NIRCam Time-Series Imaging

JWST NIRCam's time-series imaging observing mode performs rapid photometric monitoring of bright, time-variable sources. Weak lenses and subarrays may be used to improve saturation limits.

Introduction

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> *See also: NIRCam Time-Series APT Template*

The NIRCam time-series imaging mode was designed to enable precise measurements of photometric variations in relatively bright sources. It is one of two modes available for NIRCam time-series observations, the other being grism time series. These modes provide maximum stability in the observations and electronics. They are designed to accommodate bright sources. They also allow for very long uninterrupted observations, consisting of many integrations executed at high cadence and observing efficiency.

Dithers and mosaics are not allowed in this mode. (In standard imaging mode, dithers are required.)

Simultaneous imaging is obtained via a dichroic at short (0.6–2.3 μm) and long (2.4–5.0 μm) wavelengths in various extra-wide, wide, medium, and narrow NIRCam filters. Exposure times and readout patterns will be identical at both wavelengths. Therefore, filters with similar sensitivities and saturation limits should be used for both wavelengths. For example, imaging may be obtained simultaneously in two wide filters (e.g., F150W and F356W) or two narrow filters (e.g., F212N and F323N).

Weak lens

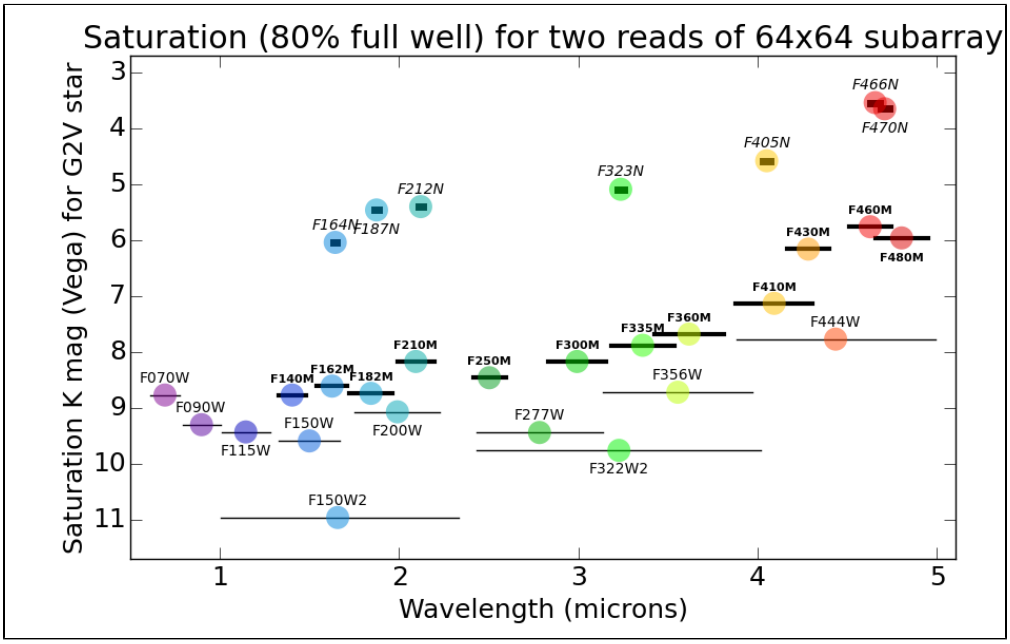
The weak lens WLP8 is available in the short wavelength channel to defocus the image of a bright source, improving the saturation limit by several magnitudes. To improve this limit further, the weak lens may be used in conjunction with subarrays, which should be 160 × 160 pixels or larger to encompass most of the defocused image and attain a proper background subtraction.

The weak lens may be paired with select filters between 1.3–2.2 μm. While the weak lens is being used in the short wavelength channel, long wavelength imaging is restricted to narrowband filters to avoid saturation. (The long wavelength grism may also be used in the NIRCam grism time-series observing mode.)

