STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

NIRCam Calibration and Pipeline Update

Alicia Canipe, on behalf of the NIRCam team

Overview

- **Getting started**
  - Where to start once your data are available
- **NIRCam calibration**
  - Calibration accuracy summary table
  - Calibration program status
- **Known issues**
  - Scattered light
  - 1/f noise
  - Alignment
  - General summary
- **Pipeline tips and tricks**
  - Suggestions for reprocessing data
- **Coming soon**
  - What are we working on?

Getting started: where to start once your data are available

Start with JDox!

1. Download your data. Try out the new MAST user interface:
   - https://mast.stsci.edu/search/ui/#/jwst
2. Reprocess your data, if needed, using a custom configuration
   - https://jwst-docs.stsci.edu/jwst-science-calibration-pipeline/running-the-jwst-science-calibration-pipeline#gsc.tab=0
3. Check the calibration status for NIRCam (more on the following slides)
   - https://jwst-docs.stsci.edu/jwst-calibration-status/nircam-calibration-status#gsc.tab=0
4. Skim through known issues for the relevant mode (more on the following slides)
   - https://jwst-docs.stsci.edu/known-issues-with-jwst-data/nircam-known-issues#gsc.tab=0
5. Use our tools for analyzing your data:
   - https://jdaviz.readthedocs.io/en/stable/index.html

NIRCam calibration: calibration accuracy summary table

Calibration	Status	Calibration	Status
Bias, readnoise	Steady	**Subarray flux transfer**	**<1%**, most cases. Worst is ~2%
Flats	**~1%**	**Grism trace**	**~0.2 pix**
Backgrounds	**5-10%** agreement with models	**Grism spec cal**	**~2 Å**
Absflux Imaging	**<1%** (most filters/detectors). Worst is ~3-4%	**Coron TA**	**<15 mas**
Absflux coron	**<1.5%** (except LWB, which is ~14%)	**Distortions/alignment (imaging)**	Relative position btwn SCAs **<0.01”** Orientations **< 0.001°**
Absflux grism	**~2%**	**Distortions/alignment (coron)**	SW: **~5-10 mas** LW: **>10 mas**
Flux stability	**<1%**		

See also: NIRCam calibration status

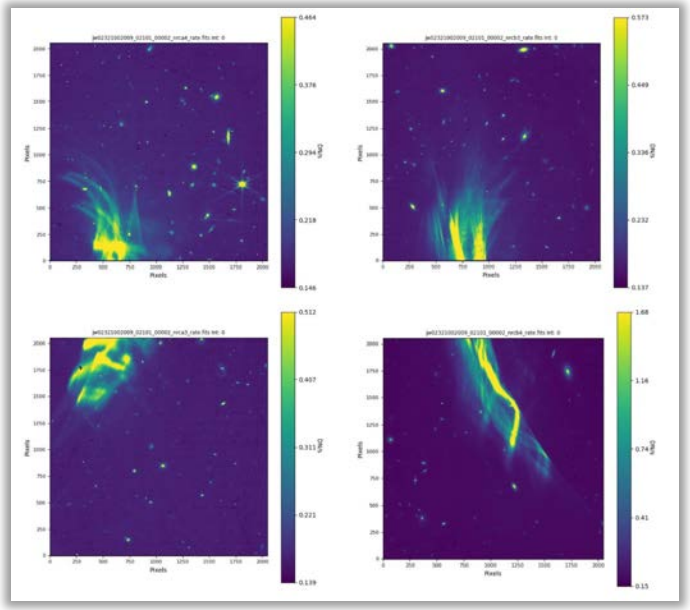
NIRCam calibration: calibration program status

