Mott Beam Dump Discussion

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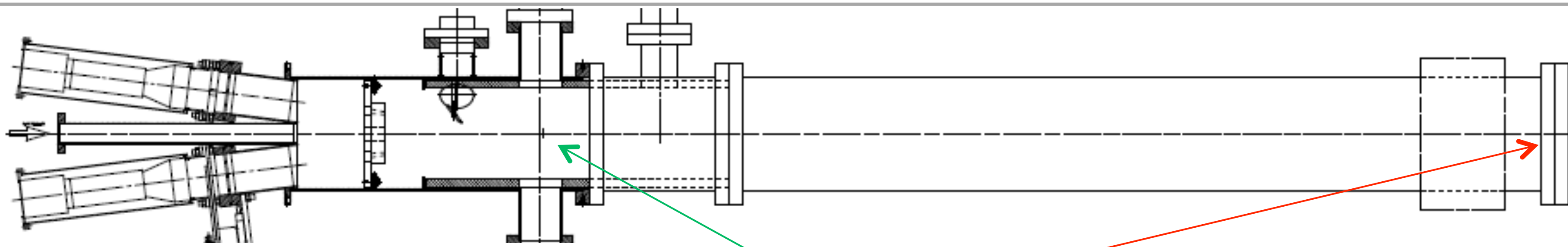
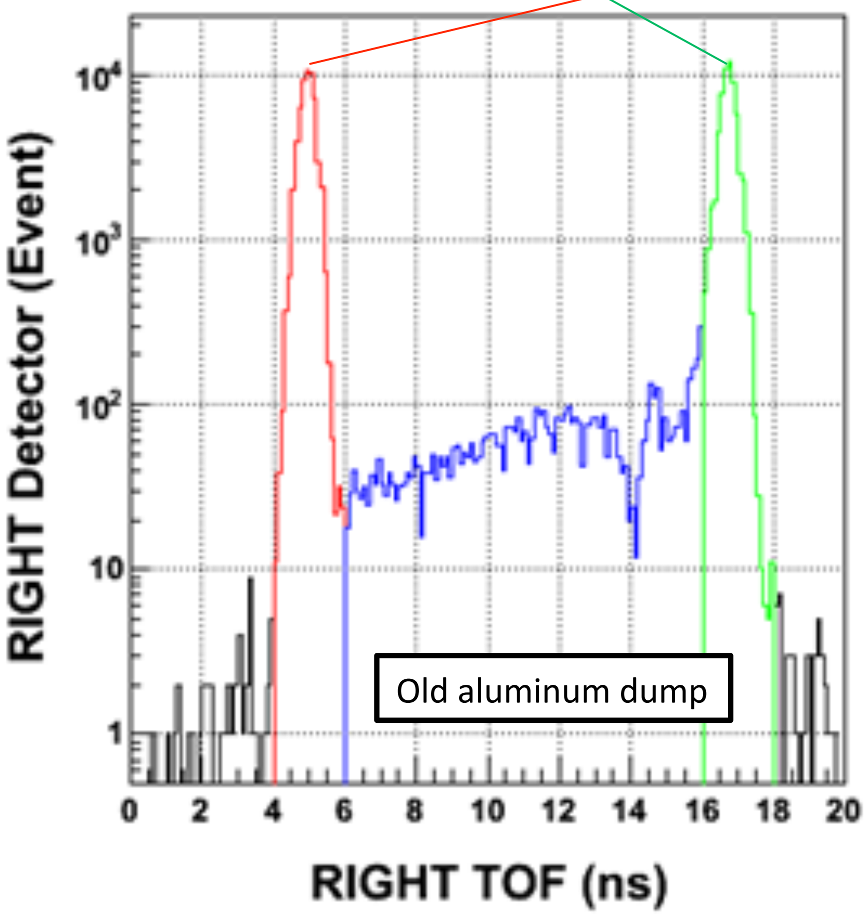
March 2014

- Why a new dump?
- Design
- Thermal analysis
- Engineered controls
- Commissioning

Why a new dump? Answer: Reduce background.





