Recycling of sediments from ECR chamber wall by the electron escape paths changing in the magnetic trap

Ł. Standyło[1], K. Sudlitz[1], J. Choiński[1], P. Gmaj[1], O. Nassar[1]

[1]*Heavy Ion Laboratory, University of Warsaw, Warsaw, Poland*

Łukasz Standyło
HIL, Warsaw

Introduction

→ **ECR plasma interacts with source elements, especially with plasma chamber**

→ **Deposition of solid elemets on plasma chamber walls is an effect that is still present**

both on conventional ECRIS and in charge breeder when metallic ions are to be bred

→ **Lining the plasma chamber to recover material deposited on the walls**

Liner is heated enough by the plasma to avoid sticking the material or
the already deposited one (oven, mivoc)

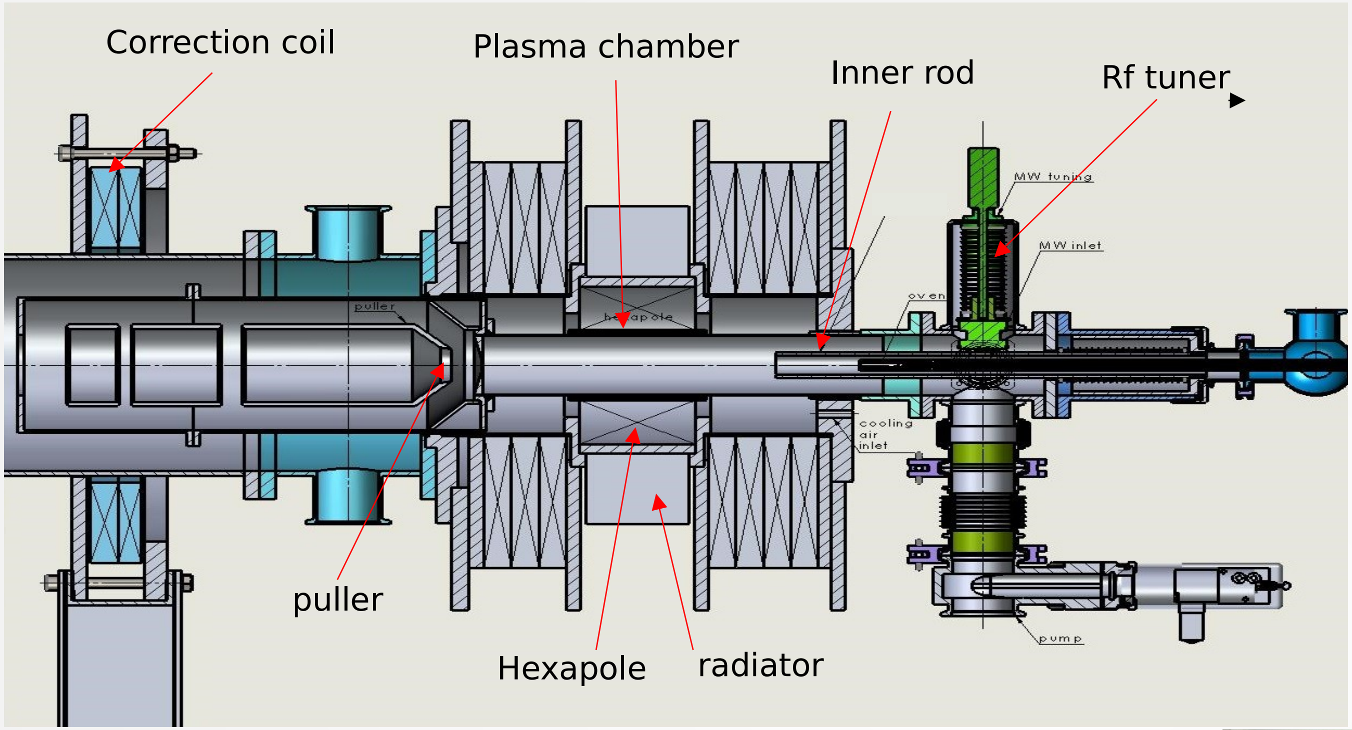
→ **Assumption: „evaporation“ of deposited material is higher at electron escape gaps**

Material stripping by electron bombardment and plasma etching as well
as more intense heating (evaporation)

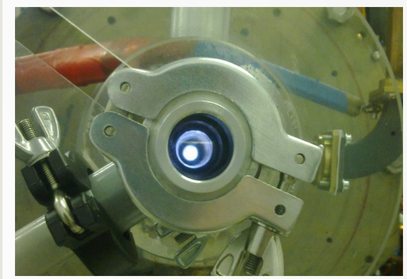
→ **Hexapole rotation change electron escape gaps and change efficiency of material recycling**

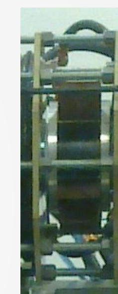
Could be significant for materials with high evaporation temp.

