Particle Tracking in Turbulence.

Fluid turbulence leads to a dramatic enhancement of transport and mixing and therefore is of great importance in a wide variety of natural and industrial processes from cloud physics to chemical reactors. These effects arise directly from the violent accelerations experienced by fluid particles as they are buffeted by enormous pressure gradients generated in incompressible turbulent flows. Despite the fundamental importance of these issues, only recently with the advance in detector technology (silicon strip, CMOS) it has become possible to measure the 3D particle trajectories in highly turbulent flows with high spatial and temporal resolution. Here we describe the use of a 3D direct imaging particle tracking technique that measures simultaneously the position, velocities and accelerations of many particles advected by the flow with very high temporal and spatial resolution. We report measurements of the statistical properties of turbulence both in space and in time when measured along the trajectory of a particle. Properties reported will include particle acceleration, Eulerian and Lagrangian velocity structure functions, two particle dispersion, and multi particle dynamics. The results are compared with predictions from Heisenberg (1948), Richardson (1925), and Batchelor (1956).

"Fluid particle accelerations in fully developed turbulence" A. La Porta et al., Nature 409, 1017-1019 (2001).
“The Role of Pair Dispersion in Turbulent Flow”. M. Bourgoin et al., Science 311, 835-838 (2006).