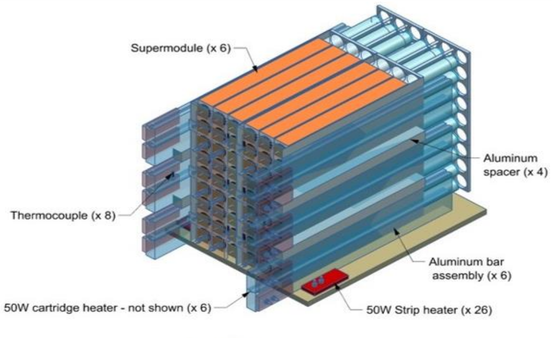
DSG Current Projects
FY 2024

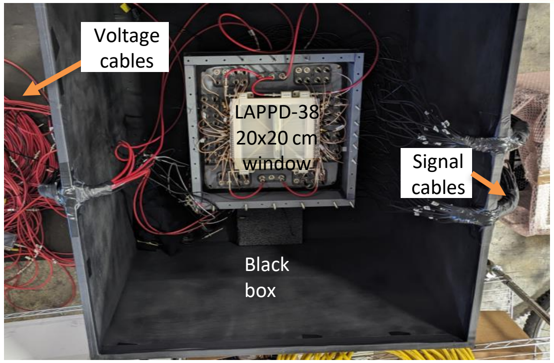
Dr. Patrizia Rossi
Detector Support Group
Wednesday, February 27, 2024

Contents



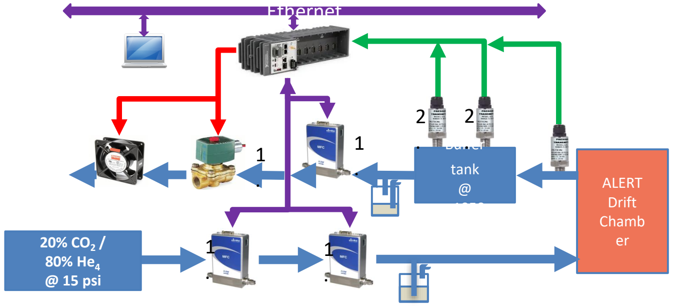
Isometric view

Hall A - ECAl

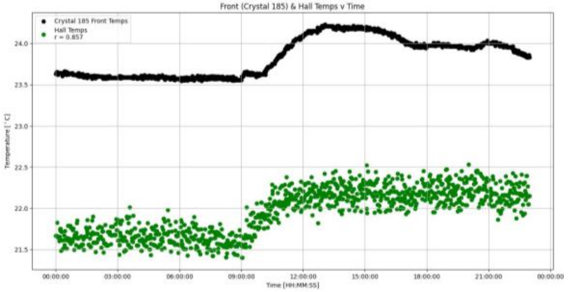


Hall A - LAPPD

Hall A - Moller

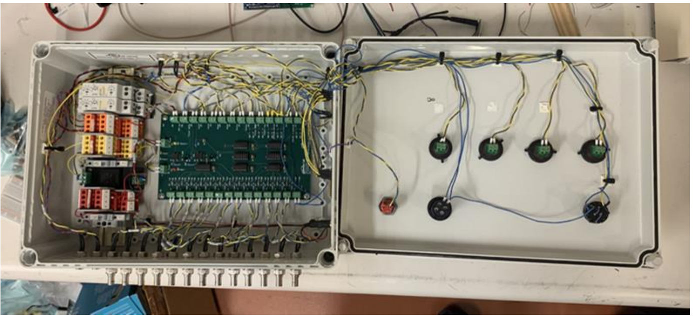


Hall B - ALERT

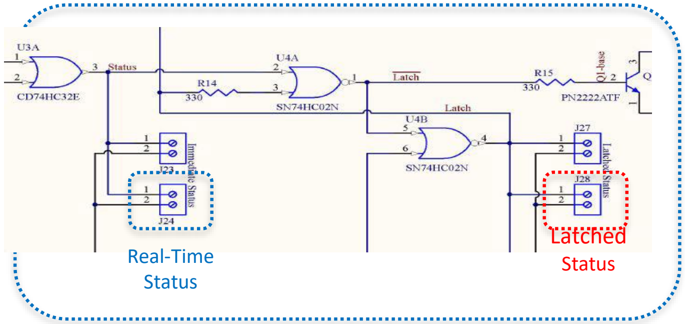


Hall C - NPS

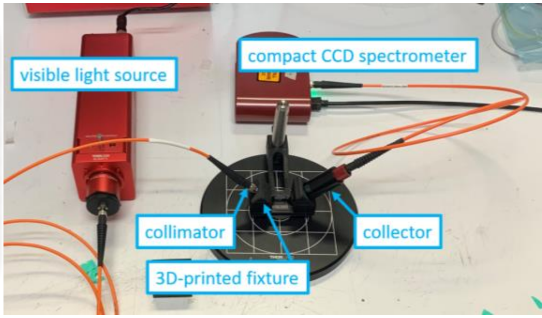
Hall D – FCAL 2



EIC- DIRC



EIC- DIRC Phoebus Alarm Handler



EIC- RICH

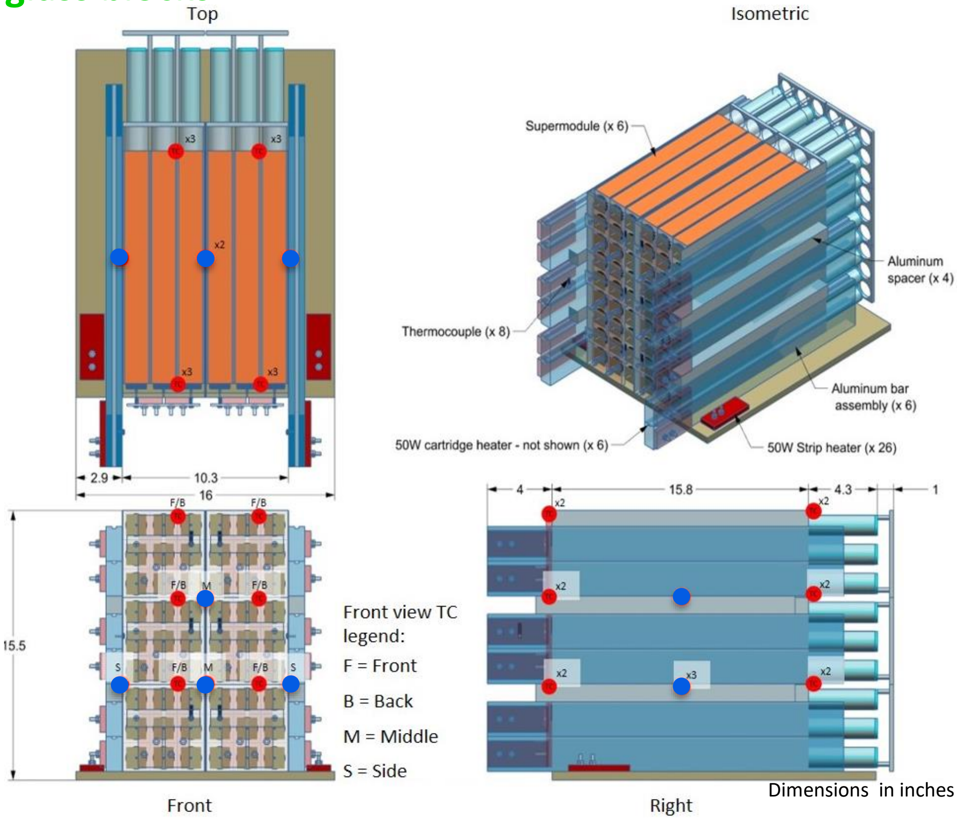
Hall A –ECAL

Marc McMullen, Peter Bonneau, Brian Eng, Mindy Leffel, and George Jacobs

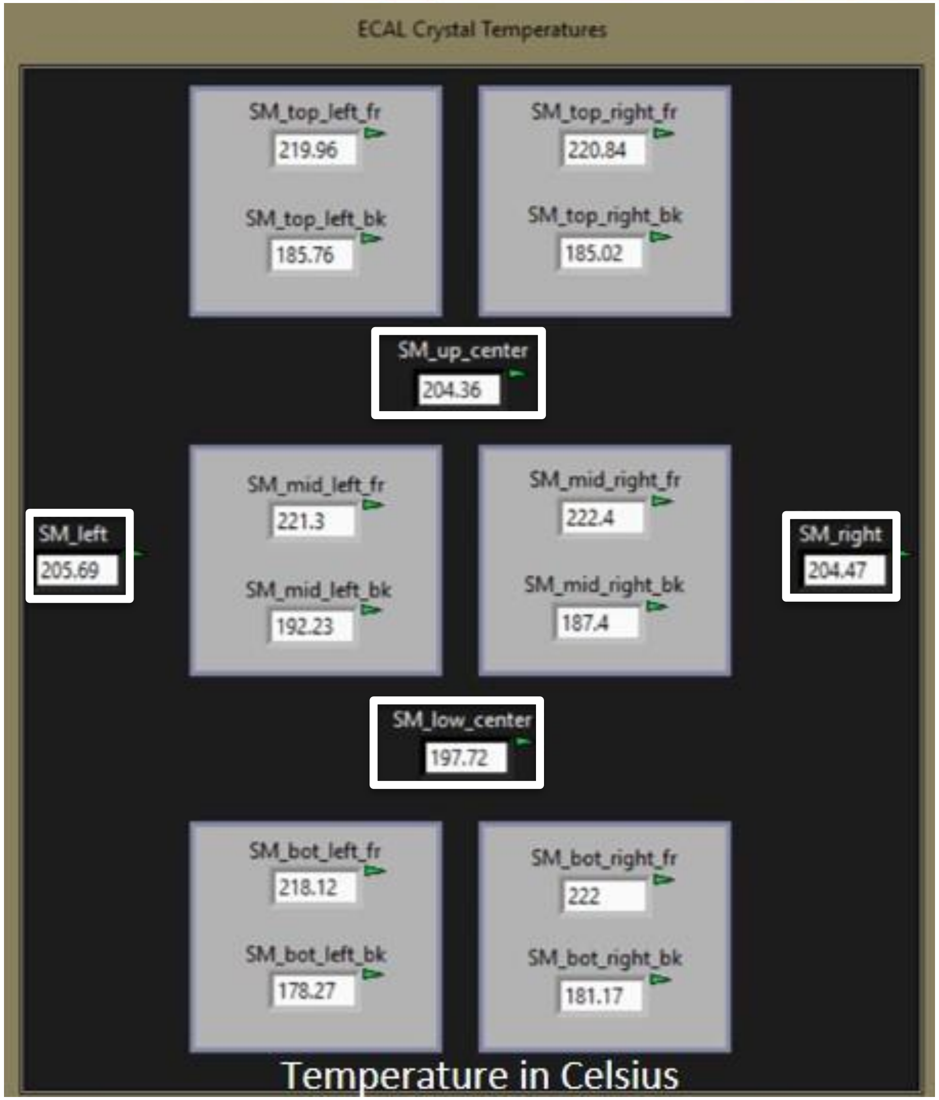
Designed, developed, and installed prototype heater Control and Monitoring (C&M) software and GUIs for the six-supermodule test stand

Operated test stand from September to November 2023

C&M maintained ~220°C on the front surface of lead glass blocks



Thermocouples (16 in all) indicated by red dots are on front and back; thermocouples indicated by blue dots are in the middle of the lead glass block array.


ECAL Crystal Temperatures

SM_top_left_fr 219.96

SM_top_left_bk 185.76

SM_top_right_fr 220.84

SM_top_right_bk 185.02

SM_up_center 204.36

SM_left 205.69

SM_mid_left_fr 221.3

SM_mid_left_bk 192.23

SM_mid_right_fr 222.4

SM_mid_right_bk 187.4

SM_right 204.47

SM_low_center 197.72

SM_bot_left_fr 218.12

SM_bot_left_bk 178.27

SM_bot_right_fr 222

SM_bot_right_bk 181.17

Temperature in Celsius

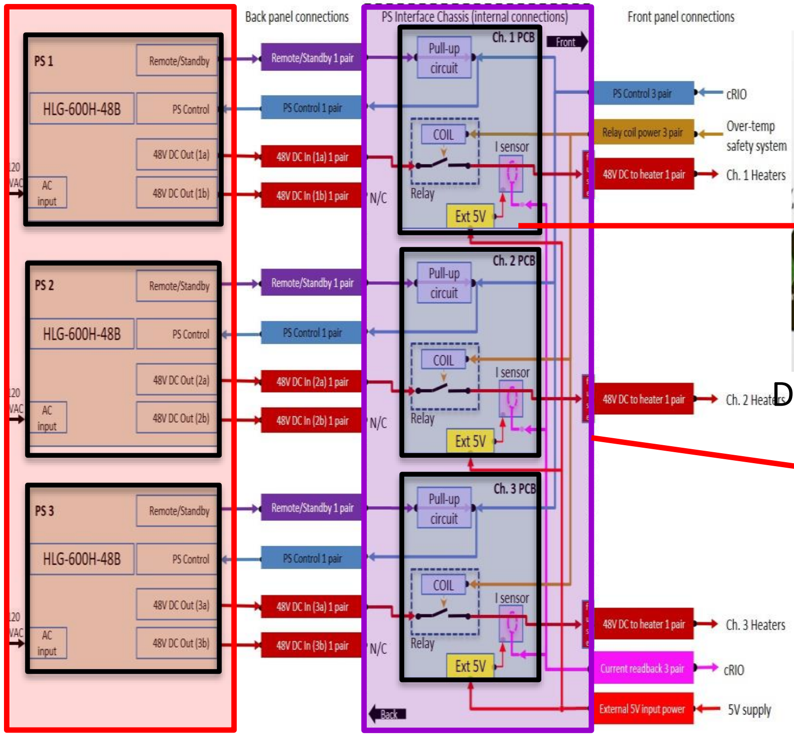
Readback on GUI shows ~220°C for the front supermodules (SM) of the crystals and ~180°C for the back super modules

Hall A –ECAL

Marc McMullen, Peter Bonneau, Brian Eng, Mindy Leffel, and George Jacobs

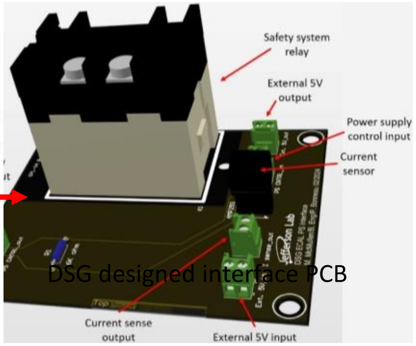
Developing heater C&M software and GUIs for whole system

- Designing and fabricating power supply interface chassis between HV supplies and C&M system
  - Power supply interface chassis (purple box) has one interface card per HV supply
  - Procuring components for 48-channel control & monitoring system
  - Fabricating 16 power supply interface chassis for 48 HV supplies
  - Fabricating electronic components and cables



