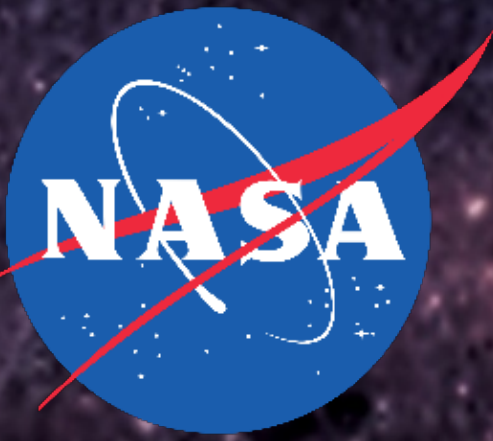
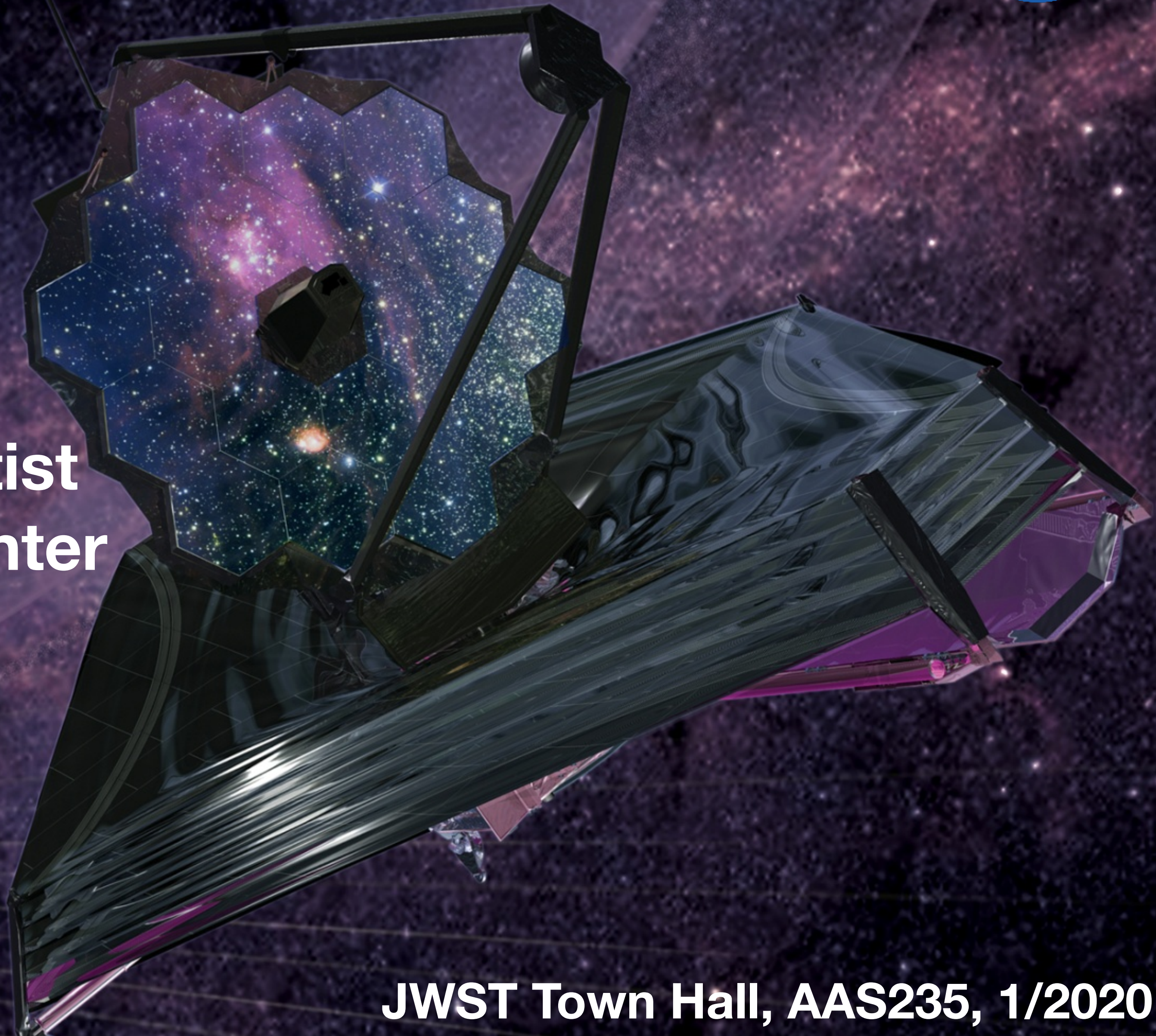


The James Webb Space Telescope: from launch to science

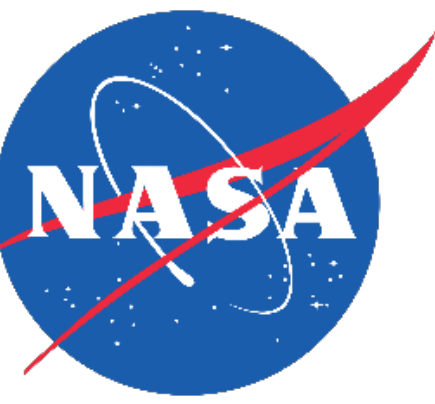


Jane Rigby
JWST Operations Project Scientist
NASA Goddard Space Flight Center



JWST Town Hall, AAS235, 1/2020

Integration, Test, Launch, Commissioning and Science



JWST sunshield deployment, Oct. 2019. Credit: NASA / Chris Gunn



Ariane 5 ECA launch vehicle. Credit: Arianespace

Commissioning and Science



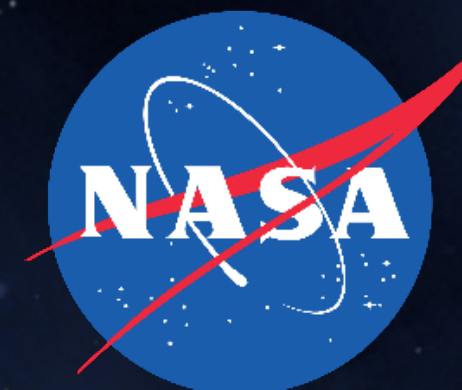
JWST sunshield deployment, Oct. 2019. Credit: NASA / Chris Gunn

How we are preparing to:

- **Commission JWST**
- **Calibrate JWST**
- **Conduct science operations**
- **Deliver science-ready data**

How we are rehearsing and testing.

