



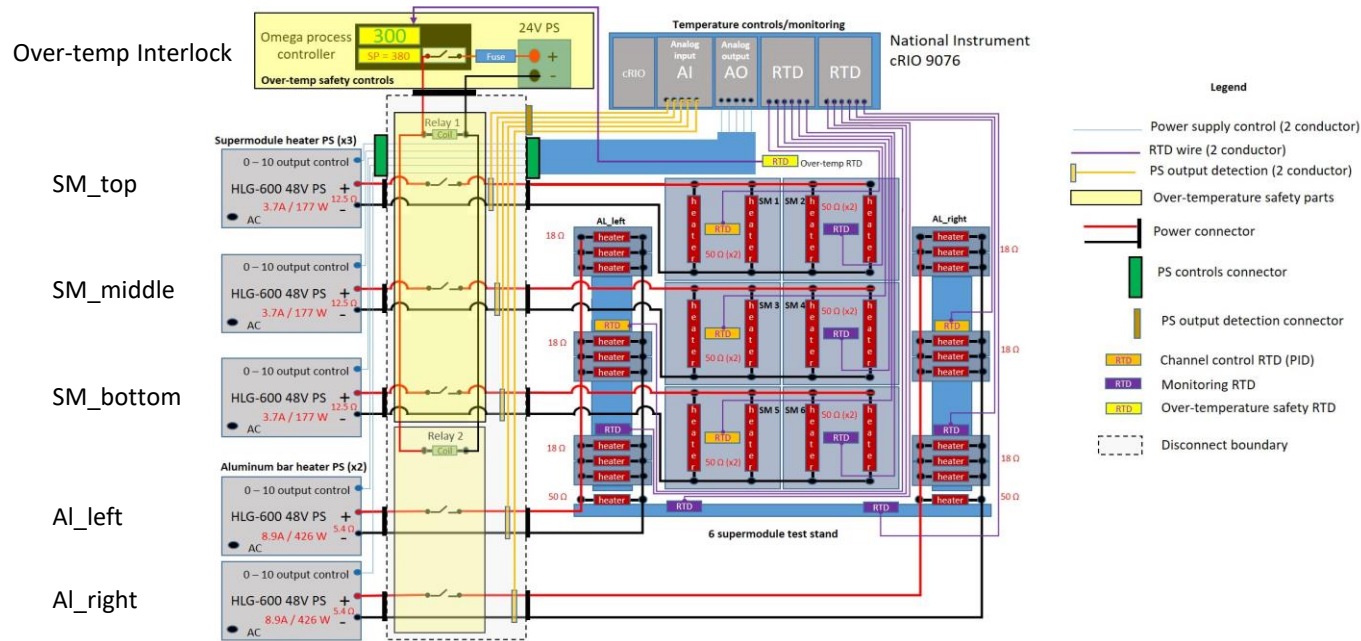
ECAL Heater Controls and Instrumentation

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Detector Support Group
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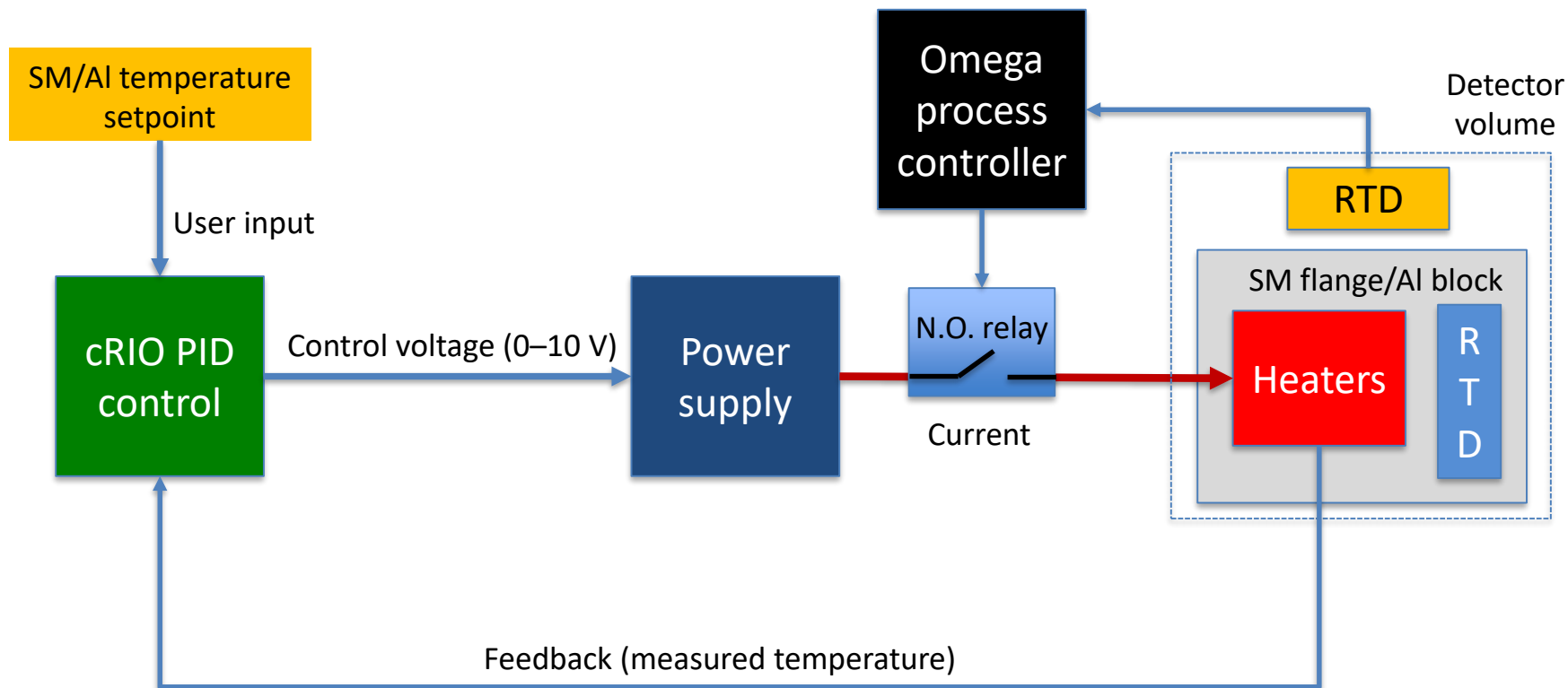
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Six-Supermodule Test Stand Diagram



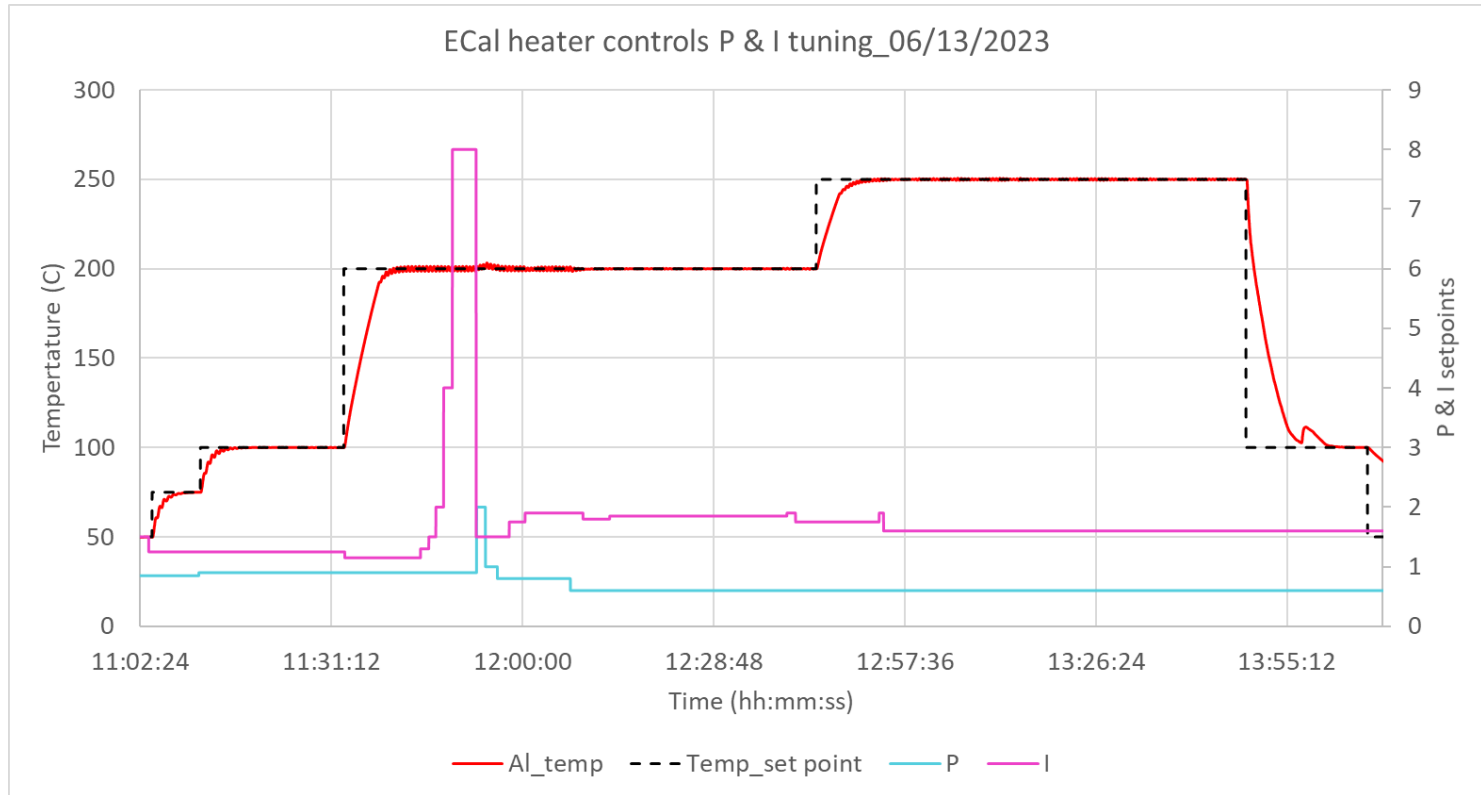
- **Five 48 V, 600 W power supplies to provide power**
 - Three supermodule (SM) channels (two SM per channel, two heaters per SM)
 - Two aluminum (Al) bar channels (10 heaters per side)
- Each channel monitors one RTD for heater control (five control RTDs)
- An Omega process controller monitors a single RTD for over-temperature interlock control

PID Controls Software With Over-Temp Interlock



- The controls software compares the setpoint vs. the feedback temperature to determine the output of the supply
- The Omega monitors the detector volume and will remove heater power if the over-temperature set point is exceeded

Controls Test Results



- A channel was tested using proportional gain (P) and integral gain (I) to control the power supply output
- The temperature remained stable at 250°C using settings of $P = 0.6$ and $I = 1.6$

Six-Supermodule Test Plan

- After assembly and EHS approval, the system will be heated (50°C – 100°C) to ensure all instrumentation and interlocks work
- The system will be ramped to operational temperatures (~290°C at the heaters) and the interlock will be tested to ensure functionality

Full System Procurement

Item	Component	Manufacturer	Units	Cost per unit	Subtotal	Lead time	Comment
	DAQ system						
1	cRIO 9045 controller	National Instruments	1	\$5,992.00	\$5,992.00	55 days	Programmable access controller
2	PS-10 power supply	National Instruments	1	\$311.00	\$311.00	55 days	cRIO power supply
3	Power cord	National Instruments	1	\$21.00	\$21.00	55 days	cRIO power cord
4	NI-9264 16 ch. analog output	National Instruments	3	\$1,812.00	\$5,436.00	55 days	Provides 0-10 V for supply control
6	NI-9213 16 ch. thermocouple module	National Instruments	3	\$2,217.00	\$6,651.00	55 days	Reads heater thermocouples for controls
8	NI-9205 32ch. analog input module	National Instruments	2	\$1,538.00	\$3,076.00	55 days	PS output current sense
	Current sensors						
11	AMP25S current sensor		44	\$14.90	\$655.60	in stock	Reads PS output current and converts to Voltage
	Temperature sensors						
12	WTK-10-60 (Type K thermocouple)	Omega	91	\$26.68	\$2,427.88	90 in stock (4 weeks)	Thermocouple rated to 482°C
13	Ceramic thermocouple connectors	Omega	91	\$12.44	\$1,132.04	53 in stock (4 weeks)	Hi temp connection to extend thermocouples
14	GG-K-20-500 thermocouple cable	Omega	10	\$467.00	\$4,670.00	2 in stock (2 weeks)	500' spool thermocouple extension wire
	Safety controls						
15	Omega CN8DPT-330 process controller	Omega	3	\$462.00	\$1,386.00	2 in stock (1 in house)	Over-temp process controller
	Safety controls Relays						
16	G7L-2A-BUBJ-CB DC24 DPST relay	Omron	22	\$17.07	\$375.54	in stock	NO 25 A contacts, 24 V coil (2 channels per relay)
				Total	\$32,134.06		

- Includes major components needed for FY-23 procurement to instrument the system for controls
- No spares are included
- Additional (wiring, connectors, cables...etc) will be procured as the project is developed

Conclusion

- DSG is modifying the six-SM ECal heater controls to use PID-based software to control an adjustable, 600 W power supply
- DSG has determined the major components to procure for the full ECal detector system
- The longest component lead time is 55 weeks
- DSG will assemble all controls and monitoring instrumentation (Mindy Leffel, George Jacobs, and Marc McMullen)

The End