LaVision
FOCUS ON IMAGING

In Application

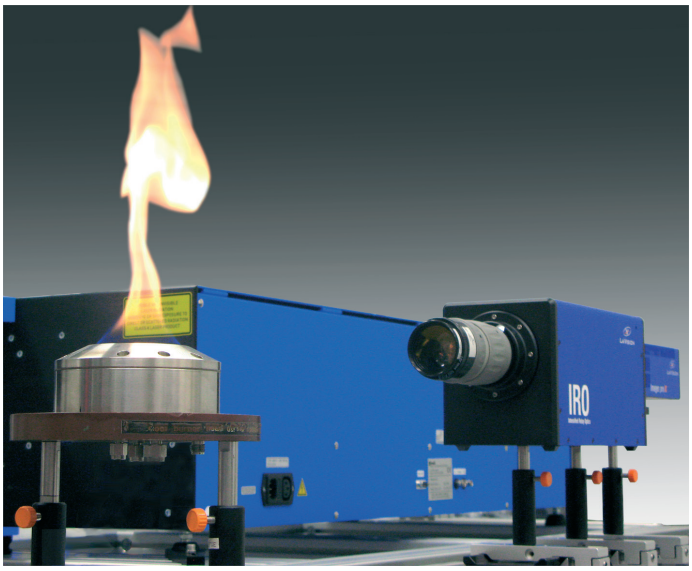
Laser Imaging for Combustion Species

FlameMaster Tunable LIF

Introduction

LaVision's **FlameMaster** system family is designed to help the scientific and engineering community to find new concepts for the realization of more efficient and cleaner combustion devices. Particularly the identification of flame precursors and radicals such as CH_2O, OH and CH yields valuable information on the processes involved in the reaction chain of hydrocarbon ignition and combustion. Furthermore, optimization of the combustion processes is greatly supported by the knowledge on the occurrence and the detection of pollutants like NO and CO.

Minor species with a concentration of a few ppm can be detected via Laser Induced Fluorescence (LIF). In order to generate the required wavelength for excitation of the specific flame species dye laser systems are used. These are pumped by Nd:YAG or Excimer lasers and are able to generate narrow-band radiation in a wide spectral range. Using a Frequency Conversion Unit (FCU) also the UV range down to a wavelength of 220 nm is covered.



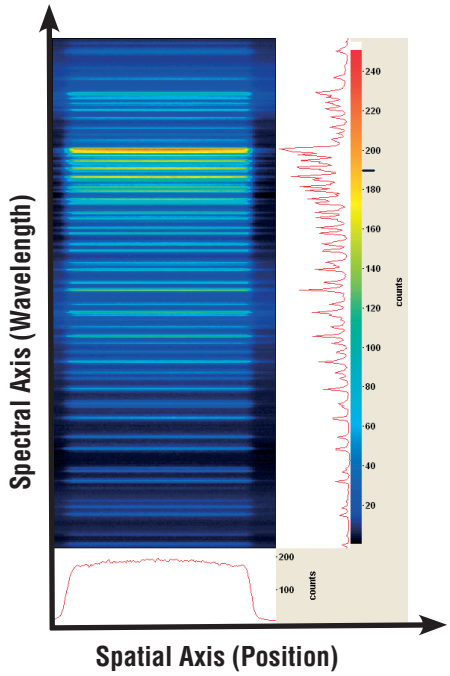


Figure 1: Excitation Spectrum

System Features

- integrated turnkey laser imaging system for multi-parameter measurements in combustion
- complete hardware control using DaVis
- Peakfinding Scan:
  Identification of molecule specific spectrum and laser calibration; automatically or manually pick one line and tune the dye laser to the desired wavelength
- Excitation Spectrum:
  Identification of molecules via their spectrum AND preserve the spatial information of the LIF signal to reveal spatially resolved species concentrations
- Laser sheet correction including compensation of local laser beam absorption to enhance accuracy of concentration measurements

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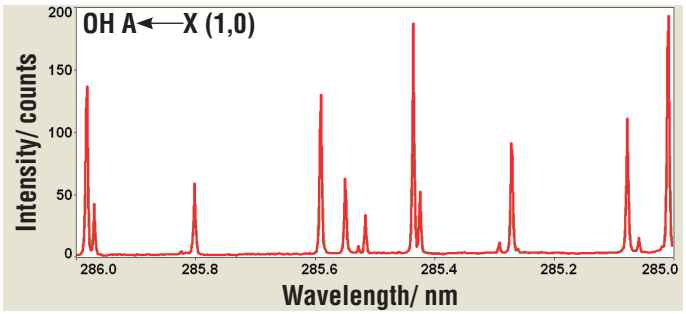

