion beam was successfully accelerated to the design energy of 2.7 MeV/u. The beam energy could be varied continuously between 1.3 and 3.1 MeV/u without any significant particle losses being measured in the cryomodule. This contribution covers the construction and commissioning of the first HELIAC cryomodule and the results of the beam test campaign.

Footnotes:

Funding Agency:

Tuesday Poster Session / 559

Beam Emittance and Twiss Parameters from Pepper-Pot Images using Physically Informed Neural Nets

Author: Ian Knight[1]

Co-author: Brahim Mustapha [2]

[1] *Georgia Institute of Technology*

[2] *Argonne National Laboratory*

Corresponding Author: ianknight@gatech.edu

In the field of accelerator physics, the quality of a particle beam is a multifaceted concept, encompassing characteristics like energy, current, profile, and pulse duration. Among these, the emittance and Twiss parameters—defining the size, shape, and orientation of the beam in phase space—serve as important indicators of beam quality. Prior studies have shown that carefully calibrated statistical methods can extract emittance and Twiss parameters from pepper-pot emittance meter images. Our research aimed to retrieve these parameters with machine learning (ML) from a transverse image of the beam after its propagation through a pepper-pot grid and subsequent contact with a scintillating plate. We applied a Convolutional Neural Network (CNN) to extract the x and y emittances and Twiss parameters (α and β), producing a six-dimensional output by simply looking at the image without calibration information. The extraction of divergence-dependent parameters, such as α and emittance, from a single image presented a challenge, resulting in a large Symmetric Mean

Absolute Percentage Error (SMAPE) of 30%. To mitigate this issue, our novel method that incorporated image data from two points along the particles' propagation path yielded promising results. β prediction achieved a low SMAPE of 3%, while α and emittance predictions were realized with a 15% SMAPE. Our findings suggest the potential for improvement in ML beam quality assessment through multi-point image data analysis.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, under Contract No. DE-AC02-06CH11357. This research used the ATLAS facility, which is a DOE Office of Nuclear Physics User Facility.

Tuesday Poster Session / 560

Cryomodule operation experience for the FRIB continuous-wave superconducting linac

Author: Wei Chang[1]

Co-authors: Danlu Zhang [1]; Hai Nguyen [1]; Kenji Saito [2]; Sang-Hoon Kim [1]; Shen Zhao [2]; Shriraj Kunjir [1]; Taro Konomi [1]; Ting Xu [2]; Walter Hartung [1]; Xiaoji Du [1]; Yoo Lim Cheon [1]; Yoonhyuck Choi [2]; Yuting Wu [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Facility for Rare Isotope Beams*

Corresponding Author: chang@frib.msu.edu

The superconducting (SC) driver linac for the Facility for Rare Isotope Beams (FRIB) includes 46 cryomodules for acceleration of heavy ions to 200 MeV per nucleon. FRIB cryomodules have been supporting sustainable and reliable delivery of high-power heavy ion beams, including 10 kW uranium beam, to the target for production of rare isotope beams to nuclear physics user experiments. The linac operates in continuous-wave mode for maximum utilization of beam from the ion source. A total of 104 quarter-wave resonators (QWRs; β=0.041 and 0.085; 80.5 MHz) equipped with stepper-motor frequency tuners and frictional mechanical dampers are operated at 4 K. A total of 220 half-wave resonators (HWRs; β=0.29 and 0.53; 322 MHz) equipped with pneumatic frequency tuners are operated at 2 K. We will present resonance control and phase stability performance as well as experience with tuner systems in linac operation. FRIB cavities are designed to be operated at a peak surface electric field of approximately 30 MV/m. We will present cavity field emission performance over the years of linac operation and discuss field emission reduction measures such as pulsed RF conditioning (presently in use) and plasma processing (in development). Automation of SC devices is a key aspect of efficient delivery of beams to users. We will present our experience with automation of SC devices such as start-up, shut-down, and fast recovery from an RF trip as well as performance tracking of linac SC devices.

Footnotes:

Funding Agency:

Supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, award number DE-SC0023633.

Tuesday Poster Session / 561

Evaluation of wakefield mitigation for upgrading the ATF final focus beamline

Author: Yuki Abe[1]

Co-authors: Kiyoshi Kubo [1]; Nobuhiro Terunuma [1]; Toshiyuki Okugi [1]

[1] *High Energy Accelerator Research Organization*

Corresponding Author: abeyuki@post.kek.jp

The KEK-ATF (Accelerator Test Facility) is an R&D facility for the final focus system to develop the nanometer beam technology required for the International Linear Collider. ATF is the best research environment for the study of wakefield effects on the nanometer small beam. The vertical beam size growth as a function of the bunch intensity was observed at the virtual interaction point (IP), which is mainly caused by wakefield. The evaluation results of wakefield effects show that wakefield sources installed in the high beta function section of the ATF final focus (FF) beamline, such as cavity BPM and vacuum flange, have strong effects on the small beam. We will upgrade the ATF-FF beamline to mitigate wakefield effects on the small beam. To confirm mitigation effects, internal shield parts were inserted into the vacuum flange, which is one of the strong wakefield source. The mitigation effect is evaluated based on the orbit response and IP vertical beam size. This report shows the evaluation results of the mitigation of the wakefild effects and the progress and current status of the work to upgrade the beamlines to reduce the effects of the wakefield.

Footnotes:

Funding Agency:

Tuesday Poster Session / **562**

First beam commissioning and beam experiments of the CiADS Front end

Author: Duanyang Jia[1]

Co-authors: Zhijun Wang [1]; Weilong Chen [1]; Yuan He [1]

[1] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: jiaduanyang@impcas.ac.cn

The China Initiative Accelerator Driven System (CiADS), a multi-purpose facility driven by a 500 MeV superconducting RF linac, is currently under construction in Huizhou, Guangdong. In order to ensure the stable operation of the superconducting linac, we conducted optimization research on the beam quality in the front-end section of CiADS. By using the point scraping method, part of the beam halo particles are removed in advance at the entrance of the LEBT, avoiding the generation of beam halo particles. On the other hand, since the beam extracted from the ECRIS contains a portion of H^{2+} and H^{3+}particles, impurity particles may lead to a decrease in the transmission efficiency of downstream accelerators. By separating the mixed beam, it is possible to measure the proportion and phase space distribution of the mixed beam at the exit of the ion source, thereby achieving accurate measurement of the proton beam. This paper mainly outlines the first beam commissioning of CiADS Front end. Additionally, the effectiveness of the point scraping method has been verified through transverse emittance measurement, and the proportion and phase space distribution of the mixed beam was measured. Furthermore, the stability of the ion source was tested, and the centroid shift of the ion source extracted beam was measured.

Footnotes:

Funding Agency:

Tuesday Poster Session / 563

On forced RF generation of CW magnetrons for SRF accelerators

Author: Gregory Kazakevich[1]

Co-authors: Gennady Romanov [2]; Rolland Johnson [3]; Timergali Khabiboulline [2]; Vyacheslav Yakovlev [2]; Yaroslav Derbenev [4]

[1] *Muons, Inc*

[2] *Fermi National Accelerator Laboratory*

[3] *MuPlus, Inc.*

[4] *Thomas Jefferson National Accelerator Facility*

Corresponding Author: gkazakevitch@yahoo.com

CW magnetrons, initially developed for industrial RF heaters, were suggested to power RF cavities of superconducting accelerators due to their higher efficiency and lower cost than traditionally used klystrons, IOTs or solid-state amplifiers. RF amplifiers driven by a master oscillator serve as coherent RF sources. CW magnetrons are regenerative RF generators with a huge regenerative gain. This causes regenerative instability with a large noise when a magnetron operates with the anode voltage above the threshold of self-excitation. Traditionally for stabilization of magnetrons is used injection locking by a quite small signal. Then the magnetron except the injection locked oscillations may generate noise. This may preclude use of standard CW magnetrons in some SRF accelerators. Recently we developed briefly described below a mode for forced RF generation of CW magnetrons when the magnetron startup is provided by the injected forcing signal and the regenerative noise is suppressed. The mode is most suitable for powering high Q-factor SRF cavities.

Footnotes:

Funding Agency:

Tuesday Poster Session / 564

Preliminary measurement of 4D beam phase space distribution using a slit emittance meter system

Author: Seunghyun Lee[1]

Co-authors: Seok Ho Moon [1]; Dong-Hwan Kim [1]; Han-Sung Kim [2]; Hyeok-Jung Kwon [1]

[1] *Korea Multi-purpose Accelerator Complex*

[2] *Korea Atomic Energy Research Institute*

Corresponding Author: shl@kaeri.re.kr

Conventional beam diagnostics generally measure 2D projections of the phase space in x-x', y-y' and z-z'. To estimate a 6D beam phase space distribution for simulations, these 2D projections are multiplied without any correlations between them. It is true only if their degrees of freedom are independent. Recent studies show that there exists correlation across conjugate pairs. This correlation can affect beam dynamics and cause beam loss. In our study, we sought to measure 4D beam phase space distribution with possible correlations across conjugate pairs. For this purpose, we used a direct method of measuring the 4D phase space distribution using slits. A set of 4 slits is used to slice the beam into a specific volume of the 4D phase space, and the charge inside each volume is measured.
KOMAC has a test bench called BTS (Beam Test Stand) which consists of a microwave ion source, LEBT, a 200 MHz RFQ and two beamlines. At one of the beamlines, we have just installed slit

emittance meter system to measure 4D beam phase space distribution. This paper presents design and fabrication of a slit emittance meter system and shows preliminary experimental results thereof.

Footnotes:

Funding Agency:

This work has been supported though KOMAC (Korea Multipurpose Accelerator Complex) operation fund of KAERI by Ministry of Sciencec and ICT, Korean Govt. (KAERI ID no. 524320-24).

