

Neutrino Factory Mercury Containment Concepts



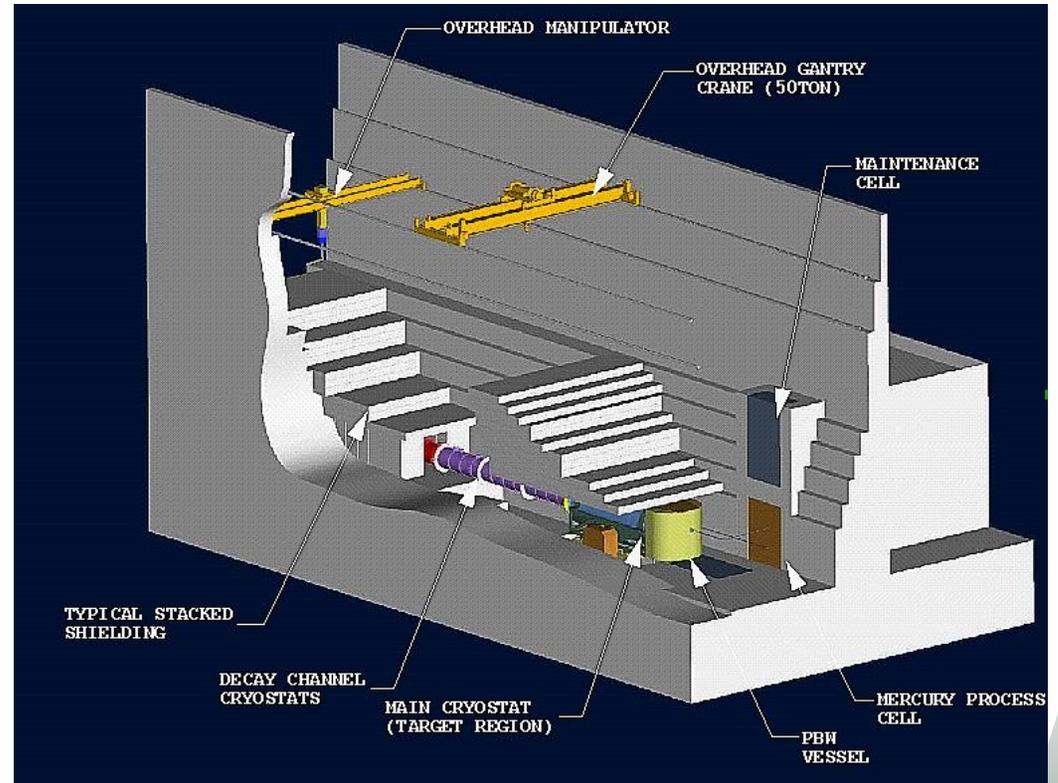
V.B. Graves

NFMCC Friday Meeting

Nov 21, 2008

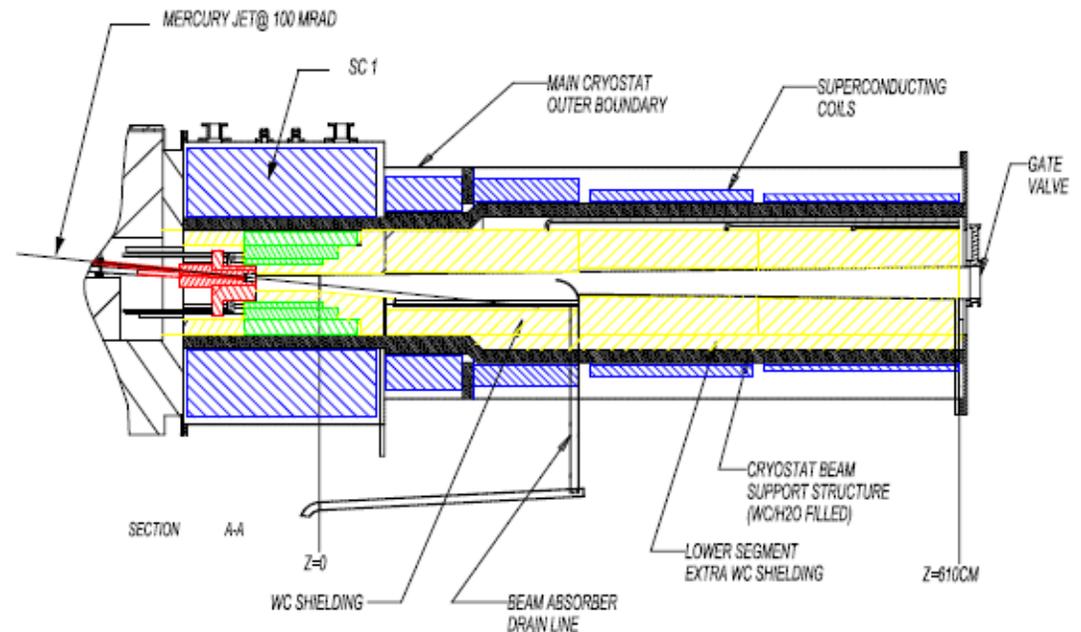
Outline

- **Neutrino Factory cryostat layouts**
- **Hg jet and pool containment**
- **Future efforts**



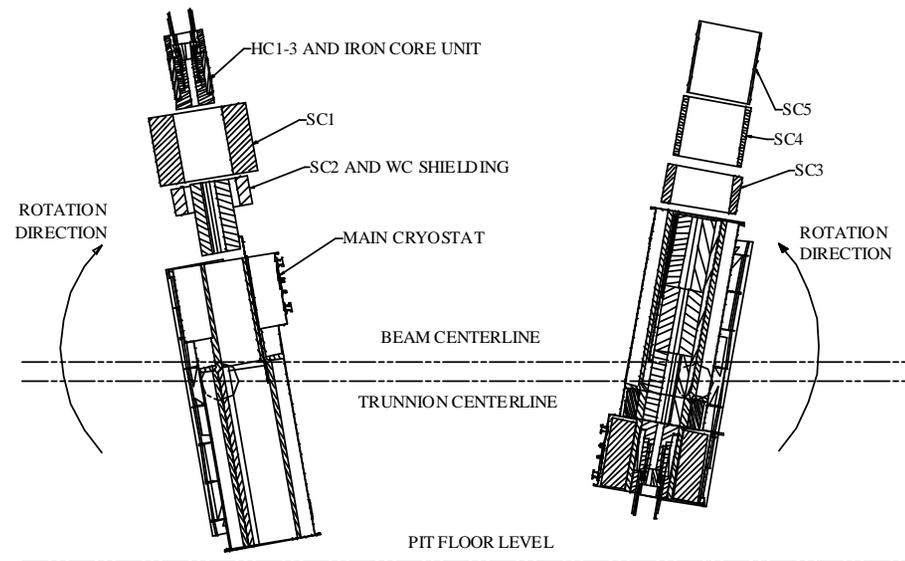
Neutrino Factory Cryostat 1 Concept

- **Five superconducting magnets (SC1-SC5)**
- **Three hollow conductor resistive magnets (HC1-HC3)**
- **Iron plug**
- **Water-cooled tungsten-carbide shielding**
- **Mercury jet containment vessel / beam stop**

