16291 - Spatially Resolving Outflows in a z~1 Extremely Red Quasar to Observe a Short-Lived Blowout Phase in Galaxy Evolution

Cycle: 28, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Paul H Sell (CoI)	University of Florida	psell@ufl.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) SDSSJ0048-0046	WFC3/UVIS	3	22-Jun-2021 11:02:00.0	yes
02	(1) SDSSJ0048-0046	WFC3/UVIS	3	22-Jun-2021 11:02:01.0	yes
03	(1) SDSSJ0048-0046	WFC3/UVIS	3	22-Jun-2021 11:02:02.0	yes
04	(1) SDSSJ0048-0046	WFC3/UVIS	3	22-Jun-2021 11:02:03.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
05	(1) SDSSJ0048-0046	WFC3/UVIS	3	22-Jun-2021 11:02:04.0	yes

15 Total Orbits Used

ABSTRACT

A key question in galaxy formation is how active galactic nuclei (AGN) interact with their host galaxies. Extremely Red Quasars (ERQs) are ideal objects to study this interaction since they are believed to be quasars caught in a short-lived phase where they are actively clearing gas from their host galaxy's central regions. Most known ERQs are at z=2-3, making it challenging to resolve details of their winds and host galaxies, even with HST. Here we propose to study the lowest redshift ERQ discovered to date (z~0.94) with the aim of directly resolving the high ionization outflow using narrow-band imaging of the [Ne V] line. The narrow band observations will provide a first look at the size and spatial distribution of a powerful quasar outflow during this key phase. The broad band observations will enable measurement of the host galaxy properties including Sersic index, evidence of merging, and recent (100 Myr) star formation. J0048-0046 provides the best possible chance to constrain the ionized gas outflow size of an ERQ, both due to its low redshift and its high level of nuclear obscuration. With the derived outflow size measurements, we can test our theories of galaxy formation and measure whether ERQ winds have enough kinetic power to blow the gas out of their hosts. These observations will also help contribute to building up a sample of ERQ hosts and outflow measurements that can be used to assess how ERQs outflows are driven and how the hosts of these galaxies evolve.

OBSERVING DESCRIPTION

We are proposing to measure the morphology and spatial extent of the quasar-driven wind in an Extremely Red Quasar at z=0.94 using WFC3-UVIS narrow-band imaging. We will trace the high ionization gas in the wind using the [Ne V] line at wavelengths of 6500-6630 in the observed frame. Broadband imaging will enable us to continuum subtract and measure the properties of the host galaxy.

We are using the narrow F657N filter to isolate the broad [Ne V] line. F657N is well centered on the [Ne V] line and has a bandpass that spans the range of velocites we expect to observe. We conservatively estimate a 3 kpc (R ~ 0.38") outflow yielding a surface brightness of 1.3e-15 erg/s/A/cm^2. A line-dither pattern is used for the rejection of hot pixels and cosmic rays while improving spatial resolution. Unfortunately, both a 3-point and 4-point dither pattern introduces read noise that does not allow us to reach our target S/N. A post-flash of 13 e- is applied based on ETC calculations using the zodiacal background of the target and the most recent recommended background level of 20 e-. We will reach S/N ~ 5 per pixel centered on the brightest region of the outflow in 6 orbits.

Broad-band imaging will allow us to correct for the stellar and QSO contiuum in the narrow-band F657N filter and allow us to measure properties of the host galaxy. The F606W filter will observe deep, off-band images with wavelengths close to our narrow-band filter. This will allow us to subtract off the continuum in the on-band images while introducing minimal noise. At radii where we expect the outflow to be present (R < 3 kpc), we will constrain the galaxy/qso continuum with a S/N >8 per pixel. The off-band image will also trace the properties of the host galaxy. A 5x5 pixel binning is appropriate for this diffuse outer-region and we can obtain S/N~3 per spatial bin with 2 orbits. To give us color information of the host galaxy, we use the F814W filter because it provides a better tracer of stellar mass. Since the host galaxy is ~2 times brighter in the F814W filter relative to F606W, we can acheive the same S/N in half the time required for F606W.

Archival photometry indicates our target is mildly variable, possibly on time scales of days. As a consequence, we require broadband exposures with F606W for each visit so that the variable continuum can be accounted for when subtracting it from the narrow band. Doing so requires us to take half-orbit exposures in each of the broad bands for visits 1 and 2. A 3-point dither pattern for F606W is the most optimal as it will allow us to remain near our target S/N while also improving cosmic ray rejection and spatial resolution. A 2-point dither pattern for F814W is the safest since going above that many points reduces us to short sub-exposures that may not reach the required background level count of 20 e- per pixel.

Due to the low background in our F657N, F606W, and F814W images CTE is a concern. The spatial extent of the outflow is expected to be small (< 10 pixels). We have therefore opted to place the targets close to the readout axis at the UVIS2-C1K1C-CTE position.

In the advent of a 2-gyro operational mode, our science will be affected in two ways. Target visibility for this proposal is widely available from late October to mid December of 2020 with 3 gyros. This visibility during the fall is greatly diminished with only 2 gyros operational. Second, all exposures for visits 2 and 3 experience around 1-2 minutes of overrun which would affect our S/N, but not greatly.

Visit

Proposal 16291, Visit 01, failed Tue Jun 22 15:02:05 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 2 (Pattern 2, Exps 2-2 in Visit 01)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(Exposure 3 (Pattern 2, Exps 3-3 in Visit 01)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3)

