Backscatter-TDLAS Detectors for Monitoring, Locating, Imaging, and Quantifying Methane Emissions

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Abstract: The urgency to reduce methane emissions to the atmosphere is driving industry adoption of advanced technologies for methane measurement and monitoring. We present a suite of laser-based sensors for detecting, locating, and measuring methane sources.

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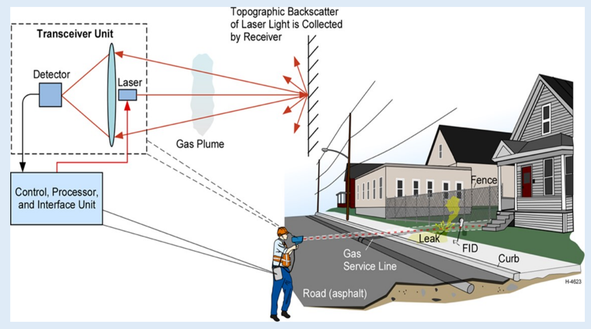
RMLD-CS

Remote Methane Leak Detector — Complete Solution



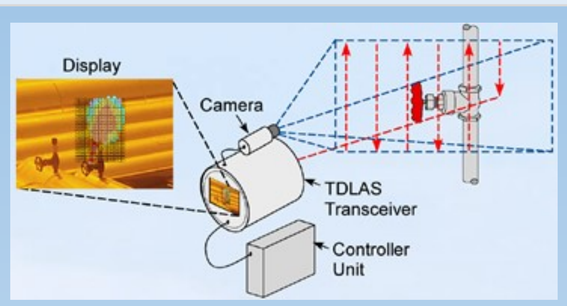
RMLD-IS was released in 2005
Ergonomic RMLD-CS was released in 2019
Over 6500 units in service

- Based on *Backscatter Tunable Diode Laser Absorption Spectroscopy (b-TDLAS)*
- Only the probe beam interacts with sample
- Little cross-species interference
- Measure methane (PPM-M) along laser path
- Fast sub-second response time
- Configurable for point, open-path, or standoff sensor
- Scan through windows

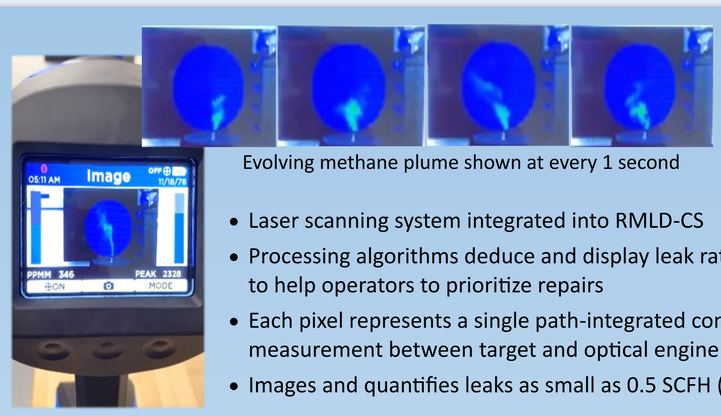
- Intrinsic Safety rating of Class I, Division II
- Operation in a variety of field conditions including a wide temperature range, light rain and fog
- Rechargeable and replaceable battery
- Phone App support
- Bluetooth
- Internal data logging
- GPS
- Color camera and display
- 100 ft standoff distance
- <0.5 SCFH detection limit

RMLD-QGI

Quantitative Gas Imager

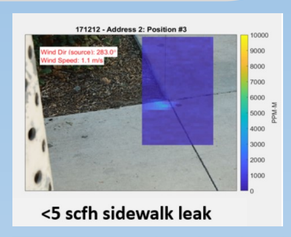


Laser beam raster-scanning to collect path-integrated gas concentration heatmap overlaid on video image of the scene



Evolving methane plume shown at every 1 second

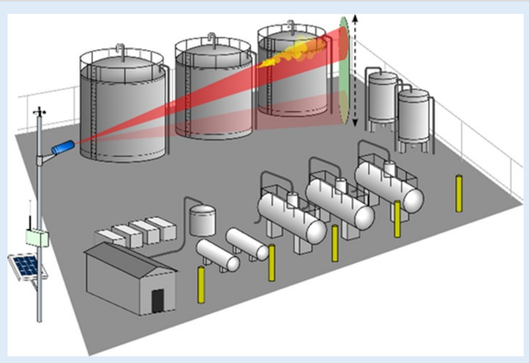
- Laser scanning system integrated into RMLD-CS
- Processing algorithms deduce and display leak rate estimates to help operators to prioritize repairs
- Each pixel represents a single path-integrated concentration measurement between target and optical engine
- Images and quantifies leaks as small as 0.5 SCFH (0.24 LPM)



<5 scfh sidewalk leak

*e*REM

***Enhanced* Remote Emission Monitor**



Laser Scanning Vertical Flux Plane

REM Prototype

Optical Engine

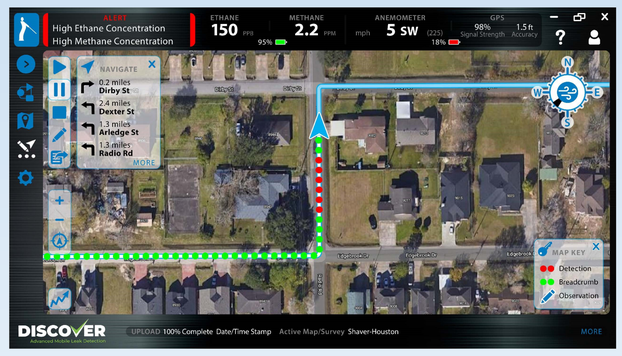
Passive Target

- Fixed laser-based open-path continuous monitoring of natural gas sites
- Detection and reporting of small to potentially explosive leaks
- Vertical or horizontal scanning of distant passive targets (>1000 ft)
- Flux quantification without inverse plume model
- Discrimination of routine venting from unintentional emission events
- Patented leak detection algorithm with high probability of detection and low false alarm rate
- Battery-powered or wall-plug
- Easy to install and align
- Provides real-time alarm notification to remote operator

DISCOVER AMLD

Advanced Mobile Leak Detector

- Components: vehicle, laser sensor, GPS, anemometer, onboard GUI
- Mid-Infrared backscatter-TDLAS fast-open air measurement
- Concurrent ethane and methane detection for discriminating natural gas from biogas
- PPB detection limits at ~10 Hz
- Approximates emission rate, leak location and coverage area
- Real-time data transfer to secured cloud for processing & reporting
- Field tests show >95% probability of detection

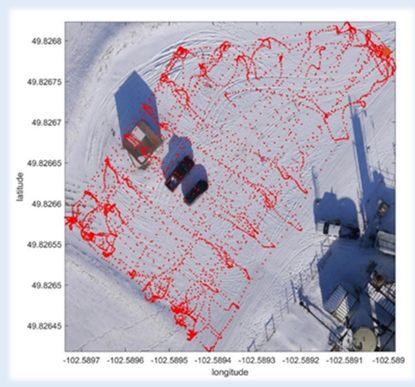


GUI onboard vehicle displaying surveyed path and detected leak indications

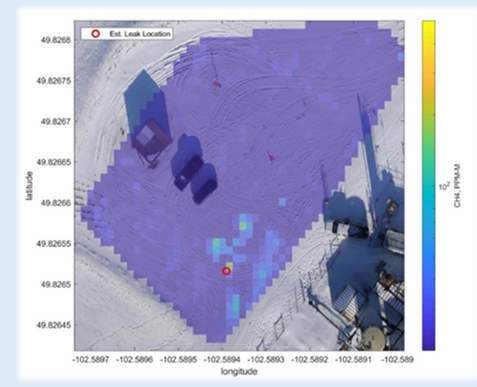
RMLD-UAV

Unmanned Aerial Vehicle

Technology	Methane detection, leak imaging and flux estimation via b-TDLAS adapted to small quadrotor UAV
Size (UAV + payload)	24” diameter, 9” depth
Weight	Approximately 3 lbs with battery
Flight Range	Within visual sight (<2000 ft) of base station
Survey altitude	30 ft typical
Endurance	30 min
Wind	30 mph
Control	•Handheld GCS •Optional computer for semi-autonomous flight w/ real-time way point updating •Automated vertical launch and land
User Interface	•Intuitive GUI w/ Google Maps API •User-defined waypoint missions •Transmits target waypoints to aircraft based on aircraft feedback
Methane and GPS Data	Class 1 Bluetooth



UAV Flight Path

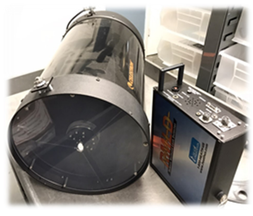


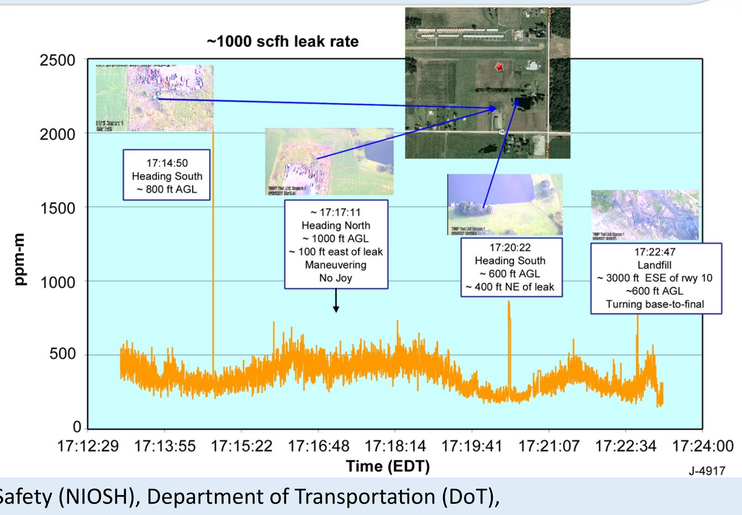
Detected Leak Plume and Source

aRMLD

Airborne RMLD

- Based on b-TDLAS with WMS
- Automated data reduction
- Integrated GPS and video imagery
- Real-time notification of leak coordinates
- Cockpit alert enables maneuvering for verification and examination
- Detecting natural gas leak smaller than 10 SCFH (equiv. to <0.04” hole in 800psia transmission pipeline
- Standoff distance <1200 ft and 6000 ft with EDFA





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