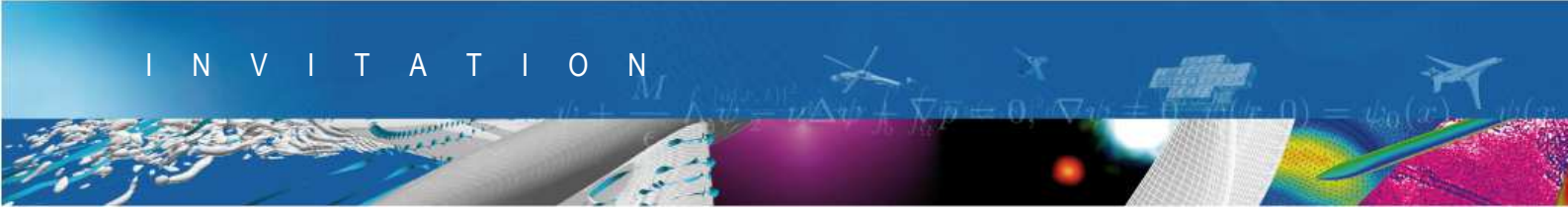

Développement de la PIV tomographique pour l'étude d'écoulements turbulents.

Soutenance de thèse – Adam CHEMINET
19 mai 2016, à 14h00
Salle AY0263 à l'ONERA Meudon

Devant le jury composé de :

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This research dissertation focuses on the developments of tomographic PIV (tomo-PIV) for the measurement of turbulent flows. It is based on the tomographic reconstruction of a volumic intensity distribution of tracer particles from projections recorded on cameras. The corresponding volumic distributions are correlated to obtain 3D displacement fields. The main research focus is on tomographic reconstruction. Indeed, its main limitation is the appearance of *ghost particles* which occurs when high tracer concentrations are required for high spatial resolution measurements.

An initial study on the imaging conditions for tomo-PIV led us to propose an alternative approach to classical tomographic reconstruction called Particle Volume Reconstruction (PVR). The idea is to integrate a more physical interpretation of the particle imaging process into the reconstruction. Implemented into a SMART reconstruction algorithm, we showed through numerical simulations that our method PVR-SMART outperforms classical reconstruction techniques like MLOS-SMART especially in the case of high seeding densities.

We introduce a cross-correlation technique for 3D-PIV (FOLKI-3D) as an extension to 3D of the FOLKI-PIV algorithm. Numerical tests confirmed that its behavior is comparable to the 2D case and quite similar to other standard iterative deformation algorithms. Numerical simulations of tomographic reconstruction characterized the robustness of the algorithm to ghost particles. FOLKI-3D was found more robust to coherent ghosts than standard deformation algorithms.

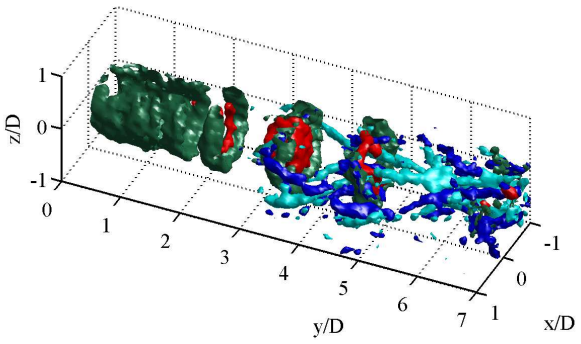

Figure 1 : Near field region of turbulent jet: Isovalues of axial velocity (red) with azimuthal (green) and radial vorticity (cyan and blue) components.

The application of PVR-SMART on experimental data was performed on a turbulent air jet (see figure left). Several seeding densities were used to compare the performance of MLOS-SMART and PVR-SMART on the near field region of the jet. An extensive study of the statistical properties of the flow and its topology showed that PVR-SMART yields velocity fields that are about 50 % less noisy than tomo-SMART.

Mots clés : TOMOGRAPHIC PIV/3D-PIV ; TURBULENCE ; TURBULENT JET ; METROLOGY ; TOMOGRAPHIC RECONSTRUCTION ; SIGNAL PROCESSING