WISE & The James Webb Space Telescope

Jonathan P. Gardner
NASA's Goddard Space Flight Center

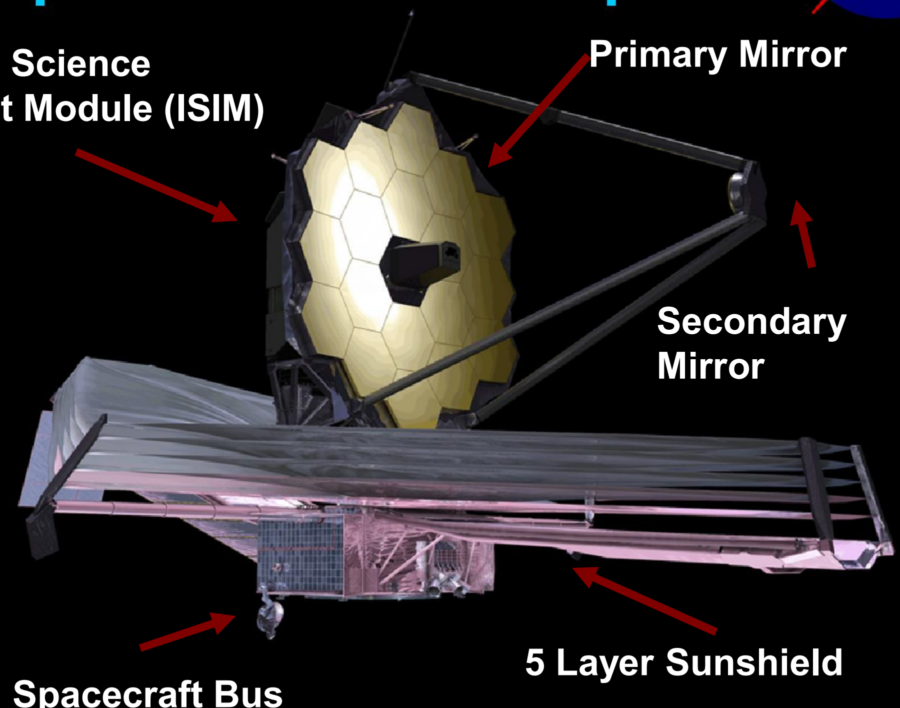
http://jwst.nasa.gov

Space Science Reviews, 2006, 123/4, 485

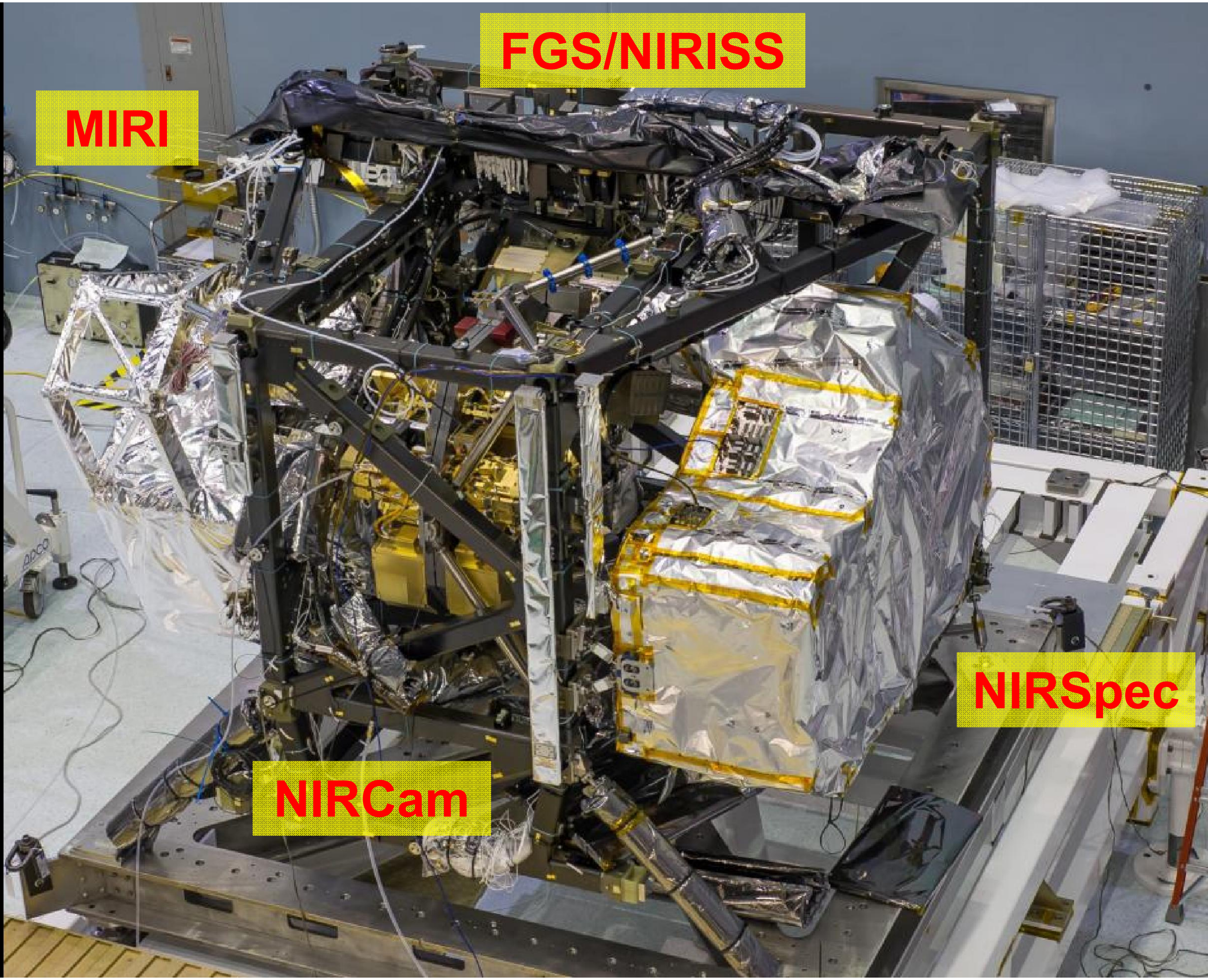

With help from:
Chas Beichman
Gerbs Bauer
Debbie Padgett
Mike Ressler
Jackie Flaherty
Jane Rigby
Nadia Zakamska
Stef Milam
Dan Stern

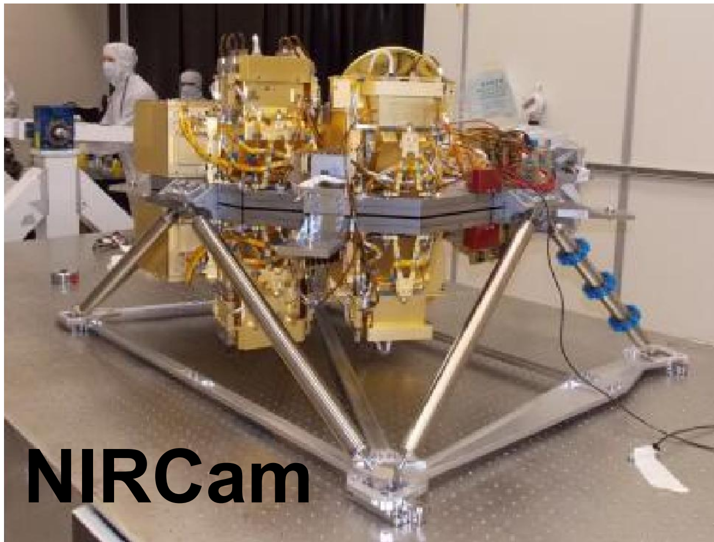
James Webb Space Telescope

- 6.6m Telescope
- Successor to Hubble & Spitzer.
- Demonstrator of deployed optics.
- 4 instruments: 0.6 to 28.5 μm
- Passively cooled to < 50 K.
- Named for 2nd NASA Administrator



- Complementary to 30m, ALMA, WFIRST, etc
- NASA + ESA + CSA: 14 countries
- Lead: Goddard Space Flight Center
- Prime: Northrop Grumman
- Operations: STScI
- Senior Project Scientist:
  Nobel Laureate John Mather
- Launch date: October 2018


FGS/NIRISS
MIRI
NIRSpec
NIRCam



NIRCam:

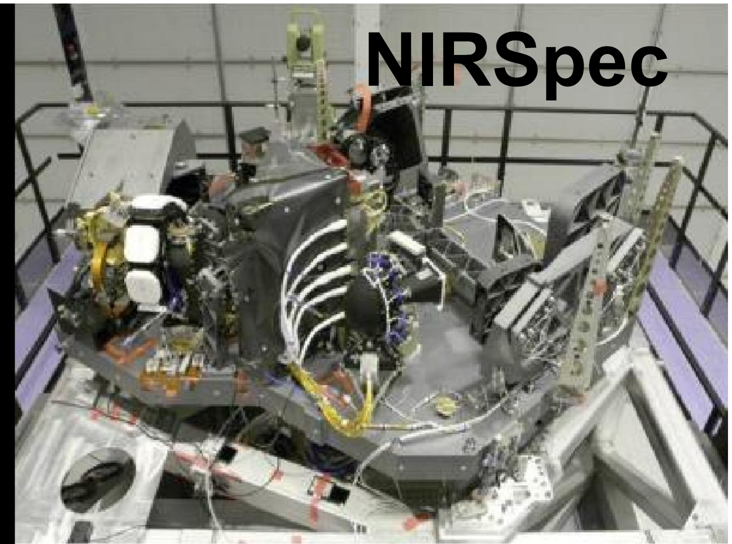
Imaging 0.6 – 5.0 µm

Broad, med & narrow

10 sq. arcmin FOV

65 mas resolution

Coronagraphy



FGS/NIRISS:

