10888 - Complexity in the Smallest Galaxies: Star Formation History of the Sculptor Dwarf Spheroidal

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Andrew A. Cole (PI)	**University of Minnesota - Twin Cities**	**cole@astro.umn.edu**
Dr. Eline Tolstoy (CoI) (ESA Member)	Kapteyn Astronomical Institute	etolstoy@astro.rug.nl

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
02	(1) ESO351-30	WFPC2	2	17-Jan-2008 15:20:31.0	yes
03	(1) ESO351-30	WFPC2	2	17-Jan-2008 15:20:34.0	yes
04	(1) ESO351-30	WFPC2	2	17-Jan-2008 15:20:38.0	yes
05	(1) ESO351-30	WFPC2	2	17-Jan-2008 15:20:41.0	yes
54	(2) ESO351-30-COPY	WFPC2	1	17-Jan-2008 15:20:44.0	yes
55	(2) ESO351-30-COPY	WFPC2	2	17-Jan-2008 15:20:46.0	yes

11 Total Orbits Used

ABSTRACT

The Sculptor dwarf spheroidal galaxy (Scl dSph) is one of the most luminous of the Milky Way dSph satellites, suffers virtually no foreground confusion or reddening because of its high galactic latitude, and is nearby at 80 kpc from the Sun. It is of great interest to astronomy to understand the detailed histories of dSph galaxies because they may be survivors of the hierarchical merging process that created giant galaxies like our own. Despite this, the age distribution of stars in Scl dSph remains remarkably poorly constrained because of a dearth of high-quality color-magnitude diagrams (CMDs) of its central regions. Scl dSph is known to be complex on the basis of shallower photometry, radial velocity studies, and investigations of the metallicity; however, the age range of significant star-formation and the proportion of stars older and younger than 10 Gyr is still completely unknown. The age of the centrally concentrated, metal-rich population has never been measured. We propose to obtain deep optical images of the core of Scl dSph with WFPC2 in order to measure the temporal evolution of its star-formation rate over its entire lifetime. The ONLY way to reliably measure the variation in star-formation rate on Gyr timescales at ages of 10-13 Gyr is with photometry of a large number of stars at and below the oldest main-sequence turnoffs to magnitudes of (B,I) = (25.1, 24.5). Because of the high stellar density and resulting image crowding, it is impossible to achieve the required level of photometric precision except with diffraction-limited imaging. These data will permit the first reliable measurement of the star-formation history of the main body of Scl dSph; limited inferences from WFPC2 data in an outer field have been made, but they were hindered not only by small number statistics but by the subsequent revelation of extremely strong population gradients in Scl dSph, such that the stars in the existing WFPC2 field are not representative of the galaxy as a whole. Our proposed program will shed strong new light on the formation processes of the smallest galaxies. Only by measuring the detailed early histories of galaxies like Scl dSph can we evaluate the impact of outside influences like ram-pressure stripping, tidal stirring, and photoionization feedback on the evolution of small galaxies.

OBSERVING DESCRIPTION

We will image the core region of the Sculptor dwarf spheroidal (ESO351-30) using the F450W and F814W filters of WFPC2. This proposal was originally intended to use ACS/WFC and has been reassigned to WFPC2 The exposures are designed to optimize the combination of sensitivity and age/metallicity resolution for the main-sequence turnoffs of stellar populations older than ~6 billion years. Our science goal requires high signal-to-noise, highly complete photometry down to magnitudes of (B, I) ~ (25.5, 24.5), two magnitudes below the oldest main-sequence turnoff. The WFCP2 online ETC shows that S/N > 25 can be achieved in ~8800 sec per filter, or approximately 4 orbits each given the visibility of the Sculptor dwarf. To minimize overheads, we will implement a standard line dither pattern by means of POS-TARG commands between visits, and fill each of the first 6 orbits with long CR-SPLIT exposures. To extend our dynamic range up the red giant branch, we use the GAIN=14 setting, and we will use

a set of 4x400sec exposures in our last visit to ensure that accurate photometry can be obtained for upper RGB stars. The radius of Sculptor is many times larger than the WFPC2 field of view, so no constraints on the orientation are required as long as all four visits are oriented the same.

ADDITIONAL COMMENTS

The Sculptor dwarf spheroidal was observed with WFPC2 under program #6866 in F555W and F814W. However, the observations were taken ~15 arcmin along the minor axis from the galaxy's center and only measured one component of the complex stellar population mix now known to be present. Our goal here is to rectify that shortcoming; the existing CMD (Monkiewicz et al. 1999) will be a valuable resource to constrain the population gradient in Sculptor.

