NIRCam Pupil and Filter Wheels

The JWST NIRCam pupil and filter wheels include the filters, weak lenses, grisms, and coronagraph Lyot stops that may be used in combination.

Introduction

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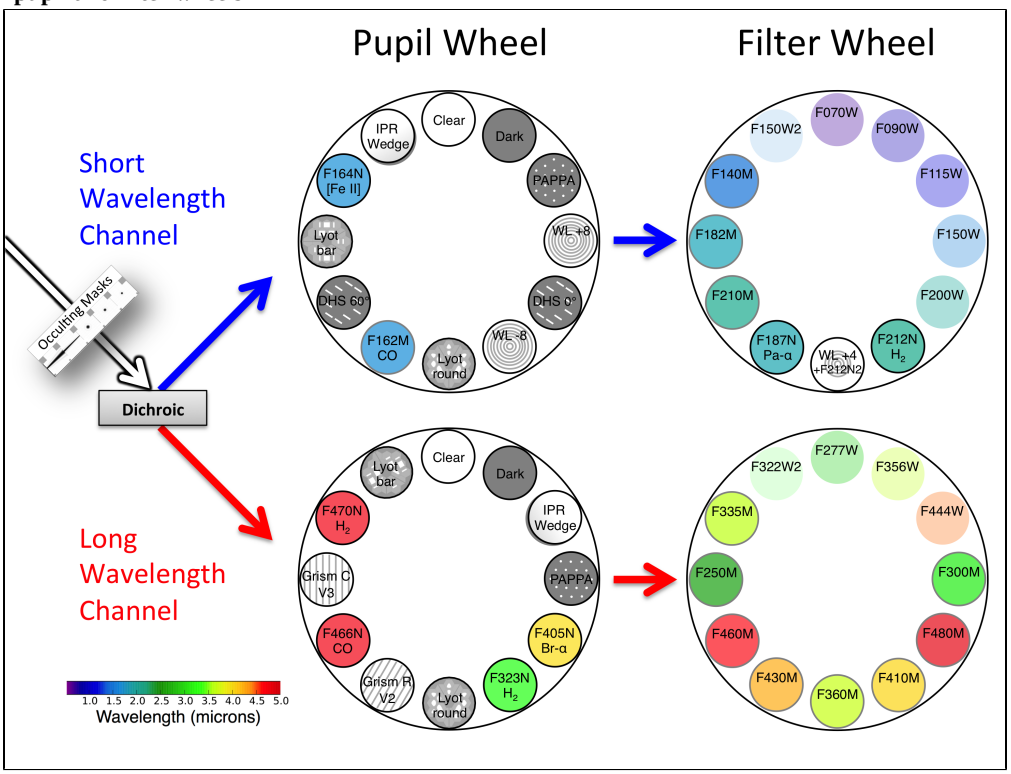
Each NIRCam module has short wavelength (0.6–2.3 μm) and long wavelength (2.4–5.0 μm) channels, each with a pupil wheel and filter wheel of 12 elements each. Many combinations of pupil and filter wheel elements are allowed as described below. These elements include:

- extra-wide-, wide-, medium-, and narrowband filters with R = λ/Δλ ~ 1, 4, 10, and 100, respectively;
- coronagraph Lyot stops to suppress diffracted light that passes the occulting masks on the focal plane;
- grism elements in the long wavelength channel—two elements are available, dispersing light along detector rows and columns, respectively;
- weak lenses to defocus light from bright sources to avoid detector saturation, and also used for telescope alignment;
- clear positions (empty holes) in the pupil wheel to be used in combination with filter wheel elements;
- dark elements used for calibration;
- other elements used only for wavefront sensing and telescope alignment, including the PAPPA (pupil alignment pinhole projector assembly), DHS (dispersed Hartman sensing), and IPR Wedge (internal phase retrieval).

Pupil and filter wheels characteristics

Figure 1. NIRCam pupil and filter wheels



Each NIRCam module contains the optical elements depicted above, including pupil and filter wheels that hold a total of 48 optical elements. Filters are color-coded by wavelength. Wider filters are shown in the figure as more transparent than narrower filters.

