



18059 - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across TW Hya

Cycle: 33, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Alycia J. Weinberger (CoI)	Carnegie Institution of Washington
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Dr. Laurent Pueyo (CoI)	Space Telescope Science Institute
Dr. Joel H. Kastner (CoI)	Rochester Institute of Technology
Dr. Schuyler G. Wolff (CoI)	University of Arizona
Dr. Rebecca Nealon (CoI) (ESA Member)	University of Warwick
Dr. Richard Alexander (CoI) (ESA Member)	University of Leicester
Prof. Sarah Elaine Dodson-Robinson (CoI)	University of Delaware
Inbok Yea (CoI)	University of Delaware

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(3) TW-HYA	STIS/CCD	1	08-Aug-2025 17:00:31.0	yes
02	(2) PSF-REF-HD85512	STIS/CCD	1	08-Aug-2025 17:00:33.0	yes
03	(3) TW-HYA	STIS/CCD	1	08-Aug-2025 17:00:34.0	yes

3 Total Orbits Used

ABSTRACT

In the era of HST, JWST, and ALMA, the initial conditions of planet formation will be laid bare through the direct imaging of planet forming regions around nearby young stars. As more and more disks are observed over multiple epochs, their dynamic and variable natures are revealed, opening new avenues of study. Recent HST/STIS observations of TW Hya have revealed as many as three shadows, originating from ~ 6 au, sweeping across the disk with different periods. We propose to observe TW Hya using HST/STIS coronagraphy with a long term monitoring program to fill in badly needed orbital phase coverage of the shadows' motion and create a homogenous, high quality dataset with archival STIS observations. Our program will elucidate the physical origin of the shadows by measuring the shadow orbital periods, their inclination relative to our line of sight, and the position angles of where each shadow appears/disappears, thus elucidating the orbits of the shadow relative to the properties of the outer disk and constraining future dynamical and hydrodynamical models of planet-disk interactions. Additionally, our observations of the three shadow periods will determine if a singular Jupiter analog is responsible for launching multiple spiral arm shadows, or if the shadows are due to three less massive planets. Disk shadow imaging is a new tool for understanding the initial conditions of planet formation at radii inaccessible by other observations.

