16839 - Transient LMXBs in Globular Clusters

Cycle: 29, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Jeroen Homan (PI) (Contact)	**Eureka Scientific Inc.**	**jeroen@space.mit.edu**
Dr. David A. Pooley (CoI)	Eureka Scientific Inc.	dpooley@trinity.edu
Dr. Craig Heinke (CoI) (CSA Member)	University of Alberta	heinke@ualberta.ca
Dr. Maureen van den Berg (CoI) (Contact)	Harvard University	mvandenberg@cfa.harvard.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) M15-TRANSIENT	ACS/WFC	2	09-Oct-2022 21:00:16.0	yes
03	(1) M15-TRANSIENT	ACS/WFC	1	09-Oct-2022 21:00:18.0	yes
02	(2) GCTRANSIENT2	ACS/WFC	2	09-Oct-2022 21:00:20.0	yes

5 Total Orbits Used

ABSTRACT

Since the discovery of globular cluster LMXBs in the 1970s, it was long assumed there was only one luminous LMXB per cluster. Deep Chandra observations of globular clusters have revealed that they contain numerous quiescent LMXB systems, any of which could go into outburst. Past Chandra studies have shown that globular clusters can indeed harbor multiple transients and that more quiescent LMXBs are hiding under the sensitivity limits of even relatively deep Chandra exposures. Here we propose a Chandra program to precisely localize new transients in globular clusters, with the aim of gaining better insight into globular cluster LMXB populations. As part of this effort we further request HST observations to identify the optical counterparts of these transients.

OBSERVING DESCRIPTION

* General background for the program

The goal of this joint Chandra/HST Target-of-Opportunity (ToO) proposal is to measure accurate coordinates of the next two X-ray transients in a globular cluster with Chandra, and to use HST subsequently to look for their optical counterparts inside the Chandra positional error circles. The Chandra error circle is large enough (about 0.6" radius) that it likely contains multiple globular-cluster stars. Comparison of the photometry that is extracted from the observations requested here with photometry from archival HST data reveals highly variable objects in the error circle, and hence the identity of the true counterpart. Our choice for the ACS/WFC is driven by the existence of a large body of archival globular-cluster images taken with this camera. We have been allocated time to do Chandra/HST follow-up for two X-ray transients. For the HST component we were granted 4 HST orbits in total (2 orbits per transient).

* The first trigger (September 2022)

Early September 2022, MAXI and subsequently Swift detected an outburst of an X-ray transient in the globular cluster M15. This X-ray transient has not been confidently identified with any of the known low-mass X-ray binaries in the cluster. We have triggered our Chandra ToO program to obtain an accurate X-ray position of the source. The Chandra observations will be performed on **September 19, 2022**. We have triggered the HST component of our program to search for the optical counterpart.

* Visit 1

Our program for Visit 1 to observe M15 consists of observations in the F435W and F814W filters as there are already archival ACS data in these filters that we can use for comparison. The observations are organized in a 4-point dither-box pattern to improve the resolution. We aim for a S/N>10 for a star of mag 25 (F435W, F814W). We also include short observations to get photometry of bright stars, and of stars near bright stars. To fit all observation in one orbit, we make use of subarrays (aperture WFC1B-1K). The positional uncertainty on the X-ray transient fits well within this field-of-view.

*** Note added on Oct 9 2022: M15 was observed on Oct 3. The observations in orbit 1 of Visit 1 (named Visit-Transient1) were successful, but the observations in orbit 2 failed. The observations in orbit 2 will be repeated, see Visit-Transient1_repeat.

