12980 - Absolute Measurement of the Cosmic Near-Infrared Background Using Eclipsed Galilean Satellites as Occulters

Cycle: 20, 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) EUROPA-OFFSET	WFC3/IR	1	20-Feb-2014 21:01:23.0	yes
02	(5) GANYMEDE-3	WFC3/IR	1	20-Feb-2014 21:01:33.0	yes
03	(3) GANYMEDE-2	WFC3/IR	1	20-Feb-2014 21:01:40.0	yes
04	(6) EUROPA-OFFSET2	WFC3/IR	1	20-Feb-2014 21:01:48.0	yes
05	(7) EUROPA-OFFSET3	WFC3/IR	1	20-Feb-2014 21:01:56.0	yes

5 Total Orbits Used

ABSTRACT

The Cosmic Infrared Background (CIB) as an integrated history of the early universe is important for the study of the Dark Ages, and it may include the light from the first stars at z~10. However, previous CIB measurements suffer from residual contamination from strong foreground emission (e.g. the zodiacal light). We propose to observe two Galilean satellites eclipsed in the shadow of Jupiter as occulting disks at near-infrared wavelengths in order to detect the absolute CIB intensity without any zodiacal light subtraction error. The zodiacal light originates inside the orbit of Jupiter; since the Galilean satellites in eclipse shield all light beyond the Jovian orbit, they should be detected as 'dark spots' if the strong CIB implied by previous observations exists. The intensity deficit of this dark spot relative to the surrounding sky directly measures the strength of the CIB, free from any assumptions about the zodiacal light. The size of the dark spot is approximately 1 arcsec in diameter and the predicted surface brightness is 70 nW/m2/sr lower than that of surrounding sky brightness, which can be detected by WFC3 IR imaging with F140W filter for two orbits integration with S/N=10 even in the strong Jovian stray light environment.

OBSERVING DESCRIPTION

The greatest difficulty in this observation results from scattered light due to the close proximity of Jupiter to the target satellites (< 80 arcseconds). According to our estimation, leak energy from encircled energy at 30 arcsec is 0.04%, and Jovian stray light at 30 arcsec is about 5 times brighter than the zodiacal light. Therefore, we will keep Jupiter out of the detector field of view (FoV) during the observation to avoid stray light from Jupiter (Jupiter is 20 magnitudes brighter than the eclipsed satellites). Observations will be conducted with non-sidereal tracking on Jupiter (outside of the FoV) to fix the stray light pattern on the detector array during the observation. This will minimize the systematic error of the Jovian stray light. Since the relative speed of the target satellites vs. Jupiter is ~0.005 arcsec/sec, we use an observing mode of SPARS=25 and NSAMP=14. In this case, the image of target satellite will be smeared because of its movement and non-destructive readouts of the detecter. Therefore, we will reconstruct the image by calculating [Nth - (N-1)th] frames and conducting the "shift and add".

Letting the eclipsed satellite move relative to the detector using Jupiter tracking has the advantage of effectively dithering the observations so that we can average out any detector issues such as scattered earthlight, structure in the darks, and the dark features called "blobs" in particular (the latter are believed to result from debris on the pick-off optics). We emphasize that we know the satellite ephemeri with great precision; the size and location of the eclipsed satellite will be accurately known, and therefore easily differentiated from detector effects. We need to put the target sattelite at the specific area on the detector to avoid the 'Death Star', the 'Wagon Wheel', and the spider pattern from the Jupiter.

We request two orbits for the eclipse observations themselves, and another two orbits in order to re-image the same field observations once the

Jupiter system has passed. This latter data will allow a measurement of any diffuse foreground galaxies which might contaminate the dark spot observation.

REAL TIME JUSTIFICATION

Since our method relies on specific astronomical events, chances for observation are limited and timing is absolutely critical; in particular, the eclipse observations must begin at the specified time.

We have decided not to observe first two minutes from the beginning of the eclipse due to potential complications from latents arising from the target when it is illuminated by sunlight. Similarly, the observations must be scheduled to avoid slewing over Jupiter.

We do not want to see the Jupiter even during the maneuver for pointing to prevent from the potential complications from latents.

