ILA
R&D GmbH
Research and
Development

Filtered Rayleigh Scattering (FRS)

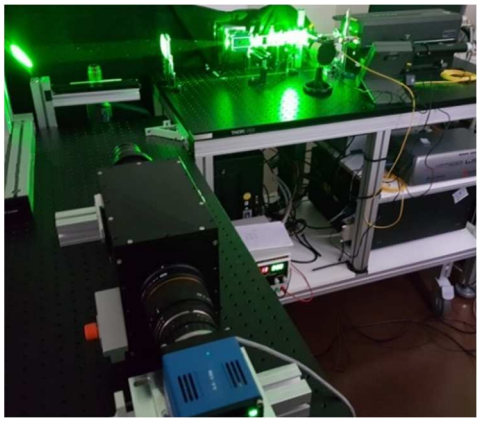

Fig. 1: FRS Measurement of a heated free jet

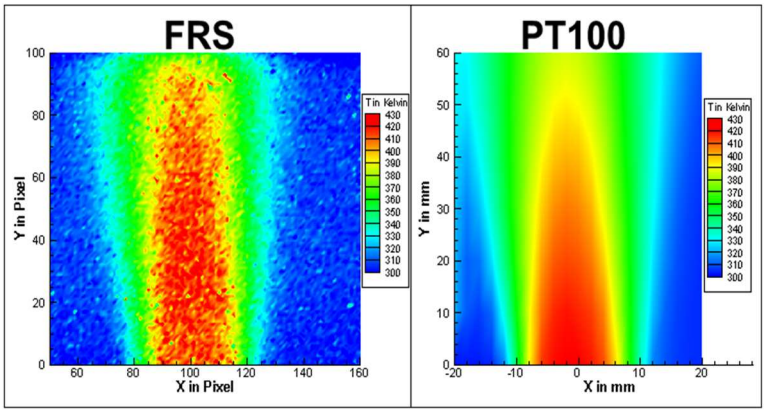

Fig.2: Comparison of the temperature distribution in a heated free jet with FRS and with a PT100 temperature probe

The non-intrusive Filtered Rayleigh Scattering (FRS) method is well suited to measure the temperature, velocity, density and pressure in unseeded gas flows. It was developed and proved by DLR. The light source is a high power cw-Laser with a precisely adjustable wavelength. The Laser is used to create a light sheet with a homogenous intensity distribution over the entire cross-section. The FRS method is based on the acquisiton of the intensity of the Rayleigh scattered light from gas molecules in a laser light sheet spectrally filtered by a molecular filter, a iodine cell. The absorption spectrum of iodine is used to eliminate the scattered light of walls and Mie scattered light. The intensity signal in the light sheet is then focused on a sCMOS chip behind the iodine cell.

The shape of the frequency spectrum is influenced by flow field parameters temperature, pressure, Doppler shift and the composition of the gas. Knowing the composition of the gas and the exact shape of the iodine absorption spectrum therefore enables determining the parameters temperature, pressure, velocity and density by using the Tenti model. To gain the information needed for the model to reconstruct the flow parameters the laser frequency is varied systematically in equidistant steps (fig.3), which is called Frequency Scanning-FRS (FSM-FRS).

Figure 1 shows the FRS measurement setup of a heated free jet. Main objective of the measurement was to determine the temperature distribution in the stream and to compare the FRS measured temperature with that of a calibrated PT100 temperature probe.

The results are shown in figure 2. The temperature distribution in the FRS graph on the left is spatially highly resolved whereas the PT100 graph shows an averaged temperature distribution due to the interpolation of 147 individual measuring points distributed over the entire measurement range. The temperature averaged over 10 pixels in the core stream and in the surrounding area show very similar results in both measurements with less then 0,4% deviation.

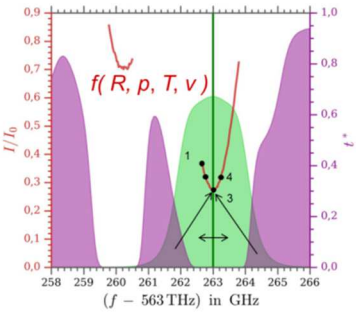

Fig.3: Frequency Scanning (FSM FRS), iodine spectrum (rosa), Rayleigh scattering spectrum (green) (Courtesy of Beuth Hochschule)

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