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EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

Near Infrared Imager and Slitless Spectrograph (NIRISS) Performance

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on behalf of the AMAZING NIRISS Team

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NIRISS Overview

- NIRISS is performing nominally
- NIRISS unavailable anomaly occurred January 3rd
  - Recovered January 5th
  - Same recovery as previous anomalies (power cycle)
  - NIRISS pure parallel WFSS observations were skipped

NIRISS Detector Calibration Improvements

Known Issue	Cause
NR-SOSS01: Too many pixels are flagged as "DO_NOT_USE" which are then set to "NaN" values in the science array.	Several detector-level reference files need to be updated to not cause certain pixels to be flagged as "DO_NOT_USE"

- New linearity, saturation, and subarray superbias files were created which no longer erroneously flag good pixels as DO_NOT_USE.
- Fixed in pipeline build 10.1:
  - Reference files active in CRDS contexts of jwst_1170.pmap and later

- Trending detector performance to create new bad pixel mask, full frame superbias, and darks reference files
- Testing 1/f noise removal algorithms

NIRISS Imaging Calibration Improvements

Known Issue	Cause
NR-I01: When the peak pixel of a compact object reaches beyond ~25,000 ADU in an integration, it starts spilling charge to its neighboring pixels. This causes an effective "widening" of the PSF and flux loss for combined, resampled products. This effect is strongest for undersampled modes (filter with pivot wavelengths < 2 μm).	This is due to the so-called "brighter-fatter effect" (BFE) in combination with how "jumps" are detected and dealt with in **calwebb_detector1** and how that affects image combination in **calwebb_image3**.

- New **charge_migration** step in **calwebb_detector1** stage of the pipeline implemented in build 10.0 (Dec 5, 2023)
- Prior to implementation of algorithm:
  - For sources most impacted by charge migration, flux losses can reach 50%
- After implementation of algorithm:
  - 1% precision in photometry measurements in both _cal.fits and _i2d.fits products
- See Goudfrooij et al. (2024, PASP, 136, 4503) for details

NIRISS Imaging Calibration Improvements (Upcoming)

- Improve source finding algorithm for undersampled PSFs (see Goudfrooij 2022) in tweakreg_catalog
  - IRAFStarFinder is option in pipeline build 10.2 (May 2024)
- Cross-instrument photometry calibration

NIRISS AMI Calibration Improvements

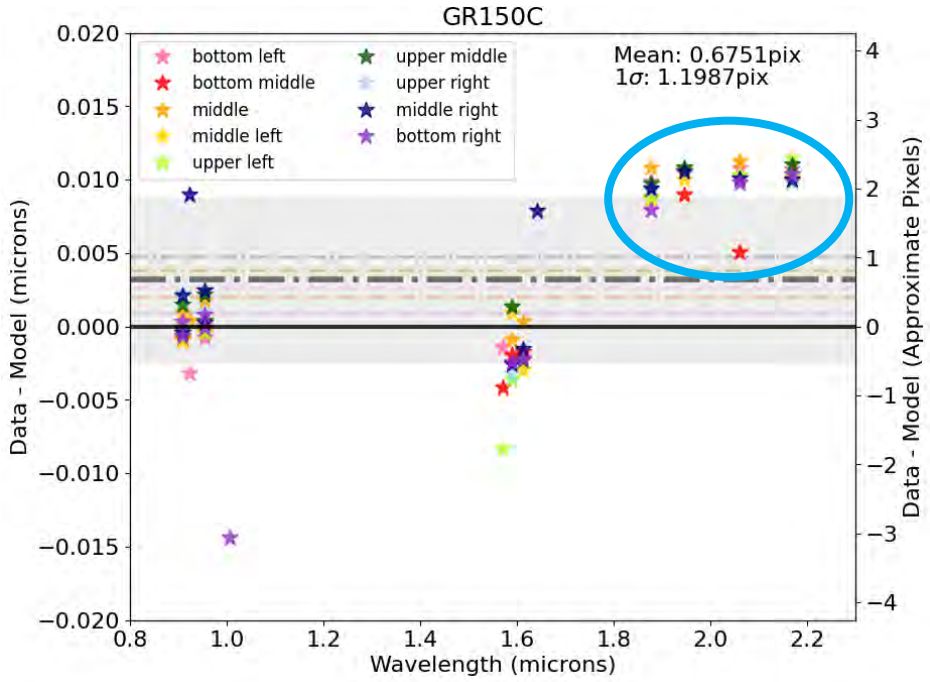
Known Issue	Cause
NR-AMI01: Interferometric properties returned by the **calwebb_ami3** stage of the pipeline require further evaluation.	The Science Calibration Pipeline is using an older version of the image plane reconstruction software.

