

High Power Hg Target Conceptual Design Review

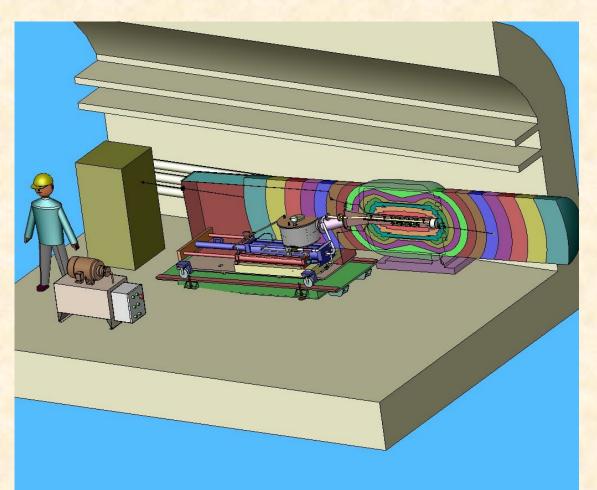
Design Requirements, Interfaces, and Schedule

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

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Design Requirements for the High Power Hg Free-jet Target Experiment

 The Hg target system is part of the proof-ofprinciple experiment to investigate the interaction of a proton beam, high magnetic field, and a freejet Hg target



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The target system delivers a free (unconstrained) jet of Hg into a 1atmosphere environment of air

- 1-cm diameter jet, delivered every 30 minutes
- Full-beam interaction length is 30-cm
- 24 GeV, 1 MW proton beam, <20x10¹² ppp
- Beam line is 121-cm (47.6") above tunnel floor
- Up to 100 pulses for the CERN test, 500 pulses for systems tests
- 15 Tesla field
- 1-sec steady state jet during the magnet peak field (unresolved)

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Magnetic Field Profile

• Peak field has a 1 second flat top at t = 9.5 s

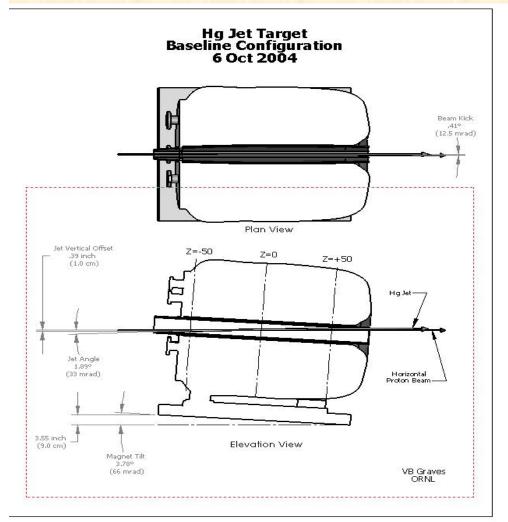
Parameters of Pulse Coil Precooled to 69 K and Energized at 600 V to 7200 A 100 T [K] **Peak Field** 90 $R[m\Omega]$ 80 I/100 70 60 V/10 50 40 30 Q [MJ] 20 10 0 9 12 15 3 Seconds

Bob Weggel's 10-14 analysis of the LN2 magnet operation

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Geometry



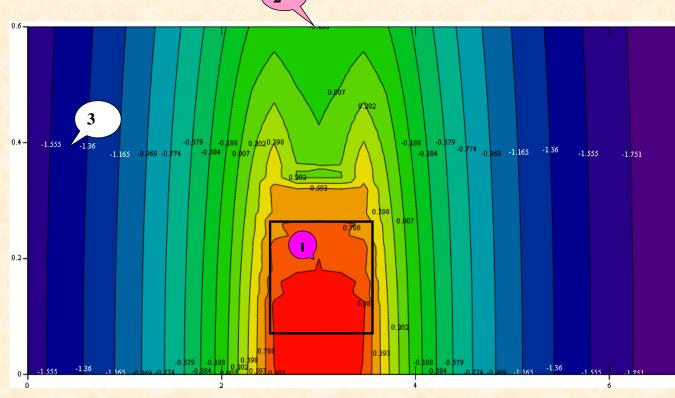
- Jet to beam is 33 millirad (1.89°); jet to magnetic axis is 100 millirad (5.73°)
- The PB crosses the jet centerline at Z=0, which is also at 15 T in the center of the solenoid

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Stray Field Plot

The 15 T field is very localized but there are substantial stray fields



 $(xyz_0, xyz_1, log(xyz_2))$

Magnetic field distribution: the axes are in meters; the rectangle is one half of the solenoid.