Saturation limits

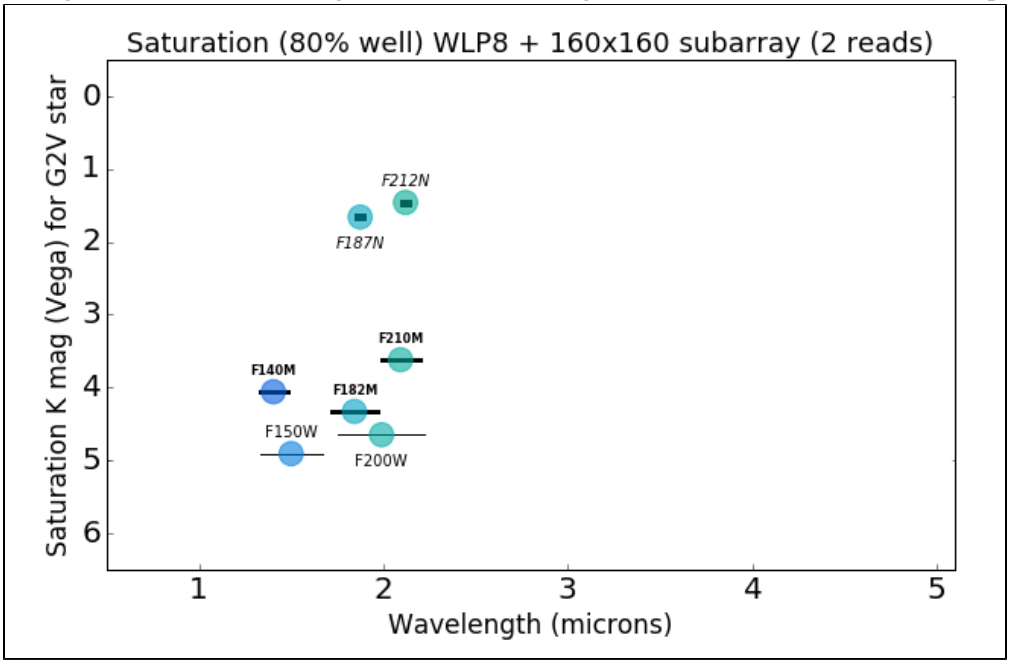
Use of the weak lens (at short wavelengths) in conjunction with the 160 × 160 pixel subarray increases saturation limits by ~11 magnitudes compared to standard full field imaging. The smallest NIRCam subarray (64 × 64 pixels; without the weak lens) enables saturation limits ~6 magnitudes brighter than full field imaging at both short and long wavelengths.

Figure 1. Saturation magnitudes for NIRCam filters in a 64 × 64 pixel subarray



Approximate saturation magnitudes (Vega K-band for a solar type G2V star) in the 64 × 64 pixel subarray for a ~0.1 s exposure (two readouts of the subarray). Saturation is defined here as 80% of the pixel well capacity. Filters are color-coded, with widths shown as horizontal bars. More precise saturation estimates may be obtained from the Exposure Time Calculator (ETC). Limits ~5 magnitudes brighter than those shown here may be achieved at 1.3–2.2 µm by using the +8-wave weak lens (WLP8) with the 160 × 160 pixel subarray (see Figure 2).

Figure 2. Saturation magnitudes for short wavelength NIRCam filters using the WLP8 weak lens with a 160 × 160 pixel subarray



Approximate saturation magnitudes (Vega K-band for a solar type G2V star), using the WLP8 weak lens, with a 160 × 160 pixel subarray for a ~0.55 s exposure (two readouts of the subarray). Saturation is defined here as 80% of the pixel well capacity. Filters are color-coded, with widths shown as horizontal bars. More precise saturation estimates may be obtained from the Exposure Time Calculator (ETC).

References

NIRCam Design Features and Performance (U. Arizona)

Beichman, C. et al. 2014, PASP, 126, 1134
Observations of Transiting Exoplanets with the James Webb Space Telescope (JWST)