

Timing Special Requirements

Timing Special Requirements (e.g. **AFTER**, **GROUP**) are used to restrict the scheduling of JWST observations by timing constraints. The Astronomer's Proposal Tool ([APT](#)) is used to enter the requirements into the proposal.

Introduction

Timing special requirements directly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

★ As noted in the [Observation Specifications](#) article, all visits within a given observation have an implicit **GROUP WITHIN 53 DAYS** special requirement, and are required to be executed at the same aperture position angle. Separate observations have no such restrictions.

The Timing Special Requirements are summarized in [Table 1](#), followed by a detailed description of each requirement.

Rules and Conventions

You should observe the following conventions and rules for special requirements:

- A <date> specification in a Special Requirement must be a geocentric date expressed in Universal Time (UT); a heliocentric Julian Date is allowed for the **PHASE/PERIOD/ZERO-PHASE** requirement. There are several formats for specifying a UT date, and these are described in General Rules for Specifying Dates and Times ([future link](#)). For example, **2011-DEC-14:17:05:41** refers to 14 December 2011, geocentric UT 17H05M41S. Only the necessary precision need be employed (e.g., **2011-DEC-14** might be adequate), but four-digit years are mandatory.
- You should select the units of all <duration> specifications from a list provided to you. The options are: days, hours, minutes, or seconds.

⚠ **Note that users may also specify a date in day-of-year format, such as 2010.189. Such a date must use a 4-digit year and a 3-digit integer for the day (fractions of days are not allowed). This capability is meant for internal STScI usage, and proposers should use it with care.**

- An observation-level special requirement applies to **ALL** the visits within that observation.
- For a scheduling window created by a requirement which creates a time-related constraint (**BETWEEN**, **AFTER <observation> BY**, and the **PHASE** range of the **PHASE/PERIOD** requirement):

- The absolute minimum window allowed is 5 minutes for an individual observation (10 minutes for **AFTER <observation> BY**).
- Windows less than one hour (3600 seconds) will incur [Direct scheduling overhead](#) to account for impacts to the scheduling of other observations (see [Time Constrained Observations](#)).
- A diagnostic will be generated if the sum of the durations of the Observations in a group length is greater than the sum of their durations, plus some padding for Observatory overheads (e.g. Momentum unloads).

Note for developer: The values above are maintained in the JWST SOC PRD.

Table 1. Supported Formats for Timing Special Requirements

FORMAT	EXAMPLE
AFTER <date>	AFTER 2018-JUL-11:12:06
AFTER <observation> [BY <duration1> TO <duration2>] [EXCLUSIVE USE OF INSTRUMENT]	AFTER 06 BY 7 DAYS TO 9 DAYS
BEFORE <date>	BEFORE 2018-SEP-11
BETWEEN <start-date> AND <end-date>	BETWEEN 2018-DEC-21 AND 2018-DEC-31
GROUP OBSERVATIONS <observation list> [WITHIN <duration>] [NON-INTERRUPTIBLE] [EXCLUSIVE USE OF INSTRUMENT]	GROUP OBSERVATIONS 05-10 WITHIN 60 DAYS
SEQUENCE OBSERVATIONS <observation list> [WITHIN <duration>] [NON-INTERRUPTIBLE] [EXCLUSIVE USE OF INSTRUMENT]	SEQUENCE OBSERVATIONS 05-07 NON-INTERRUPTIBLE
GROUP VISITS WITHIN <duration> [NON-INTERRUPTIBLE] [EXCLUSIVE USE OF INSTRUMENT]	GROUP VISITS WITHIN 1 DAYS EXCLUSIVE USE OF INSTRUMENT
PHASE <number1> TO <number2> with PERIOD <duration> and ZERO-PHASE (HJD) <date>	PHASE 0.09 TO 0.11 WITH PERIOD 1.23 HOURS AND ZERO-PHASE (HJD) 2444000
TIME SERIES OBSERVATION	TIME SERIES OBSERVATION

AFTER <date>

This requirement specifies that the observation (all visits) must start after the date given by **<date>**.

AFTER <observation> [BY <duration1> TO <duration2>] [EXCLUSIVE USE OF INSTRUMENT]

This requirement specifies that the visits in this observation must all start after the visits in the referenced **<observation>**. The **BY <duration1> TO <duration2>** option allows specification of an acceptable time interval between the observations. For example, **AFTER 6 BY 7 DAYS TO 9 DAYS** requests that no visit in the current observation start earlier than 7 days after any visit in observation 6 starts, nor will any visit in the current observation start later than 9 days after any visit in observation 6 starts.