Visit

Proposal 16839, Visit-Transient1 (01), failed Mon Oct 10 01:00:20 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 60D TO 120 D; TOO RESPONSE TIME 25.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=true		(1), (2), (3), (4), (5)

Fixed Targets

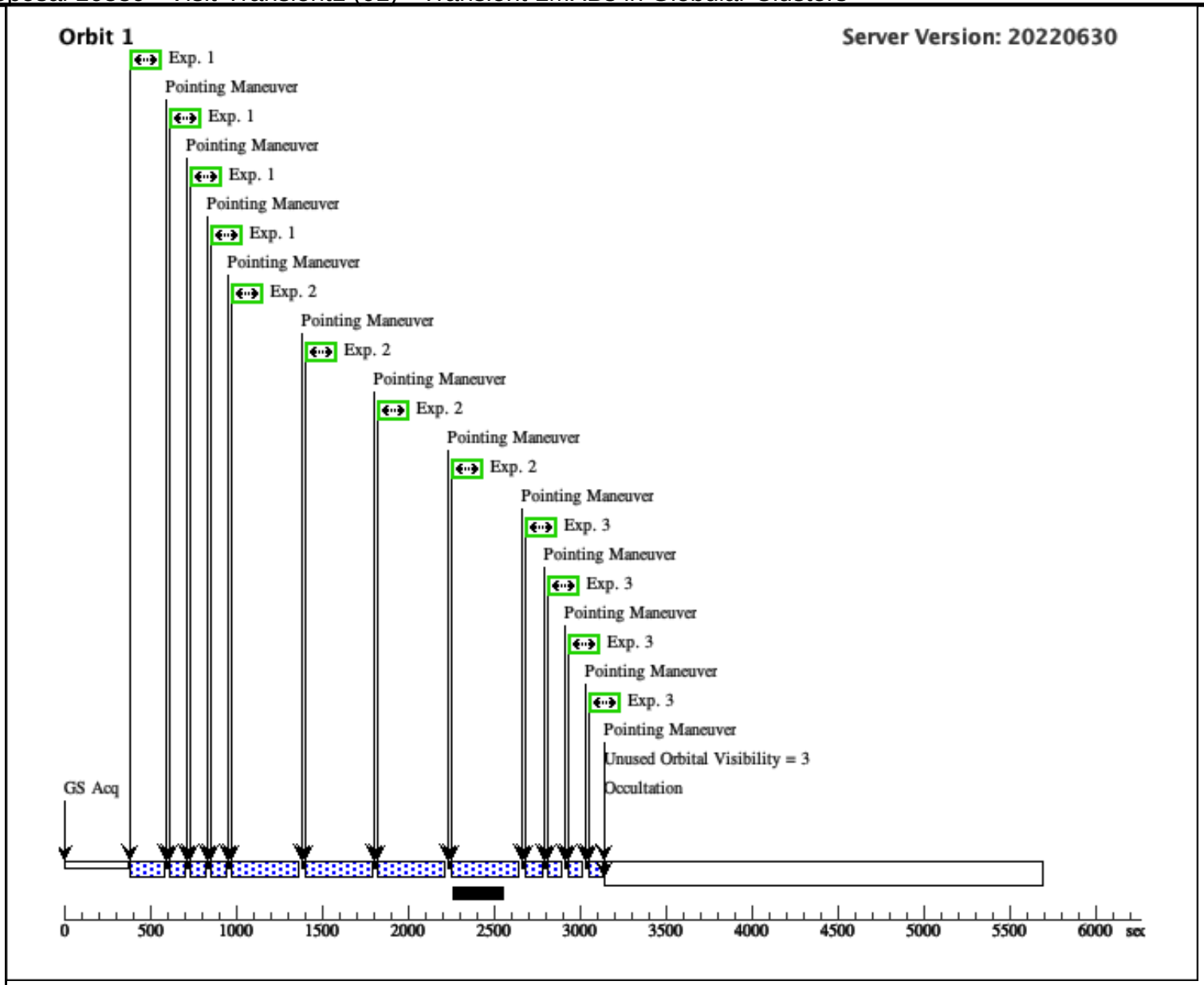
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M15-TRANSIENT	RA: 21 29 58.1240 (322.4921833d) Dec: +12 10 2.37 (12.16732d) Equinox: J2000		V=16	Reference Frame: ICRS

