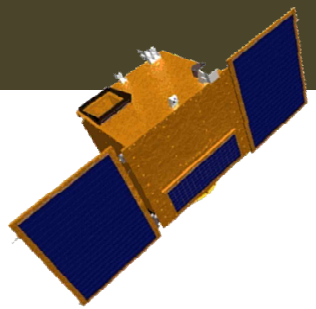


Korean Compact Infrared Space Telescope, MIRIS

D.-H. Lee[1], W.-S. Jeong[1], Y. Park[1], C.H. Ree[1], U.-W. Nam[1], B. Moon[1], S.-J. Park[1], S.-M. Cha[1], J. Pyo[1], J.-H. Park[1], K. Seon[1], D. Lee[1,2], S.-W. Rhee[3], J.-O. Park[3], H.M. Lee[4], T. Matsumoto[4,5], W. Han[1] & S. Matsuura[5],

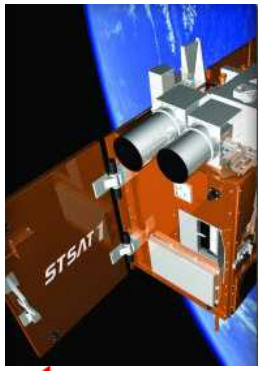
[1] KASI, Korea, [2] UST, Korea, [3] KARI, Korea, [4] ASIAA, Taiwan, [5] ISAS/JAXA, Japan

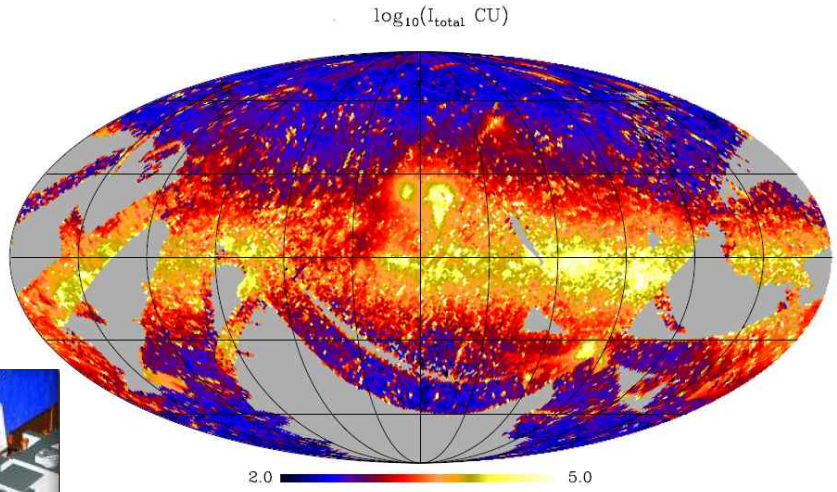
Contents

Space Observation Program in Korea

■ Science & Technology Satellite Series

- 1st satellite: FIMS (Far-ultraviolet IMaging Spectrograph) (2003)
- 2nd Satellite: Observation of Space environment by Korean Launcher Naro
- 3rd Satellite: MIRIS (Multipurpose Infrared Imaging System)



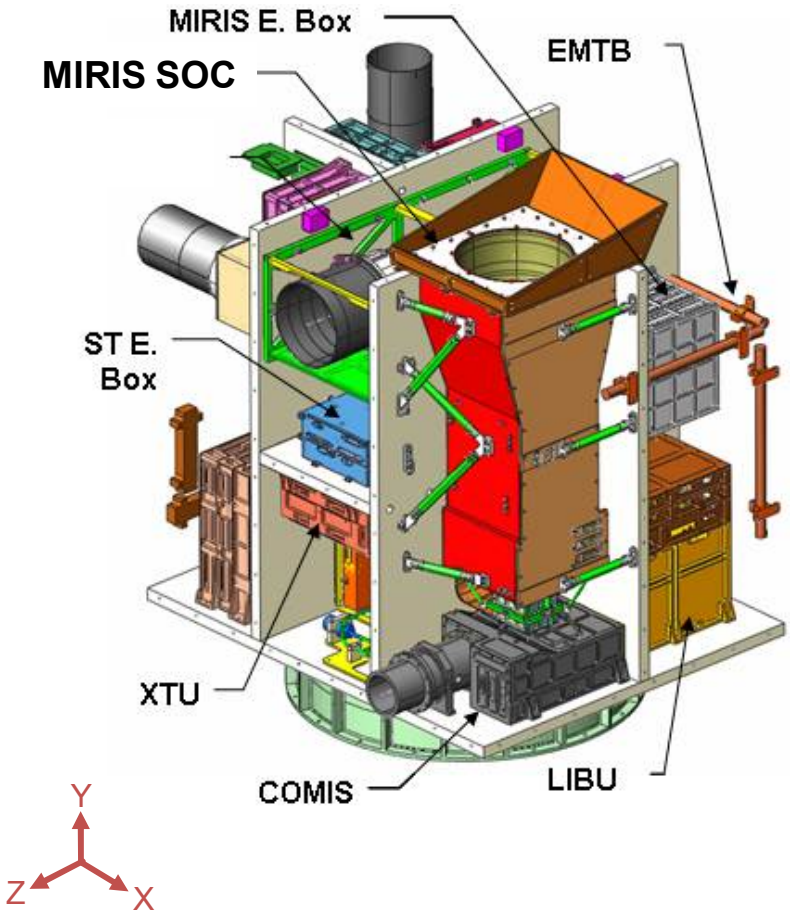


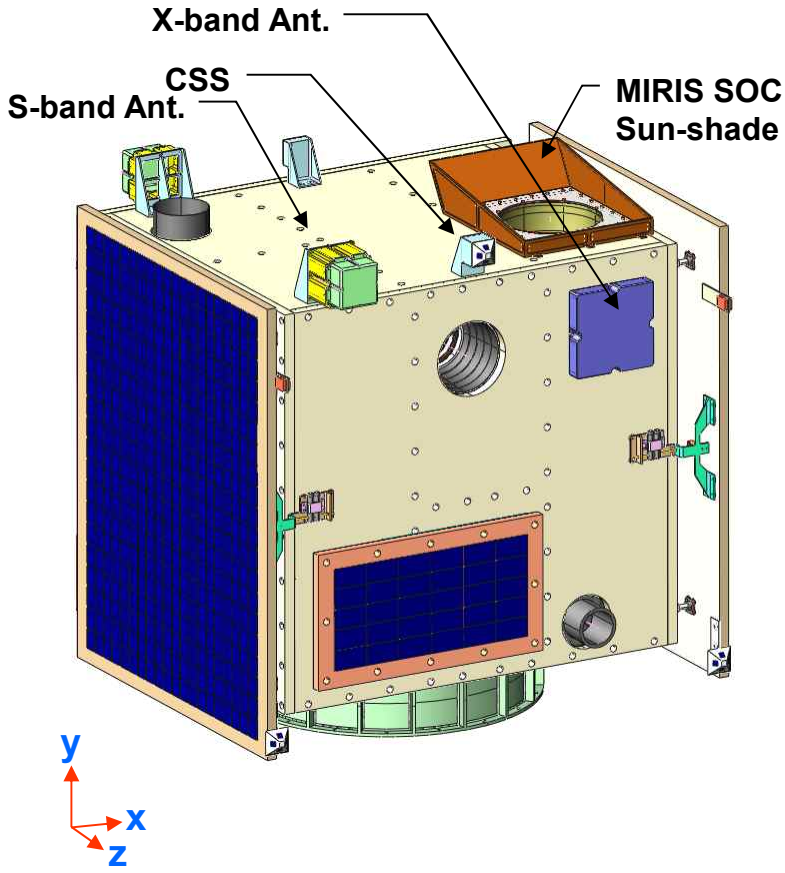
(Seon et al. 2011)

ST-SAT II

■ Primary & Secondary Payloads

- MIRIS: first infrared camera in space

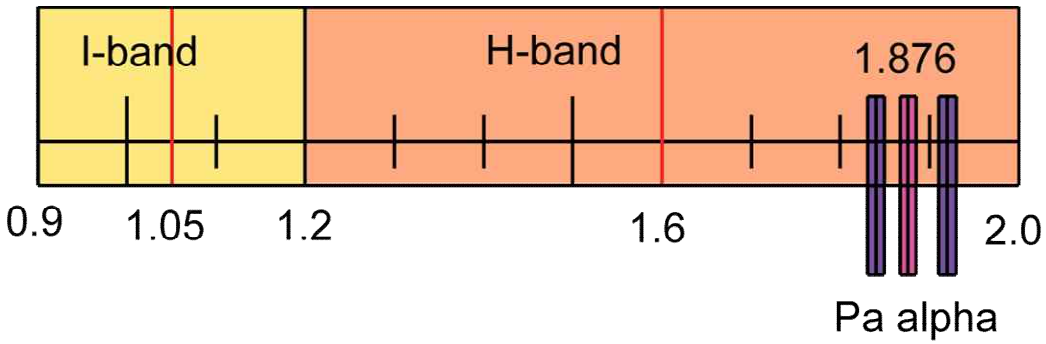




Specifications of MIRIS

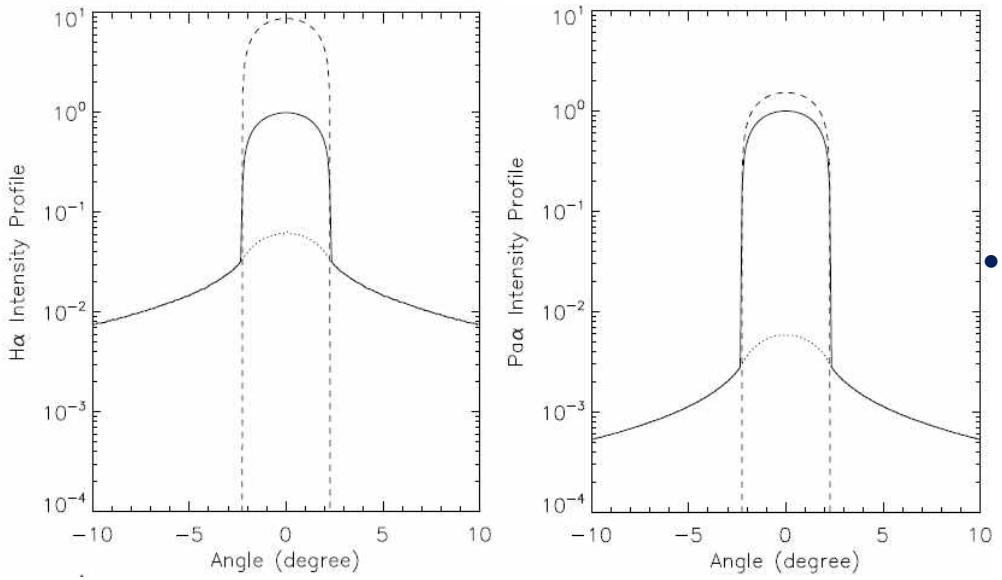
■ Specifications of Space Observation Camera

