



12670 - Detecting Isolated Black Holes through Astrometric Microlensing

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) MOA-2010-BLG-364	WFC3/UVIS	1	07-Aug-2012 21:03:57.0	yes
02	(2) OGLE-2011-BLG-0037	WFC3/UVIS	1	07-Aug-2012 21:04:10.0	yes
03	(3) OGLE-2011-BLG-310	WFC3/UVIS	1	07-Aug-2012 21:04:19.0	yes
04	(4) OGLE-2011-BLG-462	WFC3/UVIS	1	07-Aug-2012 21:04:26.0	yes
05	(3) OGLE-2011-BLG-310	WFC3/UVIS	1	07-Aug-2012 21:04:33.0	yes
06	(2) OGLE-2011-BLG-0037	WFC3/UVIS	1	07-Aug-2012 21:04:42.0	yes
07	(4) OGLE-2011-BLG-462	WFC3/UVIS	1	07-Aug-2012 21:04:50.0	yes

7 Total Orbits Used

ABSTRACT

This proposal aims to make the first detection of isolated stellar-mass black holes (BHs) in the Milky Way, and to determine their masses. Until now, the only directly measured BH masses have come from radial-velocity measurements of X-ray binaries. Our proposed method uses the astrometric shifts that occur when a Galactic-bulge microlensing event is caused by a BH lens. Out of the hundreds of bulge microlensing events found annually by the OGLE and MOA surveys, a few are found to have very long durations (>200 days). It is generally believed that the majority of these long-duration events are caused by lenses that are isolated BHs.

To test this hypothesis, we will carry out high-precision astrometry of 5 long-duration events, using the ACS/HRC camera. The expected astrometric signal from a BH lens is >1.4 mas, at least 7 times the demonstrated astrometric precision attainable with the HRC.

This proposal will thus potentially lead to the first unambiguous detection of isolated stellar-mass BHs, and the first direct mass measurement for isolated stellar-mass BHs through any technique. Detection of several BHs will provide information on the frequency of BHs in the Galaxy, with implications for the slope of the IMF at high masses, the minimum mass of progenitors that produce BHs, and constraints on theoretical models of BH formation.

OBSERVING DESCRIPTION

We will select long-duration events which do not show any light contribution from the lens. In addition, the events should have reasonably high amplifications which will ensure that the centroid shift is close to zero at the peak amplification, and will facilitate detection of the parallax signal and hence the distance estimate for the lens. It is easy to identify long-duration events and to determine their time of peak amplification well before the actual peak. Our group includes members of the microlensing survey teams who have access to the survey data for proper selection of such events.

To guard against the possibility that the geometric distortion may be dependant on the location on the detector; we will position the target at different locations along close-to-central-x-axis of the of the detector.

We will take most images in a single filter, but also take a small number of images in a different filter to check the color dependency, if any, of the astrometric shift.

Proposal 12670 (STScI Edit Number: 2, Created: Tuesday, August 7, 2012 8:04:57 PM EST) - Overview

