Hg System Operation Review

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Muon Collaboration Friday Meeting

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Outline

• Integrated testing results
• Operational experience
• Plans at CERN
Hg System Equipment

- Syringe pump
- Hydraulic power unit w/control system
- Optical diagnostic system
- Baseplate support structures
MIT Testing Result Summary

- Completed 14 runs with field (10-15-20 m/s jets, 5-10-15 Tesla fields)
- Syringe pump performed as expected, no leaks
- Expected increased Hg pressure due to field, but no effects observed
- Water vapor issues inside jet chamber resulted in addition of strip heater on exterior of chamber
- External bore heater had to be reconfigured due to clearance issues
Hg & Hydraulic Pressure Comparison - 0T vs. 15T
20m/s Hg Jets

Design Pressures:
Hg Cylinder - 100 bar
Hydraulic Cylinders - 200 bar
Nozzle Velocity Comparison - 0T vs. 15T

Syringe Command Signal

0.000 500.000 1000.000 1500.000 2000.000 2500.000 3000.000

Nozzle Velocity (cm/sec)

Syringe Command 0T  Syringe Command 15T  Nozzle Velocity 0T  Nozzle Velocity 15T

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Addition of Strip Heaters

- Approx 0.5L water not removed from system prior to Hg operations at ORNL
- Insertion into magnet caused condensation on viewports
- Modified existing flexible heaters to prevent condensation
- New heaters and controllers procured for CERN operation
Operational Experience

- Hg fill/drain process performed twice without incident
- Small Hg leak occurred at ORNL
  - Contained within secondary, no problems in cleanup
- Control system functions as expected
  - Tested emergency stop conditions
- Hg vapor detection and capture
  - Vapor monitors work as expected
  - Local ventilation system (Scavenger) quickly removes any vapors within secondary, zero emissions detected at exhaust
Hg Fill & Drain Procedures Tested

- Two fill and drain cycles completed
  - MIT cycles observed by CERN personnel
- Peristaltic pump method works well, minimizes spill risk & vapor generation
- Drain into intermediate container reduces chance of overfilling flask
- Flasks weighed empty & full to track inventory
- No spills or operational problems
Hg Leak Experienced

- Very high vapor levels inside secondary detected at ORNL
  - No vapors detected outside secondary
  - Scavenger snorkel successfully removed vapors

- Suspected Hg cylinder bellows & made effort to seal seams
  - Upon disassembly, no vapors detected inside bellows

- Small Hg leak discovered in nozzle supply threaded joint
  - Successfully removed liquid and tightened joint
Emergency Stops Tested

- Syringe pump stopped during 20m/s jet creation
- No detrimental effects on equipment
- No noticeable vibration or shudder
Plans at CERN for Hg System

• Transport all equipment into TT2/TT2A (start Apr 23)

• Open secondary containment prior to Hg loading (start May 7)
  – Procedures in place for this operation
  – Leak check primary containment (pressure decay test without opening primary)
  – Connect optical diagnostics system & adjust viewport optics
  – Install new heater strips
  – Install umbilicals and operate optical diagnostic system

• Close secondary
  – Install other umbilicals (hydraulics, sensors, vapor monitors)
  – Load Hg

• Perform Hg system commissioning tests (start May 14)
  – System can be operated and tested independently of solenoid
Conclusions

• System operating characteristics have been quantified during ORNL and MIT testing

• 15T field induced no additional pressure on Hg piping, system well within design pressures

• Secondary containment has prevented vapor escape

• Valuable operational experience gained
  – Hg leak experienced
    • Detected with instrumentation, contained within secondary, successfully mitigated
  – Control system functionality proven