13805 - Io's Atmosphere Silhouetted in Transit by Jupiter Lyman-alpha

Cycle: 22, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

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) IO (2) EUROPA	STIS/CCD STIS/FUV-MAMA	1	23-Dec-2014 21:05:31.0	yes
02	(1) IO (2) EUROPA	STIS/CCD STIS/FUV-MAMA	1	23-Dec-2014 21:05:33.0	yes
03	(1) IO (2) EUROPA	STIS/CCD STIS/FUV-MAMA	1	23-Dec-2014 21:05:34.0	yes
04	(1) IO (2) EUROPA	STIS/CCD STIS/FUV-MAMA	1	23-Dec-2014 21:05:36.0	yes

4 Total Orbits Used

ABSTRACT

Io's active volcanos both directly establish local gas plumes and indirectly establish a more global sublimation atmosphere, through plume deposited sulfur dioxide frost patches. Despite decades of study and recent observational advances the very basic question about the relative role of each of these sources is unresolved. The correlation between volcanic activity variability and Io's dramatic influence on numerous time-variable phenomenon in the Jupiter system cannot be causally linked until this answer is in hand. Our experienced team has developed a novel approach to use STIS in a new way to obtain global radial profiles of SO2 scale height distributions above both plume and sublimation dominated regions. We exploit the bright Lyman-alpha dayglow of Jupiter as a background illumination source together with the strongly absorptive nature of SO2 at 121.6 nm to image Io's atmosphere in silhouette with unprecedented detail during transit events. Our program provides the following key information for SO2: 1) First high-altitude (>400 km) radial measurements of tangential column densities and scale heights; 2) First clear measurement of sublimation densities at polar locations; 3) Volcanic densities for large and mid-sized plumes (possibly new ones); 4) Globally distributed limb profiles allowing strong distinctions between plume and sublimation dominated locations; 5) Repeated imaging on a few day and a few week timescales for improved plume variability constraints; and 6) Lyman-alpha reflectance imaging at Io central lon. ~180 deg, filling a gap in previous coverage. These new information are critical to breaking through an impasse in our understanding of Io's atmosphere.

OBSERVING DESCRIPTION

Io transits Jupiter during each of 4 requested visits with one HST orbit each. The STIS G140M mode is used with the 52"x2" slit, which completely images the 1.16" disk of Io and its surrounding gas. Central wavelength 1222A selects the Lyman-alpha feature at 121.6 nm within its 119.4-124.9 nm range. The medium resolution mode dispersion is needed for spectral purity compared with STIS G140L, and diminishes potential confusion from nearby Jupiter continuum, Io aurora, and plasma torus features.

Four visits with 1 orbit each are needed to search for plume density variability. To achieve the goal of constraining the timescales for variability in plume gas densities, two visits should be separated by a few days near Jupiter opposition and one additional visit each should be separated by ~3 weeks before and after opposition, respectively.

The proximity to Jupiter opposition in Feb. 2015 both maximizes the spatial resolution and reduces the contribution of foreground geocoronal Lyman-alpha background signals, as the geometry is aligned with Earth shadow. Observations within a few weeks of opposition (February 5, 2015) hence maximize both the size of Io and the amount of time in Earth's shadow, reducing the background from terrestrial airglow emission from ~10-15

kR to instead ~2.5-4 kR.

An essential requirement is to capture Io while in transit near Jupiter's central meridian.

Visit

Proposal 13805, IO-TRANSIT (01), implementation Wed Dec 24 02:05:37 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 01-JAN-2015:00:00:00 AND 12-MAR-2015:00:00:00

Comments: Highest accuracy guide-star tracking is desired. Consider minimizing BUFFER time down from 600 sec to reduce time lost between exposures.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IO	STD=JUPITER	STD=IO		TRANSIT OF IO ACROSS JUPITER FROM EARTH, SEP OF IO CALLISTO FROM EARTH GT 2", SEP OF IO EUROPA FROM EARTH GT 2", SEP OF IO GANYMEDE FROM EARTH GT 2", SIZE IO GT 1.0	EARTH

Comments: Io is targeted while it transits the disc of Jupiter. An ideal program would further constrain one visit/orbit to occur when Io is located exactly in the center of the plasma torus, i.e. with sub-Jupiter system III latitude of 0 deg (i.e., CML=110 deg or 290 deg) and the other three visits to occur when Io is located at the extrema of the torus (i.e., CML=20 deg or 200 deg). Torus proton charge exchange induced auroral Lyman-alpha is expected to contribute a signal of 200-500 R in the same above limb region (Trafton, AJ, 2000). One orbit at low latitudes when the charge exchange rates are highest would test this process. The scheduling odds are good that this distribution would occur by happenstance, and so specific observing windows are not included for this 'nice-to-have' constraint. However, no more than two of the four visits should occur with Io at low magnetic latitudes, so that our primary SO2 attenuation measurement are not compromised.

