



14528 - Caustic Crossing of a Strongly Lensed Massive Star

Cycle: 23, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	Targets used in Visit	Configurations used in Visit	Orbits Used	Last Orbit Planner Run	OP Current with Visit?
01	(1) CAUSTICCROSSINGCANDIDATE	WFC3/IR WFC3/UVIS	1	29-Jul-2016 13:45:08.0	yes
02	(1) CAUSTICCROSSINGCANDIDATE	WFC3/IR	1	29-Jul-2016 13:45:09.0	yes
03	(1) CAUSTICCROSSINGCANDIDATE	WFC3/IR	1	29-Jul-2016 13:45:10.0	yes
04	(1) CAUSTICCROSSINGCANDIDATE	WFC3/IR	1	29-Jul-2016 13:45:11.0	yes
05	(1) CAUSTICCROSSINGCANDIDATE	WFC3/IR WFC3/UVIS	1	29-Jul-2016 13:45:12.0	yes

5 Total Orbits Used

ABSTRACT

During a WFC3-IR visit to the MACS J1149 galaxy-cluster field in late April, we discovered a new transient approximately 5 arcseconds from the reappearance of SN Refsdal. The new object lies at the intersection of a star-forming arm of the host-galaxy of SN Refsdal at redshift $z=1.49$ and the critical curve of the galaxy cluster (<0.1 arcsec). Applying orbits from the RefsdalRedux program, we now have a light curve spanning several months which shows a sustained rise followed by multiple abrupt (< 2 days) changes in flux of ~ 1 magnitude. To determine the nature of the lensed source, we acquired optical imaging with the FrontierSN program and the rest-frame UV-through-optical spectral energy distribution is consistent with that of a B supergiant star with a pronounced Balmer break at redshift $z=1.49$. We have concluded that the object is likely the first example of a star observed crossing a cluster caustic and is probably magnified by a factor of hundreds of thousands to more than a million. We propose observations which will explain the origin of the strong fluctuations in the transient's light curve, and constrain the composition of dark matter as well as the population of stars and planets in the intracluster medium.

