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Measurements of the three-dimensional oscillatory flow in a
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MOORTELE, FILIPPO COLETTI, University of Minnesota — Above a certain
ventilation frequency, the unsteady nature of the respiratory flow becomes appar-
ent, and inhalation and exhalation cannot be approximated as quasi-stationary pro-
cesses. This is especially important in the upper and central airways, where length
and velocity scales are the largest, making inertia and acceleration effects domi-
nant 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 struc-
tures 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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