

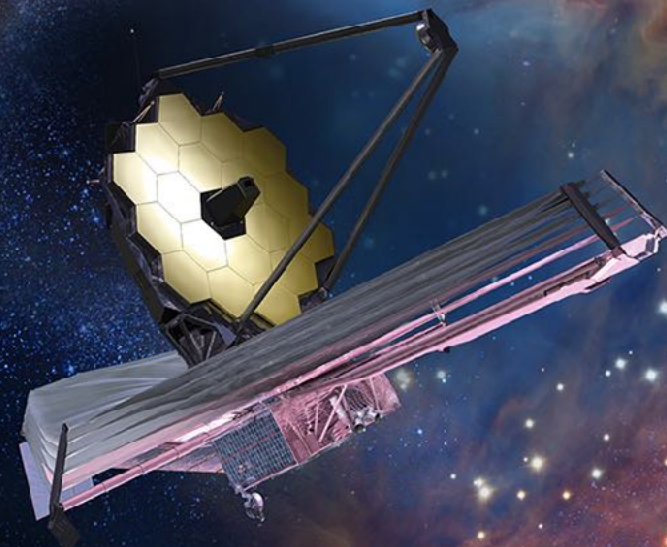


Updates on Exoplanet Science with the James Webb Space Telescope

Knicole Colón

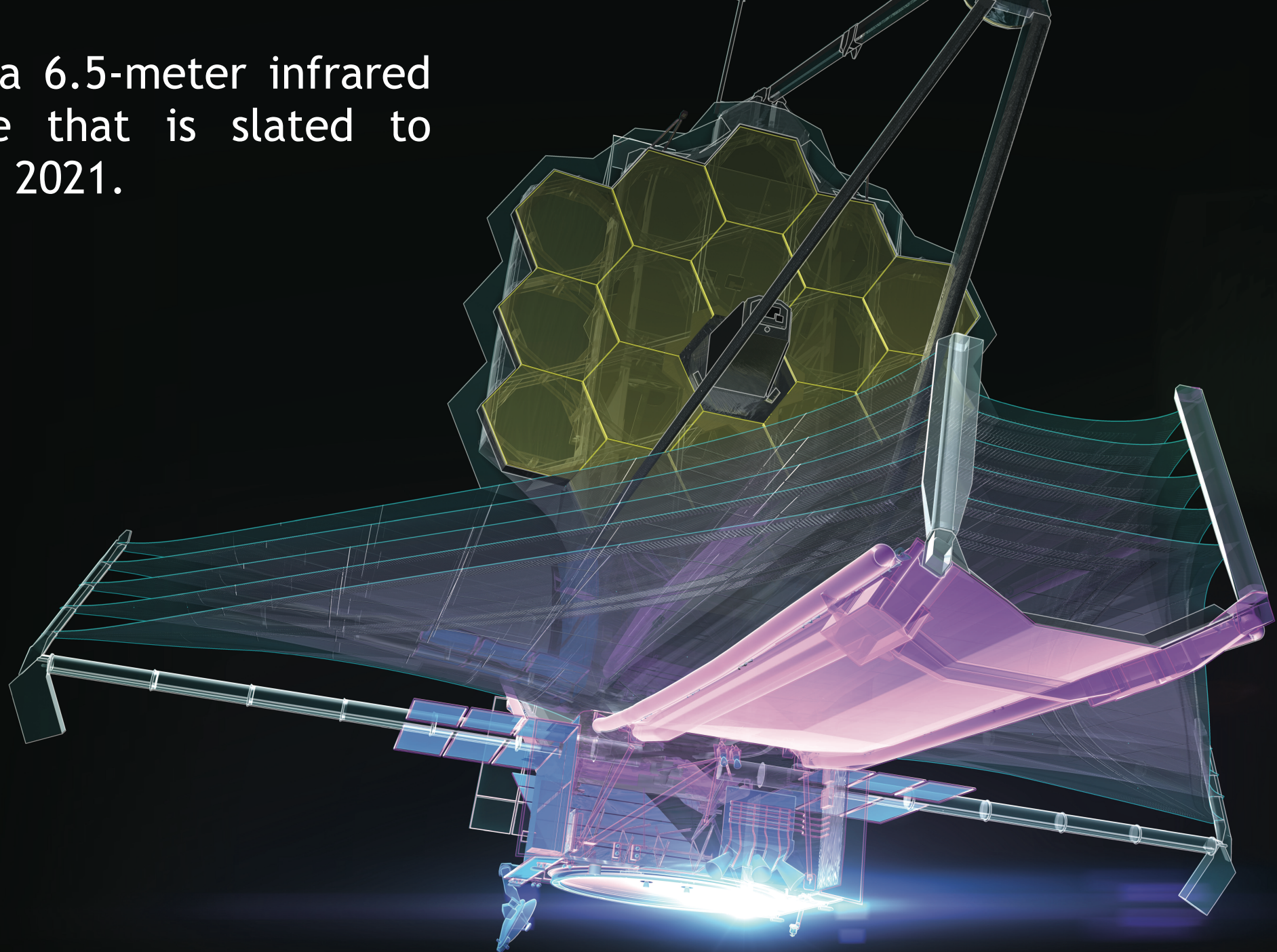
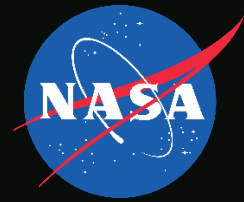
JWST Deputy Project Scientist for Exoplanet Science
NASA Goddard Space Flight Center

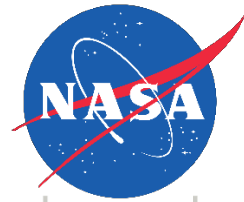
ExoPAG Meeting
19 June 2020



WEBB JAMES WEBB
SPACE TELESCOPE

JWST is a 6.5-meter infrared telescope that is slated to launch in 2021.

