NIRCam & NIRISS Wide Field Slitless Spectroscopy

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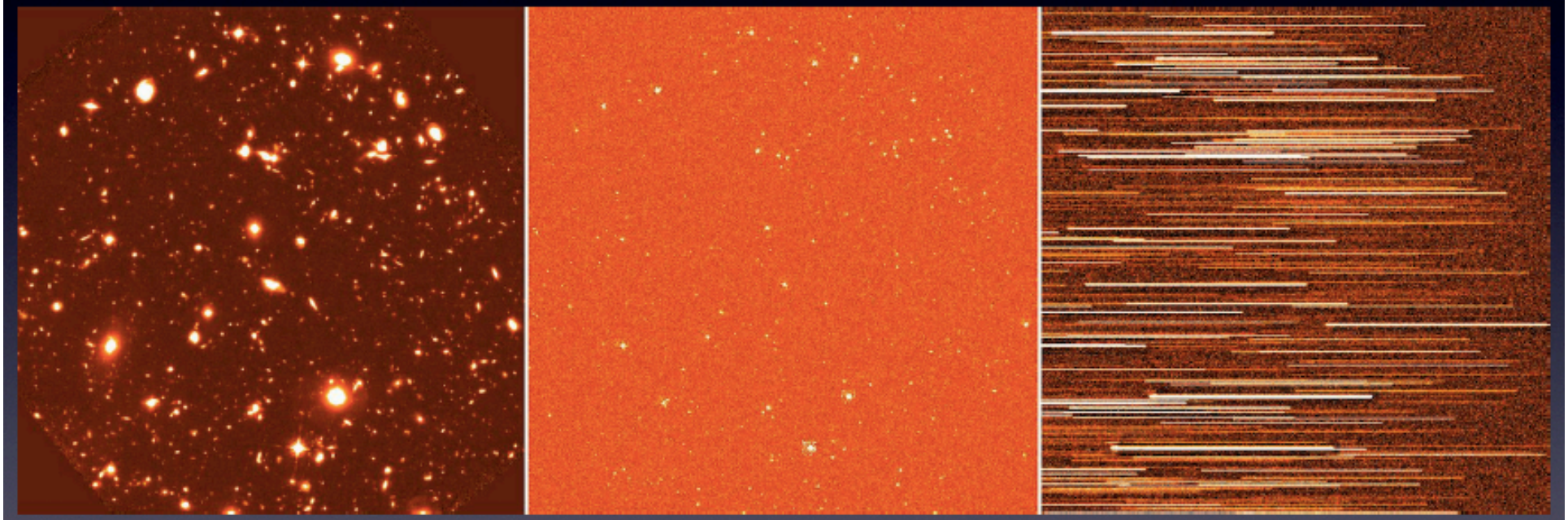
Assumptions: Grism Observations

- Two primary operational modes with different calibrations:
  - Time series data for single / few bright objects (transits), no dithers, minimal pipeline processing
    - Position single object on a pre-determined pixel sweet spot
  - MOS / WFSS observations of fainter objects with dithers, backgrounds, and contaminating spectra
    - Image first taken to determine source location, then switch to spectral mode, take multiple spectra with dithers, re-image
    - Can also be used for single objects where full calibration is desired
    - Use only small dithers (~ arcsec) to not introduce distortions
- NIRCam and NIRISS plan to take grism spectra similarly
  No known additional considerations for data acquisition or calibration
  - Ops concept for grism observations is not finalized

Simulating NIRCam Grism Survey Data

HST UDF simulation by Eeichi Egami (UA)



