



16756 - Quasars with small proximity zones: gravitationally lensed or exceptionally young?

Cycle: 29, 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) PSOJ004+17	ACS/WFC	2	15-Feb-2022 13:00:16.0	yes
02	(2) SDSSJ1335+3533	ACS/WFC	1	15-Feb-2022 13:00:17.0	yes
07	(2) SDSSJ1335+3533	ACS/WFC	1	15-Feb-2022 13:00:18.0	yes
03	(3) PSOJ158-14	ACS/WFC	2	15-Feb-2022 13:00:19.0	yes
04	(4) CFHQSJ2100-1715	ACS/WFC	2	15-Feb-2022 13:00:20.0	yes
05	(5) CFHQSJ2229+1457	ACS/WFC	2	15-Feb-2022 13:00:21.0	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>
06	(6) VDESJ0330-4025	ACS/WFC	2	15-Feb-2022 13:00:22.0	yes

12 Total Orbits Used

ABSTRACT

The existence of luminous quasars hosting supermassive black holes (SMBHs) within the first billion years of cosmic history challenges our understanding of black hole growth. However, much of our understanding relies on the assumption that the observed luminosities are intrinsic to the quasars themselves. It has long been predicted that a large fraction of high-redshift quasars should be gravitationally lensed, but to date only one lensed quasar above $z > 5$ has been confirmed despite considerable observational efforts. We propose to search for this long sought-after population of lensed quasars with HST/ACS, targeting six objects at $z \sim 6$ whose rest-frame UV spectra exhibit exceptionally small proximity zones. These quasars are excellent candidates for being gravitationally lensed objects, because the local ionizing flux implied by their small proximity zones is far below the expectation from their observed UV luminosities. We aim to apply a two-fold observing strategy using imaging both in the near-IR to search for multiple quasar images, as well as in the optical regime to target foreground lensing galaxies using the intergalactic medium as a natural long-pass filter to avoid the quasar light, in order to improve the success rate of this lensing search. In case we do not find evidence for lensing, the quasars' small proximity zones could be explained by very short UV-luminous lifetimes of less than 10,000 years, requiring either super-Eddington accretion rates or highly obscured black hole growth phases, in order to explain the concomitant SMBH growth. Thus either outcome of our proposed observations promises new insights into the formation and growth of the first SMBHs.

OBSERVING DESCRIPTION

We aim to tagert six quasars at $z \sim 6$ with ACS/WFC in two different filters, i.e. F892N and F555W. Data taken with the F892N filter will capture the quasarrest-frame UV continuum emission and will search for multiple images of the quasar at small angular separations. Observations with the wide F555W filter will search the foreground of the quasars for potential lensing galaxies along the quasar sightline without any contamination from the quasar itself, since the filter is chosen to be at lower wavelengths than the Lyman-limit.

We aim to observe each quasar for 2 orbits, one orbit for each filter (apart from target 02, i.e. SDSSJ1335+3533, which has already archival HST data with the filter F105W on WFC3-IR, program ID: #12184, resulting in a similar angular resolution). This implies that each visit consists of 1-2 orbits, ensuring easy schedulability of the program. We split each orbit into 4 exposures applying the dither pattern ACS-WFC-DITHER-BOX, which was selected as a minimally compact arrangement that provides half-integer pixel dither steps that will allow for an improved PSF

Proposal 16756 (STScI Edit Number: 2, Created: Tuesday, February 15, 2022 at 1:00:22 PM Eastern Standard Time) - Overview
reconstruction in the drizzled stack. The exposure time of ~ 520 s per dither position is chosen to maximize the orbital visibilities used. This will allow us to detect any foreground galaxies down to a magnitude of $m_{AB} \sim 28$ mag ($\sim 95\%$ completeness) with >4.3 sigma significance. The chosen longer wavelength filter F892N with a central wavelength of $\lambda = 8915$ A will image the rest-frame UV continuum emission of the quasar and enable the detection of multiple quasar images with an diffraction-limited angular resolution of approximately $0.076''$.

