15346 - Verifying a candidate counterpart to gravitational waves

Cycle: 25, Proposal Category: GO

(Availability Mode: SUPPORTED)

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	(2) NGC4993OT	WFC3/UVIS	1	19-Oct-2017 18:18:45.0	yes
02	(2) NGC4993OT	WFC3/UVIS	1	19-Oct-2017 18:18:47.0	yes
03	(2) NGC4993OT	WFC3/IR	1	19-Oct-2017 18:18:48.0	yes
04	(2) NGC4993OT	WFC3/IR	1	19-Oct-2017 18:18:48.0	yes

4 Total Orbits Used

ABSTRACT

With advances in sensitivity of gravitational wave interferometers, the direct detection of neutron star mergers should be imminent. Identification of an electromagnetic counterpart would enable a wealth of astrophysics and answer the long-standing question of whether neutron star mergers are the

missing cosmic mines of heavy elements synthesized by the r-process. We will be searching for a fast-fading optical counterpart with the new Zwicky Transient Facility at Palomar Observatory. Here, we propose to use HST/WFC3 to look for infrared emission from a single, most-promising candidate optical counterpart. The infrared emission would serve as a direct diagnostic of the radioactive decay of heavy elements.

OBSERVING DESCRIPTION

We request one disruptive ToO with HST/WFC3.

With GROWTH network follow-up of ZTF candidates, we expect to identify a promising candidate (if any) and submit the ToO trigger within 36 hours of the neutron star merger. With HST, we request the first epoch within one week and the second epoch at three weeks (Figure 2). We need two epochs to determine the rate at which the emission fades. Given current models, we expect a non-detection in the second non-disruptive epoch but it would serve as an invaluable reference to subtract any host galaxy light.

Each epoch would comprise one orbit in each of two filters: F606W and F160W. We choose F160W as it is the reddest available infrared filter. We choose F606W as that would be closest to the discovery filter for ZTF. We run the ETC assuming 50 min of integration per orbit given overheads on account of target acquisition and multiple dithers. With F606W, we would reach a depth of 26.8 mag in 1 orbit and with H-band, we would reach a depth of 26.1 mag AB with S/N=10. With this depth, the F606W filter would be sensitive to opacity < 3 cm^2 / gm and neutron star mass > 3 x 10^(-5) Msun (see Figure 2). With this depth, the F160W filter would be sensitive to ejecta mass > 0.0001 Msun and a ejecta velocity > 0.05 c. We emphasize that HST is more sensitive in H-band than a ground-based telescope due to the strong OH airglow one has to look through from the ground. The sky background from space is 6-10 mag darker at H than from a good ground-based site (e.g., Sullivan & Simcoe 2012).

We request long-term status for both Cycles 25 and Cycles 26 for the following reasons: (i) The duration of the third advanced LIGO run is expected to be approximately 9-12 months between Summer 2018 and Spring 2019. This schedule spans both cycles 25 and cycles 26. (ii) The rates of neutron star mergers is uncertain by an order of magnitude. Assuming the realistic rate, we expect one trigger per month out to 150Mpc. Given the challenges in follow-up where we need the sun, moon and weather to co-operate, we conservatively only request one disruptive ToO trigger for our most promising candidate (see trigger criterion in next section).

Our total request is 4 HST orbits.

Visit

Proposal 15346, Visit 01, completed Thu Oct 19 22:18:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ON HOLD ; TOO RESPONSE TIME 5.0D

On Hold Comments: We request the first epoch within 1 week of merger.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)

