Post doc position on CFD at CEA/University Paris-Saclay

Analysis of turbulent, forced and mixed convection flow in experimental facilities related to sodium cooled nuclear reactors

<u>Context:</u> The CEA is designing the 4th generation sodium cooled fast breeder reactor "ASTRID". Current activities on the use of CFD in the ASTRID project are focused on the validation of computational tools to predict the thermal-hydraulic behavior of sodium in the reactor vessel. As thermal-hydraulics is recognized a scientific key issue in the development of ASTRID, new experiments in water are realized for both qualification of design options and validation of code calculations. A deep analysis of selected experiments with CFD is subject of the post-doc position.

<u>Objective</u>: The proposed position is primarily focused on the analysis of the MICAS and MILIPOSO experiments. A schematic representation of the ASTRID reactor vessel including the main flow patterns is given on the left side of Fig.1. The main reactor components are shown in a plane cut vertically trough the reactor vessel. The MICAS facility represents the hot pool of ASTRID in a 1:5 scale, while the MILIPOSO facility represents the diagrid (the inlet plenum of the core) on a 1:6 scale. A vertical cut through the MICAS facility is given on the right side showing a tetrahedral meshing of 22 million elements. Solid walls are marked in red and typical boundary conditions are added.

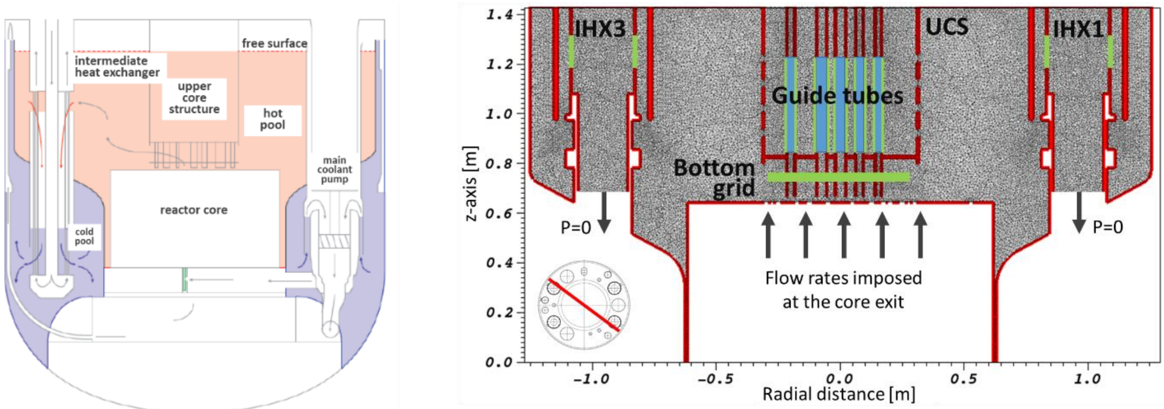

Fig.1: View of the ASTRID vessel (left) and of the MICAS facility (right)

The flow in the MICAS and MILIPOSO facilities will be analyzed with the CEA in-house code TrioCFD[1]. The use of HPC will allow access to flow features in complex geometrical structures with a high resolution in time and space. For MICAS, three key questions will be addressed in the post-doc project:

- Analysis of the flow field in the test facility for various experimental conditions and by using different turbulence modelling approaches. Recently developed dynamic mesh refinement strategies for LES will be use and improved where needed.

[1] http://www-trio-u.cea.fr/

- Analysis of the temperature field in the test facility by using two hypothesis to account for thermal effects: incompressible fluid with the Boussinesq hypothesis and low Mach number, dilatable fluid.
- Analysis of the possible entrainment of gas from the free surface into the intermediate heat exchangers (IHX). New methods to detect surface swirls will be developed.

The validation of the modelling approaches for the three key issues will be done by comparing calculation results to high quality measurements of velocity, temperature and gas entrainment swirls.

Work on MILIPOSO will be focused on the prediction of nominal and dissymmetric flow regimes (when one the reactor's three pumps is stopped): in both cases, pressure and velocity fields will be validated against experimental results.

TrioCFD: TrioCFD is the CFD reference code of the *Nuclear Energy Division* of CEA for unsteady, low Mach number, turbulent flows. The code, developed at CEA-Saclay, is especially designed for industrial CFD calculations on structured (parallelepipeds) and non-structured (tetrahedrons) grids of several hundreds of millions of elements. The object oriented, intrinsically parallel code structure is realized in C++. The user has the choice between various discretization methods and can combine several appropriate physical models including different methods to treat turbulence. The code is used on a daily basis for safety studies on massively parallel computers by using up to 10000 processor cores.

Location, Duration and Skills: The position is located in the south of Paris at CEA-Saclay. As this program is a collaboration between two CEA centers (Saclay and Cadarache), several missions to Aix-en-Provence are mandatory. A two week stay is planned to assist in an experimental campaign. The position is proposed for one year, possibly extended one additional year, depending on the progress of the project. The applicant should have consolidated knowledge in CFD, a PhD in this domain is mandatory. Good knowledge of LES and mastering the complete simulation chain (CAD-modelling, meshing, CFD-calculation and post-processing) will be appreciated. Coding experiences is a plus but not mandatory.

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