Visit

Proposal 12980, Europa eclipse (01), completed Fri Feb 21 02:02:05 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

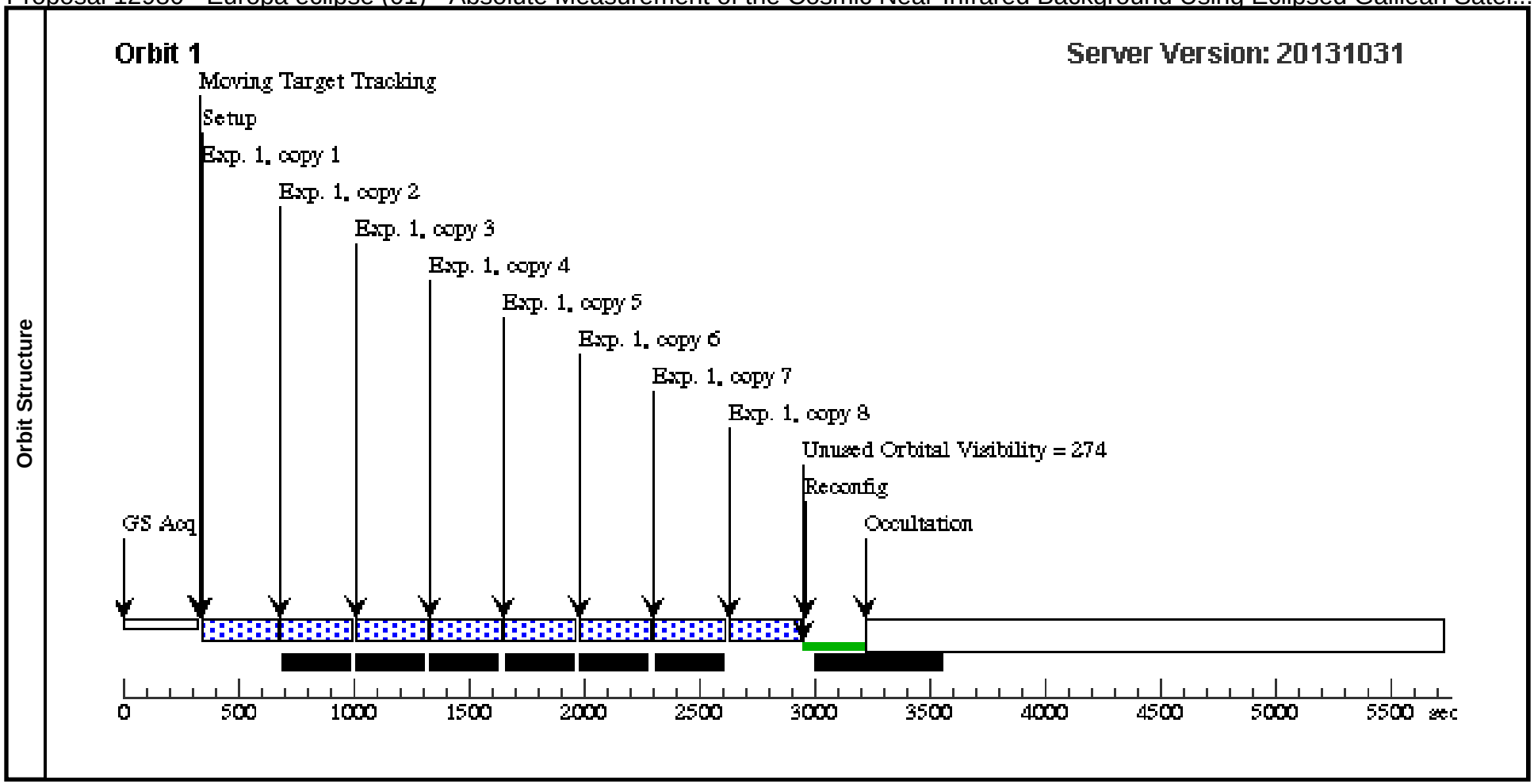
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	EUROPA-OFFSET	STD=JUPITER	TYPE=POS_ANGLE,RAD=93,ANG=62,REF=NORTH		SEP OF EUROPA JUPITER FROM EARTH GT 5", SEP OF EUROPA CALLISTO FROM EARTH GT 30", SEP OF EUROPA GANYMEDE FROM EARTH GT 30", SEP OF EUROPA IO FROM EARTH GT 15", ECL U OF EUROPA BY JUPITER	EARTH

