



## 16080 - Resolving the Host Galaxies of Fast Radio Bursts

Cycle: 27, Proposal Category: GO

(UV Initiative)

(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) FRB190711	WFC3/UVIS	1	28-Apr-2020 15:00:17.0	yes
02	(1) FRB190711	WFC3/IR	1	28-Apr-2020 15:00:19.0	yes
03	(2) FRB190714	WFC3/UVIS	1	28-Apr-2020 15:00:19.0	yes
04	(2) FRB190714	WFC3/IR	1	28-Apr-2020 15:00:20.0	yes

<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>
05	(3) FRB191001	WFC3/UVIS	1	28-Apr-2020 15:00:21.0	yes
06	(3) FRB191001	WFC3/IR	1	28-Apr-2020 15:00:22.0	yes
Z3	(2) FRB190714	WFC3/UVIS	1	28-Apr-2020 15:00:23.0	yes

7 Total Orbits Used

## **ABSTRACT**

Fast Radio Bursts (FRBs) are an enigmatic class of extragalactic object, whose study so far has been almost exclusively the domain of radio telescopes due to the inability to localize them to better than a few arcminutes. We propose to use HST to spatially resolve the morphology and distribution of star formation and stellar mass for the host galaxies of three new non-repeating FRBs localized to <1" accuracy by the Australian SKA Pathfinder telescope. Analogous to previous advances with gamma-ray bursts, supernovae, and gravitational-wave counterparts, we will explore the origin of these FRBs through detailed examination of their host galaxies. By contrast with the dwarf galaxy host of the unusual repeating FRB 121102, our complementary ground-based observations have shown these non-repeating FRBs to lie in the outskirts of more massive galaxies with a range of star formation rates. However only HST offers the spatial resolution necessary to match the precision of the radio localizations in the ultraviolet through near-infrared that is required to properly characterize their environment, and thereby shed light on the nature of their progenitor objects. We request mid-cycle observations as this unique set of non-repeating FRBs with low positional uncertainties have been identified and localized since the cycle 27 deadline, and we wish rapid turn around given the rapidly changing, exciting, and high-impact nature of the FRB field. The proposed observations, when combined with an ongoing Cycle 27 program, would provide the first comprehensive high-resolution sample of galaxies hosting non-repeating FRBs to solve the riddle of their progenitors.

## **OBSERVING DESCRIPTION**

This program images three newly discovered FRB host galaxies to measure the distributions of the star formation and mass using WFC3 UVIS and IR. The sources are all moderately luminous galaxies at redshifts <0.5, enabling the observations in a single orbit per filter. The FUV and NUV will be sampled by the WFC3/UVIS F300X filter. This filter is the broadest FUV/NUV filter available on HST enabling us to trace recent star formation via young stars. This cleanly samples the rest-frame FUV and NUV continuum of our galaxies and provides the highest throughput possible for morphological measurements. The NIR will be sampled by the WFC3/IR F160W filter. This is the reddest wide filter available on HST to measure the distribution of the stellar mass as traced by the old stellar populations.

## Proposal 16080 (STScI Edit Number: 1, Created: Tuesday, April 28, 2020 at 2:00:23 PM Eastern Standard Time) - Overview

In order to obtain images clean of cosmic rays and image artifacts and sampling the PSF phase, we use a minimum of four dither positions. For the UV measurements we will obtain four exposures, which also ensures no saturation for our bright targets. Given the short exposure times in F300X, this requires us to utilize 17e- post-flash to reach 20e- per pixel. To maximize UV throughput and minimize our pixel-based CTE correction, we place the target on chip 2 close to the readout. For the NIR observations, we wish to stay in the linear regime and minimize persistence with our bright targets, and therefore will use SPAR25 with NSAMP of 15 or 14. Since this sets the exposure time per dither position, we end up with 7 dither positions per orbit.

For the WFC3/UVIS exposures we use a dither pattern that is 5 times the standard box pattern to remove residual background patterns and enable sky darks. For the WFC3/IR exposures we use the 7-point wide dither pattern from WFC3 ISR 2016-14 (pg 17) to get a good dither for the pixel phase and artifact mitigation. We multiply those values by 3 to better deal with IR blobs, and self persistence.

