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Pulsed Laser Imaging For Explosive Event

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Pulsed-laser, camera-synchronized shadowgraph imaging of bright events, such as following detonations of solid chemical explosives, is a useful method for imaging near-field phenomena close to the explosive center of mass. The intensity of pulsed laser light over a narrow wavelength range (typically near 0.001 nanometer (nm)) and pulse time duration (typically less than 30 nanoseconds (ns)) often equals or exceeds the brightness of the explosive event, allowing imaging of features normally obscured (e.g., shock separation from detonation products). For best image quality, laser coherence should be "spoiled" to minimize laser speckle, and the laser should be able to run continuously to enable capture of the full explosive event (often several milliseconds). Commercial high repetition rate (up to 3 megaHertz (MHz)), high power (up to 100 W average power), narrow linewidth (less than 0.03 nm at 532 nm) pulsed lasers capable of continuous operation are available. We examine two systems employing diode-pumped solid state (DPSS, Coherent Inc. Avia 532-65) and hybrid fiber-DPSS (Spectra-Physics Quasar 532-95) techniques. We have been investigating using these systems in laser shadowgraphy imaging systems, as an enhancement of our previous capabilities (20 kHz, 20W, Cu-vapor laser). Both of these laser systems exhibit laser speckle when the output beam is used to illuminate a surface. To minimize speckle, we use transfer optics employing a combination of liquid-filled light pipes and optical fibers. The use of the light pipe/optical fiber combination slightly broadens the laser line width while causing dispersion to the pulse, and provides an image speckle contrast ratio nearest (but not equal) to that obtained using an arc lamp. Preliminary results show that the combination of liquid filled light pipes and optical fibers can reduce speckle to obtain speckle contrast ratios approaching those obtained using incoherent light sources. The presentation will discuss Edgerton shadowgraphy using pulsed laser illumination, light pipes filled with different media, and discuss applications to medium scale energetic material testing now underway using these systems.