eeFACT 2025 - 70th ICFA Advanced Beam Dynamics Workshop on High Luminosity Circular e+e– Colliders

Report of Contributions

https://indico.jacow.org/e/eeFACT2025

Contribution ID: **2** Type: **Invited Oral Presentation**

Welcome Address

Monday 3 March 2025 09:00 (10 minutes)

Presenter: KOSEKI, Tadashi (High Energy Accelerator Research Organization)

Contribution ID: **8** Type: **Invited Oral Presentation**

The status of the Future Circular electron-positron Collider

In 2020 the European Strategy for Particle Physics Update (ESPPU) recommended an Electroweak- and Higgs-factory as the highest priority next collider after completion of the High-Luminosity Large Hadron Collider (HL-LHC), to be followed by a hadron collider with a center-of-mass energy of about 100 TeV. The so-called integrated Future Circular Collider (FCC) program would fulfill this recommendation and foresees first, an electron-positron machine, the FCC-ee, followed by a hadron one, the FCC-hh. Both are storage ring colliders, designed to be installed in the same tunnel infrastructure with approximately 91 km circumference and integrated in the existing CERN infrastructure. Tremendous effort has been put into optimizing the FCC-ee baseline lattice, including novel arc and interaction region optics designs, an improved injection scheme,and a dedicated collimation optics. A first commissioning strategy with dedicated optics has been defined, including beam-based alignment strategies and advanced tuning techniques to achieve its ambitious design parameters. The latest status of the FCC-ee is presented here, highlighting accelerator challenges and studies to assess and overcome them.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: KEINTZEL, Jacqueline (European Organization for Nuclear Research)

Co-authors: CARLI, Christian (European Organization for Nuclear Research); ZIMMERMANN, Frank (European Organization for Nuclear Research); ROY, Ghislain (European Organization for Nuclear Research); OIDE, Katsunobu (European Organization for Nuclear Research); BENEDIKT, Michael (European Organization for Nuclear Research); TOMAS, Rogelio (European Organization for Nuclear Research)

Presenter: KEINTZEL, Jacqueline (European Organization for Nuclear Research)

Session Classification: Present and future colliders

Track Classification: WG1 : Present and future colliders

Contribution ID: **12** Type: **Invited Oral Presentation**

Project status and R&D efforts for Super Tau-Charm Facility

Super Tau-Charm Facility (STCF) was proposed as a third-generation circular electron-positron collider in the energy range of 2-7 GeV (CoM) and with a luminosity greater than 5*10ˆ34 cmˆ-2sˆ-1 @4 GeV, aiming to explore charm physics and tau physics in the next decades. This presentation will introduce the facility design and R&D efforts for STCF, including the design goal, accelerator and detector schemes, and key technological R&D efforts, with focus on the accelerator. Under the financial support of the key technology R&D project by the local provincial government and other national funding agencies, the STCF accelerator team is working on the conceptual design of the accelerator, which will be followed by the technical design, while the detector team is working on the technical design. The accelerator consists of a full-energy injector consisting of multi-section linacs and a positron accumulator ring and a double-ring collider with the crab-waist collision scheme. Key physics and technological challenges will be addressed. Ongoing R&D efforts and progresses will be summarized. The project planning will also be given.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: Prof. TANG, Jingyu (University of Science and Technology of China)

Presenter: Prof. TANG, Jingyu (University of Science and Technology of China)

Session Classification: Present and future colliders

Track Classification: WG1 : Present and future colliders

Contribution ID: **17** Type: **Invited Oral Presentation**

Beam dynamics studies to address EIC challenges.

The Electron-Ion Collider (EIC) at BNL is designed to provide a peak luminosity of 10ˆ34 cmˆ-2 secˆ-1 (electron-proton equivalent) in collisions between polarized electrons and heavy ions or polarized protons. To achieve this high luminosity, high beam currents in a large number of bunches are required, and ion beams with unequal transverse emittances need to be generated and accelerated. Experimental studies and simulations to address EIC beam dynamics challenges will be reported.

Footnotes

Funding Agency

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I have read and accept the Privacy Policy Statement

Yes

Primary author: MONTAG, Christoph (Brookhaven National Laboratory)

Presenter: MONTAG, Christoph (Brookhaven National Laboratory)

Session Classification: Optics & Beam Dynamics

Track Classification: WG3 : Optics & Beam Dynamics

Contribution ID: **19** Type: **Invited Oral Presentation**

Physics design of the STCF collider rings.

The Super Tau-Charm Facility (STCF), proposed by the University of Science and Technology of China, represents the next generation of electron-positron colliders. With a target luminosity exceeding 5×10ˆ34 cm-2s-1, the STCF aims to achieve approximately two orders of magnitude higher luminosity compared to the current BEPCII. To reach such high luminosity, a combination of large Piwinski angle collisions and the crab waist scheme, first proposed by P. Raimondi in 2006, is employed. This approach effectively enhances the luminosity. However, the extremely small beta function at the interaction point introduces significant chromaticity. Correcting this chromaticity requires the use of strong sextupoles, which in turn induces substantial nonlinear effects. These nonlinearities impose strict limitations on the dynamic and momentum apertures, thereby presenting challenges for the Touschek lifetime. In this paper, we explore the physical design considerations for the STCF collider ring, with a focus on addressing these challenges. Nonlinear optimization is performed using the Multi-Objective Genetic Algorithm to enhance performance and mitigate the impact of nonlinear effects.

Footnotes

Funding Agency

The study was supported by the National Natural Science Foundation of China (Project No. 12341501)

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Yes

Primary author: ZOU, Ye

Co-authors: TANG, Jingyu (University of Science and Technology of China); ZHANG, Linhao (University of Science and Technology of China); LUO, Qing (University of Science and Technology of China); LIU, Tao (University of Science and Technology of China)

Presenter: ZOU, Ye

Session Classification: Optics & Beam Dynamics

Track Classification: WG3 : Optics & Beam Dynamics

Contribution ID: **20** Type: **Invited Oral Presentation**

Optics correction for the electron positron future circular collider: nominal and ballistic optics

The proposed electron-positron Future Circular Collider (FCC-ee) is planned to achieve unprecedented high luminosity, enabling answers to fundamental questions in high-energy physics. Magnets field imperfections and misalignments significantly impact beam dynamics and can strongly affect the collider's performance. In this contribution, we present the current status of a developed correction procedure, as well as the alignment and field tolerances for the FCC-ee at Z-energy nominal lattice and a dedicated ballistic optics that will be used during the initial commissioning phase. proper sequence of the initial commission phase has been defined.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: MUSA, Elaf (Deutsches Elektronen-Synchrotron)

Co-author: AGAPOV, Ilya (Deutsches Elektronen-Synchrotron)

Presenter: MUSA, Elaf (Deutsches Elektronen-Synchrotron)

Session Classification: Optics & Beam Dynamics

Track Classification: WG3 : Optics & Beam Dynamics

Contribution ID: **21** Type: **Invited Oral Presentation**

Beam-beam simulation studies for the Electron-Ion Collider

Yun Luo, F. Willeke, Yue Hao, J. Qiang, D. Xu, M. Blaskiewicz, C. Montag

The Electron-Ion Collider (EIC), to be constructed at Brookhaven National Laboratory, will collide polarized high-energy electron beams with polarized hadron beams, achieving luminosities up to 1 × 10^{34} cm^{−2} s^{−1} in the center-of-mass energy range of 29-140 GeV. To achieve such high luminosity, we adopt high bunch intensities for both beams, small and flat transverse beam sizes at the interaction point (IP), and a large full crossing angle of 25 mrad with crab cavities. In this talk, we will present the challenges to the EIC beam-beam design parameters and compare them with previous e-p collider HERA and other colliders, such as the KEK-B factory and the Relativistic Heavy Ion Collider (RHIC). We will present the beam-beam interaction related design parameter optimization, optics and magnet imperfections, and noises from power supply ripples, crab cavity noises, and intra-beam scattering (IBS).

Footnotes

beam-beam talk on EIC

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: Mr LUO, Yun (Brookhaven National Laboratory (BNL))

Presenter: Mr LUO, Yun (Brookhaven National Laboratory (BNL))

Session Classification: Beam-beam & Instabilities

Track Classification: WG4 : Beam-beam & Instabilities

Contribution ID: **28** Type: **Invited Oral Presentation**

Beam-Beam & instabilities at SuperKEKB

There are several issues to limit the luminosity performance of SuperKEKB. We discuss mechanism of Sudden Beam Loss (SBL), -1 head-tail mode instability related to bunch-by-bunch feed back system, and coherent and incoherent beam-beam phenomena.

Funding Agency

Footnotes

I have read and accept the Privacy Policy Statement

Yes

Primary authors: Dr OHMI, kazuhito (High Energy Accelerator Research Organization (KEK)); Dr OHMI, kazuhito (High Energy Accelerator Research Organization (KEK))

Presenter: Dr OHMI, kazuhito (High Energy Accelerator Research Organization (KEK))

Session Classification: Beam-beam & Instabilities

Track Classification: WG4 : Beam-beam & Instabilities

Contribution ID: **30** Type: **Invited Oral Presentation**

Beam-beam Effects at CEPC

The beam-beam interaction related studies at CEPC are presented. The beam-beam limit, combined effects of beam-beam and longitudinal/transverse impedances, and mitigation study of coherent beam-beam instability are discussed. The effects of optics error on beam-beam performance are also presented. Some simulation on crosstalk between beam-beam interaction and lattice is also shown.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: ZHANG, Yuan (Institute of High Energy Physics)

Co-authors: Dr LIN, Chuntao; Prof. OHMI, Kazuhito; WANG, Na (University of Chinese Academy of Sciences); Dr LI, Zhiyuan (IHEP)

Presenter: ZHANG, Yuan (Institute of High Energy Physics)

Session Classification: Beam-beam & Instabilities

Track Classification: WG4 : Beam-beam & Instabilities

Contribution ID: **34** Type: **Invited Oral Presentation**

Optics design of the interaction region for the STCF

The Super Tau-Charm Facility (STCF), proposed in China, is a new-generation high luminosity e+/e− collider in the low-energy region of 1-3.5 GeV. To achieve the target luminosity of larger than 5×10ˆ34 cmˆ−2sˆ−1, a large crossing angle and crab-waist correction scheme is applied. It is well-known that nonlinearity within the interaction region (IR), particularly due to crab sextupoles, significantly decreases both dynamic and momentum apertures. Consequently, the design of IR optics holds critical importance in enhancing the Touschek lifetime. In this paper, we will present the modular linear optics design for the STCF IR, to facilitate nonlinear optimization. Furthermore, we will elaborate on high-order chromaticity correction methods aimed at broadening the momentum bandwidth, thereby improving the Touschek lifetime.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: ZHANG, Linhao (University of Science and Technology of China)

Co-authors: TANG, Jingyu (University of Science and Technology of China); LUO, Qing (University of Science and Technology of China); LIU, Tao (University of Science and Technology of China); ZOU, Ye (University of Science and Techonology of China)

Presenter: ZHANG, Linhao (University of Science and Technology of China)

Session Classification: Machine Detector Interface

Track Classification: WG5 : Machine Detector Interface

Contribution ID: **52** Type: **Invited Oral Presentation**

The FCC-ee polarimeter

In order to perform the precise energy calibration for the Z and WW modes of the FCC-ee machine, the use of Resonant Depolarization (RDP) method on a set of non-colliding polarized bunches is foreseen. To track the polarization state of these bunches while scanning the depolarization excitation frequency a Compton Polarimeter will be deployed on both colliding beams.

The most recent advances on the Compton Polarimeter design for FCC-ee energy calibration will be presented to the community at the eeFACT conference.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary authors: Prof. WILKINSON, Guy (Christ church university of Oxford); Dr KEINTZEL, Jacqueline (CERN); Dr MARTENS, Aurelien (Université Paris-Saclay, CNRS/IN2P3, IJCLab); Dr GRANADOS, Eduardo (CERN); Dr KIEFFER, Robert (CERN); Dr LEFEVRE, Thibaut (CERN); Dr MAZZONI, Stefano (CERN)

Presenter: Dr KIEFFER, Robert (CERN)

Session Classification: Polarization, Energy calibration, Monochromatization

Track Classification: WG8 : Polarization, Energy calibration, Monochromatization

Contribution ID: **54** Type: **Invited Oral Presentation**

Polarization status at the EIC

The Electron-Ion Collider (EIC) at Brookhaven National Laboratory will collide polarized protons between 41 and 275 GeV against polarized electrons ranging from 5 to 18 GeV, achieving luminosities up to 10ˆ34 cmˆ{-2} sˆ{-1}. We review the factors impacting the expected polarization transmission and lifetime for the EIC's Electron injector systems, Storage Ring (ESR), the Hadron injector systems and storage ring (HSR).

Footnotes

Funding Agency

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I have read and accept the Privacy Policy Statement

Yes

Primary author: Dr RANJBAR, Vahid (Brookhaven National Laboratory (BNL))

Co-authors: MONTAG, Christoph; HAMWI, Eiad (Cornell University (CLASSE)); WANG, Erdong (Brookhaven National Laboratory); HOFFSTAETTER, Georg (Cornell University (CLASSE)); HUANG, Haixin (Brookhaven National Laboratory); LOVELACE III, Henry (International Institute for Accelerator Applications); HOCK, Kiel (Brookhaven National Laboratory); SIGNORELLI, Matthew (Cornell University (CLASSE)); NAGAITSEV, Sergei (Brookhaven National Laboratory (BNL)); PTITSYN, Vadim (Brookhaven National Laboratory (BNL)); SCHOEFER, Vincent (Brookhaven National Laboratory); BERGAN, William (Brookhaven National Laboratory)

Presenter: Dr RANJBAR, Vahid (Brookhaven National Laboratory (BNL))

Session Classification: Polarization, Energy calibration, Monochromatization

Track Classification: WG8 : Polarization, Energy calibration, Monochromatization

Contribution ID: **55** Type: **Invited Oral Presentation**

Advances in Free Spin Precession Method

The free spin precession (FSP) method is considered as an alternative to the well-known approach based on the use of the resonant depolarization scanning procedure (RDP). The main advantage of FSP over RDP is that the spin tune will be determined directly from the Fourier spectrum of the signal from the Compton polarimeter measuring the oscillations of the longitudinal spin component. This would eliminate much of the ambiguity in the choice of resonant frequency value from the scan data. In addition, the procedure for measuring the free precession spectrum takes only about 1-2 seconds instead of about 5-15 minutes, as in the RDP method. The paper discusses an additional possibility of measuring the phase difference of coherent spin precession measured in several polarimeters installed on the ring. The issue of obtaining the required measurement accuracy of these phases for the FCC-ee collider was investigated.

Footnotes

Funding Agency

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Yes

Primary author: KOOP, Ivan (Russian Academy of Sciences)

Presenter: KOOP, Ivan (Russian Academy of Sciences)

Session Classification: Polarization, Energy calibration, Monochromatization

Track Classification: WG8 : Polarization, Energy calibration, Monochromatization

Contribution ID: **56** Type: **Invited Oral Presentation**

Calibrating the energy at the Future Circular electron-positron Collider

The ultimate goal of the Future Circular electron-positron Collider is performing particle physics experiments at an unprecedented precision from the Z-pole up to above the top-pair-threshold. This demands, among others, an excellent knowledge of the center-of-mass energy and, hence, the beam energies. By depolarizing polarized pilot bunches with a RF-kicker and recording the change of polarization with a 3D Compton polarimeter, it is aimed to measure the spin tune, which is directly linked to the beam energy. The current status of the plans for energy calibration at FCC-ee is presented.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: KEINTZEL, Jacqueline (European Organization for Nuclear Research)

Co-authors: BLONDEL, Alain (Geneva University); CARLI, Christian (European Organization for Nuclear Research); ZIMMERMANN, Frank (European Organization for Nuclear Research); WILKINSON, Guy (European Organization for Nuclear Research); WENNINGER, Jorg (European Organization for Nuclear Research); BENEDIKT, Michael (European Organization for Nuclear Research)

Presenter: KEINTZEL, Jacqueline (European Organization for Nuclear Research)

Session Classification: Polarization, Energy calibration, Monochromatization

Track Classification: WG8 : Polarization, Energy calibration, Monochromatization

Contribution ID: **69** Type: **Invited Oral Presentation**

Improving Beam Quality and Reliability through Low-Level RF Control in Superconducting Accelerators

Beam dynamics during acceleration are inherently sensitive to numerous external factors, particularly within superconducting linear accelerators. In such systems, the high-Q superconducting RF cavities are especially vulnerable to instabilities caused by unforeseen disturbances, which can significantly degrade beam quality or even lead to beam loss. The low-level RF (LLRF) control system, which allows for precise regulation of RF fields, is a critical component in maintaining and enhancing beam quality. Drawing on the presenter's extensive operational experience with multiple superconducting accelerators at KEK (Japan) and the Institute of Modern Physics (China), this presentation explores the pivotal role of LLRF systems in improving beam quality, increasing accelerator reliability, and advancing automation. Specific topics will include achieving ultra-low beam energy spread, enhancing beam availability, and enabling automated RF system operations.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary authors: QIU, Feng (Institute of Modern Physics, Chinese Academy of Sciences); YANG, Lijuan (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences); GAO, Zheng (Institute of Modern Physics, Chinese Academy of Sciences); Dr MA, jinying (Institute of Modern Physics, Chinese Academy of Sciences); Dr JIANG, tiancai (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: QIU, Feng (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: RF

Track Classification: WG11 : RF

Contribution ID: **77** Type: **Invited Oral Presentation**

STCF injector and positron source design

The proposal for a new generation high-luminosity electron-positron collider, the Super Tau-Charm Facility (STCF), has been put forward in China. The STCF is expected to achieve a luminosity greater than 0.5×10ˆ35 cmˆ-2 sˆ-1 and operate within a center-of-mass energy range of 2 to 7 GeV. Considering the design challenges of the STCF collider ring, swap-out injection has been suggested as one of the alternative injection methods to achieve the desired luminosity. Therefore, the STCF injector will investigate both off-axis injection and swap-out injection methods concurrently. This paper will present the research progress on these two injection methods for STCF.

Footnotes

Funding Agency

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Yes

Primary author: ZHANG, Ailin (University of Science and Technology of China)

Co-authors: GU, Duan (Shanghai Advanced Research Institute); PEI, Guoxi (Institute of High Energy Physics); TANG, Jingyu (University of Science and Technology of China); Dr HU, Tongning (Huazhong University of Science and Technology); YUAN, Youjin (University of Chinese Academy of Sciences)

Presenter: ZHANG, Ailin (University of Science and Technology of China)

Session Classification: Injector, Injection

Track Classification: WG6 : Injector, Injection

Contribution ID: **82** Type: **Invited Oral Presentation**

Charm physics studies at BESIII, Belle (II) and STCF

Electron-positron collider experiments, such as BESIII and Belle (II), along with future facilities like the Super Tau-Charm Factory (STCF), will serve as improtant laboratories for studying charm physics. BESIII operates near the threshold energy region, where it collects substantial data samples of charmed and anti-charmed hadron pairs. The proposed STCF aims to be a third-generation circular electron-positron collider with a luminosity approximately 100 times greater than that of BESIII. Meanwhile, Belle II, the upgrade of Belle, is anticipated to produce enormous number of charmed hadrons. In this presentation, a brief overview of the theoretical aspects related to charm mixing, CP violation, and rare charm decays will be given. The current status and future prospects on these topics at BESIII, Belle (II) and STCF will be discussed. Recent progress and future prospects of the precise determination of the CKM matrix elements |V_cd| and |V_cs| will also be presented. We will show that the synergy between experiments operating in near-threshold regions (such as BESIII and STCF) and at higher energies (like Belle and Belle II) is crucial for precision measurements of charm mixing and for probing charm CP violation.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: ZHANG, Yu (University of South China)

Presenter: ZHANG, Yu (University of South China)

Session Classification: Physics

Track Classification: WG2 : Physics

Contribution ID: **83** Type: **Invited Oral Presentation**

B and tau physics at e+e- colliders

The Belle II experiment at the SuperKEKB energy-asymmetric e^+e^- collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. Since the year 2019, Belle II has recorded close to 600 fb^{-1} at the center-of-mass energy of the $\Upsilon(4S)$ resonance. Together with the Belle data set, this is by far the world-largest sample of electron positron collision events at the $B\bar{B}$ threshold and allows measurements in the heavy flavour sector with unprecedented precision.

In this presentation, we will review the status of the Belle II experiment and showcase new results on B meson and τ lepton decays.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Primary author: SCHWANDA, Christoph (Austrian Academy of Sciences)

Presenter: SCHWANDA, Christoph (Austrian Academy of Sciences)

Session Classification: Physics

Track Classification: WG2 : Physics