



ESAC 2017 JWST Workshop



CANUCS: The Canadian NIRISS Unbiased Cluster Survey

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Science Case 3.4



Overview



Background: Using the NIRISS Wide Field Slitless Spectroscopy, its very high multiplexing factor and capability to spatially resolve emission lines, the Canadian NIRISS Unbiased Cluster Survey (CANUCS) will achieve several Science Goals:

- Detection and Characterization of galaxies within the reionization epoch.
- Evolution of low-mass galaxies across cosmic time.
- Resolved emission-line maps and line ratios for galaxies in the cosmic noon.

The CANUCS Observing Plan:

- NIRISS WFSS (prime)
- NIRCcam Image (prime)
- NIRCcam Image (parallel)
- NIRISS WFSS (parallel)
- NIRSpec MOS Prime
- In this exercise we will cover observations that use NIRISS WFSS prime with NIRCcam in parallel.





Overview



CANUCS targets:

The plan is to observe five strong-lensing galaxy cluster fields at $0.37 < z < 0.55$.

Five clusters required for **large sample** of distant galaxies:

- ~3000 at $z > 1$
- ~1500 with metallicities
- ~100 with spatially-resolved metallicities
- ~200 at $z > 7$

Table 2: Target List.

Cluster	RA	DEC	Redshift	Survey	<i>JWST</i> Visibility Period	
Abell 370	02:39:52.8	-01:34:36	0.375	HFF	24 Jul-16 Sep	+ 12 Dec-02 Feb
M0416.1-2403	04:16:09.4	-24:04:04	0.395	HFF	12 Aug-09 Nov	+ 27 Nov-22 Feb
M0417.5-1154	04:17:34.7	-11:54:32	0.443	RELICS	17 Aug-20 Oct	+ 26 Dec-24 Feb
M1149.6+2223	11:49:35.9	+22:23:55	0.543	HFF	19 Apr-15 Jun	+ 05 Dec-27 Jan
M1423.8+2404	14:23:47.8	+24:04:40	0.545	CLASH	13 May-24 Jul	+ 08 Jan-15 Mar

NIRISS+NIRCam

NIRSpec





Overview



Observing Plan

- NIRISS WFSS in three filters (F115W, F150W, F200W). Total integration time per filter/grism 3.2 hours. Direct imaging per filter integration time is 0.6 hours.
- NIRCам direct imaging in 8 filters (1.8 hrs exposure). Filters as follows SW: F090W, F115W, F150W, F200W. LW: F277W, F356W, F410M, F444W.
- NIRCам, parallel: 12 filters between 1 to 5 microns with about 3 hours exposure each.
- NIRISS parallels: WFSS in the F115W filter (both grisms) and F150W, F200W (one grism) for 1.5 hrs each.





Target Visibility Tool



Run the target visibility tool to find out when these targets are visible and which orients will be available.

It is also possible to use the TVT to get the window which would be the best to observe each of the target cluster fields (i.e. minimum background).





Exposure Time Calculator



For this exercise let's focus on putting together the NIRISS WFSS scene

Sources and scenes

Source 1: Pure emission line Galaxy

Choose no continuum and “do not renormalize”. In the emission lines tab generate three lines. All three have widths of 1000 km/s and strength of $3.5e-18$ erg/cm²/s. They should be centred at 1.15, 1.5 and 2 microns. This is a point source with an offset of -1 arcsec in X and 0.5 arcsec in Y.

Source 2: Galaxy with 26 AB mag in F200W

Define a point source with a flat continuum and normalize it to 26 ABmag in the NIRISS F200W filter. Define offsets of 0.7 arcsec in X and -0.5 arcsec in Y, and an orientation of +5 degrees.

Source 3: Starburst galaxy at z=2

Use the NGC3690 template and “place it” at z=2. Renormalize it to 25 ABmag in the NIRISS F200W filter. This is an extended source with a Sersic profile semi minor and major axes of 0.3 and 0.15 arcsec, and index = 1.





Exposure Time Calculator



Source 4: 28 AB mag source:

Point source with a flat continuum in fnu and normalize it to 28 ABmag in the NIRSS F200W filter. Source location: offsets of 1 arsec in X and -1.5 arcsec in Y.

Create a scene with all these 4 sources





Exposure Time Calculator



Calculations:

For WFSS observations the observing sequence is

Direct image -> GR150C -> Direct image

Direct image -> GR150R -> Direct image

Create one calculation using the designed scene

- Configure the background for the M0416 cluster (04:16:09.40 -24:04:04.00) to low.
- GR150 row dispersed, F150W filter.
- Aperture location centered on the source.
- FULL array NIS readout. Set Ngroups and ints to obtain SNR of 3.5 at 1.5 microns.
- Repeat/copy calculation for the other two filters of interest. (F115W, F200W).

Repeat calculation for the other four clusters





Exposure Time Calculator



Imaging calculations:

Configure the background for the M0416 cluster (04:16:09.40 -24:04:04.00) to low. Alternatively insert a date that will minimize the background (this information can be extracted from the target visibility tool).

Set up calculations for the F115W, F150W and F200W filters. Play with different Ngroups, Nintegrations and Nexposures using batch expansion.





ESASky



Use ESA Sky to find the clusters of interest, and display the JWST instruments footprint on it.

Identify the science apertures (NIRISS, NIRCam).

ESA Sky can be also used to download already reduced files of the target from all ESA missions.





Astronomers Proposal Tool



- Define the five clusters of interest as targets.
- Selected the NIRISS WFSS template with NIRCcam in parallel.
- Define one observation for one cluster and set up the NIRISS WFSS observing program as designed in the ETC.

Direct image → GR150C → Direct image

Direct image → GR150R → Direct image

Using 3 filters with direct image.

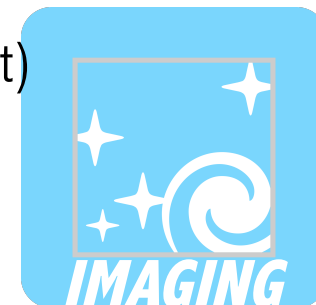
Hint: Use 8 point dithers, medium size pattern. Favor single integrations exposures.

- Set up the NIRCcam parallel observations using filters:
 - SW: F090W, F115W, F150W, F182M, F210M, F140M.
 - LW: F277W, F250M, F300W, F335M, F360M, F410M.



For each filter pair use DEEP8 if in parallel with Grism (7 groups 1 int)
MEDIUM8 if in parallel with image (5 groups 1 int)

If you have the time derive these NIRCcam values using the ETC.





Astronomers Proposal Tool



- Use special requirements to constrain the PA as follows:

Abell 370: PA range 256.43, 256.43

MACSj0416: PA range 301.43, 309.43

MACSj0417: PA range 289.43, 289.43

MACSj1149: PA range 121.43, 121.43

MACSj1423: PA range 129.43, 149.43

Visualize in Aladdin where the NIRCcam footprint falls when using these requirements.

- If time allows repeat the observation for each cluster.





Astronomers Proposal Tool



Special Requirements:

Are your requirements scientifically justified

Visit planner:

Can the observations be scheduled? If so, when? How do you check?

Warnings or Errors:

Are there any warnings or errors in APT? Are these acceptable?

