

Micro- and Meso-Scale Detonics of Explosives



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PROBLEM

- The significant phenomena in transient explosive behavior occur at *interfaces* and are strongly affected by *explosive properties*
 - Interfaces: Explosive-bridgewire, explosive-confinement, explosive-explosive
 - Explosive Properties: Chemical and mechanical nature of materials
- These phenomena can only be described properly at the *micro-* and *meso-scales*
 - Initiation length scales, crystal size scales
- Transient explosive behavior include *initiation and failure*
 - Implications to *reliability, safety, design, surveillance...*
- Science-based engineering for future component development and miniaturization demands study of these phenomena

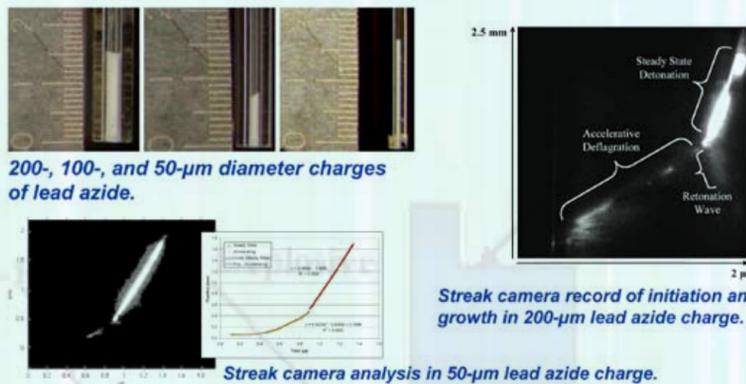
APPROACH

- Experiment configuration development, diagnostic development, and model development on explosives that are important for future development and miniaturization
 - Multidisciplinary team from multiple centers, using Sandia's unique capabilities
- Study of interfacial phenomena important to transient explosive behavior; especially initiation, but also failure
- Development of manufacturing capabilities, improved diagnostics capabilities, and improved modeling capabilities, while generating critical data



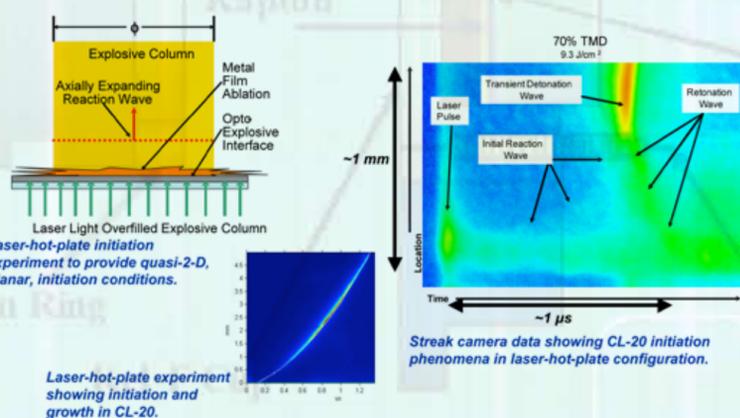
LOW-ENERGY INITIATION DEFLAGRATION-TO-DETONATION TRANSITION

- Understanding initiation and growth in miniaturized primary explosives
- Sample preparation development – fluid-based deposition/filling
- Diagnostic development – sub-mm streak camera photography



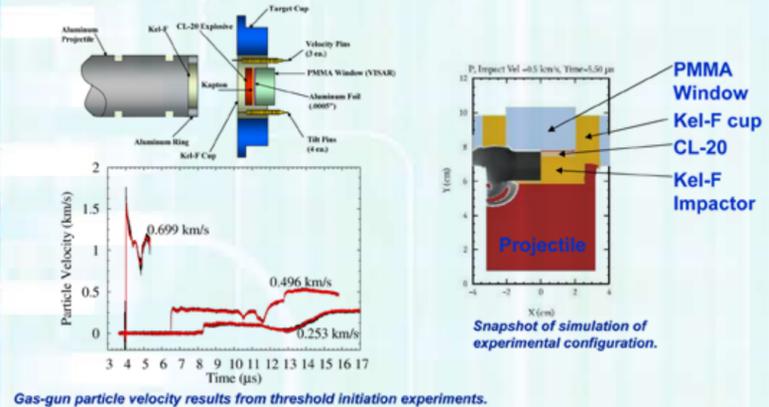
HIGH-ENERGY INITIATION SHOCK-/DEFLAGRATION-TO-DETONATION TRANSITION

- Understanding initiation and growth in Laser Exploding Bridge Wires
- Planar initiation, compaction, modeling



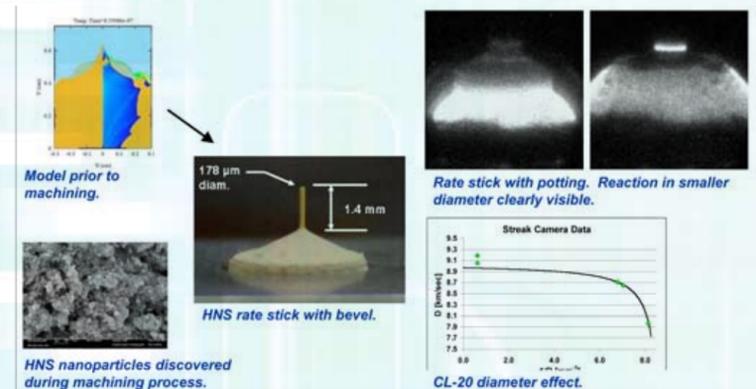
HIGH-ENERGY INITIATION SHOCK-TO-DETONATION TRANSITION

- Understanding initiation and growth in shock-initiated explosives
- Gas-gun experiments coupled with Baer-Nunziato multiphase modeling



DETONATION FAILURE SERENDIPITOUS NANOPARTICLE PRODUCTION

- Understanding failure of miniaturized explosives
- Femtosecond laser micromachining, streak camera, shadowgraphy, modeling
- Serendipitous discovery of nanoparticles from machining process



SIGNIFICANCE

- Development of advanced manufacturing techniques for miniaturized explosive charges – femtosecond laser micromachining
- Development of diagnostics for miniaturized systems – sub-mm streak camera and shadowgraph photography
 - Applies to conventional and miniaturized systems
- Critical data generation for miniaturized systems
- Development of initial models for CL-20
- Design rules for CL-20 and future components
 - Safety enhancements (Laser EBW), further miniaturization
- Development of powerful experimental tool for laser-material interactions
- Numerous publications, technical advances, patent (1), students (Master's thesis), university/lab collaborations