



15086 - Age and mass of the star cluster around the intermediate-mass black hole HLX-1

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Roberto Soria (PI) (Contact)	Curtin University	roberto.soria@curtin.edu.au
Dr. Luca Zampieri (CoI) (ESA Member)	Osservatorio Astronomico di Padova	luca.zampieri@oapd.inaf.it
Dr. Sean A. Farrell (CoI)	University of Sydney	s.farrell@physics.usyd.edu.au

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) HLX-1	WFC3/IR	2	20-Jul-2017 15:06:10.0	yes
02	(1) HLX-1	ACS/SBC WFC3/UVIS	5	20-Jul-2017 15:06:14.0	yes

7 Total Orbits Used

ABSTRACT

We propose to study the optical counterpart of the intermediate-mass black hole (IMBH) HLX-1, about 3 years after its last X-ray outburst. Previous HST observations taken at epochs closer to an outburst show a variable near-UV/blue component, plus a constant red/near-IR component. The redder component probably comes from an old stellar population around the black hole; the bluer component may be a combination of emission from an irradiated accretion disk, and from a young stellar population. Their relative contributions and the age of the stellar population(s) are still subject of debate. By re-observing the system when the irradiated component is minimal, we will determine whether the near-UV/blue optical emission has

declined even further and whether the red/near-IR optical emission has stayed approximately constant. This will tell us whether the optical counterpart is a massive star cluster, and place a strong upper limit to the young stellar population around the IMBH. Having determined the constant contribution of the stellar emission, we will then insert it into broad-band models of the emission in outburst, and obtain a better estimate of the accretion disk parameters, constraining formation and evolution scenarios for the IMBH. We will use the same set of filters as in previous HST observations, for direct comparison of brightness and colors: F140LP (ACS SBC); F300X, F336W, F390W, F555W, F621M, F775W (WFC3 UVIS); F105W, F160W (WFC3 IR). We request a total of 7 orbits.

OBSERVING DESCRIPTION

Our proposed observations are a simple, straight-forward imaging of a point-like source, the optical counterpart of HLX-1 (likely, an unresolved star cluster), in the halo of the S0 galaxy ESO243-49. We want a broad-band coverage from the near-UV to the near-IR, to constrain the age of the stellar population and the contribution of X-ray irradiation. We will use the F140LP filter of ACS SBC, six filters of WFC3 UVIS (F300X, F336W, F390W, F555W, F775W) and two filters of WFC3 IR (F105W and F160W). This is exactly the same set of filters used for the HST observations in 2012 and 2013 (and most of them were also used in 2010), see Table 1 in the Phase I scientific justification. This will make it easy to look for variability from the previous epochs; in particular, we want to test whether there is further decrease of the near-UV/near-IR flux ratio.

In 2012 and 2013, one orbit was allocated for the ACS image, and 4 orbits for the 8 WFC3 filters. We report on those results in Soria et al. (2017).

This time we request 7 orbits instead of 5. The reasons for the increased time request are:

- i) we want to test whether the optical source keeps declining, as the X-ray outbursts get shorter and less frequent. We want to be able to constrain a brightness decline as small as about half a magnitude in U and V, within the uncertainties of the 2013 and 2017/8 observation. Also, in the IR filters, the source was only detected at a signal-to-noise ratio 7, because of the strong diffuse emission from the halo of ESO243-49 and the lower spatial resolution: this made it difficult to fit the spectrum and constrain the age of the old stellar component;
- ii) the small increase in target visibility (56 min per orbit instead of 55) compared with 2010 and 2013 makes it just long enough to efficiently spread the six WFC3 UVIS observations over 4 orbits, with 4-point box dithering and >339s per exposure, without buffer dumps.

Our suggested plan for the observations is:

VISIT 1:

-- orbit 1 for WFC3 IR F105W, with WFC3-IR-DITHER-BOX-MIN, 2600s;

-- orbit 2 for WFC3 IR F160W, with WFC3-IR-DITHER-BOX-MIN, 2800s;

VISIT 2:

-- orbit 1 for ACS SBC F140LP, 4-point box dithering, 2700s of effective exposure time;

-- orbit 2 for WFC3 UVIS F300X, with UV flashing and WFC3-UVIS-DITHER-BOX, approximately 1600s split into 4 exposures of 400s each.

Then, the first 2 exposures in the F336W filter, also with UV flashing and dithering, about 400s each;

-- orbit 3 for the last 2 exposures in the F336W filter, with UV flashing and dithering, about 400s each, total of 1600s (including those of orbit 4).

Then, all 4 exposures for F390W, dithered, 400s each, total of 1600s;

-- orbit 4 for WFC3 UVIS F555W, about 1600s split into 4 dithered exposures of 400s each. Then, the first 2 exposures in the F621M filter, also with dithering, about 400s each;

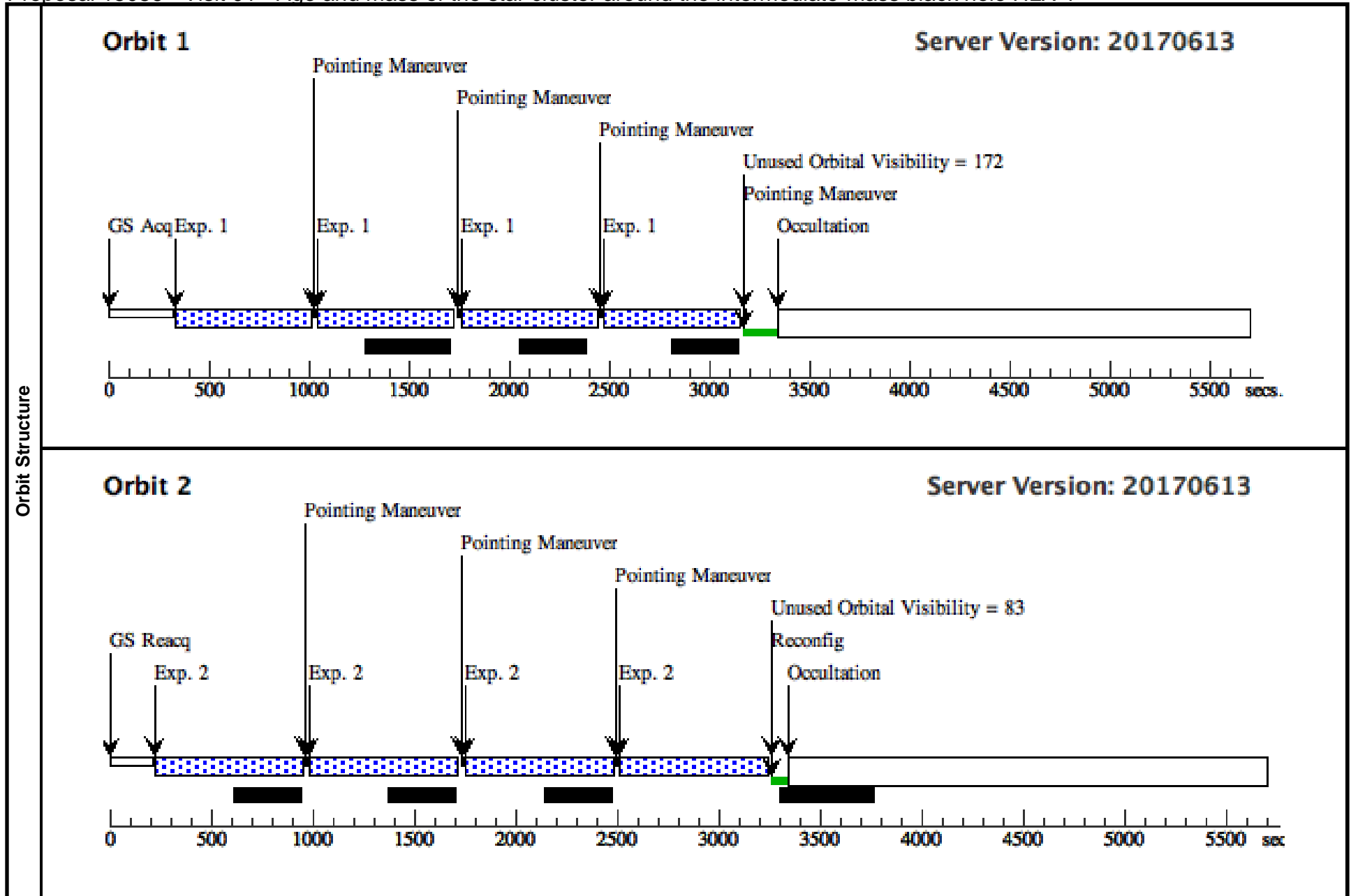
-- orbit 5 for the last 2 dithered exposures in the F621M filter, 4000s each, total of 1600s. Then, all 4 dithered exposures for F775W, 400s each, total of 1600s.

