Mercury Intense Target (MERIT) Final Design Review

Design Approach, Requirements, Schedule, and Procurement

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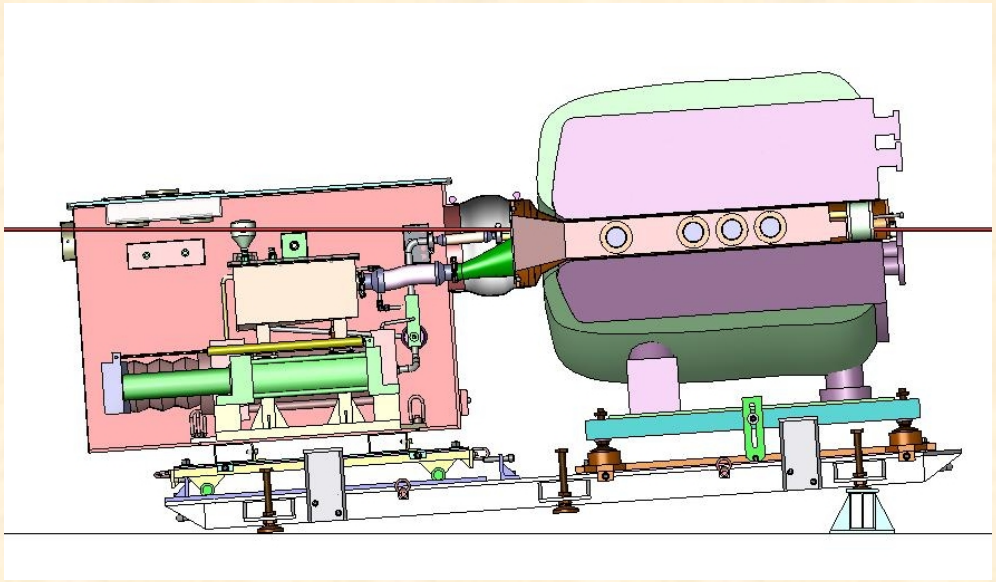
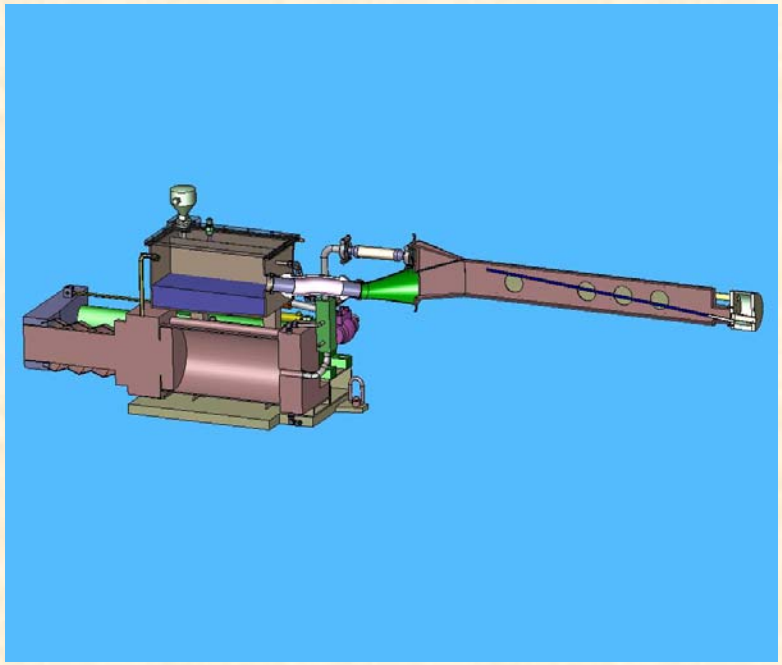
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Design Review Covers Remainder of the Hg Delivery System

(... the syringe pump is being procured)



