

eMAS

(enhanced MODIS Airborne Simulator)

Earth Science Technology Forum

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Jeff Myers
Airborne Sensor Facility
UCSC/Ames Research Center

Steve Platnick
EOS Project Science Office
Goddard Space Flight Center

Outline

- eMAS Rationale
- System Description & Design Criteria
- LW/MWIR Spectrometer for eMAS Line-Scanner
- V/SWIR Pushbroom Imaging Spectrometer
- Implementation Schedule

The eMAS project rationale

Purpose:

To provide the next generation of an airborne MODIS-like instrument with:

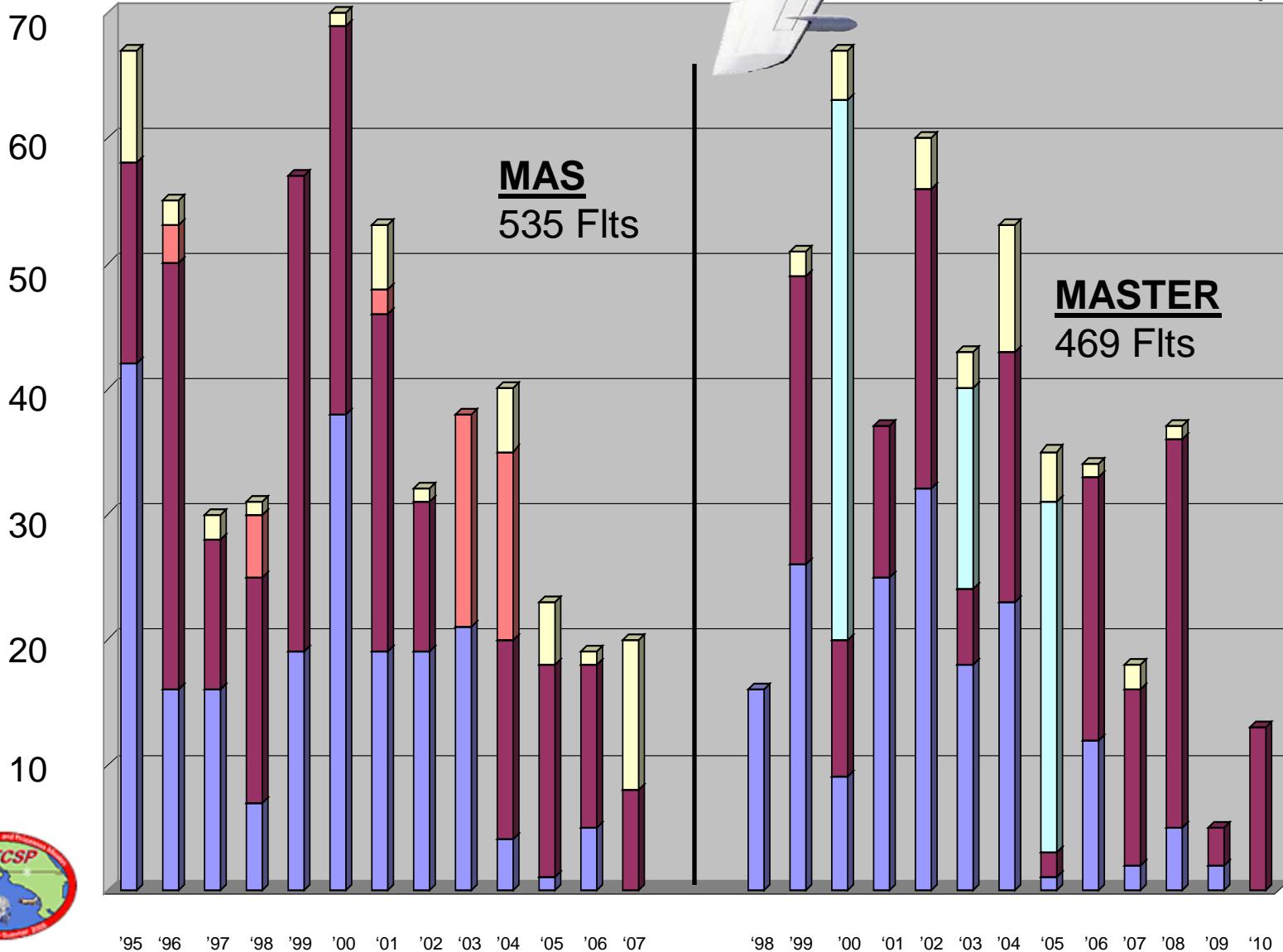
1. High spatial resolution
2. Broad range multi-spectral coverage (VNIR/SWIR-MWIR-LWIR)
3. Co-registered bands
4. A wide FOV for large area coverage
5. Repeatable spectral and radiometric calibration
6. Robustness for sustained operations
7. Mechanical cooling for long missions (e.g., Global Hawk)
... to support current and future satellite programs (e.g. HyspIRI and JPSS) as well as multi-disciplinary process studies.

The MODIS and ASTER Airborne Simulators (MAS & MASTER) are the only sensors of this type in the world, but have been heavily utilized and are nearing the end of their service life.



Historical MAS & MASTER Utilization

(Not including test and calibration flights)



- Reimbursable
- Collaborative
- Other NASA
- RA
- EOS

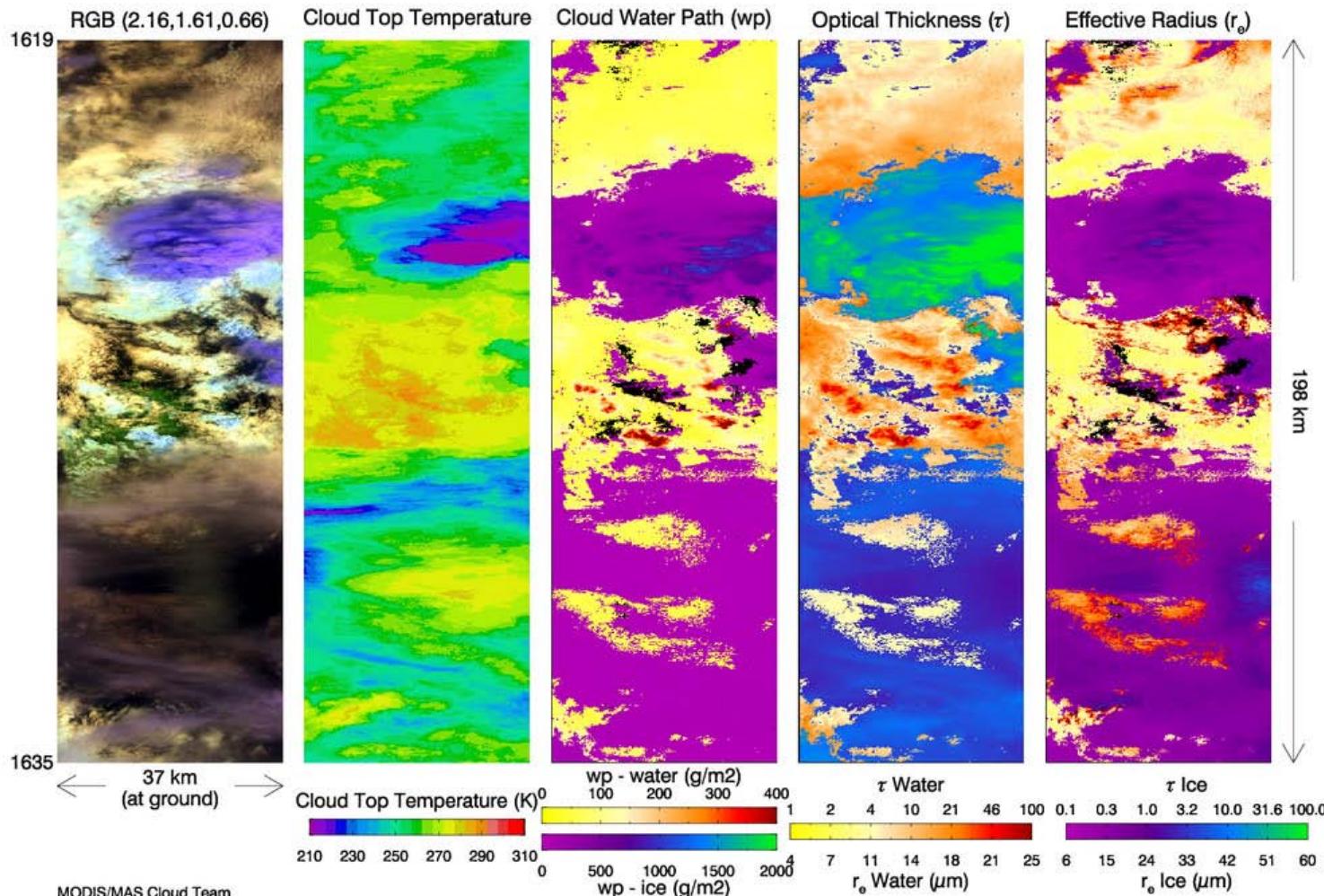


Typical Level-2 geophysical products

(As Produced by the MODIS/MAS Cloud Team)

MASTER (ASTER) Airborne Simulator 03 August 2007 Flight # 07926 Track #11

(TC4 Preliminary Retrievals - Pre-deployment Calibration)



eMAS Project Overview

ARRA Elements:

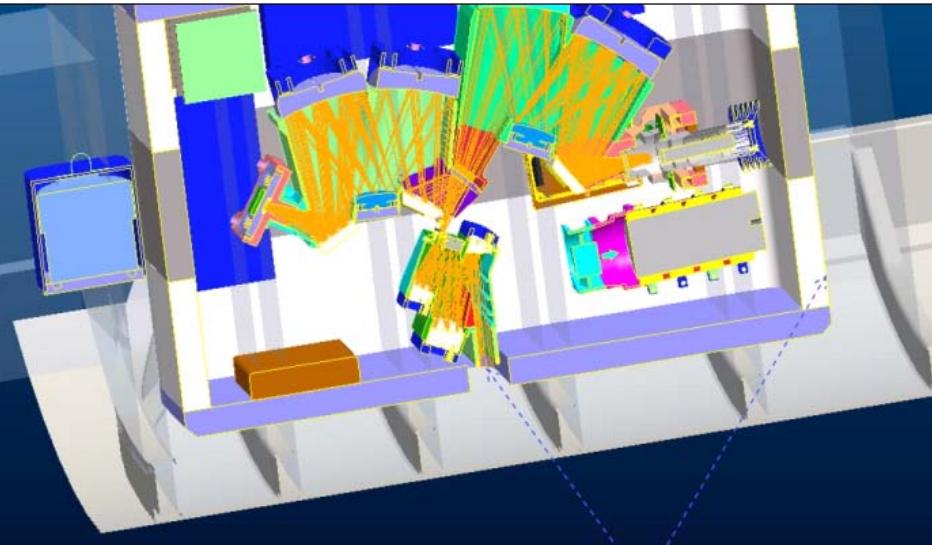
1. Upgrades to the existing MAS line-scanner (“eMAS-Scanner”)
2. New stand-alone VNIR/SWIR Imaging Spectrometer (“eMAS-IS”)

EOS/R&A Elements:

1. New digitizer & data system
2. New scanning fore-optics

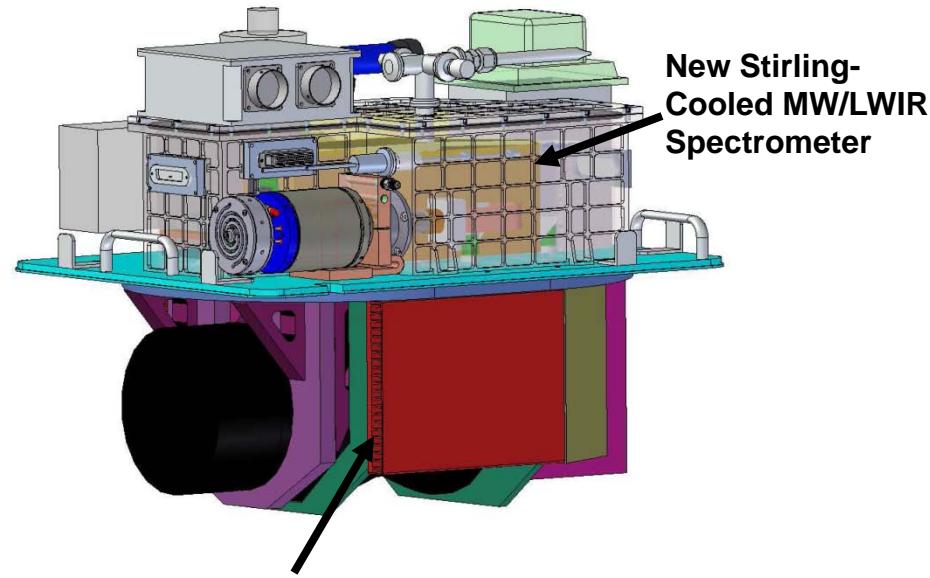
eMAS will be a suite of two bore-sighted, synchronized, instruments:

[eMAS-HSI Imaging Spectrometer](#)



(Dual-Offner V/SWIR Pushbroom)

[eMAS Scanner](#)

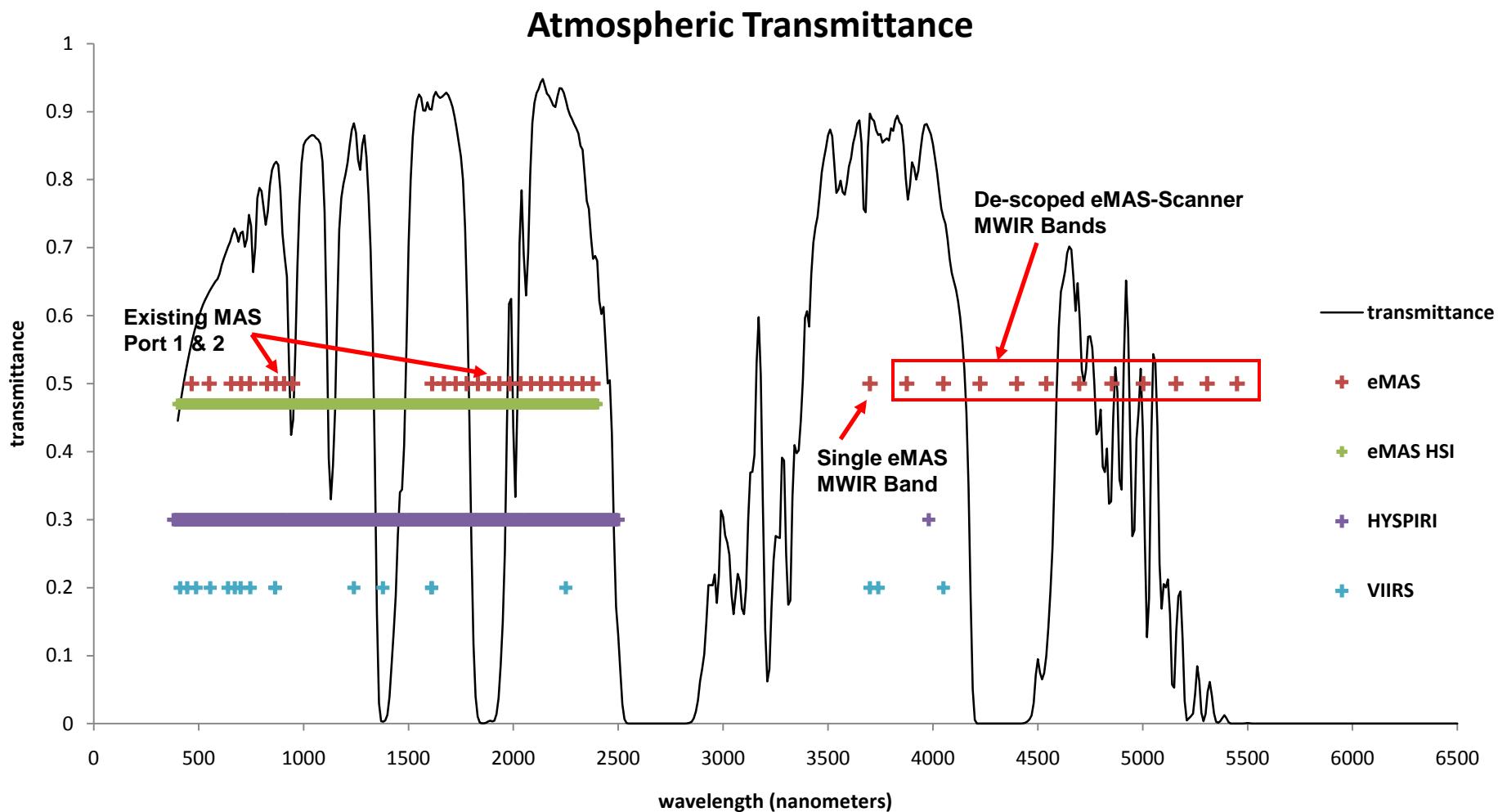


VNIR-MWIR Spectral Band Positions:

eMAS-Scanner and eMAS-Imaging Spectrometer

HypsIRI

VIIRS



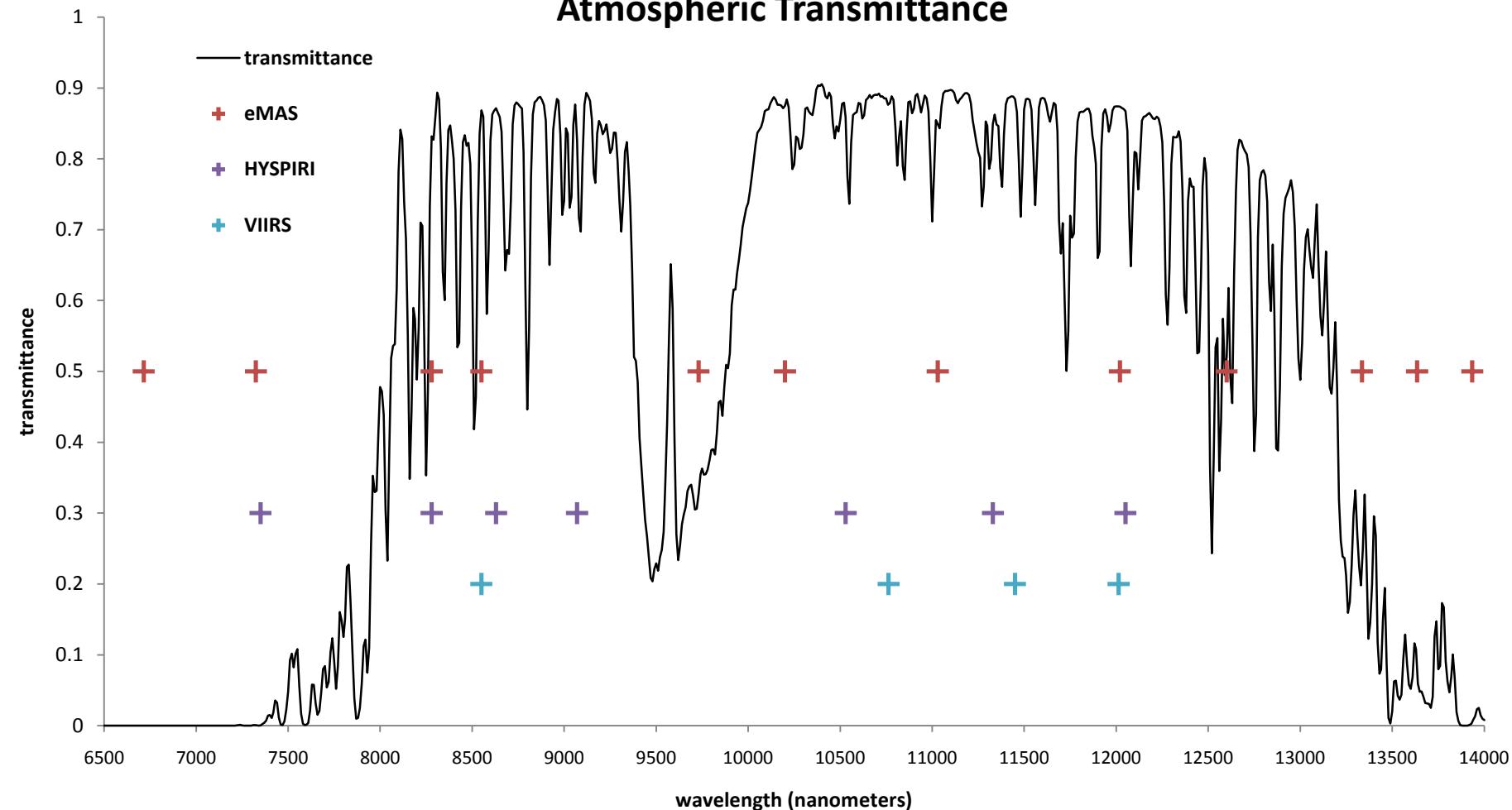
LWIR Spectral Band Positions:

eMAS-Scanner

HypsIRI

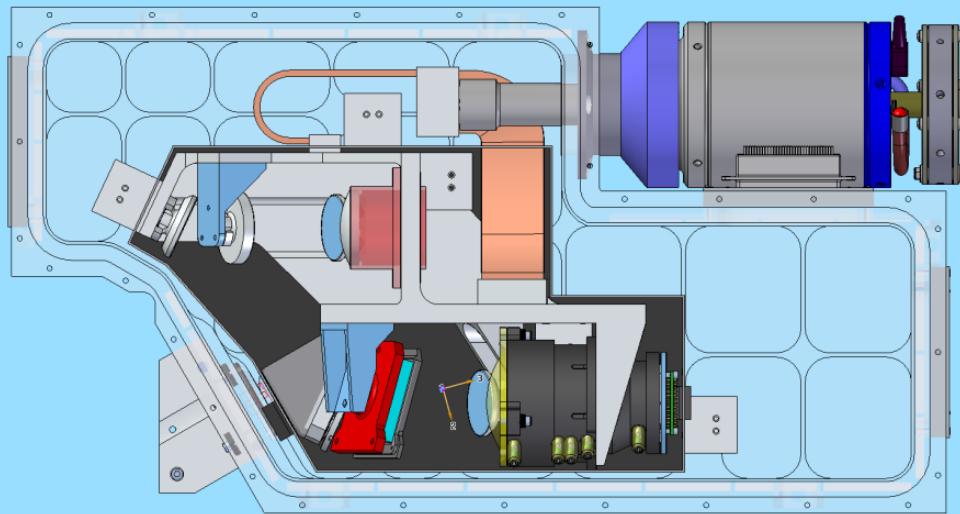
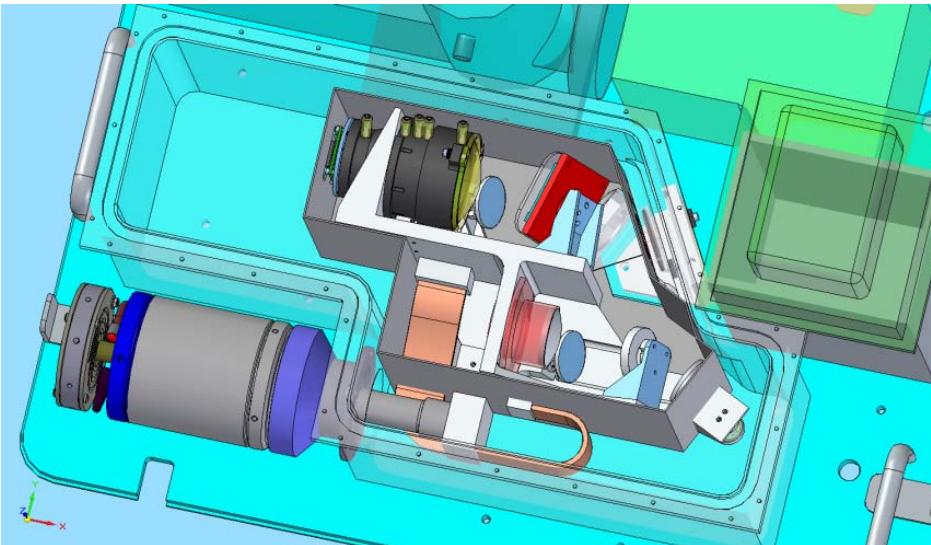
VIIRS

Atmospheric Transmittance

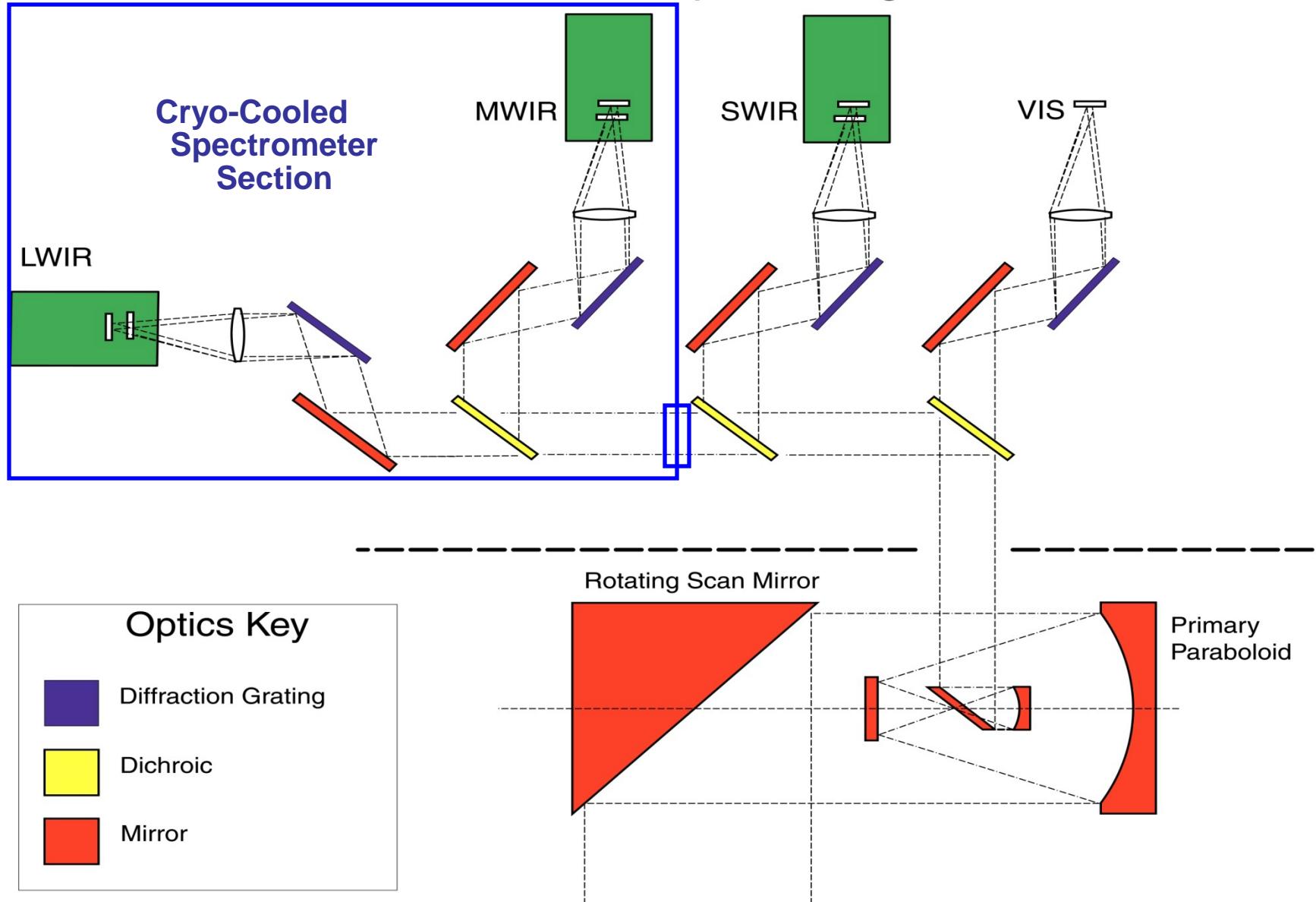


eMAS-IR Spectrometer (Space Dynamics Laboratory)

- **Cryogenic Optical Bench**
 - reduced background noise
 - Increased stability from environmental isolation
 - eMAS scanner in unpressurized compartment of superpod
- **Distortion-Correcting FPA design**
 - Reduced spectral crosstalk
 - Increased signal to detectors