Guiding

Slitless spectroscopy (R~150)

Exoplanet transits (R~750)

Non-redundant mask

NIRSpec:

Multi-object: 10 sq. arcmin

IFU: 3x3 arcsec

R~100, R~1000, R~3000

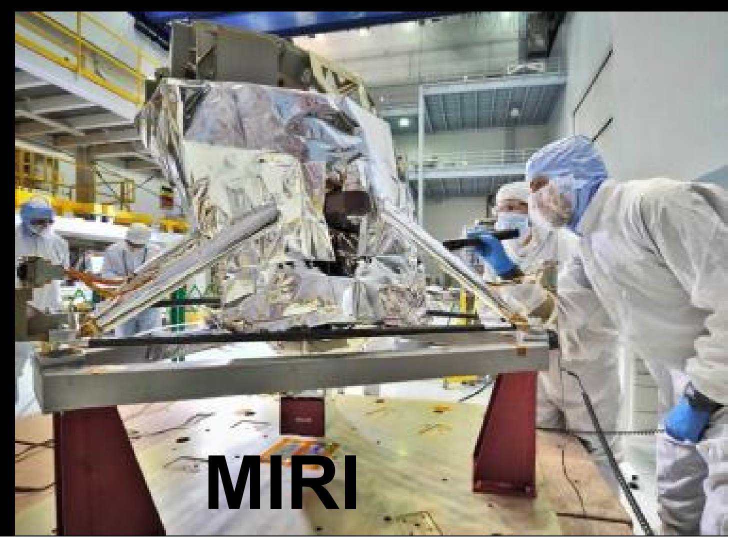
MIRI:

Imaging 5 – 28.5 µm

2 sq. arcmin FOV

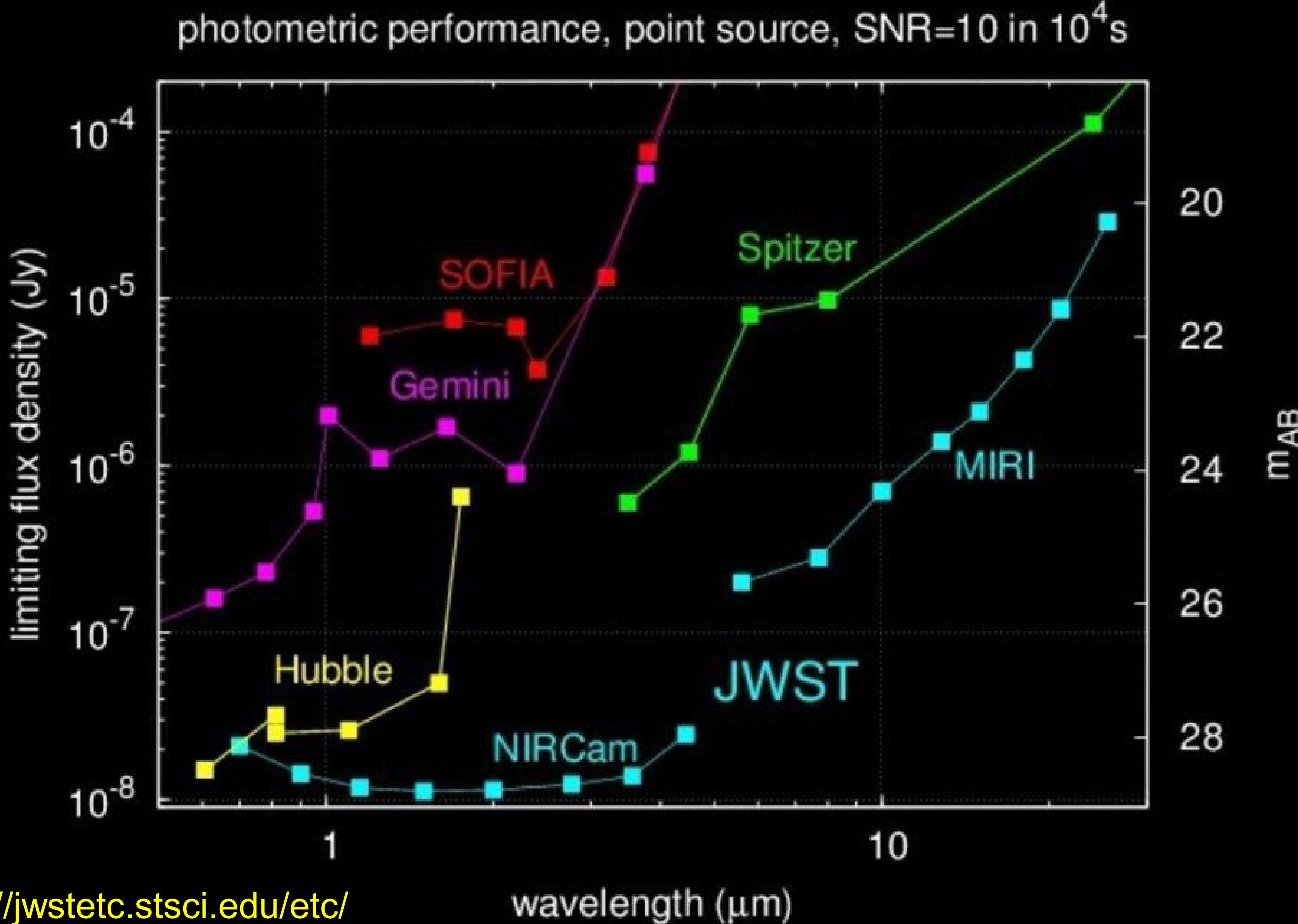
IFU R~3000

Coronagraphy



From Jane Rigby

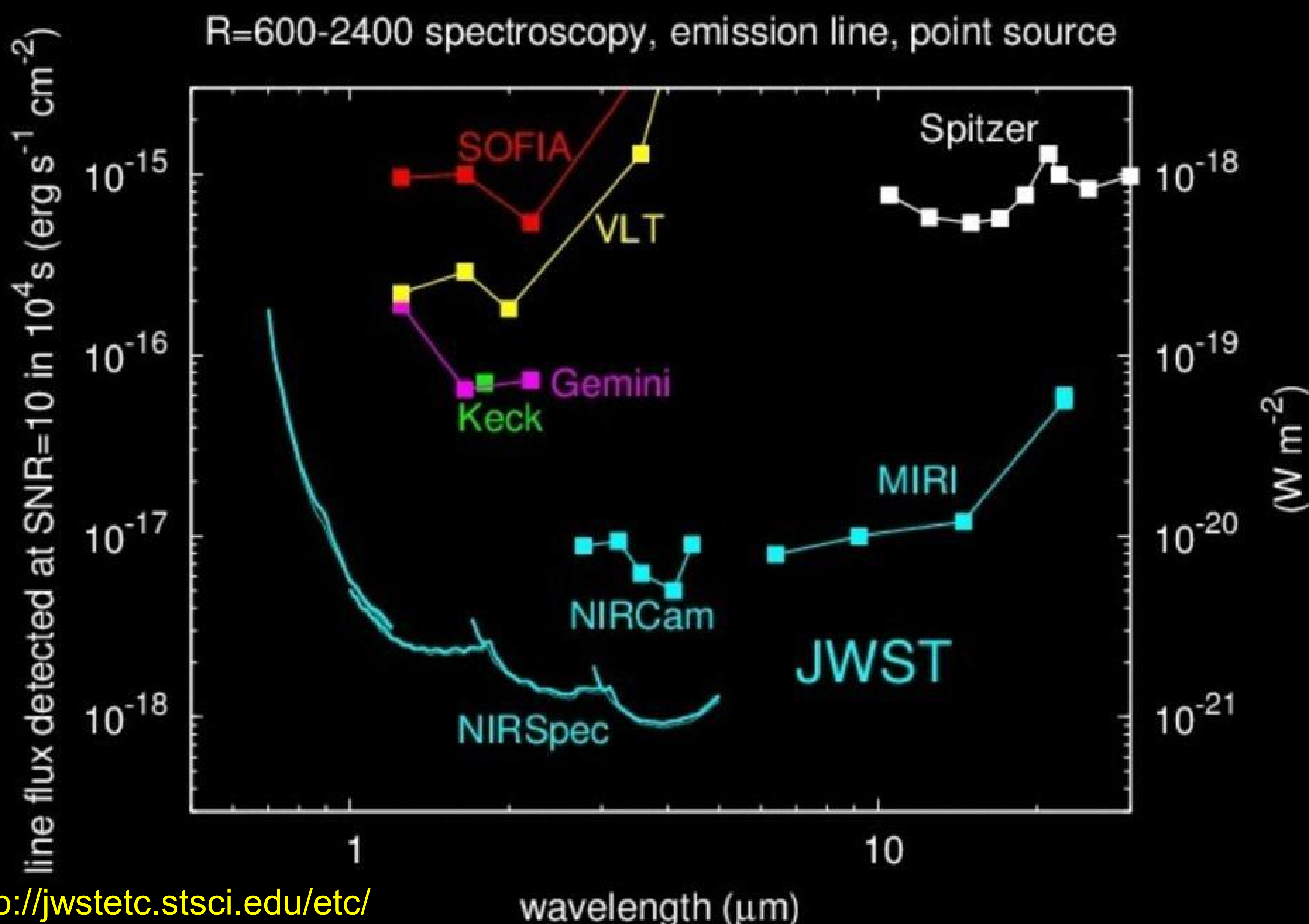
Sensitivity



http://jwstetc.stsci.edu/etc/

Sensitivity

From Jane Rigby



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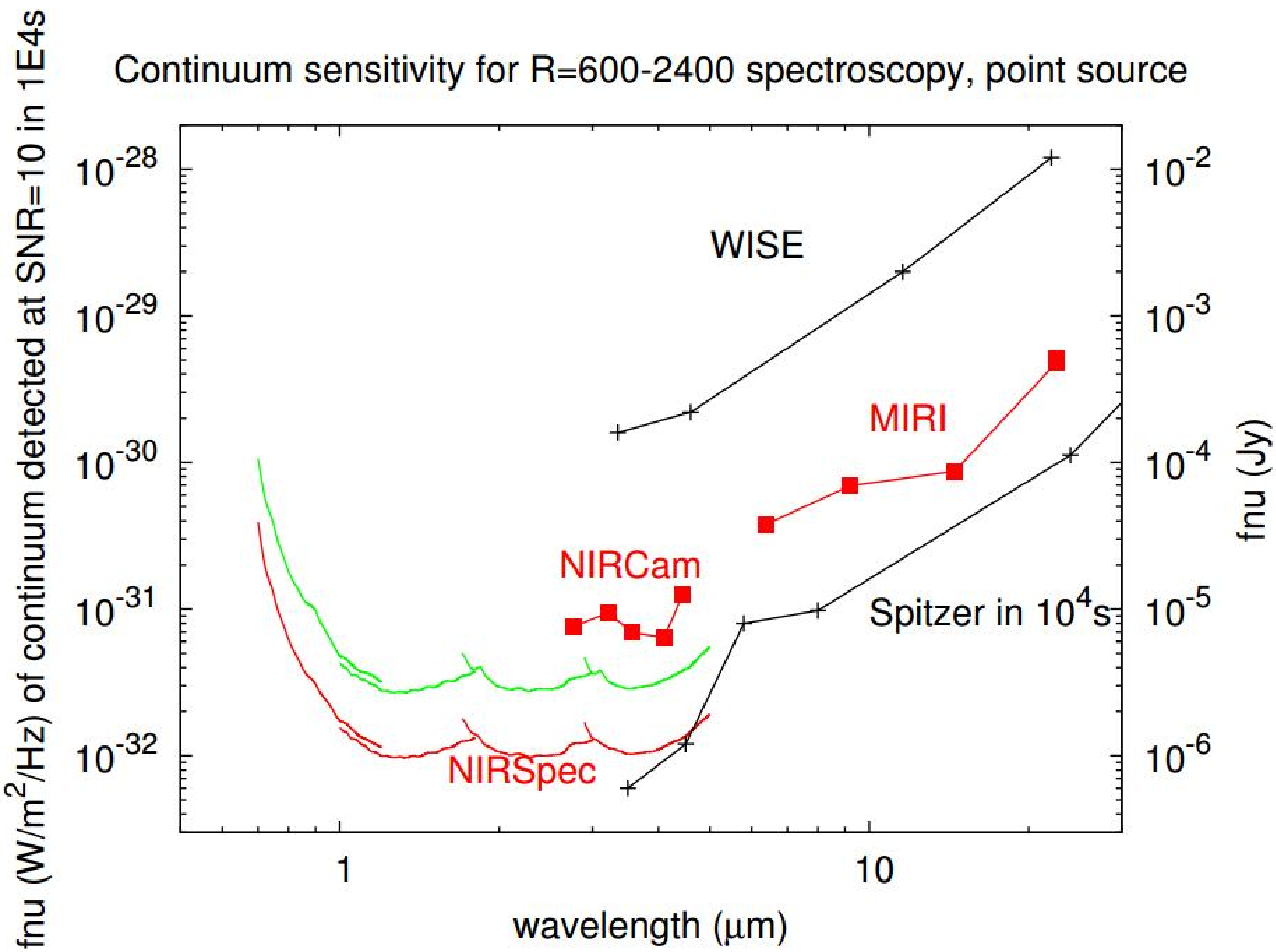
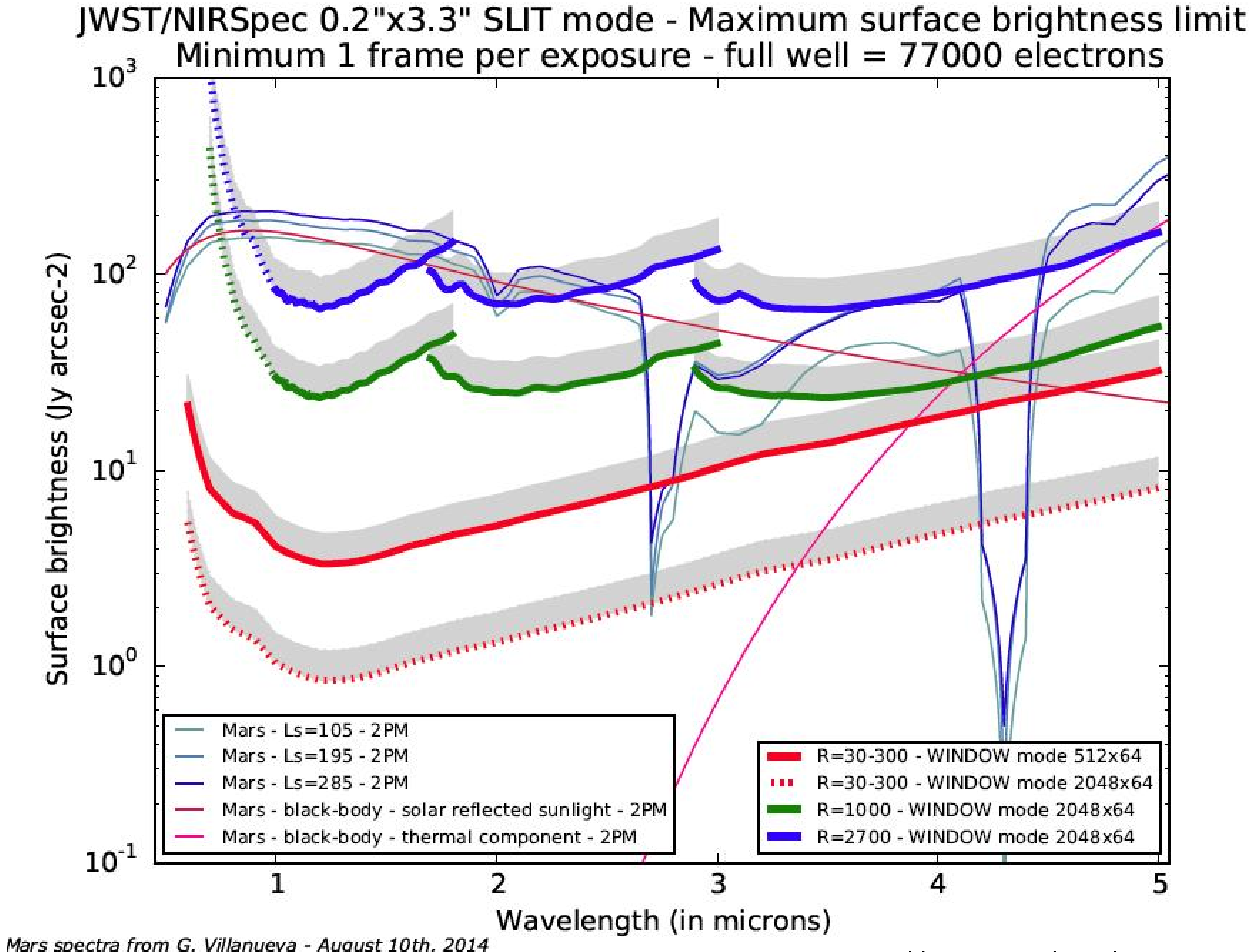
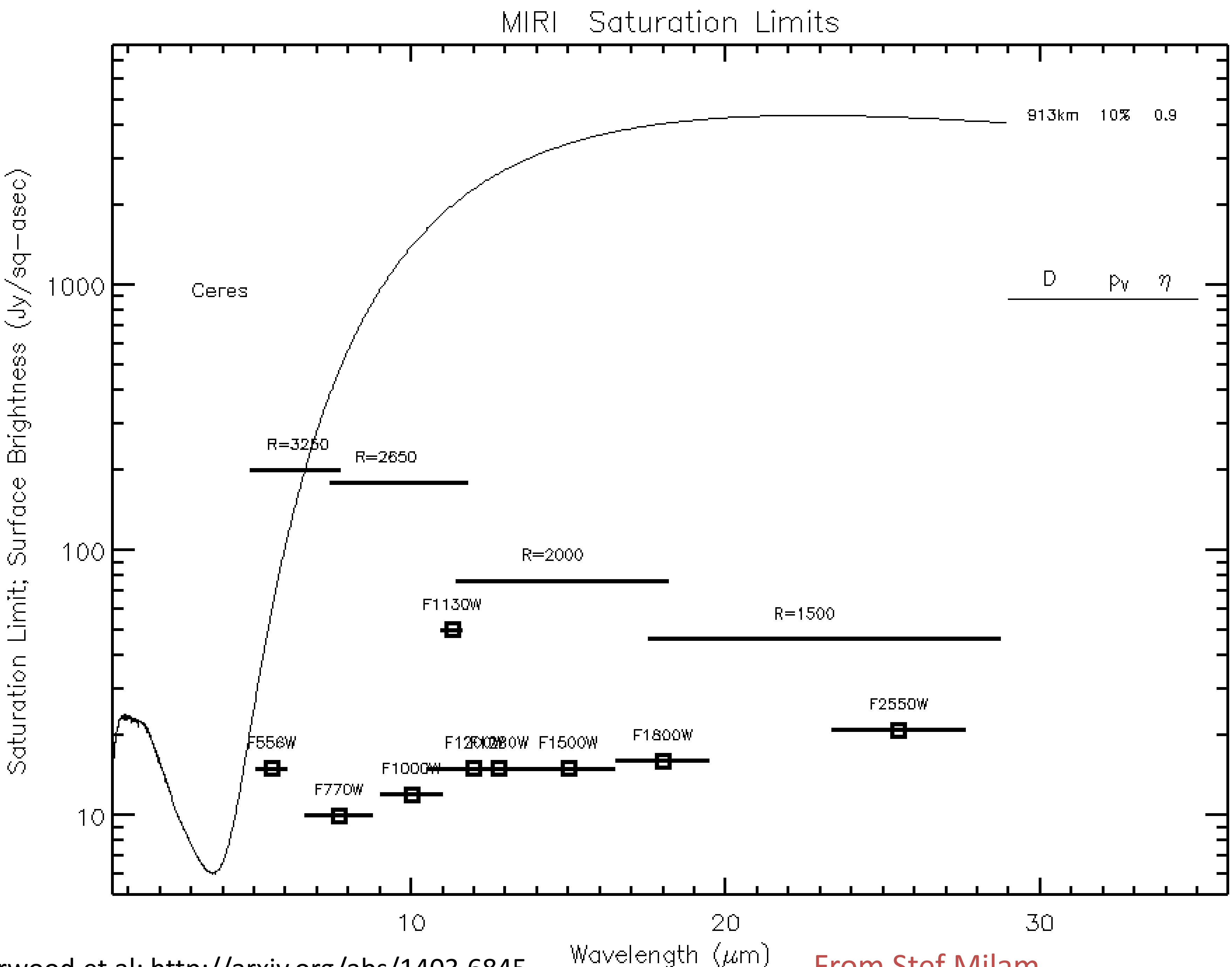