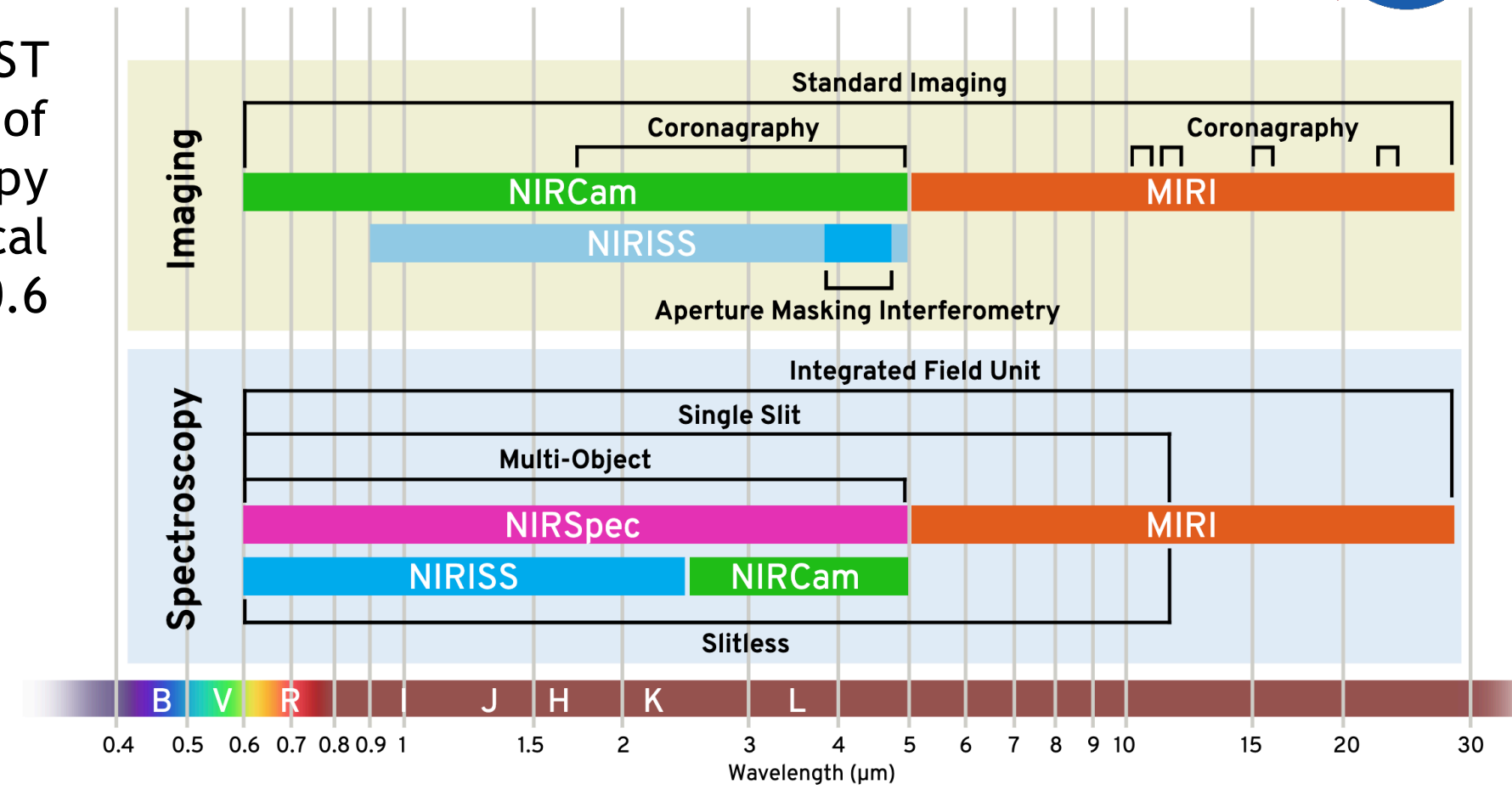




JWST Science Instruments

The four different JWST instruments cover an array of imaging and spectroscopy observing modes from optical to infrared wavelengths (0.6 to 28.5 microns).

- NIRCam
- NIRISS
- NIRSpect
- MIRI



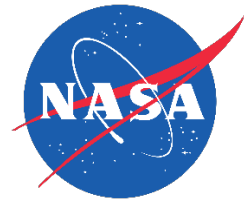
<https://jwst-docs.stsci.edu/near-infrared-camera>

<https://jwst-docs.stsci.edu/near-infrared-imager-and-slitless-spectrograph>

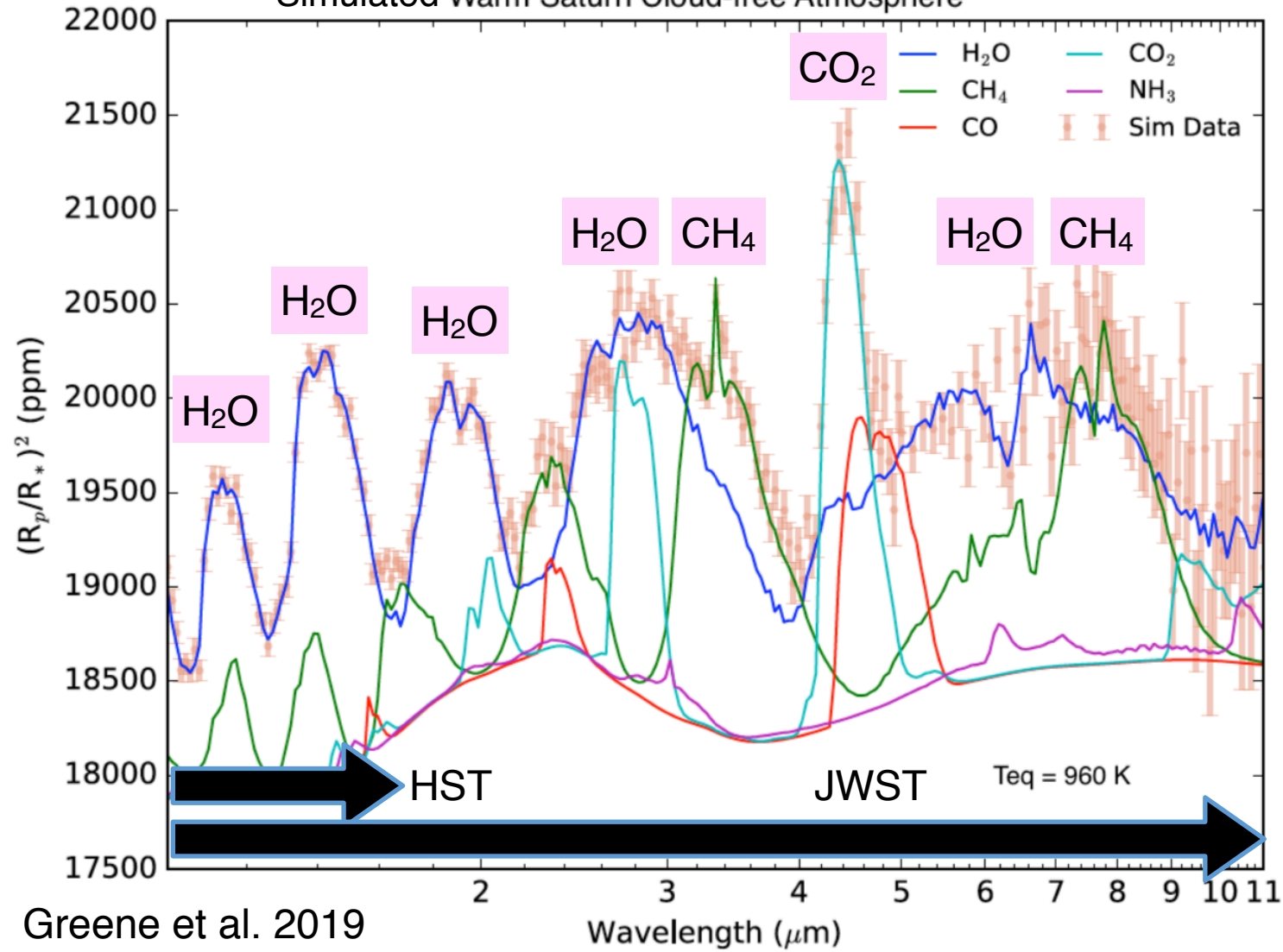
<https://jwst-docs.stsci.edu/near-infrared-spectrograph>