MAS/MASTER Optical Diagram

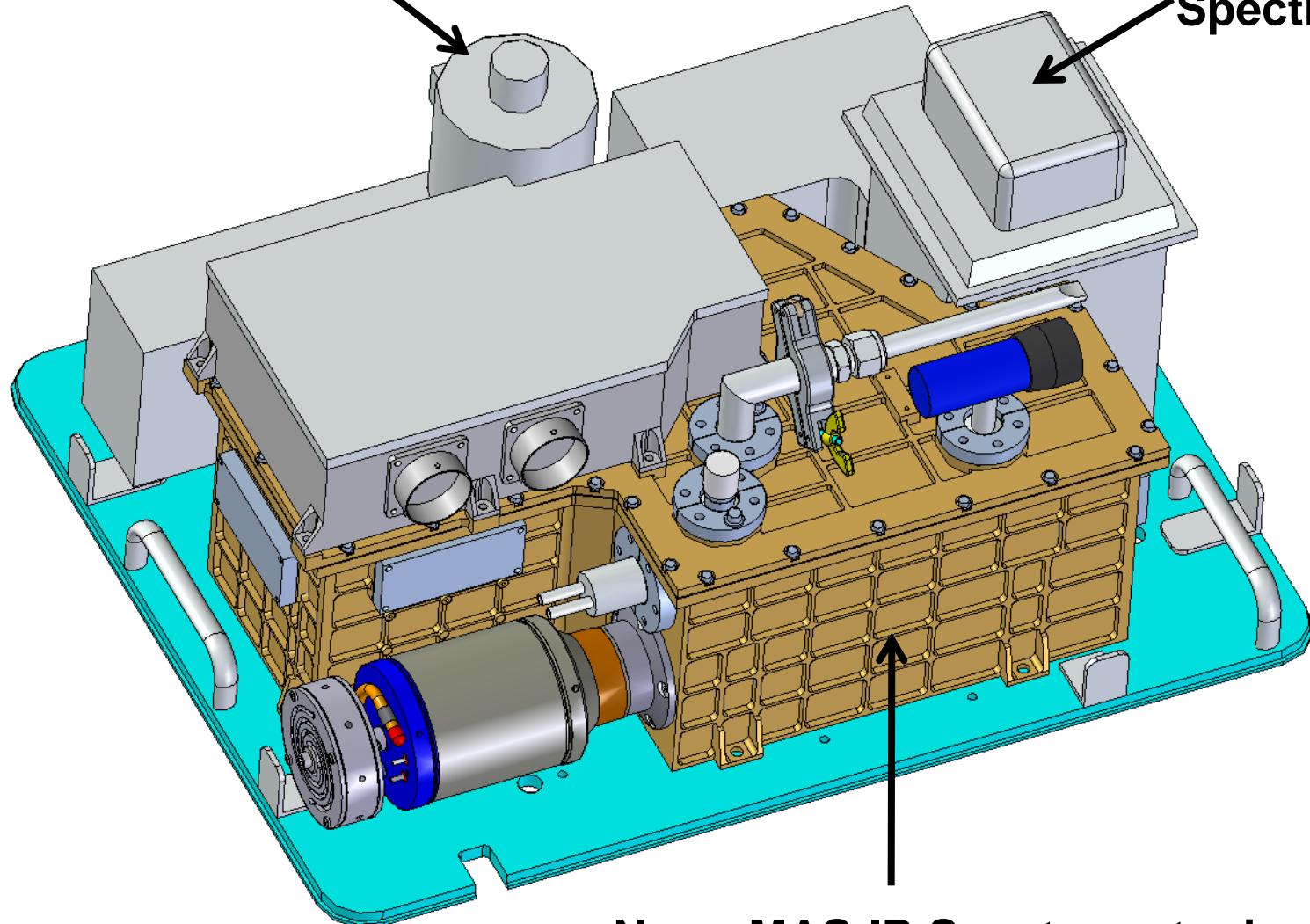


eMAS-Scanner MW/LWIR Band Comparison

<u>EMAS</u>	<u>Similar Bands in other instruments</u>				
<u>Channel</u>	<u>CWL μm</u>	<u>FWHM μm</u>	<u>VIIRS</u>	<u>MODIS</u>	<u>MAS</u>
MW1	3.65	0.18	M12	20	30
LW1	6.72	0.25	--	27	--
LW2	7.33	0.26	--	28	--
LW3	8.28	0.26	--	--	--
LW4	8.55	0.26	M14	29	42
LW5	9.73	0.26	--	30	43
LW6	10.2	0.26	--	--	44
LW7	11.03	0.26	M15	31	45
LW8	12.02	0.26	M16	32	46
LW9	12.6	0.26	--	--	--
LW10	13.34	0.26	--	33	48
LW11	13.64	0.26	--	34	--
LW12	13.94	0.26	--	35	49

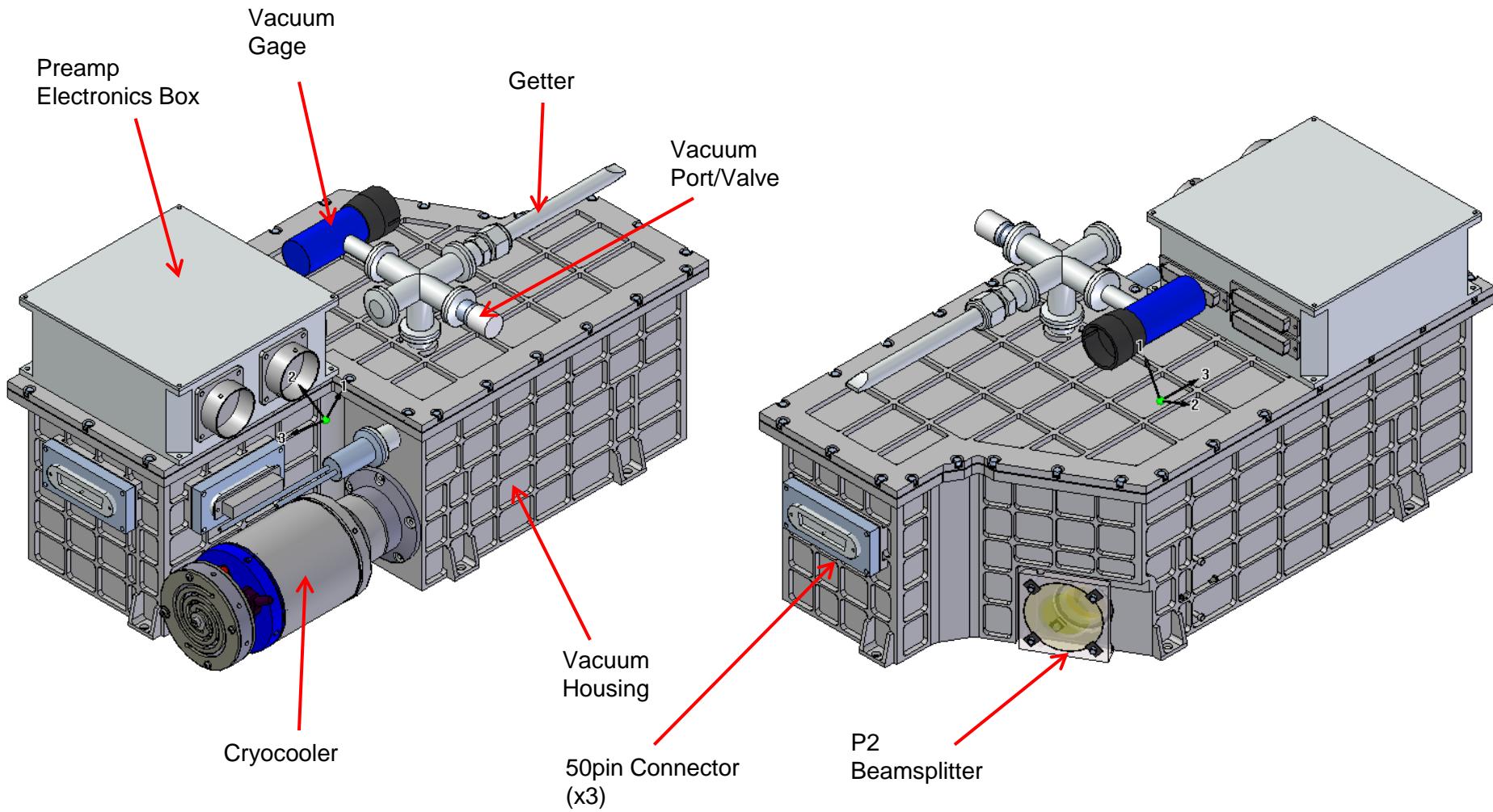
MAS SWIR Spectrometer

**MAS VNIR
Spectrometer**



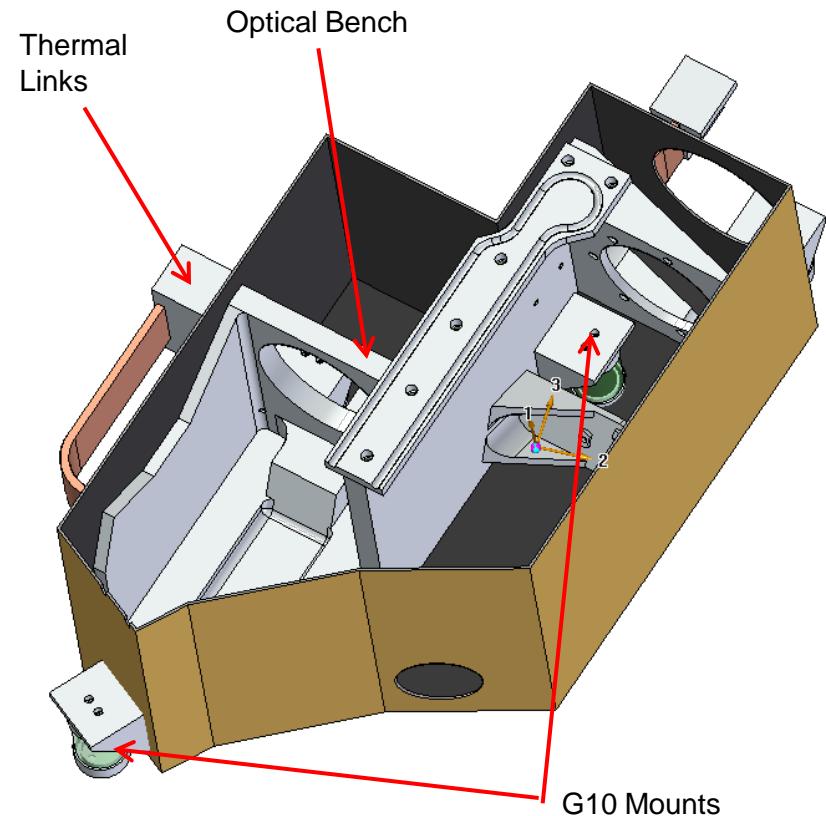
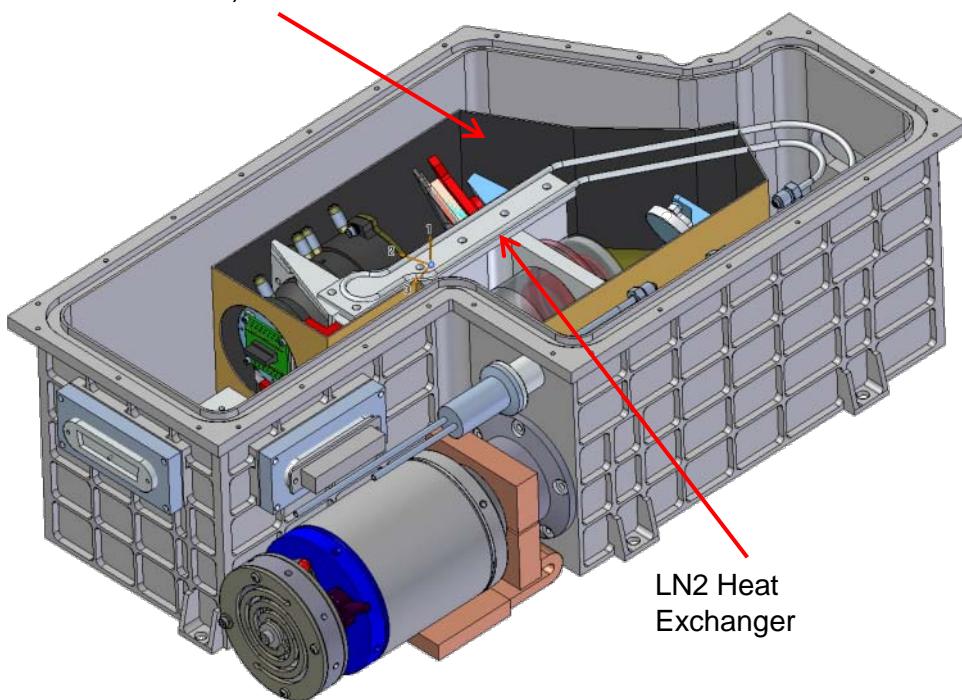
**New eMAS-IR Spectrometer installed
on optical bench**

Cryogenic Optics Enclosure

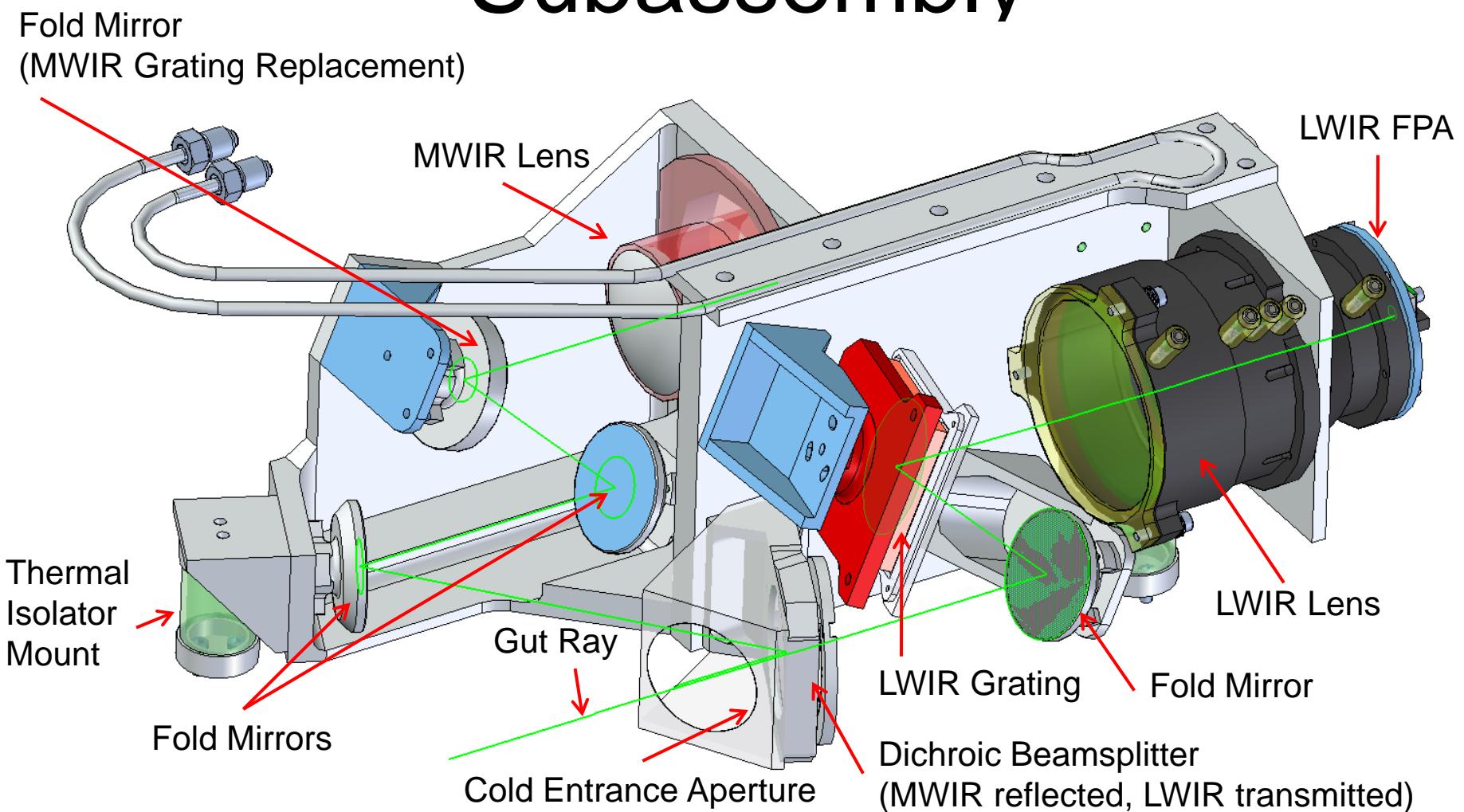


Rad Shield and Cryogenic Optics Bench

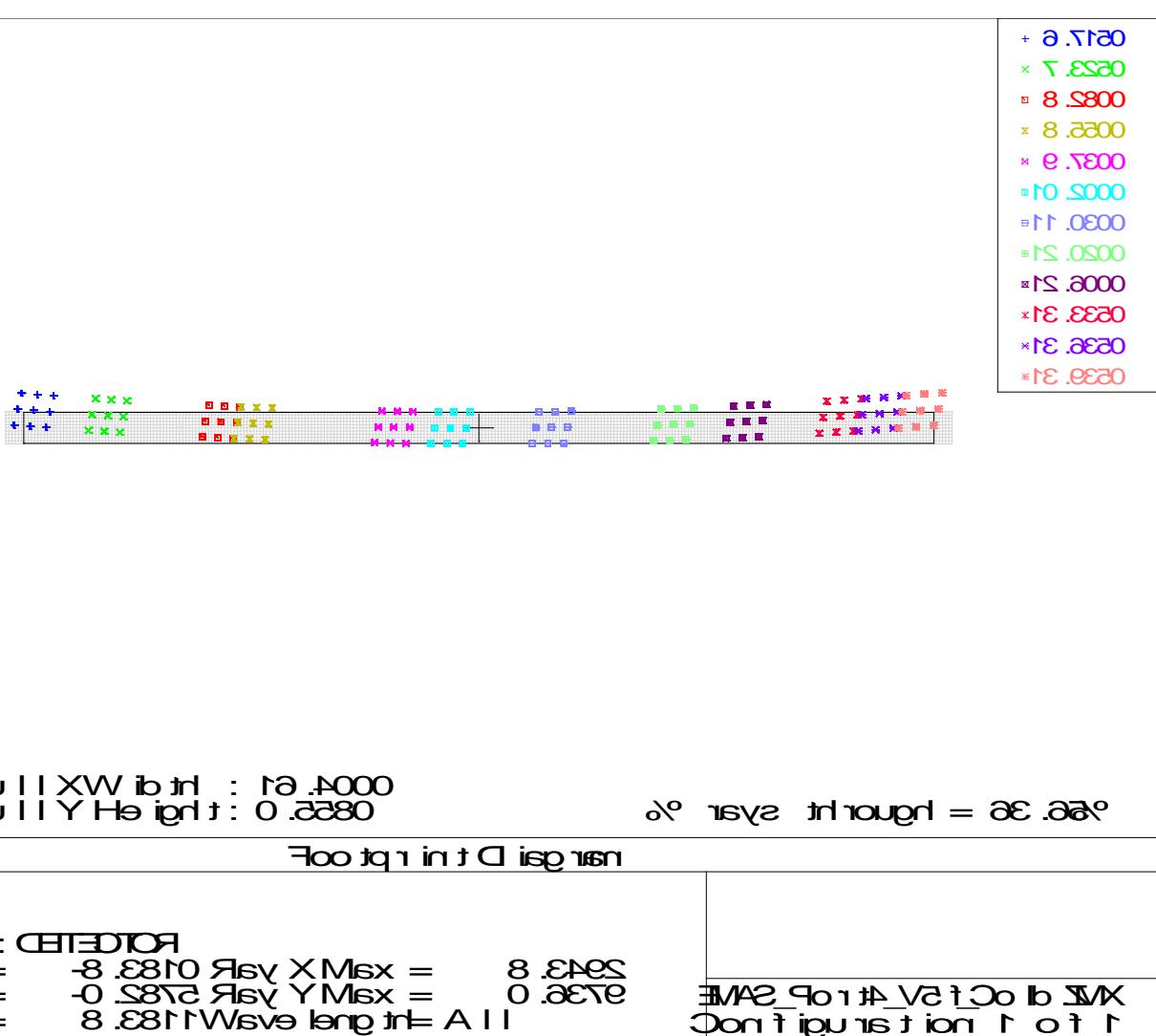
Radiation Shield
(gold plated on outside, black on inside)



Internal Optics Bench Subassembly

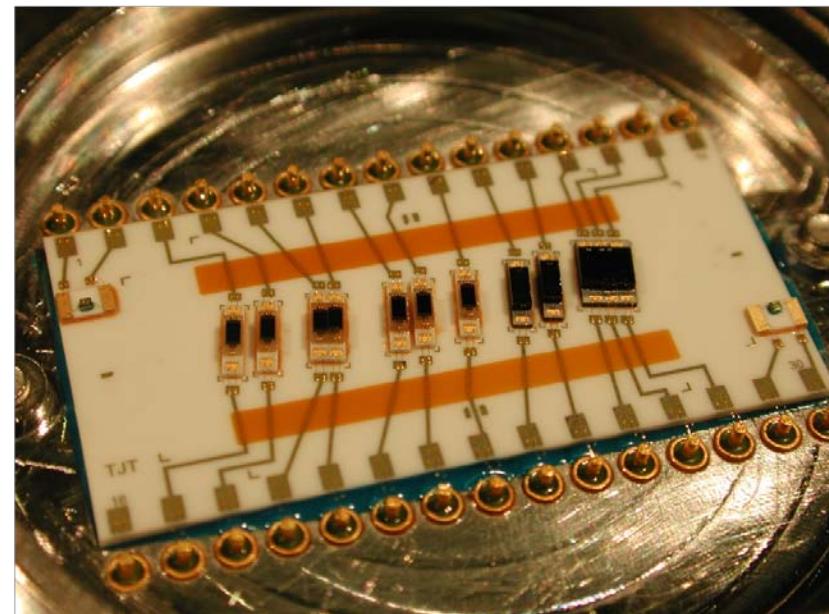
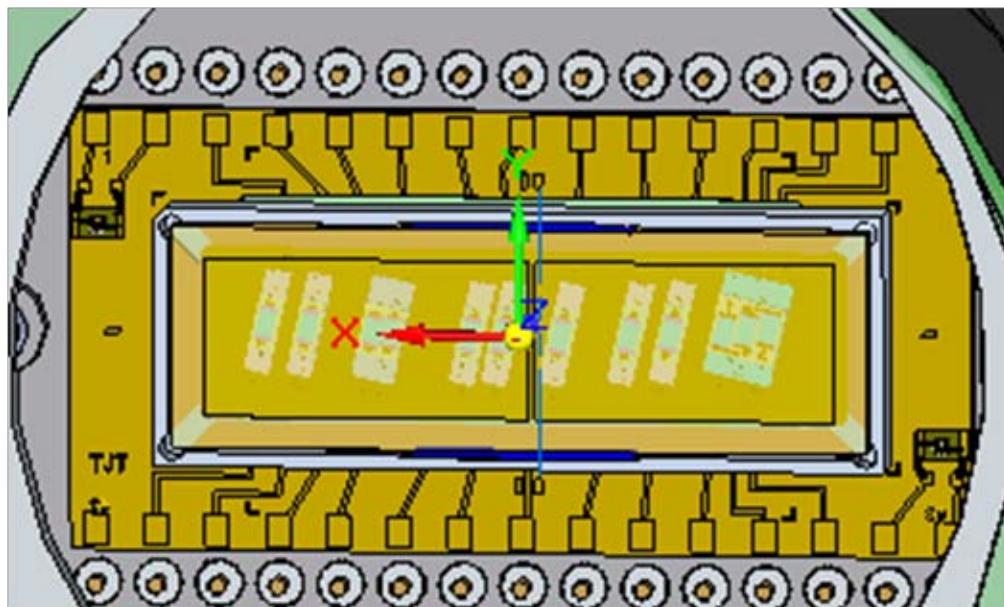
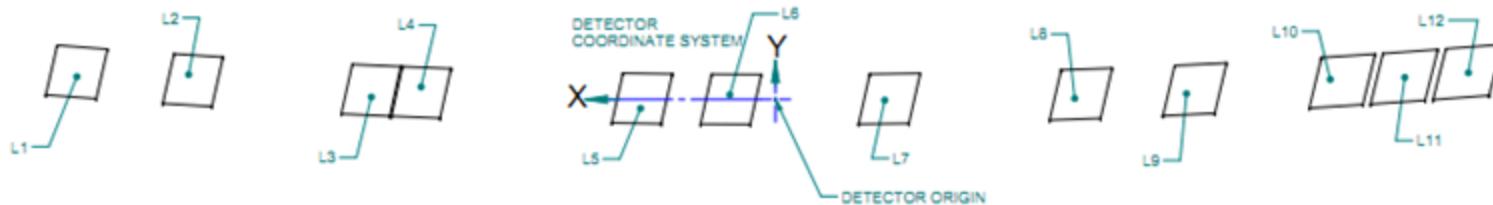


LWIR Images of Field Stop at LWIR Detector Focal Plane

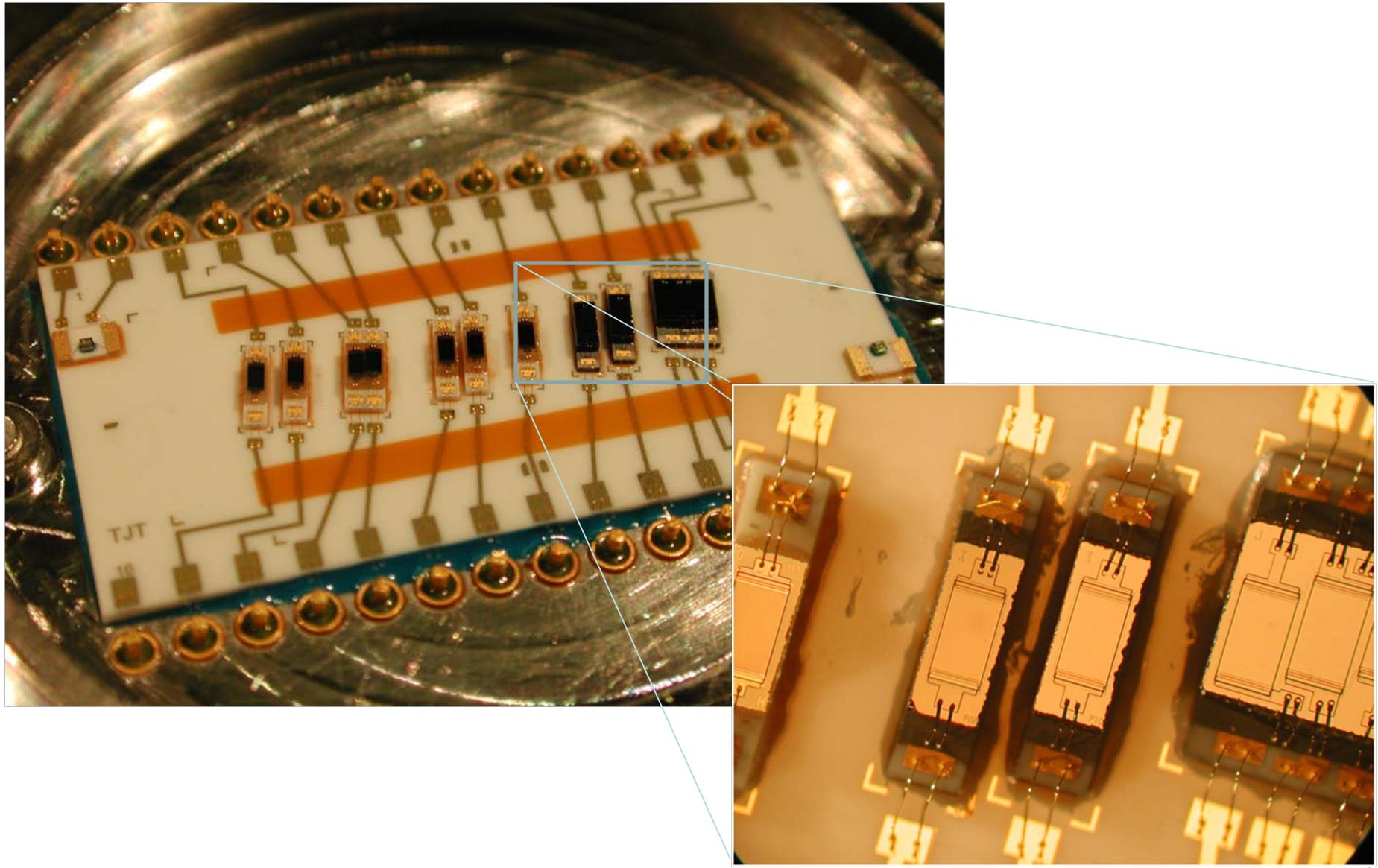


Distortion corrected FPA

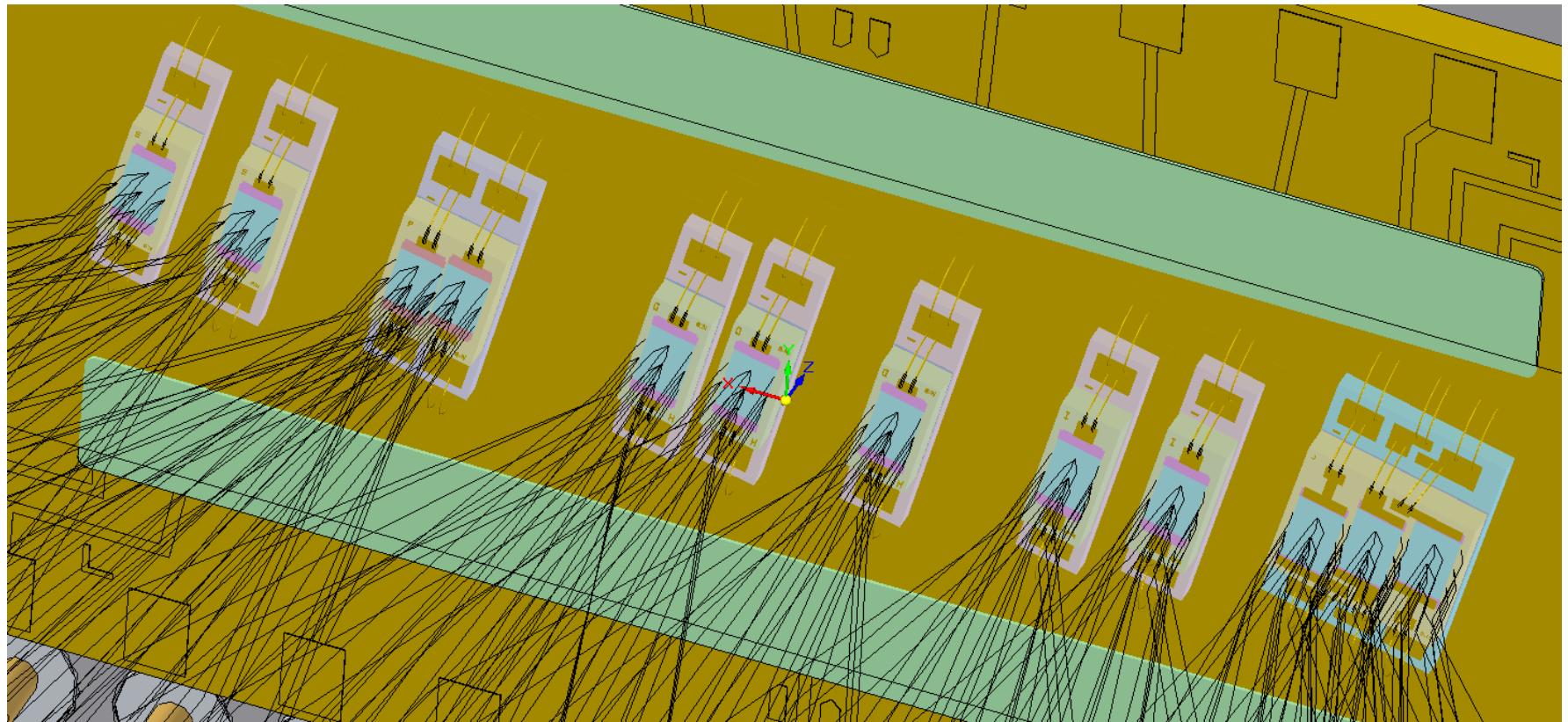
VIEW LOOKING AT TOP SURFACES OF DETECTORS



Distortion corrected FPA

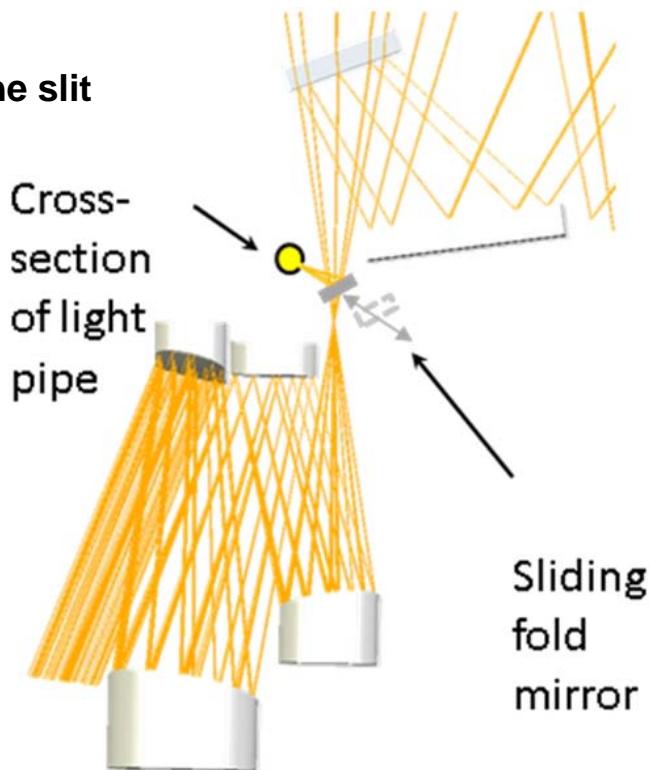
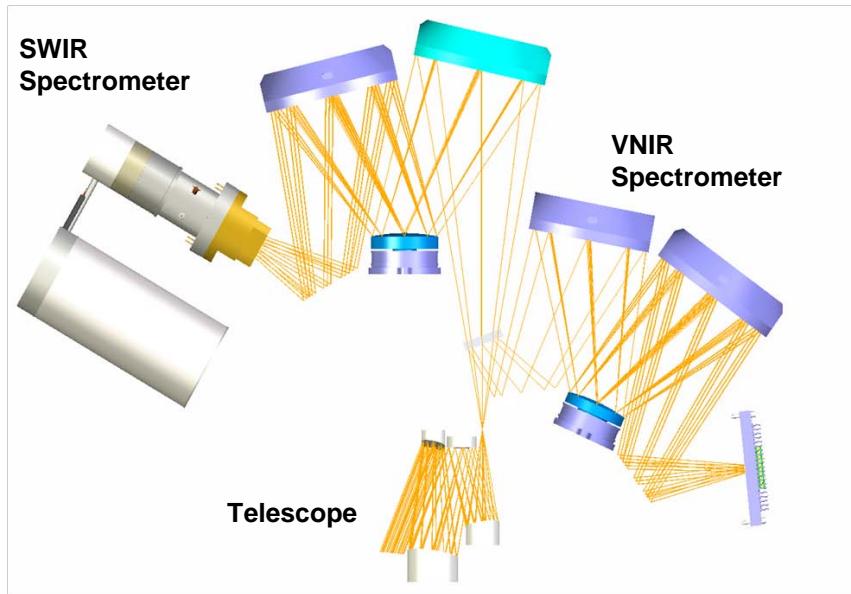


Field Stop images land precisely on FPA detectors

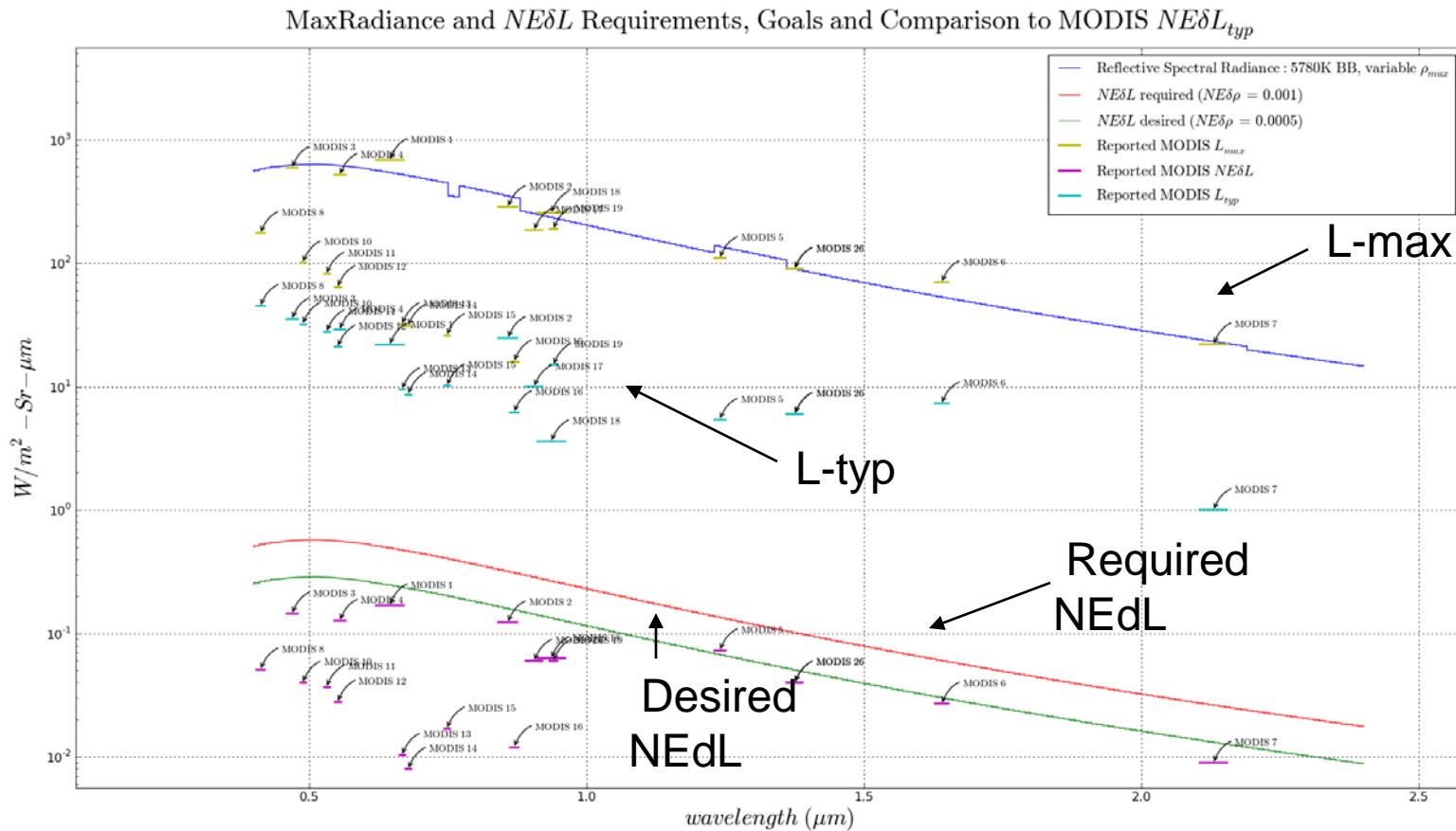


eMAS-HS Spectrometer (Brandywine Photonics)

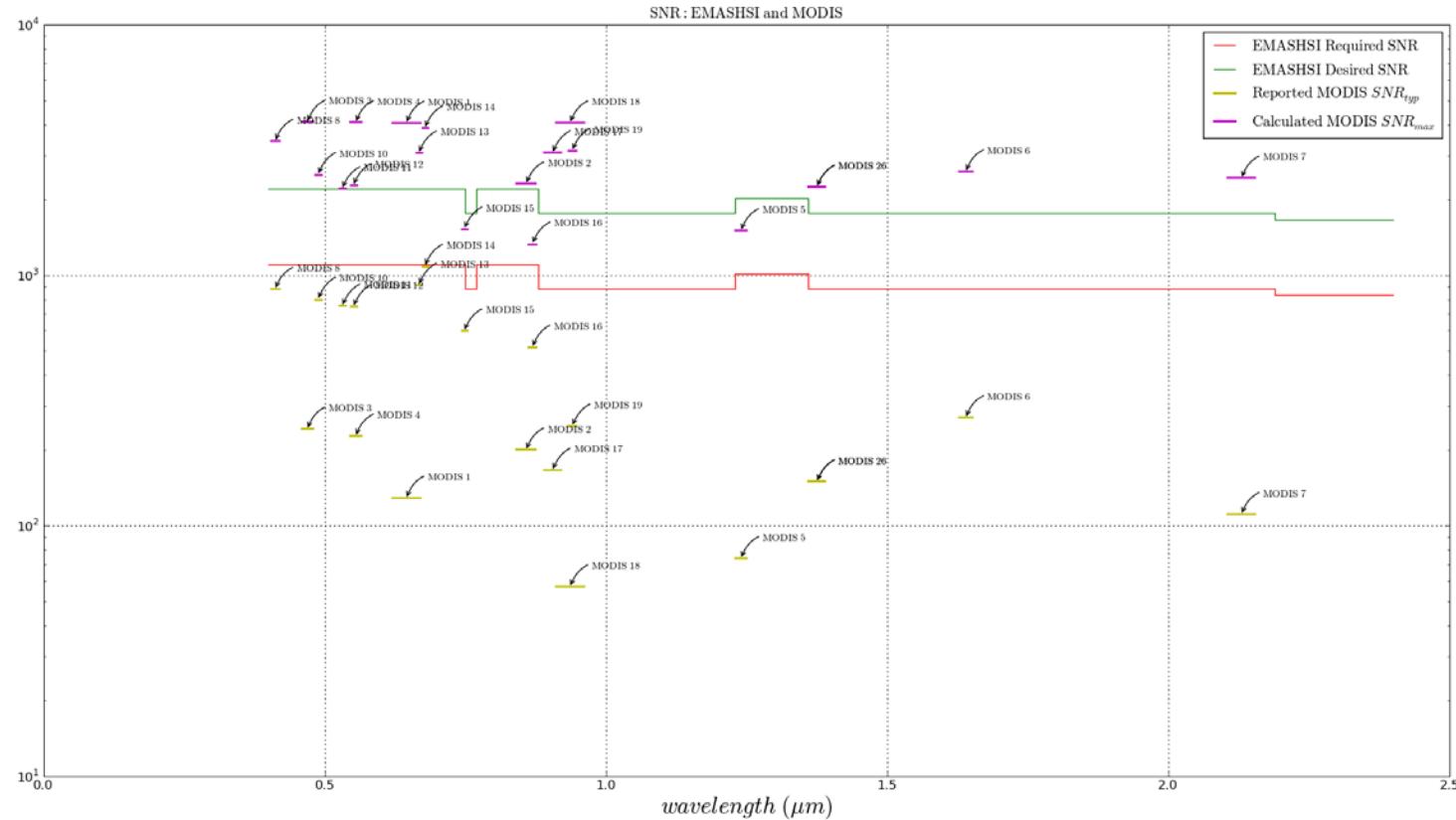
- Dichroic split dual Offner system, sharing one slit and fore optic
- Fore-optic is a 4 mirror anastigmat, 50 degree FOV, low distortion
- SWIR Spectrometer uses a cryogenic MCT FPA from Sofradir
 - Variable gain capability on a row by row basis (rows = spectral bins)
- System enclosed in 0.8 atm. pressurized box
 - Contained in the pressurized ER-2 superpod section
 - Increased confidence in ground based calibrations during flight
- Radiometric Stability Monitor
 - Flip mirror to feed broadband light source to illuminate the slit
 - Periodic check of system stability during flight



EMAS-HS Radiance requirements



EMASHSI SNR Requirements L-max



EMAS-HS First Order Properties

First Order Property	
f/#	f/2.8
Slit size	32 µm X 26.56 mm
Field of View	+/-25° FFOV, 2.1mRad IFOV
Ground projection distortion	<8 µm cross-track, <12 um along track
Spatial resolution	832 spatial samples cross track
VNIR Spectral Bands	256 X 2.5 nm resolution (2 x 1 binning)
SWIR Spectral Bands	140 x 10 nm resolution
VNIR Slit Magnification	1:1
SWIR Slit Magnification	32:30

Focal Plan Arrays

Sarnoff CCD160-250-SFT VNIR Detector Array

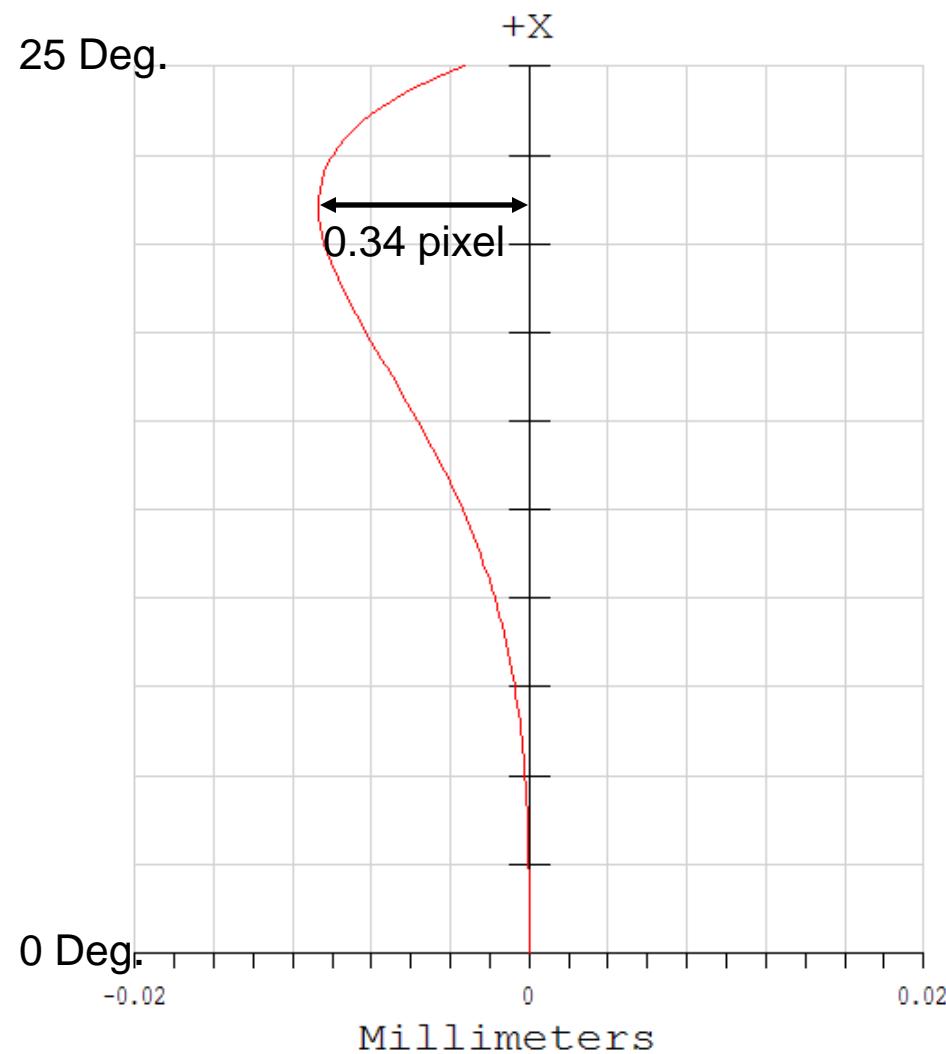
- 16 μm pitch, 2048 x 256 pixels
- Binning 2x1 on-chip, storing 830 x 256 pixels per frame
- Corresponds to 1.05 mRad IFOV
- Spatial binning to 2.1 mRad in post-processing
- Spectral sampling at 2.5 nm/band, post-processing to 10 nm

Sofradir Saturn HgCdTe SWIR Detector Array

- 30 μm pitch, 1000 x 256 pixels
- Storing 830 x 150 pixels
- Spectral sampling 10nm/band
- Programmable gain settings, by row

Ground Sample Distortion

Along-Track Distortion



- Requirement to have a flat cross track ground sample
 - across a 50 degree wide field of view
 - in order to closely match eMAS scanner system
- Requirement flows down to demanding telescope design
 - Four un-obscured aspheric mirror design

Schedule

- IR Spectrometer Delivery: 10/1/2011
- Integration into ER-2 Super-Pod: 1Q CY2012
- V/SWIR Imaging Spectrometer Delivery: 1/30/2012
- Integration into ER-2 Super-Pod: 2Q CY2012 (TBD)
 - Requires major mid-body hatch modification
- Engineering Test Flights ~ July 2012
 - eMAS IR Line-scanner may fly first