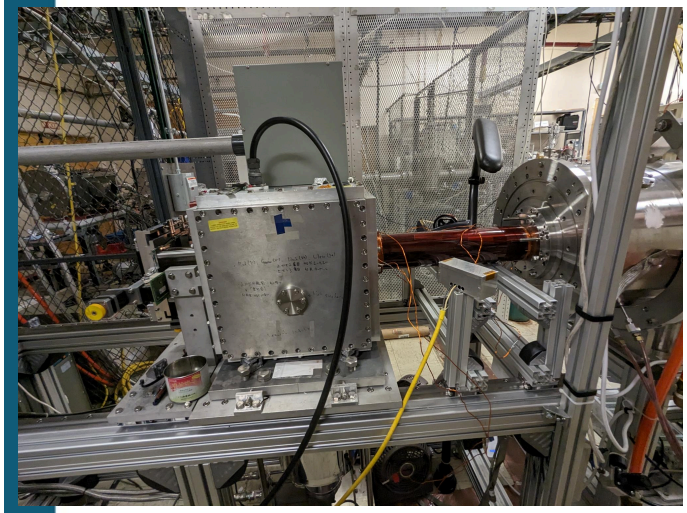
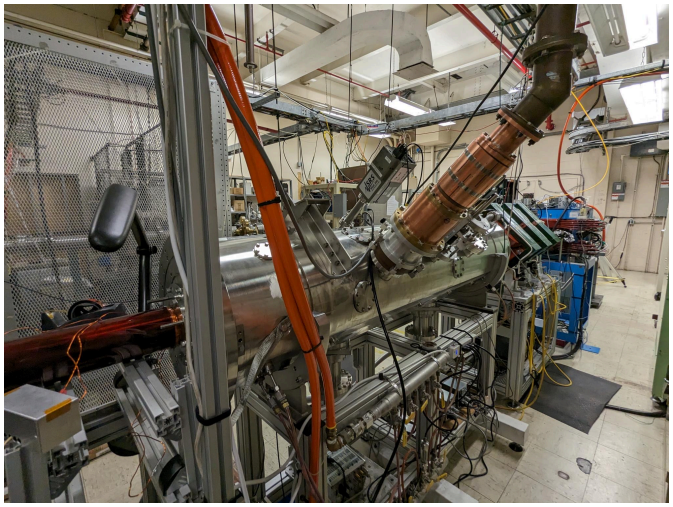
R9 (High-current LION (FOA):
The LIS technology initiative must be maintained at BNL. Report further achievements in 2024.

FY24, Accelerated Species (isotope abundances)

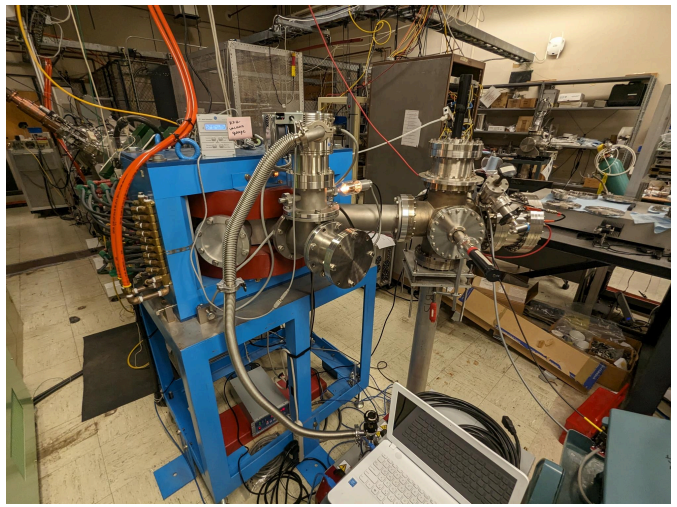
$_{12}$Mg ^{24}Mg 79%, ^{25}Mg 10%, ^{26}Mg 11%,
$_{13}$Al ^{27}Al 100%
$_{14}$Si ^{28}Si 92%, ^{29}Si 4.7%, ^{30}Si 3.1%



