STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

HIGH CONTRAST IMAGING (HCI) WITH JWST

Hands-on Session

General & Coronagraphy

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Master Class - Level 2 - Nov 19th & 20th 2019 - STScI

For this session you will need

- JMMC's **SearchCal**

Google Search "JMMC SearchCal"

or http://www.jmmc.fr/searchcal_page.htm

- The **Coronagraph Visibility Tool (CVT)**:

Google Search "JWST CVT", GitHUB github.com/spacetelescope/jwst_coronagraph_visibility

or https://jwst-docs.stsci.edu/other-tools/target-visibility-tools/jwst-coronagraphic-visibility-tool-help

Use Case: HR 8799 b c d e

The HR 8799 Science Use Case

Face on

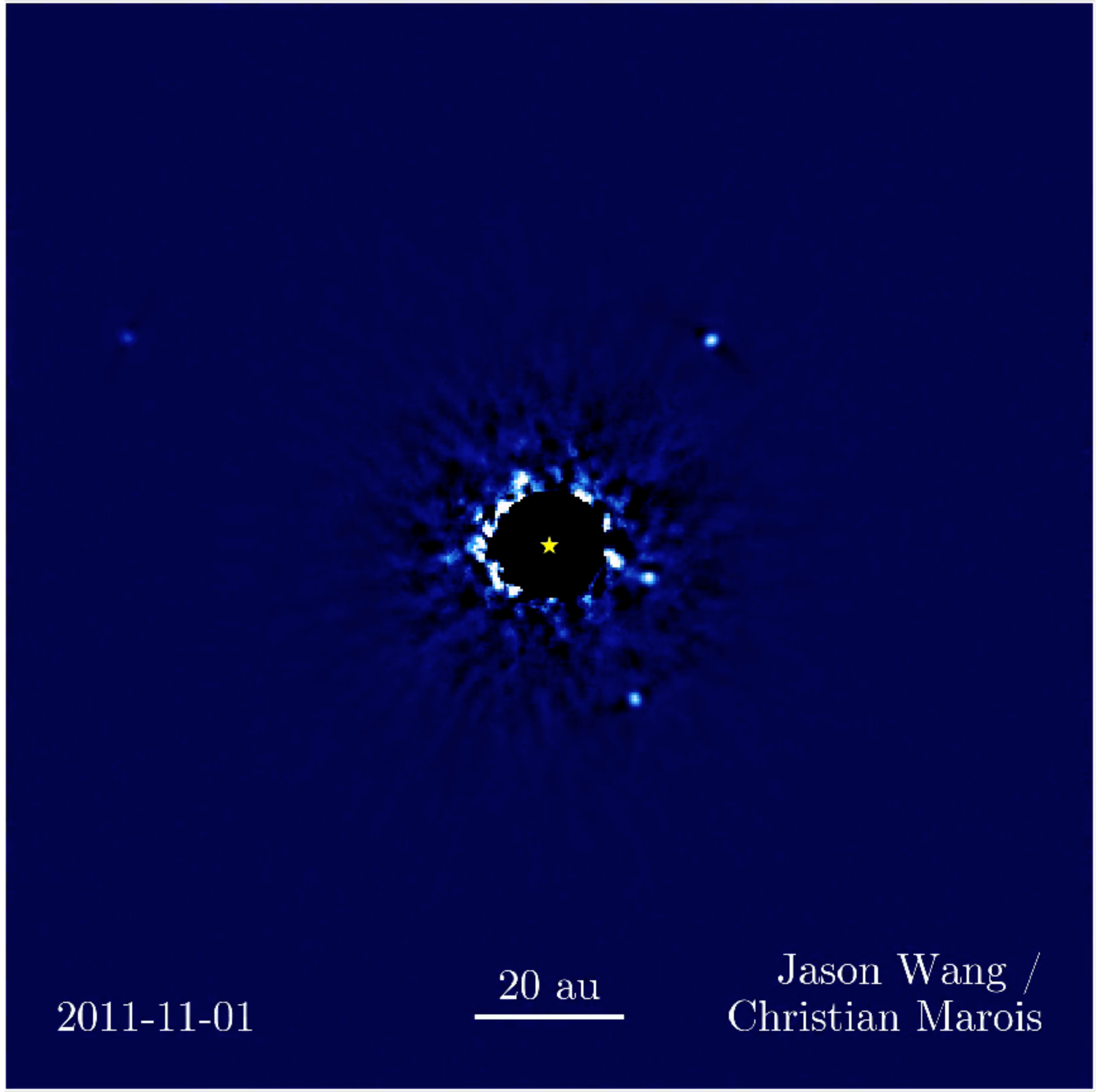
4 planets with mass < 8 M_{Jup}

b at 1.7” is the faintest

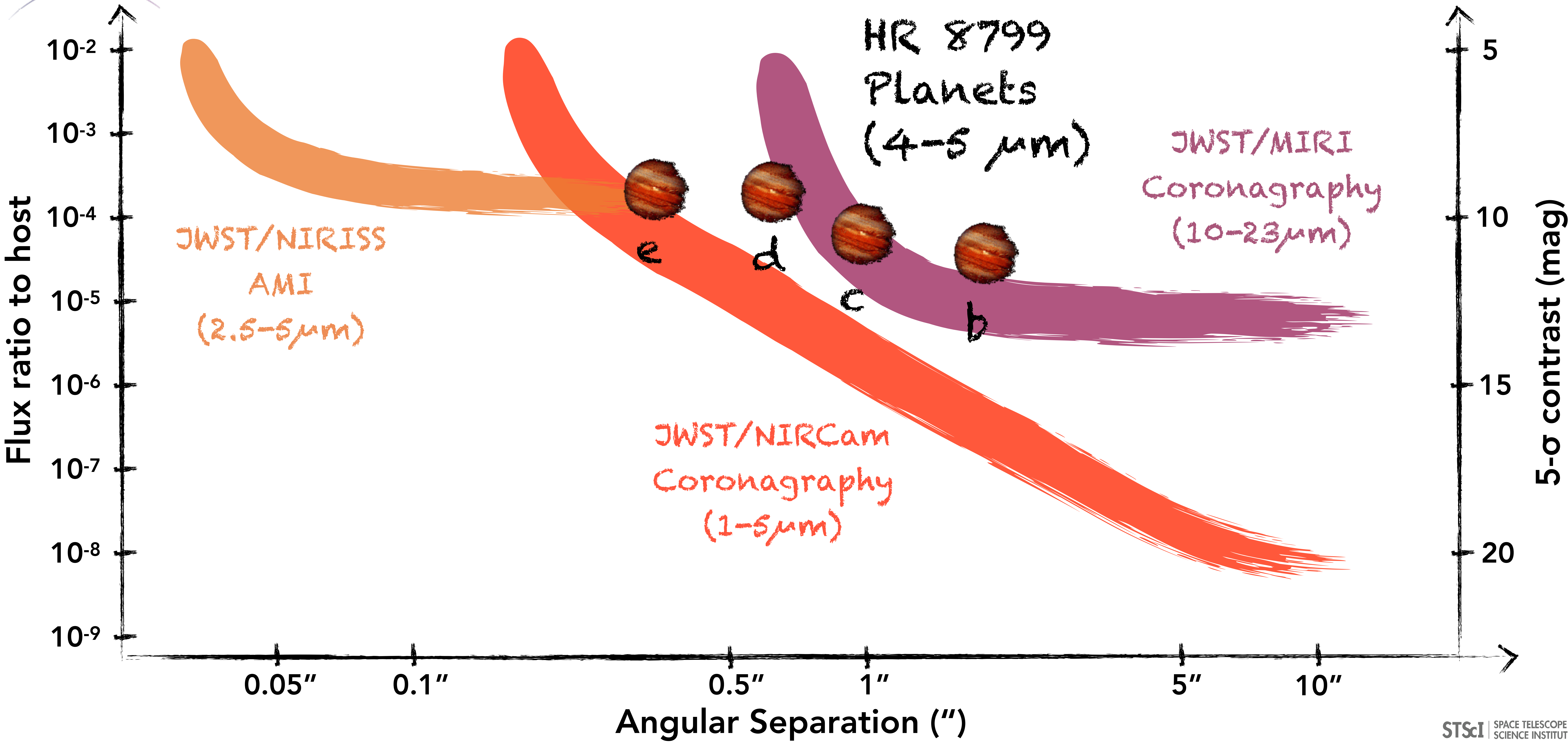
b c d e are all doable with NIRCam Coronagraphy

b & c can be done with MIRI 4QFM coronagraph

e can be attempted with NIRISS/AMI



The HR 8799 Science Use Case Versus Our Parameter Spaces



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Reference Star Selection

Exercise: Search for a more efficient reference star, methods

Find a suitable brighter reference star ($3 < K < 5$) within 5° of HR8799

(with a similar spectral type if possible)

- **Using Simbad**
- **Using JMMC/SearchCal**
- **Using the USNO single star catalog**
- **Using Python astropy, astroquery**

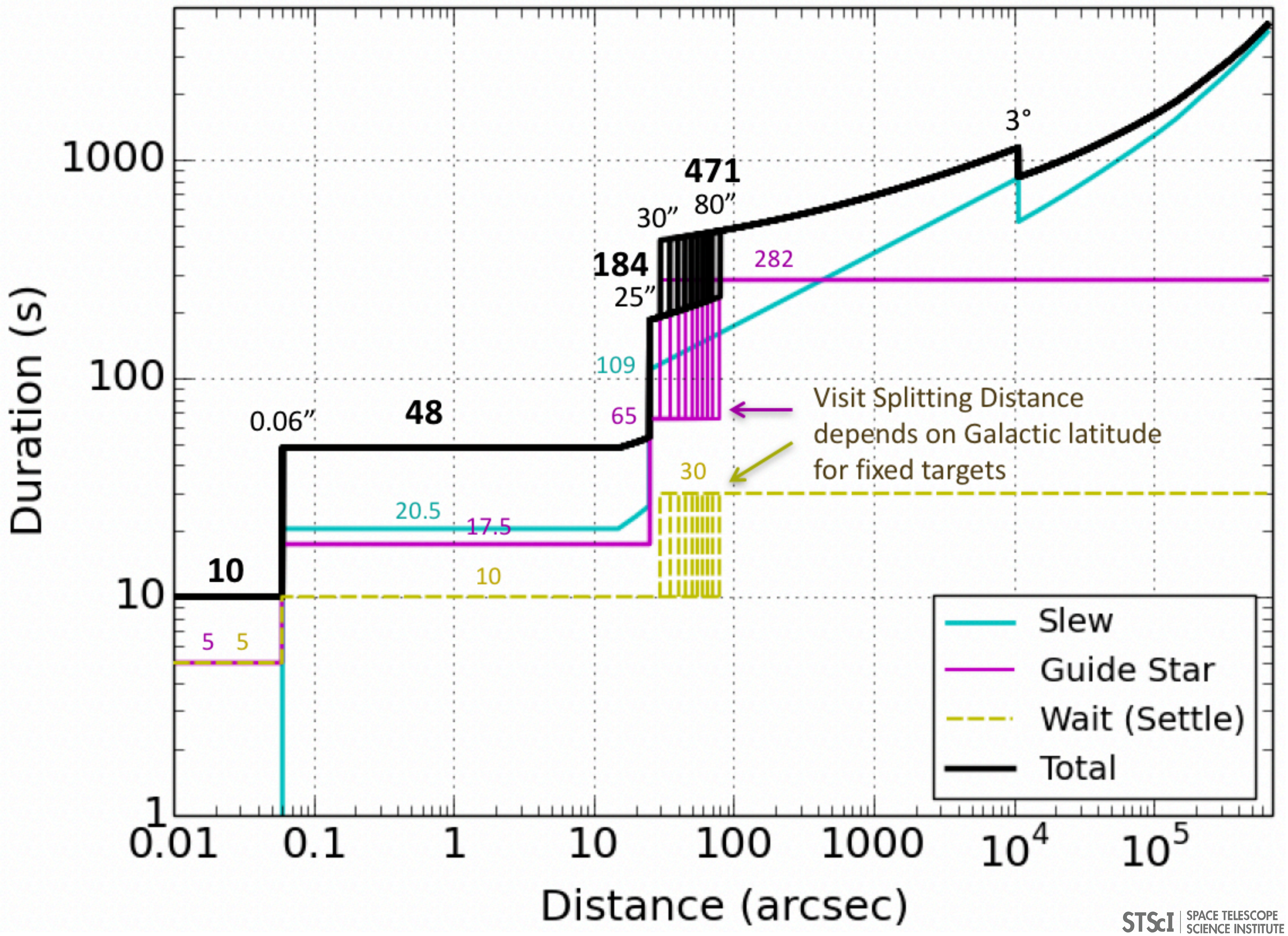
Be careful!!

- More than one solution
- Mind the risks: a close binary (with separation 0.1” to 2”) will be useless for PSF subtraction or as AMI calibrator!
- As much as possible, check archival high spatial resolution images (AO, HST or even 2MASS diffraction spikes

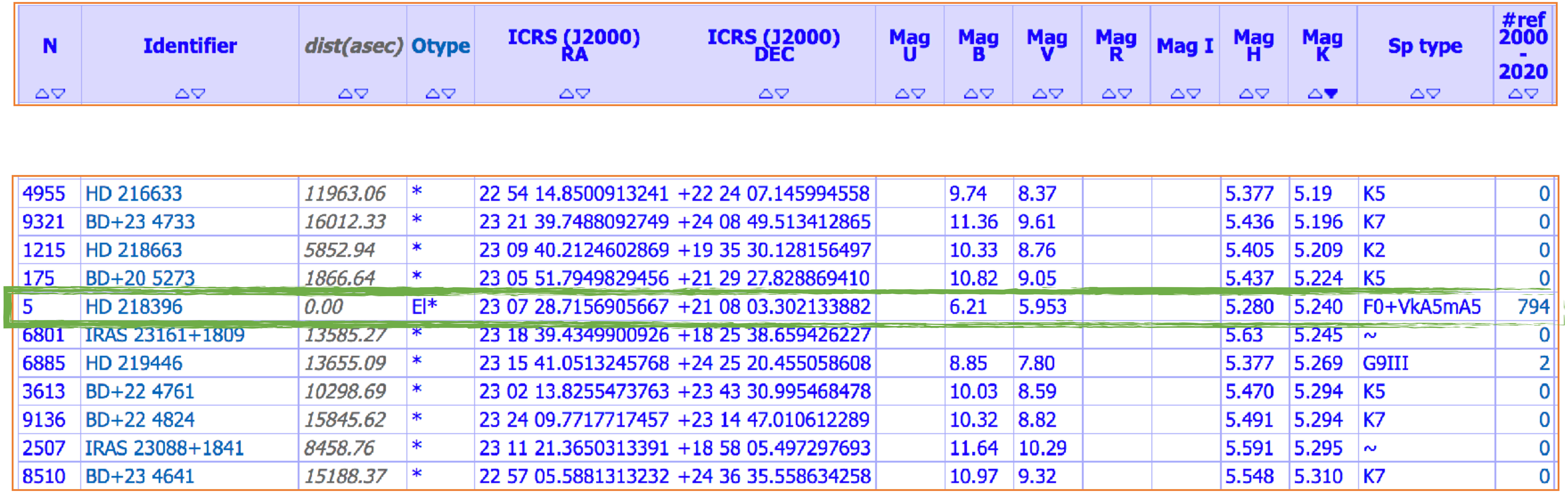
Keep in mind: slew & guide star overheads

Changing attitude

1. Update observatory pointing and roll
2. Let disturbances settle
3. Reacquire guide star
    - ✦ Fine guide (always)
    - ✦ Track (>0.06")
    - ✦ Acquisition (>25")
    - ✦ Identification (new visit)



Simbad search by coordinates and classify by K mag

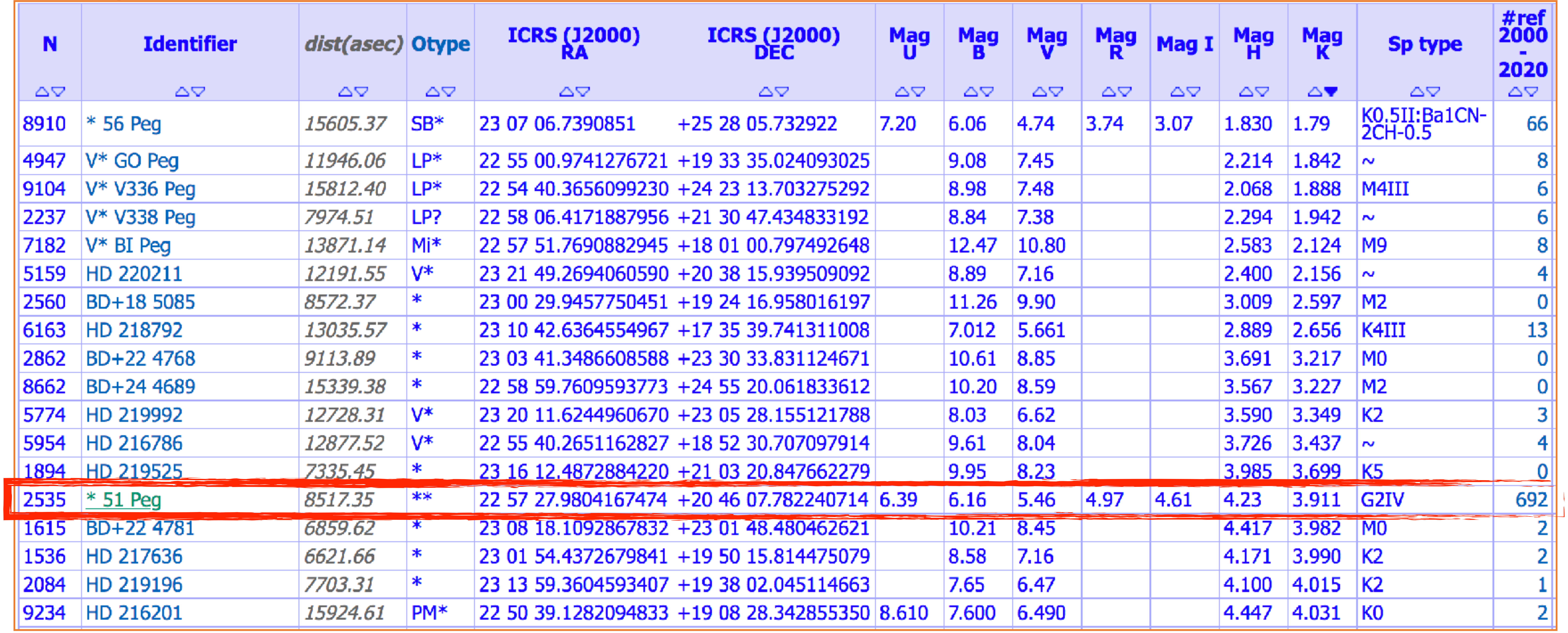


N △▽	Identifier △▽	*dist(asec)* △▽	Otype △▽	ICRS (J2000) RA △▽	ICRS (J2000) DEC △▽	Mag U △▽	Mag B △▽	Mag V △▽	Mag R △▽	Mag I △▽	Mag H △▽	Mag K △▼	Sp type △▽	#ref 2000 - 2020 △▽
4955	HD 216633	*11963.06*	*	22 54 14.8500913241	+22 24 07.145994558		9.74	8.37			5.377	5.19	K5	0
9321	BD+23 4733	*16012.33*	*	23 21 39.7488092749	+24 08 49.513412865		11.36	9.61			5.436	5.196	K7	0
1215	HD 218663	*5852.94*	*	23 09 40.2124602869	+19 35 30.128156497		10.33	8.76			5.405	5.209	K2	0
175	BD+20 5273	*1866.64*	*	23 05 51.7949829456	+21 29 27.828869410		10.82	9.05			5.437	5.224	K5	0
5	HD 218396	*0.00*	El*	23 07 28.7156905667	+21 08 03.302133882		6.21	5.953			5.280	5.240	F0+VkA5mA5	794
6801	IRAS 23161+1809	*13585.27*	*	23 18 39.4349900926	+18 25 38.659426227						5.63	5.245	~	0
6885	HD 219446	*13655.09*	*	23 15 41.0513245768	+24 25 20.455058608		8.85	7.80			5.377	5.269	G9III	2
3613	BD+22 4761	*10298.69*	*	23 02 13.8255473763	+23 43 30.995468478		10.03	8.59			5.470	5.294	K5	0
9136	BD+22 4824	*15845.62*	*	23 24 09.7717717457	+23 14 47.010612289		10.32	8.82			5.491	5.294	K7	0
2507	IRAS 23088+1841	*8458.76*	*	23 11 21.3650313391	+18 58 05.497297693		11.64	10.29			5.591	5.295	~	0
8510	BD+23 4641	*15188.37*	*	22 57 05.5881313232	+24 36 35.558634258		10.97	9.32			5.548	5.310	K7	0

HR 8799 at 0” (center of the search)

http://simbad.harvard.edu/simbad/sim-coo

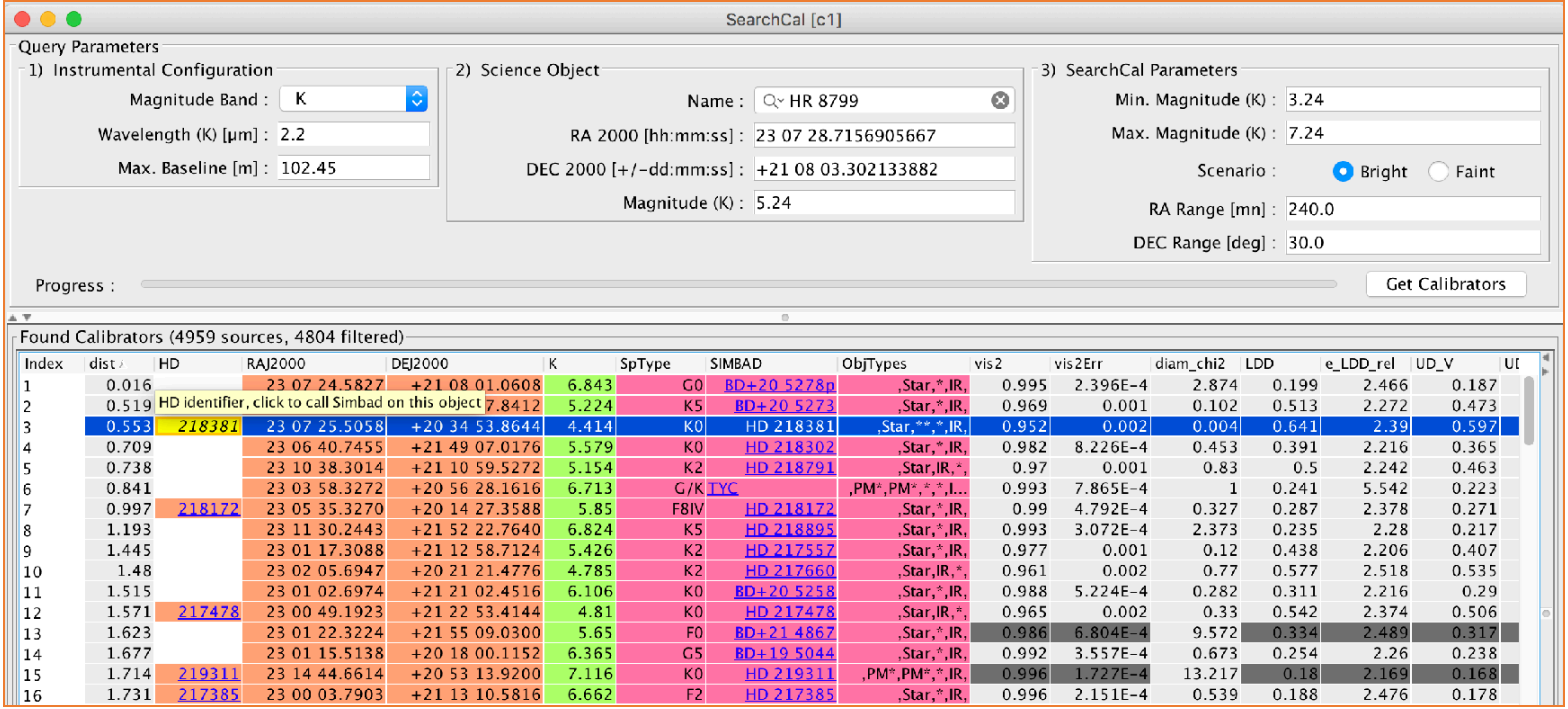
Simbad: look for a K< 5 star with a distance < 18,000 arcsec



N	Identifier	*dist(asec)*	Otype	ICRS (J2000) RA	ICRS (J2000) DEC	Mag U	Mag B	Mag V	Mag R	Mag I	Mag H	Mag K	Sp type	#ref 2000 - 2020
8910	* 56 Peg	*15605.37*	SB*	23 07 06.7390851	+25 28 05.732922	7.20	6.06	4.74	3.74	3.07	1.830	1.79	K0.5II:Ba1CN-2CH-0.5	66
4947	V* GO Peg	*11946.06*	LP*	22 55 00.9741276721	+19 33 35.024093025		9.08	7.45			2.214	1.842	~	8
9104	V* V336 Peg	*15812.40*	LP*	22 54 40.3656099230	+24 23 13.703275292		8.98	7.48			2.068	1.888	M4III	6
2237	V* V338 Peg	*7974.51*	LP?	22 58 06.4171887956	+21 30 47.434833192		8.84	7.38			2.294	1.942	~	6
7182	V* BI Peg	*13871.14*	Mi*	22 57 51.7690882945	+18 01 00.797492648		12.47	10.80			2.583	2.124	M9	8
5159	HD 220211	*12191.55*	V*	23 21 49.2694060590	+20 38 15.939509092		8.89	7.16			2.400	2.156	~	4
2560	BD+18 5085	*8572.37*	*	23 00 29.9457750451	+19 24 16.958016197		11.26	9.90			3.009	2.597	M2	0
6163	HD 218792	*13035.57*	*	23 10 42.6364554967	+17 35 39.741311008		7.012	5.661			2.889	2.656	K4III	13
2862	BD+22 4768	*9113.89*	*	23 03 41.3486608588	+23 30 33.831124671		10.61	8.85			3.691	3.217	M0	0
8662	BD+24 4689	*15339.38*	*	22 58 59.7609593773	+24 55 20.061833612		10.20	8.59			3.567	3.227	M2	0
5774	HD 219992	*12728.31*	V*	23 20 11.6244960670	+23 05 28.155121788		8.03	6.62			3.590	3.349	K2	3
5954	HD 216786	*12877.52*	V*	22 55 40.2651162827	+18 52 30.707097914		9.61	8.04			3.726	3.437	~	4
1894	HD 219525	*7335.45*	*	23 16 12.4872884220	+21 03 20.847662279		9.95	8.23			3.985	3.699	K5	0
2535	* 51 Peg	*8517.35*	**	22 57 27.9804167474	+20 46 07.782240714	6.39	6.16	5.46	4.97	4.61	4.23	3.911	G2IV	692
1615	BD+22 4781	*6859.62*	*	23 08 18.1092867832	+23 01 48.480462621		10.21	8.45			4.417	3.982	M0	2
1536	HD 217636	*6621.66*	*	23 01 54.4372679841	+19 50 15.814475079		8.58	7.16			4.171	3.990	K2	2
2084	HD 219196	*7703.31*	*	23 13 59.3604593407	+19 38 02.045114663		7.65	6.47			4.100	4.015	K2	1
9234	HD 216201	*15924.61*	PM*	22 50 39.1282094833	+19 08 28.342855350	8.610	7.600	6.490			4.447	4.031	K0	2

51 Peg at 2.4° seems the best one (G type, K =3.9)
We know it's not as binary (no problem for the PSF subtraction)

JMMC/SearchCal: developed for long-baseline interferometry



SearchCal [c1]

