JWST IAC Workshop-GO1 Proposal Planning

MIRI INTEGRAL FIELD SPECTROSCOPY OF GALAXIES

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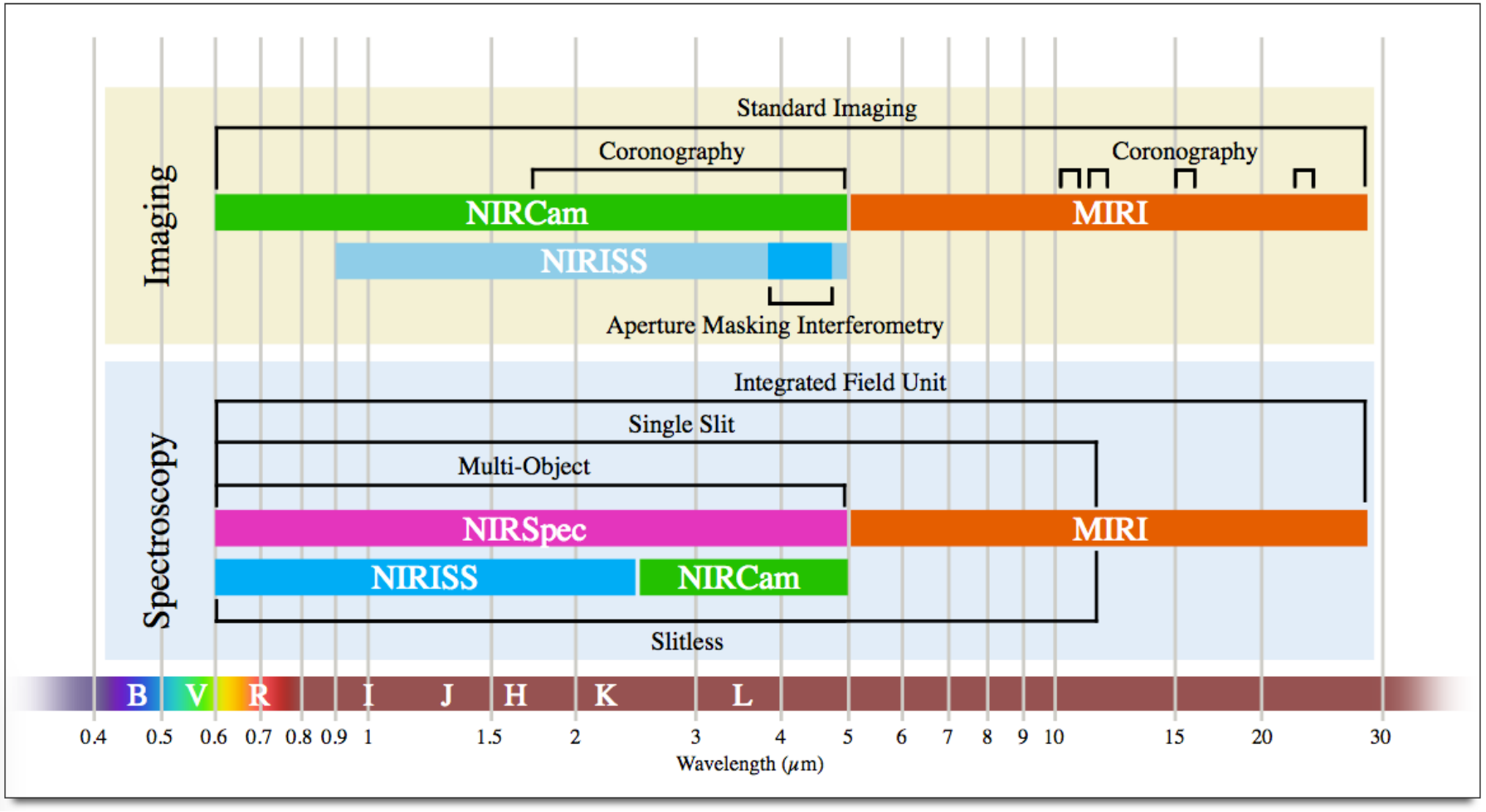
MIRI. JWST MID-INFRARED INSTRUMENT