If the difference between **<duration1>** and **<duration2>** is too small, the observation may be difficult or impossible to schedule. A difference of at least 10 minutes is required. A difference of less than one hour will incur Direct scheduling overhead (see [Time Constrained Observations](#)). Note that if **<duration 1>** is not specified, it will be treated as 0. If **<duration 2>** is not specified, it will be treated as infinity.

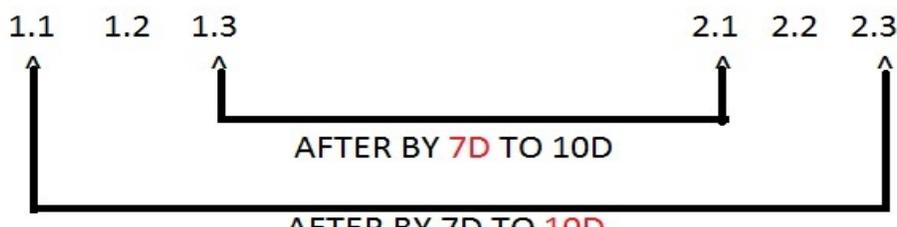
The **EXCLUSIVE USE OF INSTRUMENT** option is used to carry out an engineering procedure for a given instrument that requires two or more visits with a substantial time separation between the first and last. While the procedure is underway, no other visits using that instrument may be scheduled. An example is the NIRSpec MSA ANNEAL.

Note for developers: there needs to be a diagnostic if an **AFTER OBSERVATION BY** is created between Observations using different instruments when **EXCLUSIVE USE OF INSTRUMENT** is specified.

Note for developers: When an **AFTER** requirement is placed on two observations, APT will make the **GROUP VISITS** requirement into a **SEQ VISITS** requirement, and APT will generate two visit-to-visit after links. One link is between the first visit in the first observation and the last visit in the second observation, with the same min and max time. The other link is between the last visit in the first observation and the first visit in the second observation, again with the same min and max time. These requirements will guarantee that all visits in the second start within the observer's time window after all the visits in the first. If either Observation has only 1 visit, you still need both links, but if both have only 1 visit, there is no need for the second link. APT will have to check that.

In this example, with two observations of 3 visits each: **OBSERVATION 2 AFTER OBSERVATION 1 BY 7 DAYS TO 10 DAYS**, you will get Visit 2.1 AFTER Visit 1.3 BY 7 days to 10 days and Visit 2.3 AFTER Visit 1.1 BY 7 days to 10 days.

Graphically it looks like this:



BEFORE <date>

This requirement specifies that the observation (all visits) must start before the **<date>** given.

BETWEEN <start-date> AND <end-date>

This requirement specifies that the observation (all visits) must start (but not necessarily end) between **<start-date>** and **<end-date>**. For example, **BETWEEN 2018-SEP-14 AND 2018-SEP-21** indicates that all visits in the observation must be started after 14 September 2018 and before 21 September 2018.

The time interval **<end-date>-<start-date>** must be at least 5 minutes. Time intervals less than one hour between **<start-date>** and **<end-date>** will incur Direct scheduling overhead (see [Time Constrained Observations](#)).

Multiple **BETWEEN** Special Requirements may be specified on an observation. The observation will be allowed to execute during any of the time intervals specified. For example, the combination of **BETWEEN 2018-SEP-14 AND 2018-SEP-21** and **BETWEEN 2018-OCT-10 AND 2018-NOV-01** means that the observation must be started either between 14 September 2018 and 21 September 2018, or between 10 October 2018 and 1 November 2018. **⚠ Multiple BETWEEN intervals on the same observation may not overlap: all the other intervals must either end earlier than <start-date> or start later than <end-date>.**

For most observations the exact definition of when a visit starts is not important. But for a very tight **BETWEEN** requirement, it could be important. **<start-date>** to **<end-date>** is the range in which the start of the first science activity in the observation should begin. The start of the science activities in a visit is after the end of the slew and guide star acquisition activities. If the visit has a target acquisition then the start time is after the end of the target acquisition, and any slew to the first science pointing. Otherwise, the start time is the start of the science observation activity, which includes any mechanism and science instrument configuration.

