Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Iterative Particle Image Velocimetry Algorithm for Rotating Flows MATTHEW GIARRA, Virginia Tech, JOHN CHARONKO, Los Alamos National Laboratory, PAVLOS VLACHOS, Purdue University — Particle image velocimetry (PIV) can fail to reliably estimate fluid velocities in flows with large spatial velocity gradients because the shearing, stretching, and rotation of particle image patterns decreases the signal-to-noise ratio of cross correlations (CCs). We present a new PIV correlation algorithm called the Fourier-Mellin correlation (FMC) that accurately measures particle pattern displacements in flow regions with large rotation (like vortex cores) compared to traditional correlations by measuring rotation and then aligning particle patterns before performing Cartesian CCs. FMC reliably measures particle displacements between interrogation regions with up to 180 degrees of angular misalignment compared to 6-8 degrees for traditional correlations. We combined our FMC algorithm with iterative discrete window offset (DWO) to measure velocity and vorticity fields in synthetic PIV images of counter-rotating vortex cores and an experimental vortex ring in water. FMC with DWO reduced the errors in velocity and vorticity estimates by an order of magnitude compared to traditional correlations with DWO, increased the correlation peak height ratios in synthetic and experimental images, and accelerated the convergence of iterative image deformation algorithms.

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Date submitted: 01 Aug 2014 Electronic form version 1.4