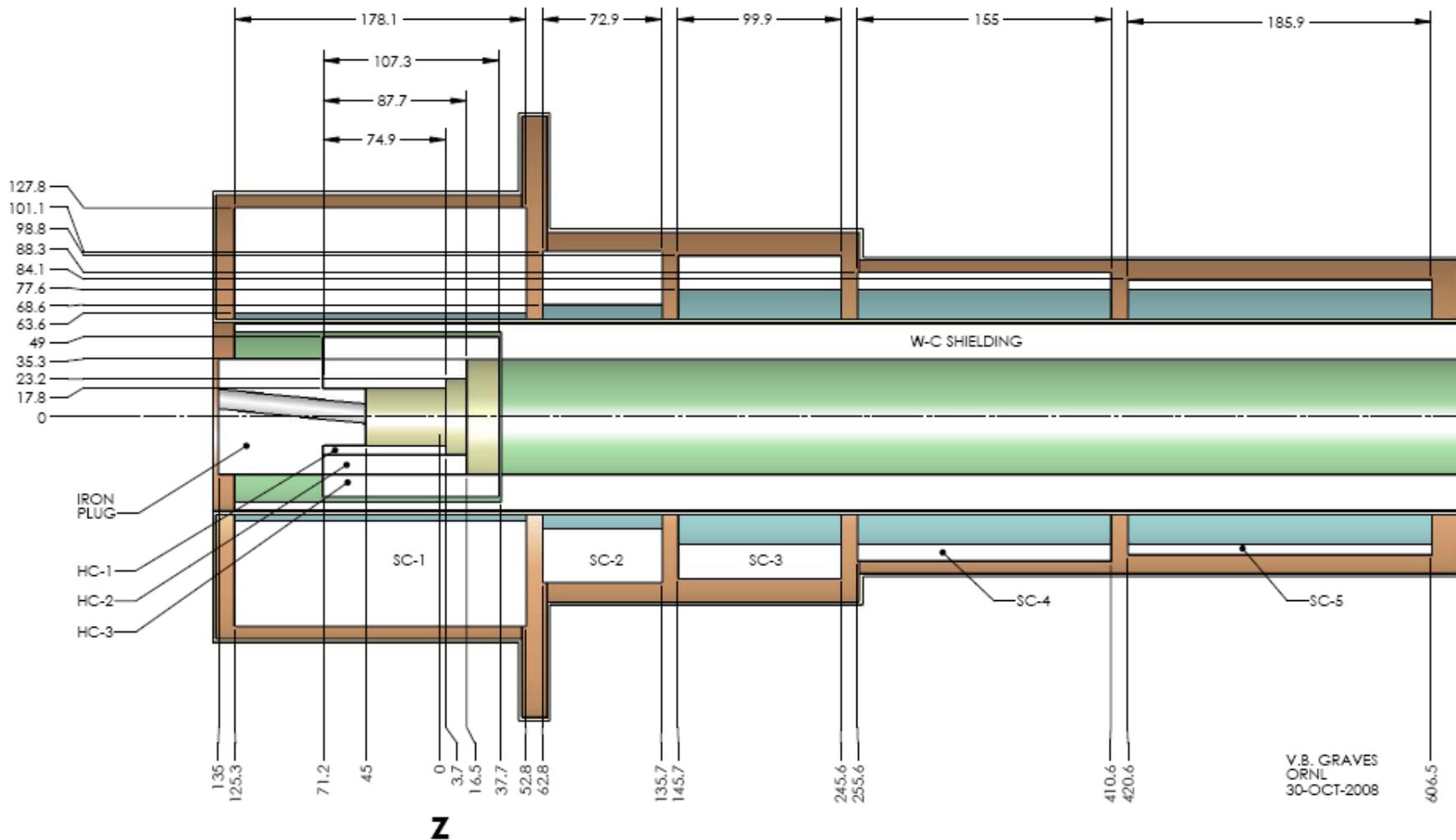


Cryostat 1 Assembly & Maintenance

- **Study II assumed main cryostat remotely assembled in cell due to component weights**
 - Handling fully assembled cryostat would require 160-ton crane
- **Concept to install components by rotating cryostat and lowering modules into it**
- **Assembly method shown probably not feasible due to connector issues**
- **Much more design effort needed to develop concept**

