High Power Hg Target Conceptual Design Review

Hg Target System Controls

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Outline

• Operating environment
• Requirements / constraints
• Power requirements
• Instrumentation
• Preliminary control system scheme
• Issues
CERN Tunnel Plan View

A. Fabich, CERN
TT2A Photos

Photos from A. Fabich, CERN

Tunnel Width 400cm (158”)

Width 1.3m (51"")
Control System Requirements & Constraints

- No existing power available in tunnel
- Power system mounted on hydraulic pump reservoir
- Operator controls 60m away
- Will require some level of communication with other control systems (solenoid, beam, diagnostics)
Magnet Operational Cycle

Parameters of Pulse Coil Precooled to 69 K and Energized at 600 V to 7200 A

Bob Weggel’s 10-14 analysis of the LN2 magnet operation
## Operating Scenario

<table>
<thead>
<tr>
<th>Time (sec.)</th>
<th>Solenoid **</th>
<th>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 @ 80ºK</td>
<td>Standby</td>
<td>Fill Hg supply line</td>
<td>Call for beam</td>
<td>Off</td>
<td></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>
<td></td>
</tr>
<tr>
<td>0 to 9.5</td>
<td>Magnet full of He gas</td>
<td>Start ramp to full current</td>
<td>Ramp Hg to full flow</td>
<td>Wait for beam</td>
<td>Standby</td>
<td></td>
</tr>
<tr>
<td>8 to 9.0</td>
<td>Magnet full of He gas</td>
<td>Ramping to full current</td>
<td>Steady state Hg jet</td>
<td>Wait for beam</td>
<td>Turn on laser lighting</td>
<td></td>
</tr>
<tr>
<td>9.5 to 10.5</td>
<td>Magnet full of He gas</td>
<td>At full current</td>
<td>Steady state Hg jet</td>
<td>24 GeV, 1 MW</td>
<td>Operate high speed camera</td>
<td></td>
</tr>
<tr>
<td>10.5 to 11.0</td>
<td>Magnet full of He gas</td>
<td>Begin de-energizing</td>
<td>Shut down syringe pump</td>
<td>Standby</td>
<td>Turn off laser light and camera</td>
<td></td>
</tr>
<tr>
<td>11.0 to 15.0</td>
<td>Magnet full of He gas</td>
<td>De-energize to zero</td>
<td>Standby</td>
<td>Standby</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>15.0 to 1800.0*</td>
<td>Fill magnet with LN₂ @ 80ºK</td>
<td>Cool down to ~80ºK</td>
<td>Refill syringe cylinder</td>
<td>Standby</td>
<td>Off</td>
<td></td>
</tr>
</tbody>
</table>

* Assumes a 30-minute dwell period.
** Solenoid power supply is in “Standby” for zero-field operation.
Power Requirements

• Hydraulic pump – 460VAC, 50-60Hz, 60A
• Proportional control valve – 24VDC
• Heater foil – 120VAC
• Hg vapor monitor – 120VAC
• Instruments – 24VDC
Instrumentation & Sensors

- Cylinder position sensor
- Hg level sensor
- Thermocouple
- Hg vapor monitor
Proportional Directional Control Valve

- Bosch Rexroth 4WREE
  - Operating pressure: up to 3000psi (210 bar)
  - Nominal flow: 8.45gpm (32 l/min)
  - Sensitivity: <= 0.05% (equates to 0.003 m/sec nozzle velocity)
  - Supply voltage: +24VDC
  - Command signal: ±10VDC
Position Sensor

- Temposonics G-series linear position sensor
  - Measured variable: displacement
  - Measuring range: 2-100in
  - Repeatability: 0.001% full stroke
  - Output: voltage or current
  - Update time: <1ms
  - Supply voltage: +24VDC
Hg Level Sensor

- Omega Instruments LVR50-PP two wire liquid level float transmitter
  - Accuracy: 0.25" over span in water
  - Specific gravity: 0.75 minimum
  - Supply voltage: 10-40 Vdc
  - Signal output: 4-20mA
  - Stainless steel construction, choice of head materials

- This particular instrument is too long, but is indicative of a simple Hg level sensor
Hg Vapor Monitor

• Specifications
  – Resolution 0.001 mg/m³
  – Detection range 0.003-0.999 mg/m³
  – Accuracy ± 5% at 0.100 mg/m³
  – Response Time 13 s in sample mode; minimum auto sample time 5 min
  – Flow rate 750 cc/min
  – Power requirements 100-120 V ~ 50/60 Hz, 1A
Preliminary Control System Scheme

- Remote control over long distance limits choices
  - Analog I/O modules need to be close to equipment and power supplies

- PLC may be adequate, investigating capabilities and functionality over required distance

- LabView controller on laptop computer is suggested
  - National Instruments recommends CompactPCI I/O modules
  - Communicates to laptop via EtherNet cable
  - Allows custom operator interface, data logging if required during development
  - Should allow straightforward integration with other control systems
Issues

• No technical control issues noted at this time
• Many details to be worked out
• Analysis needed to develop control system hierarchy