HIL test source

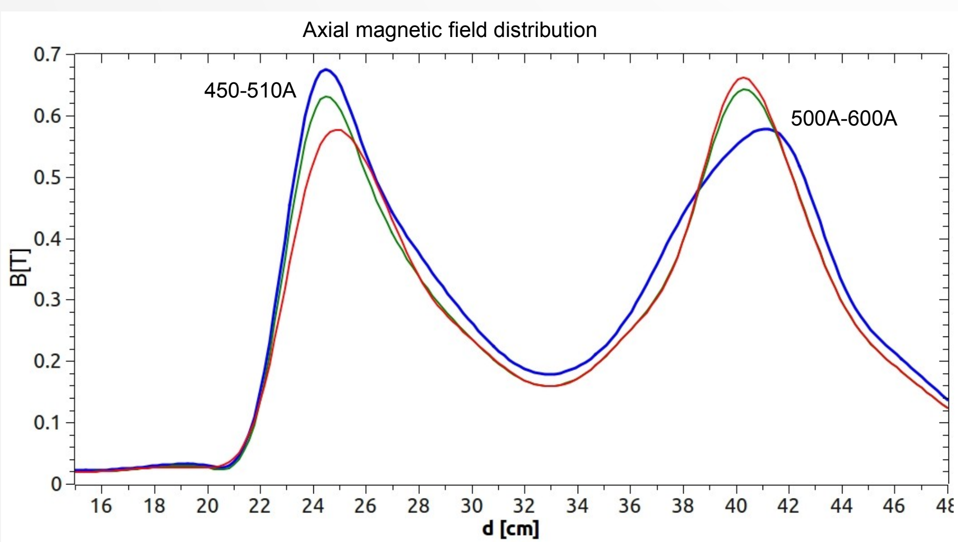


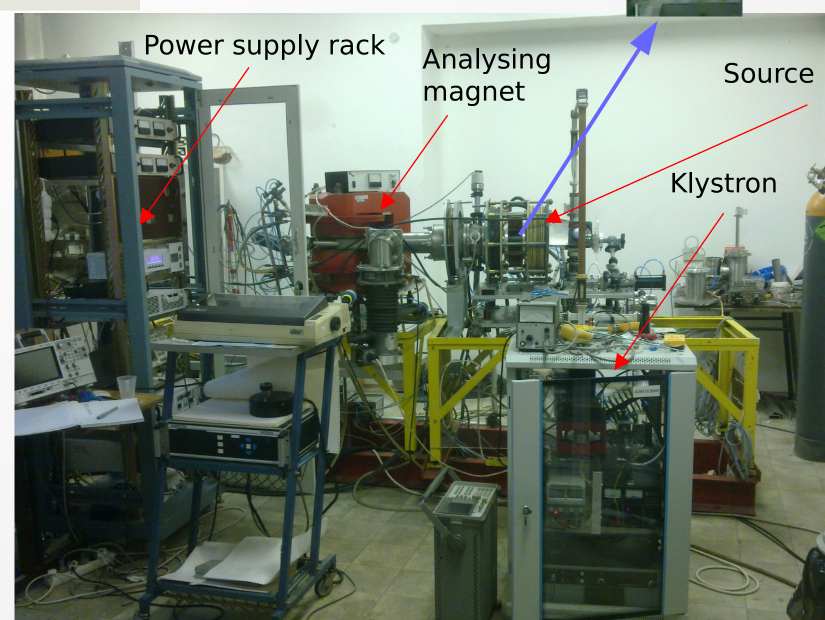
- Source voltage – 10 kV
- Axial magnetic field – 0,55 – 0,65 T
- Microwave frequency – 9,5 GHz (X-band)
- MW power used 150-300 W
- Chamber diameter – 48 mm
- Hexapole lenght – 90 mm
- Inner rod – 22 mm ext. (16 mm int.)



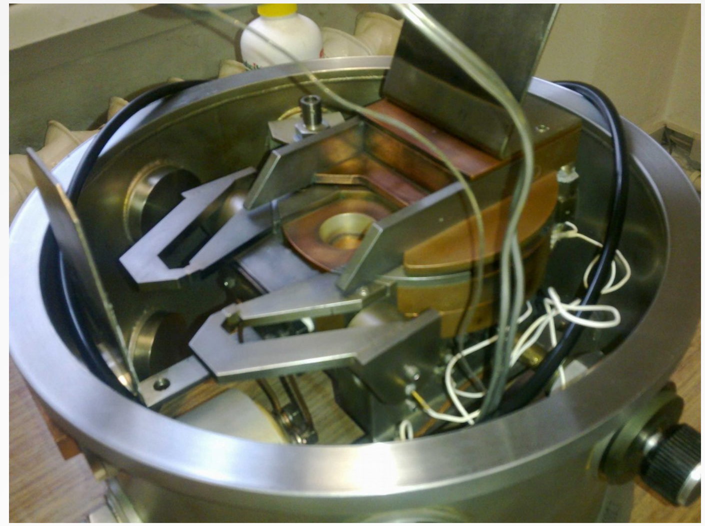


ECRIS in not fully tuned yet...

