

Moving Solids Every Way in Multiphase Flows with NEPTUNE_CFD

W. Benguigui & J. Laviéville

May 7th, 2019 -- Salome_CFD User Day

SOMMAIRE

1.

Toward any motion,

Method & User functions

2.

Applications in Energy Fields

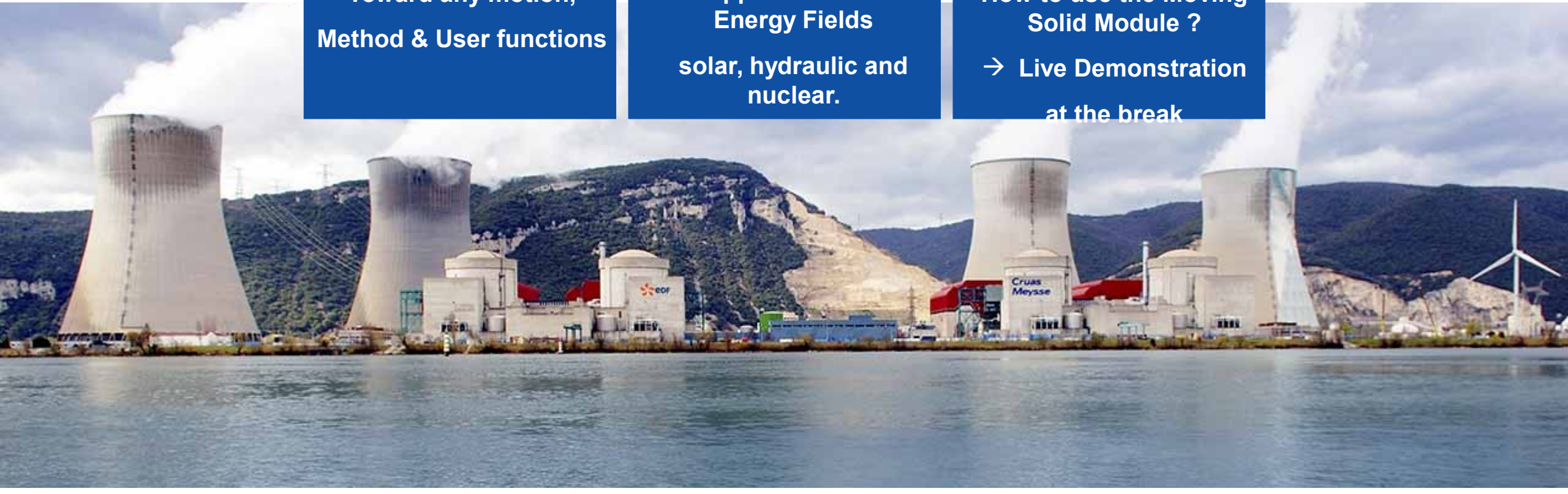
solar, hydraulic and nuclear.

3.

How to use the Moving Solid Module ?

→ Live Demonstration

at the break



I. Toward any motion, Method and User Functions

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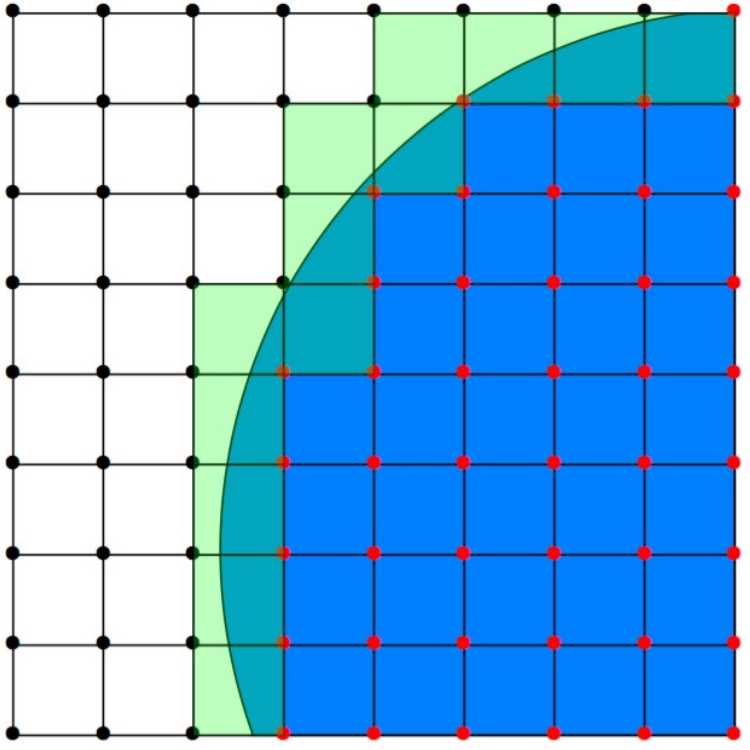
Idea: structures not explicitly meshed but defined thanks to a time-space dependent porosity.

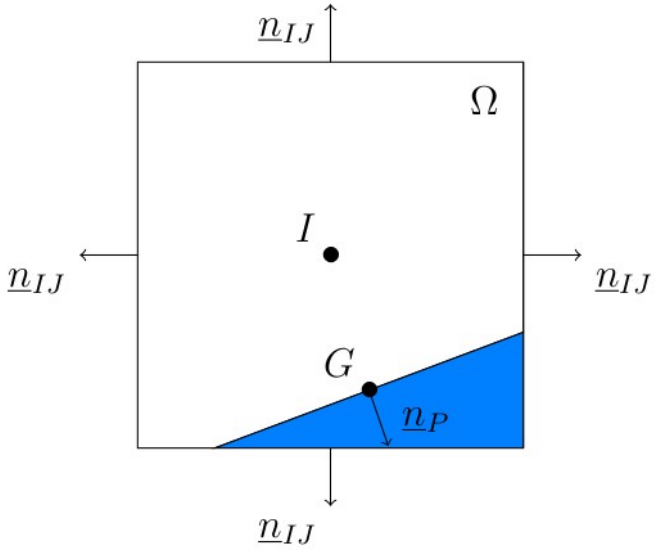
$$\sum_{k=1}^{N} \alpha_k = \varepsilon(\vec{x}, t)$$

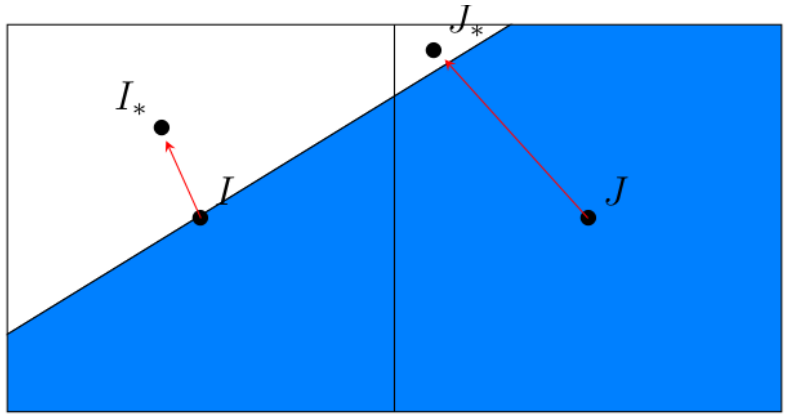


Cell treatments depending on the solid position

I. Toward any motion, Method & User Functions

- Geometric reconstruction of the wall





- Reconstruction of the wall

$$\sum_{J \in V_I} \varepsilon_{IJ} \mu_{IJ} \frac{\mathbf{U}_J - \mathbf{U}_I}{IJ} \mid\mid \mathbf{n}_{IJ} \mid\mid + \mu_I \frac{\mathbf{U}_P - \mathbf{U}_I}{IG} \mid\mid \mathbf{n}_P \mid\mid .$$

