



U.S. ARMY  
**RDECOM**

Combustion Sciences for Advanced  
Propulsion Systems



## S&T Campaign: Sciences for Maneuver Energy and Propulsion

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### Research Objective

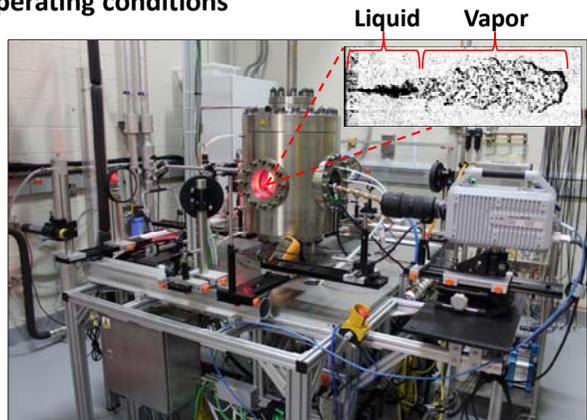
- Apply discoveries in spray and combustion science to innovate heavy-fueled piston and gas turbine engines
- Advance the understanding of propulsion systems via detailed characterization of spray processes and combustion events at realistic operating conditions



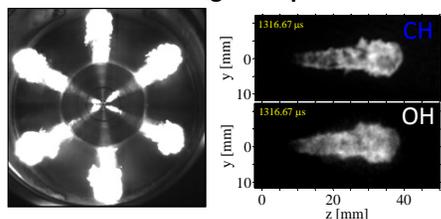
Spray Combustion Research Laboratory

### Challenges

- A complete exploration of rate of injection, spray, and combustion characteristics is required to fully understand heavy-fuel sprays at realistic engine operating conditions



High-Temperature Pressure Vessel



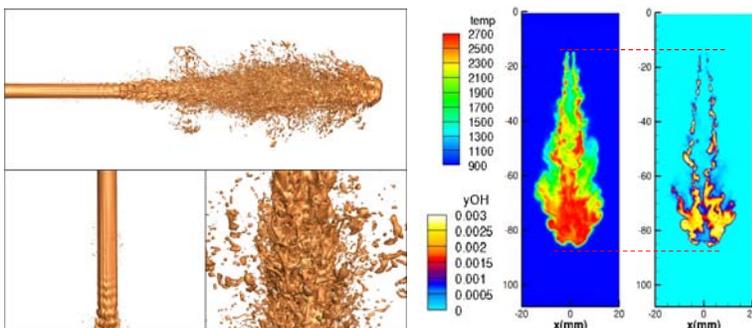
Combustion Chemiluminescence



High-Pressure Fuel Injectors

### ARL Facilities and Capabilities Available to Support Collaborative Research

- High-temperature pressure flow through chamber with optical access capable of reaching temperatures up to 1000 K and pressures up to 150 bar
- Various fuel injector benches: an air-driven pump, common rail pump, and a hydraulically actuated electronically controlled unit
- Fuel injection analyzer used to measure shot-to-shot fuel quantity, rate of injection, and hydraulic delays
- Full flexibility in controlling injection parameters of fuel injectors
- Optical diagnostics include high speed (up to 10 million frames/sec) Mie, schlieren, and chemiluminescence to measure liquid/vapor penetration and ignition delay
- Pulsed (10 Hz) Nd:YAG laser and tunable dye laser systems for planar imaging of combustion intermediate species
- McKenna flat flame burner for PLIF signal calibration
- High fidelity (DNS/LES) predictive CFD simulations of non-reacting and reacting heavy fuel sprays
- Access to DOD High Performance Computing multicore platforms for intensive CFD analysis
- Members of the Engines Research Team offer a broad array of experimental and computational expertise in areas of sprays and combustion



High Fidelity Near-Nozzle Spray

JP-8 Reacting Spray

### Complementary Expertise/Facilities/ Capabilities Sought in Collaboration

- Fuel spray and combustion chemistry expertise in areas of high temperature and pressure conditions
- Capability to measure velocity fields during spray event
- Advanced laser diagnostics methodologies to characterize combustion
- Improved capability to experimentally measure fuel droplet diameters in the near-nozzle regime