Current DSG Projects and Future Plans 4/5/2023

Patrizia Rossi
and the Detector Support Group

April 5, 2023

The Team

- Mary Ann Antonioli
- Peter Bonneau
- Aaron Brown
- Pablo Campero
- Brian Eng
- George Jacobs
- Mindy Leffel
- Tyler Lemon
- Marc McMullen
- Amrit Yegneswaran

A priori - Foregone Conclusion

DSG is making exceptional contributions to all Halls and EIC

Hall A
- Moller coil #3 test
- SoLID
- ECAL

Hall B — Solenoid, Torus, and Support

Hall C — NPS

Hall D — JEF and Support

EIC
- Beampipe
- DIRC

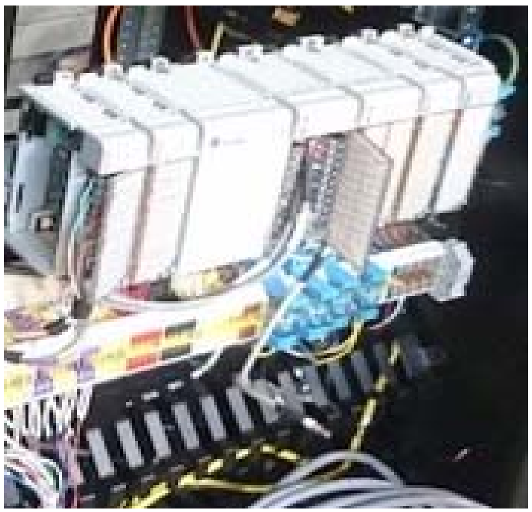
Conclusion

St. Francis of Assisi

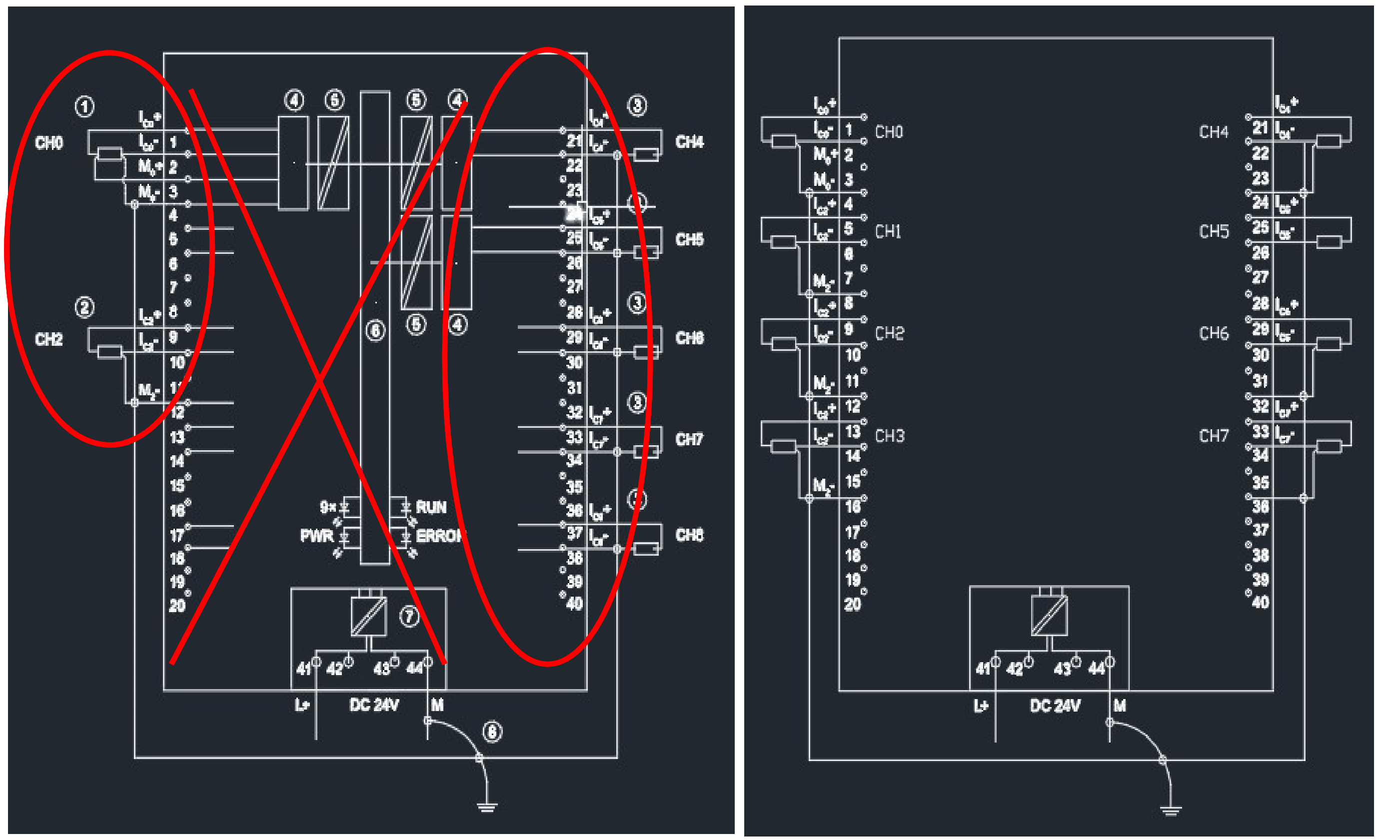
"Start by doing what is necessary, then what is possible, and suddenly you are doing the impossible."

Hall A – Møller (Brian, Aaron, Mary Ann)

- **Developing instrumentation, control, and monitoring for magnets (5 magnets; total of 42 coils)**
- **Exploring vendors other than Allen-Bradley for PLC and sensors because of inflation cost increases and supply chain lead-time issues**
  - Ordered Siemens PLC evaluation system (components are arriving)
  - Enough modules to read out sensors (resistance temperature detectors (RTDs), interlocks, and voltage taps) for one magnet
- **Generating PLC schematics for hookup of RTDs to terminal block on module**



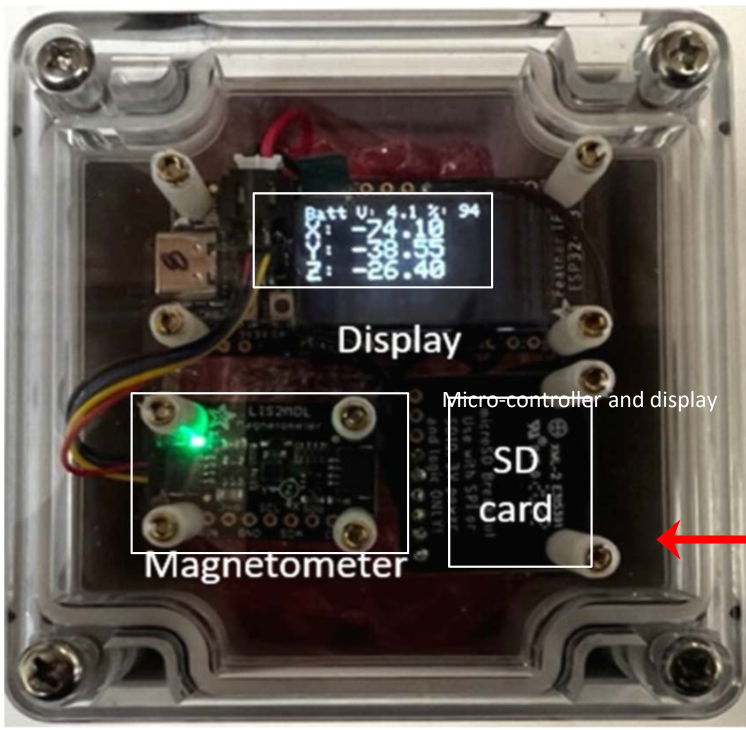
Allen Bradley PLC modules for RTDs used in coil #3 magnet test to check cyanide resin epoxy under different heat loads



Left side shows Siemens drawing, right side modified drawing by Mary Ann

Hall A - SoLID/CLEO (Brian, Mindy)

- **Probir wanted a field mapping unit to measure the fringe field**
- **Brian's concept for field mapping**
  Self-contained field mapping units with local display and storage of magnetic field;
  Battery (Li ion charging) powered to last a minimum of 24 hours of continuous data taking
- **Designed, programmed, and fabricated eight units**
- **To be used once the SoLID/CLEO magnet has been cooled and powered up**

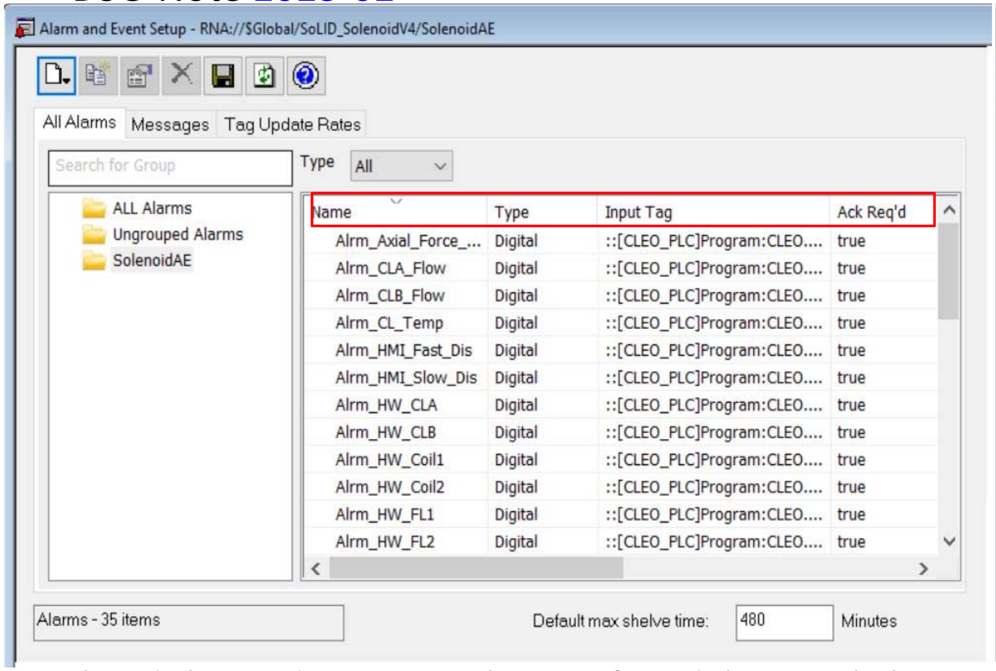


Mindy showing a fabricated field mapping unit

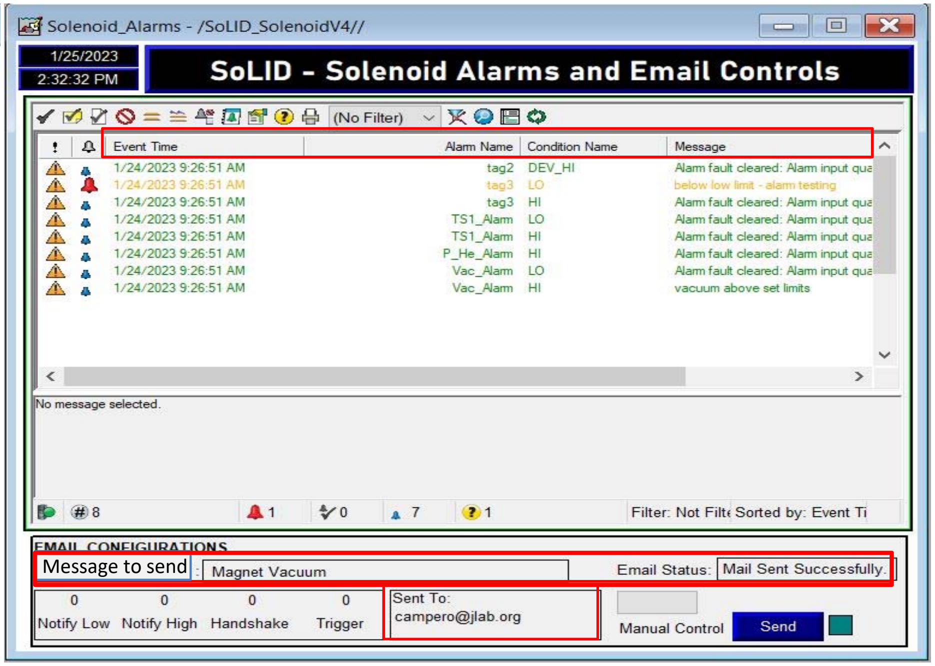
Hall A – SoLID (Pablo, Mary Ann, Mindy, Marc, Brian)

- **Developed PLC code for data transfer with EPICS for low current test**
  - Monitor cryogenic variables, voltage taps, and current load
- **Developed alarm handler system**
  - JLab's SMTP account is used to send emails to experts
- **Generated Solenoid Alarms and Email Controls HMI screen**
  - Details tripped alarms
  - Details message sent, email status, and delivery email address

DSG-Note 2023-02



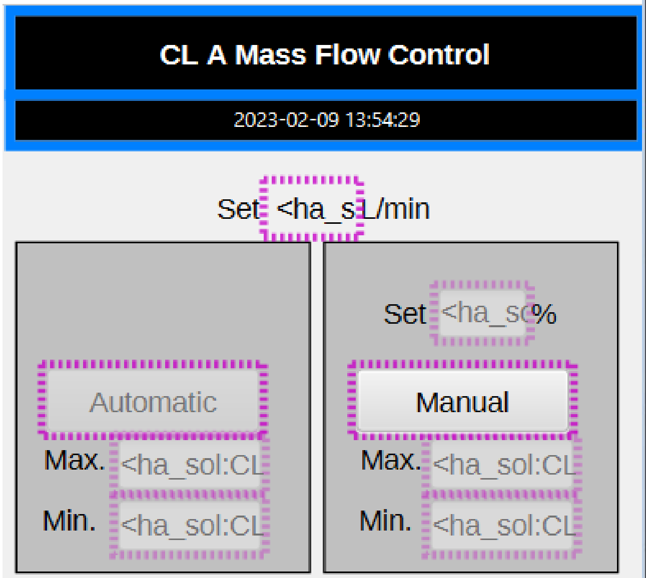
Solenoid Alarm and Event server shows configured alarm interlocks



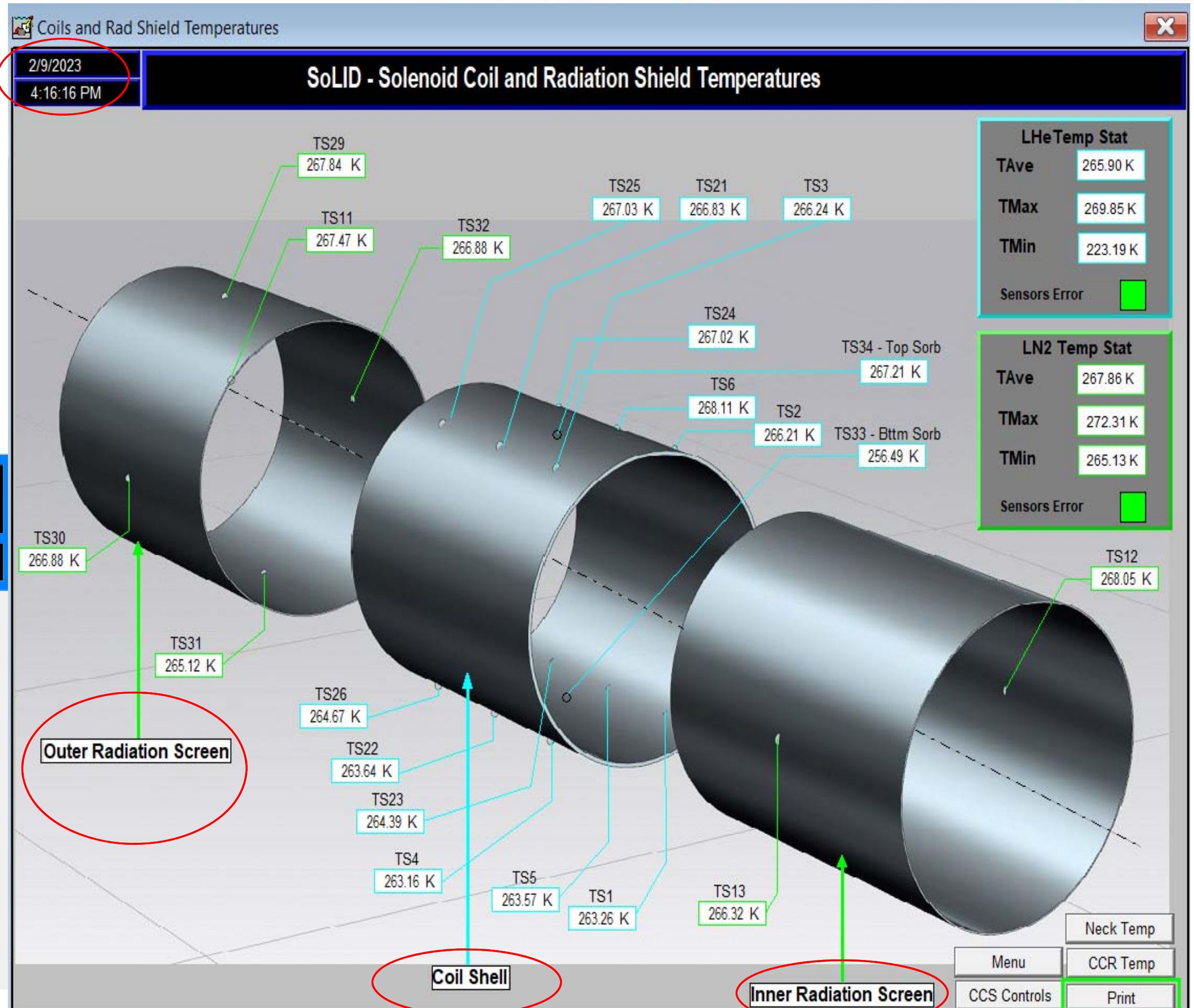
Solenoid Alarms and Email Controls HMI screen

Hall A - SoLID (Pablo, Mary Ann, Mindy, Marc, Brian)

- **Developed HMI control and monitoring system**
  - System deployed for low current test
- **Developing equivalent EPICS CSS-Phoebus system**
  - Phoebus screen features are equivalent to HMI screen features



CSS-Phoebus screen for mass flow controller of current lead A (pink frame indicates PVs not connected) developed by Mary Ann



Solenoid Coil and Radiation Shield Temperature HMI screen developed by Pablo; temperatures during cooldown of magnet shown

Hall A – ECAL (Marc, George, Brian)

1737 lead glass blocks need constant annealing of radiation damage during data taking

Marc McMullen
2023-02

This month I assembled a test stand to aid in the development of a system of controls for the ECAL supermodule heaters. The goal of the system is to maintain a target temperature at the front flange of the supermodule of 250°C. The test stand consists of a single supermodule placed in an enclosure, a power supply, and a National Instruments 9045 cRIO as the data acquisition and controls.

The EEL building's industrial oven, Fig.1, was used as an enclosure for the test stand. The internal size of the oven (4' wide, 3' high, 2' deep) is rated for 350°C making it ideal for use as an enclosure. It also is vented outside the building, which will remove any unwanted outgassing during the test.

The cRIO uses four modules for monitoring temperatures and voltages, as well as controlling power to the heater. Temperature is monitored by two four-channel RTD modules. The RTDs are for the six positions on the supermodule, the heater, and the ambient air of the oven enclosure. The voltage applied to the heater was monitored by a channel of an analog input module. Due to the limits of the analog input module, a voltage divider was installed parallel to the heater, to allow only 10% of the heater voltage to be measured for voltage verification. Finally, power to the heater is controlled by a relay which is controlled via a digital output module channel.

Power to the heater and relay is provided by a four-channel Agilent N6700B power supply. Each channel can supply 50 VDC and 5 A. The heater is rated for 125 W at 120 V. To achieve enough voltage, three channels are configured in series. The fourth channel is used to power the relay coil that requires 12 VDC.

ECAL Heater Controls Test Stand

- Assembled the test stand
- Developed control and monitoring software for a single ECAL heater and software datalogging

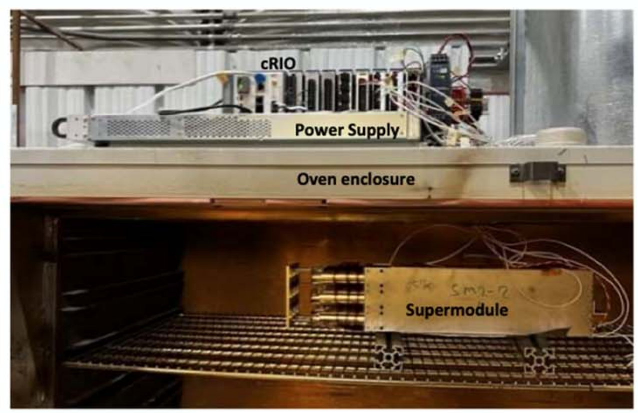
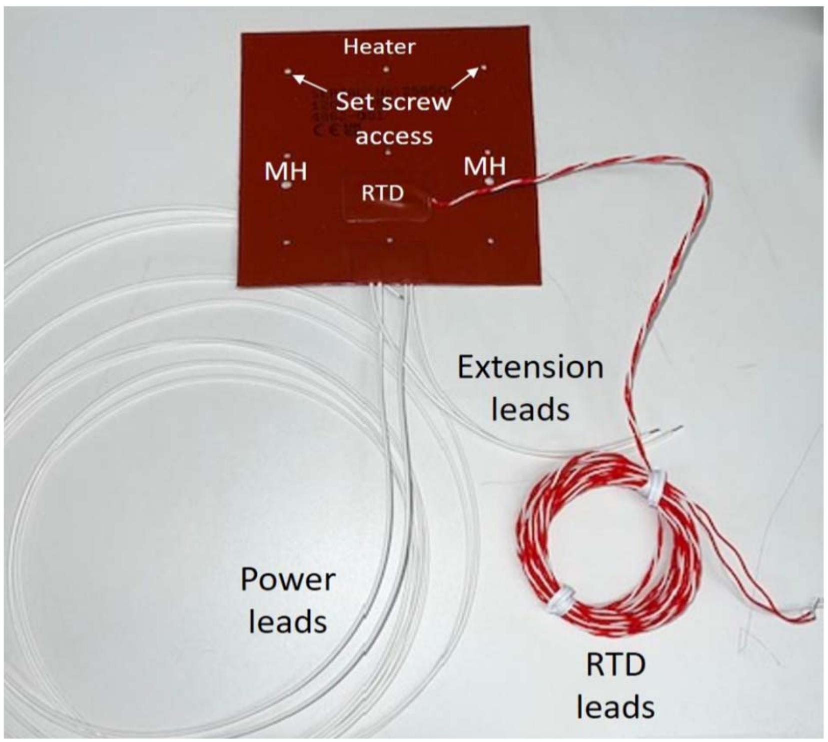


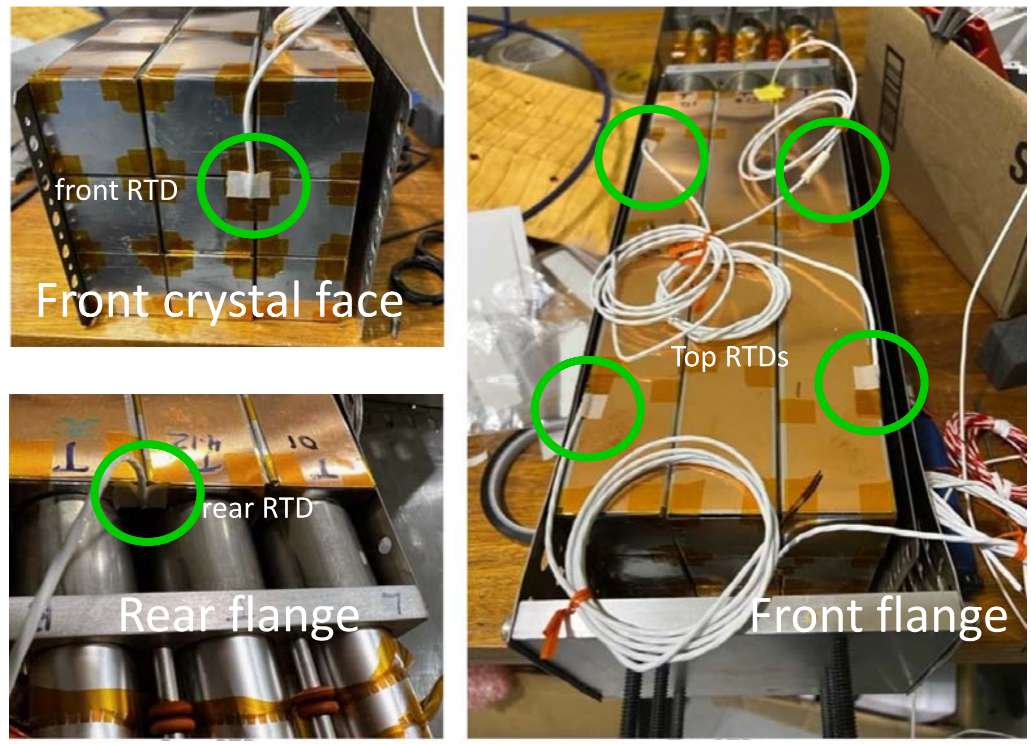
FIG.1 Supermodule in oven

Hall A – ECAL (Marc, George, Brian)

- **Goal: show that flange in front of front crystal face reaches 250°C with silicone-based, wire-wound heater designed by DSG**
- **Assembled supermodule and RTDs to test heater**
- **Developed control and monitoring in LabVIEW for power and RTDs**



Silicone-based, wire-wound heater designed by Marc

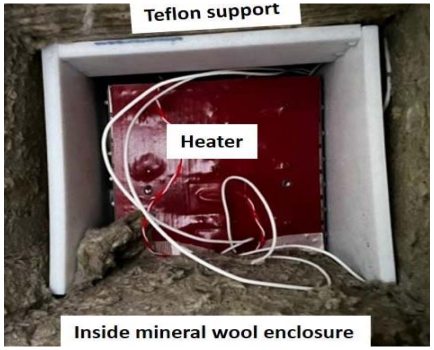


RTD locations on the supermodule

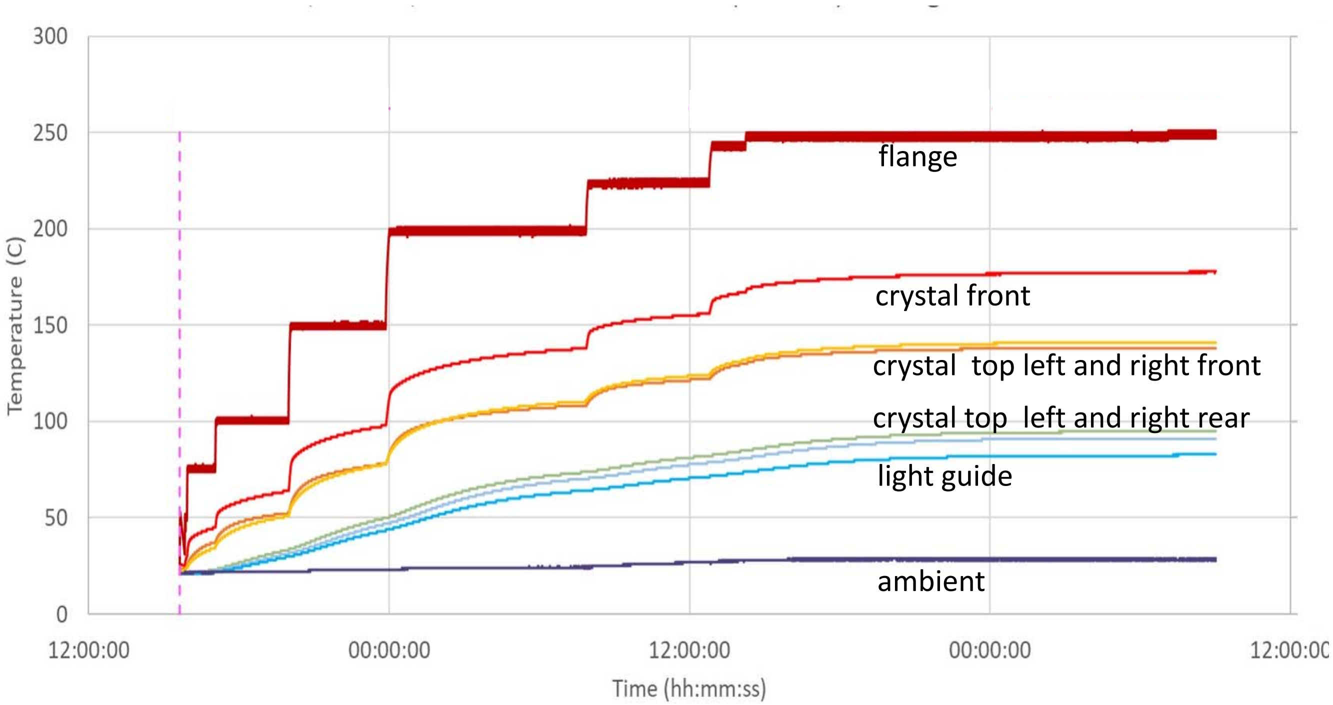
Hall A – ECAL (Marc, Brian, George)

