# NARUC

*Summer Committee Meetings*

# Committee On Gas

**Transform the Energy Industry with New Gas-fueled Technologies**

SENSIT Technologies

**Innovative Detection Solutions**

**Energy - HVAC - Industrial - Safety**

# Product Development and Commercialization

## What does it take to deliver something new?

NARUC Gas Panel
July 26, 2016

Presented by:

J. Scott Kleppe

President

Sensit Technologies

SENSIT Technologies

Founded in 1980, Sensit Technologies serves the Natural Gas, Propane, HVAC, and Fire Service markets in 40 countries

Sensit products are designed, manufactured, and serviced at our factory in Valparaiso, Indiana USA

SENSIT Technologies brands include Sensit, Trak-It, Gas-Trac, Smart Cal, Ultra-Trac

ISO 9001:2008 certified company

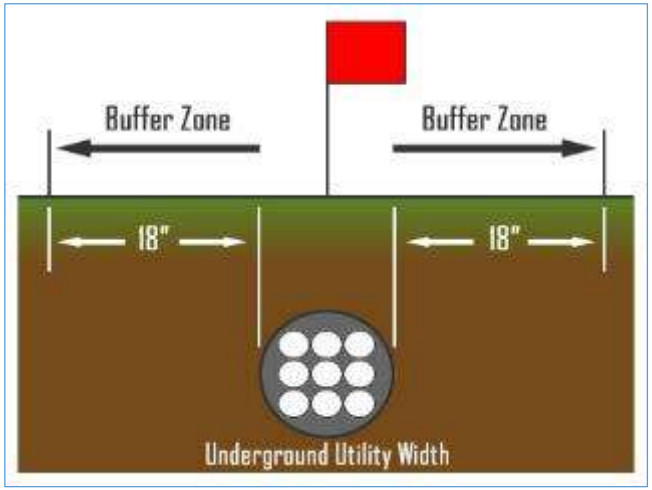
SENSIT Technologies

# The Process:


SENSIT Technologies

# Customer Need:

Locating underground pipe not locatable by traditional methods




SENSIT Technologies

# Product Development Goals

- Locate unmarked pipe
  - Gas
  - Water
  - Sewer (cross bores)
  - Electric conduit/cable
- Locate pipes under soil, grass, concrete, asphalt, and other ground covers
- No utility access required
- Easy to operate
- Detect multiple pipes

# Business Case Drivers

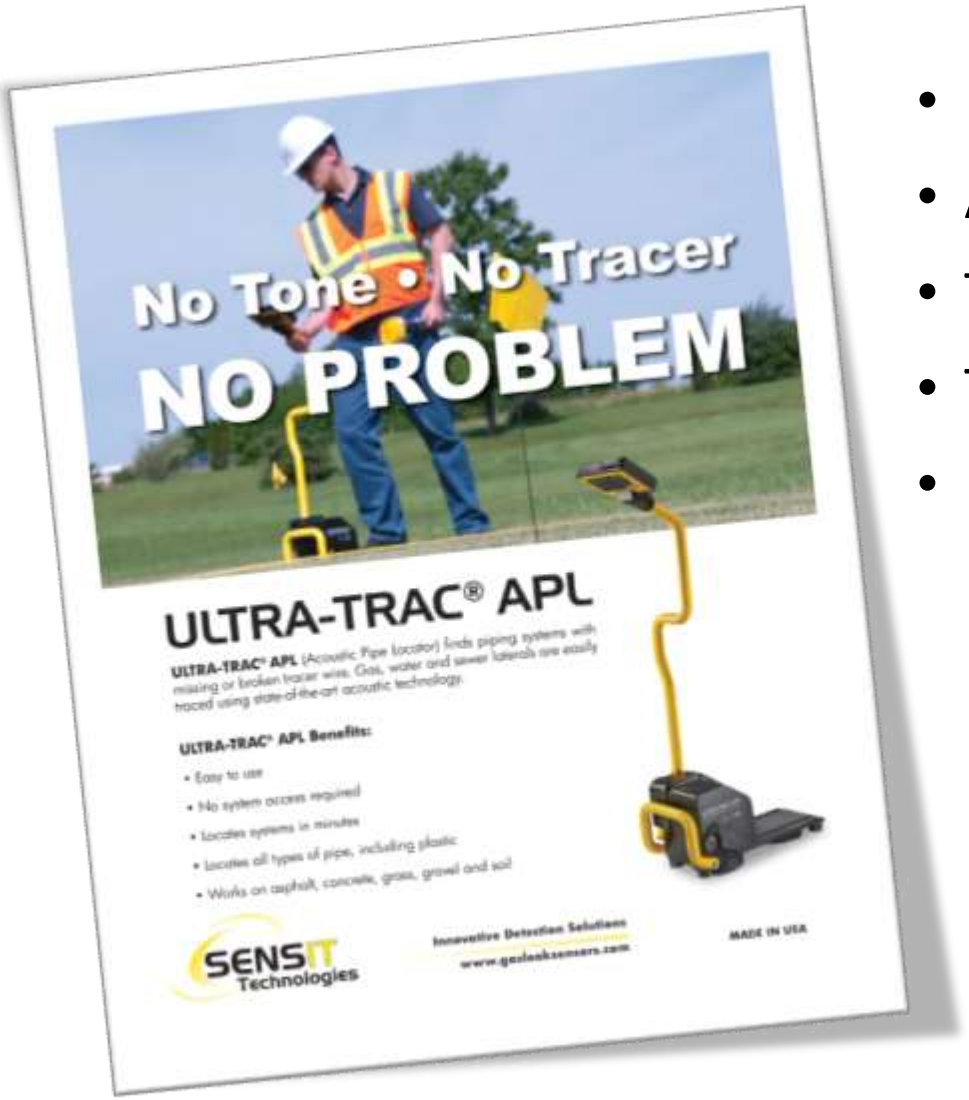

- State-of-the-art acoustic technology
- Accurately locate unmarked buried pipe
- Find plastic pipe with broken or missing trace wire
- Enhanced 3D pipe mapping

SENSIT Technologies

# Research/Development

- Project launched in late 90's
- Funded through GTI & OTD
- Significant utility support
- Licensed to SENSIT Technologies for commercialization in April, 2011 by GTI
- Market introduction in December, 2012
- Sensit investment $1.4M

# Product Launch




- Promotional Materials
- Advertising
- Training of sales staff
- Training customer service
- Demo equipment

SENSIT Technologies

# Legal Review

- Prior Art
- Patent Issuance
- Third party Certifications
- Other Liabilities

SENSIT Technologies

# Results

## - finding pipes with no trace wire




New Mexico

United Kingdom

# APL at Beijing Gas

Beijing Gas used the Ultra-Trac APL to locate a leaking pipe in one of its busy downtown neighborhoods. The APL quickly and accurately located the unmarked pipe, allowing them to dramatically decrease the size of the excavation and improve the speed and efficiency of repairs.

SENSIT Technologies

SENSIT Technologies

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# Thank you for the opportunity

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**Transform the Energy Industry with New Gas-fueled Technologies**

# Transforming the Energy Industry with New Gas-Fueled Technologies

t

Panel for NARUC's Committee on Gas

Daphne D'Zurko, NYSEARCH/NGA

ddzurko@northeastgas.org

www.nysearch.org

NYSEARCH

Northeast GAS ASSOCIATION

# NYSEARCH/NGA Technology Development Program

- (20) regulated gas company members from around North America; numerous R & D contractors
- Voluntary RD & D program with expenditures that range from $3.0 MM to $4.5 Million annually and with program currently growing
- On behalf of our members, NYSEARCH-developed and tested technologies are licensed to commercial partners
- Several commercial products from NYSEARCH in use in gas operations and engineering capacities (Heath's RMLD, Explorer/PipeTel Inspection Platforms, etc)

**NYSEARCH RANGE™ Tool**

RANGE™ stands for "Range of Acceptability for Natural Gas Equipment." NYSEARCH completed a comprehensive, geographically diverse study that determines the impacts of varying gas compositions on performance of installed residential appliances. The NYSEARCH RANGE™ Tool is now available in an easy-to-use online format.

# Existing Sensors for Residential Methane Detection leads to drive for new technology

- A number of sensors available in the market
  - All are electrochemical sensors
  - Most are dual- or multi-sensors; programmable level for detection threshold but typically set at 25% LEL
  - Price ranges from ~$30 to $90
  - Hard wired with battery back-up
  - Some are offered with wireless option


Methane + Propane


Methane + CO

Bosch Methane Wireless

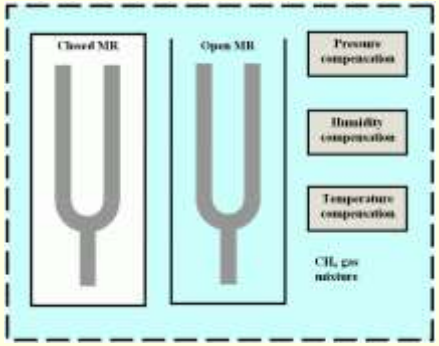
# NYSEARCH/ANI MR Methane Detector – why different

- Physical sensor; not electrochemical
- Designed and developed based on proven micro-resonator technology

- Specifications
  - Range: 0 – 100% $CH_4$
  - Lower Detection Limit (LDL): 0.25%
  - Standard AC power; battery back-up
  - Rugged, reliable, accurate
- Currently in pre-commercialization phase

# NYSEARCH/ANI MR Methane Detector – why different

- Developed based on proven micro-resonator technology
- Two tuning forks; one in a vacuum, one exposed to ambient
  - The viscosity of the gas that the second tuning fork is exposed to affects its natural frequency
  - This change allows us to identify the gas it is exposed to and determine its concentration



# NYSEARCH/ANI MR Methane Detector – why different

- Physical sensor; not electrochemical
  - No false alarms when exposed to common industrial and household chemicals
  - Chemicals tested
    - Methane
    - Acetone
    - Paint thinner
    - Bleach
    - Permanent glue
    - Furniture polish
    - Refresher
    - Spray deodorant
    - Ethanol
    - Ammonia
    - Duster
    - Detergent + bleach
    - Hairspray
    - Oven cleaner
    - Bathroom cleaner

# Stages of Testing

- Lab testing of engineering prototypes
- Lab testing of pre-commercial prototypes
- Funders testing of pre-commercial prototypes
- Prospective commercializer testing of pre-commercial prototypes
- UL testing of commercial prototype (on-going)
- Pilot Testing (plans being implemented)
- Need for market acceptance study?

# Plans for Technology Transfer and Commercialization

- Complete engineering analyses and independent validations
- Plan and implement pilot tests
- Develop information and supporting materials for manufacturers/members who are supporting implement
- Solicit prospective commercializers
- Conduct testing and negotiations with serious bidders

# Vision of Methane Detector Use in Future

- Several jurisdictions supporting potential mandates for residential methane detection
- NYSEARCH's members/LDCs looking to support reliable technology and to help define standards for installation
- UL Standard 1484 for residential methane detection to be upgraded to include standards for higher resolution on threshold for alarm and for standardization of labeling and usage

# NARUC

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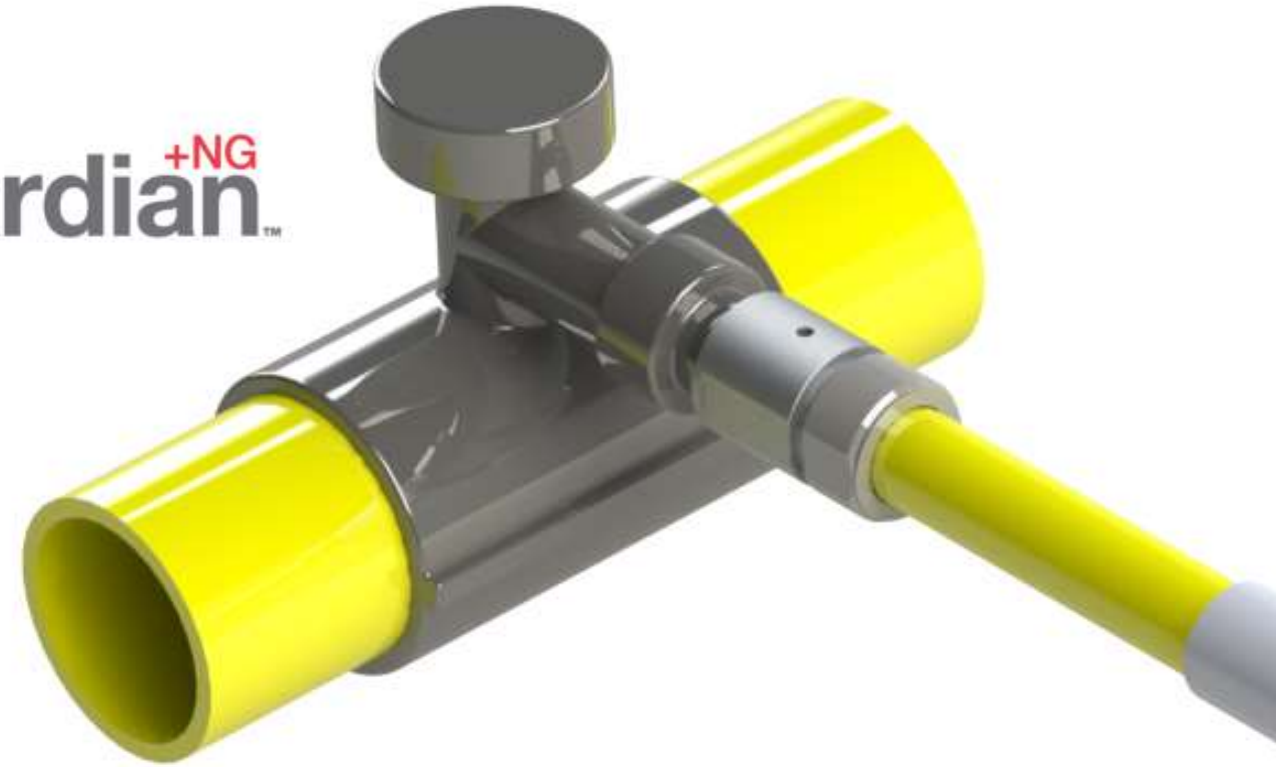
# Committee On Gas

**Transform the Energy Industry with New Gas-fueled Technologies**

LORAX SYSTEMS INC.