Commissioning JWST

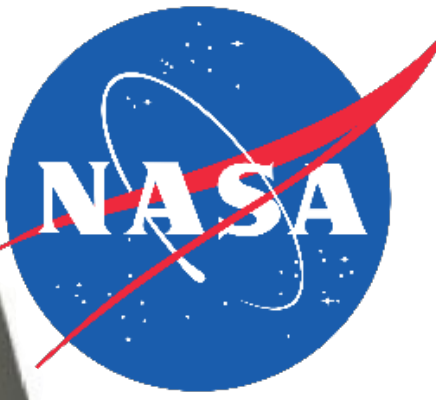


Commissioning JWST is a complex, 6 month process:

- JWST unfolds. A tower extends. The tennis-court-sized sunshield deploys. The secondary mirror supports unfold. 6 of the 18 primary mirror segments swing out on hinges.
- JWST cools passively. We must wait for the science instruments to get cold enough.
- JWST is thermally demanding. The 40-50 K telescope and science instruments are isolated from the 300K spacecraft.
- JWST is segmented. The 18 primary mirror segments must be phased, from initial alignments of millimeters, to a final alignment of tens of nanometers.
- JWST has 4 science instruments with 17 observing templates (modes).



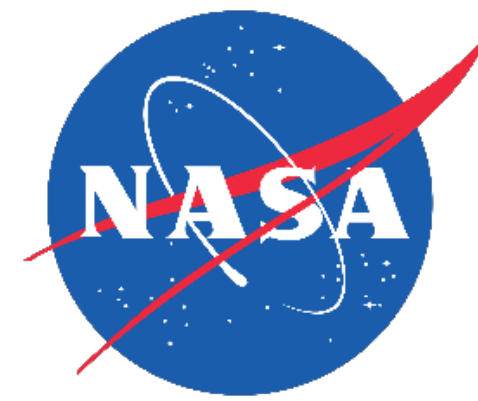
Commissioning JWST: the first month



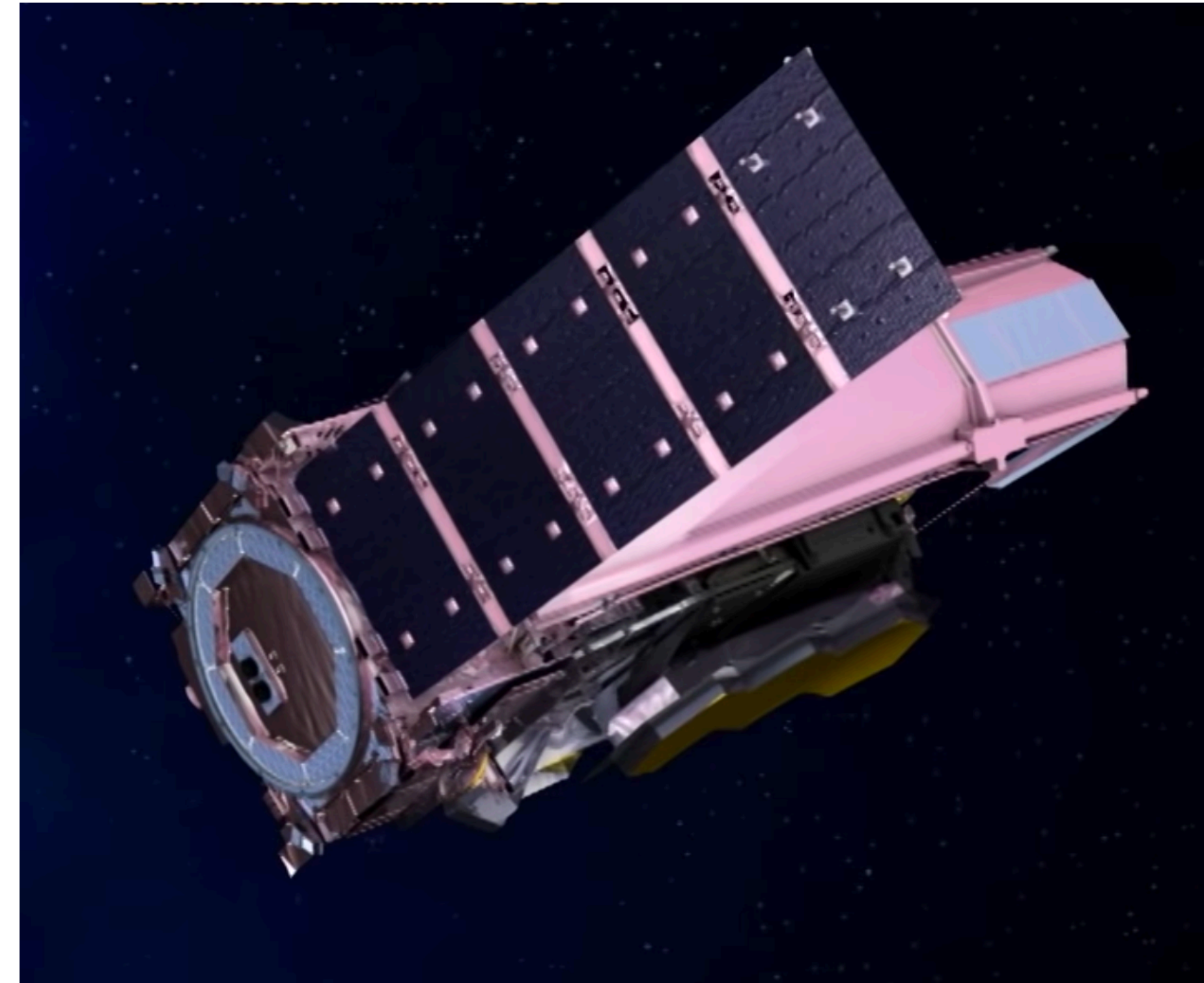
- **An Ariane 5 will launch JWST to the L2 Earth-Sun Lagrange point.**
- **30 min after launch, JWST will separate from the launch vehicle. The solar array will deploy to get power.**
- **Less than a day after launch, JWST must burn a mid-course correction to send it toward L2.**
- **In the first two weeks after launch, JWST will deploy the tower, the sunshield, the secondary mirror, and the wings of the primary mirror.**
- **Two weeks after launch, the primary mirrors segments will slowly rise from their stowed positions.**



