Planar Laser Induced Fluorescence (PLIF)

Planar Laser Induced Fluorescence (PLIF) is a common analytical technique used to study gas and fluid flows.

A laser light sheet is passed through the flowing gas or fluid. The wavelength of the laser is tuned to a specific absorption line in a molecular species within the fluid, or to a molecular tracer that can be added to the fluid. This wavelength is often in the Ultra-violet portion of the spectrum. Molecules that absorb this light transition to an excited state, and can subsequently decay by emitting light at a slightly longer wavelength in a process known as fluorescence. The rate of fluorescence is governed by conditions in the fluid or gas flow including temperature, pressure, velocity and molecular concentration. Carefully calibrated PLIF images can be used to derive the local conditions as a function of location in the flow, with each pixel in the Image Intensified CMOS image acting as an individual detector. PLIF can be combined with other flow techniques such as Particle Image Velocimetry (PIV) or Interferometric Mie Imaging (IMI) to provide enhanced measurements.

Applications

Applications for PLIF include OH imaging in flame front studies of combustion processes, flow visualization in gaseous flows including combustion engines, turbulent mixing studies in fluid dynamics, transport of drugs in blood flow, measurement of ignition and combustion in jet engines, and studies of pollutant production in combustion processes. With the ability to use high speed CMOS cameras coupled to **Gated Image Intensifiers**, PLIF can also be used for high speed visualization and measurement of fluid and gas dynamics.

Photek recommends

- **Intensified CMOS**
  iCMOS 160

  or
- **Image Intensifier**
  MCP118
- **Gate Unit**
  GM300-3 (3 ns)

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Benefits

PLIF has a number of advantages for fluid and gas flow measurements including:

- A specific molecular transition can be selected by tuning the laser to the appropriate wavelength and using an optical filter in front of the ***Image Intensified CMOS*** to block all light except for that of the selected fluorescence.
- By ***Gating the Image Intensifier*** on only when fluorescence light is being emitted, the sensitivity of the measurement is significantly enhanced. For flame studies this reduces signal contamination by the continuum emission of the flame.
- ***Fast Gating*** enables measurement of the flow in a near static condition.
- The technique is **non-destructive** to the flow under test.
- A number of molecules are typically available for PLIF within the flow in combustion and flame studies including OH, NO, O_2, and CO.

Instrumentation

The instrumental set-up for a PLIF system used in flame studies is given in Figure 1. The pulsed laser system is often a Nd:YAG pumped Dye Laser providing fast UV pulses. The laser output is optically shaped into a light sheet which passes through the flame, providing a two dimensional view of the flame in fluorescence.

A spectral filter is used to selectively measure the fluorescence signal while blocking out other light emission.

An Ultra-Violet (UV) lens is used to image the fluorescence light onto a **Gated Image Intensified CMOS**. Gate widths are typically in the tens to hundreds of nanoseconds range and are synchronized with the laser. Time gating of the image intensifier ensures that the fluorescence signal is detected while the continuous flame emission is minimized. The image intensifier is chosen to have excellent UV sensitivity in the 200 nm – 500 nm range.

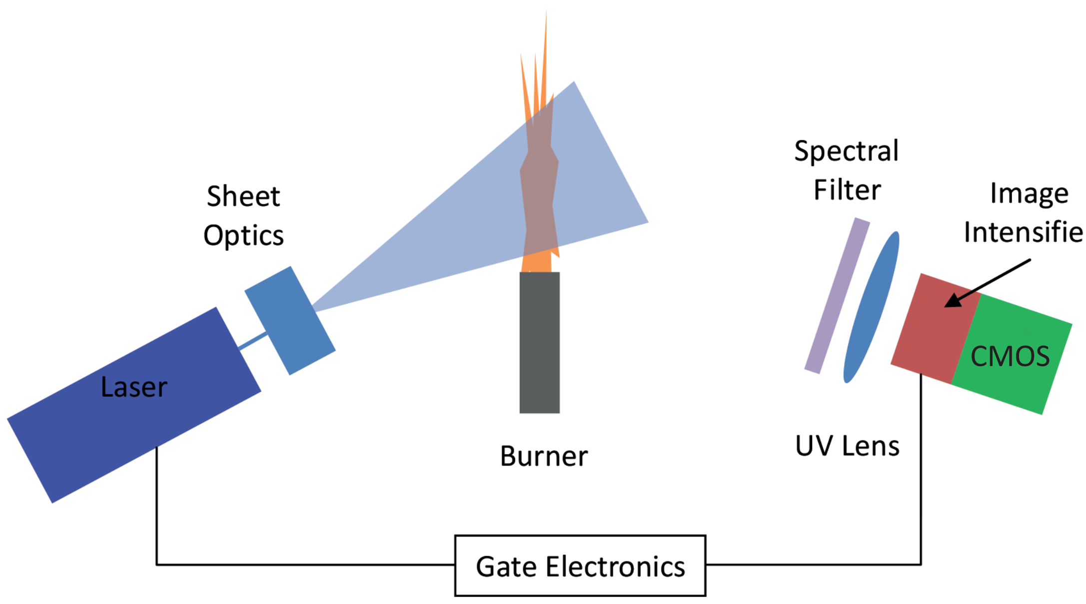

Figure 1: Typical PLIF instrumental set-up.