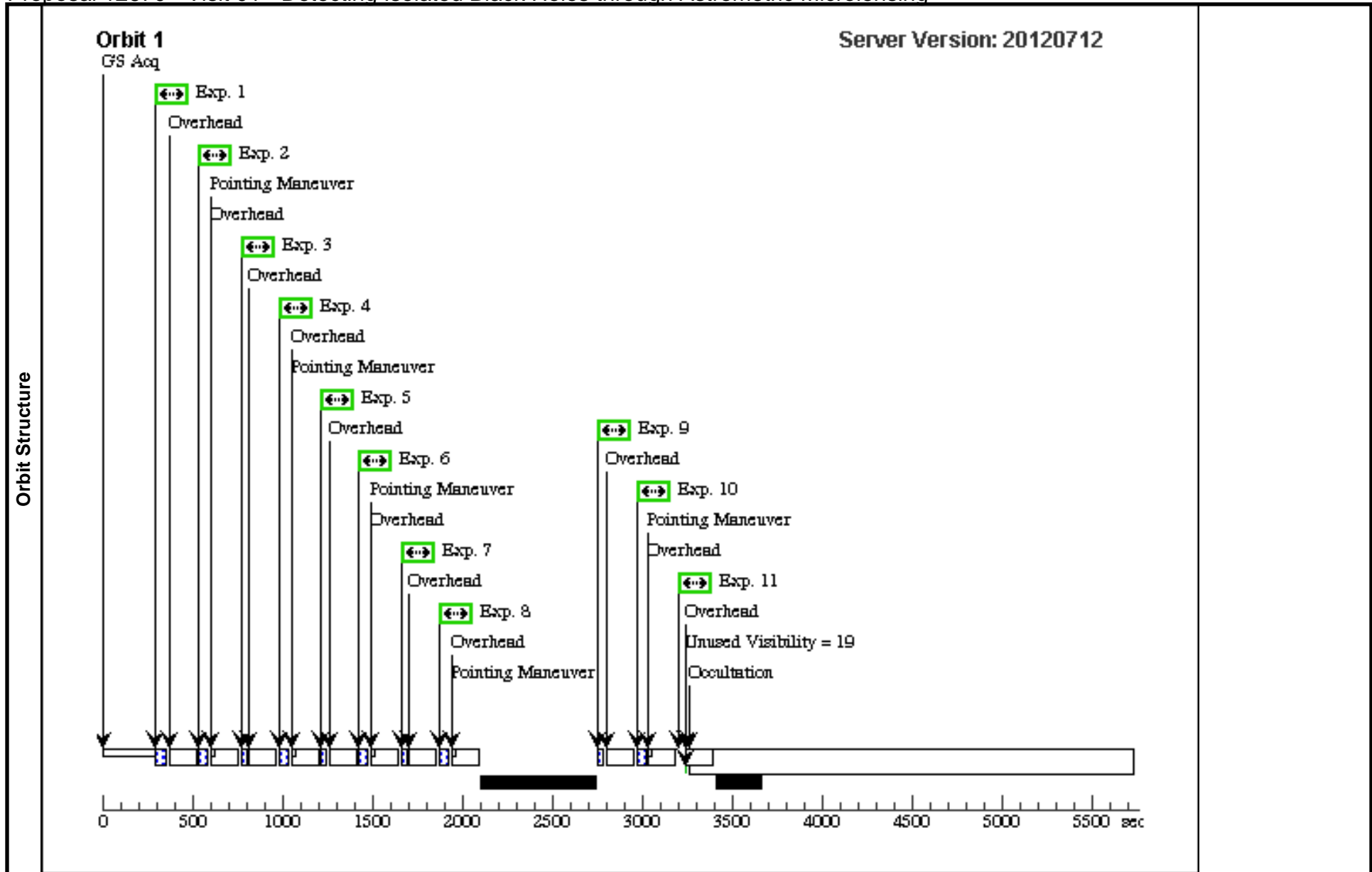
We will try to take as many images as possible in a single ORIENT for better astrometry accuracy. However, maintaining a single ORIENT may not be possible for all the observations. Since almost all of our targets are close to the ecliptic, we plan to use the same orient for nearly half of the year, and then flip it by 180 deg.

Proposal 12670 - Visit 01 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:04:58 GMT 2012

Fixed Targets	Visit				
	Proposal 12670, Visit 01, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 05-SEP-2011 AND 10-NOV-2011				
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	MOA-2010-BLG-364	RA: 17 57 5.4000 (269.2725000d) Dec: -34 27 5.00 (-34.45139d) Equinox: J2000		V=16.75+/-1.5	Reference Frame: ICRS

