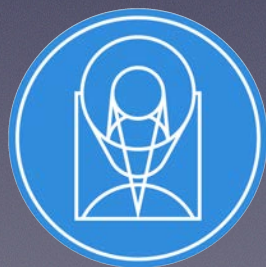


JWST Cycle 1 Calibration Plan

James Muzerolle



STScI



Cycle 1 calibration program

Goal: obtain observations needed to fully calibrate the science instruments and monitor behavior

- Includes, but not limited to, data needed for all reference files used by the calibration pipeline
 - Internal calibrations (lamps, etc), on-sky exposures
- Complete partial observations taken during Commissioning (e.g., full filter sets, improve S/N)
- Improve (spectro)photometric calibration
- Monitor the stability of key metrics and effects that may change
- Characterize instrument performance (e.g., target acquisition)

Preliminary program

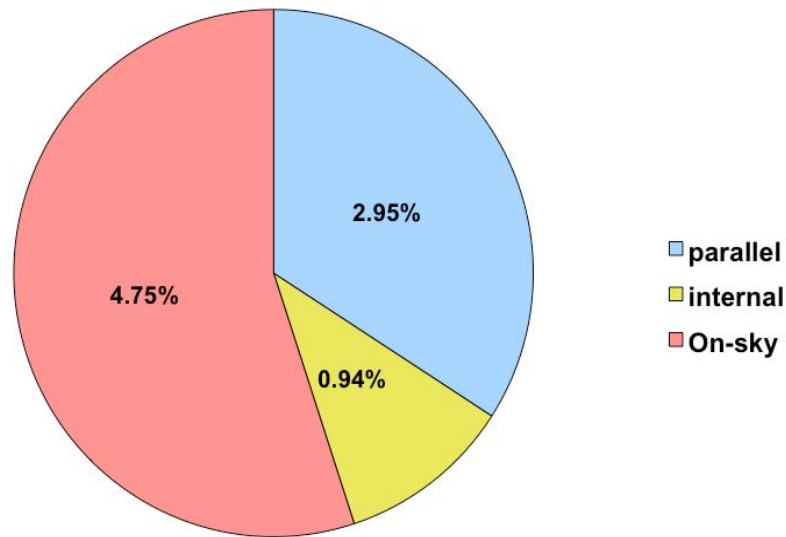
developed in 2012, incorporated into the Science Operations Design Reference Mission (SODRM) as part of efficiency study

total of 756 hours:

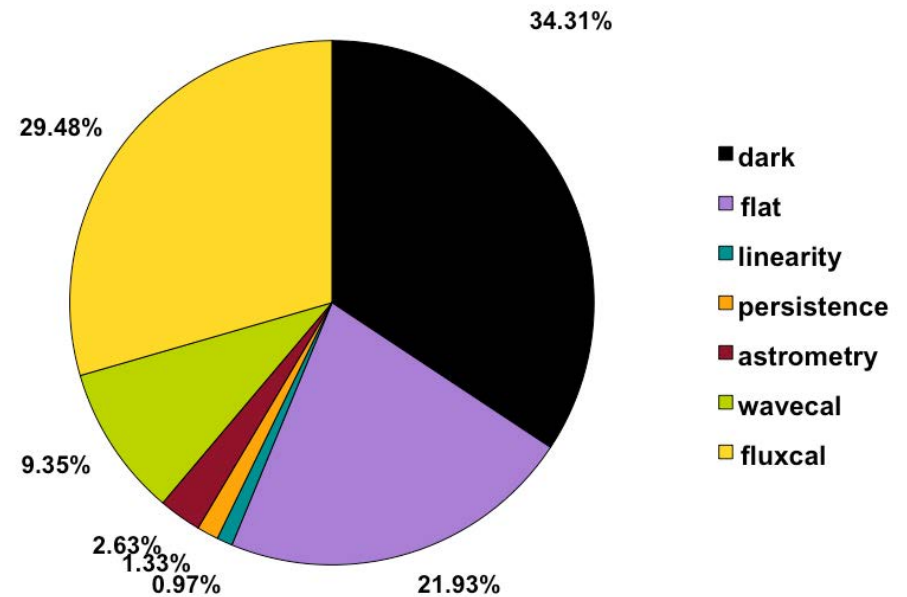
- at least 258 hrs likely to be done as parallels
- ~82 hrs internal calibrations
- on-sky fraction: ~5%