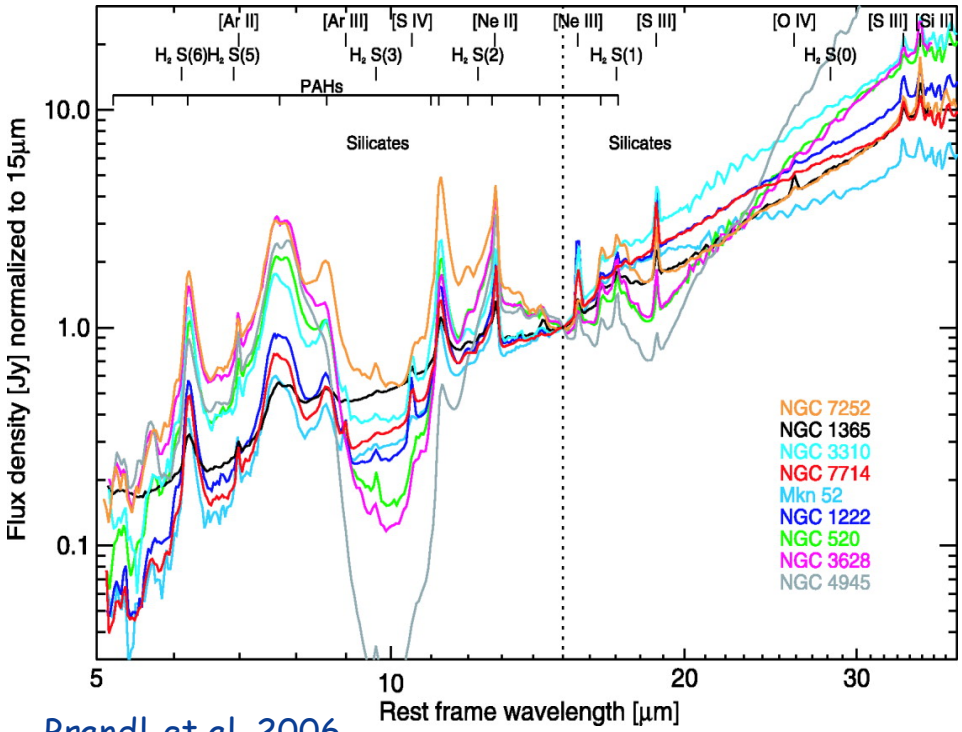
https://jwst-docs.stsci.edu/display/JTI/Mid-Infrared+Instrument%2C+MIRI



ONLY JWST INSTRUMENT COVERING THE 5 to 28 MICRONS SPECTRAL RANGE

MIRI detailed description: Rieke+, Wright+, Wells+, Glasse+, Kendrew+, Boccaletti+, Bouchet+, Ressler+, Gordon+, 2015, PASP 127

LOW-Z GALAXIES. SPECTRAL COVERAGE. MID-IR RANGE

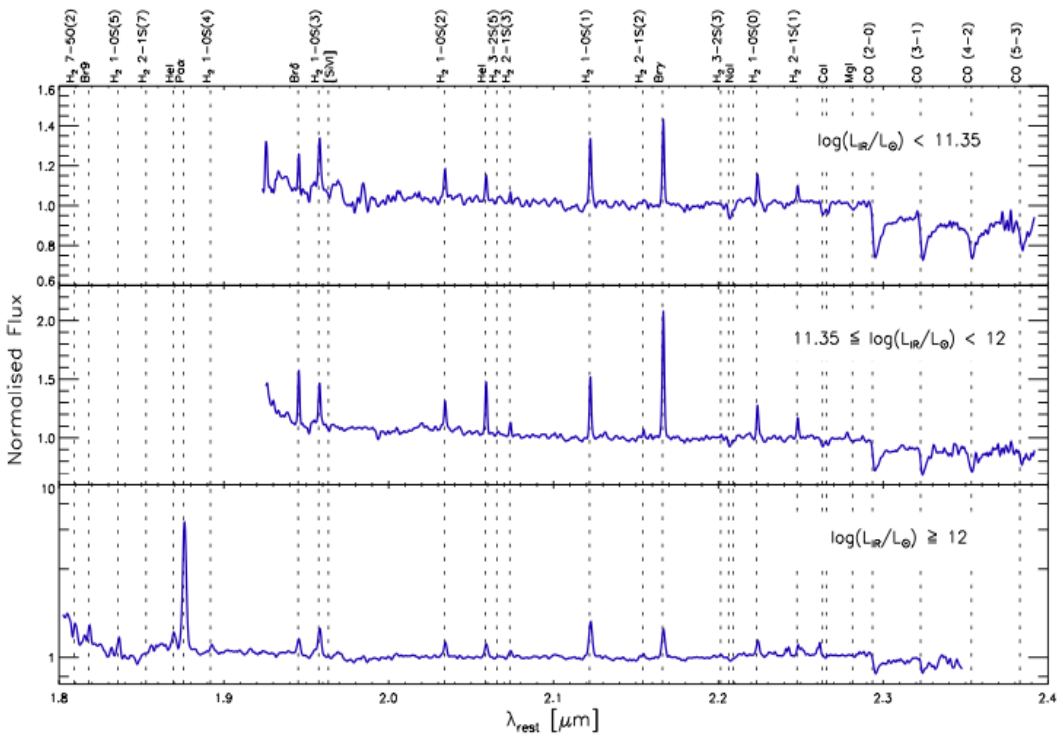


Brandl et al. 2006

Line	λ	Diagnostic
[FeII]	25.99 micron	Density/SNRs
[OIV]	25.89 micron	AGN presence?
[NeV]	24.3 micron	AGN presence
[SIII]	18.71 micron	Abundance
[NeIII]	15.56 micron	Excitation + [NeII]
[Cl II]	14.37 micron	Starformtaion
[NeV]	14.32 micron	AGN presence
[NeII]	12.81 micron	Excitation + [NeIII]
[SIV]	10.54 micron	Excitation + [NeV]
[ArIII]	8.99 micron	"ion. para. U" + [NeVI]
[NeVI]	7.6 micron	AGN and "ion. para U"
[ArII]	6.98 micron	Abundance
[FeII]	5.34 micron	Density/SNRs
PAH featur	Throughout range	Starformation
H2	Throughout range	Starformation