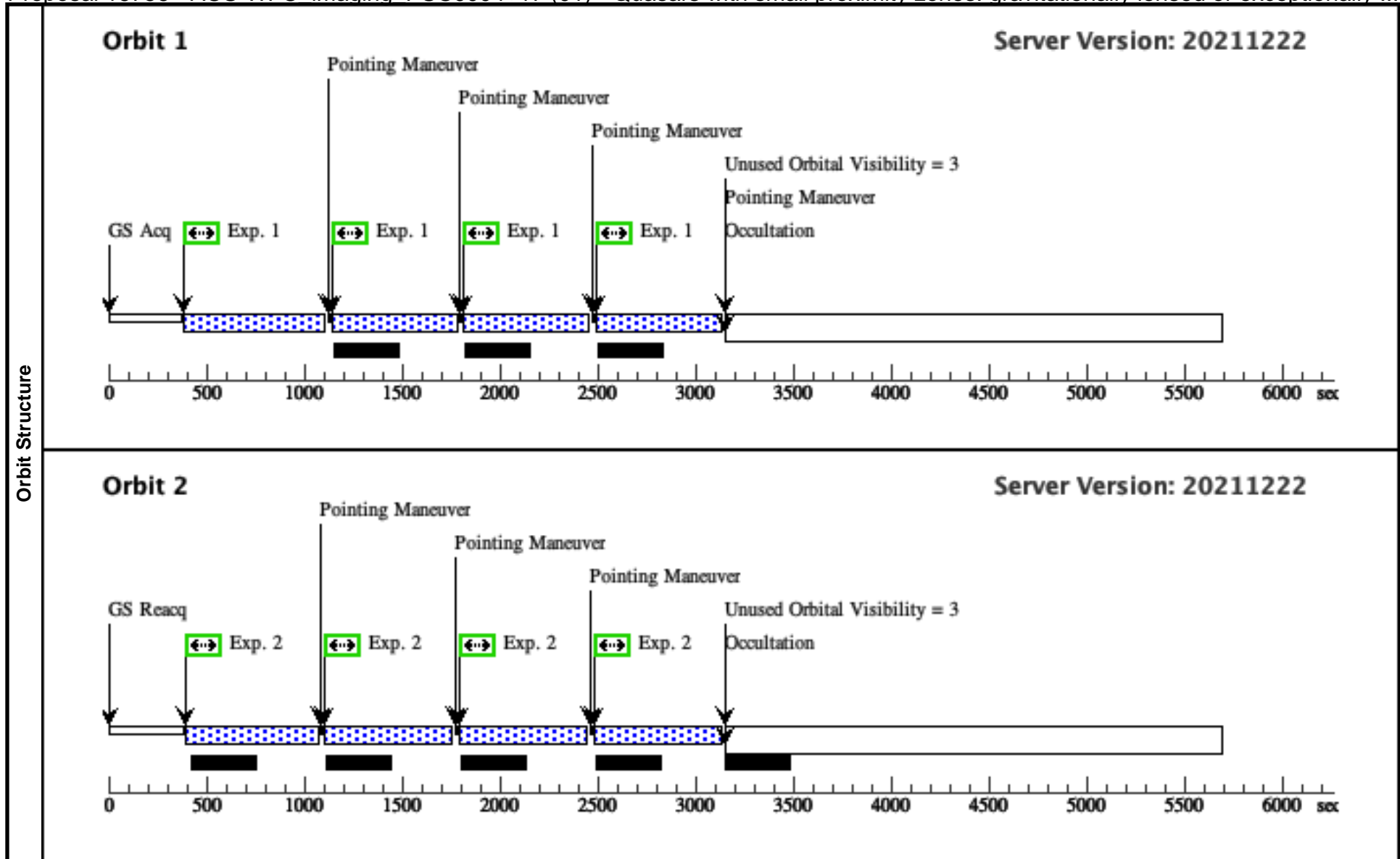
We chose the aperture WFC1, since it is in the middle of one of the two detectors avoiding potential issues with the detector gap, but nevertheless capturing all potentially lensing foreground galaxies at impact parameters of <100 arcsec from the quasar sightline, which is far more than required.

We have no orientation or timing requirements.

Proposal 16756 - ACS-WFC imaging PSOJ004+17 (01) - Quasars with small proximity zones: gravitationally lensed or exceptionally ...

