Target Performance at the LENS Neutron Source

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Outline

- Original Target Requirements
- Original Target Design
- Failure Modes
  - Thermal
  - Hydrogen Impregnation
- New Target Design
- Operating Experience with the New Target

Original Target Requirements

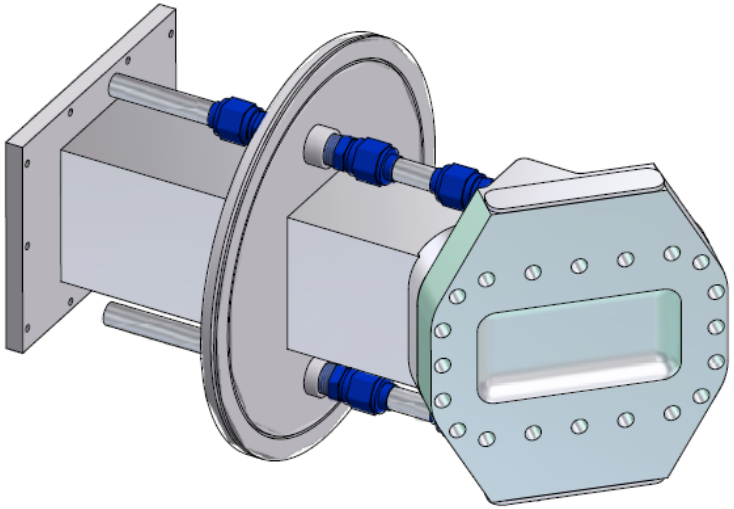
- Handle lots of beam power (39 kW)
- Efficient use of Neutrons produced.
- Low radiation both during operations and residual.

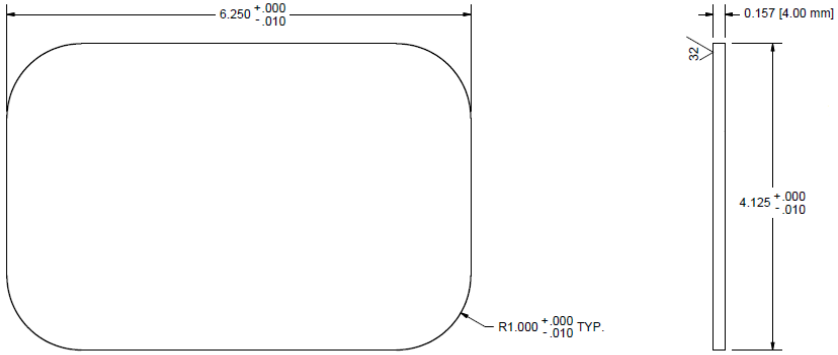
- Lots of Beam power (39 kW)
  - Spread the proton beam to large area.
  - Lots of cooling
    - Hypervaportron cooling channels
    - High pressure water system
- Efficient use of Neutrons
  - Optimized (close) geometry with the moderator
    - 45 degrees to proton beam, parallel to moderator
- Low radiation (residual …)
  - Specific choice of materials (Be and Al)
  - No O-rings

- Lots of Beam power ~~(39 kW)~~ (12 kW)
  - Spread the proton beam to large area.
  - Lots of cooling
    - ~~Hypervaportron cooling channels~~
    - ~~High pressure water system~~
- Efficient use of Neutrons
  - Optimized (close) geometry with the moderator
    - 45 degrees to proton beam, parallel to moderator
- Low radiation (residual …)
  - Specific choice of materials (Be and Al)
  - No O-rings