High Voltage Supplies

power supply interface chassis



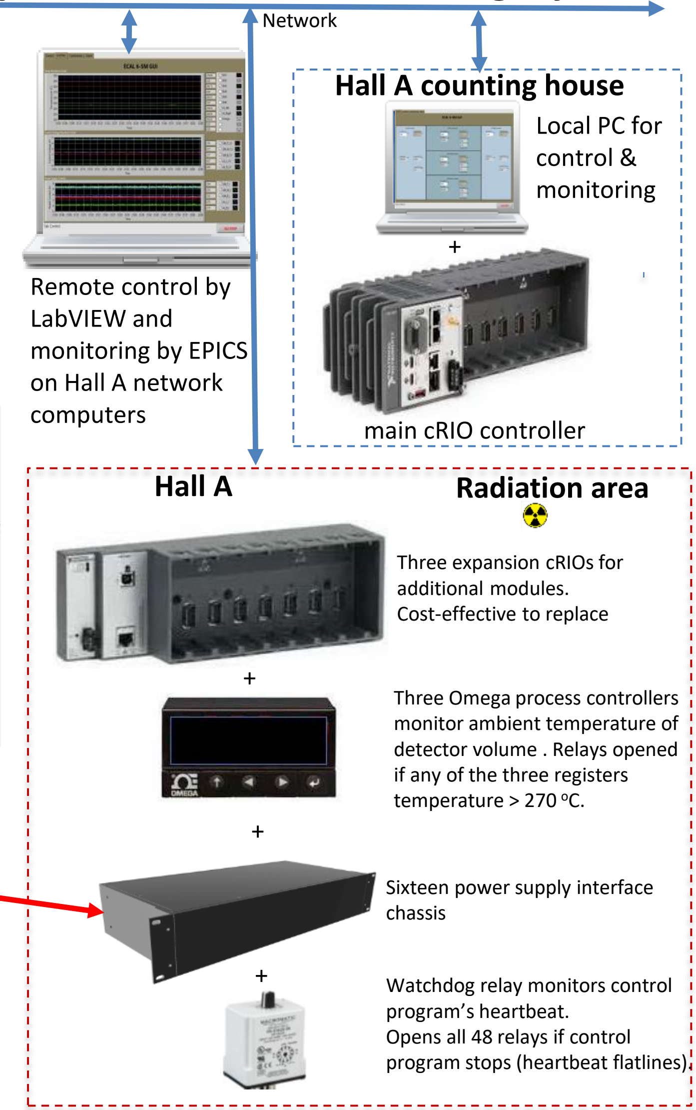
DSG designed control PCB

DSGTalk 2023-13

DSG Talk 2023-15

DSG Note 2023-53

Layout of Control & Monitoring System



Local PC for control & monitoring

main cRIO controller

Remote control by LabVIEW and monitoring by EPICS on Hall A network computers

Three expansion cRIOs for additional modules. Cost-effective to replace

Three Omega process controllers monitor ambient temperature of detector volume . Relays opened if any of the three registers temperature > 270 ºC.

Sixteen power supply interface chassis

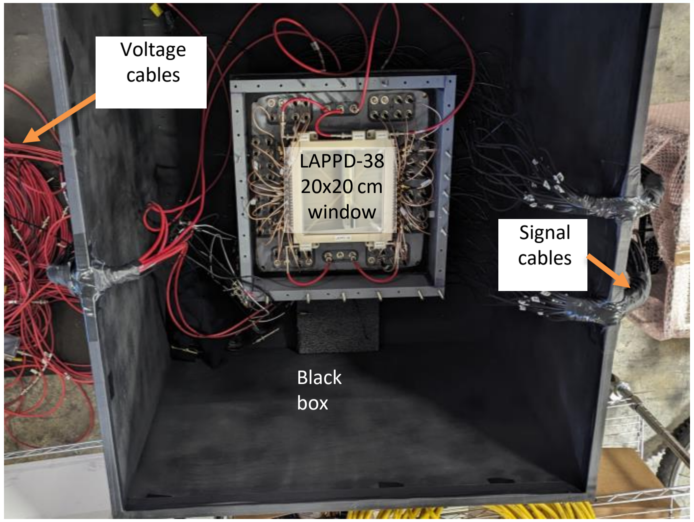
Watchdog relay monitors control program’s heartbeat. Opens all 48 relays if control program stops (heartbeat flatlines).

Components in Hall A endstation bunker

Hall A – LAPPD

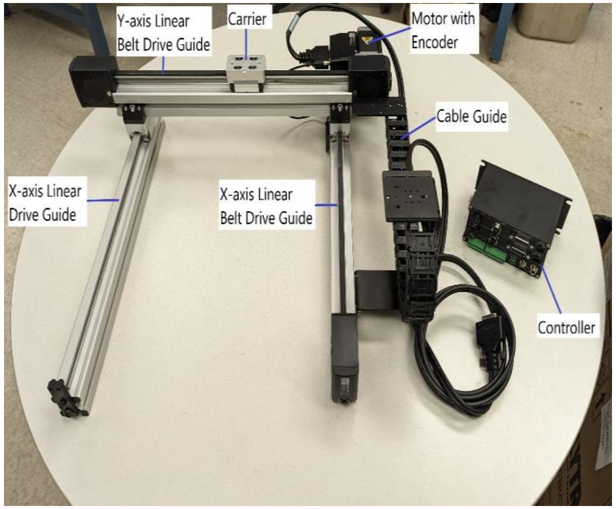
Pablo Campero and Marc McMullen

- Procured Zaber-LC40B gantry motorized positioning system to support and move LED attached to fiber
  - Linear belts (*x* and *y*) drives' guides have a motor with an embedded encoder for precise (400 μm) movement
  - Stand-alone controller outside the detector's enclosure (black box) allows local or remote controls
- Developing C&M program and GUIs to position LED and to enable automated testing
- Assembled motorized positioning system

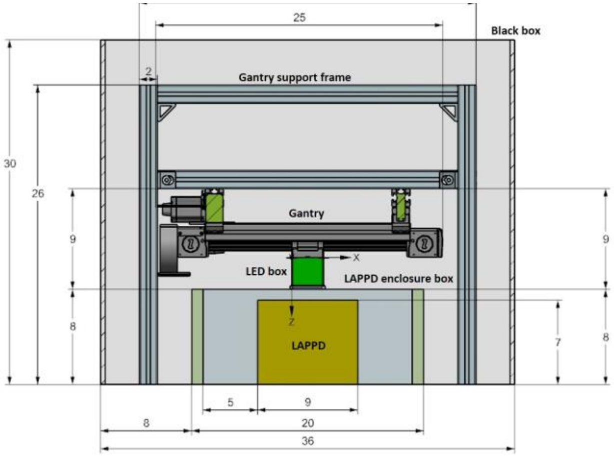


LAPPD-38 detector and components inside a black box

Marc and Pablo aligning *y*-linear belt drive guide with *x*-linear guide



Assembled motorized positioning system



All dimensions in inches

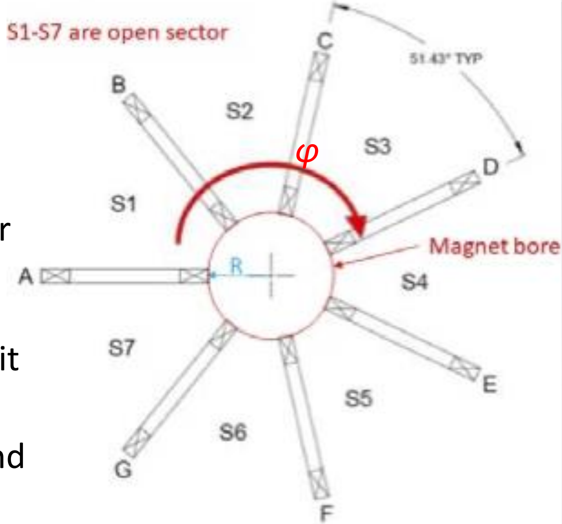
NX12 drawing of operations setup . Gantry oriented to make LED face LAPPD window

Hall A - Møller Magnets

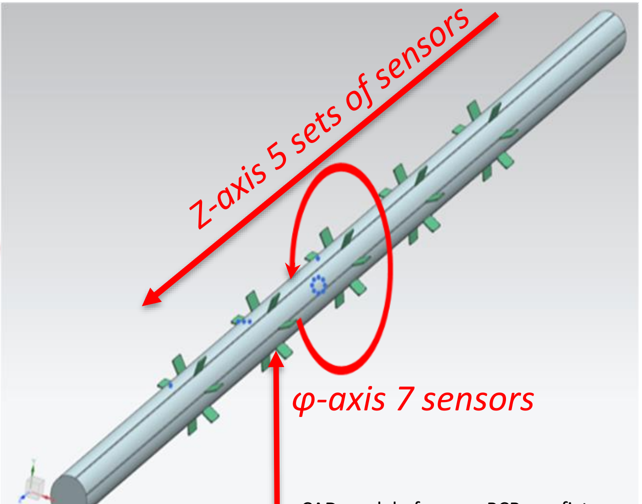
Brian Eng, Mary Ann Antonioli, and McMullen

Side view of toroidal magnets (TM)

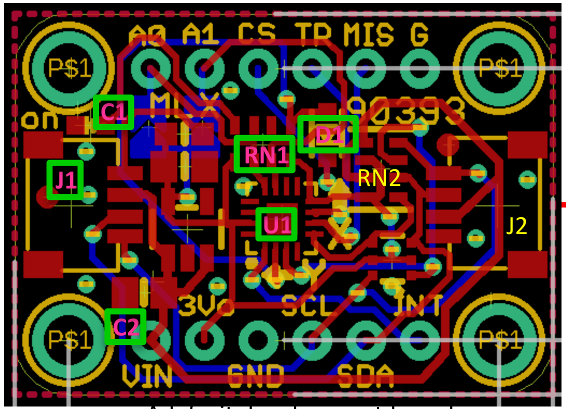
- Requirements for field mapping
  - Seven sensors in φ (one per sector)
  - Minimum of five sets of sensors along z
  - Sensor id: $S^{\mu\nu}$; μ =1,2,3,…5; ν= 1,2, 3,…7
  - Need to measure up to ~100 G
  - Deatails: PMAG0000-0100-S0057
- Selected Melexis MLX90393 magnetometer
  - Adjustable gain allows sensor full scale to be adjusted from 50 G to 500 G
- Checked magnetometer range with Adafruit development board
- DSG designed PCB reduced components and dimensions
  - 2.5 cm X 1.8 cm → 1.5 cm X 1.3 cm



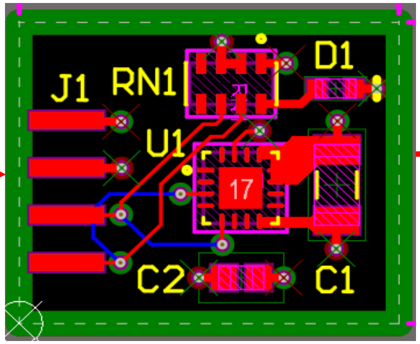
Beamline view of the seven sectors of the coil layout for all magnets



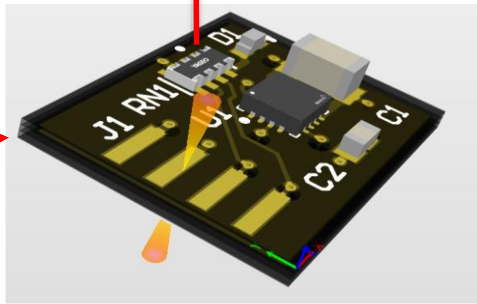
CAD model of sensor PCBs on fixture



Adafruit development board



DSG designed PCB



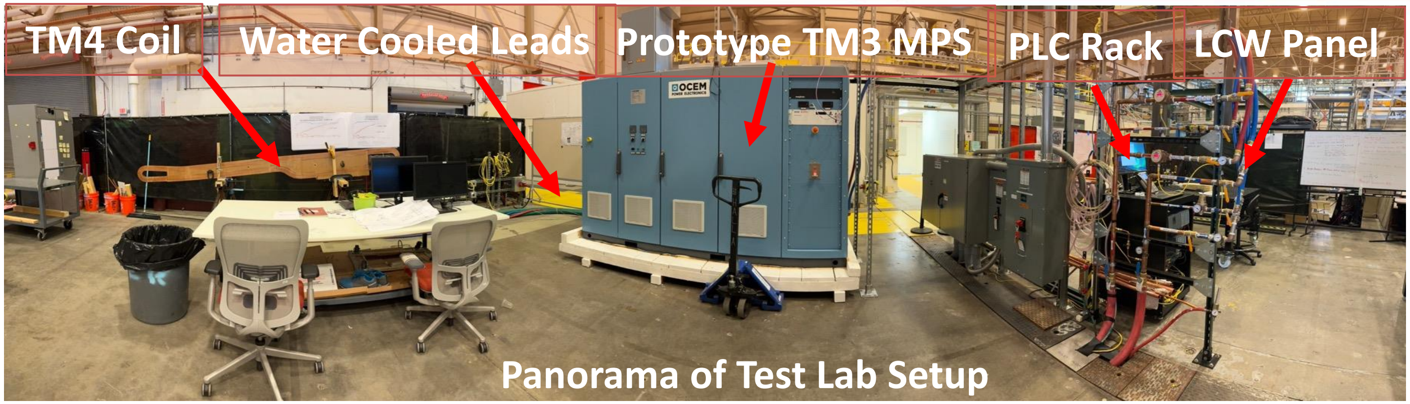
Isometric view of DSG designed PCB

Hall A - Møller MPS

Brian Eng, Mary Ann Antonioli, and McMullen

Test Lab Instrumentation and C&M system for MPS

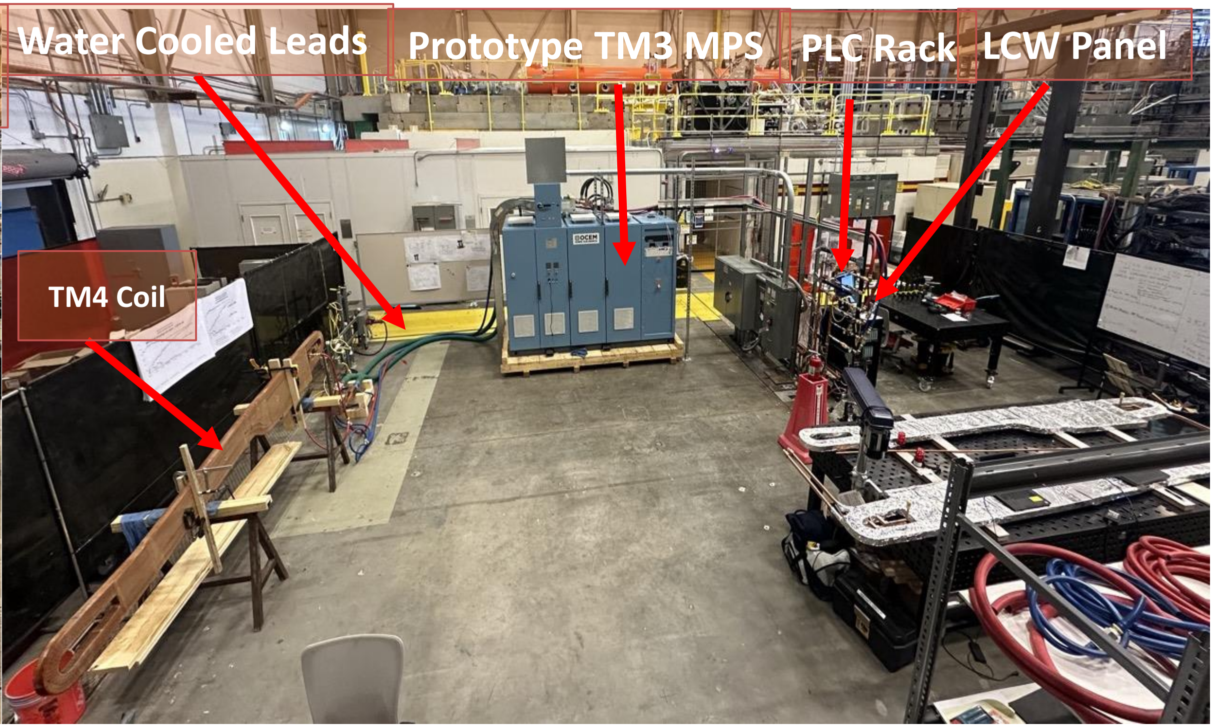
- Wired and instrumented sensors to PLC RTDs, VTs, flow meter, interlocks
- SoftIOC on RaspberryPi
  - Reads PLC tags and sends to EPICS PVs
- Able to communicate with MPS via Ethernet from PLC



Panorama of Test Lab Setup

PLC Rack

LCW Rack

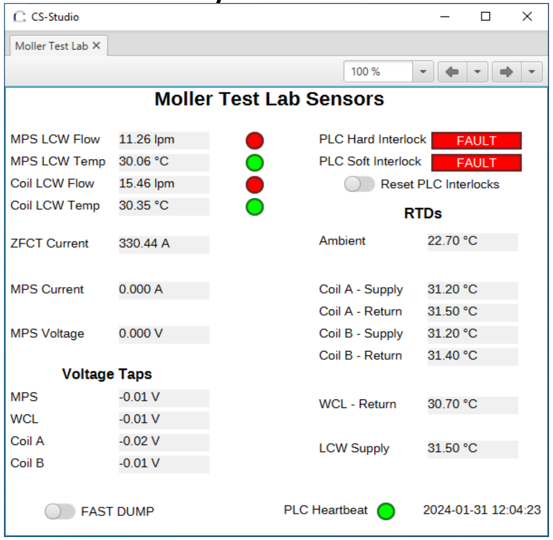


Overall View of Test Lab Setup

Hall A – Møller MPS

Brian Eng, Mary Ann Antonioli, and Marc McMullen

- For Site Acceptance Test TM3 MPS prototype connected to TM4 coil
  - Analyzed data



Moller Test Lab Sensors

MPS LCW Flow 11.26 lpm 🟥
MPS LCW Temp 30.06 °C 🟩
Coil LCW Flow 15.46 lpm 🟥
Coil LCW Temp 30.35 °C 🟩
ZFCT Current 330.44 A
MPS Current 0.000 A
MPS Voltage 0.000 V

Voltage Taps

MPS -0.01 V
WCL -0.01 V
Coil A -0.02 V
Coil B -0.01 V

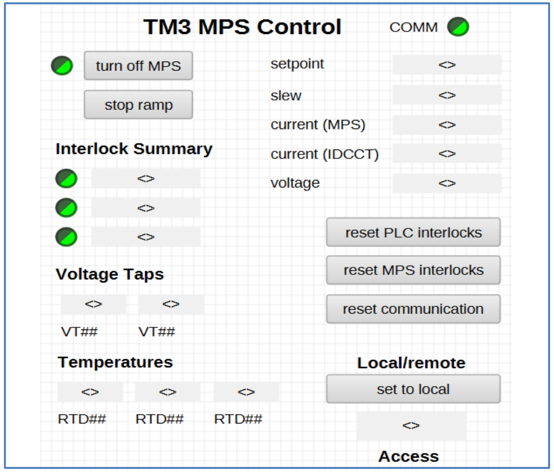
PLC Hard Interlock FAULT
PLC Soft Interlock FAULT
○ Reset PLC Interlocks

RTDs

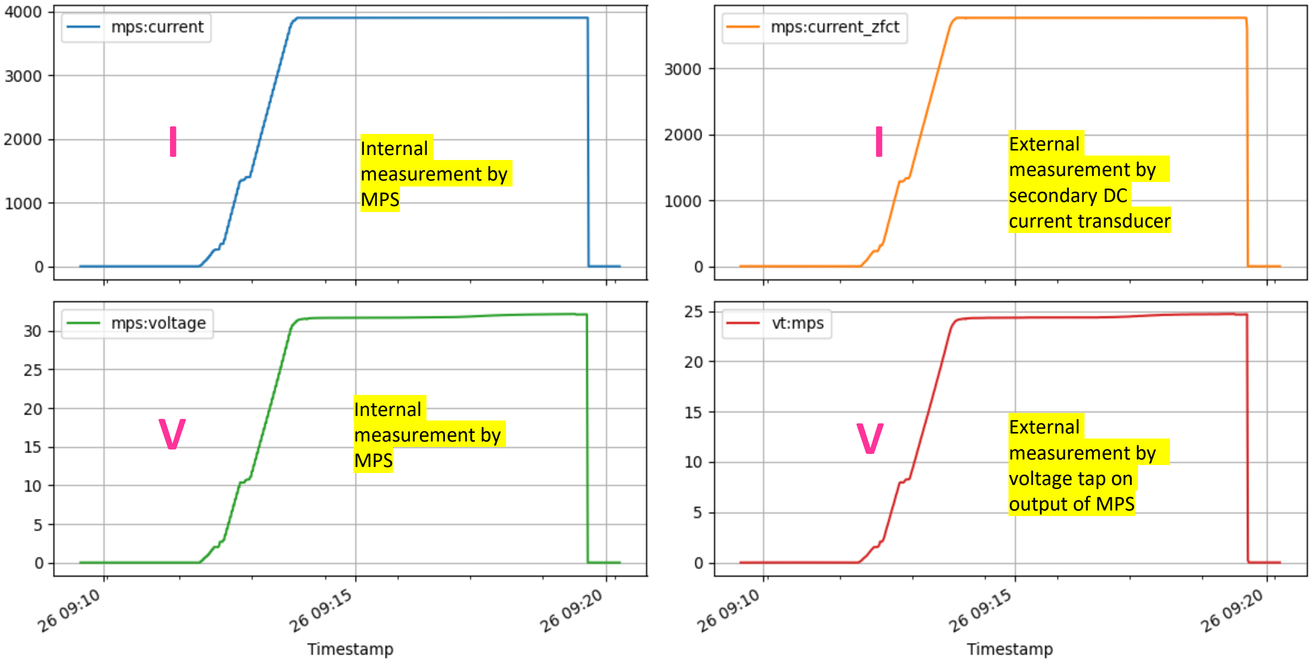
Ambient 22.70 °C
Coil A - Supply 31.20 °C
Coil A - Return 31.50 °C
Coil B - Supply 31.20 °C
Coil B - Return 31.40 °C
WCL - Return 30.70 °C
LCW Supply 31.50 °C

○ FAST DUMP
PLC Heartbeat ●
2024-01-31 12:04:23

Phoebus screen for site acceptance test



Work-in-progress Phoebus screen for MPS controls



Internal measurement by MPS

External measurement by secondary DC current transducer

Internal measurement by MPS

External measurement by voltage tap on output of MPS

Offset and gain not corrected between int. current and ext. current measurement data

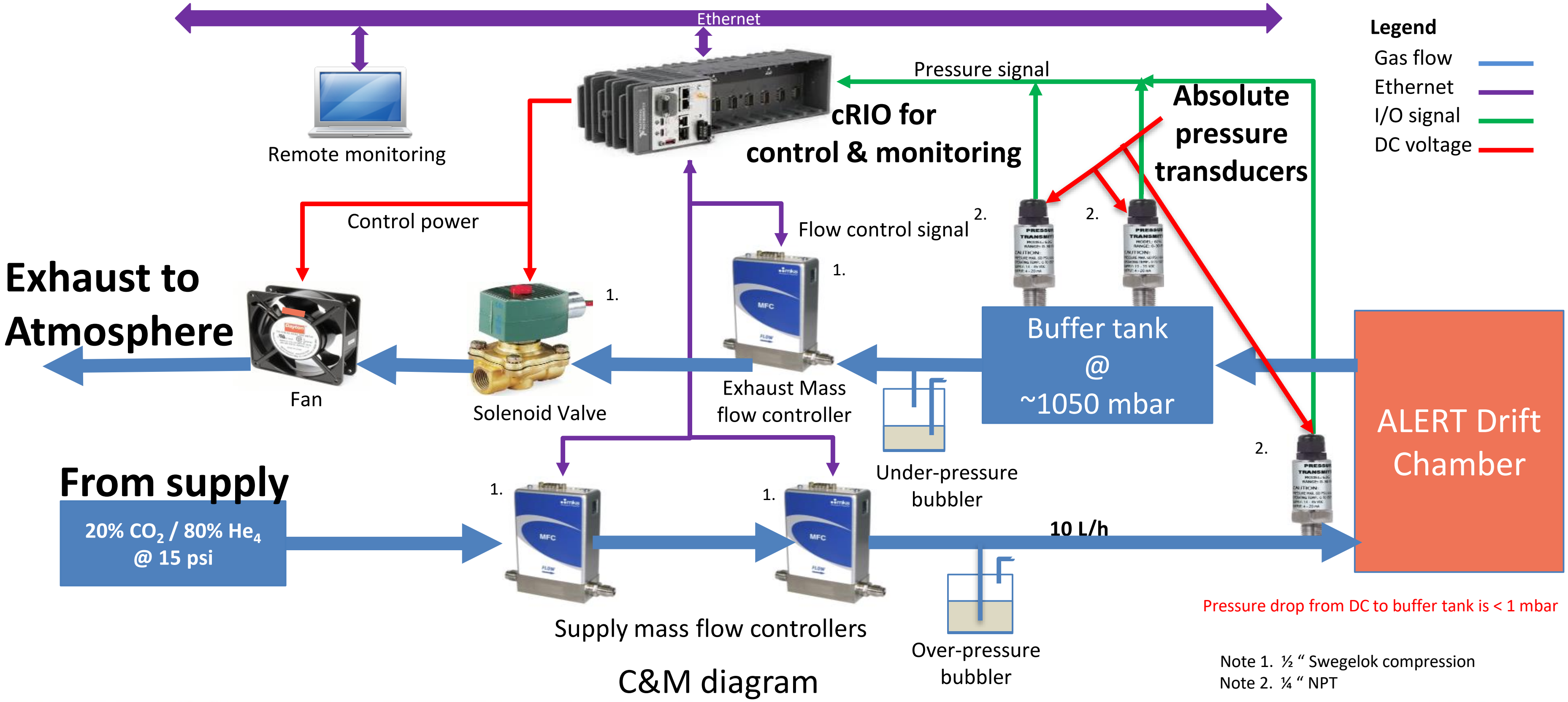
Offset and gain not corrected between int. voltage and ext. voltage measurement data

MPS for TM3 passed Site Acceptance Test

Hall B – ALERT

Marc McMullen, Brian Eng, Mindy Leffel, and George Jacobs

- Designing and developing C&M LabVIEW software for pressure-controlled He_4 CO_2 (80%:20%) gas supply
  - Specifying components
  - Fabricating and installing control equipment and cabling
  - Control designed to maintain supply flow (10 L/h) to the drift chamber
  - Control designed to maintain ~1050 mbar in the buffer tank by controlling the exhaust MFC, solenoid, and fan



C&M diagram

Pressure drop from DC to buffer tank is < 1 mbar

Note 1. ½ " Swegelok compression
Note 2. ¼ " NPT

Hall C – NPS

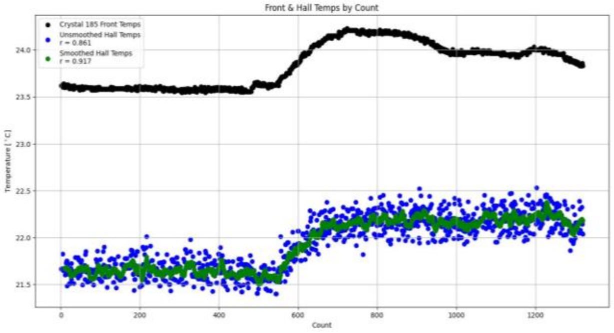
Aaron Brown, Mary Ann Antonioli, Marc McMullen, Brian Eng, Mindy Leffel, and Tyler Lemon

- Analysis of the temperature data archived in MYA shows front and rear crystal temperatures increase when ambient temperature does
- Pearson correlation coefficient *r* for crystals 185 shows

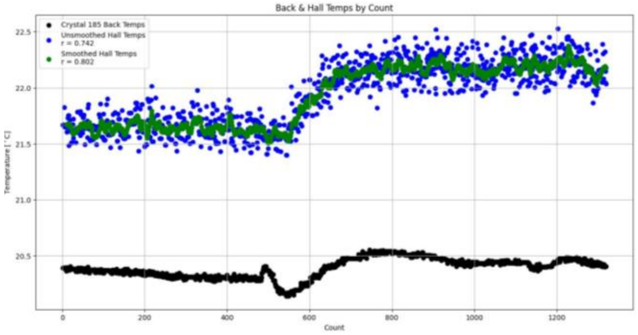
$$r = \begin{cases} 0.9 \text{ between the front sensor and ambient temperature} \\ 0.8 \text{ between the rear sensor and ambient temperature} \\ 0.8 \text{ between the front sensor and the rear sensor temperature} \end{cases}$$

_r_ values indicate a strong positive correlation

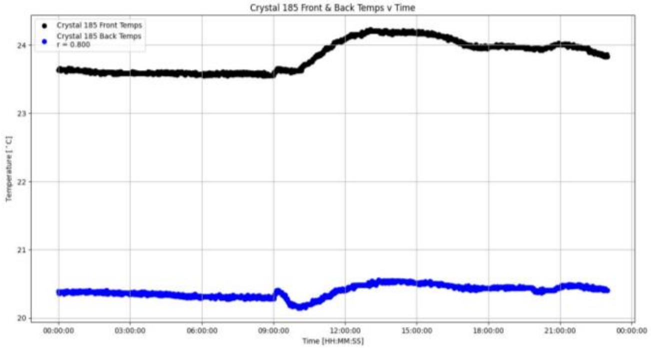
(as predicted by ANSYS simulation)



Plot of front sensor and ambient temperatures for crystal 185



Plot of rear sensor and ambient temperatures for crystal 185



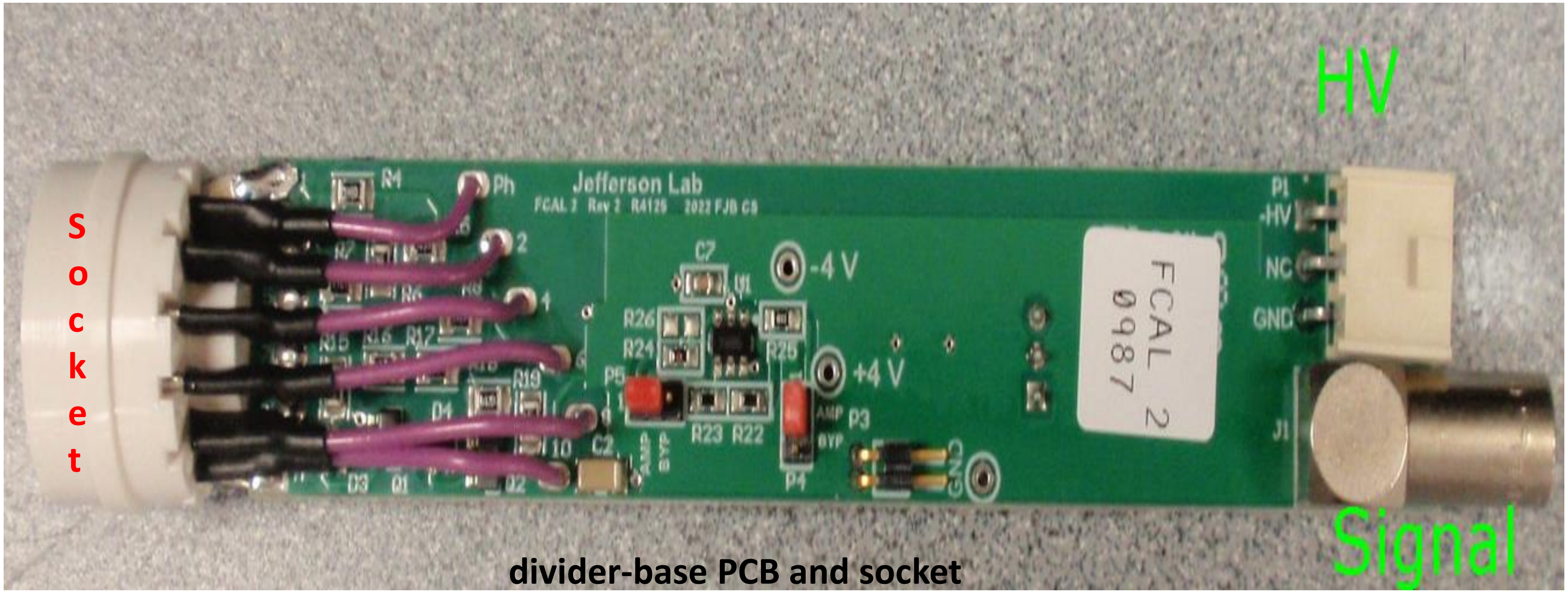
Plot of front and back sensor temperatures for crystal 185

Hall D – FCAL 2

Aaron Brown, Mindy Leffel, George Jacobs

- **Fabricating and testing sockets**
  - Soldering wires to sockets to provide HV to different dynodes and the photocathode
  - Fabricated 1550 of 1650 sockets
  - About 100 divider-board + socket left to fabricated
- **Testing of divider-base + socket aborted**
  - Regulators are being removed as they are not rad-hard

Testing of 1650 divider base PCB + sockets needs to start again



divider-base PCB and socket

EIC - DIRC

Tyler Lemon, Peter Bonneau, Marc Mcmullen, Mindy Leffel, George Jacobs

- Designing and developing laser interlock system for quartz bar quality assurance (QA) tests
  - Benchtop tests underway
  - Phoebus alarm handler under development to help monitor interlock signals
- Designing and developing photodiode readout PCB for QA tests
  - PCB designed and produced
  - Testing of PCB planned for after interlock system installation
- Designing and building shipping crates modifications to ship quartz bars from SLAC to JLab
  - As of February 5, 2024, modifications are complete to one of six crates
  - Work on all six crates will be complete by March 1, 2024

We don't box anyone till their time is up
DSG

One of six shipping crates for transporting quartz bars from SLAC to JLab. Work on crate in photo is finished.

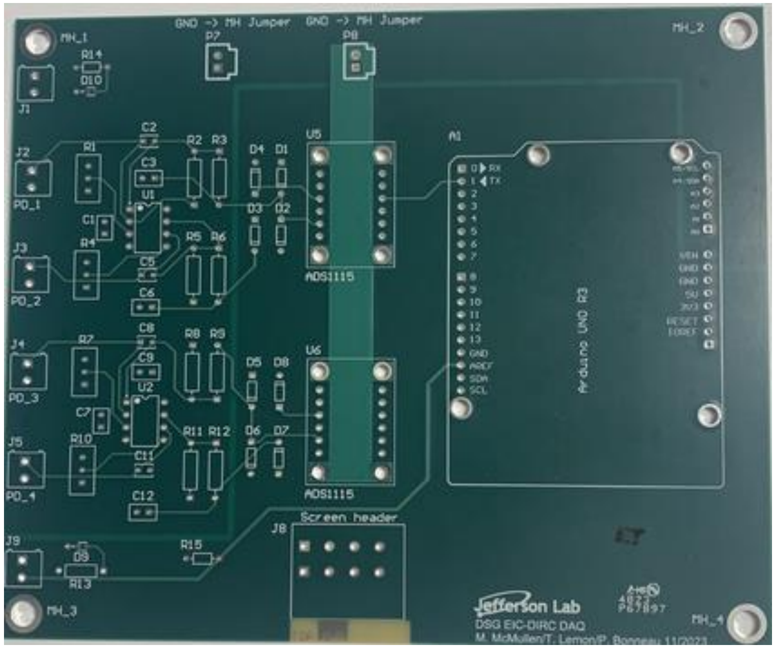
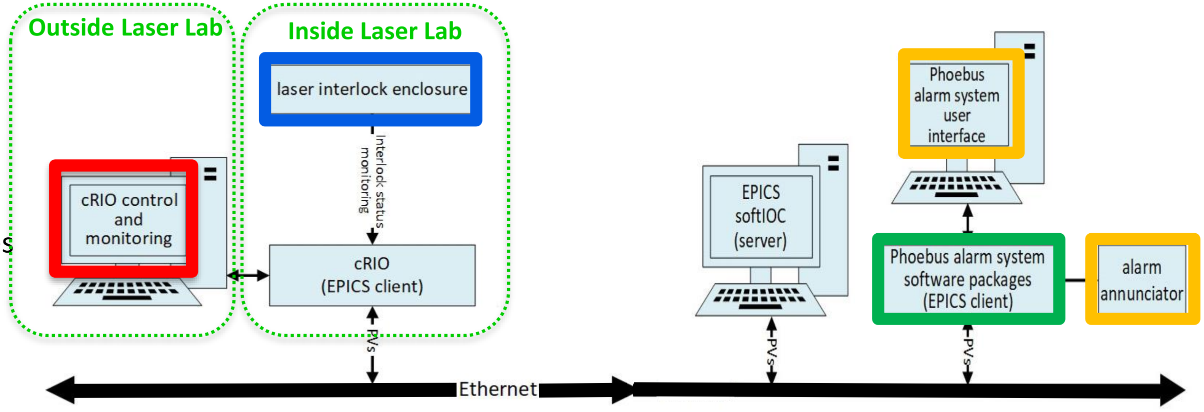


Photo of photodiode readout PCB designed by DSG.

EIC - DIRC

Pete Bonneau, Tyler Lemon, Marc Mcmullen, and Mindy Leffel

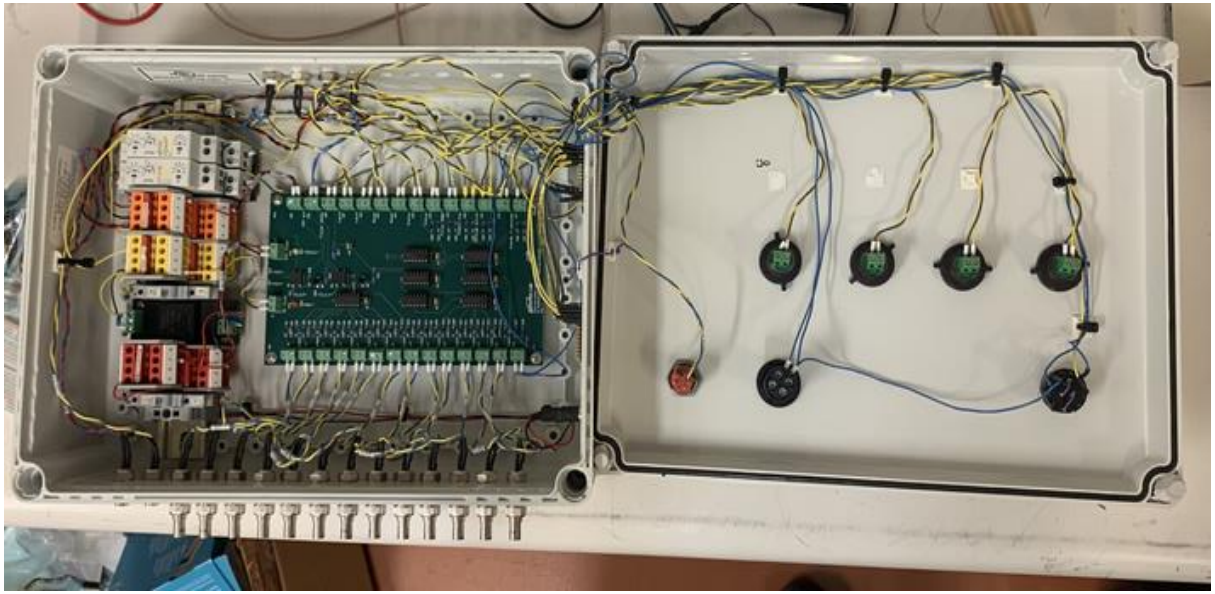
- Developing Phoebus alarm system test for EIC DIRC Laser Interlock
  - NI **cRio** monitors laser interlock status signals from **laser interlock** inside laser lab
  - **Phoebus alarm system** monitors process variables (PVs) alarm status and reports alarms
  - If a PV is in alarm state, latches PV value with timestamp
  - Alerts users of alarms via **user interface** and **annunciator**



NI cRIO monitors EIC DIRC Laser Interlock Signals

- Eight Boolean inputs to board:

1. Interior emergency stop chain button (on/off)
2. Exterior emergency stop button (on/off)
3. Laser area entry door status (open/close)
4. Laser area entry door status (redundant)
5. Optical table side wall position (up/down)
6. Sweep button engaged and sweep period not expired (yes/no)
7. Only exterior or interior control key in system (yes/no)
8. Configuration-dependent laser power-reducing filter in correct position (yes/no)



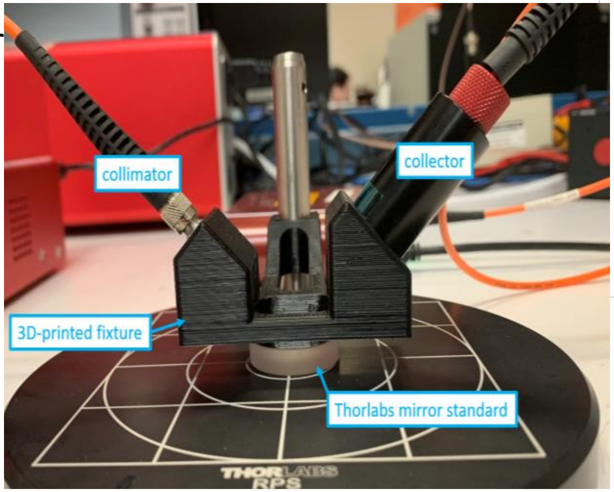
Laser interlock system's electronics designed and developed by DSG

DSG Note 2023-43 DSG Notes 2023-49 & 2023-56

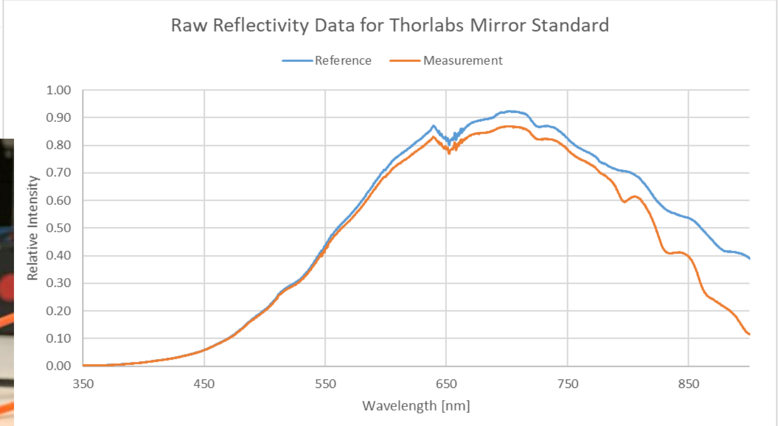
EIC - RICH

Tyler Lemon

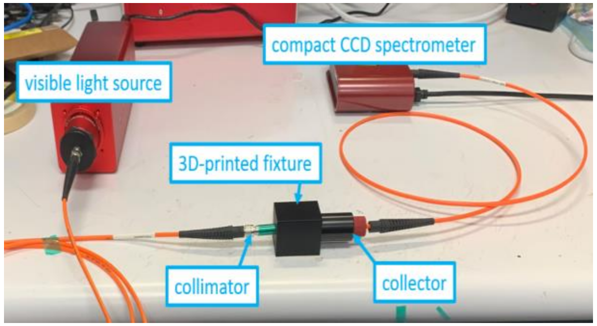
- EIC dual-radiator RICH and proximity-focusing RICH detectors generate Cherenkov light in UV spectrum (down to 200 nm)
  - Mirrors in detectors must reflect 95% of light
- Developing setup to test mirror reflectivity
  - For λ ∈ [200 nm, 350 nm]
  - Previous reflectivity test station used visible light λ ∈ [400 nm, 850 nm]
- Researched components, procured, and set up test stand for visible light—proof-of-concept test
  - Measured reflectivity of Thorlabs mirror sample is close to its specified reflectivty
- Next step: set up for UV light



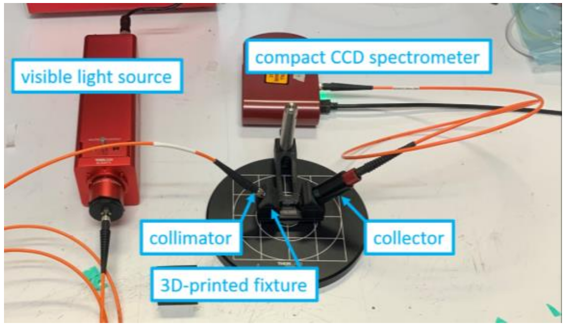
3 D Printed fixture



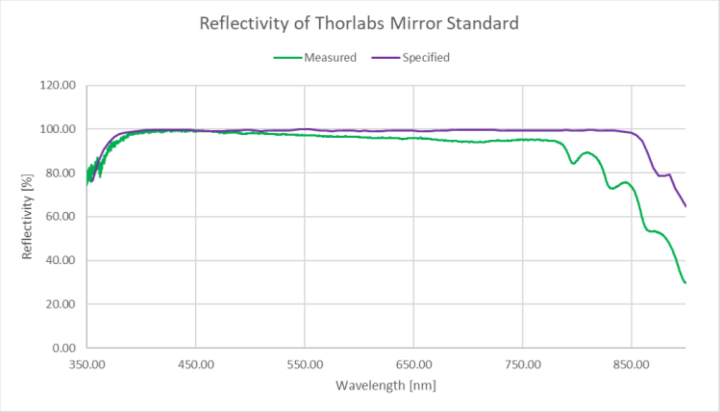
Raw data acquired using CCD. Blue trace is reference measurement (test beam collected directly). Orange trace is reflectivity measurement (test beam reflects off of mirror at a 45° angle of incidence).



Setup for reference measurement. 3D printed fixture holds collimator to point directly at collector. Test beam does not reflect off of any mirror.



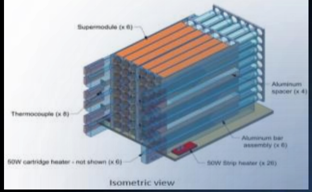
Test station set up for reflectivity measurement. 3D printed fixture holds collimator over mirror at 45°. Test beam reflects off of mirror and onto collector.



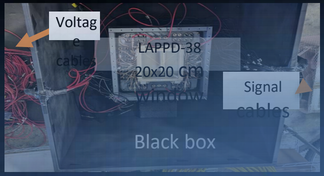
Specified reflectivity (purple). Calculated reflectivity (green by dividing measurement (orange trace) by reference data (blue trace) in the figure at the top

Conclusions

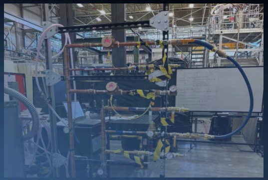
Contributing to several new projects



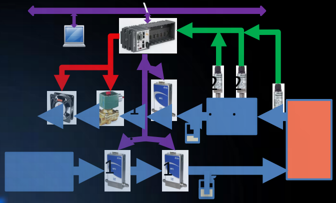
Hall A - ECAl



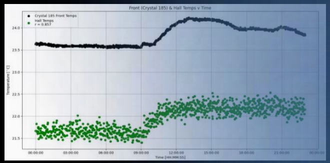
Hall A - LAPPD



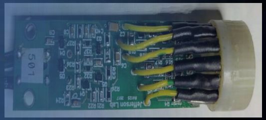
Hall A - Moller



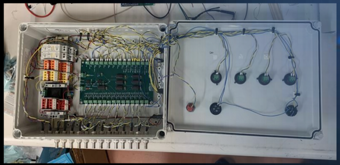
Hall B - ALERT



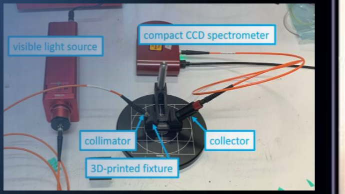
Hall C - NPS



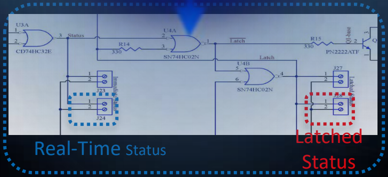
Hall D – FCAL 2



EIC- DIRC



EIC- RICH



EIC- DIRC
Phoebus Alarm Handler

DSG staff

Jlab physics division's leaders in

C&M

of detectors and magnets

Thank you for your attention