Query Parameters

1) Instrumental Configuration

Magnitude Band : K

Wavelength (K) [µm] : 2.2

Max. Baseline [m] : 102.45

2) Science Object

Name : HR 8799

RA 2000 [hh:mm:ss] : 23 07 28.7156905667

DEC 2000 [+/-dd:mm:ss] : +21 08 03.302133882

Magnitude (K) : 5.24

3) SearchCal Parameters

Min. Magnitude (K) : 3.24

Max. Magnitude (K) : 7.24

Scenario : ● Bright ○ Faint

RA Range [mn] : 240.0

DEC Range [deg] : 30.0

Progress :

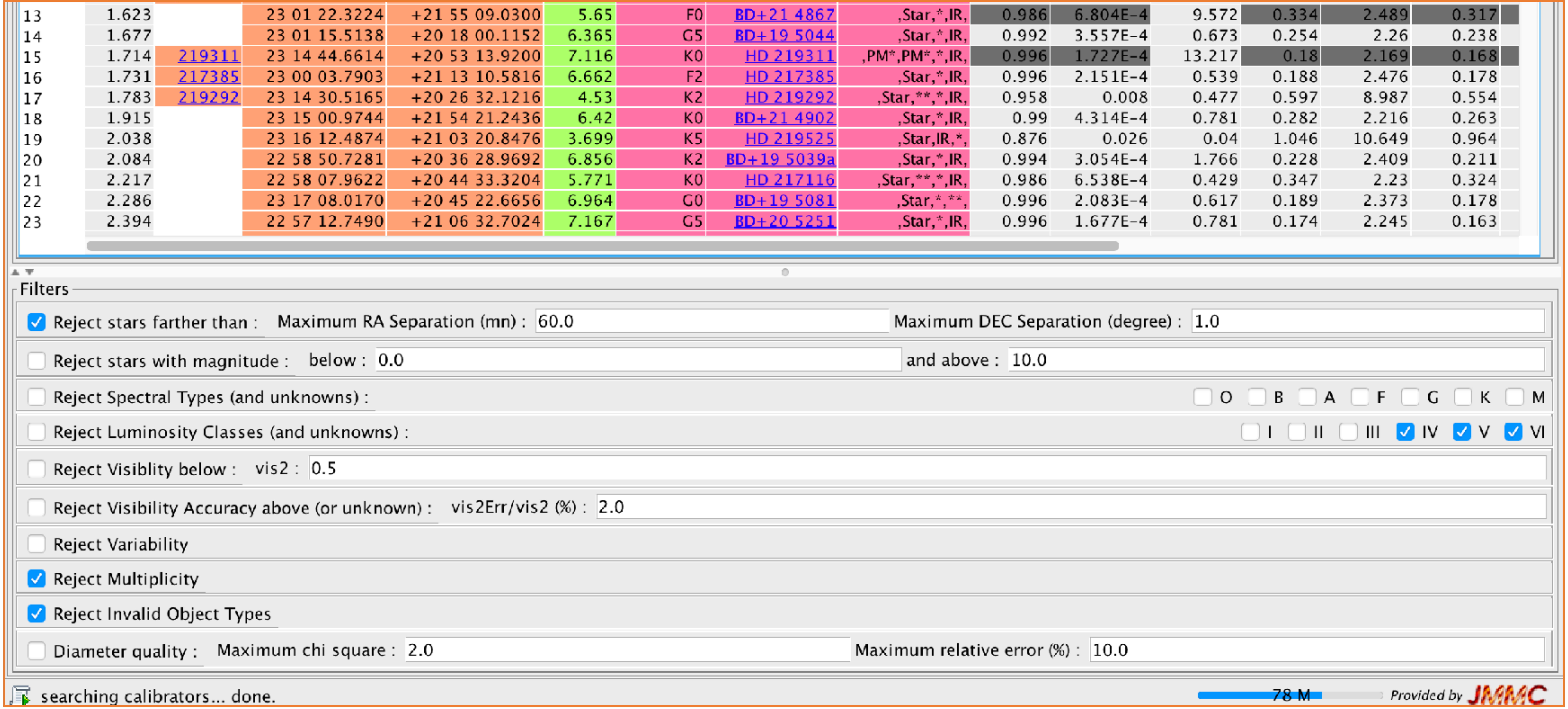
Found Calibrators (4959 sources, 4804 filtered)

HD identifier, click to call Simbad on this object

Index	dist	HD	RAJ2000	DEJ2000	K	SpType	SIMBAD	ObjTypes	vis2	vis2Err	diam_chi2	LDD	e_LDD_rel	UD_V	UI
1	0.016		23 07 24.5827	+21 08 01.0608	6.843	G0	BD+20 5278p	,Star,*,IR,	0.995	2.396E-4	2.874	0.199	2.466	0.187	
2	0.519			7.8412	5.224	K5	BD+20 5273	,Star,*,IR,	0.969	0.001	0.102	0.513	2.272	0.473	
3	0.553	218381	23 07 25.5058	+20 34 53.8644	4.414	K0	HD 218381	,Star,**,*,IR,	0.952	0.002	0.004	0.641	2.39	0.597	
4	0.709		23 06 40.7455	+21 49 07.0176	5.579	K0	HD 218302	,Star,*,IR,	0.982	8.226E-4	0.453	0.391	2.216	0.365	
5	0.738		23 10 38.3014	+21 10 59.5272	5.154	K2	HD 218791	,Star,IR,*,	0.97	0.001	0.83	0.5	2.242	0.463	
6	0.841		23 03 58.3272	+20 56 28.1616	6.713	G/K	TYC	,PM*,PM*,*,*,I...	0.993	7.865E-4	1	0.241	5.542	0.223	
7	0.997	218172	23 05 35.3270	+20 14 27.3588	5.85	F8IV	HD 218172	,Star,*,IR,	0.99	4.792E-4	0.327	0.287	2.378	0.271	
8	1.193		23 11 30.2443	+21 52 22.7640	6.824	K5	HD 218895	,Star,*,IR,	0.993	3.072E-4	2.373	0.235	2.28	0.217	
9	1.445		23 01 17.3088	+21 12 58.7124	5.426	K2	HD 217557	,Star,*,IR,	0.977	0.001	0.12	0.438	2.206	0.407	
10	1.48		23 02 05.6947	+20 21 21.4776	4.785	K2	HD 217660	,Star,IR,*,	0.961	0.002	0.77	0.577	2.518	0.535	
11	1.515		23 01 02.6974	+21 21 02.4516	6.106	K0	BD+20 5258	,Star,*,IR,	0.988	5.224E-4	0.282	0.311	2.216	0.29	
12	1.571	217478	23 00 49.1923	+21 22 53.4144	4.81	K0	HD 217478	,Star,IR,*,	0.965	0.002	0.33	0.542	2.374	0.506	
13	1.623		23 01 22.3224	+21 55 09.0300	5.65	F0	BD+21 4867	,Star,*,IR,	0.986	6.804E-4	9.572	0.334	2.489	0.317	
14	1.677		23 01 15.5138	+20 18 00.1152	6.365	G5	BD+19 5044	,Star,*,IR,	0.992	3.557E-4	0.673	0.254	2.26	0.238	
15	1.714	219311	23 14 44.6614	+20 53 13.9200	7.116	K0	HD 219311	,PM*,PM*,*,IR,	0.996	1.727E-4	13.217	0.18	2.169	0.168	
16	1.731	217385	23 00 03.7903	+21 13 10.5816	6.662	F2	HD 217385	,Star,*,IR,	0.996	2.151E-4	0.539	0.188	2.476	0.178	

http://www.jmmc.fr/searchcal_page.htm

JMMC/SearchCal: developed for long-baseline interferometry



13	1.623		23 01 22.3224	+21 55 09.0300	5.65	F0	BD+21 4867	,Star,*,IR,	0.986	6.804E-4	9.572	0.334	2.489	0.317
14	1.677		23 01 15.5138	+20 18 00.1152	6.365	G5	BD+19 5044	,Star,*,IR,	0.992	3.557E-4	0.673	0.254	2.26	0.238
15	1.714	219311	23 14 44.6614	+20 53 13.9200	7.116	K0	HD 219311	,PM*,PM*,*,IR,	0.996	1.727E-4	13.217	0.18	2.169	0.168
16	1.731	217385	23 00 03.7903	+21 13 10.5816	6.662	F2	HD 217385	,Star,*,IR,	0.996	2.151E-4	0.539	0.188	2.476	0.178
17	1.783	219292	23 14 30.5165	+20 26 32.1216	4.53	K2	HD 219292	,Star,**,*,IR,	0.958	0.008	0.477	0.597	8.987	0.554
18	1.915		23 15 00.9744	+21 54 21.2436	6.42	K0	BD+21 4902	,Star,*,IR,	0.99	4.314E-4	0.781	0.282	2.216	0.263
19	2.038		23 16 12.4874	+21 03 20.8476	3.699	K5	HD 219525	,Star,IR,*,	0.876	0.026	0.04	1.046	10.649	0.964
20	2.084		22 58 50.7281	+20 36 28.9692	6.856	K2	BD+19 5039a	,Star,*,IR,	0.994	3.054E-4	1.766	0.228	2.409	0.211
21	2.217		22 58 07.9622	+20 44 33.3204	5.771	K0	HD 217116	,Star,**,*,IR,	0.986	6.538E-4	0.429	0.347	2.23	0.324
22	2.286		23 17 08.0170	+20 45 22.6656	6.964	G0	BD+19 5081	,Star,*,**,	0.996	2.083E-4	0.617	0.189	2.373	0.178
23	2.394		22 57 12.7490	+21 06 32.7024	7.167	G5	BD+20 5251	,Star,*,IR,	0.996	1.677E-4	0.781	0.174	2.245	0.163

Filters

☑ Reject stars farther than : Maximum RA Separation (mn) : 60.0 Maximum DEC Separation (degree) : 1.0

☐ Reject stars with magnitude : below : 0.0 and above : 10.0

☐ Reject Spectral Types (and unknowns) : ☐ O ☐ B ☐ A ☐ F ☐ G ☐ K ☐ M

☐ Reject Luminosity Classes (and unknowns) : ☐ I ☐ II ☐ III ☑ IV ☑ V ☑ VI

☐ Reject Visiblity below : vis2 : 0.5

☐ Reject Visibility Accuracy above (or unknown) : vis2Err/vis2 (%) : 2.0

☐ Reject Variability

☑ Reject Multiplicity

☑ Reject Invalid Object Types

☐ Diameter quality : Maximum chi square : 2.0 Maximum relative error (%) : 10.0

searching calibrators... done.

http://www.jmmc.fr/searchcal_page.htm

Example: Python astropy / SkyCoord to find out distances

```
In [1]: from astropy import coordinates, units as u, wcs
In [2]: s1 = coordinates.SkyCoord.from_name('HR8799')
In [3]: s2 = coordinates.SkyCoord.from_name('HD220657')
In [4]: s1.separation(s2)
Out[4]: <Angle 4.72223611 deg>
In [5]: s3 = coordinates.SkyCoord.from_name('HD218261')
In [6]: s1.separation(s3)
Out[6]: <Angle 1.24333427 deg>

In [7]: sep=s1.separation(s3)
In [8]: sep.arcsec
Out[8]: 4476.003380925846
```

Coronagraphy Visibility Tool (CVT)

Exercise: Search for a more efficient reference star, 3 methods

Open the Coronagraph Visibility Tool

On your laptop if you have it installed (command line or OSX binary)

Run it on the Virtual Desktop on https://jwst-masterclass.science.stsci.edu otherwise

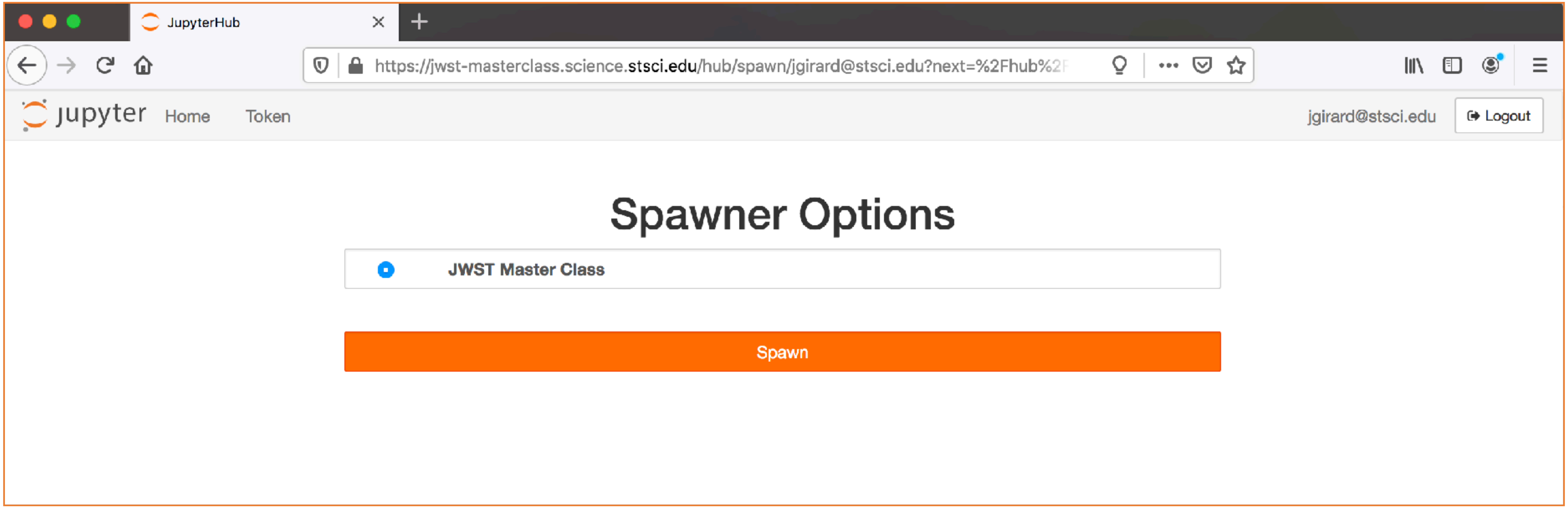
Enter HR8799 “Search” to resolve it with Simbad, then press “update plots”

Enter the b companion: PA=45° and separation=1.7” and press “update plots”

- How many days per year the star is observable with JWST?
- When (convert to MM-DD) is it ideal to observe HR8799b with the LW bar?
- How much is the maximum roll angle around that date?

Jupyter Hub Server for the Master Class

https://jwst-masterclass.science.stsci.edu



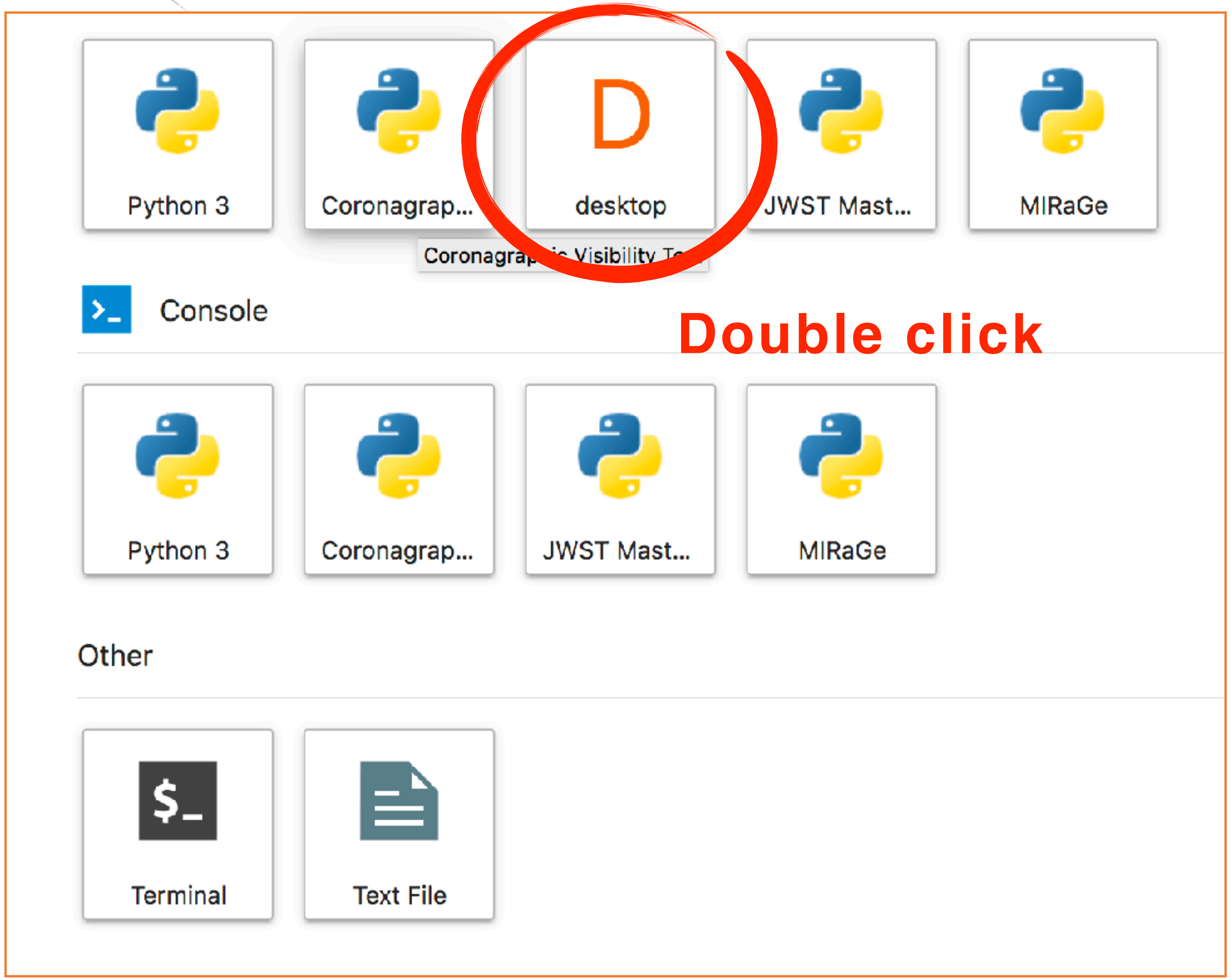
https://jwst-masterclass.science.stsci.edu/hub/spawn/jgirard@stsci.edu?next=%2Fhub%2F

Spawner Options

● JWST Master Class

May take a few minutes to load

Jupyter Hub: virtual desktop for the CVT GUI

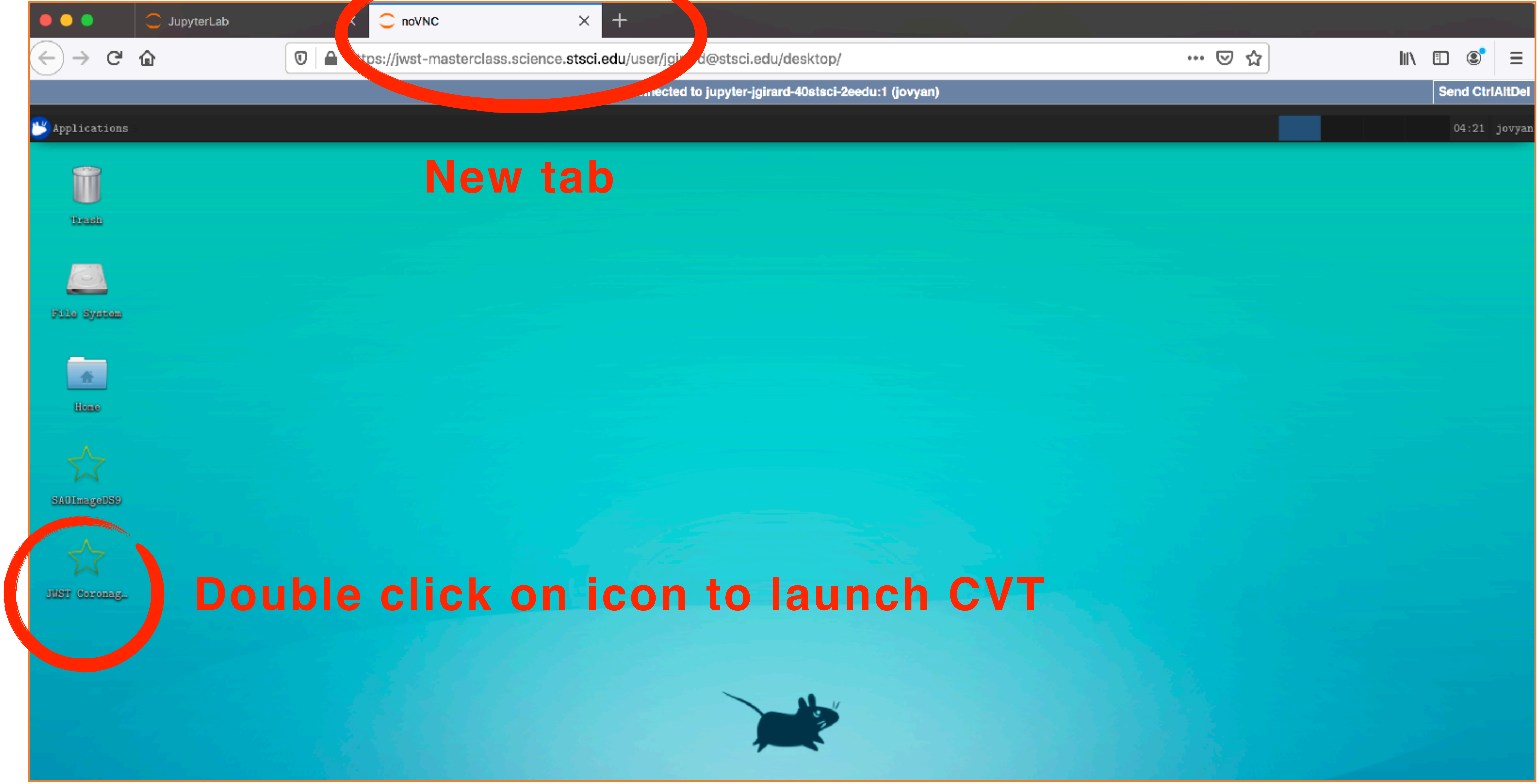


Double click

https://jwst-masterclass.science.stsci.edu

Jupyter Hub: virtual desktop for the CVT GUI

https://jwst-masterclass.science.stsci.edu



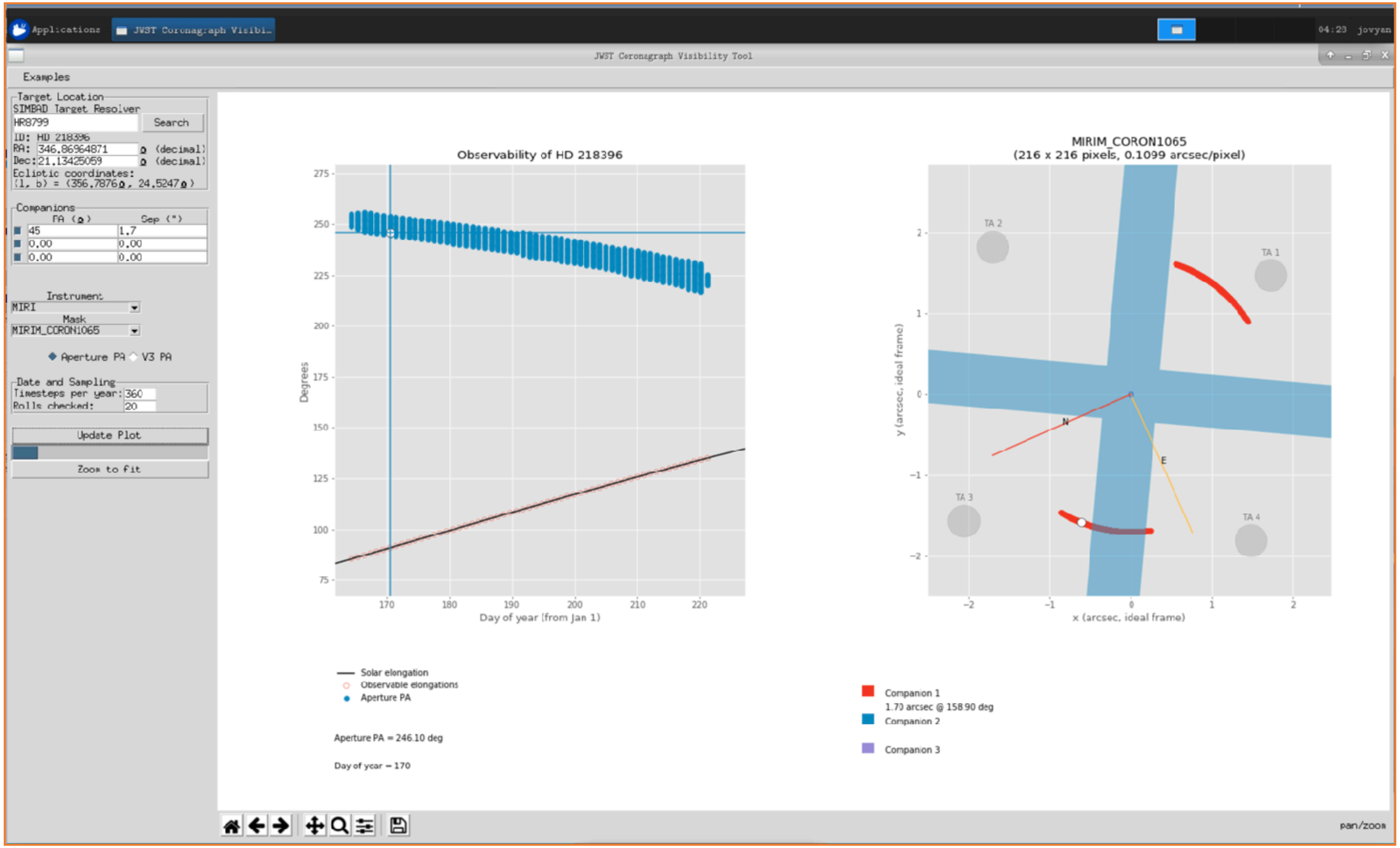
ttps://jwst-masterclass.science.stsci.edu/user/jgi d@stsci.edu/desktop/

nected to jupyter-jgirard-40stsci-2eedu:1 (jovyan)

New tab

Double click on icon to launch CVT

Jupyter Hub: virtual desktop for CVT, it runs!