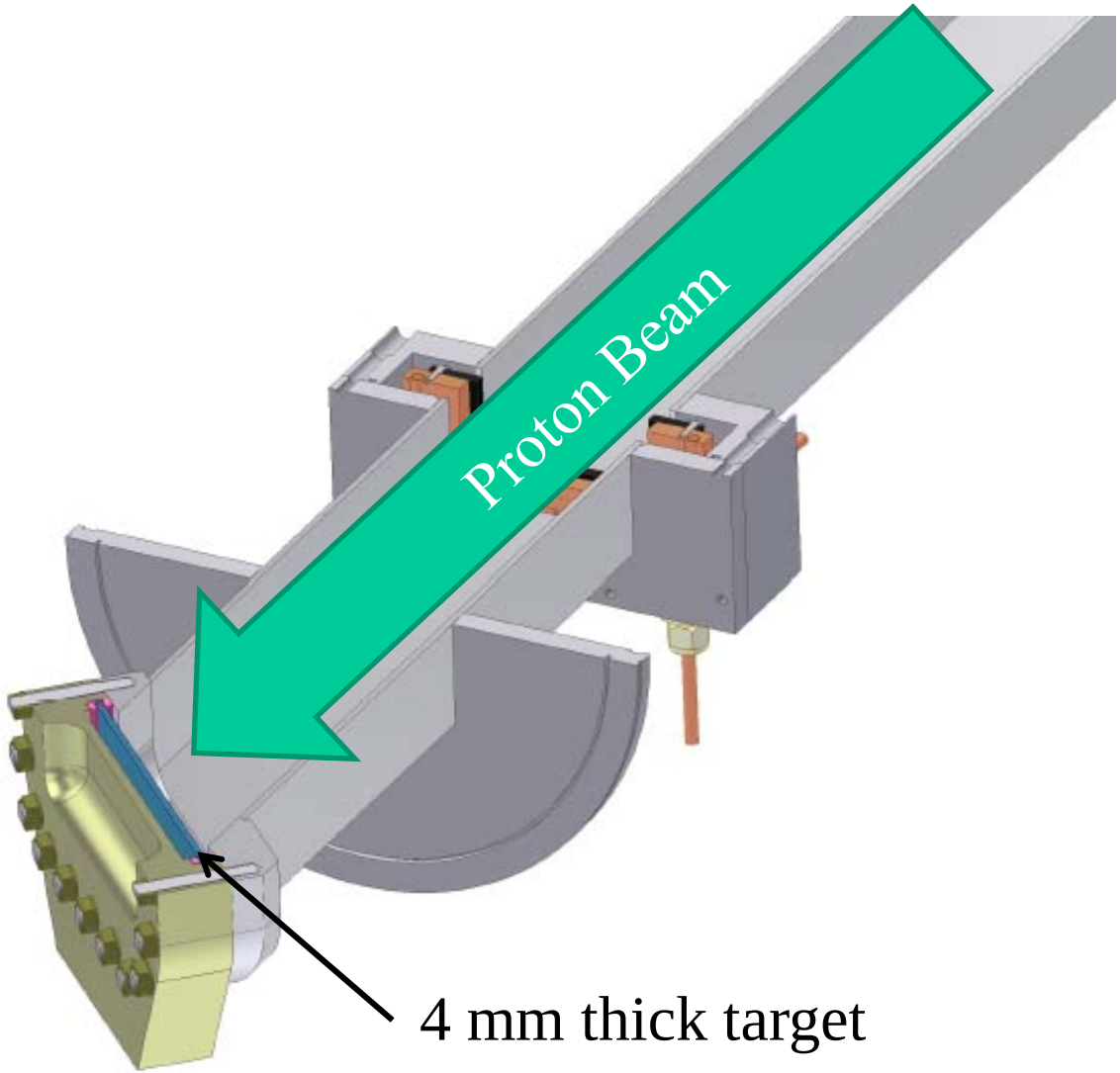
Original Target Parameters

- 105 mm x 160 mm x 4 mm flat plate Beryllium
- 45 degree angle to the proton beam
- Al metal seals on both sides of Beryllium
- Many Al bolts (studs) to compress seal.
- Cooling channels across the back

