Hot Liner for the Production of Metallic Ion Beams at GSI

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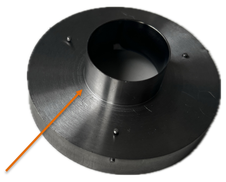
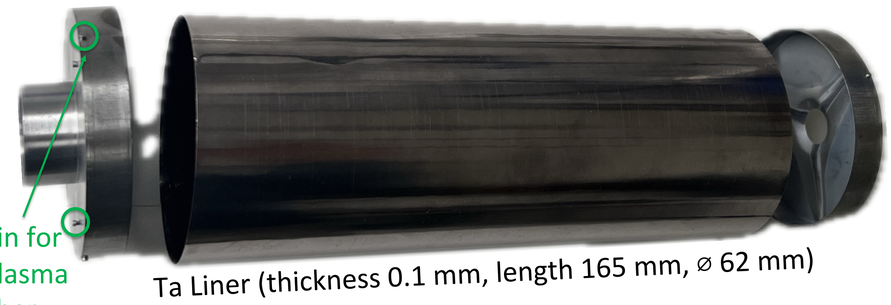
ABSTRACT: At GSI, the CAPRICE ECR Ion Source (ECRIS), installed at the High Charge State Injector (HLI), delivers continuous-wave (CW) metallic ion beams for studies and experiments carried out by nuclear physics, materials research, and superheavy elements groups. To meet the demand for ions from metals and solid compounds, thermal evaporation via resistively heated ovens is employed. The use of a hot tantalum liner, inserted into the ionization chamber, has been validated for the efficient production of high charge state ion beams from rare isotopes—such as ^{48}Ca—with high intensity and low material consumption. Recent results from the latest beam run demonstrate increased beam intensity stability and reduced material consumption. Furthermore, the hot liner helps mitigate metallic buildup on ceramic surfaces, enabling stable operation at high intensities with minimal disruptions. Results from operations with ^{52}Cr and ^{55}Mn confirm the effectiveness of the hot liner in enhancing operational stability.

Hot Liner

Ta Injection cap



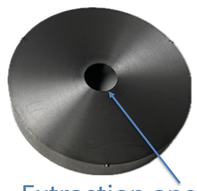
Chamber first stage aperture



1 mm pin for gap to plasma chamber

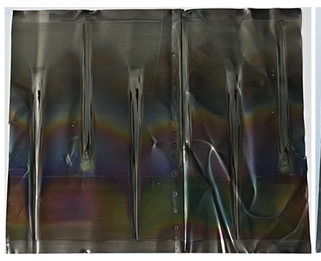
Ta Liner (thickness 0.1 mm, length 165 mm, ⌀ 62 mm)

Ta Extraction cap

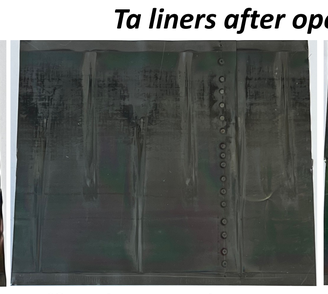


Extraction aperture (⌀ 10 mm)

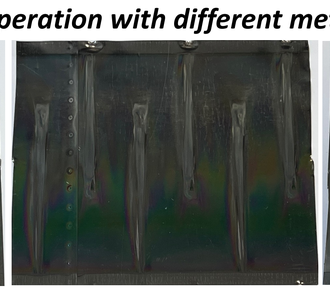
Ta liners after operation with different metallic elements



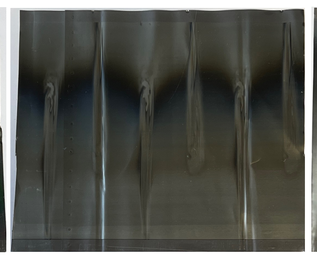
^{48}Ca (23 days) Run 1 ECRIS @ INJECTOR