I. Toward any motion, Method & User Functions

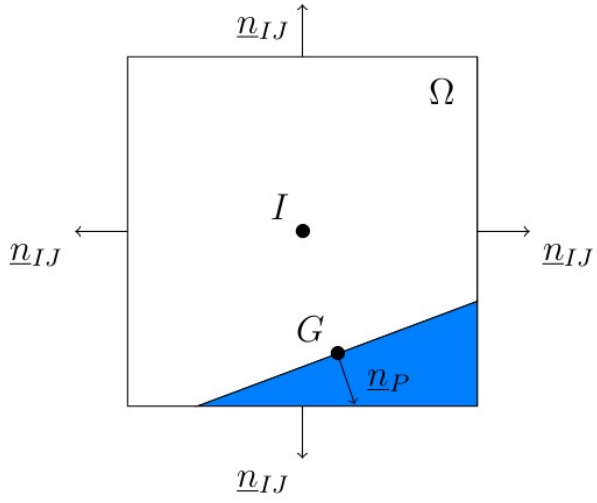
Fluid force computation

Contribution: pressure, friction, gravity

Example with pressure

$$P_G = P_I + \vec{IG}.\vec{\nabla}P_I$$

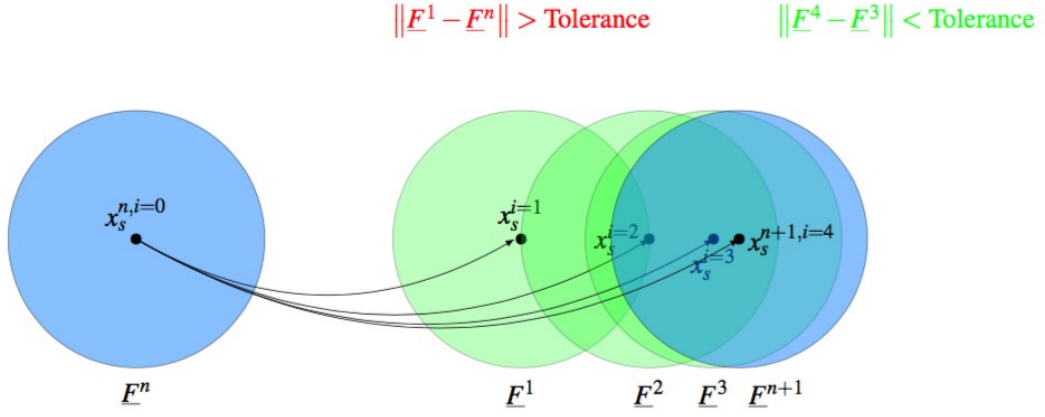
$$\vec{F}_{pressure} = \int_{\Omega} P_G \, d\vec{S}$$



Displacement computation

Newmark Algorithm: To determine the displacement of the solid depending on the fluid forces

Iterative algorithm: To correctly compute fluid forces and displacement by iterations.



I. Toward any motion, Method & User Functions

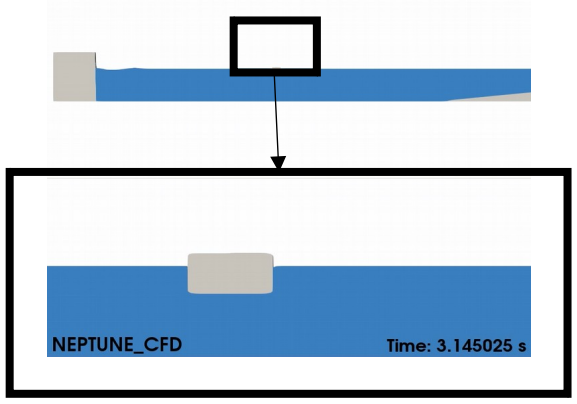
Time and Space Dependent Porosity

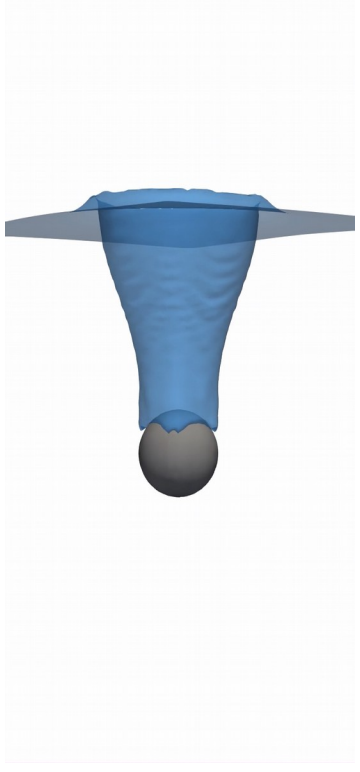
Single phase flow with NO MOTION	
Channel	Taylor-Green for IBM
Inclined Poiseuille	Couette-flow

Single phase flow with MOTION	
Cylinder with fluid velocity	Comparison to ALE
Constantly accelerated piston	Cylinder suddenly stopped

Two-phase flow with NO MOTION	
Flow around a square	**Bubble impact on a cylinder**
Dam break over an obstacle	

Two-phase flow with MOTION	
Cylinder with mixture velocity	Vane opening
Wave maker	Fall on a free surface





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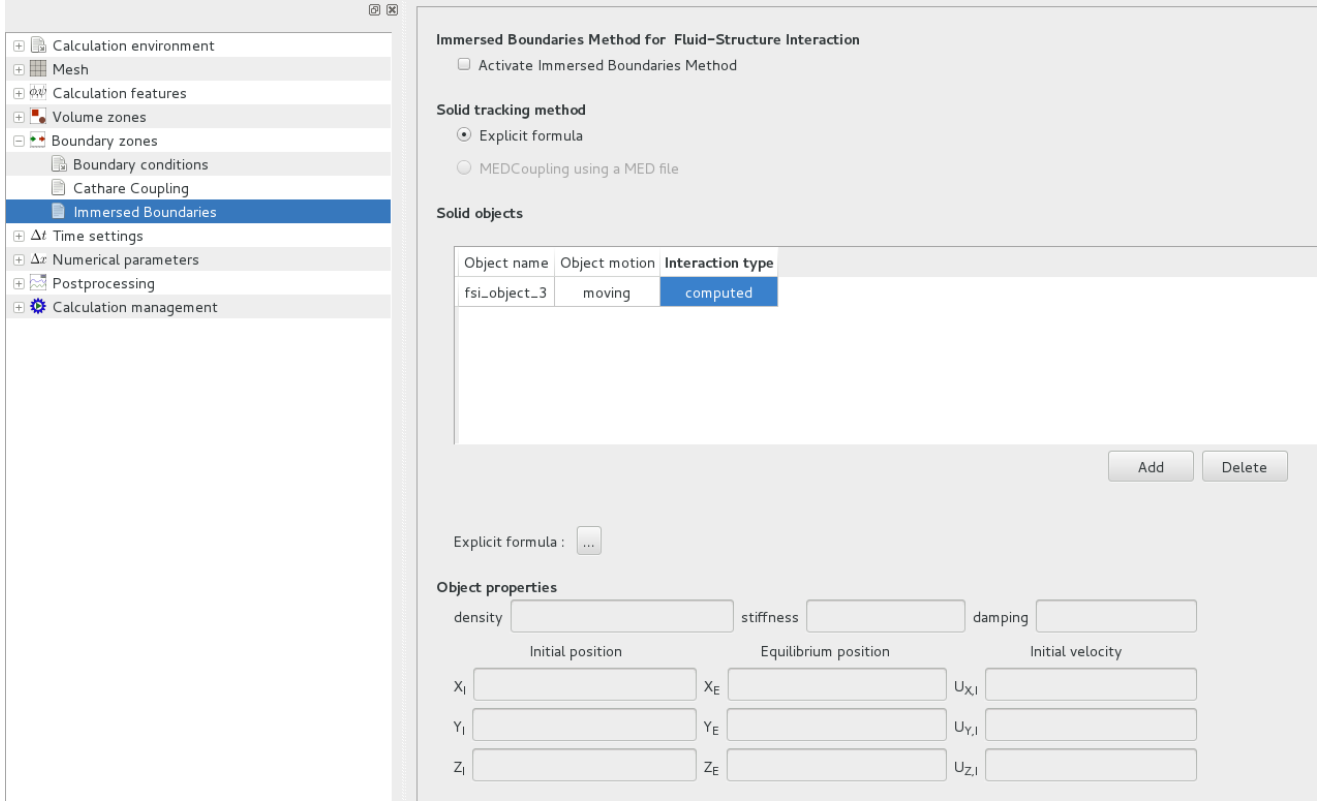


```
  /* Properties for each object */
  for (int i_ = 0; i_ < nc_fsi_object->number; i_++) {
    nc_fsi_object->density[i_] = 2145.;
    nc_fsi_object->stiffness[i_] = 5.93;
    nc_fsi_object->damping[i_] = 4.28e-4;
  }

  /* Eventually block some directions for the displacement -> 0: block and 1: free */
} else if (iappel == 1) {

  if (nc_poro_var->algo_choice == NC_VAR_PORO_ALGO_CUT_CELLS) {
    /* Example of solid position varying in time with a moving velocity */
    double ysol = 0.3 + 0.1 * t;

    if (0.25 * xyz[0] * xyz[0] + (xyz[1] - ysol) * (xyz[1] - ysol) < 0.03 * 0.03) {

      /* We are inside the solid: ipenal = 1 */
      *ipenal = 1;
    }
  }
} else if (iappel == 2) {
  /* The solid velocity is set to 0.02 in the X-direction */
  nc_poro_var->poros_velocity[iel_][0] = 0.02;
  nc_poro_var->poros_velocity[iel_][1] = 0.;
  nc_poro_var->poros_velocity[iel_][2] = 0.;

} else if (iappel == 3) {
  /* Solid internal porosity */
  nc_poro_var->solid_porosity[iel_] = 0.;
}

      nc_fsi_object->vel[i_][0] = 0.;
      nc_fsi_object->vel[i_][1] = 0.;
      nc_fsi_object->vel[i_][2] = 0.;

      /* Initial acceleration */
      nc_fsi_object->acc[i_][0] = 0.;
      nc_fsi_object->acc[i_][1] = 0.;
      nc_fsi_object->acc[i_][2] = 0.;
    }
```

