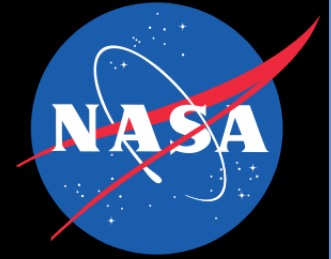
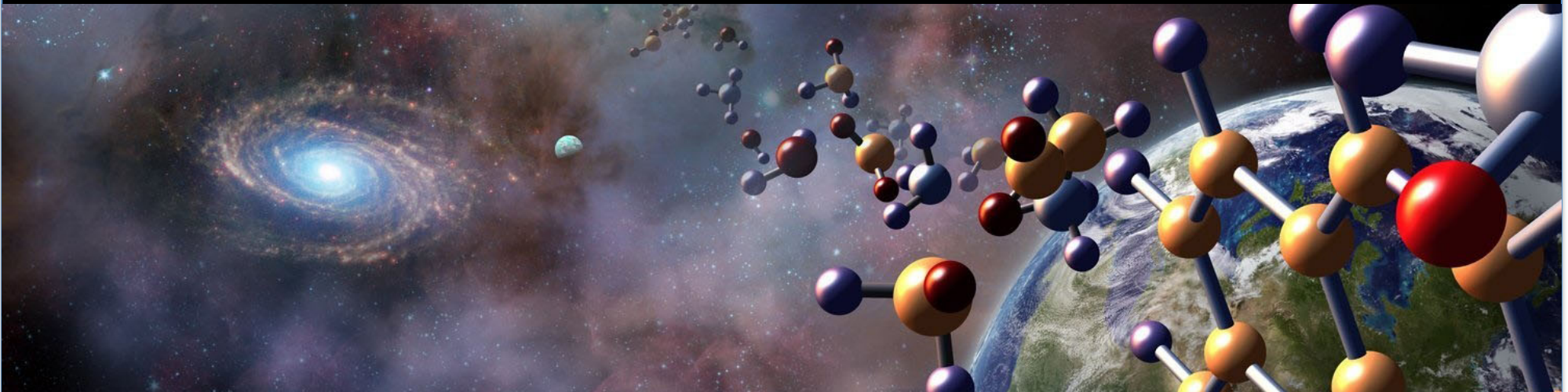




From the Rise of Metals to
Water for Habitable Worlds



Mid-Infrared Imager, Spectrometer, Coronagraph (MISC) for the Origins Space Telescope (OST)



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From the Rise of Metals to
Water for Habitable Worlds



Mid-Infrared Imager, Spectrometer, Coronagraph (MISC) for the Origins Space Telescope (OST)

- The MISC is the instrument studied for both the Mission Concepts 1 and 2 of Origins Space Telescope
- The MISC provides the OST with the capability to cover the mid-infrared wavelength range
- The MISC serves as the focal plane pointing and guiding for the observatory

MISC for the OST Mission Concept 1

- The MISC instrument for the OST Mission Concept 1 is essential to the OST search for biosignatures in the atmospheres of exoplanets via ultra-stable (<5 ppm on timescales of hours to days) spectro-photometric observations of primary and secondary transits; targetting exoplanet atmosphere constituents such as ozone, methane, and water with spectroscopy in the 5-18 μm ($R \sim 100$) and 17-25 μm ($R \sim 300$) bands.
- In its coronagraphic mode, MISC will directly image and characterize Saturn and Jupiter analogs, as well as ice giant planets at ice-melting temperatures (~ 300 K), in extrasolar planetary systems. To achieve this objective, the MISC coronagraph was designed to provide 10^{-7} contrast at $0.5''$ ($\sim 2\lambda/D$) at 10 μm .
- MISC mid-IR imaging in the 5-40 μm band will be used to study episodic accretion in circumstellar debris disks, and to support the biosignature observations, while spectroscopy with resolving power ranging from $\sim 10^2$ to 10^4 in the MISC spectral range will support prioritized observing campaigns in all of OST's science themes.

MISC for OST Mission Concept 1

(1) MISC Imager and Spectrometer Module

MISC Imager and Spectrometer Module

(Top View)

SiC
Cold Mass: 211.32kg
Warm Mass: 22kg

(Side View)

MISC Imager and Spectrometer
Wavefront Error Correction Optics

Mechanism

- Deformable Mirror
- Tip Tilt Mirror
- Slit Mirror Changer (φ4inchx4)
- Filter Wheel (φ3inchx6; triple)

