Chapter 29

NIRCam Engineering

In this chapter…

29.1 Introduction

The NIRCam Engineering templates are used for calibration and engineering activities for the NIRCam detectors. These operations may be to obtain darks, internal flat fields, exercise the filter and pupil wheels, or to perform focus checks and adjustments. The parameters described in this section are used to specify the Observations for NIRCam Engineering. More complete descriptions of the detector readout parameters, filters, detector characteristics, etc. are available in the NIRCam 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 NIRCam Engineering templates **[NCM0153]** consists of the following parameters:

Field	Details	Values	Notes
Dark [NCM0154]			
Module **[NCM0155]**	select Module	choose from list **[NCM0156]**	
Subarray **[NCM0157]**	select Subarray	choose from list **[NCM0158]**	See Table 16-1
Number of Exposures **[NCM0159]**	specify number of times to repeat exposure	number **[NCM0160]**	
Number of Groups **[NCM0161]**	specify number of groups	number **[NCM0162]**	
Number of Integrations **[NCM0163]**	specify number of integrations	number **[NCM0164]**	
Readout Pattern **[NCM0165]**	select readout pattern	choose from list **[NCM0166]**	See Table 16-2
Wheel Exercise [NCM0177]			

Field	Details	Values	Notes
Mechanism Type [NCM0178]	specify Mechanism type	choose Filter/Pupil [NCM0179]	
Wheel [NCM0180]	specify Wheel	choose from list [NCM0181]	
Number of Rotations [NCM0182]	specify number of integrations	Number (1-6) [NCM0183]	
Focus [NCM0184]			
Target Name [NCM0185\	select Target Name	choose from list [NCM0186]	from Target list
Module [NCM0187]	select Module	choose A or B [NCM0188]	
Filter [NCM0190]	select Filter	choose from list [NCM0191]	See Table 16-3 and Table 16-4
Pupil [NCM0192]	select Pupil	choose from list [NCM0193]	See Table 16-5 and Table 16-6
Number of Groups [NCM0194]	specify number of groups	number [NCM0195]	
Number of Integrations [NCM0196]	specify number of integrations	number [NCM0197]	
Readout Pattern [NCM0198]	select readout pattern	choose from list [NCM0199]	See **Error! Reference source not found.**
Linear Actuators: Starting position [NCM0200]	specify starting position of actuators in steps	number [NCM0201]	
Starting position [NCM0202]	specify starting position of actuators in sensor units	number [NCM0203]	
Starting motor phases [NCM0204]	specify starting motor phases of actuators	number [NCM0205]	
Absolute positions [NCM0206]	specify array of positions for each actuator	array of 1-10 positions [NCM0207]	
Return to Start [NCM0208]	select Return to Start mode	choose Yes or No [NCM0209]	
IPR Imaging [NCM0167]			
Target Name [NCM0168]	select Target Name	choose from list [NCM0169]	from Target list

Field	Details	Values	Notes
Module **[NCM0171]**	select Module	choose from list **[NCM0172]**	
LED Lamp **[NCM0173]**	Select LED Lamp	choose from list **[NCM0174]**	
PIL Imaging [NCM0175]			
Target Name **[NCM0176]**	select Target Name	choose from list **[NCM0113]**	from Target list
Module **[NCM0114]**	select Module	choose A or B **[NCM0142]**	
Filter **[NCM0143]**	select Filter	choose from list **[NCM0144]**	
Number of Groups **[NCM0145]**	specify number of groups	number **[NCM0146]**	
Number of Integrations **[NCM0147]**	specify number of integrations	number **[NCM0148]**	
Readout Pattern **[NCM0149]**	select readout pattern	choose from list **[NCM0150]**	
External Flat [NCM0531]			
Pointing Type **[NCM0532]**	select the type of pointing	Choose PRIME or PARALLEL **[NCM0533]**	
Target Name **[NCM0534]**	select Target Name	choose from list **[NCM0535]**	from Target list
Primary Dither Type **[NCM0536]**	select Dither Type	choose from list **[NCM0537]**	See Table 29-9
Primary Dithers **[NCM0538]**	select number of steps	choose from list **[NCM0539]**	
Camera **[NCM0540]**	select SCA for INTRASCA	SHORT, LONG **[NCM0541]**	
Dither Size **[NCM0542]**	select dither size for INTRASCA	SMALL, MEDIUM, LARGE **[NCM0543]**	See Table 29-11
Subpixel Positions **[NCM0544]**	select subpixel positions	1, 2, 3 … 63, 64 **[NCM0545]**	
Module **[NCM0546]**	select Module	choose A, B, or All **[NCM0547]**	
Subarray **[NCM0548]**	select Subarray	choose from list **[NCM0549]**	
Filter **[NCM0550]**	select filter name	choose from list **[NCM0551]**	See Table 29-3 and Table 29-4
Pupil **[NCM0552]**	select pupil name	choose from list	See Table 29-5

Field	Details	Values	Notes
		[NCM0553]	and Table 29-6
Readout Pattern **[NCM0554]**	select readout pattern	choose from list **[NCM0555]**	
Number of Groups **[NCM0556]**	specify number of groups	Number **[NCM0557]**	See Table 29-7
Number of Integrations **[NCM0558]**	specify number of integrations	Number **[NCM0559]**	See Table 29-7

29.2 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 on other Sis **[NCM0211]**.