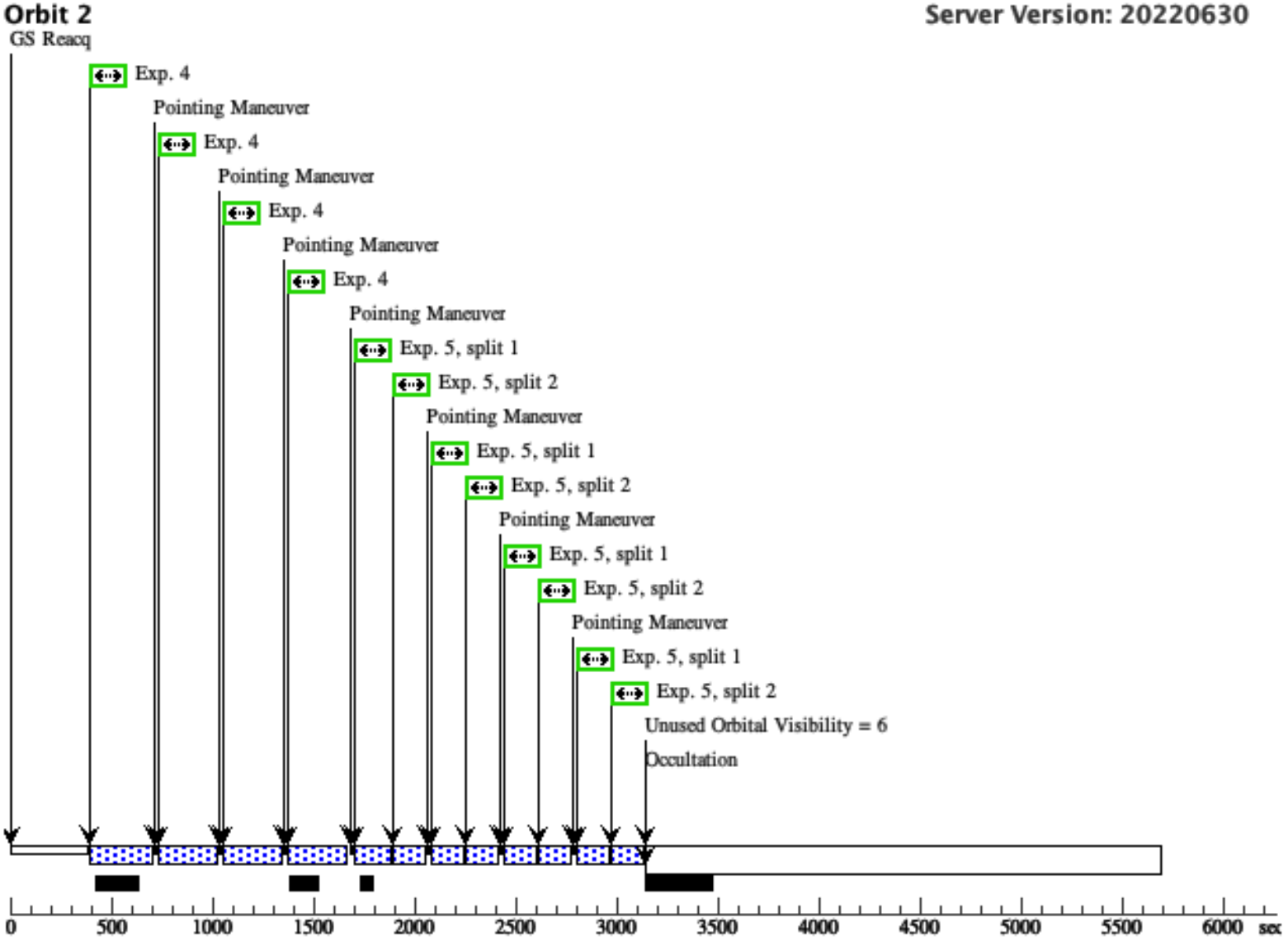
Comments: Our target is a to-be-identified star in the globular cluster M15. The counterpart that we aim to identify is expected to have a magnitude in F435W m(F435W) >~ 16.
Category=STELLAR CLUSTER
Description=[GLOBULAR CLUSTER]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	short-B-ditherbox	(1) M15-TRANSIENT	ACS/WFC, ACCUM, WFC1B-1K	F435W			Pattern 1, Exps 1-1 in Visit-Transient1 (01) (1)	15 Secs (60 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2	long-B-dithe rbox-1	(1) M15-TRANSIENT	ACS/WFC, ACCUM, WFC1B-1K	F435W			Pattern 1, Exps 2-2 in Visit-Transient1 (01) (1)	324 Secs (1296 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
3	short-I-dithe rbox	(1) M15-TRANSIENT	ACS/WFC, ACCUM, WFC1B-1K	F814W			Pattern 1, Exps 3-3 in Visit-Transient1 (01) (1)	10 Secs (40 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
4	long-B-dithe rbox-2	(1) M15-TRANSIENT	ACS/WFC, ACCUM, WFC1B-1K	F435W			Pattern 1, Exps 4-4 in Visit-Transient1 (01) (1)	220 Secs (880 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
5	long-I-dither box	(1) M15-TRANSIENT	ACS/WFC, ACCUM, WFC1B-1K	F814W	CR-SPLIT=2		Pattern 1, Exps 5-5 in Visit-Transient1 (01) (1)	168 Secs (672 Secs) *[==>(Pattern 1, Split 1)]* *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]* *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20220630
GS Reacq
Exp. 4
Pointing Maneuver
Exp. 4
Pointing Maneuver
Exp. 4
Pointing Maneuver
Exp. 4
Pointing Maneuver
Exp. 5, split 1
Exp. 5, split 2
Pointing Maneuver
Exp. 5, split 1
Exp. 5, split 2
Pointing Maneuver
Exp. 5, split 1
Exp. 5, split 2
Pointing Maneuver
Exp. 5, split 1
Exp. 5, split 2
Unused Orbital Visibility = 6
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16839, Visit-Transient1_repeat (03), implementation Mon Oct 10 01:00:20 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 60D TO 120 D; TOO RESPONSE TIME 25.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=true		(1), (2)