Image Slicer Units for MRS-M and MRS-L

MISC Imager and Spectrometer/MRS-L

MISC Imager and Spectrometer/MRS-M

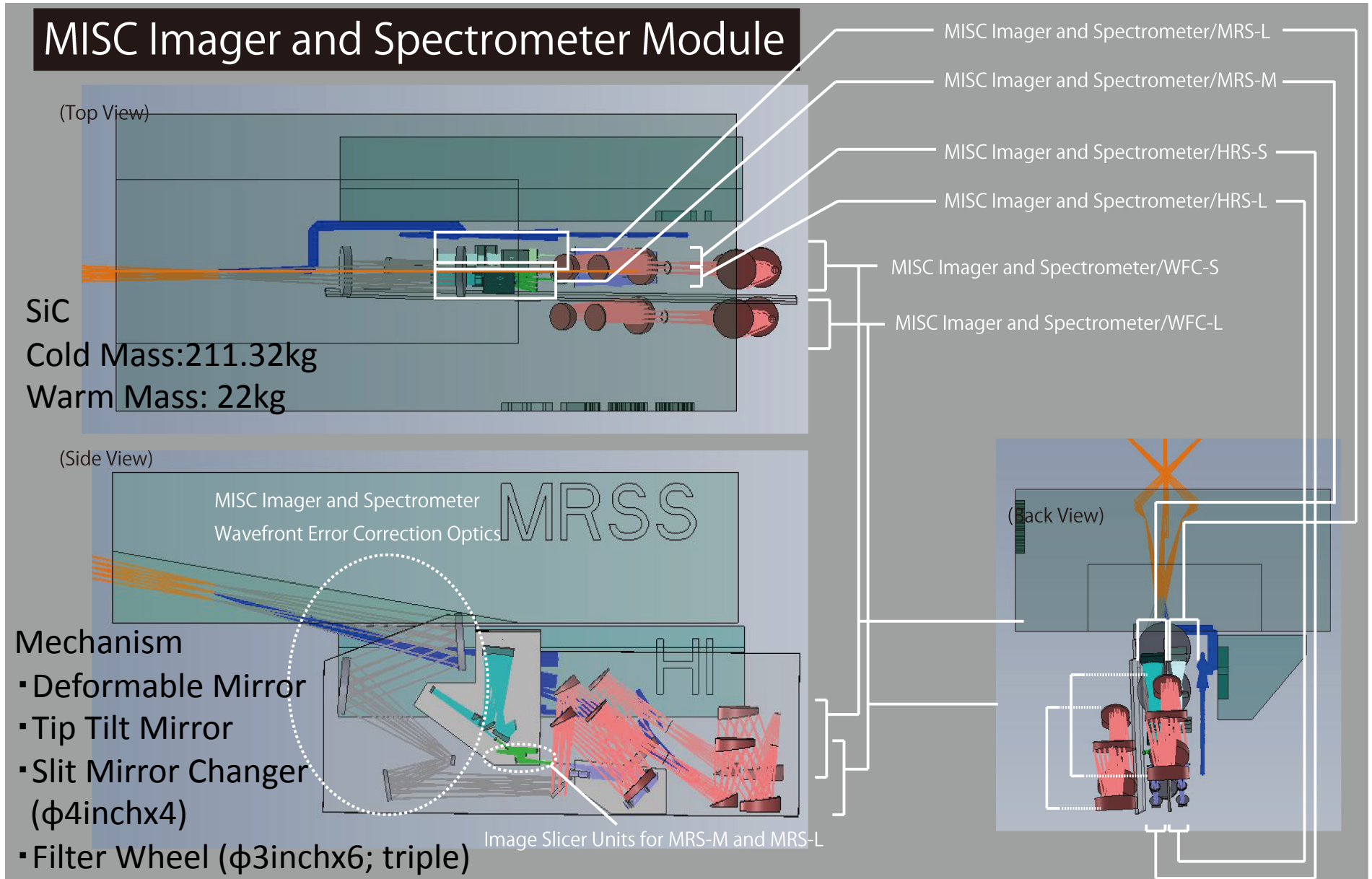
MISC Imager and Spectrometer/HRS-S

MISC Imager and Spectrometer/HRS-L

MISC Imager and Spectrometer/WFC-S

MISC Imager and Spectrometer/WFC-L

(Back View)

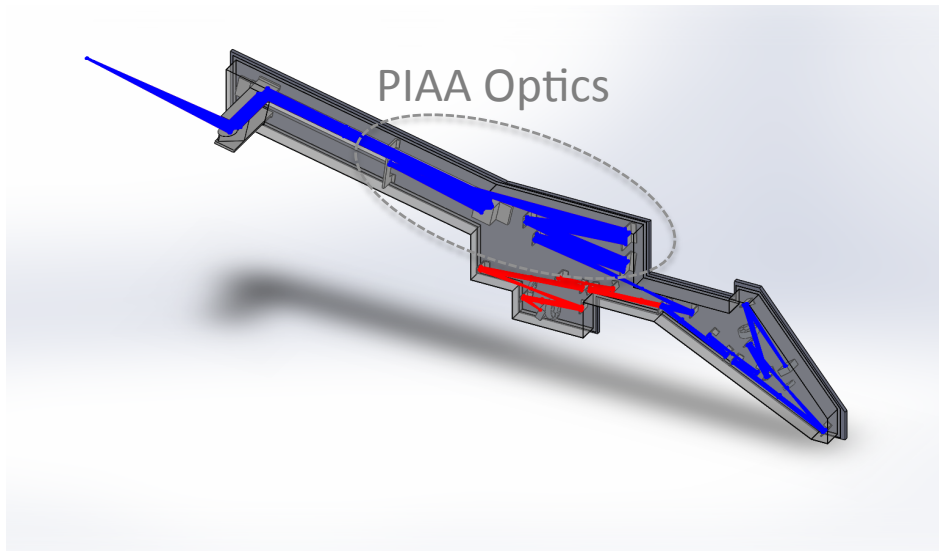


MISC for OST Mission Concept 1

(2) MISC Coronagraph Module

[See Poster #10706 -208 Fujishiro et al.]