Why a new dump? Answer: Higher beam current

The Mott is designed to best operate at 5MeV.

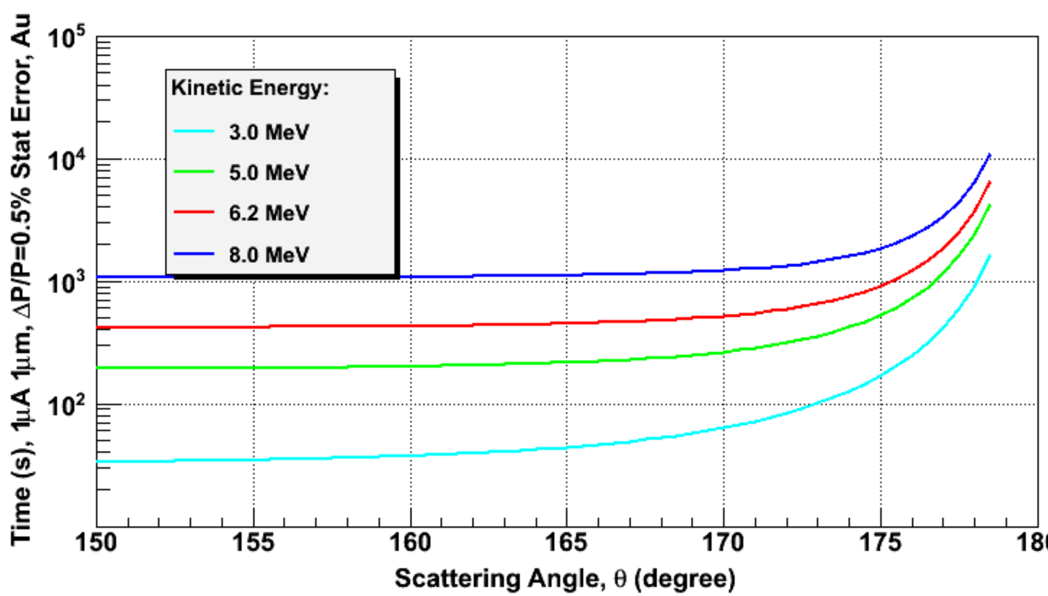
We can also operate with other MeV-energies provided by the cryounit

Our main concern for higher power is beam intensity:

- Ability to study thin target foils (100 Angstrom)
- Rapid statistics (0.25% in < 1 min)
- Measure polarization of ALL electrons for typical 1-100 uA experiment.

<u>Run time (2 detectors, 2 helicities)</u>

$$T = \frac{2N}{R} = \frac{1}{2R(\Delta P \cdot S(\theta))^2}$$



Design

PHYSICAL REVIEW VOLUME 162, NUMBER 2 10 OCTOBER 1967

Backscattering of Electrons from 3.2 to 14 MeV*

TATSUO TABATA
Radiation Center of Osaka Prefecture, Sakai, Osaka, Japan

(Received 30 March 1967)

*"…angular distribution of backscattered electrons and the backscattering coefficient were measured for **Cu, Ag, and Au** targets of **various thicknesses** at the incident energy of **6.08 MeV**, and for **Be, C, Al, Cu, Ag, Au, and U** targets of effectively **semi-infinite thickness** in the energy range **3.24-14.1 MeV**."*