Tue Feb 15 18:00:22 GMT 2022

Visit	Proposal 16756, ACS-WFC_imaging_PSOJ004+17 (01), completed Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1), (2)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	PSOJ004+17	RA: 00 17 34.4670 (4.3936125d) Dec: +17 05 10.70 (17.08631d) Equinox: J2000	Redshift: 5.8166	V=26+/-2 z_AB = 20.82+-0.07	Reference Frame: ICRS				
	<i>Comments:</i> Category=GALAXY Description=[OSO, QUASAR]									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	QSO_PSOJ004+17_F892N	(1) PSOJ004+17	ACS/WFC, ACCUM, WFC1	F850LP	FLASH=10		Pattern 1, Exps 1-1 in ACS-WFC_imaging_PSOJ004+17 (01) (1)	470 Secs (2056 Secs) [==>514.0 Secs (Pattern 1)] [==>514.0 Secs (Pattern 2)] [==>514.0 Secs (Pattern 3)] [==>514.0 Secs (Pattern 4)]	[1]
	2	FG_PSOJ004+17_F555W	(1) PSOJ004+17	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 2-2 in ACS-WFC_imaging_PSOJ004+17 (01) (1)	460 Secs (2120 Secs) [==>530.0 Secs (Pattern 1)] [==>530.0 Secs (Pattern 2)] [==>530.0 Secs (Pattern 3)] [==>530.0 Secs (Pattern 4)]	[2]



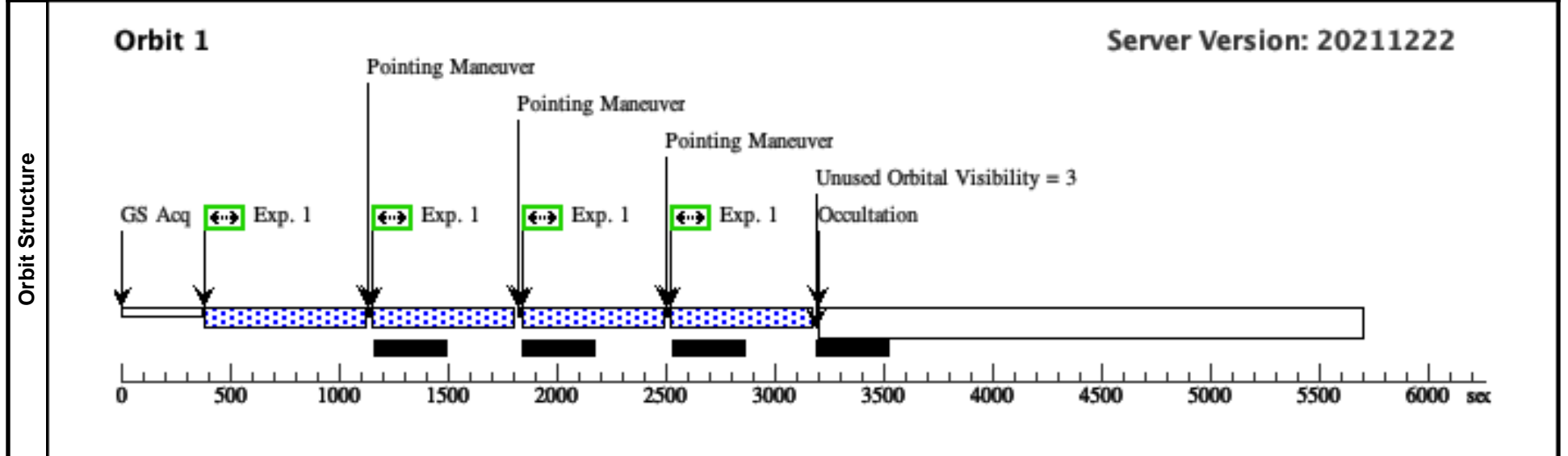
Proposal 16756 - ACS-WFC imaging J1335+3533 (02) - Quasars with small proximity zones: gravitationally lensed or exceptionally y...

Visit	Proposal 16756, ACS-WFC_imaging_J1335+3533 (02), failed Tue Feb 15 18:00:23 GMT 2022		
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)		

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false	(1)

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(2)	SDSSJ1335+3533	RA: 13 35 50.8070 (203.9616958d) Dec: +35 33 15.80 (35.55439d) Equinox: J2000	Redshift: 5.9012	V=26+/-2 z_AB = 20.10+0.11	Reference Frame: ICRS
	<i>Comments:</i> Category=GALAXY Description=[OSO, QUASAR]					

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	FG_J1335+3533_F555W	(2) SDSSJ1335+3533	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 1-1 in ACS-WFC_imaging_J1335+3533 (02) (1)	530 Secs (2120 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]



Proposal 16756 - ACS-WFC imaging J1335+3533 (07) - Quasars with small proximity zones: gravitationally lensed or exceptionally v...