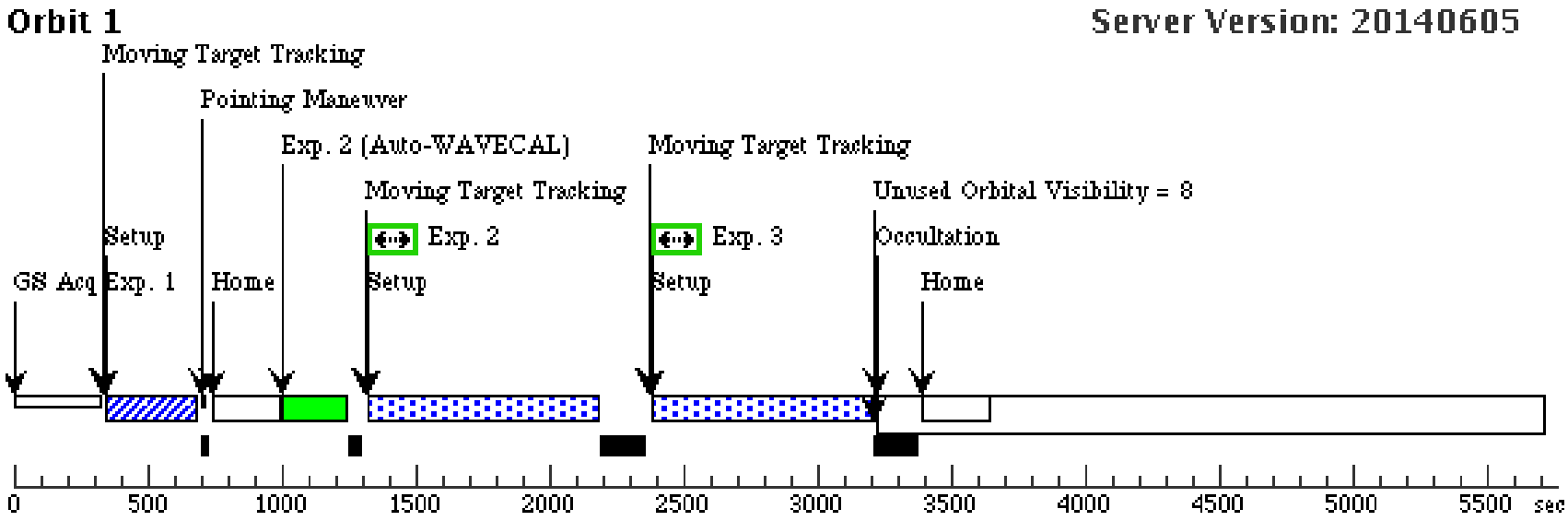
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	EUROPA	STD=JUPITER	STD=EUROPA		NOT TRANSIT OF EUROPA ACROSS JUPITER FROM EARTH, NOT ECL U OF EUROPA BY JUPITER, SEP OF EUROPA JUPITER FROM EARTH GT 2", SEP OF EUROPA CALLISTO FROM EARTH GT 2", SEP OF EUROPA GANYMEDE FROM EARTH GT 2"	EARTH

Comments: For target acquisition when Io is in Jupiter transit.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.sp.620458)	(2) EUROPA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=19; DIFFUSE-CENTER=GEOMETRIC-CENTER			0.1 Secs (0.1 Secs) *[==>]*	 ***[1]***
	Comments: Satellite can be changed to Ganymede or Callisto (Target GANYMEDE-ACQ / CALLISTO-ACQ) if more suitable for acquisition. The CHECKBOX parameter needs to be changed to 27 (GANYMEDE) or 25 (CALLISTO).								
2	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 13805, IO-TRANSIT (02), implementation Wed Dec 24 02:05:37 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 01-JAN-2015:00:00:00 AND 12-MAR-2015:00:00:00

