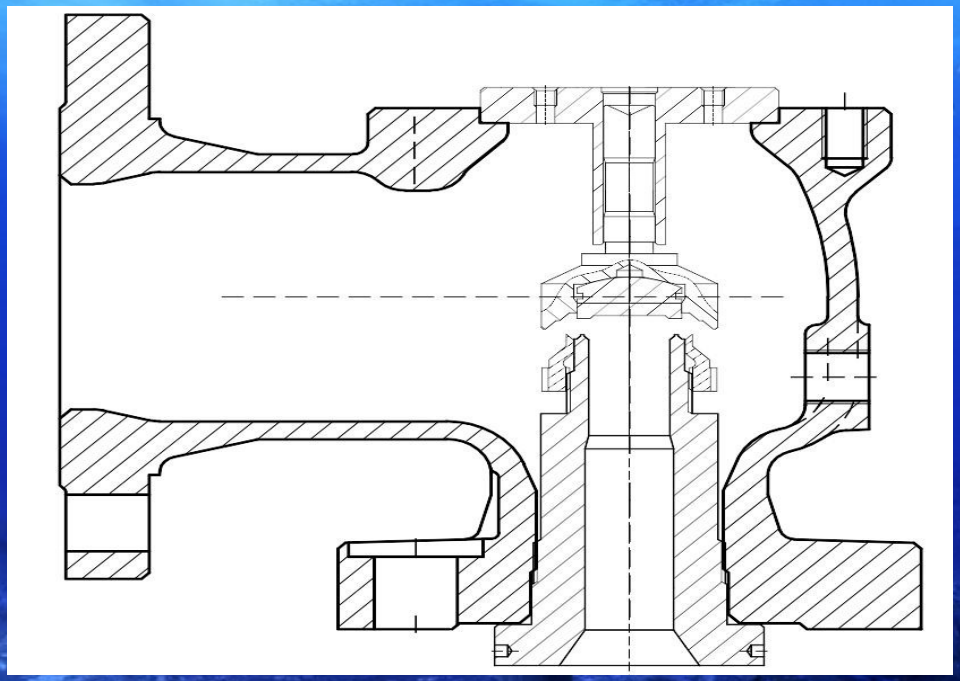


CFD study of a 1”½ safety valve

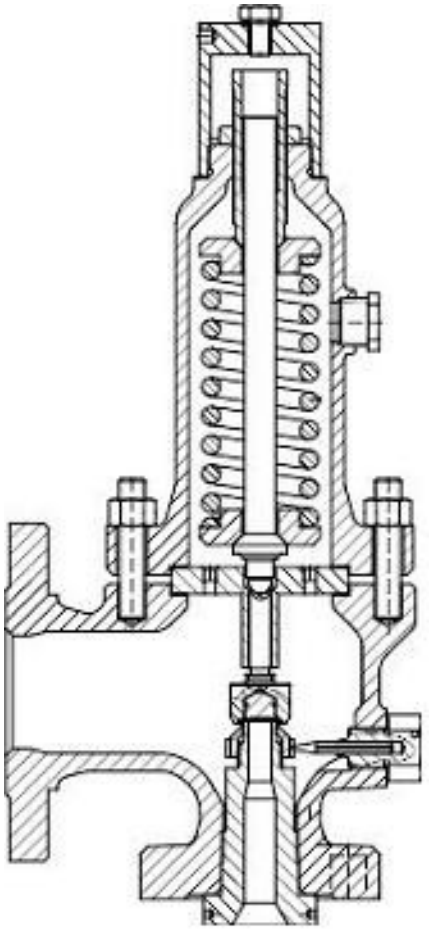
F.Dehoux & J.Ferrari

EDF R&D

StarSoupape project

- Study safety valves instabilities

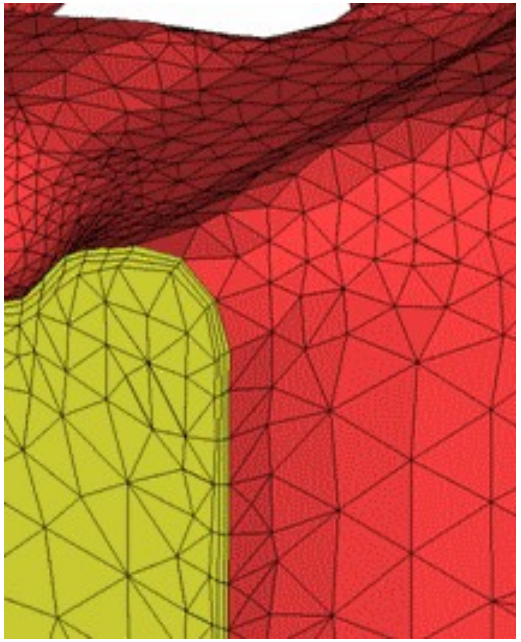
- CFD objectives: in the condition of a experimental setup (5 openings x 2 ring heights):
  - Compute Flow induced force and flow coefficient (Cv)
  - Understanding the flow



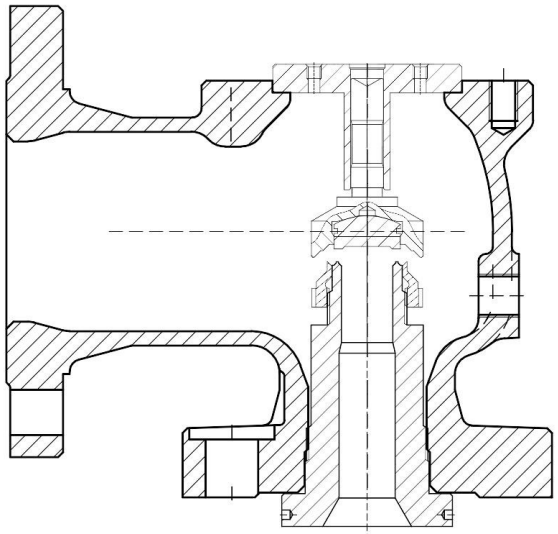
A new approach

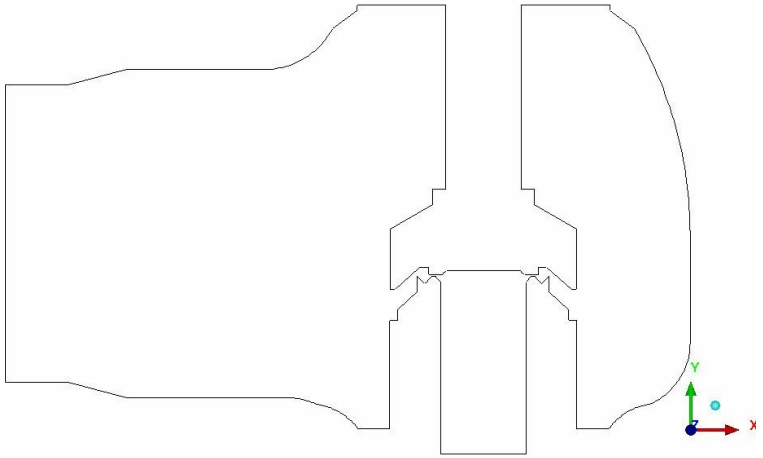
- New software: ICEMCFD (licence tetra)
- Mesh: tetrahedron + prism close to the wall
- Meshes built in-house

