

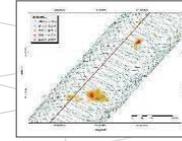
Methane to Markets

Oil and Natural Gas Technology Transfer Workshop

Airborne Differential Absorption Lidar (DIAL) Detection and Measurement of Fugitive Emissions

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25 May 2006

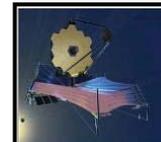


ITT – Corporate Overview

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ITT: ~\$7.0 Billion (annual revenue)

- **ITT Defense:** ~\$3.0 Billion (annual revenue)
 - Supplier of sophisticated military defense systems and provider of advanced technical and operational services to government customers.
- **ITT Space Systems Division**
 - Over 50 years as a national leader providing innovation and quality in the design, production and development of Remote Sensing, Meteorological, and Navigation satellite systems.



Evolution of Pipeline Leak Survey Technology



1970 1980 1990

- Flame Ionization Spectroscopy**
- Hand-held device
 - Slow – 1 mph
 - Need to come in contact with the plume
 - Difficult terrain and property issues
 - Industry standard equipment



2000 2001 2002

- Pass-through Optical Sensors**
- Truck mounted sensor
 - Slow – 5 mph
 - Need to come in contact with the plume
 - Difficult terrain and property issues
 - Easily damaged

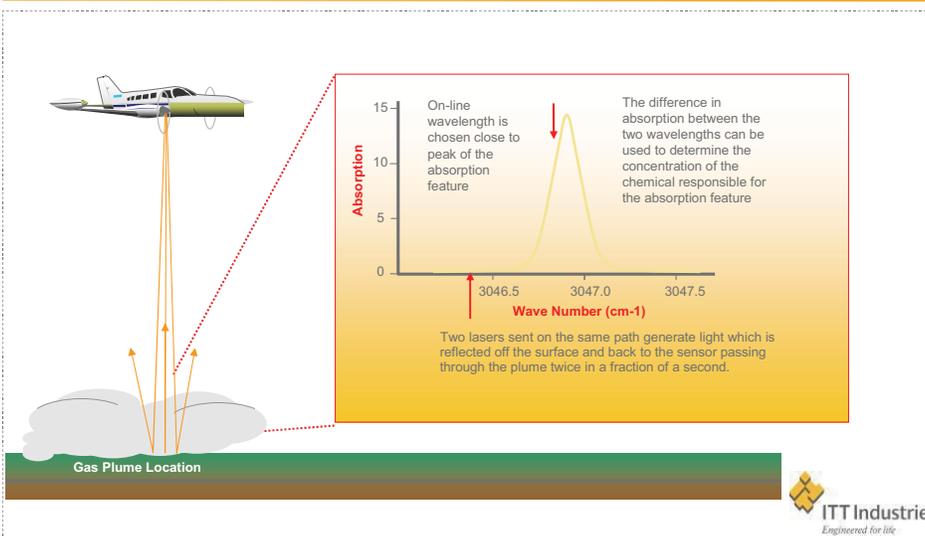


2003 2004 2005 2006

- Airborne Remote Sensing**
- Airborne DIAL Sensor
 - High sensitivity
 - Detects and quantifies emissions
 - Broad area scan pattern
 - Fast – 150 mph
 - Operates over difficult terrain and environmentally sensitive areas
 - GIS-ready results



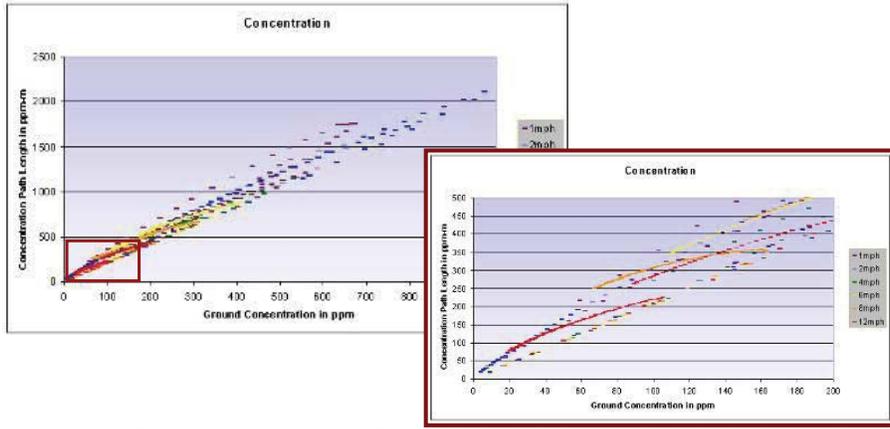
Hydrocarbon Gas Detection: Active Remote Sensing Differential Absorption LIDAR



Emission Measurements: Linear trend between Concentration (PPM) and Concentration-Path-Length (PPM-m)

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Depending on conditions, a 150ppm-m CPL will have a ground level concentration ranging from 45ppm to 70ppm.

