First beam commissioning and beam experiments of the CiADS Front end

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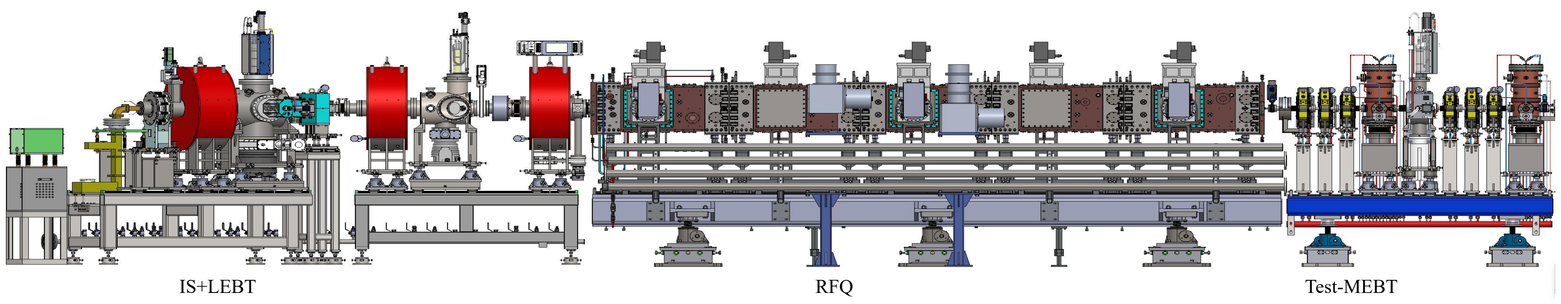
IBIC2024 Sept. 9-13, 2024 · Beijing, China

Introduction

- **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 demonstrate 5 mA beam of front-end Linac for CiADS, the normal temperature front end section has completed construction from October 2022 to May 2024. The first beam in 2023, test-MEBT update and systematic commissioning at August 2024.**
- **This paper mainly outlines the first beam commissioning and beam experiments of CiADS Front end.**

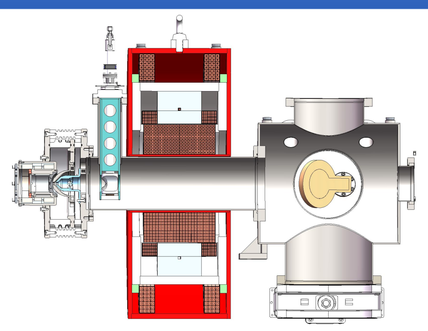


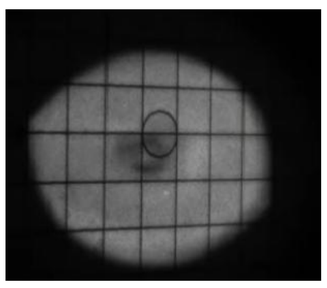
NT.front end section layout

Parameters	data	unit
Particle	H^+	-
Energy	2.1	MeV
Current	5	mA
Frequence	162.5	MHz
Opration mode	Pulse/CW	-

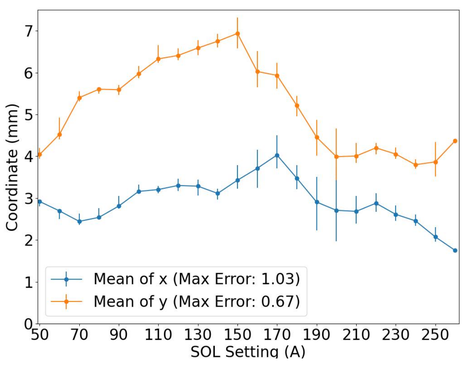
Beam parameters

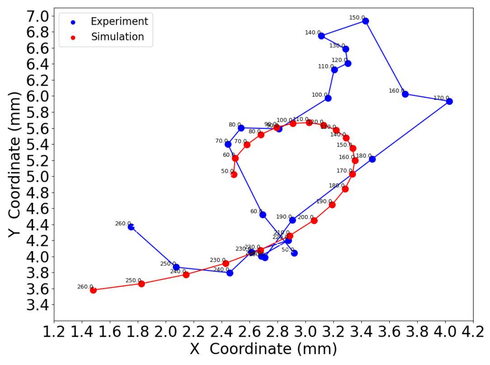
Ion source assembly error analysis





Centroid measurement

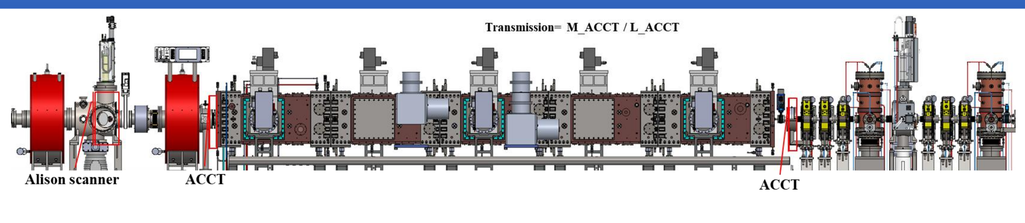


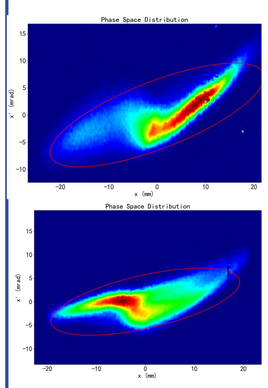


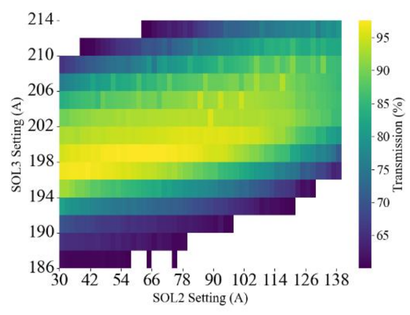
X = 0.25 mm X` = -4.78 mrad Y = 2.48 mm Y` = -1.46 mrad

