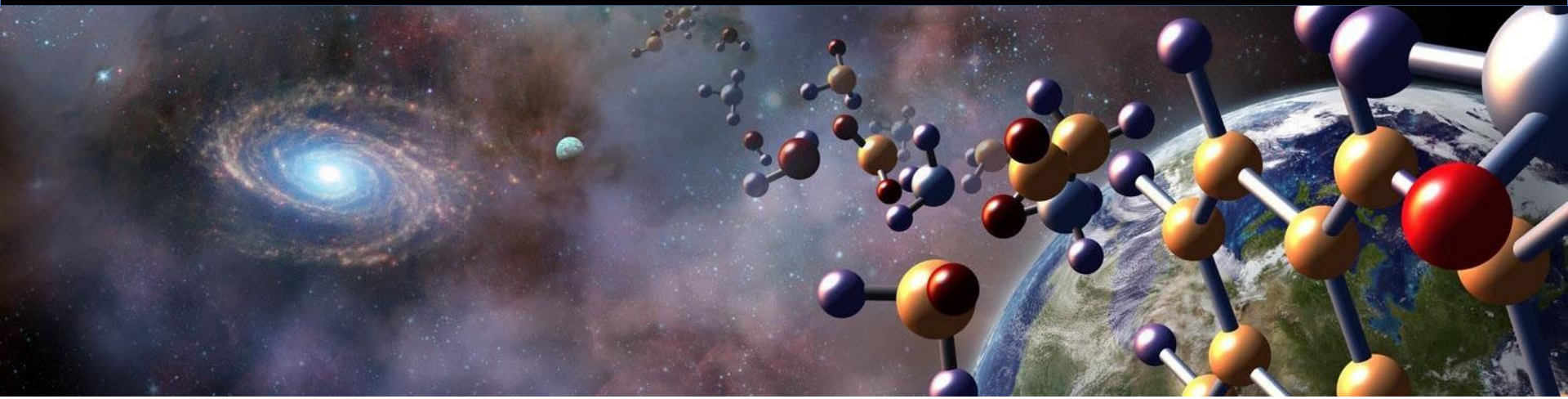
ORIGINS Space Telescope

From the Rise of Metals to Water for Habitable Worlds



Margaret Meixner

Space Telescope Science Institute,

Johns Hopkins University

on behalf of the FIRS Science Technology Definition Team

asd.gsfc.nasa.gov/firs

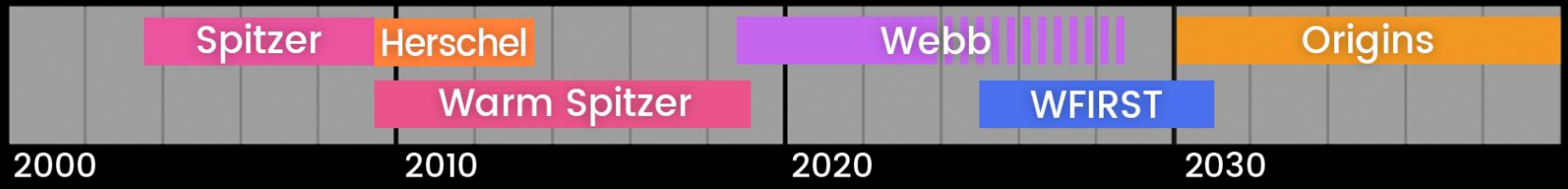
ORIGINS Space Telescope

From the Rise of Metals to
Water for Habitable Worlds

NASA Mission concept for 2020 Decadal review; launch 2030ish

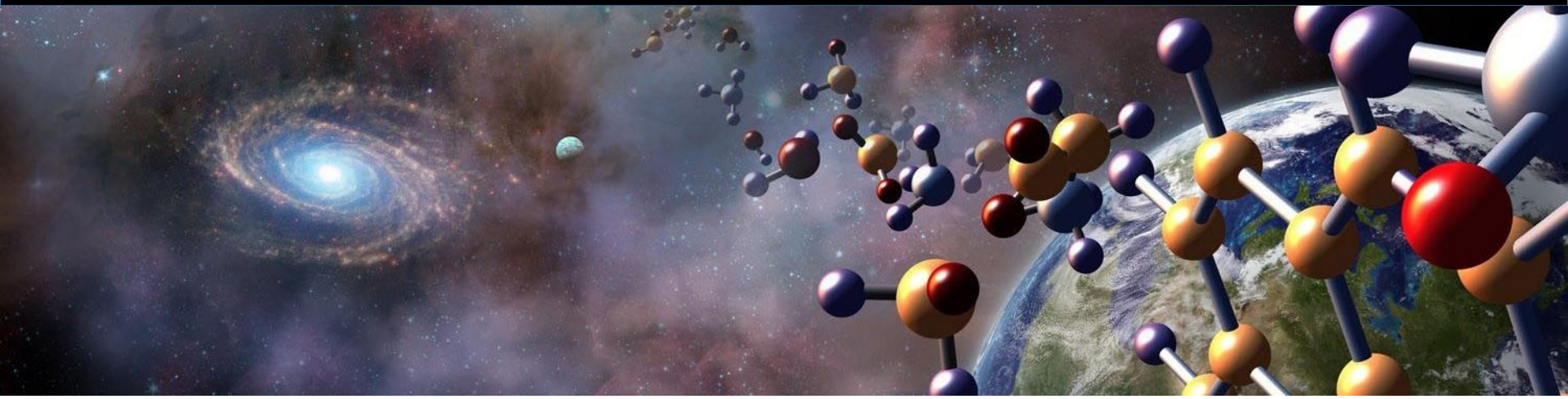
6 µm – 1000 µm (ish), Large aperture 8-15 m

