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A High-Speed Tomographic PIV System for Measuring Plankton-Generated Flow D.W. MURPHY, D.R. WEBSTER, J. YEN, Georgia Tech — Plankton such as copepods, fish larvae, and mysids occupy a fluid environment in which neither inertia nor viscosity dominates. At this intermediate Reynolds number (range of 1 to 1000), locomotion, hydrodynamic signal detection, and foraging of these organisms are influenced by both viscous and inertial effects. The millimeter length and millisecond time scales at which these animals operate present significant difficulties to obtaining flow measurements using traditional planar PIV systems, which additionally cannot quantify the three-dimensional nature of the flow. We describe the design and application of a novel PIV system comprising four high-speed cameras (2190 fps), two near IR lasers (808 nm), and the associated optics used to illuminate and interrogate a volume of approximately 1 cubic centimeter. Illumination in the near IR wavelengths does not affect copepod behavior. Fine-scale three-dimensional fluid velocity measurements around free-swimming animals provide insight into their locomotion-induced flow. Further, calculation of the complete strain rate tensor and vorticity vector allows estimation of the flow disturbance and mechanosensory reaction levels. The system also facilitates studies of organism response to environmental cues such as laboratory-generated turbulence.

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