



# 13045 - The Nature and Environment of a Luminous Starburst Galaxy During the Era of Reionization

Cycle: 20, Proposal Category: GO  
(Availability Mode: SUPPORTED)

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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) HERMES-FLS03	ACS/WFC WFC3/IR	4	06-Aug-2012 22:06:20.0	yes
02	(1) HERMES-FLS03	ACS/WFC	2	06-Aug-2012 22:06:40.0	yes

6 Total Orbits Used

## ABSTRACT

We propose HST/WFC3 and ACS observations in 5 bands to characterize the nature and the environment of the most distant sub-mm galaxy (SMG) known today, FLS3, at a redshift of 6.337. The galaxy was discovered in Herschel-HerMES with redshift measured from mm-wave spectroscopy. It is IR luminous ( $3 \times 10^{13} L_{\text{sun}}$ ), gas rich ( $10^{11} M_{\text{sun}}$ ), dusty and star-bursting. Deep optical and K-band ground-based imaging showed a near-by galaxy at 0.5 arcsecond from FLS3 with a measured redshift of 2.1. HST resolution imaging are needed to properly separate the two galaxies and constrain a lensing magnification of FLS3, if any. Previously known  $z < 4$  SMGs are in dense proto-cluster environments. The discovery of FLS3 suggests that it may also be in a proto-cluster. The HST imaging is also aimed at identifying Lyman dropout samples at  $z \sim 6.4$  associated with FLS3. With proposed data we will complete the SED and determine the stellar mass of FLS at better than 30%, a key quantity needed to understand the nature of FLS3 when combined with its star-formation rate. We will also measure the UV slope-SFR relation for a galaxy at  $z > 6$  and compare to measurements at  $z \sim 0$  to 3. With dropouts we will establish the presence of a proto-cluster and establish the dark matter halo mass scale of FLS3, a key ingredient needed to connect its evolution with massive elliptical and other galaxies seen today.

## OBSERVING DESCRIPTION

The program is related to a detection and characterization of a extremely luminous and massive dusty, starburst galaxy (hereafter FLS3) found with Herschel at  $z=6.34$ , during the epoch of reionization, and its environment. The galaxy is detected in a deep LGS-AO image with KeckII/NIRC2 in the K-band with a AB magnitude of 23.5.

The most basic goals of this program involving deep WFC3 and ACS observations of FLS3 are (i) determine the rest-frame UV SED, (ii) determine the location and size of the foreground galaxy at 0.500 away for a lens model, and (iii) identify other  $z = 6.3$  galaxies to determine the FLS3 environment and estimate the proto-cluster, if there is one associated with FLS3.

To measure stellar mass and other properties of FLS3 we make use of WFC3/F160W, F125W, and F105W filters. ACS/F814W observations are

needed to look for  $z=6$  dropouts and to characterize the foreground lensing galaxy.

We have used the on-line calculator to estimate the exposure time necessary to detect the background source with a signal-to-noise ratio (SNR)  $>10$  in the WFC3 bands. The expected depths are obtained after scaling a range of SED templates to the K-band detection.

These SEDs are appropriate for dusty starbursts and range from Arp220 to the average sub-mm galaxy SED at  $z$  of 2 to 3. We take the lowest flux density expected and require 10 sigma detections.

The total of 6 HST orbits are distributed to 3 WFC3 bands and 1 ACS/F814W band. The ACS band in the optical allow a precise detection of the nearby  $z=2.1$  galaxy about 0.5 arcseconds away from FLS3; at the shortest optical band, FLS3 is a dropout and we can measure the size and mass of the foreground galaxy accurately for a precise lensing model. A quantification of the lensing magnification is one of the goals of the approved HST program.

The immediate environment of FLS3 will be characterized with a combination of F814W, F105W and F125W images. The extended environment of FLS3, overlapping with two other sources seen within 3 to 6 arcminutes from JCMT/SCUBA2 will be imaged with coordinated-parallel observations using ACS/F814W taken over 4 orbits.

### **REAL TIME JUSTIFICATION**

To cover the interesting sub-mm/mm SCUBA2 detected targets within 3 to 6 arcminutes of FLS3 we request coordinated-parallel observations that involved WFC3 and ACS over 4 orbits.

These observations require the orientation to be 10 and 120 degrees to maximize the ACS coverage of the interesting sources.

The two orbits with ACS/F14W imaging that is mosaicing the region around FLS3 also require a range of possible orientations. They range from 60 to 160 degrees and 240 to 340 degrees.

Proposal 13045 - Visit 01 - The Nature and Environment of a Luminous Starburst Galaxy During the Era of Reionization

Tue Aug 07 02:06:49 GMT 2012

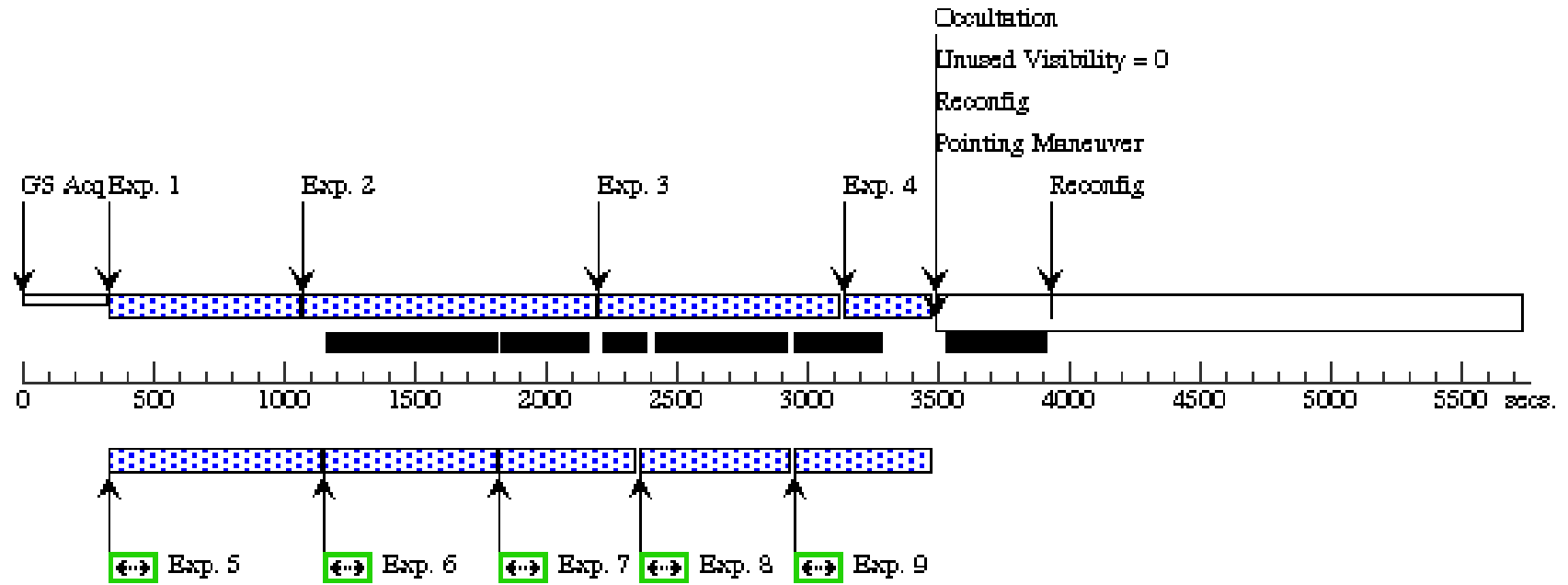
<b>Visit</b>	<b>Proposal 13045, Visit 01, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR, ACS/WFC Special Requirements: ORIENT 10D TO 150 D					
	<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>	<b>Secondary Pattern</b>	<b>Exposures</b>	
	(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN 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		(1-9)	
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>
	(1)	HERMES-FLS03	RA: 17 06 47.7840 (256.6991000d) Dec: +58 46 23.52 (58.77320d) Equinox: J2000		V=29+/-0.1 K-band (2.146 microns) 1.46 mu Jy (23.5 AB)	Reference Frame: ICRS

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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
Exposures	1	(1) HERMES-FLS03	WFC3/IR, MULTIACCUM, IR	F160W	SAMP-SEQ=SPARS 100; NSAMP=8		Pattern 1, Exps 1-9 in Visit 01 (1)	[==>(Pattern 1)]	[1]
							Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 2)]	[2]
								[==>(Pattern 3)]	[3]
								[==>(Pattern 4)]	[4]
	2	(1) HERMES-FLS03	WFC3/IR, MULTIACCUM, IR	F125W	SAMP-SEQ=SPARS 100; NSAMP=12		Pattern 1, Exps 1-9 in Visit 01 (1)	[==>(Pattern 1)]	[1]
							Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 2)]	[2]
								[==>(Pattern 3)]	[3]
								[==>(Pattern 4)]	[4]
	3	(1) HERMES-FLS03	WFC3/IR, MULTIACCUM, IR	F105W	SAMP-SEQ=SPARS 100; NSAMP=10		Pattern 1, Exps 1-9 in Visit 01 (1)	[==>(Pattern 1)]	[1]
							Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 2)]	[2]
								[==>(Pattern 3)]	[3]
								[==>(Pattern 4)]	[4]
4	(1) HERMES-FLS03	WFC3/IR, MULTIACCUM, IR	F105W	SAMP-SEQ=SPARS 25; NSAMP=14		Pattern 1, Exps 1-9 in Visit 01 (1)	[==>(Pattern 1)]	[1]	
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
							[==>(Pattern 4)]	[4]	
5	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F814W			Pattern 1, Exps 1-9 in Visit 01 (1)	600 Secs		
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 1)]	[1]	
							[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
6	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F814W			Pattern 1, Exps 1-9 in Visit 01 (1)	535 Secs		
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 1)]	[1]	
							[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
7	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F814W			Pattern 1, Exps 1-9 in Visit 01 (1)	400 Secs		
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 1)]	[1]	
							[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
8	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F625W			Pattern 1, Exps 1-9 in Visit 01 (1)	400 Secs		
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 1)]	[1]	
							[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
9	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F625W			Pattern 1, Exps 1-9 in Visit 01 (1)	400 Secs		
						Prime + Parallel Group 1-9 in Pattern 1, Exps 1-9 in Visit 01	[==>(Pattern 1)]	[1]	
							[==>(Pattern 2)]	[2]	
							[==>(Pattern 3)]	[3]	
							[==>(Pattern 4)]	[4]	

**Orbit 1**

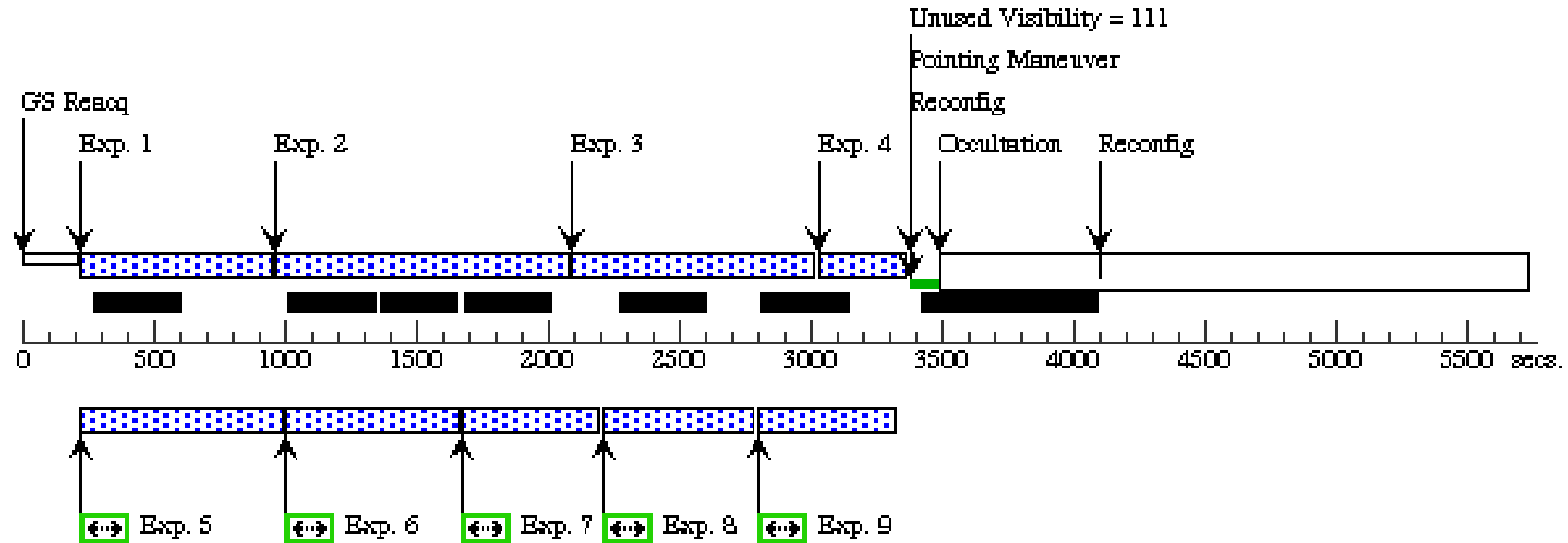
Server Version: 20120712



Orbit Structure

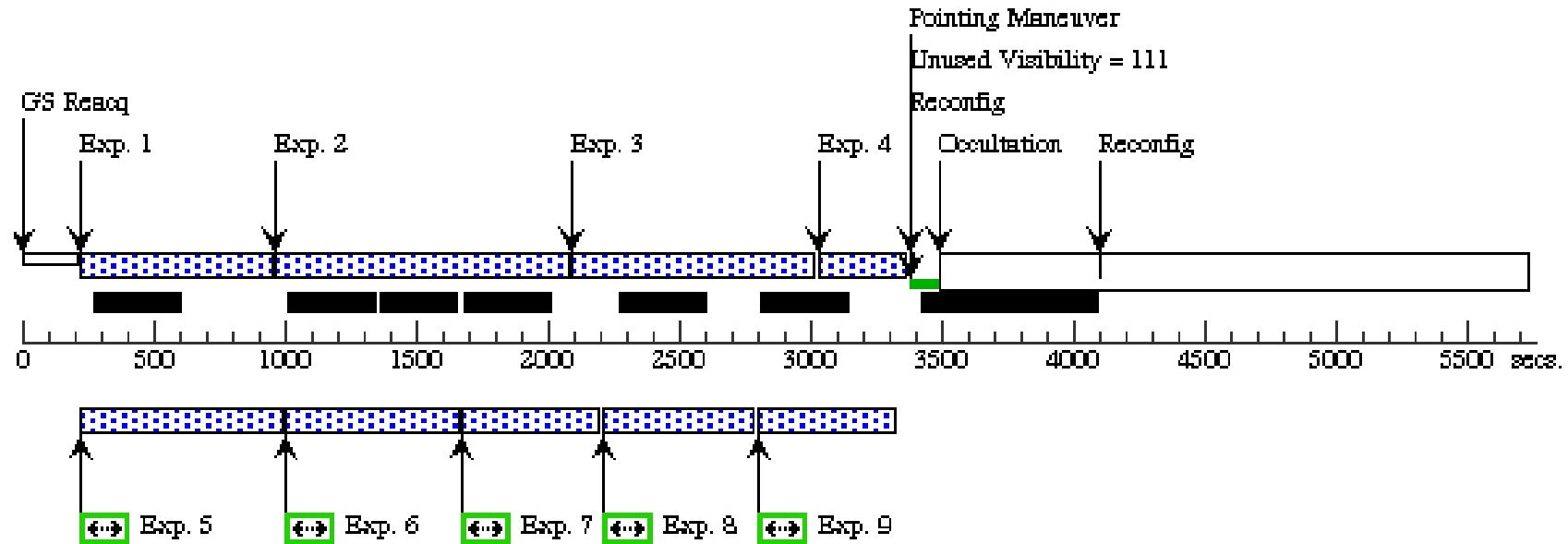
**Orbit 2**

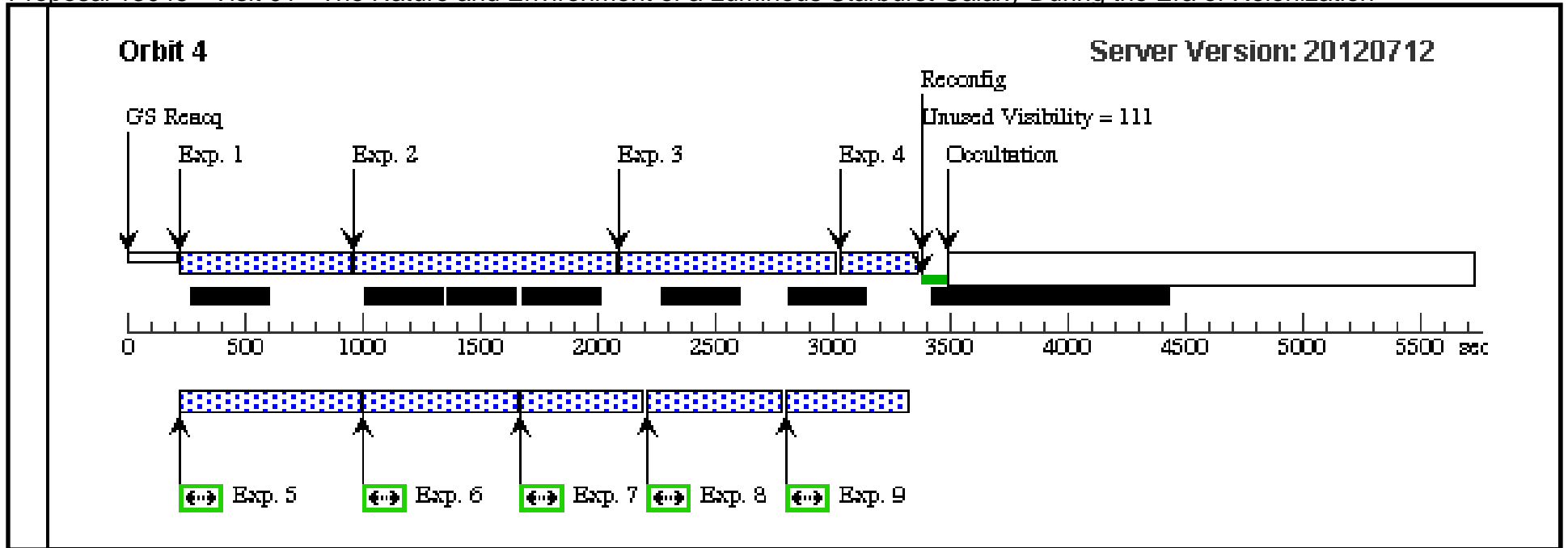
Server Version: 20120712



**Orbit 3**

Server Version: 20120712





Proposal 13045 - Visit 02 - The Nature and Environment of a Luminous Starburst Galaxy During the Era of Reionization

Tue Aug 07 02:06:55 GMT 2012

Visit	<b>Proposal 13045, Visit 02, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/WFC Special Requirements: (none)									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(2)	Pattern Type=ACS-WFC-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=45.00 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=90.0 Angle Between Sides= Center Pattern=false	Pattern Type=ACS-WFC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=3.011 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.28 Angle Between Sides= Center Pattern=false	(1-2)			
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HERMES-FLS03	RA: 17 06 47.7840 (256.6991000d) Dec: +58 46 23.52 (58.77320d) Equinox: J2000		V=29+/-0.1 K-band (2.146 microns) 1.46 mu Jy (23.5 AB)	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F814W				Pattern 2, Exps 1-2 in Visit 02 (2)	562 Secs	
									[=>(Pattern 1,1)]	[1]
									[=>(Pattern 1,2)]	
									[=>(Pattern 2,1)]	[2]
									[=>(Pattern 2,2)]	
2	(1) HERMES-FLS03	ACS/WFC, ACCUM, WFC	F625W					Pattern 2, Exps 1-2 in Visit 02 (2)	616 Secs	
									[=>(Pattern 1,1)]	[1]
									[=>(Pattern 1,2)]	
									[=>(Pattern 2,1)]	[2]
									[=>(Pattern 2,2)]	

