



**Panchromatic Fourier Transform Spectrometer
Engineering Model (PanFTS EM)
for the
Geostationary Coastal and Air Pollution Events
(GEO-CAPE)
Mission**

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PanFTS Engineering Model Overview

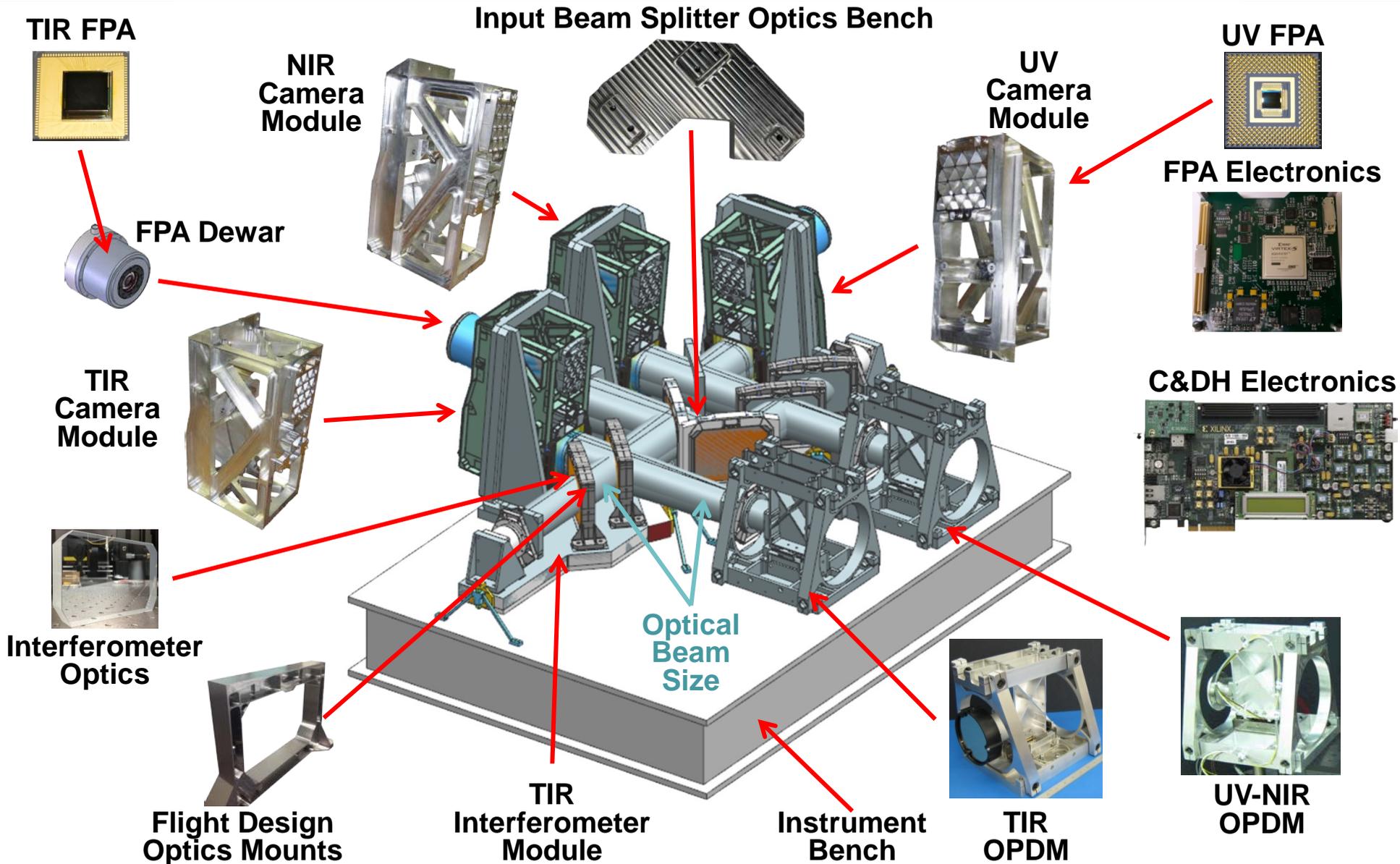
- The Panchromatic Fourier Transform Spectrometer (PanFTS) design is capable of measuring atmospheric trace gases, and aerosols using imaging Fourier Transform Spectroscopy (FTS) over the spectral range of 0.28 μm to 11 μm enabling simultaneous observations of reflected sunlight and thermal emission (day/night) to measure
 - Pollutants: O_3 , CO , CH_4 , NO_2 , NH_3 , HCHO , CHOCHO , aerosols
 - Greenhouse Gases: CO_2 , CH_4 , N_2O , O_3 , H_2O
 - Transport Tracers: HDO , N_2O , O_2 , O_4

