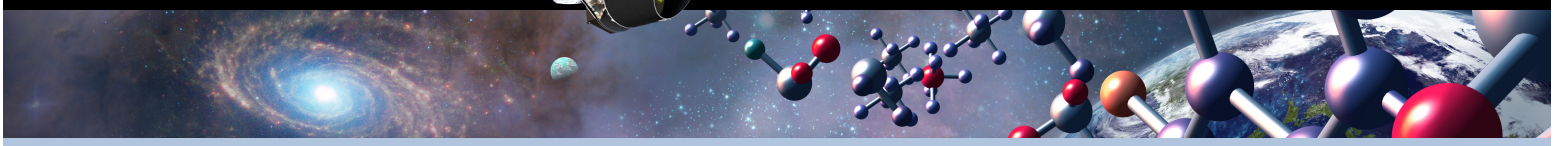
ORIGINS Space Telescope | From first light to life

National Aeronautics and Space Administration



Optical design of the *Origins* space telescope

Joseph Howard (NASA) for the Origins Space Telescope Science and Technology Definition Team

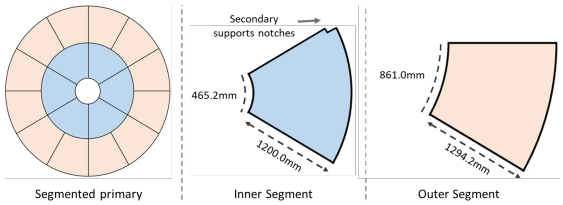
Telescope Overview

Origins is one of four large missions currently under study for the 2020 Decadal Survey in Astronomy and Astrophysics. Sensitive in the mid- and far-infrared spectrum (between 2.8 and 588 μm), *Origins* main science themes are:

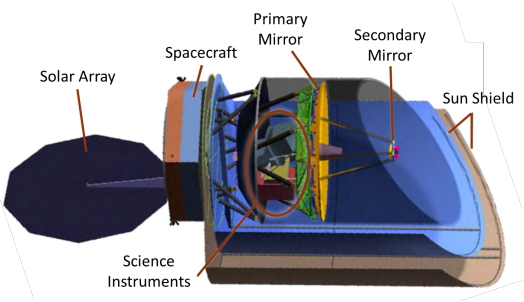
1) How do galaxies form?
2) How do the conditions for habitability develop?
3) Do planets orbiting M-dwarf stars support life?

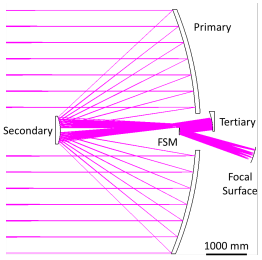
Origins is a Three-Mirror Anastigmat (TMA) design like the James Webb Space Telescope (JWST), with three powered optics (primary, secondary, and tertiary mirrors) and a flat Field-Steering Mirror (FSM). The telescope image surface is concave, with its center of curvature located at the FSM and exit pupil, which prevents defocus when tilt-scanning the FSM. The TMA architecture gives good wavefront performance over a relatively large field of view (diffraction-limited at λ = 30 μm).

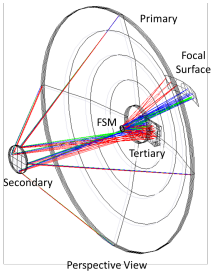
Origins is designed to fit within its launch vehicle without requiring deployments (including the primary and secondary) which helps to reduce telescope complexity and cost. The primary size (5.9 m diameter) and on-axis configuration help maximize collecting area while meeting packaging constraints. *Origins* utilizes 18 'keystone' shaped segments arranged in two annuli to form its primary mirror. Such a segmentation scheme is desirable over hexagons as it maximizes the collecting area of the mirror in a given fairing size while also reducing the effects of diffraction. Only two optical prescriptions are required for the segments, those of the inner and outer annuli. Because of its high stiffness, low density, low CTE, and high thermal conductivity, Beryllium O-30 is baselined for the optical components and instrument structure.



Optical Design







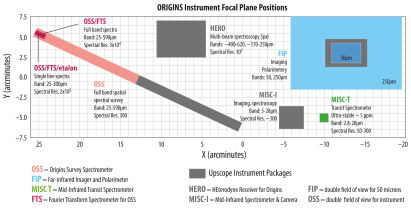
Parameter	Origins Baseline	Units
Primary Size	Circular, 5.9	Meters
***f*-number**	*f*/14.0 (telescope) *f*/0.63 (primary)	--
Effective Focal Length	82.6	Meters
Field of View	46 x 15	Arcmin
Waveband	2.8 - 588	Microns
Operating Temp.	4.5	Kelvin
Optical Performance	Diffraction limited at λ = 30 μm	
Design Form	Three Mirror Anastigmat Obstructed (on-axis pupil)	
Mirror Coatings	Protected Gold	
Optical and Structural Material	Beryllium O-30	

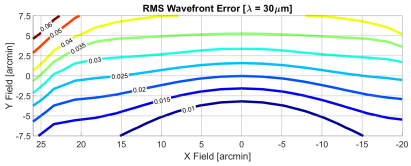
Science Instruments

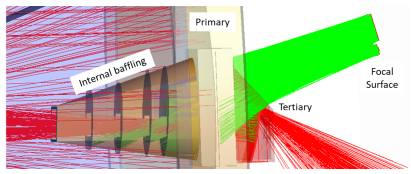
The baseline *Origins* includes three instruments:

1) Origins Survey Spectrometer (OSS) with Fourier Transform Spectrometer (FTS) and etalon
2) Mid-infrared Spectrometer Camera Transit Spectrometer (MISC-T)
3) Far-Infrared Imager Polarimeter (FIP)

A fourth instrument, the Heterodyne Receiver for *Origins* (HERO), an imaging camera module for MISC, and increased fields of view for the OSS and FIP instruments are possible upgrades.







REFERENCES:

1. *Origins* Final Report. NASA GSFC. August 2019
2. https://asd.gsfc.nasa.gov/firs/docs/#

The **Origins Space Telescope** is one of four Large Mission concepts presented to the *2020 Astronomy and Astrophysics Decadal Survey*.

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