Comments: Target is Europa eclipsed by Jupiter. Visit will be tracking on Jupiter and using a position angle and radius to offset to Europa.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) EUROPA-OFFSET	WFC3/IR, MULTIACCUM, IR	F139M	NSAMP=13; SAMP-SEQ=SPARS25	GS ACQ SCENARIO BASE1B3		302.938471 Secs X 8 (2423.508 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***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Server Version: 20131031
Moving Target Tracking
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Exp. 1, copy 2
Exp. 1, copy 3
Exp. 1, copy 4
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Exp. 1, copy 6
Exp. 1, copy 7
Exp. 1, copy 8
Unused Orbital Visibility = 274
Reconfig
Occultation
GS Acq
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 12980, Ganymede eclipse (02), completed Fri Feb 21 02:02:07 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

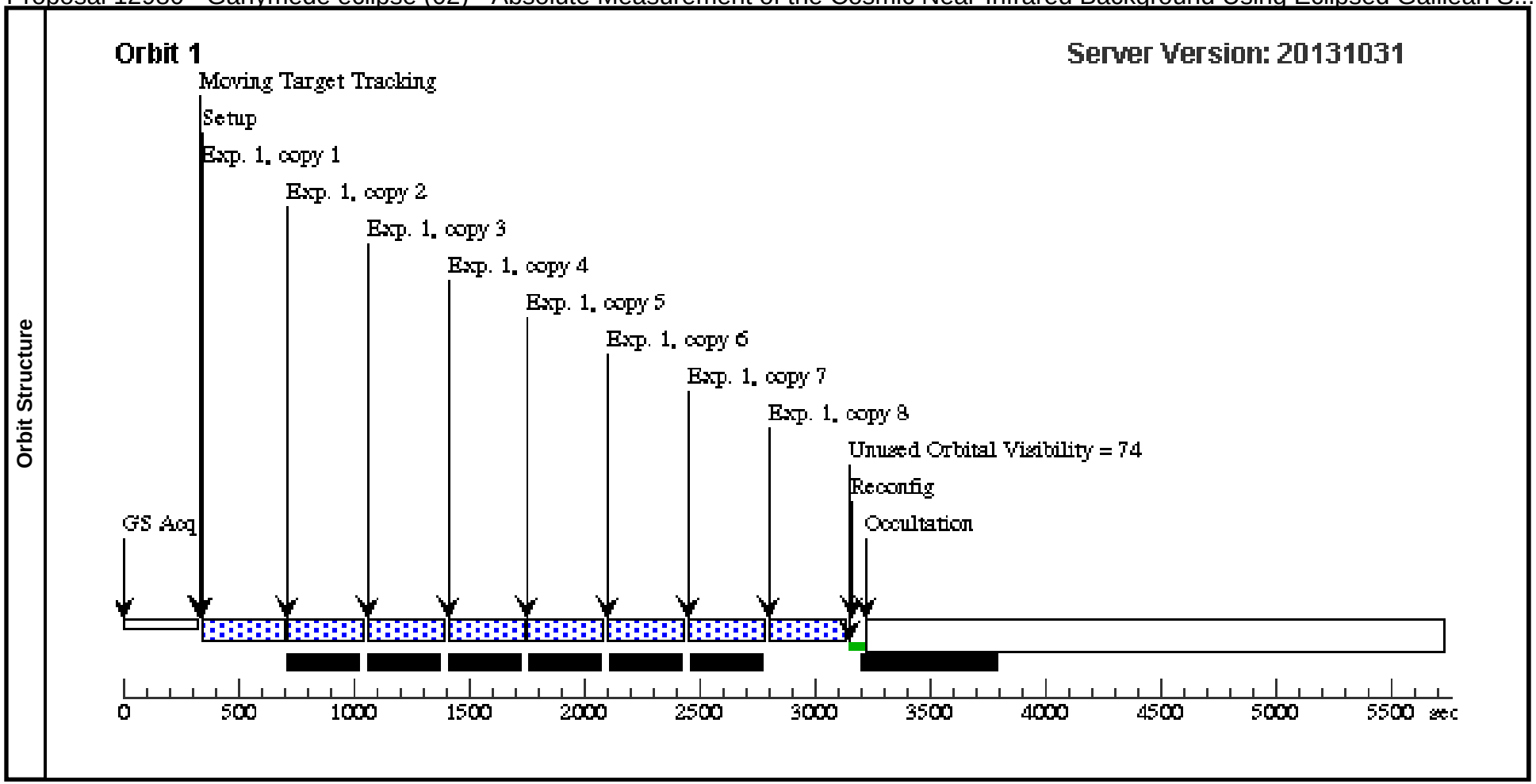
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(5)	GANYMEDE-3	STD=JUPITER	STD=GANYMEDE		SEP OF GANYMEDE-3 JUPITER FROM EARTH GT 30", SEP OF GANYMEDE-3 CALLISTO FROM EARTH GT 30", SEP OF GANYMEDE-3 IO FROM EARTH GT 30", SEP OF GANYMEDE-3 EUROPA FROM EARTH GT 24", ECL U OF GANYMEDE-2 BY JUPITER	EARTH

