NIRSpec MOS Observing Process

The JWST NIRSpec multi-object spectroscopy (MOS) observing mode requires a multi-step process for submission and update of proposals to create executable visits. This applies to all MOS spectroscopy (with or without NIRCam pre-imaging), as well as IFU and FS observations that use the MSA-based NIRSpec target acquisition process (MSATA).

Introduction

Parent articles: NIRSpec Operations → NIRSpec MOS Operations

See Also: NIRSpec MOS Proposal Checklist

The NIRSpec multi-object spectroscopy (MOS) mode provides the means to simultaneously obtain spectra of multiple objects within the 3.6' × 3.4' field of view of the Micro-Shutter Assembly (MSA). In order to accurately open the correct micro-shutters on the science sources of interest, NIRSpec MOS mode exposures must be planned and executed at a precisely-specified instrument aperture position angle. For JWST, restrictions in the observation position angle translate to constraints for the execution time window. Therefore, to permit more flexible scheduling of NIRSpec MOS mode observations during long range planning and to ensure correct execution angles, the process will consist of two steps: (1) proposal preparation and submission and (2) observation update for flight executable MOS visits after an aperture position angle is assigned by STScI.

All JWST NIRSpec IFU and FS observations that use the MSA-based target acquisition method (MSATA) must also execute at a fixed aperture position angle and will also follow this multi-step process. This article describes the observing process and timeline, and how NIRSpec aperture position angle constraints can affect observation windows.

The NIRSpec MOS and MSATA observing process

See also: NIRSpec MOS Proposal Checklist, NIRSpec Target Acquisition, NIRSpec Target Acquisition Recommended Strategies, Target Visibility Tools, and NIRSpec MSA Planning Tool, MPT

NIRSpec MOS science that requires the alignment of configured open MSA shutter "slitlets" with specific sources spread across the field of view will need to be planned and executed at a fixed NIRSpec *Aperture Position Angle* [1]. This is required in order for the science sources to align properly with the very small 0.2" × 0.46" MSA shutters. Similarly, observations with MSA-based target acquisition (MSATA) also require a fixed position angle.

JWST has significant pointing constraints on target visibility windows resulting in limited availability of orientations for a given pointing. A scheduling team at STScI will, therefore, assign a fixed aperture position angle to each MOS science program and other programs using MSATA. At proposal submission, NIRSpec MSA-based observations will not be ready to execute on the telescope. Updates to accepted programs will be needed to create more detailed observations that are flight ready.

Users should submit a NIRSpec MOS proposal prepared using the Astronomer's Proposal Tool (APT) following the instructions and guidelines for using the MSA Planning Tool (MPT). The MPT should be used to prepare *placeholder* visits for the requested observing time. MPT will use a placeholder **Aperture Position Angle** that will not constrain the scheduling of accepted programs but will be used to accurately estimate overheads; Only observatory special requirements on position angle, if present, will constrain the scheduling.
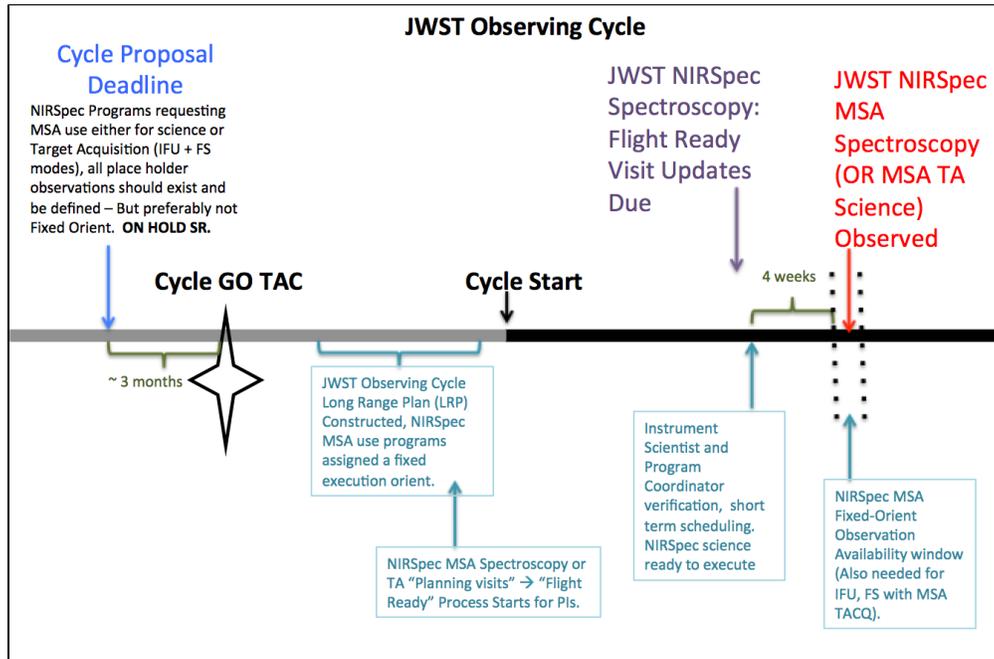
Figure 1 shows a timeline of this NIRSpec MOS or MSATA proposal submission process in the case where source planning catalogs exist and no pre-imaging observations using NIRCam are necessary.