Figure 2: Peakfinding Scan for OH

Application

The FlameMaster dye laser system is applied to a flat surface burner for the quantified detection of hydroxyl (OH) molecules. The Nd:YAG laser output at 355 nm is used to pump the dye laser. The FCU of the dye laser converts the fundamental wavelength of the dye laser for the LIF excitation of the selected OH transition line with the A←X (1,0) band. The line is identified via the Peakfinding Scan of the DaVis software. The pulse energy of several millijoules is sufficient for sheet heights up to 4 cm.

The burner is operated with premixed methane/air at a constant flow rate under ambient conditions. The averaged images below reveal the influence of the flame structure when the fraction of the fuel is increased from stoichiometric to rich conditions.

Specials and Upgrades

- Tunable Nd:YAG laser module for OH-LIF imaging
- Rayleigh Thermometry:
  Determination of flame temperature; Polarisation Rotator for enhanced signal quality and fully software integrated recording and subtraction of background scattering
- Laser Induced Incandescence (LII):
  Soot volume fraction (nano-particle size) imaging for the visualization of soot generation in combustion processes
- Raman:
  Spontaneous Raman Scattering (SRS) is used for determination of air/fuel ratio and quantification of other major species (needs spectrograph)
- Spectroscopy:
  In combination with an Imaging Spectrograph the excitation-emission spectrum can easily be recorded, which shows the spectral “fingerprint” of each molecule
- Calibration burner:
  The well-defined flame of a flat surface burner yields reproducible conditions to scale the FlameMaster system to determine absolute concentrations in the ppm range.

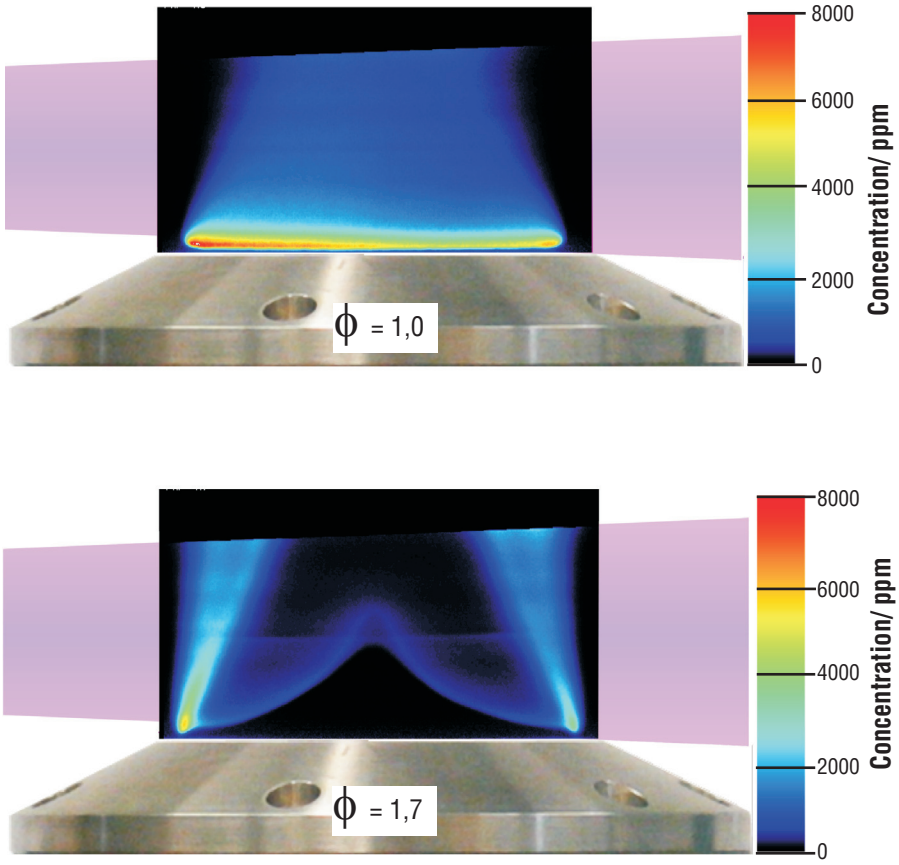

Figure 3: OH radical imaging above the calibration burner

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