



## 12927 - The role of the environment in the growth of compact red galaxies at $z \sim 2$

Cycle: 20, Proposal Category: GO

(Availability Mode: SUPPORTED)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Andrew B. Newman (PI) (Contact)</b>	<b>California Institute of Technology</b>	<b>anewman@astro.caltech.edu</b>
Prof. Richard S. Ellis (CoI)	California Institute of Technology	rse@astro.caltech.edu
Prof. Tommaso L. Treu (CoI)	University of California - Santa Barbara	tt@physics.ucsb.edu
Dr. Stefano Andreon (CoI) (ESA Member)	Osservatorio Astronomico di Brera, Milano	stefano.andreon@brera.inaf.it
Dr. Anand Raichoor (CoI) (ESA Member)	Osservatorio Astronomico di Brera, Milano	anand.raichoor@brera.inaf.it
Dr. Ginevra Trinchieri (CoI) (ESA Member)	Osservatorio Astronomico di Brera, Milano	ginevra.trinchieri@brera.inaf.it

### 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	(2) JKCS041-1	WFC3/IR	2	07-Jan-2013 21:06:04.0	yes
02	(3) JKCS041-2	WFC3/IR	4	07-Jan-2013 21:06:19.0	yes
03	(4) JKCS041-3	WFC3/IR	5	07-Jan-2013 21:06:35.0	yes
04	(5) JKCS041-4	WFC3/IR	5	07-Jan-2013 21:06:51.0	yes

16 Total Orbits Used

### ABSTRACT

Many observations now indicate that the progenitors of today's massive galaxies are very compact at high redshift and that they must have experienced significant growth in size over the past 11 Gyr. Remarkably, the rate of growth appears to increase toward  $z \sim 2$ , posing a challenge for physical mechanisms proposed to account for this assembly. Environmental trends can discriminate between growth mechanisms that are sensitive to

## Proposal 12927 (STScI Edit Number: 6, Created: Monday, January 7, 2013 9:07:00 PM EST) - Overview

local density (galaxy mergers) and those that are not (secular processes). While the size evolution of field galaxies is probed adequately in existing HST field surveys, these do not sample the densest environments. We propose WFC3 imaging and grism spectroscopy of the  $z \sim 2$  evolved galaxy cluster JKCS041, detected as a strong overdensity of red galaxies that present a tight red sequence. This is among the most distant clusters known and is seen at an epoch when the growth of massive galaxies appears quite rapid. Uniquely among the few known clusters at  $z > 1.5$ , JKCS041 exhibits an intracluster medium unambiguously detected in extended X-ray emission by Chandra. The goals of this proposal are (1) to confirm the cluster membership of red galaxies, (2) to measure the structural properties of these members in order to establish whether growth is accelerated in cluster environments at  $z \sim 2$ , and if so, whether this is likely due to enhanced merging, (3) to determine the stellar ages, masses, and star-formation activity of cluster galaxies seen at a lookback time of 10 Gyr to constrain the effect of environment in quenching star formation in the early universe.

### **OBSERVING DESCRIPTION**

Our program requires both deep imaging with adequate sub-pixel sampling and observations using both the G102 and G141 grisms at several orientations to facilitate deblending. Most of the imaging is conducted in visit 1, with 4/3 orbits in F160W and 2/3 orbits in F105W. A 4-point dither pattern is used in each, identical to the CANDELS survey.

The remaining 14 orbits are split over Visits 2-4. The first 2 orbits of Visit 2 contain a direct F105W image followed by 4 G102 grism exposures that are dithered in a 4-point pattern. The pattern is slightly wider than that used for the imaging in order to dither over defects (IR blobs, etc.). This is acceptable given that variations in the sub-pixel sampling pattern over the array are not crucial for spectroscopy. Orbits 3-4 of Visit 2 are the same as Orbits 1-2 using F160W+G141.

Visits 3 and 4 each contain 5 orbits. The structure is identical to Visit 2 with one additional orbit of two grism exposures inserted. For visit 3 and 4 the extra orbit is devoted to G141 and G102, respectively. The additional two grism exposures are positioned at the integer, integer and half-integer, half-integer points of the dither pattern (i.e. a two-point pattern).

Original Phase 2 submission: Visits 1 and 2 are unrestricted in orientation, and the need for varying orientations is implemented using ORIENT FROM constraints. These require visit 3 to execute with an ORIENT of 25-80 deg relative to visit 2, and visit 4 to execute 25-80 deg relative to visit 3.

\*\*\*Post planning windows: All visits have now been restricted to a narrow ORIENT range, just wide enough to allow for observations throughout the provided plan windows. This allowed us to arrange the pointing centers at each ORIENT to maximize the number of spectra.

