10578 - Eclipsing Binaries in the Local Group: Calibration of the Zero-point of the Cosmic Distance Scale and Fundamental Properties of Stars in M31

Cycle: 14, Proposal Category: GO

(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?*
11	(1) M31GMOS-01	ACS/SBC	1	27-Sep-2006 21:00:51.0	yes
12	(1) M31GMOS-01	ACS/HRC	1	27-Sep-2006 21:00:56.0	yes
21	(2) M31GMOS-02	ACS/SBC	1	27-Sep-2006 21:00:59.0	yes
22	(2) M31GMOS-02	ACS/HRC	1	27-Sep-2006 21:01:03.0	yes
52	(1) M31GMOS-01	ACS/HRC	1	27-Sep-2006 21:01:07.0	yes

5 Total Orbits Used

ABSTRACT

The Andromeda Galaxy (M31) is potentially a crucial calibrator for the Cosmic Distance Scale, and thus for determining the age and evolution of the Universe. Yet currently the M31 distance modulus (~750 kpc) is is still uncertain to within 0.1-0.15 mag. We have demonstrated in our work on the LMC distance that double-lined eclipsing binaries can serve as excellent "standard candles". Distances derived from eclipsing binaries are basically geometric and essentially free from many assumptions and uncertainties that plague other less direct methods, such as metallicity differences and calibration zeropoints. The absolute radii of the component stars of eclipsing binaries can be determined to better than a few percent from the time-tested analyses of their light and radial velocity curves. With accurate radii and temperatures, it is possible to determine reliable distances. We are extending our program of using eclipsing binaries as standard candles to determine an accurate distance to M31. As a first step, we are proposing to carry out HST spectroscopy of two carefully selected 19th mag early-B eclipsing binaries in M31. HST/ACS prism/grism low-resolution spectrophotometry (115-900 nm) is only missing key element of this program and is used to determine reliable values for T_eff, [Fe/H], and ISM extinction. These quantities, when combined with the results from our existing light and radial velocity curves for the two targets, will yield the stellar masses, radii, luminosities, and, importantly, the distances. The resulting fundamental stellar properties will be the first determined for stars in M31. Based on our previous experience, we expect to reduce the uncertainty of the M31 distance to better than 5%, thereby leading to a firmer calibration of the Cosmic Distance Scale and the zeropoint of H_0.

OBSERVING DESCRIPTION

In this initial study we are requesting observations of two M31 targets for a total of 2 HST orbits (one orbit per star). We have used the APT in its Phase II mode to perform detailed simulations of the exposure times and orbit planning to optimize the resulting datasets. According to the HST orbital constraints and the declination of our two targets, a visibility of 3350 s is available per orbit. Our simulations indicate that one orbit is sufficient to attain full spectral coverage (UV to near IR) with the necessary accuracy to fullfill the program's goals.

We propose to use three different prism/grism setups with the ACS SBC and HRC to obtain complete spectrophotometric coverage, from 115 nm to 900 nm: SBC/PR110L, HRC/PR200L, and HRC/G800L. As discussed by Fitzpatrick & Massa (1999, ApJ, 525, 1011) this extended wavelength coverage uniquely disentangles the stellar and interstellar parameters, yielding the quantities: Teff, log g, [Fe/H], E(B-V), and A(lambda). For example, the near UV includes the 2200 angstroms ISM dust absorption feature that will permit a firm determination of the ISM reddening of the targets.

Our exposure estimates were carried out using the latest version of the ACS spectroscopic online exposure time calculator. We assumed the intrinsic energy distribution of a B0-type star and an extinction corresponding to E(B-V)~0.2, typical for an M31 line of sight. We estimate that S/N in excess of 20:1 is necessary to secure a spectrum with sufficient quality to allow an accurate determination of the stellar and interstellar parameters. Also, this S/N requirement allows for a reliable comparison of the PR110L and PR200L fluxes in the region of overlap (around 180 nm), thus ensuring a valuable calibration cross-check. The calculations indicate that a S/N of 20:1 is obtained with exposure times of 878 s, 250 s, and 290 s, for PR110L, PR200L, and G800L, respectively. The orbit planning software confirms that such exposure times nicely fit within an orbit when all instrumental overheads are taken into account.

