Comparative assessment of PIV-based pressure evaluation techniques applied to a transonic base flow

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HIGHLIGHTS

- A comparative assessment of PIV-based pressure evaluation techniques was performed within the collaborative framework of the EU-funded ‘NIOPLEX’ FP-7 project.
- The test case represents a simulated experiment constructed from a numerical simulation of a transonic axisymmetric base flow.
- All tested pressure evaluation techniques were able of capturing the main features of the pressure fields.
- Pressure fields with satisfactory accuracy may already be obtained from a single PIV velocity snapshot, while high accuracy can be obtained with advanced PTV approaches.

ABSTRACT

A test case for PIV-based pressure evaluation techniques has been developed by constructing a simulated experiment from a ZDES simulation for an axisymmetric base flow at Mach 0.7. The test case comprises sequences of four subsequent particle images (representing multi-pulse data) as well as continuous time-resolved data. Particle images were processed using tomographic PIV processing as well as the PTV algorithm ‘Shake-The-Box’. Multiple pressure reconstruction techniques have subsequently been applied to the PIV results (Eulerian approach, iterative least-square pseudo-tracking, Taylor’s hypothesis approach, instantaneous Vortex-in-Cell) and PTV results (FlowFit, Vortex-in-Cell-plus, Voronoi-based pressure evaluation and iterative least-square pseudo-tracking). All methods were able to reconstruct the main features of the instantaneous pressure fields, including methods that reconstruct pressure from a single PIV velocity snapshot. Highly accurate pressure field reconstructions could be obtained by using PTV approaches in combination with more advanced techniques. In general, the use of longer series of time-resolved input data, when available, allows more accurate pressure field reconstruction. Noise in the input data typically reduces the accuracy of the reconstructed pressure fields, but none of the techniques was found to be critically sensitive to the amount of noise added in the present test case.