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Feedforward and Feedback Control of Boundary Layer Streaks Induced by Freestream Turbulence KEVIN A. GOUDER, Imperial College London, AHMED M. NAGUIB, Michigan State University, PHILIPPE L. LAVOIE, University of Toronto, JONATHAN F. MORRISON, Imperial College London — Sensing and cancellation of streaks early within their growth extent could enable the delay of bypass transition and eventual turbulence. Previously, we had evaluated the capability of plasma-actuator-based feedforward-feedback (FF-FB) control systems to weaken streaks induced "synthetically" in a Blasius boundary layer via dynamic roughness elements. In contrast, the current work aims to delay bypass boundary layer transition, where in the presence of freestream turbulence intensity exceeding about 1%, streaks form naturally and stochastically in the underlying boundary layer. A wall-shear-stress sensor S_U, a twin-plasma actuator, and a second sensor S_D, are installed along the streamwise direction of a flat plate, in the streaks' linear transient growth region, upstream of any turbulent spot formation. A FF control system uses the S_U output and single-point Linear Stochastic Estimation (LSE), to produce a counter-disturbance aimed to cancel the convected original streak at the S_D location. A FB loop uses any S_D output in a PI controller to correct for uncancelled disturbances resulting from, say, inaccuracies in the LSE model of the streak growth dynamics. Results demonstrate the viability of the control scheme to weaken streaks and delay bypass transition.

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