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C3Or2C-07: Development of a Cryogenic Compressor for Airborne Cryocoolers

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Superconducting electronics and spectral-spatial holographic systems are being developed for advanced digital communications. These devices must operate at cryogenic temperatures of near 4 K. Liquid helium is undesirable for mobile missions due to logistics and scarcity, and commercial low-temperature cryocoolers are unable to meet size, weight, power, and environmental requirements for many missions. Creare is developing a turbo-Brayton cryocooler that provides refrigeration at 4.2 K and rejects heat at 77 K to an upper-stage cryocooler or through boil-off of liquid nitrogen. The cooling system is predicted to reduce size, weight, and input power by at least an order of magnitude as compared to the current state-of-the-art 4.2 K cryocooler. For systems utilizing nitrogen boil-off, the boil-off rate is reasonable. This paper reviews the development of the cryo-compressor, a key cryocooler component. The cryo-compressor has heritage in the cryogenic circulator used in the space-borne NICMOS cryocooler. To produce the pressure ratios and mass flow rates required by the cryocooler, the cryo-compressor must operate at much higher operating speeds than the cryogenic circulator while still at cryogenic temperatures. This operating condition presents a challenge for stable operation of gas bearings at low viscosities. The approach to overcome this challenge and the testing of the compressor at cryogenic temperatures are the focus of this paper.

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