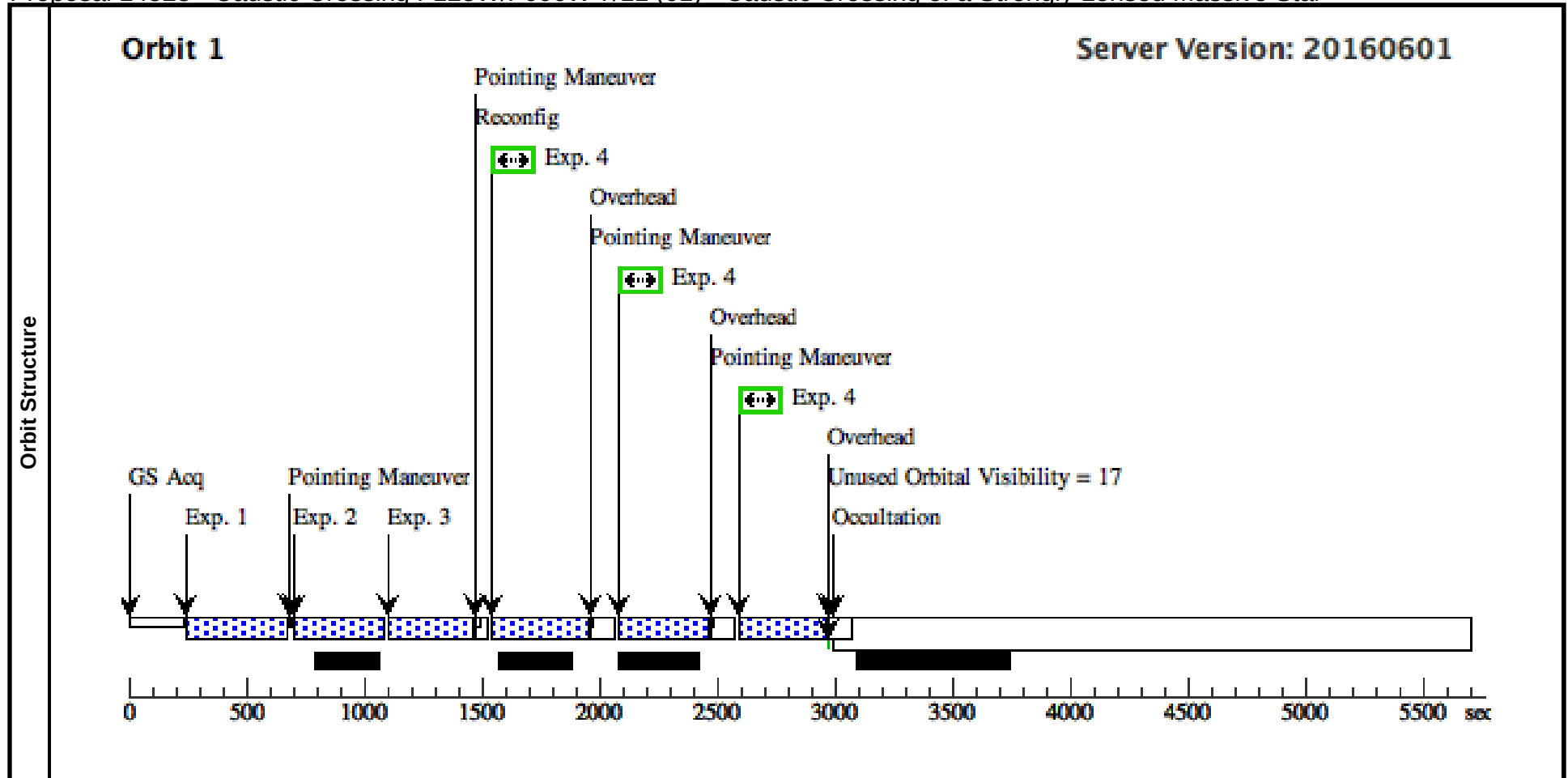
OBSERVING DESCRIPTION

To construct the light curve and improve constraints on the spectral energy distribution of the likely caustic-crossing event in the MACS1149 galaxy-cluster field, the program will acquire WFC3 imaging in five separate single-orbit visits beginning the week of July 11th through July 23rd 2016.

Three of the visits will have an even split between WFC3-IR F125W and WFC3-IR F160W integrations to provide a match with observations from the RefsdalRedux program (PID: 14199), while the remaining two will be evenly split between WFC3-IR F125W and WFC3-UVIS F606W. The WFC3-IR F125W and WFC3-UVIS F606W observations will span the clear Balmer break and confirm early observations indicating that the SED does not show substantial change, as expected for gravitational lensing.

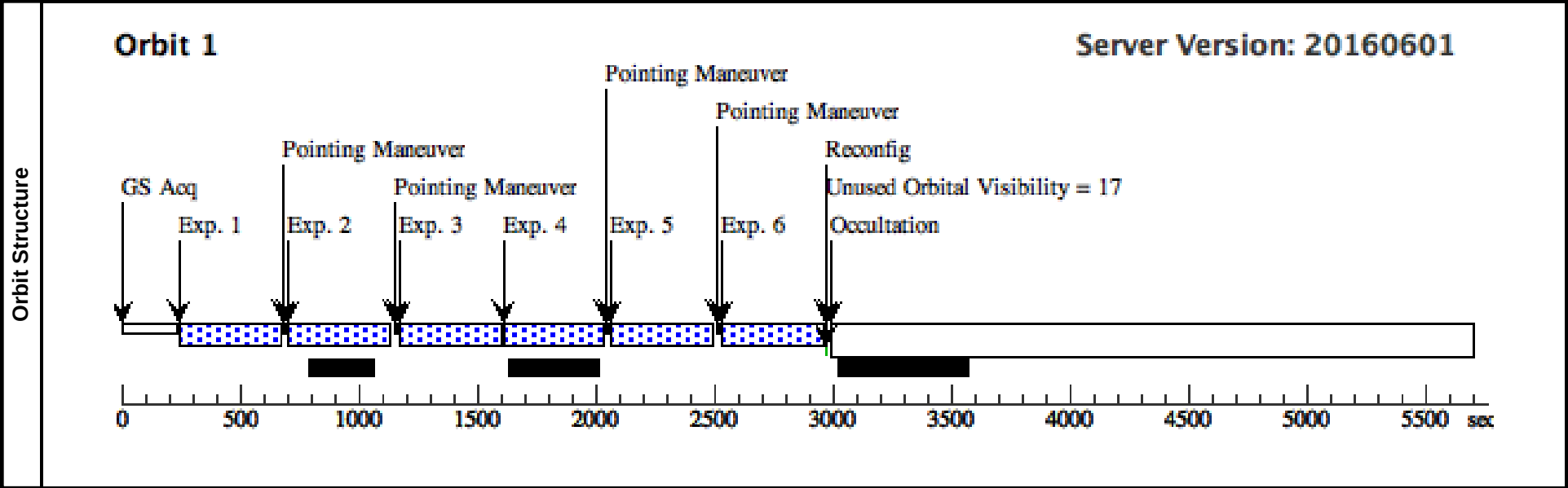
Proposal 14528 - Caustic Crossing F125W/F606W 7/11 (01) - Caustic Crossing of a Strongly Lensed Massive Star

