The Operational NASA Anomaly Gas Analyzer and Exploration Follow-Ons

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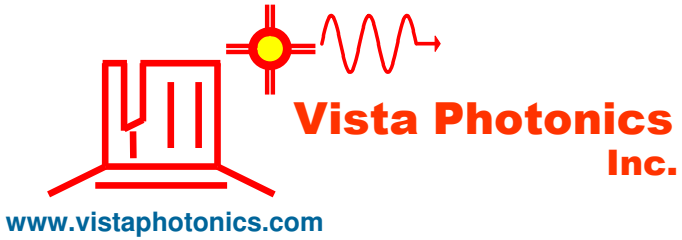
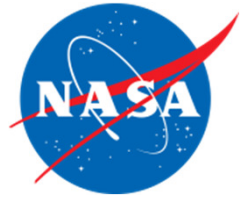




55th International Conference on Environmental Systems ICES-2026-266
12-16 July 2026, Rio Grande, Puerto Rico

Vista Photonics Background

Founded 2003

Jeff Pilgrim – President

- PhD in Chemistry
- Author of 35 publications and holds 13 US patents, 18 international patents.

Melissa Pilgrim

- Chief Administrative Officer

Bill Wood

- Chief Engineer

NASA

- JSC
  - EMU PLSS humidity tolerant CO2 monitor
  - Advanced PLSS
  - Laser Ammonia Monitor, IFCM 1 & 2, OLGA -> MGM (ISS, Flight Class 1-E)
- GRC
  - Gary Ruff – various spectroscopy based combustion products monitors
  - Photo Acoustic Spectrometer (PAS) CO measurement with RH compensation

Other Government Agencies

- DOE/DOD/EPA/USDA/NIH/DOC 47 Phase 1's, 16 Phase 2's, 21 Phase 3's

Housekeeping: Photodetection vs. PAS

Tunable diode laser absorption spectroscopy

photodetection $\frac{I}{I_0} = \exp(-\alpha), \qquad \alpha = S(T)\, g(\nu)\, n\, \ell = \sigma(\nu)\, n\, \ell$

typically interference fringe limited (systematic)

photoacoustic $\textbf{PAS Signal} \propto \frac{\mathbf{P \times \sigma \times N \times R \times dc}}{\mathbf{C_v \times (F/Q) \times A}}$

typically microphone noise limited (random)

1×10^{-5} $cm^{-1}cm$ (PD)
1×10^{-10} $cm^{-1}W$ (PAS)
100 cm/mW

Major Constituents 2011 (OLGA)

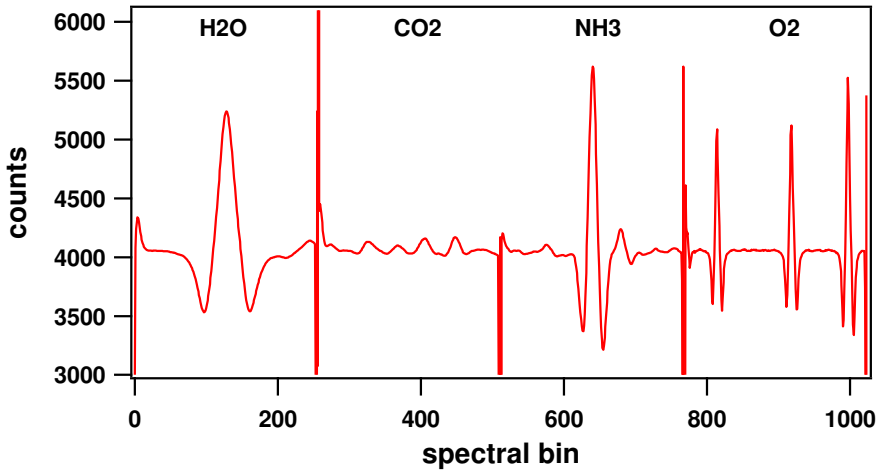
Wall power, room temperature, sea level

H2O

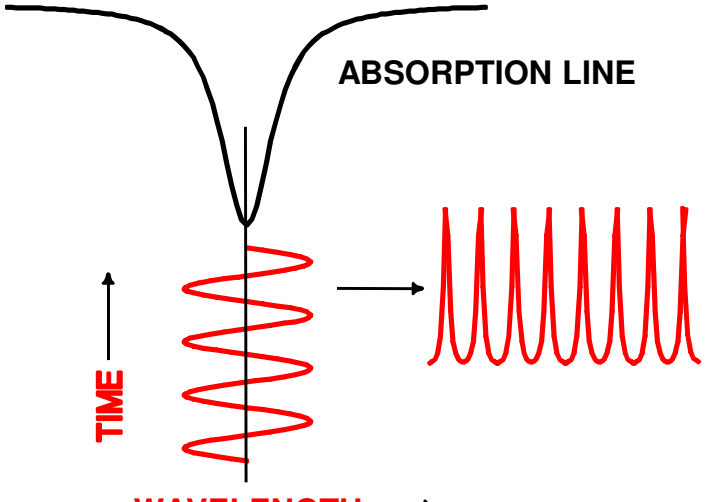
CO2

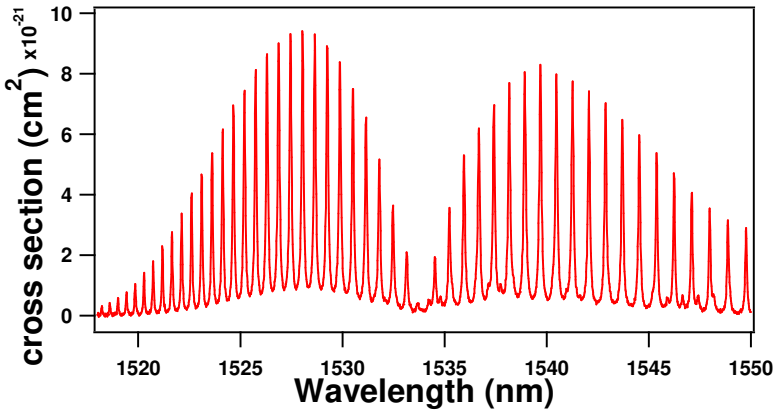
NH3

O2



Wavelength modulation with phase sensitive lock in detection





Major Constituents 2013 (MGM)