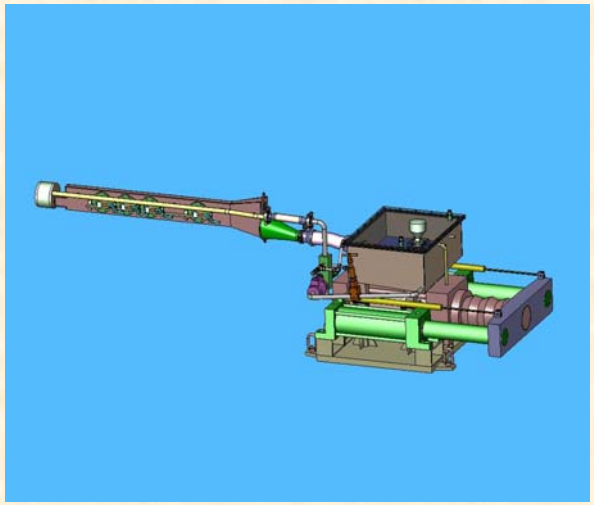


Cutaway views of the target system

Design Approach – Two Design Packages to Expedite Procurement

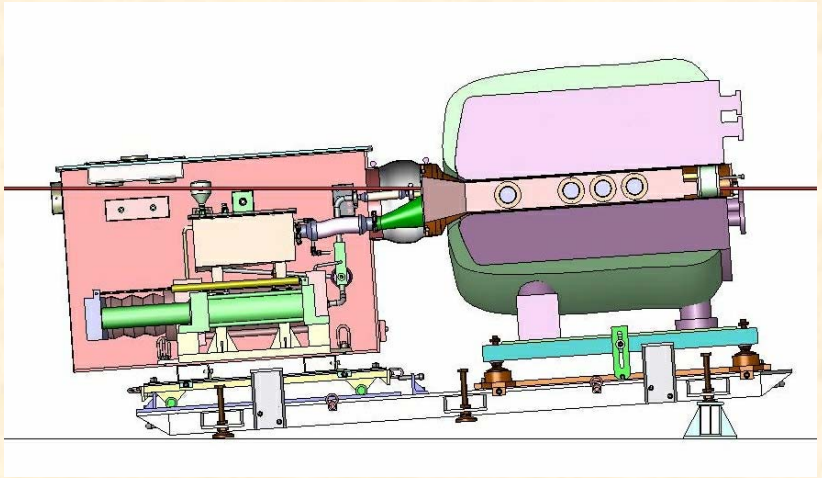
(1) Syringe Pump

- Syringe pump design replaced the original centrifugal pump due to the high pressure requirement for the system to deliver a 20 m/s jet
- Two hydraulic cylinders drive a Hg cylinder
- Stainless vs carbon steel cylinders
- Procurement underway at BNL and the vendor has been chosen



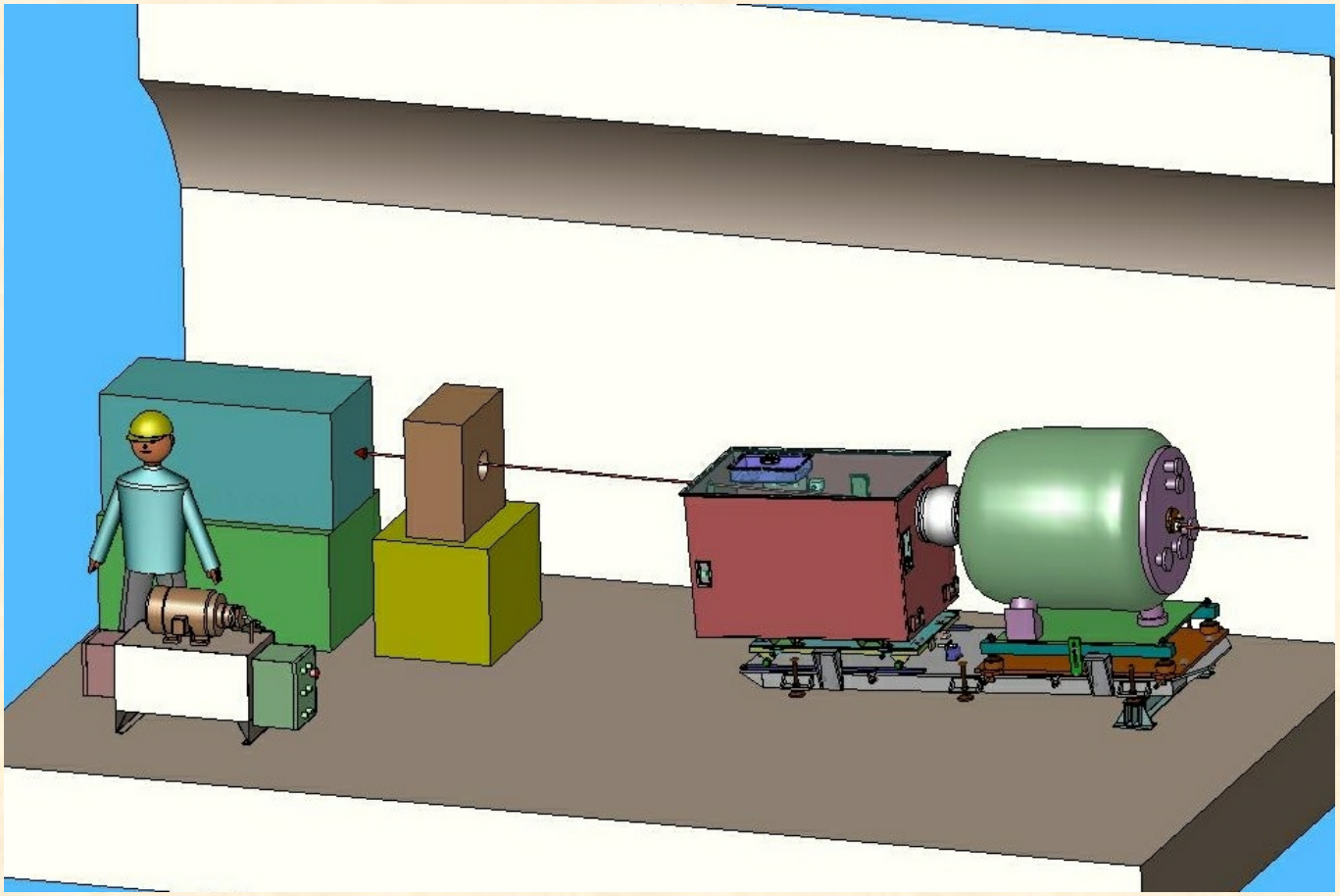
(2) Target Delivery System

- Consists of primary and secondary containments, supports, sump tank, instruments, filtered vent, supply line, laser optic windows, and beam windows
- Procurement in November using BNL procurement process



What is the MERIT?

- **The Hg Intense Target (MERIT) is part of the proof-of-principle experiment to investigate the interaction of a proton beam, high magnetic field, and free-jet Hg target**



Target Containment is Designed To Meet ISO 2919 per CERN

ISO 2919 "Classification of Sealed Source Performance" Table 2, Class 2

- **Temperature: 40º C (20 minutes); 80º C (1 hour)** ***(by analysis)***
- **External Pressure: 25 kPa absolute (60 psi) to atmospheric** ***(for the primary containment only, incl. quartz windows? – by analysis)***
- **Impact: 50 grams from 1 meter, or equivalent imparted energy**
  (P.C.-quartz windows – test?; S.C.-Lexan® panel and sleeve – test?)
- **Vibration: 3 times 10 minutes, 25-500 Hz at 49 m/s^2**
  (5 g_n, acceleration maximum amplitude) ***(n/a)***
- **Puncture: 1 gram from 1 meter, or equivalent imparted energy**
  (sleeve – test?)

Design Approach (cont.)

- **Pump equipment and target delivery system are designed at ORNL**
  - **Funding is provided for design, assembly, and testing**
- **Procure all hardware thru BNL (except for misc. items)**
- **Assemble equipment and test the system at ORNL/TTF**
  - **Characterize operating parameters of the target equipment and the laser diagnostic (pictures of Hg jet)**
  - **Ship the target to MIT along with auxiliary equipment, and support base structure**
- **Integrated system tests at MIT (w/ solenoid)**
  - **Characterize operating parameters in the magnetic field environment (pictures of Hg jet in high field)**
  - **Fit up test of solenoid/target equipment on base support structure**
  - **Ship back to ORNL – current recommendation by the ORNL Transportation Group**
  - **Ship to CERN along with all support equipment**
- **Beam-on-target tests at CERN**
  - **Proof-of-principal tests in TT2A tunnel, store, decon, pack, and**
  - **Ship mildly activated equipment plus Hg back to ORNL**

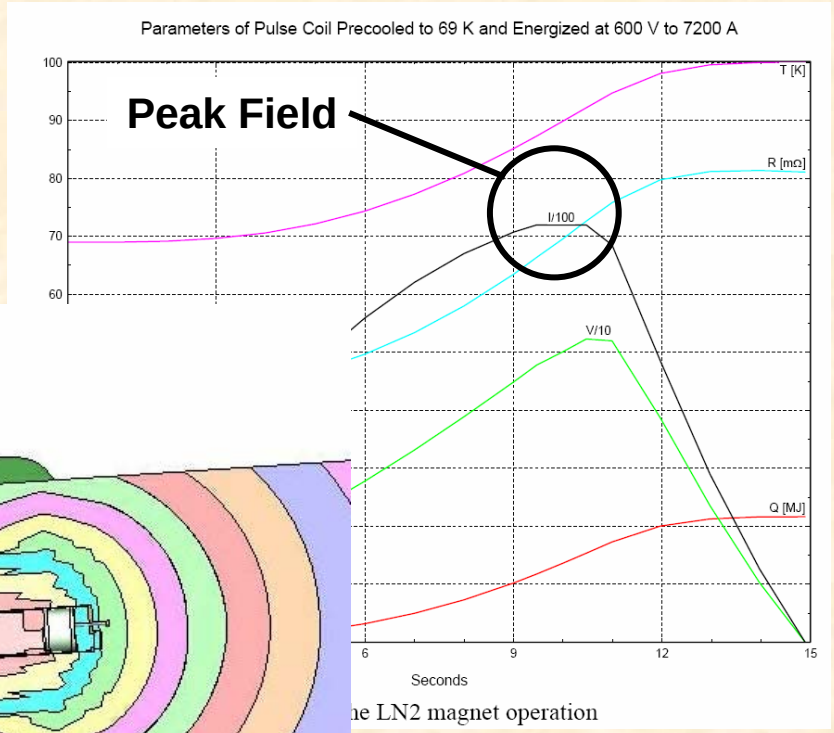
Reqmts and Operating Conditions:

Target system must deliver a stable, unconstrained jet of Hg in 1-atmosphere of air, into a 15 Tesla field

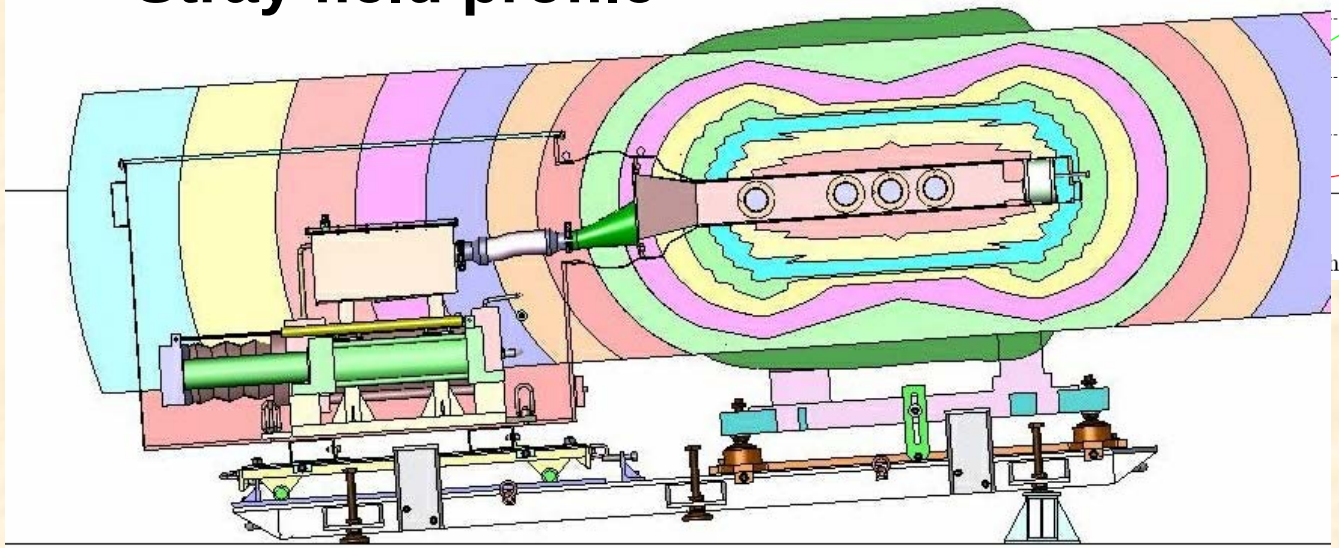
- **1-cm diameter jet at 20 m/s delivered every 30 minutes**
- **>1-sec steady state jet during the magnet peak field**
- **Full-beam interaction length is 30-cm**
- **24 GeV, 1 MW proton beam, <20x10^{12} ppp**
- **Beam line is 120-cm (47.2”) above the tunnel floor**
- **Up to 100 pulses for the CERN test, >500 operating cycles for system testing**
- **The pump equipment operates in a range of 6000 Gauss to 300 Gauss (*1 Tesla = 10^4 Gauss)***

Magnetic Field Profile

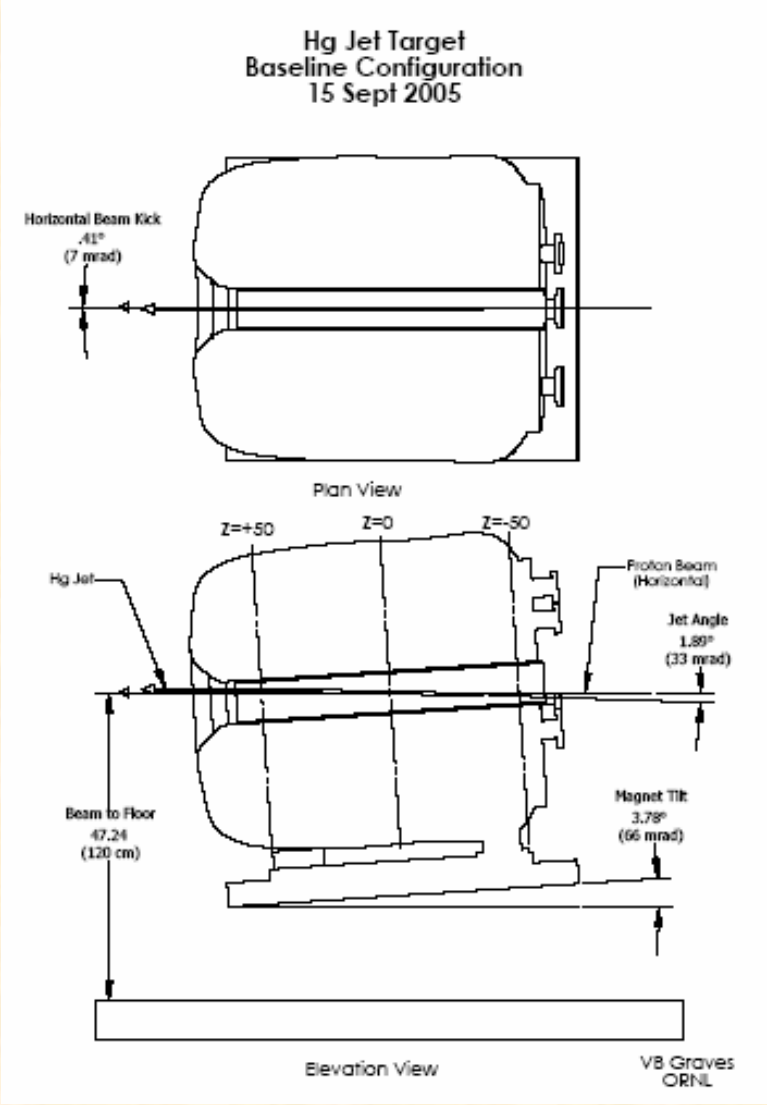
- **15 Tesla peak field has a 1-sec flat top at t = 9.5 s**