Visit	Proposal 14528, Caustic Crossing F125W/F606W 7/11 (01), implementation										Fri Jul 29 17:45:13 GMT 2016		
	Diagnostic Status: No Diagnostics												
	Scientific Instruments: WFC3/IR, WFC3/UVIS												
	Special Requirements: SCHED 100%; ORIENT 107D TO 108 D; BETWEEN 11-JUL-2016:00:00:00 AND 12-JUL-2016:00:00:00												
	Comments: 3 short WFC3-IR F125W and 3 short WFC3-UVIS F606W exposures of the caustic-crossing event in MACS1149. preferred orient = 107 or 109												
Patterns	#	Primary Pattern					Secondary Pattern					Exposures	
	(1)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false										(4)	
Fixed Targets	#	Name		Target Coordinates		Targ. Coord. Corrections			Fluxes		Miscellaneous		
	(1)	CAUSTICCROSSINGC ANDIDATE		RA: 11 49 35.6580 (177.3985750d) Dec: +22 23 48.04 (22.39668d) Equinox: J2000					V=26+/-5 Transient source is changing in b rightness rapidly. Current J Ban d magnitude ~ 26 AB.		Reference Frame: ICRS		
Exposures	#	Label	Target	Config,Mode,Aperture		Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR		F125W	NSAMP=9; SAMP-SEQ=SPAR S50	GS ACQ SCENARI O ONEB1B3		402.935899 Secs (402.936 Secs) [==>]		[1]	
	2	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR		F125W	NSAMP=8; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		352.935448 Secs (352.935 Secs) [==>]		[1]	
	3	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR		F125W	NSAMP=8; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		352.935448 Secs (352.935 Secs) [==>]		[1]	
	4		(1) CAUSTICCROS SINGCANDIDATE	WFC3/UVIS, ACCUM, UVIS		F606W			Pattern 1, Exps 4-4 i n Caustic Crossing F 125W/F606W 7/11 (01) (1)	370 Secs (1136 Secs) [==>383 Secs (Pattern 1)] [==>383 Secs (Pattern 2)] [==>370.0 Secs (Pattern 3)]		[1]	



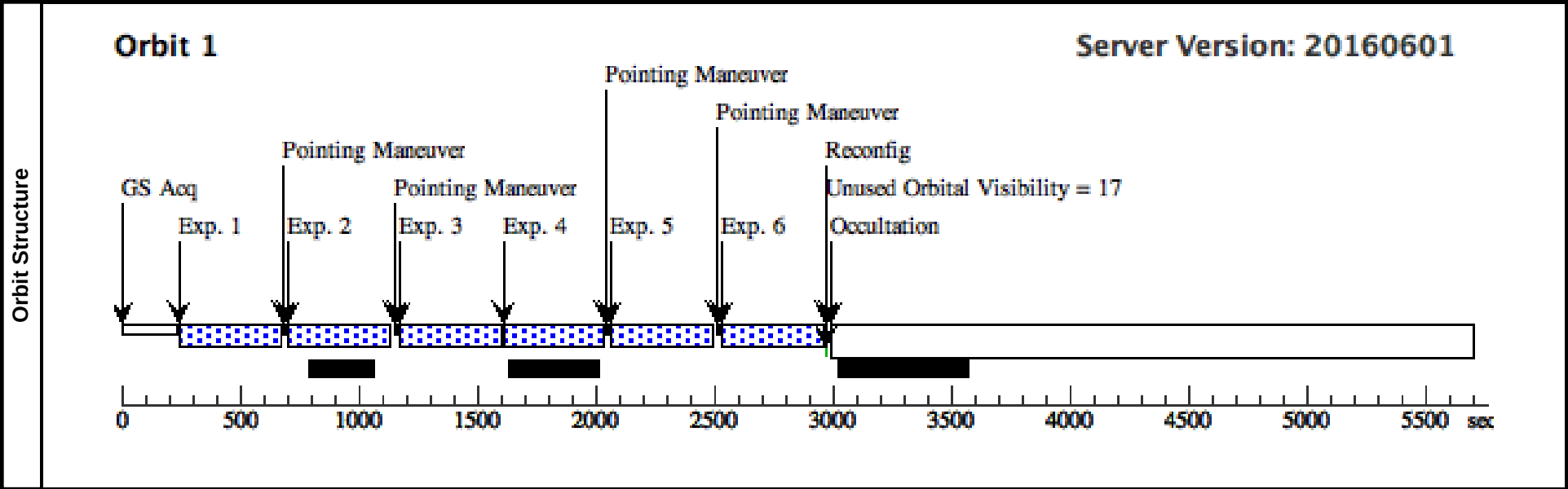
Proposal 14528 - Caustic Crossing F125W/F160W 7/14 (02) - Caustic Crossing of a Strongly Lensed Massive Star

Visit	Proposal 14528, Caustic Crossing F125W/F160W 7/14 (02), implementation Fri Jul 29 17:45:13 GMT 2016									
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 107D TO 108 D; BETWEEN 14-JUL-2016:00:00:00 AND 15-JUL-2016:00:00:00 Comments: 3 short WFC3-IR F125W and 3 short WFC3-IR F160W exposures of the caustic-crossing event in MACS1149. preferred orient = 107 or 109									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	CAUSTICCROSSINGC ANDIDATE	RA: 11 49 35.6580 (177.3985750d) Dec: +22 23 48.04 (22.39668d) Equinox: J2000		V=26+/-5 Transient source is changing in b rightness rapidly. Current J Ban d magnitude ~ 26 AB.	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	GS ACQ SCENARI O ONEB1B3		402.935899 Secs (402.936 Secs) [==>]	[1]
	2	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.451,0. 403		402.935899 Secs (402.936 Secs) [==>]	[1]
	3	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	4	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	5	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.353,1. 209		402.935899 Secs (402.936 Secs) [==>]	[1]
	6	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.804,1. 612		402.935899 Secs (402.936 Secs) [==>]	[1]



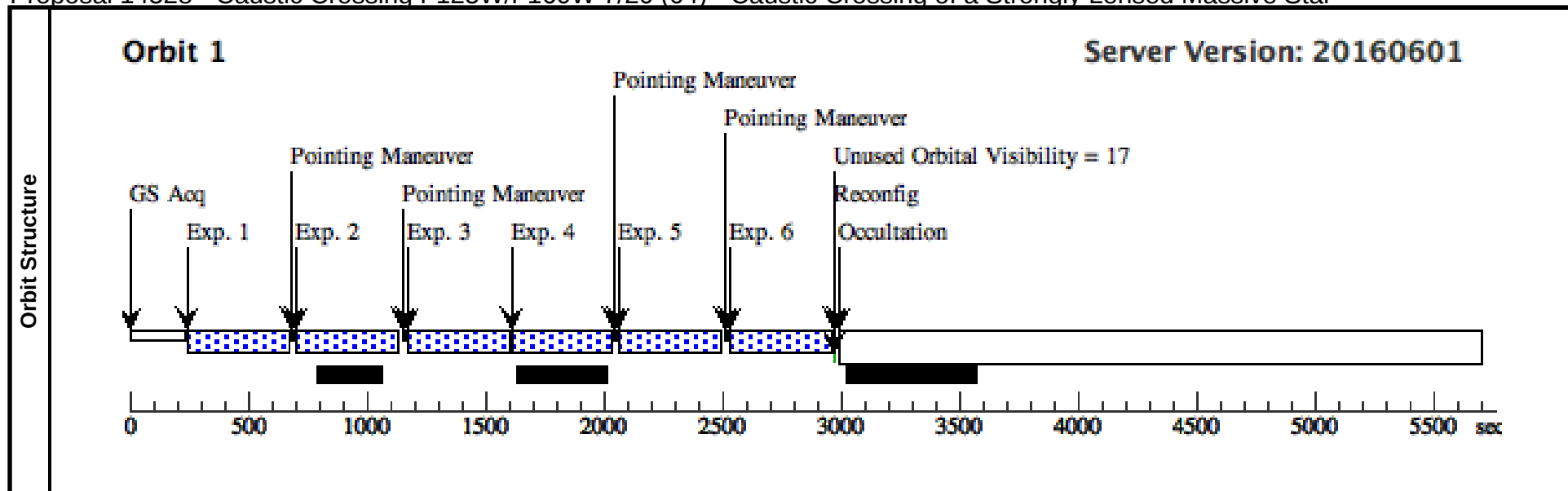
Proposal 14528 - Caustic Crossing F125W/F160W 7/17 (03) - Caustic Crossing of a Strongly Lensed Massive Star

Visit	Proposal 14528, Caustic Crossing F125W/F160W 7/17 (03), implementation Fri Jul 29 17:45:13 GMT 2016									
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 97D TO 103 D; BETWEEN 17-JUL-2016:00:00:00 AND 18-JUL-2016:00:00:00 Comments: 3 short WFC3-IR F125W and 3 short WFC3-IR F160W exposures of the caustic-crossing event in MACS1149. preferred orient = 102.1									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	CAUSTICCROSSINGC ANDIDATE	RA: 11 49 35.6580 (177.3985750d) Dec: +22 23 48.04 (22.39668d) Equinox: J2000		V=26+/-5 Transient source is changing in b rightness rapidly. Current J Ban d magnitude ~ 26 AB.	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	GS ACQ SCENARI O ONEB1B3		402.935899 Secs (402.936 Secs) [==>]	[1]
	2	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.451,0. 403		402.935899 Secs (402.936 Secs) [==>]	[1]
	3	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	4	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	5	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.353,1. 209		402.935899 Secs (402.936 Secs) [==>]	[1]
	6	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.804,1. 612		402.935899 Secs (402.936 Secs) [==>]	[1]



Proposal 14528 - Caustic Crossing F125W/F160W 7/20 (04) - Caustic Crossing of a Strongly Lensed Massive Star

Visit	Proposal 14528, Caustic Crossing F125W/F160W 7/20 (04), implementation Fri Jul 29 17:45:13 GMT 2016									
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 97D TO 103 D; BETWEEN 20-JUL-2016:00:00:00 AND 21-JUL-2016:00:00:00 Comments: 3 short WFC3-IR F125W and 3 short WFC3-IR F160W exposures of the caustic-crossing event in MACS1149. preferred orient = 102.1									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	CAUSTICCROSSINGC ANDIDATE	RA: 11 49 35.6580 (177.3985750d) Dec: +22 23 48.04 (22.39668d) Equinox: J2000		V=26+/-5 Transient source is changing in b rightness rapidly. Current J Ban d magnitude ~ 26 AB.	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	GS ACQ SCENARI O ONEB1B3		402.935899 Secs (402.936 Secs) [==>]	[1]
	2	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.451,0. 403		402.935899 Secs (402.936 Secs) [==>]	[1]
	3	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	4	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		402.935899 Secs (402.936 Secs) [==>]	[1]
	5	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.353,1. 209		402.935899 Secs (402.936 Secs) [==>]	[1]
	6	F160W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 1.804,1. 612		402.935899 Secs (402.936 Secs) [==>]	[1]



Proposal 14528 - Caustic Crossing F125W/F606W 7/23 (05) - Caustic Crossing of a Strongly Lensed Massive Star

Visit	Proposal 14528, Caustic Crossing F125W/F606W 7/23 (05), implementation Fri Jul 29 17:45:14 GMT 2016									
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: SCHED 100%; ORIENT 97D TO 103 D; BETWEEN 23-JUL-2016:00:00:00 AND 24-JUL-2016:00:00:00 Comments: 3 short WFC3-IR F125W and 3 short WFC3-UVIS F606W exposures of the caustic-crossing event in MACS1149. preferred orient = 102.1									
Patterns	#	Primary Pattern				Secondary Pattern				Exposures
	(1)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false								(4)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections		Fluxes	Miscellaneous			
	(1)	CAUSTICCROSSINGC ANDIDATE	RA: 11 49 35.6580 (177.3985750d) Dec: +22 23 48.04 (22.39668d) Equinox: J2000			V=26+/-5 Transient source is changing in b rightness rapidly. Current J Ban d magnitude ~ 26 AB.	Reference Frame: ICRS			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=9; SAMP-SEQ=SPAR S50	GS ACQ SCENARI O ONEB1B3		402.935899 Secs (402.936 Secs) [==>]	[1]
	2	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=8; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		352.935448 Secs (352.935 Secs) [==>]	[1]
	3	F125W	(1) CAUSTICCROS SINGCANDIDATE	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=8; SAMP-SEQ=SPAR S50	POS TARG 0.902,0. 806		352.935448 Secs (352.935 Secs) [==>]	[1]
	4		(1) CAUSTICCROS SINGCANDIDATE	WFC3/UVIS, ACCUM, UVIS	F606W		Pattern 1, Exps 4-4 i n Caustic Crossing F 125W/F606W 7/23 (05) (1)		370 Secs (1136 Secs) [==>383 Secs (Pattern 1)] [==>383 Secs (Pattern 2)] [==>370.0 Secs (Pattern 3)]	[1]