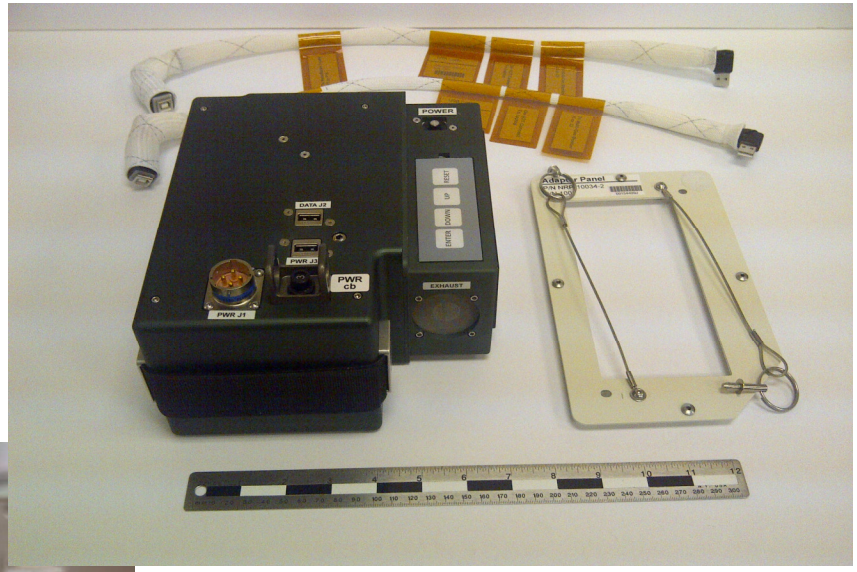
Vista developed internals

Enclosure & power from NanoRacks

All VCSEL based system

Tech Demo

Battery UPS, room temperature, sea level



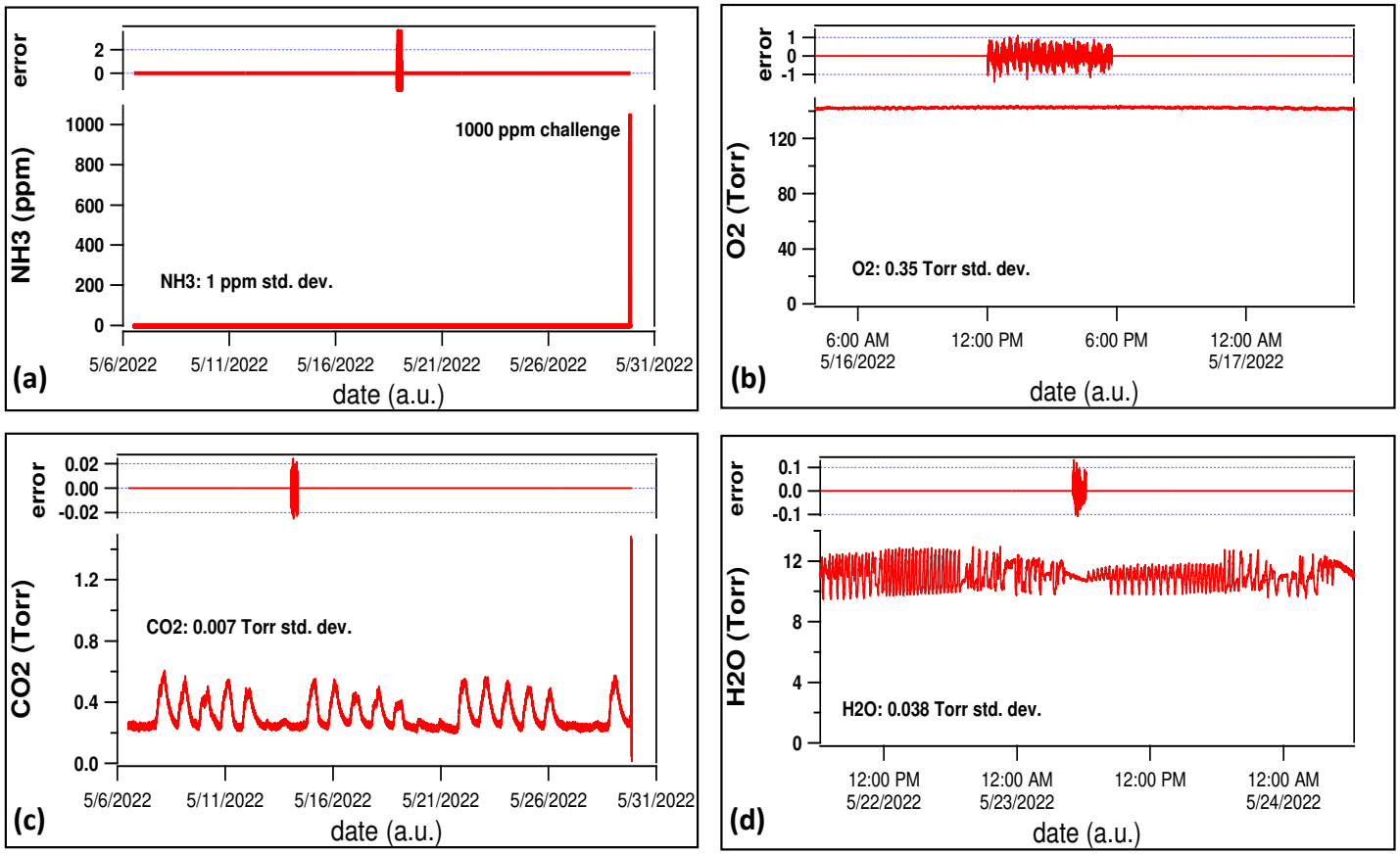
Calibrated/launched 2013 - Soyuz

On-orbit 2014-2016

Returned on Dragon 2017

Calibration good 2019

MGM – Ground Unit



VCSEL-WMS data for NH_3 (a), O_2 (b), CO_2 (c), and H_2O (d) demonstrating the ability to measure each of the gases. The measured standard deviation is included, which is used to calculate the limit of detection and accuracy for each gas.

Sensor performance

2013

MGM performance and physical parameters

Room temperature

Sea level

2019

Anomaly Gas Analyzer

Sensor requirements

-1 °C to 56 °C

9.5 to 15.6 psia (21.6 psia)

Mass	2.6 kg		
Volume	4.4 L		
Power	2.5 W		
Channel	Precision	Target Concentration Range	Actual Concentration Range
Ammonia	1.5 ppm	10 – 10,000 ppm	5 – 20, 000 ppm
Carbon Dioxide	20 ppm	500 – 25,000 ppm	250 – 30,000 ppm
Oxygen	0.05 %	14 – 32 %	4 – 36%
Water vapor	0.2 % RH	20 – 80% RH	2 – 90 % RH