- The ESTO funded PanFTS IIP-10 objectives are:
 - Develop a science plan and instrument model to ensure PanFTS addresses key Decadal Survey measurement requirements and observing scenarios as well as greenhouse gas measurements that inform climate change studies (Natraj, Kulawik, Kurosu, Bowman, et al.)
 - Formulate a PanFTS flight instrument design that has the key features needed for making all GEO-CAPE atmospheric composition science measurements
 - Build and test a full size flight like PanFTS engineering model which emulates the critical functions of the PanFTS flight instrument (e.g. the interferometer)
 - Thermal-vacuum test the PanFTS EM instrument to demonstrate the maturity of the design and capability to make measurements in the GEO space environment

ID	Activity	2011				2012				2013				2014
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
1	Instrument Modeling		Instrument Science Modeling											
2	Instrument Design				Instrument Design									
3	Procurements								Procurements					
4	Build, I&T								Build, I&T					
5	Thermal-vacuum Test												T-Vac Testing	



PanFTS EM Full Size Flight Like Components

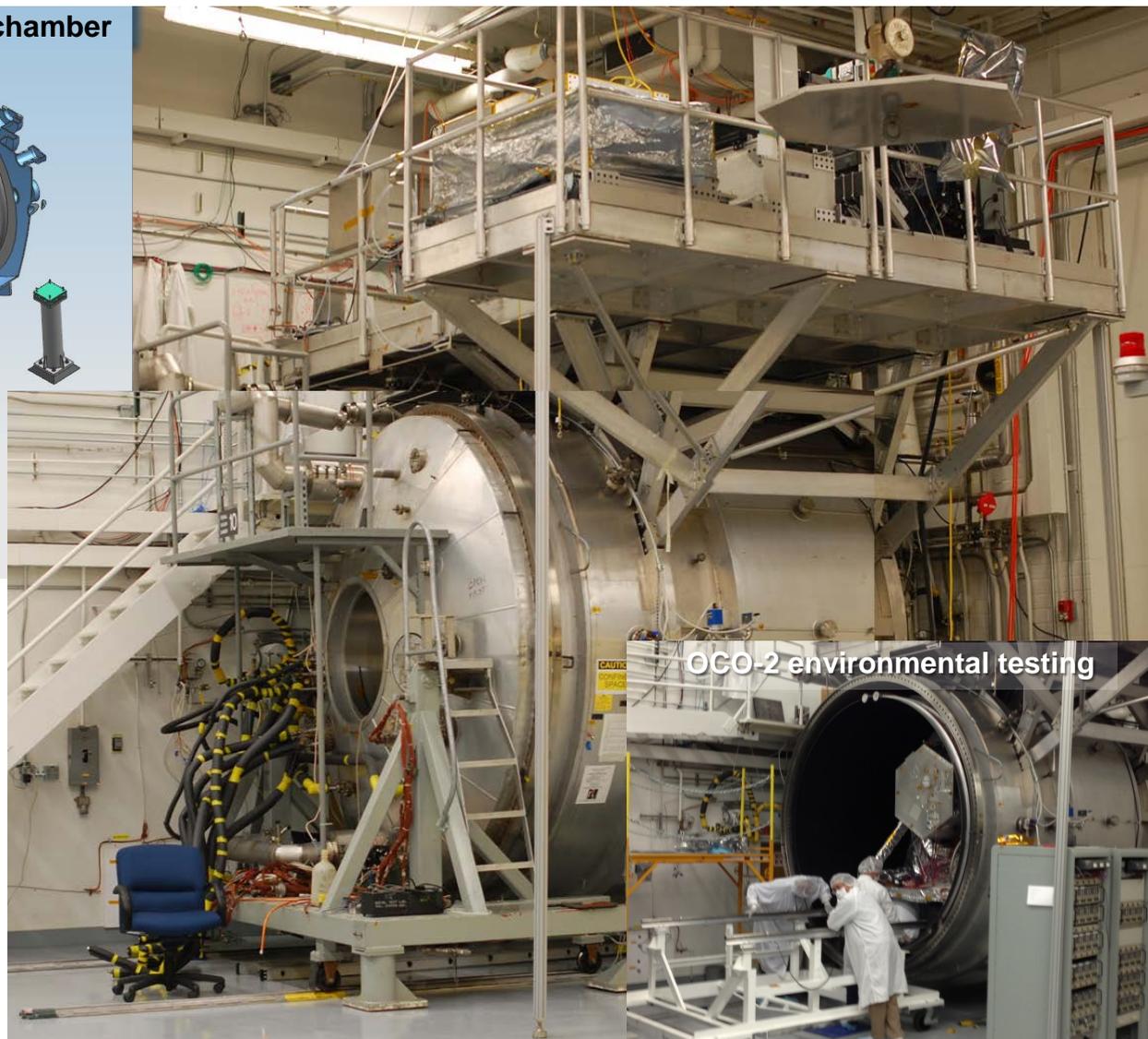
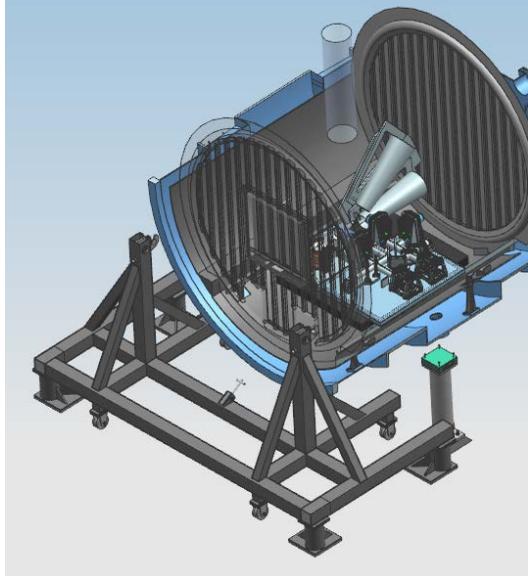


PanFTS EM components and modules are full size, flight like, and designed for launch loads and years of stable operation in the space environment



EM Tests in Space Environment Conditions

PanFTS EM and GSE fit in 10 ft. chamber



- PanFTS testing will be done in the JPL 10-foot thermal vacuum chamber used by OCO-1 and OCO-2 for environmental testing
- The EM will make simultaneous UV-NIR-TIR measurements in thermal-vacuum at -90° Celsius
- A rigorous program of testing will verify that critical flight design requirements have been achieved such as interferometer modulation efficiency, optical alignment stability, SNR and high spectral resolution

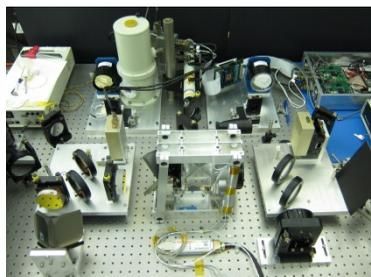
The EM will demonstrate PanFTS designs are mature



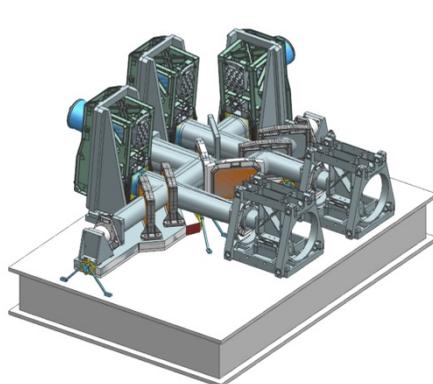
PanFTS Options for GCIRI

	O ₃ SO ₂ HCHO Aerosol	O ₃ NO ₂ (CHO) ₂ Aerosol	O ₂ Aerosol	CO		CH ₄		O ₃	NH ₃	# focal planes
PanFTS Configurations	UV ¹	Vis ¹	NIR	SWIR ¹ Total column	MWIR Partial column	SWIR ¹ Total column	TIR Partial column	TIR ¹ Partial column	TIR ¹ Partial column	
PanFTS Breadboard		✓	✓	✓	✓	✓				2
PanFTS EM	✓	✓	✓				✓	✓	✓	3
PanFTS EVI-1			✓	✓		✓				2
PanFTS GCIRI-1				✓	✓	✓				1
PanFTS GCIRI-2				✓	✓	✓	✓	✓	✓	2

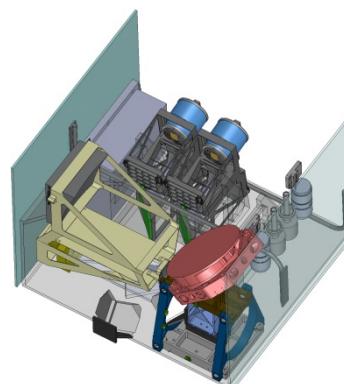
¹GEO-CAPE STM Requirement



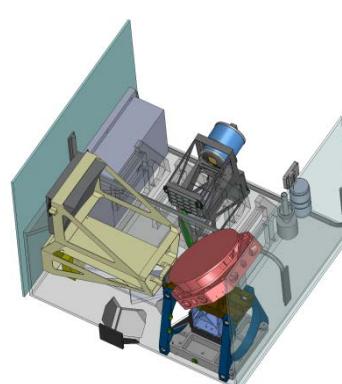
IIP-07 Breadboard



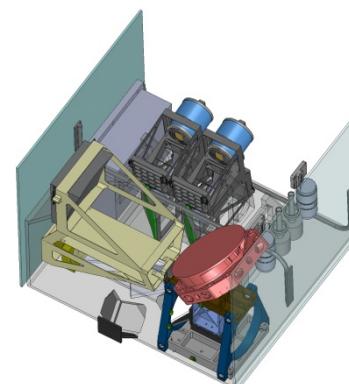
IIP-10 EM



EVI-1



GCIRI-1

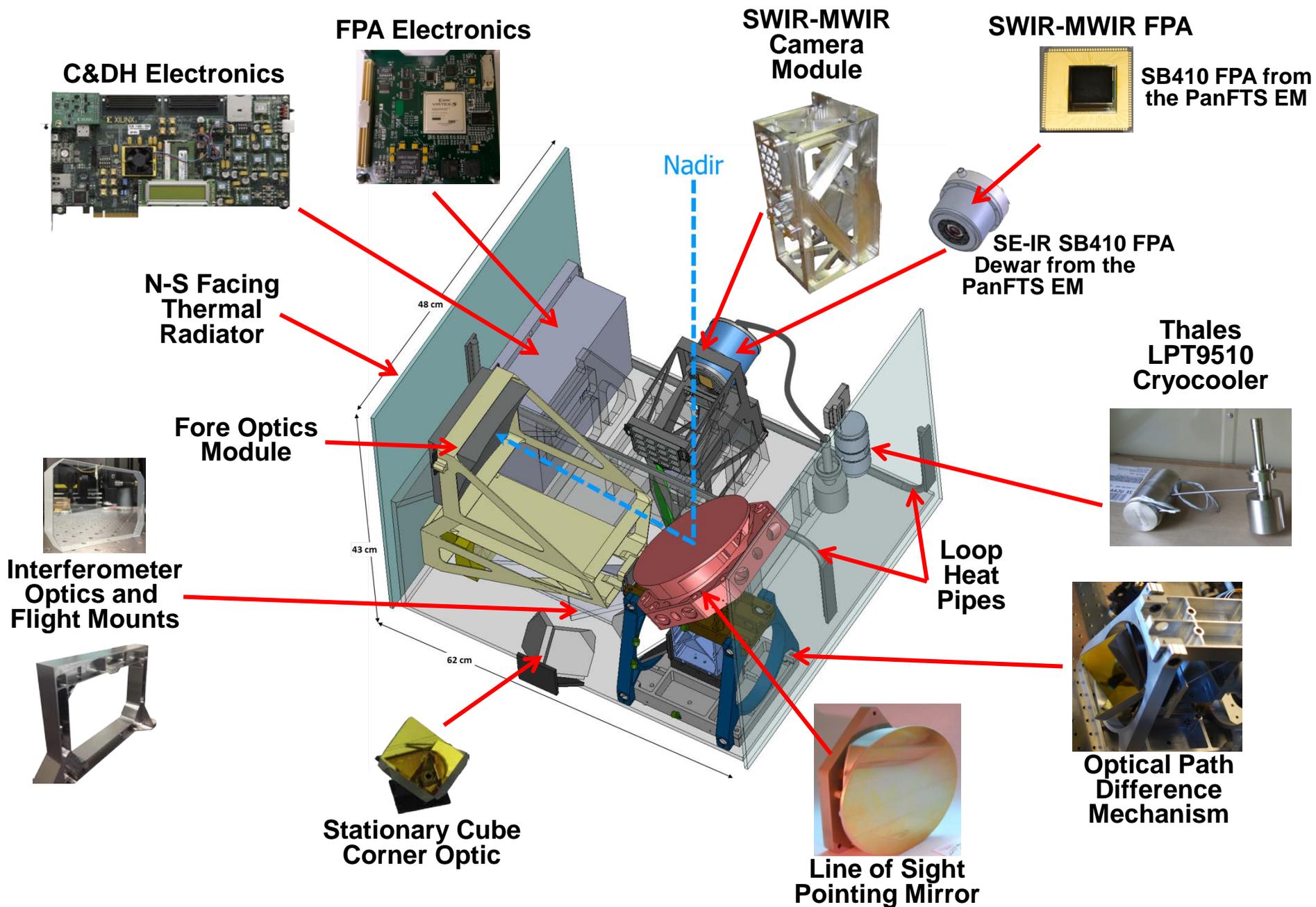


GCIRI-2

PanFTS heritage provides low risk instrument options for GCIRI

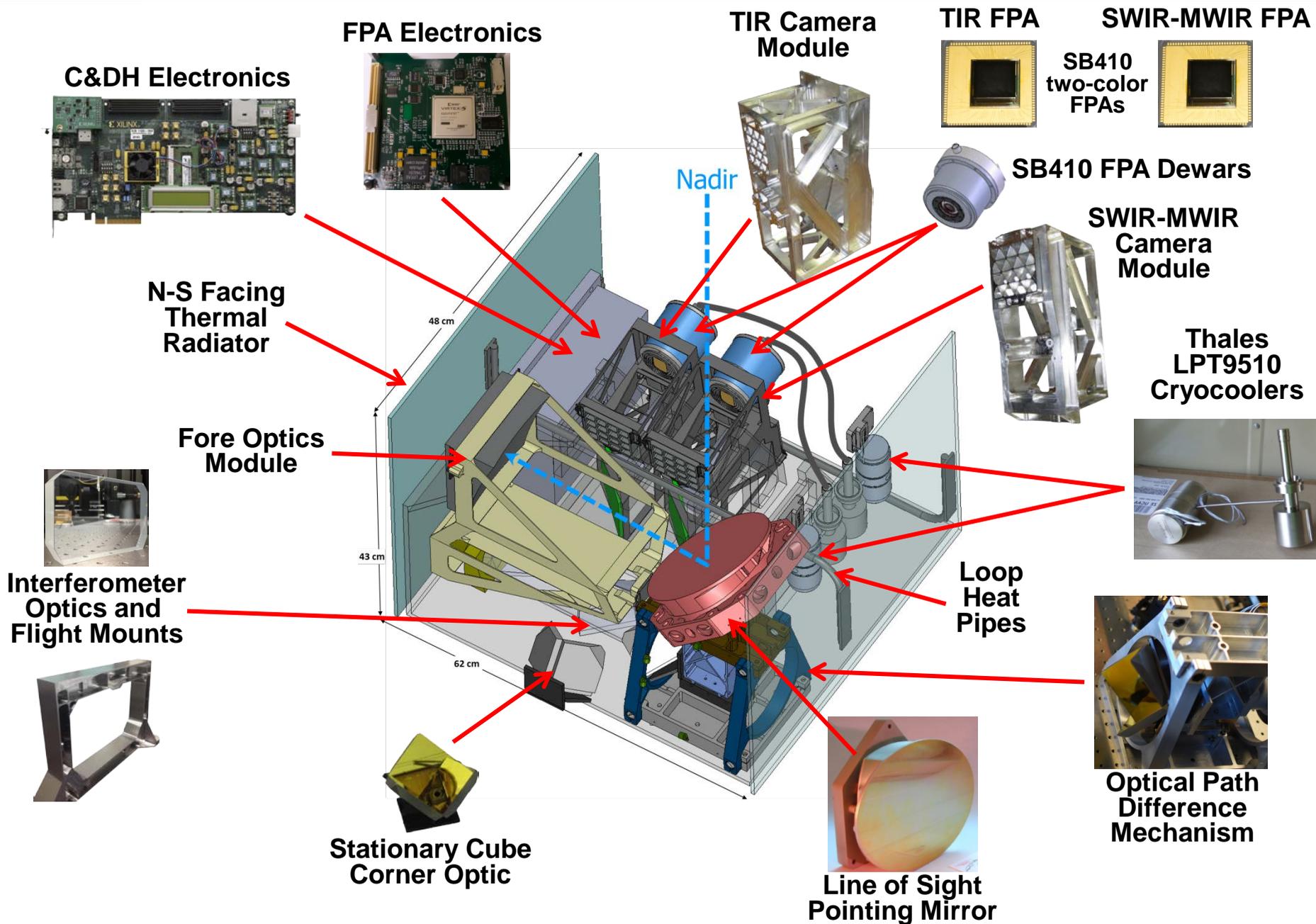


PanFTS GCIRI Option 1





PanFTS GCIRI Option 2





Cost of PanFTS GCIRI Options Compared To PanFTS EVI-1

Instrument Element	GCIRI Option		Comments about relative cost
	1	2	
Focal plane assemblies (FPAs)	↓↓	↓↓	Option 1 has one PanFTS IIP-10 TIR FPA (PanFTS EVI-1 had two IR FPAs); option 2 uses both PanFTS IIP-10 TIR FPAs
Electronics	↓↓	↓	Option 1 has a single FPA and less electronics than option 2 and PanFTS EVI-1; PanFTS IIP-10 designed, is building and testing the C&DH system for both GCIRI options
Optics	↓↓	↓↓	PanFTS IIP-10 has built and tested the camera optics modules & interferometer optical components for both GCIRI options
Interferometer including OPDM	↓	↓	PanFTS IIP-07 designed, built, and life tested in thermal-vacuum at -90° Celsius the OPDM for both options; EM interferometer optics, mounts, and benches are designed for flight
Instrument line-of-sight pointing	=	=	No change from PanFTS EVI-1
Mechanical structure, mechanisms	=	=	Option 1 is less complex but cost savings may not be significant
Thermal control system	↓	=	Option 1 has one cryocooler (PanFTS EVI-1 had two); option 2 uses the PanFTS EVI-1 two cryocooler back up thermal system
Flight S/W	↓	↓	PanFTS IIP-10 is developing much of the data and instrument control S/W for both GCIRI options
Instrument I&T	↓↓	↓	Option 1 is less complex; PanFTS IIP-10 I&T procedures are applicable for the I&T of both GCIRI options

Legend: = means same cost; ↓ means lower cost; ↓↓ means substantially lower cost, relative to PanFTS EVI-1

Both PanFTS GCIRI options would cost less than the proposed EVI-1 instrument



Summary

- **The full size flight-like PanFTS EM is currently being assembled, tested, and prepared for thermal-vacuum testing in late 2013**
- **A rigorous program of testing will demonstrate the capability for making simultaneous measurements of trace gases over a range of conditions in a space like environment**
- **PanFTS has a modular design that can be configured to make some or all GEO-CAPE atmospheric composition measurements**
- **A low risk, affordable GEO-CAPE Infrared Instrument (GCIRI) can be built using proven PanFTS designs and tested EM components**
- **The cost as well as the development and operational risks of a PanFTS GCIRI would be less than the PanFTS EVI-1 instrument proposed in 2012**
- **Many PanFTS EM components are flight ready for use in a GCIRI which shortens the time to deliver a GCIRI ready for I&T with a host spacecraft**
- **Development of a PanFTS GCIRI could begin immediately**