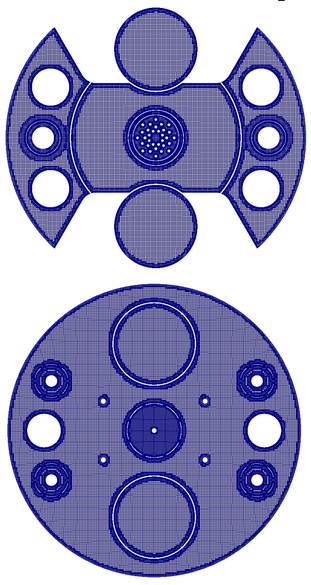
# Numerical Characterization of the Flow Field in a Water Model of Liquid Metal-Cooled Nuclear Reactor

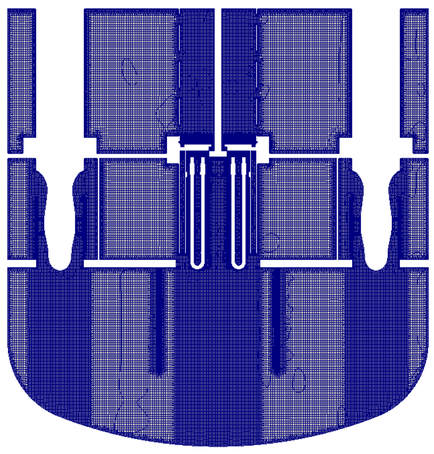
*G. Alessi, S. Buckingham, P. Planquart, L. Koloszar, S. Lopes, A. Villa-Ortiz, C. Spaccapanicca, K. Van Tichelen*

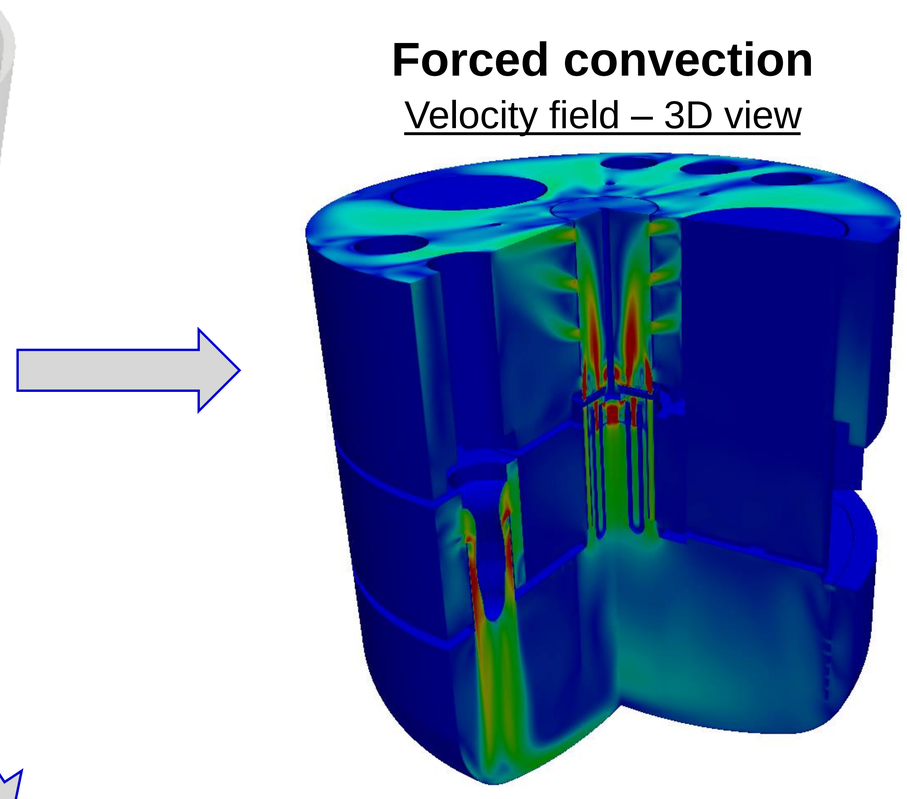
The thermal-hydraulics challenges in a nuclear reactor are numerous and mastering these is crucial for the design and safety of new reactor types. A reliable CFD solver can address a lot of the questions that arise in the nuclear reactor design, including the quest for the mitigation of accident scenarios. For this purpose, a water model of the pool-type PbBi-cooled MYRRHA reactor has been developed at the von Karman Institute in collaboration with SCK•CEN, that besides allowing an insight to the behavior of the reactor in different operational and accidental scenarios, also provides validation data for the numerical developments.

