SENSIT

INNOVATIVE DETECTION SOLUTIONS

MODULAR GAS MONITORING PLATFORM FOR
Emissions Location & Sample Acquisition

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SENSIT® FPL
Fixed Point Laser

Dual Open Path Methane Detection System

METHANE TDLAS:
TARGET APPLICATIONS

→ Facility Emissions Monitoring

→ Pipeline Emissions Monitoring

→ Leak Location Identification and Quantification Estimates

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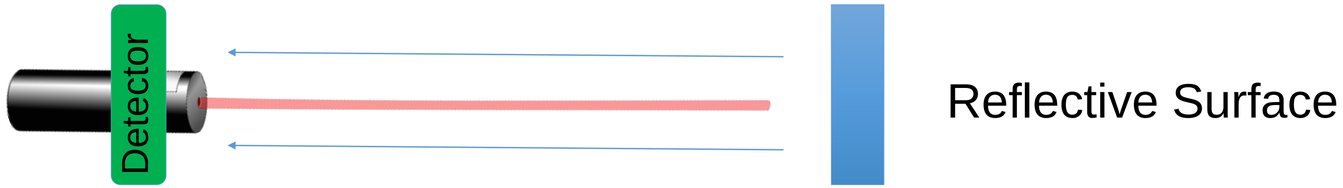
Open-Path Measurement

- Combine laser output and detector into one housing



- Aim laser at retroreflective surface
- Detect reflected intensity while scanning wavelength range associated with methane IR absorption

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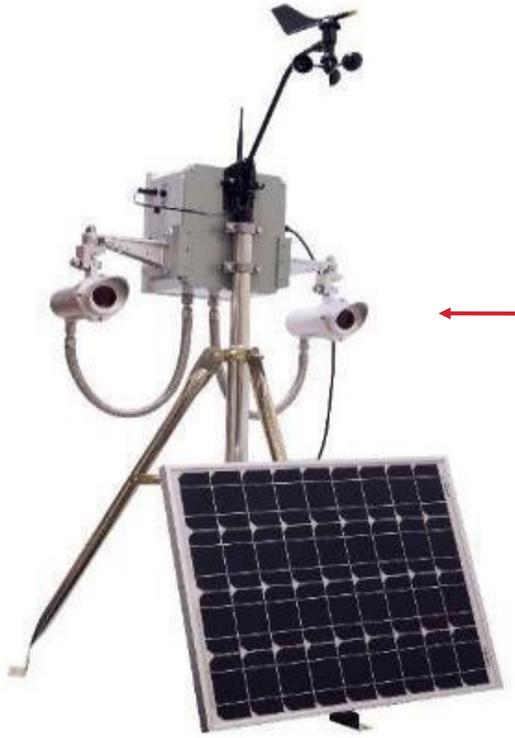
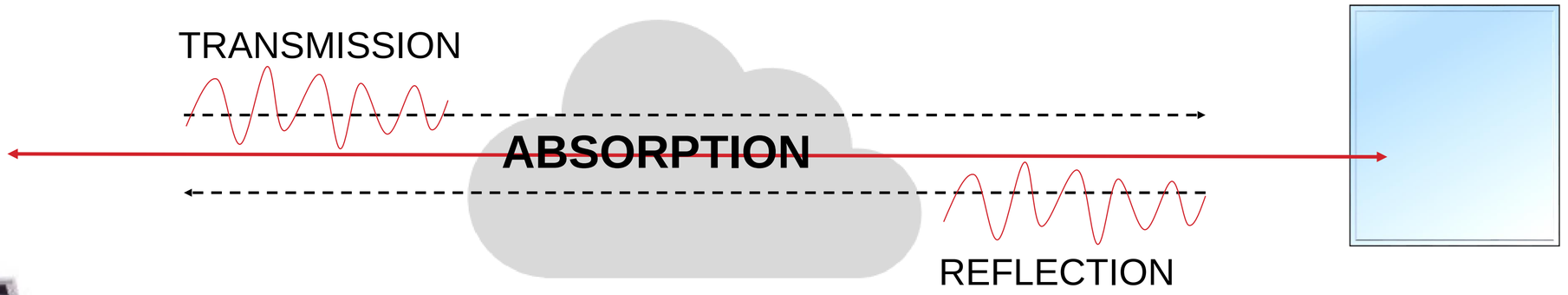
TDLAS – HOW IT WORKS

Methane Absorbs Specific Wavelengths of Light

The FPL Emits a Wavelength that is Absorbed by Methane

The Amount of Laser Light Absorbed is Proportional to the Amount of Methane in the Path of the Beam





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OPEN PATH LASER METHANE DETECTION

- DISPLAYED IN PPM-M

10 PPM — **30 meters**

30 PPM — **10 meters**

Both scenarios =
300 PPM-M

PPM-M = Concentration x Path Length

→ A plume of 10 PPM methane across 30 meters gives a Reading of 300 PPM-M

→ A plume of 30 PPM across 10 meters wide also yields a Reading of 300 PPM-M

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Typical Power Requirements

- Temperature Dependent

Temperature [°C]	Current [A]	Voltage [V]	Power [W]
-30	0.35	12	4.2
0	0.22	12	2.6
20	0.13	12	1.6
50	0.26	12	3.1

- External power:
  - AC power with a 18-24VDC transformer
  - 50W 18-24V solar panel (12V nominal)

