

# Gas flow Simulation

— feedback on CLAS12 experiment —

D. Attié

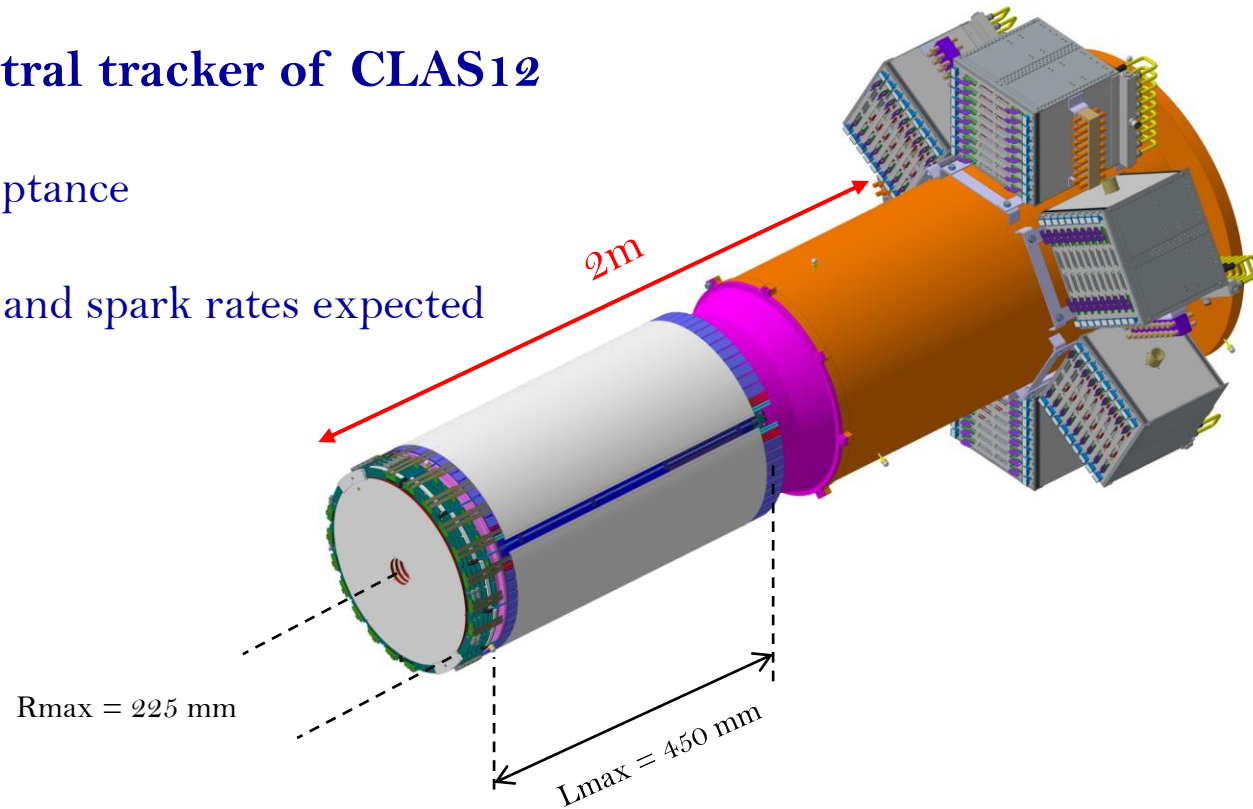
(work made by N. Sellani)

*R&D Instrumentations — Détecteurs gazeux*



- **Constraints for the central tracker of CLAS12**

- Small dead zone
- Light material in the acceptance
- Limited space
- High counting (10 MHz) and spark rates expected
- High magnetic field (5 T)



- **Micromegas solution proposed by the CEA/Saclay:**

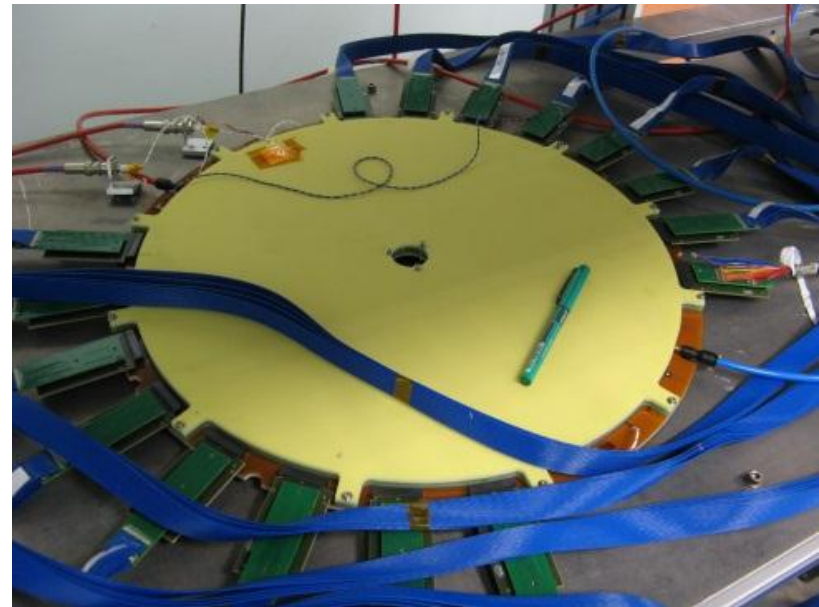
- Light material (0.3 %  $X_0$  per layer)
- Can be curved with the bulk technology
- Robust detector
- Flexibility of the working point
- 25k channels for 4 m<sup>2</sup> of detector

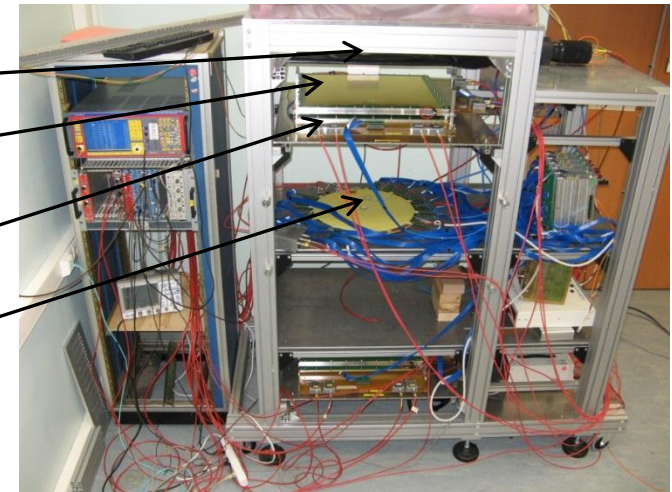
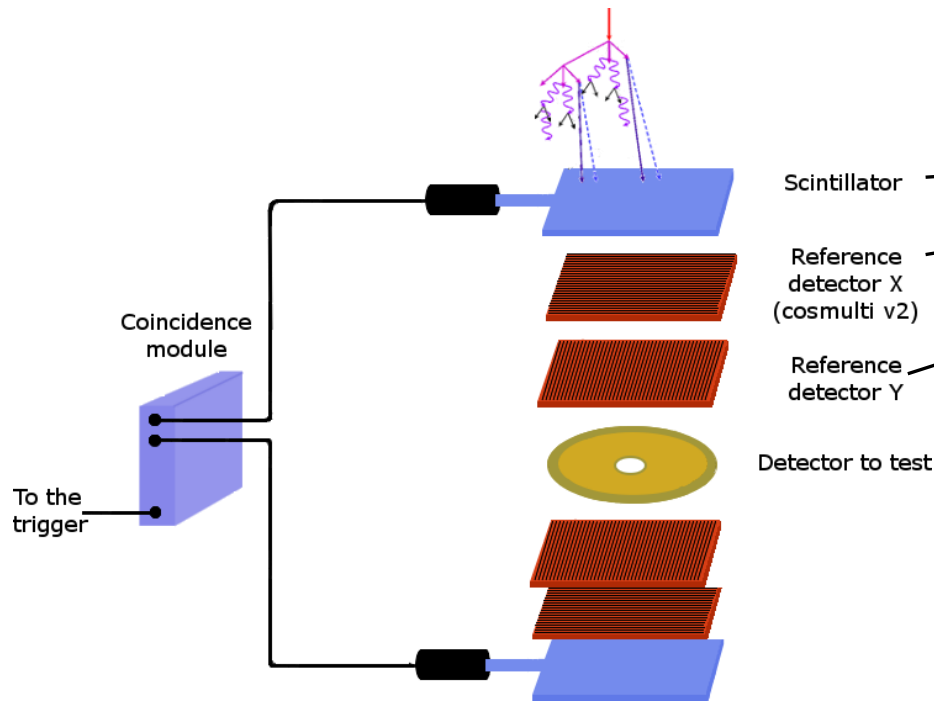
- **MVT (Micromegas Vertex Tracker)**
  - 3 double layers of Barrel detectors (Z & C):  
3mm drift gap,  $450 \times 440 \text{ mm}^2$  (CR6C) :  $6 \times 10^{-4} \text{ m}^3$  (0.6L)
  - 6 Forward detectors:  
5 mm drift gap,  $\text{Ø}430 \text{ mm}$  :  $2,9 \times 10^{-3} \text{ m}^3$  (2.9L)

