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Flow Visualization of Internal Flow in the Human Lung Network

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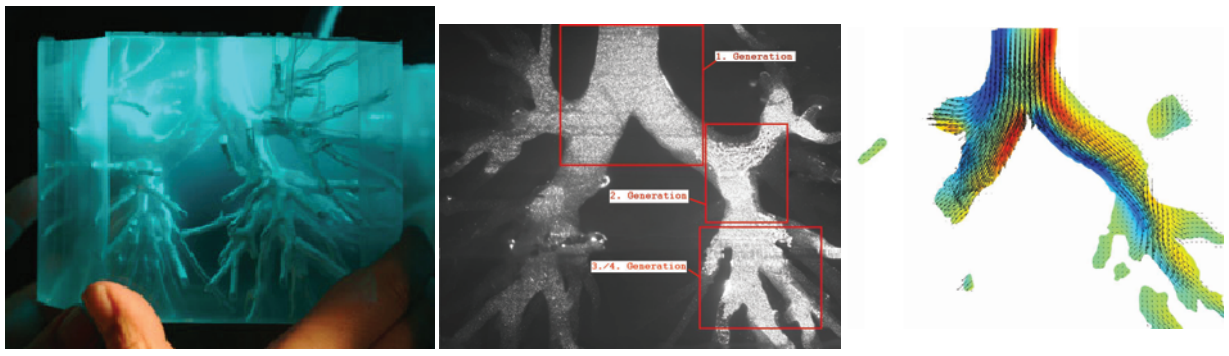

Fig. 1.

Figure 1 left shows a realistic transparent model of the human airways with the trachea at the top and 6 generations of branching representing the bronchial tube system of the lung. The model is a negative cast of a rapid prototyped kernel of the bronchial tree structure generated from a CT scan. After casting in transparent silicone, the kernel is dissolved and the bronchial tree is left as a hollow structure in the transparent silicone block. Flow studies are carried out in a pulsatile mock circuit with a mixture of water and glycerine as working fluid. The refractive index of the fluid is matched with the silicone model to visualize the internal flow structures by optical flow measurement techniques such as Particle-Image-Velocimetry (PIV).

The picture in Figure 1 at the center gives an impression of the tracer images in a light-sheet which crosses the vertical axis of the trachea. Hydrogen bubbles are used to visualize the flow. The light-sheet cuts a vertical plane across the major branch plane and extends down to branches in the 4th generation. An exemplary result of the PIV study is given in Figure 1 on the right hand side by means of the velocity field and vorticity distribution during inspiration. The results demonstrate the generation of separation regions and secondary vortex structures. As proven, the mean flow tends to follow the inner walls of the branching tubes.