Bergmans Mechatronics LLC

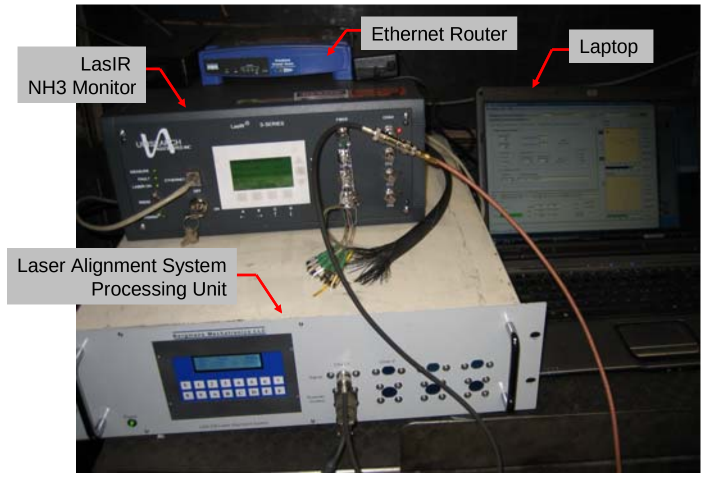
Laser Alignment System for TDL Instruments

Introduction

Tunable Diode Laser (TDL) instruments, such as the Unisearch Associates LasIR, operate by projecting a beam of laser light through a process gas to a photodiode detector. Target gas concentration along the beam path at the measurement location is then computed based on the output of the detector.

Alignment of the beam between the launch optics and detector can be a challenge for users of TDL instrument. This is particularly true for situations where beam misalignments are caused by movements of the launch optics and detector due to thermal transients or other phenomena associated with the process.

To address this issue, Bergmans Mechatronics LLC has developed the Laser Alignment System (LAS), which can be interfaced to TDL instruments for continuous and automatic beam alignment. The LAS is shown at right interfaced to a Unisearch Associates LasIR ammonia monitor.



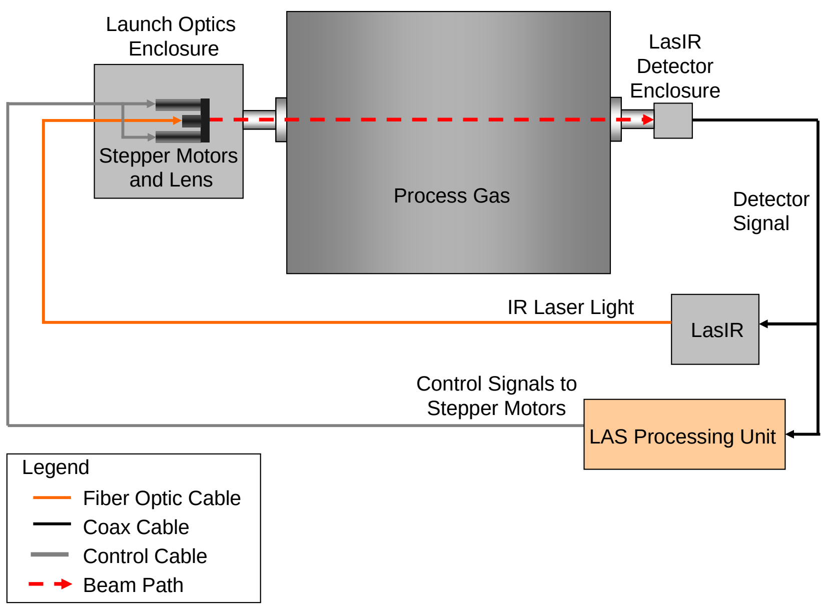
Laser Alignment System Integrated with Unisearch Associates LasIR Ammonia Monitor

System Description

The integrated Unisearch LasIR / BML LAS system operates as follows.

Laser light from the LasIR is transmitted along a fiber optic cable to a lens within the LAS launch optics enclosure and is then projected into the process gas. To enable control of the horizontal and vertical direction of the beam, the lens is fixed to an adjustable mount which is actuated by a pair of computer-controlled stepper motors.

The laser light passes though the process gas and, when the beam is aligned, enters the LasIR detector. The detector signal is then transmitted to the LasIR for measurement of the target gas concentration.