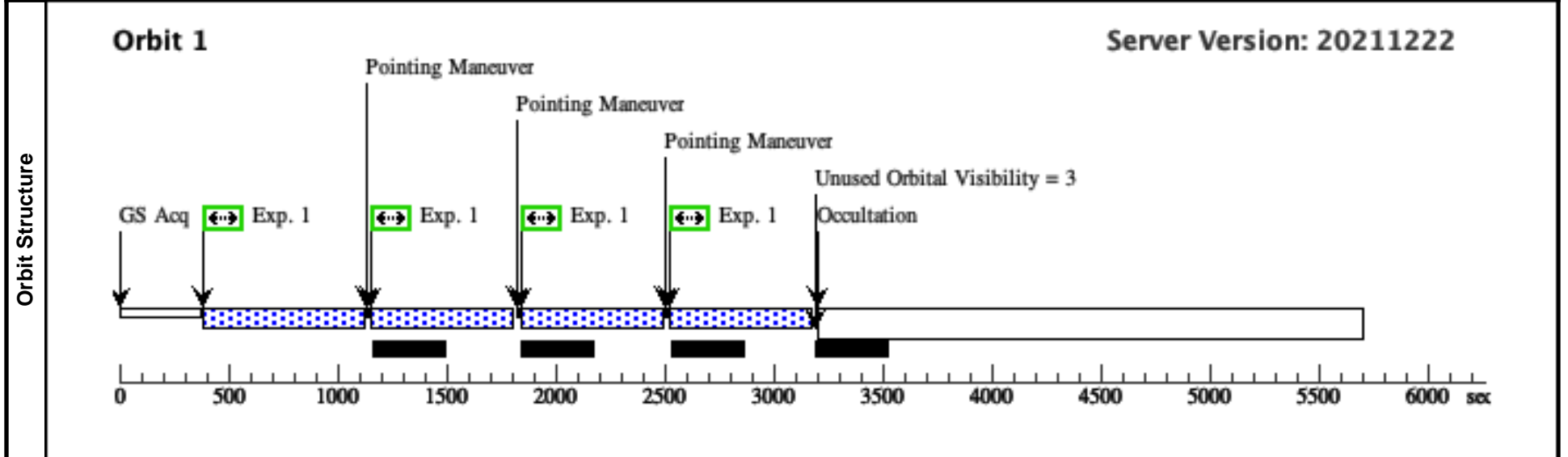
Tue Feb 15 18:00:23 GMT 2022

Visit	Proposal 16756, ACS-WFC_imaging_J1335+3533 (07)		
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)		

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false	(1)

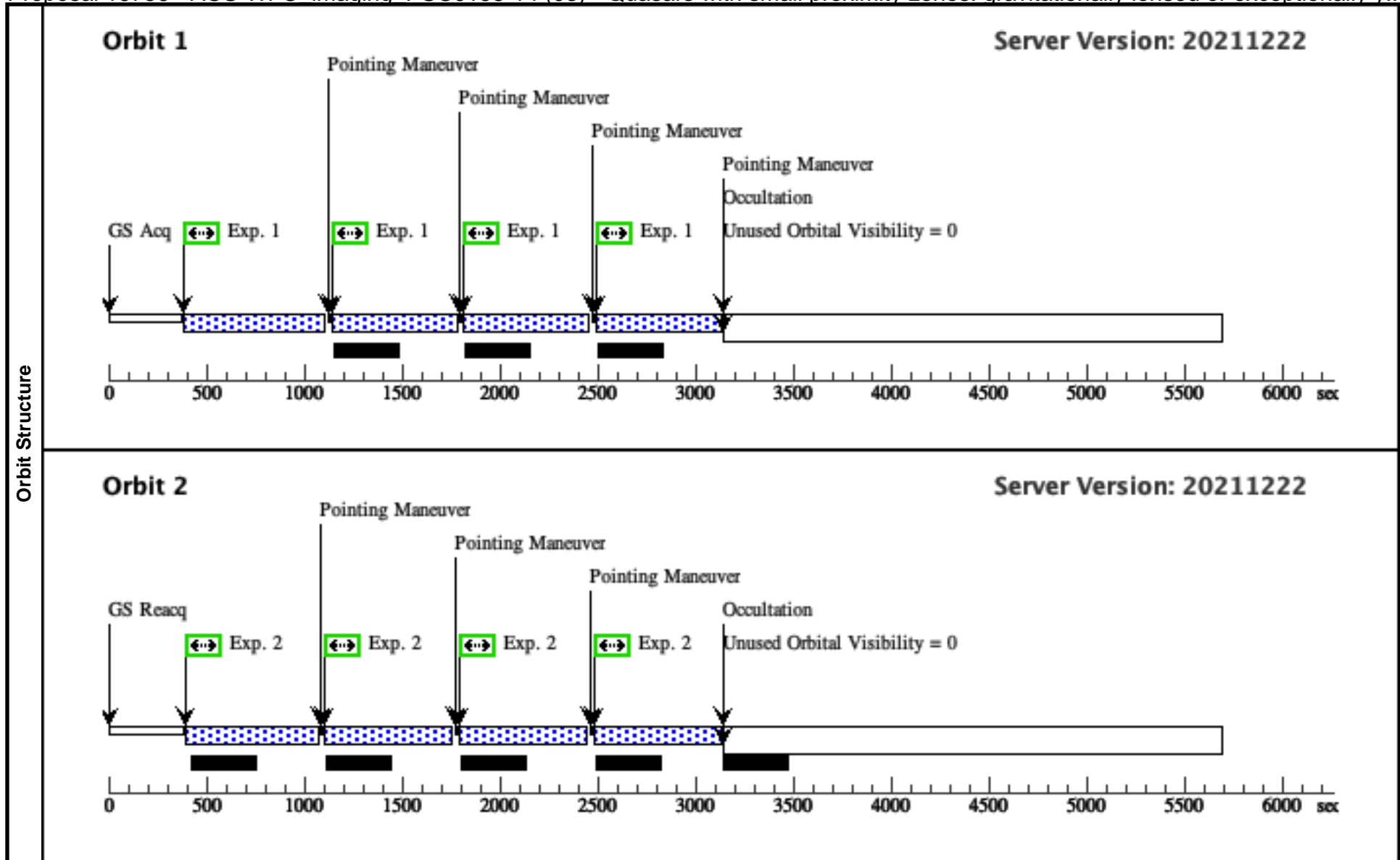
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(2)	SDSSJ1335+3533	RA: 13 35 50.8070 (203.9616958d) Dec: +35 33 15.80 (35.55439d) Equinox: J2000	Redshift: 5.9012	V=26+/-2 z_AB = 20.10+0.11	Reference Frame: ICRS
	<i>Comments:</i> Category=GALAXY Description=[OSO, QUASAR]					

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	FG_J1335+3533_F555W	(2) SDSSJ1335+3533	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 1-1 in ACS-WFC_imaging_J1335+3533 (07) (1)	530 Secs (2120 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]



