17744 - Reflections of a Violent Past: Using Light Echoes to Survey Historical Supernovae in M82

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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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	(1) M82-POS1	ACS/WFC	1	06-Jul-2026 08:00:25.0	yes
51	(1) M82-POS1	ACS/WFC	1	06-Jul-2026 08:00:26.0	yes
02	(2) M82-POS2	ACS/WFC	1	06-Jul-2026 08:00:26.0	yes
52	(2) M82-POS2	ACS/WFC	1	06-Jul-2026 08:00:26.0	yes
03	(3) M82-POS3	ACS/WFC	1	06-Jul-2026 08:00:27.0	yes
53	(3) M82-POS3	ACS/WFC	1	06-Jul-2026 08:00:27.0	yes
04	(4) M82-POS4	ACS/WFC	1	06-Jul-2026 08:00:28.0	yes
05	(5) M82-POS5	ACS/WFC	1	06-Jul-2026 08:00:28.0	yes
55	(5) M82-POS5	ACS/WFC	1	06-Jul-2026 08:00:29.0	yes
06	(6) M82-POS6	ACS/WFC	1	06-Jul-2026 08:00:29.0	yes

10 Total Orbits Used

ABSTRACT

Messier 82 (M82, NGC 3034) is the famous "Cigar Galaxy" undergoing a starburst just 3.5 Mpc away. A spectacular mosaic of the entire galaxy was created by ACS 20 years ago. Here we propose to search for undiscovered light echoes from supernovae (SNe) that exploded as much as 500 years ago. M82 is an active star-forming galaxy expected to host, on average, one SN every ten to twenty years (and has hosted 3 since 2004!). Dust is important for generating light echoes, and M82 has dust distrubuted throughout and above its stellar disk. Even supernovae hidden from our direct view by dust can reveal themselves by illuminating dust in unobscurred directions. Three confirmed SN eruptions have been detected in M82 in the past 20 years. The most recent Ia event, SN 2014J, has a well detected light echo and provides an excellent proof-of-concept for our proposed survey.

Our goal is to use HST to detect 15--20 light echoes in M82 via their resolved shapes and rapid proper motions, following Rest et al. (2005). The proper motion vectors will allow us to pair a sub-set of them with known X-ray, optical and radio supernova remnants in M82. Our survey will effectively double the sample of recent extragalactic SNe echoes, and potentially quadruple the number of echoes from historical SNe that erupted prior to the 20th century. This LE sample is the necessary first step to then use HST or ground-based telescopes to obtain spectra of the brighter LEs and thereby classify their parent SNe, creating an unprecedented demographic survey of SNe in a starburst galaxy over the last few centuries---a survey not obtainable by any other means.

OBSERVING DESCRIPTION

Summary:

We will use six orbits with the ACS/WFC and the WFCENTER two-chip readout to exactly re-create the DD-10776 3 x 2 element mosaic of starburst galaxy M 82 in the F555W filter, in order to perform difference imaging with a 19-year baseline and search for light echoes from historic supernovae. We specifically use the same instrument, the same filter, the same six fixed targets for the mosaic elements, the same ORIENT=130 requirement, and essentially the identical dither POS TARG offsets as the DD-10776 mosaic. For maximum scheduling flexibility we divide our six orbits into six visits, collecting five ~387-second exposures/dither positions in each mosaic element. The only minor changes we make are to use five dithers (instead of four), which serves to improve signal in the chip gaps and mitigate pixels lost to the saturation bleeding from the bright (V=10.0) star BD +70 587 (which is imaged two mosaic elements). Total exposures times across five ~387-second exposures in each orbit are around 1935 seconds. APT reports that all six of these one-orbit visits can be scheduled within an 8-day visibility window in late March 2025. If this too restrictive, we could broaden the orientation requirement slightly to increase the visibility window but would prefer to keep the new mosaic as identical as possible to the archival one.

Detailed description:
Our proposed and awarded goal is to create a survey of as many historical SNe in M82 as possible by obtaining a new HST imaging epoch exactly matched to an earlier ACS mosaic to search for their light echoes. The program DD-10776 in Cycle 14 used ACS/WFC in a 9.6 x 6.4 arcmin mosaic to essentially record all of M82 in deep B, V , I, and H-alpha images. As reflections of SNe near maximum, LE are brightest in B and V, and are much fainter in bluer or redder filters. Despite 15 other GO imaging programs on M82, none produce a set of deep images that simultaneously 1) use identical B or V filters from either ACS or WFC3, 2) cover more than 30% of the DD-10776 mosaic, and 3) span at least 11 years between epochs (producing >4 HST pixel shifts). All 2014J follow-up has used the WFC3 filters or ACS polarizers, and nearly all with very small sub-apertures. Large residuals remain when subtracting images taken in similar, but slightly different, filters (for example ACS/F555W versus WFC3/F555W).

We will obtain ACS F555W (V-band) imaging to exactly match the pointings from the original 2006 mosaic. The instrument+filter matching is very important, as even extremely similar filters produce highly structured backgrounds during difference imaging. Using the same pointings and roll angle will maximize the overlap for image subtractions and match the distortion corrections to increase the LE detection efficiency. SNe spectra peak around 500 nm at maximum and ACS V is more sensitive than B and less sensitive to extinction. So, for the sake of orbit efficiency, we use F555W as our single survey filter. DD-10776 needed 4 orbits per pointing with most of the time spent in exposing the H-alpha filter. We require only one orbit per pointing to reach slightly deeper in the F555W filter. To help filter cosmic rays and chip defects, each orbit is divided into five exposures at five dithered positions, closely following the DD-10776 dithers. Our dither POS TARGs combine a large three-point line dither to span the chip gap with small two-point sub-pixel dithers. DD-10776 used four F555W dithered exposures at each mosaic element; we use five by exactly replicating their four dithers and adding a third chip-gap-spanning dither. In this way any sky pixel that falls in a chip gap in one exposure is imaged in at least three others. In the DD-10776 images, mosaic elements at M82-POS3 and M82-POS4 included the 10th magnitude star BD +70 587, which saturated and bled down over 300 pixels across four columns. Our individual exposures will be about 15% longer and would bleed even further. To help mitigate this and recover real data in the bled columns, we use just three of the original DD-10776 dithers in these two mosaic elements and add a pair of sub-pixel dithered images at a large enough chip-gap-spanning offset to exclude BD +70 587 from these two images.

The ACS ETC predicts that typical sky backgrounds will provide around 27 electrons per pixel. While this is just slightly below the 30 electron threshold for the recommendation for the use of a post-flash, we note that M 82 fills much of the imaged region and the ETC also predicts that a galactic background surface brightness in V band any brighter than 24.2 magnitudes/arcsec^2 (or equivalently 7 x 10^-19 erg/cm^2/sec/angstrom/arcsec^2) will be enough to raise the per pixel electron signal to 30.