<https://jwst-docs.stsci.edu/mid-infrared-instrument>

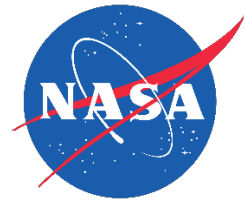
Transiting Exoplanet Science



Simulated Warm Saturn Cloud-free Atmosphere



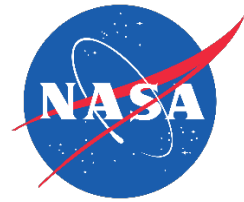
- JWST will provide a detailed look at the thermal structure and composition of exoplanet atmospheres
- JWST is particularly well-suited to provide stronger constraints on water in exoplanet atmospheres and probe carbon-bearing species like carbon dioxide and methane



Time-Series Modes

<https://jwst-docs.stsci.edu/methods-and-roadmaps/jwst-time-series-observations>

	Photometry	Spectroscopy
$\lambda \leq 5 \mu\text{m}$	NIRCam time-series imaging	NIRCam time-series grism spectroscopy NIRISS single object slitless spectroscopy (SOSS) NIRSpec bright object time-series spectroscopy (BOTS)
$\lambda \geq 5 \mu\text{m}$	MIRI imaging	MIRI low resolution slitless spectroscopy MIRI medium resolution spectroscopy



ERS Transiting Exoplanet Program

<http://www.stsci.edu/jwst/observing-programs/approved-ers-programs>

	Photometry	Spectroscopy
$\lambda \leq 5 \mu\text{m}$	NIRCam time-series imaging	<p>NIRCam time-series grism spectroscopy</p> <p>NIRISS single object slitless spectroscopy (SOSS)</p> <p>NIRSpec bright object time-series spectroscopy (BOTS)</p>
$\lambda \geq 5 \mu\text{m}$	MIRI imaging	<p>MIRI low resolution slitless spectroscopy</p> <p>MIRI medium resolution spectroscopy</p>

The Transiting Exoplanet Community Early Release Science Program

PI: Natalie Batalha

Co-PIs: Jacob L. Bean and Kevin B. Stevenson

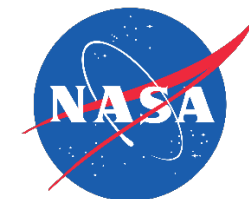
Time Allocation: 80.4 hours

Exclusive Access Period: 0 months

<https://ers-transit.github.io/index.html>

- This program will use four of the seven available time-series modes to provide a representative set of transiting exoplanet data for giant planets with bright host stars.
- These modes are anticipated to be the most commonly used for transiting exoplanet science.
- The community will have immediate access to this data, which will be collected in the first few months after commissioning.

ERS Transiting Exoplanet Program

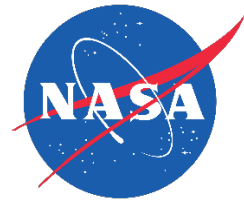


<http://www.stsci.edu/jwst/observing-programs/approved-ers-programs>

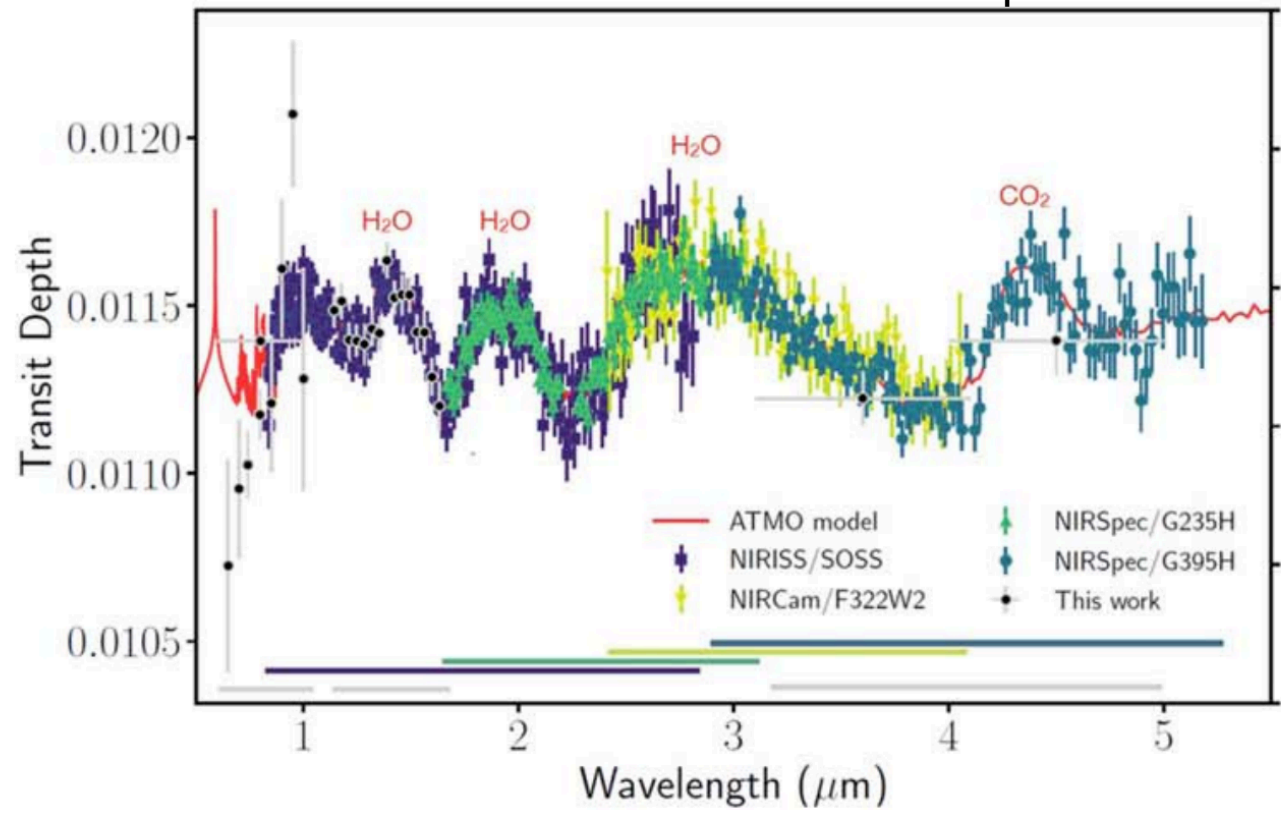
OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>
Transmission - WASP-79b			
	1	NIRISS SOSS	NIRISS Single-Object Slitless Spectroscopy
	2	NIRSpec G235H	NIRSpec Bright Object Time Series
	3	NIRSpec G395H	NIRSpec Bright Object Time Series
	4	NIRCam F322W2	NIRCam Grism Time Series
Phase Curve - WASP-43b			
	11	MIRI LRS Phase Curve	MIRI Low Resolution Spectroscopy
Bright Object - WASP-18b			
	21	NIRISS SOSS Eclipse	NIRISS Single-Object Slitless Spectroscopy

