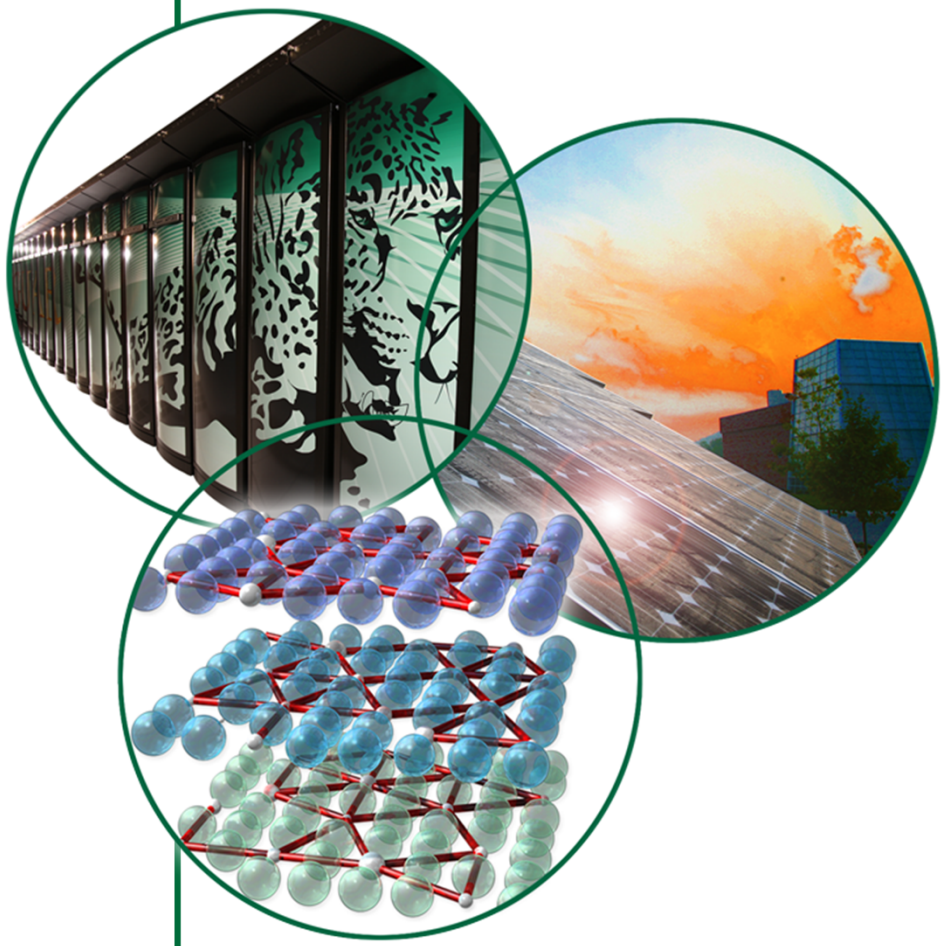
Neutrino Factory Target Vessel Concepts Updated 4/16/12

V. Graves

Target Studies EVO

April 11, 2012



U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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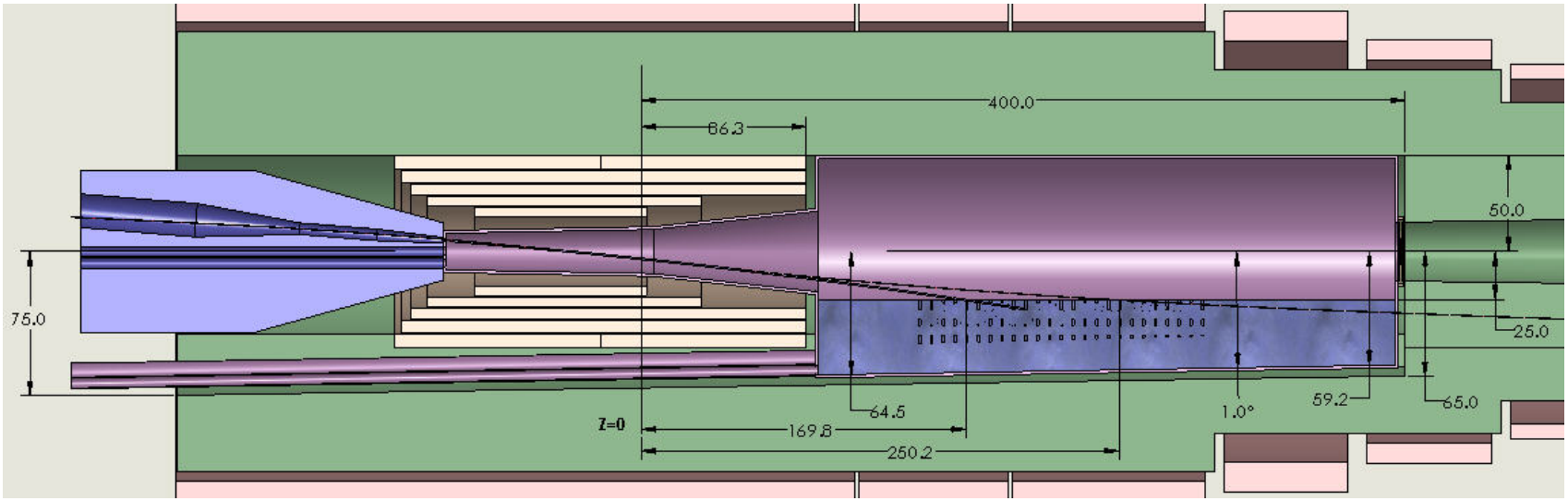
Target Vessel Requirements

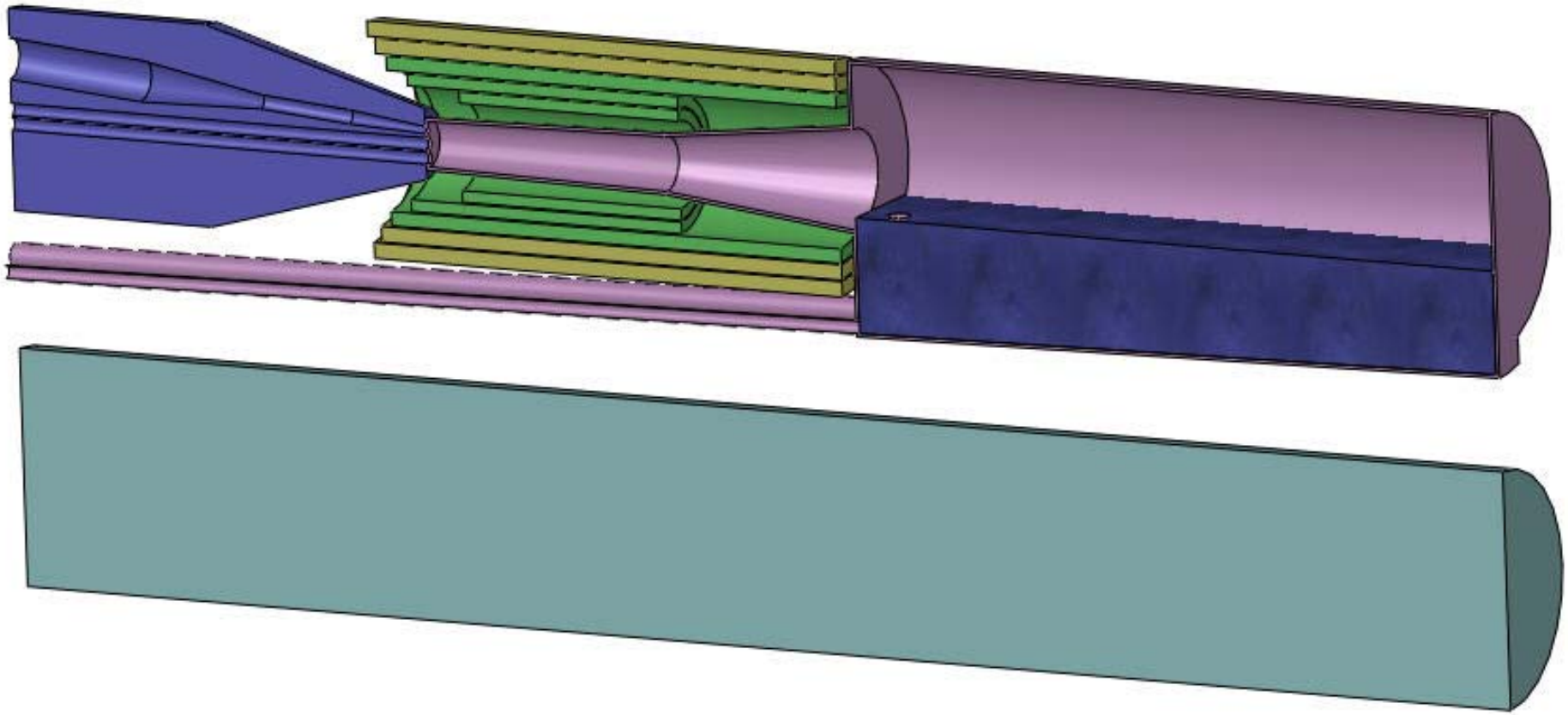
- Accurate jet placement
- Jet/beam dump pool
- Double containment of mercury
- Beam entrance port(s)
- Chamber ventilation
- Provisions for cooling
- Provisions for draining
- Additional SC coil shielding