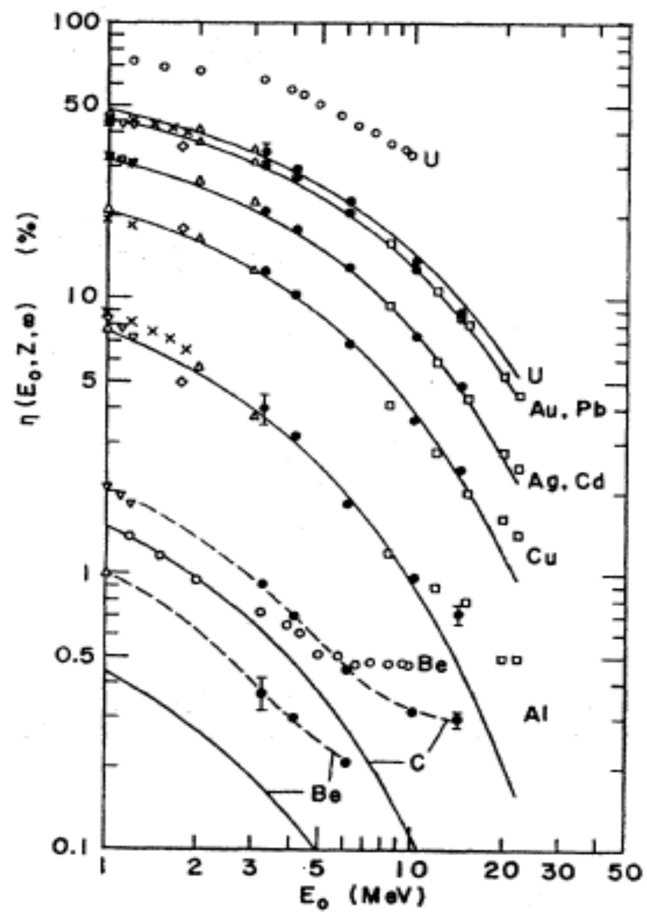
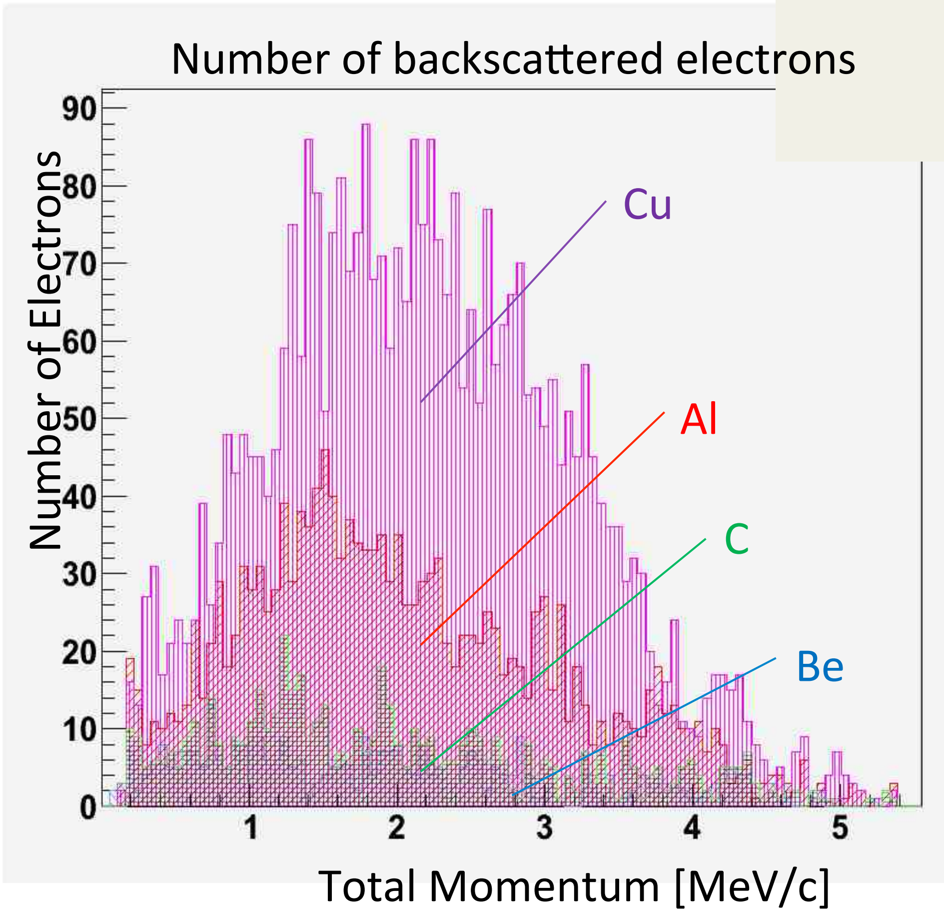


FIG. 8. Dependence of total backscattering coefficient $\eta(E_0, Z, \infty)$ for semi-infinite targets upon incident energy E_0.

