Chapter 39

NIRSpec Engineering

In this chapter…

39.1 Introduction

The NIRSpec Engineering templates/modes are used for calibration observations for the NIRSpec detectors. These observations may be to obtain darks, operate the focus mechanism, perform internal lamp exposures, anneal the MSA, detect and mask MSA shorts, characterize and run-in the filter and grating wheels, obtain images for engineering analysis, or support the JWST Optical Telescope Element (OTE) Multi-Instrument Multi-Field (MIMF) commissioning activities. The parameters described in this section are used to specify the Observations for NIRSpec Engineering modes. More complete descriptions of the detector readout parameters, filters, detector characteristics, etc. are available in the NIRSpec Instrument Handbook.

The following fields are defined in Chapter 5: Observation Number (5.1), Observation Label (5.2), Observation Comments (5.3), and Observation-Level Special Requirements (5.5), and will not be discussed in this Chapter.

The NIRSpec Engineering templates consists of the following parameters:

Field	Details	Values	Notes
Dark [NRS0190]			
Number of Exposures **[NRS0191]**	specify number of dark exposures	number **[NRS0192]**	
Readout Pattern **[NRS0193]**	specify readout pattern	NRS, NRSRAPID, **[NRS0194]**	
Number of Groups **[NRS0195]**	specify number of groups **[NRS0196]**		
Number of Integrations **[NRS0197]**	specify number of integrations **[NRS0198]**		
Focus [NRS0199]			
MSA Configuration	specify filename **[NRS0201]**		

Filename **[NRS0200]**			
Target Name **[NRS0202]**	select Target Name	choose from list **[NRS0203]**	from Target list
Filter **[NRS0204]**	select Filter	choose from list **[NRS0205]**	see Table 39-1
Readout Pattern **[NRS0206]**	specify readout pattern	NRS, NRSRAPID, **[NRS0207]**	
Number of Groups **[NRS0208]**	specify number of groups **[NRS0209]**		
Number of Integrations **[NRS0210]**	specify number of integrations **[NRS0211]**		
Relative Position **[NRS0212]**	specify array of positions	array of 1-20 positions **[NRS0213]**	
Focus Reference [NRS02014]			
Direction **[NRS0215]**	specify direction	FORWARD, REVERSE **[NRS0216]**	
Position **[NRS0217]**	specify position	MID_STROKE, LAUNCH **[NRS0218]**	
Internal Lamp [NRS0221]			
Operating Mode **[NRS0224]**	select operating mode	MSASPEC, IFU, IMAGE **[NRS0225]**	
MSA Configuration Filename **[NRS0226]**	specify filename **[NRS0227]**		
Readout Pattern **[NRS0230]**	specify readout pattern	NRS, NRSRAPID, **[NRS0231]**	
Number of Groups **[NRS0232]**	specify number of groups **[NRS0233]**		
Number of Integrations **[NRS0234]**	specify number of integrations **[NRS0235]**		
Lamp **[NRS0236]**	select lamp	choose from list **[NRS0237]**	See Table 39-3
Grating **[NRS0238]**	select grating	choose from list **[NRS0239]**	See Table 39-4
MSA Anneal [NRS0305]			

	no parameters **[NRS0405]**		
MSA Short Detection [NRS0386]			
Error Response **[NRS0387]**	specify action to take if shorts are not addressed prior to exit	PROCEED, SAFE **[NRS0388]**	
Quadlist **[NRS0389]**	specify MSA quadrant(s)	1, 2, 3, 4 **[NRS0390]**	
MSA Masking [NRS0391]			
Mask Type **[NRS0392]**	specify MSA mask type	ZERO_POTENTIAL, TRI_STATE **[NRS0393]**	
Quadlist **[NRS0394]**	specify MSA quadrant(s)	1, 2, 3, 4 **[NRS0395]**	
Filter/Grating Wheel Test [NRS0396]			
Wheel Test **[NRS0397]**	specify wheel test type	CHARACTERIZE, RUNIN **[NRS0398]**	
Wheel Direction **[NRS0399]**	specify direction	FORWARD, REVERSE, BOTH **[NRS0400]**	
Mechanism **[NRS0401]**	specify mechanism	FILTER, GRATING **[NRS0402]**	
Number of Rotations **[NRS0403]**	specify number of rotations	number **[NRS0404]**	
Imaging [NRS0170]			
Filter **[NRS0189]**	select Filter	choose from list **[NRS0327]**	
Readout Pattern **[NRS0328]**	specify readout pattern	NRS, NRSRAPID, **[NRS0329]**	
Number of Groups **[NRS0383]**	specify number of groups	number **[NRS0222]**	
Number of Integrations **[NRS0223]**	specify number of integrations	number **[NRS0228]**	

