Natural Gas Leakage Technology Forum

Mobile Monitoring for Rapid, Selective Natural Gas Leak Detection

Power and productivity for a better world™

Outline

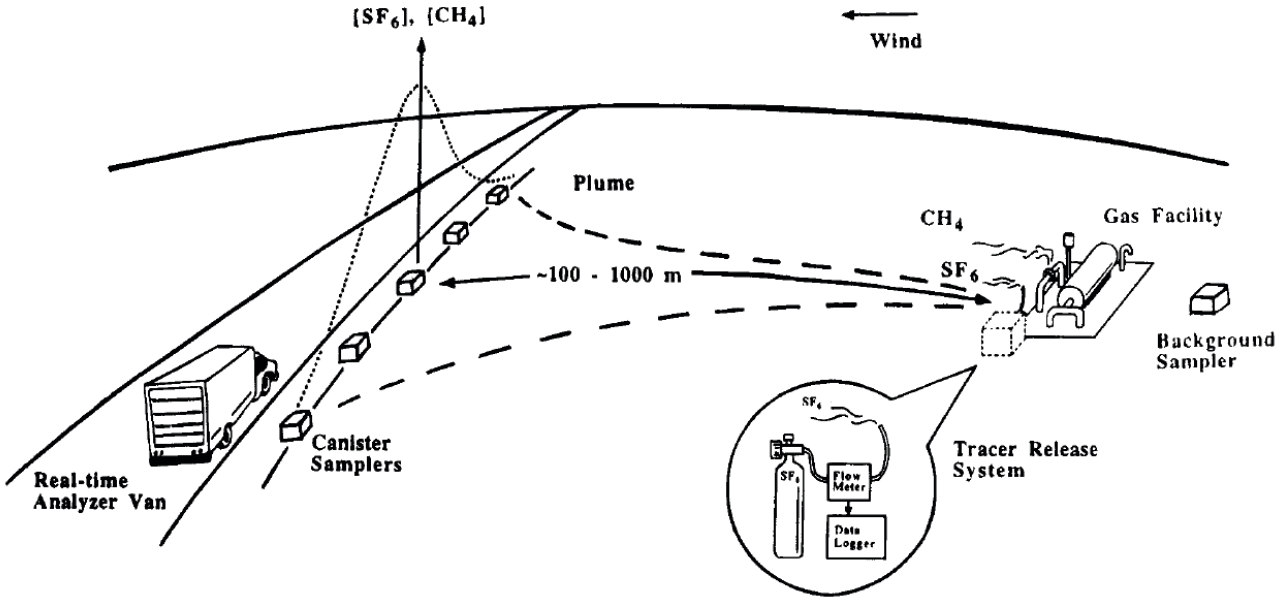
- **Company Overview**
- **LGR's Solution**
  - Methane/Ethane analyzer
  - Leak Detection and Mapping Software
- **Sample Dataset**
- **Ongoing Development**
- **Commercial Details**

Company Overview

- Founded in 1994, acquired by ABB in October 2013
- Located in Mountain View, California (Silicon Valley)
- Pioneer and world-leader in laser-based gas sensing
- Pioneers in "cavity enhanced absorption spectroscopy" (CRDS, Off-axis ICOS)
- Numerous patents granted for analytical methods
- Hundreds of publications in peer-review journals
- Target markets: industrial, environmental, research, medical
- Sold >1200 instruments on all 7 continents

LGR Solution

Mobile Monitoring Requirements



[1]Lamb, Brian K., et al. "Development of atmospheric tracer methods to measure methane emissions from natural gas facilities and urban areas." *Environmental science & technology* 29.6 (1995): 1468-1479.

- **Vehicle-mounted sensors have a long history and have been extensively vetted**
- **Allows for cost-effective surveys of large areas at a rapid pace**
- **Requires:**
  - **Manufacturable, easy-to-use gas sensors that do not require researchers**
  - **Complete sensor suite - sensor, GPS, anemometer, gas inlet…**
  - **Data aggregation, analysis and interpretation - leak detection software**
  - **Data presentation - HMI**

LGR Solution

Overview

Off-Axis ICOS Analyzer
(Methane/Ethane)

GPS
(Location)

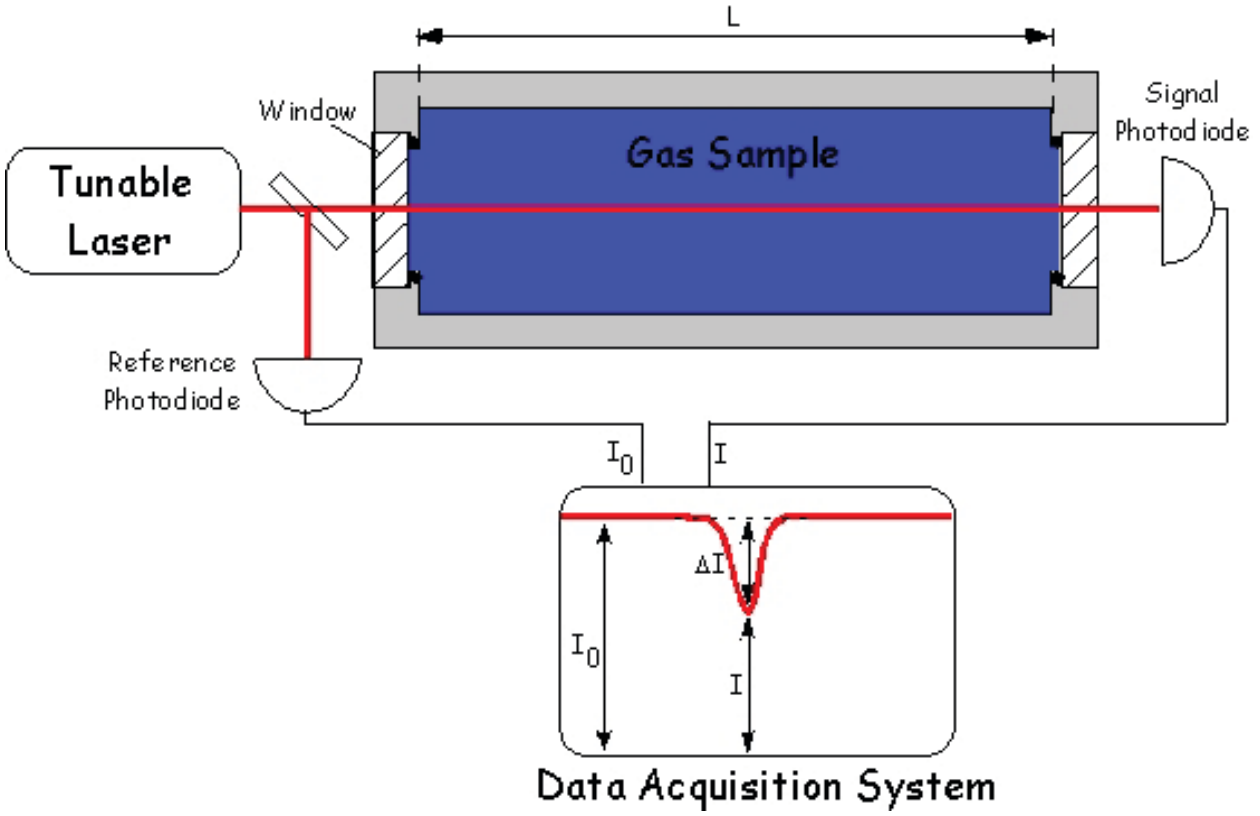
Sonic Anemometer
(Wind Speed/Direction)

Computing
(HMI/Leak Detection Software)

Enables rapid identification of the size and location of natural gas leakage with high selectivity