Starting Point: Integrated with Resistive Magnets

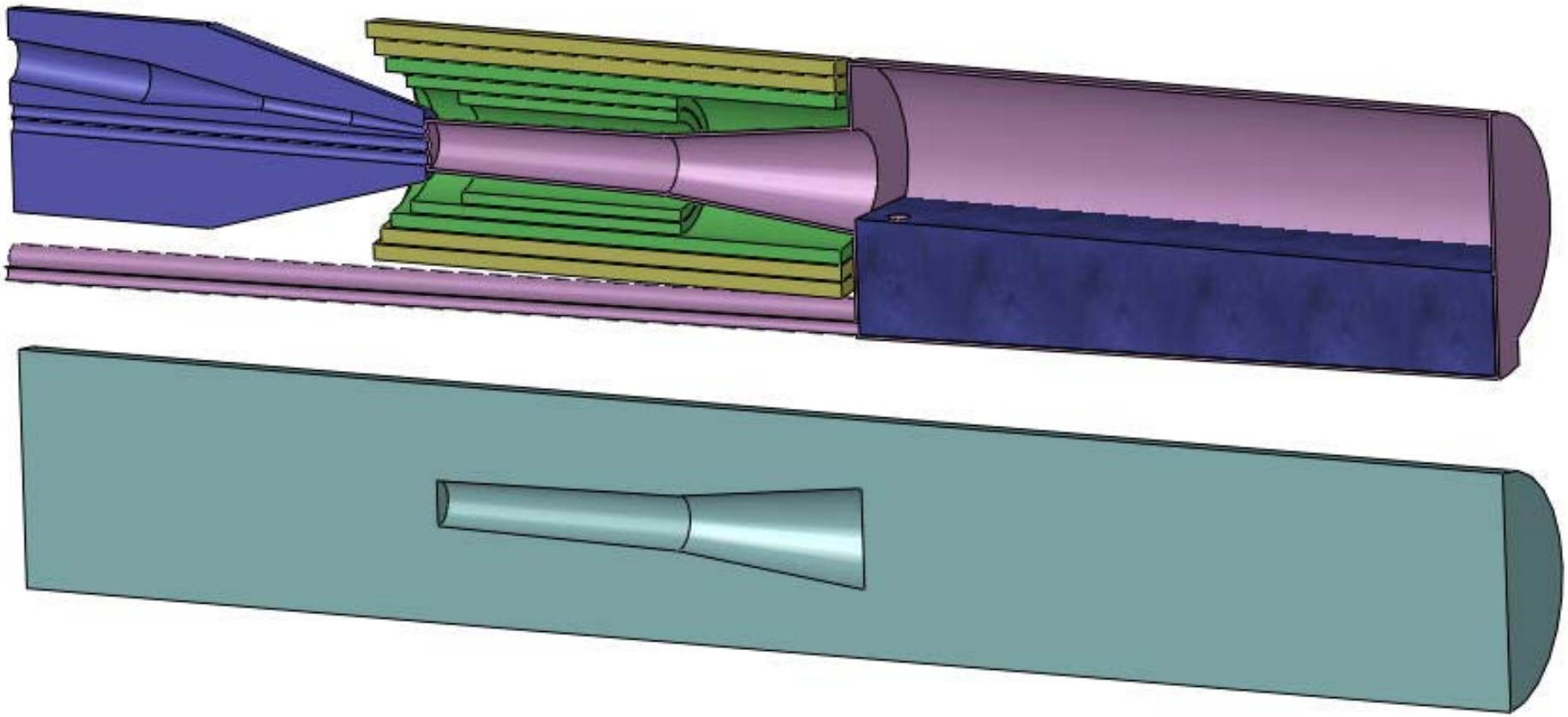


- Goal: develop concept with no resistive magnets
- Method: start with solid cylinder of SS and remove material as required