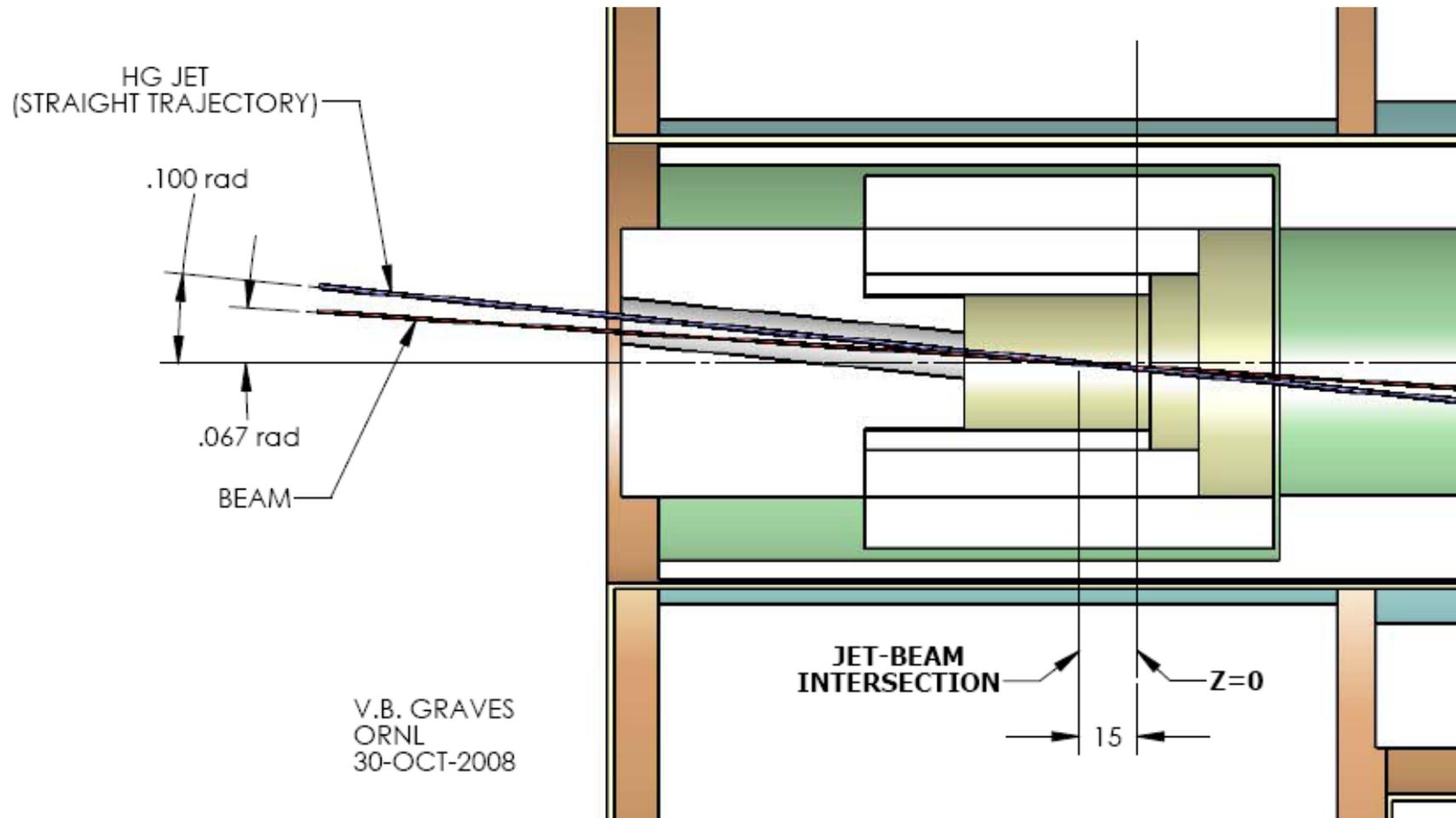


NF Cryostat 1 Dimensional Info



Based on Study II Tables 3.13, 3.14
Dimensions in cm

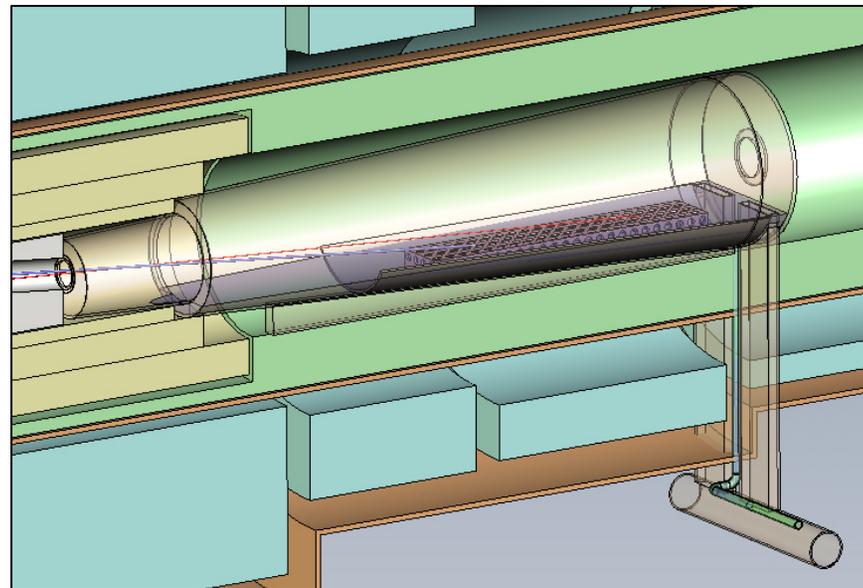
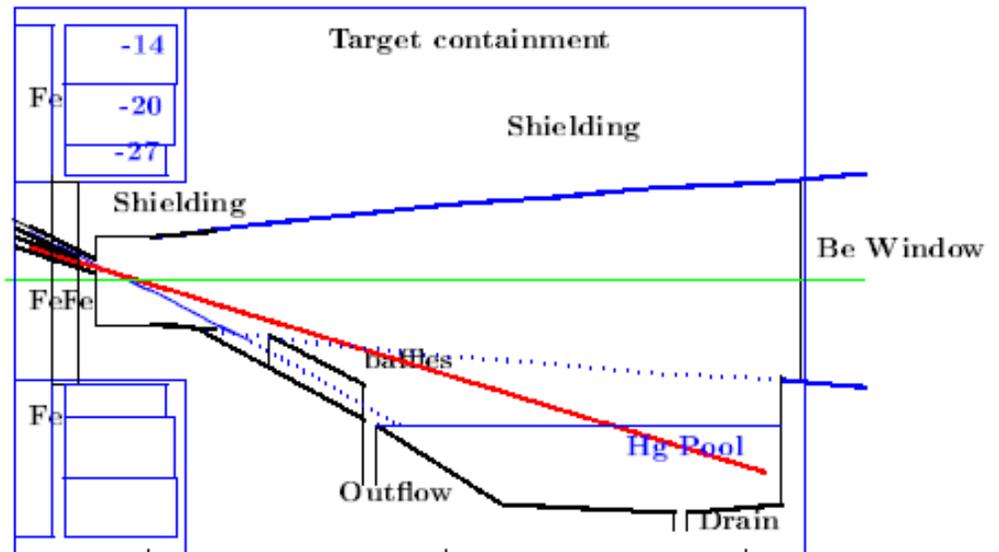
NF Hg Jet Layout



