UT-BATTELLE

[NuMu Collaboration] Friday Meeting: January 28, 2005

TARGETRY (CERN Experiment)

"Hg Free-Jet Target Design Update"

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Presentation Outline

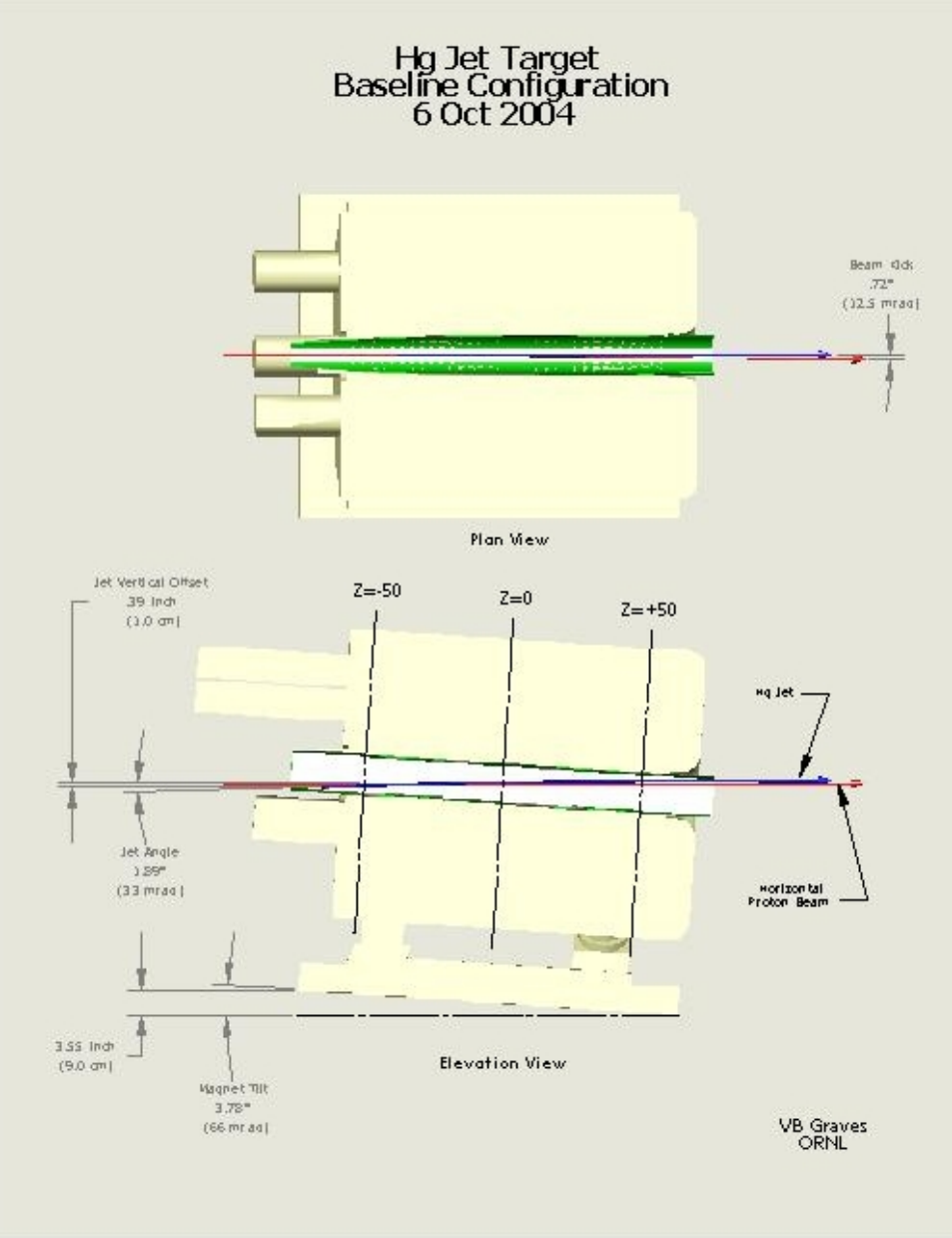
- **Baseline and alternative Hg delivery systems**
- **Nozzle design**
- **Project schedule**
- **Conclusions**