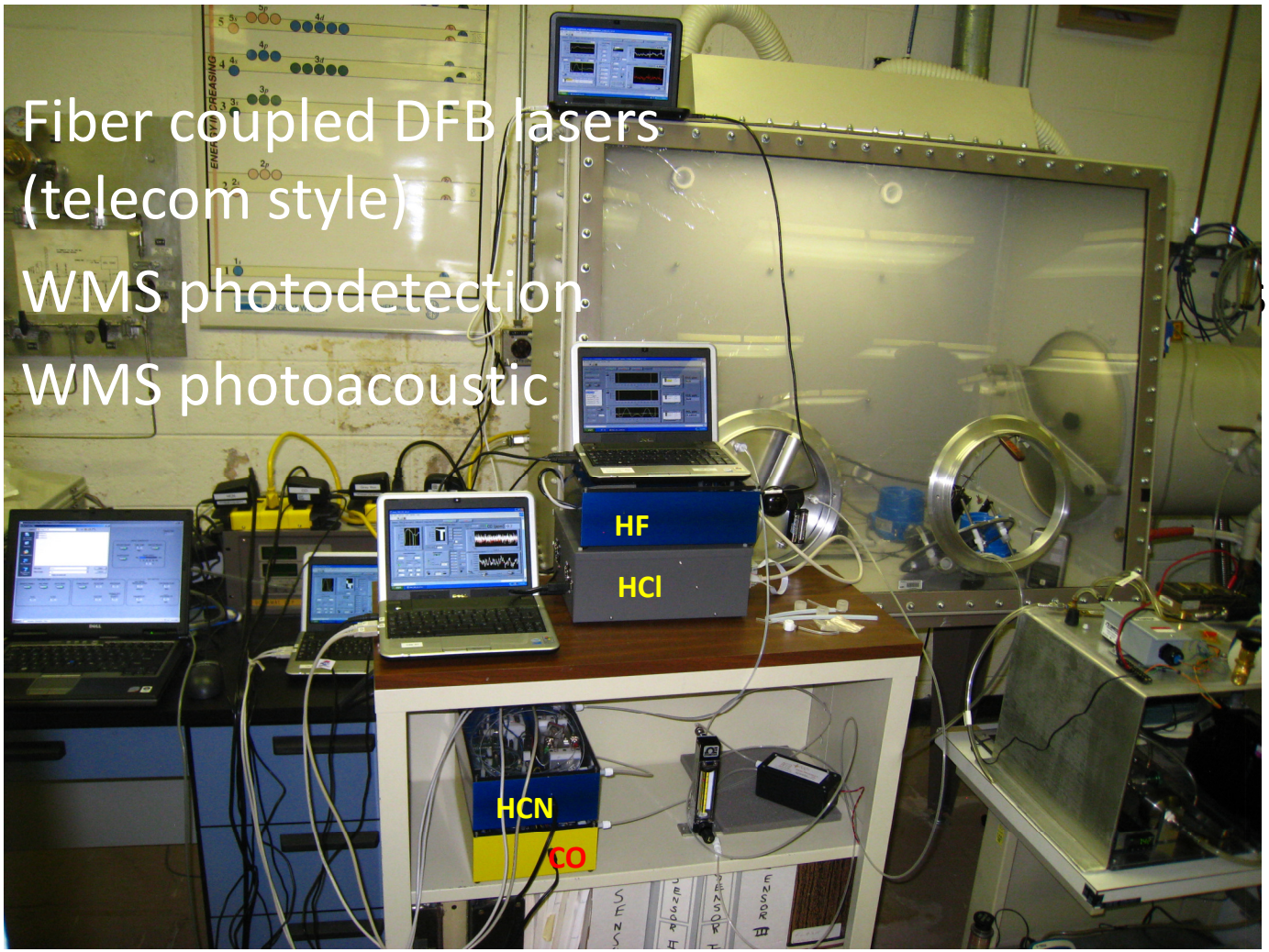
Not enough gases yet

AGA OPERATING RANGE AND ACCURACY REQUIREMENTS (JSC-47146)			
Target Gas	Operating Range	Accuracy	
CO	5 - 1000 ppm	± 5 ppm, ± 10%	55 ppm
O2	14 - 50 %	± 1 % (abs)	
CO2	395 ppm – 27,600 ppm	± 10 %	
HCN	2 - 50 ppm	± 25 %	
HCl	2 - 50 ppm	± 25 %	
HF	2 - 50 ppm	± 25 %	
NH3	10 - 30,000 ppm	± 2 ppm, ± 10 %, ± 25 %	20 ppm, 150 ppm
N2H4	2 - 10 ppm	± 2 ppm	

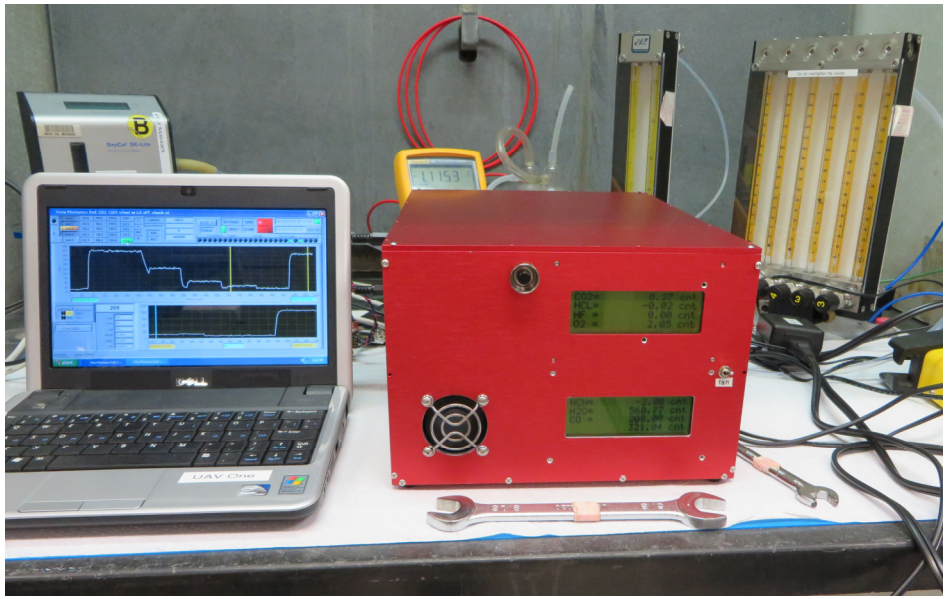
We need this stuff too

WSTF Combustion Products 2010

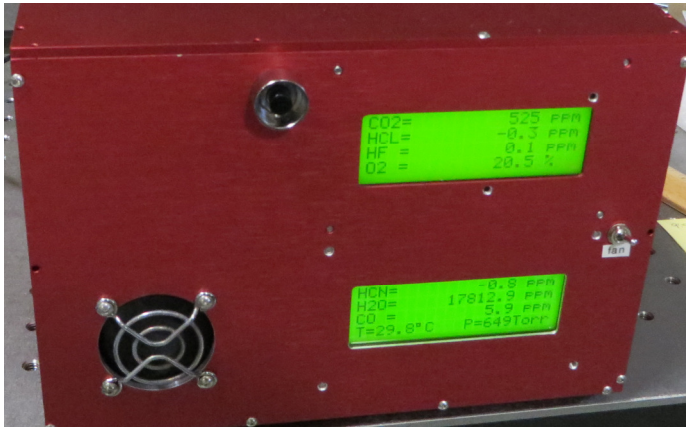
4 gases, 4 line powered systems, 4 computers



Combustion Products 2015



VCSELs, DFB & mid-IR ICL



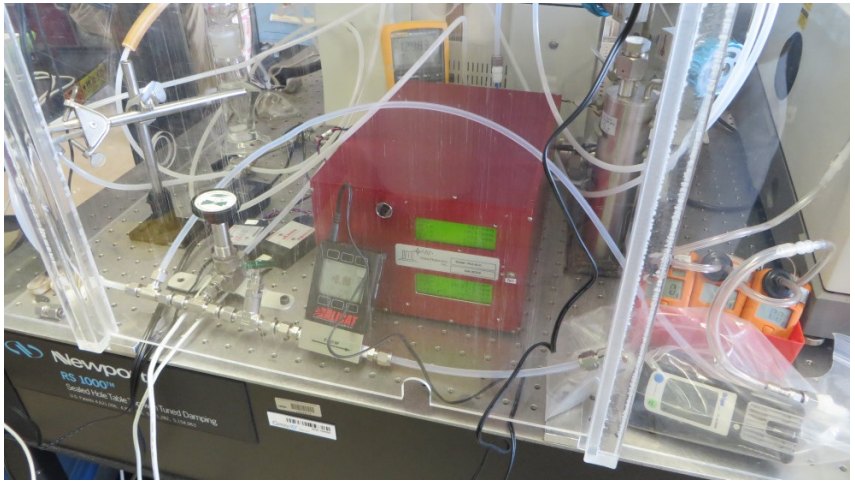
7-Gas Sensor Platform

Calibrated NASA JSC

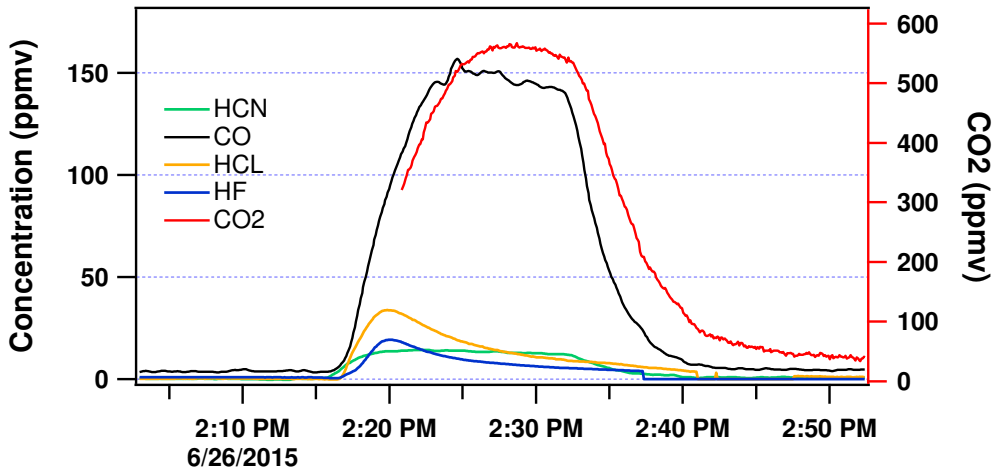
Combustion testing NASA GRC

Gases and Aerosols from Smoldering Polymers

(GASP)

