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LES of Laminar-to-Turbulent Particle-Fluid Dynamics in Human and Nonhuman Primate Airways: Applications to Aerosolized Drug Delivery Animal Testing TAYLOR GEISLER, SOURAV PADHY, ERIC SHAQFEH, Stanford Dept. of Chemical Engineering, GIANLUCA IACCARINO, Stanford Dept. of Mechanical Engineering — Both the human health benefit and risk from the inhalation of aerosolized medications is often predicted by extrapolating experimental data taken using nonhuman primates to human inhalation. In this study, we employ Large Eddy Simulation to simulate particle-fluid dynamics in realistic upper airway models of both humans and rhesus monkeys. We report laminar-to-turbulent flow transitions triggered by constrictions in the upper trachea and the persistence of unsteadiness into the low Reynolds number bifurcating lower airway. Micro-particle deposition fraction and locations are shown to depend significantly on particle size. In particular, particle filtration in the nasal airways is shown to approach unity for large aerosols (8 microns) or high-rate breathing. We validate the accuracy of LES mean flow predictions using MRV imaging results. Additionally, particle deposition fractions are validated against experiments in 3 model airways.

Taylor Geisler
Stanford Dept. of Chemical Engineering

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