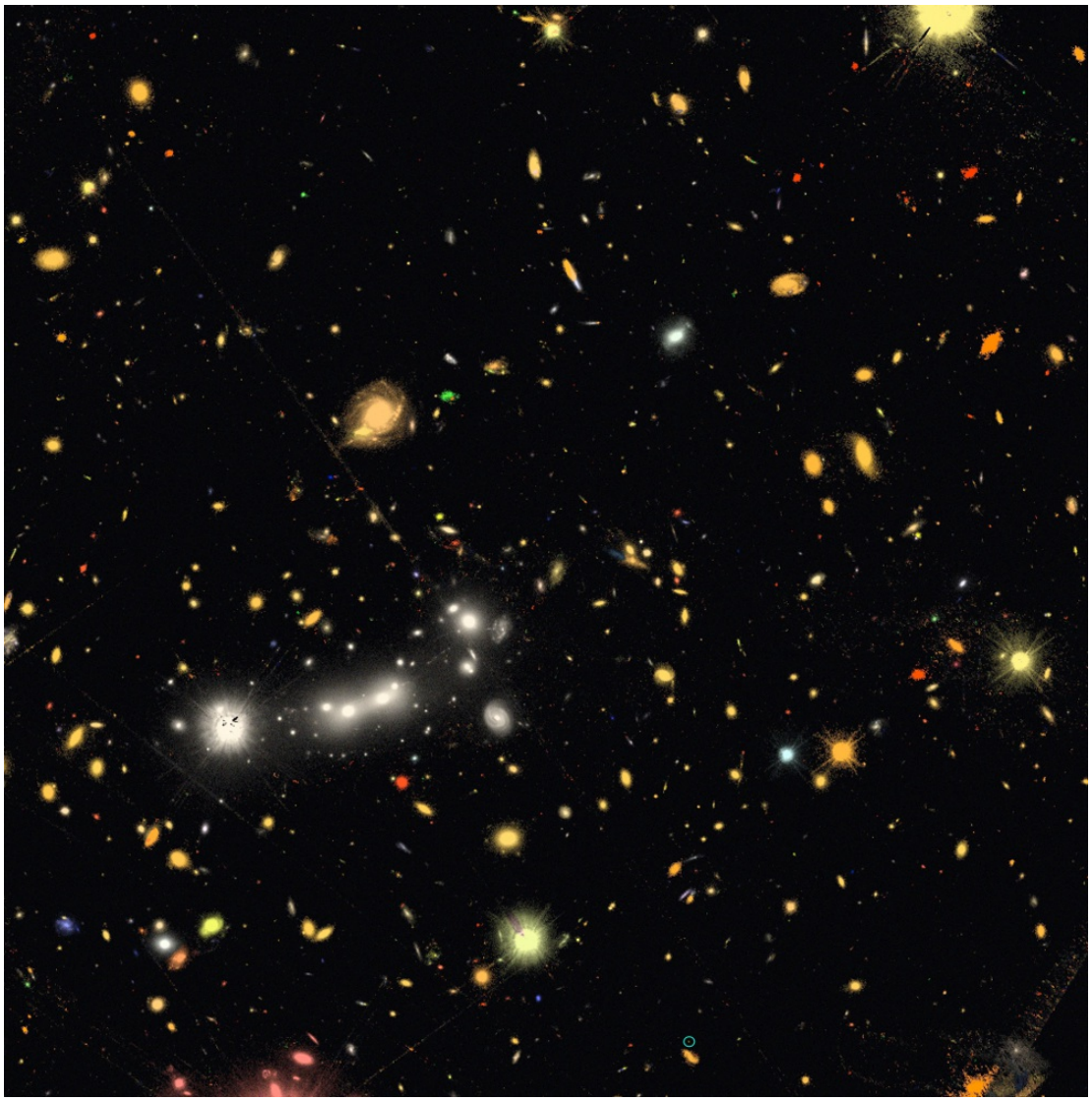
HUDF12 F160W

NIRCam G356W brightest ~500 sources

NIRCam G356W Grism spectra

