Hg System Operation Review

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Muon Collaboration Friday Meeting

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U. S. DEPARTMENT OF ENERGY

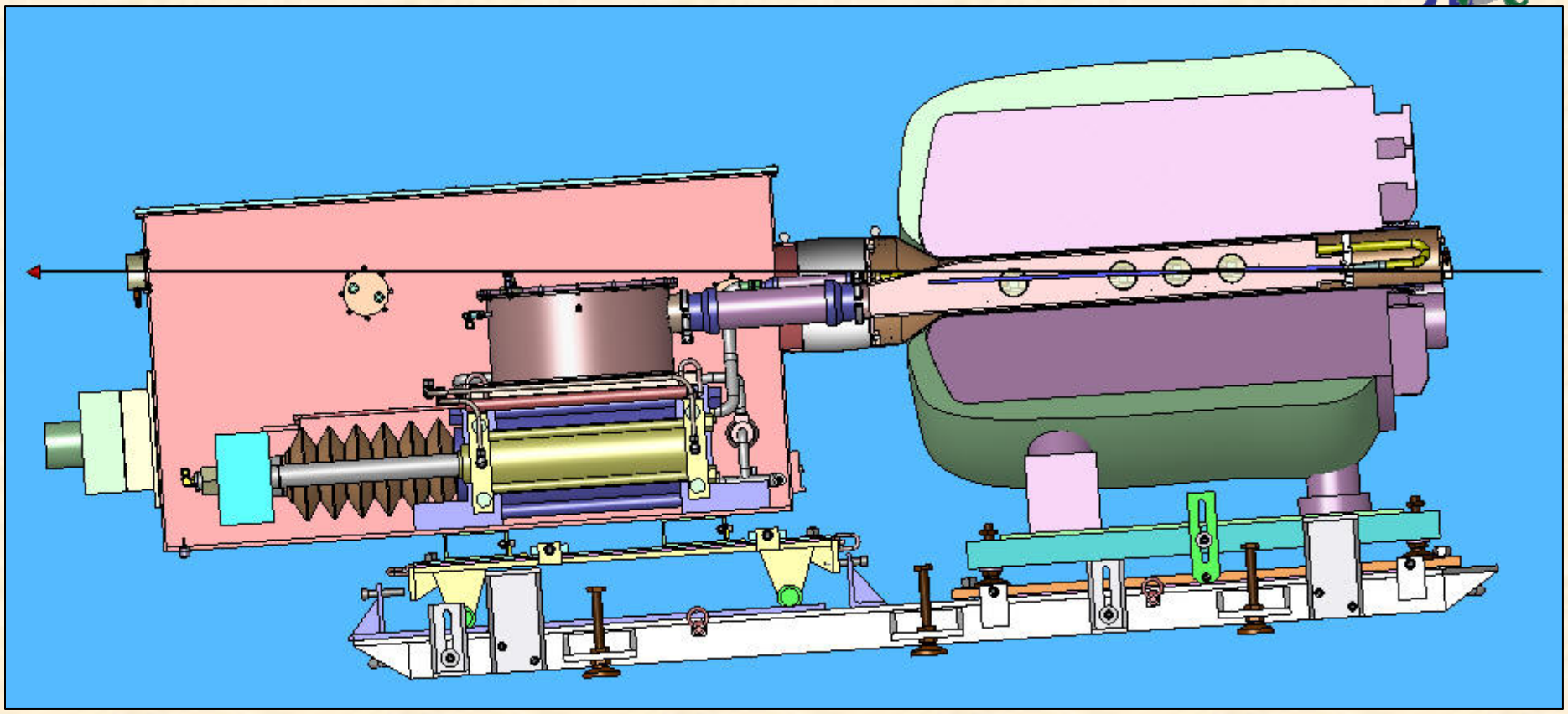
Outline

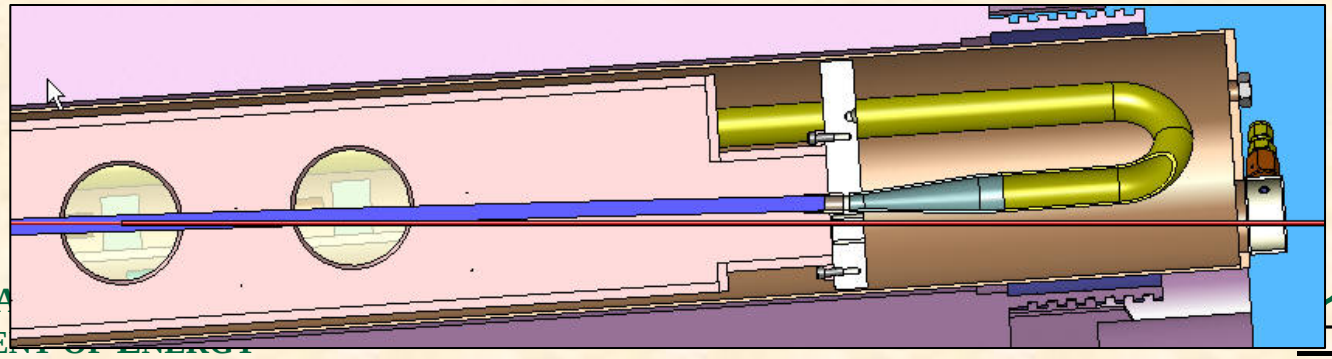
- **Integrated testing results**
- **Operational experience**
- **Plans at CERN**

Hg System Equipment

- **Syringe pump**
- **Hydraulic power unit w/control system**
- **Optical diagnostic system**
- **Baseplate support structures**

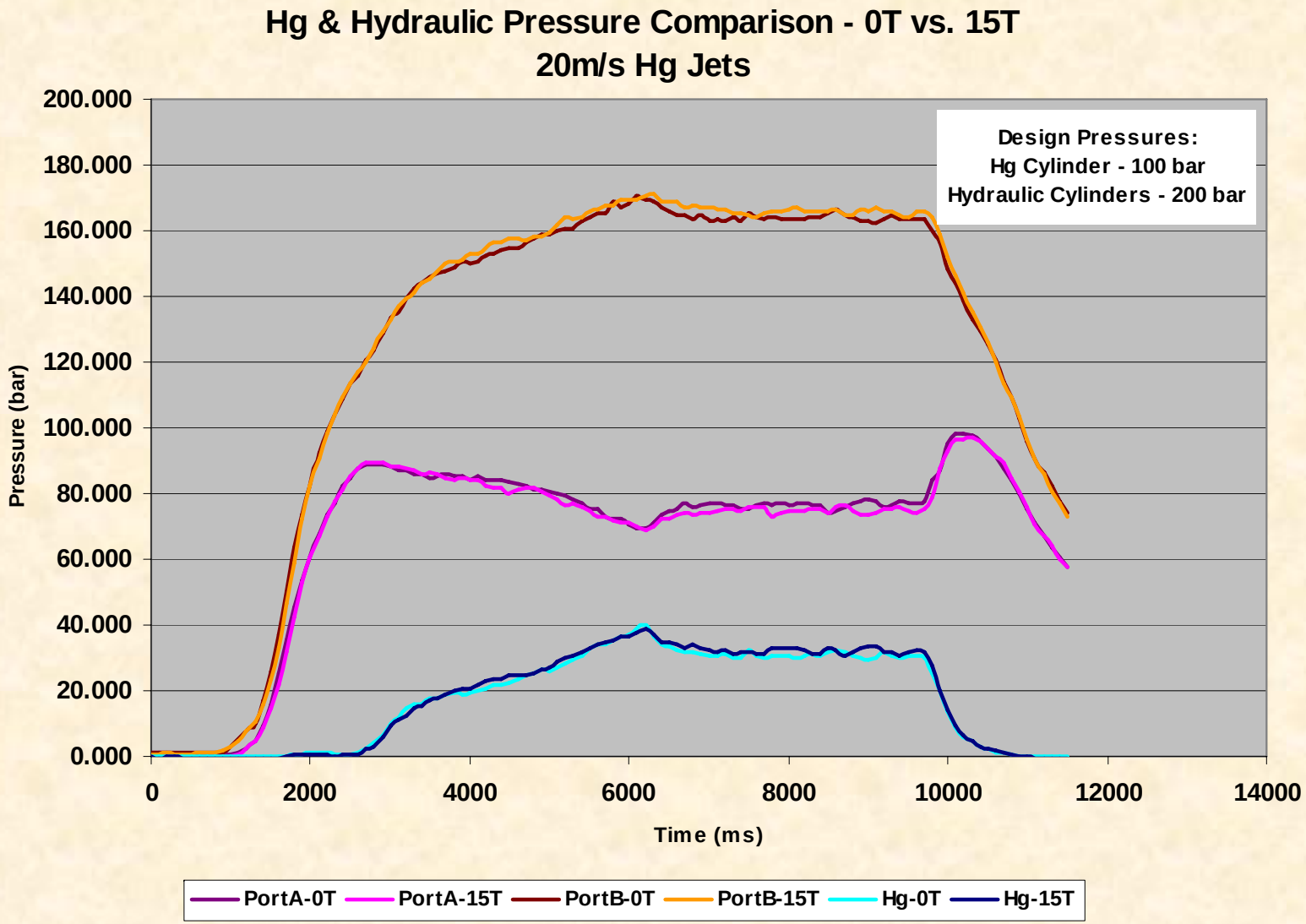
MERIT Side View



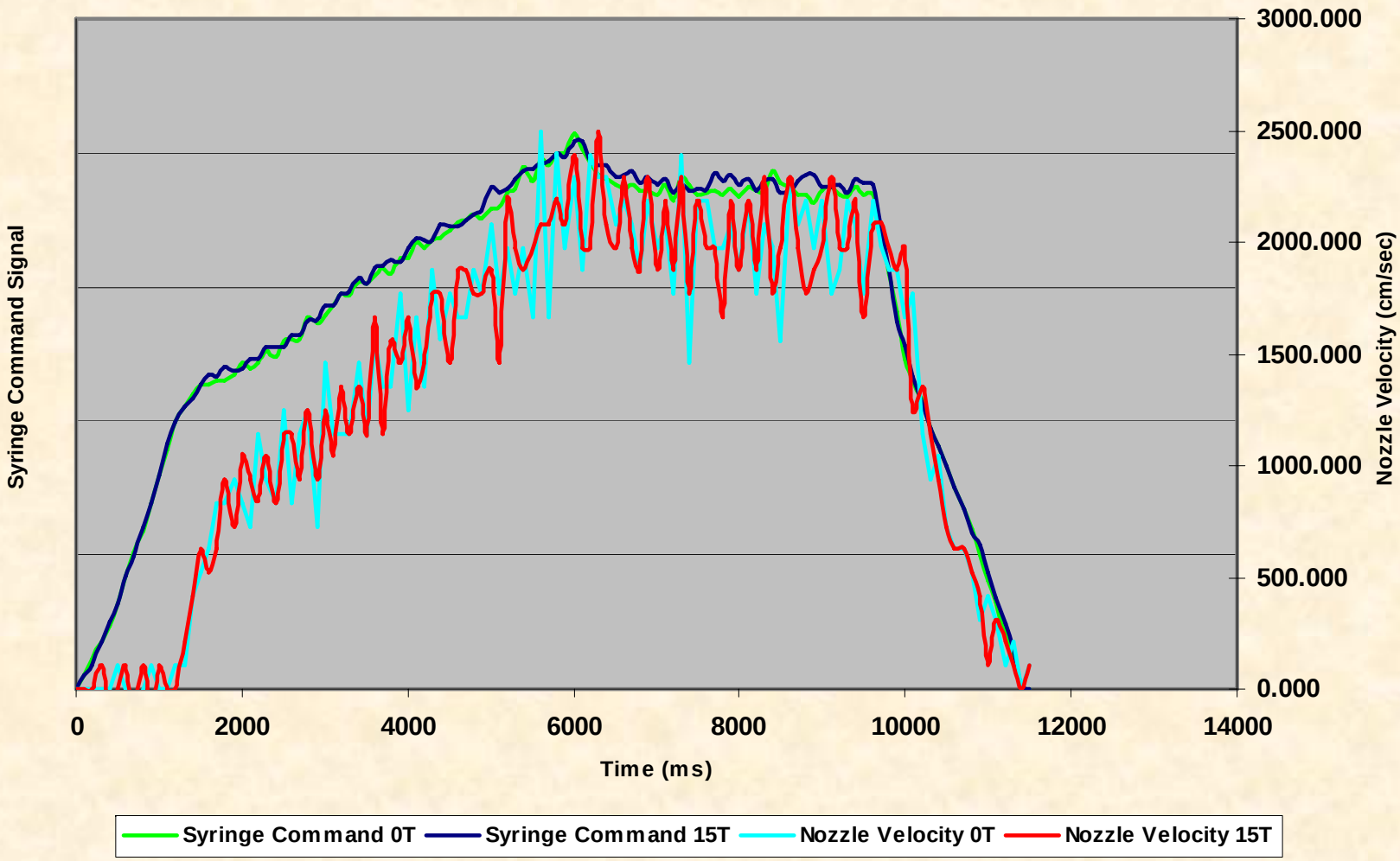


MIT Testing Result Summary

- **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**

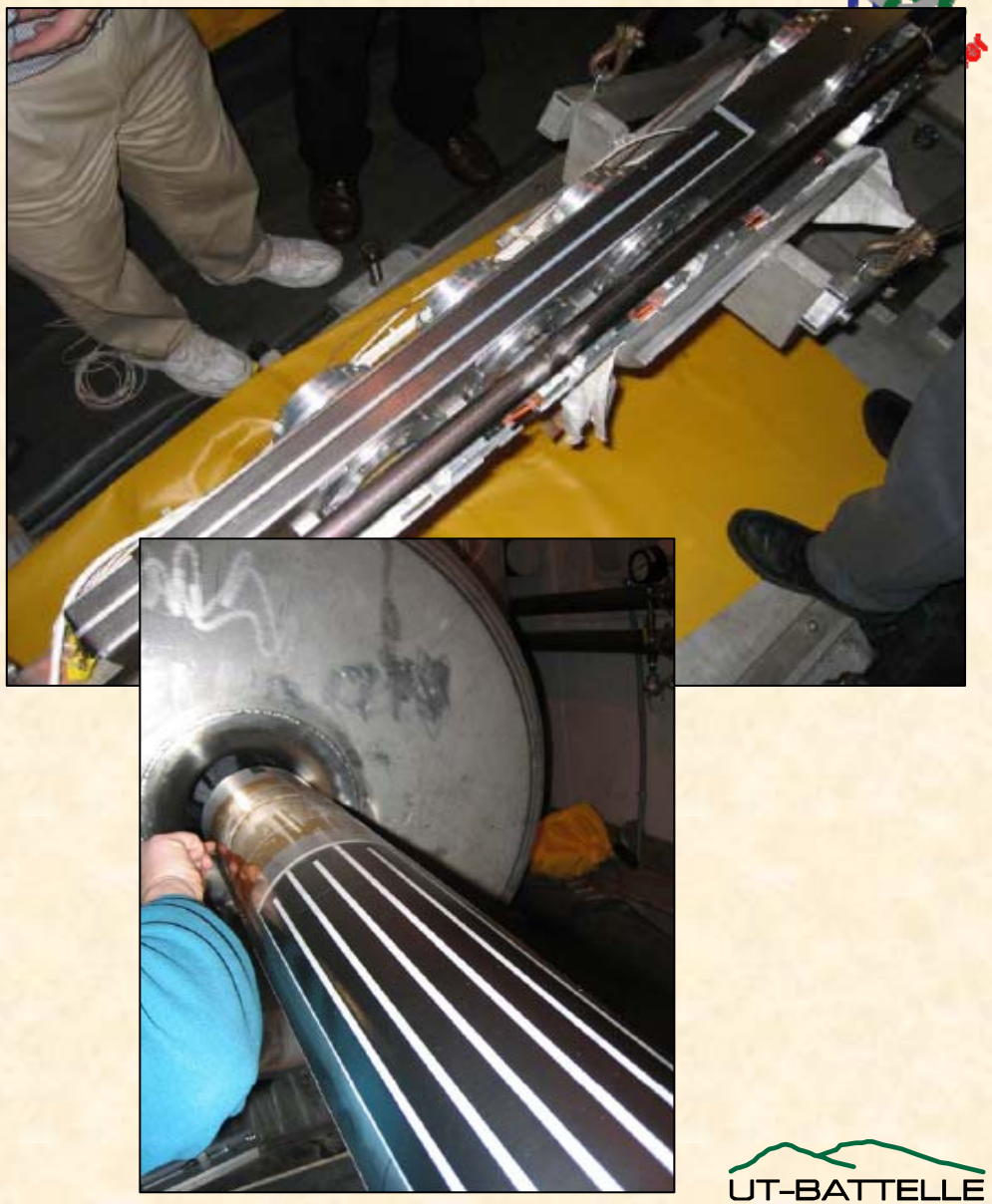

Hg & Hydraulic Pressure Comparison - 0T vs. 15T
20m/s Hg Jets
Design Pressures:
Hg Cylinder - 100 bar
Hydraulic Cylinders - 200 bar
Pressure (bar)
200.000
180.000
160.000
140.000
120.000
100.000
80.000
60.000
40.000
20.000
0.000
0
2000
4000
6000
8000
10000
12000
14000
Time (ms)
PortA-0T
PortA-15T
PortB-0T
PortB-15T
Hg-0T
Hg-15T