With this strategy, based on the Exposure Time Calculator and on our experience of the previous HST observations with the same set-up, we will reach signal-to-noise >10 in all filters, even if the brightness decline continues as seen between 2010 and 2013.

Proposal 15086 - Visit 01 - Age and mass of the star cluster around the intermediate-mass black hole HLX-1

Thu Jul 20 19:06:16 GMT 2017

Visit	Proposal 15086, Visit 01 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR Special Requirements: (none)									
	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), (2)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HLX-1	RA: 01 10 28.2700 (17.6177917d) Dec: -46 04 22.30 (-46.07286d) Equinox: J2000		V=25+/-0.5 U=24, I=24.5	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) HLX-1	WFC3/IR, MULTIACCUM, IR	F105W	NSAMP=14; SAMP-SEQ=SPAR S50			Pattern 2, Exps 1-1 in Visit 01 (2)	652.938154 Secs (2611.753 Secs)	[1]
2	(1) HLX-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S50			Pattern 2, Exps 2-2 in Visit 01 (2)	702.938605 Secs (2811.754 Secs)	[2]	



Proposal 15086 - Visit 02 - Age and mass of the star cluster around the intermediate-mass black hole HLX-1

Thu Jul 20 19:06:16 GMT 2017

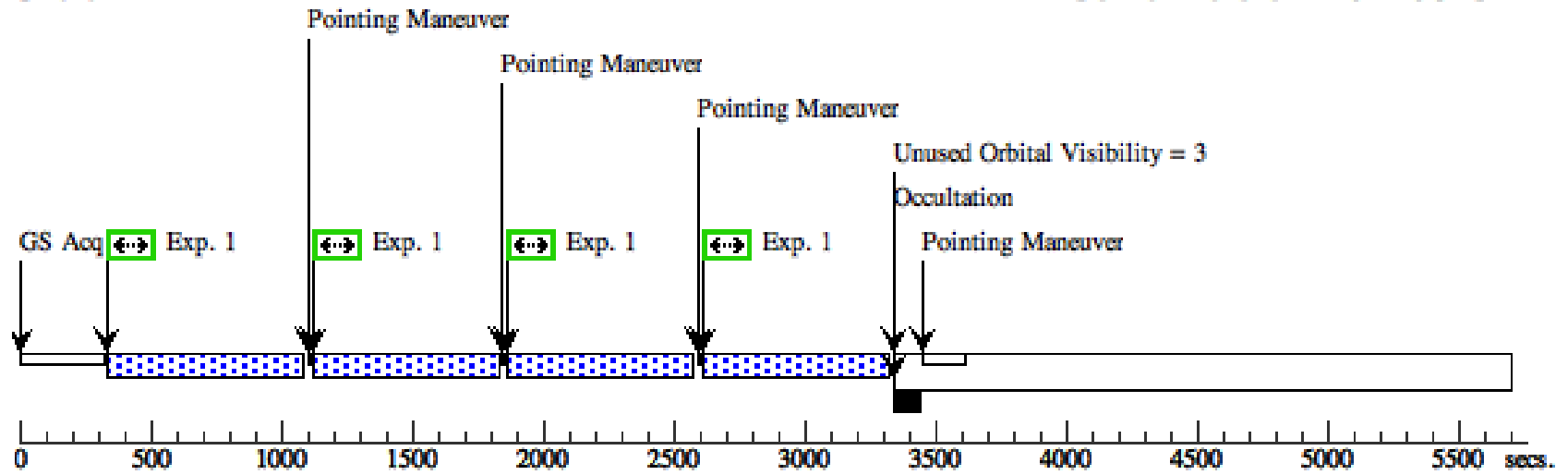
Visit	Proposal 15086, Visit 02 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS, ACS/SBC Special Requirements: (none)					
	#	Primary Pattern	Secondary Pattern	Exposures		
Patterns	(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.179 Line Spacing=0.116 Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false		(1)		
	(3)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(2), (3), (4), (5), (6), (7)		
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	HLX-1	RA: 01 10 28.2700 (17.6177917d) Dec: -46 04 22.30 (-46.07286d) Equinox: J2000		V=25+/-0.5 U=24, I=24.5	Reference Frame: ICRS

