Flame Wall Interaction

Motivation

Near wall combustion phenomena have an important impact on the efficiency and formation of unburned hydro carbons in all engine applications. This aspect is of growing interest for modern downsized internal combustion engines with increased surface-to-volume ratios. Furthermore flame wall interactions are one of the main issues in durability and lifetime of engine parts and components. These also affect the combustion chamber and turbine blades in modern gas turbines at lean combustion.

In technical applications the wall is much colder than the flame temperature. This can lead to an interruption of the chemical reaction, which is associated with a quenching process of the flame. The interaction of flame quenching with fluid motion, transport phenomena and chemical reaction has not been investigated and understood completely.

Experimental Setup

To observe the fundamental processes of flame wall interaction experimental setups with simple geometries and well defined boundary conditions are necessary. In our configuration a generic burner with a premixed jet impinges on a perpendicular orientated wall. The flame profile can be influenced by different air-fuel-ratios, Reynolds-numbers and turbulent intensities. The variation of different wall surfaces (e.g. catalytic surfaces) and wall temperatures has an additional effect on the flame propagation close to the wall.

Diagnostics

The key to understand the physical processes in flame wall interaction is the simultaneous measurement of several quantities. Modern laser based diagnostics allow an accurate measurement of several physical variables with high temporal and spatial resolution without affecting the original flow field in any way. For measuring the flow velocities Stereo Particle Image Velocimetry (PIV) is used in combination with Laser Induced Fluorescence (LIF) of the OH molecule. The OH data characterize the flame structure near the wall. Furthermore we are able to determine the flow and the wall temperatures by Coherent Anti-Stokes Raman Spectroscopy (CARS) Thermometry and Thermographic Phosphors, respectively. The instantaneous measurement of all these quantities can be used to fully characterize the physical processes in the flame and to validate numerical data of CFD simulations.

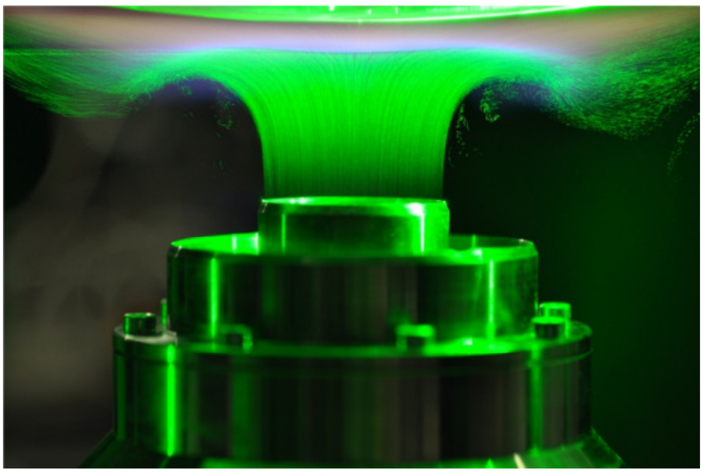

Figure 1: PIV measurement close to the wall