Development of a Global Air Quality Satellite Constellation

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EAS
ENVI ANALYTICS SYMPOSIUM

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Air pollution is obvious to see…

A clear day in Beijing

A smoggy day in Beijing

https://upload.wikimedia.org/wikipedia/commons/a/a4/Beijing_smog_comparison_August_2005.png

The unseen effects of air pollution

Air pollution causes 1 in 8 deaths globally

Air pollution damages crops

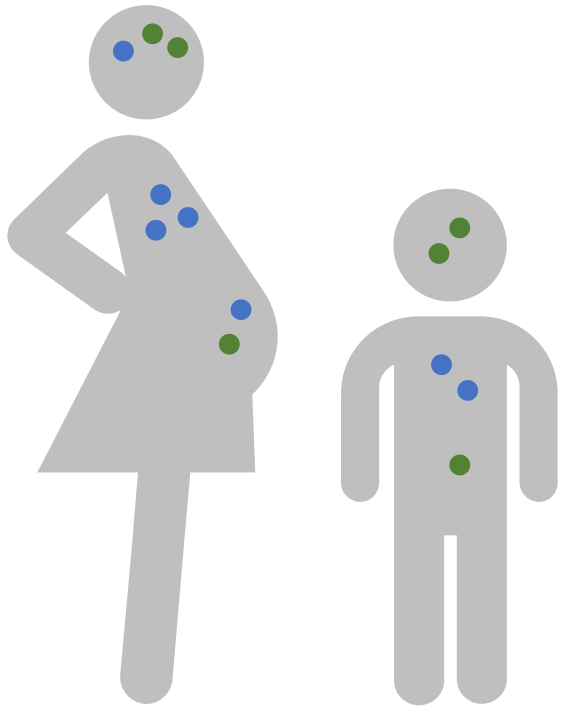
92 per cent of the global population live in places with unhealthy air quality

The unseen effects of air pollution

Corporate Concerns of Pollution

- Liability Management
- Risk Mitigation
- Disaster Avoidance
- Compliance
- Corporate Social Responsibility
- Fiscal Responsibility
- Brand Management

Health Effects of Pollution



Accepted Effects:

Shorter life
Stroke
Heart disease
Asthma
Lung cancer
Reduced lung function
Low birth weight

Possible Effects:

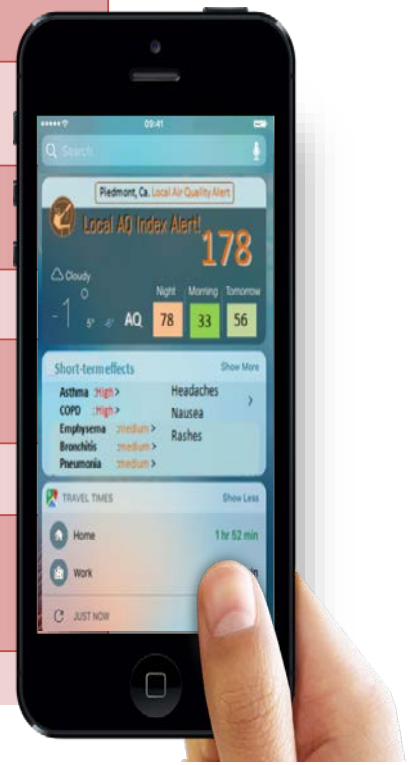
Learning disabilities
Alzheimer's
Depression
Autism
Obesity
Birth defects
Diabetes

Use case: Healthcare

Air Quality Index Levels of Health Concern	Numerical Value
Good	0 to 50
Moderate	51 to 100
Unhealthy for Sensitive Groups	101 to 150
Unhealthy	151 to 200
Very Unhealthy	201 to 300
Hazardous	301 to 500

Today

Symptom	Exposure	Pollutant	Effect	Actionable
Myocardial infarction (MI	25 µg/m³ $PM_{2.5}$ 2 hours	<PM2.5 ambient air	28%-41% increase per exposure *1996	√
In Utero development	Accumulative 9 months	Diesel exhaust VOC $PM_{2.5}$ -PM_{10}		√
Renal function cardiovascular	Accumulative	> $PM_{2.5}$ ambient air VOC		√
Systemic Lupus	1-7 days Accumulative	> $PM_{2.5}$, BC, and NOx, 03		√
Asthma	15 min Accumulative	Urban PM_{10} PM_{100} NO2 CO VOC O_3		√
Atherosclerosis		>$PM_{2.5}$ ambient air		√
Cardiopulmonary disease	14 days Accumulative	>$PM_{2.5}$ ambient air	21 % Acute decompensated heart failure (ADHF)	√
Respiratory	1-3 days	Urban $PM_{2.5}$		√

