Erratum

- The part "RandomWalk" contains misstakes which are corrected here.
- The figures 6, 7 and 8 in the article erroneously display the sampled instantaneous values instead of the average. The figures presented here are corrects. The corresponding comments in the part "Results- Nuclei density sensitivity to particle properties" are modified.

In reality, small particles have a short relaxation time and respond quickly to the flow fluctuations. Turbulence diverts the particles from their trajectory and small particles are trapped in eddies for a certain period of time. Not accounting for this leads to that the particles will follow the stream lines of the mean flow. Here we use a random walk model (Gosman & Ioannides (1983)) to include the effect of turbulent dispersion of the particles, i.e. eddies are created randomly and affect the particle trajectory. In practice, a local fluctuating component is added to the fluid velocity at the position of the particle, i.e. $\mathbf{U}_{@P}$ becomes $\tilde{\mathbf{U}}_{@P} = \mathbf{U}_{@P} + \mathbf{U}_{@P}^{fluct}$. The local fluctuating velocity can be estimated by

$$\mathbf{U}_{@P}^{fluct} = \psi\sqrt{\frac{2}{3}k} \qquad (22)$$

where ψ is a random number generated from a Gaussian distribution of zero mean and variance 1 ($\psi \in N(0,1)$) and $\sqrt{\frac{2}{3}k}$ is the local RMS fluid velocity fluctuations for isotropic turbulence. The eddy life time (t_e) and the time needed by the particle to traverse the eddy (transit time t_{tr}) are calculated as

$$t_e = \frac{C_\mu^{0.63}\frac{k^{1.5}}{\epsilon}}{|\mathbf{U}_{@P}^{fluct}|} \qquad (23)$$

$$t_{tr} = -\tau_P ln(1 - \frac{l_e}{\tau_P|\tilde{\mathbf{U}}_{@P} - \mathbf{U}_P|}). \qquad (24)$$

The random walk algorithm consists of evaluating $\mathbf{U}_{@P}^{fluct}$ according to equation (22) and a random number ψ, calculating the characteristics times t_e and t_{tr} and keeping $\mathbf{U}_{@P}^{fluct}$ constant during the interaction time $t_{int} = min(t_e, t_{tr})$.

In order to compare the influence of the size and the density, as well as the turbulence modeling, the averaged nuclei distribution has been sampled on the vertical line which goes through the lowest pressure region (line 2 in Figure 5). The average number of nuclei is sampled in Figure 6, 7 and 8. It shows that the dark blue layer in Figure 4 corresponds to a nuclei content lower than the far field density (which is 2.1e8). This layer is thicker (around 0.5 mm instead of 0.1 mm) for nuclei larger than 10 μm. For large nuclei, the distribution is very dense on the surface, exactly in the low pressure cells. For small nuclei, the high density is located from 0.1 to 0.3 mm away from the surface, and the peak is much lower. Particle with lower density behave like particles with diameter smaller than 20 μm (Figure 7).

The random walk model has an impact on the nuclei distribution, as shown in Figure 8. When turbulent dispersion is accounted for, the nuclei distribution is very dense on the surface of the hydrofoil while there is no nuclei on the first 0.2 mm near the surface without turbulent dispersion. Furthermore the oscillations away from the surface are damped.

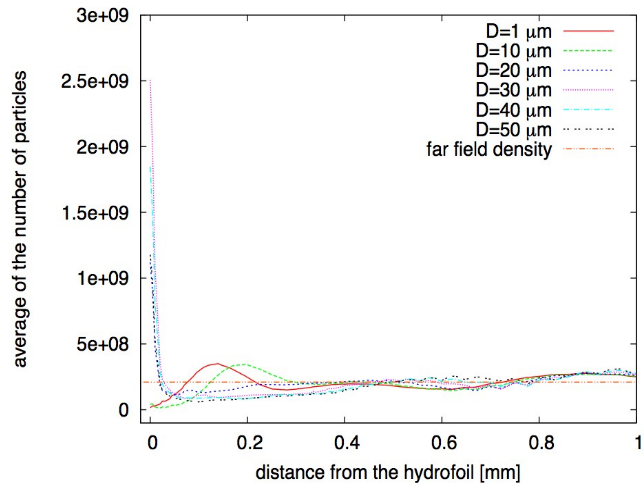

Figure 6: Sensitivity to particle size, sampling line 2

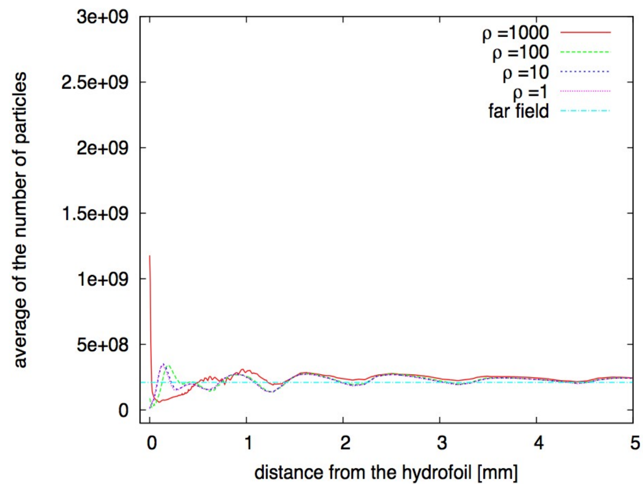

Figure 7: Sensitivity to particle density, sampling line 2

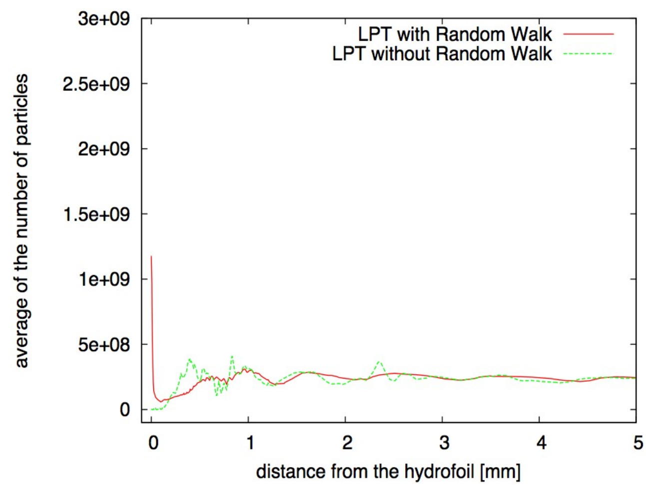

Figure 8: Sensitivity to Random Walk model, sampling line 2