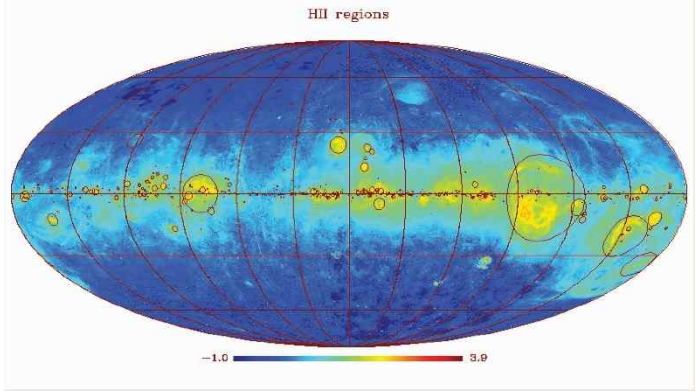
- Wavelength: 0.9 ~ 2μm — Aperture: 80 mm
- Detector FOV: 3.67° x 3.67° (Pixel : 51.6 arcsec)
  (c.f. Nyq. sampling @ 1.6μm = 4.1 arcsec)
  → limited by satellite stability
- Telescope & Sensor Temp.: 180K (Passive Cooling), 90K
- Filters (5 filters)
  - I (1.05μm), H (1.6μm), blank
  - Pa α (1.876μm), Pa α Cont



Scientific Objectives (1/3)

- Paα Emission Line Survey : Galactic plane & WIM
- Origin of Warm Ionized Medium
  - Previous study of WIM: Photoionization model
  - Recent study of WIM from FIMS: dust scattering
  - Verification of the dust scattering theory
- Physical properties of interstellar turbulence
  - Structure of WIM
  - Comparison between Paα (MIRIS) vs. Hα



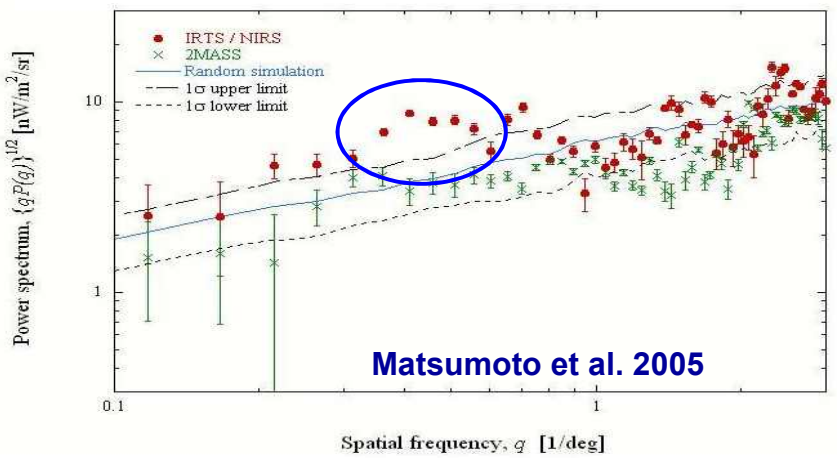


- Monte-Carlo simulation
  - Uniform dust distribution; E(B-V) = 0.1
  - Point source or Spherical H II region

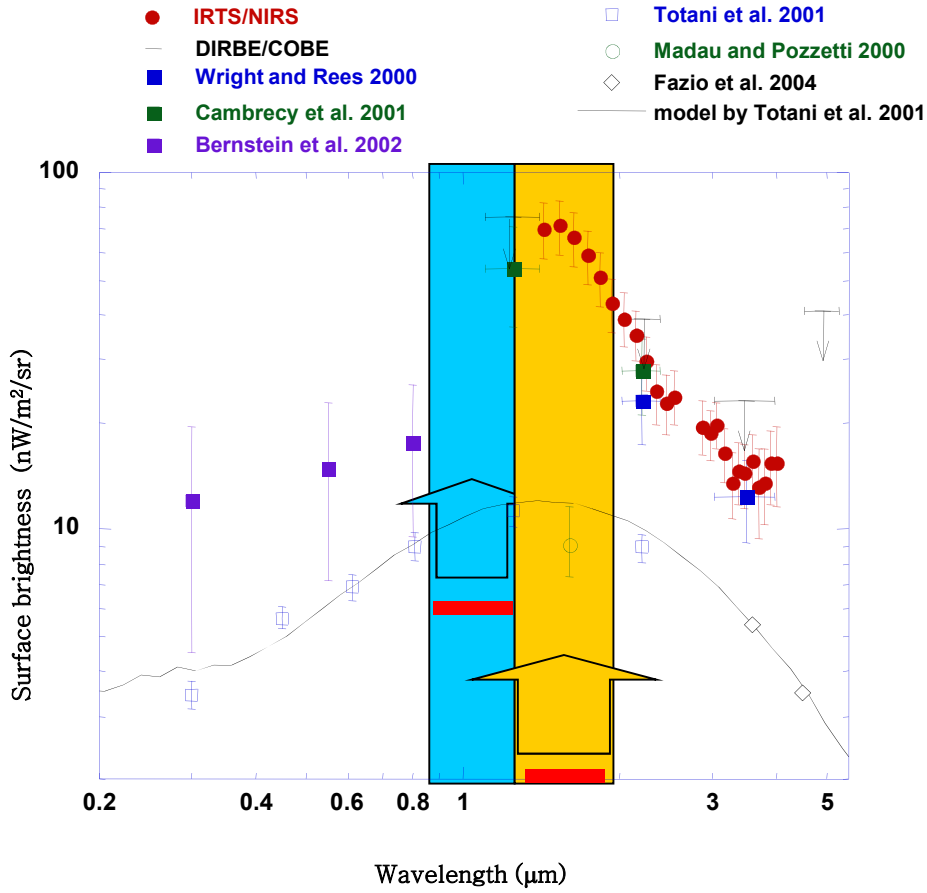
Scientific Objectives (2/3)

Observation of Cosmic Infrared Background (CIB)

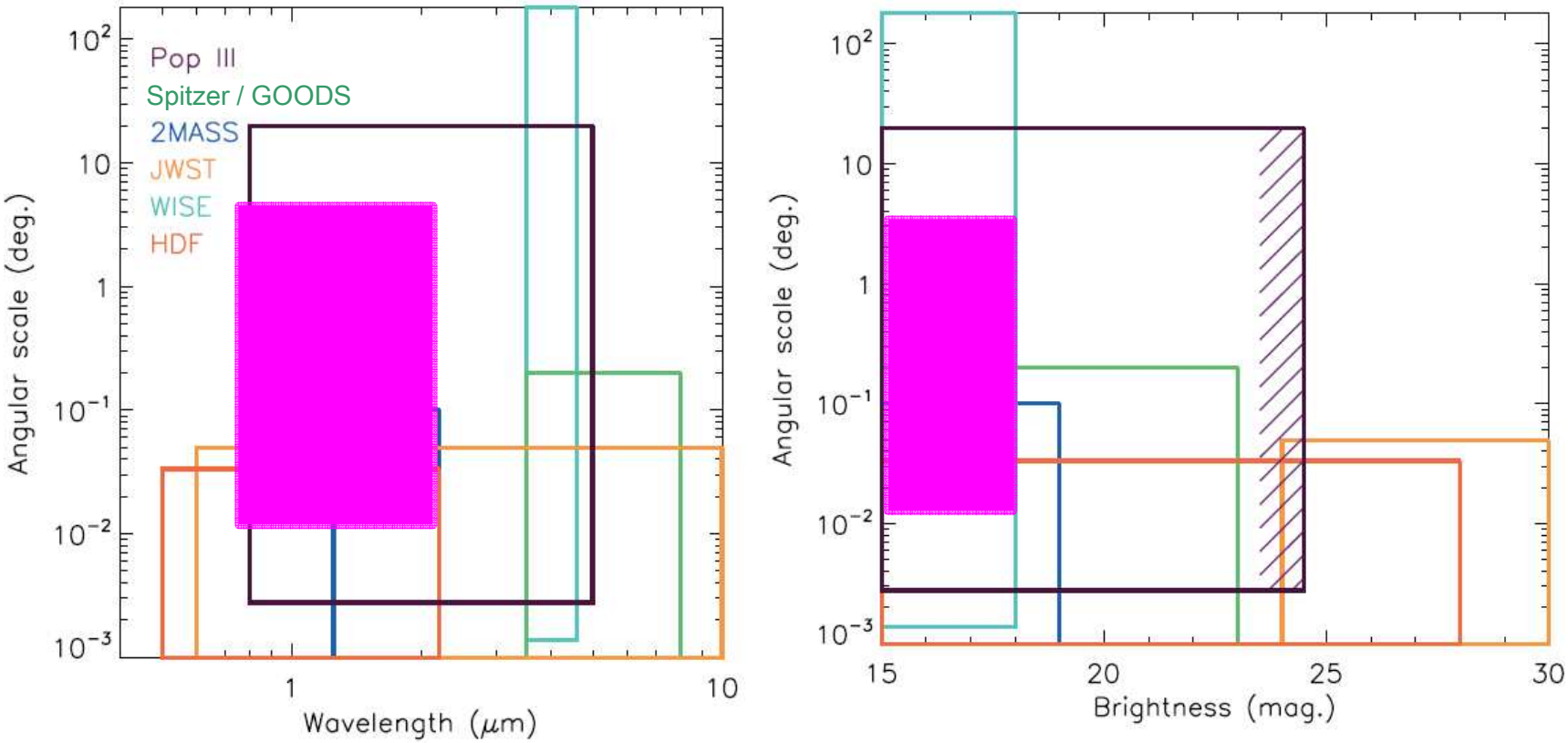
- CIB from POPIII stars
- Spectral peak of CIB
- Large scale fluctuation of CIB



Large-scale structure of CIB from IRTS observation



Parameter Space of CIB



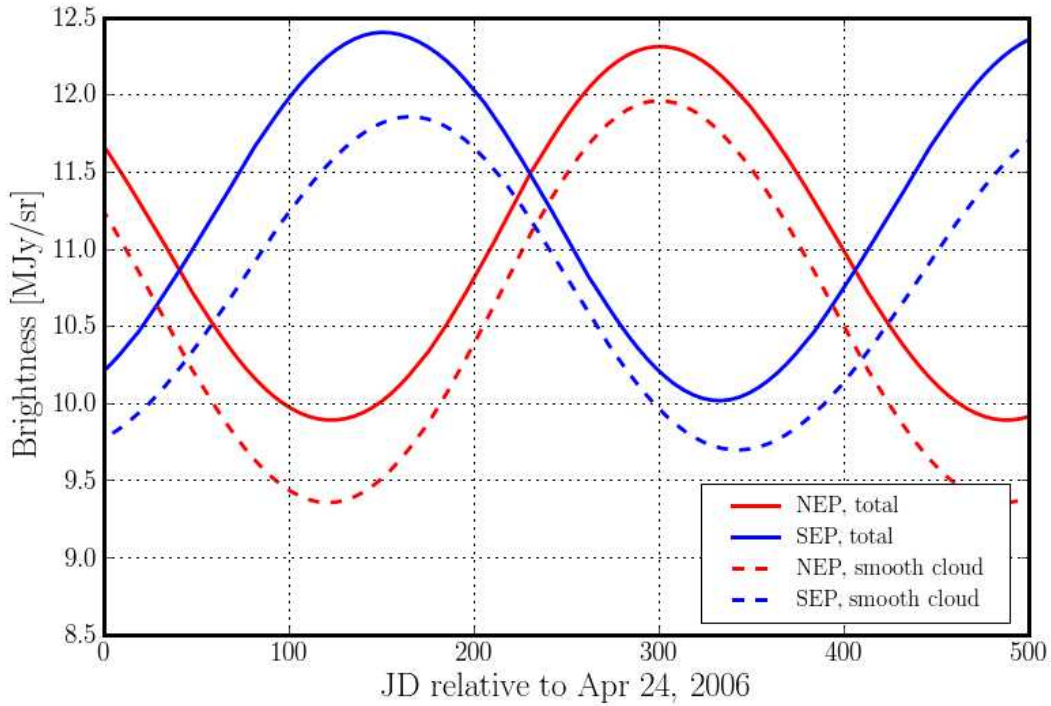
Parameter space for MIRIS:

Scientific Objectives (3/3)

■ Zodiacal foreground

- Calibration purpose: 2 orbits /day
- Simultaneous observation of NEP & SEP in 1 orbit
- Monitoring of ZL in SEP and NEP: I & H bands

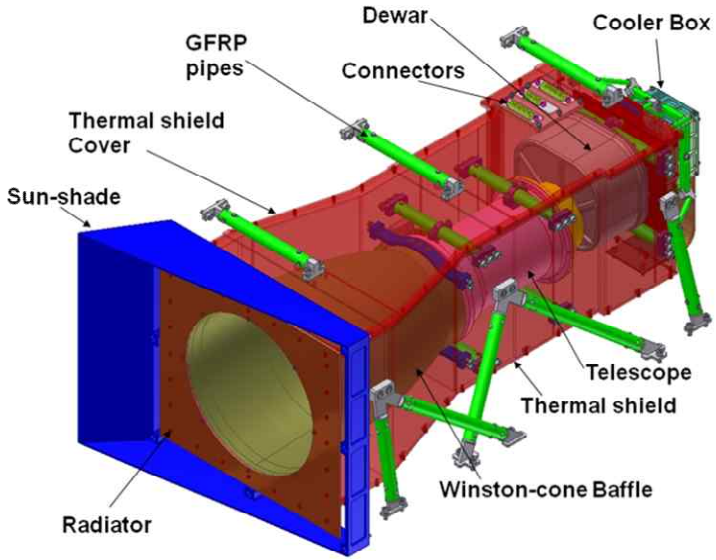
→ Revision of ZL Model & Removal of ZL component

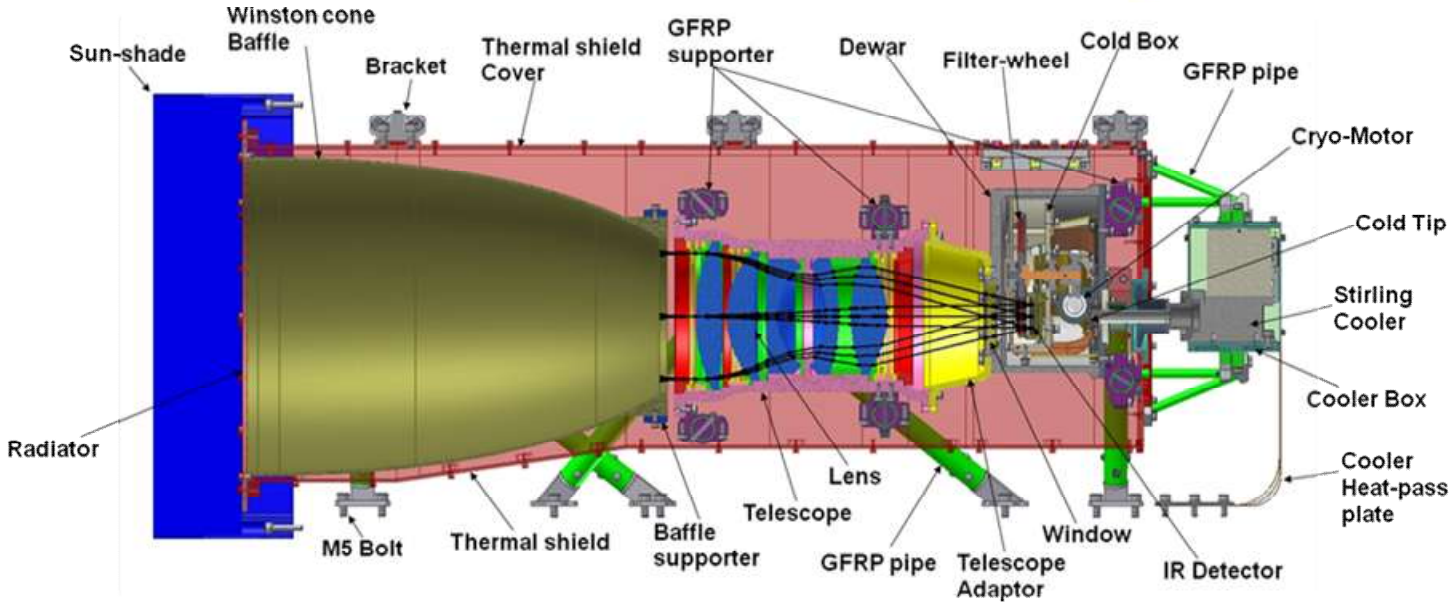


Optomechanical Design

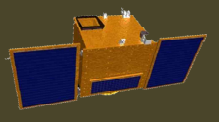
Optomechanics

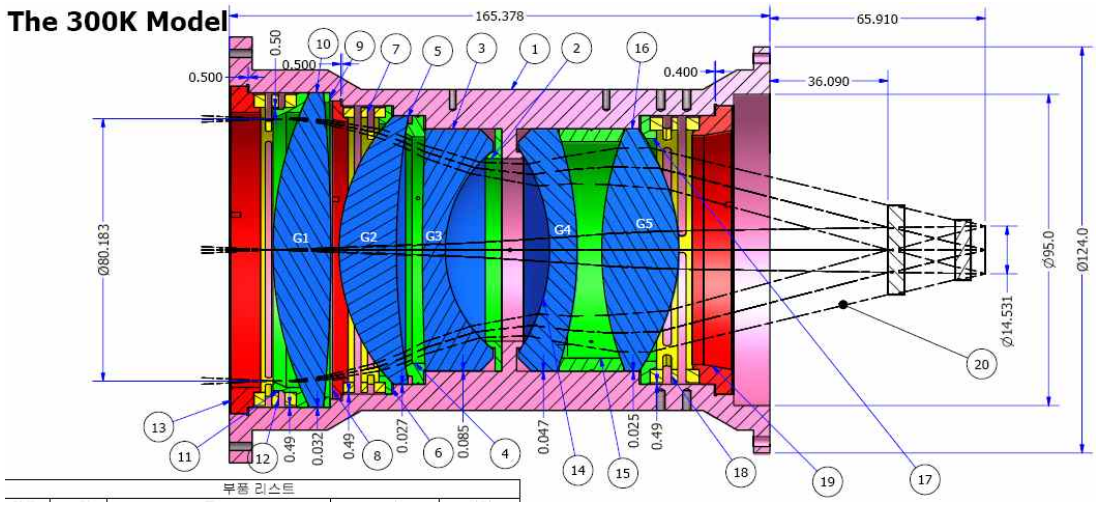
- Outer & Inner parts
- Dewar & cooler
- Passive cooling: radiator, GFRP supporter, winston cone baffle, thermal shield





Optical Design



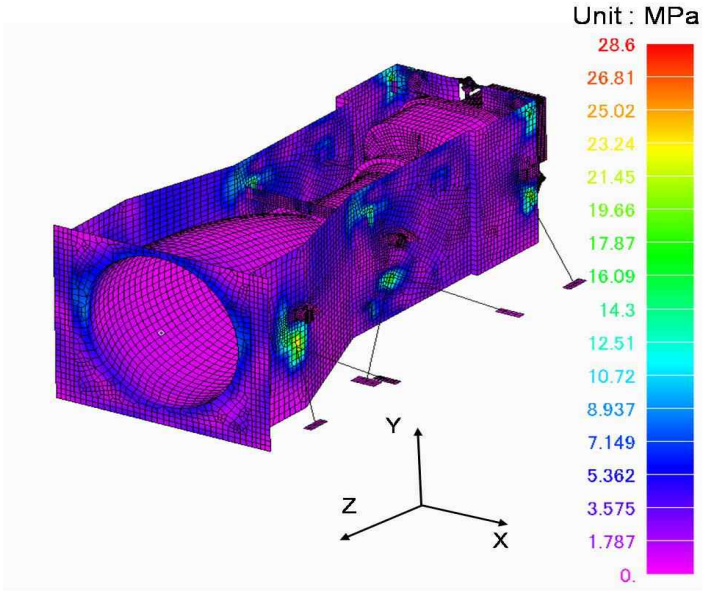


Specifications	
Wavelength	0.9 – 2 um
Aperture	80 mm
Focal ratio	f/2
Effective Focal Length	160 mm
Pixel FOV	51.6″X 51.6″
Detector FOV	3.67° x 3.67
Telescope Temperature	< 200K
Sensor/Filter Temperature	< 100K
Specifications of sensor	
Sensor Model	Teledyne PICNIC (MCT)
Pixel Size	40 um X 40 um
Sensor Dimension	256 X 256
Detecting Area	10.2 mm X 10.2 mm

Mechanical & Thermal Analysis

■ FEM analysis

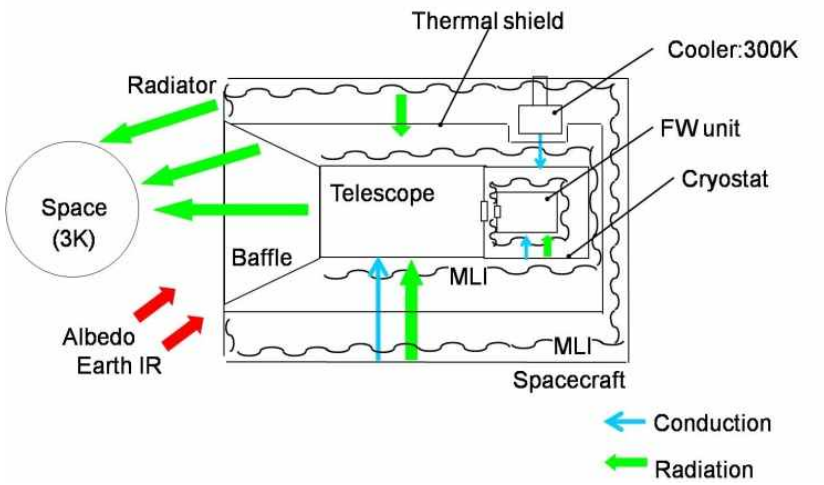
- Safety factor > 4 in all directions

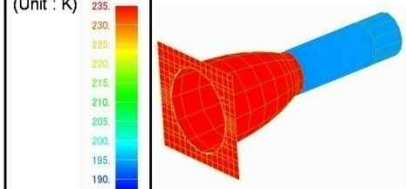
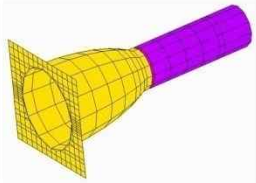


Stress in x direction

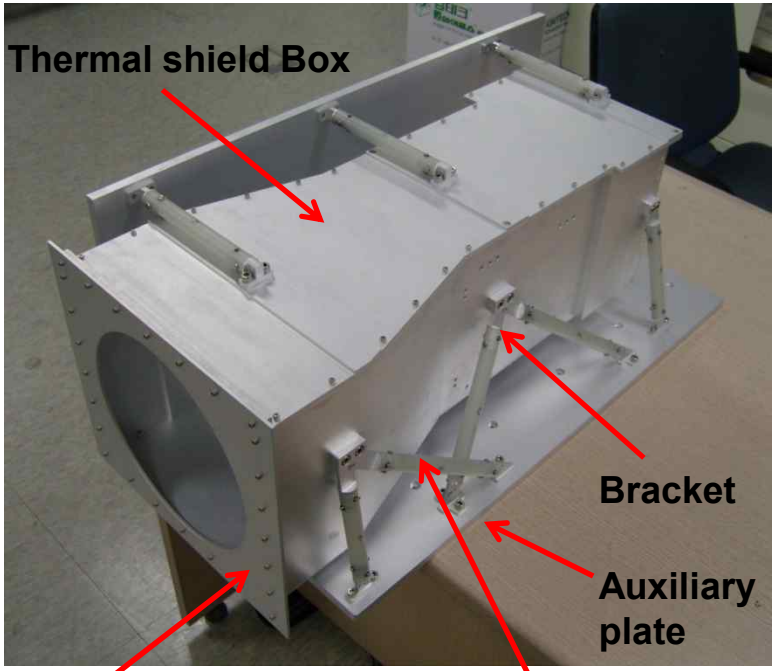
■ Thermal analysis

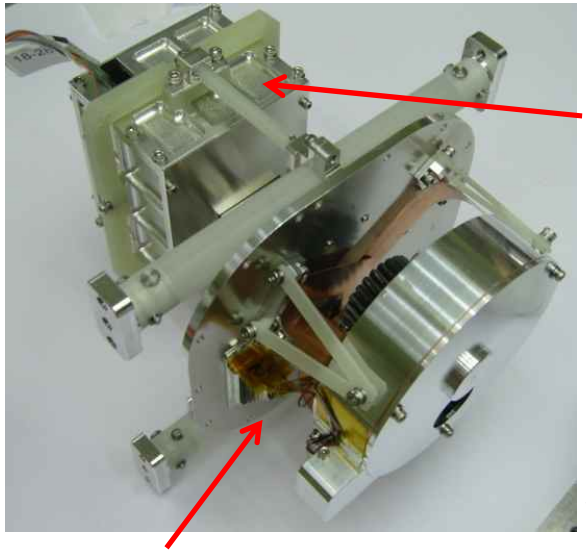
- Worst hot & cold cases

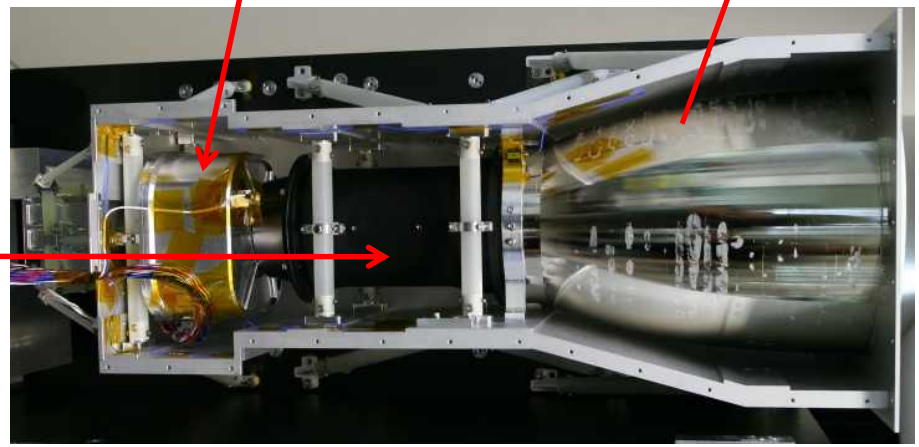


Case	A	B
Telescope temp.(K)	194.6	178.5
Heat load to Detector(mW)	183.3	149.1
Temperature distribution (Unit : K)		

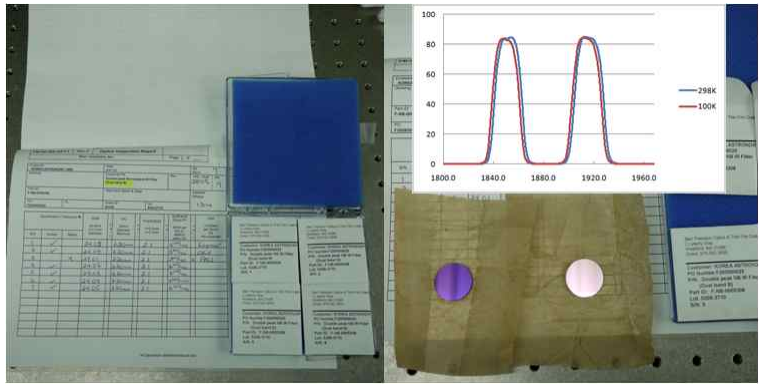
Parts of MIRIS





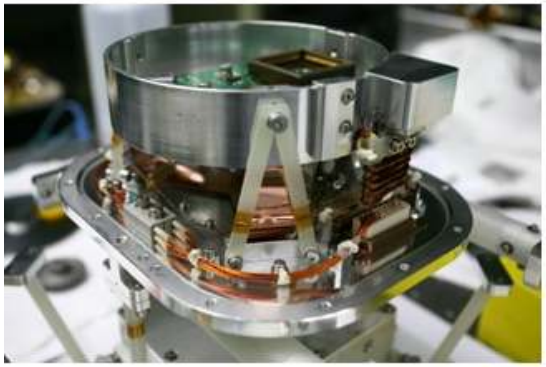


Assembly of Dewar



SOC filter

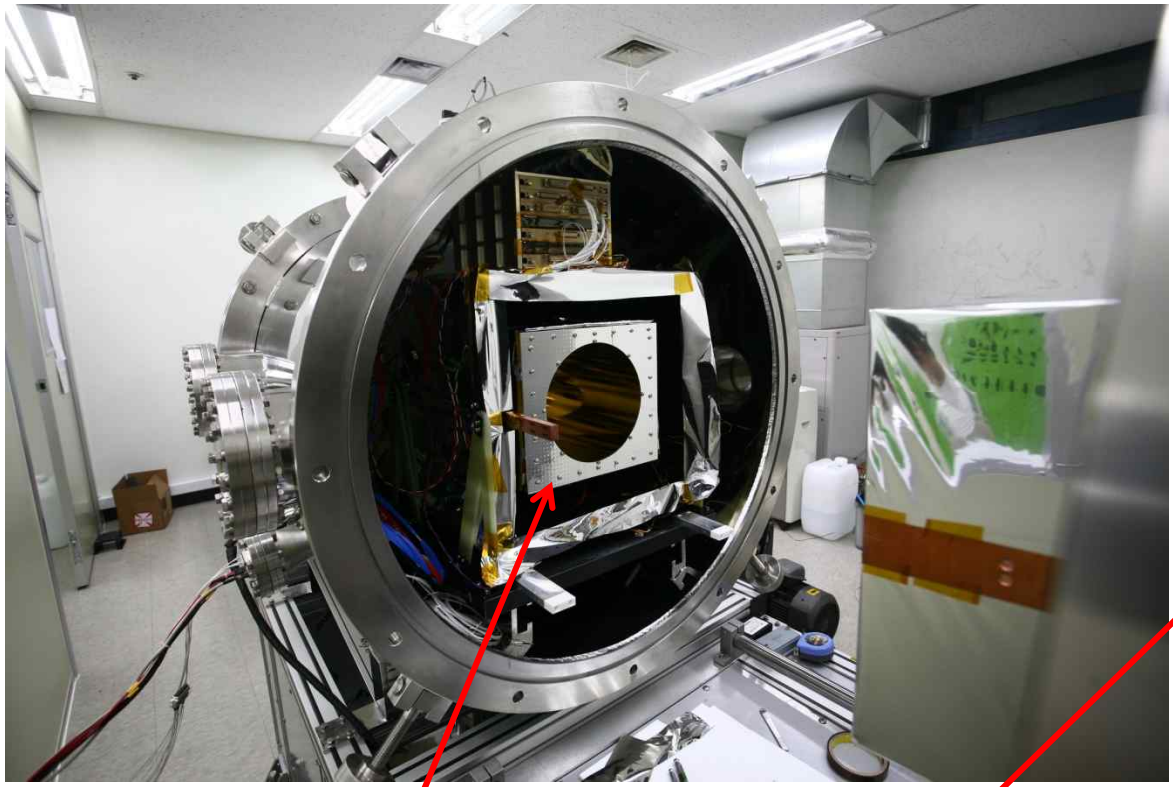
SOC filter wheel



SOC dewar

Environmental Test – Passive Cooling

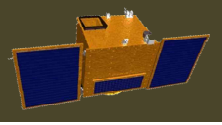
■ Confirmation of Passive Cooling : telescope < 200K



SOC Radiator

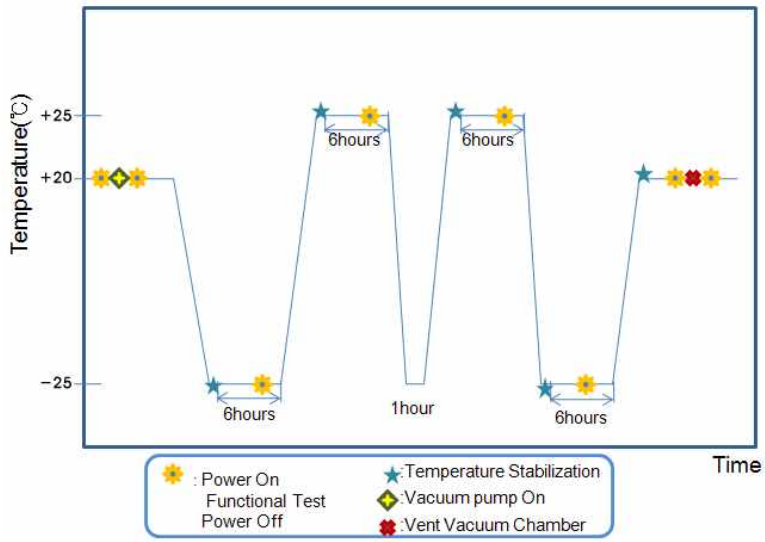
Cold Plate
(Velvet-painted)

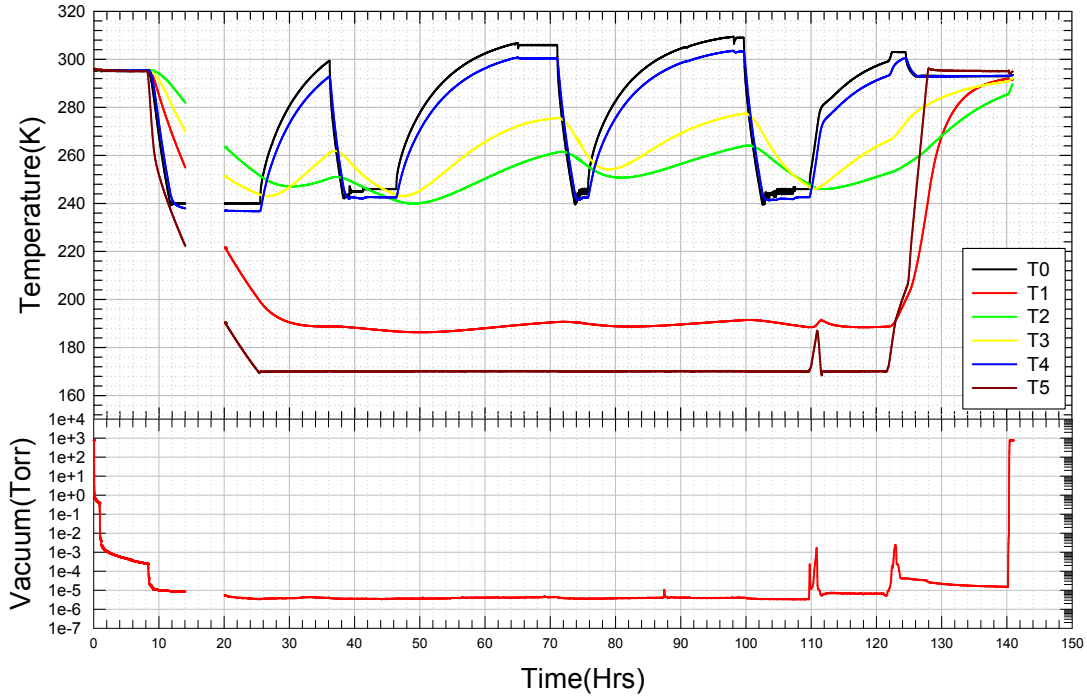
Environmental Test – Thermal/Vacuum Test



- Thermal cycles

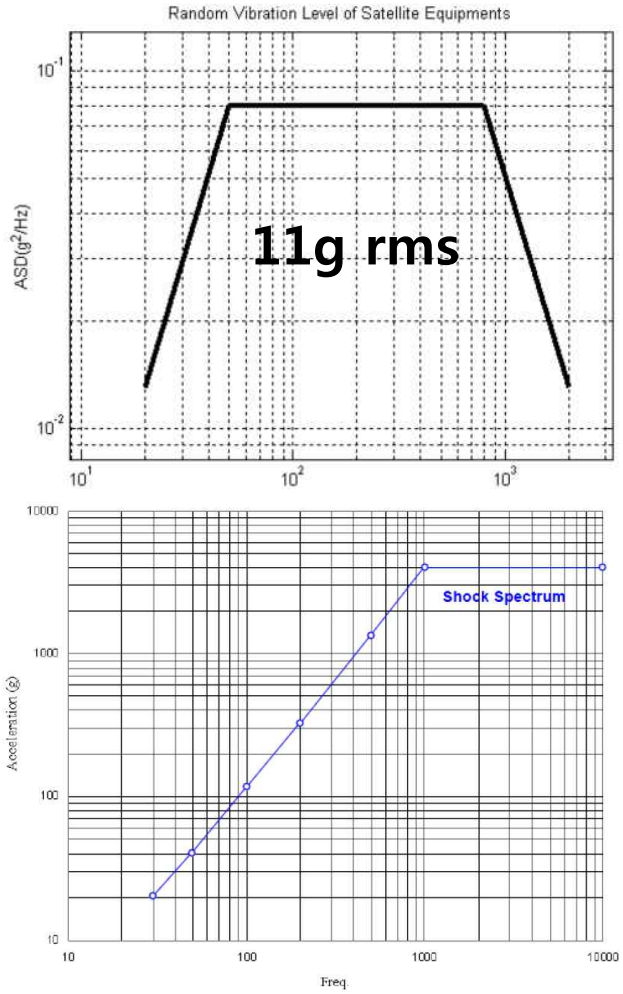
Subsystem/ Equipment	Components (PCB)	Temperature Limits (Degree C)					
		Acceptance (Operating) Range		Qualification (Operating) Range		Survival (Non-Operating) Range	
		Min	Max	Min	Max	Min	Max
MIRIS	**AO Telescope**	-80	-30	-85	-25	-90	70
	Electronics	-20	30	-25	35	-30	85

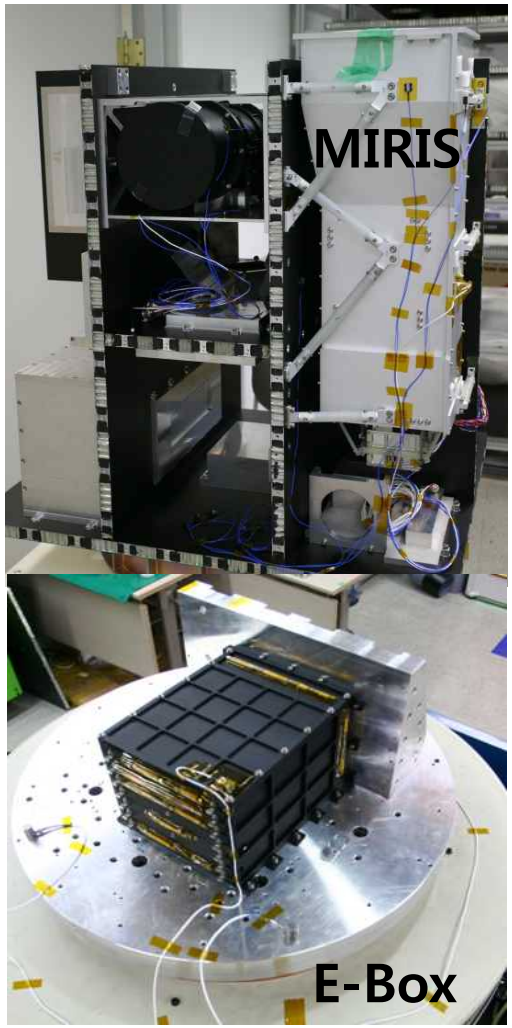




Environmental Test – Vibration/Shock, TID Test

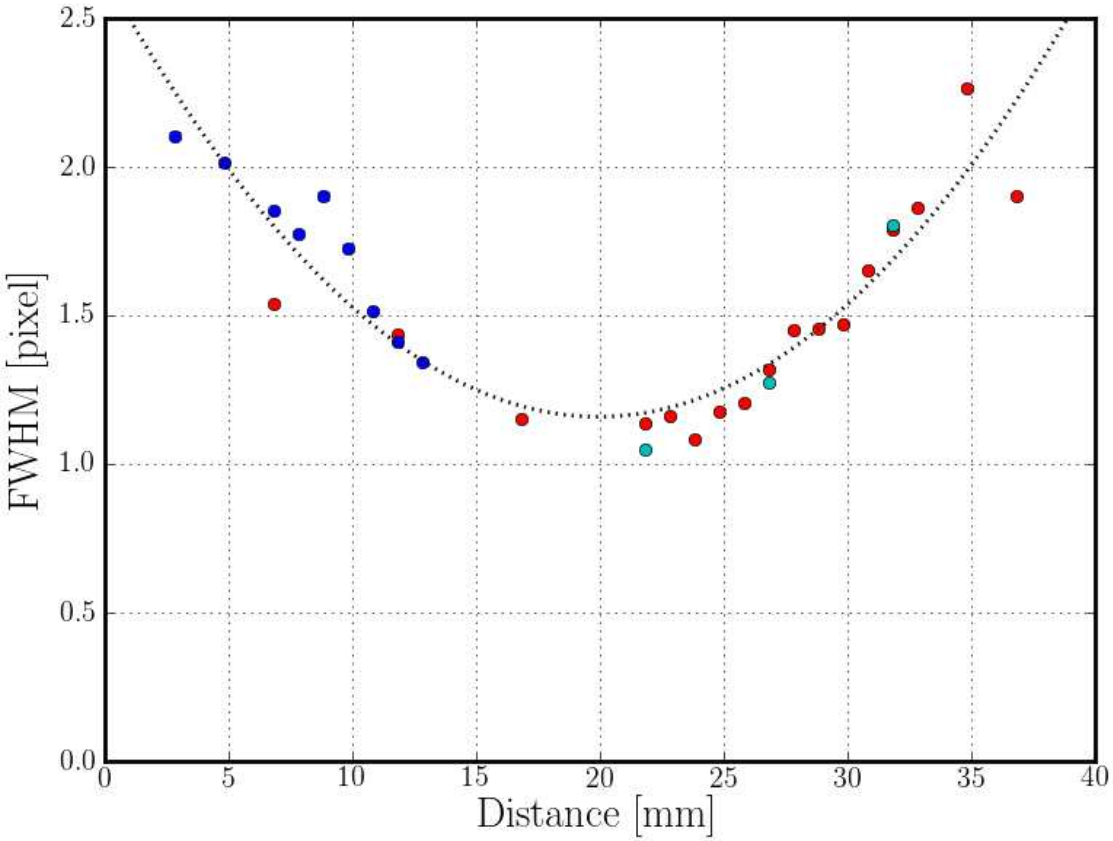
- Vibration/Shock Profile : MIRIS and E-Box
- Total Integration Dose Test: radiation exposure ~30K rad

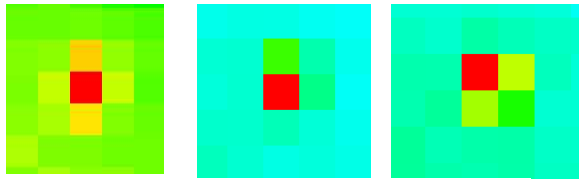


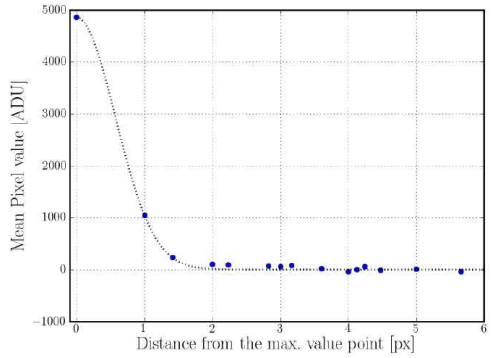


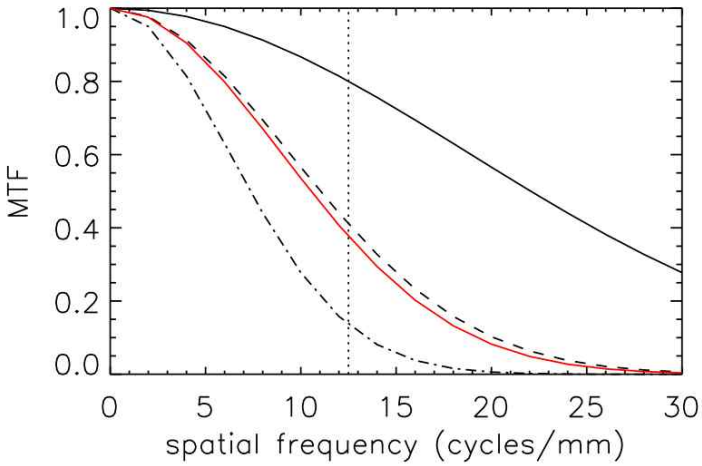
Calibration - Focus Test

- Beam profile: Gaussian
  - System MTF: ~30%





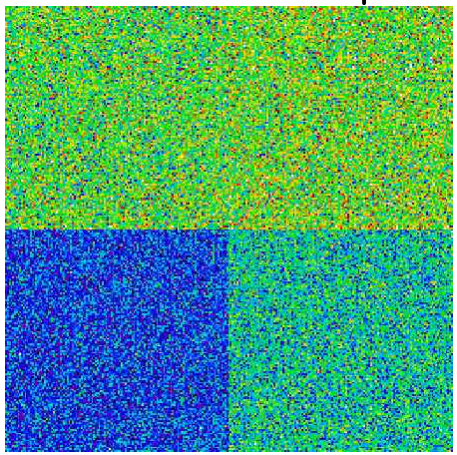


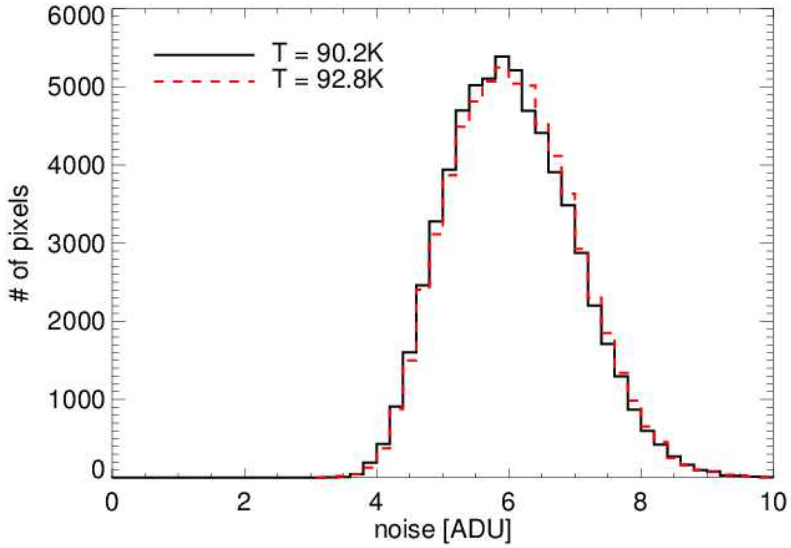


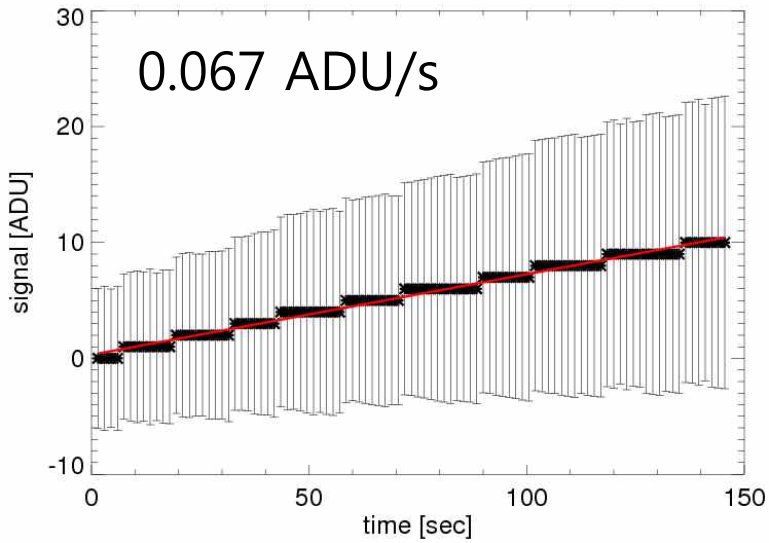
Calibration - Dark Test

- Gaussian: readout noise
- Temperature variation: ~3K
  - Increase of hot pixels: ~0.26%
  - Increase of noise < 1 ADU
  - No difference of dark on temperature variation

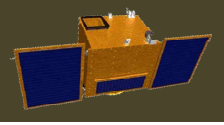
Noise map







Calibration - Gain Estimation



Mean-Variance Test

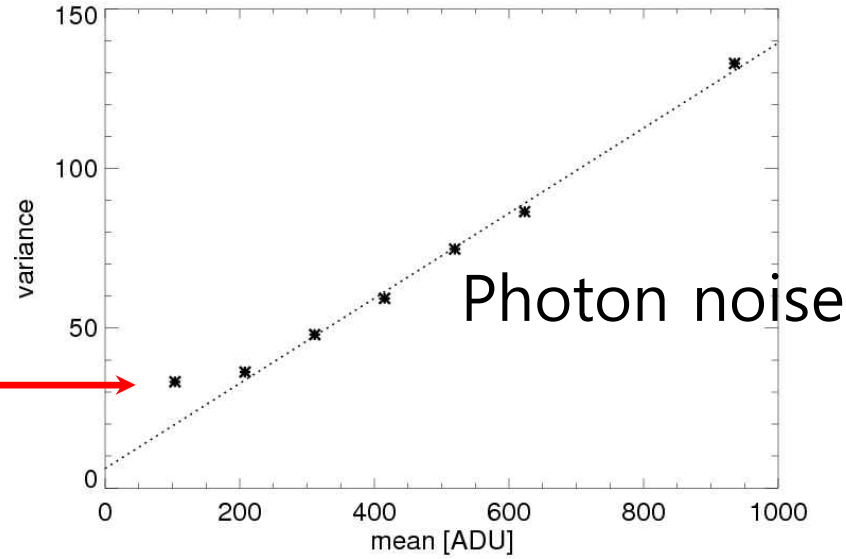
- $\sigma_T = \sqrt{\sigma_p^2 + \sigma_r^2}$
- Readout noise (σ_r) : Gaussian – constant
- Photon noise (σ_p) : Poissonian – increasing

Mean-Variance

- Readout noise ~ $45e^-$
- $45e^-$ < $50e^-$

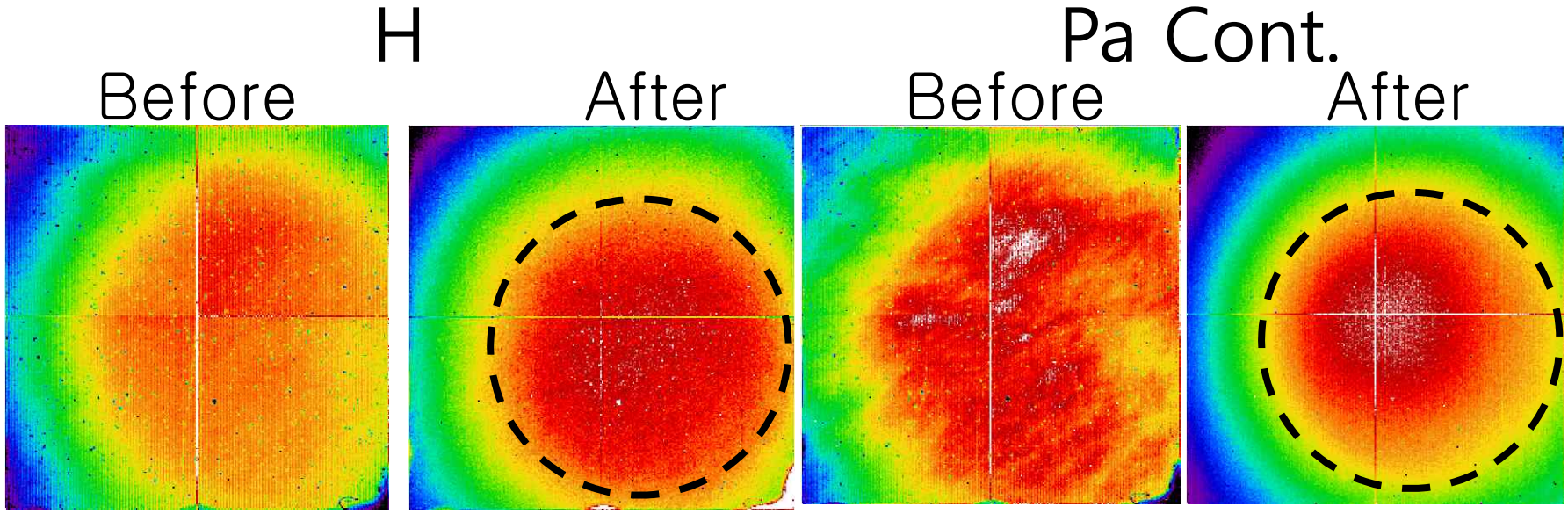
  (performance estimation)

Readout noise dominant

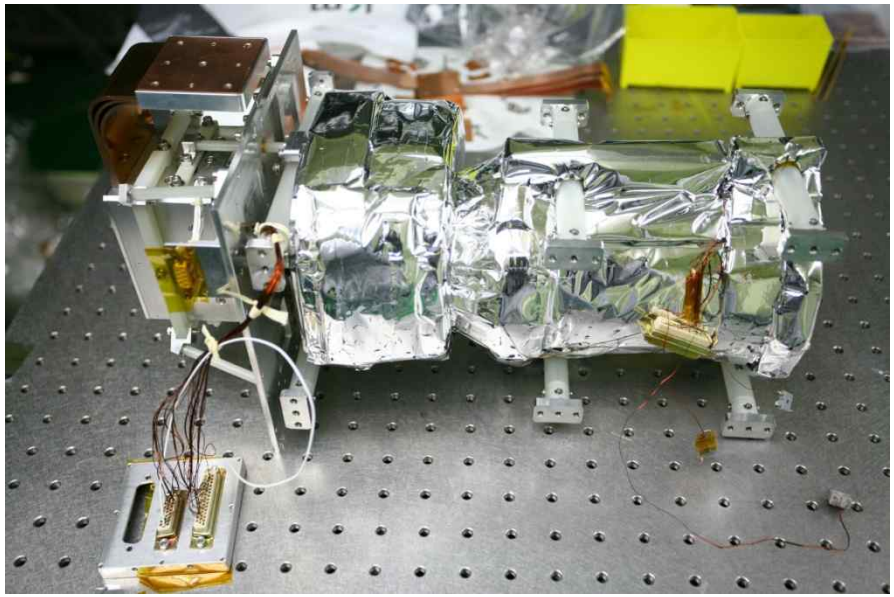


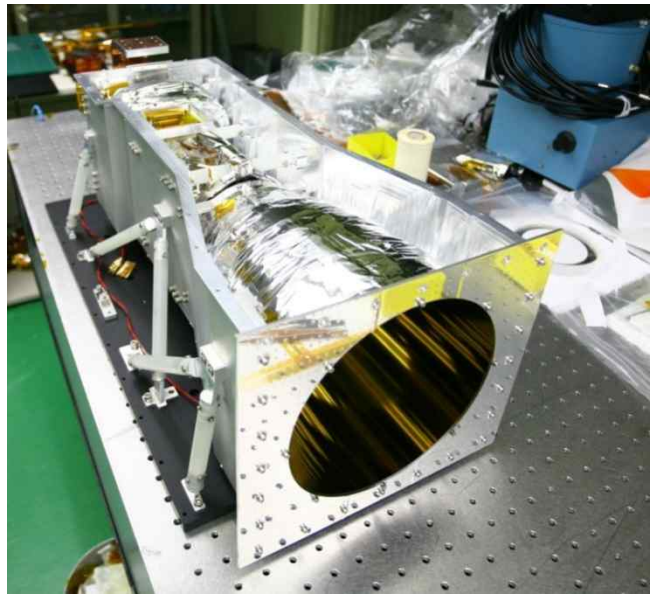
Calibration - Flat Data

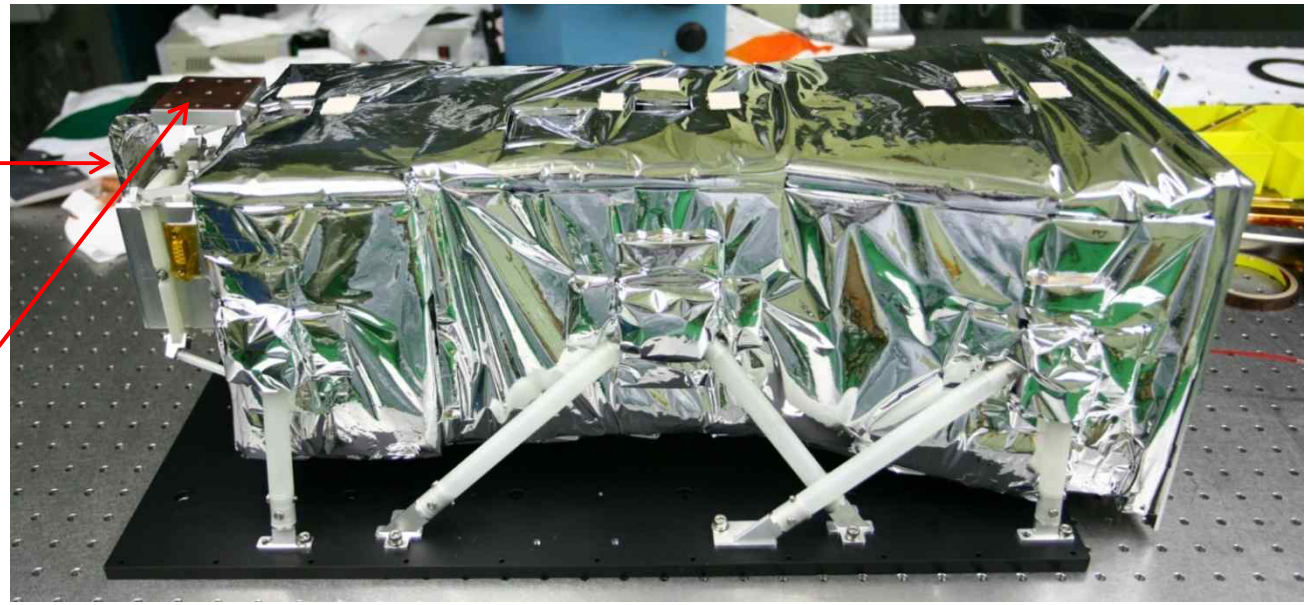
- Uniform source by integration sphere
- Flat fielding for H & Pa bands
  - Deviation: reduction of 50%, 42% for H and Pa cont., respectively
  - Flatness < 1%



MLI (Multi-Layer Insulation) Wrapping







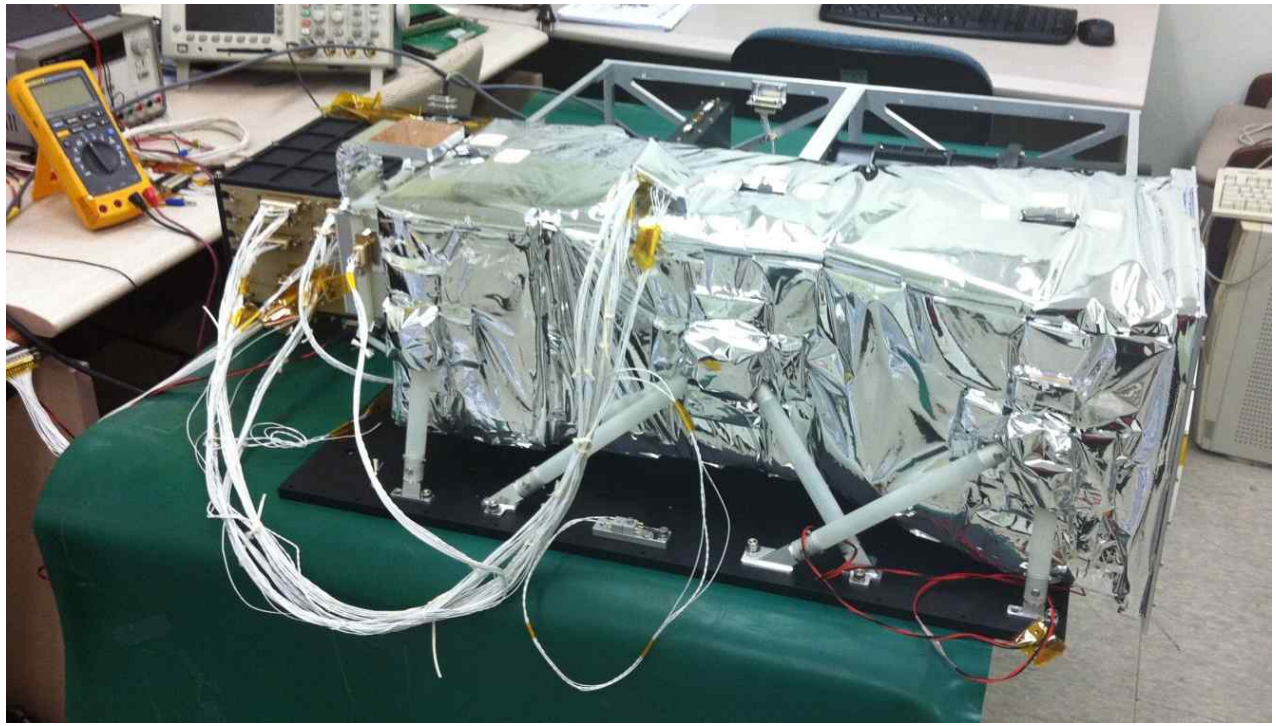
Heat-pass plate

Interface plate

MLI 30 layers

Final Functional Test

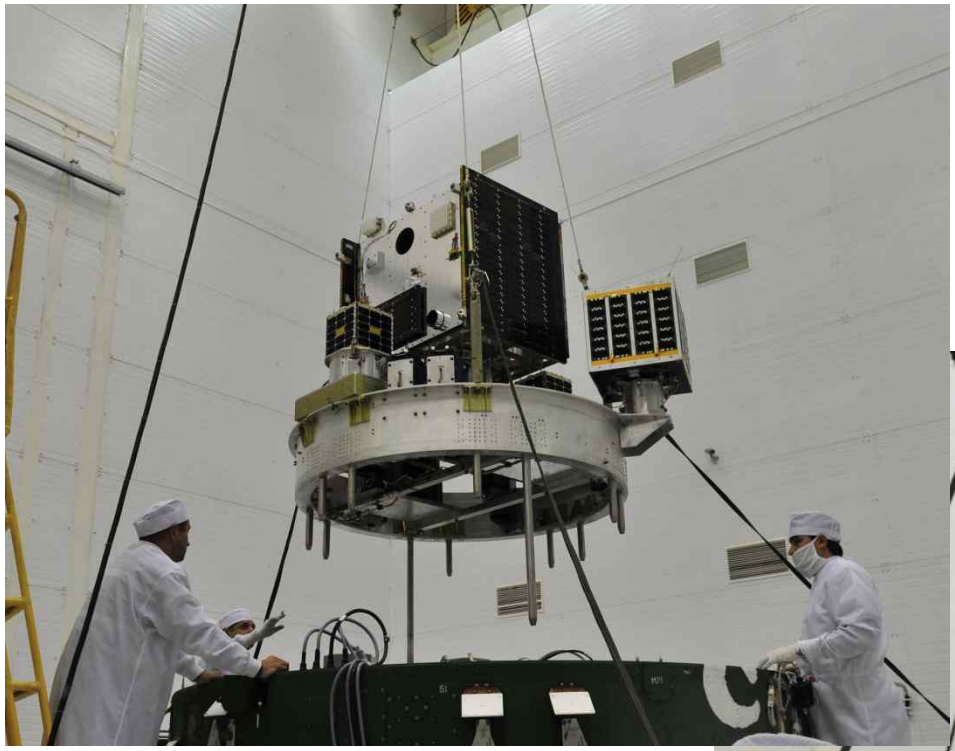
- Imaging test : OK
- Operation of filter wheel : OK
- Cooler ON/OFF: OK
- SOH data: OK

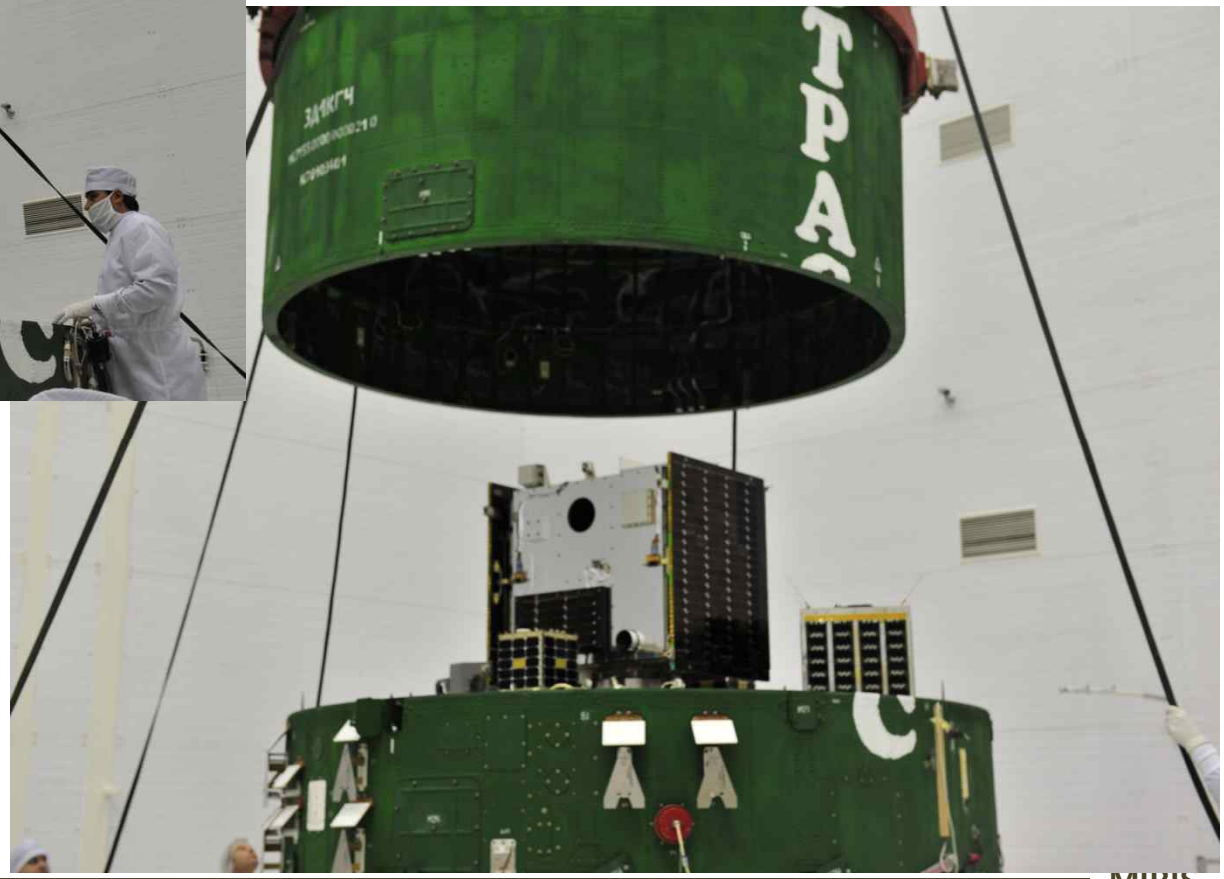


Launch Campaign

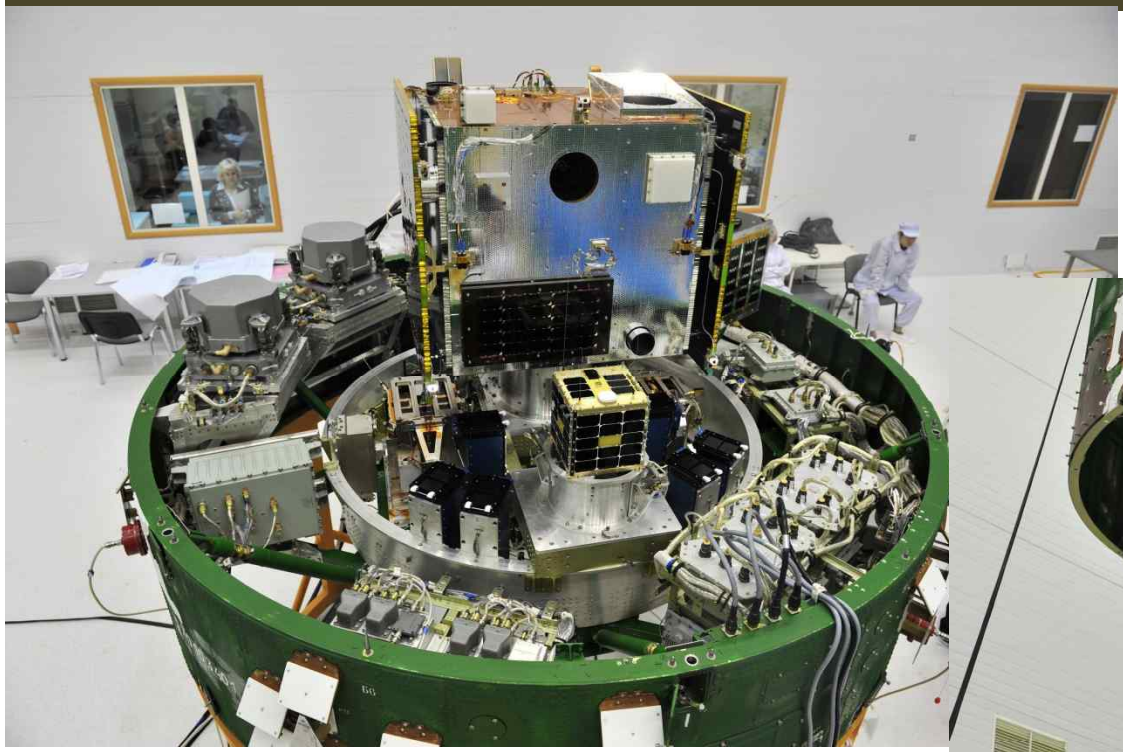
Launch Campaign

Launch Campaign

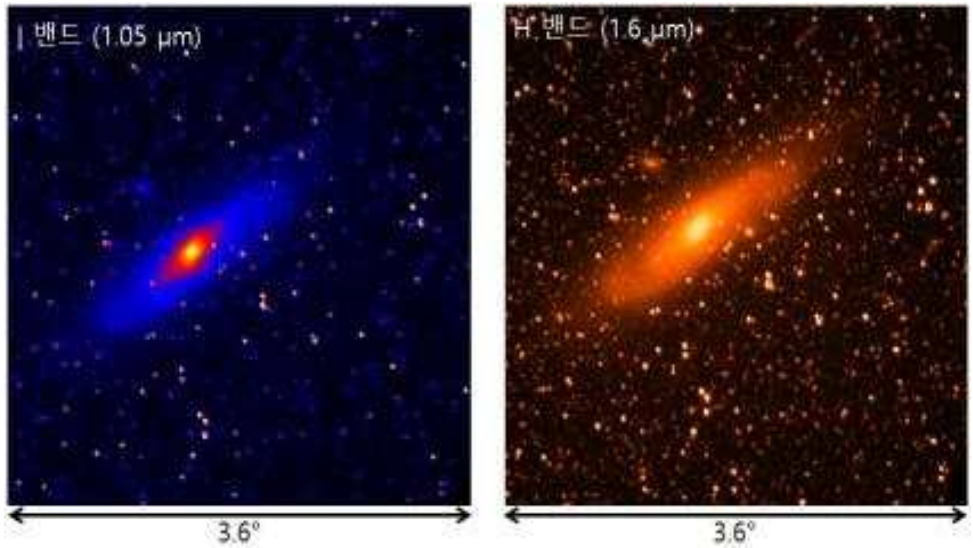




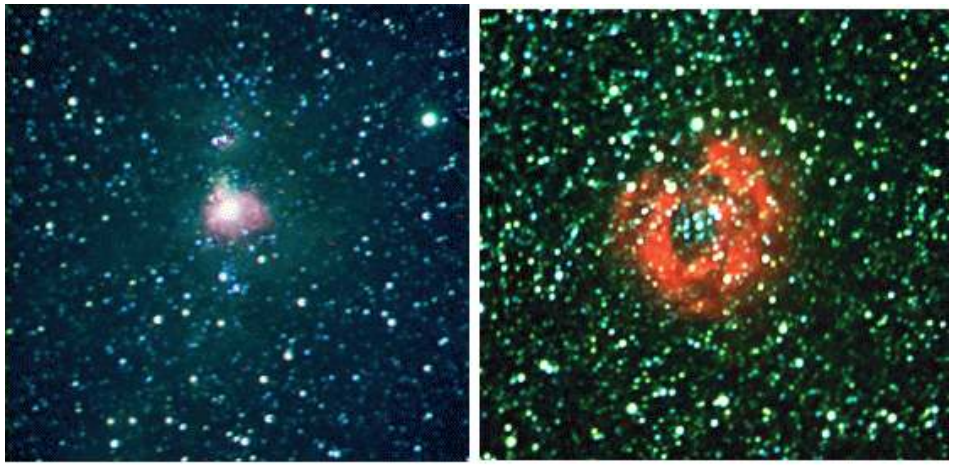
Launch Campaign



First Images



M31



Orion Nebula

Rose Nebula


Q
&
A