- **Confirmed flange temperature reached 250ºC**
- **LabVIEW-based control system to power the six-supermodule test stand is in progress**
- **Full system (188 supermodules) control and monitoring design in progress**

Insulated supermodule in oven. Industrial hygiene tested emissions to approve week-long tests



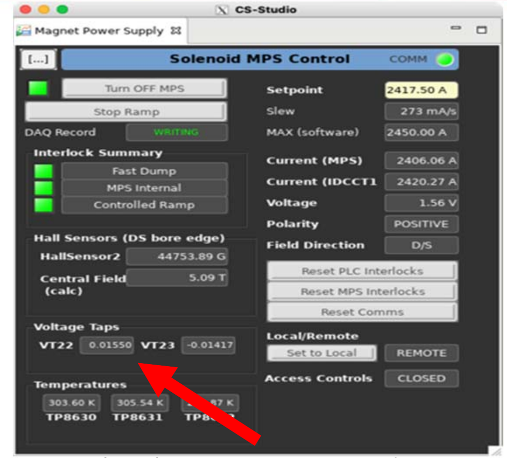
Front view of supermodule with attached heater pad



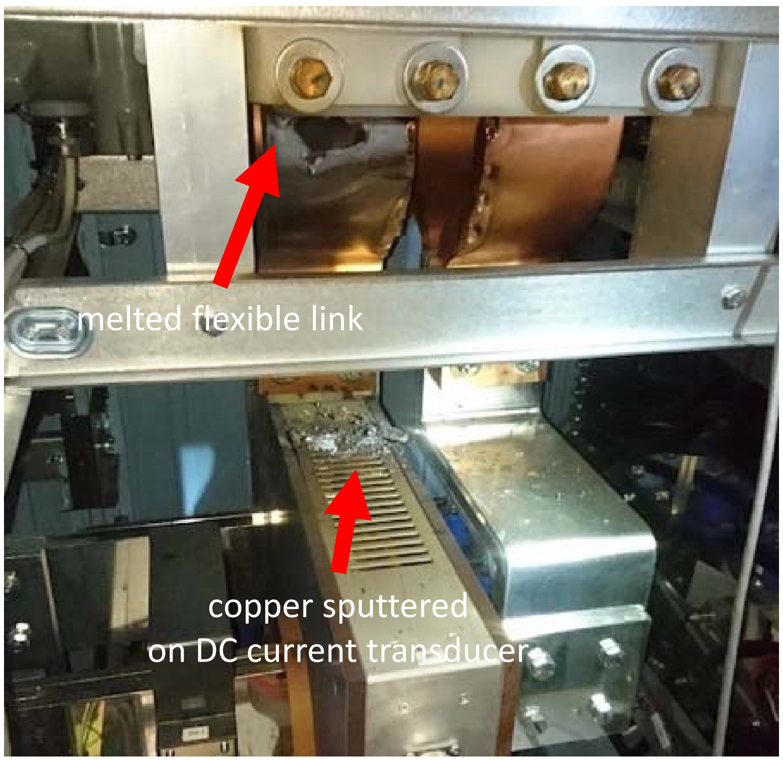
Results of the insulated heating test

Hall B –Solenoid, Torus, and Support (Brian, Aaron, Tyler, Pablo, Marc)

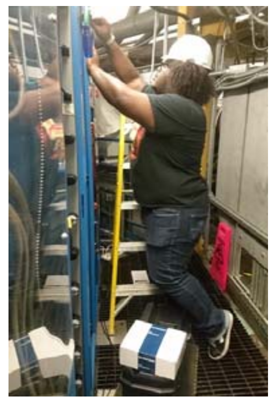
- **Recovered MPS from catastrophic failure in 80 days (~12–18 months were anticipated!)**
- **Updated PLC code to prevent polarity reversal**
  - Same code on solenoid and torus PLCs
- **Resolved SVT high current on region 2 sector 11 top (R2S11T)**
  - Pin bent on HV cable connector
- **Restored LTCC sectors 2 and 6 to operating conditions**



Display showing new VTs and RTDs



Damaged power supply



Aaron performing interlock checkout

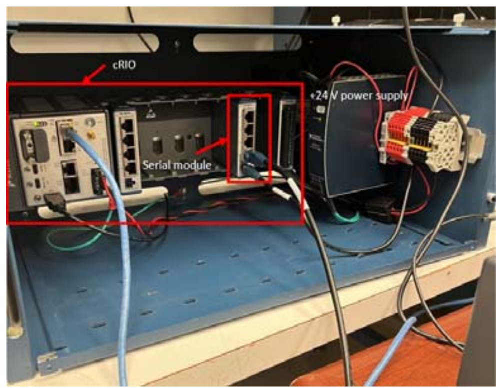
Dear Patrizia and Amrit
This is to formally let you know that magnet group, ENP recognizes the effort and contributions that Brain made and making [*sic*] in order to get HallB back running for physics.
Thanks to Brian and the whole DSG for been [*sic*] with us as always.
Regards
Probir

Employee excellence award

Hall C – NPS (Aaron and the DSG)

- **Supported noise reduction tests**
  - Implemented Faraday cage
  - Fabricated antenna probe to locate source of noise
- **Soldered ~800 PMT divider bases**
  - Soldered capacitors between signal and ground
- **Populated cRIO chassis**
  - Holds cRIO and 24-V power supply


Aaron and George covering detector with aluminum foil in EEL 108

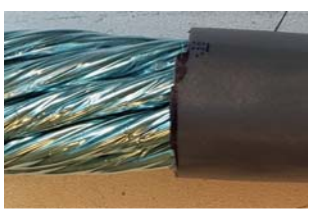


Marc populated cRIO chassis


Mindy fabricated antenna probe

Mindy soldered ~800 50-V capacitors between signal and ground on divider base

- **Fabricated 60-ft. extension cables for the 50-pin, D-sub connectors (x12)**
  1. Outer jacket removed
  2. Pairs untwisted, first layer of shielding (clear) removed
  3. Second layer of shielding (blue) removed
  4. Third layer of shielding (clear) and 50 drains removed
  5. Fifty wires stripped and tinned
  6. Wires soldered to connector, with heat shrink attached
  7. Completed cable
- **Testing cables**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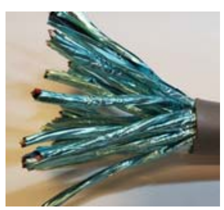
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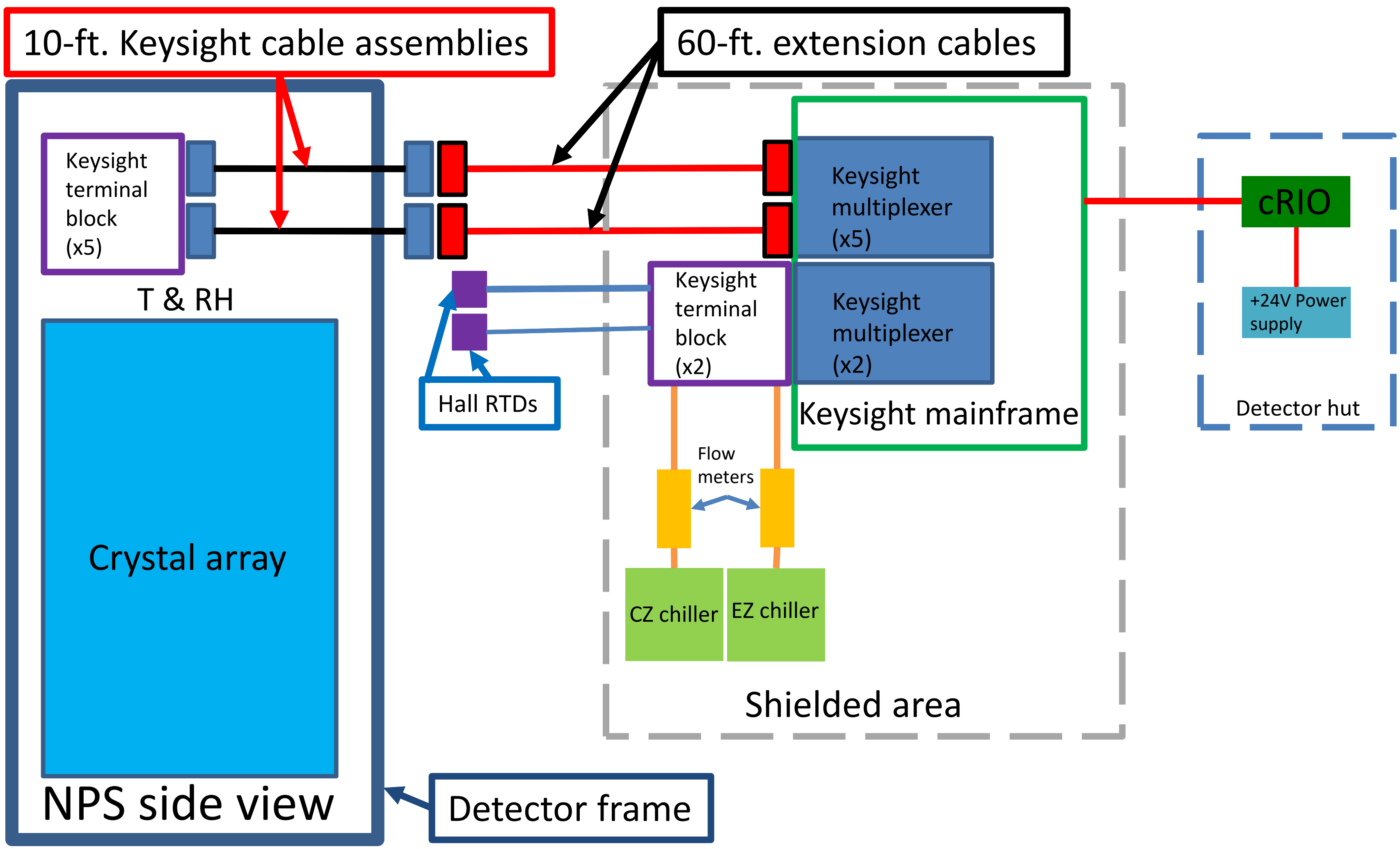
Hall C – NPS Control and Monitoring System Layout



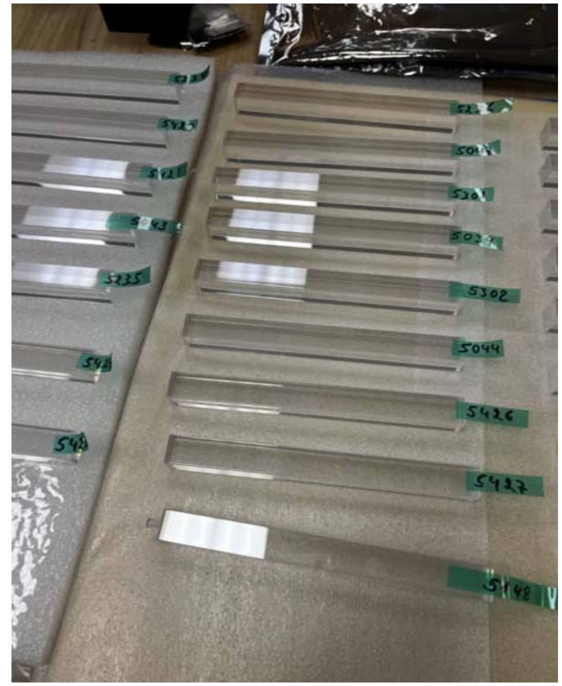
Control and monitoring system layout by Aaron

Hall D – JEF (Aaron, George, Mindy)

- **Refurbishing ComCal modules for JEF**

Modules removed from ComCal insert

Crystals are cleaned and soaked in alcohol to remove glue holding light guide in place



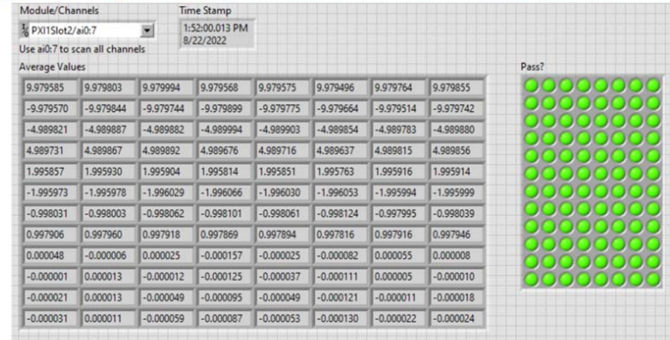
Cleaned crystals are tagged with their previous location and prepared to be rewrapped

ComCal module to be refurbished for JEF

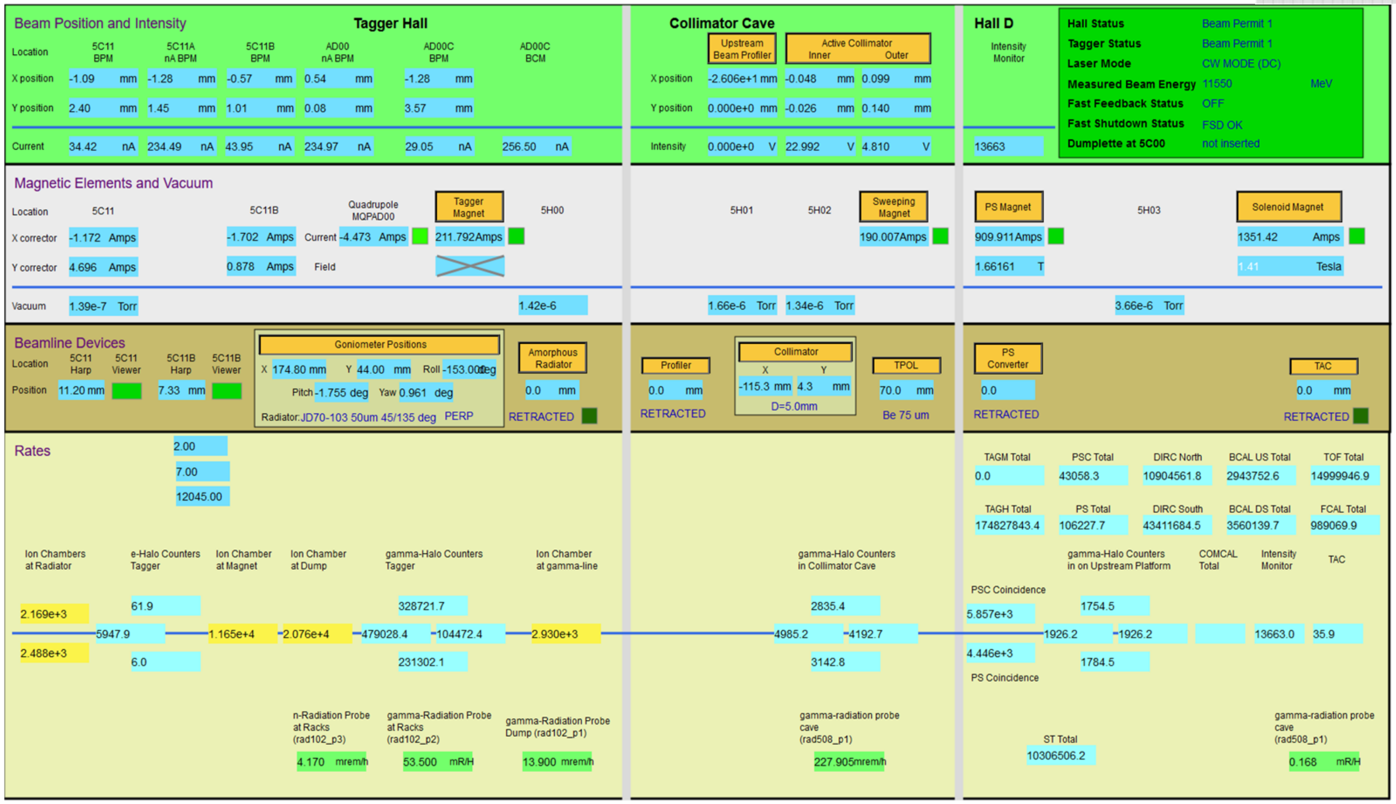
Hi Aaron,
Thanks a lot, the DSG group is helping a lot!
We need to wrap 190 crystals (+- depending on the number of spares). 95 SICASS crystals we already have in the lab, 95 CRYTUR crystals we'll receive in May.
Cheers,
Alex

Hall D – Support (Tyler, Brian)

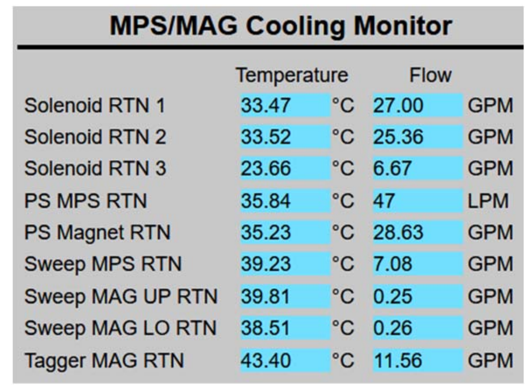
- **Developed remote monitoring of Hall D systems using WEDM**
- **Performed annual calibration of PXI's ADC modules**
  - Developed LabVIEW program for PXI that performs calibration procedure
- **Support PXI operation by ensuring system software, firmware, and hardware is up-to-date, and by procuring spares as needed**
- **Support PLC troubleshooting**
  - Debugged and resolved issues with BCAL chiller communication to EPICS



Screenshot of LabVIEW screen showing calibration results for an ADC module of the PXI. Green LEDs on the right indicate that all tests passed



GlueX overview WEDM screen developed and supported by DSG



MPS/MAG Cooling Monitor

	Temperature		Flow	
Solenoid RTN 1	33.47	°C	27.00	GPM
Solenoid RTN 2	33.52	°C	25.36	GPM
Solenoid RTN 3	23.66	°C	6.67	GPM
PS MPS RTN	35.84	°C	47	LPM
PS Magnet RTN	35.23	°C	28.63	GPM
Sweep MPS RTN	39.23	°C	7.08	GPM
Sweep MAG UP RTN	39.81	°C	0.25	GPM
Sweep MAG LO RTN	38.51	°C	0.26	GPM
Tagger MAG RTN	43.40	°C	11.56	GPM