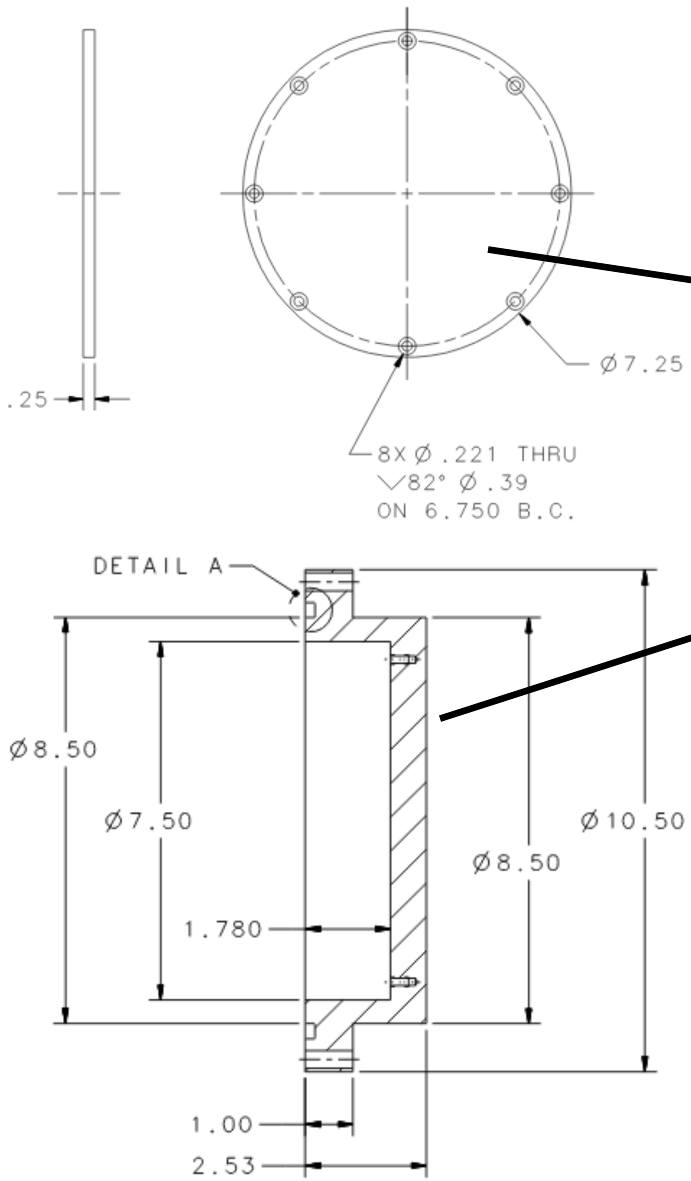
Design

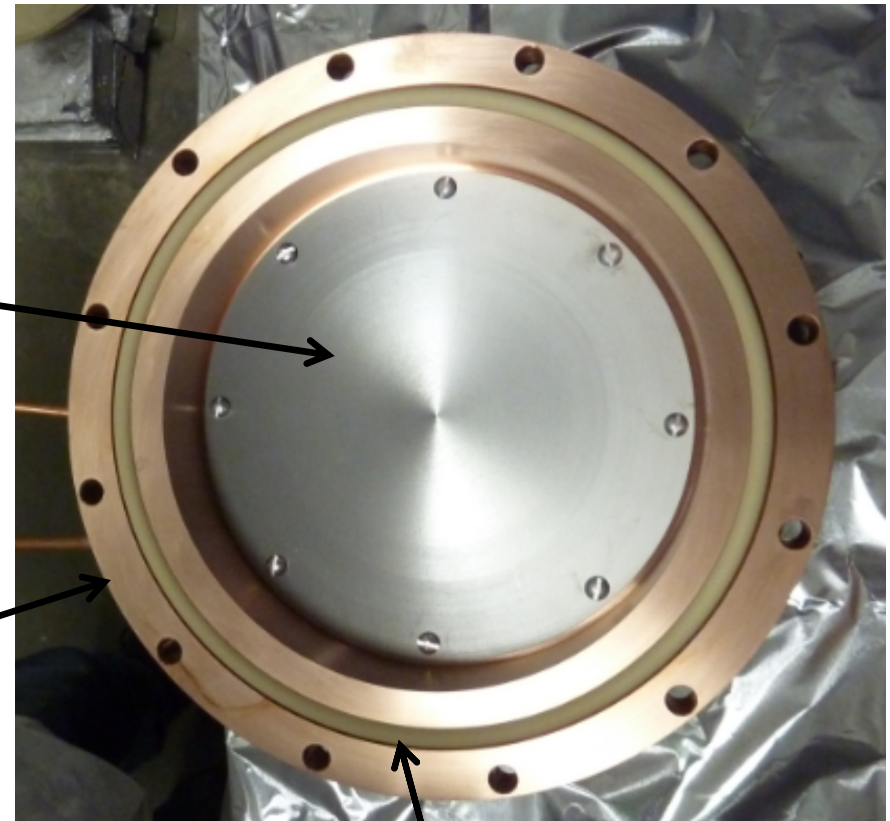
- We chose Be to minimize backscatter.
- Be thickness 0.25” is just long enough such that 10 MeV electron reach Cu surface should not reflect through Be to vacuum surface again.
- Cu was chosen next to increase stopping power and for cooling consideration, distributes heat rapidly and evenly
- Cu thickness 0.75” only thick enough to absorb remaining electron energy to minimize cost.
- X-rays aren’t problematic for Mott so modest external shielding sufficient.



- Electrons suppressed by four
- Photons suppressed by two

Design





Kalrez™ high temp (240C) o-ring

Thermal analysis

Goal

- Keep temperature at SS/Cu joint <100C

(McHugh) Use Geant4 to calculate power deposited in Be/Cu dump

- Assumed 10MeV a) 1mm at dump and b) illuminate dump
- Calculated deposition/volume in annular rings vs. depth
- Total energy >95% of beam power (<5% lost outside of dump)