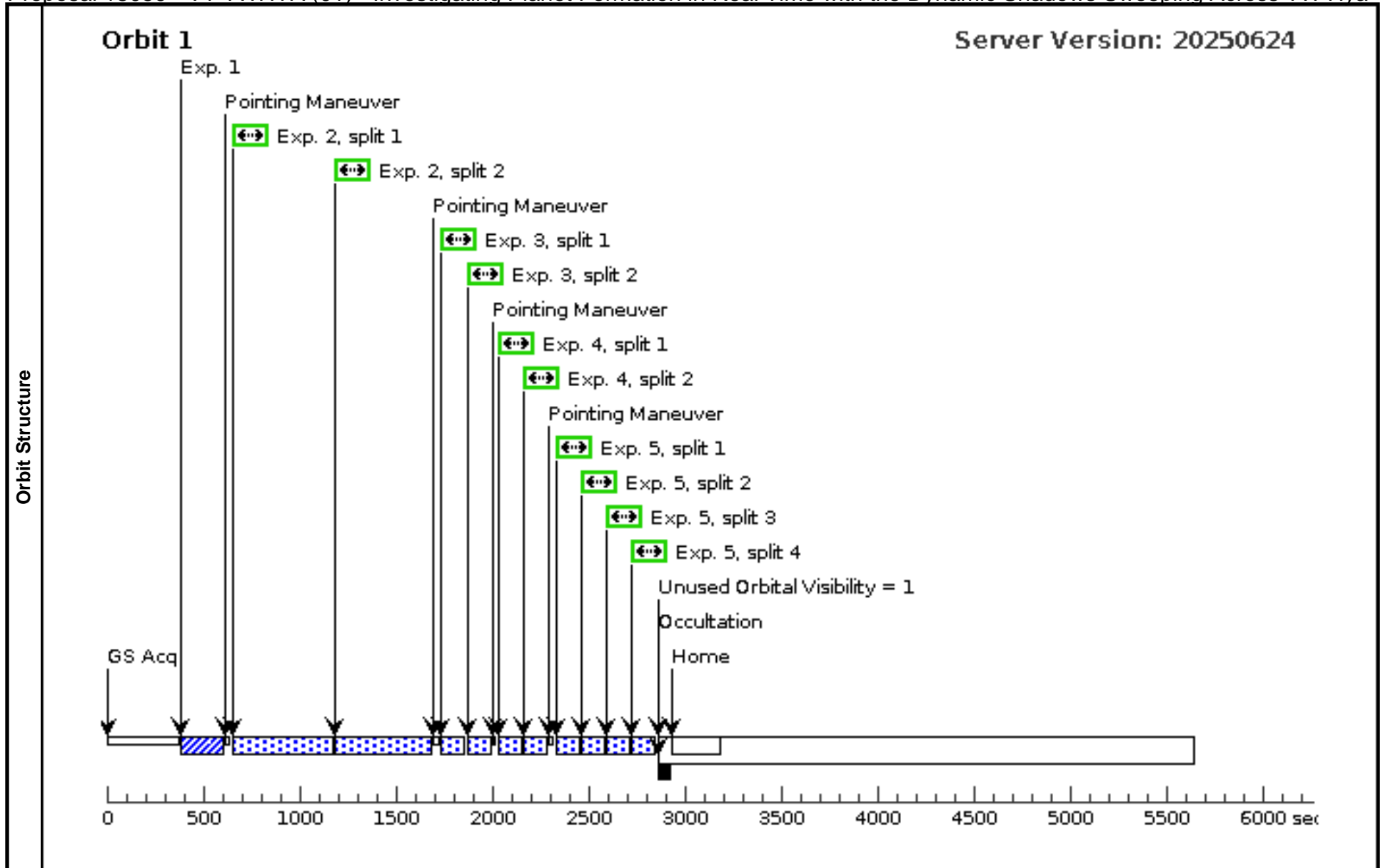
OBSERVING DESCRIPTION

This proposal patterned after 16991 with a combination of BAR10 Lower Left, BAR10 Lower Right, and BAR5 and WEDGEA1.0 50CORON aperture positions. In this program we observe TW Hya in 2 visits interleaved with one visit of the PSF star. The first and last visit of TW Hya is oriented off nominal of between ± 5 to ± 30 degrees to enhance angular coverage of the protoplanetary disk.

Proposal 18059 - V1-TWHYA (01) - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across TW Hya

Fri Aug 08 21:00:35 GMT 2025

Visit	<p>Proposal 18059, V1-TWHYA (01)</p> <p>Diagnostic Status: No Diagnostics</p> <p>Scientific Instruments: STIS/CCD</p> <p>Special Requirements: SCHED 100%</p> <p><i>Comments: TW Hya</i></p> <p><i>First sets of visits, containing three visits of TW Hya at different relative orientations with one PSF calibration observation interleaved.</i></p> <p><i>This is the first TW Hya visit in the first set.</i></p> <p><i>The four visits within each set must be executed sequentially in contiguous orbits interrupted only for Earth occultation.</i></p> <p><i>Orientation: We wish to schedule this visit (1) at -30 deg from Visit 2, with the absolute orientation of Visit 2 unconstrained.</i></p> <p><i>We allow a relative orientation tolerance from -15 deg to -30 deg to assist in guide star selection and scheduling.</i></p> <p><i>NOTE to PC: Schedule as close to -30 deg from Visit 2 as possible.</i></p> <p><i>Relative Timing: This visit (1) should immediately precede visit (2). I.e., They should be executed sequentially in "back-to-back" orbits.</i></p> <p><i>BAR5 exposure times are selected to maximize SNR close to the star (~10-15/pixel up to inner working angle) and WEDGEA1.0 are selected to be as long as possible to ensure depth exterior to 1".</i></p>																																																												
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2	TWHYA_L ONG_1	(3) TW-HYA	STIS/CCD, ACCUM, WEDGEA1.0	MIRROR	SIZEAXIS2=427; CR-SPLIT=2; GAIN=4		Sequence 1-5 Non-Int in V1-TWHYA (01)	958 Secs (958 Secs) [==>(Split 1)] [==>(Split 2)]	[1]																																																				
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5	TWHYA_B AR5_CENT ER	(3) TW-HYA	STIS/CCD, ACCUM, BAR5	MIRROR	SIZEAXIS2=100; CR-SPLIT=4; GAIN=4		Sequence 1-5 Non-Int in V1-TWHYA (01)	440 Secs (440 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[1]																																																				



Proposal 18059 - V3-PSF-TWHYA (02) - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across T...