MACS J0647+7015

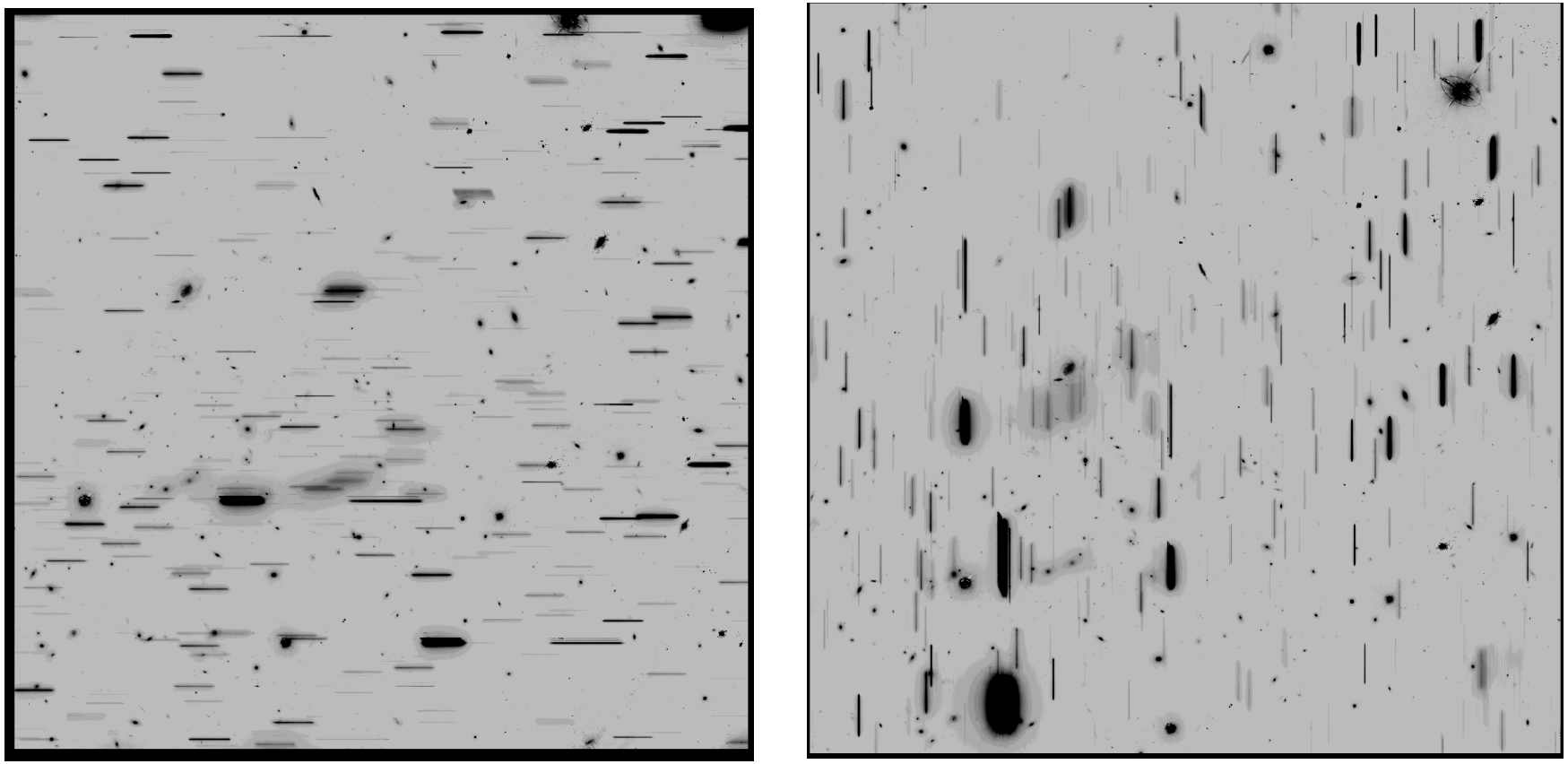
Simulated direct image of CLASH field
F090W, F150W, F200W



