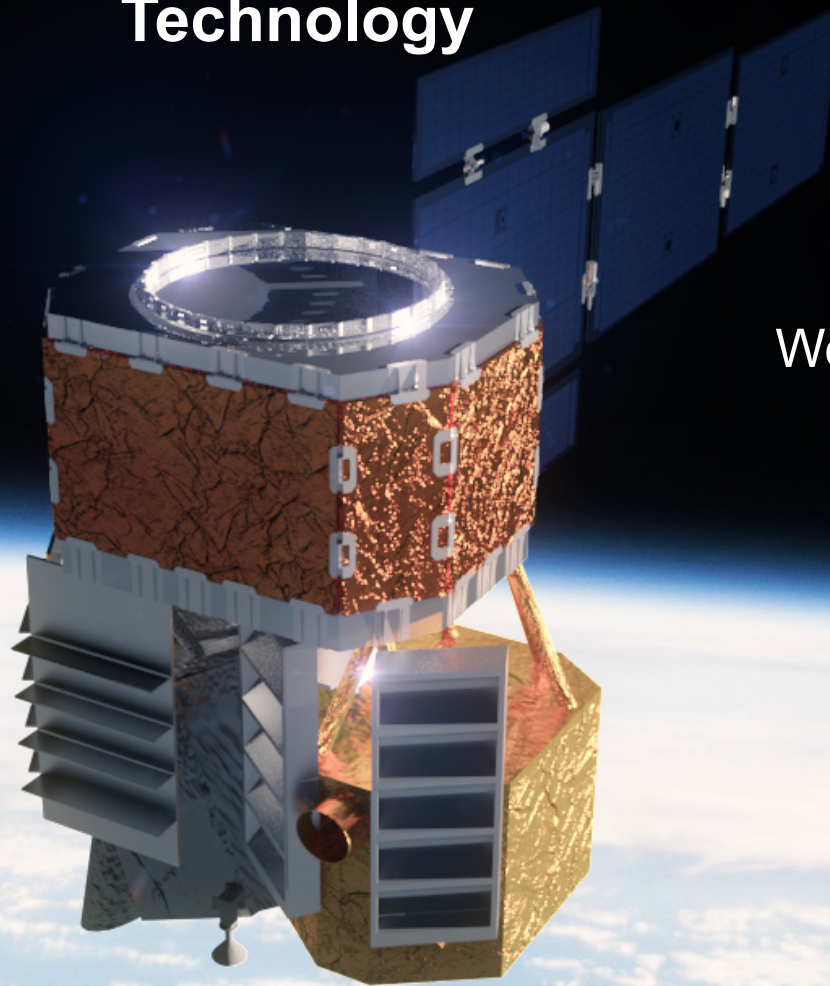# 2016 HyspIRI Mission Concept Study:
Combined VSWIR, TIR and IPM With Current Technology

Robert Green, Simon Hook, Bill Johnson, Michael Mercury and HyspIRI Team
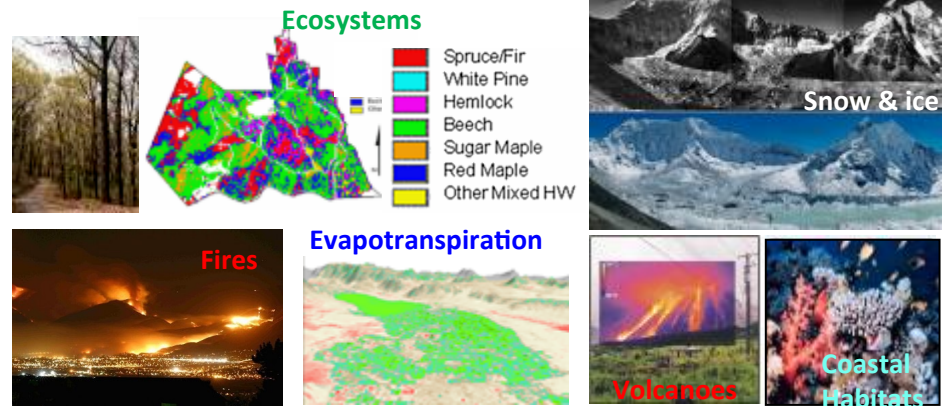
HyspIRI Workshop 2016