Tuesday Poster Session / **566**

Status of the L-band gun development at PITZ

Author: Anne Oppelt[1]

Co-authors: Andreas Hoffmann [1]; Christopher Richard [1]; Cornelius Martens [2]; Dmytro Dmytriiev [1]; Dmitry Bazyl [2]; Felix Riemer [1]; Frank Brinker [2]; Frank Stephan [1]; Frieder Mueller [1]; Grygorii Vashchenko [2]; James Good [1]; Lutz Jachmann [1]; Matthias Gross [1]; Mikhail Krasilnikov [1]; Namra Aftab [1]; Prach Boonpornprasert [1]; Sebastian Philipp [1]; Sumaira Zeeshan [1]; Winfried Koehler [1]; Xiangkun Li [1]; Xiao-Yang Zhang [3]; Zahra Lotfi [1]; Davit Kalantaryan [1]; Lucas Schaper [2]; Zohrab Amirkhanyan [1]; Anna Grebinyk [4]

[1] *Deutsches Elektronen-Synchrotron DESY at Zeuthen*

[2] *Deutsches Elektronen-Synchrotron*

[3] *Tsinghua University in Beijing*

[4] *Technische Hochschule Wildau*

Corresponding Author: anne.oppelt@desy.de

Gun5, the new generation of high-gradient normal conducting 1.3 GHz RF guns for linac driven free-electron lasers like FLASH and European XFEL is under development at the Photo Injector Test facility at DESY in Zeuthen (PITZ). Its improved cell geometry and cooling concept allow for RF pulse durations of up to 1 ms at 10 Hz repetition rate, at gradients of ˜60 MV/m at the cathode. Gun5 is also equipped with an RF probe for measurements of the RF field inside the gun.
The first gun of this type, Gun5.1, is in operation at PITZ since April 2022. Gun5.2 will be commissioned at the FALCO conditioning facility at DESY in Hamburg, starting in June 2024. This gun is equipped with a balanced (symmetric) RF waveguide feed to the coaxial power coupler to prevent a coupler kick and thus improve the beam quality delivered by the electron source.
Further guns are currently in the manufacturing process. In parallel, studies towards a more reliable cathode spring design are ongoing, in order to overcome observed issues during the high duty cycle operation of Gun5.1. This article will give an overview on all those developments.

Footnotes:

Funding Agency:

Thursday Poster Session / **567**

Application of a novel high brightness photogun for MeV ultrafast electron diffraction

Author: Thomas Lucas[1]

Co-author: Eduard Prat [2]

[1] *Paul Scherrer Institute*

[2] *Paul Scherrer Institut*

Corresponding Author: thomas.lucas@psi.ch

MeV ultrafast electron diffraction has become a new frontier for the study of molecular dynamics. With the temporal resolution of MeV-UED being limited by the electron bunch length at the target, electron sources used for this technique are becoming ever more intricate in the the push for shorter bunches length. However, moving to these complex setups makes them less feasible in a small-scale setting, such as universities, where keV-UED setups have become common place. In this paper, we use a novel traveling-wave rf photogun without any additional bunch compressor to generate ultra-short electron pulses whose lengths rival that of the most intricate magnetic or ballistic compression schemes. The broadband nature of the TW device allows for unique operation schemes that combines significant acceleration and compression all within the TW photogun. Such a device, when combined with state-of-the-art synchronization systems and lasers will be demonstrated to cross the so-called ‘50-fs time-resolution barrier’and push towards the femtosecond regime.

Footnotes:

Funding Agency:

Thursday Poster Session / 568

Development for beam injector using laser-driven ion acceleration

Authors: Akari Okano[1]; Haruya Matsumoto[2]; Hironao Sakaki[3]; Hiroshi Tsutsui[4]; Hiroyoshi Kuroki[5]; Kiminori Kondo[3]; Kiyotaka Ohtomo[6]; Kunikazu Ishii[1]; Masaharu Nishikino[3]; Norihiro Inoue[5]; Sadaoki Kojima[3]; Sayaka Oishi[1]; Tatsuhiko Miyatake[2]; Thanh-Hung Dinh[3]; Toshiyuki Shirai[7]; masayasu Hata[3]

[1] *Nara Women's-Univ.*

[2] *Kyushu University*

[3] *National Institutes for Quantum Science and Technology*

[4] *Sumitomo Heavy Industies, Ltd.*

[5] *Hitachi Zosen*

[6] *The Institute of Physical and Chemical Research*

[7] *National Institutes for Quantum Science and Technology, Accelerator and Medical Physics*

Corresponding Authors: inoue_no@hitachizosen.co.jp, okano.akari@qst.go.jp, dinh.thanhhung@qst.go.jp, kondo.kiminori@qst.go.jp, kuroki_h@hitachizosen.co.jp, nishikino.masaharu@qst.go.jp, kojima.sadaoki@qst.go.jp, sakaki.hironao@qst.go.jp, miyatake.tatsuhiko.640@s.kyushu-u.ac.jp, ohtomo@postman.riken.go.jp, shirai.toshiyuki@qst.go.jp, hata, ishii@cc.nara-wu.ac.jp, oishi.sayaka@qst.go.jp, hiroshi.tsutsui@shi-g.com, matsumoto.haruya.876@s.kyushu-u.ac.jp

The development of a few MeV/n carbon ion injector using laser-driven ion acceleration by Target-Normal Sheath Acceleration (TNSA) is carrying out. And the prototype injector has been completed at QST-Kansai in Japan. The beam commissioning is underway and first data on beam characteristics obtained from them will be presented.

Footnotes:

Funding Agency:

Thursday Poster Session / 569

Development of additively manufactured 750 MHz RFQ

Author: Toms Torims[1]

Co-authors: Ahmed Cherif [1]; Andris Ratkus [2]; Cedric Garion [1]; Guntis Pikurs [2]; Hendrik Kos [1]; Matteo Pozzi [3]; Maurizio Vedani [4]; Maurizio Vretenar [1]; Nicolas Delerue [5]; Philipp Wagenblast [6]; Samira Gruber [7]; Tobia Romano [2]; Victoria Bjelland [1]; Walter Wuensch [1]

[1] *European Organization for Nuclear Research*

[2] *Riga Technical University*

[3] *Rosler Italian*

[4] *Politecnico di Milano*

[5] *Université Paris-Saclay, CNRS/IN2P3, IJCLab*

[6] *TRUMPF Laser- und Systemtechnik GmbH*

[7] *Fraunhofer IWS*

Corresponding Authors: maurizio.vretenar@cern.ch, t.torims@cern.ch

Additive manufacturing technologies, especially powder bed fusion, are rapidly taking their place in the technological arsenal of the accelerator community. A wide range of critical accelerator components are today being manufactured additively. However, there is still much of scepticism whether additive manufacturing can address the stringent requirements set to complete accelerator components. Therefore, as an advanced proof-of-principle, a full-size, pure-copper RFQ prototype was developed and additively manufactured in the frame of the I.FAST EU project. RFQ prototypes and accompanying samples of the additively manufactured pure-copper parts were submitted to a series of standard tests at CERN to prove that this novel technology and suitable post-processing can deliver the required geometrical precision, surface roughness, voltage holding, vacuum tightness, and other relevant parameters. The results obtained are very promising and could be of great benefit to the linac community at large. The paper will discuss in detail the technological development and RFQ design improvement process along with the obtained results and future endeavours.

Footnotes:

Funding Agency:

EU Horizon 2020 Research and Innovation programme: agreement No 101004730

Thursday Poster Session / 570

First results from two Nb3Sn cavities assembled in a CEBAF quarter cryomodule

Author: Grigory Eremeev[1]

Co-authors: Anthony Reilly [2]; Brad Tennis [1]; Gianluigi Ciovati [2]; John Fischer [2]; Michael Drury [2]; Michael McCaughan [2]; Robert Rimmer [2]; Sam Posen [1]; Sergey Cheban [1]; Uttar Pudasaini [2]

[1] *Fermi National Accelerator Laboratory*

[2] *Thomas Jefferson National Accelerator Facility*

Corresponding Authors: uttar@jlab.org, grigory@fnal.gov

Two 1.5 GHz CEBAF C75-shape 5-cell accelerator cavities were coated with Nb3Sn film using the vapor diffusion technique at Fermilab and Jefferson Lab coating facilities. Both cavities were measured at 4 K and 2 K in the vertical dewar test in each lab, then assembled into a CEBAF quarter cryomodule at Jefferson Lab. The cryomodule was tested in 4 K and 2 K in the CryoModule Test Facility at Jefferson Lab. RF test results for both cavities in the cryomodule are similar to those of

the qualification test in VTS, with one cavity reaching Eacc = 7.5 MV/m and the other - 13 MV/m at 4 K. In this contribution we discuss the progress with assembling Nb3Sn cavities in a cryomodule and the first results from cryomodule testing.

Footnotes:

We would like to thank Alex Netepenko and Alex Melnychuk for help with cavity measurements, Damon Bice for cavity treatment coordination, Anna Grassellino, Alex Romanenko, Sergey Belomestnykh for their support. We also want to thank Danny Forehand, Chris Dreyfuss, Ashley Mitchell, Justin Kent, Peter Owen, and JLab technical staff for their help with preparing, assembling, and testing the cavities, and thank Rongli Geng and Anne-Marie Valente Feliciano for their support.

Funding Agency:

DOE/ SC/ NP under contract DE-AC05-06OR23177 with Jefferson Science Associates, LC., DOE ECA to G. Eremeev, Fermi Research Alliance, LLC, under Contract No. DE-AC02-07CH11359 with the DOE/ SC/ HEP.

Thursday Poster Session / **571**

Progress towards halo modeling at the SNS Beam Test Facility

Author: Kiersten Ruisard[1]

Co-authors: Alexander Aleksandrov [1]; Alexander Zhukov [1]; Austin Hoover [1]; Trent Thompson [1]

[1] *Oak Ridge National Laboratory*

Corresponding Author: ruisardkj@ornl.gov

The SNS beam test facility is a model of the SNS front end (source through medium-energy transport). On-going work at the BTF focuses on accurate modeling of the beam distribution to enable the prediction of halo losses (>100 parts per million). This presentation will discuss the latest progress towards this goal, including recent results after a reconfiguration of the test beamline and diagnostics upgrades. I will also discuss use of the test facility for developing accelerator tuning applications.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of High Energy Physics. This work has been authored by UT-Battelle, LLC under Contract No. DE-AC0

Thursday Poster Session / **572**

Research and development of coherent terahertz sources at LEBRA linac, Nihon University

Author: Takeshi Sakai[1]

Co-authors: Ken Hayakawa [1]; Kyoko Nogami [1]; Norihiro Sei [2]; Toshinari Tanaka [1]; Yasushi Hayakawa [1]; Yoske Sumitomo [1]; Yumiko Takahashi [1]

[1] *Nihon University*

[2] *National Institute of Advanced Industrial Science and Technology*

Corresponding Author: sakai.takeshi@nihon-u.ac.jp

The Laboratory for Electron Beam Research and Application (LEBRA) at Nihon University has been developing free electron laser (FEL), parametric X-ray radiation (PXR), and terahertz (THz) wave sources in collaboration with KEK and the National Institute of Advanced Industrial Science and Technology (AIST) using a 100 MeV electron linac. Each of these light sources is used for both internal and external collaborations. We are developing THz coherent edge radiation (CER), coherent transition radiation (CTR) and plane-wave coherent Cherenkov radiation (CCR) sources in the THz band for the FEL and PXR beamlines, respectively. In particular, we are developing THz wave sources using an artificial quartz hollow conical tube for the CCR source and a thin aluminum plate with a helical target surface for the THz-CTR optical vortex source. So far, we have performed parameter measurements, including beam profile and spectrum measurements, for the THz-CCR and the THz-CTR vortex beams. In this paper, we describe the development and characteristics of each THz wave source.