LineGuardian +NG™



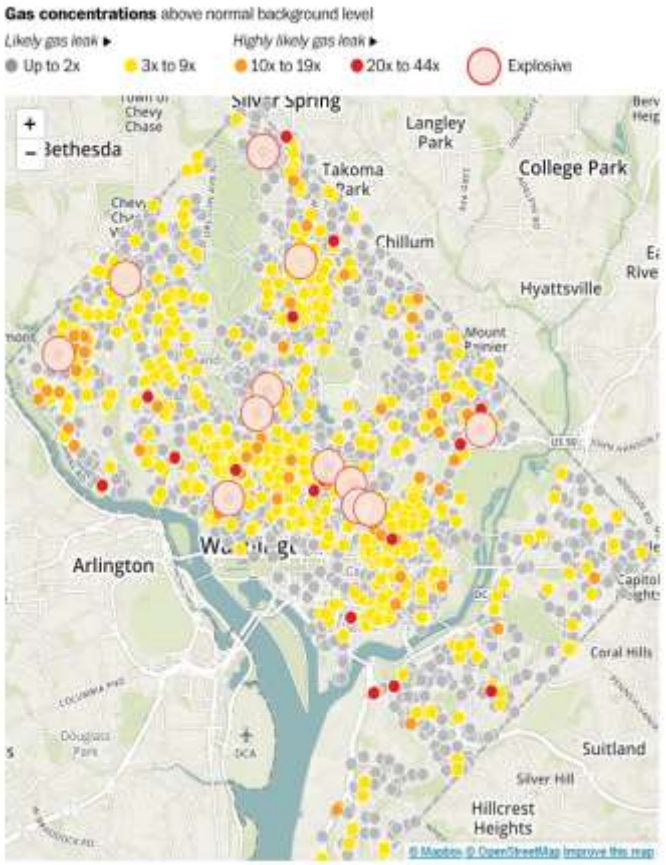
# Company

- Headquartered in Halifax Nova Scotia
  - *Incorporated in May 2010*
- Engineering & Product Development
  - *Fluid control and management*
- Current Markets
  - *Liquid fuels for commercial and consumer applications in North America*
    - Patented
    - Certified
    - In service

LORAX SYSTEMS INC.

# Project Definition

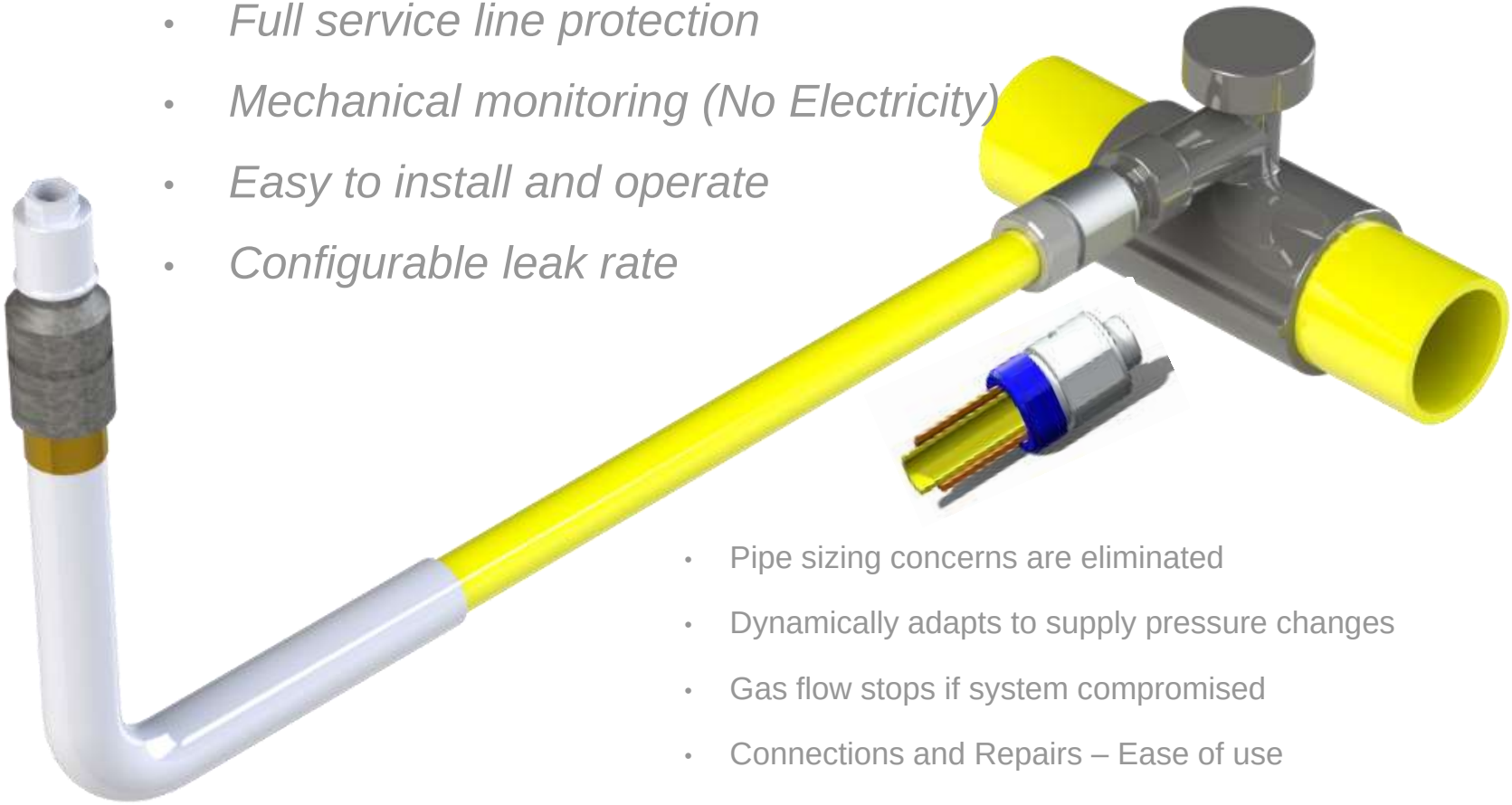
- Objective
  - *To develop an intelligent safety shutoff device that will shut off the flow of gas in the event of line or meter set damage or failure.*
- Technology
  - *Must shut off the flow of gas when a leak threshold is exceeded.*
  - *Must permit small leaks below a specified threshold*
  - *Must adapt to supply pressure changes.*
  - *Must be mechanical – no electrics*
- Implementation
  - *Ease of installation, service and monitoring*
  - *Cost effective*




# Our Vision

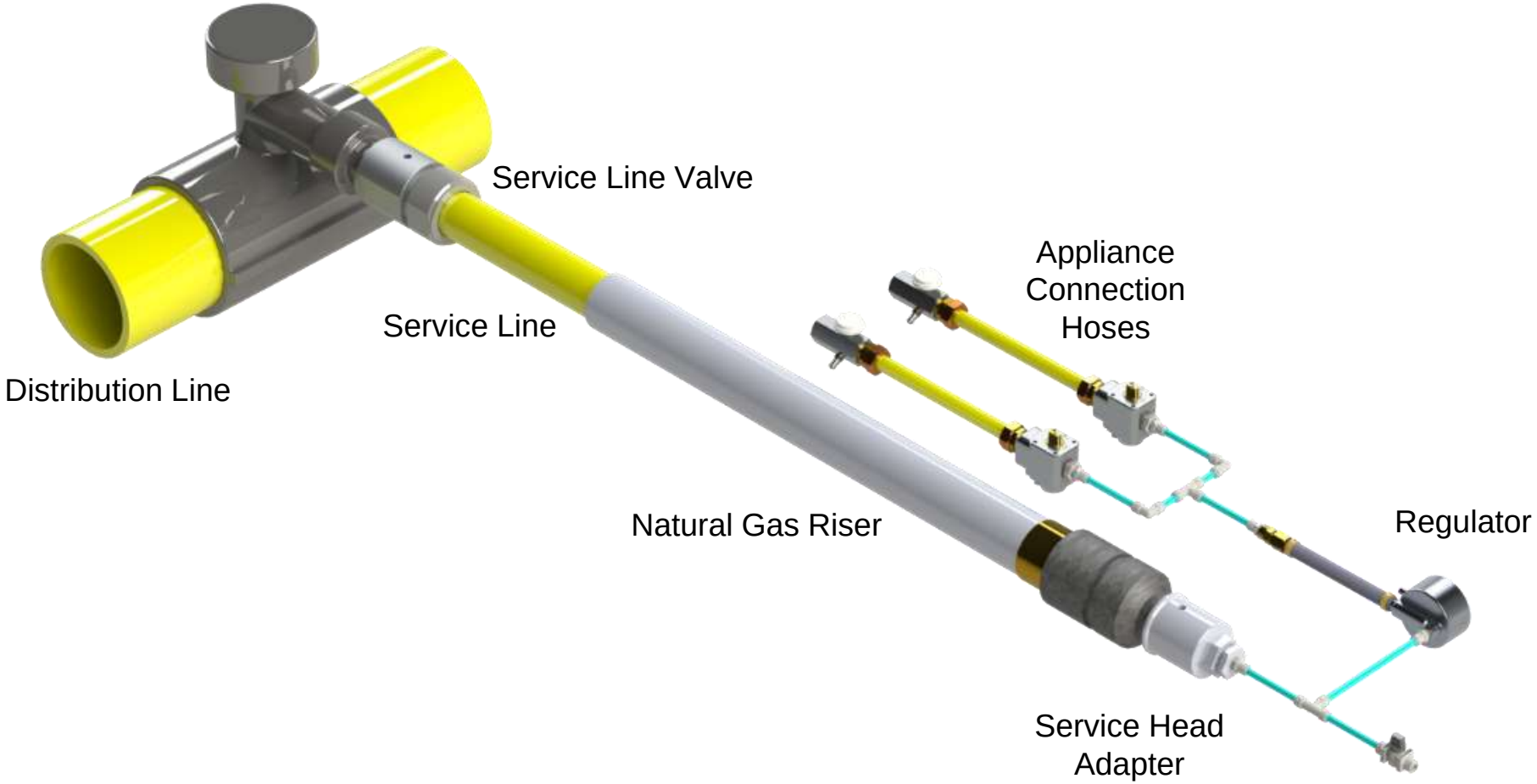
# Project Deliverables

- Full working prototype
  - *Full service line protection*
  - *Mechanical monitoring (No Electricity)*
  - *Easy to install and operate*
  - *Configurable leak rate*

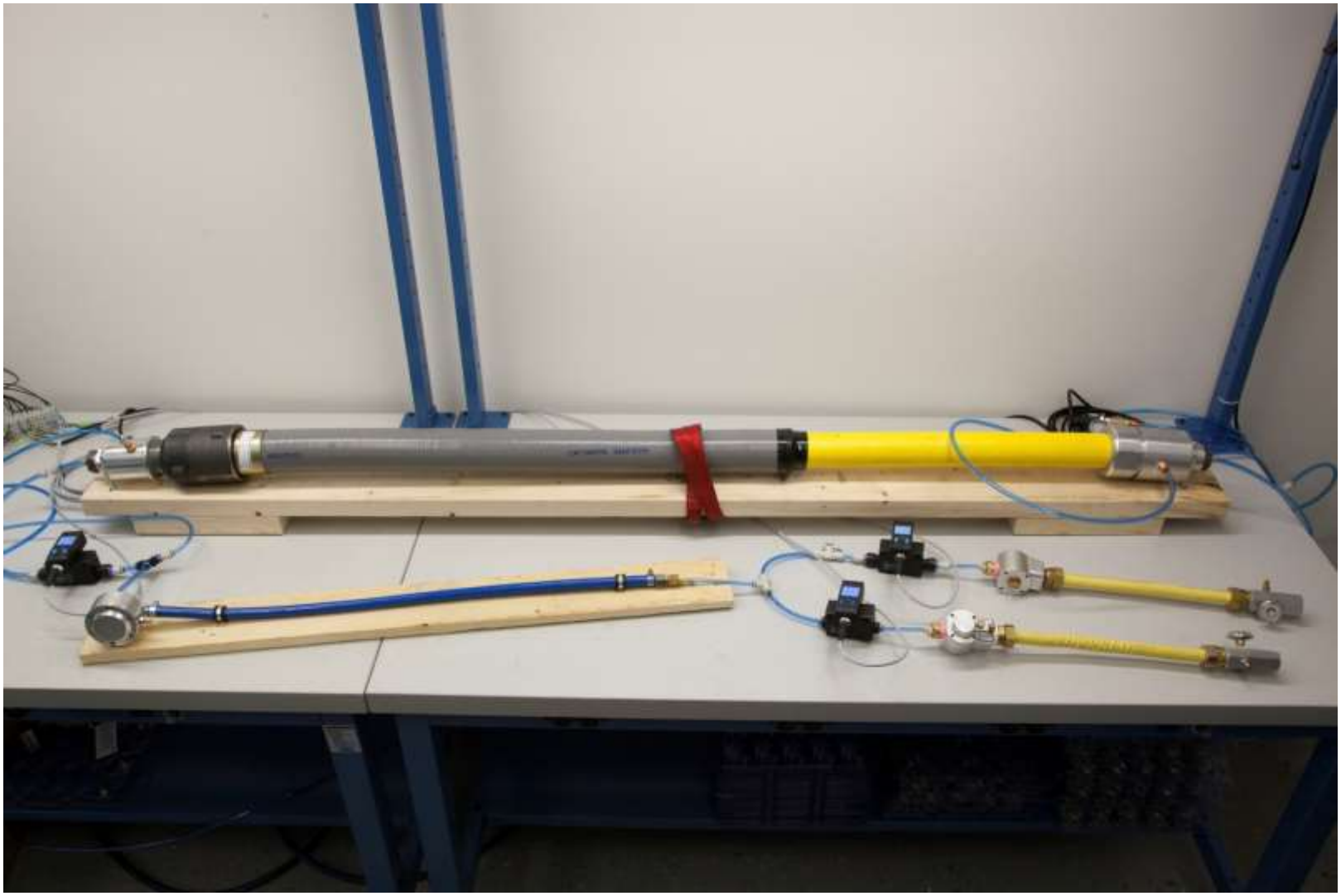


- Pipe sizing concerns are eliminated
- Dynamically adapts to supply pressure changes
- Gas flow stops if system compromised
- Connections and Repairs – Ease of use
- Electrofusion preferred means of connection

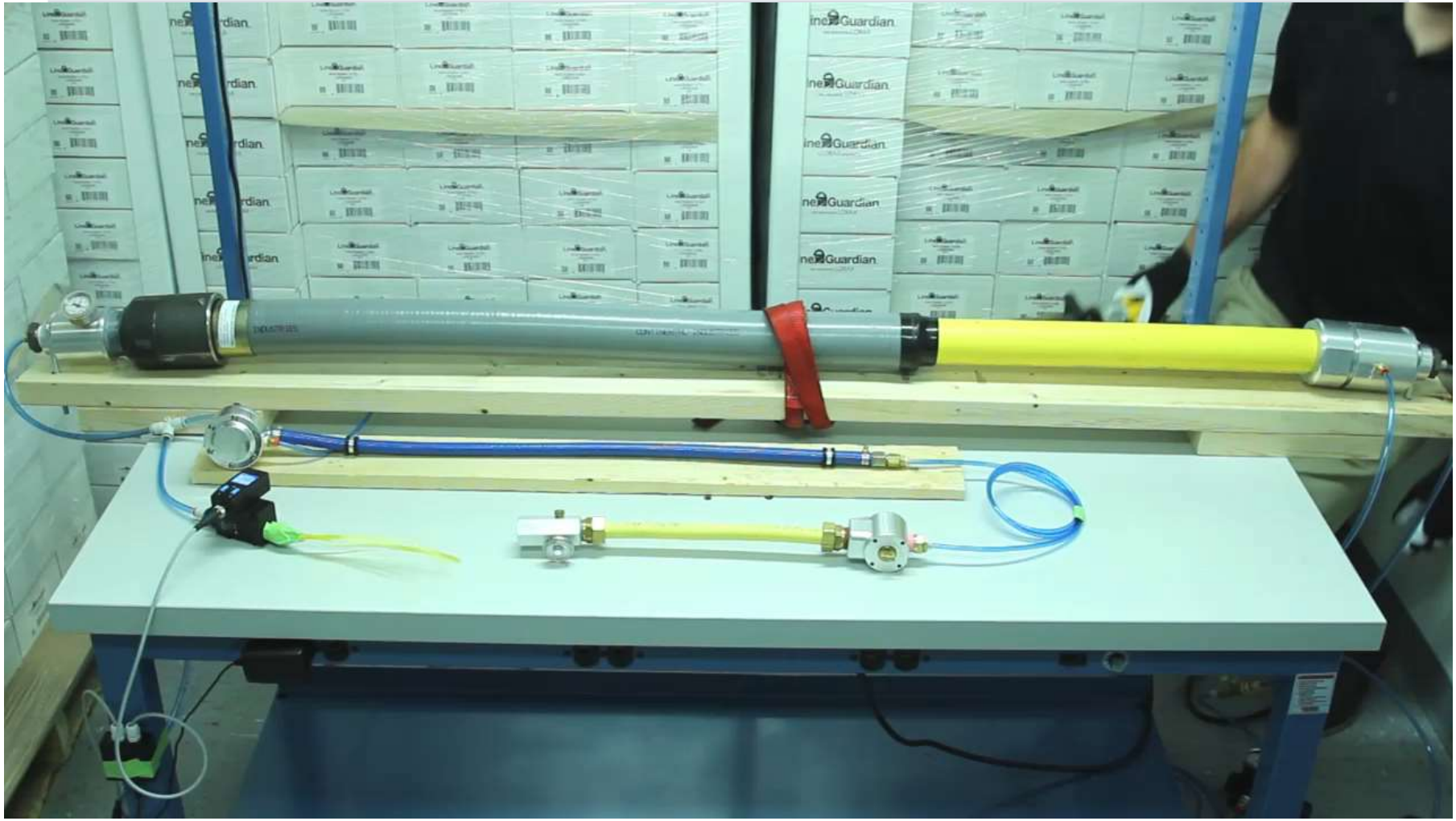
# System Prototype



# Prototype Demonstration

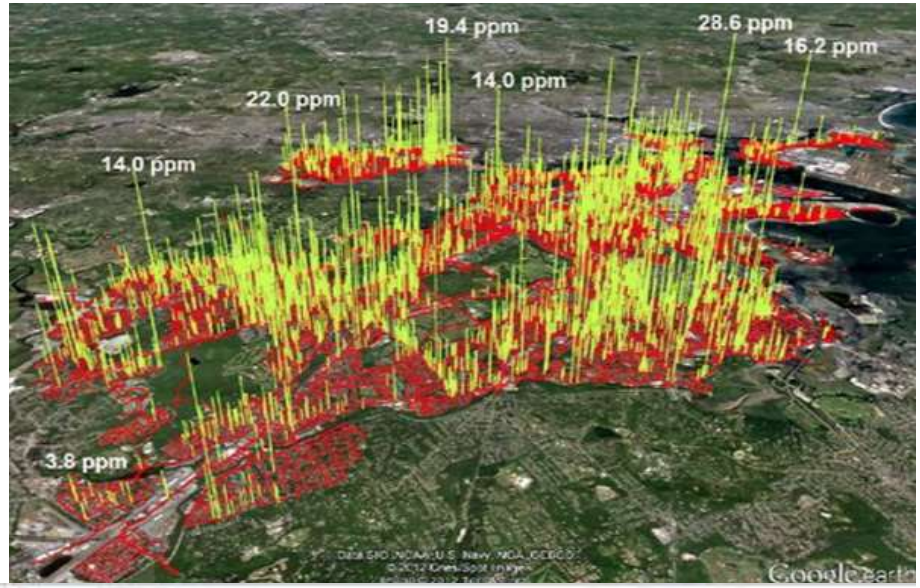


# Demonstration



# Closing Remarks

- Testing will begin at GTI this fall
- Pilot tests will begin in the spring of 2017
- Integration with other technologies to begin early 2017

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**Transform the Energy Industry with New Gas-fueled Technologies**

the Energy to Lead

# Cybersecurity Collaborative

NARUC Gas Committee Panel

Transform the Energy Industry with New Gas-fueled Technologies

July 26,  2016

gti

# CYBERSECURITY COLLABORATIVE

## DHS S&T Department of Homeland Security Science & Technology

- FUNDING = 50%
- TECHNICAL SUPPORT (ex. TTP Transition to Practice Program)
- ACCESS TO LABS & TESTING FACILITIES

## SRI International

- TECHNICAL EXPERTISE
- SME'S

## OTD Operations Technology Development NFP

- FUNDING = 50%
- MEMBER SUPPORT (10)
- PROJECT CHAMPIONS

## GTI Gas Technology Institute

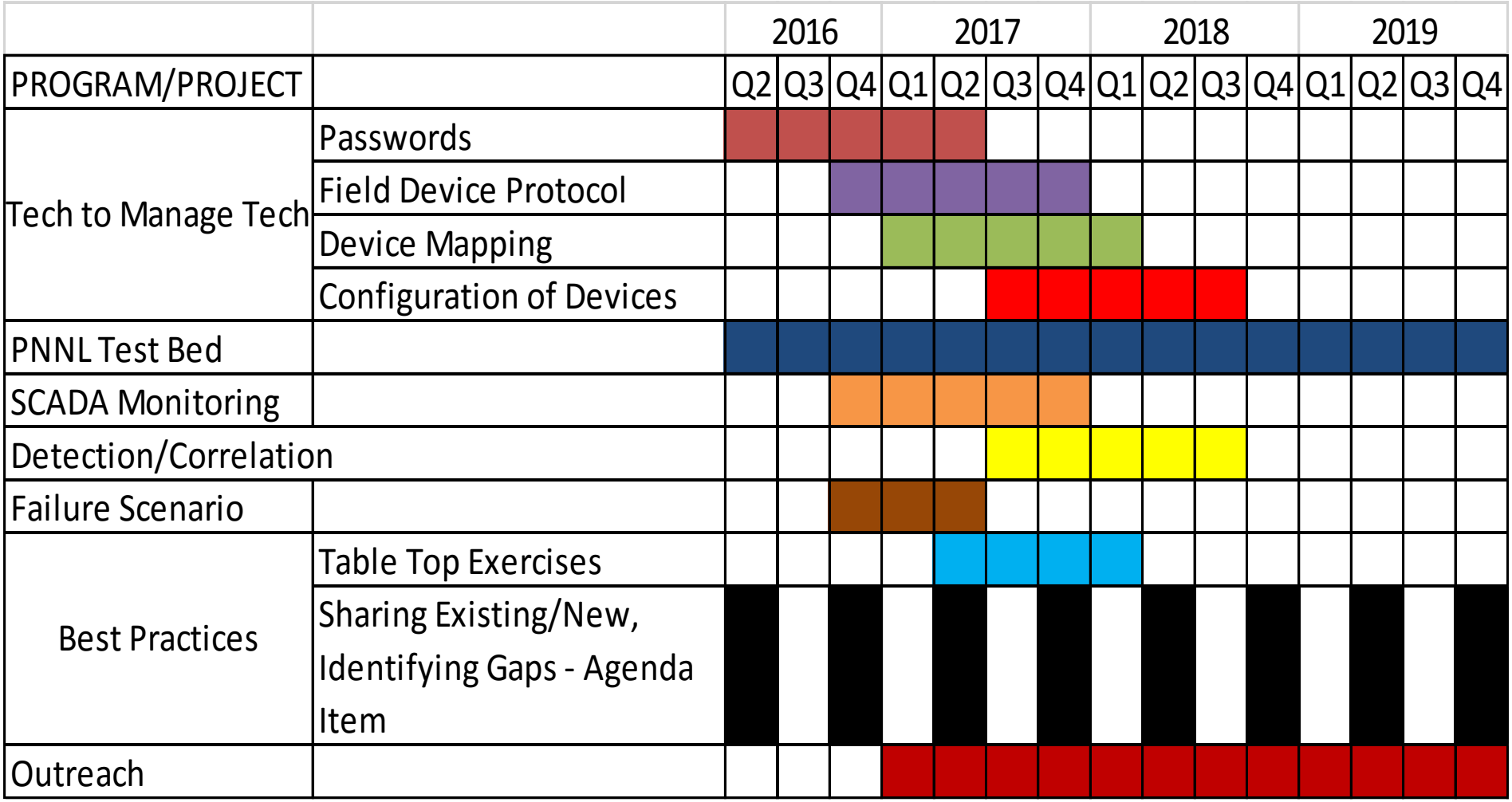
- PROGRAM ADMINISTRATION
- OUTREACH
- MEMBERS FORUM – TEAM SITE

Objective – Address high priority cybersecurity technical issues through a multi-year initiative of outreach and education, technology evaluation and transfer



gti

# Program


2016
2017
2018
2019
PROGRAM/PROJECT
Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
Tech to Manage Tech
Passwords
Field Device Protocol
Device Mapping
Configuration of Devices
PNNL Test Bed
SCADA Monitoring
Detection/Correlation
Failure Scenario
Best Practices
Table Top Exercises
Sharing Existing/New, Identifying Gaps - Agenda Item
Outreach

# Program/Project Areas

- Detection/Correlation
  - Security as part of new projects
  - Impossible to prevent
- Technology to Manage Technology (Passwords)
  - Password management/control
  - Auditable
  - Coordination between IT/OT
  - Authentication
- SCADA Monitoring
  - Real information – data integrity
  - Content – experience based judgment
  - Holistic monitoring – gradual/catastrophic change
  - Threat, risk, impact, performance – updated over time

# Best Practices

- Cloud Management
- Coordination Between Physical and Cybersecurity
- Data – Work Toward One Set
- Dispatch Environment
- Event Correlation
- Interdependency/Cascading Threats
- Odorizer Overload
- SCADA
- Supply Chain Integrity
- Training

# Contact Information

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  - 312/320-9407
  - James.marean@gastechnology.org

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# Committee On Gas

**Transform the Energy Industry with New Gas-fueled Technologies**

# ARPA-E's MONITOR Program

## *Technology to Quantify Methane Emissions*

*Nate Gorence*
*Technology-to-Market Advisor*

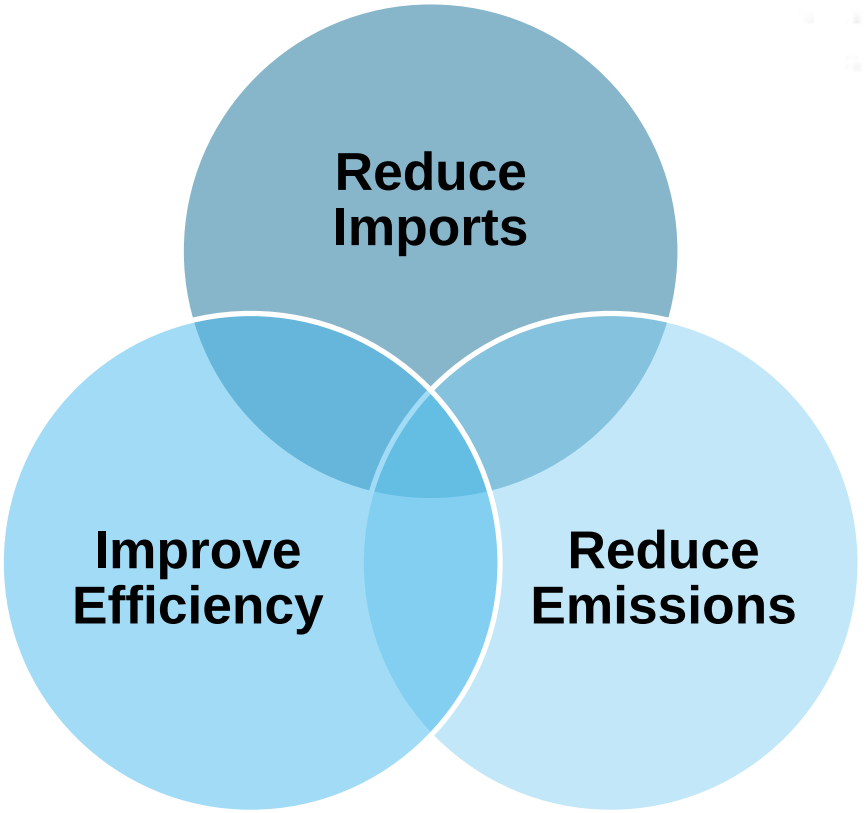
arpa·e
CHANGING WHAT'S POSSIBLE

# The ARPA-E Mission

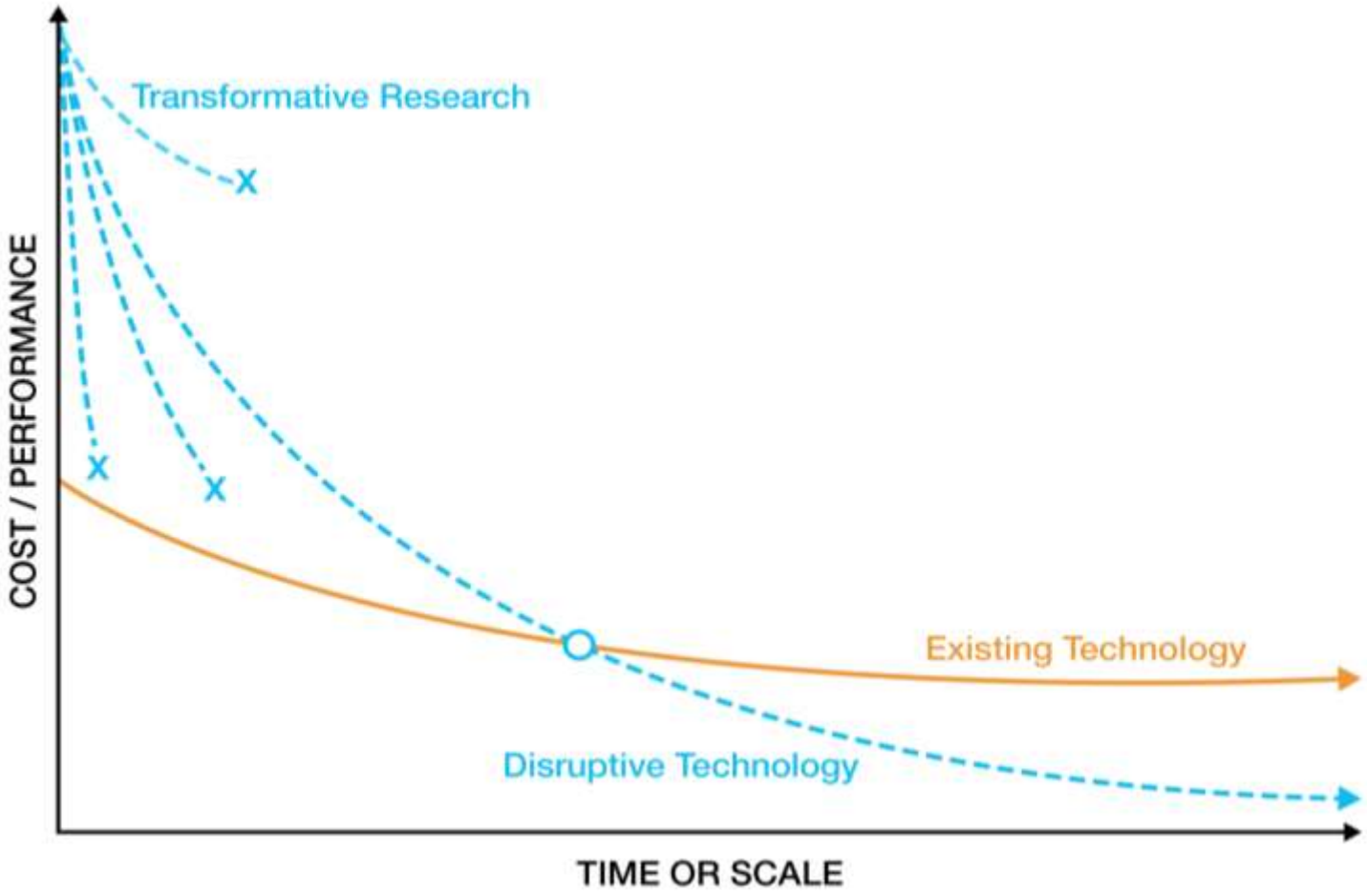
**Catalyze and support the development of transformational, high-impact energy technologies**

**Ensure America's**

- Economic Security
- Energy Security
- Technological Lead



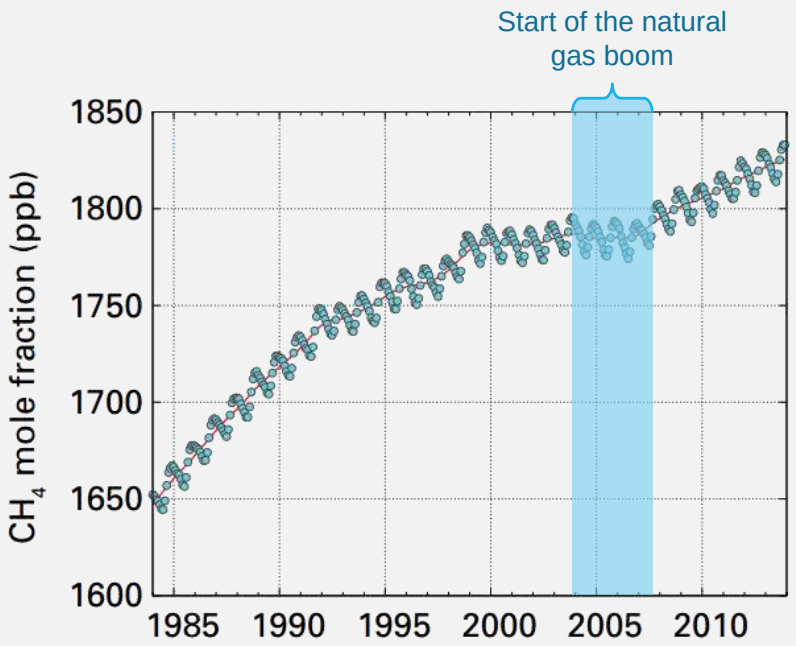
# Creating New Learning Curves



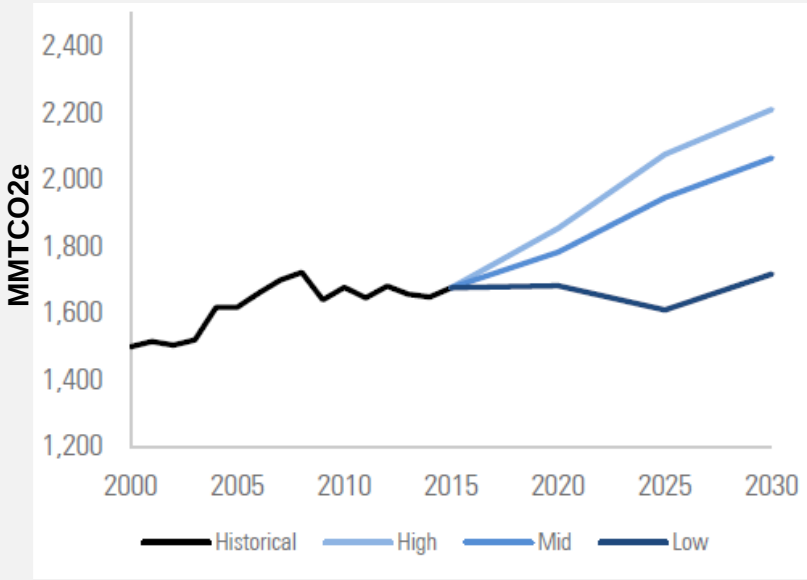
# Methane: A Growing Global Challenge

Atmospheric methane concentrations have increased about 10% since the mid-1980s and global emissions are expected to grow an additional 20% by 2030

**Atmospheric Methane Concentrations (1985-Present)**



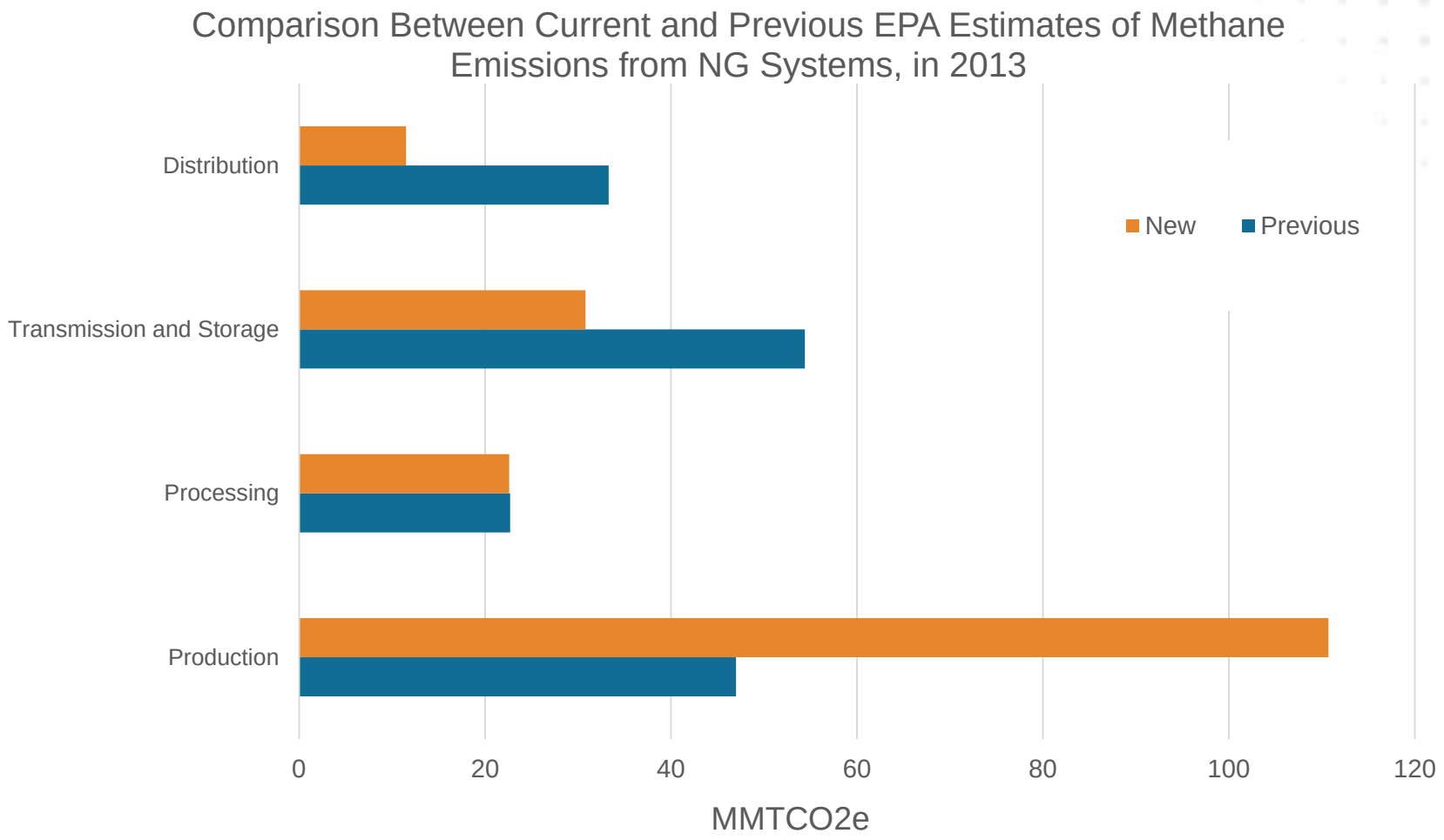

**Global oil and gas methane emissions under three production scenarios, 100-year GWP**




Source: WMO Greenhouse Gas Bulletin (Sept. 2014), Rhodium Group, Untapped Potential (April 2015)

# The U.S. Natural Gas System

# More Refined Emissions Data




Source: EPA GHG Inventory (2016)

“YOU CAN'T MANAGE WHAT YOU DON'T MEASURE.

- W. Edward Deming

“to measure is to know – if you cannot measure it, you cannot improve it”
– Lord Kelvin

# Today's Methane Sensing Solutions

?

- Ability to Locate Leaks ✓
- Low Cost ✗
- Ability to Quantify ✗

# MONITOR's Methane Detection Solutions

$CH_4$
SCFH

- Ability to Locate Leaks ✓
- Low Cost ✓
- Ability to Quantify ✓

# MONITOR Metrics & Targets

| | |
|---|---|
| Sensitivity | 1 ton per year (6 standard cubic feet per hour) |
| Economical Cost | $3,000 per site per year (for basic functionality) |
| Actionable Information | 90% methane leakage reduction with a 90% confidence level |
| Quantification | Able to estimate mass flow rate within 20% margin of error |
| Leak Location | Able to estimate location within 1 meter |
| False Positives | No more than 1 per year |
| Communications | Transmits results wirelessly to remote receiver |
| Enhanced Functionality | Methane selectivity, speciation capability, thermogenic/biogenic differentiation, continuous measurement, enhanced stability |

# Complete & Partial Solutions to Detection

## Complete measurement systems: *6 projects*

- Systems that include:
  1) Methane emission sensing
  2) Leak rate characterization and data analytics
  3) Provisions for data quality control
  4) Digital communication
  5) Enhanced functionality

parc, A Xerox Company — Palo Alto, CA

PSI Physical Sciences Inc. — Andover, MA

AERIS Technologies — Redwood City, CA

BRIDGER PHOTONICS — Bozeman, MT

IBM — Yorktown Heights, NY

REBELLION PHOTONICS — Houston, TX

## Partial measurement systems: *5 projects*

- Nascent technologies that may be too early in the development process for incorporation into a complete system
- Could significantly contribute to meeting system-level objectives
- Primarily envisioned as advances in detector technology or data analytics

THORLABS — Jessup, MD

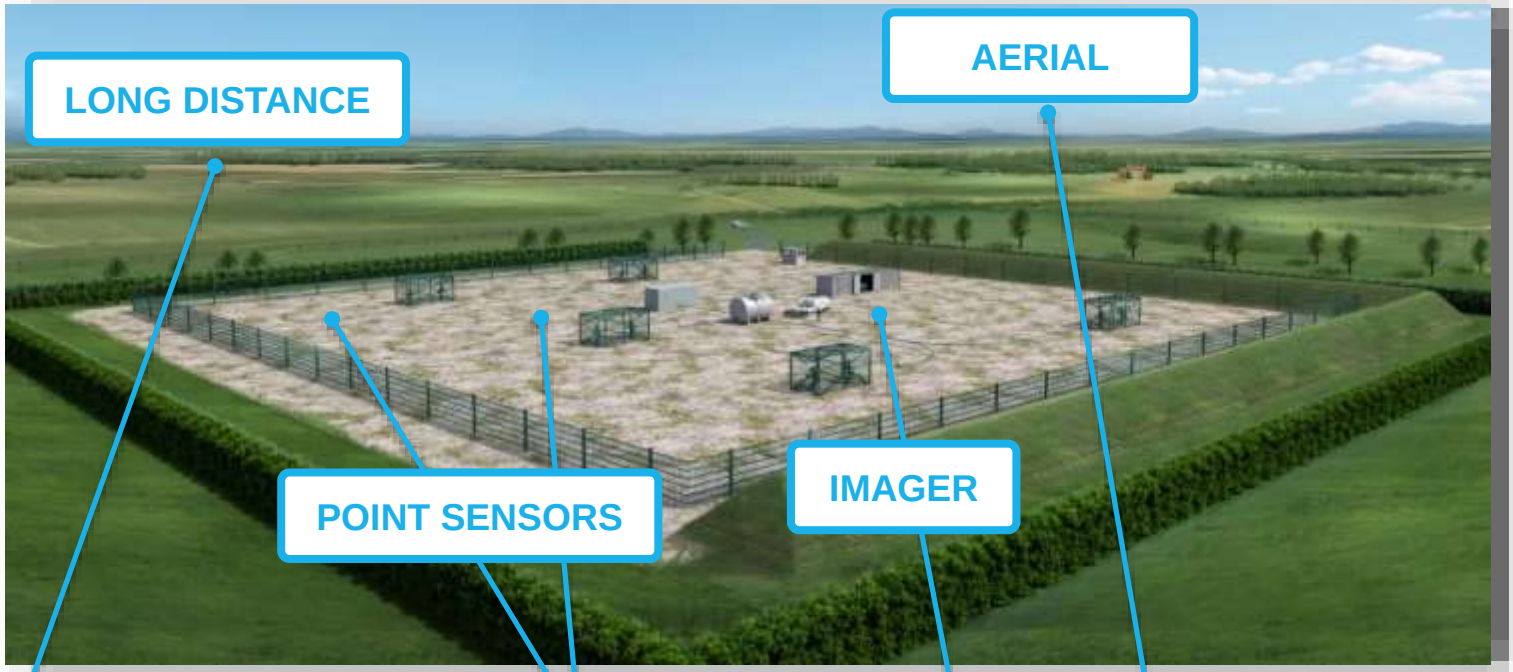
LI-COR — Lincoln, NE

GE — Niskayuna, NY

Duke University — Durham, NC

University of Colorado Boulder — Boulder, CO

# The Portfolio: Four Approaches




FIXED

University of Colorado Boulder

parc A Xerox Company

IBM

AERIS TECHNOLOGIES

LI-COR

MOBILE

Duke UNIVERSITY

REBELLION PHOTONICS

BRIDGER PHOTONICS

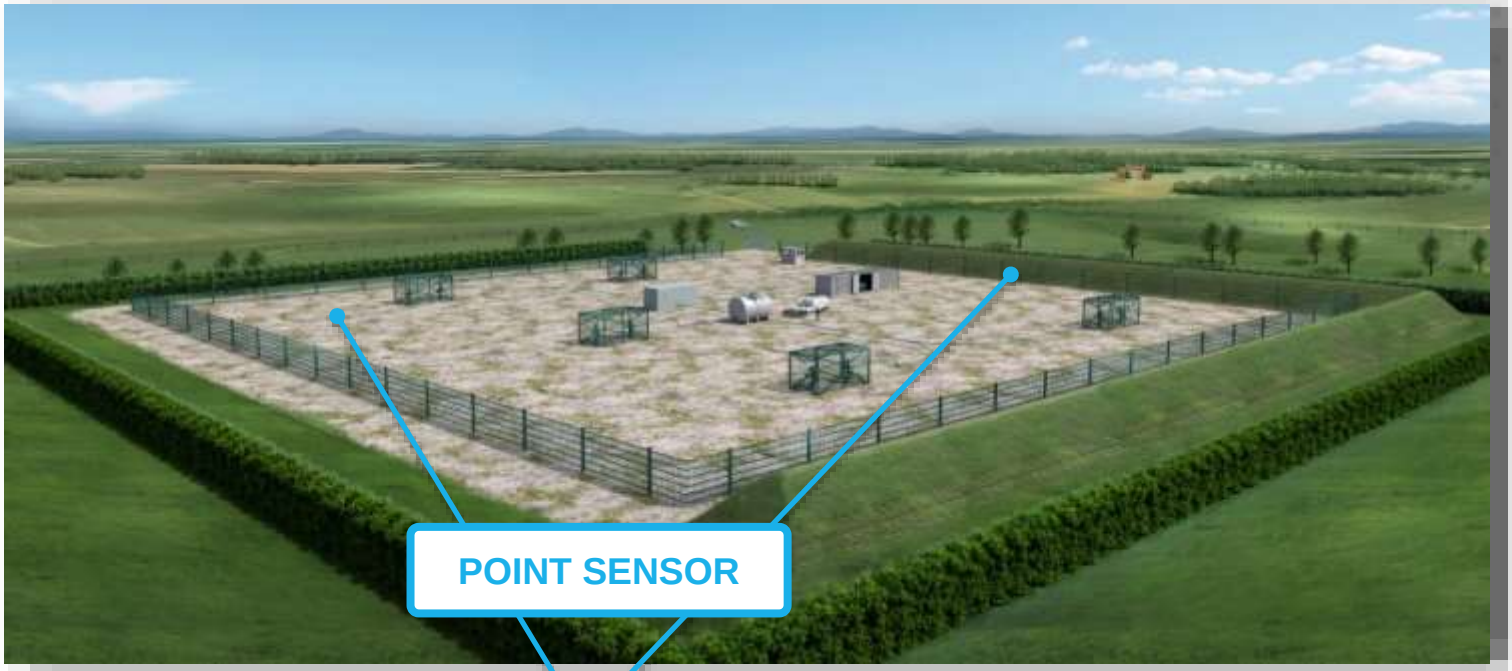
Physical Sciences Inc.

ENABLING

THORLABS

*Image courtesy of Cuadrilla Resources*

# Portfolio:
# Five Point Sensing Technologies




University of Colorado Boulder

parc A Xerox Company

IBM

Duke University

BRIDGER PHOTONICS

THORLABS

AERIS Technologies

LI-COR

REBELLION PHOTONICS

Physical Sciences Inc.

FIXED

MOBILE

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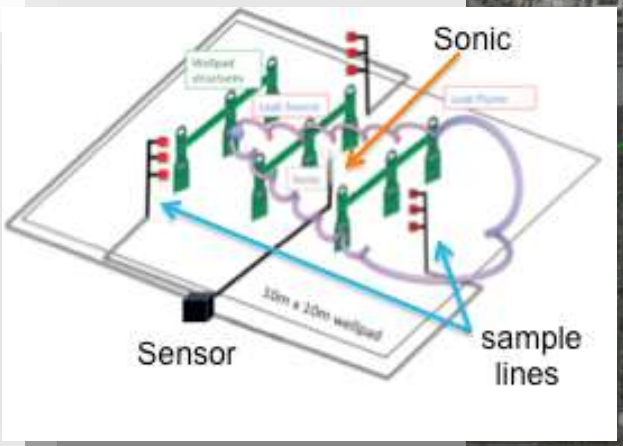
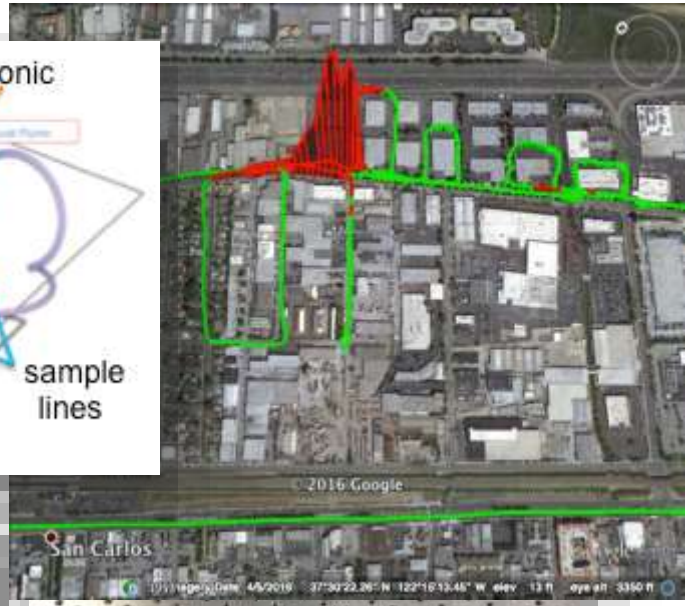
*Image courtesy of Cuadrilla Resources*

# Miniature, High Accuracy Tunable Laser Spectrometer for $CH_4/C_2H_6$ Leak Detection




**PROJECT HIGHLIGHTS**

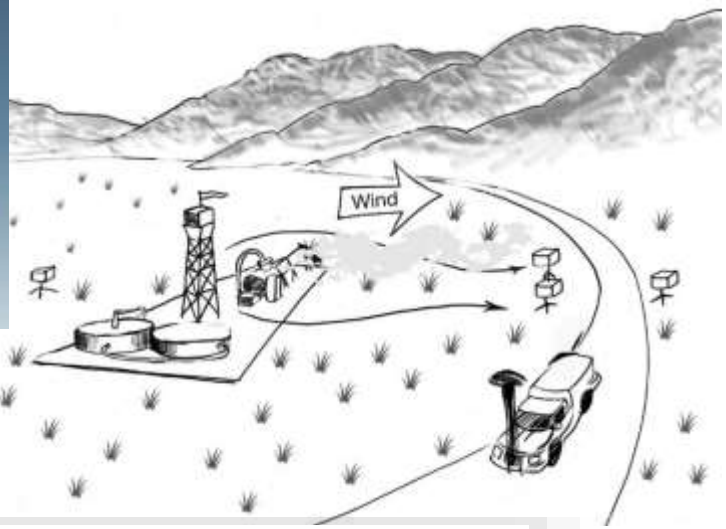
- Enables ppb/s sensitivity via simple and robust direct absorption spectroscopy
- Discriminates biogenic vs. thermogenic emissions
- 1/15th the size and power of existing in-situ laser sensors
- 100x+ more sensitive/accurate than legacy FID/NDIR
- Compatible with other industry applications that require high accuracy, real-time analyses (e.g. process control, CEMS, environmental/GHG monitoring)

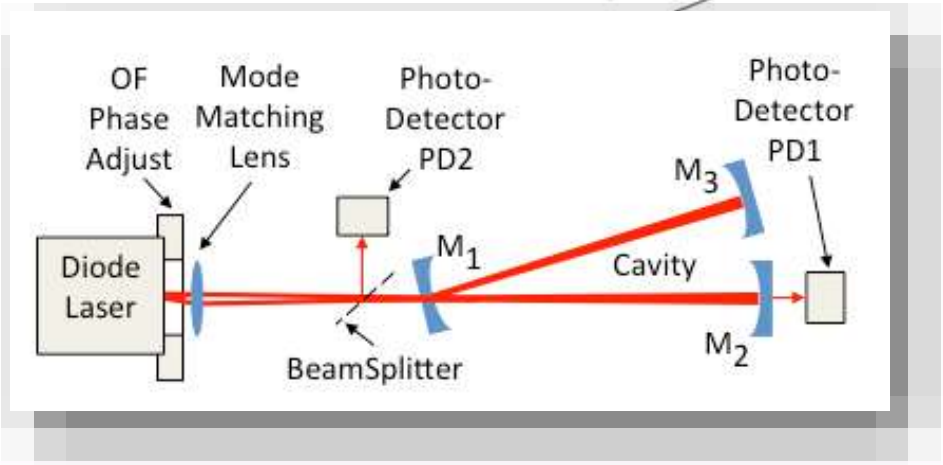
**AWARD AMOUNT:** $2.4 million

**PROJECT PARTNERS:** Los Alamos National Laboratory, Rice University

# Laser Spectroscopic Point Sensor for Methane Leak Detection

LI-COR®



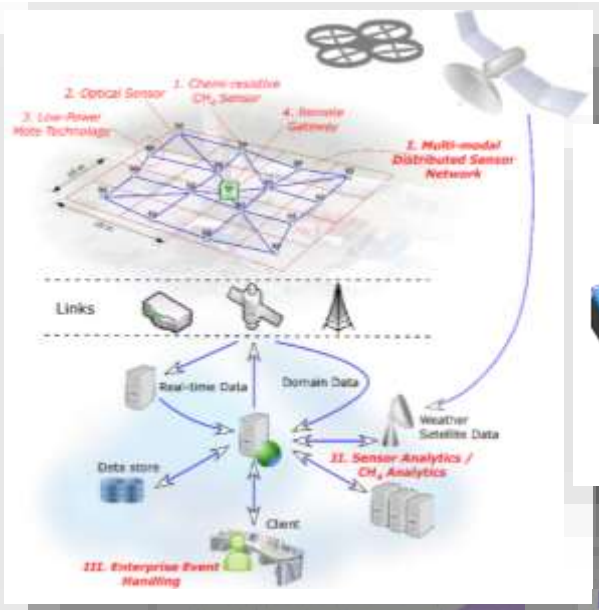

**PROJECT HIGHLIGHTS**

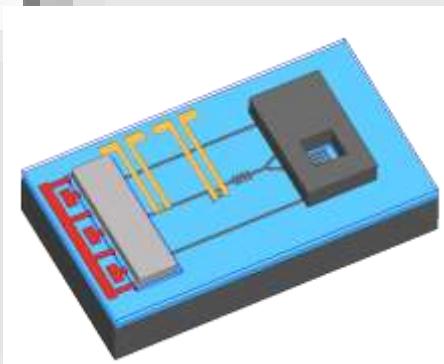
- Performance of state of the art cavity-based point sensors at reduced cost
- High sensitivity, selectivity, and stability measurements with low maintenance
- Closed path instrument is weather-proof, high-performance, and low power consumption
- Suitable for continuous or intermittent stationary and mobile applications
- Advanced spectral models and high instrument stability allow unattended operation
- Advanced manufacturing and novel design/alignment enable cost reductions

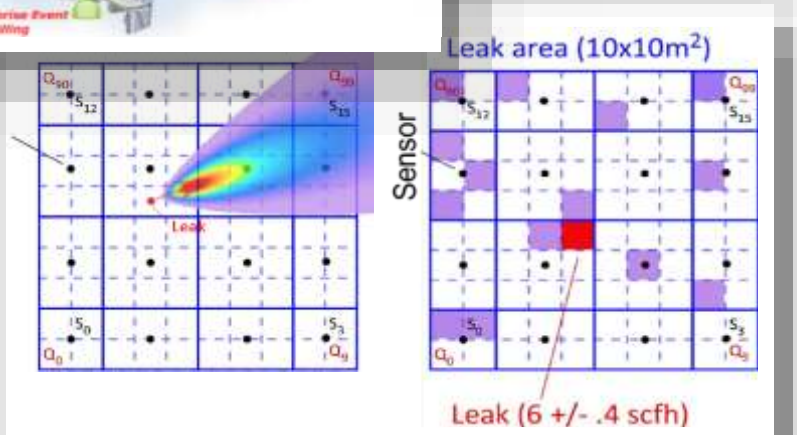
**AWARD AMOUNT:** $2.85 million

**PROJECT PARTNERS:** Colorado State University, Gener8

# On-Chip Optical Sensors and Distributed Mesh Networks for Methane Leak Detection






## PROJECT HIGHLIGHTS

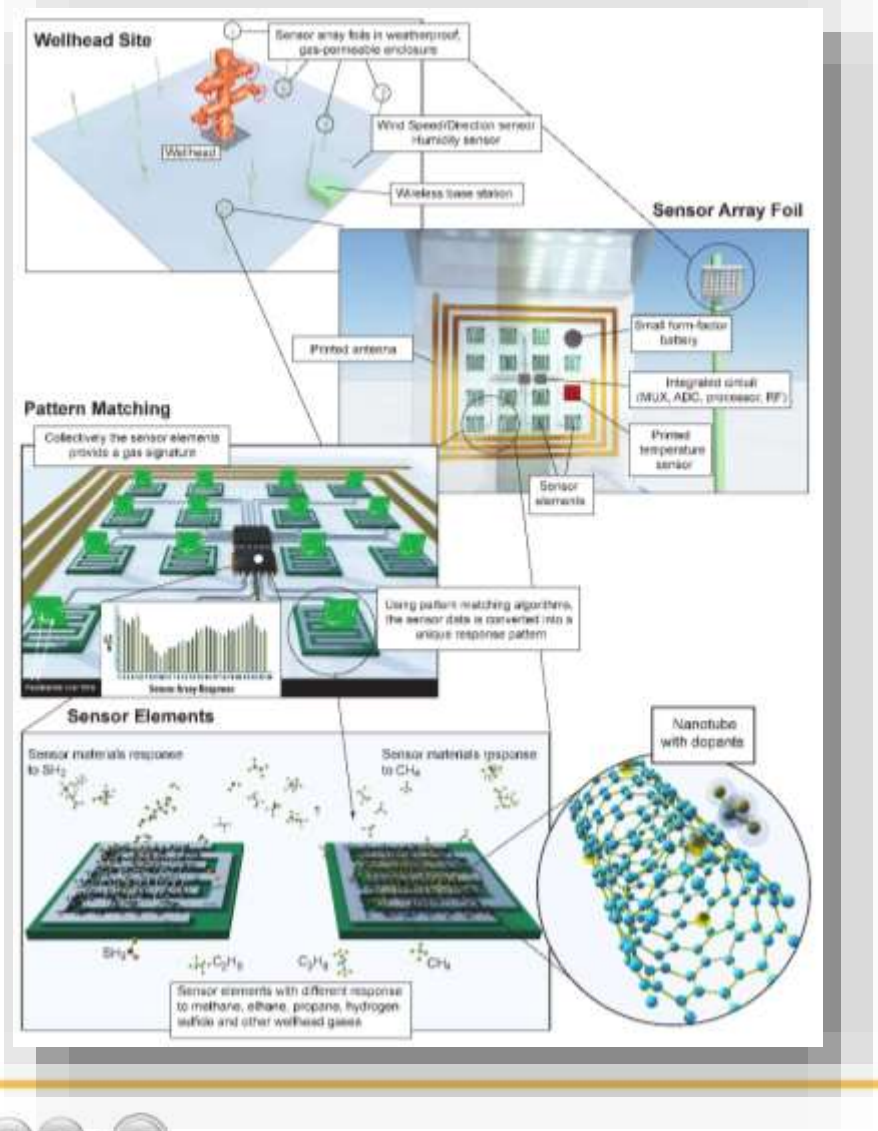
- Developing novel, low cost, on-chip optical sensors with high methane selectivity
- Distributed and modular system with self-organizing network of low-power motes
- State of the art silicon photonics technology for on-chip TDLAS
- Allows for selectivity to molecule of choice
- Orders of magnitude lower cost ($250/sensor target)
- Low power consumption (<1 Watt)
- Cloud-based analytics for source detection and localization

**AWARD AMOUNT:** $4.5 million

**PROJECT PARTNERS:** Princeton University, Harvard University, Southwestern Energy

# Printed Carbon Nanotube Sensors for Methane Leak Detection

parc
A Xerox Company




**PROJECT HIGHLIGHTS**

- Developing a mesh network of ultra-low-cost printed sensor arrays that can detect multiple gases
- Uses scalable low-cost, additive printing methods to print chemical sensor arrays based on modified carbon nanotubes
- Sensor elements with different responses to methane, ethane, propane and other wellhead gases
- Total system costs under $350 per site per year
- Multiple sensors reduces false positives
- Sub-ppm sensitivity with leak localization within 1 m

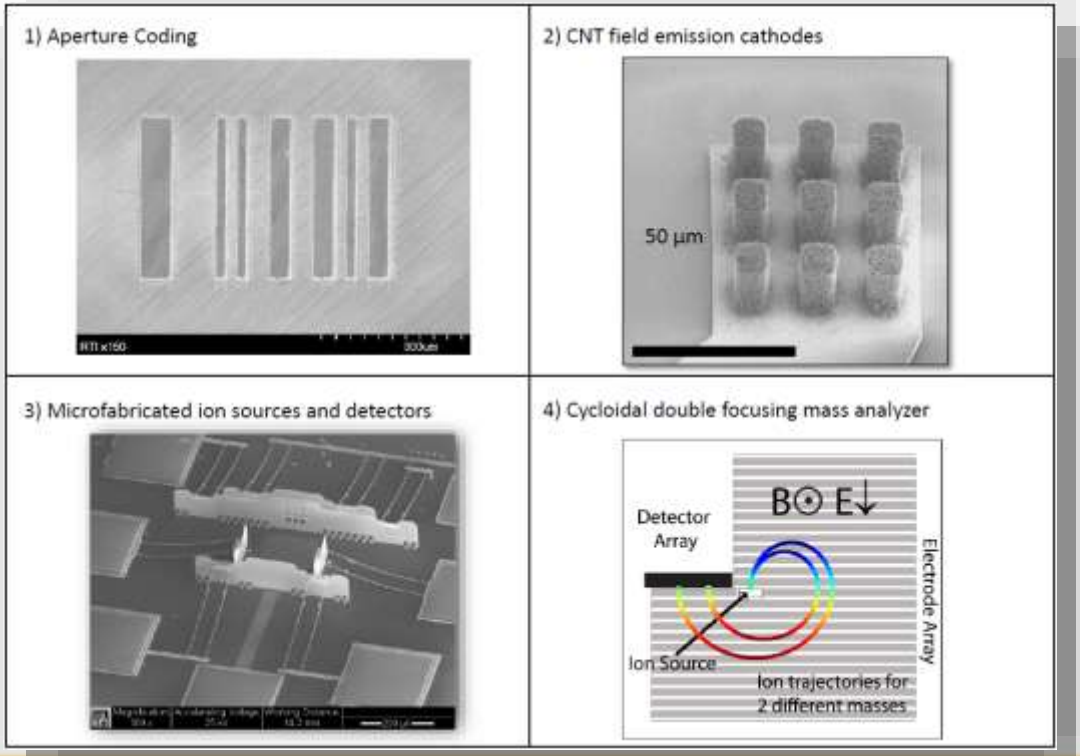
**AWARD AMOUNT:** $3.4 million

**PROJECT PARTNERS:** NASA Ames Research Center, BP, Xerox Corporation

arpa·e
CHANGING WHAT'S POSSIBLE

# Coded Aperture Miniature Mass Spectrometer for Methane Sensing

Duke UNIVERSITY




**PROJECT HIGHLIGHTS**

- Miniaturizing a mass spectrometer utilizing microfabrication and aperture coding
- High selectivity measurements at short detection times for methane as well as VOCs (such as benzene, C2-C7)
- Capable of thermogenic vs. biogenic differentiation
- Developing advanced search/location algorithms for optimum sampling

**AWARD AMOUNT:** $2.9 million

**PROJECT PARTNERS:** RTI International

# Portfolio:
# Two Long Distance Technologies


FIXED

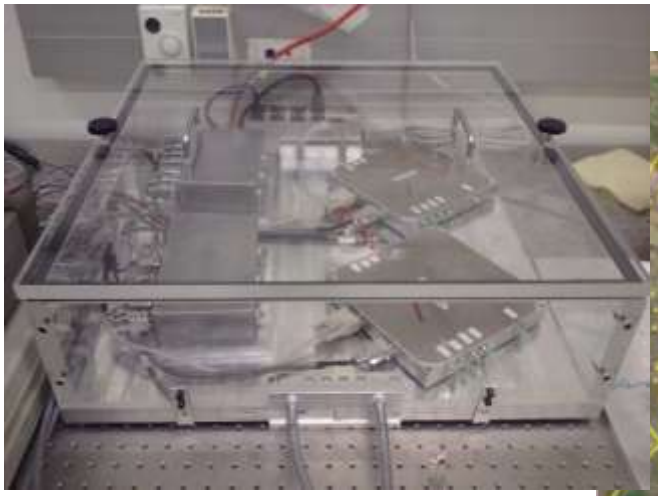
MOBILE

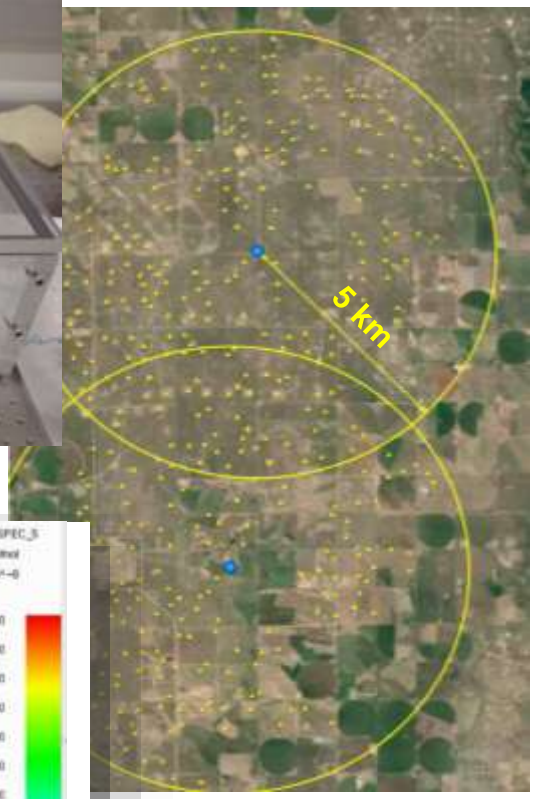
ENABLING

*Image courtesy of Cuadrilla Resources*

# Frequency Comb-based Methane Sensing

University of Colorado Boulder






**PROJECT HIGHLIGHTS**

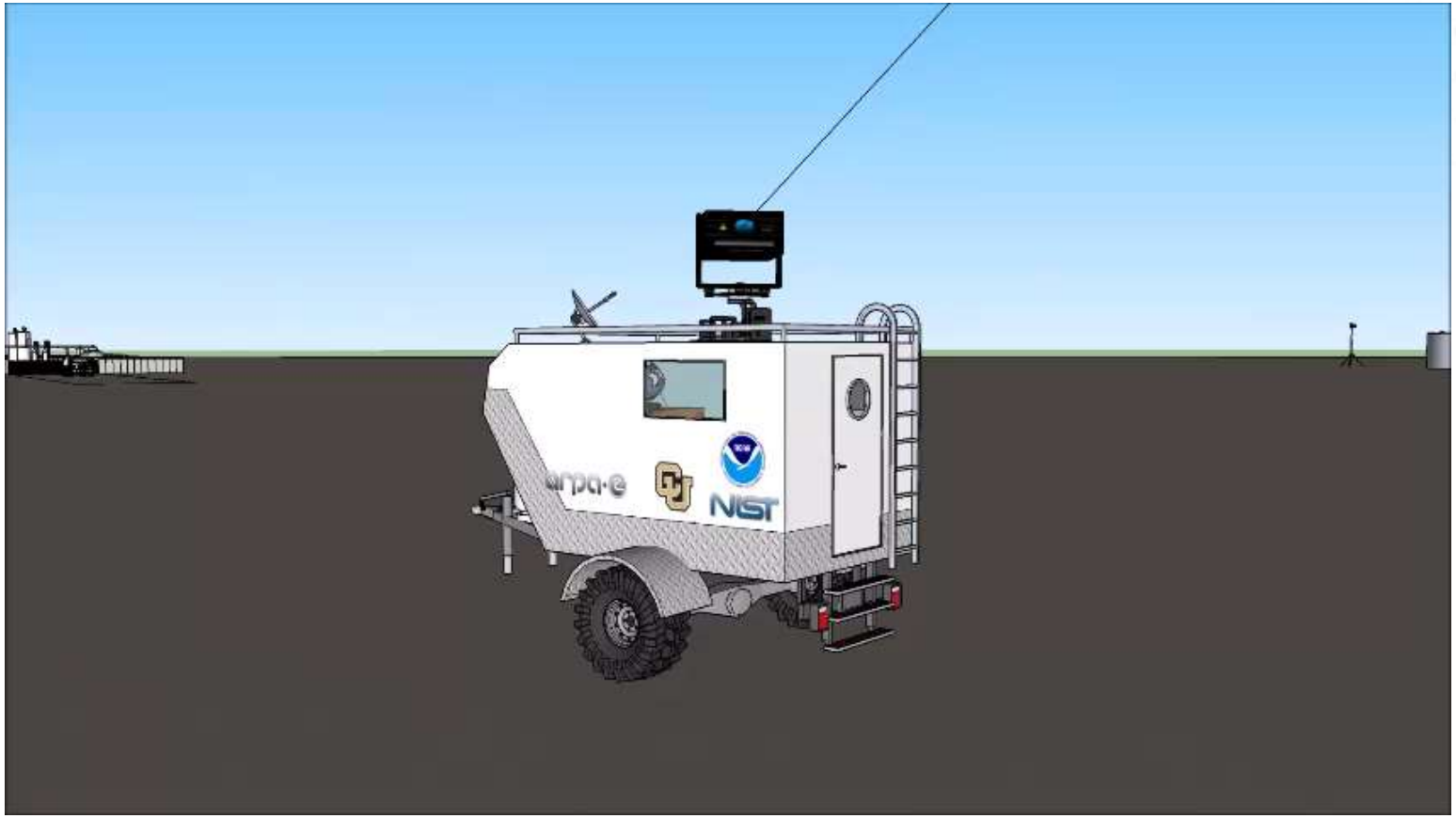
- High sensitivity (ppb-m) kilometer-scale path length measurements with specificity of FTIR
- Ability to monitor 100s of sites from a central location
- Simplifying design to reduce the cost of dual comb spectroscopy
- Multispecies sensing includes $CH_4$, $CH_4$, $H_2O$, propane, and ethane
- Coupled to large eddy dispersion modeling to provide localization

**AWARD AMOUNT:** $2.1 million

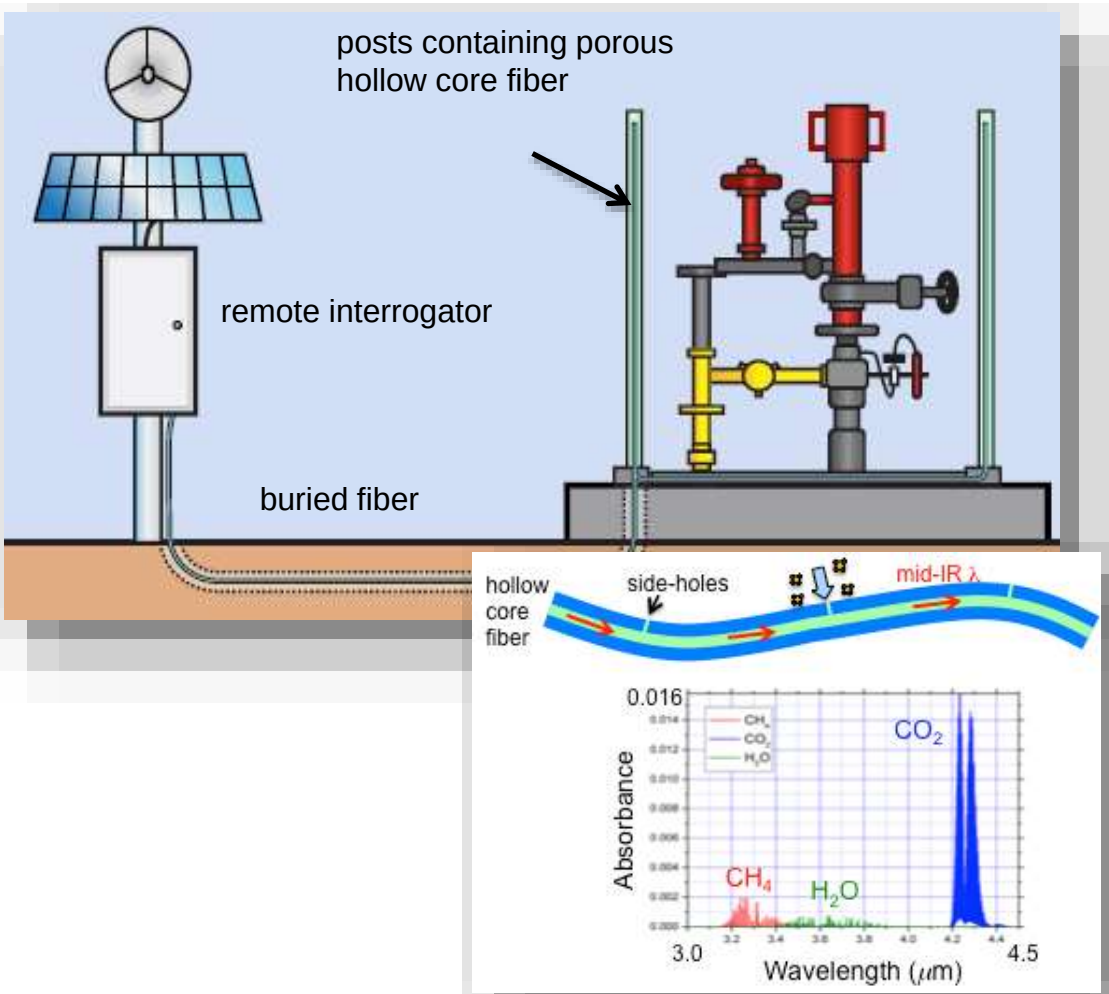
**PROJECT PARTNERS:** NIST, NOAA

# Frequency Comb-based Methane Sensing

University of Colorado Boulder



# Microstructured Optical Fiber for Methane Sensing




**PROJECT HIGHLIGHTS**

- Fiber optic sensor is broadly applicable throughout the oil and gas industry, particularly for large-scale infrastructure (such as transmission lines)
- Photonic crystal fiber design will minimize optical losses while permitting ambient gas to enter hollow core

**AWARD AMOUNT:** $1.4 million

**PROJECT PARTNERS:** Virginia Tech

# Portfolio:
# Two Aerial Technologies


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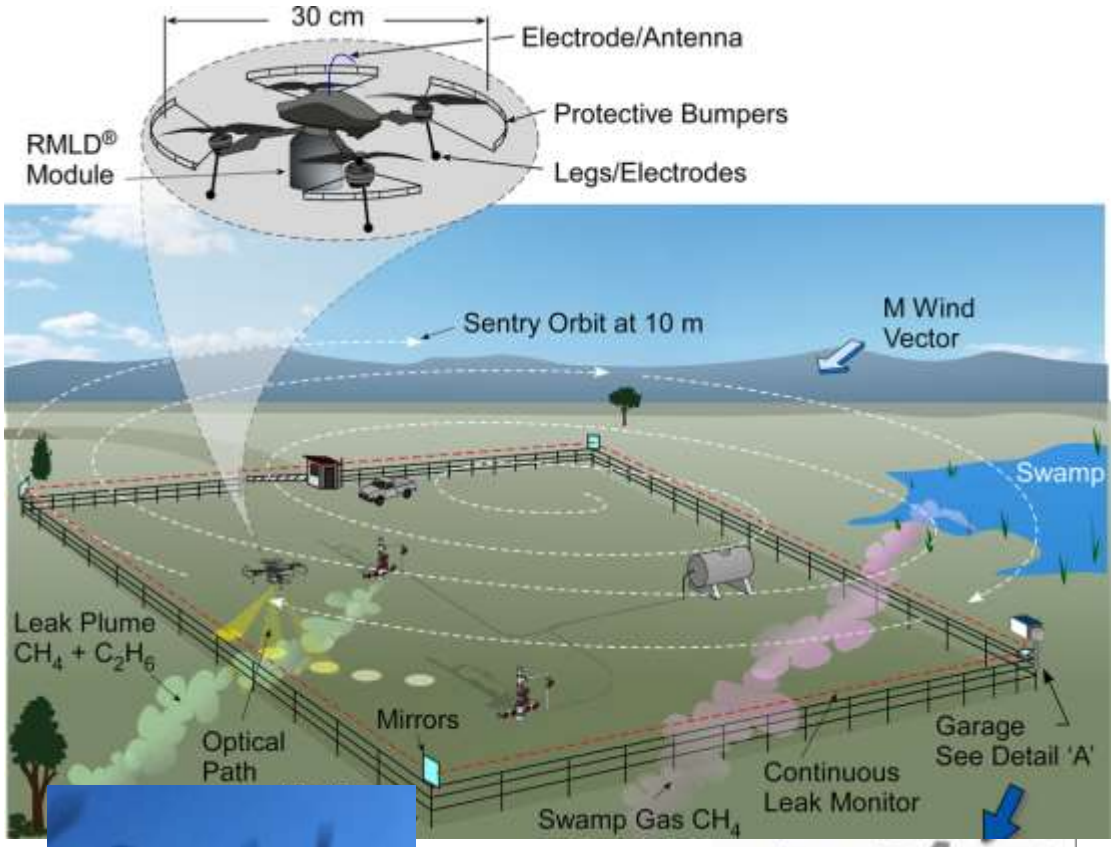
*Image courtesy of Cuadrilla Resources*

# UAV-based Laser Spectroscopy for Methane Leak Measurement

Physical Sciences Inc.