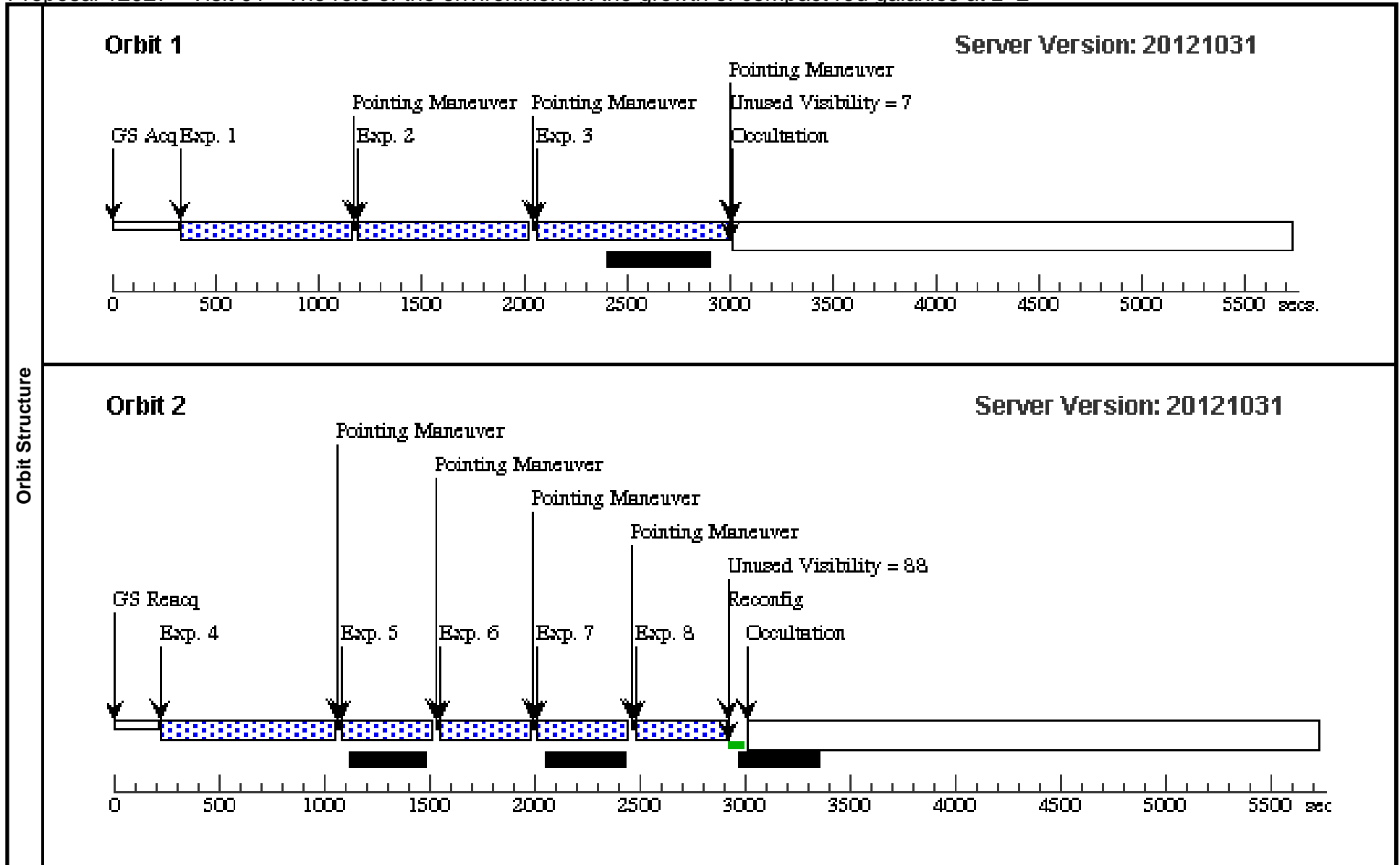
Proposal 12927 - Visit 01 - The role of the environment in the growth of compact red galaxies at z~2

Tue Jan 08 02:07:01 GMT 2013

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(2)	JKCS041-1	RA: 02 26 44.1300 (36.6838750d) Dec: -04 41 33.00 (-4.69250d) Equinox: J2000	Redshift: 2	V=(?) J = 20-23	Reference Frame: ICRS

