Development of a 20 K Thermally-Coupled Two-Stage Pulse Tube Cooler with Independent Warm Displacers

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Stirling-type pulse tube coolers are increasingly used in applications such as infrared detection and superconductivity due to their remarkable compactness, reliability, and extended mean time to failure. Nevertheless, the current efficiency of the cooler working at liquid hydrogen temperatures leaves room for improvement, sparking research interests in enhancing its efficiency. This paper presents a 20 K thermally-coupled two-stage pulse tube cooler with independent warm displacers, driven by a single compressor. Both simulation and experimental testing have been done. The simulation based on Sage shows characteristics of the system, specially the influence of the pre-cooling temperatures, displacer dimensions and its dynamics parameters. In the experiments, independent tests of the pre-cooling stage have exhibited performance agreeing well with prediction. Then, by thermally coupling the second stage with the pre-cooling stage, the performance will be characterized with different average pressures, operating frequencies and pre-cooling temperatures.