Easycool – An Adiabatic-Demagnetization-Refrigerator-based solution for high sensitivity scientific instrumentation

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EQUIPMENTS

LABORATORIES: NEEL, INAC

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Easycool is a continuous magnetic refrigerator cooling at a temperature below 100 mK. It is focused at providing a cryogen-free solution for designing advanced instrumentation for physics and astrophysics.

The challenge in the realization of Easycool is the design of an adiabatic demagnetization refrigerator (ADR) which provides two levels of continuous cooling (1K and 0.1K). Designed for scientific research and high sensitivity cryogenic detectors, this system is compatible with the more demanding applications. For validating the cooler, we have integrated the new technology of KID detectors (Kinetic Inductance Detectors) developped within the instrumentation group at Institut Néel. Those detectors have several applications in millimeter astrophysics or Teraherz radiation imaging in biology.

Easycool is based on a series of 5 adiabatic demagnetization stages. Each stage operates in a defined temperature range with a limited temperature gradient to optimize the efficiency and low mass of the cryocooler (Fig.1).

The key technologies needed for the cooler are the heat switches (gas-gap or superconductive), the magnetic materials manufacturing and the superconductive coils. Those components benefit from the high maturity and reliability of the developments made at INAC for space applications under several CNES and ESA contracts.

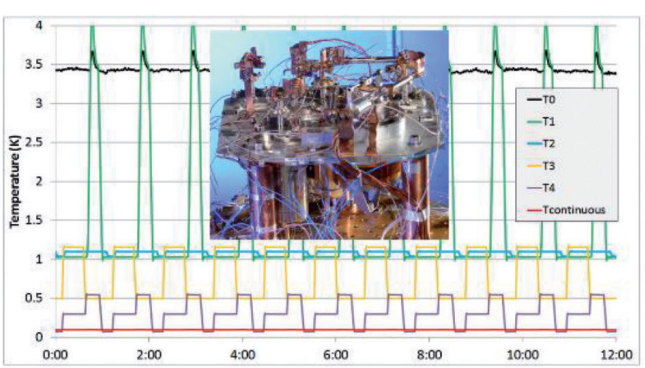

Fig.1: Temperature evolution of the 5 cooler stages (time in hours)

Easycool has been integrated in a modern cryogen-free cryostat based on a 4K Pulse-Tube cryocooler at INAC. It fully demonstrated the magnetic shielding efficiency.

We are currently developping an original solution based on a Gifford-MacMahon cryocooler and a 4K Joule-Thomson cooler in order to provide a competitive cryogen-free system with a low level of induced microvibrations, which is a limiting factor in high sensitivity intruments. This development is made in collaboration with Absolut System (Grenoble, France). Easycool will be fully operational in 2019 at NEEL for future applications (Fig.2).

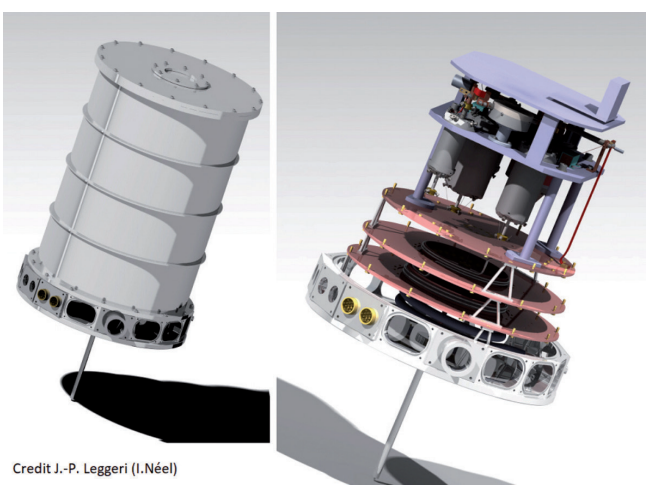

Fig.2: Integration of Easycool in an optical instrument for millimeter astrophysics.

OUTCOMES

[1] Development of an ADR Refrigerator with Two Continuous Stages, J. Low Temp. Phys. 184, 604 (2016).

PhD: Diego Paixo Brasiliano, Etude et réalisation d'une désaimantation adiabatique spatiale 4-50mK, Université Grenoble Alpes (2017)

Leverage:

Collaboration with private sector:

Entropy (Germany): licencing of the gas-heat switches for ADR products (2017)

Absolut System (France): development of a GM/JT 4K for a cryogen-free system

This plateform will support several projects based on KID detectors.