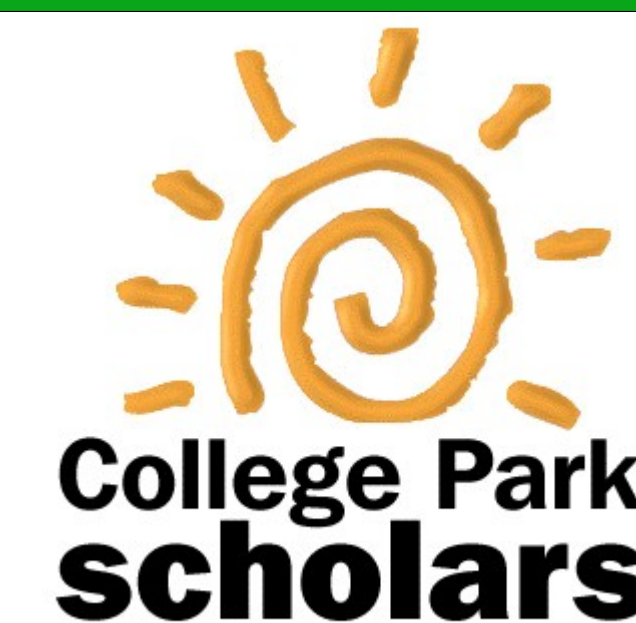




# PIPER: Discovering the Cosmic Background



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Earth Life and Time, Physics/Astronomy

## Service Site:

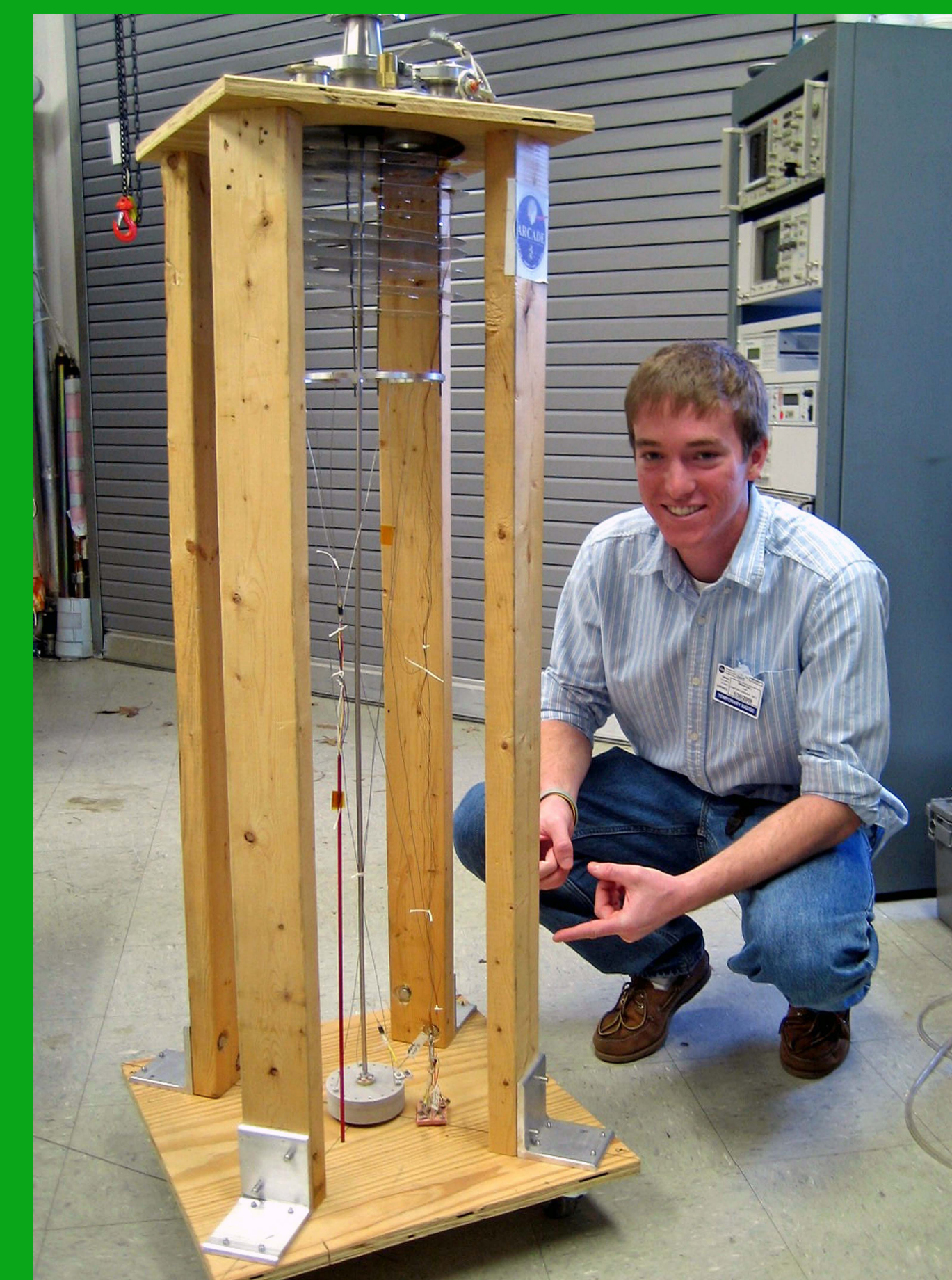
I completed my internship at NASA's Goddard Space Flight Center, located on Greenbelt Road in Greenbelt, MD. Goddard is the largest NASA center, and is home to around 10,000 civil servants and government contractors. More specifically, I worked in building 21 at Goddard, in the Microwave Lab with my site supervisors Dr. Alan Kogut, and Paul Mirel. The microwave lab is home to a diverse group of contractors, civil servants, and other interns—all of whom I worked with during my project.