ACS or WFC3:

For maximum science return on our proposal it is very important, although not absolutely critical, to use ACS/WFC and its F555W filter. The F555W filter on WFC3/UVIS has reduced throughput and a much broader bandpass, which would introduce significant structured noise into difference images between it and the 2006 ACS mosaic. Also, the full disc of M 82 has never been imaged in any WFC3 broadband filter. We are aware that one of the proposed solutions to the STScI budget is to decommission the ACS in favor of WFC3. As instructed by our contact scientist, we have structured our Phase II proposal under the assumption that ACS will be available for all of Cycle 32 and have thus replicated the DD-10776 mosaic down to its fixed targets, strict orientation, and POS TARG dithers. If ACS should be decommissioned after Cycle 32 starts, but before our March 2025 visibility window, we request that we be allowed to re-orient and re-structure our mosaic so that the orbits can be scheduled before ACS is mothballed. If ACS is decommissioned before Cycle 32 even begins, we request that our orbits be shifted to WFC3 and that we be given the flexibility to choose different mosaic positions and different, possibly multiple, WFC3 filters to best match the existing archival WFC3 imaging of M 82.

Visit

Proposal 17744, Visit 01: M82-POS1 (NE) (01), failed Mon Jul 06 12:00:29 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: First orbit, First mosaic position (M82-POS1, NE corner):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 11--14 of DD-10776, plus a fifth, more southern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

Diagnostics

(Visit 01: M82-POS1 (NE) (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

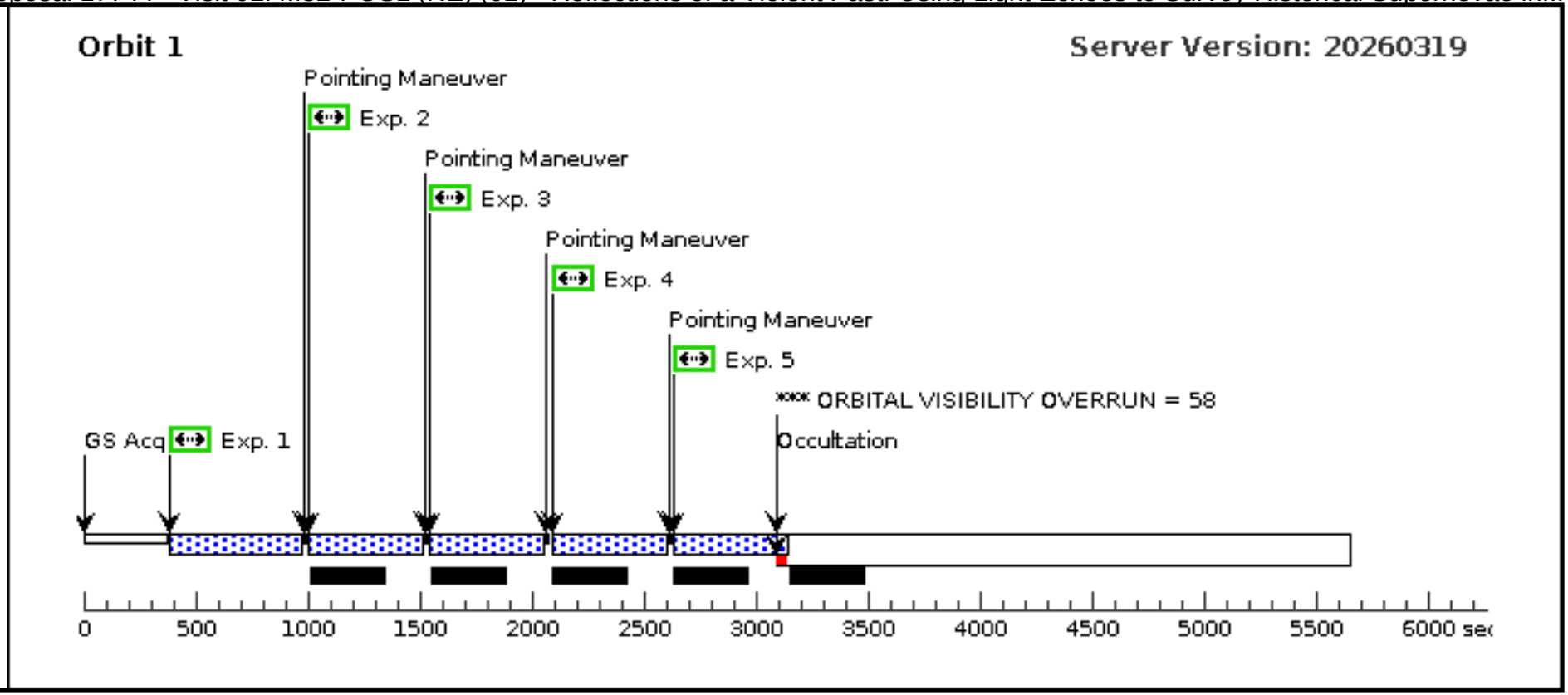
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M82-POS1	RA: 09 56 6.9731 (149.0290546d) Dec: +69 44 15.83 (69.73773d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 1, the NE corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS1-F555W-Dither1	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.247,-2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: New dither position with a negative/southward, basic chip-gap-spanning dither offset from the fixed target (position #2 in this visit), with POS TARGS -0.247", -2.84". This fifth, extra dither (relative to th e four dithers in 2006) provides for at least three exposed pixels in every chip gap. Using a downward dither relative to the fixed target pointing in mosaic elements 1 & 2 allows for more total integration time in centr al portions of the galaxy disk in the overlap zones with mosaic elements 5 & 6. Putting it first in the exposure sequence minimizes overhead time lost to the pointing maneuvers.								
2	POS1-F555W-Dither2	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1								
3	POS1-F555W-Dither3	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG +0.124, +0.084		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Small 2-point sub-pixel dither offset from position #2 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2								
4	POS1-F555W-Dither4	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Basic chip-gap-spanning dither dither offset from position #2 with POS TARGS +0.247", +2.84" , identical to DD-10776 dither position #3								
5	POS1-F555W-Dither5	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.371,3.068		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Small 2-point sub-pixel dither offset from position #4 with POS TARGS +0.371", +3.068", identical to DD-10776 dither position #4								

Orbit Structure



Visit

Proposal 17744, Visit 51: M82-POS1 (NE) repeat (51), completed Mon Jul 06 12:00:29 GMT 2026

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 305D TO 315 D; ORIENT 130D TO 130 D

Comments: First orbit, First mosaic position (M82-POS1, NE corner):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 11--14 of DD-10776, plus a fifth, more southern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

HOPR repeat of visit 01, exposure 5

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M82-POS1	RA: 09 56 6.9731 (149.0290546d) Dec: +69 44 15.83 (69.73773d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