Mode	Description of Programs	Latest reference file update
Detector-level (relevant to all modes)	Dark Current Monitor, Read Noise	Superbias, darks, readnoise: **January 2024** Bad pixel masks: **September 2024**
	Non-Linearity characterization	Linearity coefficients: Pre-launch (**Summer 2025**). Brighter-fatter analysis on-going.
	Persistence Characterization	Trap files: Discussion on-going (**TBD**)
Imaging	Sky Flats Monitor	SW flats: **Sep 2023** LW flats: **May 2023** Wisp templates: **Aug 2024**. Wisp removal notebook published.
	Distortion / Alignment Monitor (+coronagraphy)	Imaging distortion, area maps: **Feb 2024** Coron distortion: **Jul 2022** (**update imminent**) Aperture correction: Pre-launch (**Summer 2025**)
	Subarray Photometric Flux Transfers	Planned **Winter 2025**
Spectroscopy	LW Grism Spectral Calibration	Specwcs: **Sep 2023**
	LW Grism Background Calibration	Post-commissioning (**update Winter 2025**). WFSS 1/f analysis on-going.
	SW DHS Characterization	Updates **Spring/Summer 2025.** Cycle 4 commissioning program planned.
Coronagraphy	Coron PSF Characterization & TA Verification	N/A
	Dual-channel Coronagraphy: Commissioning	N/A
	Dual-channel Coron: IWA & Contrast	N/A
Cross Instrument	Absolute flux (all modes)	Photom: **Sep 2023** (imaging); **Nov 2023** (coron); **June 2024** (grism); **Winter 2025** (weak lens)
	Stability	N/A

Known issues: scattered light

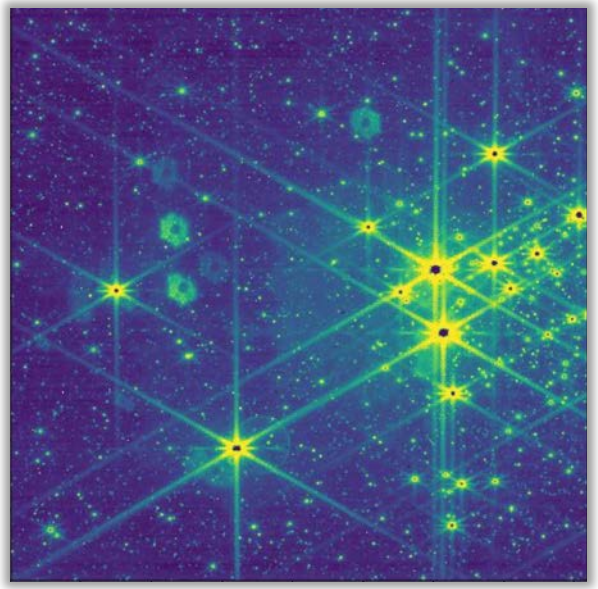
NIRCam scattered light artifacts

There are several types of scattered light that may appear in data. While some types are well-characterized (e.g., wisps), others are still under investigation (e.g., primary mirror ghosts).



Wisps are a common artifact, but they can be mitigated using the strategy in the link provided above. A correction for the pipeline is under investigation.

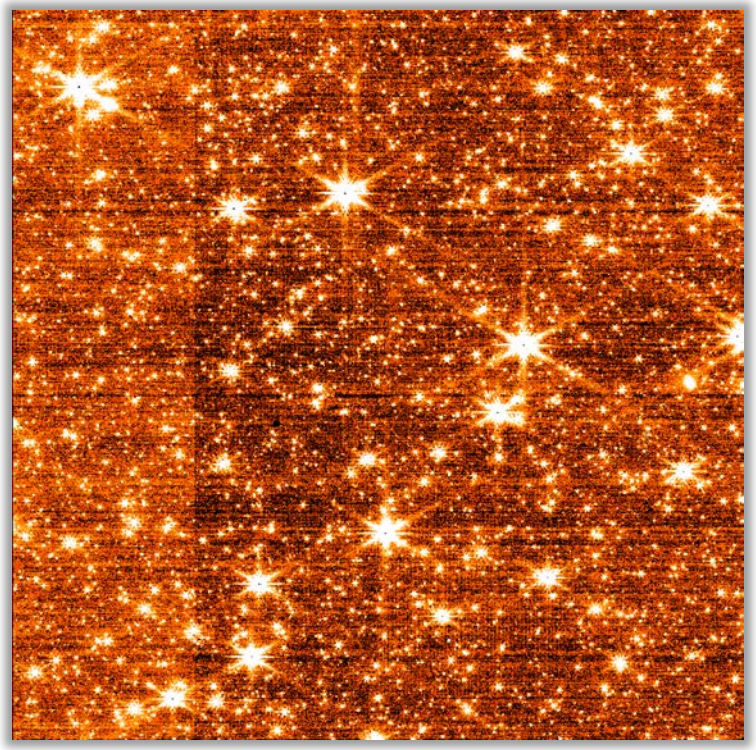
Primary mirror images are sometimes seen in data due to bright sources on or near the detectors.