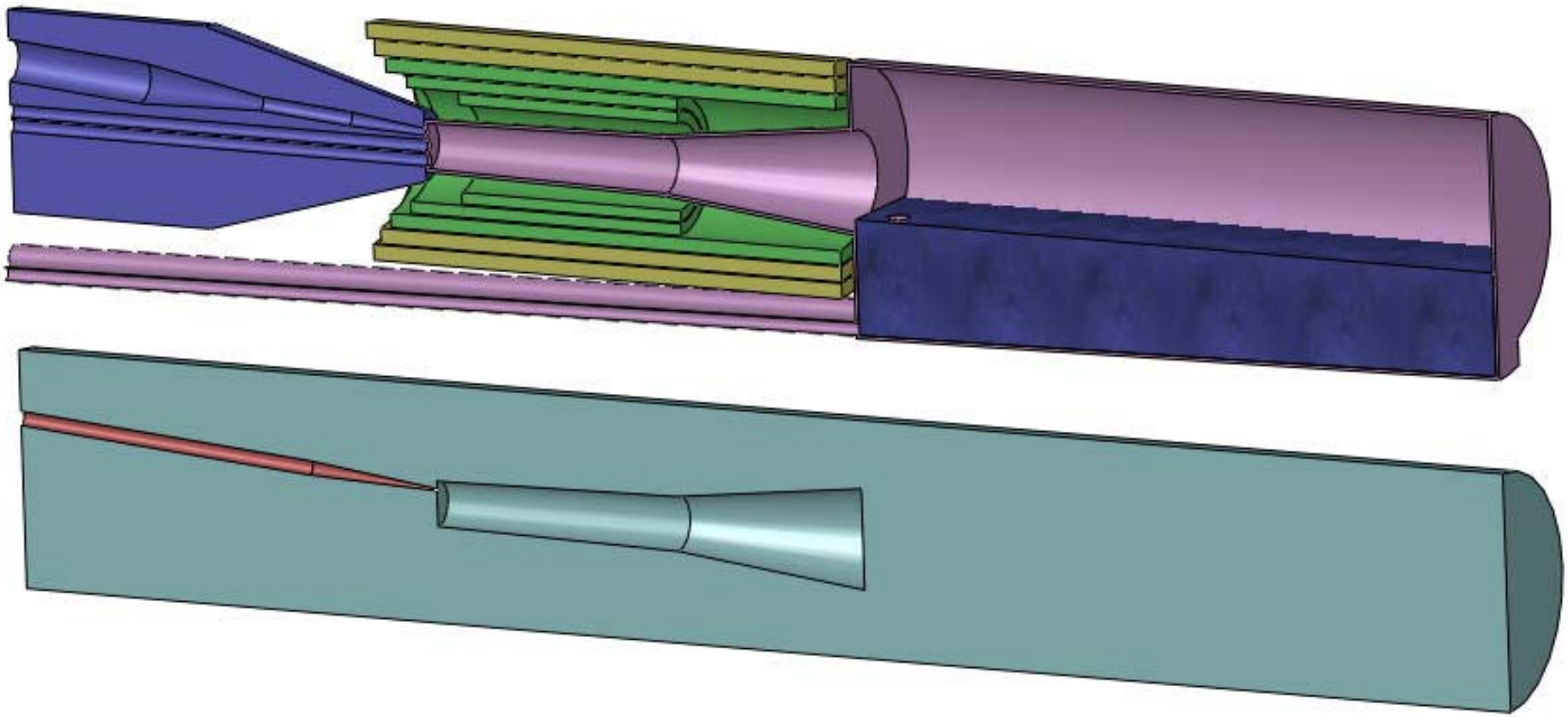
Cylinder



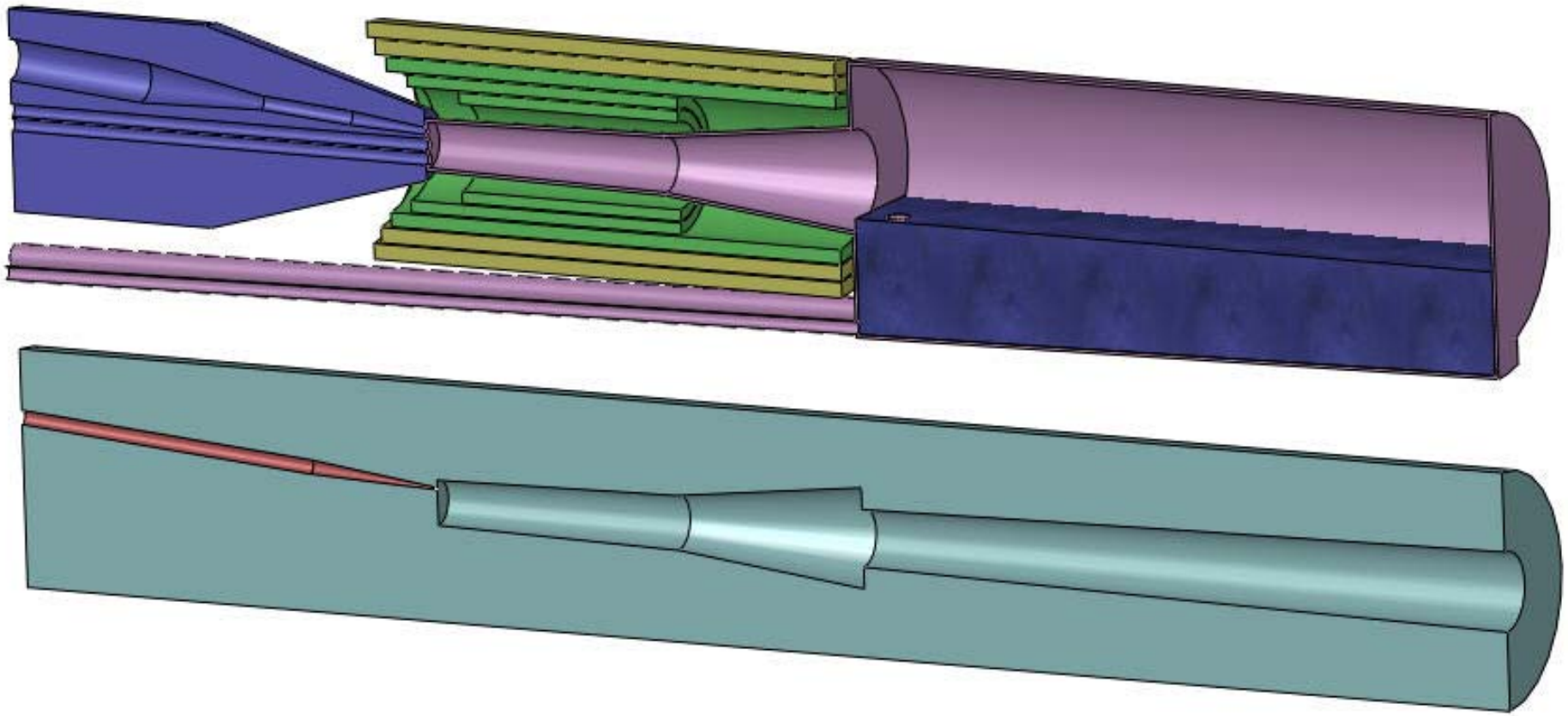
Jet/Beam Chamber



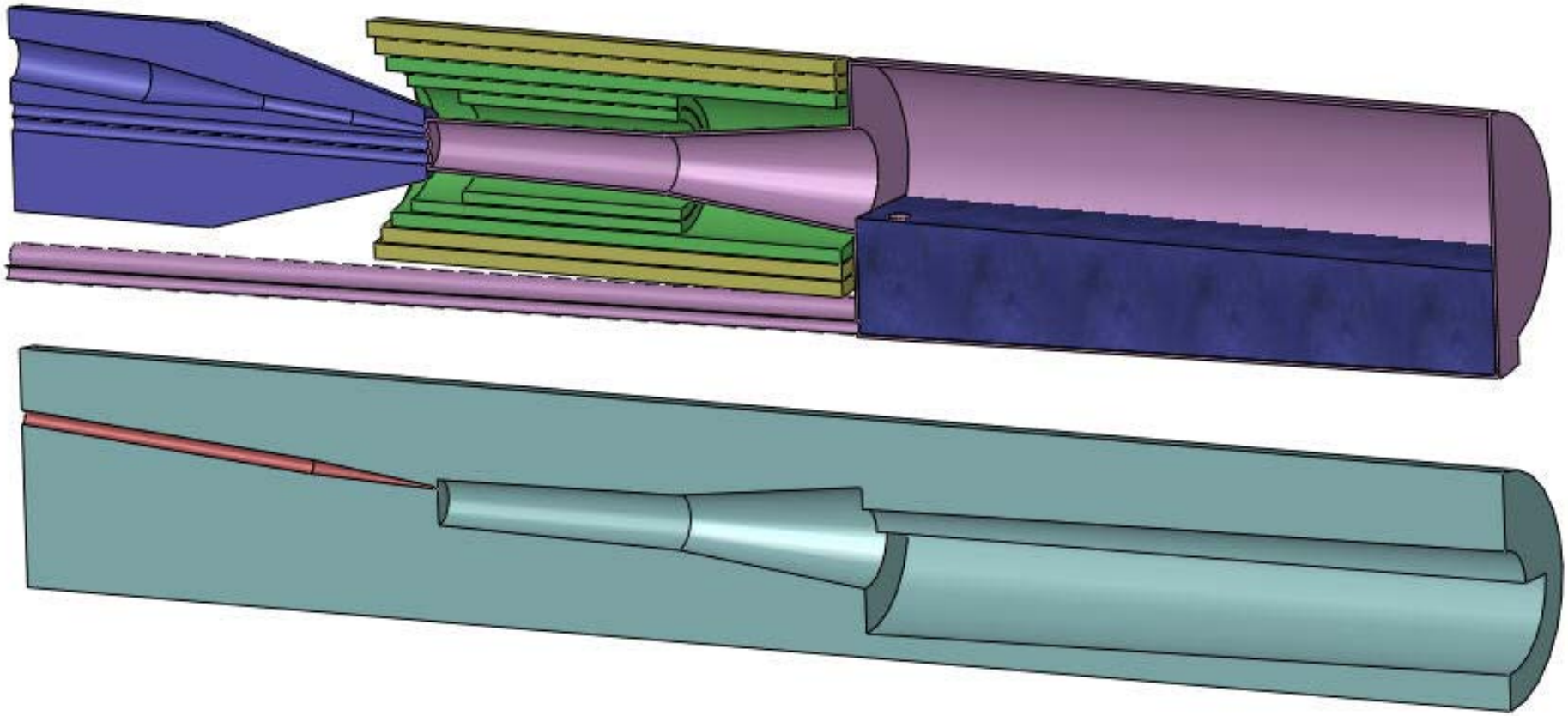
Nozzle



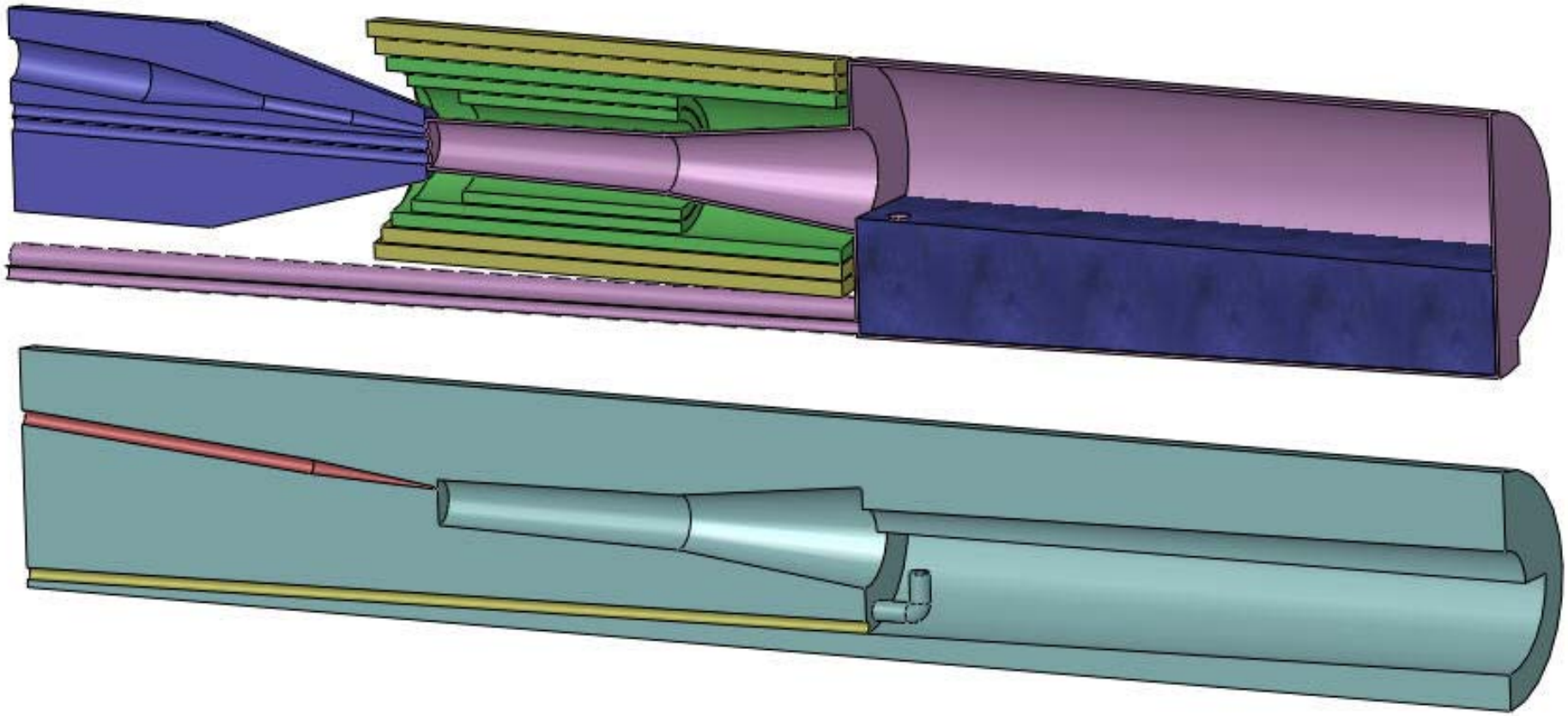
Beam Pipe



