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Design, Fabrication, and Testing of a 1 Watt at 22 Kelvin Joule Thomson Cryogenic Refrigerator

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Eta Space and Meta Vista have partnered with the NASA Kennedy Space Center to develop a novel cryogenic refrigeration cycle that has many applications to the space industry as well as for terrestrial energy markets. The cryocooler is sized to produce 1 W cooling at 22 K. Key features of this cryocooler include high efficiency, low vibration, no electromagnetic interference, high reliability and long life. The operating principles of this cryocooler are presented and the current state of development is given. The optimum refrigeration cycle state points have been established and detailed design of the compressor and cold box is complete. All fabrication has been finished and subsystem test results are presented. The compressor has been integrated with the cold box and integrated testing is ongoing. The advantages of this refrigeration cycle are of interest to the space science and exploration community for use in many potential applications. A survey of different space applications has completed and several possibilities are discussed. These applications range over several orders of magnitude in size and have a wide variety of environmental constraints. A scaling analysis has been completed to show increasing size by two or more orders or magnitude is feasible, and an assessment on modifications to meet microgravity, vacuum, radiation and thermal requirements has been completed. This report concludes that this new refrigeration cycle appears to have many space applications and development and testing of these systems will continue to be pursued.