The IMERSPEC Methodology – Presentation and Preliminary Applications

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Abstract: A new numerical methodology (IMERSPEC) combining Fourier pseudo-spectral and immersed boundary methods is being developed for fluid flow problems modeled by the Navier-Stokes equations for incompressible flows. The numerical algorithm consists in a classical Fourier pseudo-spectral methodology using the collocation method where every kind of boundary conditions are forced using an immersed boundary method (Multi Direct Forcing Method). The IMERSPEC methodology was presented by Mariano *et al*. (2010). Its performance was exemplified in two and three-dimensional numerical simulations of the Green-Taylor decaying vortex, the lid-driven cavity and flow over a square cylinder. The convergence rate, the accuracy, the influence of the Reynolds number and external domain size were analyzed. The new methodology combines the advantages of high accuracy and low computational cost provided by Fourier pseudo-spectral methods (FPSM) with the possibility of deal with complex geometries given by immersed boundary method. In this presentation the IMERSPEC methodology was applied to simulate more complex flows: a two dimensional backward facing step and a spatial developing three-dimensional round jet. The main characteristic of this methodology is that it became possible to solve non periodical problem using only the pseudo spectral Fourier method for all the directions of the problem. The pressure-velocity coupling is replaced by a product of a matrix by a vector. There is no more linear system to be solved. The results show the potentiality of a new and promising methodology.

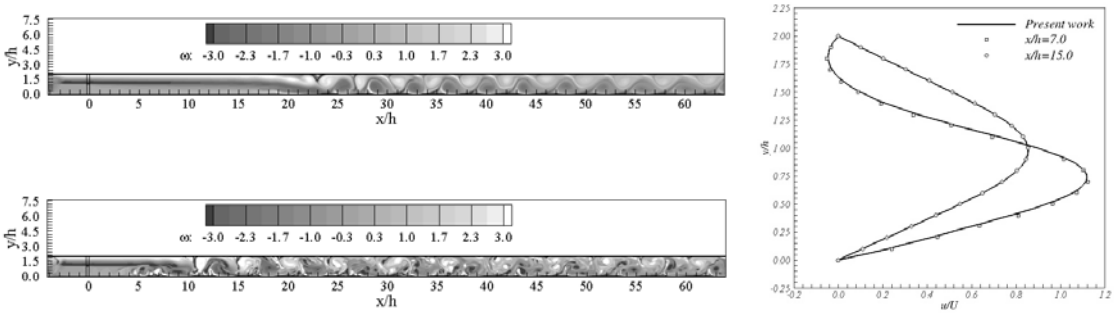

Figure 1. Backward-Facing Step flows: vorticity fields for Re_h=400 and Re_h=2,500; average mean velocity profiles.

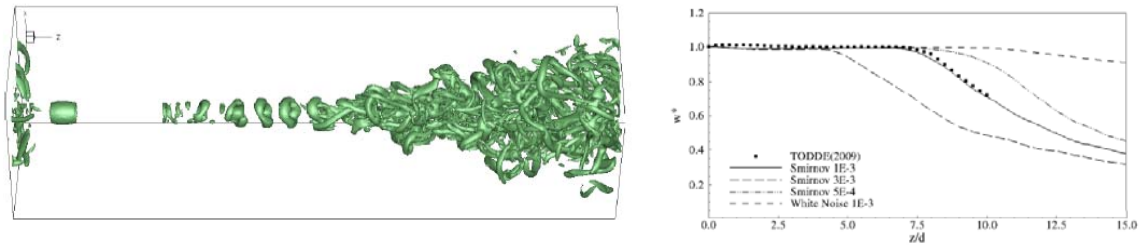

Figure 2. Spatial developing round jet, Re_d=1,050; Q criterion and axial maximum averaged velocity.