



16894 - The Variable Optical-X-ray SED of M87

Cycle: 29, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Joseph Neilsen (PI) (Contact)	Villanova University	jneilsen@villanova.edu
Prof. Daryl Haggard (CoI) (CSA Member) (Contact)	McGill University	daryl.haggard@mcgill.ca
Dr. Michael Nowak (CoI)	Washington University in St. Louis	mnowak@physics.wustl.edu
Dr. Sera Markoff (CoI) (ESA Member)	Universiteit van Amsterdam	s.b.markoff@uva.nl
Dr. Kazuhiro Hada (CoI)	National Astronomical Observatory of Japan (NAOJ)	kazuhiro.hada@nao.ac.jp
Dr. Geoffrey Bower (CoI)	Academia Sinica, Institute of Astronomy and Astrophysics	gbower@asiaa.sinica.edu.tw
Dr. Svetlana G. Jorstad (CoI)	Boston University	jorstad@bu.edu
Dr. Mislav Balokovic (CoI)	Yale University	mislav.balokovic@yale.edu
Dr. Venkatesh Ramakrishnan (CoI)	Universidad de Concepcion	vramakrishnan@udec.cl
Dr. Michael Johnson (CoI)	Smithsonian Institution Astrophysical Observatory	mjohnson@cfa.harvard.edu
Dr. Sunil Chandra (CoI)	North-West University Potchefstroom Campus	sunil.chandra355@gmail.com
Dr. Stefanie Komossa (CoI) (ESA Member)	Max-Planck-Institut für Radioastronomie	skomossa@mpifr-bonn.mpg.de
Dr. Thomas Krichbaum (CoI) (ESA Member)	Max-Planck-Institut für Radioastronomie	tkrichbaum@mpifr-bonn.mpg.de
Dr. Jaeyeong Kim (CoI)	Korea Astronomy and Space Science Institute (KASI)	jaeyeong8502@gmail.com
Dr. Alan P. Marscher (CoI)	Boston University	marscher@bu.edu
Dr. Mark Reynolds (CoI)	University of Michigan	markrey@umich.edu
Monika Moscibrodzka (CoI) (ESA Member)	Radboud Universiteit Nijmegen	m.moscibrodzka@astro.ru.nl
Hope Boyce (CoI) (CSA Member)	McGill University	hope.boyce@mail.mcgill.ca
Mr. George Wong (CoI)	University of Illinois at Urbana - Champaign	gnwong2@illinois.edu
Dr. Marcos Santander (CoI)	University of Alabama	jmsantander@ua.edu
Amanpreet Kaur (CoI)	The Pennsylvania State University	auk971@psu.edu

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>
02	(1) M-87	WFC3/UVIS	2	21-Jan-2022 11:01:04.0	yes
01	(1) M-87	WFC3/UVIS	2	21-Jan-2022 11:01:05.0	yes

4 Total Orbits Used

ABSTRACT

On behalf of the EHT's Multiwavelength (MWL) Working Group, we propose a joint campaign on M87* coordinated in part with EHT: 50 ks XMM-Newton, 4 orbits Hubble, & 50 ks NuSTAR. These observations will improve constraints on (1) the SED of M87* and its particle acceleration processes, as well as (2) the variability of the famous jet across the electromagnetic spectrum.

OBSERVING DESCRIPTION

The goal of our HST program is to study the optical and UV variability of M87 in conjunction with Event Horizon Telescope (EHT) and Chandra observations, as well as XMM-Newton and NuSTAR. We are particularly interested in tracking the relative flux and SED changes of the core and the knot HST-1 over time. Our HST observations will occur in two pieces separated by several months and consisting of two orbits each. The first piece should be coordinated with Chandra in March 2022; the second will be coordinated with XMM and NuSTAR in June/July 2022. We adopt a modified version of the WFC3/UVIS observing strategy used for historical Hubble M87 monitoring (e.g. PI:Shara). In our analysis, comparable exposures produced to 3-10% uncertainties on the core and HST-1 fluxes after subtracting the host galaxy contribution.

