WATER SPRAY CHARACTERIZATION BY RAINBOW THERMOMETRY AND PHASE DOPPLER ANEMOMETER

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The Rainbow thermometry is a non-intrusive measurement technique able to determine the size and the temperature of droplets in sprays. The rainbow in the lab is an interference fringes image formed thanks to the same scattering principle, which causes the beautiful rainbow in the sky on a rainy day when the sun is shining.

In the rainbow technique the absolute angular position of the rainbow image allows to determine the droplet temperature while the shape of one pixel line intensity of the rainbow image gives the droplet size. The temperature and size measurements are independent from each other and can be obtained simultaneously. If the measurements are performed on one single droplet at time, the technique is called Standard Rainbow Thermometry (SRT) and it is depending on the size, the temperature and the non-sphericity of this droplet. This technique has as major drawbacks an uncertainty for the temperature due to non-sphericity effects, a ripple structure and unstable signals in time. To overcome these drawbacks the Global Rainbow Thermometry (GRT) was proposed. The signal is now formed by an ensemble of droplets in a bigger probe volume. The ripple structure averages out and the signal is now time stable (like the rainbow in the nature), unfortunately the number of depending variables increases by their distributions. One goal of the project was to reduce the depending variables. This one has been done by relating the droplet non-sphericity to the droplet size using the so-called "Taylor Analogy Breakup" model. This model has been implemented in the simulating and data inversion algorithm.

Furthermore experiments were performed to compare the SRT and GRT approach (c.p. figure 1), but also GRT measurements with well established techniques, like Phase Doppler anemometry and thermocouple measurements characterizing a full cone and a flat fan water spray. For the first time it was experimentally proven that the time average of SRT signals corresponds to the GRT signal in steady state conditions.
Finally a dynamic calibration method for the temperature, as well as the droplet size using a water jet was proposed and first promising experiences were gained.

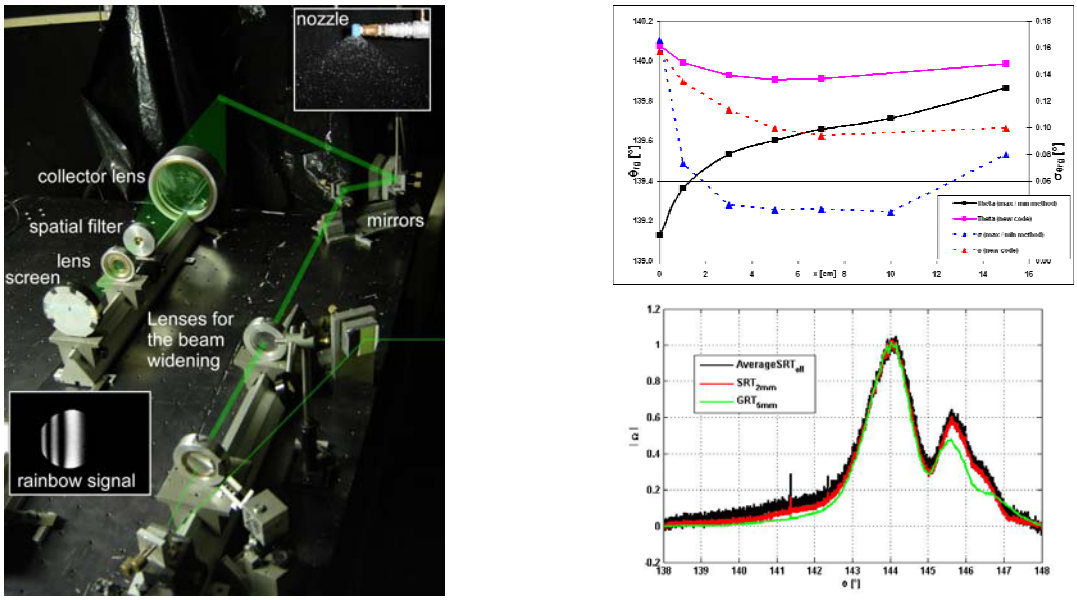

Figure 1: Experimental set up for Rainbow Thermometry (left). Comparison between unfiltered, averaged and normalized SRT and GRT signals (down-right). Radial development of the geometrical rainbow angle θ_{rg} for a full cone spray (top-right).