II. Applications in energy fields: solar, hydraulic & nuclear

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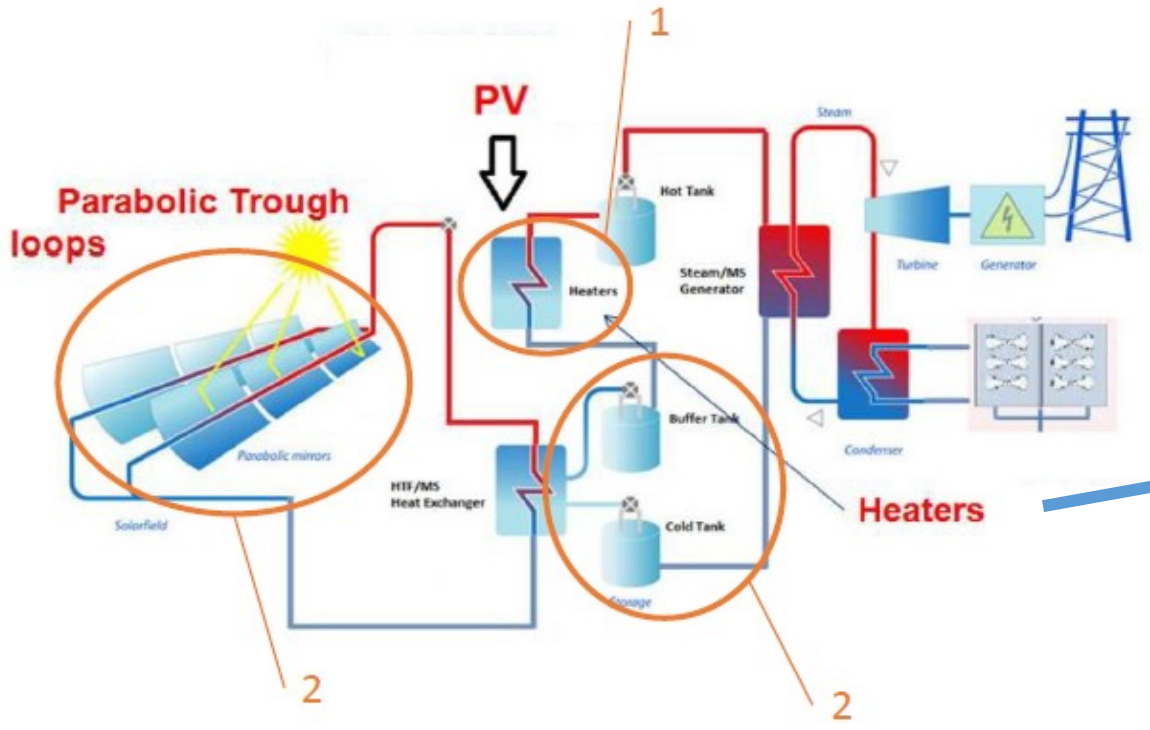
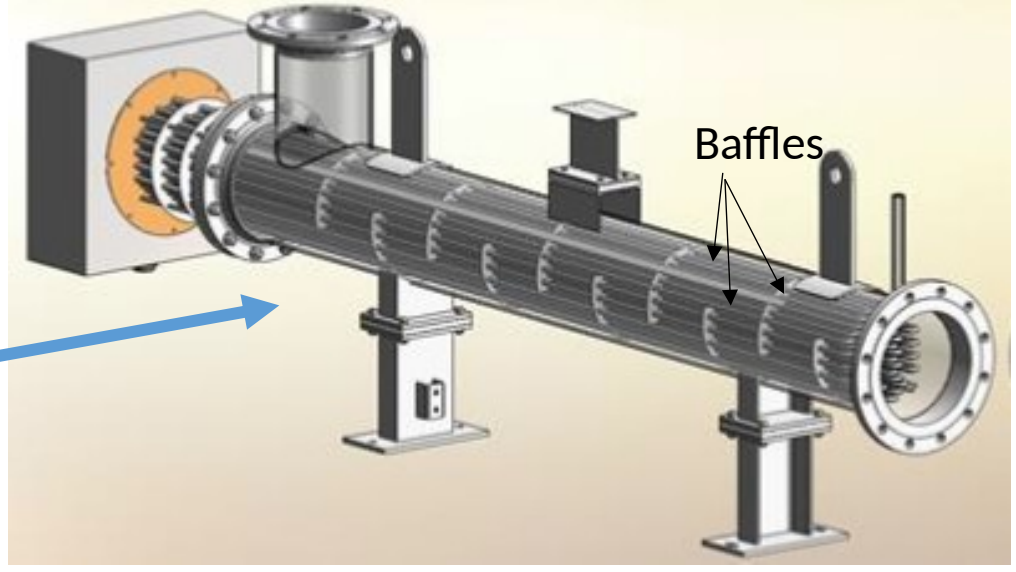
Design of a Heater for a Solar Plant





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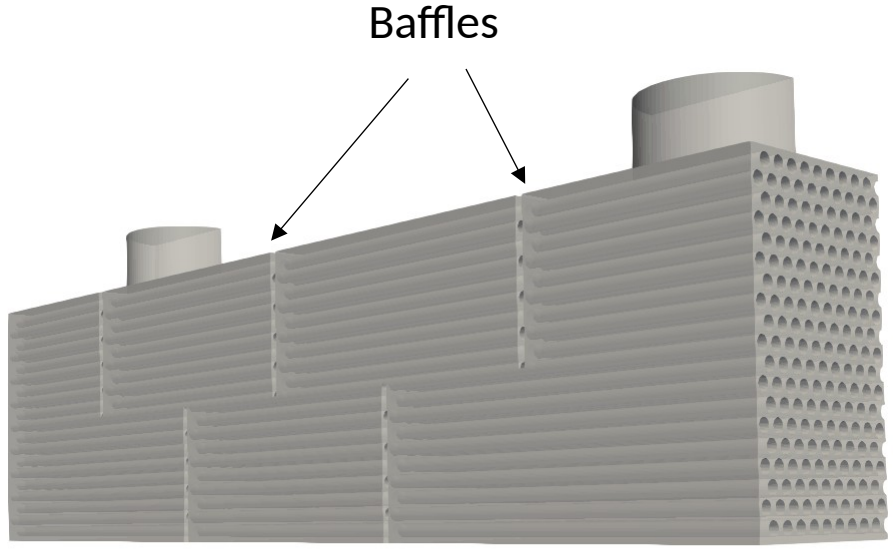
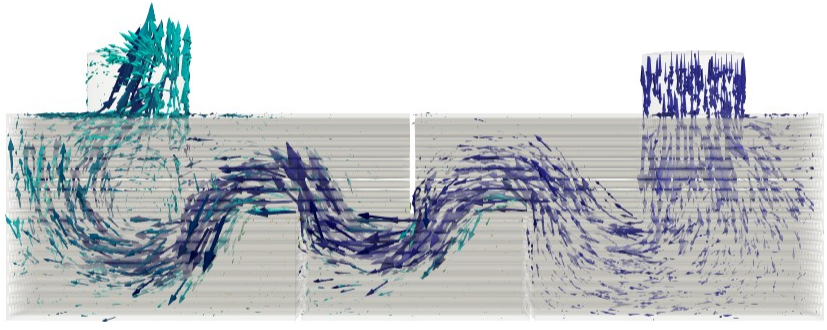
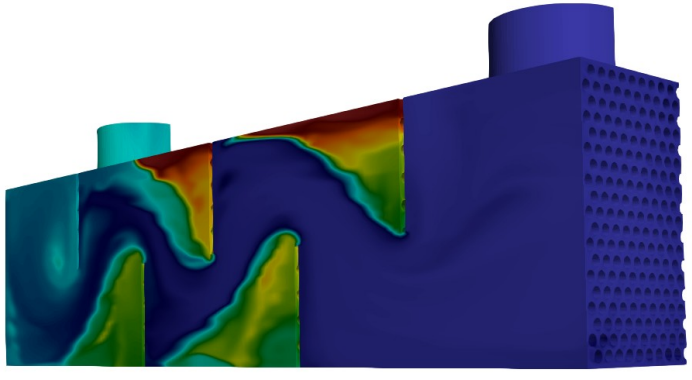


Simulation tools: Coupling between syrthes (heated tubes) and NEPTUNE_CFD (fluid and baffles with the method).