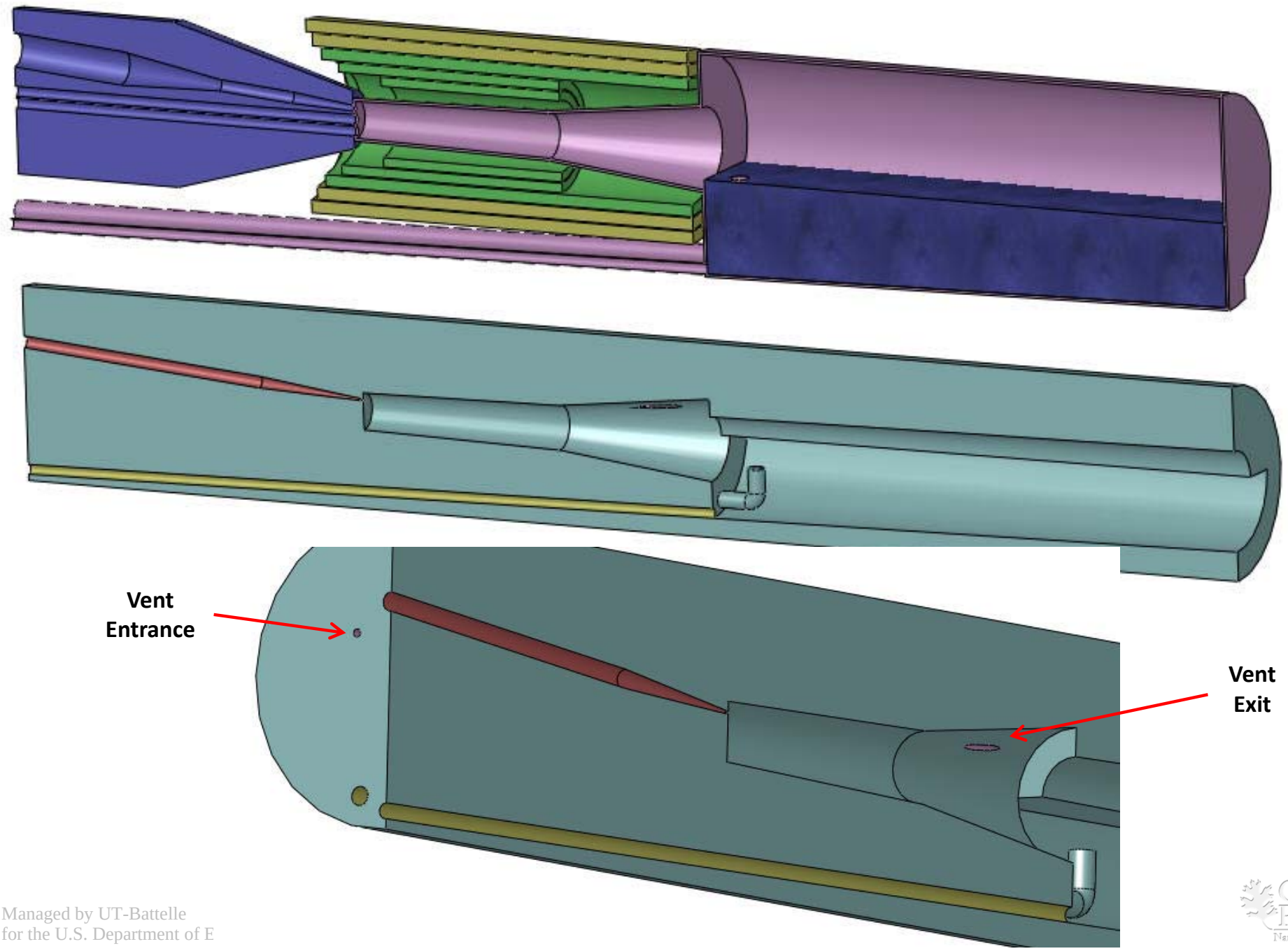
Mercury Pool Trough



Drains



Vents



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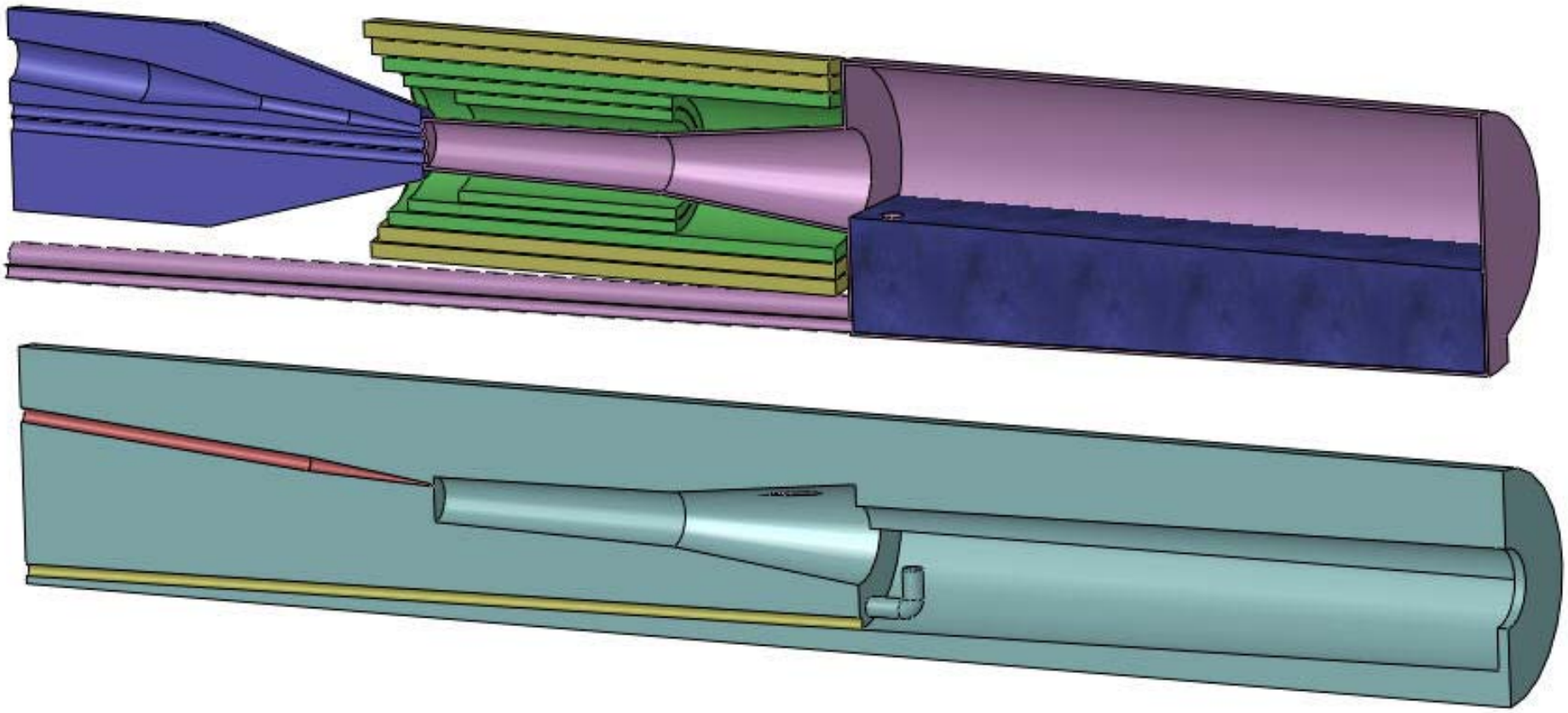
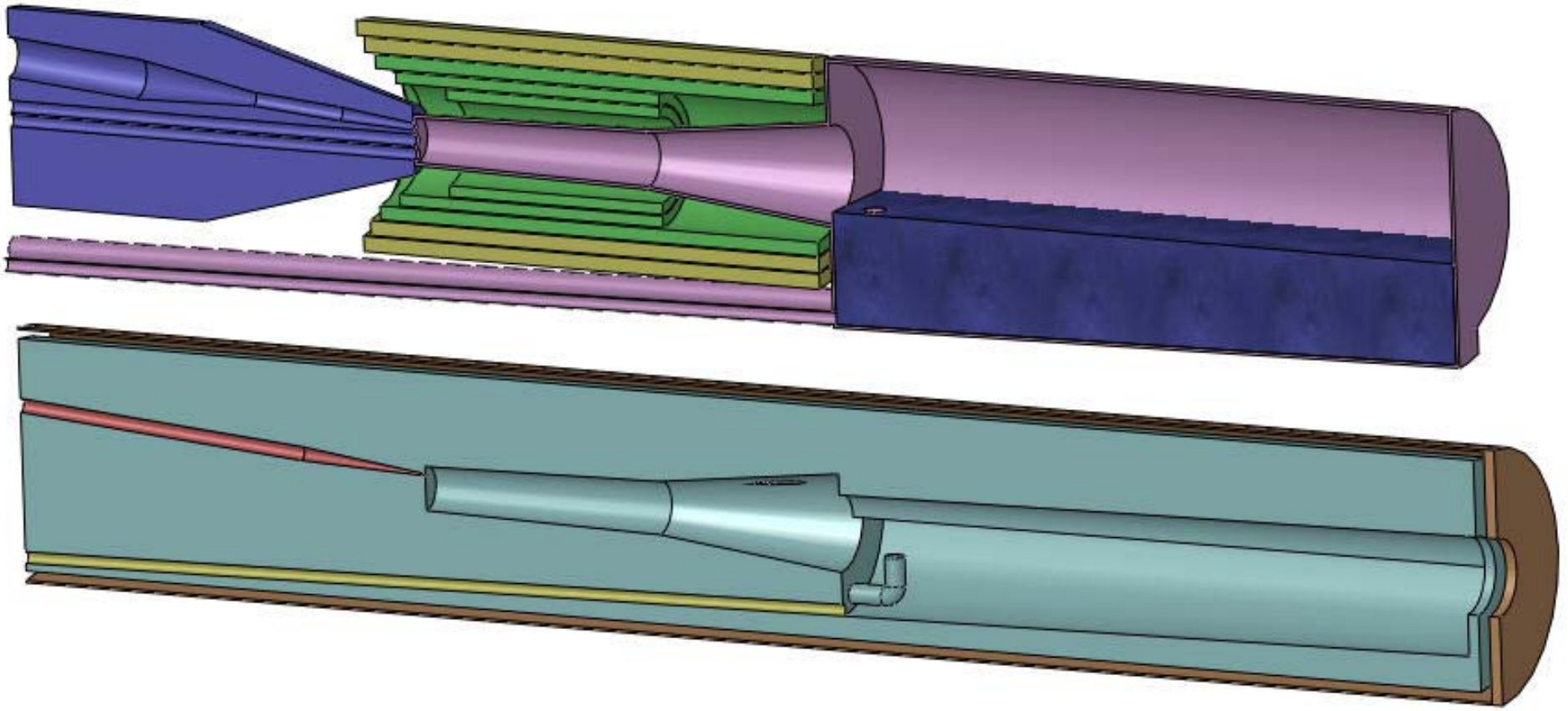
Downstream End Cap