^{48}Ca (27 days) Run 2 ECRIS @ INJECTOR



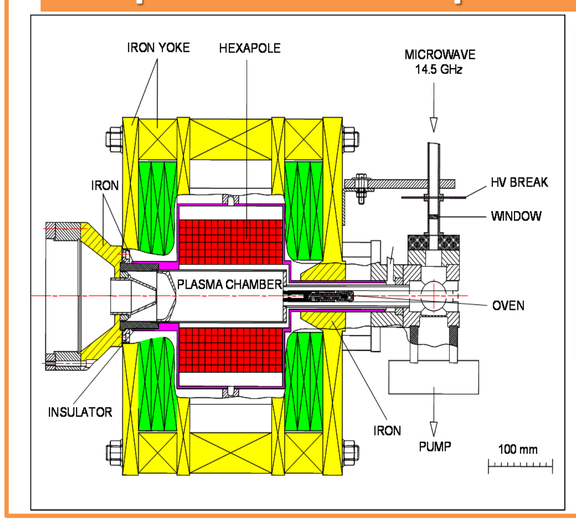
^{48}Ca (21 days) Run 3 ECRIS @ INJECTOR



^{55}Mn (3 days) ECRIS @ TESTBENCH

^{52}Cr (3 days) ECRIS @ TESTBENCH

Evaporation technique for metallic ion beams

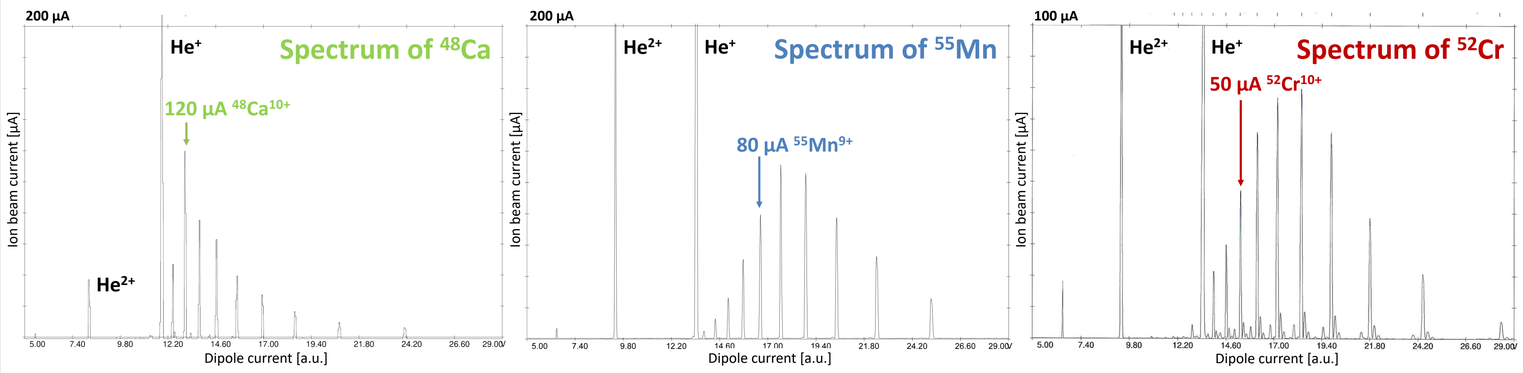


Standard Temperature Oven (STO)

