Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Scaling of Transient Growth of Instability Induced by a Periodic Array of Roughness Elements in a Blasius Boundary Layer PHILIPPE LAVOIE, University of Toronto, AHMED NAGUIB, Michigan State University, JONATHAN MORRISON, Imperial College — The receptivity of laminar boundary layers to three-dimensional perturbations and the ensuing evolution of the transient growth of disturbances have attracted much attention in recent years. The motivation for the present study is related to the development of a reduced-order model and estimator for the closed-loop control of transient growth instabilities in a laminar boundary layer. We focus here on the scaling characteristics of the streamwise component of the disturbance energy. Starting from the linearized boundary layer equations and given assumptions with respect to the boundary layer receptivity to perturbations, we derive scaling arguments for the evolution of the disturbance energy. These are examined against experimental data, which were obtained by inducing transient growth in a Blasius boundary layer in the wind tunnel using spanwise-periodic arrays of cylindrical roughness elements with different geometrical parameters. It is found that the growth and decay region of the energy evolution scale differently. The dynamical implications of the scaling presented here are discussed from the point of view of model reduction for flow control.

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Date submitted: 03 Aug 2009 Electronic form version 1.4