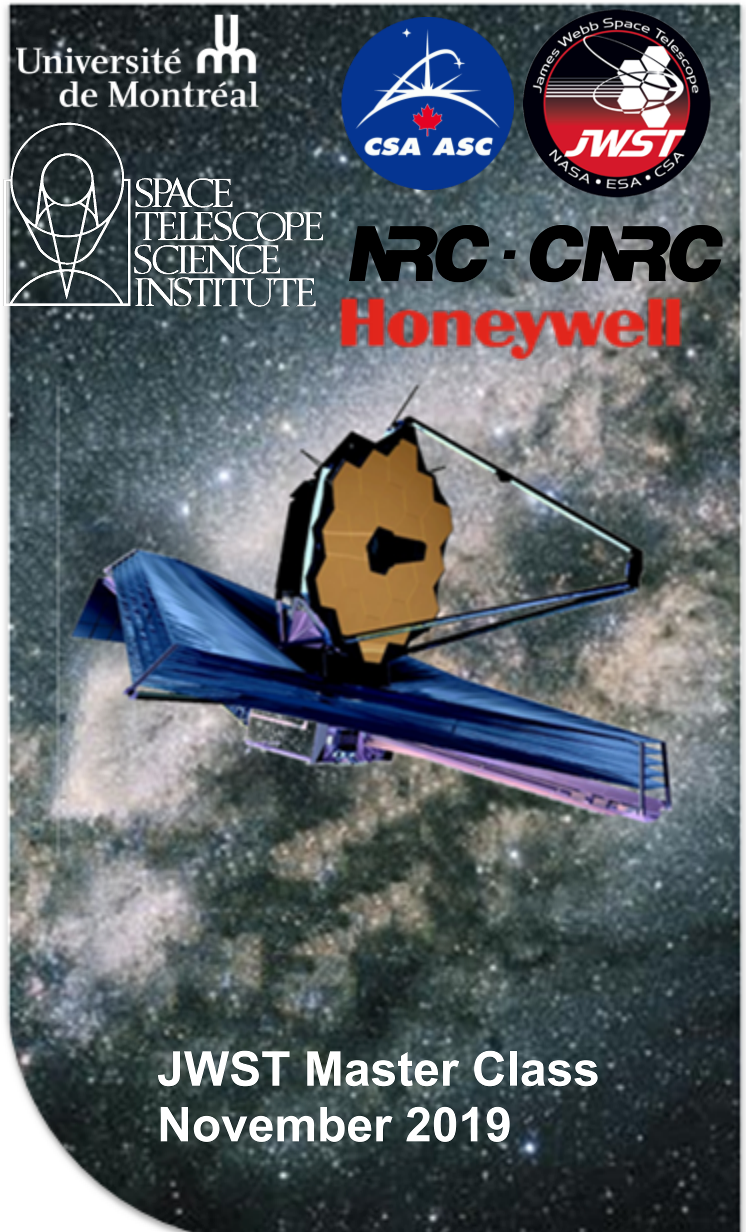
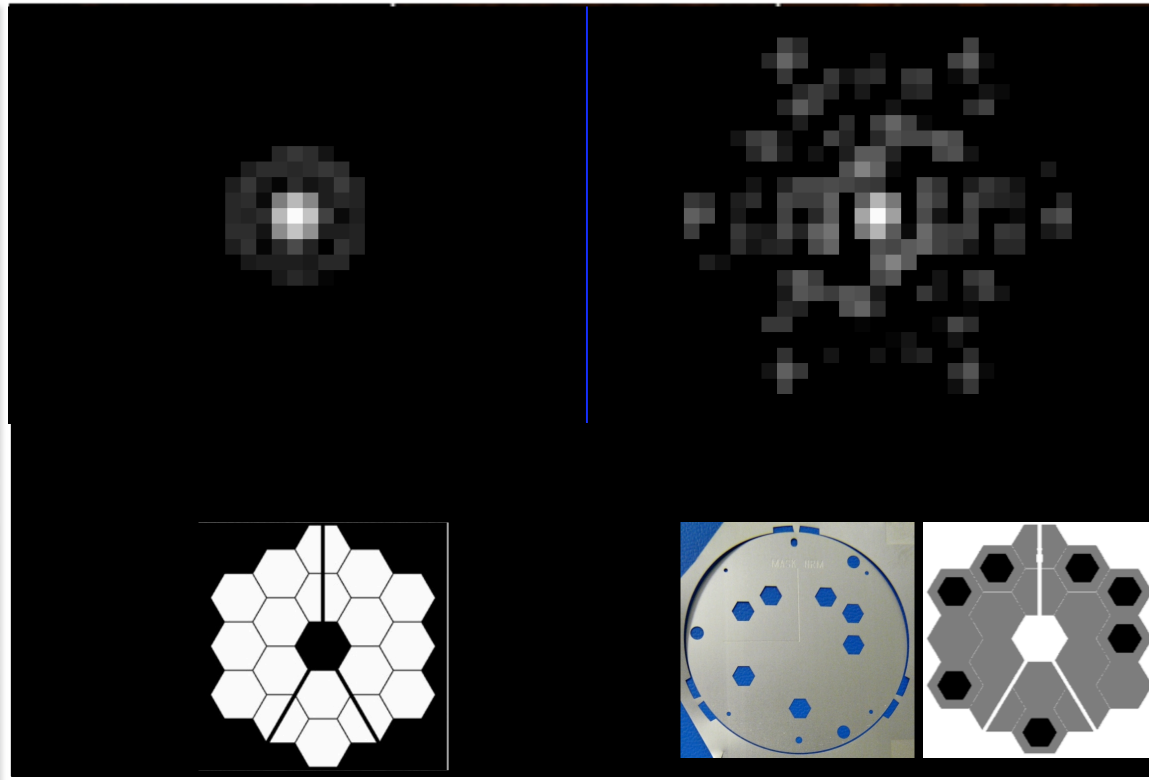
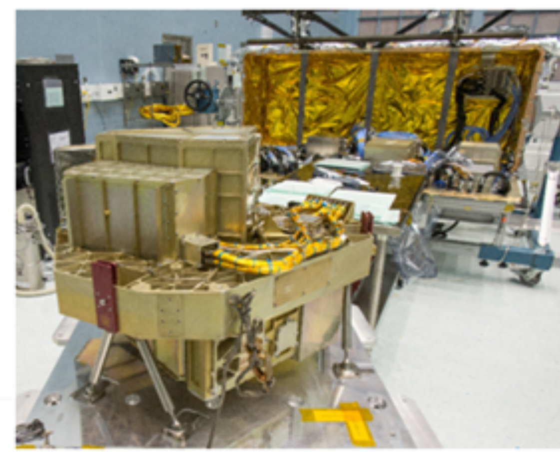






NIRISS AMI OVERVIEW AND PROPOSAL PLANNING

Deepashri Thatte, Anand Sivaramakrishnan and NIRISS team

HCI capability of NIRISS AMI

- Moderate-contrast, high angular resolution imaging for exoplanets, transition disks, AGN, Io volcanoes, exozodi disks

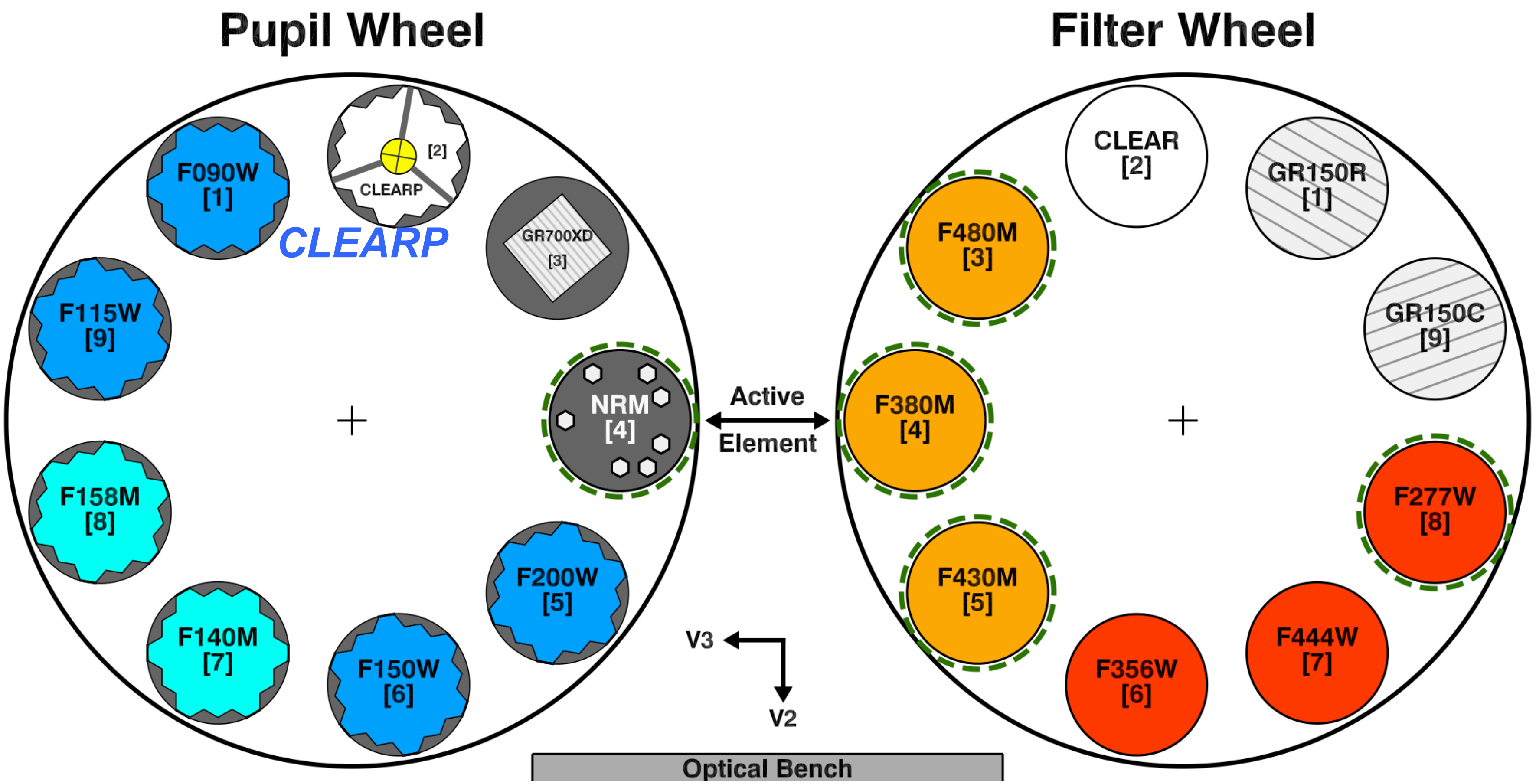
- Uses non-redundant mask (NRM) in the pupil wheel of NIRISS in conjunction with one of the 3x medium-band filters centered at 3.8, 4.3 and 4.8 µm (F380M, F430M, F480M) or a wide-band filter centered at 2.77 µm (F277W)

- Bright limit ~3 to 4 magnitudes in medium filters. Goal is to reach binary point source contrast up-to 10^{-4} at separations of ~70 – 400 mas ("behind the spot" of NIRCam coronagraphs).

- Photon-noise limited, combination of flat-field error and placement can affect performance.

- Requires TA, observing calibrator star close in time to the target, dithers available but not recommended.

Dual wheel optical elements

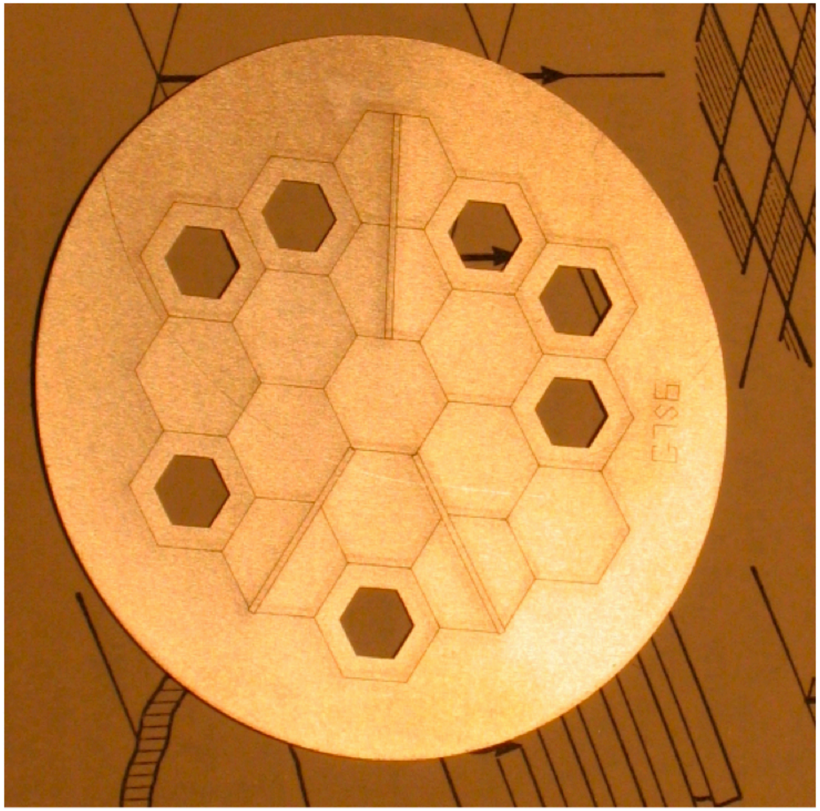


~65 mas pixels are Nyquist sampled at ~4um

F277W: reduced performance but has water band

CLEARP for 'kernel phase' on fainter targets

NIRISS NRM design



7 holes

7 x (7-1) / 2 = 21 ‘baseline’ interferometer, no vector baseline repeated

Highly calibratable images

Undersized holes accomodate inexact pupil placement

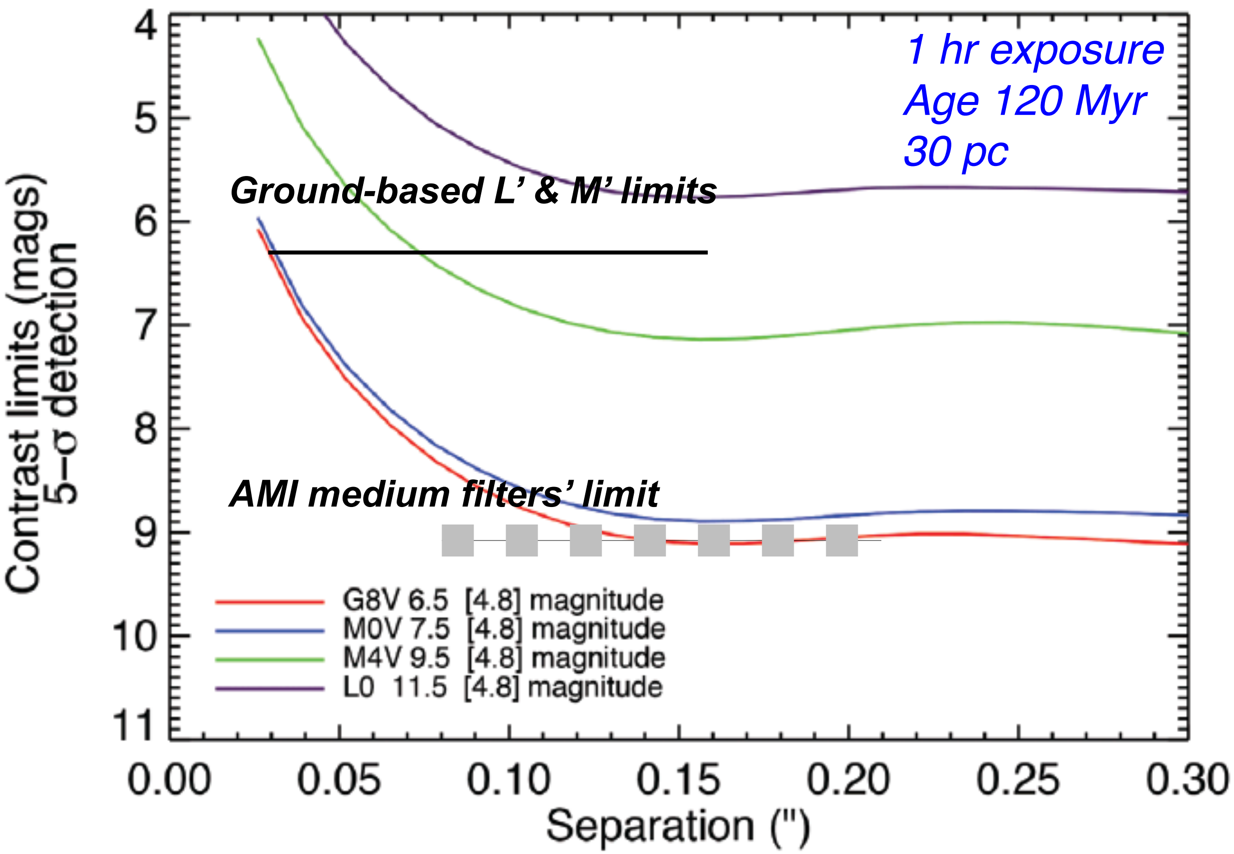
15% throughput cf. full pupil
Peak pixel ~1/40 full pupil peak pixel

Used for target acquisition for bright NIRISS SOSS (exoplanet transit spectroscopy) targets

