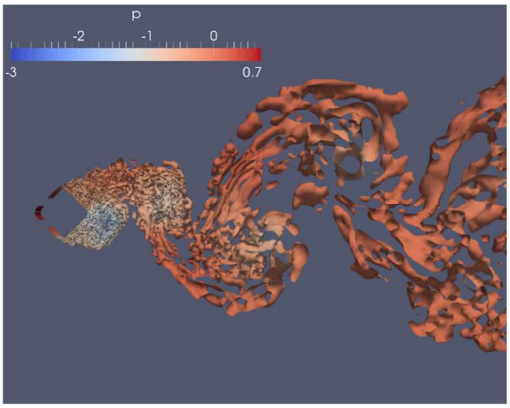
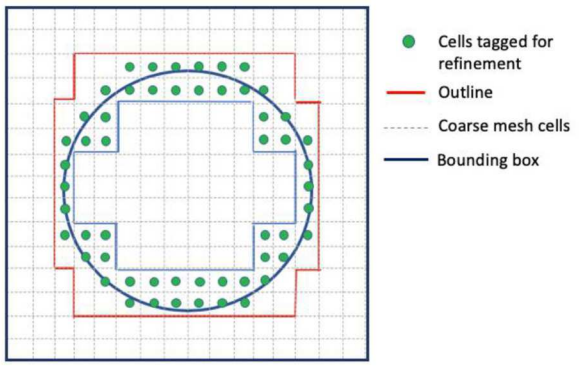
Postdoc fellowship Pprime – R.Tech

Optimization of an Immersed boundary Method (IBM) library for the analysis of wall-bounded turbulent flows





Duration of the contract and start date: the proposed contract is for a duration of 17 months with a scheduled starting date in June 2022. Some flexibility for the latter can be granted depending on the availability of the candidate.

Host Partners: R.Tech, Verniolle (80%) and Pprime Institute-ENSI Poitiers (20%). The candidate will be mainly based in Verniolle and pay some regular visits to the team at ENSI Poitiers.

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Candidate's profile: the candidate must have strong competences in the numerical simulation of turbulent flows. A PhD degree in this area of expertise is required. Previous experience using IBM would be a plus.

Eligibility: the candidate must be a French national citizen with a PhD and/or has obtained a PhD in a French Institution. In any case, the PhD diploma must have been delivered during the academic year 2021-2022 (more specifically, the postdoc position will have to end within the 3 years following the PhD defense date). **These eligibility criteria are mandatory**.

Context: the present research work aims at improving the analysis of complex flow around bodies at high speed, including configurations such as space vehicles, using numerical simulations. For these flows, the accurate prediction of several aspects such as shock waves, heat transfer, turbulence, and surface deterioration are crucial. The boundary of the objects should also be taken into account in a satisfactory manner. To do so, an immersed boundary method (IBM) over a Cartesian grid has been preferred to a classical body-fitted approach. The latter suffers from several disadvantages, not the least being that the numerical cost would be prohibitive for a moving object. R.Tech has developed a library called CYCLONE to include bodies within the computational domain by using the IBM forcing method [1-2]. The objective of this postdoc position is to improve this library, possibly by incorporating a different type of IBM method, such as the sharp interface method [3-4], which is presently under investigation at Pprime Institute. This should lead to an increase of the order of accuracy of the CYCLONE library.

Objectives: the work of the candidate will aim for the development of three synergic tasks, which are listed in the following:

1. Implementation of an interface between the library CYCLONE and an in-house code at Pprime Institute [5].
2. Development of several physical models within the library, which aim to improve the accuracy of the IBM method.
3. Validation of the models developed with application to test cases, such as a heated cylinder [6].

References

[1] A. Pinelli, I. Naqavi, U. Piomelli et J. Favier, «Immersed Boundary Method for generalised Finite Volume and finite Difference Navier-Stokes Solvers.,» Journal of Computational Physics, vol. 229, n° 124, pp. 9073-9091, 2010.
[2] E. Constant, J. Favier, M. Meldi, P. Meliga et E. Serre, «An immersed boundary method in OpenFOAM : Verification and validation,» *Computers & Fluids,* vol. 157, pp. 55-72, 2017
[3] R. Ghias, R. Mittal et H. Dong, «A sharp interface immersed boundary method for compressible viscous flows,» J. Comput. Phys., vol. 225, p. 528–553, 2007.
[4] J. H. Seo et R. Mittal, «A high-order immersed boundary method for acoustic wave scattering and low-Mach number flow-induced sound in complex geometries,» Journal of Computational Physics, vol. 230, p. 000–1019, 2011.
[5] Sebastian R, Marx D, Fortuné V, Numerical simulation of a turbulent channel flow with an acoustic liner, J. Sound Vib. 456, 306-330 (2019).
[6] J. G. Wissink et W. Rodi, «Direct numerical simulation of heat transfer from the stagnation region of a heated cylinder affected by an impinging wake,» J. Fluid Mech., vol. 669, p. 64–89, 2011.