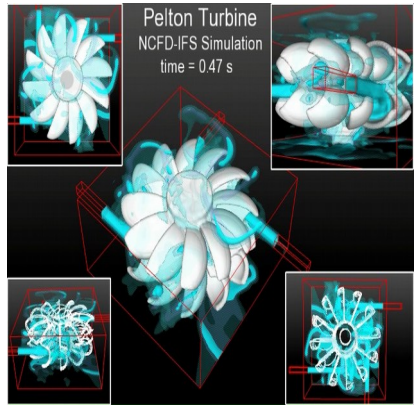
Objective: Design baffles to homogeneously heat up the fluid

Role of the method: Modify quickly the geometry with no re-meshing step



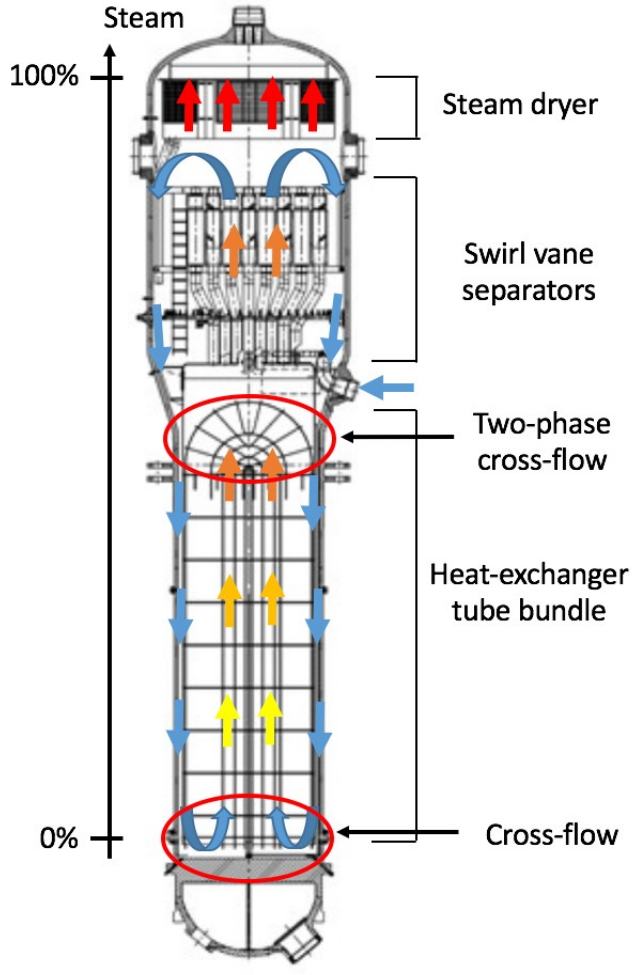


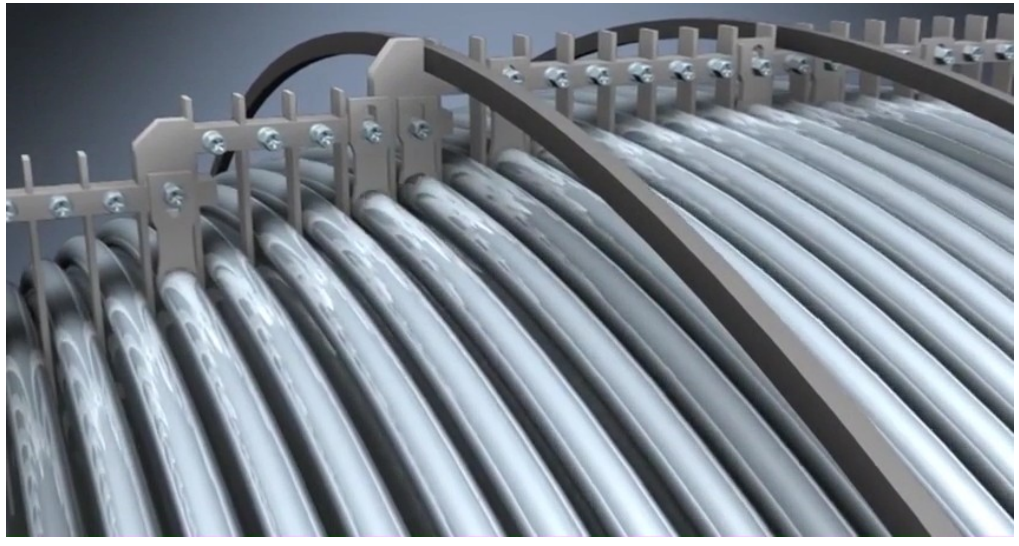
→ **To see how to design with the module, come at the Live Demo during the break !**



II. Applications in energy fields: solar, hydraulic & nuclear

Two-phase flow induced vibration in SG tube bundles.





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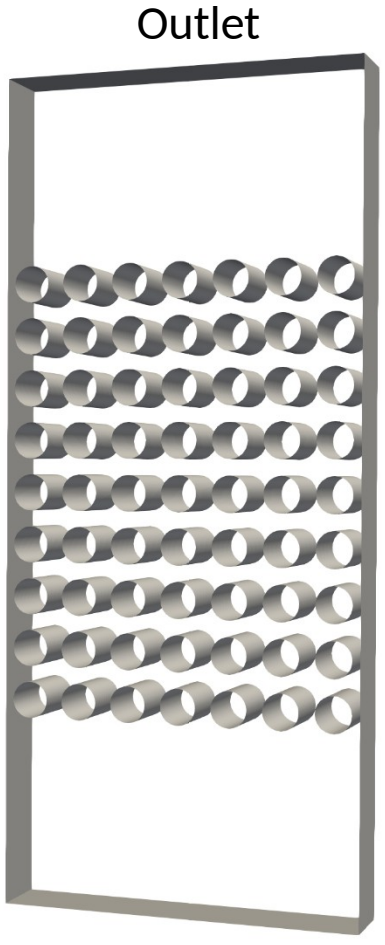
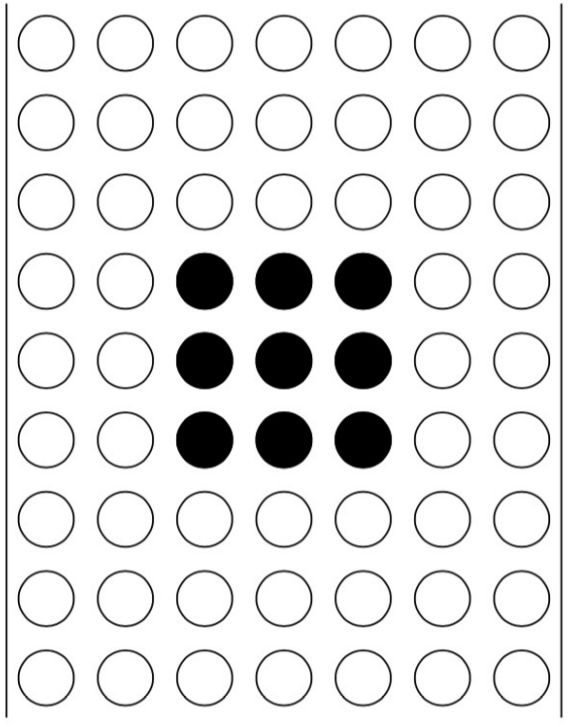
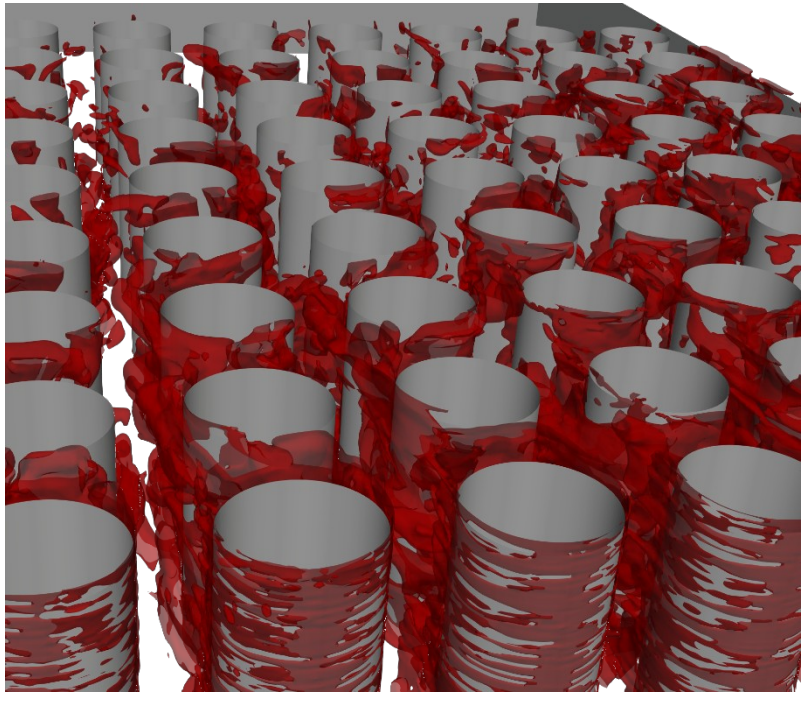