Comments: Target is Ganymede eclipsed by Jupiter.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) GANYMEDE-3	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPARS25			327.938986 Secs X 8 (2623.512 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***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Server Version: 20131031
Moving Target Tracking
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Exp. 1, copy 8
Unused Orbital Visibility = 74
Reconfig
Occultation
GS Acq
0
500
1000
1500
2000
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3000
3500
4000
4500
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5500
sec

Visit

Proposal 12980, Ganymede eclipse 2 (03), completed Fri Feb 21 02:02:08 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

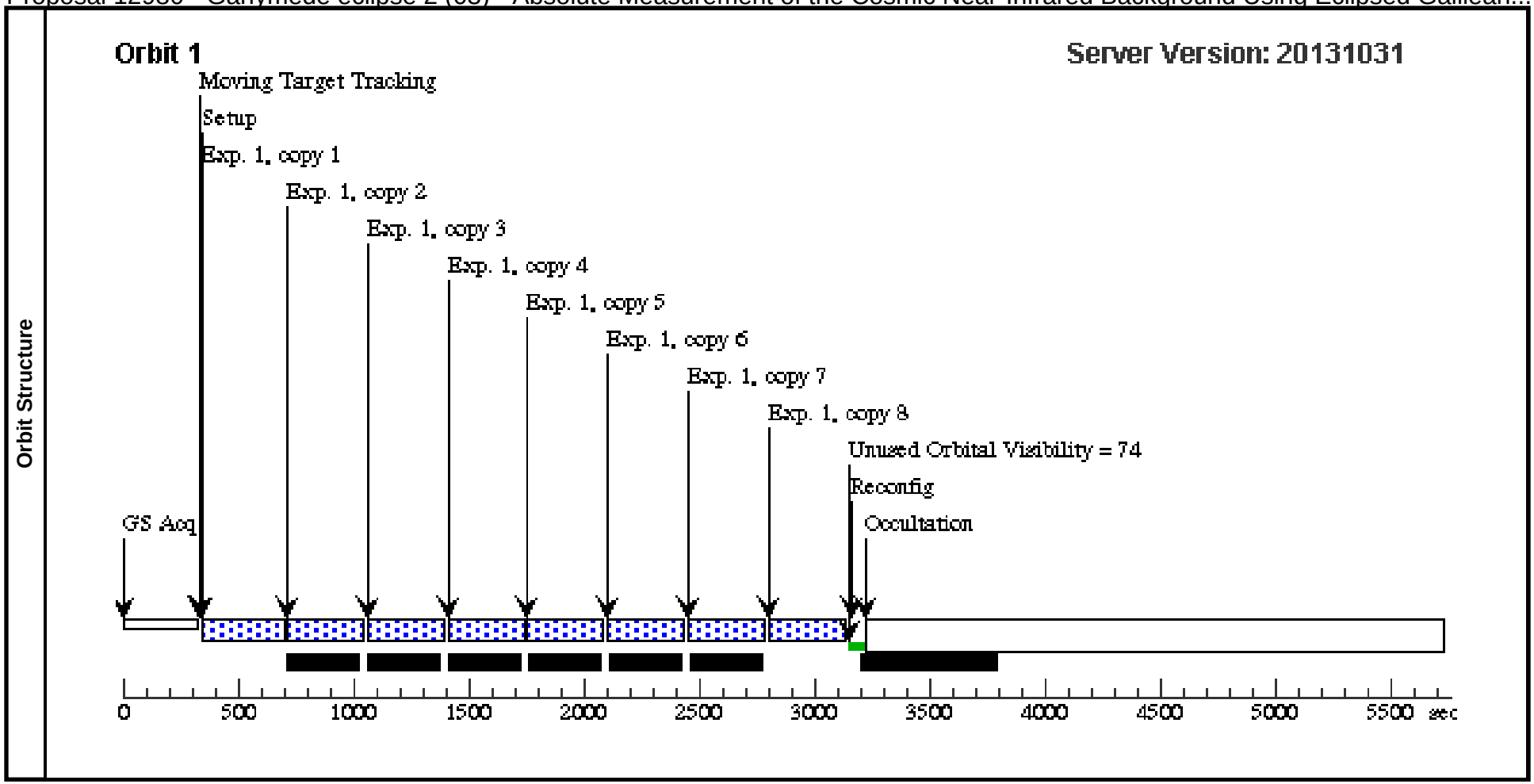
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(3)	GANYMEDE-2	STD=JUPITER	TYPE=POS_ANGLE,RAD=100,ANG=55,REF=NORTH		ECL U OF GANYMEDE-2 BY JUPITER, SEP OF GANYMEDE-2 CALLISTO FROM EARTH GT 10", SEP OF GANYMEDE-2 IO FROM EARTH GT 10", SEP OF GANYMEDE-2 EUROPA FROM EARTH GT 10"	EARTH

