Electronic Supplementary Material (ESI) for Lab on a Chip.

Large scale flow visualization and anemometry applied to lab on chip models of porous media: Supplemental materials

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All the results reported in the manuscript have been obtained using low magnification images, for which the spatial resolution is about the mesh size of the grid. The case of magnified images, which are evoked in the manuscript in section "contrast enhancement", is more complicated and is detailed below.

When using magnified images, such as that the one displayed in Fig. 2 in the manuscript (and shown below in Fig. 1), illumination through allows to enhance the contrast in the images. However, the resulting images, the analysis of the intensity modulations due to tracer particles is more complex.

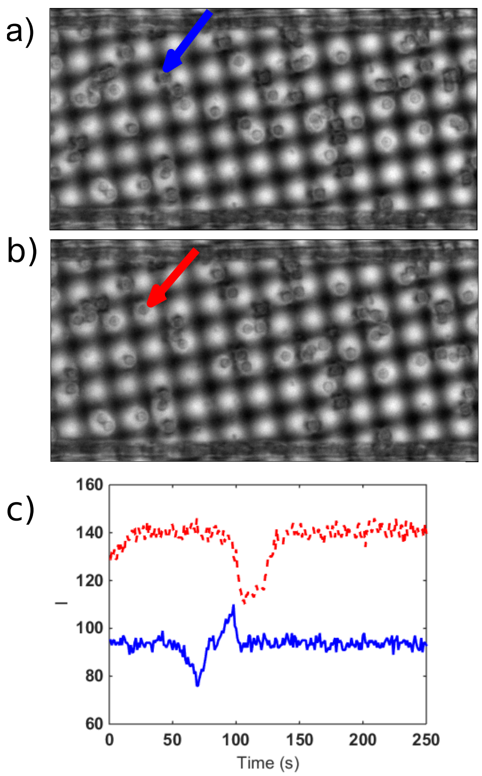

FIG. 1. (a) and (b): close-up view of a single channel. The width of the channel is $250\mu m$. The channel is filled with glycerol containing PMMA beads of diameter $20\mu m$. A grid is placed between the light pad and the microfluidic device. The mesh of the grid is $40\mu m$. The grey circles are beads.(c) Light intensity measured on two particular pixels in relation with time. The dotted red and solid blue lines are the signals recorded for respectively the beads shown by the red (a) and blue (b) arrows. The spatial resolution is $1.15\mu m/pixel$ and the mean flow velocity $V = 16\mu m.s^{-1}$.

In the presence of a flow, particle displacement leads to intensity modulation on a given pixel. Examples are displayed in Figure 1c. We note that the intensity changes depend on the location. When it is calculated on a bright pixel taken inside a hole of the grid, the intensity is lower when a particle is present. However, when the pixel is chosen in a darker area, the modulation is more complex. In the examples shown in Fig. 1c, the intensity is first lower and then higher than the baseline. This comes from complex light refraction by the beads in the vicinity of the meshes.

The fact that the intensity modulation depends on the pixel location has an important consequence: the decay of the auto-correlation function is not the same when looking at a bright pixel or at a dark one. This is illustrated in Figure 2: the value of τ_0 is greater for dark pixels than for bright ones. This effect prevents to use the time auto-correlation technique for these magnified images, as the calibration factor $a = V/\tau_0$ would depend on the pixel location.

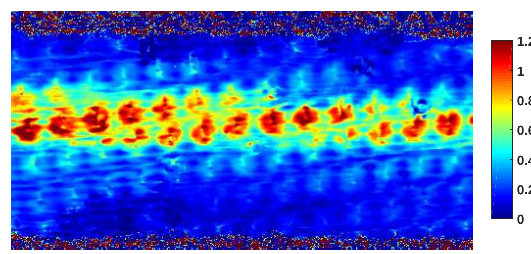

FIG. 2. Image of $1/\tau_0$ values (arbitrary units) corresponding to the experiment displayed in Fig 1.

When the camera is moved backwards, the detail of the diffraction pattern due to the grid is no more visible but the light intensity contrast between the bead and the fluid is still sufficient to be seen with this lower spatial resolution (see Fig. 3 in the manuscript). The complex intensity modulations which depends on the pixel location using a magnified view are no more visible in the sense that when the pixel size is about that of grid wavelength, all the pixel are equivalents. This is shown in Fig. 4a of the manuscript: on a given streamline, the value of the velocity determined by the technique is the same and do not depend on the exact pixel location.

It can be concluded that the mesh size should be of the order of the pixel size when using contrast enhancement by a grid in combination with the autocorrelation technique. We emphasize that standard PIV techniques are more adequate when using magnified images, since those do not require calibration and can give access to the velocity direction.