- AGN tracers: [OIV], [NeV] & [NeVI]
- Star formation: PAHs, H2 lines
- Excitation (degree of): [NeII], [NeIII], [NeV] & [NeVI]

HIGH-Z GALAXIES. SPECTRAL COVERAGE. NEAR-IR RANGE



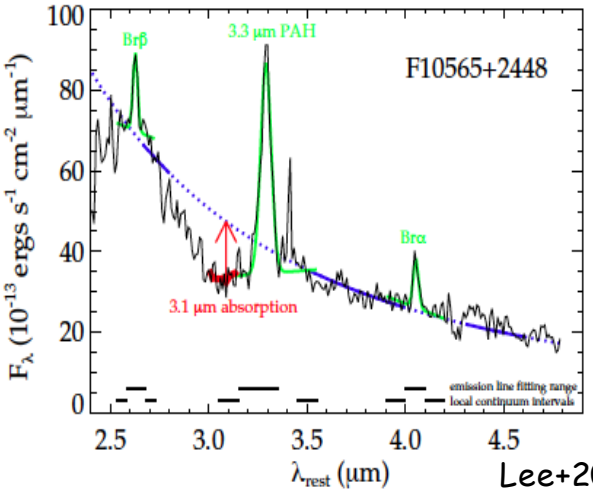
SINFONI U/LIRGs survey, Piqueras-López et al. 2012

- Coronal ISM: [SiVI], [CaVIII]
- Ionized ISM: Pa & Br H lines
- Hot molecular ISM: H_2 lines
- Shocked ISM: [FeII] lines
- Star formation: PAH 3.3μm
- Stellar pop.: CO bands

Extension of IFS to (rest-frame) near-IR

Coverage of Paα for z > 1.67

Free view of neutral PAH @ 3.3 μm & Brα

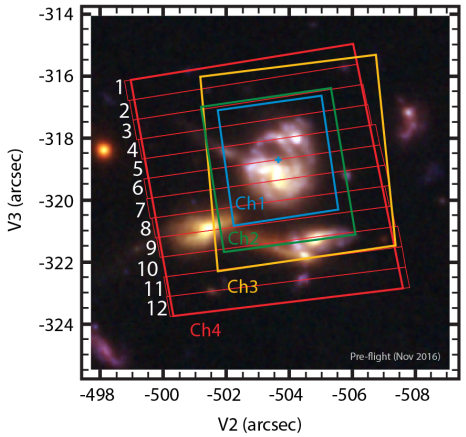


Lee+2012

MRS. FIELD OF VIEW & SPATIAL SAMPLING

- 4 IFUs provide simultaneous IFS @ 4 non-adjacent spectral ranges
- Spatial sampling, spatial resolution and FoV changes with wavelength

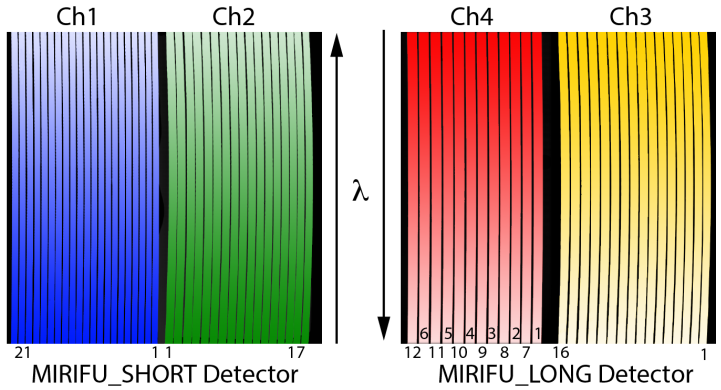
IFU Footprint on Sky



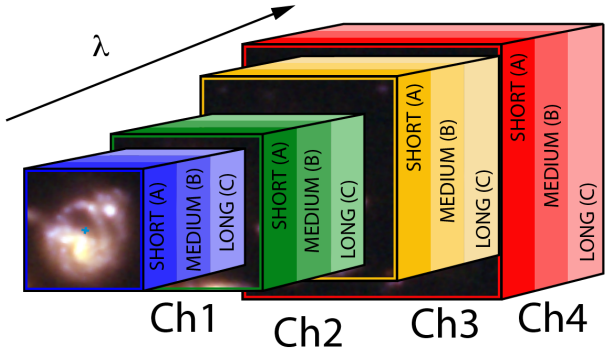
FoV: 3.7"x 3.7" (CH1)
7.4"x7.9" (CH4)

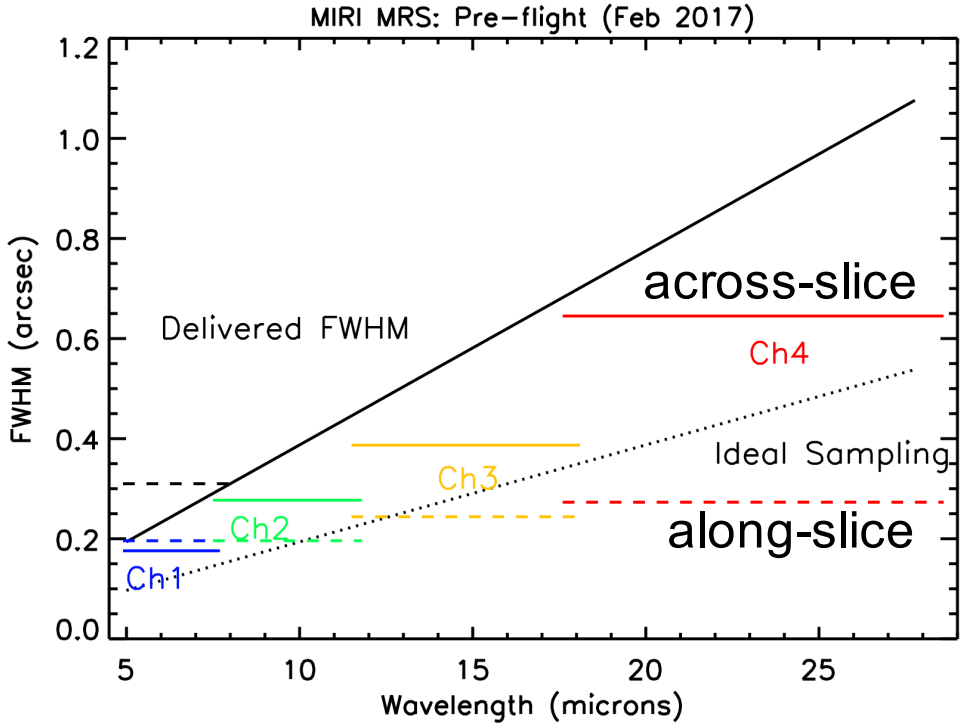
Slice: 0.18" (CH1)
0.64" (CH4)