Enables coarse & fine wavefront sensing as back-up to NIRCam

Science motivation

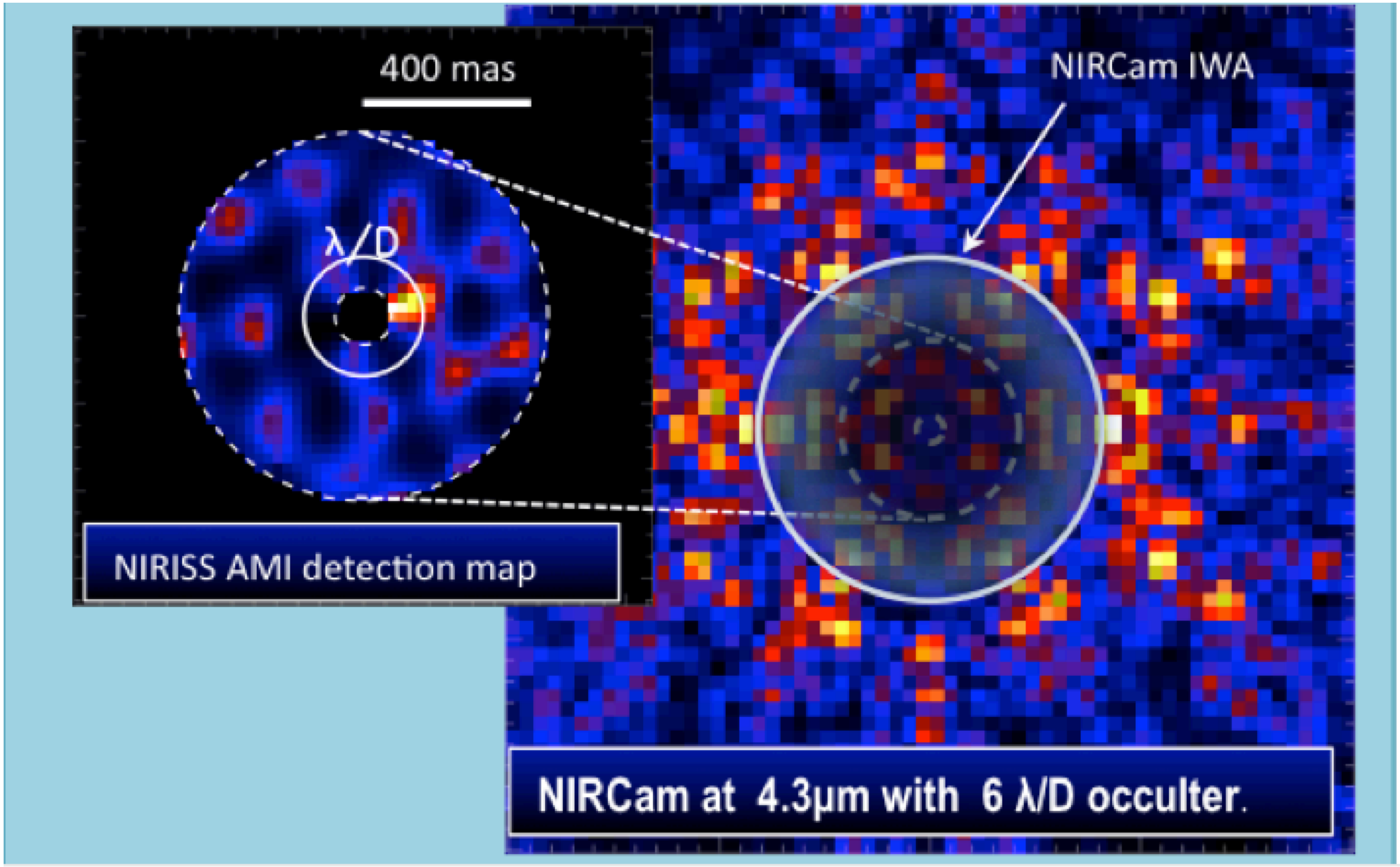
- **Probe separations of ~40 to 400 mas**
- **At contrast of up to 9 mag**
- Filters: F380M, F430M, F480M, (and F277W)



Science goals

- **Detection of planets very close (70-500 mas) to their parent star.**
- **Study of feedback and fueling structures in AGNs.**
- **Transition Disks Planets/structure**
- **Ultracool star binarity**
- **Exozodi detection**
- **Io volcano photometry**

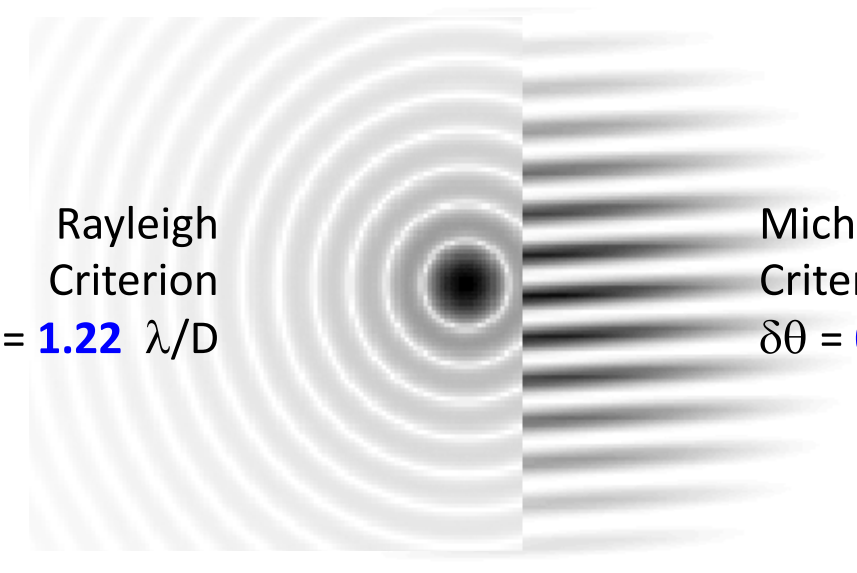
Complements NIRCam coronagraphy



Simulation of 1-2 Jupiter mass planet at 1 AU around
M0V host star at 10 pc (by NIRISS IDT). Observing time: 3 hr

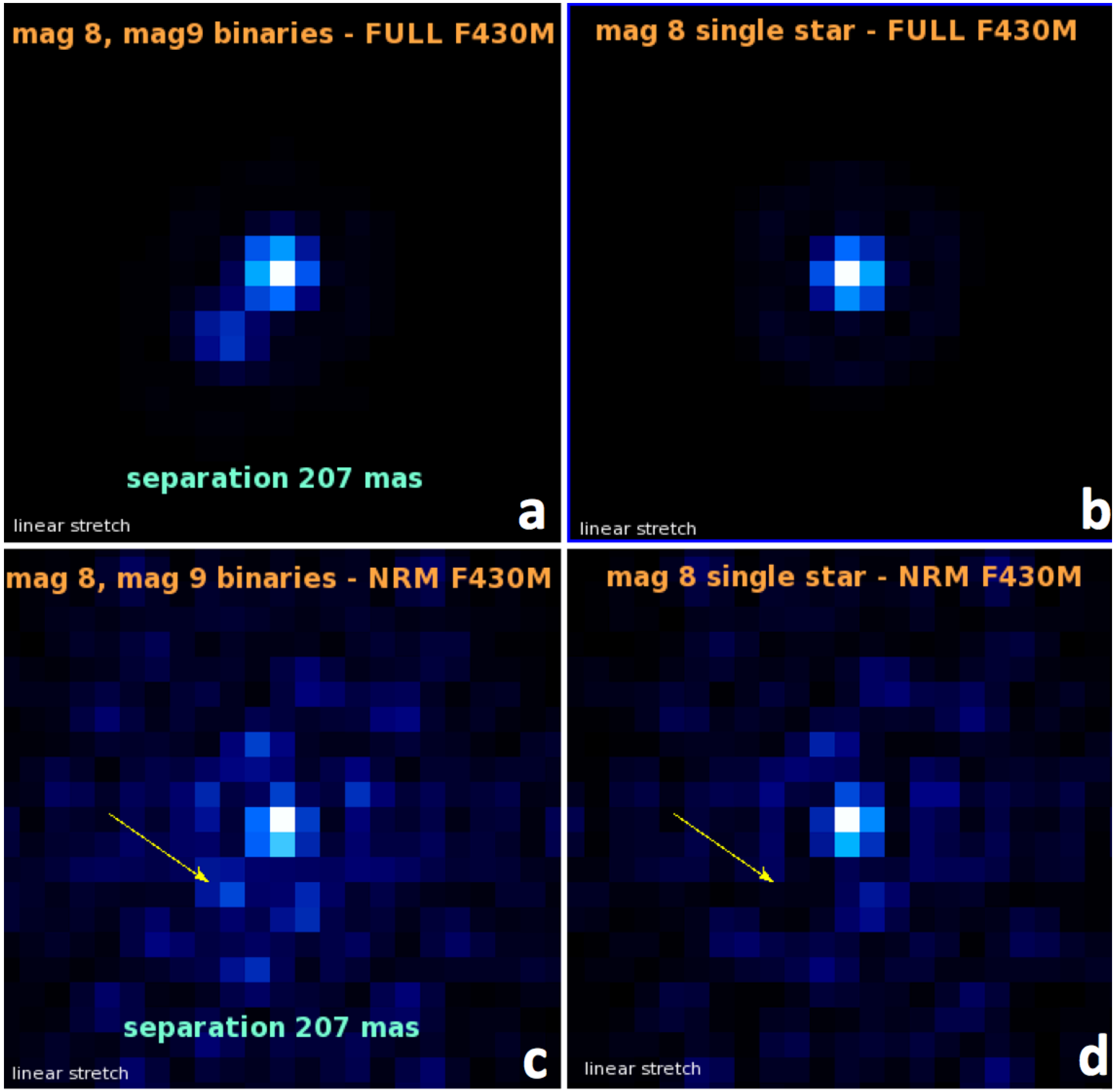
Interferometric resolution, small IWA

- $\delta\theta$ = 0.5 λ/D Michelson Criterion (NRM)
- $\delta\theta$ = 1.22 λ/D Rayleigh Criterion (Full aperture)
- $\delta\theta$ = 4λ/D NIRCam coronagraph (Inner Working Angle)



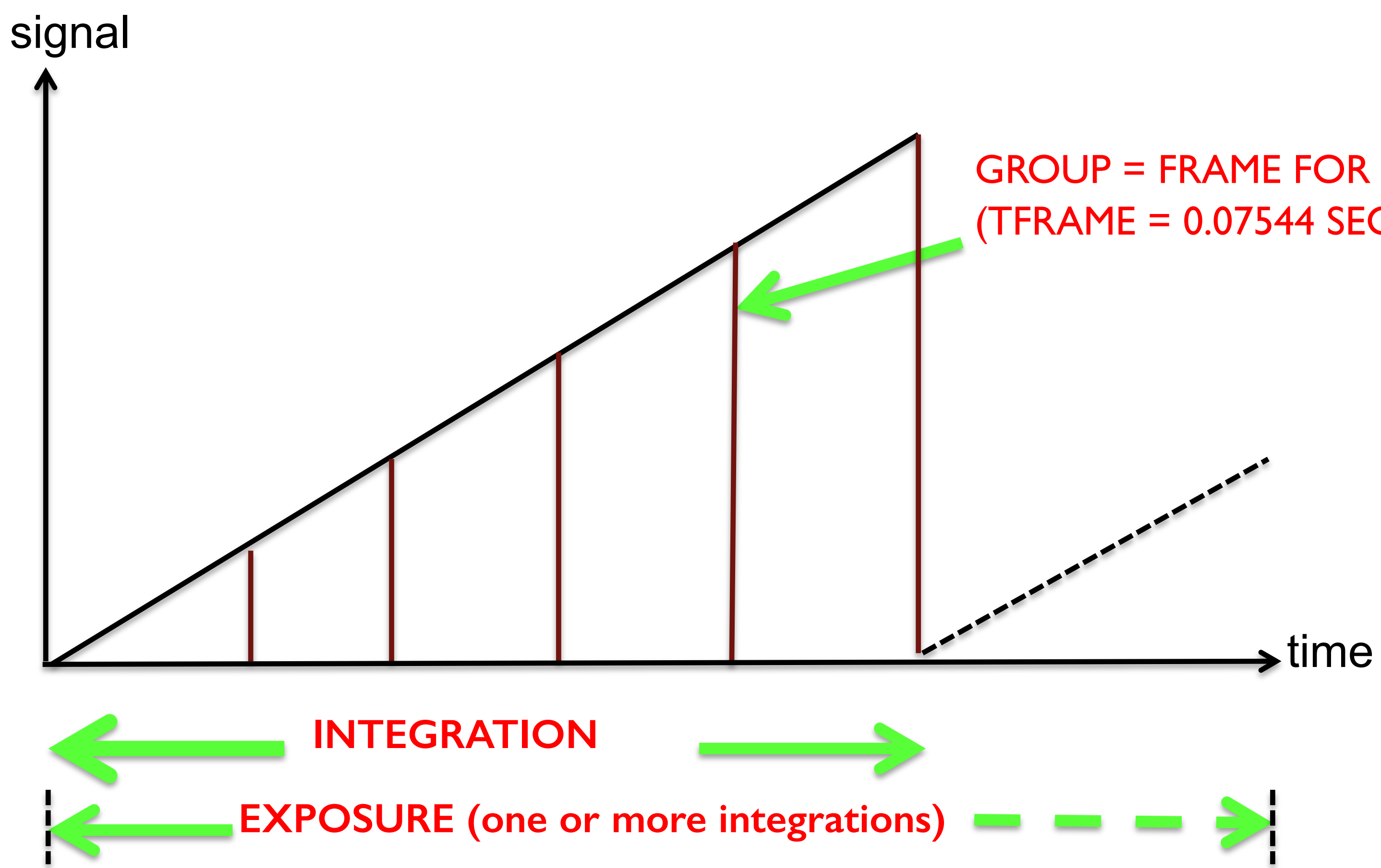
Easier to calibrate out instrumental effects

NIRISS AMI PSF



Exposure Nomenclature

The NIRISS AMI subarray is SUB80 (FULL also available)
One frame per group (NISRAPID readout pattern)

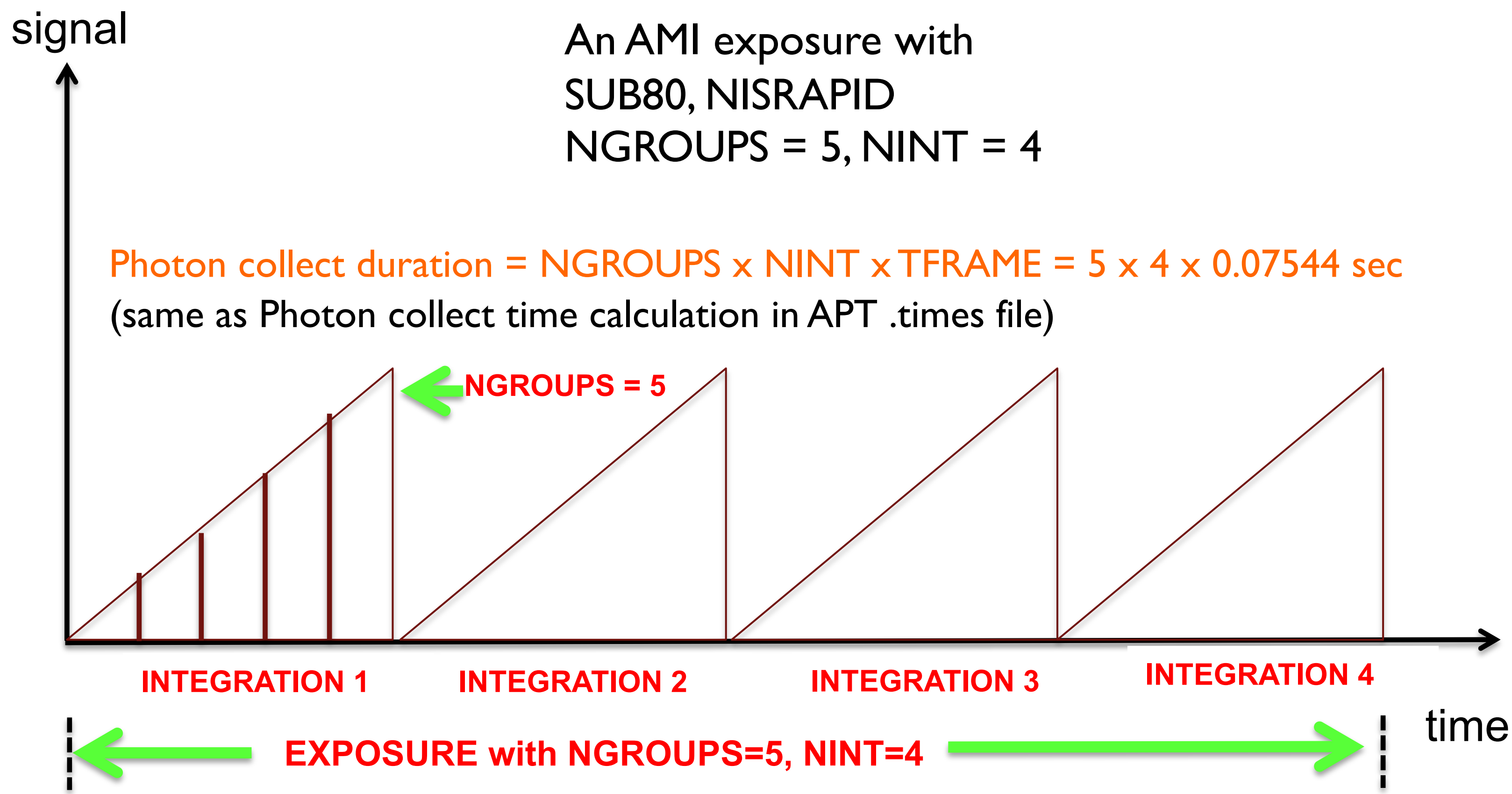


NIRISS AMI Exposure

The NIRISS AMI subarray is SUB80 (FULL also available)
One frame per group (NISRAPID readout pattern)

An AMI exposure with
SUB80, NISRAPID
NGROUPS = 5, NINT = 4

Photon collect duration = NGROUPS x NINT x TFRAME = 5 x 4 x 0.07544 sec
(same as Photon collect time calculation in APT .times file)



Note: The Total Exposure Time shown by JWST ETC includes resets, do not use it to calculate signal. Use photon collect time instead.

