



STScI | SPACE TELESCOPE
SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

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.

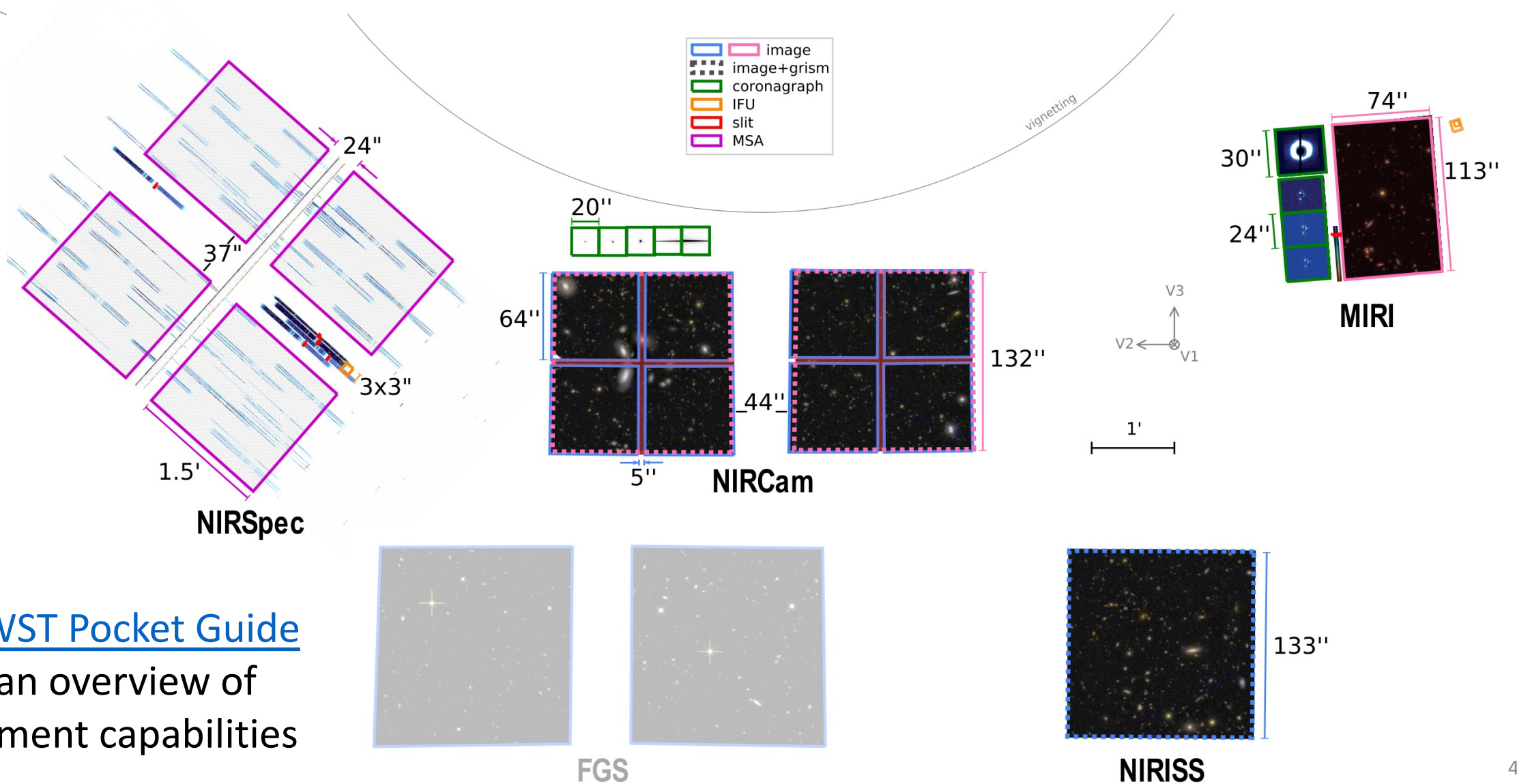


JWST mission status

- Observatory launched on 2021 Dec 25
- >20 years of propellant 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

Number 1 Status: UNKNOWN Duplication

Label My awesome JWST observation

Instrument MIRI

Template MIRI Imaging

Coordinated Parallel

Target

- MIRI Low Resolution Spectroscopy+1
- MIRI Medium Resolution Spectroscopy
- MIRI Coronagraphic Imaging

Number 1 Status: UNKNOWN Duplication

Label My awesome JWST observation

Instrument NIRSPEC

Template NIRSpec Fixed Slit Spectroscopy

Target

- NIRSpec IFU Spectroscopy
- NIRSpec MultiObject Spectroscopy
- NIRSpec Bright Object Time Series

Number 1 Status: UNKNOWN Duplication

Label My awesome JWST observation

Instrument NIRCAM

Template NIRCcam Imaging

Coordinated Parallel

Target

- NIRCcam Coronagraphic Imaging
- NIRCcam Time Series
- NIRCcam Grism Time Series
- NIRCcam Wide Field Slitless Spectroscopy

