Carrier phase (second order finite difference DNS solver)

The domain size in the streamwise, wall-normal, and spanwise direction is $\mathbf{4}\pi\delta \times \mathbf{2}\delta \times \mathbf{2}\pi\delta$ and the corresponding grid $\mathbf{192} \times \mathbf{128} \times \mathbf{160}$, respectively. Computations are operated at $\mathbf{Re_b} = \mathbf{2280}$ (based on the bulk velocity and the channel half-width) and the flow rate is kept constant. The Reynolds number based on the wall-shear velocity is **155**. The second order finite difference DNS solver is based on the model proposed by Orlandi (2000). The time discretisation is semi-implicit, *i.e.* the non-linear terms are written explicitly with a third-order Runge-Kutta scheme and the viscous terms are written implicitly using a Crank-Nicolson scheme. In the wall-normal direction, the mesh is stretched according to a hyperbolic tangent law, whereas a uniform mesh is applied in the streamwise and spanwise directions. The computational time step is $\Delta t^+ \approx 0.05$.

Dispersed phase

For the initialization and the computation of the statistics of the dispersed phase, the domain is divided in the wall-normal direction into 128 slices with each slices thickness being equal to the wall-normal grid spacing.

Initially, **5000** solid particles were distributed homogeneously in each slice. The total number of particles was thus chosen to be equal to **640 000**.

Statistics on the dispersed phase were started after a time lag of approximately $t^+ = 600$ in order to get results independent of the imposed initial conditions.

Concerning the smooth wall boundary conditions of the dispersed phase, perfectly elastic collisions were assumed when the particle center was at a distance from the wall lower than one radius. Furthermore, as soon as particles moved out of the computational domain, they were re-introduced via periodic boundary conditions.

References

Orlandi, P.: 2000, *Fluid Flow Phenomena. A numerical toolkit*, Kluwer Academic Publishers.