★ The **BEFORE**, **AFTER <date>**, and **BETWEEN** Special Requirements are mutually exclusive. An observation which specifies one may not specify either of the other two, although multiple **BETWEENs** are allowed. Note that any **BEFORE** or **AFTER <date>** may be replaced by a **BETWEEN** with a sufficiently early start date or late end date. However, **AFTER <observation>** may be combined with **BETWEEN** or **BEFORE**.

Group/Sequence Observation Link

GROUP OBSERVATIONS <observation list>
[WITHIN <duration>] [NON-INTERRUPTIBLE]
[EXCLUSIVE USE OF INSTRUMENT]

SEQUENCE OBSERVATIONS <observation list>
[WITHIN <duration>] [NON-INTERRUPTIBLE]
[EXCLUSIVE USE OF INSTRUMENT]

GROUP VISITS WITHIN <duration> [NON-
INTERRUPTIBLE] [EXCLUSIVE USE OF INSTRUMENT]
(implicit requirement)

You can link observations or visits together so that they will schedule within the *<duration>* specified, or in a *NON-INTERRUPTIBLE* manner.

If you *GROUP OBSERVATIONS*, all visits of observations included in the observation list will execute in an order determined by the scheduling system.

If you *SEQUENCE OBSERVATIONS*, all visits of observations included in the observation list must be ordered according to their observation number. For example, *SEQUENCE OBSERVATIONS 1-4 WITHIN 4 DAYS* means that all visits of observation 4 must start within 4 days of the start time of observation 1, with observations 2 and 3 executing in between. *SEQUENCE* constrains the order of the component visits. So not only do the observations start in order, the visits from observation 1 have to be done before the visits from observation 2 begin.

An observation implicitly has a *GROUP VISITS WITHIN 53 DAYS*. You can modify this requirement if you need to further restrict the window of time in which the visits will start; ⚠ *<duration> must not exceed 53 days*. Note that you can select *NON-INTERRUPTIBLE* instead of using a *WITHIN*.

WITHIN <duration>

If a *<duration>* is specified, all visits included must start within the duration given. For example, *GROUP OBSERVATIONS 7-10 WITHIN 12 HOURS* requests that all visits of observations 7 through 10 all start execution within a 12-hour interval.

Note that if the time interval given is shorter than the minimum interval to execute the visits, the visits will be unschedulable.

★ The final visit to execute will start within the `<duration>` specified, but may execute partially outside the window.

NON-INTERRUPTIBLE

If **NON-INTERRUPTIBLE** is selected, then all visits included must execute without interruption. ⚠ The total duration of a non-interruptible group may not exceed 24 hours due to scheduling concerns.

EXCLUSIVE USE OF INSTRUMENT

This option is used to carry out an engineering procedure for a given instrument that requires two or more visits with a substantial time separation between the first and last. While the procedure is underway, no other visits using that instrument may be scheduled. An example is the NIRSspec MSA ANNEAL.

Note for developers: there needs to be a diagnostic if a GROUP/SEQ is created between Observations using different instruments when Exclusive Use of Instrument is specified.

PHASE `<number1>` TO `<number2>` with PERIOD `<duration>` and ZERO-PHASE (HJD) `<date>`

This requirement supplies the **PERIOD** and **ZERO-PHASE** for observations to be made at a specific **PHASE** of a periodically variable (fixed or moving) target. `<duration>` is the period in days, hours, minutes or seconds. `<date>` is the date of the zero-phase with respect to the Sun (i.e., HJD, not a calendar date). `<number1>` to `<number2>` is the phase range in which the start of the first science activity in the observation should begin (see [Definition of First Science Activity](#)); `<number1>` and `<number2>` should be between 0.0 and 1.0.

With short periods, the phase range (difference between `<number1>` and `<number2>`) should be made as wide as possible to make scheduling easier; ⚠ note that the absolute limit is 5 minutes. Phase ranges of less than one hour between `<start-date>` and `<end-date>` will incur Direct scheduling overhead (see [Time Constrained Observations](#)).

Julian Dates must be entered in the form JDnnnnnnn.nnn (e.g., **JD2444123.4**). Only the required precision need be provided. All Julian Dates will be interpreted as heliocentric.