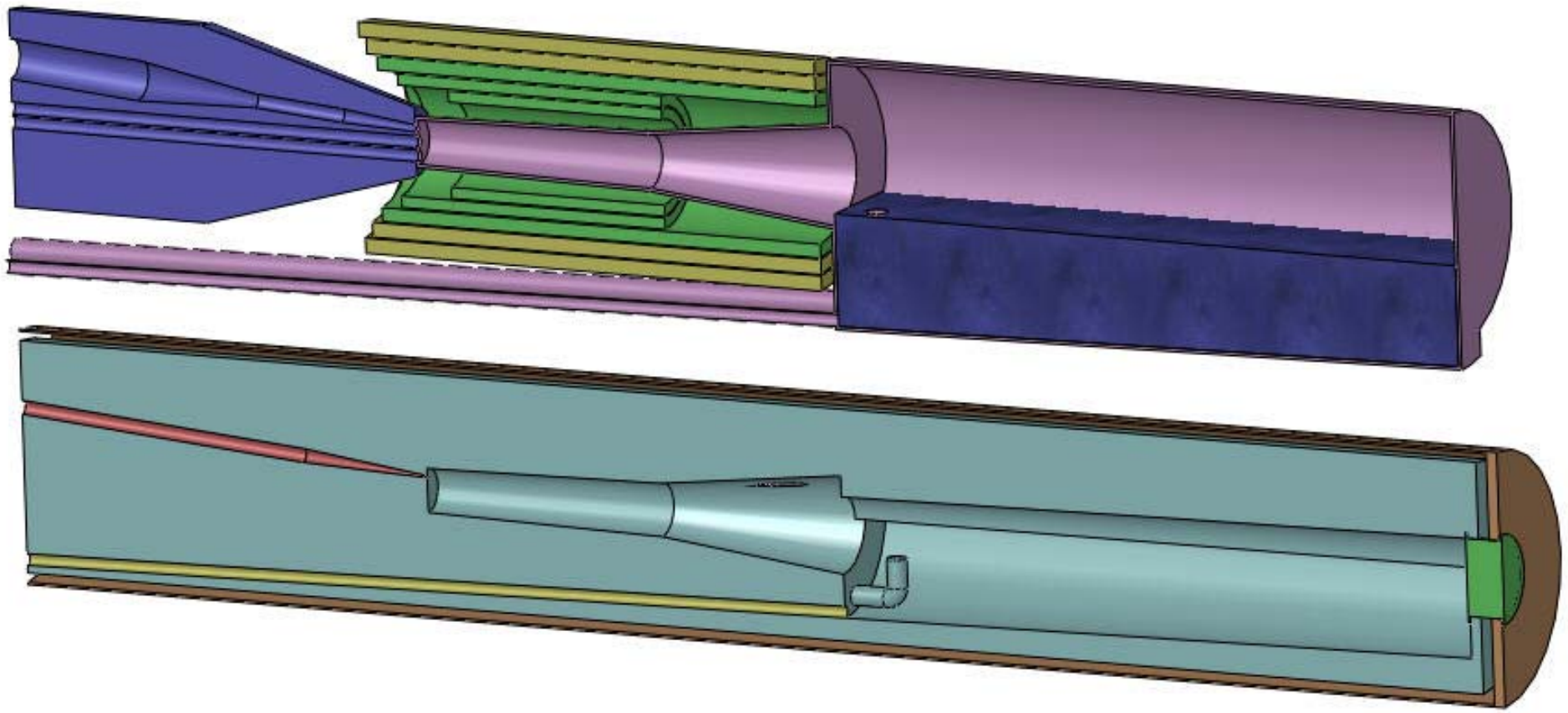


Double Wall

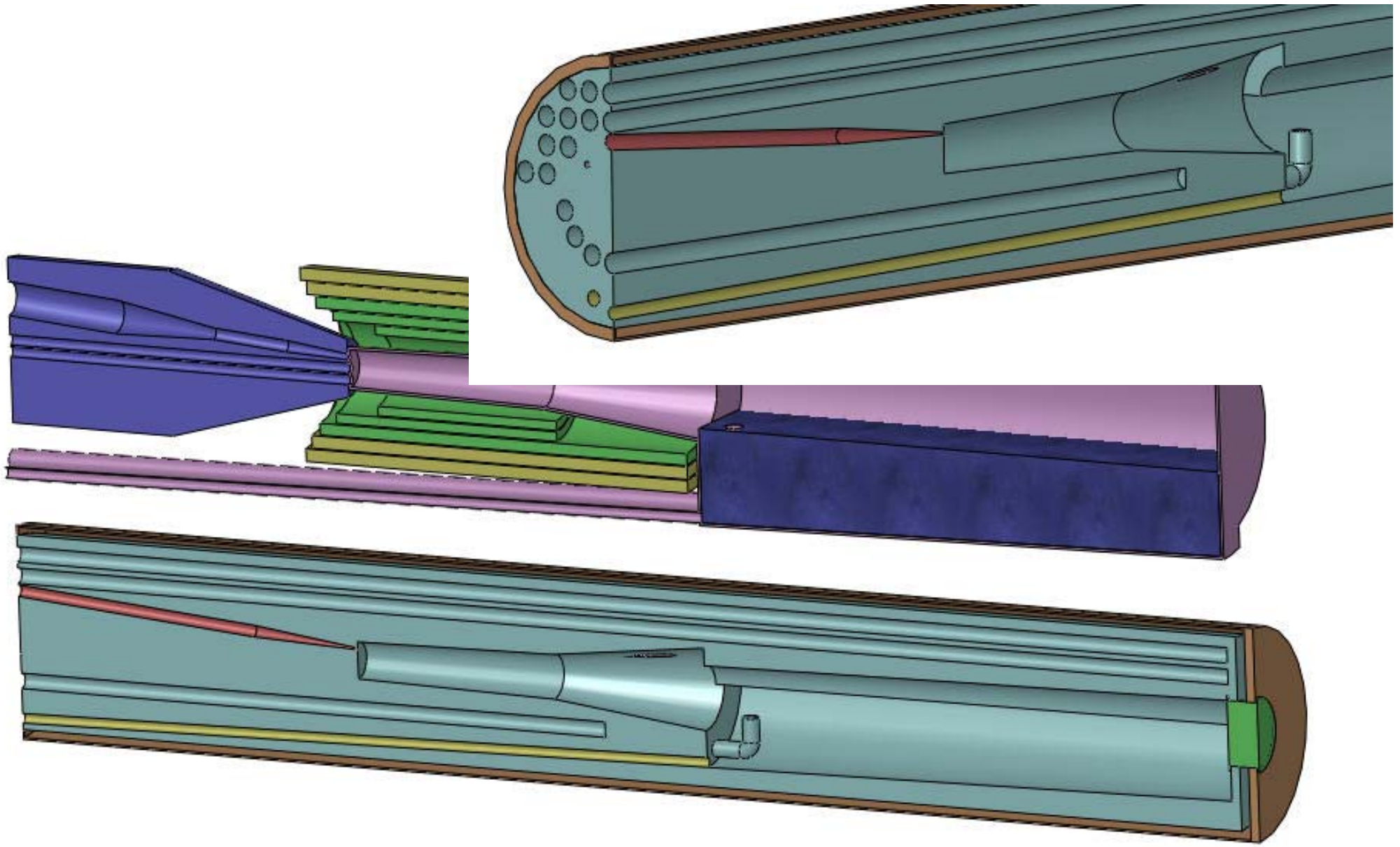


Beam Window

- Could add flow channels to interstitial space for water or helium cooling
- Beam window becomes integral part of assembly
- Be/SS interface TBD



Cooling Channels

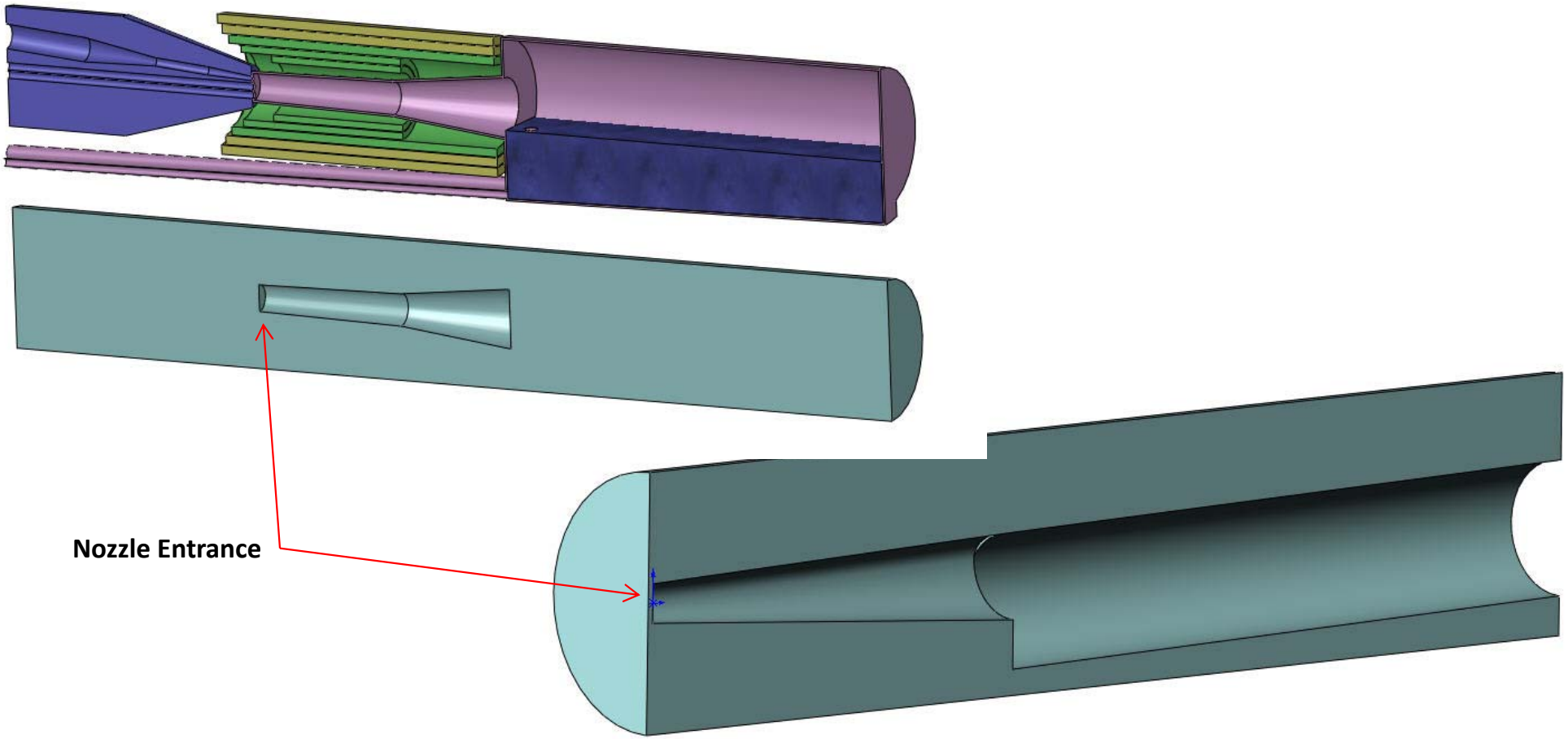


Comments

- These images were created to aid in discussion. No specific fabrication details were included.
- A machined billet will be more precise, rigid, and more accurately place the nozzle than a welded shell filled with tungsten beads.
- This concept still has numerous issues to be worked out. For instance, all fluid passages must be self-draining.
- Space on the upstream end is still a major concern. The small beam/jet angles cause significant mechanical issues.

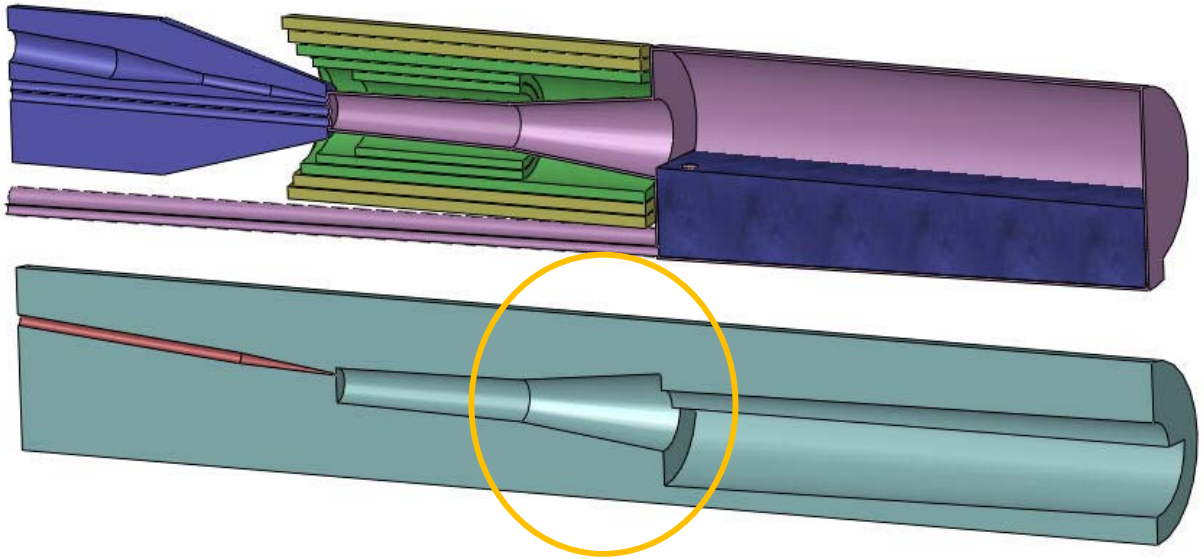
Tungsten Shielded Version

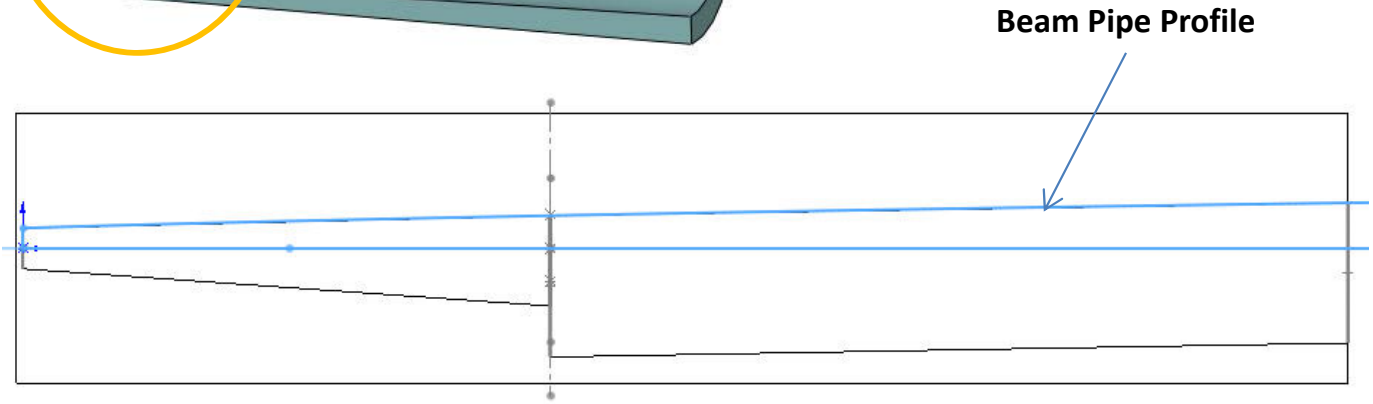
- Develop concept for welded vessel filled with tungsten beads
- Start shielded portion at Z=nozzle, replace bored holes with pipes
- Initial geometry similar to earlier concept, but shorter. Assumed Stainless Steel.



Reconsider Interior Profile

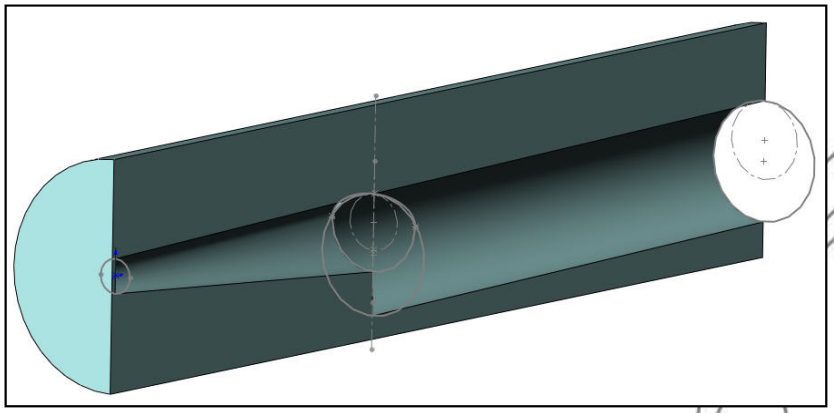
- Clean up jagged edges, abrupt transition
- Match beam pipe but allow for wider pool

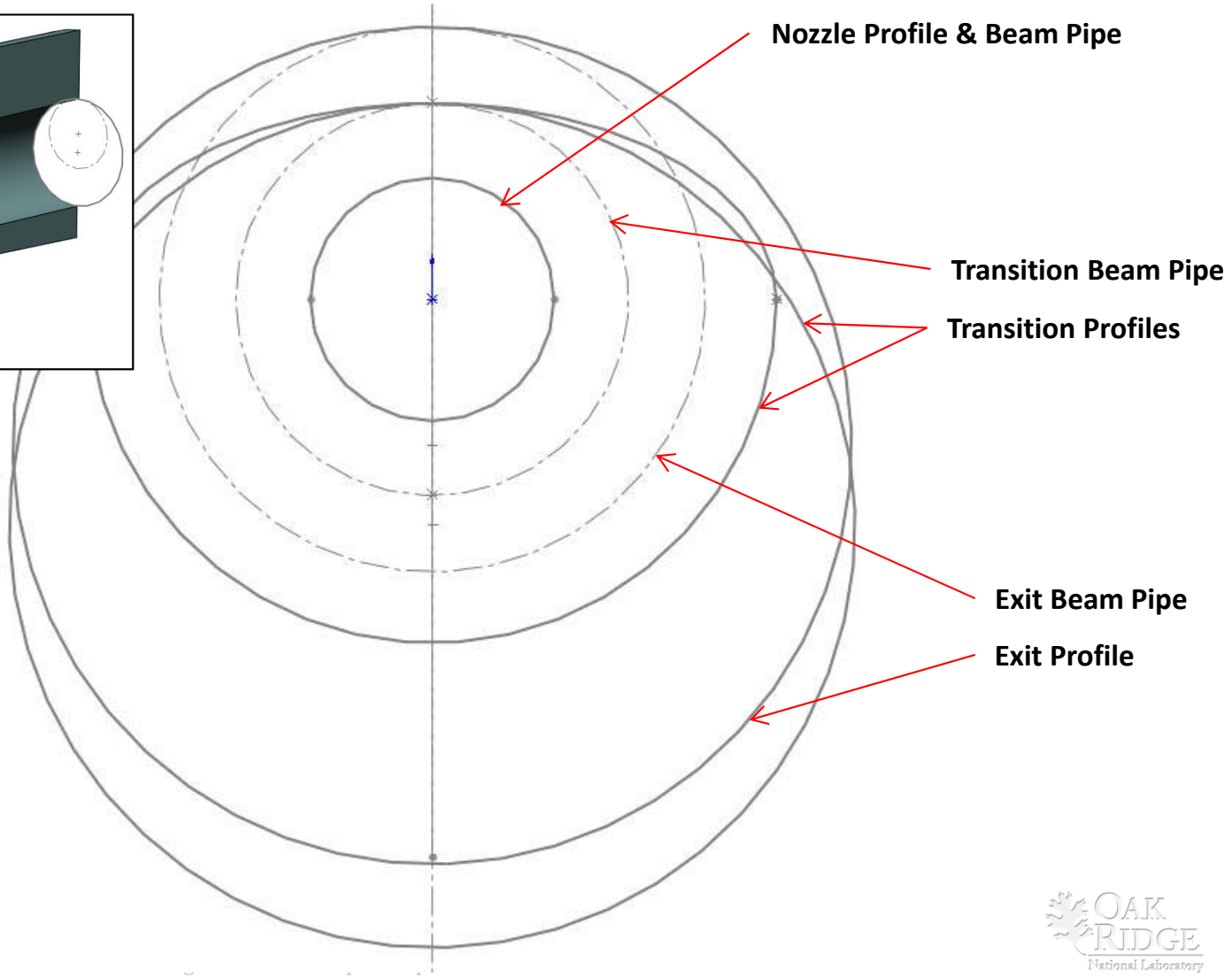




Mercury Vessel Profiles

- Vessel profile matches beam pipe only at the top. Shielding ability not symmetric around magnetic axis.
- Vessel profile expands in width & depth for pool. Shapes can be varied slightly.





