

**TECHNICAL PROGRAM  
&  
ABSTRACT DIGEST**

for

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## AIRBORNE NATURAL GAS EMISSION LIDAR (ANGEL) SYSTEM

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### ABSTRACT

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The system is housed in an 8' x 8' x 8' weatherproof shelter and uses an Ethernet link to broadcast atmospheric data and to allow remote controlled operation. The transmitter consists of a Continuum Powerlite Nd:YAG laser (300 mJ / pulse at 26 Hz) along with a 1.54- $\mu$ m DFB laser (60 mW CW), both beams are introduced into a high-pressure cell containing methane and argon. The 1064-nm pump laser is Raman-shifted to 1543 nm in methane and the DFB laser feeds the process providing higher pulse energy and better beam quality. The transmitter is capable of producing up to 250 mJ but is typically operated at about 200 mJ with an  $M^2$  of about 9 and 4-5 ns pulse duration. The 1064- and 1543-nm beams are separated after the Raman cell using a series of dichroic mirrors, reducing the amount of transmitted 1064-nm light to well within the eye-safety limits for all ranges. The Raman-shifted laser beam is expanded to 5 cm prior to transmission reducing the divergence to within the acceptance cone of the coaxial receive path. The receiver includes a 40-cm F3 Newtonian telescope. The light is collimated after the field stop to provide a suitable space to introduce a narrow-bandpass filter centered at 1543 nm. A custom set of optics is used to focus the collected light onto a 200- $\mu$ m InGaAs detector.



Figure 1. ANGEL system as installed inside a shelter.

The control system hardware uses the PXI platform to provide a flexible and robust configuration. The software was developed in LabVIEW and is structured around an event-driven state machine. The operator can remotely turn on or off the system and specify the scan pattern as well as enable/disable some specialized functions that were developed to ensure autonomous operation. These include hard target pre-scan (low gain scan of selected scan pattern to ensure that no close obstacle is present in the field of view), automatic gain adjustment (computer adjusted detector gain to ensure optimum use of data acquisition dynamic range), e-mail notification of critical failures, weather park (alison from precipitation sensor parks the scanner to protect it from inclement weather), graceful shutdown (loss of power triggers