nTOF11 Collaboration Meeting

Non-Design Issues for the Mercury Jet Target

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Mercury Fill Procedure

- Verify total inventory by weight before and after fill
- Peristaltic or vacuum pump will be used to transfer Hg from standard flasks
  - pump is connected to sump tank fill-port
- Up to twelve 2-liter flasks may be shipped to MIT and CERN
  - each flask is in an overpack container
- Hg fill operation occurs in the TT2A tunnel
  - fill directly from a flask using a steel tube insert
- Secondary containment is open during fill operation
  - local vapor sensing using the portable monitor
  - usual drip precautions ... plastic liner and gauze
  - “spill” clean up kit will be available
Peristaltic Pump & Standard Flask

Peristaltic Pump Test

Standard 2 Liter Flasks
Mercury Emptying Procedure

- Peristaltic or vacuum pump used to transfer Hg from primary containment directly into a standard flask
  - accurately monitor amount of Hg transferred into each flask using a scale and visually verify

- Some small quantity of Hg inventory will remain in the primary containment ... 100s ml ??

- Does CERN have the means to dispose of the secondary waste that will be generated
  - PPEs, gauze, plastic sheeting, tape, filters, ... ?
Target Cutaway Showing Fill Port

Peristaltic pump and standard flask ready for Hg fill operation
Equipment Installation

- The integrated systems test at MIT is practice for the activities to be done at CERN
  - Unpack target and store crates for reuse
  - Move target system, Hg flasks/overpacks, support structure, hydraulic pump and fluid into the lab
  - Place the solenoid onto the common support base structure
  - Install target into the solenoid bore
  - Align and elevate the equipment as required
  - Connect electrical and hydraulic services to the target system
  - Operate solenoid, target, and diagnostic

- Practice for CERN experiment operations:
  - Installation sequence
  - Alignment sequence
  - Service connections
  - Systems controls magnet/target/diagnostic
  - Dismantlement, removal
CERN Decommissioning

- 1 day minimum cool down for limited hands on access (1 wk. pfd.)
- Disconnect services as required
- Move equipment out of the beam line
- Store in TT2A tunnel for 1 month minimum cool down (1 yr. pfd.)
  - drain Hg into flasks in TT2A, and
  - drain hydraulic fluid into drums
  - move to surface facility
  - CERN packs equipment into original crates
  - load into sealand container
  - CERN ships to ORNL
Transport Plan

- Components to be shipped are:
  - Target system secondary/primary containment unit mounted on the “rolling cart” base structure
  - Common base support structure for the target and solenoid
  - Up to 12 overpacks containing Hg flasks
  - Hydraulic tank & fluid (~250 liters) and 20-hp motor
  - Misc. equipment and tools: vapor monitors, spill kit, PPEs, wrenches etc.
  - Satellite accumulation area (55 gal. Drum)

- Target system and hydraulic pump packed in wood crates
  - All crates are designed for fork lift handling, easy opening, and reuse

- Hg flasks shipped in overpack containers (10 gal. drum)

- Truck shipment of equipment to MIT for integrated systems testing, then return to ORNL

- Surface ship to CERN in a 20-ft sealand container

- Return to ORNL for reuse
Procurement Plan

• Long lead item – pump equipment
  – Write procurement spec for pump cylinders prior to Title II design review
  – 16 weeks delivery time for cylinders
  – start bid & award process in July 2005
  – purchase pump cylinders with FY06 $$ after Oct. 1, 2005
  – BNL handles $$ and procurement
  – $50-60K is estimated

• Target loop
  – Write procurement spec for target loop prior to Title II design review
  – start bid & award process in Oct 2005 using ORNL Procurement Group
  – $40-50K needs to be available from Collaboration

• Hg
  – obtain quantity needed from ORNL
  – Current market cost is $850/liter
Off Normal Events and Recovery

- **Worst Case: Entire Hg inventory leaks into secondary containment (SC)**
  - contained in bottom of containment box
  - after cool down move equipment out of beam line
  - after additional cool down period pump from SC emergency port to refill flasks
  - Add “new” SC (plastic bag)
  - Return equipment to ORNL

- **Likely Case: Hg vapors detected in SC**
  - After 1 day cool down monitor exterior of SC for leakage, visually inspect for leak, connect portable monitor to test port (false + ??)
  - If no apparent leak continue with testing
# Updated Schedule

CERN experiment shown in March 2007

<table>
<thead>
<tr>
<th>Hg Target System Design in TOF 1</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fabrication</strong></td>
<td>5/11</td>
<td>5/15</td>
<td>5/19</td>
<td>5/23</td>
</tr>
<tr>
<td><strong>Detector at MIT</strong></td>
<td>5/10</td>
<td>5/13</td>
<td>5/17</td>
<td>5/21</td>
</tr>
<tr>
<td><strong>CERN System Test</strong></td>
<td>5/20</td>
<td>5/24</td>
<td>5/28</td>
<td>6/1</td>
</tr>
<tr>
<td><strong>Same Target Equipped at MIT</strong></td>
<td>6/27</td>
<td>7/1</td>
<td>7/5</td>
<td>7/9</td>
</tr>
<tr>
<td><strong>Integrated System Test</strong></td>
<td>7/10</td>
<td>7/14</td>
<td>7/18</td>
<td>7/22</td>
</tr>
<tr>
<td><strong>Fabricate Hg System &amp; Dewar</strong></td>
<td>7/23</td>
<td>7/27</td>
<td>7/31</td>
<td>8/4</td>
</tr>
<tr>
<td><strong>Ship System to CERN</strong></td>
<td>10/2</td>
<td>10/6</td>
<td>10/10</td>
<td>10/14</td>
</tr>
<tr>
<td><strong>Start and Test Hg System</strong></td>
<td>11/6</td>
<td>11/10</td>
<td>11/14</td>
<td>11/18</td>
</tr>
<tr>
<td><strong>Commissioning Test</strong></td>
<td>12/6</td>
<td>12/10</td>
<td>12/14</td>
<td>12/18</td>
</tr>
<tr>
<td><strong>Ship System Back to ORNL</strong></td>
<td>2/6</td>
<td>2/10</td>
<td>2/14</td>
<td>2/18</td>
</tr>
<tr>
<td><strong>Integrate System in CERN</strong></td>
<td>3/6</td>
<td>3/10</td>
<td>3/14</td>
<td>3/18</td>
</tr>
<tr>
<td><strong>Beam On Experiment</strong></td>
<td>2/26</td>
<td>3/1</td>
<td>3/5</td>
<td>3/9</td>
</tr>
<tr>
<td><strong>Decommission</strong></td>
<td>3/12</td>
<td>7/31</td>
<td>7/35</td>
<td>7/39</td>
</tr>
</tbody>
</table>