Visit

Proposal 10888, Visit 02, completed Thu Jan 17 20:20:51 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Fixed Targets

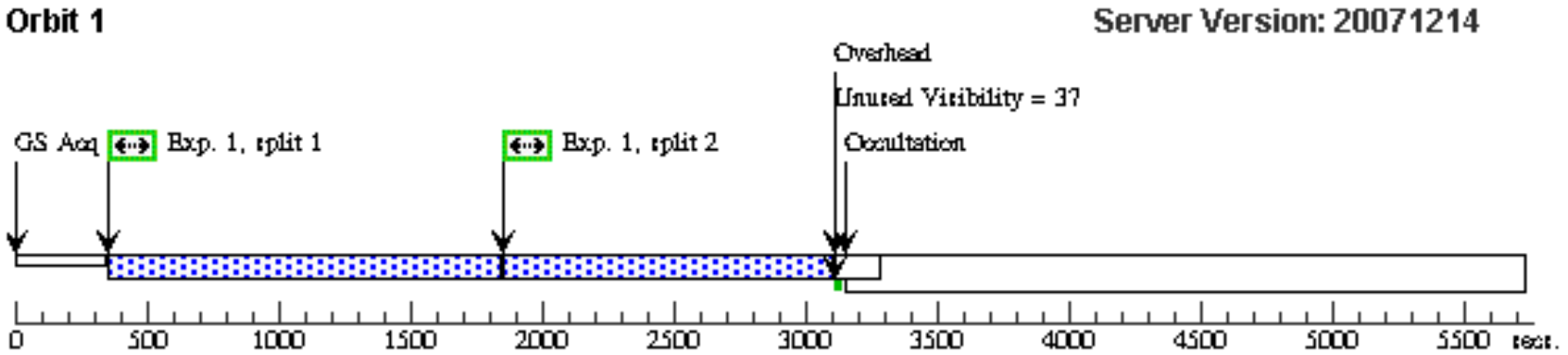
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	ESO351-30 Alt Name1: SCULPTOR-DSPH	RA: 01 00 9.3000 (15.0387500d) Dec: -33 42 33.00 (-33.70917d) Equinox: J2000		V=17.1+/-0.5 surface brightness 23.5 Vmag/arcsec^2 stellar field	Reference Frame: NED

Comments: This object was generated by the targetselector and retrieved from the NED database.

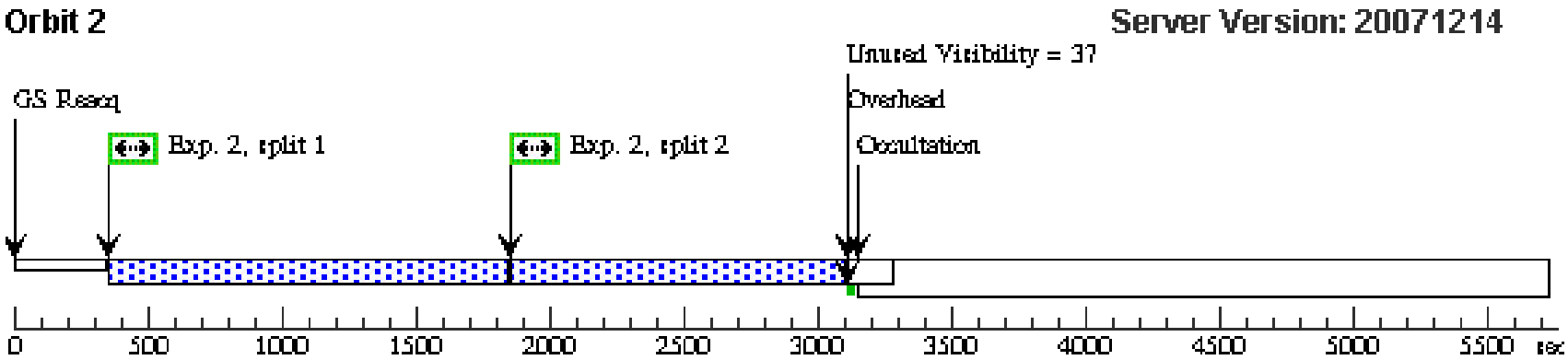
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/I	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F814W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3			2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[1]*
2	Core/B	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3			2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[2]*

Orbit Structure



Orbit Structure (continued)



Visit

Proposal 10888, Visit 03, completed Thu Jan 17 20:20:52 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: SAME ORIENT AS 02