Commissioning JWST: the first month

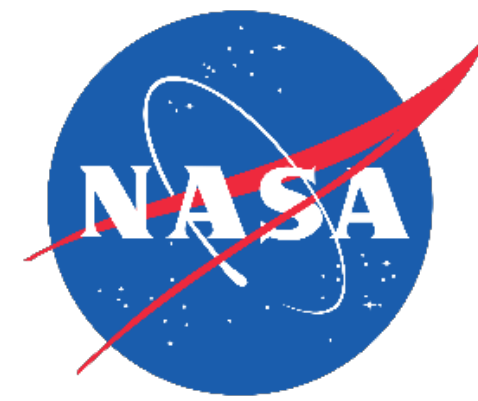


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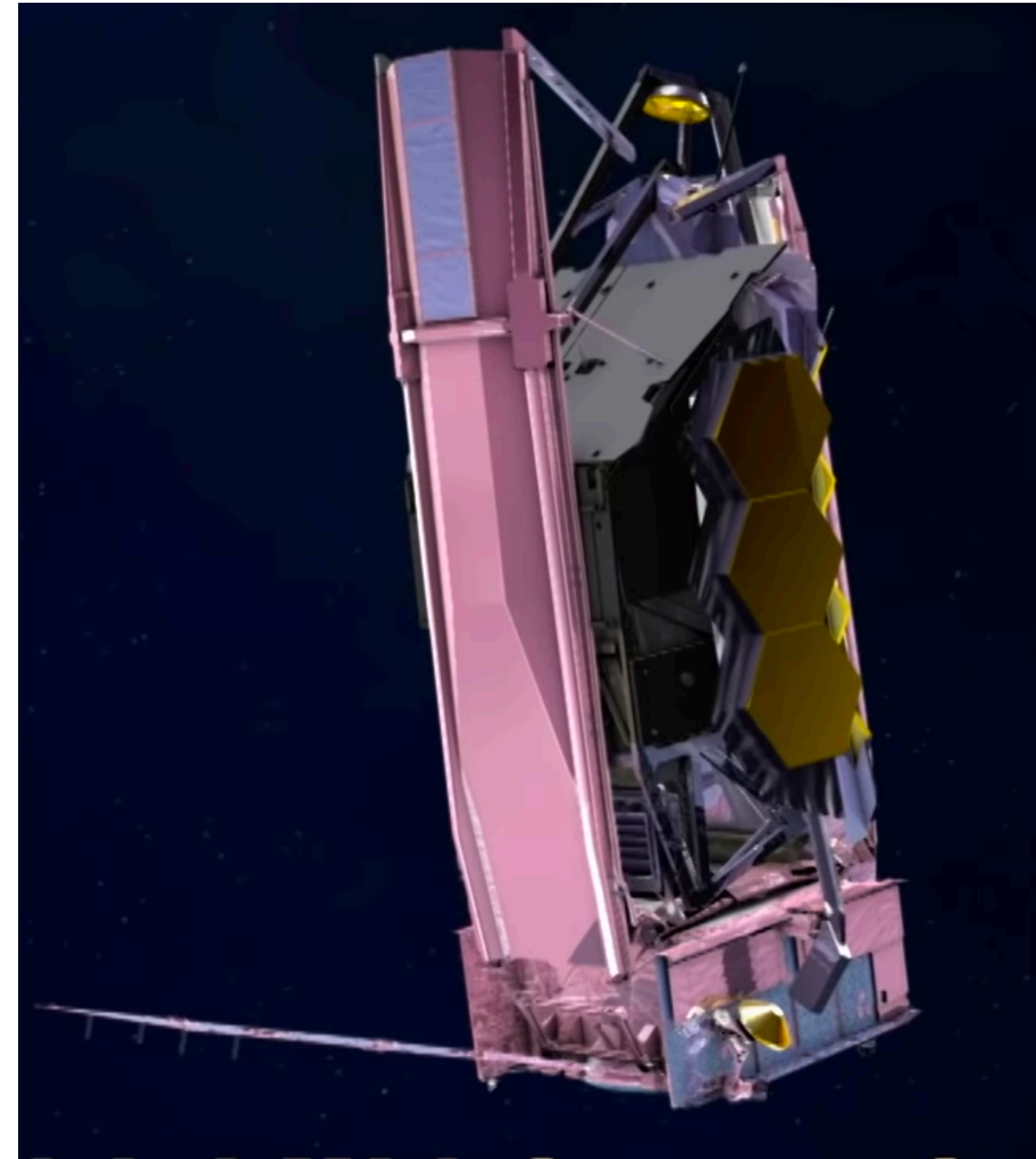