Fixed Targets

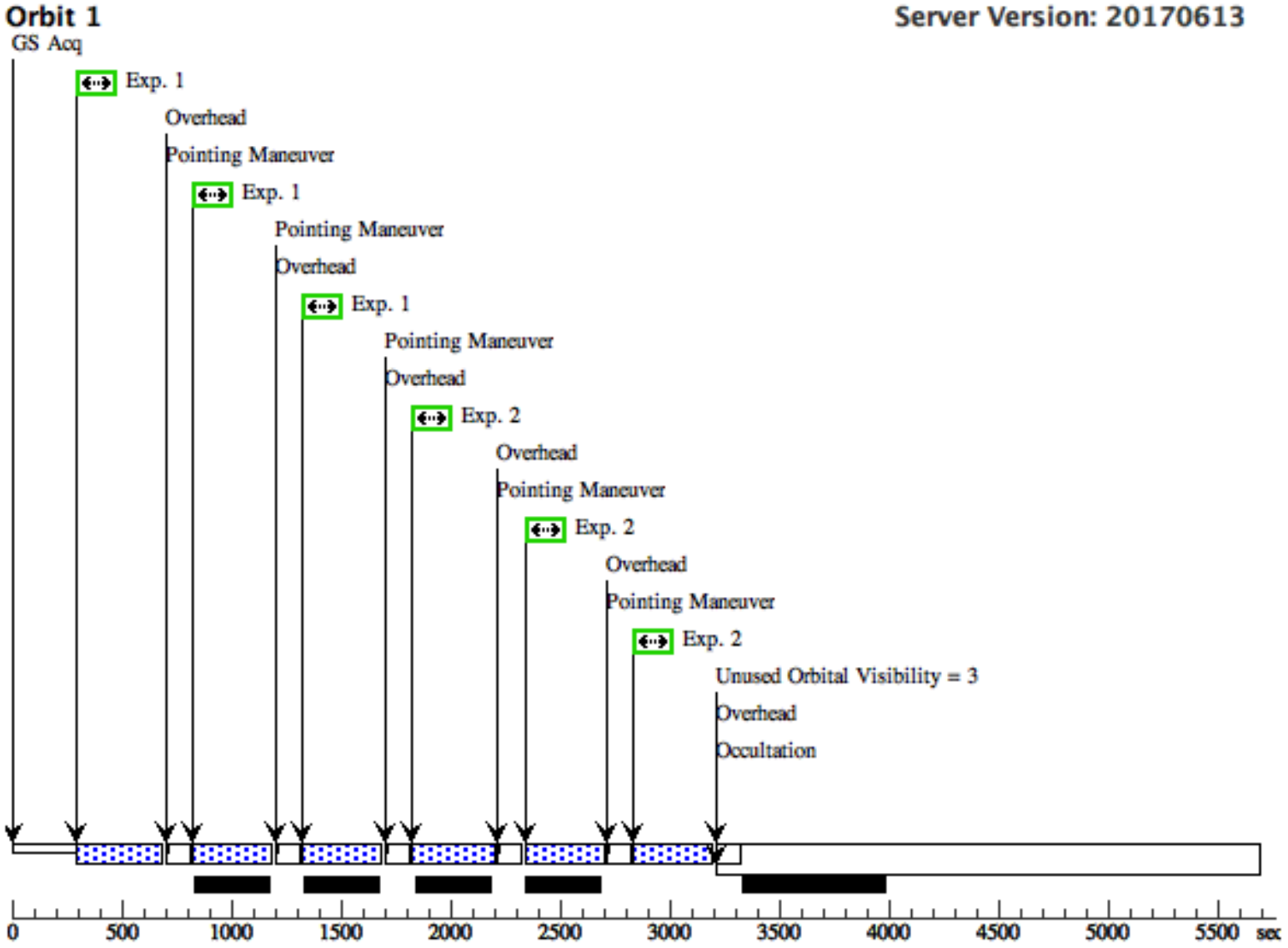
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC4993OT	RA: 13 09 48.0890 (197.4503708d) Dec: -23 22 53.35 (-23.38149d) Equinox: J2000		V=20.0	Reference Frame: ICRS

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC4993OT	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F336W	FLASH=12		Pattern 4, Exps 1-1 in Visit 01 (4)	363 Secs (1089 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(2) NGC4993OT	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F225W	FLASH=12		Pattern 4, Exps 2-2 in Visit 01 (4)	363 Secs (1089 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***

Orbit Structure



Visit

Proposal 15346, Visit 02, completed Thu Oct 19 22:18:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ON HOLD ; TOO RESPONSE TIME 5.0D; VISIBILITY INTERVAL 49 M

On Hold Comments: We request the first epoch within 1 week of merger.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)
(5)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

