



13049 - Measuring the physical properties of the Milky Way nuclear star cluster with proper motions

Cycle: 20, 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	(10) MW-NSC-V35 (11) MW-NSC-V36 (12) MW-NSC-V37 (13) MW-NSC-V38 (14) MW-NSC-V40 (15) MW-NSC-V41 (16) MW-NSC-V42 (17) MW-NSC-V43 (18) MW-NSC-V35-COPY (19) MW-NSC-V37-COPY (20) MW-NSC-V43-COPY (24) MW-NSC-V38-COPY-2 (25) NAME-SGR-A (26) NAME-SGR-A-OFFSET (27) MW-NSC-V41-OFFSET	WFC3/IR	5	12-Apr-2013 21:08:23.0	yes

5 Total Orbits Used

ABSTRACT

Nuclear star clusters have been proposed as a byproduct of galaxy formation, analogous to supermassive black holes, because their mass scales with host galaxy properties in a similar way as the (M_{bh} - σ) and (M_{bh} - M_{bulge}) relationships. While the nuclear star cluster at the center of the Milky Way offers us an opportunity to study such a system with a level of detail not possible in external galaxies, this potential has not been realized due to the impracticality in obtaining wide-field, high angular resolution, and high precision kinematic measurements from the ground. We propose to use WFC3 on HST to measure, for the first time, the proper motions of stars out beyond the half-light radius of the cluster (~7 pc). These observations will allow us to derive three fundamental properties of the cluster that have been poorly constrained in the past: (1) the total mass, (2) the distribution of mass, and (3) the rotational signature of the cluster. The underlying mass distribution and total mass are requirements for placing the Milky Way nucleus in context with galaxy scaling relationships. The rotational profile will provide constraints on the origin of the nuclear star cluster, offering perhaps a physical explanation for the link between supermassive black holes and nuclear star clusters.

OBSERVING DESCRIPTION

Our characterization of the nuclear star cluster will be conducted with both astrometric and three-filter photometric measurements. The Galactic center is optically obscured, therefore, all observations will be conducted with WFC3 in the near infrared. The specific requirements and exposure times for the astrometry and photometry are described below.

Astrometry

To achieve the science goals outlined in this proposal, we require a 3x3 mosaic with WFC3-IR to obtain complete azimuthal sampling out to 180" from the cluster center; this will enable a robust determination of the orientation of the cluster rotation as well as characterize the velocity anisotropy for mass modeling. As stated in the original proposal, we will include the central field in Cycle 20, which was not included in Cycle 18, and 19 because it was observed by another program; however, in Cycle 20, it is not observed by any other HST program, and the field is necessary to establish an astrometric reference frame. We will use the F153M medium band filter for astrometric measurements, because the broad-band H filter will saturate the bright stars ($H < 11$) before the first read. We estimate that with $t_{\text{int}}=249$ s using STEP50 readout pattern with 10 MULTIACCUM reads, we can efficiently achieve a SNR ~ 100 for $H=18$, which would be required for 1 mas astrometric precision (astrometric precision scales as 0.7 FWHM/SNR). This integration time and sampling mode requires 248 s to dump the WFC3 buffer, which can be done in parallel with the following exposure, thus minimizing readout overhead. Also importantly with this integration time, sources fainter than $H=15$ will be in no danger of saturation, ensuring that persistence will have minimal impact for most regions of the detector.

Each field will be composed of 4 dithers in sub-pixel step sizes to sample the pixel phase of the PSF to account for the under-sampled PSF of WFC3. We require that the orientation of the mosaic be the same in each cycle in order to perform precise relative astrometry. The Orient special requirement should be 90 degrees to combine this data set with that from cycle 19. We would also like the entire mosaic in F153M to be completed in 1 visit (5 orbits) in order to minimize drifts in the astrometry. To combine all fields, a 10" overlap between each field is necessary to include enough common stars to derive a robust transformation.

One additional fields adjacent to this mosaic (with a 10 arcsecond overlap) is observed to provide statistics on the number of bulge stars that may be present in our sample to gauge the effect of bulge contamination on our kinematic measurements of the cluster.

The astrometric experiment will require 5 orbits in Cycle 20.

