Solenoid Magnet
Status Report

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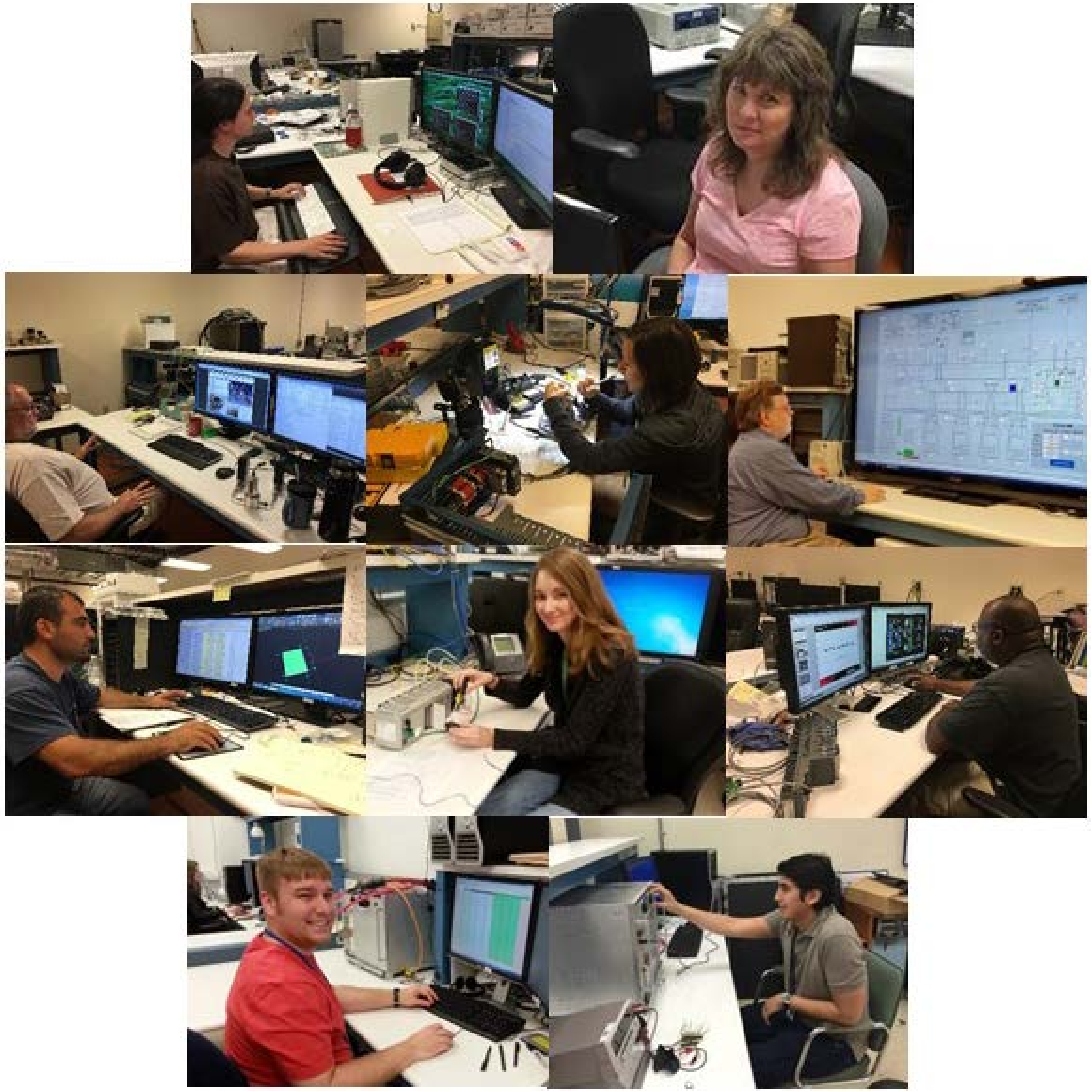
Detector Support Group

DSG STAFF



Contents

- Programming tasks
- Instrumentation tasks
- Documentation
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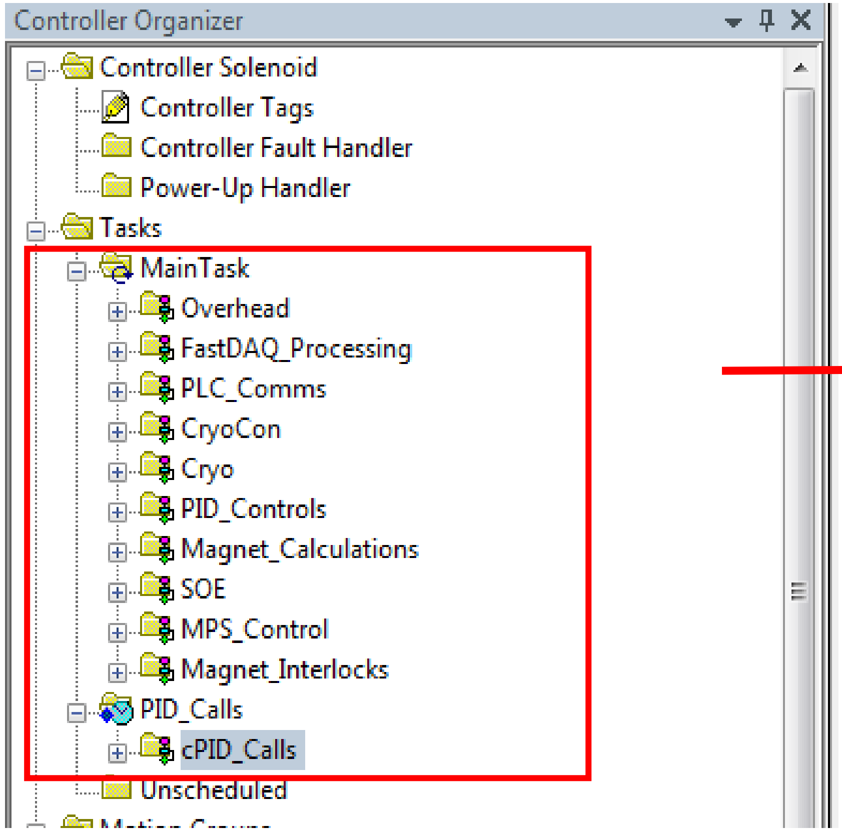
Programming tasks

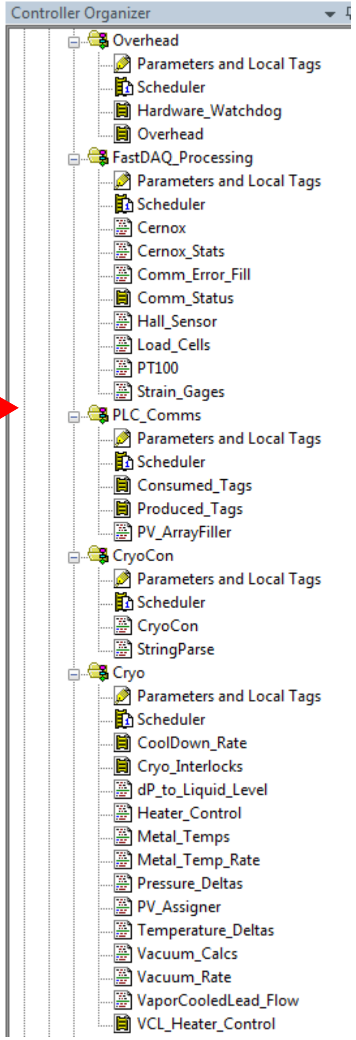
- PLC Program: controls and monitors the entire Solenoid in conjunction with cRIO and EPICS systems.
  - Consists of 11 main programs that comprise 72 routines.
    - Written on RS-Logix-5000 version 27.0.
    - Solenoid program was based on the Torus control program.
    - But several programs were modified and added with a new control logic.
  - Main control of the PLC were programed to control:
    - Cool-down operations.
    - Magnet Energization- Ramp Down/Ramp Up.
    - Vacuum monitoring.
    - Solenoid Interlock system.
    - Cool-Down Interlocks system.
- Completed on 12/15/16

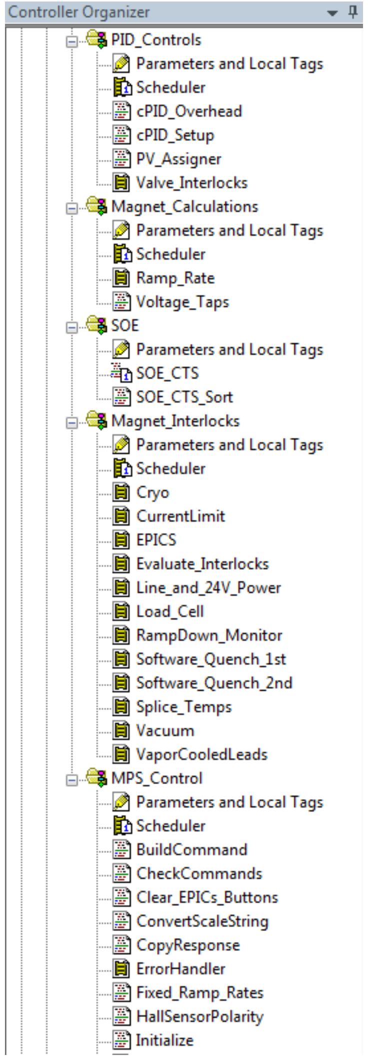
Programming tasks

Solenoid PLC program



11 main programs





72 Routines

Programming tasks

- cRIO Programming
  - <u>**Solenoid-LV-cRIO**</u> (Tyler Lemon)
    - Programming based on Torus-LV-cRIO control program.
    - But it was modified according to Solenoid magnet needs.
  - cRIO programmed to perform the following control operations:
    - Set excitation voltage and current for different types of sensors that send data to the LV-Chassis.
    - Readout sensors data from solenoid magnet:
      - Cernox and PT 100 temperature sensors
      - Load Cells
      - Hall Sensors
    - Send data readout to the Solenoid PLC.
  - Program updated to LabVIEW 2016 version.
- Completed on 02/28/17

Programming tasks

- cRIO Programming
  - **<u>Solenoid Fast DAQ</u>** cRIO programming (Tyler Lemon)
    - Programming based on Torus-Fast-cRIO control program
    - But modified according to Solenoid magnet requirements.
    - Programed to perform the following control operations:
      - Acquire data from the Voltages Taps in the Solenoid Magnet
      - Scale data according requirements.
      - Send readout data to the Solenoid PLC controller at 5 [Hz].
      - Send readout data to EPICS systems at 10 [KHz].
  - Program updated to LabVIEW 2016 version.

- Completed on 01/25/17

Solenoid Instrumentation - Tasks

- Solenoid Vacuum System control design
  - Use 24 VDC power source to main vacuum gate Pneumatic Valve PV8600.
    - Isolated Rhino 24V power supply – 3.75 A, 90 W was assigned.
  - Instrumentation to monitor vacuum signals:
    - CG8606 main vacuum gauge → PLC Analog input module (0-10 V)
    - CG8600TB gauge → PLC Analog input module (0-10 V)
    - TB8600 Turbo Pump speed→ PLC Analog input module (0-10 V)
    - PV8600 valve position → PLC Digital input module (0-31.2 V DC)
  - Clean 110 VAC power used for Vacuum instrumentation (pumps and hardware controllers)
  - Solenoid P&ID diagram corrected with the proper signal names updated on January 2017.
- Completed on 11/20/16.

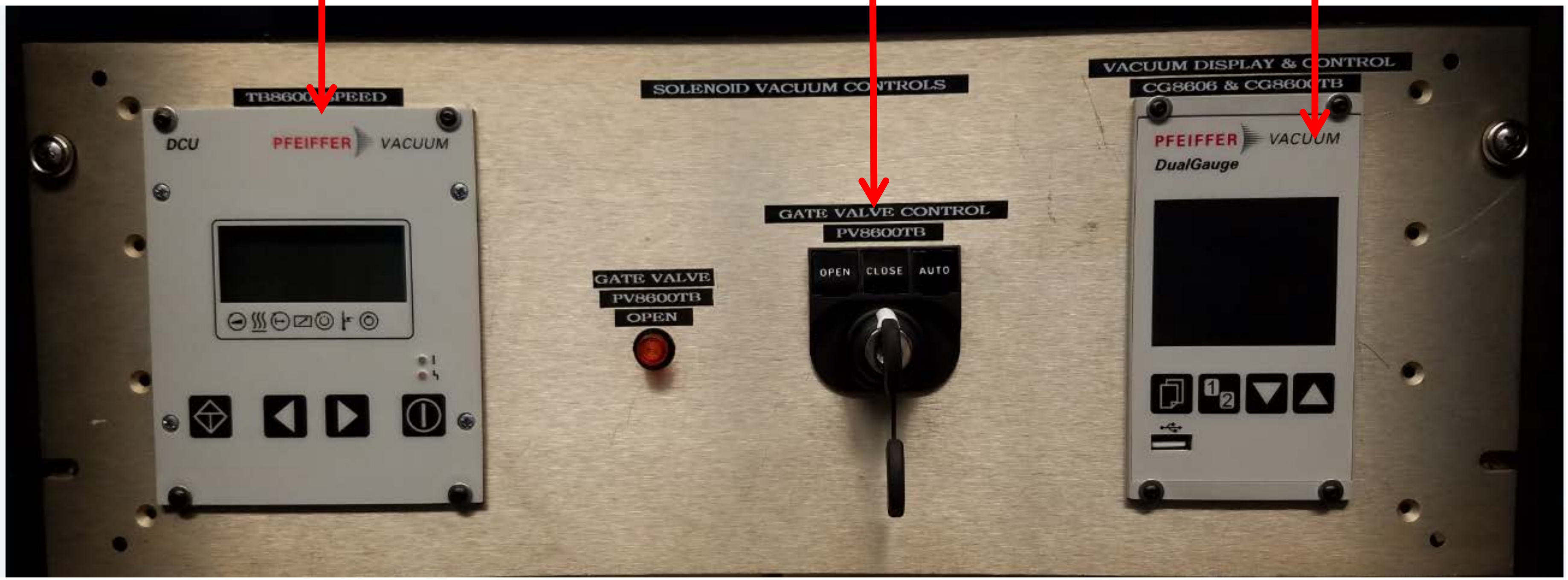
Solenoid Instrumentation - Tasks

- Solenoid Vacuum System hardware controllers

DCU Pfeiffer 002 controller pump

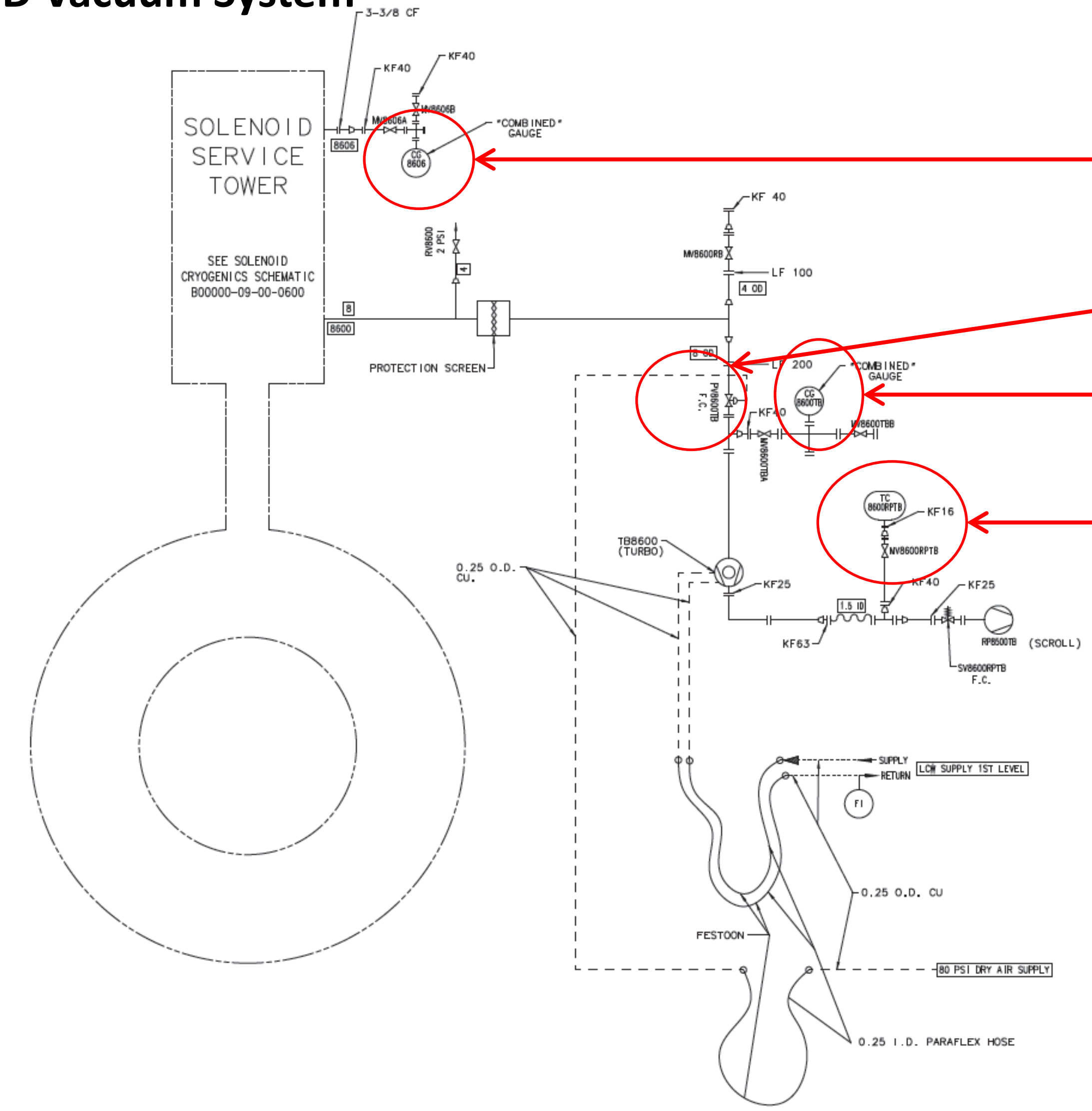
Gate Valve Manual switch

TPG2 362 Pfeiffer vacuum controller



Solenoid Instrumentation - Tasks

Solenoid P&ID Vacuum System



4 Signals Monitored by Solenoid PLC

- CG8606 - Main vacuum gauge
- PV8600 - Valve position
- CG8600TB - Vacuum gauge
- TB8600 - Turbo Pump speed

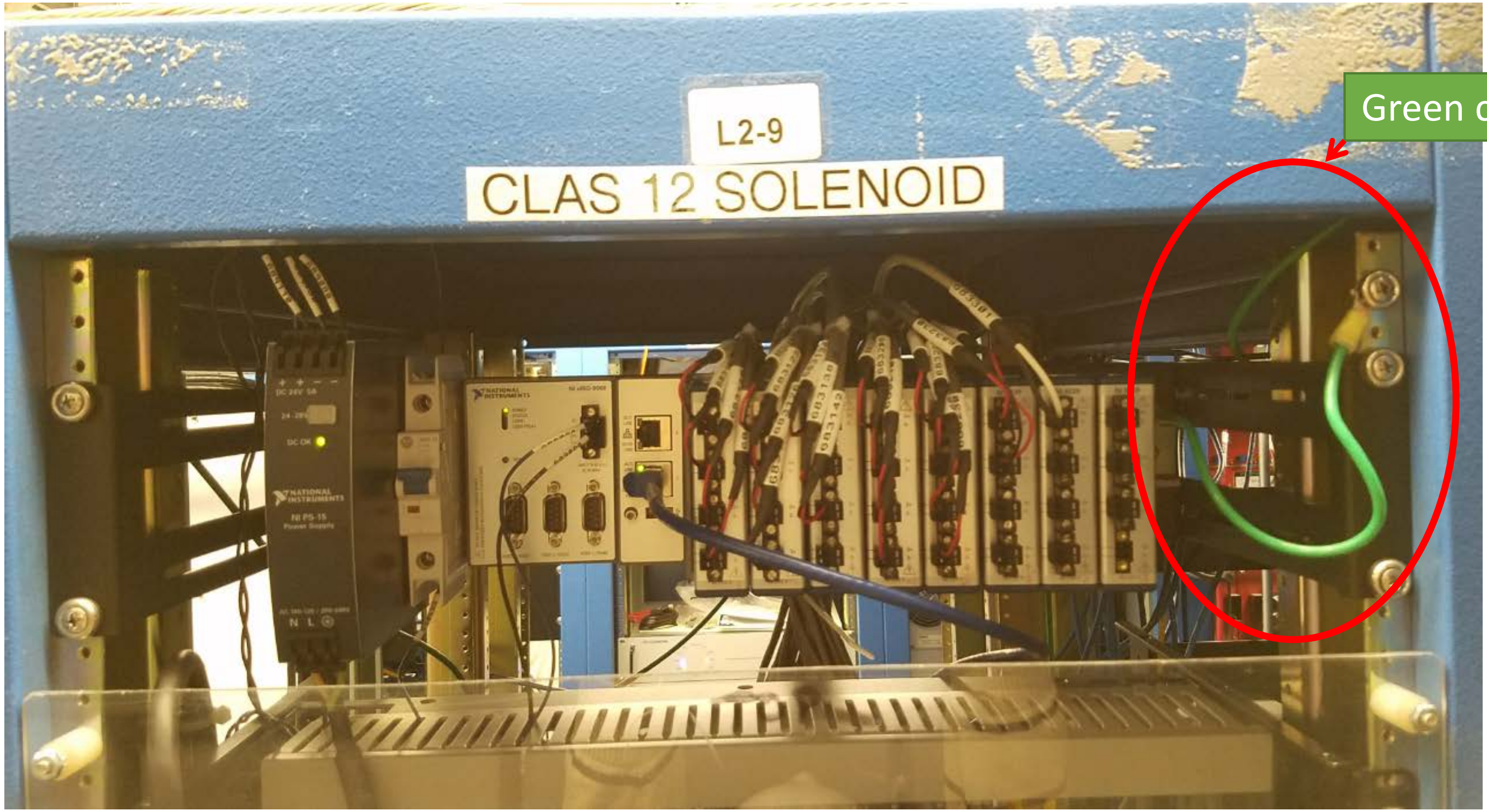
Solenoid Instrumentation - Tasks

- Solenoid cRIO grounded
  - Torus Fast DAQ cRIO presented high levels of noise in the readout Voltage Tap data.
  - As part of the noise prevention in the data acquisition for the Solenoid Voltage Tap, a ground wire was run from the chassis of Solenoid Fast DAQ cRIO to the control Rack.
  - Levels of noise did not decreased after grounding.
  - Noise problem continues being investigated
    - Possible solution: implement hardware filter

Mindy, Mary Ann and Sahin grounded Sol- FastDAQ-cRIO

Solenoid Instrumentation - Tasks

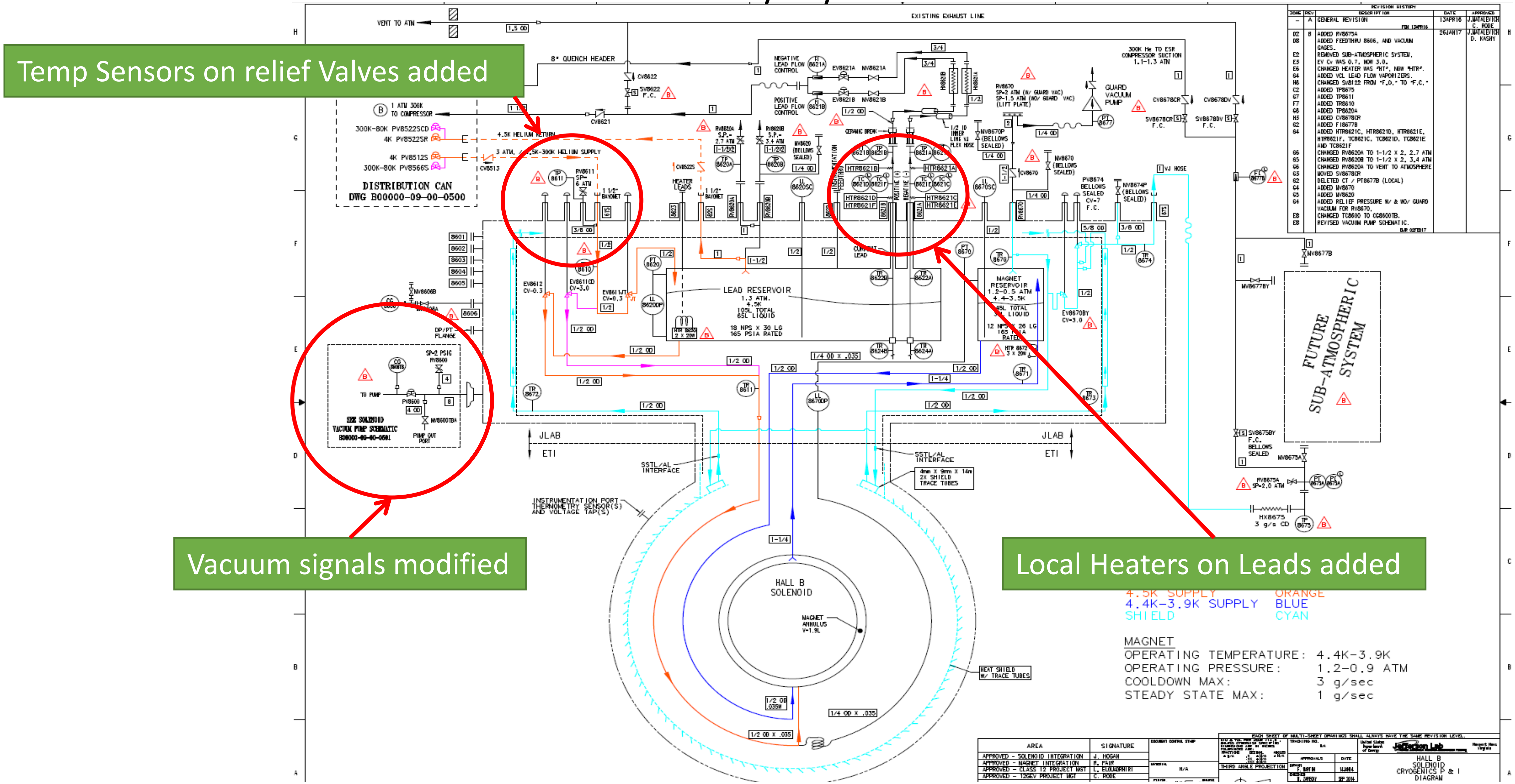
- Solenoid Fast DAQ cRIO chassis grounded to the Solenoid control rack



Green cable grounded

Solenoid Instrumentation - Tasks

Solenoid P&ID latest version issued on 26/01/17



Solenoid Instrumentation - Tasks

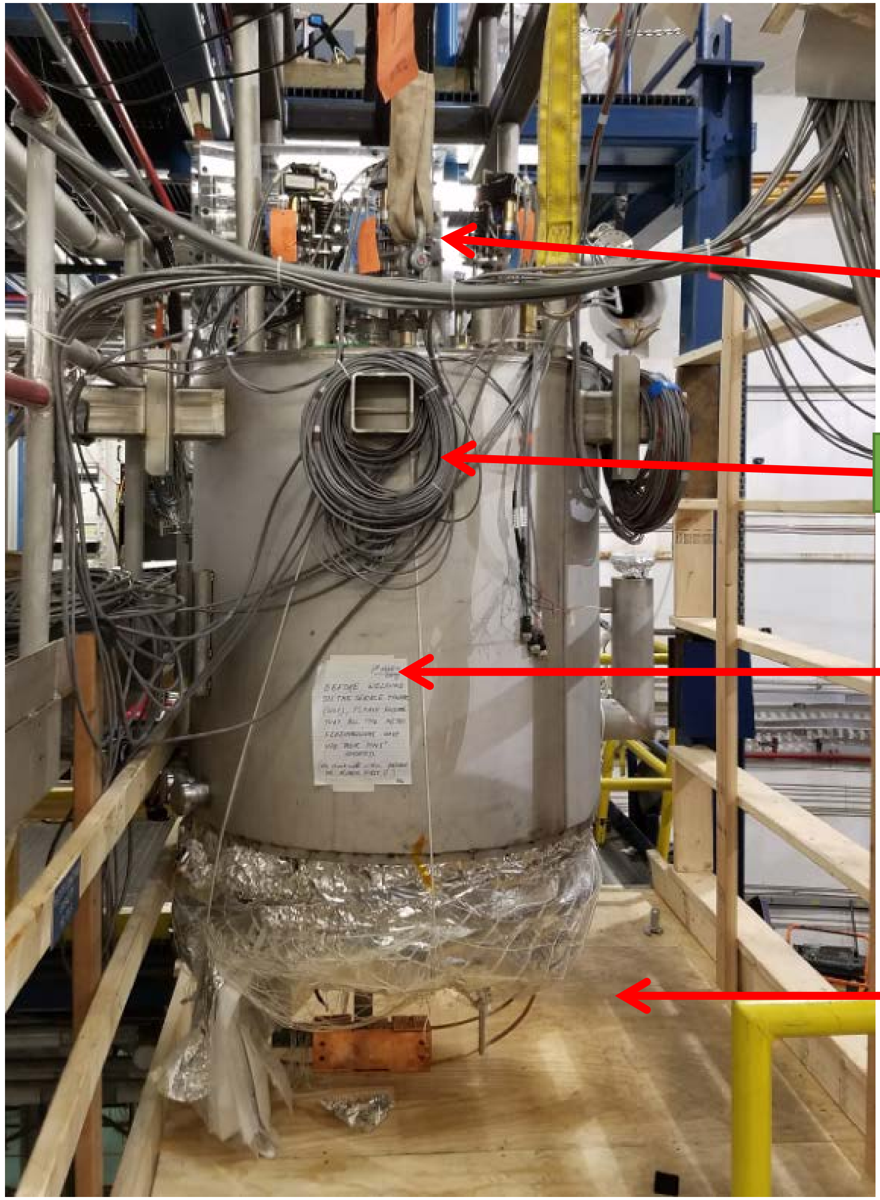
- Solenoid Service Tower (SST) Instrumentation Test
  - —Instrumentation Test PLC-EPICS Plan spreadsheet generated.
    - Document contains detailed information and procedures to perform the test.
    - Objectives of the plan test were:
      - Check hardwiring, hardware configurations, controllers and monitoring systems.
      - Ensure correct readout of the sensors in PLC controller and EPICS system.
    - Instrumentation tested specified on the spreadsheet
      - Not all sensors and instrumentation were tested, due that Helium flow is required.
    - Readout values of the instrumentation tested were recorded.
    - Section of comments to point future correction and improvements on the solenoid control system were added.
- Completed on 02/27/2017.

Solenoid Instrumentation - Tasks

- Instrumentation Test PLC-EPICS Plan spreadsheet

INSTRUMENTATION TEST PLC- EPICS PLAN												
SOLENOID SERVICE TOWER - SST												
Signal ID	Sensor Type	Calibrated - Tested	Installed	To be tested Now	To be Tested after	Action	Check	Set Point	ReadBack Controller	ReadBack PLC	ReadBack EPICS	Comments
TR8622A	Cernox	Yes	Yes	Yes		1. Verify hardwiring - Use reference DWG 0649 & 0678	√	Temp Room ~ 300 [K]	293.982	293.551	293.55	
TR8622Ar		Yes	Yes			2. Check sensor connection in the Cryocon unit - Use Cryocon maps	√		293.982	293.551	293.55	
TR8622B		Yes	Yes			3. Unplug DB9 connectors except sensor that is being checked in rear panel of Cryocon 1	√		294.418	293.987	239.99	
TR8622Br		Yes	Yes			4. Verify if sensor position correspond to the channel assigned	√		294.418	293.987	239.99	
TR8611		Yes				5. Check communication between 490-NBX module and PLC	√		clip	0	0	
TR8611r		Yes				6. Verify correct read-back values for the sensor in the PLC controller	√		clip	0	0	
TR8672		Yes				7. Check communication between PLC and EPICS	√		clip	0	0	Cryocon1 unit at Channel F has set an "Internal_Temp" sensor connected
TR8672r		Yes				8. Use the Helium SST EPICS screen to verify and monitor the temperature sensor readings in [K] units	√		clip	0	0	
TR8671		Yes				9. Record Read-back values - compare PLC and Cryocon Readings	√		clip	0	0	
TR8671r		Yes				10. Repeat the steps above with each temperature sensor	√		clip	0	0	
TR8610		No							clip	0	0	
TR8610r		No							clip	0	0	
TR8670	Cernox	Yes		Yes		1. Verify hardwiring - Use reference DWG 0649 & 0678	√	Temp Room ~ 300 [K]	clip	0	0	
TR8670r		Yes				2. Check sensor connection in the Cryocon unit - Use Cryocon maps	√		clip	0	0	
TR8673		Yes				3. Unplug DB9 connectors except sensor that is being checked in rear panel of Cryocon2	√		clip	0	0	
TR8673r		Yes				4. Verify if sensor position correspond to the channel assigned	√		clip	0	0	
TR8674		Yes				5. Check communication between 490-NBX module and PLC	√		clip	0	0	
TR8674r		Yes				6. Verify correct read-back values for the sensor in the PLC controller	√		clip	0	0	
TR8624A		Yes				7. Check communication between PLC and EPICS	√		clip(blinking)	0	0	Cryocon2 unit at Channel D has set an "Not assigned" (Internal Temp) sensor connected
TR8624B		Yes				8. Use the Helium SST EPICS screen to verify and monitor the temperature sensor readings in [K] units	√		clip(blinking)	0	0	
TP8621A	PT- 100	Yes				9. Record Read-back values - compare PLC and Cryocon Readings	√		clip	0	0	
TP8621Ar		Yes				10. Repeat the steps above with each temperature sensor	√		clip	0	0	
TP8621B		Yes							clip	0	0	
TP8621Br		Yes							clip	0	0	

Solenoid Instrumentation - Tasks



- Solenoid Service Tower was moved to Hall B on December 15th , 2016.