IFU Detector Layout



Reduced Cube Format





Figures: STScI

MIRI. MRS RESOLVING POWER

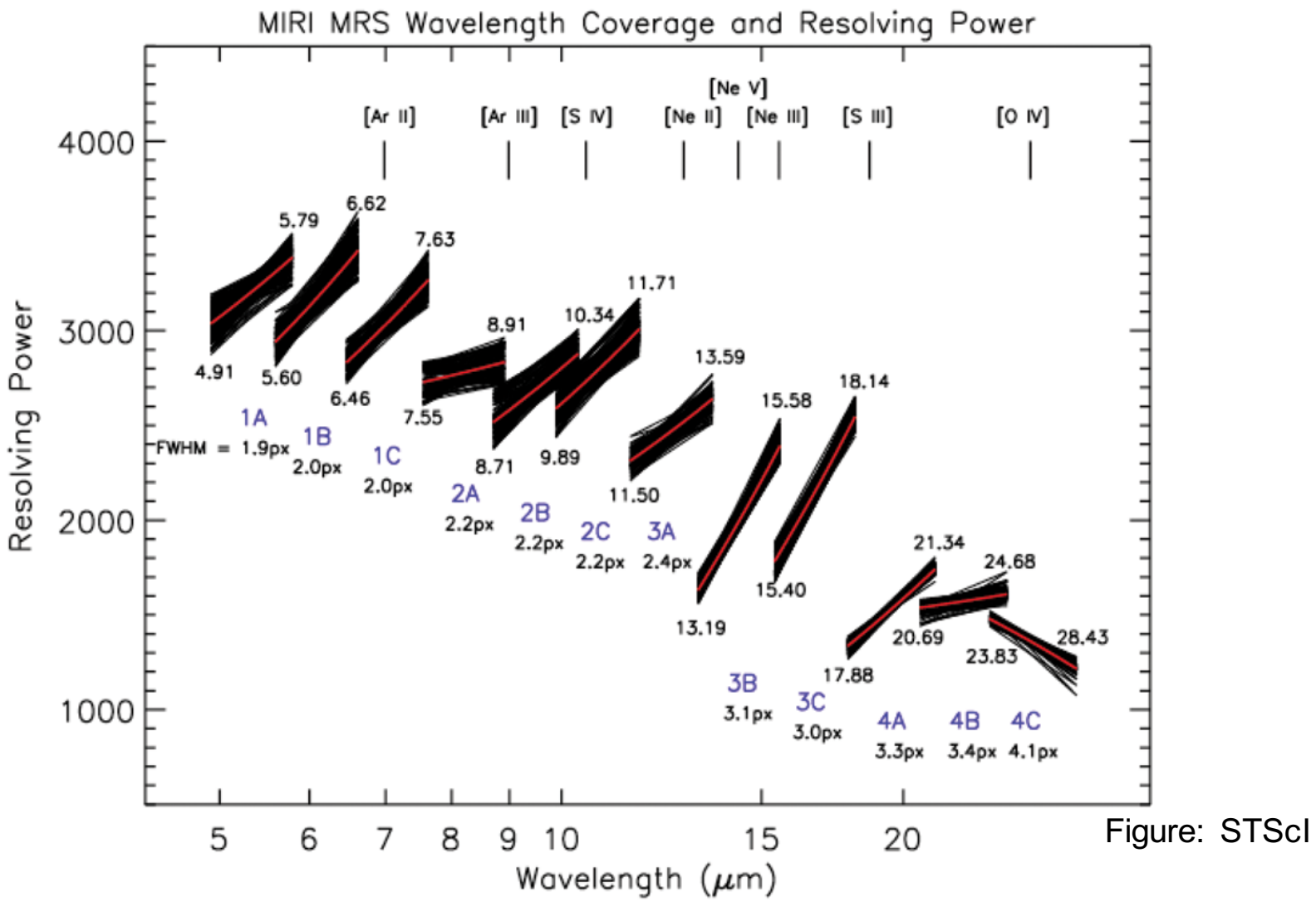


Figure: STScI

MRS provides a fixed spectral resolution of ~3200 (5 μm) to ~1200 (25 μm)

MIRI. SENSITIVITY

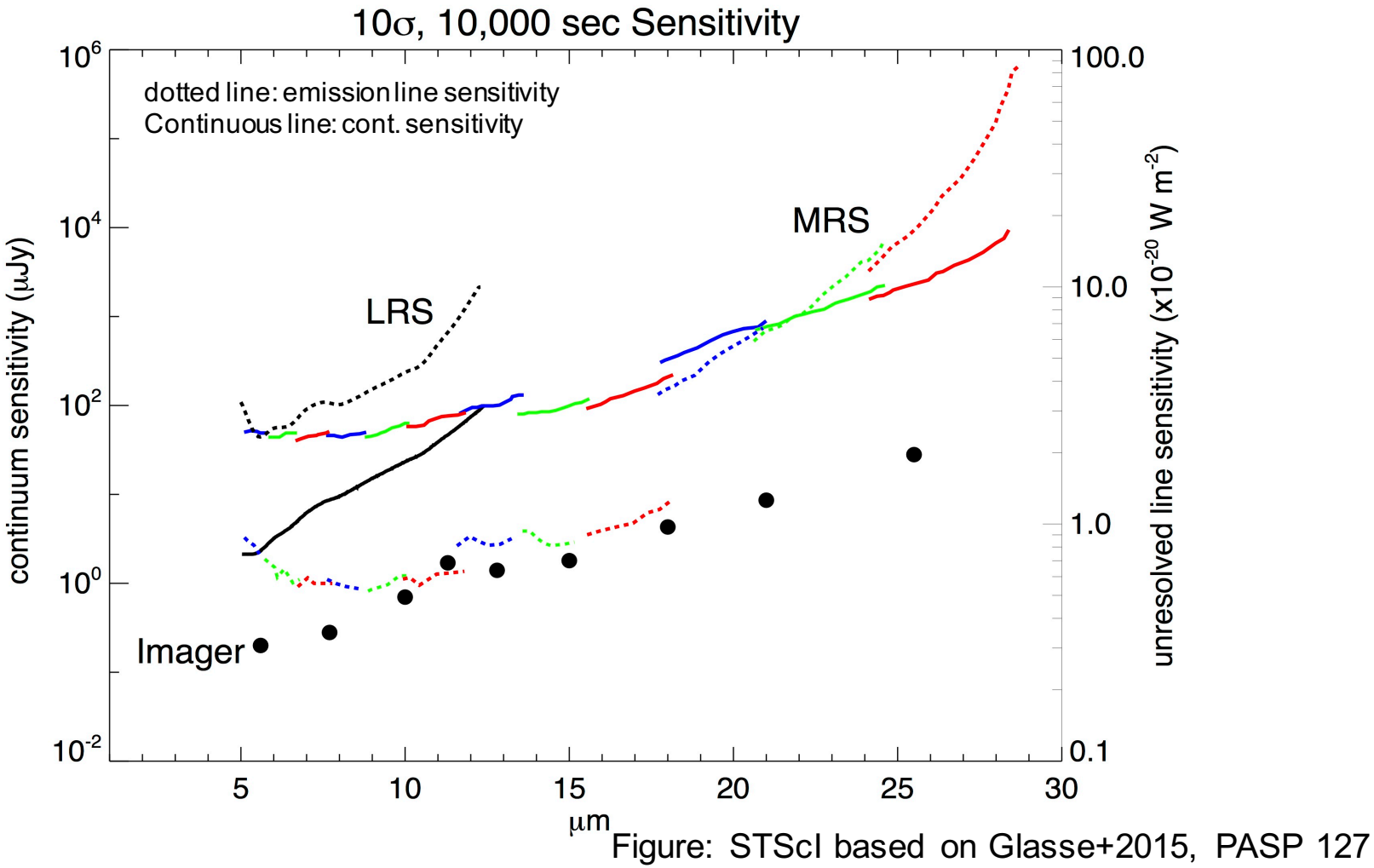
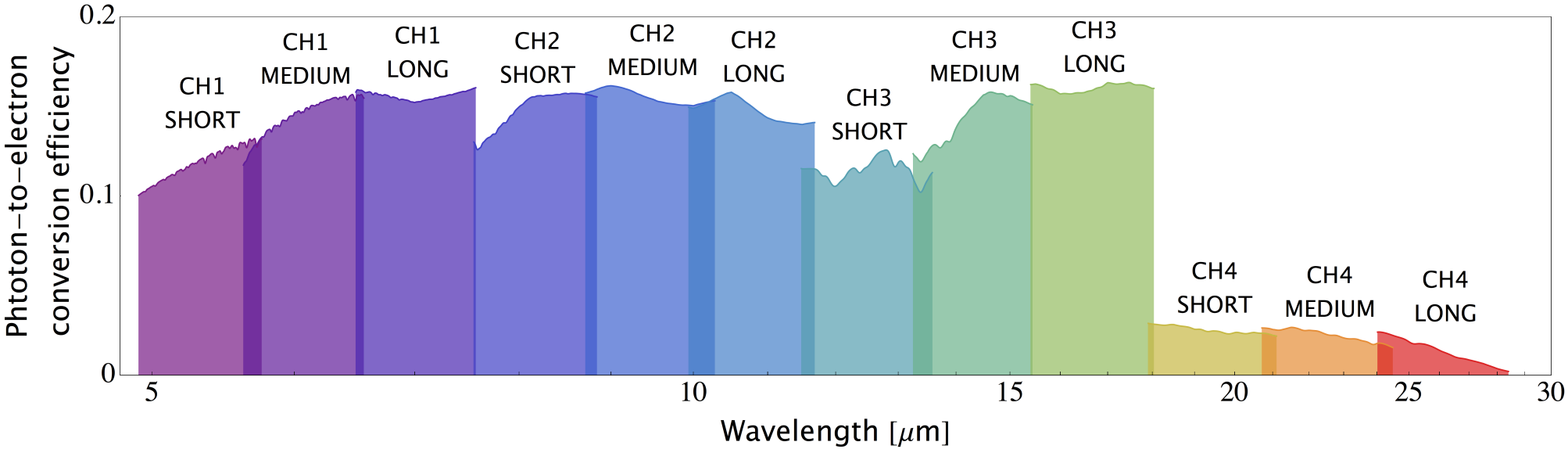