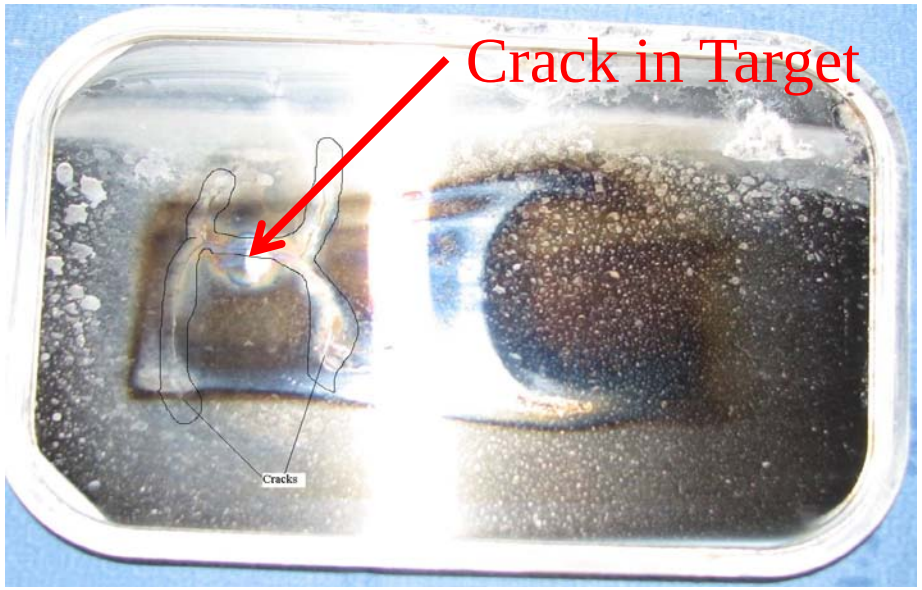




Original Target Mounting and Cooling



Target Failure: Water Chemistry



Problem

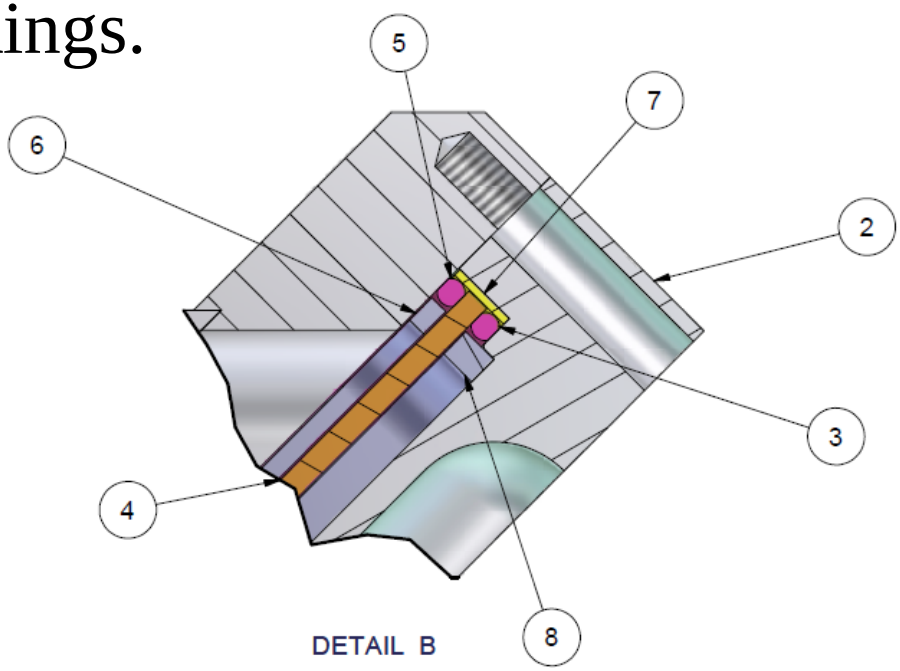
"gunk" buildup on coolant side of target lead to loss of cooling power