39.2 Dark

These parameters are required to obtain Dark observations. Note that this type of observation can be obtained as a parallel to normal science observations **[NRS0240]**.

For developers: users can specify one or more combinations of the parameters below for DARKs **[NRS0241]**.

39.2.1 Number of Exposures

NUMBER OF EXPOSURES [NEXP] (1-50) specifies the number of times the dark exposure is to be repeated **[NRS0406]**.

39.2.2 Exposure Duration

The following parameters define a dark exposure.

39.2.2.1 Readout Pattern

> **READOUT PATTERN [READOUT PATTERN] = NRS [NRS0242], NRSRAPID [NRS0243]**

This field specifies the readout pattern to be used to obtain the data. **NRS** is used for faint targets, while **NRSRAPID** is used for bright targets.

39.2.2.2 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration **[NRS0408]**.

39.2.2.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is repeated **[NRS0409]**.

Note to developers: while the SUBARRAY is not explicitly given, its value is FULL for the purposes of calculating exposure time. **[NRS0345]**

39.3 Focus

These parameters are required to perform Focus Sweeps and Focus Adjustments. Note that this type of observation cannot be obtained as a parallel to normal science observations **[NRS0248]**.

39.3.1 Target Name

Select the **TARGET NAME** **[TARGET]** from the list of targets previously entered (see Section 5.8).

39.3.2 MSA Configuration Filename

Provide the **MSA CONFIGURATION FILENAME** **[MSAFILE]** which describes the MSA mask to be used to block the light from bright stars in the field-of-view. This file should be generated by using the NIRSpec Observation Planning tool (see Chapter 8).

39.3.3 Filter

Select the name of the **FILTER** **[FILTER]** (see Table 39-1) you wish to use.

Table 39-1 Filters Available for NIRSpec Focus Observations

Filter	Filter Bandpass $\Delta\lambda$ (μm)	
F140X	0.8-2.0	**[NRS0250]**
F110W	1.0-1.2	**[NRS0251]**
F070LP	>0.7	**[NRS0252]**
F100LP	>1.0	**[NRS0253]**
F170LP	>1.7	**[NRS0254]**
F290LP	>2.9	**[NRS0255]**
CLEAR		**[NRS0256]**

39.3.4 Exposure Duration

The following parameters define a focus exposure.

39.3.4.1 Readout Pattern

READOUT PATTERN [READOUT PATTERN] = NRS [NRS0257], NRSRAPID [NRS0258]

This field specifies the readout pattern to be used to obtain the data. **NRS** is used for faint targets, while **NRSRAPID** is used for bright targets.

39.3.4.2 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration **[NRS0410]**.

39.3.4.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is performed **[NRS0411]**.

Note to developers: while the SUBARRAY is not explicitly given, its value is FULL for the purposes of calculating exposure time. **[NRS0346]**

39.3.5 Relative Position

The Refocus Mechanism Assembly (RMA) is moved from the initial position to a number of specified positions, and a focus exposure is taken at each specified position. If only the RMA start position is specified (**RELATIVE POSITION** = "0") **[NRS0261]**, a single focus exposure is taken without moving the RMA, providing the data needed to measure the current image quality. If **RELATIVE POSITION** contains a single nonzero value **[NRS0262]**, the RMA is moved once, adjusting the focus. In this case, focus exposures are taken at the initial and final positions, providing the data needed to measure the change in image quality. Finally, if **RELATIVE POSITION** contains more than one value **[NRS0263]**, the RMA is moved sequentially to each of the specified positions. Regardless of the number of positions and initial direction, a sweep will always end in the initial position. Focus exposures are taken at each RMA position, providing the data needed to measure image quality as a function of RMA position.

The **RELATIVE POSITION** [DELTARRAY] parameter specifies an array of 1 **[NRS0264]** to 20 **[NRS0265]** positions that the focus is to be moved to; note that each position must be unique (i.e. a given value can only appear once in the list) **[NRS0???].** The positions are given in motor steps (-18400 **[NRS0266]** to +18400 **[NRS0267]**), and are offsets from the current position. Note that for an adjustment to the focus, only 1 position can be specified.

39.4 Focus Reference

These parameters are required to reset the focus to one of two reference positions. This engineering operation is useful when the RMA location is unknown (for example, during commissioning) or lost (for example, if the ICSW is restarted, which resets the focus counter).

39.4.1 Direction

DIRECTION [DIRECTION] = FORWARD [NRS0269], REVERSE [NRS0270]

This parameter specifies the direction in which the focus should be moved.

39.4.2 Position

POSITION [POSITION] = MID_STROKE [NRS0271], LAUNCH [NRS0272]

This parameter specifies the reference position that the focus should be moved to.

39.5 Internal Lamp

These parameters are required to obtain Internal Lamp observations. Note that this type of observation cannot be obtained as a parallel to normal science observations **[NRS0273]**, but can be in parallel with slews **[NRS0274]**.

For each Internal Lamp exposure in an observation, specify all the parameters listed below **[NRS0510]**.

~~39.5.1 Subarray~~

39.5.2 Operating Mode

OPERATING MODE [OPMODE] = MSASPEC [NRS0275], IFU [NRS0276], IMAGE [NRS0277]

Select the **OPERATING MODE** to be used for the observations. If dispersed data is desired as seen through the MSA, select **MSASPEC**. If dispersed data is desired as seen through the IFU, select **IFU**. If imaging data is desired, select **IMAGE**.

39.5.3 MSA Configuration Filename

If the **OPERATING MODE** is **MSASPEC**, provide the **MSA CONFIGURATION FILENAME** **[NRS0278]** [MSAFILE] which describes the MSA shutter configuration to be used to define the shutters to be opened for acquisition of internal lamp data (flat or line) on the detector; this is required to avoid having overlapping spectra. This file will be generated using the NIRSpec Observation Planning Tool.

If **OPERATING MODE = IMAGE**, the **MSA CONFIGURATION FILENAME** is optional **[NRS0279]** (default is shutters all OPEN) **[NRS0280]**.

If **OPERATING MODE=IFU**, the **MSA CONFIGURATION FILENAME** is not allowed **[NRS0281]**.

39.5.4 Lamp

Select the LAMP [LAMP] (see Table 39-3) you wish to use for the observations.

Table 39-3 Lamps Available for NIRSpec Internal Lamp Observations

Source Name	Wavelength Range (μm)	Spectral Intensity (10^{13} ph s^{-1} sr^{-1} μ^{-1}) Minimum	Maximum	
FLAT1	1.0-1.8 (Band I)	1.0	40.0	**[NRS0287]**
FLAT2	1.7-3.0 (Band II)	0.6	25.0	**[NRS0288]**
FLAT3	2.9-5.0 (Band III)	0.4	15.0	**[NRS0289]**
FLAT4	1.0-1.4 (Band 0.7)	2.0	40.0	**[NRS0290]**
FLAT5	1.0-5.0 (Broadband)	0.01	1.0	**[NRS0291]**
LINE1	1.0-1.8 (Band I)	1.0	40.0	**[NRS0292]**
LINE2	1.7-3.0 (Band II)	0.6	25.0	**[NRS0293]**
LINE3	2.9-5.0 (Band III)	0.4	15.0	**[NRS0294]**
LINE4	0.6-5.0 (Broadband)	0.01	1.0	**[NRS0295]**
REF	1.3-1.7	5.0	40.0	**[NRS0296]**
TEST	0.5-1.5	1.0	10.0	**[NRS0297]**

39.5.5 Grating

If the **OPERATING MODE** is **MSASPEC** or **IFU**, select the **GRATING** [GRATING] (see Table 39-4) you wish to use for the observations.