LGR Solution

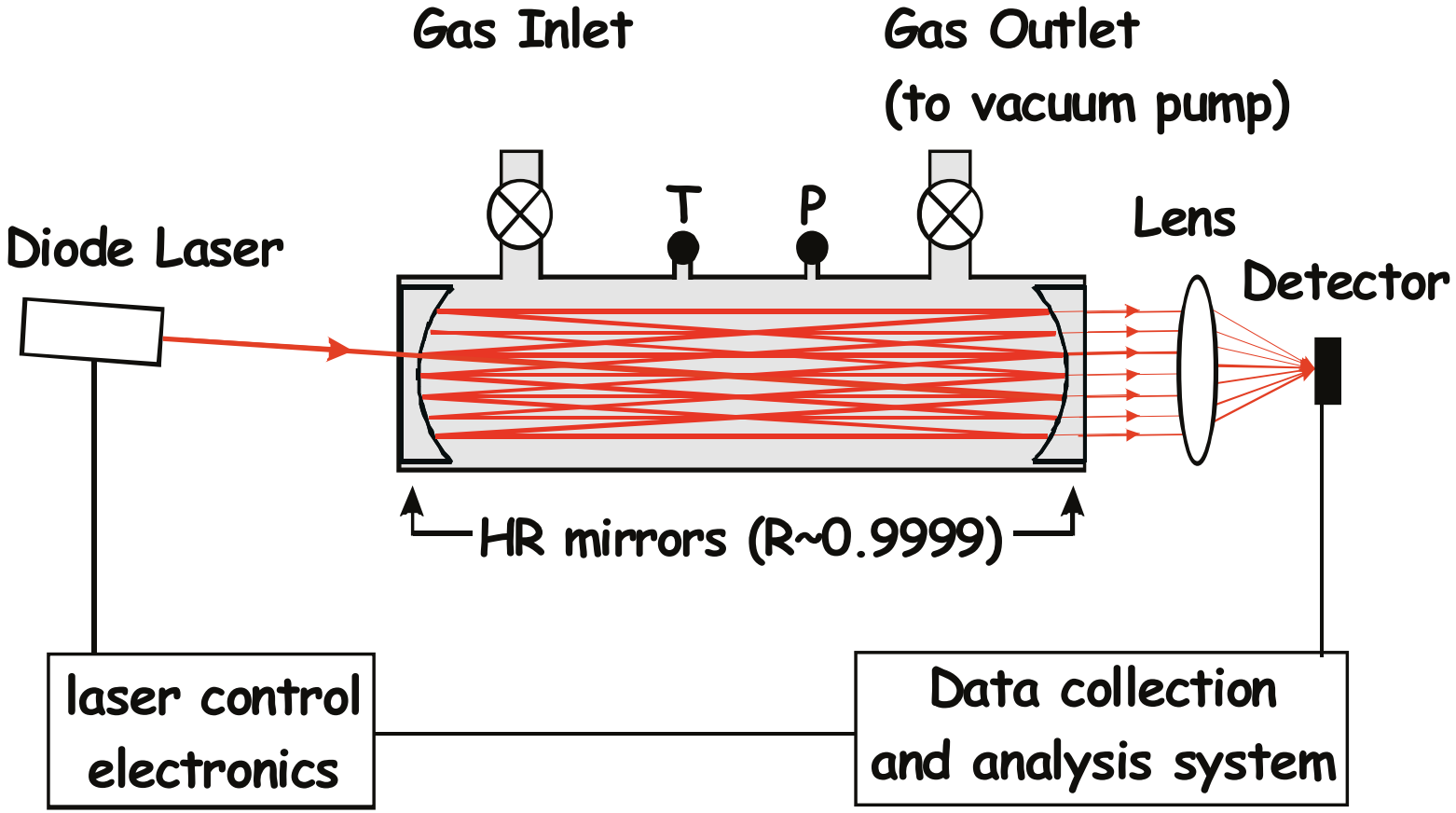
Methane/Ethane Analyzer – Conventional TDLAS



- **First-Principles Measurement** → little to no calibration required
- **Highly Selective** → only target molecule absorbs at probe wavelengths
- **Fast** → measure spectra at > 1 kHz
- **Robust** → utilizes solid-state telecommunications-grade lasers and detectors
- **Insufficient Sensitivity** → cannot measure low levels of methane and ethane

LGR Solution

Methane/Ethane Analyzer – Off-Axis ICOS



- Optical cavity provides effective pathlength of 1 – 100 km
- Increased dynamic range of 1,000 – 10,000
- Very robust – exact alignment is not critical, enabling mobile monitoring
- All advantages of conventional TDLAS, with increased sensitivity and dynamic range

LGR Solution

Methane/Ethane Analyzer - Instrument

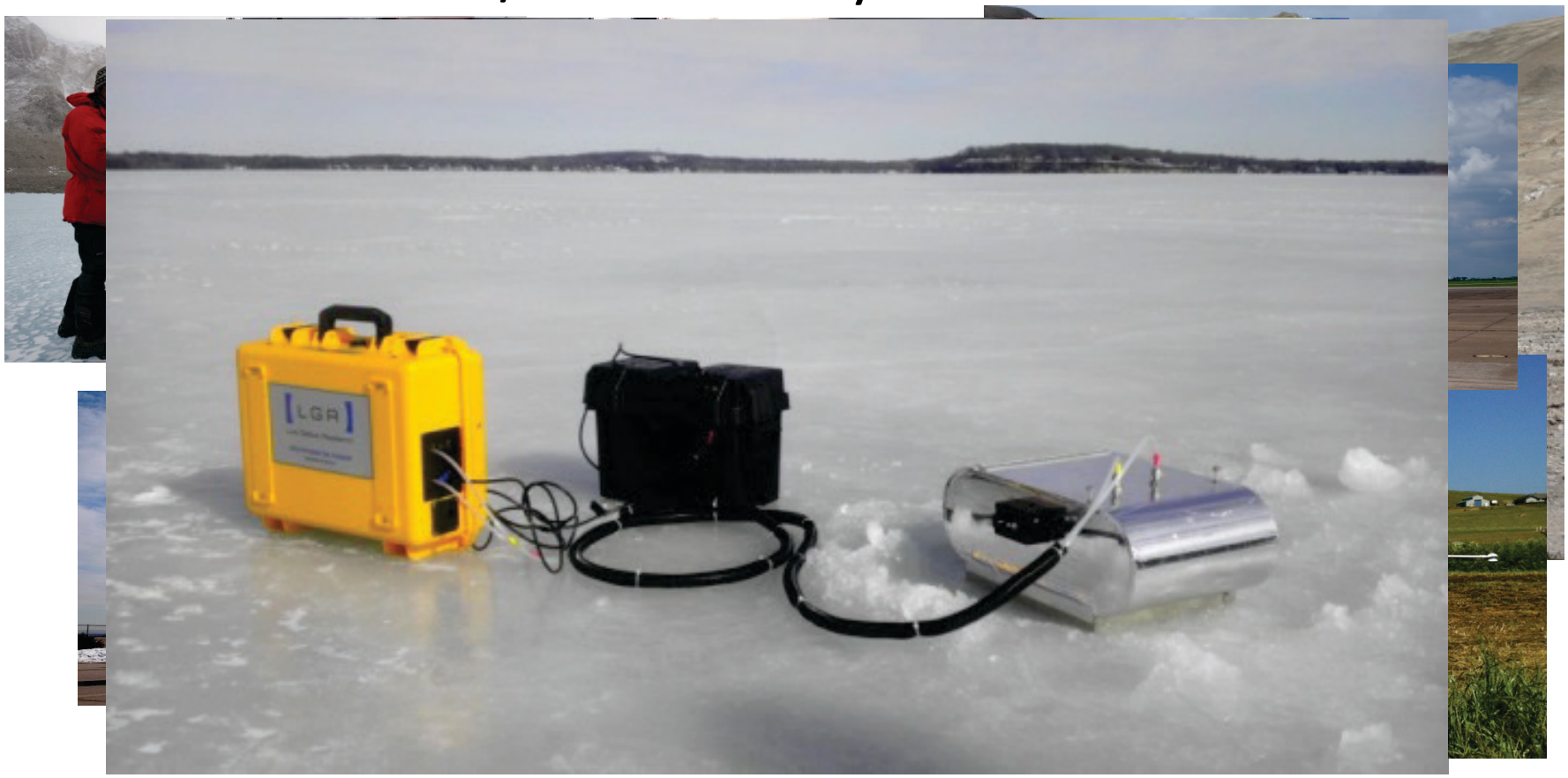
LGR Solution

Methane/Ethane Analyzer - Performance

Feature	Specification	Advantage
Highly Sensitive	Methane: 2 ppb Ethane: 10 ppb	Observe and attribute small leaks from large distances
Fast Response	Response time of up to 5 Hz	Allows for driving speeds in excess of 40 mph
Highly Selective	No interferences from ambient compounds or higher hydrocarbons	No false positives
Calibration-Free	Utilizes Off-Axis ICOS – a first principles measurement technique	No need to calibrate the analyzer
Large Dynamic Range	Methane: 1 – 100,000 ppm Ethane: 0 – 100 ppm	Accurately quantify leaks independent of distance and size
Fast Warm-Up Time	Less than 2 minutes from power on to data collection	Improves uptime and efficiency
Low Power	Analyzer and pump only require 100 W	Can power from a standard car battery power point
Wide temperature range	Operates from -5 to +50 °C	Can be deployed in a wide array of environments