Footnotes:

Funding Agency:

This work was supported by JSPS KAKENHI Grant Numbers JP19H04406, 21K12539, 23K28360, and JKA through its promotion funds from KEIRIN RACE.

Thursday Poster Session / **573**

The SARAF-LINAC project status (07/2024)

Author: Nicolas Pichoff[1]

Co-authors: Amichay Perry [2]; Antoine Chance [1]; Arik Kreisel [2]; Damien Simon [3]; Didier Uriot [1]; Eyal Reinfeld [2]; Franck Senee [3]; Francoise Gougnaud [1]; Guillaume Ferrand [1]; Ilan Shmuely [2]; Jonathan Dumas [3]; Joseph Luner [2]; Leonid Weissman [2]; Thomas Plaisant [1]

[1] *Commissariat à l'Energie Atomique et aux Energies Alternatives*

[2] *Soreq Nuclear Research Center*

[3] *Commissariat à l'Energie Atomique*

Corresponding Author: nicolas.pichoff@cea.fr

SNRC and CEA collaborate to the upgrade of the SARAF accelerator to 5 mA CW 40 MeV deuteron and proton beams (Phase 2). CEA is in charge of the design, construction and commissioning of the linac downstream the existing RFQ (SARAF-LINAC Project).
The MEBT is now installed at SNRC and has been commissioned with both proton (cw) and deuteron (pulsed) beams. Transverse and longitudinal emittances have been measured and beam transport has been com-pared with TraceWin simulations.
Cryomodules have been assembled and tested at Saclay. CM1 has been delivered to SNRC and is being integrated at SNRC.
This paper presents the results of the qualification of the cryomodules at Saclay and the commissioning at Soreq.

Footnotes:

Funding Agency:

Thursday Poster Session / **574**

THz-driven acceleration of subrelativistic electrons in tapered rectangular dielectric-lined waveguides

Author: Laurence Nix[1]

Co-authors: Joe Bradbury [1]; Christopher Shaw [1]; Robert Appleby [1]; Graeme Burt [2]; Rosa Letizia [2]; Darren Graham [3]; Morgan Hibberd [3]; Steven Jamison [2]

[1] *Cockcroft Institute*

[2] *Lancaster University*

[3] *The University of Manchester*

Corresponding Author: l.nix@lancaster.ac.uk

We have designed a tapered dielectric-lined waveguide for the acceleration of sub-relativistic electron bunches with THz-frequency electromagnetic pulses. We consider an example design based on a commercial 100keV electron gun and a THz generation scheme driven by a mJ-level regenerative amplifier laser system. With a 12μJ THz pulse we simulated acceleration of a 100keV electron bunch to 162keV with very low energy spread. A second example design shows energy doubling from 100keV to 205keV using a 22.5μJ pulse. The former of these two designs has been assembled for experimental testing. We also discuss methods to improve the efficiency of the design process using 1D particle tracking to provide better estimates of the initial geometry before optimization.

Footnotes:

Funding Agency:

Main Session TUX / 575

The 10-TeV Wakefield Accelerator collider design study

Author: Jens Osterhoff[1]

Co-authors: Axel Huebl [1]; Brendan O'Shea [2]; Cameron Geddes [1]; Carl Schroeder [1]; Chunguang Jing [3]; Eric Esarey [1]; Gwanghui Ha [4]; Jean-Luc Vay [1]; Jeroen van Tilborg [1]; John Power [5]; Mark Hogan [2]; Philippe Piot [4]; Rachel Margraf-O'Neal [5]; Remi Lehe [1]; Spencer Gessner [2]; Xueying Lu [4]

[1] *Lawrence Berkeley National Laboratory*

[2] *SLAC National Accelerator Laboratory*

[3] *Euclid Beamlabs LLC*

[4] *Northern Illinois University*

[5] *Argonne National Laboratory*

Corresponding Author: josterhoff@lbl.gov

Since its inception, the field of Advanced Accelerators has regarded future particle-physics colliders as the ultimate application of > 1 GV/m accelerator technology [1]. Over the last decades, rapid experimental and theoretical progress [2,3,4] drove a conceptual evolution of potential future colliders based on Wakefield Accelerator (WFA) technology. The recent P5 Report [5] calls for "vigorous R&D toward a cost-effective 10 TeV pCM collider based on proton, muon, or possible wakefield technologies."Specifically, the P5 Report requests "the delivery of an end-to-end design concept, including cost scales, with self-consistent parameters throughout."This presentation will outline the opportunities, requirements, and challenges for a 10 TeV WFA collider and will introduce a community-driven design study based on working groups and performance metrics including a timeline with deliverables.

Footnotes:

[1] R. Ruth et al., "A Plasma Wake Field Accelerator"Particle Accelerators, 17, 171-189 (1985).
[2] E. Esarey et al., "Physics of laser-driven plasma-based electron accelerators", Rev. Mod. Phys., 81, 1229 (2009).
[3] C. Jing, "Dielectric Wakefield Accelerators", Rev. Accel. Sci. Tech, 9, 127-149 (2016).
[4] M. Hogan, "Electron and Positron Beam–Driven Plasma Acceleration"Rev. Accel. Sci. Tech, 9, 63-83 (2016).
[5] P5 Report https://www.usparticlephysics.org/2023-p5-report/

Funding Agency:

Student Poster Session / **576**

Design of a beam transport line for external injection of plasma wakefield acceleration experiments based on BEPCII

Author: Xueyan Shi[1]

Co-authors: Yiwei Wang [1]; Haisheng Xu [2]; Dazhang Li [1]; Ande Ma [1]

[1] *Chinese Academy of Sciences*

[2] *Institute of High Energy Physics*

Corresponding Author: shixueyan@ihep.ac.cn

Laser wakefield accelerator (LWFA) and plasma wakefield acceleration (PWFA) have attracted a wealth of research interests since they can provide an accelerating gradient of ˜100 GV/m. Recently, a series of LWFA/PWFA external injection experiments are foreseen to be carried out based on the linear accelerator (LINAC) of Beijing Electron-Positron Collider II (BEPCII). We hereby present a design of the beam transport line from the BEPCII LINAC to the LWFA/PWFA experimental chamber. The constraint of the existing building and beamline of the BEPCII was considered carefully in the design. The performance of the transport line is evaluated using the particle tracking simulations, demonstrating that the bunch length of the electrons with energy of 2 GeV and charge of 2 nC can be compressed from 10 ps to 1 ps (RMS), and the beam spot size is focused from about 850 μm to 116 μm (RMS).

Footnotes:

Funding Agency:

Student Poster Session / **577**

Thin Au layers on niobium for SRF cavities

Author: Sadie Seddon-Stettler[1]

Co-authors: Matthias Liepe [1]; Nathan Sitaraman [2]; Thomas Oseroff [1]; Helena Lew-Kiedrowska [3]; Van Do [3]; Chi Wang [4]; Steven Sibener [3]

[1] *Cornell University (CLASSE)*

[2] *Cornell University*

[3] *The University of Chicago*

[4] *National Cheng Kung University*

Corresponding Author: sgs238@cornell.edu

New materials beyond the standard bulk niobium have the potential to greatly improve the performance of Superconducting Radio Frequency (SRF) cavities. Specifically, thin coatings of normal conductors such as gold have the potential to improve the key RF performance metric of quality factor. We present progress on depositing thin gold layers onto 2.6 GHz SRF cavities and testing their RF performance.

Footnotes:

Funding Agency:

U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams; U.S. Department of Energy under Award DE-SC0024137.

Student Poster Session / **578**

Mitigation of longitudinal beam losses in the FRIB linac

Author: Alec Gonzalez[1]

Co-authors: Alexander Plastun [1]; Peter Ostroumov [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: gonza603@msu.edu

The linear accelerator at the Facility for Rare Isotope Beams (FRIB) at Michigan State University uses a thin liquid Lithium film for charge stripping of high-intensity heavy ion beams. Energy straggling of the beam in the non-uniform Lithium film affects the energy distribution in the beam. This can lead to non-linear "tails"in the longitudinal phase-space beam distribution after bunching at the two 161 MHz Multi-Gap Bunchers (MGBs) between the stripper and the next accelerating segment. Some particles in these "tails"are lost in the downstream accelerator cryomodules. To mitigate these losses, we have designed a room-temperature IH-type buncher cavity with a resonant frequency of 322 MHz. The new harmonic cavities will be installed next to each MGB, linearizing the waveform of the effective bunching voltage and eliminating the formation of non-linear "tails."The increase in the energy acceptance of the post-stripper part of the accelerator reached over 50% according to our simulations. We present the electromagnetic design of this cavity along with beam dynamics simulations that demonstrate how the losses are mitigated. The construction and installation of the cavity are being pursued as an accelerator improvement project.

Footnotes:

Funding Agency:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, High Energy Physics under Cooperative Agreement award number DE-SC0018362 and Michigan State University.

Student Poster Session / **579**

DIRECT INJECTION EXTRACTION SYSTEM INTO A HIGH FREQUENCY RADIOFREQUENCY QUADRUPOLE FOR MEDICAL APPLICATIONS

Author: Aristeidis Mamaras[1]

Co-authors: Alessandra Lombardi [1]; Dimitrios Sampsonidis [2]; Eleonora Pasino [1]; Francesco Di Lorenzo [1]; Jean-Baptiste Lallement [1]; Marten Koopmans [1]

[1] *European Organization for Nuclear Research*

[2] *Aristotle University of Thessaloniki*

Corresponding Author: aristeidis.mamaras@cern.ch

As part of CERN's medical application research, a compact electrode system (< 30 cm) has been designed to facilitate low-current, multiparticle beam extraction and matching to a high-frequency RFQ. This study explores the innovative extraction system design and evaluates its simulation performance. Superfish (SF) and CST Studio Suite were employed to export the 2D and 3D electric field maps of the extraction system for beam dynamics simulations. Beam dynamics simula-tions using the Travel code have confirmed the sys-tem's ability to deliver a high-quality, low-current par-ticle beam fully matched to a 750 MHz RFQ, capable of accelerating particles with a ⍰/⍰ ratio of ½ to 1. This paper provides an overview of the key design considerations, geometry layout, and beam dynamics results.

