NIRISS Sensitivity

Sensitivity estimates are available for the JWST NIRISS observing modes (wide field sliltess spectroscopy, imaging, single object slitless spectroscopy, and aperture masking interferometry).

NIRISS observing mode sensitivities

Parent page: NIRISS Predicted Performance

Users should ultimately use the Exposure Time Calculator (ETC) for all saturation/sensitivity calculations.

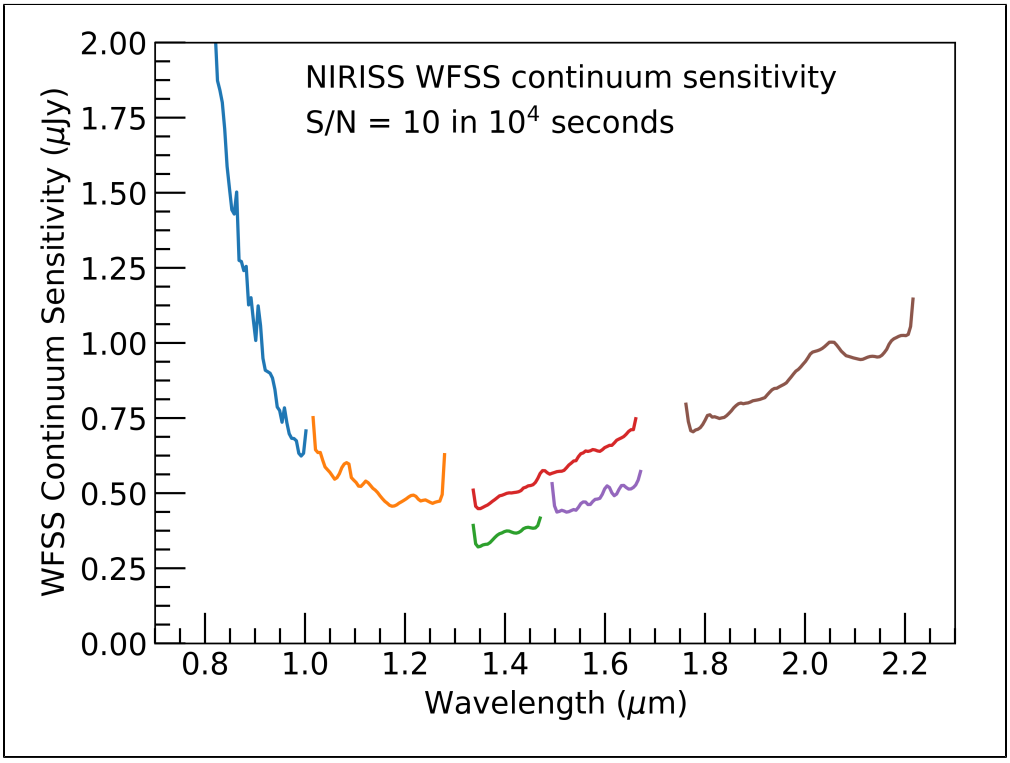
NIRISS WFSS sensitivity

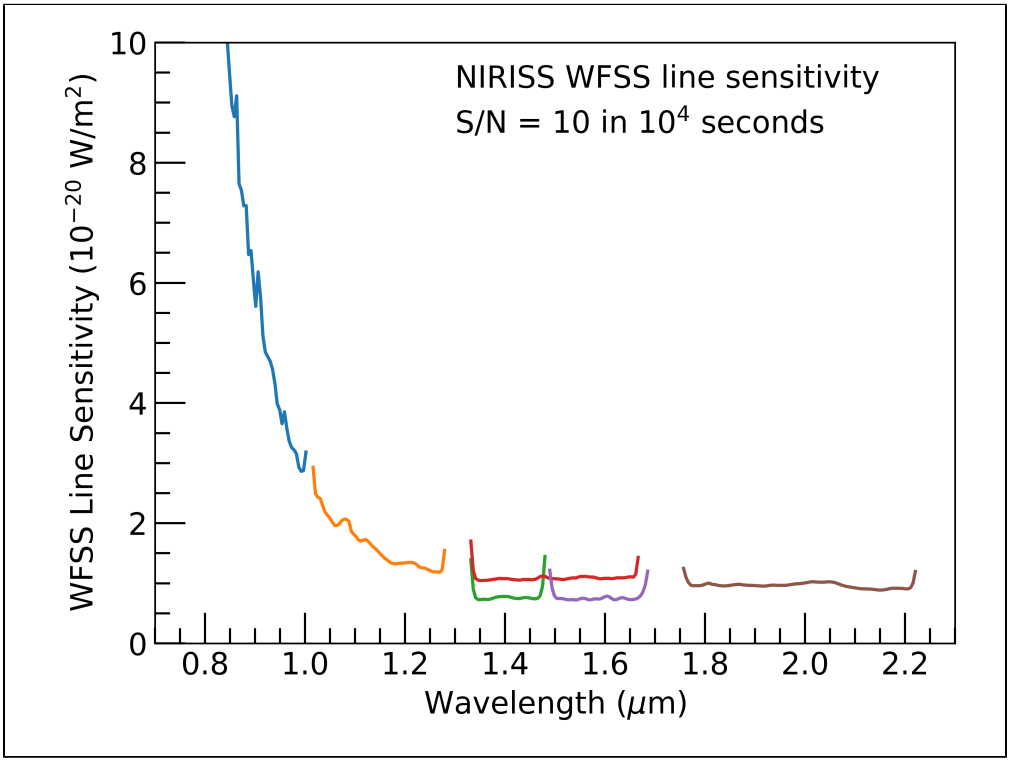
Main article: NIRISS Wide Field Slitless Spectroscopy

The NIRISS wide field slitless spectroscopy (WFSS) mode provides low resolution (R ~ 150) spectroscopy over the wavelength range 0.8–2.2 μm for every object within the 2.2' × 2.2' field of view. Blocking filters in the pupil wheel limit the wavelength coverage and spatial extent of the spectra on the detector. WFSS offers two identical grisms (GR150C and GR150R) that are mounted orthogonally to each other in the filter wheel. Use of both filters helps to mitigate contamination from overlapping spectra.

Figure 1 illustrates the S/N = 10 line flux and continuum sensitivity for a 10 ks observation through each of the blocking filters for an unresolved source. The extraction aperture is assumed to be three pixels in the cross-dispersion direction and two pixels in the wavelength direction.

Figure 1. NIRISS GR150 line flux and continuum sensitivity





Colors correspond due to the different blocking filters: blue - F090W, orange - F115W, red - F150W, green - F140M , purple - F158M, brown - F200W.

The continuum sensitivity values are generally below 2 μJy for a 10 ks exposure over most of the wavelength range, rising to larger values at the shortest wavelengths. In terms of Vega magnitudes, where on average the A0V stars have the same magnitude in all filters, the continuum sensitivity is between 22.0 and 24.5 over the whole wavelength range.

NIRISS imaging sensitivity

Main article: NIRISS Imaging

NIRISS imaging is not available as a primary observing mode but is offered as a coordinated parallel mode when another JWST instrument is the primary science instrument. Currently, NIRISS imaging in parallel is only offered when NIRCam imaging is the primary science mode. Other prime-parallel combinations involving NIRISS imaging in parallel will be considered for implementation in cycle 2.

Images are obtained through filters in the pupil wheel, spanning wavelengths 0.8 μm–2.2 μm, and in the filter wheel, covering wavelengths 2.5 μm–5.0 μm. Five medium-band filters (F140M, F158M, F380M, F430M, F480M) and seven wideband filters (F090W, F115W, F150W, F200W, F277W, F356W, F444W) are available.

NIRISS imaging is also used to take direct images before and after grism exposures in wide field slitless spectroscopy mode. Direct images allow identification of objects in the grism exposures and absolute wavelength calibration. Direct images are only available through the short wavelength filters in the pupil wheel: F090W, F115W, F140M, F150W, F158M, F200W.

Table 1 lists the broadband filter sensitivities corresponding to a S/N = 10 for a 10 ks observation of a point source. The sensitivities in the F140M and F158M filters are expected to be about a factor of 1.4 higher than the sensitivity for the F150W filter. The long wavelength medium-band filters are expected to have sensitivities that are a factor of about three higher than the F356W filter (for F380M) or the F444W filter (for F430M and F480M).

Table 1. Wideband filter point source imaging sensitivity for S/N = 10 in 10ks

Filter	nJy	Magnitude† (Vega)
F090W	14.3	28.14
F115W	12.6	27.93
F150W	11.1	27.26
F200W	9.7	27.20
F277W	10.7	27.20
F356W	10.0	26.11
F444W	15.0	25.24

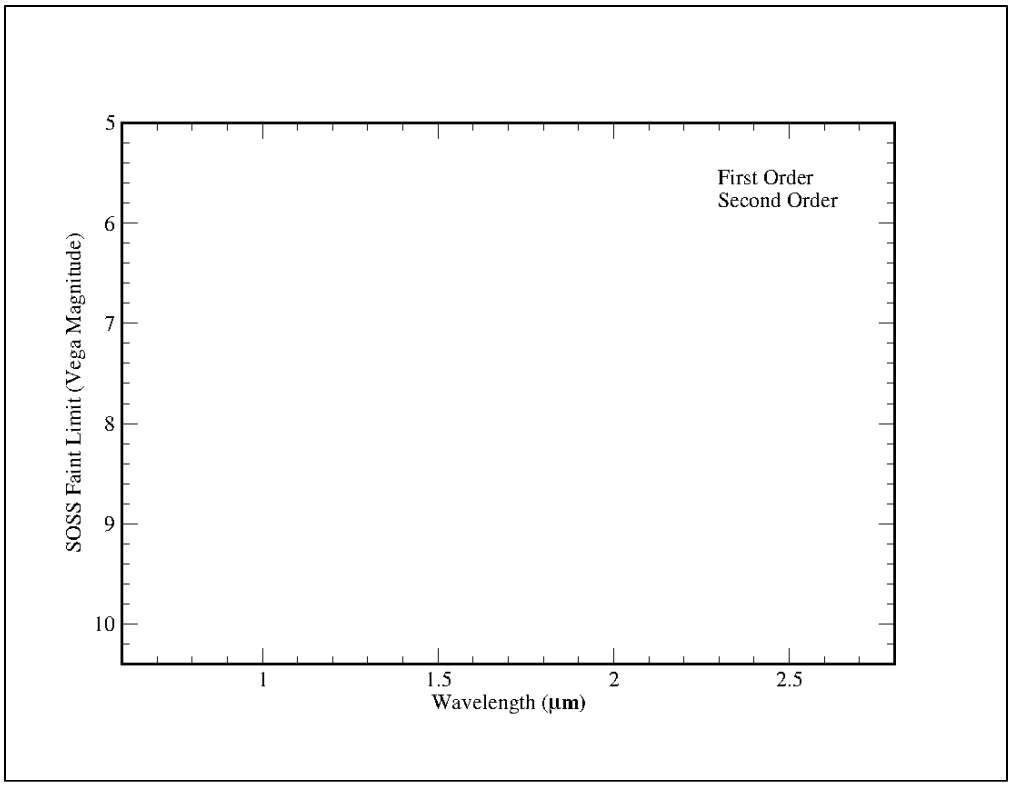
† Vega magnitudes in NIRISS filters for which the colors of an average A0V star are 0.0.

NIRISS single object slitless spectroscopy

Main article: NIRISS Single Object Slitless Spectroscopy

NIRISS single object slitless spectroscopy (SOSS) enables medium-resolution (R ≈ 700) spectroscopy at 0.6–2.8 μm, in three cross-dispersed orders for a single bright target. The SOSS observing mode makes use of the GR700XD grism and has two detector subarray readout options: ***SUBSTRIP256*** [1] and ***SUBSTRIP96***. Full frame readout is also supported.

For SOSS mode the sensitivity is calculated by requiring signal to noise of 1,000 per wavelength resolution element from four NISRAPID groups in full frame readout. At this signal-to-noise ratio, a transiting exoplanet with contrast 0.001 with respect to the star should be detectable. Figure 2 shows the Vega magnitude values for this level of contrast in the first and second orders, for a star of spectral type A0V. Given a longer time baseline or with smoothing of the spectrum, the sensitivity will be better than shown in the plot.



NIRISS aperture masking interferometry

> *Main article: NIRISS AMI-Specific Treatment of Limiting Contrast*
> *See also: NIRISS Aperture Masking Interferometry*

NIRISS aperture masking interferometry (AMI) offers high spatial resolution imaging at 2.77, 3.80, 4.30 and 4.80 μm for bright objects at separations of 70–400 mas through the use of a non-redundant mask (NRM). AMI enables the detection of faint objects around bright objects through high contrast imaging. See the AMI-specific treatment of limiting contrast for further information about the companion-to-host flux ratio of the minimum detectable companion.

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