Fixed Targets

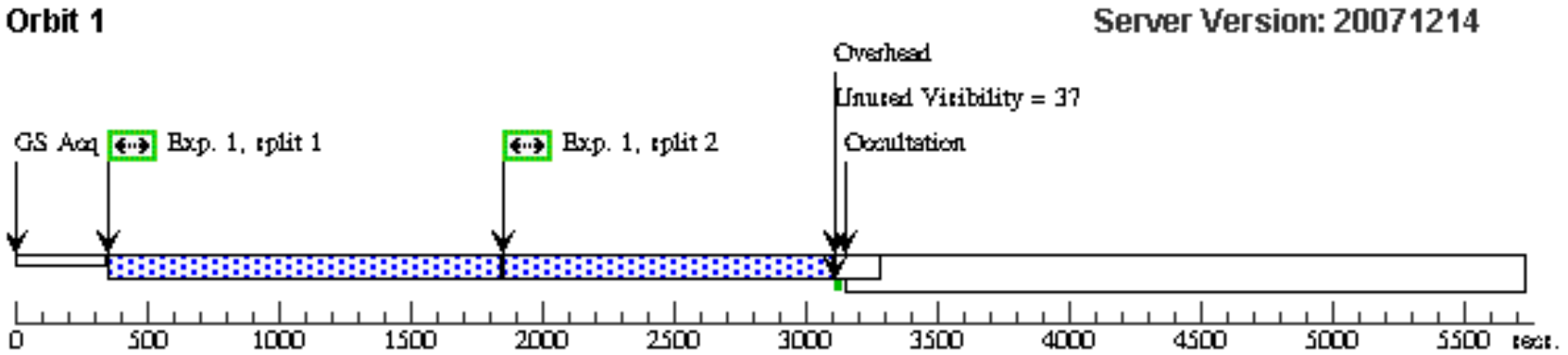
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	ESO351-30 Alt Name1: SCULPTOR-DSPH	RA: 01 00 9.3000 (15.0387500d) Dec: -33 42 33.00 (-33.70917d) Equinox: J2000		V=17.1+/-0.5 surface brightness 23.5 Vmag/arcsec^2 stellar field	Reference Frame: NED

Comments: This object was generated by the targetselector and retrieved from the NED database.

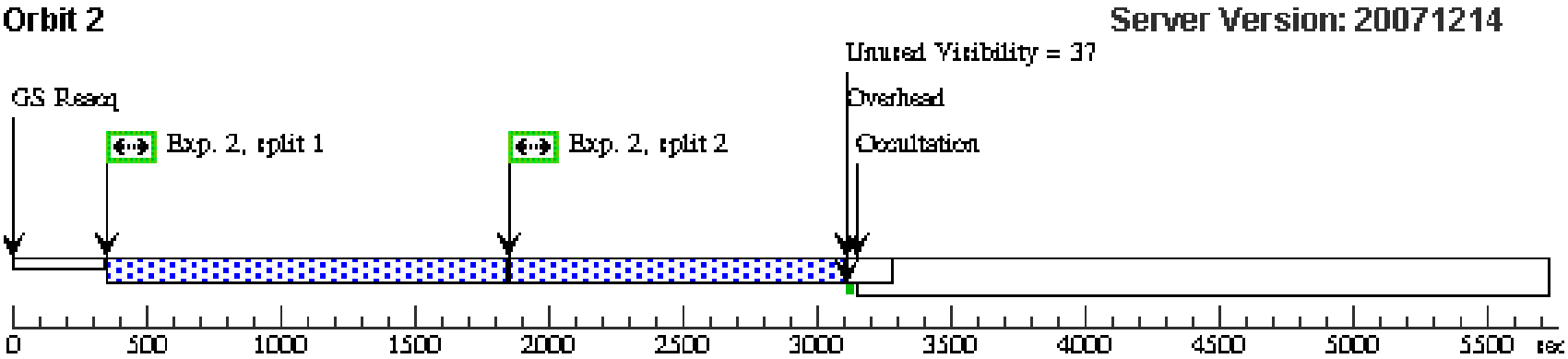
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/I	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F814W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3	POS TARG 0.25,0.25		2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[1]*
2	Core/B	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3	SAME POS AS 1		2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[2]*

Orbit Structure



Orbit Structure (continued)



Visit

Proposal 10888, Visit 04, failed Thu Jan 17 20:20:53 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: SAME ORIENT AS 02