Study Chairs: Margaret Meixner & Asantha Cooray



ORIGINS Space Telescope

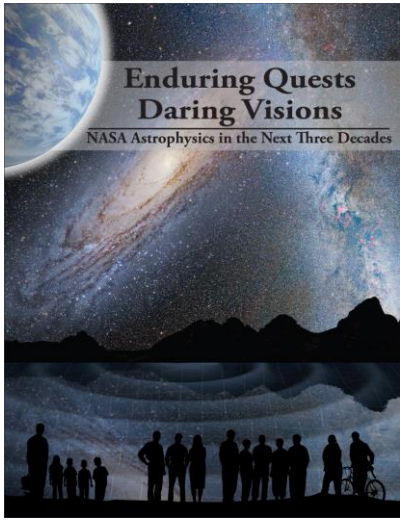
From the Rise of Metals to Water for Habitable Worlds



NASA Mission concept for 2020 Decadal review; launch 2030ish

10 µm – 1000 µm (ish), Large aperture 8-15 m

Study Chairs: Margaret Meixner & Asantha Cooray



Comes from the NASA Astrophysics Roadmap, Enduring Quests, Daring Visions

Community Chairs:

Margaret **Meixner,** STSCI, Asantha **Cooray**, UC Irvine

NASA Study Center:

Goddard Space Flight Center (GSFC): Ruth **Carter,** David **Leisawitz,** Johannes **Staguhn,** Michael **Dipirro**, Anel **Flores,** Joseph **Howard**, James **Corsetti**, Andrew **Jones**, James **Kellog**, Louis **Fantano**

NASA Head Quarters (HQ) Program Scientists (non-voting):

Kartik **Sheth** and Dominic **Benford**

Ex officio non-voting representatives:

Susan **Neff** & Deborah **Padgett**, NASA Cosmic Origins Program Office; Susanne **Alato**, SNSB; Douglas **Scott**, CAS; Maryvonne **Gerin**, CNES; Itsuki **Sakon**, JAXA; Frank **Helmich**, SRON; Roland **Vavrek**, ESA; Karl **Menten**, DLR; Sean **Carey**, IPAC

Members appointed by NASA (> 90 applications):

Lee **Armus**, NASA IPAC; Cara **Battersby**, Harvard-Smithsonian CfA; Edwin **Bergin**, University of Michigan; Matt **Bradford**, NASA JPL; Kim **Ennico-Smith**, NASA Ames; Gary **Melnick**, Harvard-Smithsonian CfA; Stefanie **Milam**, NASA GSFC; Desika **Narayanan**, University of Florida; Klaus **Pontopiddan**, STSCI; Alexandra **Pope**, University of Massachusetts; Thomas **Roellig,** NASA Ames; Karin **Sandstrom**, UC, San Diego; Kate Y. L. **Su**, University of Arizona; Joaquin **Vieira,** University of Illinois, Urbana Champaign; Edward **Wright,** UC Los Angeles; Jonas **Zmuidzinas**, Caltech

ORIGINS Space Telescope

From the Rise of Metals to Water for Habitable Worlds

NASA

Community Chairs:

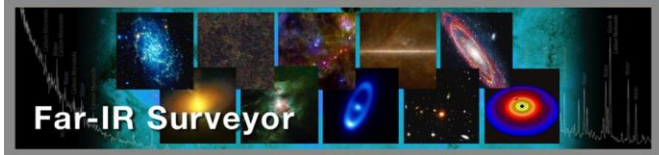
Margaret **Meixner,** STSCI, Asantha **Cooray**, UC Irvine

NASA Study Center:

Goddard Space Flight Center (GSFC): Ruth **Carter,** David **Leisawitz,** Johannes **Staguhn,** Michael **Dipirro**, Anel **Flores,** Joseph **Howard**, James **Corsetti**, Andrew **Jones**, James **Kellog**, Louis **Fantano**

NASA Head Quarters (HQ) Program Scientists (non-voting):

Kartik **Sheth** and Dominic **Benford**



Far-IR Surveyor STDT Meeting
NASA's Goddard Space Flight Center
May 12 - 13, 2016

ORIGINS Space Telescope

From the Rise of Metals to Water for Habitable Worlds

NASA

Tracing the signatures of life and the ingredients of habitable worlds

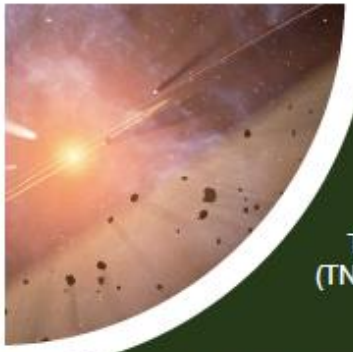
Origins will trace the trail of water from interstellar clouds, to proto-planetary disks, to Earth itself facilitating understanding of the abundance and availability of water for habitable planets.

Unveiling the Growth of Black Holes and Galaxies over Cosmic Time

Origins will reveal the co-evolution of super-massive black holes and galaxies, energetic feedback, and the dynamic interstellar medium from which stars are born.

Origins will trace the metal enrichment history of the Universe, probe the first cosmic sources of dust, the earliest star formation, and the birth of galaxies.

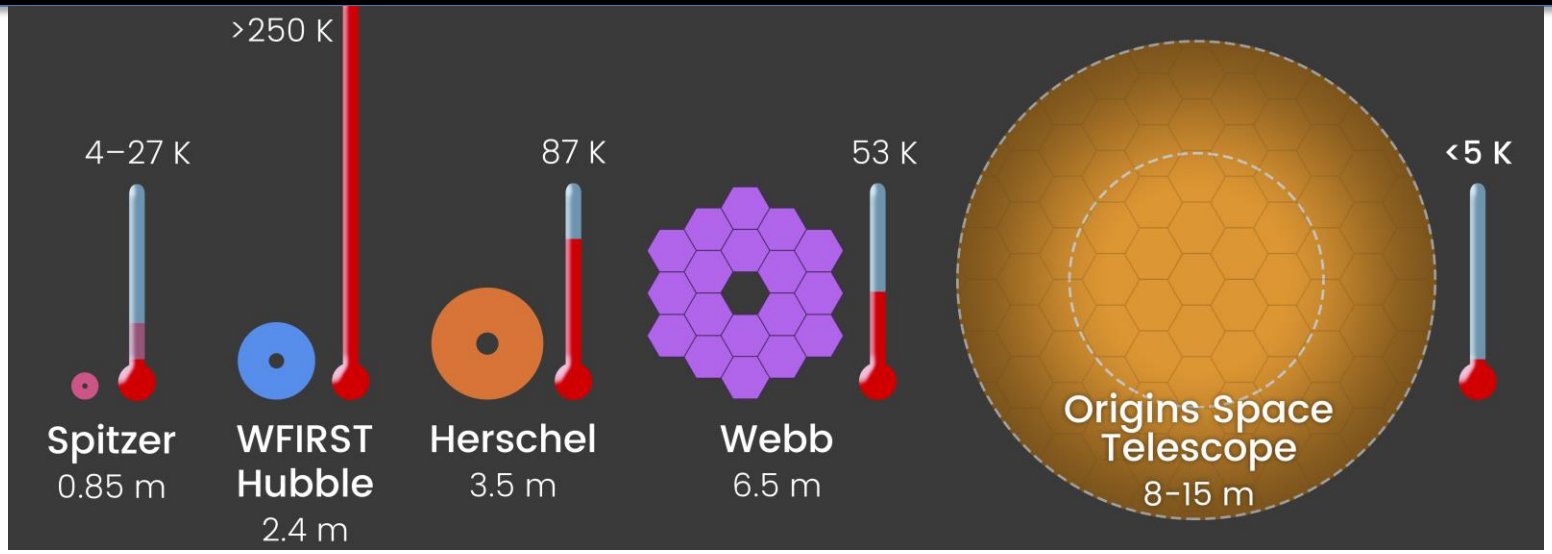
Charting the Rise of Metals, Dust, and the First Galaxies



Origins will chart the role of comets in delivering water to the early Earth, and conduct a survey of thousands of ancient Trans Neptunian Objects (TNOs) in the outer reaches of the Solar System.