Fixed Targets

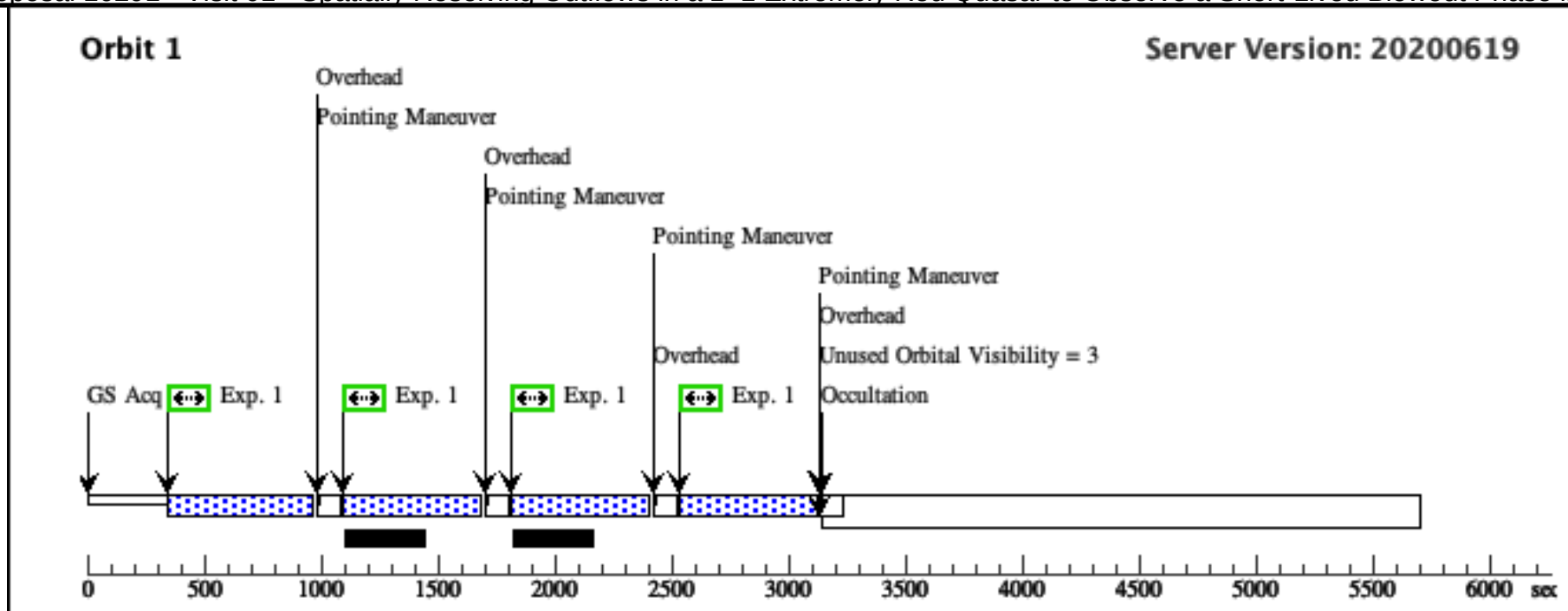
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0048-0046	RA: 00 48 46.4562 (12.1935675d) Dec: -00 46 11.96 (-.76999d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.94	V=21.27+/-.13	Reference Frame: ICRS

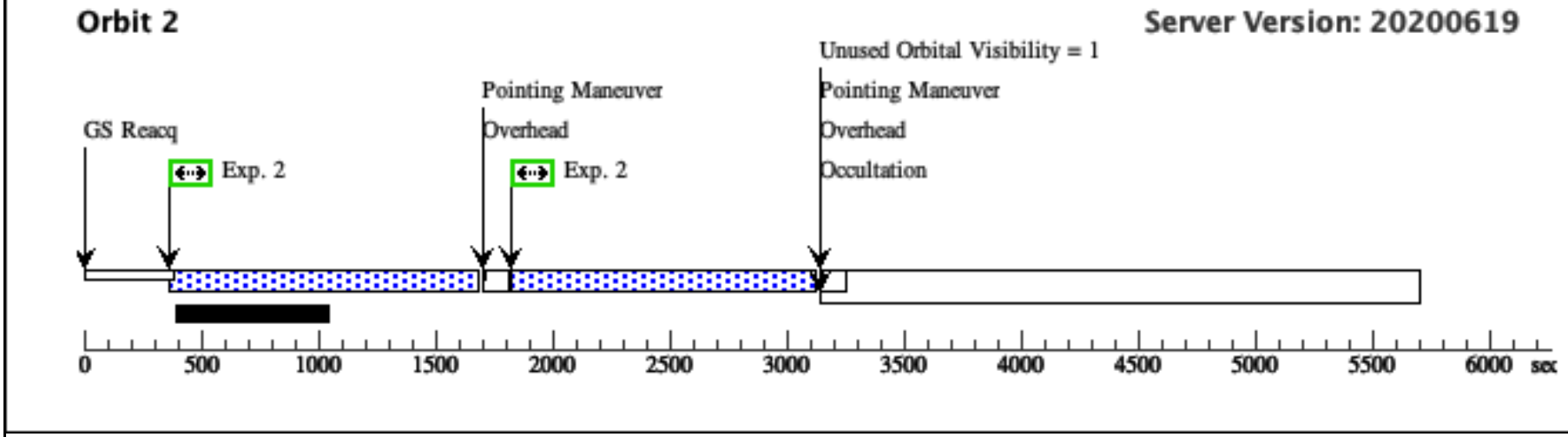
Comments:
Category=GALAXY
Description=[QUASAR]
Extended=YES

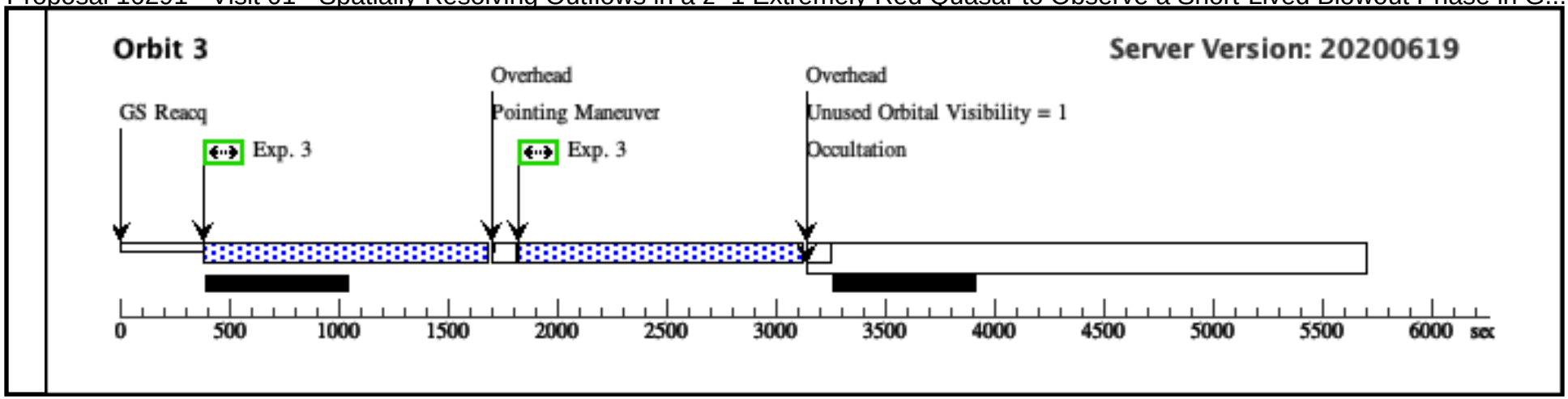
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F606W			Pattern 1, Exps 1-1 in Visit 01 (1)	675 Secs (2364 Secs) *[==>591.0 Secs (Pattern 1)]* *[==>591.0 Secs (Pattern 2)]* *[==>591.0 Secs (Pattern 3)]* *[==>591.0 Secs (Pattern 4)]*	***[1]***
2		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16		Pattern 2, Exps 2-2 in Visit 01 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[2]***
3		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16		Pattern 2, Exps 3-3 in Visit 01 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[3]***