CFM, 85% inlet void fraction



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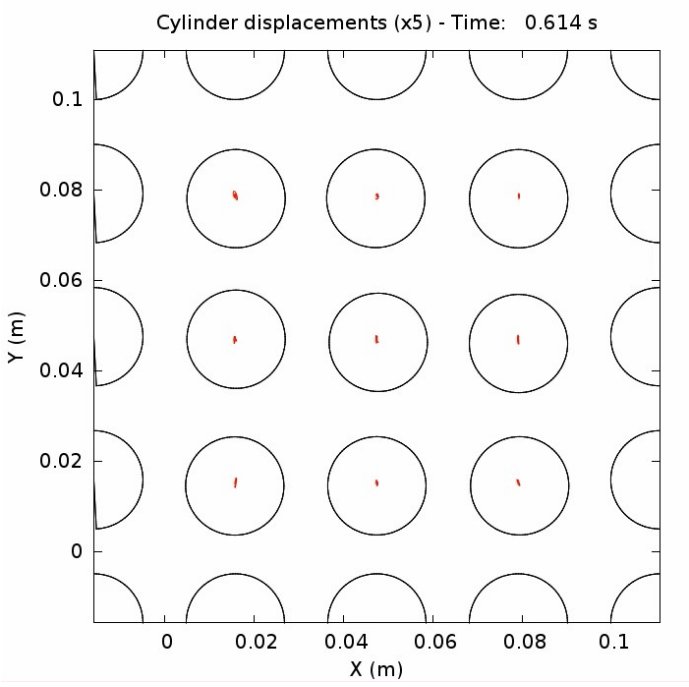
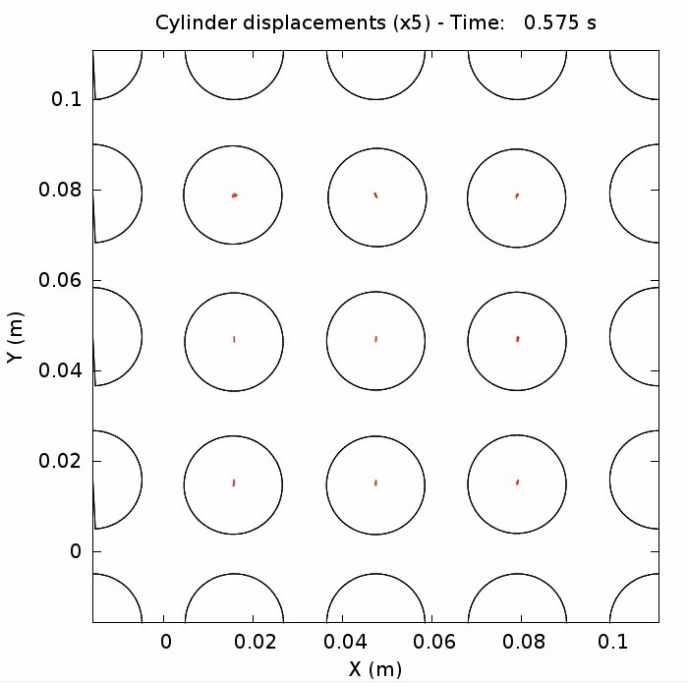
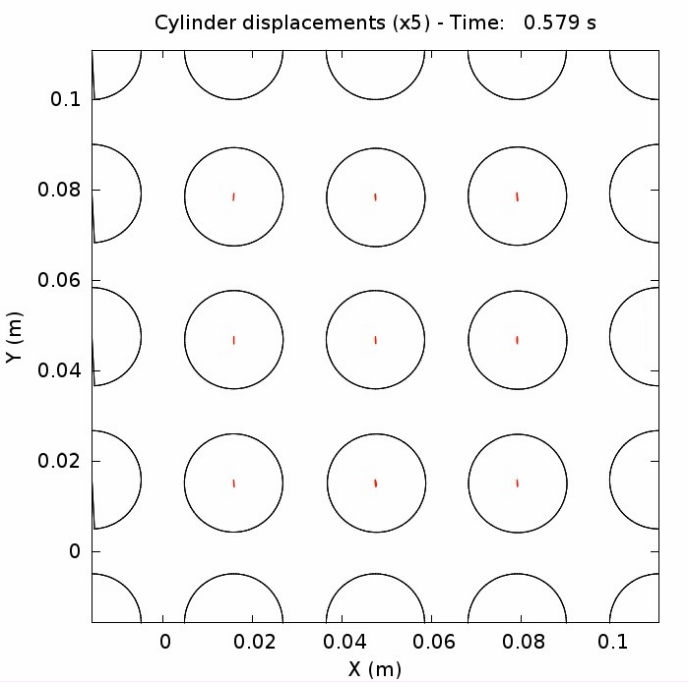