Footnotes:

Funding Agency:

Student Poster Session / **580**

Longitudinal Beam Dynamics Optimization for Infrared Terahertz FEL LINAC

Author: Yimin Yang[1]

Co-authors: Guangyao Feng [1]; Shancai Zhang [1]; Zhigang He [1]

[1] *University of Science and Technology of China*

Corresponding Author: yangyimin@mail.ustc.edu.cn

The high-repetition-rate infrared terahertz free-electron laser (IR-THz FEL) facility are progressing in the preliminary research stage, which can achieve the demand for a tunable, high-power-light source in the long wavelength spectrum and form a complementary structure of advantages with the Hefei Advanced Light Facility (HALF). In this paper, we present the design of a bunch compressor which can compress the bunch length to reach the peak current of 118 A. We also present an approach to optimize the RF parameters for the accelerating modules, which makes it feasible to generate a high-quality beam bunch that can reach the requirements for future FEL applications.

Footnotes:

Funding Agency:

Student Poster Session / **581**

Beam dynamics design for a proton Linac for a compact accelerator based neutron source

Author: Mina Abbaslou[1]

Co-authors: Marco Marchetto [1]; Philipp Kolb [1]; Robert Laxdal [1]; Tobias Junginger [1]

[1] *TRIUMF*

Corresponding Author: mabbaslou@triumf.ca

A prototype Canadian compact accelerator-driven neutron source (PC-CANS) is proposed for installation at the University of Windsor. The source is based on a high-intensity compact proton RF accelerator that delivers an average current of 10 mA of protons at 10 MeV to the target. This study can serve as a basis for the design of an initial stage of a new high-intensity compact accelerator-driven neutron source (CANS). The accelerator consists of a short radio frequency quadrupole (RFQ), followed by an efficient drift tube linac (DTL) structure. Different variants of DTL were investigated for our studies. APF, KONUS, CH-DTL, and Alvarez DTL as normal conducting cavities with a frequency of 352.2 MHz and a superconducting cavity with a lower frequency of 176.1 MHz were considered in our Linac design. Details of the beam dynamics of the RFQ and different types of DTL are presented in this paper.

Footnotes:

Funding Agency:

Student Poster Session / **582**

High pulsed power measurements of superheating fields for SRF materials

Author: Nicole Verboncoeur[1]

Co-authors: Adam Holic [1]; Matthias Liepe [1]; Ryan Porter [1]; Thomas Oseroff [1]; Liana Shpani [1]; James Sears [1]

[1] *Cornell University (CLASSE)*

Corresponding Author: nmv39@cornell.edu

The Cornell High Pulsed Power Sample Host Cavity (CHPPSHC) is a new system designed to measure the superheating field of candidate superconducting RF (SRF) materials, giving insight into their operational limits. This system is designed to reach peak magnetic fields of up to 0.5 T in only a few microseconds, allowing us to achieve a pure magnetic field quench on the sample. We present an overview of the CHPPSHC system and proof of principle data from a niobium sample.

Footnotes:

Funding Agency:

Student Poster Session / **583**

Development of plasma processing of 1.3 GHz superconducting radiofrequency cavities at TRIUMF

Author: Daniel Hedji[1]

Co-authors: Philipp Kolb [1]; Robert Laxdal [1]; Tobias Junginger [1]; Vladimir Zvyagintsev [1]; Zhongyuan Yao [1]

[1] *TRIUMF*

Corresponding Author: dhedji@triumf.ca

Superconducting RadioFrequency (SRF) technology is a key component in many particle accelerators operating in a continuous wave, or high duty cycle, mode. The on-line performance of SRF cavities can be negatively impacted by the gradual reduction in the accelerating gradient that can be attained within a reasonable field emission level. Conventional cleaning procedures are both time- and resource-exhaustive as they are done *ex-situ*. As such, *in-situ* techniques are quite attractive. Plasma processing is an emerging *in-situ* method of cleaning which utilizes a mixture of oxygen and an inert gas to chemically remove hydrocarbon-based field emitters through plasma. At TRIUMF's Advanced Rare IsotopE Laboratory (ARIEL), an R&D program is in place to develop plasma processing procedures using fundamental power couplers on 1.3 GHz ARIEL 9-cell cavities. Single cell and multi-cell processing has been performed off-line. The studies involve varying the input parameters and testing the effectiveness of the treatment through RGA analysis. The progress on the developments will be reported.

Footnotes:

Funding Agency:

Student Poster Session / **584**

Beam Emittance and Twiss Parameters from Pepper-Pot Images using Physically Informed Neural Nets

Author: Ian Knight[1]

Co-author: Brahim Mustapha [2]

[1] *Georgia Institute of Technology*

[2] *Argonne National Laboratory*

Corresponding Author: ianknight@gatech.edu

In the field of accelerator physics, the quality of a particle beam is a multifaceted concept, encompassing characteristics like energy, current, profile, and pulse duration. Among these, the emittance and Twiss parameters—defining the size, shape, and orientation of the beam in phase space—serve as important indicators of beam quality. Prior studies have shown that carefully calibrated statistical methods can extract emittance and Twiss parameters from pepper-pot emittance meter images. Our research aimed to retrieve these parameters with machine learning (ML) from a transverse image of the beam after its propagation through a pepper-pot grid and subsequent contact with a scintillating plate. We applied a Convolutional Neural Network (CNN) to extract the x and y emittances and Twiss parameters (α and β), producing a six-dimensional output by simply looking at the image without calibration information. The extraction of divergence-dependent parameters, such as α and emittance, from a single image presented a challenge, resulting in a large Symmetric Mean Absolute Percentage Error (SMAPE) of 30%. To mitigate this issue, our novel method that incorporated image data from two points along the particles' propagation path yielded promising results. β prediction achieved a low SMAPE of 3%, while α and emittance predictions were realized with a 15% SMAPE. Our findings suggest the potential for improvement in ML beam quality assessment through multi-point image data analysis.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, under Contract No. DE-AC02-06CH11357. This research used the ATLAS facility, which is a DOE Office of Nuclear Physics User Facility.

Student Poster Session / **585**

Effective thermal load mitigation in cERL injector prototype coupler through warm section modification

Author: Pragya Nama[1]

Co-authors: Ashish Kumar [2]; Dai Arakawa [2]; Eiji Kako [2]; Hiroshi Sakai [2]; Kensei Umemori [2]; Takako Miura [2]

[1] *Sokendai, the Graduate University for Advanced Studies*

[2] *High Energy Accelerator Research Organization*

Corresponding Author: pragya@post.kek.jp

Fundamental power couplers are utilized in SRF accelerators to transfer RF power from a source to the accelerating cavities. However, the issue of thermal heat load during high-power transmission in continuous wave (CW) mode operation poses a significant challenge for power couplers. To address this concern critical modifications have been implemented within the warm sections of the cERL injector prototype coupler which was previously tested for 30kW power level in CW mode operation. The modification includes implementation of active water cooling in the warm section of the coupler and material change from copper coated stainless steel to oxygen free copper for the inner conductor.
As a result, the thermal load at the inner and outer conductor was effectively mitigated during high power transmission in CW mode. Prior to the modifications, the inner conductor of the warm section reached a maximum temperature of 183℃ at 27 kW power in CW mode. However, with the modified inner conductor with water cooling, the temperature was a mere 25℃. Additionally, the overall coupler temperature of the modified coupler was significantly reduced due to the conduction cooling effect applied to other components. These results underscore the effectiveness of the implemented modifications and represent a highly effective approach for mitigating thermal load in critical coupler components.

Footnotes:

Funding Agency:

Student Poster Session / **586**

Design of 5 MeV SRF electron linac for wastewater purification

Author: Anjali Kavar[1]

Co-authors: Shigeru Kashiwagi [2]; Toshiya Muto [1]; Kai Masuda [3]; abiko hayato [1]; Fujio Hinode [1]; Ikurou Nagasawa [1]; Ken-ichi Nanbu [1]; Kotaro Shibata [1]; Ken Takahashi [1]; Kodai Kudo [1]; Hiroki Yamada [1]; Hiroyuki Hama [1]

[1] *Tohoku University*

[2] *Research Center for Accelerator and Radioisotope Science*

[3] *IFMIF/EVEDA Project Team*

Corresponding Author: anjalikavar5454@gmail.com

Superconducting Radio Frequency (SRF) technology is a proven solution for generating high-power electron beams (EB), suitable for tasks like purifying wastewater from challenging impurities such as Per- and polyfluoroalkyl substances (PFAS). This paper elaborates on effectiveness of EB treatment and outlines design considerations for a 1.3 GHz SRF linac operating at 5 MeV with an average beam current of 10 mA. To get the high average beam current, attaining a high bunch repetition rate is important. The primary focus of the paper is on designing an injector which is able to generate high repetition beam with suitable short bunches for smooth acceleration to 5 MeV in a 1.3 GHz linac. Numerical analyses for accelerator system, ensuring that the beam reaches 5 MeV with the desired characteristics, lead to a compact beamline structure. This structure includes a 100 kV thermionic gridded gun, a 650 MHz buncher cavity, a 1.3 GHz 3-cell low beta booster cavity, and three 2-cell

1.3 GHz accelerator cavities, along with necessary focusing solenoids, all compactly fitting within approximately 4 meters. The results of the numerical studies conducted for all these components will be presented in this paper.

Footnotes:

Funding Agency:

Student Poster Session / 587

Advanced algorithms for linear accelerator design and operation

Author: Ysabella Kassandra Ong[1]

Co-authors: Luca Bellan [1]; Andrea Pisent [1]; Michele Comunian [1]; Enrico Fagotti [1]; Damiano Bortolato [1]; Maurizio Montis [1]; Mauro Giacchini [1]; Osvaldo Carletto [1]

[1] *Istituto Nazionale di Fisica Nucleare*

Corresponding Author: ysaong@lnl.infn.it

In this paper, we investigate the usage of advanced algorithms adapted for optimizing the design and operation of different linear accelerators (LINACs), notably the superconducting linac ALPI at INFN-LNL and the ANTHEM BNCT facility to be constructed at Caserta, Italy. Utilizing various intelligent algorithms and machine learning techniques such as Bayesian optimization, genetic algorithms, particle swarm optimization, and surrogate modeling with artificial neural networks, we aim to enhance the design efficiency, operational reliability and adaptability of linear accelerators. Through simulations and case studies, we demonstrate the effectiveness and practical implications of these algorithms for optimizing LINAC performances across diverse applications.

Footnotes:

Funding Agency:

Student Poster Session / 588

Development of Bi-Alkali antimonide photocathodes for implementation in a 1.3 GHz superconducting rf photo-injector

Author: Ziye Yin[1]

Co-authors: John Lewellen [2]; John Smedley [3]; Sang-Hoon Kim [1]; Taro Konomi [4]; Ting Xu [4]; Walter Hartung [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Los Alamos National Laboratory*

[3] *SLAC National Accelerator Laboratory*

[4] *Facility for Rare Isotope Beams*

Corresponding Author: yin@frib.msu.edu

Electron beams with low emittance are vital for a wide range of accelerator-based applications, including free-electron lasers, Thomson scattering sources, and ultrafast electron diffraction. Superconducting Radio Frequency (SRF) photo-injectors can produce low-emittance electron beams, particularly in continuous wave (CW) operation. Among the various photo-emissive layers, bi-alkali

antimonide is favored for its high quantum efficiency (QE) and compatibility with visible light wavelengths. In 2022, an SRF photo-injector system, including a photo-cathode coating chamber, a 1.3 GHz 1.5-cell jacketed cavity, and tuner, was transferred from KEK to FRIB for R&D purposes. R&D at FRIB is oriented toward the integration of advanced photocathodes into an SRF photo-injector. This paper describes modifications to the cathode preparation chamber and first cathode deposition and characterization trials. A K2CsSb film was produced with a notably extended dark lifetime, albeit with a modest QE of approximately 2%. Extensive spectral response analyses of the layer were conducted, along with thorough assessments of measurement procedures and hardware. This presentation offers insights into the factors contributing to the low measured QE and describes plans for improving the cathode preparation chamber and the experimental procedures.

Footnotes:

Funding Agency:

Work funded by Michigan State University
yin@frib.msu.edu

Student Poster Session / **589**

Simulations of field emitters and multipacting in PIP-II Single Spoke Resonator Type-2

Author: Jacob Brown[1]

Co-authors: Alexander Sukhanov [2]; Donato Passarelli [2]; Gennady Romanov [2]; Ting Xu [3]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Fermi National Accelerator Laboratory*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: brownjac@frib.msu.edu

It has been found in benchmark tests that some Single Spoke Resonator Type-2 (SSR2) cavities have early field emission onset as well as strong multipacting barriers. A longstanding hypothesis is that field-emitted electrons in the high electric field accelerating gap can migrate and ignite multipacting bands in the low electric field regions of the cavity periphery. In this study, we use simulation techniques to examine multipacting behavior in SSR2 cavities from electrons seeded in common field emitter locations. Additionally, we investigated seed locations for areas in SSR2 cavities which may have poor coverage during high pressure water rinsing and compared the multipacting behavior.

Footnotes:

This material is based upon work supported by the U.S Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

Funding Agency:

U.S Department of Energy, DOE Office of Science User Facility, under Award Number DE-SC0023633

Student Poster Session / **590**

Smith-Purcell radiation studies towards a compact high-resolution longitudinal diagnostic

Author: Blae Stacey[1]

Co-authors: Thomas Vinatier [1]; Willi Kuropka [1]; Wolfgang Hillert [2]

[1] *Deutsches Elektronen-Synchrotron*

[2] *University of Hamburg*

Corresponding Author: blae.stacey@desy.de

A new longitudinal diagnostic has been proposed, the SPACEChip (Smith-Purcell ACcElerator Chip-based) diagnostic, which can infer information about the temporal profile of a particle bunch from the Smith-Purcell radiation spectrum generated when the bunch passes close to a dielectric grating. This is done using the bunch form factor after retrieving the phase. A simulated dielectric grating has been excited by Floquet modes to investigate the angular distribution of the Smith-Purcell radiation. Progress on the SPACEChip experimental campaign at the ARES linac at DESY will be reported, along with the expected photon yield from the structure with the ARES operational parameters.

Footnotes:

Funding Agency:

Student Poster Session / 591

Inverse inference of initial beam profile and key parameters based on automatic differentiation method

Authors: Zheng Sun[1]; Tianmu Xin[1]

Co-authors: Xiaoping Li [2]; Cai Meng [2]; Ouzheng Xiao [1]; Zhi Song [3]; Zhongtian Liu [1]

[1] *Institute of High Energy Physics*

[2] *Chinese Academy of Sciences*

[3] *Tsinghua University in Beijing*

Corresponding Author: sunzheng@ihep.ac.cn

For experiments requiring the longitudinal shaping of the beam at the exit of an electron linear accelerators, it is crucial to infer the initial beam profile at the entrance of the linear accelerator and key parameters. After passing through the dispersion section of beam bunch compressor, and the high-frequency system, the electron beam will undergo modulation on the longitudinal density. Based on the longitudinal dynamic process, this paper proposes to use automatic differentiation to provide the design of beam initial conditions and key parameters corresponding to a specific longitudinal profile of the beam at the exit of the linear accelerator. Finally, we implemented this method on a section of linear accelerator consisting of two L-band accelerating cavities, one S-band accelerating cavity, and a bunch compressor.

Footnotes:

Funding Agency:

Student Poster Session / 592

Design and simulation of Virtual Pepper Pot method for low energy proton beam

Author: Emre Cosgun[1]

Co-authors: Seok Ho Moon [2]; Dong-Hwan Kim [2]; Moses Chung [3]; Min Sup Hur [1]

[1] *Ulsan National Institute of Science and Technology*

[2] *Korea Multi-purpose Accelerator Complex*

[3] *Pohang University of Science and Technology*

Corresponding Author: e-cosgun@hotmail.com

The Virtual Pepper Pot (VPP) is a 4D transverse phase space measurement technique based on pepper-pot-like patterns that are generated by crossing each measured horizontal slit-based beamlet with all measured vertical slit-based beamlets. The VPP beam phase space distribution reconstruction and simulation are performed using the Beam Delivery Simulation (BDSIM) code, which is a Geant4 toolkit. The configuration includes a VPP 3D model slit, a scintillator screen, and a user-defined 1 MeV energy and 10 mA current proton beam distribution, characteristic of the KOMAC RFQ beam test stand. Besides VPP, pepper pot mask simulation is carried out, and the intensity and emittance differences are observed. The input beam distribution is generated from a TraceWin output file for comparison of results. The comparison between the VPP analysis results and the TraceWin input shows satisfactory results, ensuring accurate estimation of the emittance.

Footnotes:

Funding Agency:

Student Poster Session / **593**

Anomalous frequency shifts near Tc of fundamental and higher-order modes in medium-velocity 644 MHz superconducting elliptical cavities

Author: Sean Moskaitis[1]

Co-authors: Peter Ostroumov [1]; Sang-Hoon Kim [1]; Yoo Lim Cheon [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

Corresponding Author: moskaiti@frib.msu.edu

Recent studies indicate the magnitude of an anomalous decrease in the resonant frequency, so-called frequency dip, near critical temperature of superconducting niobium cavities, Tc, correlates to the cavity quality factor, Q0, and impurities introduced into the superconducting niobium surfaces, such as nitrogen or oxygen. We measured frequency dips in both 644 MHz fundamental mode (FM) and 1.45 GHz higher-order mode (HOM) of single-cell elliptical cavities for FRIB energy upgrade (FRIB400) R&D. These measurements were performed in cavities with the following surface treatments: 1) electropolished (EP) only, 2) nitrogen-doped (N-doping), 3) medium-temperature (mid-T) baked and then hydrofluoric (HF) acid rinsed. We will present measured frequency dips and compare them to cavity Q0 performance in the FM. Frequency-dependent behavior of frequency dips with various surface treatments will also be discussed as our experimental setup has a unique feature compared to previous studies, which allows for measurement of frequency dips in different modes within the same cavity, in other word, on the same surfaces.

Footnotes:

Funding Agency:

Work supported by the U.S. Department of Energy using resources of the Facility for Rare Isotope Beams, a DOE Office of Science User Facility, under Award Number DE-SC0023633.

Student Poster Session / 594

Dust contamination in the TRIUMF electron linear accelerator: charging, detachment and migration of micrometer sized particulates

Author: Aveen Mahon[1]

Co-authors: Devon Lang [1]; James Keir [1]; Philipp Kolb [1]; Thomas Planche [1]

[1] *TRIUMF*

Corresponding Author: amahon@triumf.ca

Dust particulates are always present to some degree inside the vacuum space of particle accelerators, causing a variety of issues. At the LHC, beam loss events have been linked to the interaction of charged dust with the proton beams. In superconducting rf cavities, dust contamination leads to field emission, limiting the accelerating gradient and causing damage to external beamline components. Facilities such as the SLAC LCLS-II and TRIUMF electron linear accelerator see progressive onsets in field emission that cannot simply be explained by vacuum events. The environment of a particle accelerator provides an ideal opportunity for dust to gain charge, which is one of the main drivers of dust grain dynamics in vacuum. However, fundamental parameters such as the dust composition and charge to mass ratio of these grains are unique to each accelerator environment and remain largely unknown. We will present an analysis of dust samples taken from TRIUMF linear accelerators, detailing their size, composition and potential sources. Preliminary results from experimental studies on the charging, detachment and migration mechanisms acting on micron sized particulates will also be presented.

