S16.07-1644 - High-Efficiency Modified Collins Cycle Cryocooler

PI: Brady Krass , Triton Systems, Inc. - Chelmsford, MA

SBIR·STTR America's Seed Fund™ POWERED BY NASA

NON-PROPRIETARY DATA

IDENTIFICATION AND SIGNIFICANCE OF INNOVATION

Existing low-temperature space cryocoolers are inefficient, requiring 10 kW of electrical power to provide 1 Watt of cooling at 4 Kelvin. Large-scale terrestrial helium liquefaction plants only require about 1 kW per Watt of cooling at 4 Kelvin. The proposed cryocooler design will permit scaling down terrestrial cryogenic refrigeration technology to provide about 200 mW of cooling at 4 Kelvin without sacrificing the efficiency of the large-scale systems. A 4X to 5X efficiency improvement is expected, as well as the potential for improved system integration. This will reduce the power budget for cooling and increase the budget for space-science.

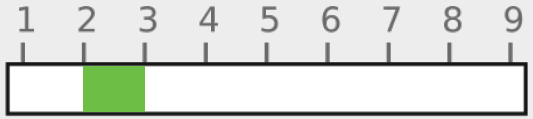
TECHNICAL OBJECTIVES AND PROPOSED DELIVERABLES

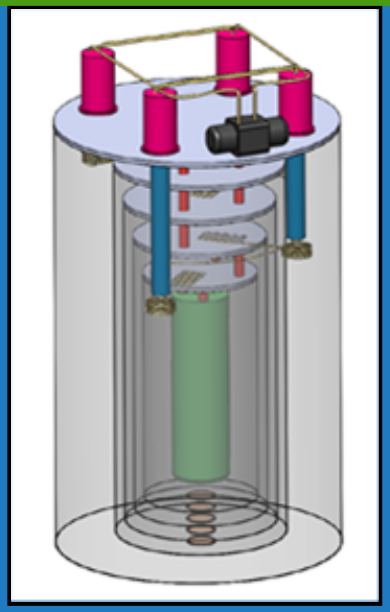
Phase I Objectives:
In Phase I the Triton team will develop the design of a 4-stage Modified Collins Cycle cryocooler that will be built and demonstrated in Phase II. The design effort will address unique aspects of a multi-stage machine that were not relevant in previous work focused on single-stage floating piston expander development. It will target a specific set of multi-stage loads defined by our NASA sponsor. The design will include a complete thermodynamic model, heat exchanger analysis and design, control system design, selection of standard components and mechanical design of custom components.

Phase I Deliverable:
The Phase I deliverable will be a report that details the results of thermodynamic modeling and presents the detailed design of a 4-stage prototype cryocooler to be built and tested in Phase II.

TRL

Estimated





NASA APPLICATIONS

The next generation of space telescopes, including the LYNX (X-ray surveyor) and Origins Space Telescope (far IR surveyor) that are planned for launch in 2030, will require cooling to 4K and will benefit from development of this technology. Successful development will result in 4X to 5X reduction of power for cryogenic cooling.

NON-NASA APPLICATIONS

The principal non-NASA application is cooling of low-temperature superconducting magnets used in MRI and NMR imaging machines. Other applications include cooling low-temperature superconducting electronics, including quantum computing. This is an ideal technology for cooling devices using magnesium diboride superconductors.

FIRM CONTACTS

Collette Jolliffe
Triton Systems, Inc.
EMAIL: cjolliffe@tritonsystems.com
PHONE: (978) 856-4158