U_H = 1 m/s



U_H = 2 m/s



U_H = 3 m/s

CFM, 85% inlet void fraction

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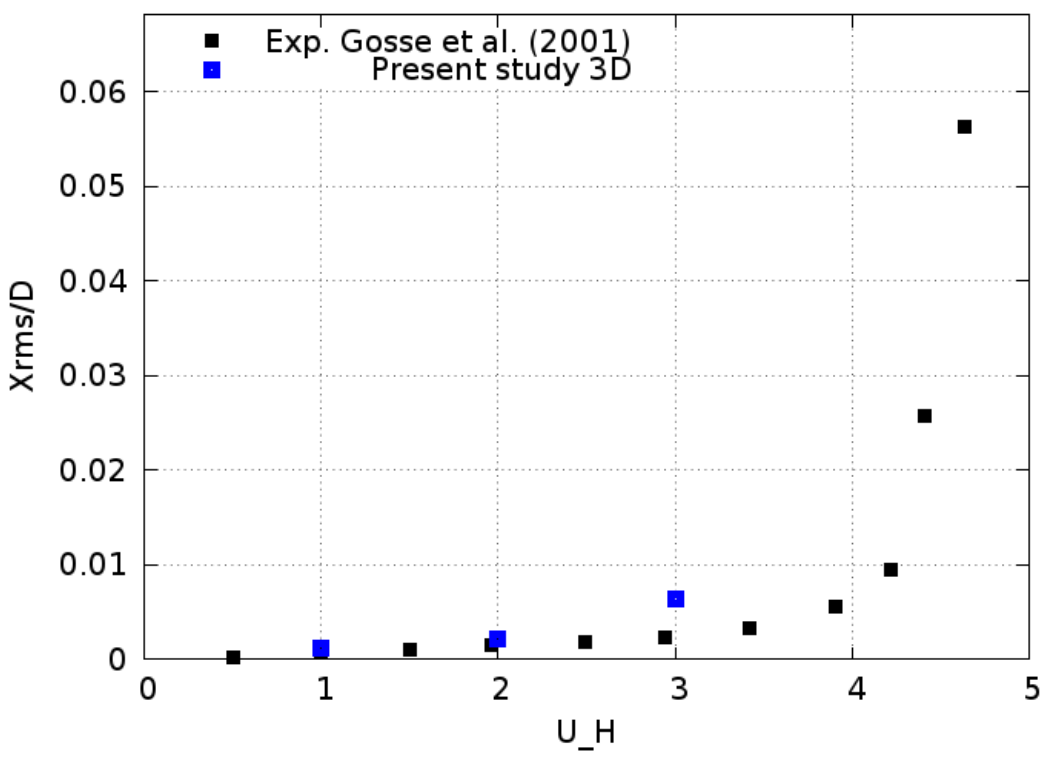
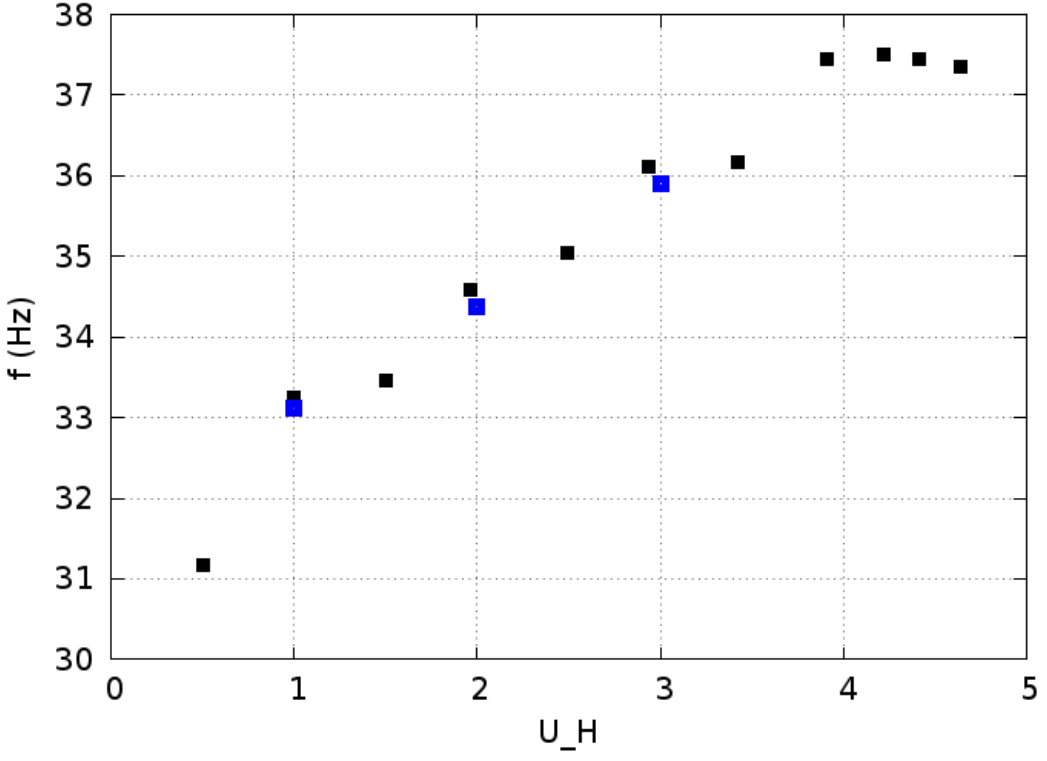
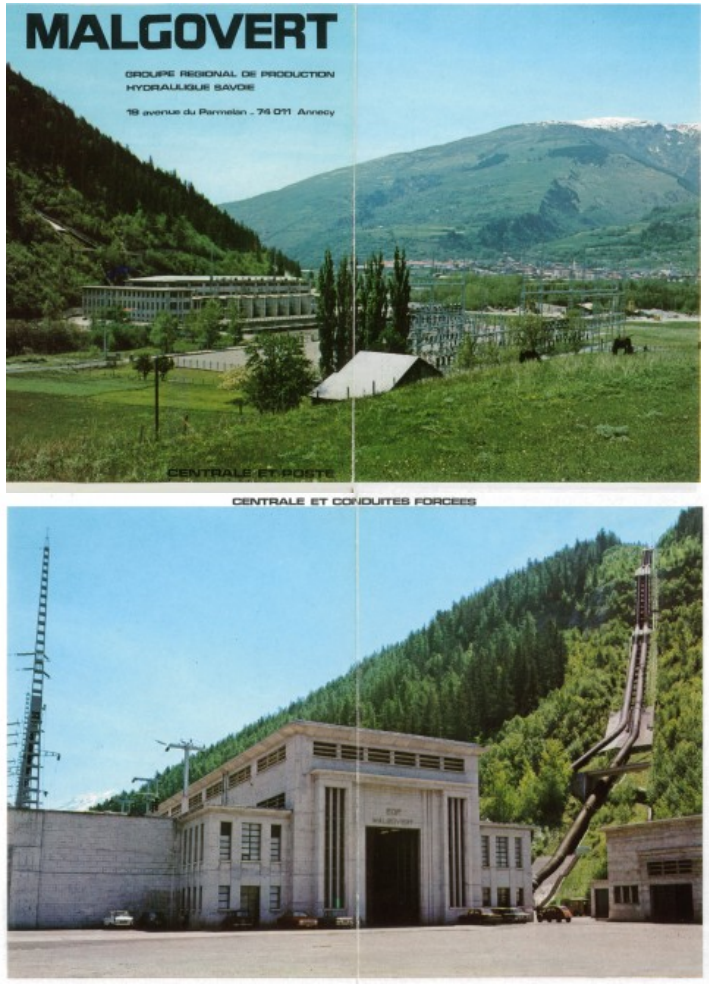


