Research Objective

- Understanding the physics of gun interior ballistics, gun muzzle blast/flash, and rocket internal ballistics.
- Develop and validate high-fidelity modeling capabilities to predict multidimensional, multiphase, chemically-reacting flow fields for solid propellant gun charges and rocket engines used for tactical armament propulsion.
- Develop and validate chemical kinetics mechanisms for solid propellants used in Army guns as well as minimum-smoke and composite propellants used in Army missiles.
- Create synergism between computational physics-based models and experimental facilities (full- and laboratory-scale).

Challenges

- Mitigating high-pressure fields associated with gun muzzle blast (pressure, temperature, signature).
- Fundamental understanding of the interaction of reaction kinetics and high-pressure, multi-phase fluid dynamics in propulsion systems (guns, rocket engines).
- Reducing kinetics mechanisms to computationally tractable sizes while maintaining accuracy over wide range of pressures, temperatures, and compositions.
- Difficult obtaining quality validation data over range of conditions for strand-burners and small rocket engines.
- Developing efficient computational methods and algorithms.

ARL Facilities and Capabilities

Available to Support Collaborative Research

- Expertise in physics-based computational model development (lumped-parameter, CFD, burnrate models) for gun charges and tactical rocket engines.
- Expertise in gas-phase chemical kinetics mechanism generation/customization for solid propellants developed for use in gun charges, igniters, and rockets.
- Complementary computational and experimental resources for gun interior ballistics, gun muzzle blast, and solid propellant strand burn visualization and rate data.
- Gun ballistic ranges and laboratory-scale test facilities.
- DOD Supercomputing Resource Center (DSRC).

Select experimental facilities (CW from upper left: windowed strand burner, muzzle blast/flash Schlieren, gun interior ballistics simulator.)

Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- Mitigation techniques for high-pressure fields produced by blast from propulsion systems (e.g., gun muzzle blast).
- Precision bench-level experiments for the measurement of gun charge dynamics during ignition-phase.
- High-quality validation data (propellant strand burn rate and chemical composition, engine internal pressure and temperature) over wide range of operating conditions (10,000+ psi) and propellant compositions.
- Shock tube data to support gas-phase chemical kinetics mechanism development for specific critical reactions.
- Solid (condensed) phase kinetics for high-pressure, multi-phase, chemically-reacting flows.