29.2.1   Module

MODULE [MODULE] = A **[NCM0212]**, B **[NCM0213]**, ALL **[NCM0214], A1 [NCM0245], A2 [NCM0240], A3 [NCM0246], A4 [NCM0241], ALONG [NCM0243], B1 [NCM0247], B2 [NCM0258], B3 [NCM0248], B4 [NCM0249], BLONG [NCM0257]**

This parameter specifies the module that is to be used. The modules are defined as follows:

Module	Definition
A	All short and long wavelength detectors in Module A
B	All short and long wavelength detectors in Module B
ALL	All detectors in Module A and then all detectors in Module B
A1-A4	SCA Ax in Module A, where x = 1-4
ALONG	The long wavelength detector in Module A
B1-B4	SCA Bx in Module B, where x = 1-4
BLONG	The long wavelength detector in Module B

See the NIRCam Instrument Handbook for more details.

29.2.2   Subarray

SUBARRAY [SUBARRAY] = SUB160, SUB320, SUB640, FULL

This value specifies the region of the SCA that is to be read out. Subarrays other than **FULL** can only be specified if **MODULE** is B **[NCM0xxx]**. See Table 29-1 for details.

Table 29-1 Readout Regions for NIRCam Darks

	Subarray	Rows	Columns	Light Sensitive Columns
[NCM0215]	FULL	2048	2048	TBD
[NCM0348]	SUB160	160	160	All
[NCM0219]	SUB320	320	320	All
[NCM0220]	SUB640	640	640	All

For developers: users can specify one or more combinations of the parameters below for DARKs. **[NCM0221]**

29.2.3   Number of Exposures

NUMBER OF EXPOSURES [NEXP] specifies the number of times the dark exposure is to be repeated **[NCM0438]**.

29.2.4   Exposure Duration

The following parameters define a dark exposure.

29.2.4.1   Readout Pattern

READOUT PATTERN [READOUT PATTERN] = DEEP8, DEEP2, MEDIUM8, MEDIUM2, SHALLOW4, SHALLOW2, BRIGHT2, BRIGHT1, RAPID

This field specifies the readout pattern to be used to obtain the data. Note that for **MODULE=ALL**, **READOUT PATTERN=RAPID** or **BRIGHT2**, and **SUBARRAY=FULL**, **NGROUPS** must be less than or equal to 4 and **NINTS** must be 1. See **Table** for when to use the various readout patterns.

29.2.4.2   Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration **[NCM0439]** (see Table 29-2 for the maximum values).
.

29.2.4.3   Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is repeated **[NCM0440]** (see Table 29-2 for the maximum values).

Table 29-2 Maximum Number of Integrations and Groups for Darks

Readout Pattern	Maximum Integrations	Maximum Groups	Usage
RAPID (MODULE=ALL)	10 1	50 4	Fastest mode possible
BRIGHT1	10	10	bright objects; high BKG/wide filters
BRIGHT2 (MODULE=ALL)	10 1	10 4	bright objects; high BKG/wide filters
SHALLOW2	10	10	shallow surveys/bright objects; high BKG/ wide filters
SHALLOW4	10	10	shallow surveys/bright objects; moderate BKG/narrow or medium filters
MEDIUM2	10	20	medium/shallow surveys; moderate BKG/wide filters
MEDIUM8	10	20	medium/shallow surveys; low BKG/narrow filters
DEEP2	10	20	deep surveys; moderate BKG/wide filters
DEEP8	10	20	deep surveys; low BKG/narrow filters

Table 29-2 Maximum Number of Integrations and Groups for Darks

Readout Pattern	Maximum Integrations	Maximum Groups	Legal Min/Max	Illegal Min/Max
RAPID (MODULE=ALL)	10 1	50 4	**[NCM0222]** **[NCM0230]**	**[NCM0234]** **[NCM0234]**
BRIGHT1	10	10	**[NCM0223]**	**[NCM0231]**
BRIGHT2 (MODULE=ALL)	10 1	10 4	**[NCM0224]** **[NCM0239]**	**[NCM0232]** **[NCM0346]**
SHALLOW2	10	10	**[NCM0225]**	**[NCM0339]**
SHALLOW4	10	10	**[NCM0226]**	**[NCM0235]**
MEDIUM2	10	20	**[NCM0227]**	**[NCM0236]**
MEDIUM8	10	20	**[NCM0228]**	**[NCM0237]**
DEEP2	10	20	**[NCM0229]**	**[NCM0238]**
DEEP8	10	20	**[NCM0244]**	**[NCM0242]**

29.3   Wheel Exercise

These parameters are required to rotate the specified wheel 360°. Note that this type of observation cannot be obtained as a parallel to normal science observations, but can be in parallel with slews.