Characterizing Small Bodies in the Solar System

Technical Definition



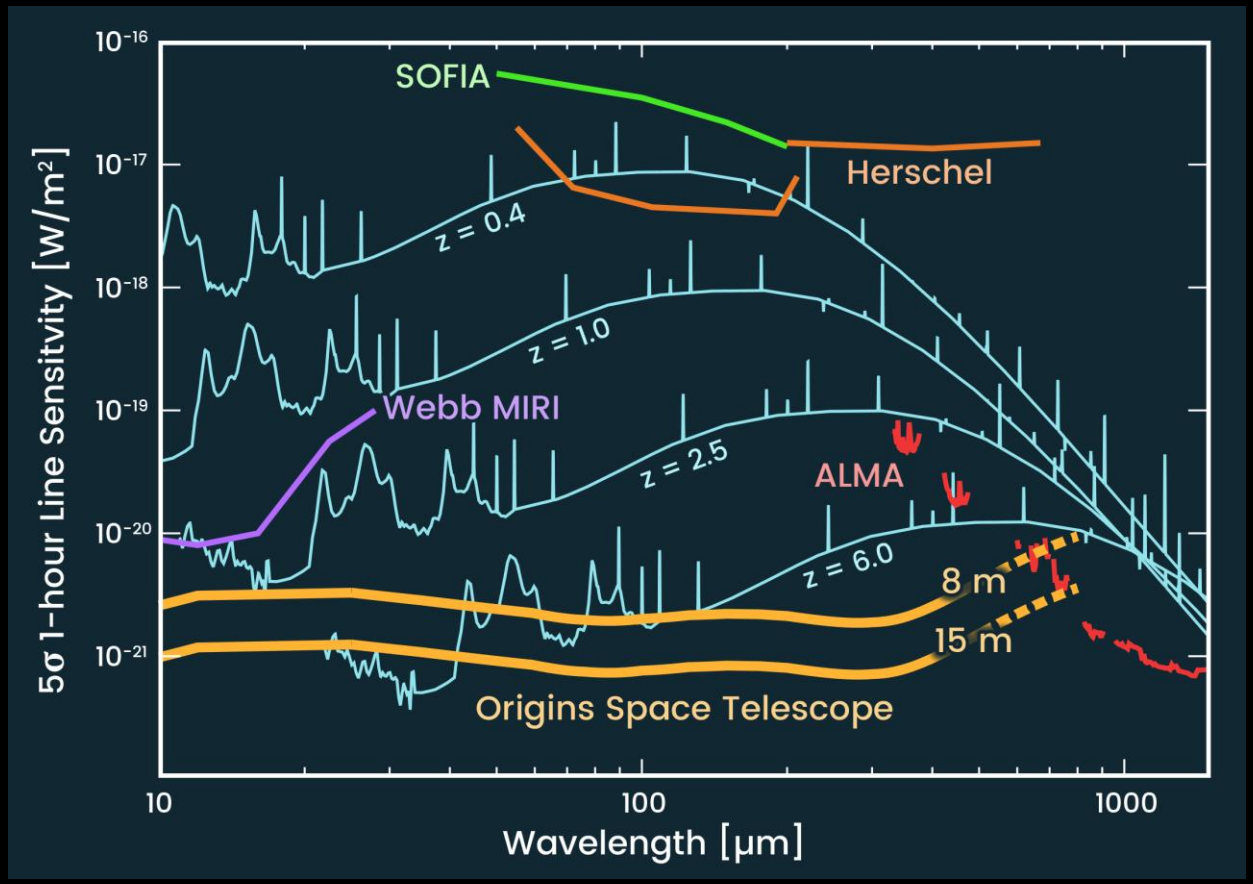
Telescope Parameters

Aperture Diameter	FOV	Diffraction Limited at	Temperature
8-15 m	0.5-1 square degree	40 µm	~4 K

ORIGINS Space Telescope

Technical Definition

Potential Wavelength Coverage from 5 μm–1 mm



Instrument Specifications					
Instrument	Wavelength Coverage μm	Spectral Resolution (λ/Δλ)	Field of view #spatial pixels	Typical Required Sensitivity:	Other

Instrument Specifications					
Instrument	**Wavelength Coverage μm**	**Spectral Resolution (λ/Δλ)**	**Field of view #spatial pixels**	**Typical Required Sensitivity:**	**Other**
Low-Res Spectrometer	35 to 500	low-res~500 high-res~10^4	100 per channel	10^{-21} W/m^2 (spectral line)	multi-channel

Technical Definition

Instrument Specifications					
Instrument	**Wavelength Coverage μm**	**Spectral Resolution (λ/Δλ)**	**Field of view #spatial pixels**	**Typical Required Sensitivity:**	**Other**
Low-Res Spectrometer	35 to 500	low-res~500 high-res~10^4	100 per channel	10^{-21} W/m^2 (spectral line)	multi-channel
High-Res Spectrometer	50 to 500	low-res ~ $8x10^4$ high-res~$5x10^5$	100	10^{-21} W/m^2 5 σ (spectral line)	photo-counting

Technical Definition

Instrument Specifications					
Instrument	**Wavelength Coverage μm**	**Spectral Resolution (λ/Δλ)**	**Field of view #spatial pixels**	**Typical Required Sensitivity:**	**Other**
Low-Res Spectrometer	35 to 500	low-res~500 high-res~10^4	100 per channel	10^{-21} W/m^2 (spectral line)	multi-channel
High-Res Spectrometer	50 to 500	low-res ~ $8x10^4$ high-res~$5x10^5$	100	10^{-21} W/m^2 5 σ (spectral line)	photo-counting
Heterodyne Spectrometer	150 to 500	~10^7	10 - 100	2 mK in 0.2 km/s @ 1 THz	polarized, background limited

Technical Definition

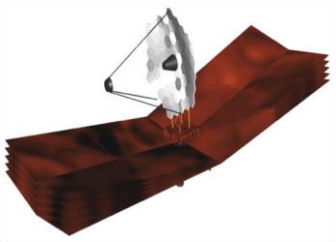
Instrument Specifications					
Instrument	**Wavelength Coverage μm**	**Spectral Resolution (λ/Δλ)**	**Field of view #spatial pixels**	**Typical Required Sensitivity:**	**Other**
Low-Res Spectrometer	35 to 500	low-res~500 high-res~10^4	100 per channel	10^{-21} W/m^2 (spectral line)	multi-channel
High-Res Spectrometer	50 to 500	low-res ~ 8x10^4 high-res~5x10^5	100	10^{-21} W/m^2 5 σ (spectral line)	photo-counting
Heterodyne Spectrometer	150 to 500	~10^7	10 - 100	2 mK in 0.2 km/s @ 1 THz	polarized, background limited
Far-infrared imager	35 to 500	R~15	100,000	1 μJy - 10 mJy (confusion limit)	5 to 10 channels, polarimetry, spectral line filters

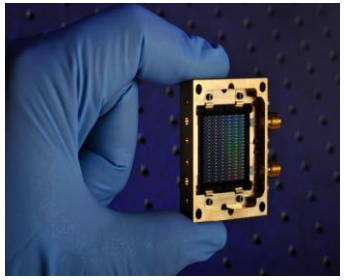
Instrument Specifications					
Instrument	**Wavelength Coverage μm**	**Spectral Resolution (λ/Δλ)**	**Field of view #spatial pixels**	**Typical Required Sensitivity:**	**Other**
Low-Res Spectrometer	35 to 500	low-res~500 high-res~10^4	100 per channel	10^{-21} W/m^2 (spectral line)	multi-channel
High-Res Spectrometer	50 to 500	low-res ~ $8x10^4$ high-res~$5x10^5$	100	10^{-21} W/m^2 5 σ (spectral line)	photo-counting
Heterodyne Spectrometer	150 to 500	~10^7	10 - 100	2 mK in 0.2 km/s @ 1 THz	polarized, background limited
Far-infrared imager	35 to 500	R~15	100,000	1 μJy - 10 mJy (confusion limit)	5 to 10 channels, polarimetry, spectral line filters
Mid-Infrared Instrument	6 to 40	imager: R~15, spectrometer: R>500	10^6	photometric: 1 μJy @10 μm	coronagraph~ 10^-6 @ 0.5" @ 10 μm