- 3-6 Days run time without charge

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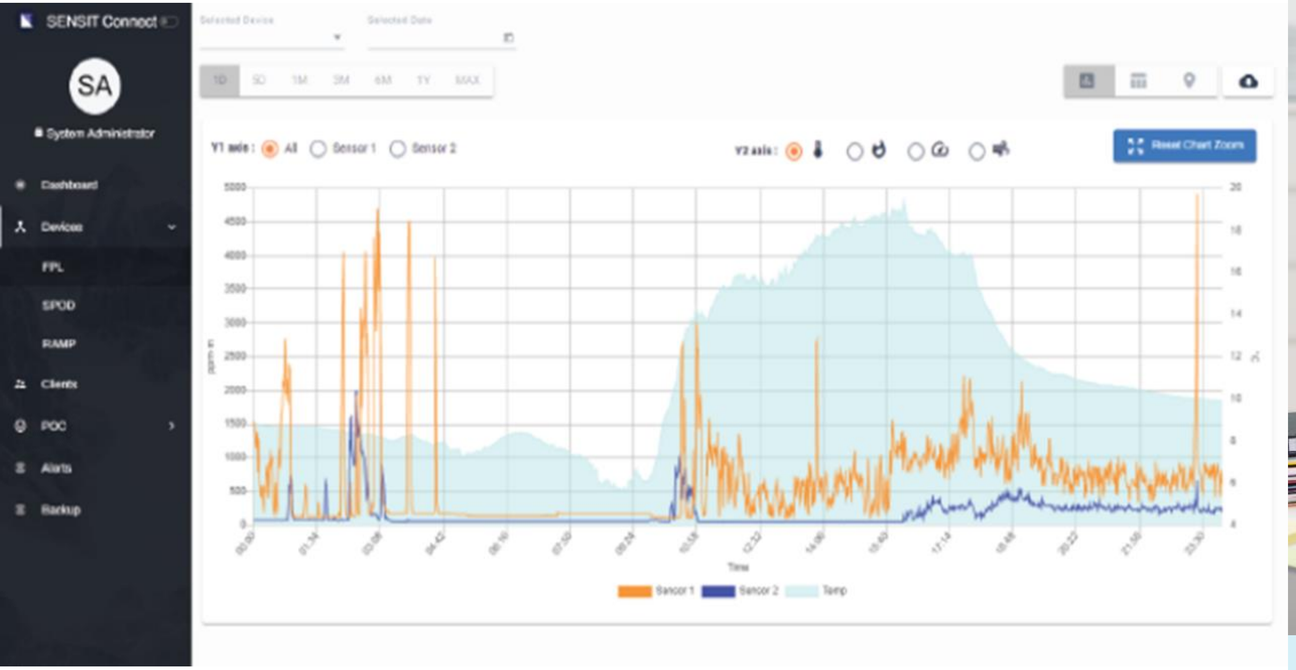
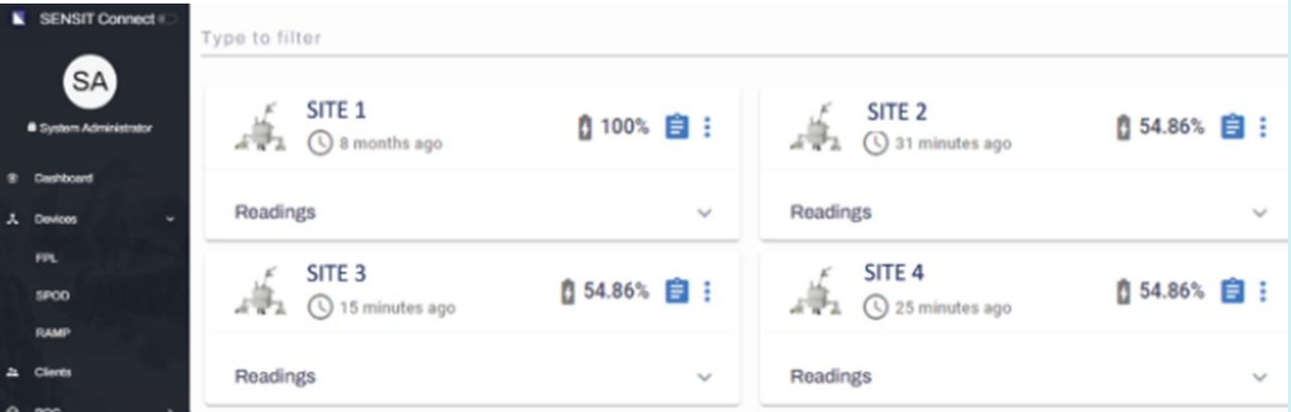
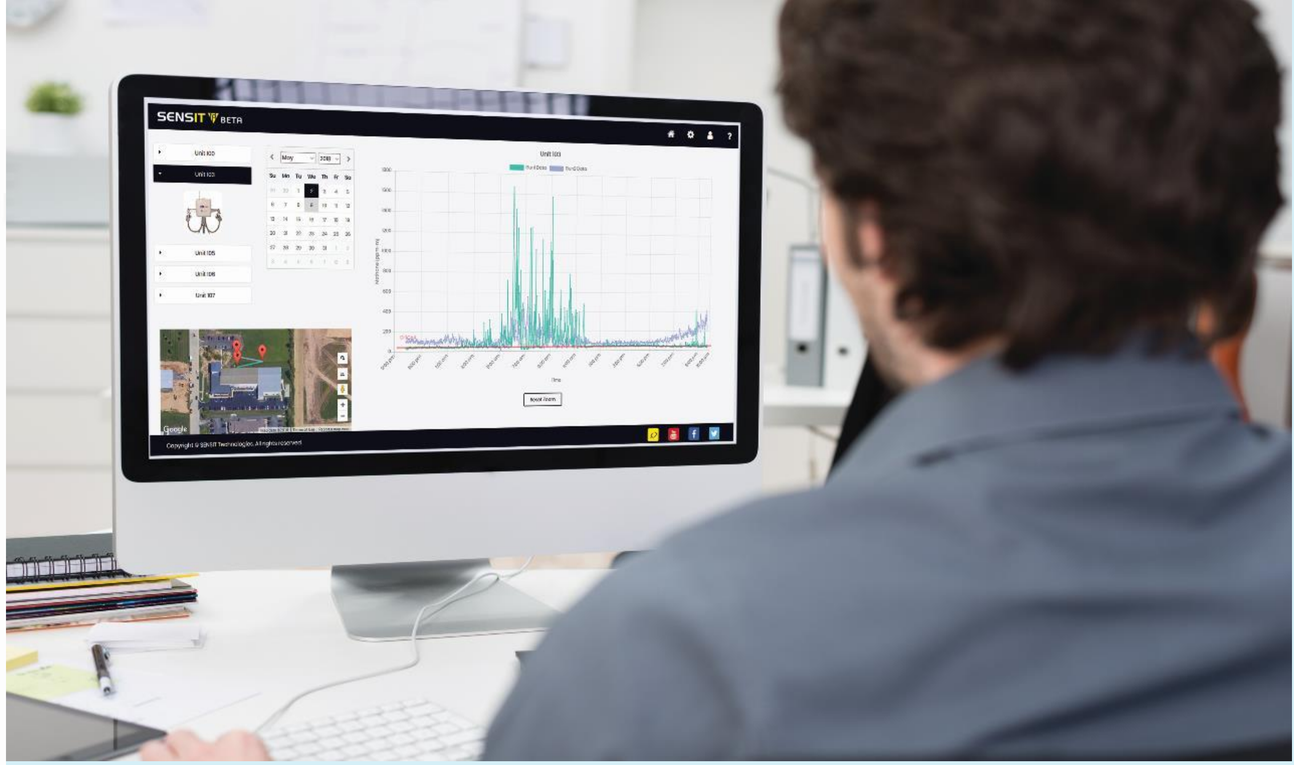
SENSITCONNECT.NET







Web-based application portal for viewing and managing SENSIT Environmental Monitors.

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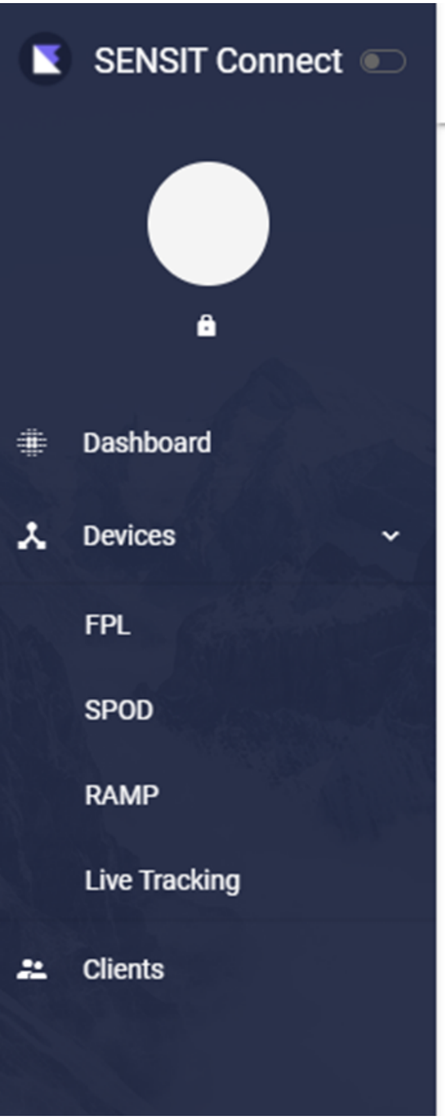
SENSITCONNECT WEB PLATFORM



Compile and analyze data from all monitoring devices

EN

- Data visualization
- Location and tracking info
- Device health and settings
- Alarm thresholds for notifications or local alarms
- Processed and raw data download
- Real-time remote detection localization of leaks

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Three Case Studies

1. Methane Detection Challenge

2. Methane Emissions Under Wind Conditions

3. Continuous Methane Emissions at Metering and Regulatory Stations

Case Study #1
Methane Detector Challenge

- **Technical Requirements**
  - Robust, outdoor capability
  - CH_4 selective
  - Self-powered
  - Remote monitoring capability
  - <$20K in price (target)

Top performer in all categories!

- **Accuracy confirmed with…**
  - Picarro during tightly controlled environment in enclosed chamber
  - Boreal during open air environment

