Neutrino Factory Mercury Containment Concepts

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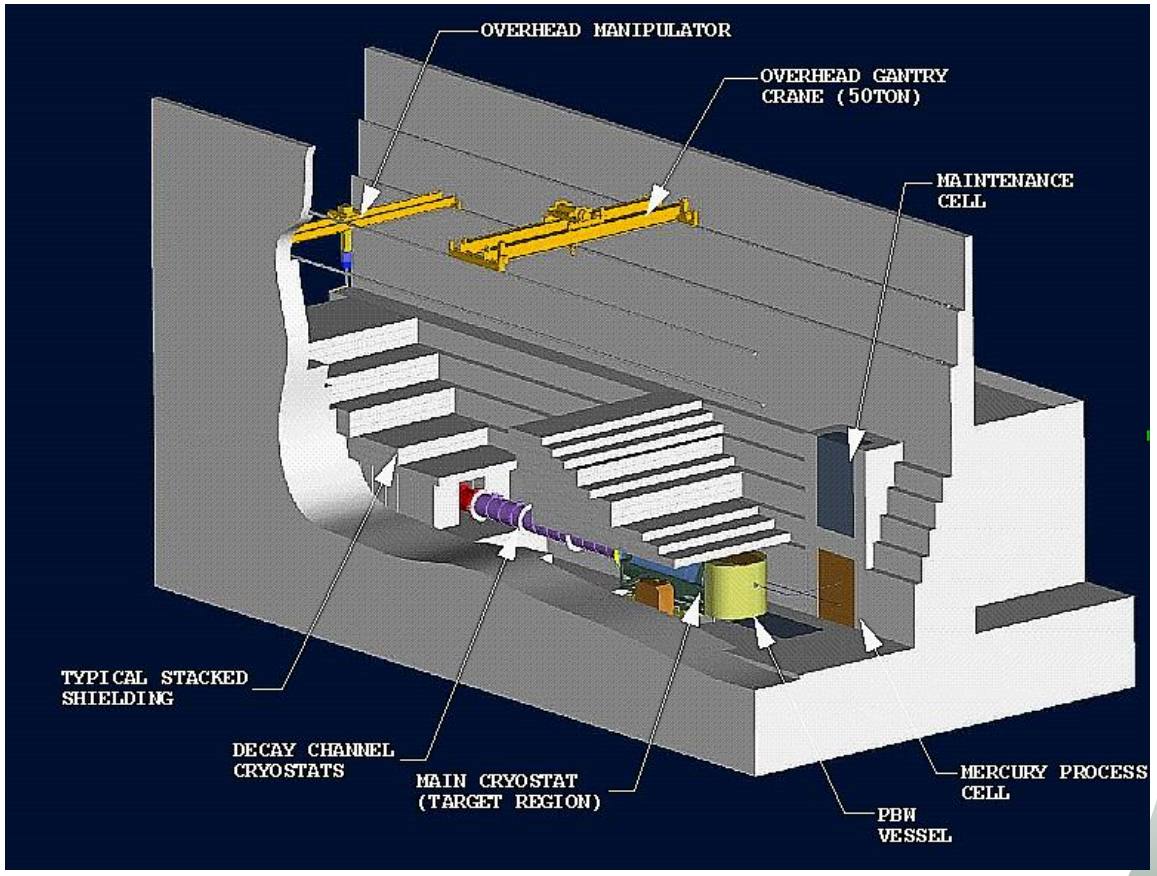
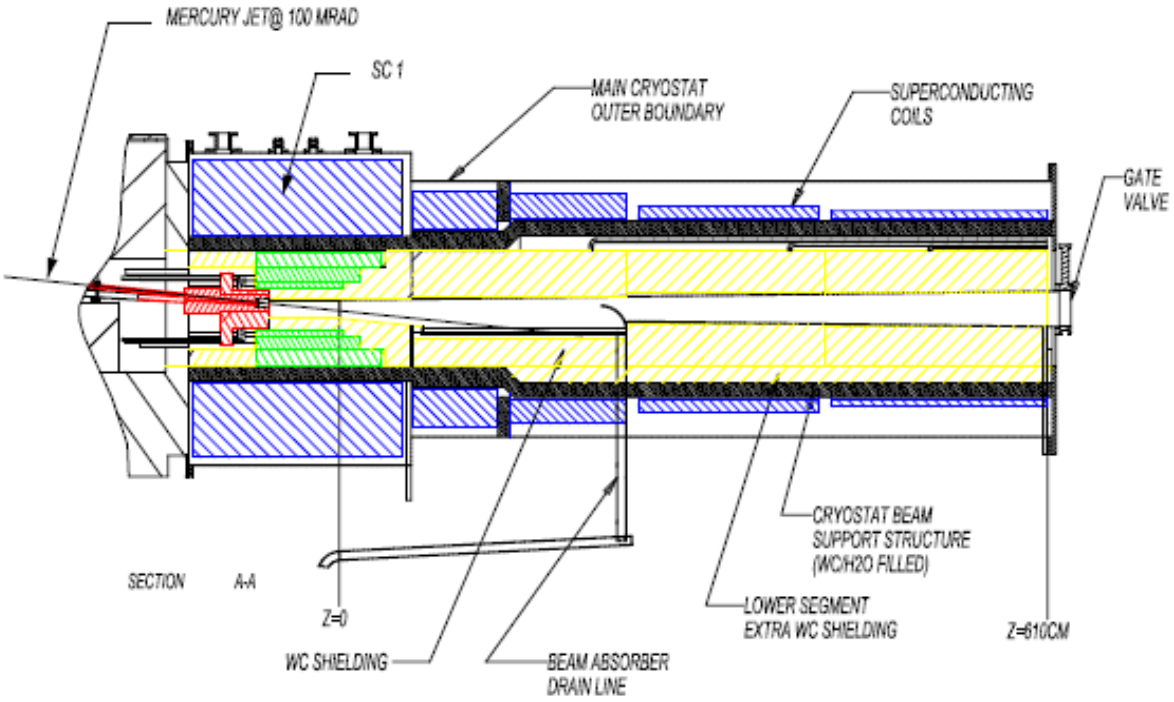
Outline