Contents

- Science Summary

- Mission Concept Lineage

- 2016 Concept Overview

- Orbit + Coverage

- HyspIRI Payload (VSWIR, TIR, IPM)

- Spacecraft

- Telecom link

- MOS/GDS

- Conclusion

HyspIRI Science Summary

HyspIRI Science

- **Climate:**
  - Ecosystem biochemistry, condition & feedback; spectral albedo; carbon/dust on snow/ice; biomass burning; evapotranspiration

- **Ecosystems:**
  - *Global* biodiversity, plant functional types, physiological condition, and biochemistry including agricultural lands

- **Fires:**
  - Fuel status; fire frequency, severity, emissions, and patterns of recovery *globally*

- **Coral reef and coastal habitats:**
  - *Global* composition and status

- **Volcanoes:**
  - Eruptions, emissions, regional and *global* impacts

Ecosystems

- Spruce/Fir
- White Pine
- Hemlock
- Beech
- Sugar Maple
- Red Maple
- Other Mixed HW

Snow & ice

Fires

Evapotranspiration

Volcanoes

Coastal Habitats

- **Geology and resources:**
  - *Global* distributions of surface mineral resources and improved understanding of geology and related hazards

- **Applications:**
  - Disasters, EcoForecasting, Health/AQ, Water

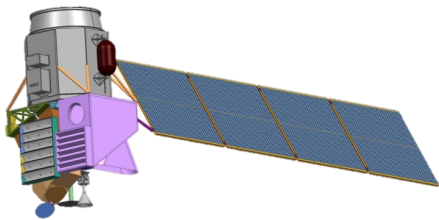**Preparatory airborne campaigns have been advancing and refining science, applications, algorithms, and processing**

Mission Concept Lineage

- ## Level 1 Measurement Requirements
  - Vetted by community at workshops and in literature (many refereed journal articles)
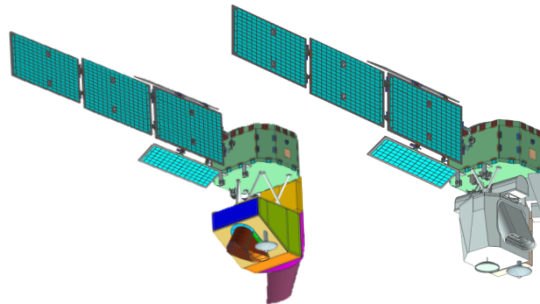
- ## Implementation options:

Original HyspIRI Baseline (2012)

VSWIR 60 m / 19 day
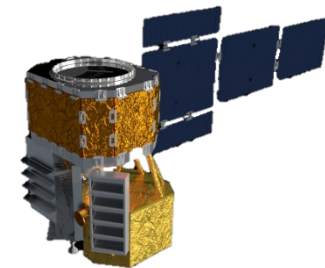
TIR 60 m / 5 day

3-5 years

SmallSat Free-Fliers (2015)

VSWIR 30 m / 16 day

TIR 60 m / 4 day

2 years

Meets SLI Rqt's

Updated HyspIRI Baseline (2016)