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

SwRI

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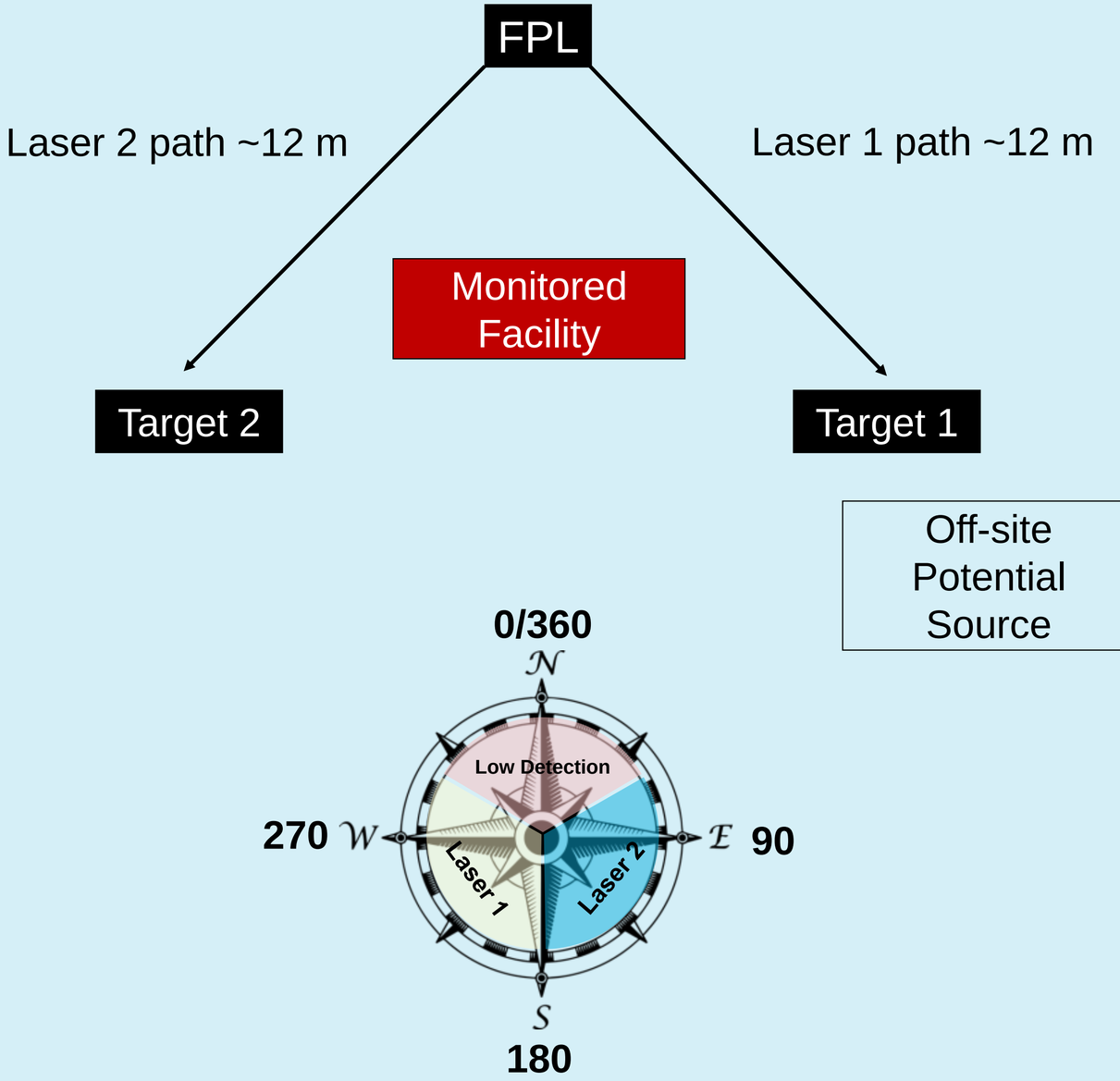
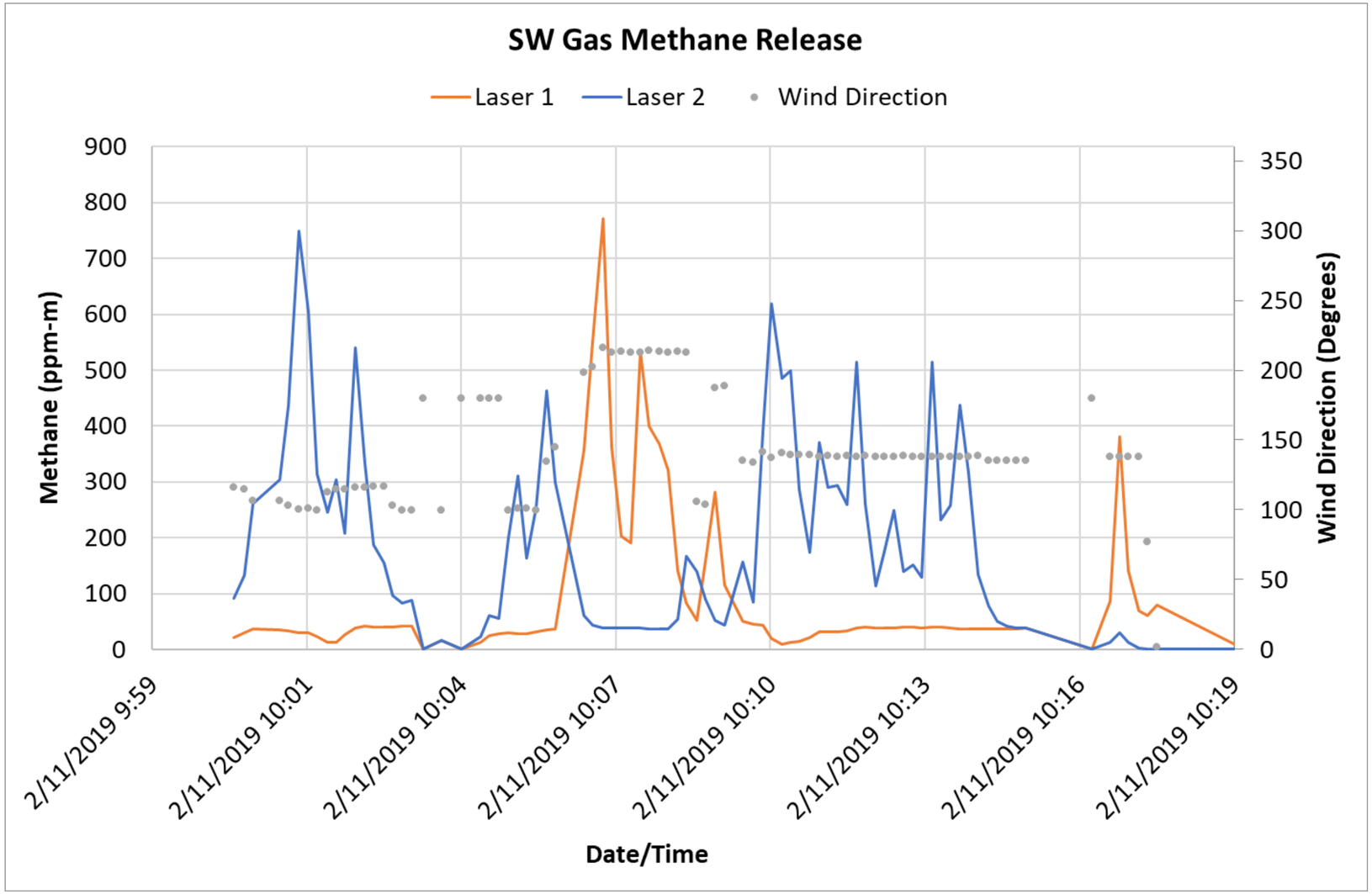
CASE STUDY #2: CH_4 EMISSIONS & WIND

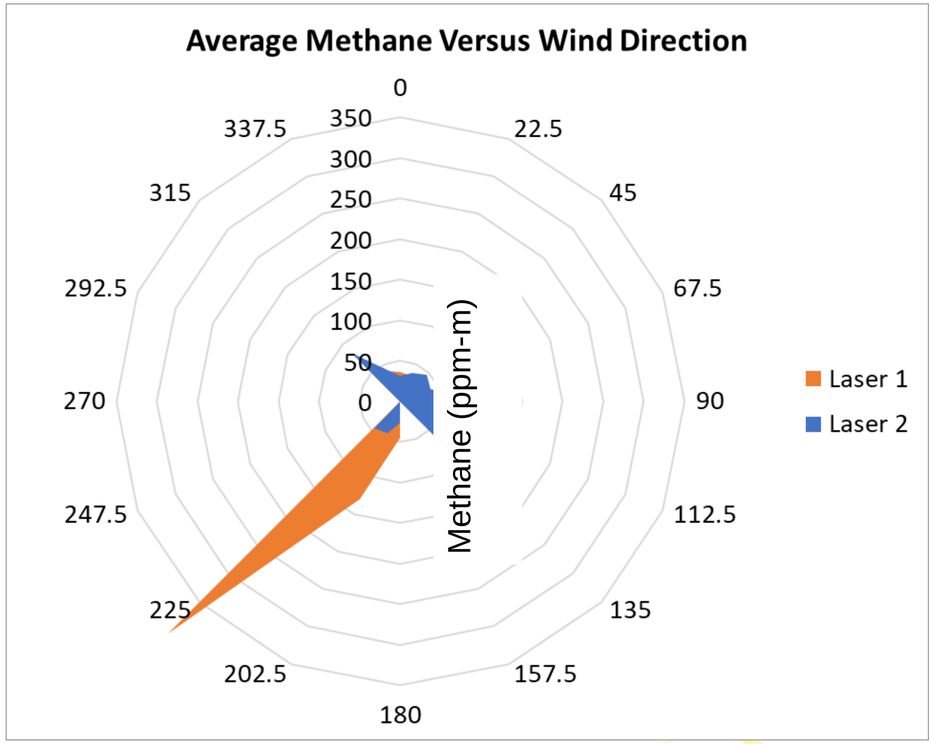


Methane Signal vs Wind Direction



Laser 1 methane average is highest for a SW wind (225°)

Laser 2 methane average is highest for a SE wind (135°)



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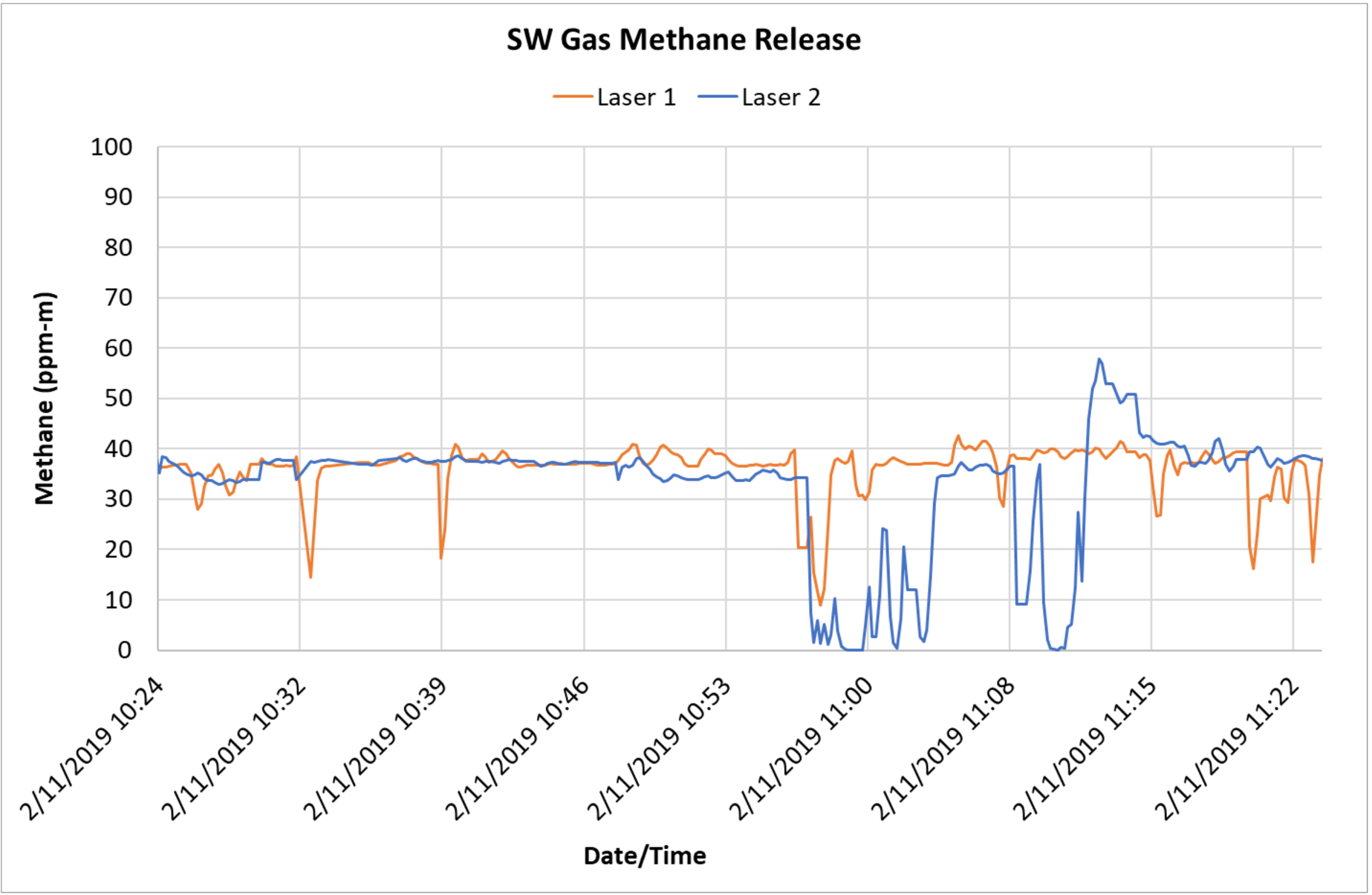
Background Capture Period



Downward spikes are result of blocked optical path from numerous people on site.

System stability outside of path blockage is better than +/- 5 ppm-m

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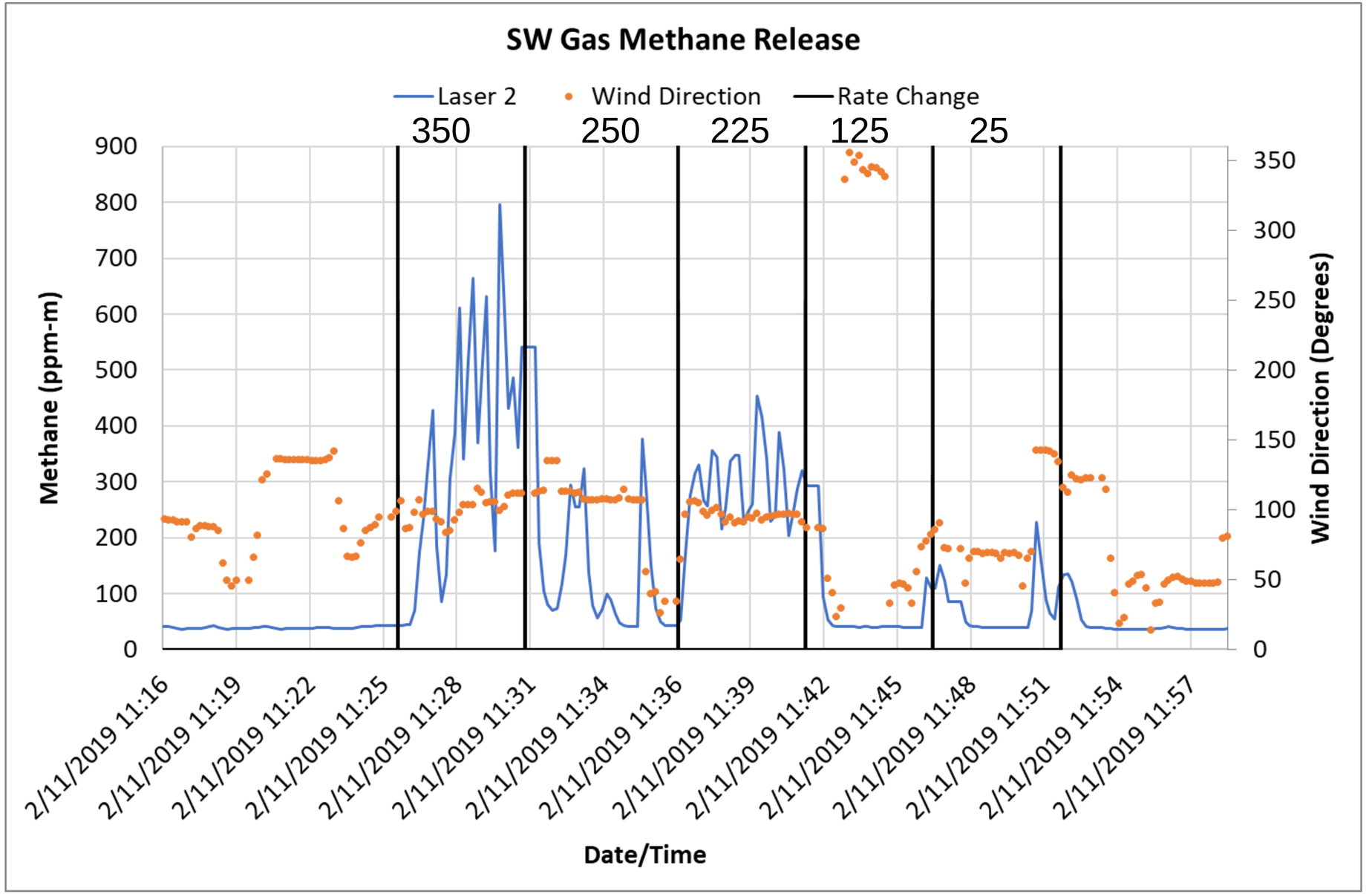
Methane Signal vs Wind Direction (Stepped)



Wind direction not observed to be in the S, SW, W range for laser 1.