We do not place any orient constraints on the program, which makes this easy to schedule. We therefore do not foresee any issues if we have to go to 1 gyro mode. We note that this means that the UV and IR overlap in our area of interest, but depending on the orient they will not overlap significantly in other areas.

Proposal 16080 - FRB190711UV (01) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:23 GMT 2020

<b>Visit</b>	<b>Proposal 16080, FRB190711UV (01), scheduling</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/UVIS Special Requirements: (none)
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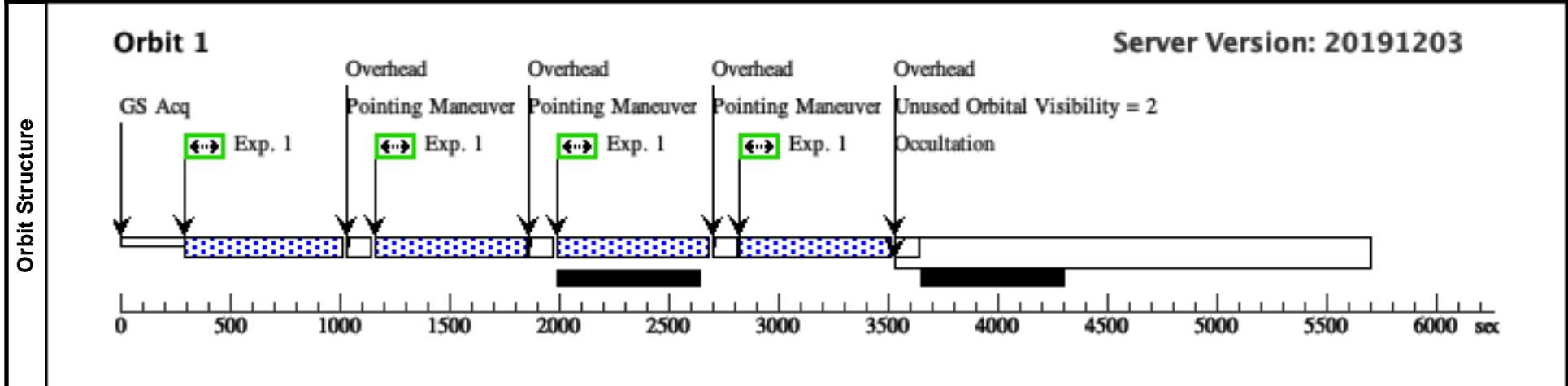
<b>Diagnostics</b>	(Exposure 1 (Pattern 1, Exps 1-1 in FRB190711UV (01))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser
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<b>Patterns</b>	#	<b>Primary Pattern</b>	<b>Secondary Pattern</b>	<b>Exposures</b>
	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.865 Line Spacing=0.56 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

<b>Fixed Targets</b>	#	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>
	(1)	FRB190711	RA: 21 57 40.6560 (329.4194000d) Dec: -80 21 28.58 (-80.35794d) Equinox: J2000		V=23.7+/-0.3	Reference Frame: ICRS

*Comments:*  
 Category=GALAXY  
 Description=[HIGH REDSHIFT GALAXY]