Target Location
SIMBAD Target Resolver: HR8799
ID: HD 218396
RA: 346.86964871 ° (decimal)
Dec: 21.13425059 ° (decimal)
Ecliptic coordinates:
(l, b) = (356.7876 °, 24.5247 °)

Companions

	PA (°)	Sep (")
■	45	1.7
■	0.00	0.00
■	0.00	0.00

Instrument: MIRI
Mask: MIRIM_CORON1065
◆ Aperture PA ◇ V3 PA

Date and Sampling
Timesteps per year: 360
Rolls checked: 20

— Solar elongation
○ Observable elongations
● Aperture PA

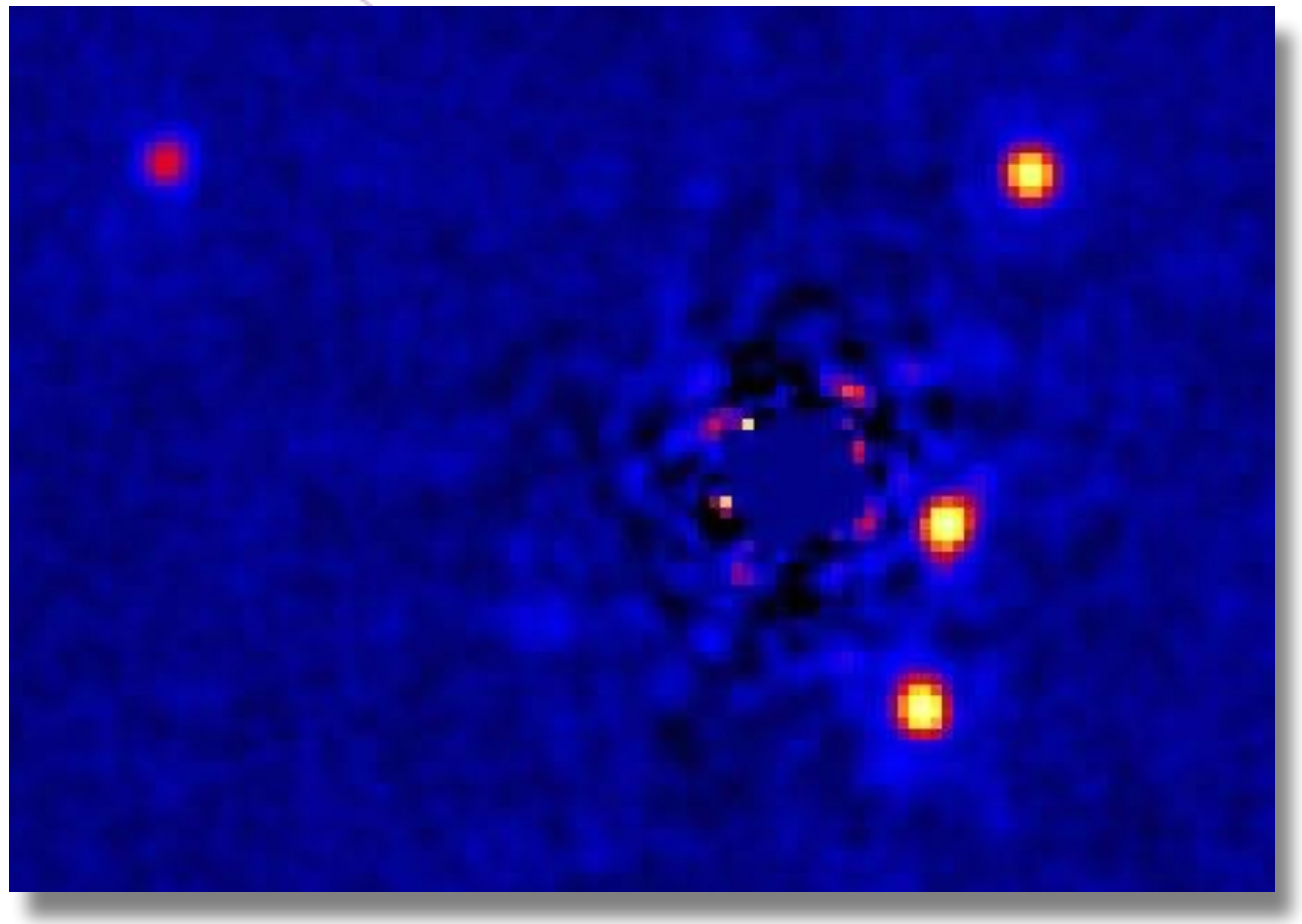
Aperture PA = 246.10 deg

Day of year = 170

🟥 Companion 1
1.70 arcsec @ 158.90 deg
🟦 Companion 2
🟪 Companion 3

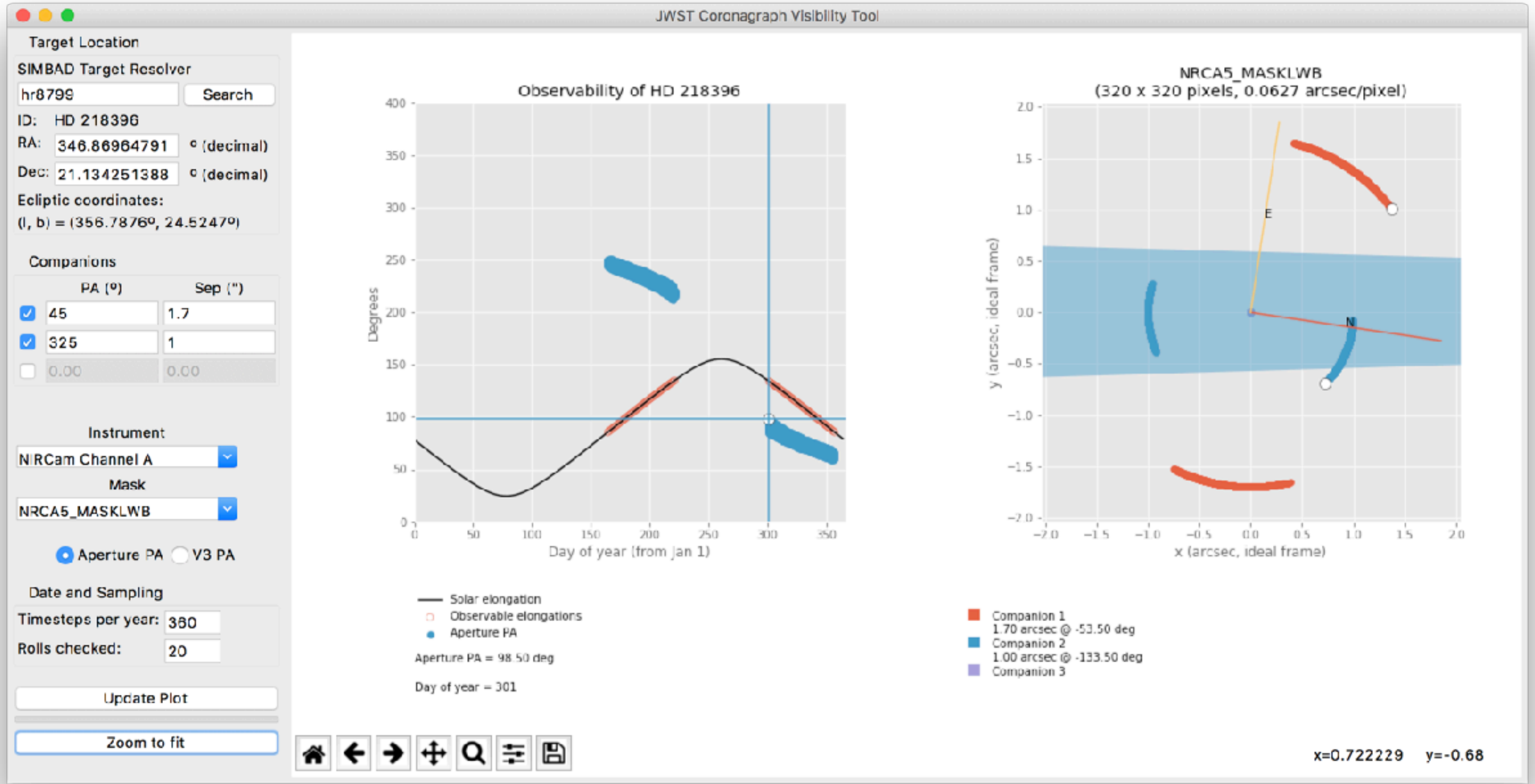
https://jwst-masterclass.science.stsci.edu

Example Science Program: the HR8799 4-planet system



discovered by Marois, here Currie et al. 2014

Coronagraph Visibility Tool (CVT)



JWST Coronagraph Visibility Tool

Target Location

SIMBAD Target Resolver

hr8799 | Search

ID: HD 218396

RA: 346.86964791 ° (decimal)

Dec: 21.134251388 ° (decimal)

Ecliptic coordinates:

(l, b) = (356.7876º, 24.5247º)

Companions

	PA (º)	Sep (")
☑	45	1.7
☑	325	1
☐	0.00	0.00

Instrument: NIRCam Channel A

Mask: NRCA5_MASKLWB

● Aperture PA ○ V3 PA

Date and Sampling

Timesteps per year: 360

Rolls checked: 20

Update Plot

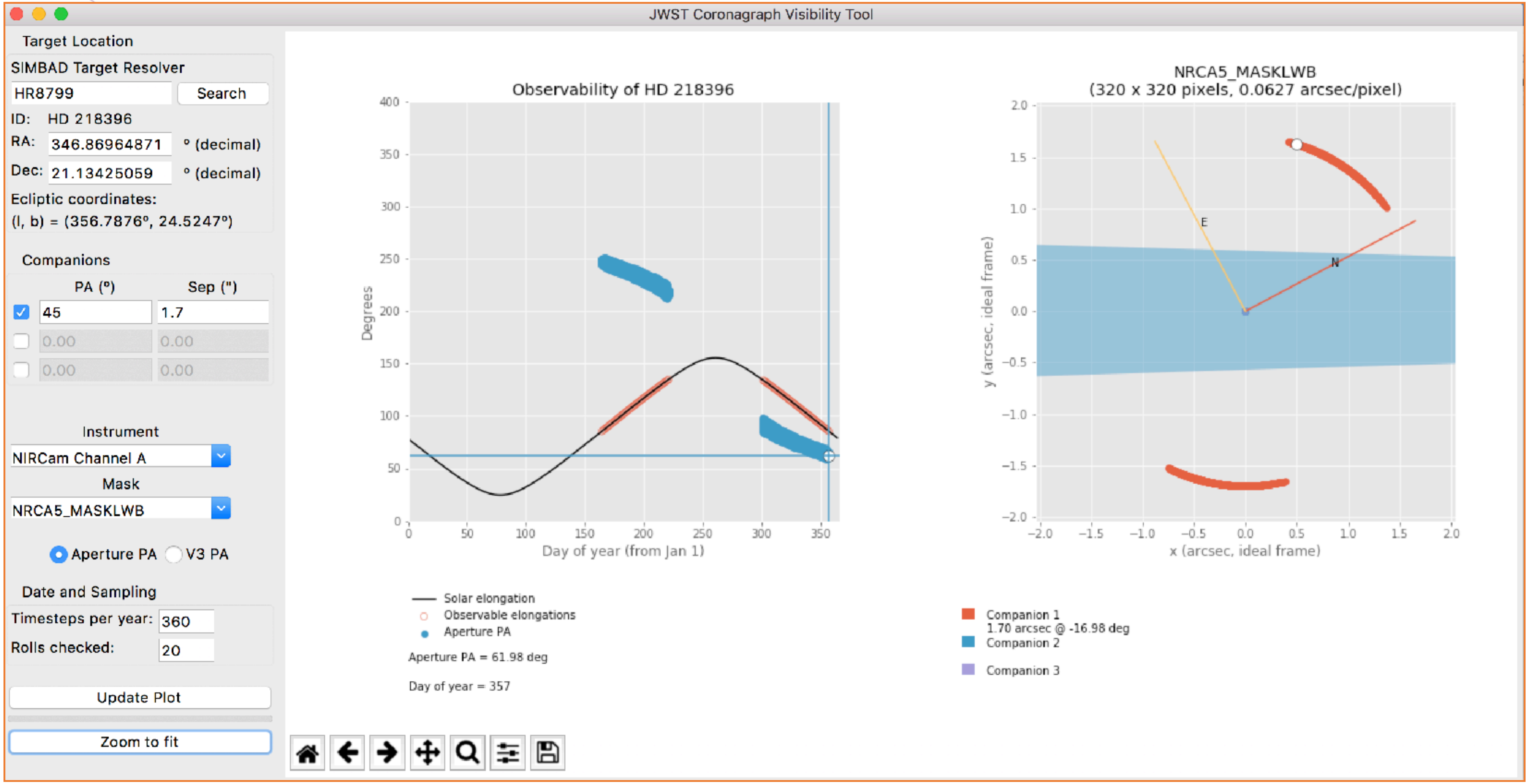
Zoom to fit

Aperture PA = 98.50 deg

Day of year = 301

x=0.722229 y=-0.68

Jupyter Hub: best time to observe HR8799 b?



Target Location

SIMBAD Target Resolver

HR8799 Search

ID: HD 218396

RA: 346.86964871 ° (decimal)

Dec: 21.13425059 ° (decimal)

Ecliptic coordinates:

(l, b) = (356.7876°, 24.5247°)

Companions

	PA (°)	Sep (")
☑	45	1.7
☐	0.00	0.00
☐	0.00	0.00

Instrument: NIRCam Channel A

Mask: NRCA5_MASKLWB

● Aperture PA ○ V3 PA

Date and Sampling

Timesteps per year: 360

Rolls checked: 20

Aperture PA = 61.98 deg

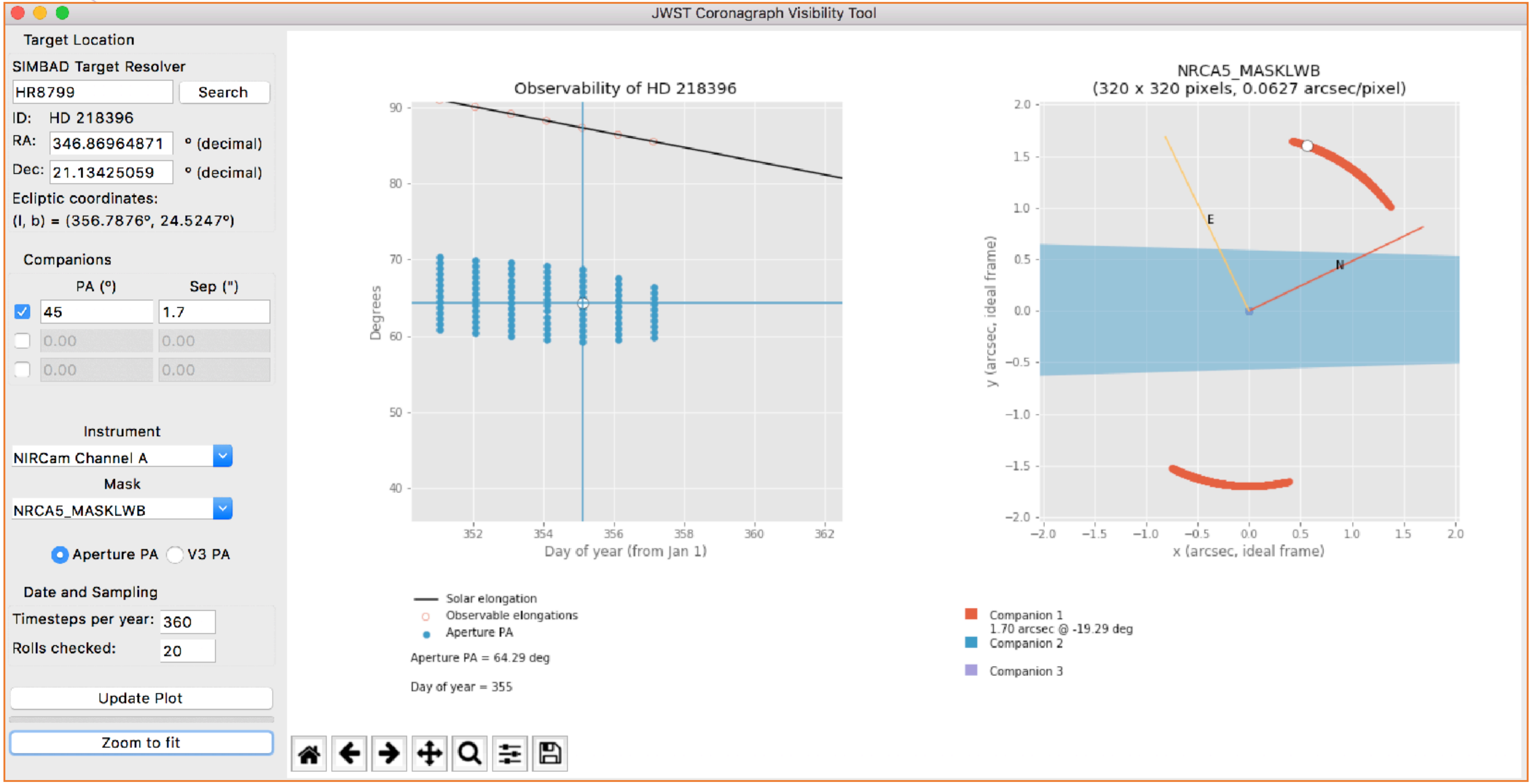
Day of year = 357

🟥 Companion 1
1.70 arcsec @ -16.98 deg

🟦 Companion 2

🟪 Companion 3

Jupyter Hub: roll angle “stroke”?



SIMBAD Target Resolver: HR8799

ID: HD 218396

RA: 346.86964871 ° (decimal)

Dec: 21.13425059 ° (decimal)

Ecliptic coordinates:
(l, b) = (356.7876°, 24.5247°)

	PA (°)	Sep (")
☑	45	1.7
☐	0.00	0.00
☐	0.00	0.00

Instrument: NIRCam Channel A

Mask: NRCA5_MASKLWB

● Aperture PA ○ V3 PA

Timesteps per year: 360

Rolls checked: 20

Aperture PA = 64.29 deg

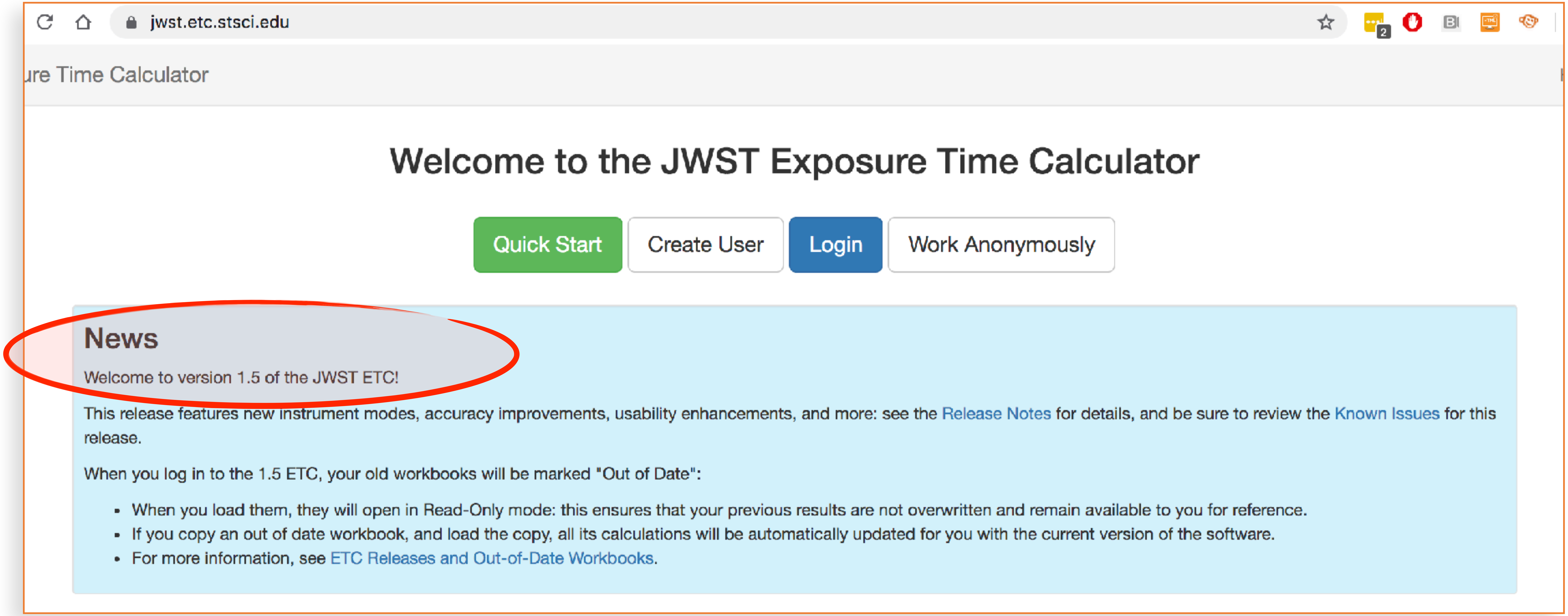
Day of year = 355

Companion 1
1.70 arcsec @ -19.29 deg

ETC Calculations

ETC: Exposure Time Calculator

https://jwst.etc.stsci.edu/



Welcome to the JWST Exposure Time Calculator

News

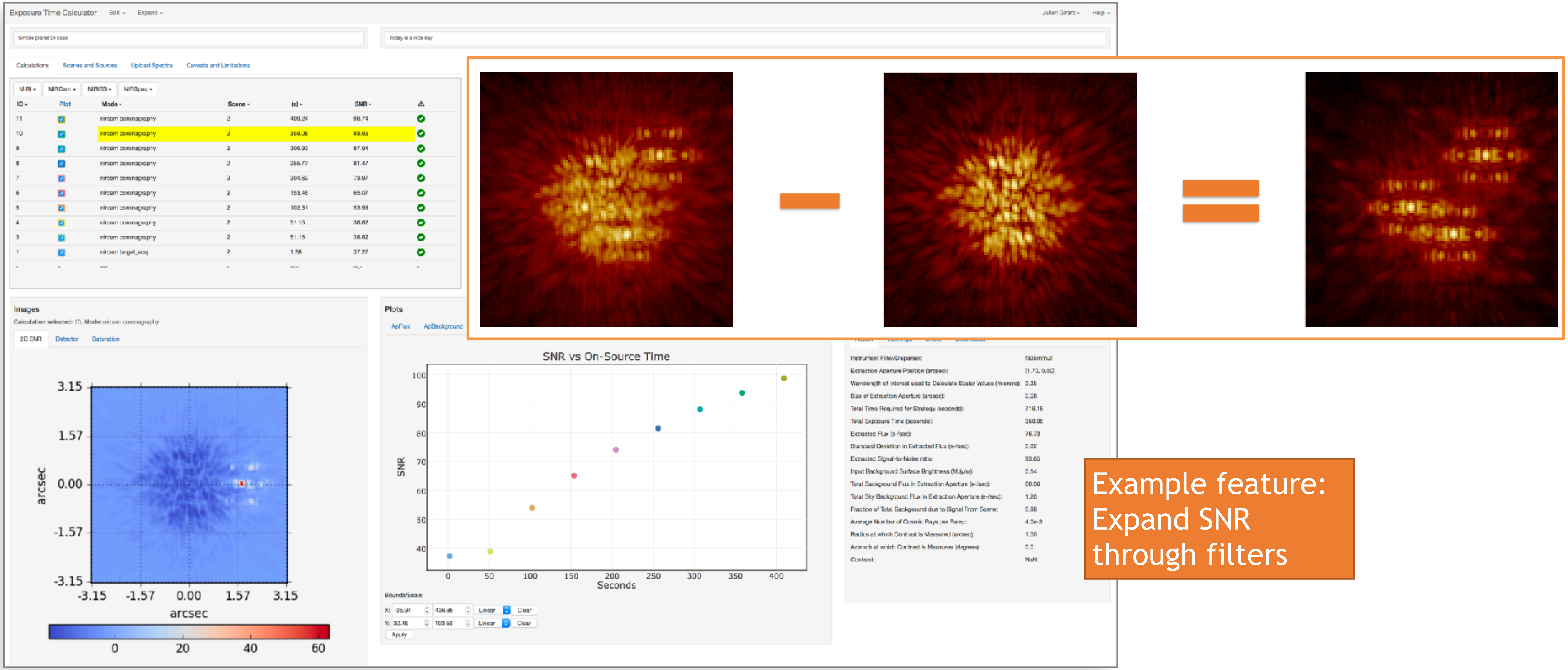
Welcome to version 1.5 of the JWST ETC!

This release features new instrument modes, accuracy improvements, usability enhancements, and more: see the Release Notes for details, and be sure to review the Known Issues for this release.

When you log in to the 1.5 ETC, your old workbooks will be marked "Out of Date":

- When you load them, they will open in Read-Only mode: this ensures that your previous results are not overwritten and remain available to you for reference.
- If you copy an out of date workbook, and load the copy, all its calculations will be automatically updated for you with the current version of the software.
- For more information, see ETC Releases and Out-of-Date Workbooks.

ETC for Coronagraphy: PSF subtraction from a reference star



ID	Plot	Mode	Scene	(s)	SNR	⚠
11	☑	nircam coronagraphy	2	408.24	98.74	✓
10	☑	nircam coronagraphy	2	358.06	93.65	✓
9	☑	nircam coronagraphy	2	306.93	87.94	✓
8	☑	nircam coronagraphy	2	255.77	81.47	✓
7	☑	nircam coronagraphy	2	204.62	73.97	✓
6	☑	nircam coronagraphy	2	153.46	65.07	✓
5	☑	nircam coronagraphy	2	102.31	53.99	✓
4	☑	nircam coronagraphy	2	51.15	38.82	✓
3	☑	nircam coronagraphy	2	51.15	38.82	✓
1	☑	nircam target_acq	2	1.88	37.27	✓
-	-	---	-	--.-	--.-	-

Calculation selected: 10, Mode: nircam coronagraphy

X: -25.94 436.86

Y: 32.45 103.68

Instrument Filter/Disperser:	f335m/null
Extraction Aperture Position (arcsec):	[1.70, 0.00]
Wavelength of interest used to Calculate Scalar Values (microns):	3.35
Size of Extraction Aperture (arcsec):	0.08
Total Time Required for Strategy (seconds):	716.16
Total Exposure Time (seconds):	358.06
Extracted Flux (e-/sec):	76.73
Standard Deviation in Extracted Flux (e-/sec):	0.82
Extracted Signal-to-Noise ratio:	93.65
Input Background Surface Brightness (MJy/sr):	0.14
Total Background Flux in Extraction Aperture (e-/sec):	60.36
Total Sky Background Flux in Extraction Aperture (e-/sec):	1.20
Fraction of Total Background due to Signal From Scene:	0.98
Average Number of Cosmic Rays per Ramp:	4.0e-3
Radius at which Contrast is Measured (arcsec):	1.00
Azimuth at which Contrast is Measured (degrees):	0.0
Contrast:	NaN

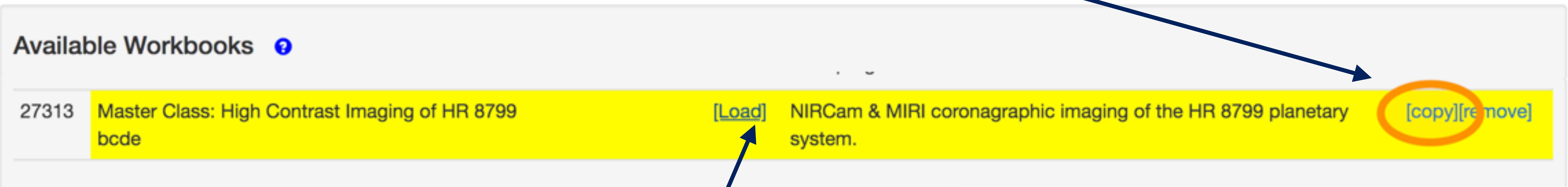
Example feature:
Expand SNR
through filters

jwst.etc.stsci.edu

ETC Workbook for HR8799 b c d e: #27313

Open the Exposure Time Calculator (Google Search "JWST ETC" or jwst.etc.stsci.edu)

Make a Copy of the shared workbook.