Orbit Structure






Orbit 3
Server Version: 20200619
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Pointing Maneuver
Exp. 3
Overhead
Unused Orbital Visibility = 1
Occultation
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Visit

Proposal 16291, Visit 02, failed Tue Jun 22 15:02:05 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 3 (Pattern 2, Exps 3-3 in Visit 02)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(Exposure 4 (Pattern 2, Exps 4-4 in Visit 02)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3), (4)
(3)	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		(1)

Fixed Targets

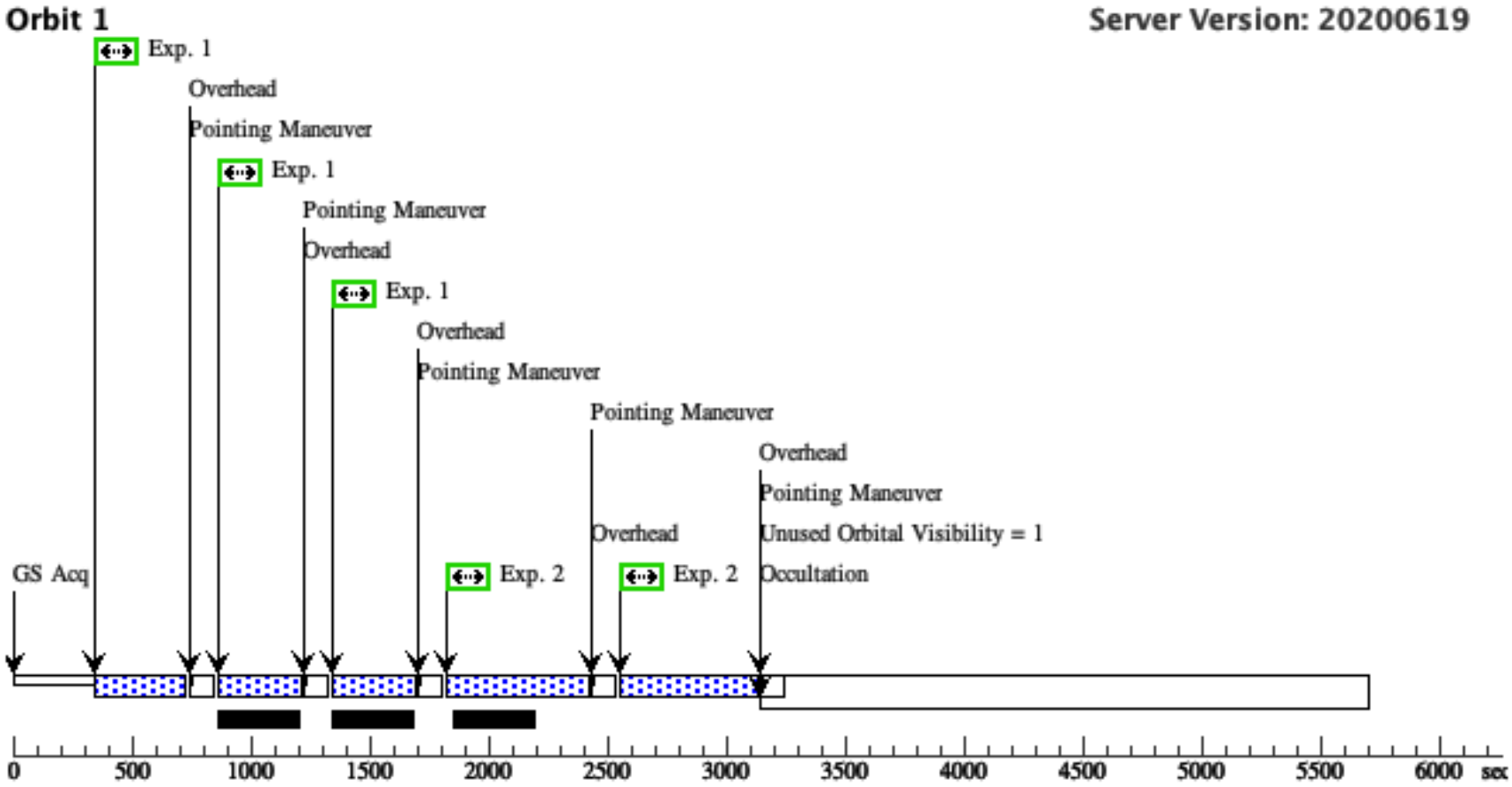
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0048-0046	RA: 00 48 46.4562 (12.1935675d) Dec: -00 46 11.96 (-.76999d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.94	V=21.27+/-.13	Reference Frame: ICRS