CLASH Survey: Postman et al. 2012

MACS J0647+7015: Coe et al. 2013

Dispersing into Rows and Columns

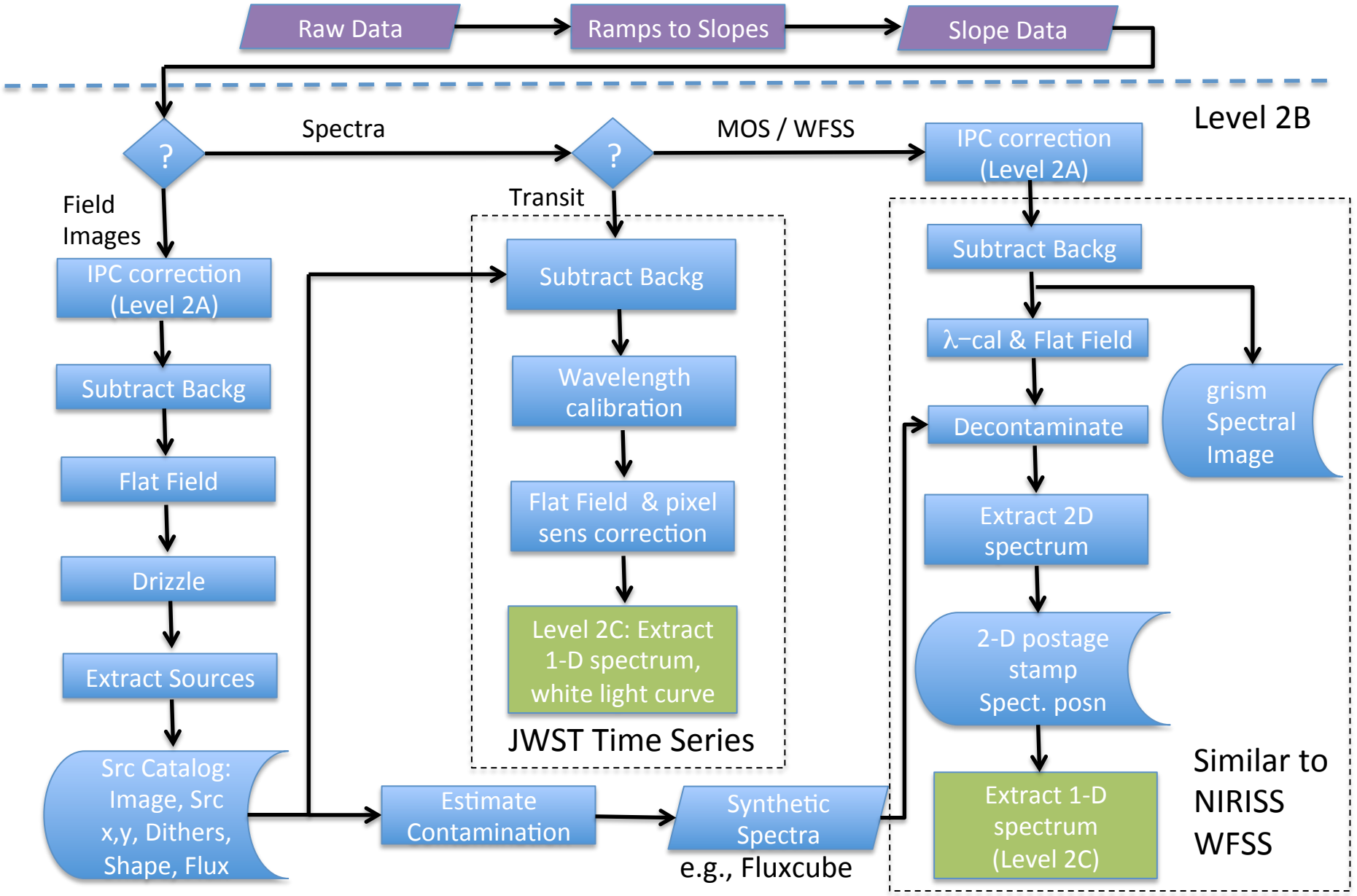


Simulated GR150R (left) and GR150C (right) images of the CLASH field through the F200W filter.

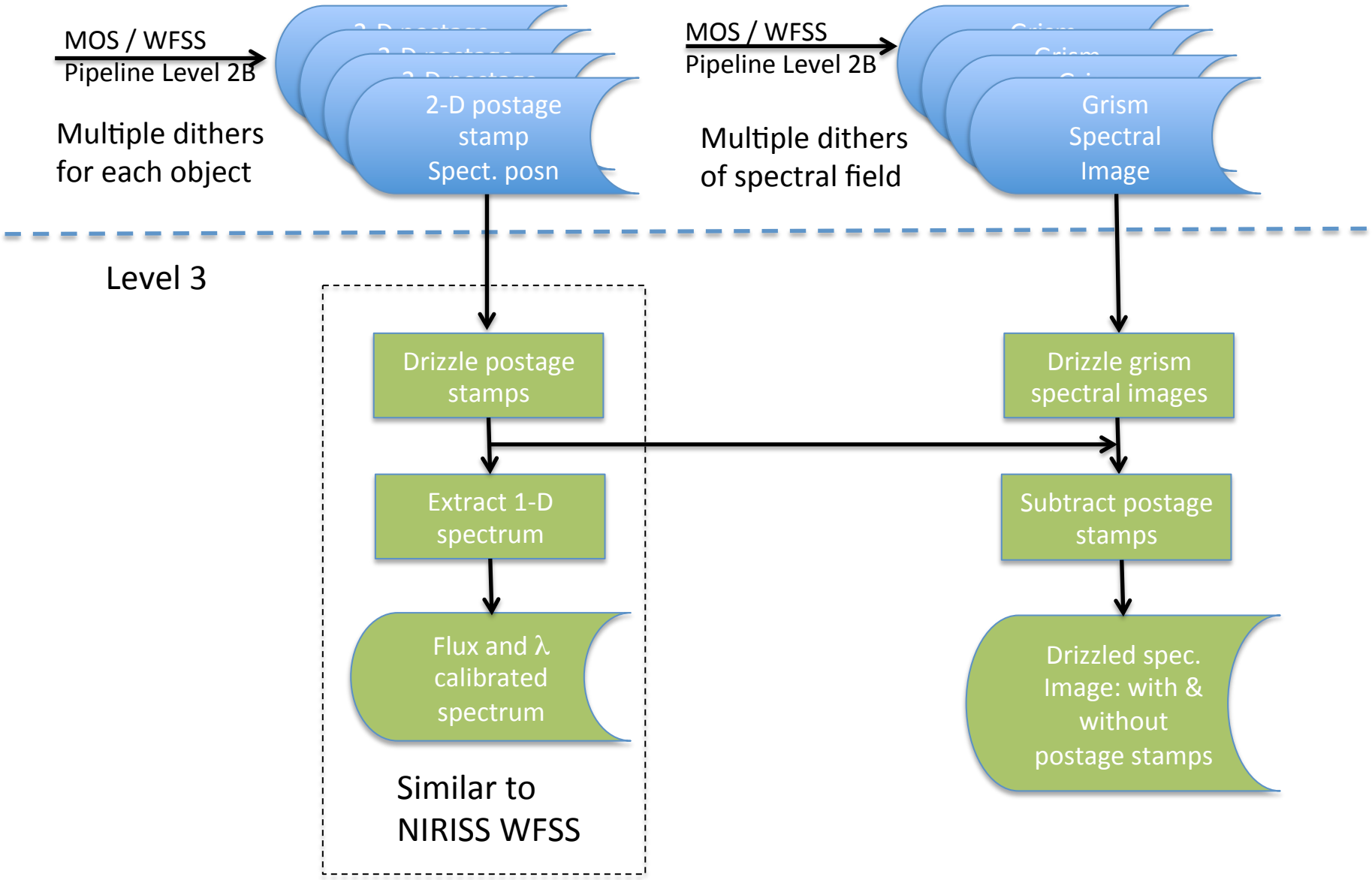
Assumptions: Grism Data Calibration

- Assume that dark current, linearity, and latents are corrected in ramps-to-slopes (Level 2A).
  - No IPC correction for time series / transits
- Plan is to calibrate NIRCam grism spectra similarly to NIRISS as much as possible (time series and WFSS / MOS)
  - NIRCam should be able to use many of the same components as the NIRISS pipeline (whether built on either HST aXe or NIRSpec MSA)
- MOS / WFSS spectra are corrected for backgrounds, contamination by other spectra, flat-fielded, and drizzled together before extraction
  - Wavelength-dependent flat field data cubes are difficult to obtain and may limit calibrations of MOS / WFSS data
- Use JWST HgCdTe time series pipeline for transits (N Lewis)
  - No L2A IPC correction, background subtraction, wavelength calibration, flat field, 'box' 1-D spectral extraction, white light curve

NIRCam Grism Data Calibration Pipeline (Level 2B)



NIRCam Grism Data Calibration Pipeline (MOS / WFSS Level 3)



NIRCam Grism Calibration Reference Files

File	Usage / Step	Comment
Spectral traces (e.g., aXe LWAR_F444W.conf)	λ cal., 1-D extractions	Offset from image, dispersion, and shape, 1 file per grism for each filter
Sensitivity functions (e.g, A.F444W.1st.sens.fits)	Flux calibration & error est.	1 for each grism, order, filter. Includes throughput and grism efficiency each λ
λ-dependent flat field	Flat fielding	3-D flat field: 2-D flat @ each wavelength
Master sky image	Subtract background	Global telescope + zodi emission, 1 image ea. grism & filter, scaled when used
PSF at each λ (can scale)	Imaging, 1-, 2-D extraction	Determine if image source is extended
Geometric distortions	λ cal.?, Drizzle	May not be needed for small dithers

NIRCam Grism Data Products