Solution

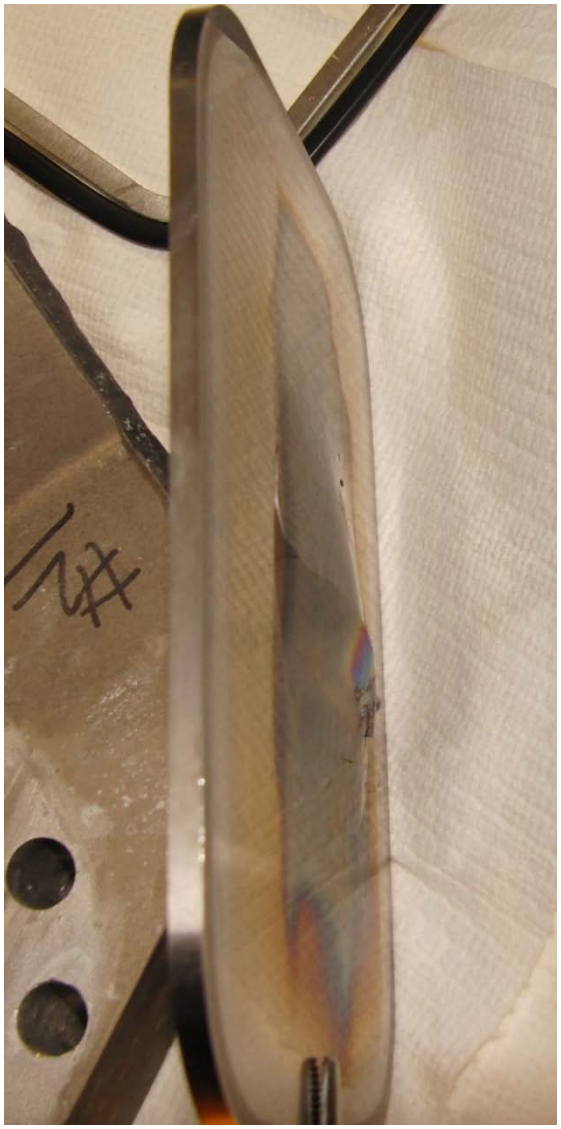
All Al water system (no Cu)
Water additives (Sodium Nitrate)
Sacrificial element in cooling loop

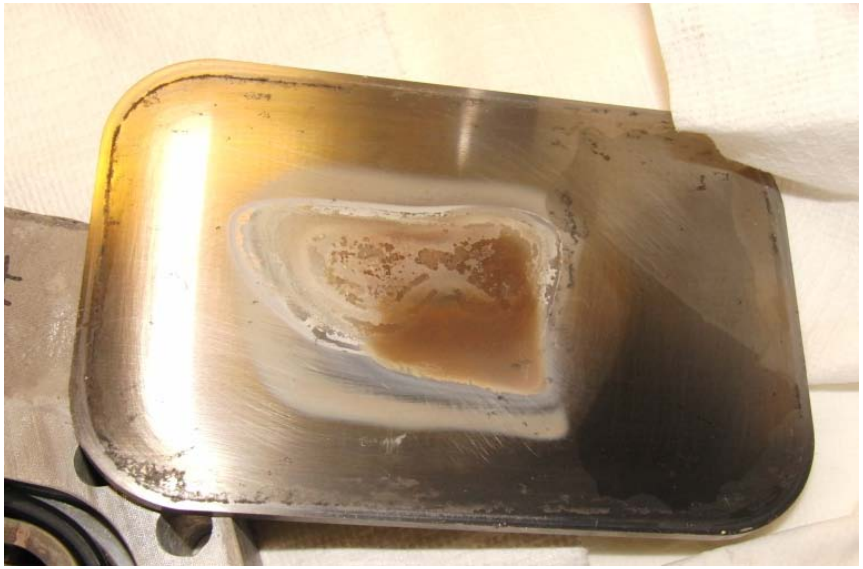
Failure Mode: Al Seals

- Expansion and contraction cycles of target with beam turned on and off cause Al seals to leak.
- Redesign with O-Rings.



