

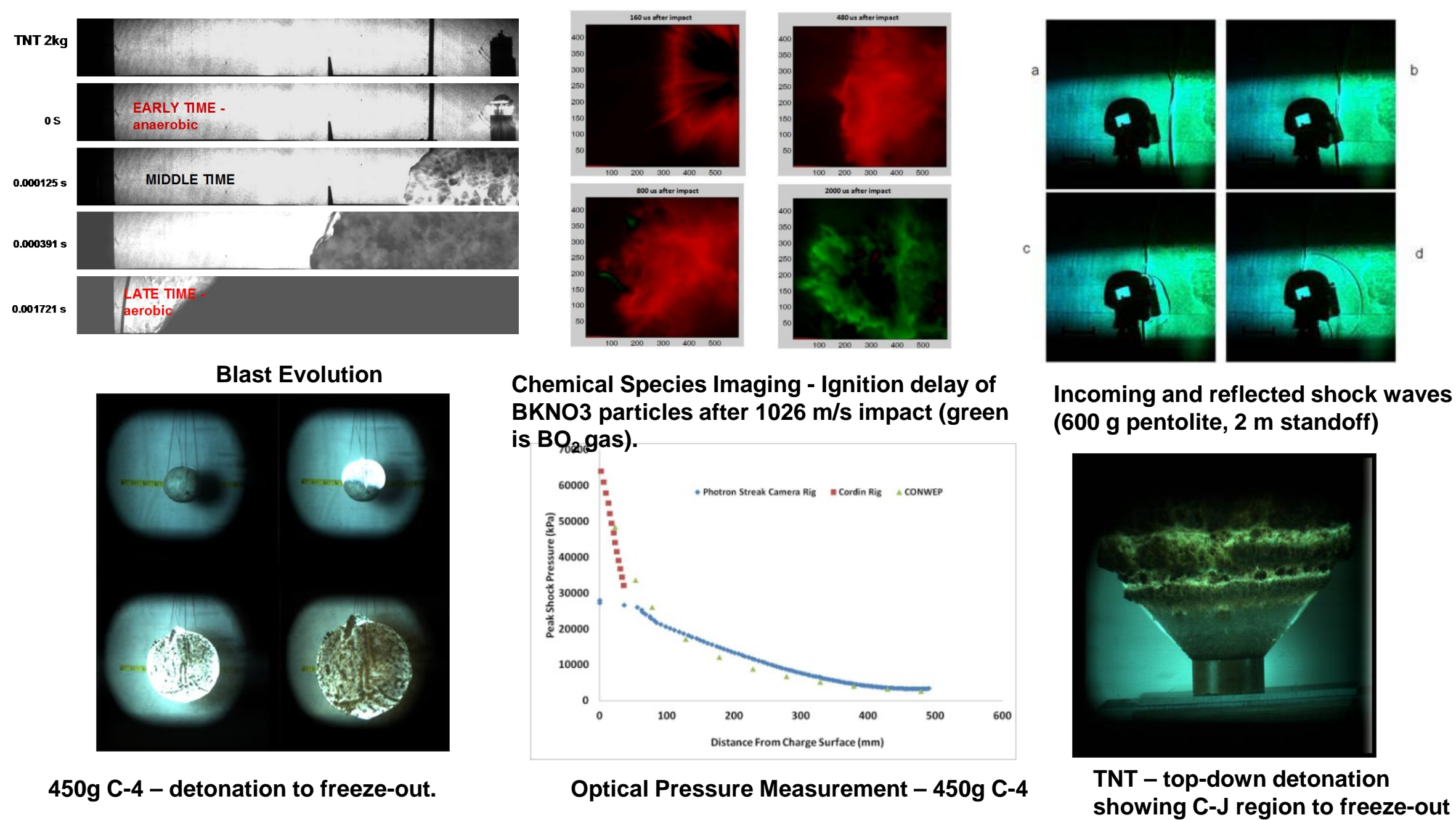
## S&T Campaign: Sciences for Lethality and Protection

*Kinetic Lethality*  
*Propulsion and Launch*

Kevin McNesby  
(410) 306-1383  
kevin.l.mcnesby.civ@mail.mil

## Research Objective

- Utilize high speed imaging to optically measure pressure, temperature, and chemical species during explosive events.
- Use shockwave imaging to measure blast energy deposited on target.



