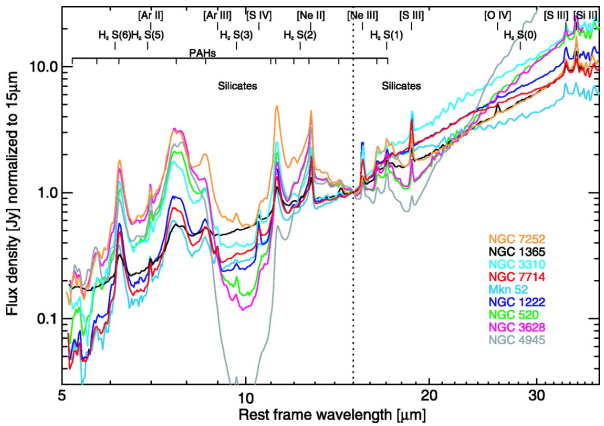
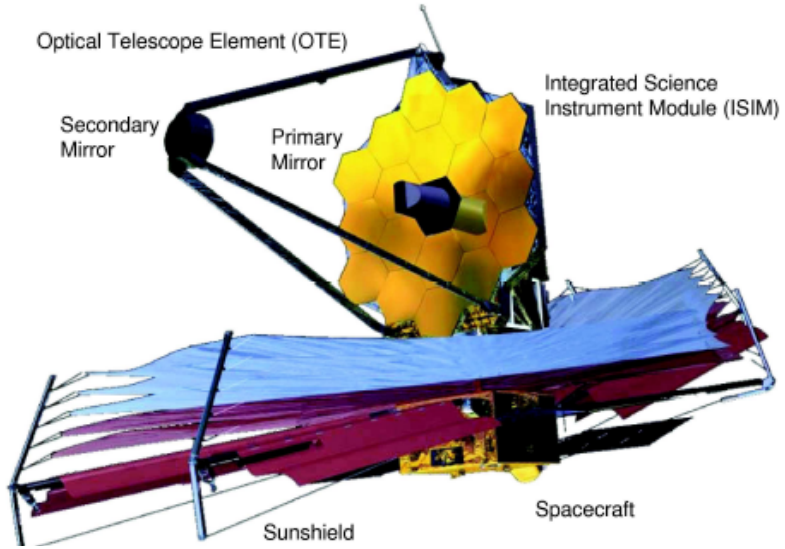
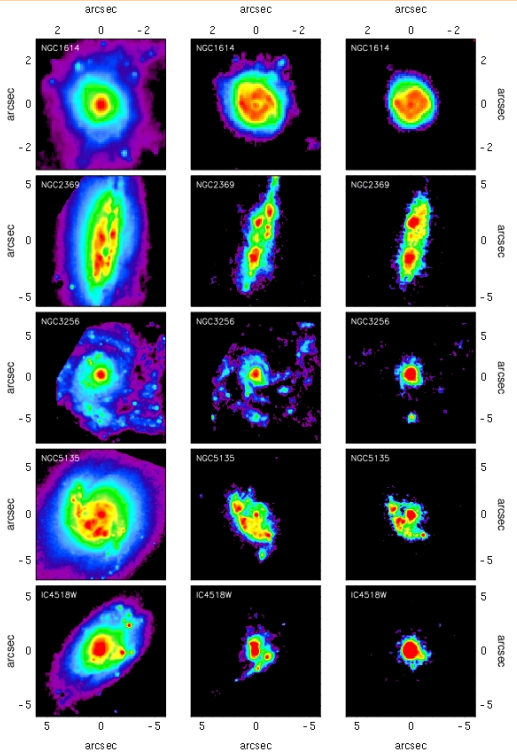
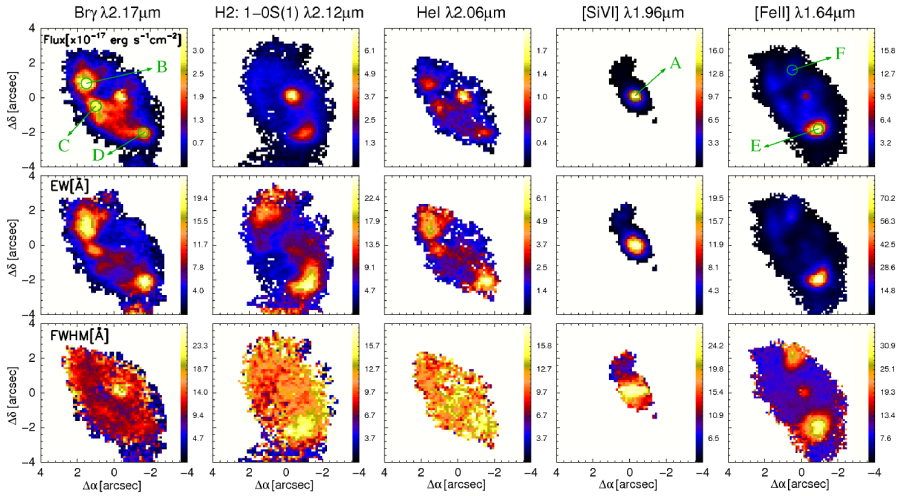
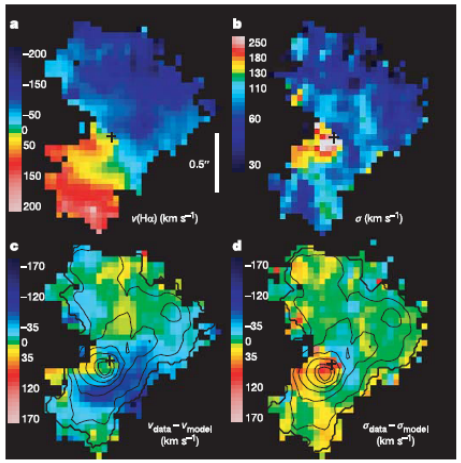
JWST-MIRI. OUR FUTURE MID-IR WINDOW INTO THE UNIVERSE

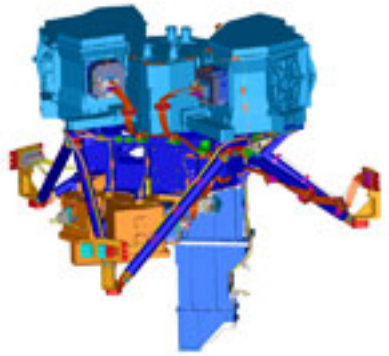






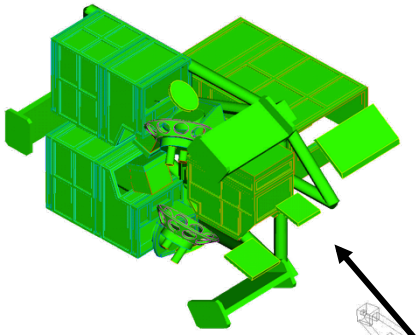




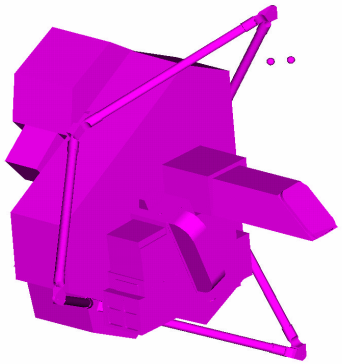


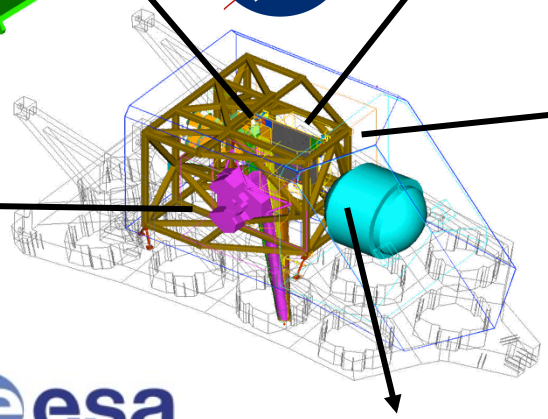
JWST. SCIENCE INSTRUMENTS

Fine Guidance Sensor & Tunable Filter
- 1.2 to 4.8 μm operation
- Guide star acquisition & tracking
- Tunable filter imager
  2 (2048x2048)
  68mas pixels



Near Infrared Camera (NIRCam)
- 0.6 to 5 μm operation
- Wide Field Imaging
- Coronagraph imaging capability
- Supports WFS&C
- 2 (4096x4096) 31mas pixels
- 2 (2048x2048) 62mas pixels





Near Infrared Spectrometer
(NIRSpec)
- 0.6 to 5 μm operation
- Simultaneous Spectra of
  >100 objects
- λ/Δλ ~ 100 to 1000
- 2 (2048x2048) 100mas pixels

Mid Infrared Instrument (MIRI)
- 5 to 28 μm operation
- Science Discovery Space
- Imaging
  1 (1024x1024) 110mas pixels
- Spectroscopy
  2 (1024x1024) 200-470mas pixels

Solid Hydrogen Dewar
- Cools MIRI detectors to ~7K
- 5 year lifetime
- Studying Cryo-cooler

Jet Propulsion Laboratory
California Institute of Technology

MIRI. JWST MID-INFRARED INSTRUMENT

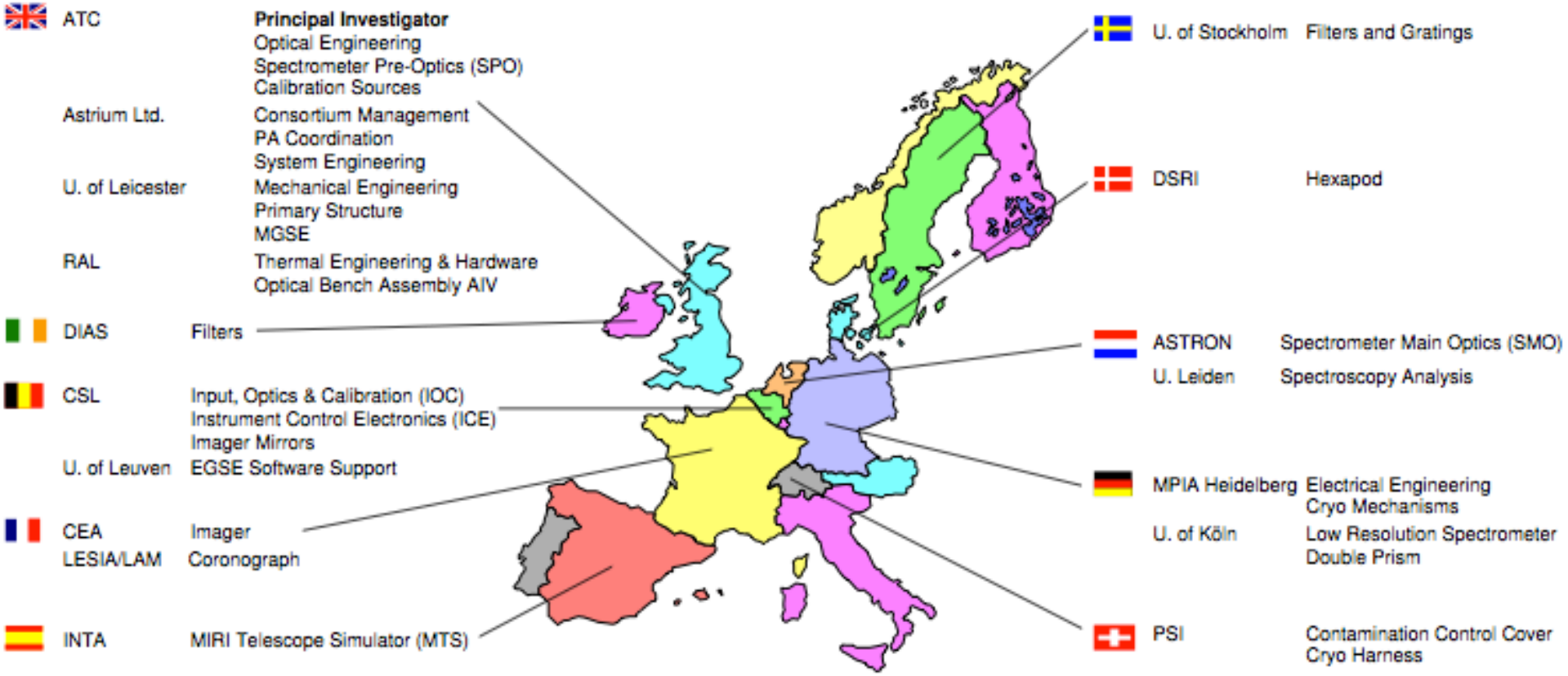
- 50%-50% European – american instrument

- US PI: G. Rieke (U. Arizona)
- US contribution: detectors & cryocooler (JPL, UA, NASA)

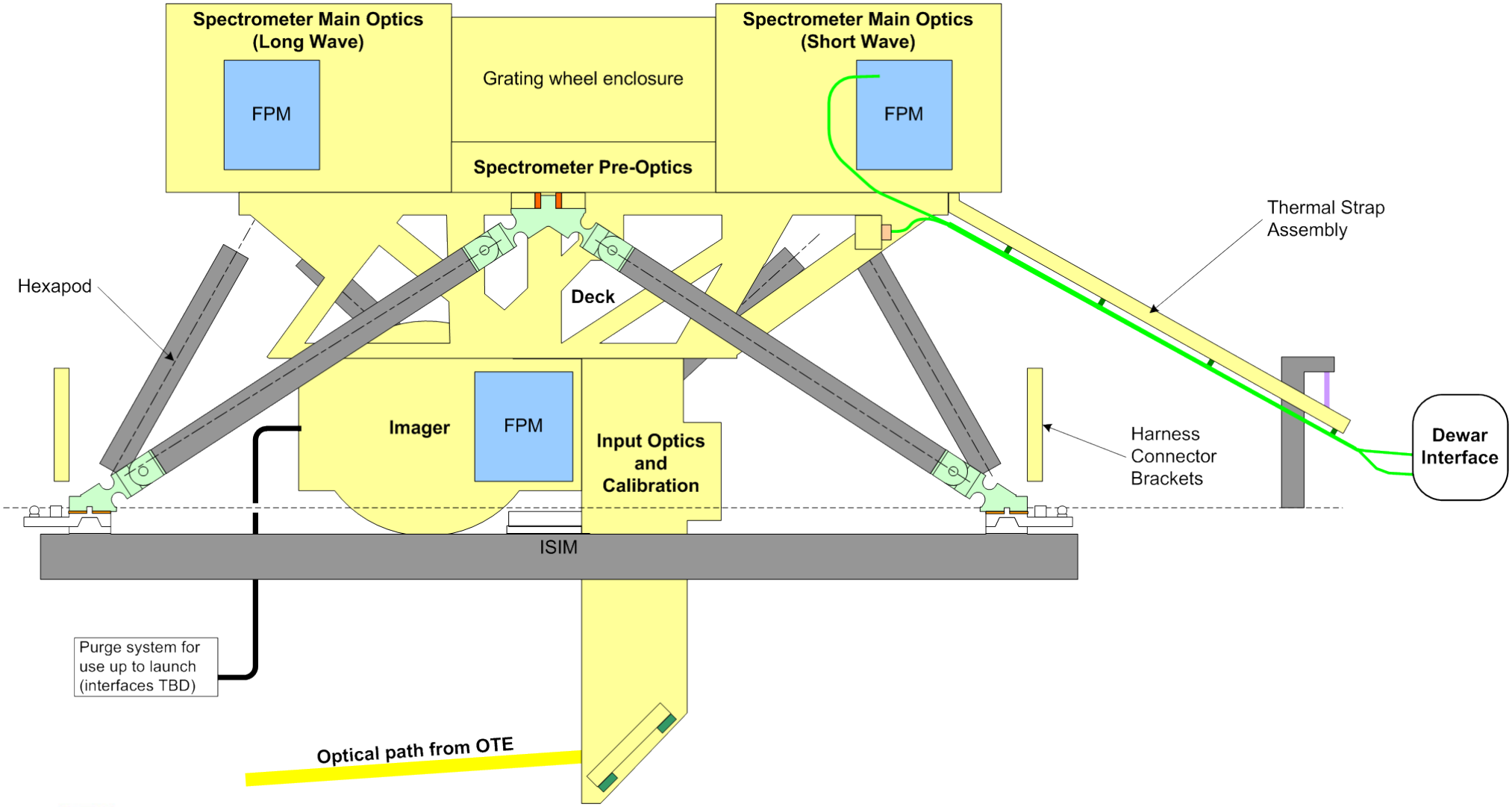
- EC PI: G. Wright (UK-ATC)
- EC contribution: OTA
- Built by european consortium: 10 countries, 28 institutes

MIRI EUROPEAN CONSORTIUM

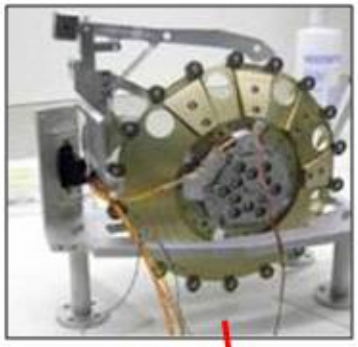
European Consortium Who & Where



MIRI. CONFIGURATION

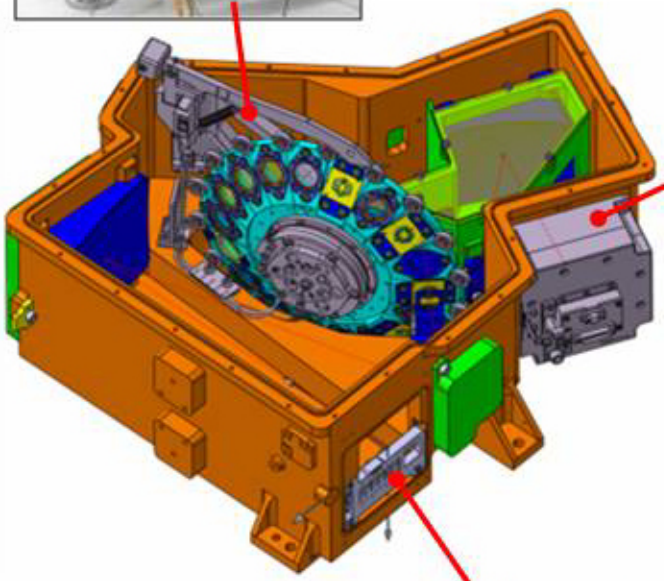


The MIRI Imager



18 Station Filter Wheel

- Filters (10), LRS prism (1), chronographic diaphragms and filters (4), open (1), closed+PAR(1), lens (1)

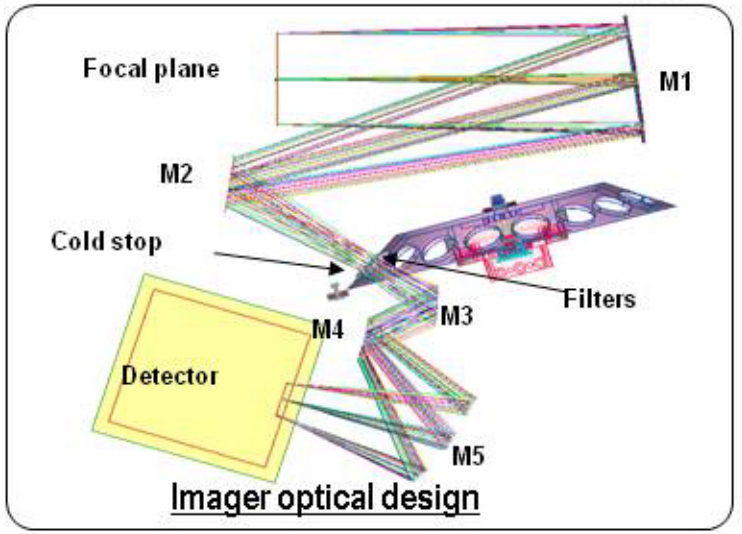


Focal Plane Module

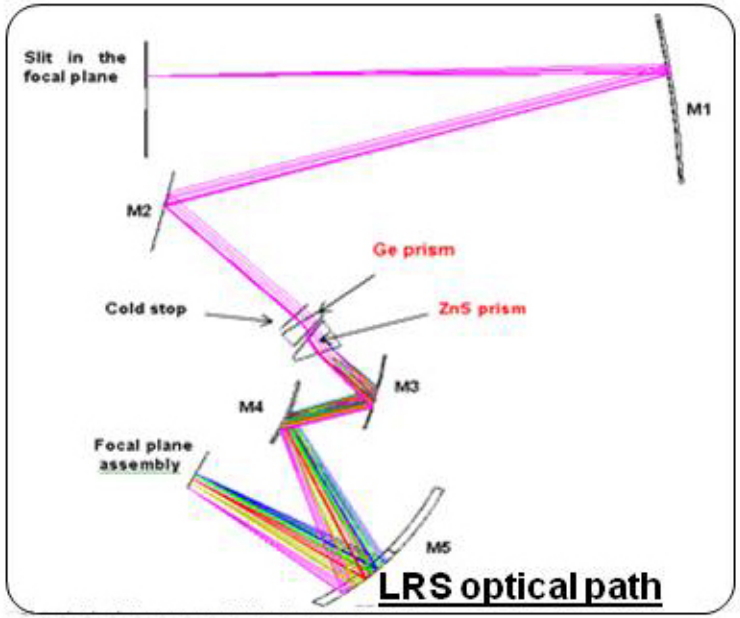
- 6.7K operating temperature
- 1024 x 1024 Si:As detector array thermally and electrically isolated from housing

Coronagraphic masks

- 4QPM (3)
- Lyot mask (1)

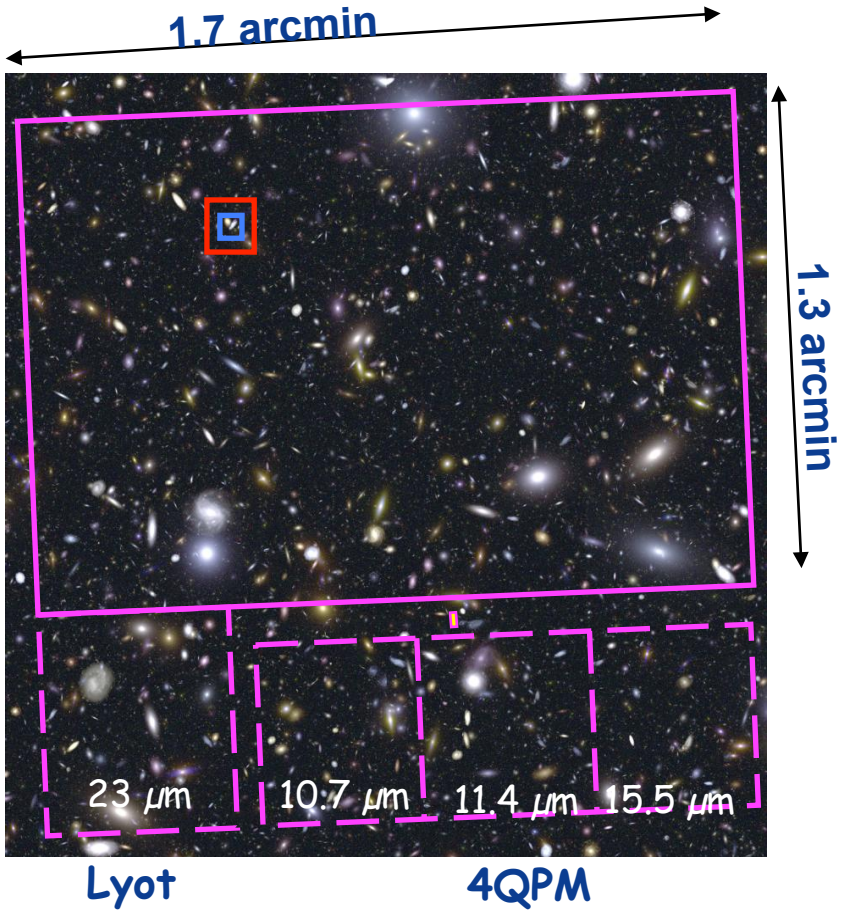


Imager optical design



LRS optical path

MIRI IMAGER



	λ(μm)	Δλ(μm)	Comment
F560W	5.6	1.2	Broad Band
F770W	7.7	2.2	
F1000W	10	2	Silicate, Broad Band
F1130W	11.3	0.7	PAH, Broad Band
F1280W	12.8	2.4	Broad Band
F1500W	15	3	Broad Band
F1800W	18	3	Silicate, Broad Band
F2100W	21	5	Broad Band
F2550W	25.5	4	Broad Band
F2550WR	25.5	4	Redundant Filter, Risk Reduction
FND	Neutral Density		For Coron. Acquis.
F1065C	10.65	0.53	Phase mask, NH3, silicate
F1140C	11.4	0.57	Phase mask, cont. or PAH
F1550C	15.5	0.78	Phase mask, cont.
F2300C	23	4.6	Focal Plane Mask, Debris Disk
OPAQUE	Blackened Blank	N/A	For Darks