http://jwstetc.stsci.edu/etc/



From Stef Milam

Norwood et al: http://arxiv.org/abs/1403.6845



Norwood et al: http://arxiv.org/abs/1403.6845

From Stef Milam

From Dan Stern

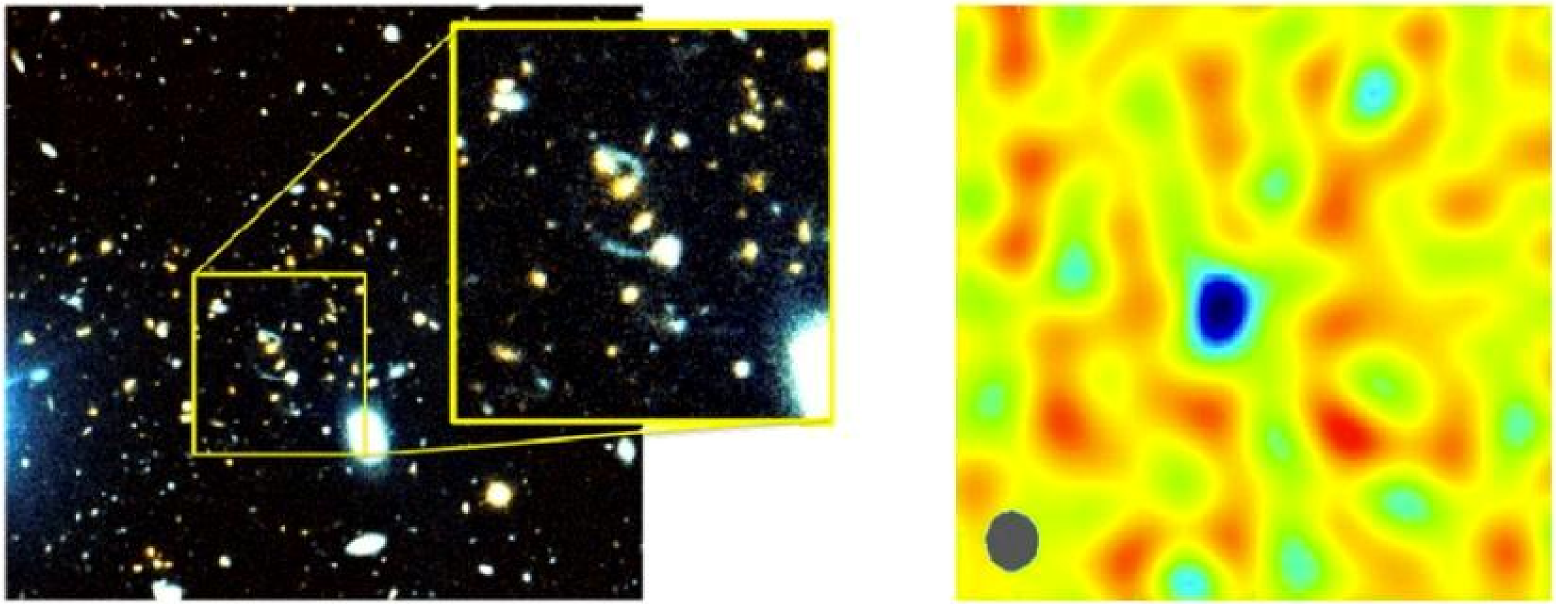
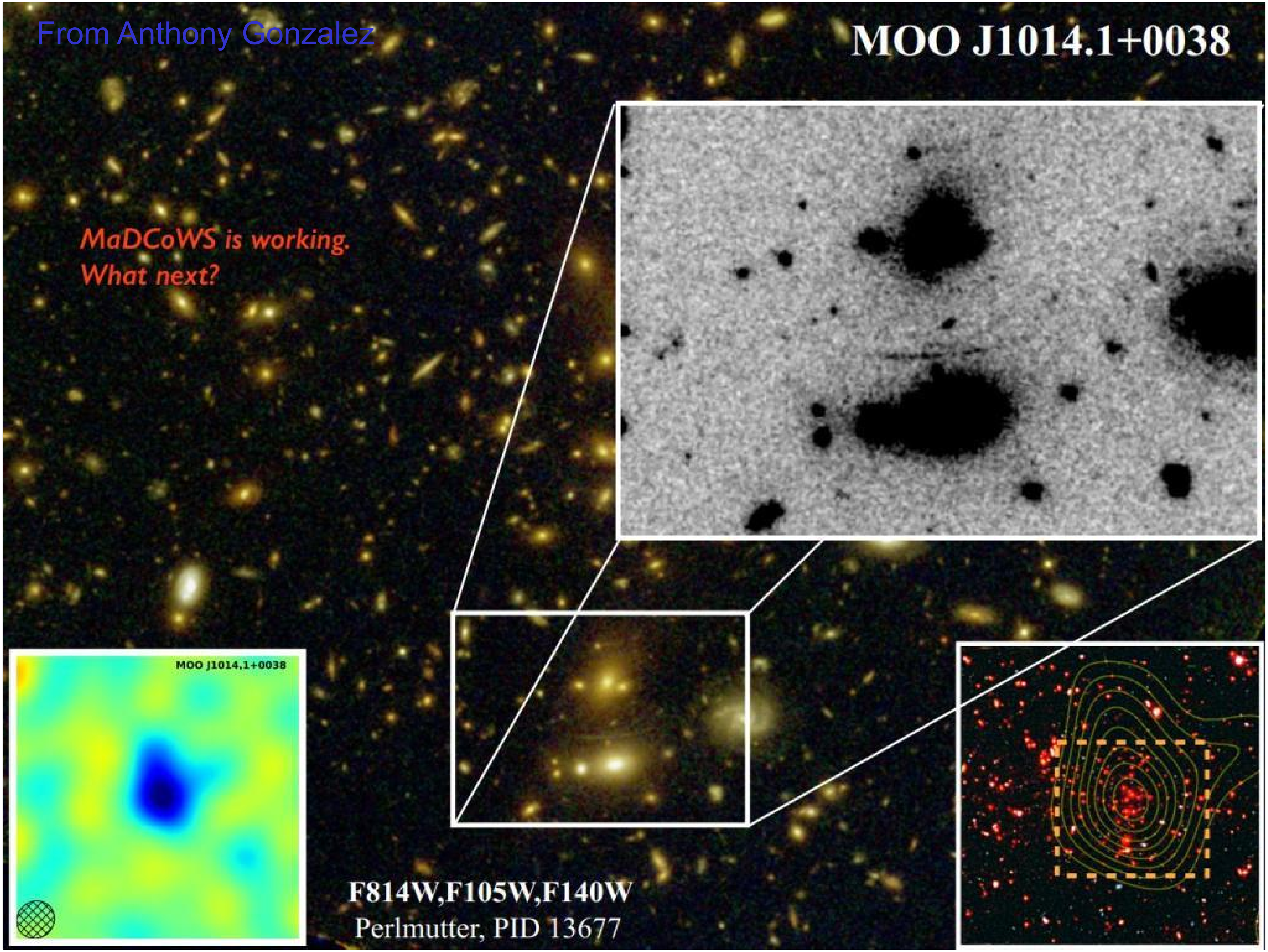


Figure 1-11. *Distant galaxy clusters discovered by WISE (Brodwin et al. in prep.). With MaxWISE, thousands more such clusters are expected to be discovered over the entire sky. (**Left**) Gemini r'z' image of a spectroscopically confirmed z = 1.0 cluster, illustrating likely strong arcs. High resolution followup of the MaxWISE cluster sample will allow a robust arc statistics analysis. (**Right**) This CARMA S-Z measurement yields $M \sim 6 \times 10^{14}\ M_\odot$ for a spectroscopically confirmed z = 1.2 cluster found by WISE. The 0.8′ CARMA beam is shown at lower left.*

