# Multi-model coupling in fast dynamics with Fluid-Structure Interaction for complex flows calculated by a Finite-Volume approach

Journée des Doctorants 2019

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# Topic Introduction

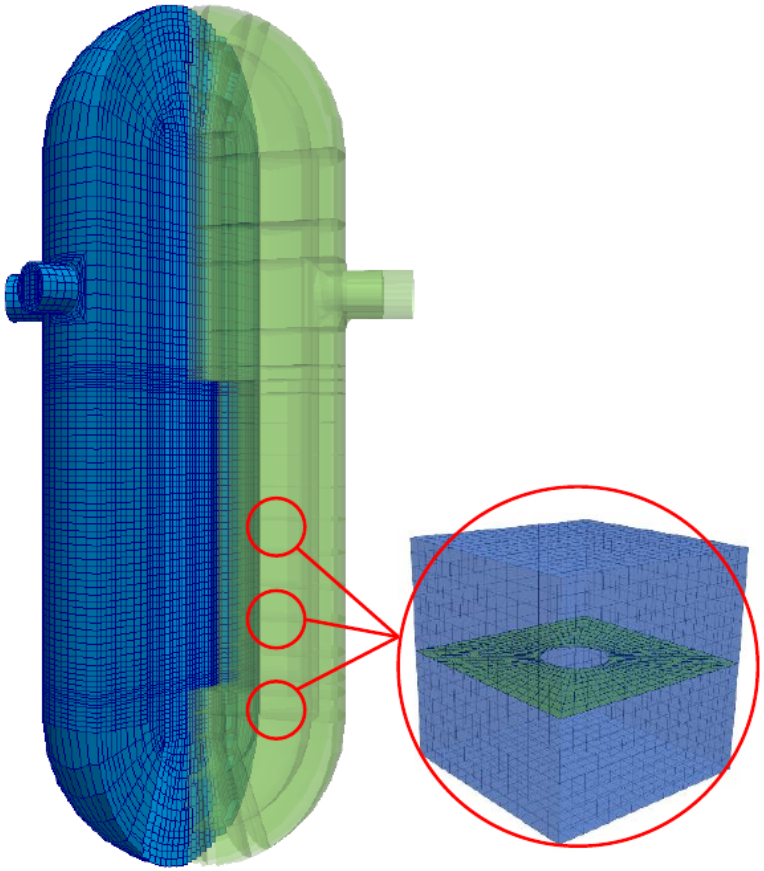


FIGURE – Modeling of a reactor core with a geometrical multi-scale approach.

## Industrial Context

- Loss of Primary Coolant Accident (LOCA) in Pressurized Water Reactor(PWR) :
  - Distribution of shock waves,
  - Two-phase phenomena close to the leak,
- Optimisation of calculation times by adding local geometric details in a non-intrusive way (adding a perforation of the wall),
- Expansion of the approach to other situations of multi-component flows with fluid-structure interaction.

# Topic Introduction

## Technical and scientific context

- Finite Volume Multi-model approach
- Multi-Component model → Two-phase model
- Fluid Structure Interaction