Fixed Targets

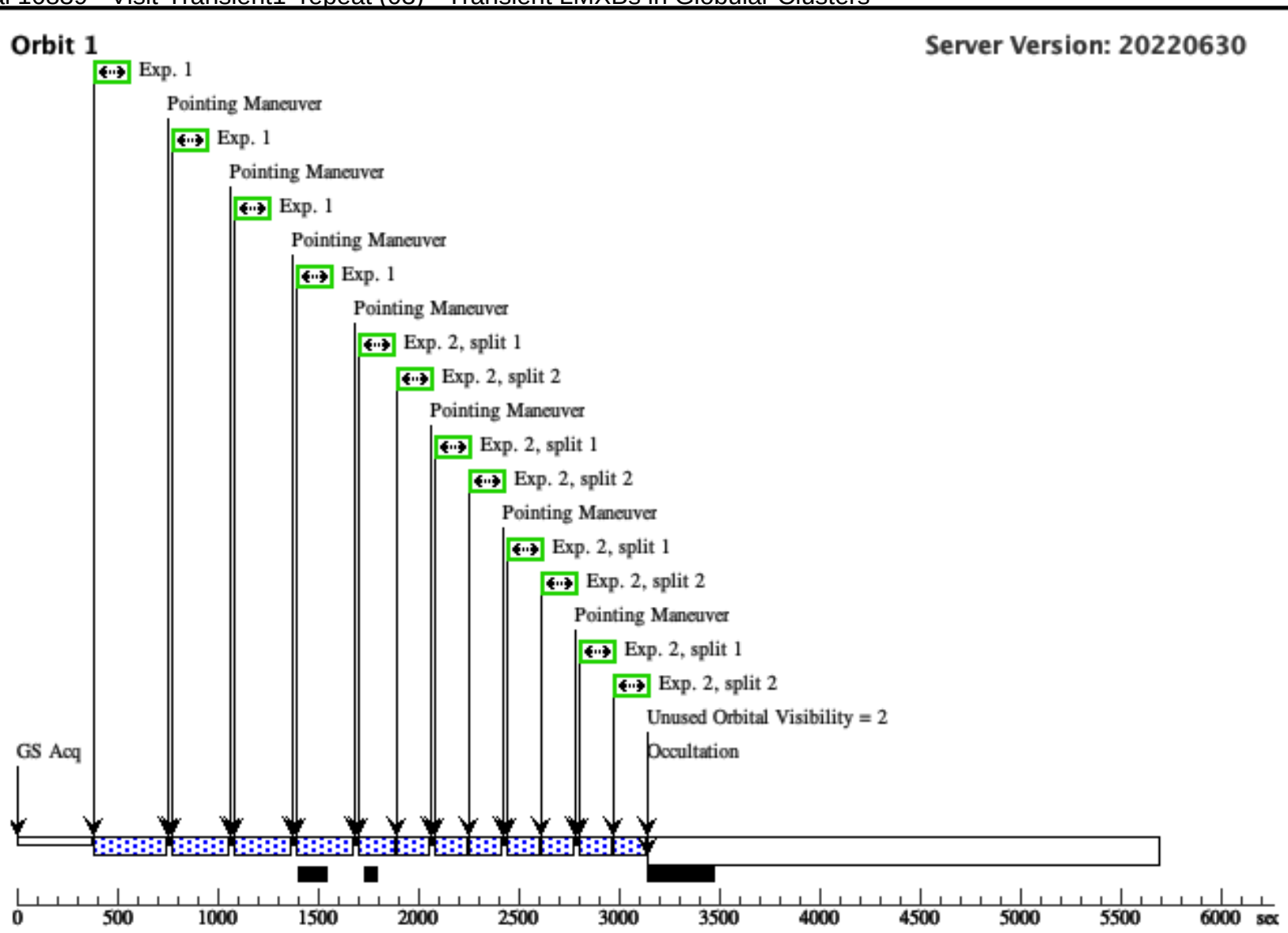
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M15-TRANSIENT	RA: 21 29 58.1240 (322.4921833d) Dec: +12 10 2.37 (12.16732d) Equinox: J2000		V=16	Reference Frame: ICRS