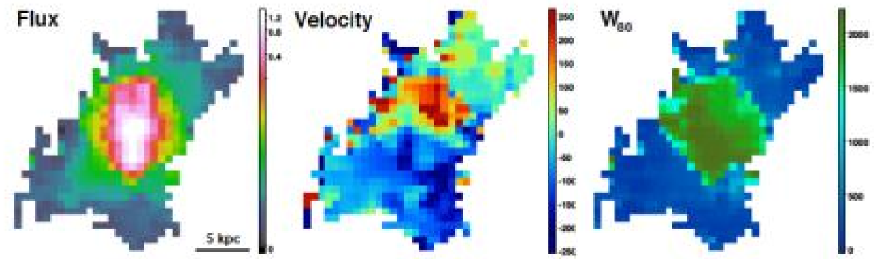
MaDCoWS: Brodwin et al, 2014


From Anthony Gonzalez
MOO J1014.1+0038
MaDCoWS is working.
What next?
MOO J1014.1+0038
F814W,F105W,F140W
Perlmutter, PID 13677

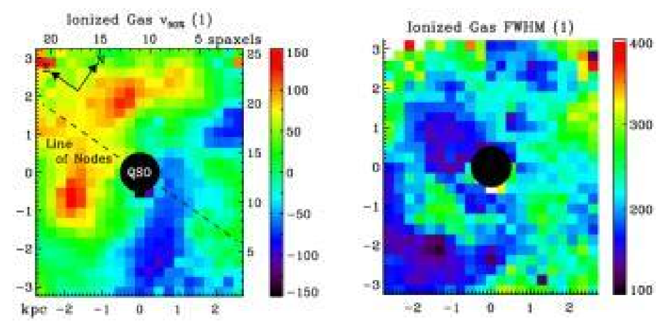
From Nadia Zakamska

Quasar feedback

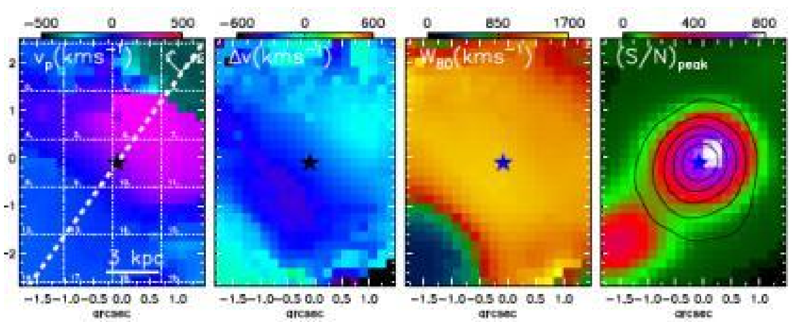
- A major unresolved issue in galaxy formation
- Limits the maximal baryonic mass in galaxies
- Puts galaxies on black hole / bulge correlations
- At low z, IFUs are revolutionizing studies of quasar winds
- New discoveries of galaxy-wide quasar-driven feedback
- Need observations at the peak of galaxy formation, quasar accretion epoch at z=2-3



z=0.5: Liu, Zakamska, Greene, Nesvadba, Liu 2013



z<0.1: Veilleux, Rupke 2011

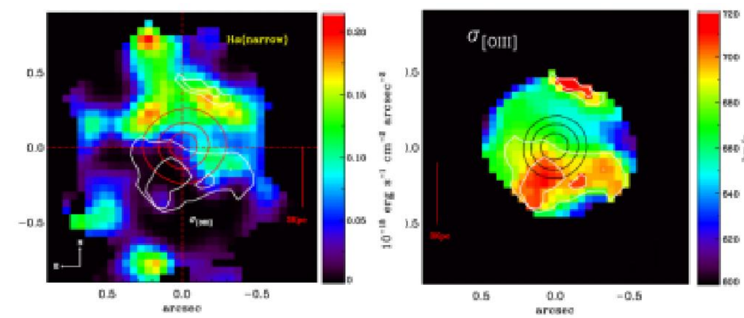


z=0.2: Harrison et al. 2014

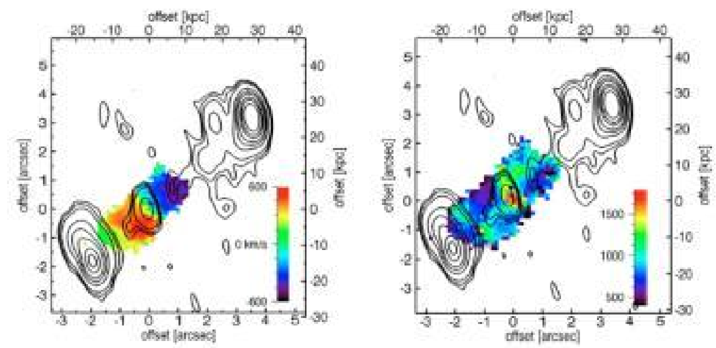
From Nadia Zakamska

Quasar feedback at 2 < z < 3

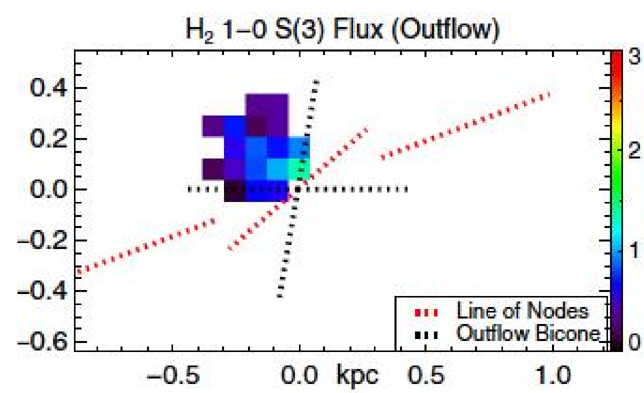
- With JWST, both ionized gas emission lines and ro-vibrational lines of H_2 can be accessed
- Ionized lines: now only possible for a handful of objects
- Warm molecular gas: currently impossible to observe at z>0.1; carries mass & energy of the quasar wind
- WISE provides ideal targets: the most luminous obscured quasars



Cano-Diaz et al. 2012, z=2.4, ionized gas



Nesvadba et al. 2008, z=2.4, ionized gas

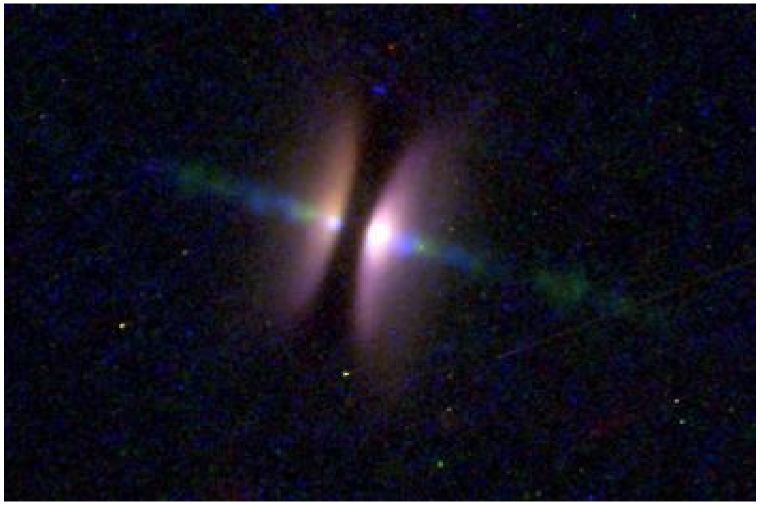


Rupke & Veilleux 2013, z<0.1molecular outflow

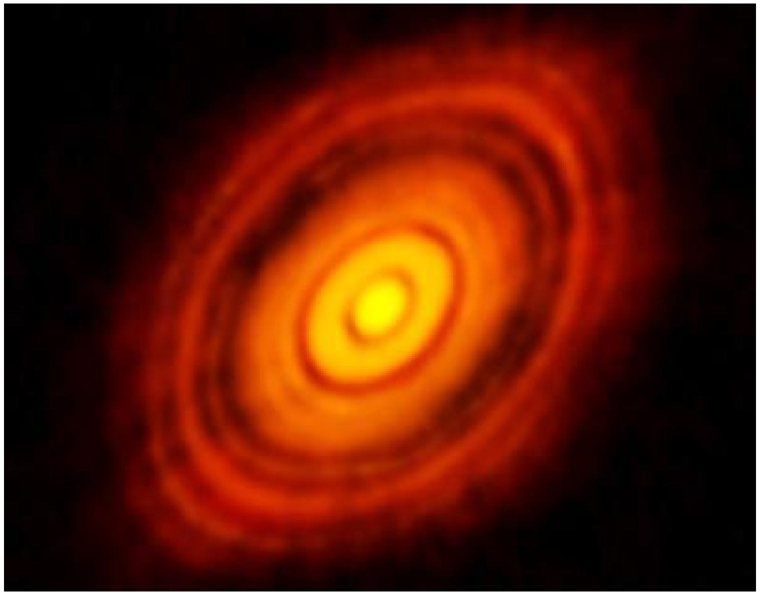
From Debbie Padgett

Young Stellar Objects (YSOs)

- YSO disk may have 4-5 magnitudes of excess in mid-IR but at most few% of NIR in scattered light; unless edge-on, disks are hard to see!
- Giant planets in the process of formation, as well as associated structures in the disk.
- Thousands of YSOs are known within 1 kpc from infrared excess discovered by IRAS, ISO, Spitzer, and WISE
- JWST observations:
  - Low-mass YSOs in nearby galaxies for IMF
  - Spectroscopy of water lines and other gas tracers in young disks
  - Resolved scattered light imaging of YSO nebulosity in nearby clouds
  - Resolved studies of YSO emission line jets
  - Discovery of young giant planets at peak emission around 4.5 μm



