JWST Observatory and Instrument Performance

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Welcome!

- Thank you for contributing to the success of JWST!
- STScI instrument teams will review accepted programs and recommend revisions, if appropriate. Proposals do not have to be perfect.
- Please ask if technical aspects of a proposal are unclear.
JWST mission status

• Observatory launched on 2021 Dec 25
• >20 years of propellent after insertion into nominal L2 halo orbit
• Commissioning was successful and observatory is fully operational
• Normal science operations began in July 2022
• Observatory performance generally exceeds requirements
• MIRI sensitivity has declined at long wavelengths but is stabilizing
• Various instrumental artifacts complicate data analysis
• JWST has obtained >10k exposures in >1500 visits for >250 programs
• Refereed papers appearing daily, the science is amazing!
Instrument apertures in the JWST field of view

See JWST Pocket Guide for an overview of instrument capabilities
APT view of 17+1 science modes

- Imaging, Coronagraphic imaging, Slitless spectroscopy
- Slit spectroscopy, Multi-object spectroscopy, Integral field spectroscopy
- Time series, Mosaics, Parallels, Moving targets, Visit constraints, Crowded fields, etc.
MIRI MRS sensitivity has declined at long wavelengths but is stabilizing.

ETC predicts count rate at end of Cycle 3
MIRI imaging sensitivity has declined less and is also stabilizing

- ETC does not model the lower count rate
- Observer news recommended aiming for 5% higher S/N ratio in the 25.5 and 21.0 µm filters
- Program reviews will make sure observers are aware
Absolute pointing accuracy and guiding stability are usually excellent

- Absolute pointing accuracy is usually better than 0.2 arcsec
  - Requirement was 1 arcsec

- Guiding stability is usually better than 2 mas RMS
  - Pre-launch goal was 7 mas RMS
  - No measurable contribution from cryocooler or reaction wheels
  - Brief excursions when high-gain antenna moves during TSO exposures
But acquisition and guiding failures can occur

• Guide star acquisition fails about 2% of the time
  ▪ Causes
    o ID step fails because guide star catalog is missing bright sources, especially for crowded fields
    o New hot pixel confuses centroid, especially when tracking moving targets
    o Guide star has companion or extended structure
    o Observatory pointing knowledge corrupted during earlier visit
  ▪ Mitigation
    o Repeat visit with a different guide star
    o Add sources to guide star catalog (e.g., GALACTICNUCLEUS catalog, 2019A&A...631A..20N)
    o Update bad pixel mask on board

• Target acquisition fails less than 1% of the time
  ▪ Causes
    o Wrong guide star acquired
    o Incorrect coordinates, epoch, or proper motion for science target or offset TA target
Occasional mirror adjustments maintain outstanding image quality

93.0% of the time has measured OTE WFE < 70 nm rms

Requirement was < 150 nm RMS
Image quality is projected to remain excellent for many years

- Projection assumes no more C3-type impacts
- Each mirror segment can be adjusted in piston, tip, tilt, and radius of curvature
- Not doing radius of curvature corrections now, but it is easy to include them
- Requirement was WFE < 150 nm RMS

Current WFE floor is 59 nm RMS
Micrometeoroid impacts on primary mirror

- Observed impact rate is about what we expected prior to launch.
- Typically 2-4 detectable impacts per month.
- Each impact has minimal effect on wavefront error (WFE) after correction.
- Only outlier is the impact on mirror segment C3 in May 2022.
Anomalous micrometeoroid impact on mirror segment C3

**Ground Measurements for Individual segments**

Interferometry measurements from NASA XRCF

**Recent Best Mirror Alignment**

NIRCam wavefront sensing on 2022-06-21

59 nm rms
Reduce risk of additional C3-type micrometeoroid impacts

- Micrometeoroid avoidance zone (MAZ) is a cone within 75 deg of the direction the Earth is moving around the Sun
- APT asks observers to explain why MAZ usage is required to achieve their science goals
- The TAC will not see and will not consider MAZ usage
- The MAZ constraint reduces target visibility, making scheduling more difficult
Scheduling JWST is challenging

- **Observatory constraints**
  - Sunshield limits pitch (85-135°) and especially roll (±5°)
  - Field of regard on any given day is only 39% of the sky
  - MAZ further constrains scheduling opportunities
  - Downlink bandwidth is limited even with nominal DSN downlinks
  - Failed acquisitions, observatory anomalies, etc.

- **Observer constraints**
  - Visit timing constraints, including targets of opportunity
  - Visit orient constraints, which are another form of timing constraints
  - Location on the sky, which is not uniform
  - Data generation rate
APT encourages observers to manage data generation rate

- Downlink bandwidth is a limited resource that must be managed
- DSN contacts can be shortened or skipped for various reasons
- The data recorder on board has limited capacity (about 1 day)
- Observers must have a science justification to exceed quotas
- We downlink data during observations, so data rate is important, not data volume
Pure parallel programs

• Pure parallels will...
  ▪ Attach parallel exposures to unrelated prime visits with available slots
  ▪ Increase observatory productivity

• Pure parallels will not...
  ▪ Impact the prime visit or observatory pointing
  ▪ Move mechanisms while the prime instrument is exposing
  ▪ Interfere with parallel calibrations
  ▪ Overfill the data recorder

• Observer have complained...
  ▪ Fewer slots than anticipated with desired duration and similar pointing
Useful resources

• JWST Pocket Guide
• JWST Interactive Sensitivity Tool
• JDox home page
• Cycle 3 Call for Proposals