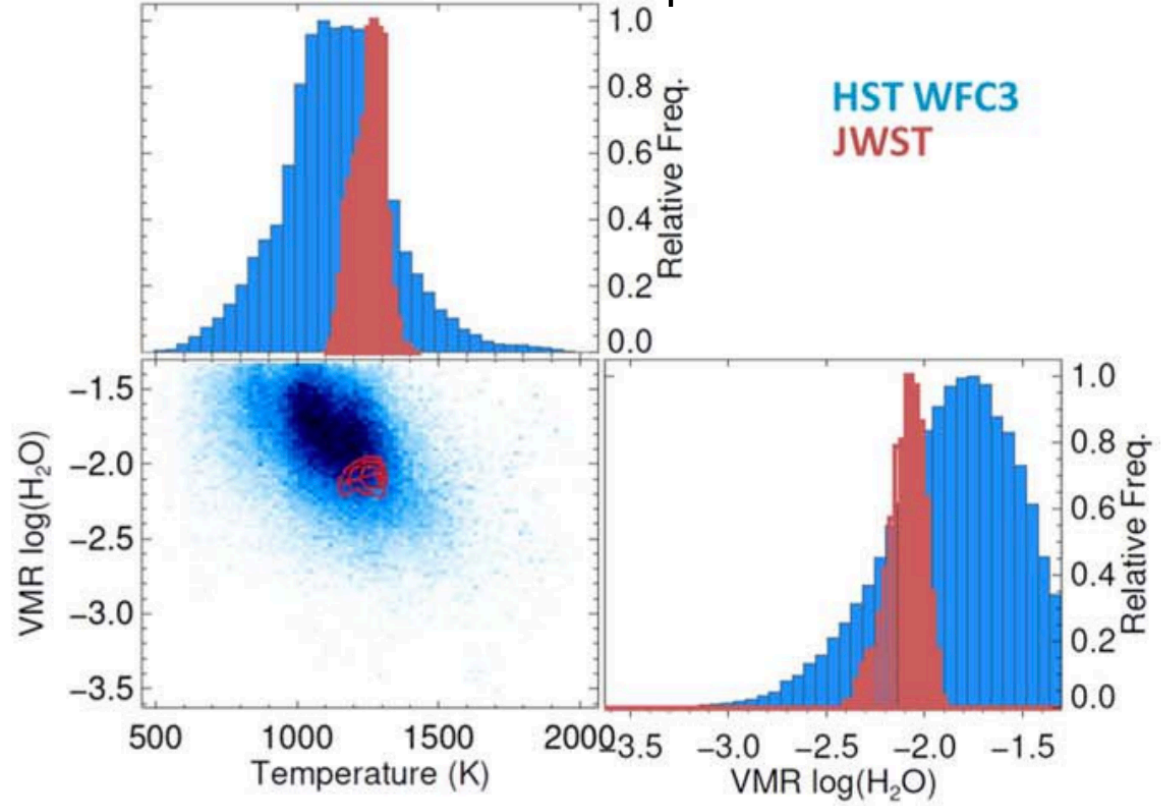
ERS Transiting Exoplanet Program



WASP-79b observed transmission spectrum and simulated JWST transmission spectrum

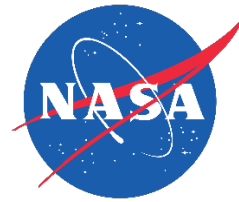


Water abundance and temperature constraints from HST and anticipated from JWST



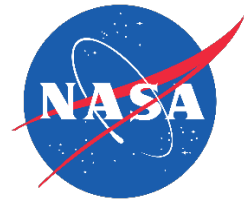
Sotzen et al. 2020

GTO Transiting Exoplanet Programs

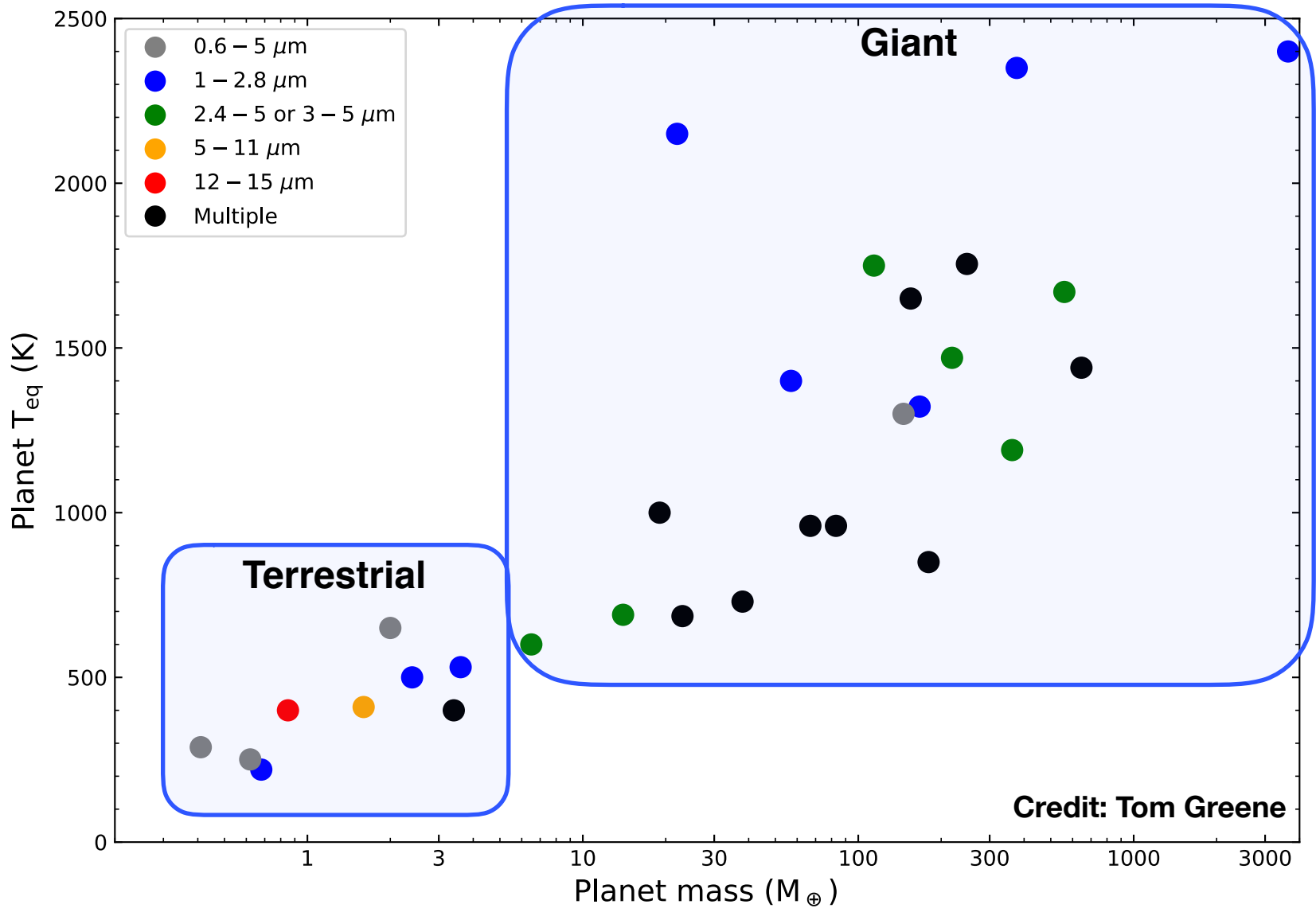


- Guaranteed Time Observation (GTO) Programs will use 738 hours and will be conducted over the first couple cycles of JWST
- GTO targets are finalized and are not expected to change before the GO Cycle 1 deadline
- 28 unique exoplanets will be observed
- 5 exoplanets come from the Transiting Exoplanet Survey Satellite
- GTO observations cover transits, eclipses, phase curves at a variety of wavelengths
- <http://www.stsci.edu/jwst/observing-programs/approved-gto-programs>