Low response for laser 2 for north wind.

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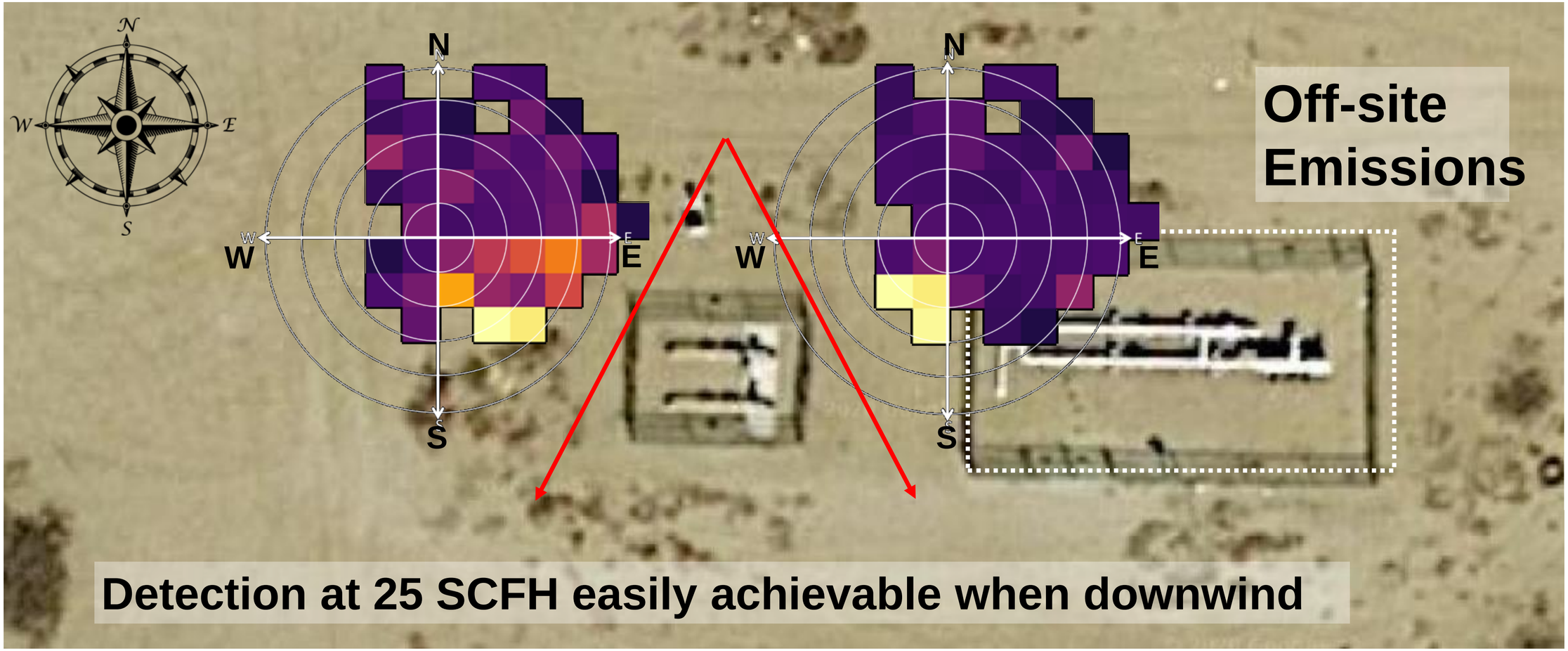
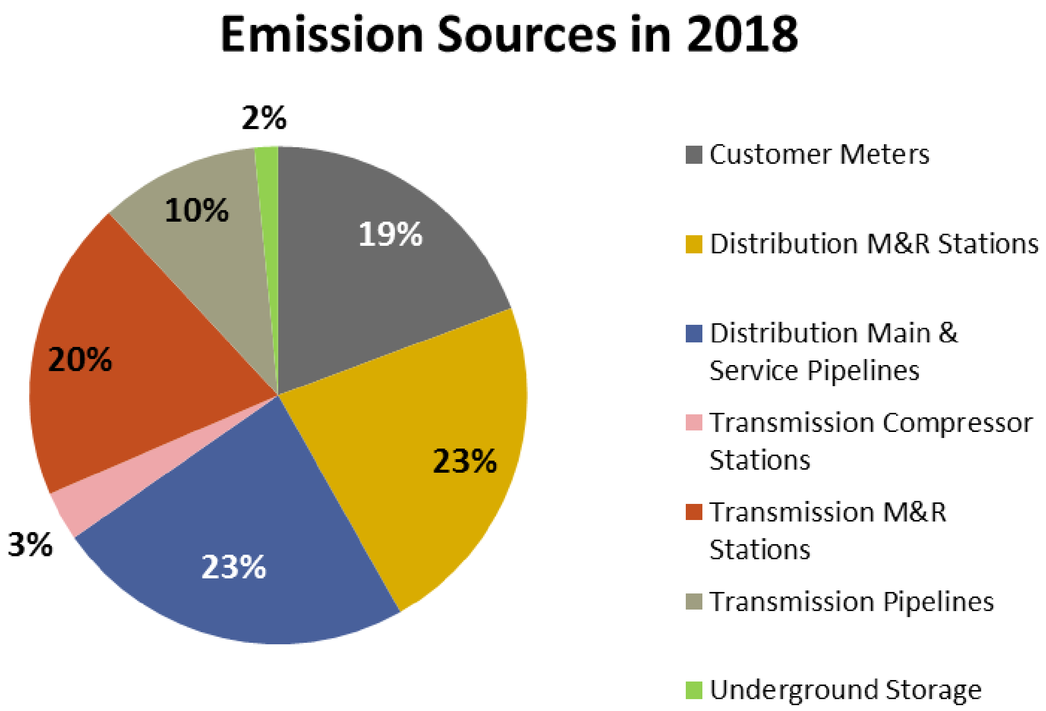
FPL CONTROLLED RELEASE TESTING

(25-350 SCFH RELEASE)



CASE STUDY #3: (CA SB-1371)

