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Measurements of the three-dimensional oscillatory flow in a double bifurcation ANDRAS NEMES, SAHAR JALAL, TRISTAN VAN DE MOORTELE, FILIPPO COLETTI, University of Minnesota — Above a certain ventilation frequency, the unsteady nature of the respiratory flow becomes apparent, and inhalation and exhalation cannot be approximated as quasi-stationary processes. This is especially important in the upper and central airways, where length and velocity scales are the largest, making inertia and acceleration effects dominant over viscous dissipation. We experimentally investigate the primary features of the oscillatory flow through a symmetric double bifurcation which models the self-similar branching of the human bronchial tree. We consider a range of Reynolds and Womersley numbers relevant to physiological conditions between the trachea and the lobar bronchi. Three-component, three-dimensional velocity fields are acquired at multiple phases within the ventilation cycle using magnetic resonance imaging (MRI), and are complemented with instantaneous two-dimensional fields obtained by particle image velocimetry (PIV). The phase-averaged volumetric data provide a description of the rich flow topology, characterizing the main secondary flow structures and their spatio-temporal evolution. The instantaneous measurements reveal some of the dynamics of the laminar-to-turbulent transition in the bifurcations, and its aperiodicity throughout the respiratory cycle.

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