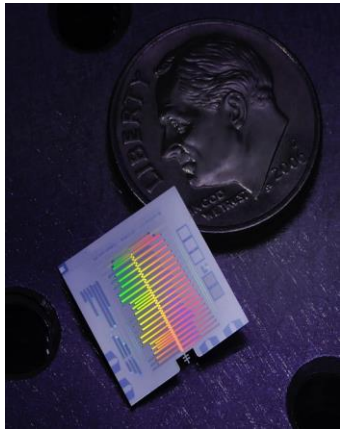
ORIGINS Space Telescope

New Science Requires New Technologies

New Technology	New Capability
Space	Wavelength coverage JWST<—>ALMA
Cold Mirror	Spectroscopic line sensitivity
Large Telescope	Spatial resolution and sensitivity
Large Detector Arrays	Wide field imaging
Compact Gratings & Integrated Spectrometers	3D mapping
Mid-IR Coronagraph	Exoplanet+Disk Characterization



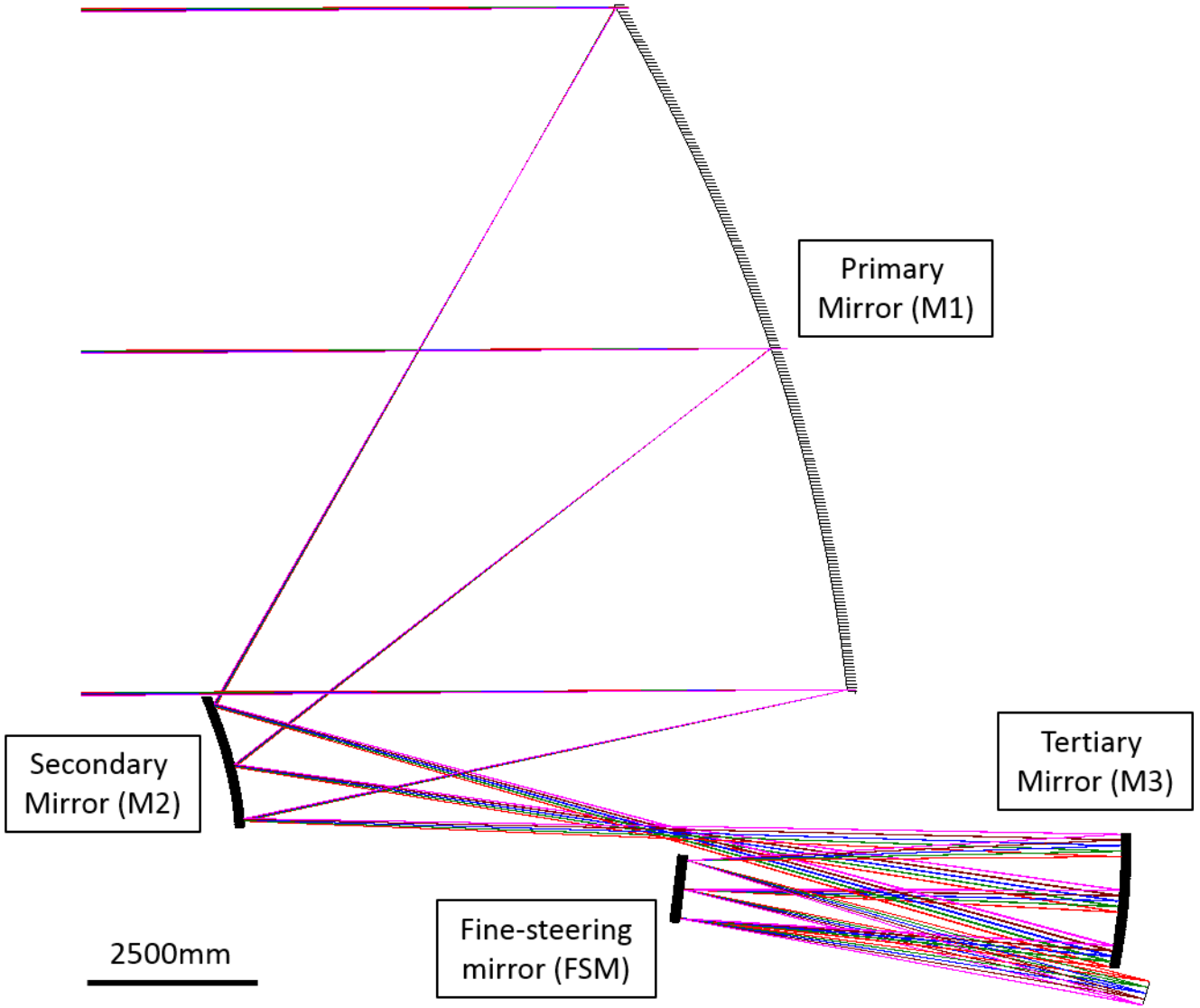




Bradford

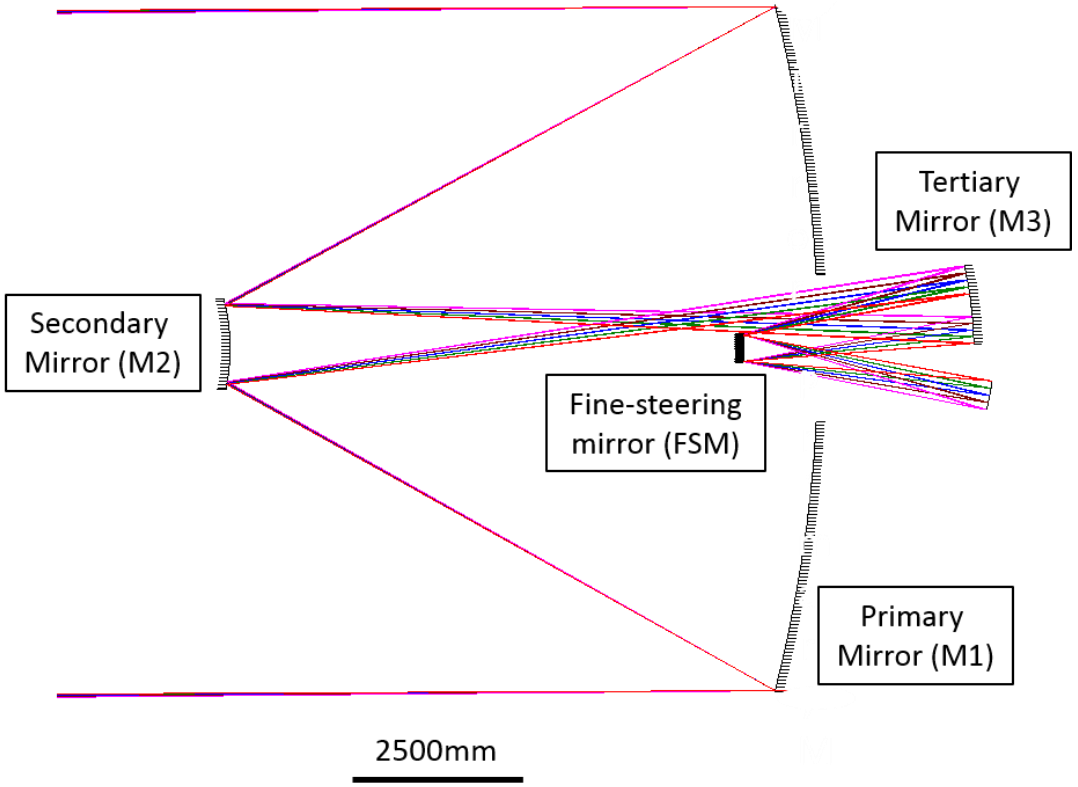
ORIGINS Space Telescope

Technical Definition: Telescope Design



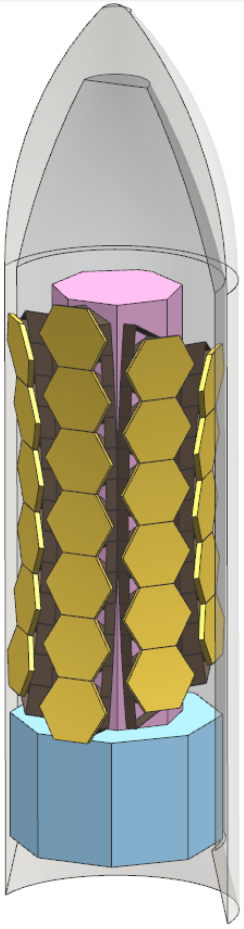
ORIGINS Space Telescope

Technical Definition: Telescope Design

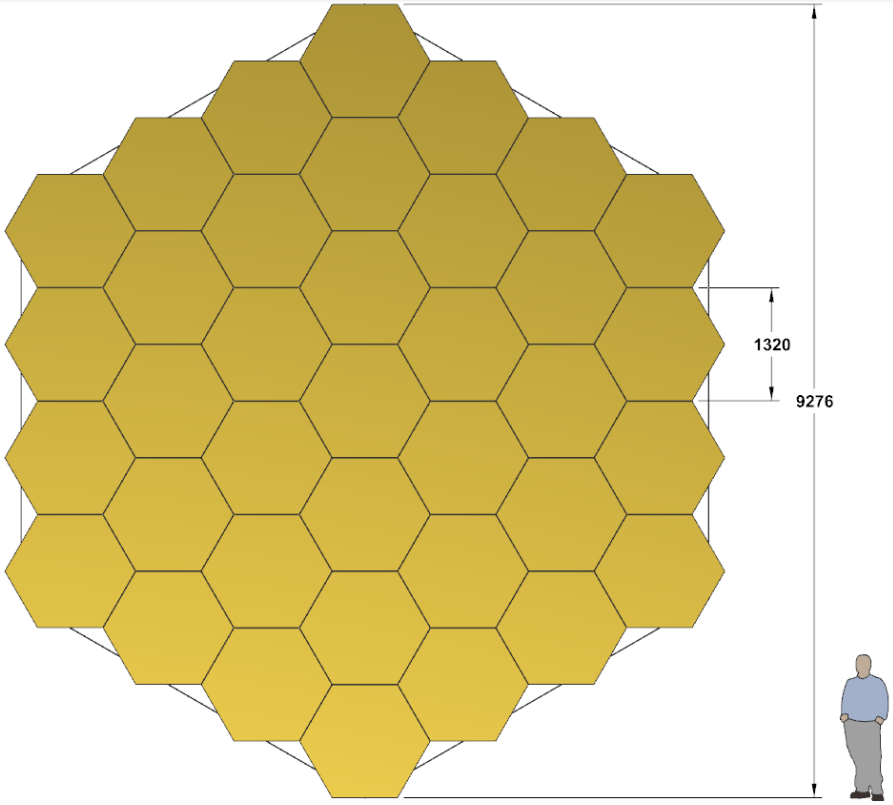


ORIGINS Space Telescope

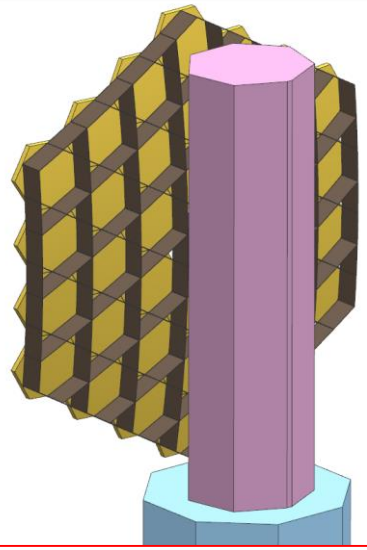
Technical Definition: JWST Segment 56 m^2 Area