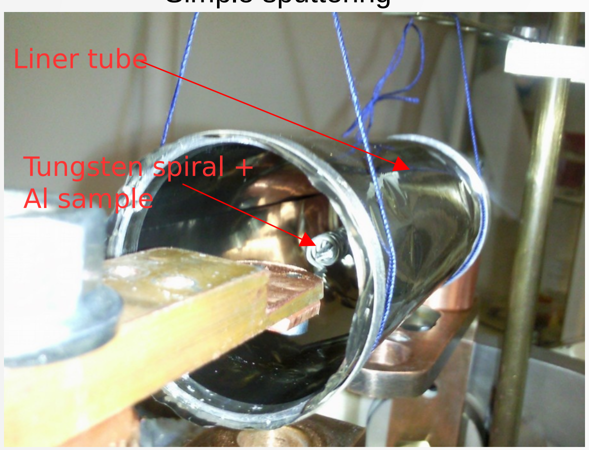




Plasma chamber liner

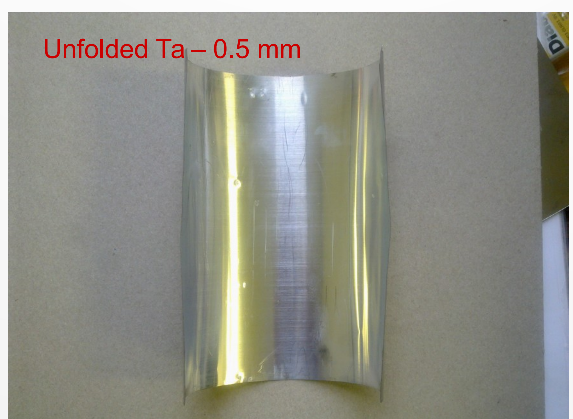


Simple sputtering



Spiral method - ~400 – 500 μg/cm²

Sputtered inhomogenous layer



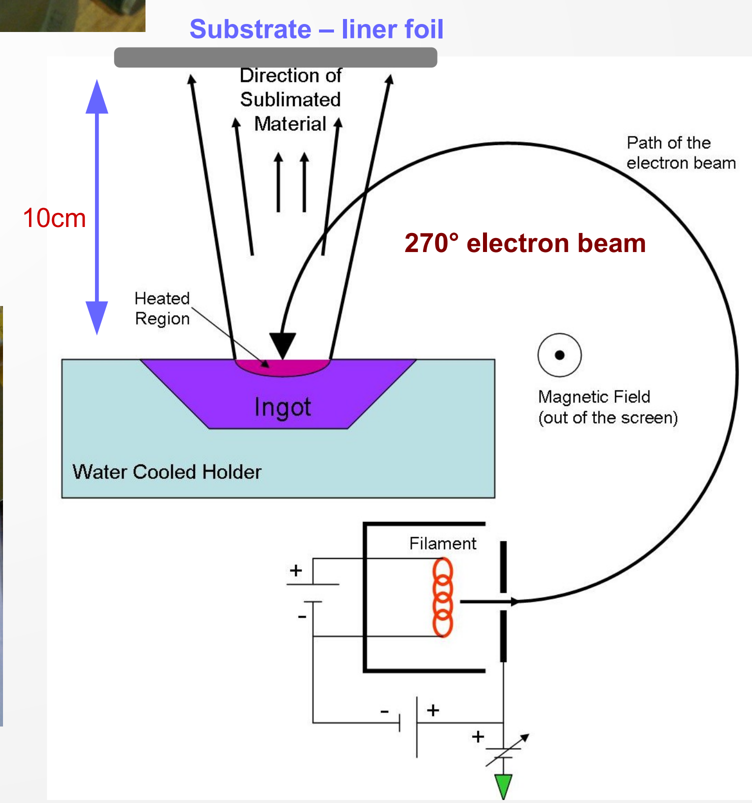
Multi-Hearth Electron Beam Source

Maximum Power - 6 kW

Emission Voltage - 10 kV

EBS method - ~200 – 220 μg/cm²

Sputtered homogenous layer



Liner heating

The temperature distribution is not homogenous due to the electron escape gaps.

Two solutions:

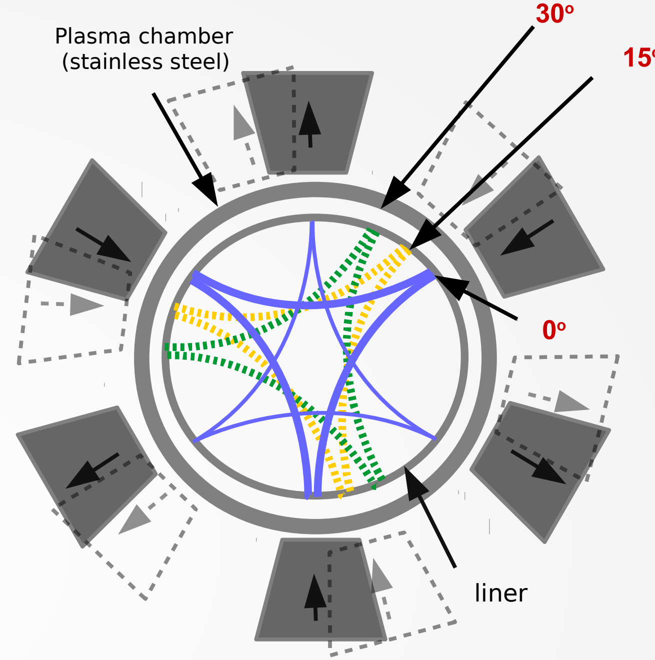
Rotated plasma chamber (liner)

Rotated hexapole

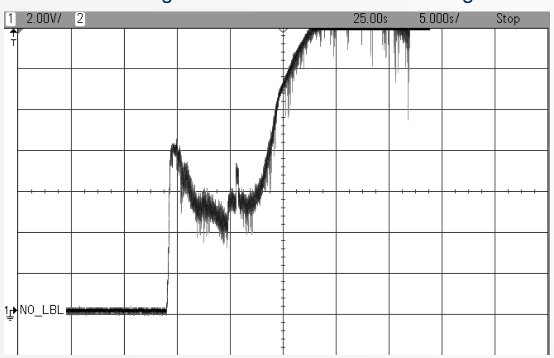
→ Changing the radial position of hexapolar magnetic field