The targets are faint stars and have nearby companions but high-accuracy ground-based astrometry is available. Thus, the coordinates of the proposed stars are known to a precision better than 1 arcsec and no problems with

target acquisition are expected.

Visit

Proposal 10578, Visit 11, scheduling Thu Sep 28 01:01:10 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 90.0D TO 180.0 D; Period 5.75263 D AND ZERO-PHASE JD2452546.381

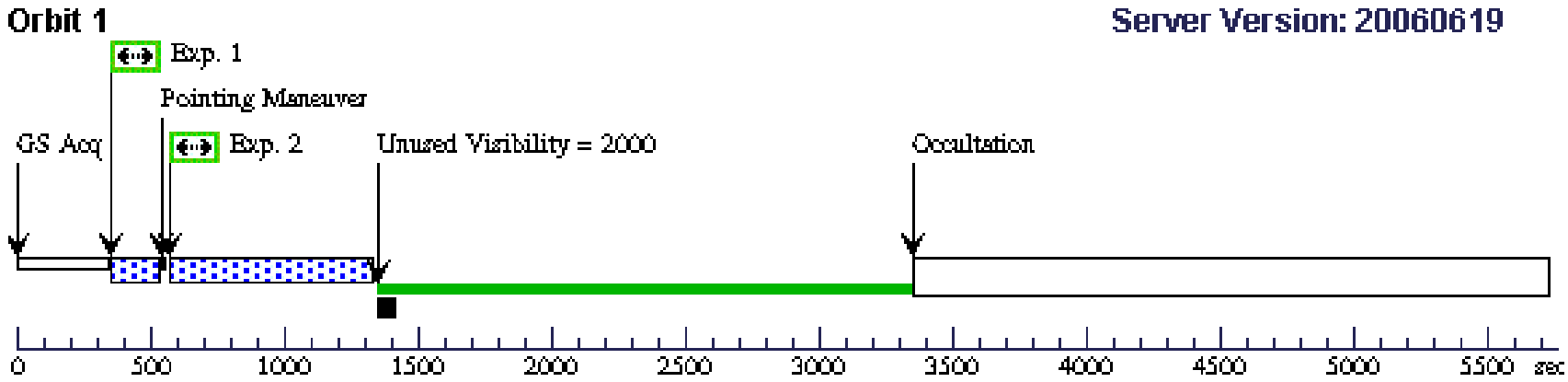
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M31GMOS-01	RA: 00 44 23.3000 (11.0970833d) Dec: +41 27 8.20 (41.45228d) Equinox: J2000		V=19.24+/-0.01 B-V = 0.09 +/- 0.01	Coordinate Source: Own imaging

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	10	(1) M31GMOS-01	ACS/SBC, ACCUM, SBC	F125LP		PHASE 0.6 TO 0.95		113.0 Secs	
								[==>]	***[1]***
2	10	(1) M31GMOS-01	ACS/SBC, ACCUM, SBC	PR110L				711.0 Secs	
								[==>]	***[1]***

Orbit Structure



Visit

Proposal 10578, Visit 12, completed Thu Sep 28 01:01:11 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