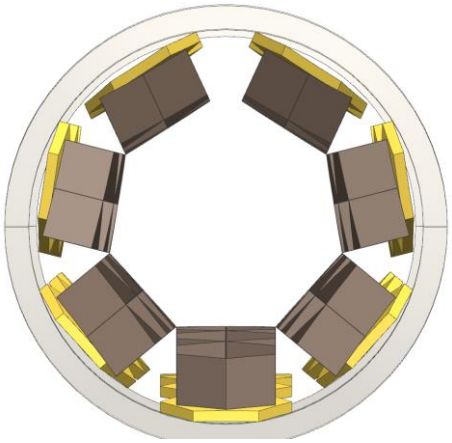
5m x 19.8m Fairing
Inst: 48m^3
Bus: 38m^3



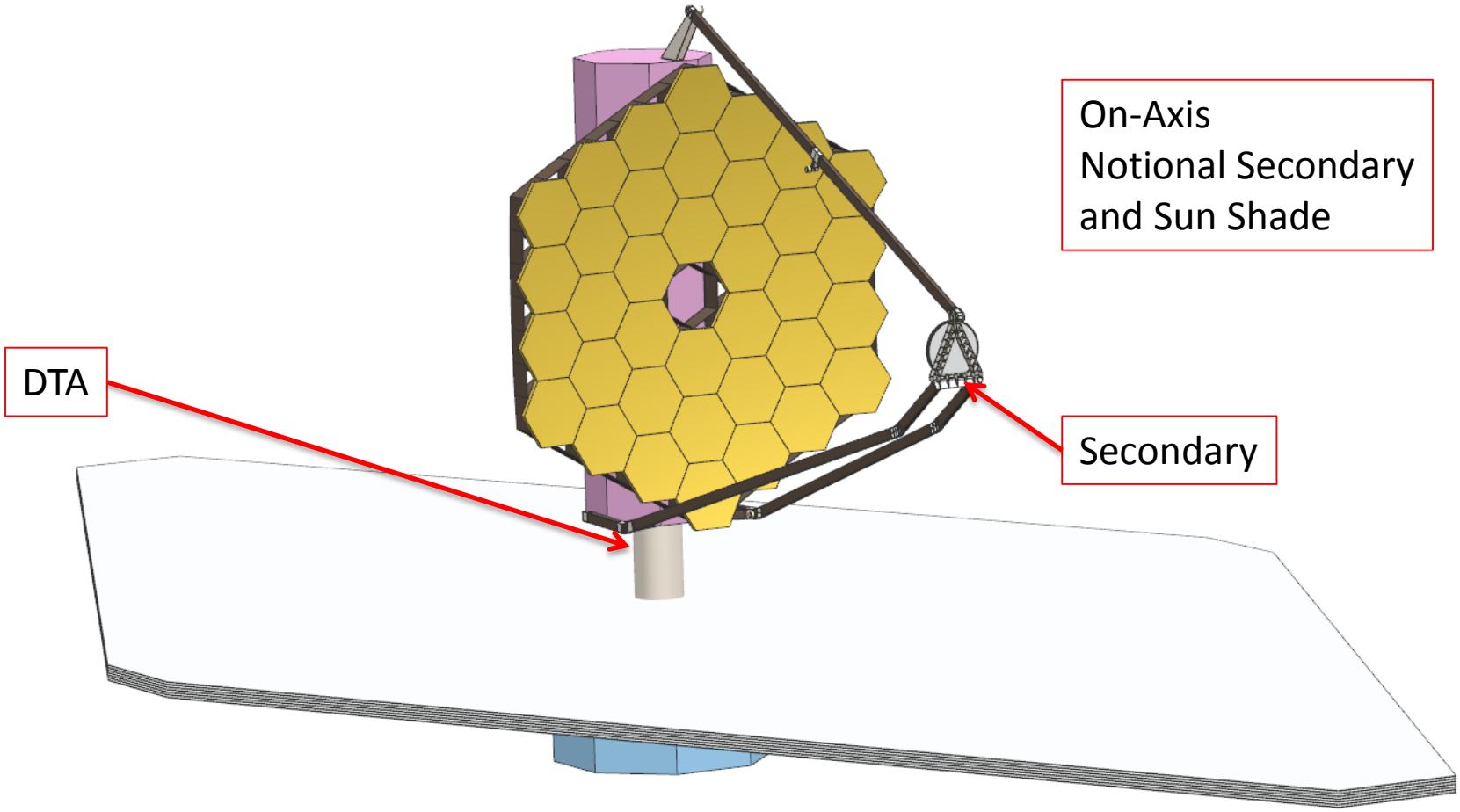
Off-Axis 9.3m Diameter
Projected Area: ~56m^2
37 Segments
Segment Flat to Flat: 1320mm
Mass Rough Estimate: 3462 kg