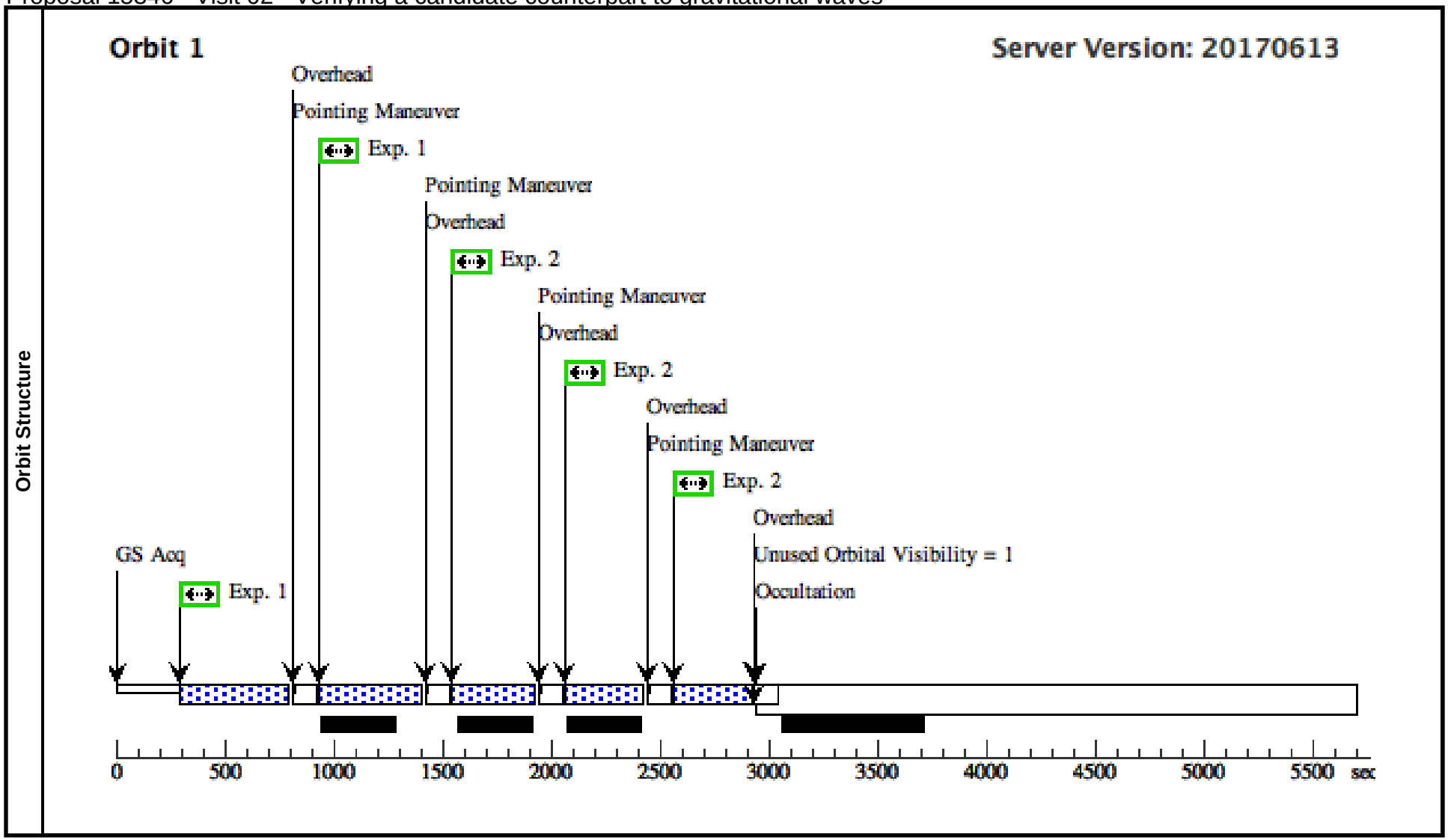
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC4993OT	RA: 13 09 48.0890 (197.4503708d) Dec: -23 22 53.35 (-23.38149d) Equinox: J2000		V=20.0	Reference Frame: ICRS

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC4993OT	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F336W	FLASH=12		Pattern 5, Exps 1-1 in Visit 02 (5)	473 Secs (946 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	*[1]*
2		(2) NGC4993OT	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F275W	FLASH=12		Pattern 4, Exps 2-2 in Visit 02 (4)	363 Secs (1089 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	*[1]*