Comments: Our target is a to-be-identified star in the globular cluster M15. The counterpart that we aim to identify is expected to have a magnitude in F435W m(F435W) >~ 16.
Category=STELLAR CLUSTER
Description=[GLOBULAR CLUSTER]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	long-B-dithe rbox-2	(1) M15-TRANSIEN T	ACS/WFC, ACCUM, WFC1B-1K	F435W			Pattern 1, Exps 1-1 i n Visit-Transient1_re peat (03) (1)	208 Secs (832 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2	long-I-dither box	(1) M15-TRANSIEN T	ACS/WFC, ACCUM, WFC1B-1K	F814W	CR-SPLIT=2		Pattern 1, Exps 2-2 i n Visit-Transient1_re peat (03) (1)	168 Secs (672 Secs) *[==>(Pattern 1, Split 1)]* *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]* *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]*	***[1]***

Orbit Structure



Visit

Proposal 16839, Visit-Transient2 (02), implementation Mon Oct 10 01:00:21 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ON HOLD ; TOO RESPONSE TIME 25.0D

On Hold Comments: Target of Opportunity

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=true		(3), (6)

Generic Targets

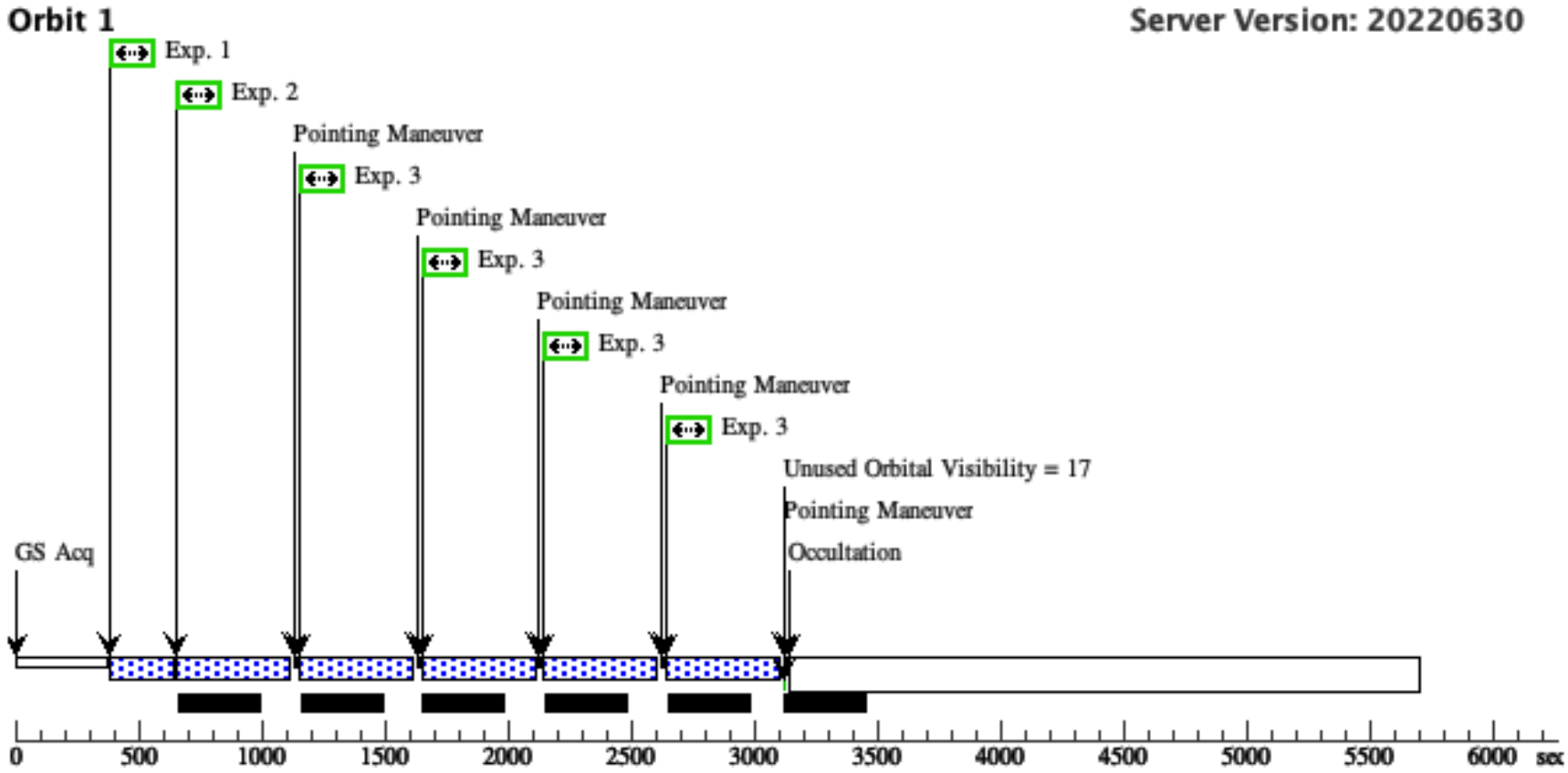
#	Name	Criteria	Description
(2)	GCTRANSIENT2	second trigger of globular-cluster X-ray transient program	X-RAY TRANSIENT

