Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Uncertainty quantification in volumetric Particle Image Velocimetry. SAYANTAN BHATTACHARYA, Purdue University, JOHN CHARONKO, Los Alamos National Laboratory, PAVLOS VLACHOS, Purdue University — Particle Image Velocimetry (PIV) uncertainty quantification is challenging due to coupled sources of elemental uncertainty and complex data reduction procedures in the measurement chain. Recent developments in this field have led to uncertainty estimation methods for planar PIV. However, no framework exists for three-dimensional volumetric PIV. In volumetric PIV the measurement uncertainty is a function of reconstructed three-dimensional particle location that in turn is very sensitive to the accuracy of the calibration mapping function. Furthermore, the iterative correction to the camera mapping function using triangulated particle locations in space (volumetric self-calibration) has its own associated uncertainty due to image noise and ghost particle reconstructions. Here we first quantify the uncertainty in the triangulated particle position which is a function of particle detection and mapping function uncertainty. The location uncertainty is then combined with the three-dimensional cross-correlation uncertainty that is estimated as an extension of the 2D PIV uncertainty framework. Finally the overall measurement uncertainty is quantified using an uncertainty propagation equation. The framework is tested with both simulated and experimental cases. For the simulated cases the variation of estimated uncertainty with the elemental volumetric PIV error sources are also evaluated. The results show reasonable prediction of standard uncertainty with good coverage.

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Date submitted: 03 Aug 2016 Electronic form version 1.4