- The volume within the conductor is > 9.7 T (red), > 6.1 T (orange).
- The field at Z=0, R=0.6 is >0.6 T, at R=1.0 (base support structure), B> ~0.1 T (1000 G).
- The field at Z=-2.5, R=0.4 (pump motor) is 0.03<B<0.07 T (300-700 G).

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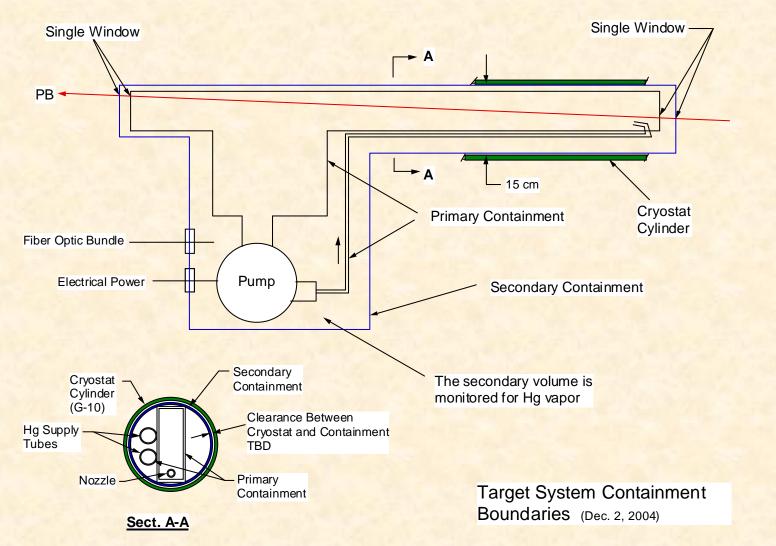
Req'mts (cont.)

- Environment primary and secondary containments have air at 1 atmosphere
 - Air activation is not an issue since the air is not purged after each pulse and 1 hour of waiting is sufficient for decay
 - May require cartridge filtration like the WNR Bubble Test Loop
- Both containments are designed for 1 atmosphere overpressure





Containment Schematic



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Target Containment is Designed To Meet ISO 2919 (per CERN)

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

- Temperature: -40° C (20 minutes), +80° C (1 hour)
- External Pressure: 25 kPa absolute (60 psi) to atmospheric
- Impact: 50 grams from 1 meter, or equivalent imparted energy
- Vibration: 3 times 10 minutes, 25-500 Hz at 49 m/s² (5 g_n, acceleration maximum amplitude)
- Puncture: 1 gram from 1 meter, or equivalent imparted energy



Requirements (cont.)

- Target system materials shall be stainless steel type 316 or 304, but ...
- Base support structure may be fabricated from painted carbon steel or aluminum
- Gaskets shall be non-reactive with Hg and radiation tolerant to 10⁴ rads
- Operating temperature of the Hg shall be from 20°C to 100°C
- Installation align and insert the target probe into the solenoid bore within ±1.0 mm, and position the target/solenoid assembly to the beam line within ±0.5 mm (fiducials are to be located on the solenoid)



Instrumentation

- Hg vapor sensor to monitor the secondary containment atmosphere, with remote readout
- Temperature sensor to monitor mercury in the sump tank, with remote readout
- Position sensor on syringe to monitor Hg flow rate through cylinder
- Viewing window(s) on the sump tank for visual observation during system tests

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Other Req'mts

- Filling/Draining Hg vacuum pump or peristaltic pump
- Maintenance/Handling equipment is assembled hands on but maintained and operated with minimal contact by personnel
- Design Life designed for 10,000 start/stop cycles
- Operating Cycle up to 20 seconds of 1-cm jet every 30 minutes, up to the temperature limit of the Hg inventory





Interfaces

- Solenoid the bore of the magnet positions the target cassette
- Proton Beam Windows the upbeam and downbeam windows are mounted to the primary and secondary containments; Ti6AI4V alloy
- Optical Diagnostics 3 windows, lenses, prisms located on the primary containment, fiber optic cables, and cable penetrations into the secondary containment
- Base Support Structure base structure is shared with the solenoid
- Facilities ORNL (TTF) for equipment testing, MIT (?) for integrated system tests, and CERN for the experiment



Issues Yet To Be Addressed

- Power supply/frequency for pump system at CERN
- Electrical cable ... who provides ~50 m of length
- Labor for installation at MIT, CERN
- What are the safety concerns ...
 - Ventilation
 - Decommissioning/disposal

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Project Schedule

Based on performing the experiment at CERN in early FY07

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