LGR Solution

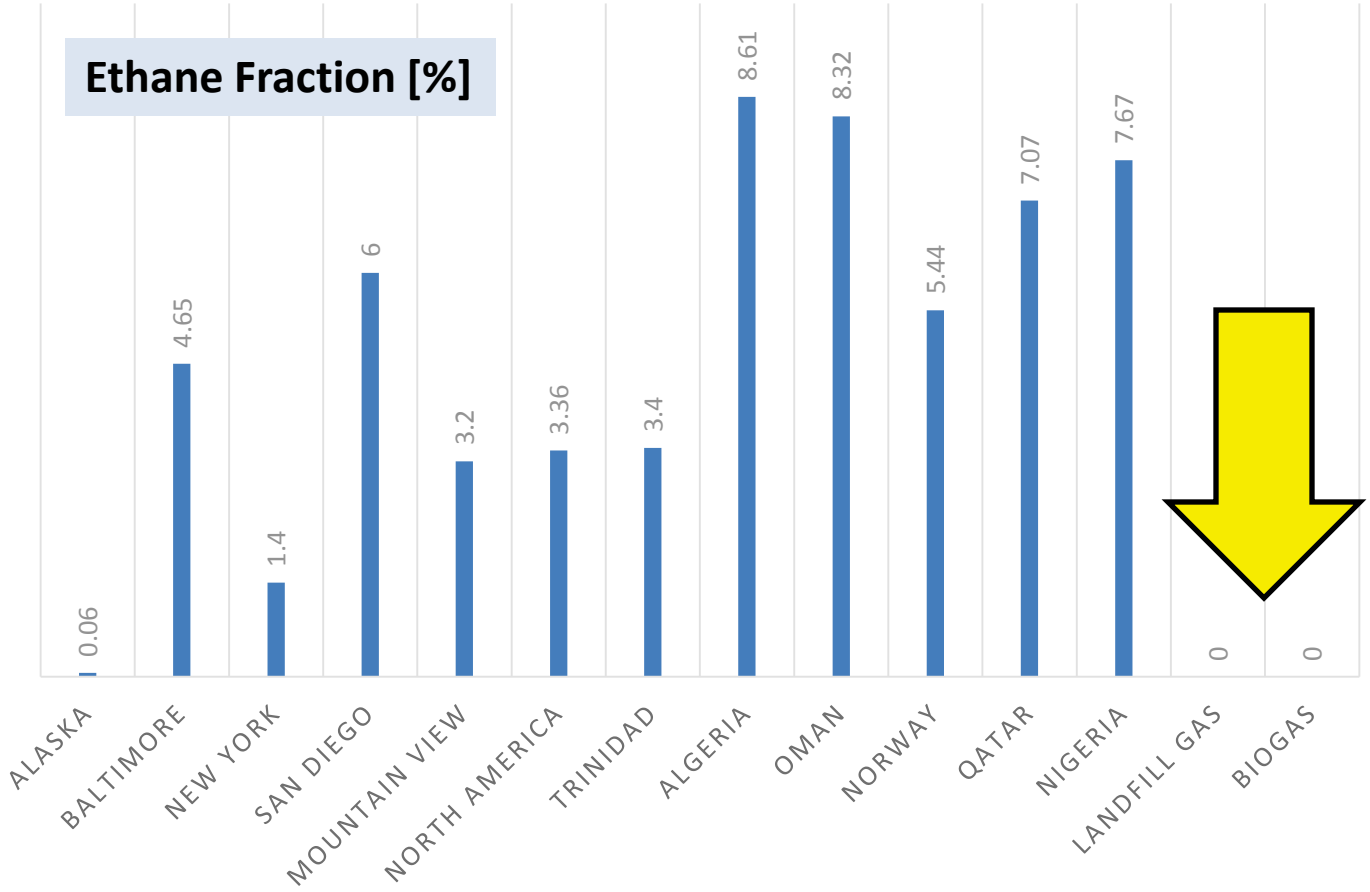
Methane/Ethane Analyzer - Robustness



- No temperature control required → fast warm-up
- No vibrational damping required → easy to mount
- Mirrors can be cleaned in the field → field serviceable
- Has been successfully deployed in harsh conditions on all 7 continents

LGR Solution

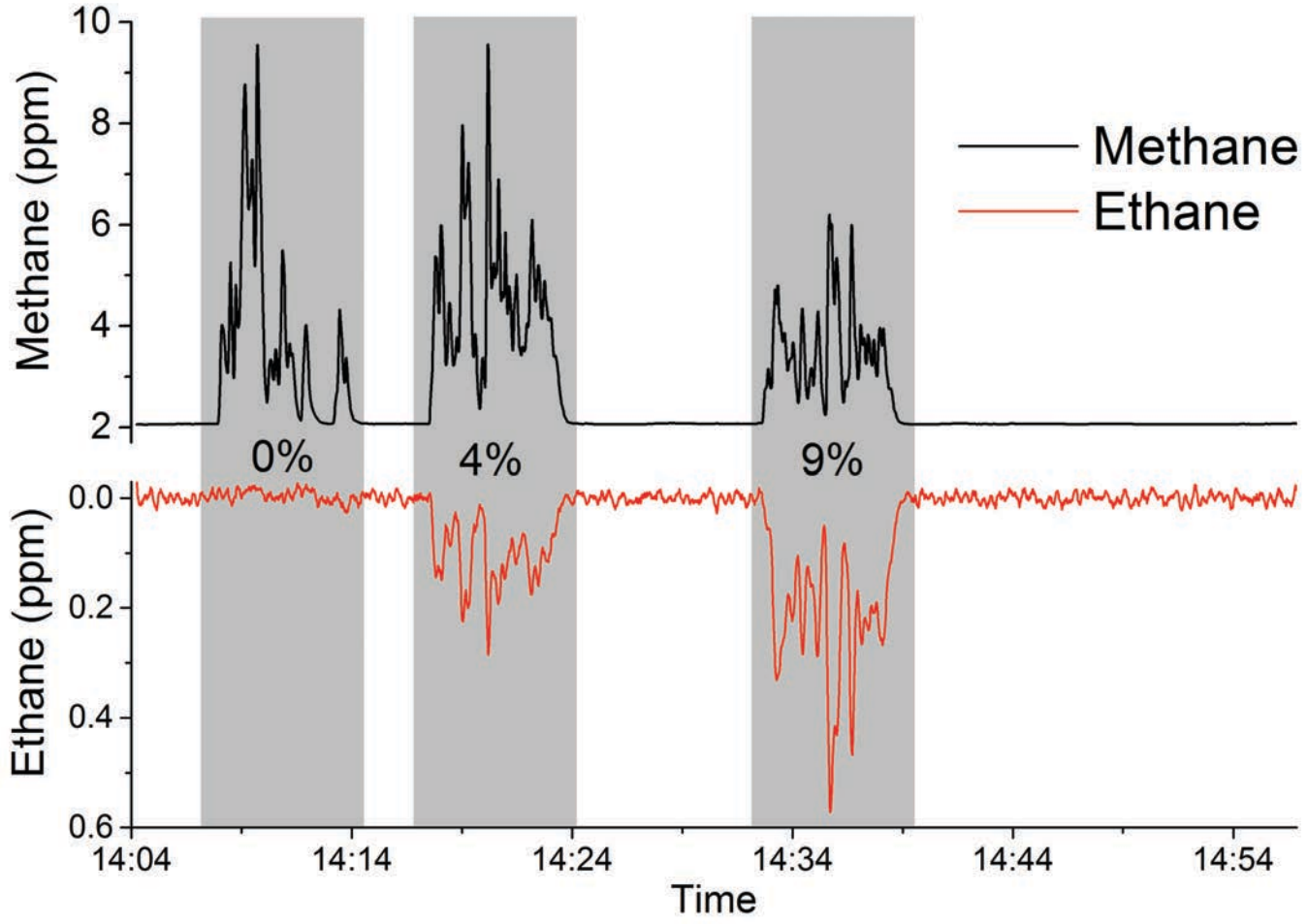
Methane/Ethane Analyzer – Why Measure Ethane?



- Ethane is a fingerprint of natural gas leakage not found in biogas
- Methane isotopes are not unique and ratios may change with soil migration
- In ethane-poor regions, system can operate in methane-only mode

