Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Diablo 2.0: A modern DNS/LES code for the incompressible NSE leveraging new time-stepping and multigrid algorithms DANIELE CAVAGLIERI, THOMAS BEWLEY, UC San Diego, ALI MASHAYEK, MIT — We present a new code, Diablo 2.0, for the simulation of the incompressible NSE in channel and duct flows with strong grid stretching near walls. The code leverages the fractional step approach with a few twists. New low-storage IMEX (implicit-explicit) Runge-Kutta time-marching schemes are tested which are superior to the traditional and widely-used CN/RKW3 (Crank-Nicolson/Runge-Kutta-Wray) approach; the new schemes tested are L-stable in their implicit component, and offer improved overall order of accuracy and stability with, remarkably, similar computational cost and storage requirements. For duct flow simulations, our new code also introduces a new smoother for the multigrid solver for the pressure Poisson equation. The classic approach, involving alternating-direction zebra relaxation, is replaced by a new scheme, dubbed tweed relaxation, which achieves the same convergence rate with roughly half the computational cost. The code is then tested on the simulation of a shear flow instability in a duct, a classic problem in fluid mechanics which has been the object of extensive numerical modelling for its role as a canonical pathway to energetic turbulence in several fields of science and engineering.

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Date submitted: 31 Jul 2015 Electronic form version 1.4