Fri Aug 08 21:00:35 GMT 2025

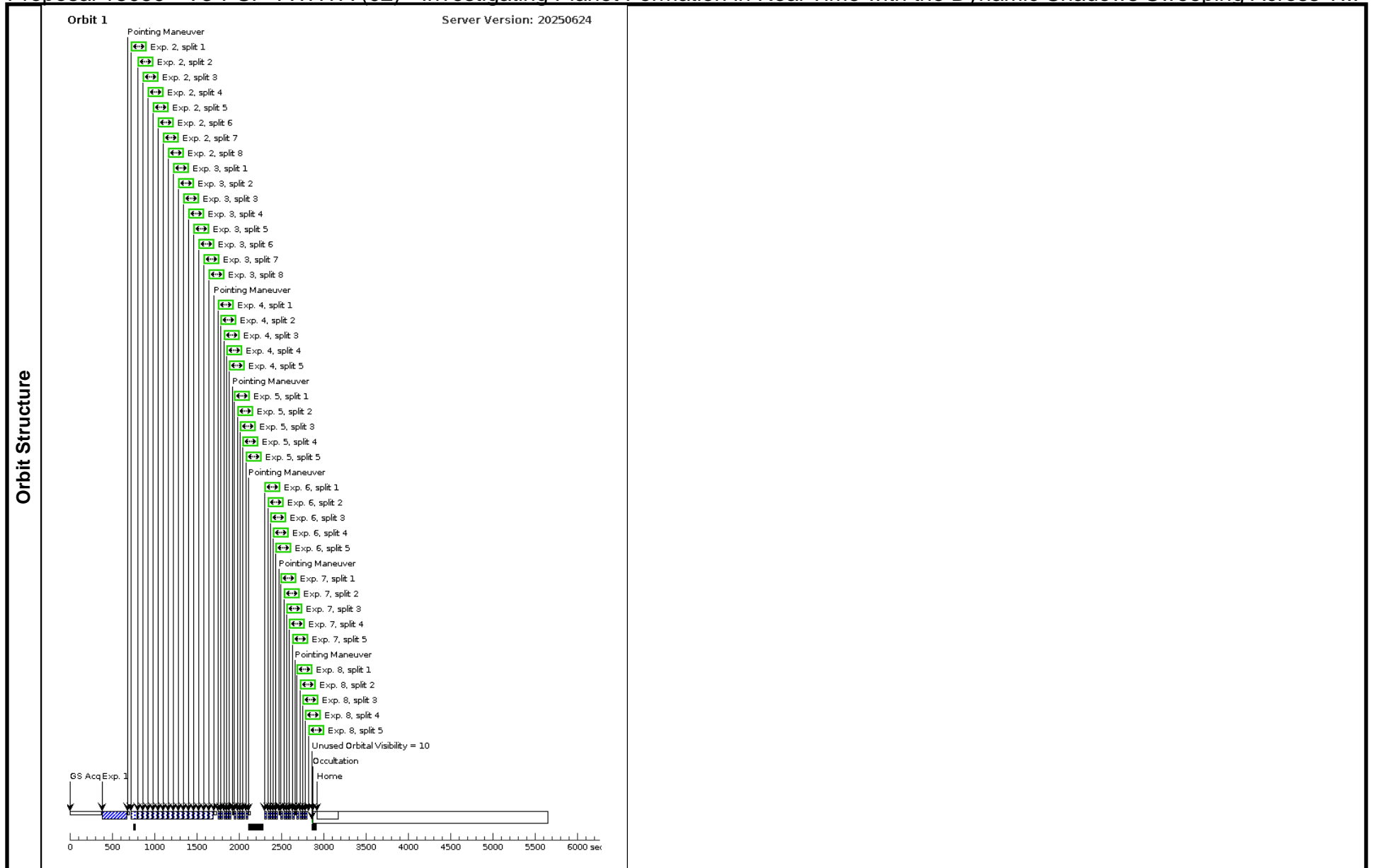
Visit	<p>Proposal 18059, V3-PSF-TWHYA (02)</p> <p>Diagnostic Status: No Diagnostics</p> <p>Scientific Instruments: STIS/CCD</p> <p>Special Requirements: SCHED 100%; AFTER 01 BY .5 Orbits TO 1.5 Orbits</p> <p>Comments: PSF (HD 85512). PSF calibration target for TW Hya. $V = 7.636$. $B - V = +1.15$. Spex. K6Vk</p> <p><i>This is the PSF star calibrator for the flanking visits (1-4). We levy no orientation constraints on this visit (3). However, we choose this target since it has been used in the past for TW Hya. So as Visits 2 and 3 must be scheduled in sequential contiguous orbits, if scheduled at nominal roll (as we expect also Visit 2 will be) then we expect absolute orientations of Visits 2 and 3 to be very similar (within a few degrees). This is important so we maintain similar Sun and Beta angles for the science target and its PSF calibrator,</i></p> <p><i>Relative Timing: This visit (3) should immediately follow visit 2 and immediately precede visit 4. I.e., they should be executed sequentially in "back-to-back" orbits.</i></p>												
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Proposal 18059 - V3-PSF-TWHYA (02) - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across T...

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	PSF-TWHY A_ACQ (STIS.ta.144 7816)	(2) PSF-REF-HD855 12	STIS/CCD, ACQ, F25ND3	MIRROR		GS ACQ SCENARI O BASE103	Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	.7 Secs (0.7 Secs) [==>]	[1]
<i>Comments: K6V nearby star V=7.65 Exptime rounded to nearest 0.1 second, assumed to get SNR=100.</i>									
2	PSF_TWHY A_LONG_1	(2) PSF-REF-HD855 12	STIS/CCD, ACCUM, WEDGEA1.0	MIRROR	SIZEAXIS2=427; CR-SPLIT=8; GAIN=4		Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	248 Secs (248 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)] [==>(Split 7)] [==>(Split 8)]	[1]
3	PSF_TWHY A_LONG_2	(2) PSF-REF-HD855 12	STIS/CCD, ACCUM, WEDGEA1.0	MIRROR	SIZEAXIS2=427; GAIN=4; CR-SPLIT=8		Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	248 Secs (248 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)] [==>(Split 7)] [==>(Split 8)]	[1]
4	PSF_TWHY A_BAR10_ LR	(2) PSF-REF-HD855 12	STIS/CCD, ACCUM, BAR10	MIRROR	SIZEAXIS2=100; CR-SPLIT=5; GAIN=4	POS TARG 1.33805, -1.30016	Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	56 Secs (56 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
5	PSF_TWHY A_BAR10_ LL	(2) PSF-REF-HD855 12	STIS/CCD, ACCUM, BAR10	MIRROR	SIZEAXIS2=100; CR-SPLIT=5; GAIN=4	POS TARG -1.2327 0,-1.30535	Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	56 Secs (56 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
6	PSF-TWHY A_BAR5_C ENTER	(2) PSF-REF-HD855 12	STIS/CCD, ACCUM, BAR5	MIRROR	SIZEAXIS2=100; CR-SPLIT=5; GAIN=4		Sequence 1-8 Non-In t in V3-PSF-TWHY A (02)	56 Secs (56 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]

Proposal 18059 - V3-PSF-TWHYA (02) - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across T...

7	PSF-TWHY A_BAR5_P LUSDITHE R	(2) PSF-REF-HD855 STIS/CCD, ACCUM, BAR5	MIRROR	SIZEAXIS2=100; CR-SPLIT=5; GAIN=4	POS TARG 0.00247 95,0.0124497	Sequence 1-8 Non-Int in V3-PSF-TWHY A (02)	56 Secs (56 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
8	PSF-TWHY A_BAR5_M INUSDITH ER	(2) PSF-REF-HD855 STIS/CCD, ACCUM, BAR5	MIRROR	SIZEAXIS2=100; CR-SPLIT=5; GAIN=4	POS TARG -0.0024 7955,-0.0124497	Sequence 1-8 Non-Int in V3-PSF-TWHY A (02)	56 Secs (56 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]



Proposal 18059 - V2-TWHYA (03) - Investigating Planet Formation in Real Time with the Dynamic Shadows Sweeping Across TW Hya

Fri Aug 08 21:00:35 GMT 2025

Visit	<p>Proposal 18059, V2-TWHYA (03)</p> <p>Diagnostic Status: Informational</p> <p>Scientific Instruments: STIS/CCD</p> <p>Special Requirements: SCHED 100%; ORIENT 5D TO 30D FROM 01; AFTER 02 BY .5 Orbits TO 1.5 Orbits</p> <p><i>Comments: TW Hya</i> <i>three visits of TW HYA at different relative orientations with one PSF calibration observation interleaved.</i> <i>This is the second TW Hya visit in the first set.</i> <i>The four visits within the set must be executed sequentially in contiguous orbits interrupted only for Earth occultation.</i></p> <p><i>Orientation: There are no orientation constraints on this visit (2).</i> <i>This visit at nominal roll as scheduled by STScI.</i> <i>Visits 1, 3, 4 carry relative orientation constraints w.r.t. this visit.</i></p> <p><i>Relative Timing: This visit (2) should immediately follow Visit 1 and immediately precede Visit 3 in back-to-back orbits.</i></p>																																																																
	<p>Diagnosics</p> <p>(V2-TWHYA (03)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.</p>																																																																
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<table border="1"> <thead> <tr> <th>#</th> <th>Label (ETC Run)</th> <th>Target</th> <th>Config,Mode,Aperture</th> <th>Spectral Els.</th> <th>Opt. Params.</th> <th>Special Reqs.</th> <th>Groups</th> <th>Exp. Time (Total)/[Actual Dur.]</th> <th>Orbit</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>TWHYA_A_CQ (STIS.ta.1447817)</td> <td>(3) TW-HYA</td> <td>STIS/CCD, ACQ, F28X50LP</td> <td>MIRROR</td> <td></td> <td>GS ACQ SCENARIO BASE103</td> <td>Sequence 1-5 Non-Int in V2-TWHYA (03)</td> <td>.2 Secs (0.2 Secs) [==>]</td> <td>[1]</td> </tr> <tr> <td>2</td> <td>TWHYA_L_ONG_1</td> <td>(3) TW-HYA</td> <td>STIS/CCD, ACCUM, WEDGEA1.0</td> <td>MIRROR</td> <td>SIZEAXIS2=427; CR-SPLIT=2; GAIN=4</td> <td></td> <td>Sequence 1-5 Non-Int in V2-TWHYA (03)</td> <td>958 Secs (958 Secs) [==>(Split 1)] [==>(Split 2)]</td> <td>[1]</td> </tr> <tr> <td>3</td> <td>TWHYA_B_AR10_LL</td> <td>(3) TW-HYA</td> <td>STIS/CCD, ACCUM, BAR10</td> <td>MIRROR</td> <td>SIZEAXIS2=100; CR-SPLIT=2; GAIN=4</td> <td>POS TARG -1.23270,-1.30535</td> <td>Sequence 1-5 Non-Int in V2-TWHYA (03)</td> <td>220 Secs (220 Secs) [==>(Split 1)] [==>(Split 2)]</td> <td>[1]</td> </tr> <tr> <td>4</td> <td>TWHYA_B_AR10_LR</td> <td>(3) TW-HYA</td> <td>STIS/CCD, ACCUM, BAR10</td> <td>MIRROR</td> <td>SIZEAXIS2=100; CR-SPLIT=2; GAIN=4</td> <td>POS TARG 1.33805,-1.30016</td> <td>Sequence 1-5 Non-Int in V2-TWHYA (03)</td> <td>220 Secs (220 Secs) [==>(Split 1)] [==>(Split 2)]</td> <td>[1]</td> </tr> <tr> <td>5</td> <td>TWHYA_B_AR5_CENT_ER</td> <td>(3) TW-HYA</td> <td>STIS/CCD, ACCUM, BAR5</td> <td>MIRROR</td> <td>SIZEAXIS2=100; CR-SPLIT=4; GAIN=4</td> <td></td> <td>Sequence 1-5 Non-Int in V2-TWHYA (03)</td> <td>440 Secs (440 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]</td> <td>[1]</td> </tr> </tbody> </table>						#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	1	TWHYA_A_CQ (STIS.ta.1447817)	(3) TW-HYA	STIS/CCD, ACQ, F28X50LP	MIRROR		GS ACQ SCENARIO BASE103	Sequence 1-5 Non-Int in V2-TWHYA (03)	.2 Secs (0.2 Secs) [==>]	[1]	2	TWHYA_L_ONG_1	(3) TW-HYA	STIS/CCD, ACCUM, WEDGEA1.0	MIRROR	SIZEAXIS2=427; CR-SPLIT=2; GAIN=4		Sequence 1-5 Non-Int in V2-TWHYA (03)	958 Secs (958 Secs) [==>(Split 1)] [==>(Split 2)]	[1]	3	TWHYA_B_AR10_LL	(3) TW-HYA	STIS/CCD, ACCUM, BAR10	MIRROR	SIZEAXIS2=100; CR-SPLIT=2; GAIN=4	POS TARG -1.23270,-1.30535	Sequence 1-5 Non-Int in V2-TWHYA (03)	220 Secs (220 Secs) [==>(Split 1)] [==>(Split 2)]	[1]	4	TWHYA_B_AR10_LR	(3) TW-HYA	STIS/CCD, ACCUM, BAR10	MIRROR	SIZEAXIS2=100; CR-SPLIT=2; GAIN=4	POS TARG 1.33805,-1.30016	Sequence 1-5 Non-Int in V2-TWHYA (03)	220 Secs (220 Secs) [==>(Split 1)] [==>(Split 2)]	[1]	5	TWHYA_B_AR5_CENT_ER	(3) TW-HYA	STIS/CCD, ACCUM, BAR5	MIRROR	SIZEAXIS2=100; CR-SPLIT=4; GAIN=4		Sequence 1-5 Non-Int in V2-TWHYA (03)	440 Secs (440 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[1]
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