LGR Solution

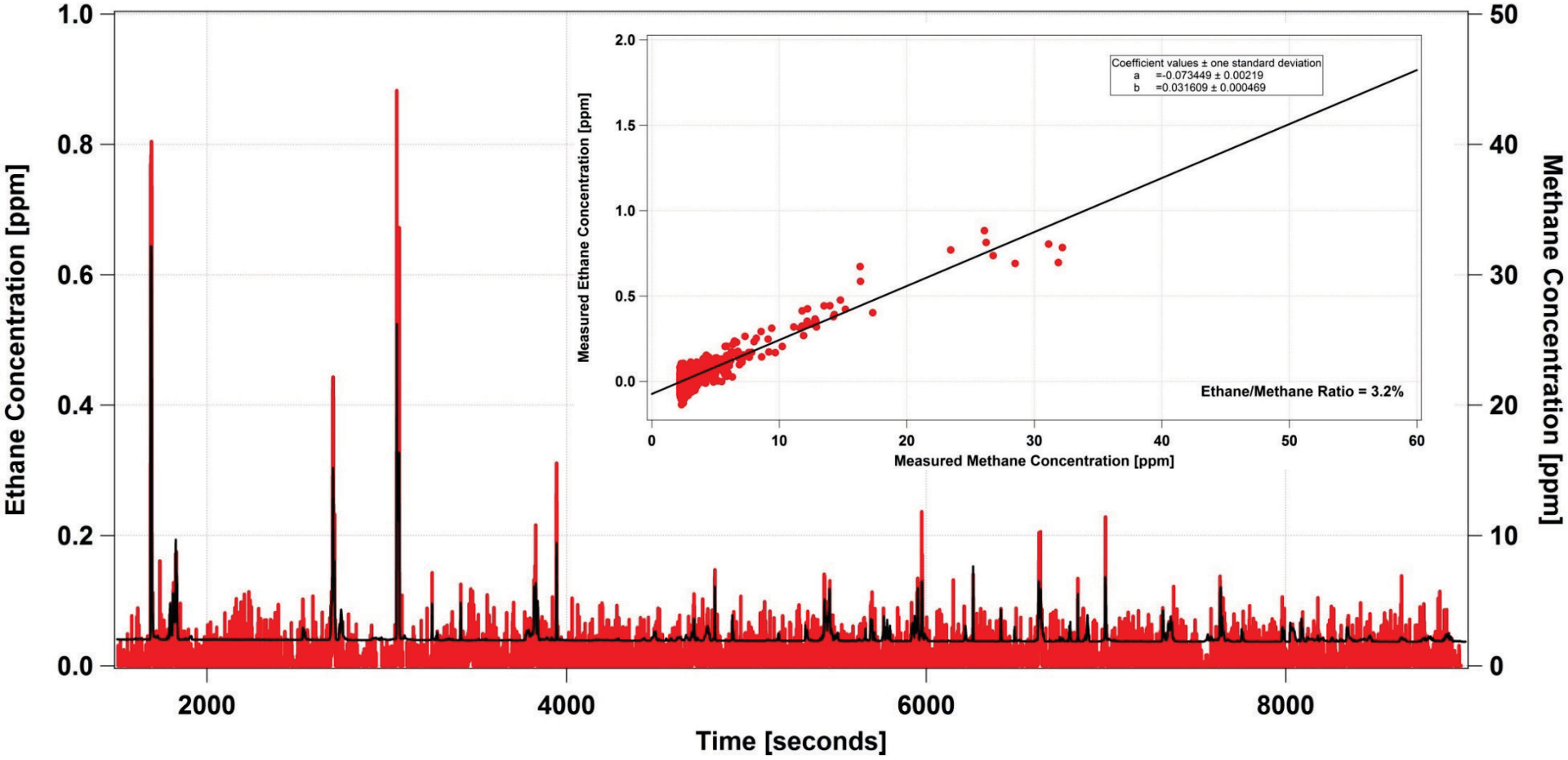
Methane/Ethane Analyzer – Controlled Release



- **Controlled release of pure methane, 4% ethane/methane, and 9% ethane/methane**
- **Analyzer can readily detect ethane and quantify ethane/methane fraction**

LGR Solution

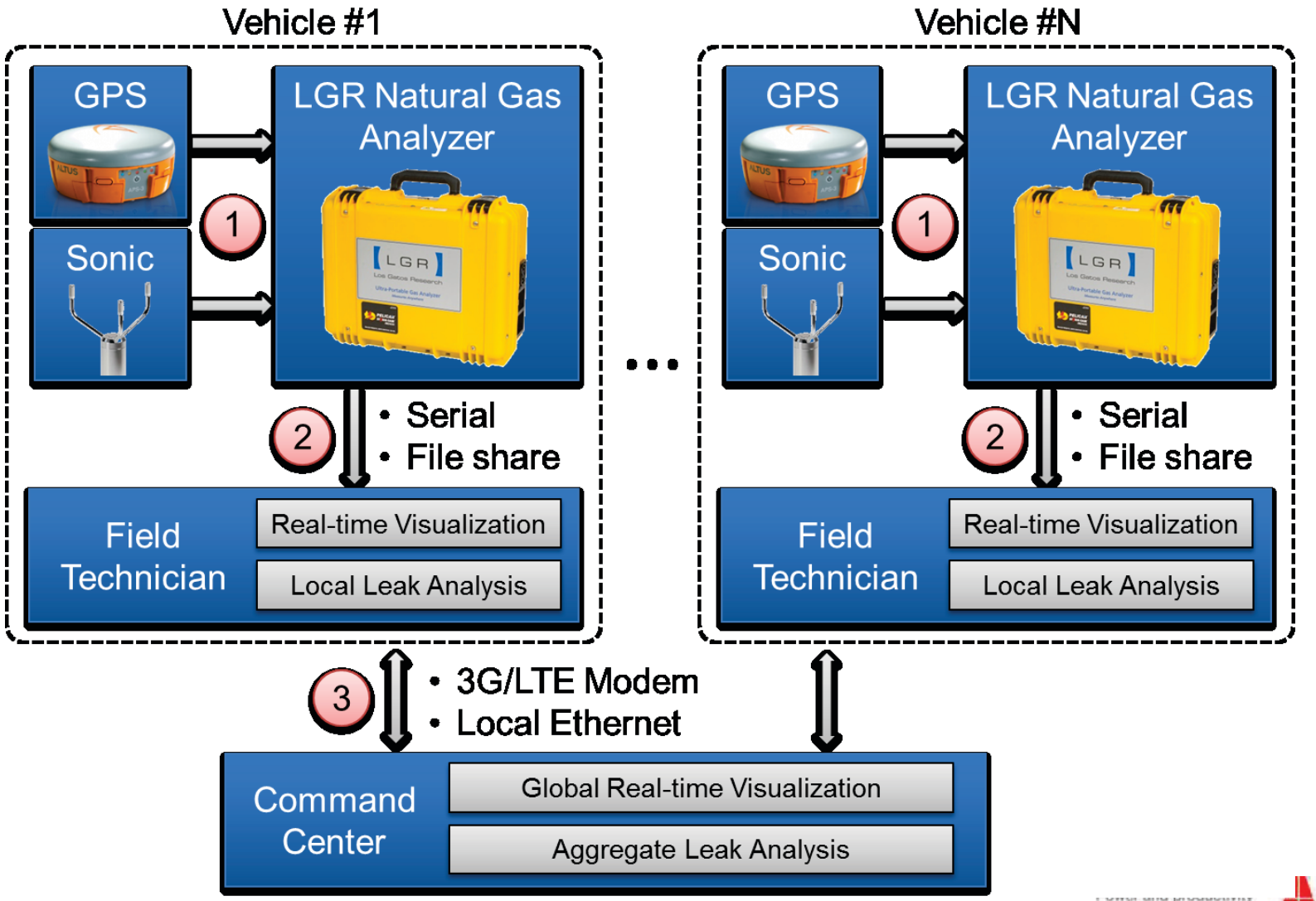
Methane/Ethane Analyzer – Preliminary Data



- Preliminary demonstration at PG&E training facility in Livermore, California
- Ethane vs. methane slope = 3.2%, matches PG&E natural gas composition

