Resolving the dynamics of inertial solid particles approaching a contraction in a turbulent circular pipe using index-matched tomographic imaging

Dvir Feld*, Gal Friedmann*, Jibu Jose* and Omri Ram*

The effect of solid inertial particles on the transient evolution of the flow in a pipe is studied using time-resolved tomographic Particle Image Velocimetry (PIV). The 40 mm pipe, as well as the 1/8" acrylic spheres, are refractive index matched to the fluid in the system using 62% solution of Sodium Iodide, which facilitates unobstructed optical access across the pipe and particles without distortions or reflections[1]. Four Phantom v2640 4MP cameras capture the flow which is seeded with 10-micron tracer particles at 6600Hz, from which the time-resolved 3D flow field is reconstructed. The current study attempts to better understand the two-way coupling between the solid particle dynamics and the flow field. The study focuses on the effect of area contraction in the pipe. Refractive index matching allows us to characterize the flow before and after the obstruction and capture the flow around the solid particles as they move through the contraction. The results will be used to understand the mechanisms that affect the particle's motion, fluid-particle interaction, and individual particle-wall interactions[2]. Furthermore, the measurement will allow for calculating the pressure distribution across the channel using 3D GPU-based parallel line omni-directional integration of the material acceleration[3]. The current contribution focuses on the interaction of an individual solid particle that moves through a contraction. The turbulence statistics associated with the abrupt contraction in the center of the circular channel are investigated before the addition of solid particles. Preliminary flow measurements past the abrupt contraction (from D=40mm to D=20mm) are provided in figure 1 taken with Reynolds number of 73000. The talk will present further details on the experimental technique, flow measurements, and the measurements of the solid sphere moving through the contraction.

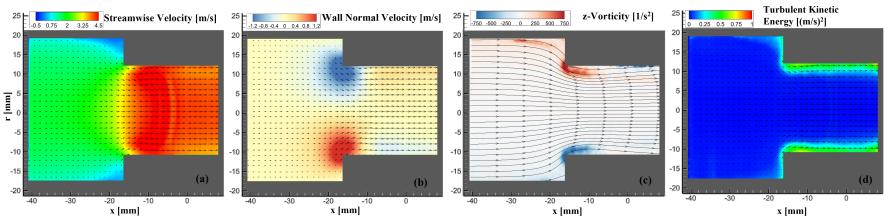

Figure 1: Averaged results for mid plane in circular channel flow (a) Streamwise velocity; (b) Wall normal velocity; (c) Vorticity with streamlines and (d) Turbulent Kinetic Energy estimated from 500 realizations at Re_d=73000

*Faculty of Mechanical Engineering, Technion - Israel Institute of Technology, Haifa, Israel

[1]Bai and Katz, *Exp in Fluids.* **55(4)** (2014).
[2]Shokri et al., *Int. J. Multiphase Flow.* **89** (2017).
[3]Wang and Katz, *Exp in Fluids.* **60(4)** (2019).