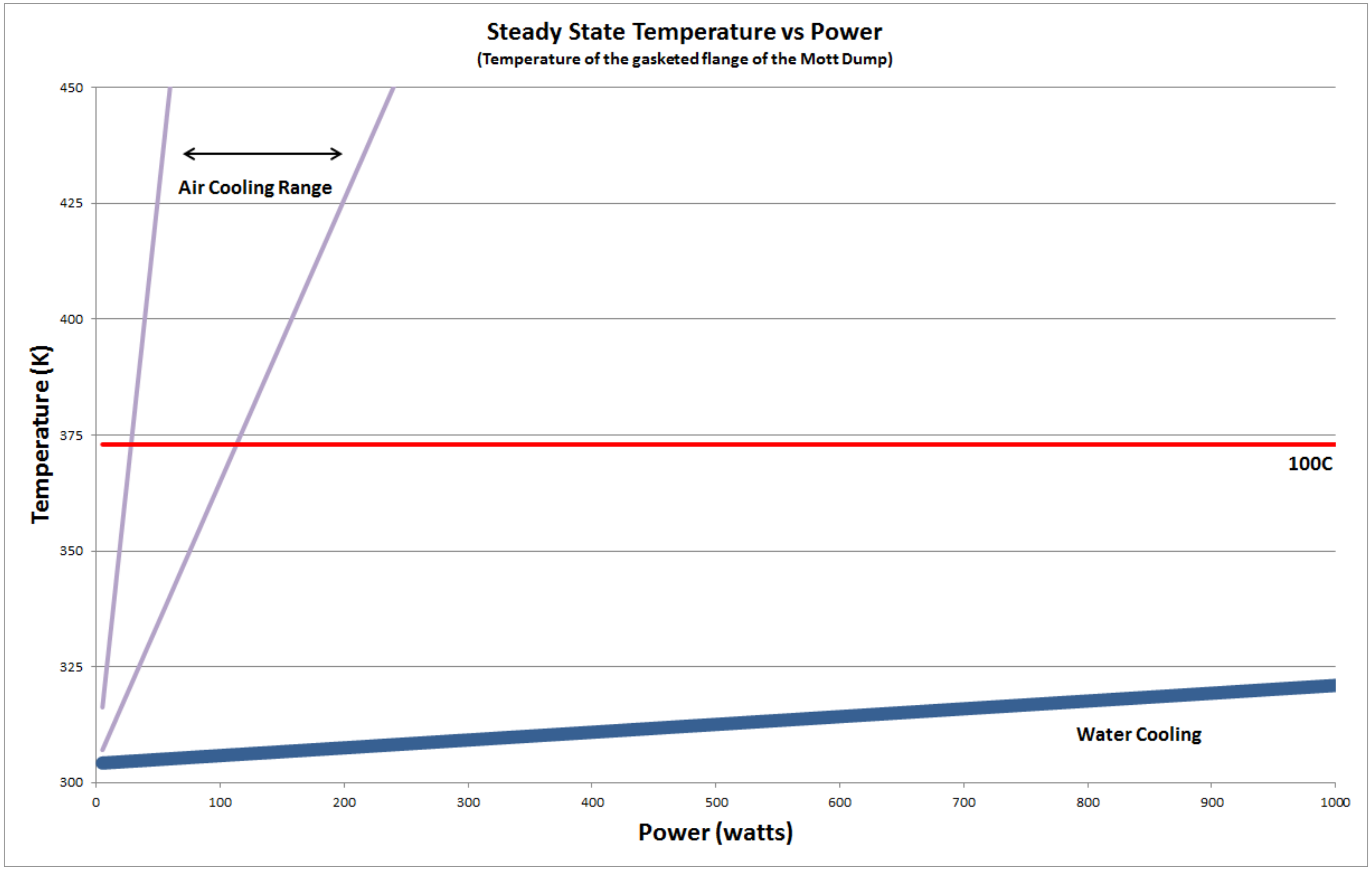
(Adderley) Design and fabricate cooling circuit to clamp on Cu radius

- Two turn cooling circuit brazed to clamping ring
- West arc cooling loop supplies injector manifold at 35C during operations
- Measured 2GPM flow as-installed

(Matalevich) Perform thermal analysis of proposed installation

- Built ANSYS model with deposition and cooling parameters
- Assumed 35C/0.5GPM on active cooling + air on remaining surface

