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Nozzle Turbulent Boundary Layer Influence on Sound in a Mach 0.9 Jet RYAN FONTAINE, Department of Mechanical Science & Engineering, University of Illinois, GREGORY ELLIOTT, JOANNA AUSTIN, Department of Aerospace Engineering, University of Illinois, JONATHAN FREUND, Departments of Mechanical Science & Engineering and Aerospace Engineering, University of Illinois — One of the principal challenges in the prediction and design of low-noise nozzles is the thinness of the near-nozzle mixing layers at the high-Reynolds-numbers of engineering conditions. The specific challenge will depend in part on the upstream conditions, but typically we expect that the jet leaving the nozzle will have $Re_D \sim 5 \times 10^6$ at application scales. Including this in design approaches presents a significant challenge. It is well known that small-scale experiments will have relatively thicker near-nozzle shear layers, which can hamper their applicability to high-Reynolds-number design. Though they can nominally be run at sufficiently high Reynolds numbers, faithfully representing these regions within a large-eddy simulation is likewise a challenge because the locally largest scales are so small. A family of nozzles designed to change the exit thickness of the turbulent boundary layer with otherwise identical flow conditions is studied experimentally to quantify the sensitivity of the far-field sound to nozzle shear layer conditions, which are quantified with very-near-nozzle PIV measurements. The influence is pronounced, though less significant than the well-known sensitivity of far-field sound to laminar versus turbulent boundary near-nozzle shear layers.

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