Heavy Ion Beam Induced Vacuum Effects in the AGOR-Cyclotron

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High intensity, heavy ion beams interact with rest gas in the cyclotron. Subsequent desorption on the walls degrades the vacuum causing a positive feedback loop. Experiments are performed to determine the effect of various parameters.

Beamloss Mechanism:

Primary beamloss is due to interaction with rest gas (mostly N_2, O_2, H_2 and He) and depends on

- The Energy of the beam (E/A)
- The charge state Q
- The pumping speed (local pressure)

The ion can undergo

- Pickup *of an electron*

$$A^{q+} + B \rightarrow A^{(q-1)+} + [B^{+}]$$

- Stripping *of an electron*

$$A^{q+} + B \rightarrow A^{(q+1)+} + [B + e^{-}]$$

Beamloss due to desorption:

Secondary beamloss is caused by beam particles with q±1 hitting the walls. Desorption depends on

- Energy of the particles hitting the walls
- The charge state
- Material present on the walls
- Angle of incidence (unknown)

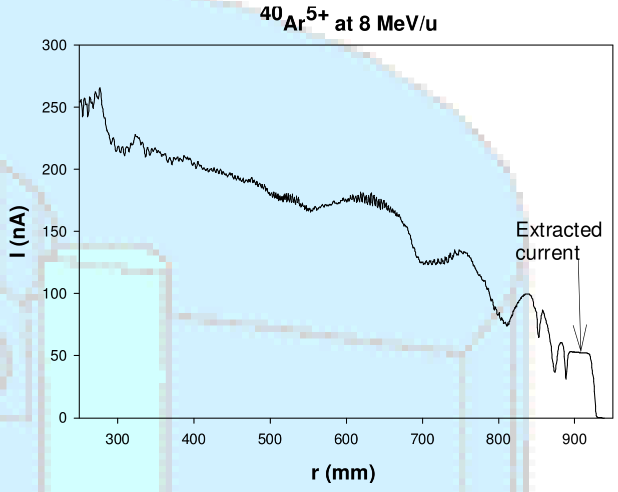
Problems:

- Measurement method affects vacuum and thus skews results. This can be neglected at low intensity
- Interior of AGOR (r < 250 mm) is invisible, only indirect measurements possible.

High Intensity Argon beam

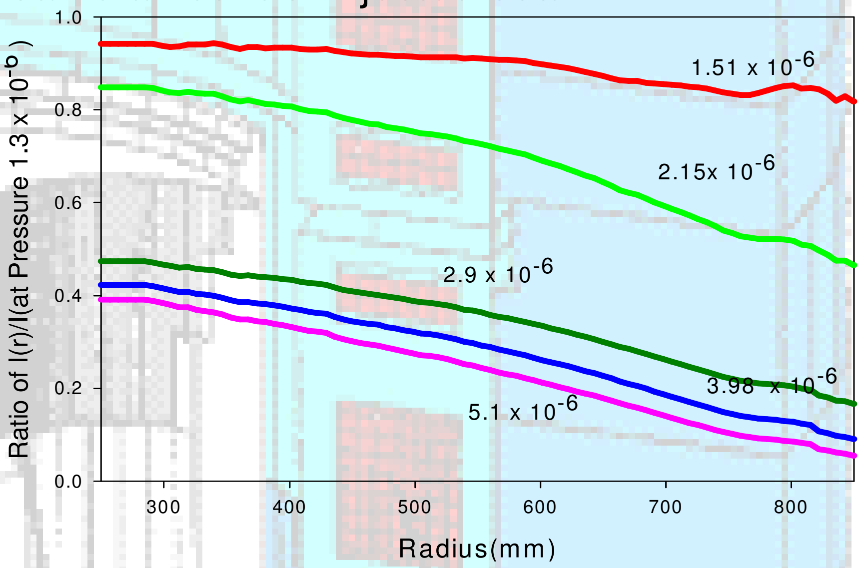
Beamloss due to interaction with rest gas at P=1.4x10^{-6}bar.

Measurement done with wire intercepting part of beam.

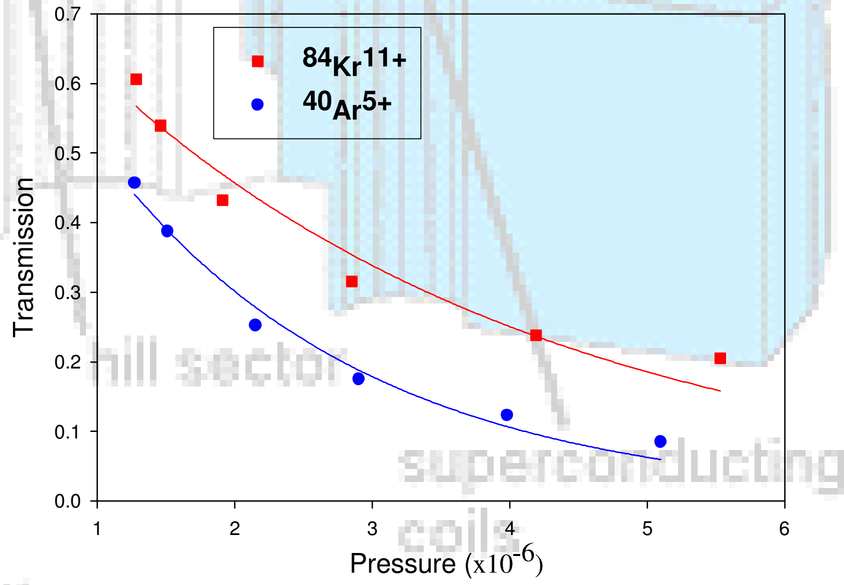


Measurement of effects of vacuum on transmission for low intensity beams.

Ratio of $^{40}Ar^{5+}$ beam current to current at a base pressure of 1.3x10^{-6} bar for varying base pressure for same amount of injected beam.



Comparison of different ions.



$\mu(^{84}Kr^{11+}) = 0.3$; $\mu(^{40}Ar^{5+}) = 0.52$

Future Plans:

- Modeling beamloss and desorption.

$$I_{out} = I_{in} \exp(-\mu P) \quad [Beamloss]$$
$$P = P_0 + Q_d(I_{in} - I_{out})/S_p \quad [Desoprtion]$$

- Continued investigation with available low energy beams.
- Measurement with extracted beams on samples of material [Desorption].

Created on 31/10/2008