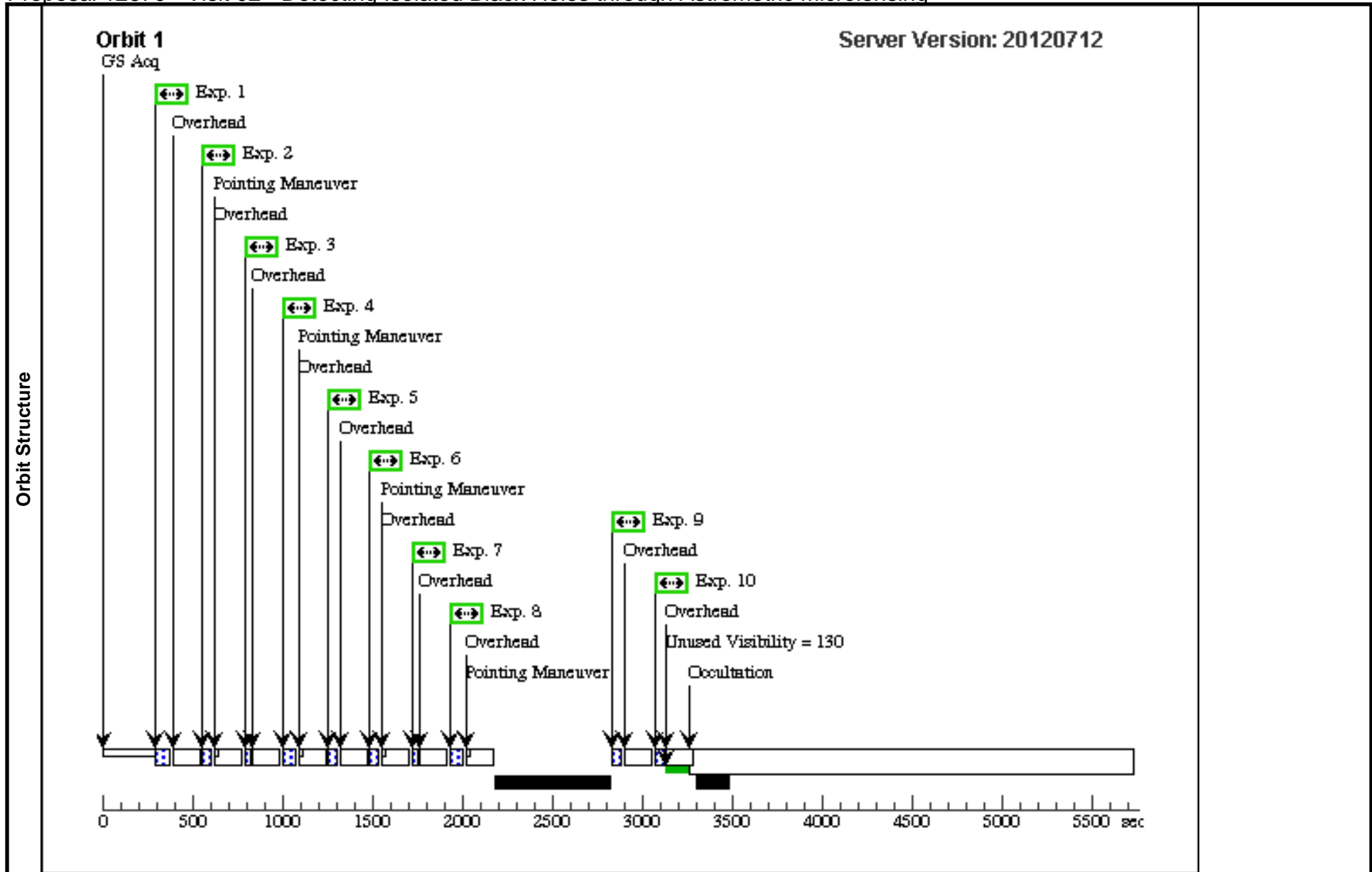
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 10.4,9.0; GS ACQ SCENARI O BASE1B3		30 Secs [==>]	[1]
	2		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 1		30 Secs [==>]	[1]
	3		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 22.25,9.0		30 Secs [==>]	[1]
	4		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 3		30 Secs [==>]	[1]
	5		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 16.31,19.27		30 Secs [==>]	[1]
	6		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 5		30 Secs [==>]	[1]
	7		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 4.45,19.25		30 Secs [==>]	[1]
	8		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 7		30 Secs [==>]	[1]
	9		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG -1.45,8.95		30 Secs [==>]	[1]
	10		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 9		30 Secs [==>]	[1]
	11		(1) MOA-2010-BLG-364	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 4.53,-1.30		30 Secs [==>]	[1]



Proposal 12670 - Visit 02 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:00 GMT 2012

