Research in Combustion, Sprays, Energetics, and High-Speed Flows for Propulsion, Energy, and Transportation Systems

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Applications

Gas-Turbines

We are interested in studying complex flows relevant to many advanced propulsion devices.

Reciprocating Engines

Hypersonic Engines and Vehicles

wardauto.com
aerospaceengineeringblog.com
ucdavis.edu
Laser Diagnostics

- Our work pushes the boundaries of laser technology to allow high power output at high repetition rates to capture dynamic events in thermal-fluid systems.

- The burst-mode laser we helped to develop below allows MHz imaging.

- We are also developing new ways to exploit ultrafast (femtosecond and picosecond) lasers.

- An example is the system shown above for temperature and species measurements using ultrafast fs/ps coherent anti-Stokes Raman spectroscopy.

Dedic, et al. 2015

Slipchenko, et al. 2015
Turbulent flows in practical devices are 3D and dynamic.

Need to capture 3D species and velocity distributions to predict performance.

We are studying turbulence-flame dynamics using advanced 3D laser-based imaging techniques.

3D Velocity, Planar Species
Venkateswaran, et al. 2014

3D Laser Tomography of Soot
Gord, et al. 2015

Flame Studies at AFRL
High-Speed Flows

- High-speed fluid mechanics are important in space reentry and new high-speed propulsion concepts
- Measurements must be careful to avoid perturbing the flow and capture fast transients
- Our advanced diagnostics can capture shock-flow interactions, turbulent transition, and flame stabilization

NASA Facilities for up to Mach 10 Flow

MHz Rate Planar Laser Imaging

Jiang, et al. 2011
Dense Sprays

- Dense sprays create opaque, multiphase environments that are extremely difficult to study.
- Ultrafast femtosecond or picosecond time gating allows 3D imaging in opaque sprays.

Schmidt, et al. 2008

Ma, et al. 2014

No Time Gate 2 ps Time Gate 3D Rendering with Multiple Views
X-ray Imaging

Validation of 3D CT of Sprays in an Impinging Jet Injector

X-ray Tube Source 3D Computed Tomography

X-ray Tube Source Radiographic Image

Heindel, et al. 2007
Halls, et al. 2014
Meyer, et al. 2010

Validation using Synchrotron X-ray Source

- APS Water
- ISU Water
- ISU 15% KI
- ISU 15% KI CT

Horizontal Location [mm]
Equivalent Path Length [µm]

Testing 3D CT in a Hollow Cone Spray
Funding

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