Solar array deployment. Credit: Northrop Grumman

Commissioning JWST: the first month

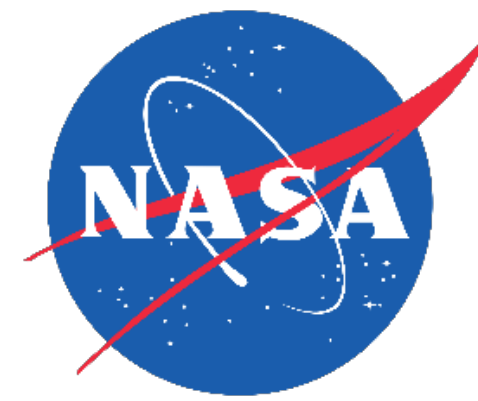


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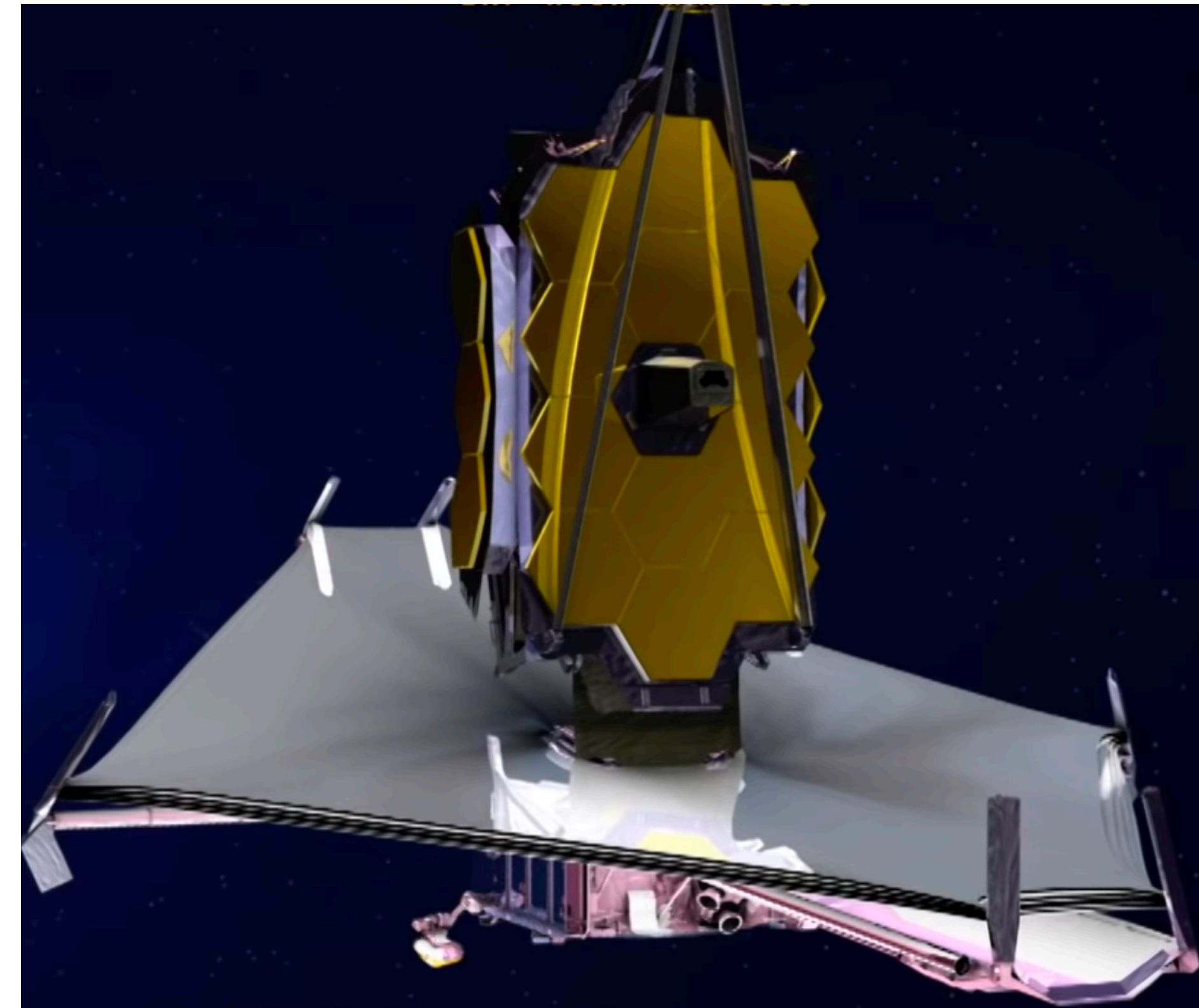


Mid-course-correction. Credit: Northrop Grumman

Commissioning JWST: the first month



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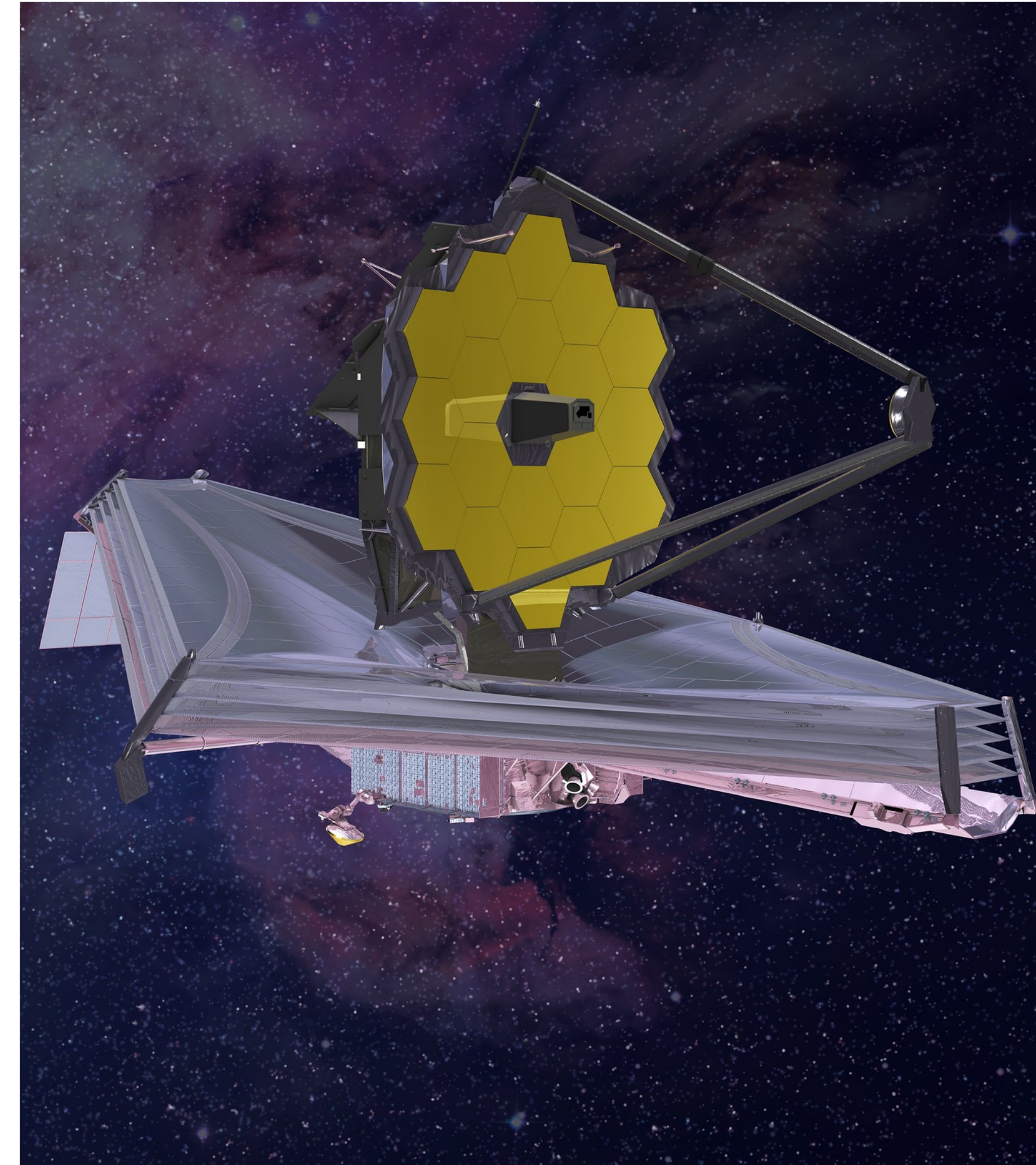