-> *most recent overheads analysis by the Efficiency WG allocates 6%*

Cycle 1 calibration duration
(% of total time)



percentage of time by category



However, the preliminary plan was done with limited knowledge of instrument performance

- A comprehensive update, using knowledge from ground tests and leveraging the Commissioning plan, is now in progress

plan update: process

- Members from all STScI instrument teams contributing effort, with significant input from IDTs
- Cross-instrument focus group (including IDT members from NIRSpec & MIRI) overseeing the work and coordinating common activities & targets
- Separate working groups organizing targets for flux, wavelength, astrometric calibration
- reference file traceability matrix and commissioning overlap analysis
 - document listing reference files, related Commissioning activities, relevant existing data
- activity summaries analogous to Commissioning Activity Requests (CARs)
 - high-level description of each activity, estimated duration, frequency, deliverables, etc

example program summary

TITLE: NIRSpec dark monitor

ID: NS-001

TYPE (calibration/monitor/characterization): calibration, monitor

DESCRIPTION: These observations will provide a set of dark frames for measuring the detector dark current and read noise. Given the expected low dark current signal, a total exposure time of 10^4 seconds should yield a dark current signal-to-noise per pixel ~ 10 (*TBC pending FM ground test results*). To mitigate negative effects of an uncertain cosmic ray hit rate, individual integrations should be limited to ~ 3000 seconds. The arrays will be read out in NRSRAPID mode in order to best identify discrete cosmic ray events; the likely exposure sequence would be 3 integrations with 300 groups each.

TIMING CONSTRAINTS: To be repeated \sim twice monthly (*TBC*).

DURATION (per observation; also give total if repeated): 10^4 seconds per observation, ~ 70 hours total over the entire cycle.

DATA REQUIREMENTS (per observation; also give total if repeated): ~ 15 GB per observation, ~ 360 GB total over the entire cycle.

ANALYSIS, DATA PRODUCTS, TOOL NEEDS: The detector dark current will be determined by measuring the signal slope over the entire exposure. The detector read noise will be calculated by measuring the variance between the individual groups. Hot and noisy pixels will be identified as those that deviate by more than 3 sigma (*TBC*) from the mean signal/rms across the array. Repeat measurements will provide a means of monitoring any changes in these characteristics over time. All of the data will be combined to construct the dark and bias reference files for the calibration pipeline.

DELIVERABLES: Dark, bias, & bad pixel mask reference files; trending data for dark current, read noise, and bad pixels

ARE DEDICATED OBSERVATIONS REQUIRED (yes/no/maybe)? Yes

IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL (yes/no/maybe)? Yes

IS GUIDING REQUIRED (yes/no)? No

CAN THIS ACTIVITY BE DONE DURING SPACECRAFT SLEWS (yes/no/maybe)? Yes

IS THIS ACTIVITY SENSITIVE TO WFS (yes/no/maybe)? No

COMMENTS: The individual integrations do not have to be contiguous, but should be scheduled within a 24 hour period (*TBC*).

