Irradiation Beam Line Design of the 1 MeV/n RFQ at KOMAC

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KAERI

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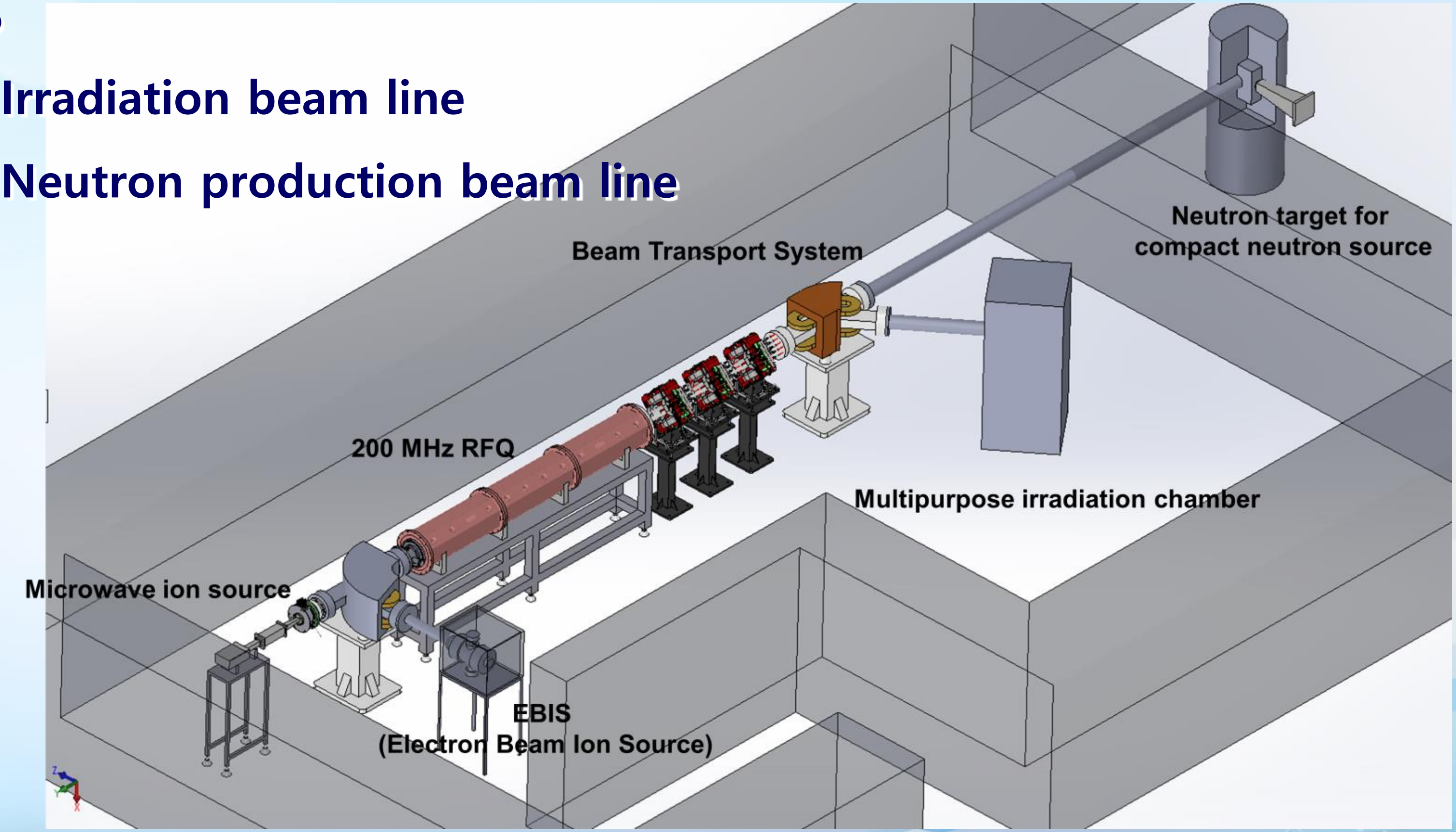
KOMAC
Korea Multi-Purpose Accelerator Complex
양성자가속기연구센터

1 MeV/n RFQ based ion beam facility

- Beam species: proton, D+, 4He2+, highly ionized heavy ion (A/q < 2.5)
- Beam energy: 1 MeV/n
- Beam current: max. 10 mA
- RF duty: 10%
- Beam line 1: Irradiation beam line
- Beam line 2: Neutron production beam line



Injector Status

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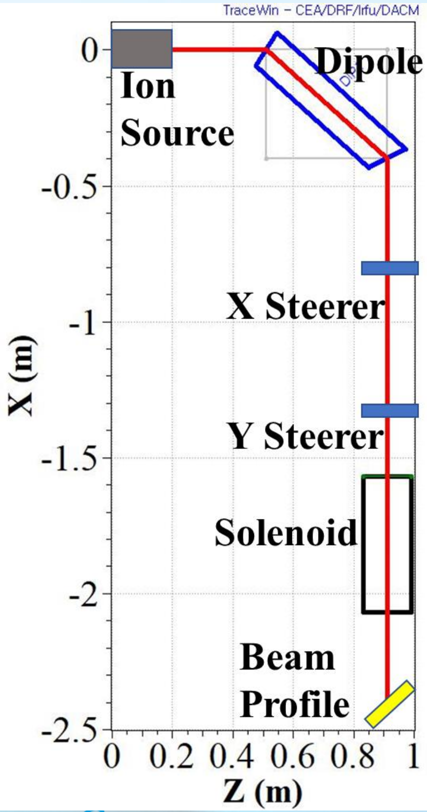
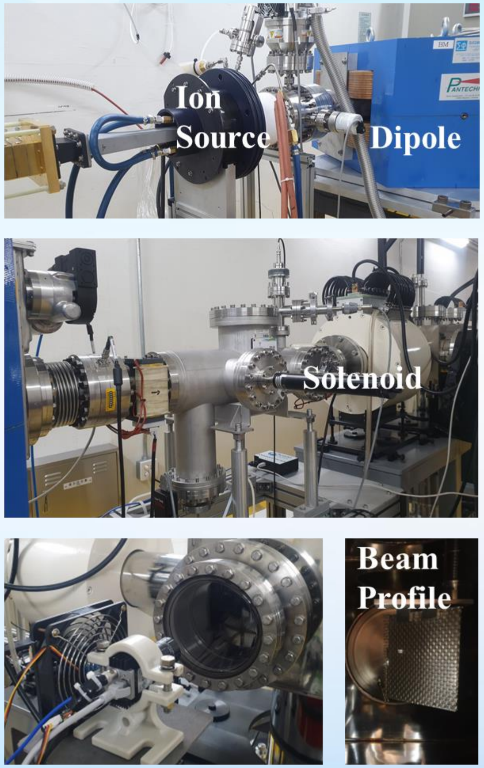
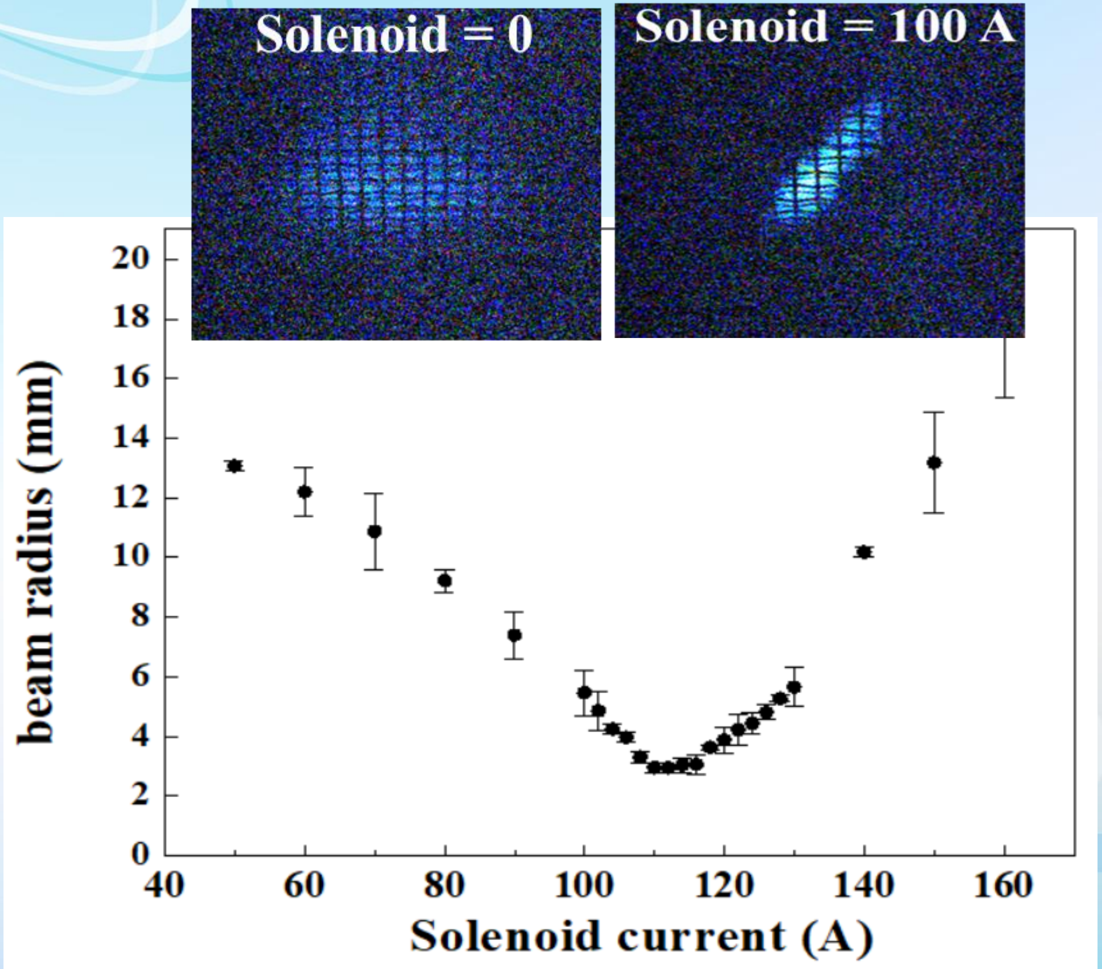
- Microwave ion source: injector for 1 MeV/n RFQ, test stand of 100 MeV ion source
- LEBT system: Bending magnet + steerer 2 sets + solenoid 2 sets
- Under beam test





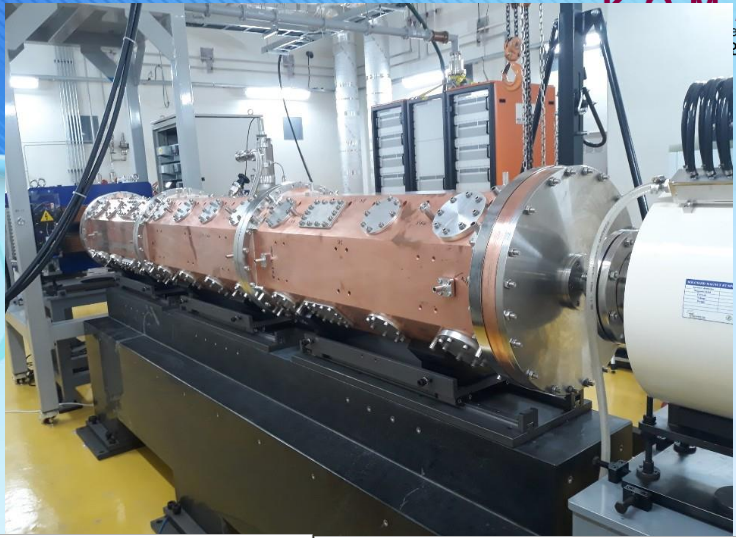
Injector



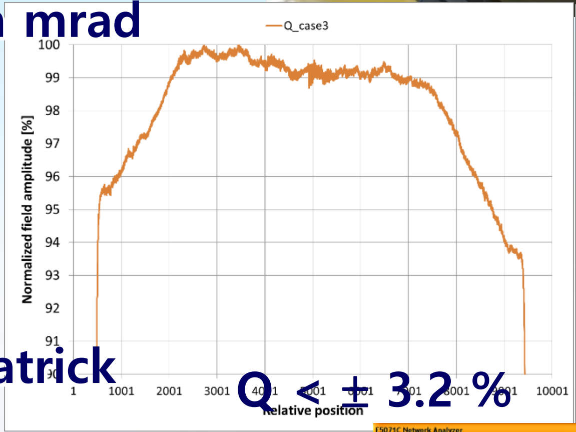
Solenoid scan

RFQ Status

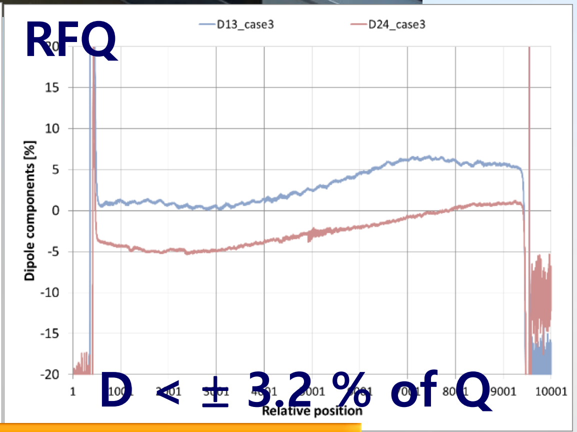
- Reference particle: 4 He 2+
- Input beam energy: 25 keV/n
- Output beam energy: 1 MeV/n
- Peak beam current: 10 mA
- Emittance (nor. Rms): 0.14 pi mm mrad
- Type: 4 vane
- RF frequency: 200 MHz
- RF power (wall): 130 kW
- Maximum electric field: 1.63 Kilpatrick
- ρ/r0: 0.87
- Length: 320 cm
- Transmission: 96.4 %
- Under field tuning



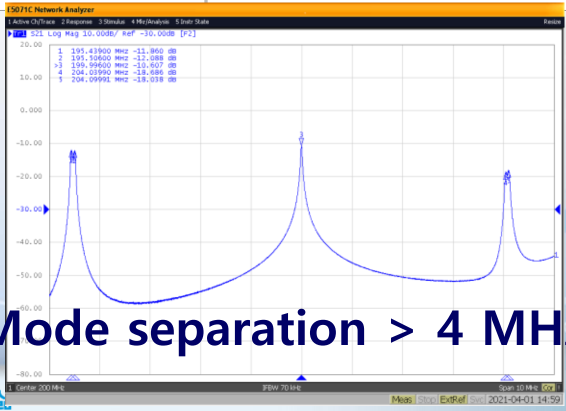
RFQ



Q < ± 3.2 %



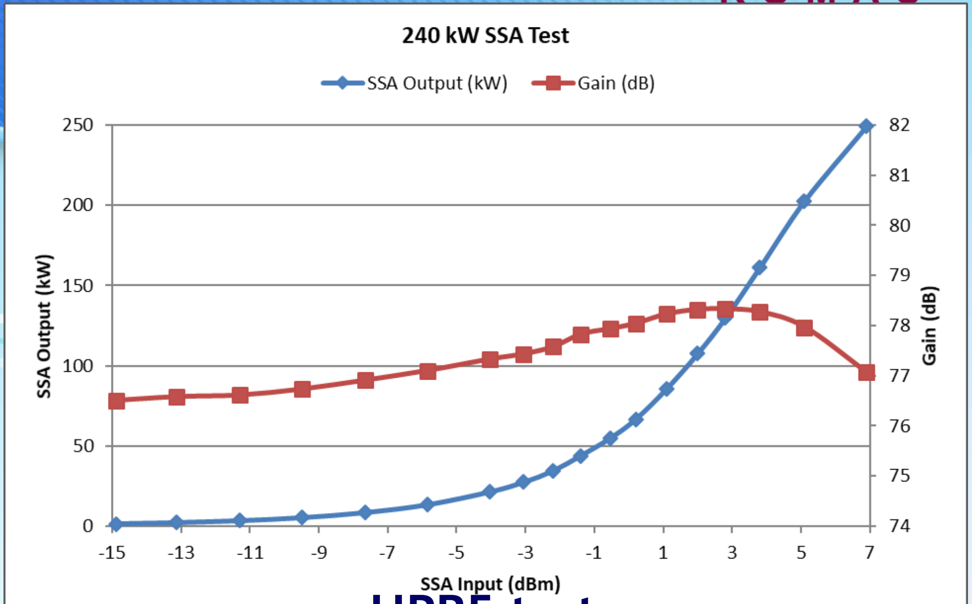
D < ± 3.2 % of Q



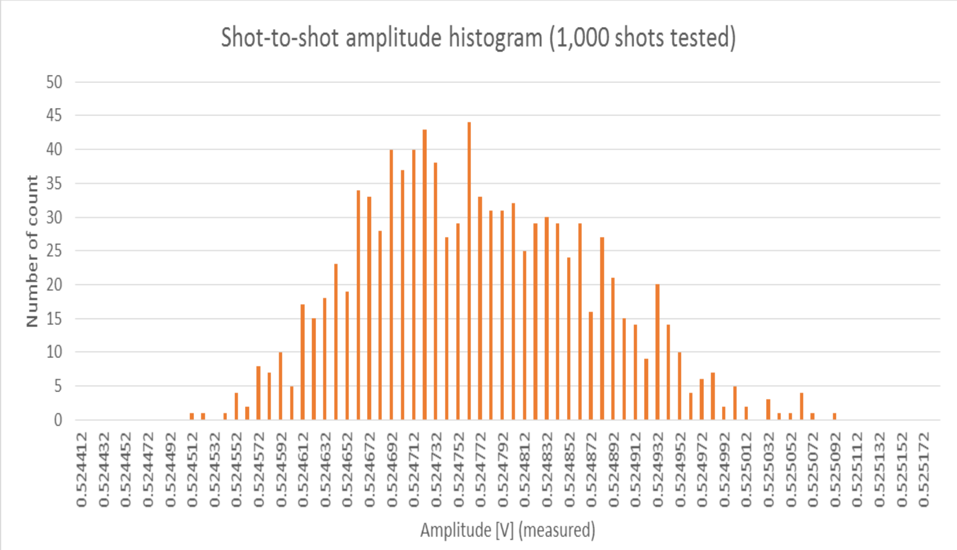
Mode separation > 4 MHz

RF System Status

- Frequency: 200 MHz
- RF power: 240 kW
- RF duty: 10%
- Amplifier type: Solid state amplifer
- LLRF control: Digital based
- Under test



HPRF test



LLRF control test at test stand
(RMS stability < 0.02%)

Solid state amplifier

Irradiation Beam Line

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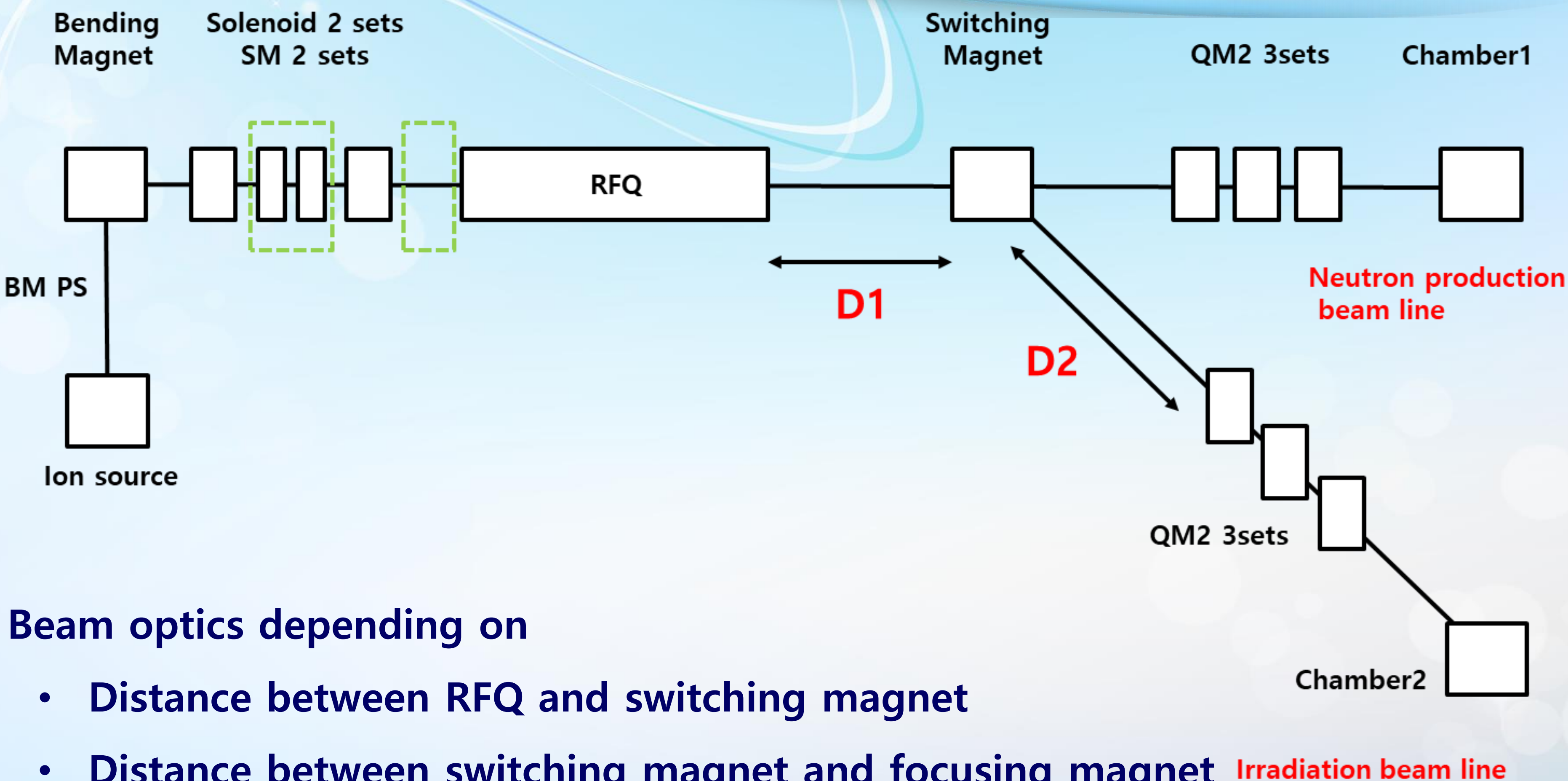
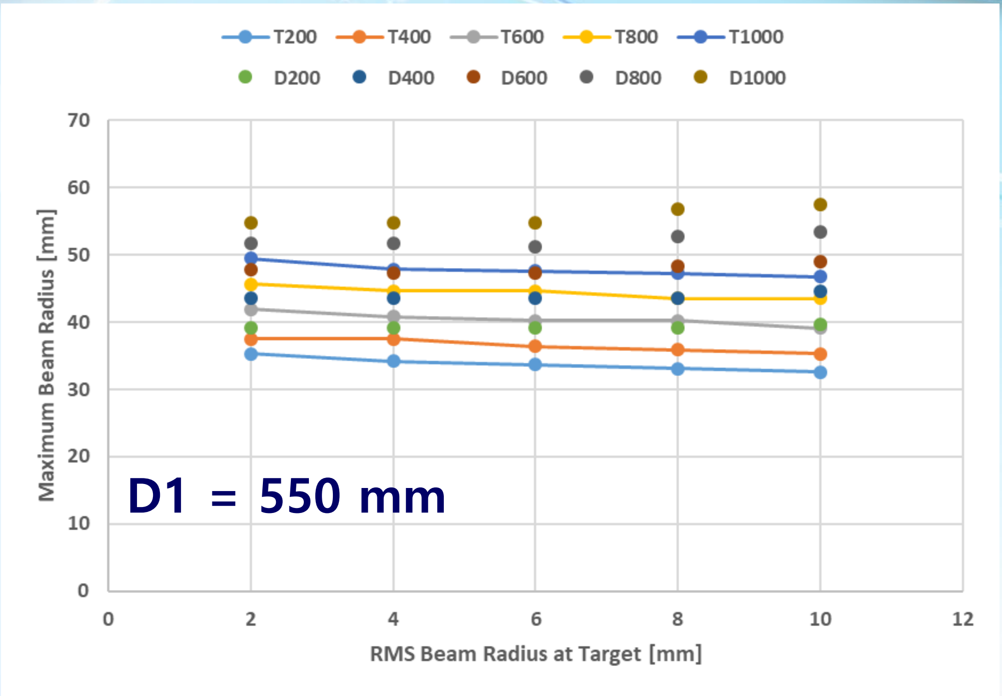
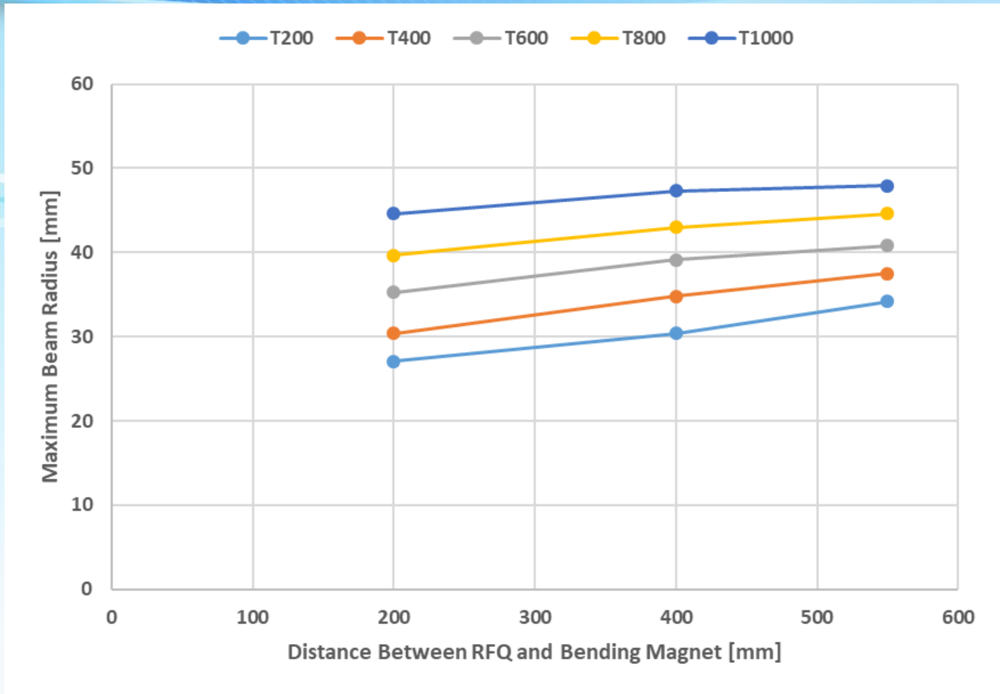


- Beam optics depending on
  - Distance between RFQ and switching magnet
  - Distance between switching magnet and focusing magnet
  - Type of focusing magnet (doublet or triplet)

Irradiation Beam Line



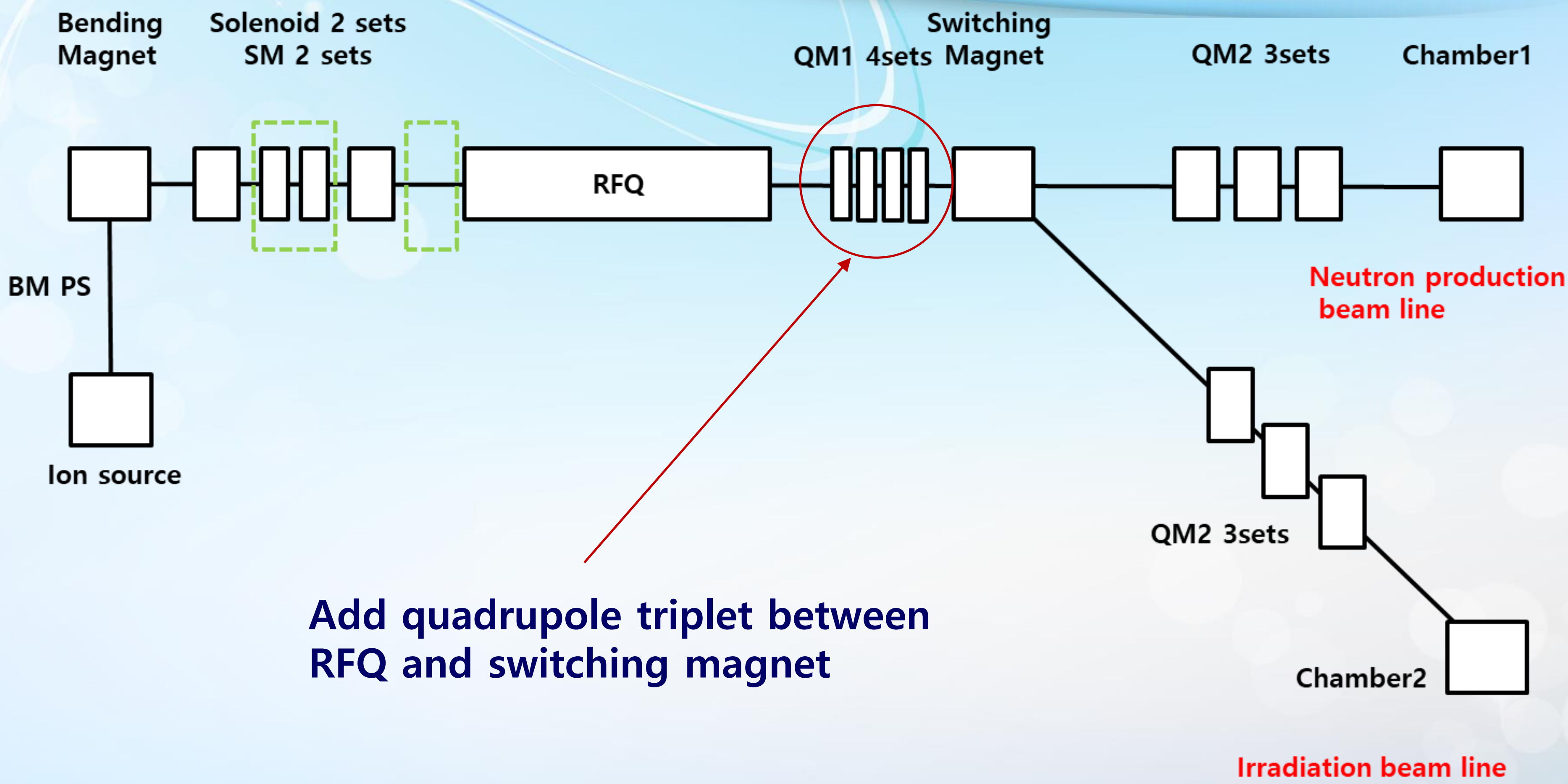
Maximum beam radius along the beam line depending on the focusing magnet type (doublet or triplet) and D2



Maximum beam radius along the beam line depending on D1 and D2 for triplet case

- Beam size (doublet case) is more larger than beam pipe radius at some cases
- Triplet makes smaller beam size than doublet
- But the beam size is still large in triplet case compared with the beam pipe

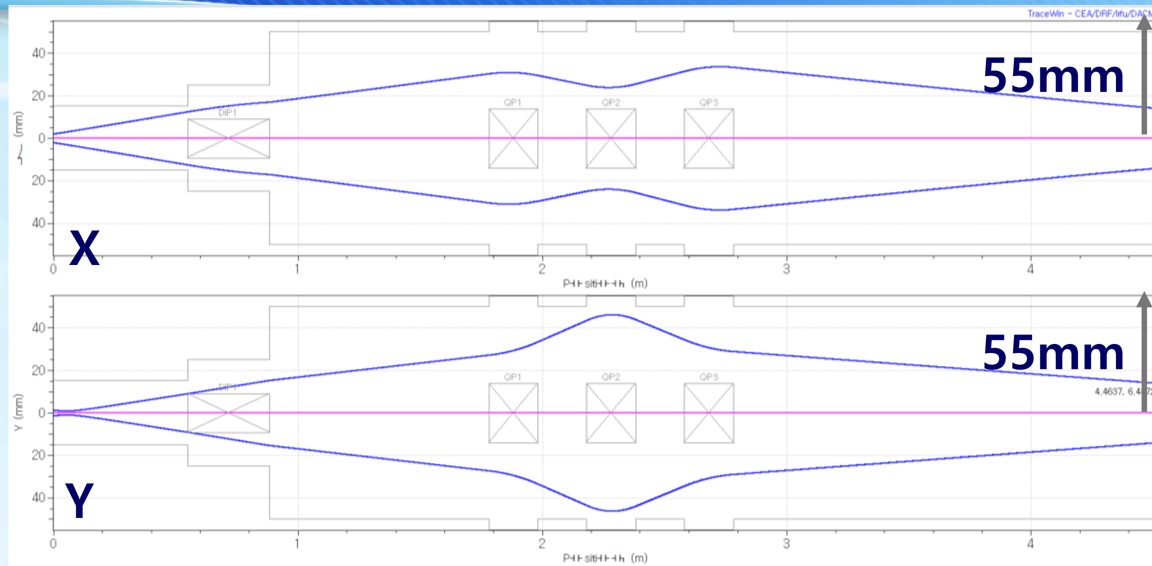
Modified beam line



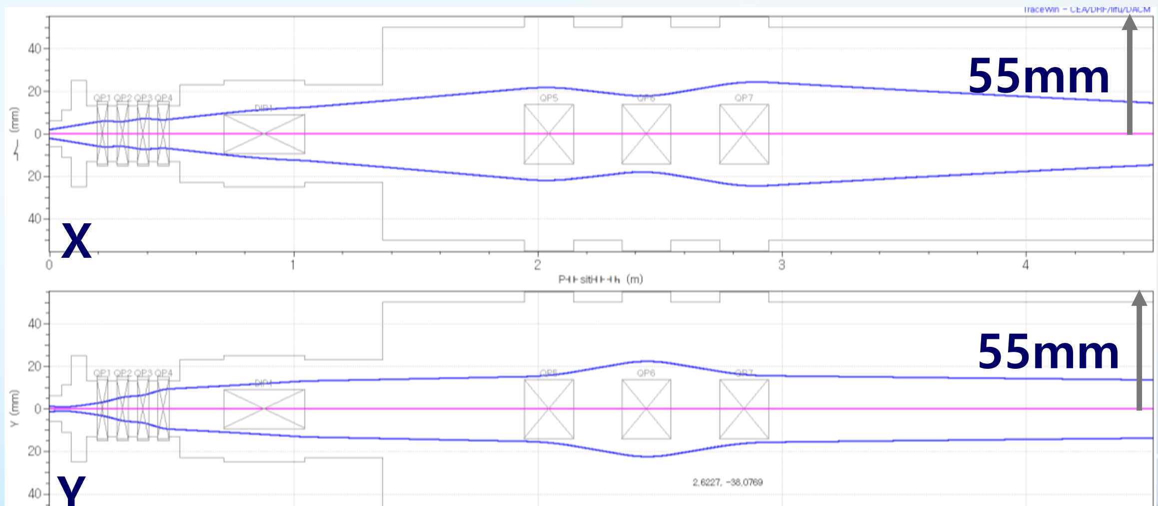
Add quadrupole triplet between RFQ and switching magnet

Beam envelope

Triplet only in the beam line

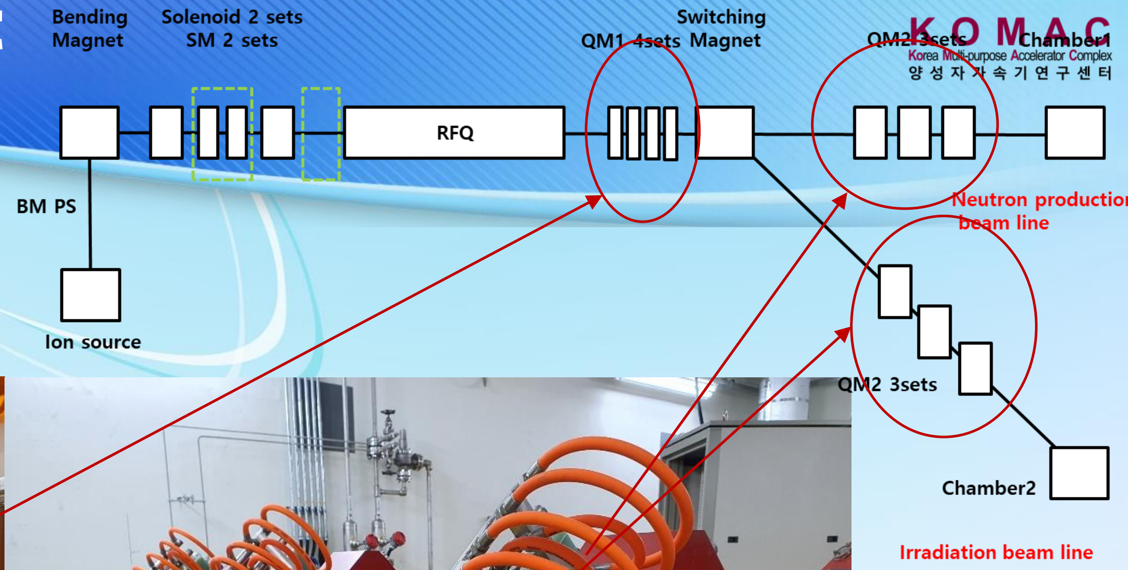


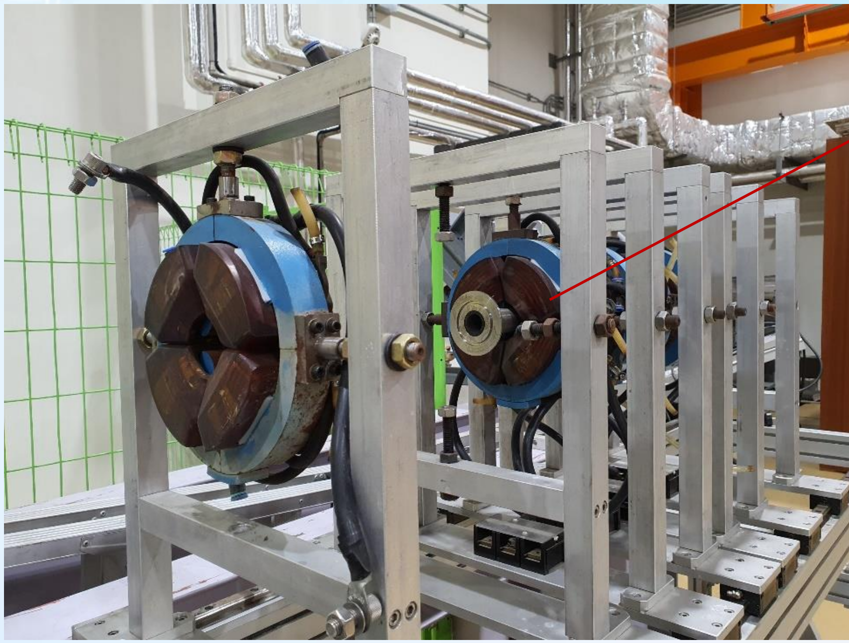
Triplet between RFQ and switching magnet and in the beam line



Beam size can be reduced and beam adjustment flexibility can be increased

Quadrupole magnet





Pole gap diameter: 30 mm
Effective length: 46 mm
Field gradient: 2.8 kG/cm @ 100A

Pole gap diameter: 100 mm
Effective length: 200 mm
Field gradient: 0.5 kG/cm

Summary

- 1 MeV/n RFQ based ion beam facility
  - Irradiation purpose + neutron production
  - Test stand of 100 MeV proton linac

- Status
  - Microwave ion source based injector: under beam test
  - RFQ: under field tuning
  - RF system: under high power, low level control test

- Irradiation beam line
  - RFQ – triplet – switching magnet – triplet – irradiation chamber