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Adaptive spectral filtering of PIV cross correlations MATTHEW GIARRA, Virginia Tech , PAVLOS VLACHOS, Purdue University, AETHER LAB TEAM — Using cross correlations (CCs) in particle image velocimetry (PIV) assumes that tracer particles in interrogation regions (IRs) move with the same velocity. But this assumption is nearly always violated because real flows exhibit velocity gradients, which degrade the signal-to-noise ratio (SNR) of the CC and are a major driver of error in PIV. Iterative methods help reduce these errors, but even they can fail when gradients are large within individual IRs. We present an algorithm to mitigate the effects of velocity gradients on PIV measurements. Our algorithm is based on a model of the CC, which predicts a relationship between the PDF of particle displacements and the variation of the correlation's SNR across the Fourier spectrum. We give an algorithm to measure this SNR from the CC, and use this insight to create a filter that suppresses the low-SNR portions of the spectrum. Our algorithm extends to the ensemble correlation, where it accelerates the convergence of the measurement and also reveals the PDF of displacements of the ensemble (and therefore of statistical metrics like diffusion coefficient). Finally, our model provides theoretical foundations for a number of "rules of thumb" in PIV, like the quarter-window rule.

Matthew Giarra
Virginia Tech

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