Ares Ultraviolet Laser Induced Fluorescence (UV LIF) Standoff System Development and Testing

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Motivation—Due to the increasing threat of bio-terrorism, we developed a remote sensing system to provide advanced warning of biological weapons threats. Our goal was to design a lidar that was relatively small, inexpensive, and rapidly deployable, specifically suited for homeland security applications.

Accomplishment—We have designed, built and tested a UV laser induced fluorescence (LIF) remote sensing system for the detection of biological aerosols at standoff ranges from 0.5 km to 5.0 km. This lidar system was constructed using commercial off-the-shelf components wherever possible, and the optical and electronic subsystems are modular and small enough to be deployed in a passenger van.

A schematic diagram of the Ares UV LIF lidar system is shown in Fig. 1. A flashlamp-pumped, frequency-tripled, Q-switched Nd:YAG laser provides ~10-ns-wide excitation pulses at 355 nm. Backscattered and fluorescent light collected by an 18.75-cm-diameter Maksutov telescope is collimated and directed to a long-pass dichroic beamsplitter which reflects light with wavelengths shorter than ~360 nm, effectively separating the elastically backscattered laser light from the LIF light. The elastically scattered light is focused onto a photomultiplier tube (PMT) where it is detected and subsequently digitized to provide a record of the aerosol backscatter intensity as a function of range with 1.5 m resolution. Laser induced fluorescence collected by the telescope passes through the long-pass filter and is focused onto the entrance pinhole of an imaging spectrometer. The LIF spectrum is detected by a gated, intensified charge coupled device (ICCD).

The UV LIF lidar system is mounted in a 2-axis gimbal that allows scanning ±45º in azimuth and ±20º in elevation. Figure 2 is a photograph of the Ares system mounted in a van ready for deployment. In operation, the lidar is scanned in azimuth over the desired field-of-regard while the aerosol backscatter signal from the PMT is monitored for evidence of aerosol clouds. When an aerosol cloud is detected, the lidar is automatically pointed at the cloud, and range-gated LIF spectra are recorded using the spectrometer/ICCD. After a nominal 10-second data collection, the LIF spectra are analyzed using Classical Least Squares routines to determine whether or not the cloud contains biological aerosols. The spectrally resolved LIF signal contains valuable information about the spectral shape which is key in discriminating biological from non-biological aerosols.

The Ares lidar system has been successfully operated in a variety of field tests including a DoD-sponsored Product Qualification Test (PQT) at Dugway Proving Ground in Utah which tested its performance as a standoff bio sensor.

Significance—Ares has demonstrated the efficacy of using temporally and spectrally resolved LIF in a practical remote sensing instrument to detect and discriminate threat bio-logical aerosols. As a result of successful field testing, Sandia has signed a Cooperative Research & Development Agreement (CRADA) with Smiths Detection, Edgewood to transfer this technology to industry.

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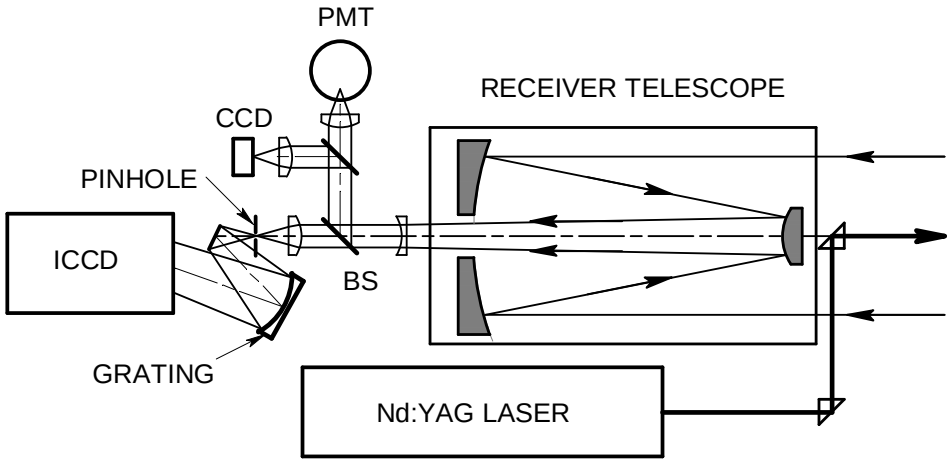

Figure 1. Schematic of the optical system for the Ares UV LIF lidar system.

Figure 2. Photograph of the Ares UV LIF system mounted in a van ready for deployment.