Barrel prototype

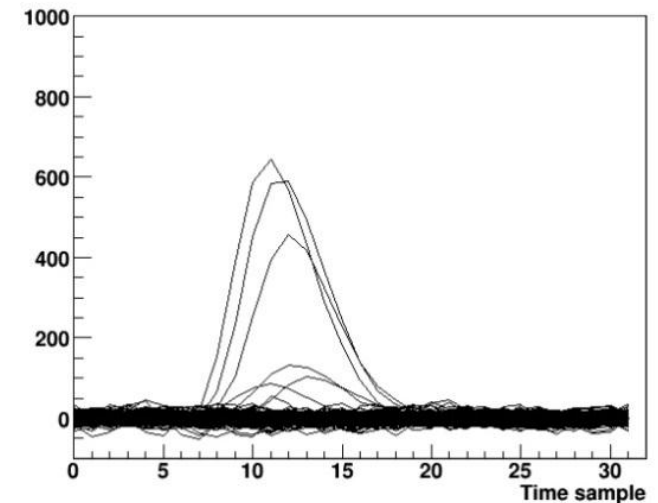


Forward prototype

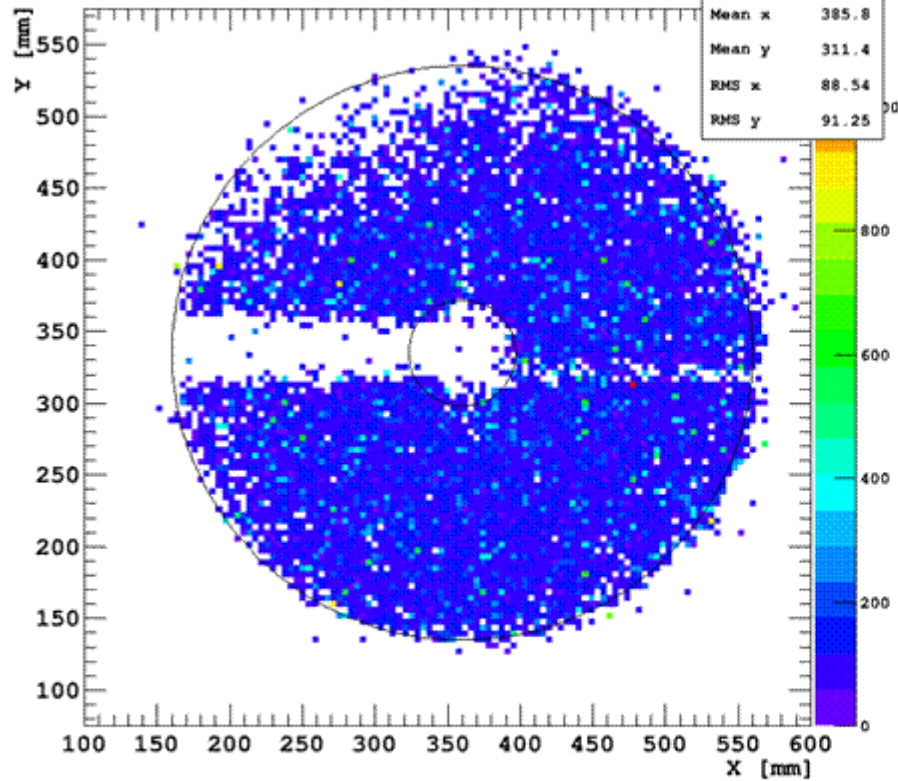




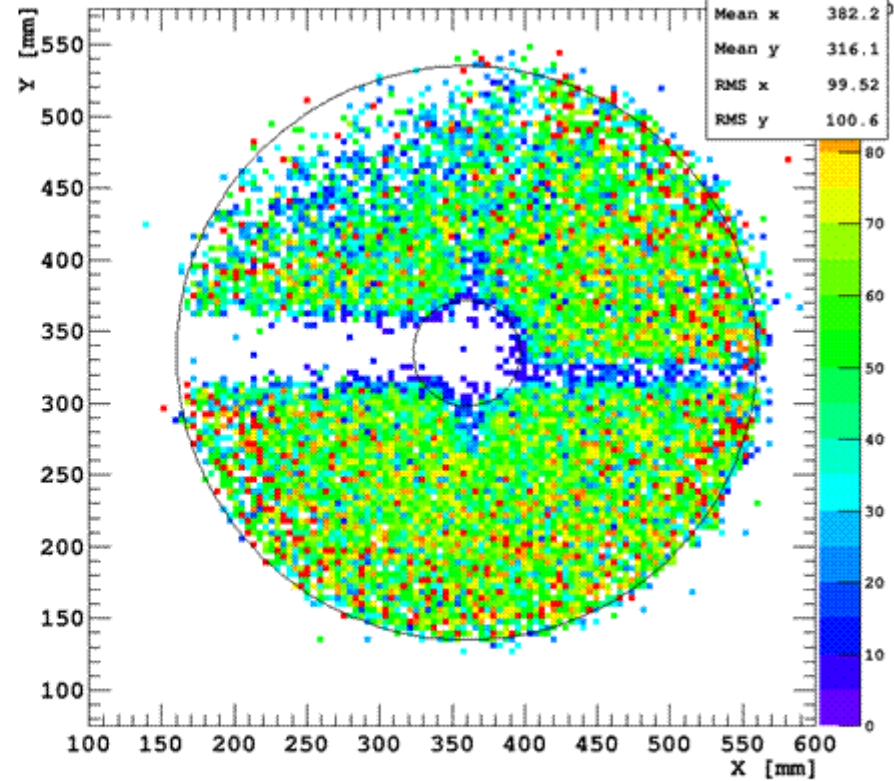
- The two forward prototypes have been tested
- For both, more than 500,000 triggers have been recorded
- For each trigger, when a cluster is reconstructed in all the reference detectors, the track is interpolated to the prototype
- The position interpolated is then compared to the cluster reconstructed in the detector under test



Gain [ADC channel]

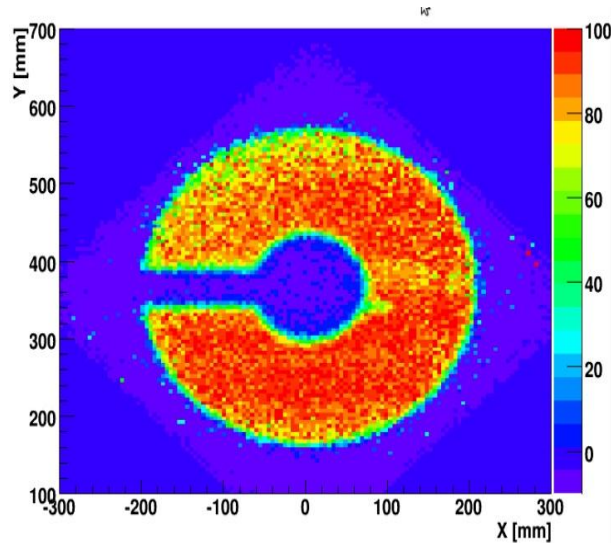


Efficiency

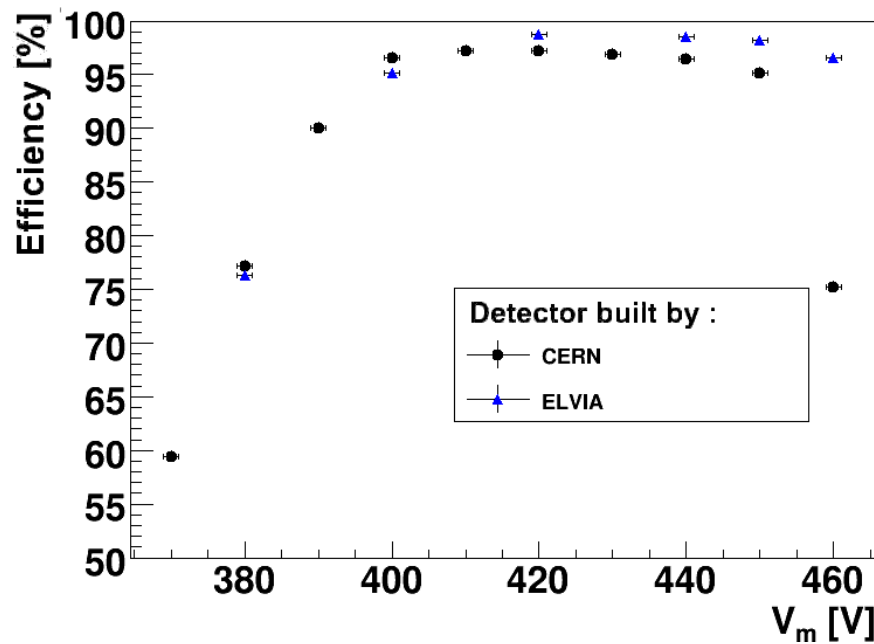
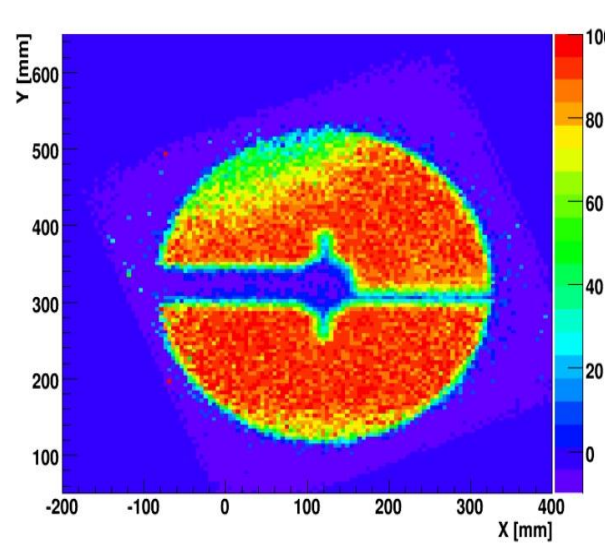


$$V_{\text{mesh}} = 370 \text{ V}$$

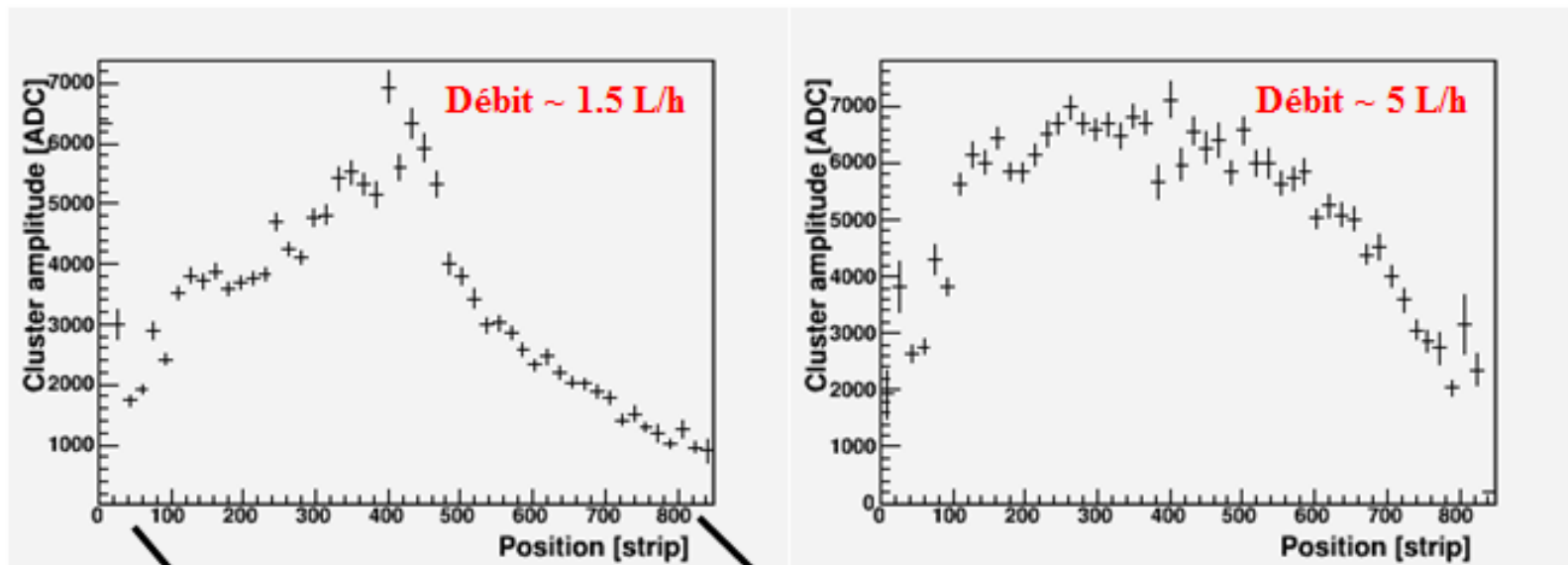
Prototype by ELVIA



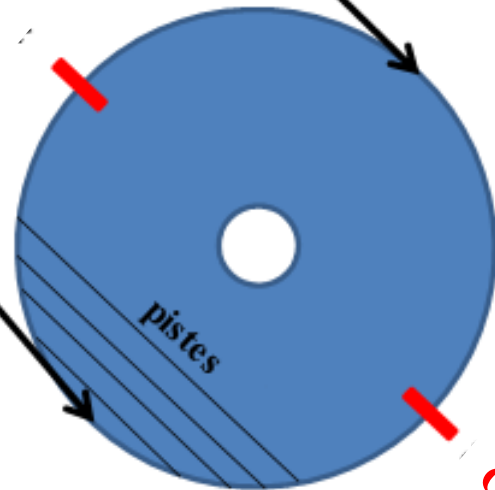
Prototype by CERN



- Excellent efficiency on almost all the detector
- Low efficiency on the top left part of the detector due to gas leak
- Efficiency around 95 %



Inlet

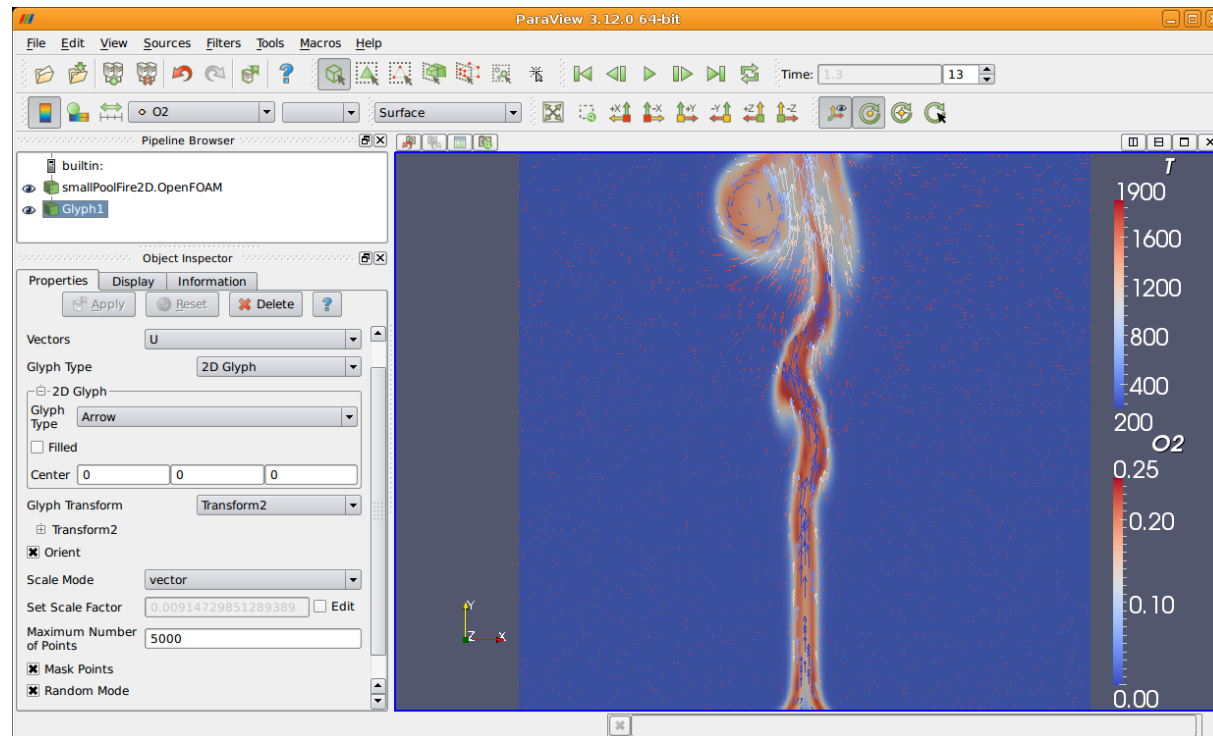


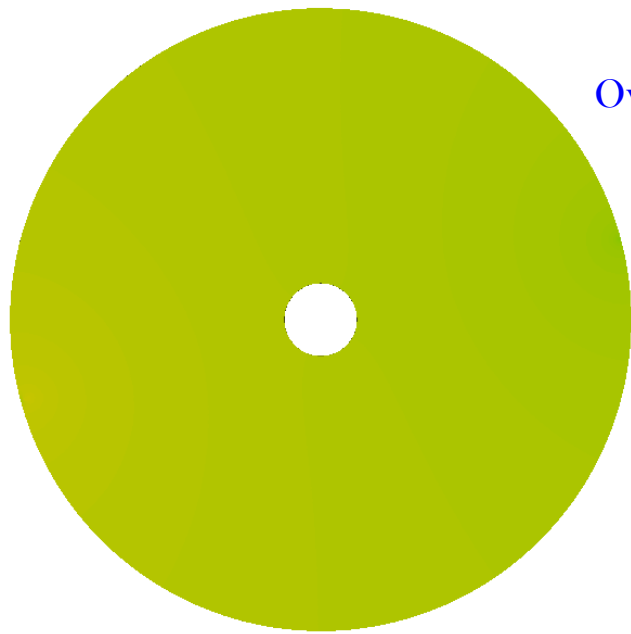
- Open questions:
  - Only leak?
  - Outgassing speed?