Sunshield deployment. Credit: Northrop Grumman

Commissioning JWST: the first month

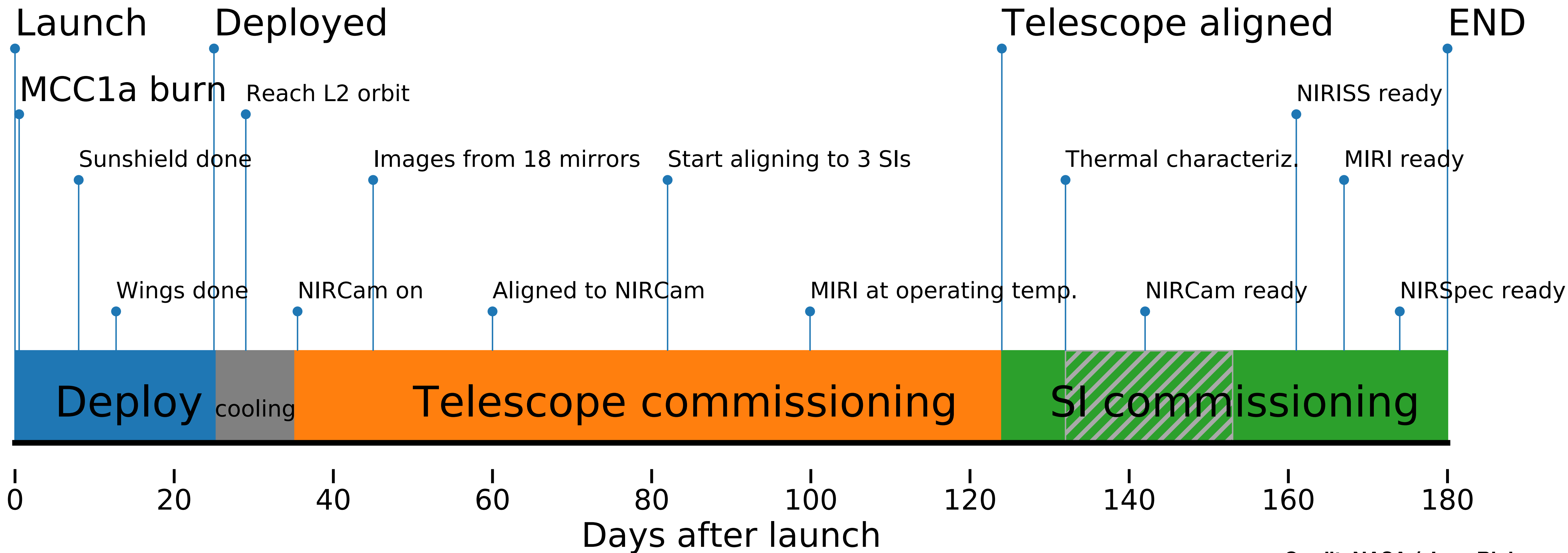


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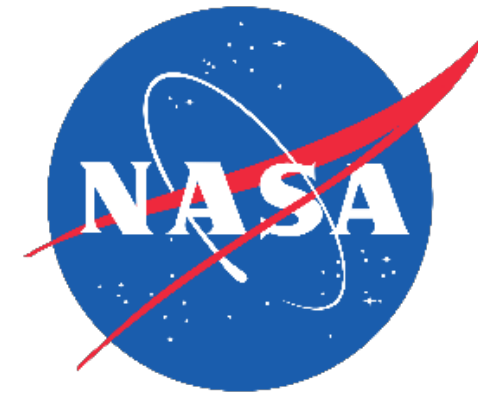
Deployed JWST. Credit: NASA