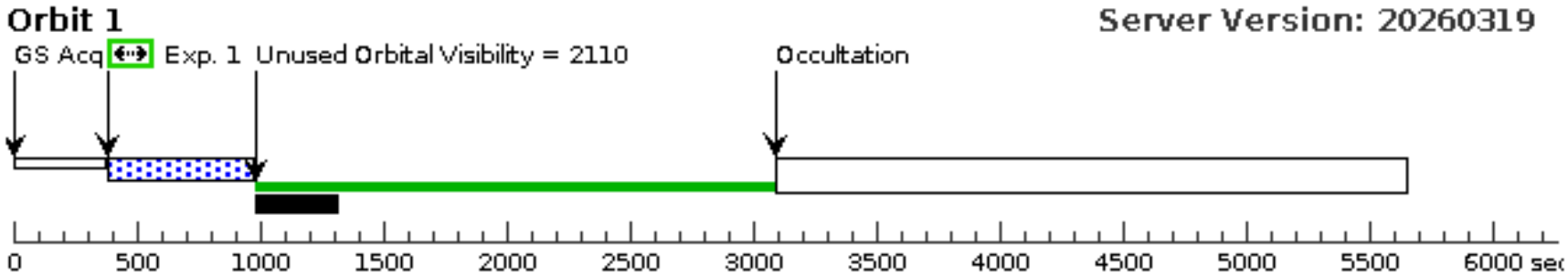
Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 1, the NE corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS1-F555W-Dither5	(1) M82-POS1	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.186,9.268		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Small 2-point sub-pixel dither offset from position #4 with POS TARGS +0.371", +3.068", identical to DD-10776 dither position #4

Orbit Structure



Visit

Proposal 17744, Visit 02: M82-POS2 (NCent) (02), failed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: Second orbit, second mosaic position (M82-POS2, N central region):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 21--24 of DD-10776, plus a fifth, more southern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

Diagnostics

(Visit 02: M82-POS2 (NCent) (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

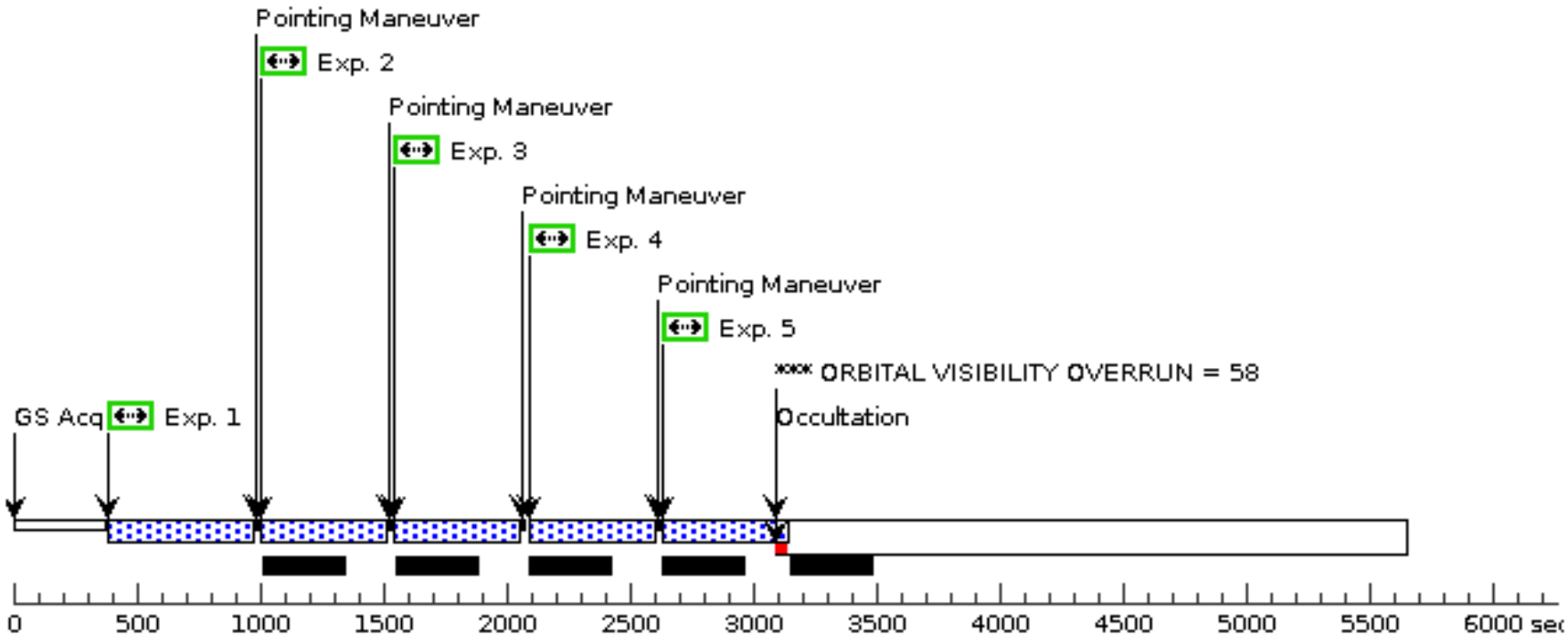
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M82-POS2	RA: 09 55 42.1040 (148.9254333d) Dec: +69 41 53.82 (69.69828d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 2, the N central region of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS2-F555W-Dither1	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.247,-2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: New dither position with a negative/southward, basic chip-gap-spanning dither offset from the fixed target (position #2 in this visit), with POS TARGS -0.247", -2.84". This fifth, extra dither (relative to th e four dithers used in DD-10776) provides for at least three exposed pixels in every chip gap. Using a downward dither relative to the fixed target pointing in mosaic elements 1 & 2 allows for more total integration ti me in central portions of the galaxy disk in the overlap zones with mosaic elements 5 & 6. Putting it first in the exposure sequence minimizes overhead time lost to the pointing maneuvers.								
2	POS2-F555W-Dither2	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1								
3	POS2-F555W-Dither3	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG +0.124, +0.084		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Small 2-point sub-pixel dither offset from position #2 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2								
4	POS2-F555W-Dither4	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Basic chip-gap-spanning dither dither offset from position #2 with POS TARGS +0.247", +2.84" , identical to DD-10776 dither position #3								
5	POS2-F555W-Dither5	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.371,3.068		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
	Comments: Small 2-point sub-pixel dither offset from position #3 with POS TARGS +0.371", +3.068", identical to DD-10776 dither position #4								

Orbit Structure



Visit

Proposal 17744, Visit 52: M82-POS2 (NCent) repeat (52), completed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D; ORIENT 305D TO 315 D

Comments: Second orbit, second mosaic position (M82-POS2, N central region):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 21--24 of DD-10776, plus a fifth, more southern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

HOPR repeat of visit 02, exposure 4.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M82-POS2	RA: 09 55 42.1040 (148.9254333d) Dec: +69 41 53.82 (69.69828d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