- Conditions:
  - Same overall flow rate  $\sim 1.5$  to  $5\text{L/h}$
  - Assuming full volume of gas as an initial state
  - Stationary state calculation representing the renewing of the gas flow during the operation time
  - Similar behavior for laminar/turbulent flow
- OpenFoam for (computational fluid dynamics) CFD calculation of the pressure distribution and the velocity field
- Surface roughness not taken into account

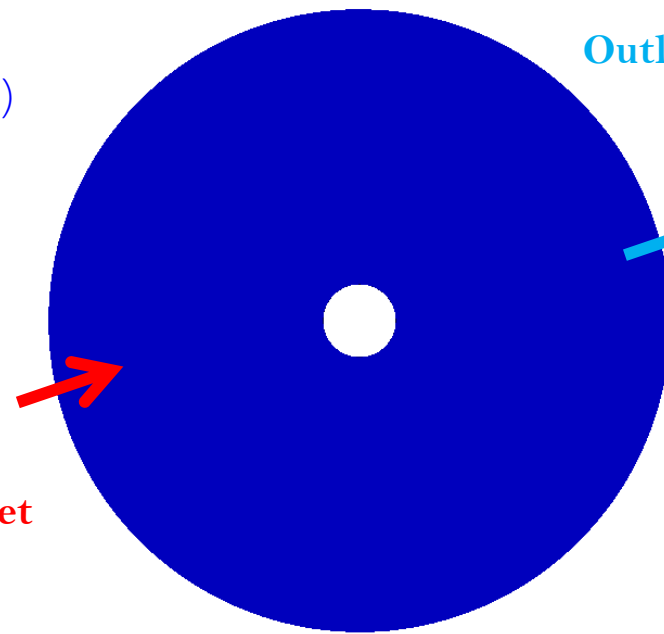
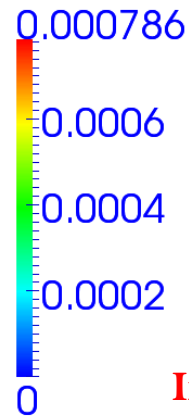


- **OpenFOAM** (Open Field Operation and Manipulation): numerical solvers and pre-/post-processing utilities for the solution of continuum mechanics problems, including computational fluid dynamics (CFD)
- Finite Elements simulation
- Sellami Nadia (SIS) [nadia.sellami@cea.fr](mailto:nadia.sellami@cea.fr)



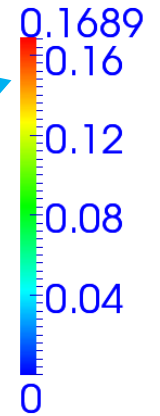


Overpressure (mbar)

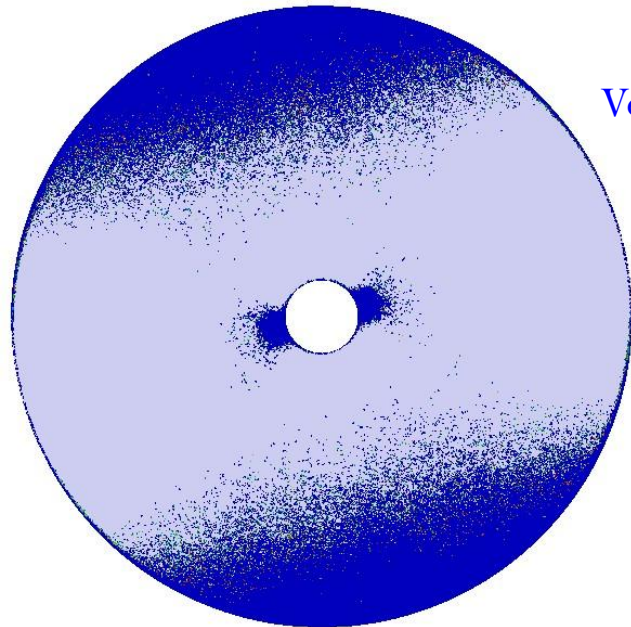


Outlet

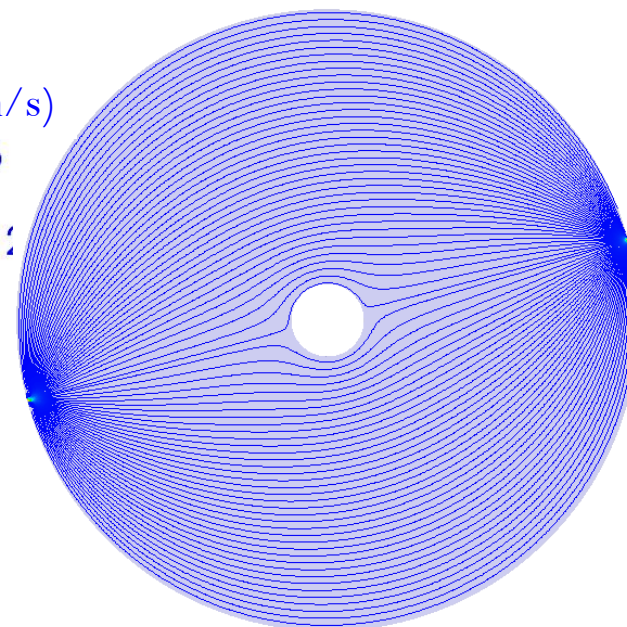
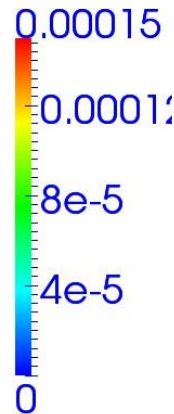
Velocity (m/s)



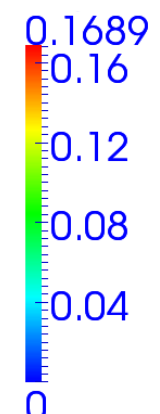
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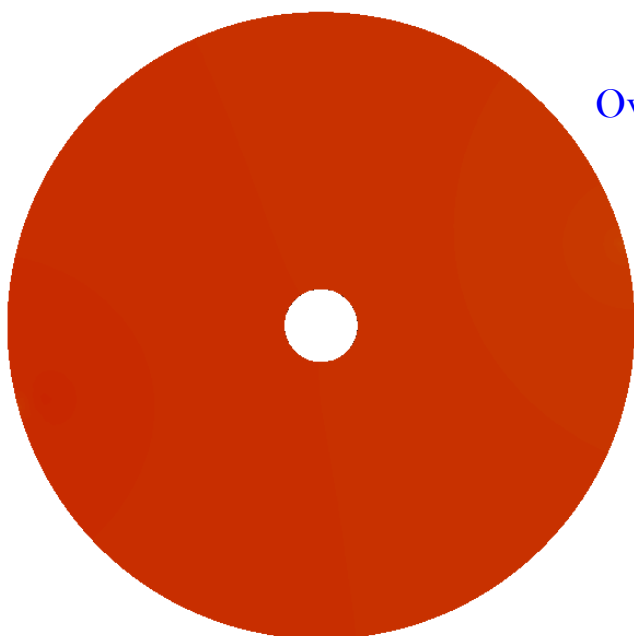


Velocity amplitude (m/s)

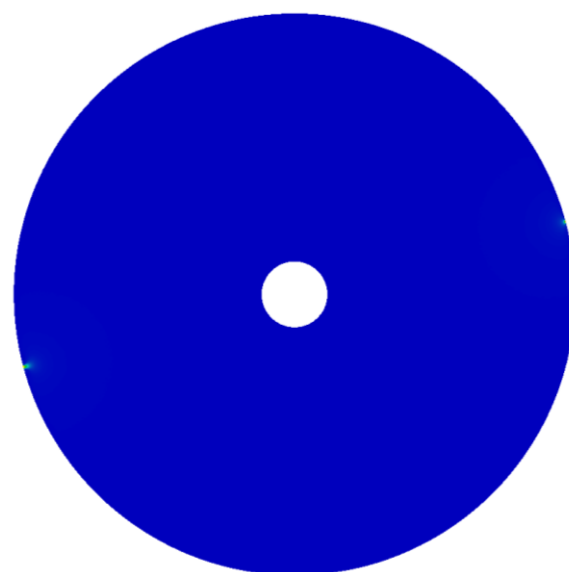
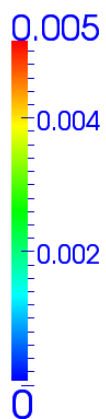


Velocity (m/s)

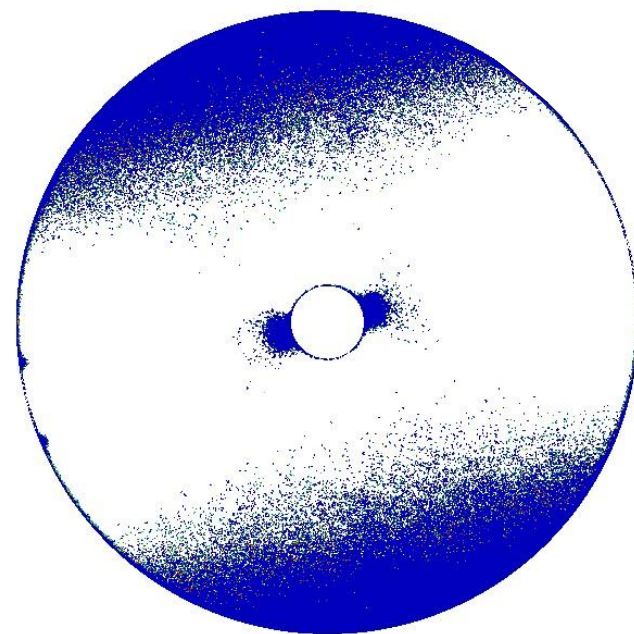
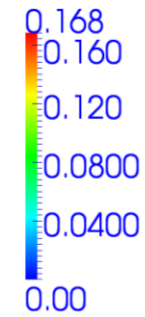




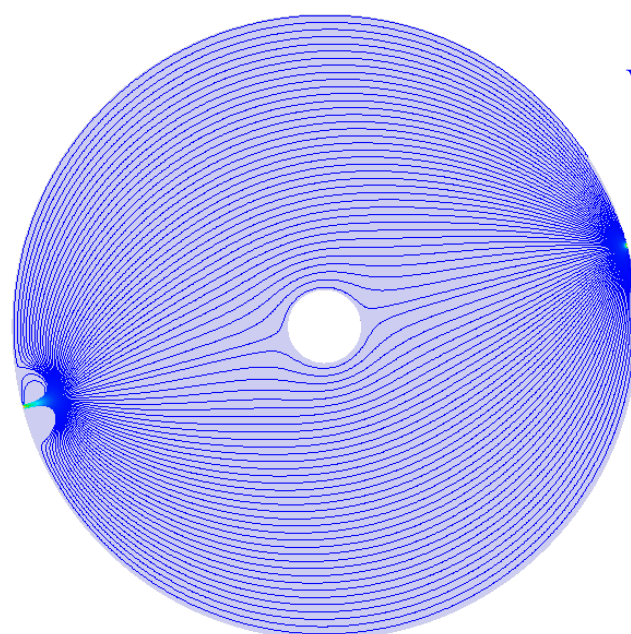
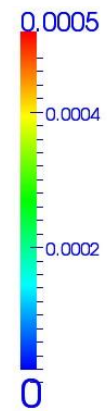
Overpressure (mbar)



