



**CLIMATE &
CLEAN AIR
COALITION**
TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS

GLOBAL METHANE FORUM

**April 16-18,
2018**

**Beanfield/
Enercare Centre**

Toronto, Canada

Followed by:

***CCAC Working Group
Meeting***

April 19-20, 2018



Methane tracking microsats & AI

*One solution to rule them all:
detecting every methane emitter on Earth, daily*

Richard L. Lachance, Ph.D.
Co-founder & CTO



Bluefield *Keep Earth cool*



Methane is the new CO₂

- Methane is **100x more potent than CO₂** (10 year period)
- **1/4 of global warming** is due to methane emissions
- **Trillions of \$** and **millions of lives at stake**



How much of all GHGs?





Every % we get wrong ...

What is the situation?



Agencies and regulators are struggling to get a handle on accurate emissions of methane



“New study raises big questions on U.S. fugitive methane emissions.” (2013)



“Solid waste disposal more than doubles EPA estimates.” (2015)

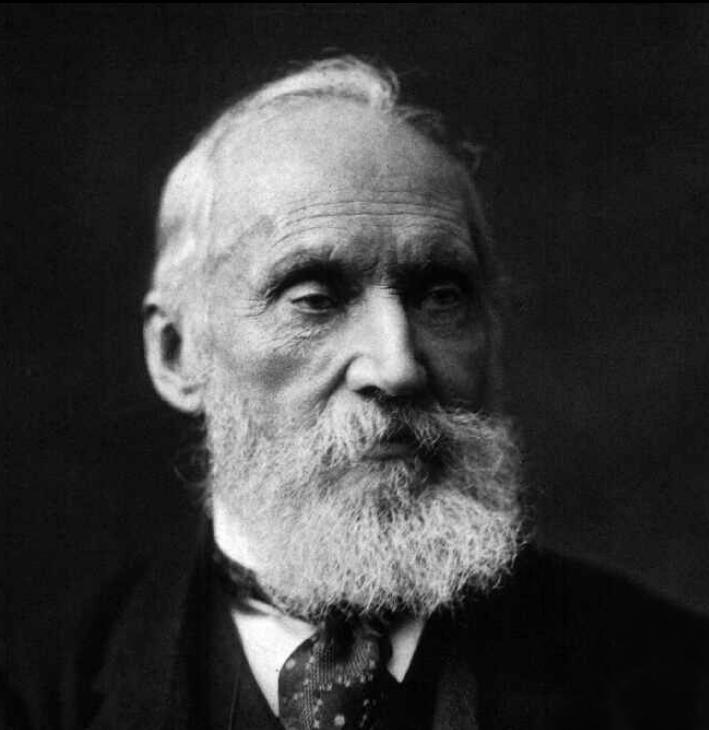


“The U.S. has been emitting a lot more methane than we thought, says EPA.” (2015)



“Uncertainty surrounds U.S. livestock methane emission estimates” (2017)

The decisions we make are only as good as the data they are based on



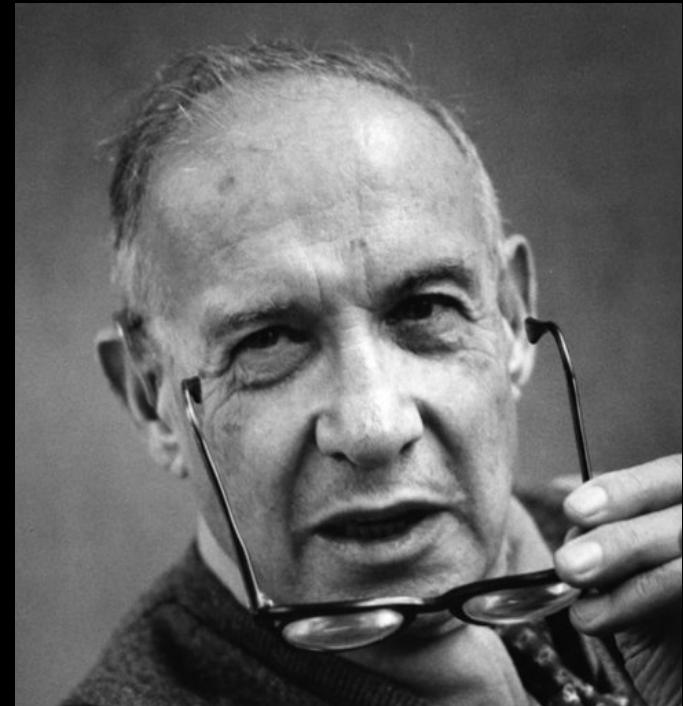
“To measure is to know”

– Lord Kelvin

*“If you can’t measure it,
you can’t improve it”*

*“You can’t manage
what you can’t measure”*

– Management thinker Peter Drucker



Models & local measurement



Methodology



Microsatellite sensors + AI = a scalable, cost-effective solution

Global coverage

Detect and quantify every methane leak larger than **15 kg/h** at **20 m** resolution.

Timely, actionable information

Daily monitoring and analytics ensure leaks don't go undetected, reducing risk by orders of magnitude.

Easy to access via a subscription

Clients receive data products digitally as a service.



at 20 m resolution..