🔔 Note that the **PHASE** requirement you specify on a multi-visit observation will be applied to each Visit individually. If different phases are needed for the different visits then the visits need to be in separate observations. If you need your visits/observations to be in the same periodic cycle, you need to also use a **GROUP VISITS/OBSERVATIONS WITHIN `<duration>`** requirement (making `<duration>` the **PERIOD** of the system).

If a target has multiple periods which must be satisfied simultaneously, the **PERIOD ZERO-PHASE** Special Requirement should refer to the shorter of the two periods and the longer period can be specified using multiple **BETWEEN** Special Requirements that cover the next year and a half. Please contact [jwsthhelp](#) if you need to use this technique.. (Example: The target is an X-ray pulsar. The observation needs to occur in a particular phase of the 35-hour binary period as well as a particular phase of the 2-month on/off period. Use the **PERIOD ZERO-PHASE** Special Requirement for the 35-hour period and then specify the 2-month period with multiple **BETWEENs**.)

Definition of First Science Activity: For most observations the exact definition of when a visit starts is not important. But for a very tight PHASE requirement it could be important. The start of the science activities in a visit is after the end of the slew and guide star acquisition activities. If the visit has a target acquisition then the start time is after the end of the target acquisition, and any slew to the first science pointing. Otherwise, the start time is the start of the science observation activity, which includes any mechanism and science instrument configuration.

With short periods, the phase range (difference between $\langle \text{number1} \rangle$ and $\langle \text{number2} \rangle$) should be made as wide as possible to make scheduling easier. There is an absolute minimum on the phase computed scheduling duration given by $(\langle \text{number2} \rangle - \langle \text{number1} \rangle) * \text{PERIOD}$ as noted above under [Rules and Conventions](#) .

Developer note: As indicated in the box above, PHASE may only be used for external observations.

TIME SERIES OBSERVATION

This requirement specifies that a special time series pipeline will be used to process the data. It also signals to APT to allow (warning instead of error) longer exposure times. The table below indicates for which templates this requirement is valid. Note that when this requirement is specified, you **MUST** also specify the **NO PARALLEL** requirement (parallel observations are not allowed during time series observations).

Instrument	Template	Status
MIRI	Imaging	may be added by observer
	LRS (Subarray=Full)	not allowed
	LRS (Subarray=Slitlessprism)	automatically added, may be removed by observer
	MRS	not allowed
	Coronagraphy	not allowed
NIRCam	Imaging	not allowed
	Coronagraphic Imaging	not allowed
	Time Series	automatically added, may not be removed by observer

	Grism Time Series	automatically added, may not be removed by observer
	Wide Field Slitless Spectroscopy	not allowed
NIRSpec	Fixed Slit Spectroscopy	not allowed
	IFU Spectroscopy	not allowed
	Multi-Object Spectroscopy	not allowed
	Bright Object Time Series	automatically added, may not be removed by observer
NIRISS	Imaging	not allowed
	Wide Field Slitless Spectroscopy	not allowed
	Single Object Slitless Spectroscopy	automatically added, may be removed by observer
	Aperture Masking Interferometry	not allowed

Change log

Version 5 (April 16, 2019)

1. Editorial change (moved change log to main article).

Version 4 (January 26, 2018)

1. [PR 86735](#) - added text describing direct scheduling overhead for tight timing windows.

Version 3 (December 27, 2017)

1. [PR 88411](#) - added note to TSO about needing NO PARALLEL

Version 2 (October 19, 2017)

1. [PR 87867](#) - added new Time Series Observation requirement

(January 18, 2017)

Updated the time minimum length of a time constraint that would not incur an special overhead. (Per meeting with Lou Strolger on 1/13/17.)

Version 1 (June 28, 2016)

This is the converted Word File from [Chapter 7](#).

Related links

[General Special Requirements](#)

[Solar System Special Requirements](#)

[Aperture Position Angle Special Requirements](#)

General Rules for Specifying Dates and Times ([future link](#))

Keywords

Timing Special Requirements

Timing Special Requirements description

Format definitions

Boldface italics type indicates the name of an APT parameter or a value for a parameter.

 **Red** text indicates restrictions on a parameter.

 Black text indicates an important note.

Purple text indicates the parameter is [Limited Access](#) .

 Black text indicates an useful suggestion.

Brown text indicates notes for the developers.

Items in brackets - <value> - are required values.

Items in square brackets - [<value>] - are optional.

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