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



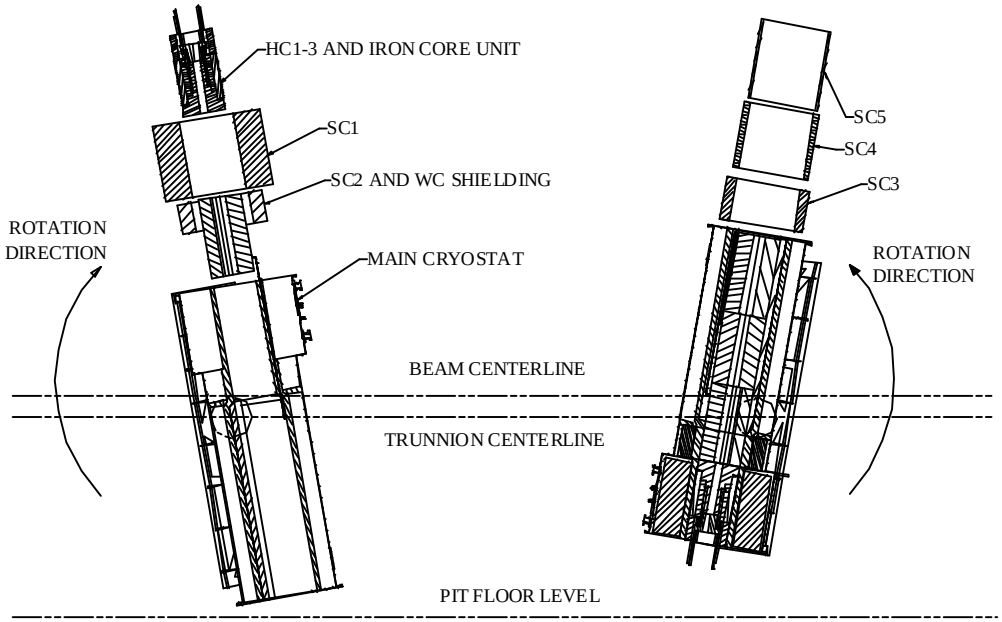
Neutrino Factory Cryostat 1 Concept

- **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