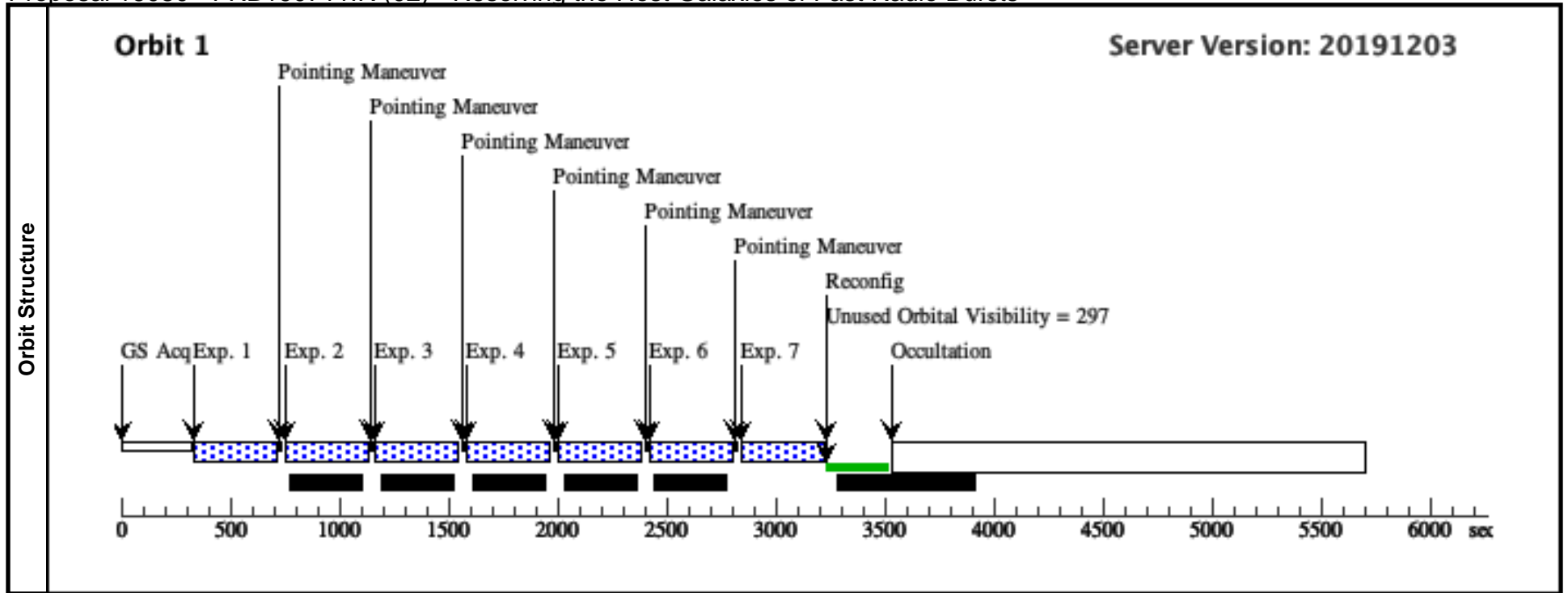
<b>Exposures</b>	#	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	(1) FRB190711	(1) FRB190711	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F300X	FLASH=17		Pattern 1, Exps 1-1 in FRB190711UV (01) (1)	623 Secs (2780 Secs) [=>695.0 Secs (Pattern 1)] [=>695.0 Secs (Pattern 2)] [=>695.0 Secs (Pattern 3)] [=>695.0 Secs (Pattern 4)]	[1]



Proposal 16080 - FRB190711IR (02) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:23 GMT 2020

