UT-BATTELLE

High Power Hg Target Conceptual Design Review

Hg Target System Controls

V.B. Graves
P.T. Spampinato
T.A. Gabriel

Oak Ridge National Laboratory

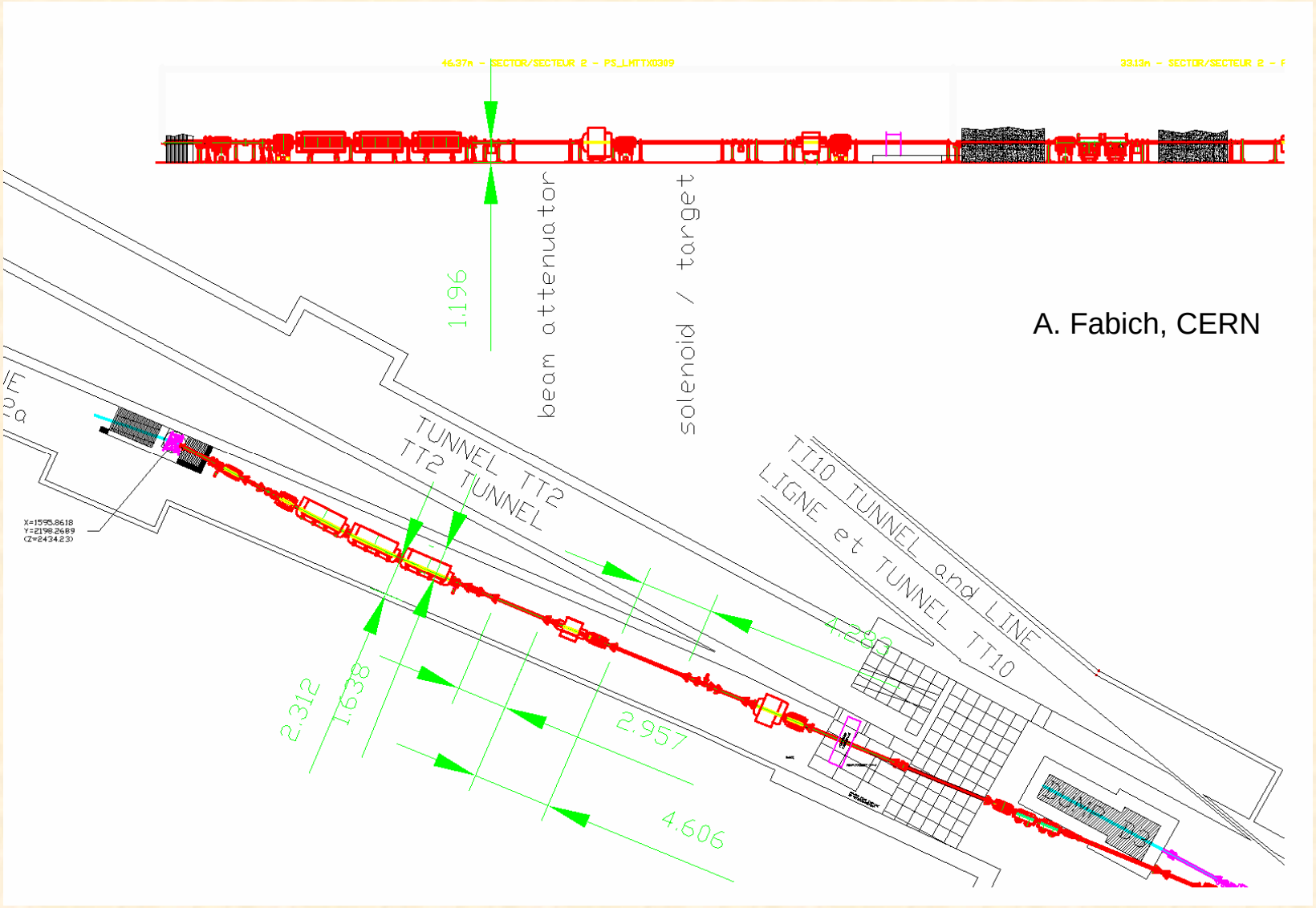
February 7-8, 2005

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Outline

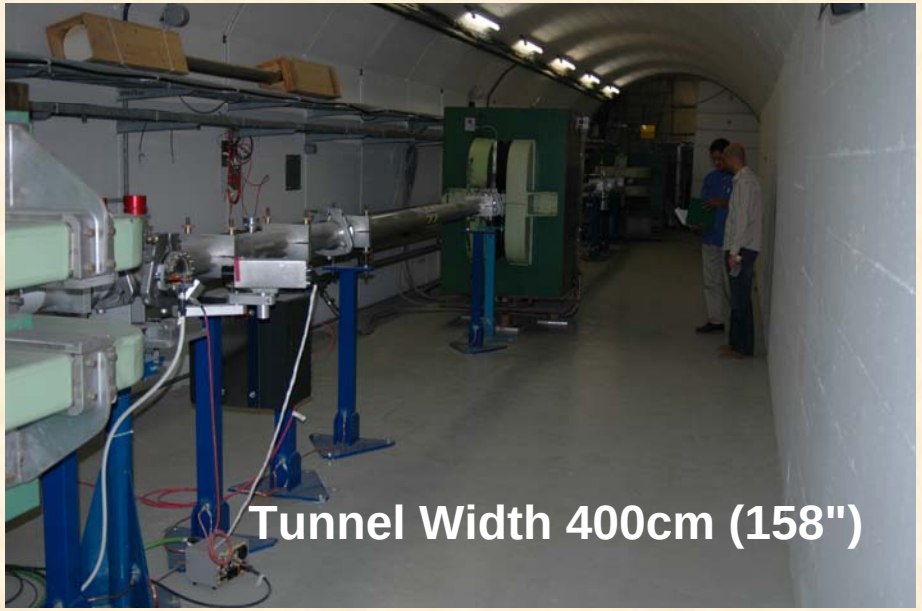
- **Operating environment**
- **Requirements / constraints**
- **Power requirements**
- **Instrumentation**
- **Preliminary control system scheme**
- **Issues**

