NIRSpec pipeline concept

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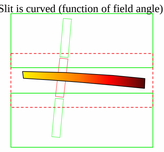
Instrument characteristics:

1) used on a diffraction-limited telescope --> PSF varies with λ
2) wide wavelength range (0.6 - 5 μm) --> chromatic slit losses
3) off-axis telescope and wide field of view --> significant distortion
4) reflective optics (including dispersive elements) --> large, variable slit curvature
5) multi-object spectrograph --> every detector pixel sees every wavelength

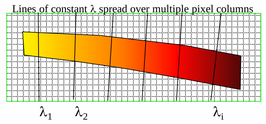
Headaches.....

Rectifying NIRSpec Spectra

Slit is curved (function of field angle)

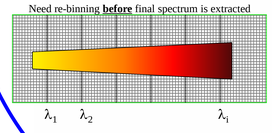


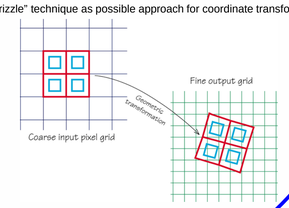
Lines of constant λ spread over multiple pixel columns



Use "Drizzle" technique as possible approach for coordinate transformation

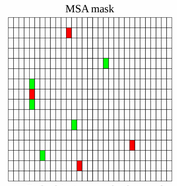
Need re-binning **before** final spectrum is extracted





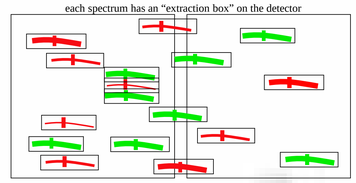
Defining the extraction windows

MSA mask

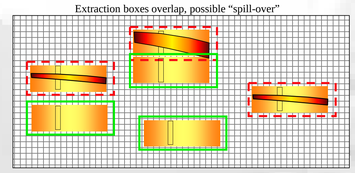


Red: object, green: background

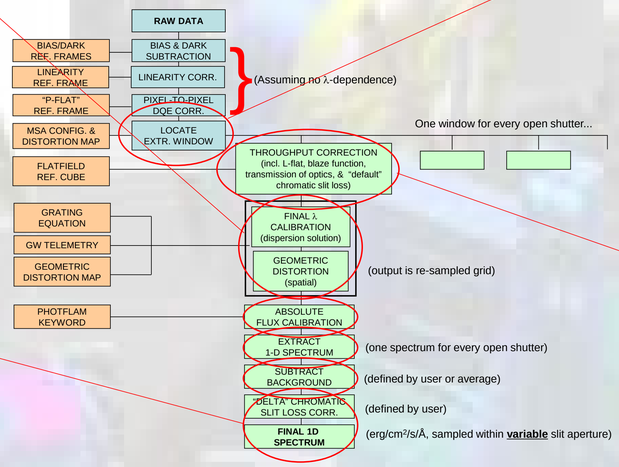
each spectrum has an "extraction box" on the detector



Extraction boxes overlap, possible "spill-over"

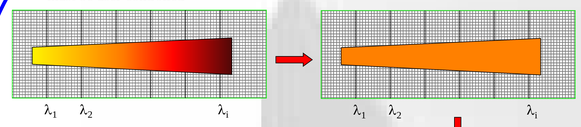


An outline of the NIRSpec pipeline



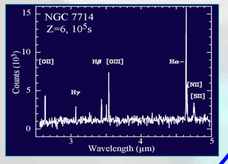
"Delta" correction for chromatic slit loss

- depends on source shape **and** position within shutter
- must be user-controlled



Collapse to 1-D spectrum

- depends on source extent and background subtraction
- must be user-controlled

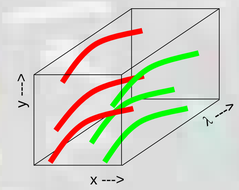


For quick-look analysis, pipeline subtracts TBD "default" background

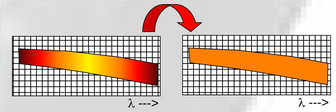
"Flat-fielding" NIRSpec spectra

Throughput correction of

Need a "throughput" data cube
(for each filter/grating combination)



Output: (assuming a source with flat spectrum)

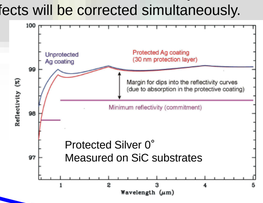


Goal: to correct for the **total** instrumental throughput variations, both as a function of wavelength (e.g. optics transmission, blaze function) and field angle (e.g. DQE, vignetting).

Contributions to the "Throughput correction"

- ❑ reflection curves of all mirrors: f(λ), f(x,y)
- ❑ transmission curves of filters: f(λ)
- ❑ blaze function of grating: f(λ), f(x,y)
- ❑ large-scale response of detector (L-flat): f(λ), f(x,y)

All of these contributions need to be measured at component level and built into a physical/optical instrument model. Once NIRSpec is assembled, they cannot be measured individually. However, once a shutter has been specified, all of them are - in principle - deterministic, and can be accurately modeled. Using the instrument model, all these effects will be corrected simultaneously.

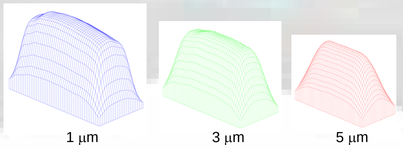


Protected Silver 0°
Measured on SiC substrates

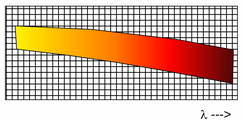
However…

The bummer: chromatic slit loss

Fixed slit size, but variable PSF width…



… causes "flaring" and intensity gradient



A "default" correction for e.g. a perfectly centered point source can be included in throughput correction. The user needs to optimise this correction at a later stage.

James Webb Space Telescope