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Postage-Stamp PIV: Small Velocity Fields at 400 kHz for Turbulence Spectra Measurements STEVEN BERESH, JOHN HENFLING, RUSSELL SPILLERS, Sandia National Laboratories — Time-resolved particle image velocimetry (TR-PIV) recently has been demonstrated in high-speed flows using a pulse-burst laser at repetition rates reaching 50 kHz. However, the turbulent behavior at all but the largest scales occurs at still higher frequencies. Pulse-burst PIV can be achieved at higher frequencies if the field of view is greatly reduced and lower laser pulse energy is accepted. Current technology allows image acquisition at 400 kHz for sequences exceeding 4,000 frames, but for a small array of only 128 120 pixels, giving rise to the moniker of postage-stamp PIV. Despite the limited spatial extent, this approach is well-suited to measuring turbulent velocity spectra in high-speed flows because it is not subject to frozen turbulence assumptions and it can employ advanced algorithms using the closely-spaced laser pulses and local spatial information. The resulting spectra reveal two regions exhibiting power-law dependence describing the turbulent decay. One is the well-known inertial subrange with a slope of -5/3 at high frequencies. The other displays a -1 power-law dependence for a decade of mid-range frequencies corresponding to the energetic eddies measured by PIV, which appears to have been previously unrecognized for high-speed free shear flows.

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