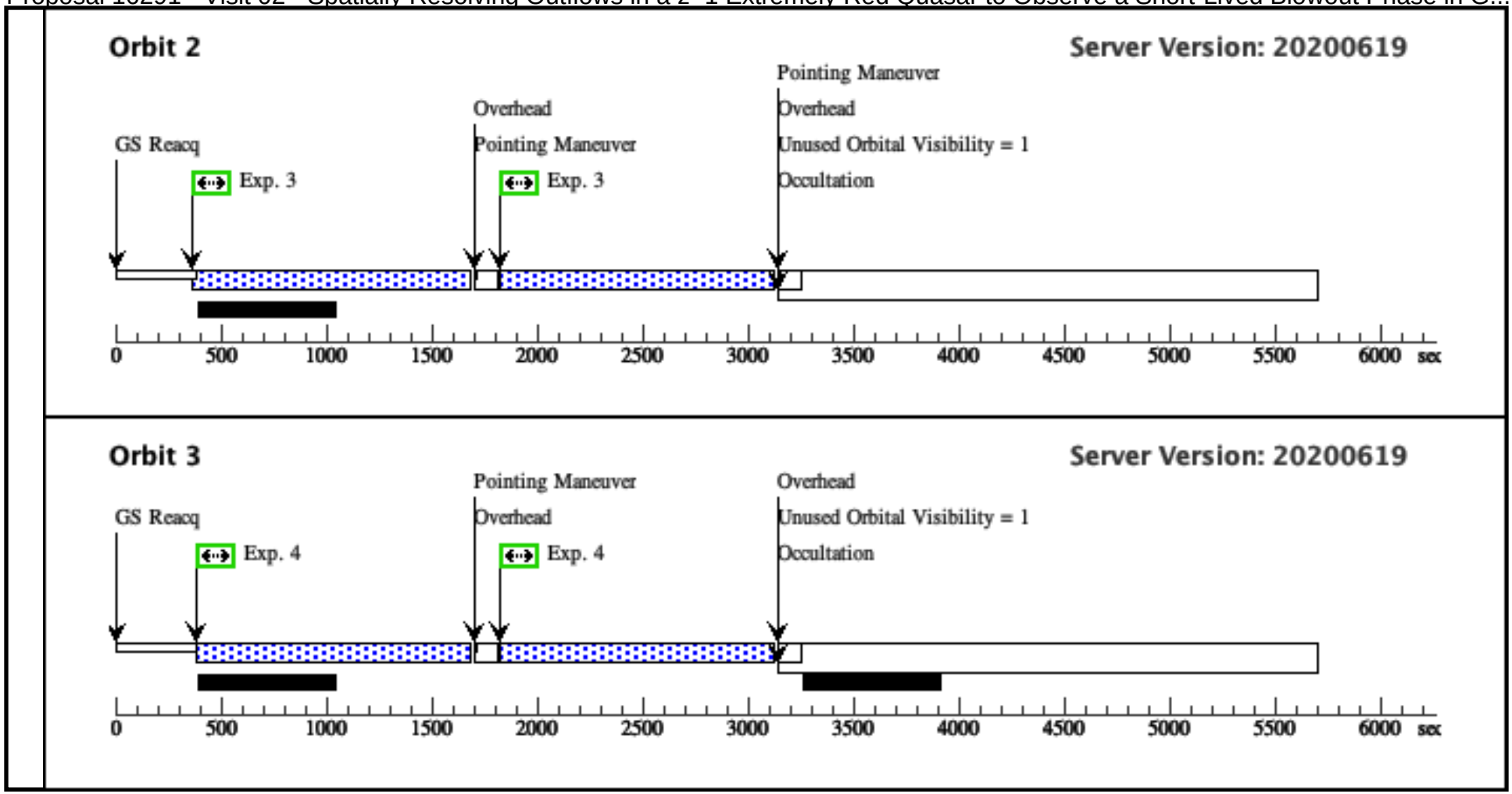
Comments:
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F606W		POS TARG +.5,+.5	Pattern 3, Exps 1-1 in Visit 02 (3)	450 Secs (1059 Secs) *[==>353.0 Secs (Pattern 1)]* *[==>353.0 Secs (Pattern 2)]* *[==>353.0 Secs (Pattern 3)]*	***[1]***
2		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F814W		POS TARG +.5,+.5	Pattern 2, Exps 2-2 in Visit 02 (2)	675 Secs (1156 Secs) *[==>578.0 Secs (Pattern 1)]* *[==>578.0 Secs (Pattern 2)]*	***[1]***
3		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG +.5,+.5	Pattern 2, Exps 3-3 in Visit 02 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[2]***
4		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG +.5,+.5	Pattern 2, Exps 4-4 in Visit 02 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[3]***

Orbit Structure

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Pointing Maneuver
Exp. 3
Pointing Maneuver
Overhead
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Orbit 3
Server Version: 20200619
GS Reacq
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
Overhead
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Visit

Proposal 16291, Visit 03, scheduling Tue Jun 22 15:02:05 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 3 (Pattern 2, Exps 3-3 in Visit 03)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(Exposure 4 (Pattern 2, Exps 4-4 in Visit 03)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3), (4)
(3)	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		(1)