Integrated LAS / LasIR System Schematic

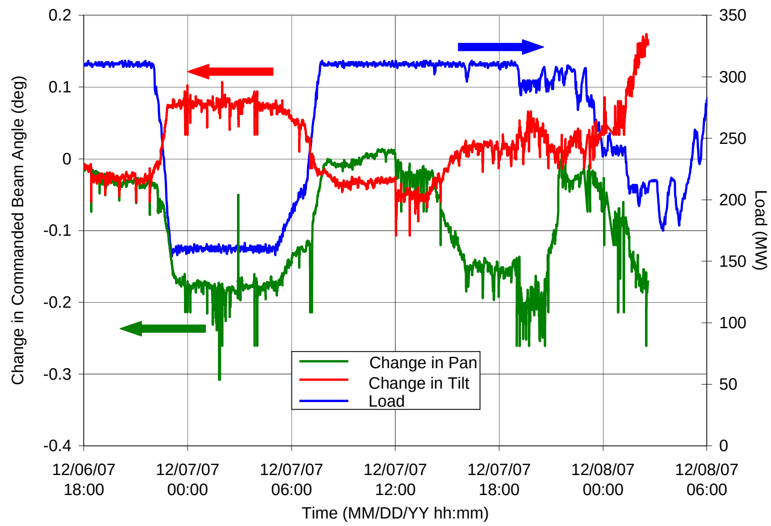
The LAS also receives the LasIR detector signal and independently evaluates the signal strength. An optimization algorithm in the LAS Processing Unit adjusts the two stepper motors in the launch optics enclosure with the objective of maximizing the detector signal strength. Through continuous maximization of the signal strength, the LAS is able to keep the beam aligned despite relative movements of the launch optics and detector.

System Performance

Operation of a prototype LAS with the LasIR was demonstrated on a Midwestern coal-fired power plant unit in late 2007 and early 2008. This testing successfully supported measurement of ammonia concentrations over a 28' pathlength at a location upstream of the unit economizer.

At right is selected data acquired during this program. This figure shows the commanded beam pan and tilt angles required to maintain beam alignment across the duct. Also shown in this plot is the unit load.

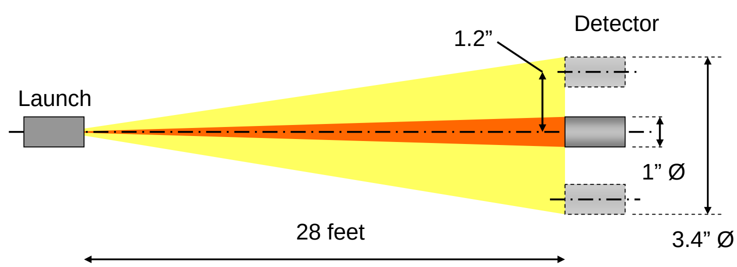
This data shows how changes in the unit load can dramatically affect the beam alignment across the duct due to thermally induced movement of the duct walls. For example, the first downward step in load results in a combined change in command angle of 0.2°.



Commanded LAS Pan and Tilt Angles and Unit Load During Prototype Testing over 28' Pathlength

LAS Improves Signal Strength

The relative movement between the launch and detector optics due to a ±0.2° angular displacement over a 28' path is illustrated at right. In this figure, the detector is shown to move ±1.2" relative to the axis between the nominal locations of the optical components.



Relative Motion Between Launch and Detector Optics

One approach to address this type of movement is to expand the beam such that light from the laser always strikes the detector (yellow beam). Alternatively, an automatic alignment system can be used, thereby allowing the beam to be focused down to the diameter of the detector lens (orange beam). In this example, the laser power density at the detector for the expanded beam is only 9% of the focused beam.

In general, any decrease in power at the detector will have an adverse affect on the signal-to-noise ratio (SNR) of the measurements and could adversely affect measurement quality. Also, at lower signal strengths, the TDL instrument will be more susceptible to experiencing data drop-outs due to opacity.

Conclusion

The BML Laser Alignment System should be considered for use with TDL sensors for three key reasons:

1) the automated alignment function reduces the effect of launch optics and detector movements;
2) the focused LAS beam permits higher quality measurements due to increased SNR; and,
3) the focused LAS beam reduces susceptibility to opacity.

Contact

Bergmans Mechatronics LLC
1616 Bedford Lane, Unit A
Newport Beach, CA 92660
p: 714-474-8956 | f: 949-646-1429 | w: www.bergmans.com