Footnotes:

Funding Agency:

Student Poster Session / 595

Evaluating beam neutralization and transport dynamics in laser-driven ion accelerators

Author: Haruya Matsumoto[1]

Co-authors: Hironao Sakaki [2]; Keisuke Nagashima [2]; masayasu Hata [2]; Tomoyuki Endo [2]; Yukinobu Watanabe [1]; Kiminori Kondo [2]

[1] *Kyushu University*

[2] *National Institutes for Quantum Science and Technology*

Corresponding Author: matsumoto.haruya.876@s.kyushu-u.ac.jp

We are developing a laser-driven ion accelerator aimed at downsizing heavy ion therapy devices. The ion beam produced by this accelerator exhibits low emittance(transverse emittance is approximately 10-3 π mm-mrad and longitudinal emittance is approximately 10-5 eV・s), with a very short pulse width (about picoseconds). As a result, the peak current reaches the kA level. However, explosive beam divergence is mitigated by co-moving electrons that neutralize the beam's space

charge in the high-density region immediately following acceleration. This study involved acceleration calculations and transport calculations of proton beams over 40 cm (up to just before the quadrupole magnet) using the Par-ticle-in-Cell (PIC) simulation code to assess the ion beam's space charge neutralization characteristics. This presentation will show the results of our simulations using the PIC code, which analyzed the degree of neutralization by co-moving electrons. The results suggest the potential for optimizing target thickness when utilizing of specific energy ions produced by laser-driven ion acceleration. The results suggest confirmation of the space charge neutralization phenomenon in the laser-accelerated ion beam.

Footnotes:

Funding Agency:

Student Poster Session / **597**

Halo formation based on 2D and 3D particle-core model

Author: Xinmiao Wan[1]

Co-author: Zhihui Li [1]

[1] *Sichuan University*

Corresponding Author: 419591863@qq.com

Using 2D and 3D particle-core models, we thoroughly studied potential resonance interactions between particles and core in matched beams within complete periodic and double periodic channels. By keeping consistent geometrical structures and phase advances, we compared the Poincaré sections obtained from both models. The findings show that the differences between the models are negligible. This implies that the predicted resonance orders remain consistent, and the size of the resonance island shows only minor discrepancies.
We conducted in-depth studies on resonance behavior in matched beams within periodic structures with varying zero-current phase advances (σ0) using a 3D particle-core model. Our research discovered that a 4:1 resonance phenomenon is triggered when σ0 surpasses 90°. Particularly, in beams influenced by space charge effects, particles within the 4:1 resonance island have the potential to transform into halo particles, a transformation not observed in beams governed by emittance. When σ0 is less than 90° and space charge effects are substantial, 6:1 resonance may emerge. Contrary to the conventional belief that 2:1 resonance caused by mismatch in uniform focusing channels drives particles towards higher amplitude regions, our study revealed that not 2:1 resonance results in particle migration to larger amplitudes. Our research employed TraceWin to confirm these insights, offering valuable contributions to the comprehension of beam dynamics in SCLs.

Footnotes:

Funding Agency:

Student Poster Session / **599**

Laser assist scattering with thermal electron in elliptical and circular polarized laser field

Author: Saddam Dhobi[1]

Co-authors: Buddha Shah [2]; Jeevan Nakarmi [1]; Kishori Yadav [1]; Saddam Dhobi [1]; Suresh Gupta [1]

[1] *Tribhuvan University*

[2] *Nepal Academy of Science and Technology*

Corresponding Author: saddamdhobe@gmail.com

The objective of this research work is to design and develop laser-assisted thermal electron and hydrogen scattering, using theoretical model for elliptical and circular polarized laser. To develop the model, Volkov wave function for thermal case in elliptical and circular polarized laser field was designed and designed wave function is used to obtain S-matrix using Kroll-Watson approximation and born first approximation, with the help of S-matrix, T-matrix was obtained to study the DCS for elliptical and circular polarized laser. The obtained T-matrix was used to compute nature of DCS for linear and elliptical polarized laser field using MATLAB with computing parameters value for laser photon energy (1 eV to 3 eV), incidence thermal electron energy (0.511 MeV to 4 MeV) and temperature (280 K to 300 K). The DCS nature found decrease with increasing in incidence energy of thermal electron with constructive and distractive interference as well as superposition also take palce. In addition, the DCS with thermal electron found higher than non-thermal electron in presence of laser field with scattering angle and incidence energy of the electron.

Footnotes:

Funding Agency:

No

Student Poster Session / **600**

Advancements in Nb_3Sn growth for SRF technology

Author: Liana Shpani[1]

Co-authors: Chi Wang [2]; Helena Lew-Kiedrowska [3]; Matthias Liepe [1]; Steven Sibener [3]; Van Do [3]

[1] *Cornell University (CLASSE)*

[2] *National Cheng Kung University*

[3] *The University of Chicago*

Corresponding Author: ls936@cornell.edu

Nb_3Sn is the most promising alternative material for the future of superconducting radio-frequency (SRF) technology, steadily advancing towards practical applications. Having a critical temperature twice that of niobium, Nb_3Sn offers the potential for developing smaller, more powerful, and more efficient accelerators. We have designed a comprehensive study to synthesize and characterize substrate treatments at nucleation temperatures following the thermal vapor diffusion growth process to improve the uniformity of Nb_3Sn coatings, pushing its performance closer to fundamental limits.

Footnotes:

Funding Agency:

Work supported by the National Science Foundation under Grant No. PHY-1549132, the Center for Bright Beams and U.S. DOE grant No. DE-SC0008431.

Student Poster Session / **601**

Feasibility study for dual higher-order-modes for plasma processing of FRIB superconducting coaxial resonators

Author: Patrick Tutt[1]

Co-authors: Kyle Elliott [1]; Paolo Berrutti [2]; Sang-Hoon Kim [1]; Ting Xu [3]; Walter Hartung [1]; Wei Chang [1]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Brookhaven National Laboratory (BNL)*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: tutt@frib.msu.edu

In-situ plasma processing is a promising technique to reduce field emission in superconducting radio-frequency cavities and thus maintain maximum accelerator performance for long-term operation. Continuous-wave accelerators such as FRIB are more challenging than pulsed accelerators due to relatively weak coupling (Qext = 2E6 to 1E7 for FRIB) via the fundamental power coupler (FPC). This results in an unfavorable mismatch at room temperature and makes fundamental-mode plasma processing difficult. Hence we have investigated the use of higher-order-modes (HOMs) with less FPC mismatch. Several HOMs are promising for lower-mismatch plasma generation. However, HOMs often present a less favorable plasma distribution. To improve the plasma distribution, we are studying techniques to drive the plasma with two HOMs simultaneously. Plasma development results will be presented for FRIB beta = 0.085 quarter wave resonators including ignition threshold measurements and plasma distribution assessments.

Footnotes:

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

Funding Agency:

Project supported by Department of Energy (DOE) Office of Science User Facility under Award number DE-SC0023633.

Student Poster Session / **602**

Microscopic understanding of the effects of impurities in low RRR SRF cavities

Author: Katrina Howard[1]

Co-authors: Daniel Bafia [2]; Zu-Hawn Sung [2]; Wieslawa Dziedzic-Misiewicz [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: khoward99@uchicago.edu

The SRF community has shown that introducing certain impurities into high-purity niobium can improve quality factors and accelerating gradients. We question why some impurities improve RF performance while others hinder it. The purpose of this study is to characterize the impurities of niobium coupons with a low residual resistance ratio (RRR) and correlate these impurities with the RF performance of low RRR cavities so that the mechanism of impurity-based improvements can be better understood and improved upon. The combination of RF testing, temperature mapping, frequency vs temperature analysis, and materials studies reveals a microscopic picture of why low RRR cavities experience low BCS resistance behavior more prominently than their high RRR counterparts. We evaluate how differences in the mean free path, grain structure, and impurity profile

affect RF performance. The results of this study have the potential to unlock a new understanding on SRF materials and enable the next generation of high Q/high gradient surface treatments.

Footnotes:

Funding Agency:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

Student Poster Session / 603

Measurement of CSR-affected beams using generative phase space reconstruction

Author: Juan Pablo Gonzalez-Aguilera[1]

Co-authors: Ryan Roussel [2]; Auralee Edelen [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *SLAC National Accelerator Laboratory*

Corresponding Author: jpga@uchicago.edu

Linear accelerators with dispersive elements experience projected emittance growth due to coherent synchrotron radiation (CSR) effects which become relevant for highly compressed beams. Even though this is a widely known effect, conventional measurement techniques are not precise enough to resolve the multi-dimensional effects in detail, namely the different rotations of transverse phase space slices throughout the longitudinal coordinate of the bunch. In this work, we apply our generative-model-based six-dimensional phase space reconstruction method in the detailed measurement of CSR effects at the Argonne Wakefield Accelerator Facility in simulations. Additionally, we study the current resolution limitations of the phase space reconstruction method and perform an analysis of its accuracy and precision in simulated cases.

Footnotes:

Funding Agency:

This work was supported by the U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams.

Student Poster Session / 604

Decoupling of nitrogen and oxygen impurities in doped SRF cavities

Author: Hannah Hu[1]

Co-authors: Daniel Bafia [2]; Young-Kee Kim [1]

[1] *University of Chicago*

[2] *Fermi National Accelerator Laboratory*

Corresponding Author: hannahhu@uchicago.edu

The performance of superconducting radiofrequency (SRF) cavities is critical to enabling the next generation of efficient high-energy particle accelerators. Recent developments have focused on altering the surface impurity profile through in-situ baking, furnace baking, and doping to introduce and diffuse beneficial impurities such as nitrogen, oxygen, and carbon. However, the precise role and properties of each impurity are not well understood. In this work, we attempt to disentangle the role of nitrogen and oxygen impurities through time-of-flight secondary ion mass spectrometry of niobium samples baked at temperatures varying from 75-800 C with and without nitrogen injection. From these results, we developed treatments recipe that decouple the effects of oxygen and nitrogen in doping treatments. Understanding how these impurities and their underlying mechanisms drive further optimization in the tailoring of impurity profiles for high-performance SRF cavities.

Footnotes:

Funding Agency:

Work supported by the Fermi National Accelerator Laboratory, managed and operated by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy.

Student Poster Session / **605**

Preliminary design of Transverse deflecting structure systems for Shenzhen Superconducting Soft-X-ray Free Electron Laser

Author: Zongbin Li[1]

Co-authors: Jiahang Shao [1]; Huang Qizhang [1]; Jia Yang [2]; Weiqing Zhang [1]

[1] *Institute of Advanced Science Facilities*

[2] *Dalian Institute of Chemical Physics*

Corresponding Author: lizongbin@mail.iasf.ac.cn

Transverse Deflecting Structures (TDS) are commonly used in Free Electron Laser (FEL) facilities for the measurement of longitudinal information of electron beam, including bunch length, temporal distribution, slice emittance, etc. Shenzhen Superconducting Soft-X-ray Free Electron Laser (S3FEL) is a high-repetition-rate FEL recently proposed for scientific research and applications. In S3FEL, TDSs that work at S-band (2997.222 MHz) and X-band (11988.889 MHz) will be utilized for the diagnosis and analysis of longitudinal phase space of electron bunches along the beamline. In this manuscript, we present the preliminary design of both S-band and X-band TDS systems of S3FEL, including system layout, deflecting structures, pulse compressors, RF distribution networks, etc. Additionally, we introduce a new parallel-coupled TDS cavity with variable polarization for multi-dimensional phase space diagnostics.