VSWIR 30 m / 16 day

TIR 60 m / near 4 day

3-5 years

Meets SLI Rqt's

2016 Concept Overview

- ## 2016 Mission Concept Goal
  - Update the HyspIRI mission concept baseline to use the latest developments in instrument, spacecraft and ground systems.
  - Use only existing technology
    - PHyTIR, ECOSTRESS and CWIS have brought the latest TIR and VSWIR to >= TRL 6
    - IPM based on Space cube 2.0 >= TRL 6
    - Flight system, Ground System and Science Data System all use existing technology
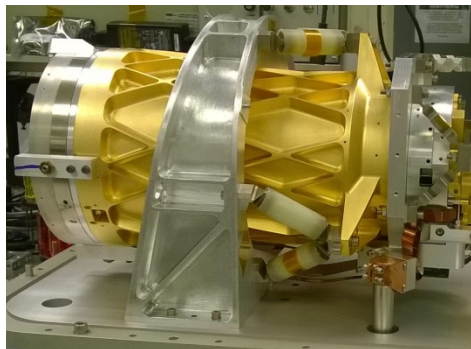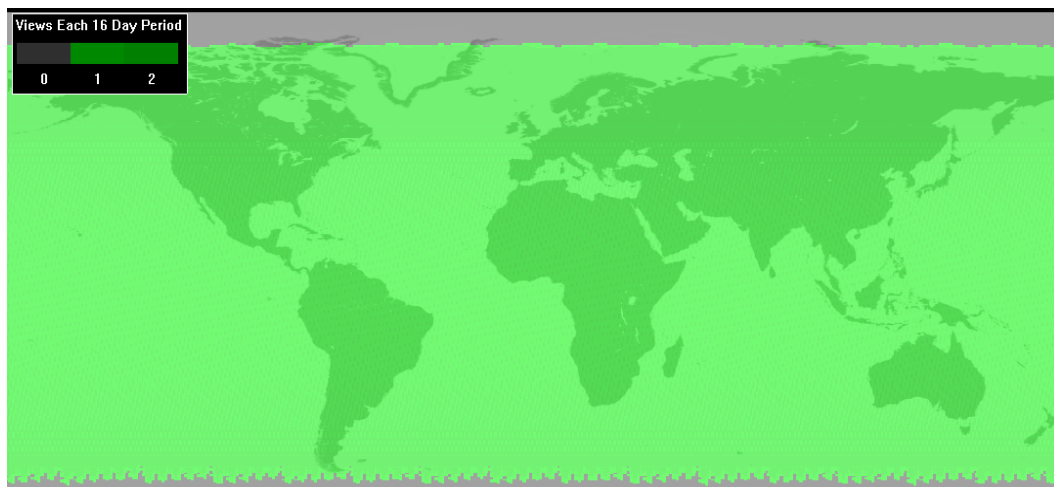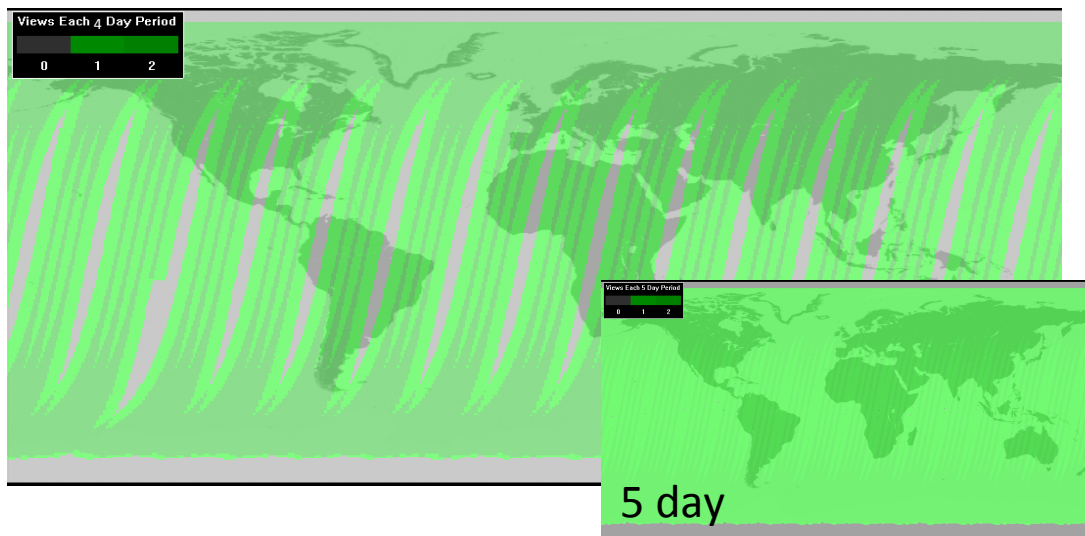

SLI Swath Dyson
(CWIS)

PHyTIR

Orbit and Coverage

504 km Sun Synchronous Orbit (10:30 AM LMTDN)