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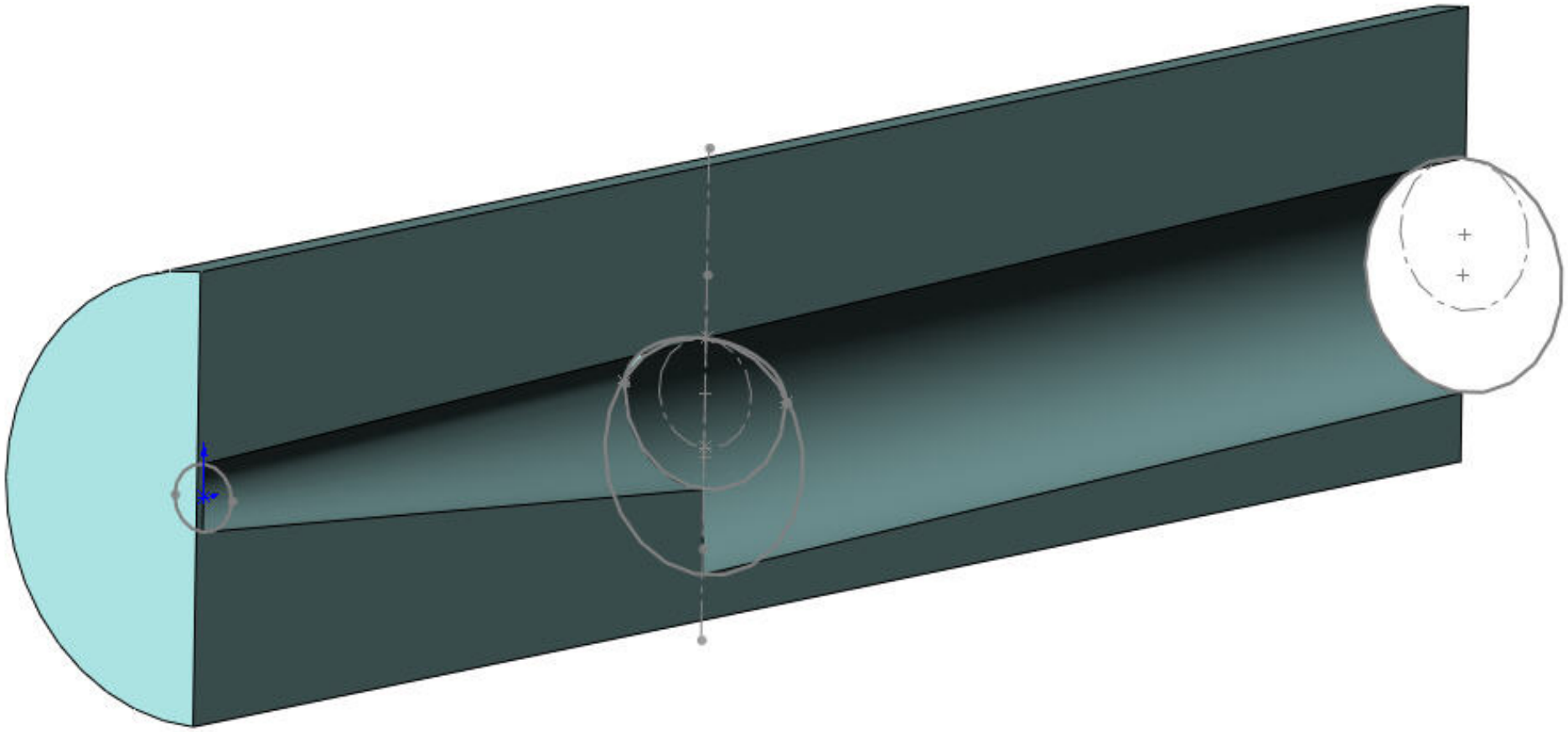
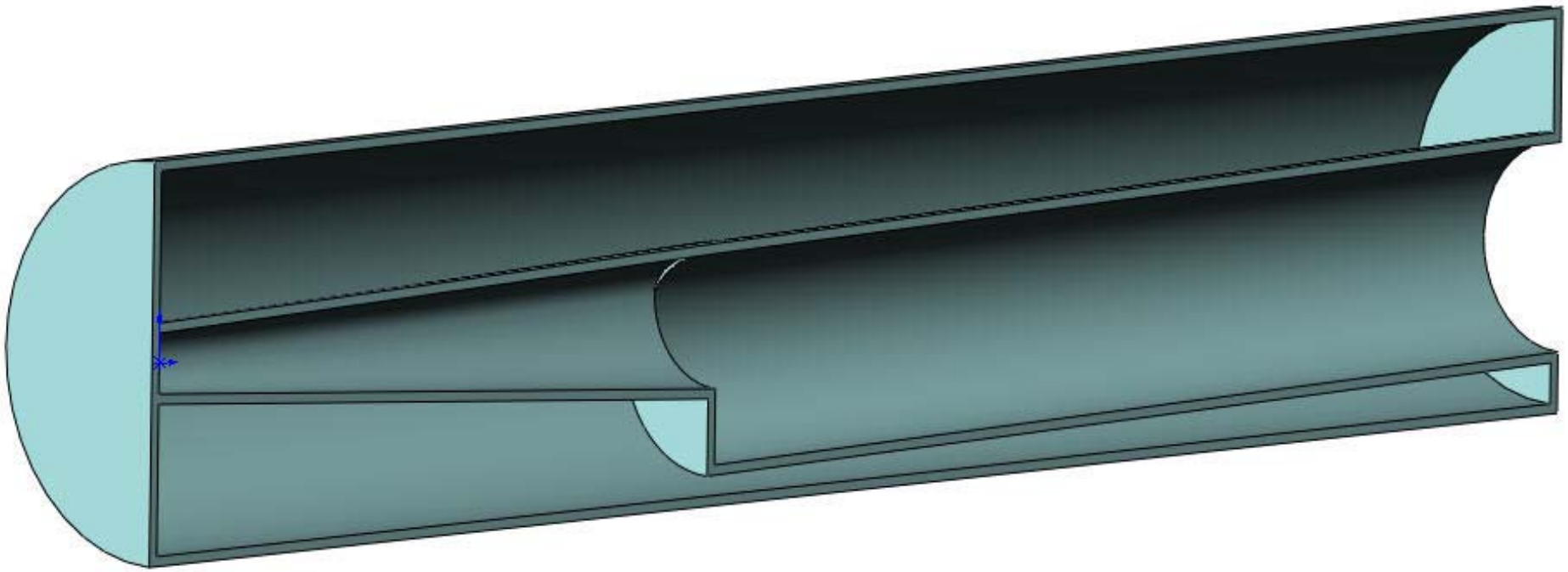
Enlarged Profiles

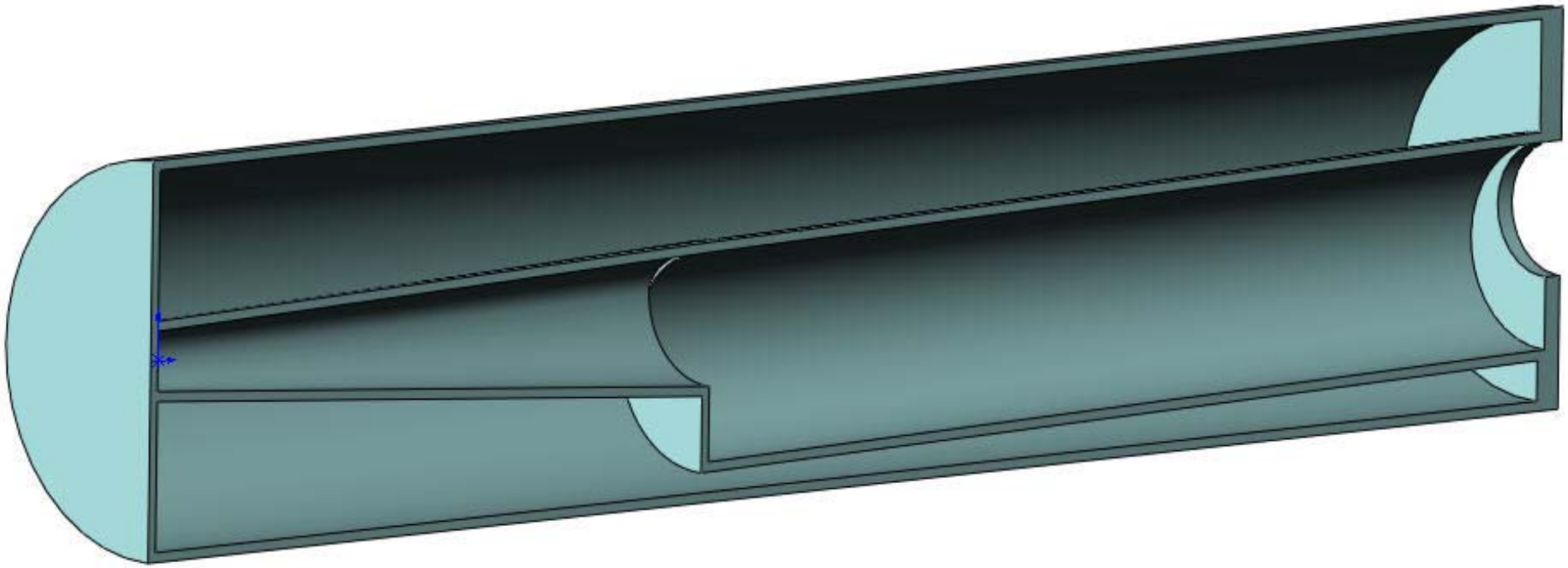


Shell Geometry

- Start of deviation from earlier, solid concept
- Create region for tungsten shielding