LCW monitoring WEDM screen developed by DSG

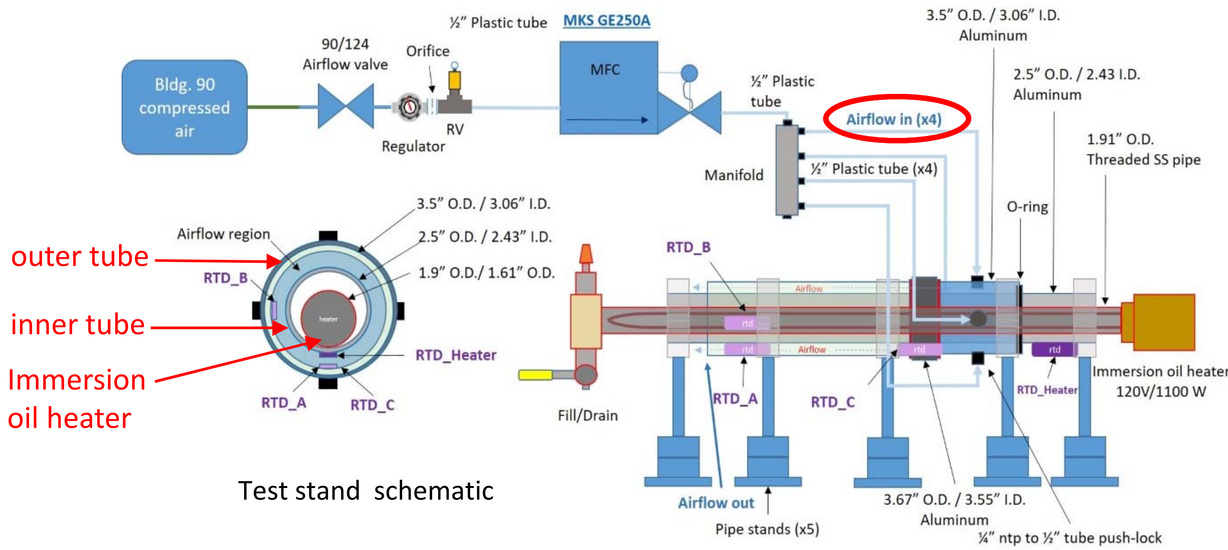
Tyler,
That looks great!
Thanks,
Scot Spiegel
Hall D Work Coordinator

EIC – Beampipe (Marc, George)

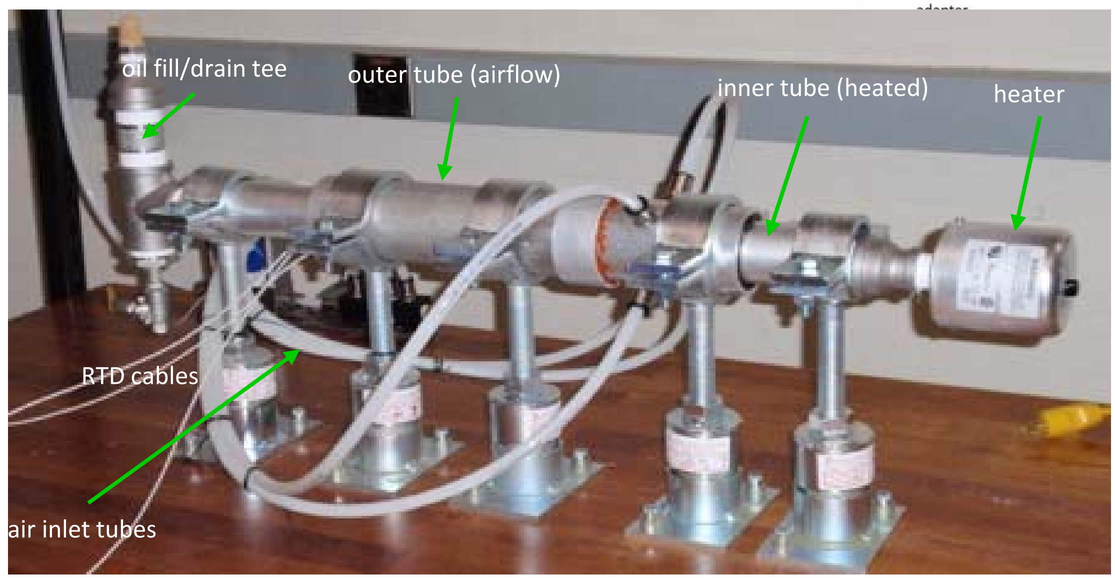
- **Built model of beampipe and silicon layer 1 (SL1)**
  - Immersion oil heater to warm beampipe (inner tube)
  - Outer tube represents SL1
  - Air flow from right to left between inner tube (beampipe) and outer tube (SL1) measured by MKS mass flow controller
  - Acquired data for two days and analyzed data

Plans

- Start Ansys simulation of test stand
- Insulate inner tube with aerogel (1 mm) and rerun test

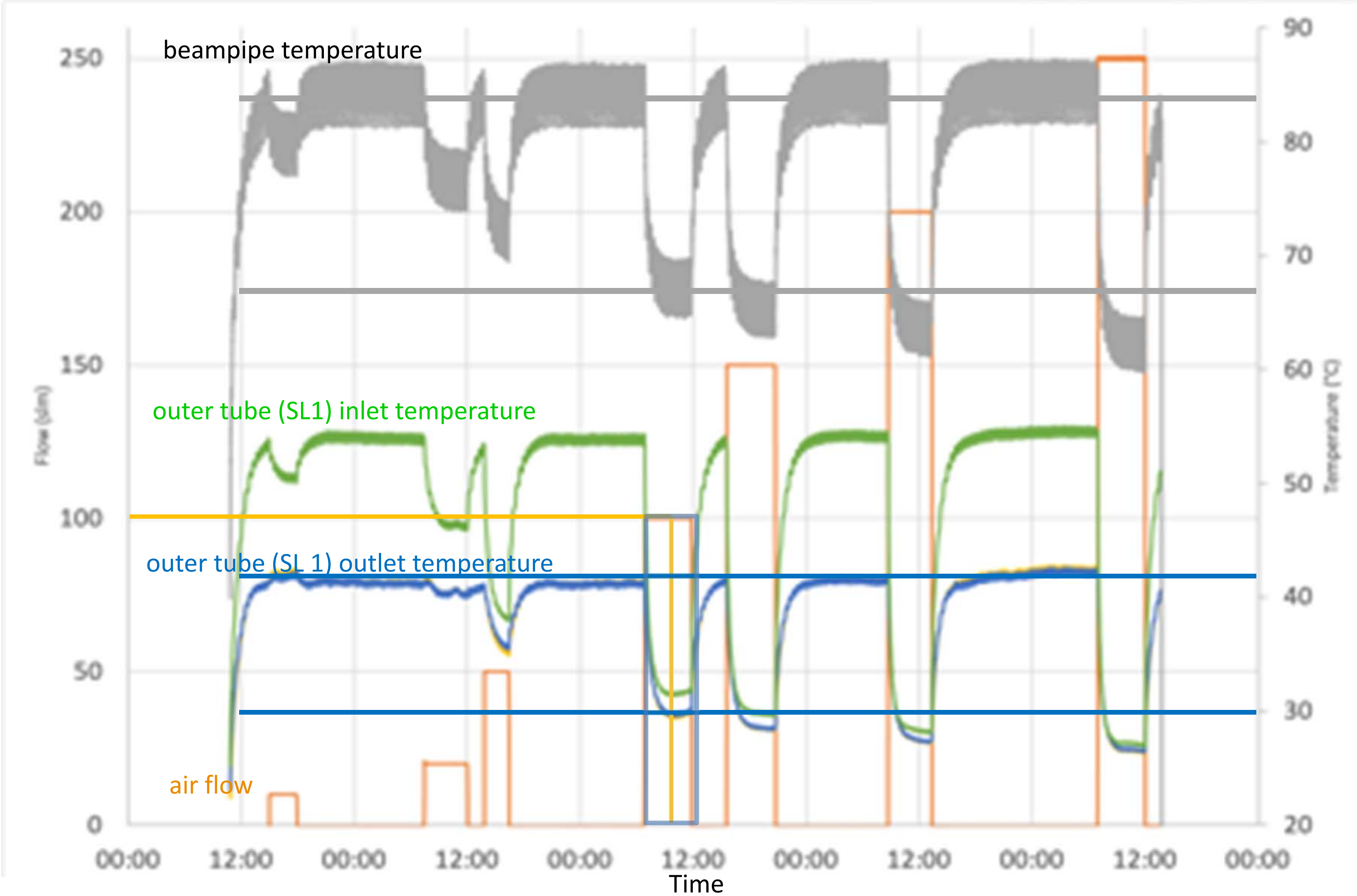


Test stand schematic



Test stand built by Marc and George

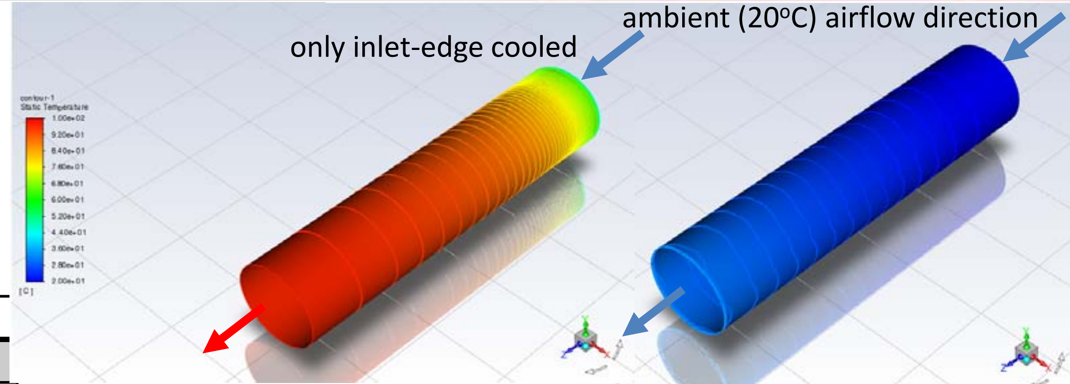
EIC – Beampipe Results without Aerogel (Marc, George, Brian)



Outer tubes outlet temp. ~45°C without air flow. At 100 slm air flow, outer tube outlet temp. ~30°C; beampipe temperature falls to ~65°C. Rolf and BNL engineers suggested insulating beampipe with aerogel.