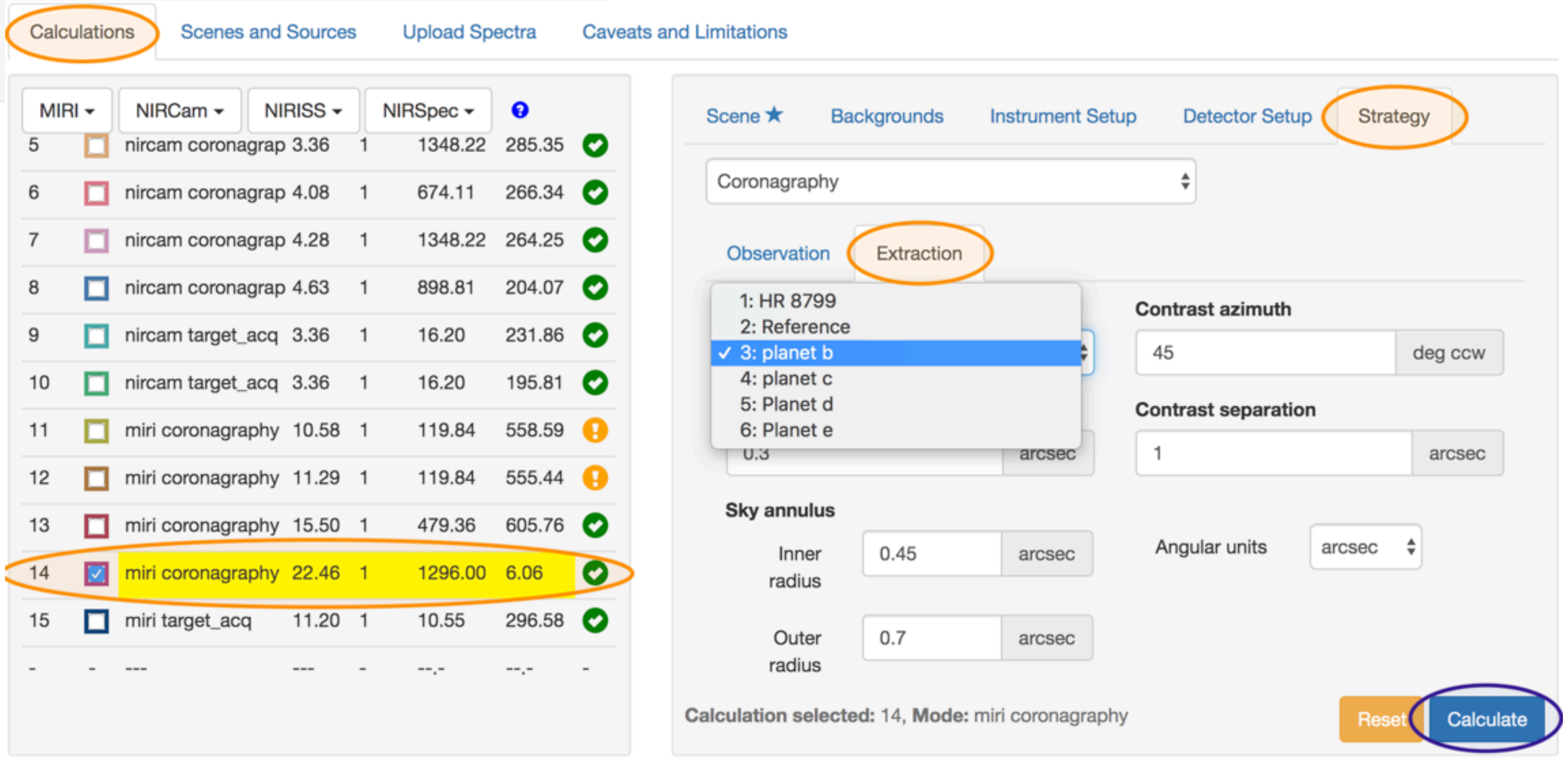


27313	Master Class: High Contrast Imaging of HR 8799 bcde	[Load]	NIRCam & MIRI coronagraphic imaging of the HR 8799 planetary system.	[copy][remove]

Load the new workbook.

Under the *Extraction/ Strategy* tab, try changing the *SNR Source*.

- **Which planets are visible with the MIRI F2300C/Lyot coronagraph?**



5	☐	nircam coronagrap	3.36	1	1348.22	285.35	✓
6	☐	nircam coronagrap	4.08	1	674.11	266.34	✓
7	☐	nircam coronagrap	4.28	1	1348.22	264.25	✓
8	☐	nircam coronagrap	4.63	1	898.81	204.07	✓
9	☐	nircam target_acq	3.36	1	16.20	231.86	✓
10	☐	nircam target_acq	3.36	1	16.20	195.81	✓
11	☐	miri coronagraphy	10.58	1	119.84	558.59	!
12	☐	miri coronagraphy	11.29	1	119.84	555.44	!
13	☐	miri coronagraphy	15.50	1	479.36	605.76	✓
14	☑	miri coronagraphy	22.46	1	1296.00	6.06	✓
15	☐	miri target_acq	11.20	1	10.55	296.58	✓
-	-	---	---	-	--.-	--.-	-

Coronagraphy

1: HR 8799
2: Reference
✓ 3: planet b
4: planet c
5: Planet d
6: Planet e

0.3 arcsec

Contrast azimuth 45 deg ccw

Contrast separation 1 arcsec

Sky annulus

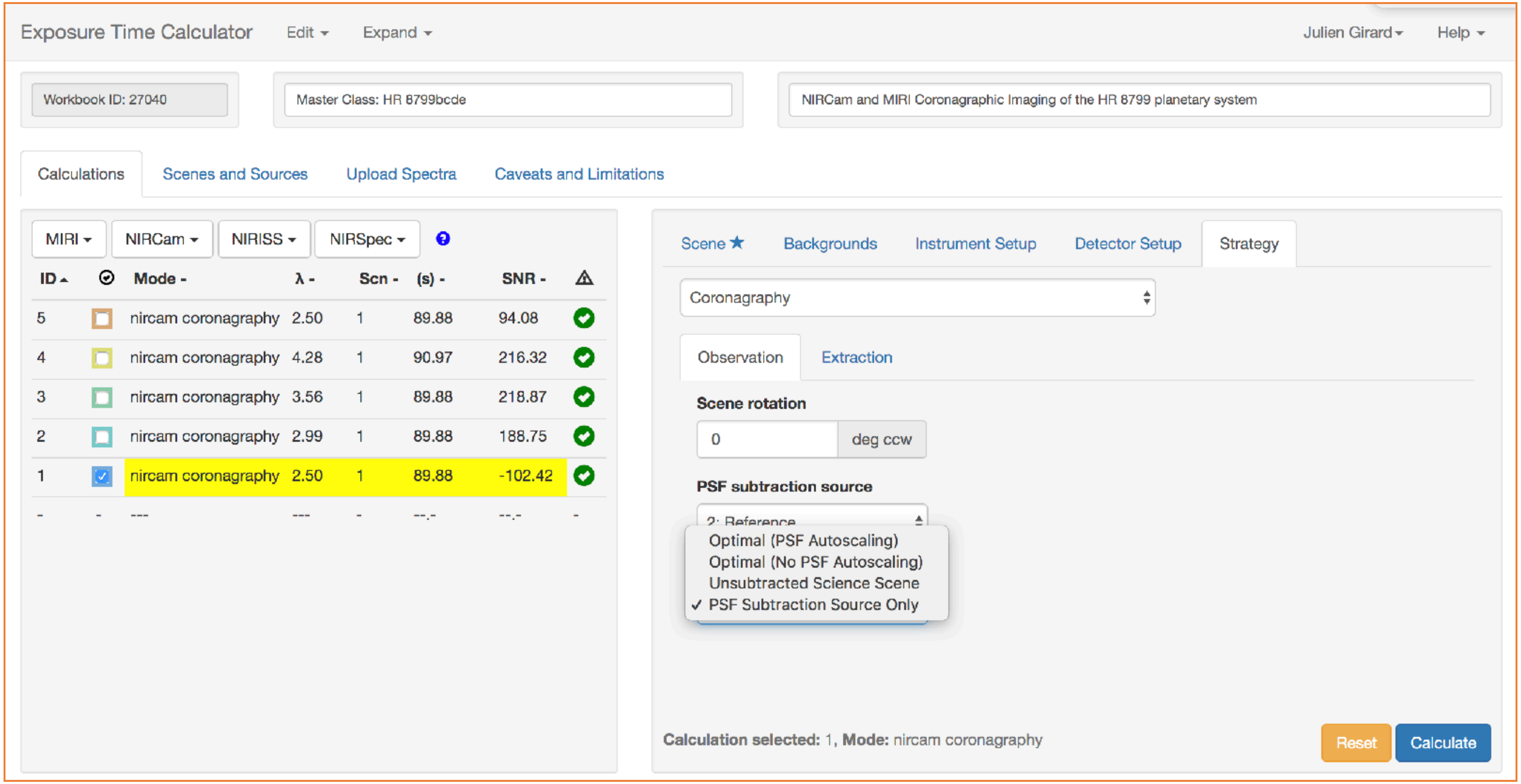
Inner radius 0.45 arcsec

Outer radius 0.7 arcsec

Angular units arcsec

Calculation selected: 14, **Mode:** miri coronagraphy

ETC Workbook: PSF Subtraction Source (4 options)



Workbook ID: 27040

Master Class: HR 8799bcde

NIRCam and MIRI Coronagraphic Imaging of the HR 8799 planetary system

ID	⊘	Mode	λ	Scn	(s)	SNR	⚠
5	☐	nircam coronagraphy	2.50	1	89.88	94.08	✓
4	☐	nircam coronagraphy	4.28	1	90.97	216.32	✓
3	☐	nircam coronagraphy	3.56	1	89.88	218.87	✓
2	☐	nircam coronagraphy	2.99	1	89.88	188.75	✓
1	☑	nircam coronagraphy	2.50	1	89.88	-102.42	✓
-	-	---	---	-	--.-	--.-	-

Coronagraphy

Scene rotation

0 deg ccw

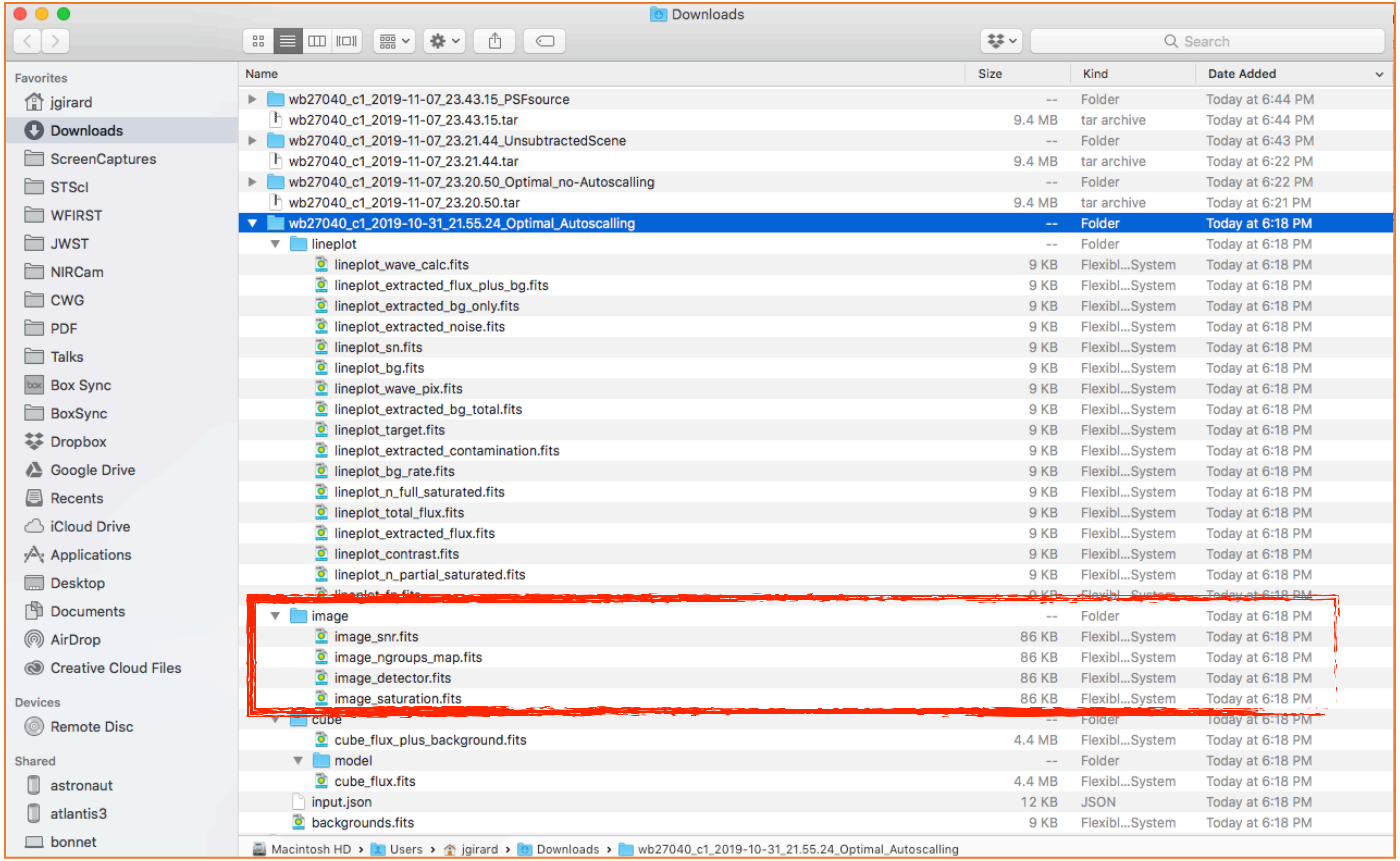
PSF subtraction source

2: Reference

Optimal (PSF Autoscaling)
Optimal (No PSF Autoscaling)
Unsubtracted Science Scene
✓ PSF Subtraction Source Only

Calculation selected: 1, **Mode:** nircam coronagraphy

ETC Workbook for HR8799 b c d e: #27313, downloaded files



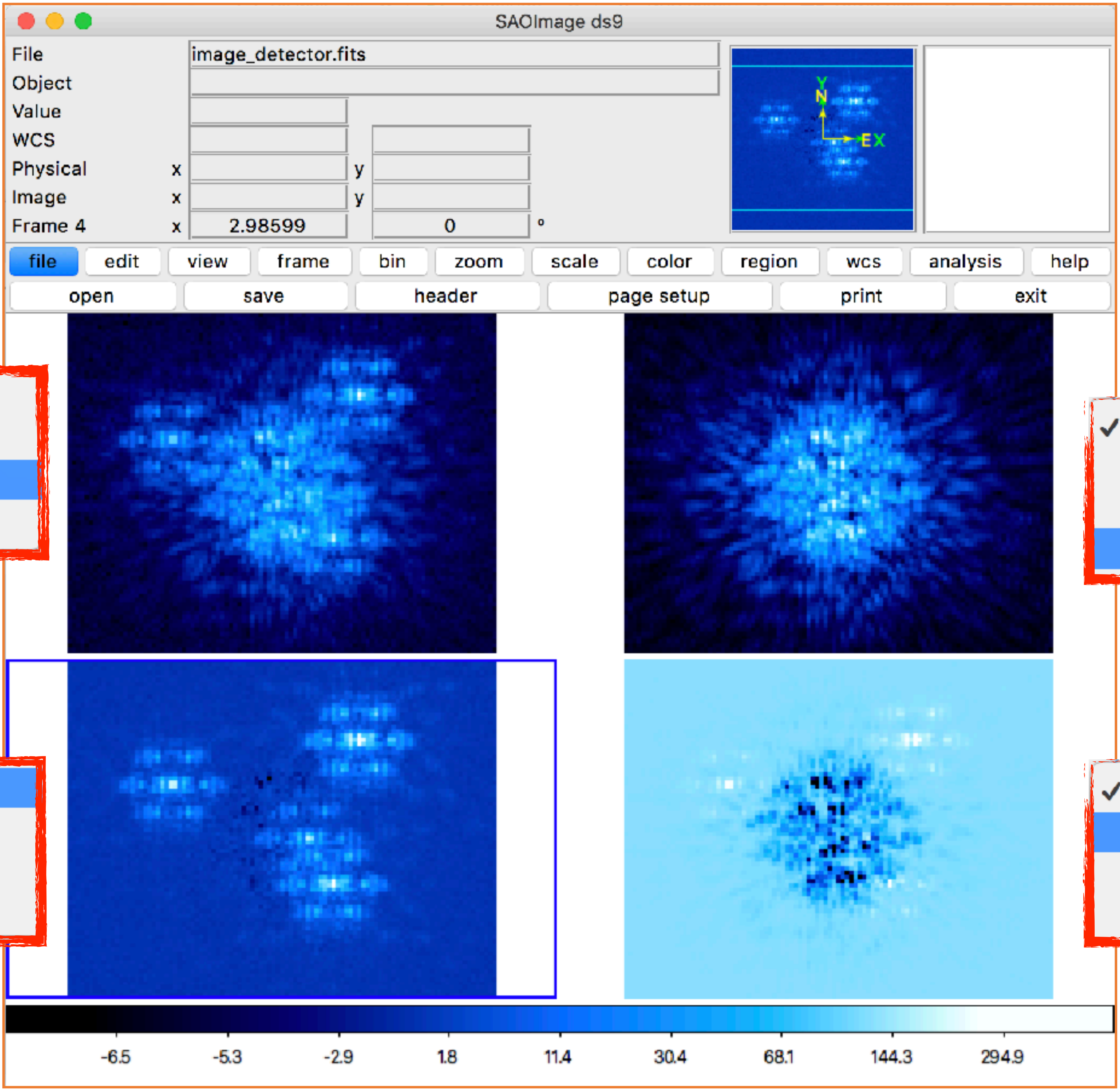
Name	Size	Kind	Date Added
wb27040_c1_2019-11-07_23.43.15_PSFsource	--	Folder	Today at 6:44 PM
wb27040_c1_2019-11-07_23.43.15.tar	9.4 MB	tar archive	Today at 6:44 PM
wb27040_c1_2019-11-07_23.21.44_UnsubtractedScene	--	Folder	Today at 6:43 PM
wb27040_c1_2019-11-07_23.21.44.tar	9.4 MB	tar archive	Today at 6:22 PM
wb27040_c1_2019-11-07_23.20.50_Optimal_no-Autoscalling	--	Folder	Today at 6:22 PM
wb27040_c1_2019-11-07_23.20.50.tar	9.4 MB	tar archive	Today at 6:21 PM
wb27040_c1_2019-10-31_21.55.24_Optimal_Autoscalling	--	Folder	Today at 6:18 PM
lineplot	--	Folder	Today at 6:18 PM
lineplot_wave_calc.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_flux_plus_bg.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_bg_only.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_noise.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_sn.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_bg.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_wave_pix.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_bg_total.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_target.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_contamination.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_bg_rate.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_n_full_saturated.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_total_flux.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_extracted_flux.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_contrast.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_n_partial_saturated.fits	9 KB	Flexibl...System	Today at 6:18 PM
lineplot_fp.fits	9 KB	Flexibl...System	Today at 6:18 PM
image	--	Folder	Today at 6:18 PM
image_snr.fits	86 KB	Flexibl...System	Today at 6:18 PM
image_ngroups_map.fits	86 KB	Flexibl...System	Today at 6:18 PM
image_detector.fits	86 KB	Flexibl...System	Today at 6:18 PM
image_saturation.fits	86 KB	Flexibl...System	Today at 6:18 PM
cube	--	Folder	Today at 6:18 PM
cube_flux_plus_background.fits	4.4 MB	Flexibl...System	Today at 6:18 PM
model	--	Folder	Today at 6:18 PM
cube_flux.fits	4.4 MB	Flexibl...System	Today at 6:18 PM
input.json	12 KB	JSON	Today at 6:18 PM
backgrounds.fits	9 KB	Flexibl...System	Today at 6:18 PM

ETC Workbook for HR8799 b c d e: #27313, downloaded files

- Optimal (PSF Autoscaling)
- Optimal (No PSF Autoscaling)
- Unsubtracted Science Scene
- ✓ PSF Subtraction Source Only

Default

- ✓ Optimal (PSF Autoscaling)
- Optimal (No PSF Autoscaling)
- Unsubtracted Science Scene
- PSF Subtraction Source Only



SAOImage ds9

File image_detector.fits

Frame 4 x 2.98599 0 °

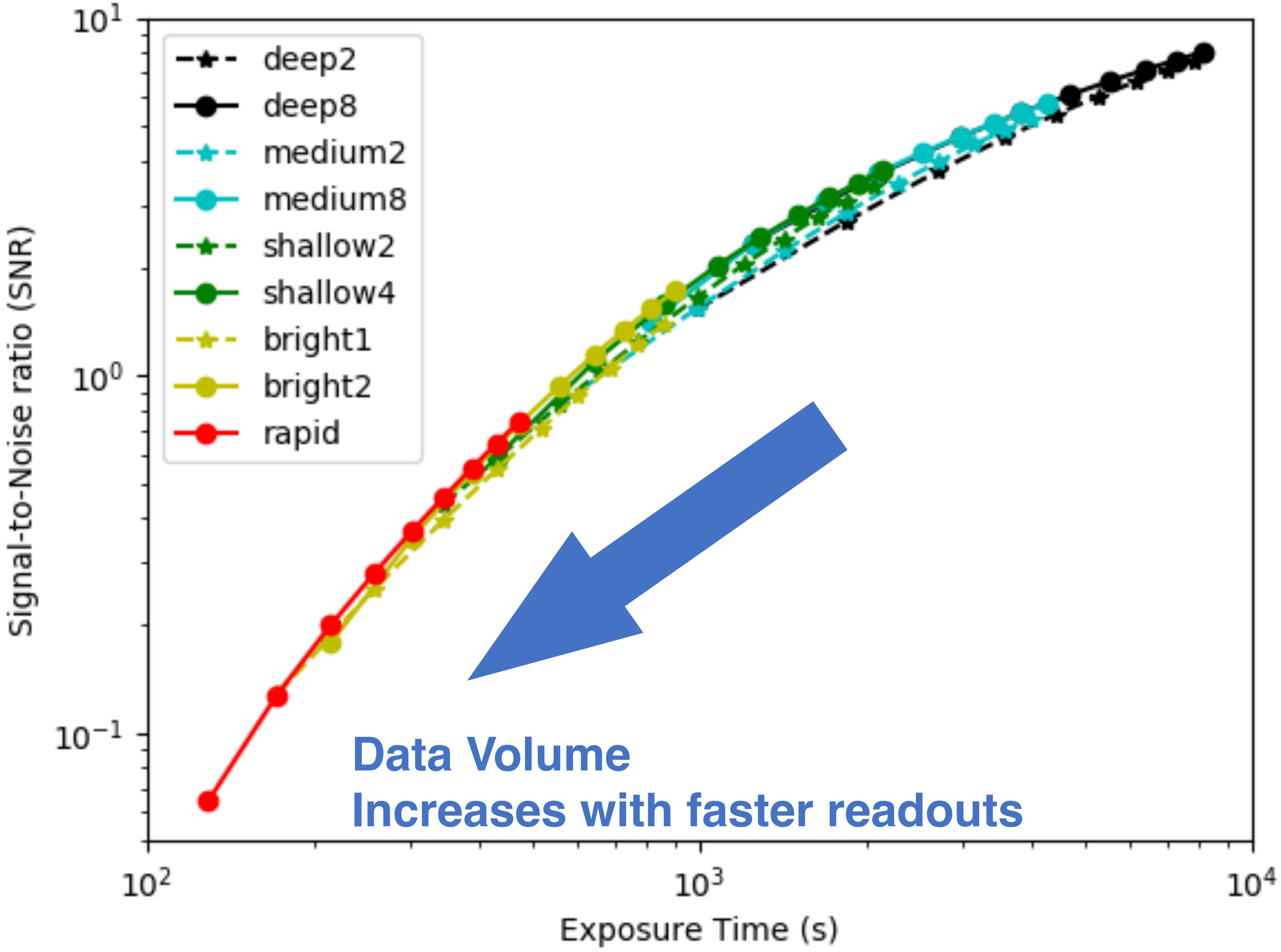
- ✓ Optimal (PSF Autoscaling)
- Optimal (No PSF Autoscaling)
- Unsubtracted Science Scene
- PSF Subtraction Source Only

- ✓ Optimal (PSF Autoscaling)
- Optimal (No PSF Autoscaling)
- Unsubtracted Science Scene
- PSF Subtraction Source Only

ETC: Finding the best exposure parameters

Selecting the optimal combination of readout pattern, ngroups, nints and nexps is a trade-off

- ✦ More frames decreases read noise
- ✦ Shorter groups increases data volume
- ✦ Longer groups increases the chance of a cosmic ray hit during the group
- ✦ Shorter integrations make ramp fits more uncertain in the presence of non-linearity
- ✦ More dithered exposures decreases flat field errors (not currently modeled by ETC!)
- ✦ Patterns that skip a lot of frames have higher read noise, but have slightly better duty cycle

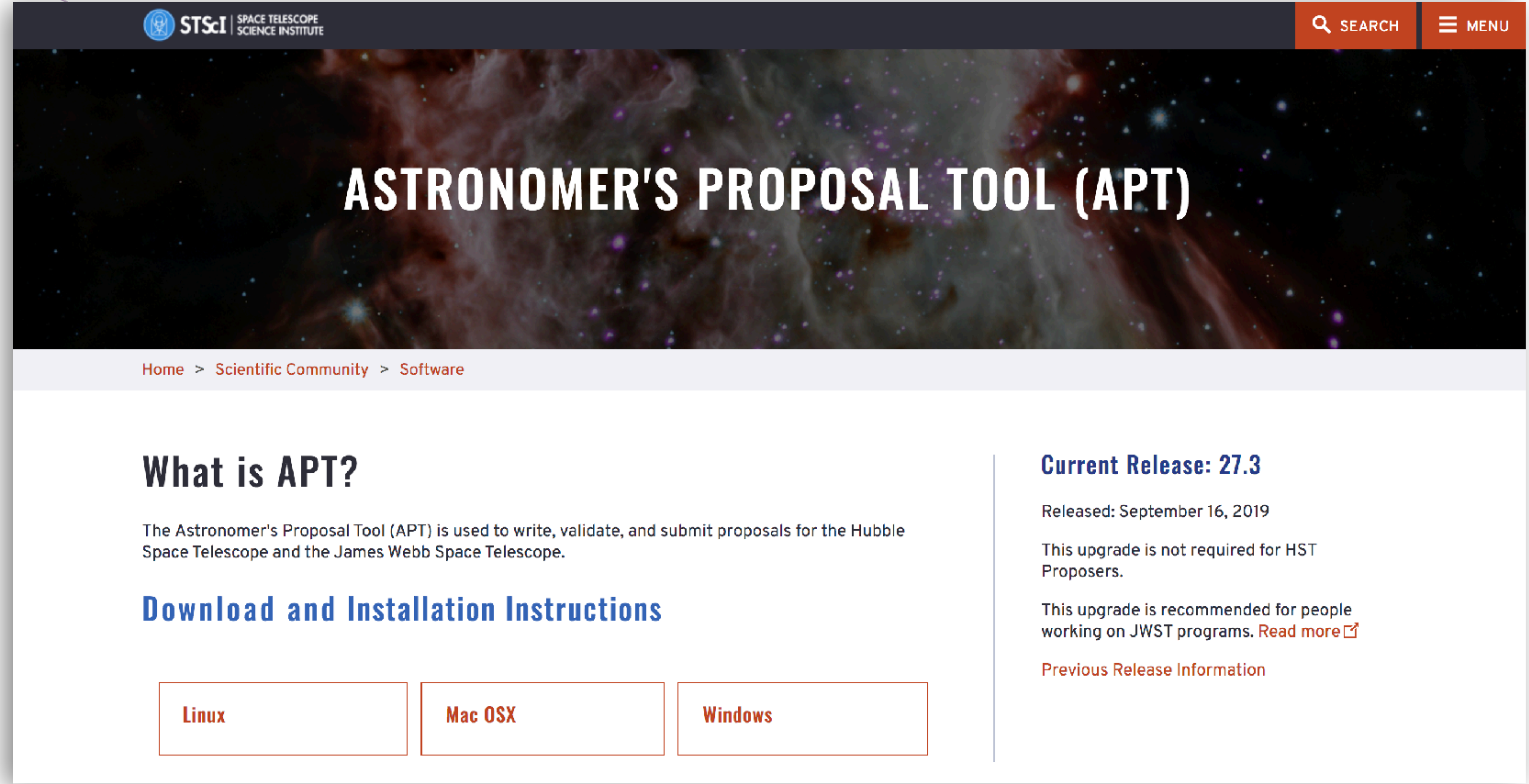


Data Volume
Increases with faster readouts

APT & smart (time) accounting

APT 27.3

www.stsci.edu/scientific-community/software/astronomers-proposal-tool-apt



ASTRONOMER'S PROPOSAL TOOL (APT)

What is APT?

The Astronomer's Proposal Tool (APT) is used to write, validate, and submit proposals for the Hubble Space Telescope and the James Webb Space Telescope.

Download and Installation Instructions

Current Release: 27.3

Released: September 16, 2019

This upgrade is not required for HST Proposers.

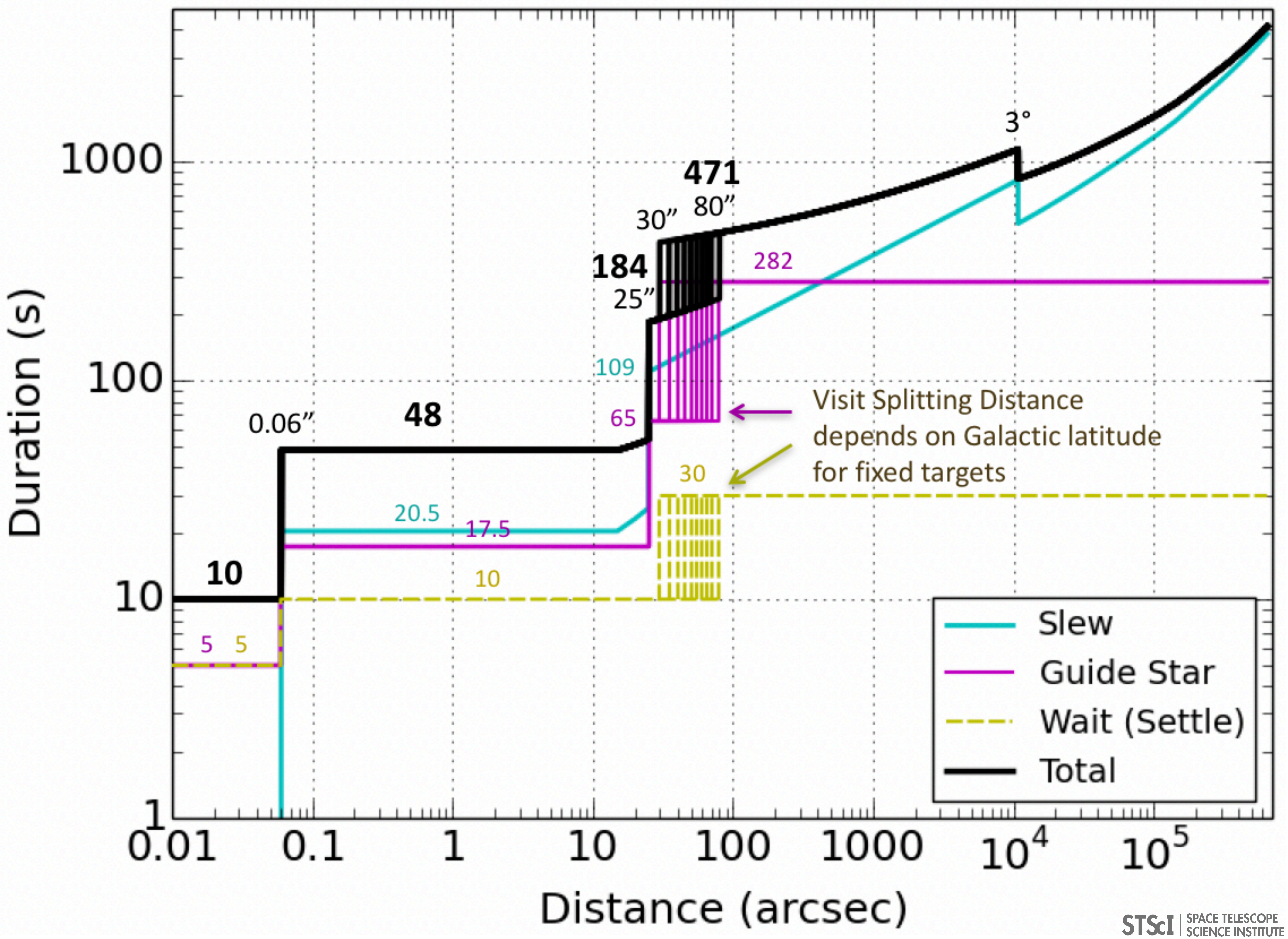
This upgrade is recommended for people working on JWST programs. Read more

Previous Release Information

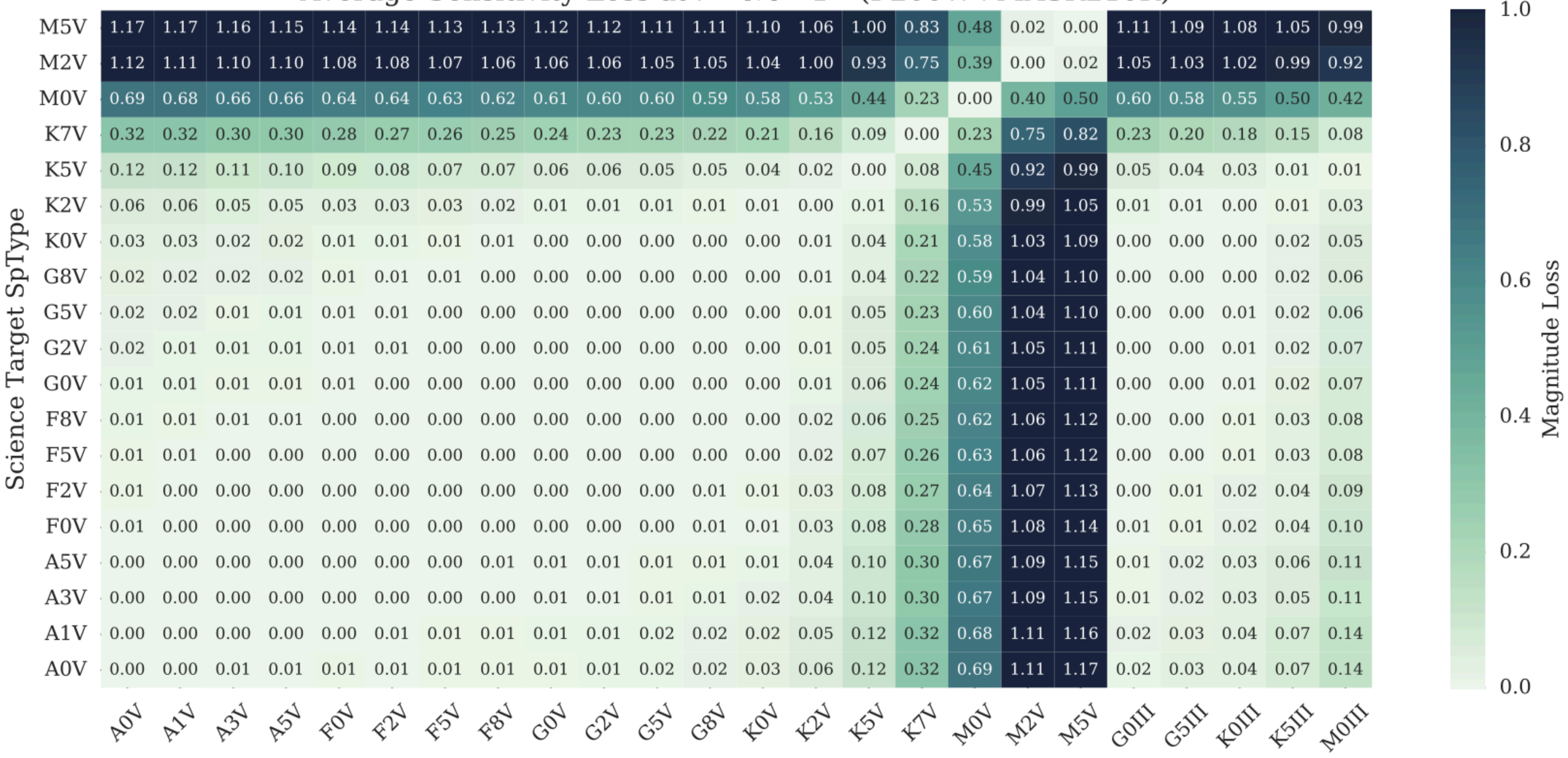
Reference star & overheads: slew, settle, reacquire guide star

Changing attitude

1. Update observatory pointing and roll
2. Let disturbances settle
3. Reacquire guide star
   - ✦ Fine guide (always)
   - ✦ Track (>0.06")
   - ✦ Acquisition (>25")
   - ✦ Identification (new visit)



Selecting a PSF Reference Star (avoid spectral mismatch)

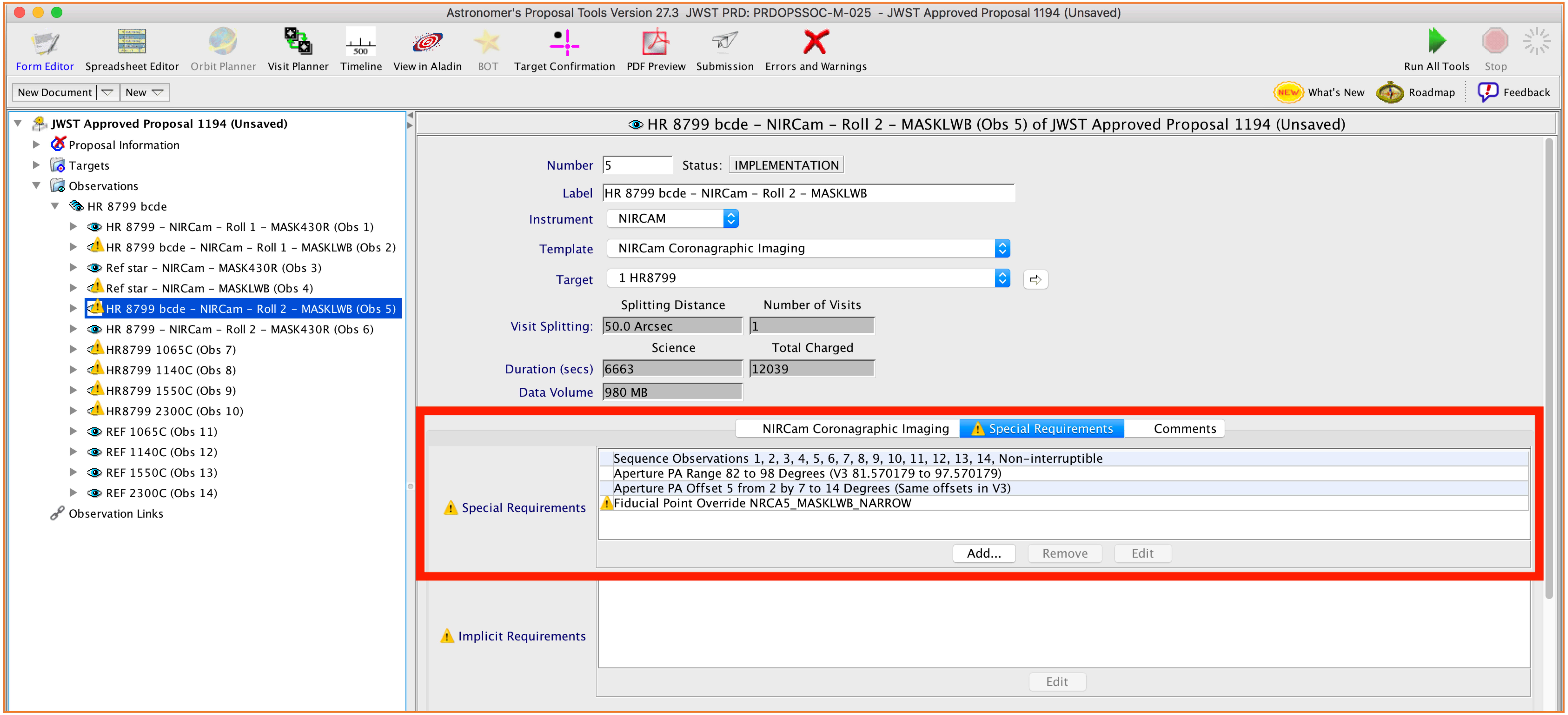


Average Sensitivity Loss at $r = 0.5 - 2''$ (F200W+MASK210R)

	A0V	A1V	A3V	A5V	F0V	F2V	F5V	F8V	G0V	G2V	G5V	G8V	K0V	K2V	K5V	K7V	M0V	M2V	M5V	G0III	G5III	K0III	K5III	M0III
M5V	1.17	1.17	1.16	1.15	1.14	1.14	1.13	1.13	1.12	1.12	1.11	1.11	1.10	1.06	1.00	0.83	0.48	0.02	0.00	1.11	1.09	1.08	1.05	0.99
M2V	1.12	1.11	1.10	1.10	1.08	1.08	1.07	1.06	1.06	1.06	1.05	1.05	1.04	1.00	0.93	0.75	0.39	0.00	0.02	1.05	1.03	1.02	0.99	0.92
M0V	0.69	0.68	0.66	0.66	0.64	0.64	0.63	0.62	0.61	0.60	0.60	0.59	0.58	0.53	0.44	0.23	0.00	0.40	0.50	0.60	0.58	0.55	0.50	0.42
K7V	0.32	0.32	0.30	0.30	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.21	0.16	0.09	0.00	0.23	0.75	0.82	0.23	0.20	0.18	0.15	0.08
K5V	0.12	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.02	0.00	0.08	0.45	0.92	0.99	0.05	0.04	0.03	0.01	0.01
K2V	0.06	0.06	0.05	0.05	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.16	0.53	0.99	1.05	0.01	0.01	0.00	0.01	0.03
K0V	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.21	0.58	1.03	1.09	0.00	0.00	0.00	0.02	0.05
G8V	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.22	0.59	1.04	1.10	0.00	0.00	0.00	0.02	0.06
G5V	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.23	0.60	1.04	1.10	0.00	0.00	0.01	0.02	0.06
G2V	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.24	0.61	1.05	1.11	0.00	0.00	0.01	0.02	0.07
G0V	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.24	0.62	1.05	1.11	0.00	0.00	0.01	0.02	0.07
F8V	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.25	0.62	1.06	1.12	0.00	0.00	0.01	0.03	0.08
F5V	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.26	0.63	1.06	1.12	0.00	0.00	0.01	0.03	0.08
F2V	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.08	0.27	0.64	1.07	1.13	0.00	0.01	0.02	0.04	0.09
F0V	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.08	0.28	0.65	1.08	1.14	0.01	0.01	0.02	0.04	0.10
A5V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.10	0.30	0.67	1.09	1.15	0.01	0.02	0.03	0.06	0.11
A3V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.04	0.10	0.30	0.67	1.09	1.15	0.01	0.02	0.03	0.05	0.11
A1V	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.05	0.12	0.32	0.68	1.11	1.16	0.02	0.03	0.04	0.07	0.14
A0V	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.06	0.12	0.32	0.69	1.11	1.17	0.02	0.03	0.04	0.07	0.14

credit: Jarron Leisenring (pyNRC)

APT: special requirements, Non-interruptible sequence



HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION

Label: HR 8799 bcde – NIRCam – Roll 2 – MASKLWB

Instrument: NIRCAM

Template: NIRCam Coronagraphic Imaging

Target: 1 HR8799

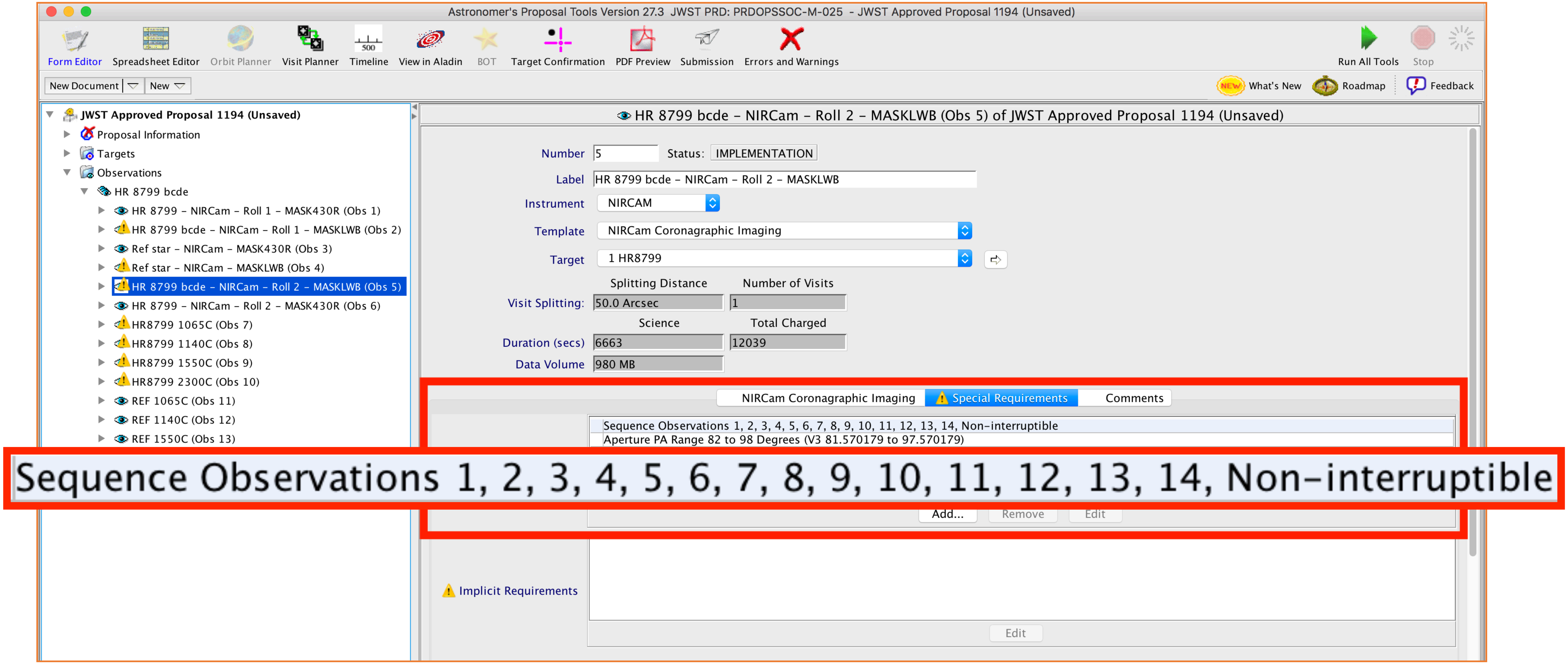
Visit Splitting: Splitting Distance 50.0 Arcsec; Number of Visits 1

Duration (secs): Science 6663; Total Charged 12039

Data Volume: 980 MB

Special Requirements:
- Sequence Observations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, Non-interruptible
- Aperture PA Range 82 to 98 Degrees (V3 81.570179 to 97.570179)
- Aperture PA Offset 5 from 2 by 7 to 14 Degrees (Same offsets in V3)
- Fiducial Point Override NRCA5_MASKLWB_NARROW

APT: special requirements, Non-interruptible sequence



Astronomer's Proposal Tools Version 27.3 JWST PRD: PRDOPSSOC-M-025 - JWST Approved Proposal 1194 (Unsaved)

- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 – NIRCam – Roll 1 – MASK430R (Obs 1)
      - HR 8799 bcde – NIRCam – Roll 1 – MASKLWB (Obs 2)
      - Ref star – NIRCam – MASK430R (Obs 3)
      - Ref star – NIRCam – MASKLWB (Obs 4)
      - HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5)
      - HR 8799 – NIRCam – Roll 2 – MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)

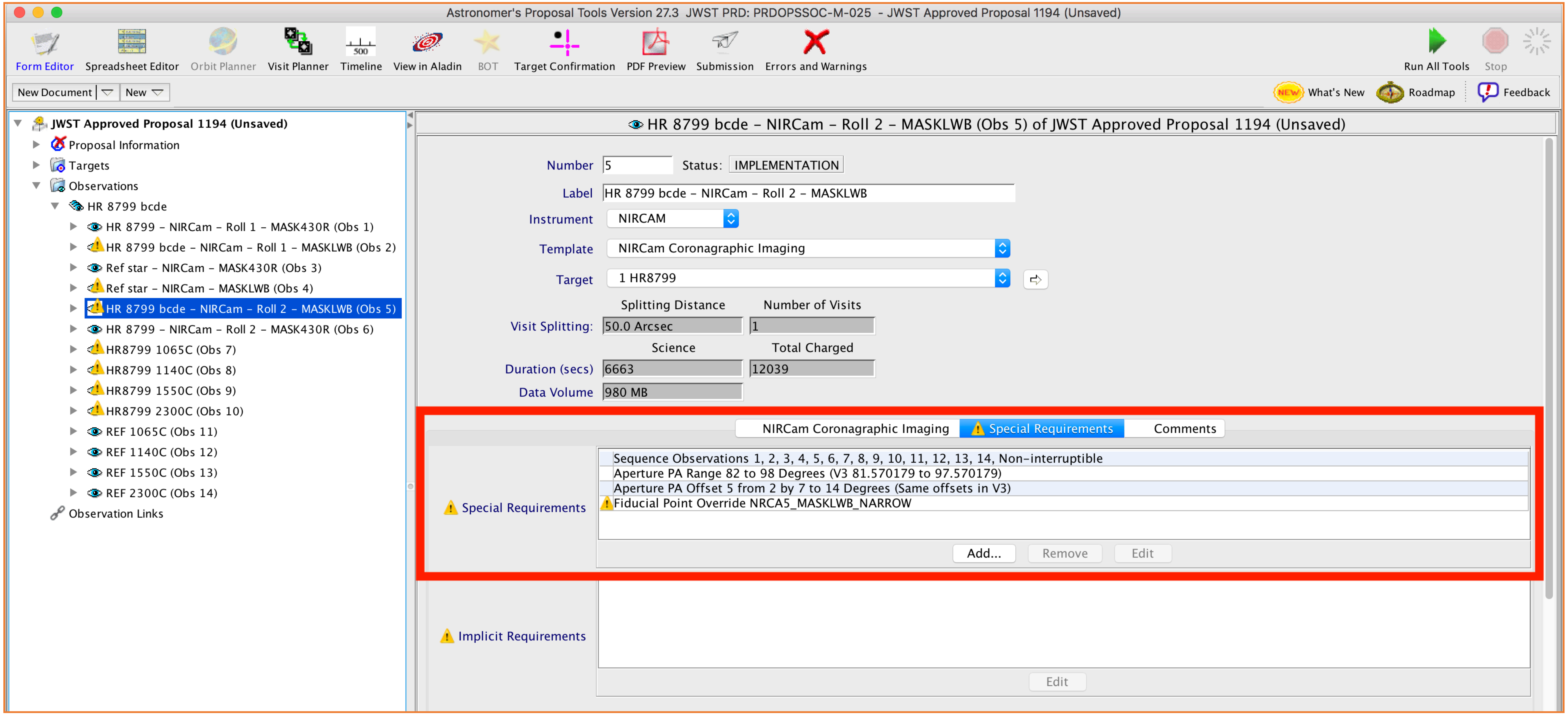
HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION
Label: HR 8799 bcde – NIRCam – Roll 2 – MASKLWB
Instrument: NIRCAM
Template: NIRCam Coronagraphic Imaging
Target: 1 HR8799
Visit Splitting: Splitting Distance 50.0 Arcsec; Number of Visits 1
Duration (secs): Science 6663; Total Charged 12039
Data Volume: 980 MB

Sequence Observations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, Non-interruptible
Aperture PA Range 82 to 98 Degrees (V3 81.570179 to 97.570179)

Sequence Observations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, Non-interruptible

APT: special requirements, Fiducial Pointing Override



- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 – NIRCam – Roll 1 – MASK430R (Obs 1)
      - HR 8799 bcde – NIRCam – Roll 1 – MASKLWB (Obs 2)
      - Ref star – NIRCam – MASK430R (Obs 3)
      - Ref star – NIRCam – MASKLWB (Obs 4)
      - HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5)
      - HR 8799 – NIRCam – Roll 2 – MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION

Label: HR 8799 bcde – NIRCam – Roll 2 – MASKLWB

Instrument: NIRCAM

Template: NIRCam Coronagraphic Imaging

Target: 1 HR8799

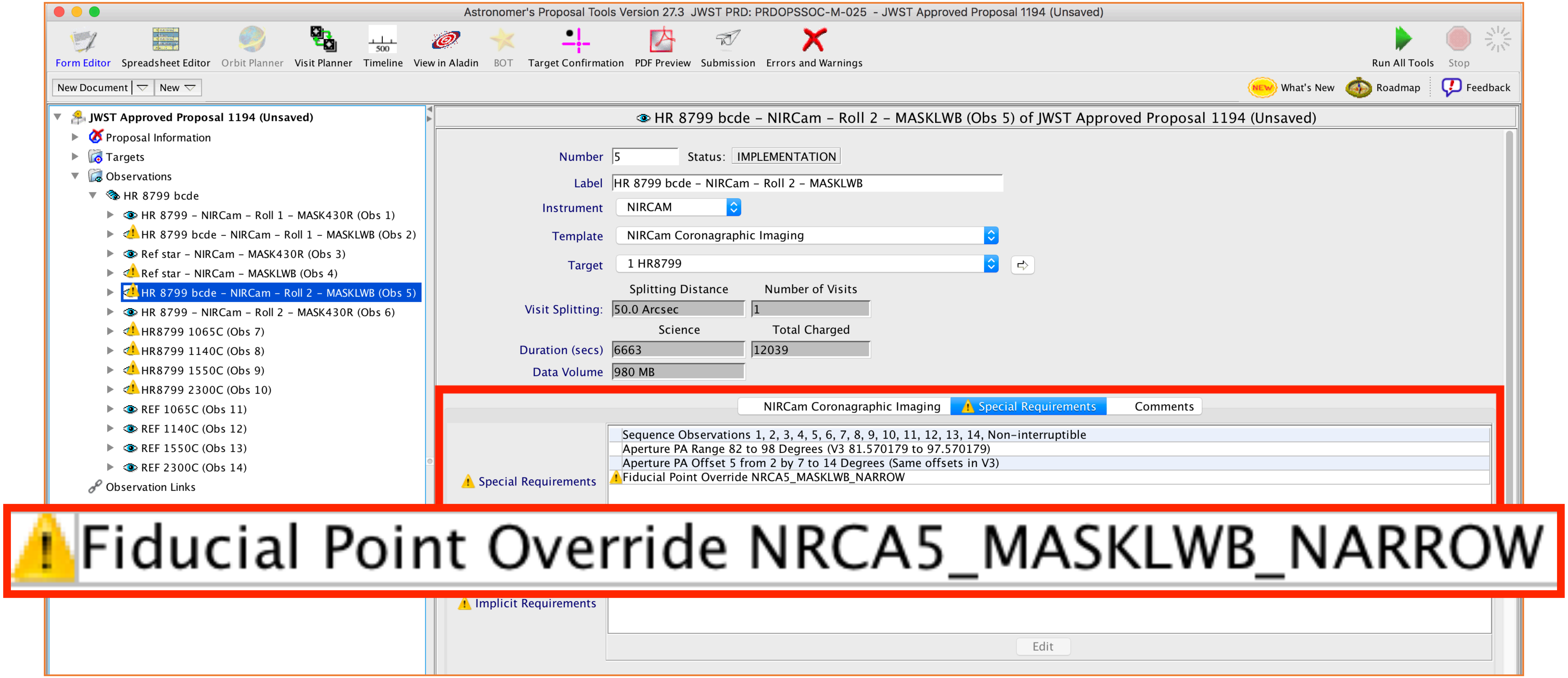
	Splitting Distance	Number of Visits
Visit Splitting:	50.0 Arcsec	1
	Science	**Total Charged**
Duration (secs)	6663	12039
Data Volume	980 MB	

⚠ Special Requirements

- Sequence Observations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, Non-interruptible
- Aperture PA Range 82 to 98 Degrees (V3 81.570179 to 97.570179)
- Aperture PA Offset 5 from 2 by 7 to 14 Degrees (Same offsets in V3)
- ⚠ Fiducial Point Override NRCA5_MASKLWB_NARROW

⚠ Implicit Requirements

APT: special requirements, Fiducial Pointing Override



Astronomer's Proposal Tools Version 27.3 JWST PRD: PRDOPSSOC-M-025 - JWST Approved Proposal 1194 (Unsaved)

- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 – NIRCam – Roll 1 – MASK430R (Obs 1)
      - HR 8799 bcde – NIRCam – Roll 1 – MASKLWB (Obs 2)
      - Ref star – NIRCam – MASK430R (Obs 3)
      - Ref star – NIRCam – MASKLWB (Obs 4)
      - HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5)
      - HR 8799 – NIRCam – Roll 2 – MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION

Label: HR 8799 bcde – NIRCam – Roll 2 – MASKLWB

Instrument: NIRCAM

Template: NIRCam Coronagraphic Imaging

Target: 1 HR8799

Visit Splitting: Splitting Distance 50.0 Arcsec; Number of Visits 1

Duration (secs): Science 6663; Total Charged 12039

Data Volume: 980 MB

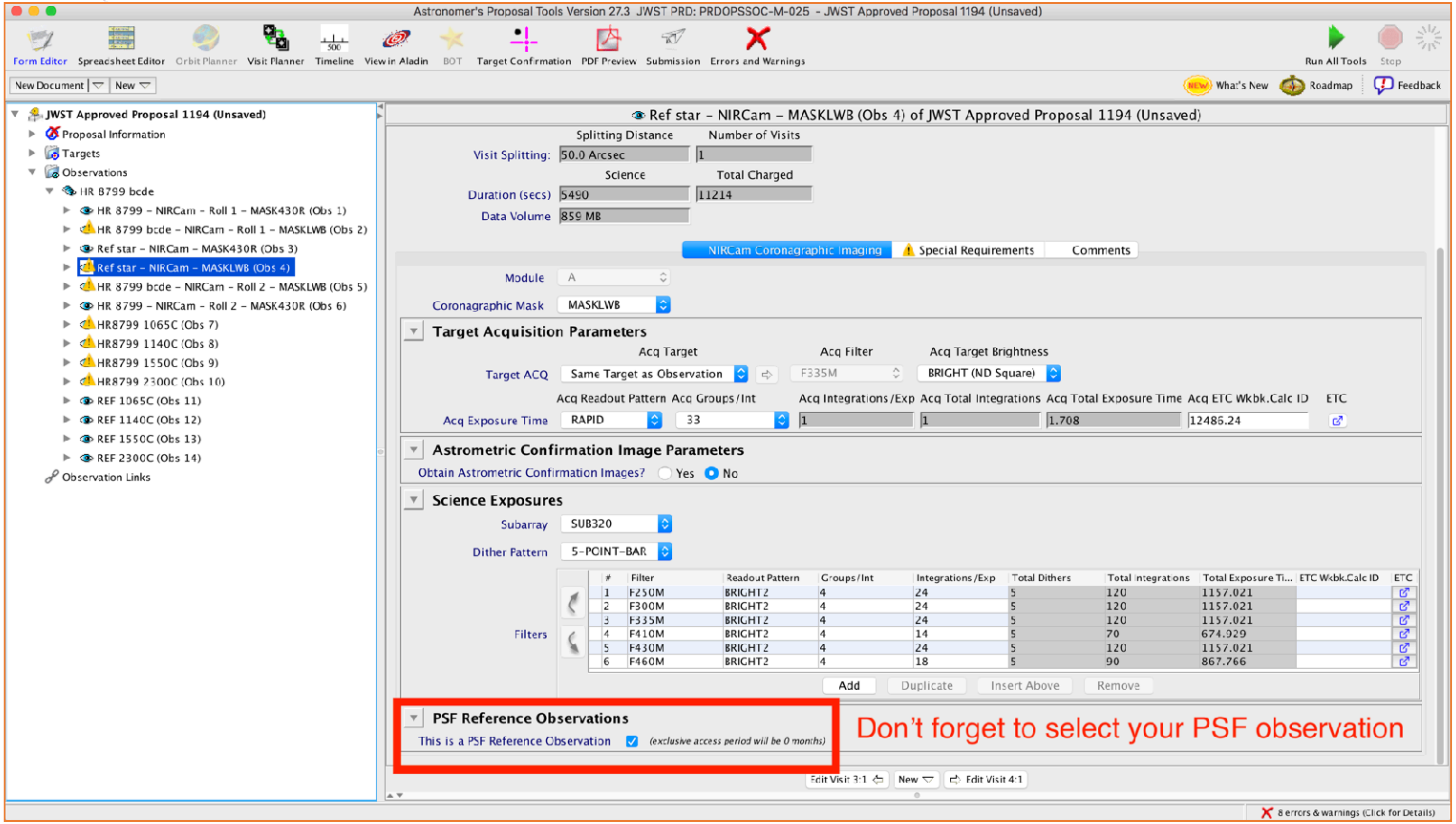
Special Requirements:

- Sequence Observations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, Non-interruptible
- Aperture PA Range 82 to 98 Degrees (V3 81.570179 to 97.570179)
- Aperture PA Offset 5 from 2 by 7 to 14 Degrees (Same offsets in V3)
- Fiducial Point Override NRCA5_MASKLWB_NARROW

Fiducial Point Override NRCA5_MASKLWB_NARROW

Implicit Requirements

APT: PSF reference stars



- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 – NIRCam – Roll 1 – MASK430R (Obs 1)
      - HR 8799 bcde – NIRCam – Roll 1 – MASKLWB (Obs 2)
      - Ref star – NIRCam – MASK430R (Obs 3)
      - Ref star – NIRCam – MASKLWB (Obs 4)
      - HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5)
      - HR 8799 – NIRCam – Roll 2 – MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

Ref star – NIRCam – MASKLWB (Obs 4) of JWST Approved Proposal 1194 (Unsaved)

	Splitting Distance	Number of Visits
Visit Splitting:	50.0 Arcsec	1

	Science	Total Charged
Duration (secs)	5490	11214
Data Volume	859 MB	

NIRCam Coronagraphic Imaging | Special Requirements | Comments

Module: A

Coronagraphic Mask: MASKLWB

Target Acquisition Parameters

	Acq Target	Acq Filter	Acq Target Brightness
Target ACQ	Same Target as Observation	F335M	BRIGHT (ND Square)

	Acq Readout Pattern	Acq Groups/Int	Acq Integrations/Exp	Acq Total Integrations	Acq Total Exposure Time	Acq ETC Wkbk.Calc ID	ETC
Acq Exposure Time	RAPID	33	1	1	1.708	12486.24	

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ○ Yes ● No

Science Exposures

Subarray: SUB320

Dither Pattern: 5-POINT-BAR

Filters

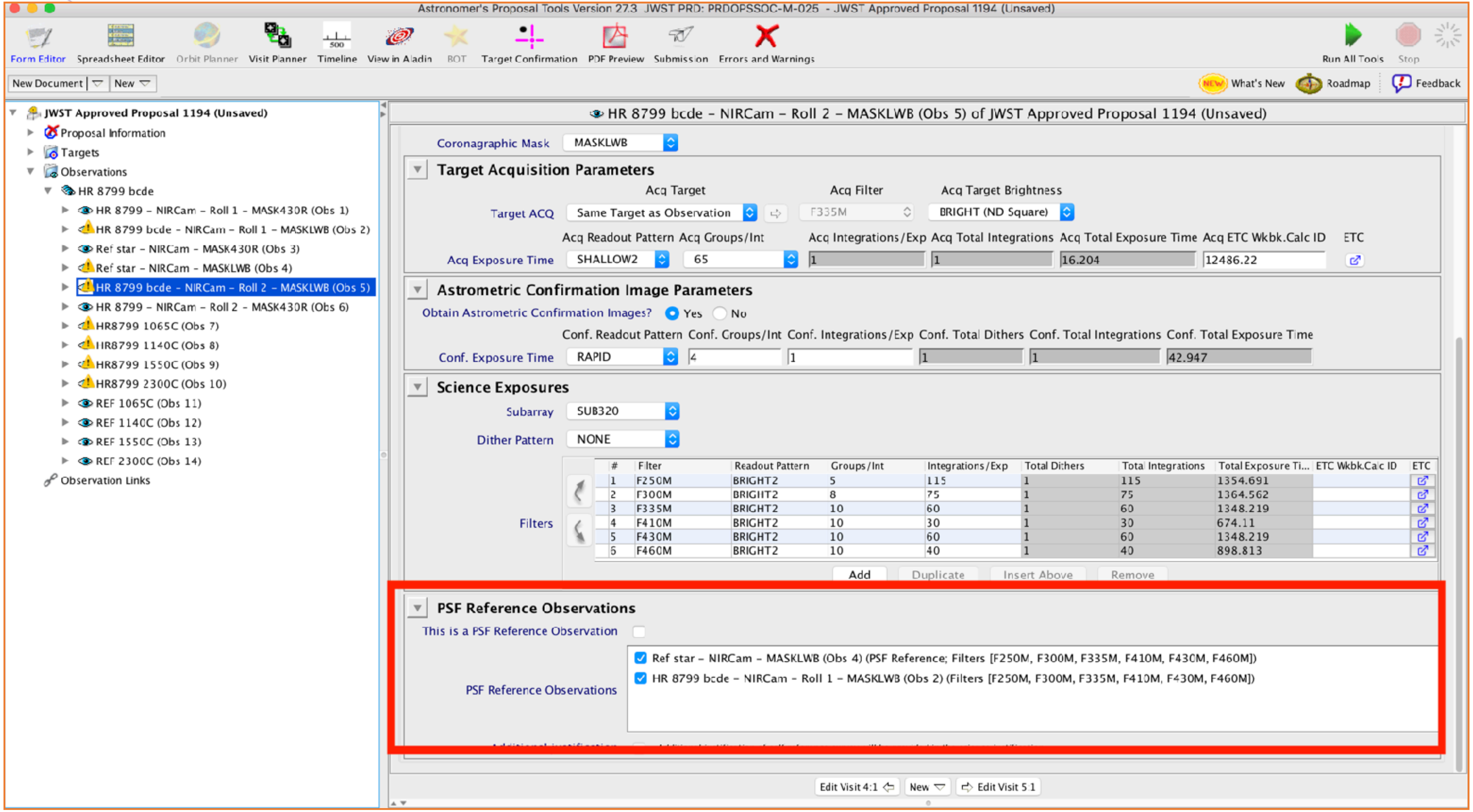
#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Ti...	ETC Wkbk.Calc ID	ETC
1	F250M	BRIGHT2	4	24	5	120	1157.021		
2	F300M	BRIGHT2	4	24	5	120	1157.021		
3	F335M	BRIGHT2	4	24	5	120	1157.021		
4	F410M	BRIGHT2	4	14	5	70	674.929		
5	F430M	BRIGHT2	4	24	5	120	1157.021		
6	F460M	BRIGHT2	4	18	5	90	867.766		

PSF Reference Observations

This is a PSF Reference Observation ☑ *(exclusive access period will be 0 months)*

Don't forget to select your PSF observation

APT: PSF reference stars



- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 - NIRCam - Roll 1 - MASK430R (Obs 1)
      - HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2)
      - Ref star - NIRCam - MASK430R (Obs 3)
      - Ref star - NIRCam - MASKLWB (Obs 4)
      - HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5)
      - HR 8799 - NIRCam - Roll 2 - MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Coronagraphic Mask: MASKLWB

Target Acquisition Parameters

Target ACQ — Acq Target: Same Target as Observation; Acq Filter: F335M; Acq Target Brightness: BRIGHT (ND Square)

Acq Exposure Time — Acq Readout Pattern: SHALLOW2; Acq Groups/Int: 65; Acq Integrations/Exp: 1; Acq Total Integrations: 1; Acq Total Exposure Time: 16.204; Acq ETC Wkbk.Calc ID: 12486.22; ETC

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ● Yes ○ No

Conf. Exposure Time — Conf. Readout Pattern: RAPID; Conf. Groups/Int: 4; Conf. Integrations/Exp: 1; Conf. Total Dithers: 1; Conf. Total Integrations: 1; Conf. Total Exposure Time: 42.947

Science Exposures

Subarray: SUB320

Dither Pattern: NONE

Filters

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Ti...	ETC Wkbk.Calc ID	ETC
1	F250M	BRIGHT2	5	115	1	115	1354.691		
2	F300M	BRIGHT2	8	75	1	75	1364.562		
3	F335M	BRIGHT2	10	60	1	60	1348.219		
4	F410M	BRIGHT2	10	30	1	30	674.11		
5	F430M	BRIGHT2	10	60	1	60	1348.219		
5	F460M	BRIGHT2	10	40	1	40	898.813		

PSF Reference Observations

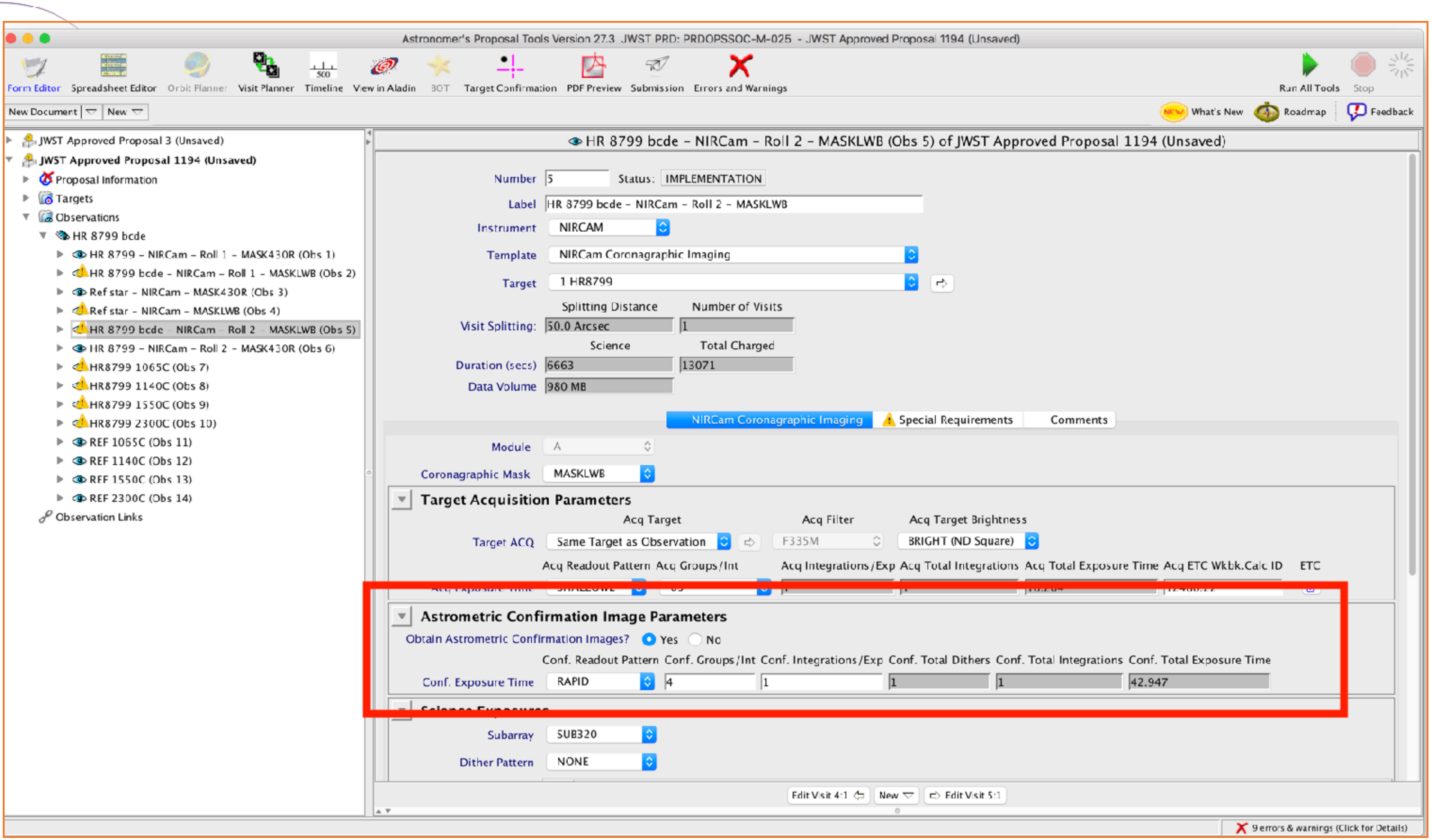
This is a PSF Reference Observation ☐

PSF Reference Observations:

☑ Ref star - NIRCam - MASKLWB (Obs 4) (PSF Reference; Filters [F250M, F300M, F335M, F410M, F430M, F460M])

☑ HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2) (Filters [F250M, F300M, F335M, F410M, F430M, F460M])

APT: smart accounting, astrometric confirmation image (TA)



Astronomer's Proposal Tools Version 27.3 JWST PRD: PRDOPSSOC-M-025 - JWST Approved Proposal 1194 (Unsaved)

- JWST Approved Proposal 3 (Unsaved)
- **JWST Approved Proposal 1194 (Unsaved)**
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 – NIRCam – Roll 1 – MASK430R (Obs 1)
      - HR 8799 bcde – NIRCam – Roll 1 – MASKLWB (Obs 2)
      - Ref star – NIRCam – MASK430R (Obs 3)
      - Ref star – NIRCam – MASKLWB (Obs 4)
      - HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5)
      - HR 8799 – NIRCam – Roll 2 – MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

HR 8799 bcde – NIRCam – Roll 2 – MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION

Label: HR 8799 bcde – NIRCam – Roll 2 – MASKLWB

Instrument: NIRCAM

Template: NIRCam Coronagraphic Imaging

Target: 1 HR8799

	Splitting Distance	Number of Visits
Visit Splitting:	50.0 Arcsec	1

	Science	Total Charged
Duration (secs)	6663	13071
Data Volume	980 MB	

Module: A

Coronagraphic Mask: MASKLWB

Target Acquisition Parameters

	Acq Target	Acq Filter	Acq Target Brightness
Target ACQ	Same Target as Observation	F335M	BRIGHT (ND Square)

Acq Readout Pattern Acq Groups/Int Acq Integrations/Exp Acq Total Integrations Acq Total Exposure Time Acq ETC Wkbk.Calc ID ETC

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ● Yes ○ No

	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Dithers	Conf. Total Integrations	Conf. Total Exposure Time
Conf. Exposure Time	RAPID	4	1	1	1	42.947

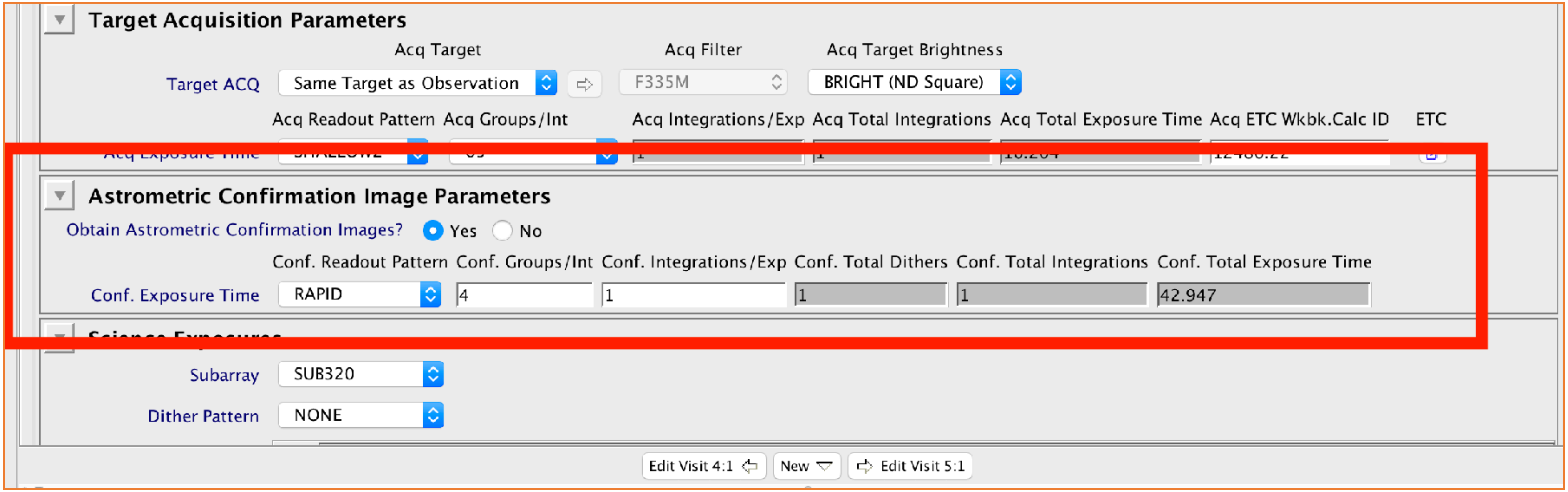
Science Exposures

Subarray: SUB320

Dither Pattern: NONE

9 errors & warnings (Click for Details)

APT: optional, full frame astrometric confirmation images (TA)



Target Acquisition Parameters

	Acq Target	Acq Filter	Acq Target Brightness
Target ACQ	Same Target as Observation	F335M	BRIGHT (ND Square)

Acq Readout Pattern Acq Groups/Int Acq Integrations/Exp Acq Total Integrations Acq Total Exposure Time Acq ETC Wkbk.Calc ID ETC

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ● Yes ○ No

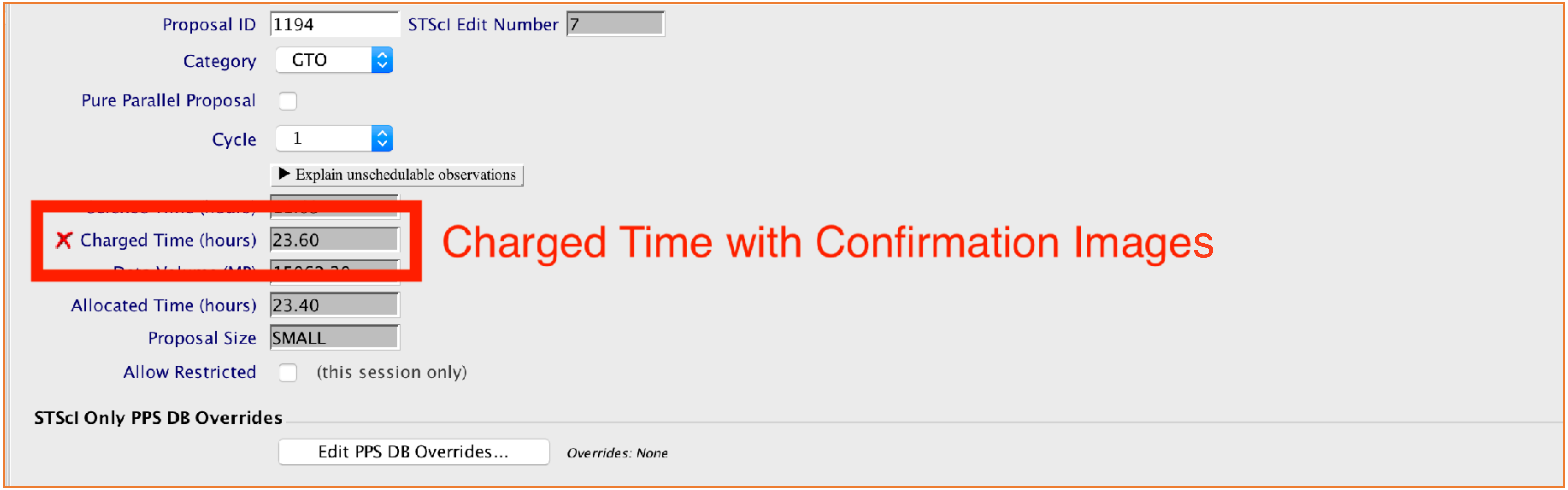
	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Dithers	Conf. Total Integrations	Conf. Total Exposure Time
Conf. Exposure Time	RAPID	4	1	1	1	42.947

Science Exposures

Subarray: SUB320

Dither Pattern: NONE

APT: smart accounting, astrometric confirmation images (TA)



Proposal ID 1194

STScI Edit Number 7

Category GTO

Pure Parallel Proposal ☐

Cycle 1

Charged Time (hours) 23.60

Allocated Time (hours) 23.40

Proposal Size SMALL

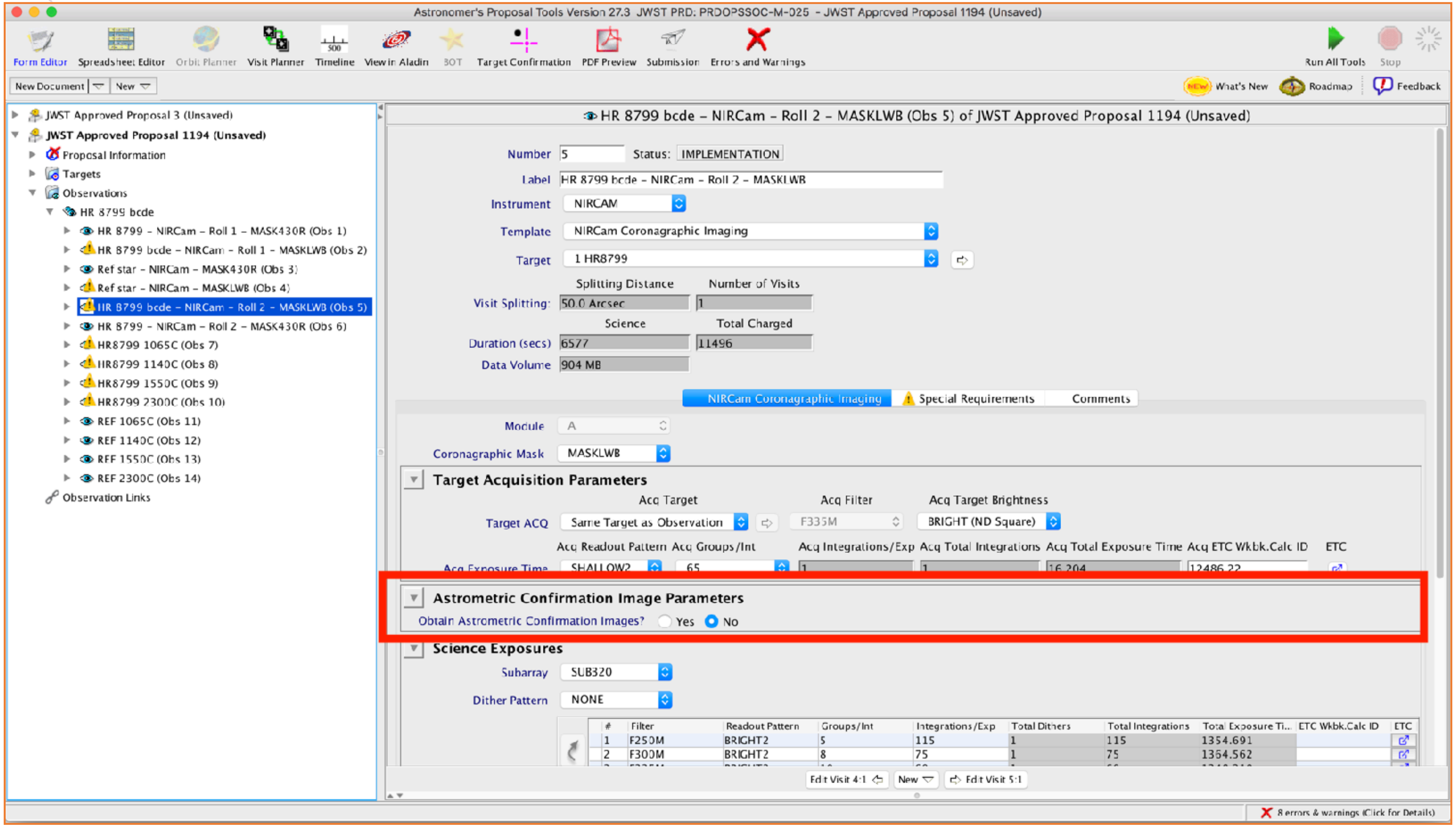
Allow Restricted ☐ (this session only)

STScI Only PPS DB Overrides

Overrides: None

Charged Time with Confirmation Images

APT: smart accounting, astrometric confirmation image (TA)



- JWST Approved Proposal 3 (Unsaved)
- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 - NIRCam - Roll 1 - MASK430R (Obs 1)
      - HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2)
      - Ref star - NIRCam - MASK430R (Obs 3)
      - Ref star - NIRCam - MASKLWB (Obs 4)
      - HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5)
      - HR 8799 - NIRCam - Roll 2 - MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5) of JWST Approved Proposal 1194 (Unsaved)

Number: 5 Status: IMPLEMENTATION
Label: HR 8799 bcde - NIRCam - Roll 2 - MASKLWB
Instrument: NIRCAM
Template: NIRCam Coronagraphic Imaging
Target: 1 HR8799