Footnotes:

Funding Agency:

Student Poster Session / **606**

Circular modes for linacs

Author: Onur Gilanliogullari[1]

Co-authors: Brahim Mustapha [2]; Pavel Snopok [1]

[1] *Illinois Institute of Technology*

[2] *Argonne National Laboratory*

Corresponding Author: ogilanliogullari@anl.gov

Circular mode beams are beams with non-zero angular momentum and strong inter-plane plane coupling. This coupling can be achieved in linear accelerators (linacs) through magnetization of electrons or ions at the source. Depending on the magnetization strength, the intrinsic eigenmode emittance ratio can be large, which produces intrinsic flatness. This flatness can either be converted to real plane flatness or can be maintained as round coupled beam through the system. In this paper, we discuss rotation invariant designs that allow circular modes to be transported through the lattice while accelerating and maintaining its circularity including low-energy space charge effects. We demonstrate that with rotation invariant designs the circularity of the mode can be preserved as round beam while maintaining intrinsic flatness to be converted to flat beam later or injected into a ring.

Footnotes:

Funding Agency:

This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

Student Poster Session / **607**

Automation of sample alignment for neutron scattering experiments

Author: Breeana Pritchard[1]

Co-authors: Jonathan Edelen [1]; Morgan Henderson [1]

[1] *RadiaSoft LLC*

Corresponding Author: breeana@radiasoft.net

Sample alignment in neutron scattering experiments is critical to ensuring high quality data for the users. This process typically involves a skilled operator or beamline scientist. Machine learning has been demonstrated as an effective tool for a wide range of automation tasks. RadiaSoft in particular has been developing ML tools for a range of accelerator applications including beamline automation. In this poster we will present recent developments for selecting and aligning multiple samples at the HB-2A powder diffractometer at HFIR.

Footnotes:

Funding Agency:

This work is supported by DOE Office of Science Office of Basic Energy Science award number DE-SC0021555.

Student Poster Session / **608**

Impact of coherent synchrotron radiation effect on generalized longitudinal strong focusing insertion unit

Author: Jihong Bian[1]

Co-authors: Chuanxiang Tang [1]; Wenhui Huang [1]; Xiujie Deng [1]; Zizheng Li [1]

[1] *Tsinghua University in Beijing*

Corresponding Author: bianjh21@mails.tsinghua.edu.cn

The generalized longitudinal strong focusing (GLSF) scheme is a potential approach for a steady-state mi-crobunching (SSMB) storage ring, leveraging the ultra-low vertical emittance in the storage ring. It achieves active vertical-longitudinal coupling through an inser-tion unit, further compressing bunch length from the hundreds of nanometers scale in the main ring to the nanometers scale, thus emitting radiation. Due to the extremely short bunch length, coherent synchrotron radi-ation (CSR) effect may significantly impact beam dynam-ics. We developed a particle tracking program based on one-dimensional CSR model to preliminarily evaluate the influence of CSR effect in the GLSF scheme under current design parameters. Our work contributes to the future optimization of the GLSF scheme.

Footnotes:

Funding Agency:

Student Poster Session / **609**

Accelerating structures for the FCC-ee pre-injector complex: RF design, optimization, and performance analysis

Author: Adnan Kurtulus[1]

Co-authors: Alexej Grudiev [1]; Andrea Latina [1]; Jean-Yves Raguin [2]; Paolo Craievich [2]; Simona Bettoni [2]

[1] *European Organization for Nuclear Research*

[2] *Paul Scherrer Institut*

Corresponding Author: adnan.kurtulus@cern.ch

The Future Circular Collider electron-positron (FCC-ee) pre-injector complex demands high-performance RF accelerating structures to achieve reliable and efficient acceleration of beams up to 20 GeV. In this study, we describe an analytical approach to RF design for the traveling-wave (TW) structures including a pulse compression system to meet the rigorous specifications of the FCC-ee pre-injector complex. The fundamental mode at 2.8 GHz and Higher Order Mode (HOM) characteristics were determined through the utilization of lookup tables and analytical formulas, enabling efficient exploration of extensive parameter ranges. Optimization of the structure geometry and in particular the iris parameters was performed to address key challenges including maximizing effective shunt impedance, minimizing surface fields, and effectively damping long-range wakes through HOM detuning. Moreover, we investigated the impact of beam-loading effects on the bunch-to-bunch energy spread. Comprehensive thermal and mechanical analyses were carried out to evaluate the impact on the accelerating structure performance during operation at a repetition frequency of 100 Hz.

Footnotes:

Funding Agency:

Student Poster Session / **610**

Physical design of the injector for XiPAF-upgrading

Author: Canbin Yue[1]

Co-authors: Pengfei Ma [1]; Qingzi Xing [1]; Baichuan Wang [2]; Changtong Du [1]; Shu-xin Zheng [1]; Xialing Guan [3]; Mingtong Zhao [2]; Wolong Liu [2]; Minwen Wang [1]; Wei Lv [2]; Zhongming Wang [2]; Xuewu Wang [1]

[1] *Tsinghua University in Beijing*

[2] *State Key Laboratory of Intense Pulsed Radiation Simulation and Effect*

[3] *Tsinghua University*

Corresponding Author: ycb19@mails.tsinghua.edu.cn

This paper describes the physical design of one linac injector for the proton/heavy ion synchrotron, which is under construction for Xi'an 200 MeV Proton Application Facility(XiPAF) heavy ion upgrading project. A heavy ion linac injector will be constructed close to the existing proton linac injector. The heavy ion injector consists of one electron cyclotron resonance(ECR) source, one low energy beam transport(LEBT) section, one radio frequency quadrupole(RFQ) accelerator, one interdigital H-type drift tube linac(IH-DTL), and one linac to ring beam transport(LRBT) section. Heavy ion beams will be accelerated to 2 MeV/u. The unnormalized 99%-particles emittances at the injection point of proton and heavy ion are optimized to be lower than 10 and 16 □ mm·mrad, respectively. Besides, low dispersion at the injection point is obtained to minimize the beam offset caused by the dispersion mismatch in the synchrotron. Three scrapers are installed in the LRBT to meet the requirment of emittance and dispersion.

Footnotes:

Funding Agency:

Student Poster Session / **611**

Compact field emission electron gun driven by terahertz wave

Author: Wentao Yu[1]

Co-authors: Chuangye Song [1]; Kai Peng [1]; Longding Wang [2]; Sijie Fan [1]; Wenhui Huang [1]; Yixiao Fu [2]

[1] *Tsinghua University in Beijing*

[2] *Tsinghua University*

Corresponding Author: ywt15@tsinghua.org.cn

Accelerator-based light sources require high brightness electron bunches to improve performance in exploring structure of matter. Higher acceleration gradient is the key to generate high brightness electron bunches and is more feasible with higher frequency and shorter pulse length electromagnetic wave according to previous empirical formulas. A tapered rectangle waveguide structure driven by terahertz wave is designed as a compact electron gun. A nanotip is fabricated by focused ion beam (FIB) in the center to enhance the field and to emit electrons. The average emission charge per pulse is measured by Pico ammeter, and the peak value reaches 10fC. The max electron energy beyond 4keV is measured from the signal of channel electron multiplier behind a -4kV metal girds, revealing that maximum acceleration gradient is beyond 100MeV/m. These results indicate promising performance of compact terahertz electron gun in high brightness electron injection. Further research will be done in the future.

Footnotes:

Funding Agency:

Student Poster Session / **612**

Tomography Development at ATLAS

Author: Anthony Tran[1]

Co-authors: Brahim Mustapha [2]; Yue Hao [3]

[1] *Facility for Rare Isotope Beams, Michigan State University*

[2] *Argonne National Laboratory*

[3] *Facility for Rare Isotope Beams*

Corresponding Author: tranant2@msu.edu

Beam tomography is a method for reconstructing the higher-dimensional beam from its lower-dimensional projections. This provides an understanding of the beam's transverse phase space, enabling better modeling and predicting downstream beam loss. We will show methods of extrapolating confidence intervals of our reconstructed beam and explore a new beam tomography algorithms using Markov Chain Monte Carlo (MCMC).
\end{abstract}

Footnotes:

Funding Agency:

Student Poster Session / **613**

Limitations of the EuXFEL 3rd harmonic cryomodule in high duty cycle operation

Author: Bozo Richter[1]

Co-authors: Andrea Bellandi [1]; Julien Branlard [1]; Artur Heck [1]; Max Herrmann [1]; Karol Kasprzak [1]

[1] *Deutsches Elektronen-Synchrotron*

Corresponding Author: bozo.richter@desy.de

Future High Duty Cycle (HDC) operation scenarios of the European X-ray Free Electron Laser (EuXFEL) promise increased bunch repetition rate and photon delivery, at the cost of changing system requirements and moving away from the current mode of Short Pulse (SP) operation. To assess whether the third harmonic cryomodule design is also suitable for Long Pulse (LP) and Continuous Wave (CW) operation, key parameters of the spare module are examined at the Accelerator Module Test Facility (AMTF). For Radio-Frequency (RF) related energy efficiency, the cavity resonance tuning precision and the loaded quality factor tuning range are investigated. As performance indicators, limitations on attainable cavity gradient and RF stability are quantified. The results show that the module in its current design is insufficient for LP at high duty cycles and CW at the required operating points. The installed 3-stub tuners only yield maximum loaded quality factors between 5.3e6 and 1.9e7, and the mechanical cavity tuner prohibits tuning precision within the intended cavity half bandwidth. Also, some higher order mode couplers do not allow CW operation at required gradients. Nevertheless, closed-loop RF stability measured in single cavity control is comparable to that of the third harmonic system of EuXFEL.

Footnotes:

Funding Agency:

This work was funded in the context of the R&D program of the European XFEL.

