Doctoral school of Engineering Science – 072 : Thesis subject

Title: Reconstruction of finely resolved velocity vector fields in turbulent flows from low resolution measurements.

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Laboratory: - The thesis will be done in collaboration between « Laboratoire de Mécanique de Lille » (LML, UMR CNRS 8107, http://www.univ-lille1.fr/lml/) and « Laboratoire d'Automatique, Génie Informatique et Signal » (LAGIS, UMR CNRS 8219). At LML 70 researchers and University teachers work in the fields of Civil Engineering, Solid Mechanics and Fluid Dynamics. The team working on turbulence is recognized for its work on wall turbulence using optical metrology . The *Signal & Image Processing group of the LAGIS* gathers a wide range of expertise ranging from graphical codes to information forensics, object tracking, imperfect data processing, polarimetric imaging and inverse problems.

Fellowship: Lille 1 University & Regional Council, starting: 01/10/2013, duration: 3 ans

Candidate: Highly motivated by research in Fluid Dynamics and/or Signal Processing, she/he has a good background in mathematics and ideally in fluid mechanics. She/he appreciates working in a small team, is autonomous and has initiative. She/he writes and speaks English fluently.

Context and objective: The improvement of experimental techniques combined with the constant increase of computing resources have contributed to a better knowledge of turbulence which remains one of the most challenging problem in physics. The derivation of accurate models for turbulent flows require detailed time and space descriptions of the coherent structures of turbulence. However, the eduction and complete characterization of these structures in high Reynolds turbulent flows remains a very difficult task either experimentally or numerically. The direct numerical simulation (DNS) of realistic turbulent flows will still remain out of reach for a very long time. Moreover no current experimental technique is able to provide the full space and time resolved description of turbulent flows at large Reynolds numbers. Ideally, one would like to measure the three spatial velocity components of the velocity field with a high frequency acquisition rate. The most advanced optical techniques such as PIV (Particles Image Velocimetry) can provide the three velocity components in a plane yet; however the time sampling rate is low compared to the dynamics of the flow. Time resolved data remains restricted to single point or few points measurements distributed sparsely in the flow (hot wire). As a consequence, one has to choose between measurements which are well resolved either in space or in time: no single technique permits a compromise.

The main purpose of this PhD project is to propose a method to numerically reconstruct a measurement with the best space and time resolutions from two different kinds of measurements. This approach will be formulated as an inverse problem where the reconstructed high resolution measurement must be consistent with the two available physical (or numerical) measurements. Several measurements databases will be used to calibrate and validate the proposed approach.