

## Numerical simulation of pulse tube cryocoolers for space

**Contact:** Sylvain MARTIN DRF//INAC/SBT/LCCS [Sylvain.MARTIN@cea.fr](mailto:Sylvain.MARTIN@cea.fr) 04 38 78 02 66

**PhD may follow:** Yes

### Summary :

The aim of this project is to develop a numerical simulation a pulse tube cryocoolers working between 100 K and 4 K. A 1D method already allowed us to modelize the oscillating flow of a pulse tube. A model that takes into account the thermal transfer into a real gas shall be developed.

The internship will be followed by the CEA/SBT (pulse tube and cryogenic expert) and by the CETHIL (expert in numerical simulation in thermal transfer in fluid media). It will mainly take place in Lyon in CETHIL office with a strong collaboration with CEA/SBT.

### Full description :

CEA and CETHIL are looking for an internship candidate for a duration of at least 5 months (Master 2 level).

The Low Temperature Laboratory (SBT) from CEA/INAC is involved in technological cryogenic research in a large temperature range from 120 K down to few tens of millikelvins. CETHIL (CNRS, INSA, UCBL) has a strong expertise in numerical simulation for systems involving flow study coupled to thermal transfer.

In SBT, the LCCS team (Cryocoolers and space cryogenics lab) develops small cryocoolers ranging from 50 mK up to 50 K. Among those developments, the pulse tube is a key component in the team. Based on the Stirling thermodynamic cycle, it allows to reach temperature between 4 K and 100 K with helium. They are used in satellite for earth observation (MTG, Met-Image) around 50 K. For space observation mission (ATHENA/X-IFU), a system able to reach 15 K has been developed and a prototype demonstrates an ultimate temperature of 4 K.

In CETHIL, the involved team has a strong expertise in numerical simulation of thermal transfer in fluid media. They are using CFD simulation and have developed their own numerical simulation dedicated to thermal studies. The team is also using massive parallel computation.

Based on the expertise of the 2 laboratories, the aim of the internship is to develop a model of a pulse tube that allows to cover the temperature range of 100 K - 4 K. A better comprehension of the phenomena inside the pulse tube is expected. Hence, a faster improvement of the performances. The tool shall also be able to size multi-stage systems (Dual stage pulse tube, 15 K PT ...).

For the moment, a 1D semi-analytical method and a 1D numerical code has been developed jointly with SBT and CETHIL to simulate the oscillating flow of a pulse tube cooler. From the existing tools, the current project shall modify those tools in order to take into account the thermal heat transfer into real gas. The numerical results will then be compared to the experimental results obtained in CEA/SBT.

The internship will take place in Lyon at CETHIL place with a strong collaboration with SBT. Some visit to CEA are planned. The internship can lead to PhD thesis CEA/CETHIL.

The candidate shall be in last year of engineering school or master in the field of thermal, mechanic and energetic. He (she) should have good scholarship grades with knowledges in thermodynamics, thermal transfer and programming with some interests in thermal machines and physics.

### Requested skills :



INSTITUT NANOSCIENCES  
ET CRYOGÉNIE

la recherche, ressource fondamentale  
research - a fundamental resource

MEM | PHELIQS | SBT | SPINTEC | SYMMES

[inac.cea.fr](http://inac.cea.fr)

Numerical simulation, Thermodynamic, Thermal transfer