METERING AND REGULATION STATIONS



M&R stations estimated 43% of reported system emissions

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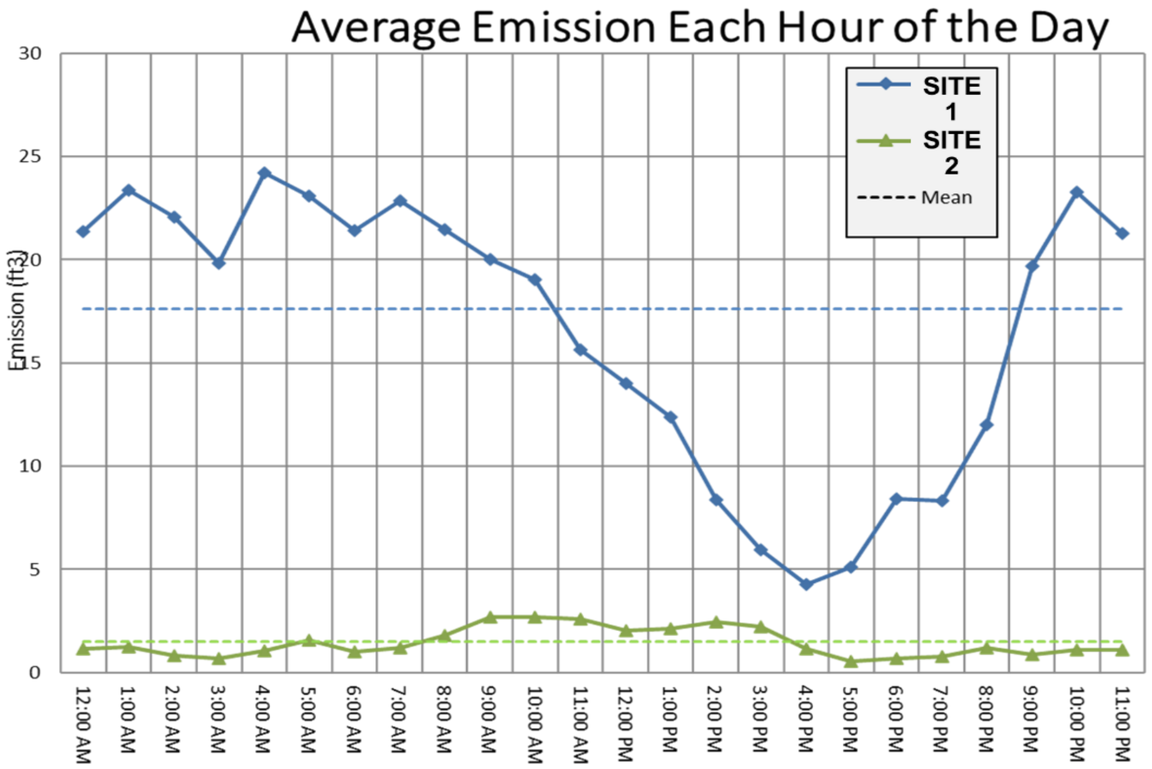
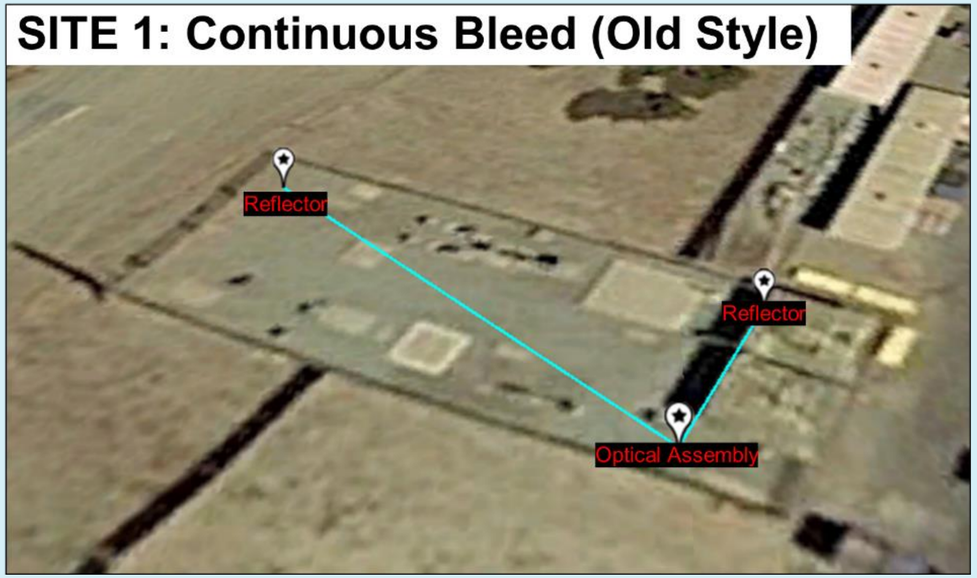
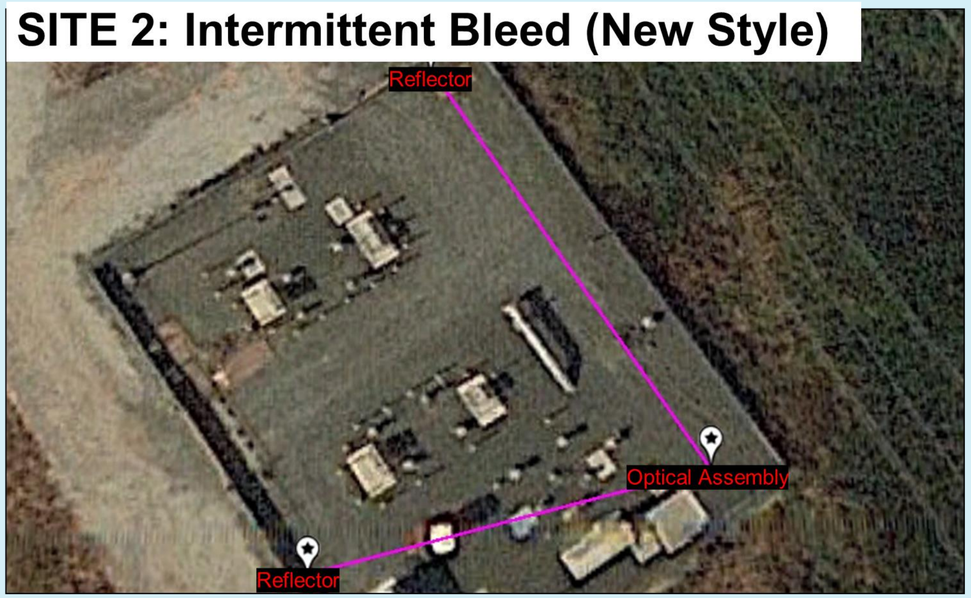
M&R EMISSIONS SITE SURVEY



- Emissions variations due to flow and valve actuation requirements during the day
- Spot measurements are insufficient due to the variability throughout the day
- Continuous monitoring captures dynamics of the emissions





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FPL SYSTEM OVERVIEW – DUAL OPEN PATH

Base Technology	Tunable Laser Diode Absorption Spectroscopy at 1653 nm
Detection Threshold	5 ppm-m
Accuracy	± 10% (± 5 ppm-m minimum)
Response Time (T90)	<10 seconds
Range	Up to 50m with a 3M 3930 Prismatic Sheet
Class IIIa Lasers	5 mW max output (2.5 mW/cm2)
Operating Temperature	-20°C to 50°C
Enclosure	NEMA 4X Aluminum Enclosure
Weight	50 lbs
Mounting	Pole, Tripod, Strut
Aiming	Internal Red Cross IIIa Laser used for Optical Alignment
Periodic Maintenance	Wiping down Reflector and Solar Pane

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CONCLUSIONS

- **Remote Monitoring:** Minimal user interaction
- **Long-term Monitoring:** Continuous, self-sustained operation
- **Large-Area Monitoring:** Detects methane along entire path
- **Proven Accuracy:** Better than +/- 5 ppm-m (or +/- 10%) outdoors
- **Leak Location Estimation:** Back trace emissions with wind data

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SWANA
SOLID WASTE ASSOCIATION OF NORTH AMERICA

QUESTIONS?

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ACCESSORIES (STANDARD AND OPTIONAL)

Standard (Included)

- ✓ Tripod
- ✓ Pole Mount Solar Panel
- ✓ Reflectors (for open path)
- ✓ Analog Anemometer
- ✓ AC Power Adapter
- ✓ USB Configuration Cable

Optional

- \+ Audible/Visual alarm
- \+ Ground/Wall Solar Panel
- \+ Heated Reflector
- \+ Ultrasonic Weather Station
- \+ Sample Collection
- \+ Modular Sensor Input (VOC/PM)

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Gas Sampling Modules

FPL

Canister Valve Controller

Valve + Canister

Sorption Tube Pump

Thermal Desorption Tube

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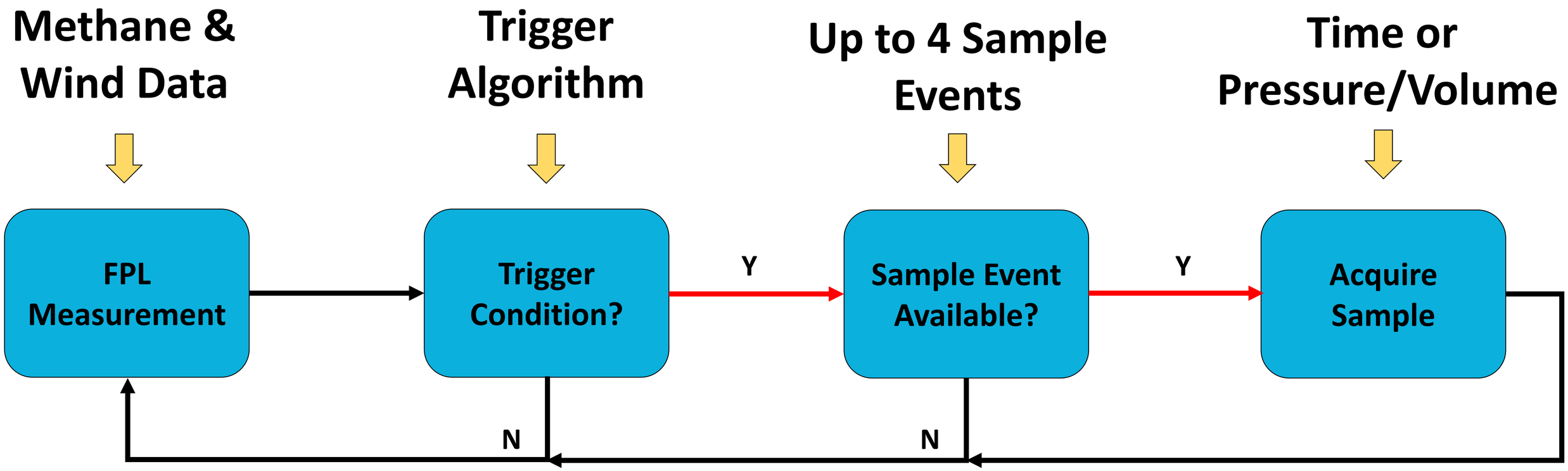
SAMPLE ACQUISITION PROCESS



Sample Trigger Algorithms

Concentration Threshold

Concentration Threshold: ppm
Threshold Duration: (seconds)

Wind Speed and Direction

Minimum Wind Speed: (m/s)
Wind Direction Range: (°)

Combination Concentration and Wind

Wind Speed Ranges: (m/s)
Concentration Threshold: (ppm-m) Threshold Duration: (seconds)
Wind Direction Range: (°)

Quadrant Sampling

4 Wind Direction Quadrants: Adjustable

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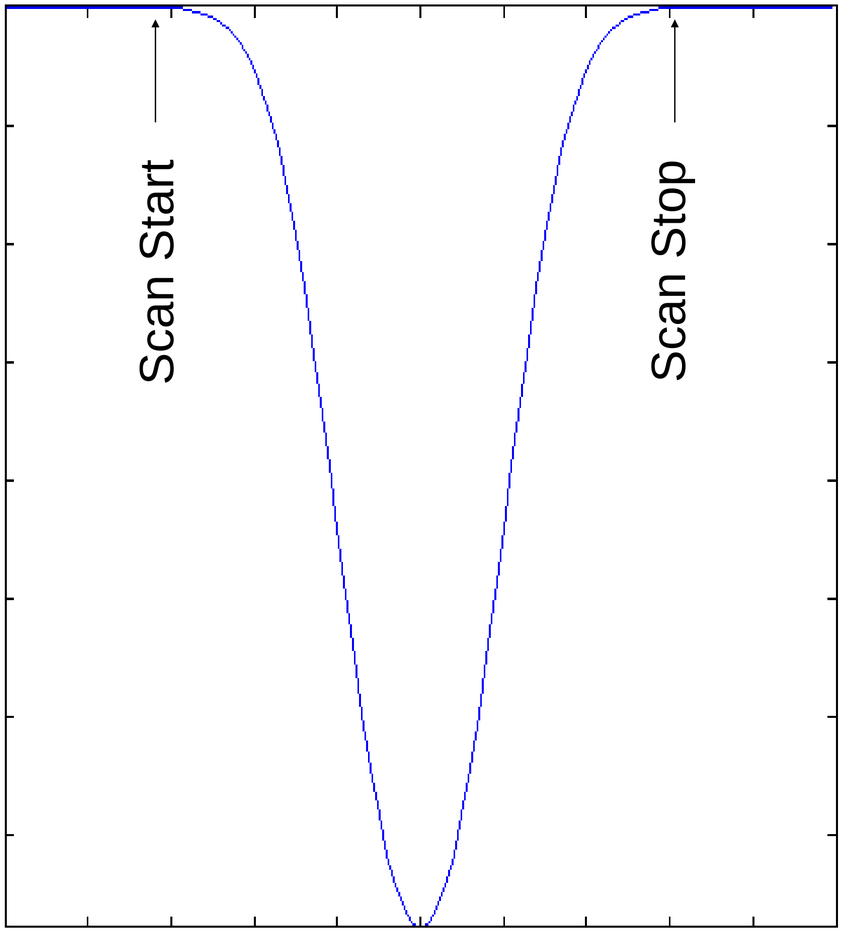
TUNING THE LASER



→ Tune laser diode wavelength to single absorption line

→ Sweep across wavelength range by changing diode temp/injection current

→ Combine laser output and detector into one housing

→ Detect reflected intensity while scanning wavelength range (open path or multipath internal cell)

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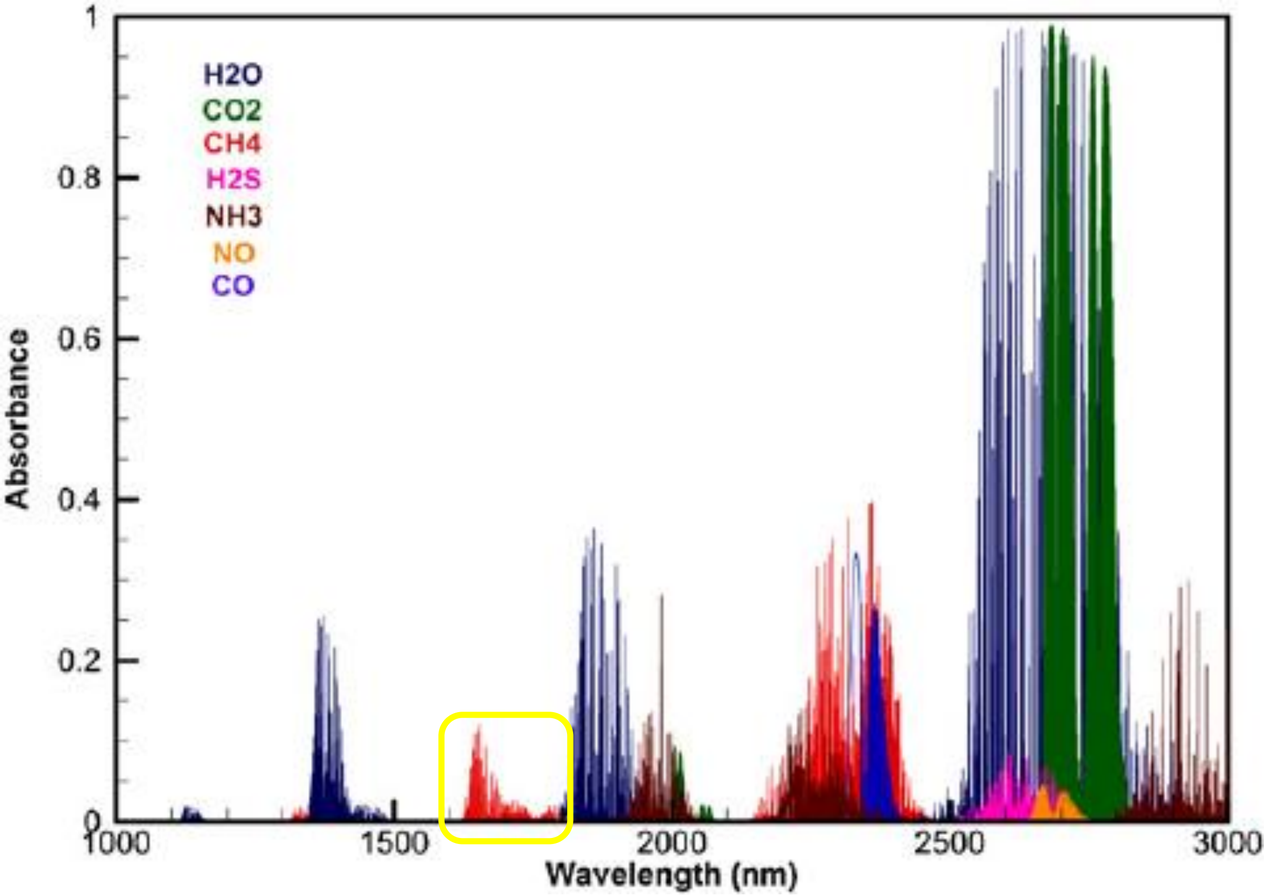
THEORY OF OPERATION – IR METHANE DETECTION



→ Infrared light absorption by common gases

→ Maximize absorption strength (easy detection)

→ Minimize interference (cross-sensitivity)