Comments: Target is Ganymede eclipsed by Jupiter.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) GANYMEDE-2	WFC3/IR, MULTIACCUM, IR	F139M	NSAMP=14; SAMP-SEQ=SPARS25			327.938986 Secs X 8 (2623.512 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***


Orbit Structure
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Server Version: 20131031
Moving Target Tracking
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Exp. 1, copy 3
Exp. 1, copy 4
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Exp. 1, copy 6
Exp. 1, copy 7
Exp. 1, copy 8
Unused Orbital Visibility = 74
Reconfig
Occultation
GS Acq
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500
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Visit

Proposal 12980, Europa eclipse 2 (04), failed Fri Feb 21 02:02:09 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 255D TO 255 D

Solar System Targets

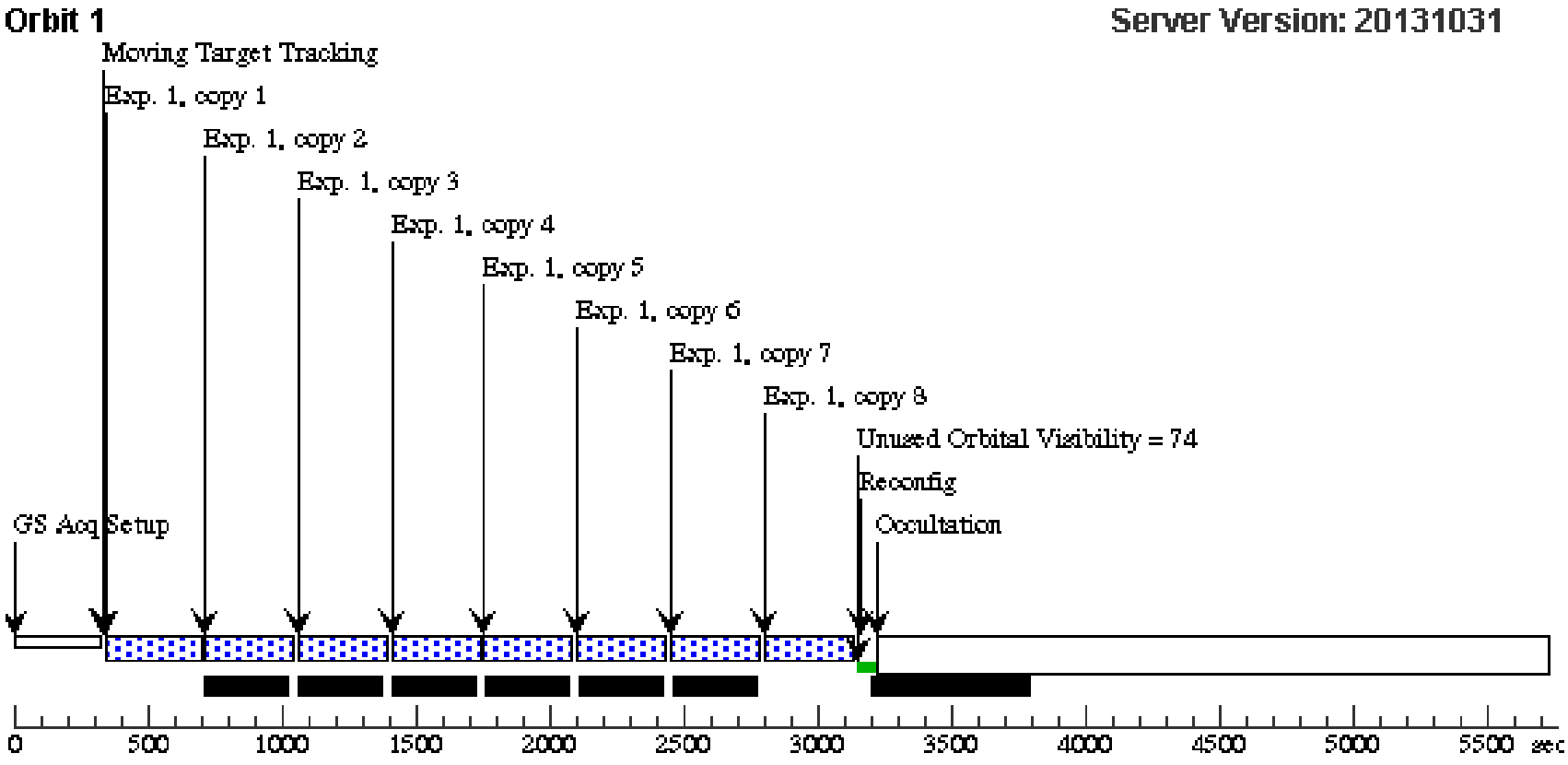
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(6)	EUROPA-OFFSET2	STD=JUPITER	TYPE=POS_ANGLE,RAD=105,ANG =280,REF=NORTH		SEP OF EUROPA JUPITER FROM EARTH GT 10", SEP OF EUROPA CALLISTO FROM EARTH GT 30", SEP OF EUROPA GANYMEDE FROM EARTH GT 30", SEP OF EUROPA IO FROM EARTH GT 15", ECL U OF EUROPA BY JUPITER	EARTH

Comments: Target is Europa eclipsed by Jupiter. Visit will be tracking on Jupiter and using a position angle and radius to offset to Europa.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(6) EUROPA-OFFSET2	WFC3/IR, MULTIACCUM, IR	F139M	NSAMP=14; SAMP-SEQ=SPARS25			327.938986 Secs X 8 (2623.512 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***

Orbit Structure



Visit

Proposal 12980, Europa eclipse 2 (05), implementation Fri Feb 21 02:02:10 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 117D TO 117 D

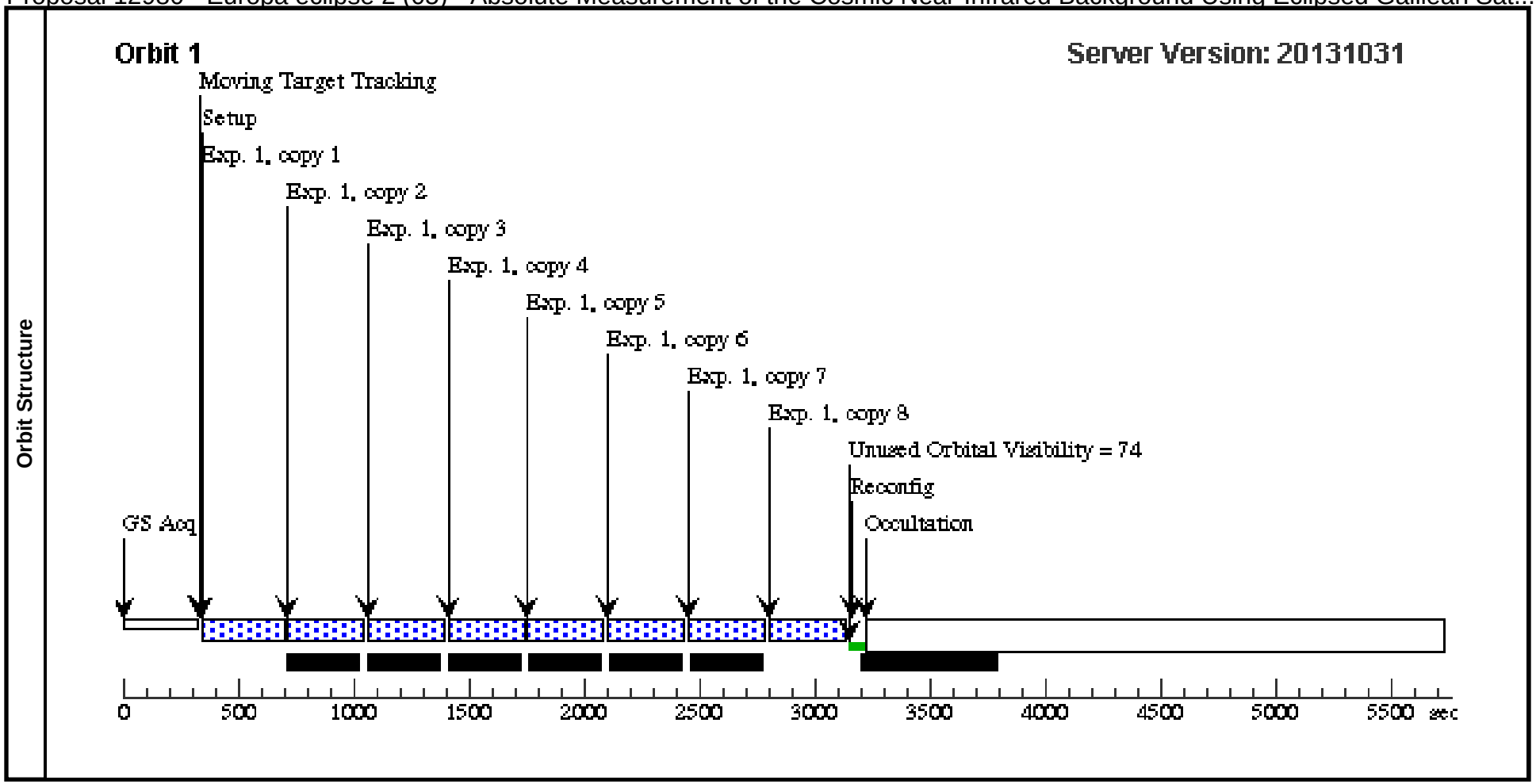
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(7)	EUROPA-OFFSET3	STD=JUPITER	TYPE=POS_ANGLE,RAD=95,ANG=80,REF=NORTH		SEP OF EUROPA JUPITER FROM EARTH GT 10", SEP OF EUROPA CALLISTO FROM EARTH GT 30", SEP OF EUROPA GANYMEDE FROM EARTH GT 30", SEP OF EUROPA IO FROM EARTH GT 15", ECL U OF EUROPA BY JUPITER	EARTH

Comments: Target is Europa eclipsed by Jupiter. Visit will be tracking on Jupiter and using a position angle and radius to offset to Europa.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(7) EUROPA-OFFSET3	WFC3/IR, MULTIACCUM, IR	F139M	NSAMP=14; SAMP-SEQ=SPARS25			327.938986 Secs X 8 (2623.512 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20131031
Moving Target Tracking
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Exp. 1, copy 1
Exp. 1, copy 2
Exp. 1, copy 3
Exp. 1, copy 4
Exp. 1, copy 5
Exp. 1, copy 6
Exp. 1, copy 7
Exp. 1, copy 8
Unused Orbital Visibility = 74
Reconfig
Occultation
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