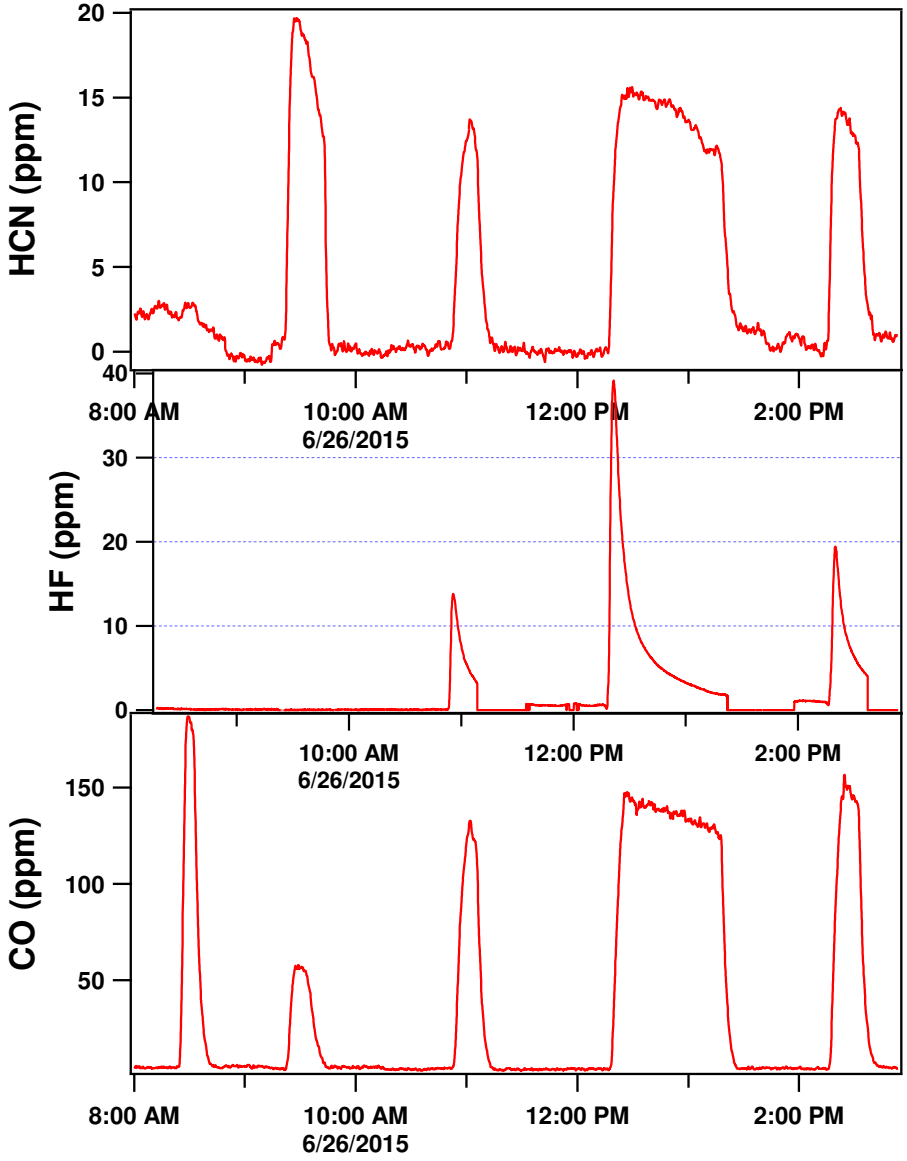


Combustion Products 2015



Combustion runs at GASP

cigarette-wool-wooly mix



Combined vs. Integrated 2017

Two complete systems in one box, wall power

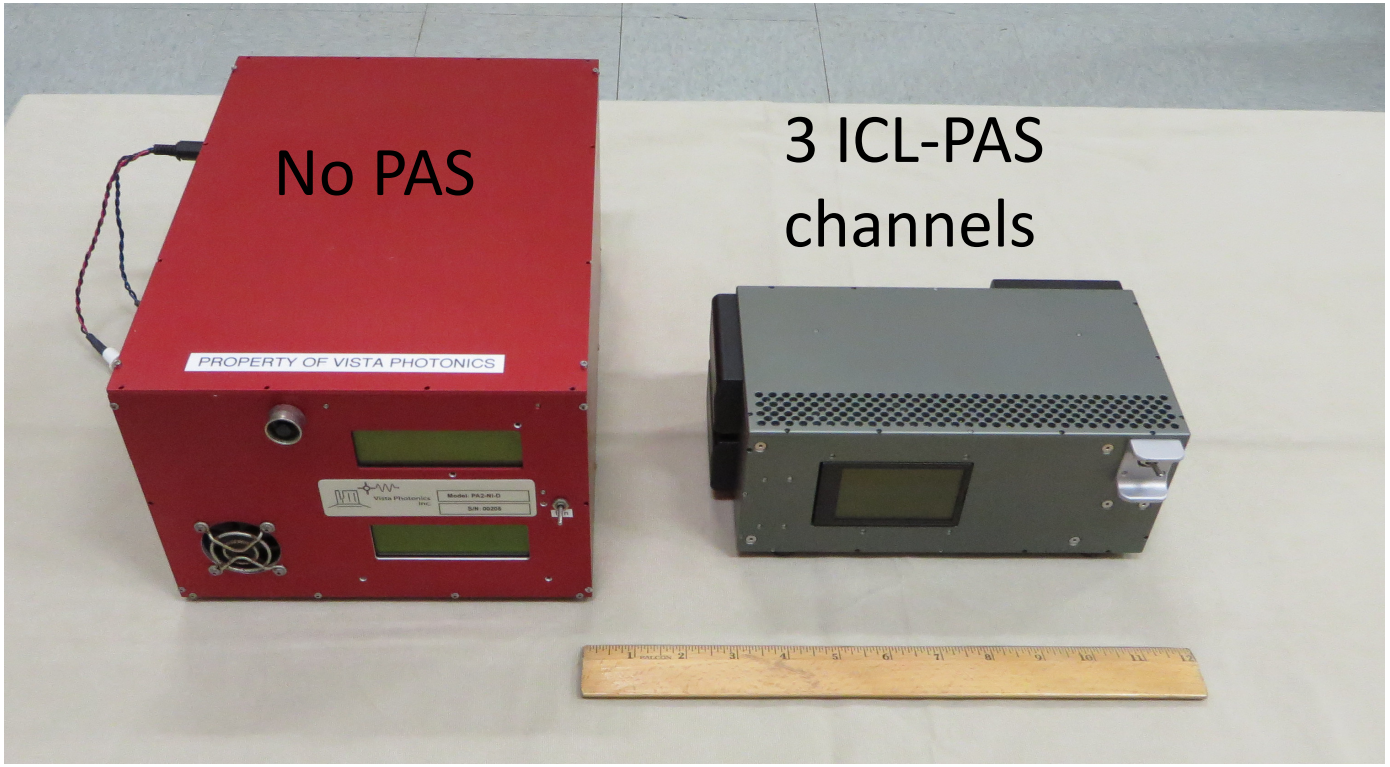
7-gases

Size driven by CO & HCN

One system in one box

