17726 - Time delay cosmography with strong cluster lenses

Cycle: 32, Proposal Category: GO

(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) SDSSJ0909+4449	ACS/WFC	2	29-Oct-2024 16:00:59.0	yes
02	(1) SDSSJ0909+4449	ACS/WFC	2	29-Oct-2024 16:01:00.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(2) SDSSJ1326+4806	ACS/WFC	2	29-Oct-2024 16:01:01.0	yes
04	(2) SDSSJ1326+4806	ACS/WFC	2	29-Oct-2024 16:01:02.0	yes
05	(6) COOLJ0335-1928	ACS/WFC	2	29-Oct-2024 16:01:03.0	yes
06	(6) COOLJ0335-1928	ACS/WFC	2	29-Oct-2024 16:01:04.0	yes
07	(2) SDSSJ1326+4806	WFC3/UVIS	2	29-Oct-2024 16:01:04.0	yes

14 Total Orbits Used

ABSTRACT

We propose to assemble a complete data set of HST and JWST imaging for the complete known sample of 8 gravitational lens systems where a variable quasar is multiply lensed by a cluster of galaxies. Such lens systems produce image separations and time delays an order of magnitude larger than the much more common galaxy-scale lensed quasars. All these systems are targets of completed or ongoing photometric monitoring programs, allowing us to measure time delays between the lensed quasar images. Time delay values with 1-2% uncertainty have already been measured in half of these lens systems, and preliminary time delays are available for all; similar precision will be reached in the remaining systems within ~2 years. The long time delays, coupled with space-based imaging which provide a large number of additional lensing mass constraints from image families of lensed sources at different redshifts, make these cluster-lensed quasars spectacular targets for determining the Hubble constant H0. The Refsdal method, based on measuring time delays between multiple, strongly gravitationally lensed images of variable sources can provide unique insight into the origin of the intriguing "Hubble tension" between local distance ladder and cosmic microwave background-based determinations of H0. To enable such H0 measurements for the full sample of 8 lensed quasars, we request HST imaging for three systems with no prior space-based data, complemented by JWST imaging at longer wavelengths for the full sample of 8 lenses, as well as modest archival support, to construct precise and accurate models of the lensing mass distribution across the entire sample and derive a joint H0 measurement.

OBSERVING DESCRIPTION

This program consists of 14 orbits of broad-band imaging, spread over 7 visits, each with 2 orbits per visit. Each visit uses a single filter.

Visits 01-06: ACS/WFC imaging. This is programmed as a 2-orbit visit, with a total of 8 frames obtained, dithering along a line with a gap-crossing dither step for each additional frame. For each orbit, the POS TARG option is used to implement an initial offset from the center of ACS/WFC chip

1. The purpose of this offset is to move the center of the strong-lens high-magnification region (which coincides with the provided J2000 target coordinates) somewhat closer to the center of the full WFC field, while also avoiding the part of the chip most affected by CTE effects. This offset is small enough that the region where we expect to find multiple images of gravitationally lensed sources will still be on the same ACS chip as the cluster center for any ORIENT value. Each orbit employs a ACS-WFC-DITHER-BOX pattern to allow for drizzling/sub-sampling and better modelling of the PSF. The two orbits have different POS TARG values, yielding a relative shift between the orbits that ensures that all positions in the chip gap region are covered by at least 6 exposures, ensuring efficient removal of artifacts such as cosmic rays and CTE effects.

Visit 07: WFC3/UVIS imaging. This two-orbit visit is dedicated to WFC3-UVIS imaging in the F390W filter. A total of 4 exposures are made across two orbits, emplying a WFC3-UVIS-GAP-LINE dither pattern to ensure that all positions in the inter-chip region is covered by at least 3 exposures. The POS TARG option is used to apply an initial offset of the target away from the center of WFC3/UVIS chip 2 towards the center of the full WFC3/UVIS field. This offset is small enough that the entire sky region where we expect to find multiple images of gravitationally lensed sources will remain on chip2 for any ORIENT value. A Post Flash of 7 e- is applied to mitigate CTE effects.

Possible impact of potential reduced gyro operations: We do not require a specific roll angle for these observations. Also, the roll angles for separate visits of the same field need not be the same. This should maximise the schedulability of the observations, even for the case where the observing windows are further limited by reduced gyro mode (the impact of a reduced gyro mode on limiting the spatial scan speed should also not have a significant effect on our fixed target observations).

