Simulation of complex high Reynolds flows with a VMS method and adaptive meshing

A. Durin*[,a], D. Chalet[a], T. Launay[b], C. Ratajczack[b], L. Silva[c] and T. Coupez[c]

[a] École Centrale de Nantes, LHEEA Lab. (ECN/CNRS), Nantes, France
e-mail: audrey.durin@ec-nantes.fr, web page: https://lheea.ec-nantes.fr

[b] MANN+HUMMEL, Laval, France
web page: https:// www.mann-hummel.com/

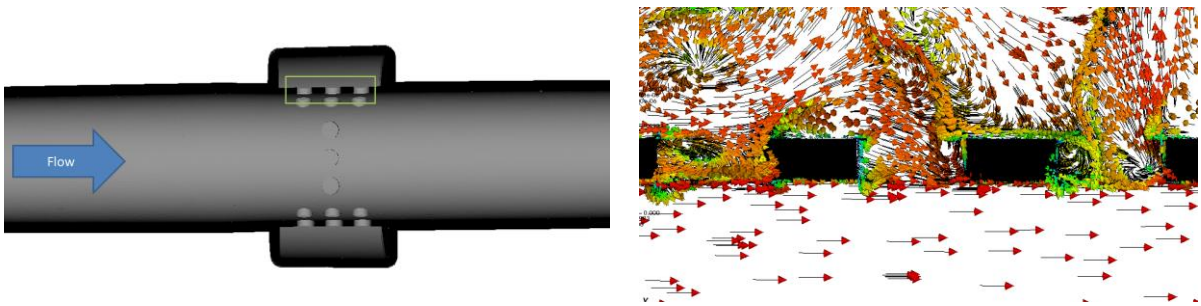
[c] École Centrale de Nantes, ICI Lab., Nantes, France
web page: http://ici.ec-nantes.fr/

ABSTRACT

Many not well understood phenomena occurring in high velocity turbulent flows need very accurate analysis and simulations at different scales. For example, the whistling noise phenomenon, which is related to vortexes appearance in high Reynolds air flows in ducts, implies a very precise description of the flow at the very small scales, especially near the solid walls of the duct, on which boundary layer division may occur.

In our work, the Variational Multiscale method [1] has been coupled to automatic anisotropic adaptive meshing [2], allowing the capture of very complex flows at high Reynolds number. The adaptive procedure is based on the error evaluation on several chosen quantities (phase location, velocity, velocity direction changes) and it provides the capture of very thin flow motions, even close to the walls or boundaries.

In order to show the interest of such approach, simulations of flows on resonator-like geometries have been performed, reputed to whistle for certain flow rates. We have implemented a method to qualitatively discriminate whistling from non-whistling flow rates, based on the appearance of certain vortexes on the obtained flow patterns [3].



(a) (b)

Fig. 1 – Example of flow in a complex geometry at high Reynolds number: (a) half 3D geometry and flow direction, (b) normalized velocity vectors showing local flow direction

REFERENCES

[1] T. Coupez and E. Hachem, "Solution of high-Reynolds incompressible flow with stabilized finite element and adaptive anisotropic meshing", *Comput. Methods Appl. Mech. Engrg.*, Vol. **267**, pp. 65–85, (2013).

[2] T. Coupez, L. Silva and E. Hachem, "Implicit Boundary and Adaptive Anisotropic Meshing", in *New Challenges in Grid Generation and Adaptivity for Scientific Computing*. Springer International Publishing, pp. 1–18, (2015).

[3] J. Jeong and F. Hussain, "On the identification of a vortex", *J. Fluid Mech.*, Vol. **285**, pp. 69–94, (1995).