# MyrrhaFoam: A CFD model for the study of the thermal hydraulic behavior of MYRRHA

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**ABSTRACT**

Numerical analysis of the thermohydraulic behavior of the innovative flexible fast spectrum research reactor, MYRRHA, under design by the Belgian Nuclear Research center (SCK•CEN) is a very challenging task. The primary coolant of the reactor is Lead Bismuth Eutectic, LBE, which is an opaque heavy liquid metal with low Prandtl number. The simulation tool needs to involve many complex physical phenomena to be able to predict accurately the flow and thermal field in the pool type reactor.

In the past few years, within the frame of a collaboration between SCK•CEN and the von Karman Institute, a new platform, MyrrhaFoam, was developed based on the open source simulation environment, OpenFOAM. The current tool can deal with incompressible buoyancy corrected steady/unsteady single phase flows. It takes into account conjugate heat transfer in the solid parts which is mandatory due to the expected high temperature gradients between the different parts of the reactor. The temperature dependent properties of LBE are also considered. MyrrhaFoam is supplemented with the most relevant thermal turbulence models for low Prandtl number liquids up to date.

**KEYWORDS**
computational fluid dynamics, heat transfer, , liquid metals, fast reactors

## 1. INTRODUCTION

The Belgian Nuclear Research Centre is working since several years on the design of MYRRHA, a flexible fast spectrum nuclear reactor. This is a global first demonstration project for a new type of reactor, piloted by a particle accelerator – ADS. The thermal hydraulics of nuclear applications imposes huge challenges to numerical solvers due to the wide range of scales and physics involved in such flows. Industrial approaches are necessary to support the design phase of new nuclear reactors and to analyze already existing ones. This work shows the numerical development of a simulation environment that can handle all the relevant physical aspects from thermal hydraulic point of view.

During the design phase of the MYRRHA reactor, the geometry is constantly evolving. The current study is based on version 1.4. A picture of the reactor and the relevant physical aspects is proposed in Figure 1. The numerical simulation aims to resolve the primary coolant flow and heat transfer. Conjugate heat transfer plays a significant role due to the high gradients, so its effect is considered, as well. The primary

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