Common Epoch: 26-Mar-2024:15:13:29

Number 1 Status: UNKNOWN Duplication

Label My awesome JWST observation

Instrument NIRISS

Template NIRISS Imaging

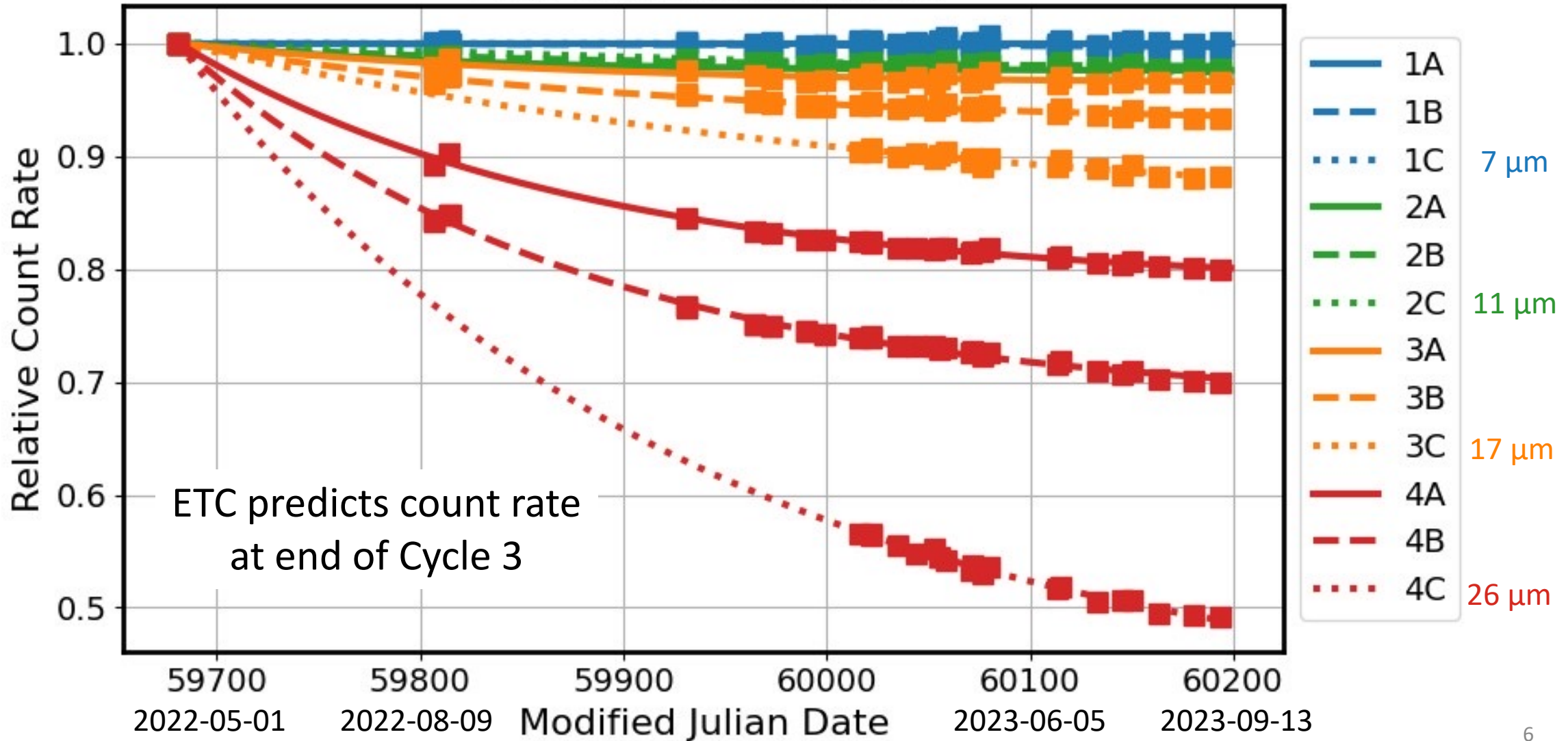
Target

- NIRISS Wide Field Slitless Spectroscopy
- NIRISS Single-Object Slitless Spectroscopy
- NIRISS Aperture Masking Interferometry

Imaging, Coronagraphic imaging, Slitless spectroscopy
Slit spectroscopy, Multi-object spectroscopy, Integral field spectroscopy
Time series, Mosaics, Parallels, Moving targets, Visit constraints, Crowded fields, etc.