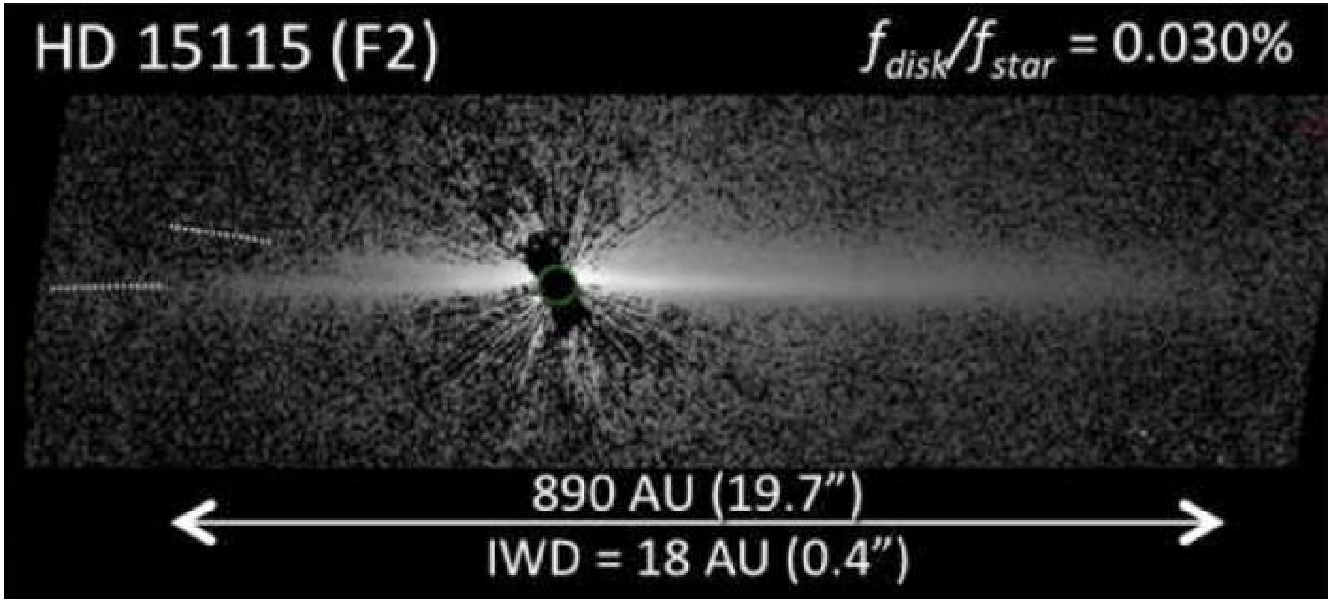
HST image of edge-on YSO disk (Duchêne et al. 2014)



HL Tauri disk from ALMA

From Debbie Padgett

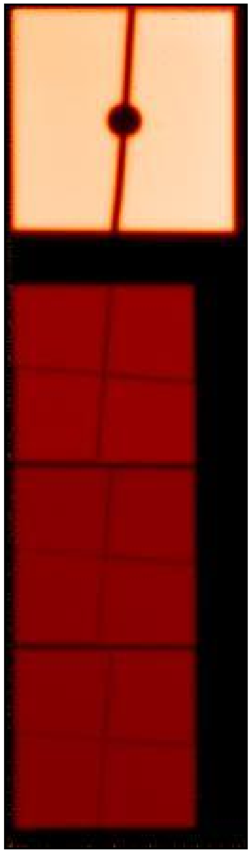
Debris Disk Science



HST/STIS image of debris disk (Schneider et al. 2014)

- Debris disks are optically thin disks primarily composed of dust particles liberated by planetesimal collisions
- Scattered light is << 1% of total NIR light, so contrast a challenge
- JWST will be able to resolve known disks at 2 - 5 µm for grain characterization
- Warm debris disks are associated with stellar youth, so good targets for finding warm young giant planets at 4.5 µm
- High sensitivity means JWST could detect new unresolved debris disks to great distances

MIRI Coronography



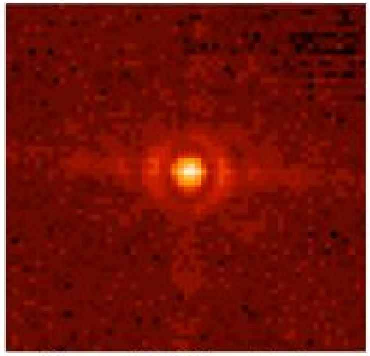


Figure 45: PSF at 11.4μm

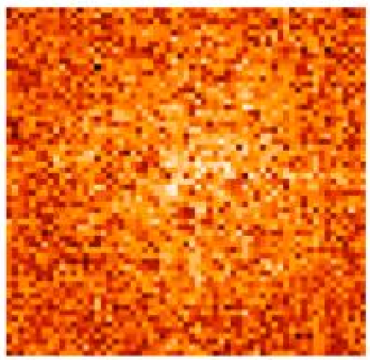


Figure 46: Coronagraphic image at 11.4μm

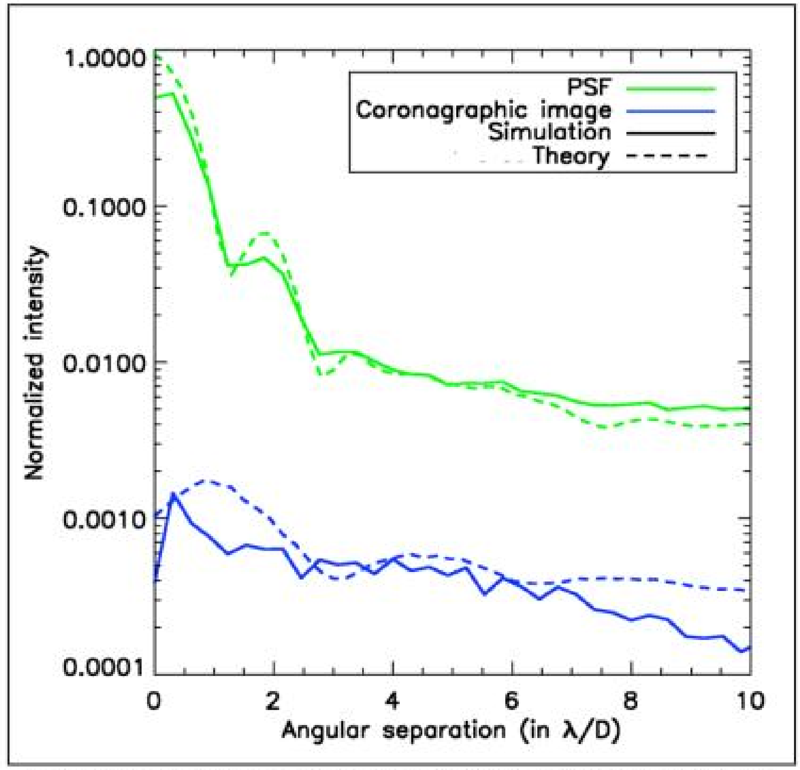


Figure 47: Normalized coronagraphic profile (blue line) and PSF (green line) compared to simulated profiles (doted lines) at 11.4μm

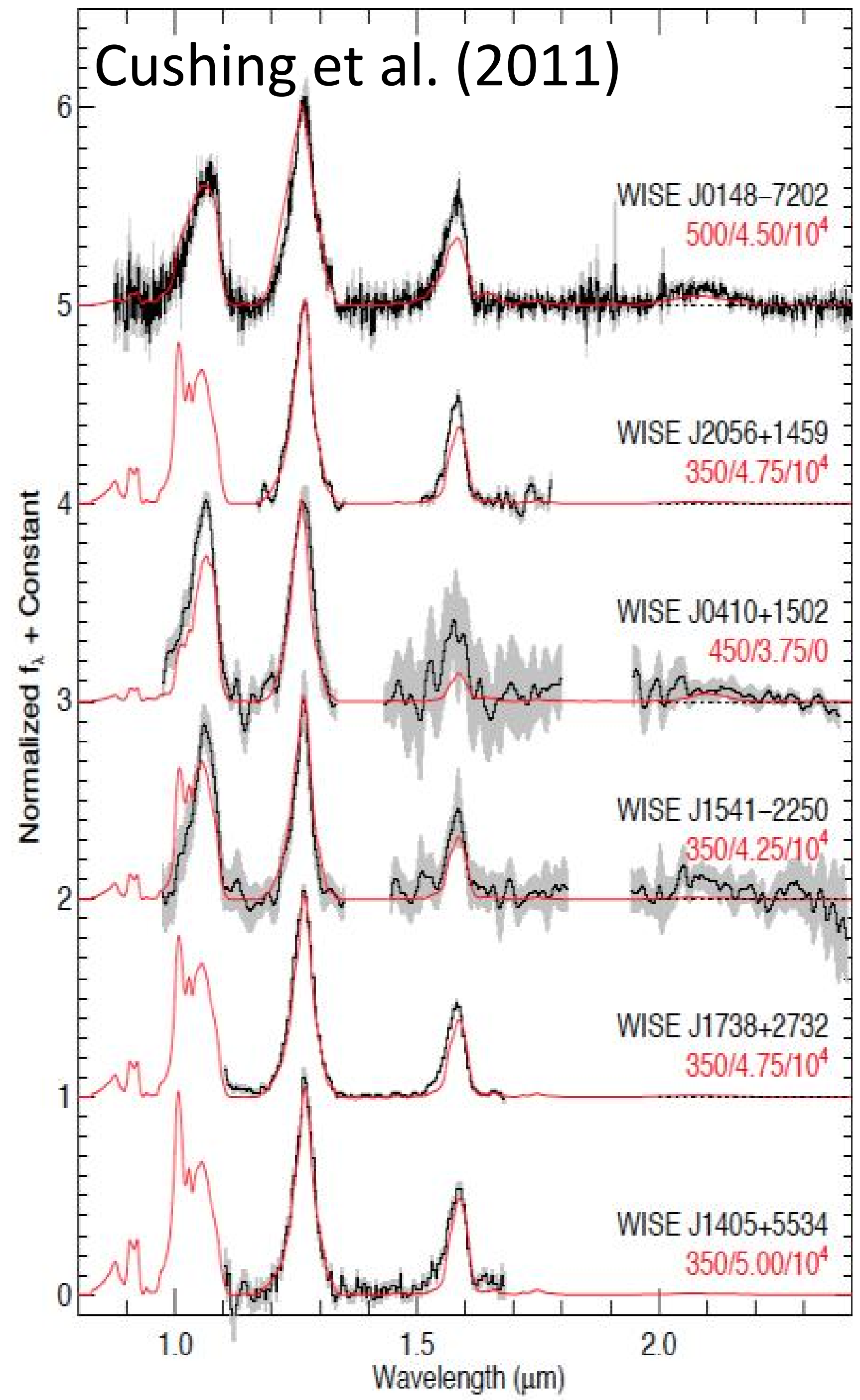
- Lyot coronagraph can be used with any filter, but 23 μm has an optimized mask
- You can put the source on the central disk, or on the supporting arms

From Mike Ressler

WISE Y dwarfs are ExoPlanet Analogs

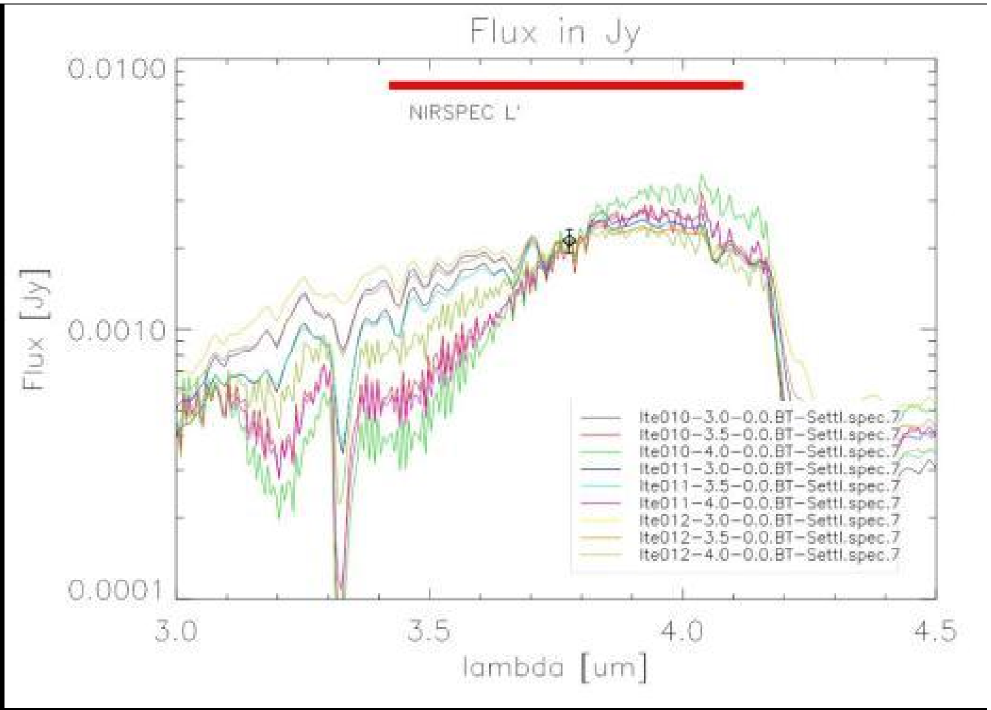
- Y dwarfs have temperatures <500 K
- >17 Y dwarfs known
- Parallaxes show distances from 2-15 pc
- 3rd closest object to Sun is WISE Y dwarf (Luhman 2014)
- Models suggest M~ 5-20 M_{jup}
- Similar object orbiting WD 0806-661 (Luhman 2011) with known distance (19 pc) and age (2 Gyr)

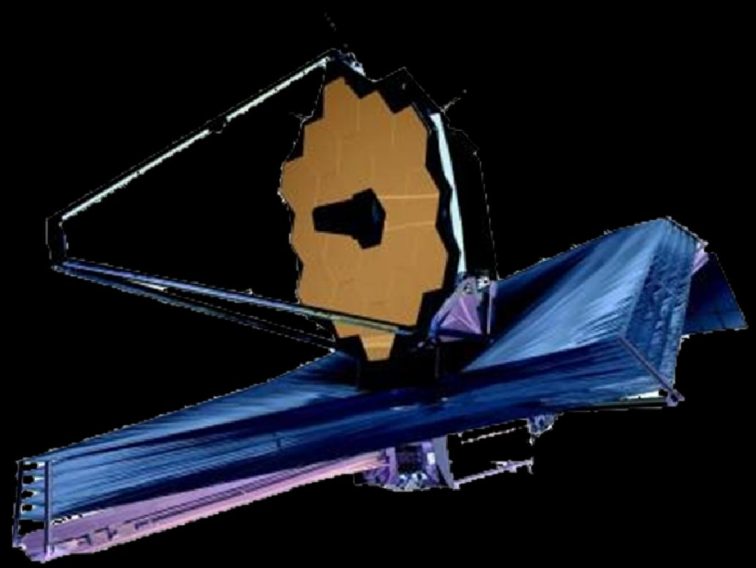
From Chas Beichman



Distinguishing Between BDs & "Planets"

- Models show significant differences due to Log g (age) and metallicity
- Core accretion → 2-6× higher metallicity in Jupiter compared to Sun
- Y dwarf spectroscopy at Keck, HST limit
- JWST spectra of BDs (SNR>100) in a few hours per source
- These are free-floating objects: don't need coronagraphy, so full spectra are possible.

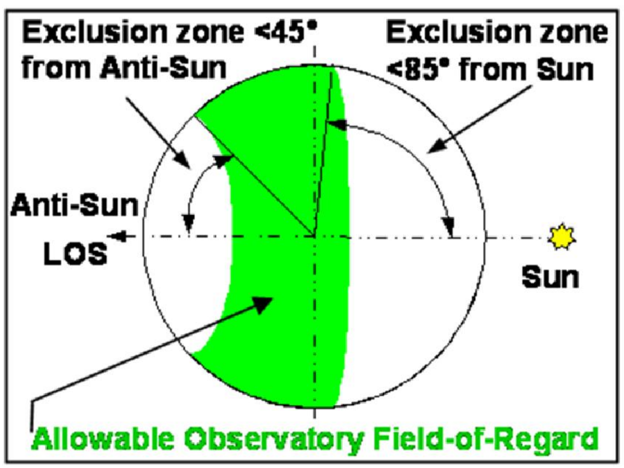


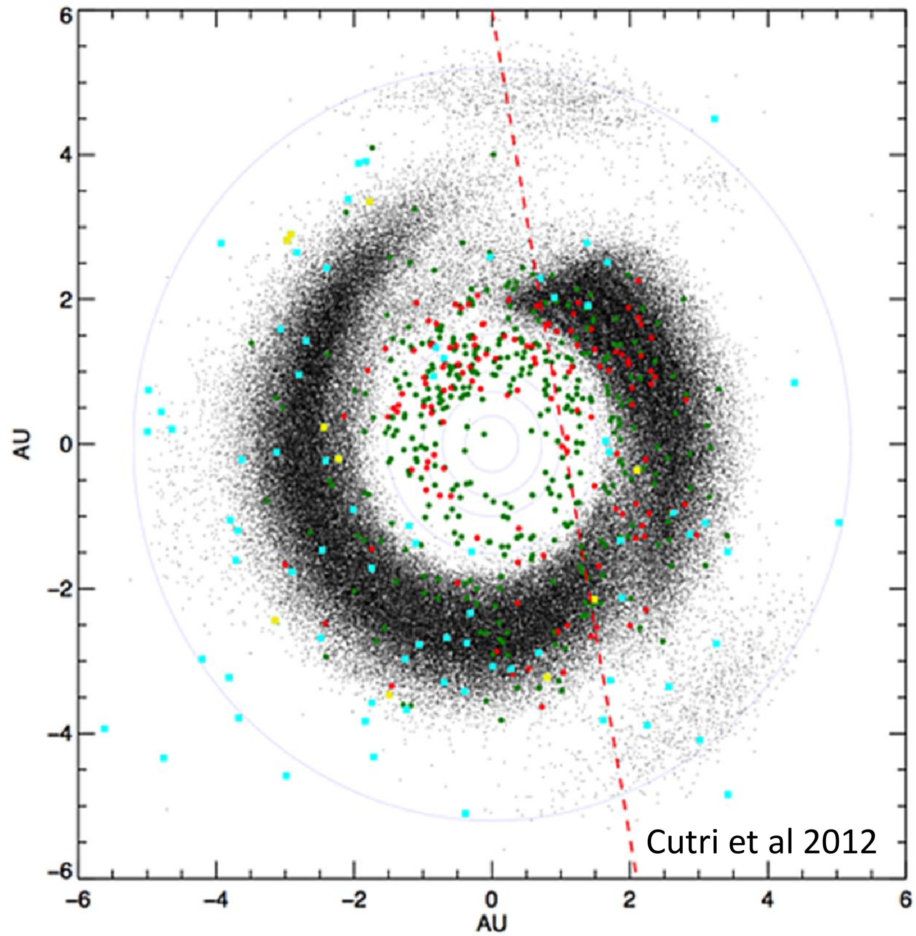


From Chas Beichman

JWST & WISE/NEOWISE Moving Objects

- JWST will facilitate a vast array of solar system studies:
  - Centaurs, Giant Planet Satellites and Trojan Asteroids, and Distant Comets (beyond Jupiter) will largely be accessible to study by JWST.
  - Objects within Jupiter's orbit inward, to the main belt asteroids, will be observable near their orbital stationary points.