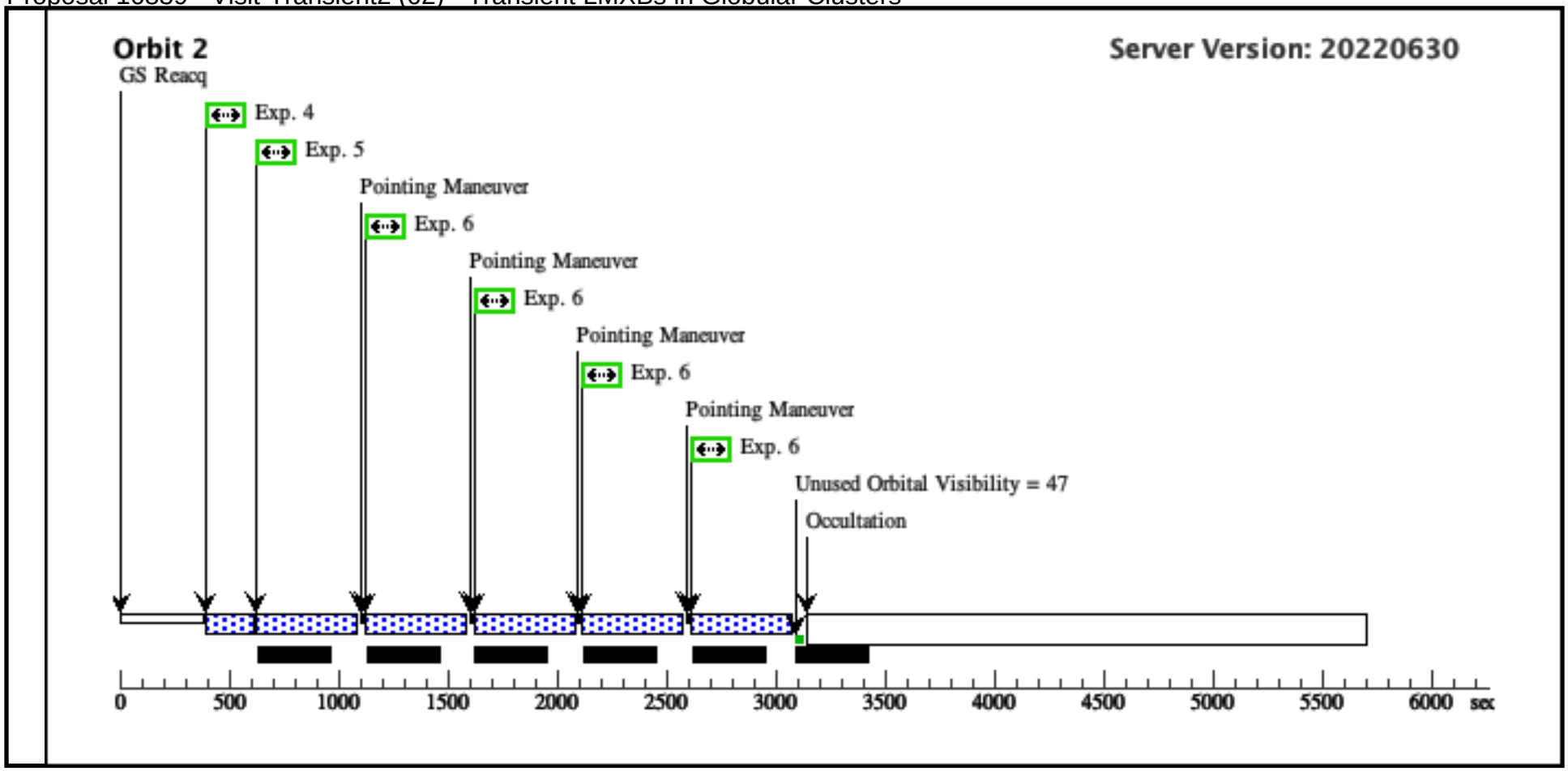
Comments: next X-ray transient discovered in a Galactic globular cluster, whose position can only be accurately determined with Chandra

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	short-V	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F606W	FLASH=25			30 Secs (30 Secs)	
								[==>]	***[1]***
2	long-V-centerbox	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F606W				340 Secs (340 Secs)	
								[==>]	***[1]***
3	long-V-ditherbox	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F606W			Pattern 1, Exps 3-3 in Visit-Transient2 (02) (1)	340 Secs (1360 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
4	short-I	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F814W	FLASH=25			30 Secs (30 Secs)	
								[==>]	***[2]***
5	long-I-centerbox	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F814W				340 Secs (340 Secs)	
								[==>]	***[2]***
6	long-I-ditherbox	(2) GCTRANSIENT2	ACS/WFC, ACCUM, WFC1	F814W			Pattern 1, Exps 6-6 in Visit-Transient2 (02) (1)	340 Secs (1360 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20220630
GS Reacq
Exp. 4
Exp. 5
Pointing Maneuver
Exp. 6
Pointing Maneuver
Exp. 6
Pointing Maneuver
Exp. 6
Pointing Maneuver
Exp. 6
Unused Orbital Visibility = 47
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec