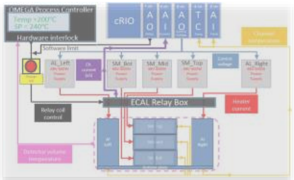
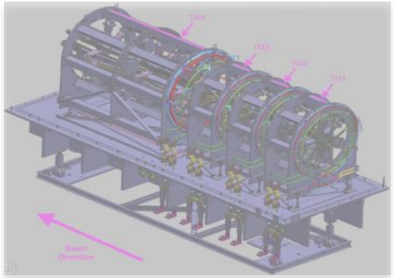
DSG Projects FY 2023

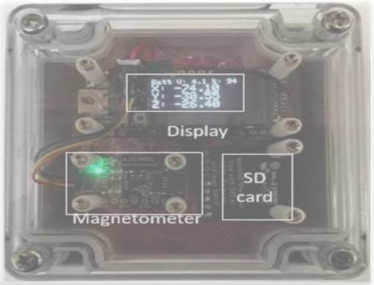
Dr. Patrizia Rossi
Detector Support Group
Tuesday, October 10, 2023

Contributions

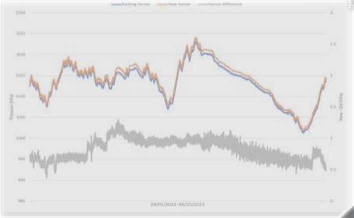
- **Hall A**
  - Møller and CLEO magnets
  - ECAL



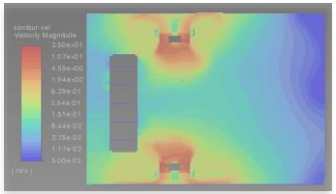




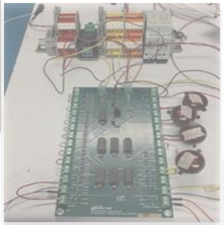
- **Hall B**
  - Environment Monitoring System



- **Hall C**
  - NPS



- **Hall D**
  - FCAL 2



- **EIC**
  - DIRC
  - Beampipe Test Stand

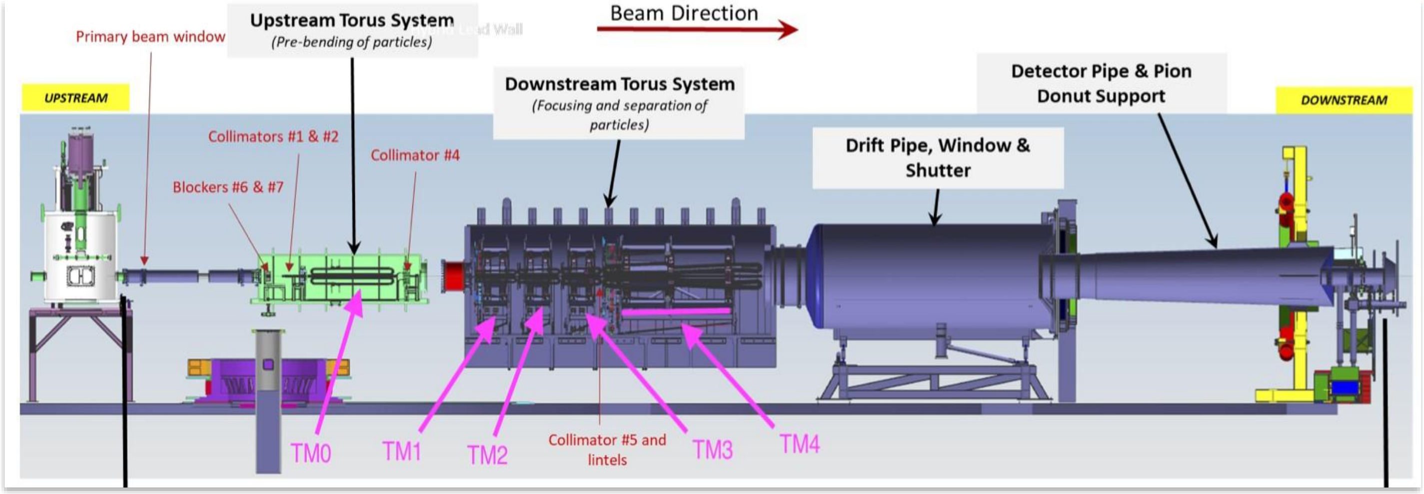
- **DSG R&D**
  - Phoebus Alarm System

Hall A - Magnets

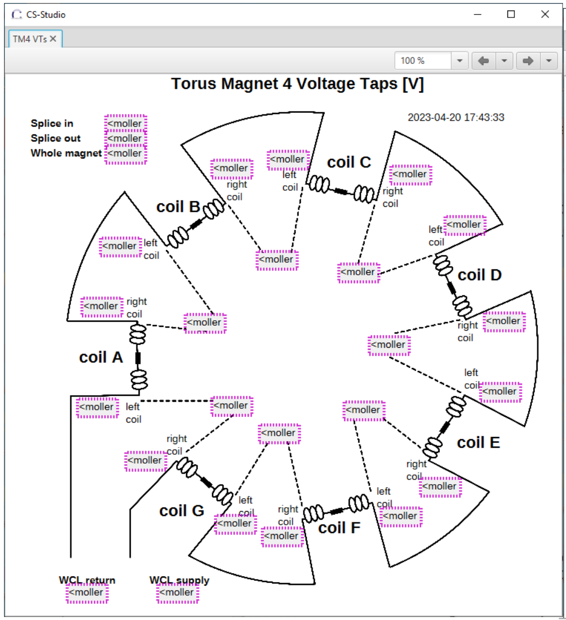
Eng and Antonioli

Møller magnets

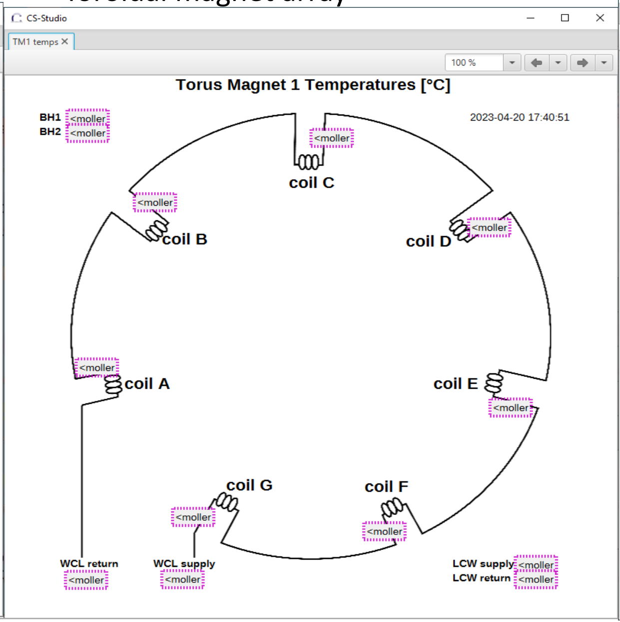
- Set up communications between Siemens S7-1500 PLC controller and EPICS softIOC
- Developing instrumentation and control wiring diagrams
  - Drawings of temperature sensors and hardware voltage taps – complete
  - Drawings of voltage tap for PLC – in progress
- Developing CSS Phoebus screens for monitoring
  - Magenta boxes in the screens to the right are shown instead of values because EPICS softIOC is not running



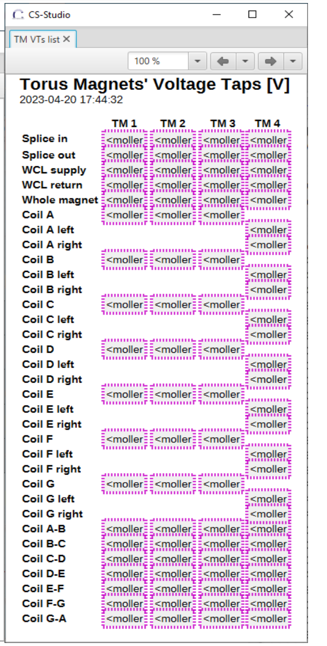
Toroidal magnet array



Phoebus voltage tap screen for Magnet 4



Phoebus coil temperature screen for Magnet 1



Phoebus voltage tap summary

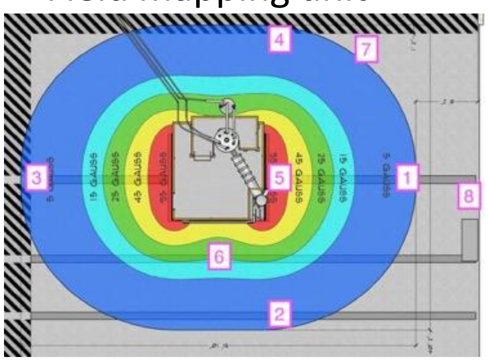
Hall A - Field Mapping of SoLID aka CLEO

Eng and Leffel

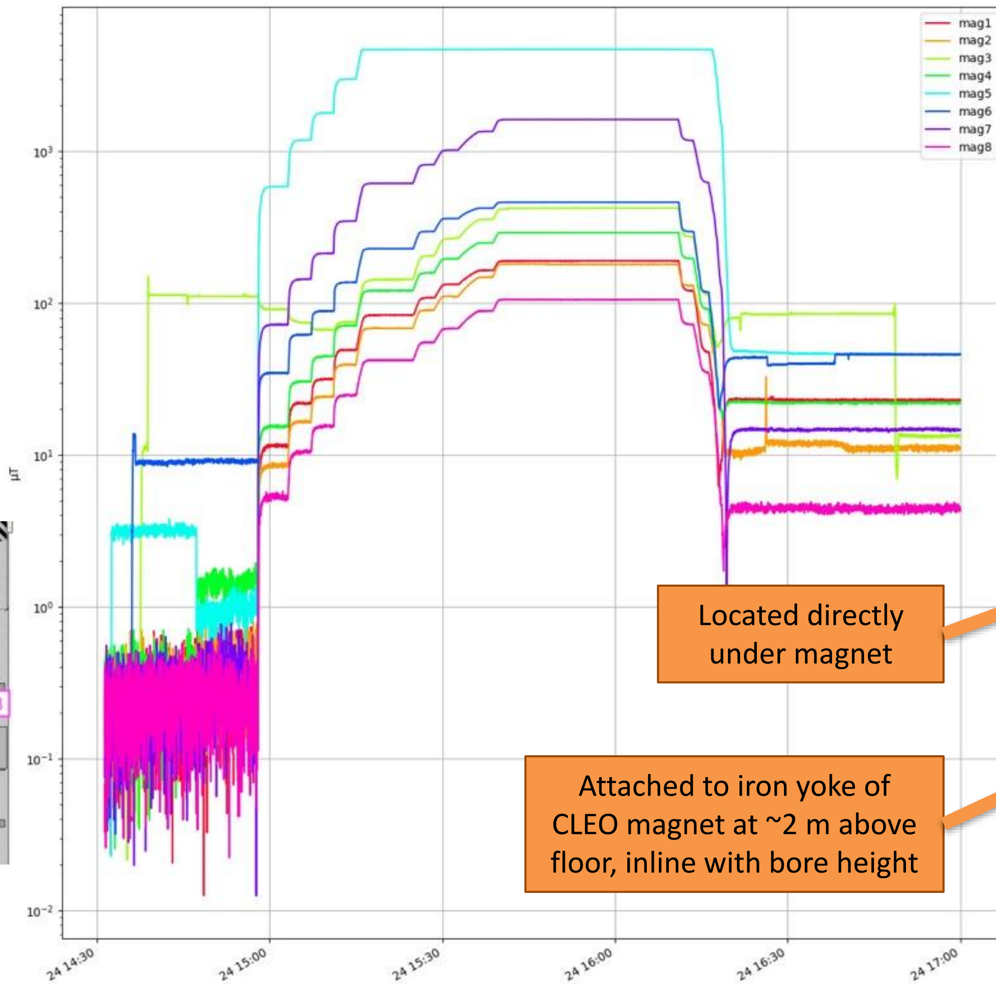
Researched , designed, fabricated, installed, acquired data, and analyzed CLEO field

- Designed, fabricated, and deployed eight field–mapping units to measure **B** during ~100 A test
  - Fringe field after powering down the magnet is around the earth's magnetic field 0.25 G—0.65 G

Field mapping unit



Location of units



Field magnitude in μT for each unit during magnet ramp up and down

Unit	Max Field (G)
1	1.90
2	1.81
3	4.28
4	2.92
5	46.98
6	4.62
7	16.20
8	1.05

Maximum field recorded

DSG Notes:2023-07, 2023-19

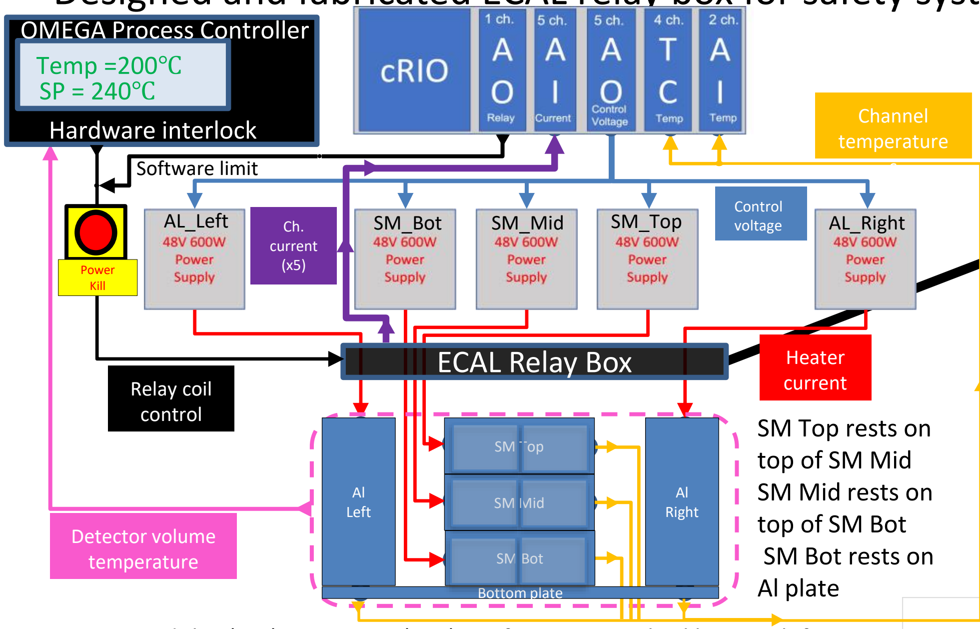
Hall A - ECAL Six-Supermodule Heater

McMullen, Eng, and Leffel

Developed PID control, monitoring, and safety system

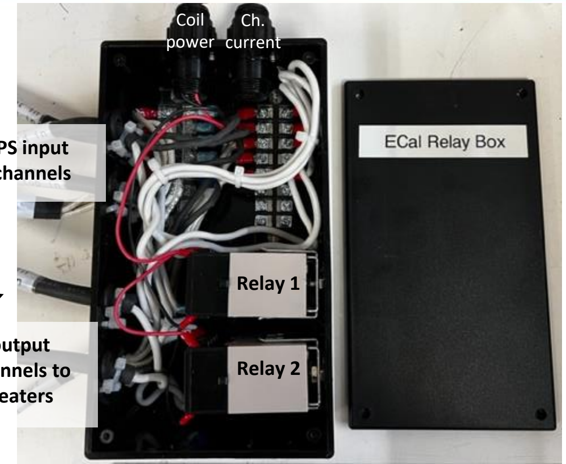
– Heater controls has five channels each with individual PID controls

- Designed and fabricated ECAL relay box for safety system



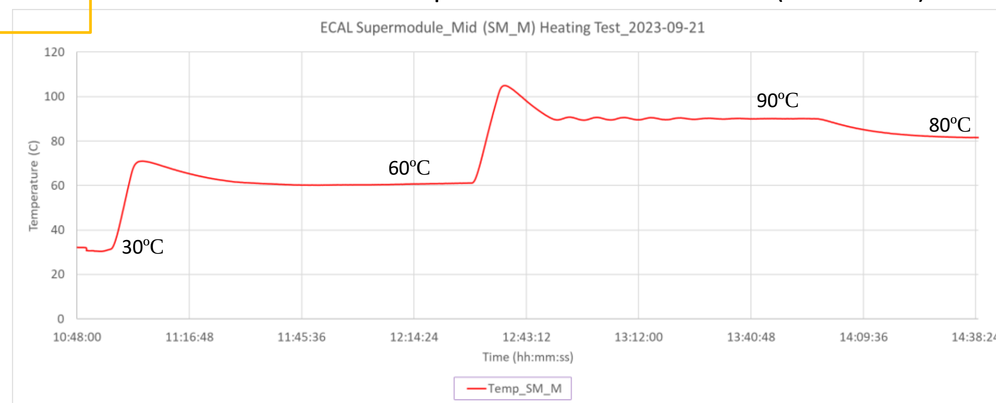
SM Top rests on top of SM Mid
SM Mid rests on top of SM Bot
SM Bot rests on Al plate

Super modules (SM) set up in a (3x2) configuration with Al bars on left and right for support. The three rows of SM and the two columns of Al support are independently powered. The Omega process controller safety system (top left in figure) prevents over-temperature events.

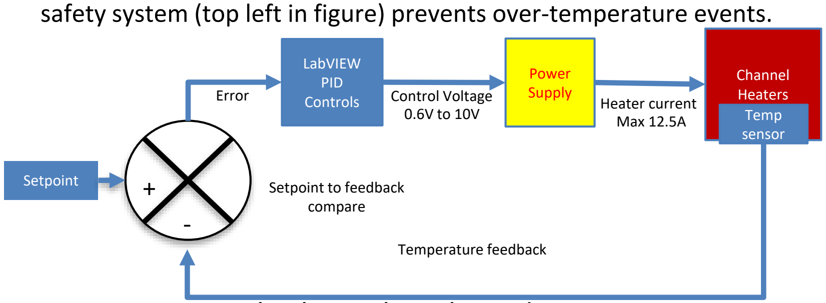


ECAL relay box

- Relays open to prevent over-temperature event
- Each heater control channel has an input from the power supply and an output to the heater
  - Relay 1 is for the three supermodule heater channels
  - Relay 2 is for the two aluminum bar heater channels
- Each channel has a hall probe to measure current (not visible)



Heating test, over a range of temperatures <100°C, demonstrates PID control works for the middle supermodule (SM_M)



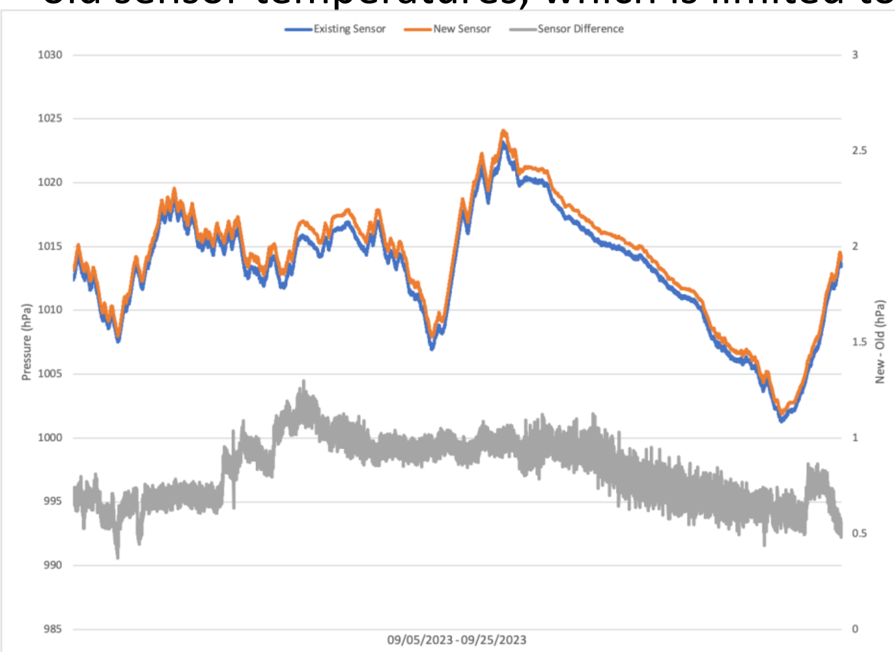
Single channel PID logic diagram

Hall B - Environment Monitoring System

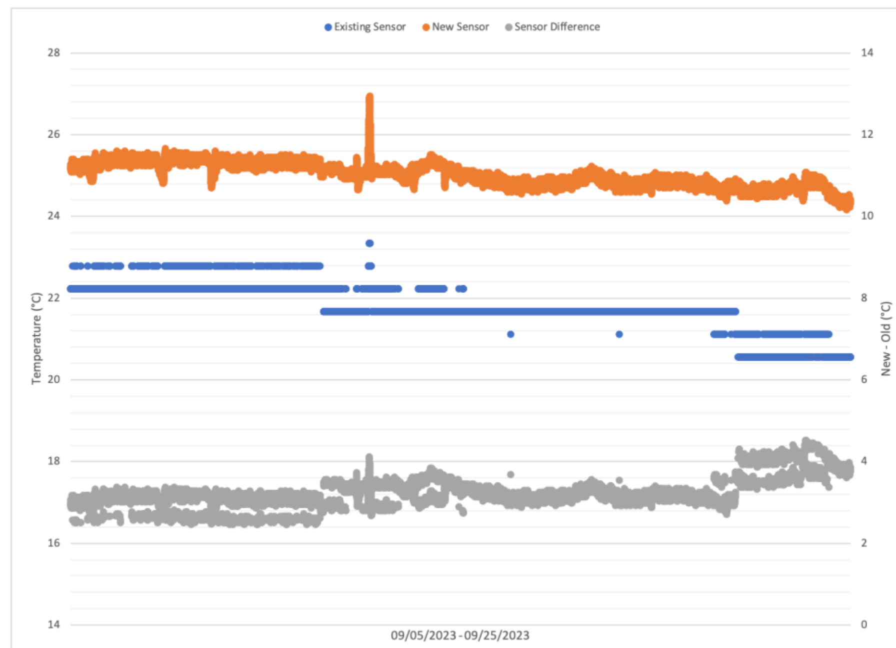
Eng

Researched, designed, and implemented environment monitoring system

- Bosch BMP390 sensor system configured and deployed
  - System has Olimex ESP32-POE-ISO microcontroller
    - Allows a single cable for networking and power
  - Bosch has a pressure and temperature accuracy of ±3 Pa and ±0.5°C
- EPICS output of the Bosch pressure measurements and old sensors agree with each other
- EPICS output of Bosch temperature measurements has better resolution than EPICS output of old sensor temperatures, which is limited to 1°F



Pressure comparison



Temperature comparison

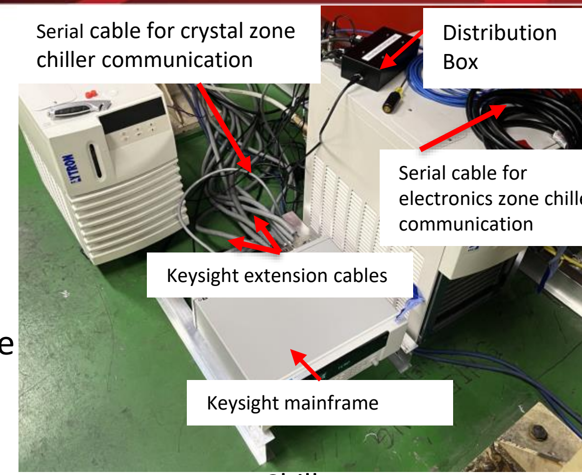
Existing sensor data converted to match units of new sensors

Hall C – NPS Controls and Monitoring System

Brown, Antonioli, and Bonneau

Designed, coded, and installed control and monitoring system

- Fabricated distribution box
  - Provides +24 V to external flowmeters of the crystal and electronics zone chillers, which are read out using the Keysight mainframe
- Developed EPICS Phoebus GUIs to control and monitor temperature, relative humidity, and dewpoint
  - Phoebus screens for control and monitoring temperatures of back crystal zone shown below has been implemented in the Hall
  - Values shown in the monitoring screen below are values read in real time by the system



Chiller system

Control

Crysta	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]	Crystal	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]
0	0	30	Enabled	Enabled	300	Enabled	Enabled	30	540	0	30	Enabled	Enabled	300	Enabled	Enabled	30
5	0	30	Enabled	Enabled	300	Enabled	Enabled	30	550	0	30	Enabled	Enabled	300	Enabled	Enabled	30
10	0	30	Enabled	Enabled	300	Enabled	Enabled	30	560	0	30	Enabled	Enabled	300	Enabled	Enabled	30

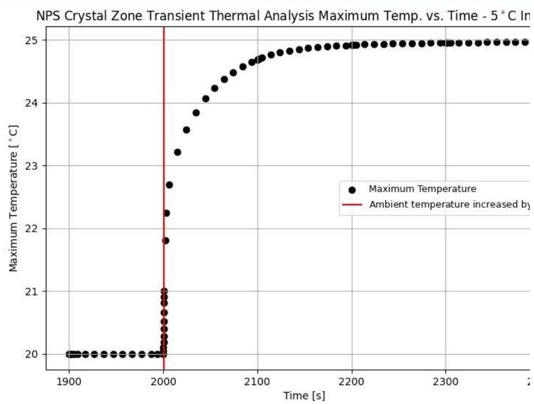
Monitoring

Crystal	T [°C]	Avg [°C]	σ [°C]	Intlk status	Latch status	Crystal	T [°C]	Avg [°C]	σ [°C]	Intlk status	Latch status
0	22.12	22.65	0.42			540	21.73	22.14	0.35		
5	21.73	22.14	0.35			550	16.49	15.63	0.49		
10	21.40	21.70	0.29			560	14.91	13.61	0.78		

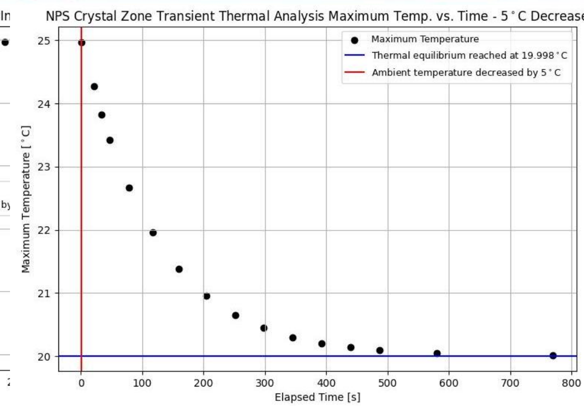
High and low temperature alarm limits can be set (blue box, top screenshot). Monitored rolling average of temperatures (over 300 measurements;red box, bottom screenshot). With interlock enabled, if average temperature >30°C, high voltage trips after 30 s

Ansys thermal analysis

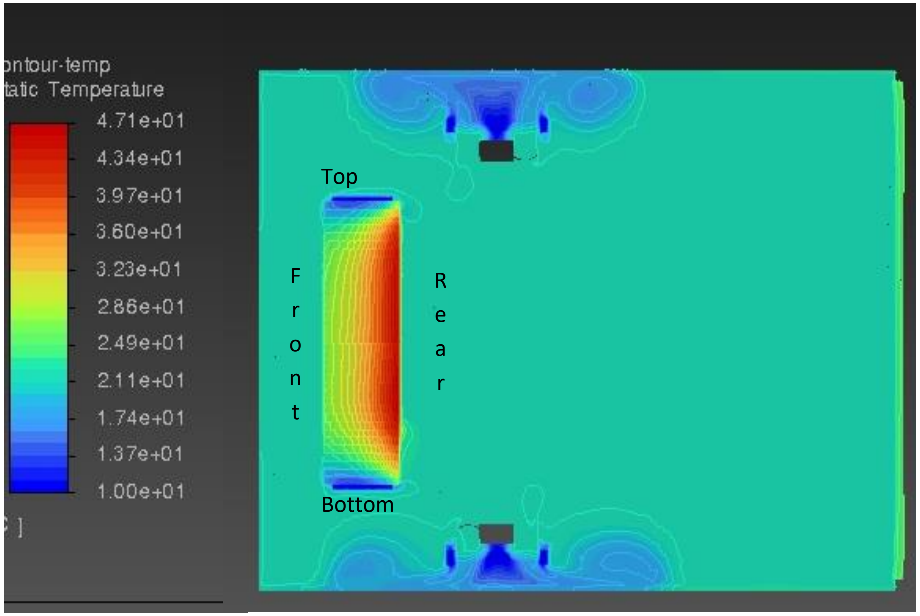
- **Ansys Mechanical transient analysis results concur with [steady-state analysis results]**
- **Ansys Fluent steady state model includes all required material thermal properties, cell conditions, boundary conditions and Shell Conduction features**
  - Result is being analyzed



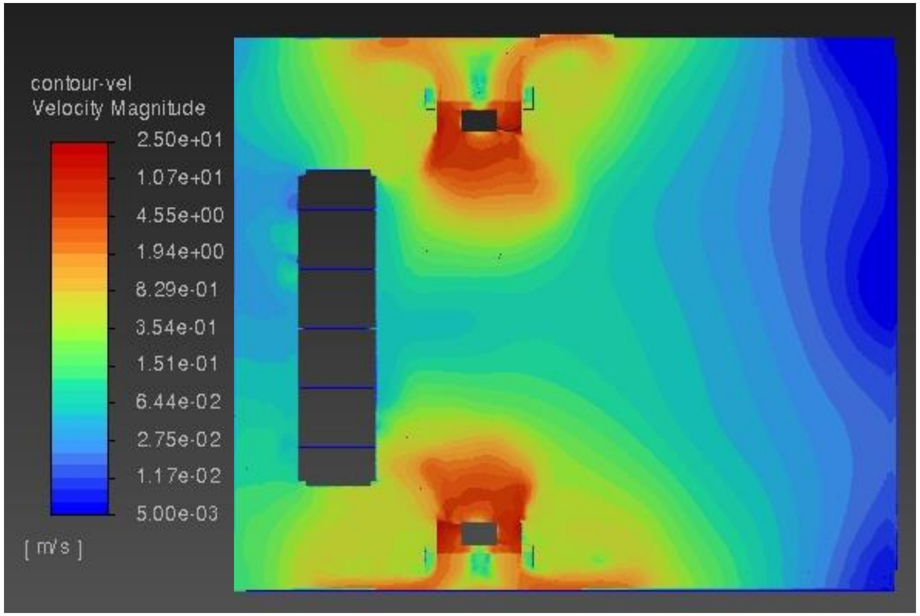
Central crystals reached thermal equilibrium at ~25°C when ambient temperature increased from 20°C to 25°C



Central crystals reached thermal equilibrium at ~20°C when ambient temperature decreased from 25°C to 20°C



Temperature plot (right- side view of NPS enclosure and crystal array). Lower temperature (blue color) at cooling plate and fans 10°C



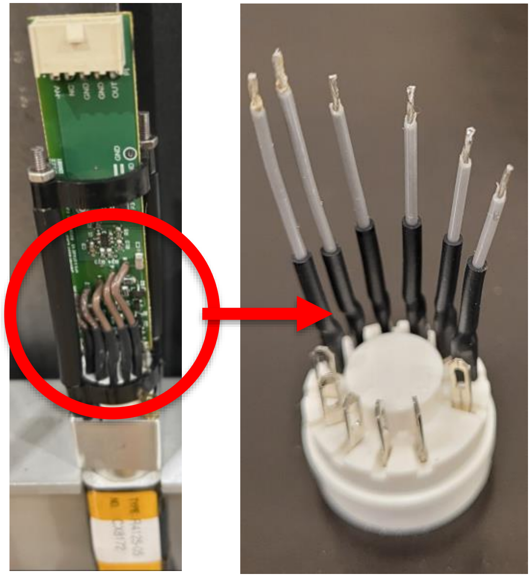
Velocity contour plot (right-side view of NPS enclosure and crystal array). Shows airflow due to fans, inside the detector and through the crystals

Leffel, Jacobs, and Antonioli

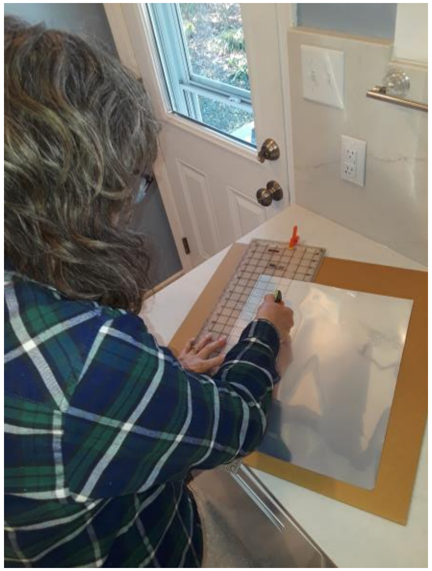
Hardware support for FCAL 2

- Refurbished 72 $PbWO_4$ crystals from the ***ComCal insert*** of FCAL 1
  - Unwrapped enhanced specular reflector (ESR) from crystal
  - Removed light guide cup by submerging the light guide in diluted acetone for 2-3 hours
  - Cleaned crystal with alcohol
  - Visually inspected crystal for defects
  - Rewrapped with ESR if needed (112 total of 140)
- Pre-shaped 112 ESR foils in oven to wrap refurbished crystals
- Wrapped 833 $PbWO_4$ **SICCAS (Chinese) and CRYTUR (Czech Republic)** crystals with ESR foil and Tedlar
- Soldering PMT (Hamamatsu R41253355027) divider base connectors with wires to provide high voltage to different dynodes and the photocathode (585 of ~1750 completed)

Mindy Leffel soldering wires to PMT divider base connector



Left: Populated PMT divider, right: connector



Mary Ann Antonioli cutting ESR film to size

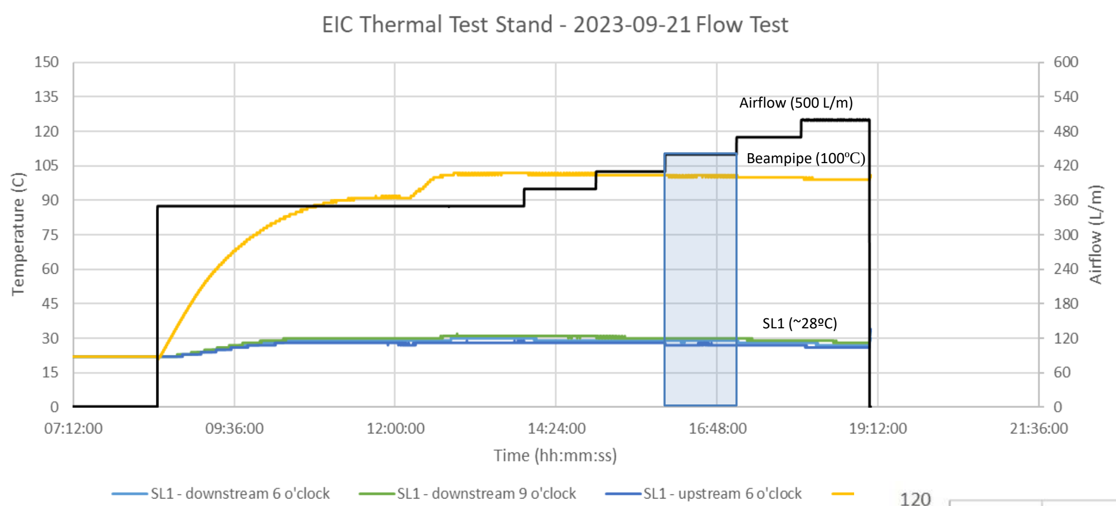
EIC - Beampipe Test Stand

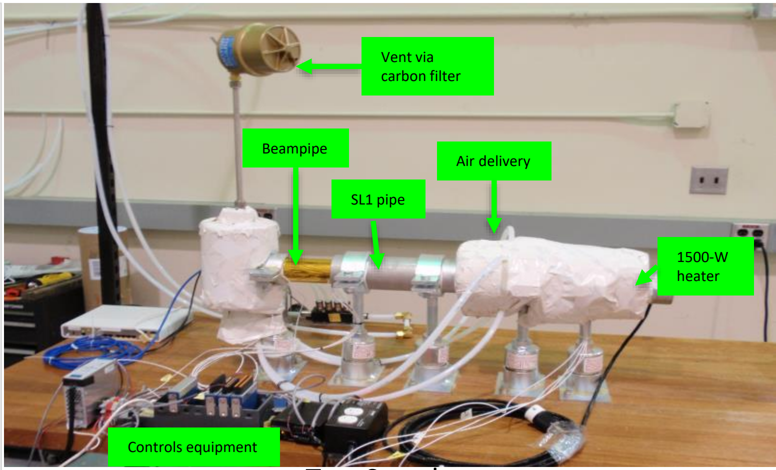
McMullen, Jacobs, and Campero

Volumetric flow rate test to cool silicon layer 1 below 30ºC with 20ºC ambient air

- Test with six layers of thermal reflector (0.078” thickness) and beamline temperature at 100ºC
- **Temperature of Al pipe that represents silicon layer 1 is ~30ºC for airflow of ~450 L/m**

DSG Note 2023-29 DSG Note 2023-26 DSG Talk 2023-01



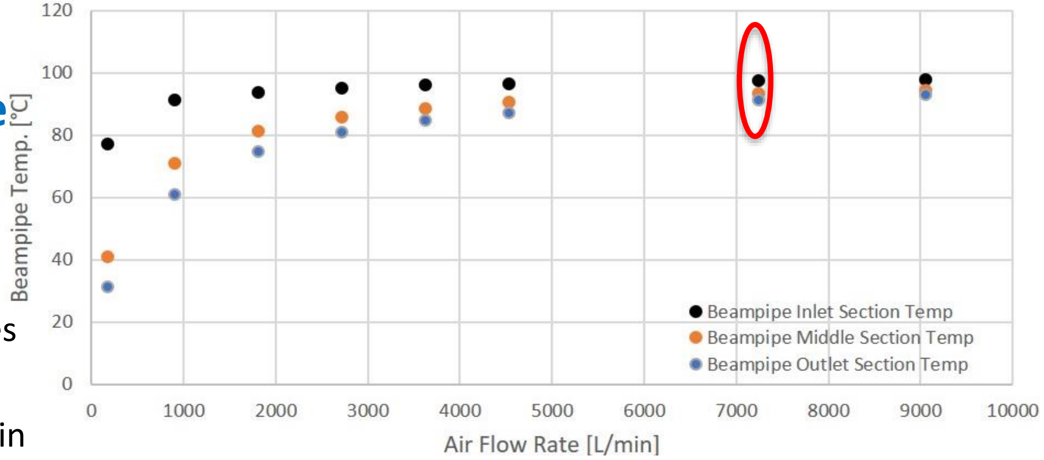


Test Stand

Plot shows airflow, beampipe temperature, and SL1 temperature

Ansys simulation of 9-m long beampipe

- 9-m long beryllium beam pipe model with three layers of Kapton insulator (0.39 mm)
- Simulated temperature changes along beampipe when inlet is at 100ºC for eight different inlet velocities
- Temperature of the inlet, middle, and outlet regions converge to 100ºC for volumetric flow rate >7250 L/min

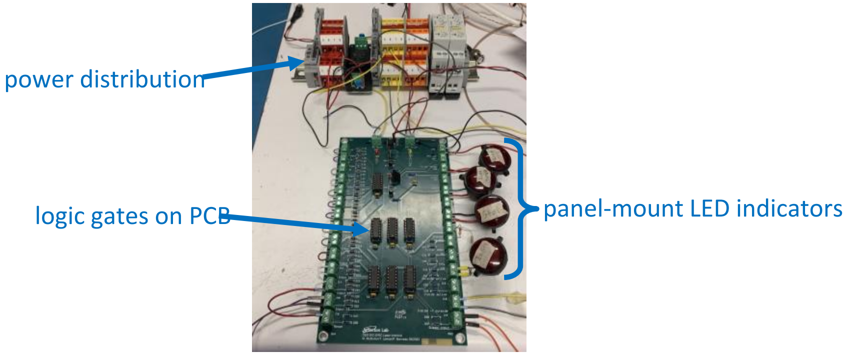


EIC – DIRC and RICH

Lemon, McMullen, Jacobs, and Bonneau

Designing laser test lab and associated peripherals

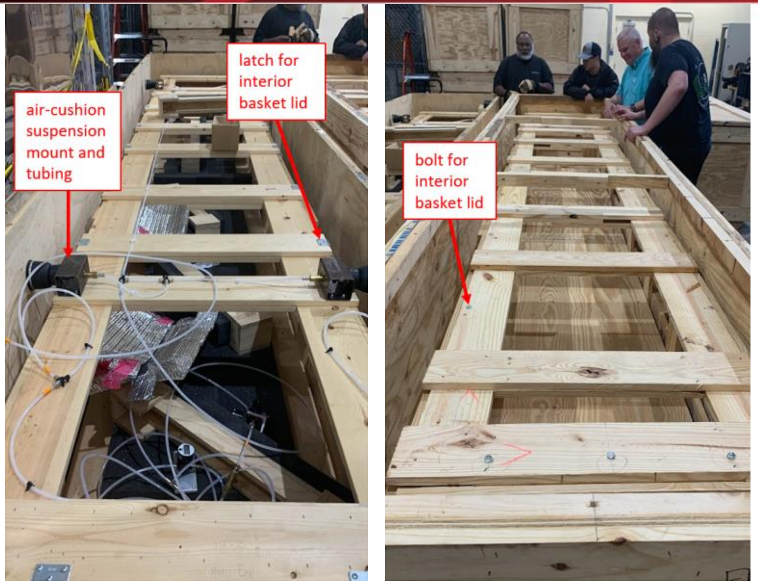
- Designed, prototyped, fabricated, and debugged laser interlock system



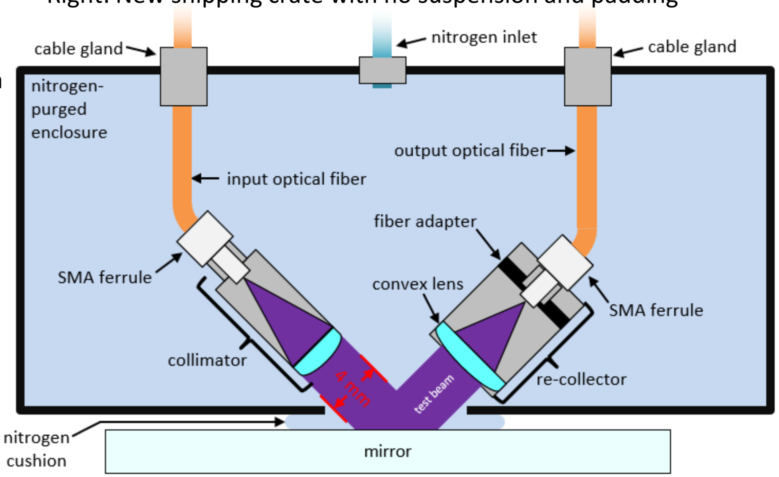
Assembled laser interlock PCB

- Designed photodiode readout circuit
- Developed Laser Operational Safety Procedure and training course for project
- Reviewing modifications to quartz bar shipping crates
  - Six crates received from vendor do not have necessary air-cushioned suspension system, foam for additional padding, and hand-removable latches
- Proposed design for mirror-reflectivity measurements for dual-radiator and proximity-focusing RICHs
  - Reflectivity probe on hand is not rated for UV and can be irreversibly damaged in as little as three hours, reducing fibers' transmissivity to 30%
  - Beam mainly propagated through UV-rated optical fibers
  - Collimator adapts diverging light from fiber to a 4-mm diameter beam
  - Light reflects off mirror at a 45° incident angle
  - Beam is re-collected into an optical fiber for routing to spectrometer using a convex lens and fiber adapter mounted in a lens tube

DSG Note 2023-39



Left: Shipping crate previously used to transport quartz bars with all necessary suspension and padding
Right: New shipping crate with no suspension and padding



Design of proposed reflectivity probe for deep UV

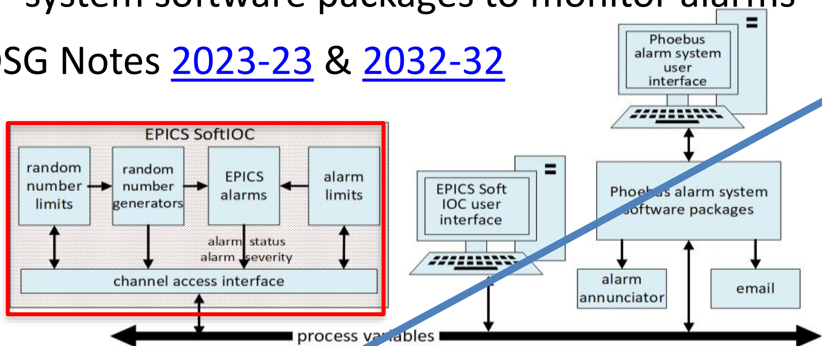
DSG R&D - Phoebus Alarm System

Bonneau

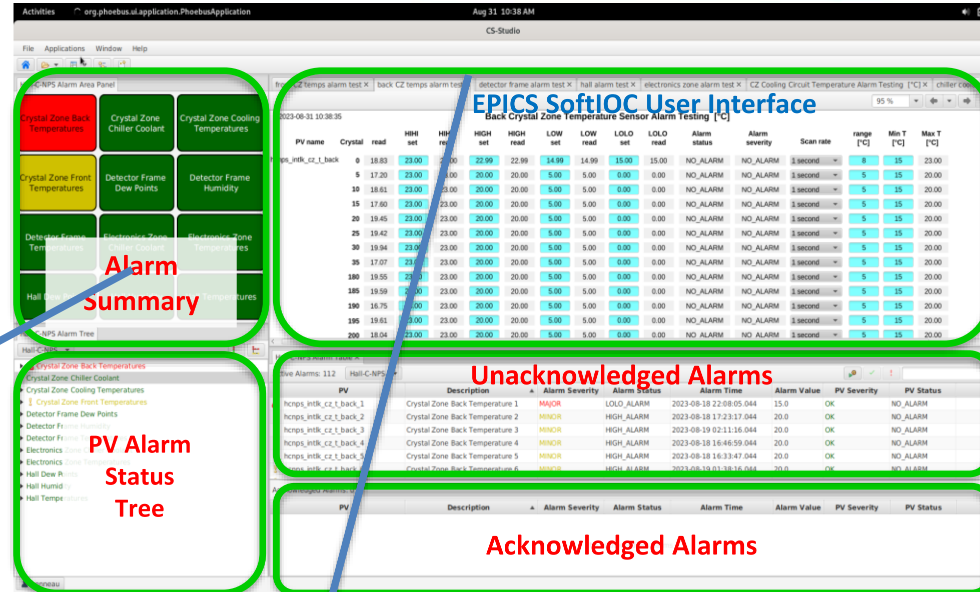
• Implementing Phoebus alarm system with EIC DIRC interlock

- Programmed applications in EPICS softIOC to simulate detector signals and Phoebus alarm system software packages to monitor alarms

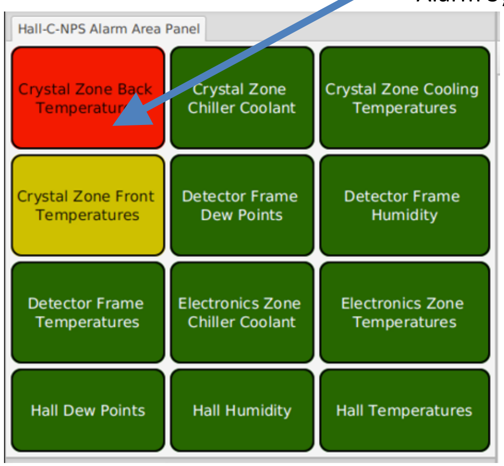
DSG Notes 2023-23 & 2032-32



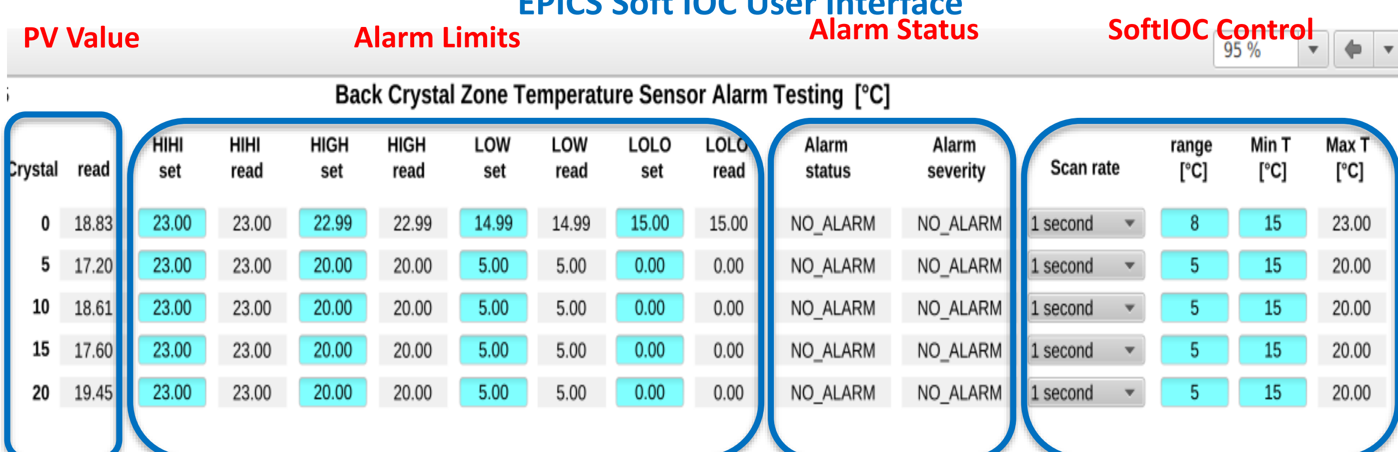
Alarm System setup



Overview screen simulated data



Alarm summary. Red indicates major severity, amber minor severity



Crystal	read	HIHI set	HIHI read	HIGH set	HIGH read	LOW set	LOW read	LOLO set	LOLO read	Alarm status	Alarm severity	Scan rate	range [°C]	Min T [°C]	Max T [°C]
0	18.83	23.00	23.00	22.99	22.99	14.99	14.99	15.00	15.00	NO_ALARM	NO_ALARM	1 second	8	15	23.00
5	17.20	23.00	23.00	20.00	20.00	5.00	5.00	0.00	0.00	NO_ALARM	NO_ALARM	1 second	5	15	20.00
10	18.61	23.00	23.00	20.00	20.00	5.00	5.00	0.00	0.00	NO_ALARM	NO_ALARM	1 second	5	15	20.00
15	17.60	23.00	23.00	20.00	20.00	5.00	5.00	0.00	0.00	NO_ALARM	NO_ALARM	1 second	5	15	20.00
20	19.45	23.00	23.00	20.00	20.00	5.00	5.00	0.00	0.00	NO_ALARM	NO_ALARM	1 second	5	15	20.00

Close-up of EPICS user interface showing monitored values, alarm limits, status, severity, and scan rate

Summary

In the areas of

- system design
- research and development
- coding
- test and measurement
- electronics design
- fabrication
- assembly

***dsg* made contributions to several Hall projects and to EIC**