Highlights of the Princeton Target Design Meeting
November 15-16, 2004
Princeton University, NJ

Attendees:

Adrian Fabich	Van Graves	Harold Kirk
Kirk McDonald	Bill Sands	Phil Spampinato
Peter Titus	Thomas Tsang	

The items listed in this document were summarized from the notes that Van and I took during the meeting. - Phil Spampinato

Princeton Hg Pump Tests

- Tests will be performed at Princeton using the 20-hp mercury pump to demonstrate/observe nozzle characteristics and mercury retrieval characteristics.
- The test configuration will be changed from vertical to horizontal to simulate the jet characteristics in the "catcher" region.

Target Design Requirements/Discussions:

- 20 m/s jet velocity is based on the rep rate of the beam that is effectively at 50 Hz.
- The angle between the Hg jet axis and the magnetic field axis should be on the order of 100 mrad.
- The full beam interaction length is 30-cm (the "diamond" intersections add another 30-cm).
- The nozzle exit must be as close as possible to the proton beam: the center of the nozzle exit should be 10mm below the beam center.
- The nozzle should be positioned so the jet center crosses the beam center at Z=0.
- The jet must operate at 0-field and at full field, which may require a "movable" nozzle. Unless the Hg jet is in the same place in both conditions, additional optics will be required.
- Solenoid forces on the Hg in the nozzle will tend to move the nozzle tubing sideways, so some structural supports may be required depending on nozzle length.
- The primary containment chamber should incorporate a curved roof to provide maximum headroom for the Hg jet and minimize the potential for jet impact at the down-beam end of the solenoid.
- The target controller (or some higher level controller) will receive signals from the beam line as a prompt to begin Hg jet operations; this is related to timing issues for operations. There will not be a target system Emergency-stop coupled to the proton beam; safety interlocks should not be mixed with issues of timing. The beam is available every ~45 seconds, and should be "asked" for ~40 seconds before it is needed. TTL signals are likely to be required.

- The target baseline is single windows for the primary and secondary containments until the CERN committee says otherwise.
- The Hg jet deflector shown in the target system models should be fabricated from the same Ti6Al4 alloy as the beam windows and should be as thin as possible. The desired deflection angle is 45 degrees. Heating loads imparted by the beam onto the deflector are 100 J/gm/pulse.
- The instruments will include a vapor monitor mounted to the secondary containment, a flow meter to monitor Hg velocity, and a temperature monitor in the sump tank; a viewing window will also be added to the tank for observation during system testing.
- The interstitial space between the primary and secondary containment chambers has become extremely valuable real estate for system components; the primary containment chamber will be minimized to provide maximum interstitial space.
- Mercury flow in the nozzle region is proving to be a difficult issue. More design and analysis is needed in this area.
- Current target design incorporates two 1-inch Hg supply lines. These will be located on the same side of the primary containment to provide maximum room for the optic lenses and prisms.

<u>Miscellaneous:</u>

- The “fixed” magnet support could be the primary fiducial for the assembled solenoid/target.
- Fiducials that locate the magnetic axis, i.e. the centerline of the windings, and the position of “Z = 0” are needed; fiducials for the target to locate the nozzle will also be needed.
- It needs to be decided if the target insert tube should fit “snuggly” into the magnet bore, or if the insert could be made “small enough” to accommodate magnet bore tolerances and dimensional “shrinkage” during the cool down process. The magnet can support the weight of the primary & secondary tubes if needed.
- The G-10 tube can be eliminated to gain 8-9 mm of radial space, if the target secondary-containment tube incorporates a strip heater to maintain an ambient temperature condition.
- May need fiducial marks (with phosphorous paint) on the up-beam and down-beam secondary windows for final alignment to the beam line.
- A 2inch-thick soft iron plate may be needed to shield the Hg pump from solenoid field effects.
- The electronics in the Jerome Hg-vapor monitor, or the electronics of any other monitor, will have to be moved out of the beam region.

<u>CERN:</u>

- The solenoid and the target will be lowered into the TT2 tunnel from a ground surface shaft 6 x 6 meters; the equipment will move along the floor of the TT2 at a 7° down slope and turn through a shield opening 135-cm wide. The maximum allowable length of a component is 3 meters. The floor surface in the TT2A tunnel is horizontal. (Rigging operations/handling in both tunnels will be slow – sufficient time must be scheduled for moving and setting up the equipment.)

Lifting operations using the CERN “turtle” is limited to 3.6 tonnes, therefore, the CERN rigging group will develop other means for lifting the magnet component that will weigh >4 tonnes.

- Electrical power for the mercury pump is available at CERN as single-phase, 230 volts, or 3-phase, 380 volts; the simplest solution appears to be installing a transformer to meet the pump requirement of 3-phase, 460 volts (90 amperes).
- The control room will be ~50 meters from the experiment at the tunnel elevation; the cryogenic system will be ~60 meters from the experiment at the ground elevation.
- Additional shield blocks and beam stoppers are required in the TT2A tunnel for personnel safety.

Laser Diagnostic:

- More than one diagnostic lens could be placed along the beam interaction region; the positions will be determined when a lens design is chosen; a diagnostic port will also be located in the “catcher” region down beam from the interaction region.
- Tapered fiber bundles are the likely choice for transmission and are ~1/4 inch diameter.
- A right-angle prism could be used to avoid large bends at the fiber exit, and sealed bulkhead-type fittings will maintain the hermetic integrity of the secondary containment.
- The quartz window could be an integral part of the lens to maximize use of the limited space between the primary and secondary containment boundaries.

PAC ‘05:

- Van/Phil to submit a paper to the PAC’05 summarizing the target design, progress, test plan, etc. The conference is in Knoxville in May 2005 – abstract deadline is Dec. 10. (It may include a brief discussion about the Princeton tests, windows, and diagnostics.)
- Harold will present the overall CERN test program.
- Peter will present magnet test results to the extent that they are available.

Other Meetings:

- February 4-5, 2005 are the dates for the target system Conceptual Design Review, to be held at ORNL.
- February 14 is the next Collaboration Meeting in Berkeley (LBL); Van and/or Phil will present the target system design status per Harold’s request.

Actions:

- Phil to check with magnet experts at the ORNL Fusion Energy Division regarding operating rotating equipment in stray magnetic fields; Peter to ask diagnostic experts at MIT.
- Phil to send Kirk information on differential pressure sensors/venturis that could be used for flow measurements in the Princeton Hg jet tests.
- Van/Phil to reconfirm that the pump motor will operate at 50 Hz.

- Van to update the SolidWorks models with information obtained at the meeting, and provide dimensioned views for diagnostics integration.
- Phil to confirm temperature rise in Hg for current design.
- Van to determine if the Yaskawa controller can accommodate TTL signals.
- Thomas to send Van (preliminary) dimensions for a lens assembly, and other related information for fibers, prisms, etc., around December 10.
- Phil to add a “Diagnostic” column to the slide depicting preliminary thoughts on the Hg Target Operating Scenario, and change “Solenoid” to “Solenoid Power Supply” and “Cryogenic System.”
- Phil to draft an abstract for the PAC’05 for submission before Dec. 10, 2004.