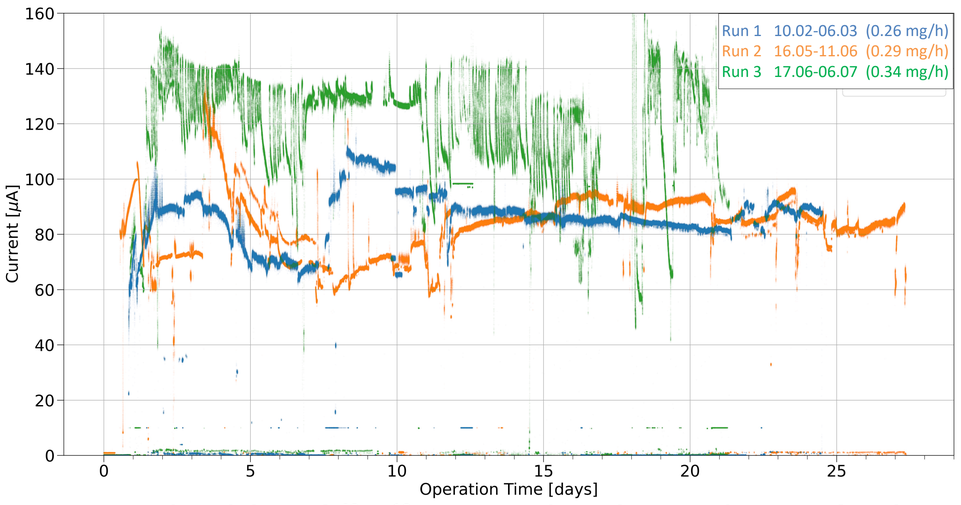
STO OPERATING PARAMETERS

- Power: 2-120 W
- Temperature: 400 -1550 °C

Charge state distributions of ^{48}Ca, ^{55}Mn and ^{52}Cr measured with hot liner

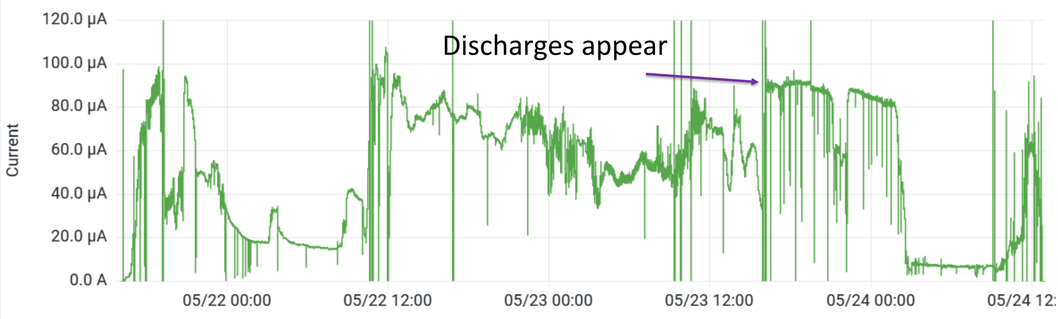


^{48}Ca^{10+} ion production - beam time 2025



Intensity and stability of ^{48}Ca^{10+} measured at the Faraday Cup for three blocks of ^{48}Ca ion beam with the hot liner. The material consumption (with recycling) is indicated in the legend.

^{55}Mn stability improvement



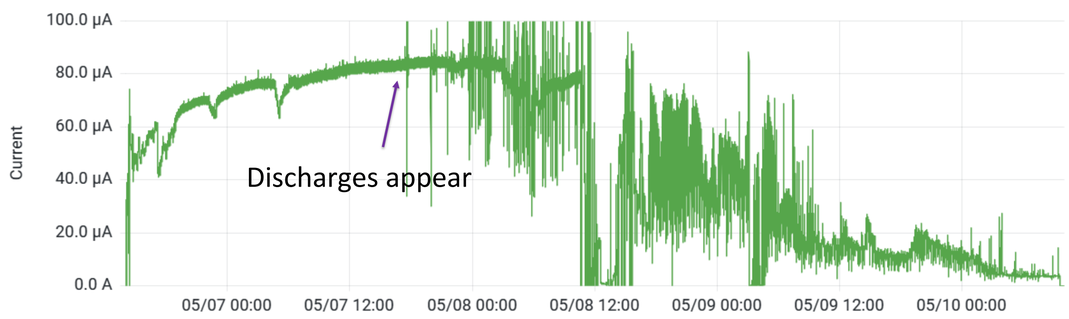
^{55}Mn^{9+} intensity at the Faraday Cup with hot liner

With hot liner:

- Discharges delayed until Day 2
- Reduced discharges frequency
- Improved beam stability
- No visible traces on ceramic isolator

Without hot liner:

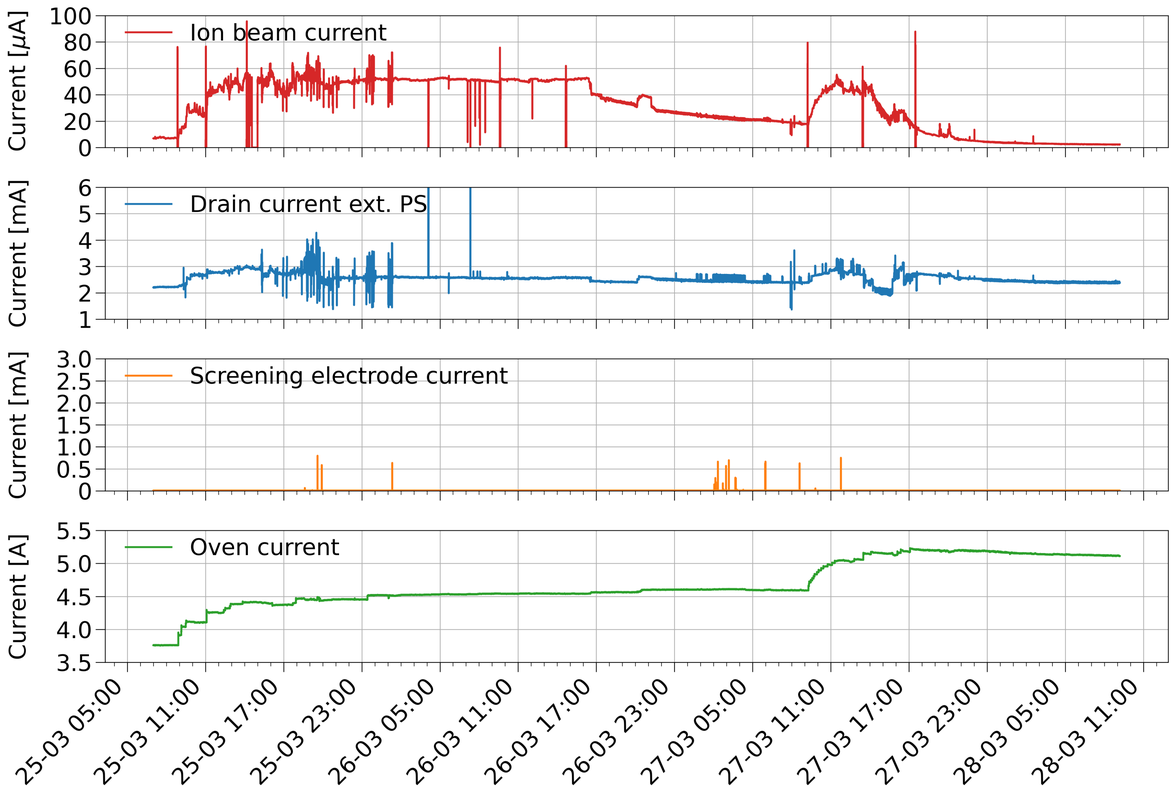
- Discharges started on Day 1
- Once every few minutes
- Affected beam stability

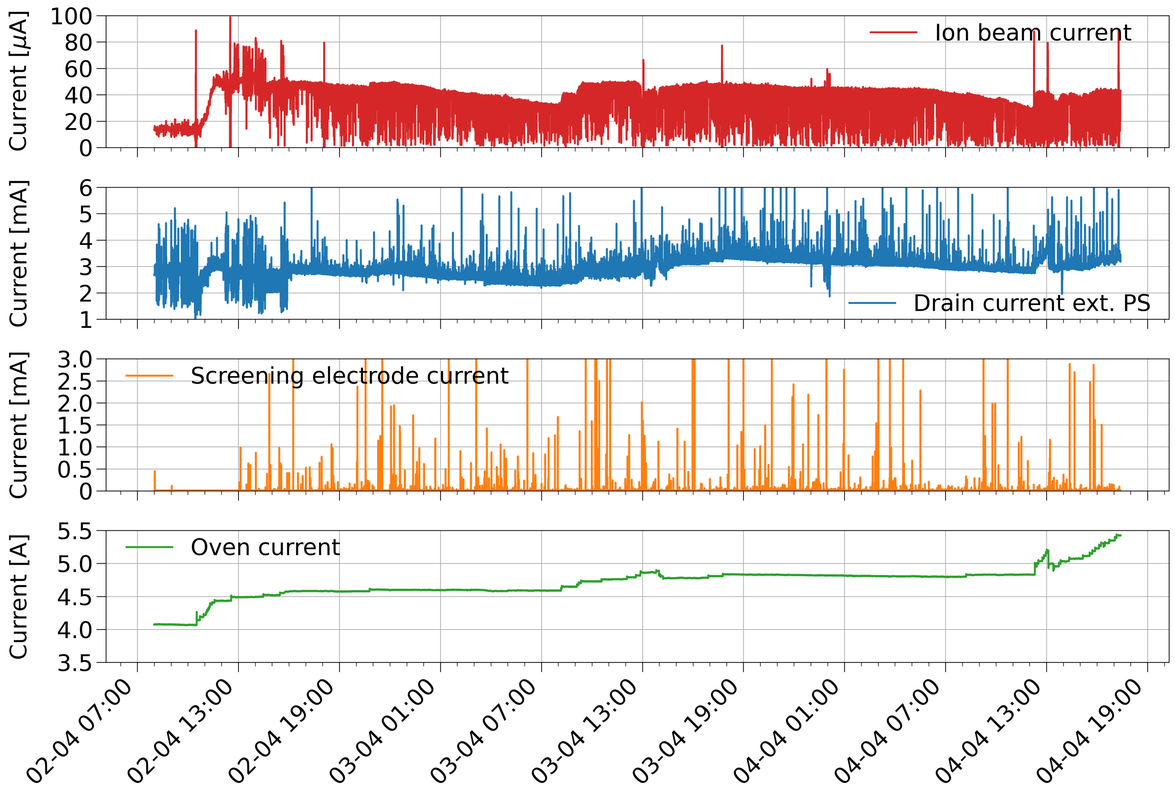


^{55}Mn^{9+} intensity at the Faraday Cup without hot liner

^{52}Cr performance improvement

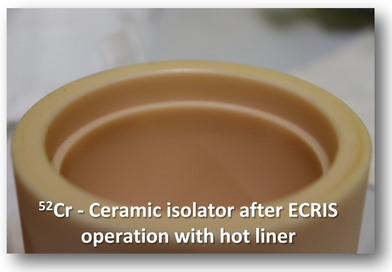
^{52}Cr^{10+} intensity, drain current of the extraction power supply, current at the screening electrode and oven current with hot liner (left) and without hot liner (right)





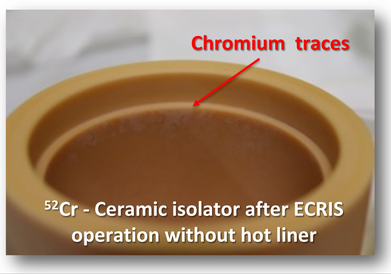
With hot liner:

- No discharges measured at the screening and at the extraction power supplies.
- Improved beam stability
- No visible traces on the ceramic isolator



^{52}Cr - Ceramic isolator after ECRIS operation with hot liner

Ceramic isolator in the extraction area



^{52}Cr - Ceramic isolator after ECRIS operation without hot liner

Without hot liner:

- Discharges fast build-up
- Screening and extraction power supplies affected
- Ion beam unstable
- ^{52}Cr traces and spots on ceramic isolator