Experiment Purpose/Requirements

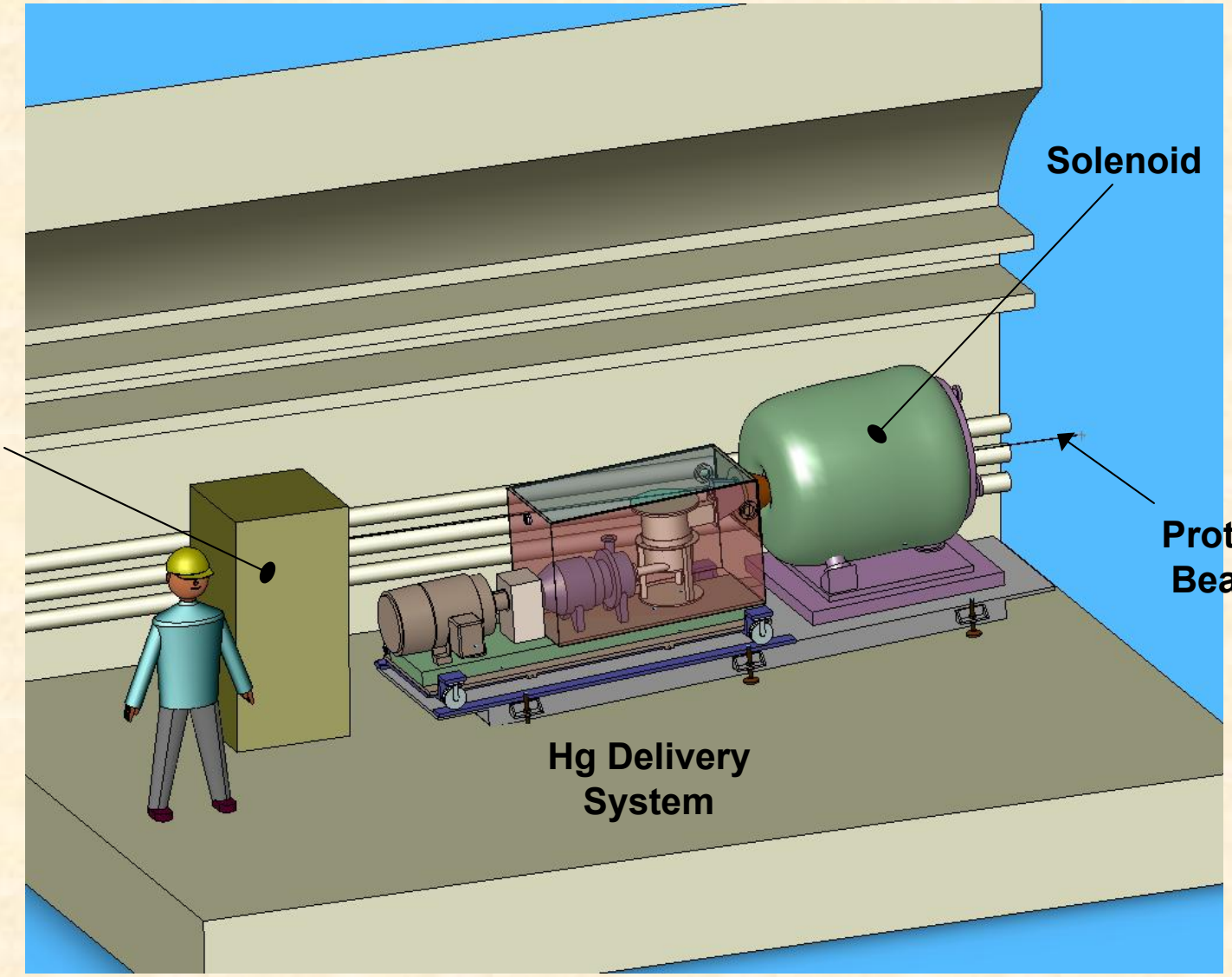
- **Proof-of-principle test to demonstrate interaction of Hg free jet and proton beam within a 15 T magnetic field**
- **Observe beam/jet interaction with high-speed optics**
- **Hg Jet**
  - **1cm dia, 20m/s (~25gpm)**
- **Magnet**
  - **Cryogenically cooled to 80°K, 15T field for 1 sec, 15 cm bore**
- **Diagnostics**
  - **Fiber-optic system integrated with high speed camera**
- **CERN facility beam 24 GeV, 1 MW**
  - **Up to 20 x 10^{12} protons per pulse**
- **Pulse-on-demand mode of operation**
- **Period between beam shots approximately 30 minutes to allow magnet cooling**
  - **40-100 beam shots over 1 week period**

Experiment Geometric Configuration

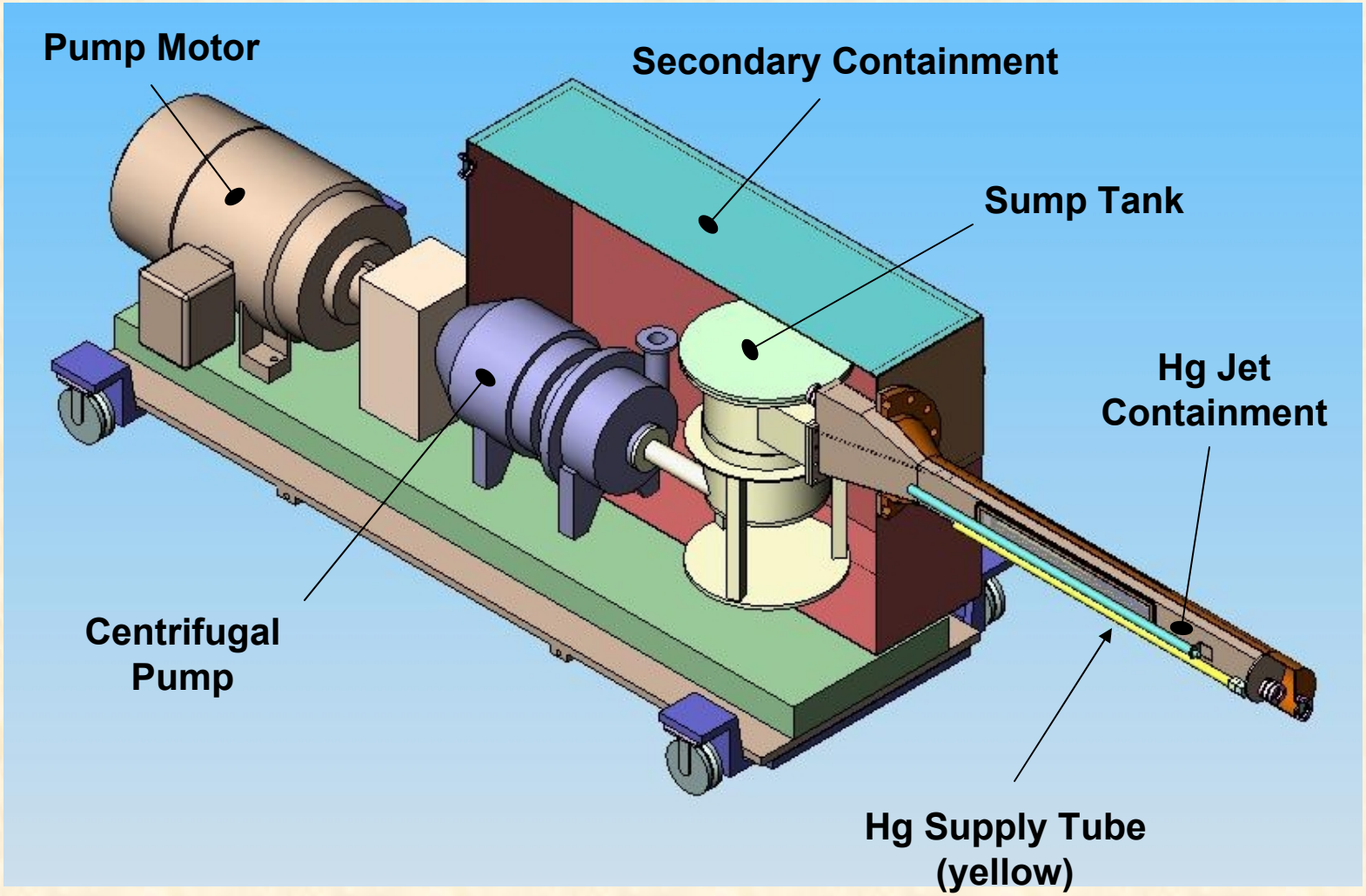
- **Experiment is prototypic of a N.F. facility target layout**
  - **Magnet tilt (wrt beam) = 66 mrad (3.8°)**
  - **Hg jet tilt (wrt magnet axis) = 100 mrad (5.7°)**
  - **Hg jet center intersects beam center at Z=0**