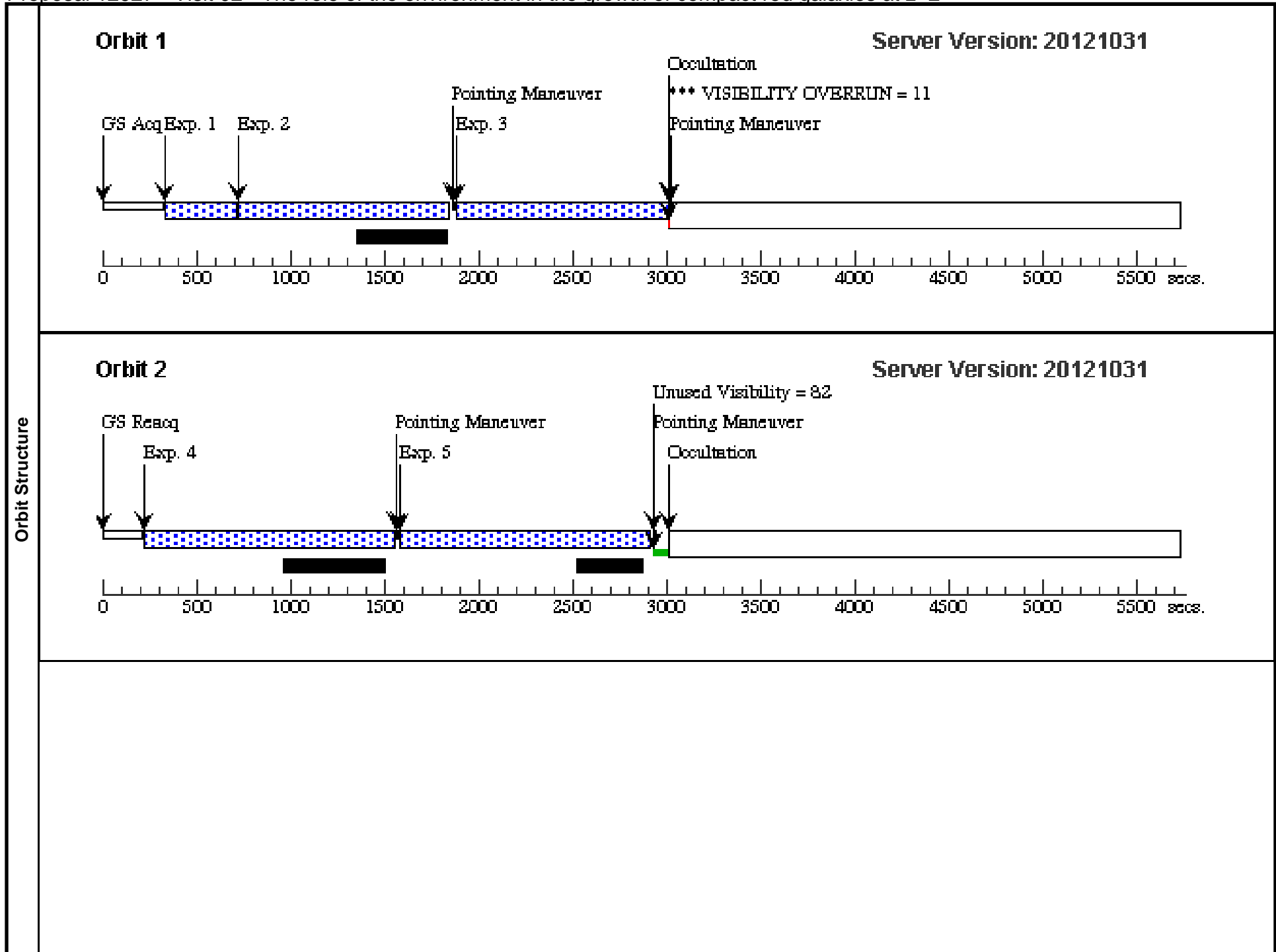
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS 100; NSAMP=9	POS TARG -0.338,- 0.303; GS ACQ SCENARI O BASE1B3	[==>]	[1]		
	2	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS 100; NSAMP=9	POS TARG -0.608,0 .242	[==>]	[1]		
	3	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS 100; NSAMP=10	POS TARG 0.270,0. 303	[==>]	[1]		
	4	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS 100; NSAMP=9	POS TARG 0.540,-0 .242	[==>]	[2]		
	5	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F105W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG -0.338,- 0.303	[==>]	[2]		
	6	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F105W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG -0.608,0 .242	[==>]	[2]		
	7	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F105W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.270,0. 303	[==>]	[2]		
	8	(2) JKCS041-1	WFC3/IR, MULTIACCUM, IR-FIX	F105W	NSAMP=9; SAMP-SEQ=SPAR S50	POS TARG 0.540,-0 .242	[==>]	[2]		



Proposal 12927 - Visit 02 - The role of the environment in the growth of compact red galaxies at z~2

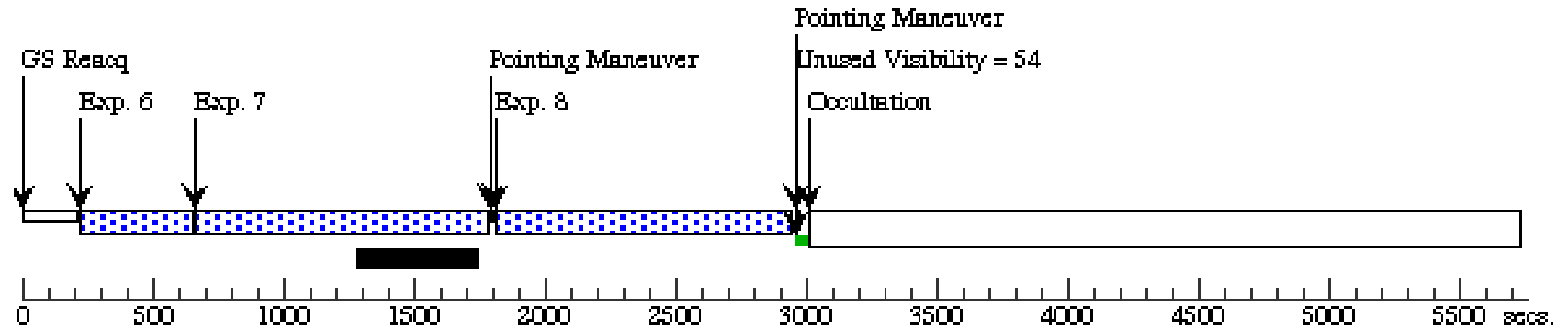
Tue Jan 08 02:07:05 GMT 2013

<b>Visit</b>	Proposal 12927, Visit 02, completed Diagnostic Status: Warning Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 347D TO 353 D									
	(Visit 02) Warning (Orbit Planner): VISIBILITY OVERRUN									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(3)	JKCS041-2	RA: 02 26 43.8400 (36.6826667d) Dec: -04 41 45.12 (-4.69587d) Equinox: J2000	Redshift: 2	V=(?) J = 20-23	Reference Frame: ICRS				
<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/[Actual Dur.]</b>	<b>Orbit</b>
	1	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	F105W	SAMP-SEQ=SPARS 25; NSAMP=15	POS TARG 0,null; GS ACQ SCENARI O BASE1B3	[==>]		[1]	
	2	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null	[==>]		[1]	
	3	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24	[==>]		[1]	
	4	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21	[==>]		[2]	
	5	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787	[==>]		[2]	
	6	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	F160W	SAMP-SEQ=STEP1 00; NSAMP=10	POS TARG 0,null	[==>]		[3]	
	7	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null	[==>]		[3]	
	8	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24	[==>]		[3]	
	9	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21	[==>]		[4]	
10	(3) JKCS041-2	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787	[==>]		[4]		