Tuesday Poster Session / 614

IMPACTX space charge modeling of high intensity linacs with mesh refinement

Author: Chad Mitchell[1]

Co-authors: Arianna Formenti [1]; Axel Huebl [1]; Jean-Luc Vay [1]; Ji Qiang [1]; Marco Garten [1]; Remi Lehe [1]; Ryan Sandberg [1]

[1] *Lawrence Berkeley National Laboratory*

Corresponding Author: chadmitchell@lbl.gov

High intensity linacs pose a challenge to efficient beam dynamics modeling due to the high numerical resolution required for accurate prediction of beam halo and losses. The code ImpactX represents the next generation of the particle-in-cell code IMPACT-Z, featuring s-based symplectic tracking with 3D space charge, parallelism with GPU acceleration, adaptive mesh-refinement, modernized language features, and automated testing. While the code contains features that support the modeling of both linear and circular accelerators, we describe recent code development relevant to the modeling of high-intensity linacs (such as beam transport for the Fermilab PIP-II linac), with a focus on space charge benchmarking and the impact of novel code capabilities such as mesh refinement.

Footnotes:

Funding Agency:

Main Session FRY / 615

Free-electron lasers for advanced semiconductor manufacturing needs

Author: James Rosenzweig[1]

[1] *University of California, Los Angeles*

Corresponding Author: rosenzweig@physics.ucla.edu

There is intense current interest in applying short-wavelength FELs to semiconductor manufacturing. Next-generation FEL techniques are being developed to address two advanced chip fabrication challenges: high-average-power lithography sources; and few-nm-resolution metrology. Aspects of the significant new activity in EUV lithography FELs, likely to impact the industry in the coming years, are reviewed. Beyond lithography, new, non-destructive 3D methods are critical to future US semiconductor manufacturing. Storage ring-based studies of chip imaging with coherent hard X-rays using ptychographic tomography and laminography techniques have achieved 4-nm voxel resolution. The methods are rapidly maturing, but the coherent X-ray source characteristics must be improved. An ultra-compact X-ray FEL is an attractive, compact and cost-effective option for chip fabrication plants. Contours of a design, based on ultra-high electron beam brightness, high-gradient acceleration, and cutting-edge regenerative amplifiers, that can deliver the needed coherent flux are examined. A development path, from concept to rapid realization of a transformative XFEL-based application is discussed.

Footnotes:

Funding Agency:

Thursday Poster Session / 616

CBXFEL design, production, and installation status

Author: Marion White[1]

Co-authors: Alberto Lutman [2]; Aliaksei Halavanau [2]; Andrew Bernhard [1]; Antonino Miceli [1]; Chunguang Jing [3]; Courtney Curtis [2]; Davide Bianculli [1]; Deming Shu [1]; Diling Zhu [2]; Eugene Kraft [2]; Georg Gassner [2]; Jayson Anton [1]; Jeong-Wan Park [1]; Jeremy Mock [2]; Joseph Sullivan [1]; Keenan Lang [1]; Kenji Tamasaku [4]; Keshab Kauchha [1]; Kwang-Je Kim [1]; Lahsen Assoufid [1]; Maria Alessandra Montironi [2]; Mario Balcazar [2]; Mauricio Camarena [3]; Namrata Balakrishnan [2]; Peifan Liu [1]; Rachel Margraf-O'Neal [1]; Ryan Lindberg [1]; S. Joshua Stein [1]; Sheikh Mashrafi [1]; Shweta Saraf [2]; Steven Kearney [1]; Taito Osaka [4]; Xavier Permanyer [2]; Xianbo Shi [1]; Yuri Shvyd'ko [1]; Zhirong Huang [2]

[1] *Argonne National Laboratory*

[2] *SLAC National Accelerator Laboratory*

[3] *Euclid Beamlabs LLC*

[4] *RIKEN SPring-8 Center*

Corresponding Author: mwhite@aps.anl.gov

Use of a cavity-based X-ray free electron laser (CBXFEL) is potentially a way to dramatically improve the stability and coherence of existing XFELs. A proof-of-principle project is underway as a collaboration between Argonne National Laboratory (ANL), The Institute of Physical and Chemical Research in Japan (RIKEN), and SLAC National Accelerator Laboratory. The CBXFEL is expected to operate using 9.831 keV photons from LCLS, using synthetic diamonds as cavity Bragg mirrors. The LCLS copper linac will deliver two electron bunches 624 RF buckets apart, resulting in a total X-ray cavity length of 65500.87 mm. The final X-ray cavity design, and installation and production status will be presented.

Footnotes:

Funding Agency:

Thursday Poster Session / 617

Progress and challenges in traveling-wave (TW) SRF cavity development

Author: Fumio Furuta[1]

Co-authors: Roman Kostin [2]; Vyacheslav Yakovlev [1]

[1] *Fermi National Accelerator Laboratory*

[2] *Euclid TechLabs, LLC*

Corresponding Author: ffuruta@fnal.gov

Traveling-wave (TW) technology can push the accelerator field gradient of niobium SRF cavity to 70MV/m or higher beyond the limit of 50˜60MV/m in Standing-wave (SW) technology. The early stages of TW SRF cavity developments had been funded by several SBIR grants to Euclid Techlabs and completed in collaboration with Fermilab through a 1-cell prototype and a proof-of-principle 3-cell TW cavity. The TW resonance excitation in the 3-cell TW cavity at 2K was demonstrated through the low power RF test in early 2024. A high-power test of the 3-cell in TW mode being

prepared. To advance a design and technology to fabricate a novel high gradient TW SRF cavity, FNAL proposed a half-meter TW RF design and R&Ds to realize that are in progress. Here we will report the recent progress in the 3-cell TW cavity and the challenges towards a half-meter scale TW cavity.

Footnotes:

Funding Agency:

Monday Poster Session / 618

Data acquisition and characterization software for radio-frequency (rf) systems

Author: Sohum Suthar[1]

Co-author: Branko Popovic [1]

[1] *Argonne National Laboratory*

Corresponding Author: sohumksuthar@gmail.com

In accelerator physics, radio-frequency (rf) systems play a pivotal role in particle beam acceleration and diagnostics. This work presents a graphical interface designed with Python for interaction with rf instruments, enabling efficient data acquisition, processing, and visualization. Leveraging advanced software tools, the system enables efficient management and analysis of rf data. This capability is crucial for optimizing experimentation and streamlining data flow. The modular architecture is implemented on various systems and is demonstrated with the current 200kW Solid State Amplifier (SSA) test setup at the Advanced Photon Source.

Footnotes:

Funding Agency:

Student Poster Session / 619

Data acquisition and characterization software for radio-frequency (rf) systems

Author: Sohum Suthar[1]

Co-author: Branko Popovic [1]

[1] *Argonne National Laboratory*

Corresponding Author: sohumksuthar@gmail.com

In accelerator physics, radio-frequency (rf) systems play a pivotal role in particle beam acceleration and diagnostics. This work presents a graphical interface designed with Python for interaction with rf instruments, enabling efficient data acquisition, processing, and visualization. Leveraging advanced software tools, the system enables efficient management and analysis of rf data. This capability is crucial for optimizing experimentation and streamlining data flow. The modular architecture is implemented on various systems and is demonstrated with the current 200kW Solid State Amplifier (SSA) test setup at the Advanced Photon Source.

Footnotes:

Funding Agency:

Student Poster Session / **620**

RF Tuning analysis of a 750 MHz Carbon RFQ for Medical Applications

Author: Gabriela Moreno[1]

Co-authors: Jorge Giner Navarro [2]; Concepcion Oliver [1]; Daniel Gavela [1]; Pedro Calvo [1]; Miguel Lopez [1]; Ángel Rodríguez Páramo [1]; Jone Etxebarria [1]; Jose Perez Morales [1]; Alessandra Lombardi [3]; Unai Etxebeste Rodríguez [4]

[1] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*

[2] *Instituto Universitario de Ciencia de los Materiales*

[3] *European Organization for Nuclear Research*

[4] *Egile Mechanics S.L.*

Corresponding Author: gabriela.moreno@ciemat.es

This work is part of the development study of a linac injector for hadron therapy with carbon ion beams. The initial cavities of the future injector consist of two 750 MHz Radio Frequency Quadrupoles (RFQ), which are based on the compact CERN High-Frequency RFQ. These RFQs are designed to accelerate the ions from 15 KeV/u to 5 MeV/u. Each RFQ, with a length of 2 meters, comprises four individual modules and 32 tuners, 8 per module.
Certain design choices, manufacturing imperfections, and misalignments lead to local variations in the frequency and field distribution within the RFQs. The tuning procedure corrects these perturbations in the TE210 operating mode using a bead pull system and movable tuners.
The aim of this article is to determine the maximum field correction achieved through this tuning without affecting the beam dynamics. For this purpose, a set of electromagnetic deviations that introduces significant dipole components to the cavity is simulated, using CST Studio. Using the tuning algorithm, this EM deviation is corrected while the dynamic beam modifications are studied.

Footnotes:

Funding Agency:

Main Session TUY / **622**

Exhibitor/Sponsor Lightning Talks

Thursday Poster Session / **625**

Dust contamination in the TRIUMF electron linear accelerator: charging, detachment and migration of micrometer sized particulates

Author: Aveen Mahon[1]

Co-authors: Devon Lang [1]; James Keir [1]; Philipp Kolb [1]; Thomas Planche [1]

[1] *TRIUMF*

Corresponding Author: amahon@triumf.ca

Dust particulates are always present to some degree inside the vacuum space of particle accelerators, causing a variety of issues. At the LHC, beam loss events have been linked to the interaction of charged dust with the proton beams. In superconducting rf cavities, dust contamination leads to field emission, limiting the accelerating gradient and causing damage to external beamline components. Facilities such as the SLAC LCLS-II and TRIUMF electron linear accelerator see progressive onsets in field emission that cannot simply be explained by vacuum events. The environment of a particle accelerator provides an ideal opportunity for dust to gain charge, which is one of the main drivers of dust grain dynamics in vacuum. However, fundamental parameters such as the dust composition and charge to mass ratio of these grains are unique to each accelerator environment and remain largely unknown. We will present an analysis of dust samples taken from TRIUMF linear accelerators, detailing their size, composition and potential sources. Preliminary results from experimental studies on the charging, detachment and migration mechanisms acting on micron sized particulates will also be presented.

Footnotes:

Funding Agency:

Main Session FRY / 627

Closeout

Authors: John Byrd[1]; Sam Posen[2]

[1] *Argonne National Laboratory*

[2] *Fermi National Accelerator Laboratory*

Corresponding Authors: jbyrd@anl.gov, sposen@fnal.gov

Footnotes:

Funding Agency: