Pulse Tube Interference in Cryogenic Sensors - General Abstract

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When a voltage is applied to a thin superconducting strip cooled just above its critical temperature, the superconductor becomes its own internal thermostat; an increase in temperature will cause the resistance to rise, which lowers the amount of current and drops the temperature. Likewise, a decrease in temperature causes the resistance to fall, increasing the current and raising the temperature. This change in current due to changes in energy makes the superconductor an ideal energy sensor. Due to the low noise, precise energy resolution, and time stamping of particles, these detectors have several potential applications, ranging from measuring cosmic microwave background, dark matter detection, or measuring the mass of the neutrino. SLAC is currently developing tools to readout data from an array of 10000 of these sensors.

A pulse tube cryocooler is used to maintain a sensor temperature of 100 mK. This device relies on a piston pushing fluid through a series of tubes and chambers, and creates a periodic, high pitched whistle. When looking at the sensor data, we noticed distortions that were synchronized with the sound from the pulse tube. To determine the nature of this noise and a possible solution, we used a detector with an extremely high sampling rate to measure the sensor data. However, when analyzing the data, there was no indication of any noise whatsoever.

Although no conclusions could be drawn from the sensor data, it was determined that the cause of the distortion were 0.3 mm steel cables carrying signals through the cryogenic chamber. Replacement of these cables ceased the interference in the sensor.