**Z=0 defined as end of jet-beam
interaction region**

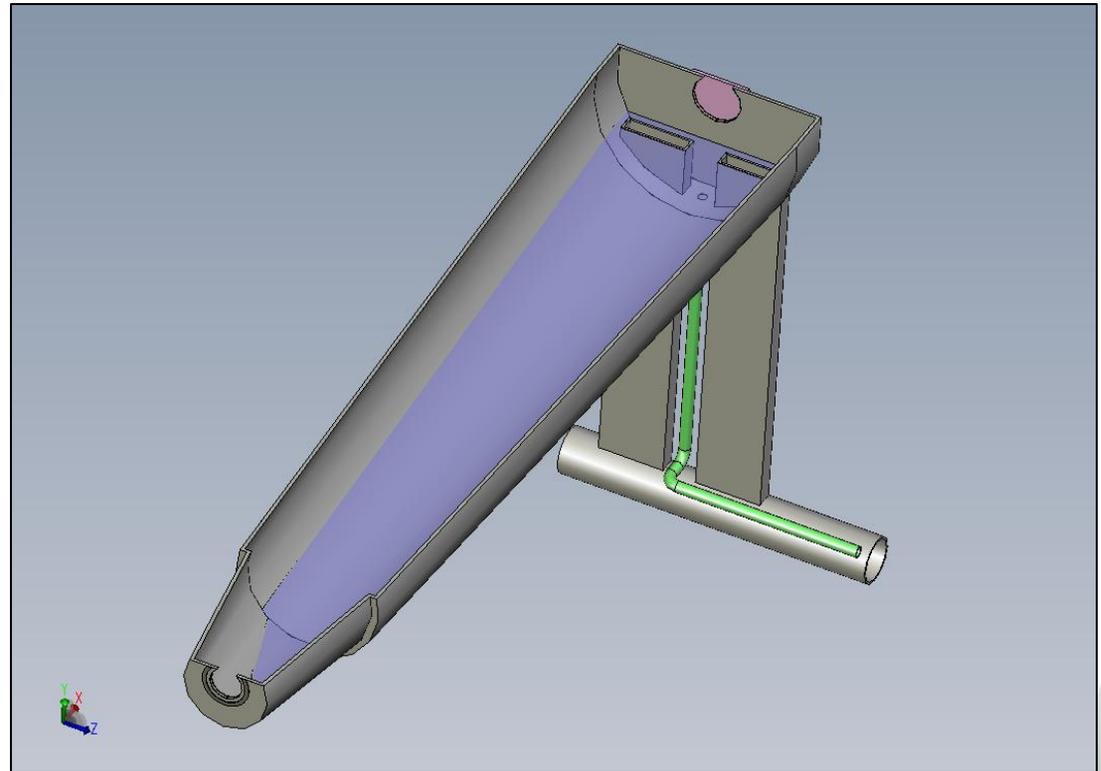
Study II Mercury Containment Vessel

- Document gave cursory mention of mercury pool containment vessel but no mechanical detail
- Development of 3D models gives new perspective and offers insight into real issues that will have to be resolved



Mercury Vessel Functions & Features

- **Functionality**
 - Jet and beam dumps
 - Liquid and vapor containment barrier
 - Hg drainage
 - Hg splash mitigation
- **Features**
 - Upstream opening for nozzle (encloses nozzle)
 - Hg overflow and vessel drains
 - Air-space vent (not shown)
 - Iron plug and downstream cryostat seals
 - Downstream particle window

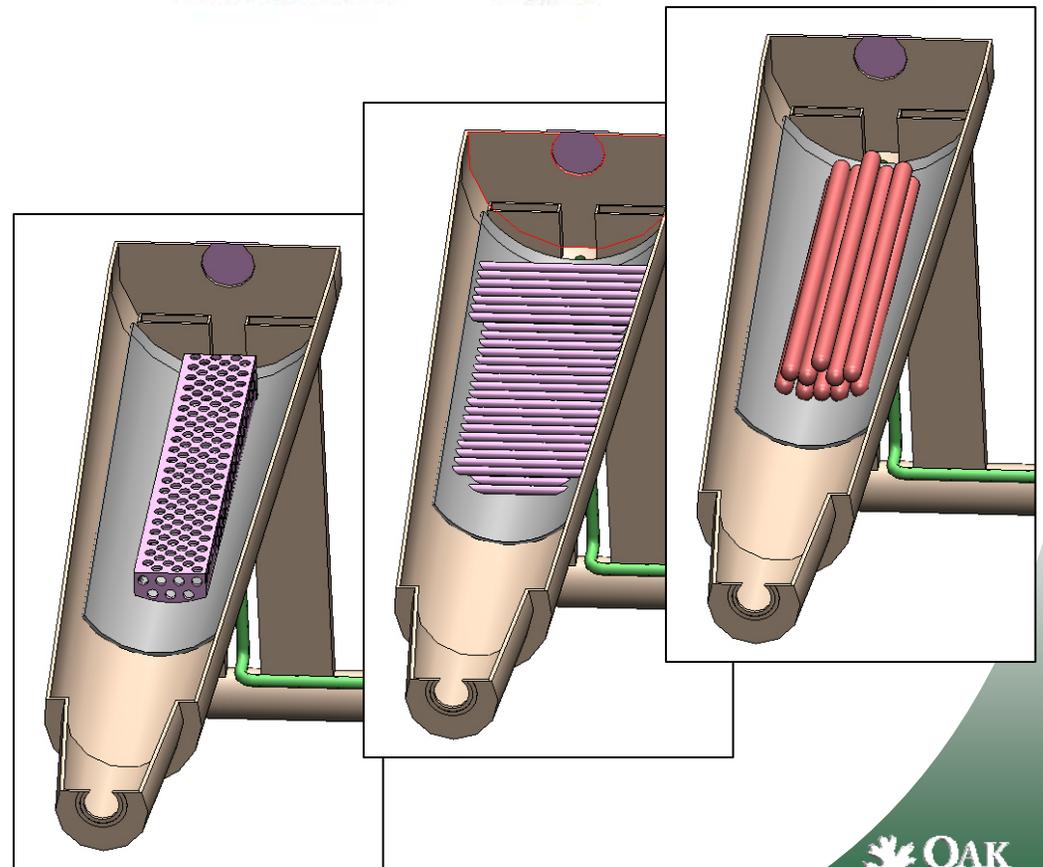
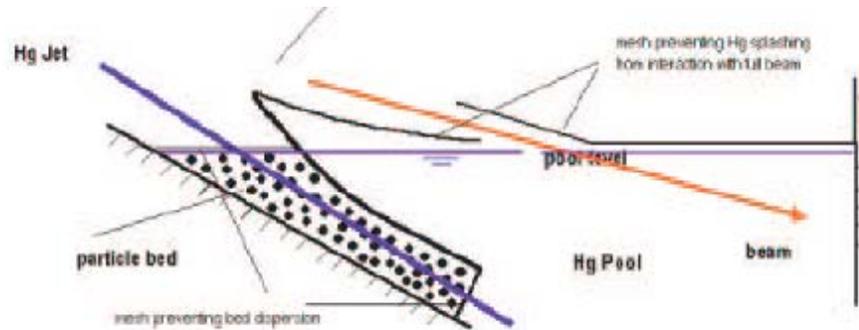


Containment Design Requirements

- **Material compatible with high-field magnets**
 - Must also withstand some number of full-power beam pulses with no Hg in vessel (accident scenario)
- **Desire no replaceable components**
- **Provide support for Hg weight**
 - ~80 liters, 1 metric ton in “short” configuration shown
- **Sloped (1°-2°) for gravity Hg drain**
- **Overflow drain for 30m/s jet (2.4 lps)**
- **Vent for gas transfer**
- **Passive means of Hg circulation to provide thermal mixing**

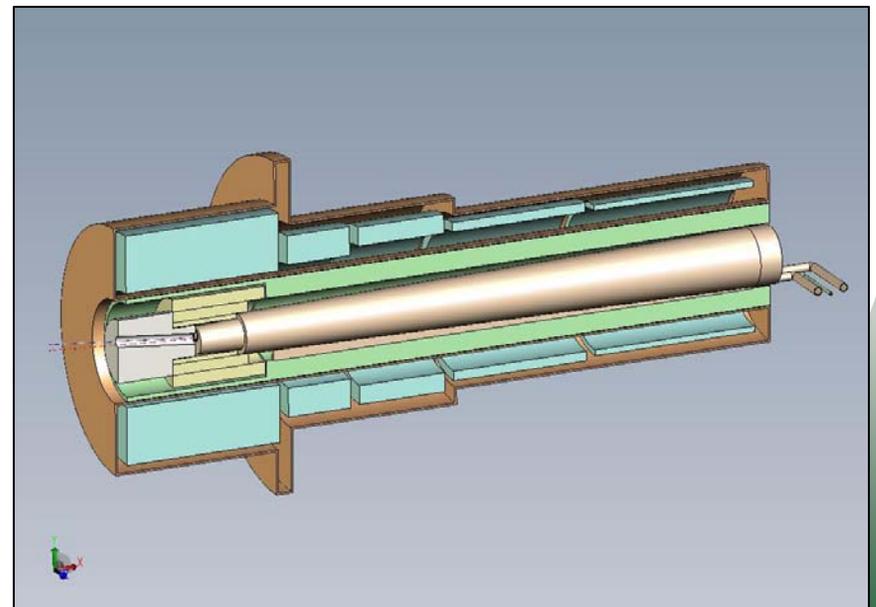
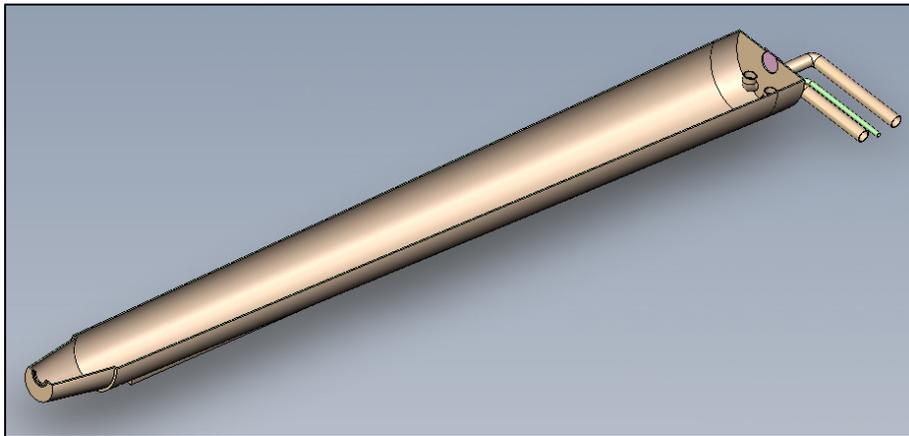
Splash Mitigation

- **Study II assumed a particle bed of tungsten balls to minimize effects of jet entering pool**
- **Many other feasible concepts to accomplish this function**
- **Simulation/analytical studies may be useful to limit options**
- **Prototypic testing needed for comparison & final determination**



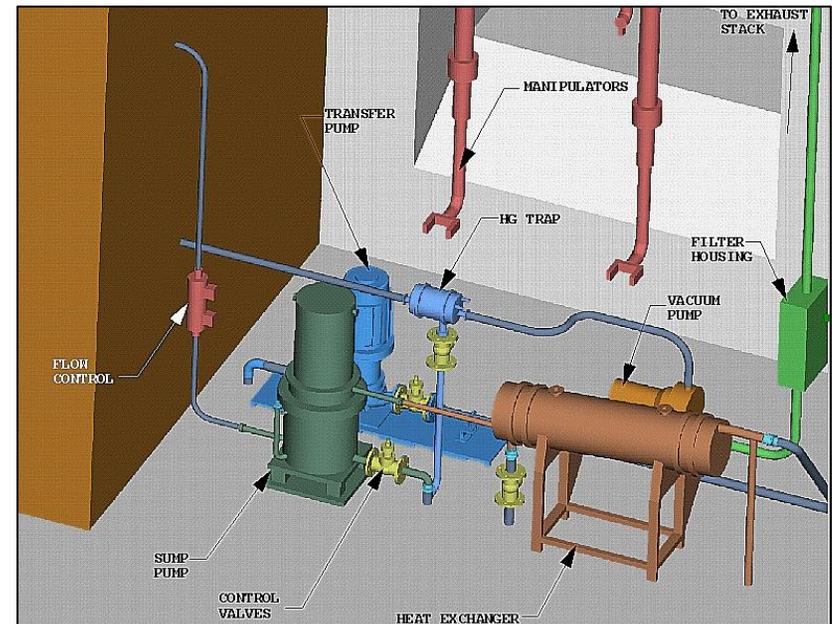
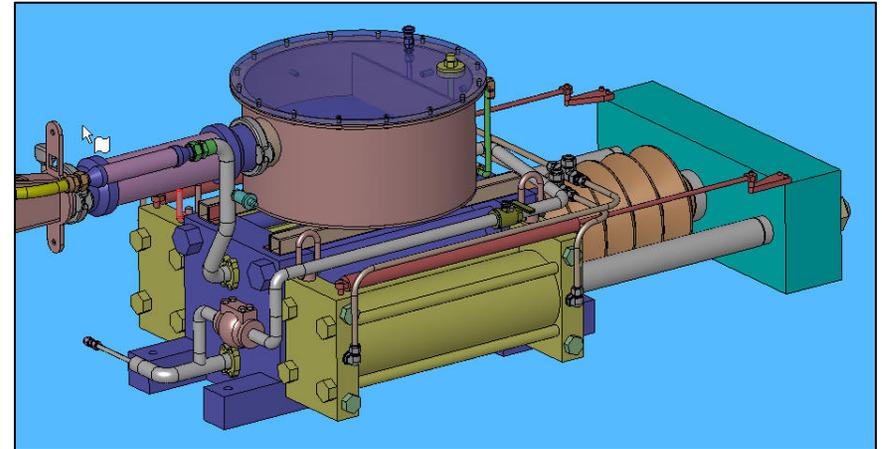
Alternative Vessel Drainage

- Penetrations through cryostat will complicate design and assembly
- End drain configuration may be required for assembly reasons or to interface with downstream cryostats
- Increases Hg volume significantly



Future Efforts

- **Follow-On Testing**
 - Given funding, would like to pursue design of a jet pool test bed using MERIT syringe pump
 - More prototypic nozzle configuration
 - Allow direct viewing of jet and splash
 - Replaceable splash mitigation hardware
 - Replaceable nozzles
- **Continue low-key effort to further the mercury system design**
- **Neutrino Factory International Design Study will provide a mechanism to further development of the main cryostat concept**



Summary

- **3D conceptual model of a Neutrino Factory mercury containment vessel has been developed**
- **Integration of this vessel into the enclosing cryostat will require further engineering**
- **Splash mitigation R&D will be required**
- **The IDS should provide a platform for a broader review of the entire system**