Development and Testing of a Miniaturized Pulse Tube Cryocooler for Ground and Space Applications

T. Hurot, Y. Icart, Absolut System, France; J.C. Terme, Lynred, France; G. Aubry, HGH, France

With the rise of earth observation constellations based on small satellites, size optimised and cost-effective coolers are needed. Integrated Detector Dewar Cooler Assembly are well suited for these applications but are typically based on rotary Stirling coolers with high vibrations and low lifetime. While pulse-tube cryocoolers solve these issues thanks to the absence of moving parts in the cold finger, scaling down pulse-tube cryocoolers without compromising thermodynamic efficiency poses technical challenges.

On the compressor side, the miniaturization of the piston and actuators requires an increase in drive frequency. On the cold finger side, this higher frequency results in lower thermal diffusion depth in the regenerator and heat exchangers, which impacts performance.

In this context, Absolut System is developing a miniaturised high frequency pulse tube cryocooler, including the compressor and cold finger. The cooler is designed for applications between 90 K and 150 K, with an emphasis on size and reliability. It can easily accommodate standard tactical type dewars. Several engineering models of complete IDDCAs based on Absolut System's cooler coupled with Lynred's infrared detectors are being manufactured. An electro-optical performance demonstration of the IDDCA integrated in a camera will be conducted by HGH.

In this paper, the design of the compressor and cold finger will be described, and the initial bread board test set up and results will be presented. Future evolutions of the system will be discussed, as well as upcoming qualification work.