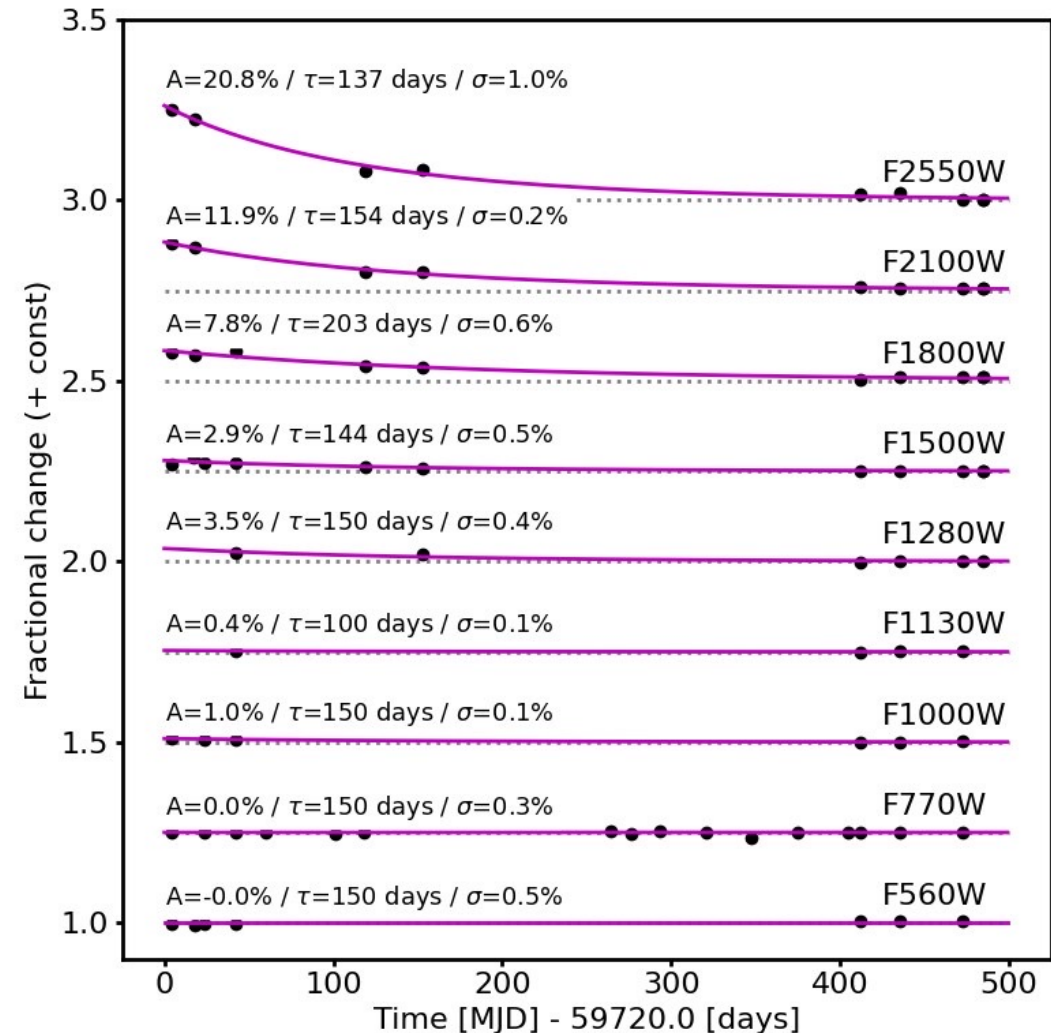
MIRI MRS sensitivity has declined at long wavelengths but is stabilizing





MIRI imaging sensitivity has declined less and is also stabilizing

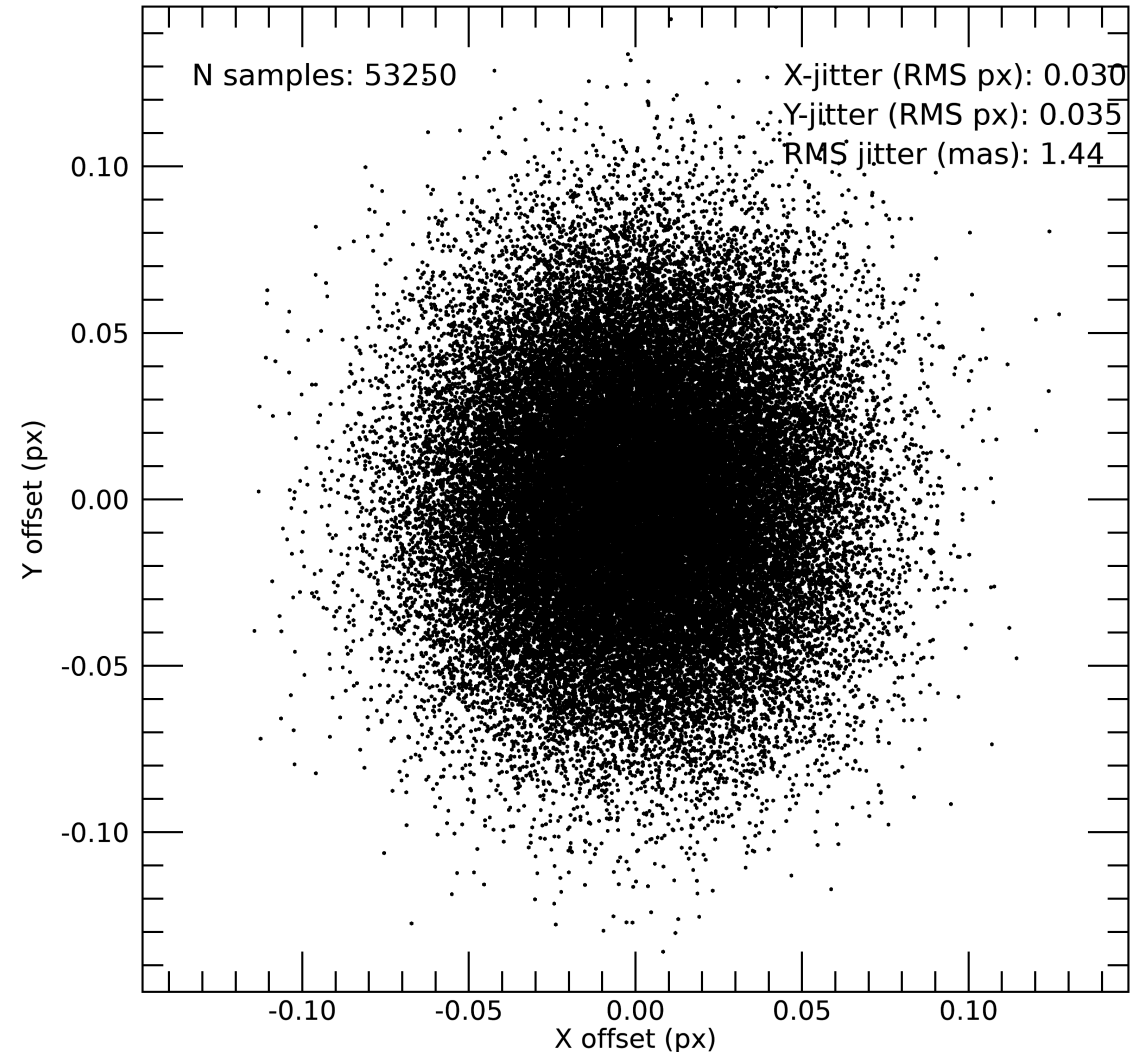
- ETC does not model the lower count rate
- Observer news recommended aiming for 5% higher S/N ratio in the 25.5 and 21.0 μm filters
- Program reviews will make sure observers are aware





