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Ultra-high Speed Imaging for Initiator and Detonator Performance Characterization

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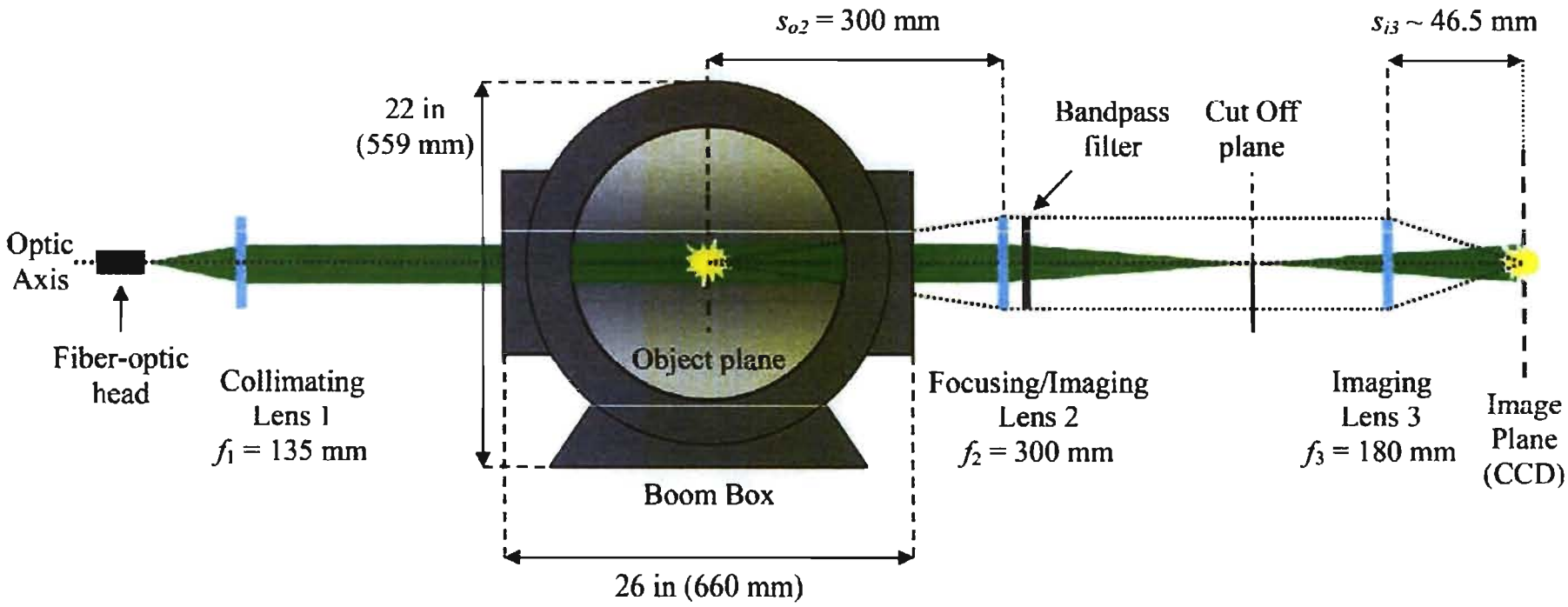
Visualizing detonator output: Inline schlieren imaging



A cut-off mechanism can be utilized to directly visualize density gradients (schlieren imaging) or removed to directly visualize light deflection due to the density gradients (backlight imaging).

