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Laser Diagnostics in Lean Premixed Stratified Flames

Motivation

For fundamental understanding of flames and in the scope of model validation for numerical simulations a detailed knowledge of the velocity field and the thermo kinetic state of generic flows is necessary. Generic flames such as stratified flames represent effects or geometries of technical combustion devices. Insights can contribute to optimize combustion processes and to improve technical applications.

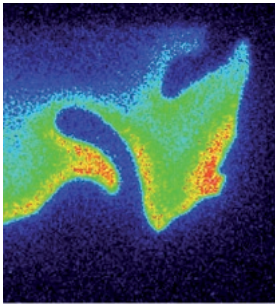
Methods

Spectroscopic techniques are a very efficient, non intrusive method to provide various data about reacting and non-reacting flows. Laser spectroscopy is a sensitive state-of-the-art technique featuring the possibility of high spatial and temporal resolution measurements.

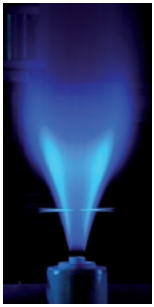
- Spontaneous Raman/Rayleigh line scattering (1D) is used to obtain all major species concentrations and the temperature at once on single shot basis. For this a high power laser pulse is focused into the probe volume. The scattered light is collected using low f number imaging optics, dispersed by a transmission spectrometer, and detected by sensitive CCD cameras.
- Laser induced fluorescence (LIF) serves to detect resonantly minor species such as OH, CH, or CO. Combined with simultaneous Raman/Rayleigh scattering it can be extended to a quantitative technique. The presence of these radicals and intermediate species gives information about the chemical reaction state and the position of the flame front.
- Tracer planar laser induced fluorescence (Tacer PLIF) can be used to study isothermal or pre-igniting mixing processes.
- Laser Doppler velocimetry (LDV) is applied to measure up to three velocity components in a 0D-probe volume.
- Particle imaging velocimetry (PIV) is a planar technique to determine up to three velocity components.

Flames of Interest

Beside turbulent swirling methane flames especially lean premixed stratified flames with Re numbers over 10,000 and thermal powers up to 100 kW are examined. A stratified burner provides the possibility to investigate the various effects of Re number, equivalence ratio, shear, stratification, and fuel type in the context of turbulence-chemistry interaction.



OH-LIF image of a vortex structure in a turbulent flame



Stratified flame passed by laser beams for laser Doppler velocimetry (LDV) measurements