- **calwebb_ami3** is being updated to use state-of-the-art ImPlaneIA algorithm, expected to be released in pipeline build 10.2 (May 2024)

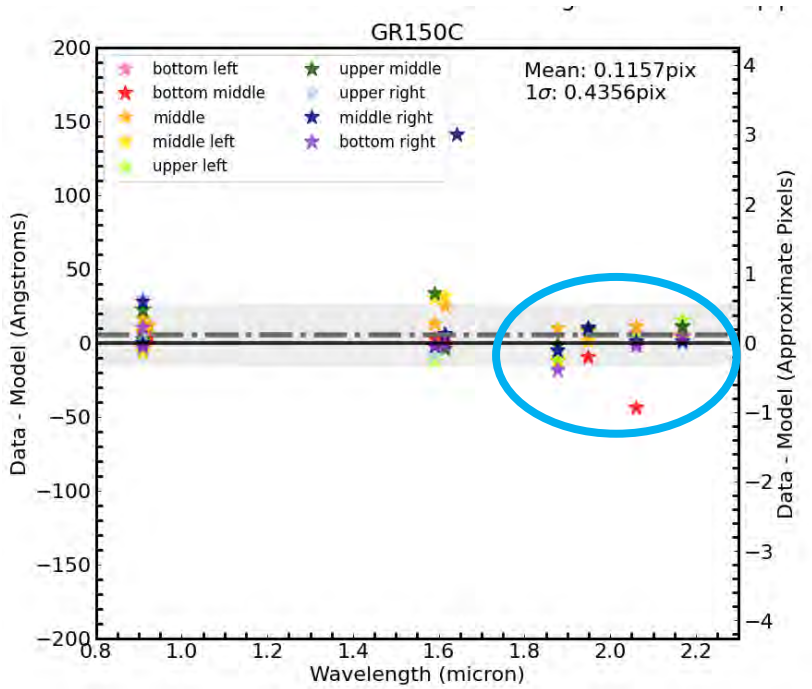
NIRISS WFSS Calibration Improvements

Known Issue	Solution
NR-WFSS03: There is an offset in the wavelength zeropoint that is most pronounced in the F200W filter.	Updated filteroffset files that include WFSS exposures were delivered to CRDS and are available as of CRDS version jwst_1176.pmap and later.

Before



After



NIRISS WFSS Calibration Improvements (Upcoming)

Known Issue	Cause
NR-WFSS01: Spectral traces are offset from the sources in the cross-dispersion direction.	The shape of the spectral traces varies as a function of detector position.

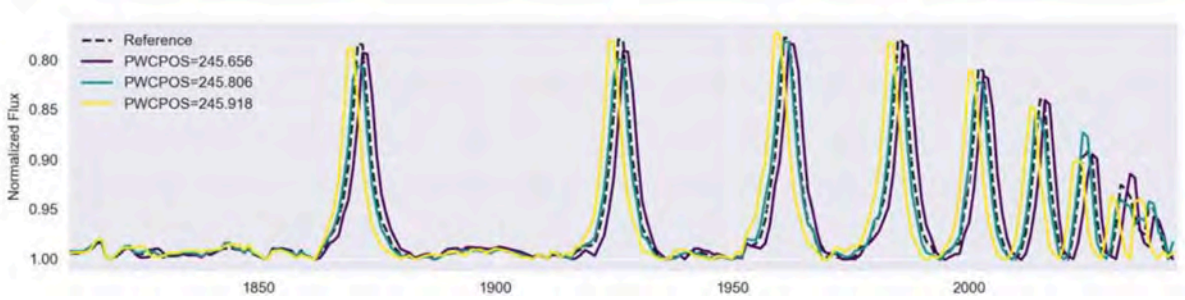
- Trace shape calibration on-going.
- Will deliver updated specwcs reference files as calibrations for each Filter + GR150 grism pair are completed and tested.