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
 - ID step fails because guide star catalog is missing bright sources, especially for crowded fields
 - New hot pixel confuses centroid, especially when tracking moving targets
 - Guide star has companion or extended structure
 - Observatory pointing knowledge corrupted during earlier visit
 - Mitigation
 - Repeat visit with a different guide star
 - Add sources to guide star catalog (e.g., GALACTICNUCLEUS catalog, 2019A&A...631A..20N)
 - Update bad pixel mask on board
- Target acquisition fails less than 1% of the time
 - Causes
 - Wrong guide star acquired
 - Incorrect coordinates, epoch, or proper motion for science target or offset TA target



Occasional mirror adjustments maintain outstanding image quality

JWST Wavefront Monitoring & Maintenance, Cycles 1 & 2

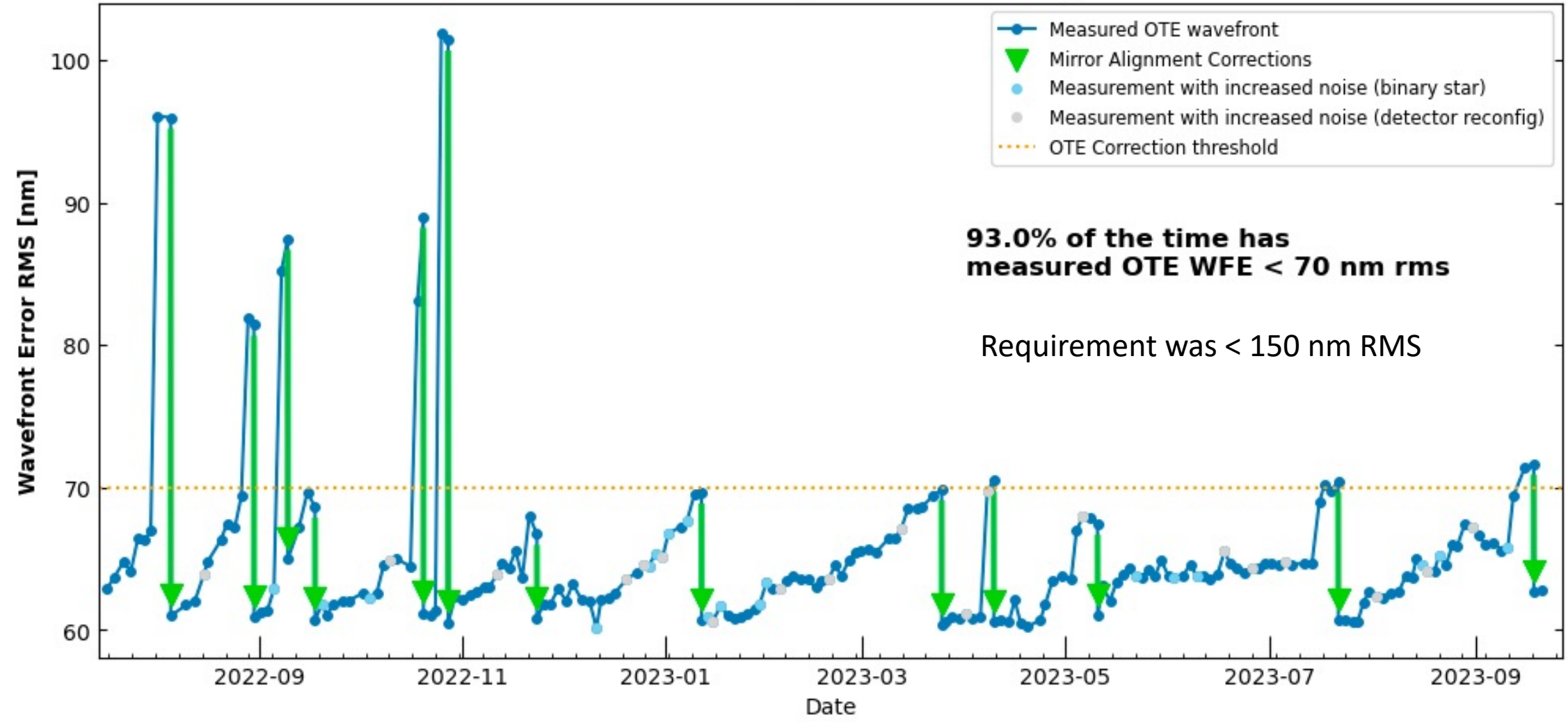
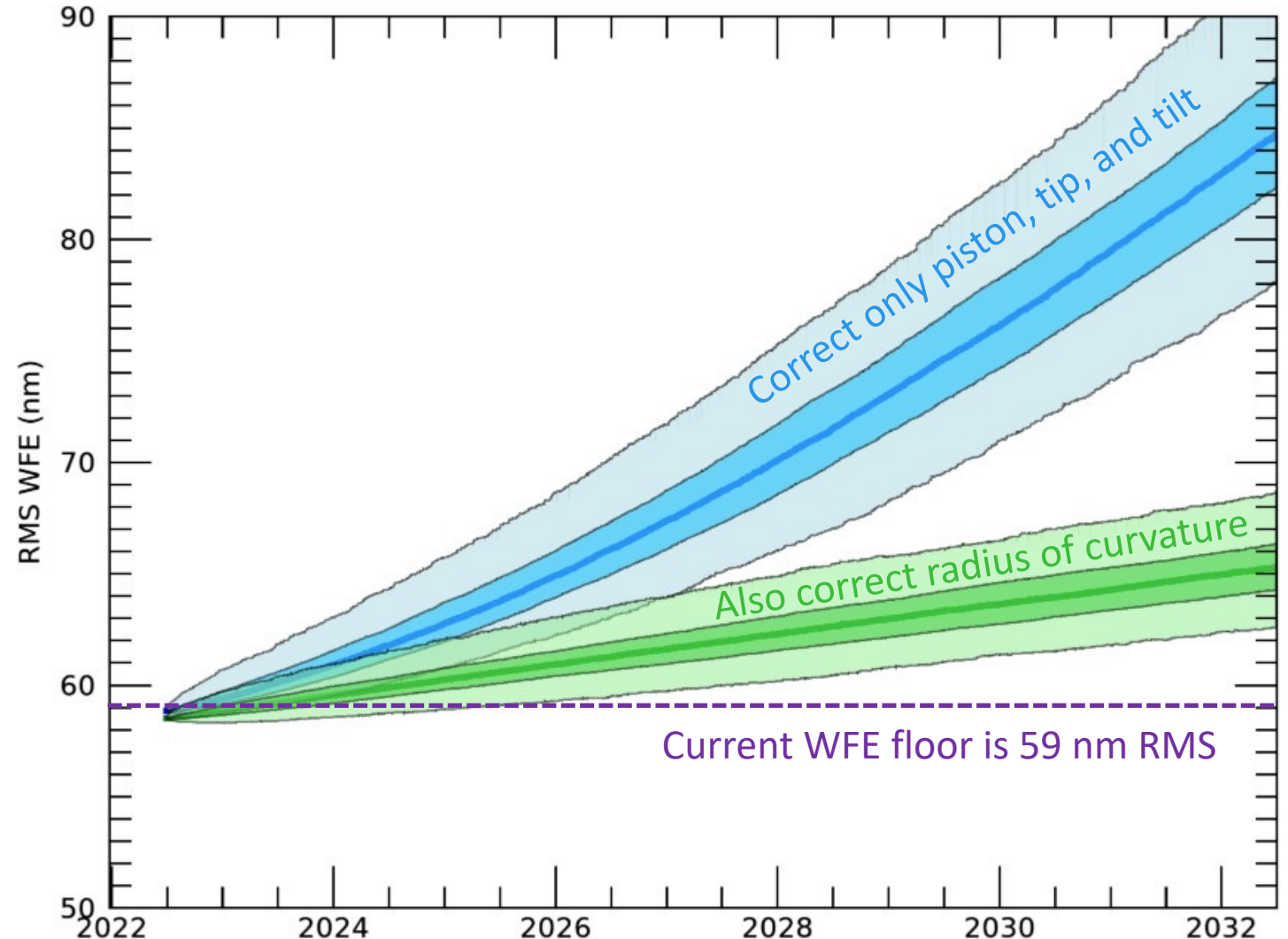




