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Effects of 3D PIV post-processing on impulse and force analysis in vortical flows LEAH MENDELSON, ALEXANDRA TECHET, MIT — Vortical flows measured using 3D PIV techniques are fundamentally filtered versions of physical phenomena, with velocity information lost below the length and time scales of the measurement system. In the context of propulsive vortices, such as those generated during biological locomotion, these factors, combined with experimental noise and error, can lead to inaccuracies in analysis of the vortex momentum and net thrust. As a result, while 3D velocity measurements remove many of the assumptions required to analyze planar PIV data, they should not be considered absolute physical quantities. Our work focuses on post-processing for 3D PIV data sets to enable the extraction of accurate, quantitative 3D force measurements for unsteady vortical propulsion. In this study, we compare utilizing measurement signal processing techniques, orthogonal decomposition, and identification of coherent structures to measure the impulse of a canonical vortex ring generated by a mechanical piston. In particular, we consider the ability of these methods to confront the influences of limited spatial resolution and arbitrary geometries, and make recommendations for a general procedure for propulsion analysis from 3D PIV data, regardless of which PIV technique is used to obtain the velocity fields.

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