EIC – Beampipe (Pablo, Brian)

- **Added 0.5-mm aerogel to the model around beampipe**
  - **Simulated model with 5 mm of separation between beampipe and SL1 with and without air flow velocity through the annulus space and enclosure**



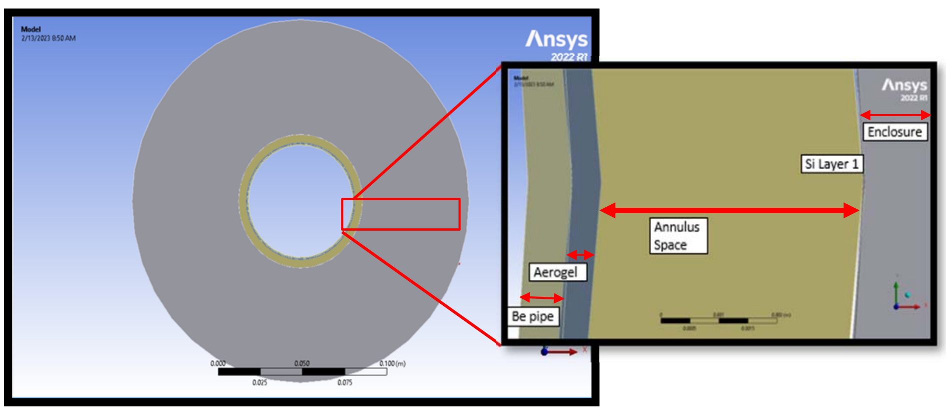
Isometric view (with aerogel). Air flow velocity 0.001 m/s (low flow)

Isometric view (with aerogel). Air flow velocity of 2 m/s

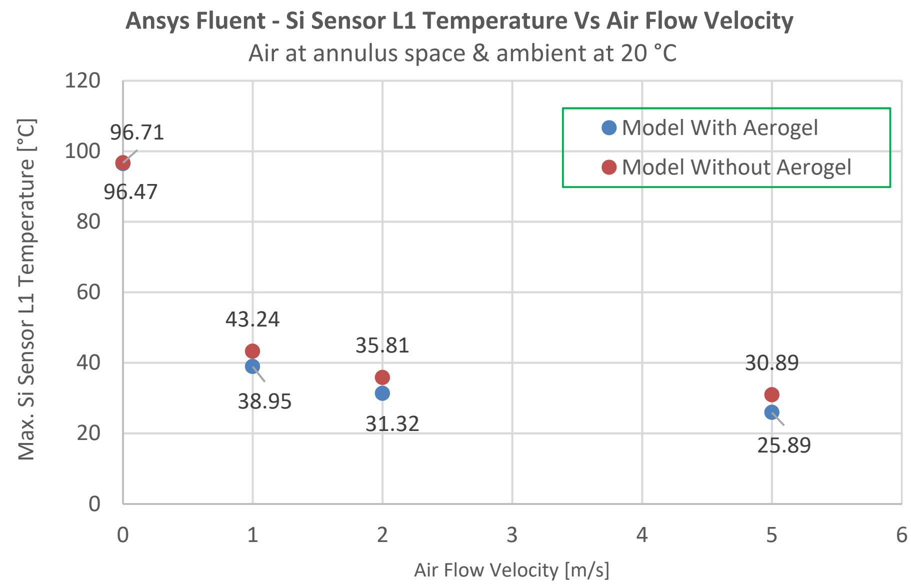
Upcoming tasks

- Simulate aerogel thermal properties and thicknesses

Ansys Fluent Thermal Conditions	
Solver	Fluid Flow Fluent
Model	k-omega, Shear Stress Transport (SST)
Precision	Double
Simulation Iterations	100
Beryllium pipe inner face temperature	100 °C
Air temperature	20 °C
Air flow velocity	0 to 5 m/s

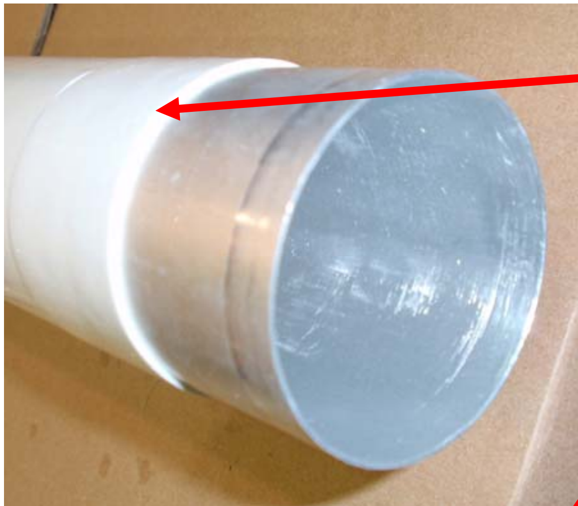


Model with 5-mm separation with aerogel (0.5 mm) implemented for simulation

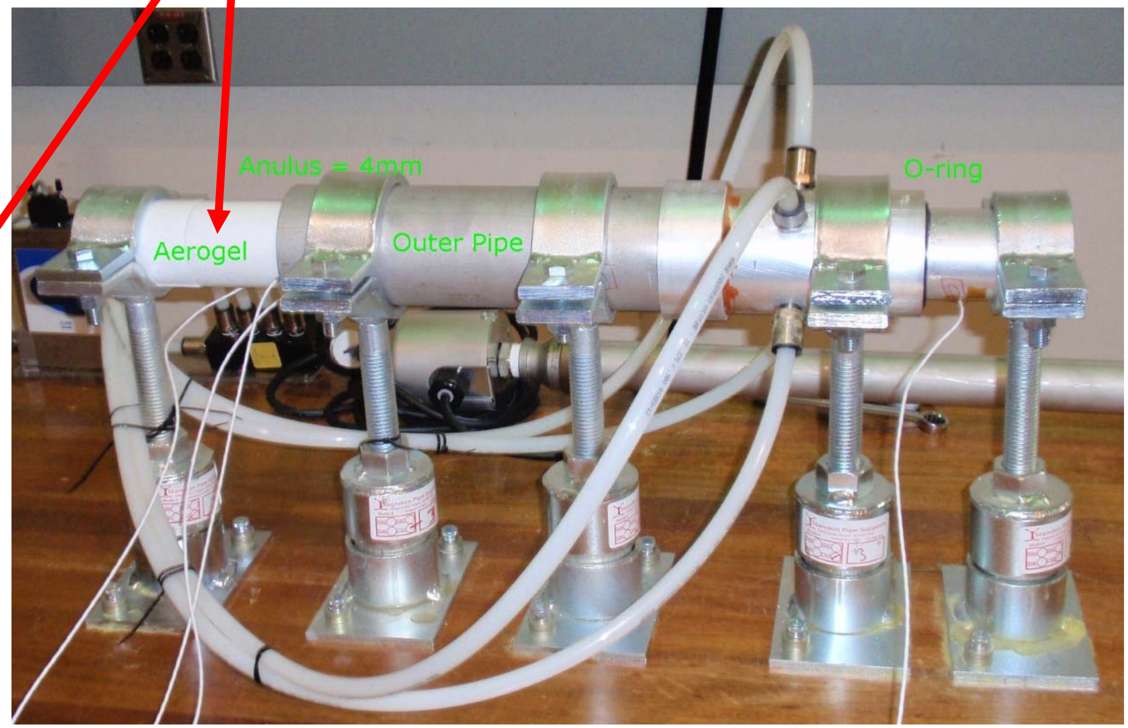


Simulation shows insulating beampipe with 0.5-mm aerogel decreases, for any flowrate >0 m/s, the temperature of silicon layer