Fixed Targets

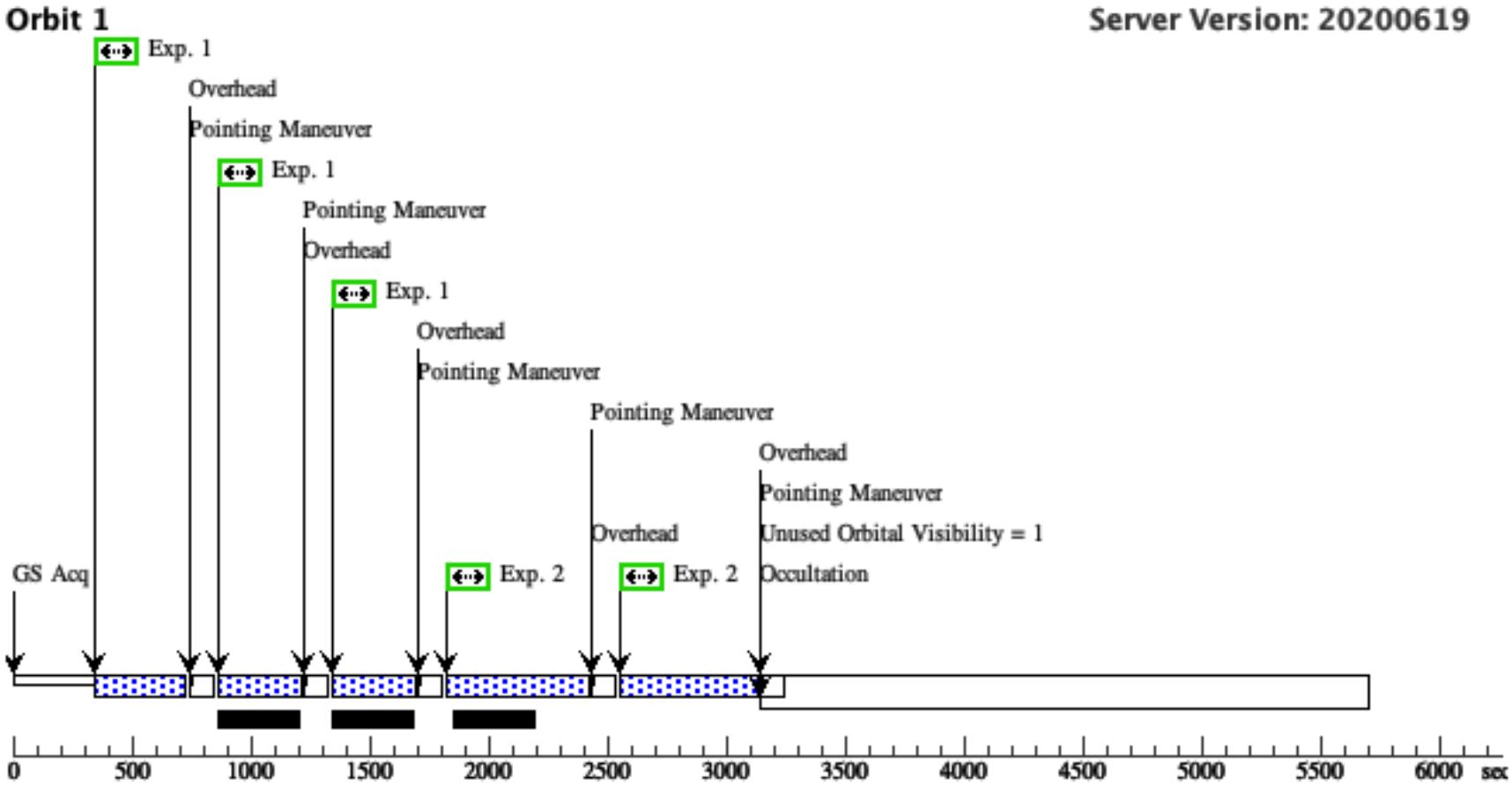
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0048-0046	RA: 00 48 46.4562 (12.1935675d) Dec: -00 46 11.96 (-.76999d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.94	V=21.27+/-.13	Reference Frame: ICRS

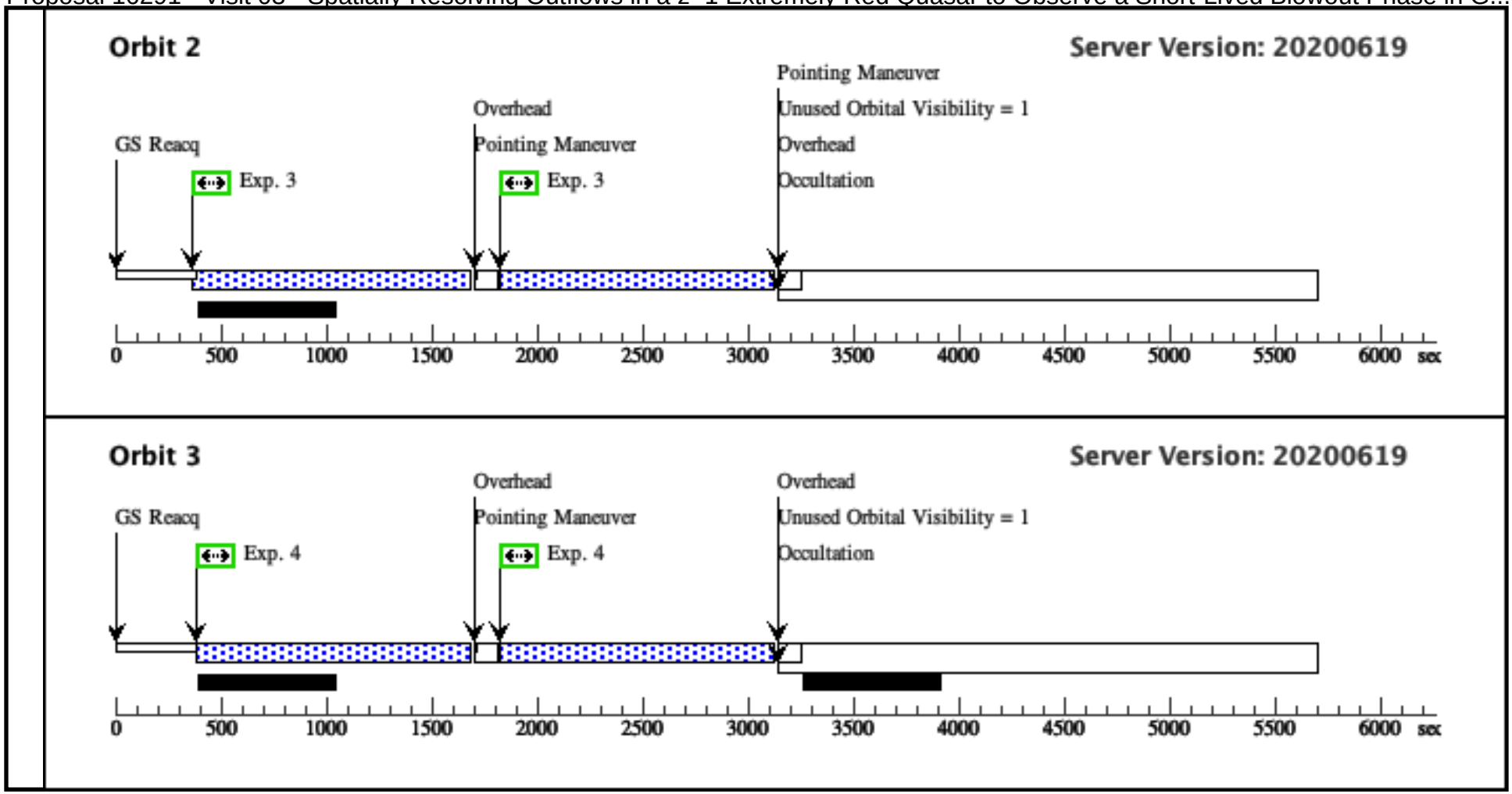
Comments:
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F606W		POS TARG -.5,-.5	Pattern 3, Exps 1-1 in Visit 03 (3)	450 Secs (1059 Secs) *[==>353.0 Secs (Pattern 1)]* *[==>353.0 Secs (Pattern 2)]* *[==>353.0 Secs (Pattern 3)]*	***[1]***
2		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F814W		POS TARG -.5,-.5	Pattern 2, Exps 2-2 in Visit 03 (2)	675 Secs (1156 Secs) *[==>578.0 Secs (Pattern 1)]* *[==>578.0 Secs (Pattern 2)]*	***[1]***
3		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG -.5,-.5	Pattern 2, Exps 3-3 in Visit 03 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[2]***
4		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG -.5,-.5	Pattern 2, Exps 4-4 in Visit 03 (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[3]***