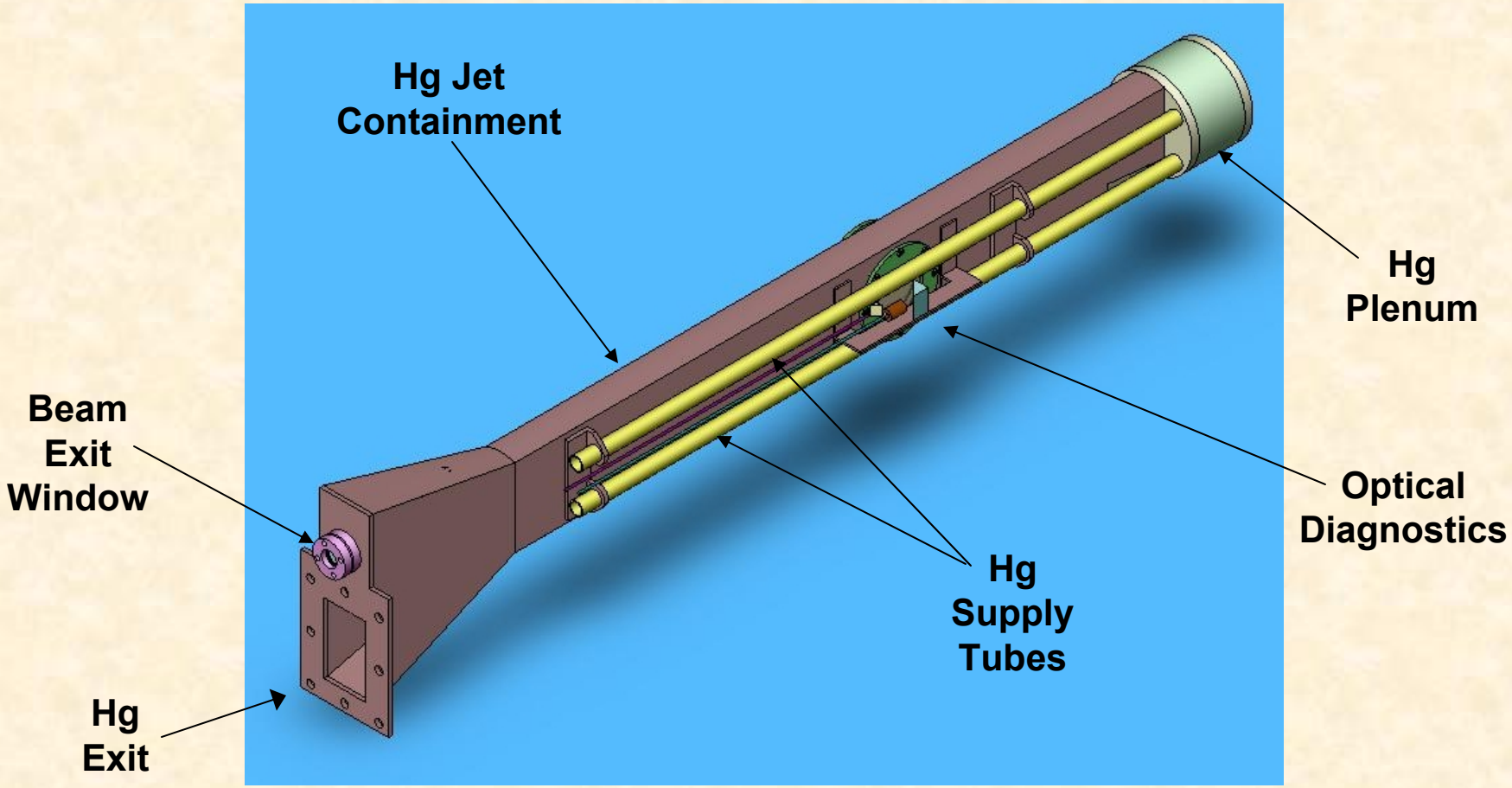
System Overview - Baseline



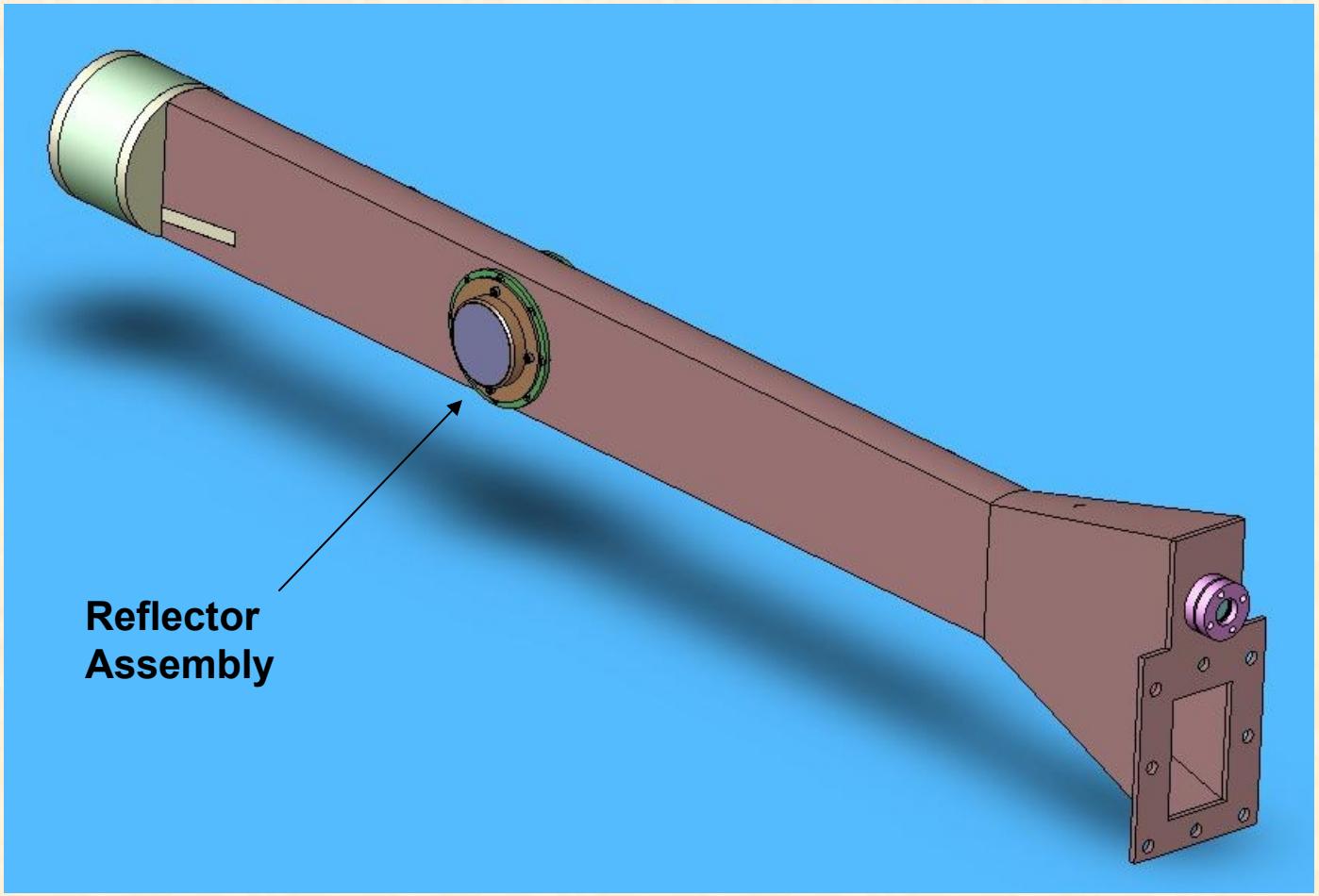
Baseline Hg Delivery System



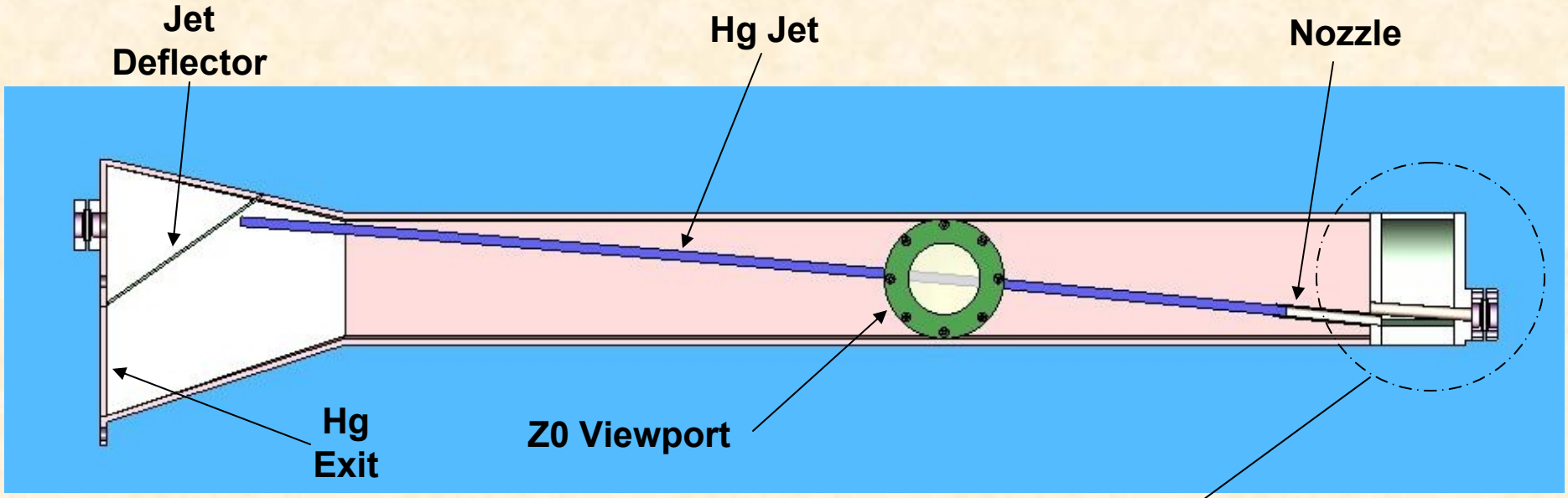
Primary Containment, Right Side