File	Usage / Step	Comment
Image Catalog	Pre/post WFSS observations	Dithered image, extracted sources (incl. fluxes & locations), dither info
Contamination spectra (synthetic)	Decontamination WFSS	Produced by fluxcube, subtracted from spectral images
Full grism image dithers	Level 2B	All unextracted spectra: intermed. product
2-D postage stamps, wavelength calibrated	Primary Level 2B product	1 per object per integration. Flux calibrated with errors and positions.
1-D spectral extractions	Produced with postage stamps, Level 2C	1 per object per integration. Flux calibrated with errors and position info. Final product for time-series data.
Drizzled postage stamps, wavelength calibrated	Level 3 WFSS	Produced by drizzling the multiple dithers of each object. Flux calibrated with errors.
Drizzled 1-D extraction	Level 3 WFSS	Extracted from Drizzled postage stamps. Flux calibrated with errors.
Drizzled spectral images	Level 3 WFSS	Final spectral images: with all spectra and with postage stamps removed

Open Issues

- Are there any issues with using the same WFSS architecture as NIRISS ?
  - Are the individual 1D extractions from MOS / WFSS Level 2C useful?
- Can the time series pipeline planned for JWST (NIRISS) work on NIRCam data?
  - Same detectors as NIRISS, simpler extractions (not cross-dispersed)
  - Same IPC correction approach?
- Can the images of the MOS / WFSS field be processed by a standard imaging pipeline?
  - Do we always image the filed in the same filter used with the grism? Need to avoid latents.
- What is maximum dither size to avoid spatial or spectral distortion?
- What options for the final dispersed image:
  - 1 with all spectra and one with postage stamps removed?
- Can we scale the entire master background image, or do its zodi + telescope components need to be done separately?