NIRISS SOSS Calibration Improvements

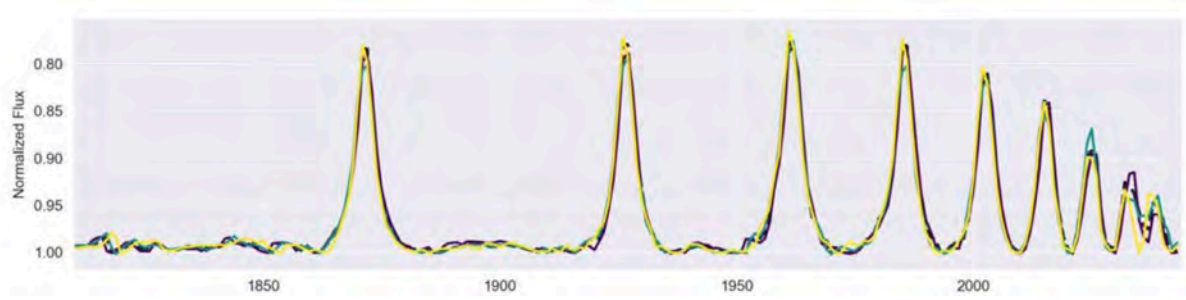
Known Issue	Cause
NR-SOSS02, NR-SOSS03: The shape of the spectral trace and wavelength solution varies from visit-to-visit.	The actual pupil wheel position (PWCPOS) that sets the GR700XD grism in the optical path does not land exactly at commanded position, causing both a distortion in spectral trace and wavelength solution.

✓ Released PASTASOSS package to predict position of trace and wavelength solution for any SOSS visit (Baines et al. 2023a, Baines et al. 2023b)

- Improves wavelength accuracy from 4 pixels to 0.5 pixels



Before



After

NIRISS SOSS Calibration Improvements

Implementation of PASTASOSS functionality into pipeline is on-going

NIRISS STScI Team

Steph LaMassa
NIRISS Manager

Paul Goudfrooij
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Tyler Baines

Aarynn Carter

Welcome to new members:
Aarynn Carter
Russell Ryan

Rachel Cooper

Joe Filippazzo

André Martel

Rachel Plesha

Russell Ryan

Open
(CSA hire)

Anand
Sivaramakrishnan

Tony Sohn

Jo Taylor

Deepashri Thatte

Kevin Volk
(CSA)

Open
(CSA hire)

Backup Slides

JWST Pipeline User Support: Jupyter notebook tutorials for pipeline processing

- Imaging notebook for non-crowded field passed science and technical review by JWST Data Analysis Tools (JDAT) Team
  - Expect to be published soon
- WFSS notebooks illustrate processing data through **calwebb_image2** → **calwebb_image3** and **calwebb_spec2** to extract spectra for source(s) of interest
  - Going through team review, expect to be submitted to JDAT for science and technical review shortly
- SOSS notebooks to to illustrate processing data through **calwebb_detector1** → **calwebb_spec2** and running PASTASOSS to improve wavelength solution and extract 1D spectrum are going through team review
  - Expect to be submitted to JDAT for science and technical review shortly
- AMI notebooks on hold pending implementation of updated algorithm in **calwebb_ami3**

Current Calibration Accuracy

- Astrometric
  - 3 mas relative
  - 0.1” absolute (w/o TA)
  - 2 mas absolute (w/ TA)
- Photometric (Imaging)
  - 2% at short wavelengths, 5% at longer wavelengths
  - WFSS: 2.5%
  - SOSS: 1% in orders 1 & 2; 5% for order 3 (not officially supported, though Cycle 2 GO Cal program to calibrate order 3)
  - AMI: 5% for F277W/F380M/F430M; 8% for F480M
- WFSS
  - Wavelength: 0.3-0.44 pixel (14 – 21 Å)
  - Spectral trace: offset of 2-3 pixels between predicted and actual trace positions in cross-dispersion direction (currently being calibrated using serendipitous detections of point sources in Cycle 1 GO, GTO, ERS programs)

Current Calibration Accuracy

- SOSS wavelength
  - 0.5 pixel accuracy (when using PASTASOSS)
- AMI: can detect companions down to a contrast of 7.5 magnitudes when detecting 10^8 photons (with planned **calwebb_ami3** updates)

On-going Calibration Efforts

- Improvements in image reconstruction codes for AMI to push to a contrast level of 9 magnitudes when detecting 10^8 photons

Detector Trending

- Analysis of Cycle 1 internal flats calibration data (using internal lamp) show no degradation in sensitivity since commissioning.
- Analysis of Cycle 1 - 2 stability monitoring calibration program (using imaging through the F200W filter) show:
  - No evidence of degradation in sensitivity since commissioning (sensitive to a floor of ~1%)
  - No evidence in change of PSF quality since commissioning
- Analysis of Cycle 1-2 calibration of same flux standard (BD+60-1753) through GR700XD grism (0.6 – 2.8 μm)
  - Data show flat trend within 2σ of statistical errors of ~0.25%
  - Decrease of ~0.4% compared with commissioning, but need longer baseline and more data to see if significant beyond scatter in measurements and uncertainties in background subtraction