CERN Tunnel Plan View



A. Fabich, CERN

TT2A Photos

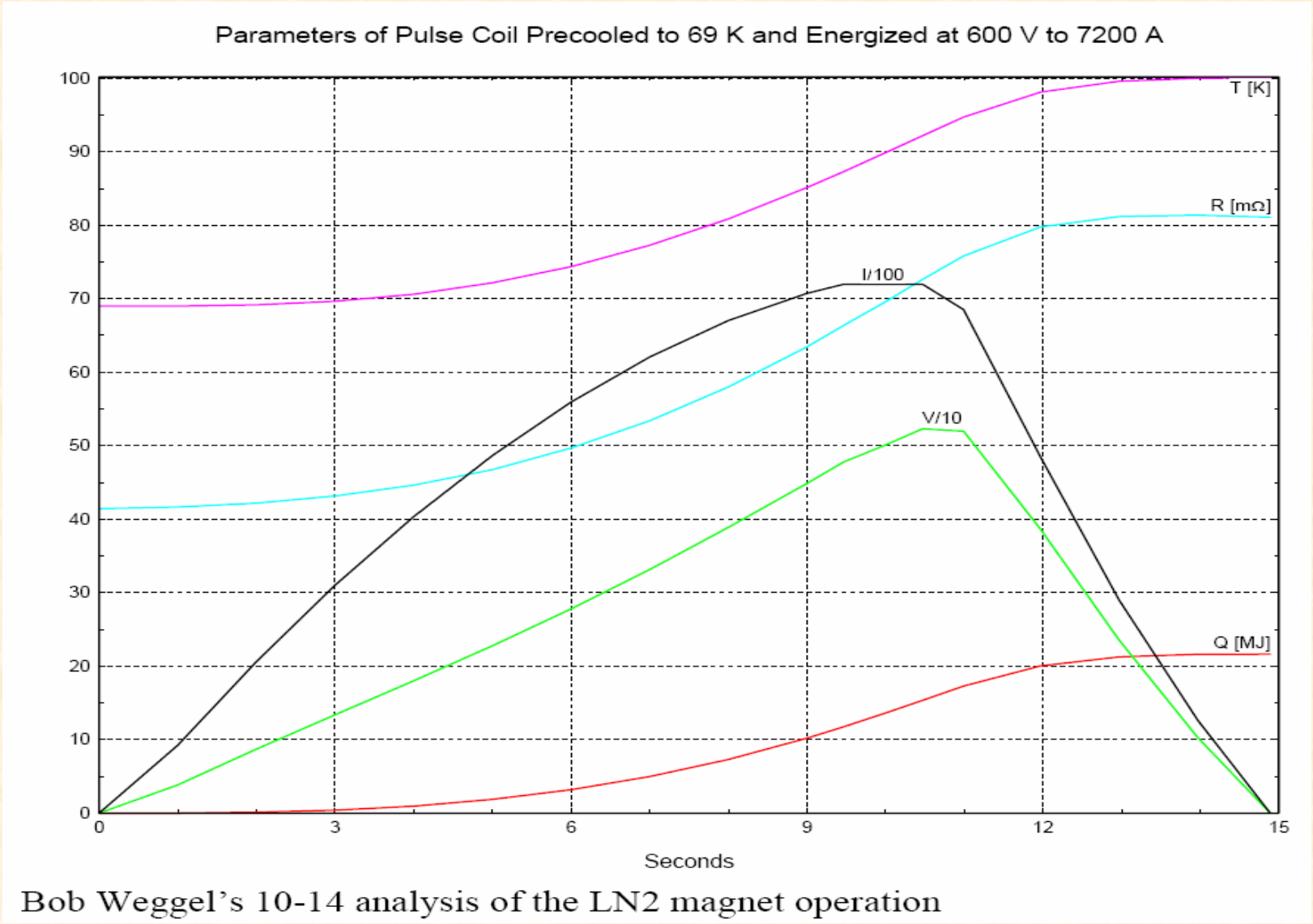


Photos from A. Fabich, CERN

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



Bob Weggel's 10-14 analysis of the LN2 magnet operation

Operating Scenario

Time (sec.)	Solenoid **		Target Pump System	Proton Beam	Optical Diagnostic
	Cryogenics	Power Supply			
minus 30	Magnet full of LN_2 @ 80ºK	Standby	Fill Hg supply line	Call for beam	Off
minus 10	Purge LN_2 with gaseous He	Standby	Standby	Wait for beam	Standby
0 to 9.5	Magnet full of He gas	Start ramp to full current	Ramp Hg to full flow	Wait for beam	Standby
8 to 9.0	Magnet full of He gas	Ramping to full current	Steady state Hg jet	Wait for beam	Turn on laser lighting
9.5 to 10.5	Magnet full of He gas	At full current	Steady state Hg jet	24 GeV, 1 MW	Operate high speed camera
10.5 to 11.0	Magnet full of He gas	Begin de-energizing	Shut down syringe pump	Standby	Turn off laser light and camera
11.0 to 15.0	Magnet full of He gas	De-energize to zero	Standby	Standby	Off
15.0 to 1800.0*	Fill magnet with LN_2 @ 80ºK	Cool down to ~80°K	Refill syringe cylinder	Standby	Off

* Assumes a 30-minute dwell period.