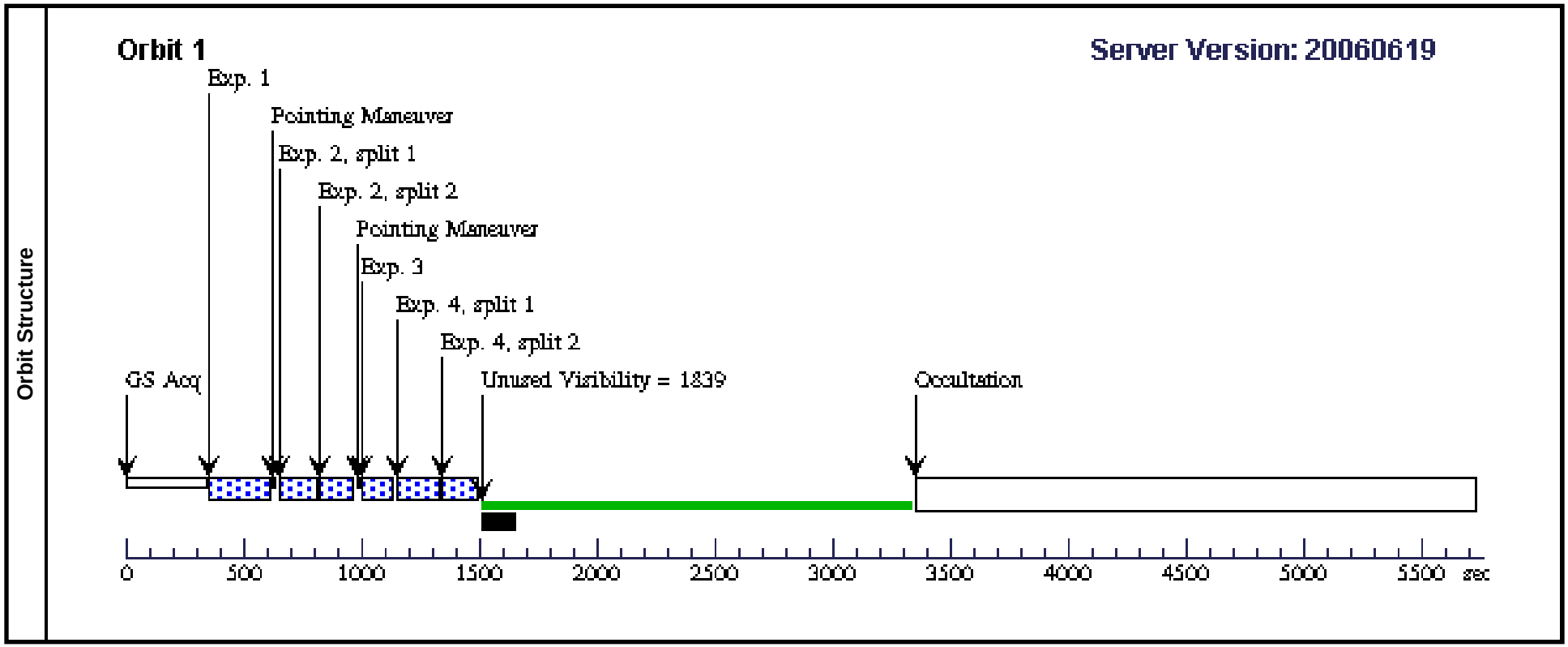
Special Requirements: ORIENT 90.0D TO 180.0 D; Period 5.75263 D AND ZERO-PHASE JD2452546.381

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M31GMOS-01	RA: 00 44 23.3000 (11.0970833d) Dec: +41 27 8.20 (41.45228d) Equinox: J2000		V=19.24+/-0.01 B-V = 0.09 +/- 0.01	Coordinate Source: Own imaging

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	F330W	CR-SPLIT=NO	PHASE 0.6 TO 0.45		138.0 Secs	
								[==>]	***[1]***
2	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	PR200L	AUTOIMAGE=NO			202.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
3	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO			40.0 Secs	
								[==>]	***[1]***
4	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	G800L	AUTOIMAGE=NO			235.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20060619
Exp. 1
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Exp. 3
Exp. 4, split 1
Exp. 4, split 2
GS Acq
Unused Visibility = 1839
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 10578, Visit 21, completed Thu Sep 28 01:01:11 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 100.0D TO 110.0 D; ORIENT 175.0D TO 195.0 D; Period 3.5496967 D AND ZERO-PHASE JD2452204.422

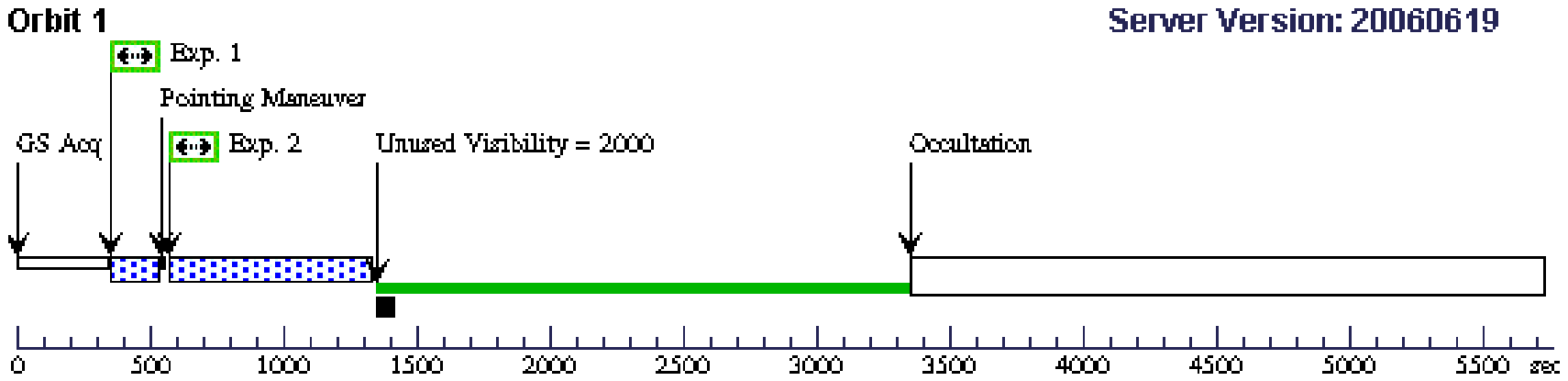
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M31GMOS-02	RA: 00 44 38.0000 (11.1583333d) Dec: +41 29 23.50 (41.48986d) Equinox: J2000		V=19.43+/-0.01 B-V = -0.08 +/- 0.01	Coordinate Source: Own imaging

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	10	(2) M31GMOS-02	ACS/SBC, ACCUM, SBC	F125LP		PHASE 0.65 TO 0.85		113.0 Secs *[==>]*	 ***[1]***
2	10	(2) M31GMOS-02	ACS/SBC, ACCUM, SBC	PR110L				711.0 Secs *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 10578, Visit 22, completed Thu Sep 28 01:01:12 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

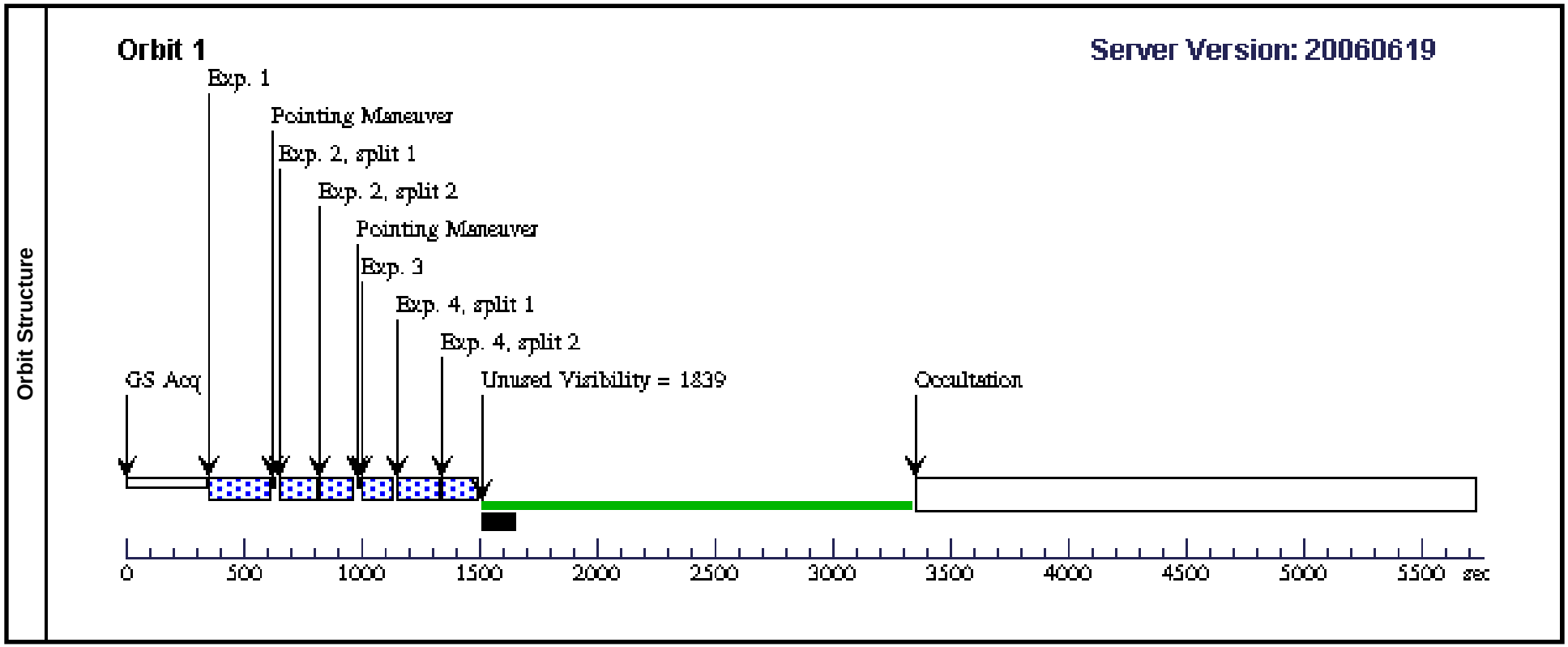
Special Requirements: ORIENT 100.0D TO 110.0 D; ORIENT 175.0D TO 195.0 D; Period 3.5496967 D AND ZERO-PHASE JD2452204.422

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M31GMOS-02	RA: 00 44 38.0000 (11.1583333d) Dec: +41 29 23.50 (41.48986d) Equinox: J2000		V=19.43+/-0.01 B-V = -0.08 +/- 0.01	Coordinate Source: Own imaging

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	10	(2) M31GMOS-02	ACS/HRC, ACCUM, HRC	F330W	CR-SPLIT=NO	PHASE 0.65 TO 0.85		138.0 Secs *[==>]*	 ***[1]***
2	10	(2) M31GMOS-02	ACS/HRC, ACCUM, HRC	PR200L	AUTOIMAGE=NO			202.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	 ***[1]***
3	10	(2) M31GMOS-02	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO			40.0 Secs *[==>]*	 ***[1]***
4	10	(2) M31GMOS-02	ACS/HRC, ACCUM, HRC	G800L	AUTOIMAGE=NO			235.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	 ***[1]***


Orbit Structure
Orbit 1
Server Version: 20060619
Exp. 1
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Exp. 3
Exp. 4, split 1
Exp. 4, split 2
GS Acq
Unused Visibility = 1839
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 10578, Visit 52 Thu Sep 28 01:01:13 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: ORIENT 90.0D TO 180.0 D; Period 5.75263 D AND ZERO-PHASE JD2452546.381

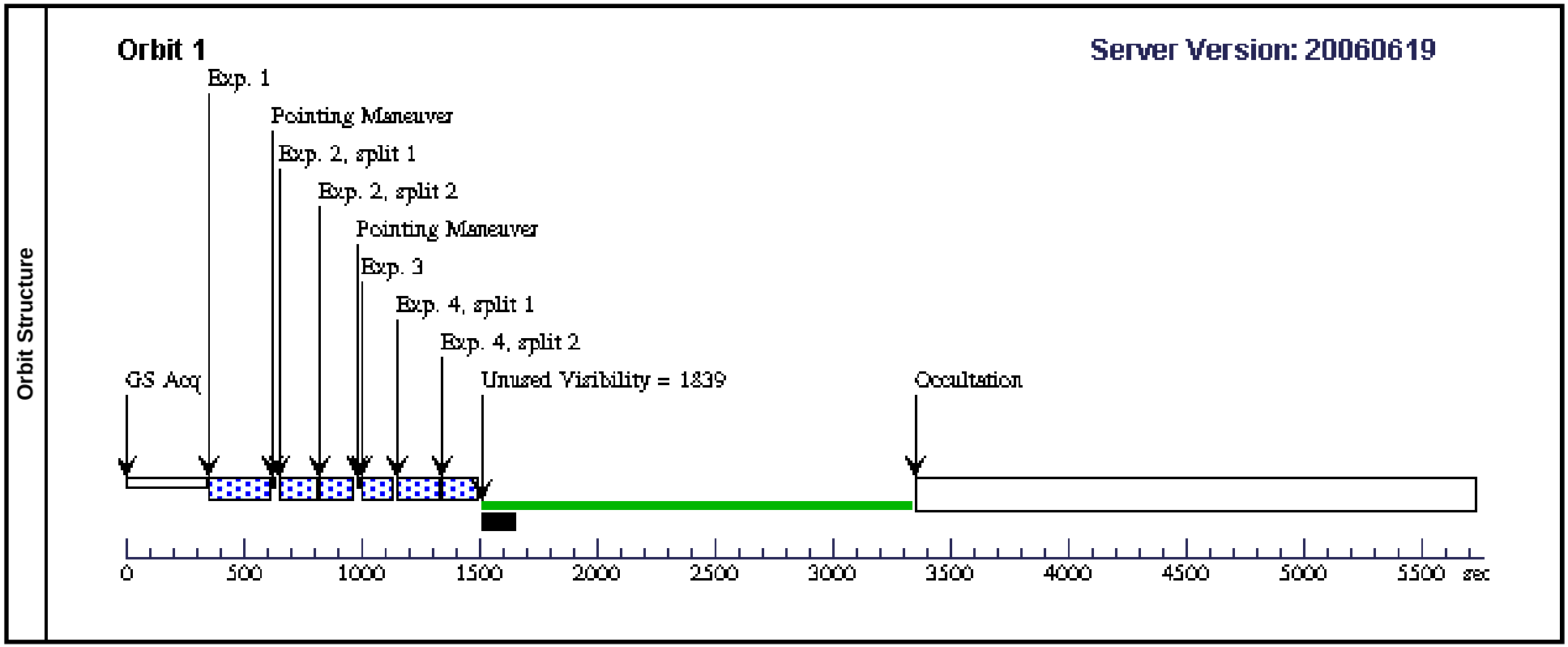
Comments: Visit 12 failed due to an ACS suspend. This visit replaces visit 12.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M31GMOS-01	RA: 00 44 23.3000 (11.0970833d) Dec: +41 27 8.20 (41.45228d) Equinox: J2000		V=19.24+/-0.01 B-V = 0.09 +/- 0.01	Coordinate Source: Own imaging

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	F330W	CR-SPLIT=NO	PHASE 0.6 TO 0.45		138.0 Secs	
								[==>]	***[1]***
2	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	PR200L	AUTOIMAGE=NO			202.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
3	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO			40.0 Secs	
								[==>]	***[1]***
4	10	(1) M31GMOS-01	ACS/HRC, ACCUM, HRC	G800L	AUTOIMAGE=NO			235.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***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sec