Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Oscillatory Flow in the Human Airways from the Mouth through Several Bronchial Generations ANDREW BANKO, Stanford University, FILIPPO COLETTI, University of Minnesota, CHRIS ELKINS, JOHN EATON, Stanford University — The time-varying flow is studied experimentally in an anatomically accurate model of the human airways from the mouth through the fourth to eighth generation of the bronchi. The airway geometry is obtained from the CT scan of a healthy adult male of normal height and build. The three-component, three-dimensional mean velocity field is obtained throughout the entire model using phase-locked magnetic resonance velocimetry. A pulsatile pump drives a sinusoidal waveform (inhalation and exhalation) with frequency and stroke-length such that the mean trachea Reynolds number at peak inspiration is Re = 4200 and the Womersley number is $\alpha = 7$. This represents a regime of moderate exertion. Integral parameters are defined to quantify the degree of velocity profile non-uniformity (which correlates with axial dispersion) and secondary flow strength (which correlates with lateral dispersion). It is found that the streamwise momentum flux and secondary flow strength increase and decrease in proportion throughout most of the breathing cycle. On the other hand, the strength of secondary flows during the 10% of the breathing cycle surrounding flow reversal remains approximately half of that at peak inspiration while the streamwise momentum flux goes to zero. The strong and persistent secondary flows have important implications for dispersion of scalar or particulate contaminants in the lungs.

Andrew Banko
Stanford University

Date submitted: 29 Jul 2014 Electronic form version 1.4