Target Failure: Hydrogen Impregnation 13 MeV





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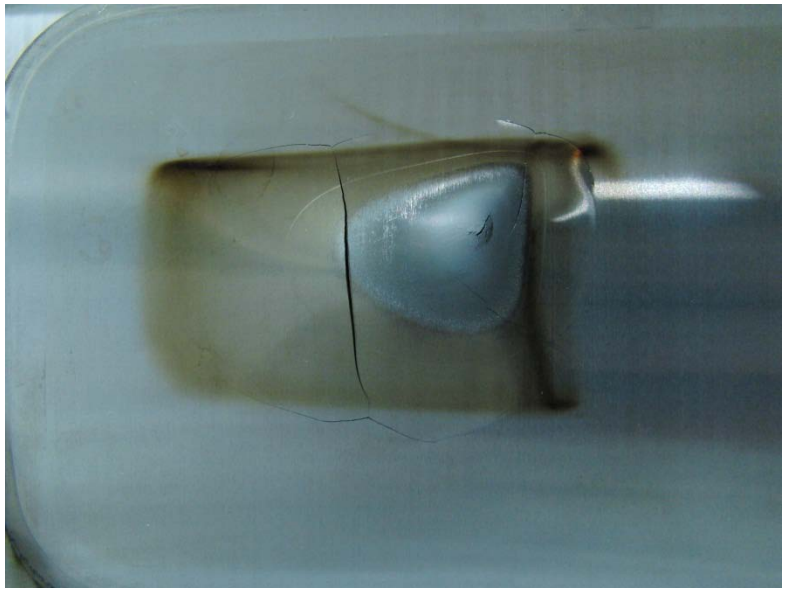