Fixed Targets

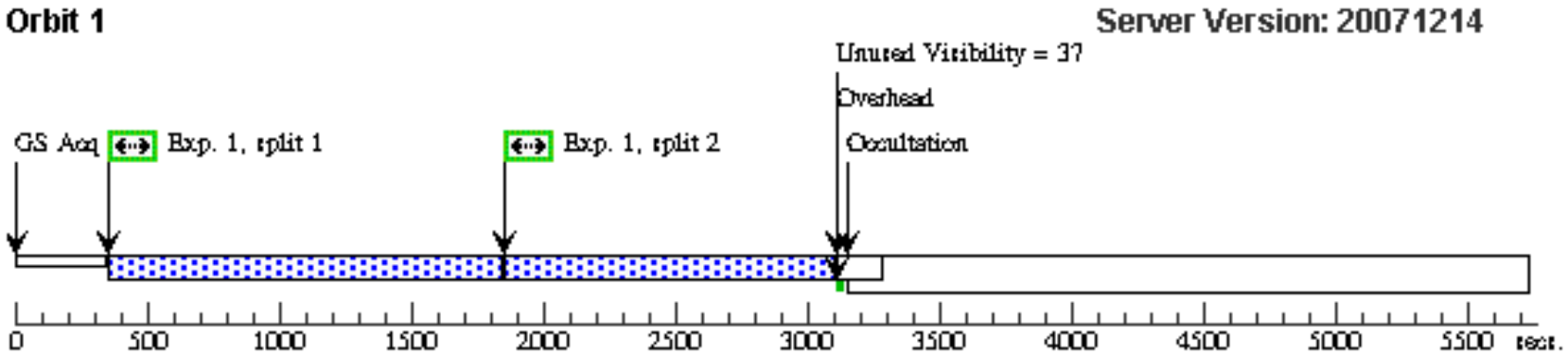
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	ESO351-30 Alt Name1: SCULPTOR-DSPH	RA: 01 00 9.3000 (15.0387500d) Dec: -33 42 33.00 (-33.70917d) Equinox: J2000		V=17.1+/-0.5 surface brightness 23.5 Vmag/arcsec^2 stellar field	Reference Frame: NED

Comments: This object was generated by the targetselector and retrieved from the NED database.

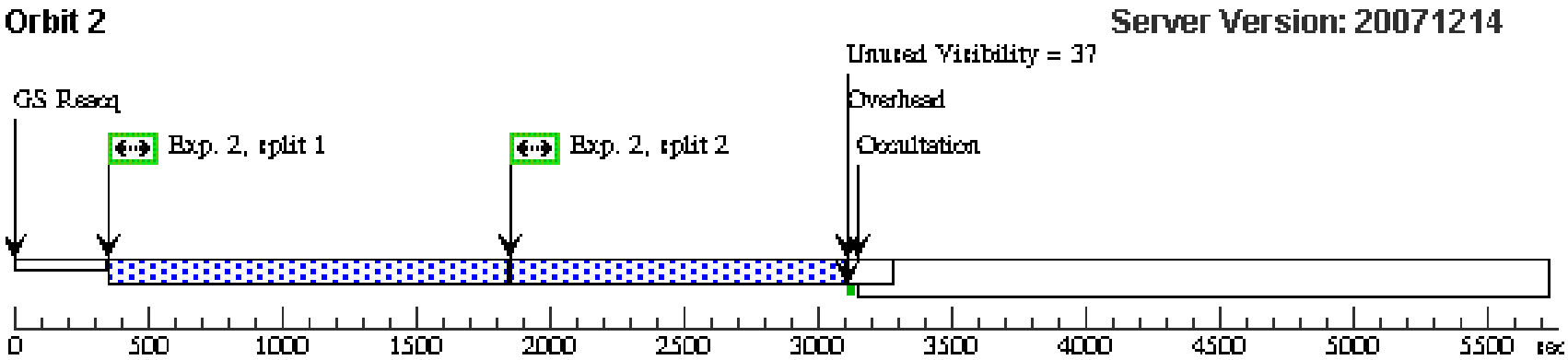
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/I	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F814W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3	POS TARG -0.25,-0.25		2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[1]*
2	Core/B	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3	SAME POS AS 1		2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[2]*

Orbit Structure



Orbit Structure (continued)



Visit

Proposal 10888, Visit 05, failed Thu Jan 17 20:20:53 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: SAME ORIENT AS 02

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFPC2-LINE	Coordinate Frame=POS-TARG		(1), (2)
	Purpose=DITHER	Pattern Orientation=45.0		
	Number Of Points=2	Angle Between Sides=		
	Point Spacing=0.3535	Center Pattern=false		
	Line Spacing=			

Fixed Targets

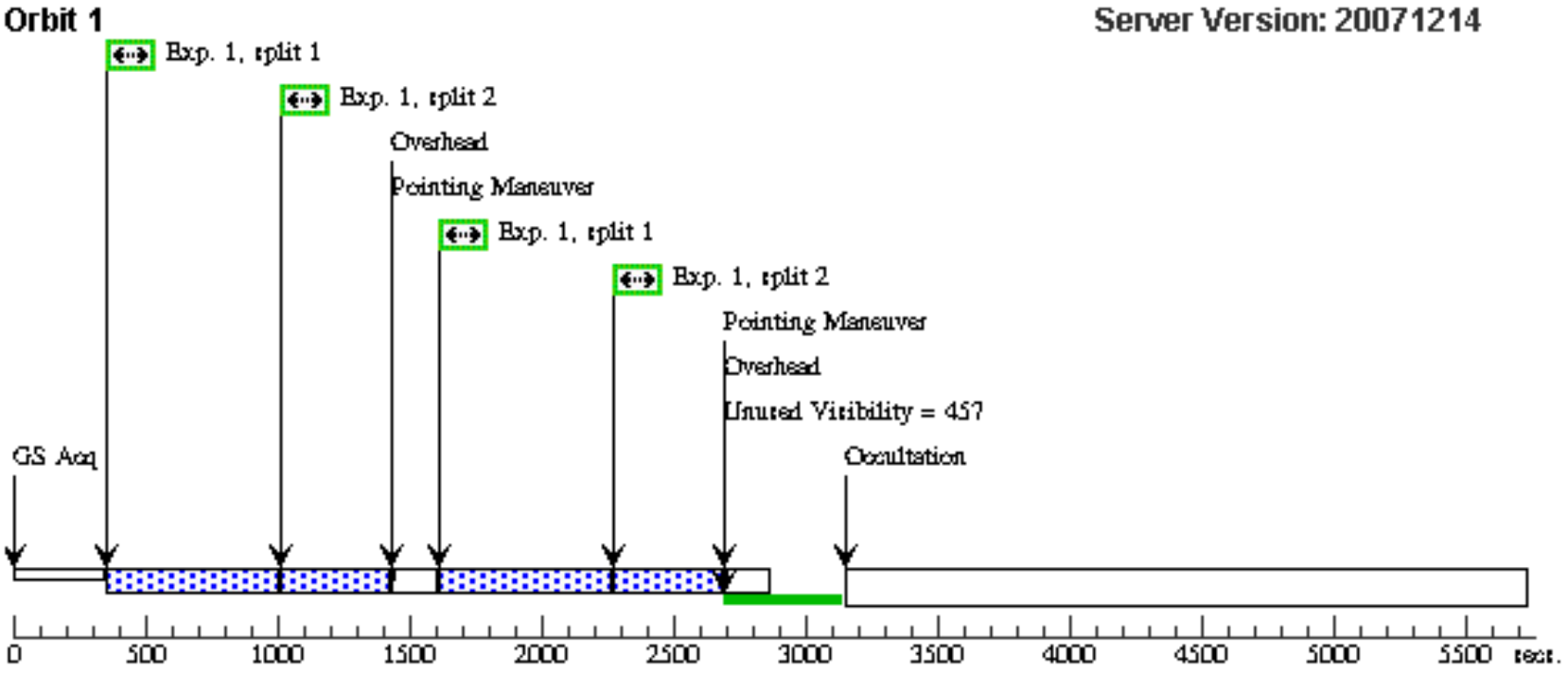
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	ESO351-30	RA: 01 00 9.3000 (15.0387500d)		V=17.1+/-0.5	Reference Frame: NED
	Alt Name1: SCULPTOR-DSPH	Dec: -33 42 33.00 (-33.70917d)		surface brightness 23.5 Vmag/arcsec^2 stellar field	
		Equinox: J2000			

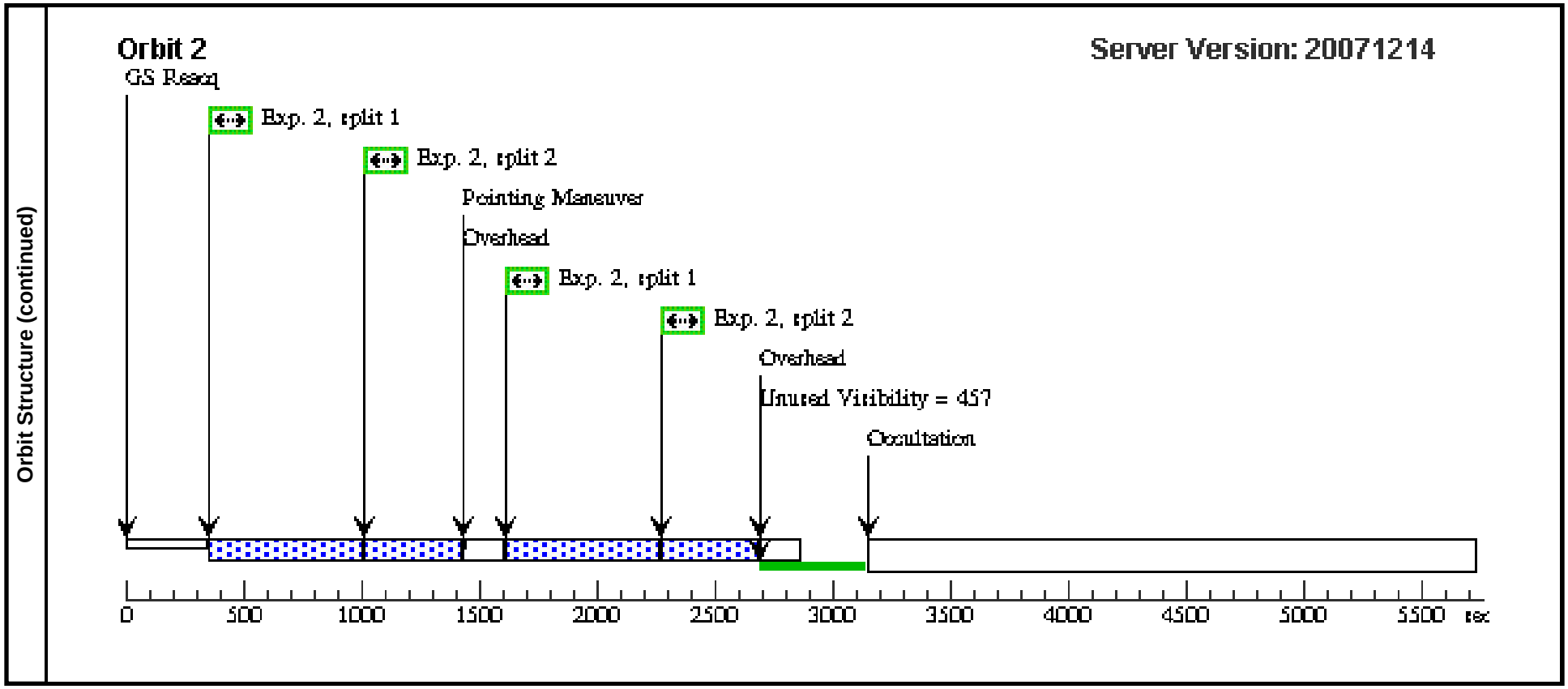
Comments: This object was generated by the targetselector and retrieved from the NED database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/I	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F814W	ATD-GAIN=15		Pattern 1-1 (1)	800.0 Secs	
								[==>(Pattern 1, Split 1)]	***[1]***
								[==>(Pattern 1, Split 2)]	
								[==>(Pattern 2, Split 1)]	
								[==>(Pattern 2, Split 2)]	
2	Core/B	(1) ESO351-30	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15		Pattern 2-2 (1)	800.0 Secs	
								[==>(Pattern 1, Split 1)]	***[2]***
								[==>(Pattern 1, Split 2)]	
								[==>(Pattern 2, Split 1)]	
								[==>(Pattern 2, Split 2)]	

Orbit Structure




Orbit Structure (continued)
Orbit 2
Server Version: 20071214
GS Reacq
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Overhead
Exp. 2, split 1
Exp. 2, split 2
Overhead
Unused Visibility = 457
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 10888, Visit 54, implementation Thu Jan 17 20:20:54 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: SAME ORIENT AS 02

Fixed Targets

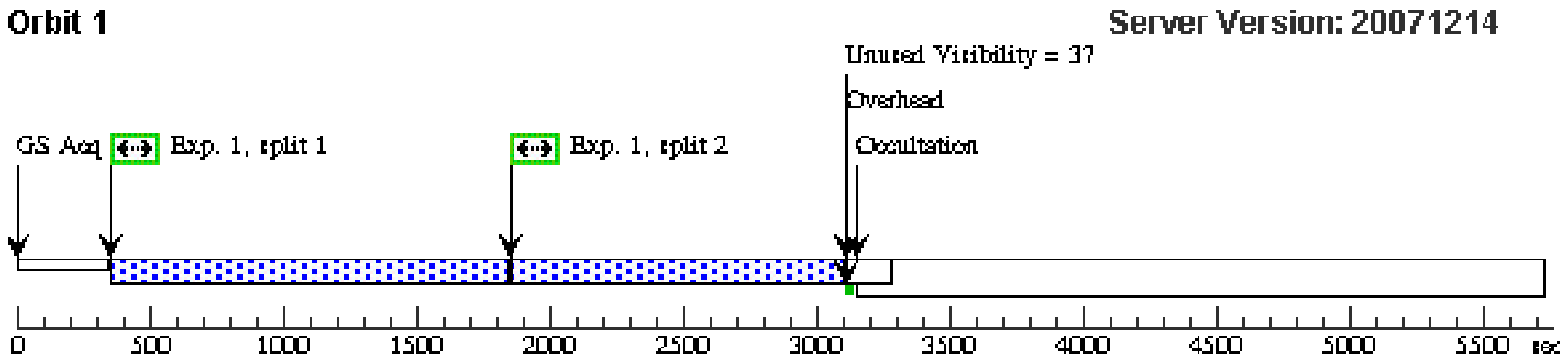
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	ESO351-30-COPY Alt Name1: SCULPTOR-DSPH	RA: 01 00 9.3000 (15.0387500d) Dec: -33 42 33.00 (-33.70917d) Equinox: J2000		V=17.1+/-0.5 surface brightness 23.5 Vmag/arcsec^2 stellar field	Reference Frame: NED

