Joint measurements and sample data evaluation for the LII workshop 2005 in Duisburg

For the preparation of the workshop on LII to be held in Duisburg, Germany, Sept. 25-28, 2005 the organizers propose **target flames** and **sample data**. The aim is to have as many groups as possible use their experimental approach to measure LII (and potentially additional quantities) in a pre-defined identical environment. Three target flames have been chosen that seem widespread in combustion labs.

On the workshop in Duisburg we would also like to compare the different models that are frequently used for LII data analysis. Therefore, we provide three data sets of time-resolved LII measurements performed under different conditions. Both, the temporal and spatial laser profile is provided and also the calibration factors for the two-color experiments. The initial temperature of the soot particles after the laser pulse can be analyzed in the way everybody feels most comfortable with.

Target flames

What should be measured?

The aim of the conference is the comparison of the LII measurement results in terms of soot volume fraction, mean particle size and width of the particle size distribution. It is important to closely stick to the operating conditions and measuring locations mentioned below. If additional quantities (temperature, gas-phase concentration, attenuation, scattering, TEM sampling) can be provided from the respective labs, the data would be most welcome.

Which flames are preferred?

Three different target flames have been chosen that are frequently used for fundamental studies or for calibration. We hope that each lab has access to at least one of these burner configurations. In case of the availability of all flames, we would suggest to perform measurements from all the configurations possible. If no burner is available, please consider to build one. The drawings of a Santoro burner can be downloaded from the website or can be sent on request. We will monitor the process and might come up with suggestions in case it turns out that the group clearly prefers one or two of the suggested configurations

How is the project organized?

The following instructions should contain the relevant information about the flame configurations and measurement conditions. To facilitate co-ordination: Please send a message to Max Hofmann (max.hofmann@pci.uni-heidelberg.de) before July, 18 and answer the following questions:

- Which flame(s) will be investigated
- Which measurements will be performed (LII + additional measurements)

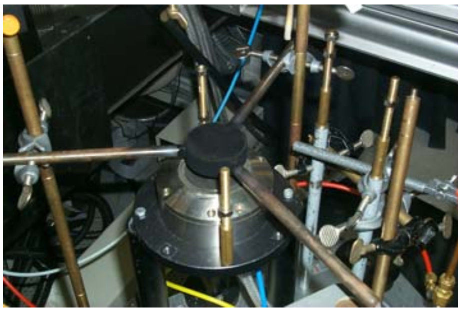
On the workshop the results obtained by the various groups will be compared and potential reasons for discrepancies will be discussed.

In case you want to participate but do not have access to any of the suggested burner configurations: Please contact Max to discuss possibilities of providing a burner for a limited time.

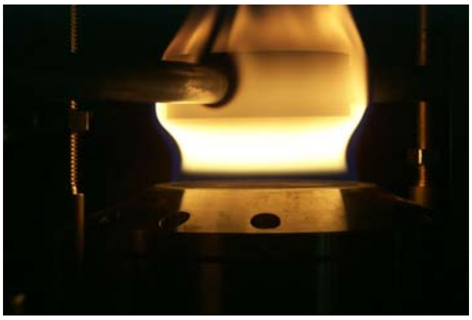
Burner configurations:

McKenna burner:

- Ethylene/air flame
- Equivalence ratio: 2.1
- Total gas flow: 10 slm
- Stabilization plate at 21 mm height above burner.
  diameter of the plate: 60 mm/ thickness of the plate: 20 mm → see images
- Measurement position: centerline location at 12 mm height above burner
- Measurement approximately 15 mins after ignition to provide more or less defined thermal conditions



Burner with stabilization plate



Stabilized flame

Gülder burner

- Ethylene/air flame
- Ethylene flow: 0.194 slm
- Coflow of air: 284 slm
- This produces a flame with a visible height of ~65 mm → see image
- Measurement position: centerline location at 42 mm height above burner

Gülder burner flame

Santoro burner

- Ethylene/air flame
- Ethylene flow: 0.231 slm
- Coflow of air: 43 slm
- chimney to stabilize the flame
- Measurement position: centerline location at 50 mm height above burner

Santoro burner flame

Sample data

On the workshop in Duisburg we would also like to compare the different models that are frequently used for LII data analysis. Therefore, we provide three data sets of time-resolved LII measurements performed under different conditions. Both, the temporal and spatial laser profile is provided and also the calibration factors for the two-color experiments. The initial temperature of the soot particles after the laser pulse can be analyzed in the way everybody feels most comfortable with.

Each of the files represents a set of two-color data of raw LII signals in excel file format. The files can be downloaded from the website at **http://www.vug.uni-duisburg.de/ivg/lii-measurement.html .** There are four worksheets in each file. The first two represent the raw data for detection channels 1 and 2, the third is a plot of this data, and the fourth provides the modelling parameters. These parameters include the spatial and temporal profiles of the laser beam, as well as the calibration values for each channel. Note that all of these parameters are different for each data set.

The following should also be noted:

- The excitation wavelength for all provided data sets was 532 nm, generated with a frequency-doubled Nd:YAG laser.
- Each file provides two channel data for one experiment. The header information gives a time offset and time step which will allow you to map out the measured voltage signal. By applying the correct calibration factor one can map out the absolute intensity of each channel. The time base is relative to the Q-switch sync signal. There is no direct correlation between the absolute time base of the LII data and the absolute time base of the temporal profile of the laser pulse.
- The laser was not injection seeded
- All the data presented are multipulse averages
- Jitter is < 1 ns
- Time response of the LII signal photomultipliers is 1.8 ns
- A photodiode detector was used to characterize the temporal profile of the laser, with a 1 ns rise time and digitized at 8 bits resolution
- Regarding the filter function for the detection, they are typical multi-cavity interference filters that can be reasonably approximated with a square profile. Of course, this introduces an error, but all models being compared will then have the same error
- The calibration is the absolute sensitivity of the detection system (lenses, filters, photomultipliers) and is calibrated with an irradiance source at the probe volume location.

For fairness in the analysis of the data we do not provide more information about the type of flame in which the experiments have been performed.

- Cond_A.xls, is a mid-level fluence experiment (0.50 mJ/mm^2). The soot did not reach sublimation temperatures. The ambient temperature was estimated to be approximately 1750 K.

- Cond_B.xls, is a higher-level fluence experiment (0.75 mJ/mm^2). The soot reached sublimation temperatures. The ambient temperature was estimated to be approximately 1750 K.

- Cond_C.xls is a mid-level fluence experiment (0.8 mJ/mm^2). The soot did not reach sublimation temperatures. The ambient temperature was estimated to be approximately 575 K.

Everybody is kindly invited to apply his own model for data evaluation. If you have typically use models of different degrees of refinement we would like to encourage you to use all of them. During the meeting in Duisburg we will compare the results which have been calculated with the different models. Additional comparison will be provided with independent measurements. This is an excellent chance for you to test your approach in different measurement situations that might be inaccessible to you usually. For the LII community this is an excellent opportunity to locate typical problems or problematic measurement conditions.