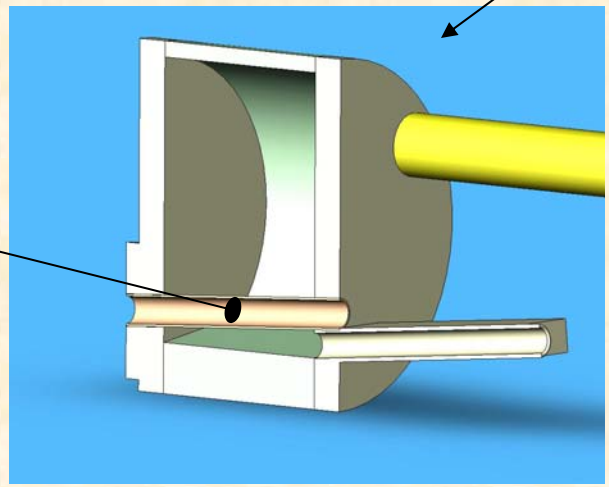


Primary Containment, Left Side

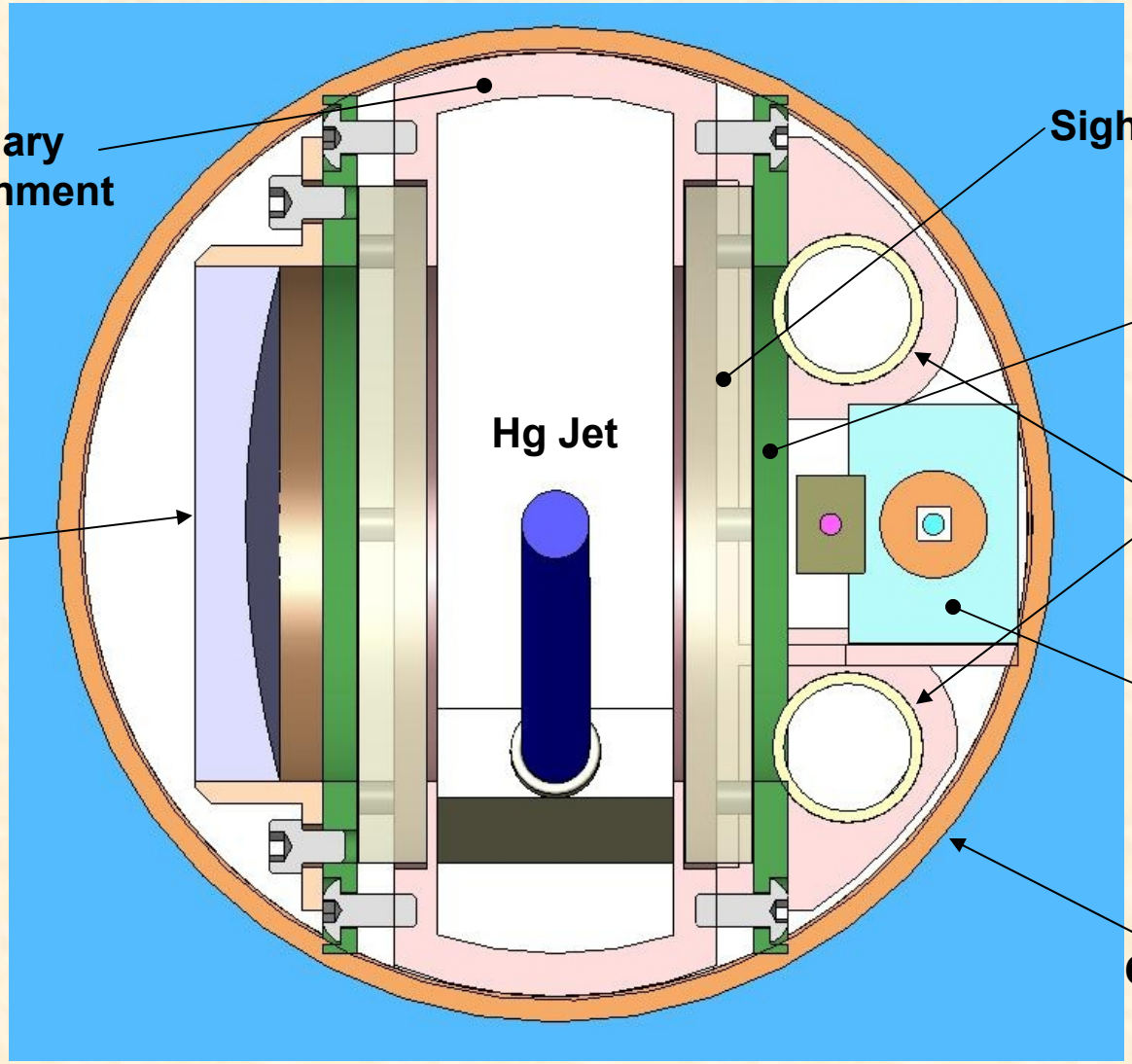


Primary Containment, Side View



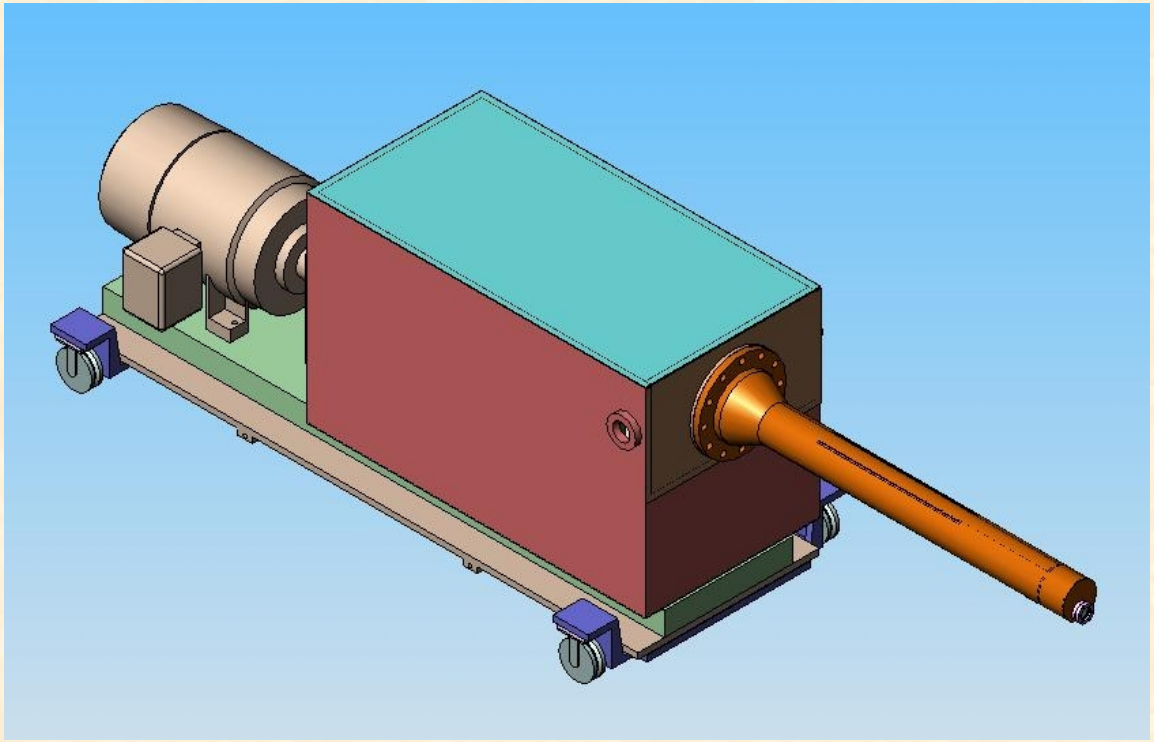


Primary Containment, Z=0 End View



Secondary Containment

- **Encloses entire primary containment system**
- **Contains Hg leaks, Hg vapors**
- **Provides access to optical diagnostics, on-board sensors**
- **Incorporates beam windows**

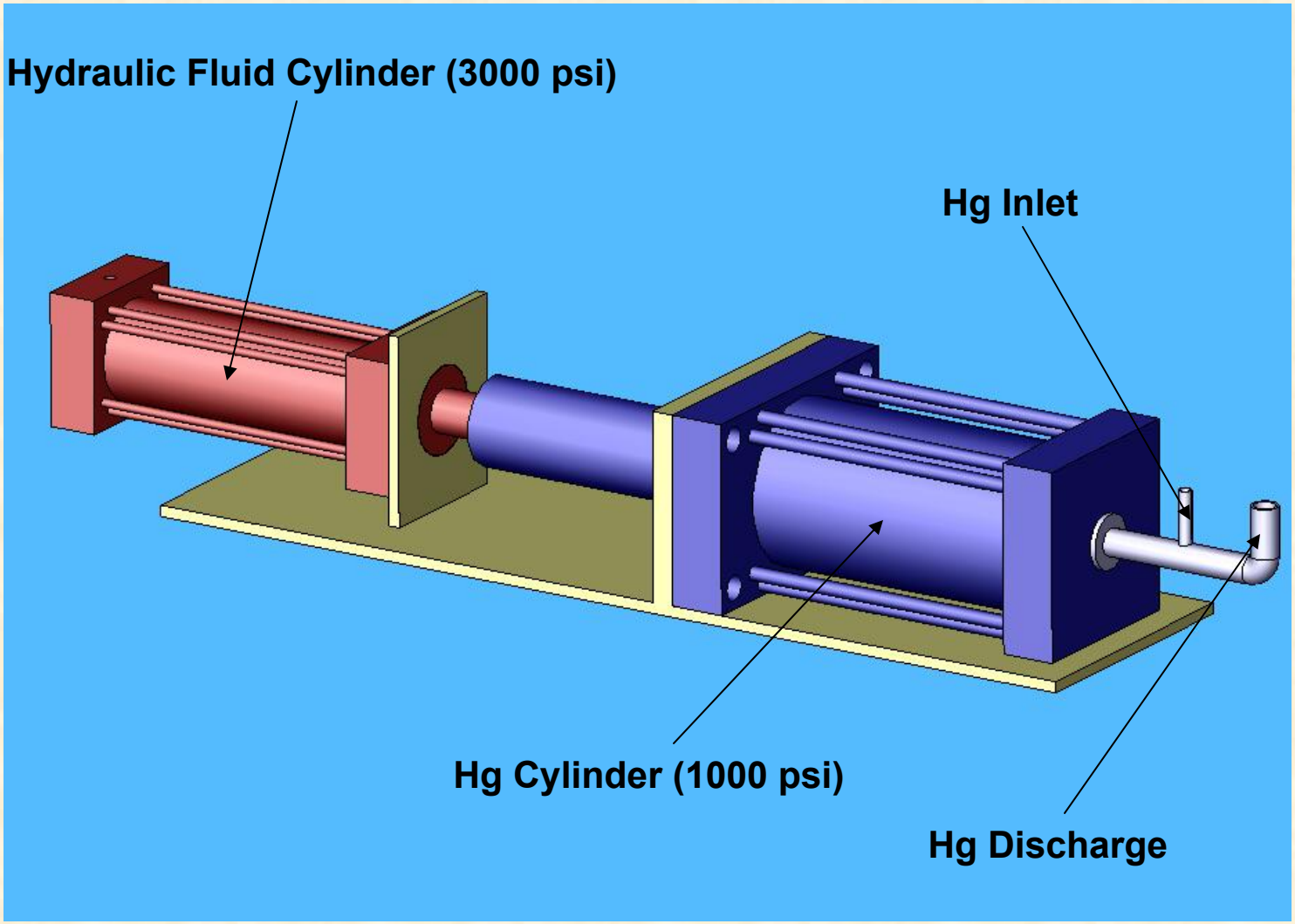


Pump Issues

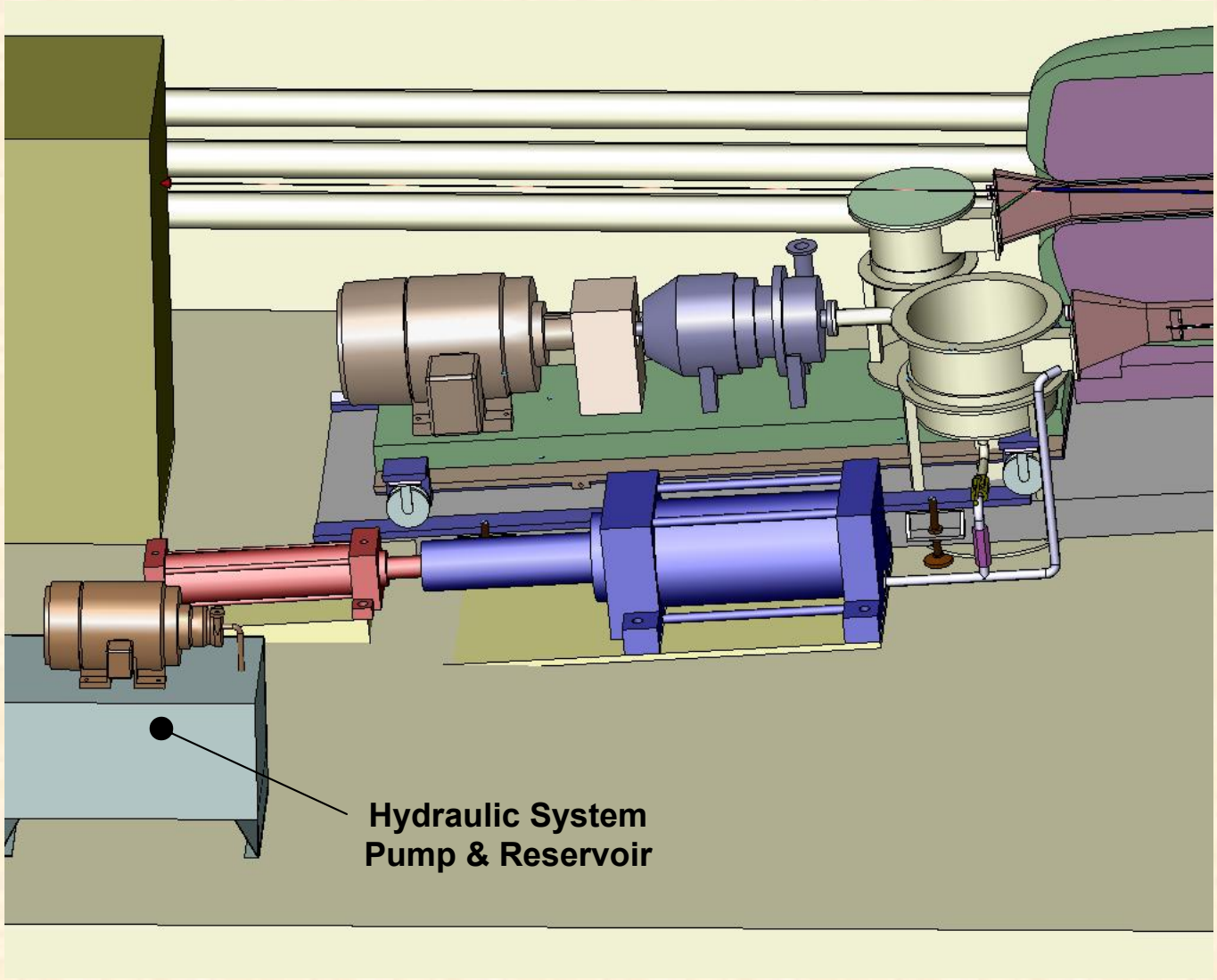
- **Pump inefficiency adds 40.5 hp of heat energy into the Hg flow**
  - **For a 12 liter Hg volume → 2.4°F/sec temperature rise**
  - **External heat exchanger may be required**
- **System pressure drops (flow losses) in the current design exceed pump output**