Comments: This object was generated by the targetselector and retrieved from the NED database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/B	(2) ESO351-30-COPY	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15; CR-SPLIT=0.5; CR-TOLERANCE=0.3	POS TARG -0.25,-0.25		2400.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	*[1]*

Orbit Structure



Visit

Proposal 10888, Visit 55, implementation Thu Jan 17 20:20:54 GMT 2008

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: SAME ORIENT AS 02

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFPC2-LINE	Coordinate Frame=POS-TARG		(1), (2)
	Purpose=DITHER	Pattern Orientation=45.0		
	Number Of Points=2	Angle Between Sides=		
	Point Spacing=0.3535	Center Pattern=false		
	Line Spacing=			

Fixed Targets

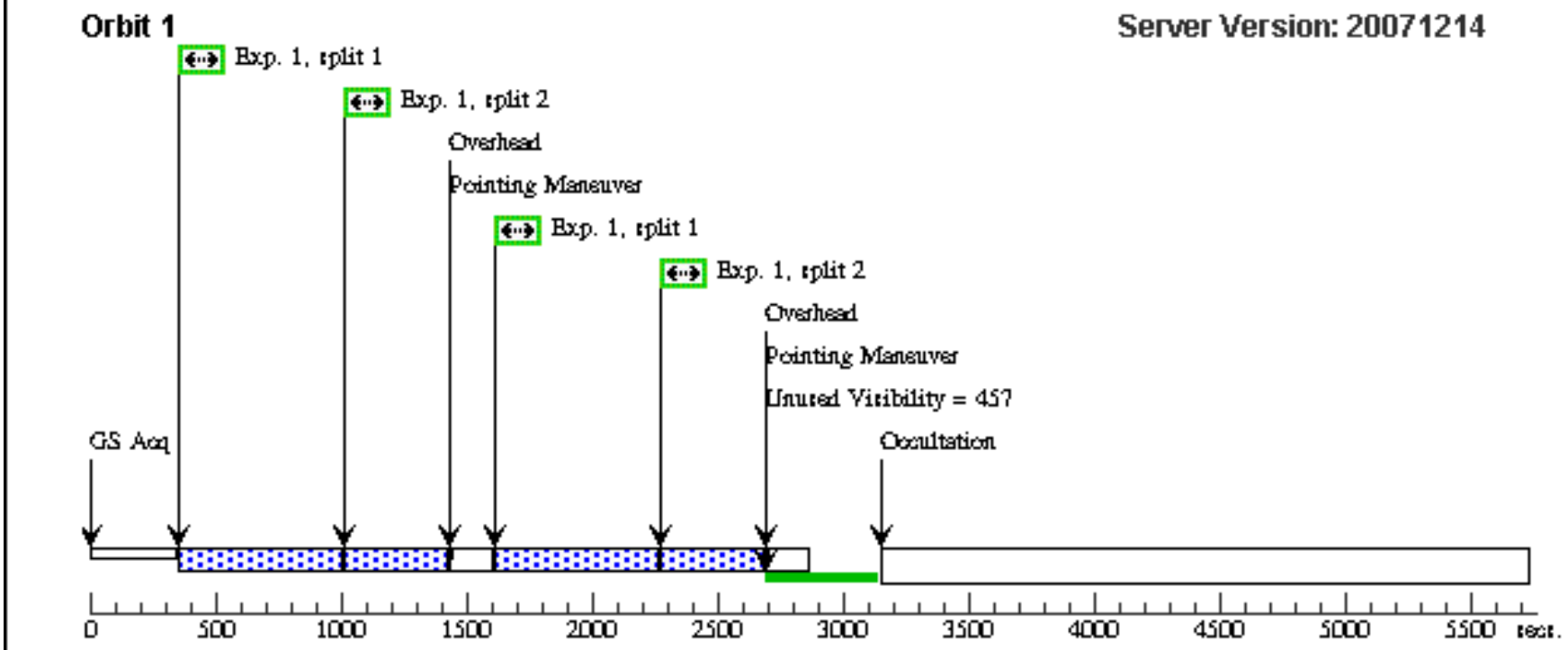
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	ESO351-30-COPY	RA: 01 00 9.3000 (15.0387500d)		V=17.1+/-0.5	Reference Frame: NED
	Alt Name1: SCULPTOR-DSPH	Dec: -33 42 33.00 (-33.70917d)		surface brightness 23.5 Vmag/arcsec^2 stellar field	
		Equinox: J2000			