The spring and summer observations are similar, with adjustments to compensate for varying orbital visibility of M87. Generally each consists of two orbits to acquire observations in F275W and F814W (orbit 1) and F390W and F606W (orbit 2) in ACCUM mode. For the summer visit to be coordinated with NuSTAR and XMM-Newton, the first orbit consists of three dithered 496 s exposures in F275W and two dithered 352 s exposures in F814W in ACCUM mode, for a total of 2192 s on source; the second orbit has 2x 571 s in F390W and 3x 349 s in F606W. ETC calculations are given for the nucleus and are approximate as they neglect the host galaxy. The remaining ~1 ks per orbit is covered by overhead (setup, readouts, filter changes, and dithering). We mitigate CTE with a flash to increase the background; sub-exposures reduce cosmic rays.

Reduced visibility in March requires shorter exposures. The first orbit consists of three dithered 438 s exposures in F275W and two dithered 348 s exposures in F814W in ACCUM mode, for a total of 2046 s on source; the second orbit/visit has 2x 482 s in F390W and 3x348 s in F606W. Per our

Proposal 16894 (STScI Edit Number: 1, Created: Friday, January 21, 2022 at 11:01:06 AM Eastern Standard Time) - Overview
accepted XMM/HST/NuSTAR proposal, this visit should be scheduled within 1 day of a Chandra/EHT observation.

Proposal 16894 - Summer (02) - The Variable Optical-X-ray SED of M87

Fri Jan 21 16:01:06 GMT 2022

Visit	Proposal 16894, Summer (02), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: PCS MODE FINE; BETWEEN 04-JUN-2022:00:00:00 AND 14-JUL-2022:00:00:00 <i>Comments: This observation should be scheduled to overlap with XMM-Newton observations; the "between" requirement represents the window where XMM observations can occur.</i>
	(F606W (02.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

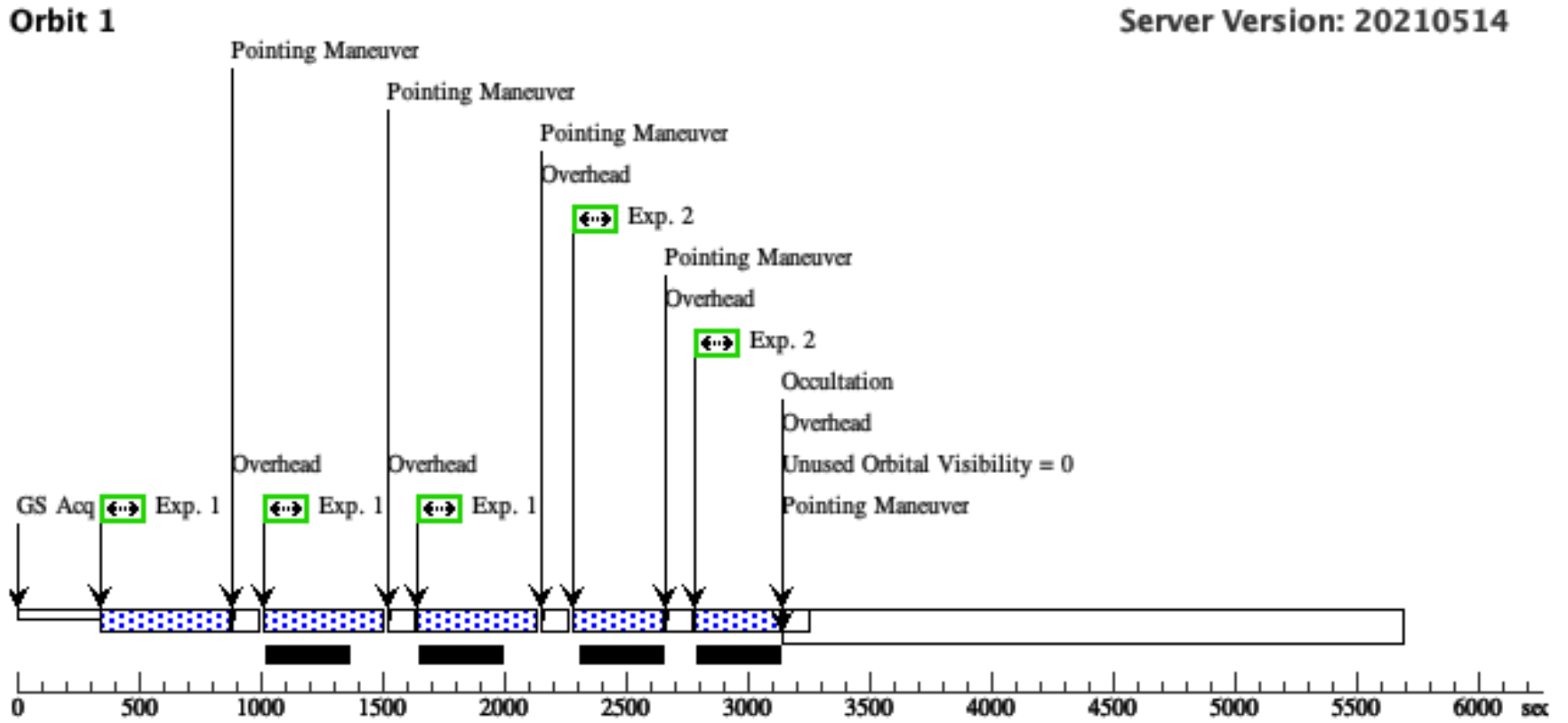
Diagnosics	(F606W (02.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser
	(F606W (02.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=DITHER Number Of Points=3 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3)