**

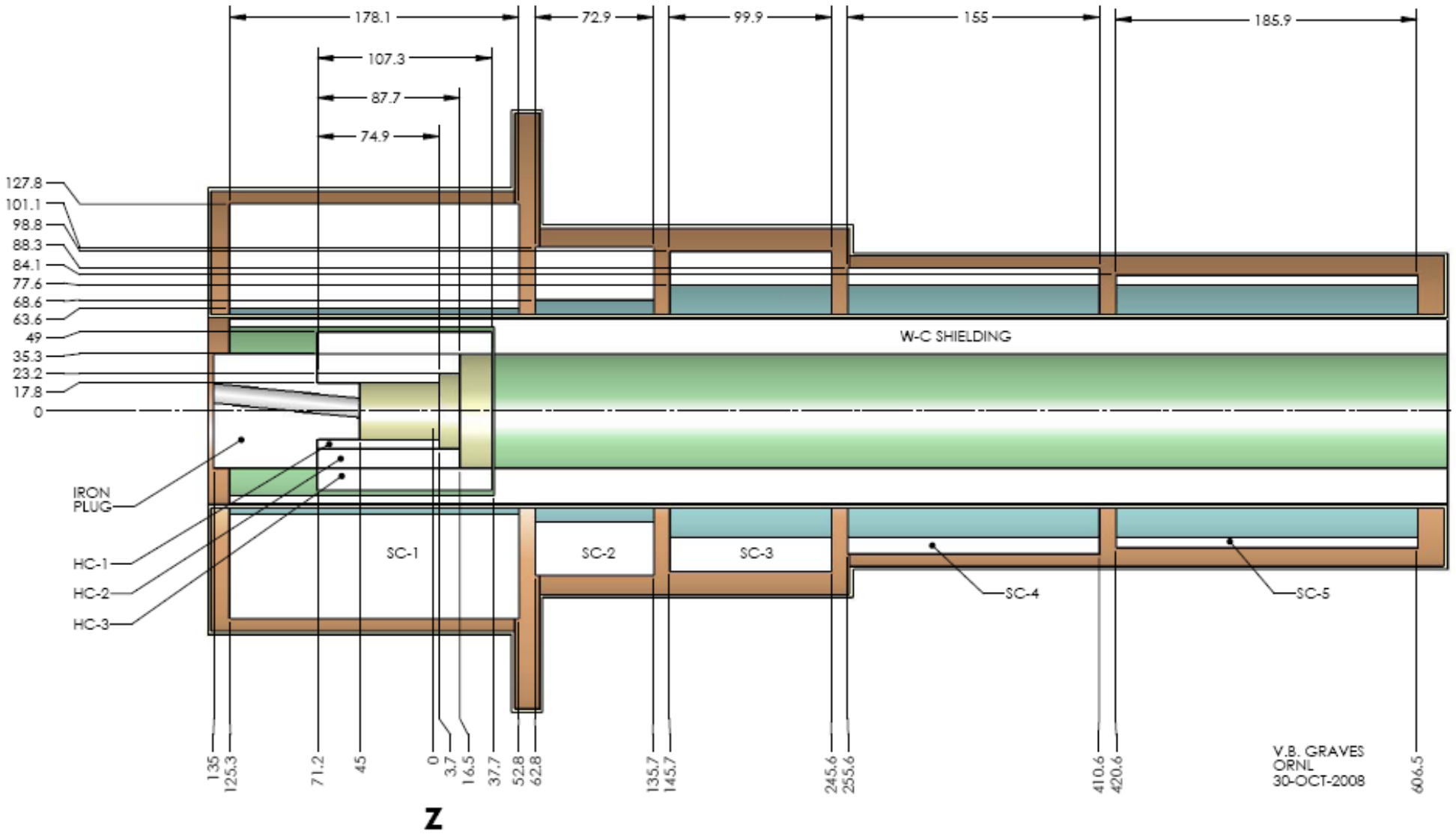


Cryostat 1 Assembly & Maintenance

- **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**

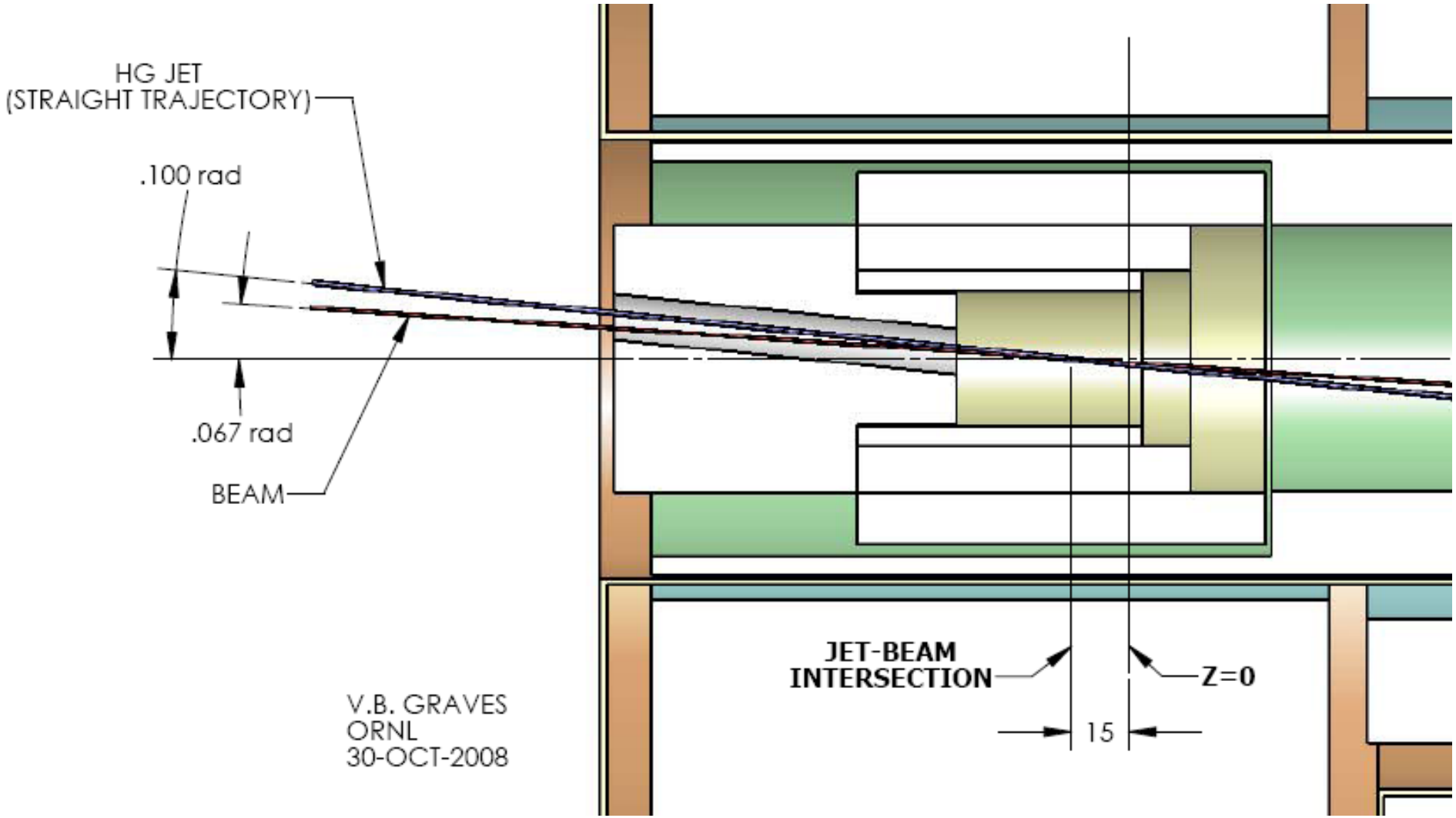


NF Cryostat 1 Dimensional Info



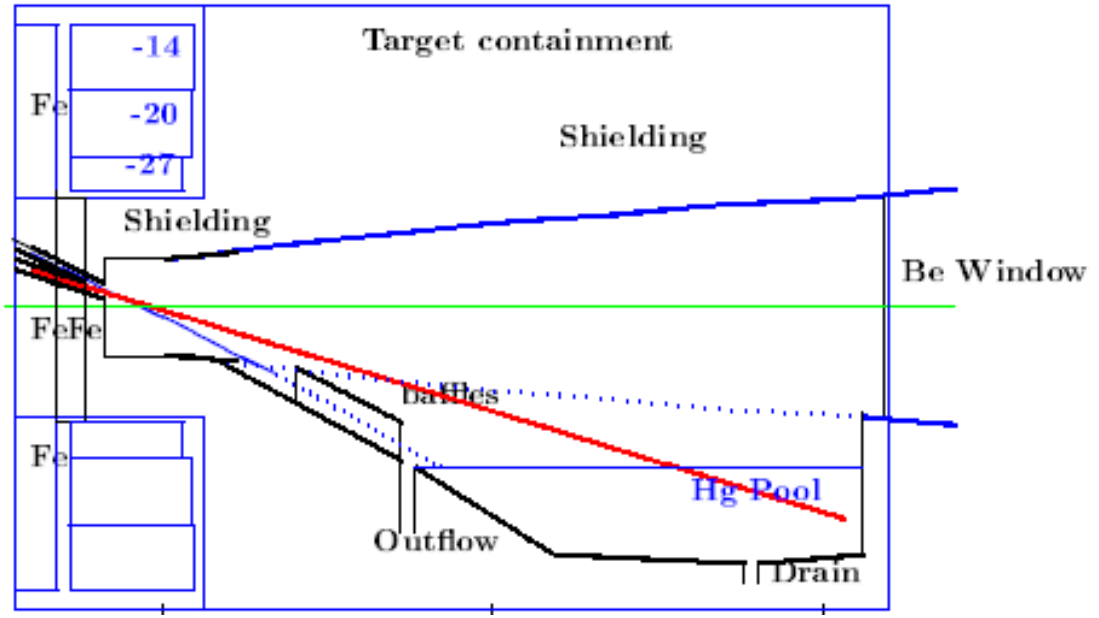
Based on Study II Tables 3.13, 3.14
Dimensions in cm

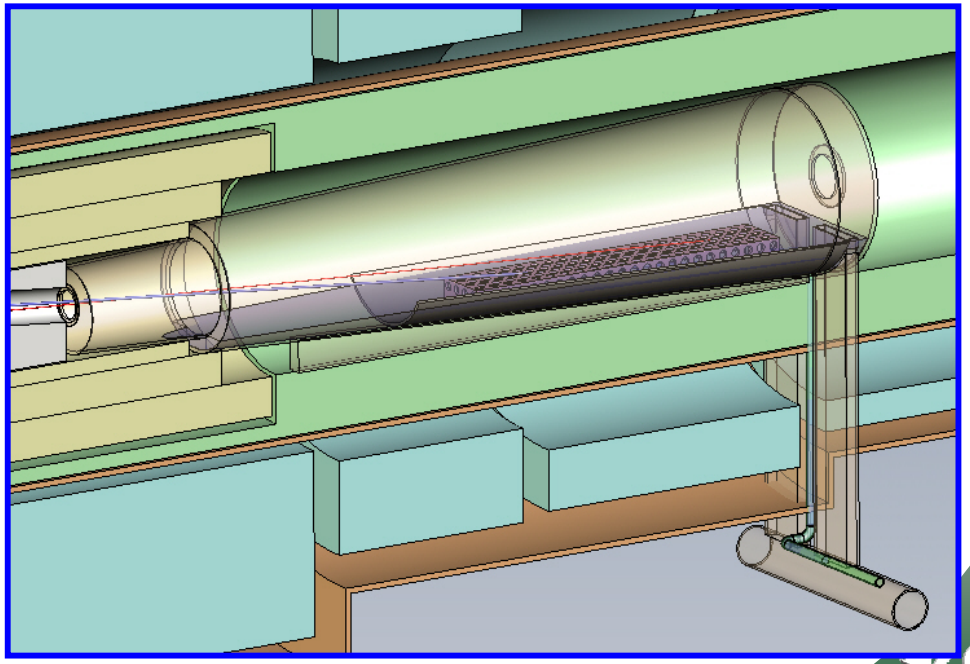
NF Hg Jet Layout



Study II Mercury Containment Vessel

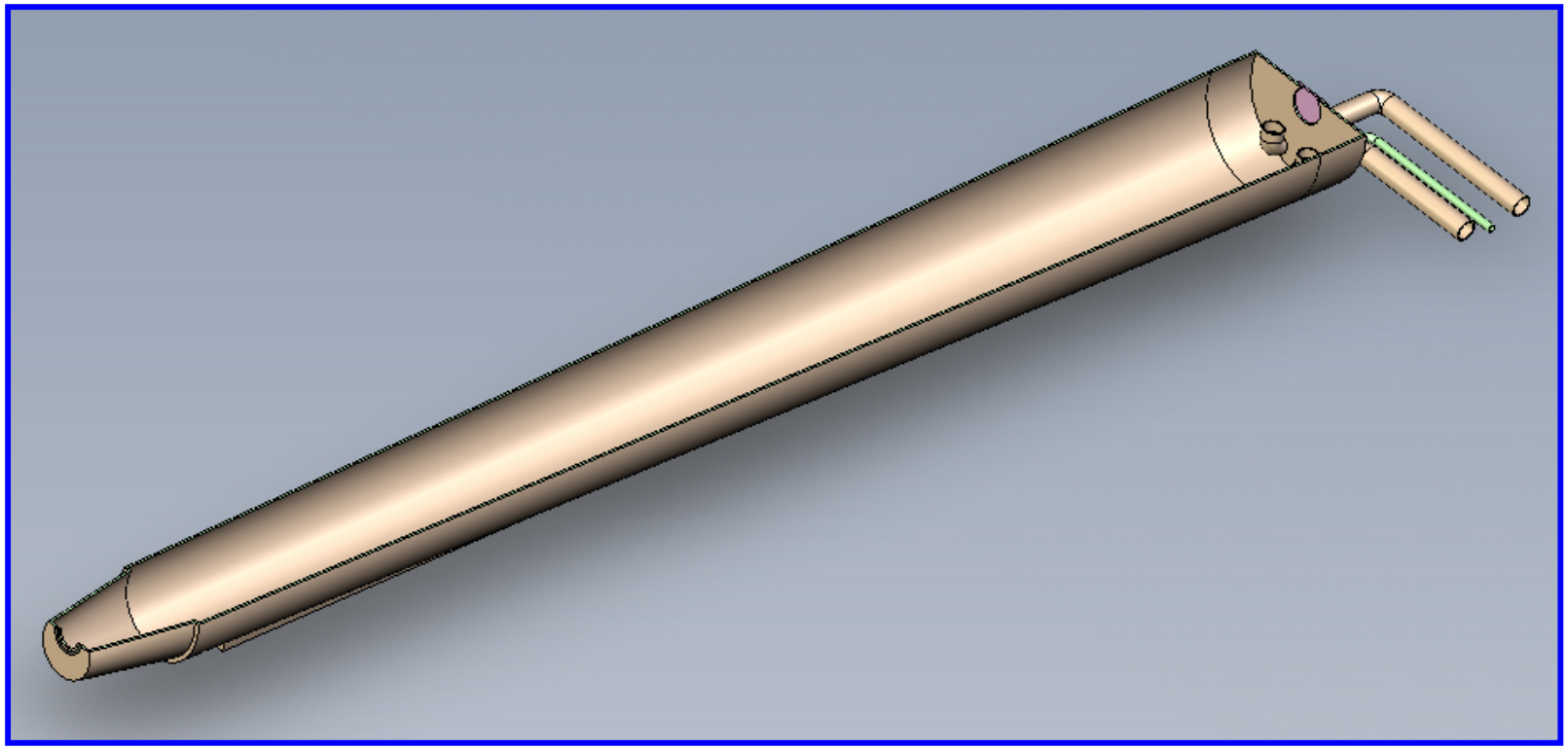
- **Document gave cursory mention of mercury pool containment vessel but no mechanical detail**
- **Development of 3D models gives new perspective and offers insight into real issues that will have to be resolved**