Visit

Proposal 17726, SJ0909_F435W (01), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

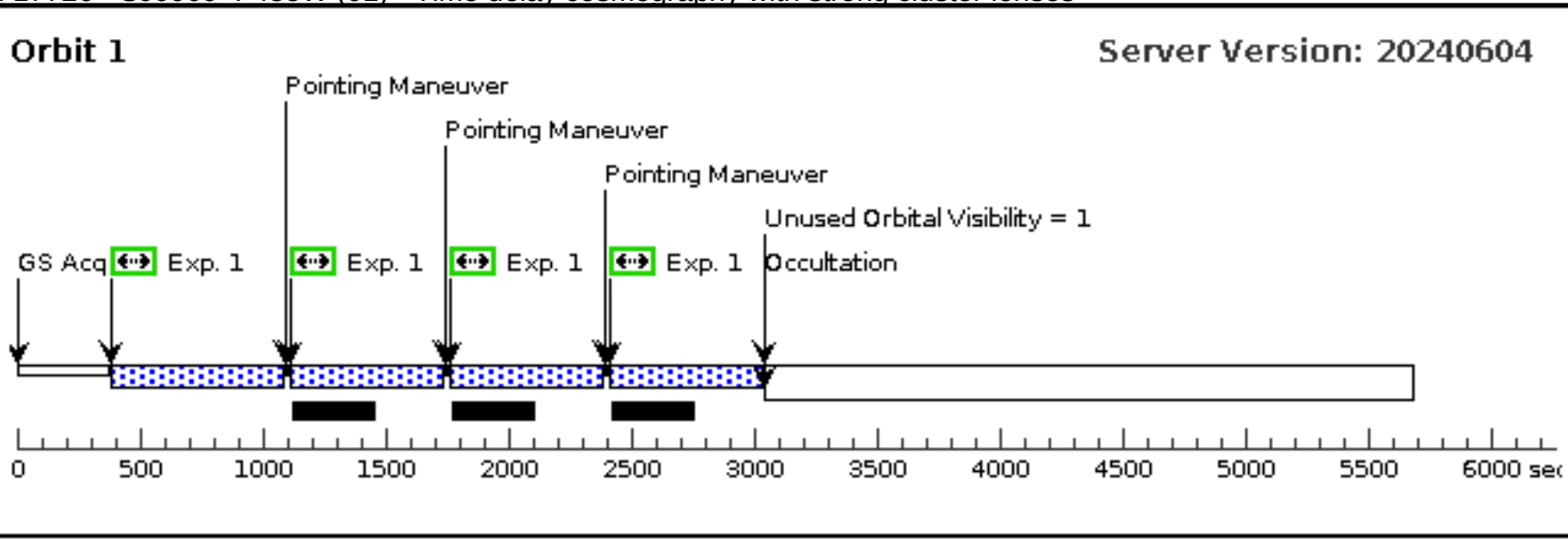
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0909+4449	RA: 09 09 46.3600 (137.4431667d) Dec: +44 49 48.90 (44.83025d) Equinox: J2000	Redshift: 0.92	V=21.6+/-0.4 brightest quasar image, g=21.8; r=21.4 (variable)	Reference Frame: ICRS

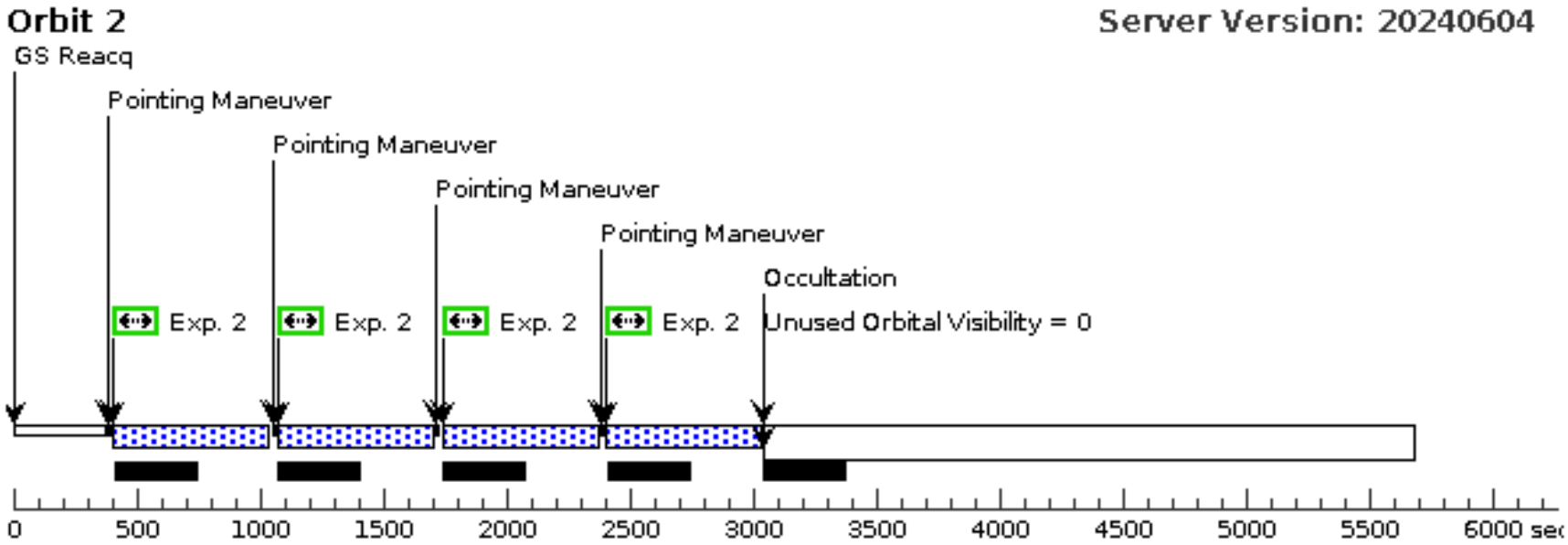
Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, HIGH REDSHIFT CLUSTER, POOR CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0909+4449	ACS/WFC, ACCUM, WFC1-FIX	F435W		POS TARG 0.0,-30.0	Pattern 1, Exps 1-1 in SJ0909_F435W (01) (1)	492 Secs (1968 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(1) SDSSJ0909+4449	ACS/WFC, ACCUM, WFC1-FIX	F435W		POS TARG 0.415,-22.055	Pattern 1, Exps 2-2 in SJ0909_F435W (01) (1)	506 Secs (2024 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 17726, SJ0909_F606W (02), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