- 16 day global coverage for VSWIR

- 4 day near-global coverage for TIR
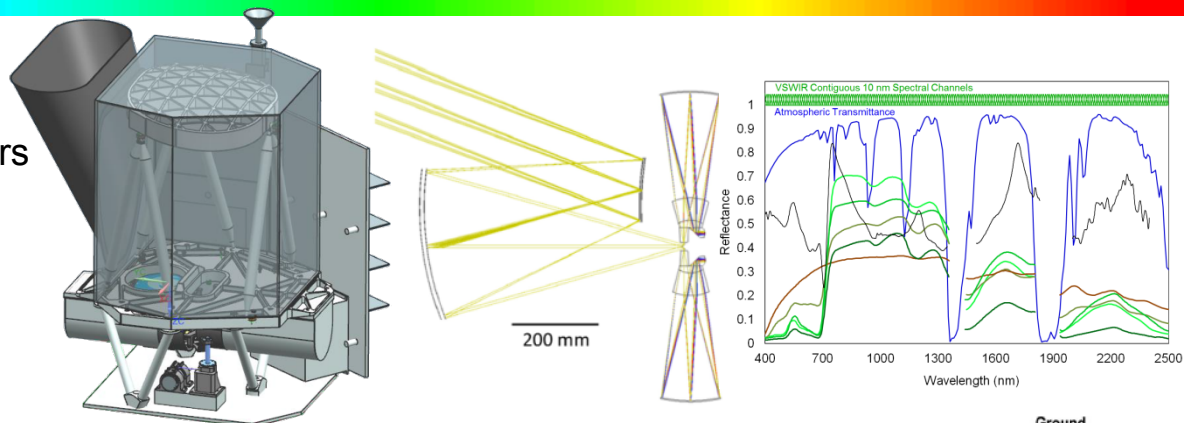
  – Full coverage in 5 days
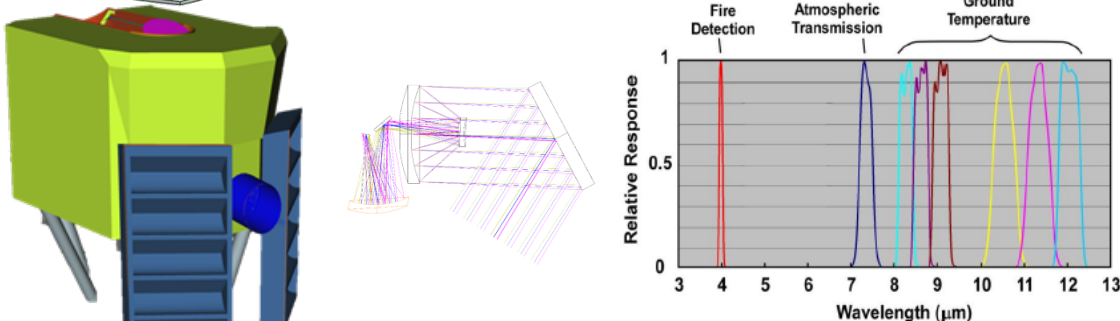

5 day

HysplRI Payload

- ## VSWIR
  - 2x CWIS Dyson spectrometers
  - 185 km swath
  - 30 m resolution
  - 83 kg
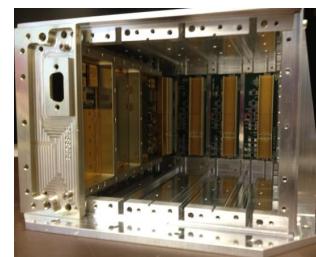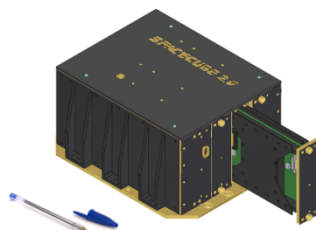 - 100 W

- ## TIR
  - PhyTIR Demo on ECOSTRESS
  - 518 km swath
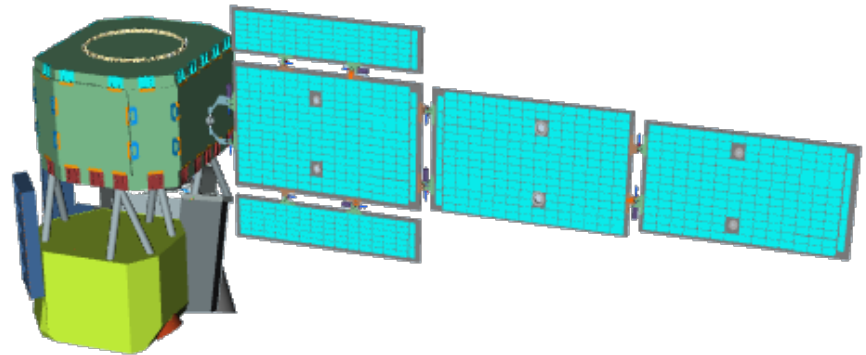 - 60 m resolution
  - 48 kg
  - 170 W

- ## IPM
  - Four Card Flight Unit
  - 5 x 7 x 9 inches
  - 5.8 kg
  - 20 watts (typical)

Spacecraft Payload Capability

- Solutions from various multiple vendors can accommodate payload (CBE):
  - 137 kg
  - 290 W
  - 450 Gb / orbit
  - 400 GB onboard storage (7 nominal orbits worth of storage)
  - Pointing (3 sigma):
    - 36 arcsec knowledge
    - 6 arcsec/frame stability
    - 0.25 deg control

Telecom Link

- 1 Gbps Ka-Band single polarization link using QPSK modulation

- Uses Ka Modulator (KAM) and Solid State Power Amplifier (SSPA) developed for NISAR Program (Launch in 2020)

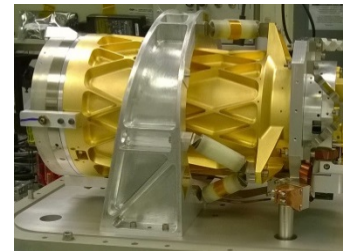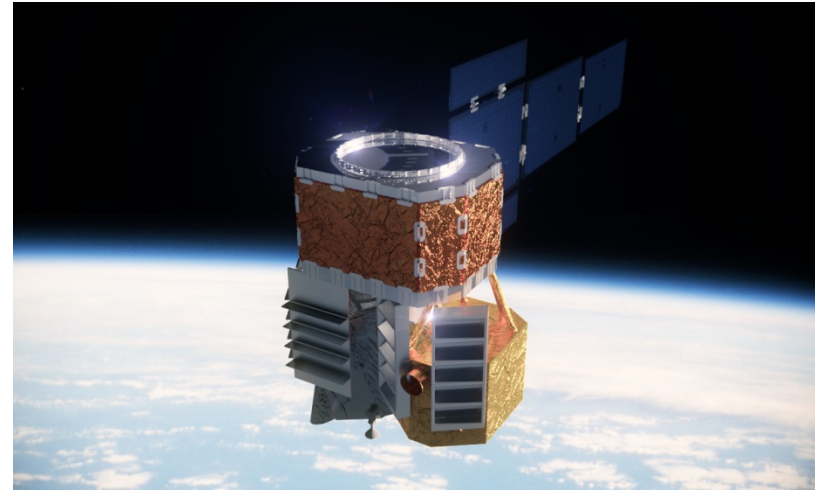- 2 axis gimbal to maximize downlink time per orbit

MOS/GDS + Onboard Compression

- MOS/GDS
  - HyspIRI preparatory campaign data system experience
  - Ka Band being planned on NiSAR (Launch in 2020)
  - Uses ground stations operated by KSAT through the NEN in Svalbard and Antarctica
    - Ka-band already in use at those locations
  - 10 minutes of ground station access each orbit
  - 600 Gb per orbit capability
    - 450 Gb orbit average data volume
- Onboard Processing
  - 4:1 Fast lossless compression (Klimesh, Kiely, Yeh)
  - Cloud screening using 0.45 and 1.25 µm channels (Thompson et al.)
- Ground processing
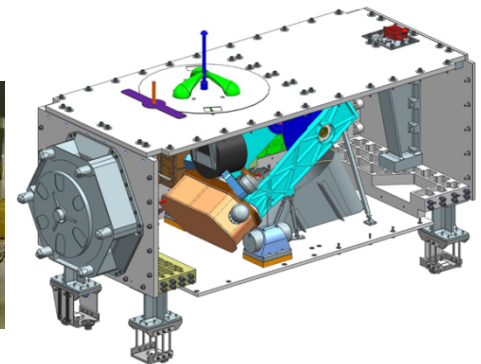 - HyspIRI airborne preparatory campaign pipeline demonstrated

Conclusion

- 2016 HyspIRI Mission Concept:
  - VSWIR: 16 day / 30 m
  - TIR: near 4 day / 60 m
- Enabled by:
  - Onboard data compression and cloud screening
  - Proven Ka-Band link to ground
- Builds upon:
  - ECOSTRESS EV-I selected instrument
  - SLI Dyson spectrometer design published in Optical Engineering
  - HyspIRI Airborne Preparatory Campaign

SLI Dyson (CWIS)

ECOSTRESS