AMI Brightness limits (Vegamag) SUB80

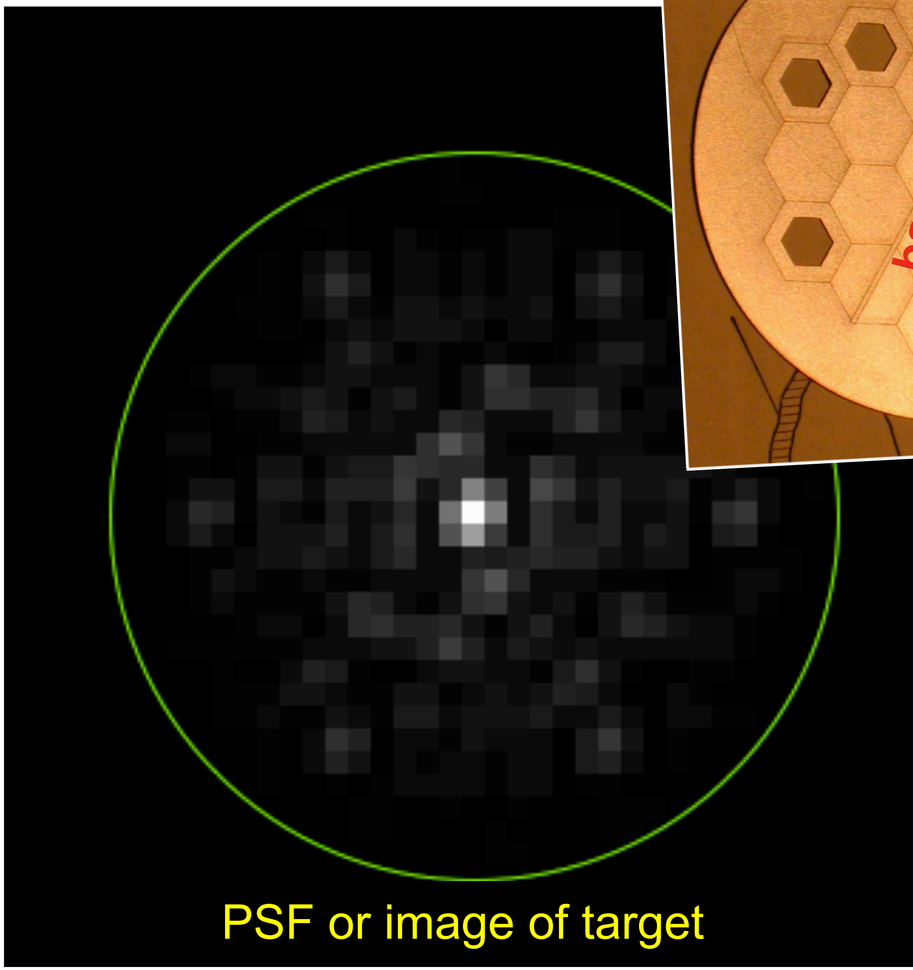
Filter	NGROUPS 1	NGROUPS 2
F277W	7.0	7.6
F380M	4.1	4.7
F430M	3.4	4.0
F480M	3.1	3.7

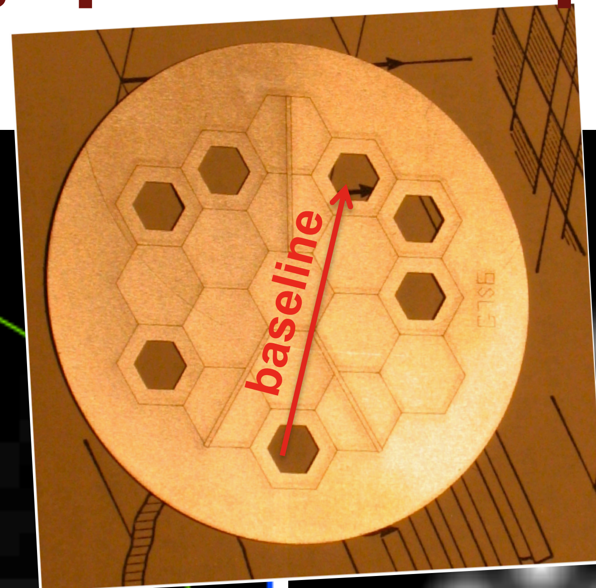
30,000 e^- pixel signal limit, pixel-centered PSF

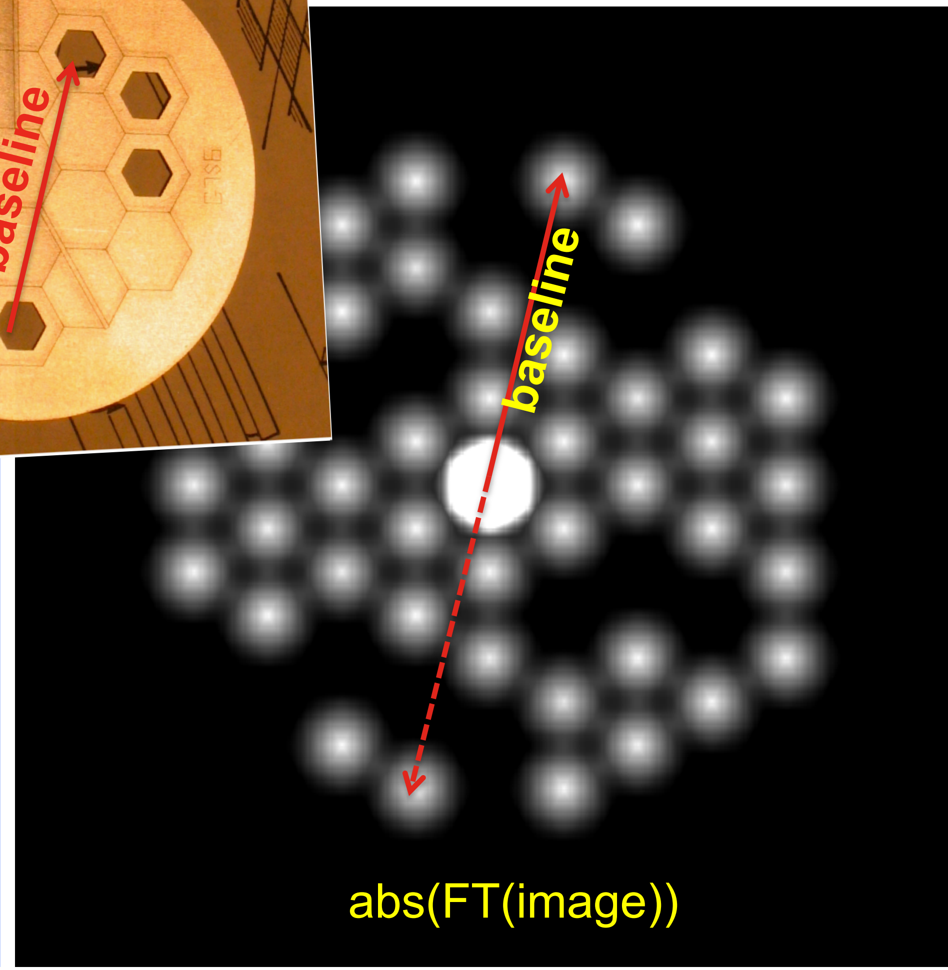
Add ~4 mag to these to get CLEARP SUB80 brightness limit (cf NRM)
Add ~5.5 mag to get FULL detector NRM brightness limit (cf SUB80)
Add ~9.5 mag to get FULL CLEARP brighness limit

Fringe phases & amplitudes

Interferometric view

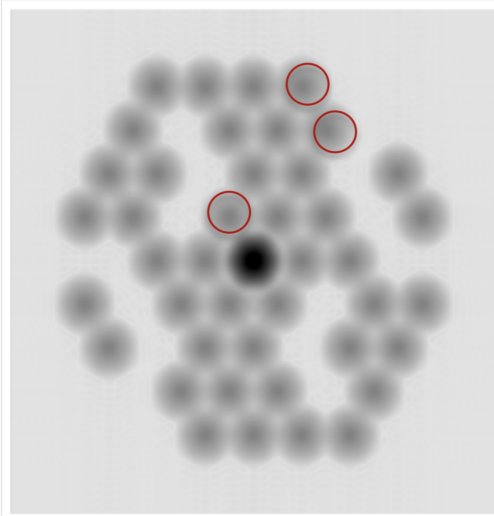


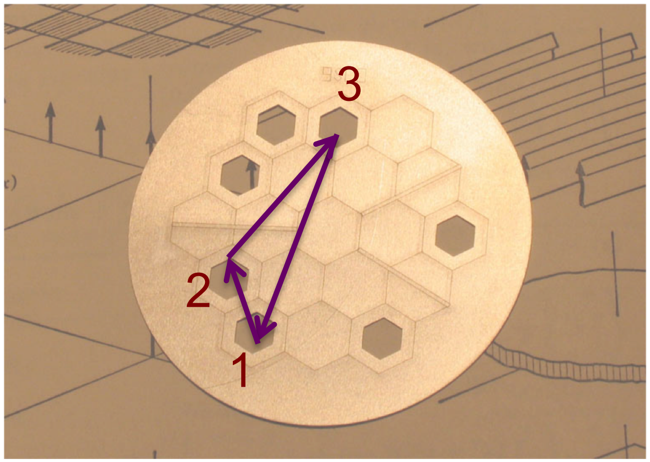




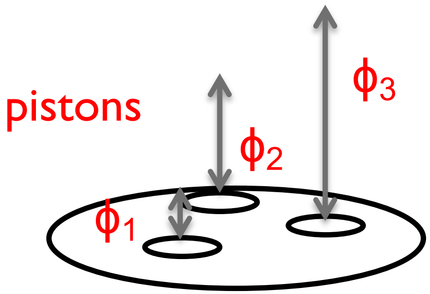
7 hole mask: 21 independent baselines. FT has central splodge + 42 splodges
Get fringe visibilities & (Fourier) phases of each of the 21 fringes (42 numbers)

Closure phase measures structure





For three holes, sum of 3 fringe phases = closure phase



$$\phi_{i,j} = \phi_j - \phi_i$$

$$\phi_{1,2} + \phi_{2,3} + \phi_{3,1} = 0$$

Non-zero closure phases are a result of structure or measurement errors

Contrast ~ $1/\sigma_{CP}$

Calibrating Closure phases & SqV

For a point source;
Closure phase (CP) should be 0
square visibility (SqV) should be 1

Remove residual error/instrumental contribution to closure phases by calibrating with the point source calibrator star

Subtract CAL CPs from Target CPs

$$CP_{target} = (CP_{target} + CP_{instrument}) - (CP_{calibrator} + CP_{instrument})$$

Any non-zero closure phase is due to asymmetry in the source.
CPs do not measure centro-symmetric structure, but SqV's do

Divide target visibilities by calibrator visibilities
Square calibrated visibilities to get SqV

Fit science data to fringe quantities

AMI Operations

- AMI Target Acquisition in 64 x 64 subarray (SUBTAAMI)
  - NGROUPS – odd numbers between 1 & 19 (avoid saturation)
  - NISRAPID readout
    - Acquire in F480M, MASK_NRM for bright, CLEARP faint
    - Small Angle Maneuver to SUB80 science subarray POS 1

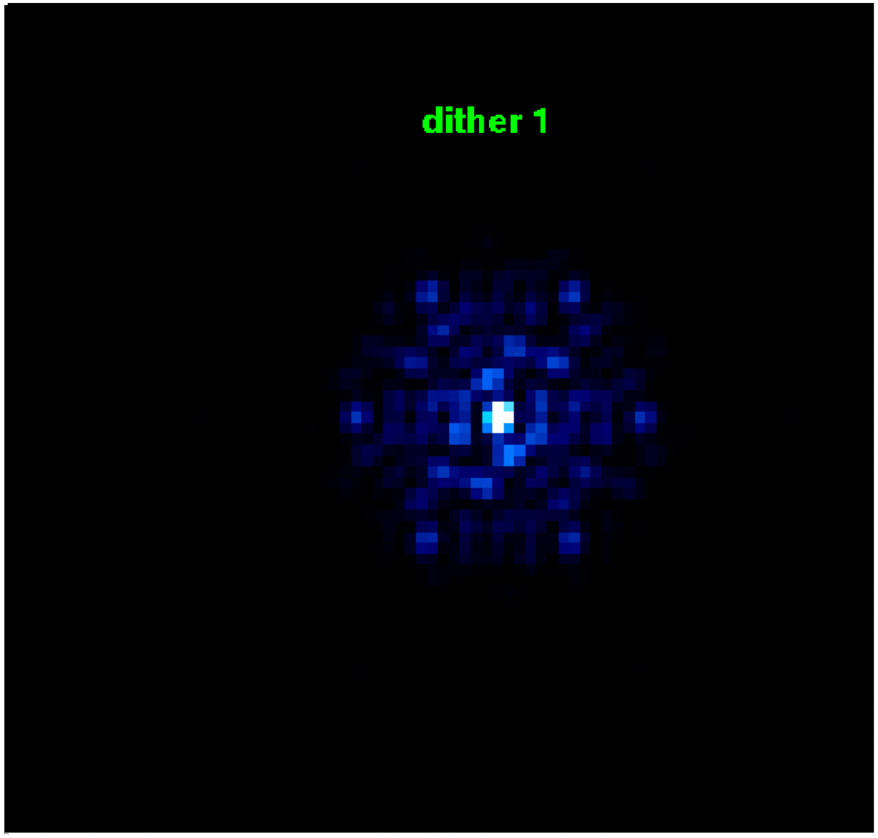
- AMI data acquisition in SUB80: 80 x 80 subarray
  - 80 x 76 light sensitive, 4 rows of reference pixels
  - NISRAPID readout only for SUB80 (select NGROUPS, NINT)
    - Recommend POS 1 only (default is pixel center)
      - Expected POS 1 placement to ~5 mas per axis
      - User-selected offset possible
      - Dithers possible but not recommended
- SUB80 frame time 0.07544 s (approx 1 /15 s)
- Full detector possible (optional TA), NISRAPID, 10.7 s frame time
  - NIS available for FULL

SUB80 AMI subarray 5.2” × 4.9”

76 x 80 light sensitive pixels

Target placement at POS 1

Sub-dithers available, use with caution



Dithers possible but not recommended.

NIRISS AMI Observation planning: Step 1 Select science targets(s) and calibrator(s)

- Select Science Target & (optional) PSF CAL[ibrator] star
  - Check if target and calibrator are visible using JWST General Target Visibility Tool (GTVT) or APT.
  - Similar spectral type & brightness
- Vet potential calibrators for IR excess, strong spectral lines, binarity
  - Catalog searches, 8m-class ground NRM, VLT & LBT interferometry (e.g. SearchCal)
- Shared CALs save time
  - For low required contrast (eg BD binaries) – use existing/simulated CAL
  - Cooperate across programs to select & share CALs

NIRISS AMI Observation planning:

Step 2 Exposure depth estimation

- **Binary point source**

Nphotons = 1.5 x N_{hole}^2 / (contrast ratio)^2 ----- Ireland (2013)
= 73.5 / (contrast ratio)^2

Considering the fact that NRM has not been used in space before, we use a slightly more conservative value of:
Nphotons = 100 / (contrast ratio)^2
For example, to detect a contrast ratio of 10^{-3}
Nphotons =100 / $(0.001)^2 = 10^8$

- Therefore we need 10^8 photons from the target (and also the calibrator) with NRM and the F480M in the ETC

NIRISS AMI Observation planning

Step 3 – JWST ETC

- Estimate exposure parameters using JWST ETC
  - Stay below a signal limit of 30000 electrons in the peak pixel of an integration
    - When two neighboring pixels accumulate charge at very different rates, photoelectrons from the brighter pixel migrate to its neighboring pixels (charge migration)
    - ETC issues a warning when this signal limit is exceeded
    - This signal limit is lower than the true non-linearity based saturation limit for the NIRISS detector
  - Calculate exposure parameters to reach required exposure depth (total photons) needed to detect contrast

- The extended wings of the AMI PSF can be used for data analysis
  - Strategy tab: Choose noiseless sky background when defining the extraction parameters for the source flux and for the background to be used for background subtraction. The extended PSF makes background subtraction difficult and AMI analysis handles background in the data.
  - Use the following aperture extraction radius for point sources
    - F480M: 2.5″, F430M: 2.3″, F380M: 2.0″, F277W: 1.6″

- A note about Total Exposure Time in ETC
  - The exposure time reported by ETC includes reset time, equivalent to one tframe, between each integration and the time for full-frame reset of pixels outside the subarray, which occurs before every integration when the detector is in subarray mode. No photons are recorded during this reset time, so these reset times should not be included when calculating the total number of photons.
  - Use Photon collect time = NGROUPS × NINT × TFRAME to estimate signal

NIRISS AMI Observation planning

Step 4 AMI specific steps in JWST APT

- Use JWST ETC to calculate NGROUPS and NINT needed to reach the required exposure depth. Input to APT.

- A target acquisition (TA) is required when using a subarray and strongly recommended for full frame readout to ensure that the target is always placed on the same detector pixel.

- We recommend using GAIA DR2 archive to get coordinates and proper motion of the sources and 2015.5 for epoch in APT

- TA is performed with the F480M filter prior to the start of science observations. Therefore starting an exposure sequence with the F480M filter is most efficient. If using all the filters the sequence F480M, F380M, F430M, and F277W produces the least motion of the Filter Wheel.