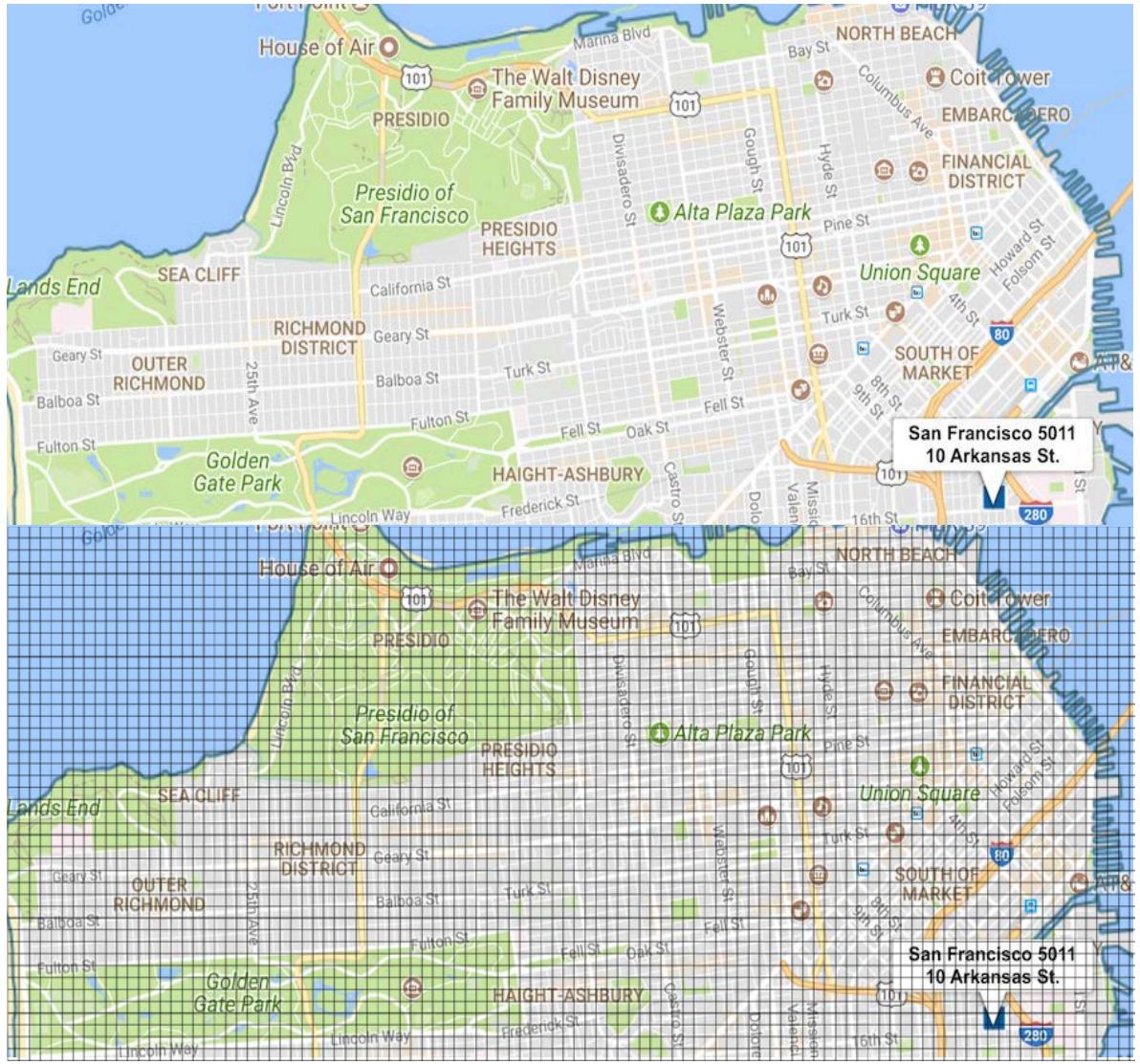


Tomorrow

Use case: Monitoring and compliance

Before

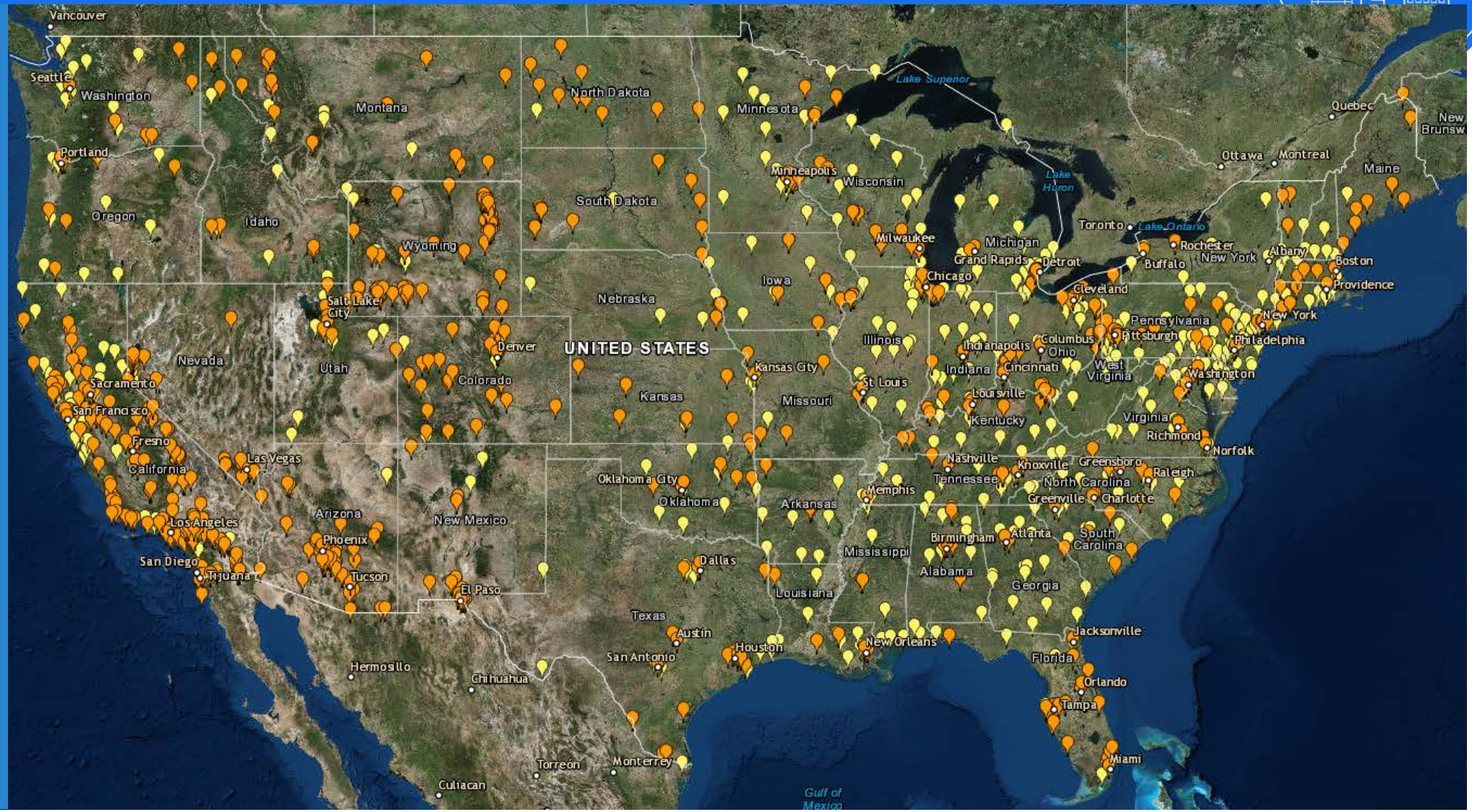
After



The limits of “free”