## Issue Confronting Site:

In the Microwave Lab, I worked on the Primordial Inflation Polarization Explorer (PIPER). The term *primordial inflation* refers to a very important aspect of the Big Bang theory: the idea that the universe had a period of incredible expansion almost instantly after its formation. PIPER is a balloon-borne instrument whose purpose is to collect data from the cosmic microwave background in order to get a better understanding of cosmology and the Big Bang Theory, especially this period of exponential expansion. The cosmic microwave background itself is basically a picture of the universe 300,000 years after it was formed. It was at this time that the plasma that made up the universe cooled to the point that photons could escape and move through space freely. It is these photons that we can observe and study. One of the obstacles facing PIPER is getting the instrument cold enough to be able to see the microwave signal clearly. This means submerging the optics in superfluid helium in order to reach a temperature of around 2.7 K—the current temperature of the photons from the 300,000 year old plasma. Superfluid is the state of matter where the liquid's viscosity is zero and is obtained for helium by pumping a vacuum on it in its purely liquid state. The benefit of this superfluidity is that it is extremely cold—very near absolute zero (0 K). This is the main issue I focused on during my time with NASA, along with a number of other, smaller jobs.

## Activities:

My main activity in the lab was helping to create the indium window seal. This meant creating a seal for a quartz window that served as a prototype for the actual window that would surround the optics in the superfluid helium during its flight. There were a number of different designs for the seal, and the one I helped to create was the only one that stopped any leakage when submerging it in the superfluid helium (this process is called thermocycling). I also created a set of metal baffles that served to keep external heat from radiating inside the dewar in which we did the thermocycling, as well as several silicon molds that would help create the many thermistors (devices used to measure temperature based on changes in their resistances) needed for future testing. I also did other small jobs around the lab, like creating metal pieces used for testing with the software SolidWorks.



## Impact:

My work at NASA was important to the progress of the PIPER project in a few ways. First, the indium window seal I helped to make was the first one to pass the superfluid helium test. Although it needed to be crash tested (testing it with the goal of *trying* to break the seal) and thermocycled numerous more times, all the other seals had failed the first helium without even getting to the superfluid stage. Doing the silicon molds, soldering, and designing metal pieces using the SolidWorks program allowed for my site supervisors to progress in the designing of PIPER. My project had a significant impact on me, as well. Not only did I get to use some of the best resources and equipment out there, but more importantly I was able to work with a diverse group of people. This included other interns from places ranging from Puerto Rico to New York, as well as a large group of NASA specialists. Being able to get hands-on experience was an important goal for me going into the project, and will be beneficial for me as a physics and astronomy major.

## Future Work:

My work at NASA allowed for the many workers of PIPER to move onto other parts of the design. PIPER is going to be a four or five year project, and in some ways my five week internship might seem somewhat insignificant. However, I helped to take care of a number of both large (indium window seal) and small (silicon molds, thermal shielding metal baffles) details. Hopefully sometime in the future I can return to NASA and continue learning and working, whether on the PIPER or some other new and exciting project.

## Acknowledgments:

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