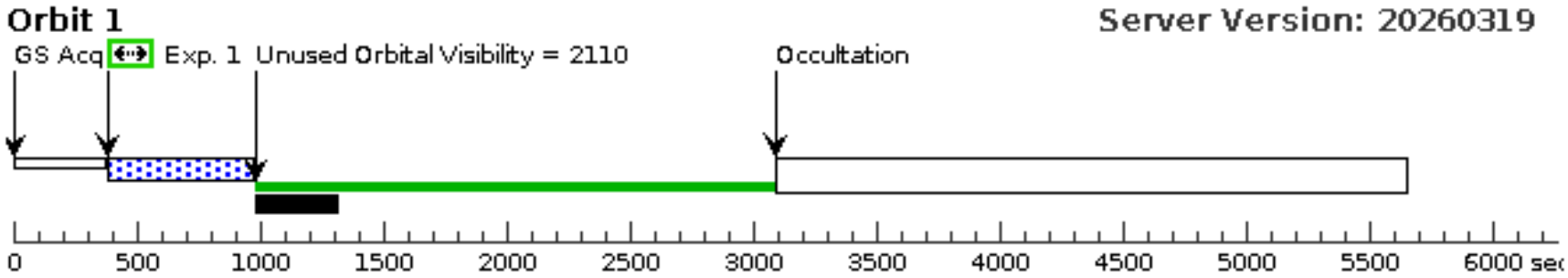
Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 2, the N central region of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS2-F555W-Dither4	(2) M82-POS2	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.186,+9.268		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Basic chip-gap-spanning dither dither offset from position #2 with POS TARGS +0.247", +2.84" , identical to DD-10776 dither position #3

Orbit Structure



Visit

Proposal 17744, Visit 03: M82-POS3 (NW) (03), failed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: Third orbit, third mosaic position (M82-POS3, NW corner):
Three of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the three F555W exposures in Visits 31--33 of DD-10776, plus two exposures/dithers in a 2-point sub-pixel dither pair that are shifted by 4x the standard chip-gap-spanning dither with POS TARGs of +0.988, +11.936 and +1.112, +12.020 arcseconds. These fourth and fifth dither positions i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled over more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't sampled in 2006. The two new dither postions come last in the orbit to save overhead time from the pointing maneuvers.
Using the pixel coordinates of the saturated star in the 2006 Visit 31 drizzled (_drc) images, the POS TARGs for dithers 4 & 5 here should place the star at least 2.8 arcseconds/55 pixels off the bottom of the CCD.

Diagnostics

(Visit 03: M82-POS3 (NW) (03)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

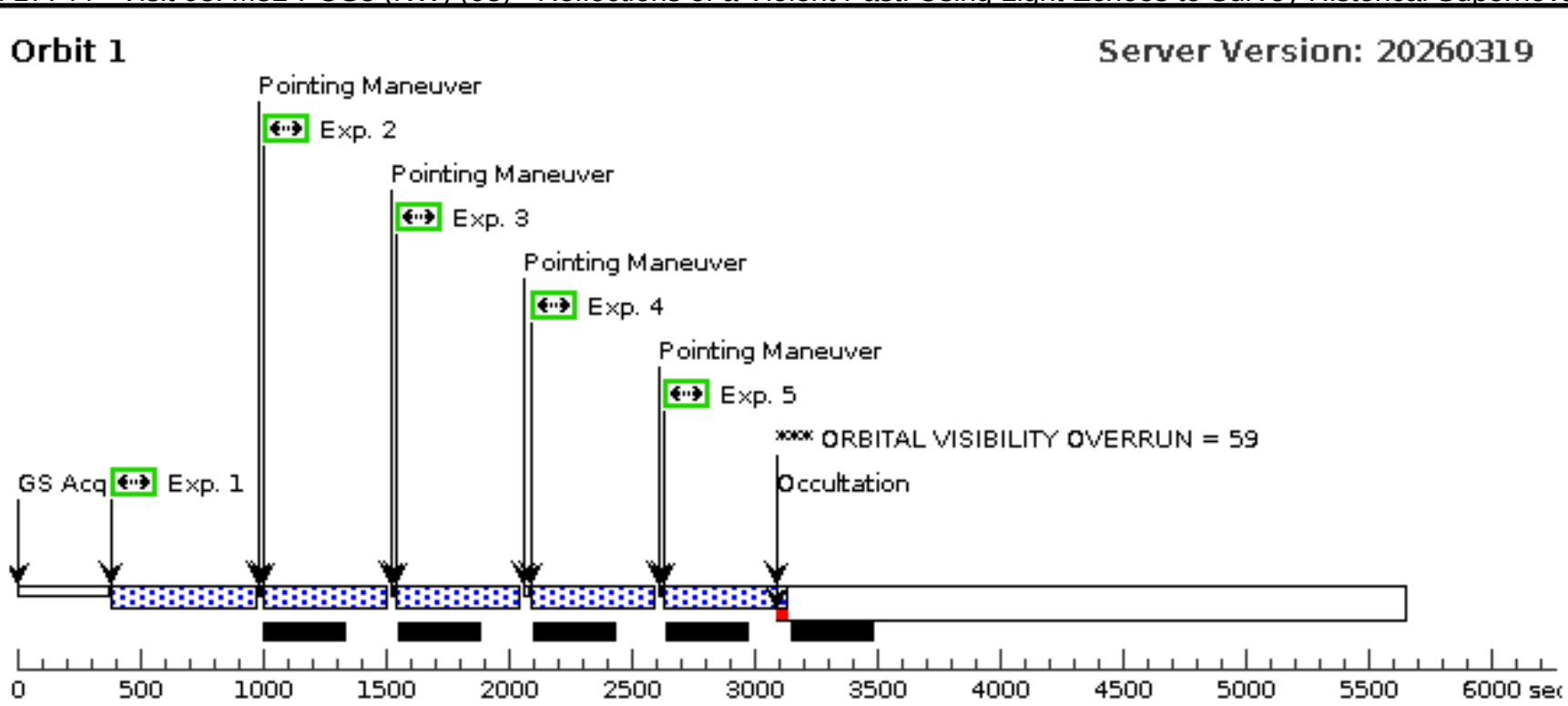
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	M82-POS3	RA: 09 55 17.3229 (148.8221787d) Dec: +69 39 31.80 (69.65883d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 3, the NW corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS3-F555W-Dither1	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			381.0 Secs (381 Secs) *[==>]*	 ***[1]***
Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1 in Visit 31									
2	POS3-F555W-Dither2	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.124,0.084		381.0 Secs (381 Secs) *[==>]*	 ***[1]***
Comments: Small 2-point sub-pixel dither offset from position #1 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2 in Visit 32									
3	POS3-F555W-Dither3	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		381.0 Secs (381 Secs) *[==>]*	 ***[1]***
Comments: Basic chip-gap-spanning dither dither offset from position #1 with POS TARGS +0.247", +2.984" , identical to DD-10776 dither position #3 in Visit 33									
4	POS3-F555W-Dither4	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.988,11.936		381.0 Secs (381 Secs) *[==>]*	 ***[1]***
Comments: New dither position with a positiive/northward, 4x multiple of the basic chip-gap-spanning dither, with POS TARGS +0.988", +11.936". The fourth and fifth dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled along more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't imaged in 2006.									
5	POS3-F555W-Dither5	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 1.112,12.020		381.0 Secs (381 Secs) *[==>]*	 ***[1]***
Comments: New dither position with a positiive/northward, 4x multiple of the basic chip-gap-spanning dither plus a 2-point sub-pixel dither, with net POS TARGS +1.112", +12.020". The fourth and fifth dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled along more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't imaged in 2006.									