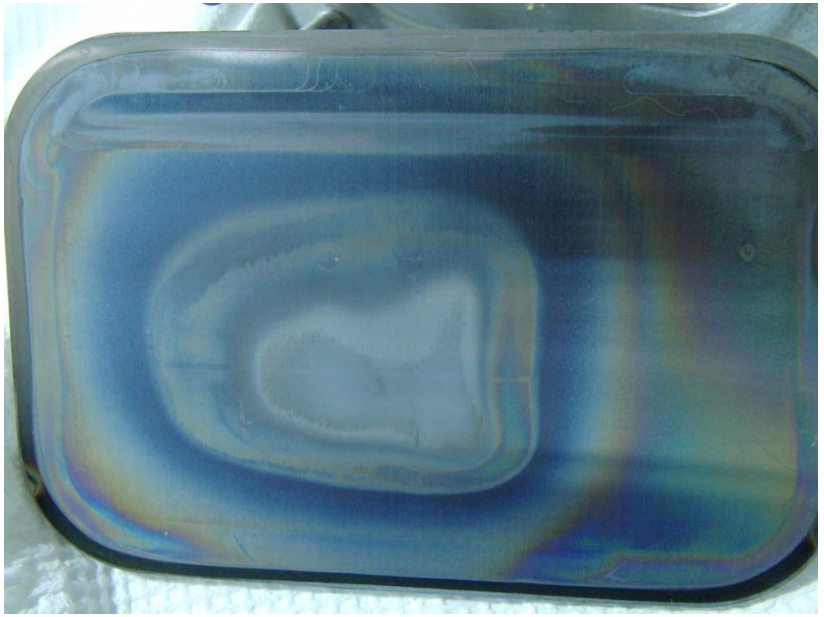

Target Failure: Hydrogen Impregnation 7 MeV

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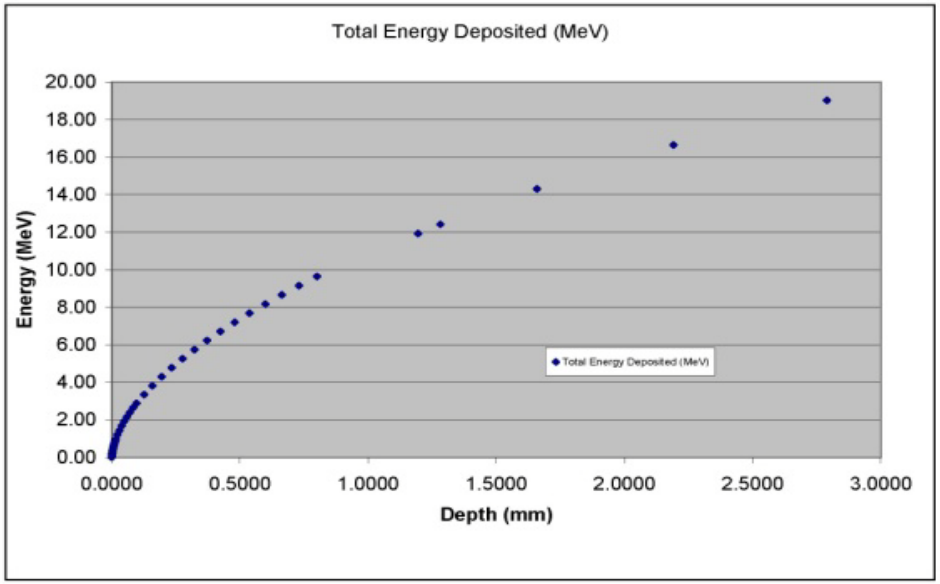
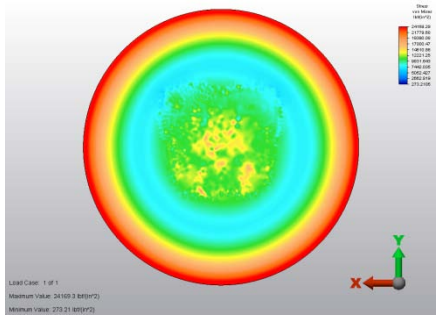
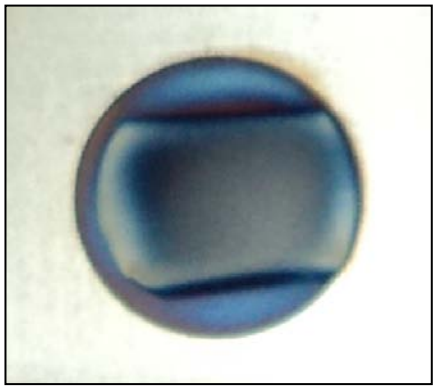
New Target Design

Thin target -> protons stop in cooling water
Last ~2 MeV of protons don't generate neutrons
-> 5% loss in flux

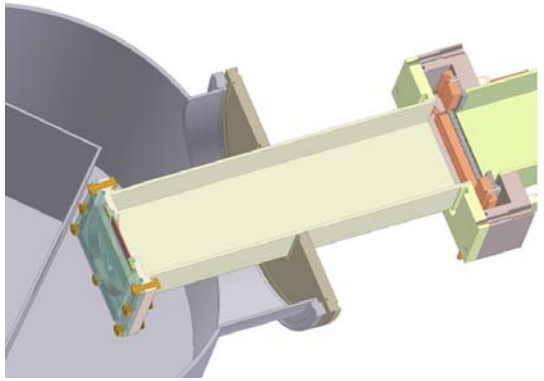




Stress Calculations



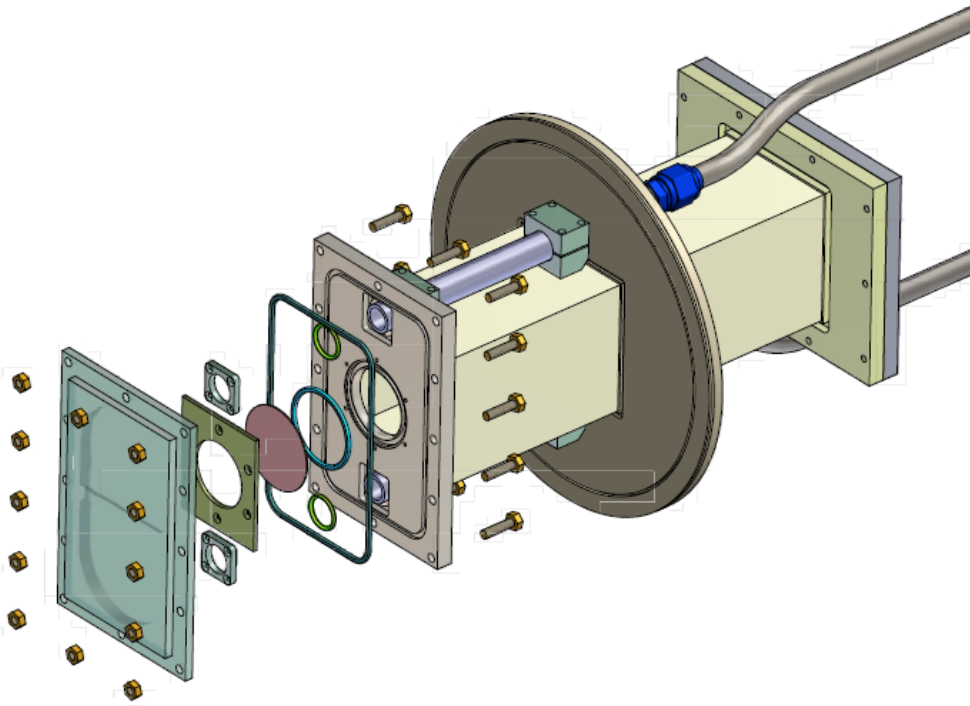
Smaller Beam Size



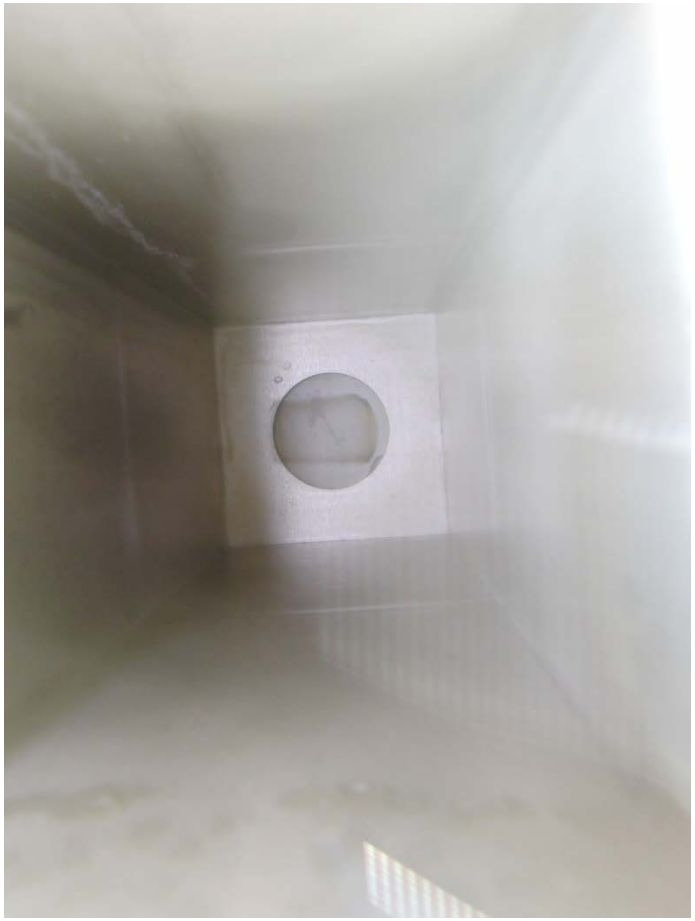
Target farther from moderator

New Target Parameters

- 63.5 mm diameter x 1.2 mm thick flat plate Beryllium
- 0 degree angle to the proton beam
- O-ring seal vacuum side of Beryllium
- 6 small screws (SS) holding cover plate to compress seal.
- Cooling across the back
- Simpler assembly



New Target Failure
-> Junk Buildup ~200 beam hours

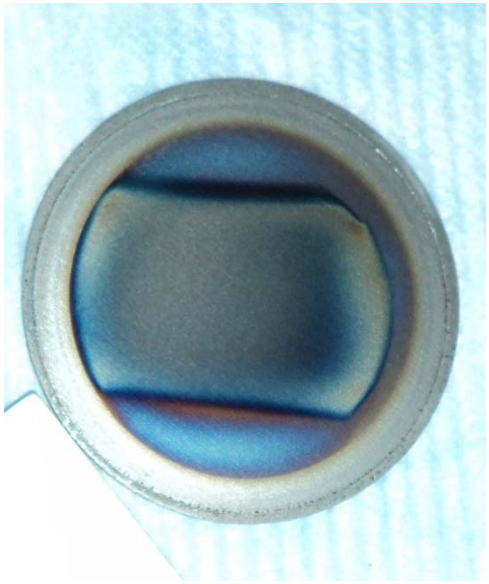


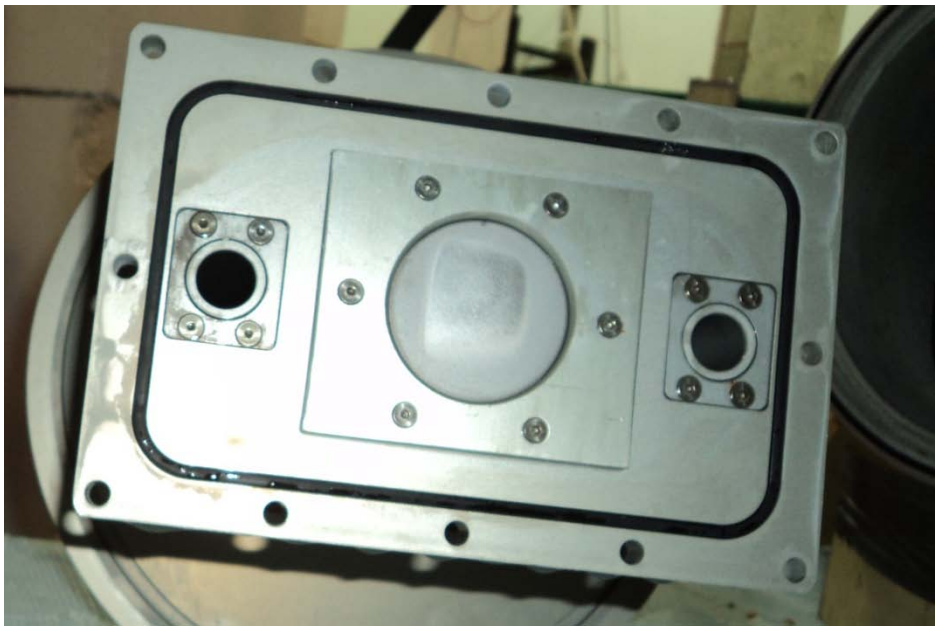
Latest Target Water System

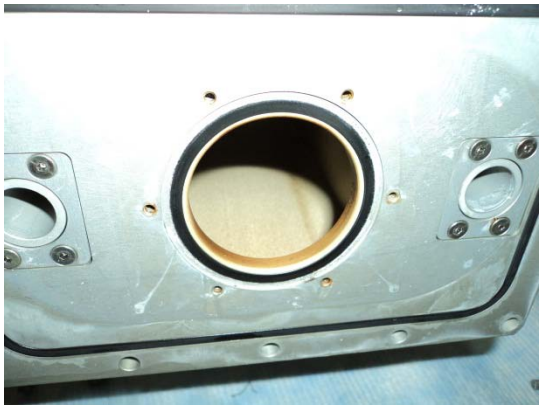
- De-Ionizing filter
- Charcoal Filter
- 5 micron paper filter
- 5 Gallons per minute
- 5 PSIG at target
- Monitor:
  - Resistivity (> 1 Mohm-cm)
  - TDS < 0.5 milligrams/liter

New Target Latest Failure – O-Rings

After 600 Beam Hours @ 3 kW
8 months real time







Summary

- Current Target design has now outlasted all others by a factor of 2 in beam hours.
  - Target thickness (1.2 mm) chosen so Protons stop in the cooling water not in the target.
  - Target area is now 50 mm diameter for pressure differential.
  - Beam is focused and collimated to this size.
  - Water system now includes De-Ionizing filters.
  - Water system is monitored for resistivity and Total Dissolved Solids to replacing filters.