NPS Crystal Array Thermal Analysis with Ansys

Aaron Brown
2022-04

NPS Crystal Array Thermal Analysis with Ansys

For this simulation the ambient temperature was set to 22°C and there was no heat load applied to the crystals. Perimeter cooling was fixed at 10°C, [1, 2]. Temperature probes were placed on the front and rear faces of each crystal of the NPS crystal array model. These temperature values were extracted from the Ansys thermal simulation to a text file using the IronPython script get-results4.py.

After parsing the data file from the Ansys simulation using a Python program I developed called parse-temps.py, I developed two additional python programs to plot a histogram and a streamline plot.

To plot the histogram, I developed a Python program called ansysHist.py. This program uses the temperature values for the front crystal faces and generates bins that are 1.5°C wide. These bins are assigned a color (blue to red representing cooler to warmer temperatures) and plotted as a histogram, Fig. 1. The histogram shows that roughly 210 cystal temperatures were close to the ambient temperature of 22°C.

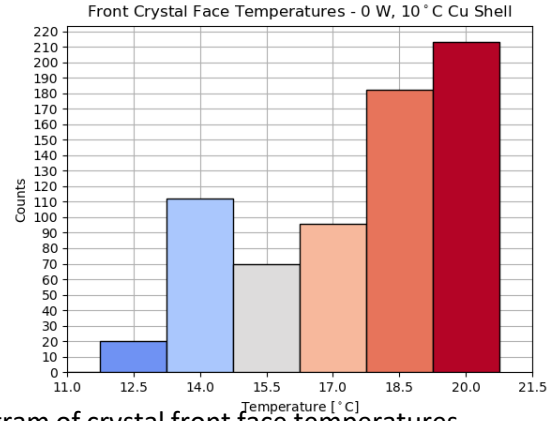

FIG 1. Histogram of crystal front face temperatures

- **Generated histogram plot displaying the number of crystal faces in each temperature range**
- **Generated streamline plot to display heat flow**
- **Determined ~20% of front crystal faces are close to ambient (22°C**

NPS: Crystal Array Thermal Analysis

To generate the streamline plot, I developed a Python program called gradTest.py. This program takes the temperature data and converts it to a 36 x 30 matrix. This matrix is flipped and rotated 90° so that the temperature values' locations in the matrix correspond to the location of the crystal face for each value.

The program then calls the numpy.gradient function and uses the extracted temperature values as the input. The numpy.gradient function returns two matrices, one for the change in the x-direction, and one for the change in the y-direction. A problem I encountered was that the matrices returned by the numpy.gradient function were in the reverse order than I expected.

The program then plots the 36 x 30 grid of squares to represent the front crystal faces. This grid is overlaid with the streamline plot which uses the x and y matrices returned from the numpy.gradient function as the x and y inputs. The streamline plot, Fig. 2, shows that the heat flows from the central region with higher temperatures to the edges with lower temperatures.

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

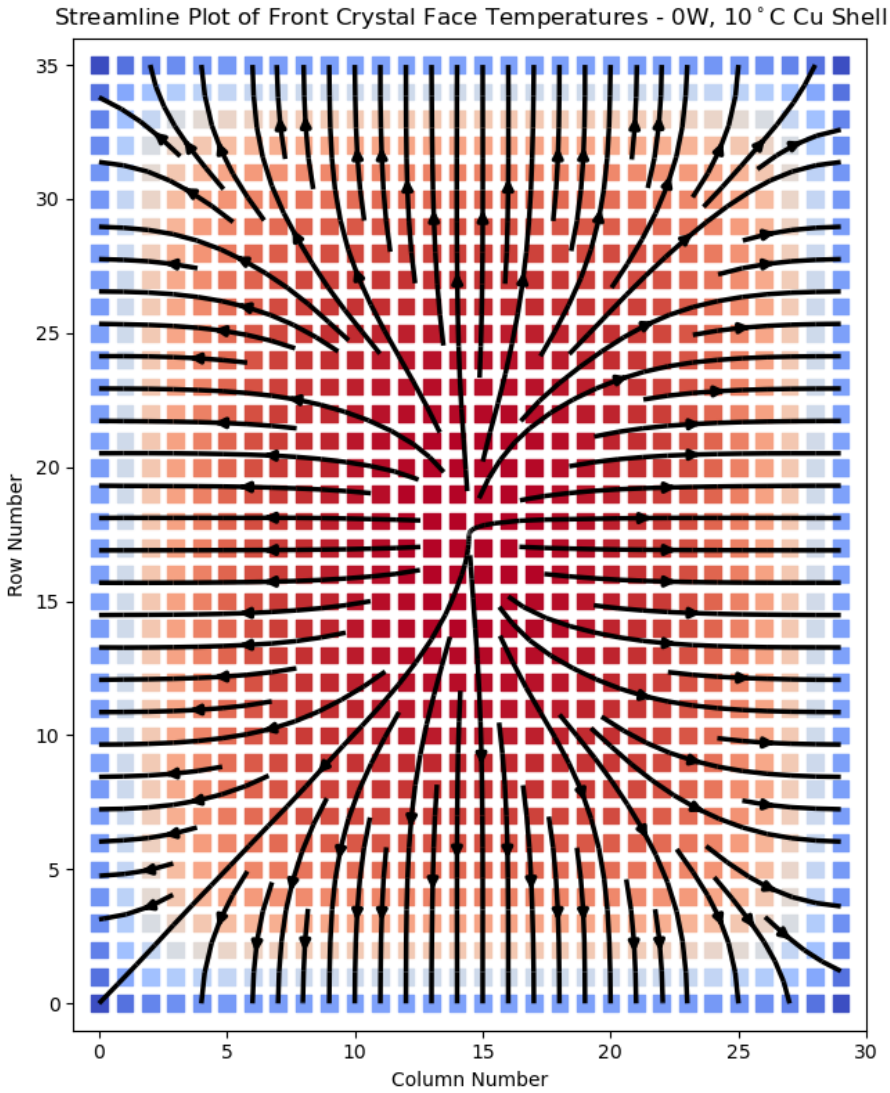

FIG 2. Streamline plot of front crystal face temperatures