29.3.1　　Mechanism Type

MECHANISM TYPE [MECH TYPE] = **FILTER [NCM0260]**, **PUPIL [NCM0261]**

This parameter specifies the mechanism type to be exercised.

29.3.2　　Wheel

WHEEL [WHEELSLIST] = **SHORTA [NCM0262]**, **SHORTB [NCM0263]**, **LONGA [NCM0264]**, **LONGB [NCM0265]**, **ALL [NCM0266]**

This parameter specifies the wheel(s) to be exercised. You may specify one wheel **[NCM0267]**, more than one wheel (up to all four) **[NCM0268]** or **ALL [NCM0269]**. Specifying a list of two to four wheels will exercise those wheels serially and in the order specified. Specifying **ALL** exercises all four wheels in parallel.

29.3.3　　Number of Rotations

NUMBER OF ROTATIONS [NROTATIONS] [NCM0312] specifies the number of time to rotate the selected wheel(s) (between 1 and 6, inclusive).

29.4　Focus

These parameters are required to obtain Focus observations. An exposure with these parameters will be taken before any position change and then after each position change requested. Note that this type of observation can be obtained as a parallel to normal science observations.

At the present time, the NIRCam science team has insisted that the NIRCam focus template should include user inputs to define the starting focus position (in both steps and sensor units). It seems possible that this might cause confusion and prevent users from running a focus set. At the present time, the focus template is defined in the manner requested by the NIRCam team, but if this proves problematic then changes to this template definition might be warranted in the future.

29.4.1　　Target Name

Select the **TARGET NAME [TBD]** from the list of targets previously entered (see).
[NCM0075]

29.4.2   Module

MODULE **[MODULE]** = A **[NCM0076]**, B **[NCM0151]**

This parameter specifies the module that is to be used.

29.4.3   Filter

Select the name of the **FILTER [FILTLONG, FILTSHORT]** pair (see Table 29-3 and Table 29-4) you wish to use (one for the Short Wavelength and one for the Long Wavelength cameras). You may select a filter pair **[NCM0340]**, a single filter **[NCM0341]**, or no filters **[NCM0342]**.

Table 29-3 Filters Available for NIRCam Short Wavelength Camera Focus Observations

Filter	Center Wavelength λ_0 (µm)	Filter Bandpass $\Delta\lambda$ (µm)	Comment	
F070W	0.70	0.175		**[NCM0313]**
F090W	0.90	0.225		**[NCM0314]**
F115W	1.15	0.288		**[NCM0315]**
F150W	1.50	0.375		**[NCM0316]**
F150W2	1.50	1.000		**[NCM0317]**
F200W	2.00	0.500		**[NCM0318]**
F140M	1.14	0.140		**[NCM0319]**
F182M	1.82	0.221		**[NCM0320]**
F210M	2.10	0.210		**[NCM0321]**
F187N	1.87	0.019	Pα	**[NCM0322]**
F212N	2.12	0.021	H$_2$	**[NCM0323]**
WLP4			Weak Lens, +4 waves defocus	**[NCM0324]**

Table 29-4 Filters Available for NIRCam Long Wavelength Camera Focus Observations

Filter	Center Wavelength λ_0 (µm)	Filter Bandpass $\Delta\lambda$ (µm)	Comment	
F277W	2.77	0.693		**[NCM0325]**
F322W2	3.22	1.610		**[NCM0326]**

F356W	3.56	0.890		**[NCM0327]**
F444W	4.44	1.110		**[NCM0328]**
F250M	2.50	0.167		**[NCM0329]**
F300M	3.00	0.300		**[NCM0330]**
F335M	3.35	0.335		**[NCM0331]**
F360M	3.60	0.360		**[NCM0332]**
F410M	4.10	0.410		**[NCM0333]**
F430M	4.30	0.200		**[NCM0334]**
F460M	4.60	0.200		**[NCM0335]**
F480M	4.80	0.400		**[NCM0336]**

29.4.4   Pupil

Select the name of the **PUPIL [PUPILLONG, PUPILSHORT]** pair (see Table 29-5 and Table 29-6) you wish to use (one for the Short Wavelength and one for the Long Wavelength cameras). You may select a pupil pair **[NCM0343]**, a single pupil **[NCM0344]**, or no pupils **[NCM0345]**.

Table 29-5 Pupils Available for NIRCam Short Wavelength Camera Internal Flats

	Pupil	Center Wavelength λ_0 (µm)	Filter Bandpass $\Delta\lambda$ (µm)	Comment
[NCM0270]	CLEAR			Imaging pupil
[NCM0271]	MASKRND			Round mask 1
[NCM0272]	MASKBAR			Bar mask2
[NCM0274]	F162M	1.62	0.151	CO (6-3)
[NCM0275]	F164N	1.64	0.016	Fe II
[NCM0277]	GDHS0			Dispersed Hartman Sensor 0 degrees
[NCM0278]	GDHS60			Dispersed Hartman Sensor 60 degrees
[NCM0279]	PINHOLES			
[NCM0280]	WL1			Weak Lens (-8 waves defocus)
[NCM0281]	WL2			Weak lens (+8 waves defocus)

Table 29-2 Pupils Available for NIRCam Long Wavelength Camera Internal Flats

	Pupil	Center Wavelength λ_0 (μm)	Filter Bandpass $\Delta\lambda$ (μm)	Comment
[NCM0282]	CLEAR			Imaging pupil
[NCM0283]	MASKRND			Round mask 1
[NCM0284]	MASKBAR			Bar mask2
[NCM0286]	F323N	3.23	0.032	H_2
[NCM0287]	F405N	4.05	0.041	Brα
[NCM0289]	F466N	4.66	0.047	
[NCM0290]	F470N	4.70	0.047	
[NCM0291]	GRISMR			Spectrum parallel to detector rows
[NCM0292]	GRISMC			Spectrum parallel to detector columns
[NCM0293]	PINHOLES			

29.4.5 Exposure Duration

The following parameters define a focus exposure.

29.4.5.1 Readout Pattern

**READOUT PATTERN [READOUT PATTERN] = DEEP8 [NCM0294],
DEEP2 [NCM0295], MEDIUM8 [NCM0296], MEDIUM [NCM0297],
SHALLOW4 [NCM0298], SHALLOW2 [NCM0299], BRIGHT2
[NCM0300], BRIGHT1 [NCM0301], RAPID [NCM0302]**

This field specifies the readout pattern to be used to obtain the data; see Table 29-7 for when to use the various readout patterns.

29.4.5.2 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration **[NCM0436]** (see Table 29-7 for the maximum values).

29.4.5.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is repeated **[NCM0437]** (see Table 29-7 for the maximum values)..

Table 29-7 Maximum Number of Integrations and Groups for Focus and PIL Imaging

Readout Pattern	Maximum Integrations	Maximum Groups	Usage
RAPID	10	10	Fastest mode possible
BRIGHT1	10	10	bright objects; high BKG/wide filters
BRIGHT2	10	10	bright objects; high BKG/wide filters
SHALLOW2	10	10	shallow surveys/bright objects; high BKG/ wide filters
SHALLOW4	10	10	shallow surveys/bright objects; moderate BKG/narrow or medium filters
MEDIUM2	10	10	medium/shallow surveys; moderate BKG/wide filters
MEDIUM8	10	10	medium/shallow surveys; low BKG/narrow filters
DEEP2	10	20	deep surveys; moderate BKG/wide filters
DEEP8	10	20	deep surveys; low BKG/narrow filters

Table 29-7 Maximum Number of Integrations and Groups for Focus and PIL Imaging

Readout Pattern	Max Int	Max Grp	Legal Focus Min/Max	Illegal Focus Min/Max	Legal PIL Min/Max	Illegal PIL Min/Max
RAPID	10	10	**[NCM0449]**	**[NCM0458]**	**[NCM0499]**	**[NCM0508]**
BRIGHT1	10	10	**[NCM0450]**	**[NCM0459]**	**[NCM0500]**	**[NCM0509]**
BRIGHT2	10	10	**[NCM0451]**	**[NCM0460]**	**[NCM0501]**	**[NCM0510]**
SHALLOW2	10	10	**[NCM0452]**	**[NCM0461]**	**[NCM0502]**	**[NCM0511]**
SHALLOW4	10	10	**[NCM0453]**	**[NCM0462]**	**[NCM0503]**	**[NCM0512]**
MEDIUM2	10	10	**[NCM0454]**	**[NCM0463]**	**[NCM0504]**	**[NCM0513]**
MEDIUM8	10	10	**[NCM0455]**	**[NCM0464]**	**[NCM0505]**	**[NCM0514]**
DEEP2	10	20	**[NCM0456]**	**[NCM0465]**	**[NCM0506]**	**[NCM0515]**
DEEP8	10	20	**[NCM0457]**	**[NCM0466]**	**[NCM0507]**	**[NCM0516]**

29.4.6 Linear Actuators

The Linear Actuators are the devices that control the image focus.

29.4.6.1 Starting Position in Steps

This parameter specifies the **STARTING POSITION [LASTEPSLIST]** of each of the 3 actuators in Steps (-11900 to +11900). **[NCM0303]**

29.4.6.2 Starting Position in Sensor Units

This parameter specifies the **STARTING POSITION [LASUNITSLIST]** of each of the 3 actuators in Sensor units (-32767 to +32767). **[NCM0304]**

29.4.6.3   Starting Motor Phases

This parameter specifies the **STARTING MOTOR PHASE** [LAPHASELIST] of each of the 3 actuators (1-6). **[NCM0305]**

Note for developers: the 3 values above are all integers, with the first 2 requiring a sign.

29.4.6.4   Absolute Positions

The **ABSOLUTE POSITION** [LA1LIST, LA2LIST, LA3LIST] parameter specifies an array of 1 to 10 sets of positions (each composed of a value for each of the three actuators). Individual actuator values can range from -11900 to +11900 **[NCM0306]**. If only one position is listed the focus will be adjusted to that position and stay there. If multiple positions are listed they will be executed in the exact order specified **[NCM0307]** and the option to return to the original position is available (next parameter) **[NCM0308]**.

29.4.6.5   Return to Start

> **RETURN TO START** [RETURN TO START] = YES **[NCM0309]** (default) **[NCM0310]**, NO **[NCM0311]**

If multiple positions have been listed, this parameter is available to request if the Actuator should be returned to its original position (**YES**) or left at the final position (**NO**). If one position has been requested, this parameter will default to NO (focus mechanism is left at the specified position).

For the developers: Basically, what we need is a table like the following:

Parameter	Actuator 1	Actuator 2	Actuator 3
LASTEPSLIST	value	value	value
LASUNITSLIST	value	value	value
LAPHASELIST	value	value	value
Position 1	LA1value	LA2value	LA3value
Position 2	LA1value	LA2value	LA3value
…	…	…	…
Position 10	LA1value	LA2value	LA3value

Also, if one actuator position is specified, the parameter should not be set.

29.5 IPR Imaging

These parameters are required to obtain observations with the Internal Phase Retrieval (IPR) wedges while flashing the LED lamps. The data will be analyzed to measure the wavefront error

internal to NIRCam, and to track that WFE over time. Calibration measurements will be taken based on the combination of Module and LED Lamp.

Note that this type of observation must be executed as a prime, as it requires an external pointing. Therefore the special requirement **PARALLEL** is not allowed **[NCM0xxx]**.

29.5.1   Module

MODULE [MODULE] = A [NCM0216], B [NCM0217], ALL [NCM0218], ASHORT [NCM0347], ALONG [NCM0443], BSHORT [NCM0444], BLONG [NCM0445]

This parameter specifies the module that is to be used. The modules are defined as follows:

Module	Definition
A	All short and long wavelength detectors in Module A
B	All short and long wavelength detectors in Module B
ALL	All detectors in Module A and then all detectors in Module B
ASHORT	All 4 SCAs in the short wavelength detector for Module A
ALONG	The long wavelength detector in Module A
BSHORT	All 4 SCAs in the short wavelength detector for Module B
BLONG	The long wavelength detector in Module B

See the NIRCam Instrument Handbook for more details.

29.5.2   LED Lamp

LED LAMP [LEDLAMP] = PRIME [NCM0446], REDUNDANT [NCM0447], BOTH [NCM0448]

This parameter specifies the LED lamp that is to be used.

29.6 PIL Imaging

These parameters are required to obtain observations with the Pupil Imaging Lens (PIL) in the short wavelength beam of Module A or Module B. Note that this type of observation must be executed as a prime, as it requires an external pointing. Therefore the special requirement PARALLEL is not allowed **[NCM0466]**.

29.6.1   Target Name

Select the **TARGET NAME [TBD]** from the list of targets previously entered (see Section 5.8) **[NCM0467]**.

29.6.2   Module

MODULE [MODULE] = A [NCM0468], B [NCM0469]

This parameter specifies the module that is to be used.

29.6.3   Filters

Select the name of each short wavelength filter [**FILTSHORT**] you wish to use (see Table 29-8). There is no limit on the number of filters **[NCM0470]**, but there is a limit of 70 minutes (TBD) for total exposure time in PIL observations **[NCM0471]**.

Table 29-8 Filters Available for PIL Imaging

Filters		Filters	
F187N	**[NCM0472]**	WLM8+F150W	**[NCM0517]**
F212N	**[NCM0473]**	WLM8+F200W	**[NCM0518]**
F150W	**[NCM0474]**	WLM8+F150W2	**[NCM0519]**
F200W	**[NCM0475]**	MASKRND+F150W	**[NCM0520]**
F140M	**[NCM0476]**	MASKRND+F200W	**[NCM0521]**
WLP4	**[NCM0477]**	MASKRND+F150W2	**[NCM0522]**
PINHOLES+F150W	**[NCM0478]**	MASKBAR+F150W	**[NCM0523]**
PINHOLES+F200W	**[NCM0479]**	MASKBAR+F200W	**[NCM0524]**
GDHS0+F140M	**[NCM0480]**	MASKBAR+F150W2	**[NCM0525]**
GDHS0+F150W2	**[NCM0481]**	MASKIPR+F150W	**[NCM0526]**
GDHS60+F140M	**[NCM0482]**	MASKIPR+F200W	**[NCM0527]**
GDHS60+F150W2	**[NCM0483]**	MASKIPR+F150W2	**[NCM0528]**
WLP8+F150W	**[NCM0484]**	F162M+F150W2	**[NCM0529]**
WLP8+F200W	**[NCM0485]**	F164N+F150W2	**[NCM0530]**
WLP8+F150W2	**[NCM0486]**		

29.6.4   Exposure Duration

For each filter chosen you will also give the exposure duration parameters (Readout Pattern, Number of Groups, and Number of Integrations) **[NCM0487]**
.

29.6.4.1 Readout Pattern

> **READOUT PATTERN [READOUT PATTERN] = RAPID [NCM0496], BRIGHT1 [NCM0495], BRIGHT2 [NCM0494], SHALLOW2 [NCM0493], SHALLOW4 [NCM0492], MEDIUM2 [NCM0491], MEDIUM8 [NCM0490], DEEP2 [NCM0489], DEEP8 [NCM0488]**

This field specifies the readout pattern to be used to obtain the data. See Table 29-7 for when to use the various readout patterns.

29.6.4.2 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration (see Table 29-7 for the maximum values) **[NCM0497]**.

29.6.4.3 Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] specifies the number of times the integration is repeated (see Table 29-7 for the maximum values) **[NCM0498]**.

29.7 External Flat

The NIRCam External Flats template is to be used for all Flat-field observations using external targets. Note that this type of operation can be obtained as prime **[NCM0560]** or as a parallel to normal science observations **[NCM0561]**.

29.7.1   Pointing Type

> **POINTING TYPE [TBR] = PARALLEL [NCM0562] (default) [NCM0563], PRIME [NCM0564]**

This parameter allows the user to control whether the data will be obtained in parallel like other calibrations, or as a primary observation like regular science.

Note for developers: If **PARALLEL**, the target will be set to **NONE** (and not changeable) **[NCM0565]** and **PARALLEL** special requirement will be added **[NCM0566]**. If **PRIME**, the target will be changed from **NONE** to **NONE SELECTED** **[NCM0567]** so the user will be prompted to select a target. If **POINTING TYPE** = **PARALLEL**, set **PRIMARY DITHER TYPE** to **NONE** **[NCM0568]**.

Note for developers: This field is not saved directly into the database, but instead should cause the **PARALLEL** special requirement to be added to template when **PARALLEL** is chosen.

29.7.2 Target Name

Select the **TARGET NAME** [TBD] from the list of targets previously entered (see Section 5.4) A target is only allowed if **POINTING_TYPE** = **PRIME** **[NCM0569]**.

29.7.3 Dither Patterns

The following parameters define the dither patterns for NIRCam External Flats. If the **POINTING TYPE** is **PRIME**, the user must select one of the following Dither Patterns **[NCM0570]**.

29.7.3.1 Primary Dither Type

> **PRIMARY DITHER TYPE** [DITHER_FOV] = **NONE [NCM0571]**, **FULL [NCM0572]**, **INTRAMODULE [NCM0573]**, **INTRASCA [NCM0574]**

Note for developers: PRIMARY DITHER TYPE should be a required field **[NCM0575]**, and there should be no default value (i.e. do not make NONE the default) **[NCM0576]**.

This parameter specifies the type of primary dither pattern (see Table).

Table 29-9 Primary Dither Type Available for NIRCam External Flats

Primary Dither Type	Description
NONE	No dithering
FULL	Covers the 40" gap between modules
INTRAMODULE	Covers the 5" gaps between SCAs, but not the module gap
INTRASCA	Moves a target around a single SCA

29.7.3.1.1 None

This value indicates no dithering will be performed.

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29.7.3.1.2   Full

The following parameter is needed to specify the **FULL** dither **[NCM0577]**.

29.7.3.1.2.1   *Primary Dithers*

PRIMARY DITHERS [PRIMARY_DITHERS] = 2, 3, 6, 9, 3TIGHT, 15, 21, 27, 36, 45

This parameter indicates the number of steps in the primary dither (see Table 29-10).

Table 29-10 PRIMARY DITHERS available for PRIMARY DITHER TYPE=FULL

PRIMARY DITHERS		Description
2	**[NCM0578]**	2-point pattern for NIRSpec pre-imaging
3	**[NCM0579]**	3-point pattern that maximizes inner area of 2× coverage
6	**[NCM0580]**	6-point pattern that maximizes area of 4× coverage (minimum 3×-coverage everywhere)
9	**[NCM0581]**	9-point pattern that maximizes area of 6× coverage (minimum 5×-coverage everywhere)
3TIGHT	**[NCM0582]**	3-point pattern that maximizes depth of 3× coverage
15	**[NCM0583]**	
21	**[NCM0584]**	
27	**[NCM0585]**	Specific patterns to take optimally flat coverage
36	**[NCM0586]**	
45	**[NCM0587]**	

29.7.3.1.3   Intramodule

The following parameter is needed to specify the **INTRAMODULE** dither **[NCM0588]**.

29.7.3.1.3.1   *Primary Dithers*

PRIMARY DITHERS [PRIMARY_DITHERS] = 2 **[NCM0589]**, 3, 4, 5, 6, 7, 8 **[NCM0590]**, 9, 10, 11, 12, 13, 14, 15, 16 **[NCM0591]**

This parameter specifies the number of primary dither points covering the 40" module gap.

29.7.3.1.4   Intrasca

The following parameters are needed to specify the **INTRASCA** dither **[NCM0592]**.

29.7.3.1.4.1   Camera

CAMERA [CAMERA] = SHORT [NCM0593], LONG [NCM0594]

This parameter indicates the SCA that will have optimized coverage.

29.7.3.1.4.2   Dither Size

DITHER SIZE [DITHER_SIZE] = SMALL [NCM0595], MEDIUM [NCM0596], LARGE [NCM0597]

This parameter specifies the size of the dither in arcseconds. The definition of **DITHER SIZE** depends on the Camera as shown in Table 29-11.

Table 29-11 Recommended DITHER SIZE based on object size and CAMERA

Camera	Object Size (diameter)	Dither Size
Short	<10"	10" (LARGE)
	10" – 30"	1" (MEDIUM)
	30" – 50"	0.1" (SMALL)
Long	<20"	20" (LARGE)
	20" – 60"	2" (MEDIUM)
	60" – 100"	0.2" (SMALL)

29.7.3.1.4.3   Primary Dithers

PRIMARY DITHERS [PRIMARY_DITHERS] = 2 [NCM0598], 3, 4, 5, 6, 7, 8, 9, 10 [NCM0599], … 23, 24, 25 [NCM0600]

This parameter specifies the number of primary dither points.

29.7.3.2   Subpixel Positions

SUBPIXEL POSITIONS [SUBPIXEL_POSITIONS] = 1 [NCM0601], 2, 3, 4, 5, 6 [NCM0602]… 62, 63, 64 [NCM0603]

This parameter specifies the secondary dither points used for every primary dither point and is allowed for all DITHER FIELD OF VIEW values, including **NONE [NCM0604]**.

Note for developers: see Appendix F2 for dithering details.

29.7.4   Module

MODULE [MODULE] = A [NCM0605], B [NCM0606], ALL [NCM0607]

This parameter specifies the module to be used to obtain the data.

29.7.5   Subarray

SUBARRAY [SUBARRAY] = FULL [NCM0608], SUB640 [NCM0609], SUB320 [NCM0610], SUB160 [NCM0611], SUB400P [NCM0612], SUB160P [NCM0613], and SUB64P [NCM0614]

This parameter specifies the region of the SCA that is to be read out. Subarrays other than **FULL** are only allowed if **MODULE = B [NCM0615]**. If selecting **SUB400P**, **SUB160P**, or **SUB64P**, only one short wavelength SCA and the long wavelength SCA will be read out.

29.7.6   Filters

Select the name of each **FILTER [FILTLONG, FILTSHORT]** pair (see Table 29-3 and Table 29-4) that you wish to use **[NCM0616]**. If **POINTING TYPE** is specified as **PARALLEL**, only one long and one short filter may be selected **[NCM0617]**.

29.7.7   Pupils

Select the name of each pupil [**PUPILLONG, PUPILSHORT**] pair (see Table 29-5 and Table 29-6) that you wish to use **[NCM0618]**. If **POINTING TYPE** is specified as **PARALLEL**, only one long and one short pupil may be selected **[NCM0619].**

Note for Developers: The following tables summarize the allowed Filter Wheel + Pupil Wheel element combinations in the NIRCam Short Wavelength and Long Wavelength channels, respectively. Checks on the validity of these combinations should be implemented in the APT template. Table elements

"ok" can be selected **[NCM0620]**, elements "W" will generate a warning **[NCM0621]**, and elements "E" will generate an error; **[NCM0622]** the PAPPA and Flat/Dark elements ("D") are disallowed and cannot be selected by the user **[NCM0623]** since no (or no significant) external light will reach the detectors if the Flat/Dark (PAPPA) element is in the beam.

Short wavelength channel		Pupil wheel (grouped by function)											
		Clear	Flatfield/Dark	Coronagraph 1 (round)	Coronagraph 2 (bar)	F164N	F162M	PINHOLES	WL 1 (+8)	WL 2 (-8)	GDHS0	GDHS60	MASKIPR
Filter Wheel	F070W [NCM0637]	ok	D	E	E	E	E	D	W	W	E	E	W
	F090W [NCM0638]	ok	D	E	E	E	E	D	W	W	E	E	W
	F115W [NCM0639]	ok	D	E	E	E	E	D	W	W	W	W	W
	F150W [NCM0640]	ok	D	E	E	ok	E	D	W	W	W	W	W
	F200W [NCM0641]	ok	D	ok	ok	E	E	D	W	W	W	W	W
	F212N [NCM0642]	ok	D	ok	ok	E	E	D	ok	ok	W	W	ok
	WLP4 [NCM0643]	ok	D	E	E	E	E	D	ok	ok	E	E	ok
	F187N [NCM0644]	ok	D	ok	ok	E	E	D	ok	ok	W	W	W
	F210M [NCM0645]	ok	D	ok	ok	E	E	D	W	W	W	W	W
	F182M [NCM0646]	ok	D	ok	ok	E	E	D	W	W	W	W	W
	F140M [NCM0647]	ok	D	E	E	E	E	D	W	W	ok	ok	W
	F150W2 [NCM0648]	ok	D	E	E	ok	ok	D	W	W	ok	ok	W

Long wavelength channel		Pupil wheel (grouped by function)											
		Clear	Flat/Dark	Coronagraph 1 (round)	Coronagraph 2 (bar)	F323N	F405N	F466N	F470N	Outward Pinholes	GrismR (V2)	GrismC (V3)	MASKIPR
Filter Wheel	F277W [NCM0649]	ok	D	W	ok	E	E	E	E	D	ok	ok	W
	F356W [NCM0650]	ok	D	ok	ok	ok	E	E	E	D	ok	ok	W
	F444W [NCM0651]	ok	D	ok	ok	E	ok	ok	ok	D	ok	ok	W
	F300M [NCM0652]	ok	D	ok	ok	E	E	E	E	D	W	W	W
	F480M [NCM0653]	ok	D	E	ok	E	E	W	W	D	W	W	W
	F410M [NCM0654]	ok	D	ok	ok	E	W	E	E	D	ok	ok	W
	F360M [NCM0655]	ok	D	ok	ok	E	E	E	E	D	W	W	W
	F430M [NCM0656]	ok	D	ok	ok	E	E	E	E	D	W	W	W
	F460M [NCM0657]	ok	D	ok	ok	E	E	W	E	D	W	W	W
	F250M [NCM0658]	ok	D	W	ok	E	E	E	E	D	W	W	W
	F335M [NCM0659]	ok	D	ok	ok	W	E	E	E	D	W	W	W
	F322W2 [NCM0660]	ok	D	W	W	ok	E	E	E	D	ok	ok	W

29.7.8 Readout Pattern

READOUT PATTERN [READOUT PATTERN] = MEDIUM2 [NCM0624] (default) [NCM0625], RAPID [NCM0626], BRIGHT1 [NCM0627],

BRIGHT2 [NCM0628], SHALLOW2 [NCM0629], SHALLOW4 [NCM0630], MEDIUM8 [NCM0631], DEEP2 [NCM0632], DEEP8 [NCM0633]

This field specifies the readout pattern to be used to obtain the data. See Table 29-7 for when to use the various readout patterns.

29.7.9 Number of Groups

NUMBER OF GROUPS [NGROUPS] specifies the number of groups in an integration (see Table 29-7 for the maximum values) **[NCM0634]**. The default value is 10 **[NCM0635]**.

29.7.10   Number of Integrations

NUMBER OF INTEGRATIONS [NINTS] field specifies the number of times the integration is repeated **[NCM0636]** (see Table 29-7 for the maximum values).