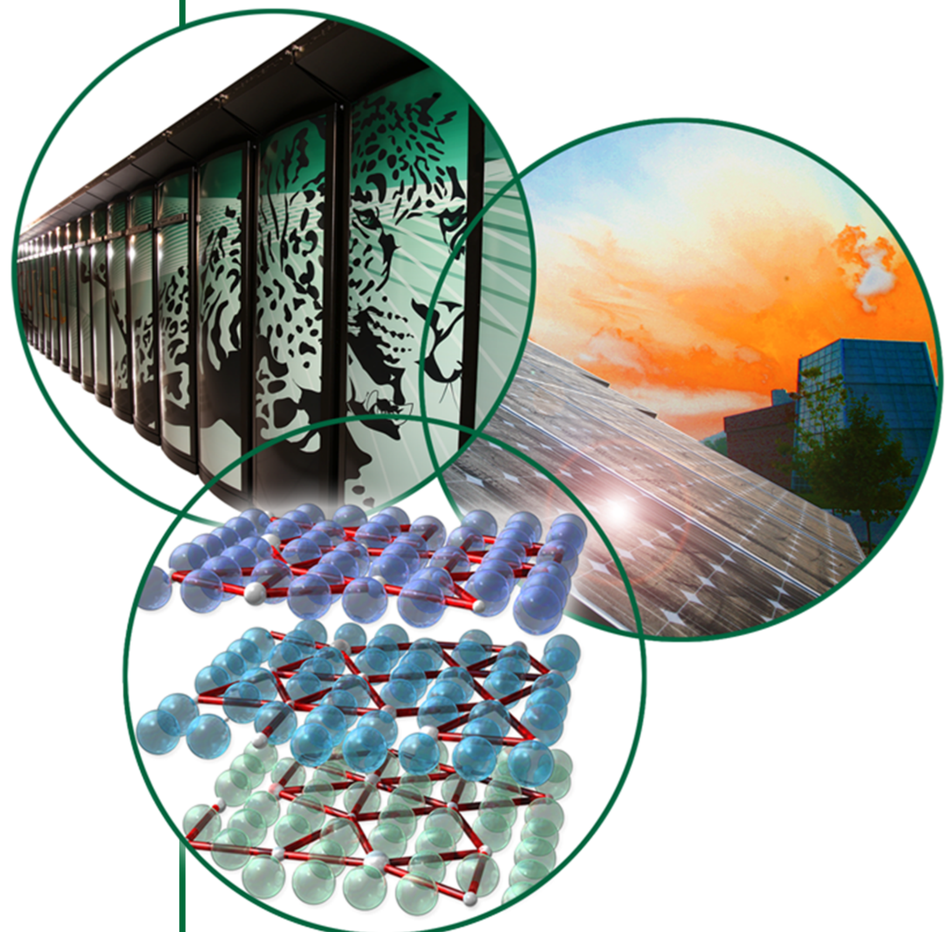
Mercury Chamber Update

V. Graves



NF-IDS Meeting

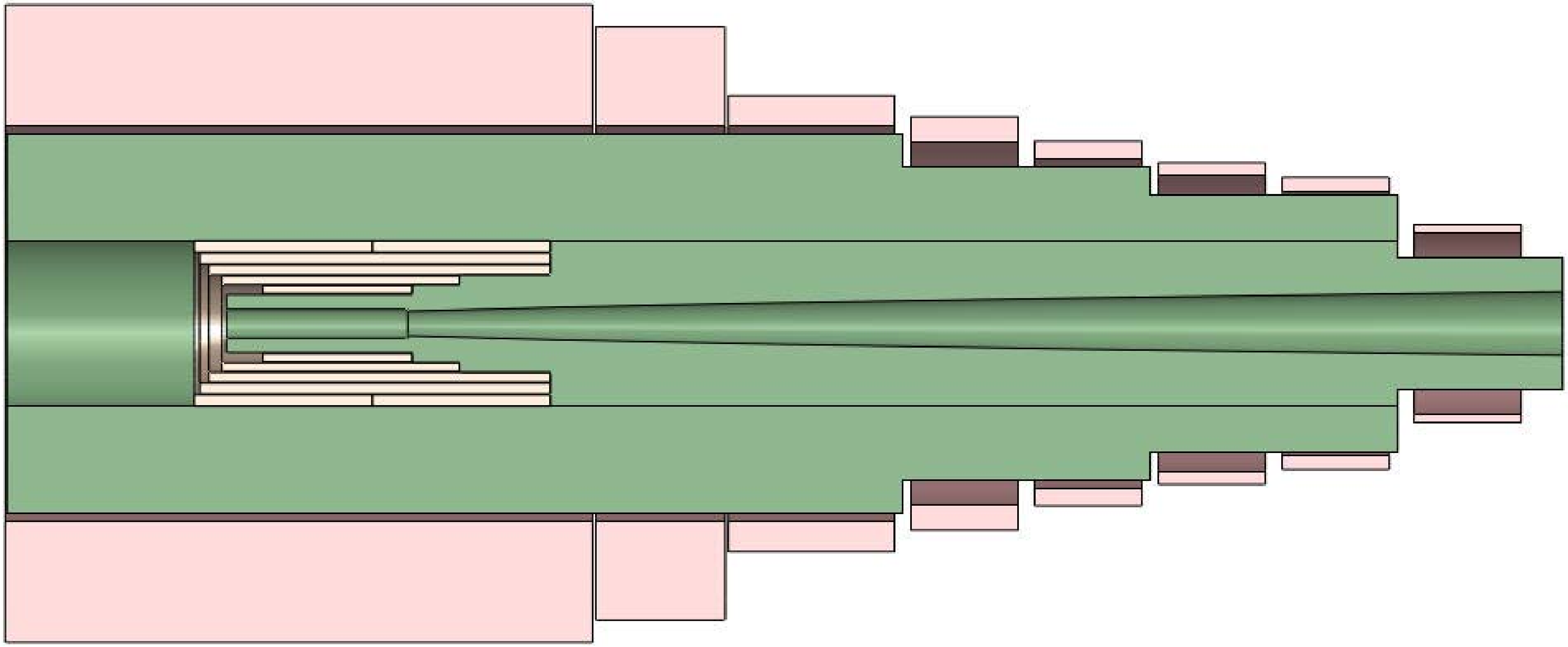
October 4, 2011

U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Starting Point: Coil and Shielding Concept IDS120H

