Workshop

Code Coupling for Multi-Physics and Multi-Scale Simulations in Nuclear Equipment

Organization: Joris Degroote, Henri Dolfen (Ghent University), Angel Papukchiev (Gesellschaft für Anlagen- und Reaktorsicherheit)

Using simulations in the design and licensing of nuclear reactors often requires that these simulations take into account different physical disciplines simultaneously. At the same time, validation of the software tools is of crucial importance, so it is beneficial to couple mature software tools for these multi-physics simulations, rather than developing a new tool. In addition, designers need to investigate a large number of cases, so the run time of the simulations has to be acceptable. Multi-scale simulations can help to reduce the computational time by only having a detailed model of the region of interest and coupling it with simplified models of the rest of the system to have accurate boundary conditions for the detailed model.

In this workshop you will learn about the issues that can be encountered when coupling codes for multi-physics simulations, with a focus on fluid-structure interaction (FSI). Instabilities in the coupling will be explained and it will be shown how they can be remedied. You will couple a flow simulation with a structural simulation for the propagation of a pressure wave in an elastic pipe using the Python code CoCoNuT. You will also learn how you can obtain a multi-scale simulation by coupling a computational fluid dynamics (CFD) model for a region with complex flow with a fast model for the rest of the installation, such as a fast mechanical model, a lumped model or a system thermal-hydraulics (STH) code.

Preliminary program

09:00 Lecture 1: Definition of coupled problems, stability analysis of iterative methods (Joris Degroote)
09:45 Coffee break
10:00 Lecture 2: Coupling of CFD codes with structural mechanics and STH programs for nuclear reactor safety applications (Angel Papukchiev)
10:45 Coffee break
11:00 Lecture 3: Partitioned fluid-structure interaction simulation (Joris Degroote)
11:45 Lunch break

13:00 Exercise 1: Stability analysis of Gauss-Seidel iterations for flow in a flexible pipe (Henri Dolfen)

13:45 Coffee break

14:00 Exercise 2: Implementation of quasi-Newton coupling (Henri Dolfen)

14:45 Coffee break

15:00 Exercise 3: Accelerating the coupling with reuse from previous time steps (Henri Dolfen)