Stray field profile

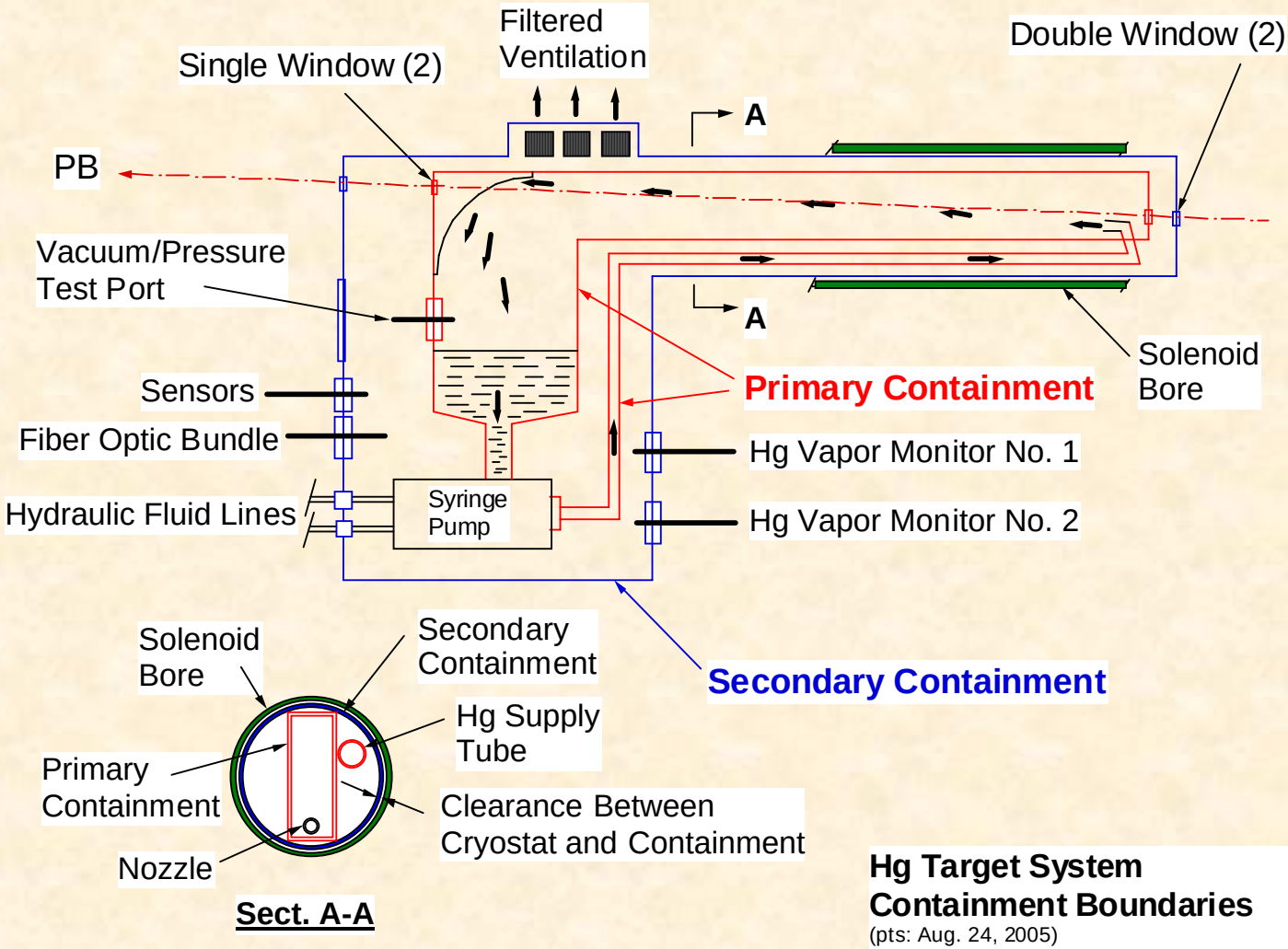


Geometry of the Interaction Region



- **0.4° horizontal kick**
- **Jet to beam is 33 millirad (1.89°); *jet to magnetic axis is 100 millirad (5.73°)***
- **The PB crosses the jet centerline at Z=0, which is also at 15 T in the center of the solenoid**