Known issues: 1/f noise

NIRCam 1/f noise (horizontal banding)

NIRCam detector readout electronics generate 1/f noise during detector operations and signal digitization, which appears as horizontal banding across the width of images. There are a couple options to mitigate this type of noise using the pipeline:



Reference pixel correction: This step corrects for drifts in the readout electronics. Build 11.2 of the pipeline includes a new algorithm (the Simple Improved Reference Subtraction, or SIRS, method), which reduces read noise by 5-10% relative to running a median filter of the reference pixels (the default method), which significantly improves 1/f noise. It will be an option for manual reprocessing, but may become the new default in the future.

Clean flicker noise: This is a new step available in Build 11.1 that corrects for 1/f noise in data for all NIR instrument modes. While it's currently turned off by default, observers can use the correction on their data manually. For further details, see 1/f Noise.

Known issues: alignment

Image alignment

Source position uncertainties after alignment are typically very small fractions of a pixel; however, sometimes mosaic tiles may appear to have WCS values that are offset from their expected locations by a larger amount. Two common reasons are: FGS guiding on the incorrect guide star for some of the tiles, and small uncertainties in the locations of the detectors relative to one another in the focal plane.

Small WCS offsets between modules, detectors, and exposures can often be corrected by tuning the parameters of the tweakreg step, as described in the NIRCam imaging known issues page. If tweakreg does not perform well, the JWST/HST Alignment Tool, written by members of the community and the NIRCam team, is another option for observers.

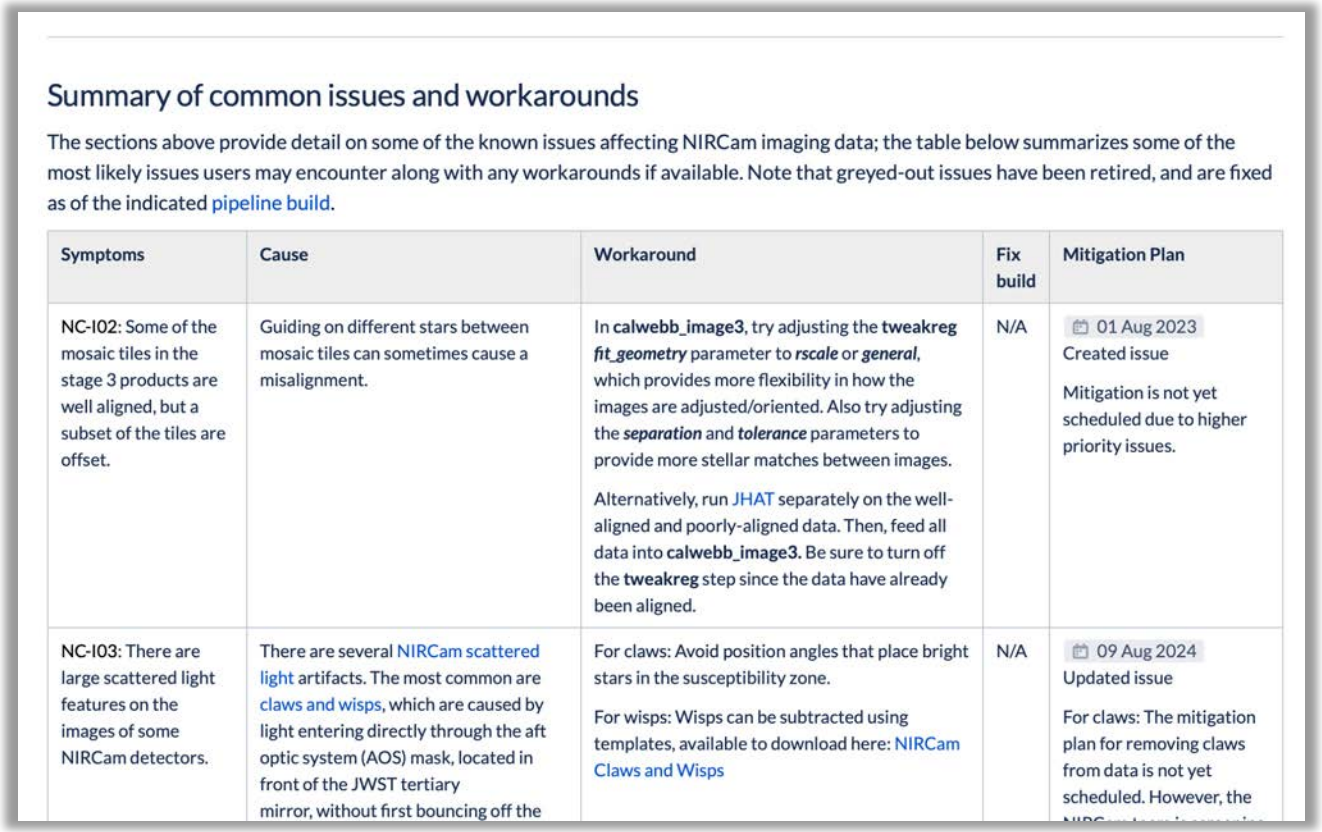
Large WCS offsets can be due to missing engineering data. In this case, observers can run the ***set_telescope_pointing*** script on data with a bad WCS to resolve the issue. This script is part of the ***jwst*** package.

Known issues: general summary

A more comprehensive list of known issues is provided in the JDox pages listed below:

- NIRCam Known Issues
  - NIRCam Coronagraphy Known Issues
  - NIRCam Imaging Known Issues
  - NIRCam Time-Series Known Issues
  - NIRCam WFSS Known Issues

Each page includes a section titled "Summary of common issues and workarounds" that provides a table with symptoms and causes for commonly reported issues, along with the fixes that have been made in the pipeline or elsewhere.



Summary of common issues and workarounds

The sections above provide detail on some of the known issues affecting NIRCam imaging data; the table below summarizes some of the most likely issues users may encounter along with any workarounds if available. Note that greyed-out issues have been retired, and are fixed as of the indicated pipeline build.

Symptoms	Cause	Workaround	Fix build	Mitigation Plan
NC-I02: Some of the mosaic tiles in the stage 3 products are well aligned, but a subset of the tiles are offset.	Guiding on different stars between mosaic tiles can sometimes cause a misalignment.	In **calwebb_image3**, try adjusting the **tweakreg** ***fit_geometry*** parameter to ***rscale*** or ***general***, which provides more flexibility in how the images are adjusted/oriented. Also try adjusting the ***separation*** and ***tolerance*** parameters to provide more stellar matches between images. Alternatively, run JHAT separately on the well-aligned and poorly-aligned data. Then, feed all data into **calwebb_image3.** Be sure to turn off the **tweakreg** step since the data have already been aligned.	N/A	01 Aug 2023 Created issue Mitigation is not yet scheduled due to higher priority issues.
NC-I03: There are large scattered light features on the images of some NIRCam detectors.	There are several NIRCam scattered light artifacts. The most common are claws and wisps, which are caused by light entering directly through the aft optic system (AOS) mask, located in front of the JWST tertiary mirror, without first bouncing off the	For claws: Avoid position angles that place bright stars in the susceptibility zone. For wisps: Wisps can be subtracted using templates, available to download here: NIRCam Claws and Wisps	N/A	09 Aug 2024 Updated issue For claws: The mitigation plan for removing claws from data is not yet scheduled. However, the

Pipeline tips and tricks: suggestions for reprocessing data

See the "Pipeline Notes" sections in the NIRCam Known Issues pages for tips and tricks to re-run the pipeline:

General

Issues with saturation? Try using the zeroframe to compute slopes for pixels with a good first frame or group.

Imaging

Specify final pixel scale and rotation angle of mosaics using resample step parameters.

Wide-field Slitless Spectroscopy

Perform a first-order correction for contamination by turning on the ***wfss_contam*** step.

Time-Series

Mitigate excess cosmic ray flagging by skipping the jump step or performing row-by-row refpix subtraction.

Coronagraphy

Skip dark correction in the pipeline to improve the performance of the jump detection step.

Coming soon: what are we working on?

- **Reference files**
  - Linearity coefficients
  - Aperture corrections
- **Calibration pipeline**
  - WFSS pipeline improvements
    - Contamination correction
    - Background scaling
    - 1/f noise removal
  - Pipeline updates for SW grism time series
- **Data analysis**
  - PSF and aperture photometry JDAT notebooks using flight data
- **Documentation**
  - Non-linearity characterization
  - Grism calibration
  - Coronagraphic PSF characterization and TA verification
  - Absolute flux and stability

Serpens Nebula, NASA, ESA, CSA, STScI, K. Pontoppidan (NASA-JPL), J. Green (STScI)