Orbit Structure

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Occultation
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GS Reacq
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Pointing Maneuver
Exp. 4
Overhead
Unused Orbital Visibility = 1
Occultation
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Visit

Proposal 16291, visit 1 copy (04) Tue Jun 22 15:02:05 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 2 (Pattern 2, Exps 2-2 in visit 1 copy (04))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(Exposure 3 (Pattern 2, Exps 3-3 in visit 1 copy (04))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3)

Fixed Targets

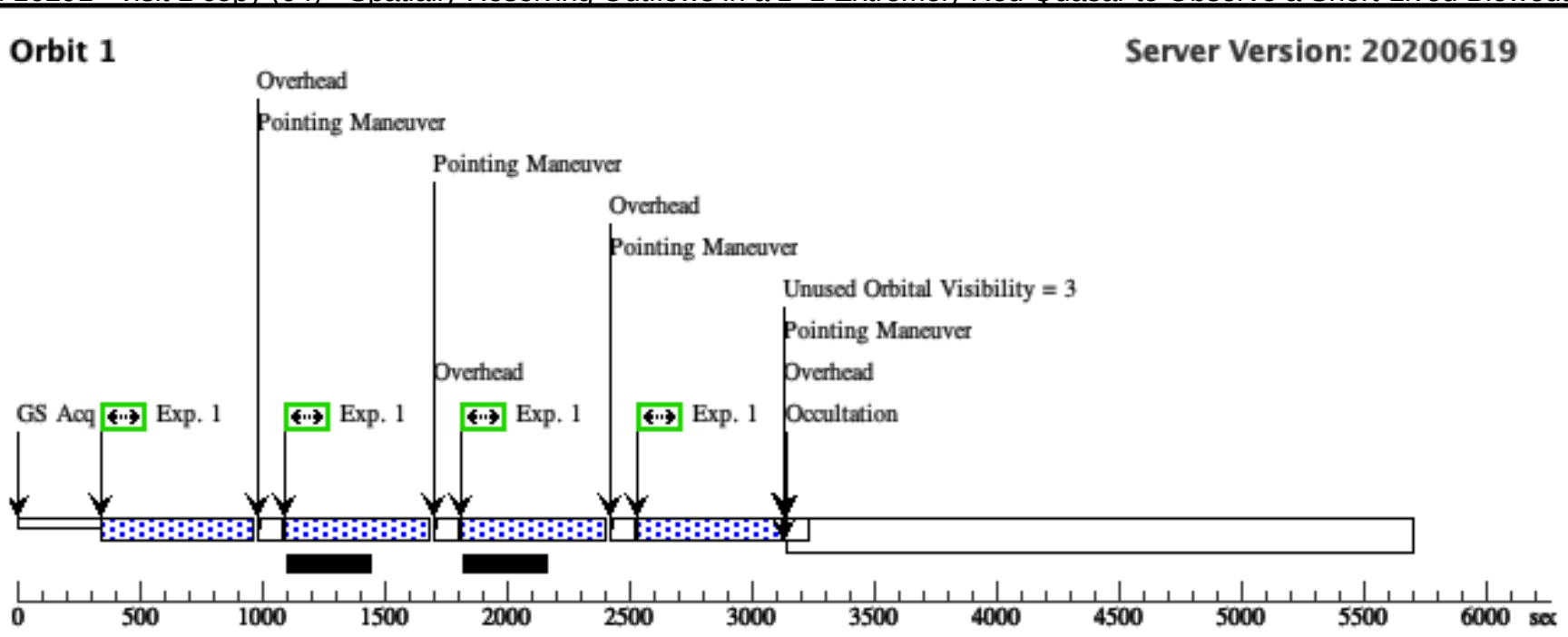
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0048-0046	RA: 00 48 46.4562 (12.1935675d) Dec: -00 46 11.96 (-.76999d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.94	V=21.27+/-.13	Reference Frame: ICRS

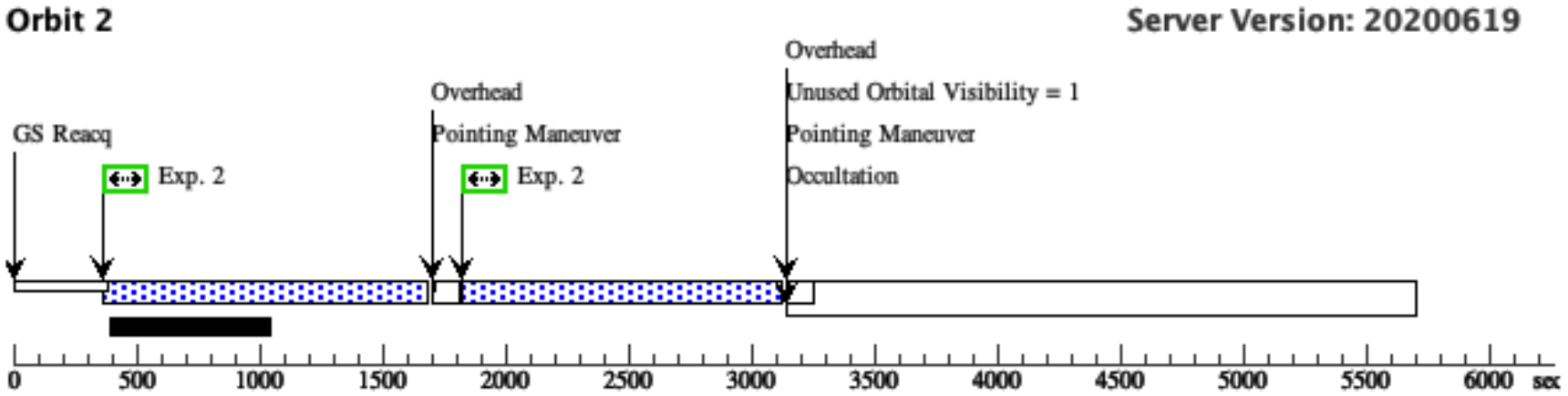
Comments:
Category=GALAXY
Description=[QUASAR]
Extended=YES