Containment Schematic



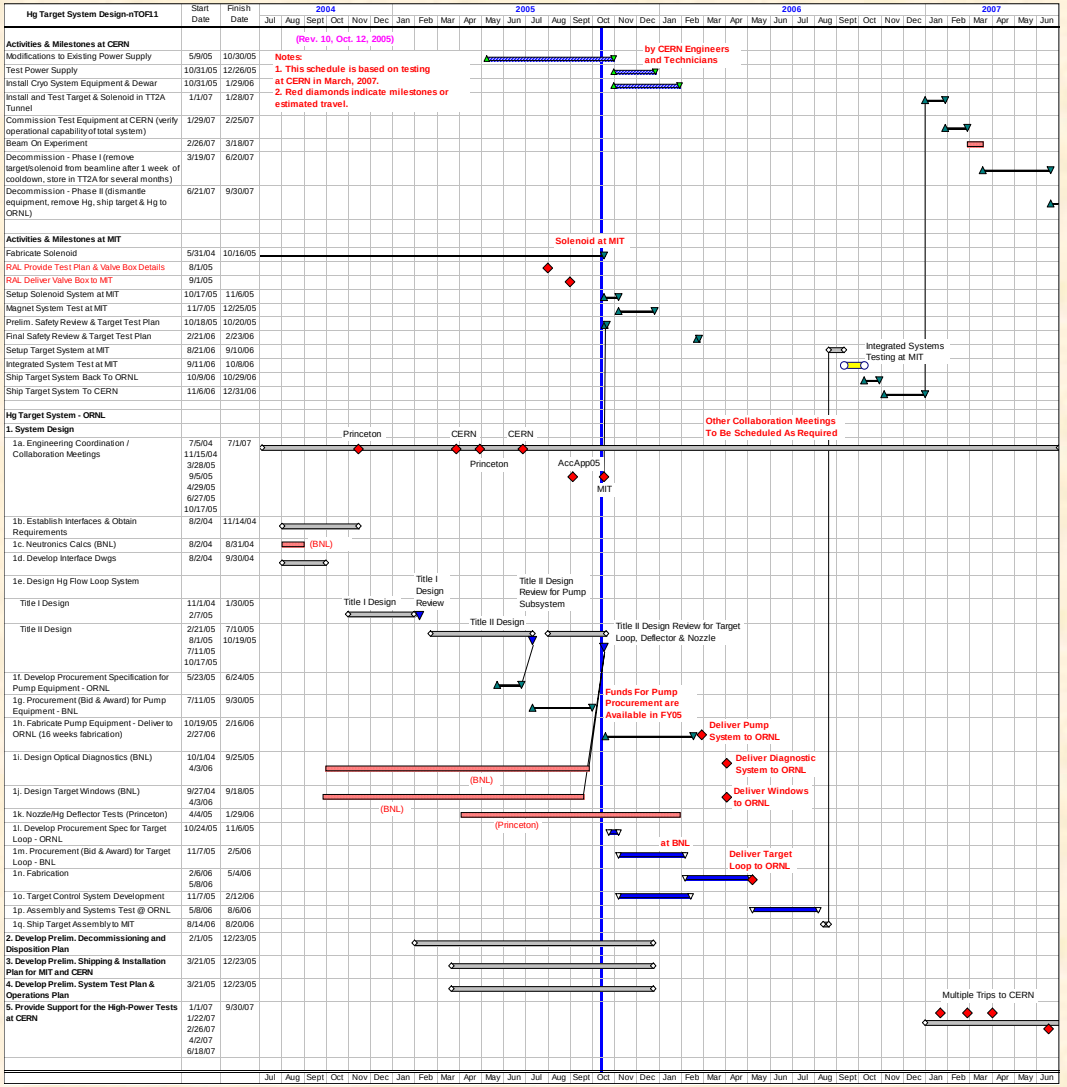
Hg Target System Containment Boundaries
(pts: Aug. 24, 2005)

Operational Requirements (cont.)

- **Target system (wetted) materials shall be stainless steel 316 or 304; other materials shall be non-magnetic, i.e., the aluminum base support**
- **Gaskets/seals shall be non-reactive with Hg and radiation tolerant to 10^4 rads (prelim. estim.)**
- **Nominal operating temperature of the Hg is 25°C**
- **Installation/alignment:**
  - **target probe axis into solenoid bore, concentric within ±1.0 mm**
  - **position target/solenoid assembly to beam line within ±0.5 mm *(fiducials are to be located from the solenoid)***

Project Schedule

- **Assemble syringe pump and target hardware May 2006**
- **Target system tests at ORNL Jul-Aug 2006**
- **Integrated system tests at MIT Sep-Oct 2006**
- **Beam-on-target experiment at CERN Mar-Apr 2007**



Procurement Plan

- **Procurement will be handled thru BNL since ORNL funding is limited to equipment design, assembly, and testing**
  - **Complete the Final Design Review – in process**
  - **Update design – next week**
  - **Write a fabrication specification that consists primarily of Solid Works® drawings – two weeks**
  - **Send specifications to BNL - before the end of November**
  - **Delivery of target system hardware including support structure to ORNL - spring 2006**

Conclusions

- **Procurement for delivery has slipped ~ 1 month**
  - **Not a problem; sufficient slack in schedule**
- **Syringe pump system contract awarded – BNL**
- **Delivery system procurement to BNL before the end of November**
- **Target system is on schedule to meet April 2007 testing at CERN**