**Title of Investigation:**

**Low Tc (4 K) SQUID Readout to Characterize a High Tc (90 K) TES Bolometer**

**Principal Investigator:**

**Brook Lakew**

**Other In-house Members of Team:**

**J.A. Chervenak (Code 553), T. Stevenson (Code 553), S. Aslam (Code 553), and J. C. Brasunas (Code 693)**

**External Collaborators:**

**K. Irwin (National Institute of Standards and Technology/Boulder)**

**Initiation Year:**

**FY 2004**

**Aggregate Amount of Funding Authorized in FY 2003 and Earlier Years:**

**$0**

**FY 2004 Authorized Funding:**

**$60,000**

**Actual or Expected Expenditure of FY 2004 Funding:**

**In-house: $25,000; Contracts: $30,000 (GST Corp); Miscellaneous parts: $5,000**

**Status of Investigation at End of FY 2004:**

**To be continued in FY 2005 with funds remaining from FY 2004 and earlier years**

**Expected Completion Date:**

**September 2005**

**Purpose of Investigation:**

The purpose of this investigation is to provide the Goddard Space Flight Center with moderately cooled Far-Infrared (IR) Transition Edge Superconducting (TES) bolometers that are voltage biased. Bolometers are composite infrared detectors, which usually operate at very low temperatures. Missions to the outer planets typically do not carry cryogens to cool their focal planes. For example, the lowest achieved temperature on the Cassini orbiter is 80 K. The bolometers and detectors being developed in this project will be critical for future missions to the outer planets because they operate at temperatures that are reached without the use of liquid cryogens.

## Accomplishments to Date:

The project involves challenging thermal interfacing and magnetic-field shielding issues. Most of the assembly work has been completed. A low critical temperature (Tc) SQUID (Superconducting Quantum Interference Device) obtained from the National Institute of Standards and Technology (NIST) in Boulder, Colorado, has been installed in a shielded 5-metal tube.


*Figure 1. LEFT Low Tc SQUID unit*

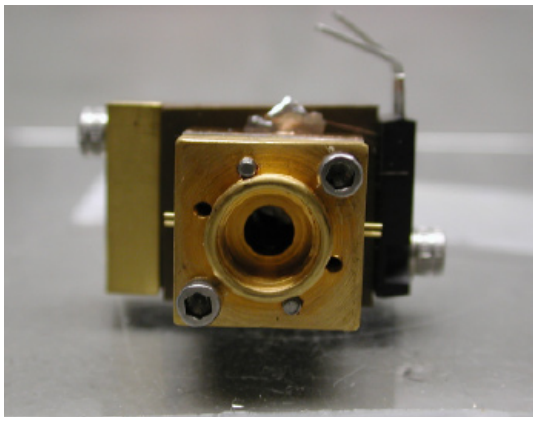

*Figure 2. RIGHT High Tc far IR bolometer developed at the Goddard Space Flight Center*

The TES temperature stage has been built and installed. Multiple wirings have been done and the external readout electronics are almost complete.

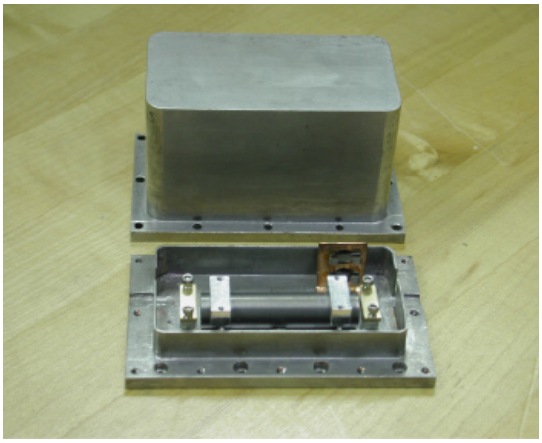

*Figure.3. SQUID housing box, plus 5-metal cylindrical shield*

## Planned Future Work:

A high Tc thin film tape wire that will be the thermal and electrical interface between high Tc detector and low Tc SQUID is being fabricated. After all the assembly is finished, a characterization test will be conducted.

## Summary:

Voltage biasing of high Tc TES bolometers using a SQUID is a first. If successful, a high Tc SQUID development is planned together with a two-dimensional array of TES bolometers. A far-IR camera operating at 90 K, with an order-of-magnitude higher sensitivity than the far-IR sensors on Cassini/CIRS, would benefit the Goddard Space Flight Center. Because of stringent power and mass budget requirements, instruments developed to study the outer Solar System have used passive coolers to cool focal planes to 80 K. The TES camera would be a critical component in future space-based planetary instruments. We will judge our success on whether we are able to operate a

high Tc SQUID with TES bolometer simulated by a low-noise resistor and resolve thermal issues and the integration of a low Tc SQUID and high Tc TES bolometer. Technical risk factors that might have, or that in fact have, prevented us from achieving success included a noisy SQUID even with 5 metal shielding. In addition, we have not resolved the thermal issues and we do not have enough funds to cover contractor manpower, if additional support is needed.