Comments: Highest accuracy guide-star tracking is desired. Consider minimizing BUFFER time down from 600 sec to reduce time lost between exposures.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IO	STD=JUPITER	STD=IO		TRANSIT OF IO ACROSS JUPITER FROM EARTH, SEP OF IO CALLISTO FROM EARTH GT 2", SEP OF IO EUROPA FROM EARTH GT 2", SEP OF IO GANYMEDE FROM EARTH GT 2", SIZE IO GT 1.0	EARTH

Comments: Io is targeted while it transits the disc of Jupiter. An ideal program would further constrain one visit/orbit to occur when Io is located exactly in the center of the plasma torus, i.e. with sub-Jupiter system III latitude of 0 deg (i.e., CML=110 deg or 290 deg) and the other three visits to occur when Io is located at the extrema of the torus (i.e., CML=20 deg or 200 deg). Torus proton charge exchange induced auroral Lyman-alpha is expected to contribute a signal of 200-500 R in the same above limb region (Trafton, AJ, 2000). One orbit at low latitudes when the charge exchange rates are highest would test this process. The scheduling odds are good that this distribution would occur by happenstance, and so specific observing windows are not included for this 'nice-to-have' constraint. However, no more than two of the four visits should occur with Io at low magnetic latitudes, so that our primary SO2 attenuation measurement are not compromised.

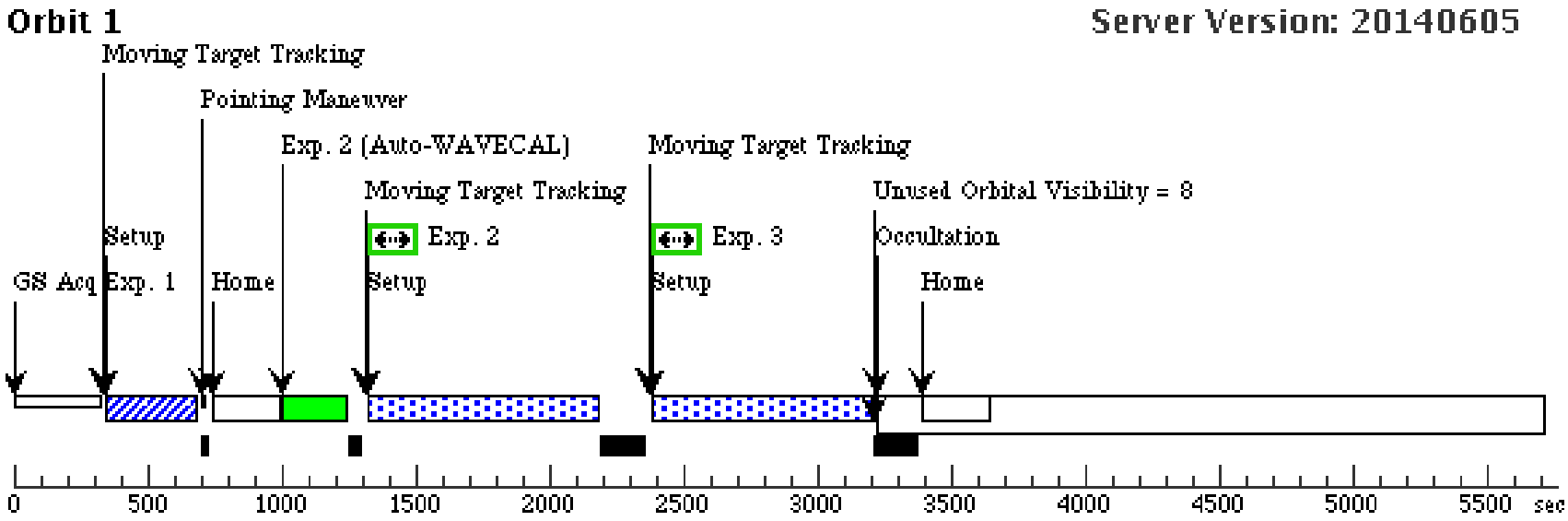
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	EUROPA	STD=JUPITER	STD=EUROPA		NOT TRANSIT OF EUROPA ACROSS JUPITER FROM EARTH, NOT ECL U OF EUROPA BY JUPITER, SEP OF EUROPA JUPITER FROM EARTH GT 2", SEP OF EUROPA CALLISTO FROM EARTH GT 2", SEP OF EUROPA GANYMEDE FROM EARTH GT 2"	EARTH

Comments: For target acquisition when Io is in Jupiter transit.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.sp.620458)	(2) EUROPA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=19; DIFFUSE-CENTER=GEOMETRIC-CENTER	GS ACQ SCENARIO BASE1B3		0.1 Secs (0.1 Secs) *[==>]*	 ***[1]***
Comments: Satellite can be changed to Ganymede or Callisto (Target GANYMEDE-ACQ / CALLISTO-ACQ) if more suitable for acquisition. The CHECKBOX parameter needs to be changed to 27 (GANYMEDE) or 25 (CALLISTO).									
2	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	GS ACQ SCENARIO BASE1B3; QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 13805, IO-TRANSIT (03), implementation Wed Dec 24 02:05:37 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 01-JAN-2015:00:00:00 AND 12-MAR-2015:00:00:00

Comments: Highest accuracy guide-star tracking is desired. Consider minimizing BUFFER time down from 600 sec to reduce time lost between exposures.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IO	STD=JUPITER	STD=IO		TRANSIT OF IO ACROSS JUPITER FROM EARTH, SEP OF IO CALLISTO FROM EARTH GT 2", SEP OF IO EUROPA FROM EARTH GT 2", SEP OF IO GANYMEDE FROM EARTH GT 2", SIZE IO GT 1.0	EARTH

Comments: Io is targeted while it transits the disc of Jupiter. An ideal program would further constrain one visit/orbit to occur when Io is located exactly in the center of the plasma torus, i.e. with sub-Jupiter system III latitude of 0 deg (i.e., CML=110 deg or 290 deg) and the other three visits to occur when Io is located at the extrema of the torus (i.e., CML=20 deg or 200 deg). Torus proton charge exchange induced auroral Lyman-alpha is expected to contribute a signal of 200-500 R in the same above limb region (Trafton, AJ, 2000). One orbit at low latitudes when the charge exchange rates are highest would test this process. The scheduling odds are good that this distribution would occur by happenstance, and so specific observing windows are not included for this 'nice-to-have' constraint. However, no more than two of the four visits should occur with Io at low magnetic latitudes, so that our primary SO2 attenuation measurement are not compromised.

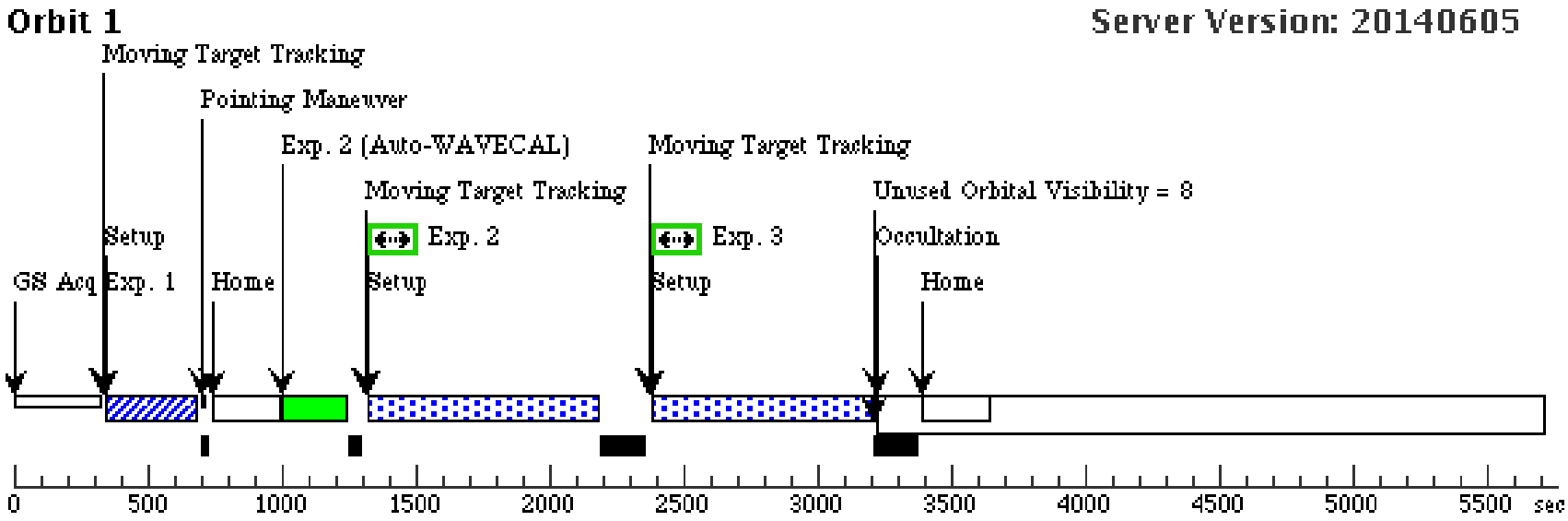
(2)	EUROPA	STD=JUPITER	STD=EUROPA		NOT TRANSIT OF EUROPA ACROSS JUPITER FROM EARTH, NOT ECL U OF EUROPA BY JUPITER, SEP OF EUROPA JUPITER FROM EARTH GT 2", SEP OF EUROPA CALLISTO FROM EARTH GT 2", SEP OF EUROPA GANYMEDE FROM EARTH GT 2"	EARTH

Comments: For target acquisition when Io is in Jupiter transit.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.sp.620458)	(2) EUROPA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=19; DIFFUSE-CENTER=GEOMETRIC-CENTER	GS ACQ SCENARIO BASE1B3		0.1 Secs (0.1 Secs) *[==>]*	 ***[1]***
Comments: Satellite can be changed to Ganymede or Callisto (Target GANYMEDE-ACQ / CALLISTO-ACQ) if more suitable for acquisition. The CHECKBOX parameter needs to be changed to 27 (GANYMEDE) or 25 (CALLISTO).									
2	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	GS ACQ SCENARIO BASE1B3; QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 13805, IO-TRANSIT (04), implementation Wed Dec 24 02:05:37 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 01-JAN-2015:00:00:00 AND 12-MAR-2015:00:00:00

Comments: Highest accuracy guide-star tracking is desired. Consider minimizing BUFFER time down from 600 sec to reduce time lost between exposures.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IO	STD=JUPITER	STD=IO		TRANSIT OF IO ACROSS JUPITER FROM EARTH, SEP OF IO CALLISTO FROM EARTH GT 2", SEP OF IO EUROPA FROM EARTH GT 2", SEP OF IO GANYMEDE FROM EARTH GT 2", SIZE IO GT 1.0	EARTH

Comments: Io is targeted while it transits the disc of Jupiter. An ideal program would further constrain one visit/orbit to occur when Io is located exactly in the center of the plasma torus, i.e. with sub-Jupiter system III latitude of 0 deg (i.e., CML=110 deg or 290 deg) and the other three visits to occur when Io is located at the extrema of the torus (i.e., CML=20 deg or 200 deg). Torus proton charge exchange induced auroral Lyman-alpha is expected to contribute a signal of 200-500 R in the same above limb region (Trafton, AJ, 2000). One orbit at low latitudes when the charge exchange rates are highest would test this process. The scheduling odds are good that this distribution would occur by happenstance, and so specific observing windows are not included for this 'nice-to-have' constraint. However, no more than two of the four visits should occur with Io at low magnetic latitudes, so that our primary SO2 attenuation measurement are not compromised.

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	EUROPA	STD=JUPITER	STD=EUROPA		NOT TRANSIT OF EUROPA ACROSS JUPITER FROM EARTH, NOT ECL U OF EUROPA BY JUPITER, SEP OF EUROPA JUPITER FROM EARTH GT 2", SEP OF EUROPA CALLISTO FROM EARTH GT 2", SEP OF EUROPA GANYMEDE FROM EARTH GT 2"	EARTH

Comments: For target acquisition when Io is in Jupiter transit.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.sp.620458)	(2) EUROPA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=19; DIFFUSE-CENTER=GEOMETRIC-CENTER	GS ACQ SCENARIO BASE1B3		0.1 Secs (0.1 Secs) *[==>]*	 ***[1]***
Comments: Satellite can be changed to Ganymede or Callisto (Target GANYMEDE-ACQ / CALLISTO-ACQ) if more suitable for acquisition. The CHECKBOX parameter needs to be changed to 27 (GANYMEDE) or 25 (CALLISTO).									
2	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	GS ACQ SCENARIO BASE1B3; QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.620458)	(1) IO	STIS/FUV-MAMA, TIME-TAG, 52X2D1	G140M 1222 A	BUFFER-TIME=600	QASISTATES STIS CCD OPERATE OPERATE		800 Secs (800 Secs) *[==>]*	 ***[1]***

Orbit Structure