Image quality is projected to remain excellent for many years

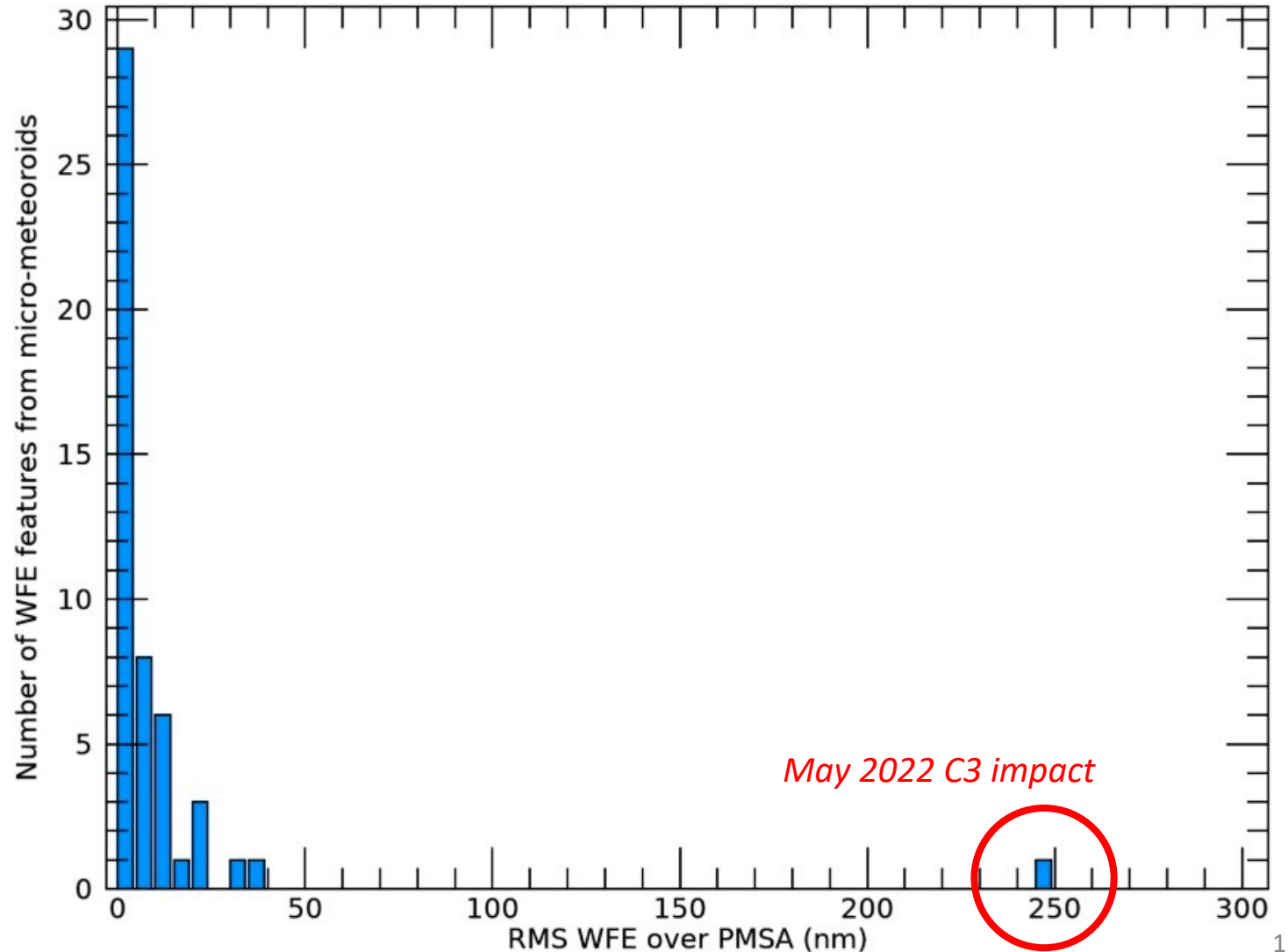
- Projection assumes no more C3-type impacts
- Each mirror segment can be adjusted in piston, tip, tilt, and radius of curvature
- Not doing radius of curvature corrections now, but it is easy to include them
- Requirement was $\text{WFE} < 150 \text{ nm RMS}$





Micrometeoroid impacts on primary mirror

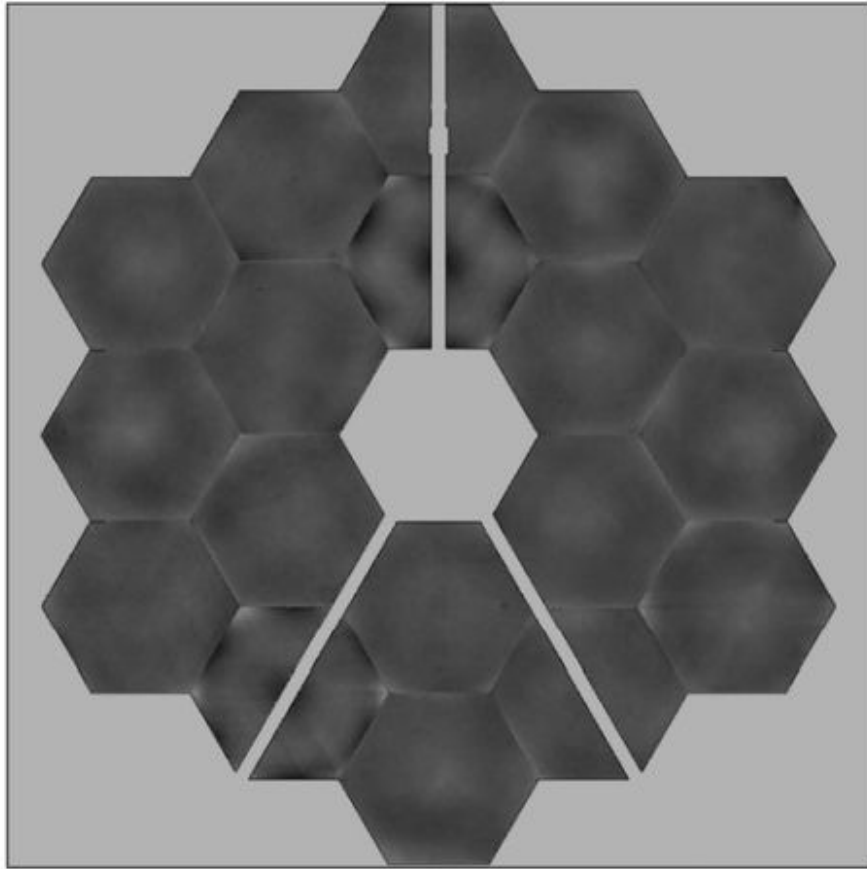
- Observed impact rate is about what we expected prior to launch
- Typically 2-4 detectable impacts per month
- Each impact has minimal effect on wavefront error (WFE) after correction
- Only outlier is the impact on mirror segment C3 in May 2022