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Sat Apr 13 01:08:44 GMT 2013

Visit	<p>Proposal 13049, Visit 01, scheduling</p> <p>Diagnostic Status: No Diagnostics</p> <p>Scientific Instruments: WFC3/IR</p> <p>Special Requirements: ORIENT 270D TO 271 D; AFTER 01-AUG-2013:00:00:00</p> <p><i>Comments: Astrometric fields. The orientation should be 270 in order to optimally combine with observations from cycle 18 and 19 in order to measure proper motions. We request that the observations be made with the same guide stars as cycle 18 (GO-12182) if possible. One adjacent field to the north-east of the mosaic is used for calibration of the effect of bulge star contamination in the cluster kinematic measurements. This cycle will include the central field as it will not be observed by any other HST program and is required to establish an astrometric reference frame for the mosaic. We also request that the observations be made after August 1st, 2013 in order to obtain a sufficient timebaseline between Cycle 19 and Cycle 20 to achieve our astrometric goals.</i></p>			
	Patterns	#	Primary Pattern	Secondary Pattern
(1)		Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=true	(1), (3), (4), (6), (7), (9), (10), (12), (13), (15)

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#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(10)	MW-NSC-V35	RA: 17 45 53.0746 (266.4711442d) Dec: -29 00 15.96 (-29.00443d) Equinox: J2000		V=14+/-0.1 J=9.7, H=7.2, K=6.0	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(11)	MW-NSC-V36	RA: 17 45 46.1714 (266.4423808d) Dec: -29 01 47.61 (-29.02989d) Equinox: J2000		V=14+/-0.1 J=9.5, H=8.6, K=8.3	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(12)	MW-NSC-V37	RA: 17 45 39.2683 (266.4136179d) Dec: -29 03 19.23 (-29.05534d) Equinox: J2000		V=14+/-0.1 J=9.5, H=8.6, K=6.8	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(13)	MW-NSC-V38	RA: 17 45 46.9441 (266.4456004d) Dec: -28 58 56.49 (-28.98236d) Equinox: J2000		V=14+/-0.1 J=9.7, H=7.2, K=6.0	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(14)	MW-NSC-V40	RA: 17 45 33.1377 (266.3880738d) Dec: -29 01 59.72 (-29.03326d) Equinox: J2000		V=14+/-0.1 J=9.1, H=7.5, K=6.7	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(15)	MW-NSC-V41	RA: 17 45 40.8135 (266.4200562d) Dec: -28 57 37.01 (-28.96028d) Equinox: J2000		V=14+/-0.1 J=11.0, H=10.0, K=8.1	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(16)	MW-NSC-V42	RA: 17 45 33.9104 (266.3912933d) Dec: -28 59 8.62 (-28.98573d) Equinox: J2000		V=14+/-0.1 J=10.9, H=9.8, K=8.3	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
(17)	MW-NSC-V43	RA: 17 45 27.0072 (266.3625300d) Dec: -29 00 40.20 (-29.01117d) Equinox: J2000		V=14+/-0.1 J=9.1, H=7.5, K=6.7	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					