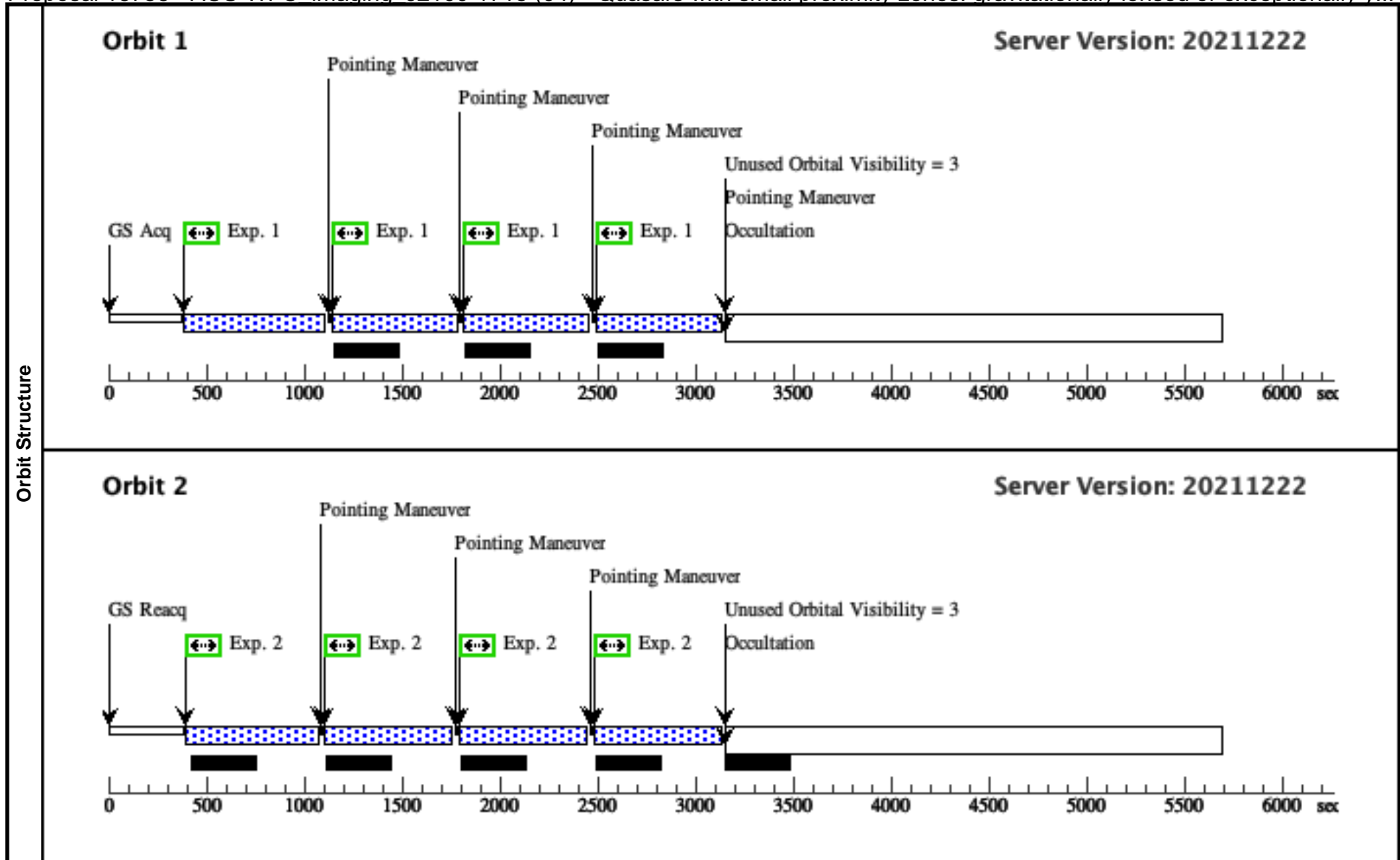
Proposal 16756 - ACS-WFC imaging PSOJ158-14 (03) - Quasars with small proximity zones: gravitationally lensed or exceptionally v...

Visit	Proposal 16756, ACS-WFC_imaging_PSOJ158-14 (03), completed Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)					Tue Feb 15 18:00:23 GMT 2022				
Patterns	#	Primary Pattern Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Secondary Pattern Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false	Exposures (1), (2)						
Fixed Targets	#	Name (3) PSOJ158-14	Target Coordinates RA: 10 34 46.5090 (158.6937875d) Dec: -14 25 15.85 (-14.42107d) Equinox: J2000	Targ. Coord. Corrections Redshift: 6.0685	Fluxes V=26+/-2 z_AB = 19.44+-0.08	Miscellaneous Reference Frame: ICRS <i>Comments:</i> Category=GALAXY Description=[OSO, QUASAR]				
Exposures	#	Label 1 QSO_PSOJ158-14_F89 2N 2 FG_PSOJ158-14_F555 W	Target (3) PSOJ158-14	Config,Mode,Aperture ACS/WFC, ACCUM, WFC1	Spectral Els. F850LP F555W	Opt. Params. FLASH=10	Special Reqs.	Groups Pattern 1, Exps 1-1 in ACS-WFC_imaging_PSOJ158-14 (03) (1) Pattern 1, Exps 2-2 in ACS-WFC_imaging_PSOJ158-14 (03) (1)	Exp. Time (Total)/[Actual Dur.] 466 Secs (2052 Secs) [=>513.0 Secs (Pattern 1)] [=>513.0 Secs (Pattern 2)] [=>513.0 Secs (Pattern 3)] [=>513.0 Secs (Pattern 4)] 470 Secs (2116 Secs) [=>529.0 Secs (Pattern 1)] [=>529.0 Secs (Pattern 2)] [=>529.0 Secs (Pattern 3)] [=>529.0 Secs (Pattern 4)]	Orbit [1] [2]



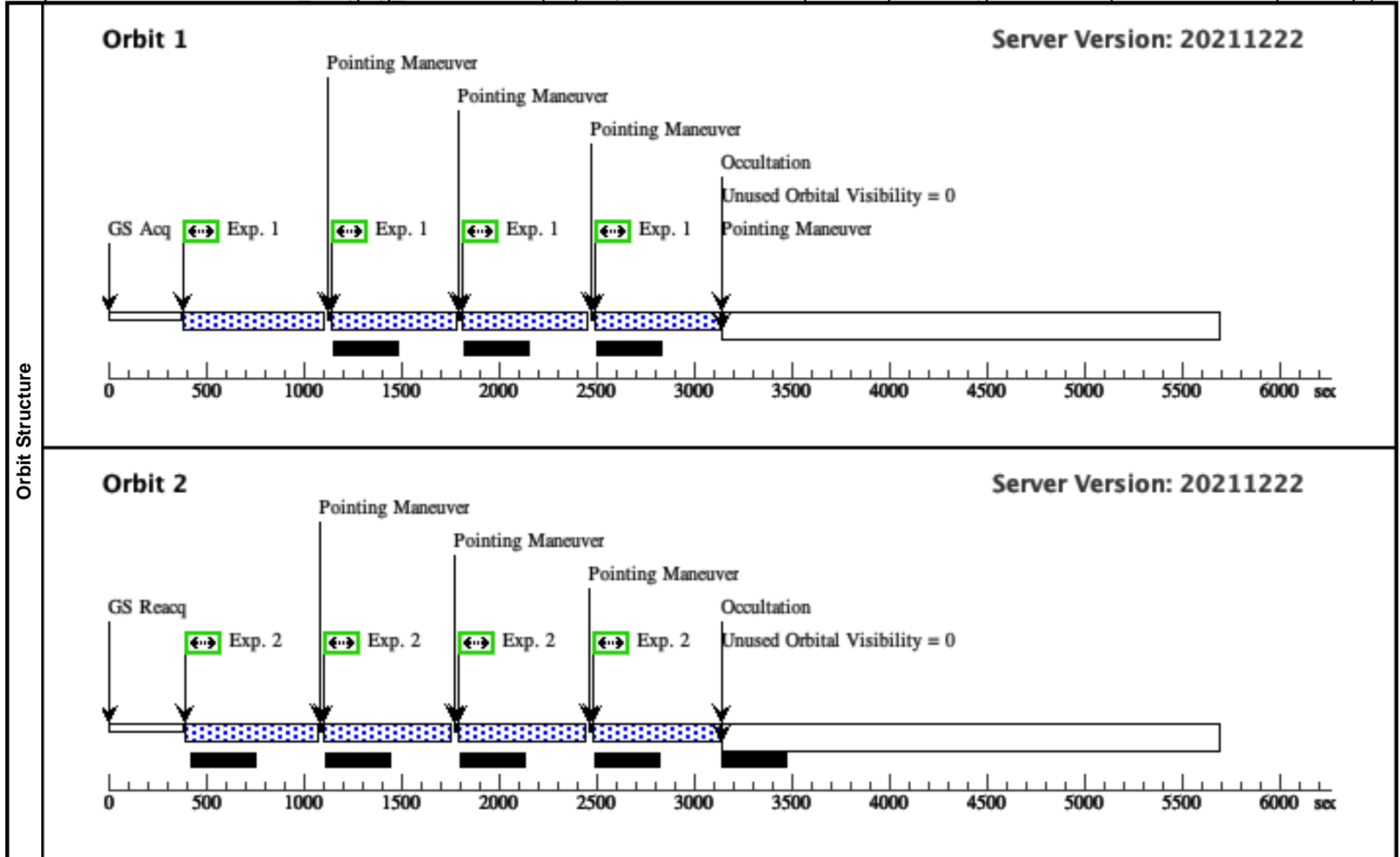
Proposal 16756 - ACS-WFC imaging J2100-1715 (04) - Quasars with small proximity zones: gravitationally lensed or exceptionally y...

Visit		Proposal 16756, ACS-WFC_imaging_J2100-1715 (04), completed Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)					Tue Feb 15 18:00:23 GMT 2022			
Patterns	#	Primary Pattern		Secondary Pattern		Exposures				
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false			(1), (2)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(4)	CFHQSJ2100-1715	RA: 21 00 54.6160 (315.2275667d) Dec: -17 15 22.50 (-17.25625d) Equinox: J2000	Redshift: 6.0806	V=26+/-2 z_AB = 22.35+-0.09	Reference Frame: ICRS				
<i>Comments:</i> Category=GALAXY Description=[OSO, QUASAR]										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	QSO_J2100-1715_F892 N	(4) CFHQSJ2100-1715	ACS/WFC, ACCUM, WFC1	F850LP	FLASH=10		Pattern 1, Exps 1-1 in ACS-WFC_imaging_J2100-1715 (04) (1)	400 Secs (2056 Secs) [==>514.0 Secs (Pattern 1)] [==>514.0 Secs (Pattern 2)] [==>514.0 Secs (Pattern 3)] [==>514.0 Secs (Pattern 4)]	[1]
2	FG_J2100-1715_F555W	(4) CFHQSJ2100-1715	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 2-2 in ACS-WFC_imaging_J2100-1715 (04) (1)	400 Secs (2120 Secs) [==>530.0 Secs (Pattern 1)] [==>530.0 Secs (Pattern 2)] [==>530.0 Secs (Pattern 3)] [==>530.0 Secs (Pattern 4)]	[2]	



Proposal 16756 - ACS-WFC imaging J2229+1457 (05) - Quasars with small proximity zones: gravitationally lensed or exceptionally y...

Visit	Proposal 16756, ACS-WFC_imaging_J2229+1457 (05), completed Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)					Tue Feb 15 18:00:23 GMT 2022				
Patterns	#	Primary Pattern	Secondary Pattern	Exposures						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192		Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1), (2)				
	(5)	CFHQSJ2229+1457	RA: 22 29 1.6490 (337.2568708d) Dec: +14 57 8.98 (14.95249d) Equinox: J2000	Redshift: 6.1517	V=26+/-2 z_AB = 22.03+-0.05	Reference Frame: ICRS				
<i>Comments: Category=GALAXY Description=[OSO, QUASAR]</i>										
	1	QSO_J2229+1457_F982_57N	(5) CFHQSJ2229+14	ACS/WFC, ACCUM, WFC1	F850LP	FLASH=10		Pattern 1, Exps 1-1 in ACS-WFC_imaging_J2229+1457 (05) (1)	400 Secs (2052 Secs) [==>513.0 Secs (Pattern 1)] [==>513.0 Secs (Pattern 2)] [==>513.0 Secs (Pattern 3)] [==>513.0 Secs (Pattern 4)]	[1]
	2	FG_J2229+1457_F555_57W	(5) CFHQSJ2229+14	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 2-2 in ACS-WFC_imaging_J2229+1457 (05) (1)	400 Secs (2116 Secs) [==>529.0 Secs (Pattern 1)] [==>529.0 Secs (Pattern 2)] [==>529.0 Secs (Pattern 3)] [==>529.0 Secs (Pattern 4)]	[2]



Proposal 16756 - ACS-WFC imaging J0330-4025 (06) - Quasars with small proximity zones: gravitationally lensed or exceptionally y...

Visit	Proposal 16756, ACS-WFC_imaging_J0330-4025 (06), completed Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)					Tue Feb 15 18:00:23 GMT 2022				
Patterns	#	Primary Pattern	Secondary Pattern	Exposures						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192		Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1), (2)				
	(6)	VDESJ0330-4025	RA: 03 30 27.9200 (52.6163333d) Dec: -40 25 16.20 (-40.42117d) Equinox: J2000	Redshift: 6.249					V=26+/-2 z_AB = 20.66+-0.02	Reference Frame: ICRS
Comments: Category=GALAXY Description=[OSO, QUASAR]										
	1	QSO_J0330-4025_F892_N 5	(6) VDESJ0330-402	ACS/WFC, ACCUM, WFC1	F850LP	FLASH=10		Pattern 1, Exps 1-1 in ACS-WFC_imaging_J0330-4025 (06) (1)	400 Secs (2140 Secs) [==>535.0 Secs (Pattern 1)] [==>535.0 Secs (Pattern 2)] [==>535.0 Secs (Pattern 3)] [==>535.0 Secs (Pattern 4)]	[1]
	2	FG_J0330-4025_F555W 5	(6) VDESJ0330-402	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 2-2 in ACS-WFC_imaging_J0330-4025 (06) (1)	400 Secs (2204 Secs) [==>551.0 Secs (Pattern 1)] [==>551.0 Secs (Pattern 2)] [==>551.0 Secs (Pattern 3)] [==>551.0 Secs (Pattern 4)]	[2]

