

NIRCam Imaging and NIRISS WFSS of Galaxies Within Lensing Clusters

Example Science Program #33

This example science program provides a walk-through of developing a JWST observing program using NIRISS Wide Field Slitless Spectroscopy as a prime observing mode and NIRCam Imaging as a coordinated parallel mode. The overarching science goals are from the [GTO program "NIRISS Unbiased Cluster Survey \(CANUCS\)"](#) to provide context for navigating the Exposure Time Calculator and setting up the observation templates in the Astronomers Proposal Tool.

Main article: [NIRISS Wide Field Slitless Spectroscopy](#), [NIRISS WFSS Recommended Strategies](#), [JWST Parallel Observations](#)

See also: [Step-by-Step ETC Guide for NIRISS WFSS and Parallel NIRCam Imaging of Galaxies in Lensing Clusters](#),

[Step-by-Step APT Guide for NIRISS WFSS and NIRCam Parallel Imaging of Galaxies in Lensing Clusters](#)

The Canadian NIRISS Unbiased Cluster Survey (CANUCS) is a GTO program designed to study galaxies within and lensed by galaxy clusters. The main science goals are to:

- measure physical properties (star formation rates, metallicities, abundances) of dwarf galaxies from $1 < z < 5$;
- spatially resolve emission lines, metallicities, and star formation rates of lensed galaxies at $z > 1$;
- detect extreme emission line galaxies from $1 < z < 8$ and determine their evolution in their numbers and their properties;
- discover and characterize galaxies in the era of reionization ($z > 7$) via spectral diagnostics (continuum breaks, Ly α emission lines; broad-band dropouts).

The NIRISS [Wide Field Slitless Spectroscopy](#) (WFSS) mode is designed to obtain spectra in the 0.8–2.2 μm wavelength range for every source within the 2.2' \times 2.2' field of view (FOV) of the NIRISS detector. WFSS offers two [grisms](#) for this mode, GR150R and GR150C, that are mounted orthogonally to each other in the filter wheel. A grism observation is performed with a blocking filter in the pupil wheel which limits the wavelength range of the observed spectra (which also reduces the spectral overlap between orders). Since the NIRISS WFSS point spread function (PSF) is undersampled, [dithering](#) of NIRISS grism exposures is required. A direct image is taken before and after each set of dithered grism exposures to determine object positions, define the wavelength zeropoint of the dispersed spectra, and to facilitate modeling of spectral overlaps (i.e., "contamination").

NIRISS WFSS is the only JWST observing mode that permits slitless spectroscopy between 0.8–2.2 μm and is well-suited to measure emission lines from a large sample of galaxies over a range of redshifts. NIRISS has a high multiplexing factor and is thus optimal for a deep survey since it can obtain spectra for >1000 objects in one observation. The orthogonal mounting of the GR150R and GR150C grisms helps to mitigate contamination from overlapping sources.

NIRCam imaging, executed as a [coordinated parallel observation](#) in this program, is designed to detect galaxies with strong emission lines based on their medium-band filter excesses in regions several arcminutes away from and adjacent to the lensing clusters (here "adjacent" is defined by the relative locations of NIRISS and NIRCAM in the [JWST focal plane](#) and the spacecraft roll angle).

The CANUCS program will observe five strong lensing galaxy cluster fields with the **F115W**, **F150W**, and **F200W NIRISS filters** to optimize emission line and wavelength coverage. CANUCS will observe the parallel fields with 12 wide and medium [NIRCam filters](#). For illustrative purposes, we focus on one of the clusters from the *HST* Frontier Fields.

The [Step-by-Step ETC Guide](#) walks the user through navigating the [JWST Exposure Time Calculator \(ETC\)](#) to determine exposure parameters appropriate for the science goals for this program.

The [Astronomer's Proposal Tool \(APT\)](#) is used to submit JWST proposals. The [Step-by-Step APT Guide](#) provides instructions for filling out the [APT observation templates](#), where NIRISS WFSS is the prime observing mode and NIRCam imaging is a coordinated parallel mode. The exposure parameters determined by the ETC are specified in the APT observation template.

Continue the tutorial:

[Step-by-Step ETC Guide](#)

[Step-by-Step APT Guide](#)