# Optical Methods for Spray and Combustion Diagnostics

**Introduction and motivation**

Optical measurement techniques are very valuable tools for spray and combustion diagnostics. Most experimental spray research is based on spray characterization using various types of optical diagnostics. In combustion engine research, experiments in an engine with optical access can provide detailed information about the in-cylinder processes, not possible through the conventional cylinder pressure and emissions measurements. With advanced lasers, cameras, etc. it is possible to study phenomena by imaging with high spatial resolution, follow processes with very high time resolution and use the wavelength selectivity for species detection. The set-ups of experiments involving optical diagnostics is often unique and involve a combination of techniques. Thus, to be in the forefront CERC needs resources for designing, performing and evaluating optical experiments and the role of this project is to provide such knowledge.

**Results**

A range of optical measurements have been carried out, often in collaboration with different CERC projects. The studies include high-speed imaging in different modes, planar laser sheet imaging and chemiluminescence spectroscopy with a few examples are described here. High-speed video imaging techniques have been developed and applied for Diesel spray characterization. A combination of UV and visible extinction (shadow) imaging was carried out to investigate the distribution of liquid and vapor phase fuel. For the characterization of reacting Diesel sprays a combination of cameras were used to detect OH* chemiluminescence, soot luminescence and soot extinction. The latter enabled line-of-sight concentration measurements. The video techniques were also combined with planar laser-induced fluorescence (PLIF) for OH detection in the Diesel flame.

PLIF in combination with Mie scattering has also been used to investigate liquid and vapor fuel distributions, for example to follow the selective evaporation of components of gasoline-like and ethanol-based fuels. Fluorescence tracers marking different high- and low-volatile components were used to investigate the distribution relative to each other and to the liquid fuel.

In an engine with optical access in the cylinder head and through the piston fuel and temperature distributions were determined with two-color PLIF before ignition, and chemiluminescence light from the subsequent combustion was filmed with video cameras and improved understanding of the combustion process could be obtained by analyzing correlations between the two.

**Conclusions**

This project has supported several other CERC projects with measurement set-ups for advanced spray and combustion diagnostics. Many of the set-ups have been unique combinations of video imaging, PLIF and/or spectroscopic methods, and delivered valuable data for the respective project. These activities will continue with further developments for more accurate absorption and fluorescence measurements.

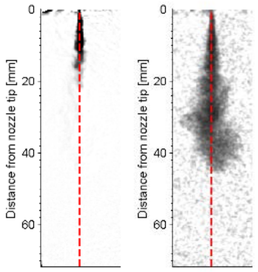


Figure 1. Visible and UV shadow images showing the extent of liquid and liquid+vapor phase fuel distributions.

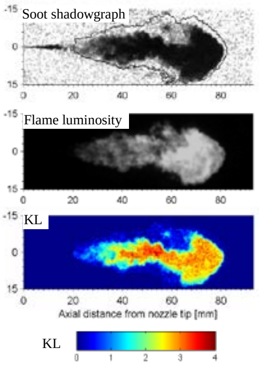


Figure 2. Soot shadow and luminescence images and derived KL factor in reacting Diesel spray.