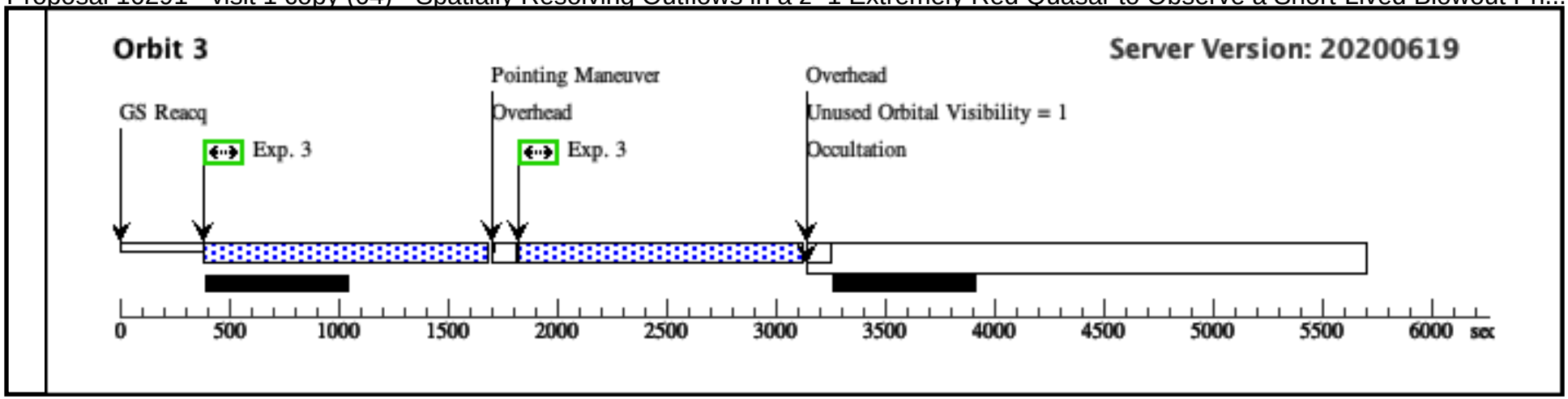
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F606W			Pattern 1, Exps 1-1 in visit 1 copy (04) (1)	675 Secs (2364 Secs) *[==>591.0 Secs (Pattern 1)]* *[==>591.0 Secs (Pattern 2)]* *[==>591.0 Secs (Pattern 3)]* *[==>591.0 Secs (Pattern 4)]*	***[1]***
2		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16		Pattern 2, Exps 2-2 in visit 1 copy (04) (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[2]***
3		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16		Pattern 2, Exps 3-3 in visit 1 copy (04) (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[3]***

Orbit Structure






Orbit 3
Server Version: 20200619
GS Reacq
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Overhead
Unused Orbital Visibility = 1
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sec

Visit

Proposal 16291, Visit 2 copy (05) Tue Jun 22 15:02:06 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 3 (Pattern 2, Exps 3-3 in Visit 2 copy (05))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(Exposure 4 (Pattern 2, Exps 4-4 in Visit 2 copy (05))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3), (4)
(3)	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		(1)

Fixed Targets

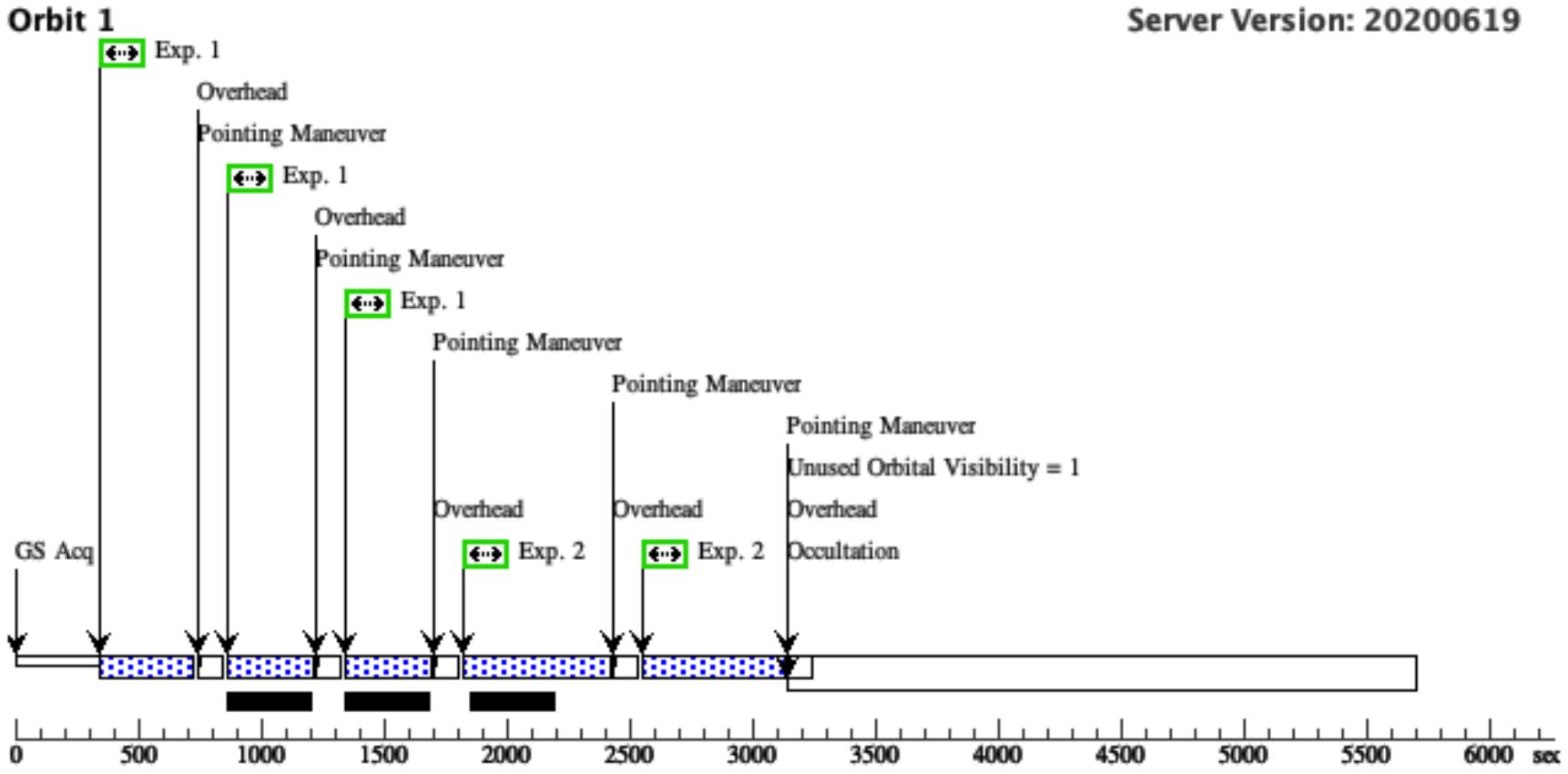
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ0048-0046	RA: 00 48 46.4562 (12.1935675d) Dec: -00 46 11.96 (-.76999d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.94	V=21.27+/-.13	Reference Frame: ICRS