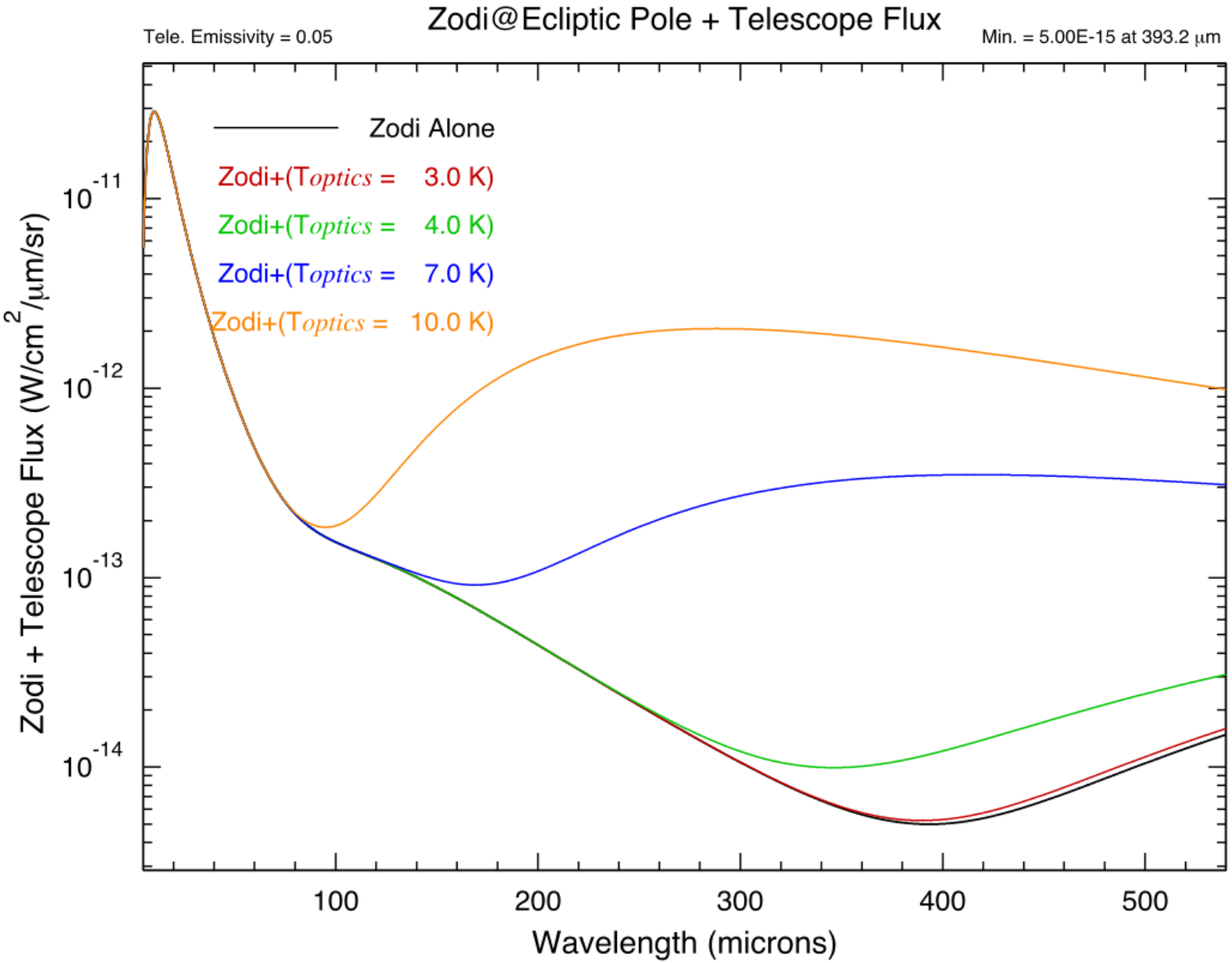
Backplane Depth: ~495mm



Technical Definition: Secondary & Shade



Technical Definition: Telescope Temperature



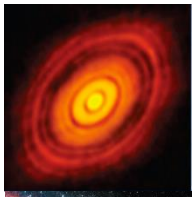
Melnick

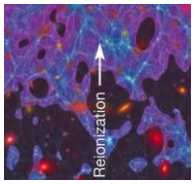
STDT Schedule

- **January to July 2017:**
  - Complete preliminary designs for telescope and instruments
  - Secure instrument design contributions
  - Identify technology drivers
- **August to September 2017**
  - Define required technologies
  - Complete preliminary mission design
- **January to March 2018:**
  - Finalize Telescope and Instrument Designs
  - Finalize mission design including spacecraft bus
- **April to August 2018:**
  - Identify de-scope options
  - End-to-end Mission cost estimations
- **January 2019:**
  - Submit the final study report to NASA HQ
- **March 2019:**
  - Far-IR Study Results presentation to Decadal Committee

ORIGINS Space Telescope

How do I get involved?





What's happending now:

- Five science working groups: membership is open to the community (US and foreign)
- Deciding on science questions in the post-JWST, 15 years of ALMA operations in an era of Extremely Large Telescope (ELT) and guiding instrument and telescope design.

Solar System: Stefanie Milam
Planet Formation and Exoplanets: Klaus Pontoppidan and Kate Su
Milky-Way, ISM and Local Volume of Galaxies: CaranBattersby and Karin Sandstrom
Galaxy and Blackhole Evolution Over Cosmic Time: Lee Armus and Alexandra Pope
First Billion Years: Joaquin Vieira, Matt Bradford