

## **PROJECT SUMMARY**

Firm: Creare  
Contract #: NNX11CE86P  
Project Title: An Ultra Low Power Cryo-Refrigerator for Space

### **Purpose of the Research**

On this program, Creare developed and demonstrated an innovative cryocooler that requires extremely low input power. The work addressed NASA's need expressed in Topic S1.07 for an ultra-low power cryocooler that provides 300 mW of refrigeration at 35 K. The technology supports future satellites, probes and astronomical observatories utilizing superconducting bolometers, and infrared, far infrared, submillimeter and X-ray detectors. Military space applications include space-based surveillance for Operationally Responsive Space missions.

### **Brief Description of the Research Carried Out**

During the Phase II project, we built and tested a technology demonstration unit comprising a cryocooler, cryo-radiator and control electronics. The testing including thermal vacuum tests on the system and launch vibration testing on a critical cryocooler component.

### **Research Findings or Results**

The Phase II test results were excellent. During cryocooler system performance testing, the cryocooler produced 280 mW to 550 mW of net refrigeration at load temperatures from 35.0 K to 40.5 K. The AC electrical input power was less than 18 W at 150 K. The peak efficiency was 8.4% relative to the Carnot efficiency. All components met or exceeded performance expectations. Improvements to the multi-layer insulation were also identified that could significantly increase net refrigeration. Following cryocooler system testing, the recuperator assembly was vibration tested up to 12.4 Grms without failure. The work completed on this program increased the TRL from 4 to 5/6. The next step for the technology would be to build and test an optimized engineering model cryocooler for a particular mission or mission class. The overall mass of the flight cryocooler, cryo-radiator and electronics is predicted to be 6.2 kg, the area of the cryo-radiator is 0.8 m<sup>2</sup> and the input power to the compressor is predicted to be less than 9 W. The input power is an order of magnitude less than current state-of-the-art cryocoolers that utilize a 300 K heat sink.

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