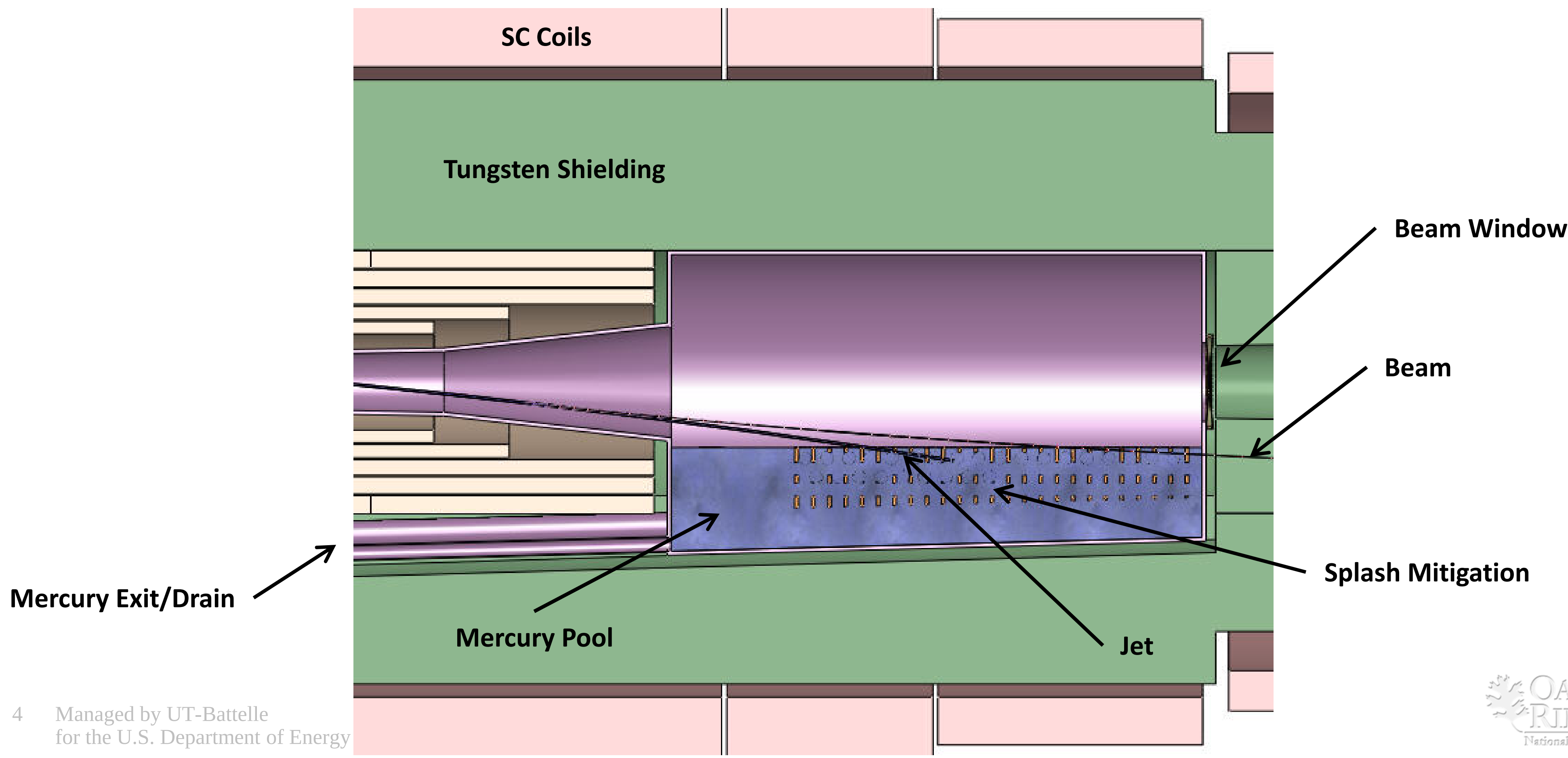


Mercury Chamber Basics

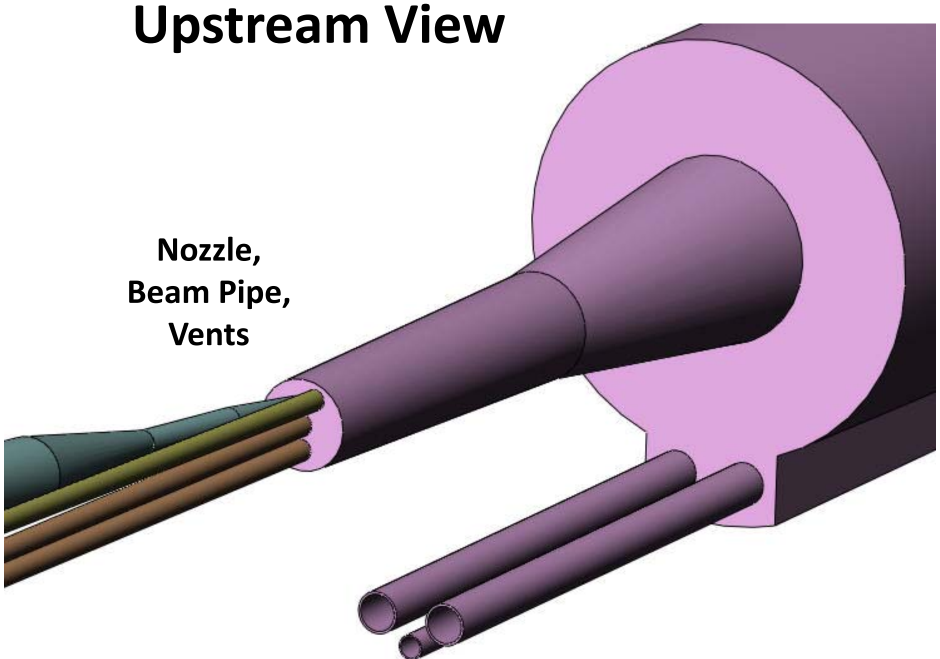
- Chamber serves as both jet and beam dumps
  - Chamber must encompass the nozzle tip
- No openings into chamber during operation
  - Mercury flows in a closed loop
  - Likely will be double-walled for mercury containment, possibly water cooled
- No embedded sensors
- Gravity drain of mercury required
  - Bulk flow exits chamber via overflow drain(s)
  - Maintenance drain for beam-off operations
- Penetrations (ports) into chamber
  - Nozzle
  - Hg drains (overflow and maintenance)
  - Vents (in and out)
  - Beam windows (upstream and downstream)
  - Shell cooling?

