Tests for the Hall A Electromagnetic Calorimeter Supermodule Heater

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As the crystals [1] of Hall A's Super BigBite Electromagnetic Calorimeter (ECAL) detector are exposed to radiation, the clear crystals become cloudy, thus less efficient. Annealing the crystals through heat counteracts the effects of radiation; one way is to continuously apply 250°C to the front flange, Fig. 1, of the supermodule. This note discusses testing of a custom-built heater to apply the heat.

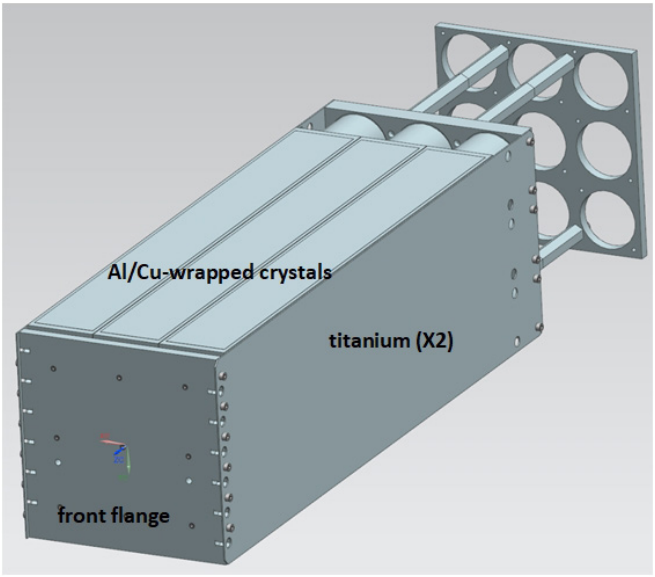

FIG. 1. NX12 model of ECAL supermodule.

DSG developed the specifications needed for a custom-designed, silicon-based, wire-wound heater, as follows:

5" x 5" heaters with mounting hole (MH) pattern to match provided drawing of front flange,

Input voltage of 120 VAC/48 VDC,

Power of 5–10 W/in^2,

Continuous operating temperature of 250°C,

Lead length of 96" integrated with an adhesive-backed temperature sensor, and 6" leads to connect multiple heaters in parallel.

Custom Heaters and Research provided the solution that met the requirements, Fig. 2. Twelve heaters were ordered for testing.

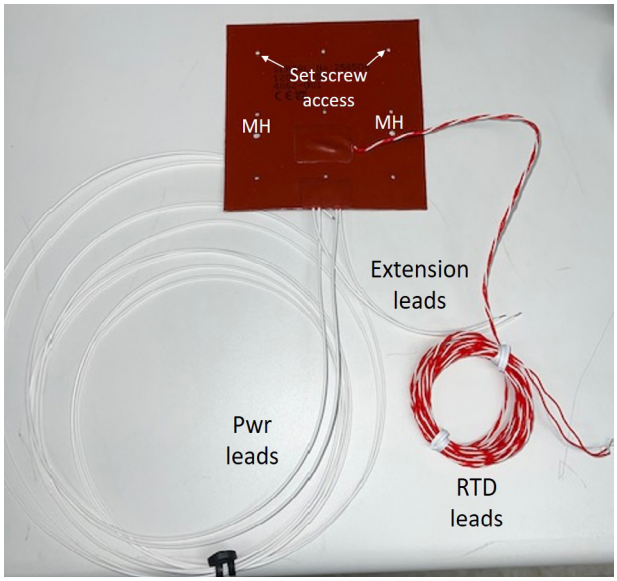

FIG. 2. Custom Heaters and Research design.

DSG developed a test for the heater as well as the control and monitoring system. For the test, the heaters will have two, 4-mm MH and an adhesive to attach the heater to the flange.

An Agilent N6700B bench top power supply will provide 48 VDC to the heater's power leads, Fig. 3. The power supply provides ~2.7 A to the 18-AWG Teflon leads of the heater.

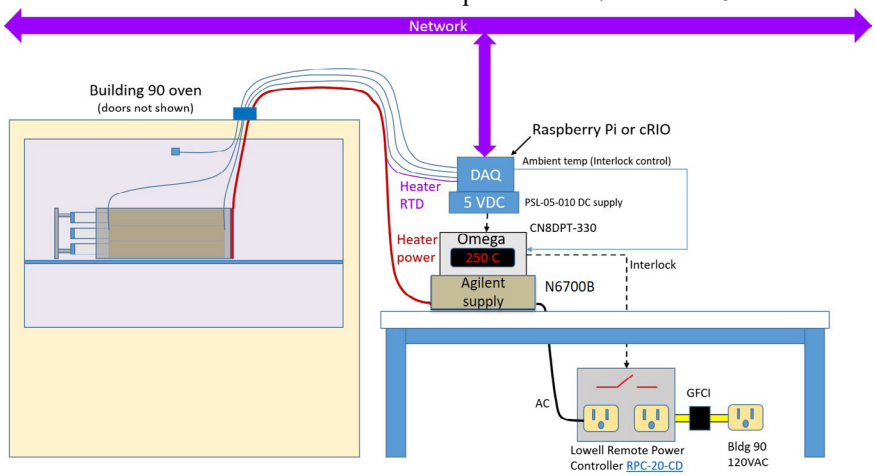

FIG. 3. Test setup diagram using oven as an enclosure.

A Raspberry Pi single board computer will be used to monitor the heater's built-in RTD, as well as RTDs measuring temperature on the front and rear faces of the crystals. For safety, an independent RTD will be monitored by an Omega CN8DPT-330 process controller, which will control an AC control relay that will remove power to the Agilent supply, should the safe temperature setpoint be exceeded.

In addition to testing the controls, monitoring, and interlocks, the test will measure the temperature on the face of the crystal while the front flange is being heated to the target temperature of 250ºC.

In parallel to the planned heater test, DSG is conducting a thermal analysis using Ansys. The simulation will show the heat transfer from the front flange, through the metallic components of the supermodule to the face of the crystal.

In conclusion, DSG will test a custom-designed heater by attaching it to a supermodule's front flange and applying power. The supermodule will be placed inside an oven and monitored using software running on a Raspberry Pi. This test will help determine the ability of the heater design to apply sufficient heat to the supermodule.

[1] G. Niculescu, et al., An Update on the SBS ECal, 2017