



12016 - The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Cycle: 17, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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	(1) NAME-PDS-144S	ACS/SBC	1	13-Dec-2010 21:01:10.0	yes
04	(1) NAME-PDS-144S	STIS/CCD STIS/FUV-MAMA	2	13-Dec-2010 21:01:16.0	yes
06	(5) V-NQ-UMA	ACS/SBC	1	13-Dec-2010 21:01:20.0	yes
07	(5) V-NQ-UMA	ACS/SBC	1	13-Dec-2010 21:01:22.0	yes
08	(2) PDS-144-OFFSET	ACS/WFC	1	13-Dec-2010 21:01:25.0	yes

<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>
09	(1) NAME-PDS-144S	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	1	13-Dec-2010 21:01:29.0	yes
10	(1) NAME-PDS-144S	ACS/SBC	1	13-Dec-2010 21:01:32.0	yes

8 Total Orbits Used

ABSTRACT

High-Inclination PMS stars are optimally oriented to measure disk size, height, to detect jets, and to directly probe disk composition. Placing these data into evolutionary context requires dates for the systems and measurements of L bol, and extinction. For such stars, X-ray data provide L x, but also N(H) and the total extinction. FUV data measures L UV, and constrains the shape of the extinction curve. Recent studies have suggested that the frequency of Jovian-mass planets is higher for systems with intermediate-mass stars, due to disk mass or composition. While suitable low mass YSOs are well-represented in the Chandra and HST archives, similar data are lacking for higher mass systems. We propose joint Chandra and HST imaging of PDS 144 to fill this gap.

OBSERVING DESCRIPTION

This proposal combines optical and FUV imagery of the Herbig Ae binary system PDS 144. In the optical, we propose obtaining ACS SBC F606W imagery at the same orientation as archival HST data to facilitate jet studies and to establish which stars in the field are co-moving with the PDS 144 binary. The proposed orientation permits inclusion of a weak T Tauri star some 80.8" from the Herbig Ae stars in the ACS WFC field of view. In the FUV, we plan SBC F165LP, F140LP, and F122M imagery. PDS 144N (A0Ve) is viewed at 83 degrees from pole-on; the star is fully occulted to 10 microns (Perrin et al. 2006), and will not be directly observed in the FUV, closely resembling T Tau S A/B. We expect to see a dark lane at the location of the star, together with light scattered from the envelope and fluorescent H2 emission. PDS 144S (A2Ve) is viewed at 70 degrees from pole-on. After PSF subtraction in the visible, we see a dark lane at F555W. We expect that for extinction by small grains ($R=3.1$ or 4.0), the lane will become more conspicuous at shorter wavelengths. We have estimated the count rate for PDS 144S in two ways: 1) assuming A1V Kurucz spectrum (slightly too early in type) with $V=12.8$ (historical average) and $E(B-V)=0.5$, and by comparison with VV Ser (A2Ve, $i=70D$, similar distance, extinction, etc.).

With the first set of assumptions, we expect 10.362 c/s within 0.4" of PDS 144S (assuming the star is directly visible), with a peak pixel count rate of

1.816 c/s at F140LP, and 3.097 c/s within 0.4" and a peak pixel rate of 0.651 c/s at F165LP (ACS ETC 122730 and 122729 respectively). In both cases the peak pixel rate is well below the variable source bright limits.

Photometric variability of PDS 144: All Sky Automated Survey data for PDS 144 shows that the binary has typically been within 0.3 in V of 12.8 (see <http://www.astrouw.edu.pl/asas/?psect=acvs&page=details&id=154915-2600.9>). One lone excursion to V=11.69 has been recorded in the last 3000 days of photometry. ASAS fits a nominal period of 930 days to PDS 144 (presumably PDS 144S dominates the variability): the applicable phase of the (thus far non-repeating) optical max corresponds to early April 2010, but our time constraint for the SBC observations (see below) excludes this interval. We therefore expect PDS 144S to be near V=12.8 at the epoch of the SBC observations, presenting no safety issues for SBC observations.