A list of the exoplanet and brown dwarf ERS and GTO targets is available here (compiled by Tom Greene, Aarynn Carter, Knicole Colón).



ERS & GTO Transiting Exoplanet Targets



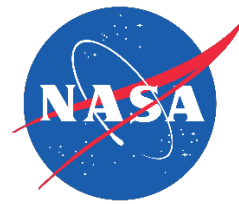
Terrestrial

- GJ-1132b
- GJ-357b
- L98-59c
- L98-59d
- LP791-18c
- TRAPPIST-1b
- TRAPPIST-1d
- TRAPPIST-1e
- TRAPPIST-1f

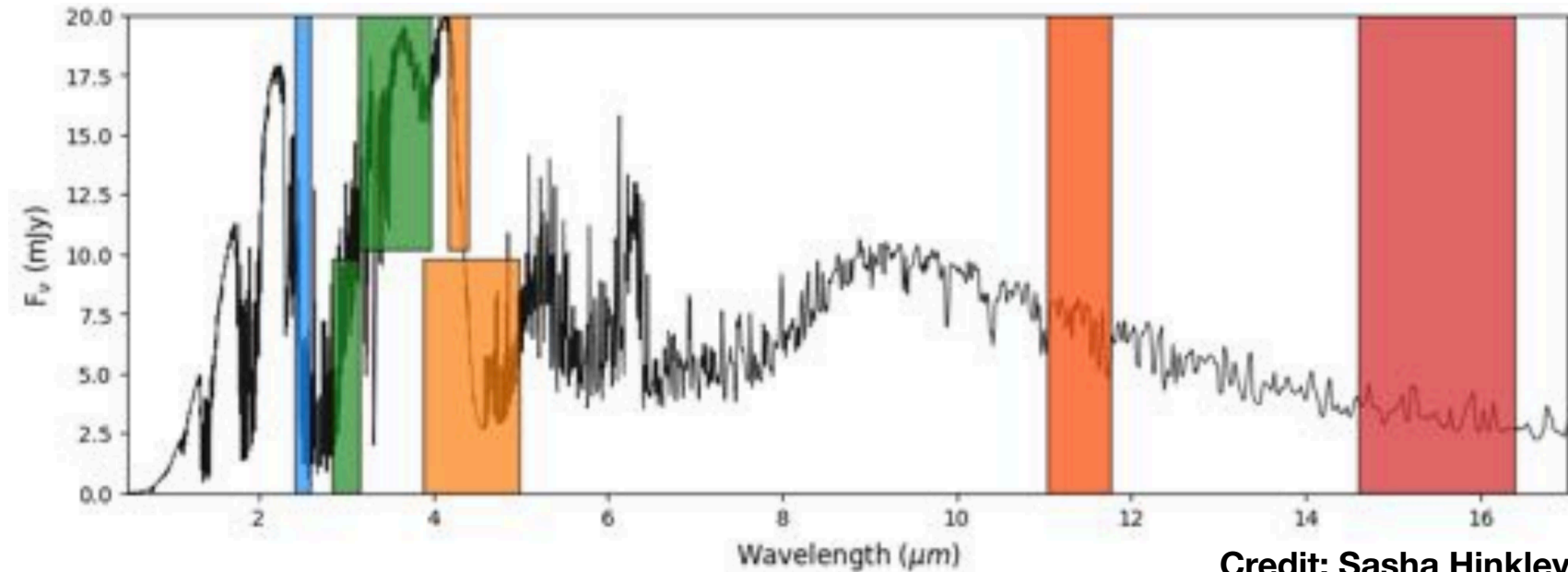
Giant

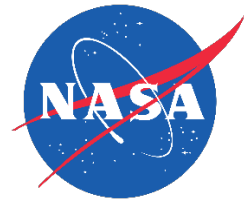
- GJ-1214b
- GJ-3470b
- GJ-436b
- HAT-P-1b
- HAT-P-12b
- HAT-P-26b
- HD-149026b
- HD-189733b
- HD-209458b
- TOI-193.01
- WASP-107b
- WASP-121b
- WASP-127b
- WASP-17b
- WASP-18b
- WASP-43b
- WASP-52b
- WASP-69b
- WASP-77Ab
- WASP-79b
- WASP-80b

Direct Imaging of Exoplanets and Disks



- JWST will provide increased sensitivity at 3-5 microns compared to some ground-based observations
- Directly-imaged exoplanets are largely unexplored beyond 5 microns, the wavelengths that JWST will cover
- JWST will provide key insights into the physical characteristics of these exoplanets

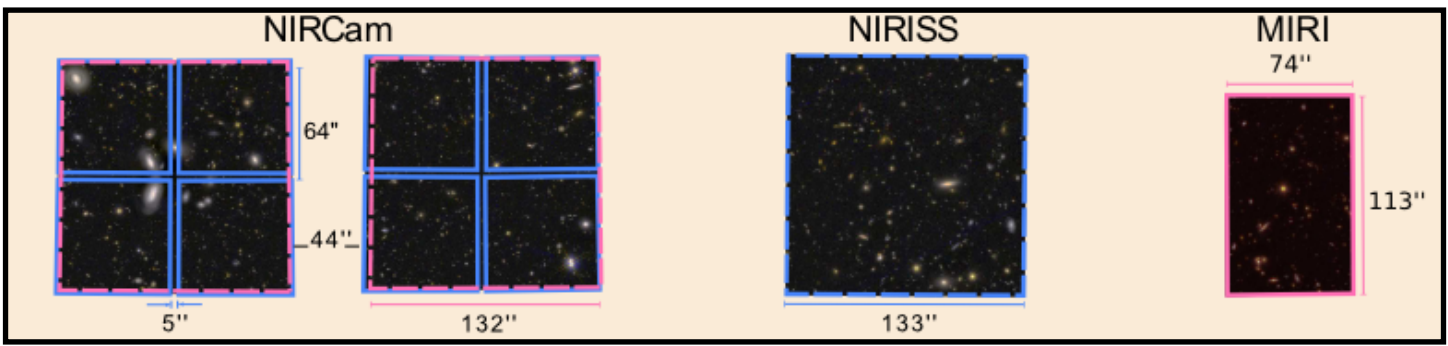




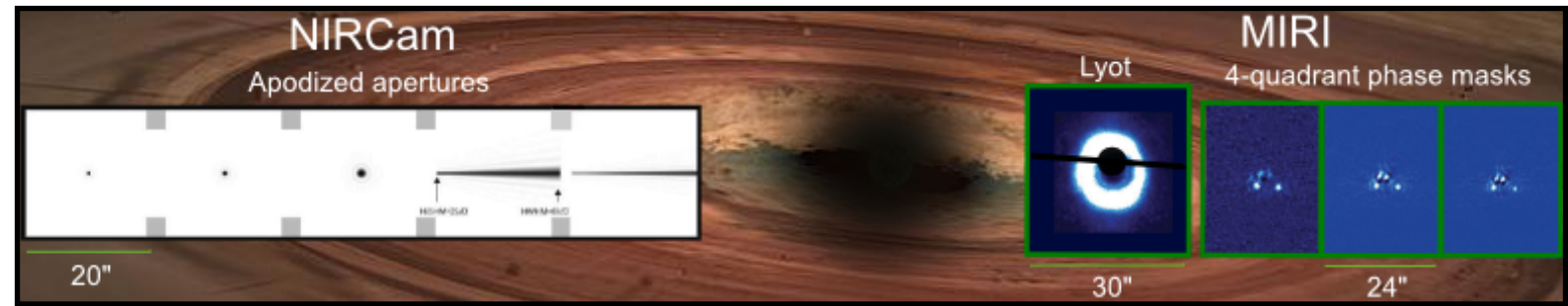
Direct Imaging Modes

<http://www.stsci.edu/jwst/instrumentation/imaging-modes>

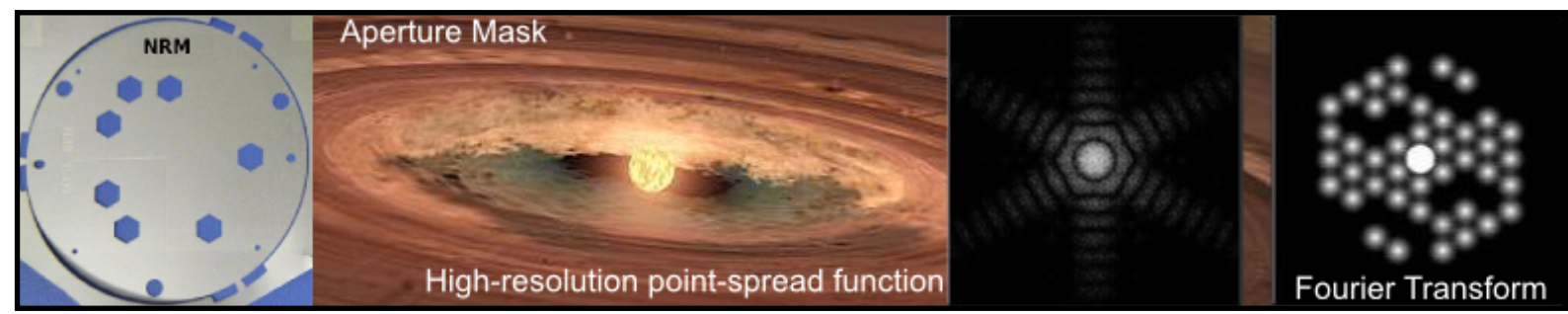
Direct Imaging with MIRI, NIRCcam, NIRISS

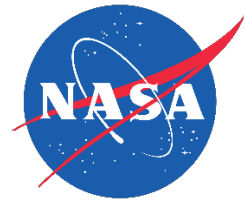


Coronagraphy with MIRI, NIRCcam



Aperture Masking Interferometry with NIRISS





ERS Direct Imaging Exoplanet Program

<http://www.stsci.edu/jwst/observing-programs/approved-ers-programs>

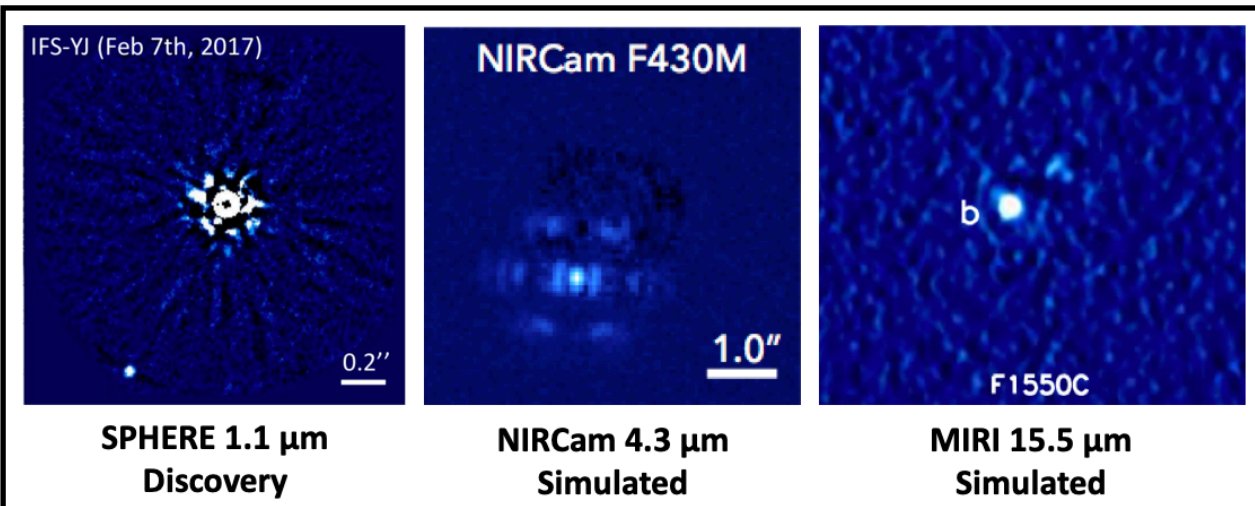
High Contrast Imaging of Exoplanets and Exoplanetary Systems with JWST

PI: Sasha Hinkley

Co-PIs: Andrew Skemer and Beth Biller

Time Allocation: 54.3 hours

Exclusive Access Period: 0 months



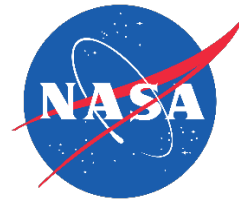
HIP 65426b - warm giant planet (*MIRI, NIRCcam Coronagraphic Imaging, NIRISS Aperture Masking Interferometry*)

VHS 1256b - wide-separation planetary mass companion (*NIRSpec IFU Spectroscopy, MIRI Medium Resolution Spectroscopy*)

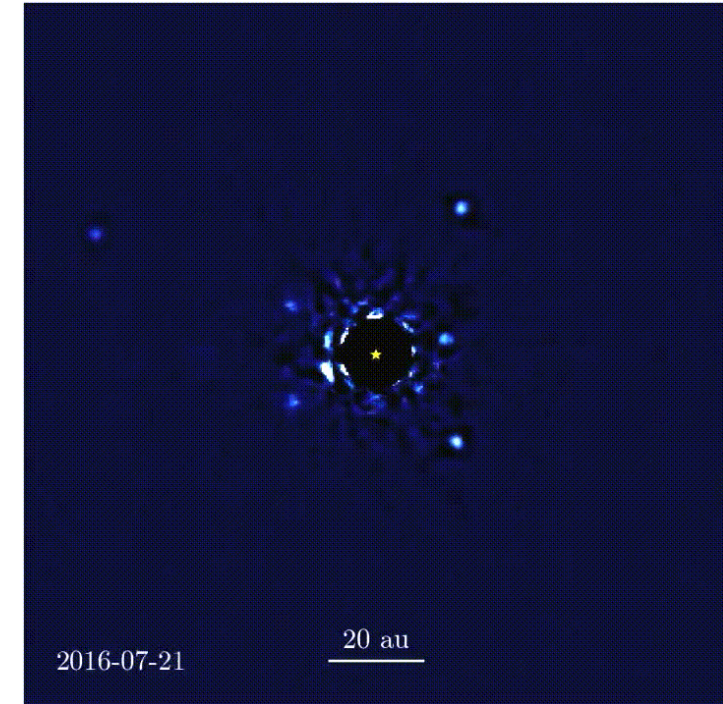
HD 141569A - young debris disk (*MIRI, NIRCcam Coronagraphic Imaging*)

HIP 65426b (Chauvin et al. 2017 / Sasha Hinkley)

GTO Direct Imaging Exoplanet Programs

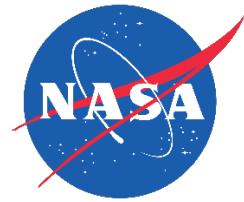


- Guaranteed Time Observation (GTO) Programs will use 217 hours and will be conducted over the first couple cycles of JWST
- GTO targets are finalized and are not expected to change before the GO Cycle 1 deadline
- Over 30 unique systems will be observed
- <http://www.stsci.edu/jwst/observing-programs/approved-gto-programs>



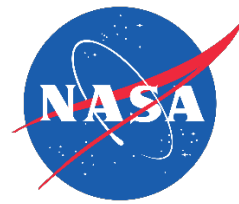
HR 8799; Credit: Wang/Marois

A list of the exoplanet and brown dwarf ERS and GTO targets is available here (compiled by Tom Greene, Aarynn Carter, Knicole Colón).



JWST: Current Status

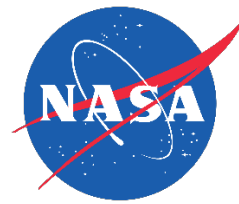
Integration & Test Activities Ongoing



JWST sunshield deployment (October 2019). Credit: NASA / Chris Gunn

- Progress continues to be made even with impacts from COVID-19
- JWST is now entering the final stages of observatory integration and testing

Integration & Test Activities Ongoing



JWST Deployable Tower Assembly extension (June 2020). Credit: Northrop Grumman
<https://www.nasa.gov/feature/goddard/2020/tower-extension-test-a-success-for-nasa-s-james-webb-space-telescope>



JWST Deployable Tower Assembly fully stowed. Credit: Northrop Grumman

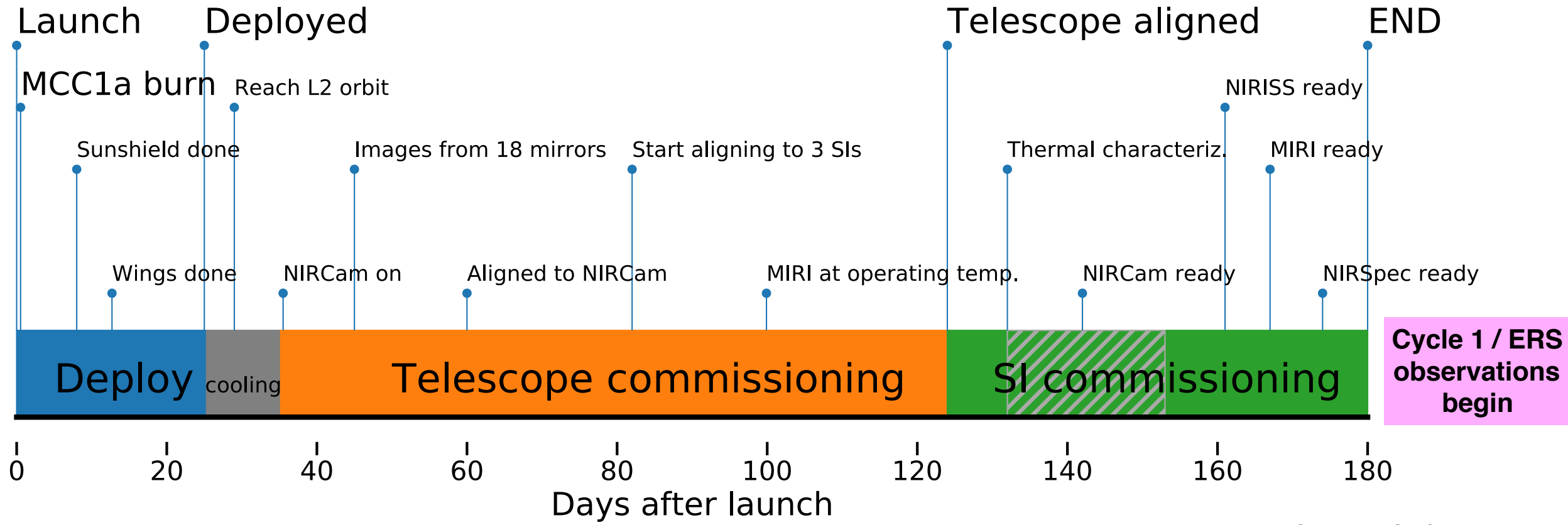
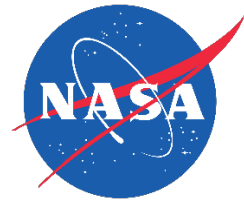


