NIRISS WFSS Dithers

The JWST NIRISS wide field slitless spectroscopy (WFSS) mode has a predefined number of dither steps and sizes. Dithering is required to mitigate NIRISS PSF undersampling at wavelengths < 2 μm.

NIRISS WFSS dithering capabilities

> *Parent pages: NIRISS Operations → NIRISS Dithers*
> *Main article: NIRISS Wide Field Slitless Spectroscopy*
> *See also: NIRISS WFSS Recommended Strategies, NIRISS WFSS Template APT Guide*

The NIRISS wide field slitless spectroscopy (WFSS) observing sequence can be constructed using the GR150R grism, GR150C grism, or a combination of both grisms. Dithering is required for WFSS observations because the JWST point spread function (PSF) is heavily undersampled by NIRISS when observing at the wavelengths covered by WFSS. Dithers can strongly improve the effective sampling of the PSF.

Dither pattern steps for WFSS are chosen to have sufficient spacing (typically ≥3 pixels) along both rows and columns to accommodate exposures with GR150R and GR150C grisms. The dither patterns are chosen to achieve the best possible pixel-phase sampling for a given number of dither positions.

The selection of dither patterns for WFSS is made by specifying two parameters:

- Number of dither steps (***Image Dithers*** [1]): 2, 3 ,4 ,6, 8, 12, and 16 steps. The first step corresponds to the initial pointing.
- Dither step amplitude (***Pattern Size***): ***SMALL*** (~0.3"), ***MEDIUM*** (~0.6"), or ***LARGE*** (~1.2").

As to the latter parameter, consider that smaller dither amplitudes yield the benefit of higher conservation of pixel phase sampling across the detector (due to varying geometric distortion), while larger dither amplitudes allow one to step over larger targets and hence offer a better mitigation of flat-fielding errors for astronomical scenes involving such targets. The user should choose the best compromise for a given science case. The ***MEDIUM*** patterns (the default choice in the APT template for the WFSS mode) was chosen to be appropriate for extragalactic studies at moderate to high redshifts. The ***SMALL*** patterns are thought to be useful for sparse fields of compact sources, while the ***LARGE*** patterns should be useful for observing astronomical scenes involving relatively large objects (e.g., galaxies at relatively low redshift).

The spatial offsets with respect to the central pointing (step #1 in all patterns) are given in the tables below for the NIRISS WFSS dither patterns.

Table 1. WFSS mode offsets for the *SMALL* dither patterns

# of Dithers (*Image Dithers*)	Step #	ΔX pixels	ΔY pixels	ΔX arcsec	ΔY arcsec
2	1	0.000	0.000	0.0000	0.0000
	2	3.500	3.500	0.2289	0.2296
3					
	1	0.000	0.000	0.000	0.000
	2	4.333	4.333	0.2833	0.2842
	3	8.667	8.667	0.5668	0.5686
4					
	1	0.000	0.000	0.0000	0.0000
	2	5.000	2.500	0.3270	0.1633
	3	2.500	6.000	0.1635	0.3947
	4	-2.500	4.500	-0.1635	0.2973
6					
	1	0.000	0.000	0.0000	0.0000
	2	-2.000	3.500	-0.1308	0.2312
	3	-4.667	8.500	-0.3052	0.5615
	4	2.667	6.000	0.1744	0.3946
	5	4.333	2.000	0.2834	0.1305
	6	6.667	-2.500	0.4360	-0.1667
8					
	1	0.000	0.000	0.0000	0.0000
	2	5.000	2.500	0.3270	0.1633
	3	3.500	7.000	0.2289	0.4603
	4	-1.500	4.500	-0.0981	0.2970
	5	-2.500	-1.000	-0.1635	-0.0652
	6	2.500	1.500	0.1635	0.0981
	7	1.000	6.000	0.0654	0.3951

	8	-4.000	3.500	-0.2616	0.2318
12					
	1	0.000	0.000	0.000	0.000
	2	5.000	2.500	0.3270	0.1633
	3	3.500	7.000	0.2289	0.4603
	4	-1.500	5.500	-0.0981	0.3629
	5	-2.500	-1.000	-0.1635	-0.0652
	6	2.000	1.500	0.1308	0.0983
	7	1.000	6.000	0.0654	0.3951
	8	-4.500	3.500	-0.2943	0.2320
	9	-2.000	2.000	-0.1308	0.1324
	10	2.500	4.500	0.1635	0.2958
	11	1.500	9.000	0.0981	0.5927
	12	-4.000	6.500	-0.2616	0.4295
16					
	1	0.000	0.000	0.000	0.000
	2	5.000	2.500	0.3270	0.1633
	3	4.500	7.000	0.2943	0.4600
	4	-1.500	5.500	-0.0981	0.3629
	5	-2.500	-1.500	-0.1635	-0.0981
	6	2.500	-1.000	0.1635	-0.0666
	7	1.000	6.000	0.0654	0.3951
	8	-5.000	3.500	-0.3270	0.2321
	9	-3.500	1.000	0.1635	0.0669
	10	3.500	4.500	0.2289	0.2955
	11	2.000	9.500	0.1308	0.6255
	12	-4.000	5.000	-0.2616	0.3307

	13	-6.000	1.500	-0.3924	0.1006
	14	-1.000	3.000	-0.0654	0.1980
	15	-0.500	8.000	-0.327	0.5273
	16	-6.500	7.500	-0.4251	0.4962

Table 2. WFSS mode offsets for the *MEDIUM* dither patterns

# of Dithers (*Image Dithers*)	Step #	ΔX pixels	ΔY pixels	ΔX arcsec	ΔY arcsec
2					
	1	0.000	0.000	0.0000	0.0000
	2	6.500	6.500	0.4251	0.4264
3					
	1	0.000	0.000	0.0000	0.0000
	2	6.333	6.333	0.4141	0.4155
	3	12.667	12.667	0.8283	0.8310
4					
	1	0.000	0.000	0.0000	0.0000
	2	8.000	4.500	0.5231	0.2942
	3	3.500	11.000	0.2289	0.7239
	4	-3.500	7.500	-0.2289	0.4953
6					
	1	0.000	0.000	0.0000	0.0000
	2	-4.000	7.500	-0.2616	0.4954
	3	-7.667	14.500	-0.5014	0.9578
	4	3.667	11.000	0.2398	0.7238
	5	7.333	4.000	0.4795	0.2614
	6	10.667	-3.500	0.6975	-0.2338

8					
	1	0.000	0.000	0.0000	0.0000
	2	8.000	4.500	0.5231	0.2942
	3	3.500	11.000	0.2289	0.7239
	4	-3.500	7.500	-0.2289	0.4953
	5	-4.000	-2.000	-0.2616	-0.1306
	6	4.000	2.500	0.2616	0.1636
	7	-0.500	9.000	-0.0327	0.5932
	8	-7.500	5.500	-0.4904	0.3647
12					
	1	0.000	0.000	0.0000	0.0000
	2	8.000	4.500	0.5231	0.2942
	3	3.500	11.000	0.2289	0.7239
	4	-3.000	6.500	-0.1962	0.4292
	5	-4.500	-1.500	-0.2943	-0.0975
	6	4.000	3.000	0.2616	0.1965
	7	-1.000	8.500	-0.0654	0.5604
	8	-7.500	5.000	-0.4904	0.3317
	9	-2.500	2.000	-0.1635	0.1325
	10	6.500	7.500	0.4251	0.4923
	11	1.000	12.000	0.0654	0.7905
	12	-5.500	9.5000	-0.3597	0.6277
16					
	1	0.000	0.000	0.000	0.000
	2	8.000	3.500	0.5231	0.2283
	3	3.500	11.000	0.2289	0.7239
	4	-3.500	7.500	-0.2289	0.4953

	5	-4.500	-2.500	-0.2943	-0.1634
	6	5.000	2.000	0.3270	0.1303
	7	-1.000	9.5000	-0.0654	0.6263
	8	-7.500	5.000	-0.4904	0.3317
	9	-2.000	2.500	-0.1308	0.1653
	10	6.500	7.000	0.4251	0.4594
	11	1.500	13.500	0.0981	0.8892
	12	-6.000	10.000	-0.3924	0.6608
	13	-5.000	1.500	-0.3270	0.1003
	14	3.000	6.000	0.1962	0.3945
	15	-1.500	12.000	-0.0981	0.7912
	16	-8.500	8.500	-0.5558	0.5627

Table 3. WFSS mode offsets for the *LARGE* dither patterns

# of Dithers (*Image Dithers*)	Step #	ΔX pixels	ΔY pixels	ΔX arcsec	ΔY arcsec
2					
	1	0.000	0.000	0.0000	0.0000
	2	12.500	12.500	0.8174	0.8200
3					
	1	0.000	0.000	0.0000	0.0000
	2	12.333	12.333	0.8065	0.8091
	3	24.667	24.667	1.6130	1.6282
4					
	1	0.000	0.000	0.0000	0.0000
	2	16.000	8.500	1.0463	0.5554
	3	7.500	22.000	0.4904	1.4476

	4	-7.500	15.500	-0.4904	1.0237
6					
	1	0.000	0.000	0.0000	0.0000
	2	-8.000	14.500	-0.5231	0.9579
	3	-14.667	28.500	-0.9591	1.8825
	4	6.667	22.000	0.4360	1.4478
	5	14.333	8.000	0.9373	0.5229
	6	20.667	-7.500	1.3515	-0.5005
8					
	1	0.000	0.000	0.0000	0.0000
	2	16.000	8.500	1.0463	0.5554
	3	7.500	22.000	0.4904	1.4476
	4	-7.500	15.500	-0.4904	1.0237
	5	-8.000	-4.000	-0.5231	-0.2612
	6	8.000	4.500	0.5231	0.2942
	7	-0.500	18.000	-0.0327	1.1863
	8	-15.500	11.500	-1.0136	0.7625
12					
	1	0.000	0.000	0.000	0.000
	2	16.000	8.500	1.0463	0.5554
	3	7.500	22.000	0.4904	1.4476
	4	-7.500	15.500	-0.4904	1.0237
	5	-6.500	-4.500	-0.4250	-0.2946
	6	10.000	4.000	0.6539	0.2606
	7	1.000	18.500	0.0654	1.2188
	8	-13.500	11.000	-0.8828	0.7289
	9	-4.000	6.500	-0.2616	0.4295

	10	12.500	14.000	0.8174	0.9189
	11	3.000	28.000	0.1962	1.8443
	12	-9.500	21.500	-0.6212	1.4197
16					
	1	0.000	0.000	0.000	0.000
	2	16.000	8.500	1.0463	0.5554
	3	7.500	22.000	0.4904	1.4476
	4	-7.500	15.500	-0.4904	1.0237
	5	-6.500	-3.500	-0.4250	-0.2287
	6	10.000	4.000	0.6539	0.2606
	7	1.500	18.500	0.0981	1.2187
	8	-13.000	11.000	-0.8501	0.7288
	9	-4.000	6.500	-0.2616	0.4295
	10	12.500	14.000	0.8174	0.9189
	11	3.500	27.500	0.2289	1.8112
	12	-9.000	21.000	-0.5885	1.3866
	13	-11.000	2.500	-0.7193	0.1680
	14	5.000	10.000	0.3270	0.6575
	15	-3.500	24.000	-0.2289	1.5826
	16	-16.500	17.500	-1.0790	1.1582

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

References

Goudfrooij, P. 2015 JWST-STScI-004466

NIRISS Dither Patterns for the WFSS and Imaging Observing modes