Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Nonlinear optimal perturbations in a curved pipe ENRICO RINALDI, JACOPO CANTON, Linn FLOW Centre, KTH, OANA MARIN, MICHEL SCHANEN, Mathematics and Computer Science Division, Argonne National Laboratory, PHILIPP SCHLATTER, Linn FLOW Centre, KTH — We investigate the effect of curvature on transition to turbulence in pipes by comparing optimal perturbations of finite amplitude that maximise their energy growth in a toroidal geometry to the ones calculated in the absence of curvature. Our interest is motivated by the fact that even small curvatures, of the order of $d = R_{pipe}/R_{torus} < 10^{-10}$, are sufficient to induce substantial changes to the laminar velocity profile and its linear stability, thus suggesting that peculiarities may also be observed in the nonlinear regime. In our study, we consider flows at several subcritical Reynolds numbers in a torus with $d = 0.01$. We use state-of-the-art numerical algorithms, capable of tackling the optimisation problem on large computational domains, coupled to a high-order spectral-element code, which is used to perform direct numerical simulations (DNS) of the full Navier-Stokes and their adjoint equations. Results are compared to the corresponding states in straight pipes and differences in their structure and evolution are discussed. Furthermore, the newly calculated initial conditions are used to identify coherent flow structures that are compared to the ones observed in recent DNS of weakly turbulent and relaminarising flows in the same toroidal geometry.

Jacopo Canton
Linn FLOW Centre, KTH

Date submitted: 01 Aug 2017 Electronic form version 1.4