Accepted NIRSpec MOS or MSATA proposals will be assigned an **Aperture Position Angle** after the JWST cycle Long Range Plan (LRP) is created. The assigned angle will correspond to an execution window that has been analyzed for schedulability compared to all accepted JWST science programs. This assigned execution NIRSpec aperture position angle will be communicated back to teams so they may start the MOS observation planning process. The on-sky executable MOS science or MSATA observations are planned to their assigned aperture position angle by users, after programs are accepted by the TAC. "Flight ready update" MSA programs are constructed and submitted by observing teams through APT, with the same interface as the proposal. The due date for these flight-ready executable science visits will be about four weeks before the scheduling window for the spectral observation execution (see Table 1).

Some science use cases may require constraints on aperture position angle for efficient data acquisition. MOS or MSATA proposals that request constraints on the NIRSpec aperture position angle are discouraged, but not prohibited if the science justifies it. Presentation of some considerations on aperture position angles for MOS science cases are included below.

> ⊘ The selection of TA parameters for MSATA is not required at proposal submission. During program update, after an **Aperture Position Angle** has been assigned by STScI, the final target acquisition parameters will be defined by the user through the selection of a set of reference stars for each Visit. At program update, suitable reference stars must be present in the user's input Catalog in order for this process to work, as described in the article on MSATA.

Figure 1. Timeline of the NIRSpec MOS observing process

A timeline figure of the JWST NIRSpec MOS observing flow during an observing cycle.

Table 1 shows the expected timeline for STScI review of flight executable NIRSpec MOS or MSATA program updates, which will be due to STScI 28 days (four weeks) prior to the observation scheduling window. Users are welcome to submit programs before this 28 day window, but should also be advised that the shutter operability can change on short timeframes, so final planning of MOS programs should be done close to the deadline to prevent the loss of primary science targets. It is anticipated that 28 days is the minimum time needed by STScI staff to process MOS or MSATA flight ready program updates. This process will be re-assessed during Cycle 1 science operations. The timescale for reviews of the MOS and MSATA flight updates will be updated appropriately once experience is gained.

Table 1. STScI review of flight executable MOS or MSATA observations

Time frame before science observation window	STScI NIRSpec flight executable program review activity
28 to 21 Days	Instrument scientist review of MOS or MSATA observations
21 to 14 Days	Program coordinator checks of MOS or MSATA observations
14 to 0 Days	Short term scheduling of executable visits

[1] *Bold italics* font style is used to indicate parameters, parameter values, and/or special requirements that are set in the APT GUI.

# Example effect of fixed aperture position angle constraints on observation execution windows

Requesting fixed or a highly constrained NIRSpec *Aperture Position Angle* for MOS science or MSATA will translate directly to constraints on schedulability in the observing Cycle. Figure 2 shows two APT Visit Planner views of available execution windows for observations planned with identical MOS planning parameters and science duration. Both observations are at the same pointing position; the available possible aperture position angles span a range of 30°. The top visit planner view in Figure 2 is for an observation with an aperture position angle special requirement and a range of 0°. This observation has only eight days of schedulability over a year-long JWST observing cycle. The bottom Visit Planner view has no aperture position angle special requirement, and an available execution window of 54 days.

An analysis of two science use cases that explain limits for this recommendation are presented. Very strict constraints on execution position angles are discouraged but not forbidden. All requests for tighter aperture position angle special requirement range constraints on MOS or MSATA programs must be well-justified in the technical case for the proposal.

- For optimal schedulability of NIRSpec MOS and MSATA observations, programs should have no aperture position angle special requirements or an available angle constraint range of at least 20° –30° covering the visibility window to improve program schedulability.
- All requests for tighter aperture position angle special requirement range constraints on MOS or MSATA programs must be well justified in the technical case for the proposal.

Figure 2. Visit planner observing windows for two planned observations at constrained vs. unconstrained APA
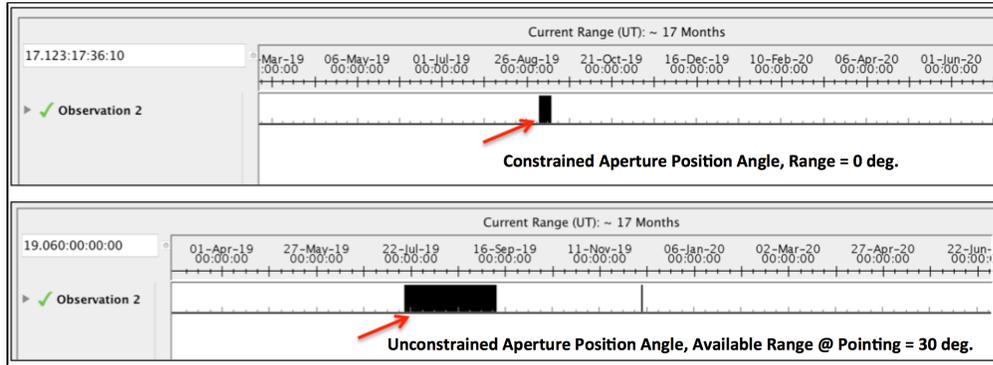
Shown here are visit planner observing window views of a highly constrained proposed aperture position angle (top) and unconstrained proposed aperture position angle (bottom). The more constrained observing window is only eight days long—it is defined by an "Aperture Position Angle special requirement" with 0° range. The unconstrained position angle plan has no special requirement constraint over the possible NIRSpec position angle range of 30°. This allows for science to be scheduled more optimally in the long range plan (LRP), over a wider 54 day window.