Hyperspectral – Infrared Imager (HyspIRI) Mission

HyspIRI VSWIR Instrument

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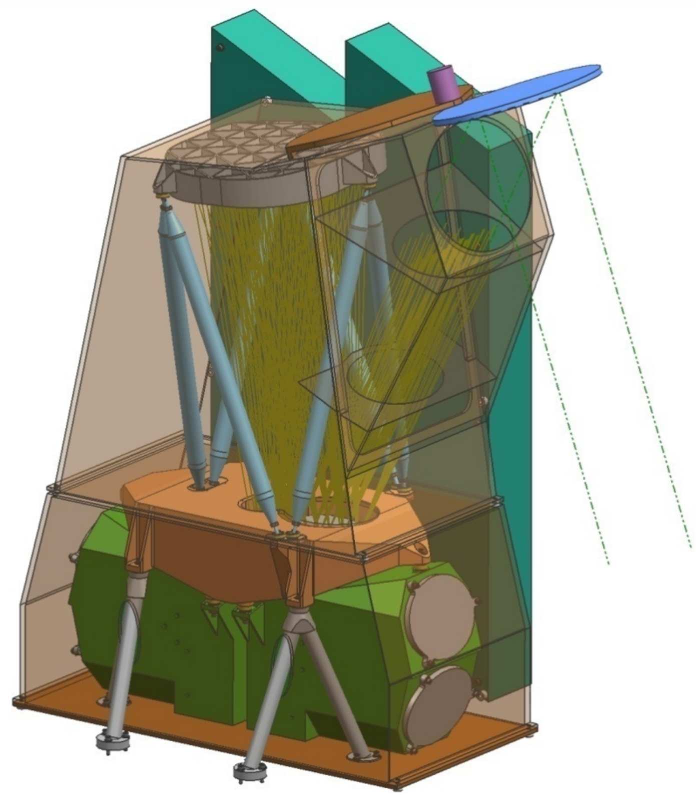
VSWIR - Instrument Concept

- *Outline*

    1. *Introduction*
    2. *Key Requirements & Performance*
    3. *Key Trades and Results*
    4. *Technology Readiness & Heritage*

HyspIRI – VSWIR



Mass (CBE)	***55Kg***
Power (Ave.)	***41Watts***

HyspIRI Mission

Key VSWIR Requirements

Radiometric	Requirement	Status
Range & Sampling	0 to 1.5 x benchmark radiance, 14 bits	Demonstrated via analysis and 14 bit ADC bread board electronics and various airborne systems
Accuracy	>95% absolute radiometric, 98% on-orbit reflectance, 99.5% stability	Demonstrated – AVIRIS, MaRS, AVIRIS NG
Precision (SNR)	See spectral plots at benchmark radiances	Demonstrated via analysis of measurements
Linearity	>99% characterized to 0.1 %	Demonstrated via test, MaRS and M3, AVIRIS NG
Polarization	<2% sensitivity, characterized to 0.5 %	Demonstrated via analysis of design and test data on the grating
Scattered Light	<1:200 characterized to 0.1%	Demonstrated in MaRS and M3 – Ongoing Studies

Spectral	Requirement	Status
Range	380 to 2500 nm (solar reflected spectrum)	Demonstrated – AVRIS, MaRS, M3, AVIRIS NG
Sampling	<= 10 nm {uniform over range}	Demonstrated – MaRS, M3, AVIRIS NG
Response	<= 1.3 X sampling (FWHM) {uniform over range}	Demonstrated – MaRS, M3, AVIRIS NG
Accuracy	<0.5 nm	Demonstrated – MaRS, M3, AVIRIS NG

Key VSWIR Requirements

Spatial	Requirement	Status
Range	>145 km	Demonstrated by design and analysis (150 km)
X-track Sampling	>2400	Demonstrated by design and analysis (2500)
Sampling	<= 60m (Nadir)	Demonstrated by design and analysis
Response	<= 1.2X sampling (FWHM)	Demonstrated by MaRS and M3, AVIRIS NG
Uniformity		
Spectral Cross-Track	>95% cross-track uniformity {<0.5 nm min-max over swath}	Demonstrated by MaRS and M3, AVIRIS NG
Spectral-IFOV-Variation	>95% spectral IFOV uniformity {<5% variation over spectral range}	Demonstrated by MaRS and M3, AVIRIS NG

Other Key	Requirement	Status
Data rate	~ 300 Mbits per second	Met by preliminary architecture and parts selection – all required parts are at or above TRL 6
Compression	4:1 lossless (was 3:1 in 2011)	Met by algorithm test on MaRS data. Algorithms implemented in breadboard electronics and flight FPGA
Pointing Knowledge	30m radius (3σ) ~ 9 arcsec (3σ) = 3 arcsec (1σ) reconstructed	VSWIR design supports stability below these levels.
Mass	<55 kg	Met by current Al design with 30% margin – working to increase margin

Instrument Approach

Spectroscopy in the range 400 to 2500 nm at 10 nm with high uniformity and high precision (SNR) is required to capture the molecular absorption and constituent scattering signatures for this mission. The following instrument options have been considered to achieve this objective.

