
SESSION 2: Stirling & Pulse Tube Cryocoolers - Analytical

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Development of 5W Class Pulse Tube Cooler for Space Use

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Sumitomo Heavy Industries, Ltd. (SHI) has been used a single-stage Stirling cooler as a cooler for infrared sensors and radiation shield for the Earth observation satellite Shikisai and the scientific satellites Suzaku, Kaguya and Akatsuki. In addition, the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) and the Hitomi X-ray science satellites are equipped with 4K cooler consisted of two-stage Stirling cooler and JT cooler to realize a liquid helium-free cooling system. Cooler for space use is required high reliability, small size, light weight, high efficiency and low vibration. SHI's Stirling coolers have an active balancer for the expander to decrease the induced vibration from displacer movement, and the driver for driving this balancer is a disadvantage compared with pulse tube cooler. The performance of a single-stage Stirling cooler made by SHI has a cooling capacity of 2.2 W at 77 K with electric input of 50 W. However, users plan to increase the number of sensors to improve observation accuracy in the near future. There is a possibility that the cooling capacity needs to be increased, and there is a similar demand for a 4K cooler. Since the pulse tube expander has no moving parts, it is advantageous for the reliability of cooler and no necessary of a driver for the active balancer of expander. We started to develop single-stage pulse tube with cooling capacity of 5 W at 77 K since 2017, and we tested three types of expander (In-line type, U-shape type and co-axial type). This paper describes the design of the cooler and the results from the cooler performance test, the induced vibration measurement of new compressor, the performance calculation results by numerical simulation.