Commissioning JWST

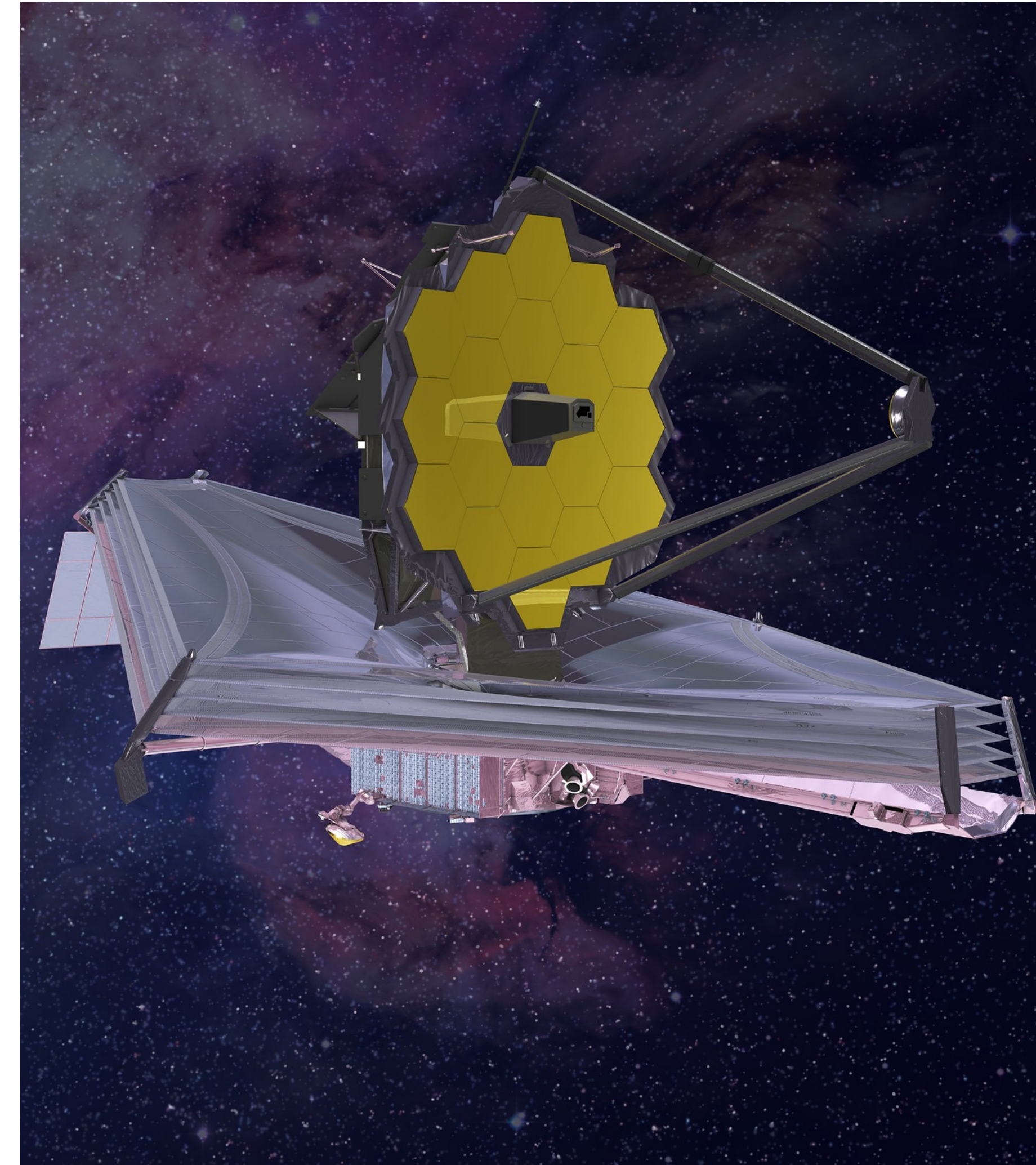


Credit: NASA / Jane Rigby

The end of JWST commissioning



- Commissioning is not calibration. Commissioning determines that the observatory is working correctly, and that the science instruments are calibratable.
- The calibration program will execute in Cycle 1, interspersed with the science program.
- Based on analysis of commissioning data, mode by mode, each science instrument mode will be approved as ready for science operations.
- The Early Release Observations (EROs) will be taken near the end of commissioning. They are designed to have wide public appeal and demonstrate that JWST works. Released in a major press conference.



