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IN APPLICATION

Diesel Spray Investigation with Ultra-High-Speed Camera UltraSpeedStar

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The trend to high pressure fuel injection, development of multiple injection and rate shaping shows the tremendous efforts to raise Diesel engine efficiency. More stringent exhaust gas limits like EURO III and IV prompt more developments. One of the key factors to reach these targets is the improvement of the injection system.

A deeper understanding of the temporal behavior of the complex injection process is achieved with ultra-high-speed imaging. The high pressures claim extremely short interframe times in the range of tens of microseconds. Additionally, a high spatial imaging resolution is requested.

In the laboratories of Delphi Automotive Systems Luxembourg injection systems have been compared in terms of symmetry and reproducibility. Characteristic data of shot-to-shot variations, spray penetration and cone angle are derived. The resulting huge amount of data is reduced with new data reduction algorithms.

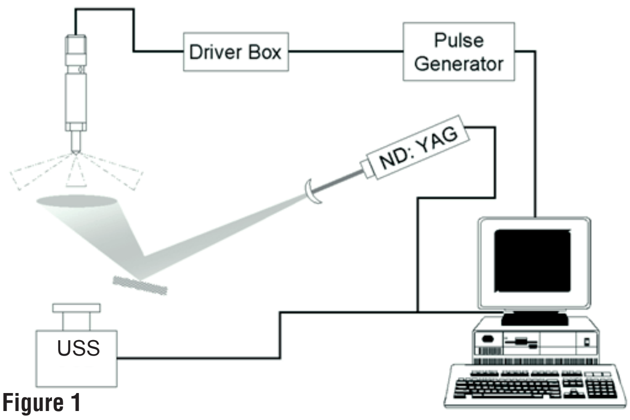

Figure 1
Experimental Setup

For the investigations Delphi Automotive Systems uses the **UltraSpeedStar** camera system from LaVision with 16 frames at a maximum frame rate of 1 MHz. The system integrates a pulsed DPSS laser illuminating the spray. In the shown measurements the laser light was expanded to obtain an overall front illumination. The droplets reflect the light in so-called Mie-scattering and the camera detects the droplet distribution.

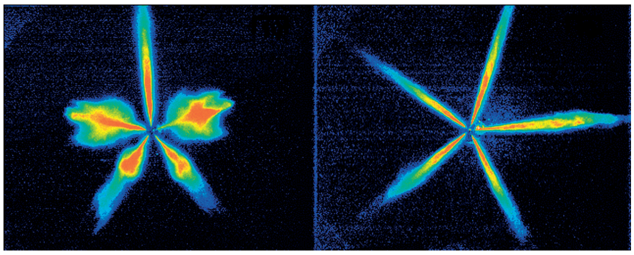

Figure 2
Spray distribution at 620 µs after injection start. On the left from a non-homogeneous on the right from homogeneous injection nozzle, both operated at a pressure of 600 bar. The temporal evolution is shown in steps of 30 µs on the back of this page (figure 4).

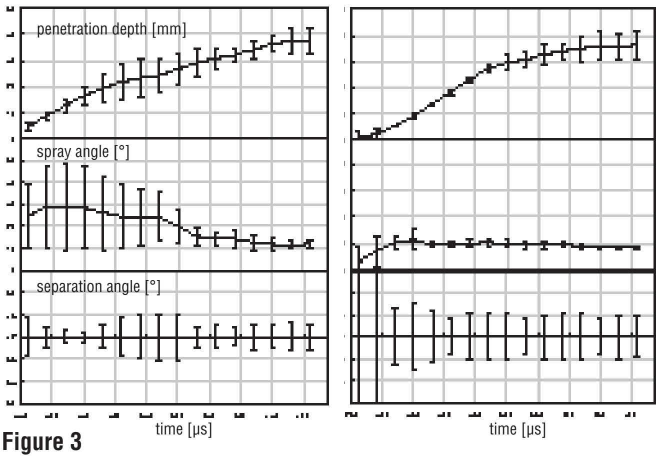

Figure 3
Penetration depth (top), spray angle (middle) and separation angle (bottom) of the injection shown in figure 2 – non-homogeneous (left) and homogeneous (right). The plots include mean values and standard deviations of 10 successive injections.

The time resolved sequences allow a clear distinction between phenomena of spray development occurring in one cycle from those occurring with cycle-to-cycle variation. Another big advantage of the ultra-high-speed system against single shot camera systems is the reduction of measurement time. Time-consuming cleaning of the observation windows is reduced. Therefore, the test stand is used with higher efficiency.

* "Study on a Diesel Common Rail Spray Development Separated from Shot to Shot Variation", Dr. W. Reckers et al., Thiessel 2002, Valencia.

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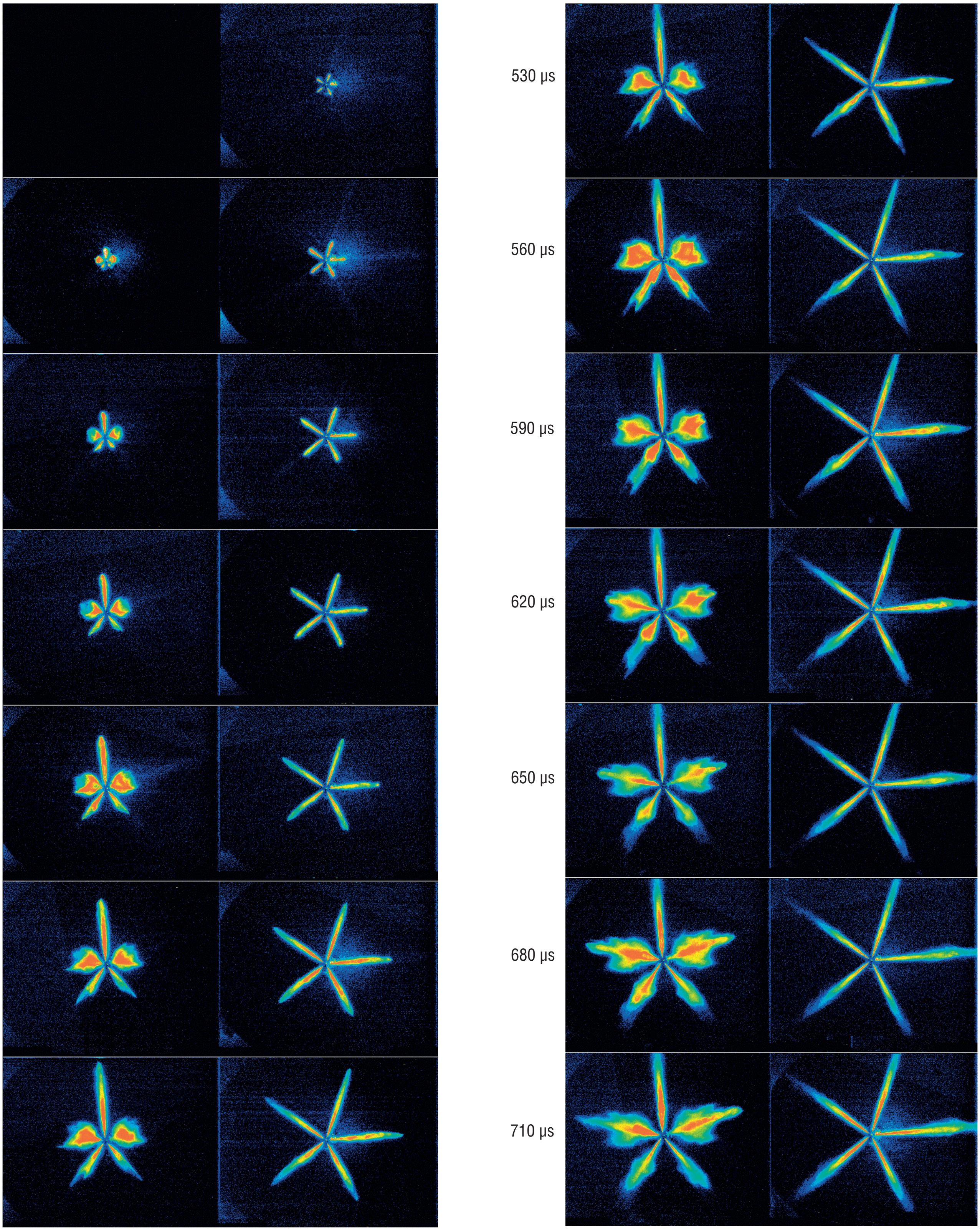

Figure 4

Time resolved fuel droplet distribution of two injection processes from different noozles: ***A.*** *non-homogenous and* ***B.*** *homogeneous. Looking at the image pairs one compares the fuel droplet distribution of the different injectors at the same time after injection start. The evolution in time of the individual injection processes is shown in time intervals of 30 µs.*

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