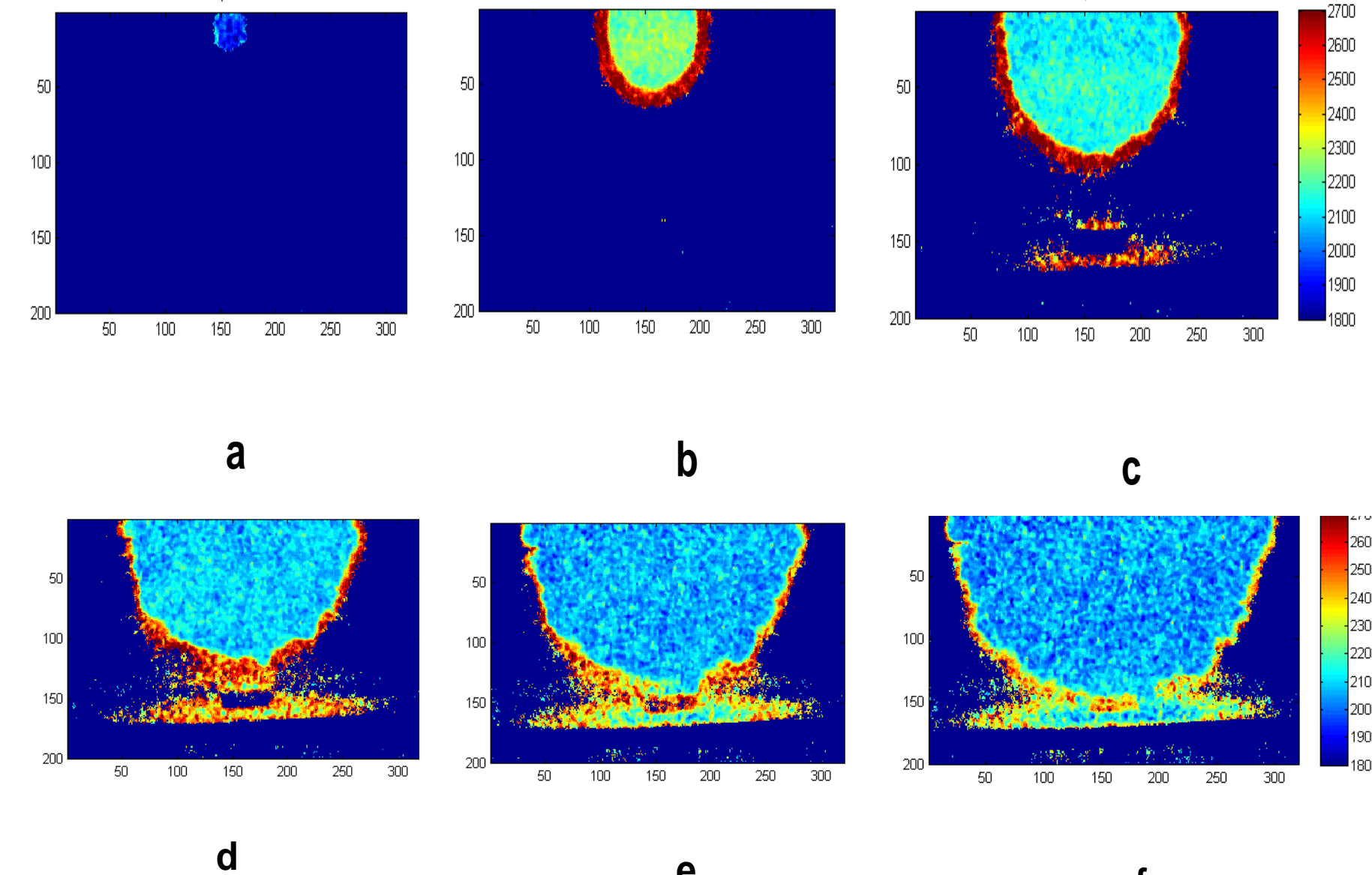
Examples of high speed imaging techniques applied to explosive events.

## ARL Facilities and Capabilities Available to Support Collaborative Research

- Detonation Science Facility, Indoor/Outdoor Ranges, NEW to 20 kg.
- Low-parallax High Brightness Imaging Facility (unique to US).
- High Speed, High Definition framing cameras to 2.5 Mfps.
- Imaging emission spectroscopy.
- Charge formulation, manufacture, testing.
- Small scale testing of novel energetics.
- All classical explosive characterization tests (wedge, cylex, detonation velocity, etc.) performed.
- 4-channel Photonic Doppler Velocimetry (PDV) rig on site.
- Digital and film-based streak cameras.
- Full color, two-color imaging pyrometry.

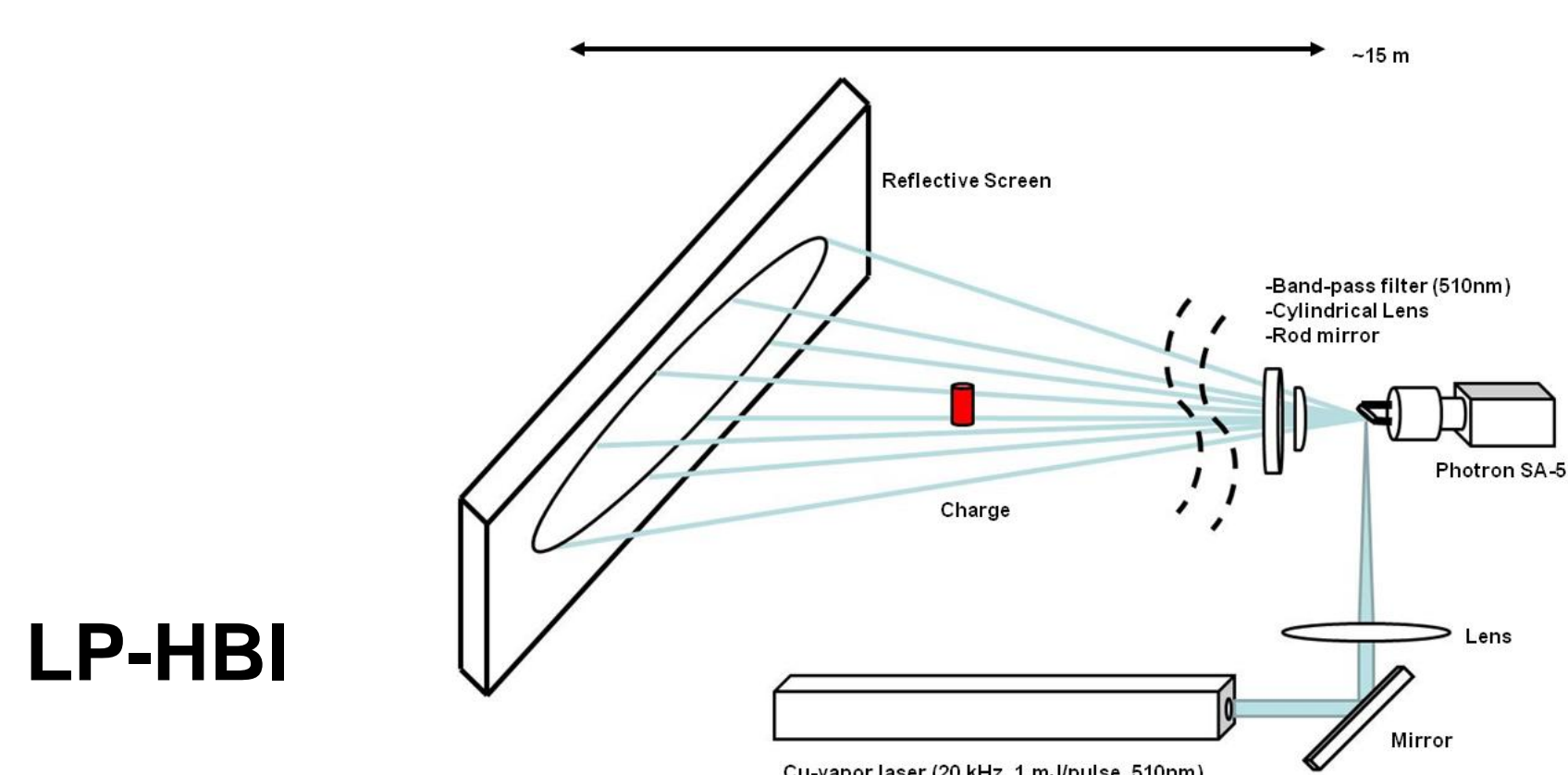
## Challenges

- Single shot mapping of all explosive parameters at real scale (several kg) to include peak shock pressure, surface temperature, chemical species at fireball surface.
- Moving imaging frame rate from tens of kHz to MHz
- Active imaging (laser sheet probing at large scale).
- Ultra-high brightness femtosecond imaging.
- Forcing metals to react in vicinity of detonation front.

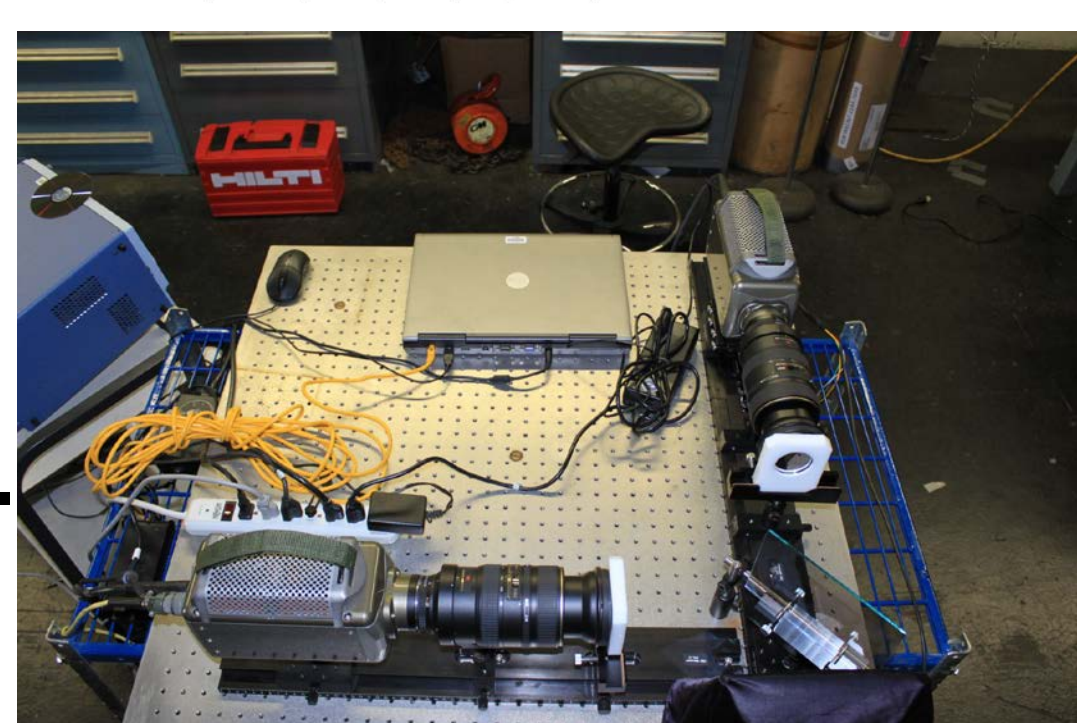


Full-color imaging pyrometry measurements for a 227 g charge of C-4 at 63.5 cm standoff from a table used to simulate an armor surface. Time sequence: a<b<c<d<e<f with a time interval of 71  $\mu$ s. Note the hot outer surface of the fireball indicating the primary shock wave location.

Low-Parallax High-Brightness Imaging (LP-HBI) - imaging incident and reflected shocks



Two-camera imaging rig for mapping temperature, species.



ARL rigs for characterizing explosives range from large outdoor facilities (schematic of LP-HBI at top) to portable table-top two-camera imaging systems

## Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- Stereoscopic imaging of blast flow fields.
- Time-gated imaging capable of discriminating photon travel duration.
- Chemical kinetic modeling of particle combustion at high temperatures.
- High speed tomography using limited lines of sight.
- Atomistic modeling of shock reflections in air and in condensed media.

Sample Publications: "Optical Measurement of Peak Air Shock Pressures Following Explosions," Kevin L. McNesby\*, Matthew M. Biss, Richard A. Benjamin and Ronnie A. Thompson, Propellants, Explosives, Pyrotechnics; Vol. 39, pages 59-64 (2014); "Optically Measured Explosive Impulse," Matthew M. Biss and Kevin L. McNesby, Exp Fluids (2014) 55:1749