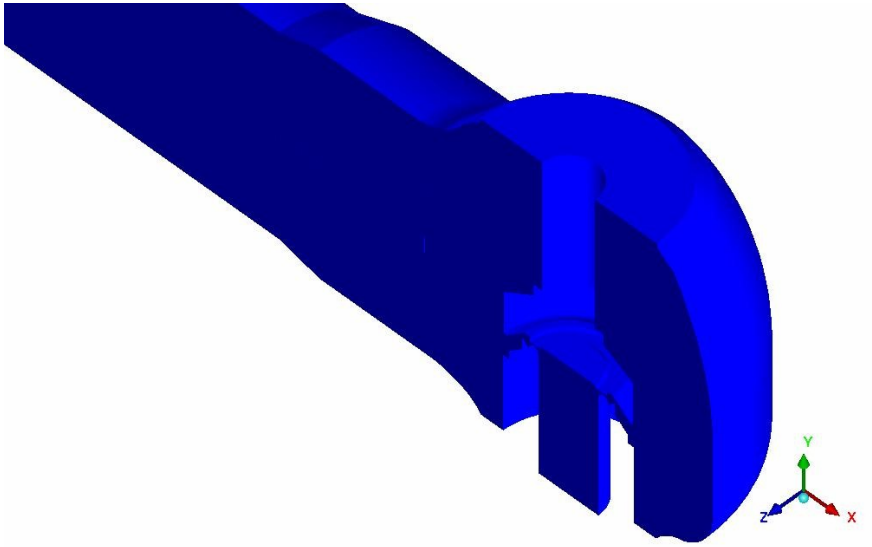
- To:
  - Use real specialized tools
  - Mesh and compute in parallel
  - Build many meshes
  - Be able to modify the mesh later

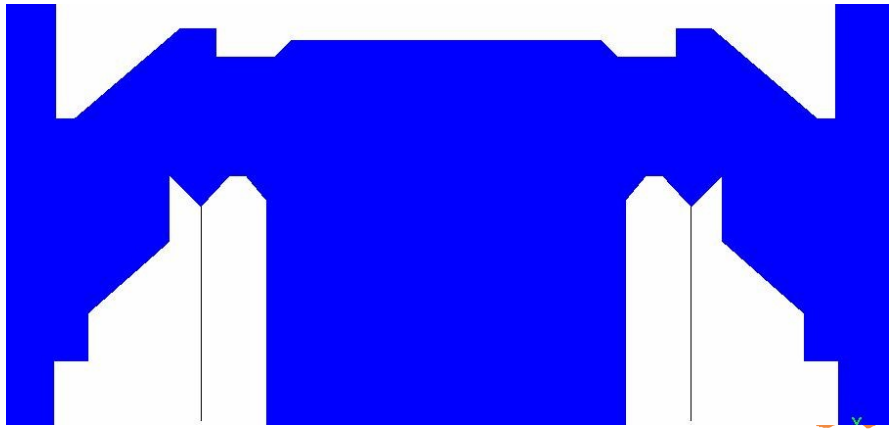


The safety valve: WEIR Sarazin type G DN=1”½

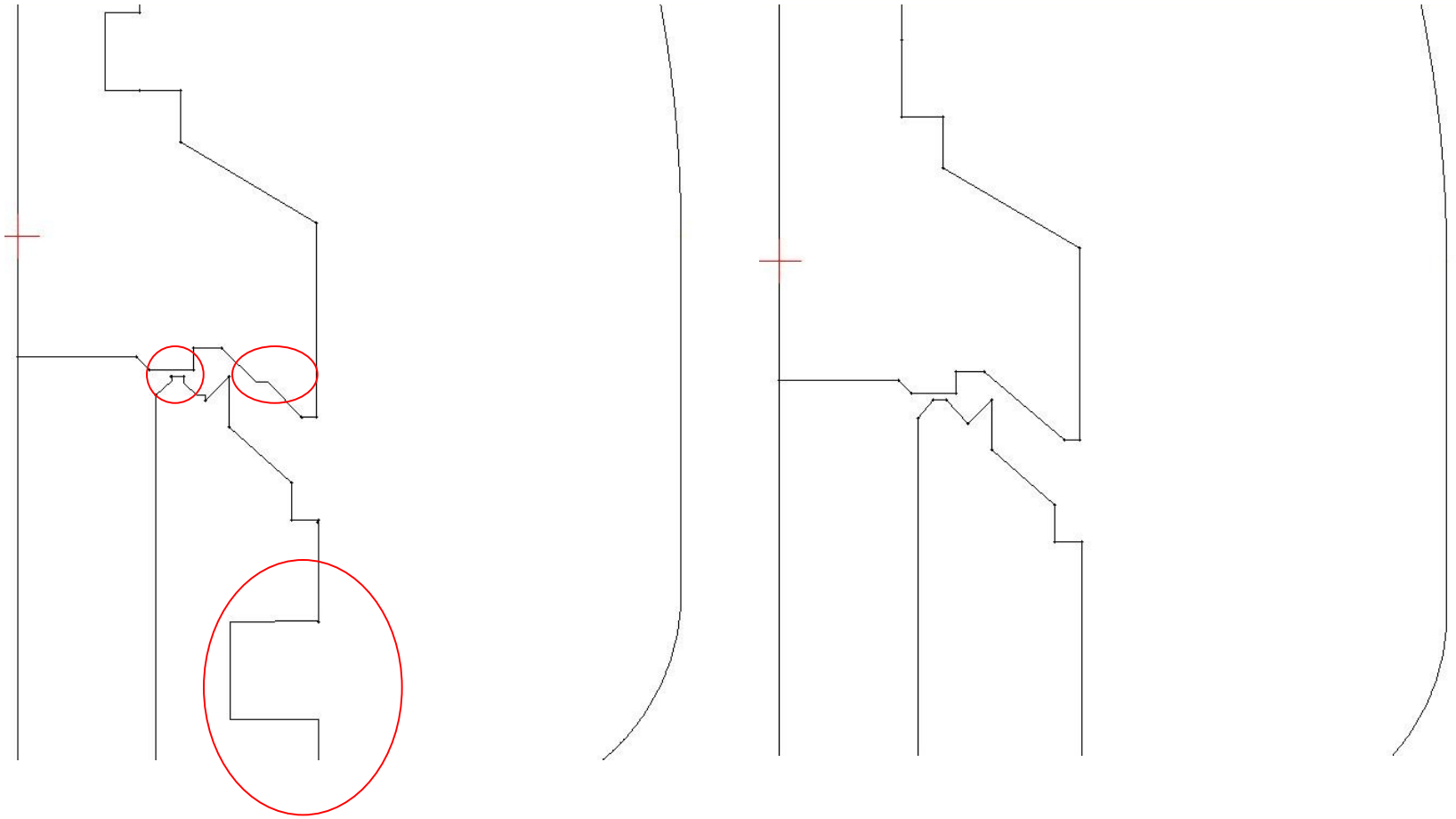






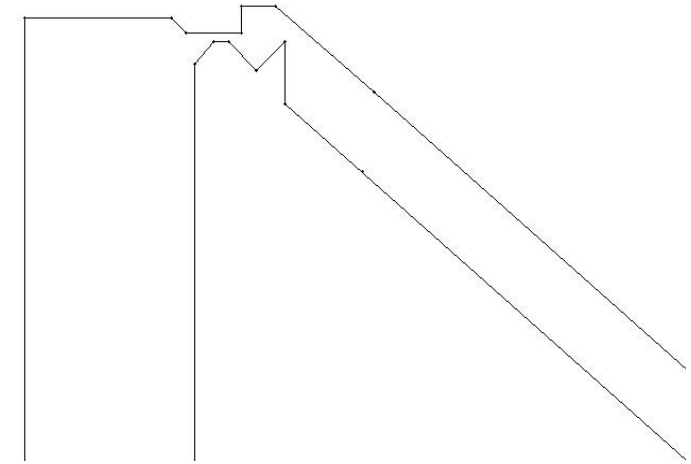


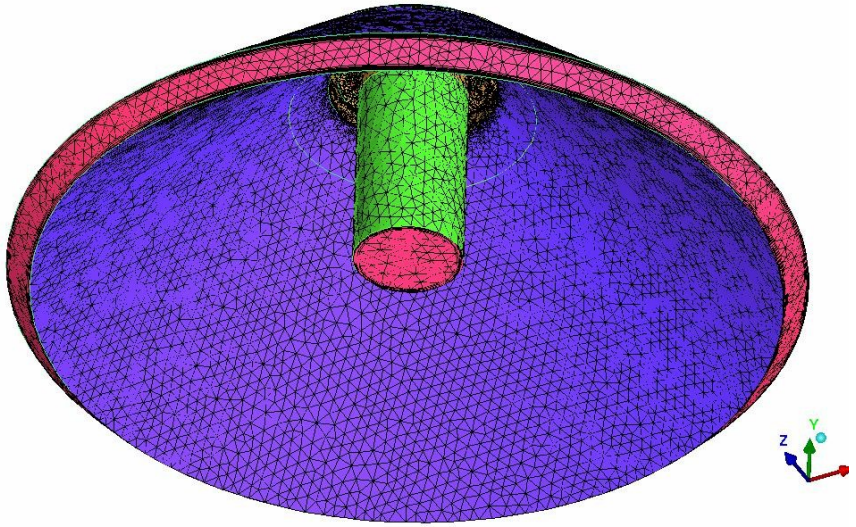
Geometry simplification



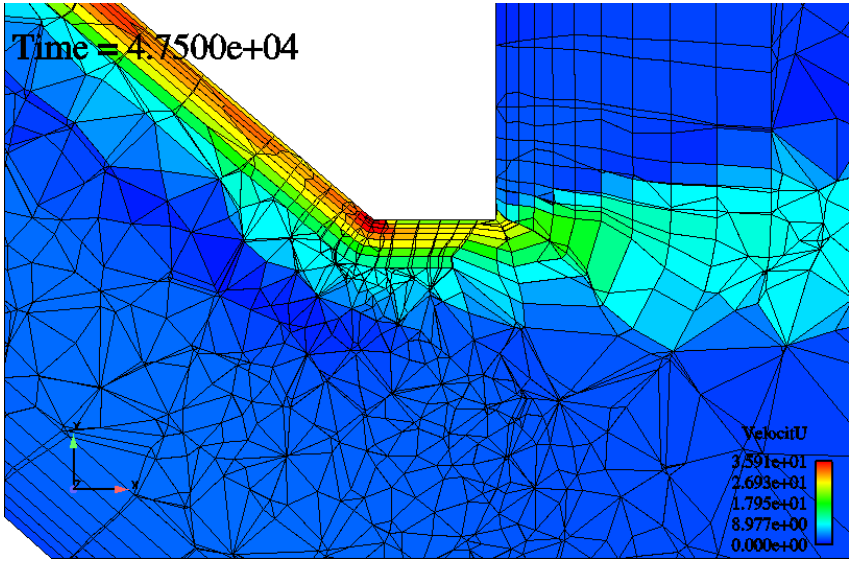
The test mesh

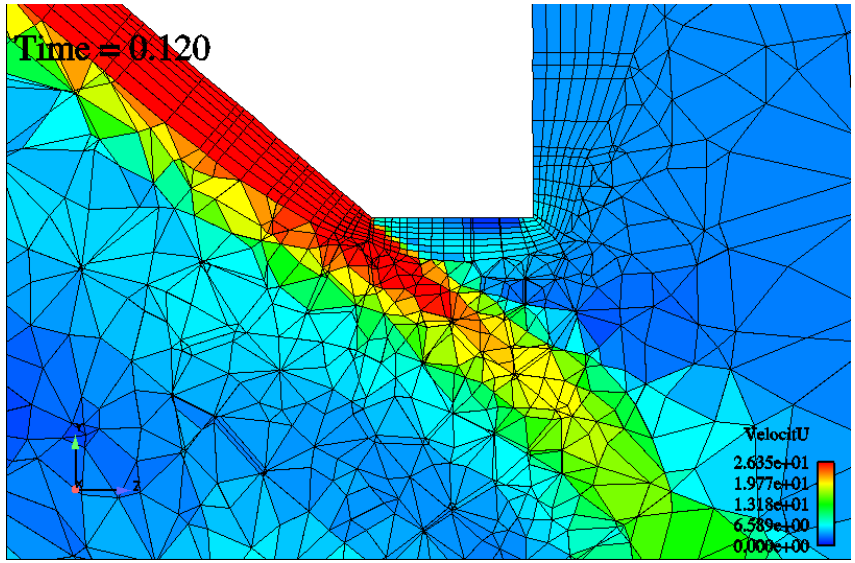
- To start the study (3 months)





Example of encountered issues





Mesh independency : Richardson

$$A = A(h) + \alpha \cdot h^{k} + \beta \cdot h^{k+1} + \gamma \cdot h^{k+2} + \ldots$$

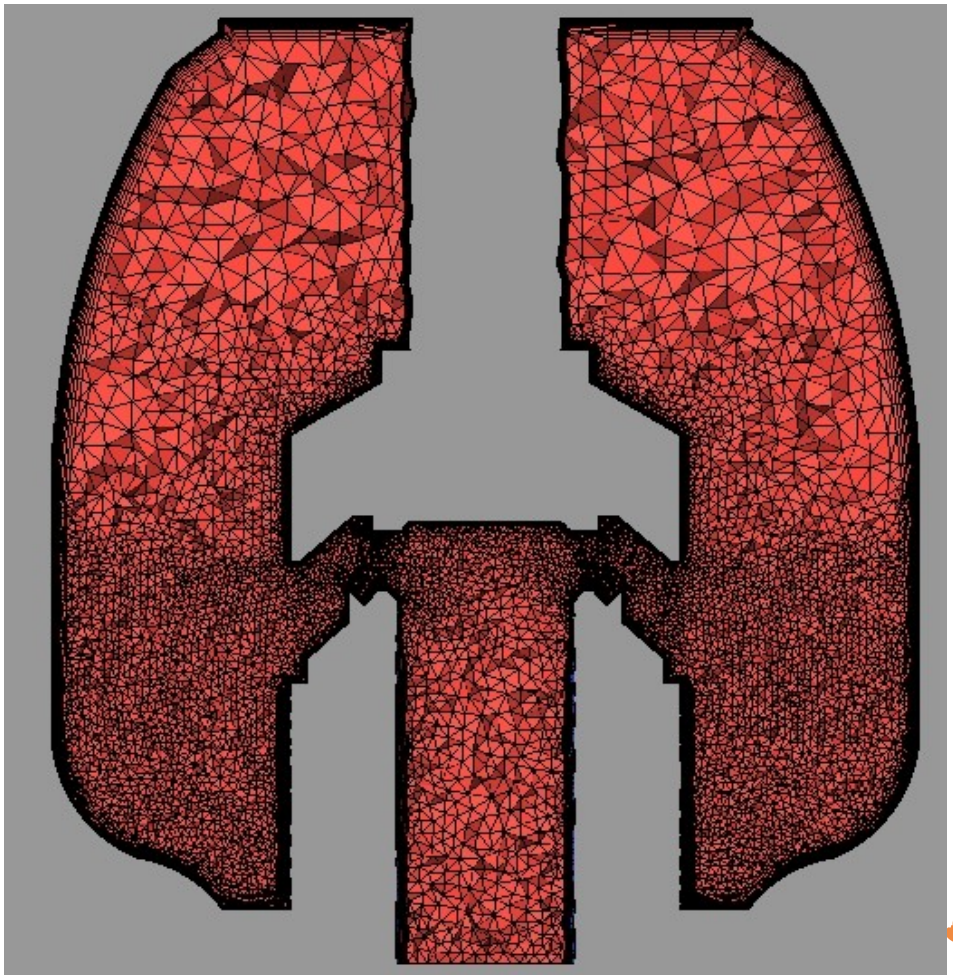
	effort	
h	A(h)	B(h) avec k=3,2
0,01	2268,6	2590,9
0,005	2556,1	2590,9
0,0035	2560,2	2594,4
0,0025	2587,1	-

$$k = \left\{ \ln\left(\frac{A(h_4) - A(h_2)}{A(h_4) - A(h_3)} \right) \cdot \frac{\ln\left(\frac{h_3}{h_4} \right)}{\ln\left(\frac{h_2}{h_4} \right)} \right\} \Big/ \ln\left(\frac{h_2}{h_3} \right)$$

Final Mesh

~ 3 000 000 elements

36 h using 64 to 256 procs on the CCRT

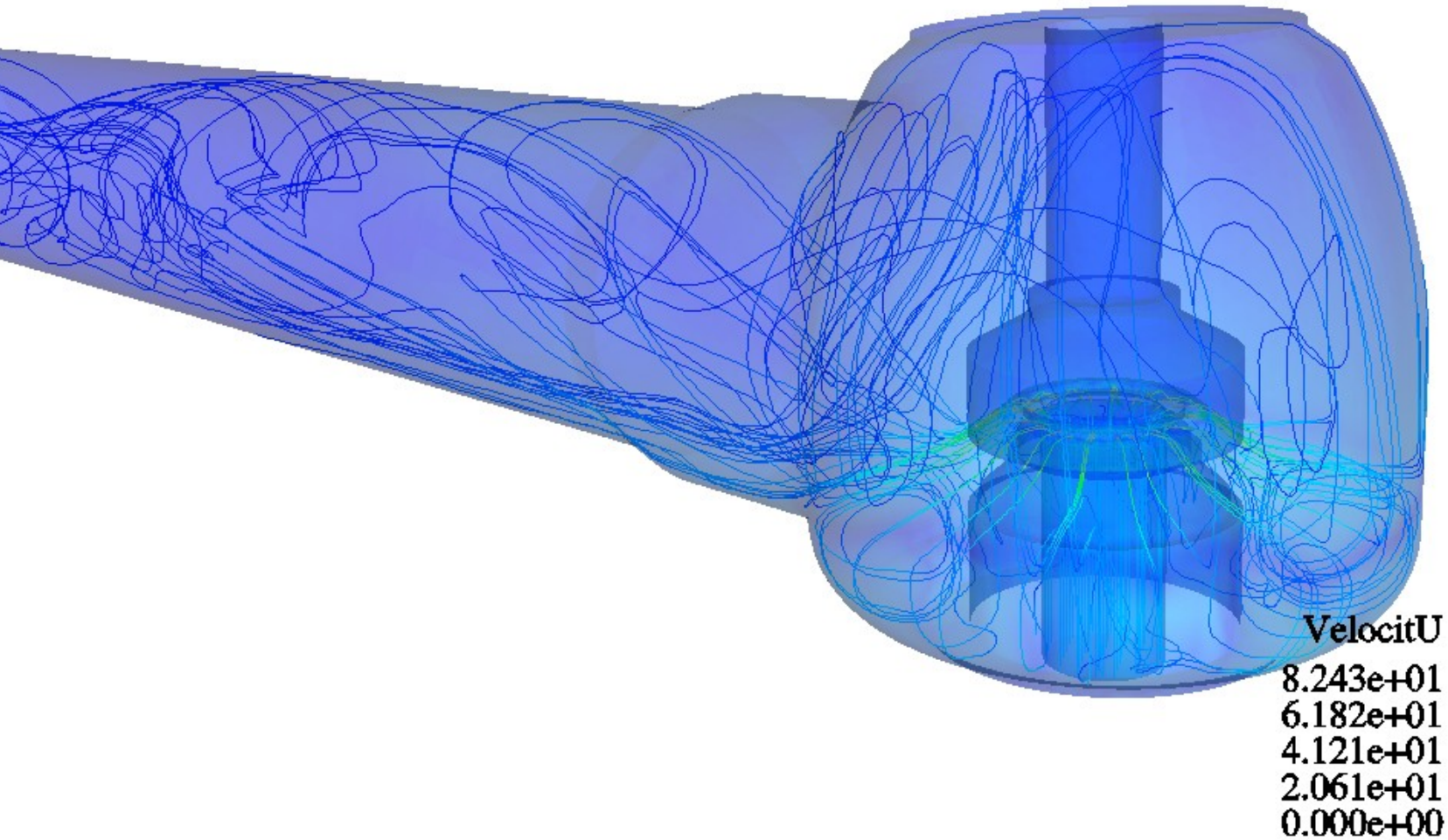


Computation options

- Turbulens model k-ω SST
- One-phase
- Stationary
- Others:
  - Upwind scheme for K et ω
  - Reinforced velocity-pressure coupling (IPUCOU=1)
  - Reconstruction of the flux (IRCFLU=1)
  - Gradients reconstruction based on the extended neighborhood (IMRGRA=2)

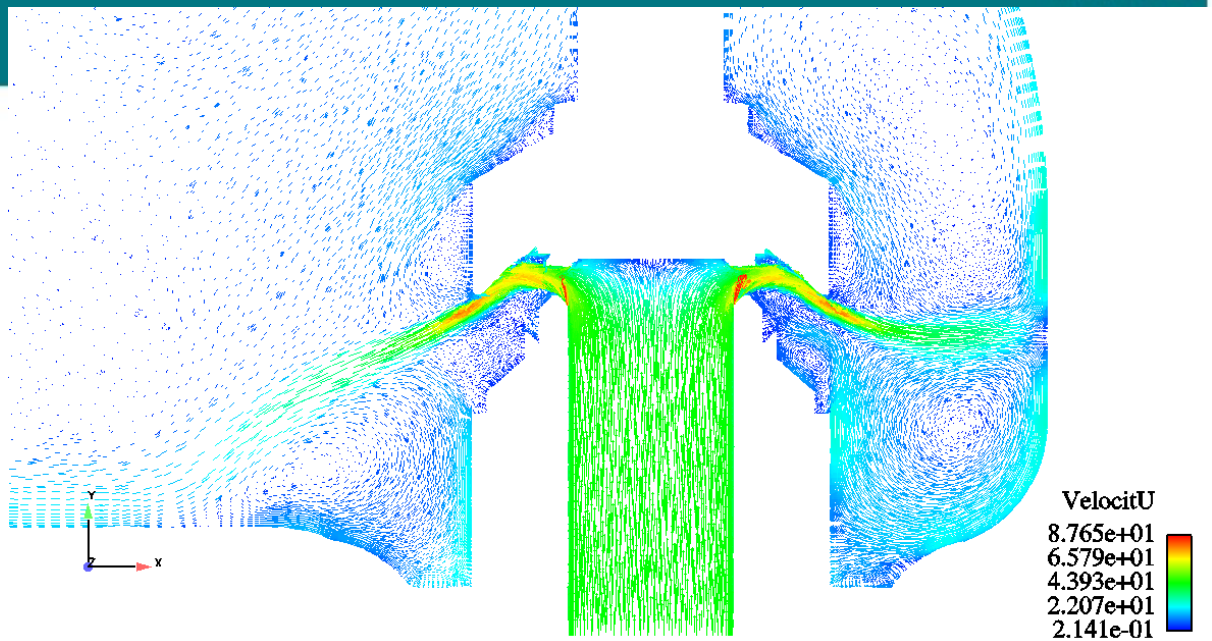
EDF R&D

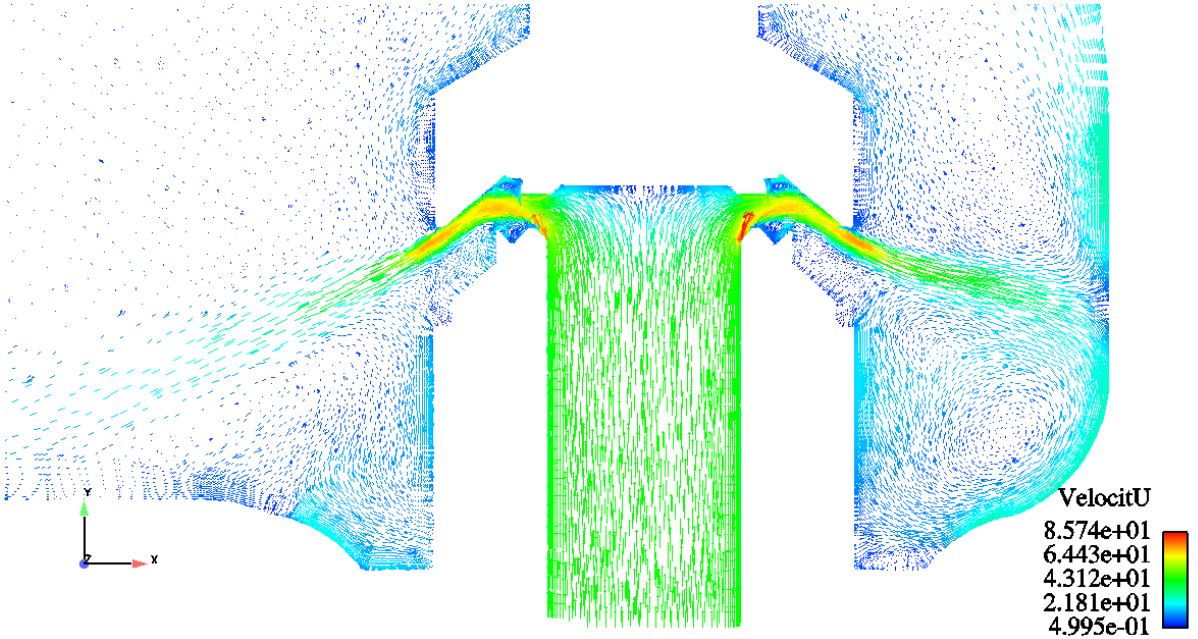
The flow



The flow

- Opening: 3,8mm

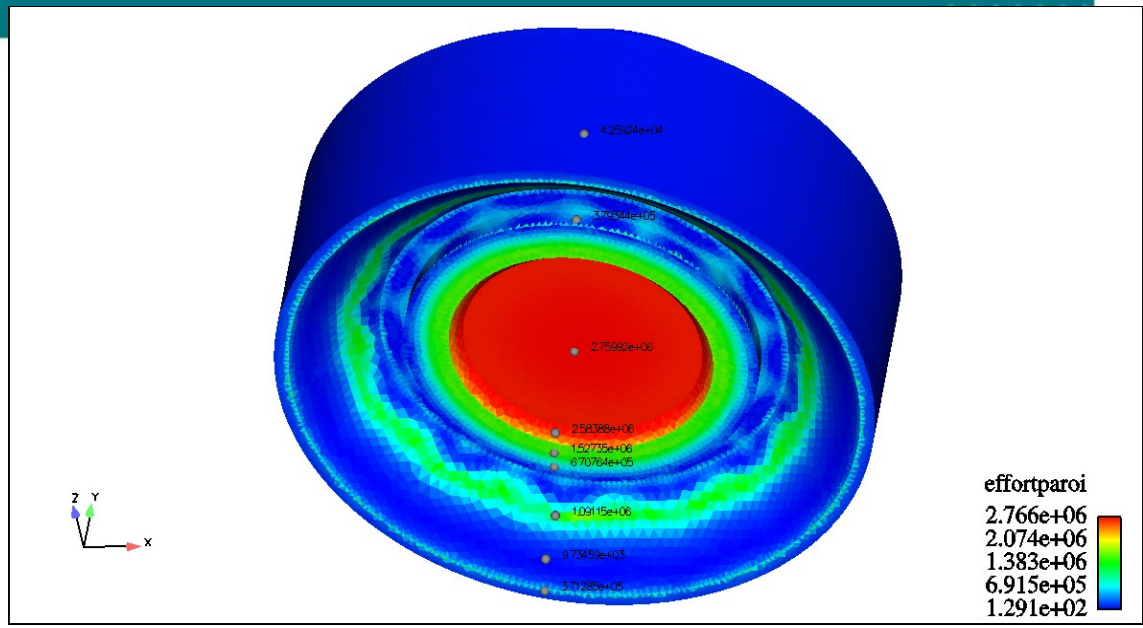




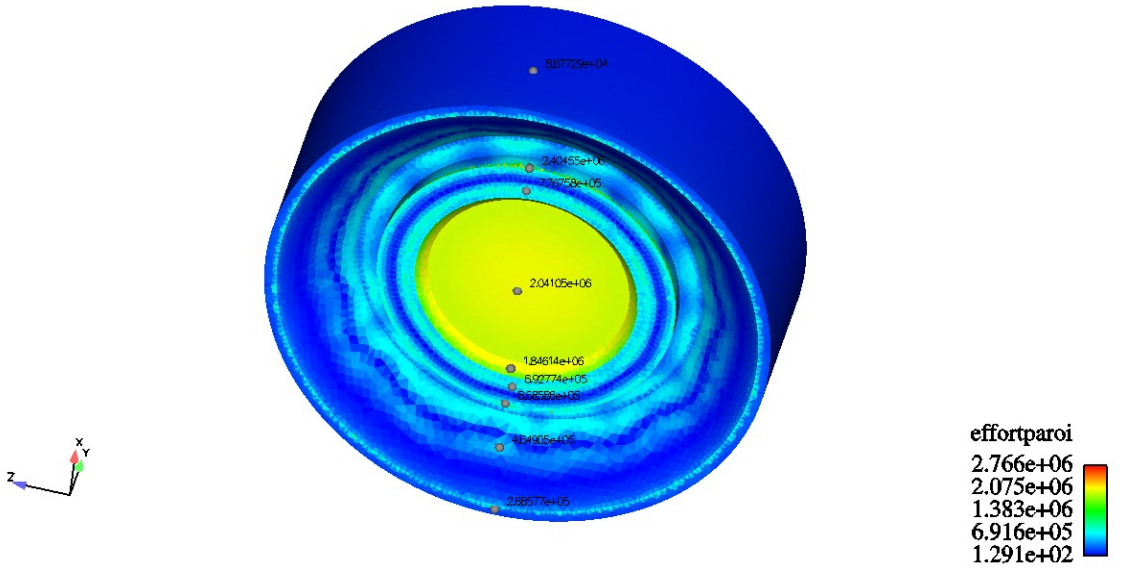
Pressure on the plug: opening : 1,5mm

Low ring position

counter intuitive

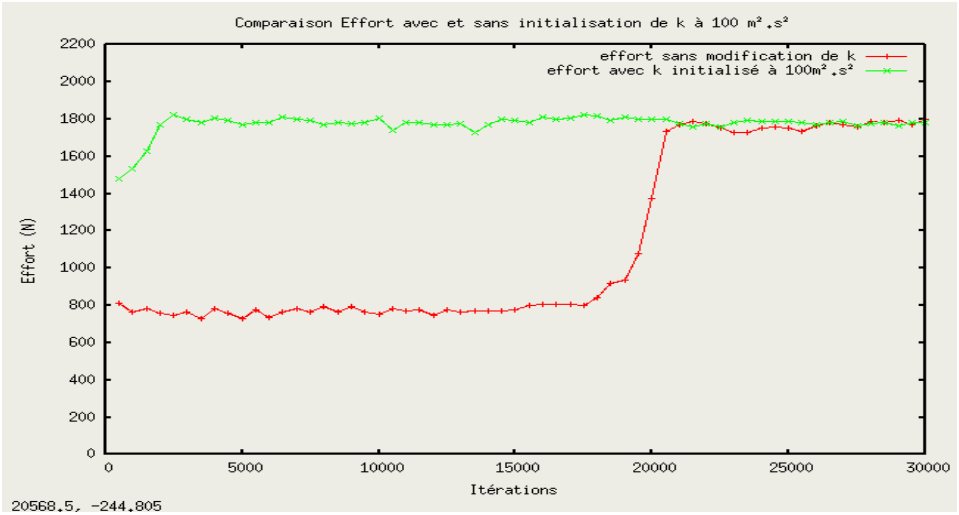


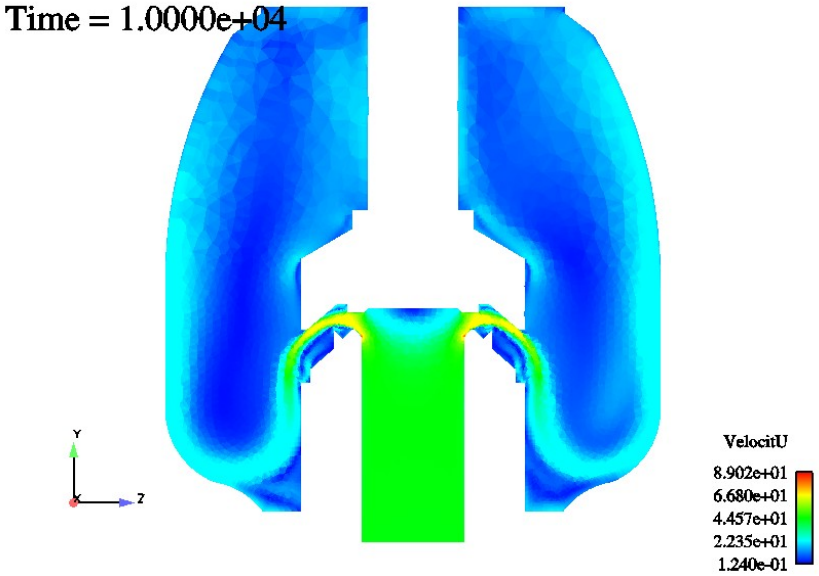
High ring position

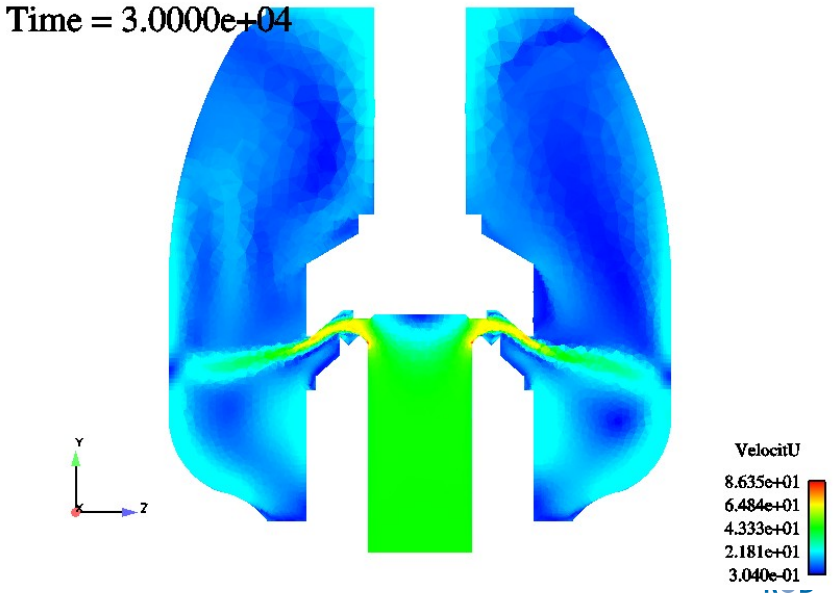


Coanda effect?

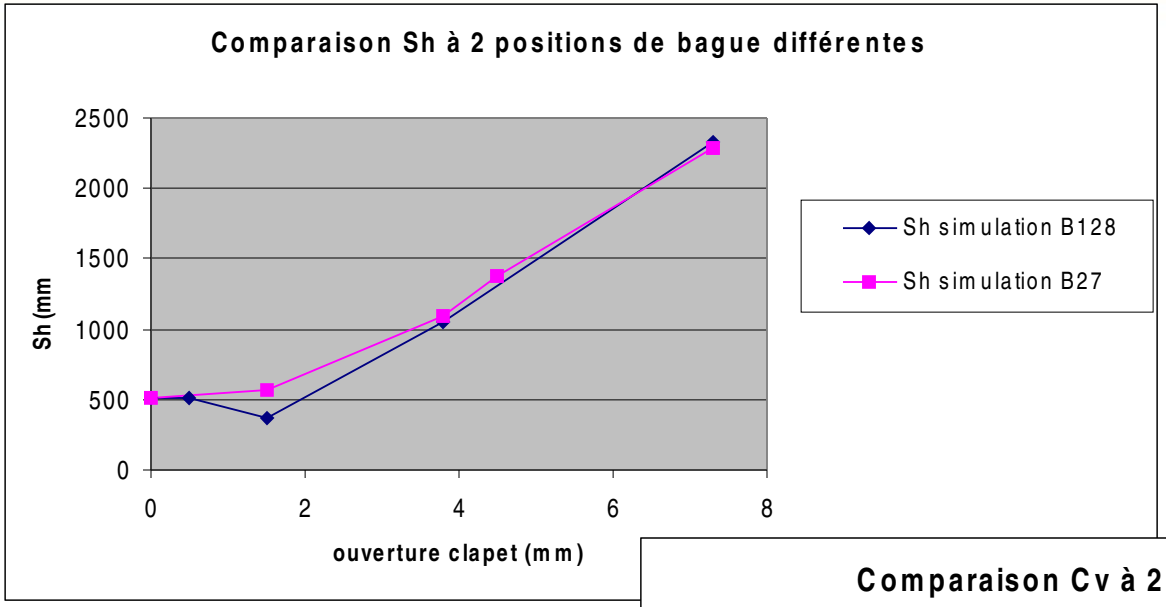
Issue at 0,5mm opening and low ring position

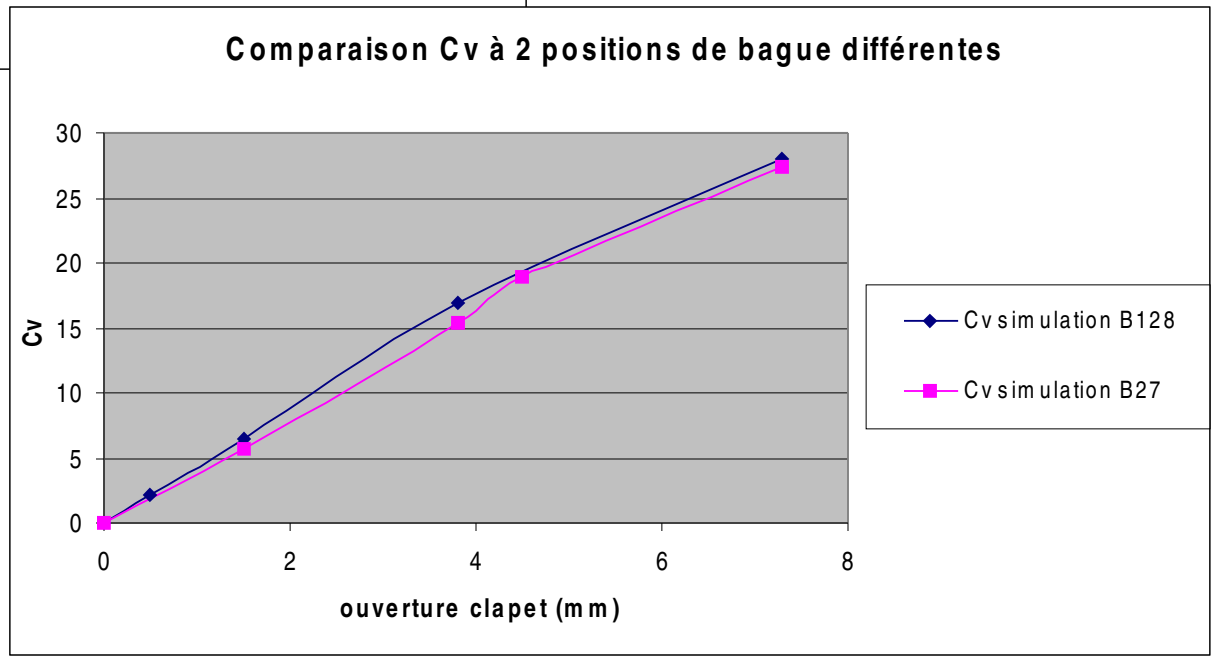




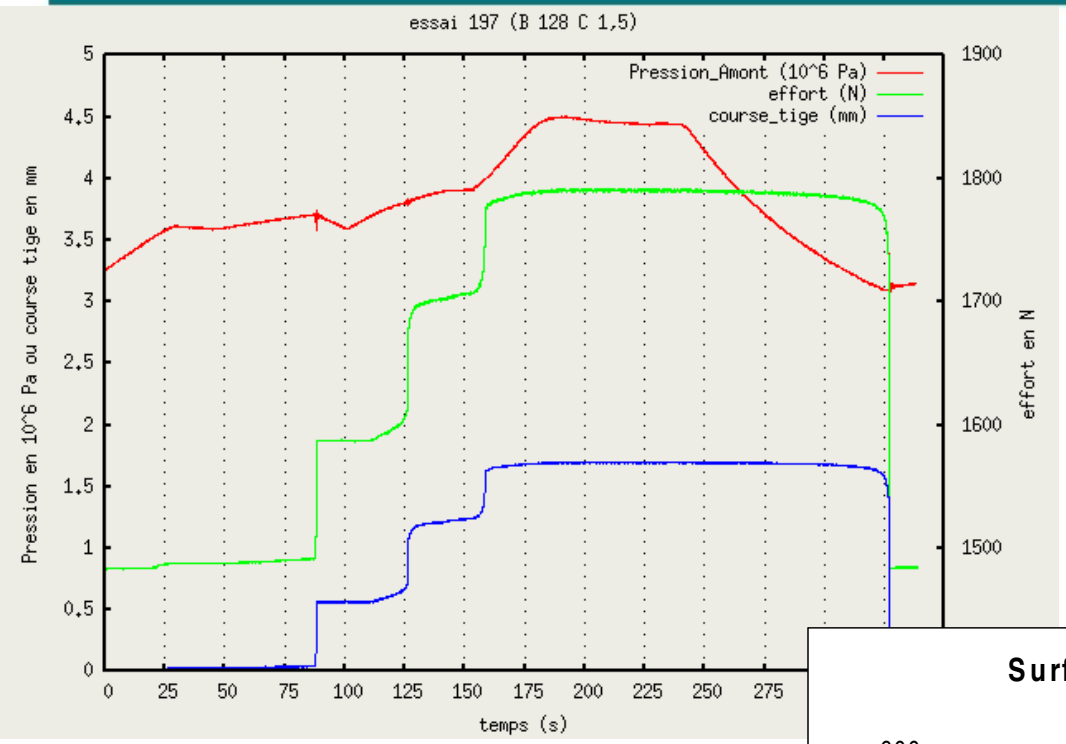


Results

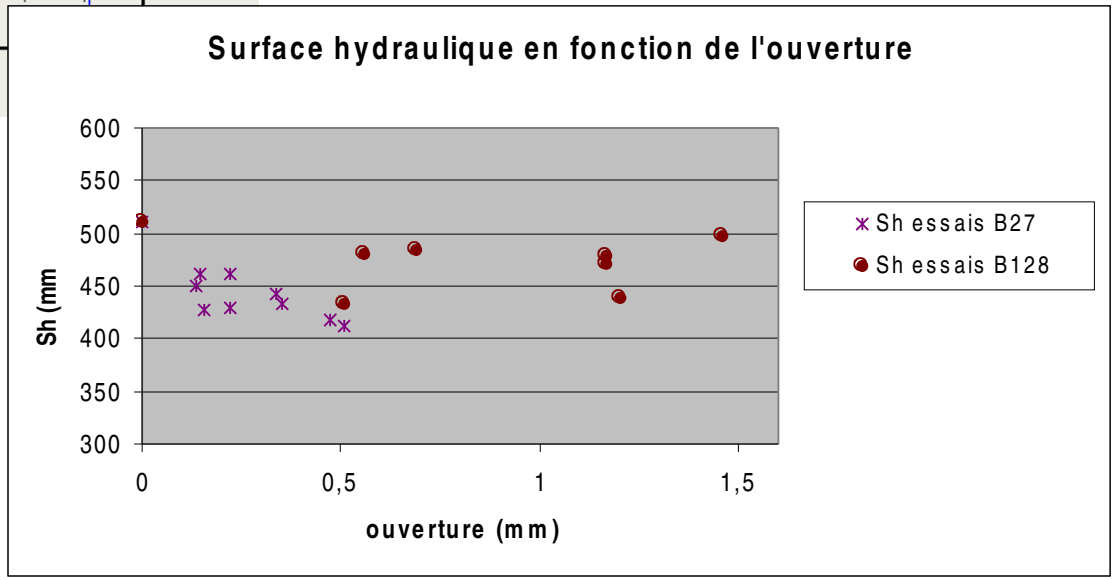

Comparaison Sh à 2 positions de bague différentes
2500
2000
1500
1000
500
0
Sh (mm
0
2
4
6
8
ouverture clapet (mm)
Sh simulation B128
Sh simulation B27


Comparaison Cv à 2 positions de bague différentes
30
25
20
15
10
5
0
Cv
0
2
4
6
8
ouverture clapet (mm)
Cv simulation B128
Cv simulation B27

Experimental results

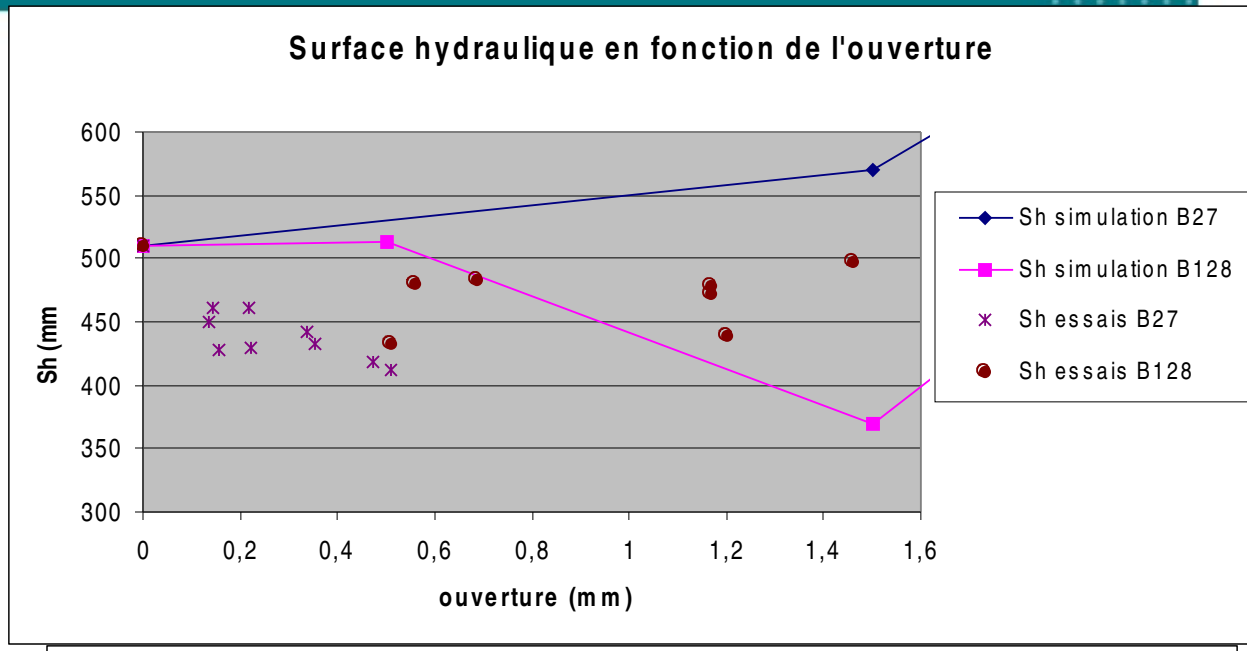


Finding the stability points...

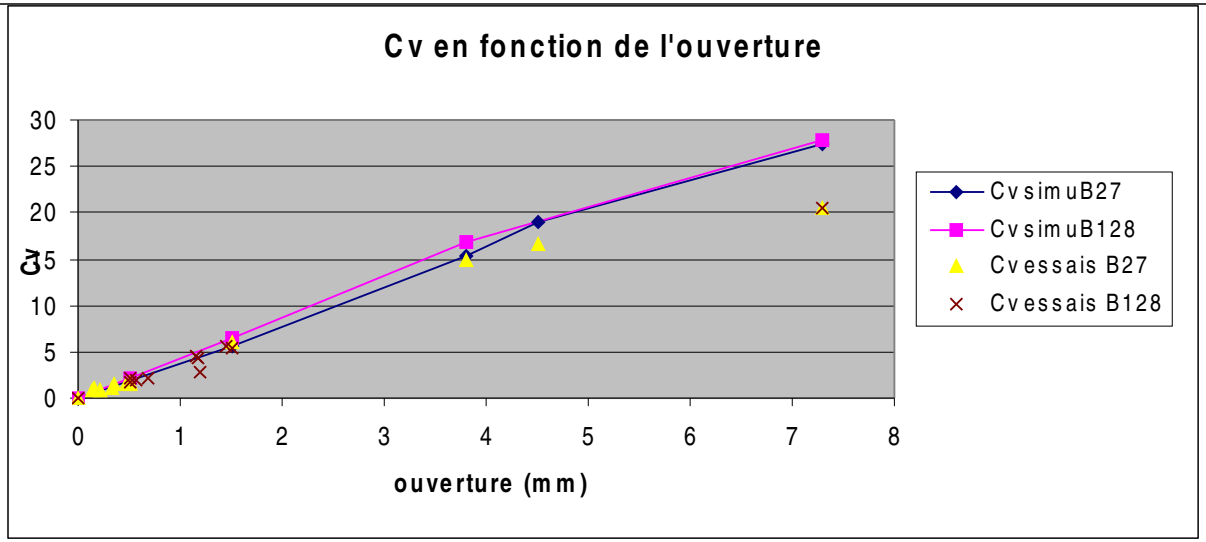


Comparison

- Cavitation has no effect on the fluid flow induced force at low opening



- The recovery factor (FI) estimated after a former experiment on another valve



Conclusion

- A tutorial ICEMCFD : a new maillage within 4h
- Une computation « method » for tetra-prism meshes with *code_saturne*
- Issue at opening=0,5mm and low ring position

- The simulation gives fair results (at least)

EDF R&D

Futur

- Use of the data in an analytical stability model
- Supplementary tests performed to get accurately FI
- Two-phase flow computation with *Neptune*?
- Exchange with Code_Saturne developpers ...

EDF R&D

Fred

- PhD probable at MFEE

EDF R&D