↓

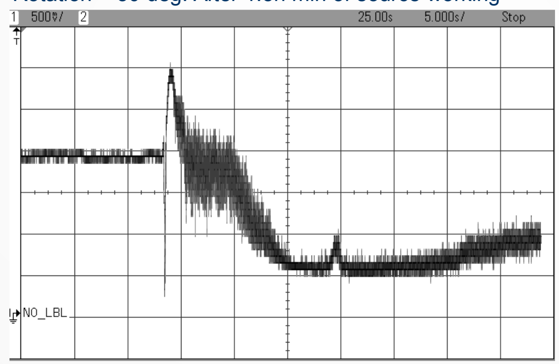
small changes of minimum-B structure



Rotation ~30 deg. After 15 min of source working



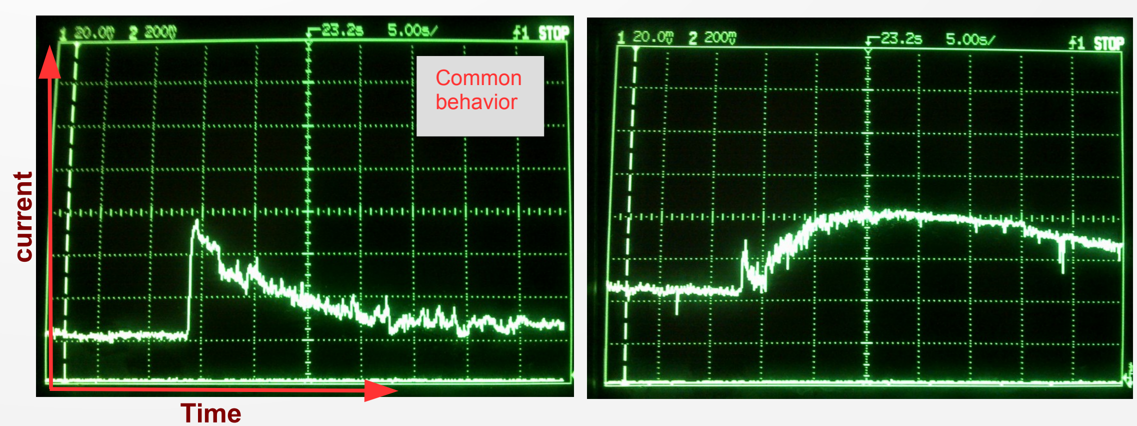
Rotation ~30 deg. After 1.5h min of source working



Optimization to find regularities in the behavior of the beam current at hexapole rotation

