Title: Advanced modelling of cooling architectures and cryogen distribution for large-scale research infrastructures

PhD Summary:

Optimized and reliable large-scale cryogenic refrigeration systems are required for superconducting devices cooling, thermal shielding and ultra-high vacuum pumping of the next generation of high-energy particle physics instruments and fusion reactors. No modeling tool is currently able to design and optimize the complete cooling chain of these systems. The objectives of this thesis is to develop such tool. Several key components are missing and their development and integration in a global model will be the objectives of this work.

Innovative refrigeration technologies such as high-efficiency turbo-Brayton cycles are under consideration as part of the cooling chain of large-scale cryogenic systems. One of the challenges is the need for refrigeration over a broad temperature range (at least 20-65 K as well as 100- 200 K), which imposes the use of mixed refrigerants. Data on the physics of mixing are missing to be able to model such devices. A set of measurements of different mixings (in particular low temperature Helium-Neon mixing) should provide enough information to be able to come up with a model for this sub system.

Large centrifugal compressors operating in series or parallel are another key technology with currently no simple tool to predict and optimize performances. The CEA-SBT has already worked of the subject, both from analytic and Computational Fluid Dynamics (CFD) points of view. The second part of this thesis is a careful simulation benchmarked against known experimental measurements.

The final part of this work is to gather the different modeling components into libraries for the new tool developed by CEA-SBT, SimCryogenics. This tool will be benchmarked using existing cryogenic systems such as the 400 W test facility at CEA-SBT. Different innovative architectures and cooling chains will finally be simulated to determine their efficiencies and limits.

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More details on EASITrain network and eligibility conditions: https://easitrain.web.cern.ch/

Starting date:

- 01/10/2017

Research field:

- Engineering Science
  - Thermal energy, combustion, flows
  - Mechanics, energetics, process engineering
  - Mathematics, Numerical simulations

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