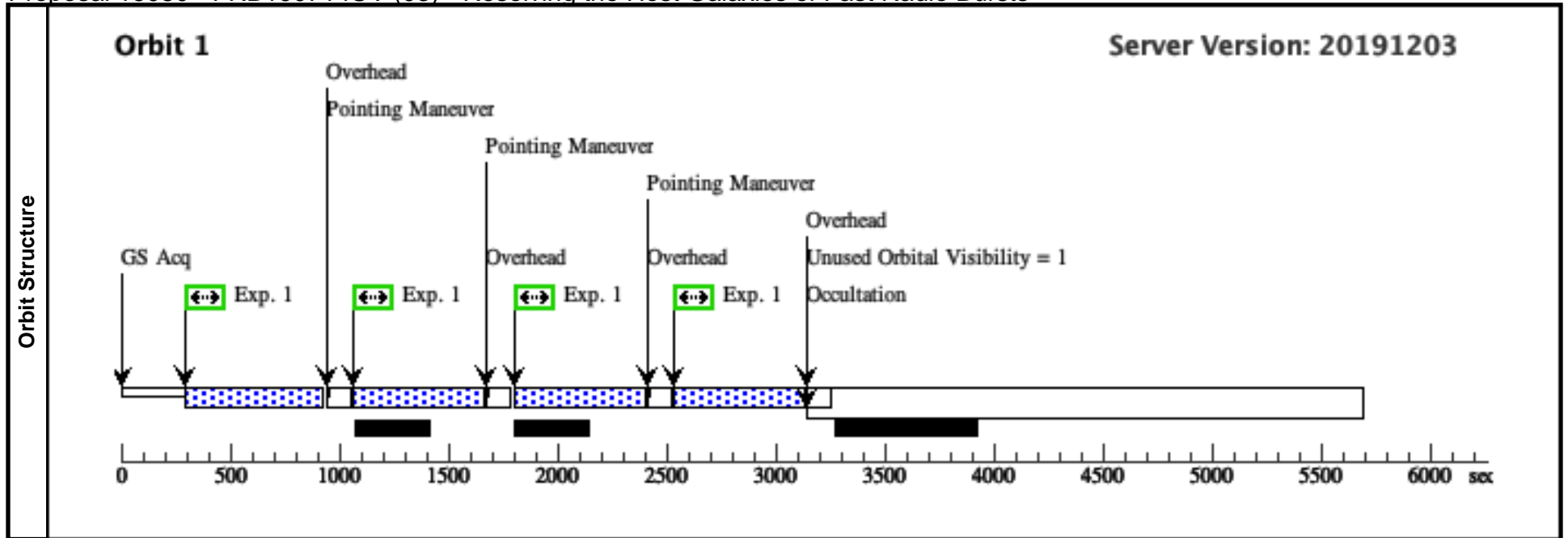
Visit	<b>Proposal 16080, FRB190711IR (02), scheduling</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR Special Requirements: (none)									
	Fixed Targets	# <b>Name</b> <b>Target Coordinates</b> <b>Targ. Coord. Corrections</b> <b>Fluxes</b> <b>Miscellaneous</b> (1)      FRB190711      RA: 21 57 40.6560 (329.4194000d) Dec: -80 21 28.58 (-80.35794d) Equinox: J2000  Comments: Category=GALAXY Description=[HIGH REDSHIFT GALAXY]								
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25				352.939501 Secs (352.94 Secs) [==>]	[1]
	2	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 2.091,0. 162			352.939501 Secs (352.94 Secs) [==>]	[1]
	3	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 4.179,0. 324			352.939501 Secs (352.94 Secs) [==>]	[1]
	4	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 0.174,1. 92			352.939501 Secs (352.94 Secs) [==>]	[1]
	5	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 2.265,2. 082			352.939501 Secs (352.94 Secs) [==>]	[1]
	6	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 4.356,1. 881			352.939501 Secs (352.94 Secs) [==>]	[1]
	7	(1) FRB190711	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPAR S25	POS TARG 1.164,3. 843			352.939501 Secs (352.94 Secs) [==>]	[1]



Proposal 16080 - FRB190714UV (03) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:23 GMT 2020

<b>Visit</b>	<b>Proposal 16080, FRB190714UV (03), failed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	(Exposure 1 (Pattern 1, Exps 1-1 in FRB190714UV (03))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser									
<b>Diagnosics</b>										
<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>	<b>Secondary Pattern</b>			<b>Exposures</b>				
	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.865 Line Spacing=0.56 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false				(1)				
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(2)	FRB190714	RA: 12 15 55.0800 (183.9795000d) Dec: -13 01 14.34 (-13.02065d) Equinox: J2000		V=20.8+/-0.3	Reference Frame: ICRS				
<i>Comments:</i> Category=GALAXY Description=[HIGH REDSHIFT GALAXY]										
<b>Exposures</b>	<b>#</b>	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	(2) FRB190714	(2) FRB190714	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F300X	FLASH=17		Pattern 1, Exps 1-1 in FRB190714UV (03) (1)	694 Secs (2396 Secs) [==>599.0 Secs (Pattern 1)] [==>599.0 Secs (Pattern 2)] [==>599.0 Secs (Pattern 3)] [==>599.0 Secs (Pattern 4)]	[1]

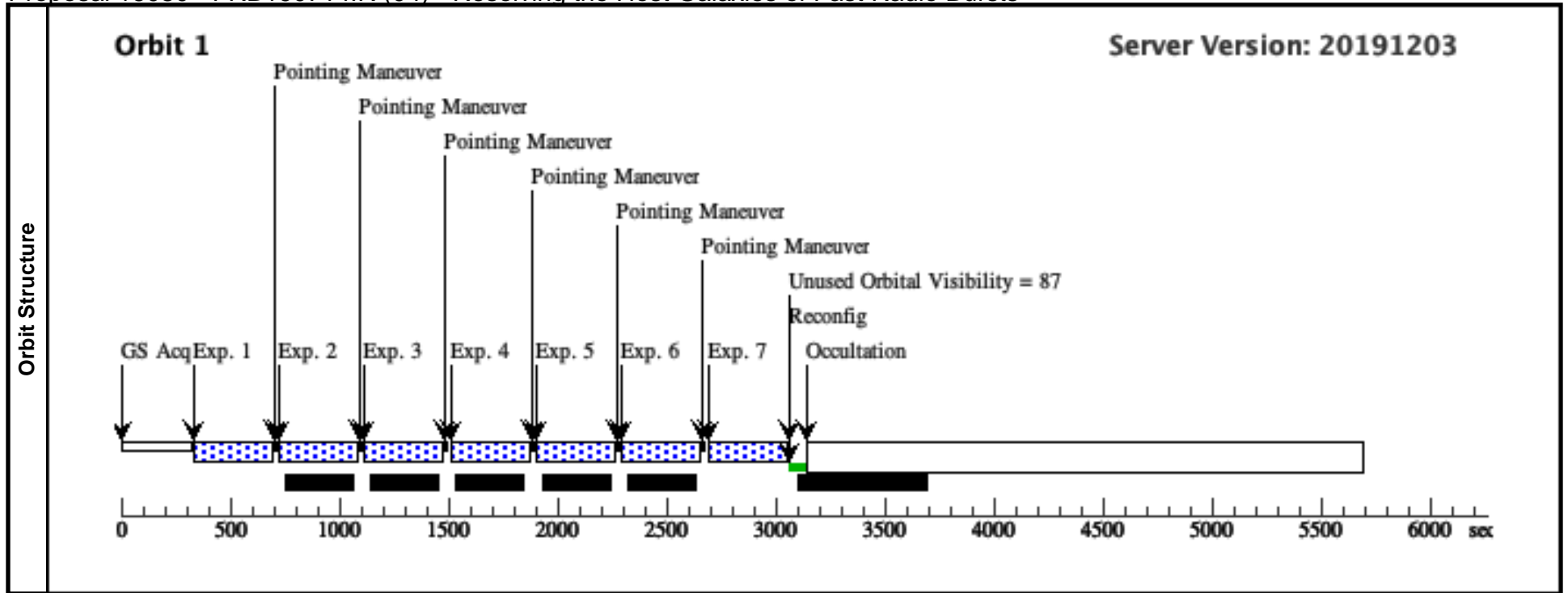




Proposal 16080 - FRB190714IR (04) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:24 GMT 2020

Visit	<b>Proposal 16080, FRB190714IR (04), scheduled</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR Special Requirements: (none)									
	Fixed Targets	# <b>Name</b> <b>Target Coordinates</b> <b>Targ. Coord. Corrections</b> <b>Fluxes</b> <b>Miscellaneous</b> (2)      FRB190714      RA: 12 15 55.0800 (183.9795000d) Dec: -13 01 14.34 (-13.02065d) Equinox: J2000 Comments: Category=GALAXY Description=[HIGH REDSHIFT GALAXY]								
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25				327.938986 Secs (327.939 Secs) [==>]	[1]
	2	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 2.091,0. 162			327.938986 Secs (327.939 Secs) [==>]	[1]
	3	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 4.179,0. 324			327.938986 Secs (327.939 Secs) [==>]	[1]
	4	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 0.174,1. 92			327.938986 Secs (327.939 Secs) [==>]	[1]
	5	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 2.265,2. 082			327.938986 Secs (327.939 Secs) [==>]	[1]
	6	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 4.356,1. 881			327.938986 Secs (327.939 Secs) [==>]	[1]
	7	(2) FRB190714	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 1.164,3. 843			327.938986 Secs (327.939 Secs) [==>]	[1]



Proposal 16080 - FRB191001UV (05) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:24 GMT 2020