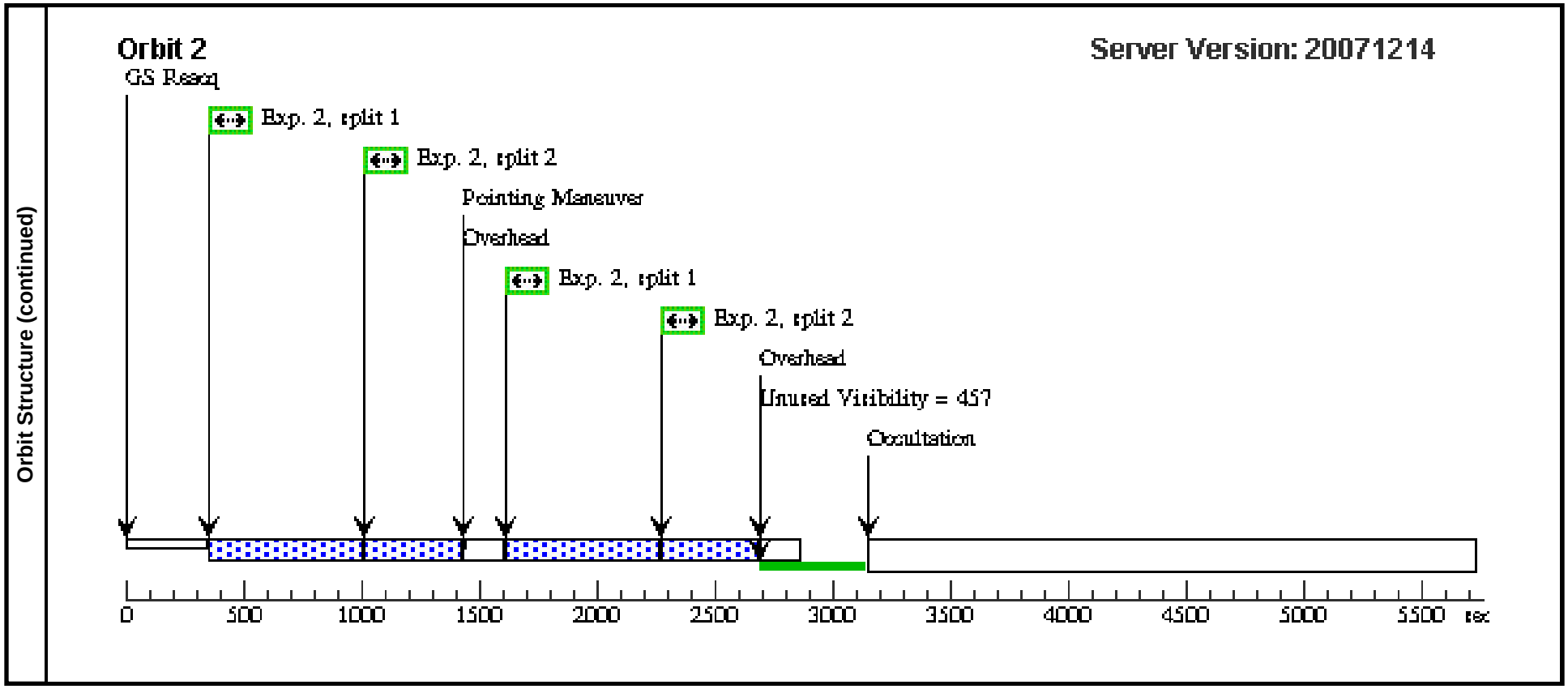
Comments: This object was generated by the targetselector and retrieved from the NED database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Core/I	(2) ESO351-30-COPY	WFPC2, IMAGE, WFALL-FIX	F814W	ATD-GAIN=15		Pattern 1-1 (1)	800.0 Secs	
								[==>(Pattern 1, Split 1)]	***[1]***
								[==>(Pattern 1, Split 2)]	
								[==>(Pattern 2, Split 1)]	
								[==>(Pattern 2, Split 2)]	
2	Core/B	(2) ESO351-30-COPY	WFPC2, IMAGE, WFALL-FIX	F450W	ATD-GAIN=15		Pattern 2-2 (1)	800.0 Secs	
								[==>(Pattern 1, Split 1)]	***[2]***
								[==>(Pattern 1, Split 2)]	
								[==>(Pattern 2, Split 1)]	
								[==>(Pattern 2, Split 2)]	

Orbit Structure




Orbit Structure (continued)
Orbit 2
Server Version: 20071214
GS Reacq
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Overhead
Exp. 2, split 1
Exp. 2, split 2
Overhead
Unused Visibility = 457
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec