Title: Experimental and Numerical Study of Innovative Compact Heat Sinks made by Metal Additive Manufacturing in the Turbulent Subcooled Boiling Regime

Description: The LARAMED (LAboratory of Radionuclides for MEDicine) project is devoted to R&D activities aimed at optimizing the accelerator-based production of novel radioisotopes having high potential in improving the diagnosis and treatment of cancer. One of the most critical technological challenges in increasing their yield resides in developing proper cooling systems for solid targets able to withstand the heating power generated by accelerated charged particles interaction with the bombarded material. Indeed, the LARAMED project is intended to exploit the 70 MeV high current (up to 500 μ A) proton-beam of the cyclotron of the SPES (Selective Production of Exotic Species) project present at LNL. To meet this requirement, cooling solutions based on optimized heat sinks in combination with the most favorable thermo-fluid dynamic parameters should be adopted. Conventional solid targets cooling systems relies on single-phase water forced convection, whereas more efficient cooling solutions, for example adopted for electronics, exploit the latent heat of vaporization of this fluid by allowing water to boil during its transit inside the heat sink channels. However, this technique is not already applied in this field due to the lack of knowledge in the design and management of this fluid regime. Thus, it is of interest to correctly characterize the fluid behavior in different thermal and hydraulic conditions to obtain the maximum advantage from this technique.

Activities: The proposed activity will include the collaboration in the experimental campaigns with the available test rig and in the related numerical simulation s for accurate benchmarking of unconventional 3D printed metal heat sink geometries. This will be carried out in both single phase and two phases flow regimes, in terms of heat transfer efficiency and pressure drop. From this point of view, the student will assist the data reduction of the acquired measurements and will learn to perform basic operations in multiphase heat transfer modelling of fluid flow with phase change. Upon acquisition of the required skills and successful completion of the assigned tasks, there will be the possibility to participate in the design of an optimized heat sink and its experimental test to validate the new manufactured geometry.

Tutors: Gabriele Sciacca (gabriele.sciacca@lnl.infn.it)

Juan Esposito (juan.esposito@lnl.infn.it)

Activity period: June-July 2022, otherwise September-October 2022

Local Secretariat: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:

The software tools Ansys, Solidworks, Matlab and Labview will be involved in the experience.

Publications and reports concerning the project:

• LARAMED: A Laboratory for Radioisotopes of Medical Interest

(https://doi.org/10.3390/molecules24010020)

• Cyclotron Produced Radionuclides: Principles and Practice (https://www-

pub.iaea.org/MTCD/publications/PDF/trs465_web.pdf)

LNL Summer closing period in August.

Free lunch at LNL Canteen.