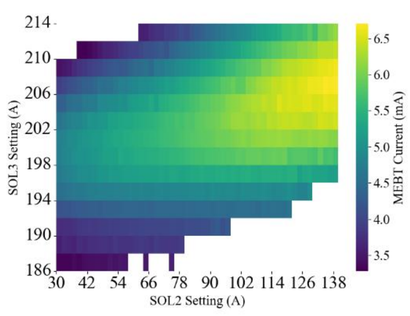
The exit electrode may deviate by 0.2mm relative to the center of the solenoid magnetic field with Beam-based measurement.

Beam match of LEBT with RFQ









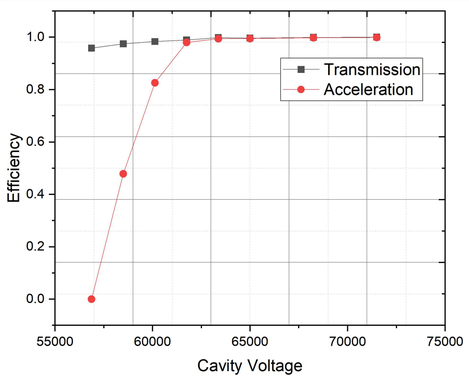
Emittance measurement by Alison scanner

Sol. Scan Vs. RFQ transmission

Sol. Scan Vs. intensity out of RFQ

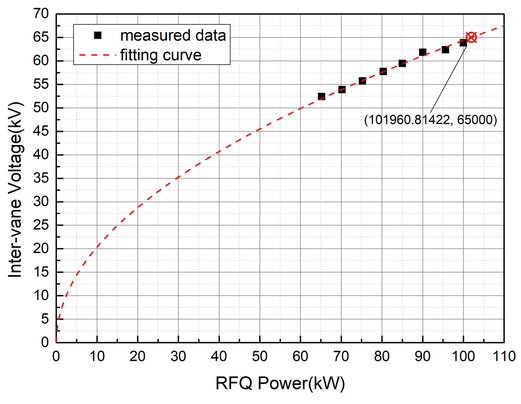
- **Beam emittance is about 0.15 Pi. mm. mrad， measured by Alison scanner at LEBT, less than the RFQ input requirement;**
- **The optimal matching point for emittance coincides with the center of the highest transmission efficiency in the maps, and this scheme is used for the RFQ match by solenoid scan.**

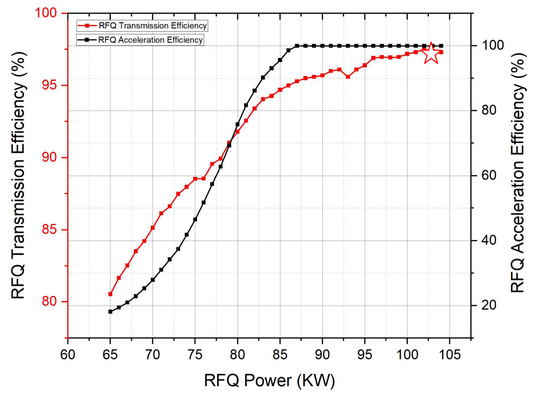
Calibration for RFQ cavity voltage



Transmission= M_ACCT / L_ACCT
Acc. efficiency=M_FC / M_ACCT

Inter-vane voltage of RFQ Vs. Beam transmission



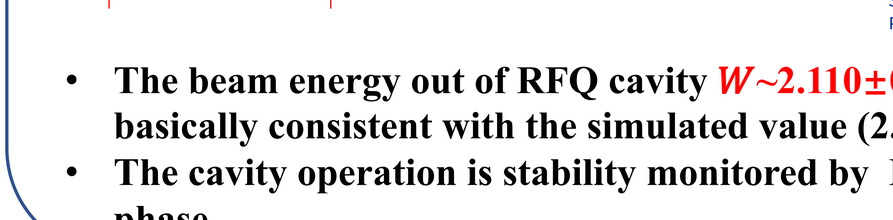


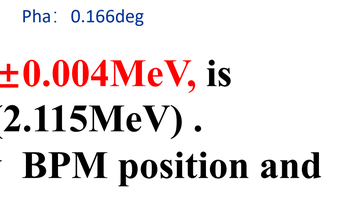
Bremsstrahlung measurement of inter-vane voltage

Inter-vane voltage of RFQ Vs. Beam transmission

- **The calibration results of the bremsstrahlung effect and beam-based RFQ cavity voltage are relatively consistent.**
- **The RFQ design cavity voltage of 65 kV corresponds to a cavity power of 102 kW.**

Exit beam energy measurement and stability





Mean Data： X~-1.58mm Y~-3.05mm Pha：145.84deg
Standard Deviation: X~0.044mm Y~0.090mm
Pha： 0.166deg

- **The beam energy out of RFQ cavity *W*~2.110±0.004MeV, is basically consistent with the simulated value (2.115MeV) .**
- **The cavity operation is stability monitored by BPM position and phase.**

Conclusion

- **Based on the CiADS front end device, some beam experiments have been completed. We have conducted simulations and experiments on the ion source, LEBT section, and RFQ, respectively, to verify the usability and stability of the machine.**
- **In the future, more technological means will be verified based on this device to ensure the stable operation of the 5mA superconducting linac of the final CiADS.**