Figure: STScI based on Glasse+2015, PASP 127

MRS provides a sensitivity x20-100 better than Spitzer

MIRI. MRS SPECTRAL RANGE & COVERAGE

https://jwst-docs.stsci.edu/display/JTI/MIRI+Medium-Resolution+Spectroscopy



	CH1	CH2	CH3	CH4
λ (μm)=	4.9-7.8	7.5-11.9	11.5-18.2	17.5-28.8

- MRS selects Short, Medium or Long band (1, 2 or all three bands)
- Full spectral coverage (5 to 28.8 μm) requires three settings: S+M+L
- Overheads and science time increase for full spectral coverage

RECOMMENDATION: consider the location of specific high-priority spectral features, and select carefully the specific settings needed for your science

JWST/MIRI BACKGROUND

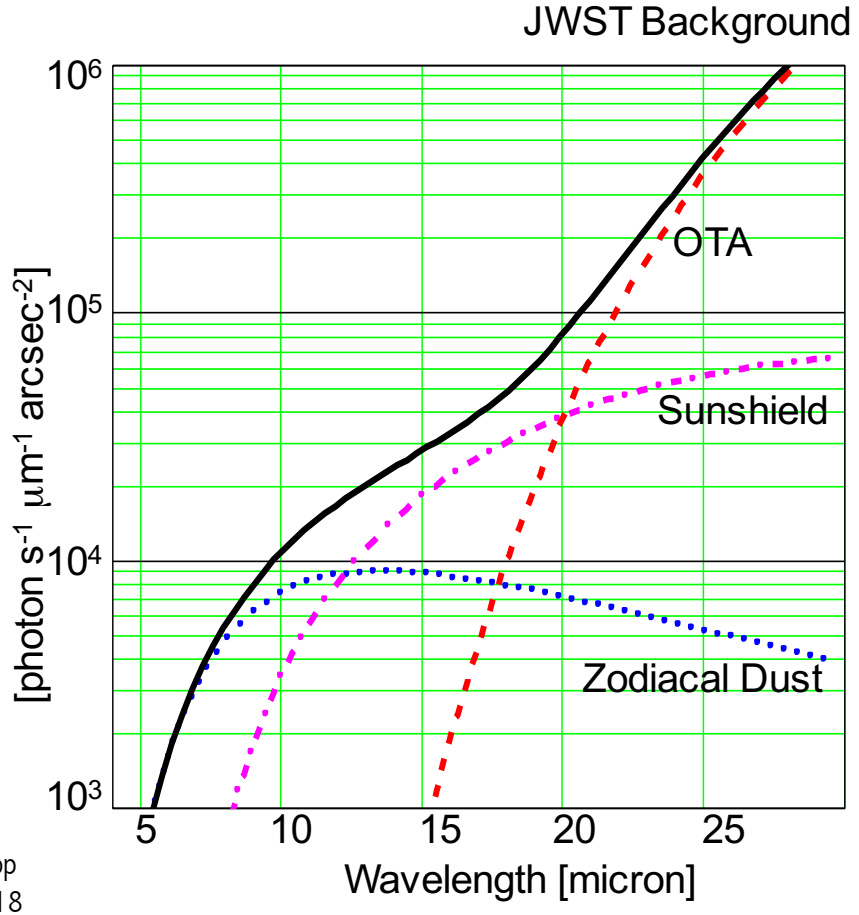
https://jwst-docs.stsci.edu/display/JPP/JWST+Background+Model

- Zodiacal light dominates the background for MIRI at λ < 12 μm
- JWST telescope thermal environment dominates at λ > 12 μm
- Stable during typical exposure times

RECOMMENDATION:

Strategy depends mainly on source´s size

1) Size of the source small wrt FoV:
   Nodding on source, i.e. within the FoV
2) Size of source large wrt FoV:
   Nodding off-source, i.e. background



MRS DITHERING/NODDING

https://jwst-docs.stsci.edu/display/JTI/MIRI+MRS+Dithering

DITHERING/NODDING IS A MUST!

- Main reasons:
  - Good PSF sampling for MIRI IFS
  - Detector cosmetic/defects/characteristics (minimize)
  - Accurate background measurements
  - Others: Enlarge FoV

Relative importance:

MODE	BACKGR ZODIACAL	BACKGR THERMAL	BACKGR INSTR.	PSF SAMPLING	DETECTOR COSMETIC
MIRI-CH1	++	–	–	++	+
MIRI-CH2	++	+	–	++	+
MIRI-CH3	+	++	–	+	+
MIRI-CH4	+	++	–	+	+

++ Dominant / + Relevant / +– Subject to science case / – Non relevant

MRS DITHERING/NODDING

- Dithering/nodding for PSF and cosmetic
  Fixed patterns (optimized as a function of the spectral range).

  Two- and four-point (recommended)

- Dithering/nodding for background

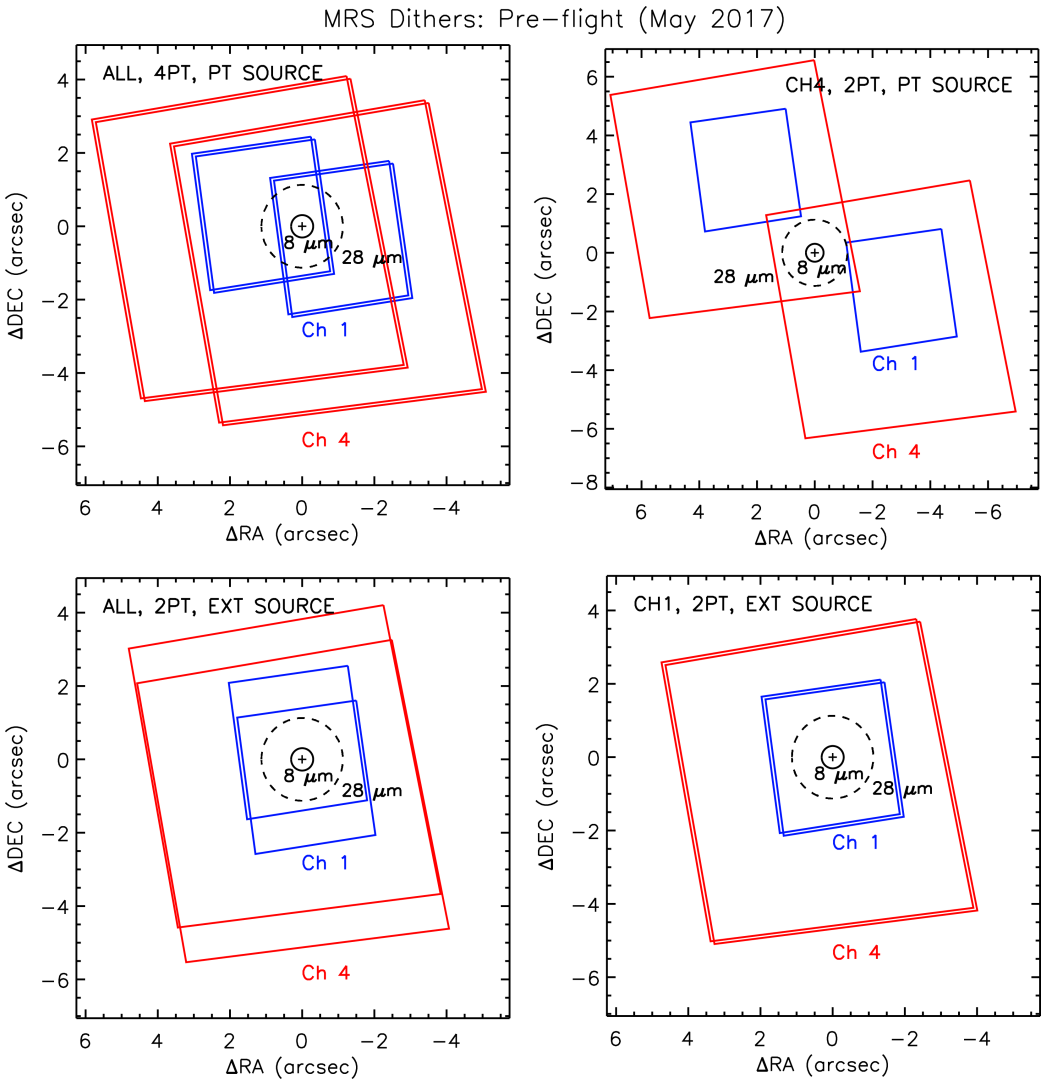
  One background pointing away from target, if extended