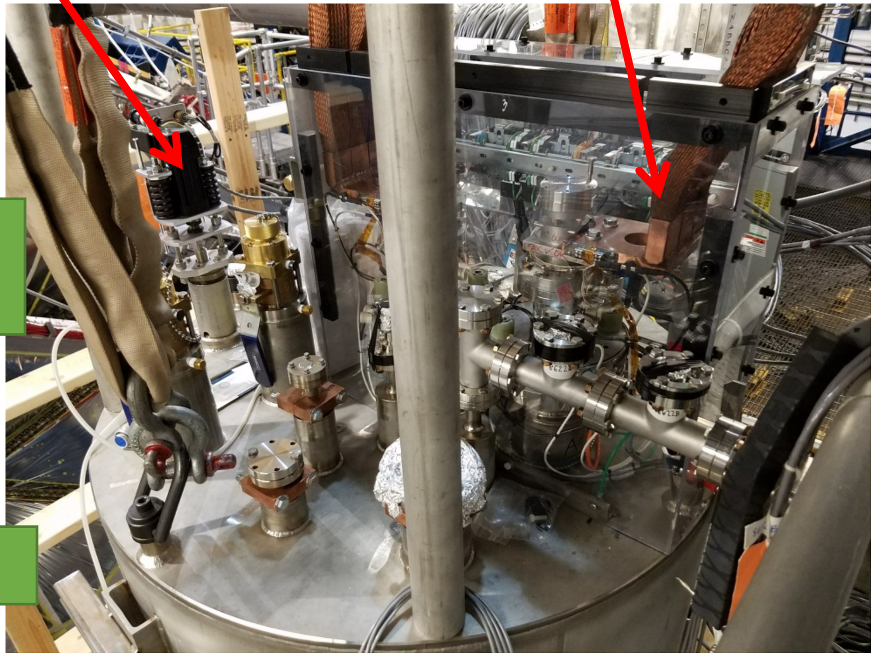
Instrumentation – EV valves

Lead connectors

Data sensor Cables

Vessel- Solenoid Service Tower

Provisional platform



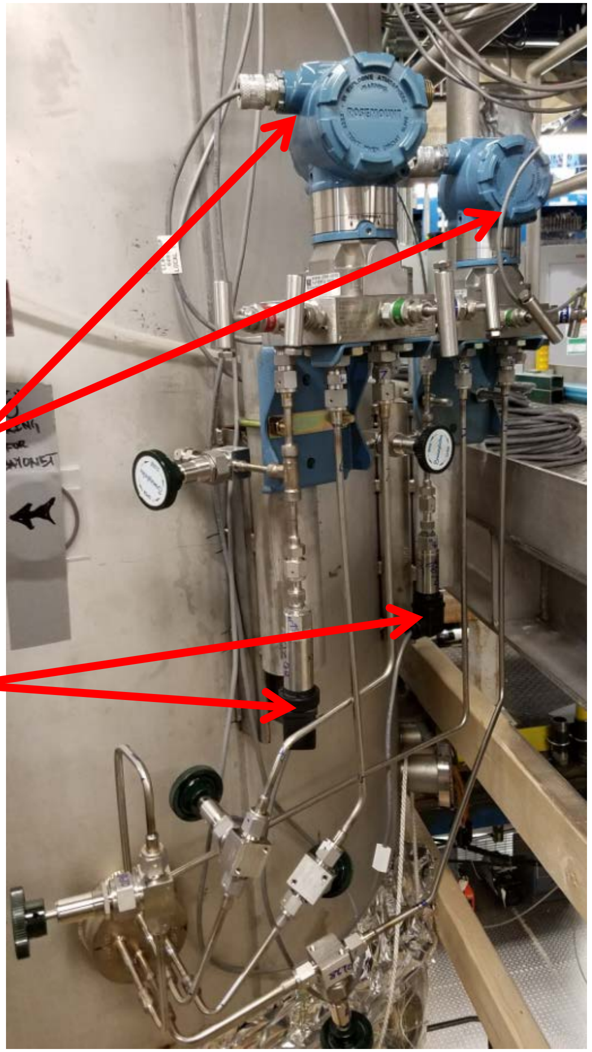
Solenoid Instrumentation - Tasks

- Solenoid Service Tower (SST) Instrumentation Test
  - The following sensors and instrumentation were tested on the SST
    - Cernox temperature sensors. – total 20
      - Additional test perform in the Cryocon units 1,2 and 3.
    - PT-100 Temperature sensors. - total 16
    - Pressure transducers – total 2
    - Differential Pressure transducers – Total 2
    - LVDTs - Lineal variable differential transducers – Total 4.
      - Additional configuration made in DIP switches was required.
    - Valves
      - Electric Valves EV – Total 4
      - Pneumatic valve PV- Total 1
- Completed on 02/27/2017.

Solenoid Instrumentation - Tasks

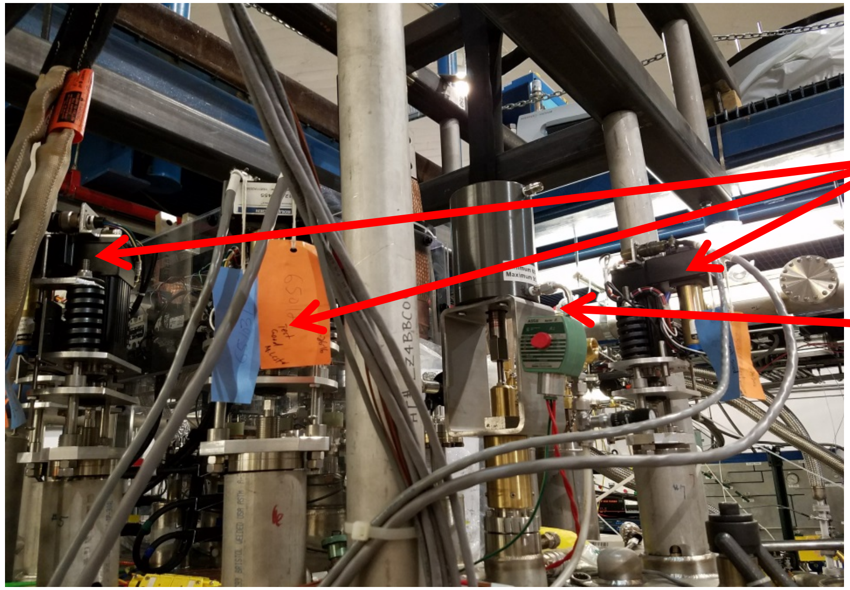
- Solenoid Service Tower (SST) Instrumentation Test

