Pulse Tube Cryocooler at 4 K: Customization for Sensitive Cryoelectronic Applications in "Dry" Low Noise Cryostats

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***Abstract* – Pulse Tube Cryocooler (PTC) providing temperatures of 4 K by "dry" cooling represents a reliable alternative to conventional bath cryostats with liquid helium. Wherever liquid helium is not available or the increasingly long measurement times of state-of-the-art experiments exceeds the refill interval of liquid helium cryostats, "dry" cryocoolers are utilized. Within the family of regenerative cooling systems, PTCs distinguish themselves by the absence of moving parts inside the cold head. This makes them the preferred choice for sensitive and low noise applications. Unfortunately, PTCs and conventional Gifford-McMahon coolers, exhibit periodic variations in displacement by some microns and in temperature by some hundreds of mK due to the compression/decompression of the working fluid (helium) inside the cold head. This intrinsic effect has to be accounted for in the adaptation of the pulse tube cooler to the individual application. Here, we present successful solutions for dry cooling of sensitive experiments with pulse tube coolers. Since the intrinsic disturbance effects scale with the size of the cold head, the pulse tubes have been minimized to run with low input powers but still providing sufficient cooling power for cooling cryoelectronic devices such as JJ-voltage standards. Customized stages can additionally reduce the residual mechanical vibration amplitude to below 1 nm [4] and dampen the temperature oscillation by more than an order of magnitude [5, 6]. The advanced combination of these adaptations meets the highest requirements the dry cooling of the airborne THz bolometer-telescope of the SOFIA observatory airplane.**

***Keywords (Index Terms)* – Cryocooler, pulse tube, cold head, regenerative cooling, cryocooler vibration, cryocooler temperature stability, THz bolometer telescope, SOFIA stratospheric observatory.**

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