9-gases on battery power

“free” hydrazine

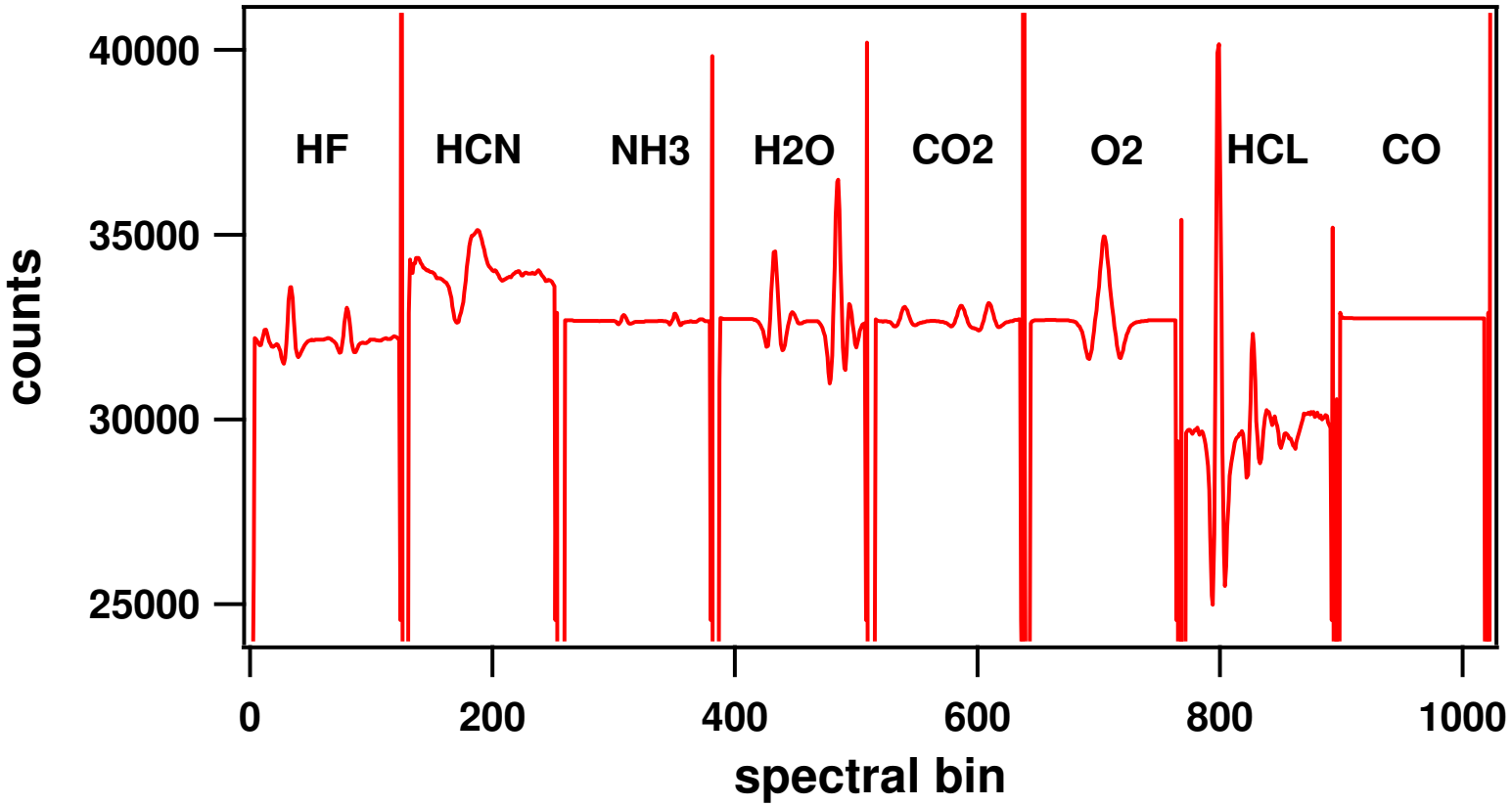


AGA with new hydrazine 2018

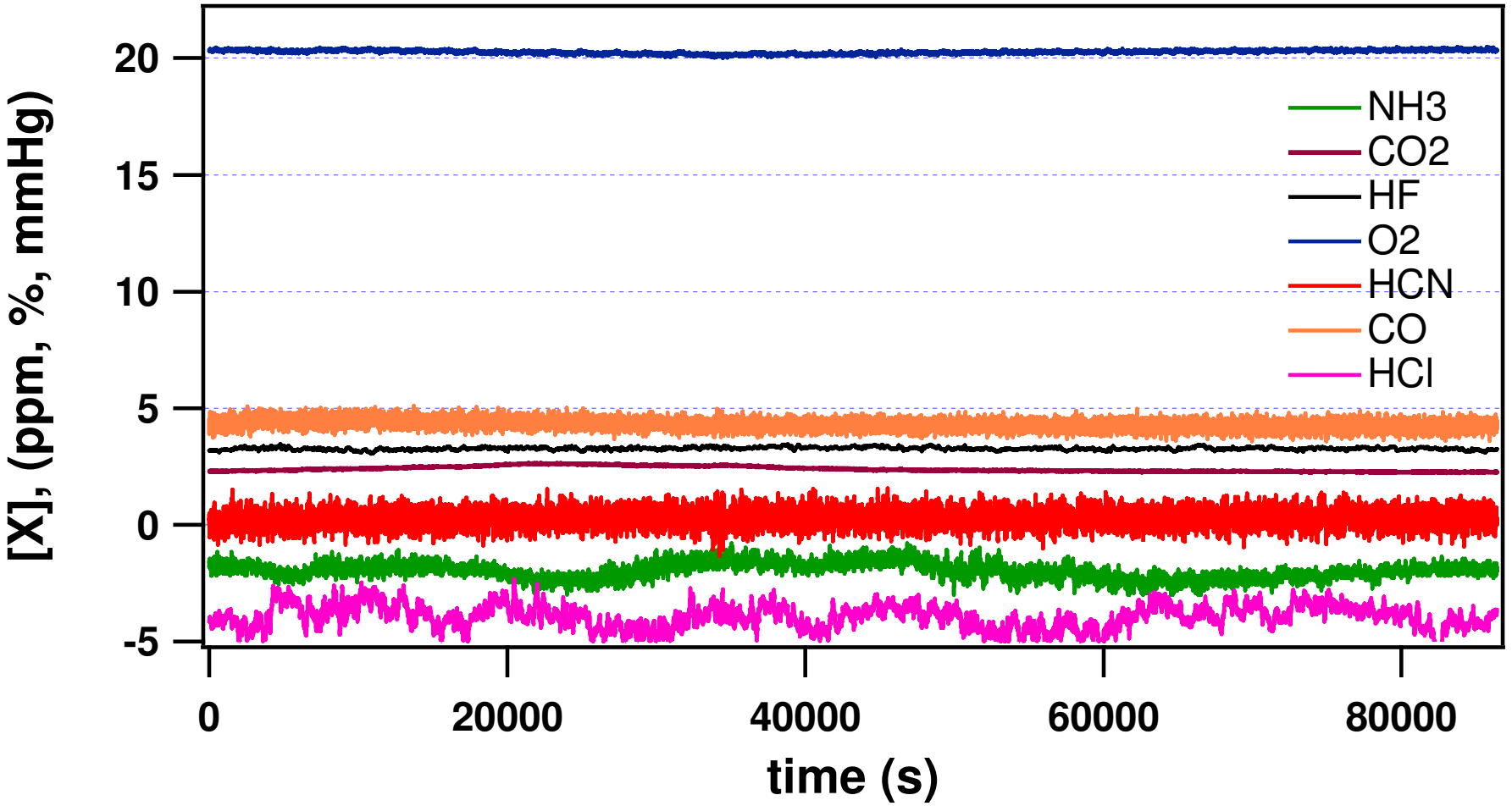
AGA engineering development units

Spectral analysis

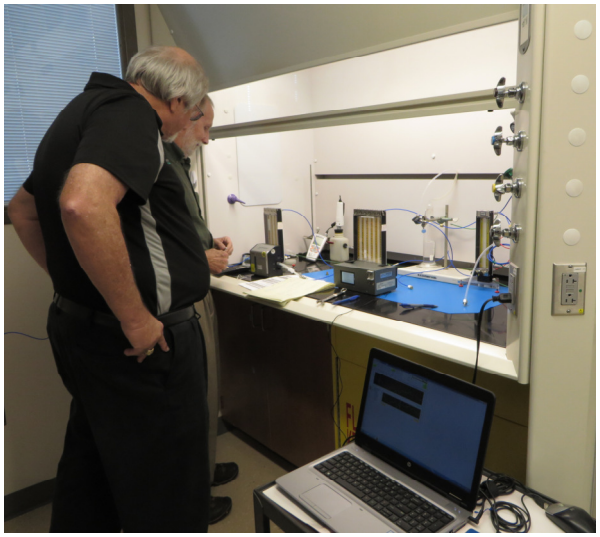
Anomaly Gas Analyzer on-orbit mode