## PROJECT HIGHLIGHTS

- Continuous leak monitoring with leak quantification and real-time alarm notification
- Two modes of operation: continuous perimeter monitoring and search mode to pinpoint leak location
- Speciation of methane and ethane differentiates thermogenic vs. biogenic emission
- Improved production processes reduce costs of mid-IR Interband Cascade Laser (ICL) sources

**AWARD AMOUNT:** $2.9 million

**PROJECT PARTNERS:** Heath Consultants, Thorlabs, Princeton University, University of Houston, Cascodium

# Mobile LiDAR Sensors for Methane Leak Detection

BRIDGER PHOTONICS

**PROJECT HIGHLIGHTS**

- Simultaneous, rapid, and precise 3D topography and methane gas sensing on fixed or mobile platform
- Capable of covering a broad range: a frequency-swept laser beam is transmitted to a topographical target 1-300 m from the sensor
- Produces detailed situational awareness reports derived from overlaid methane concentration, 3D topography, and RGB picture data
- Potentially able to achieve a minimum leak rate detection of 1 gram per minute
- Estimated between ~$1,400-2,200 per well per year

**AWARD AMOUNT:** $1.5 million

# Portfolio:
# One Imaging Camera Technology


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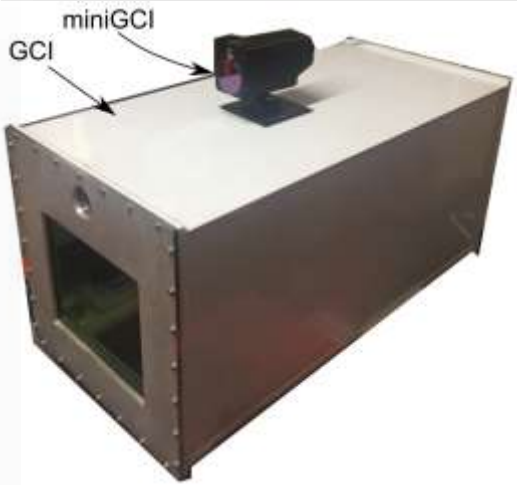
*Image courtesy of Cuadrilla Resources*

# Portable Imaging Spectrometer for Methane Leak Detection

REBELLION PHOTONICS




**PROJECT HIGHLIGHTS**

- Miniaturization of Rebellion's Gas Cloud Imager (GCI), a long-wave infrared imaging spectrometer
- Camera will be lightweight and portable – the size of a Red Bull can - and capable of being incorporated into personal protective equipment
- Data processing uses cloud-based computing architecture that streams results to mobile device

**AWARD AMOUNT:** $4.3 million

# Portfolio:
# One Enabling Technology

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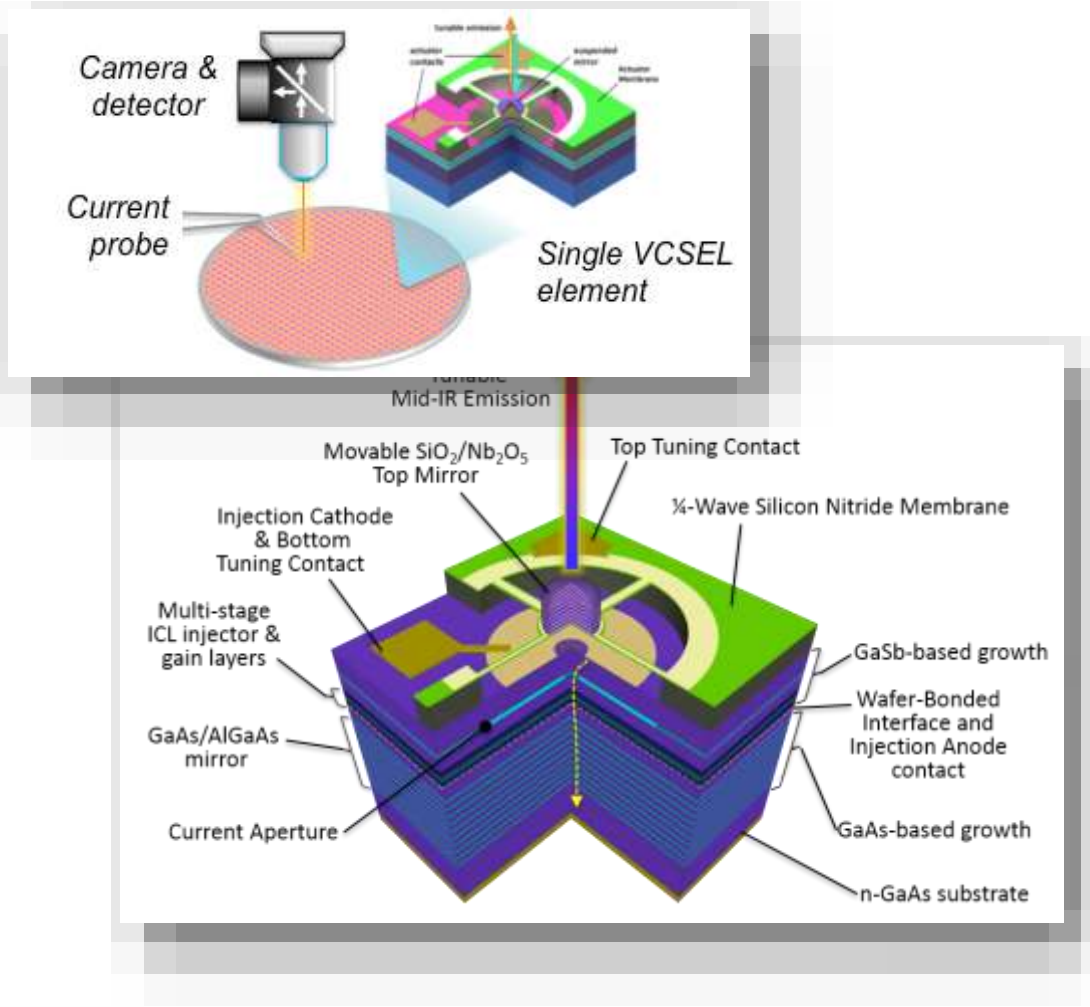
*Image courtesy of Cuadrilla Resources*

# Tunable Mid-infrared Laser for Methane Sensing



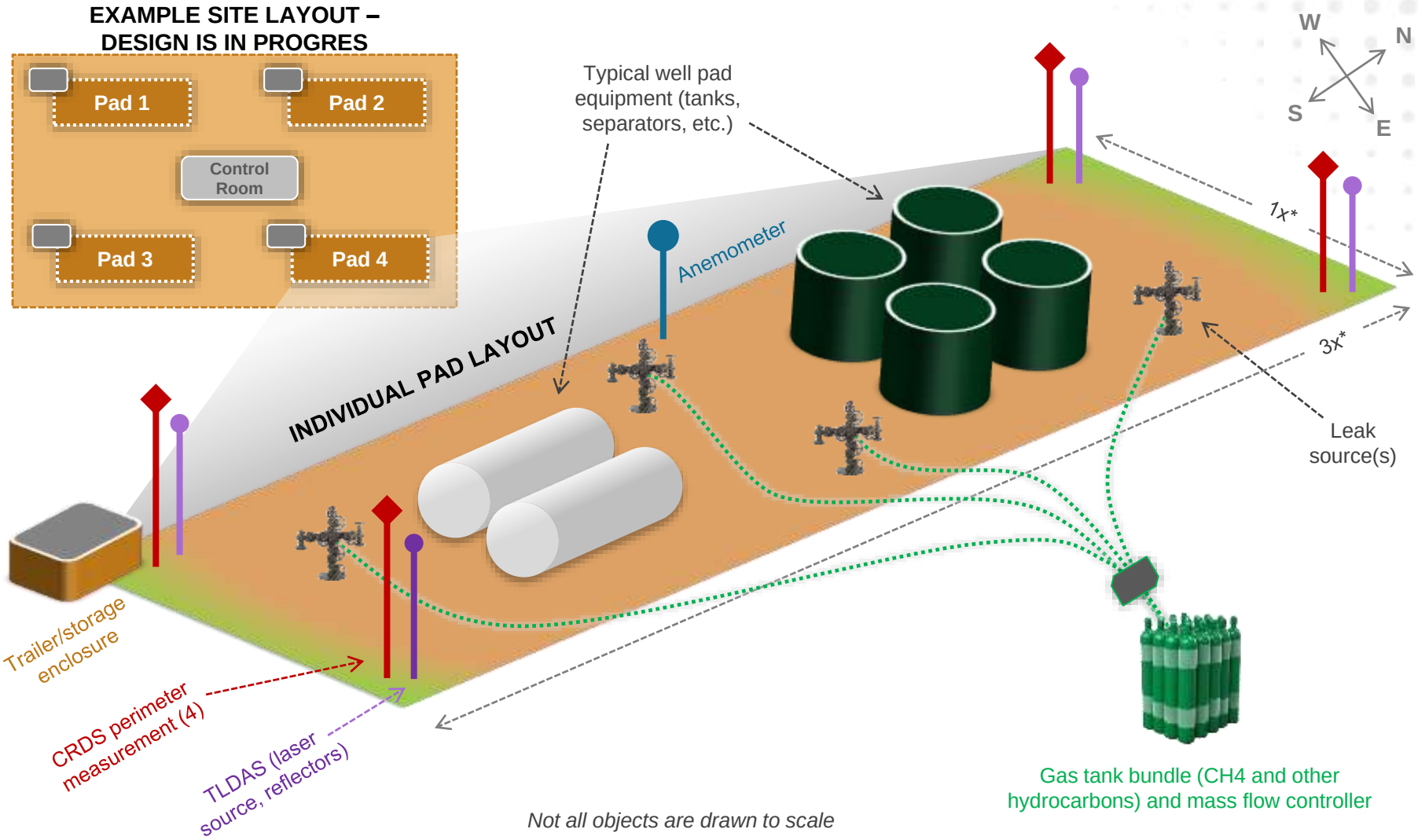

**PROJECT HIGHLIGHTS**

- Innovative, low-cost mid-IR laser with VCSEL architecture
- Integrated micro-electro-mechanical system (MEMS) mirror enables a wide tuning range
- Approximately 40x reduction in laser cost, applicable across a wide array of sensors and applications

**AWARD AMOUNT:** $1.9 million

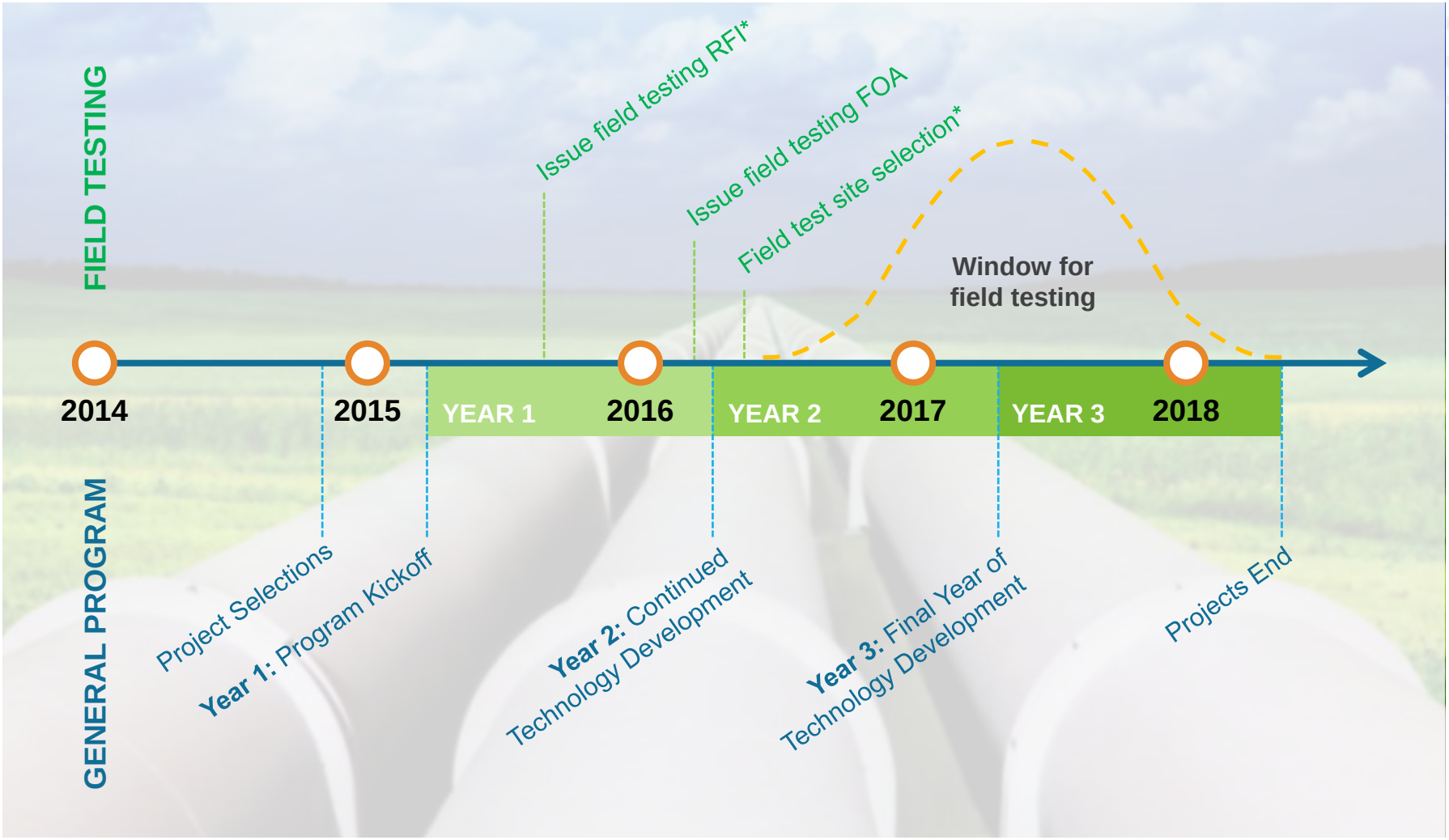
**PROJECT PARTNERS:** Thorlabs Quantum Electronics, Praevium Research, Rice University

# CSU: Methane Emissions Test Facility




*1x3 size ratio is approximate

# The MONITOR Timeline: ARPA-E & Beyond




*Subject to change

# Engagement and Partnerships

- Engagement with:
  - All sectors of oil and gas industry
  - Environmental community
  - Regulatory community (EPA, BLM, PHMSA, NARUC and several states)
    - "The BLM also seeks to account for advances in continuous emissions monitoring technology, and also for other advances in leak detection technologies, which may result from ongoing technology development efforts such as the DOE ARPA–E MONITOR program."

- Partnerships:

INTERSTATE TECHNOLOGY & REGULATORY COUNCIL
Advancing Environmental Solutions

  - Comprised of state, federal, industrial & environmental leaders
  - Commissioned to create technical/regulatory guidelines to produce a comparative methodology to evaluate state-of-the-art methane detection technologies vs traditional technologies (OGI and Method 21)

# Policy Needs

**Main goal:** Avoid technology lock-in; move towards quantification

- MONITOR technologies will enable:
  - Quantification, continuous monitoring, wireless communication—at low-cost and with high sensitivity
  - Result: leak prioritization, non-arbitrary measurement intervals or concentration thresholds, and decreased personnel costs
- Policy needs:
  - Inclusion of a technology onboarding mechanism—i.e. an explicit lookback to ensure that yesterday's technologies aren't "locked in"
- Policy should move towards:
  - Mass flow thresholds and continuous monitoring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