Mercury Intense Target (MERIT)
Final Design Review

Design Approach, Requirements, Schedule, and Procurement

P.T. Spampinato
V.B. Graves
T.A. Gabriel

MERIT Collaboration Meeting
MIT Plasma Science & Fusion Center
October 17-19, 2005
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/s² *(5 gₙ, 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
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
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

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY
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