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Impact of cold finger geometry on low temperature pule tube cooler performances

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Pulse tube developments at CEA/SBT are focused on low-temperature Pulse tube cryocoolers, and more specifically on a basis of the cold tip architecture of the PT15K cooler previously developed by ALAT/TCBV/CEA. This pulse tube cooler was made to work at 15K, here, the objectives are to decrease its working temperature in order to produce a significant cooling power around 8K or lower.
A "last"stage of a low temperature PT cooler has been developed at CEA few years ago and reached a temperature of 4K while precooled at 20 K, nevertheless, it was too demanding in term of heat flux at pre-cooling interface to be compatible with our current space like PT pre-coolers.
Here we adopt a step-by-step approach to decrease the working temperature while keeping reasonable level of heat flux at interfaces, leading to a better overall thermodynamic efficiency. The first step was to modify slightly the architecture of the pulse tube cold finger in order to add a second interface for pre-cooling. The second step involves dimension reductions of the PT 15K cold finger to reduce the heat flux at pre-cooling interfaces.
Several pulse tube geometries have been designed, built and tested in order to evaluate the heat flux required at precooling interfaces, as well as the evolution of the pulse tube performances. The influence of the precooling temperature, and the heat flux associated have been studied for different interface temperatures to create a large database. Coupling this data base with the performance database of an existing two-stage PT cooler can be used to optimize a future three-stage cooler.
All these preliminary results were obtained using a standard stainless steel mesh regenerator. In the future, tests will be carried out with a regenerator featuring a specific heat anomaly to improve performance at low temperatures.

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