Keep in mind

- Time dedicated to SAMs can be relevant for short on-target exposures:

  SAM < 3 arcsec: ~25 seconds

  SAM > 3 arcsec: ~65 seconds

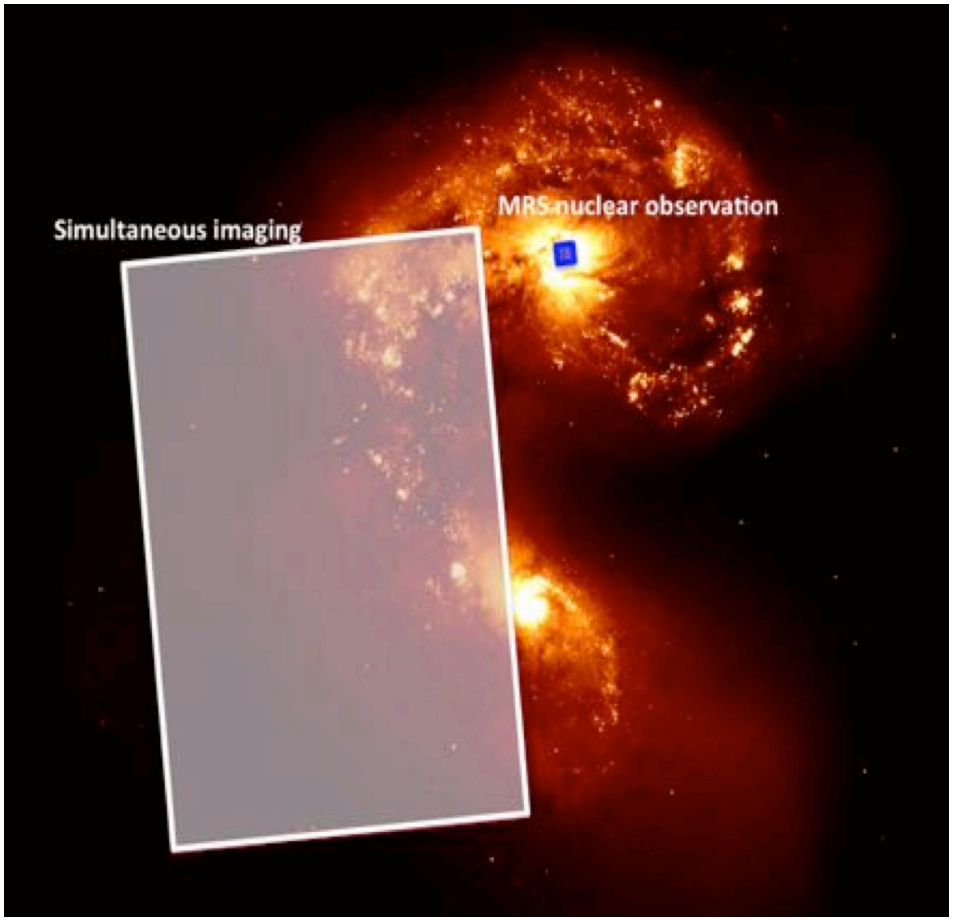


RECOMMENDATION: think about how to optimize the size and number of dithers according to the size of your source and science case

MRS-IMAGER SIMULTANEOUS OBSERVATIONS (SIMO)

Default in APT: MRS (prime) + MIRIM (simultaneous)
[≠ parallel]

- Imager has better PSF and larger FoV -> Refine the MRS astrometry
- Very useful for dithers, mosaics, and deep observations:
  - Combine cubes of faint/undetected sources from different visits
  - Mosaics of diffuse emission
  - Multi-epoch serendipitous discoveries
- Filters can be changed when MRS conf. changes



RECOMMENDATION: think about the additional science (multi-filter configurations) for only 30 sec extra overhead per filter

Image: STScI

SUMMARY

- JWST NIRSpec and MIRI IFS (coordinated) programs extremely powerful. Open a qualitative new window into studies of low- & high-z galaxies because its unique combination of feaures:
  - Increased sensitivity by factors 100 wrt previous instruments
  - Wide spectral coverage from the optical (0.6μm) to the mid-IR (28μm)
  - Stable sub-arcsec angular resolution over the entire spectral range
  - Similar intermediate (R~2000-3000) spectral resolution over spectral range

… Think your observational strategy carefully to optimize your science and overall JWST return

https://jwst-docs.stsci.edu/display/JPP/MIRI+MRS+Recommended+Strategies