The James Webb Space Telescope: from launch to science

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Integration, Test, Launch, Commissioning and Science


Ariane 5 ECA launch vehicle. Credit: Arianespace

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Commissioning and Science

How we are preparing to:

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

How we are rehearsing and testing.
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.
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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.
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.
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