Fixed Targets

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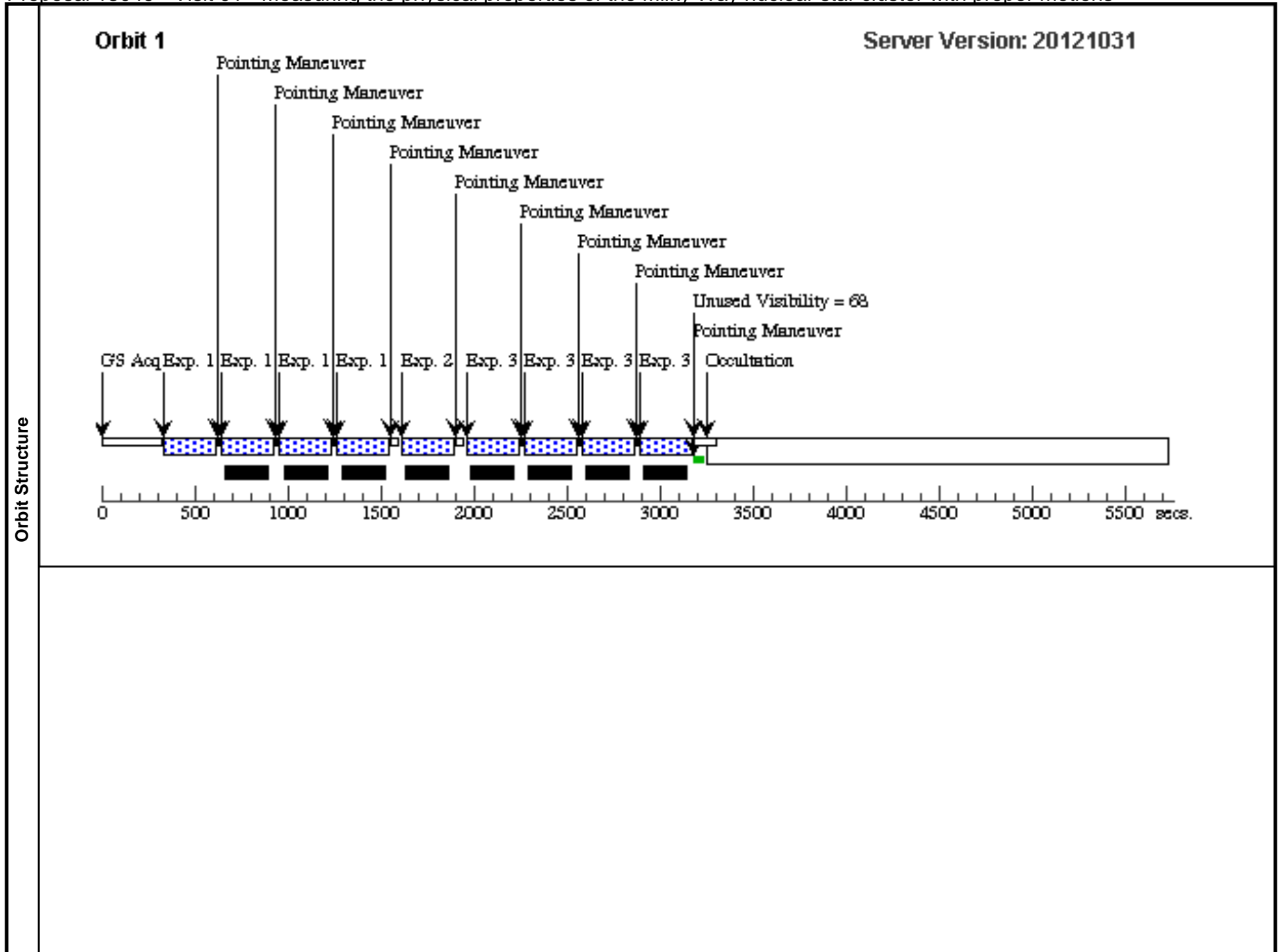
(18)	MW-NSC-V35-COPY	RA: 17 45 46.6310 (266.4442958d) Dec: -29 00 27.48 (-29.00763d) Equinox: J2000	V=14+/-0.1 J=9.7, H=7.2, K=6.0	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(19)	MW-NSC-V37-COPY	RA: 17 45 39.6121 (266.4150504d) Dec: -29 01 55.43 (-29.03206d) Equinox: J2000	V=14+/-0.1 J=9.5, H=8.6, K=6.8	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(20)	MW-NSC-V43-COPY	RA: 17 45 33.3962 (266.3891508d) Dec: -29 00 34.65 (-29.00963d) Equinox: J2000	V=14+/-0.1 J=9.1, H=7.5, K=6.7	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(24)	MW-NSC-V38-COPY-2	RA: 17 45 47.7699 (266.4490412d) Dec: -28 56 7.45 (-28.93540d) Equinox: J2000	V=14+/-0.1 J=9.7, H=7.2, K=6.0	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(25)	NAME-SGR-A	RA: 17 45 40.0409 (266.4168371d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000	V=14	Reference Frame: SIMBAD
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(26)	NAME-SGR-A-OFFSET	RA: 17 45 40.4659 (266.4186079d) Dec: -28 59 5.45 (-28.98485d) Equinox: J2000	V=14	Reference Frame: SIMBAD
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
(27)	MW-NSC-V41-OFFSET	RA: 17 45 44.4429 (266.4351788d) Dec: -28 56 50.34 (-28.94732d) Equinox: J2000	V=14+/-0.1 J=11.0, H=10.0, K=8.1	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				