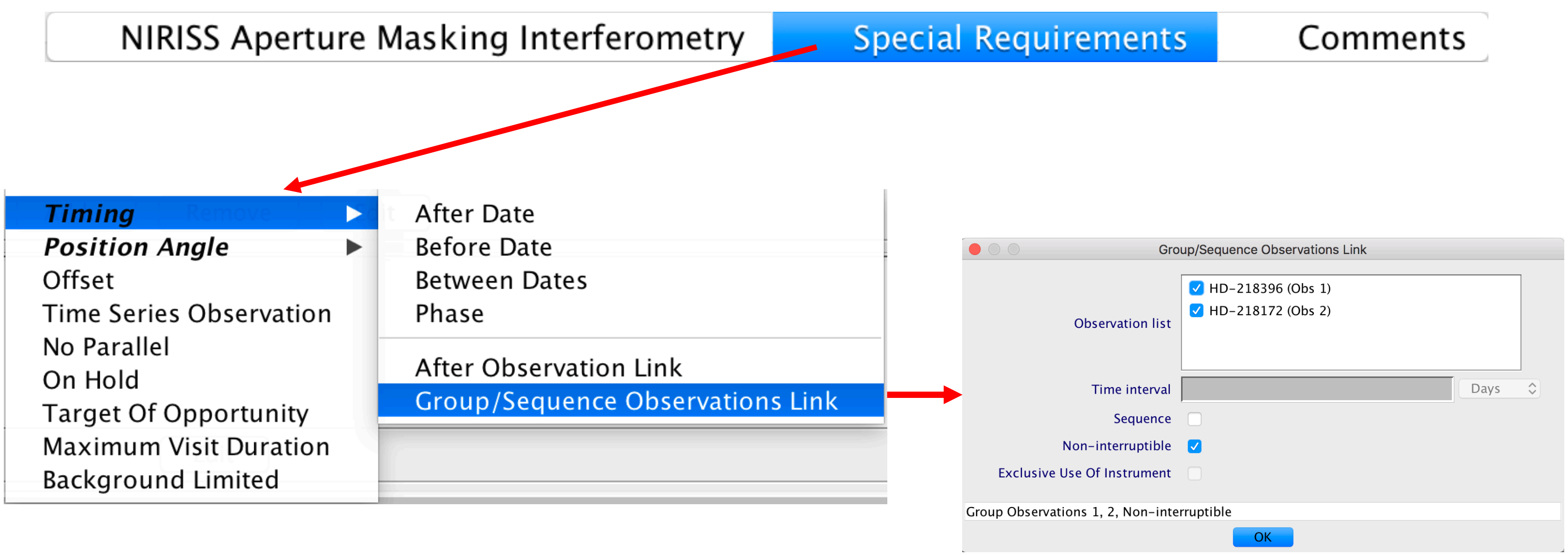
NIRISS AMI Observation planning

Step 4 – AMI specific steps in JWST APT continued…

- Use same positioning (eg POS 1, because of flat-field error)
- For higher contrast needs science target and calibrator should be observed close in time and without PM/SM adjustments between observations.

  Special Requirement tab,

  - *Timing requirement of Group/Sequence Observations Link, selecting target(s) and calibrator(s) from the Observation list box*
  - *Non-interruptible option*

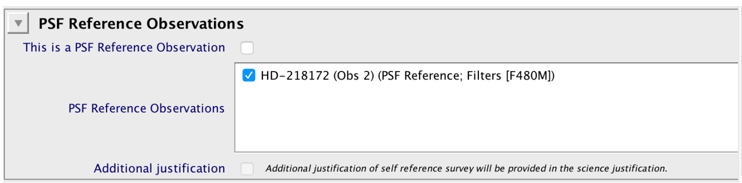


NIRISS AMI Observation planning

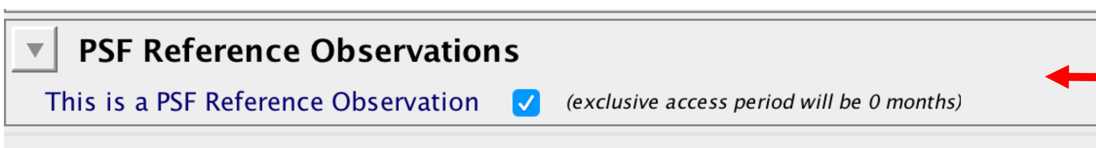
Step 4 – AMI specific steps in JWST APT continued…

- Small slews between target and calibrator improves efficiency and stability

- Under PSF Reference Observation in Form Editor select PSF reference star to associate target with the calibrator for target observation. Choose 'This is a PSF Reference Observation' for calibrator observation. This tells the JWST pipeline to calibrate target with a specific calibrator(s).



For target observation

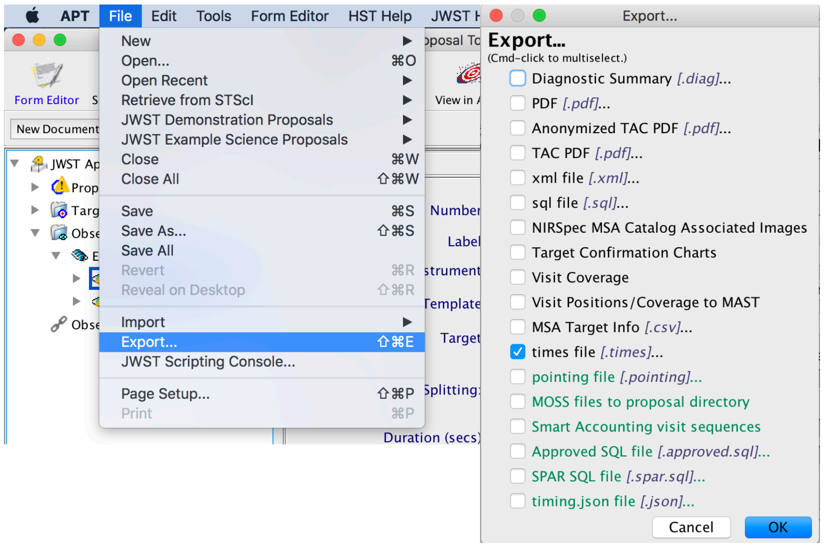


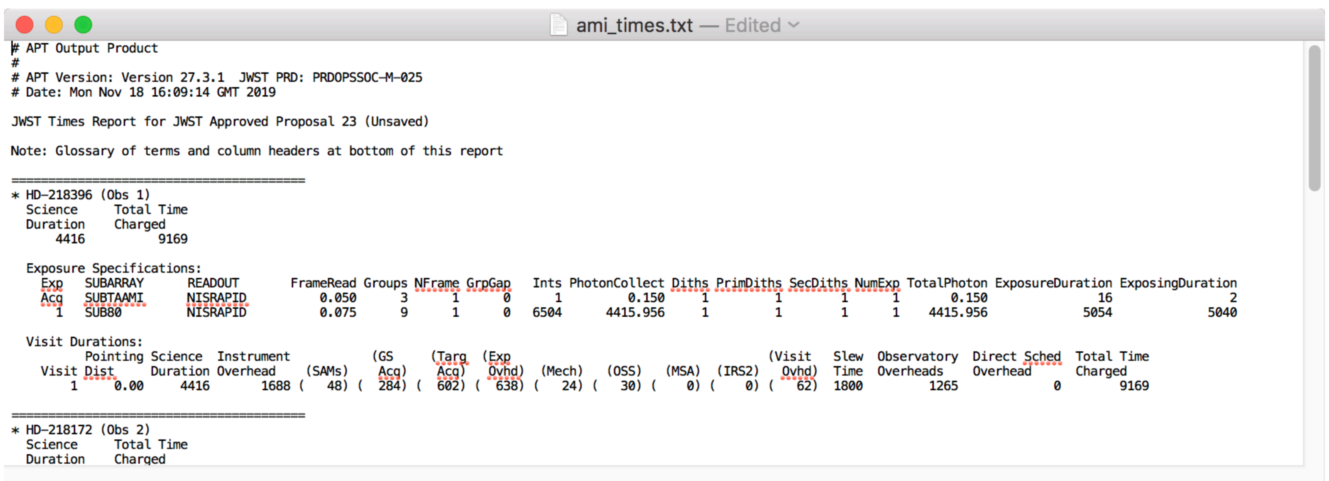
For calibrator observation

- Verify that you entered correct coordinate information by creating target confirmation charts, view observation in Aladin
- Run visit planner
- Run Smart Accounting

NIRISS AMI Observation planning

APT timing report

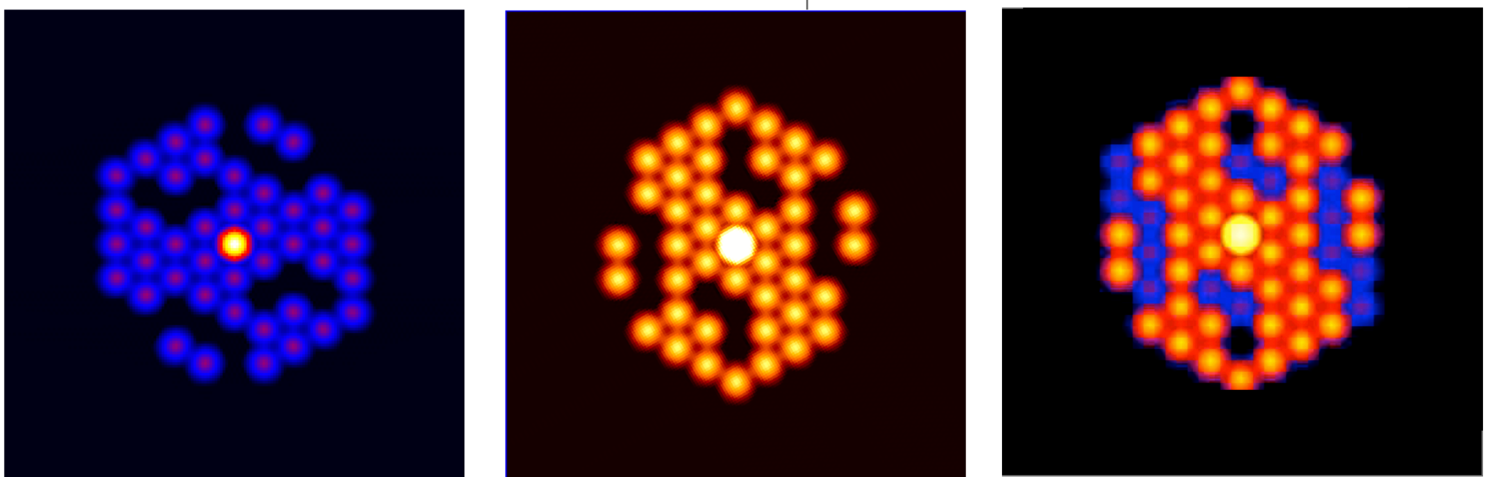





```
# APT Output Product
#
# APT Version: Version 27.3.1  JWST PRD: PRDOPSSOC-M-025
# Date: Mon Nov 18 16:09:14 GMT 2019

JWST Times Report for JWST Approved Proposal 23 (Unsaved)

Note: Glossary of terms and column headers at bottom of this report

========================================
* HD-218396 (Obs 1)
  Science      Total Time
  Duration     Charged
      4416           9169

  Exposure Specifications:
    Exp   SUBARRAY       READOUT         FrameRead Groups NFrame GrpGap    Ints PhotonCollect Diths PrimDiths SecDiths NumExp TotalPhoton ExposureDuration ExposingDuration
    Acq   SUBTAAMI       NISRAPID            0.050      3      1      0       1         0.150     1         1        1      1       0.150               16                2
      1   SUB80          NISRAPID            0.075      9      1      0    6504      4415.956     1         1        1      1    4415.956             5054             5040

  Visit Durations:
          Pointing Science  Instrument          (GS       (Targ   (Exp                               (Visit   Slew  Observatory  Direct Sched  Total Time
    Visit Dist      Duration Overhead    (SAMs)   Acq)      Acq)    Ovhd)  (Mech)    (OSS)     (MSA)   (IRS2)   Ovhd)   Time  Overheads    Overhead      Charged
        1     0.00      4416        1688 (    48) (  284) (  602) (  638) (    24) (    30) (     0) (     0) (   62)  1800        1265           0         9169

========================================
* HD-218172 (Obs 2)
  Science      Total Time
  Duration     Charged
```

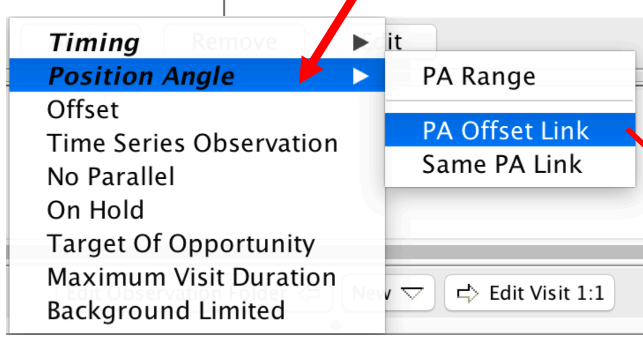
Rotate for good uv-coverage

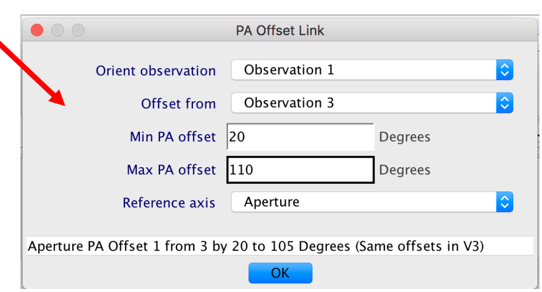
Rotation helps fill uv plane coverage



60 deg rotation

Use Special Requirement tab, to select Position Angle and then PA Offset Link to rotate an observation with respect to another observation. Sun angle constraints limit possible rotations.





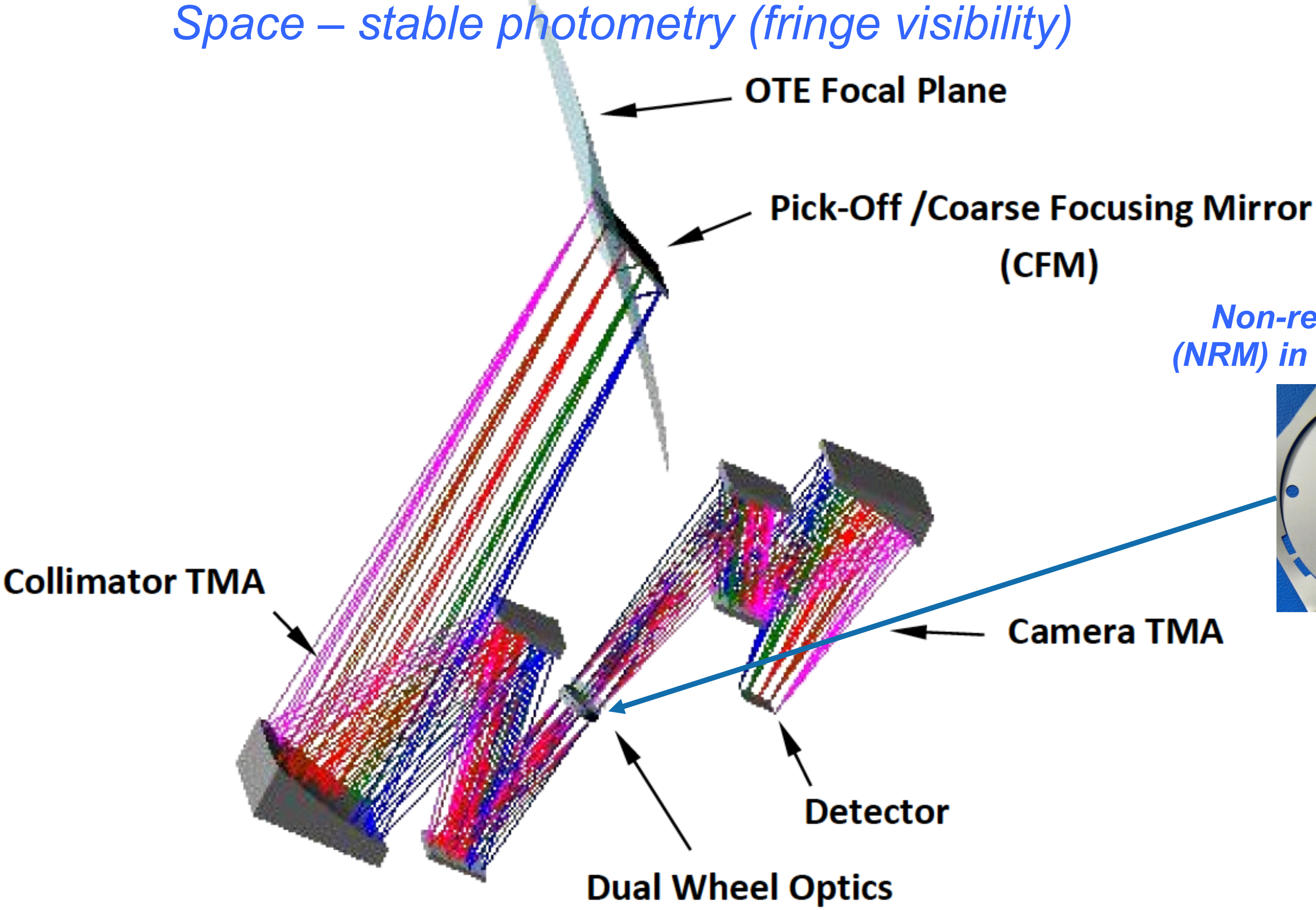
Summary

- Moderate-contrast, high angular resolution imaging using NRM+Filter (F480M, F430M, F380M, F277W)
- Exoplanets, AGNs, Transition Disks Planets/structure, Exozodi disks, Io volcano photometry
- Bright limit ~3 to 4 magnitudes in medium filters.
- Binary point source contrast goal: up-to 10^{-4} at separations of ~70–400 mas
- Complementary to NIRCam coronagraph
- AMI TA 64x64, SUB80 array with NISRAPID readout for data acquisition, FULL array available
- Calculate exposure parameters (NGROUPS, NINT) using JWST ETC, use those as an input to JWST APT.
- Send your questions to JWST help desk https://stsci.service-now.com/jwst