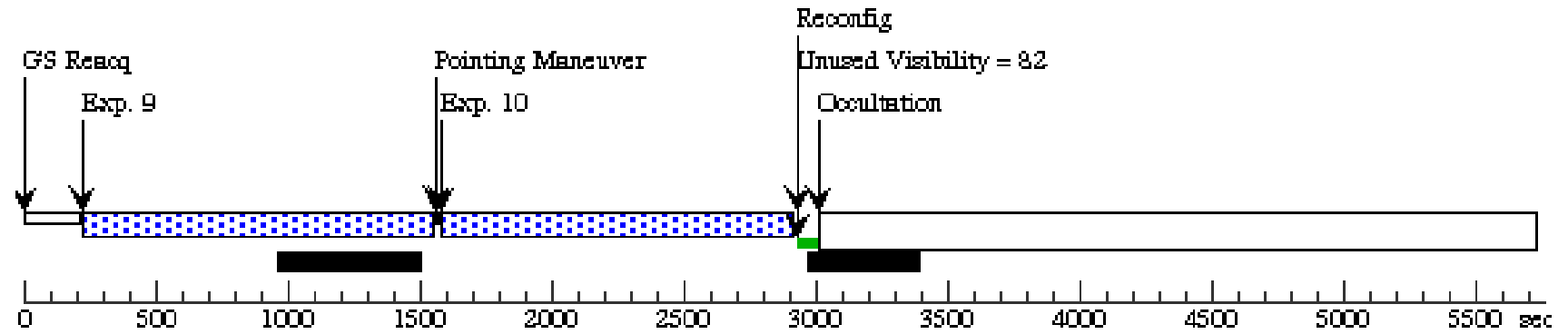
### Orbit 3

Server Version: 20121031



### Orbit 4

Server Version: 20121031

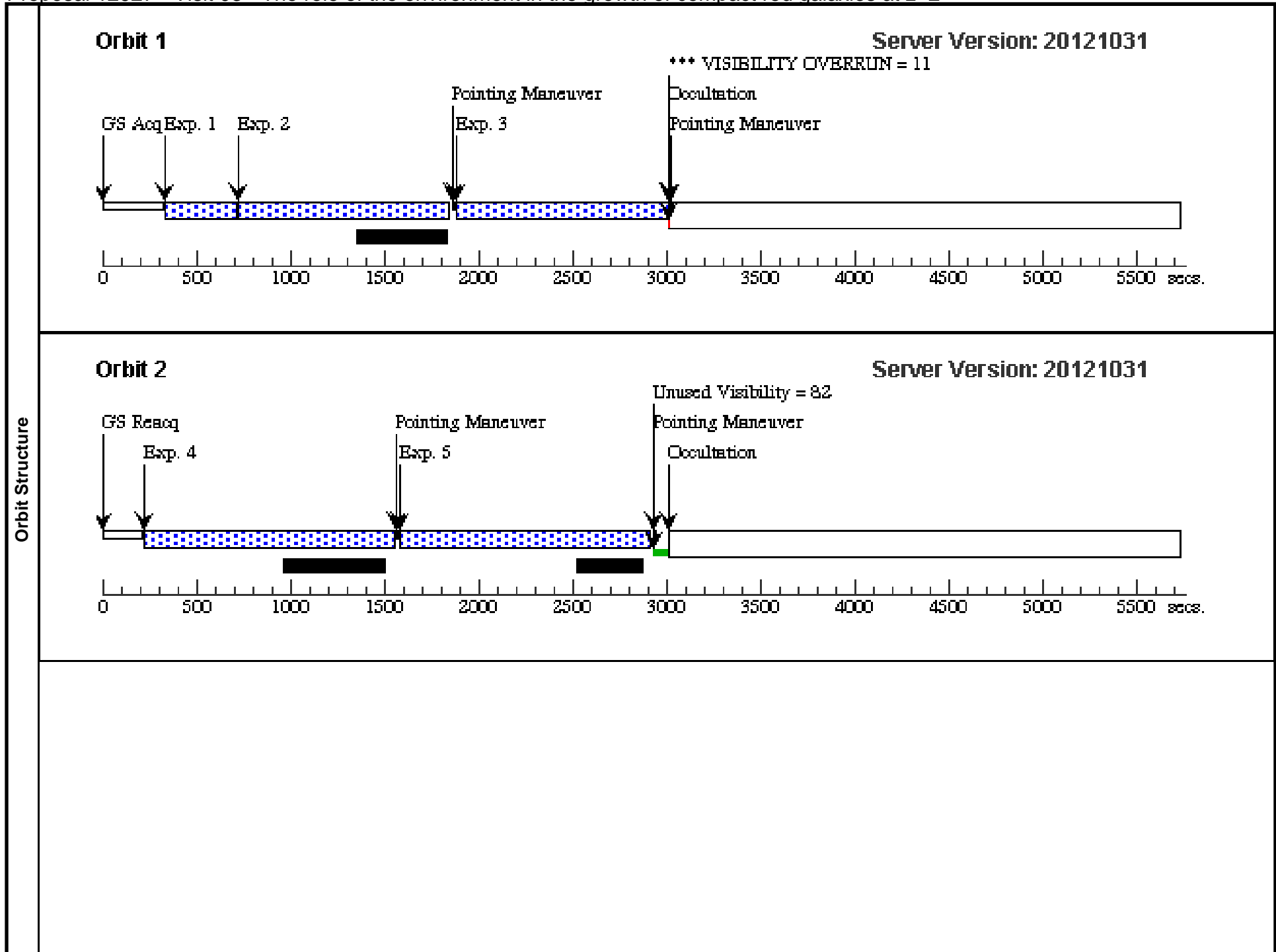


Proposal 12927 - Visit 03 - The role of the environment in the growth of compact red galaxies at z~2

<b>Visit</b>	Proposal 12927, Visit 03, completed <span style="float: right;">Tue Jan 08 02:07:09 GMT 2013</span> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 12D TO 18 D					
	(Visit 03) Warning (Orbit Planner): VISIBILITY OVERRUN					
<b>Diagnosics</b>						
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>
	(4)	JKCS041-3	RA: 02 26 43.9700 (36.6832083d) Dec: -04 41 31.41 (-4.69206d) Equinox: J2000	Redshift: 2	V=(?) J = 20-23	Reference Frame: ICRS

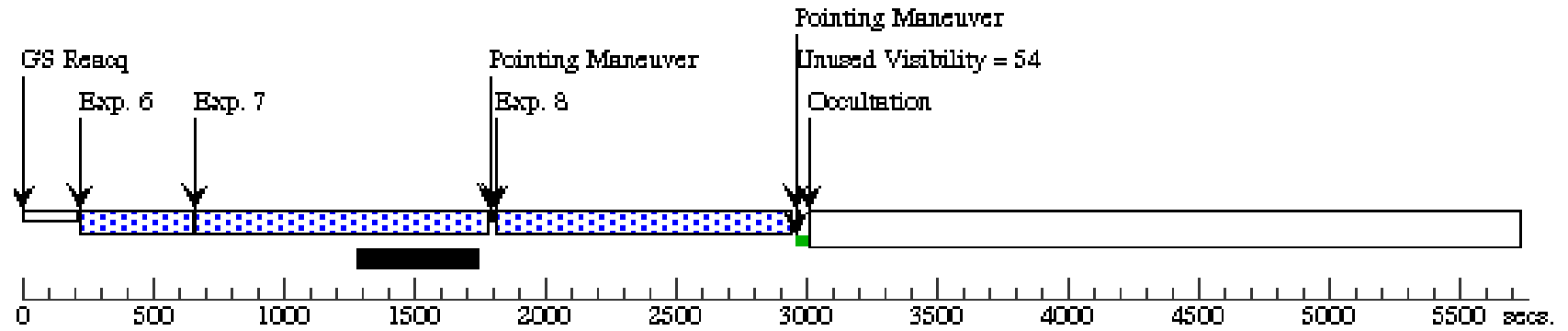
Proposal 12927 - Visit 03 - The role of the environment in the growth of compact red galaxies at z~2

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	F105W	SAMP-SEQ=SPARS 25; NSAMP=15	POS TARG 0,null; GS ACQ SCENARI O BASE1B3		[==>]	[1]
	2	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null		[==>]	[1]
	3	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24		[==>]	[1]
	4	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21		[==>]	[2]
	5	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787		[==>]	[2]
	6	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	F160W	SAMP-SEQ=STEP1 00; NSAMP=10	POS TARG 0,null		[==>]	[3]
	7	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null		[==>]	[3]
	8	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24		[==>]	[3]
	9	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21		[==>]	[4]
	10	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787		[==>]	[4]
	11	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0,0		[==>]	[5]
12	(4) JKCS041-3		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.473,0. 787		[==>]	[5]	



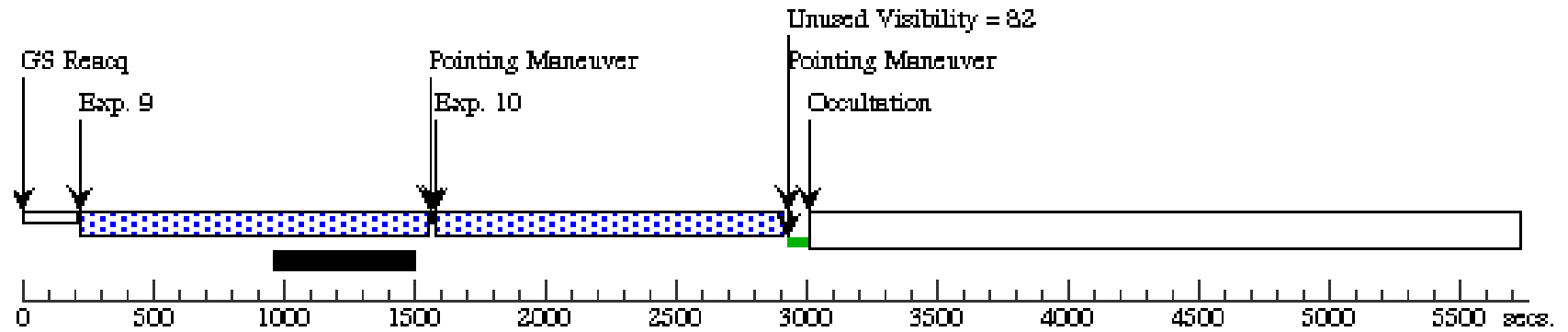
### Orbit 3

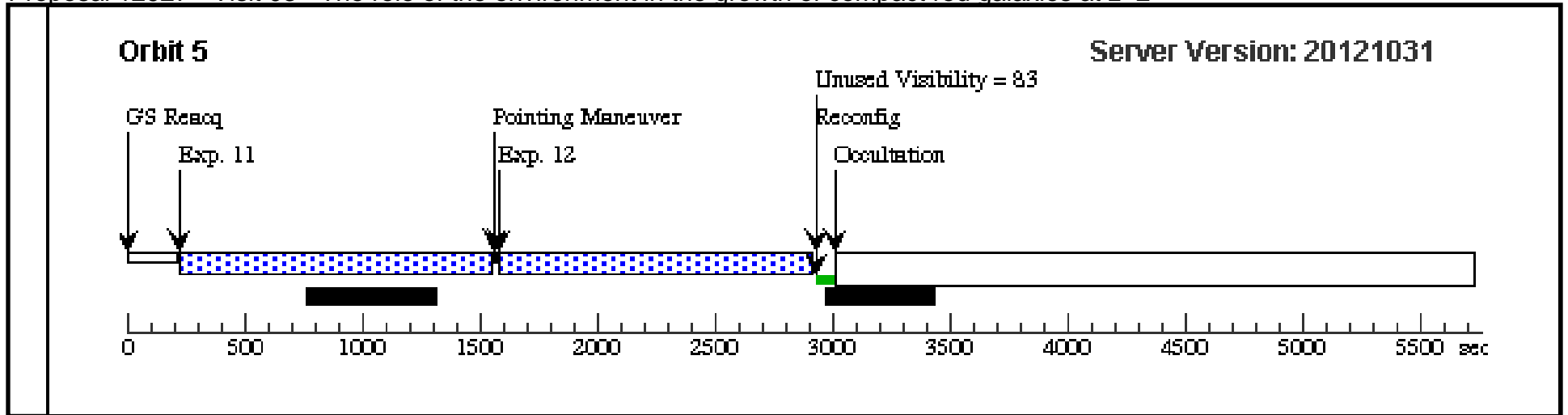
Server Version: 20121031



### Orbit 4

Server Version: 20121031



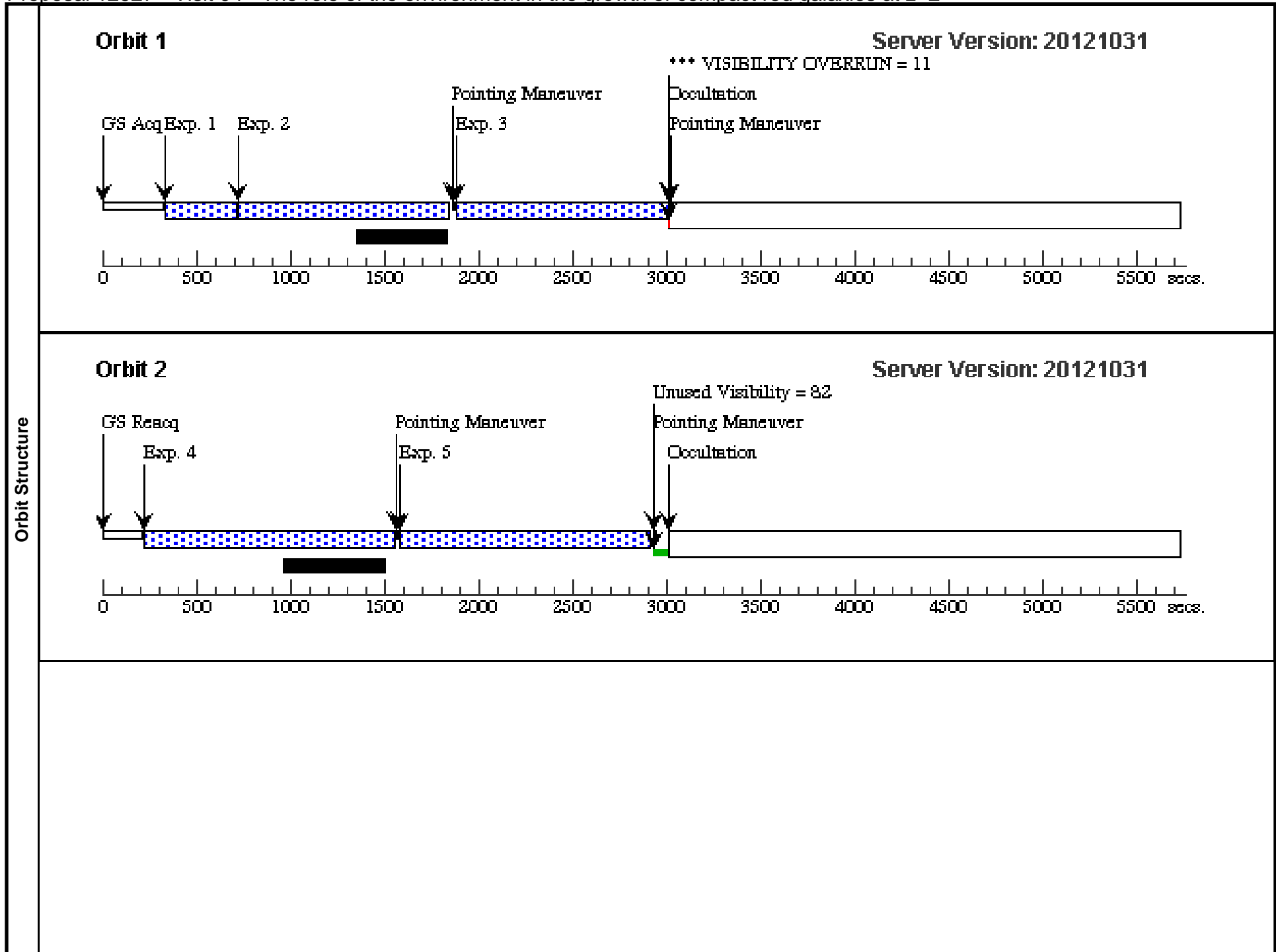


Proposal 12927 - Visit 04 - The role of the environment in the growth of compact red galaxies at z~2

<b>Visit</b>	<b>Proposal 12927, Visit 04, scheduled</b> <span style="float: right;">Tue Jan 08 02:07:13 GMT 2013</span> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/IR Special Requirements: SCHED 100%; ORIENT 60D TO 60 D					
	(Visit 04) Warning (Orbit Planner): VISIBILITY OVERRUN					
<b>Diagnosics</b>						
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>
	(5)	JKCS041-4	RA: 02 26 43.3700 (36.6807083d) Dec: -04 41 49.80 (-4.69717d) Equinox: J2000	Redshift: 2	V=(?) J = 20-23	Reference Frame: ICRS

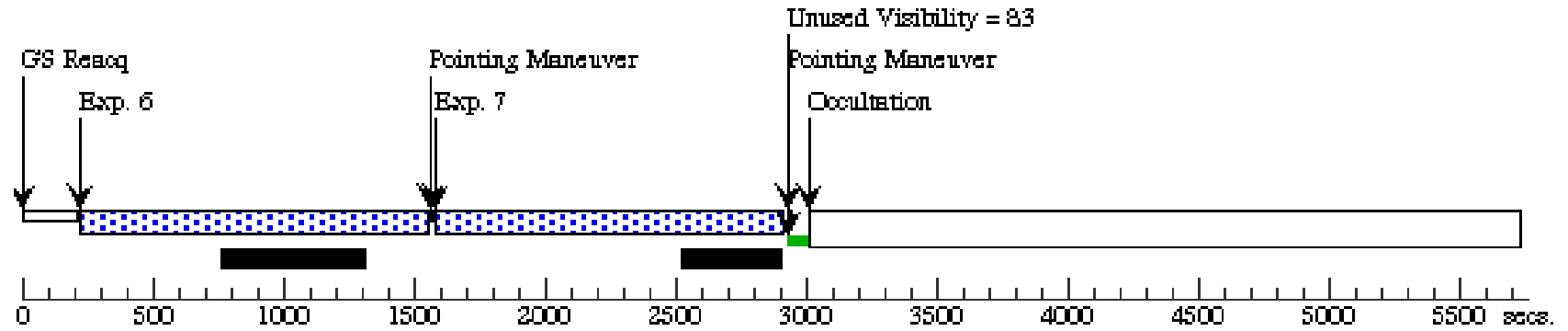
Proposal 12927 - Visit 04 - The role of the environment in the growth of compact red galaxies at z~2

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	F105W	SAMP-SEQ=SPARS 25; NSAMP=15	POS TARG 0,null; GS ACQ SCENARI O BASE1B3		[==>]	[1]
	2	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null		[==>]	[1]
	3	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24		[==>]	[1]
	4	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21		[==>]	[2]
	5	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787		[==>]	[2]
	6	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0,0		[==>]	[3]
	7	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G102	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.473,0. 787		[==>]	[3]
	8	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	F160W	SAMP-SEQ=STEP1 00; NSAMP=10	POS TARG 0,null		[==>]	[4]
	9	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 0,null		[==>]	[4]
	10	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=12	POS TARG 1.35,0.4 24		[==>]	[4]
	11	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG 0.878,1. 21		[==>]	[5]
12	(5) JKCS041-4		WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS 100; NSAMP=14	POS TARG -0.473,0 .787		[==>]	[5]	



### Orbit 3

Server Version: 20121031



### Orbit 4

Server Version: 20121031