VV Ser (SWP 48866) has a faint blue continuum ($3E-15$ erg/cm/cm/s/A) with superposed H₂ emission and no photospheric/stellar activity features visible, similar to our observation of the classical T Tauri star AA Tau (i=75D). The continuum is a factor of 5 fainter than T Tauri N. T Tauri was successfully observed using the ACS SBC in the same imaging modes that we propose using in this study. For both PDS 144 stars, we anticipate that the bulk of signal will be starlight scattered by the circumstellar envelopes, as well as any emission from the bipolar jets.

Jets: The jets from PDS 144 N and S have similar surface brightness to the HH 409 jet associated with HD 163296 in the optical. We anticipate that in the FUV the jet will be predominantly observed in Lyman alpha (F122M), but cannot exclude some molecular hydrogen knots visible in F140LP. At Lyman alpha, HH409A had a flux of $4.7E-13$ erg/cm/cm/s/arcsec². In 2 ksec, we anticipate 12.4 c/s/arcsec², for S/N=7, neglecting extinction. Given the envelope around PDS 144, we expect that the jets will be detectable when they emerge from the envelope in the FUV and not in immediate proximity to the stars.

There is a faint star lying between PDS 144N and S. Optical/NIR photometry suggests that it may be a halo K giant, rather than physically associated with PDS 144. However, Goddard Fabry-Perot imagery suggests that there may be a jet component arising in the vicinity of this star. The identification of this object will be addressed by the optical imaging planned in visit 8, and also with B and V imagery planned for the 2nd quarter of 2010 at the Apache Point Observatory 3.5m telescope. Scheduling of the ACS WFC imagery prior to the FUV observations will allow us to refine exposure estimates. We have specified a 75-100 day lag for the SBC observations relative to the WFC imagery. This lag will allow us to evaluate current photometry for the

system, identify all jet-driving sources in the field in time to refine plans for the SBC exposures. Chandra expects that PDS 144 may be observed either in early April or in June/July, so it is possible that we will have the X-ray data in hand prior to the SBC observation, providing an additional safety check for the SBC exposures.

Bright Object Issues (other than PDS 144S): The BOT flags a source at 15 49 14.1 -26 00 59.6 as O5V. The archival ACS WFC imagery suggest that the object has $V-I > 1.0$, which is inconsistent with this source being an unreddened O star: it is much more likely to be another halo K giant, presenting no safety risks for the SBC exposures.

In the event that the F140LP is unavailable, we will obtain shorter wavelength optical/NUV imagery of PDS 144.