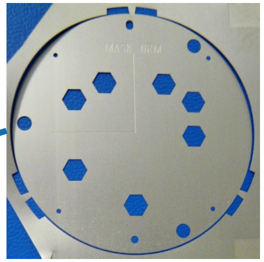
NIRISS AMI backup slides

NIRISS optical design layout

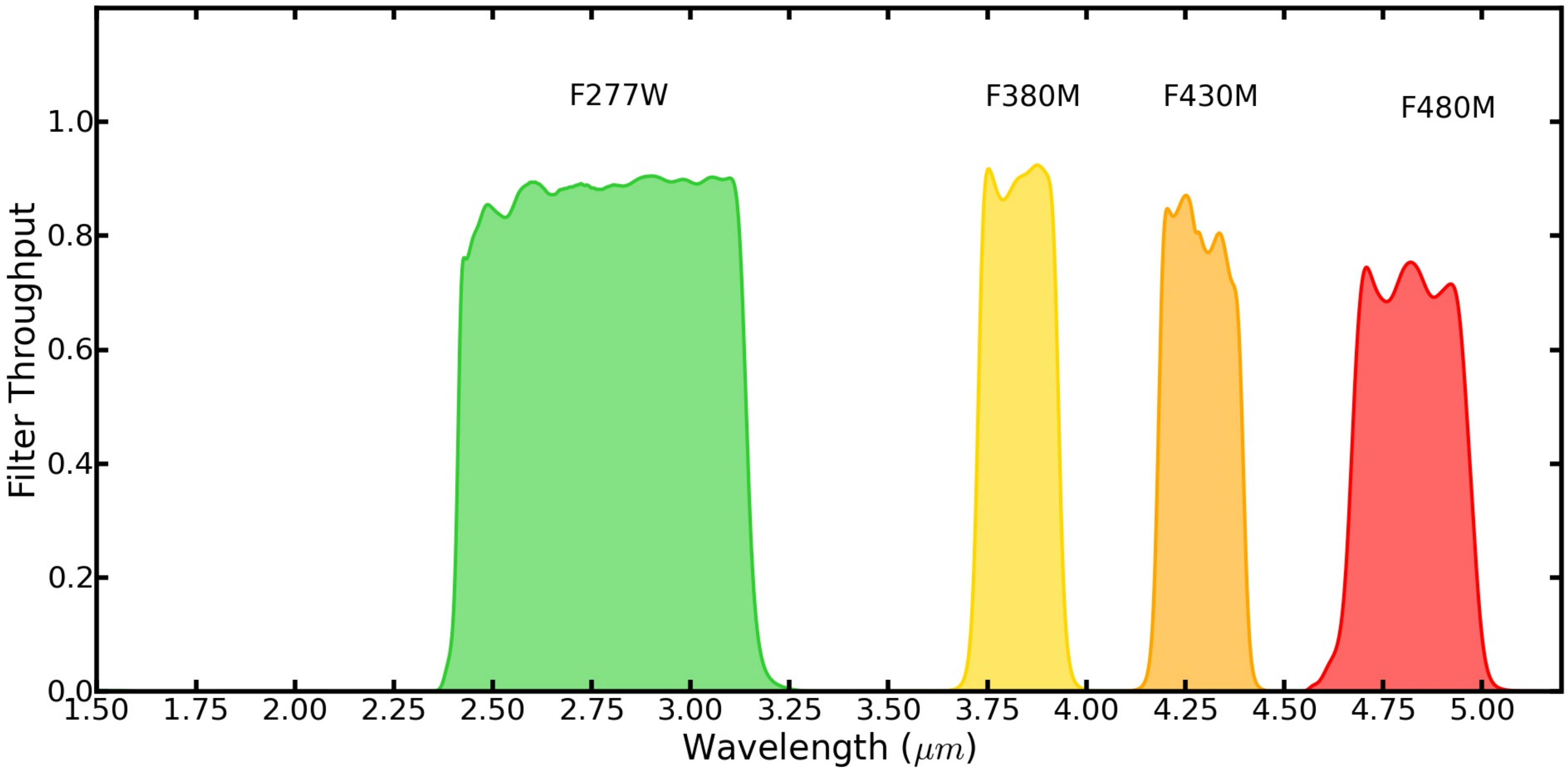
All-reflective design - no chromatic aberration
Space – no atmospheric differential refraction
Space – stable photometry (fringe visibility)



Non-redundant mask (NRM) in pupil wheel (PW)



AMI filter bandpasses

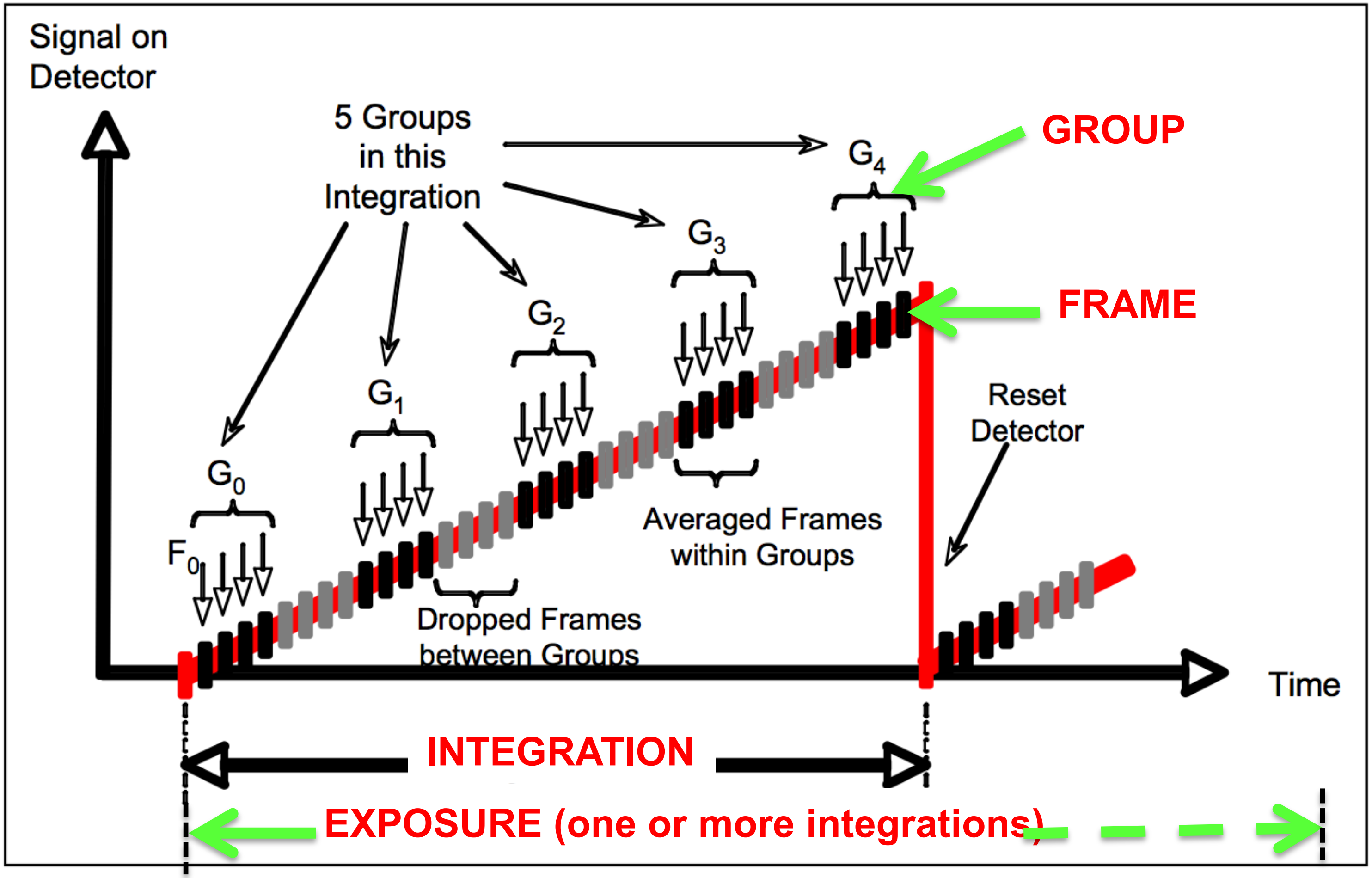


Binary point source contrast ~9+ magnitudes for F380M, F430M, F480M

Reduced perfomance with F277W (not Nyquist sampled) – but good for breaking Brown Dwarf/Jovian Log g/Teff degeneracy to constrain bulk physical properties (Artigau et al. SPIE 2012)

Data Structure
Readout pattern, NGROUPS, NINT

**For NIRISS AMI subarray is SUB80,
readout pattern is NISRAPID (one frame per group)**



NGROUPS: number of groups in an integration

NINT: number of integrations in an exposure

EXPOSURE: The end result of one or more *INTEGRATIONS* over a finite period of time.

EXPOSURE defines the contents of a *single FITS file*

Figure adapted from JWST Mission Operations Concept Document JWST-OPS-002018 Revision E 2014

Post-observations: Calibrate imaging data

- **JWST imaging data analysis on Target or CAL**
  - Common to other JWST imaging, eg NIRCam imaging
  - Correct for non-linearity, flat field, cosmic rays, etc

  To be determined from on-sky performance:
  - ***EITHER*** Average all exposures
    - One final image
  - ***OR*** Average all groups (recommended)
    - NINT images (per exposure – might need multiple exposures)
    - Better for statistics, image quality/stability monitoring

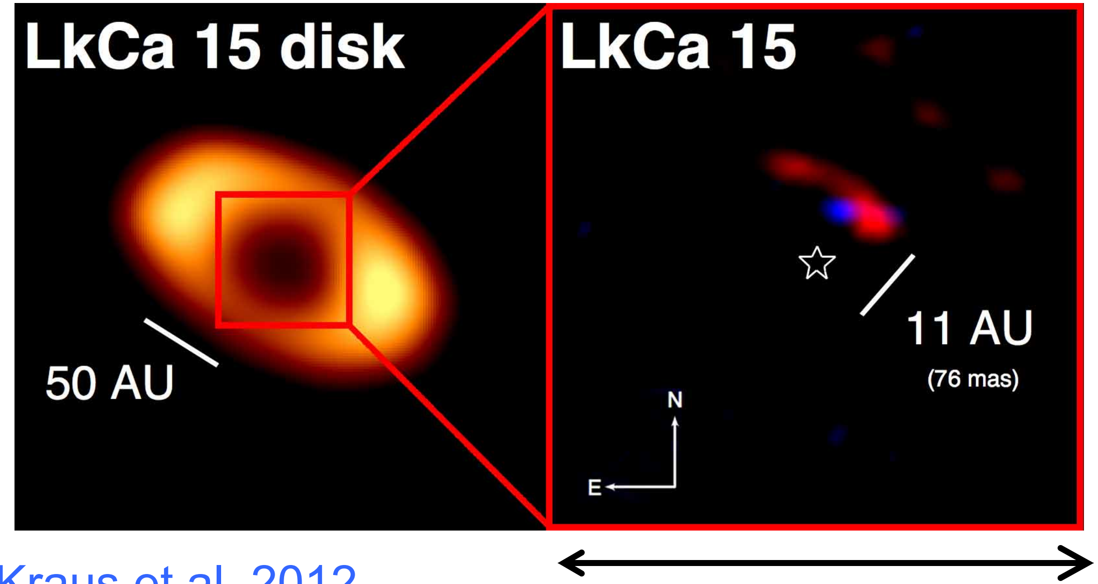
- **Extract observables:**
  - ***EITHER Case A:*** Fringe amplitudes (visibilities) & phases, flux
    - Binary or multiple star model fitting
  - ***OR Case B:*** Use image data for image reconstruction
    - CAL PSF and Target image

Fringe phases & amplitudes

- **Numerical Fourier transform to a complex number array**
  - Conceptually easier to understand but not what we do
  - Measure splodge heights (fringe visibilities), splodge phases in FT(data)
  - Bad pixels corrupt an FT
  - Fix bad pixels then FT? Tricky.
- **Fit analytical model to image (recommended)**
  - Fit analytical fringe model to image, ignore bad pixels
    - Determine ***pupil rotation*** from image
  - Least squares extraction of 21 fringe phases & visibilities, flux, pedestal
  - Calculate:
    - Closure Phases (CPs)
    - Squared visibilities (SqV)
  - See Greenbaum et al. ApJ 2015 for algorithm
  - Implemented in JWST pipeline
- **Fit model of science data to fringe quantities**

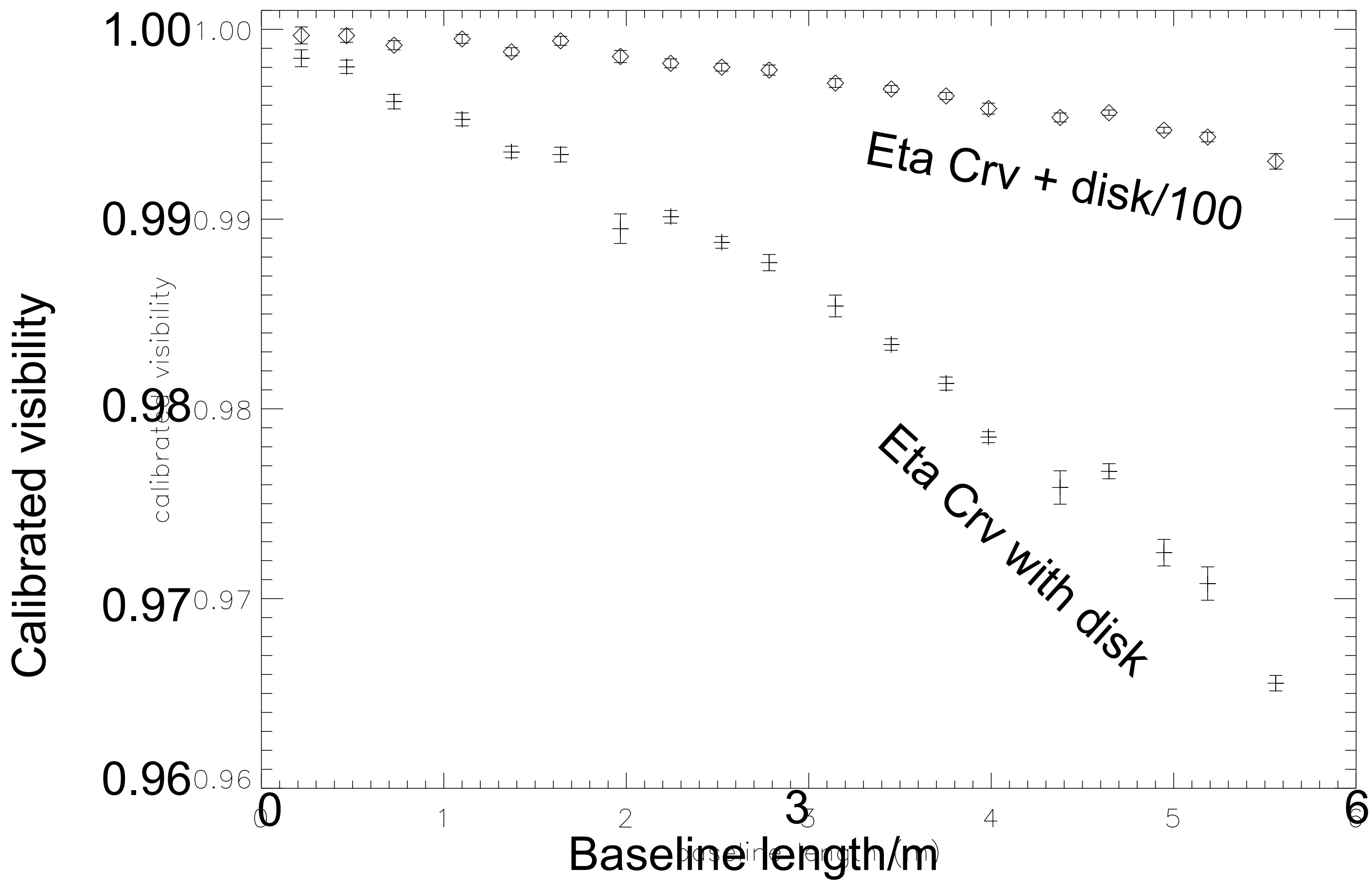
Exoplanet Imaging with AMI

- Three medium-band filters: 3.8, 4.3 & 4.8 μm
  - Provide good constraints on log g and Teff
- Follow-up of GPI/SPHERE planets with separation less than ~0.5 arcsec and contrast $>10^{-4}$ @ 4 um.
  - Photometry and astrometry (e.g. Beta Pic b) (on flip side of FGS)
- Detection/confirmation/disambiguation/follow-up of suspected protoplanets in transitional disks (e.g. LkCA 15 disk)