<b>Visit</b>	<b>Proposal 16080, FRB191001UV (05), completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/UVIS Special Requirements: (none)
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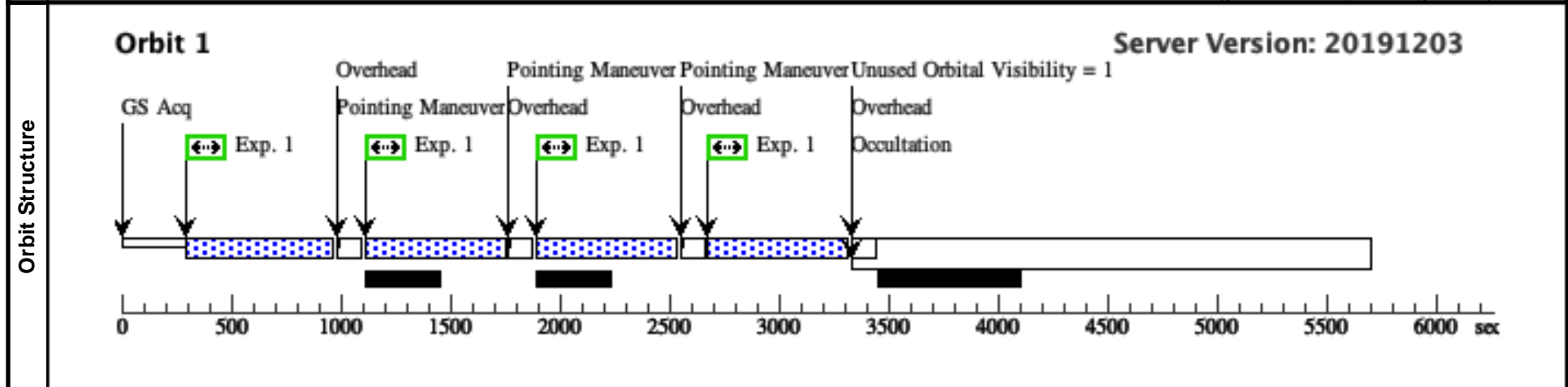
<b>Diagnostics</b>	(Exposure 1 (Pattern 1, Exps 1-1 in FRB191001UV (05))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser
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<b>Patterns</b>	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.865 Line Spacing=0.56 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

<b>Fixed Targets</b>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(3)	FRB191001	RA: 21 33 24.6480 (323.3527000d) Dec: -54 44 53.99 (-54.74833d) Equinox: J2000		V=18.4+/-0.3	Reference Frame: ICRS

*Comments:*  
 Category=GALAXY  
 Description=[HIGH REDSHIFT GALAXY]

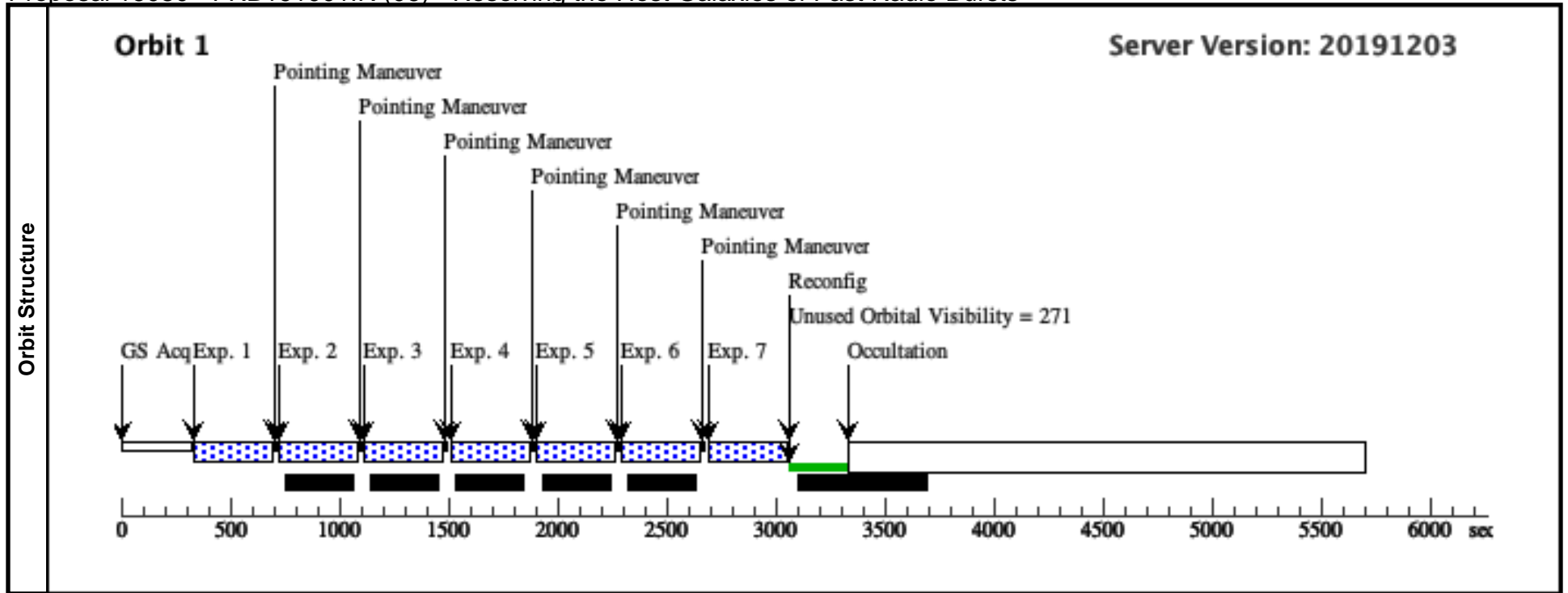
<b>Exposures</b>	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(3) FRB191001	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F300X	FLASH=17		Pattern 1, Exps 1-1 in FRB191001UV (05) (1)	600 Secs (2580 Secs) [==>645.0 Secs (Pattern 1)] [==>645.0 Secs (Pattern 2)] [==>645.0 Secs (Pattern 3)] [==>645.0 Secs (Pattern 4)]	[1]