Bird's eye view

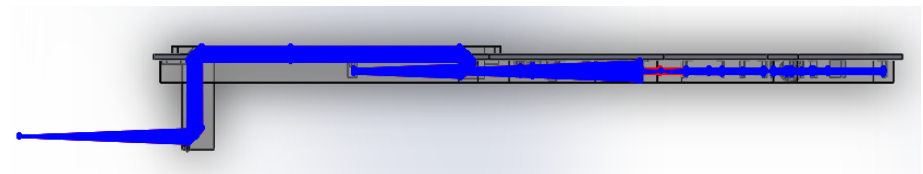


A6061-T6

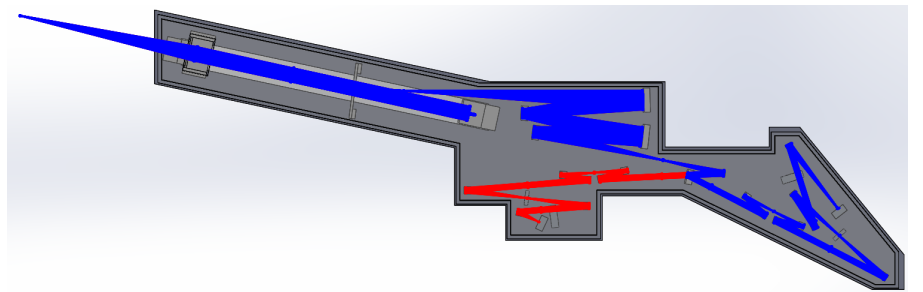
Cold Mass: 50.23kg

Warm Mass: 10kg

Top view



Side view



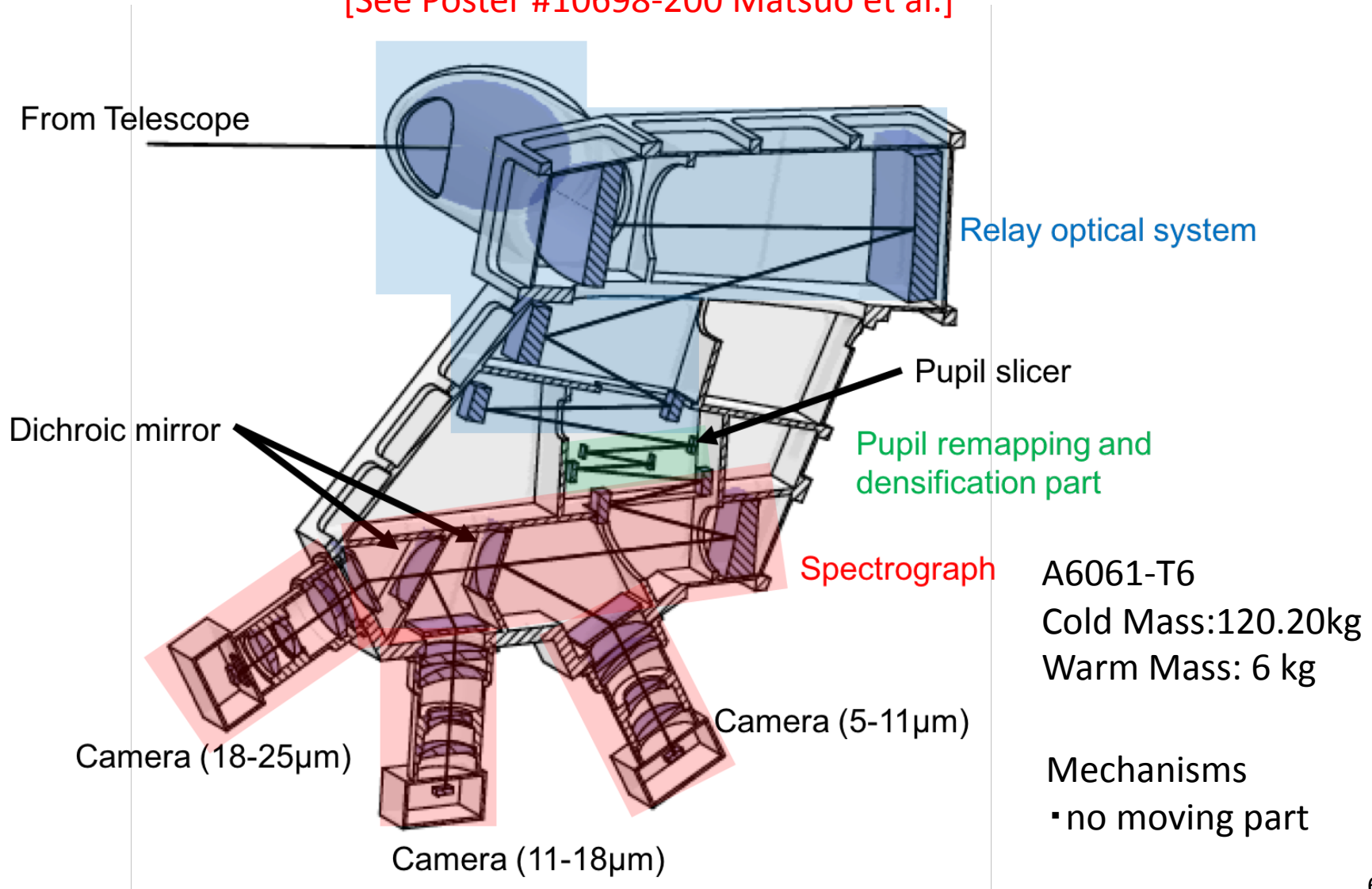
Mechanism

- Deformable Mirror
- Tip Tilt Mirror
- Slit Wheel #1 ($\phi 0.5\text{inch} \times 6$)
- Filter Wheel #2 ($\phi 1\text{inch} \times 6$; triple)

MISC for OST Mission Concept 1

(3) MISC Transit Spectrometer Module

[See Poster #10698-200 Matsuo et al.]



A Fact Sheet of MISC for OST Mission Concept 1

(http://exoplanets.astron.s.u-tokyo.ac.jp/OST/MISC/index_misc_concept_1.html)

Module	Mid-IR Imager Spectrometer Channel			Transit Channel	Coronagraph Channel
	Imager/Low-Res Spec.	Medium-Res Spec.	High-Res Spec.	(Densified Pupil Spec.)	(PIAACMC)
	WFI-S/-L	MRS-S/-M/-L	HRS-S/-L	TRA-S/-M/-L	COR-S/-L
Bandpass (μm)	6–38	5–36	12–18, 25–38	5–26	6–38
Spectral Resolution	5–10 [Imager] 300 [Low-Res Spec.]	1000–1500	20,000–30,000	>100 (TRA-S, TRA-M) 300 (TRA-L)	300
Full FOV	3 arcmin x 3 arcmin [Imager]	3 arcsec x 5 arcsec [with IFU]		3 arcsec x 3 arcsec	5.5 arcsec x 5.5 arcsec
Slit for Spectroscopy	Length; 3 arcmin Width; 0.26 arcsec (WFI-SG1) 0.40 arcsec (WFI-SG2) 0.65 arcsec (WFI-LG1) 1.00 arcsec (WFI-LG2) [low-resolution Spec.]	Length; 3 arcsec (MRS-S/MRS-M/MRS-L) Width; 0.33 arcsec (MRS-S) 0.55 arcsec (MRS-M) 1.0 arcsec (MRS-L) Mum of Slices; 11 (MRS-S) 9 (MRS-M), 5 (MRS-L)	Length; 1.0 arcsec (HRS-S) 2.0 arcsec (HRS-L) Width; 0.5 arcsec (HRS-S) 1.0 arcsec (HRS-L)		Length; 1 arcmin Width; 0.26 arcsec (COR-SG1) 0.40 arcsec (COR-SG2) 0.65 arcsec (COR-LG1) 1.00 arcsec (COR-LG2)
Detectors	2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [S] 2kx2k Si:Sb (18 $\mu\text{m}/\text{pix}$) [L]	2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [S] 2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [M] 1kx1k Si:Sb (18 $\mu\text{m}/\text{pix}$) [L]	2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [S] 1kx1k Si:Sb (18 $\mu\text{m}/\text{pix}$) [L]	2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [S] 2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [M] 2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [L]	2kx2k Si:As (30 $\mu\text{m}/\text{pix}$) [S] 1kx1k Si:Sb (18 $\mu\text{m}/\text{pix}$) [L]
pixel scale	0.088 arcsec/pix	0.0615 arcsec/pix (MRS-S) 0.10 arcsec/pix (MRS-M) 0.15 arcsec/pix (MRS-L)	0.17 arcsec/pix [S] 0.34 arcsec/pix [L]	0.1 arcsec/pix	0.05 arcsec/pix (COR-S) 0.10 arcsec/pix (COR-L)
Specification (Sensitivity/ Stability/ Contrast)	Sensitivity [Imager]; <i>1-hour 5σ Continuum Sens. for a Point Source</i> 0.027 μJy @5 μm , 0.16 μJy @10 μm , 0.26 μJy @15 μm , 0.37 μJy @20 μm , 0.55 μJy @25 μm , 0.63 μJy @30 μm , 0.7 μJy @35 μm Sensitivity [Low-Res Spec.]; <i>1-hour 5s Continuum Sens. for a Point Source (R=300)</i> 0.6 μJy @5 μm , 1.3 μJy @10 μm , 4.0 μJy @15 μm , 5.0 μJy @20 μm , 8.8 μJy @25 μm , 11.2 μJy @30 μm , 37.5 μJy @35 μm	Sensitivity; <i>1-hour 5s Continuum Sens. for a Point Source ($R \sim 1200$)</i> 3 μJy @7 μm , 10 μJy @15 μm , 30 μJy @24 μm , 100 μJy @32 μm <i>1-hour 5s Line Sens. for a Point Source</i> 1x10 ⁻²¹ W/m ² @7 μm , 2x10 ⁻²¹ W/m ² @15 μm , 3x10 ⁻²¹ W/m ² @24 μm , 1x10 ⁻²⁰ W/m ² @32 μm	Sensitivity; <i>1-hour 5s Line Sens. for a Point Source</i> 1x10 ⁻²¹ W/m ² @15 μm , 3x10 ⁻²¹ W/m ² @30 μm	Photometric stability; better than 10 ppm on timescales of hours to days (excluding the fluctuation of detector gain)	Average contrast; 7x10 ⁻⁶ for 10% band 1x10 ⁻⁶ for 4% band in 0.88–3.6 λ /D

MISC for the OST Mission Concept 2

-The MISC instrument for the OST Mission Concept 2 is still essential to the OST search for biosignatures in the atmospheres of exoplanets via ultra-stable (<5 ppm on timescales of hours to days) spectro-photometric observations of primary and secondary transits;

targetting exoplanet atmosphere constituents such as ozone, methane, and water with spectroscopy in the 5-18 μm ($R \sim 100$) and 17-25 μm ($R \sim 300$) bands.