** Solenoid power supply is in “Standby” for zero-field operation.

Power Requirements

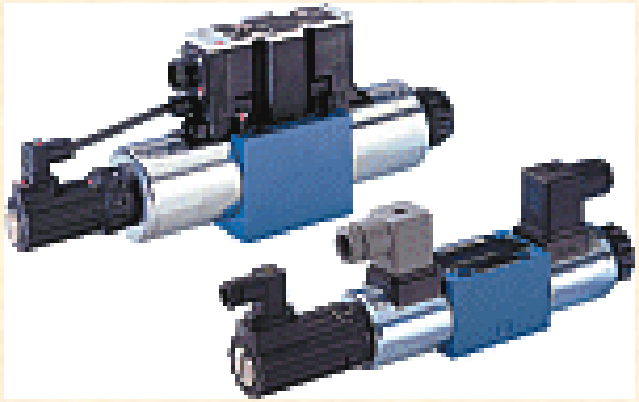
- **Hydraulic pump – 460VAC, 50-60Hz, 60A**
- **Proportional control valve – 24VDC**
- **Heater foil – 120VAC**
- **Hg vapor monitor – 120VAC**
- **Instruments – 24VDC**

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

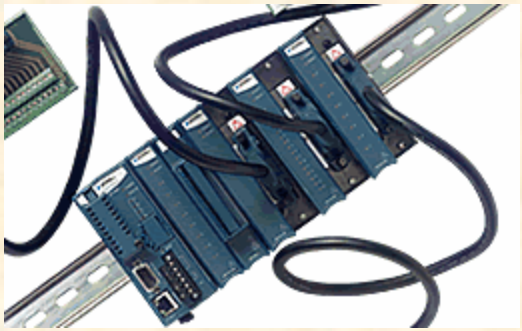
- **Omega Instruments LVR50-PP two wire liquid level float transmitter**
  - **Accuracy: 0.25" over span in water**
  - **Specific gravity: 0.75 minimum**
  - **Supply voltage: 10-40 Vdc**
  - **Signal output: 4-20mA**
  - **Stainless steel construction, choice of head materials**
- **This particular instrument is too long, but is indicative of a simple Hg level sensor**

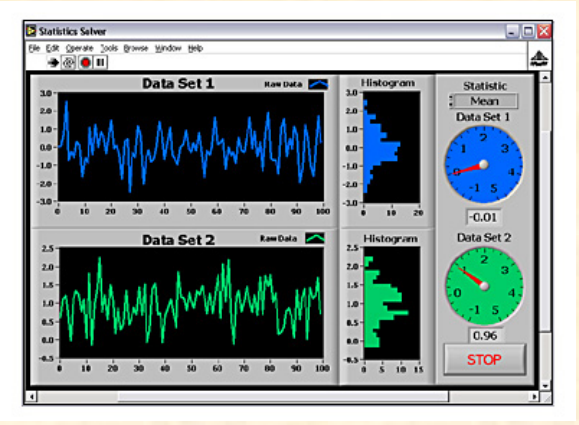
Hg Vapor Monitor

- **Specifications**
  - **Resolution 0.001 mg/m3**
  - **Detection range 0.003-0.999 mg/m3**
  - **Accuracy ± 5% at 0.100 mg/m3**
  - **Response Time13 s in sample mode; minimum auto sample time 5 min**
  - **Flow rate 750 cc/min**
  - **Power requirements100-120 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**