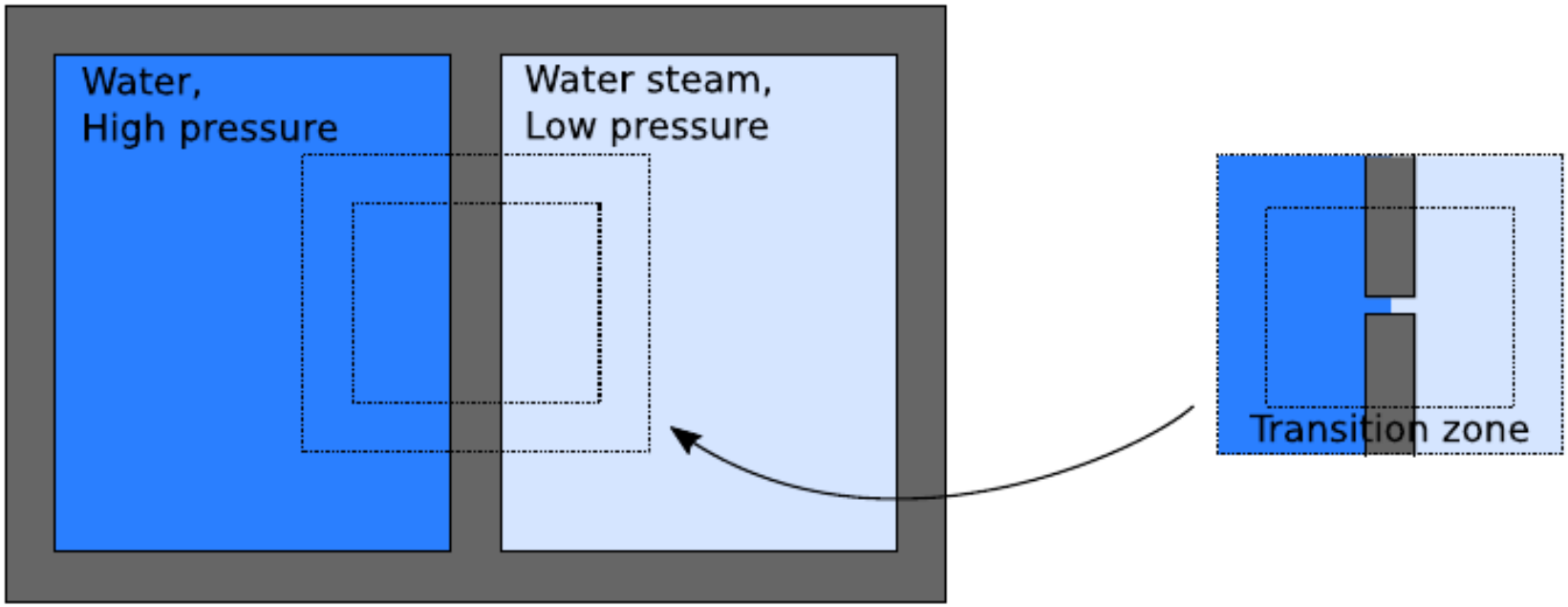
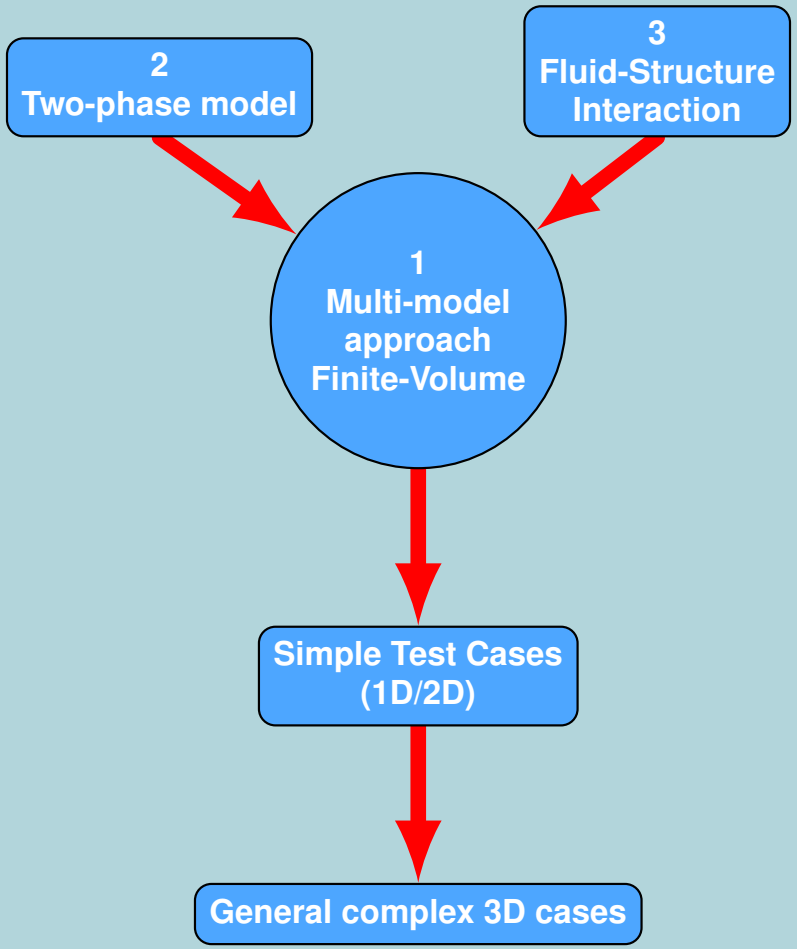



FIGURE – Case of a two-scale model.

# Topic Introduction

## Technical and scientific context



# Progress of the thesis

## Initial State

Alexandre Fernier's thesis on multi-model coupling in finite elements,
Mefisto : A c++ modular code using finite volumes or finite elements (FV in our case).

## Major Stages

- Multi-model coupling : communication between meshes by the chimera method (ghost cells), $\rightarrow$ ☑
- Test on a 1D Sod Shock Tube, $\rightarrow$ ☑
- Multi-component $\rightarrow$ Multiphase Implementation, (In progress)
- Test on a 1D Two-phase Shock Tube,
- Extension to 2D/3D case with geometric mesh intersection and neighbor detection,
- Fluid-structure interaction with immersed boundaries.

# First Results

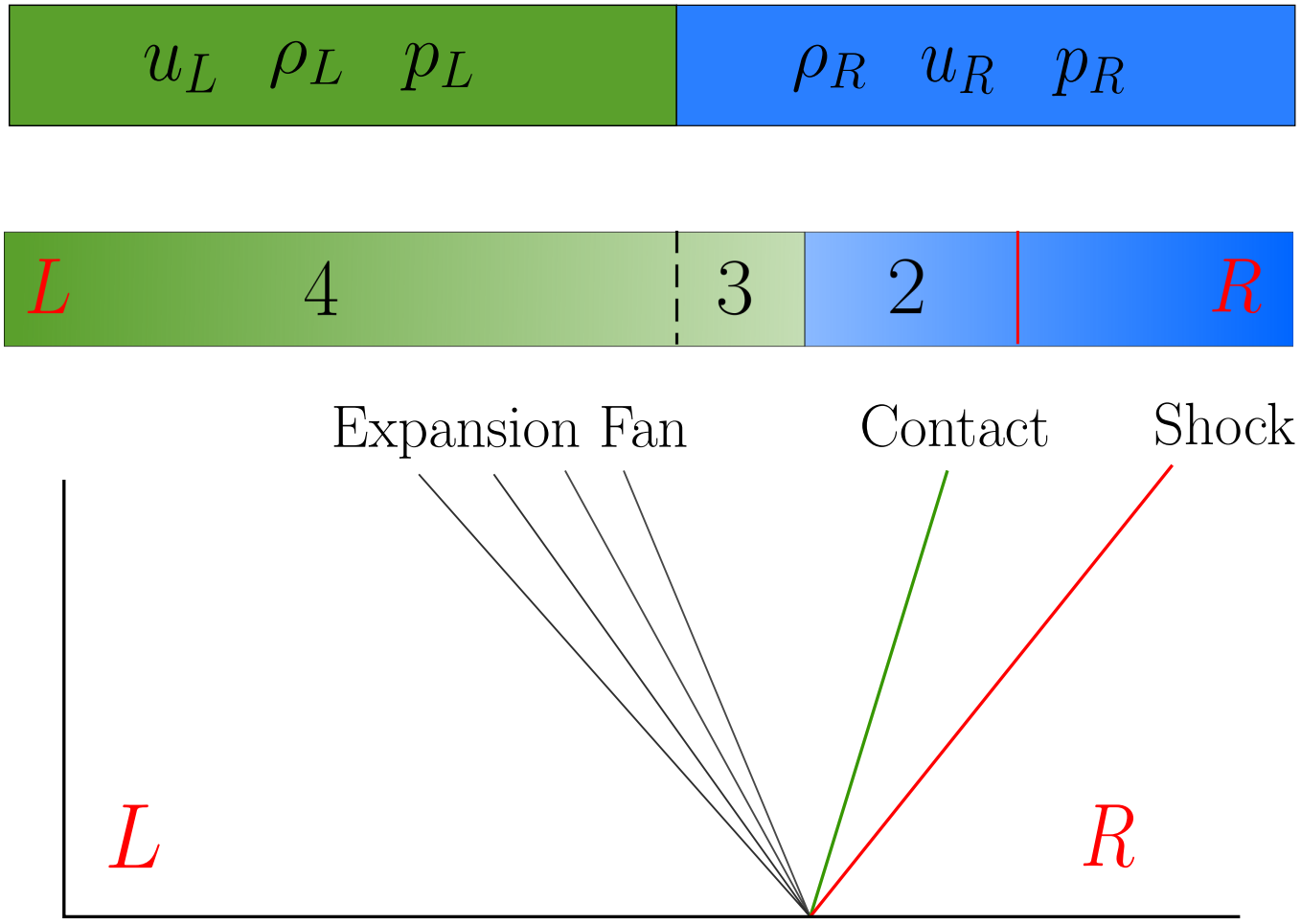



FIGURE – Sod Shock Tube case presentation.

# First Results

## Overlapped Sod Shock Tube

First Results of the Sod Shock Tube using 300 cells. The mesh is splitted in two parts (1/3 and 2/3).

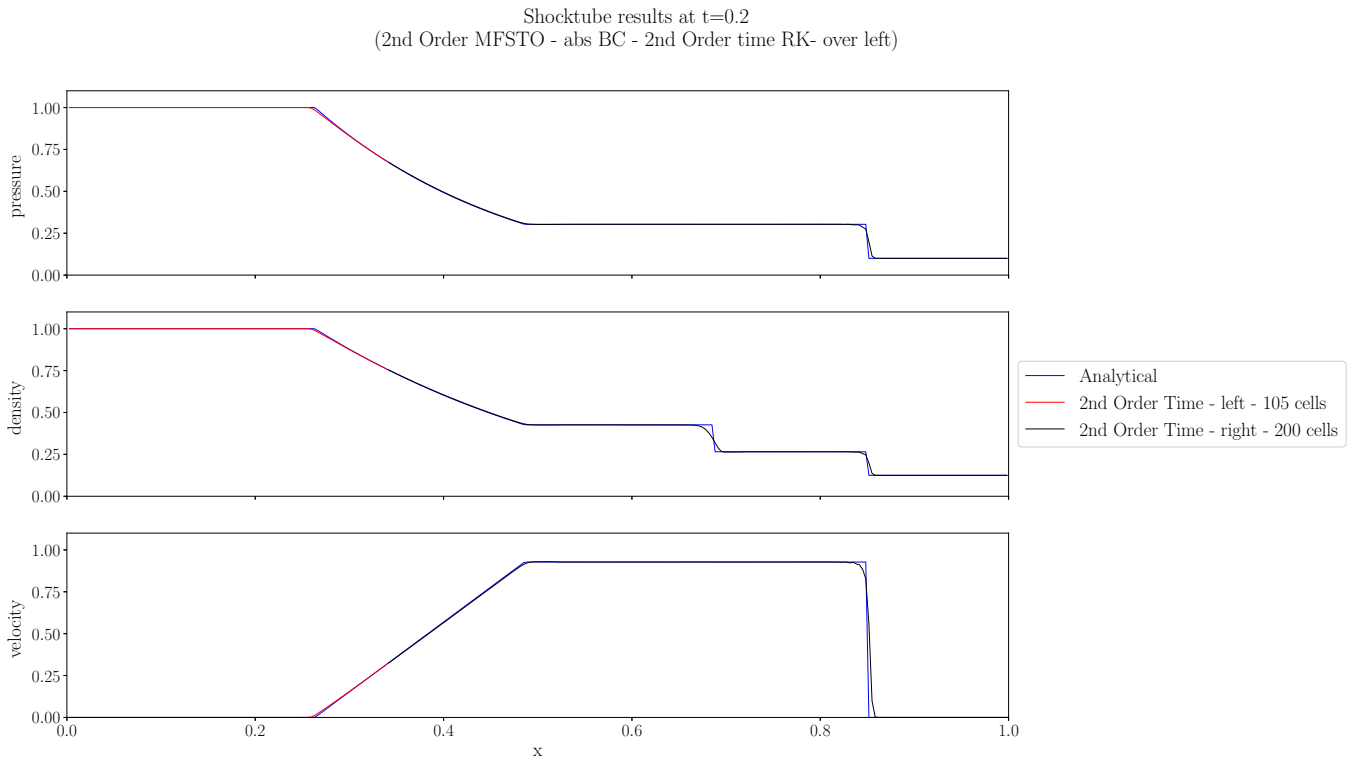



FIGURE – Sod Shock Tube Result using a 2nd Order Runge-Kutta scheme at $t = 0.2$, communication zone on the left-hand side of the mesh. 300 cells.

# Main References


- Book - Toro and Eleuterio (2009) *Riemann Solvers and Numerical Methods for Fluid Dynamics,*
- Thesis - Fernier (2019) *Couplage Multi-echelle pour l'Interaction Fluide Structure en Dynamique Rapide,*
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- Article - Enander and Sjogreen (1993) *Conservative and Non-Conservative Interpolation between Overlaping grids for Finite Volume Solutions of Hyperbolic Problems,*
- Article - Wang (1995) *A Fully Conservative Interface Algorithm for Overlapped Grids*
- Article - Drikakis and Majewski (2001) *Investigation of Blending Function Based Overlapping Grid Technique for Compressible Flows,*
- Article - Wang and Currao (2017) *An Immersed Boundary Method for Fluid-Structure Interaction with Compressible Multiphase Flows*