Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

On the H-type transition to turbulence: Laboratory experiments and reduced-order modeling SHYUAN CHENG, LEONARDO CHAMORRO, PHILLIP ANSELL, University of Illinois at Urbana-Champaign — A laboratory investigation was conducted to explore the sources of local, high-amplitude velocity fluctuations produced at the late stage of boundary layer transition. The velocity fluctuations were induced with Tollmien-Schlichting (TS) waves into a laminar flat-plate boundary layer under a zero-pressure gradient. Proper orthogonal decomposition (POD) was used to extract the dominant modal contributions within this transitional flow. The first four POD modes exhibited spatial shapes consistent with canonical hairpin vortices; also, a peak frequency matching that of the fundamental TS wave is evidenced in the time-dependent mode coefficients. Higher-order modes demonstrate a combination of sub- and super-harmonics of the TS wave frequency, these higher modes represent hairpin packets. A reduced-order model for the Reynolds shear stress (RSS) overshoot is proposed by considering conditional averaging. The model shows that the first four POD modes with $\approx$ 15\% of the energy captured $\approx$ 85\% of the peak RSS amplitude at the overshoot location, indicating that lower portion of large-scale hairpin vortices is largely responsible for the overshoot mechanism.

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Date submitted: 31 Jul 2020 Electronic form version 1.4