Table 1. NIRCam pupil and filter wheel elements

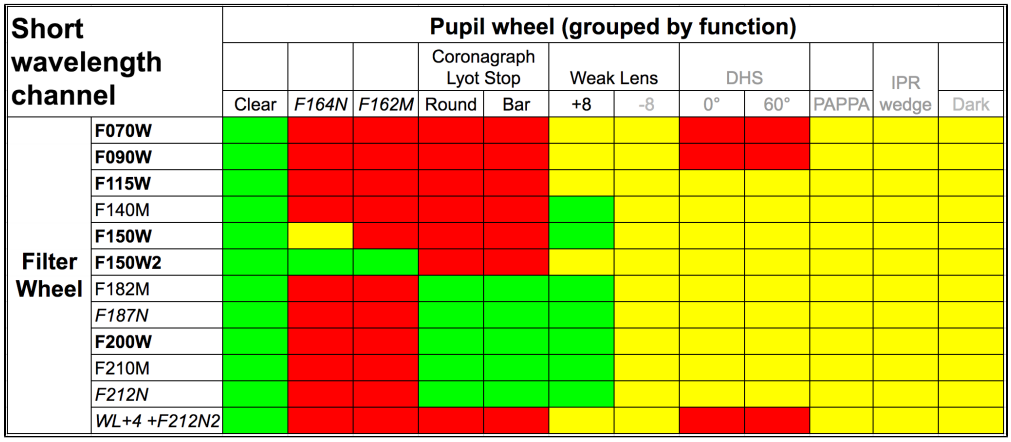
Short wavelength channel (0.6–2.3 μm)		Long wavelength channel (2.4–5.0 μm)	
Pupil wheel	**Filter wheel**	**Pupil wheel**	**Filter wheel**
CLEAR	**F070W**	CLEAR	**F277W**
Dark	**F090W**	Dark	**F356W**
PAPPA	**F115W**	IPR Wedge	**F444W**
WL +8	**F150W**	PAPPA	F300M
DHS 0°	**F200W**	*F405N Br-α*	F480M
WL -8	*F212N* H_2	*F323N* H_2	F410M
Lyot round	WL+4 +F212N2	Lyot round	F360M
F162M CO	*F187N Pa-α*	Grism R V2	F430M
DHS 60°	F210M	*F466N CO*	F460M
Lyot bar	F182M	Grism C V3	F250M
F164N [Fe II]	F140M	*F470N* H_2	F335M
IPR Wedge	**F150W2**	Lyot bar	**F322W2**

Notes:

- Black: bandpass filters named W2**,** W, M, *N* have R = λ/Δλ ~ 1, 4, 10, 100, respectively
- Orange: coronagraphic Lyot stops in the pupil wheels used in conjunction with filters and focal plane occulting masks
- Green: grism elements disperse spectra along detector rows (R) or columns (C), used in conjunction with filters
- Magenta: WL, weak lens, used to defocus for mirror alignment or bright star imaging without saturation
- Gray: CLEAR positions, empty holes in the pupil wheel
- Wavefront sensing/calibration (not available for science)
    - DHS, dispersed Hartman sensing (sub-aperture grisms): coarse phasing alignment of JWST's mirrors
    - PAPPA, pupil alignment pinhole projector assembly: align NIRCam with the JWST Optical Telescope Element (OTE)
    - IPR, internal phase retrieval, wedge: measure NIRCam wavefront errors using LEDs mounted on coronagraphs
    - Dark: blocks incoming light for dark current measurements

Allowed combinations between pupil and filter wheel elements

Figure 2. Allowed combinations of optical elements in the NIRCam short wavelength channel



Filter wheel elements (left column) may be paired with pupil wheel elements (top row) as listed below. Pupil wheel elements in gray on the right are only available for wavefront sensing and calibration, not science.

Pair availability

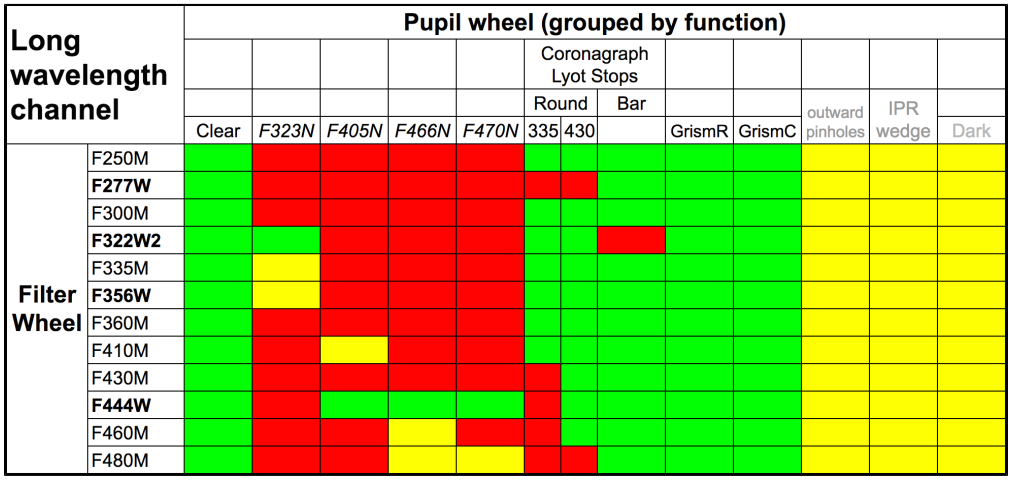
- Green: available for science

- Yellow: restricted use for wavefront sensing, calibration, or engineering"

- Red: disallowed; not useful

Names of wide, medium, and narrow filters are formatted as bold, regular, and italic, respectively.

Figure 3. Allowed combinations of optical elements in the NIRCam long wavelength channel



Available pupil and filter wheel pairings for the long wavelength channel. Same color codes as Figure 2.
- Green: available for science
- Yellow: restricted use for wavefront sensing, calibration, or engineering"
- Red: disallowed; not useful
Names of wide, medium, and narrow filters are formatted as bold, regular, and italic, respectively.

335, 430: the filters allowed in combination with a round coronagraph Lyot stop depend on the occulting mask used: MASK335R[1] or MASK430R.

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