LaVision
FOCUS ON IMAGING

In Application

Simultaneous Multi Parameter Imaging for SI Engine Diagnostics

Velocities, Stoichiometry Map, Droplet Size and Temperature

During fuel injection the droplets are penetrating into the hot environment inside the cylinder. Spray break-up, droplet evaporation and mixture preparation are occurring simultaneously. In order to spatially and temporally resolve these highly transient processes, laser based imaging techniques are favorable. One solution to separate both phases in two-phase flows is the tracer-based technique of Laser Induced Exciplex Fluorescence (LIEF).

LIEF System

For quantitative results of the transient evaporation process in sprays the exciplex system must essentially satisfy two requirements:

- sufficient **spectral separation** of vapor and liquid phase emission
- **co-evaporation** of tracer and model fuel

The only known combination also meeting the second condition is fluorobenzene (FB) with diethylmethylamine (DEMA) for the model fuel n-hexane.

The power of this technique is the **simultaneous** 2D measurement of multiple scalars in a single-shot:

1. **vapor phase distribution (quantitative)**
2. **droplet distribution (qualitative)**
3. **droplet temperature (quantitative, ensemble average)**

With double-pulsed laser excitation, two additional quantities can be derived from the images, i.e.

4. **vapor phase velocity (2C/2D)**
5. **droplet velocity (2C/2D)**.

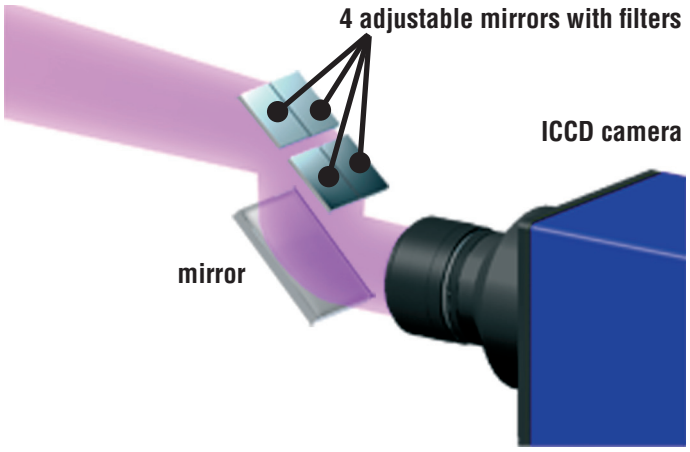

Figure 1: 4-way mirror optics with ICCD camera

The first application of Multi-2D LIEF to a firing SI-engine has been demonstrated by Wieske et al. (2006).
Further characterization of the spray with respect to droplet break-up and evaporation requires determination of droplet sizes. One approach is the detection of the elastically scattered light. With this forth 2D-information, relating exciplex fluorescence (~ D^3) and scattering (~ D^2) gives the

6. **Sauter Mean Diameter (SMD) or D32 (qualitative).**

Though determination of D32 via LIF/Mie is usually suffering from effects like temperature dependence of the LIF and ensemble averaging, again, this LIEF approach is superior to other applications. The absolute temperature dependence can be corrected for with an in-situ calibration. Furthermore and which is most essential, tracer and model fuel are co-evaporative and exciplex fluorescence solely originates from the liquid fuel.

LaVisionUK Ltd
2 Minton Place / Victoria Road
Bicester, Oxon / OX26 6QB / United Kingdom
E-Mail: sales@lavision.com / www.lavisionuk.com
Phone: +44-(0)-870-997-6532 / Fax: +44-(0)-870-762-6252

LaVision GmbH
Anna-Vandenhoeck-Ring 19
D-37081 Göttingen / Germany
E-Mail: info@lavision.com / www.lavision.com
Tel. +49-(0)551-9004-0 / Fax +49-(0)551-9004-100

LaVision Inc.
211 W. Michigan Ave. / Suite 100
Ypsilanti, MI 48197 / USA
E-mail: sales@lavisioninc.com / www.lavisioninc.com
Phone: (734) 485 - 0913 / Fax: (240) 465 - 4306

LAVISION
FOCUS ON IMAGING

Simultaneous Multi Parameter Imaging for SI Engine Diagnostics

Velocities, Stoichiometry Map, Droplet Size and Temperature

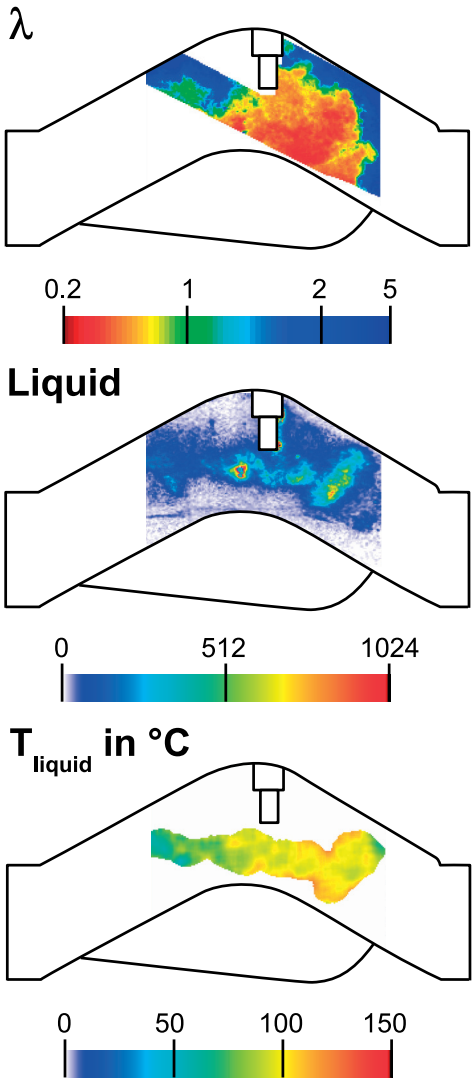

Figure 2: Single-shot results of lambda, liquid phase distribution and droplet temperature

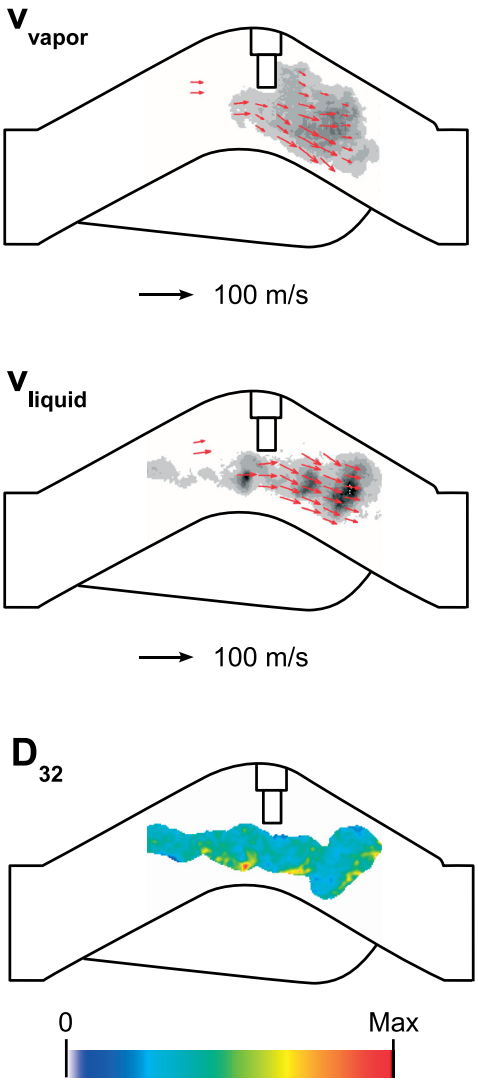

Figure 3: Single-shot results of vapor and liquid phase velocities and mean droplet diameter D32

Application

The Multi-2D imaging technique of the exciplex system FB/DEMA in n-hexane enables an almost complete characterization of the fuel spray in single-shot measurements.

Wieske et al. (2006) show the application of a 4-way mirror optics with one image intensified double-frame camera in a fired air guided optical DISI engine. Results in Figs. 2 and 3 courtesy of P. Wieske and G. Grünefeld (The study was funded by BMBF within 03GRA1AC).

P. Wieske, S. Wissel, G. Grünefeld and S. Pischinger, Improvement of LIEF by Wavelength-Resolved Acquisition of Multiple Images using a Single CCD Detector, Applied Physics B, vol. 83 (2006) 2, pp. 323-329

P. Wieske, S. Wissel, G. Grünefeld, M. Graf, S. Pischinger, Experimental Investigation of the Origin of Cyclic Fluctuations in a DISI Engine by Means of Advanced Laser Induced Exciplex Fluorescence Measurements, SAE Technical Paper 2006-01-3378, 2006

LaVisionUK Ltd
2 Minton Place / Victoria Road
Bicester, Oxon / OX26 6QB / United Kingdom
E-Mail: sales@lavision.com / www.lavisionuk.com
Phone: +44-(0)-870-997-6532 / Fax: +44-(0)-870-762-6252

LaVision GmbH
Anna-Vandenhoeck-Ring 19
D-37081 Göttingen / Germany
E-Mail: info@lavision.com / www.lavision.com
Tel. +49-(0)551-9004-0 / Fax +49-(0)551-9004-100

LaVision Inc.
211 W. Michigan Ave. / Suite 100
Ypsilanti, MI 48197 / USA
E-mail: sales@lavisioninc.com / www.lavisioninc.com
Phone: (734) 485 - 0913 / Fax: (240) 465 - 4306