Nozzle Velocity Comparison - 0T vs. 15T



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

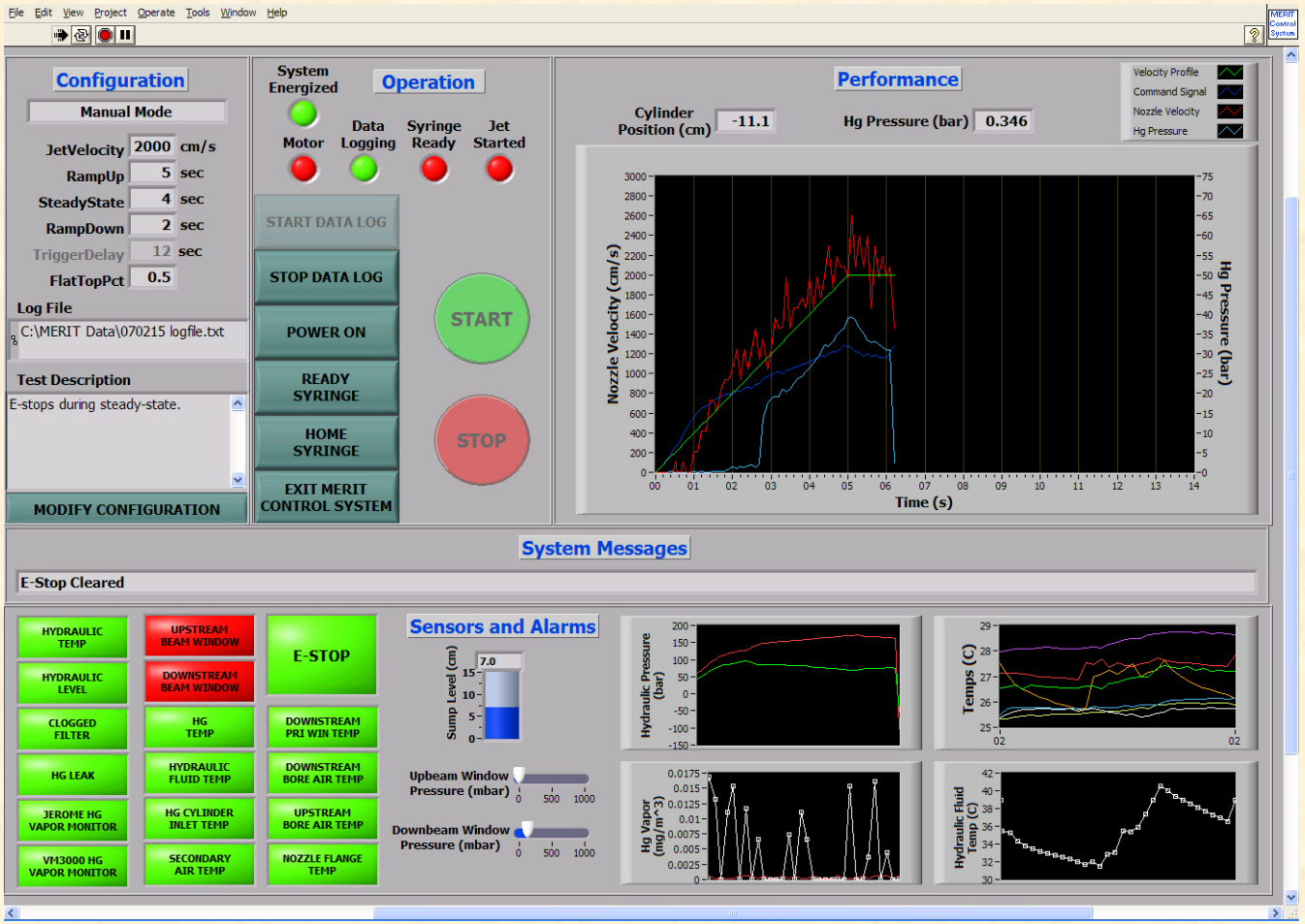
- **Two fill and drain cycles completed**
  - **MIT cycles observed by CERN personnel**
- **Peristaltic pump method works well, minimizes spill risk & vapor generation**
- **Drain into intermediate container reduces chance of overfilling flask**
- **Flasks weighed empty & full to track inventory**
- **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**