	Splitting Distance	Number of Visits
Visit Splitting:	50.0 Arcsec	1

	Science	Total Charged
Duration (secs)	6577	11496
Data Volume	904 MB	

NIRCam Coronagraphic Imaging | Special Requirements | Comments

Module: A
Coronagraphic Mask: MASKLWB

Target Acquisition Parameters

	Acq Target		Acq Filter	Acq Target Brightness
Target ACQ	Same Target as Observation		F335M	BRIGHT (ND Square)

	Acq Readout Pattern	Acq Groups/Int	Acq Integrations/Exp	Acq Total Integrations	Acq Total Exposure Time	Acq ETC Wkbk.Calc ID	ETC
Acq Exposure Time	SHALLOW2	65	1	1	16.204	12486.22	

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ○ Yes ● No

Science Exposures

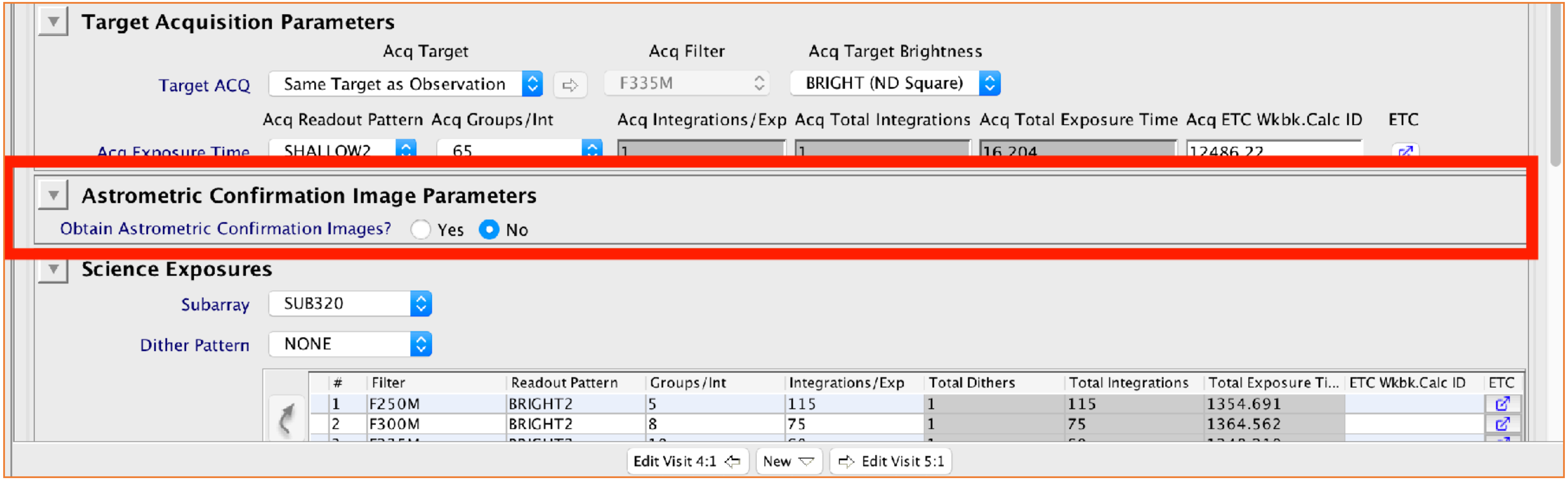
Subarray: SUB320
Dither Pattern: NONE

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Ti...	ETC Wkbk.Calc ID	ETC
1	F250M	BRIGHT2	5	115	1	115	1354.691		
2	F300M	BRIGHT2	8	75	1	75	1364.562		

Edit Visit 4:1 | New | Edit Visit 5:1

8 errors & warnings (Click for Details)

APT: optional, full frame astrometric confirmation images (TA)



Target Acquisition Parameters

	Acq Target	Acq Filter	Acq Target Brightness
Target ACQ	Same Target as Observation	F335M	BRIGHT (ND Square)

	Acq Readout Pattern	Acq Groups/Int	Acq Integrations/Exp	Acq Total Integrations	Acq Total Exposure Time	Acq ETC Wkbk.Calc ID	ETC
Acq Exposure Time	SHALLOW2	65	1	1	16.204	12486.22	

Astrometric Confirmation Image Parameters

Obtain Astrometric Confirmation Images? ○ Yes ● No

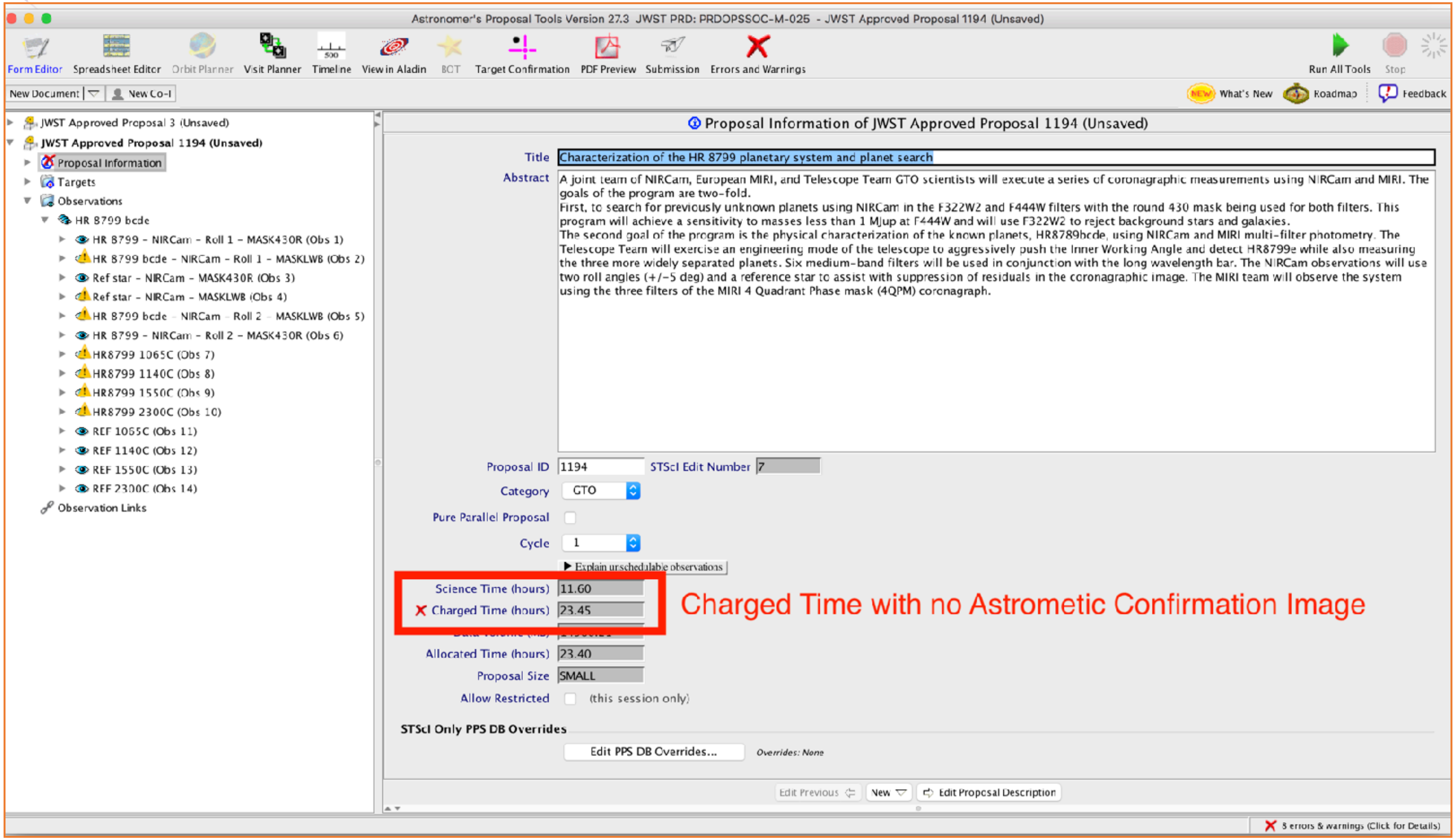
Science Exposures

Subarray: SUB320

Dither Pattern: NONE

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Ti...	ETC Wkbk.Calc ID	ETC
1	F250M	BRIGHT2	5	115	1	115	1354.691		
2	F300M	BRIGHT2	8	75	1	75	1364.562		

APT: smart accounting, astrometric confirmation image (TA)



- JWST Approved Proposal 3 (Unsaved)
- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
  - Observations
    - HR 8799 bcde
      - HR 8799 - NIRCam - Roll 1 - MASK430R (Obs 1)
      - HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2)
      - Ref star - NIRCam - MASK430R (Obs 3)
      - Ref star - NIRCam - MASKLWB (Obs 4)
      - HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5)
      - HR 8799 - NIRCam - Roll 2 - MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links

Proposal Information of JWST Approved Proposal 1194 (Unsaved)

Title: Characterization of the HR 8799 planetary system and planet search

Abstract: A joint team of NIRCam, European MIRI, and Telescope Team GTO scientists will execute a series of coronagraphic measurements using NIRCam and MIRI. The goals of the program are two-fold.
First, to search for previously unknown planets using NIRCam in the F322W2 and F444W filters with the round 430 mask being used for both filters. This program will achieve a sensitivity to masses less than 1 MJup at F444W and will use F322W2 to reject background stars and galaxies.
The second goal of the program is the physical characterization of the known planets, HR8789bcde, using NIRCam and MIRI multi-filter photometry. The Telescope Team will exercise an engineering mode of the telescope to aggressively push the Inner Working Angle and detect HR8799e while also measuring the three more widely separated planets. Six medium-band filters will be used in conjunction with the long wavelength bar. The NIRCam observations will use two roll angles (+/-5 deg) and a reference star to assist with suppression of residuals in the coronagraphic image. The MIRI team will observe the system using the three filters of the MIRI 4 Quadrant Phase mask (4QPM) coronagraph.

Proposal ID: 1194 STScI Edit Number: 7

Category: GTO

Pure Parallel Proposal: ☐

Cycle: 1

▶ Explain unschedulable observations

Science Time (hours): 11.60

✗ Charged Time (hours): 23.45

Allocated Time (hours): 23.40

Proposal Size: SMALL

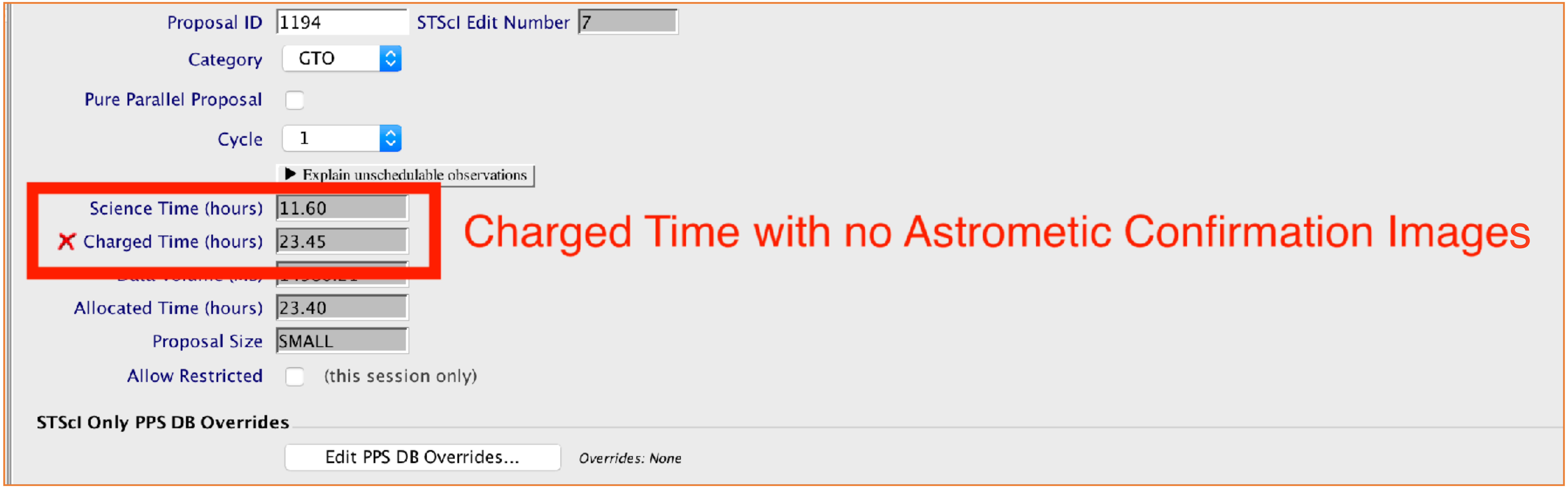
Allow Restricted: ☐ (this session only)

STScI Only PPS DB Overrides

Edit PPS DB Overrides... Overrides: None

Charged Time with no Astrometic Confirmation Image

APT: smart accounting, astrometric confirmation images (TA)



Proposal ID 1194 STScI Edit Number 7

Category GTO

Pure Parallel Proposal ☐

Cycle 1

▶ Explain unschedulable observations

Science Time (hours) 11.60

✗ Charged Time (hours) 23.45

Data Volume (MB) [illegible]

Allocated Time (hours) 23.40

Proposal Size SMALL

Allow Restricted ☐ (this session only)

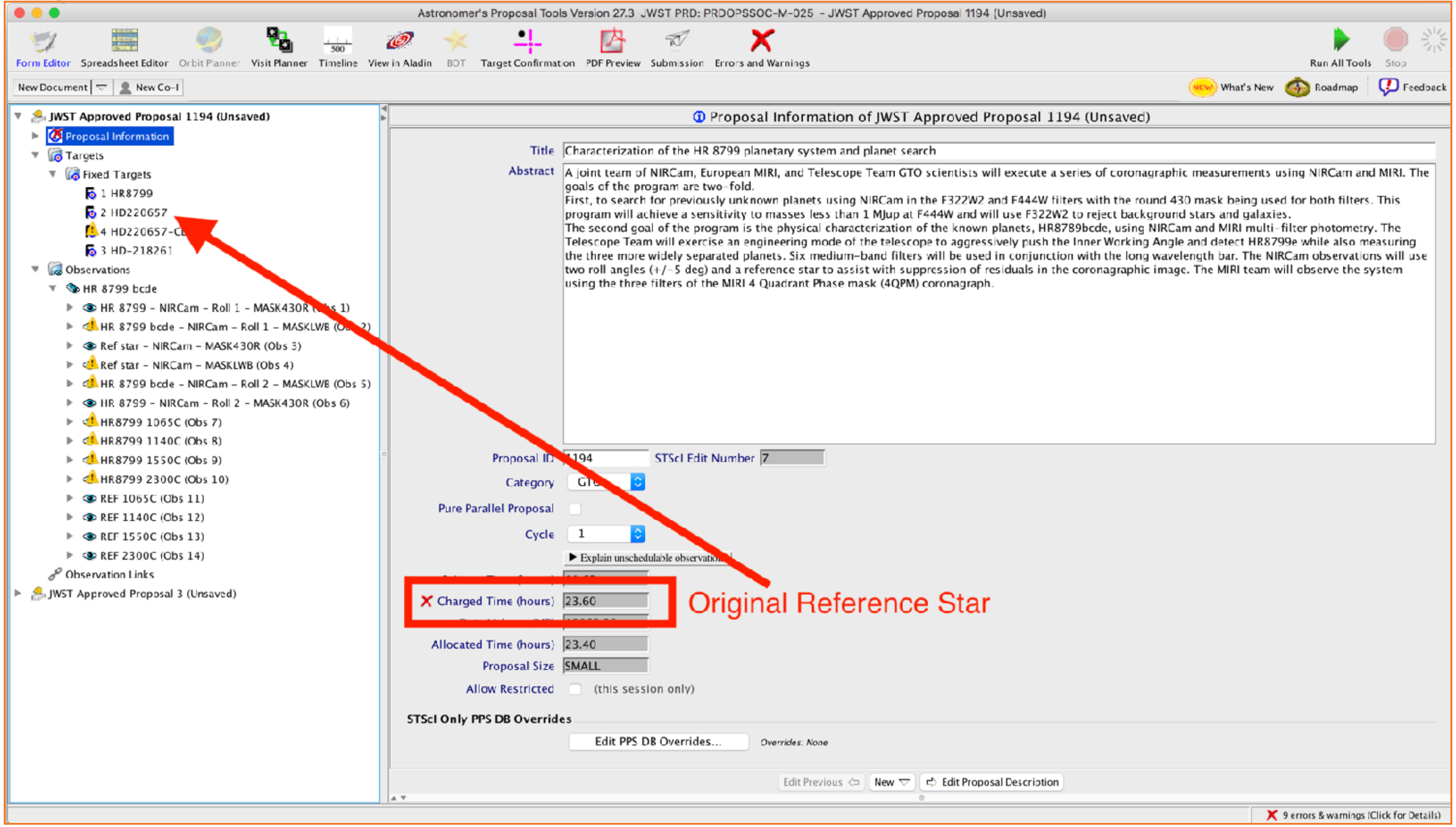
STScI Only PPS DB Overrides

Edit PPS DB Overrides... *Overrides: None*

Charged Time with no Astrometic Confirmation Images

Taking astrometric confirmation images add 0.15h (9 min) in this case

APT: smart accounting, closer PSF reference star



Astronomer's Proposal Tools Version 27.3 JWST PRD: PRDOPSSOC-M-025 - JWST Approved Proposal 1194 (Unsaved)

- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
    - Fixed Targets
      - 1 HR8799
      - 2 HD220657
      - 4 HD220657-C
      - 3 HD-218261
  - Observations
    - HR 8799 bcde
      - HR 8799 - NIRCam - Roll 1 - MASK430R (Obs 1)
      - HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2)
      - Ref star - NIRCam - MASK430R (Obs 3)
      - Ref star - NIRCam - MASKLWB (Obs 4)
      - HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5)
      - HR 8799 - NIRCam - Roll 2 - MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links
- JWST Approved Proposal 3 (Unsaved)

Proposal Information of JWST Approved Proposal 1194 (Unsaved)

Title: Characterization of the HR 8799 planetary system and planet search

Abstract: A joint team of NIRCam, European MIRI, and Telescope Team GTO scientists will execute a series of coronagraphic measurements using NIRCam and MIRI. The goals of the program are two-fold.
First, to search for previously unknown planets using NIRCam in the F322W2 and F444W filters with the round 430 mask being used for both filters. This program will achieve a sensitivity to masses less than 1 MJup at F444W and will use F322W2 to reject background stars and galaxies.
The second goal of the program is the physical characterization of the known planets, HR8789bcde, using NIRCam and MIRI multi-filter photometry. The Telescope Team will exercise an engineering mode of the telescope to aggressively push the Inner Working Angle and detect HR8799e while also measuring the three more widely separated planets. Six medium-band filters will be used in conjunction with the long wavelength bar. The NIRCam observations will use two roll angles (+/-5 deg) and a reference star to assist with suppression of residuals in the coronagraphic image. The MIRI team will observe the system using the three filters of the MIRI 4 Quadrant Phase mask (4QPM) coronagraph.

Proposal ID: 1194 STScI Edit Number: 7
Category: GT
Pure Parallel Proposal: ☐
Cycle: 1
▶ Explain unschedulable observation
✗ Charged Time (hours): 23.60
Allocated Time (hours): 23.40
Proposal Size: SMALL
Allow Restricted: ☐ (this session only)

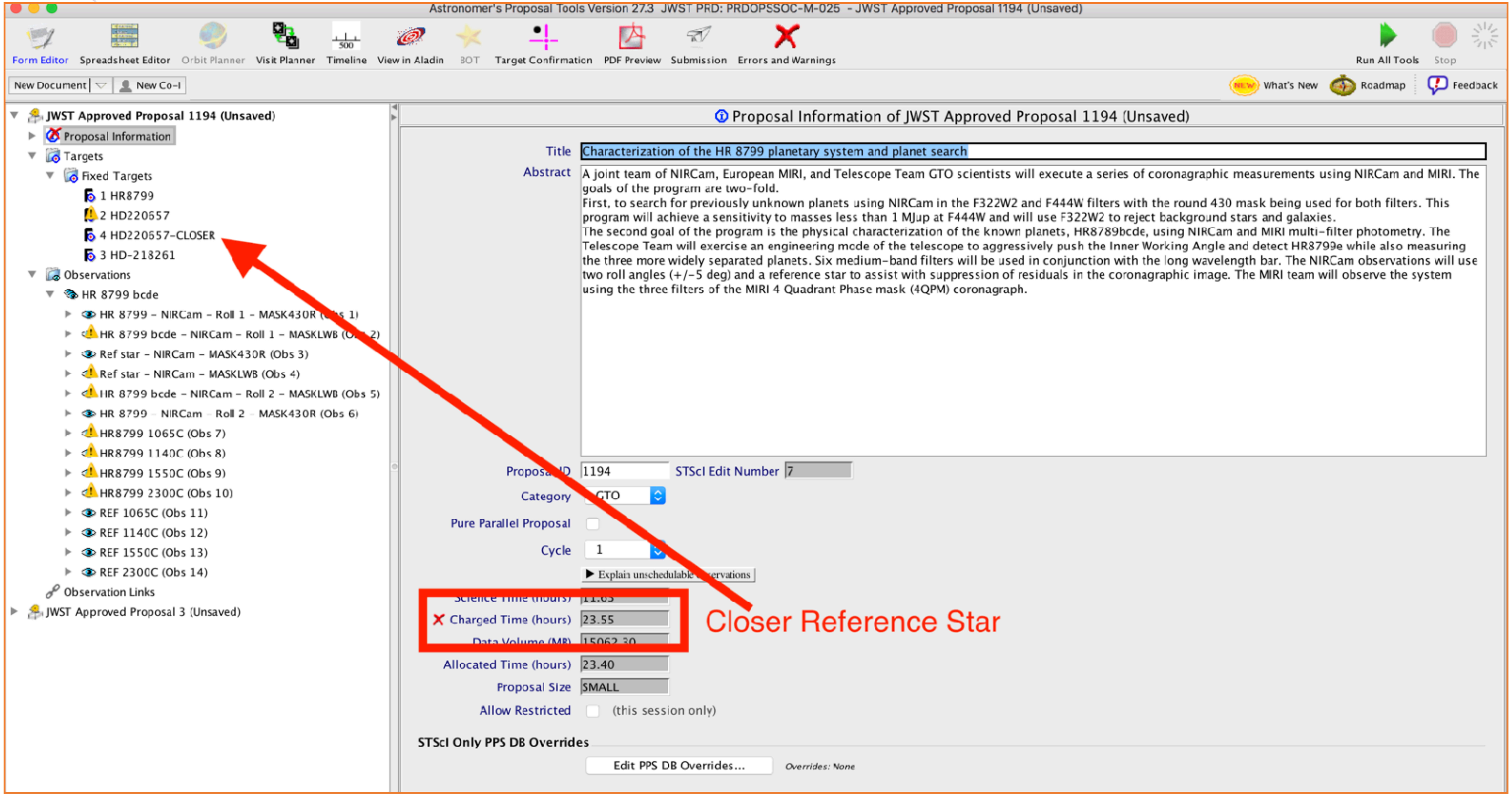
STScI Only PPS DB Overrides

Overrides. None

✗ 9 errors & warnings (Click for Details)

Original Reference Star

APT: smart accounting, closer PSF reference star



- JWST Approved Proposal 1194 (Unsaved)
  - Proposal Information
  - Targets
    - Fixed Targets
      - 1 HR8799
      - 2 HD220657
      - 4 HD220657-CLOSER
      - 3 HD-218261
  - Observations
    - HR 8799 bcde
      - HR 8799 - NIRCam - Roll 1 - MASK430R (Obs 1)
      - HR 8799 bcde - NIRCam - Roll 1 - MASKLWB (Obs 2)
      - Ref star - NIRCam - MASK430R (Obs 3)
      - Ref star - NIRCam - MASKLWB (Obs 4)
      - HR 8799 bcde - NIRCam - Roll 2 - MASKLWB (Obs 5)
      - HR 8799 - NIRCam - Roll 2 - MASK430R (Obs 6)
      - HR8799 1065C (Obs 7)
      - HR8799 1140C (Obs 8)
      - HR8799 1550C (Obs 9)
      - HR8799 2300C (Obs 10)
      - REF 1065C (Obs 11)
      - REF 1140C (Obs 12)
      - REF 1550C (Obs 13)
      - REF 2300C (Obs 14)
  - Observation Links
- JWST Approved Proposal 3 (Unsaved)

Proposal Information of JWST Approved Proposal 1194 (Unsaved)

Title: Characterization of the HR 8799 planetary system and planet search

Abstract: A joint team of NIRCam, European MIRI, and Telescope Team GTO scientists will execute a series of coronagraphic measurements using NIRCam and MIRI. The goals of the program are two-fold.
First, to search for previously unknown planets using NIRCam in the F322W2 and F444W filters with the round 430 mask being used for both filters. This program will achieve a sensitivity to masses less than 1 MJup at F444W and will use F322W2 to reject background stars and galaxies.
The second goal of the program is the physical characterization of the known planets, HR8789bcde, using NIRCam and MIRI multi-filter photometry. The Telescope Team will exercise an engineering mode of the telescope to aggressively push the Inner Working Angle and detect HR8799e while also measuring the three more widely separated planets. Six medium-band filters will be used in conjunction with the long wavelength bar. The NIRCam observations will use two roll angles (+/-5 deg) and a reference star to assist with suppression of residuals in the coronagraphic image. The MIRI team will observe the system using the three filters of the MIRI 4 Quadrant Phase mask (4QPM) coronagraph.

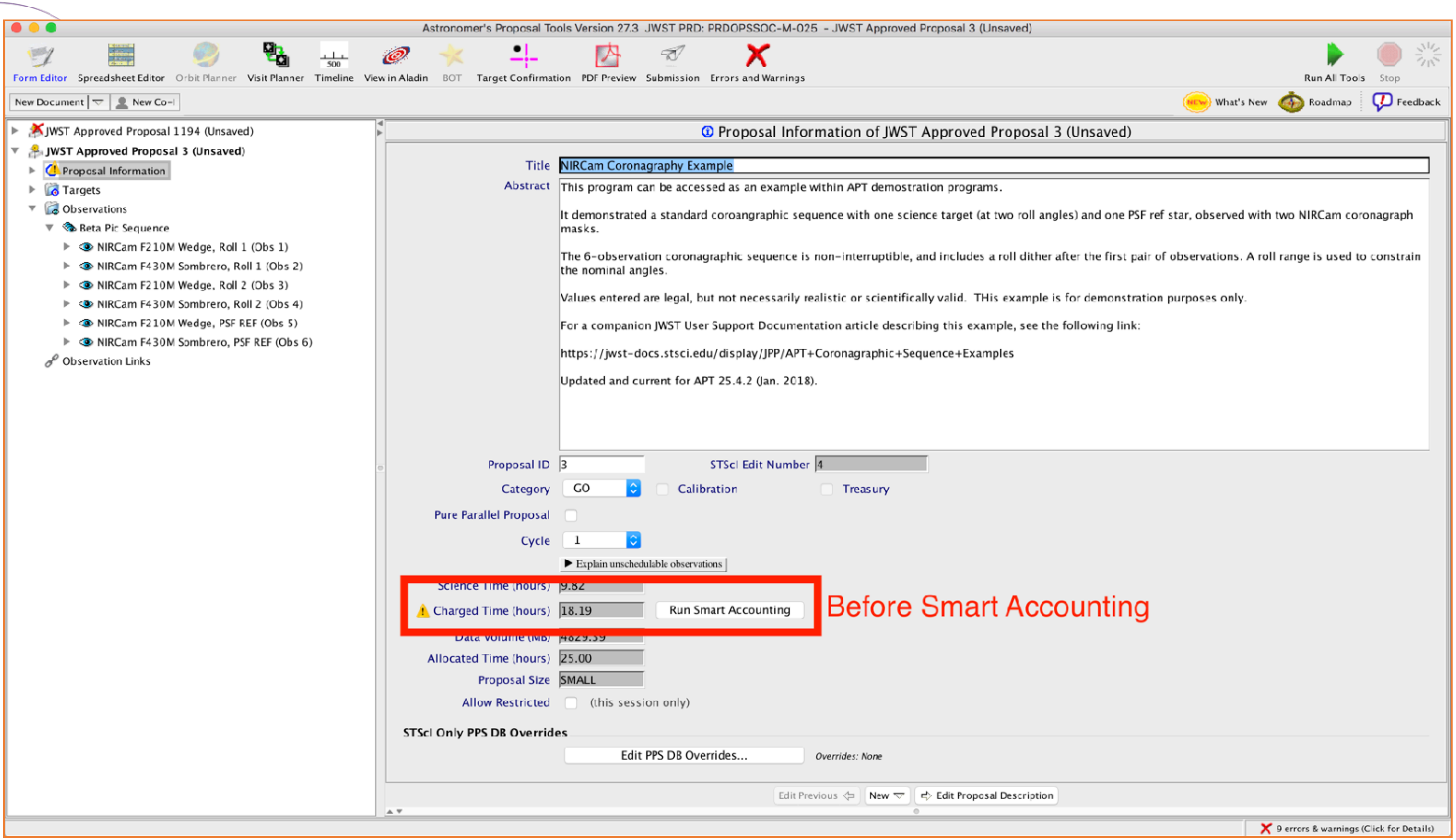
Proposal ID: 1194 STScI Edit Number: 7
Category: GTO
Pure Parallel Proposal: ☐
Cycle: 1
▶ Explain unschedulable observations
Science Time (hours): 11.65
✗ Charged Time (hours): 23.55
Data Volume (MB): 15062.30
Allocated Time (hours): 23.40
Proposal Size: SMALL
Allow Restricted: ☐ (this session only)

STScI Only PPS DB Overrides

Edit PPS DB Overrides... Overrides: None

Closer Reference Star

APT: smart accounting, astrometric confirmation image (TA)



Title: NIRCam Coronagraphy Example

Abstract: This program can be accessed as an example within APT demostration programs.