Nature of the experiment lends itself to a non-continuous flow system, so …

Alternative Hg Delivery System



Syringe Pump Size Comparison

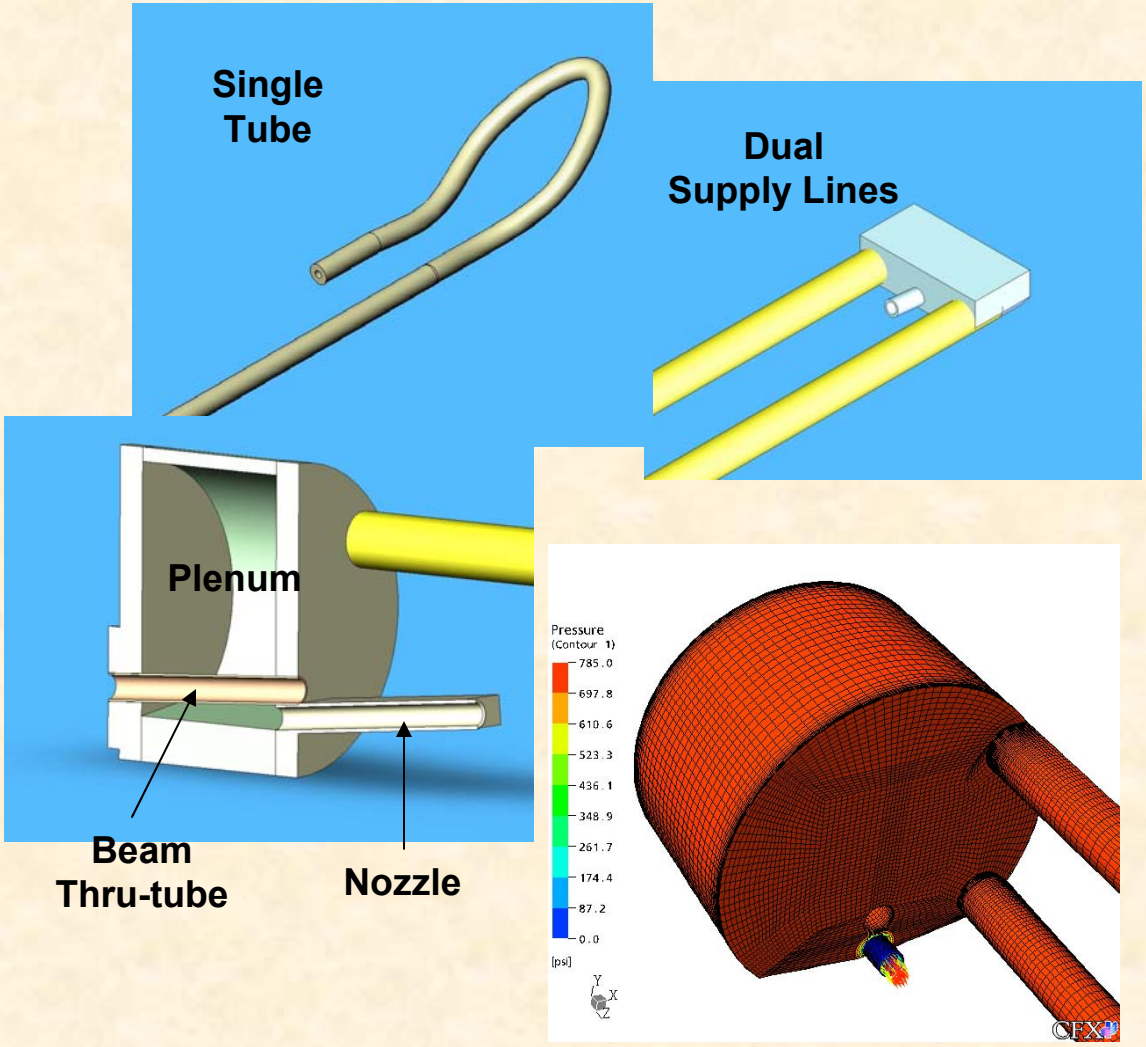


Syringe Performance Benefits

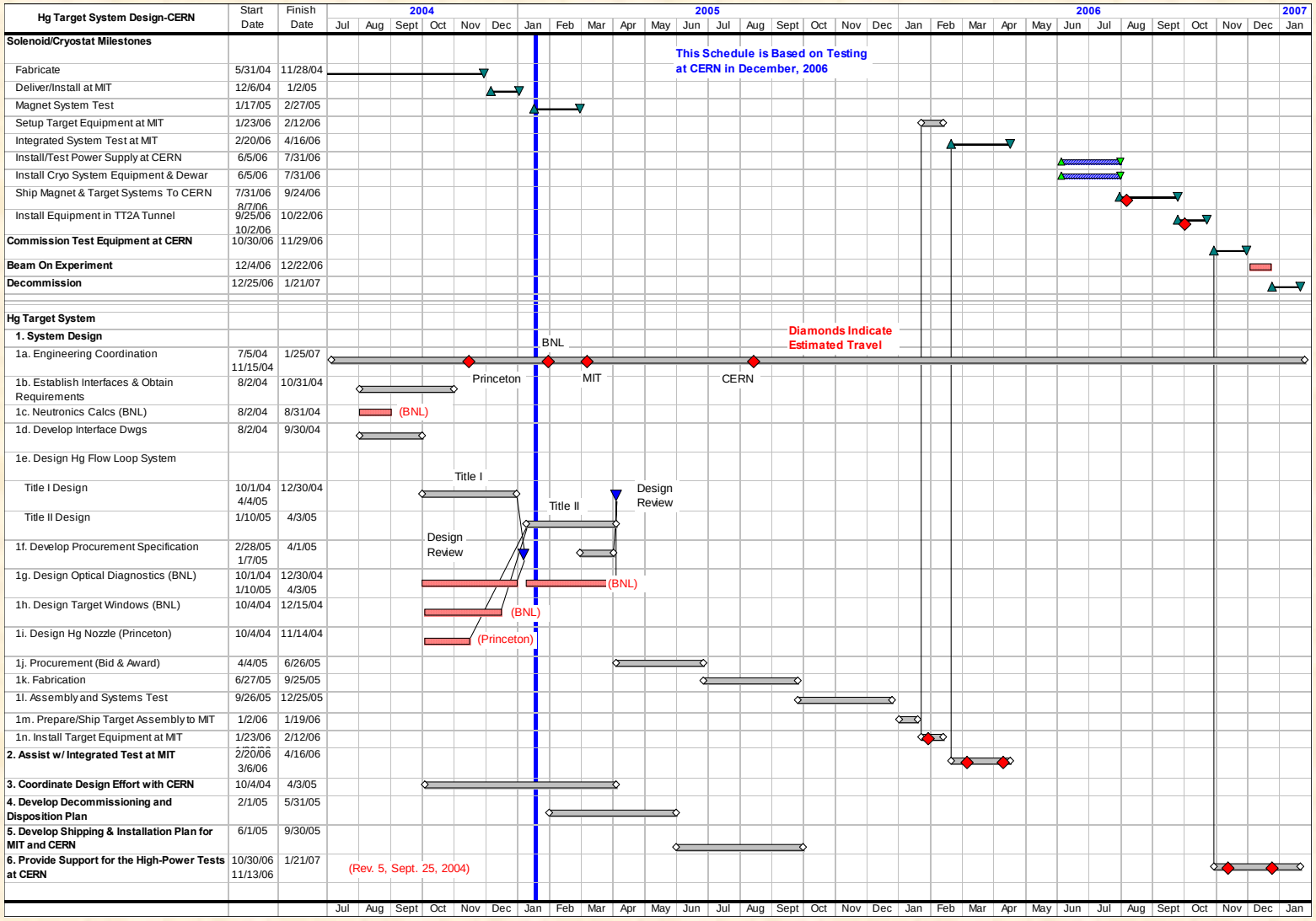
- **Piston-driven jet has excess capacity to overcome flow losses**
  - **Minor nozzle/piping changes are required but will not affect Hg delivery ability**
- **No significant heat imparted to Hg by piston**
  - **Majority of heat losses isolated to the hydraulic system**
- **No heat exchanger required**
- **Lower power requirements**
  - **Initial vendor discussions estimate 20hp for syringe vs. 60hp for pump**

Nozzle Design Still Evolving

- **Various concepts considered, problems with changing flow direction inside magnet bore**
- **Flow analysis performed, indicates plenum is sufficient, but nozzle design needs refinement**



Project Schedule (based on Dec. '06 testing at CERN ??) – Presently, No Critical Path Items



Hg Target Schedule Highlights

Title 1 Design Review at ORNL	**Feb 7-8, 2005**
Title 2 Design Review	**April '05**
Target System Fabrication (dependent on funding)	**July '05 – Sept '05**
Assembly & Testing at ORNL	**Oct '05 – Dec '05**
Integrated Testing w/Magnet	**Feb '06 – Apr '06**
Equip. Installation at CERN	**Oct '06 – Nov '06**
Beam-on Tests at CERN	**Dec '06**

Conclusions

- **Hg system conceptual design underway**
- **Baseline design is likely to be changed from centrifugal to syringe pump**
- **More nozzle analysis needed**
- **Design to be completed April 2005**
- **Fabrication in summer 2005 if funding is available**
- **Target system tests Oct-Dec 2005 at ORNL**