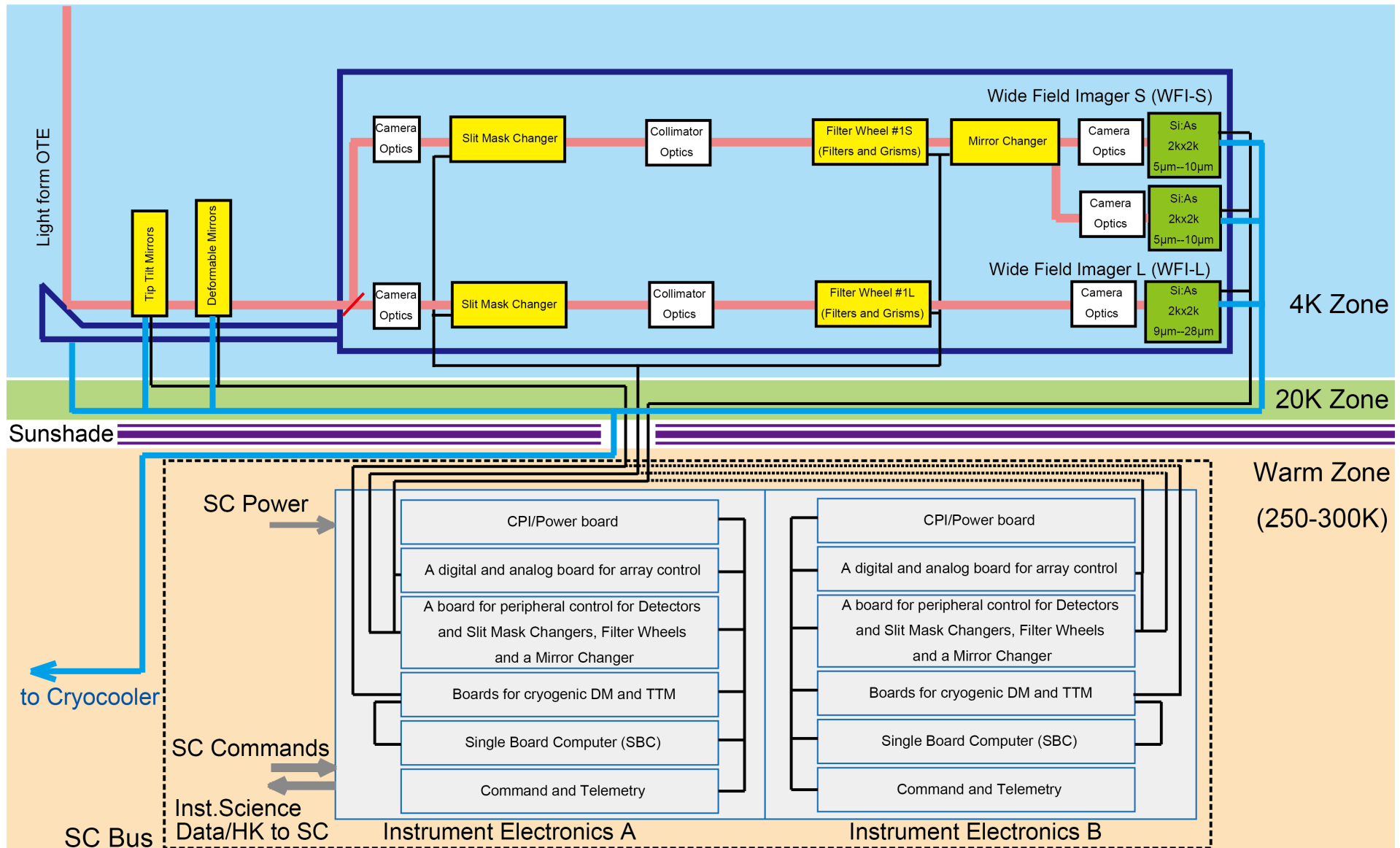
- No coronagraphic mode

-MISC mid-IR imaging in the 5-28 μm band will be used for general objective and the spectroscopy in the 5-28 μm with resolving power of >300 will be used to measure the mid-infrared dust features and ionic lines at z up to ~ 1 in Rise of Metals & Black Hole and Feedback programs.

MISC for OST Mission Concept 2

(1) MISC Wide Field Imager (WFI) Module

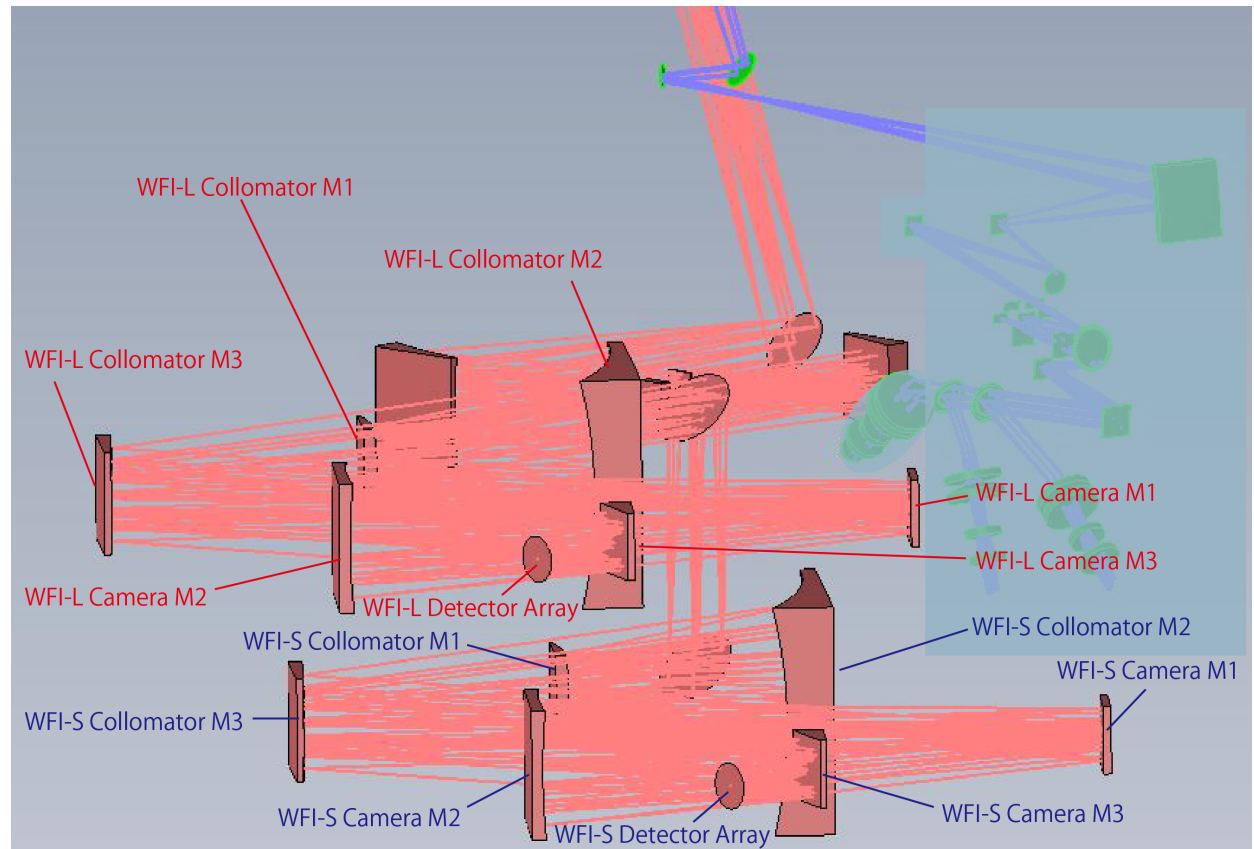
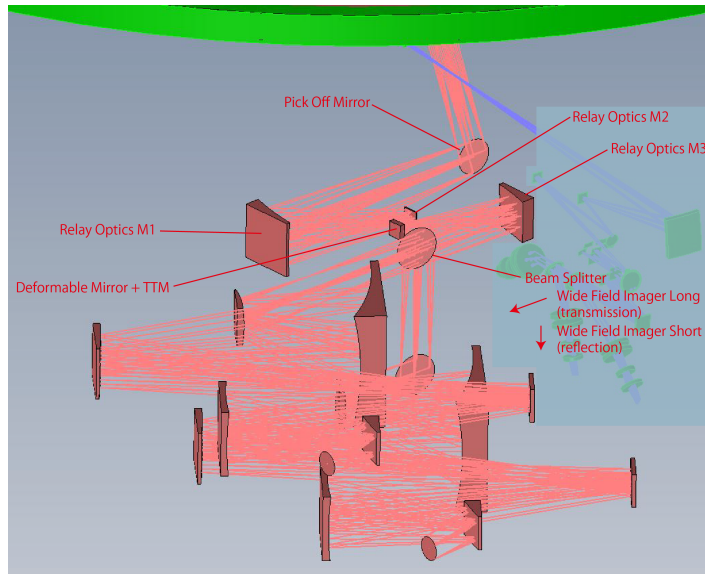
OST/MISC/Wide Field Imager (WFI)



MISC for OST Mission Concept 2

(1) MISC Wide Field Imager (WFI) Module

Entire view of optical design of MISC Wide Field Imager Module for OST Mission Concept 2



Mechanisms

- Deformable Mirror
- Tip Tilt Mirror
- Filter Wheels ($\phi 3\text{inch} \times 6$ x triple wheels for WFI-S and WFI-L)
- Slit Mask Changers ($\phi 4\text{inch} \times 2$ for WFI-S, $\phi 4\text{inch} \times 4$ for WFI-L)
- Beam Changer (b/w WFI-S1 and S2)

Cold Mass: 255.25kg(A6061-T6), 113.54kg(Be), 161.14kg(CO720)

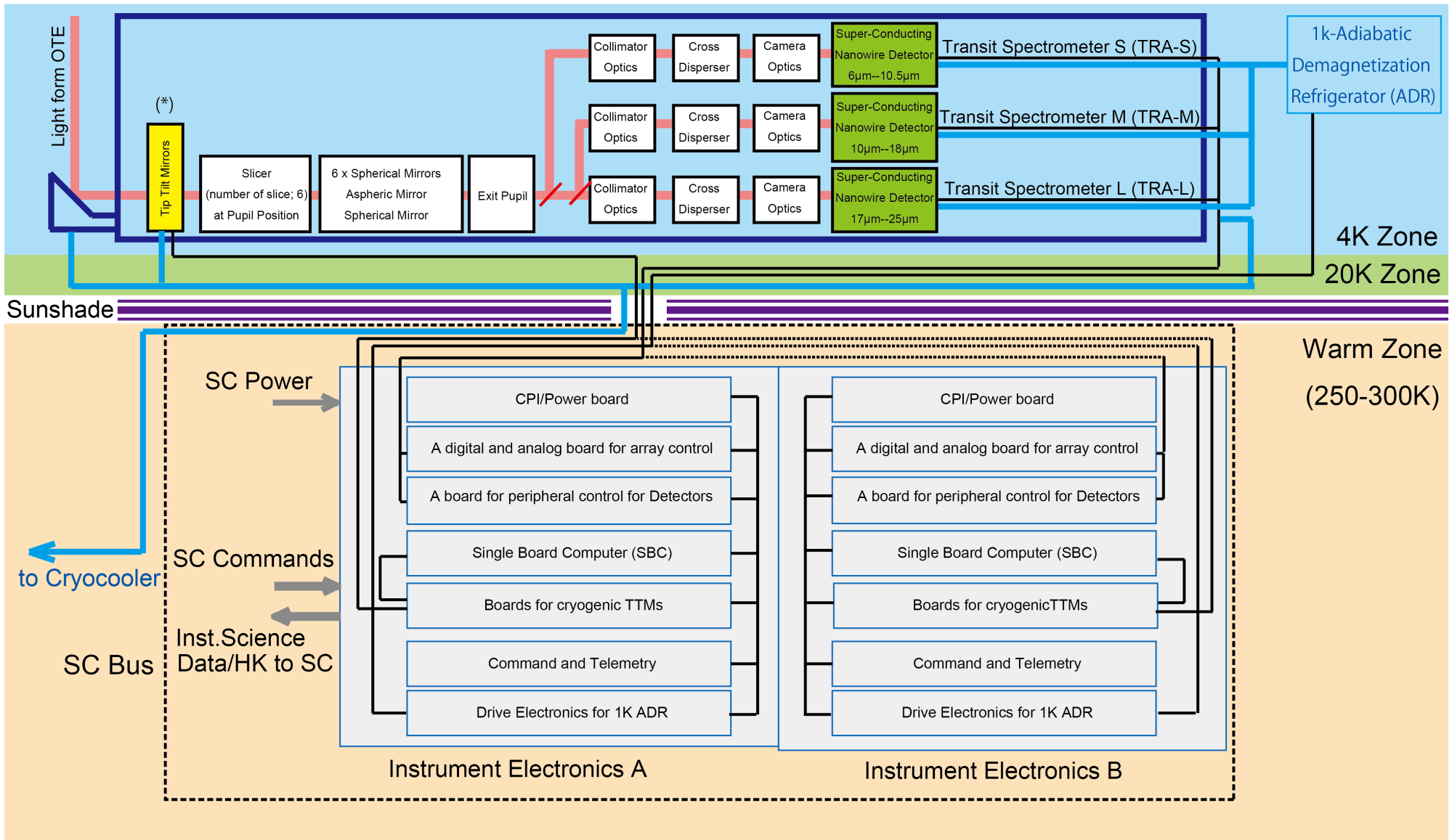
Warm Mass: 36 kg (Inst. Electronics A & B, Harness)



MISC for OST Mission Concept 2

(2) MISC Transit Spectrometer (TRA) Module

OST/MISC Transit Spectrometer

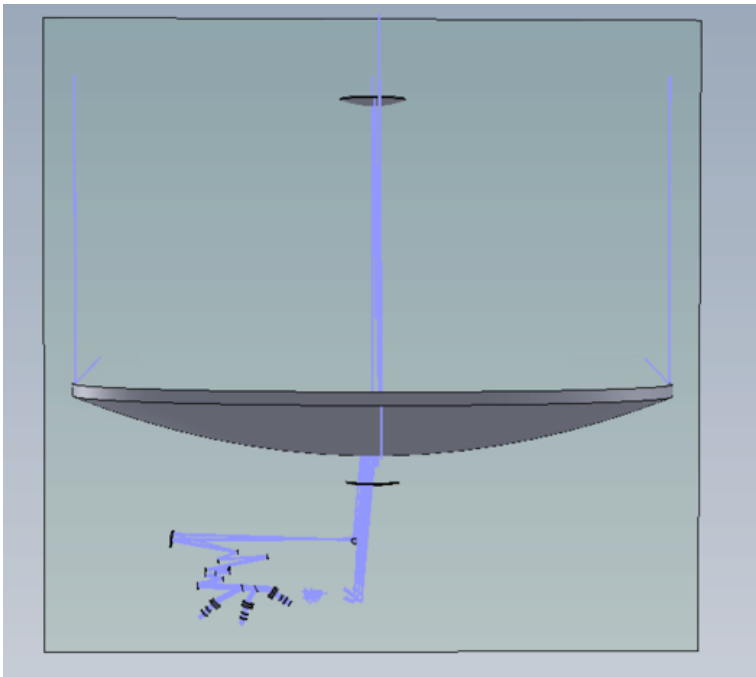


MISC for OST Mission Concept 2

(2) MISC Transit Spectrometer (TRA) Module

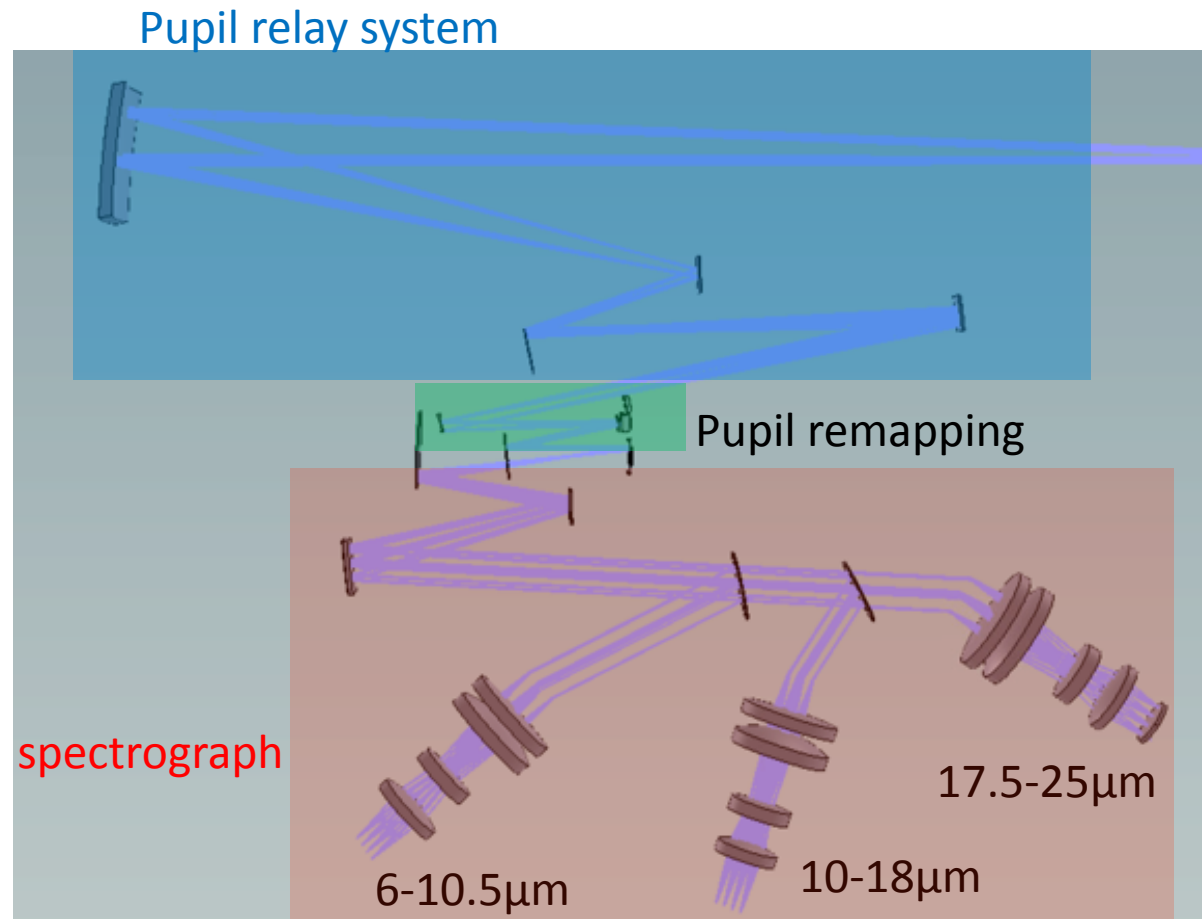
[See Poster #10698-200 Matsuo et al.]

Entire view of optical design of MISC
Transit Spectrometer Module for
OST Mission Concept 2



Mechanisms

- 1K Adiabatic Demagnetization refrigerator (ADR)
- no moving part

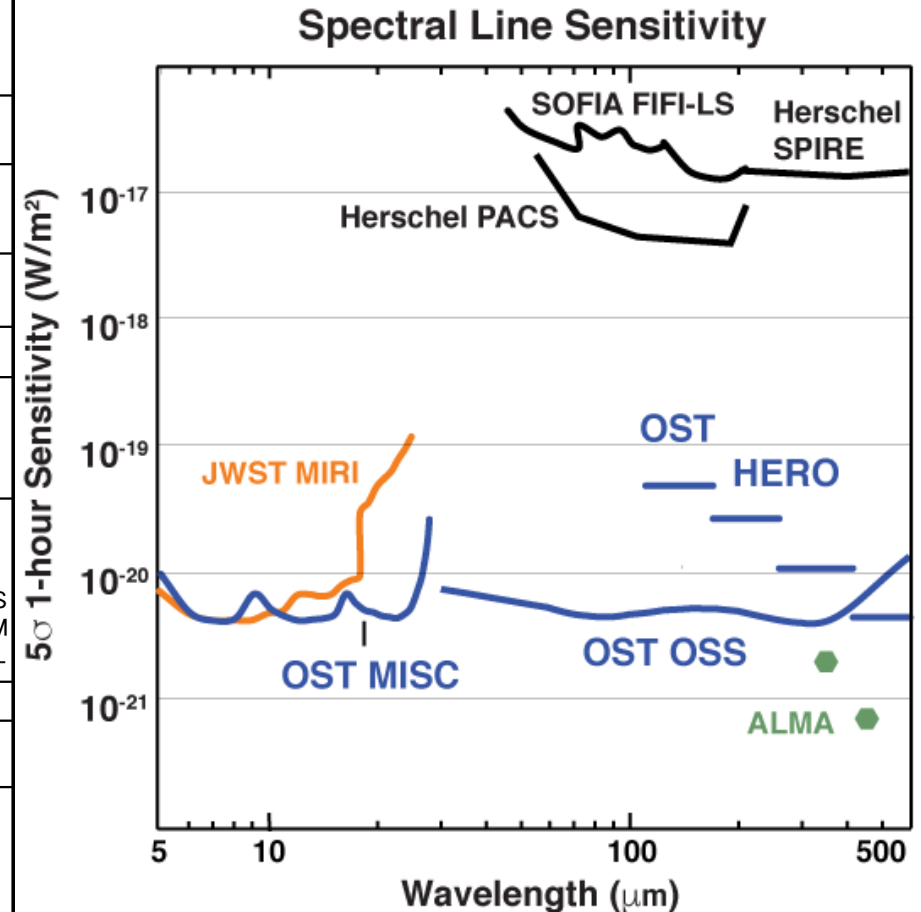


Cold Mass: 116.0kg(A6061-T6), 70.60kg(Be), 85.73kg(CO720)
Warm Mass: 22 kg (Inst. Electronics A & B, Harness)

A Fact Sheet of MISC for OST Mission Concept 2

(http://exoplanets.astron.s.u-tokyo.ac.jp/OST/MISC/index_misc_concept_2.html)

Module	MISC Wide Field Imager	MISC Transit Spectrometer
	Imaging / Low-Res. Spec. with Grisms	Densified Pupil Spec.
	WFI-S1, S2/WFI-L	TRA-S/-M/-L
Operating Modes	MIR Imaging MIR Low-Res. Spec. (slit) MIR Low-Res. Spec. (slitless) MIR Scan Mapping	MIR Super Stable Spec.
Bandpass (μm)	5--28	6--25
Angular Resolution	0.21 arcsec@5 μm , 0.38 arcsec@9 μm , 0.68 arcsec@16 μm , 0.98 arcsec@23 μm , 1.18 arcsec @27.6 μm	Angular resolution is not important
Spectral Resolution	5-10 for MIR Imaging 300 for MIR Low-Res. Spec.	>100 (TRA-S, TRA-M) 300 (TRA-L)
Full FOV	3 arcmin x 3 arcmin [Imager]	3 arcsec x 3 arcsec
Slit for Spectroscopy	Length; 3 arcmin Width; 0.4 arcsec (WFI-SG1) 0.7 arcsec (WFI-LG1), 1.2 arcsec (WFI-LG2)	N/A
Detectors	three 2kx2k Si:As arrays - two for WFI-S - one for WFI-L	tweleve super-conducting nanowire detector arrays [TBD] (a single array size; 5pix x 140 pix) - four 5pix x 140pix arrays for TRA-S - four 5pix x 140pix arrays for TRA-M - four 5pix x 140pix arrays for TRA-L
Pixel Scale	0.088 arcsec/pix	0.1 arcsec/pix
Scanning Speed	MIR Scan (width; 180 arcsec) Max. 1.5 -- 22.5 [arcsec/sec]	N/A
Specification (Sensitivity/ Stability/ Contrast)	Sensitivity [Imager]; <i>1h5σ Cont. Sensitivity for a Point Source</i> 0.06 μJy @5 μm , 0.25 μJy @9 μm , 0.64 μJy @16 μm , 0.96 μJy @23 μm , 1.93 μJy @25 μm Sensitivity [Low-Res Spec.(R=300)]; <i>1h5s Line Sensitivity for a Point Source</i> 5.0E-21W/m ² @6 μm , 4.5E-21W/m ² @8 μm , 5.3E-21W/m ² @10 μm , 4.3E-21W/m ² @12 μm , 5.2E-21W/m ² @18 μm , 5.4E-21W/m ² @24 μm , 1.1E-20W/m ² @26 μm , 5.4E-19W/m ² @28 μm	Photometric stability; 5 ppm with a goal of 1 ppm on timescales of hours to days



Summary

The MISC is the instrument studied for both the OST Mission Concepts 1 & 2

The MISC for the OST Mission Concept 1;

- MISC Imager ($R=5-10$) and Spectrometers ($R=10^2-10^4$) covering $5-38\mu\text{m}$
- MISC Transit Spectrometer achieving $<5\text{ppm}$ on timescales of hours to days
- MISC Coronagraph achieving 10^{-6} contrast at $0.88-3.6\lambda/D$ with PIAACMC
- MISC Imager serves as the focal plane pointing and guiding for the OST

The MISC for the OST Mission Concept 2;

- MISC Wide Field Imager ($R=5-10$, $R=300$ with grisms) covering $5-28\mu\text{m}$
- MISC Transit Spectrometer achieving $<5\text{ppm}$ on timescales of hours to days
- No Coronagraph capability
- MISC Imager serves as the focal plane pointing and guiding for the OST