REAL TIME JUSTIFICATION

N/A

CALIBRATION JUSTIFICATION

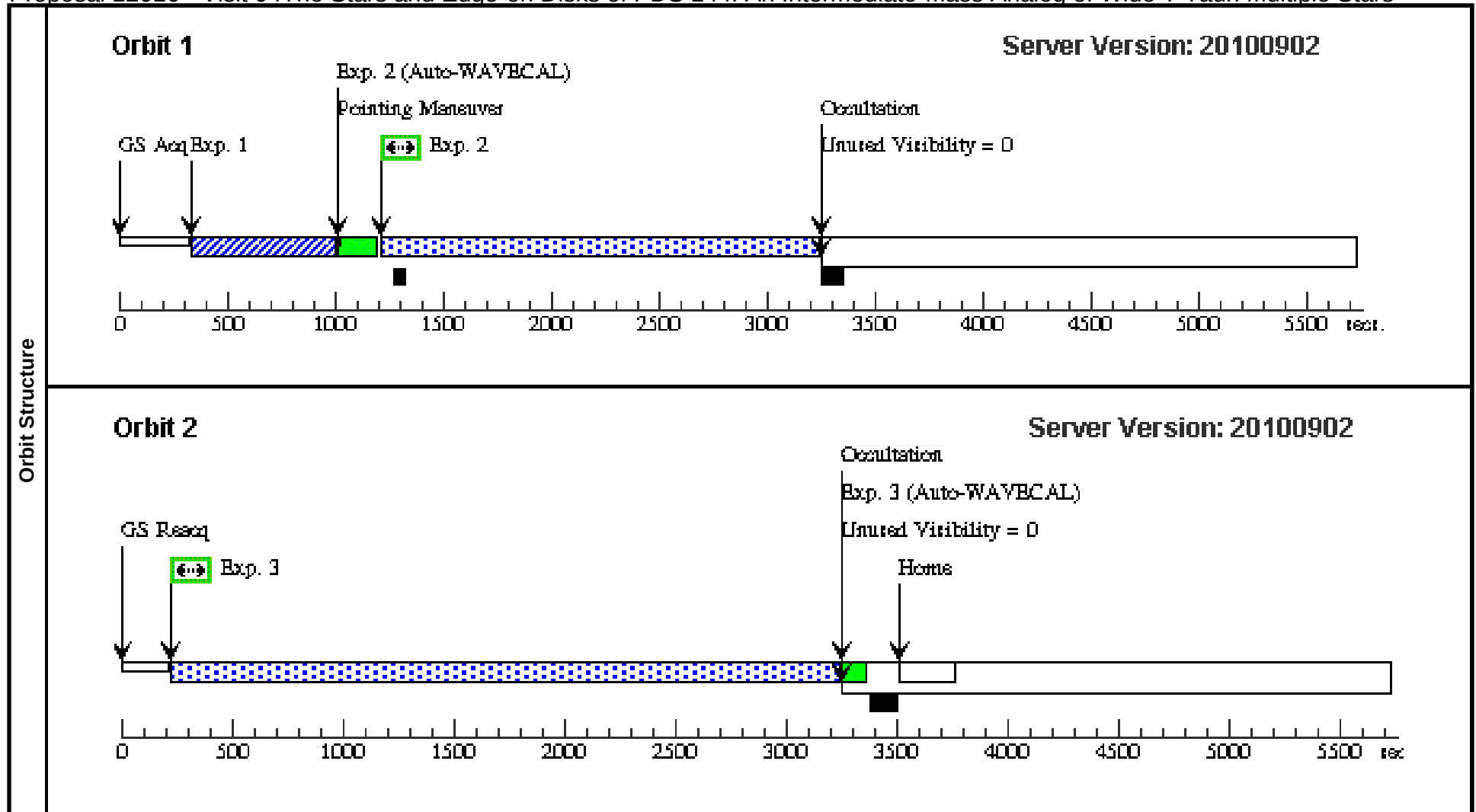
We require deep PSF imagery at F140LP and F165LP to fully analyze our imagery, and propose the ACS SBC spectrophotometric standard HS 2027+0651 (WD 2027 +068) for this purpose. This star has already been successfully used to calibrate the ACS SBC, and has archival deep PSF data with F122M. These calibration images will not only support our program, but will facilitate analysis of data from programs 11336 and 10489.

Proposal 12016 - Visit 01The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

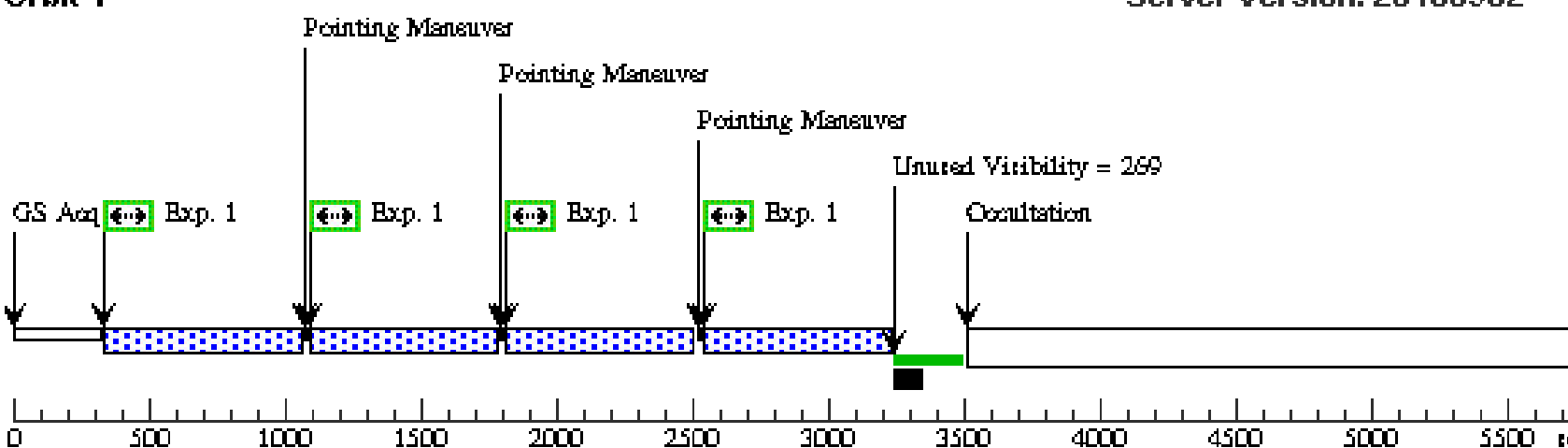
Visit	Proposal 12016, Visit 01, completed										Tue Dec 14 02:01:35 GMT 2010	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: ACS/SBC											
	Special Requirements: ON HOLD FOR 09											
On Hold Comments: STIS observation to confirm safety for SBC observing.												
Patterns	#	Primary Pattern				Secondary Pattern				Exposures		
	(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.179 Line Spacing=0.116				Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false				(1)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(1)	NAME-PDS-144S	RA: 15 49 15.4250 (237.3142708d) Dec: -26 00 52.48 (-26.01458d) Equinox: J2000		Proper Motion RA: null Proper Motion Dec: null Epoch of Position:		V=12.8+/-0.3 B-V=0.5, TYPE=A2V		Reference Frame: ICRS			
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.											
	Spectral type for PDS 144S updated. Keck Hires spectra show spectral type for PDS 144S is A4-A5, not the A2 listed on SIMBAD.											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]		Orbit	
	1		(1) NAME-PDS-144S	ACS/SBC, ACCUM, SBC-FIX	F165LP		LOW-SKY	Pattern 1, Exps 1-1 in Visit 01 (1)	620. Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]		[1]	
Orbit Structure	Orbit 1											
	Server Version: 20100902											

Proposal 12016 - Visit 04The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Visit	Proposal 12016, Visit 04, implementation								Tue Dec 14 02:01:36 GMT 2010	
	Diagnostic Status: No Diagnostics									
	Scientific Instruments: STIS/FUV-MAMA, STIS/CCD									
	Special Requirements: ORIENT 167.5D TO 3.5 D; ON HOLD FOR 09									
	On Hold Comments: STIS observation to confirm safety for SBC observing.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	NAME-PDS-144S	RA: 15 49 15.4250 (237.3142708d)	Proper Motion RA: null	V=12.8+/-0.3	Reference Frame: ICRS				
			Dec: -26 00 52.48 (-26.01458d)	Proper Motion Dec: null	B-V=0.5,					
			Equinox: J2000	Epoch of Position:	TYPE=A2V					
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.									
Spectral type for PDS 144S updated. Keck Hires spectra show spectral type for PDS 144S is A4-A5, not the A2 listed on SIMBAD.										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(1) NAME-PDS-144S	STIS/CCD, ACQ, F28X50OIII	MIRROR				100.0 Secs	
									[==>]	[1]
	2		(1) NAME-PDS-144S	STIS/FUV-MAMA, ACCUM, 52X2	G140L				2200. Secs	
					1425 A				[==>1972.0 Secs]	[1]
3		(1) NAME-PDS-144S	STIS/FUV-MAMA, ACCUM, 52X2	G140L				2600. Secs		
				1425 A				[==>3007.0 Secs]	[2]	



Proposal 12016 - Visit 06 The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Visit	Proposal 12016, Visit 06, completed										Tue Dec 14 02:01:37 GMT 2010	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: ACS/SBC											
	Special Requirements: GROUP 06,07 WITHIN 7D											
Patterns	#	Primary Pattern				Secondary Pattern				Exposures		
	(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.179 Line Spacing=0.116				Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false				(1)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(5)	V-NQ-UMA	RA: 13 25 45.5321 (201.4397171d)		Proper Motion RA: -0.02659sec of time/yr		V=7.286+/-0.05		Reference Frame: ICRS			
		Alt Name1: HD-116956	Dec: +56 58 13.78 (56.97049d)		Proper Motion Dec: 0.0112arcsec/yr							
		Alt Name2: HIP-65515	Equinox: J2000		Parallax: 0.045" Epoch of Position: 2000. Radial Velocity: -13.1 km/sec							
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.												
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]		Orbit	
	1		(5) V-NQ-UMA	ACS/SBC, ACCUM, SBC-FIX	F165LP			Pattern 1, Exps 1-1 in Visit 06 (1)	700. Secs			
									[=>662.0 Secs (Pattern 1)]		[1]	
									[=>662.0 Secs (Pattern 2)]			
									[=>662.0 Secs (Pattern 3)]			
									[=>662.0 Secs (Pattern 4)]			
Orbit Structure	Orbit 1											
	Server Version: 20100902											
												

Visit	Proposal 12016, Visit 07, completed										Tue Dec 14 02:01:38 GMT 2010	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: ACS/SBC											
	Special Requirements: SAME ORIENT AS 06											
Patterns	#	Primary Pattern				Secondary Pattern				Exposures		
	(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.179 Line Spacing=0.116				Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false				(1)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(5)	V-NQ-UMA	RA: 13 25 45.5321 (201.4397171d)		Proper Motion RA: -0.02659sec of time/yr		V=7.286+/-0.05		Reference Frame: ICRS			
		Alt Name1: HD-116956	Dec: +56 58 13.78 (56.97049d)		Proper Motion Dec: 0.0112arcsec/yr							
		Alt Name2: HIP-65515	Equinox: J2000		Parallax: 0.045" Epoch of Position: 2000. Radial Velocity: -13.1 km/sec							
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.												
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]		Orbit	
	1		(5) V-NQ-UMA	ACS/SBC, ACCUM, SBC-FIX	F140LP			Pattern 1, Exps 1-1 in Visit 07 (1)	700. Secs [==>662.0 Secs (Pattern 1)] [==>662.0 Secs (Pattern 2)] [==>662.0 Secs (Pattern 3)] [==>662.0 Secs (Pattern 4)]	[1]		
Orbit Structure	Orbit 1											Server Version: 20100902
	The diagram illustrates the orbit structure over a 5500-second timeline. It begins with a 'GS Acq' (Green Arrow) at approximately 250 seconds, followed by 'Exp. 1' (green box with crosshairs) at 350 seconds. This sequence is repeated three times, with 'Pointing Maneuvers' (vertical arrows) occurring at approximately 1100, 1800, and 2500 seconds. The fourth 'Exp. 1' occurs at approximately 2600 seconds. Following this, there is a period of 'Unused Visibility' (indicated by a green bar) from approximately 3200 to 3400 seconds, and finally, an 'Occultation' (indicated by a black bar) from approximately 3400 to 3500 seconds. The timeline is marked with major ticks every 500 seconds from 0 to 5500.											

Proposal 12016 - Visit 08 The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Visit	Proposal 12016, Visit 08, completed										Tue Dec 14 02:01:39 GMT 2010									
	Diagnostic Status: No Diagnostics																			
	Scientific Instruments: ACS/WFC																			
	Special Requirements: ORIENT 282.8D TO 286.8 D																			
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Fluxes			Miscellaneous								
	(2)	PDS-144-OFFSET	RA: 15 49 15.5200 (237.3146667d)			Proper Motion RA: 0sec of time/yr			V=12.8+/-0.5			Reference Frame: ICRS								
			Dec: -26 00 50.20 (-26.01394d)			Proper Motion Dec: 0arcsec/yr			TYPE=A2V,											
			Equinox: J2000			Epoch of Position:			B-V=0.5											
	Comments: No measured proper motion in literature; coordinates duplicate archival ACS imagery of PDS 144 to minimize geometric distortion residuals.																			
Exposures	#	Label	Target	Config,Mode,Aperture		Spectral Els.		Opt. Params.		Special Reqs.		Groups		Exp. Time/[Actual Dur.]		Orbit				
	1		(2) PDS-144-OFFSET	ACS/WFC, ACCUM, WFC1		F606W		CR-SPLIT=2		GS ACQ SCENARI				280. Secs						
		T								O SINGLE				[==>(Split 1)]		[1]				
														[==>(Split 2)]						
	2		(2) PDS-144-OFFSET	ACS/WFC, ACCUM, WFC1		F606W		CR-SPLIT=2						5. Secs						
		T												[==>(Split 1)]		[1]				
														[==>(Split 2)]						
3		(2) PDS-144-OFFSET	ACS/WFC, ACCUM, WFC1		F606W								15. Secs							
	T												[==>]		[1]					
Orbit Structure	Orbit 1 GS Acq Unused Visibility = 527 Occultation															Server Version: 20100902				

Proposal 12016 - Visit 09The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Visit	Proposal 12016, Visit 09, completed										Tue Dec 14 02:01:40 GMT 2010										
	Diagnostic Status: No Diagnostics																				
	Scientific Instruments: STIS/FUV-MAMA, STIS/CCD, STIS/NUV-MAMA																				
	Special Requirements: ORIENT 250.0D TO 74.0 D																				
Fixed Targets	#	Name		Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous											
	(1)	NAME-PDS-144S		RA: 15 49 15.4250 (237.3142708d)		Proper Motion RA: null		V=12.8+/-0.3		Reference Frame: ICRS											
				Dec: -26 00 52.48 (-26.01458d)		Proper Motion Dec: null		B-V=0.5,													
				Equinox: J2000		Epoch of Position:		TYPE=A2V													
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.																					
Spectral type for PDS 144S updated. Keck Hires spectra show spectral type for PDS 144S is A4-A5, not the A2 listed on SIMBAD.																					
Exposures	#	Label	Target	Config,Mode,Aperture		Spectral Els.		Opt. Params.		Special Reqs.		Groups		Exp. Time/[Actual Dur.]				Orbit			
	1		(1) NAME-PDS-144S	STIS/CCD, ACQ, F28X50III		MIRROR								26.0 Secs							
														[==>]				[1]			
	2		(1) NAME-PDS-144S	STIS/FUV-MAMA, ACCUM, 52X2		G140L								1200 Secs							
						1425 A								[==>]				[1]			
3		(1) NAME-PDS-144S	STIS/NUV-MAMA, ACCUM, 52X2		G230L								600. Secs								
					2376 A								[==>]				[1]				
Orbit Structure	Orbit 1 Server Version: 20100902 GS Acq Exp. 1 Pointing Maneuver Exp. 2 (Auto-WAYBCAL) Exp. 2 Exp. 3 (Auto-WAYBCAL) Exp. 3 Unused Visibility = 53 Occultation Home </																				

Proposal 12016 - Visit 10 The Stars and Edge-on Disks of PDS 144: An Intermediate-Mass Analog of Wide T Tauri Multiple Stars

Visit	Proposal 12016, Visit 10, completed										Tue Dec 14 02:01:40 GMT 2010																													
	Diagnostic Status: No Diagnostics																																							
	Scientific Instruments: ACS/SBC																																							
	Special Requirements: SAME ORIENT AS 01; ON HOLD FOR 09																																							
	On Hold Comments: STIS observation to confirm safety for SBC observing.																																							
Patterns	#	Primary Pattern										Secondary Pattern										Exposures																		
	(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.179 Line Spacing=0.116										Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false																				(1)								
Fixed Targets	#	Name		Target Coordinates				Targ. Coord. Corrections				Fluxes				Miscellaneous																								
	(1)	NAME-PDS-144S		RA: 15 49 15.4250 (237.3142708d) Dec: -26 00 52.48 (-26.01458d) Equinox: J2000				Proper Motion RA: null Proper Motion Dec: null Epoch of Position:				V=12.8+/-0.3 B-V=0.5, TYPE=A2V				Reference Frame: ICRS																								
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Spectral type for PDS 144S updated. Keck Hires spectra show spectral type for PDS 144S is A4-A5, not the A2 listed on SIMBAD.																																							
Exposures	#	Label	Target	Config,Mode,Aperture				Spectral Els.		Opt. Params.		Special Reqs.		Groups		Exp. Time/[Actual Dur.]				Orbit																				
	1		(1) NAME-PDS-144S	ACS/SBC, ACCUM, SBC-FIX				F122M				LOW-SKY		Pattern 1, Exps 1-1 in Visit 10 (1)		620. Secs [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]				[1]																				
Orbit Structure	Orbit 1																				Server Version: 20100902																			