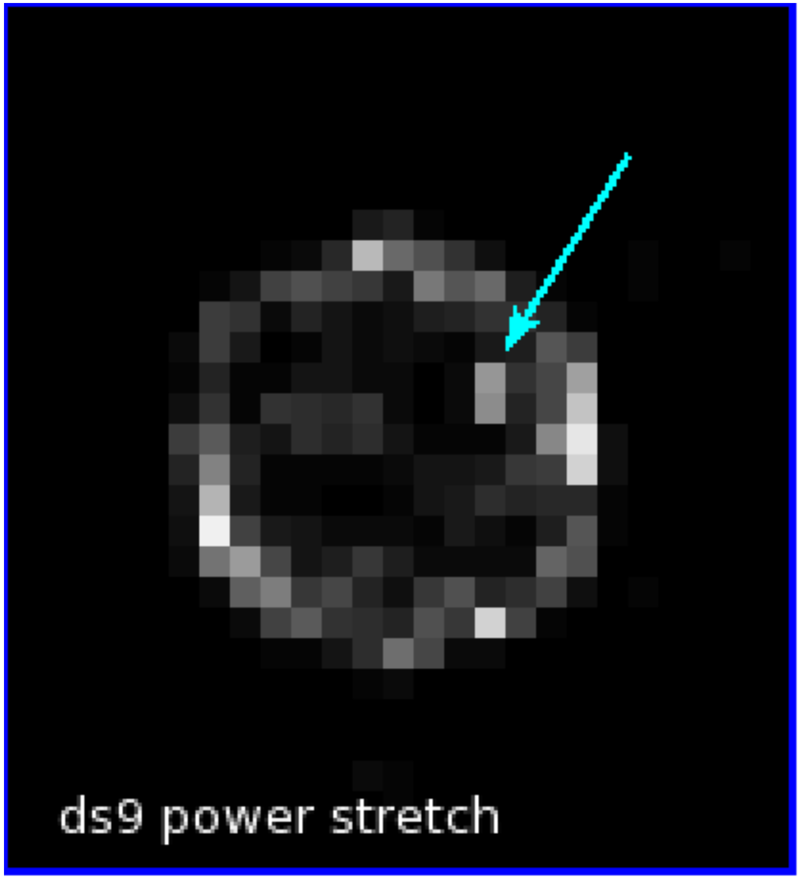
Kraus et al. 2012

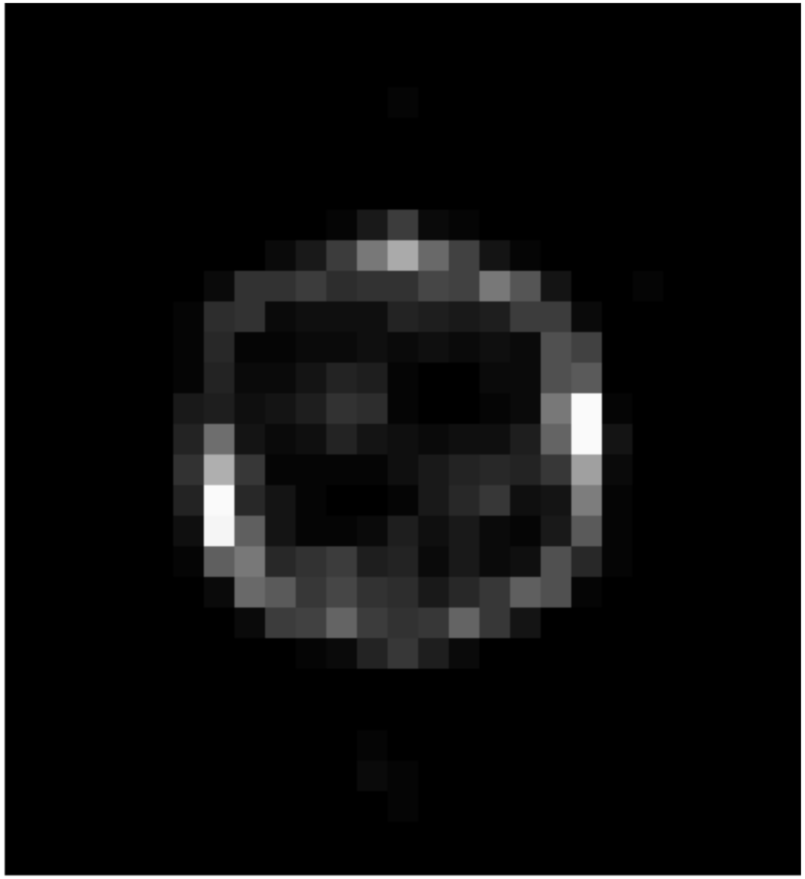
Exozodi measurement



Simulated F480M and F380M visibility of Eta Crv + MCFOST disk model and Eta Crv with 1/100 the dust mass in the disk (Tuthill & Sivaramakrishnan). NIRISS photometric and JWST pointing stability should enable this measurement. Cf. ground > ~5% visibility errors

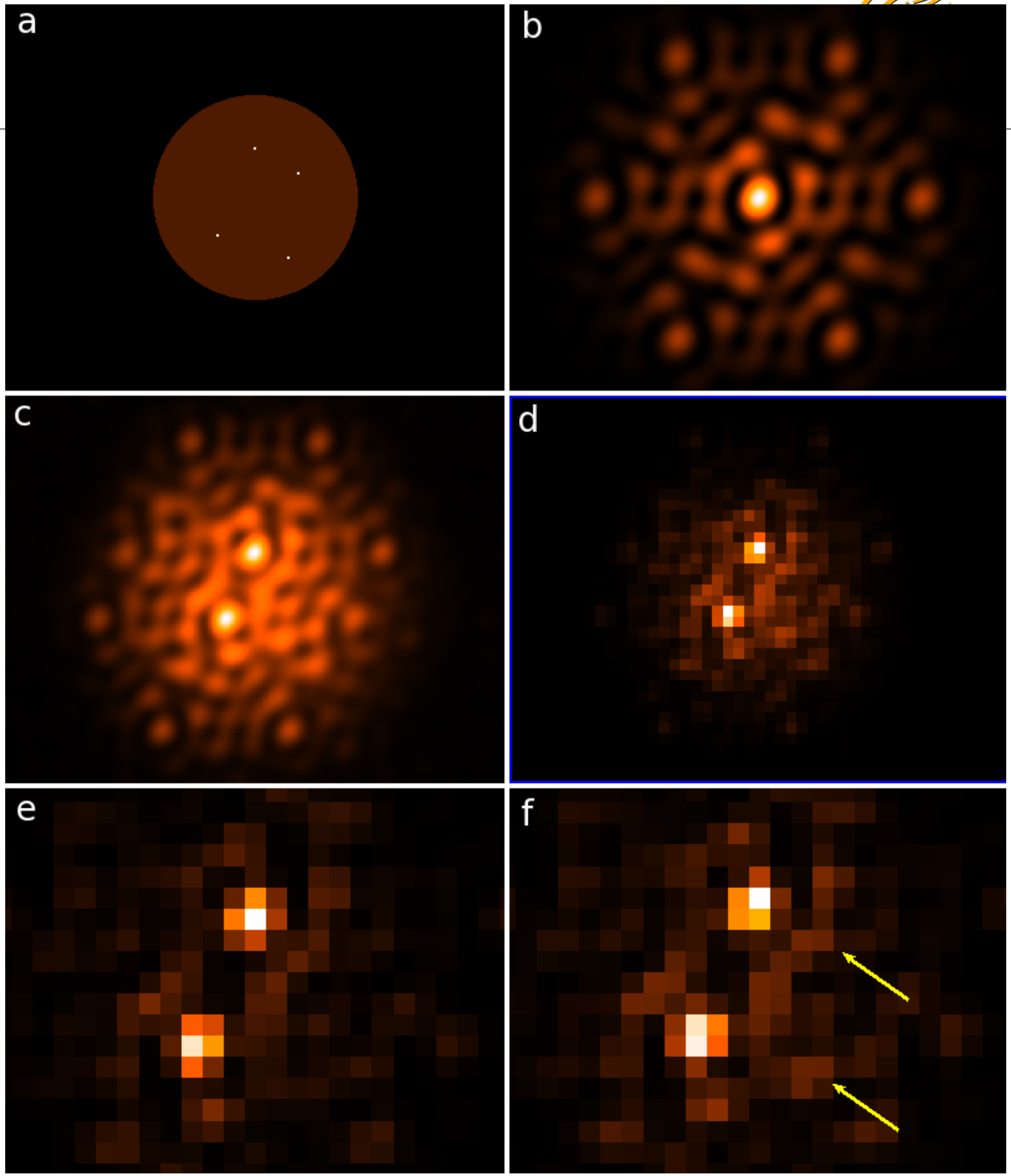
Io vulcanism





Simulated F430M images of Jupiter’s closest Galilean moon, Io, with and without a typical volcanic event, after a Laplacian-like filter is applied to the simulated data. Space-based ***photometry*** of such a volcanic event should improve upon ground-based adaptive optics photometry (Thatte et al. LPSC 2015)

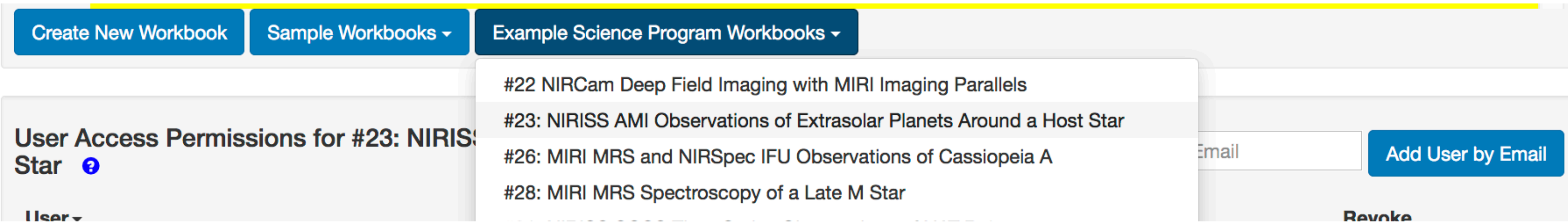
Simulated volcanoes on Jupiter's moon Io



NIRISS AMI hands-on exercises

Example science program in JWST ETC

1. Log in to JWST ETC and Open program #23



Create a scene with another target with spectral type F0V, vegamag=6.5, normalized in NIRISS F430M. Name the source ‘Target 2’ and name the scene ‘Target 2 Scene’

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the ‘Maximum number of Groups Before Saturation’ value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

AMI calculations in JWST ETC

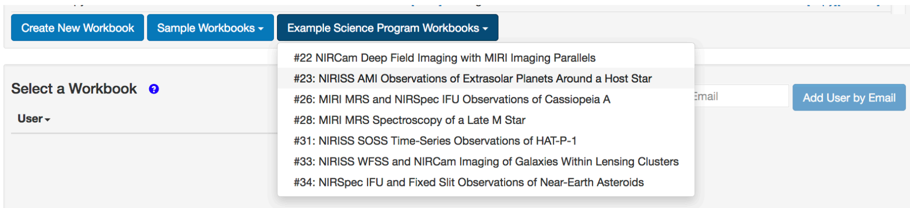
2. What is the magnitude (Vegamag) of the brightest F0V star that you can observe with NGROUPS=7 in F480M, F380M?

3. Create calculations to calculate NGROUPS and NINT required to get 10^7 photons from HD37093. Use Vegamag = 5.47 normalized in F380M and vegamag=5.46 normalized in F430M and F480M

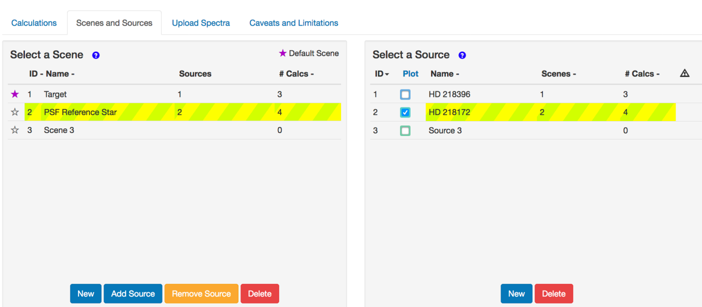
4. Calculate NGROUPS=1 and NGROUPS=2 bright limits (Vegamag) for a A0V star observed with F380M.

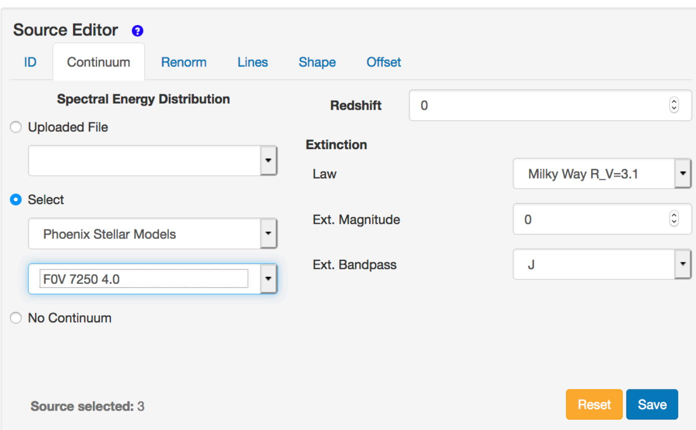
AMI calculations in JWST ETC
Answers to questions

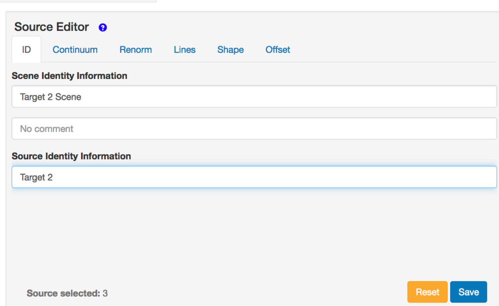
1. Log in to JWST ETC and Open program #23



2. Create a scene with another target with spectral type F0V, vegamag=6.5, normalized in NIRISS F430M. Name the source ‘Target 2’ and name the scene ‘Target 2 Scene’

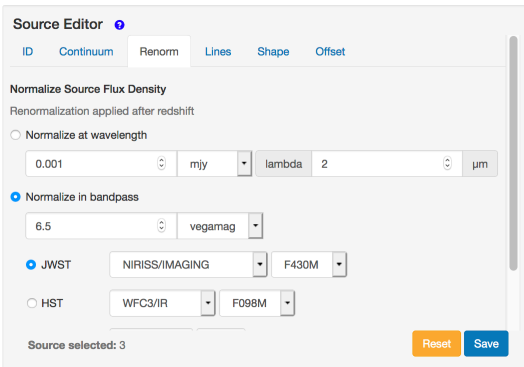


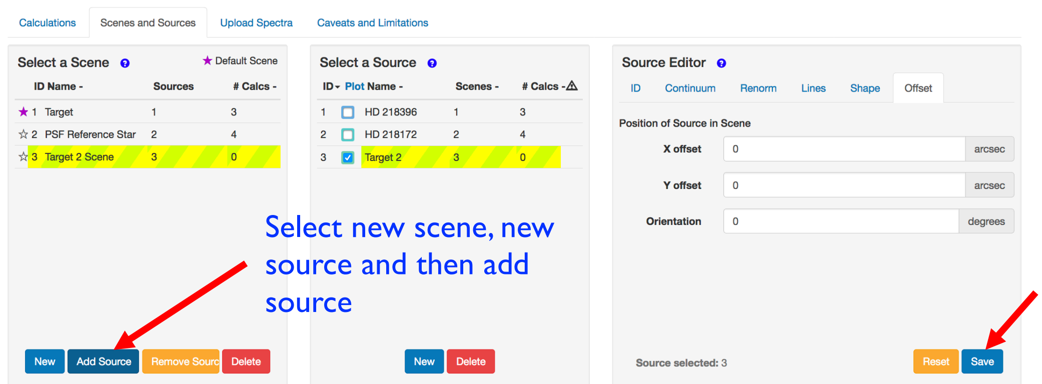




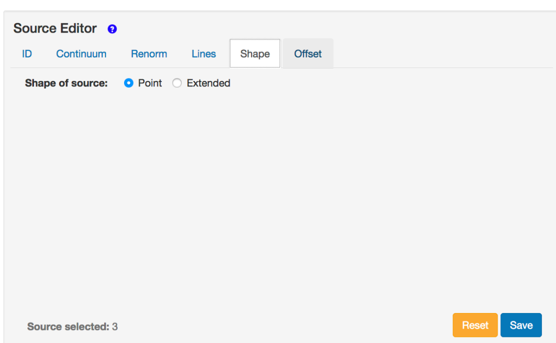
AMI calculations in JWST ETC
Answers to questions

2. Create a scene with another target with spectral type F0V, vegamag=6.5, normalized in NIRISS F430M. Name the source 'Target 2' and name the scene 'Target 2 Scene' continued…





Select new scene, new source and then add source



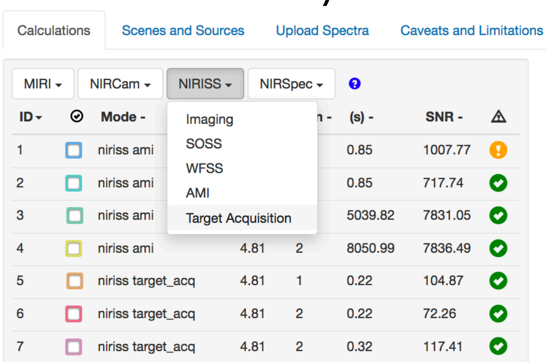
AMI calculations in JWST ETC

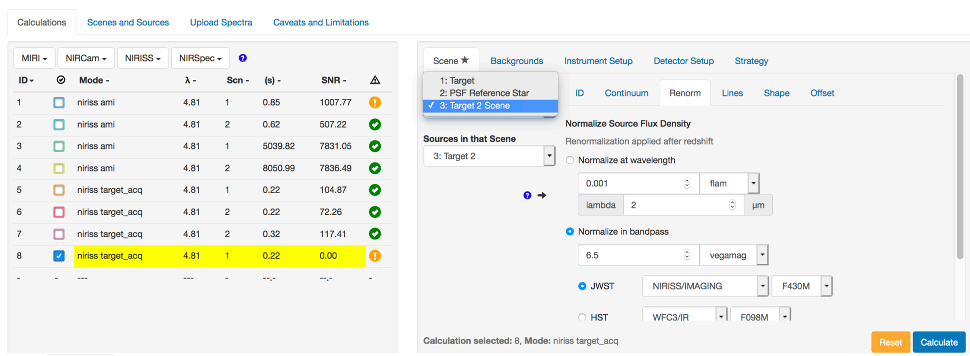
Answers to questions

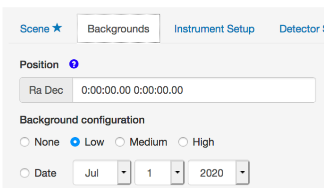
i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
  - Use photon collect time formula and Extracted Flux in the Reports panel

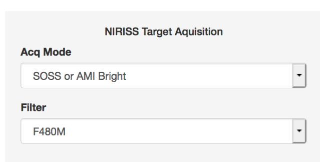
vi. What contrast can you reach with 10^9 total photons?