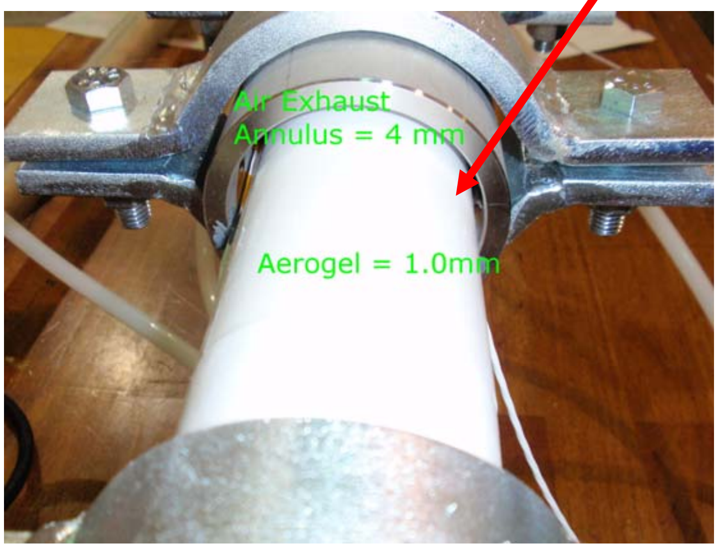
EIC – Beampipe Test Stand with Aerogel



Beampipe wrapped with 1-mm aerogel



Side view of test stand; beampipe with aerogel



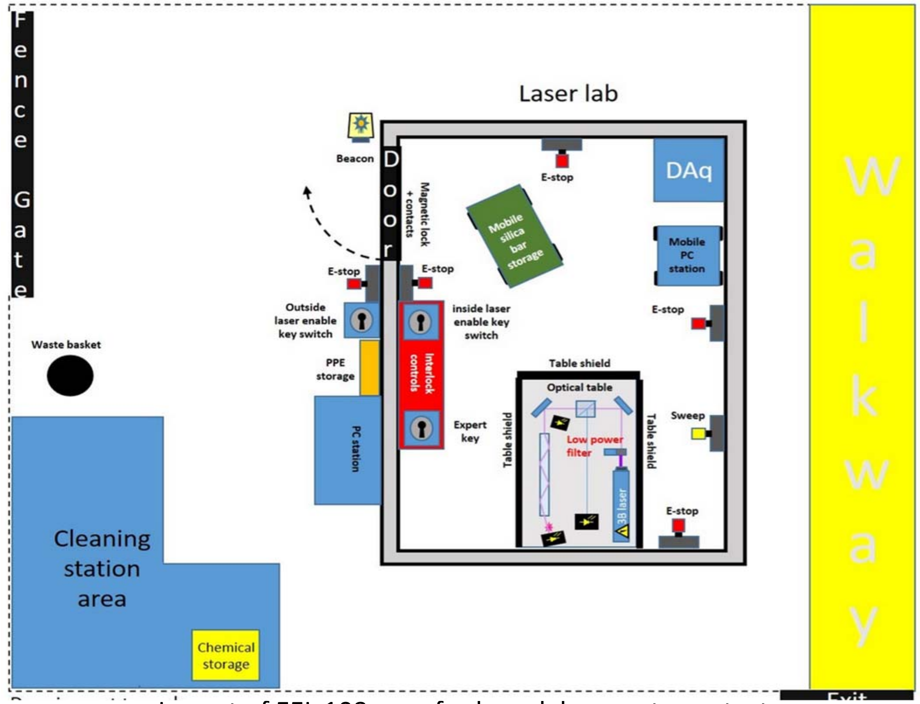
Top view of test stand; beampipe with aerogel

- Testing in progress
  - With new immersion heater
- Ansys analysis in progress

EIC – DIRC (Tyler, Marc)

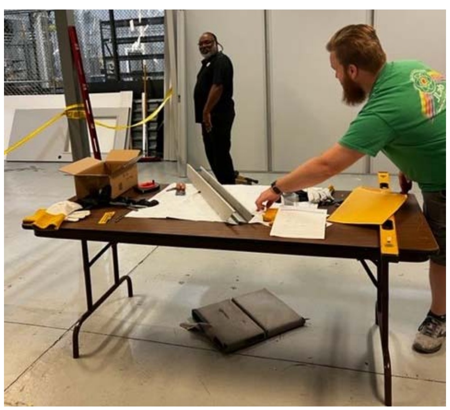
- **Coordinating acceptance tests for detector's quartz bars**
  – Ensuring new sub-room for test station's laser area in EEL 108 is constructed as required for the test
- **Generating safety documentation**
  – Laser OSP and training plan approved
  – OSP for cleaning and preparation of bars is in progress
- **Designing laser interlock system**
  DSG-Note 2023-01
- **Developing DAQ system for tests**

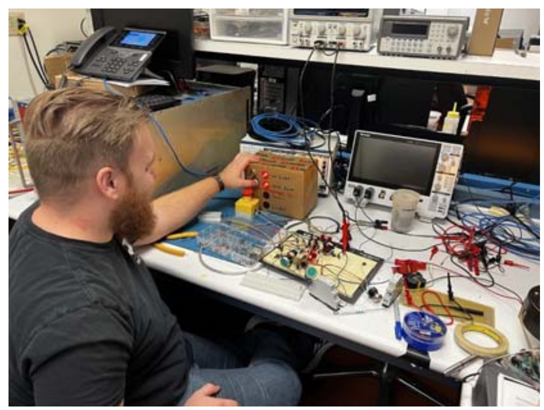
Upcoming tasks
– Develop full automation using linear and rotary stages
– Run acceptance tests to check bars reflectivity
– Contribute to analysis of test data



Layout of EEL 108 area for laser lab acceptance tests

Marc and Tyler checking blueprint dimensions of sub-room for planning its layout




Tyler testing prototype of laser interlock

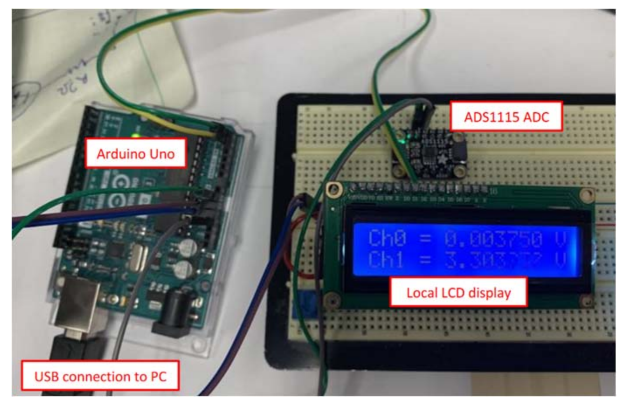
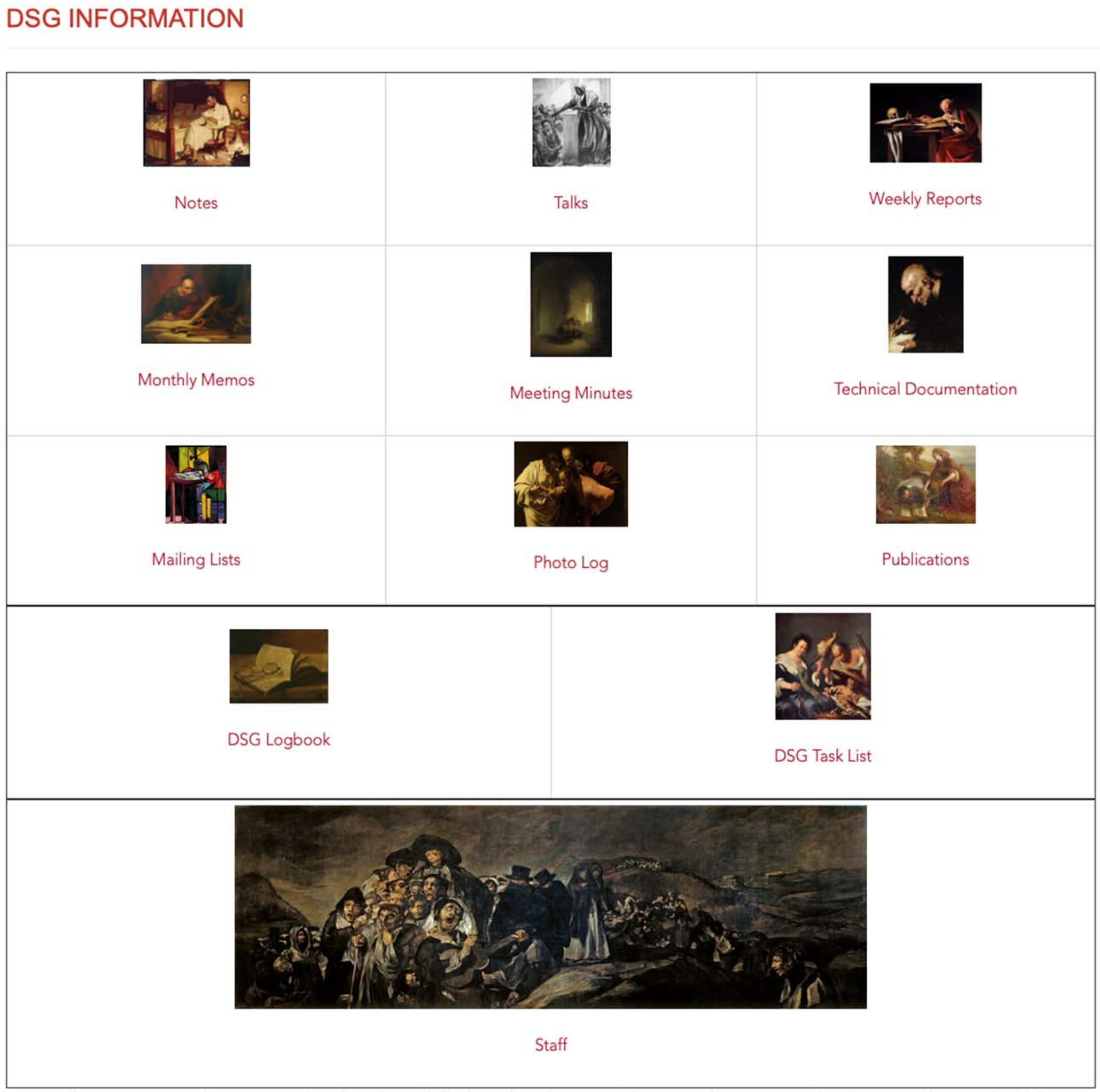


Photo of breadboard prototype DAQ

DSG Website



[DSG Website]

A posteriori - Conclusion

DSG is collaborating with all Halls on many of their projects and EIC, and making exceptional contributions

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