Orbit Structure



Visit

Proposal 17744, Visit 53: M82-POS3 (NW) (53), implementation Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 309D TO 311 D; ORIENT 130D TO 130 D

Comments: NEW VISIT 53 IS A FULL REPEAT OF MOSTLY FAILED VISIT 03, AWARDED FIVE NEW EXPOSURES
Third orbit, third mosaic position (M82-POS3, NW corner):
Given that the two successful exposures in Visit 03 both fully incorporate the bright star at the bottom (SE) edge of the field of view, the five new exposures here are positioned to give two more images sampling the bright star on the chip (exposures 01 & 02), while the remaining three are shifted slighyt NW to avoid the star and allow us to cleanly sample the underlying galaxy lost to the saturated columns and also place the chip gaps differently from the successful Visit 03 exposures. If scheduled for a Fall 2026 execution, the optimal orienation is around 310 degrees. The orient range from 309--311 degrees chosen here keeps the inverted footprint very similar to the original March 2006 and March 2026 images, expands the schedulability windows, and avoids overlaps of the chip gap with the two successful Visit 03 exposures. If this new visit cannot be scheduled in Fall 2026, we will need to adjust the POSTARGS to achieve the same goals for a 130 degree orient in Sping 2027.

Original description of Visit 03:
Three of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the three F555W exposures in Visits 31--33 of DD-10776, plus two exposures/dithers in a 2-point sub-pixel dither pair that are shifted by 4x the standard chip-gap-spanning dither with POS TARGs of +0.988, +11.936 and +1.112, +12.020 arcseconds. These fourth and fifth dither positions i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled over more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't sampled in 2006. The two new dither postions come last in the orbit to save overhead time from the pointing maneuvers.
Using the pixel coordinates of the saturated star in the 2006 Visit 31 drizzled (_drc) images, the POS TARGs for dithers 4 & 5 here should place the star at least 2.8 arcseconds/55 pixels off the bottom of the CCD.

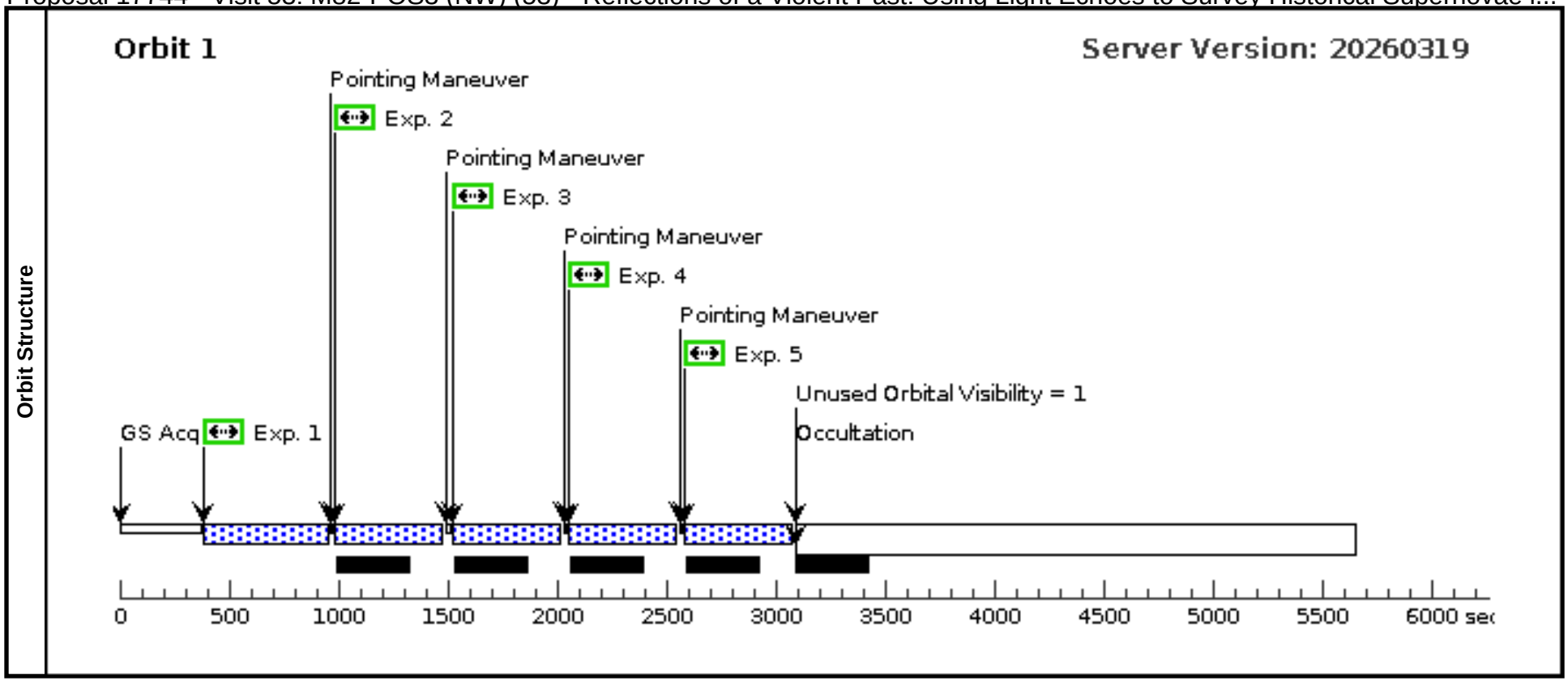
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	M82-POS3	RA: 09 55 17.3229 (148.8221787d) Dec: +69 39 31.80 (69.65883d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 3, the NW corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS3-F555W-Dither1	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.000,-2.068		369.0 Secs (369 Secs) *[==>]*	***[1]***
Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1 in Visit 31									
2	POS3-F555W-Dither2	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.124,-2.002		369.0 Secs (369 Secs) *[==>]*	***[1]***
Comments: Small 2-point sub-pixel dither offset from position #1 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2 in Visit 32									
3	POS3-F555W-Dither3	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,-1.794		369.0 Secs (369 Secs) *[==>]*	***[1]***
Comments: Basic chip-gap-spanning dither dither offset from position #1 with POS TARGS +0.247", +2.984" , identical to DD-10776 dither position #3 in Visit 33									
4	POS3-F555W-Dither4	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.124,-13.520		369.0 Secs (369 Secs) *[==>]*	***[1]***
Comments: New dither position with a positiive/northward, 4x multiple of the basic chip-gap-spanning dither, with POS TARGS +0.988", +11.936". The fourth and fifth dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled along more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't imaged in 2006.									
5	POS3-F555W-Dither5	(3) M82-POS3	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.247,-13.604		369.0 Secs (369 Secs) *[==>]*	***[1]***
Comments: New dither position with a positiive/northward, 4x multiple of the basic chip-gap-spanning dither plus a 2-point sub-pixel dither, with net POS TARGS +1.112", +12.020". The fourth and fifth dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the bottom of the aperture that saturated and bled along more than 300 pixels across four columns in the DD-10776 images, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't imaged in 2006.									