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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
Exposures	1	(10) MW-NSC-V35	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 1-1 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(18) MW-NSC-V35- COPY	WFC3/IR, MULTIACCUM, IR-FIX	F153M	NSAMP=10; SAMP-SEQ=STEP5 0	POS TARG 0,0		[==>]	[1]
	3	(11) MW-NSC-V36	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 3-3 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	4	(12) MW-NSC-V37	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 4-4 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2]
	5	(19) MW-NSC-V37- COPY	WFC3/IR, MULTIACCUM, IR-FIX	F153M	NSAMP=10; SAMP-SEQ=STEP5 0	POS TARG 0,0		[==>]	[2]
	6	(14) MW-NSC-V40	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 6-6 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2]
	7	(17) MW-NSC-V43	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 7-7 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[3]
	8	(20) MW-NSC-V43- COPY	WFC3/IR, MULTIACCUM, IR-FIX	F153M	NSAMP=10; SAMP-SEQ=STEP5 0	POS TARG 0,0		[==>]	[3]
	9	(16) MW-NSC-V42	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 9-9 i n Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[3]
	10	(15) MW-NSC-V41	WFC3/IR, MULTIACCUM, IR-FIX	F153M	SAMP-SEQ=STEP5 0; NSAMP=10		Pattern 1, Exps 10-1 0 in Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[4]
	11	(27) MW-NSC-V41- OFFSET	WFC3/IR, MULTIACCUM, IR-FIX	F153M	NSAMP=10; SAMP-SEQ=STEP5 0	POS TARG 0,0		[==>]	[4]

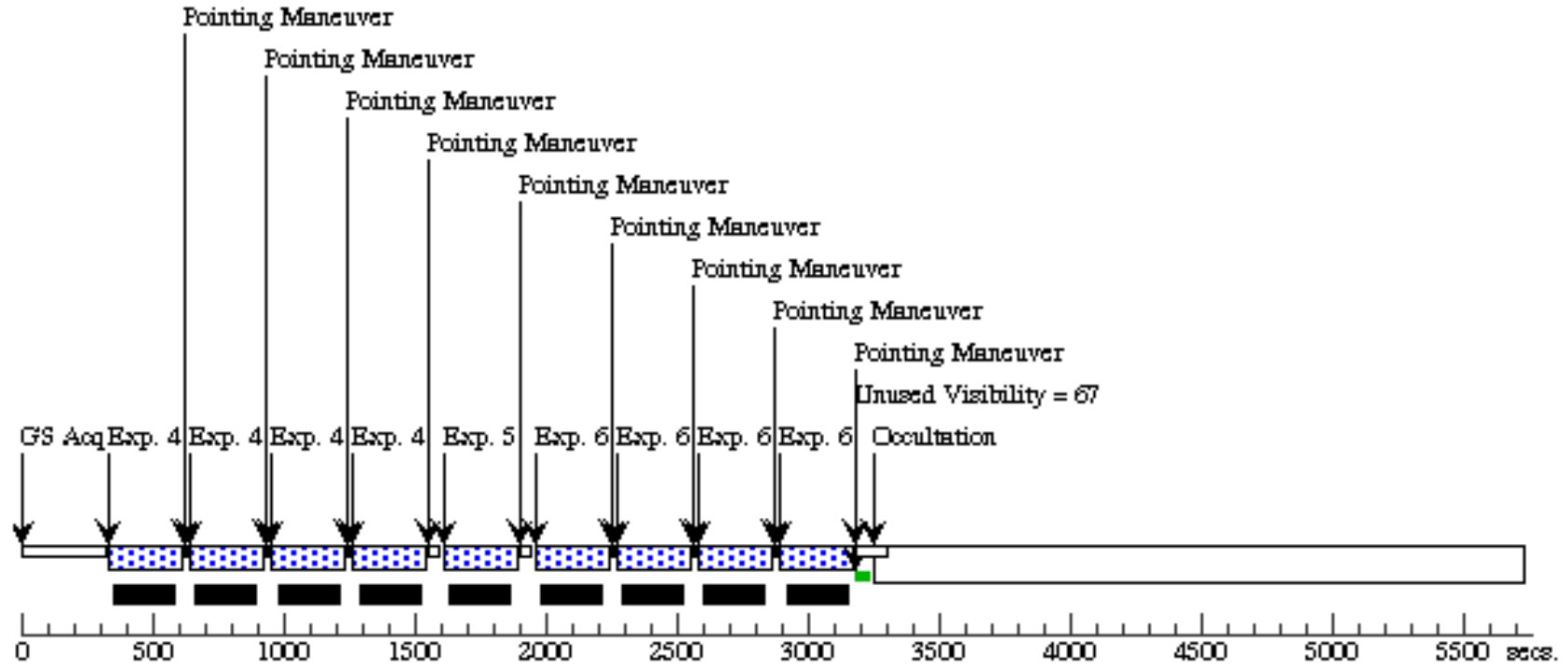
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12	(24) MW-NSC-V38- COPY-2	WFC3/IR, MULTIACCUM, IR-FIX F153M	SAMP-SEQ=STEP5 0; NSAMP=10	Pattern 1, Exps 12-1 2 in Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[4]
13	(25) NAME-SGR-A	WFC3/IR, MULTIACCUM, IR-FIX F153M	NSAMP=10; SAMP-SEQ=STEP5 0	Pattern 1, Exps 13-1 3 in Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[5]
14	(26) NAME-SGR-A- OFFSET	WFC3/IR, MULTIACCUM, IR-FIX F153M	NSAMP=10; POS TARG 0,0 SAMP-SEQ=STEP5 0		[==>]	[5]
15	(13) MW-NSC-V38	WFC3/IR, MULTIACCUM, IR-FIX F153M	SAMP-SEQ=STEP5 0; NSAMP=10	Pattern 1, Exps 15-1 5 in Visit 01 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[5]