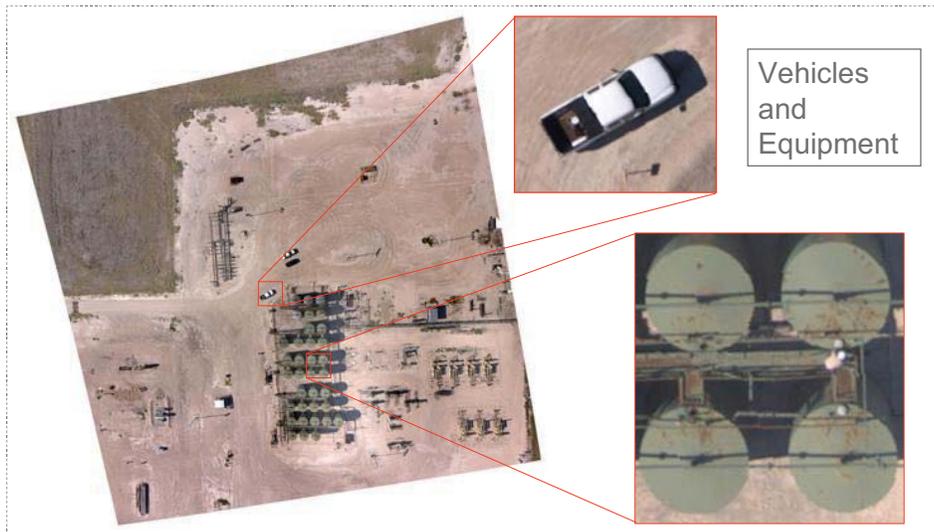


ITT Airborne Natural Gas Emission Lidar (ANGEL) Service Aircraft: DIAL Sensor System and Supporting Hardware

6



High-Resolution Digital Color Imagery

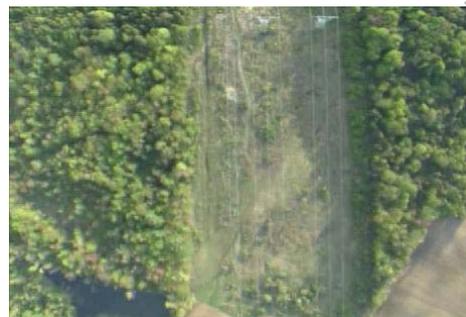


Vehicles
and
Equipment



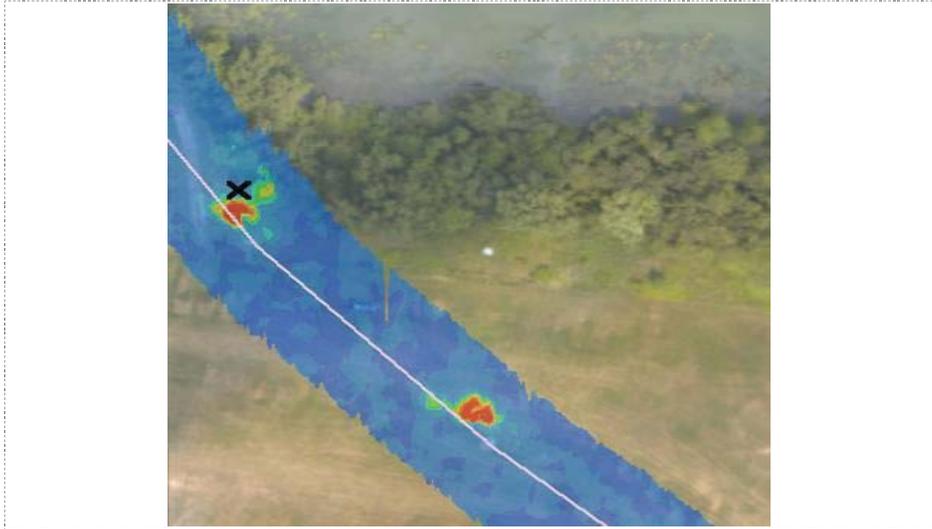
Digital Color Video System Patrol any right-of-way from your desktop

- 3-chip RGB Digital Video System
- Allows you to easily patrol any pipeline segment from your desktop computer.
- Play, pause, fast forward, rewind, and even print video frames from digital files.
- Encodes video data with GPS information, so precise locations can be identified.
- Provides permanent record of aerial patrolling, easement conditions, encroachment monitoring, intrusion detection, and problem areas.