Initial Concepts for IDS120h Mercury Chamber

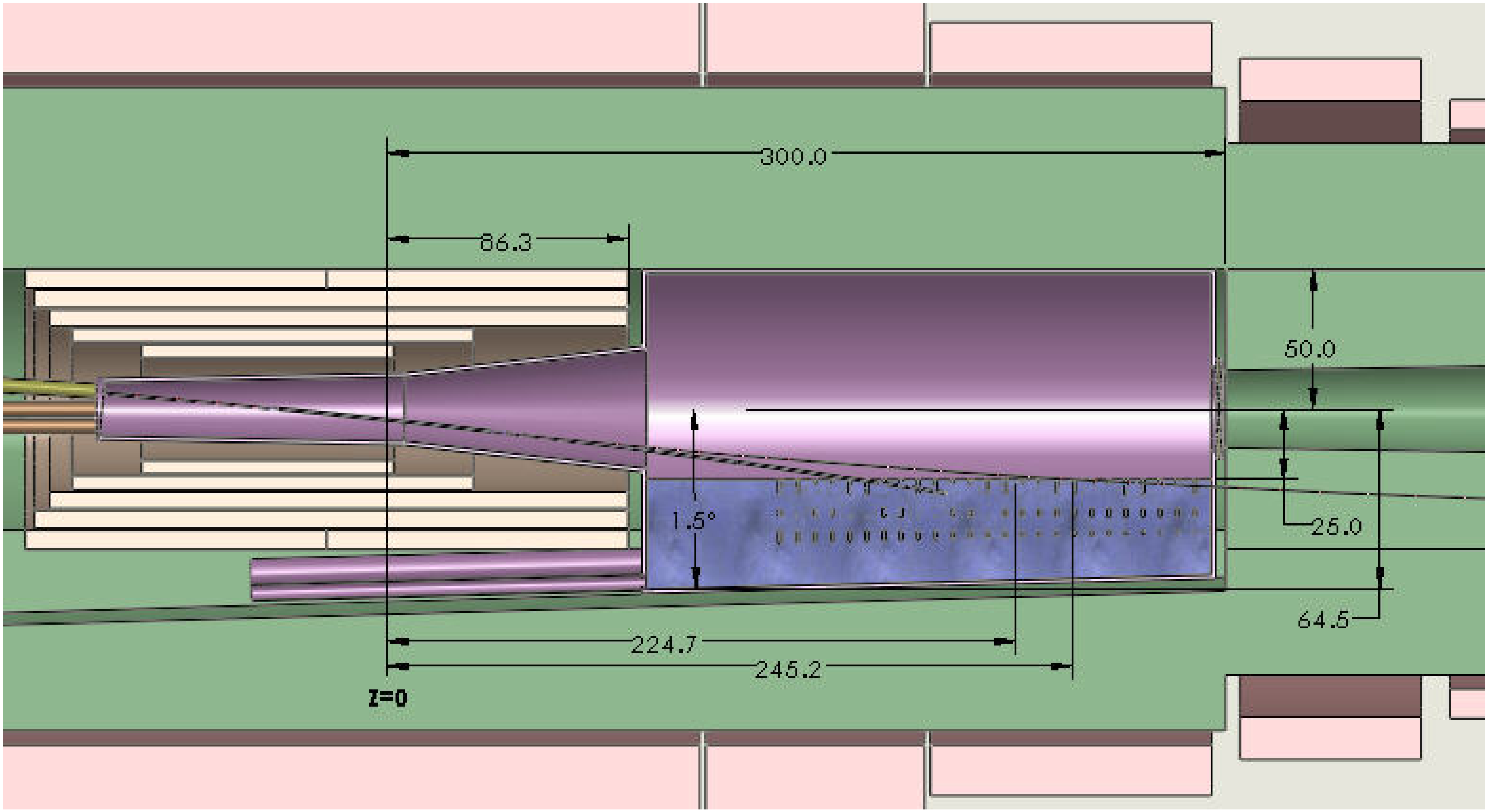
- Axisymmetric chamber design requires displacement of significant tungsten shielding
- Drainage system located under resistive coils



3D Isometrics

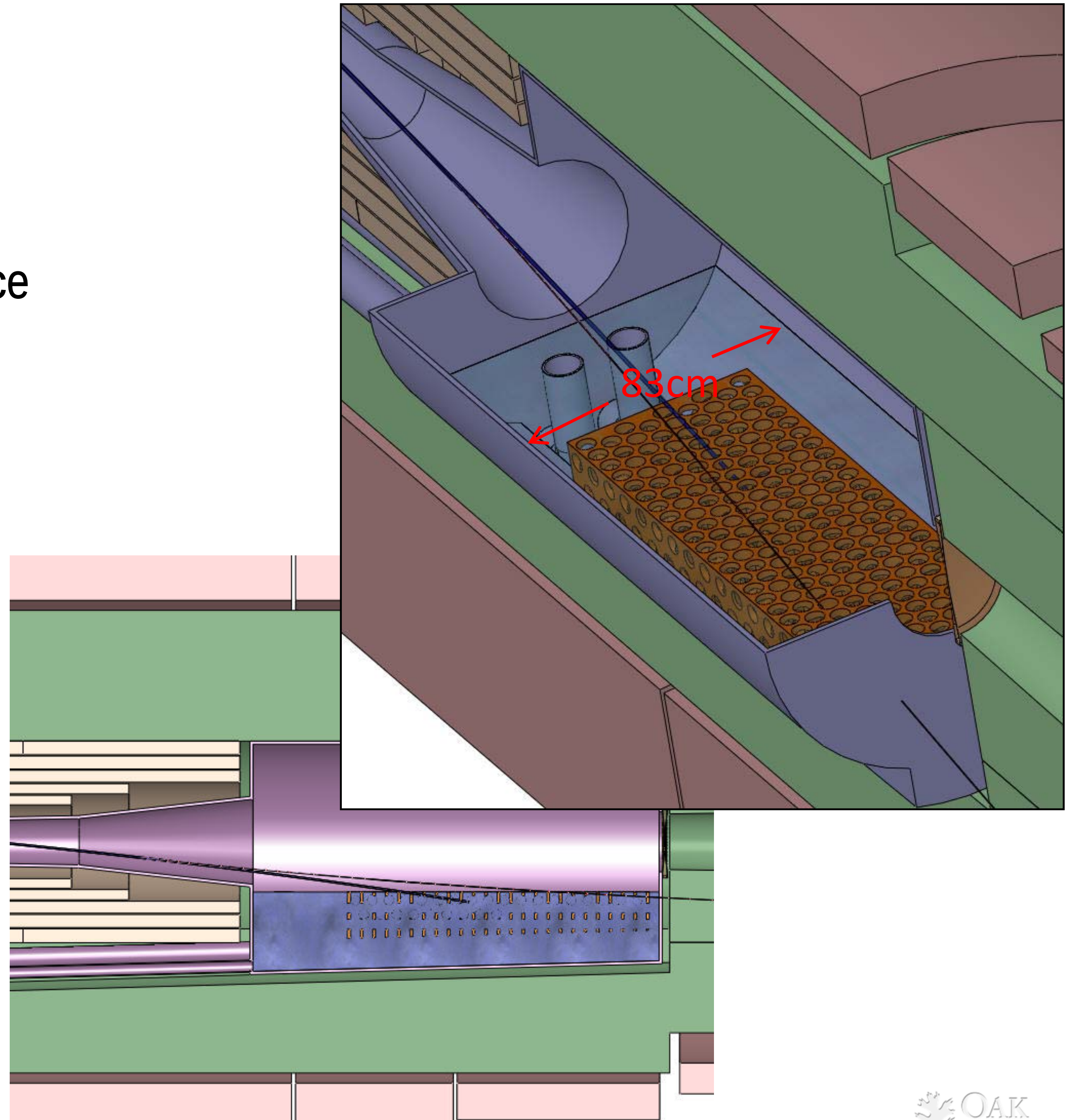


Conceptual Chamber Dimensions (cm)

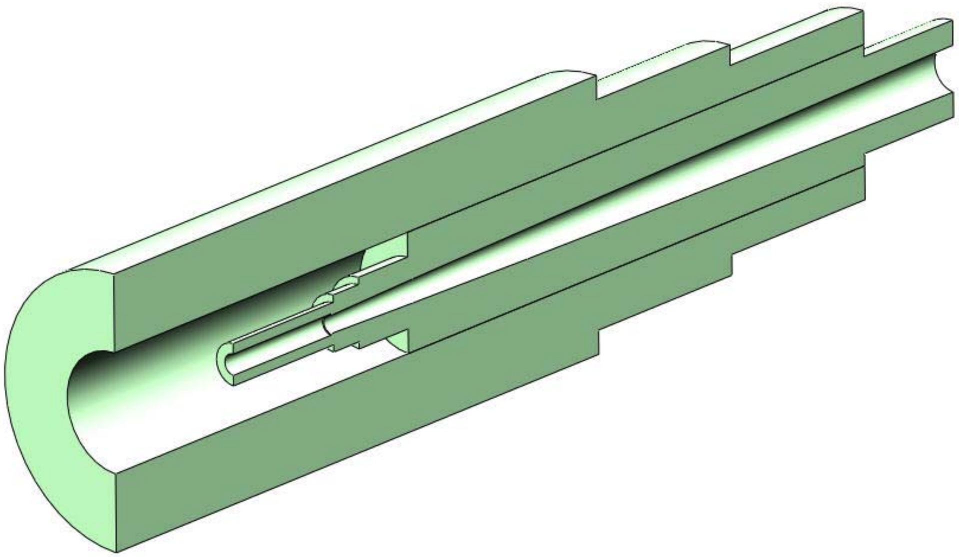


Comments on this Concept

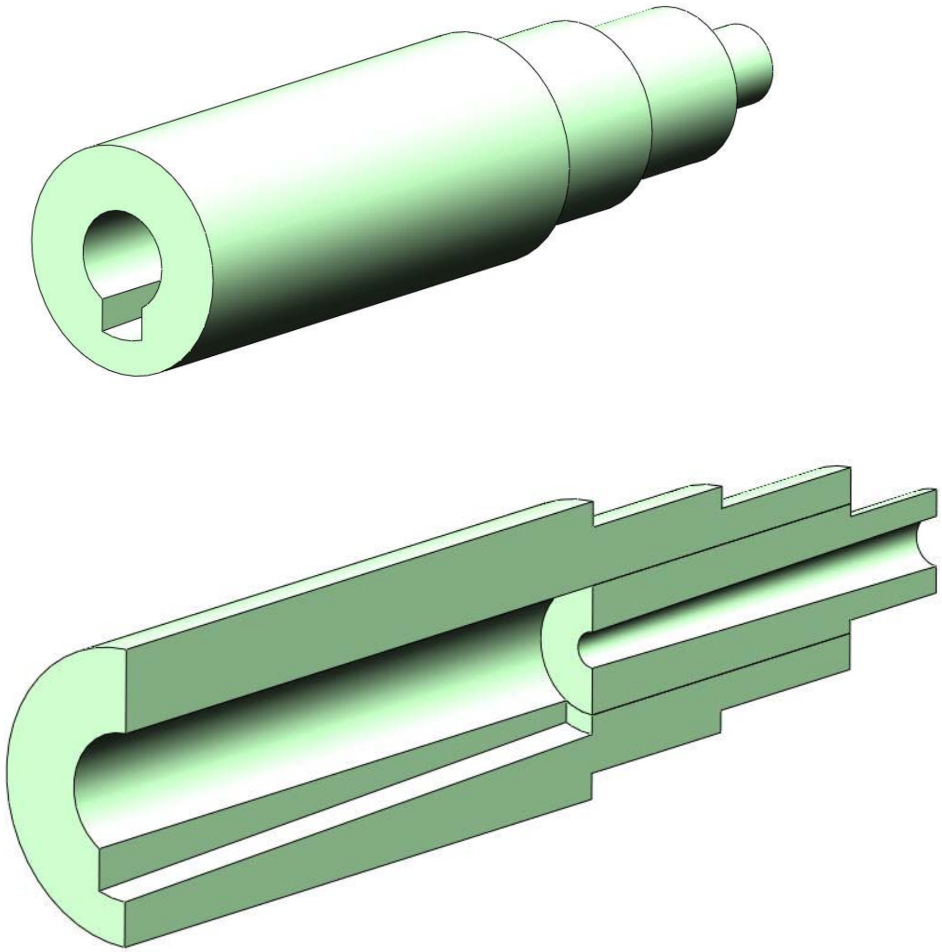
- All bottom surfaces sloped for drainage
- Pool width maximized
- Splash & wave mitigation space and depth available
- Accommodates curved beam trajectory
- Loss of top and side tungsten shielding
- Resistive coil shielding would have to be a separate component
- Support of chamber and mercury required (~6ton)



Shielding Loss



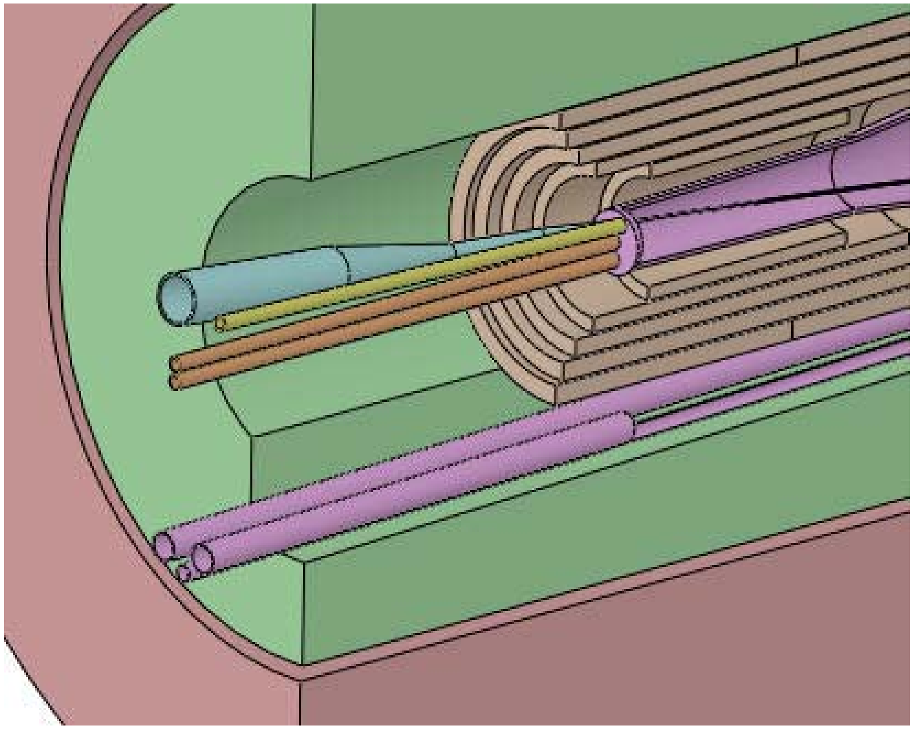
IDS120h Shielding



Shielding for Axisymmetric Mercury Chamber

Mercury Chamber Front End

- Prefer single, closed volume chamber (no seals) for mercury jet, pool, and drain
- Assume all required ports on upstream end
  - Hg nozzle, beam pipe, 2 vents, 3 drains
  - Must have adequate length to exit SC 1



Functional in concept, but not how it would be implemented

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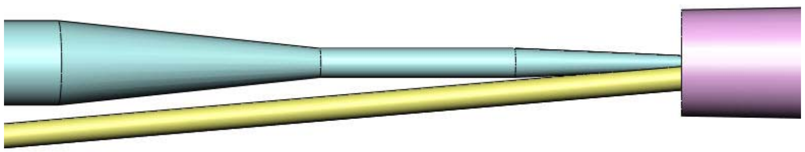
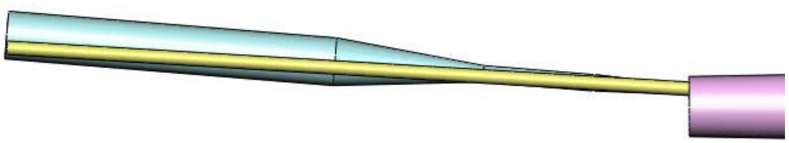
Beam Pipe and Nozzle

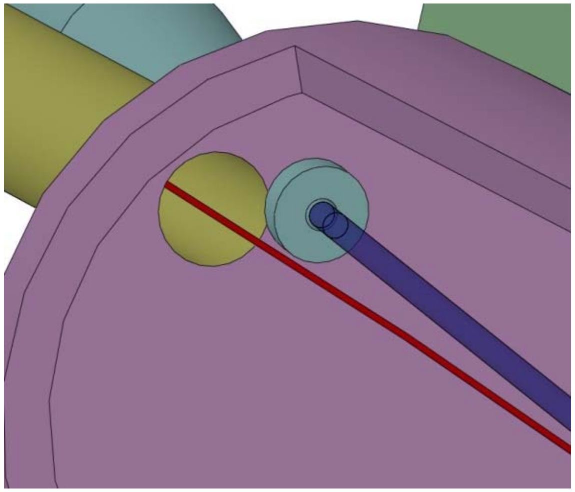
- Small angles in nozzle beam pipe cause some mechanical issues
- SC coil design causes curved beam path trajectory well upstream of target, significantly affects beam pipe