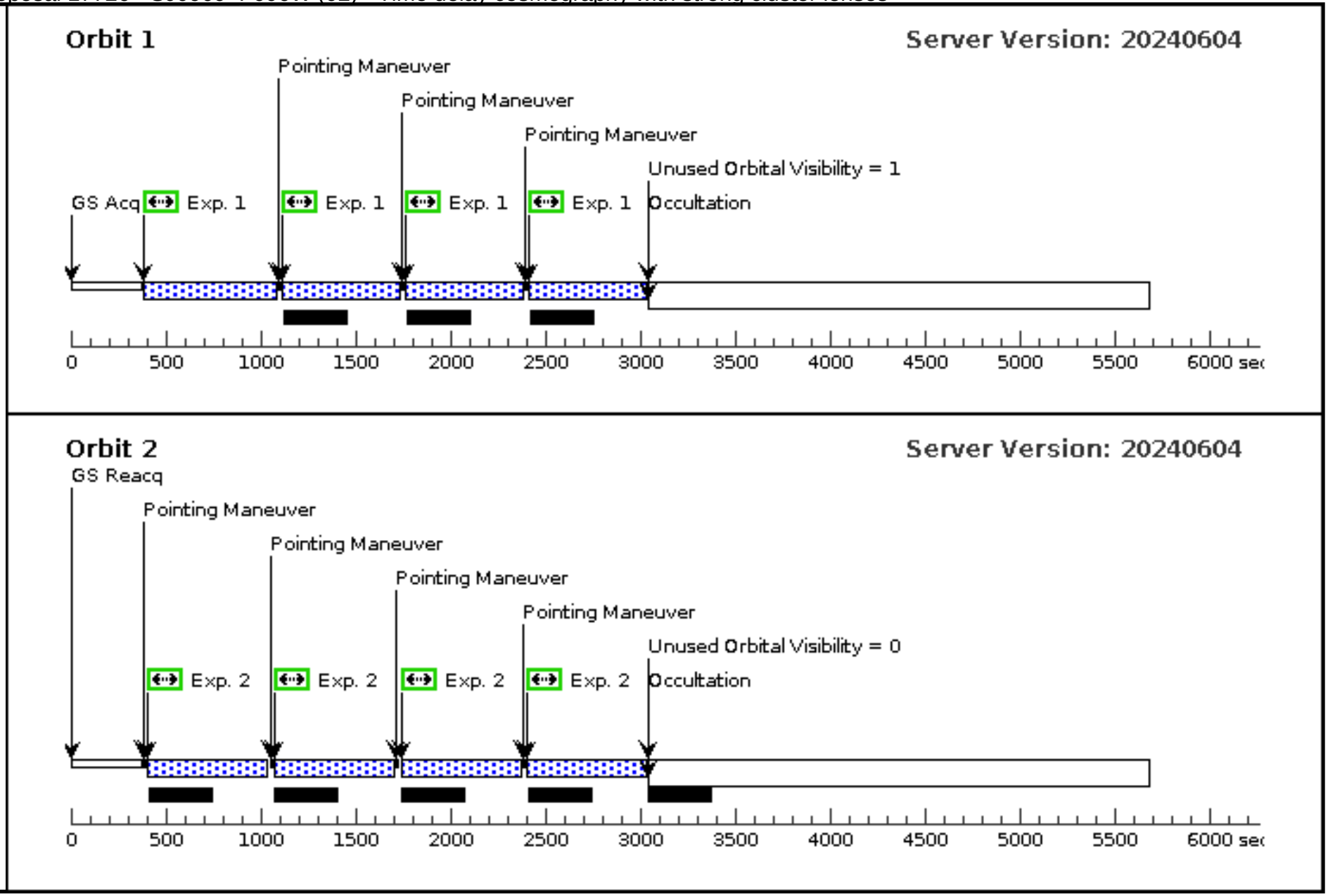
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0909+4449	RA: 09 09 46.3600 (137.4431667d) Dec: +44 49 48.90 (44.83025d) Equinox: J2000	Redshift: 0.92	V=21.6+/-0.4 brightest quasar image, g=21.8; r=21.4 (variable)	Reference Frame: ICRS

Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, HIGH REDSHIFT CLUSTER, POOR CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0909+4449	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 0.0,-30.0	Pattern 1, Exps 1-1 in SJ0909_F606W (02) (1)	492 Secs (1968 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(1) SDSSJ0909+4449	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 0.415,-22.055	Pattern 1, Exps 2-2 in SJ0909_F606W (02) (1)	506 Secs (2024 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure



Visit

Proposal 17726, SJ1326_F475W (03), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

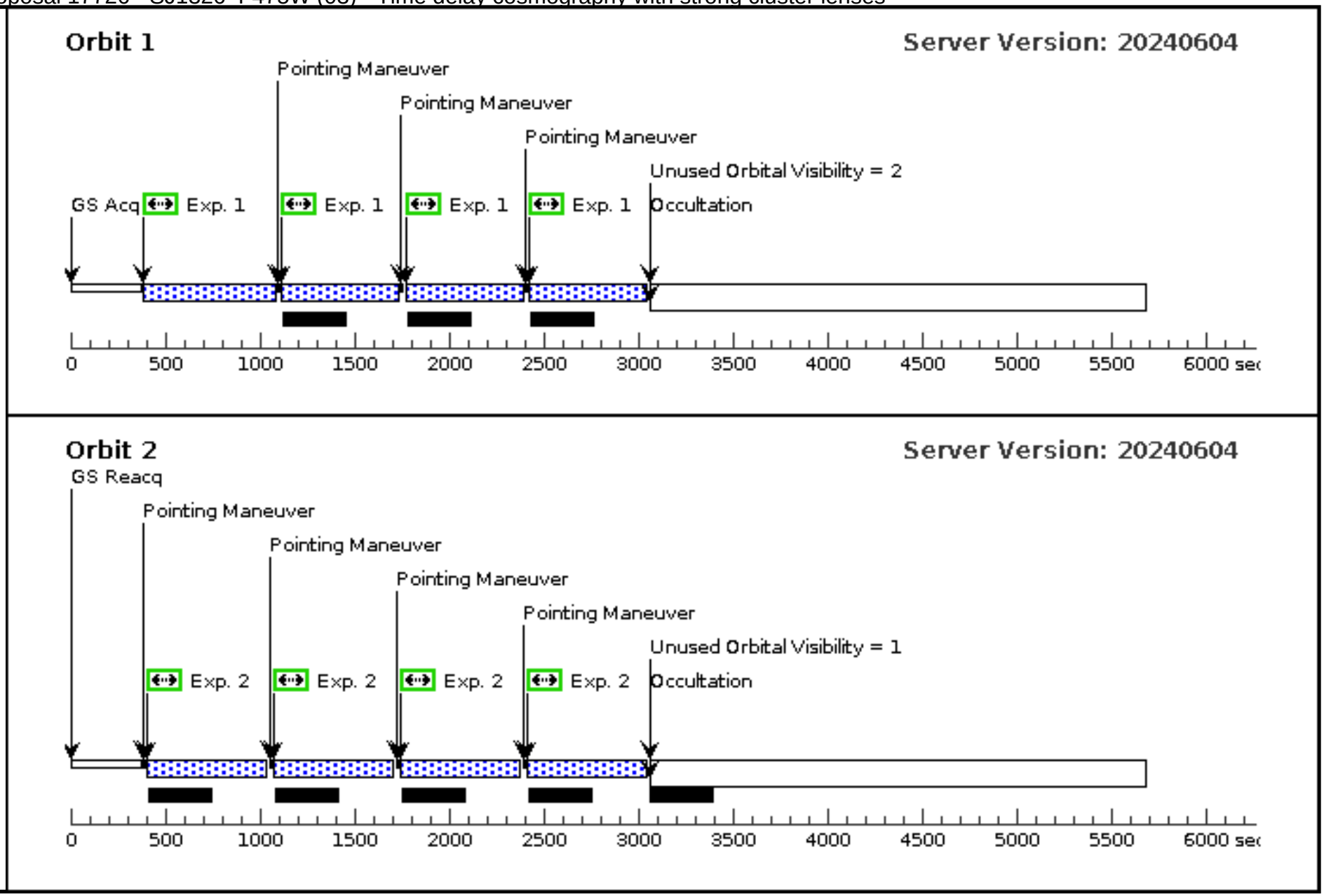
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ1326+4806	RA: 13 26 0.0200 (201.5000833d) Dec: +48 06 43.60 (48.11211d) Equinox: J2000		V=20.85+/-0.5 brightest quasar image, g=20.95; r=20.75 (variable)	Reference Frame: ICRS

Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, RICH CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) SDSSJ1326+4806	ACS/WFC, ACCUM, WFC1-FIX	F475W		POS TARG 0.0,-25.0	Pattern 1, Exps 1-1 in SJ1326_F475W (03) (1)	495 Secs (1980 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) SDSSJ1326+4806	ACS/WFC, ACCUM, WFC1-FIX	F475W		POS TARG 0.415,-17.055	Pattern 1, Exps 2-2 in SJ1326_F475W (03) (1)	509 Secs (2036 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure



Visit

Proposal 17726, SJ1326_F625W (04), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

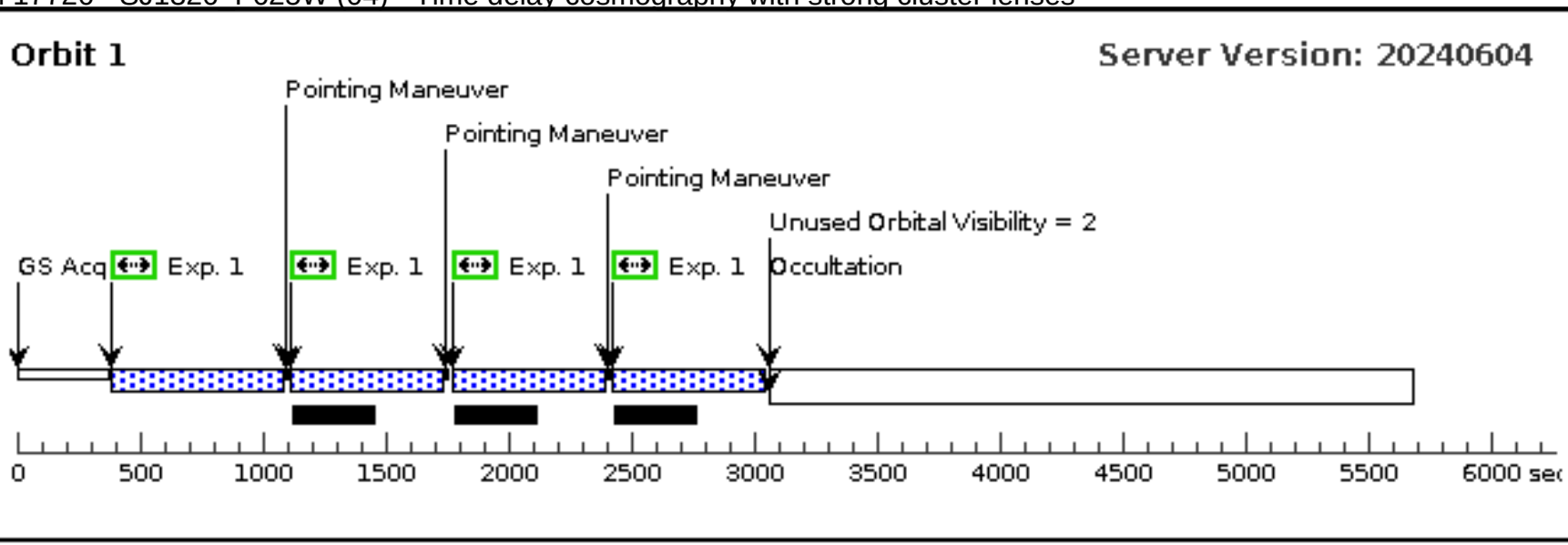
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ1326+4806	RA: 13 26 0.0200 (201.5000833d) Dec: +48 06 43.60 (48.11211d) Equinox: J2000		V=20.85+/-0.5 brightest quasar image, g=20.95; r=20.75 (variable)	Reference Frame: ICRS