- **Selected: Offner spectrometer (Hyperion, CRISM, ARTEMIS, M3, COMPASS^{air} TB^{air})**
  - Full range from 380 to 2500 nm demonstrated. Efficiency for high SNR optimized with multiple blaze grating demonstrated. Uniformity from design through alignment demonstrated. Snapshot acquisition detector. Dispersion efficiency tunable to optimize use of detector.
- Prism dispersion spectrometer
  - Dispersion is non-uniform. Cross-track and spectral-IFOV uniformity not inherent in optical design. Dispersion efficiency not tunable in detail to optimize use of detector full well.
- Wedge/Linear-variable filter spectrometer
  - Full spectral range coverage from 380 to 2500 nm has not been demonstrated maintaining 10 nm spectral sampling and response function. Filter uniformity is a concern over wide spectral and spatial domain. Fast, high throughput, beams interplay with filter spectral bandpass undermines uniformity.
- Fourier Transform Spectrometer
  - Not typically built to operate below 1 micron. Detector dynamic range and photon shot noise concern. Architecture for > 2000 cross track elements and >200 spectral channels not identified. Not well suited for wide or moderate field of view. Requires IMC.
- Liquid Crystal Tunable & Acousto -Optical Tunable
  - Time sequential acquisition undermines uniformity. Low TRL, polarization sensitive. Limited spectral range. Requires IMC.

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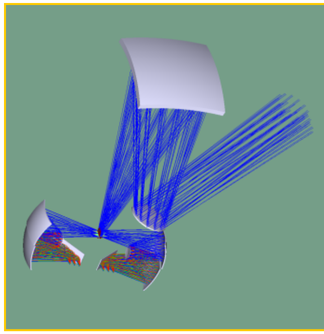
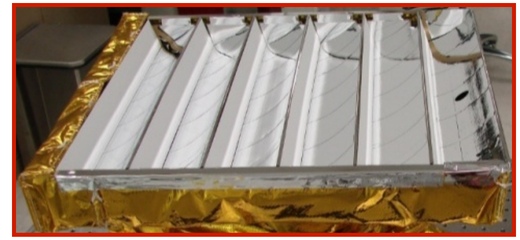
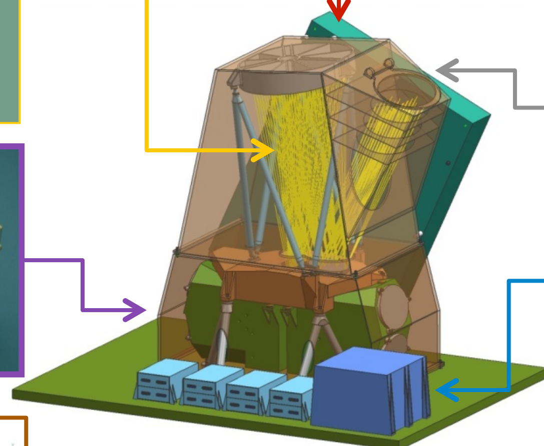
VSWIR Concept

Optics
- Front End Telescope consists of a primary spherical mirror and a secondary aspherical mirror
- Back End Spectrometers consist of 2 optimized Offner spectrometers



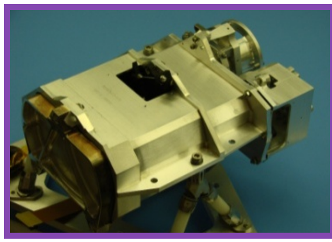
Radiator
- Area $0.6 m^2$
- M3 technology heritage

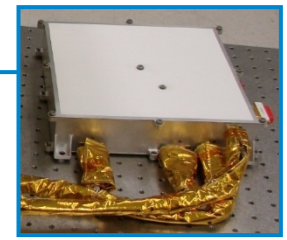




Baffle/Cover/Cal Panel
- *Launch cover*
- *Used as a solar reflectance calibration target*

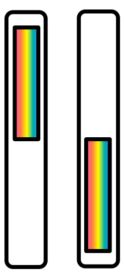
Spectrometers (2x)
- 2 identical Offner spectrometers
- Each contains:
  - E-Beam grating
  - Si air slits
  - FPA assembly

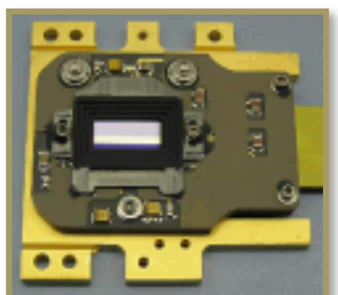




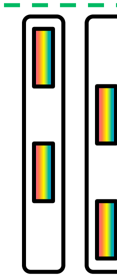
Electronics
- M3 Derivative 4x
- Electronic concept is based upon available flight approved parts
- Ins. control, Data Compression, mode control

FP A (2x)
- Mount is adjustable in 6 DOF
- Thermal strap connects mount to radiator
- Each assembly contains two Teledyne 6604b detector arrays
- Includes integral OSF





2010 approach
- Teledyne 6604a detectors; full flight heritage from M3.
- Analog I/O
- Each spectrum readout as snapshot, so that there is no time delay, yaw, or jitter impact to the spectral-IFOV-uniformity.



Key Technologies are Proven

1. Uniform Offner spectrometer (Mouroulis Design)

2. Finely adjustable optics and detector mounts that can be locked within fraction of a micron (0.1 microns)

3. Electron beam fabricated gratings

4. Electron beam fabricated air slits (non-uniformity < .05 microns)

5. Alignment and calibration sources and methodologies to achieve and verify requirements.