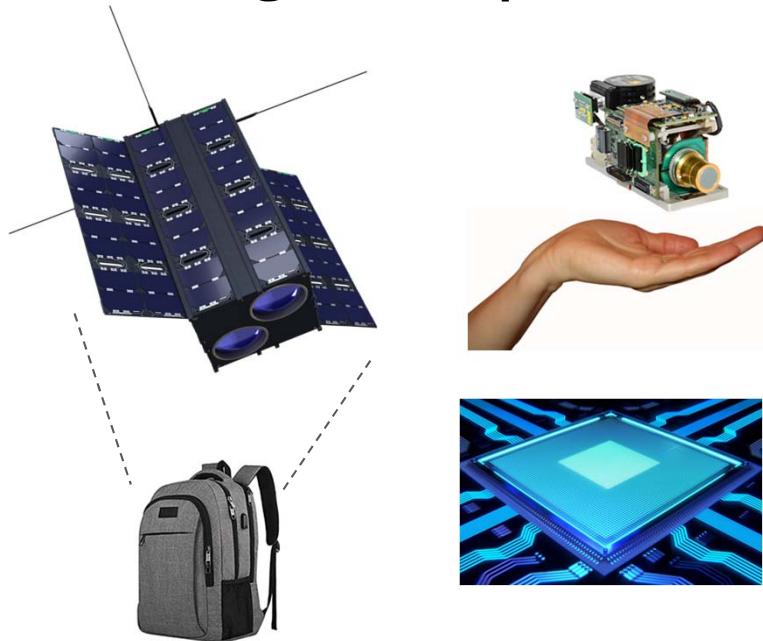
Foundation for effective actions

- Current methane monitoring approaches are not scalable to the size of the problem
- Millions of miles of pipelines, hundreds of thousands of gas wells - measured with trucks and helicopters!?



Why now?

- Components **1% cost and size** compared with 10 years ago + **Improved detectors**
- AI and image processing **10,000 times faster** and more capable than 5 years ago
- Cheaper and **commoditized access to space** with weekly launches starting 2019
- Shareholders and banks (managing \$80 trillion) **demand climate risk data** from oil & gas companies, methane emissions are the top concern



Space 2.0



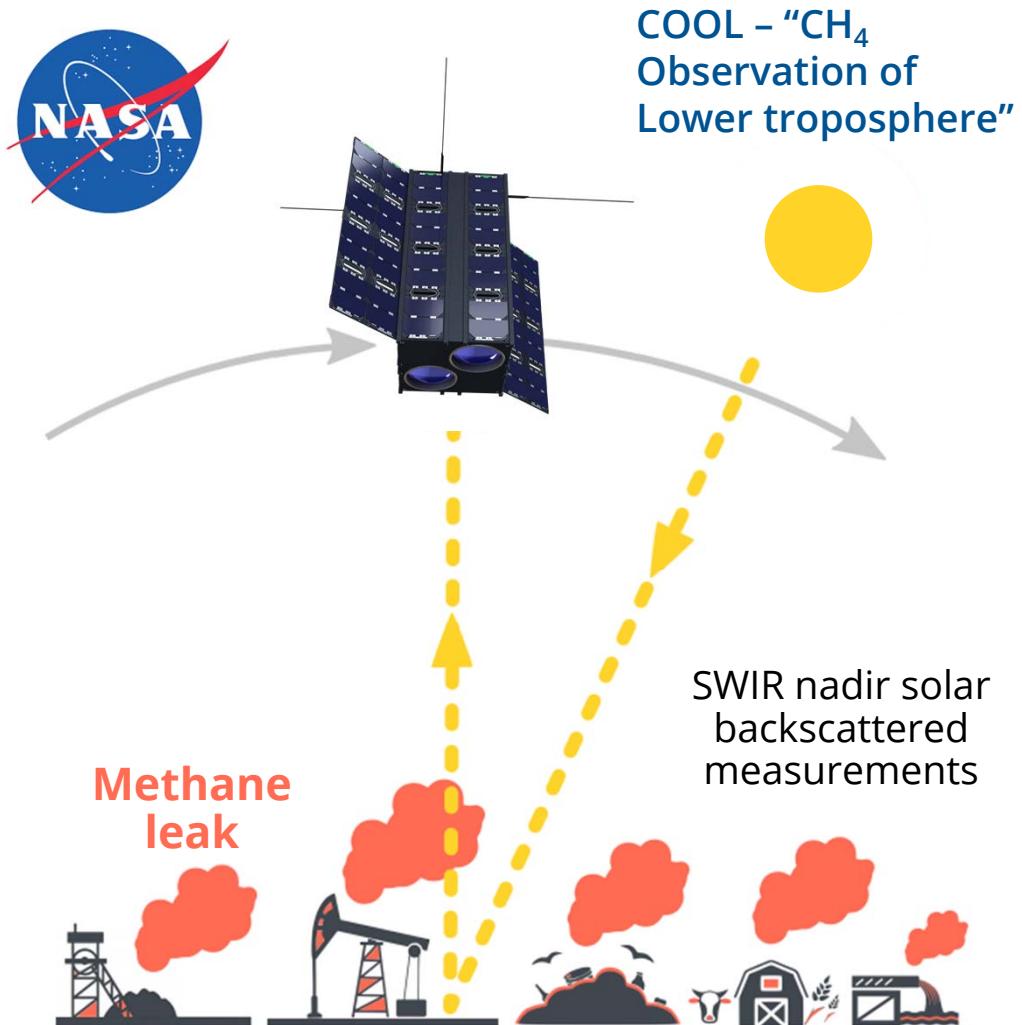
Miniaturized solution

- **Bluebird 1 could totally fit inside a typical 0.8 cubic feet microwave** (with folded solar panels of course!)

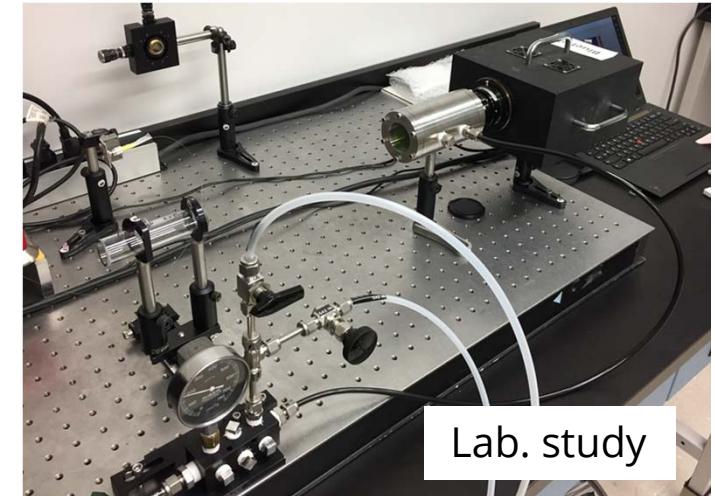
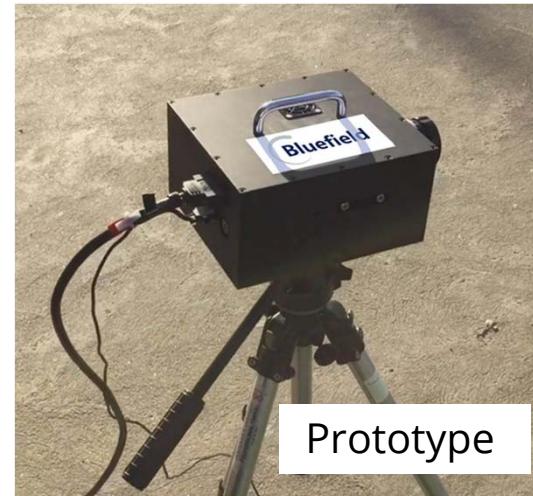


At 1/100 of the cost

Bluefield proprietary technology

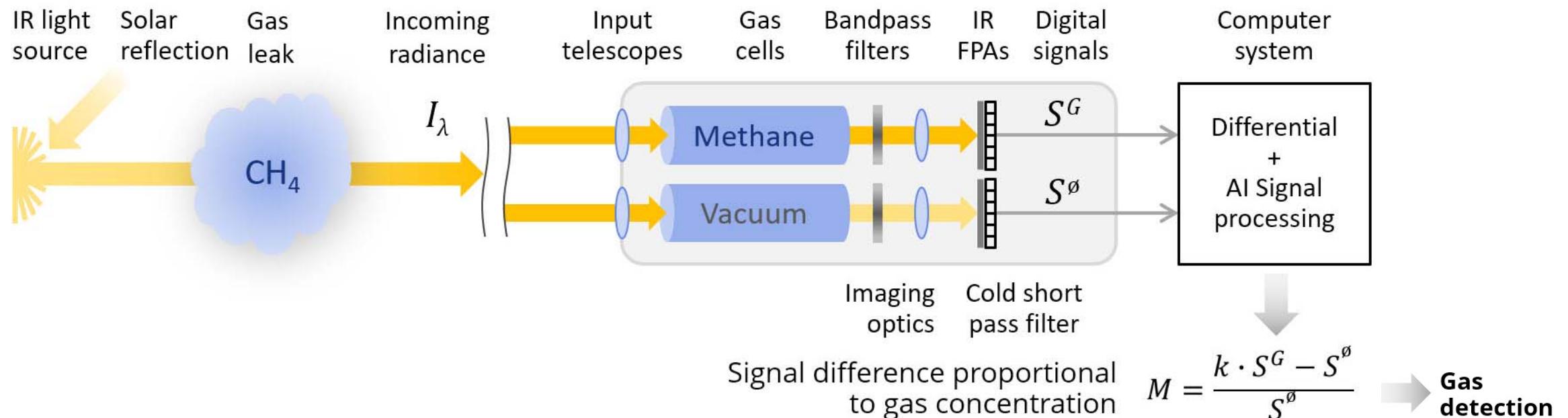


- We are using **proven NASA technology** (in orbit since the 1970s)
- **Prototype demonstration in 2017**
 - 5 patents in preparation
- Three planned **airborne field campaigns**



Gas Filter Correlation Radiometry

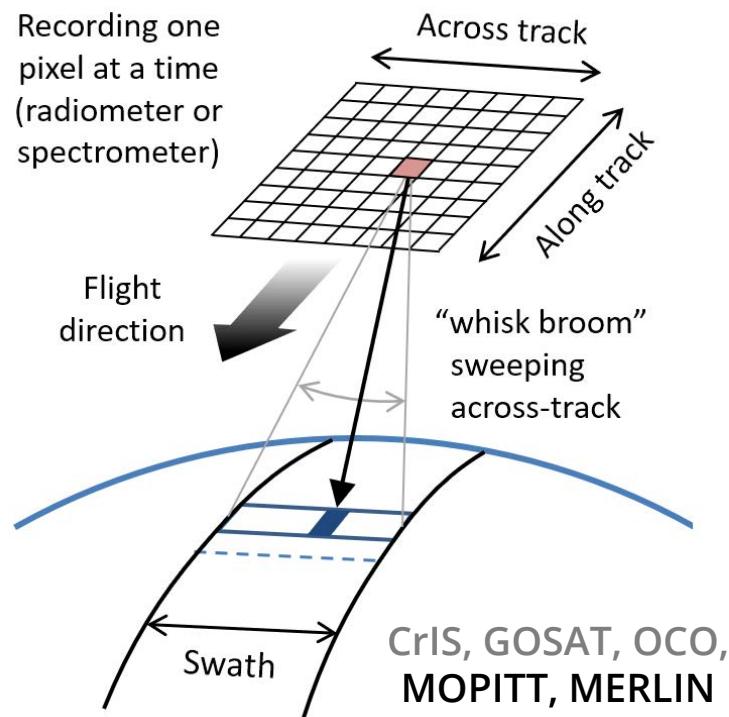
- GFCR is arguably the **best approach** for trace gas measurement from a micro satellite, offering **intrinsic high selectivity** + high rejection of contaminant gases & interferents
- Such a radiometer naturally integrates the gas absorption spectral signature using an **internal gas cell** containing a sample of methane, acting as the perfect filter, **eliminating the need to digitally record & analyze high-density spectral information**



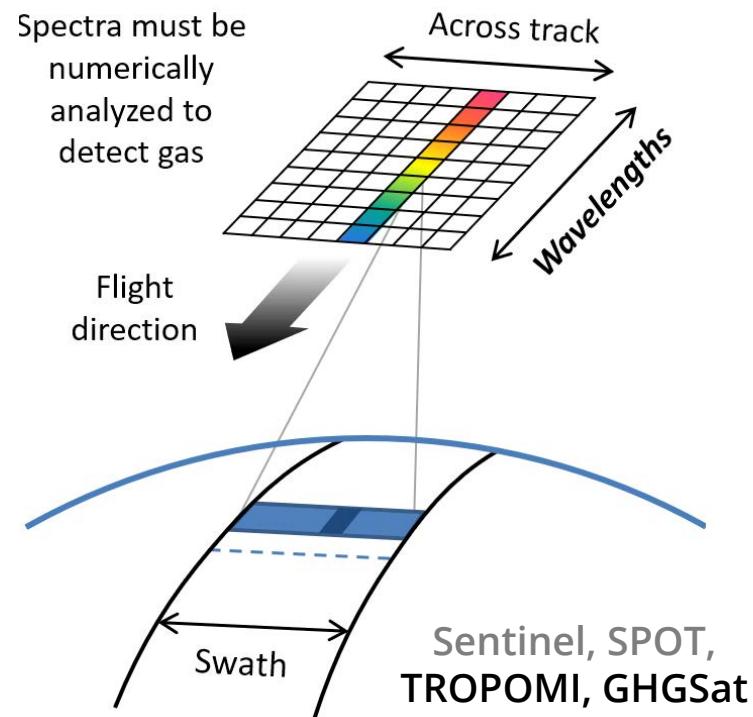
Spectro-radiometer imager

- “Push-frame” measurement mode gathers more photons, allowing **continuous recording at a high frame rate and massive oversampling**, leading to **significant increase of the SNR** (factor of 10+ wrt classic scanning systems)

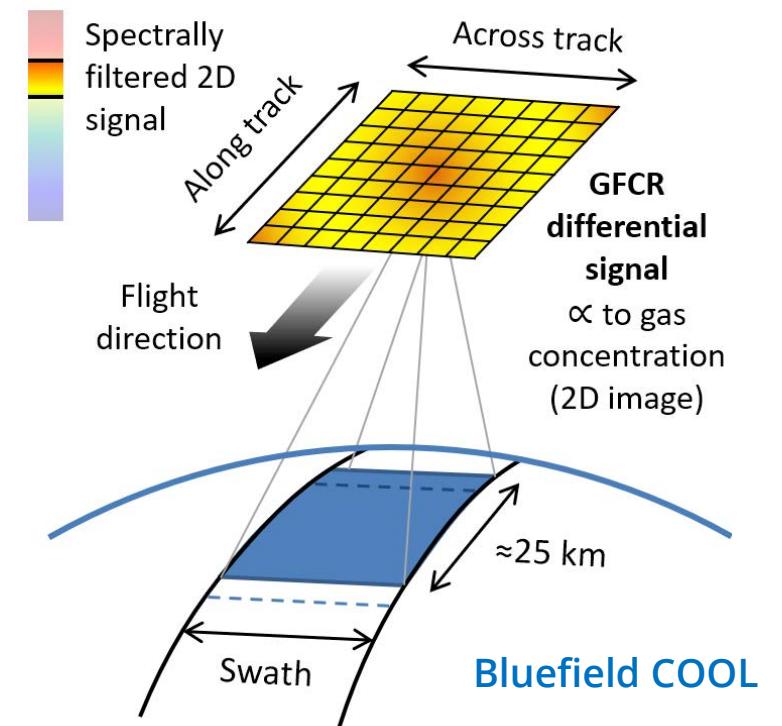
Whisk-broom scanning



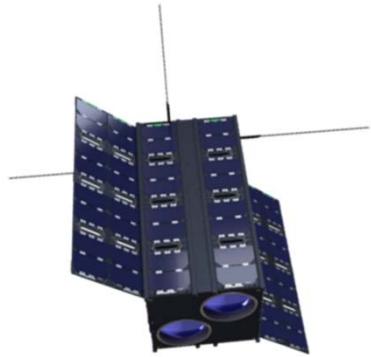
Push-broom scanning



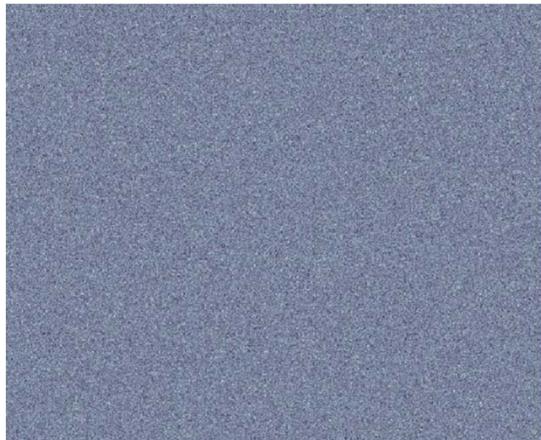
Push-frame staring



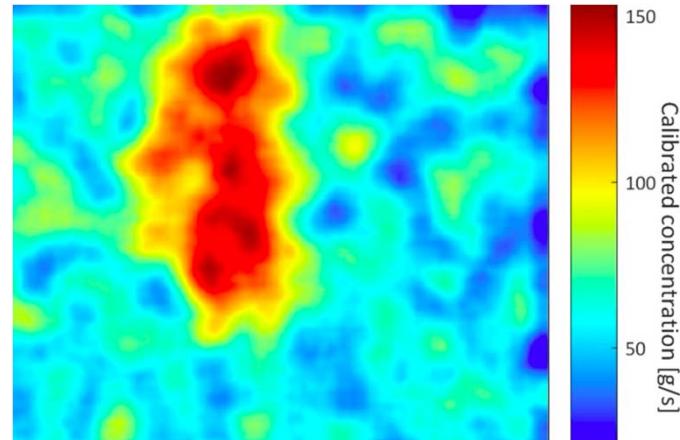
This is how Bluefield's technology works



Raw data stream from
microsat sensor



+ Pattern recognition
enhancement with AI



= Timely emissions info
& analytics for clients

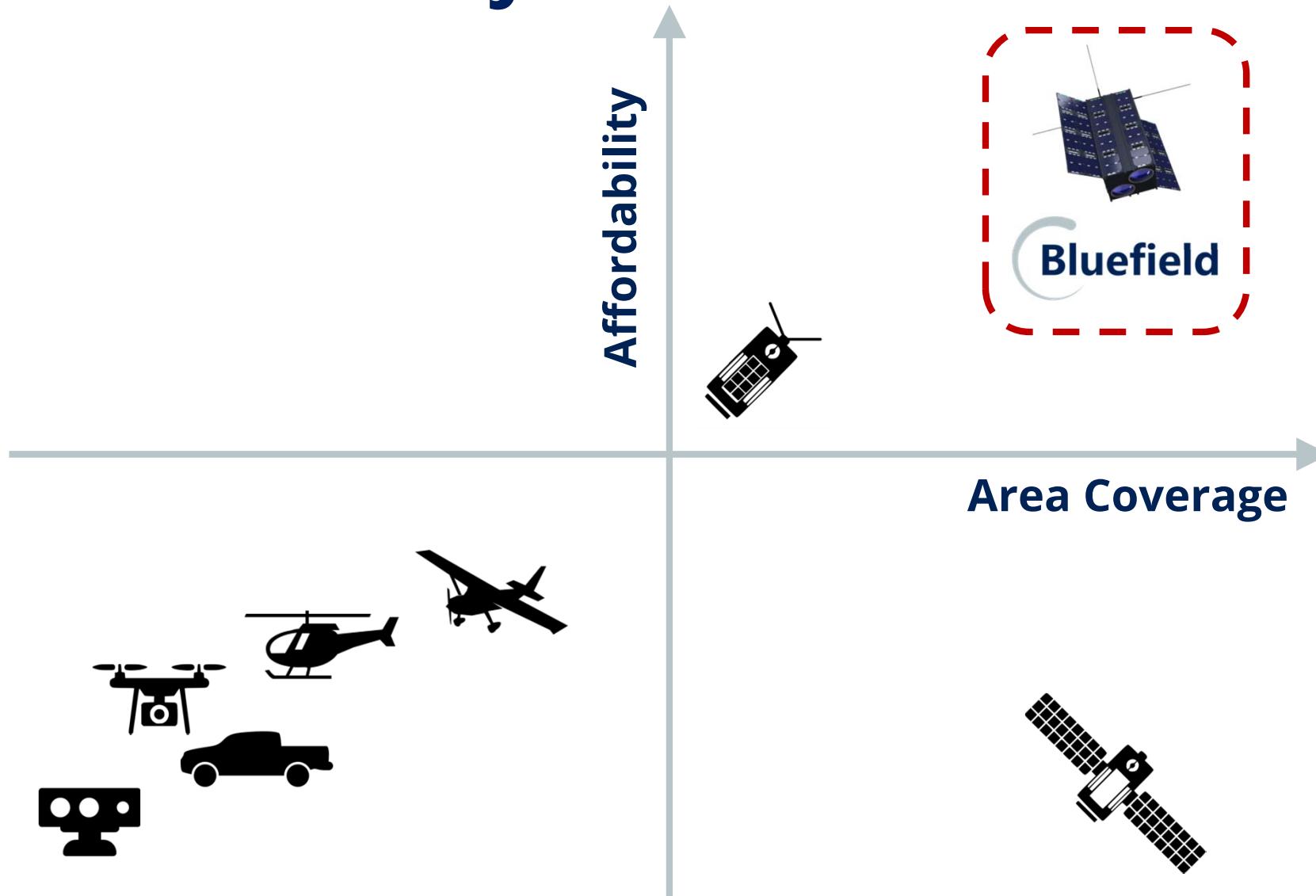


AI & Machine Learning

- The COOL technology further augments the GFCR sensor performance by using **advanced image processing** enhanced by **Artificial Intelligence**
 - Using **massive oversampling**, our AI uses **pattern recognition** on the unique and rich data from our sensor
- This allows the extraction of minute quantity of information from **large background noisy signal** in order to *detect, identify, visualize and quantify* trace gas plumes
- New **Machine Learning** techniques will be implemented for **automatic analysis and near real time identification** of weak gas leaks in large streams of mega-pixel IR images recorded at high frame rate, achieving **unprecedented precision**.



Benefits / Scalability



Affordability & coverage for global scale

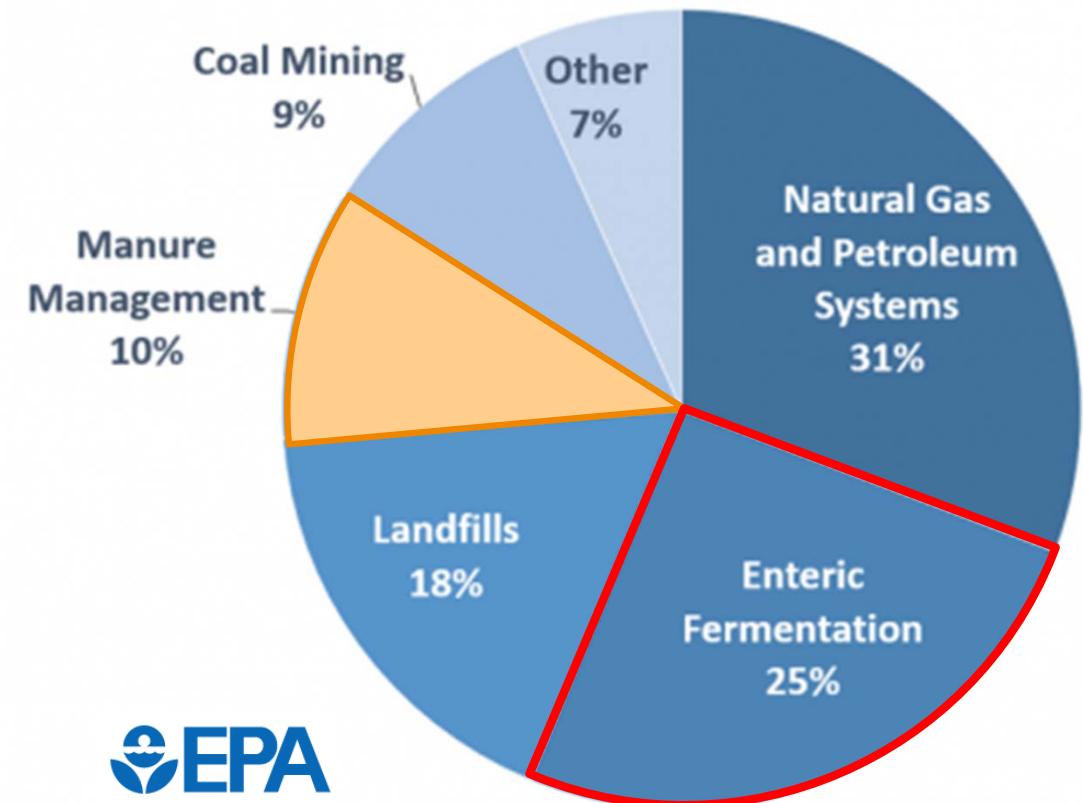


Bluefield brings an unbeatable offer for large coverage

SOLUTIONS	Cost (per km ² per measurement)	Revenue	Coverage (per day in km ²)
Stationary sensors	\$\$\$\$	\$\$\$\$	0.00001
Trucks, helicopters, drones	\$\$\$	\$\$\$	2-50
Airplane	\$\$	\$\$	200
 Bluefield	¢	\$	50,000

Main sources of methane emissions

- Globally, over 60% of total CH₄ emissions come from human activities
- Methane is emitted from **industry**, **agriculture**, & **waste management** activities
- Domestic livestock (**beef 71%**, **dairy 24%**, goats, and sheep) produce large amounts of CH₄ as part of their **normal digestive process**.
- Also, when animals' manure is stored or managed in lagoons or holding tanks, CH₄ is produced.
- When livestock and manure emissions are combined, the **Agriculture sector is the primary source of CH₄ emissions**.



Information about methane leak levels



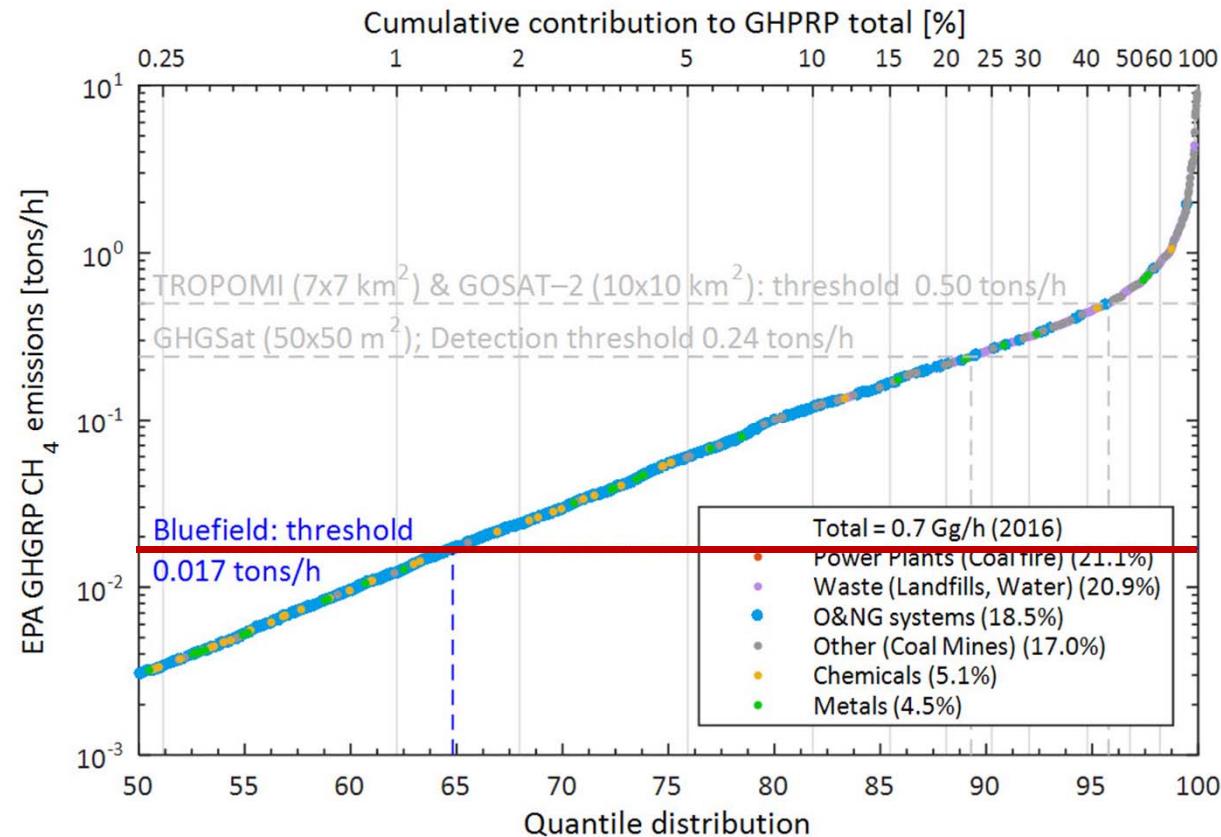
15 kg/h Bluefield detection threshold (10 m plume, 10 km/h wind, 100 ppm-m)

-
- Biggest single leak in history = Aliso Canyon **60,000 kg/h (peak)**
 - Coal mines flow **1000 kg/h (mid-level)**
 - Natural gas wells **1..15 kg/h per well**
 - Water treatment plants **5–100 kg/h**
- Herd livestock (Narrabri 150,000 animals) **300 kg/h (120 L/day)**
Diary cow manure emission **900 kg/h**
- Peatland average fluxes: **25 mg/h/m²** **10 kg/h (over 20 m × 20 m)**
 - Wetland highest fluxes measured **≈ 7.5 mg/h/m²**
 - Average rice growing season emissions **< 0.01 mg/h/m²**

Detection performance

- With a **low detection threshold**, Bluefield will be able to **detect 98.6%** of all ground based device-level emissions, compared to a quite limited subset by competitors

Bluefield orbital sensors will **detect essentially all of the methane point sources emitters** from the 2016 EPA national total GHGRP inventory



Our higher sensitivity level (15 kg/h) allowing us to detect for example:

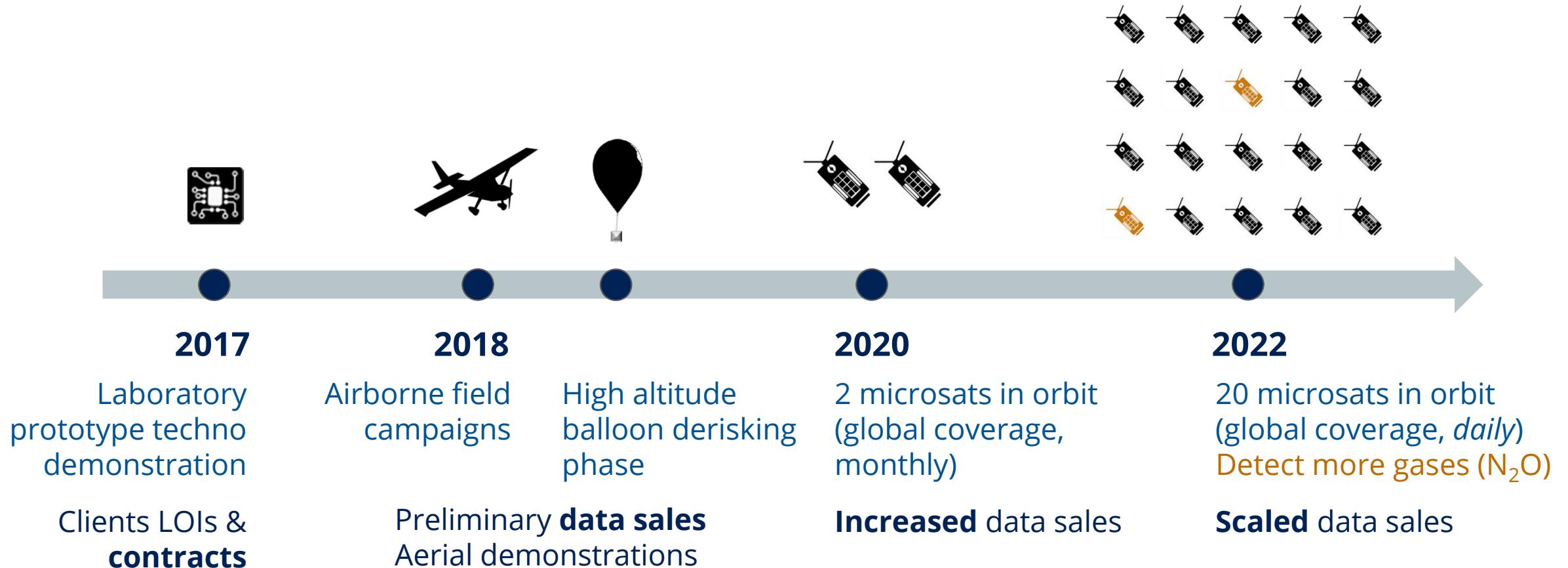
- 163 sources, or 12.0% of top **Power Plants** (mainly Coal) 1357 emitters, compared to only 2 sources by GHGSat, (81x more), and
- 589 sources, or 49.3% of top **Oil & Gas** 1194 emitters, compared to only 14 sources by GHGSat (42x more)

Assessing global methane emissions



Ratio	Industry type (sector)	Detected sources	% of total emissions
21.1%	1) Power Plants (e.g Coal burning power)	12.0%	84.1%
20.9%	2) Waste (landfills, wastewater treatment, composting)	89.5%	99.9%
18.5%	3) Petroleum & Natural Gas Systems	49.3%	90.3%
17.0%	4) Other (Coal mines, vehicles, etc.)	8.15%	99.9%
5.1%	6) Chemicals	4.6%	90.3%
4.5%	7) Metals	5.2%	95.9%
3.4%	8) Pulp and Paper	36.2%	99.0%
1.9%	9) Refineries	37.7%	88.5%
TBD	AGRICULTURAL	TBD	TBD

Milestones



Our team



Yotam Ariel
CEO



Richard L. Lachance
CTO



Brian Leslie
Director of Sales



Erik Laan
VP of Engineering



Giancarlo Cesarello
Application
Specialist



Bill Heaps
Instrument
Head



Judi Krzyzanowski
Environmental
Scientist



Gidon Eshel
Data Analyst



Charles Miller
Chief Technology
Advisor

Having experience at:



Awards & publicity



**Bloomberg
Business**

Forbes

**SCIENTIFIC
AMERICAN**



**EXTREME TECH
CHALLENGE**



Sponsored
by Shell





Bluefield

Keeping Earth cool



It means we are
keeping Earth cool

