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# Beam optics study of KAHIF MEBT beam line

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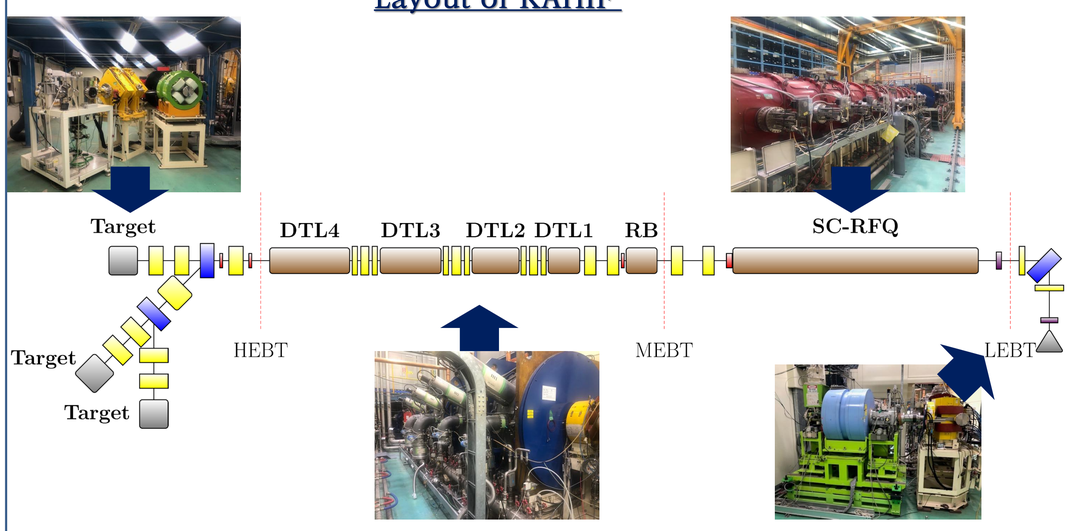
**Abstract:** As an ion beam irradiation facility, KAERI Heavy ion Irradiation Facility (KAHIF) has been constructed at KAERI, Daejeon. The facility is being utilized for research the nuclear fusion materials and nuclear reactor materials, especially structural material study. The dedicated accelerator system could produce ion beams up to 1.0 MeV/u with 300 uA. In KAERI, a few projects are proposed based on KAHIF accelerator system. One of the major projects, the facility is now preferring to provide Fe ion beam. In order to deliver the stable Fe beam, the beam optics is studied and the results are presented in this paper.

## KAERI Heavy ion Irradiation Facility

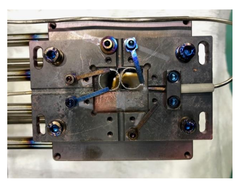
### Layout of KAHIF

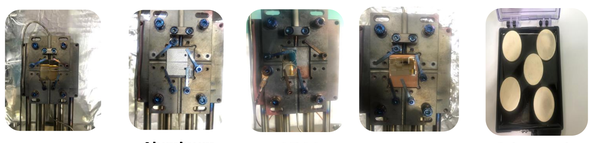



### Results of the He and Ar ion beam irradiation test

| | He ion beam | Ar ion beam |
|---|---|---|
| Ion species | $He^{+}$ | $Ar^{10+}$ |
| Beam energy (MeV) (mode) | 0.7, 1.2, 1.9, 2.9, 4.2 (SCRFQ, IH1~4 mode) | 6.9, 42.3 (SCRFQ, IH4 mode) |
| Peak beam current (eμA) @ a Faraday cup in the target chamber | 7.8 (@ 1.09 MeV/u) | 1.9 (@ 0.17 MeV/u) 0.8 (@ 1.09 MeV/u) |
| Duty cycle (%) | 28.8 | |
| Pulse repetition frequency (Hz) | 120 | |
| Pulse width (ms) | 2.4 | |
| Average beam current (eμA) | 2.24 | 0.23 |
| Maximum beam power (W) | 33.0 | 34.3 |
| Beam irradiation condition | Horizontal / Vacuum | |
| Beam particle flux (#/$m^2$·s) | $4.9 \times 10^{17}$ | $5.1 \times 10^{15}$ |
| Beam spot size ($mm^2$) | 10 × 10 | |

### Sample holder and target samples

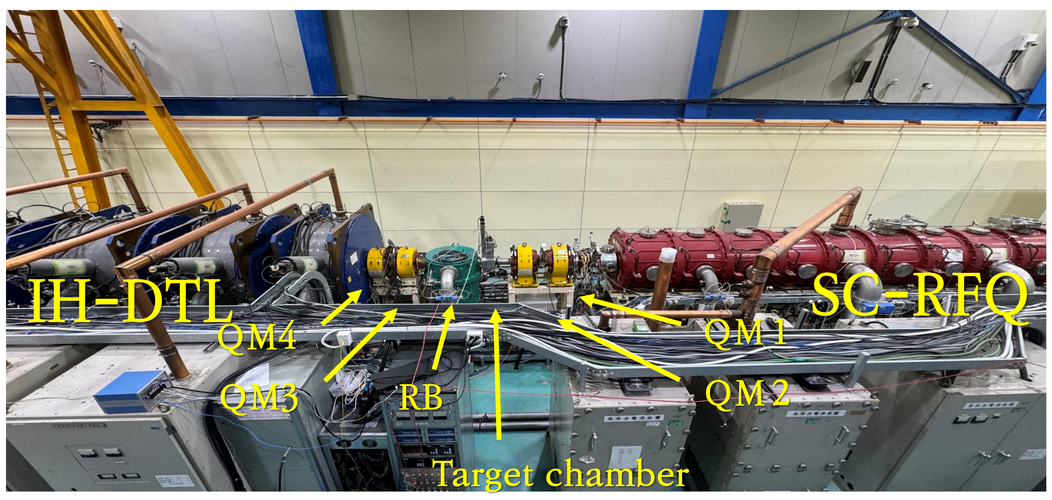




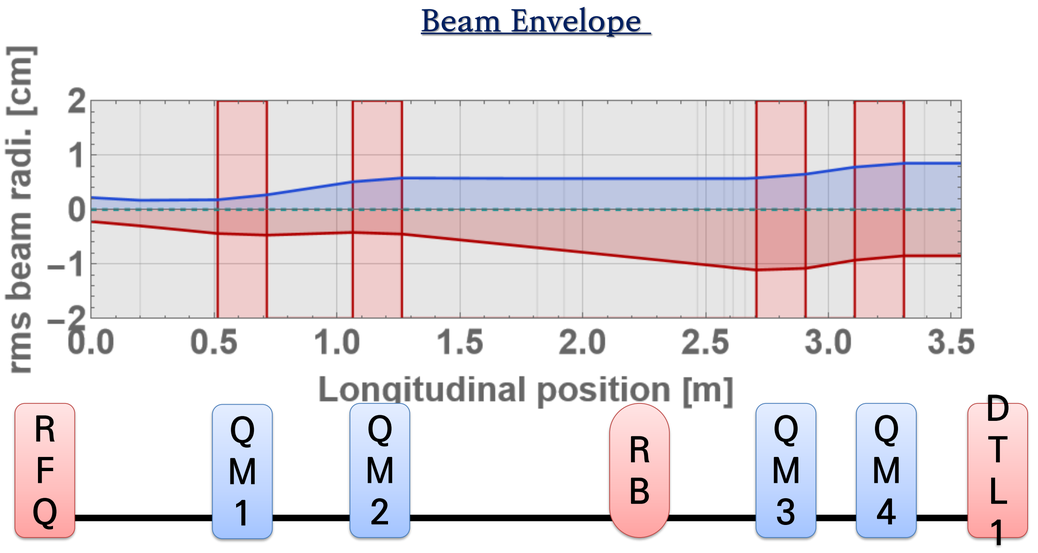
Fe alloy (Nuclear Fuel) | Aluminum B4C (Neutron Moderator) | ARAA Steel (Nuclear Fusion) | SUS 316L (Nuclear Fue-Cladding) | Gd ceramic (Nuclear Fuel-Burnable Absorber)

## Beam Optics Simulation Results($Fe^{2+}$)

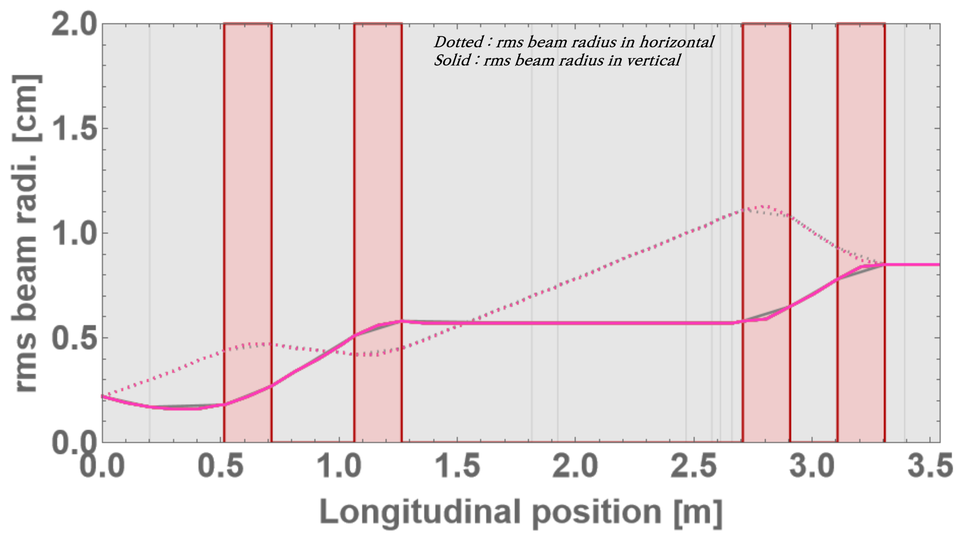
### Layout of KAHIF MEBT Line




### Beam Envelope

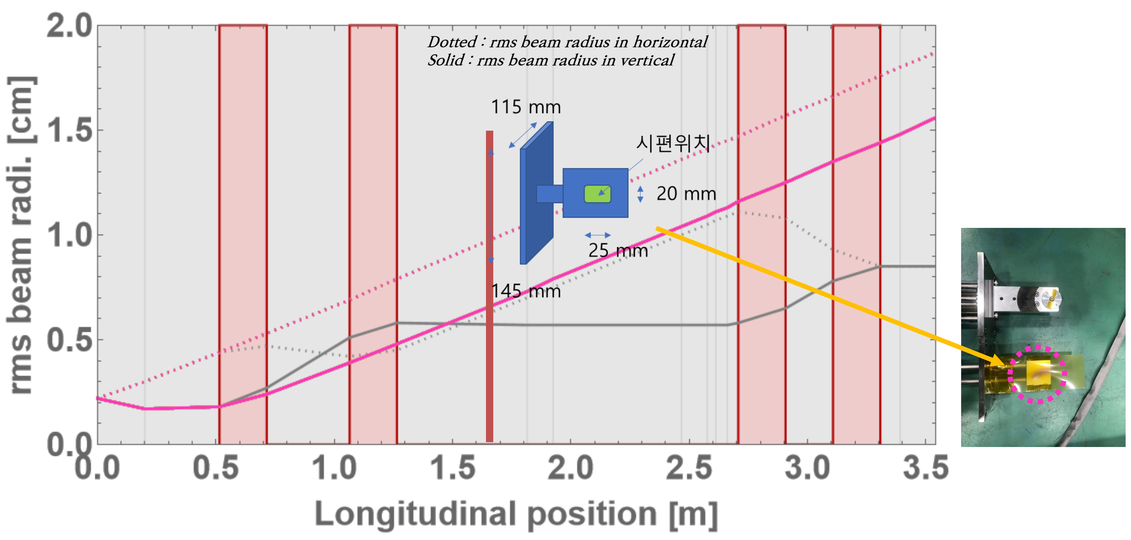



### Beam Radius




- With or without operation of QM1 and QM2, the beam radius is defocused or focused.

### Beam Radius and Size




- The gafchromic film was used for measuring the beam size on sample holder.
- It is confirmed that the QM1 and QM2 should be turn on for focusing the beam size.

## Summary

- Beam optics simulations by TRANSPORT has been studied for Fe ion beam acceleration in KAHIF MEBT line..
- Considering the charge state margin, $^{58}Fe^{2+}$ ion beam is selected to simulation of beam optics. With the QMs, the radius of beam will be maintained in 1 cm.
- Without the QMs, the radius of beam will be increased up to 1.5 cm in horizontal direction. The specifications of these considerations will be studied.
- These beam optics study results are expected to use actual Fe ion beam commissioning. For the future works, the beam optics will be simulated with other charge states of Fe ion.

## Reference

[1] S.-R. Huh *et al.*, "Status and Plans for the Daejeon Ion Accelerator Complex at KAERI", *Proceedings of Korean Nuclear Society Autumn Meeting*, 2015.
[2] S.-R. Huh *et al.*, "Status of IH and RFQ Linacs in the Daejeon Ion Accelerator Complex at KAERI", *Proceedings of the Korean Nuclear Society Spring Meeting*, 2016.
[3] S.Lee *et al.*, "Proposal of Compact Accelerator -based Neutron Source (CANS) by using $^{7}Li$-d nuclear reactions", *Proceedings of Korean Nuclear Society Spring Meeting*, 2023

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