Cryogenic Thermometry Readout System for The Simon's Observatory's Large Aperture Telescope Receiver

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The Cosmic Microwave Background

Cosmology studies origins of the universe as a whole, all the way from the big bang to the modern accelerating universe model and including the different epochs such as the infant universe, inflation, recombination/ reionization, and galaxy evolution. By looking at the CMB today, we learn about the distant, ancient universe.

Introduction to Devlin Lab

In Professor Devlin's lab this Summer, I gained an incredible amount of experience and guidance. From learning about electronics and cryogenics, to being able to use Solidworks with confidence to manual labor working inside the telescope receiver, I really have done it all this Summer. A special thanks to everyone in the lab to whom I am very grateful for guiding and teaching me: *Mark Devlin (PI), Michele Limon, Simon Dicker, Bob Thornton, Jeffrey Iuliano, Jack Orlowski-Scherer, Ningfeng Zhu, Tanay Bhandarkar, Anna Kofman, Karen Perez Sarmiento, Saianeesh Keshav Haridas*

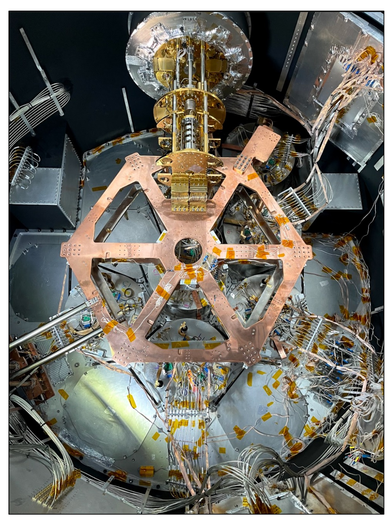
Simon's Observatory

The Simons Observatory is a new Cosmic Microwave Background (CMB) telescope being built in The Atacama desert, Chile. SO will consist of a series of telescopes to collect CMB photons, the oldest light in the universe. It will investigate the CMB radiation to better understand the physics of the very early universe, the nature of dark energy and dark matter, the properties of neutrinos, and the formation of structures in the universe. SO will achieve unrivaled sensitivity and is a global collaboration of over 250 scientists from over 40 institutions.

The Large Aperture Telescope

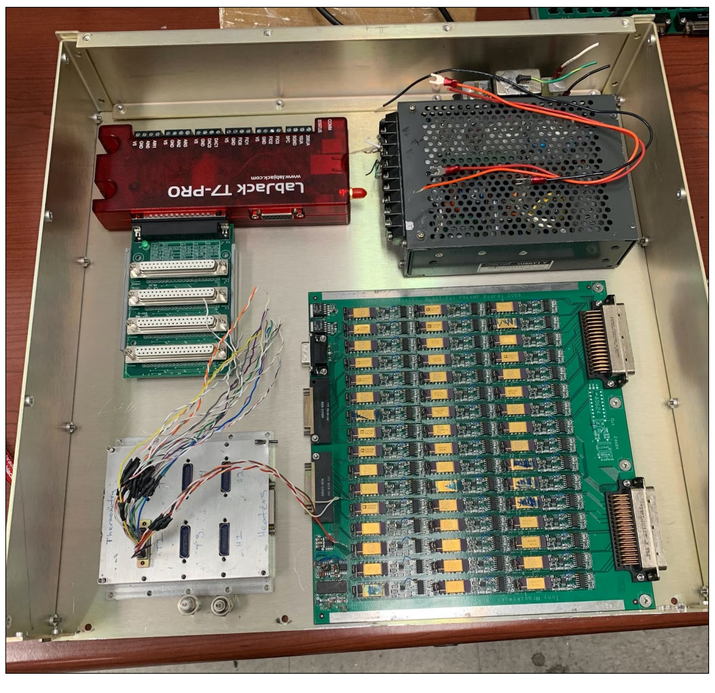
The LATR is being integrated and tested at the University of Pennsylvania under the direction of Prof. Mark Devlin. The LATR will have 13 optics tubes, with a respective window aperture diameter of 35 cm. For the first deployment, it will only house seven of the optics tubes amounting to a total of more than 30,000 detectors. The three silicon lenses in each tube are responsible for refocusing the light onto the detector. The LATR's cryogenic systems will cool the detectors to 100 mK.

LATR at UPenn



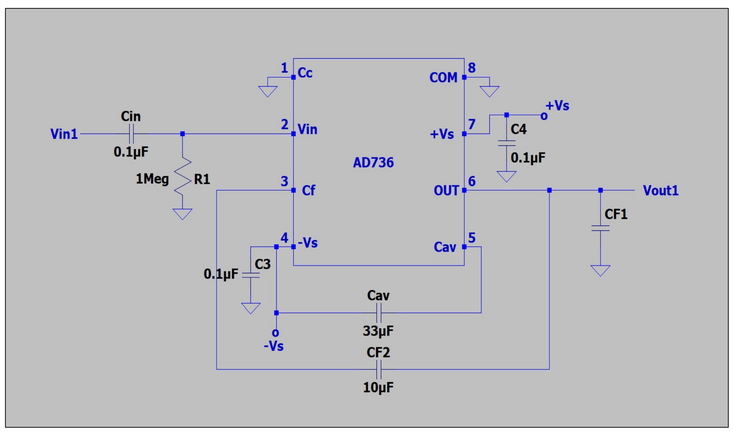
Cryogenic Readout System

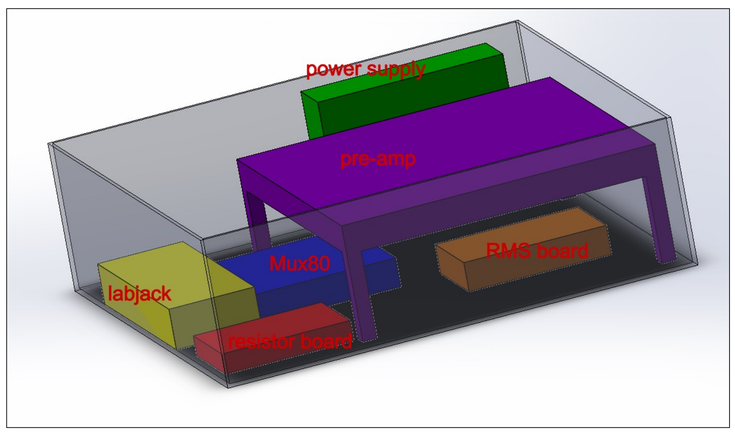
Tasked with designing the cryogenic thermometry readout system for the large aperture telescope receiver, our system was required to be able to read out temperatures as low as 100mK.
Below is a picture of most of the elements that will be included in the final box.
Despite already having most of the components, we had to correctly rewire them and write the code to go with it. In addition, we designed an RMS board which is now in progress of being made by the High Energy Physics department at UPenn.



Progress and Schematics

After we designed the simplified RMS board's circuit diagram, we drew up a board schematic with connectors and wrote up all necessary pinouts. This is what the top diagram shows. Using Solidworks as shown in the diagram below that it was found that, by stacking the Preamplifier and RMS boards, everything can fit into as small box as possible.





The Future of the Project

Once the panels and the RMS board for the box come back, the process of testing can begin. This is what I will continue to do during the Fall semester.
If all goes as expected, our cryogenic thermometry readout system will attach to the LATR and will be able to measure temperature fluctuations at extremely cold temperatures.
This will then be taken to Chile in 2022 and be used there to ensure temperatures inside the LATR are what they should be.

References

https://simonsobservatory.org/