International Conference on Advanced Optical Technologies
University of Erlangen-Nürnberg, March 13th – 15th 2019

Improved instantaneous droplet sizing in automotive sprays using the LIF/Mie ratio and structured illumination

Matthias Koegl[1,2], Kevin Baderschneider[1], Yogeshwar Nath Mishra[1], Bernhard Hofbeck[1], Stefan Will[1,2], Lars Zigan[1,2]

[1]Lehrstuhl für Technische Thermodynamik (LTT), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany
[2]Erlangen Graduate School in Advanced Optical Technologies (SAOT), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany
matthias.koegl@fau.de

This paper presents an improved method for 2 and 3-dimensional measurements of the droplet size distribution of automotive sprays and its application to a gasoline multi-jet DISI (direct-injection spark-ignition) spray studied in an injection chamber. The gasoline replacement TolIso (65 vol% isooctane and 35 vol% toluene) is used to achieve a gasoline-like atomization and combustion behaviour without the regional mixture variations of commercial gasoline. The imaging method is based on a simultaneous detection of Mie-scattering and liquid laser-induced fluorescence (LIF) using two sCMOS-cameras. Two-phase SLIPI (Structured Laser Illumination Planar Imaging) is applied for both techniques for suppression of multiple light scattering. As fluorescent tracer, the luminescence dye “Nile Red” is added to the liquid fuel, which is excited at 532 nm using a Nd:YAG laser. From the instantaneous LIF/Mie ratio images, quantitative planar measurements of the droplet Sauter Mean Diameter (SMD) are conducted using calibration data from single spherical droplets. For this purpose, a droplet generator was employed, which produces a droplet chain in a wide range of droplet sizes relevant for DISI-sprays. A high-resolution microscopic setup was used for calibration of the LIF/Mie ratio as a function of SMD. Effects of liquid fuel temperature, laser power and dye concentration on the LIF/Mie ratio are studied in detail. The calibration data is used to quantify the droplet size distribution of the DISI spray, which was studied for an injection pressure of 8 MPa and ambient conditions of 0.2 MPa and 298K. The spray evolution and structure were analyzed in 3D and selected planes in terms of SMD.