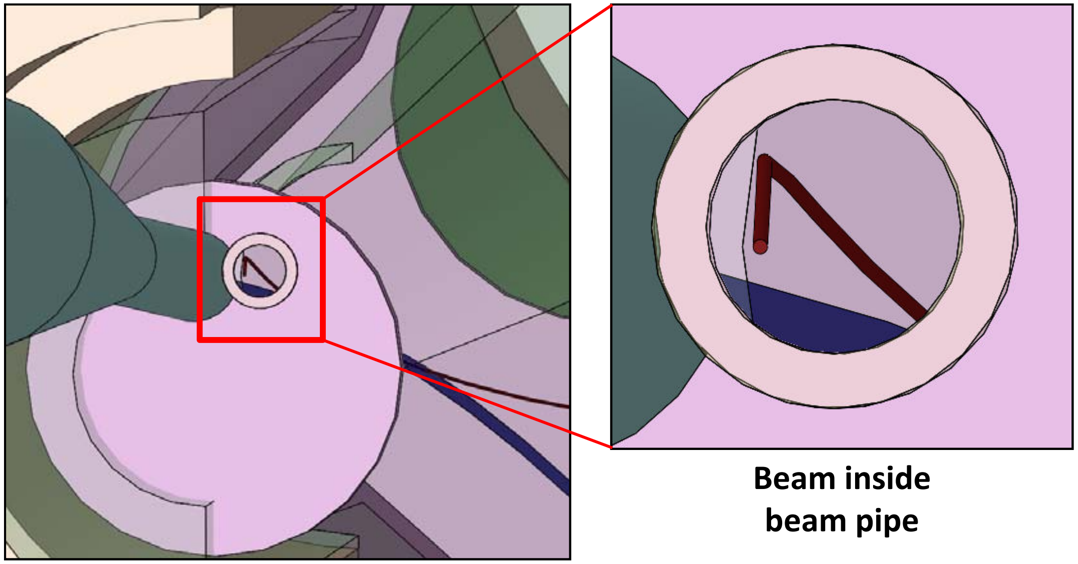
Plan View



Elevation View



View Inside Chamber

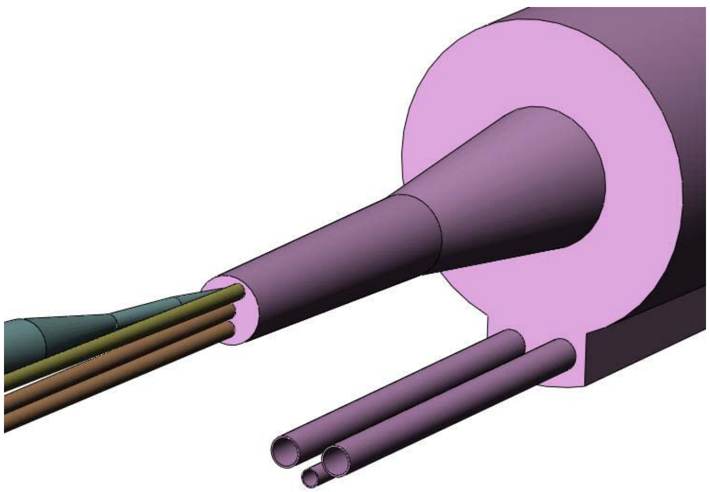


Looking down beam pipe

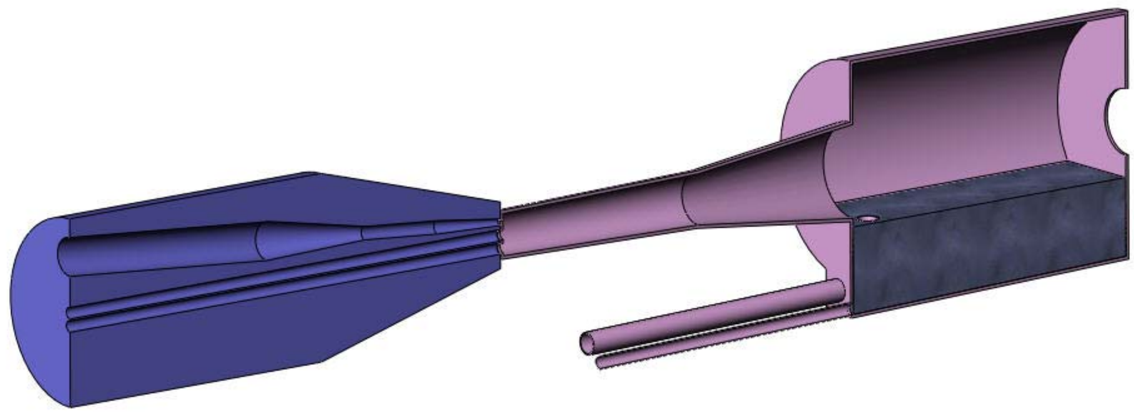
Beam inside beam pipe

Nozzle Cartridge

- Nozzle module placement critical to facility operations
  - Repeatable and rugged design required for remote operations
- Long slender pipes don't lend themselves to this scheme