Table 39-4 Gratings Available for NIRSpec Internal Lamp Observations

Grating	Center Wavelength λ_0 (μm)	Filter Bandpass $\Delta\lambda$ (μm)	Resolution	Operating Mode	
G140M	TBD	TBD	~1000	MSASPEC, IFU	**[NRS0298]**
G235M	2.35	1.3	~1000	MSASPEC, IFU	**[NRS0299]**
G395M	3.95	2.1	~1000	MSASPEC, IFU	**[NRS0300]**
G140H	TBD	TBD	~2700	MSASPEC, IFU	**[NRS0301]**
G235H	2.35	1.3	~2700	MSASPEC, IFU	**[NRS0302]**
G395H	3.95	2.1	~2700	MSASPEC, IFU	**[NRS0303]**
PRISM	2.8	4.4	~100	MSASPEC, IFU	**[NRS0304]**
MIRROR					

Note: If **OPERATING MODE** = **IMAGE**, the grating will not be selectable **[NRS0229]**; the MIRROR will be automatically used instead.

Note for developer: APT needn't populate the grating field in the sql export; it will be set to NULL by the database. **[NRS0347]**

39.5.6 Exposure Duration

The following parameters define the exposure duration for each internal lamp exposure.

39.5.6.1 Readout Pattern

READOUT PATTERN [READOUT PATTERN] **= NRS [NRS0282], NRSRAPID [NRS0283]**

This field specifies the readout pattern to be used to obtain the data. **NRS** is used for faint targets, while **NRSRAPID** is used for bright targets.

39.5.6.2 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration **[NRS0413]**.

39.5.6.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is performed **[NRS0414]**.

39.6 MSA Anneal

This engineering feature heats the MSA and maintains an elevated temperature for 15 minutes in order to free stuck shutters. After a passive cool-down period enforced by scheduling, the magnetic arm motor is re-enabled when the temperature is safe.

Note for developer: It is intended that two visits will be created **[NRS0415]** - one for MSA heating followed a second visit for the cool-down verification check, with an implied spacing AFTER BY 10 hours (TBR) **[NRS0416]**. No other NRS visit may execute until NRSCOOLMAIN has executed **[NRS0417]**.

There are no parameters for this template **[NRS0245]**.

39.7 MSA Short Detection

This engineering feature detects MSA electrical shorts and attempts to remedy them by loading updated zero-potential masks to the Micro-shutter Control Electronics (MCE). In the event that the quadrant current remains elevated, additional short detection is performed via the tri-state masks.

The following parameters define MSA Short Detection.

39.7.1 Error Response

ERROR RESPONSE [ERESPONSE] **= PROCEED [NRS0418], SAFE [NRS0419]**

ERROR RESPONSE specifies the action to take if a high current situation exists at the end of the MSA Short Detection procedure. A value of **PROCEED** indicates that NIRSpec operations may continue at the conclusion of the visit. A value of **SAFE** causes the NIRSpec subsystems to be commanded into the Preferred Safe state.

39.7.2 Quadlist

QUADLIST [QUADLIST] = 1 [NRS0420], 2 [NRS0421], 3 [NRS0422], 4 [NRS0423]

This parameter specifies the quadrants to be analyzed. You may specify one to four unique quadrants **[NRS0424]**. Specifying a list of multiple quadrants will execute the procedure on the quadrants one-by-one in the order specified **[NRS0425]**.

39.8 MSA Masking

This engineering feature allows the user to apply a set of zero-potential or tri-state masks to the MSA; one each for the 171-side and the 365-side of the specified quadrants. Masking of multiple quadrants can be done in a single visit by specifying multiple quadrant numbers **[NRS0426]**.

There is an implicit special requirement SPECIAL COMMANDING attached to visits created by this template. In order to prepare the files needed for this request the commanding staff need to be notified **[NRS0427]**.

The following parameters define MSA Masking.

39.8.1 Mask Type

MASK TYPE [MASKTYPE] = ZERO_POTENTIAL [NRS0428], TRI_STATE [NRS0429]

This parameter specifies the type of mask to update.

39.8.2 Quadrant List

QUADLIST [QUADLIST] = 1 [NRS0430], 2 [NRS0431], 3 [NRS0432], 4 [NRS0433]

This parameter specifies the quadrant(s) to be masked. You may specify one to four unique quadrants **[NRS0434]**. Specifying a list of multiple quadrants will execute the procedure on the quadrants one-by-one in the order specified **[NRS0435]**.

39.9 Filter/Grating Wheel Test

This engineering template supports Filter or Grating Wheel Characterization as well as Filter or Grating Wheel Run-In.

During characterization, the specified wheel is rotated an entire cycle, position by position, with the high capacity telemetry buffer enabled and dumped for each move.

During the run-in test, the specified wheel is rotated an entire cycle from 1 to 50 times as indicated by the **NUMBER OF ROTATIONS** parameter in order to distribute the lubricant. Each cycle consists of a move of 3 positions in the specified direction, followed by another move of 3 positions and then a move of 2 positions, returning the wheel to its initial position.

The following parameters define Filter/Grating Wheel Characterization and Run-In.

39.9.1 Wheel Test Type

WHEEL TEST [WHEELTEST] = CHARACTERIZE [NRS0436], RUNIN [NRS0437]

This parameter specifies whether to run the Filter/Grating Wheel Characterization procedure or the Filter/Grating Wheel Run-In procedure

39.9.2 Wheel Direction

WHEEL DIRECTION [DIRECTION] = FORWARD [NRS0438], REVERSE [NRS0439], BOTH [NRS0440]

This parameter (used for both mechanisms) specifies whether to rotate the Filter or Grating wheel in the **FORWARD**, **REVERSE**, or **BOTH** directions (forward first, followed by reverse).

39.9.3 Mechanism

MECHANISM [MECHANISM] = FILTER [NRS0441], GRATING [NRS0442]

This parameter specifies the mechanism to exercise.

39.9.4 Number of Rotations

The **NUMBER OF ROTATIONS [ROTATIONS]** parameter specifies the number of full rotations of the Filter or Grating wheel to be executed during the Filter/Grating Wheel Run-In procedure **[NRS0443]**. This parameter is a positive integer from 1 to 100 **[NRS0444]**. If a

WHEEL DIRECTION of **BOTH** is specified, the full number of rotations is applied to each direction.

This parameter is only allowed if WHEEL TEST = RUNIN **[NRS0445]**.

39.10 NIRSpec Imaging

The following parameters are required to obtain Imaging observations for standalone engineering measurements. These images may be used to check NIRSpec focus, evaluate MSA shutter performance, or for other diagnostic purposes. The grating wheel is set to **MIRROR**.

The following parameters define NIRSpec Imaging. For each filter that you use, specify the name of the filter and the exposure duration parameters.

39.10.1 Filter

Select the name of the **FILTER** **[FILTER]** (see …) you wish to use.

39.10.2 Exposure Duration

The following parameters define an Imaging exposure.

39.10.2.1 Readout Pattern

READOUT PATTERN [READOUT PATTERN] = NRS (default), NRSRAPID

This field specifies the readout pattern to be used to obtain the image data. . **NRS** is used for faint targets, while **NRSRAPID** is used for bright targets.

39.10.2.2 Number of Groups

NUMBER OF GROUPS **[NGROUPS]** specifies the number of groups in an integration.

39.10.2.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] specifies the number of times the integration is performed.

Note for developers: The SUBARRAY is not explicitly given, and its value is FULL for the purposes of calculating photon collection time.
