Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Karhunen-Loève Eigenfunction Decomposition of Drag Reduced Turbulent Pipe Flow Results from a Spectral Element Direct Numerical Simulation KENNETH BALL, ANDREW DUGGLEBY, Virginia Polytechnic Institute and State University — Results of a Karhunen-Loève Eigenfuncion Decomposition of the Direct Numerical Simulation flow field for both a fully turbulent pipe flow and a drag reduced pipe flow through spanwise wall oscillation will be presented. The flow field is decomposed into the eigenfunctions and eigenvalues of the two-point spatial correlation tensor for each azimuthal and axial wavenumber, and the energy and structure of the eigenfunctions are compared between the two flows to identify those structures affected by the wall oscillations and the mechanism responsible for drag reduction. The dynamical contribution of each eigenfunction mode, determined by orthogonal projection with the turbulent flow field, will also be examined. The flow field data is generated using NEK5000, a spectral element Navier-Stokes solver, where the polar-cylindrical coordinate singularity is avoided by solving the flow in Cartesian coordinates with a stadium-like element cross-section. Near the center of the pipe, a Cartesian configuration is used, while near the wall, the elements are mapped to a polar configuration. Each element uses 10th order Legendre Lagrangian interpolants in each direction, with a local Jacobi/Conjugate Gradient solver and a global Schwarz Multigrid solver. The flow field is generated for $Re_\tau = 150$ using 2560 elements and a length of 20 R.

Andrew Duggleby
Virginia Polytechnic Institute and State University

Date submitted: 11 Aug 2005

Electronic form version 1.4