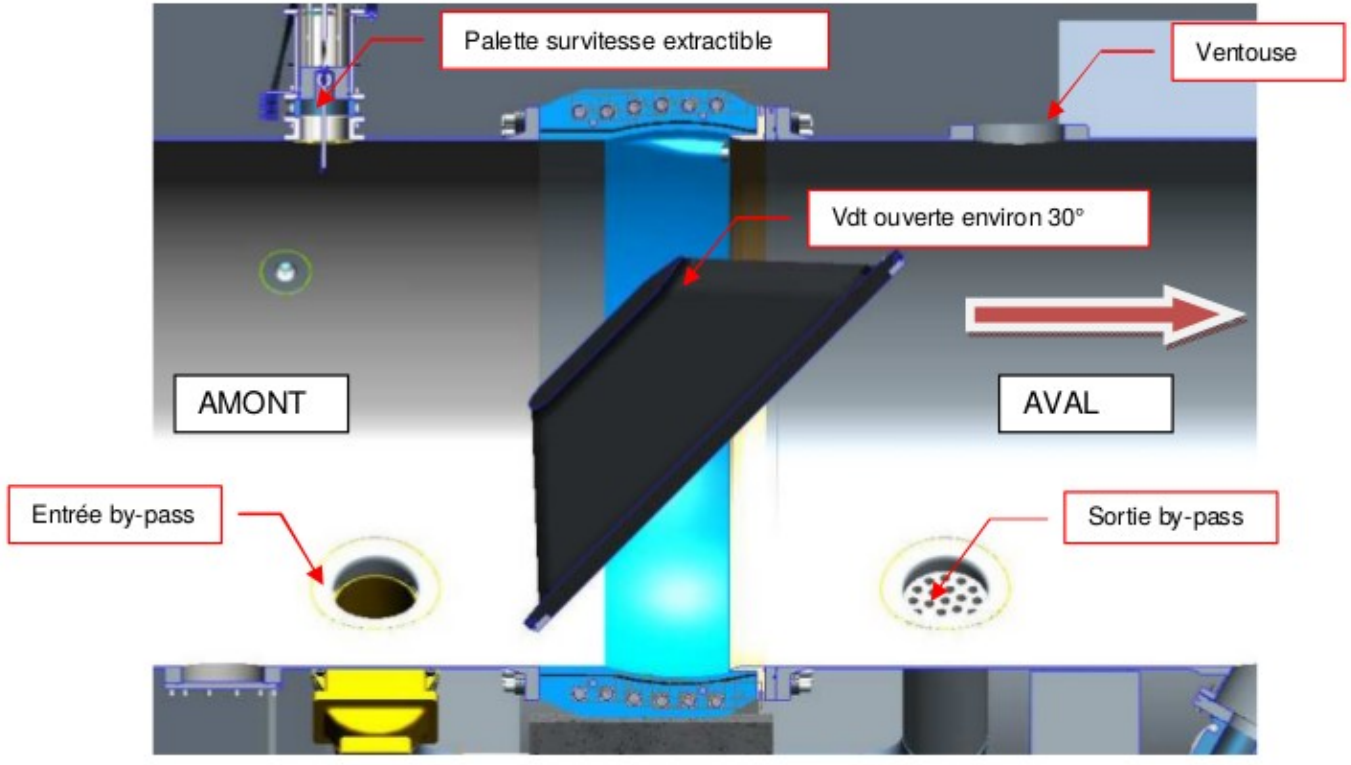


CFM, 85% inlet void fraction

II. Applications in energy fields: solar, hydraulic & nuclear

Closure of a Valve in a Penstock pipe





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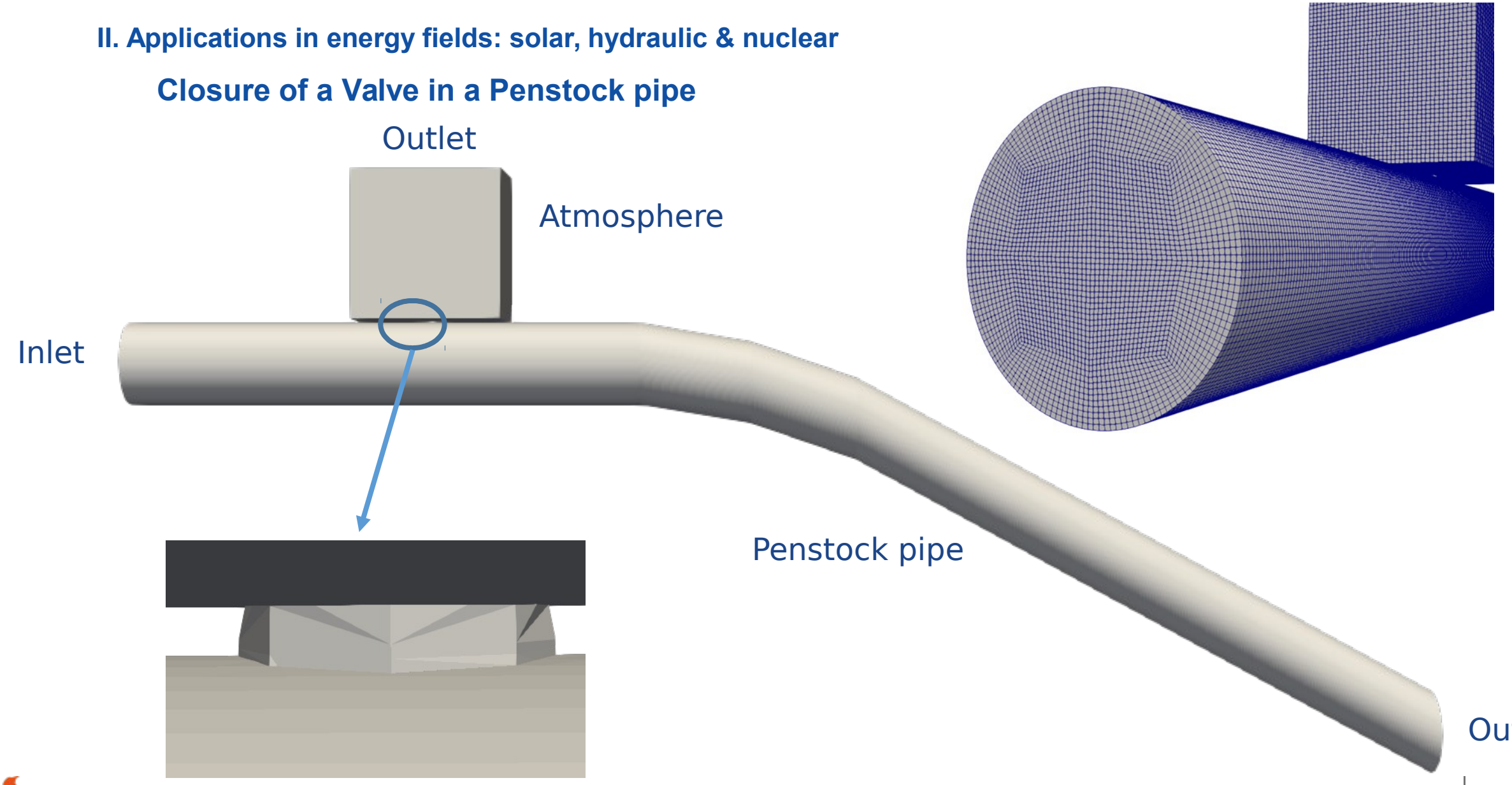
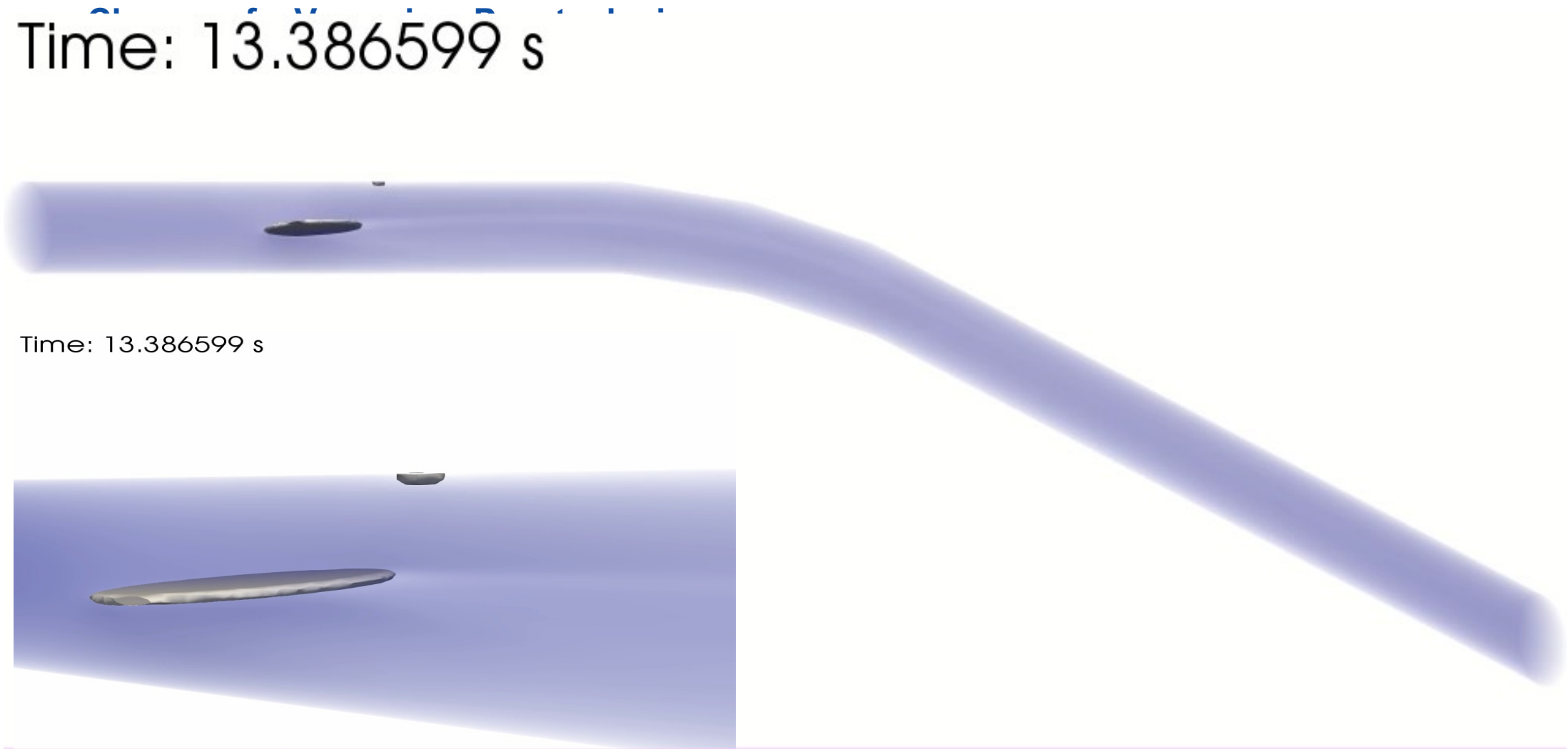