Plasma Chamber



RFQ accelerator and beam line



Dipole magnet and end of beamline

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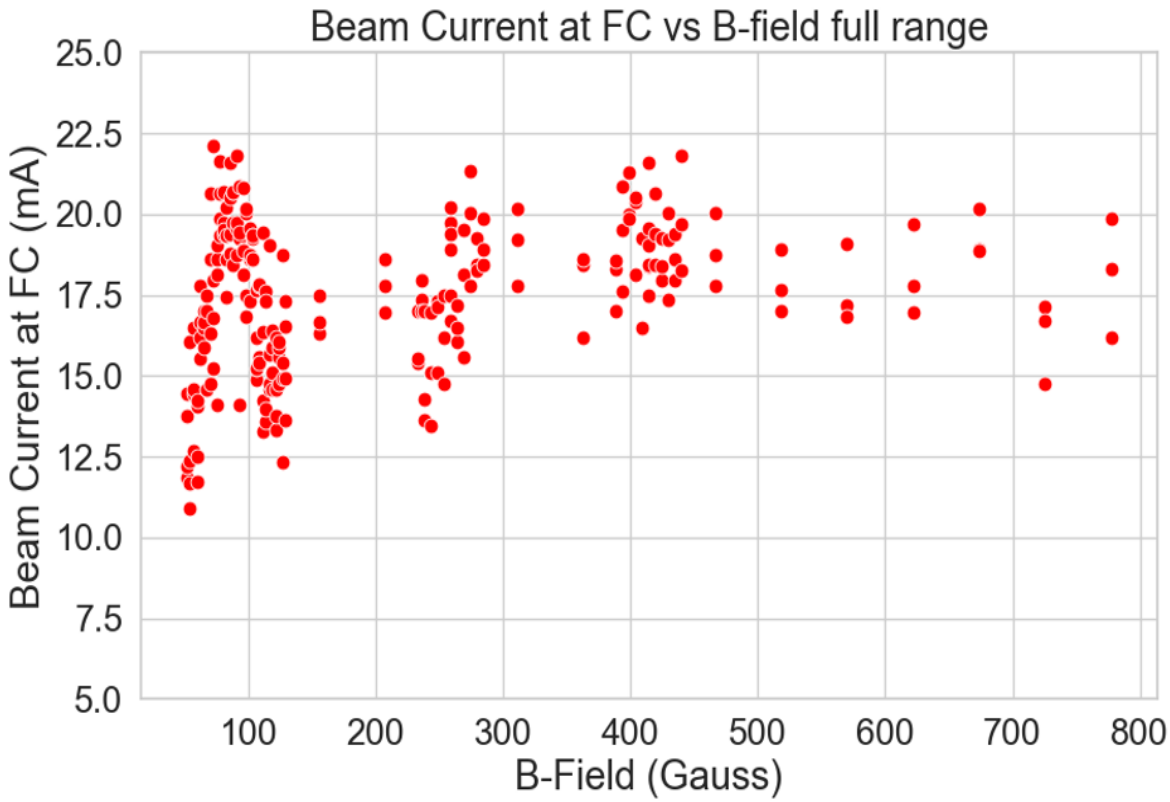
Test RFQ facility

$_{12}Mg^{9+}$

Solenoid B-field Optimization



- Lower B-fields were identified for optimization of beam currents.
- Higher beam currents were observed in a periodic pattern in relation to B-fields.

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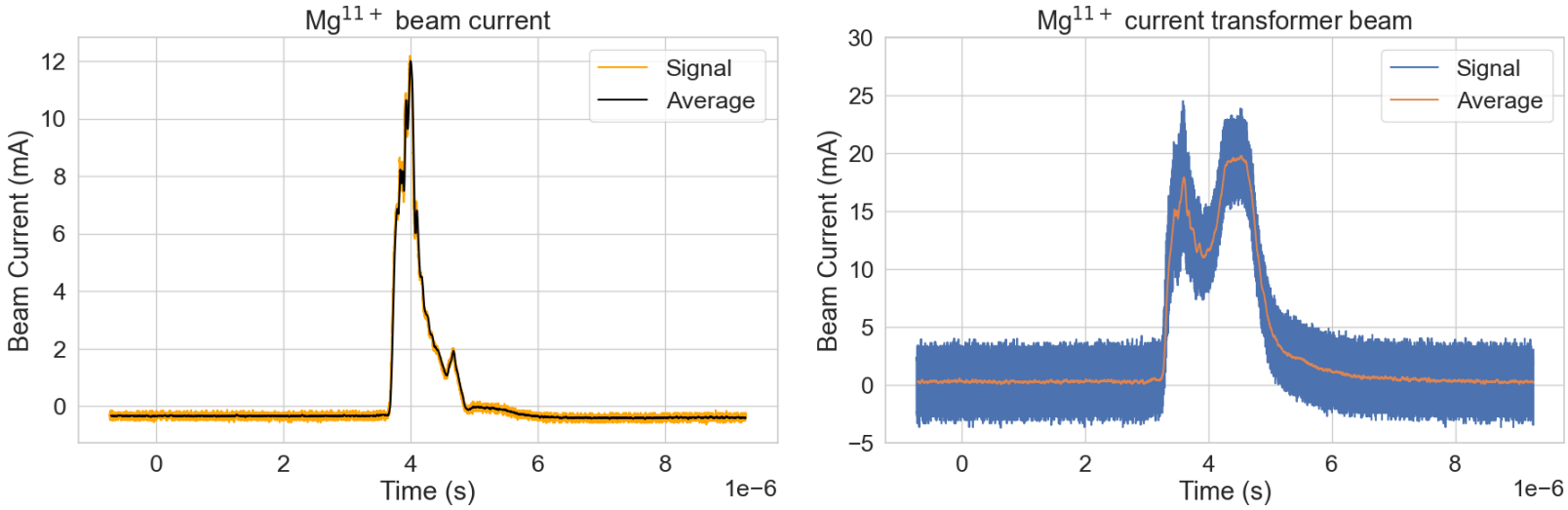
$_{12}Mg^{11+}$

Mg^{11+}



- 12.34 mA of Mg^{11+} was detected behind 71% transparent metal mesh.
- The measurement without the mesh would be 17.13 mA. (3.5 x 10^9 particles)

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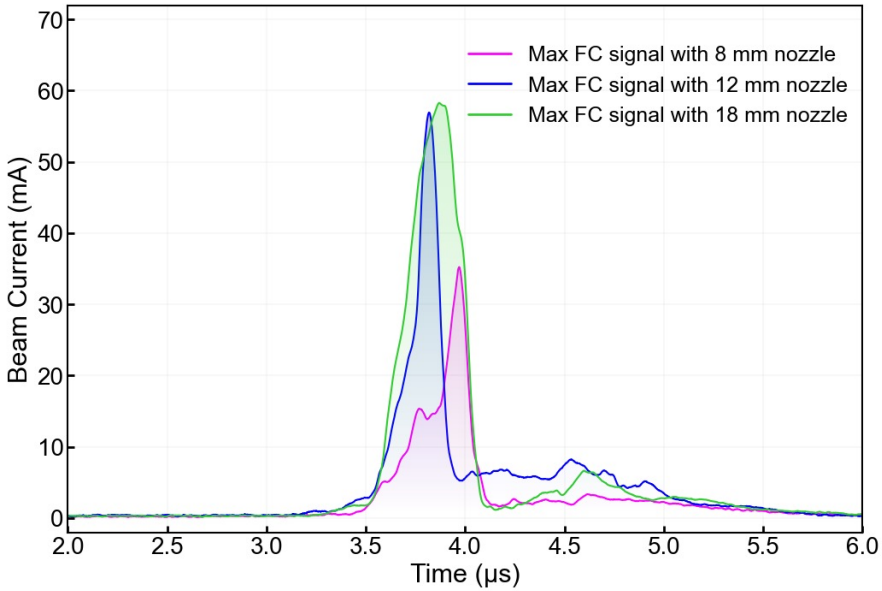
$_{13}Al^{11+}$

Beam extraction aperture

Nozzle Size	No of Particles	Peak beam current
8 mm	3.8×10^9	35.10 mA
12 mm	6.9×10^9	56.70 mA
18 mm	1.0×10^{10}	58.10 mA



- Pink – 8 mm aperture nozzle
- Blue – 12 mm aperture nozzle
- Green - 18 mm aperture nozzle

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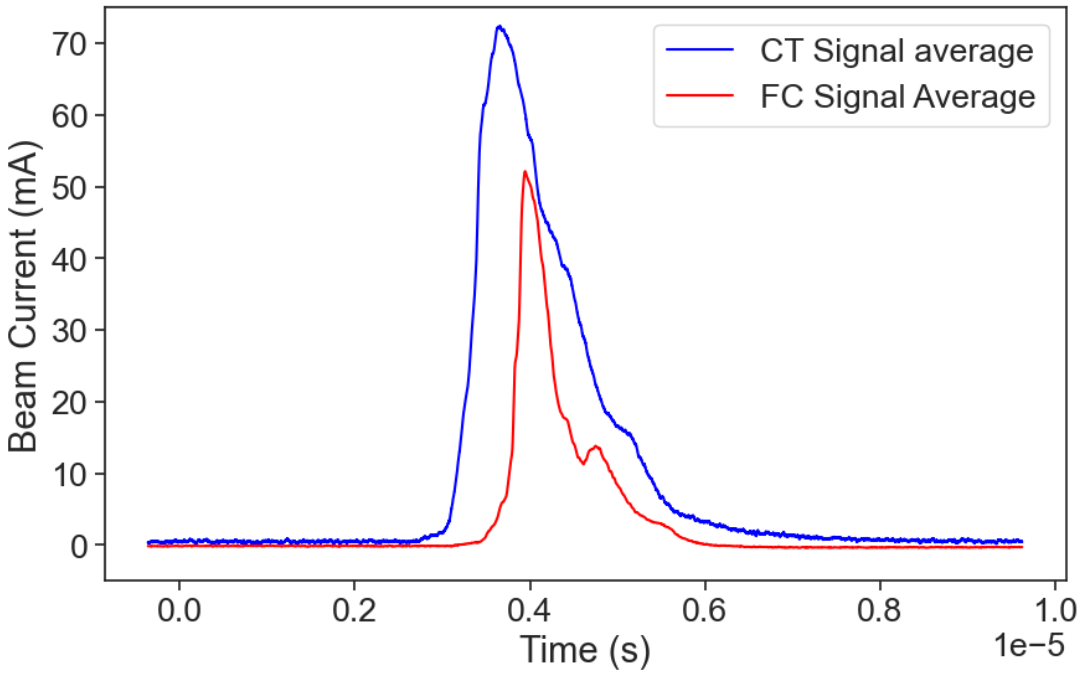
$_{13}Al^{10+}$

- For Al^{10+}, accelerated ion beam current exceeded 50 mA again.
- Red- FC behind the bend
- Blue – Current transformer signal

Al^{10+}



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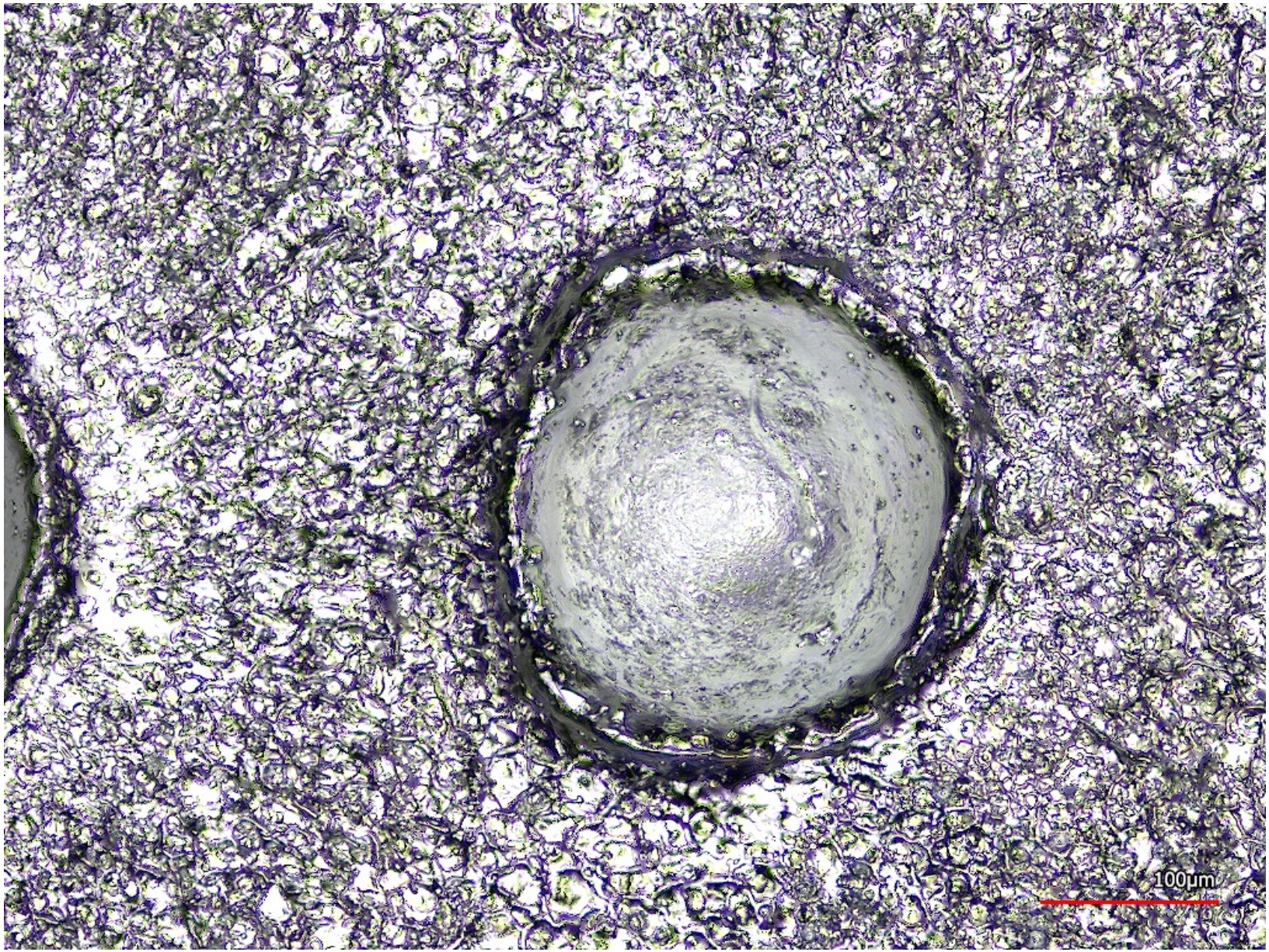
$_{13}Al$



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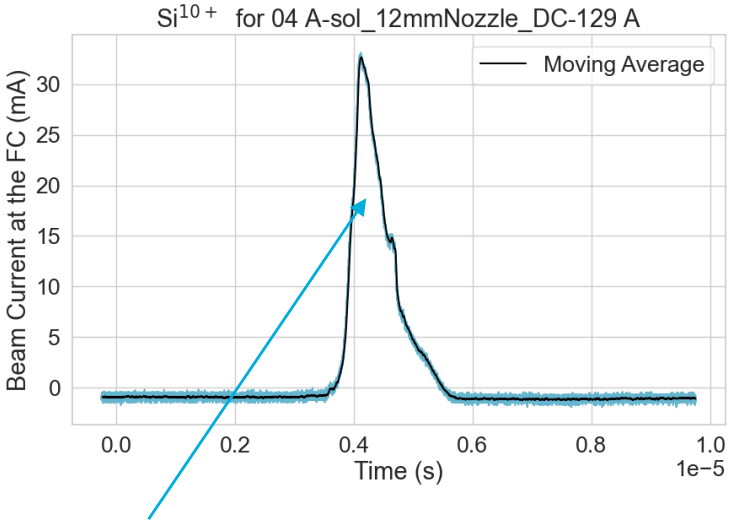
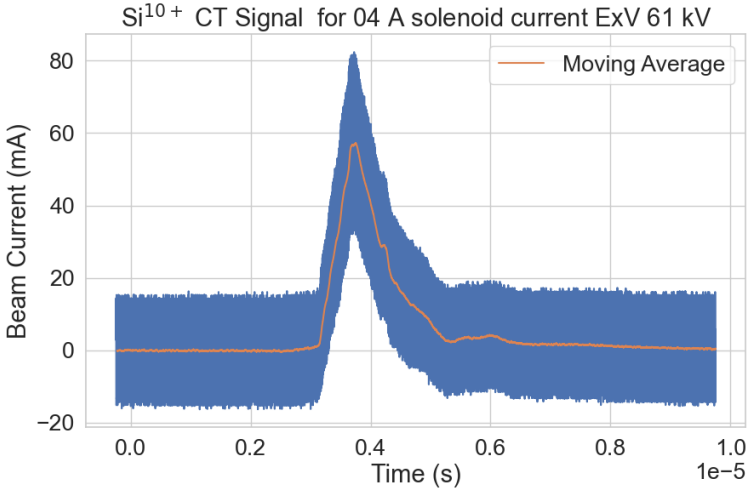
Crater size is about 200 µm

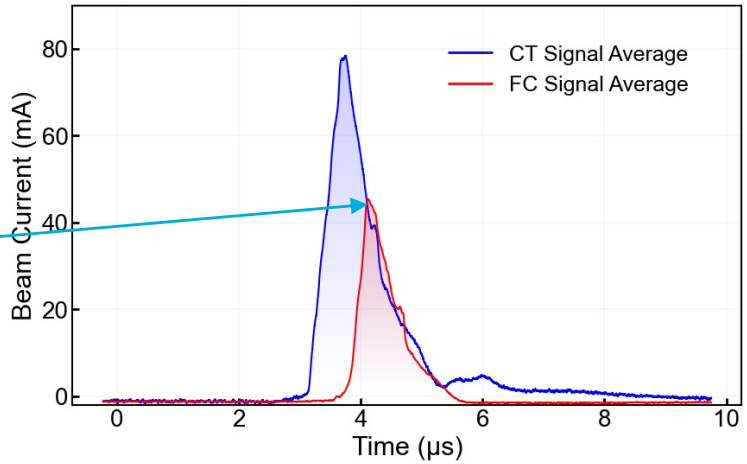
$_{14}Si^{10+}$





- Beam Current- 33.67 mA

- Beam Current with mesh compensation- 46.76 mA
- No of Particles-1.8x10^{10}



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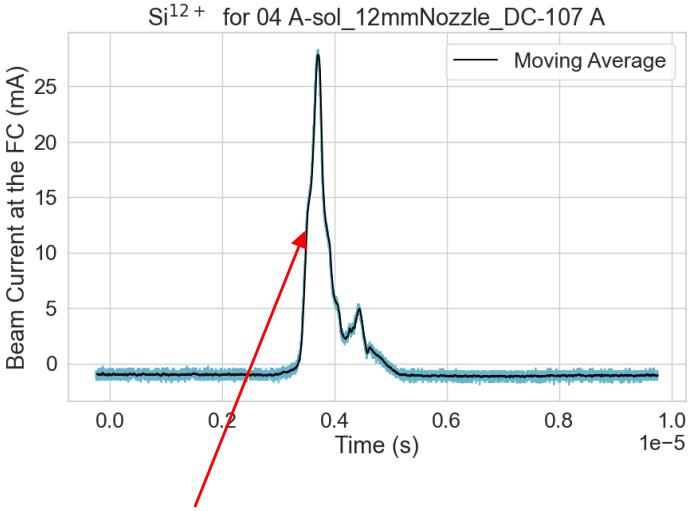
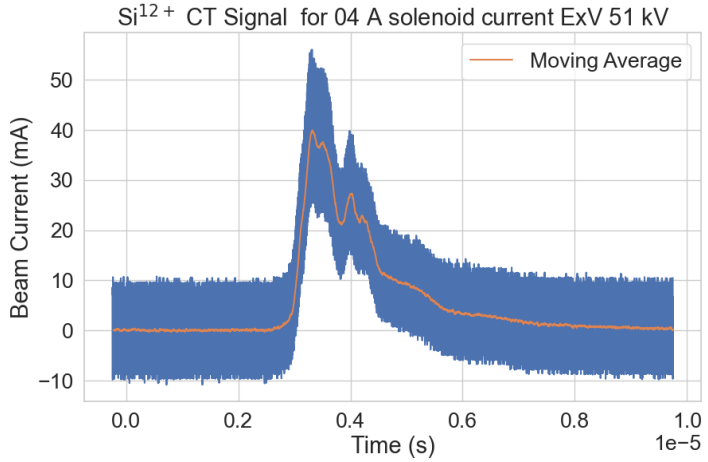
$_{14}Si^{12+}$

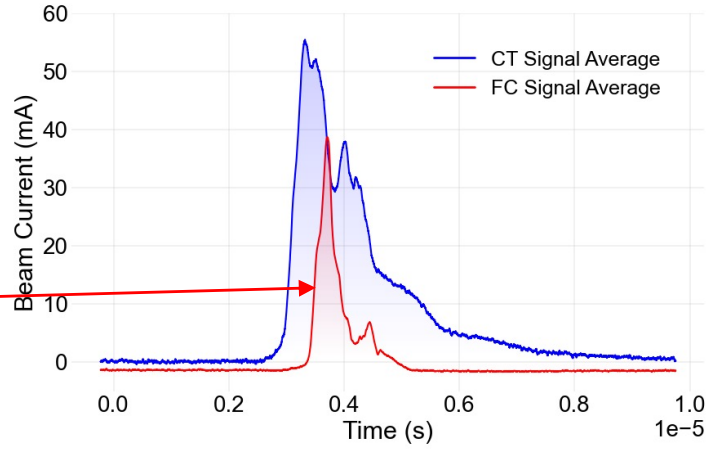
Si^{12+}



FC Beam Current behind the mesh : 28.91 mA



FC Beam Current with mesh compensation: 40.15 mA
No of Particles: $7.7x10^9$



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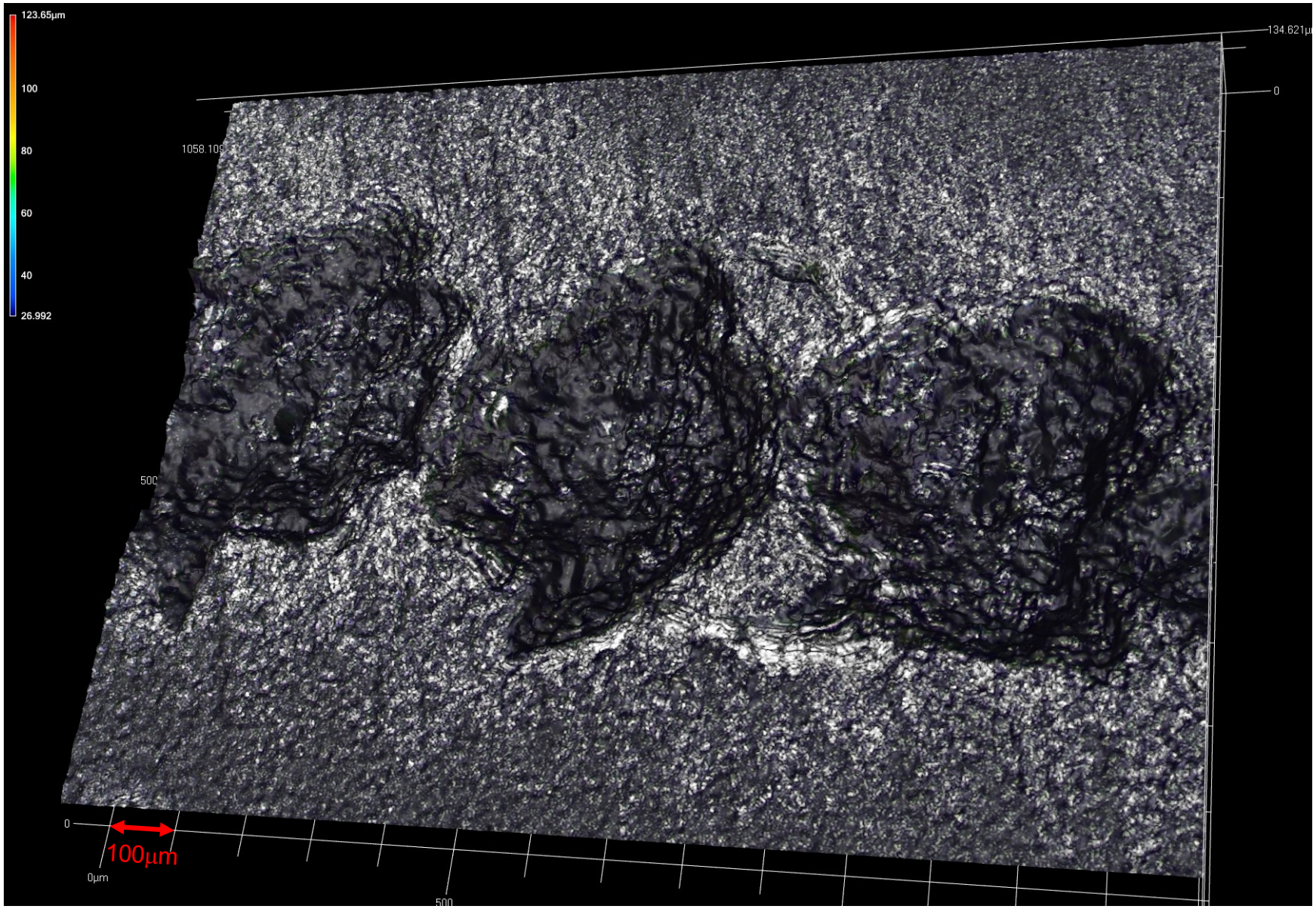
$_{14}Si$



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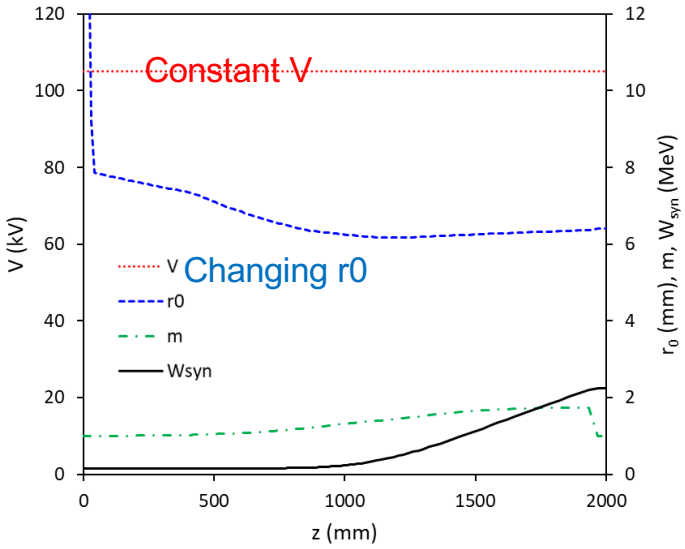
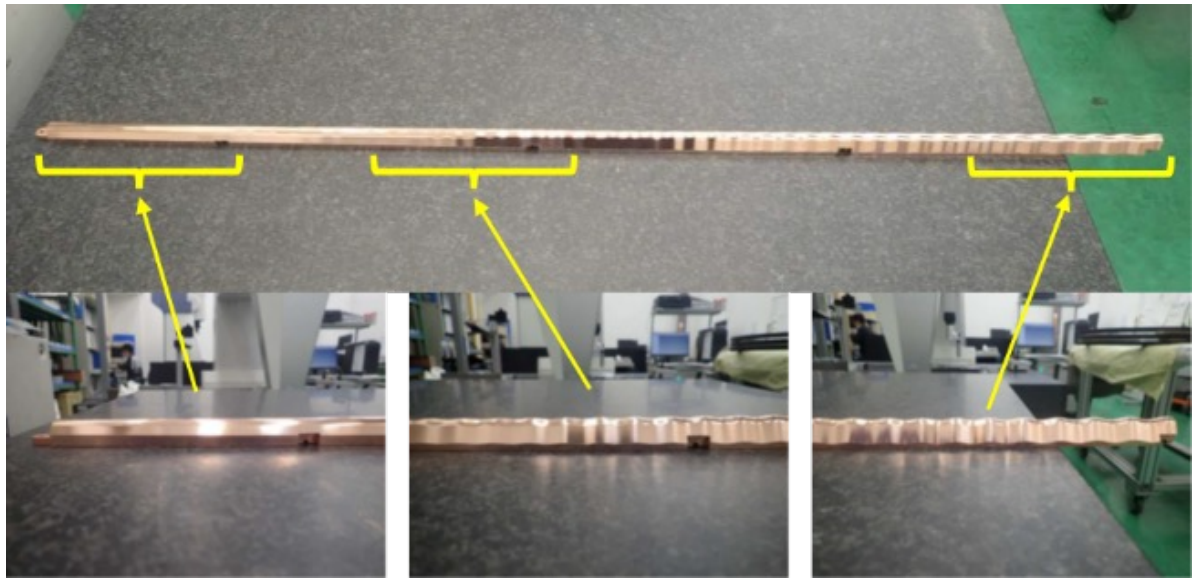
New vanes are being installed at the RFQ

Variable focusing force strategy

Resonant frequency	**100 MHz**
Accelerated particle	$^{7}Li^{3+}$
Peak beam current	≧100 emA
Input energy	21.8 keV/u
Output energy	320 keV/u
Imput normalized rms emittance	0.33 mmmrad
Number of cells	138
Rod length	1997.5 mm
V	105 kV
r_0(without RMS)	6.2-7.8 mm
Transverse vane-tip curvature	Variable (≦1.0r_0)
E_{max} (Kilpatrick factor)	≦22.3 MV/m (1.96)



Vane voltage is always constant, but the beam aperture varies from place to place.



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Conclusion (Major deliverables up to now)

1. World records of peak currents were achieved on B, C, Mg, Al, Si.
2. New beam extraction system enhance beam current dramatically.
3. Aluminum(Al^{11+}) peak current exceeds 55 mA
4. Effect of the guide solenoid was studied.
5. Particle number is limited by the laser performance.
   Particle number is propotional to the laser energy
   More than ten times of particle number can be easily achieved
6. New RFQ vanes are being installed.
   (expected to accelerate more than 120 mA)
7. NCE was submitted and the research will continue in FY 2025.