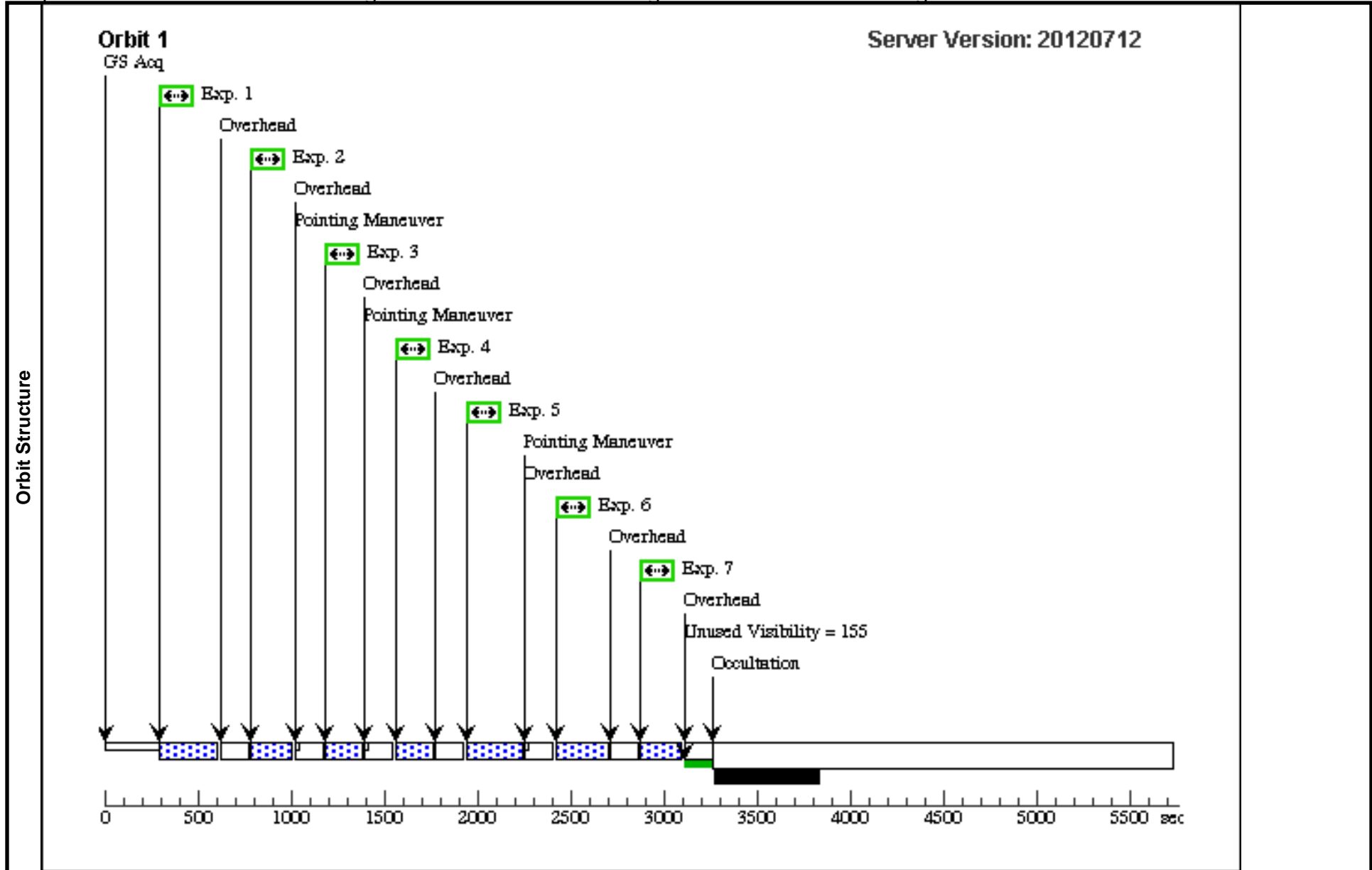
Fixed Targets	Visit									
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	Proposal 12670, Visit 02, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 20-OCT-2011 AND 07-NOV-2011									
	(2)	OGLE-2011-BLG-0037	RA: 17 55 55.8300 (268.9826250d) Dec: -30 33 39.70 (-30.56103d) Equinox: J2000		V=17.5	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 10.4,9.0; GS ACQ SCENARI O BASE1B3		50 Secs [==>]	[1]
	2		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 1		30 Secs [==>]	[1]
	3		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 22.25,9.0		30 Secs [==>]	[1]
	4		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 3		50 Secs [==>]	[1]
	5		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 16.31,19.27		50 Secs [==>]	[1]
	6		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 5		30 Secs [==>]	[1]
	7		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 4.45,19.25		30 Secs [==>]	[1]
	8		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 7		50 Secs [==>]	[1]
	9		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG -1.45,8.95		50 Secs [==>]	[1]
10		(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 9		30 Secs [==>]	[1]	



Proposal 12670 - Visit 03 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:04 GMT 2012

Fixed Targets	Visit									
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	OGLE-2011-BLG-310	RA: 17 51 25.3900 (267.8557917d) Dec: -30 24 35.00 (-30.40972d) Equinox: J2000		V=18	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 22.25,9; GS ACQ SCENARI O BASE1B3		280 Secs [==>]	[1]
	2		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 1		200 Secs [==>]	[1]
	3		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG 10.37,20 .85		200 Secs [==>]	[1]
	4		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG -1.45,8. 95		200 Secs [==>]	[1]
	5		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG -1.45,8. 95		280 Secs [==>]	[1]
	6		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 10.48,-2 .85		280 Secs [==>]	[1]
	7		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 6		200 Secs [==>]	[1]

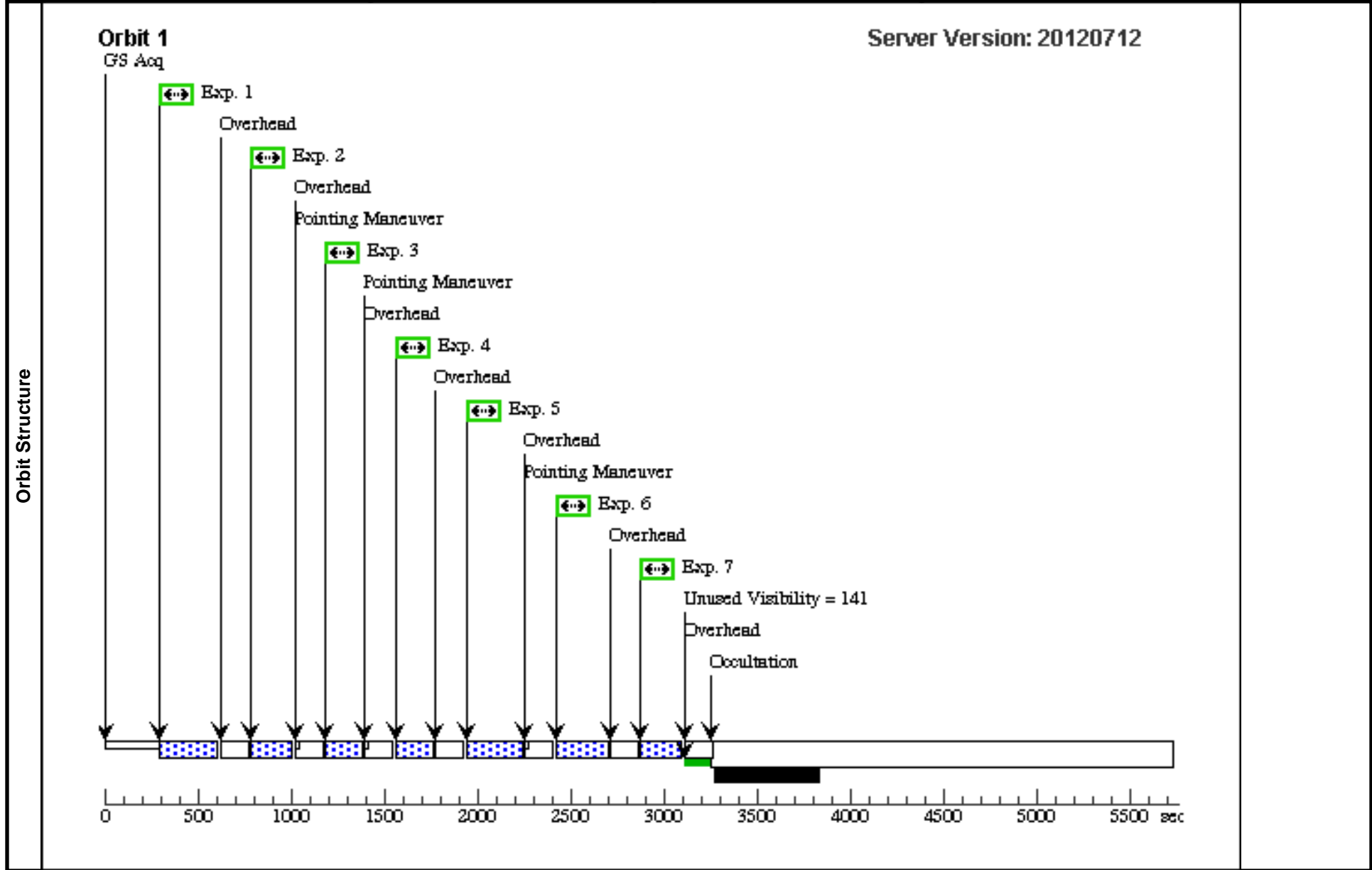


Proposal 12670 - Visit 04 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:05 GMT 2012

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(4)	OGLE-2011-BLG-462	RA: 17 51 40.1900 (267.9174583d) Dec: -29 53 26.30 (-29.89064d) Equinox: J2000			V=20.25+/-0.1

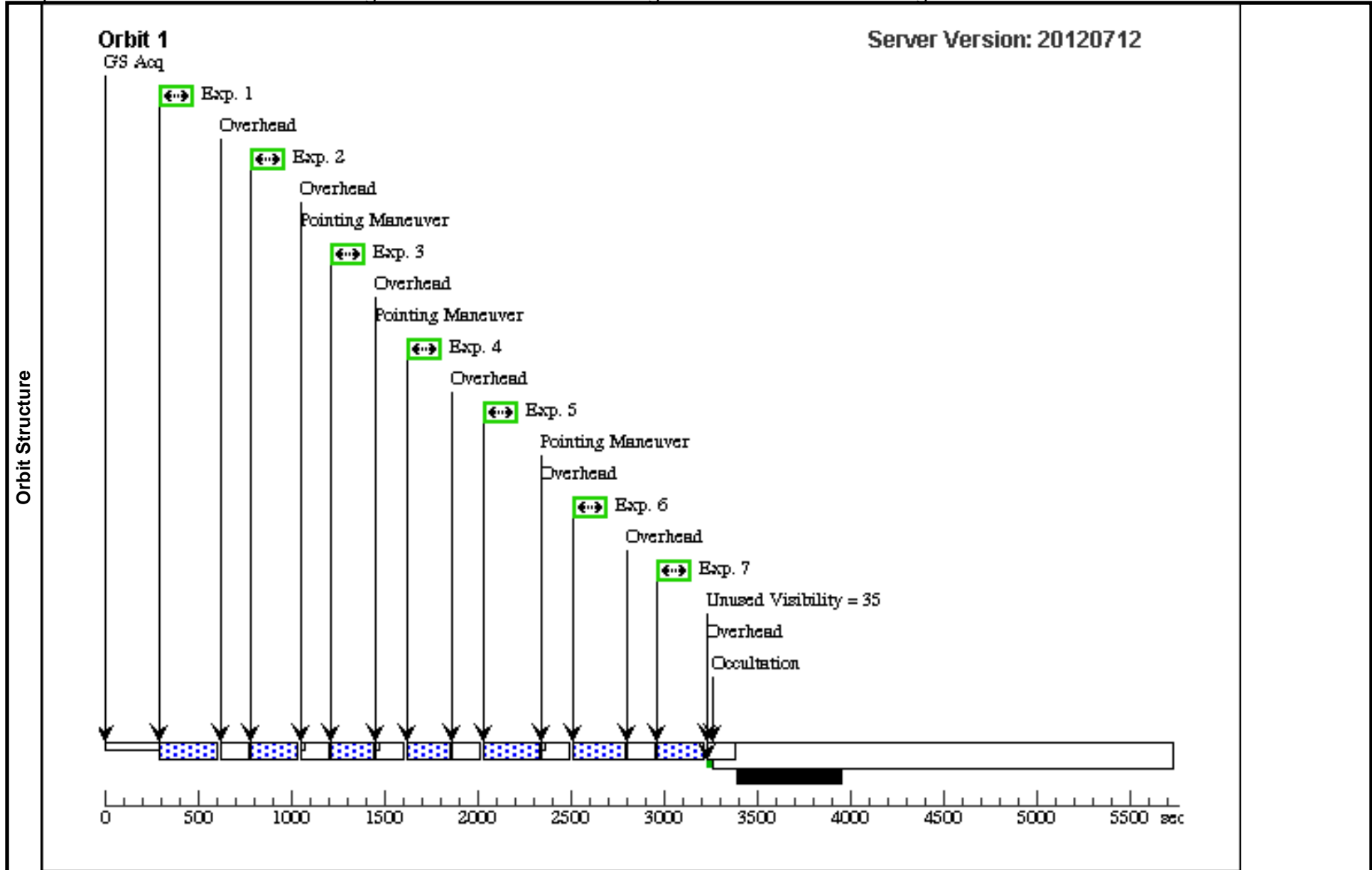
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 22.25,9; GS ACQ SCENARI O BASE1B3		280 Secs [==>]	[1]
	2		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 1		200 Secs [==>]	[1]
	3		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG 10.37,20 .85		200 Secs [==>]	[1]
	4		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG -1.45,8. 95		200 Secs [==>]	[1]
	5		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG -1.45,8. 95		280 Secs [==>]	[1]
	6		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 10.48,-2 .85		280 Secs [==>]	[1]
	7		(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 6		200 Secs [==>]	[1]



Proposal 12670 - Visit 05 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:06 GMT 2012

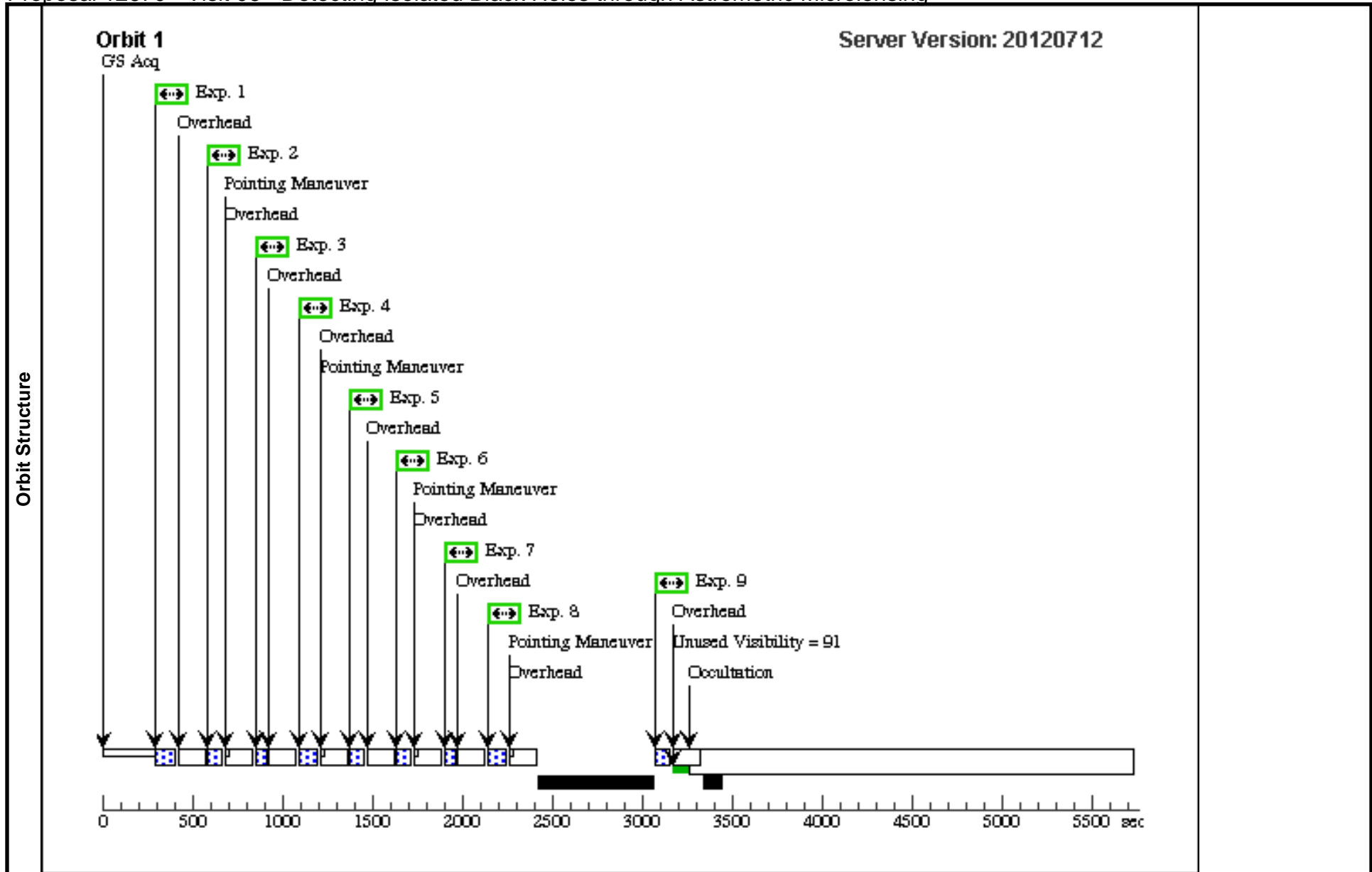
Fixed Targets	Visit									
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	OGLE-2011-BLG-310	RA: 17 51 25.3900 (267.8557917d) Dec: -30 24 35.00 (-30.40972d) Equinox: J2000		V=18	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 22.25,9; GS ACQ SCENARI O BASE1B3		280 Secs [==>]	[1]
	2		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 1		230 Secs [==>]	[1]
	3		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG 10.37,20 .85		230 Secs [==>]	[1]
	4		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG -1.45,8. 95		230 Secs [==>]	[1]
	5		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG -1.45,8. 95		280 Secs [==>]	[1]
	6		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 10.48,-2 .85		280 Secs [==>]	[1]
	7		(3) OGLE-2011-BL G-310	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 6		230 Secs [==>]	[1]