NOT THIS WELDMENT CONCEPT

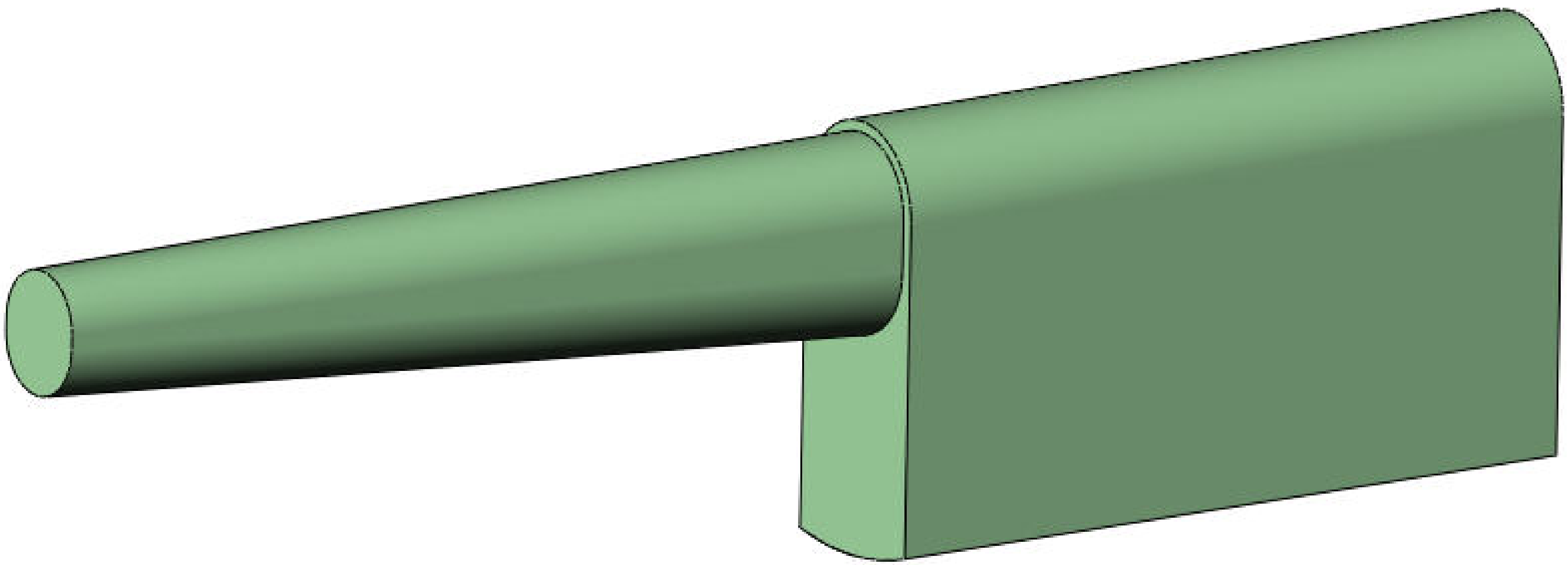


MACHINED BLOCK(S) FOR RIGIDITY AND ACCURACY

- Could also implement via "cartridges" which insert into the larger block
- Cooling will be needed
- Drainage system implemented in similar fashion
- Provides some structural support for remote handling
- Must also provide space for resistive coil utilities

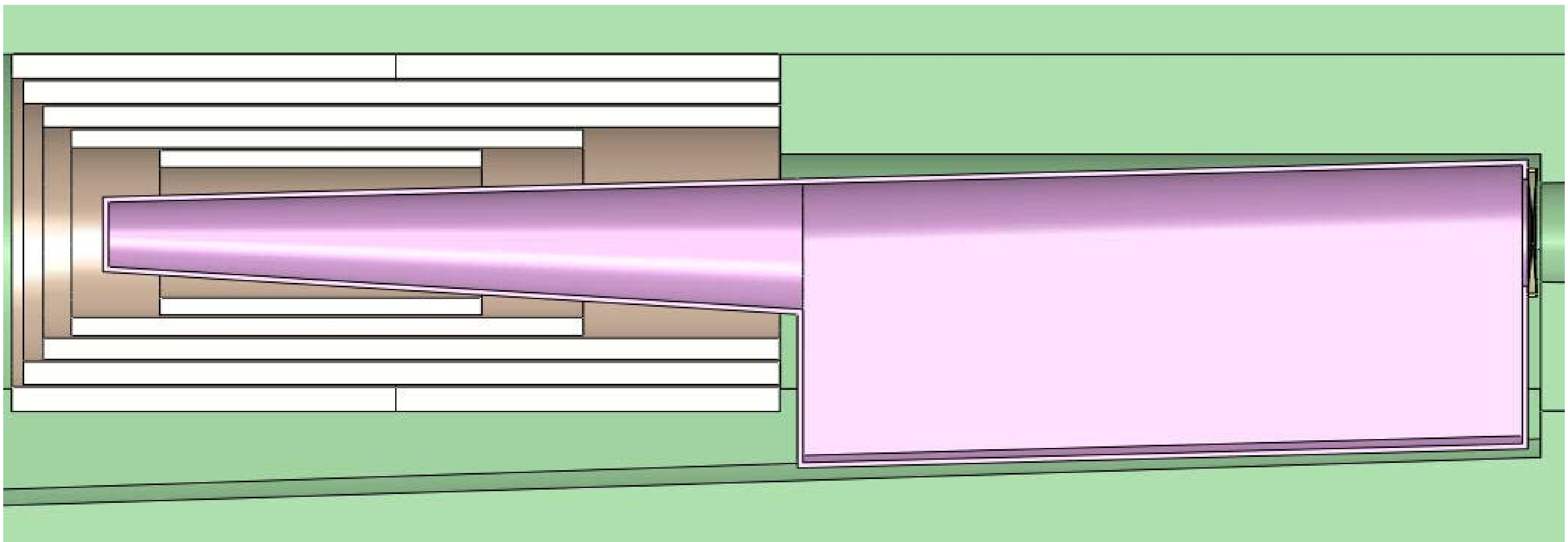
Minimal Width Chamber Concept

- Minimize shielding removal
- Non-axisymmetric design
- Narrower mercury pool and drainage system
- All other issues previously discussed apply as well

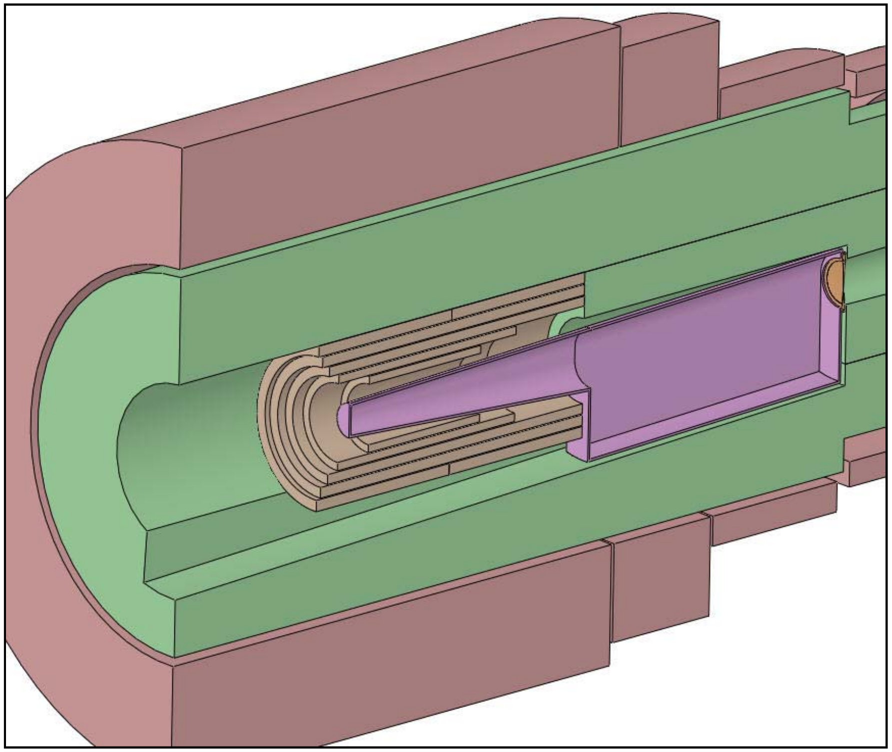


Minimal Width Chamber

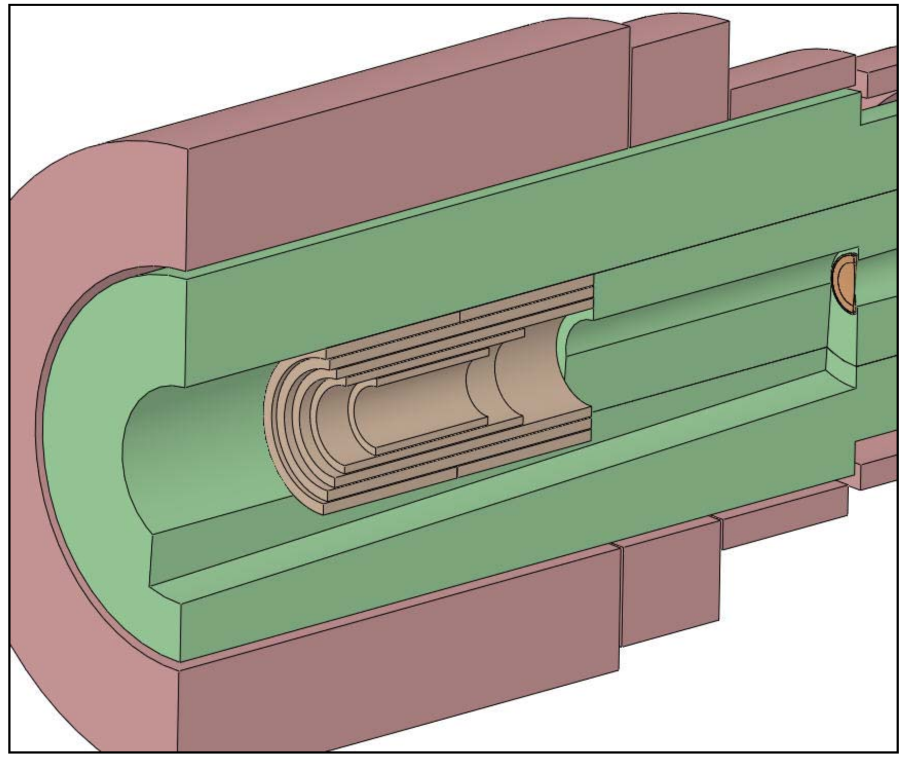
- Preserves more tungsten shielding
- Width determined by downstream beam window
- Creates narrower mercury pool (35cm vs. 83cm)
  - Wave / splash mitigation issues, beam stopping



Minimal Width Chamber Isometrics



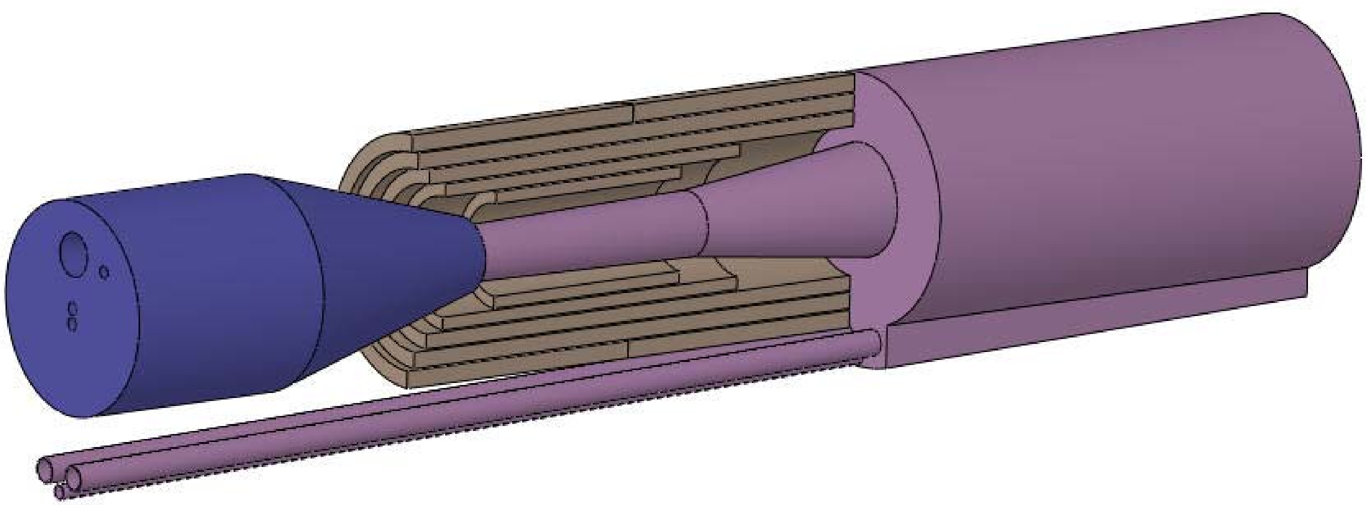
Chamber in Place
(drain not shown)



Shielding Shape

Manufacturing

- Hg chamber encompass hourglass-shaped resistive magnets
- Very complex geometry, tight positional placement required
- Machine where possible, minimize welding
- Insert portion of chamber through magnets, weld downstream components
- Will have to handle chamber and coils as a single module



Some Engineering Issues

- Means of vertical support
- Double-wall mercury containment
  - Chamber wall(s) cooling
- Beam pipe and nozzle mechanical layout
- Shielding resistive coils
- Long upstream magnets
  - More difficult remote handling for inner components
  - Affects proton beam trajectory well before it impacts target

Mercury Chamber Wish List

- Eliminate resistive coils
- Enlarge resistive coils such that a cylindrical mercury chamber can be pulled through them
- If above not possible, then an integrated coil/chamber design required
- Minimize coil length of all upstream magnets