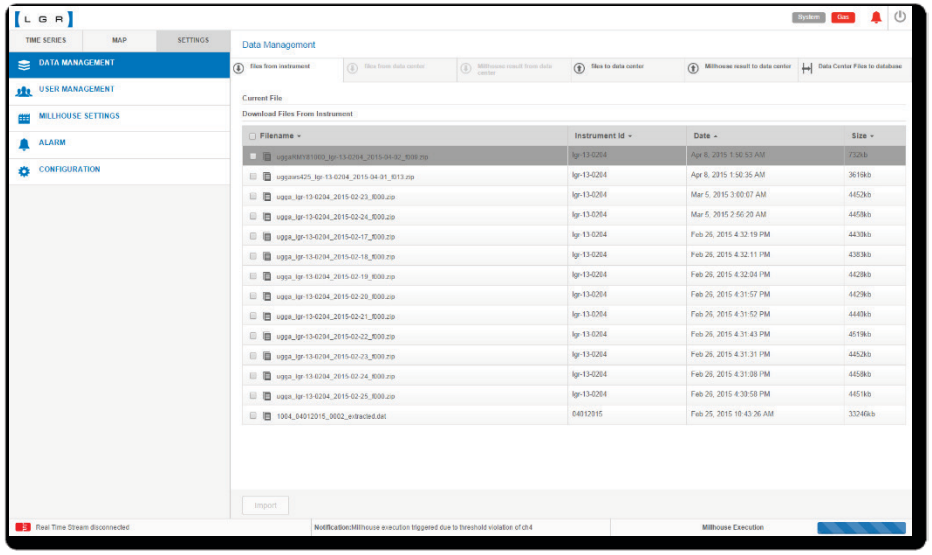
LGR Solution

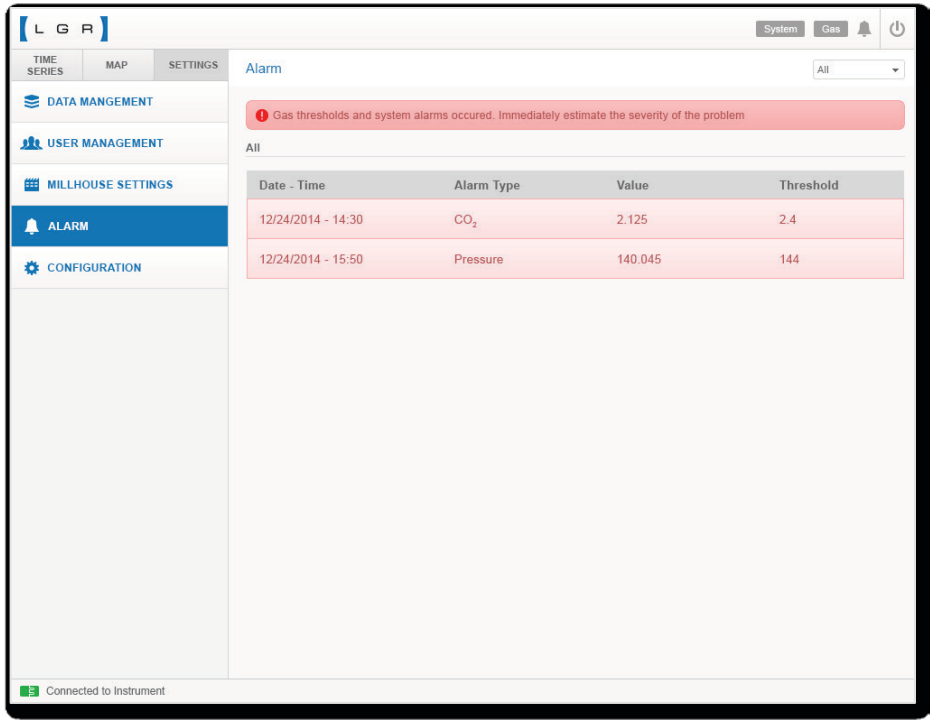
Leak Detection Software – Overview

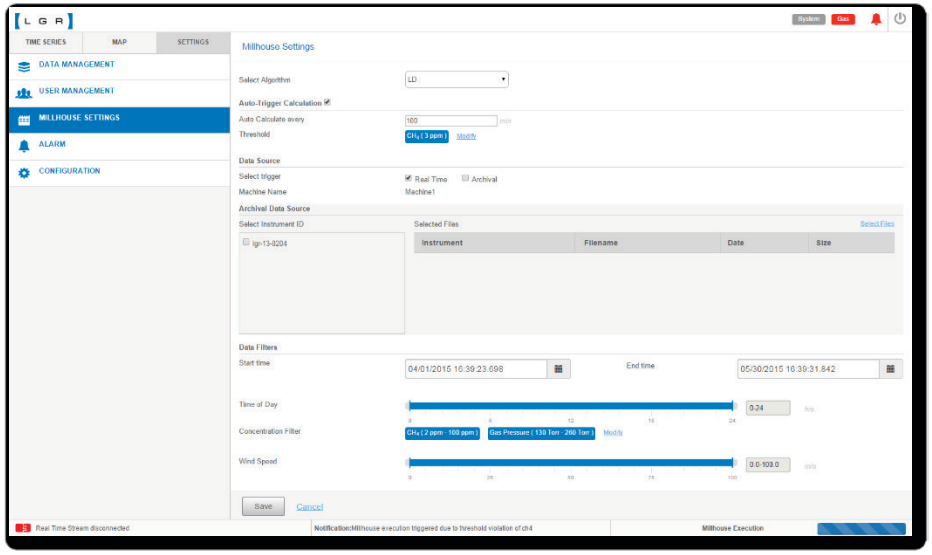


LGR Solution

Leak Detection Software – Administrative Screens





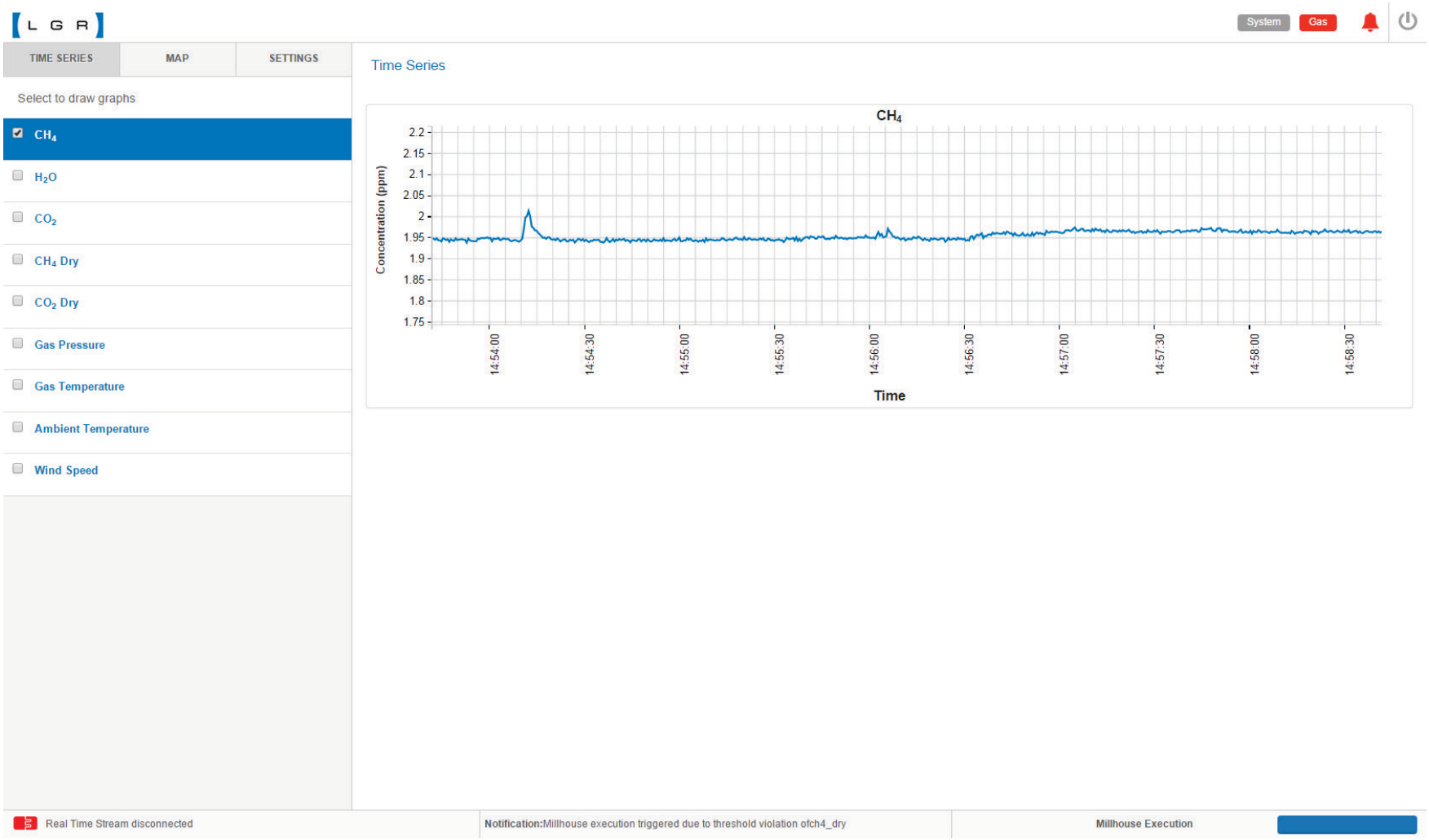


- Login screen with access levels
- Data management
- Alarm setpoints and readouts
- Leak detection settings