Detonator output into PMMA

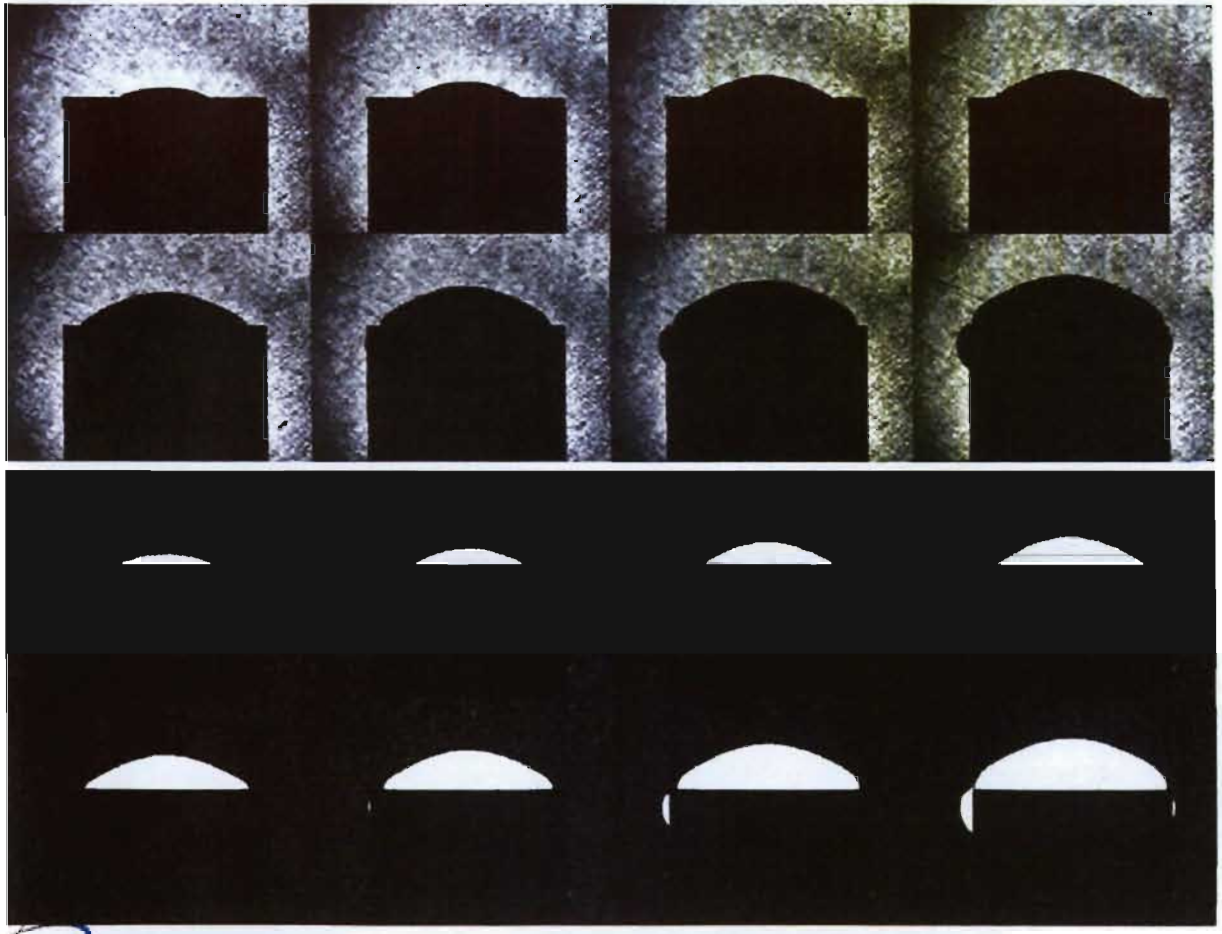
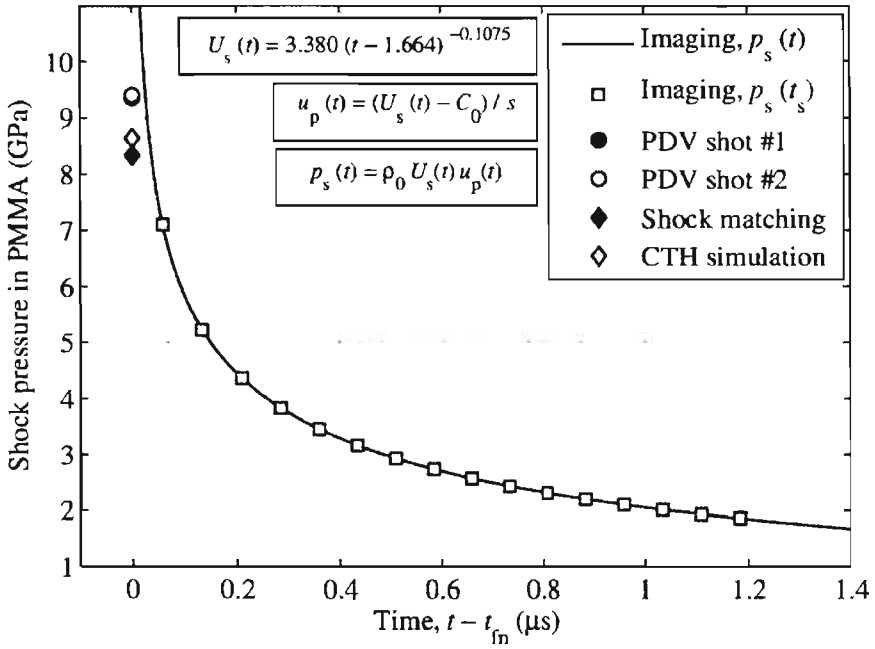


Image sequence depicts explosive breakout across the surface of the detonator by capturing the shock wave explosively-driven into PMMA.

Difference fields calculated from a reference image allow asymmetries in explosive breakout to be directly visualized (frames 6, 7, and 8).

Detonator Output into PMMA: Shock pressure comparisons

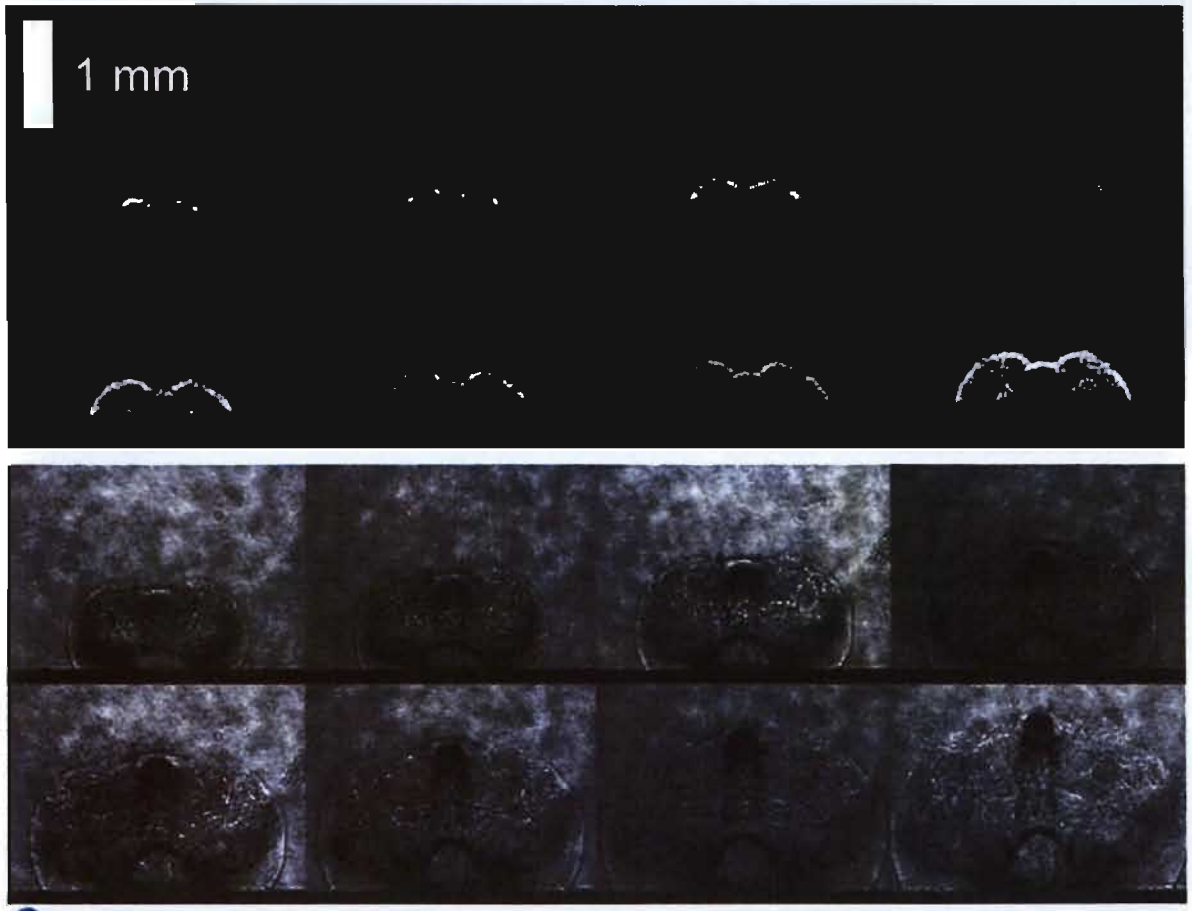


Interface variables	*Shock matching (calculation)	Numerical Simulation (CTH)	Experiment (PDV)
u_{int} (mm/us)	1.458	1.38	1.577 1.583
P_{int} (GPA)	8.33	8.64	9.35 9.40

*CTH results suggest the shock strength in Ni decays by 8% over the 241 um cup thickness

Using the known shock Hugoniot for PMMA, the calculated equation for shock velocity is mapped to shock pressure (top left). Overall agreement between imaging experiments, PDV experiments, and calculations is good; however, asymptotic behavior of the power-law fit limits the accuracy of the reduced imaging data at very short times. Work is progressing to determine a more appropriate fit model based on shock physics.

Initiator Output into air: Schlieren imaging of 15 mil chip slapper



5 ns exposures, 20 ns inter-frame delay

Schlieren imaging is used to visualize gradients in density caused by shock waves, expanding plasma fronts, etc.

Backlight imaging is used to visualize ejecta, flyers, regions of high density, etc.

The combined methods provide a novel tool for directly visualizing the performance of micro-initiator devices.