# Innovative cooling by Pulsating Heat Pipe for HTS superconducting coil

## Objective and Scientific Interest

The objective of the project ***is the realization and testing of an oscillating heat pipe-cooled HTS superconducting coil with 'Metal-as-Insulation' winding***. These innovative coils, derived from the R&D of the Superconducting Magnets Laboratory (LEAS) of the Cryogenics and Magnetism Accelerator Department (DACM) of CEA Paris-Saclay, are usually cooled by helium baths [4][5]. These cooling methods are complex, expensive (liquefaction / refrigeration) and inefficient, heavy and slow. The technical interest of this type of heat pipe, stemming from the R&D of the Cryogenic Laboratory of the same department is linked to its great capacity to transfer heat, passive operation, lightness and simplicity of construction. As an indication, these oscillating heat pipes are at least 10 times lighter than an equivalent thermal link made of copper at the temperatures of liquid nitrogen. The unprecedented combination of these two technologies on a demonstrator generating a few teslas is an important advancement for the development of high magnetic field magnet. This would be a world first for this type of superconducting magnet.

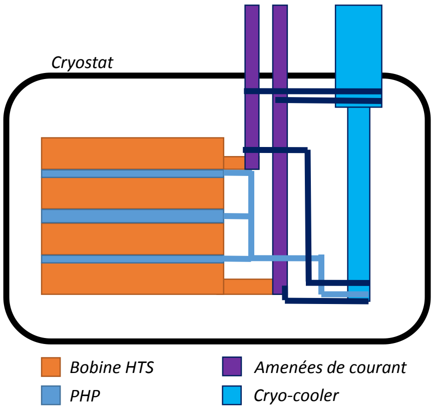


Schéma de l'expérience

## Post-doctoral work

As a first step, the postdoctoral fellow will work with the two DACM teams to design the superconducting magnet (thermal, cryogenic, mechanical and magnetic) and a specific heat pipe. Its integration of which must be done initial phase of the design (heat pipe and cold-head cooled current leads). This is a complex task, given the multi-physical approach to be used. This task will last from three to six months. For the next three months, the postdoctoral fellow will follow the manufacture of the demonstrator carried out internally by the technical teams of the two laboratories by re-using the test facility and the available manufacturing tools. During the second year, the postdoctoral fellow will participate in the evolution of the existing test facility (instrumentation and acquisition) and will carry out the characterization tests of the thermal and magnetic performances of the prototype as well as the analysis of the results.

| M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 | M13 | M14 | M15 | M16 | M17 | M18 | M19 | M20 | M21 | M22 | M23 | M24 |
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| *Magnet and heat pipe design* | | | | | | *Prototype realisation and test facility set-up* | | | | | *Instrumentation and acquisition, characterization tests and results analysis* | | | | | | | | | | | | |

# Candidate

The candidate must have a PhD or an equivalent relevant experience in the field of applied physics, or a related field with an expertise in magnetism, mechanical design and heat transfer.

*Experience:*

- Proven experience in conducing experimental test facility and measurement of temperature, pressure and voltage and low-level current,
- Proven experience in thermal, magnetic and mechanical designs,
- Familiarity with vacuum and cryogenic technology.

*Technical skills:*

- Design of mechanical and thermal systems in the fields of physics (cryo-magnetism...),
- Use of experimental data acquisition system (Labview...),
- Analysis and interpretation of experimental results.

*Language:*

- Very good knowledge of English: ability to write scientific reports and publications and to make oral presentations.

## Contacts:

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A letter of motivation, CV and two recommendation letters are requested.

*References*

[1] R. Bruce et al. *Thermal performance of a meter-scale horizontal nitrogen Pulsating Heat Pipe*, Cryogenics Vol. 93, 2018, Pages 66-74.

[2] M. Barba et al. *Experimental study of Large-scale cryogenic Pulsating Heat Pipe*, Adv. Cryo. Eng. IOP Conf. Series: Materials Science and Engineering 278 (2017) pp. 012156.

[3] R. Bruce, et al. *Cryogenic Design of a Large Superconducting Magnet for Astroparticle Shielding on Deep Space Travel Missions*, Physics Procedia 67, 2015.

[4] P. Fazilleau et al., *Metal-as-insulation sub-scale prototype tests under a high background magnetic field*, SUPERCONDUCTOR SCIENCE & TECHNOLOGY, vol. 31, 2018.

[5] T. Lécrevisse et al., *Metal-as-insulation variant of no-insulation HTS winding technique: pancake tests under high background magnetic field and high current at 4.2 K*, SUPERCONDUCTOR SCIENCE & TECHNOLOGY, vol. 31, 2018.