Power and productivity for a better world™

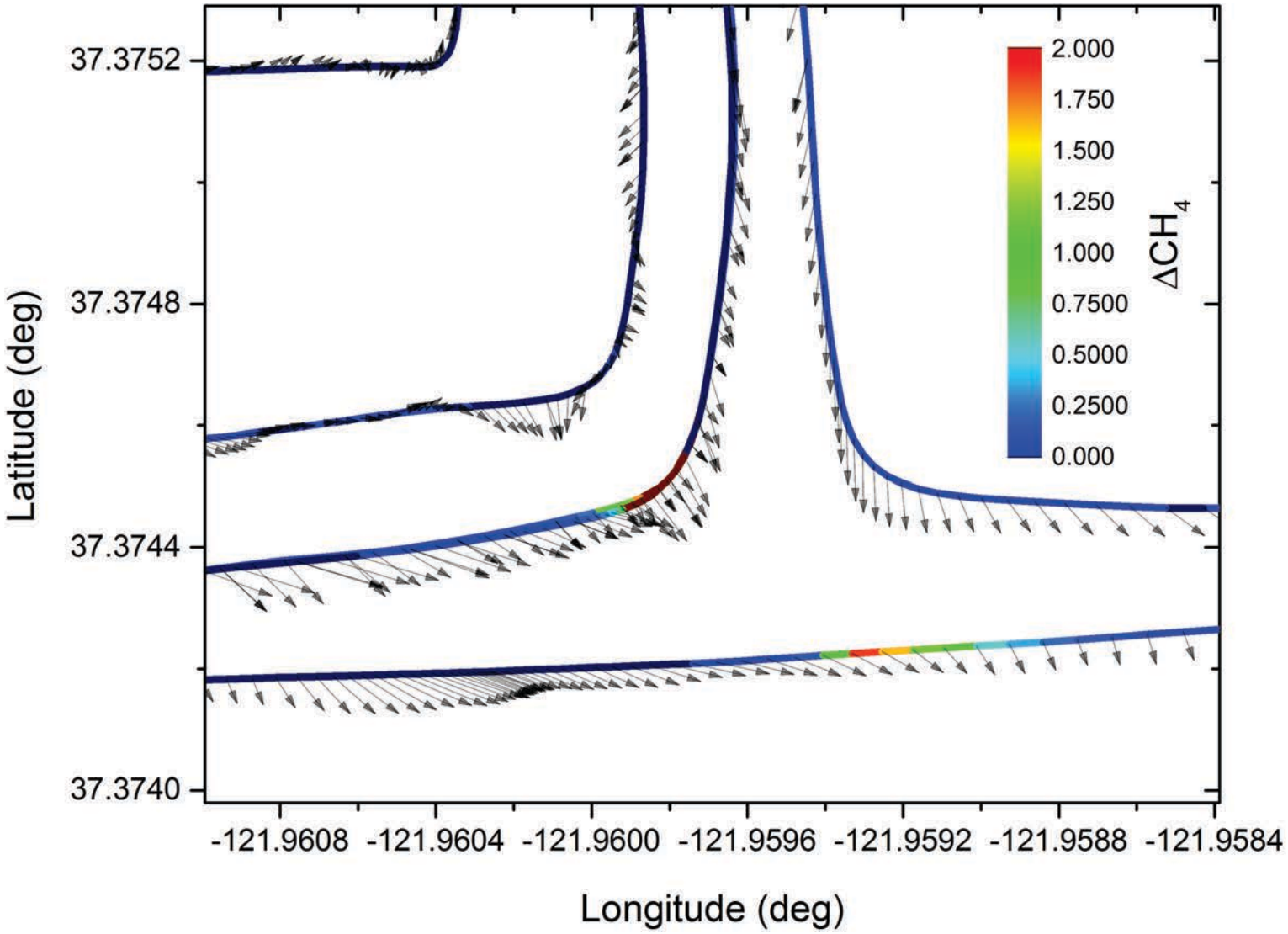
LGR Solution

Leak Detection Software – Measured Time Series



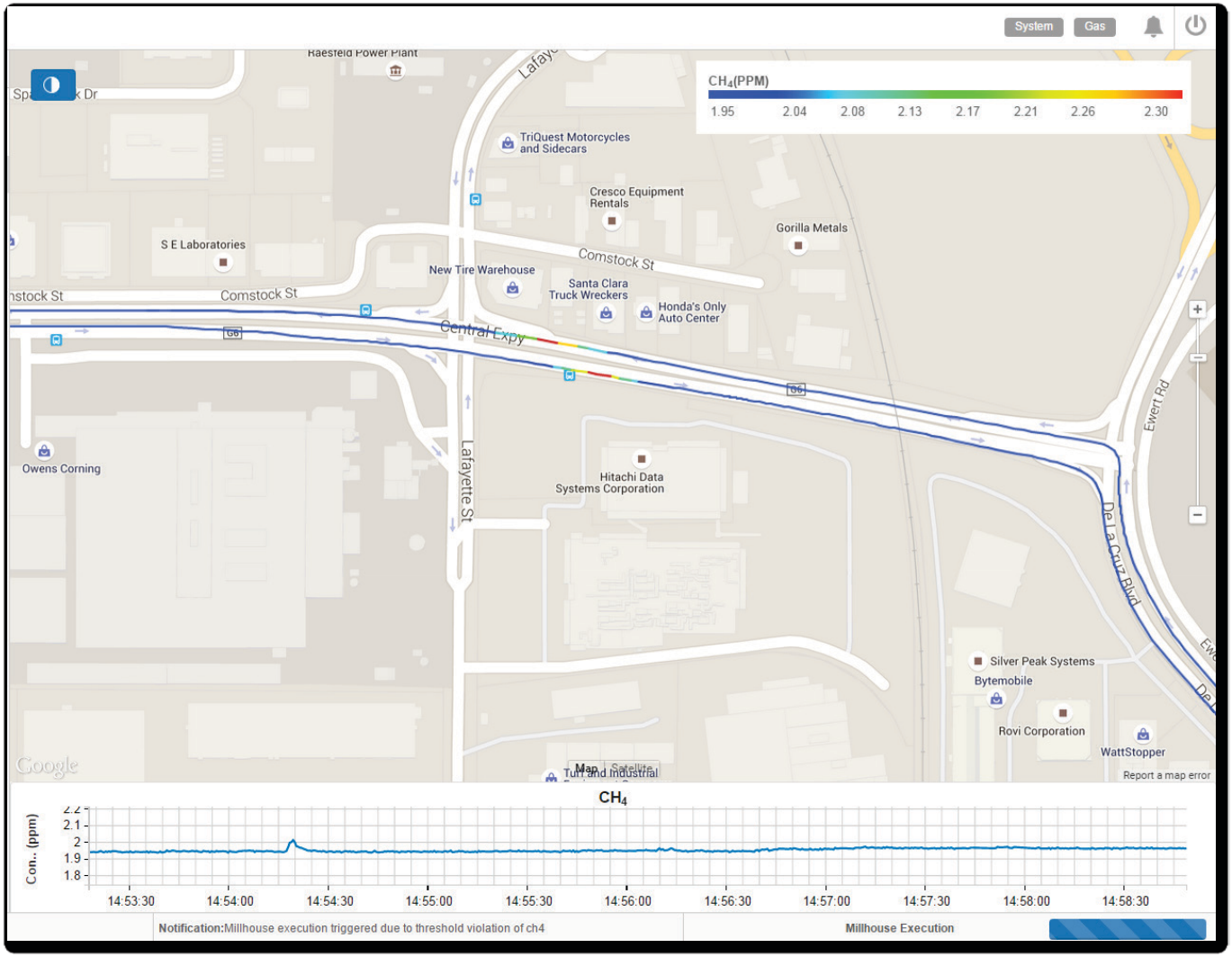
LGR Solution

Leak Detection Software – Raw Measured Data



LGR Solution

Leak Detection Software – Map View

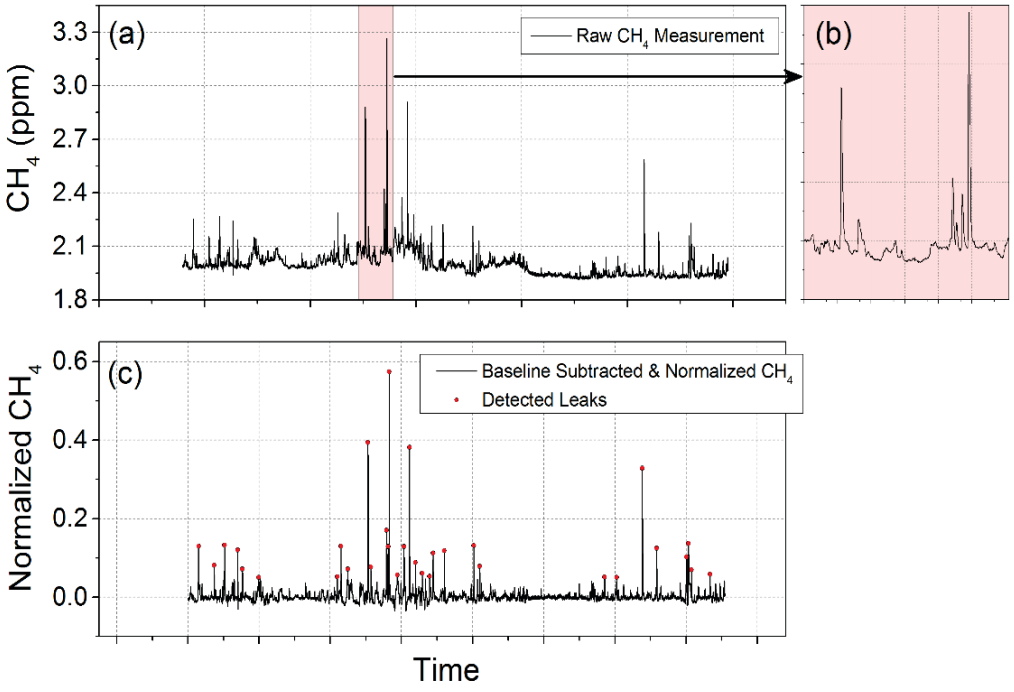


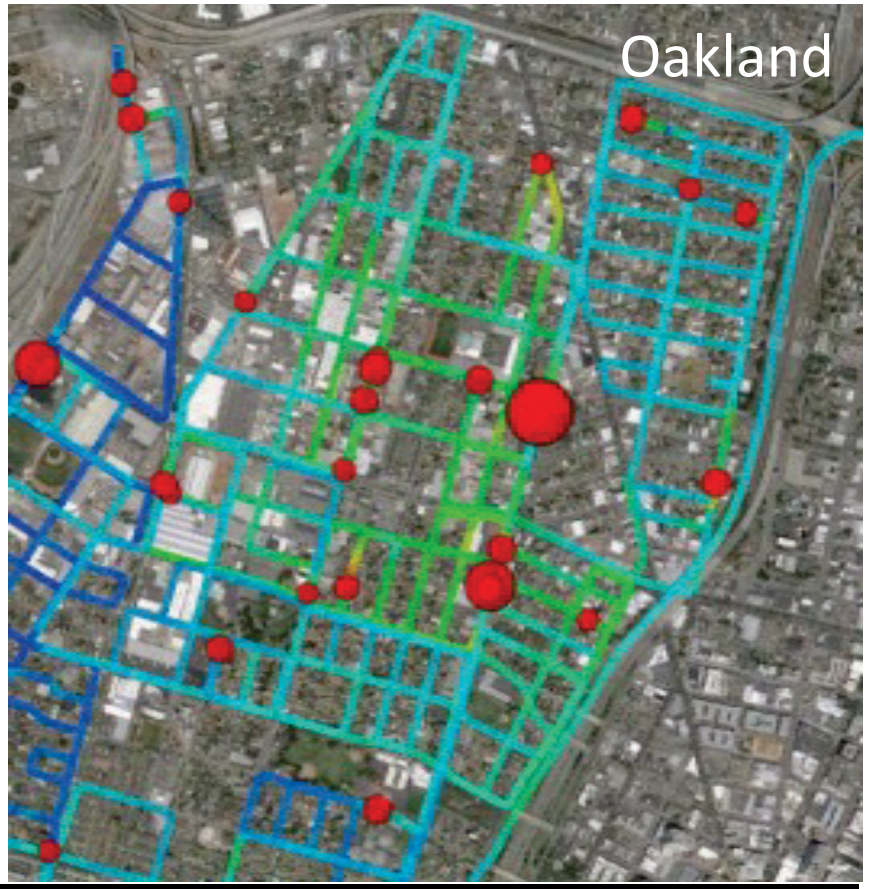
- **Wind vectors removed for clarity**