Proposal 15086 - Visit 02 - Age and mass of the star cluster around the intermediate-mass black hole HLX-1

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
Exposures	1	(ACS.im.1011865)	(1) HLX-1	ACS/SBC, ACCUM, SBC	F140LP		Pattern 1, Exps 1-1 in Visit 02 (1)	675 Secs (2748 Secs) [=>687.0 Secs (Pattern 1)] [=>687.0 Secs (Pattern 2)] [=>687.0 Secs (Pattern 3)] [=>687.0 Secs (Pattern 4)]	[1]	
	<p><i>Comments: ACS.im.1011860 ETC run done using the well-determined Vega brightness in the U band and the best-fitting model spectrum. ACS.im.1011865 ETC run done using the observed flux density at 1500 Ang, from 2013. The two runs give essentially the same result, S/N = 10 for the requested exposure time. This is our best estimate of how the source will look like in 6 months' time. However, it could turn out to be a factor of 2 brighter or fainter, so the S/N could be ~7 or ~15.</i></p>									
	2		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F300X	FLASH=12		Pattern 3, Exps 2-2 in Visit 02 (3)	384 Secs (1536 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[2]
	3		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F336W	FLASH=12		Pattern 3, Exps 3-3 in Visit 02 (3)	402 Secs (1571 Secs) [=>384.0 Secs (Pattern 1)] [=>383.0 Secs (Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[2] [3]
	4		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=10		Pattern 3, Exps 4-4 in Visit 02 (3)	403 Secs (1612 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[3]
	5		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F555W			Pattern 3, Exps 5-5 in Visit 02 (3)	402 Secs (1636 Secs) [=>409.0 Secs (Pattern 1)] [=>409.0 Secs (Pattern 2)] [=>409.0 Secs (Pattern 3)] [=>409.0 Secs (Pattern 4)]	[4]
	6		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F621M	FLASH=6		Pattern 3, Exps 6-6 in Visit 02 (3)	402 Secs (1629 Secs) [=>409.0 Secs (Pattern 1)] [=>408.0 Secs (Pattern 2)] [=>406.0 Secs (Pattern 3)] [=>406.0 Secs (Pattern 4)]	[4] [5]
7		(1) HLX-1	WFC3/UVIS, ACCUM, UVIS2	F775W	FLASH=6		Pattern 3, Exps 7-7 in Visit 02 (3)	402 Secs (1612 Secs) [=>403.0 Secs (Pattern 1)] [=>403.0 Secs (Pattern 2)] [=>403.0 Secs (Pattern 3)] [=>403.0 Secs (Pattern 4)]	[5]	

Orbit 1

Server Version: 20170613



Orbit Structure