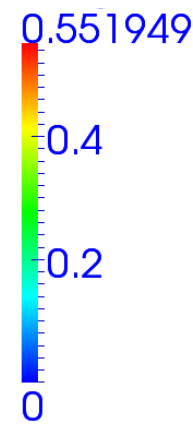
Velocity (m/s)

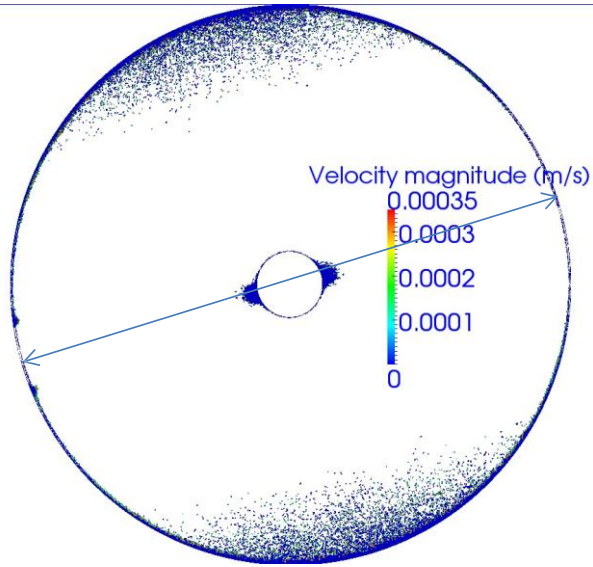


Velocity (m/s)

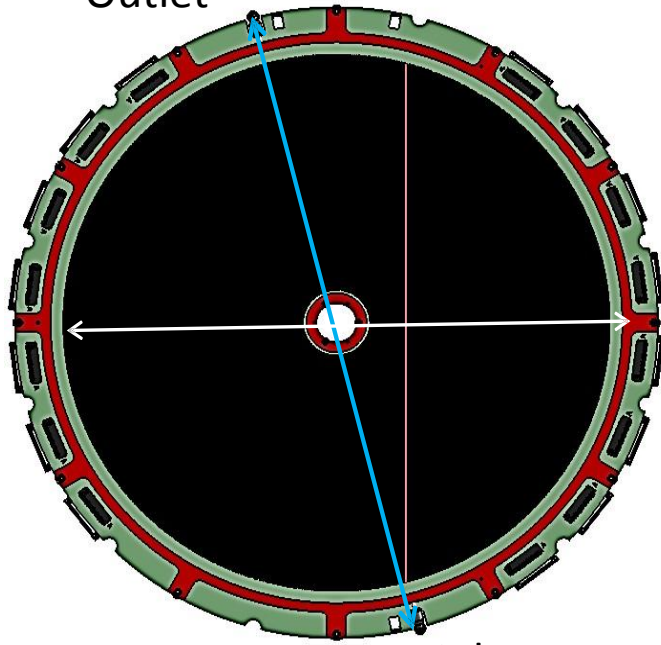


Velocity (m/s)

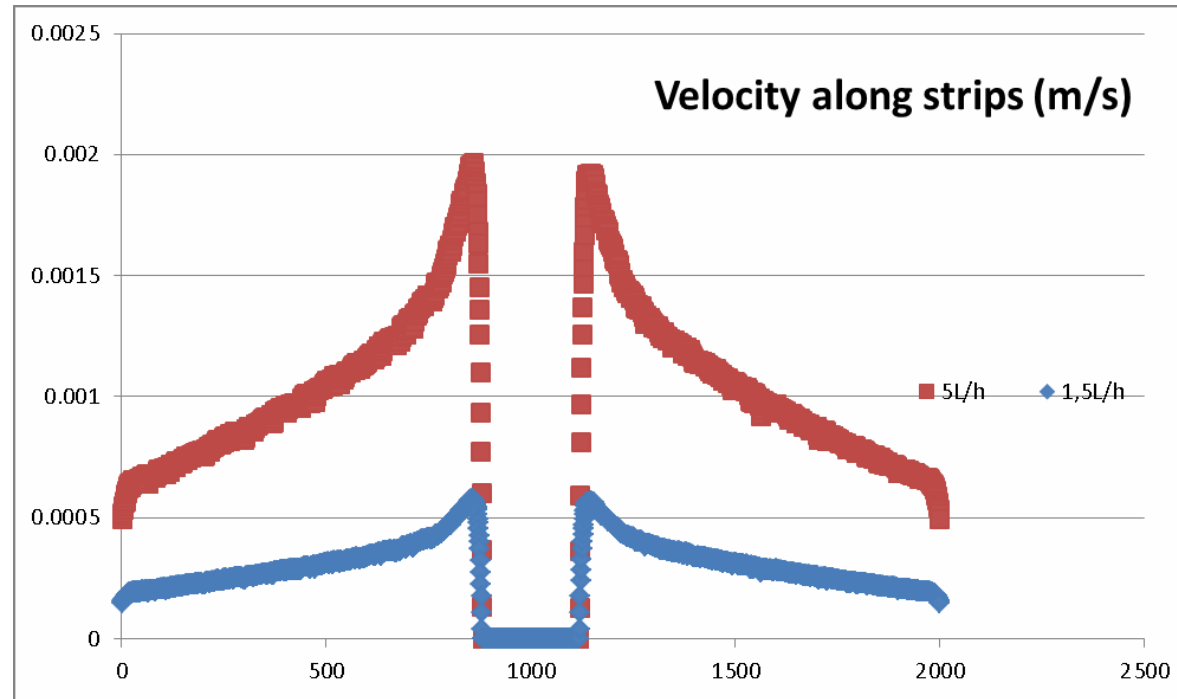


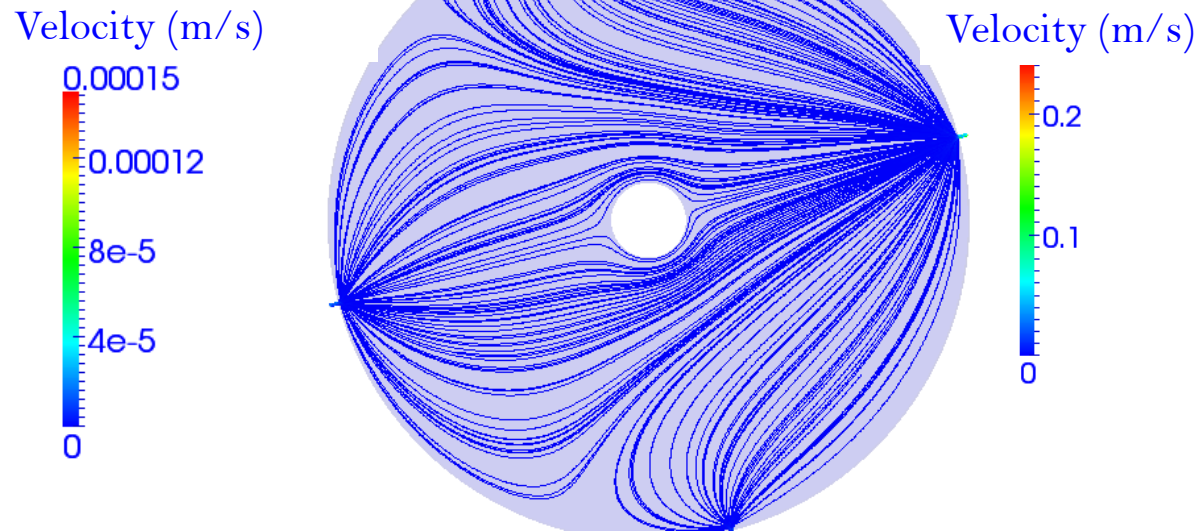
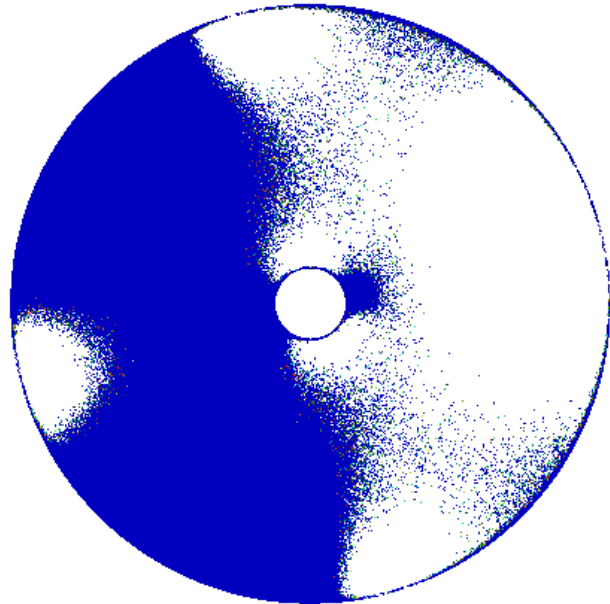
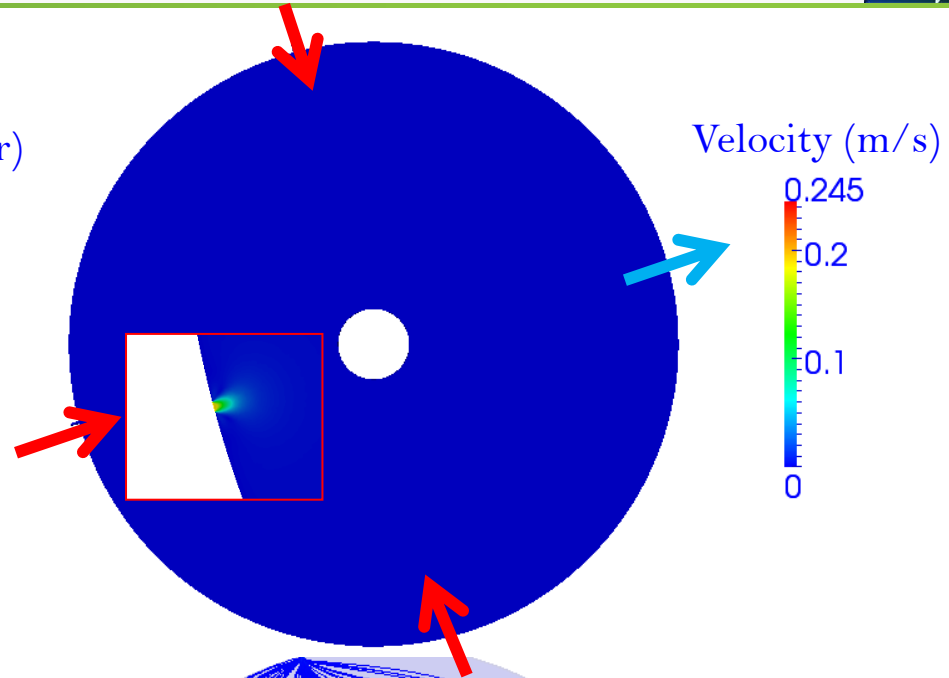
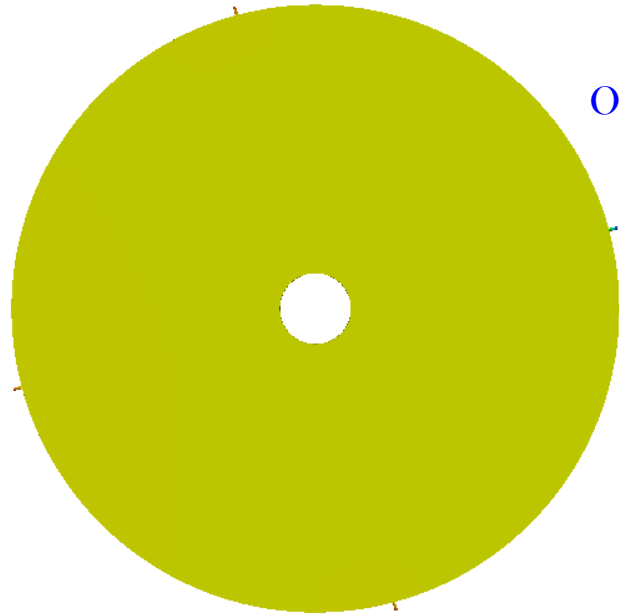


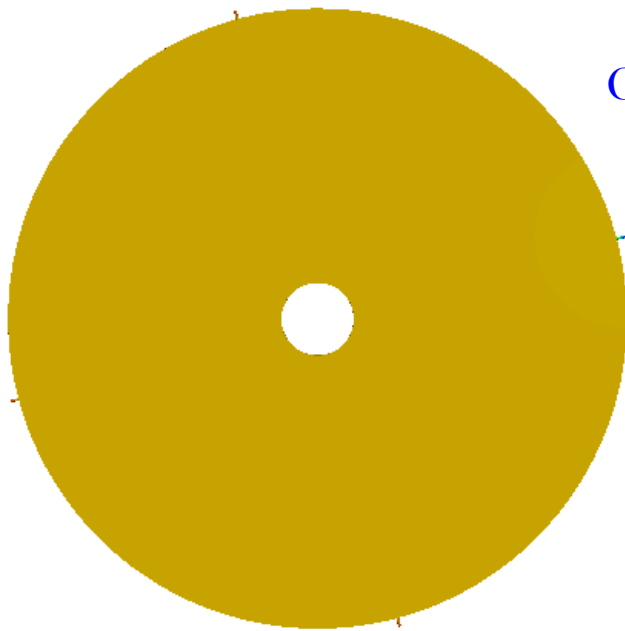
Outlet



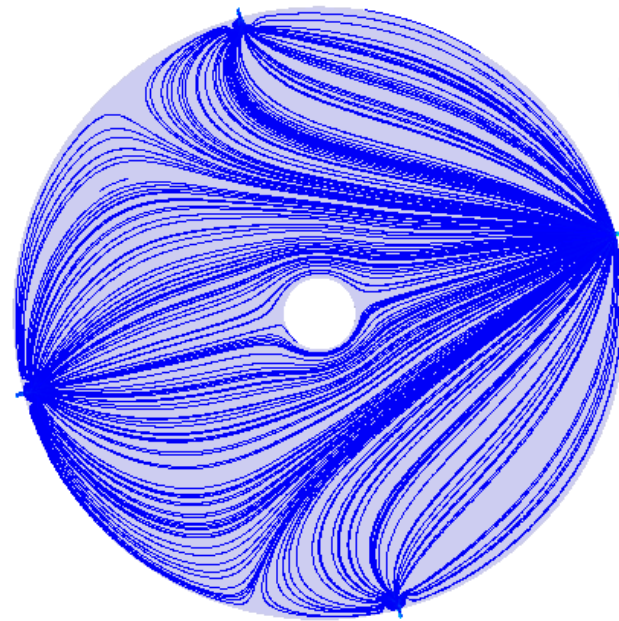
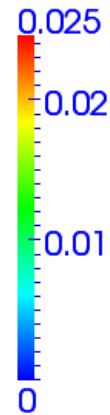
Inlet



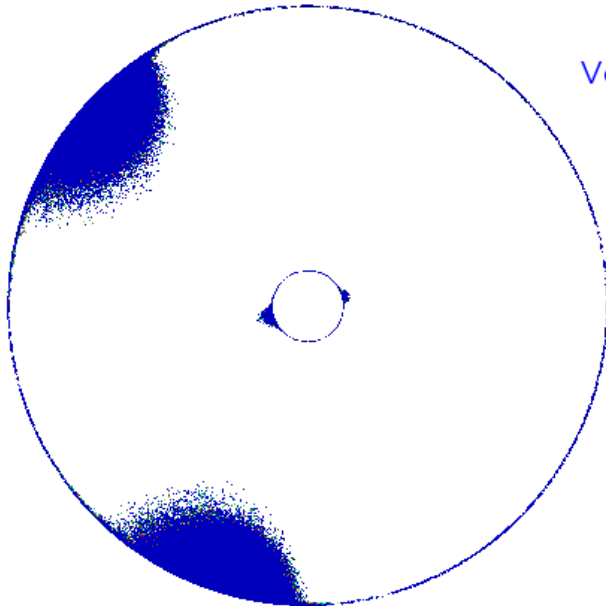
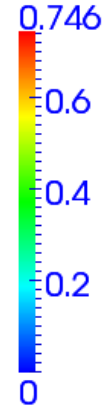




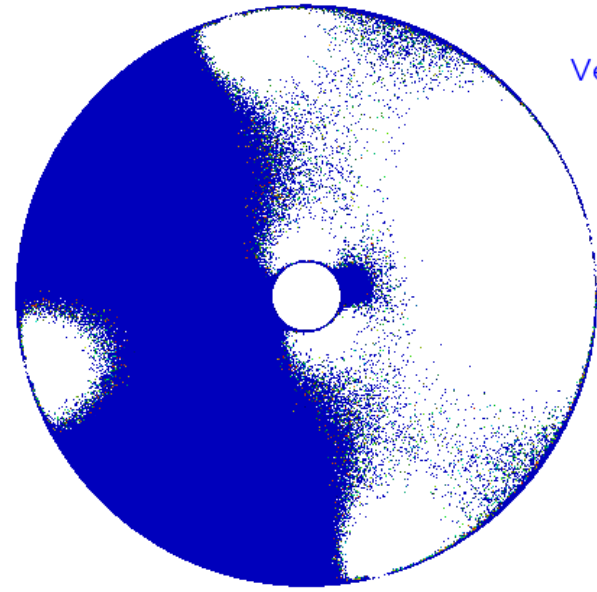
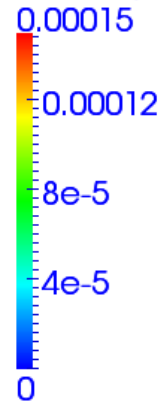
Overpressure



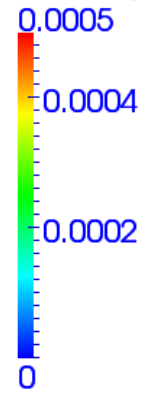
U Magnitude

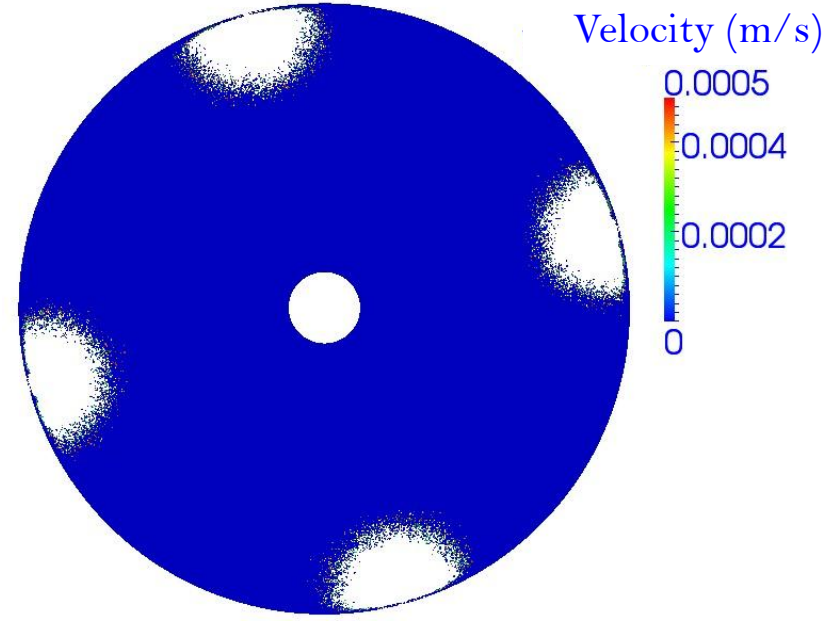
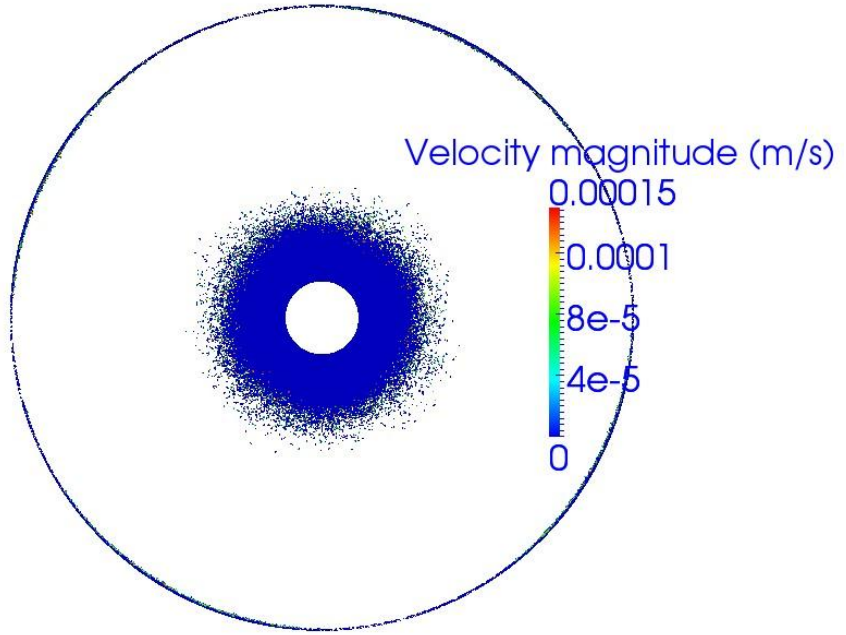
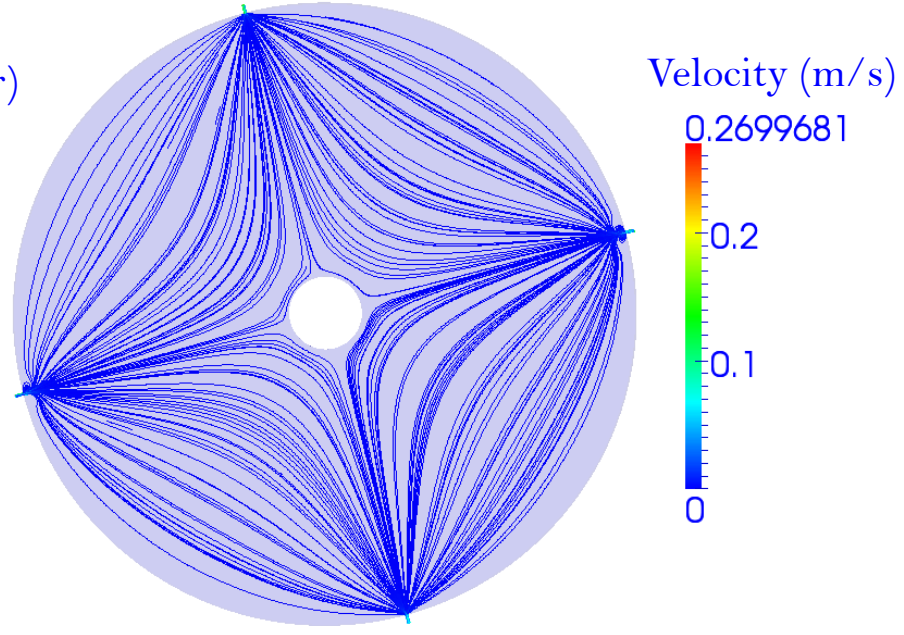
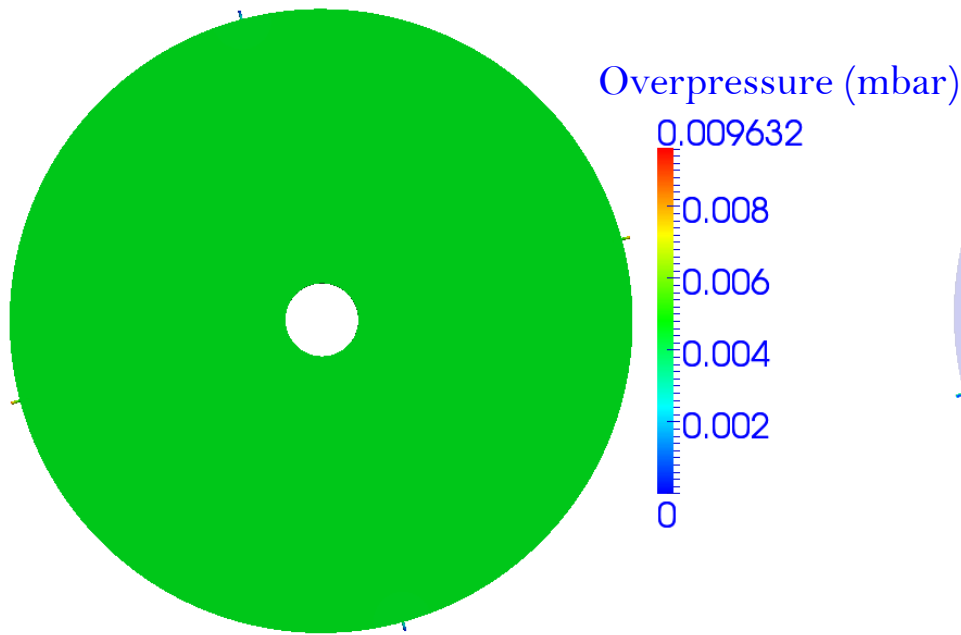


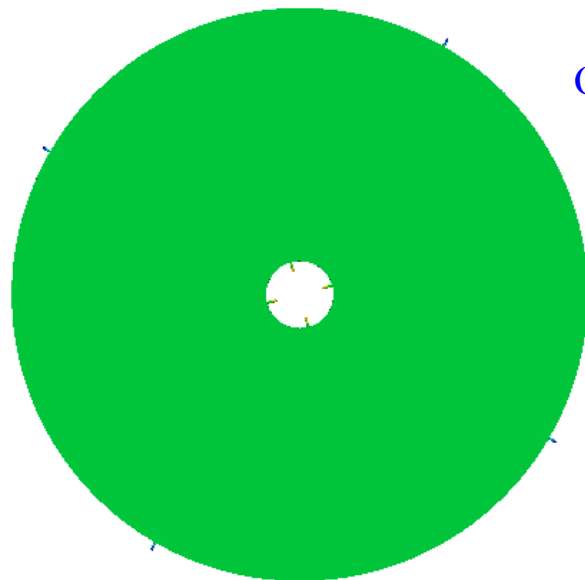
Velocity magnitude



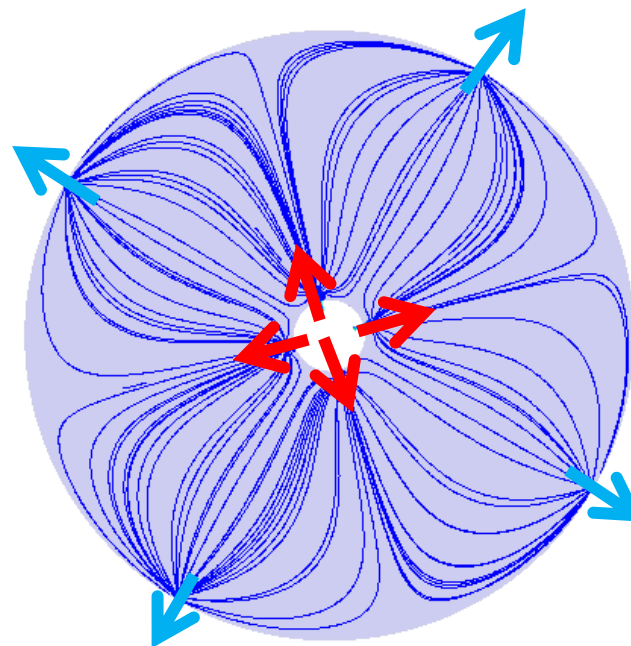
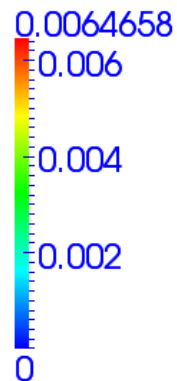
Velocity magnitude



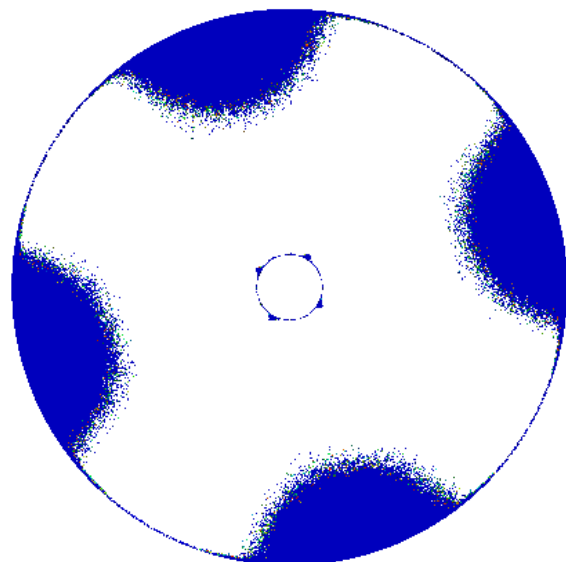




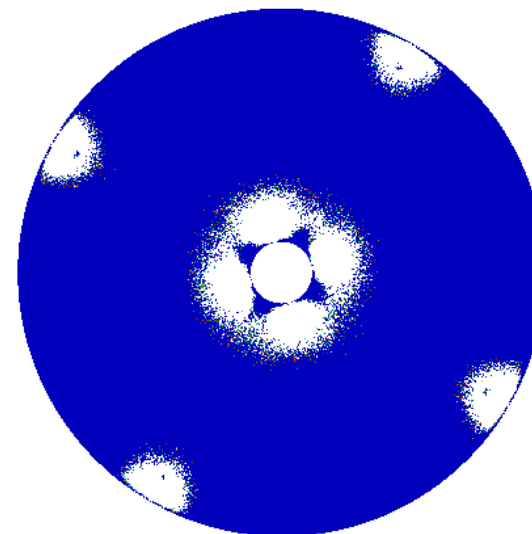
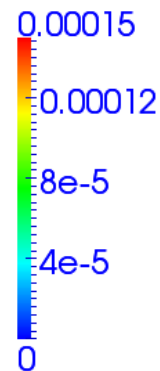
Overpressure (mbar)



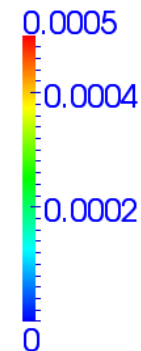
Velocity (m/s)



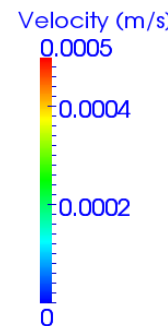
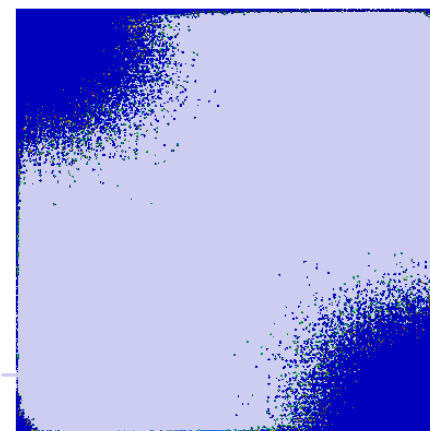
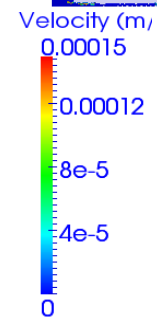
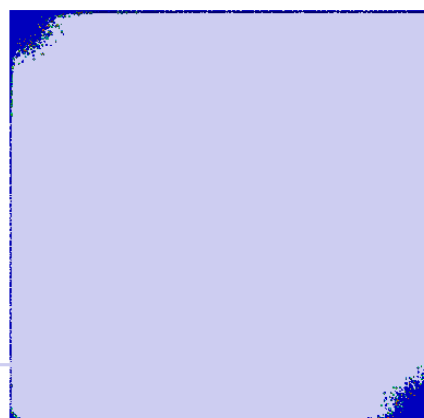
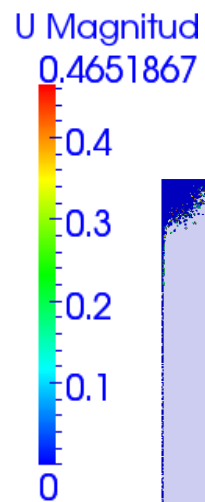
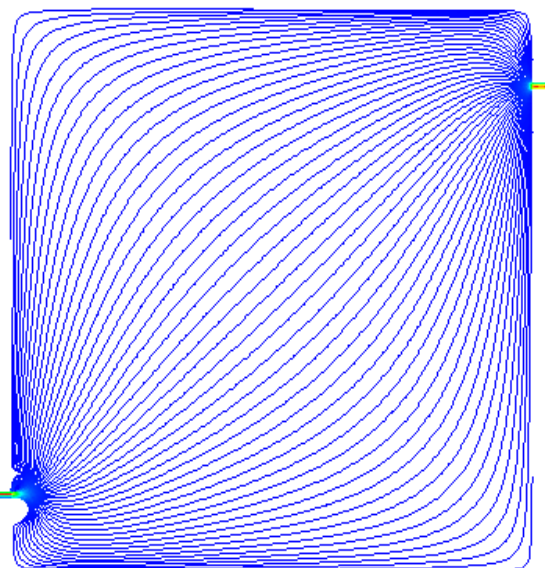
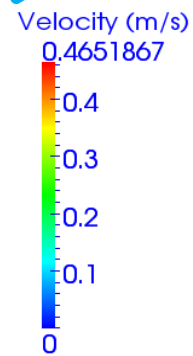
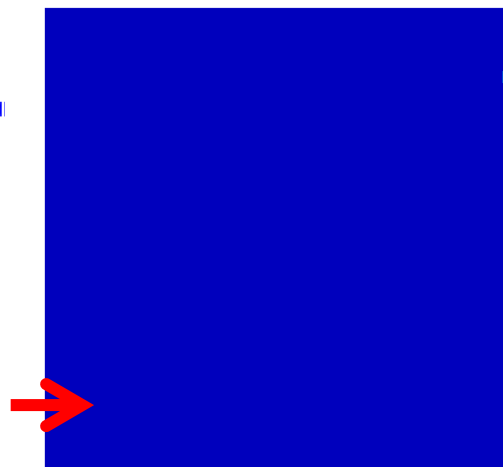
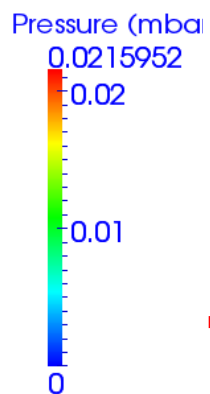
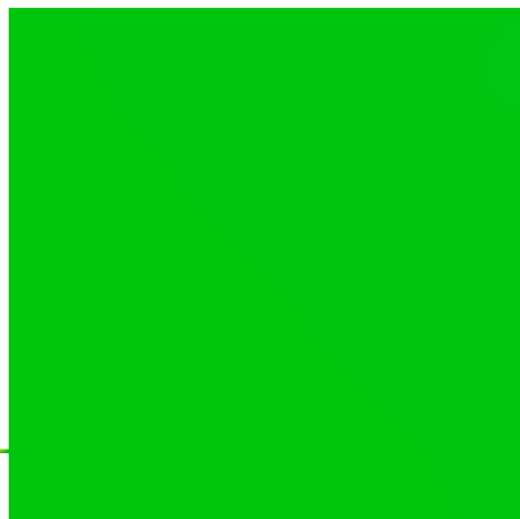
Velocity amplitude (m/s)

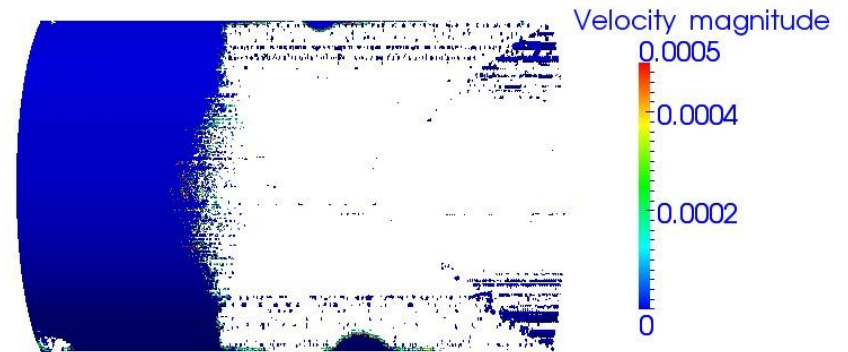
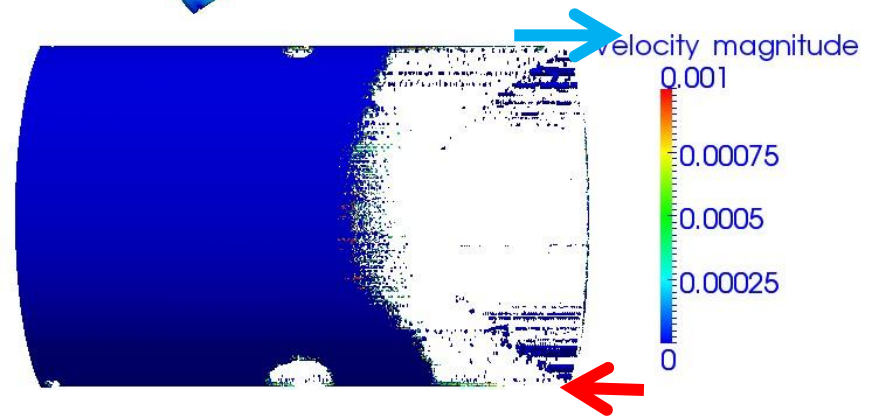
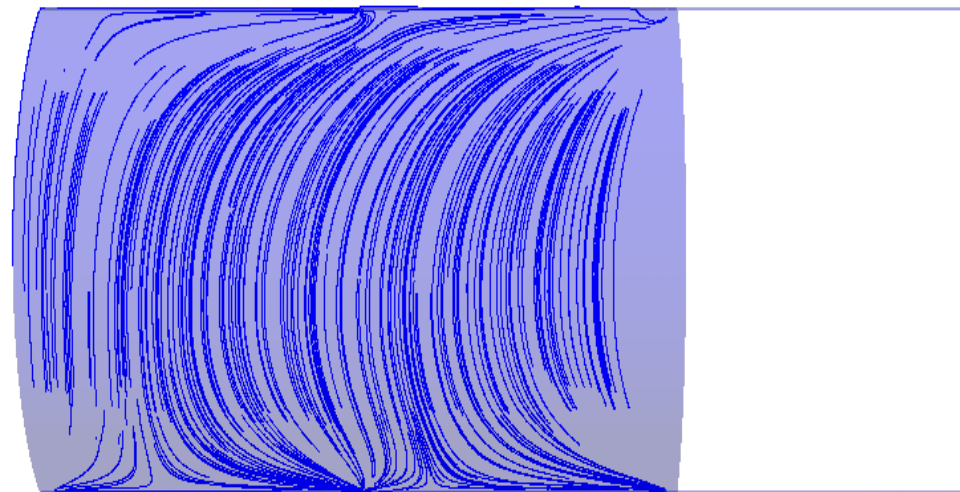
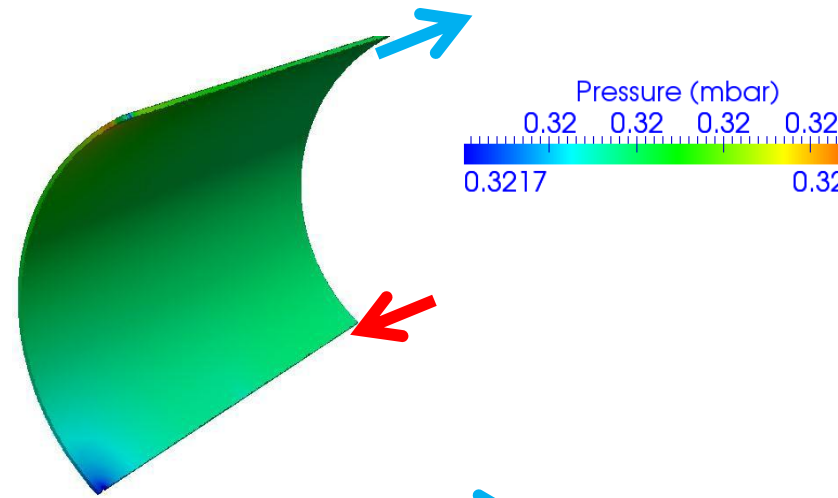
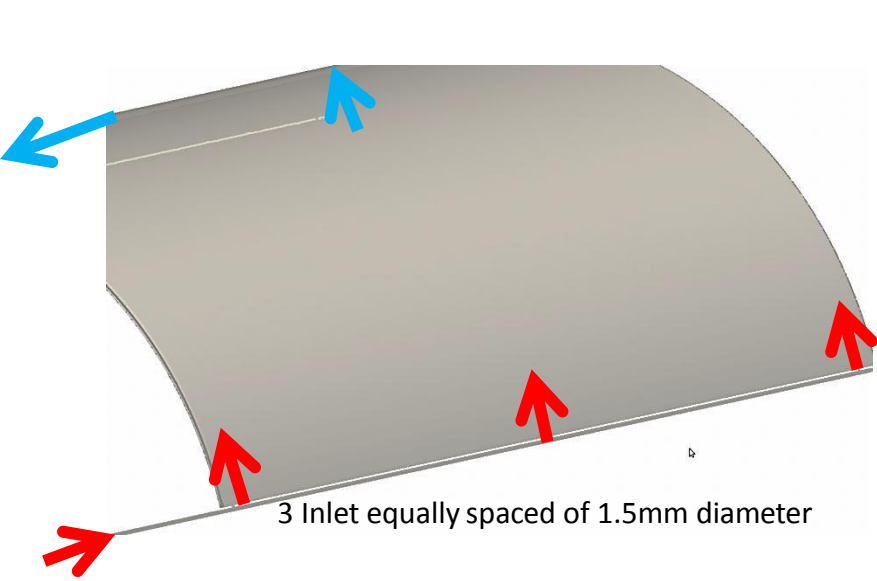


Velocity amplitude (m/s)

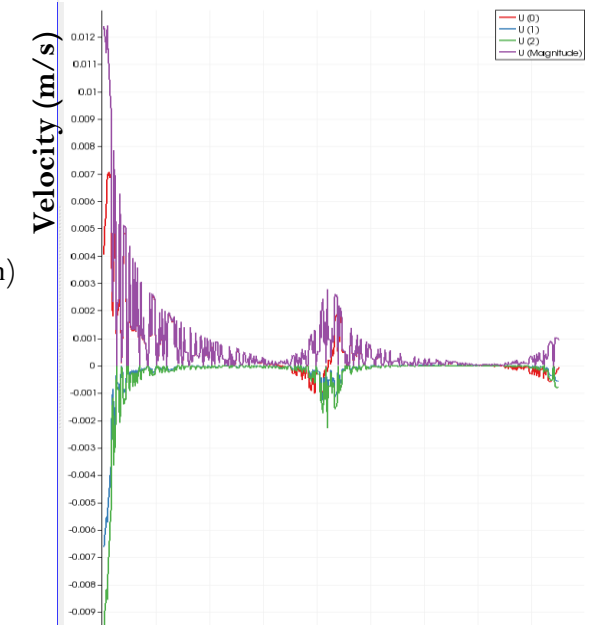
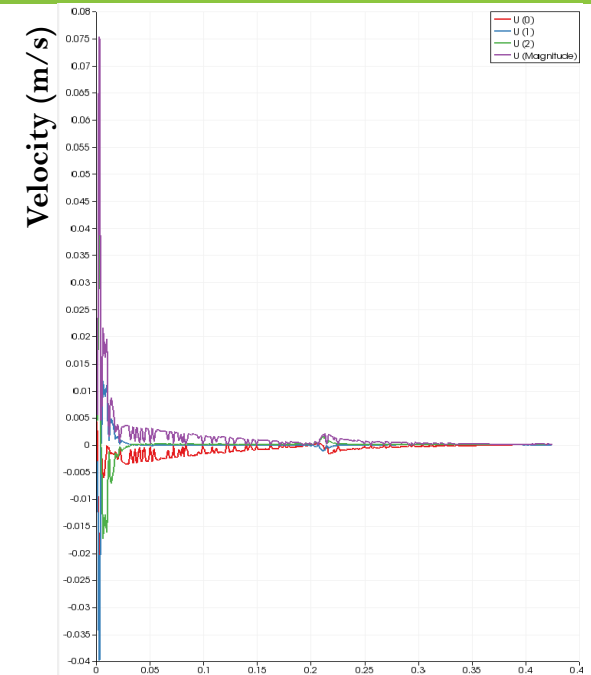
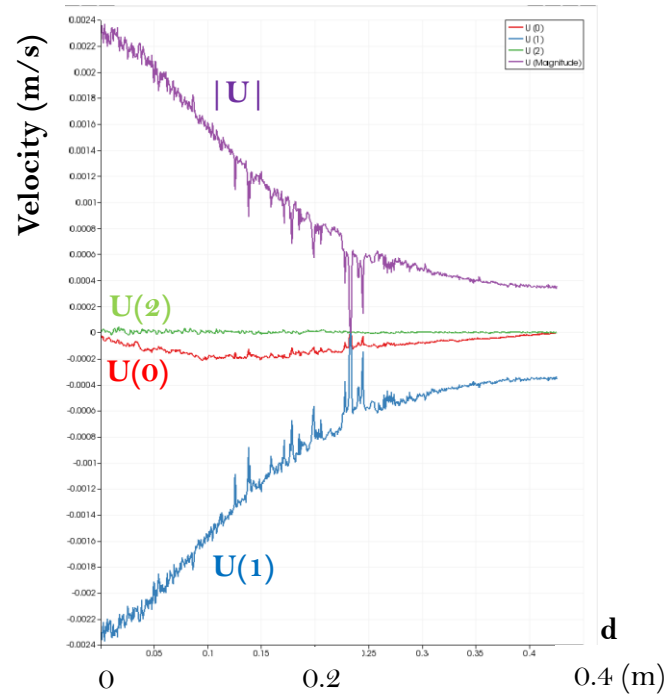
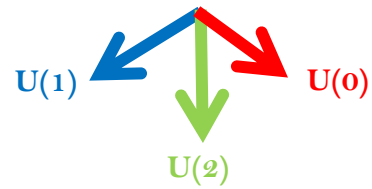
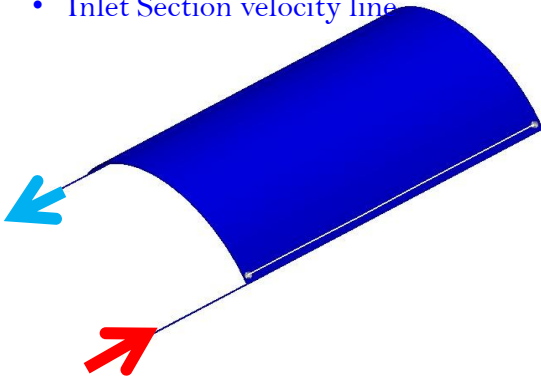




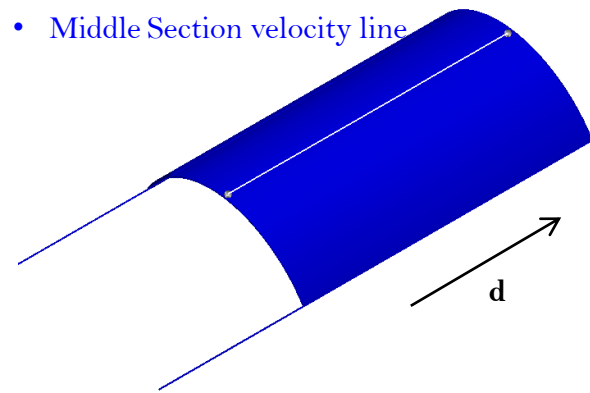




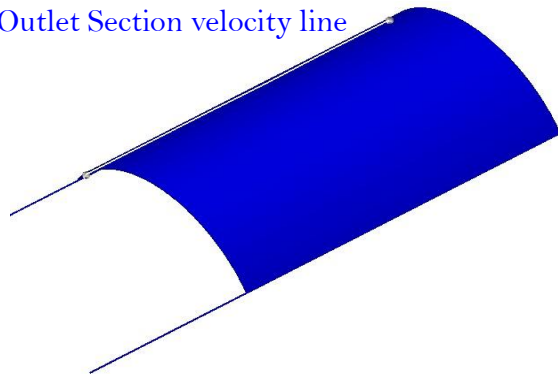
- Inlet Section velocity line

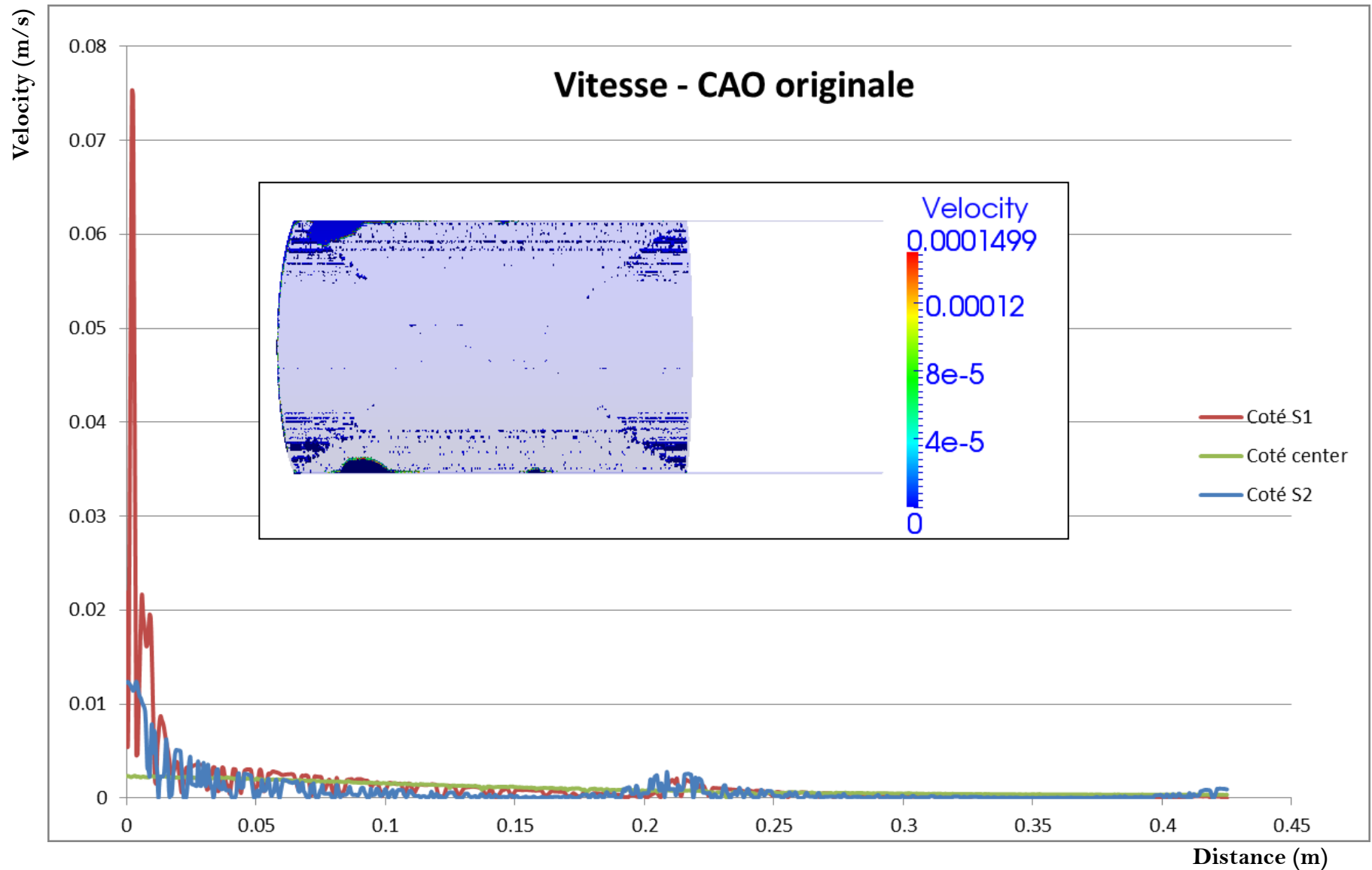


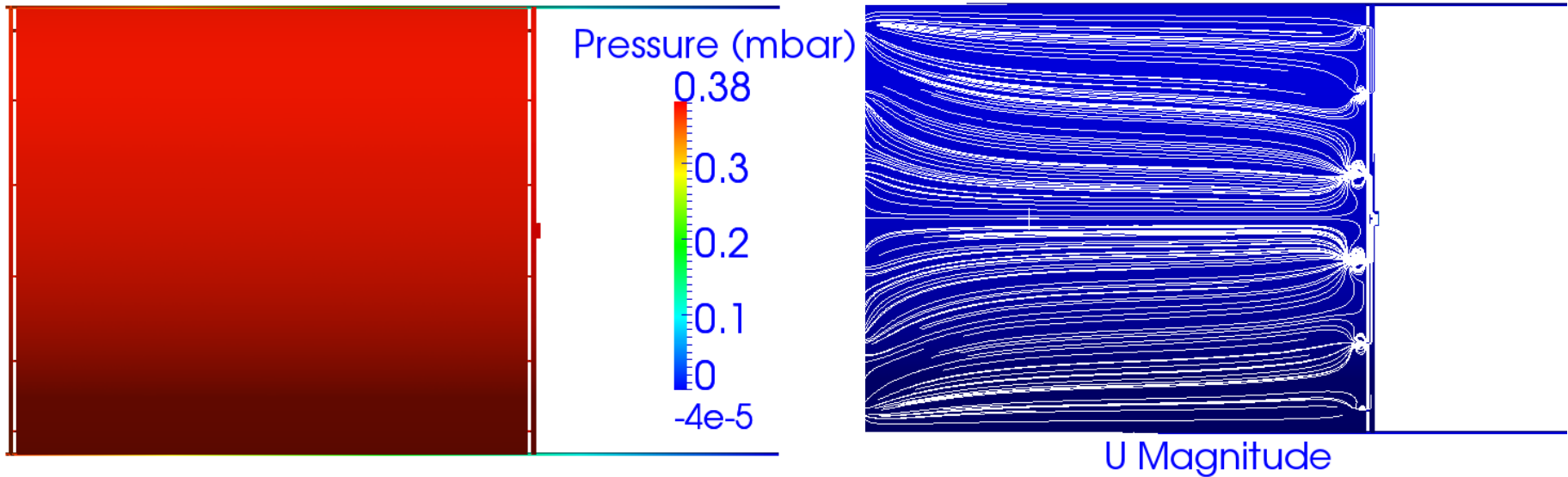
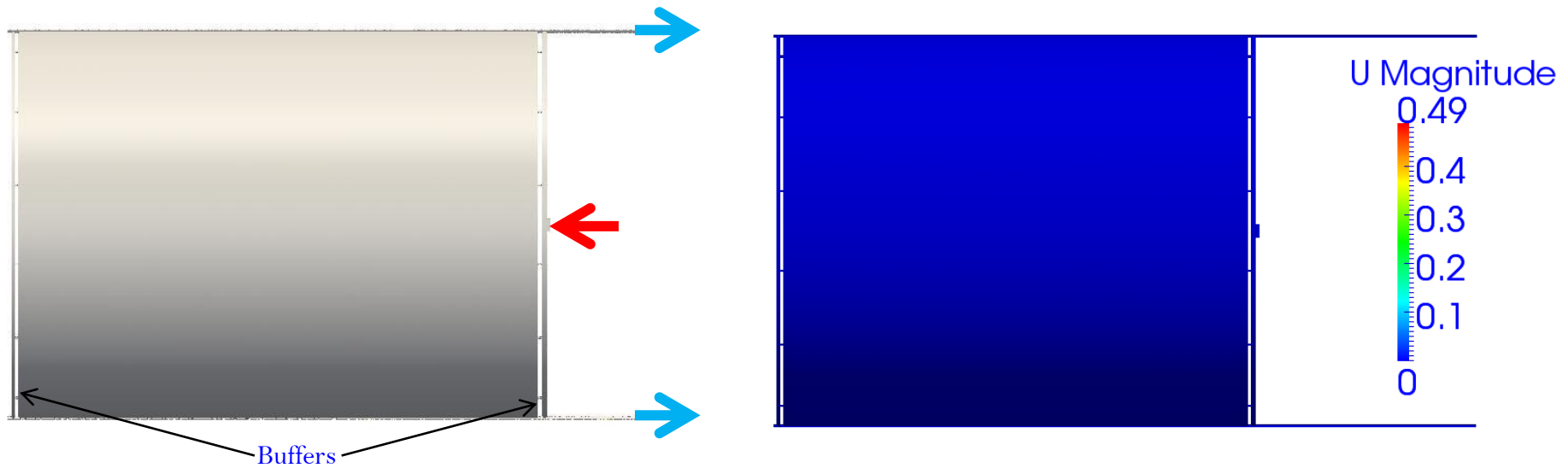
- Middle Section velocity line

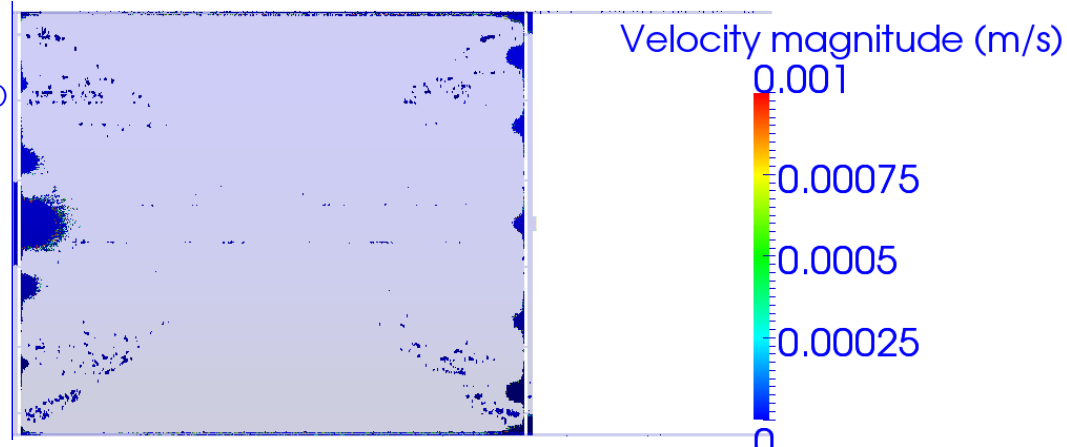
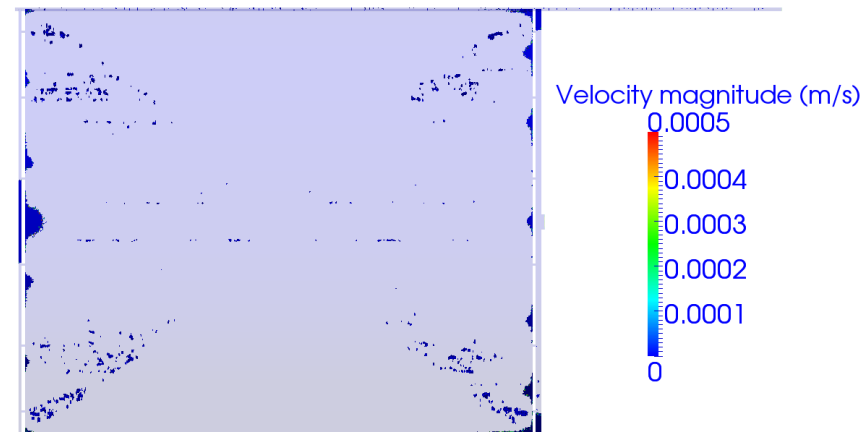
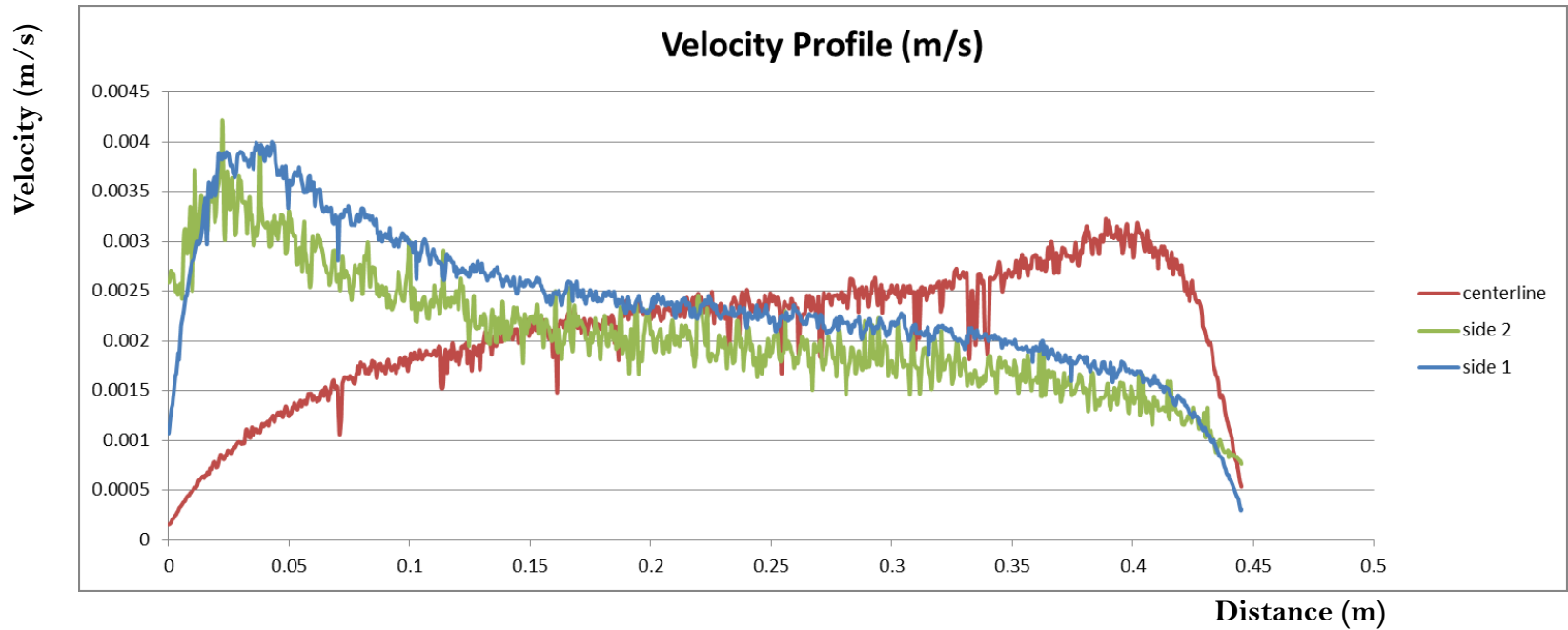


- Outlet Section velocity line









- Small volume chambers are sensitive to outgassing
- Simulation of gas flow have been made to optimize the Clas12 detector design
- For more details, please contact [Nadia.Sellani@cea.fr](mailto:Nadia.Sellani@cea.fr)