AUTHOR/DATE: James Muzerolle / May 15 2017

Example activity list: NIRCcam

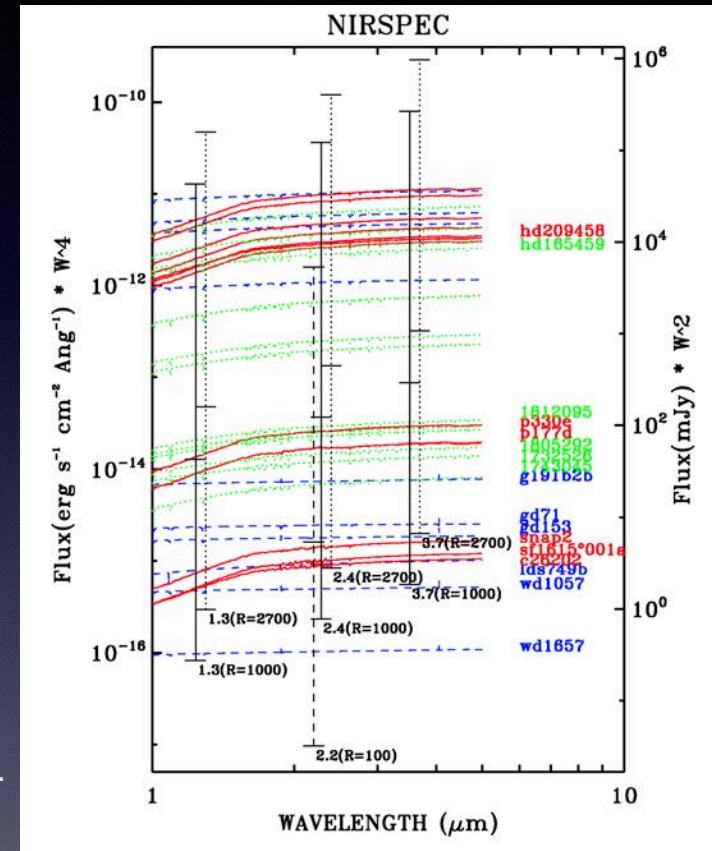
- Dark current & readnoise monitor
- Sky flat field monitor
- Stellar flat fields
- Photometric zeropoint monitor
- Linearity characterization
- Persistence characterization
- PSF characterization
- Astrometry & distortion monitor
- LW grism calibration
- Coronagraphic calibration

plan update: timeline

- Complete initial drafts of calibration activity summaries
 - **October 2017**
- Request for IDT feedback (if not already obtained above)
 - **fall 2017**
- Webb Mission Office review/approval
 - **Dec 2017**
- Complete baseline Cycle 1 APT programs
 - **spring 2018**
 - **Update summer/fall 2018, and again by end of Commissioning**

Target planning: absolute flux calibration

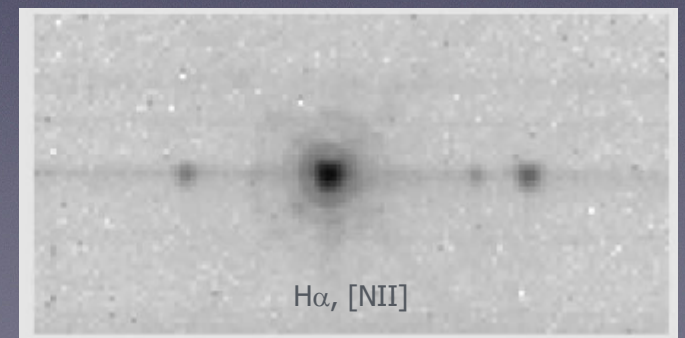
- Working group led by K. Gordon & R. Bohlin, representation from all STScI instrument teams
 - See community lecture by Gordon (<https://jwst.stsci.edu/science-planning/workshops-and-lectures/jwst-community-lectures>)
- compiling & characterizing a set of spectrophotometric standards
 - A, G-type stars & WDs, known fluxes from 0.6-28.5 microns
 - nominal requirement 5% photometric abs flux accuracy (10% spectrophotometric), <1% goal
 - cross-calibration with HST, Spitzer, ground-based





Target planning: wavelength calibration

- Working group effort led by J. Muzerolle, members from all STScI instrument teams and some IDTs
- Compiling & characterizing celestial objects (primarily emission line sources) as calibrators
 - NIRSpect: NGC 6543 extended PN halo (**verification of instrument model*)
 - NIRCam/NIRISS grisms: unresolved PN in LMC
 - MIRI MRS/LRS: Be stars



Target planning: astrometric calibration

- Working group effort led by J. Sahlmann, members from all STScI instrument teams and some IDTs
 - *See community lecture by J. Anderson*
- well-characterized stellar field in LMC
 - HST observations, cross-matching with Gaia -> ~2 mas astrometry
- all SIs will have at least 2 observations during Commissioning
 - refinement, monitoring during cycle 1

plan update: timeline

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