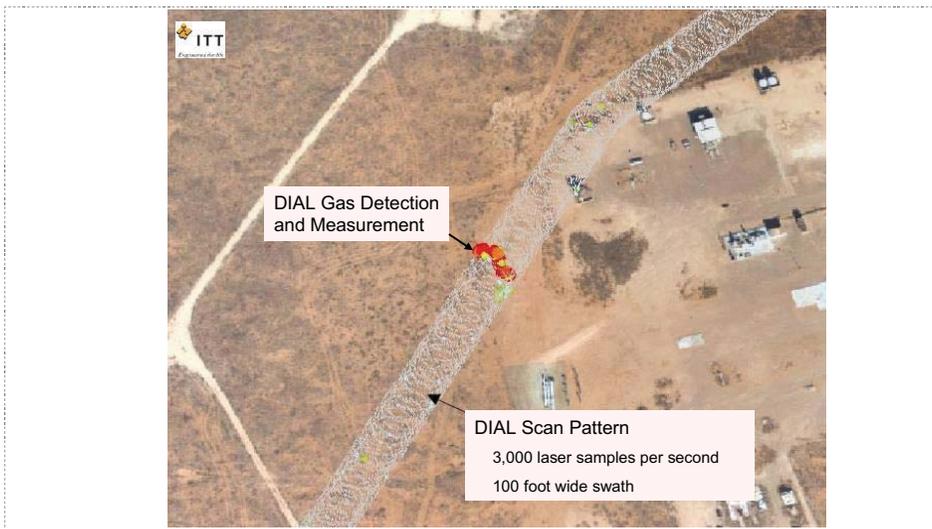
ITT Airborne Natural Gas Emission Lidar (ANGEL) Service Aircraft:
Computer controlled pointing, scanning and tracking system

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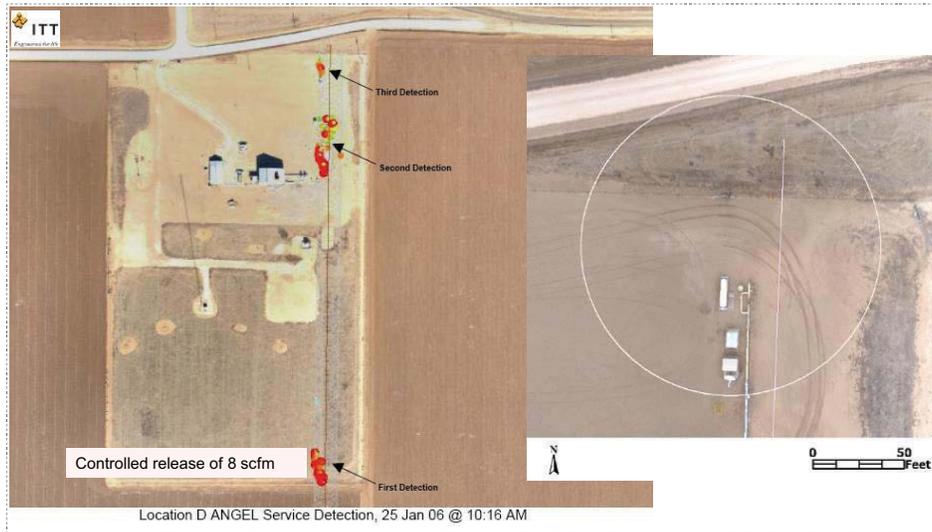
DIAL Detection and Measurement of Hydrocarbon Gases
Example #1: Pipeline Route – Texas

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DIAL Detection and Measurement of Hydrocarbon Gases Example #2: Pipeline Route – Texas

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Engineered for life

DIAL Detection and Measurement of Hydrocarbon Gases Example #3: Light Crude Tank Farm

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DIAL Detection and Measurement of Hydrocarbon Gases
 Less than 3 seconds of collection from 1,000' altitude

DIAL Scan Pattern



DIAL Detection and Measurement of Hydrocarbon Gases
 Example #3: Light Crude Tank Farm

Hatches CLOSED



CPL (PPM-m)	
0 - 50	White
50 - 100	Light Blue
100 - 150	Medium Blue
150 - 200	Dark Blue
200 - 250	Teal
250 - 300	Light Green
300 - 350	Yellow-Green
350 - 400	Yellow
400 - 450	Orange
450 - 610	Red



DIAL Detection and Measurement of Hydrocarbon Gases Example #3: Light Crude Tank Farm

Hatches
OPEN



CPL (PPM-m)	
0 - 50	White
50 - 100	Light Blue
100 - 150	Blue
150 - 200	Dark Blue
200 - 250	Green
250 - 300	Light Green
300 - 350	Yellow
350 - 400	Orange
400 - 450	Red
450 - 610	Dark Red



DIAL Detection and Measurement of Hydrocarbon Gases Example #4: Detection over grass – Open field.

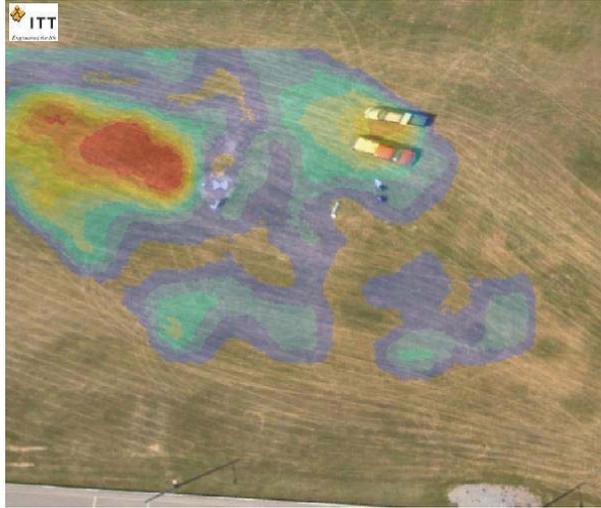
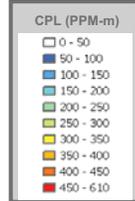


DIAL Detection and Measurement of Hydrocarbon Gases

Less than 3 seconds of collection from 1,000' altitude

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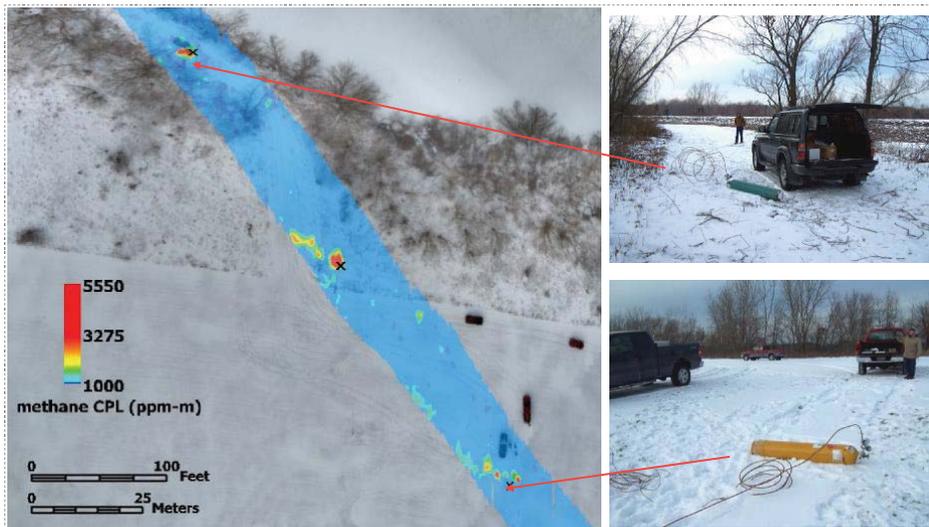
DIAL results



DIAL Detection and Measurement of Hydrocarbon Gases

Example #5: Detection over snow (3 separate 4 scfm releases)

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Conclusions — Airborne DIAL can detect and measure fugitive gas emissions

- ✓ Airborne DIAL can provide a unique, comprehensive, and unobstructed view of area emissions.
- ✓ Airborne DIAL can detect specific hydrocarbon gases/vapors (i.e. methane, ethane, propane, gasoline, condensates, etc.).
- ✓ Airborne DIAL can quantify area emissions and provide quantitative information on a plume's size and shape.
- ✓ Airborne DIAL can directly measure the various concentration-path-lengths (ppm-m) within area emissions.
- ✓ Airborne DIAL can operate day or night, and when integrated into a fixed wing aircraft can survey up to 1,000 pipeline miles per day.



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- BP America, Inc.
- El Paso Production
- National Fuel Gas Company
- Northern Natural Gas



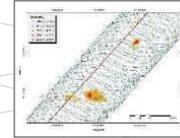
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