AEROSOLS PARTICLES DEPOSITION IN THE LUNGS: MICRO PIV IN SCALE 1 LUNG BIFURCATION

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Studies related to aerosol transport and deposition in the alveolar region of the lung, have been mostly restricted to numerical studies, which require further experimental validation. Indeed, there are only few experimental studies with quantitative data due to the complexity of measurements in extremely low Reynolds-numbers (in the order of 0.5) encountered in the lower lung airways. The previous experimental studies focused on aerosol trajectories in scaled-up models but because of the scale difference, the aerosols similarity was only partially satisfied. In order to validate the CFD computations for aerosol trajectories, experiments where both flow and aerosols similarities are satisfied simultaneously, are required.

This work focused on the feasibility study of Micro-PIV experiments in scale 1:1 lung single bifurcation manufactured by a rapid prototyping technique. This manufacturing technique was chosen for its remarkable capability of manufacturing very small complex geometries, including pipes with circular cross sections of 300 µm diameter in transparent polymerized resin (Figure 1 left).

Because only few PIV tracers (fluorescent micro-spheres about 3 µm diameter) were visible in some regions of the model, a new hybrid interrogation technique has been used to process the images. A combination of image overlapping and ensemble averaging of the correlations improved the measurements in very noisy regions. Although this technique needs an optimum compromise between image overlapping and ensemble averaging, it has been shown that better measurements can be obtained when the number of samples, i.e. of images, is limited.

Micro PIV measurements (presented in Figure 1 right) were compared with the theoretical Poiseuille profile expected in the branches for such low Re (~ 0.5). Measurements are in good agreement with the theory in the mother branch. In the daughter branches, the poorer optical access, due to a combination of both high surface roughness and model refractive index variation, reduced the measured velocity.

Finally, the Micro-PIV measurements were compared to previous PIV measurements performed in an almost 50 times scaled up bifurcation model. The non dimensional velocity profiles have shown good agreement. This last result shows that PIV measurements allows to obtain very accurate measurements in flow field sizes differing by almost two orders of magnitude.

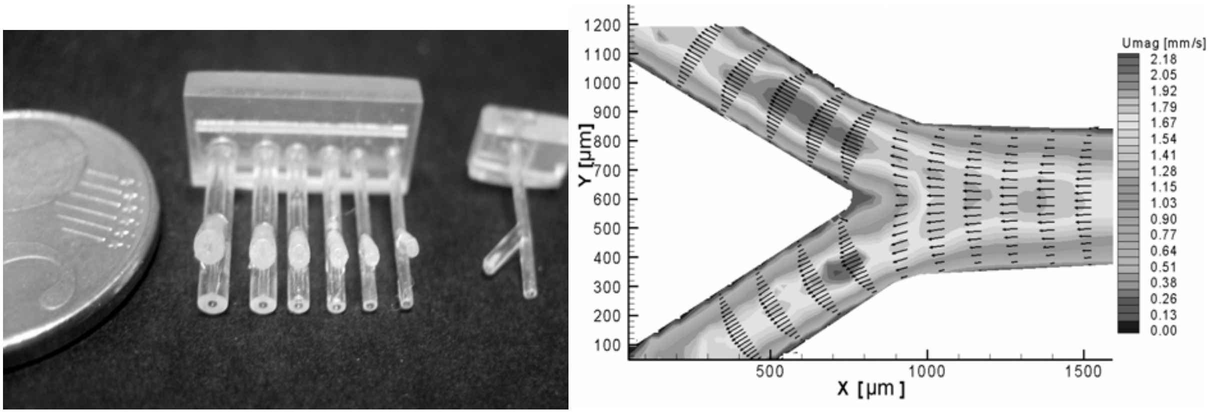

Figure 1: Rapid prototyped bifurcation model at scale 1:1 (left) and Micro PIV measurements (right)