It demonstrated a standard coroangraphic sequence with one science target (at two roll angles) and one PSF ref star, observed with two NIRCam coronagraph masks.

The 6-observation coronagraphic sequence is non-interruptible, and includes a roll dither after the first pair of observations. A roll range is used to constrain the nominal angles.

Values entered are legal, but not necessarily realistic or scientifically valid. THis example is for demonstration purposes only.

For a companion JWST User Support Documentation article describing this example, see the following link:

https://jwst-docs.stsci.edu/display/JPP/APT+Coronagraphic+Sequence+Examples

Updated and current for APT 25.4.2 (Jan. 2018).

Proposal ID: 3

STScI Edit Number: 4

Category: GO

☐ Calibration

☐ Treasury

Pure Parallel Proposal: ☐

Cycle: 1

Science Time (hours): 9.82

Charged Time (hours): 18.19

Data Volume (MB): 4829.59

Allocated Time (hours): 25.00

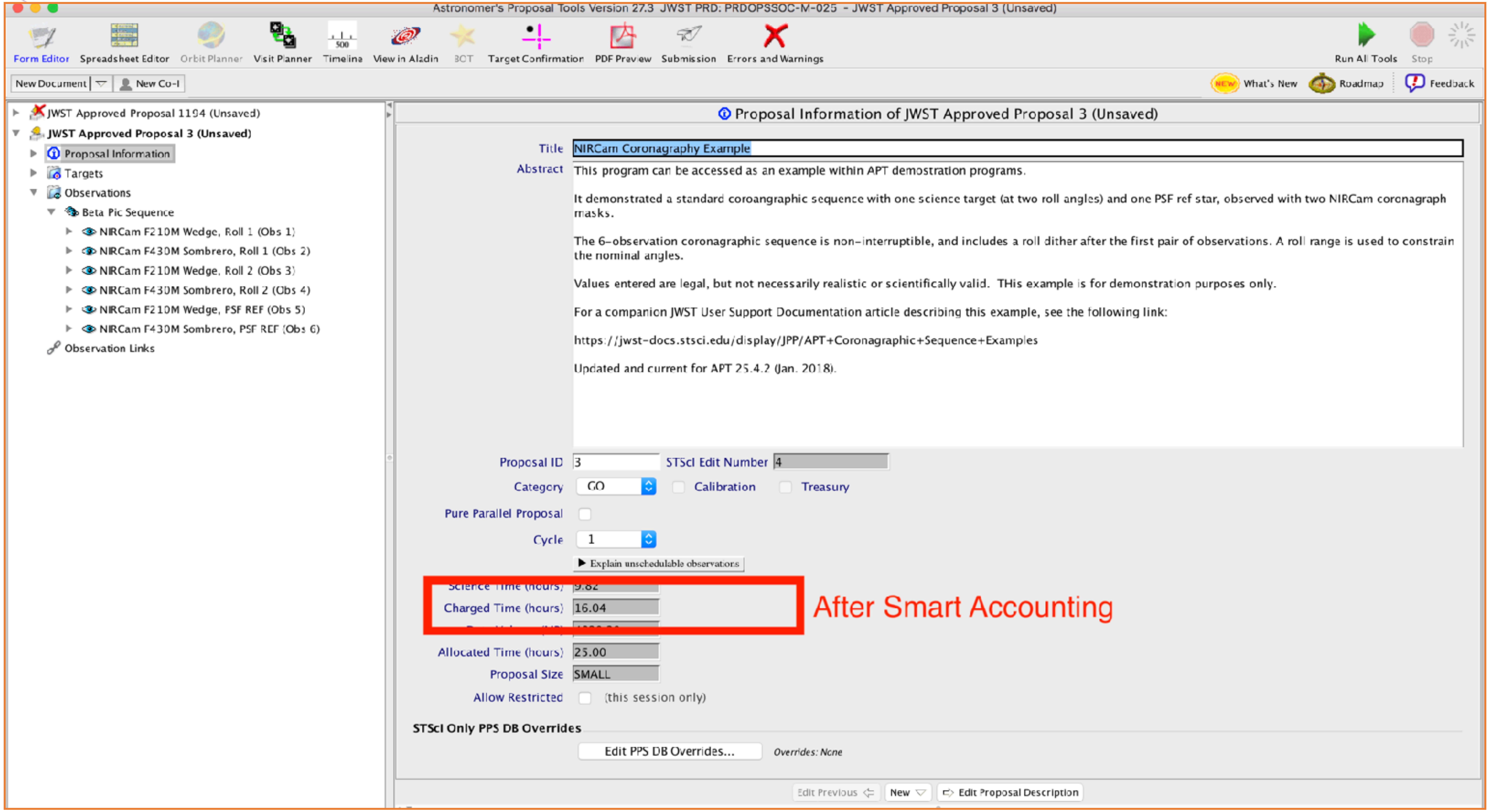
Proposal Size: SMALL

Allow Restricted: ☐ (this session only)

Overrides: None

Before Smart Accounting

APT: smart accounting, astrometric confirmation image (TA)



Proposal Information of JWST Approved Proposal 3 (Unsaved)

Title: NIRCam Coronagraphy Example

Abstract: This program can be accessed as an example within APT demonstration programs.

It demonstrated a standard coroangraphic sequence with one science target (at two roll angles) and one PSF ref star, observed with two NIRCam coronagraph masks.

The 6-observation coronagraphic sequence is non-interruptible, and includes a roll dither after the first pair of observations. A roll range is used to constrain the nominal angles.

Values entered are legal, but not necessarily realistic or scientifically valid. THis example is for demonstration purposes only.

For a companion JWST User Support Documentation article describing this example, see the following link:

https://jwst-docs.stsci.edu/display/JPP/APT+Coronagraphic+Sequence+Examples

Updated and current for APT 25.4.2 (Jan. 2018).

Proposal ID: 3
STScI Edit Number: 4
Category: GO
☐ Calibration
☐ Treasury
Pure Parallel Proposal: ☐
Cycle: 1
Science Time (hours): 9.82
Charged Time (hours): 16.04
Allocated Time (hours): 25.00
Proposal Size: SMALL
Allow Restricted: ☐ (this session only)

STScI Only PPS DB Overrides

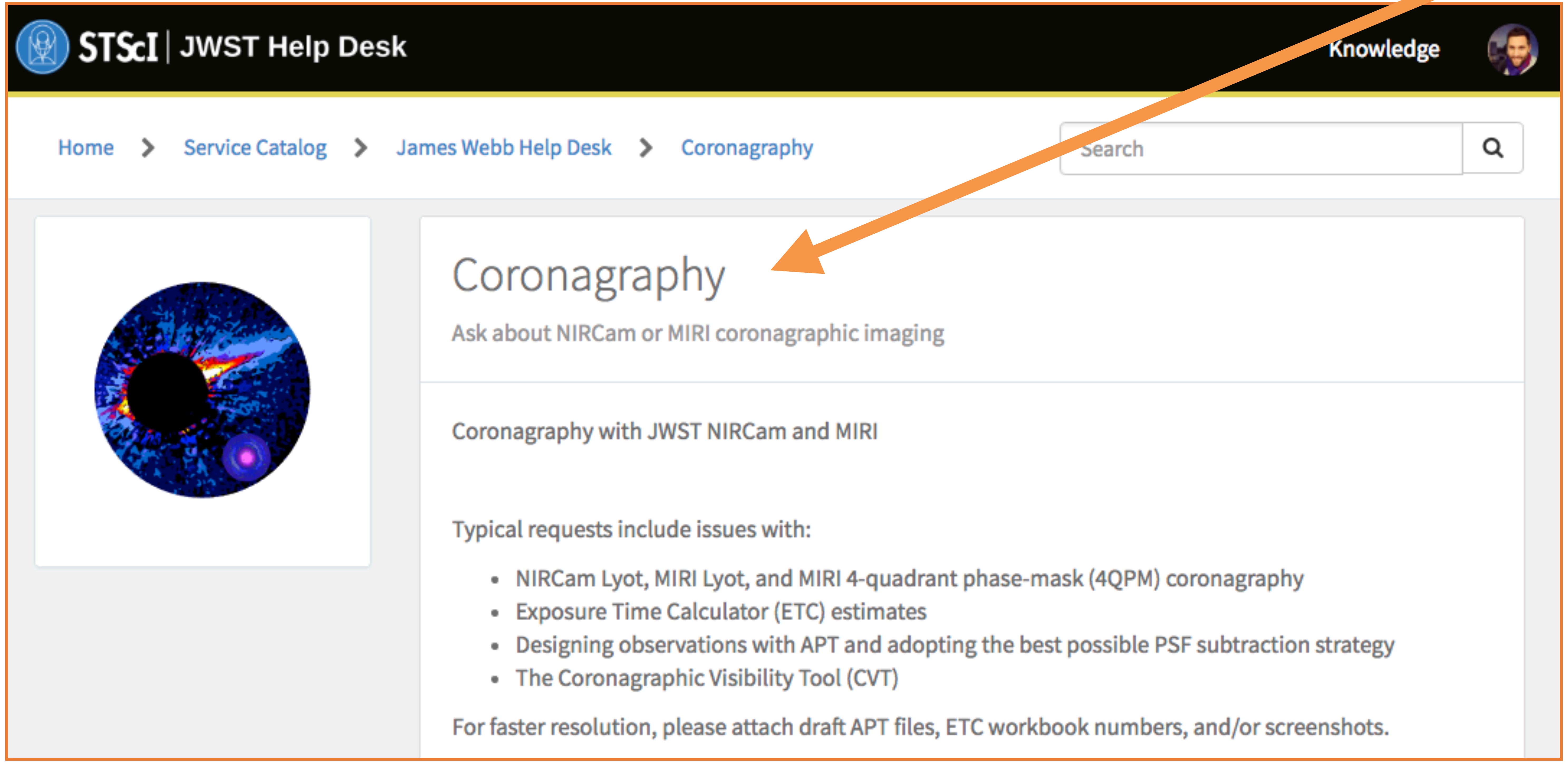
Overrides: None

After Smart Accounting

Extra Slides & Extra Resources

Help Desk

jwsthelp.stsci.edu



STScI | JWST Help Desk

Home > Service Catalog > James Webb Help Desk > Coronagraphy

Coronagraphy

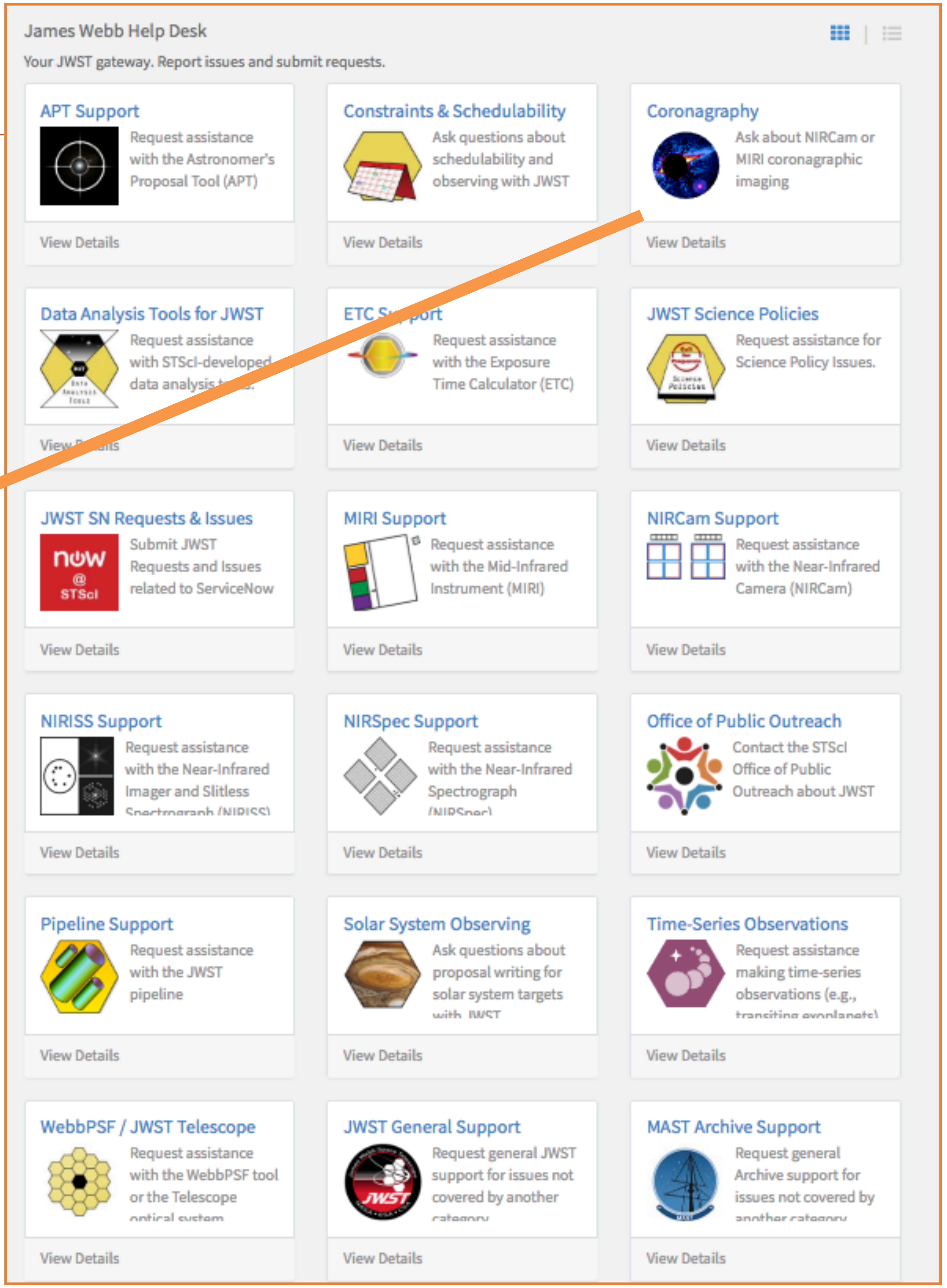
Ask about NIRCam or MIRI coronagraphic imaging

Coronagraphy with JWST NIRCam and MIRI

Typical requests include issues with:

- NIRCam Lyot, MIRI Lyot, and MIRI 4-quadrant phase-mask (4QPM) coronagraphy
- Exposure Time Calculator (ETC) estimates
- Designing observations with APT and adopting the best possible PSF subtraction strategy
- The Coronagraphic Visibility Tool (CVT)

For faster resolution, please attach draft APT files, ETC workbook numbers, and/or screenshots.



James Webb Help Desk

Your JWST gateway. Report issues and submit requests.

APT Support
Request assistance with the Astronomer's Proposal Tool (APT)
View Details

Constraints & Schedulability
Ask questions about schedulability and observing with JWST
View Details

Coronagraphy
Ask about NIRCam or MIRI coronagraphic imaging
View Details

Data Analysis Tools for JWST
Request assistance with STScI-developed data analysis tools.
View Details

ETC Support
Request assistance with the Exposure Time Calculator (ETC)
View Details

JWST Science Policies
Request assistance for Science Policy Issues.
View Details

JWST SN Requests & Issues
Submit JWST Requests and Issues related to ServiceNow
View Details

MIRI Support
Request assistance with the Mid-Infrared Instrument (MIRI)
View Details

NIRCam Support
Request assistance with the Near-Infrared Camera (NIRCam)
View Details

NIRISS Support
Request assistance with the Near-Infrared Imager and Slitless Spectrograph (NIRISS)
View Details

NIRSpec Support
Request assistance with the Near-Infrared Spectrograph (NIRSpec)
View Details

Office of Public Outreach
Contact the STScI Office of Public Outreach about JWST
View Details

Pipeline Support
Request assistance with the JWST pipeline
View Details

Solar System Observing
Ask questions about proposal writing for solar system targets with JWST
View Details

Time-Series Observations
Request assistance making time-series observations (e.g., transiting exoplanets)
View Details

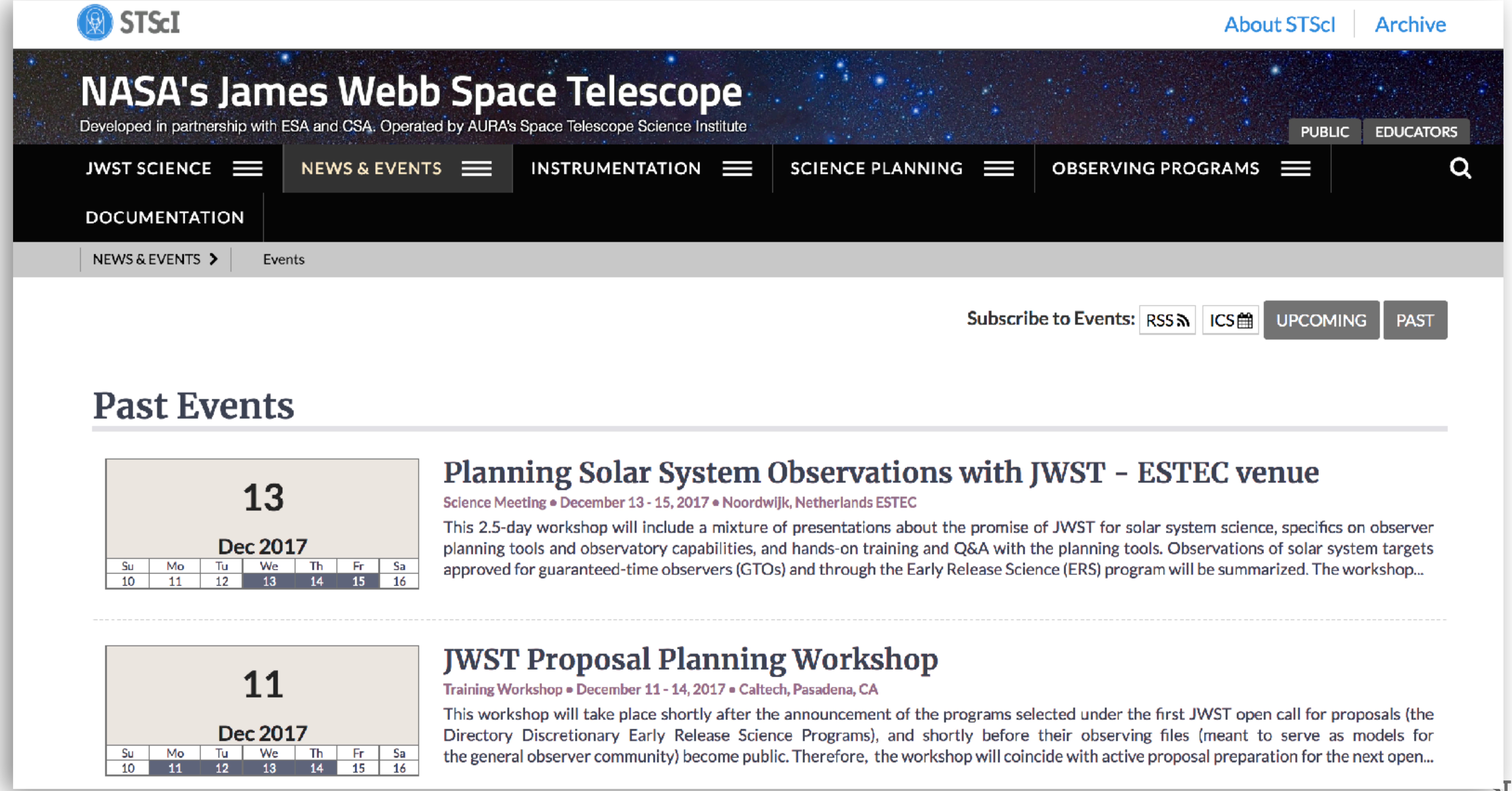
WebbPSF / JWST Telescope
Request assistance with the WebbPSF tool or the Telescope optical system
View Details

JWST General Support
Request general JWST support for issues not covered by another category
View Details

MAST Archive Support
Request general Archive support for issues not covered by another category
View Details

https://jwst.stsci.edu/events

Proposal Planning Workshop: material, presentations



NASA's James Webb Space Telescope

Developed in partnership with ESA and CSA. Operated by AURA's Space Telescope Science Institute

Past Events

13

Dec 2017

Su	Mo	Tu	We	Th	Fr	Sa
10	11	12	13	14	15	16

Planning Solar System Observations with JWST - ESTEC venue

Science Meeting • December 13 - 15, 2017 • Noordwijk, Netherlands ESTEC

This 2.5-day workshop will include a mixture of presentations about the promise of JWST for solar system science, specifics on observer planning tools and observatory capabilities, and hands-on training and Q&A with the planning tools. Observations of solar system targets approved for guaranteed-time observers (GTOs) and through the Early Release Science (ERS) program will be summarized. The workshop...

11

Dec 2017

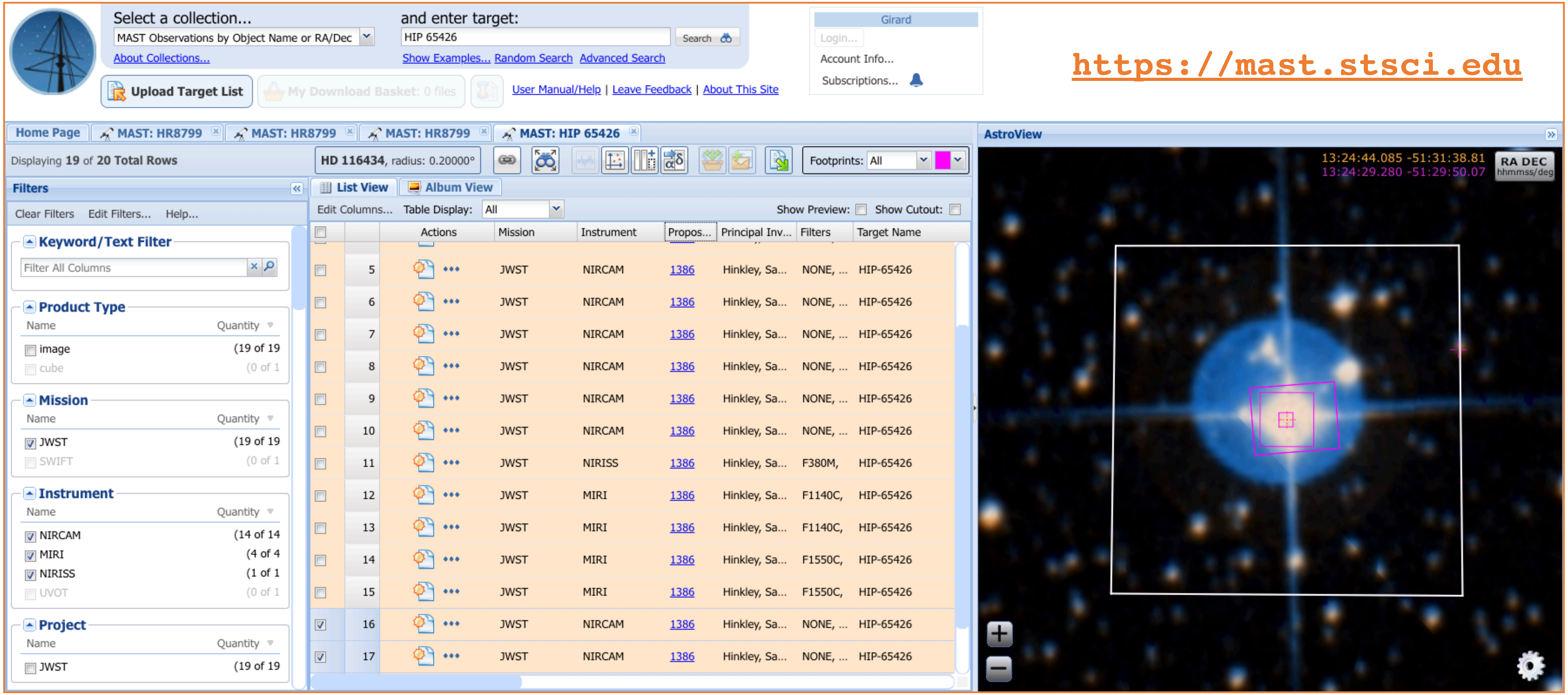
Su	Mo	Tu	We	Th	Fr	Sa
10	11	12	13	14	15	16

JWST Proposal Planning Workshop

Training Workshop • December 11 - 14, 2017 • Caltech, Pasadena, CA

This workshop will take place shortly after the announcement of the programs selected under the first JWST open call for proposals (the Directory Discretionary Early Release Science Programs), and shortly before their observing files (meant to serve as models for the general observer community) become public. Therefore, the workshop will coincide with active proposal preparation for the next open...

Approved programs on MAST: example of ERS #1386 (Hinkley)



https://mast.stsci.edu

Select a collection... MAST Observations by Object Name or RA/Dec

and enter target: HIP 65426

Displaying 19 of 20 Total Rows

HD 116434, radius: 0.20000°

Footprints: All

Filters

Keyword/Text Filter

Filter All Columns

Product Type

Name	Quantity
☐ image	(19 of 19
☐ cube	(0 of 1

Mission

Name	Quantity
☑ JWST	(19 of 19
☐ SWIFT	(0 of 1

Instrument

Name	Quantity
☑ NIRCAM	(14 of 14
☑ MIRI	(4 of 4
☑ NIRISS	(1 of 1
☐ UVOT	(0 of 1

Project

Name	Quantity
☐ JWST	(19 of 19

Table Display: All

Show Preview: ☐ Show Cutout: ☐

☐		Actions	Mission	Instrument	Propos...	Principal Inv...	Filters	Target Name
☐	5	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	6	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	7	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	8	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	9	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	10	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☐	11	•••	JWST	NIRISS	1386	Hinkley, Sa...	F380M,	HIP-65426
☐	12	•••	JWST	MIRI	1386	Hinkley, Sa...	F1140C,	HIP-65426
☐	13	•••	JWST	MIRI	1386	Hinkley, Sa...	F1140C,	HIP-65426
☐	14	•••	JWST	MIRI	1386	Hinkley, Sa...	F1550C,	HIP-65426
☐	15	•••	JWST	MIRI	1386	Hinkley, Sa...	F1550C,	HIP-65426
☑	16	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426
☑	17	•••	JWST	NIRCAM	1386	Hinkley, Sa...	NONE, ...	HIP-65426

13:24:44.085 -51:31:38.81
13:24:29.280 -51:29:50.07