Cernox and PT-100 Temp Sensors Read by the Cryocon units



Differential Pressure Transducers

Pressure Transducers



EV Valves

PV Valve

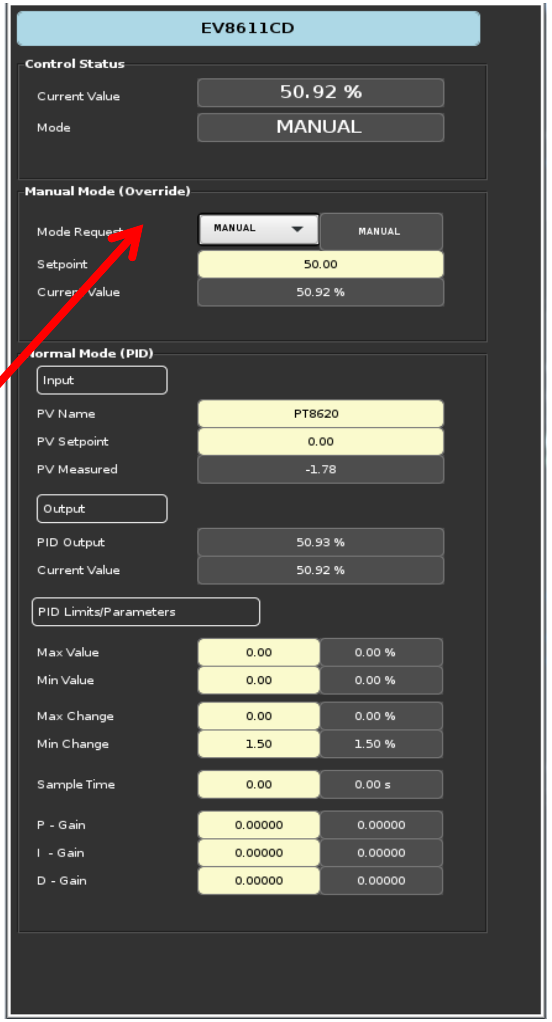
Solenoid Instrumentation - Tasks

- Solenoid Service Tower (SST) Instrumentation Test
  - PLC control programs and routines associates with the instrumentation were tested.
    - PID Loops run as expected.
    - Configuration and scale factors (Engineering units) on the PLC were verified.
  - Issues regarding to the control hardwiring for the instrumentation on SST were solved
    - Input signal for Pneumatic Valve 8674 was changed.
      - Signal changed from analog PLC module to Relay output module.
      - Swapped air connector for valve.
    - PLC relay module was replaced (1 channel burned due wrong wiring).
      - Reassigned proper channel for OPEN JT86 relay output signal.
      - Tested 24 V DC relay output to all signals Open/Close for the EV valves.
  - Correction of the solenoid controls drawings and documentation related
    - DWG B00000900-0640, 0623 and 0626 were updated.
- Completed on 02/27/2016.

Solenoid Instrumentation - Tasks

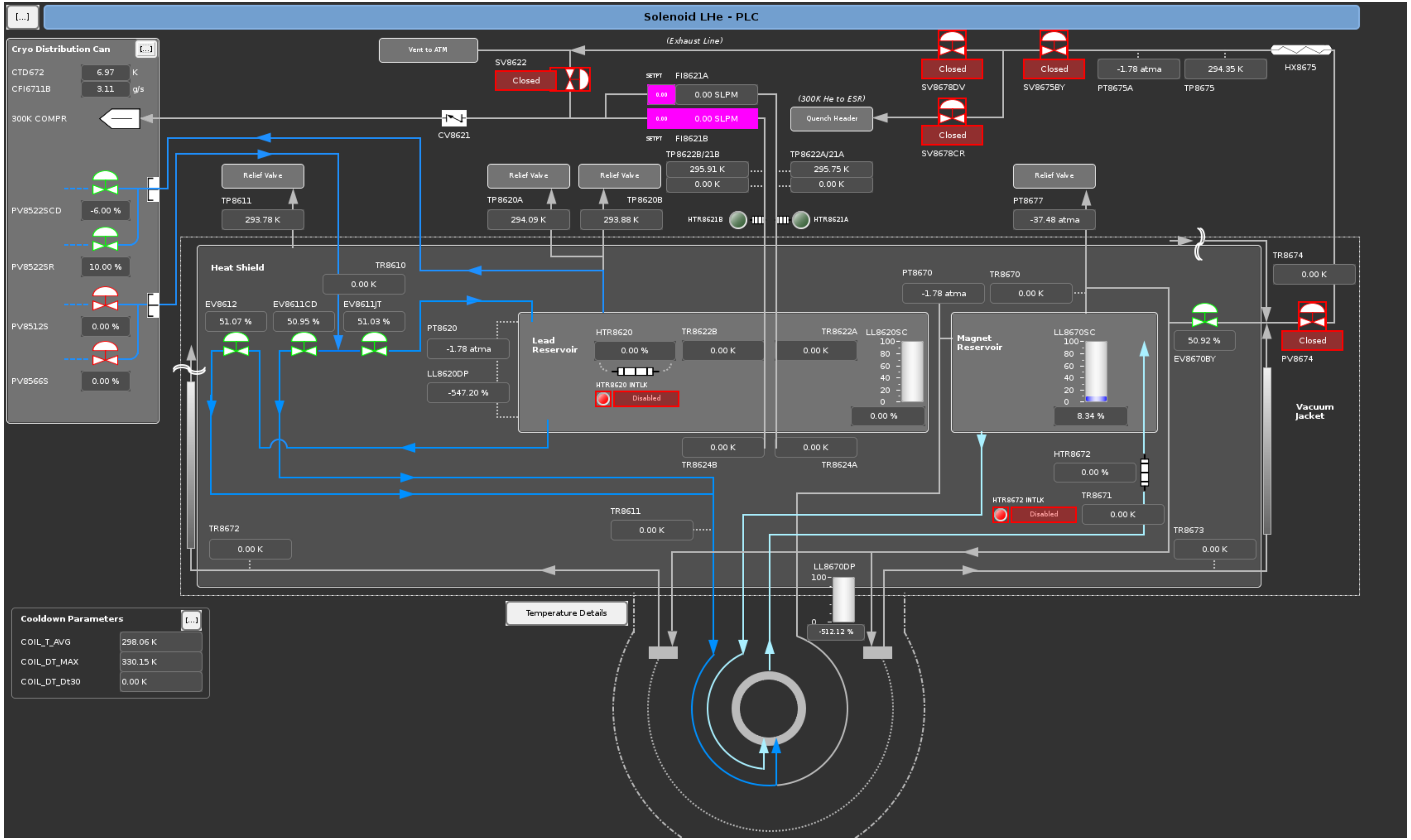
- Solenoid Service Tower (SST) Instrumentation Test
  - —EPICS Screens were tested
    - Communication between PLC and EPICS was tested.
    - Solenoid Helium SST screen readouts for all the sensors and valves responded as expected.
      - Contributed to correct valve indicator for valve PV8674.
      - Noticed differences to get into PID controls screens for heaters.
    - Tested functionality of the PID control screens used to set the values to control OPEN/CLOSE for the EV valves.
      - Tested Manual Mode.
      - Verified stability and response for the valves at 50 percent open.

EV8611CD control PID screen



Solenoid Instrumentation - Tasks

- Solenoid Helium – SST Screen used to perform Test.