- **User selectable display variables**

Power and productivity for a better world™

LGR Solution

Leak Detection Software – Simplest Leak Identifier

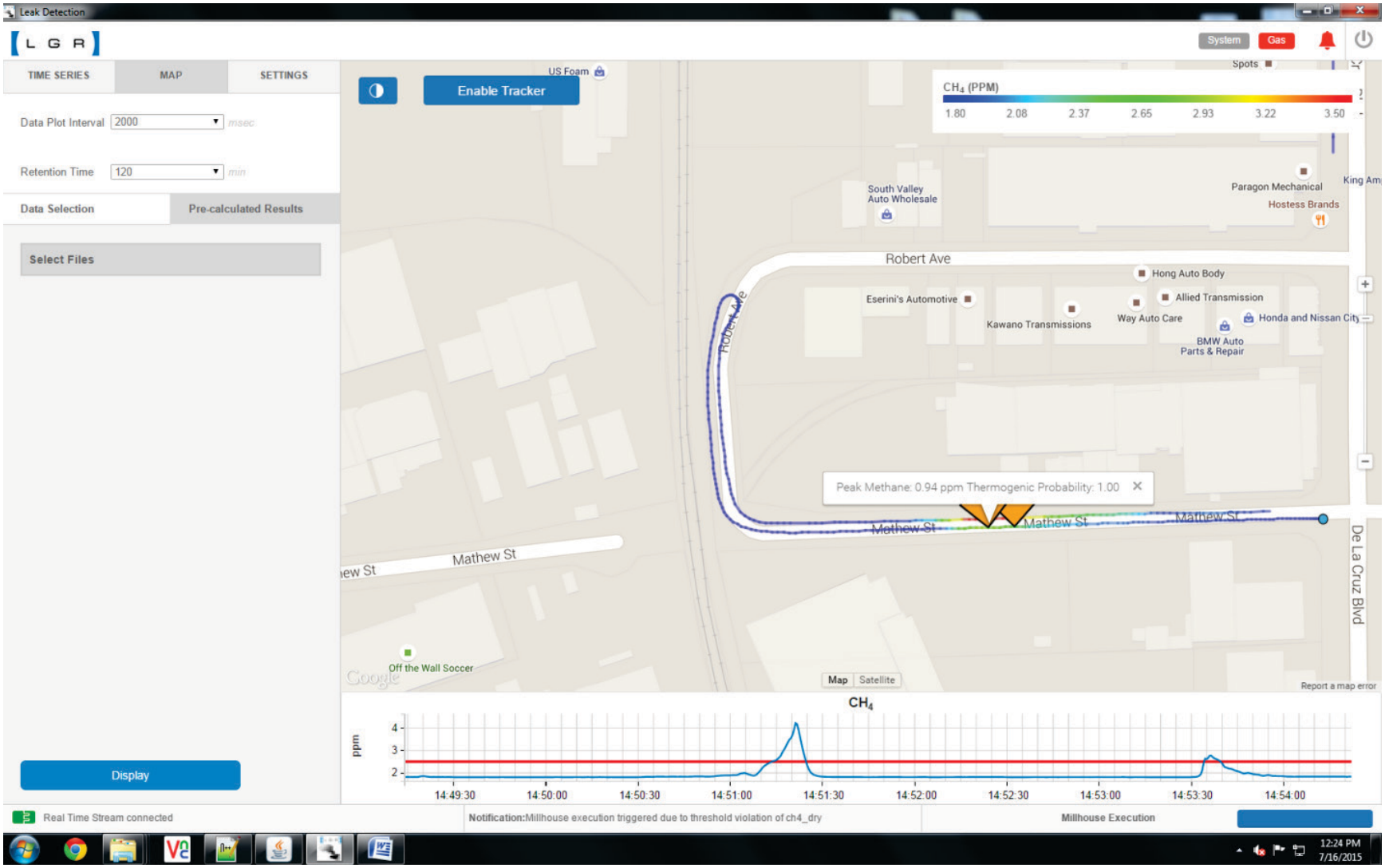




- **Remove slowly varying background changes in methane**
- **Identify significant methane peaks (user determined)**
- **Mark peaks by location and amplitude**
- **Not using wind vector information**

LGR Solution

Leak Detection Software – Leak Representation



LGR Solution

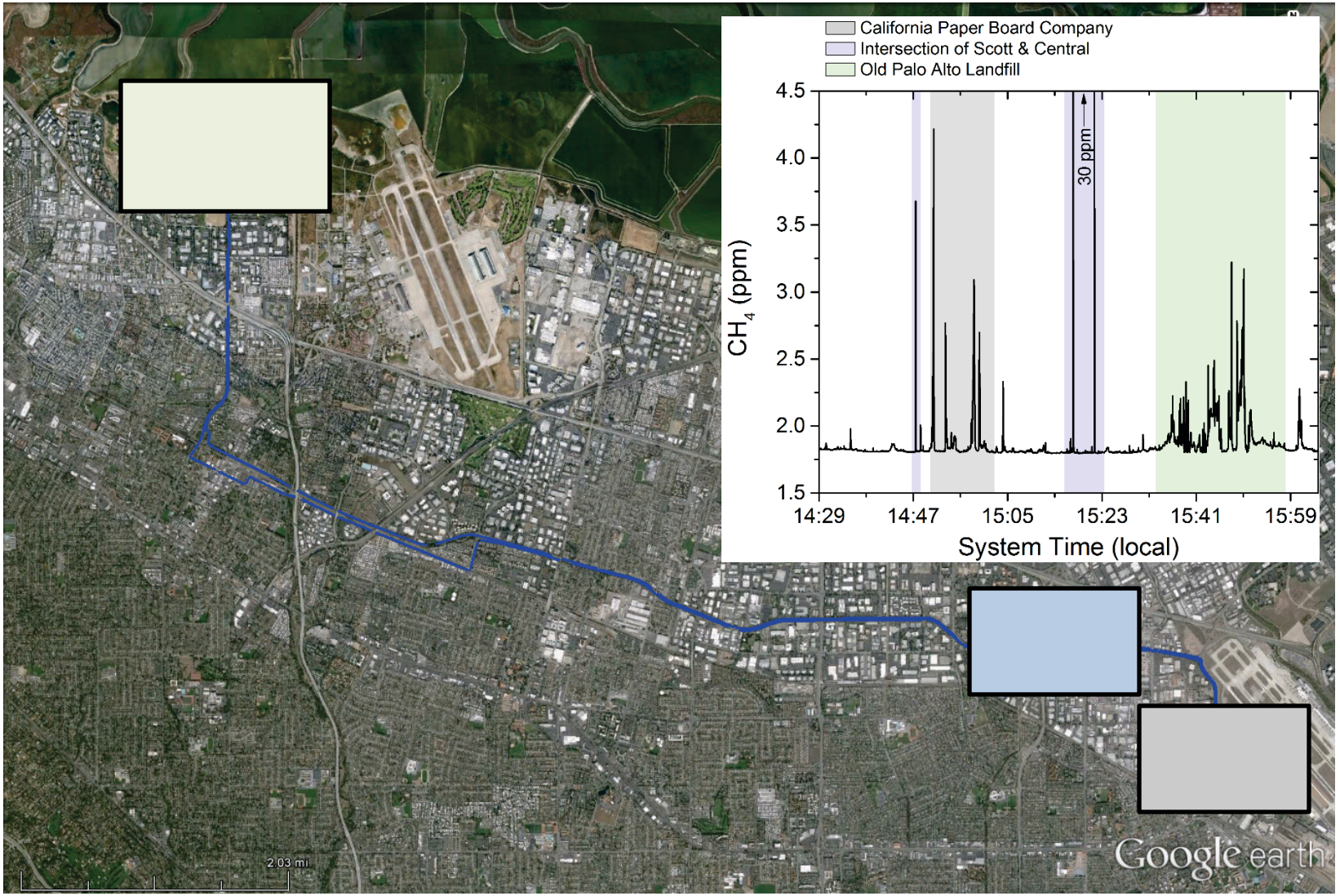
Leak Detection Software – Report Generation

Identification #	Longitude	Latitude	DCH4	P(Ethane!=0)	Wind Direction	Wind Dir Error
1	-121.9592	37.3742	1.1959	0.1707	323.3522	20.9102
2	-121.9437	37.3634	2.4051	1.0000	350.7418	17.8192
3	-121.9437	37.3634	0.9446	0.9996	352.7219	22.3281
4	-121.9436	37.3634	1.2156	1.0000	355.8145	12.8568
5	-121.9431	37.3634	0.5092	0.9968	13.1709	20.9858
6	-121.9597	37.3746	27.8146	1.0000	312.0846	19.9007
7	-121.9598	37.3745	9.6297	1.0000	304.5190	23.7575
8	-122.0707	37.4283	1.3830	0.5725	294.4153	5.3405
9	-122.0707	37.4283	0.9000	0.3775	266.0482	13.7702
10	-122.0706	37.4284	0.6802	0.2359	294.2117	8.2749
11	-122.0706	37.4284	0.8830	0.7481	275.8201	6.3103
12	-122.0709	37.4283	1.2796	0.5062	279.1875	5.0638

- Raw Measurement output - GPS, methane levels, ethane levels, wind direction, wind speed, diagnostics information
- Processed text output - analysis settings, driver info, time/date, system info, leak position, leak amplitude
- Custom User Interface - interactive maps and printable maps with GPS coordinates
- High degree of report configurability

Sample Dataset

Drive with 3 Leak Locations



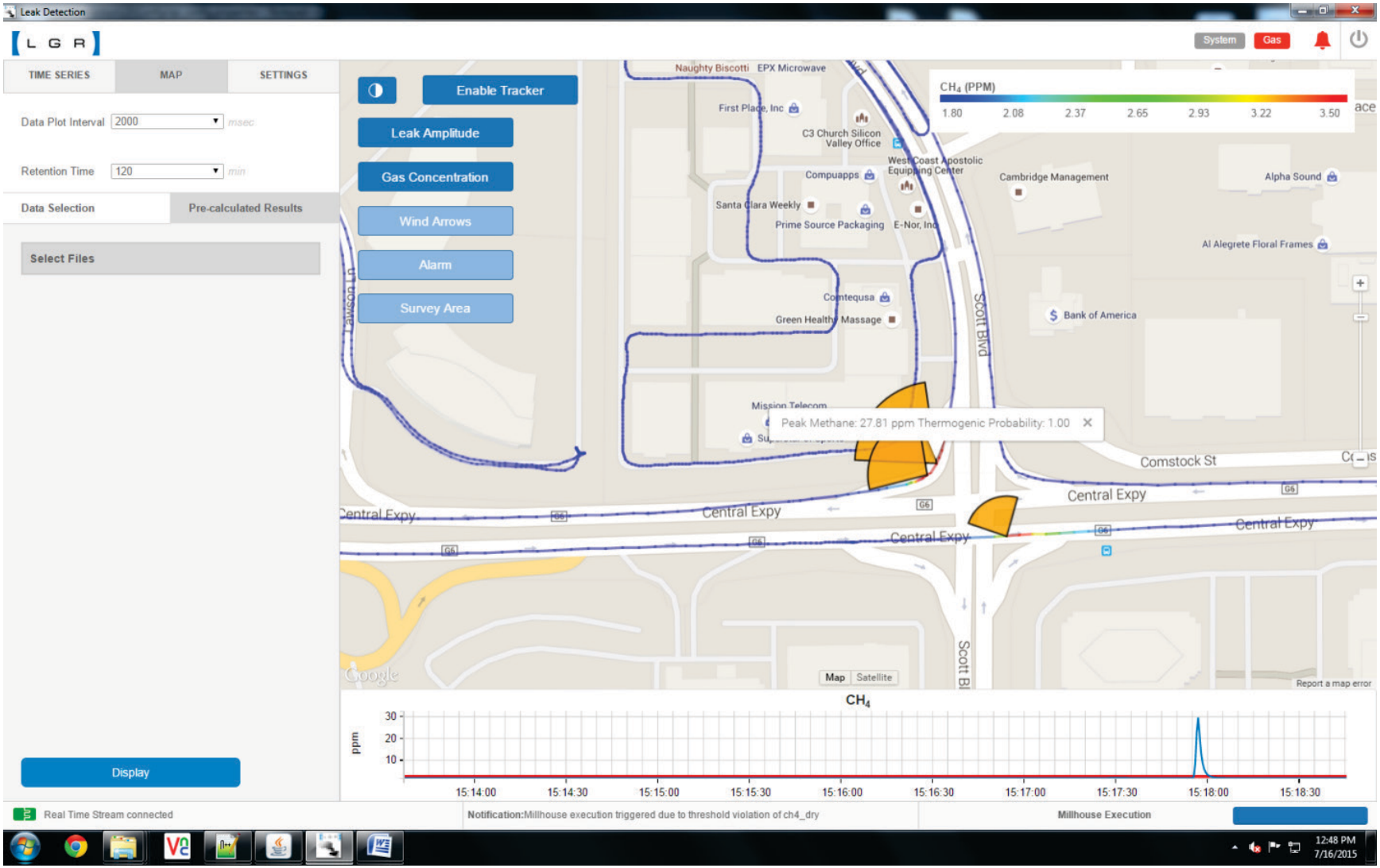
Sample Dataset

Expanded View of Leak Locations

- **3 distinct methane leak locations**
- **Simplified leak detection algorithm**
- **Use ethane measurements to identify natural gas leaks**

Sample Dataset

Leak Location Identification



Ongoing Development

- **Improved natural gas diffusion models**
  - Estimate leak distance
  - Account for gas diffusion under real-world conditions
- **Continue to improve user interface based on customer feedback**
- **Further improve ethane detection sensitivity**
  - Attribute small methane peaks
- **Integration with GIS**
  - Pipeline data

Commercial Details

- **Cost-Competitive**
  - Cost per identified leak is very low
  - Minimized false-positives due to simultaneous methane/ethane measurements
  - Highly cost-competitive versus other mobile technologies
- **Demonstration field tests are welcome**
- **Data is owned by the customer**
  - LGR provides complete hardware solution
  - Data is acquired, held, and owned by the customer
  - LGR offers software solutions to analyze the data and identify leak locations
- **LGR solution can be tailored to customer need**
  - Optional components include sonic anemometer, vehicle communication, and networked data center

Questions?

Manish Gupta, Ph.D.
Chief Technology Officer
Los Gatos Research

67 East Evelyn Ave, Suite 3
Mountain View, CA 94041
Direct: 650-965-7772 ext 226
Email: m.gupta@lgrinc.com

[L G R]
Los Gatos Research
A MEMBER OF THE ABB GROUP

www.lgrinc.com