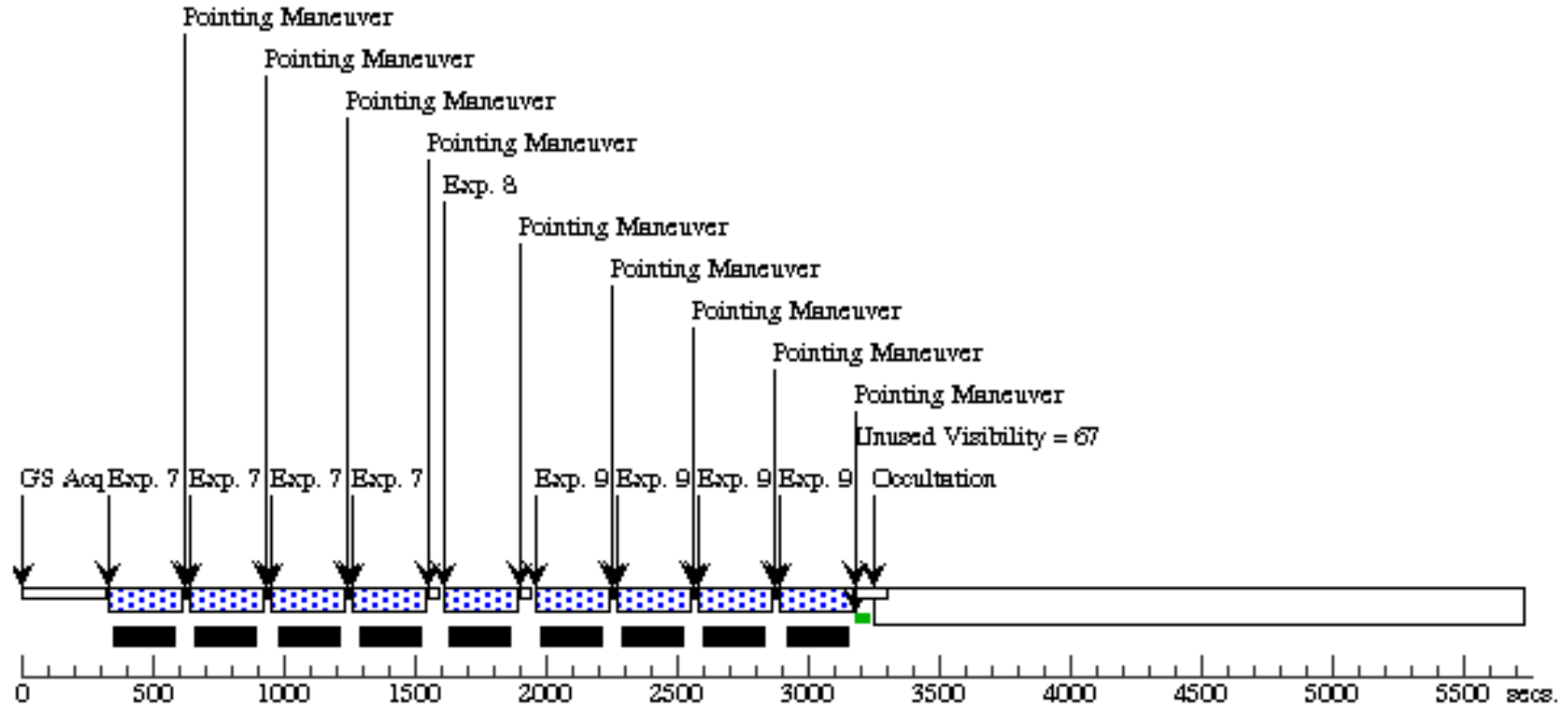
Orbit 2

Server Version: 20121031



Orbit 3

Server Version: 20121031



Orbit 4

Server Version: 20121031

