NPS Crystal Array Thermal Analysis with Ansys

Aaron Brown
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For this simulation, the ambient temperature was set to 20°C and the heat load applied to the rear face of each crystal was 0.3 W. The 0.3 W per crystal was determined from the expected operating voltages of 605 V (high voltage) and 4.5 V (low voltage) with expected operating currents of 405 µA (high voltage) and 18 mA (low voltage) for each of the PMTs of the NPS crystal array. This gives a total wattage of 352 W, which when divided by a total of 1080 PMTs, gives ~0.3 W per PMT channel.

The crystal array model was revised to more closely resemble the actual crystal array. The copper cooling shell was moved back so that there was no overlap between the copper and carbon fiber dividers at the front of the crystal array. This resulted in almost all of the heat being dissipated through the mu-metal dividers at the rear of the crystal array and reduced temperatures for the single peripheral crystal chosen for analysis, Fig. 1.

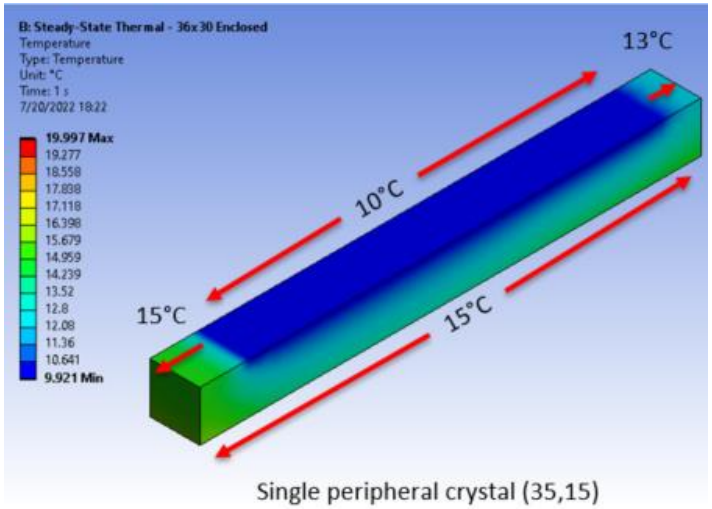

FIG. 1. Temperature profile of single peripheral crystal

- **Refined simulation model of NPS crystal array using Ansys DesignModeler**
- **Generated new histogram plot displaying the number of front crystal faces in each temperature range**
- **Determined ~50% of front crystal faces are close to ambient temperature of 20°C**

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As with previous simulations [1,2,3], temperature probes were placed on the front and rear faces of each crystal of the NPS crystal array model and these temperature values were extracted from the Ansys thermal simulation using the IronPython script get-results4.py.

After parsing the data file from the Ansys simulation, I plotted a histogram, Fig. 2, using a Python program I developed called ansysHist.py. This program uses the temperature values for the front crystal faces and generated bins that are 1.5°C wide. With the new model configuration, the number of crystals at or near ambient temperature (~20°C) increased from ~20% to ~50% of crystals, Fig. 3. The front face temperature of the peripheral crystals was ~15°C.

[1] Brown, Aaron DSG Monthly Memo 2022-01
[2] Brown, Aaron DSG Monthly Memo 2022-02
[3] Brown, Aaron DSG Monthly Memo 2022-04

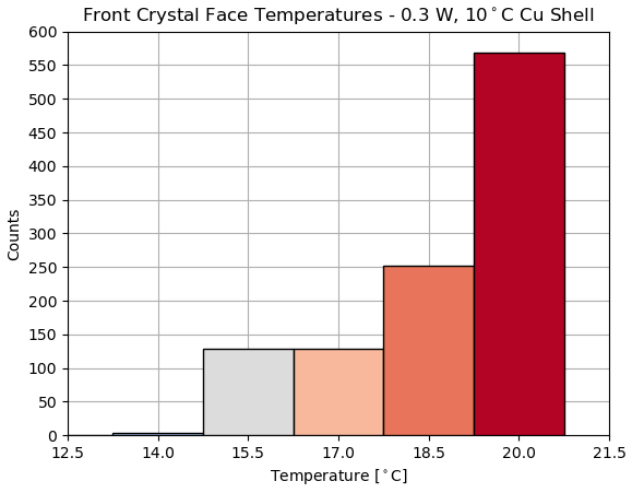

FIG. 2. Histogram plot of crystal front face temperatures

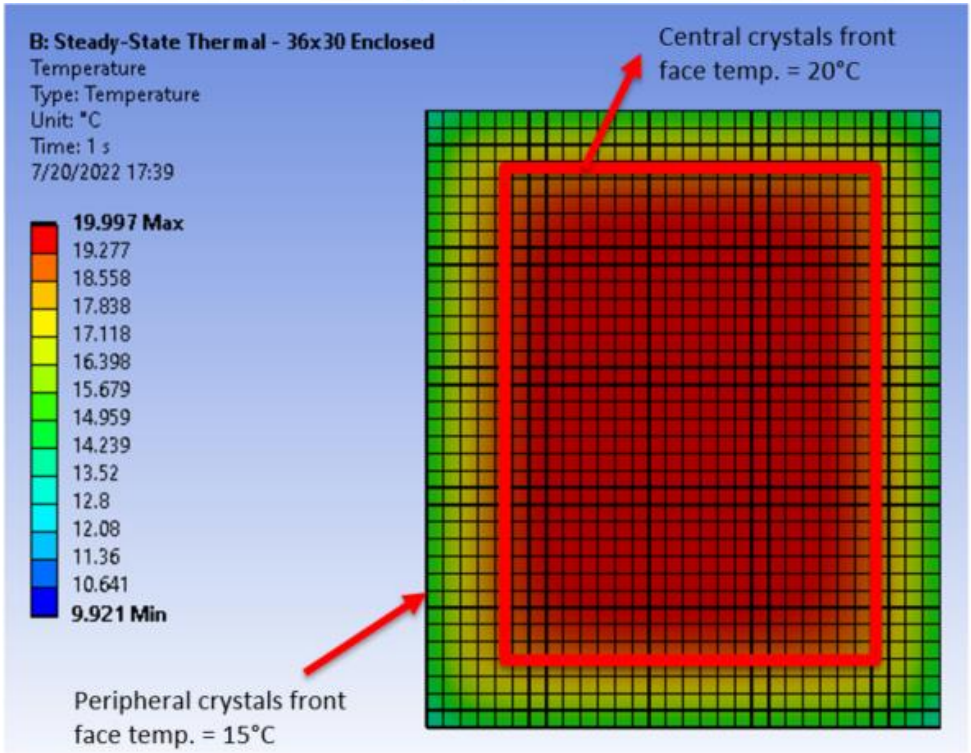

FIG.3. Temperature profile of front crystal face temperatures from revised crystal array model