Orbit Structure
Orbit 1
Server Version: 20260319
Pointing Maneuver
Exp. 2
Pointing Maneuver
Exp. 3
Pointing Maneuver
Exp. 4
Pointing Maneuver
Exp. 5
Unused Orbital Visibility = 1
Occultation
GS Acq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17744, Visit 04: M82-POS4 (SW) (04), completed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: Fourth orbit, fourth mosaic position (M82-POS4, SW corner):
Three of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the three F555W exposures in Visits 41--43 of DD-10776, plus two exposures/dithers in a 2-point sub-pixel dither pair that is shifted by 4x the standard chip-gap-spanning dither with POS TARGs of -0.247, -2.984 and -0.371, -0.3.068 arcseconds. These two new dither positions i) primarily avoid a bright 10th magnitude star near the top of the aperture that saturated and bled over more than 300 pixels across four columns in the 2006 pointing, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new northern strip at the top of the aperture that wasn't sampled in 2006. The two new dither postions come first in the orbit to save overhead time from the pointing maneuvers.
Using the pixel coordinates of the saturated star in the 2006 Visit 43 drizzled (_drc) images, the POS TARGs for dithers 1 & 2 here should place the star at least 2.8 arcseconds/55 pixels off the bottom of the CCD.

Diagnostics

(Visit 04: M82-POS4 (SW) (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	M82-POS4	RA: 09 55 46.9871 (148.9457796d) Dec: +69 37 32.42 (69.62567d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 4, the SW corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS4-F555W-Dither1	(4) M82-POS4	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.247,-2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: New dither position with a negative/southward, basic chip-gap-spanning dither offset from the fixed target (position #3 in this visit), with POS TARGS -0.247", -2.984". The new first and second dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the top of the aperture that saturated and bled along more than 300 pixels across four columns in the 2006 pointing, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new southern strip at the bottom of the aperture that wasn't imaged in 2006.

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	POS4-F555W-Dither2	(4) M82-POS4	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.371,-3.068		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: New dither position with a negative/southward, basic chip-gap-spanning dither plus a small 2-point sub-pixel dither offset from position #1, with POS TARGS -0.371", -3.068". The first and second dither positions in this orbit i) primarily avoid a bright 10th magnitude star (BD +70 587) near the top of the aperture that saturated and bled along more than 300 pixels across four columns in the 2006 pointing, but also ii) provide for at least three exposures in every pixel in the chip gap, and also iii) provide for at least two exposures in nearly every pixel in the new southern strip at the bottom of the aperture that wasn't imaged in 2006.

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	POS4-F555W-Dither3	(4) M82-POS4	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1 from Visit 41

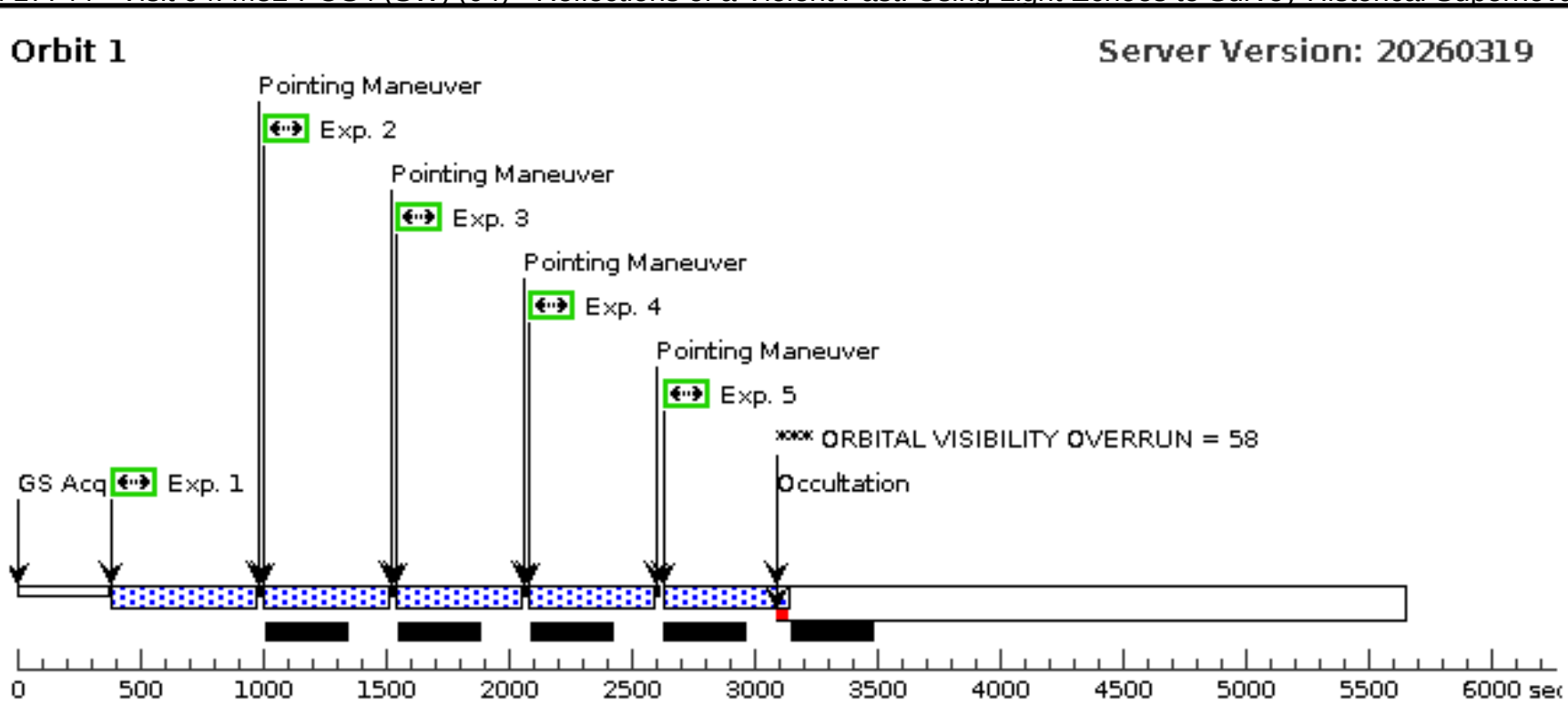
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	POS4-F555W-Dither3	(4) M82-POS4	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG +0.124, +0.084		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Small 2-point sub-pixel dither offset from position #2 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2 from Visit 42

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
5	POS4-F555W-Dither4	(4) M82-POS4	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Basic chip-gap-spanning dither dither offset from position #2 with POS TARGS +0.247", +2.84" , identical to DD-10776 dither position #3 from Visit 43

Orbit Structure



Visit

Proposal 17744, Visit 05: M82-POS5 (SCent) (05), failed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: Fifth orbit, fifth mosaic position (M82-POS5, S central region):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 51--54 of DD-10776, plus a fifth, more northern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

Diagnostics

(Visit 05: M82-POS5 (SCent) (05)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

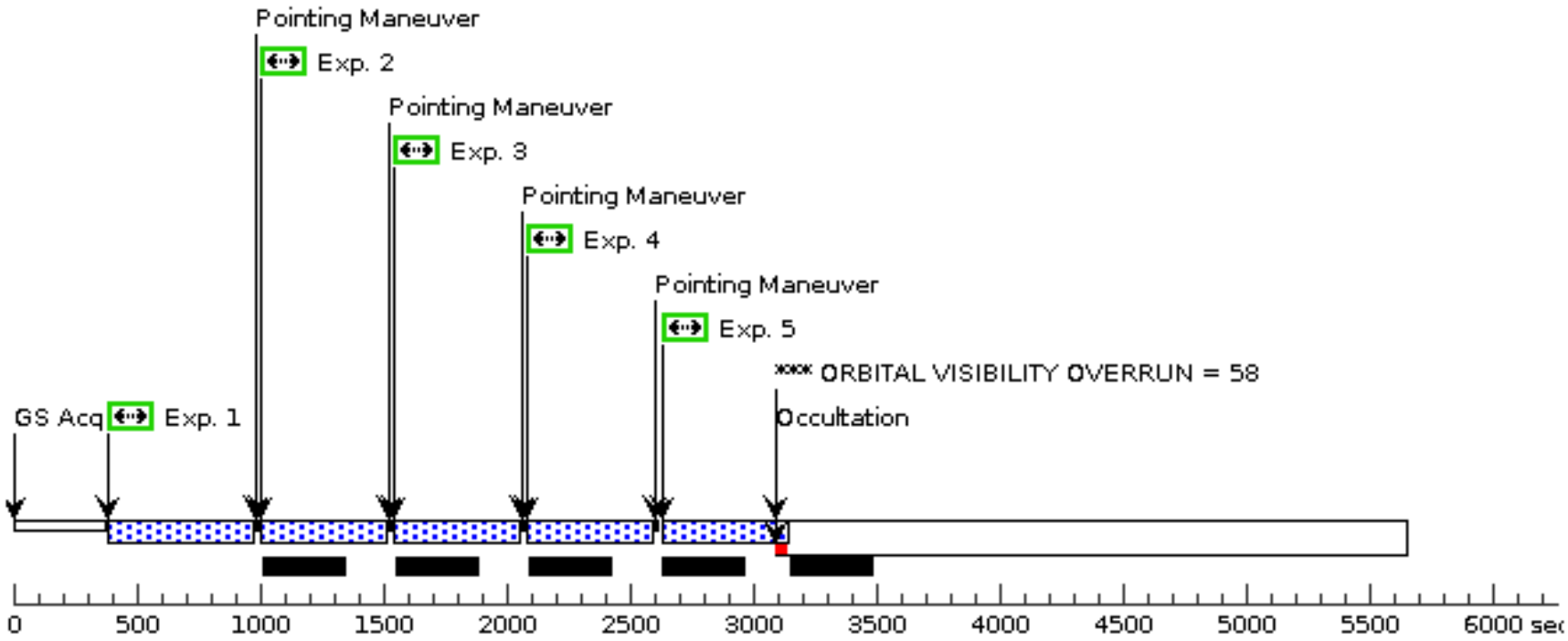
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	M82-POS5	RA: 09 56 12.1050 (149.0504375d) Dec: +69 39 54.57 (69.66516d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 5, the S central region of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS5-F555W-Dither1	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1									
2	POS5-F555W-Dither2	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.124,0.084		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Small point dither offset from position #1 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2									
3	POS5-F555W-Dither3	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Gap closing dither offset from position one with POS TARGS +0.247", +2.984" , identical to DD-10776 dither position #3									
4	POS5-F555W-Dither4	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.371,3.068		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Small point dither offset from position #4 with POS TARGS +0.371", +3.068", identical to DD-10776 dither position #4									
5	POS5-F555W-Dither5	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.494,5.968		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: New dither position with a positiive/northward, chip-gap-spanning dither, with POS TARGS +0.494", +5.968". This fifth dither (relative to the four dithers in DD-10776) provides for at least three exposed pixels in every chip gap. Using a posittive dither relative to the fixed target pointing in mosaic elements 5 & 6 allows for more total integration time in central portions of the galaxy disk in the overlap zones with mosaic elements 1 & 2. Putting it last in sequence minimizes overhead time lost to the pointing maneuvers.									

Orbit Structure



Visit

Proposal 17744, Visit 55: M82-POS5 (SCent) (55), implementation Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 309D TO 311 D; ORIENT 130D TO 130 D

Comments: REPEAT OF FIRST EXPOSURE OF VISIT 05 ONLY:
Fifth orbit, fifth mosaic position (M82-POS5, S central region):
Repeat of first exposure from Visit 05 that was corrupted by multiple satellite streaks. When scheduled at the 180-degree opposite orientation from the original (in Fall 20026), the orient range of 310.0 degrees +/-1.0 degrees and the new postargx,y values of -0.494, -5.968 arcseconds allow for nearly identical overlap with the original image footprint, but more importantly, it places the chip gap completely with no overlap of the previous four successful images. As a bonus, it is further from the wings of the PSF and diffraction spikes of the bright star at the southern edge. Adding +/-1 degree in the orient allows for an expanded schedulability window in Fall 2026. If the visit cannot be scheduled in Fall 2026, we will likely need to adjust the orient and postargs for a visit scheduled in Spring 2027.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	M82-POS5	RA: 09 56 12.1050 (149.0504375d) Dec: +69 39 54.57 (69.66516d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

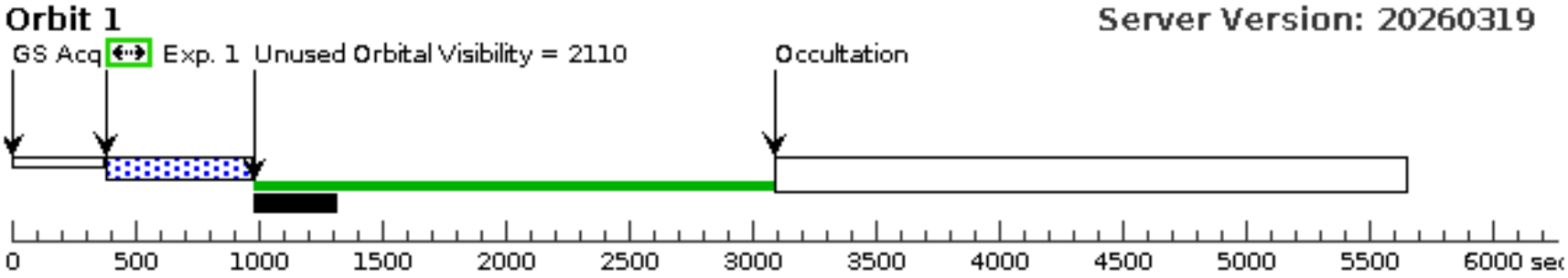
Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 5, the S central region of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS5-F555W-Dither1	(5) M82-POS5	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG -0.494,-5.968		382.0 Secs (382 Secs) *[==>]*	 ***[1]***

Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1

Orbit Structure



Visit

Proposal 17744, Visit 06: M82-POS6 (SE) (06), completed Mon Jul 06 12:00:30 GMT 2026

Diagnostic Status: Warning

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 130.0D TO 130.0 D

Comments: Sixth orbit, sixth mosaic position (M82-POS6, SE corner):
Four of five exposures/dithers executed with identical target, orientation requirement, and POS TARG offsets as the F555W exposures in Visits 61--64 of DD-10776, plus a fifth, more northern, chip-gap-spanning dither postion to provide at least three exposures in every pixel falling in a chip gap.

Diagnostics

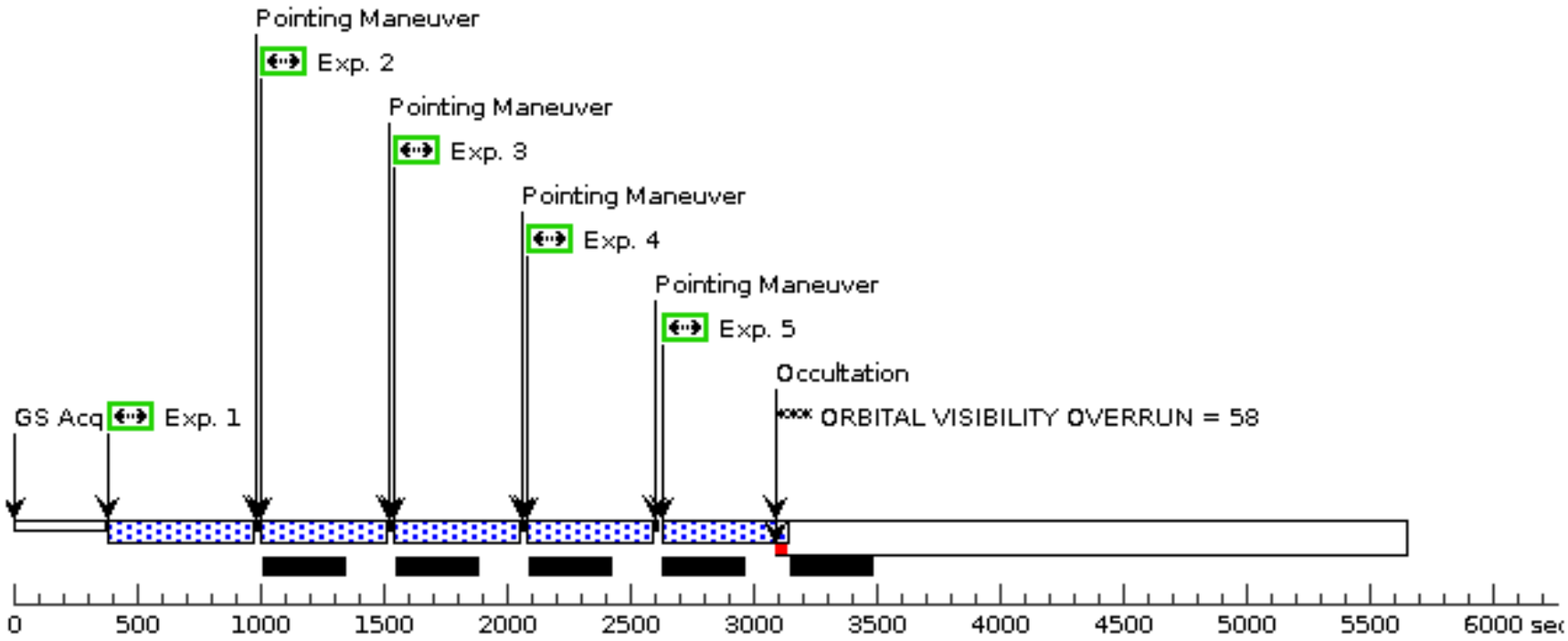
(Visit 06: M82-POS6 (SE) (06)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	M82-POS6	RA: 09 56 36.4872 (149.1520300d) Dec: +69 42 16.90 (69.70469d) Equinox: J2000		V=19.0+/-0.1	Reference Frame: GSC1

Comments: Our proposal is to redo the DD-10776 ACS/WFC six-element mosaic of M82 from 2006 as exactly as possible. This target information is copied as closely as possible from the DD-10776 Phase II file for Position 6, the SE corner of their 3 x 2 element mosaic of M 82.
Category=GALAXY
Description=[SEYFERT, STARBURST]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	POS6-F555W-Dither1	(6) M82-POS6	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0			382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Default pointing on fixed target with no dither, exactly identical to DD-10776 dither position #1									
2	POS6-F555W-Dither2	(6) M82-POS6	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.124,0.084		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Small point dither offset from position #1 with POS TARGS +0.124", +0.084", identical to DD-10776 dither position #2									
3	POS6-F555W-Dither3	(6) M82-POS6	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.247,2.984		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Gap closing dither offset from position one with POS TARGS +0.247", +2.984" , identical to DD-10776 dither position #3									
4	POS6-F555W-Dither4	(6) M82-POS6	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.371,3.068		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: Small point dither offset from position #4 with POS TARGS +0.371", +3.068", identical to DD-10776 dither position #4									
5	POS6-F555W-Dither5	(6) M82-POS6	ACS/WFC, ACCUM, WFCENTER	F555W	CR-SPLIT=NO; GAIN=2.0	POS TARG 0.494,5.968		382.0 Secs (382 Secs) *[==>]*	 ***[1]***
Comments: New dither position with a positiive/northward, chip-gap-spanning dither, with POS TARGS +0.494", +5.968". This fifth dither (relative to the four dithers in DD-10776) provides for at least three exposed pixels in every chip gap. Using a posittive dither relative to the fixed target pointing in mosaic elements 5 & 6 allows for more total integration time in central portions of the galaxy disk in the overlap zones with mosaic elements 1 & 2. Putting it last in sequence minimizes overhead time lost to the pointing manuevers.									

Orbit Structure