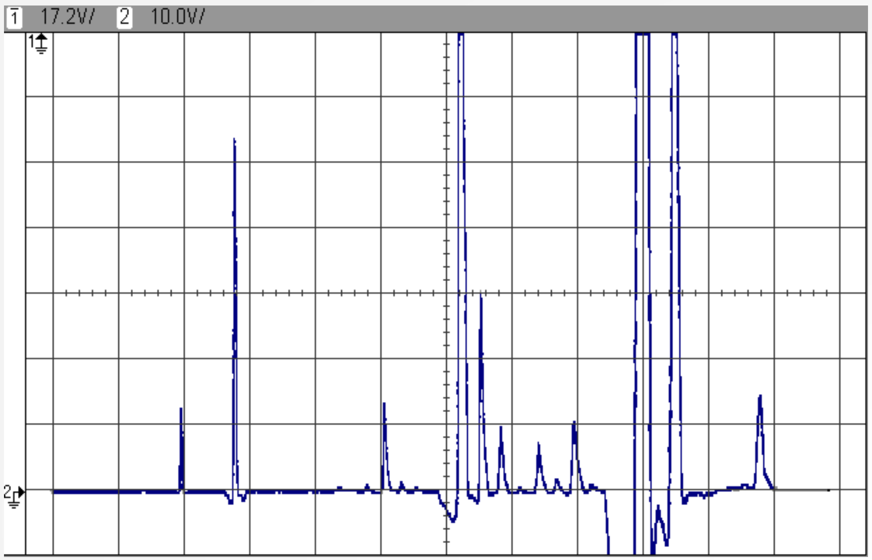
Average angular velocity: 6º/sec

Average time for beam current stabilization ~ 10 – 15 sec

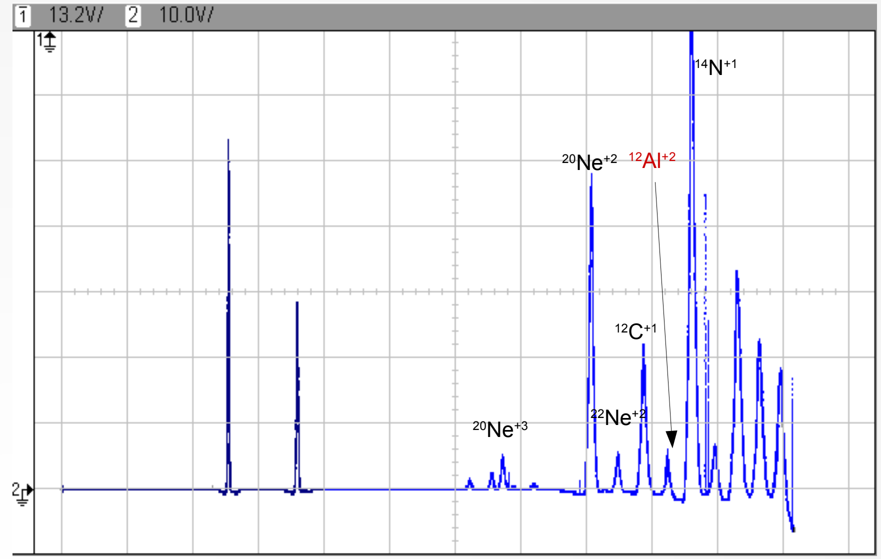


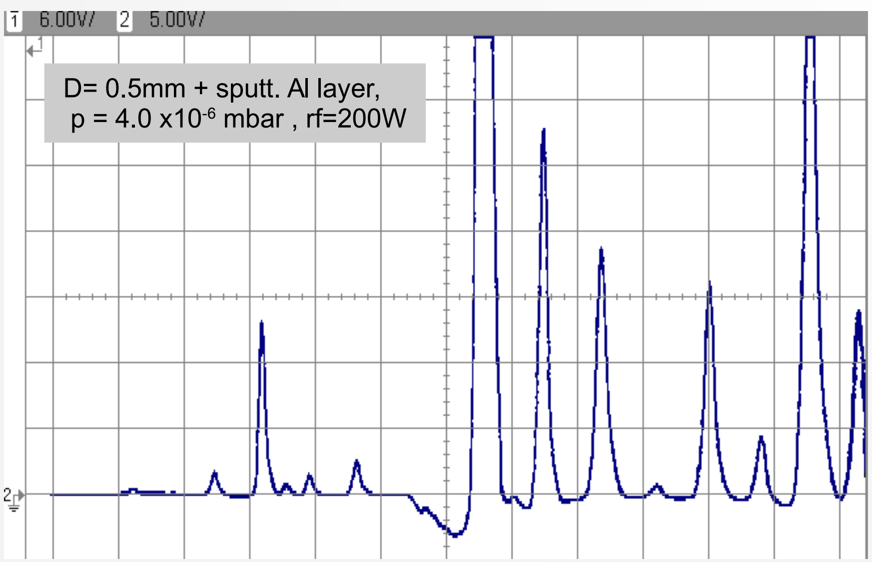
Tantal liner

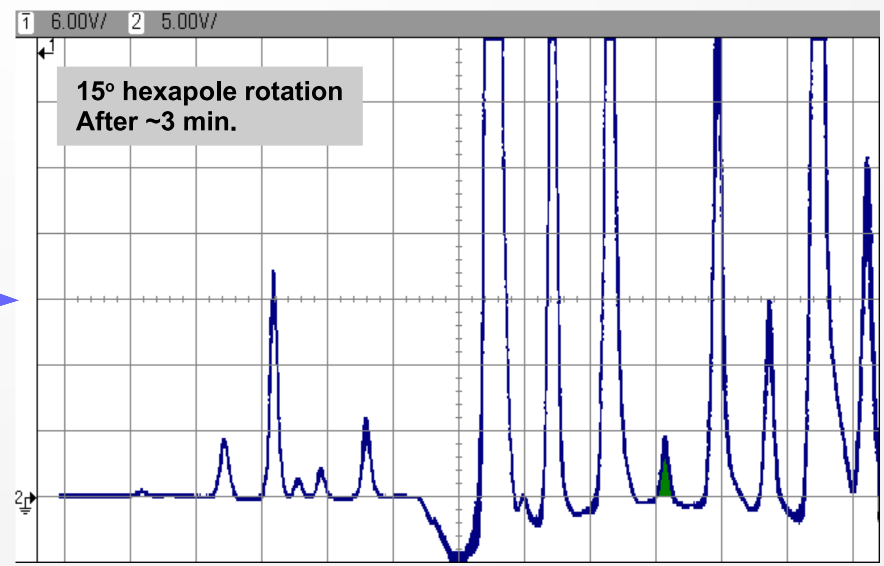
No liner, p = 5 x10^{-6} mbar , rf=270W



D= 0.5mm + sputt. Al layer, p = 4.4 x10^{-6} mbar , rf=230W

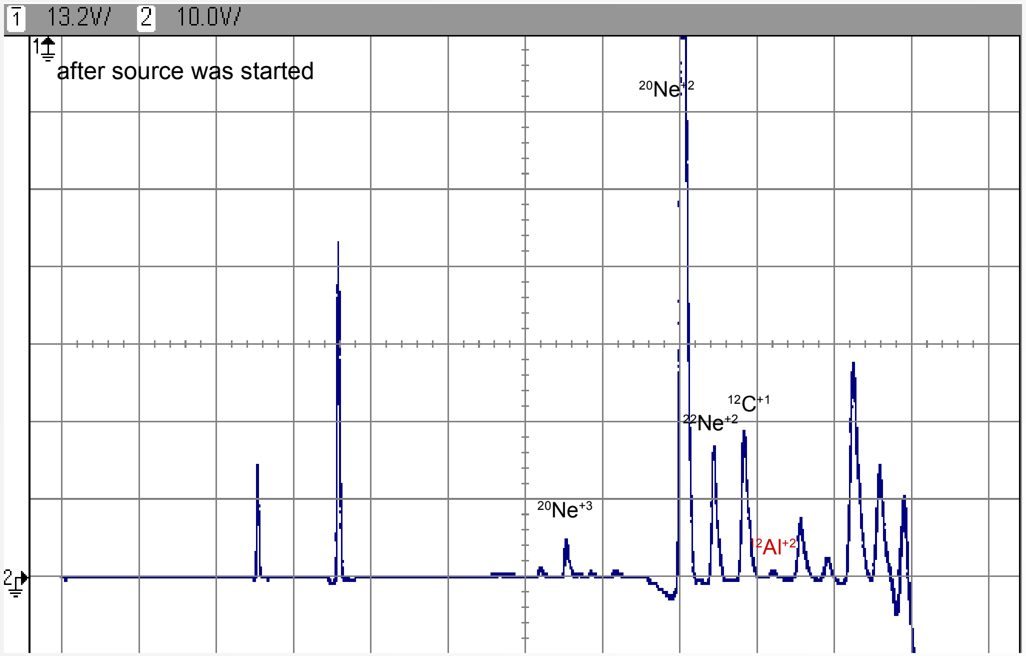


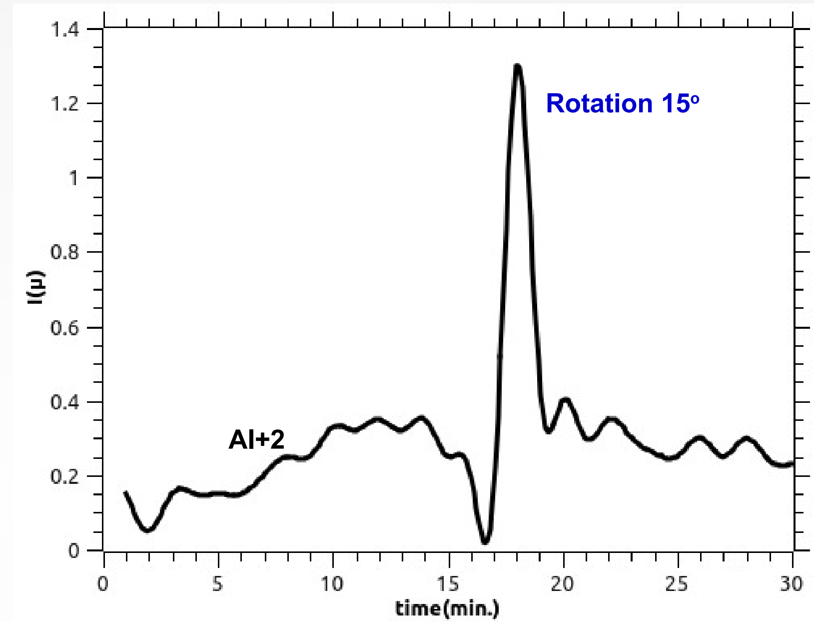


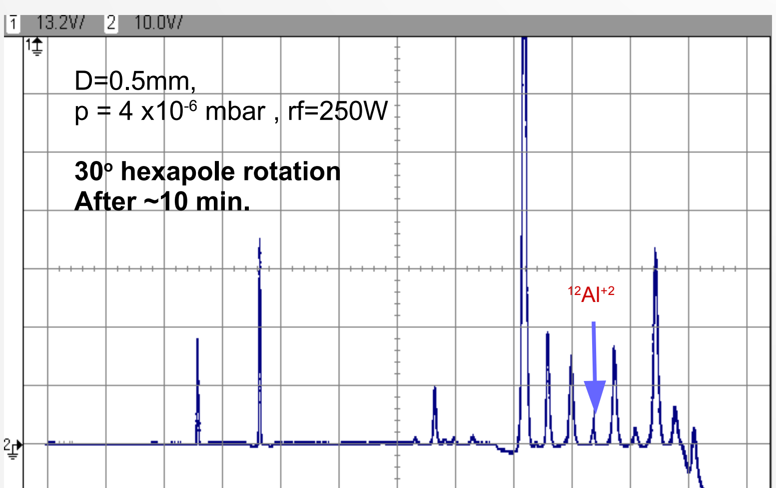