Proposal 16080 - FRB191001IR (06) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:24 GMT 2020

Visit	<b>Proposal 16080, FRB191001IR (06), scheduled</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR Special Requirements: (none)									
	Fixed Targets	# <b>Name</b> <b>Target Coordinates</b> <b>Targ. Coord. Corrections</b> <b>Fluxes</b> <b>Miscellaneous</b> (3)      FRB191001      RA: 21 33 24.6480 (323.3527000d) Dec: -54 44 53.99 (-54.74833d) Equinox: J2000 Comments: Category=GALAXY Description=[HIGH REDSHIFT GALAXY]								
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25				327.938986 Secs (327.939 Secs) [==>]	[1]
	2	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 2.091,0. 162			327.938986 Secs (327.939 Secs) [==>]	[1]
	3	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 4.179,0. 324			327.938986 Secs (327.939 Secs) [==>]	[1]
	4	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 0.174,1. 92			327.938986 Secs (327.939 Secs) [==>]	[1]
	5	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 2.265,2. 082			327.938986 Secs (327.939 Secs) [==>]	[1]
	6	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 4.356,1. 881			327.938986 Secs (327.939 Secs) [==>]	[1]
	7	(3) FRB191001	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPAR S25	POS TARG 1.164,3. 843			327.938986 Secs (327.939 Secs) [==>]	[1]



Proposal 16080 - Visit 03 HOPR FRB190714UV (Z3) - Resolving the Host Galaxies of Fast Radio Bursts

Tue Apr 28 19:00:24 GMT 2020

<b>Visit</b>	<b>Proposal 16080, Visit 03 HOPR FRB190714UV (Z3)</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	(Exposure 1 (Pattern 1, Exps 1-1 in Visit 03 HOPR FRB190714UV (Z3))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser									
<b>Diagnosics</b>										
<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>	<b>Secondary Pattern</b>			<b>Exposures</b>				
	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.865 Line Spacing=0.56 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false				(1)				
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(2)	FRB190714	RA: 12 15 55.0800 (183.9795000d) Dec: -13 01 14.34 (-13.02065d) Equinox: J2000		V=20.8+/-0.3	Reference Frame: ICRS				
<i>Comments:</i> Category=GALAXY Description=[HIGH REDSHIFT GALAXY]										
<b>Exposures</b>	<b>#</b>	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	(2) FRB190714	(2) FRB190714	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F300X	FLASH=17		Pattern 1, Exps 1-1 in Visit 03 HOPR FRB190714UV (Z3) (1)	694 Secs (2396 Secs) [==>599.0 Secs (Pattern 1)] [==>599.0 Secs (Pattern 2)] [==>599.0 Secs (Pattern 3)] [==>599.0 Secs (Pattern 4)]	[1]