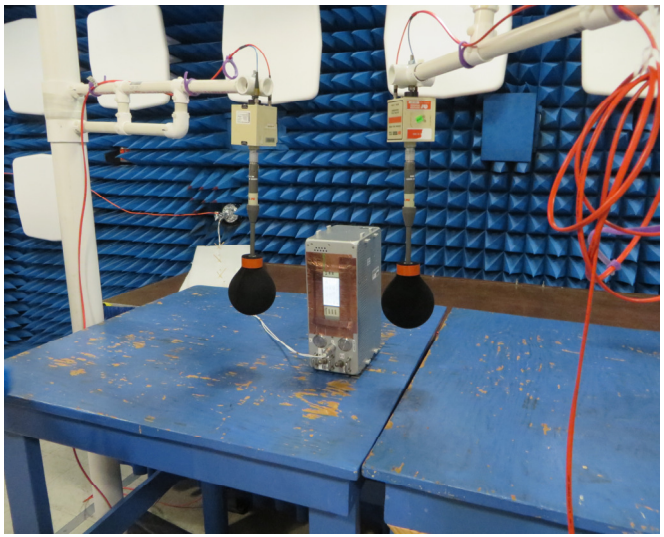


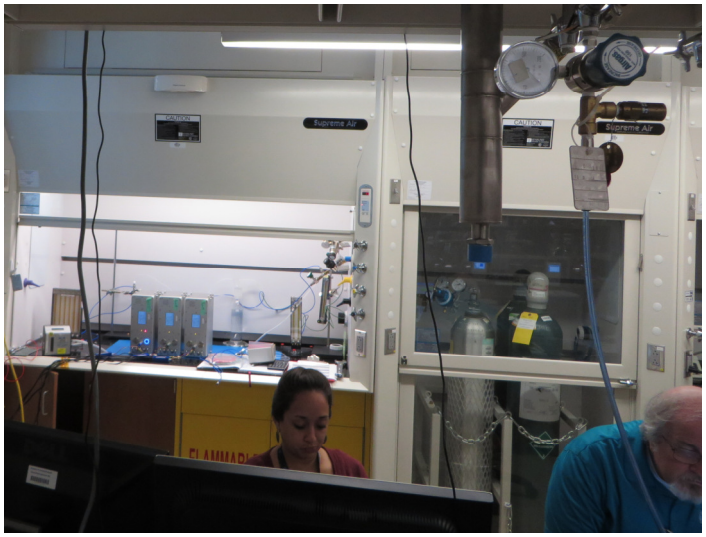
Sensor accuracy

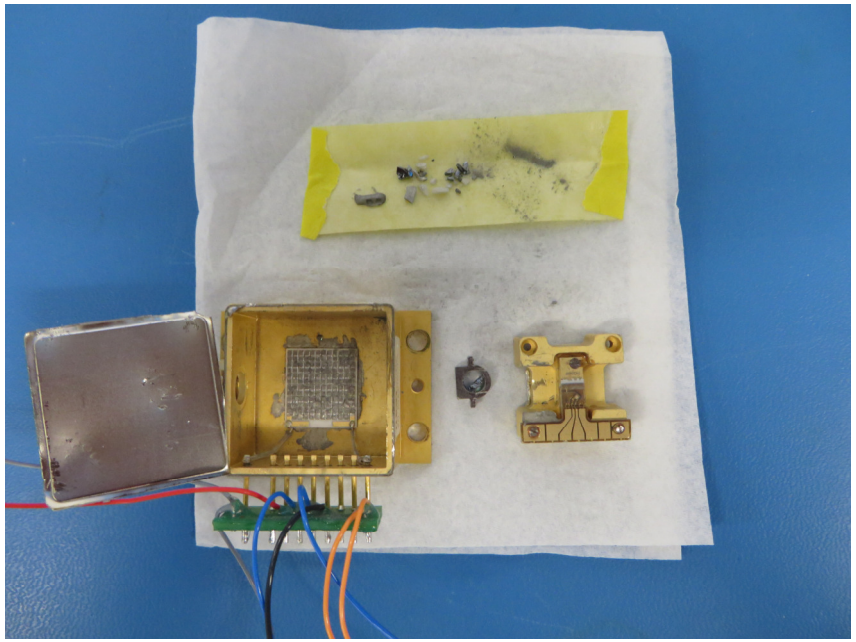


Test, test, test









AGA prototype:

Cross sensitivity determination

low RH affects CO

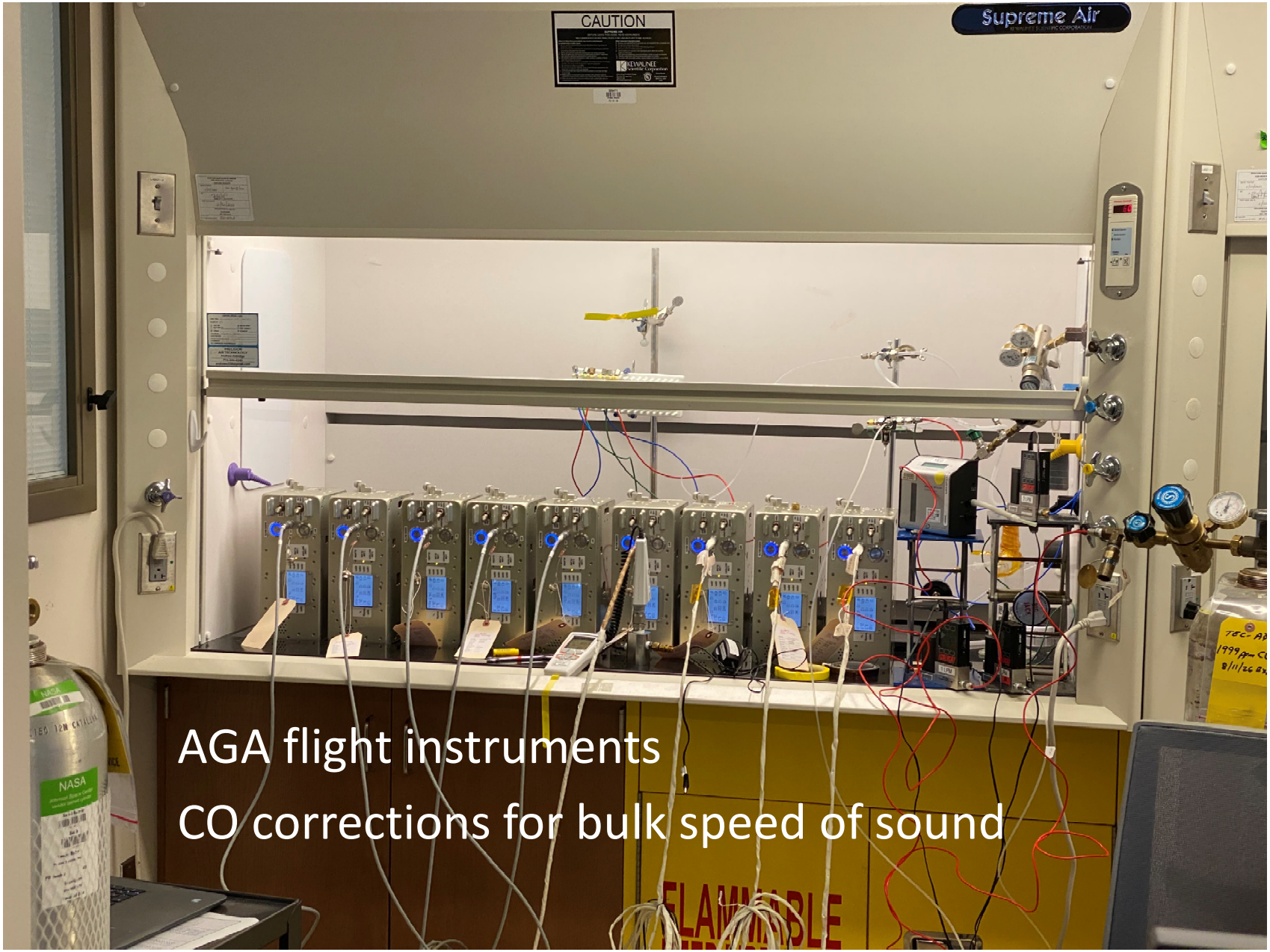
NH3 >300 ppm affects acid gases

AGA EDUs:

Radiation, EMI susceptibility, shock

Flight build 6/2020 to 10/2021

Flight calibrations 5/2022



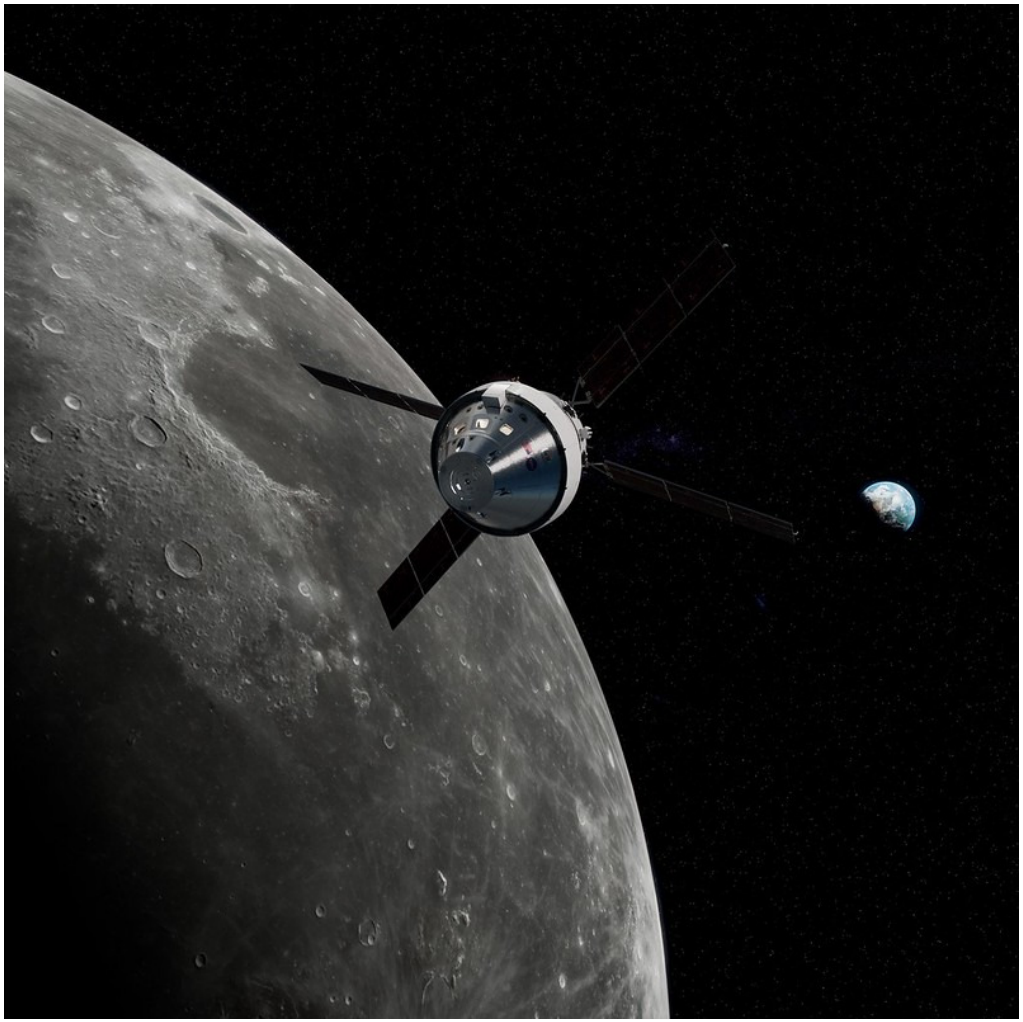
Present Evolution AGA 1.0

Mass	4.3 kg			
Volume	6.0 L			
Power	6.5 W			
Channel	Accuracy	Concentration Range	Display Resolution	Limit of Quantitation
Ammonia	2 ppm	10 – 30,000 ppm	1 ppm	3 ppm
Carbon Dioxide	0.2 mmHg	0.3 – 21 mmHg	0.1 mmHg	0.1 mmHg
Oxygen	1 %	14 – 50 %	0.1 %	0.3 %
Water vapor	N/A	1.9 – 40 mmHg	N/A	
Carbon Monoxide	5 ppm	5 – 1,000 ppm	1 ppm	2 ppm
HF	1 ppm	2 – 50 ppm	1 ppm	0.6 ppm
HCl	1 ppm	2 – 50 ppm	1 ppm	2.7 ppm
HCN	1 ppm	2 – 50 ppm	1 ppm	2.1 ppm

- AGA runs on 2 camcorder batteries for 10 + hours
- 7” x 11” x 4.5”
- Pressure corrected for operation from 9.5 to 15.6 psia
- Temperature corrected for operation from -1 to 56 Celsius

Testing in Orion Mock-up 12/2022

Artemis 2 April 2026



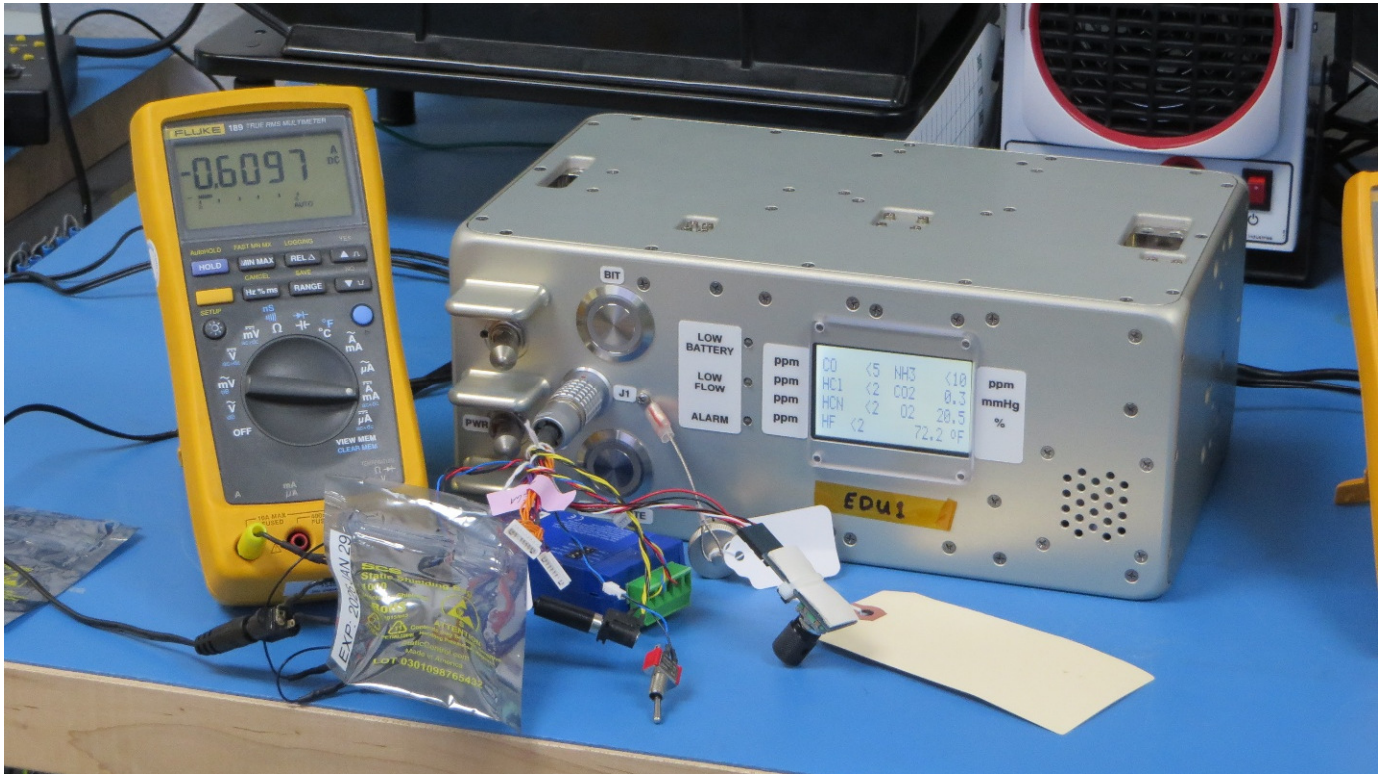
Two Anomaly Gas Analyzers onboard, non-standard

1 for LAM contingency

Artemis 2 April 2026

Brian or Nick, Can I get a photo of AGA running on Artemis 2?