→ ~1650 nm near-IR window is best compromise

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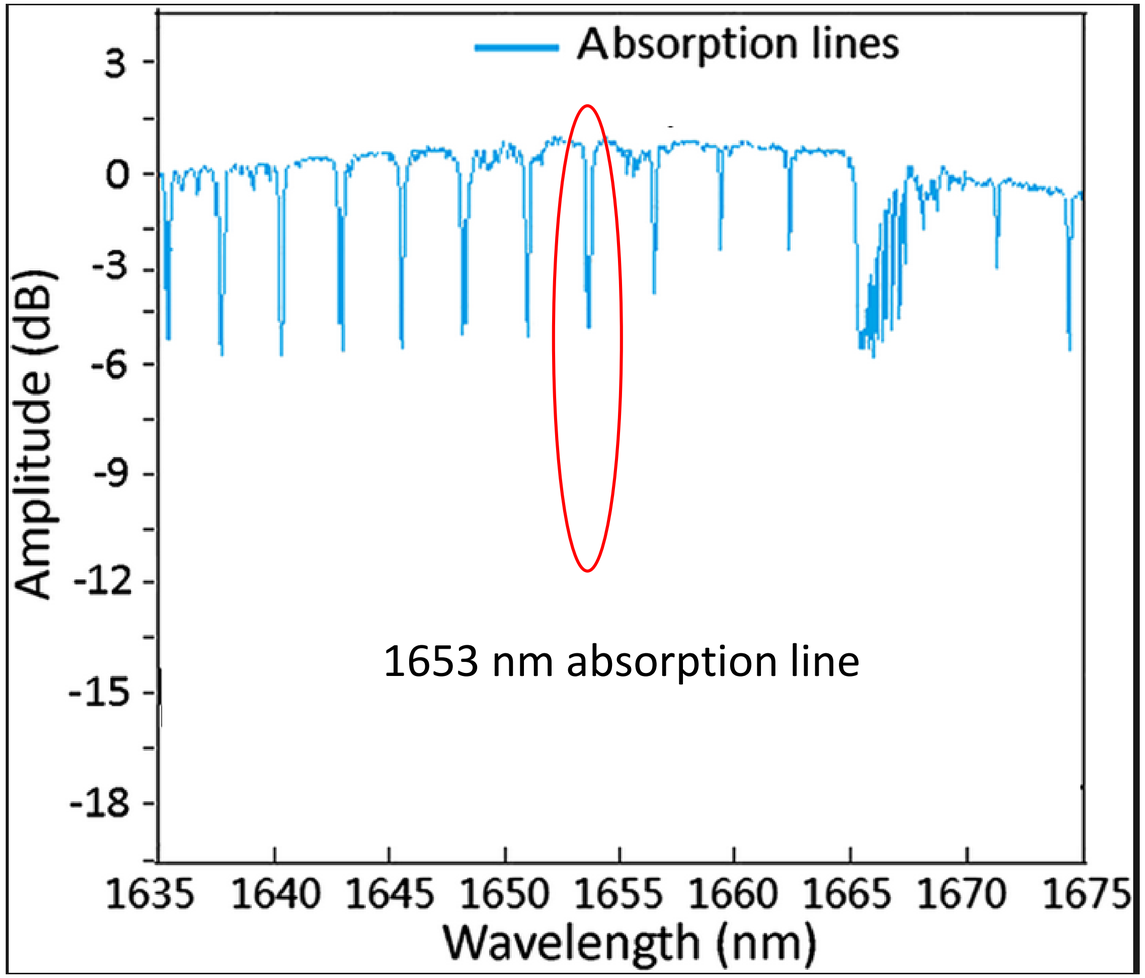
CH_4 FINE IR SPECTRA



→ Narrow absorption lines (highly selective

→ Low absorption surrounding peaks (Built-in direct absorption reference reading)

→ 1653 nm selected to avoid any nearby gas absorption and cross sensitivity

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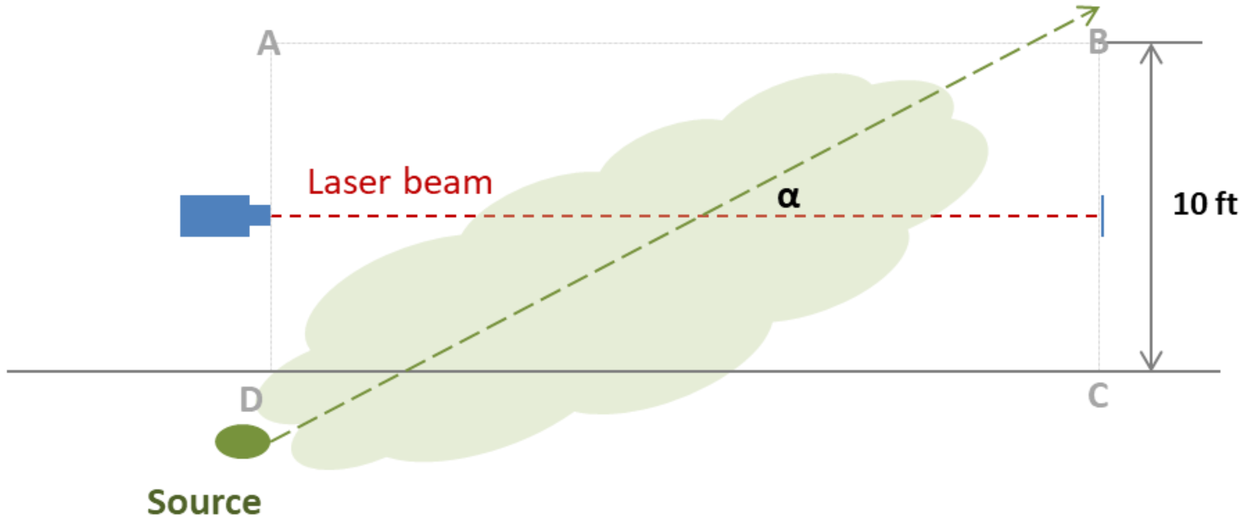
EMISSIONS ESTIMATION (POINT SOURCE)



$$Flow = \left(\frac{\overline{meas}}{L} - c_{\infty}\right) \cdot L \cdot h \cdot \sin\alpha \cdot w_{Speed}$$

$\overline{meas}$: $Measurement\ averaged\ on\ 10\ minutes\ [ppm \cdot m]$
h: $Height\ of\ the\ plane\ (ABCD)\ [m]$
L: $Length\ of\ the\ laser\ beam\ [m]$
c_{∞}: $Background\ methane\ concentration\ [ppm]$
α: $Angle\ between\ the\ wind\ direction\ and\ the\ plan\ (ABCD)[degrees]$
W_{Speed}: $Wind\ speed\ [m \cdot s^{-1}]$

- Assumptions:
  1. All methane molecules from the source cross the vertical plane (ABCD) defined by the laser beam extended from the ground to a maximum height of 10 feet.
  2. The integrated concentration of methane across the laser beam is representative of the average concentration across the plane (ABCD)

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Additional Landfill Monitoring Options

- Types of surface emission monitors
  - Multi-gas Analyzers (RAMP)
  - VOC Monitors (SPOD)
  - Surface Emission Monitors (PMD2)
- Role of monitor
  - Locate source (GPS accuracy of 2m)
  - Identify areas for remediation
  - Assist methane capture or flaring
- Mapping and Charting emissions
  - *GIS360*
  - *SENSIT CONNECT*

https://youtu.be/Vm2UpPwrR3I

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SENSIT SPOD **VOC Emissions Monitor**

Weight	Base unit: 6.75 lbs
Dimensions	D x W x H (6” x 8” x 16”)
Mounting	Attached mounting flanges *Tripod accessory available*
Runtime	2-3 days battery backup
Temp Range	-20°C to 50°C
Data Storage	Data backup and diagnostic inf

Ultrasonic Weather Station: Wind Speed, Direction, Humidity, Temperature, and Pressure

Cellular ***(4G IoT Modem Included)*** **Local RF Out**
(LoRaWAN Optional)

Illuminated Power Button

Locking Option

NEMA 4X Polycarbonate

18-24V Power and TTL Comm

Auxiliary Port
(Canister and Sorption Tube)

PID Element ***(2ppm FS, 10.6eV)***

SENSIT RAMP **Air Quality Monitor**

Weight	Base unit: 7.5 lbs
Dimensions	2D x W x H (6” x 10” x 12”)
Mounting	Attached mounting flanges *Tripod accessory available*
Runtime	3-15 days battery backup
Temp Range	-2°C to 50°C
Data Storage	Data backup and diagnostic

Cellular ***(4G IoT Modem Included)*** **Local RF Out**
(LoRaWAN Optional)

Illuminated Power Button

18-24V Power and TTL Comm Port

Auxiliary Port
(Accessories)

NEMA 4X Polycarbonate

Gas Sensor Openings

SENSIT RAMP **Sensor Capabilities**

- Capable of monitoring five gaseous chemical pollutants and particulate matter PM2.5 (redundant PM option)
- PPB resolution for VOCs, CO, H_2S, NO, NO_2, O_3, SO_2
- Temperature, humidity, pressure
- Anemometer input for wind direction/speed
- Four additional I/O ports for integrating additional instrumentation