JWST is planned to launch on top of ESA's Ariane 5 in 2021 from French Guiana

It will undergo a month long 1.5 million km journey to its destination at the second Lagrange point

Commissioning JWST

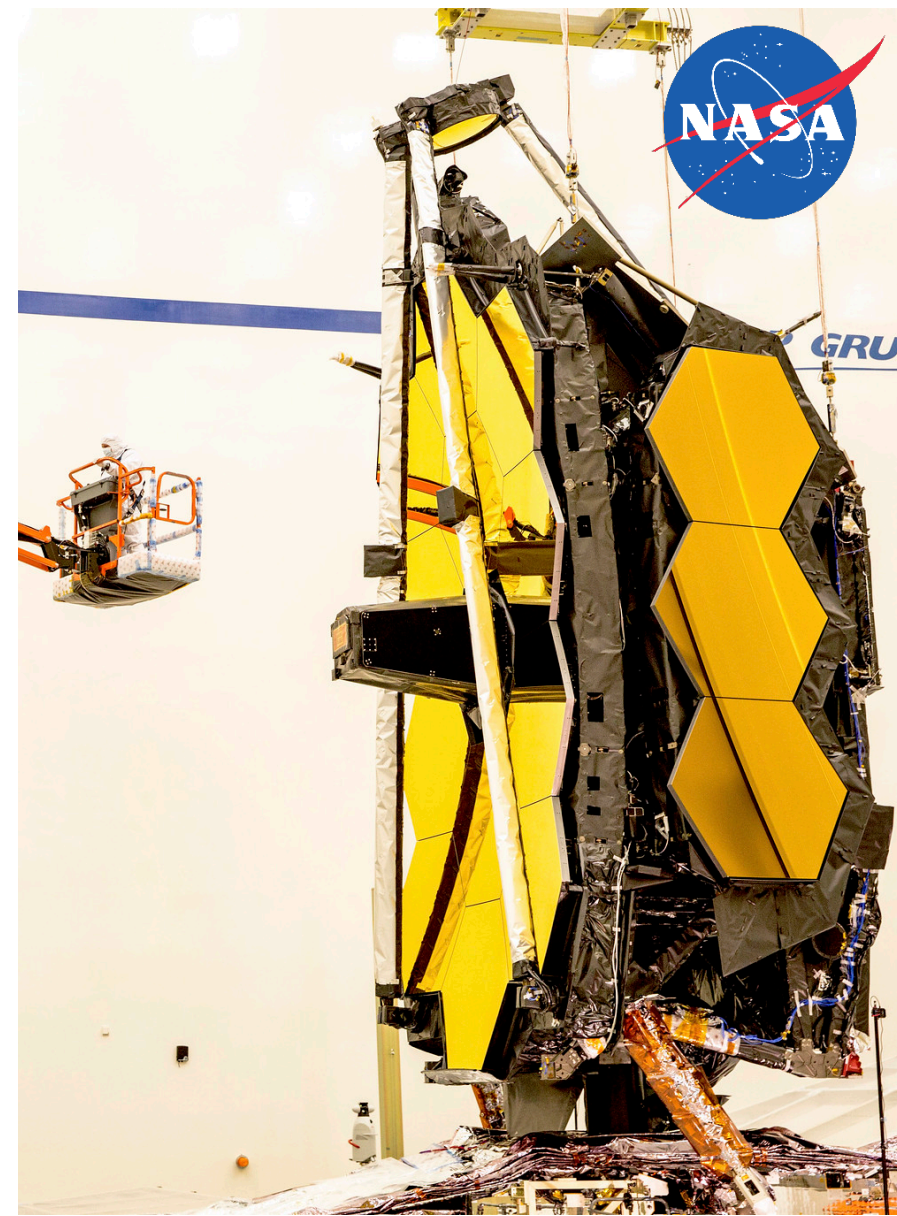
This is a complex, 6 month process.



Credit: NASA / Jane Rigby

Starting Science with JWST

- JWST is anticipated to launch in 2021. Six months after launch, commissioning is planned to end, and science operations to begin.
- The Cycle 1 proposal deadline has been postponed due to COVID-19. The deadline is TBD and will potentially be sometime this fall. Additional updates are anticipated by late July 2020.
- Up to 6,000 hours will be available for Cycle 1 GO programs using the full suite of JWST instrumentation.
- The Cycle 1 schedule will intersperse observations from ERS, GTO, GO, and calibration programs.



Credit: Northrop Grumman

Proposal Planning, Performance, and More: <https://jwst-docs.stsci.edu/>
<http://www.stsci.edu/jwst/science-planning/calls-for-proposals-and-policy>

Impacts of Launch Delay

In response to the SAG 20 report.

- TESS targets that are well-suited to atmospheric observations have now been added to GTO programs.
- There is now more time to collect UV and other preparatory observations with HST ahead of JWST, but potentially less time for the missions to overlap.
- Spitzer operations ended in early 2020, so the exoplanet community is now missing access to an infrared space facility.



Credit: NASA/Chris Gunn

Impacts of Launch Delay

In response to the SAG 20 report.

- Master Class workshops were led by STScI to prepare the community to submit Cycle 1 proposals
- Community efforts to propose large-scale Cycle 1 programs are now in progress (e.g., [TRAPPIST-1 initiative](#), rocky planet emission collaboration)
- Data challenges are now being planned (e.g., [ERS Transit Program team](#), NIRCcam team)
- Development of new data analysis training campaigns is being led by STScI
- Additional work is ongoing and papers are in preparation by the SI teams detailing e.g., NIRCcam noise performance, NIRISS/SOSS end-to-end pipeline



Credit: NASA/Chris Gunn



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