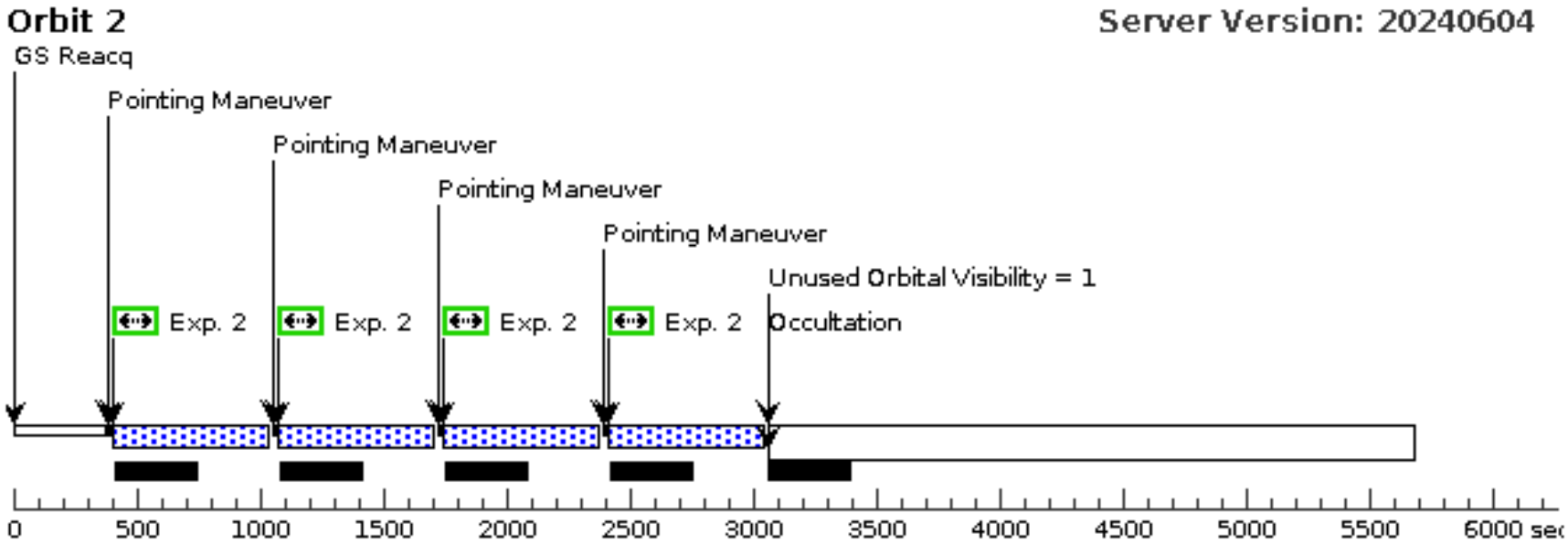
Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, RICH CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) SDSSJ1326+4806	ACS/WFC, ACCUM, WFC1-FIX	F625W		POS TARG 0.0,-25.0	Pattern 1, Exps 1-1 in SJ1326_F625W (04) (1)	495 Secs (1980 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) SDSSJ1326+4806	ACS/WFC, ACCUM, WFC1-FIX	F625W		POS TARG 0.415,-17.055	Pattern 1, Exps 2-2 in SJ1326_F625W (04) (1)	509 Secs (2036 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 17726, CJ0335_F475W (05), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

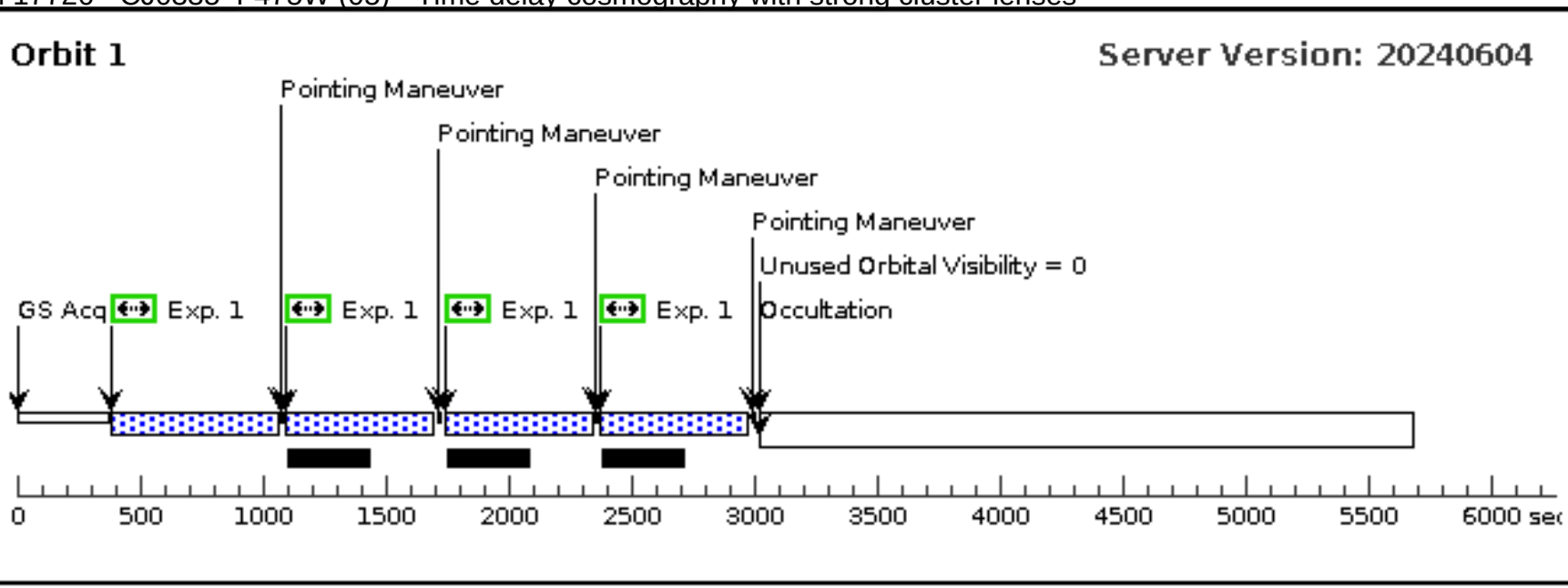
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	COOLJ0335-1928	RA: 03 35 4.1997 (53.7674988d) Dec: -19 27 54.05 (-19.46501d) Equinox: J2000		V=21.5+/-0.4 brightest quasar image, g=21.8; r=21.2 (variable)	Reference Frame: ICRS

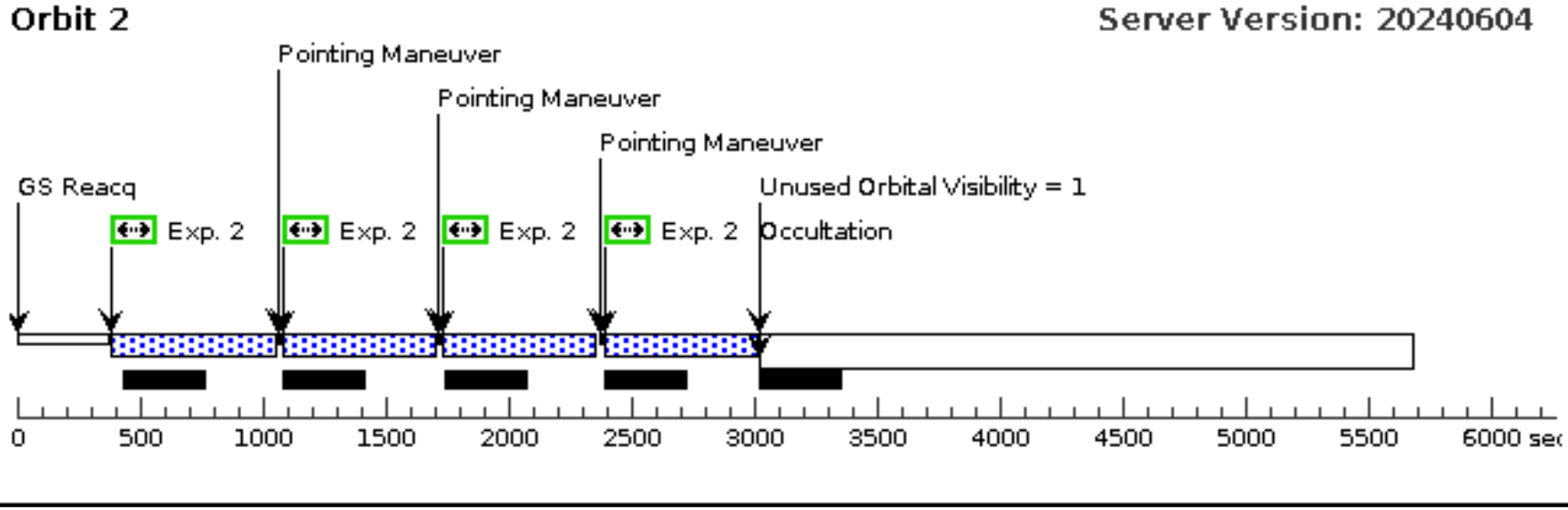
Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, RICH CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(6) COOLJ0335-1928	ACS/WFC, ACCUM, WFC1-FIX	F435W		POS TARG 0.0,-20.0	Pattern 1, Exps 1-1 in CJ0335_F475W (05) (1)	479 Secs (1916 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(6) COOLJ0335-1928	ACS/WFC, ACCUM, WFC1-FIX	F475W		POS TARG 0.415,-12.055	Pattern 1, Exps 2-2 in CJ0335_F475W (05) (1)	494 Secs (1976 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 17726, CJ0335_F625W (06), implementation Tue Oct 29 20:01:05 GMT 2024

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=0.265 Line Spacing=5.011	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false		(1), (2)

Fixed Targets

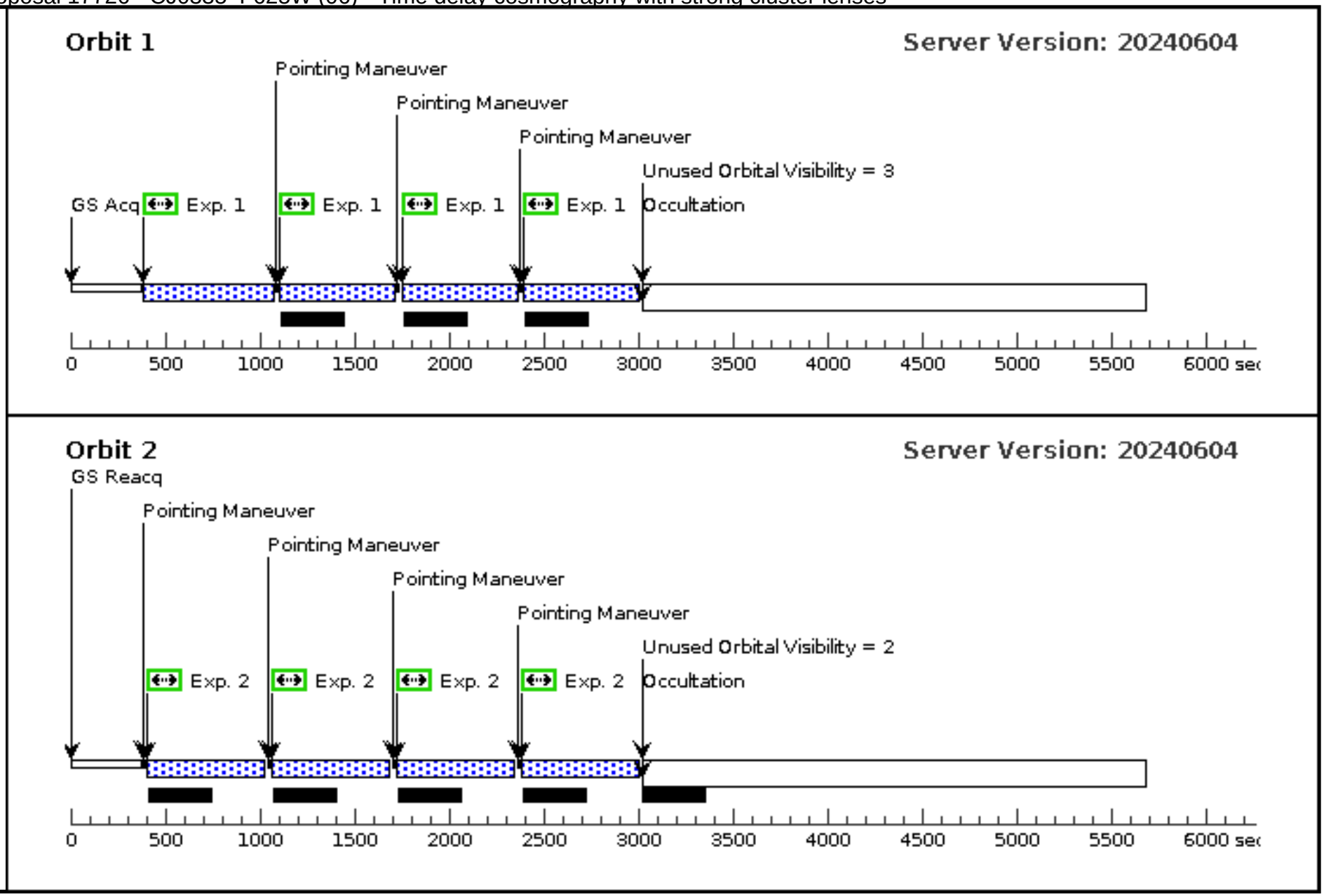
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	COOLJ0335-1928	RA: 03 35 4.1997 (53.7674988d) Dec: -19 27 54.05 (-19.46501d) Equinox: J2000		V=21.5+/-0.4 brightest quasar image, g=21.8; r=21.2 (variable)	Reference Frame: ICRS

Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, RICH CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(6) COOLJ0335-1928	ACS/WFC, ACCUM, WFC1-FIX	F625W		POS TARG 0.0,-20.0	Pattern 1, Exps 1-1 in CJ0335_F625W (06) (1)	485 Secs (1940 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(6) COOLJ0335-1928	ACS/WFC, ACCUM, WFC1-FIX	F625W		POS TARG 0.415,-12.055	Pattern 1, Exps 2-2 in CJ0335_F625W (06) (1)	499 Secs (1996 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure



Visit

Proposal 17726, CJ1326_F390W (07), implementation Tue Oct 29 20:01:05 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=WFC3-UVIS-GAP-LINE	Coordinate Frame=POS-TARG		(1)
	Purpose=DITHER	Pattern Orientation=85.759		
	Number Of Points=4	Angle Between Sides=		
	Point Spacing=2.414	Center Pattern=false		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ1326+4806	RA: 13 26 0.0200 (201.5000833d)		V=20.85+/-0.5	Reference Frame: ICRS
		Dec: +48 06 43.60 (48.11211d)		brightest quasar image,	
		Equinox: J2000		g=20.95; r=20.75 (variable)	

Comments:
Category=CLUSTER OF GALAXIES
Description=[GRAVITATIONAL LENS, RICH CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) SDSSJ1326+4806	WFC3/UVIS, ACCUM, UVIS2-FIX	F390W	FLASH=7.0	POS TARG 0.0,9.0; GS ACQ SCENARIO ONEB1O3	Pattern 3, Exps 1-1 in CJ1326_F390W (07) (3)	1273 Secs (5216 Secs)	
								[==>1310.0 Secs (Pattern 1)]	***[1]***
								[==>1310.0 Secs (Pattern 2)]	
								[==>1298.0 Secs (Pattern 3)]	***[2]***
								[==>1298.0 Secs (Pattern 4)]	

Orbit Structure