Power deposition and thermal analysis



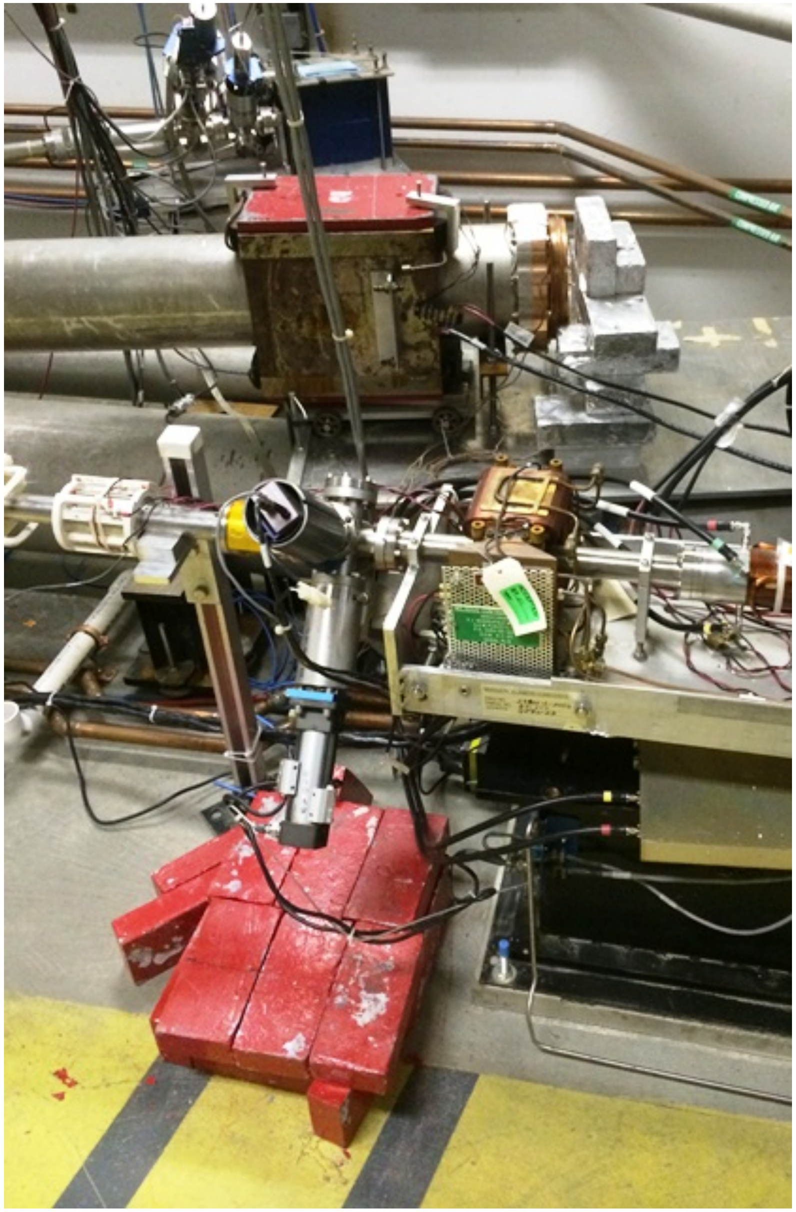
- Copper distributes heat rapidly independent of small spot or full illumination
- Variation in energy (3-10 MeV) will not change deposition profile significantly

Engineered controls

New controls added to support higher beam current

- FSD on target motion
- FSD on beam current threshold
- FSD on valve closed
- FSD on loss of dump water flow

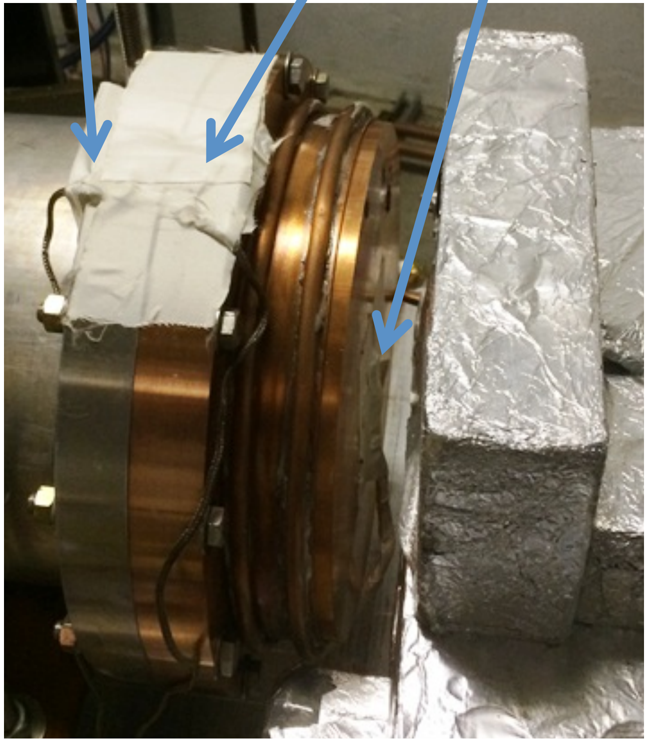
Commissioning



- Increase current from 0-100uA
- Use Mott FSD and BLM
- Monitor dump temperature and vacuum

<u>Monitor Temperature</u>

SS Flange Cu Flange Dump Face



Summary

A new beam dump assembled from a beryllium disk and copper end flange has been built and installed to the Mott.

The beryllium is hoped to reduced dump background by a factor of 4 improving operation at 499 MHz.

The water cooled copper is hoped to allow for beam operation at higher operating currents.

Four engineered controls have been added to the Mott.

A commissioning ATLIS test plan is submitted.