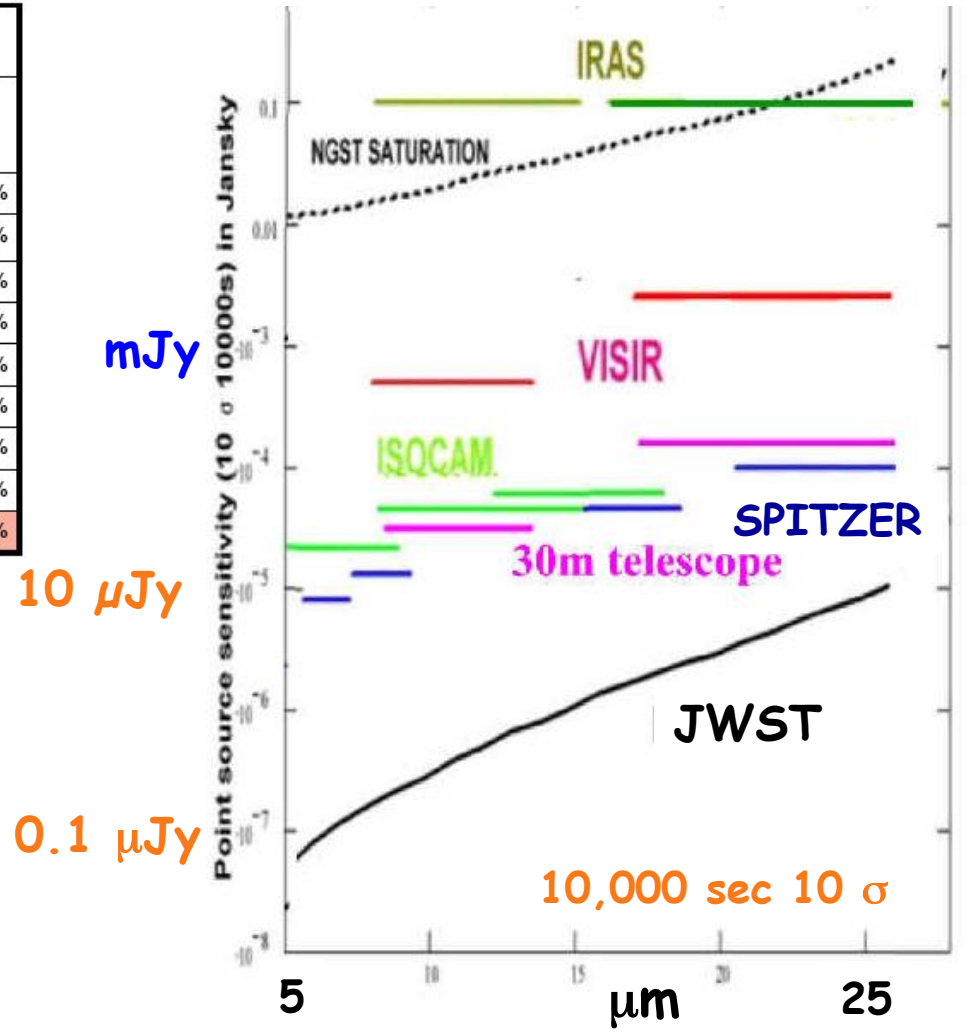
Low Resolution Spectrograph

5-14 μm spectral range
5" x 0.6" slit
R of 100-200

http://www.roe.ac.uk/ukatc/consortium/miri/index.html

MIRI IMAGING SENSITIVITY

Imager Filter		Point source sensitivity (10 sigma in 10,000 sec) [micro-Jansky]		
Wavelength [μm]	Passband [μm]	Requirement (FRD)	Design CBE	Margin
5.6	1.2	0.18	0.13	28%
7.7	2.2	0.27	0.22	19%
10.0	2.0	0.70	0.54	23%
11.3	0.7	1.66	1.33	20%
12.8	2.4	1.33	0.99	26%
15.0	3.0	1.77	1.28	28%
18.0	3.0	4.32	3.18	26%
21.0	5.0	8.63	7.13	17%
25.5	4.0	28.3	28.3	0%



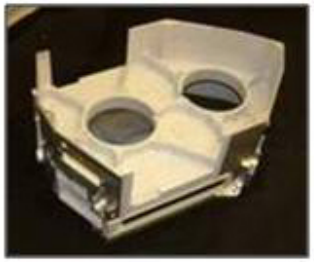
MIRI

~ 10^4 deeper than VLT

~ 10-100 deeper than Spitzer

http://www.roe.ac.uk/ukatc/consortium/miri/index.html

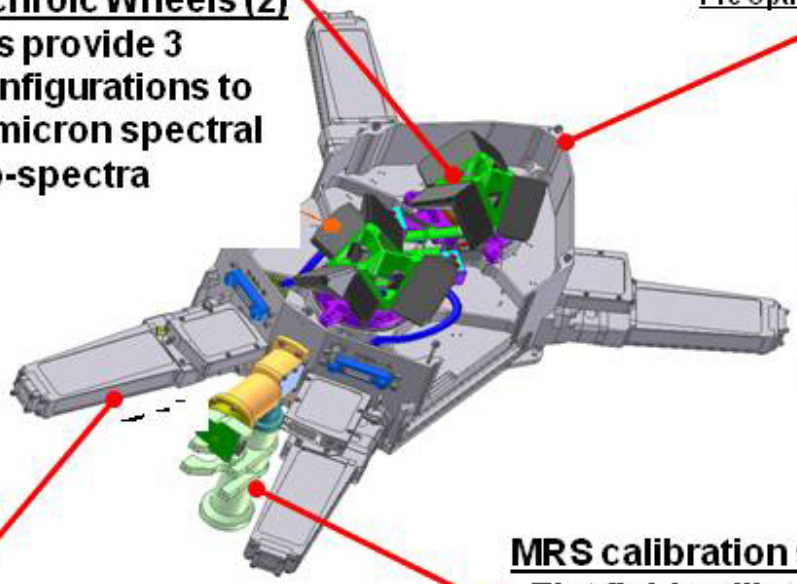
The MIRI Spectrometer (MRS)

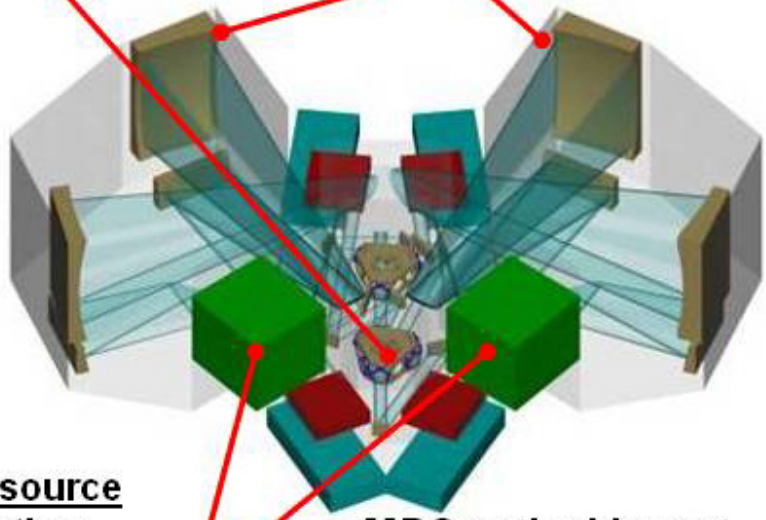


Pre Optics

Main Optics (2)

Grating and Dichroic Wheels (2)
- 2 mechanisms provide 3 observation configurations to cover the 5-28 micron spectral range in 12 sub-spectra





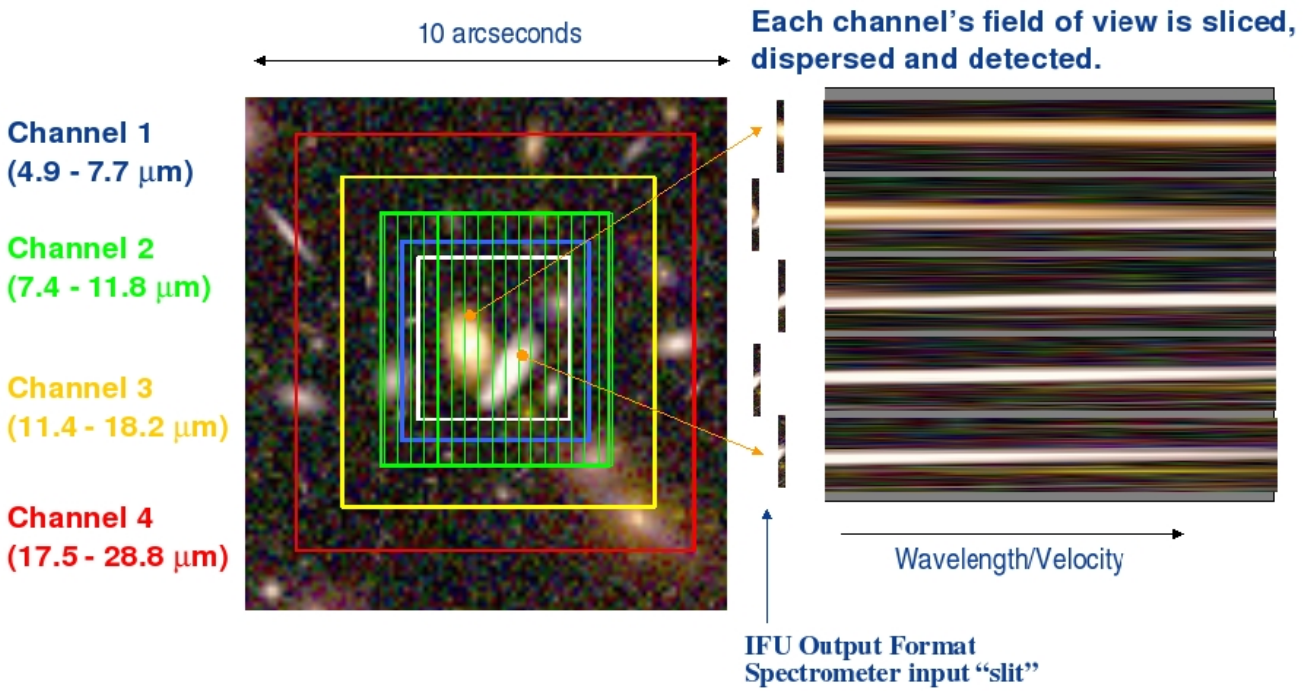
MRS calibration source
- Flat field calibration

MRS optical layout

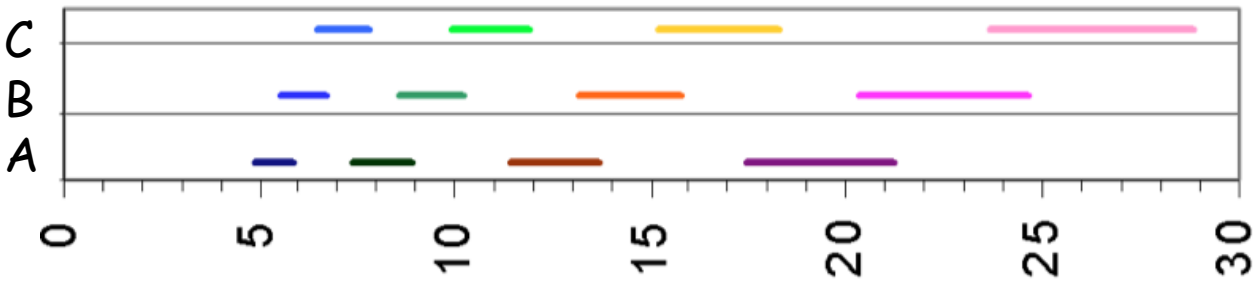
Integral Field Units (4)
- Spatial re-configuration of field into the spectrometer input "slit"

Focal Plane Modules (2)
- 6.7K operating temp
- Precise temperature and alignment stability

MIRI IFS. CHARACTERISTICS



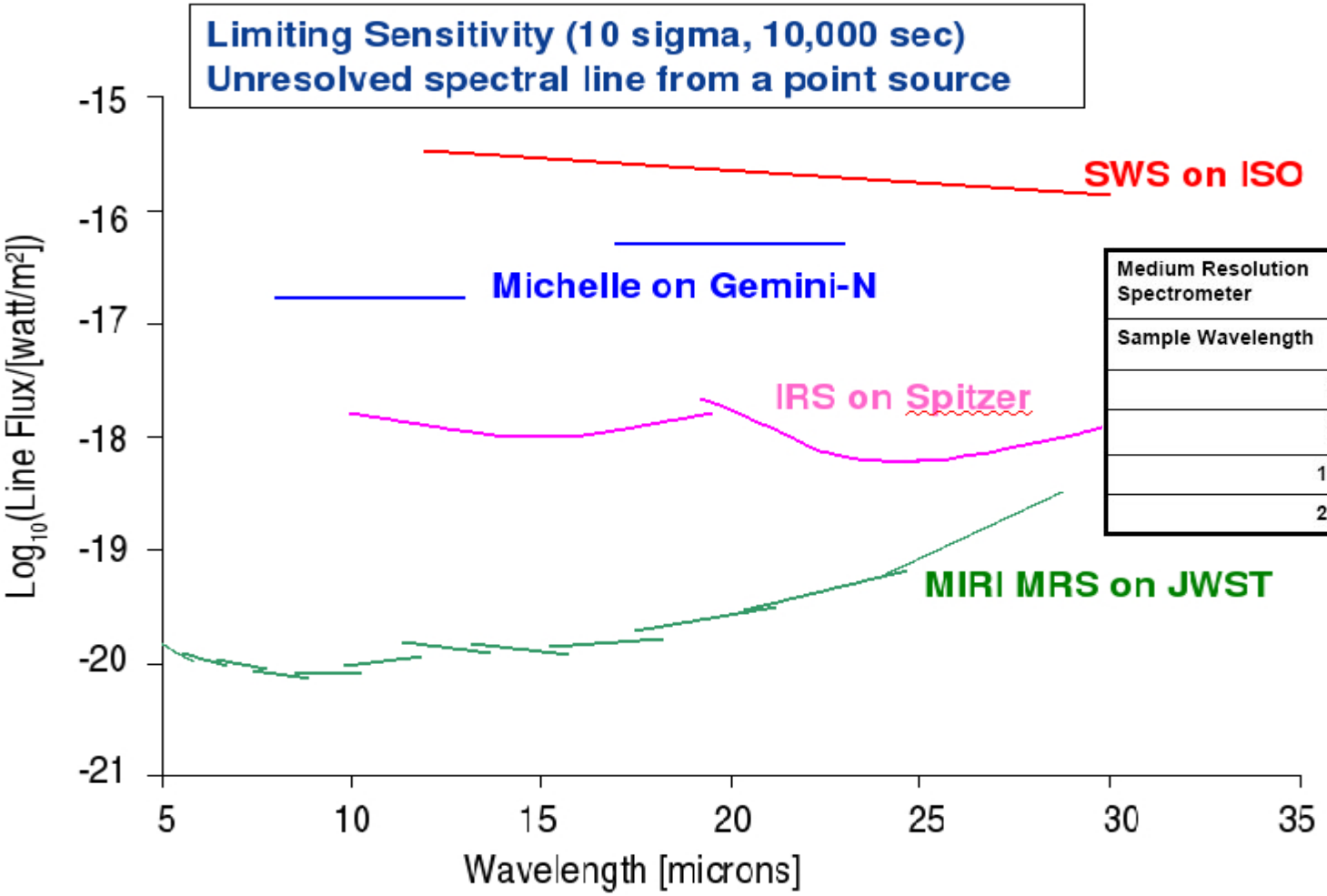
Sub-band	Wavelength Coverage [μm]
1A	4.9 - 5.8
1B	5.6 - 6.7
1C	6.5 - 7.7
2A	7.5 - 8.8
2B	8.6 - 10.2
2C	10.0 - 11.8
3A	11.5 - 13.6
3B	13.3 - 15.7
3C	15.3 - 18.1
4A	17.6 - 21.0
4B	20.5 - 24.5
4C	23.9 - 28.6



Channel	1	2	3	4
Number of Slices (N)	21	17	16	12
Wavelength range (μm)	5.5 – 7.7	7.7 – 11.9	11.9 – 18.3	18.3 – 28.3
Slice width Pixel size (arcsec)	0.176 0.196	0.277 0.196	0.387 0.245	0.645 0.273
FoV (arcsec)	3x 3.87	3.5x 4.42	5.2x 6.19	6.7x 7.73
Resolving Power	2400 - 3700	2400 - 3600	2400 - 3600	2000 - 2400

http://www.roe.ac.uk/ukatc/consortium/miri/index.html

MIRI SPECTROGRAPH SENSITIVITY



Medium Resolution Spectrometer	Sensitivity for spectral line detection (10 sigma in 10,000 sec) x 10^{-21} W/m2	
Sample Wavelength	Requirement (FRD)	Design
6.4	12.2	7.0
9.2	9.9	7.4
14.5	11.6	5.8
22.5	59.7	29.6

MIRI STATUS

- FM calibration campaign @ RAL last summer
- Longest (european) single test cryotest campaign of “pre-delivery” ever
  - 86 days (May to August 2011)
  - 51 people for a total of ~6000 person-hours
  - 2465 test scripts & 6.5 TB of data
- All the testing we intended to do was carried out
- There were no major or obvious problems with the instrument
- It was a very thorough set of tests
  - all the different MIRI optical configurations and modes were exercised
  - Characterised “flight like” operations, dithers, bright sources, faint sources, extended illumination, very low levels of illumination
- Performance & calibration tests under analysis
- Preparation for the NASA/ESA acceptance review underway
- Expected delivery in december 2011 – january 2012 (TBD)

MIRI SCIENCE TEAM

- Large european science team (about 60 people)
  - + MIRI-PI and national PIs (10)
  - + 30 coIs (3 scientists per country)
  - + IS & Test Team (~20 postdocs)

- US science team
  - + US PI & 3 coIs (owners of GT)
  - + Few associated STScI MIRI IS

- Guarantee Time: 450h for EC team + 450h US team

EC MIRI GT SCIENCE

- GT distributed over a broad range of areas (representing EC-ST interests)
- Internal proposal + review process in 2010
- Common interests with US team in some areas
- Projects divided into three categories: Large, medium & small

- Large projects (~ 100h each):
  - High-z Universe
  - Protoplanetary disks
  - Exoplanets

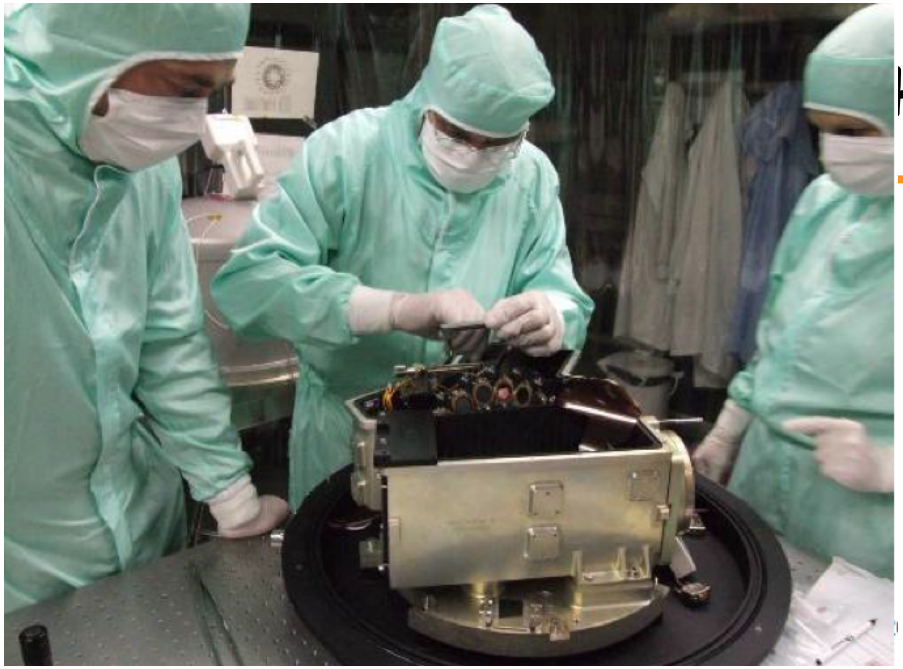
- Medium projects (~ 50h)
  - Protostars & outflows

- Small projects (< 20h each)
  - High-z targeted galaxies (seed program)
  - Nearby galaxies
  - ISM

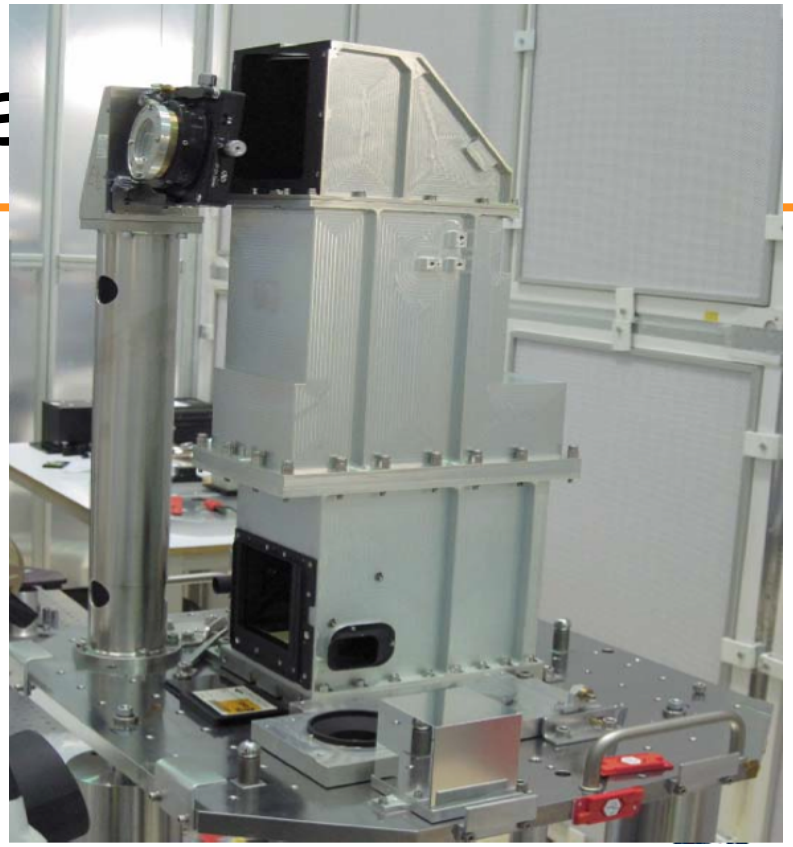
MIRI. UNIQUE & REVOLUTIONARY WINDOW INTO THE (HIGH-Z) UNIVERSE

- Complete 5-28 um coverage
- Sub-arcsec imaging (x10 better than Spitzer, ~ VLT, GTC, Gemini)
- Spatially resolved, sub-arcsec (0.2"- 0.6") 2D mid-IR spectroscopy
- Spectral resolution of R ~3000 (mid-IR x5 Spitzer HR IRS)
- Sensitivity x10-100 better than Spitzer

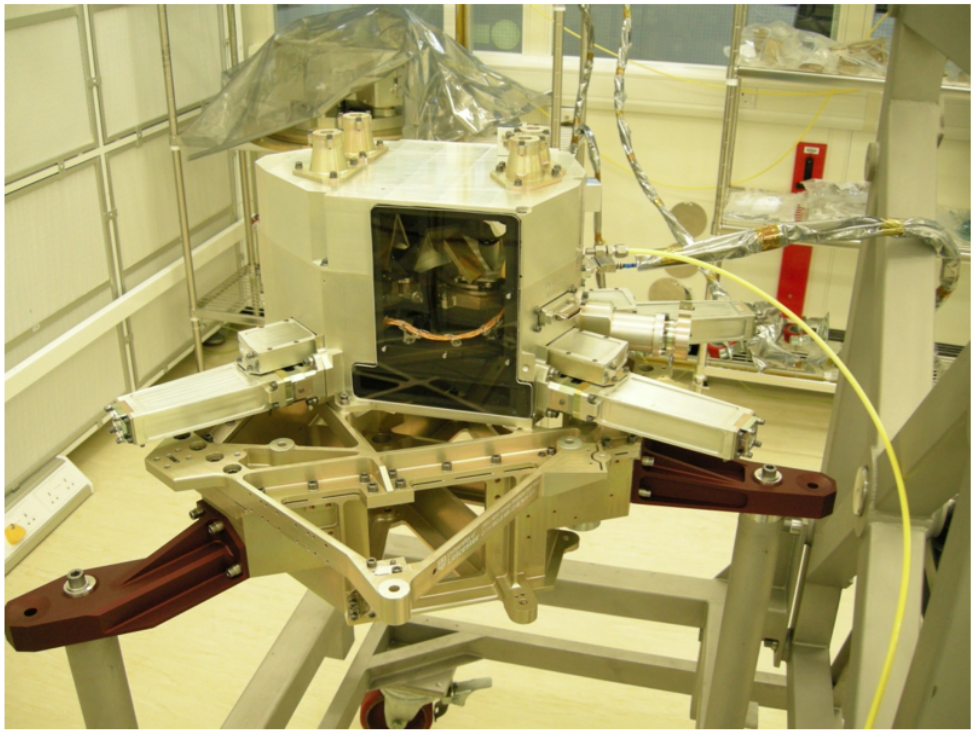
HARDWARE



imager

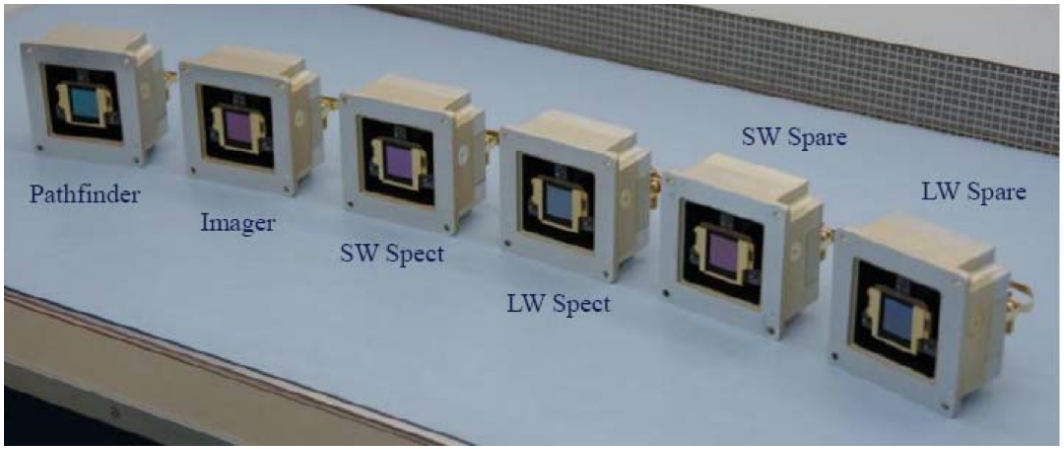


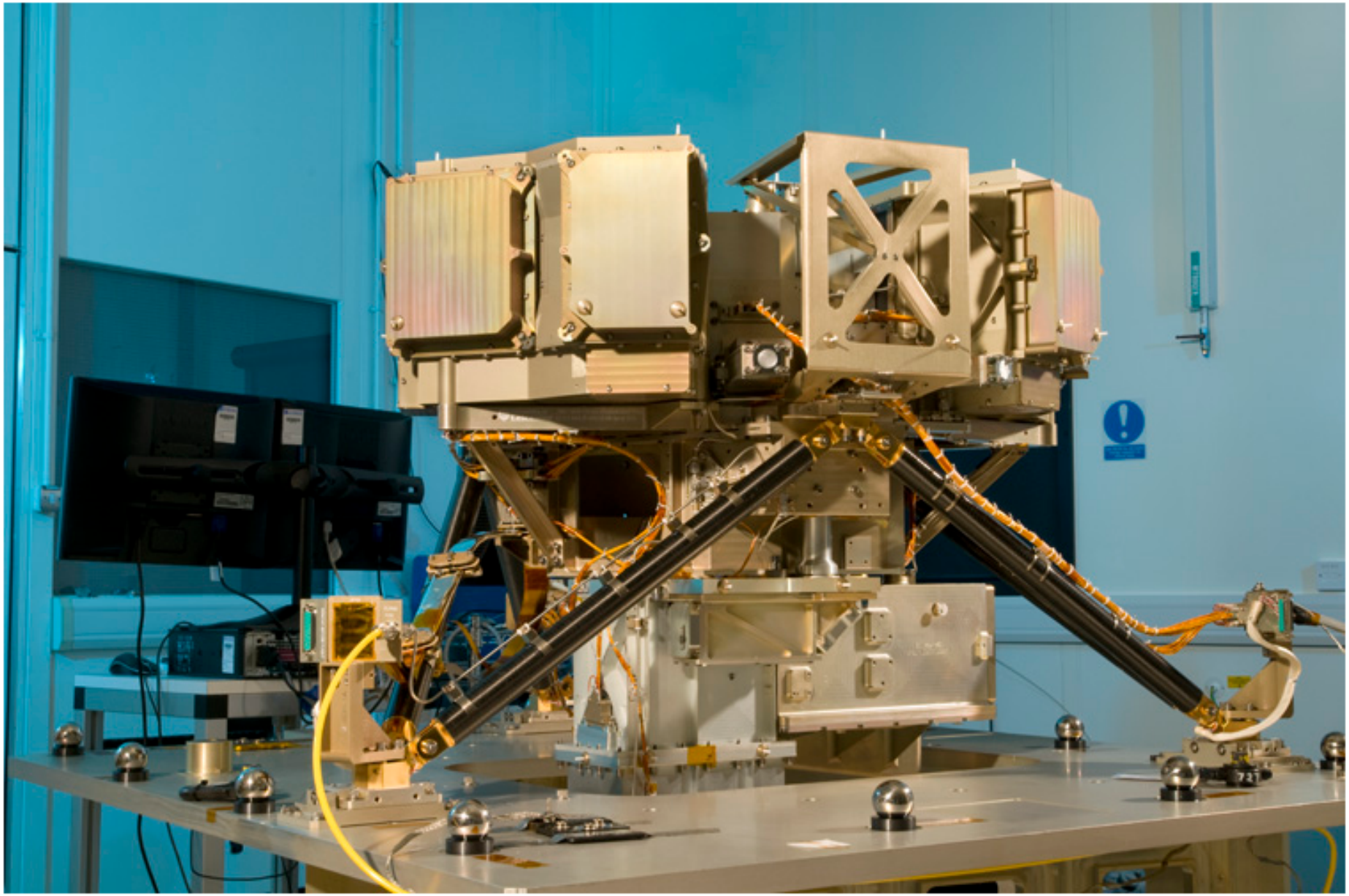
Input optics



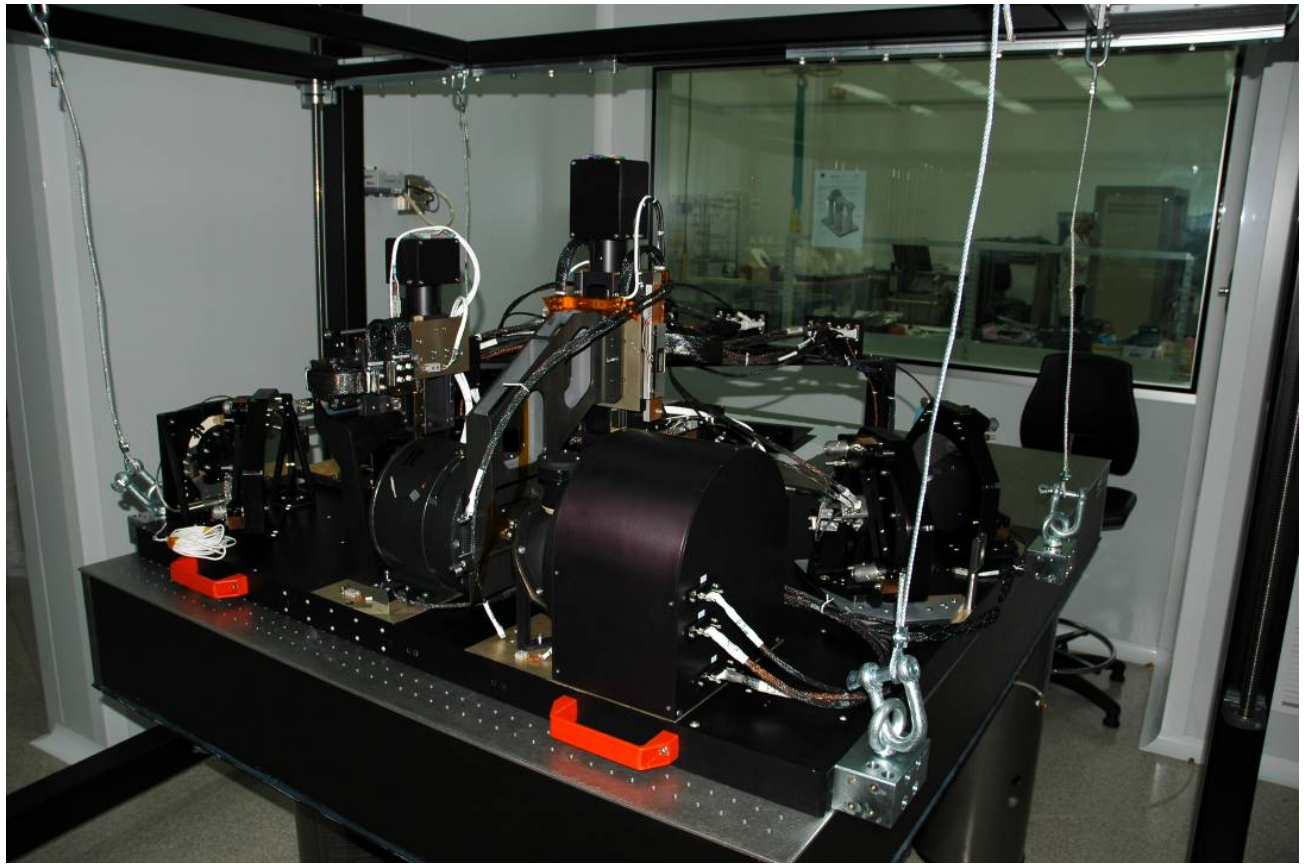
MRS

detectors



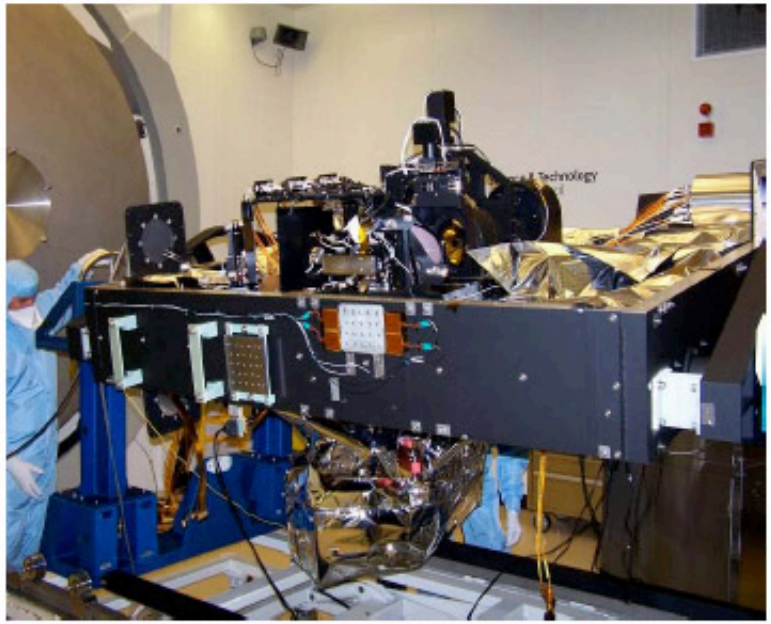


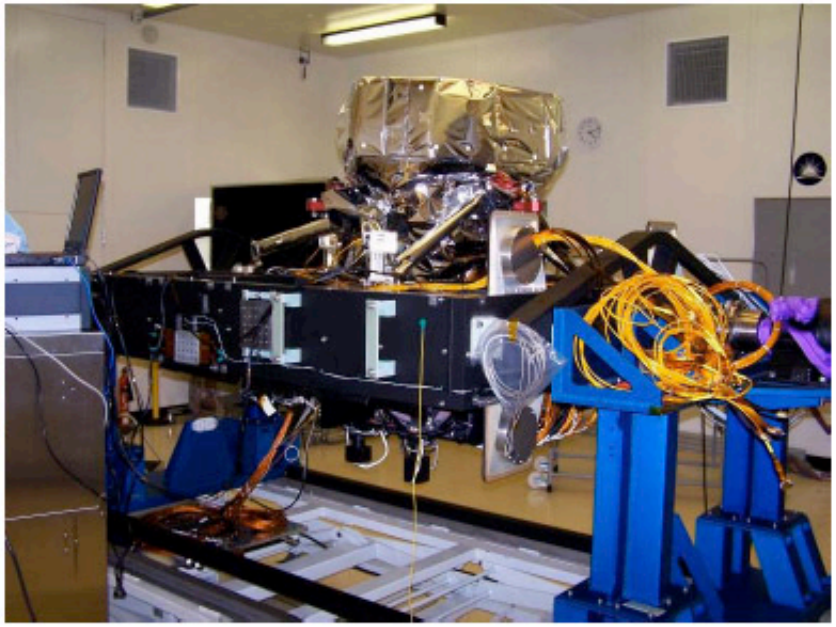
MIRI TELESCOPE SIMULATOR (MTS)

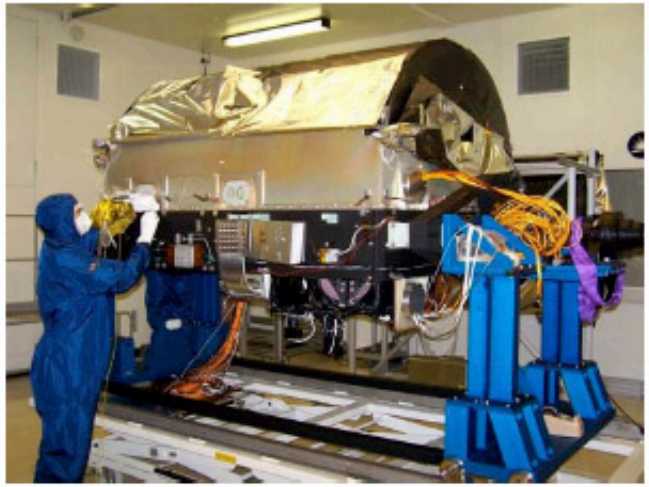


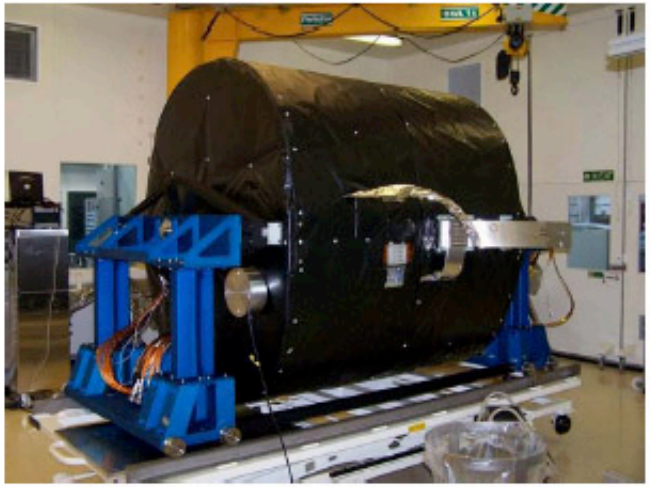
Opto-mechanical instrument designed to operate in environment similar to deep space (40K & vacuum)

JWST. MIRI & MTS

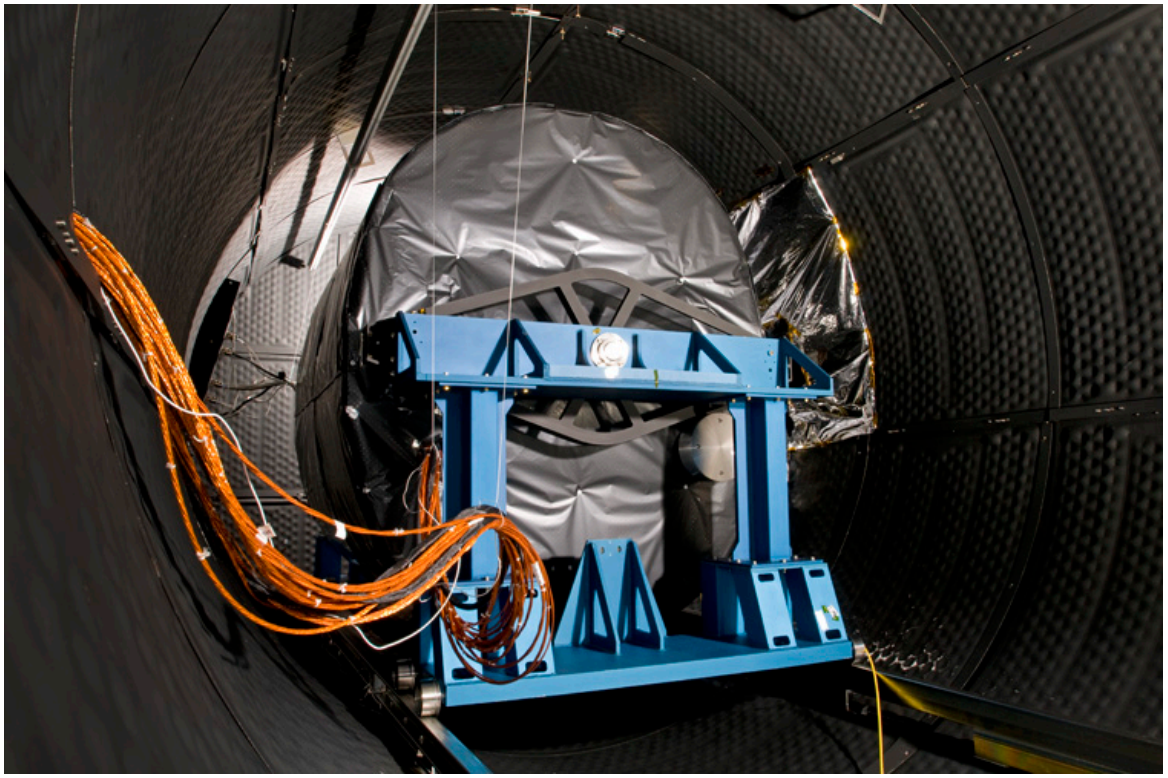




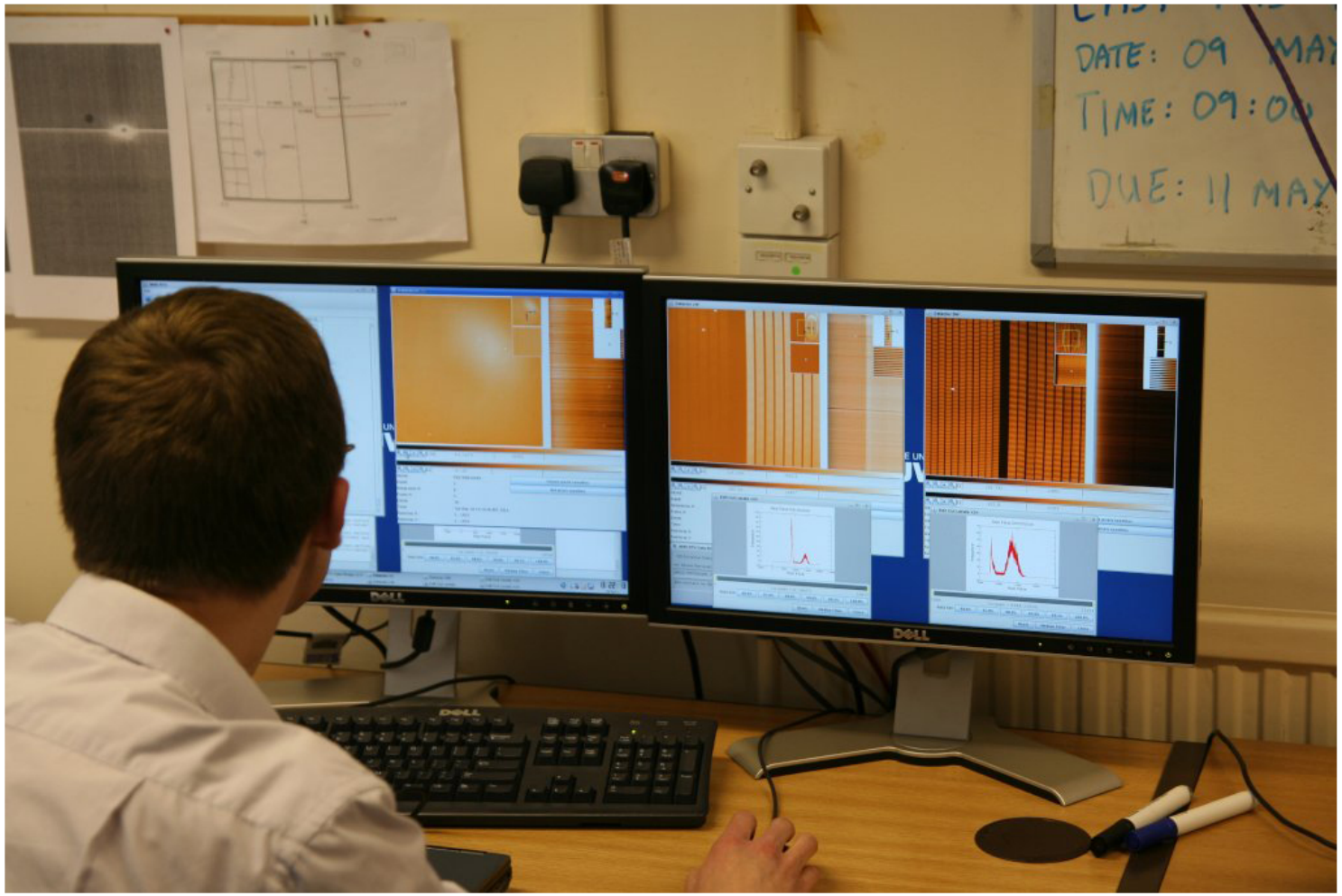




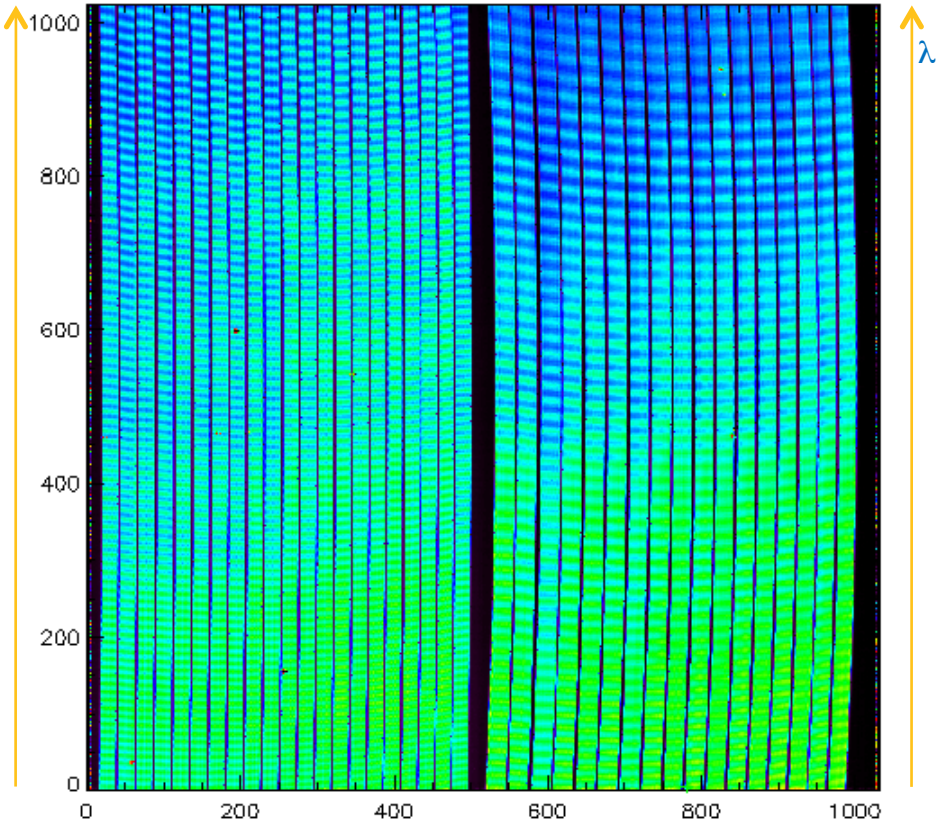
MIRI @ RAL CRYOGENIC CHAMBER



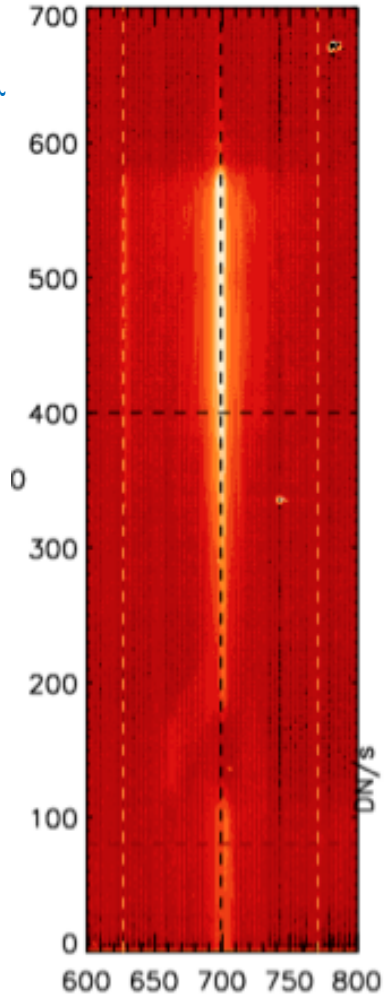
MIRI FM. FIRST LIGHT



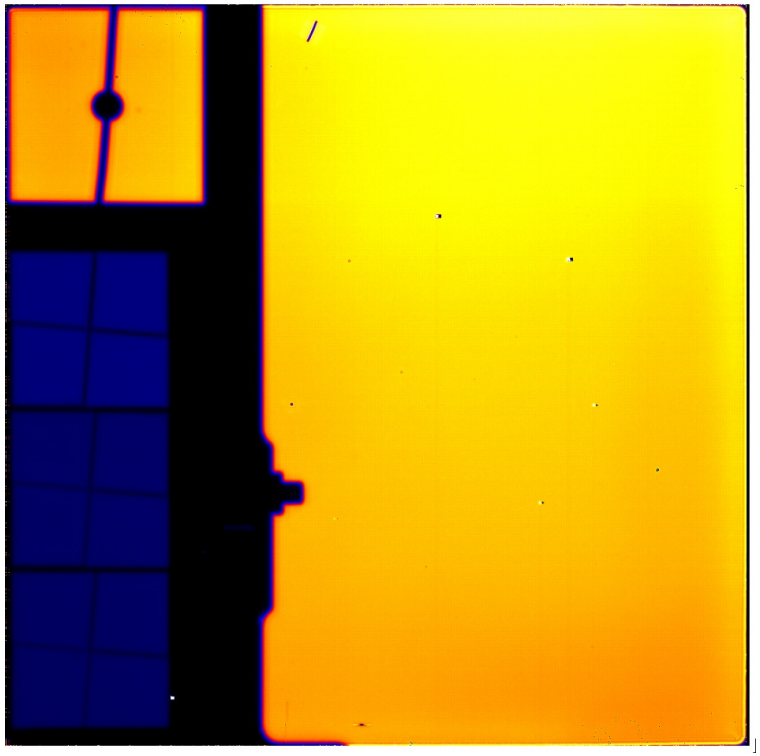
MIRI FM. FIRST LIGHT



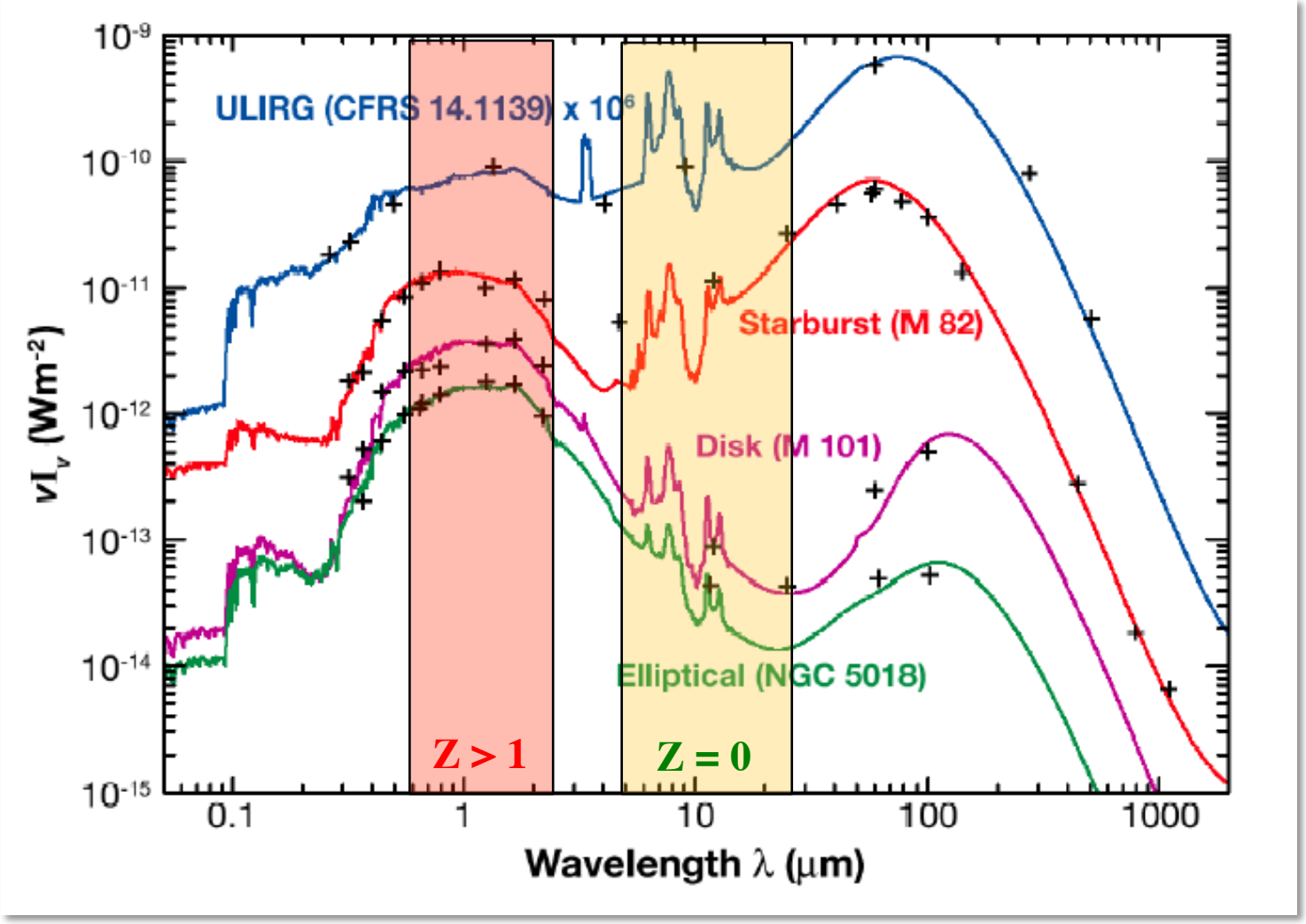
Channel 1C (6.5 – 7.7 μm)



Channel 2C (10.0 – 11.8 μm)



MIRI. ADVANTAGES FOR STUDIES OF HIGH-Z GALAXIES



Near-IR (& red) stellar bump

Lagache et al. 2005, ARAA

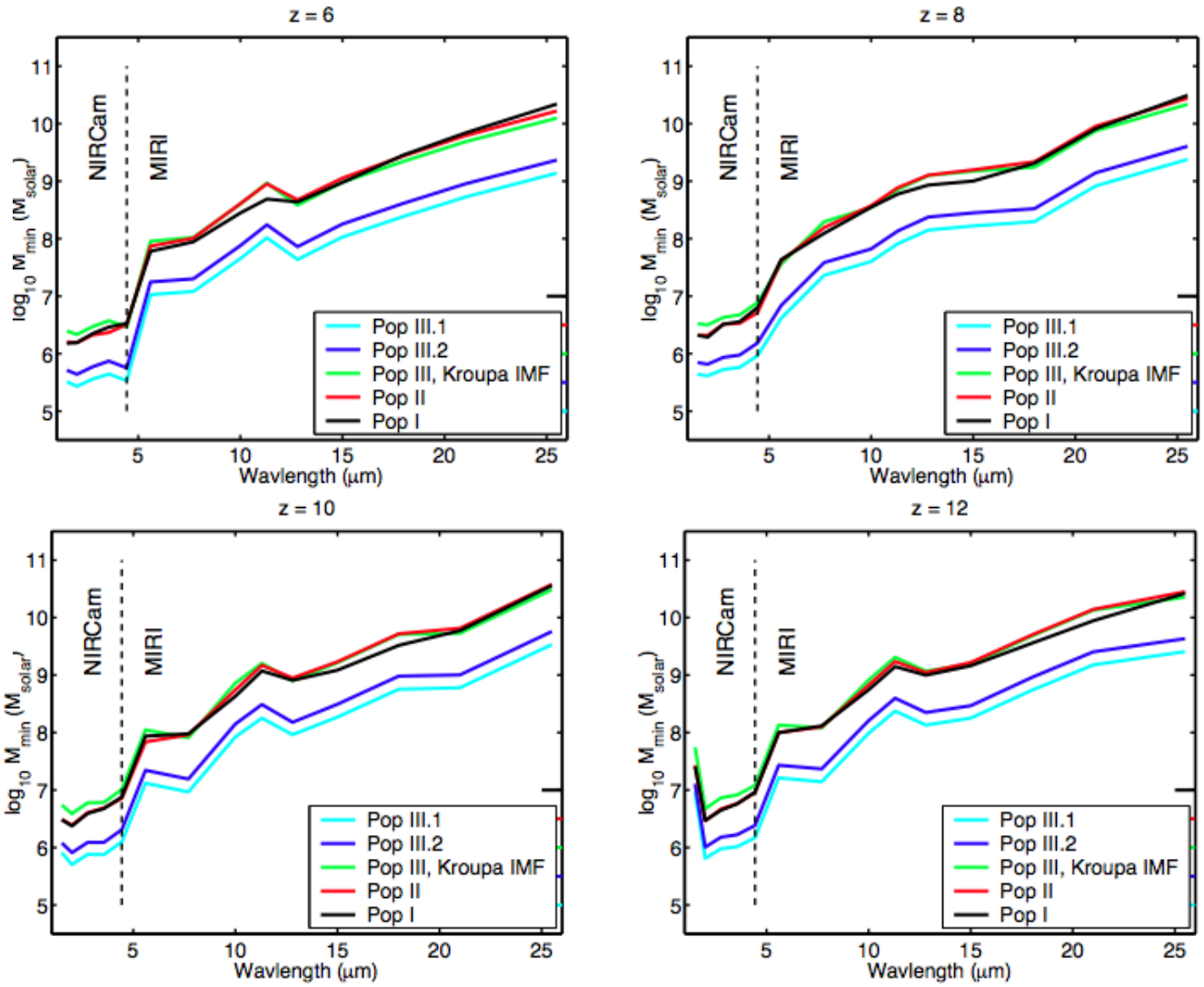
JWST/MIRI-UDF

100 hours; 10σ

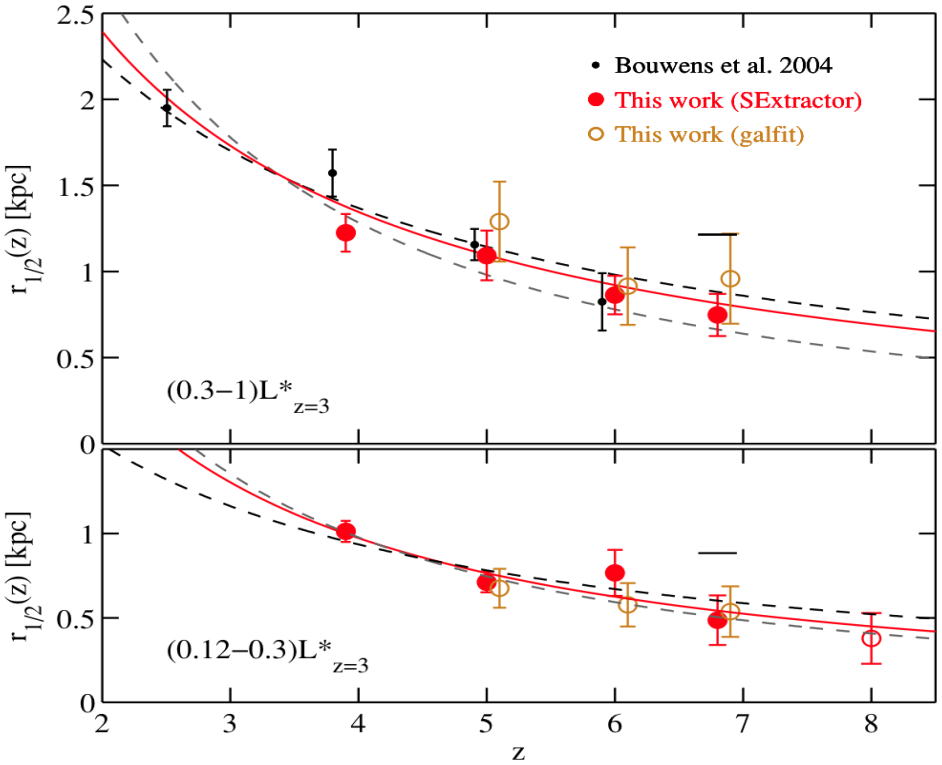
	Filter	λ (μm)	m_{AB}
NIRCam	F070W	0.70	29.9
	F090W	0.90	30.4
	F115W	1.15	30.6
	F150W	1.50	30.7
	F200W	2.00	30.9
	F277W	2.77	30.6
	F356W	3.56	30.6
	F444W	4.44	30.1
MIRI	F560W	5.60	27.6
	F770W	7.70	27.3
	F1000W	10.0	26.3
	F1130W	11.3	25.3
	F1280W	12.8	25.5
	F1500W	15.0	25.2
	F1800W	18.0	24.3
	F2100W	21.0	23.5
	F2550W	25.5	22.3

Model:
10 Myr+nebular

Zackrisson et al. 2011

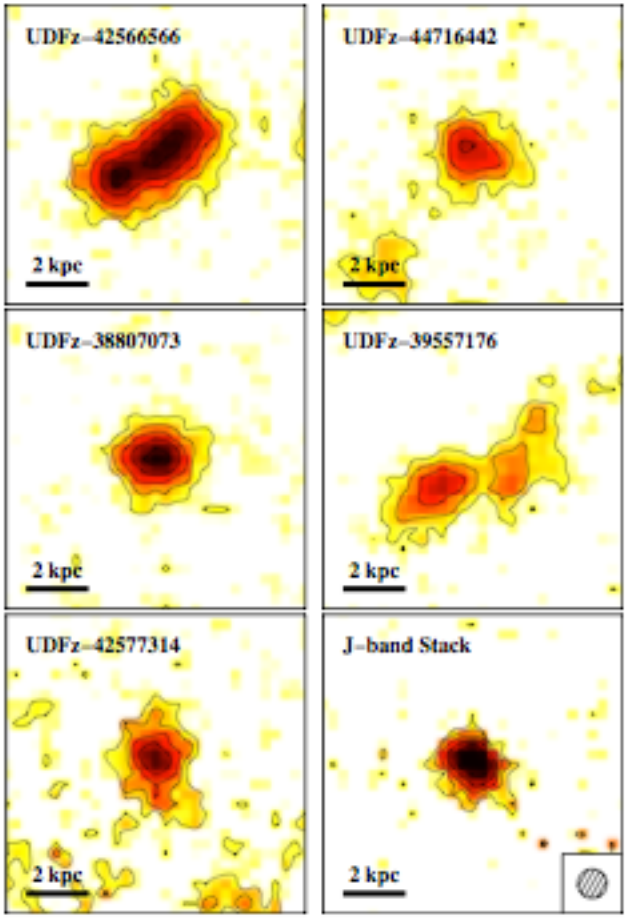


NEAR-IR SIZE & MORPHOLOGY EVOLUTION



Oech et al. 2010

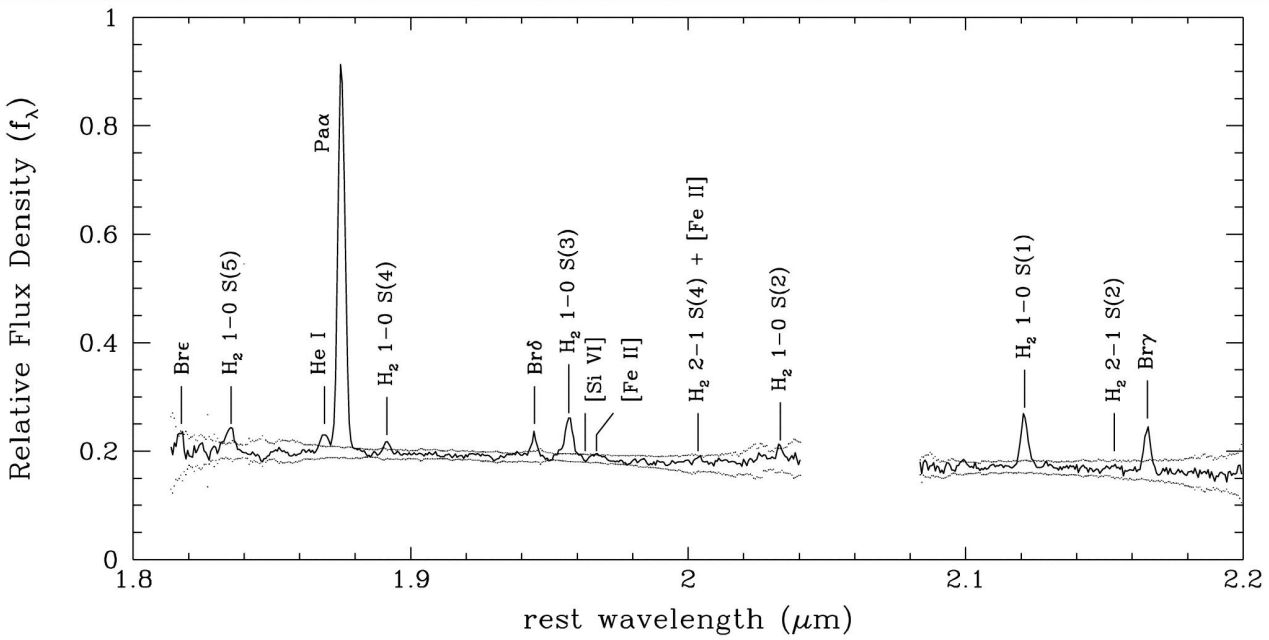
WFPC3
UV-rest frame
Z = 6.8



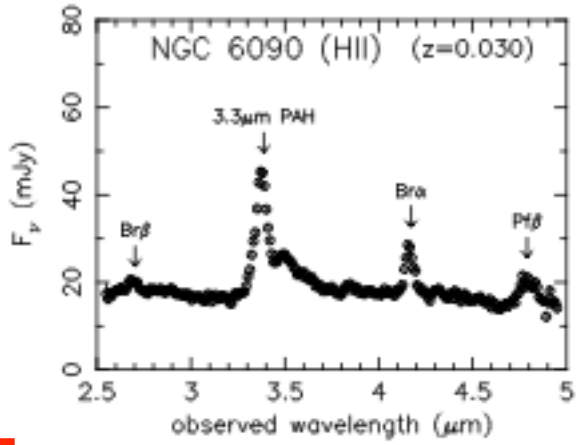
MIRI: SIZE – MORPHOLOGY EVOLUTION @ Z > 1
INTERMEDIATE-OLD STELLAR POPULATIONS

MIRI. NEAR-IR SPECTRAL REST FRAME @ Z>1

Murphy et al. 1999



- Coronal ISM: [SiVI] 1.96μm
- Ionized ISM: Pa & Br H lines
- Hot molecular ISM: H_2 lines
- Shocked ISM: [FeII] 1.64μm
- Stellar pop.: CO bands



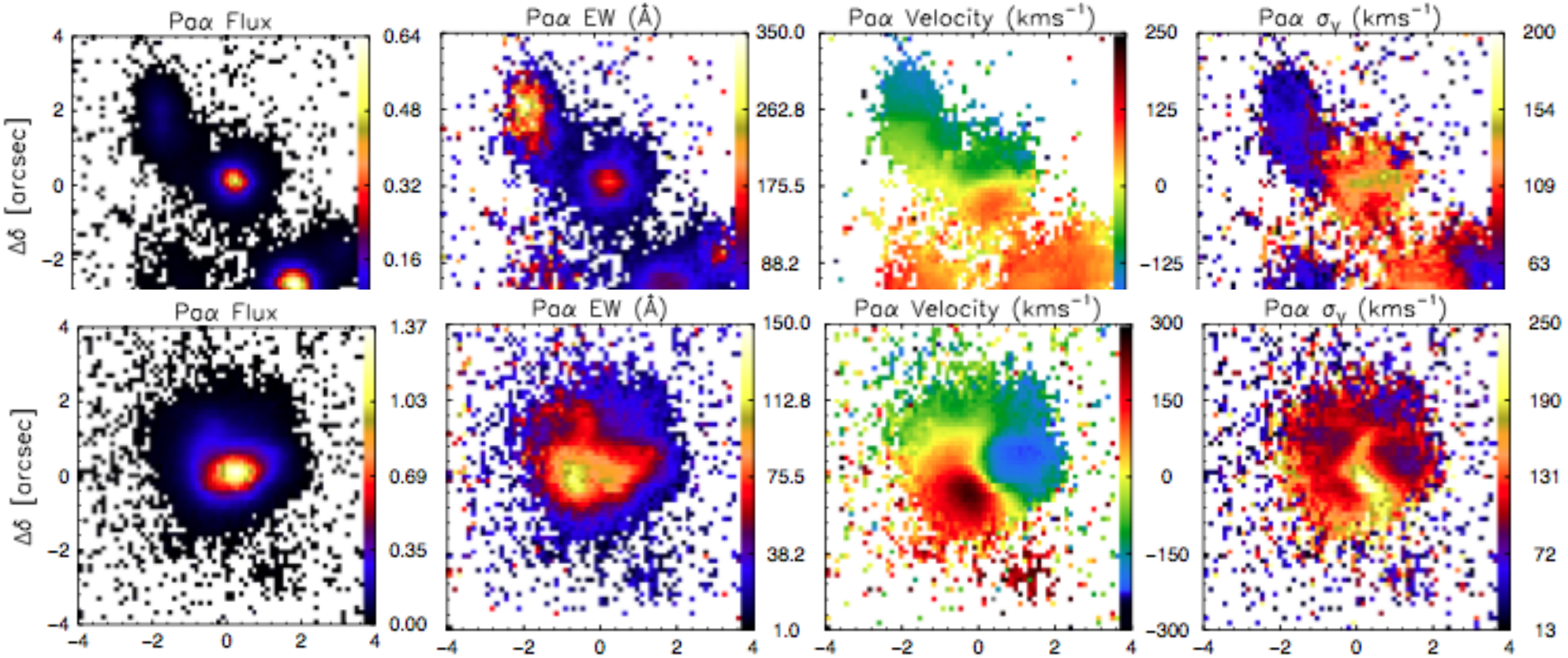
Imanishi et al. 2010

H+K spectral range into MIRI range for z > 1

Continuous coverage of Paα (strongest near-IR line)

2011

Paα IFS OF HIGH-Z STARBURSTS. Kpc- SCALE STRUCTURE AND KINEMATICS



Piqueras et al. in progress

Low-z (U)LIRGs
VLT SINFONI near-IR IFS
R = 4000 (K)
FWHM ~ 1 kpc = MIRI IFS of high-z starbursts