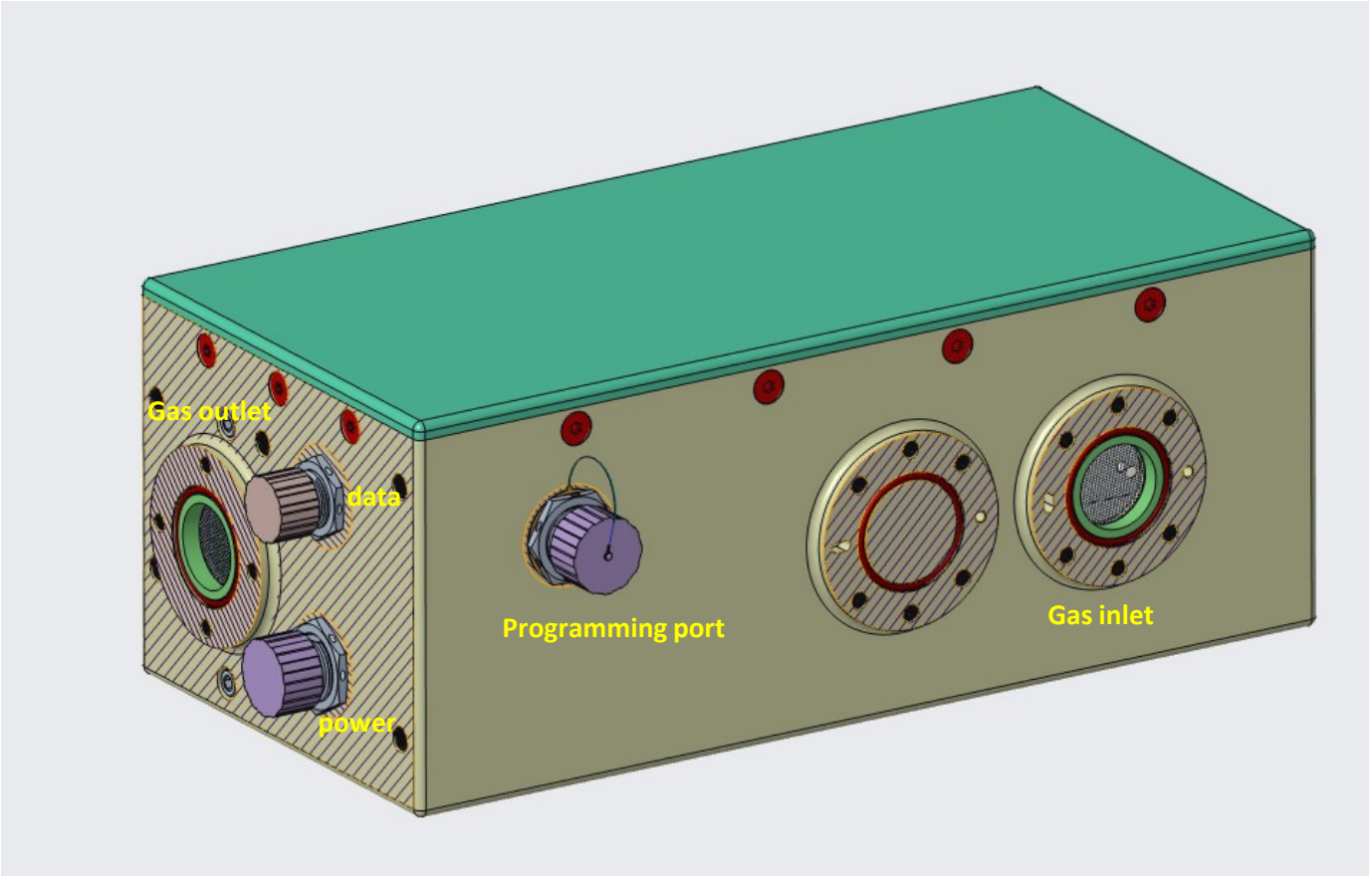
HLS AGA 2026 (v. 1.5)



- Remote on/off
- Software/firmware through front panel
- Parameterize system through front panel
- Better thermal isolation for PAS
- Fireport mode

Gateway (HALO) 2026

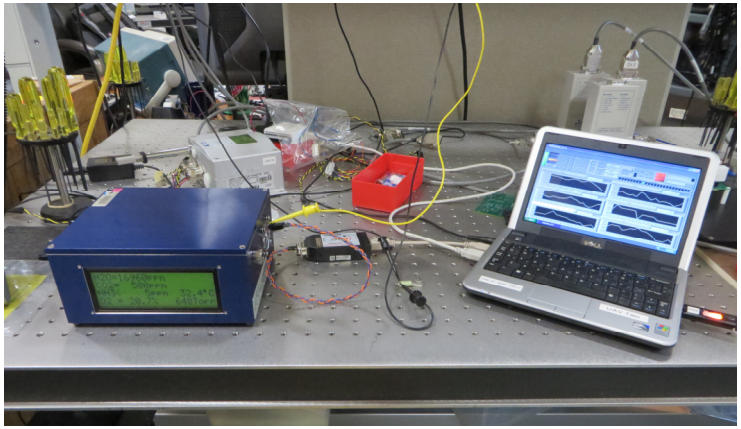
HALO PCM (paused)



Mass	4.54 kg		
Volume	5.35 L		
Power	3 – 4 W		
Temperature	4 – 27 C		
Pressure	9.5–15.2 psia		
Channel	Accuracy	Concentration Range	Display Resolution
Carbon Dioxide	10 %	1 – 16 mmHg	0.1 mmHg
Oxygen	0.5 %	97.5 – 190.5 mmHg	1 mmHg
Water vapor	5 %	0.5 – 25.7 mmHg	0.1 mmHg

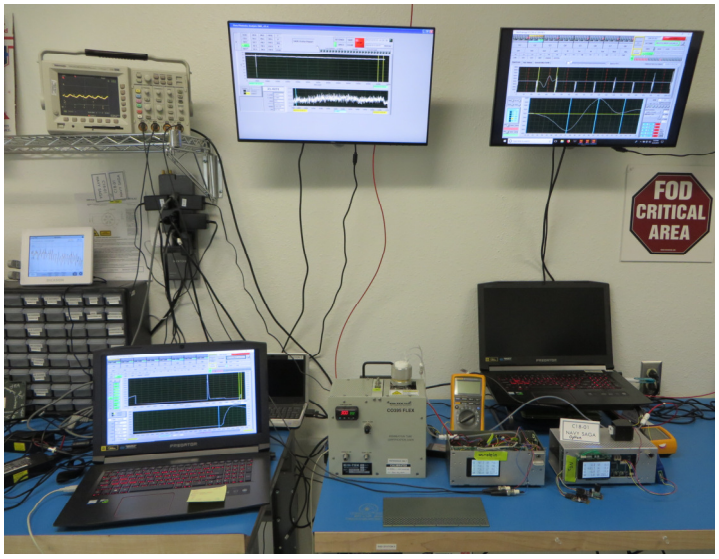
Submarine sensor development

MGM for sea trial (2017)



NASA SENSORS

AGA for sea trial



NAVY SENSORS

SBIR submarine AGA development

NAVSEA Phase 1, Option, Phase 2

2018-2022

NH3, CO2, CO, C2H4, O2, H2O, R134a, R12, NO2, N2O, formaldehyde, acrolein

Submarine sensor development

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NASA JSC: Jeff Doi, William Wallace

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Vista Photonics: Bill Wood, Miguel Casias, Ivan White

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