NRG is looking for an BSc/MSc thesis/internship student for:

Direct numerical simulation of two-phase flows in nuclear reactors

Background

The Nuclear Research and Consultancy Group (NRG) is responsible for a continued nuclear research effort in the Netherlands. A significant part of that effort is dedicated to thermal-hydraulic analysis of nuclear reactors during accident scenarios, to improve safety. Many postulated accident scenarios will exhibit two-phase flows, such as bubbles formed in a reactor core or steam flow in the hot leg of the reactor vessel. A proper understanding of such two-phase flows is thus important

In this MSc. thesis assignment, we will perform Direct Numerical Simulation (DNS) of two-phase flows relevant to nuclear reactors. DNS solves the governing fluid equations, that are derived from first principles, directly, without the need for additional models. As such, DNS is computationally expensive. Thus, suitable two-phase DNS codes that are tailored to the peculiarities of the flow problem at hand must be developed. While NRG has used DNS for two-phase flows extensively in the past, a re-evaluation must be made of the currently used codes, as well as an identification of possible other suitable codes.

First, the project will start with such an identification, and a documentation of certain key properties of the codes, such as the numerical schemes and discretizations used, the adopted two-phase advection method (e.g., algebraic or geometric), parallel performance, the suitability of the code to run on GPUs, etc. Second, the most promising code will be selected, and tested in single-phase benchmark problems such as lid-driven cavity flow and turbulent channel flow, and in two-phase benchmark problems such as simple advection of a bubble or a rising bubble case. Third, the selected code will be applied to the simulation of turbulent co-current Taylor bubble flow (see picture below), of which NRG has recently generated reference data using the Basilisk code.

The project location will be at NRG's site in Petten, the Netherlands. NRG offers a monthly allowance, as well as compensation for housing and transportation for the period of your stay.

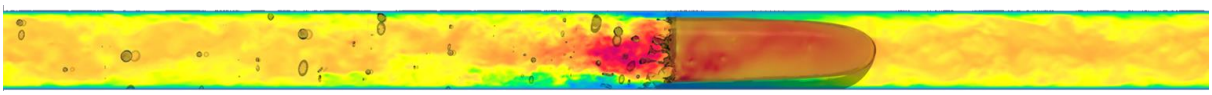

Fig. 1: Snapshot of a DNS of turbulent co-current Taylor bubble flow, in Basilisk.

Objectives/Results

- Selection of a suitable two-phase DNS code
- Development of single-phase and two-phase benchmark cases with the selected DNS code
- Systematic assessment of the performance of the selected DNS code
- Simulation of turbulent co-current Taylor bubble flow

Your profile

- MSc. student in applied science, with specialization in CFD
- Good knowledge of turbulence, multiphase flows and numerical methods

- Required computer experience: Linux and Python
- Recommended computer experience: Fortran, C and C++
- Fluency in written and spoken English
- Good analytical and problem solving skills
- Dedicated, good communication and social skills, independent

Our offer

- A challenging thesis project with a scientific scope, to be executed within a successful team with an informal atmosphere and an excellent reputation
- Strong support from enthusiastic members of the team
- Monthly allowance/stipend
- Housing and transportation compensation for the period of stay

Contact details

NRG
Dr.ir. Edo Frederix
frederix@nrg.eu