## Computational mesh



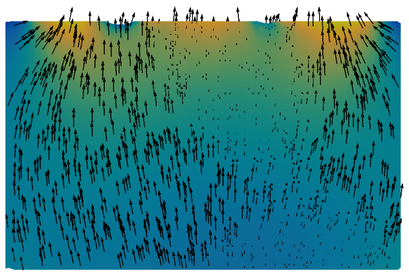
- 24 millions of cells
- 216 processors on the Genius cluster



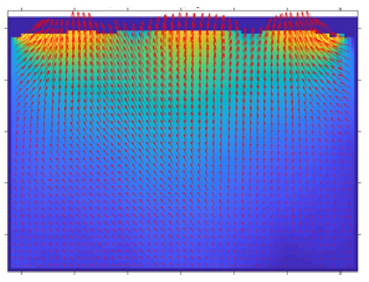


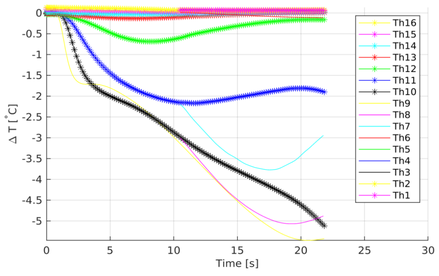
## Validation of the flow field

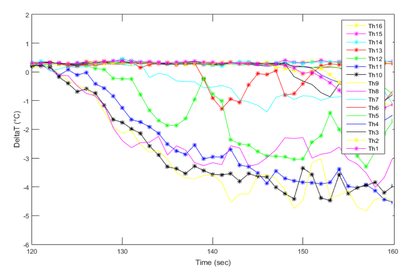
CFD



Experiment



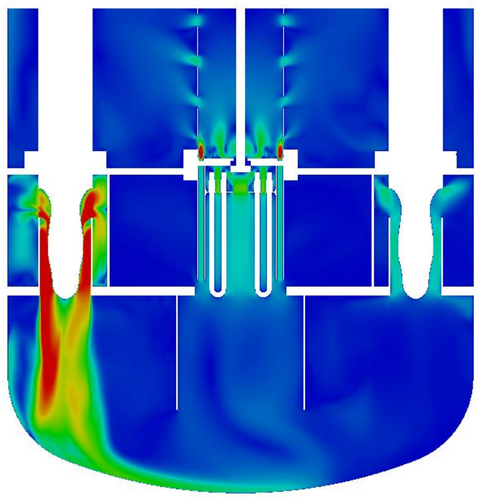


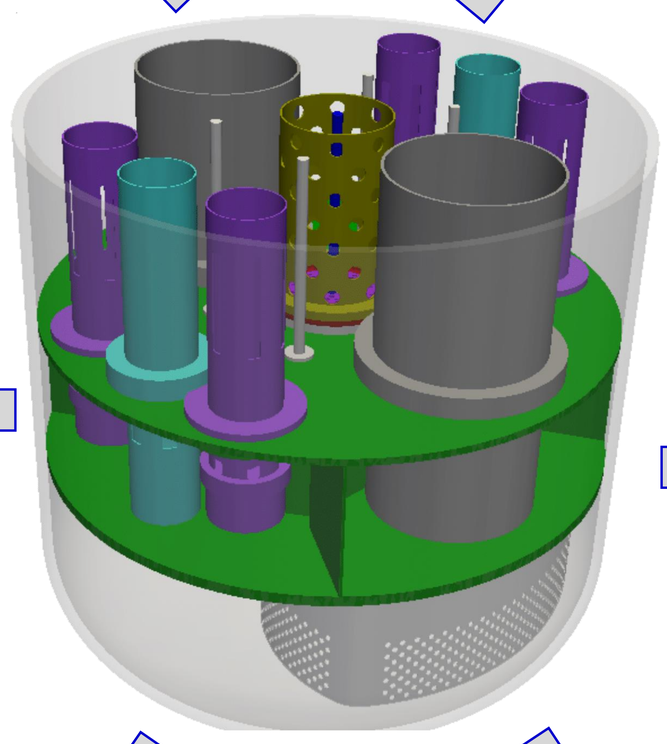




Validation of the numerical results is an essential requisite to asses the reliability of the code developed. Validation against pressure and thermocouple sensors and PIV visualization is performed.

## Accident scenario One Pump Failure

Velocity field





The failure of a pump would modify the operational condition of the reactor, changing the thermal-hydraulics flow behavior. The working pump increases its load in an attempt to compensate the failed pump.

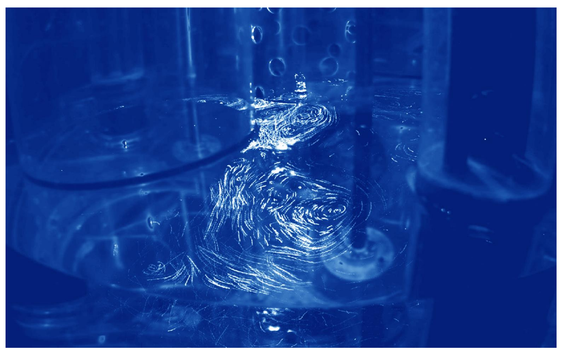
## Forced convection

Velocity field – 3D view

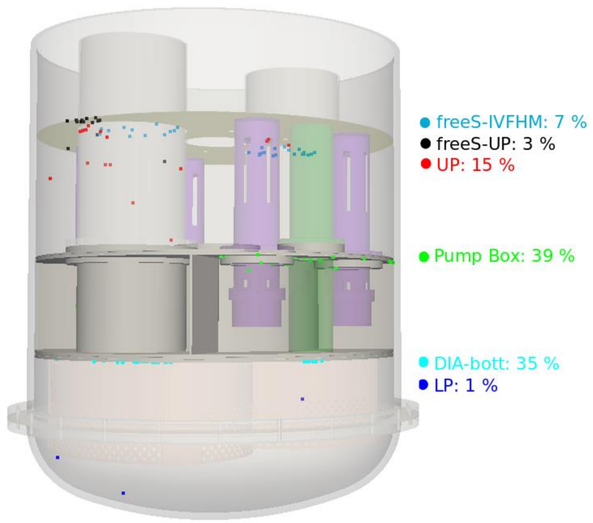


## Accident scenario Particle Dispersion

Experiment



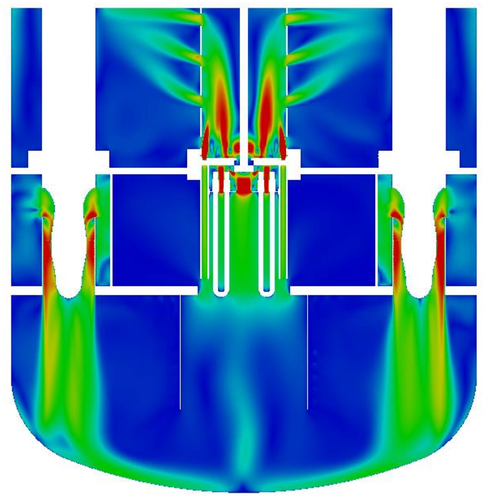
CFD



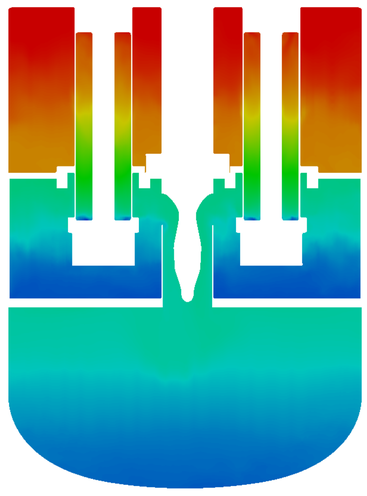

The dispersion of solid particles could represent a threat since most of the reactor's mechanical components are designed to operate in single-phase flow regime. In case of the unlikely event of a pin failure, fuel products would be directly released into the coolant. Among the threats are progressing core damage, criticality effects related to fuel accumulation and coolability effects due to blockage and local heat flux increase.

## Forced and natural convection

Velocity field forced convection



Temperature field natural convection



The analysis in forced circulation condition aims to study the thermal-hydraulics flow characteristics during the nominal operating condition of the reactor. The natural convection study arise when the pumps are off to facilitate the system maintenance or in accidental conditions. Flow stratification appears in the plenum, introducing thermal stress to the reactor components. This needs to be accounted for in the design.

SCK•CEN

von Karman Institute for Fluid Dynamics