Air valve in case of pressure drop

II. Applications in energy fields: solar, hydraulic & nuclear



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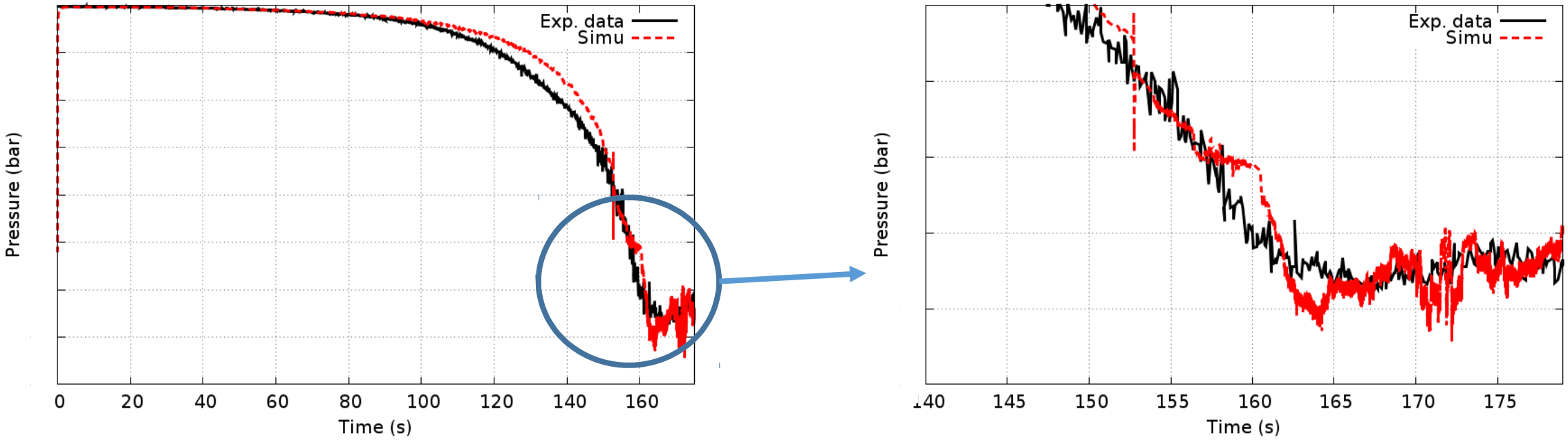
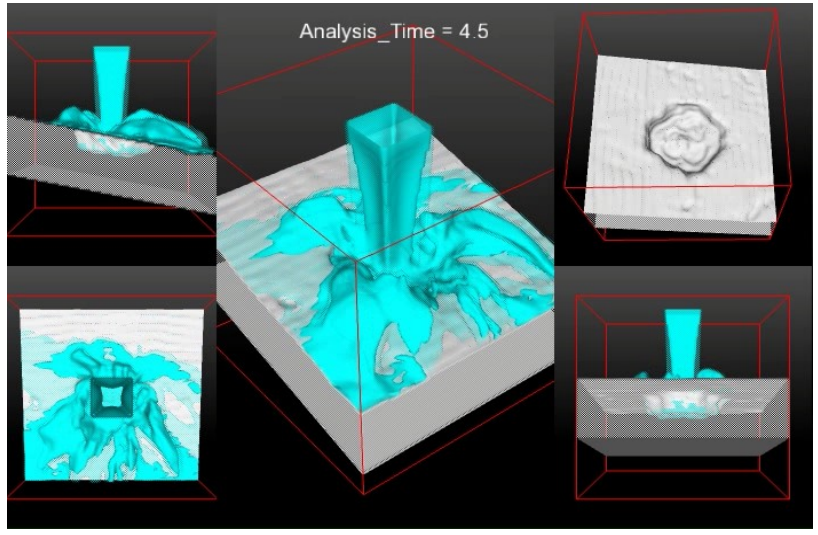
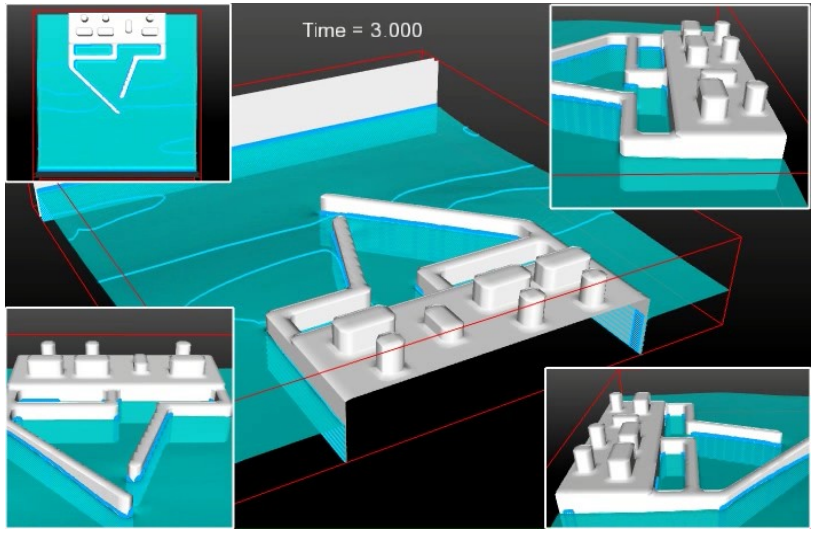
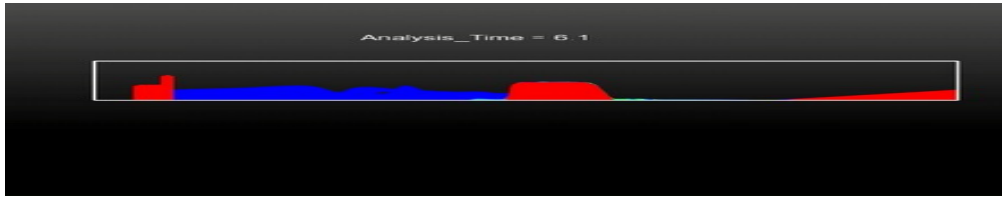


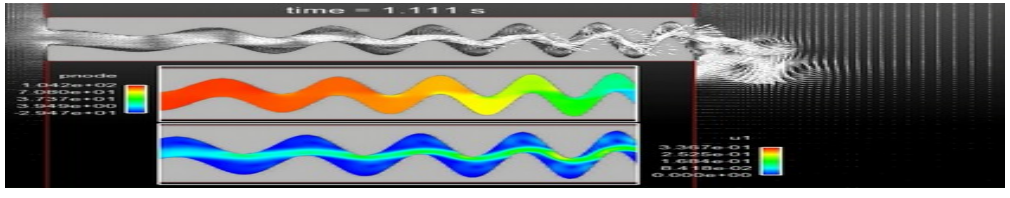
→ Valve opening time: -3,5% of error

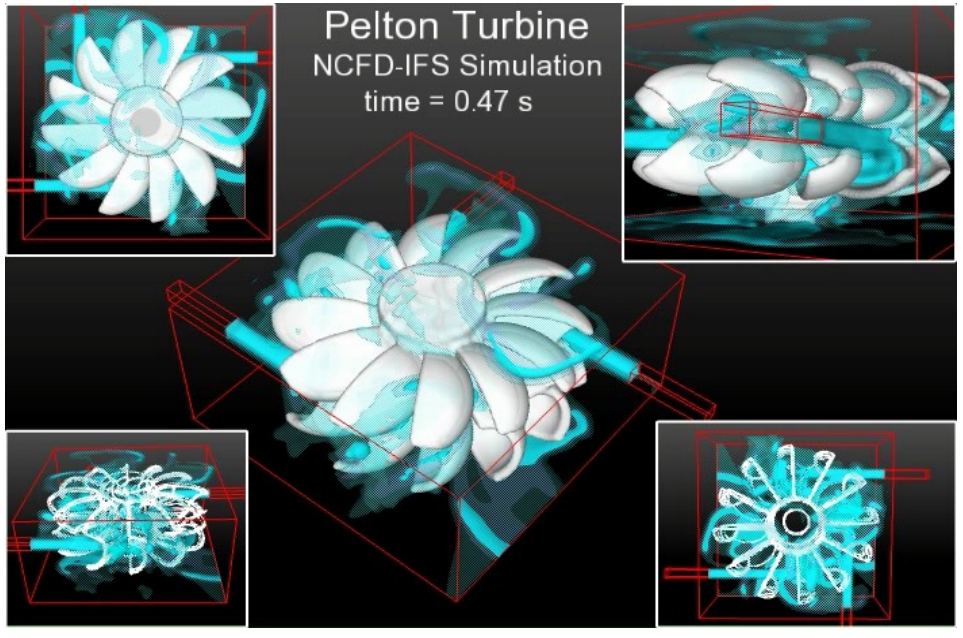
Other applications in progress











How to use it ?

→ Live Demonstration during the break !

THANKS