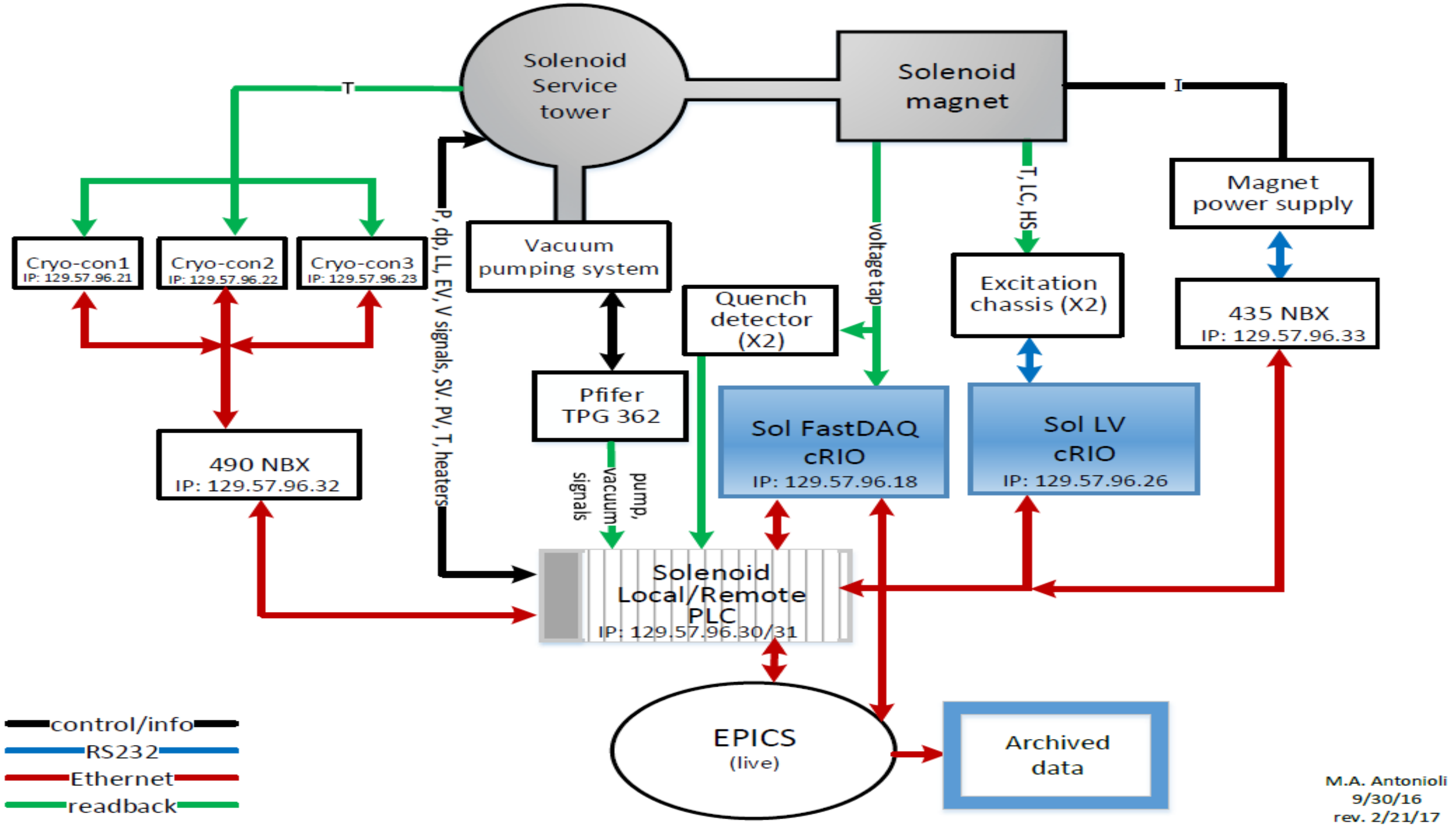


Solenoid Documentation –Tasks

- Solenoid Cooldown Documentation
  - 1. B00000000901-P011 Hall B Solenoid System Cryogenics, Pre-Cooldown Instrument Checkout Procedure.
    - Provide a general procedure for verifying ‘sensible’ readouts of cryogenic instruments prior to cooldown and to make available a location to record the results of the same.
- Completed on 02/16/17
  - 2. B00000402-S001 Hall B Magnet and Cryogenic Control
    - Describes the main control systems and sensors implemented in the Solenoid Magnet .
- Completed on 03/20/17

Solenoid Documentation –Tasks

—Solenoid Magnet and Cryogenic Control Diagram Updated



Solenoid Documentation –Tasks

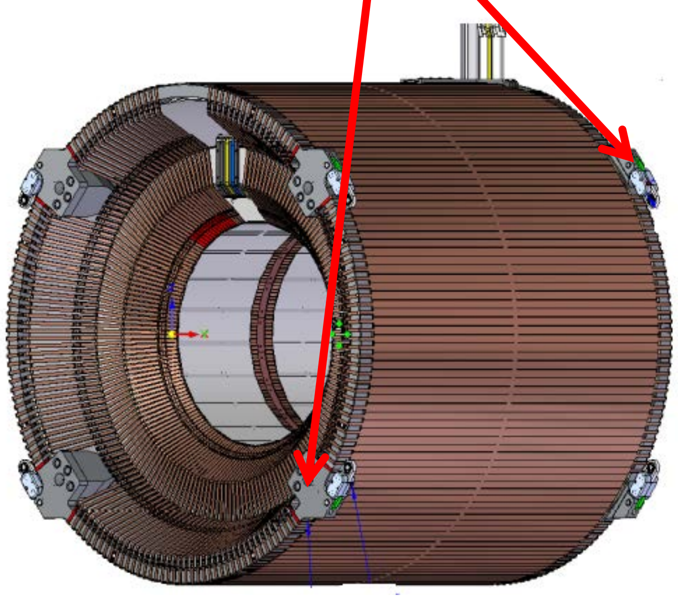
- Solenoid Pre-Power Up Documentation
  - 3. B000000400-P005 Hall B Solenoid Pre-Pre-Power-Up Interlock Checkout procedure.
    - Describes steps to perform interlocks checks before energization of the magnet.
- Completed on 02/16/17

  - 4.B000000400-P003 Hall B Solenoid Pre-Power-Up Instrument Checkout Procedure.
    - Describes a general procedure for verifying 'sensible' readouts of instruments prior to energization.
- Completed on 02/13/17

Upcoming Solenoid Tasks

- Expected delivery for the Solenoid Magnet to JLab has been shifted to **May 9th 2017.**
  - —Reason for delay:
    - During the load transfer of the coils to the cryostat vacuum jacket at the end of January, several components of the suspension system broke.
    - This was caused by the steel parts for the support system not being made according to the mechanical drawings.
  - —Once the magnet arrives the following tasks will be performed by Hall B and magnet group (to be completed ~ 6 weeks after delivered)
    - Location and installation of the magnet in the Hall B.
    - Welding of main structure and line components of the Solenoid
    - Wiring of the sensors and instrumentation related.

Solenoid Suspension Components



Upcoming Solenoid Tasks

- DSG group will be involve in the next tasks:
  - Full test of the PLC control program
  - Test cRIO low voltage LabVIEW program
  - Test cRIO Fast DAQ LabVIEW program
  - Complete instrumentation test on the SST
  - Test Instrumentation and sensors of the Solenoid magnet
  - Perform Pre-power up Interlocks checklist procedure.
  - Perform Solenoid System Cryogenics, Pre-Cooldown Instrument Checkout Procedure.
  - Fix problems related to acquisition data – In progress
    - Based on the current problems presented on the Torus magnet
      - Tested hardware filter to the Voltage Tap signals that will be added on the Solenoid.
      - Solution to avoid problem of readout 350 K error on the Sol-LV-cRIO is being investigated.

Conclusion

- DSG contributed to:
  - Developing programs for PLC and cRIO controllers
  - Improving the control and monitoring systems
  - Testing Instrumentation
    - Hardware and wiring verification
    - Configuration of controllers, sensors and instrumentation .
  - Documenting control systems and procedures.
  - Solving discrepancies with technical documentation.

Thank you