NIRSpec sentivity – MOS mode
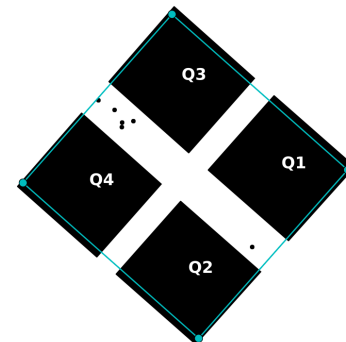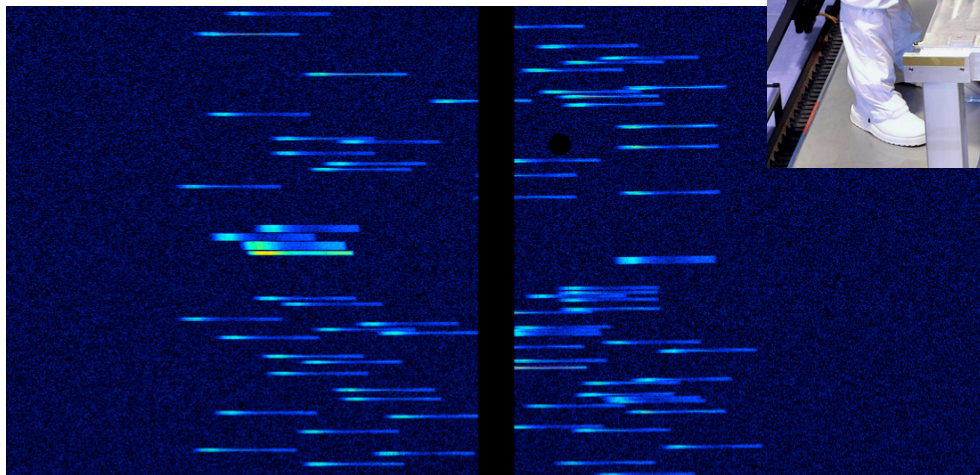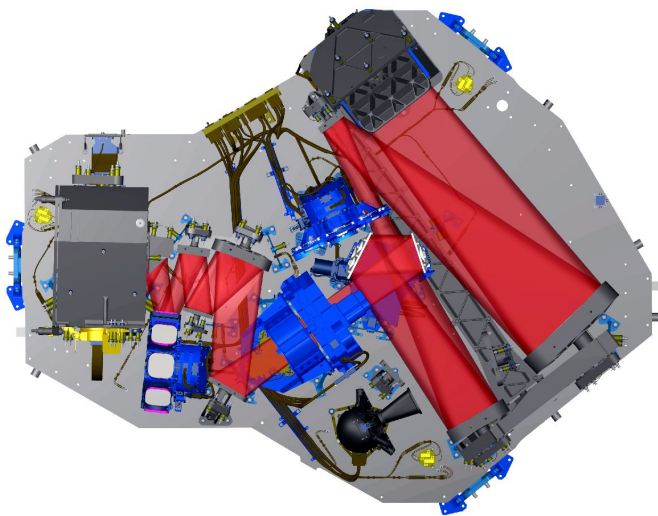
Estimating NIRSpec sensitivity…

- The sensitivity of an instrument is one of the major performance indicators for NIRSpec.

  - A typical science driver for pushing NIRSpec to its limits is the ability to conduct spectroscopic deep fields.

- NIRSpec has been designed and developed to meet a set of requirements on how deep it should be able to go for certain types of observations.

  - Subset of key configurations, long exposures…

  - Somewhat "simplified" approach.

  ➔ So far so good, NIRSpec is on track to meet or exceed these requirements.

James Webb Space Telescope

NIRSpec sensitivity requirements MOS mode

- Set #1: ability to observe very faint and **compact continuum** sources at **low spectral resolution** and over the full spectral range.

Wavelength (μm)	Continuum Flux (erg s^{-1} cm^{-2} Hz^{-1})	
1.5	1.36×10^{-30}	AB=26.1
3.0	1.18×10^{-30}	AB=26.2
4.5	3.00×10^{-30}	AB=25.2

Point source **centered** in a micro-shutter.
Signal to noise of **10** per spectral resolution element.
Total **(integration)** time on source of **10^4 s**.

$$AB = -2.5 \times \log_{10}(f) - 48.60 \text{ with } f \text{ in erg s}^{-1} \text{ cm}^{-2} \text{ Hz}^{-1}$$

James Webb Space Telescope

NIRSpec sensitivity requirements MOS mode

- Set #2: ability to observe very faint and **compact emission-line** sources at **medium spectral resolution** and over the full spectral range.

| Wavelength (µm)	Line Flux (erg s^{-1} cm^{-2})
1.2	9.8×10^{-19}
1.6	7.4×10^{-19}
2.0	5.2×10^{-19}
2.7	4.2×10^{-19}
3.4	3.2×10^{-19}
4.5	3.2×10^{-19}

Point source **centered** in a micro-shutter.
Signal to noise of **10** per spectral resolution element.
Total **(integration)** time on source of **10^5** s.

NIRSpec sensitivity requirements MOS mode

- The usual words of caution…

    - These are only requirements and they reflect a given (simple) observation strategy.

    - Actual number reflecting that actual status of the instrument and more and more realistic observing strategy will progressively become available.

- The STScI ETC prototype

    - Available on–line (see below).

    - You will notice the same type of words of caution.

    http://jwstetc.stsci.edu/etc/input/nirspec/spectroscopic/
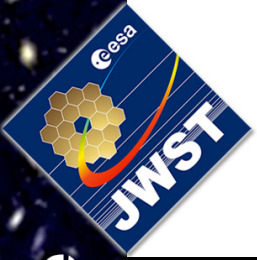
Elements of sensitivity computation White board exercises…

- #1 – Understanding the various noise regimes and how your signal to noise behaves in these regimes
    - "detector", "background", "photon-noise" limited.
    - life in an Universe where you cannot get exposures as long as you would like to…
    - good throughput is good news…
    - the optimization that Stephan's software will do for you.

$$S/N \equiv \frac{E(\hat{S})}{\sqrt{\mathrm{Var}(\hat{S})}} = \frac{E(S)}{\sqrt{\mathrm{Var}(S) + \left(1 + \frac{1}{n_B}\right)(\mathrm{Var}(B) + \mathrm{Var}(D))}}$$

Elements of sensitivity computation White board exercises...

- #1 – continuum versus emission-line / point source versus extended source