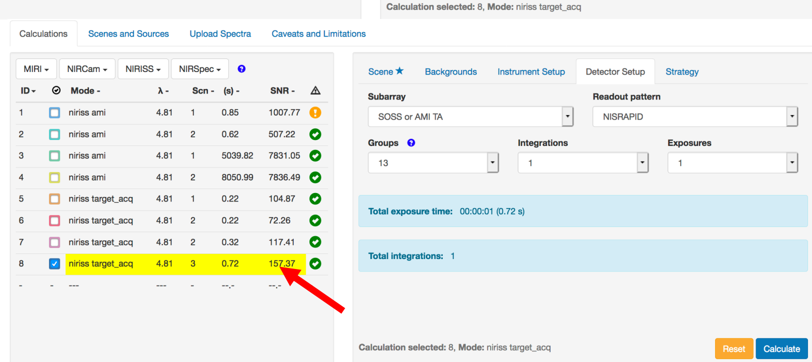
i







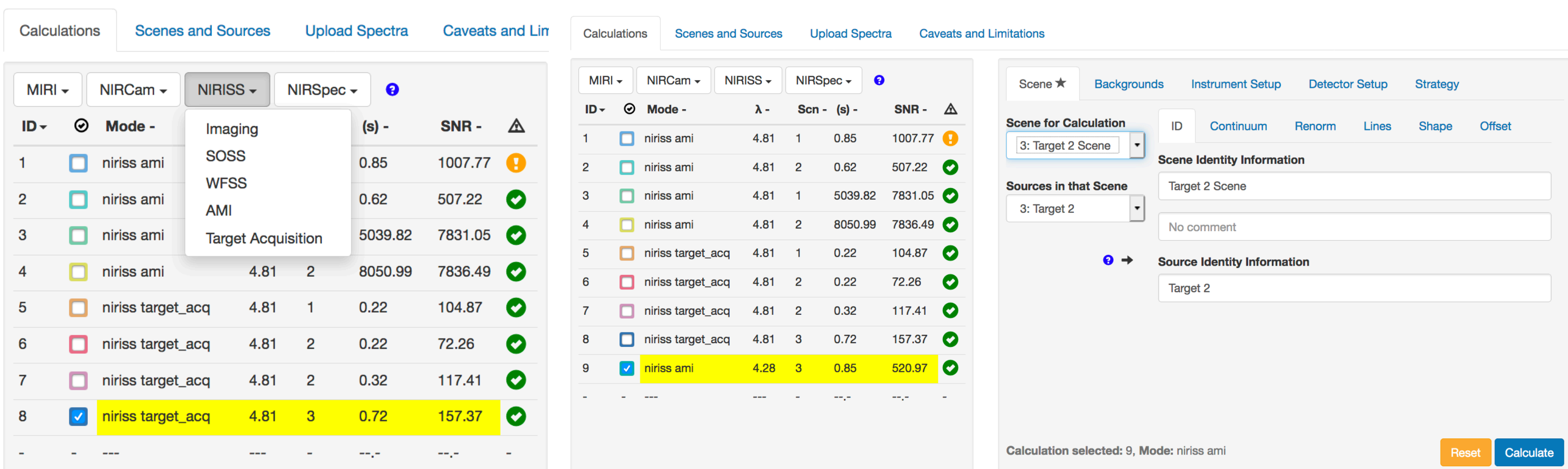




AMI calculations in JWST ETC
Answers to questions

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

ii

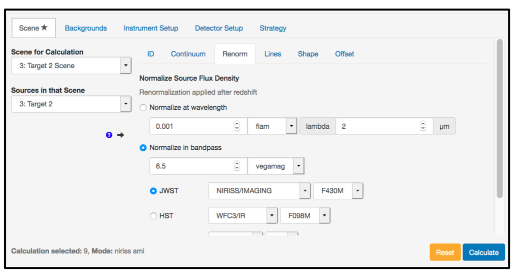


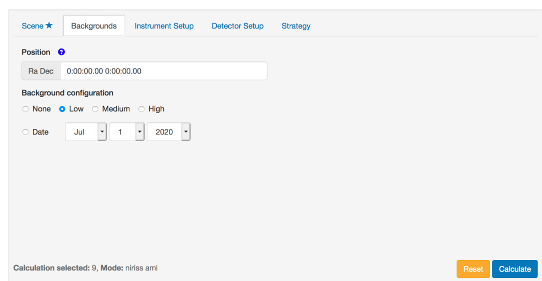
AMI calculations in JWST ETC
Answers to questions

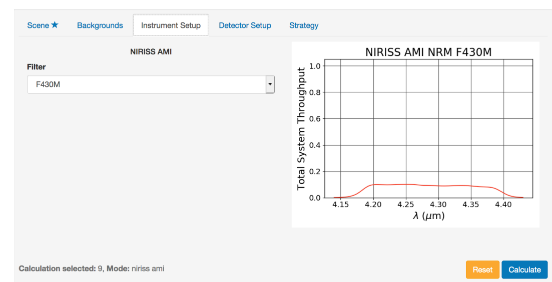
i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

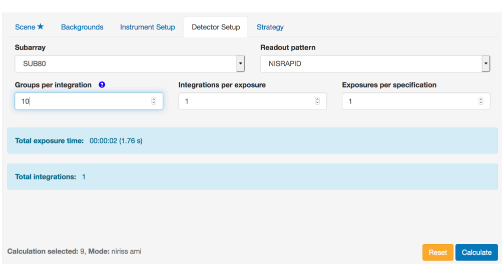
iii

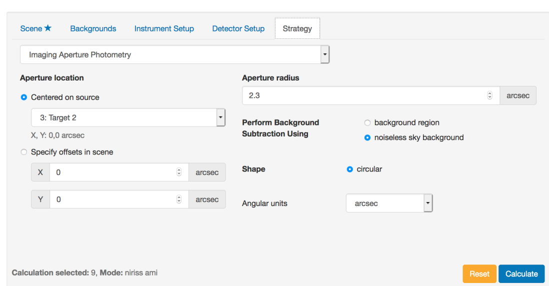
Update Scene, background, Instrument Setup and Strategy and run the calculation with default Detector Setup







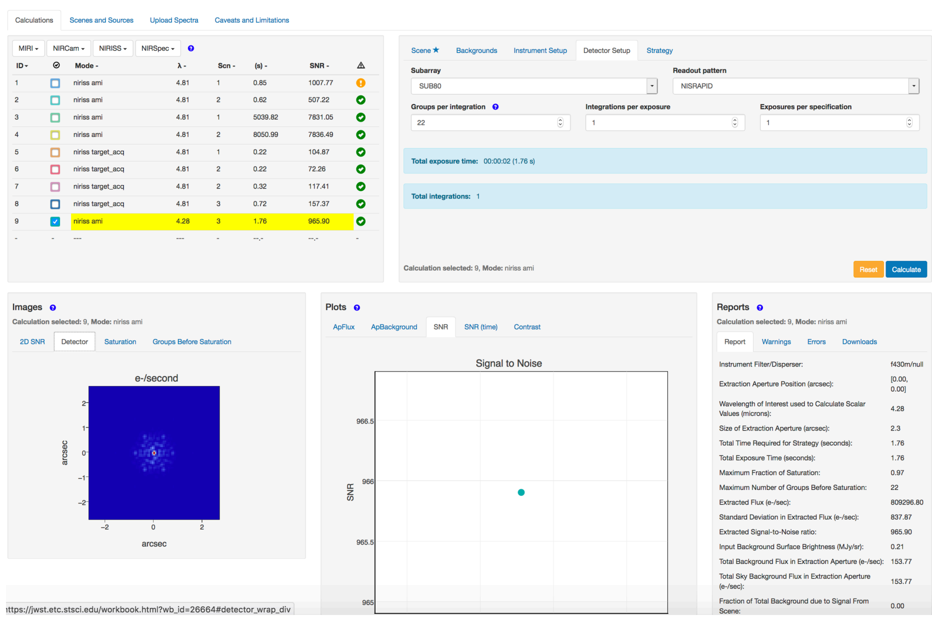




AMI calculations in JWST ETC
Answers to questions

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

iii
continued

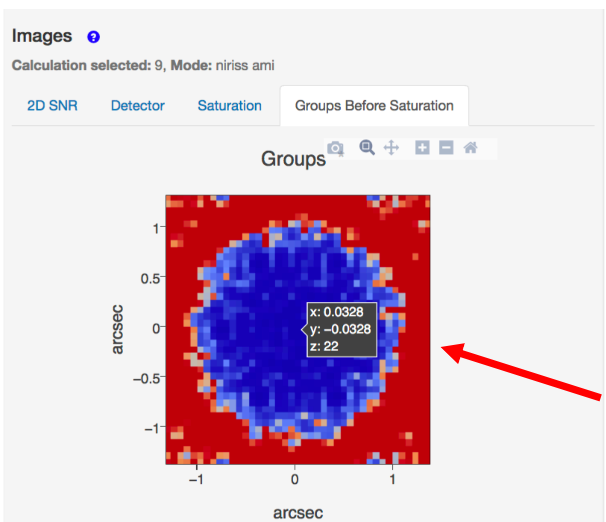


Maximum Number of Groups Before saturation value is 22 from the Reports panel. Therefore set Groups per integration to 22. (NGROUPS)

AMI calculations in JWST ETC
Answers to questions

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

iv



* * When two neighboring pixels accumulate charge at very different rates, the brighter pixel "spills" photoelectrons on to its neighbor, but the reverse does not occur. This effect becomes pronounced above about 30,000 e- in the bright pixel. We mitigate this effect in AMI data by setting an effective saturation limit lower than the true non-linearity-based saturation limit for the NIRISS detector.

Reports

Calculation selected: 9, Mode: niriss ami

Report | Warnings | Errors | Downloads

Instrument Filter/Disperser:	f430m/null
Extraction Aperture Position (arcsec):	[0.00, 0.00]
Wavelength of Interest used to Calculate Scalar Values (microns):	4.28
Size of Extraction Aperture (arcsec):	2.3
Total Time Required for Strategy (seconds):	1.76
Total Exposure Time (seconds):	1.76
Maximum Fraction of Saturation:	0.97
Maximum Number of Groups Before Saturation:	22
Extracted Flux (e-/sec):	809296.80
Standard Deviation in Extracted Flux (e-/sec):	837.87
Extracted Signal-to-Noise ratio:	965.90
Input Background Surface Brightness (MJy/sr):	0.21
Total Background Flux in Extraction Aperture (e-/sec):	153.77
Total Sky Background Flux in Extraction Aperture (e-/sec):	153.77
Fraction of Total Background due to Signal From Scene:	0.00
Average Number of Cosmic Rays per Ramp:	1.3e-4

Maximum number of Groups Before *saturation in the brightest pixel of AMI PSF.

AMI calculations in JWST ETC

Answers to questions

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
  - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

V

Total Time Required for Strategy (seconds):	1.76
Total Exposure Time (seconds):	1.76
Maximum Fraction of Saturation:	0.97
Maximum Number of Groups Before Saturation:	22
Extracted Flux (e-/sec):	809296.80
Standard Deviation in Extracted Flux (e-/sec):	837.87
Extracted Signal-to-Noise ratio:	965.90
Input Background Surface Brightness (MJy/sr):	0.21

```
Total photons = flux × NGROUPS × NINT × TFRAME
 NINT = Total photons/(flux × NGROUPS × TFRAME)
      =  10⁹ / (809296.80 e-/sec × 22 × 0.07544 sec)
      =  744.5  –> Round up to 745
```

AMI calculations in JWST ETC
Answers to questions

i. Create a Target Acquisition calculation for this source
ii. Create a new calculation to use this scene
iii. Calculate NGROUPS for an observation with NRM + F430M
iv. Compare the 'Maximum number of Groups Before Saturation' value with the central pixel value in Groups Before Saturation image
v. Calculate NINT to get 10^9 total photons in the exposure.
   - Use photon collect time formula and Extracted Flux in the Reports panel
vi. What contrast can you reach with 10^9 total photons?

vi

sqrt(100/(10**9)) = 0.0003

AMI calculations in JWST ETC

Answers to questions

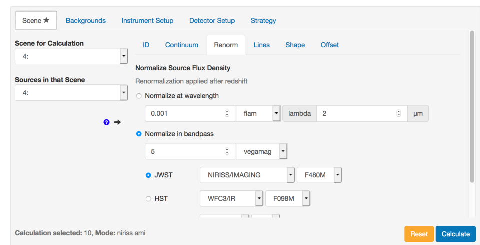
2. What is the vegamag magnitude of the brightest F0V star that you can observe with NGROUPS=7 in F480M, F380M?

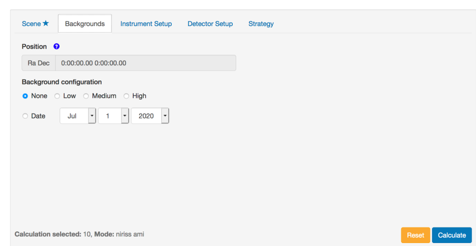
- F480M

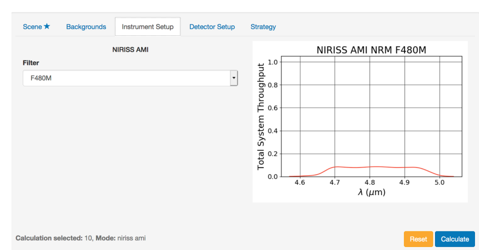
Vegamag =5 gives maximum number of Groups Before Saturation as 7.
Vegamag = 5.1 gives maximum number of Groups Before Saturation as 8.
Therefore vegamag=5 is the NGROUP=7 bright limit for F480M

- F380M

vegamag = 6
for NGROUPS=7







Reports

Calculation selected: 10, **Mode:** niriss ami

Report | Warnings | Errors | Downloads

Instrument Filter/Disperser:	f480m/null
Extraction Aperture Position (arcsec):	[0.00, 0.00]
Wavelength of Interest used to Calculate Scalar Values (microns):	4.81
Size of Extraction Aperture (arcsec):	2.5
Total Time Required for Strategy (seconds):	0.62
Total Exposure Time (seconds):	0.62
Maximum Fraction of Saturation:	0.91
Maximum Number of Groups Before Saturation:	7
Extracted Flux (e-/sec):	2877649.50
Standard Deviation in Extracted Flux (e-/sec):	3275.57
Extracted Signal-to-Noise ratio:	878.52
Input Background Surface Brightness (MJy/sr):	0.00
Total Background Flux in Extraction Aperture (e-/sec):	0.00
Total Sky Background Flux in Extraction Aperture (e-/sec):	0.00
Fraction of Total Background due to Signal From Scene:	0.00

AMI calculations in JWST ETC

Answers to questions

3. Create calculations to calculate NGROUPS and NINT required to get 10^7 photons from HD37093. Use Vegamag = 5.47 normalized in F380M and vegamag=5.46 normalized in F430M and F480M

Answer:
This is similar to calculations 2, 3 and 4 in NIRISS AMI Examples sample workbook. The only difference is in the total number of photons which will change the number of integrations.

F480M NGROUPS=11, NINT = 7
F430M NGROUPS=8, NINT = 8
F380M NGROUPS=4, NINT = 11

AMI calculations in JWST ETC
Answers to questions

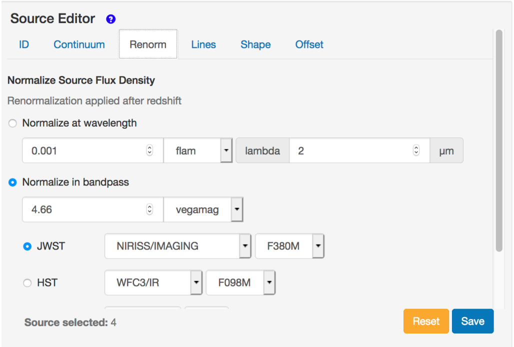
4. Calculate NGROUPS=1 and NGROUPS=2 bright limits (Vegamag) for A0V star observed with F380M.

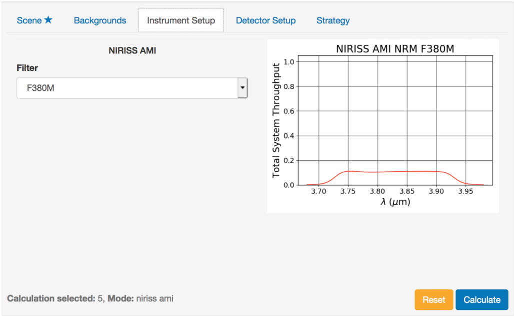
This is similar to Example 3 in NIRISS AMI Examples. Only the filter is different.

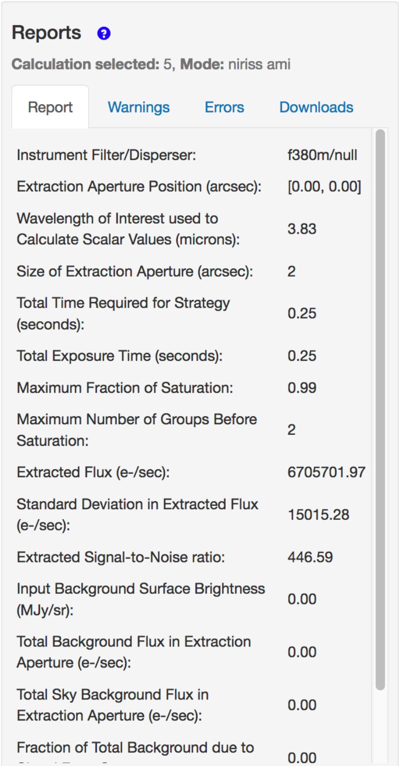
NGROUPS=2 bright limit
For F380M

4.66

Change the magnitude to
4.65 and look at the warning message





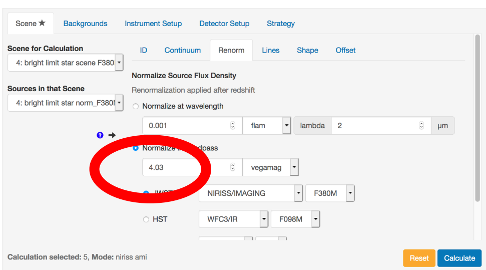


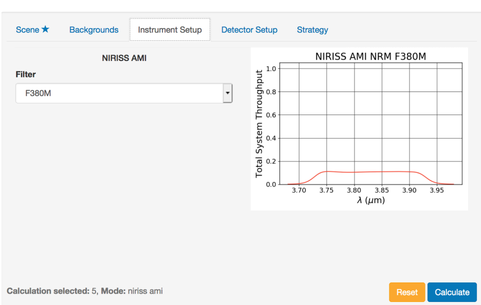
AMI calculations in JWST ETC
Answers to questions

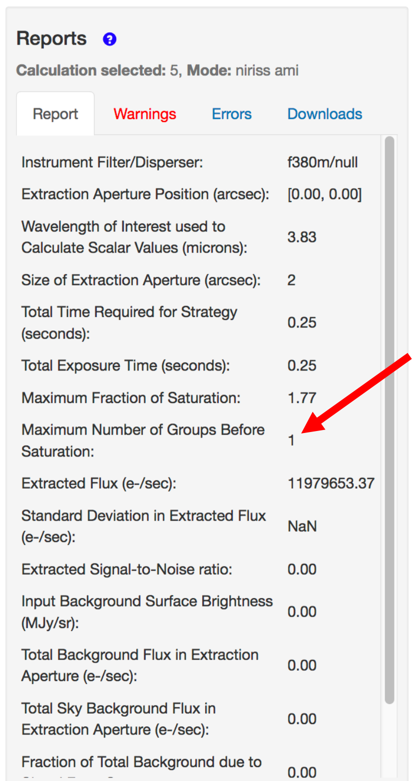
4. Calculate NGROUPS=1 and NGROUPS=2 bright limits (Vegamag) for A0V star observed with F380M.

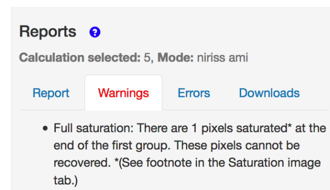
This is similar to Example 3 in NIRISS AMI Examples. Only the filter is different.

NGROUPS=1 bright limit for F380M is 4.03. Change the magnitude to 4.02 and look at the central pixel in Groups Before Saturation image.

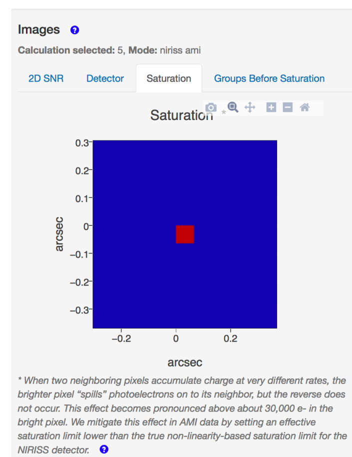




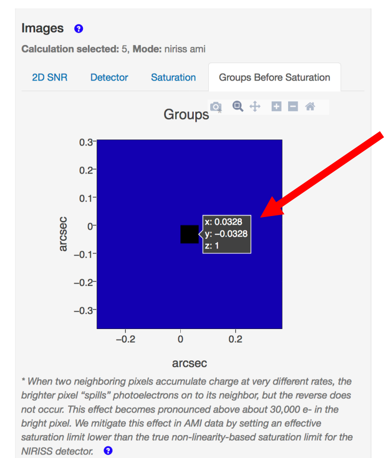




Signal limit exceeded in group 2 but not in group 1



Saturation image

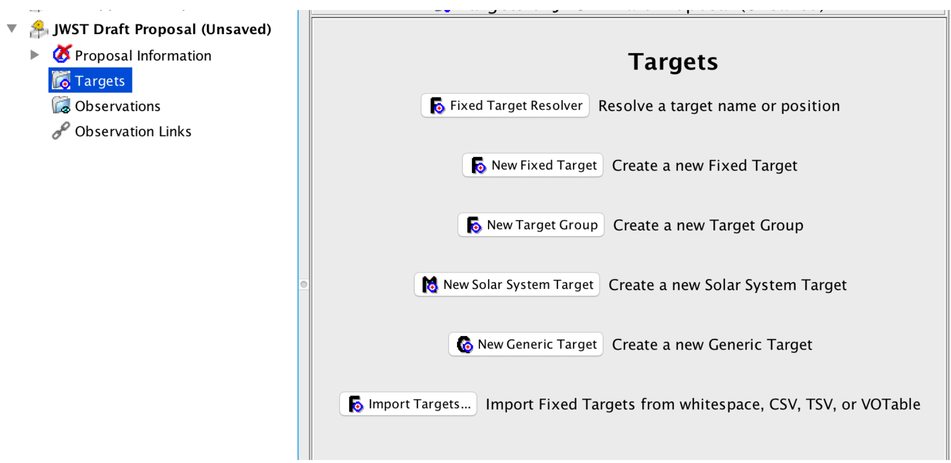


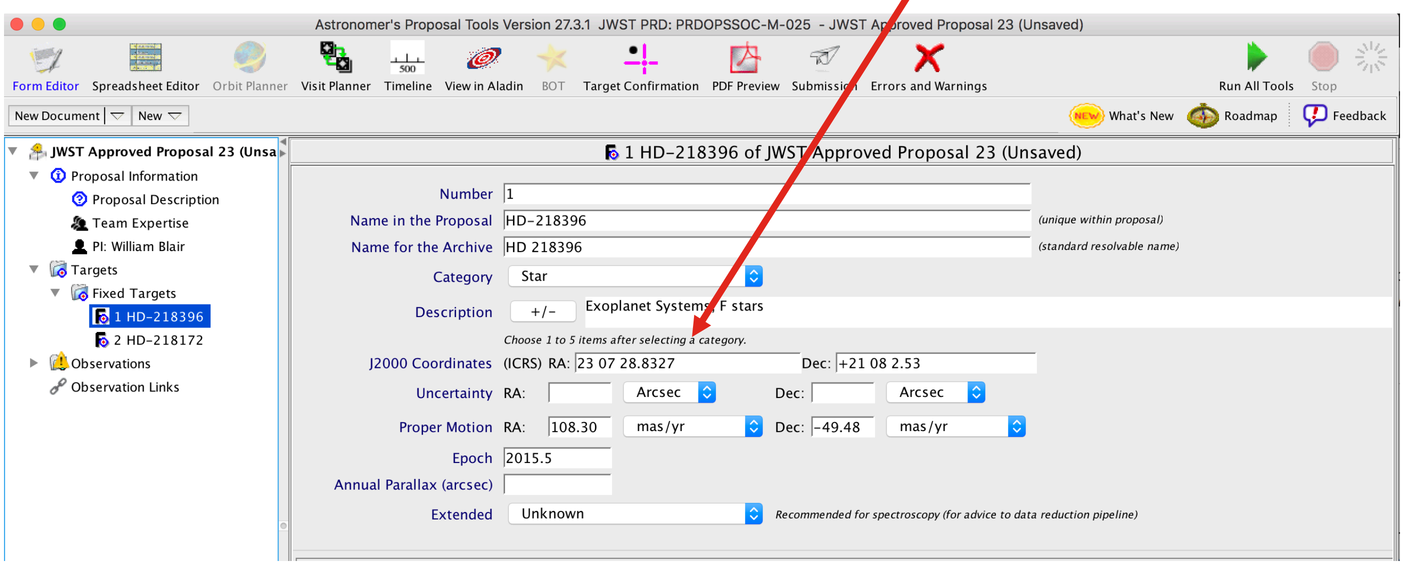
Groups Before Saturation image

Example science program in JWST APT
AMI Specific strategies

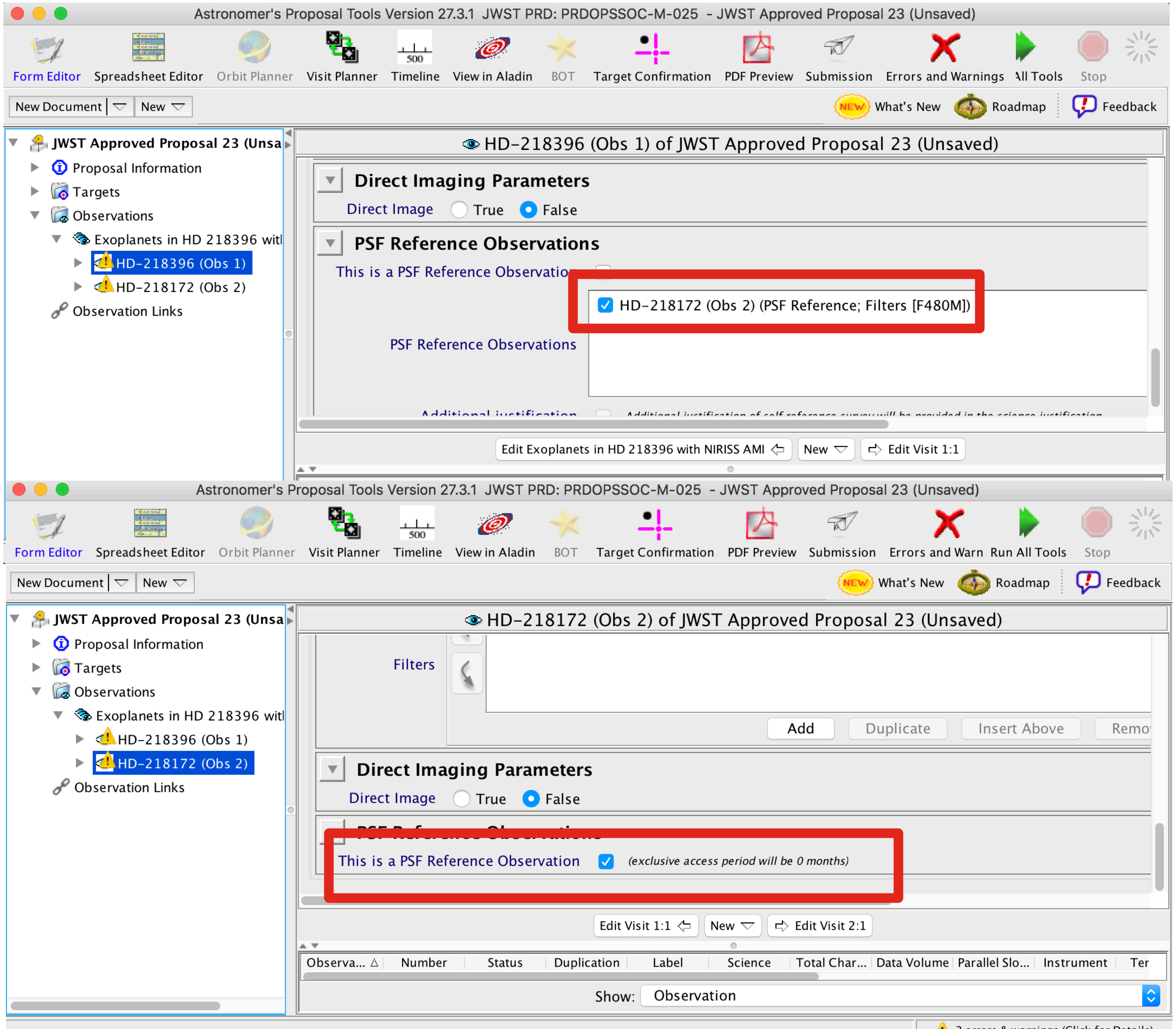
Get coordinates from GAIA DR2 archive, enter epoch as 2015.5

- Use Fixed Target Resolver to search for target and then manually update coordinates OR
- Select New Fixed target and update information.



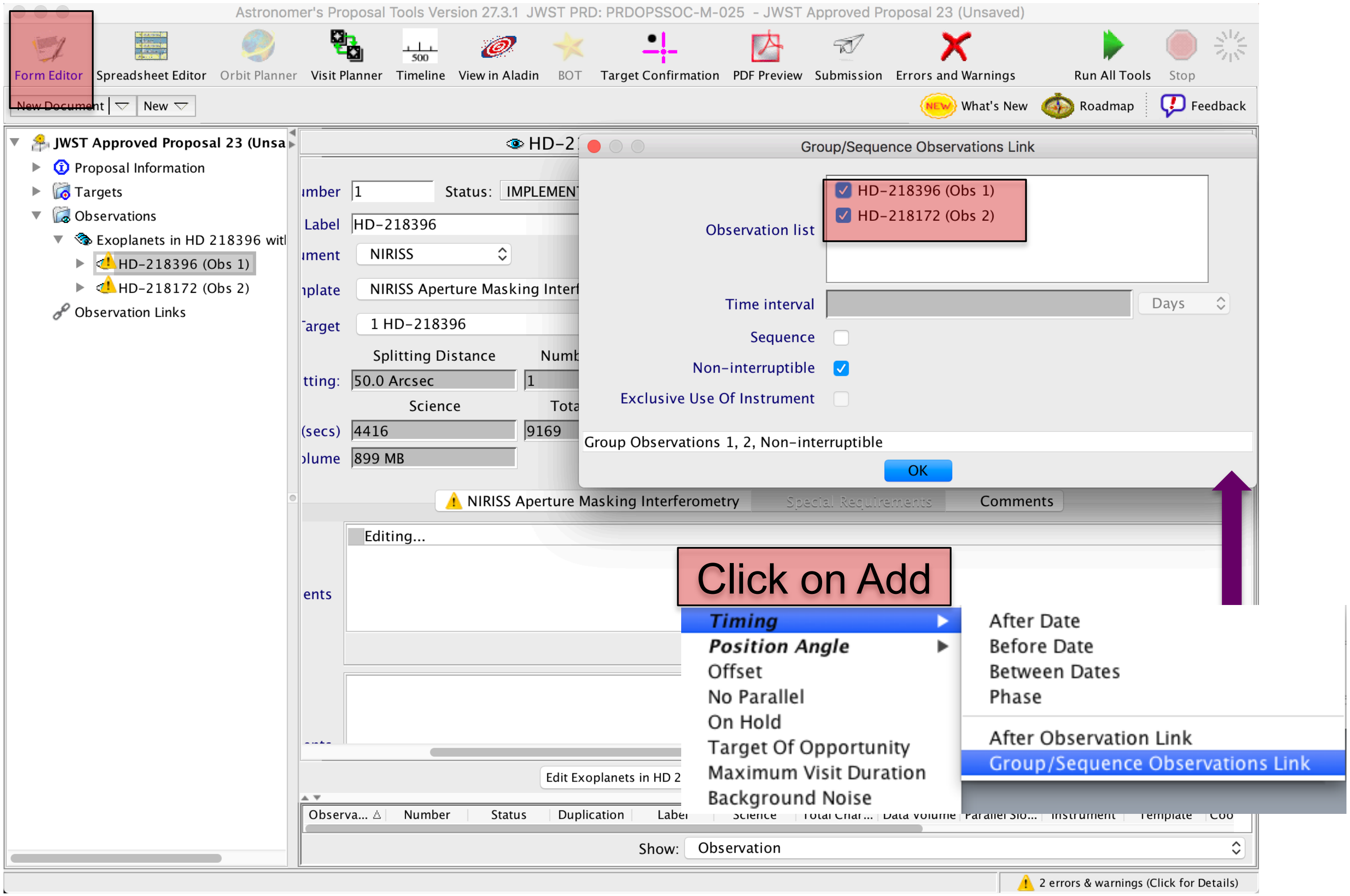


Example science program in JWST APT



Example science program in JWST APT AMI Specific strategies

Adding Special Requirements



Example science program in JWST APT
AMI Specific strategies

Create 'NIRISS AMI Observations of Extrasolar Planets around a Host Star' proposal and compare with the existing program.

- Select target HR8799(or HD218396) and calibrator (HD218172).
- Enter/update coordinates, proper motion using information from Gaia DR2 archive, use 2015.5 epoch.
- Create observations for each source using NIRISS AMI template.
- Update exposure parameters using calculations 5 and 7 for Target Acquisition and calculations 3 and 4 for science observations in JWST ETC example science program workbook #23: NIRISS AMI Observations of Extrasolar Planets Around a Host Star.
- Create Group non-interruptible Special Requirement for the target and the calibrator.
- Update PSF Reference Observations field for the target and the calibrator.
- Run visit planner
- Run Smart accounting
- Create the times report (via APT File – Export) to look at an ASCII listing of charged times
- Create Target Confirmation Charts and view the observations in Aladin.