**Notes:**
1. This Schedule is Based on Testing at CERN in March, 2007
2. Red diamonds indicate Estimated Travel

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**Solenoid/Cryostat Milestones**

- Fabricate 5/31/04 5/15/05
- Deliver/Install at MIT 5/16/05 6/26/05
- Magnet System Test at MIT 6/27/05 8/28/05

**Integrated Systems Testing at MIT**

- Set up Target Equipment at MIT 7/10/06 7/30/06
- Integrated System Test at MIT 7/31/06 9/24/06

**Other Collaboration Meetings to be Scheduled**

1. **System Design**
   - Engineering Coordination 7/5/04 11/1/04
   - Establish Interfaces & Overall Requirements 8/2/04 11/2/04
   - Developing Interface Dwg 8/2/04 9/30/04
   - System Design 7/5/04 11/1/04
   - Title II Design Review for Pump Subsystem 2/21/05 3/2/05
   - Title II Design Review for Target Loop & Nozzle Design 2/21/05 3/2/05

2. Develop Decommissioning and Disposition Plan
3. Develop Shipping & Installation Plan for MIT and CERN
4. Develop System Test Plan & Operations Plan
5. Provide Support for the High-Power Tests at CERN

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**Updated Schedule**

**CERN experiment shown in March 2007**

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**OAK RIDGE NATIONAL LABORATORY**

**U.S. DEPARTMENT OF ENERGY**

Princeton Meeting April 29-30, 2005
Schematic Diagram

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY
Princeton Meeting April 29-30, 2005
# Operations

<table>
<thead>
<tr>
<th>(Approx.) Time (sec.)</th>
<th>Solenoid Cryogenics</th>
<th>Power Supply</th>
<th>Target Pump System</th>
<th>Proton Beam</th>
<th>Optical Diagnostic</th>
</tr>
</thead>
<tbody>
<tr>
<td>minus 30</td>
<td>Magnet full of LN₂ @ 80°K</td>
<td>Standby</td>
<td>Refill syringe pump w/ Hg</td>
<td>Call for beam</td>
<td>Off</td>
</tr>
<tr>
<td>minus 10</td>
<td>Purge LN₂ with gaseous He</td>
<td>Standby</td>
<td>Standby</td>
<td>Wait for beam</td>
<td>Standby</td>
</tr>
<tr>
<td>0 to 8</td>
<td>Magnet full of He gas</td>
<td>Ramp to full current</td>
<td>Pressurize Hydraul. Cylinder</td>
<td>Wait for beam</td>
<td>Standby</td>
</tr>
<tr>
<td>8 to 8.5</td>
<td>Magnet full of He gas</td>
<td>Ramp to full current</td>
<td>Maintain Cylinder Pressure</td>
<td>Wait for beam</td>
<td>Standby</td>
</tr>
<tr>
<td>8.5 to 9.5</td>
<td>Magnet full of He gas</td>
<td>At full current</td>
<td>Activate syringe for 20 m/s jet</td>
<td>24 GeV, 1 MW</td>
<td>Operate laser and high speed camera</td>
</tr>
<tr>
<td>9.5 to 10.0</td>
<td>Magnet full of He gas</td>
<td>Begin de-energizing</td>
<td>Shut down syringe pump</td>
<td>Standby</td>
<td>Off</td>
</tr>
<tr>
<td>10.0 to 13.5</td>
<td>Magnet full of He gas</td>
<td>De-energize to zero</td>
<td>Standby</td>
<td>Standby</td>
<td>Off</td>
</tr>
<tr>
<td>13.5 to 1800.0*</td>
<td>Fill magnet with LN₂ @ 80°K</td>
<td>Cool down to ~80°K</td>
<td>Standby</td>
<td>Standby</td>
<td>Off</td>
</tr>
</tbody>
</table>

* Assumes a 30-minute dwell period.
Operations (cont.)

Current, Resistance and Resistive Voltage of E951 Magnets Energized from 82 K

- **Blue Curves**: Resistance in mΩ
- **Black Curves** [kA] and **Red Curves** [V/100]
- Black curves: Current, \( I \) [kA]
- Blue curves: Resistance, \( R \) [mΩ]
- Red curves: \( V_R = I \cdot R \) [100's of volts]

Solid curves: 704 V, 1-second flat top
Dashed curves: 684 V, 0.01-s flat top
Dotted curves: 671 V, 0.02-s flat top

Seconds from Start of Pulse