Images of Sprays and Combustion in the MTU Constant Volume Combustion Vessel

Dr Jeff Naber
Jaclyn Nesbitt
Combustion Vessel Hardware – Internal View

• Looking into the combustion vessel – fan and electrodes on top of the window – used to generate conditions representative of IC engines. Straight in front – diesel injector tip – where fuel sprays from. On left and right side – sapphire windows. Image is taken looking through a window port in the vessel (the sapphire window is removed). The circles on the four corners of the injector window are intake and exhaust valves – let gases in and out of the chamber.
Combustion and Spray High Speed Imaging

Combustion Test in 12% Oxygen
Time after Start of Injection Displayed on Image
LaVision UltraSpeedStar 16 CCD Camera

Spray Imaging
ICCD Camera

Injector Tip

Combustion Test in 12% Oxygen
1 ms after Start of Injection
ICCD Camera
CV Premixed Burn

CV Filled to 223 Psia, Heated to 180°C
Mixture yields 2% $O_2$ after burn

Fan Off, 695 Psia Peak Pressure

Fan On, 779 Psia Peak Pressure
Spray images of diesel fuel into the chamber. Black triangle at the top is the tip of the injector. This imaging is done using shadowgraph imaging which enables visualization of the vapor phase of the spray. Images span 0.1 to 1.5 ms after the start of fuel injection.
Spray images of diesel fuel into the chamber. White triangle at the top is the tip of the injector. This imaging is done using Mie scattering imaging which enables the visualization of the liquid phase of the spray (We won’t see the fuel which has evaporated due to the high temperature in the combustion vessel). Images span 0.1 to 1.5 ms after the start of fuel injection.
Electrode orientation in combustion vessel – in reference to the images in the next slide.

Spark discharge occurs in this region and then spreads out.
Spark Discharge Images – Spanning 3 to 7 ms after Spark
Sample Images - High Pressure Diesel Sprays

1800 bar fuel injection ULSD D2 fuel, 1.5 ms injection duration, 129 µm single hole nozzle on Bosch Gen II common rail injector, ambient density of \(34.2 \text{ kg/m}^3\)

Time after start of injection on image

Mie Scattering Liquid Phase 373 K \(N_2\)

Shadowgraph Vapor Phase 373 K \(N_2\)

Mie Scattering Combusting 1030 K 21% \(O_2\)
Gasoline Direct Injection (GDI) Sprays

E85 into 1 bar Nitrogen, 117 bar injection pressure, 6 hole nozzle, 1.6 ms injection duration

Laser Scattering
1000 ns exposure; 0.6 ms after SOI

Shadowgraph Imaging
192 µs exposure; time after SOI on image