Deployed JWST. Credit: NASA

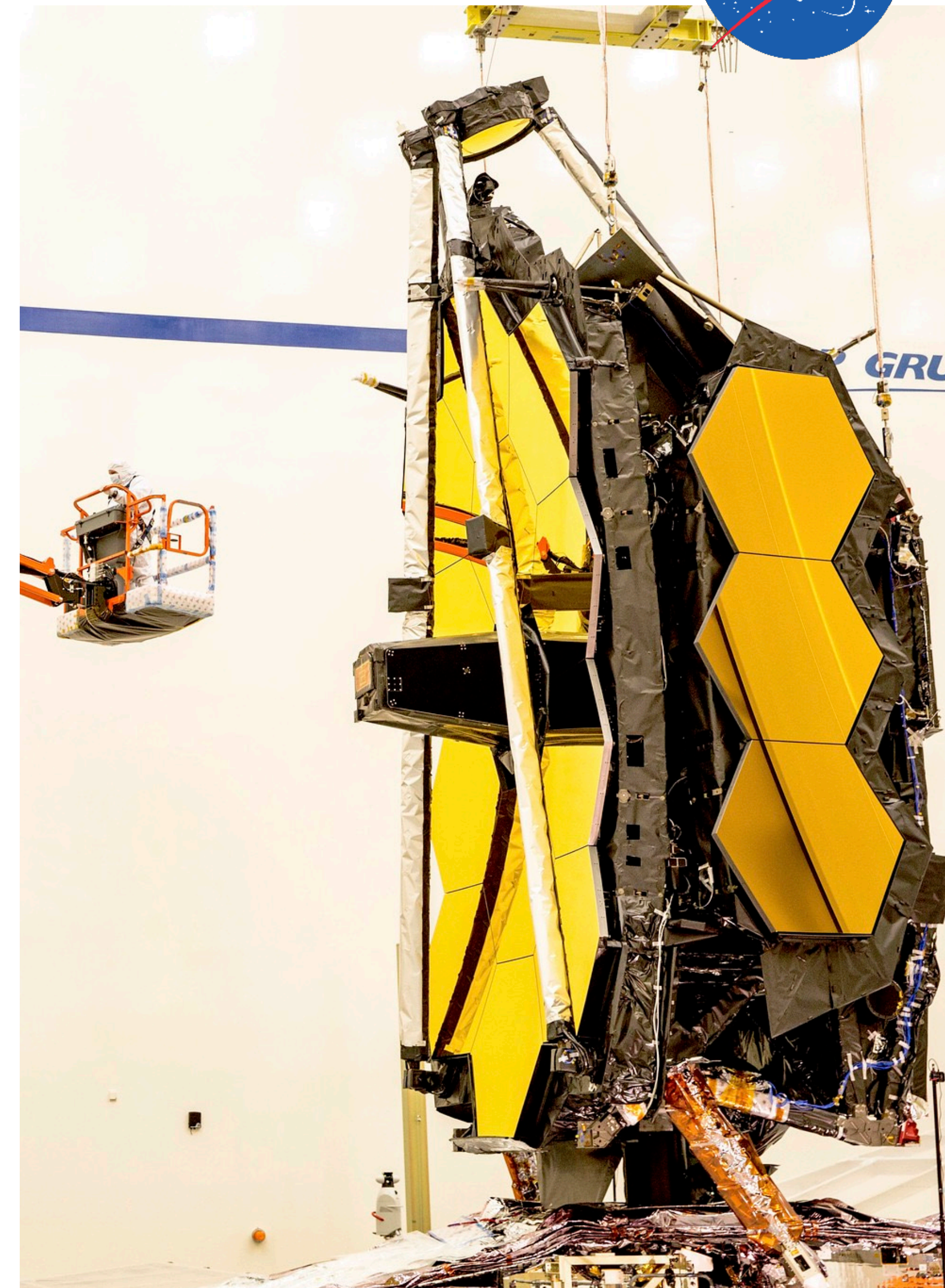
Starting JWST Cycle 1

- Six months after launch, commissioning is planned to end, and science operations to begin.
- The Cycle 1 schedule will intersperse observations from GO, GTO, ERS, and calibration programs.
- Many of the calibrations will be done in parallel.
- Scheduling JWST is not trivial. 39% of the sky is observable at any time; 100% over the course of a year. Zodiacal background for a given target varies seasonally.

GO: General Observer

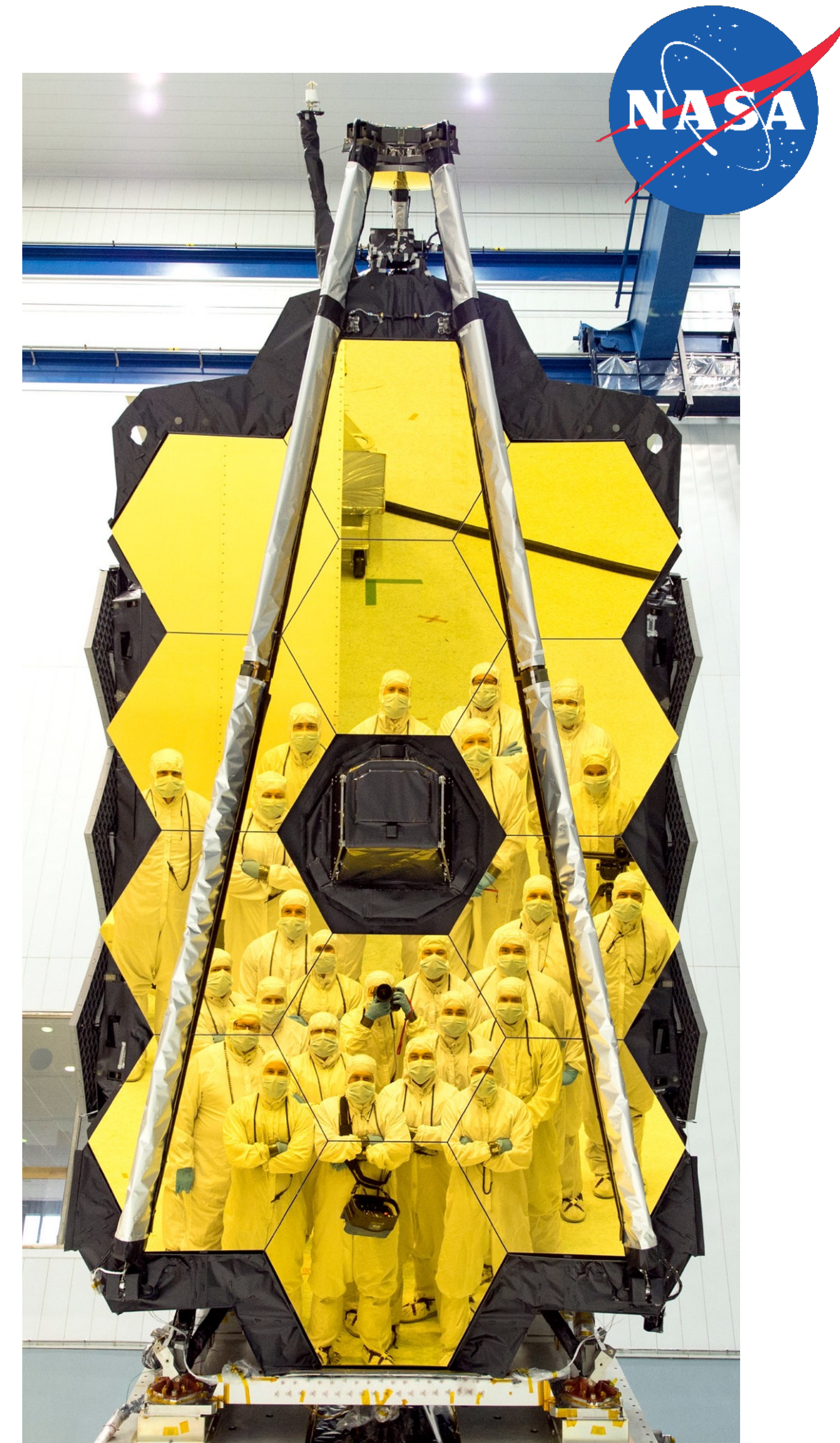
GTO: Guaranteed Time Observer

ERS: Director's Discretionary Time Early Release Science



Availability of early JWST data

- Commissioning data goes public at the end of commissioning. Mostly stars for wavefront sensing, but some observations may have some scientific value.
- Early Release Science (ERS) programs are front-loaded toward the first half of Cycle 1. Data will be public immediately, and ERS teams will deliver high-level data products ASAP.
- Large GO programs and some GTO programs will go public immediately.
- Initially, science data will be calibrated based on ground test data, plus some initial calibrations from commissioning. Calibration will improve as we go deeper into Cycle 1.