Orbit 1
Server Version: 20170613
Orbit Structure
Overhead
Pointing Maneuver
Exp. 1
Pointing Maneuver
Overhead
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Overhead
Unused Orbital Visibility = 1
Occultation
GS Acq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15346, Visit 03, implementation Thu Oct 19 22:18:50 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: BETWEEN 01-DEC-2017:00:00:00 AND 10-DEC-2017:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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=false		(1)

Fixed Targets

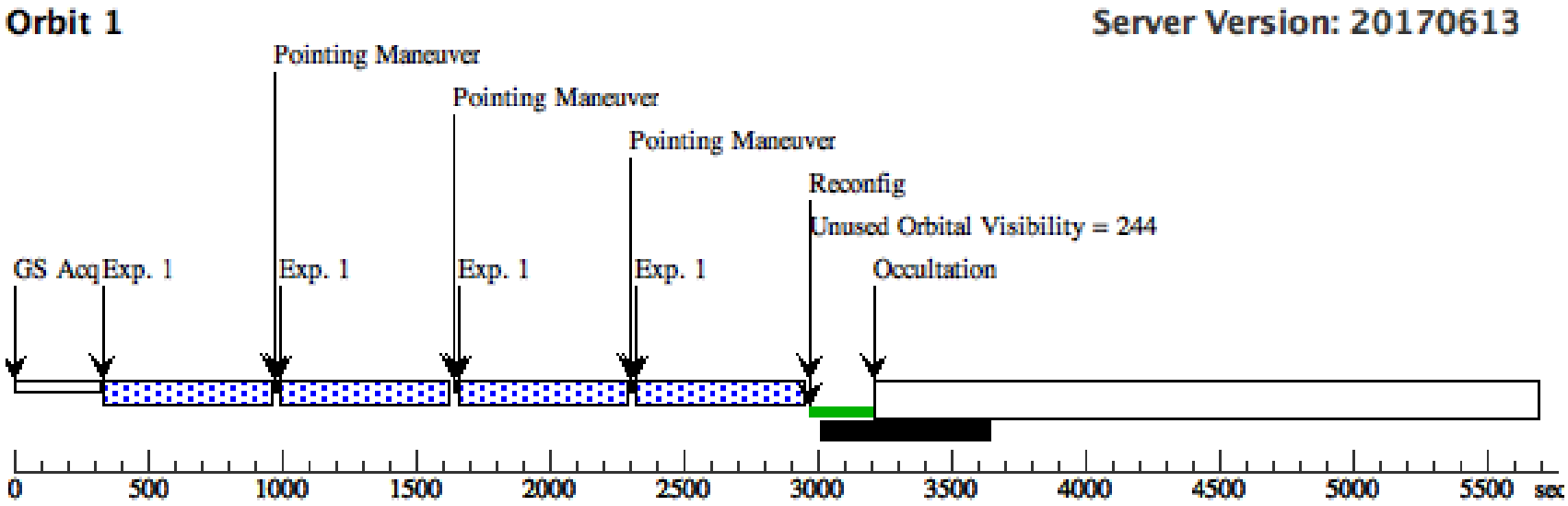
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC4993OT	RA: 13 09 48.0890 (197.4503708d) Dec: -23 22 53.35 (-23.38149d) Equinox: J2000		V=20.0	Reference Frame: ICRS

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC4993OT	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=7; SAMP-SEQ=SPARS100		Pattern 2, Exps 1-1 in Visit 03 (2)	602.934229 Secs (2411.737 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	*[1]*

Orbit Structure



Visit

Proposal 15346, Visit 04, implementation Thu Oct 19 22:18:50 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: AFTER 03 BY 30 D TO 120 D; ON HOLD

On Hold Comments: would like the data for visit 03 before refining visit 04

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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=false		(1)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC4993OT	RA: 13 09 48.0890 (197.4503708d) Dec: -23 22 53.35 (-23.38149d) Equinox: J2000		V=20.0	Reference Frame: ICRS

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC4993OT	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=7; SAMP-SEQ=SPARS100		Pattern 2, Exps 1-1 in Visit 04 (2)	602.934229 Secs (2411.737 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	*[1]*

Orbit Structure