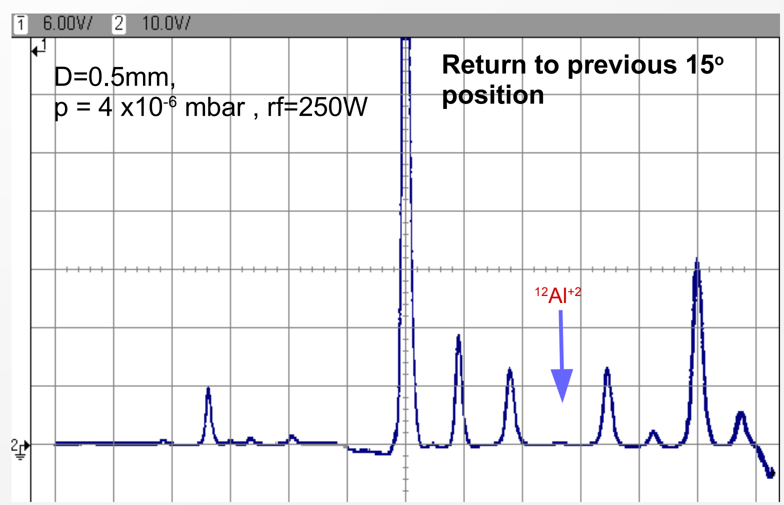
Titanium liner

D= 0.1mm+ sputt. Al layer, p = 6 x10^{-6} mbar , rf=250W

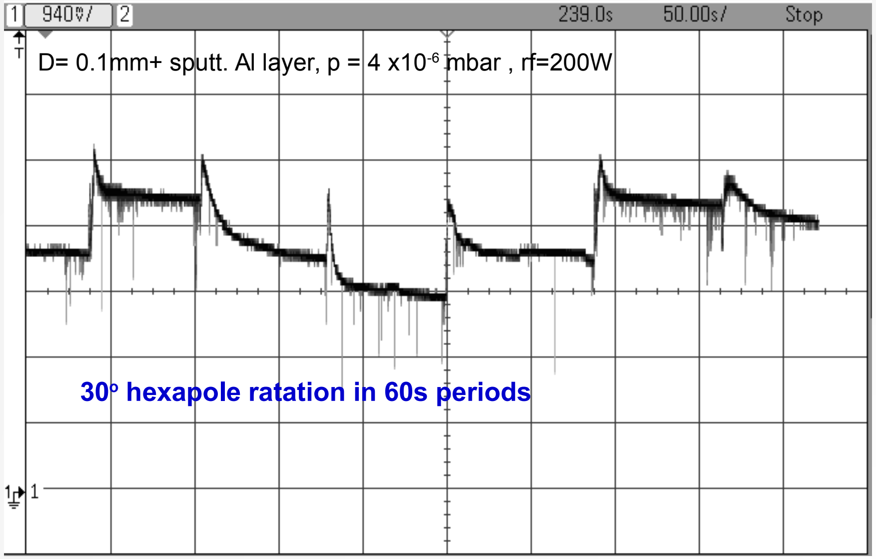






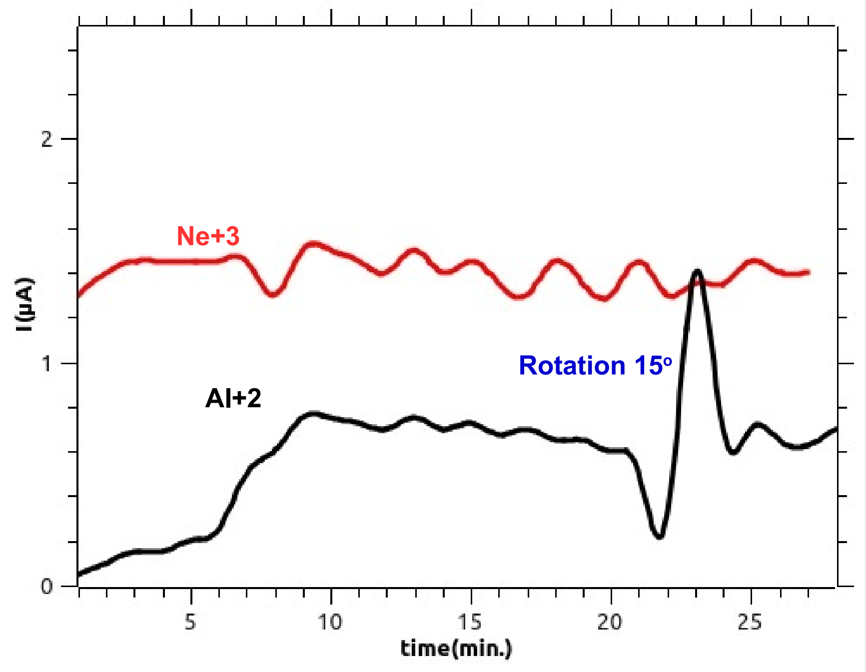


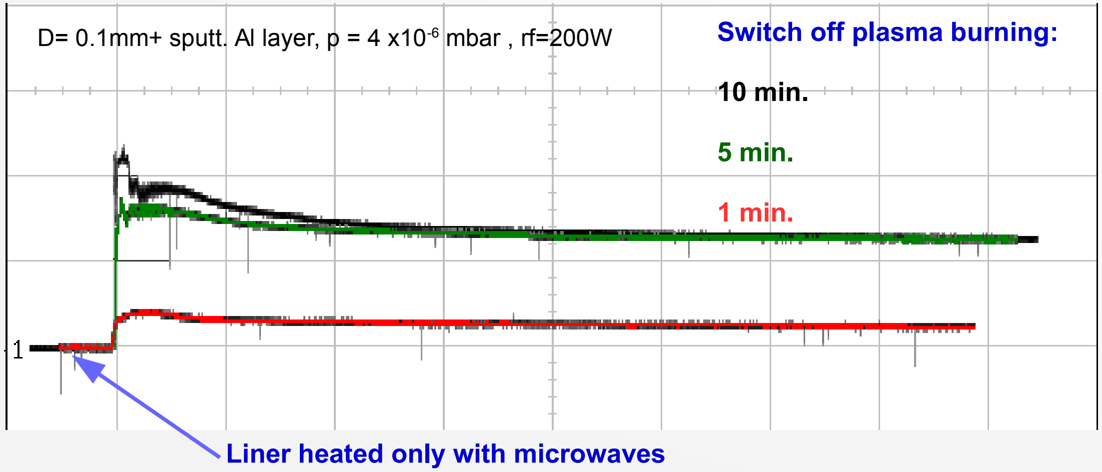
Titanium



Over time, the material burns out and current begins to drop

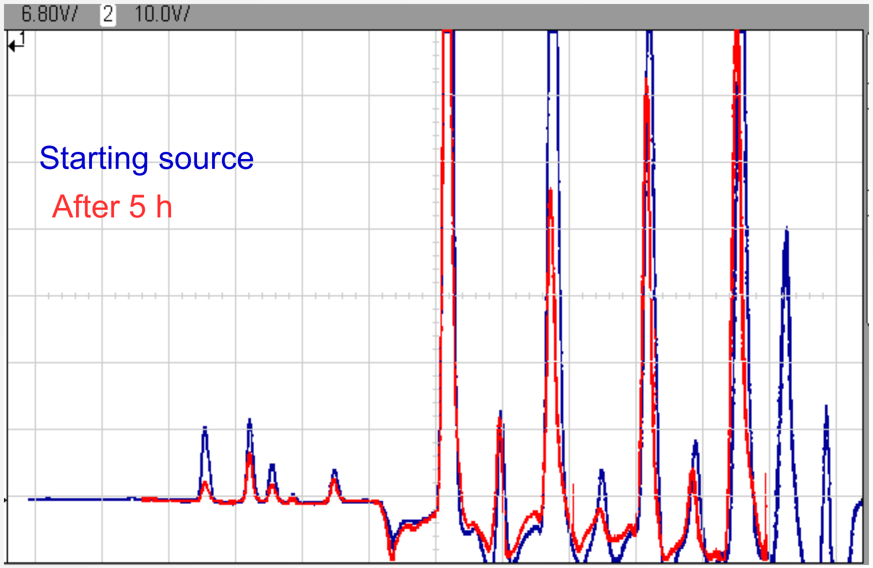
- hexapole rotation affect only on Al bem current



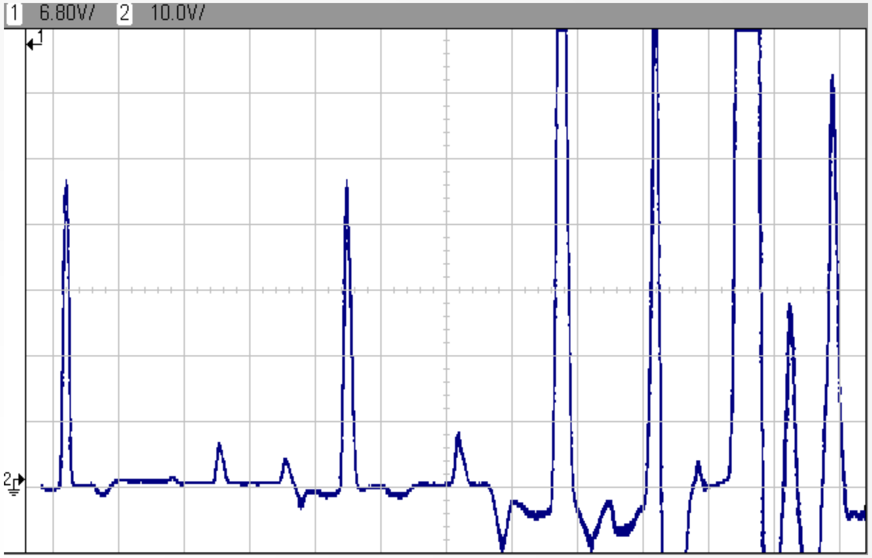


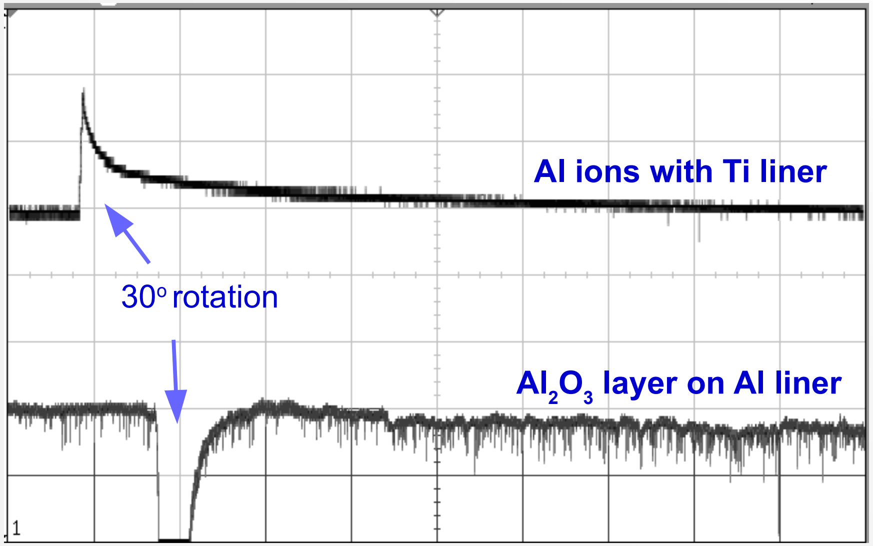
Aluminium liner

D= 1.3mm + Al_2O_3 layer, p = 5.8 x10^{-6} mbar , rf=200W, gas: neon



D= 1.3mm + Al_2O_3 layer, p = 9 x10^{-6} mbar , rf=200W, gas: oxygen





After hexapole rotation on aluminium oxide beam current Al+2
Drops instantly and after heating of electron gaps it is recovered.

Situation different from observed with Al sputtered on Ti liner.

Conclusions

Experiments with thermally insulated liners made of different materials combined with rotary hexapole

→ **No visible changes in heating of liner with different material and thickness was observed**

→ **Changes in beam currents from hexapole rotation were easier to observe with thin liner**

Thin liner (0.1mm) was easier (faster) to heat up than thicker one (0.5mm)

→ **Efficiency of electron escape paths changing seems to depend on type of deposited material**

Effect associated with hexapole rotation is promising way to improve work of conventional ECRIS and charge breeder.

Thank You!