Active National Terrestrial Monitoring Stations

- PM 2.5 Monitoring Stations
- PM 10 Monitoring Stations



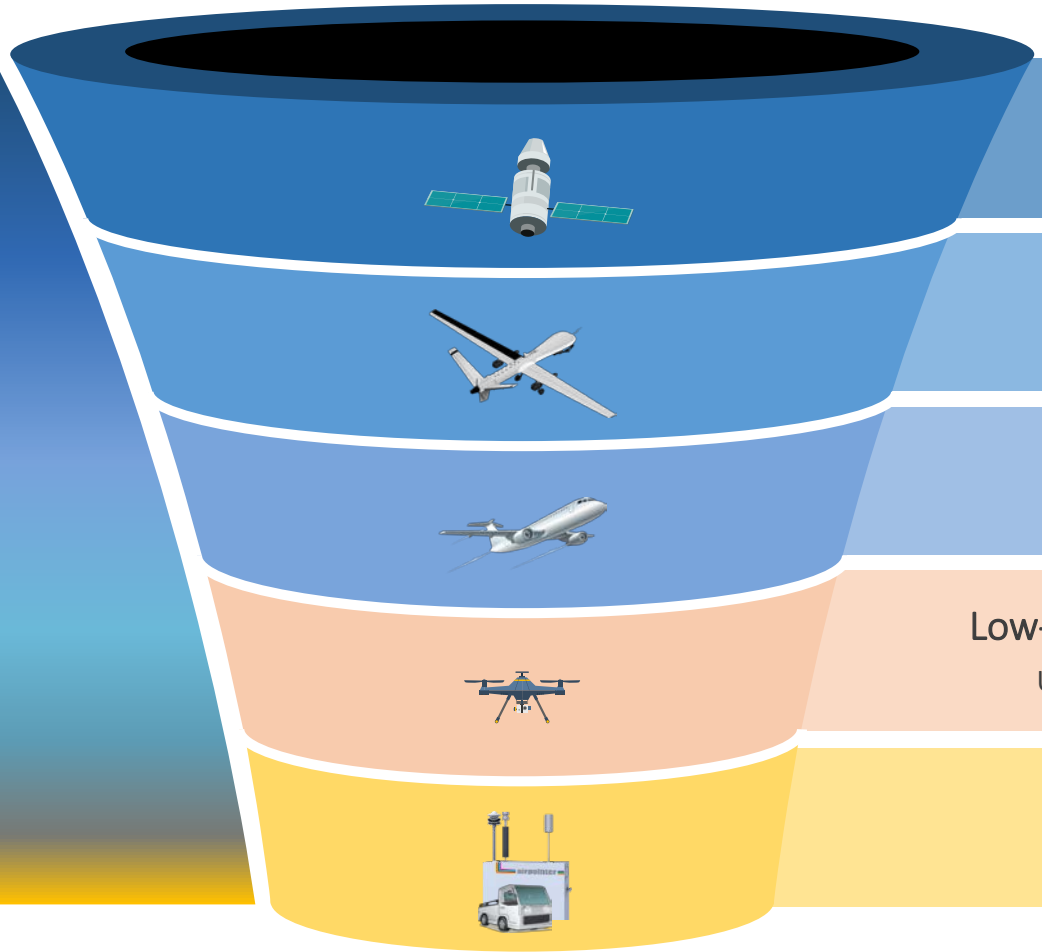
How can we improve monitoring?

- Develop a satellite constellation to provide global updates many times a day

System of systems approach

Air Pollution:

- Particulates, ozone, nitrogen oxides, volatile compounds, carbon monoxide, CO_2 and methane



LEO Satellites
up to 500 miles

High-Flying UAVs
up to 60,000 feet

Aircraft
up to 45,000 feet

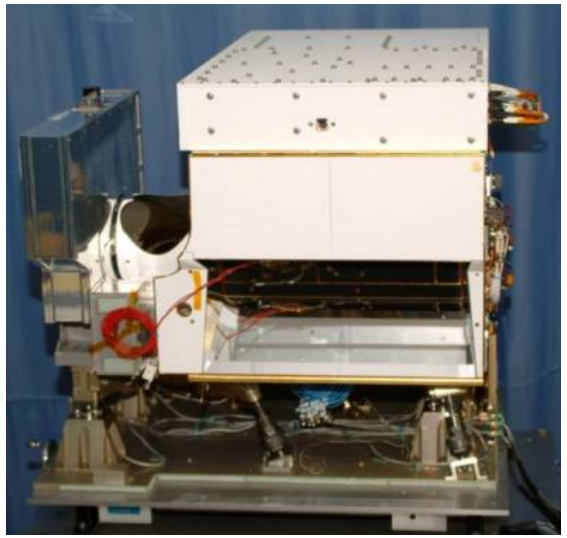
Low-Flying Drones
up to 500 feet

Mid-Range UAVs
up to 12,000 feet

Ground
up to 30 feet

L3Harris space heritage

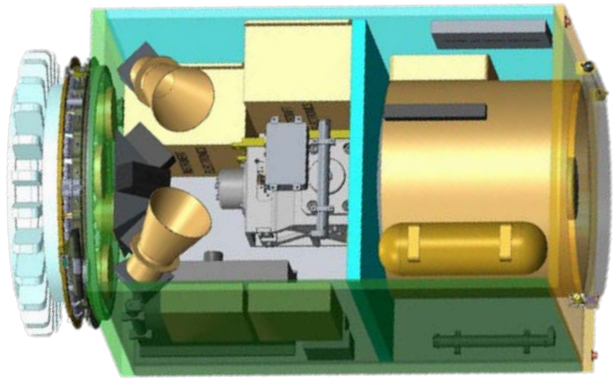
CrIS (On-Orbit Since 2011)



- 2211 spectral channels
- 3.9-15.4 microns
- 0.625 cm^{-1} resolution
- Superb on-orbit performance
- Four CrIS instruments expected in orbit

GOSAT-2 (2018 Launch)

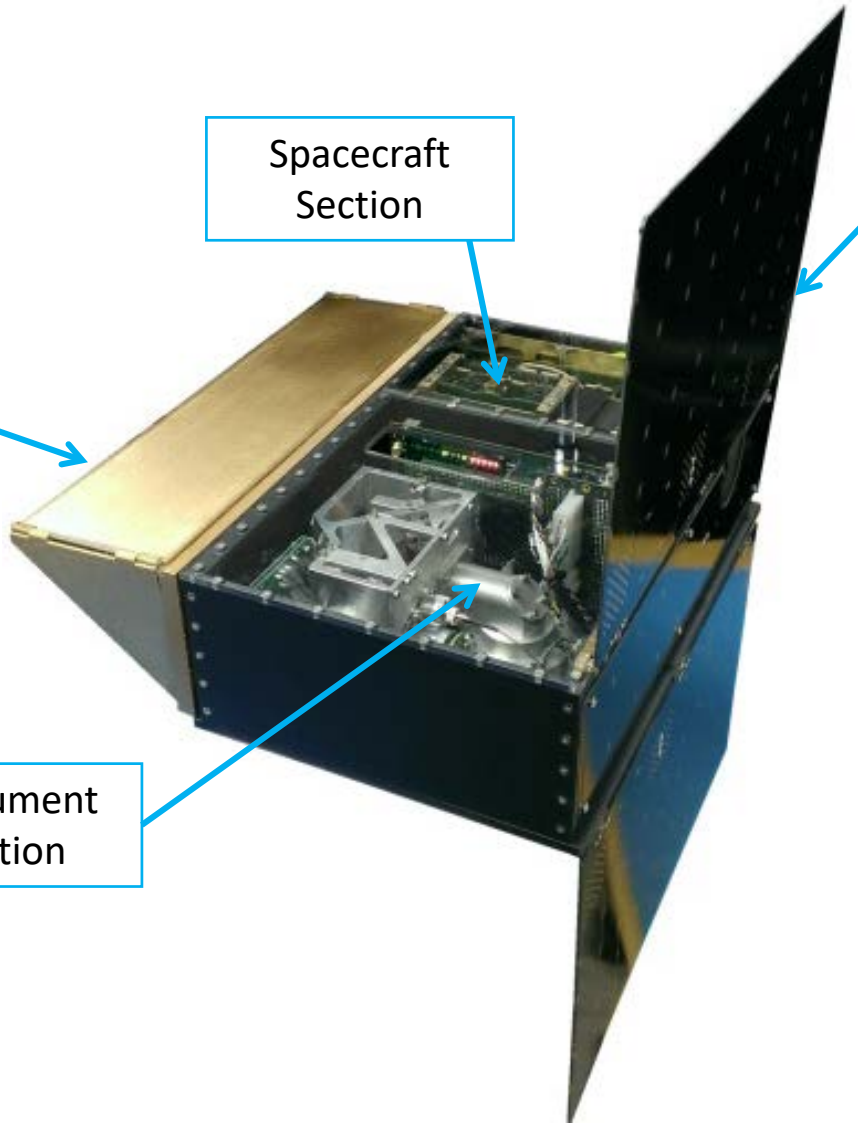
- 10,380 channels
- 0.75-14.3 microns
- 0.2 cm^{-1} resolution



L3Harris HyperCube™

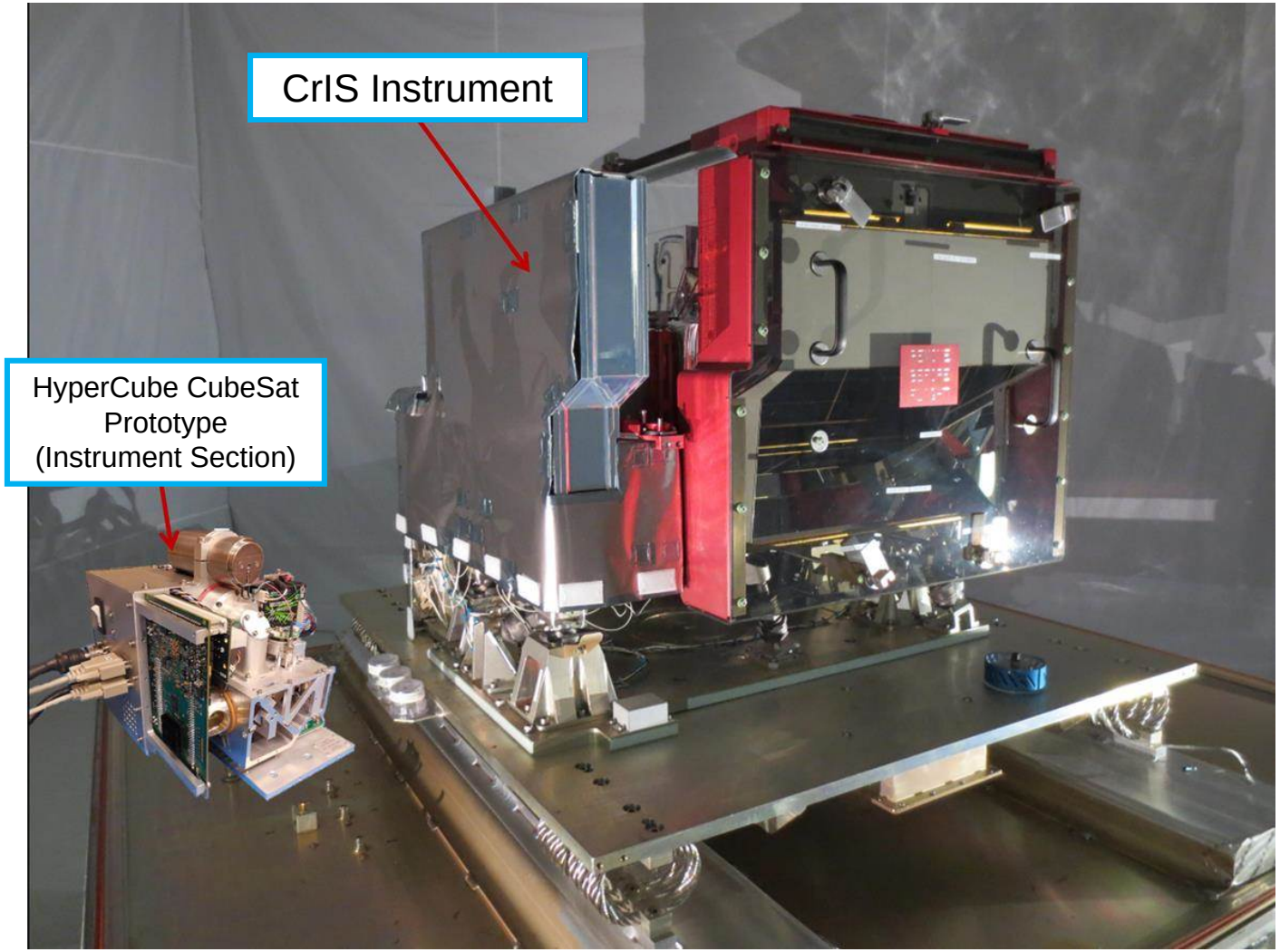
- 6U compatible
- SWIR / MWIR / LWIR
- 637 channels

Hypercube™



Parameter	Value
Spectral Range	5.7 – 8.3 microns
Spectral Resolution	1.26 cm^{-1}
NEdN	0.15 $mW/(cm^{-1} m^2 sr)$
Swath	1351 km
GSD	4.0 km; 20x20 array
Mass	5 kg
Power	20 W

Hypercube vs CrIS



High resolution example

- In this scenario, a single satellite provides high spatial and SNR

Thank-you!

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