Proposal 12670 - Visit 06 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:08 GMT 2012

Visit	Proposal 12670, Visit 06, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 04-MAY-2012 AND 08-MAY-2012									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(2)	OGLE-2011-BLG-0037	RA: 17 55 55.8300 (268.9826250d) Dec: -30 33 39.70 (-30.56103d) Equinox: J2000		V=17.5	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 10.4,9.0; GS ACQ SCENARI O BASE1B3		80 Secs [==>]	[1]
	2	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 1		60 Secs [==>]	[1]
	3	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 22.25,9.0		60 Secs [==>]	[1]
	4	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 3		80 Secs [==>]	[1]
	5	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 16.31,19.27		80 Secs [==>]	[1]
	6	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 5		60 Secs [==>]	[1]
	7	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 4.45,19.25		60 Secs [==>]	[1]
	8	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 7		80 Secs [==>]	[1]
	9	(2) OGLE-2011-BL G-0037	(2) OGLE-2011-BL G-0037	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG -1.45,8.95		60 Secs [==>]	[1]



Proposal 12670 - Visit 07 - Detecting Isolated Black Holes through Astrometric Microlensing

Wed Aug 08 01:05:09 GMT 2012

Visit	Proposal 12670, Visit 07 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 02-SEP-2012:00:00:00 AND 15-SEP-2012:00:00:00									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(4)	OGLE-2011-BLG-462	RA: 17 51 40.1900 (267.9174583d) Dec: -29 53 26.30 (-29.89064d) Equinox: J2000		V=20.25+/-0.1	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 22.25,9; GS ACQ SCENARI O BASE1B3		290 Secs [==>]	[1]
	2	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 1		190 Secs [==>]	[1]
	3	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG 10.37,20 .85		190 Secs [==>]	[1]
	4	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	POS TARG -1.45,8. 95		190 Secs [==>]	[1]
	5	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG -1.45,8. 95		290 Secs [==>]	[1]
	6	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W	CR-SPLIT=NO	POS TARG 10.48,-2 .85		290 Secs [==>]	[1]
	7	(4) OGLE-2011-BL G-462	(4) OGLE-2011-BL G-462	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	CR-SPLIT=NO	SAME POS AS 6		190 Secs [==>]	[1]

