Design of RISP RFQ COOLER BUNCHER

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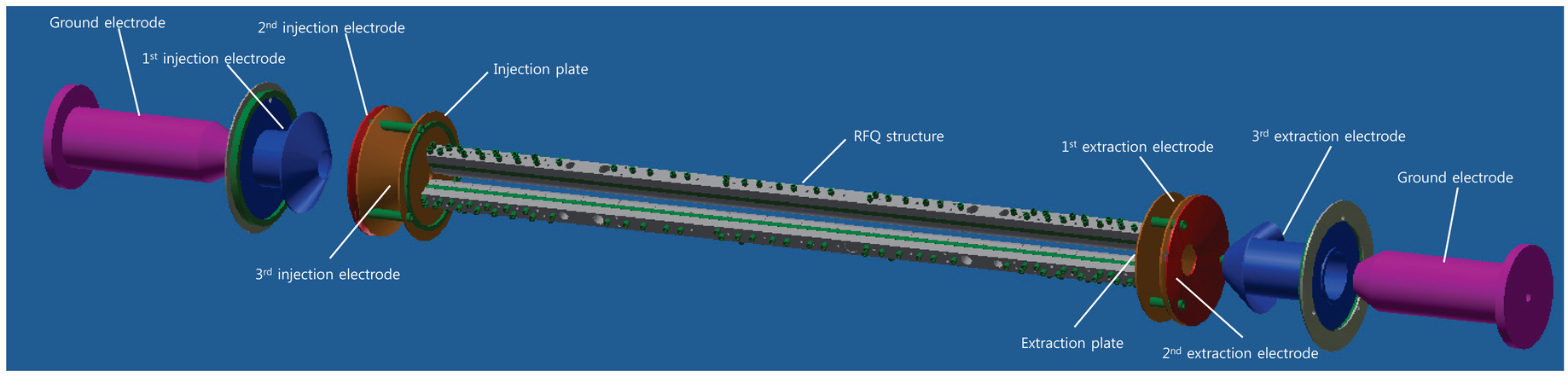
■ Abstract

Under RISP project, wide variety of intense rare isotope ion beams will be provided. An EBIS charge breeder has been designed to charge breed these beams. Its optimum operation requires injection of bunched beam with small emittance and energy spread. An Radiofrequency Quadrupole Cooler Buncher (RFQCB) is designed to meet these requirements. In this re spect, the RFQCB should efficiently accept high intensity continuous beams and deliver to EBIS bunched beams with emittance around 3 π.mm.mrad, energy spread < 10 eV and short bunch width (~10 μs). A new design concept to be implemented in this RFQCB have been developed, including a novel injection/extraction electrodes geometry with improved differen tial pumping system. Simulations have shown high efficiency of transmission more than 93 % of incoming ions for beam intensities up to 1 μA with improved beam quality. A set of be am diagnostics tools including Faraday cups, pepper-pot emittance-meter with MCP based detector are designed to characterize the ion beams.

■ Optics design of RFQ Cooler-Buncher



❑ Injection section:

- Slow down input beams to some tens eV by a set of electrostatic electrodes

❑ RFQ chamber:

- Cooling and bunching of ions
- RFQ structure:
  - Length 797mm, Radius 7mm & gap of 0.4 mm
  - 27 segments: 7 of 20mm; 13 of 40mm; 6 of 20mm; 1 of 7 mm

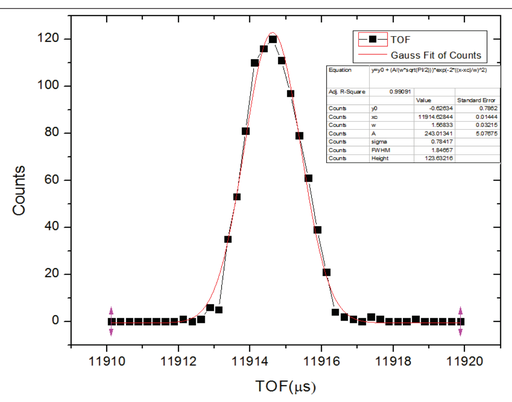
❑ Extraction section:

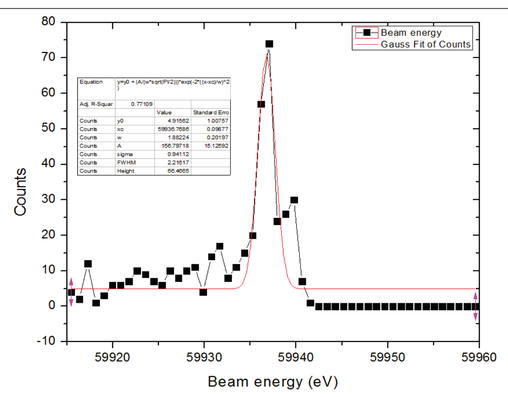
- Extract and speed up ion back to the same initial energy

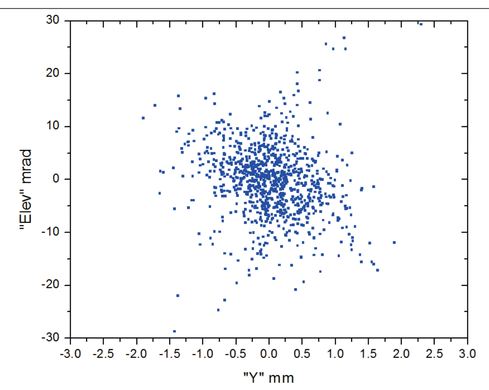
■ Simulation results

❑ Bunch mode simulation results

- For 10 nA beam current:
  - Cooling time 10 ms
  - Transmission > 93%
  - Beam emittance 3.1 π.mm.mrad,
  - Bunch time width 1.9 μs
  - Energy spread 2.2 eV

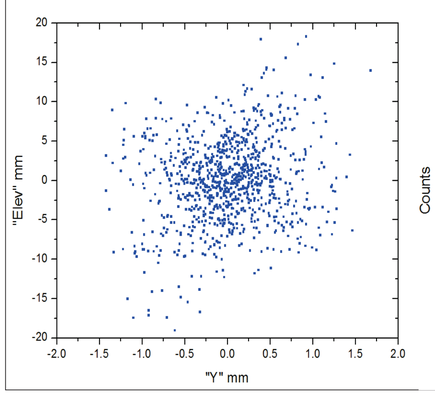


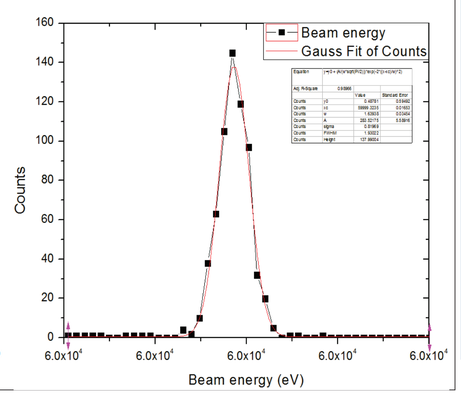




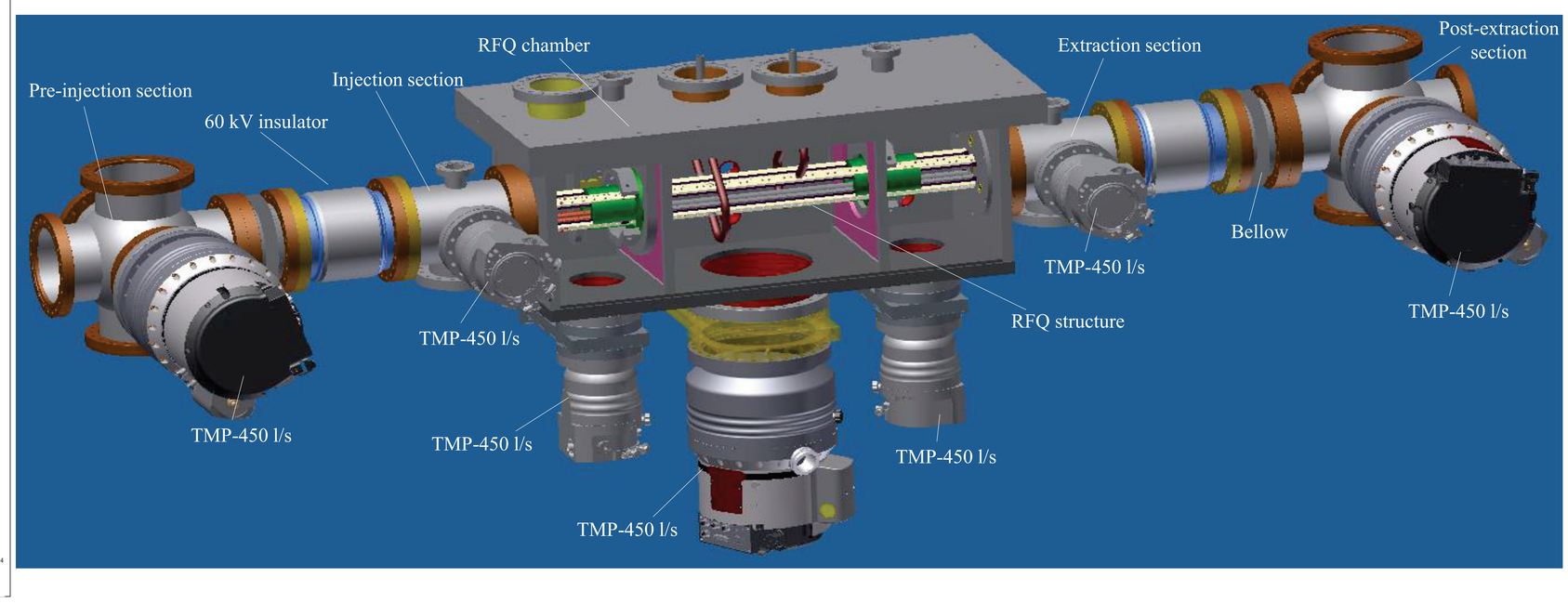
❑ DC mode simulation results

- Low beam current 10 nA:
  - More than 95 % of incoming ions can be transmitted
  - Energy spread ~ 2 eV and beam emittance ~2.9 π.mm.mrad
- High beam current: 1000 nA
  - Ion transmission remains above 95 %
  - ~3.4 eV energy spread and ~4 π.mm.mrad emittance





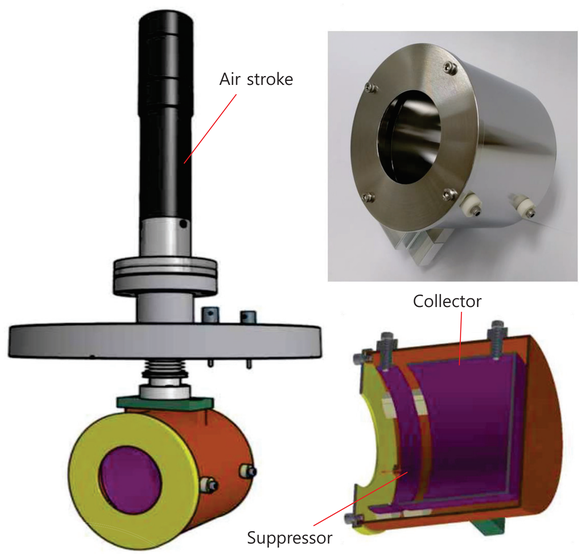
■ Engineering model of the RISP RFQ Cooler-Buncher



■ Beam diagnostics

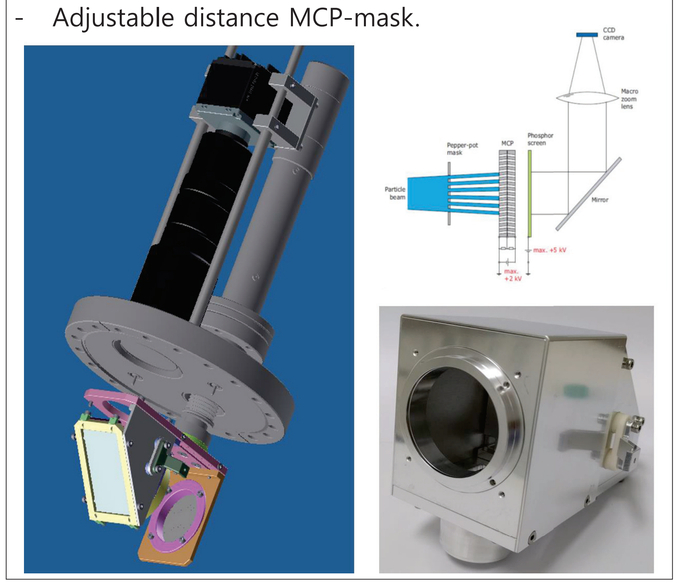
❑ Faraday cups

- Beam current measurements for ion transmission
- Faraday cup system:
  - Beam collector
  - Suppressor avoiding the creation of
  - Air stroke
- Large input aperture (47mm), suppressor and a beam collector cavity.



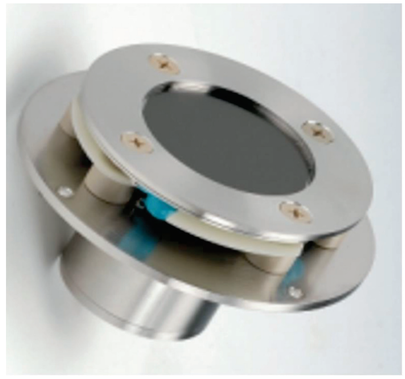
❑ Pepper pot emittance meter

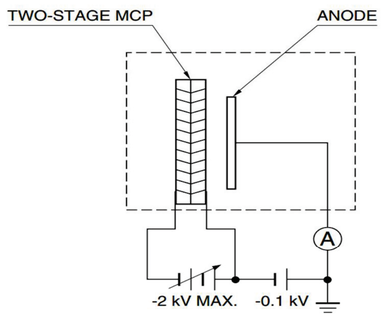
- Pepper pot emittance meter system:
  - Pepper pot mask forming beamlets
  - MCP screen providing secondary electrons
  - Phosphor screen emitting lights
  - CCD for beam image
- Pepper pot mask: active area 40 mm, mask aperture 40 mm, hole separation/size 1mm/20um
- Adjustable distance MCP-mask.



❑ MCP detector

- Measurement of TOF and bunch time width.
- MCP detector system: two-stage MCP followed by an anode.





■ Summary

- The manufacture of the various subsystems has been started:
  - Optics system and engineering drawing have been done.
  - Differential pumping systems with improved capacity is developed.
  - RF system providing highest RF voltage is being designed
  - Beam diagnostics tools are designed and manufactured.
- The control command and DAQ systems are under development.
- Off-line test is planned for the next year.