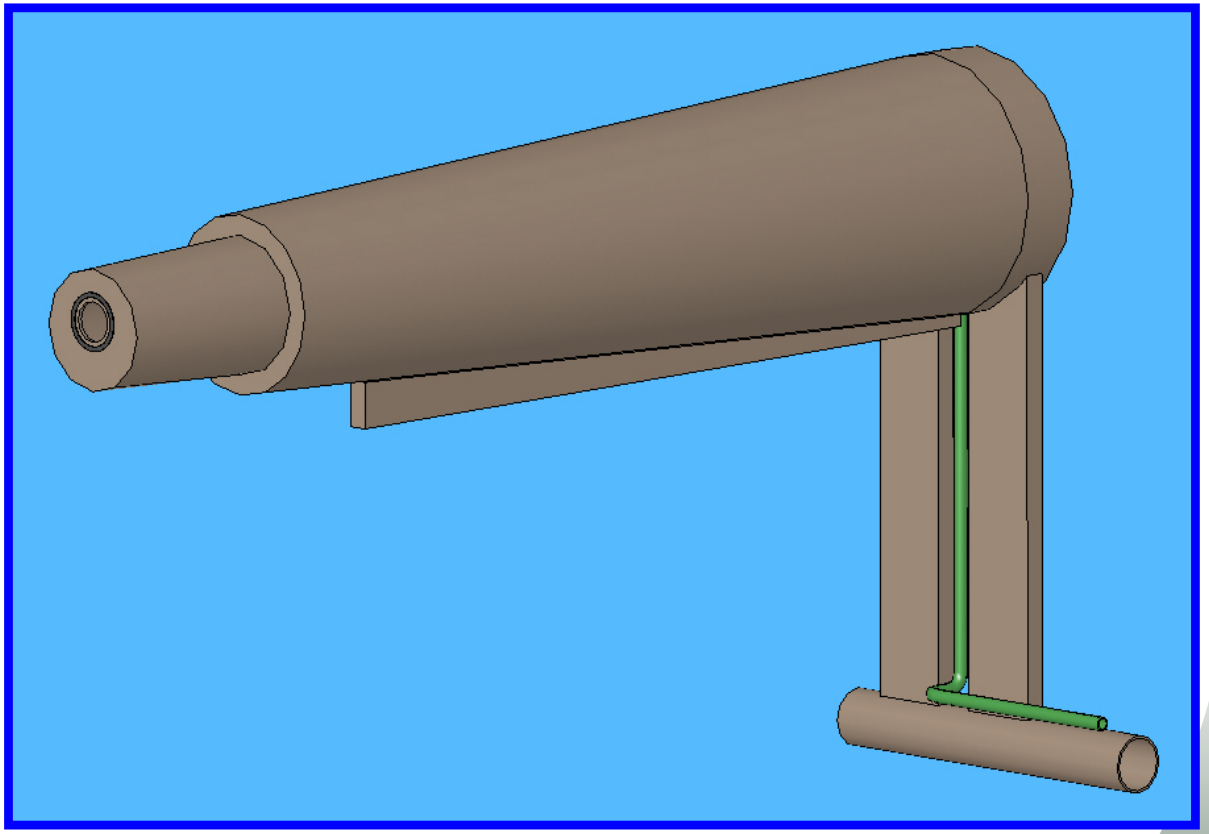
Alternative Vessel Drainage

- **Penetrations through cryostat will complicate design and assembly**
- **End drain configuration may be preferred**



Mercury Vessel Functions

- **Jet and beam dumps**
- **Liquid and vapor containment barrier**
  - **Protects cryostat & shielding walls from contamination**
- **Hg splash mitigation**
- **Hg drainage**
- **Exit beam window**



Mercury Vessel Features

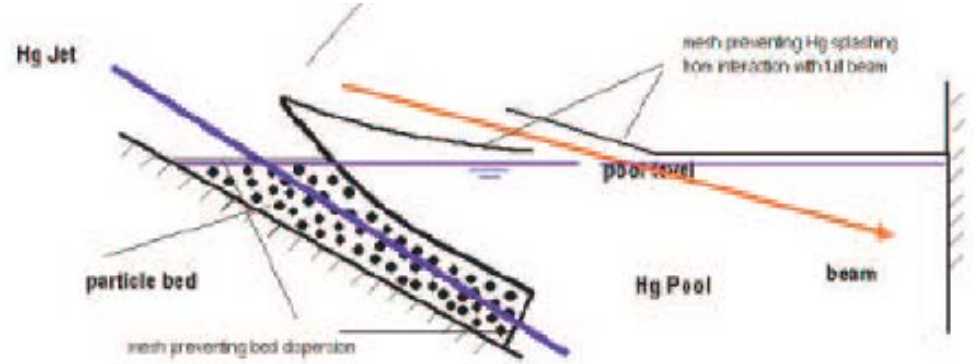
- **Upstream opening for nozzle (encloses nozzle)**
- **Hg overflow and vessel drains**
- **Air-space vent (not shown)**
- **Iron plug and downstream cryostat seals**
- **Downstream particle window**

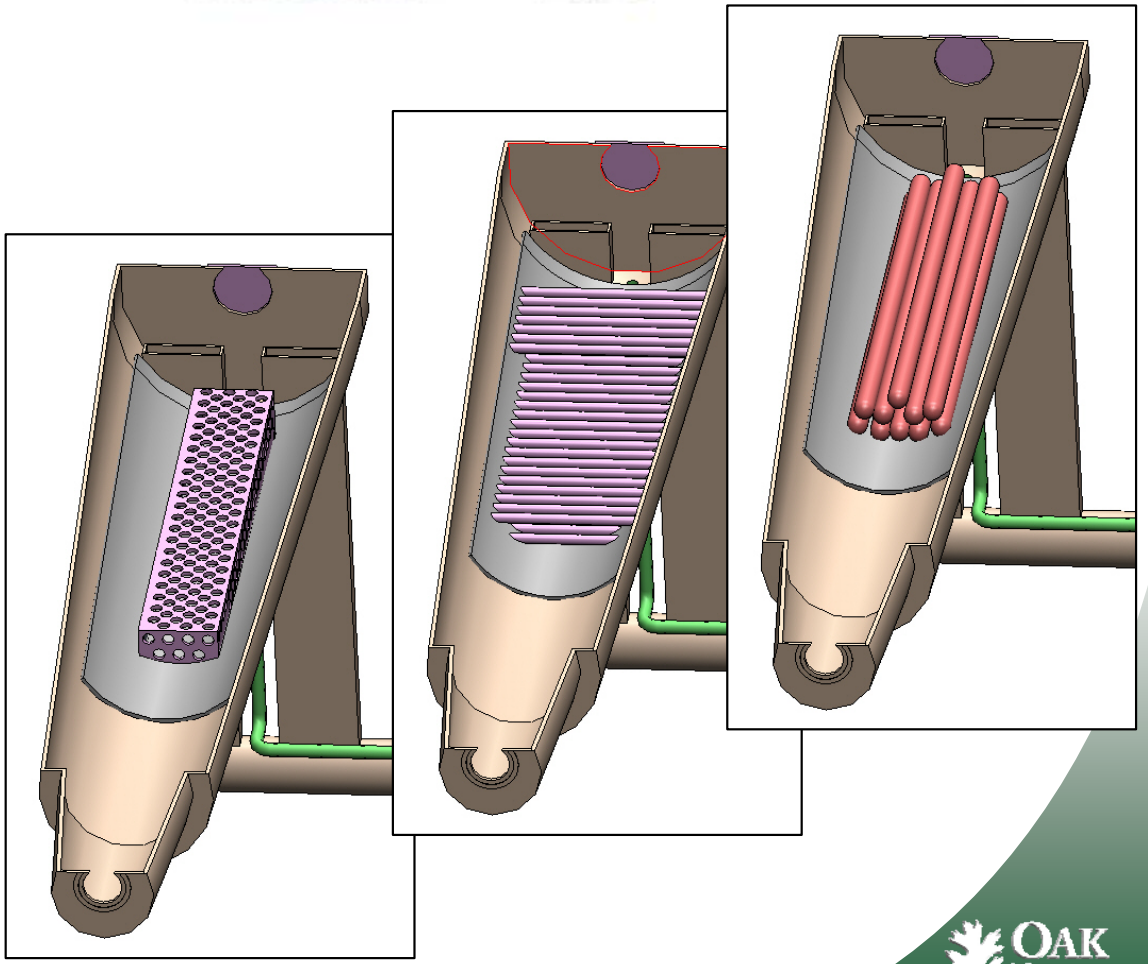
Containment Design Requirements

- **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**

Splash Mitigation

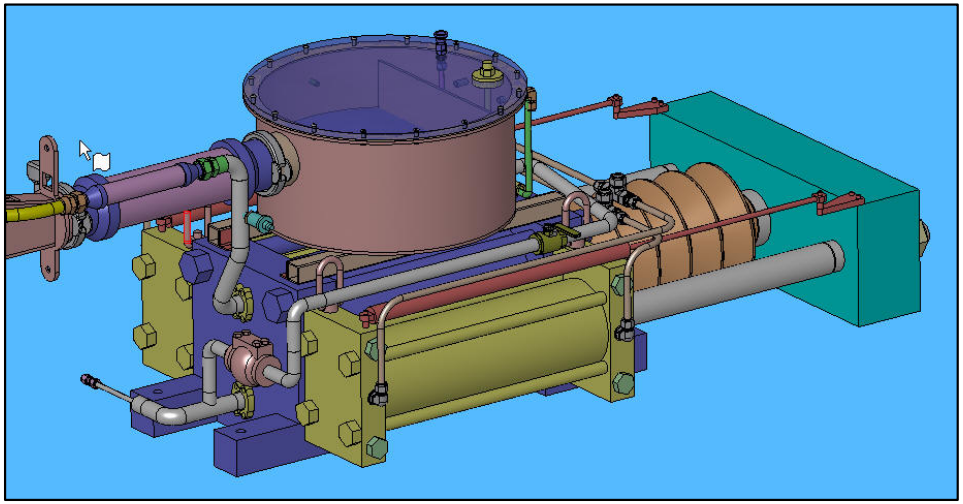
- **Study II assumed a particle bed of tungsten balls to minimize effects of jet entering pool**
- **Many other feasible concepts to accomplish this function**
- **Simulation/analytical studies may be useful to limit options**
- **Prototypic testing needed for comparison & final determination**

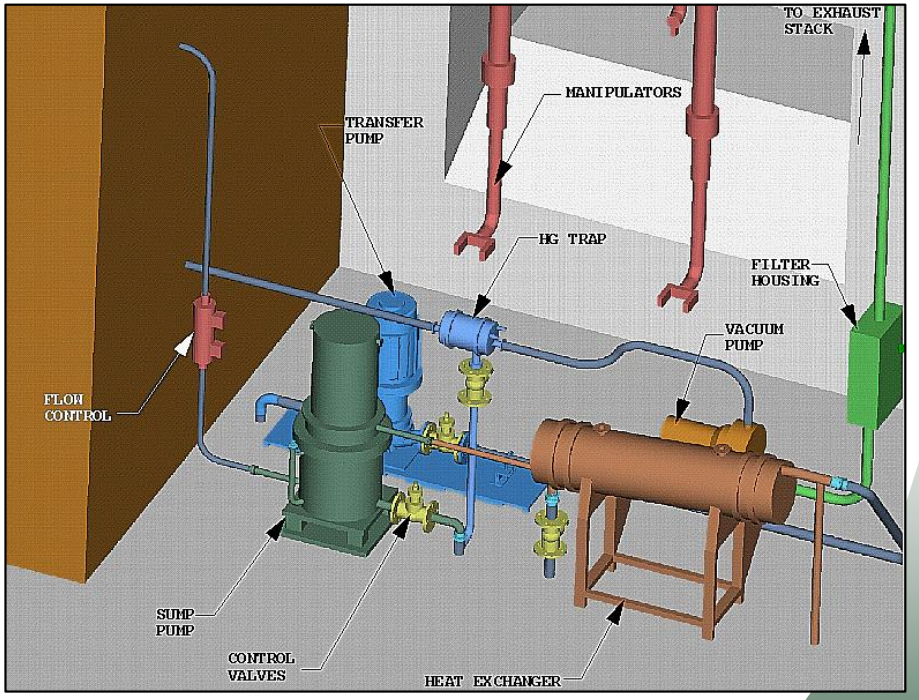




Future Efforts

- **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**