EXPERIMENTAL INVESTIGATION OF AEROSOL DEPOSITION IN LUNG AIRWAYS

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Aerosol particles are increasingly recognized either as possible health risks in the environment or as diagnostic and therapeutic tool in medical research. In particular, small particles, which do not deposit in the airways but reach the gas-exchange surfaces of the alveolar region in the lower pulmonary region, are considered as potential health risks. Numerous numerical studies have been performed on the deposition of these aerosols, but a validation with experimental data is missing. The objective of this project was therefore to not exactly reflect conditions in human lung but to be close enough to allow a comparison with numerically obtained trajectories. For this reason the performed work served furthermore as a feasibility study for future experimental research on aerosol deposition in the lower airway generations.
An experimental investigation was conducted on the behaviour of aerosol particles in the alveolar lung region. The 18^{th} airway generation was modelled by a double bifurcation. An initial parameter study was made on to ensure that simulations would be made under realistic conditions. Two different diameters of particles were used in the experiments. A modified experimental set-up was redesigned and built. Newly designed flow meters were incorporated to measure the low flow rates. Adapted signal processing software was written to extract the flow rate.

A new tracking algorithm was written to extract the time-resolved particle positions from digitally recorded images. In this algorithm, the predictor for the particle's next position was based on the previous particle positions. To test the performances of the algorithm, image generators were created to produce time-resolved images. Sinusoidal trajectories and uniform displacements were used in the Monte-Carlo simulations, highlighting any shortcomings of the algorithm.

PIV measurements were performed to obtain a velocity map of the fluid motion inside the bifurcation (Figure 1-left). The airway Reynolds number, based on the main branch diameter was 2.24. Velocity profiles were extracted and streamlines were generated. The latter allowed a comparison between the flow streamlines and the obtained particle trajectories (Figure1-right).

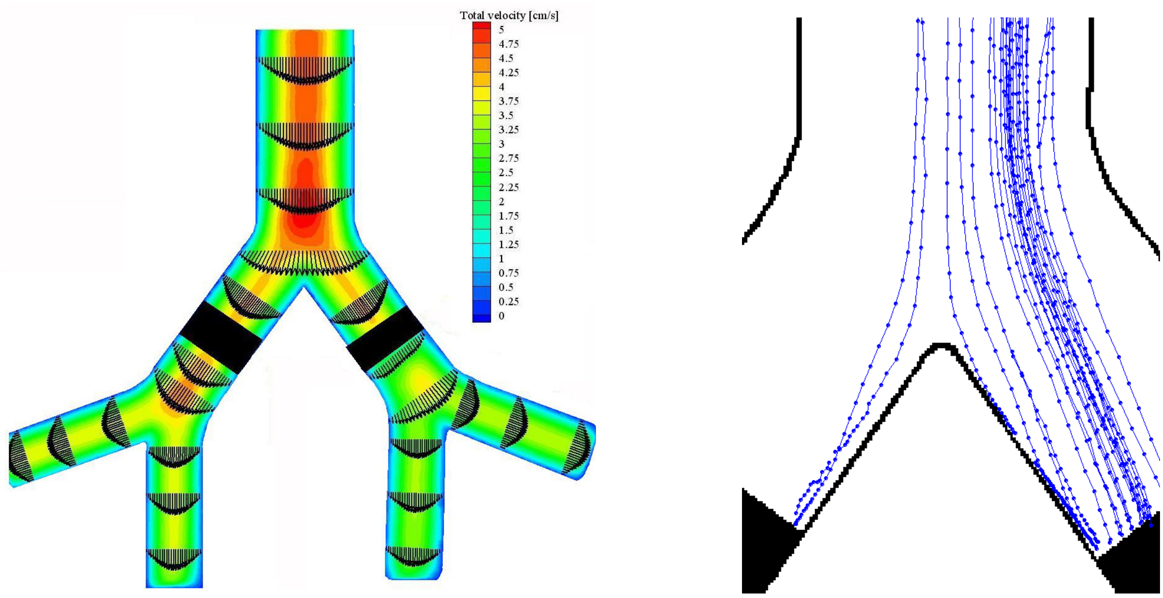

Figure 1: (Left) Total velocity field obtained from PIV measurements (Right) Extraction of trajectories of lead particles, 1mm in diameter. Measurements were performed for a Reynolds number of 2.24