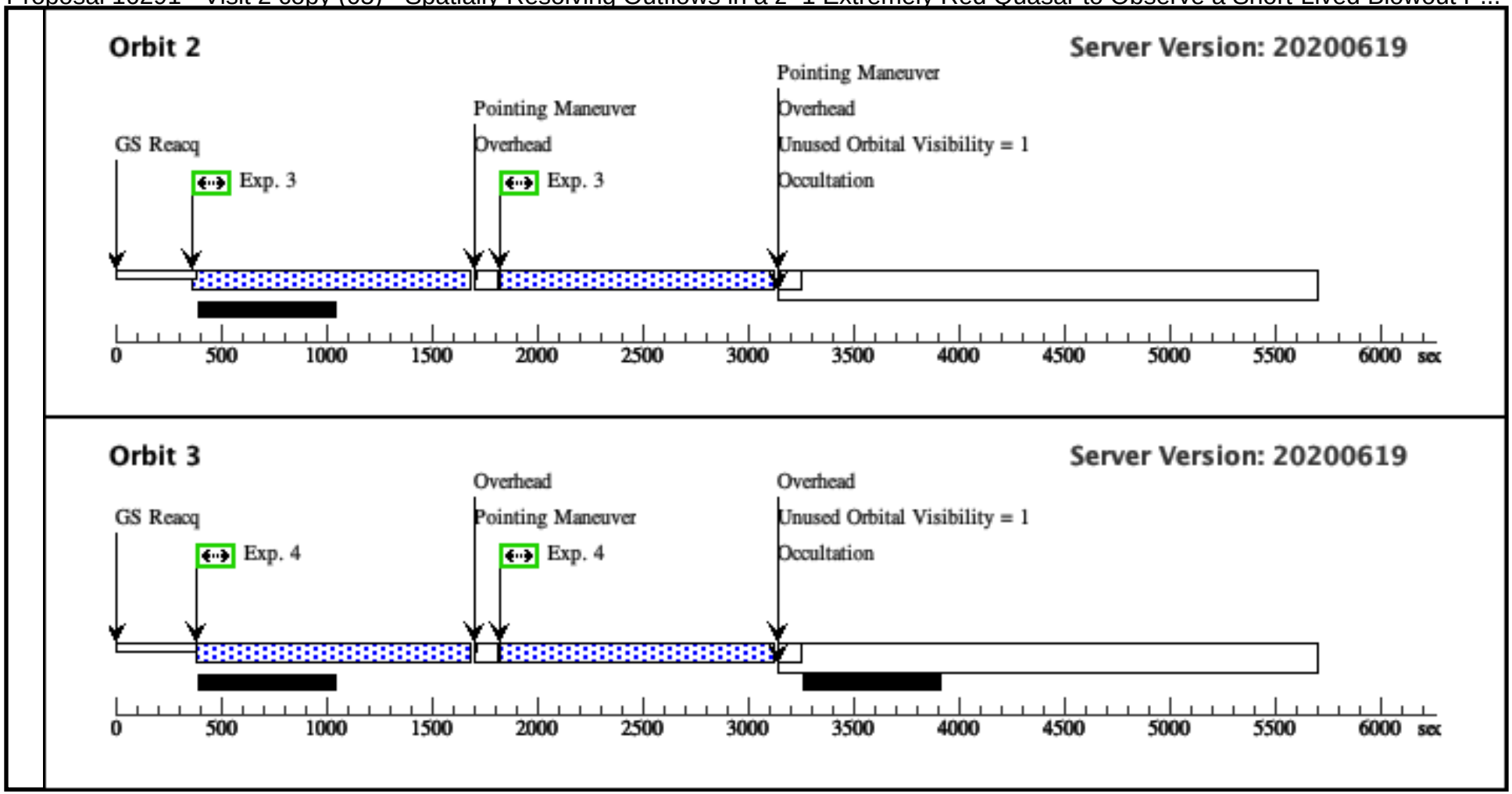
Comments:
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F606W		POS TARG +.5,+.5	Pattern 3, Exps 1-1 in Visit 2 copy (05) (3)	450 Secs (1059 Secs) *[==>353.0 Secs (Pattern 1)]* *[==>353.0 Secs (Pattern 2)]* *[==>353.0 Secs (Pattern 3)]*	***[1]***
2		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F814W		POS TARG +.5,+.5	Pattern 2, Exps 2-2 in Visit 2 copy (05) (2)	675 Secs (1156 Secs) *[==>578.0 Secs (Pattern 1)]* *[==>578.0 Secs (Pattern 2)]*	***[1]***
3		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG +.5,+.5	Pattern 2, Exps 3-3 in Visit 2 copy (05) (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[2]***
4		(1) SDSSJ0048-0046	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F657N	FLASH=16	POS TARG +.5,+.5	Pattern 2, Exps 4-4 in Visit 2 copy (05) (2)	1350 Secs (2604 Secs) *[==>1302.0 Secs (Pattern 1)]* *[==>1302.0 Secs (Pattern 2)]*	***[3]***

Orbit Structure




Orbit 2
Server Version: 20200619
GS Reacq
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Pointing Maneuver
Overhead
Unused Orbital Visibility = 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec
Orbit 3
Server Version: 20200619
GS Reacq
Exp. 4
Overhead
Pointing Maneuver
Exp. 4
Overhead
Unused Orbital Visibility = 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec