14256 - High-Precision Proper Motions in the M87 Jet

Cycle: 23, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) M87-JET	WFC3/UVIS	1	24-Jul-2015 23:04:22.0	yes
02	(1) M87-NUCLEUS	STIS/NUV-MAMA	1	24-Jul-2015 23:04:24.0	yes

2 Total Orbits Used

ABSTRACT

As the nearest galaxy with an optical jet, M87 affords an unparalleled opportunity to study extragalactic jet phenomena at the highest resolution. We have previously obtained HST images of the jet with unprecedented resolution which show detailed shock structures as well as numerous unresolved condensations over the first few arcseconds of the jet. Our previous HST monitoring observations have found superluminal motion at speeds up to 6c in many of these features, and showed the formation of new emission regions and rapid variability.

The STIS/NUV instrument presents a unique opportunity to measure proper motions in the M87 jet with a single highly stable, high resolution detector across a 19 yr timebase. We will use these new data, together with existing STIS/NUV data, to map the velocity field of the jet with much higher accuracy than previously possible. This will allow us to measure the bulk deceleration of the jet, transverse motions, accelerations /

decelerations of individual features, and numerous fainter jet features. We will use this to test models for the structure and kinematics of relativistic jet flows, synchrotron emission regions, and AGN in general.

OBSERVING DESCRIPTION

We will obtain STIS NUV F25QTZ images of the jet using a setup which closely duplicates our previous monitor observations. Sub-exposures will be dithered to improve PSF sampling by the 0.024" pixels and minimize detector artifacts. ACCUM mode is used for greatest consistency with past monitoring observations. We do not expect any bright object issues for either the M87 nucleus or jet, but a WFC3 observation (Visit 1) is included prior to STIS NUV-MAMA (Visit 2) for added safety; Visit 2 is ON-HOLD pending results of the WFC3 observation.

WFC3 observations are made 30 to 100 days prior to the STIS MAMA observations. Filters F225W, F475W, and F814W are used. A sub-array near the C amplifier is used to reduce data volume issues and CTE effects. A POST-FLASH of 12 electrons is used.

Bright object discussion for STIS NUV-MAMA:

We have used an identical observation (same mode and filter) taken in May 2013 to perform a baseline check of the MAMA-NUV count rate. The brightest feature in image oc1w01w8q.flt was the nucleus which had a total of 70207 counts in 590 sec, or 119 counts/sec, or F(lambda)=7.4e-16 erg cm-2 s-1 A-1. With these inputs the ETC gives the brightest pixel as 30 counts/sec (STIS.im.733860). The nucleus is in fact resolved, and the observed brightest pixel was 11 counts/sec in that image. Both of these values are well below the limit of 100 counts/sec.

We also note the target was observed in January and June 2015 in program 13759 using the same mode without incident (those data are proprietary).

The M87 jet has been previously seen to produce a bright flare with an e-folding (factor 3) rise time ~1 year. Hence, as added precaution, we have scheduled the WFC3 F225W observation 30 - 120 days prior to the STIS NUV MAMA observation. These data will be reduced promptly, and an updated flux and ETC run will be provided prior to the STIS NUV MAMA observation. The STIS NUV-MAMA observation is ON-HOLD pending the WFC3 result.

Visit

Proposal 14256, WFC3 (01) Sat Jul 25 03:04:25 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: SCHED 100%; ORIENT 110D TO 110 D; ORIENT 200D TO 200 D; ORIENT 290D TO 290 D

Comments: ORIENTs chosen to place jet along diagonal of sub-array, so as to get more of the jet. Target is M87-JET which is near Knot F in the middle of the jet; this keeps it centered on the detector at different ORIENTs.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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		(1), (2), (3)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M87-JET	RA: 12 30 48.8400 (187.7035000d) Dec: +12 23 31.00 (12.39194d) Equinox: J2000		V=16.7	Reference Frame: ICRS

Comments: Position in Knot F near middle ot the jet.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.733857)	(2) M87-JET	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F225W	FLASH=12; CR-SPLIT=NO		Pattern 1, Exps 1-1 in WFC3 (01) (1)	260 Secs (1040 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: ETC calculation based on expected flux in single WFC3 pixel in F225W for bright region of Knot A.

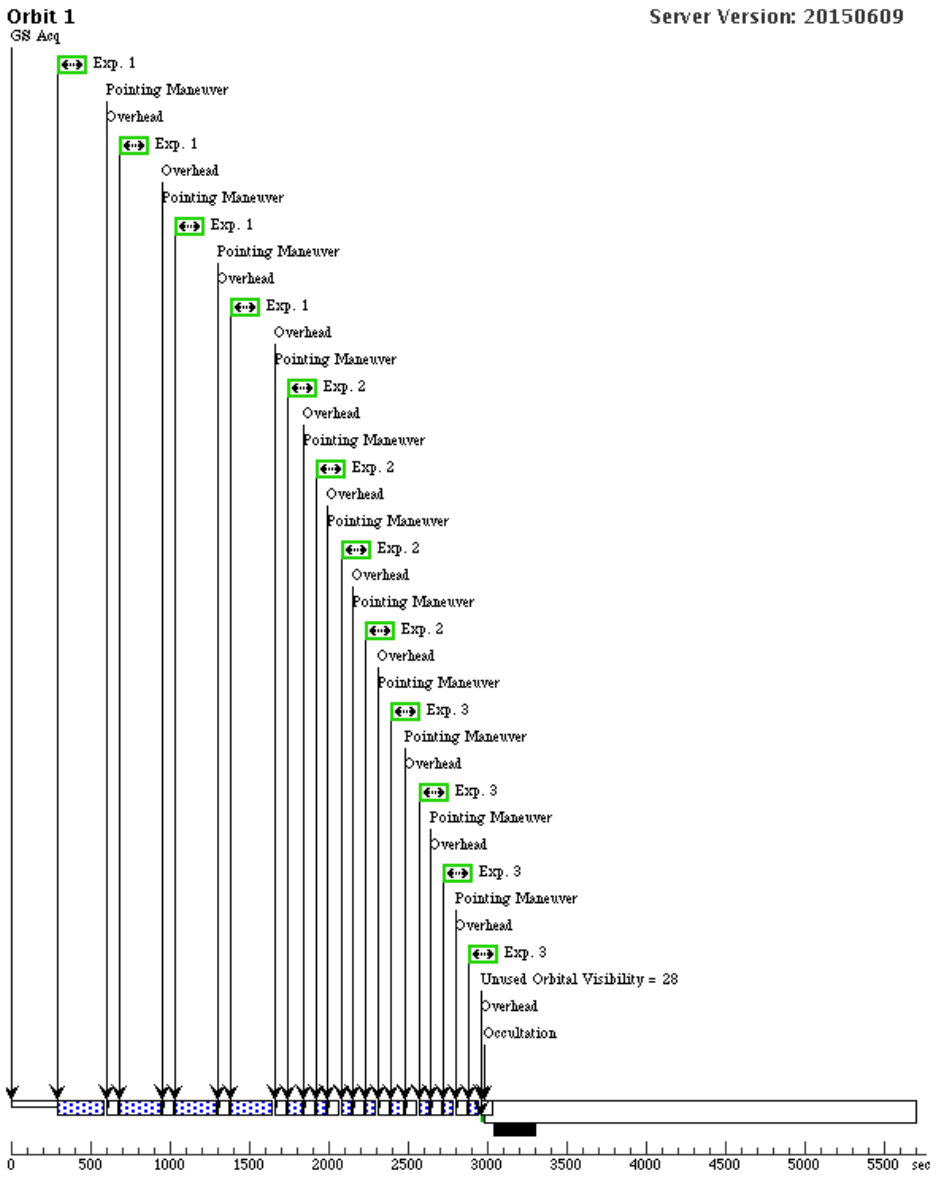
2	(WFC3UVIS.im.733856)	(2) M87-JET	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F475W	FLASH=12; CR-SPLIT=NO		Pattern 1, Exps 2-2 in WFC3 (01) (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: ETC calculation based on expected flux in single WFC3 pixel in F475W for bright region of Knot A.

3	(WFC3UVIS.im.733855)	(2) M87-JET	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=12; CR-SPLIT=NO		Pattern 1, Exps 3-3 in WFC3 (01) (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: ETC calculation based on expected flux in single WFC3 pixel in F814W for bright region of Knot A.

Orbit Structure



Visit

Proposal 14256, STIS NUV-MAMA (02) Sat Jul 25 03:04:26 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/NUV-MAMA

Special Requirements: SCHED 100%; ORIENT 105.D TO 105. D; AFTER 01 BY 30 D TO 120 D; ON HOLD ; ON HOLD FOR 01

Comments: Visit 2 is on hold pending fluxes from Visit 1 and check of bright object issues. Nominally it should schedule 30 to 120 days after Visit 1. Both visits have ORIENT constraints.

STIS NUV-MAMA ORIENT chosen to match prior epochs of monitoring observations. POS TARG used to place middle of jet near center of detector. Dithering used to improve PSF sampling and remove any detector artifacts. ACCUM used for greatest consistency with prior observations.

On Hold Comments: Visit 2 is on hold pending Bright Object check based on F225W fluxes from Visit 1.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M87-NUCLEUS	RA: 12 30 49.3590 (187.7056625d) Dec: +12 23 29.00 (12.39139d) Equinox: J2000		V=16.7	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.im.73860)	(1) M87-NUCLEUS	STIS/NUV-MAMA, ACCUM, F25QTZ	MIRROR		POS TARG -7,7		585 Secs (585 Secs) *[==>]*	 ***[1]***
Comments: ETC calculation based on May 2013 STIS NUV F25QTZ observation of the M87 nucleus (brightest feature), assuming it is unresolved, gives 30 counts/sec. In reality the nucleus is slightly extended, and the actual observered count rate for brightest pixel was 11 counts/sec. Both numbers are well below brightest pixel limit of 100 counts/sec. For added safety against flaring behavior in the jet, an F225W image will be taken in Visit 1 approx 30 to 120 days before the STIS NUV-MAMA visit.									
2	(STIS.im.73860)	(1) M87-NUCLEUS	STIS/NUV-MAMA, ACCUM, F25QTZ	MIRROR		POS TARG -6.496,6.748		585 Secs (585 Secs) *[==>]*	 ***[1]***
3	(STIS.im.7338460)	(1) M87-NUCLEUS	STIS/NUV-MAMA, ACCUM, F25QTZ	MIRROR		POS TARG -6.244,6.244		585 Secs (585 Secs) *[==>]*	 ***[1]***
4	(STIS.im.73860)	(1) M87-NUCLEUS	STIS/NUV-MAMA, ACCUM, F25QTZ	MIRROR		POS TARG -6.748,6.496		585 Secs (585 Secs) *[==>]*	 ***[1]***

Orbit Structure