ORIGINS Space Telescope

From the first stars to life

National Aeronautics and Space Administration

The Mid-Infrared Imager/Spectrometer/Coronagraph (MISC) for Origins Space Telescope (OST) : Mission Concept 1

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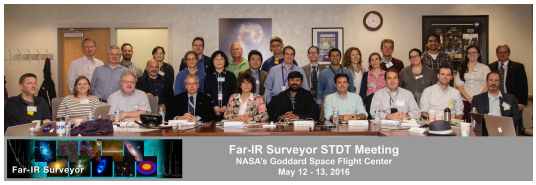
Abstract: *The Origins Space Telescope (OST) is the mission concept for the Far-infrared Surveyor studied for the 2020 Astronomy and Astrophysics Decadal survey. Among the five instruments studied for the Origins Space Telescope (OST), JAXA is leading the study of the Mid-infrared Imager/ Spectrometer/ Coronagraph (MISC) with NASA/ Ames in the framework of the community-based Science and Technology Definition Team (STDT) study.*

Origins Space Telescope STDT activity



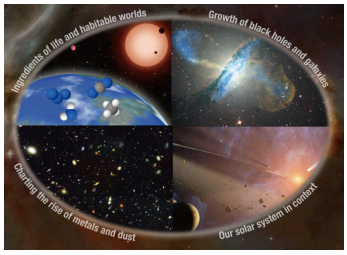
F2F Meetings;
2016 May : 1st F2F STDT Meeting (@NASA GSFC)
2016 Aug. : 2nd F2F STDT Meeting (@NASA GSFC)
2016 Nov. : 3rd F2F STDT Meeting (@Ball Aerospace)
2017 Mar. : 4th F2F STDT Meeting (@Spitzer Science Center)
2017 Jun. : 5th F2F STDT Meeting (@S. Dillion Ripley Center)
2017 Sep. : 6th F2F STDT Meeting (@Space Telescope Science Institute)

Regular web meetings (OST STDT telecon, MISC telecons);
Bi-weekly OST STDT telecon (2016.4-) [Fri.(US)/Sat.(Japan)]
Bi-weekly MISC Science Telecon (2017.3-) [Fri.(US)/Sat.(Japan)]
Weekly MISC Instrument Telecon (2017.2-) [Mon.(US)/Tue.(Japan)]

— Sep., 2017: Complete Concept 1 study
Oct. 31, 2017: Interim Report draft due
Nov. 17, 2017: Interim Report Review (version 1)
Dec. 29, 2017: The more concise and smaller Interim report (version 2) input due
Oct. 2017 – : Concept 2 study (cost-capped at $3B [TBD])

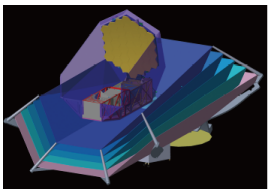
Key Scientific Goals

- To characterize exoplanet atmospheres looking for bio-signatures in transiting planets and directly imaging thermal emission in Jupiter- and Saturn- exoplanet analogs.
- To measure water across cosmic time from the first galaxies to proto-planetary disks to hundreds of comets in the solar system to solve the mystery of the origin of water on Earth.
- To study proto-galaxies before the epoch of reionization in the cosmic dark ages and map the evolution of metals and chemistry over all cosmic time.



Origins Space Telescope (OST): Mission Concept 1

Primary mirror	9.1m off axis
Temperature	4 K
Wavelengths	5—660μm
Instruments	MISC, FIP, MRSS, HRS, HERO
Lunch date	2030s
Orbit	Sun-Earth L2
Lifetime	5 years, 10+ year goal

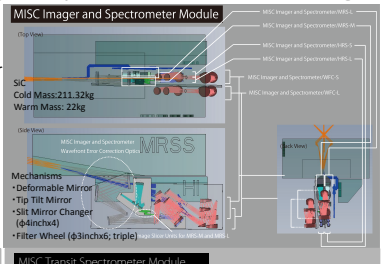


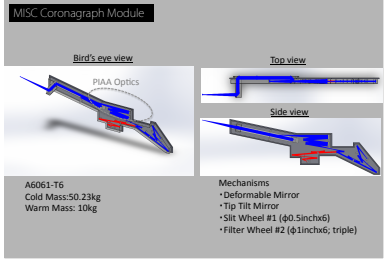
OST Instruments: Mission Concept 1

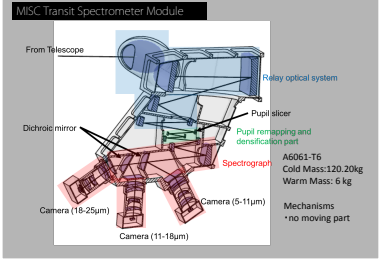
Instrument	Wavelength (μm)	R($\Delta\lambda/\lambda$)	Observing Modes
MISC: Mid-Infrared Imager, Spectrometer, Coronagraph	5—38	15, 300, 1200, $2.5x10^4$	Imaging, Spectroscopy Coronagraphy (10^{-6} contrast) Transit spectrometer (<10ppm stability)
MRSS: Medium Resolution Survey Spectrometer	30—660	500, $4x10^4$	Multi-band Spectroscopy Survey, Pointed
FIP: Far-Infrared Imager and Polarimeter	40, 80, 120, 240	15	Broad band imaging Field of view: 2'.5x2'.5, 7'.5x7'.5 Differential polarimetric imaging
HERO: Heterodyne Receiver for OST	63—66, 111—610	10^7	Multi-beam spectroscopy
HRS: High Resolution Spectrometer	25—200	$5x10^4$, $5x10^5$	spectroscopy

The Mid-infrared Imager/Spectrometer/Coronagraph (MISC) for OST : Mission Concept 1

The MISC consists of the MISC I & S module, the MISC COR module and the MISC TRA module. The MISC I & S offers (1) a wide field imaging (3 arcmin x 3 arcmin) and low-resolution spectroscopic capability with filters and grisms for 6–38μm, (2) a medium-resolution (R ~1,000) Integral Field Unit (IFU) spectroscopic capability for 5–38 μm and (3) a high-resolution (R ~25,000) slit spectroscopic capability for 12–18 and 25–36 μm. The MISC COR module employs PIAA coronagraphy method and covers 6–38 μm achieving 10^{-7} contrast at 0.5 arcsec from the central star. The MISC TRA module employs a densified pupil spectroscopic design and covers 5–26μm by achieving 3–5 ppm of spectro-photometric stability.







Module	MISC Imager & Spectrometer			MISC Transit Spectrometer	MISC Coronagraph
	Imager/Low-Res Spec.	Medium-Res Spec.	High-Res Spec.	(Densified Pupil Spec.)	(PIAA)
	WFI-S/-L	MRS-S/-M/-L*	HRS-S/-L	TRA-S/-M/-L	COR-S/-L
Bandpass (μm)	6—38	10—36 (goal: 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) # 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 (30μm/pix) [S] 2kx2k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 2kx2k Si:As (30μm/pix) [M] 1kx1k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 1kx1k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 2kx2k Si:As (30μm/pix) [M] 2kx2k Si:As (30μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 1kx1k Si:Sb (18μm/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] :** *1-hour 5σ Continuum Sens. for a Point Source* 0.031μJy@5μm, 0.18μJy@10μm, 0.29μJy@15μm, 0.41μJy@20μm, 0.61μJy@25μm, 0.70μJy@30μm, 0.78μJy@35μm **Sensitivity [Low-Res Spec.]:** *1-hour 5σ Continuum Sens. for a Point Source* (R=300) 0.88μJy@5μm, 1.3μJy@10μm, 4.5μJy@15μm, 5.8μJy@20μm, 9.9μJy@25μm, 13.8μJy@30μm, 43μJy@35μm	**Sensitivity:** *1-hour 5σ Continuum Sens. for a Point Source (R~1200)* 3.4μJy@7μm, 11μJy@15μm, 34μJy@24μm,114μJy@32μm *1-hour 5σ Line Sens. for a Point Source* $1.1x10^{-21}$ W/m² @7μm, $2.3x10^{-21}$ W/m² @15μm, $3.4x10^{-21}$ W/m² @24μm, $1.1x10^{-20}$ W/m² @32μm	**Sensitivity:** *1-hour 5σ Line Sens. for a Point Source* $1.2x10^{-21}$ W/m² @15μm, $3.6x10^{-21}$ W/m² @30μm	**Photometric stability:** 3-5 ppm on timescales of hours to days (excluding the fluctuation of detector gain)	**Average contrast:** $7x10^{-8}$ for 10% band $1x10^{-6}$ for 4% band in 0.88-3.6λ/D

* MRS-S is an optional function

The **Origins Space Telescope** is the mission concept for the **Far Infrared Surveyor**, a study in development by NASA in preparation for the *2020 Astronomy and Astrophysics Decadal Survey*.

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