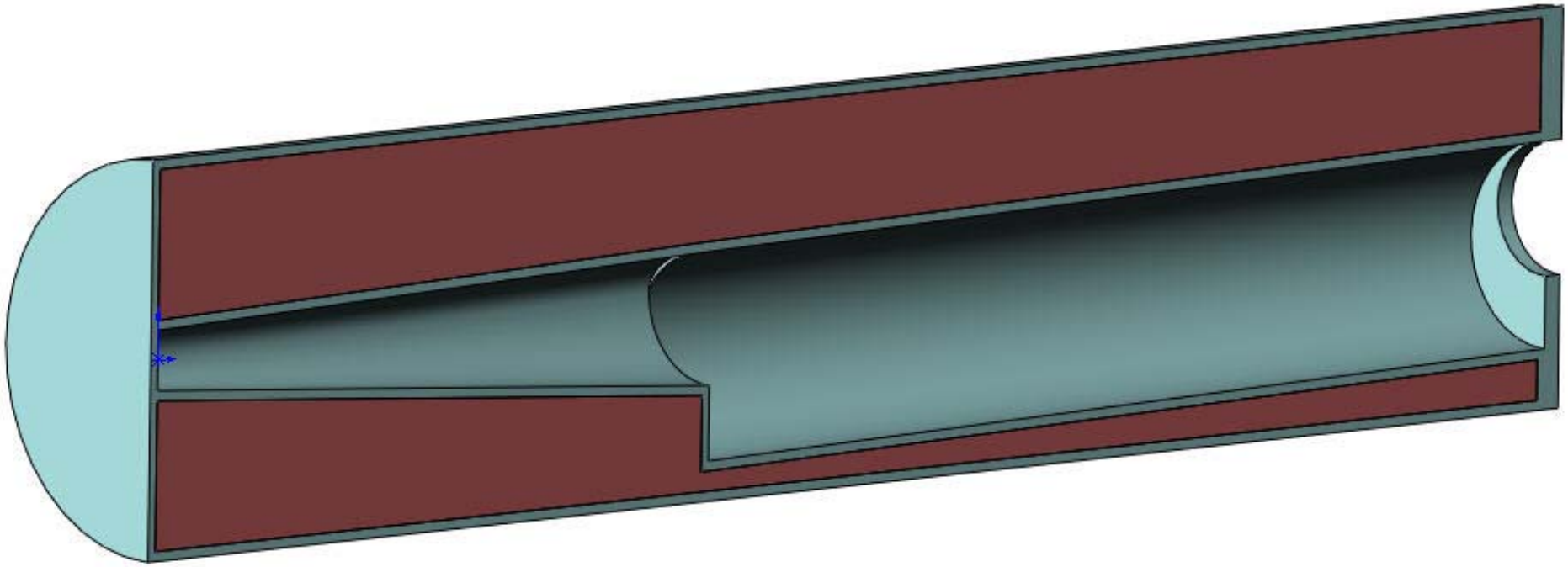


Add End Cap for Beam Window



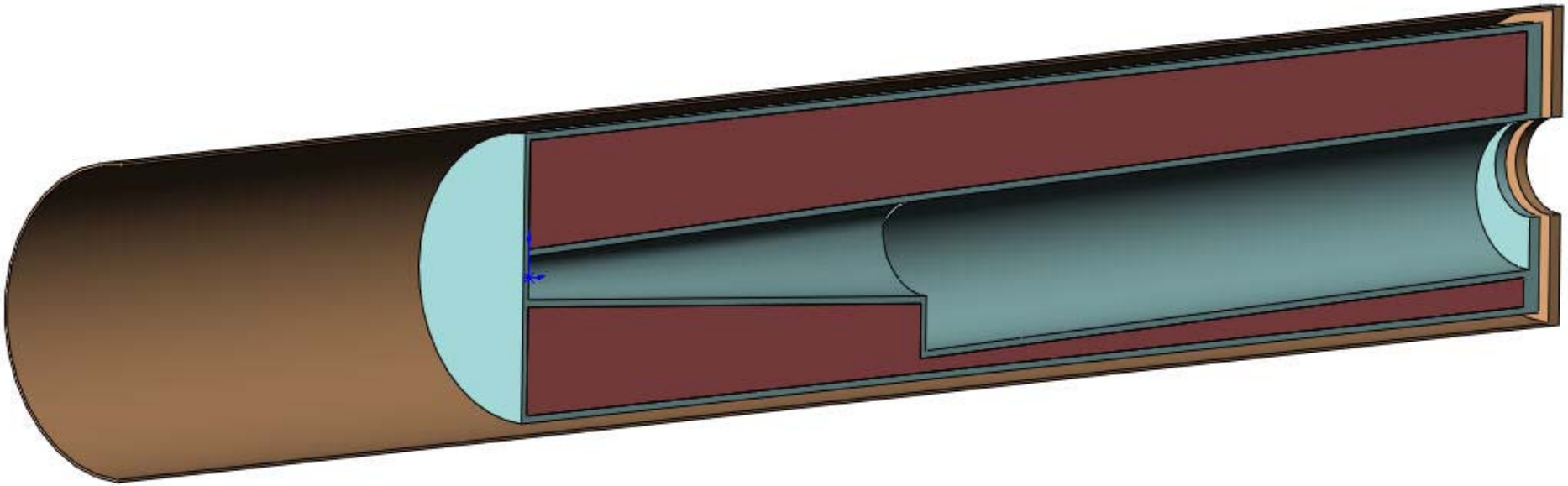
Add Tungsten

- Helium- or water-cooled beads
  - Would include multiple sectors for inlets/outlets
  - Water cooling requires slopes for drainage
- Tungsten not axi-symmetric
- Structural supports required



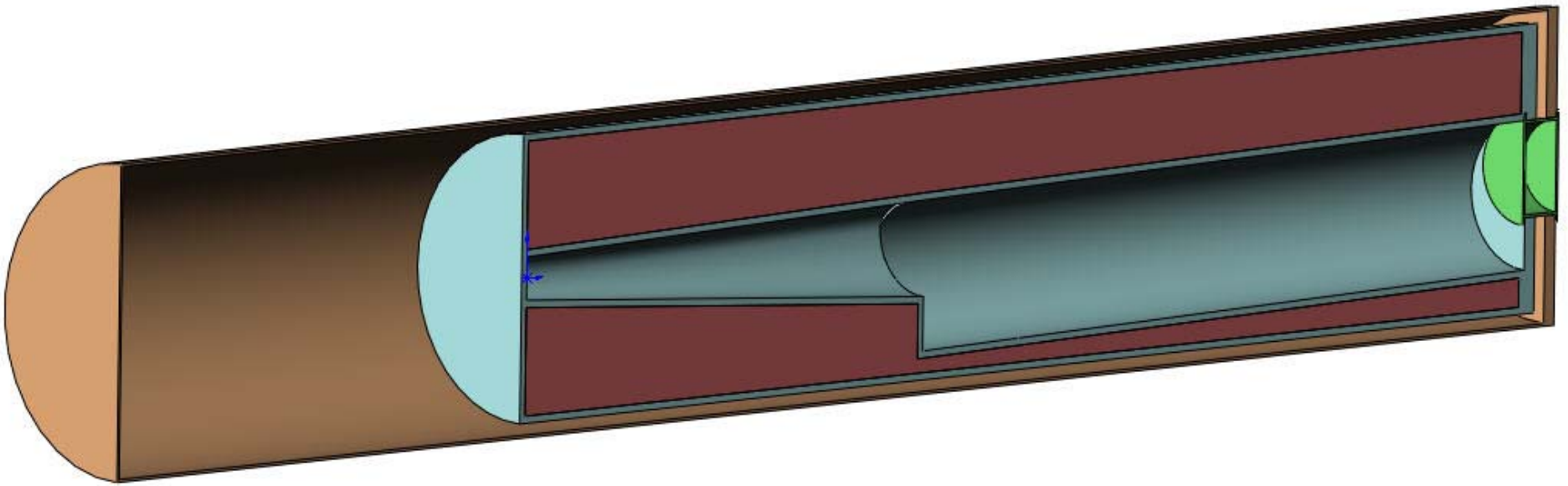
Double Containment Shell

- Interior module requires rigid confinement within exterior shell



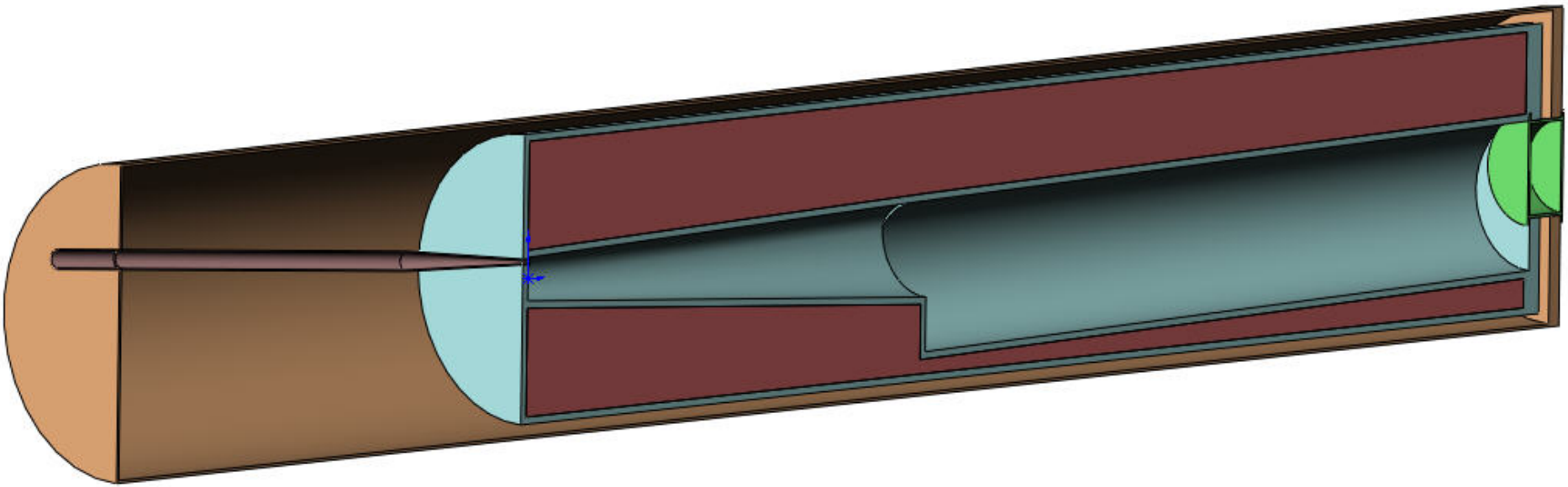
Add End Cap and Beam Window

- Hollow beam window for double-wall mercury confinement
  - Be/SS interface
- Could fill interstitial with water or helium for additional cooling (beam window requires cooling)



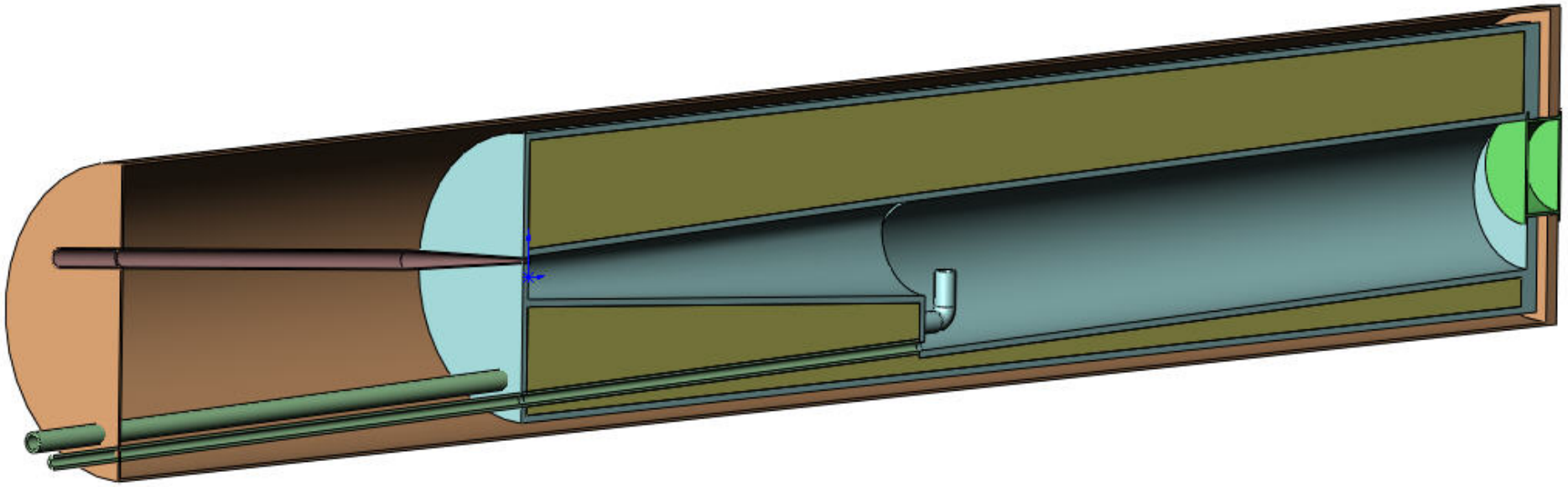
Nozzle Piping

- Extends between vessels
  - Double pipe required outside secondary vessel
  - Upstream length determined by handling considerations



Drain Piping in a Similar Fashion

- Other pipes needed for beam(s), cooling, vents
- This becomes a single module for RH
- Flanged connections to external services



Comments

- Welded structure less precise than earlier, machined module
  - Could affect nozzle accuracy
  - Tungsten/mercury weight requires significant support structure
  - Target module location determined by guides/features inside SC shielding module