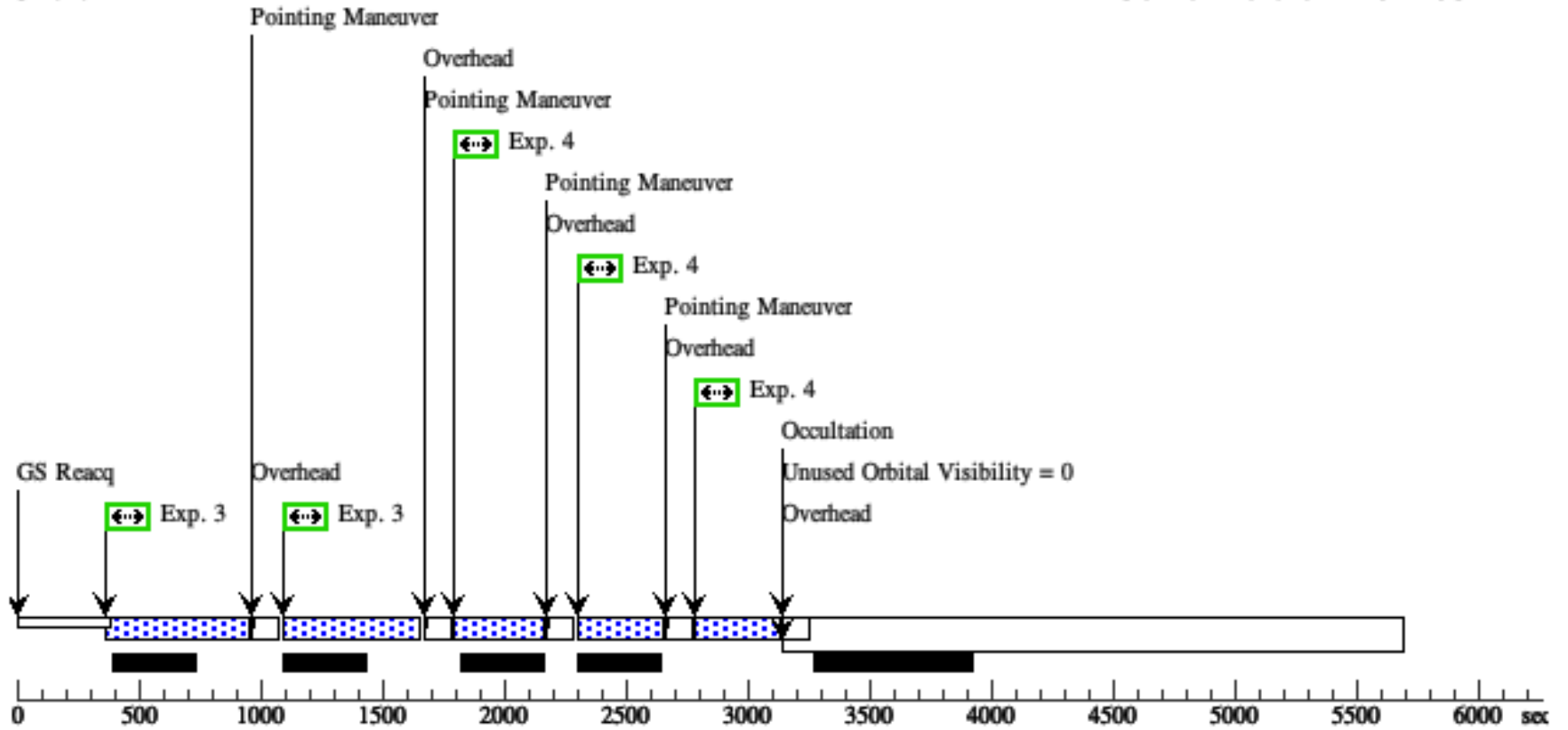
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	M-87	RA: 12 30 49.4149 (187.7058954d) Dec: +12 23 28.21 (12.39117d) Equinox: J2000	Proper Motion RA: -5.480328945655651E-4 sec of time/yr Proper Motion Dec: 0.010734 arcsec/yr Epoch of Position: 2015.5	V=8.63	Reference Frame: SIMBAD
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[ELLIPTICAL, JET, KNOT, NUCLEUS]						

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F275W (WFC3UVI S.im.168506 3)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F275W	FLASH=20			Pattern 1, Exps 1-1 i n Summer (02) (1)	496 Secs (1488 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]
2	F814W (WFC3UVI S.im.168506 7)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=15			Pattern 2, Exps 2-2 i n Summer (02) (2)	348 Secs (696 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[1]
3	F390W (WFC3UVI S.im.168506 9)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F390W	FLASH=17			Pattern 2, Exps 3-3 i n Summer (02) (2)	567 Secs (1134 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[2]
4	F606W (WFC3UVI S.im.168507 0)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F606W	FLASH=13			Pattern 1, Exps 4-4 i n Summer (02) (1)	349 Secs (1047 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[2]

Orbit Structure



Orbit 2



Proposal 16894 - March (01) - The Variable Optical-X-ray SED of M87

Fri Jan 21 16:01:06 GMT 2022

Visit	<p>Proposal 16894, March (01), implementation</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: WFC3/UVIS</p> <p>Special Requirements: PCS MODE FINE; SCHED 80%; BETWEEN 16-MAR-2022:00:00:00 AND 29-MAR-2022:00:00:00</p> <p><i>Comments: This visit should be scheduled within one day of a Chandra/EHT observation; the "between" requirement represents the window where Chandra/EHT observations will occur.</i></p>
	<p>(F606W (01.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser</p>

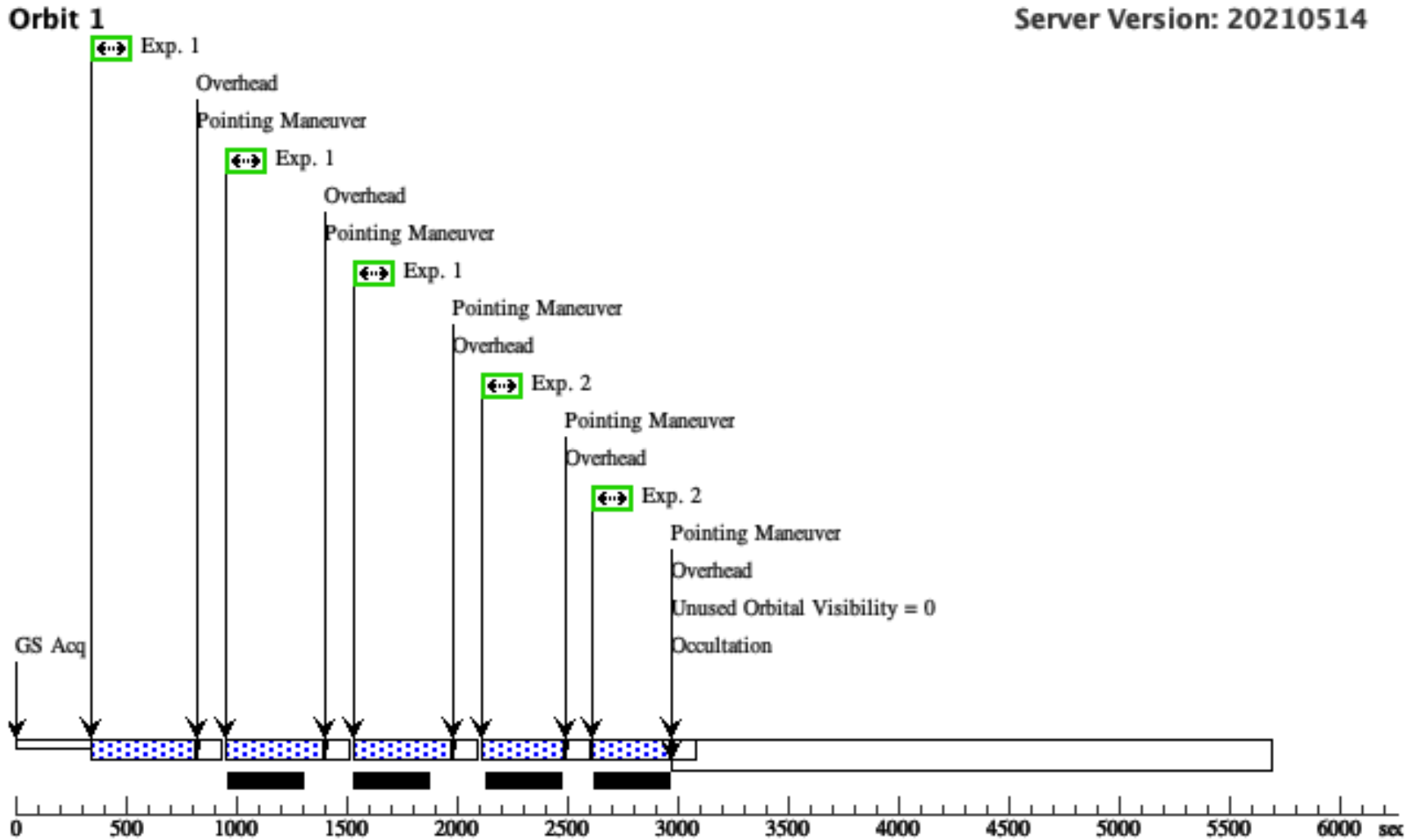
Diagnosics	<p>(F606W (01.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser</p>

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=DITHER Number Of Points=3 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3)

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	M-87	RA: 12 30 49.4149 (187.7058954d) Dec: +12 23 28.21 (12.39117d) Equinox: J2000	Proper Motion RA: -5.480328945655651E-4 sec of time/yr Proper Motion Dec: 0.010734 arcsec/yr Epoch of Position: 2015.5	V=8.63	Reference Frame: SIMBAD
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p>Category=GALAXY</p> <p>Description=[ELLIPTICAL, JET, KNOT, NUCLEUS]</p>						

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F275W (WFC3UVI S.im.168505 0)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F275W	FLASH=20		Pattern 1, Exps 1-1 i n March (01) (1)	438 Secs (1314 Secs)	
								[==>(Pattern 1)]		
								[==>(Pattern 2)]	[1]	
								[==>(Pattern 3)]		
2	F814W (WFC3UVI S.im.168505 4)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=15		Pattern 2, Exps 2-2 i n March (01) (2)	349 Secs (698 Secs)		
								[==>(Pattern 1)]		
								[==>(Pattern 2)]	[1]	
3	F390W (WFC3UVI S.im.168505 7)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F390W	FLASH=17		Pattern 2, Exps 3-3 i n March (01) (2)	482 Secs (964 Secs)		
								[==>(Pattern 1)]		
								[==>(Pattern 2)]	[2]	
4	F606W (WFC3UVI S.im.168505 9)	(1) M-87	WFC3/UVIS, ACCUM, UVIS-FIX	F606W	FLASH=13		Pattern 1, Exps 4-4 i n March (01) (1)	348 Secs (1044 Secs)		
								[==>(Pattern 1)]		
								[==>(Pattern 2)]	[2]	
								[==>(Pattern 3)]		

Orbit Structure



Orbit 2