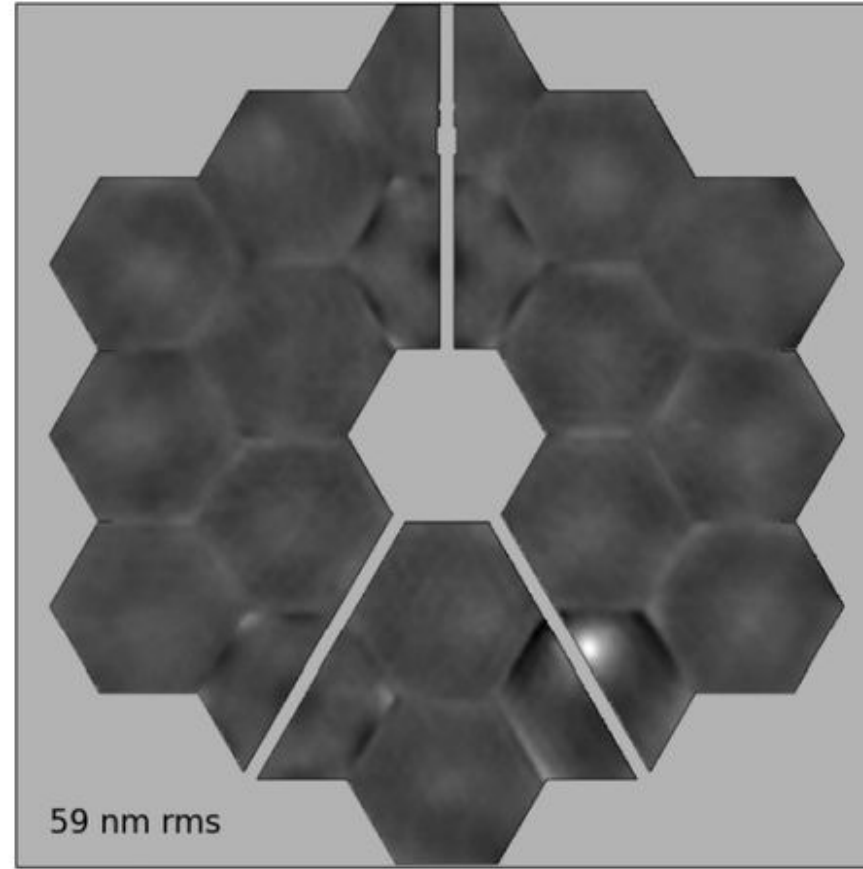
Anomalous micrometeoroid impact on mirror segment C3