JWST Operations

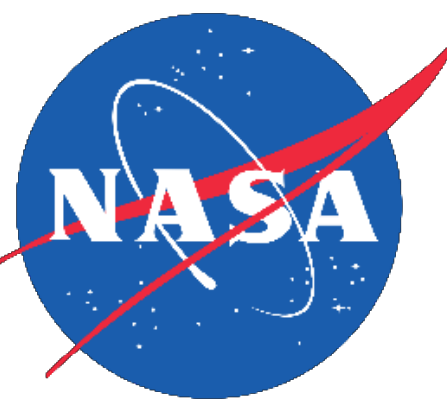
- The JWST Mission Operations Center (MOC) is located at STScI in Baltimore, MD.
- The backup MOC is located at NASA GSFC in Greenbelt, MD.
- We are halfway through an intensive set of rehearsals. We rehearse launch, deployments, telescope phasing, science instrument commissioning, and normal science operations. 9 rehearsals in 2019; 14 scheduled for 2020.
- The bigger rehearsals involve >100 people, from NASA, Northrop Grumman, Ball Aerospace, Raytheon, the science instrument development teams, and STScI.
- In 2020, we will do 2 major tests that the MOC can command the flight spacecraft. Already tested communication to the Deep Space Network and TDRSS.



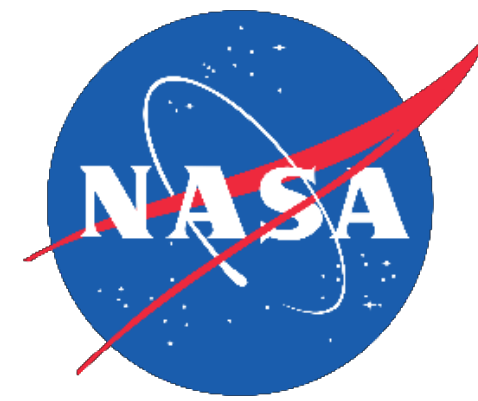
The JWST Flight Control Room at the MOC. Credit: STScI



Mission Systems Engineering Room at the MOC. Credit: STScI

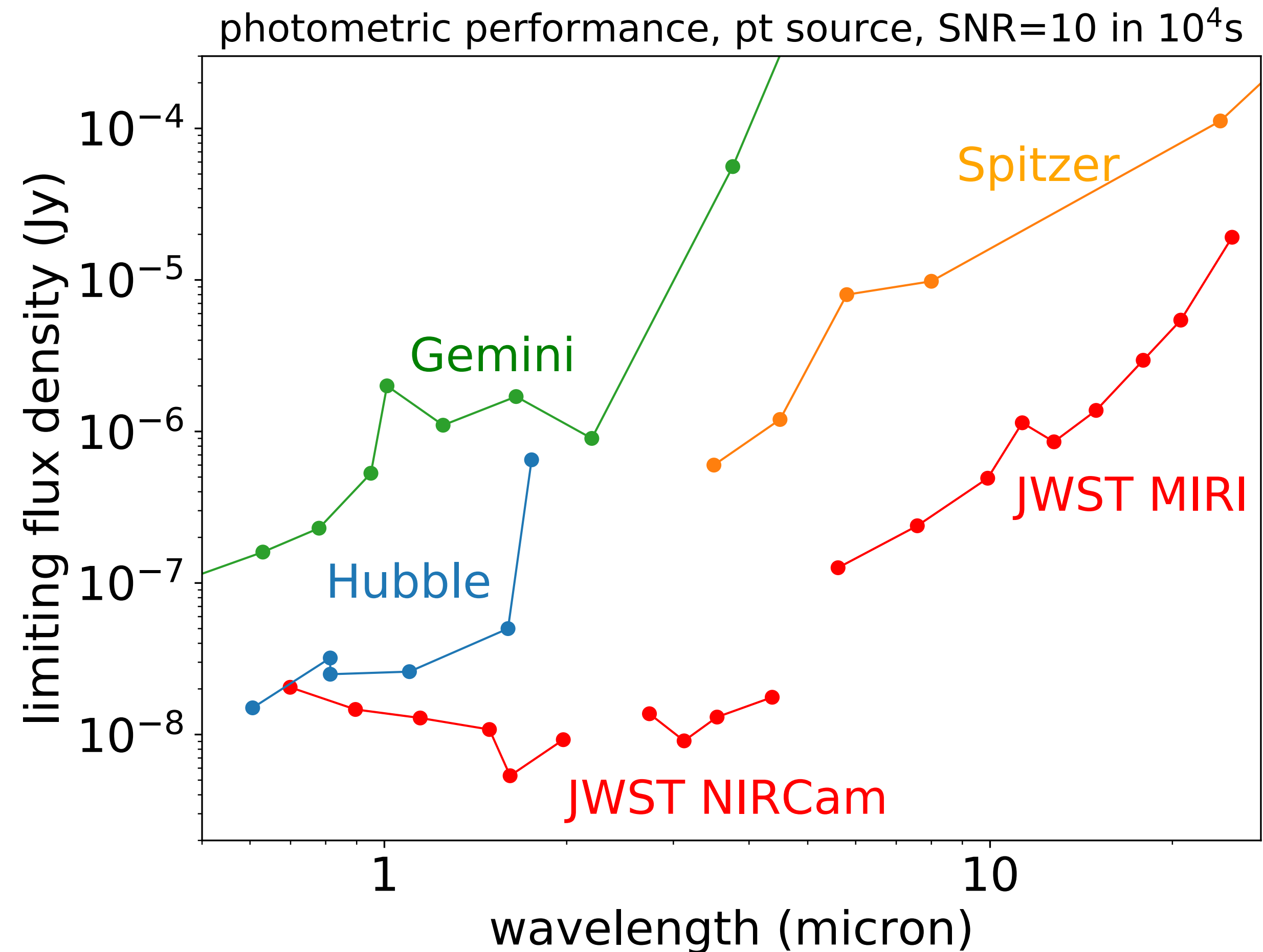


We will be ready to commission and operate JWST.



JWST will have far greater sensitivity than previous observatories, and far more sophisticated instrumentation, including integral field and multi-object spectroscopy.

We will be ready to deploy and commission JWST, characterize on-orbit performance, execute science operations, and deliver science-ready data to the community. We are extensively rehearsing.



Credit: NASA / Jane Rigby, using Pandeia 1.5