Ground Measurements for Individual segments

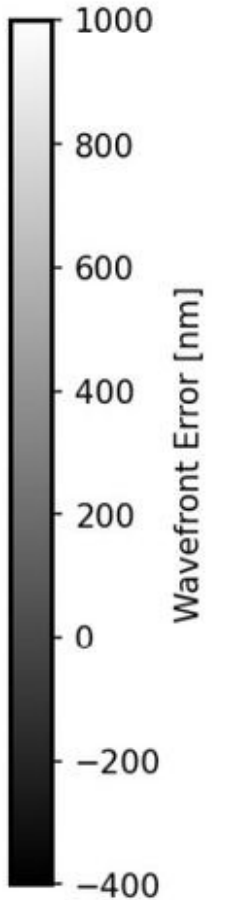


Interferometry measurements from NASA XRCF

Recent Best Mirror Alignment



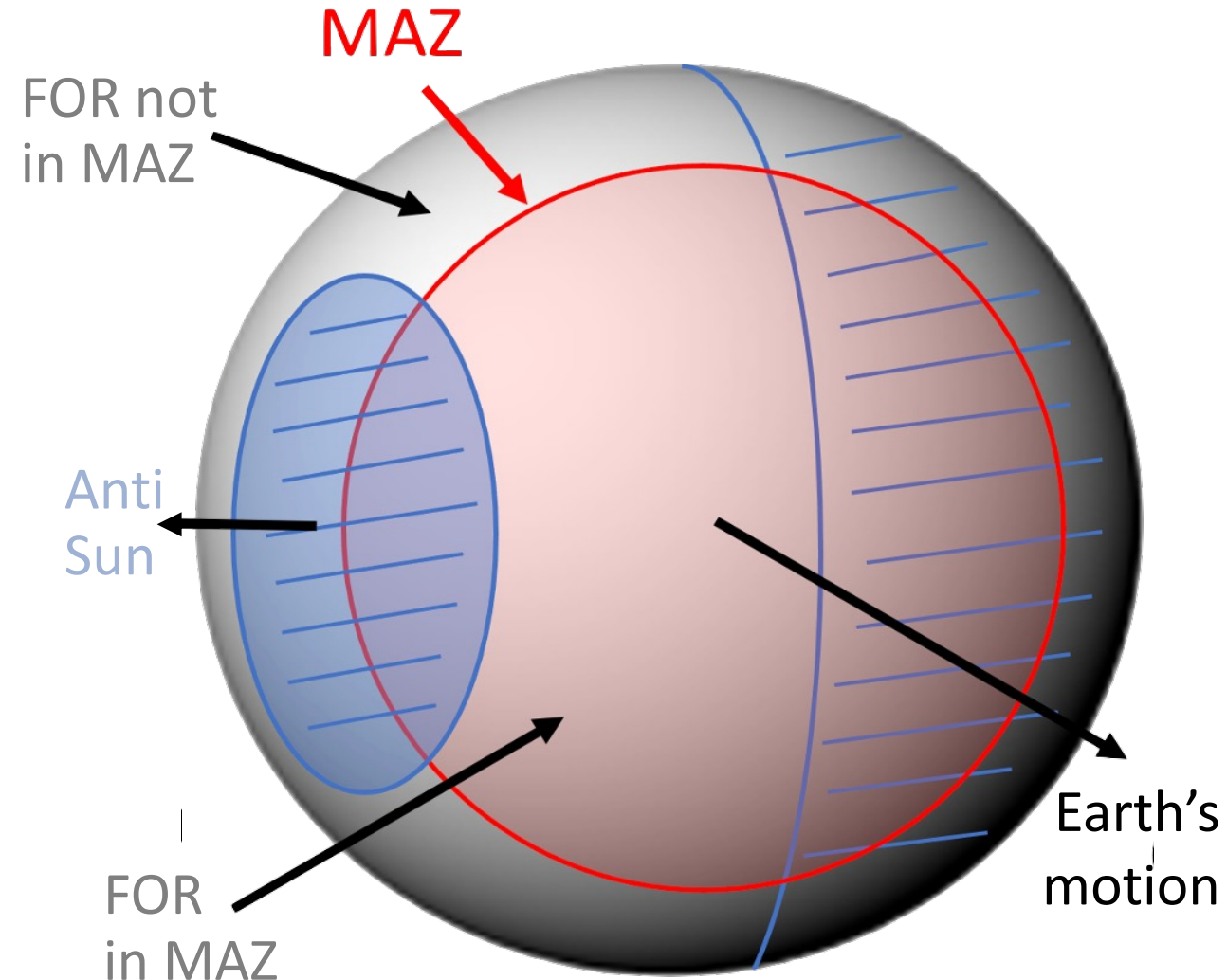
NIRCam wavefront sensing on 2022-06-21





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





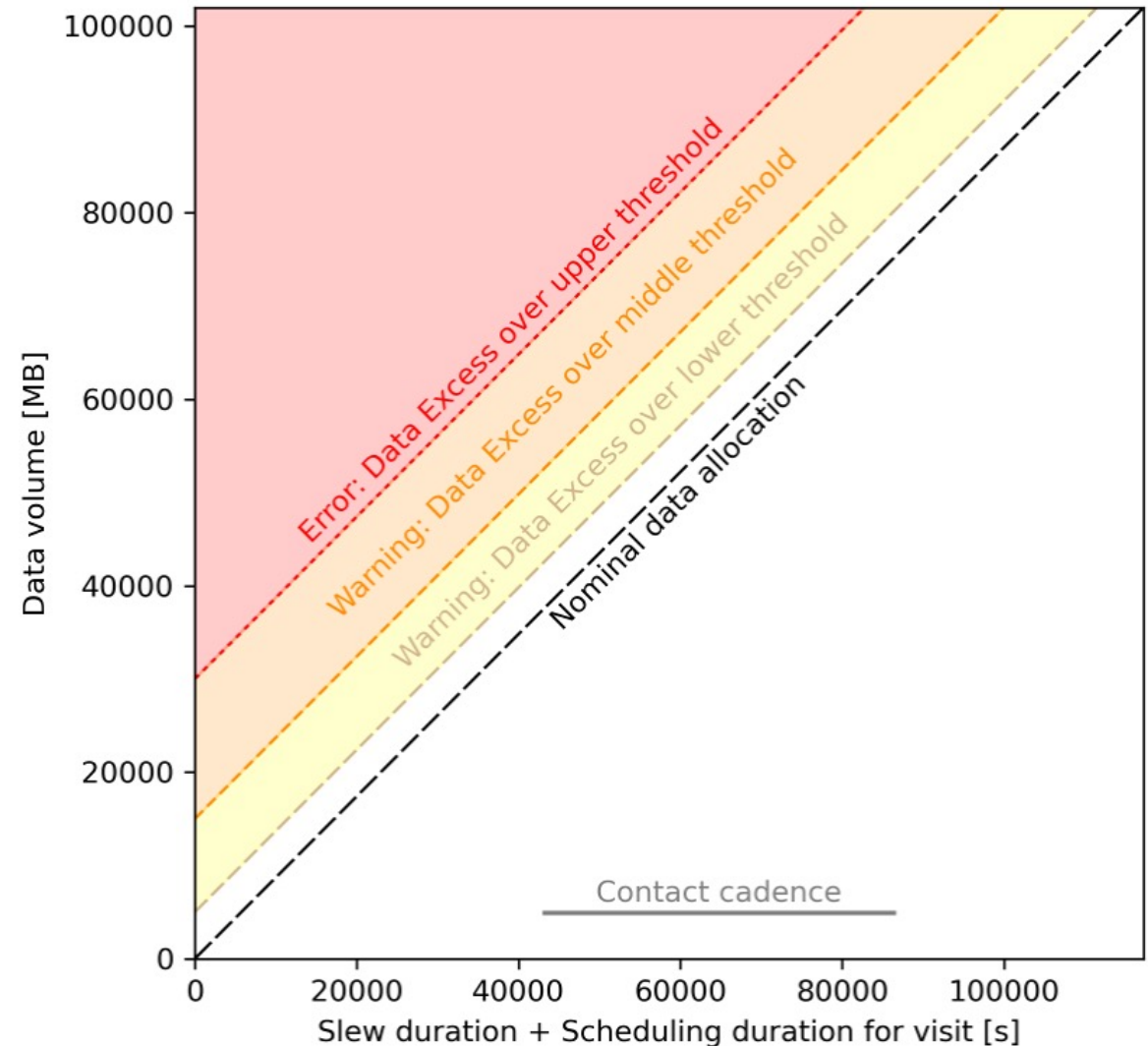
Scheduling JWST is challenging

- **Observatory constraints**
 - Sunshield limits pitch (85-135°) and especially roll ($\pm 5^\circ$)
 - 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](#)