WISE-Observed:

- Known NEOs
- WISE-discovered NEOs
- Known Comets
- WISE-discovered Comets

From Gerbs Bauer

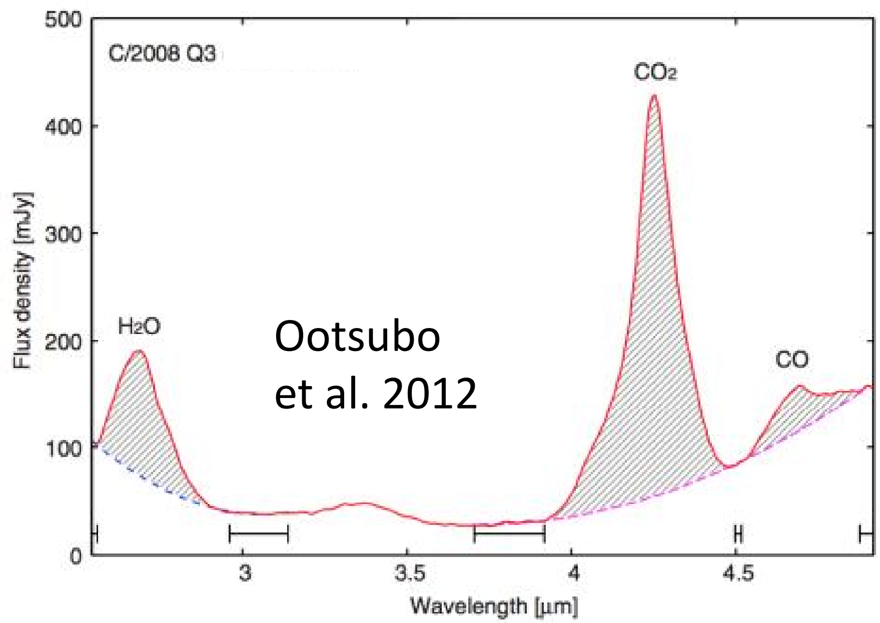
From Gerbs Bauer

JWST & NEOWISE

• JWST will be capable of focused studies of Solar System Objects of interest identified by NEOWISE.

•*IR Spectroscopy*

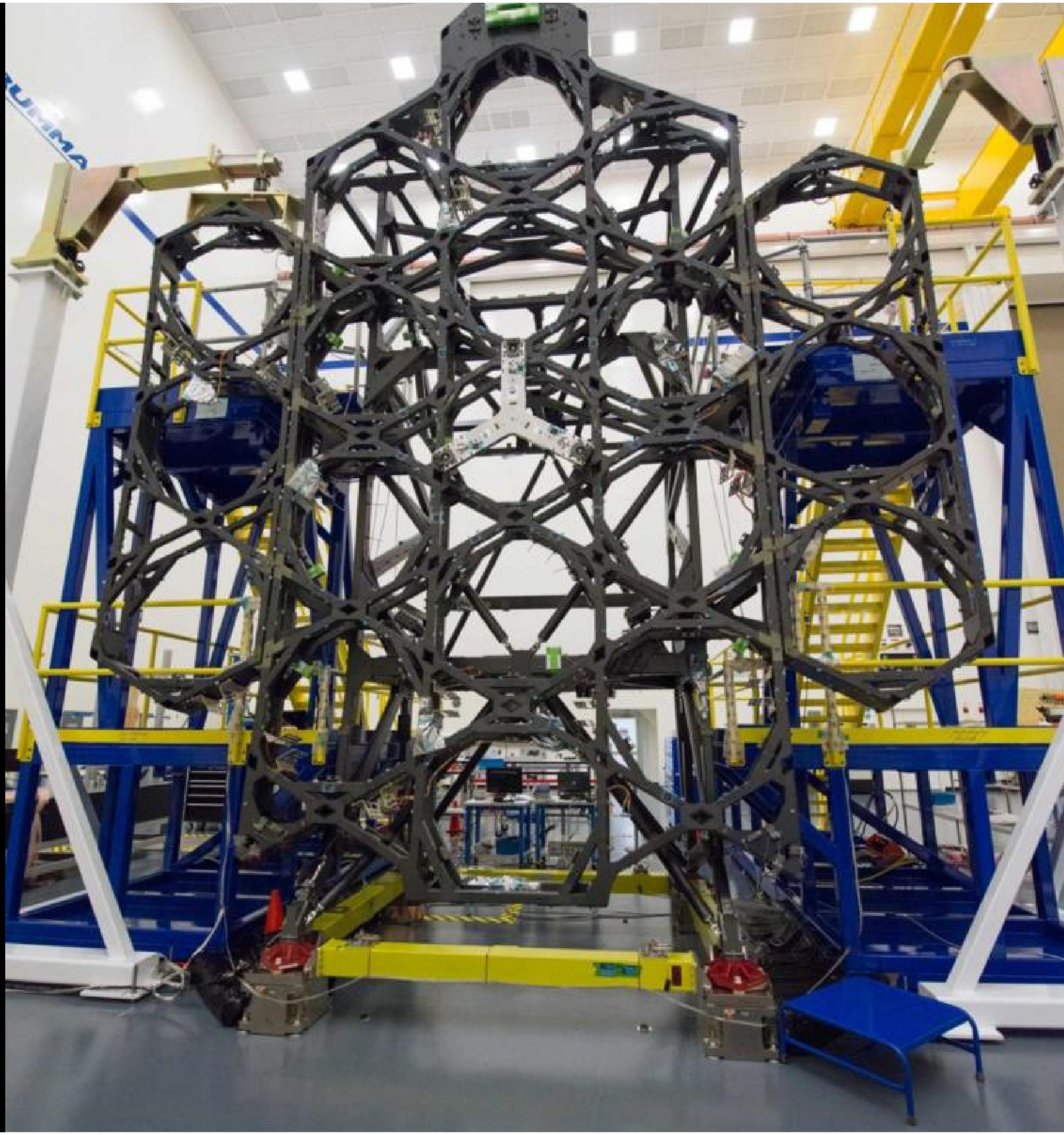
- Cometary dust and emission lines (e.g. CO & CO_2-active comets) out to large distances.
- Surface Spectroscopy of Trojan Asteroids and Centaurs (Volatiles, organics, silicates and thermal properties).



Ootsubo et al. 2012

•*IR imaging/photometry*

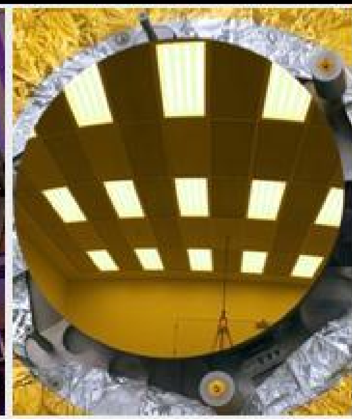
- Comet Dust Trails, Dust Particle Characteristics (Morphology, Albedo, size distributions)
- Small Body Thermal Surface Properties



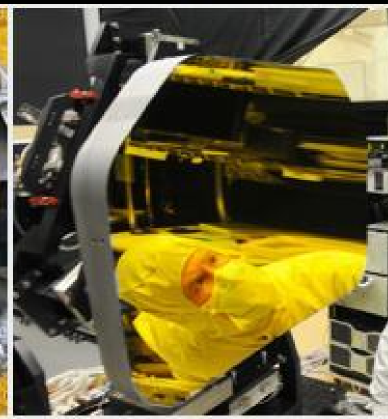
JWST's Flight Mirrors Complete

Primary Mirror Segment

Secondary Mirror

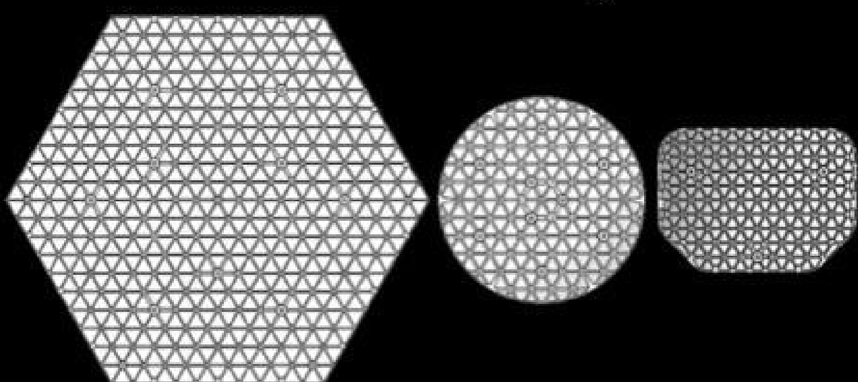


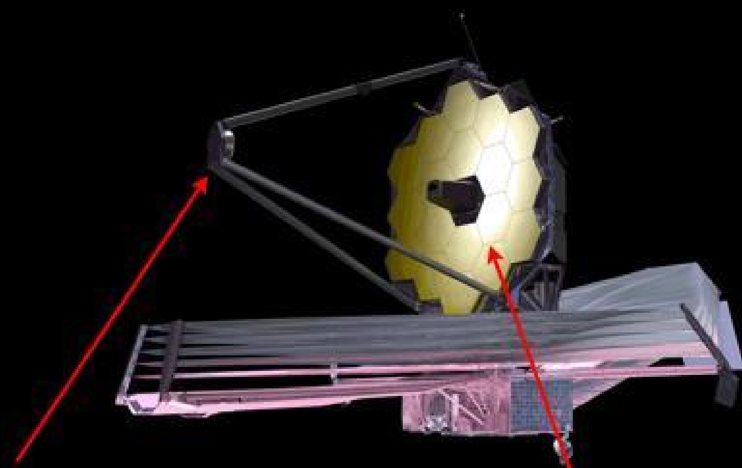
Tertiary Mirror



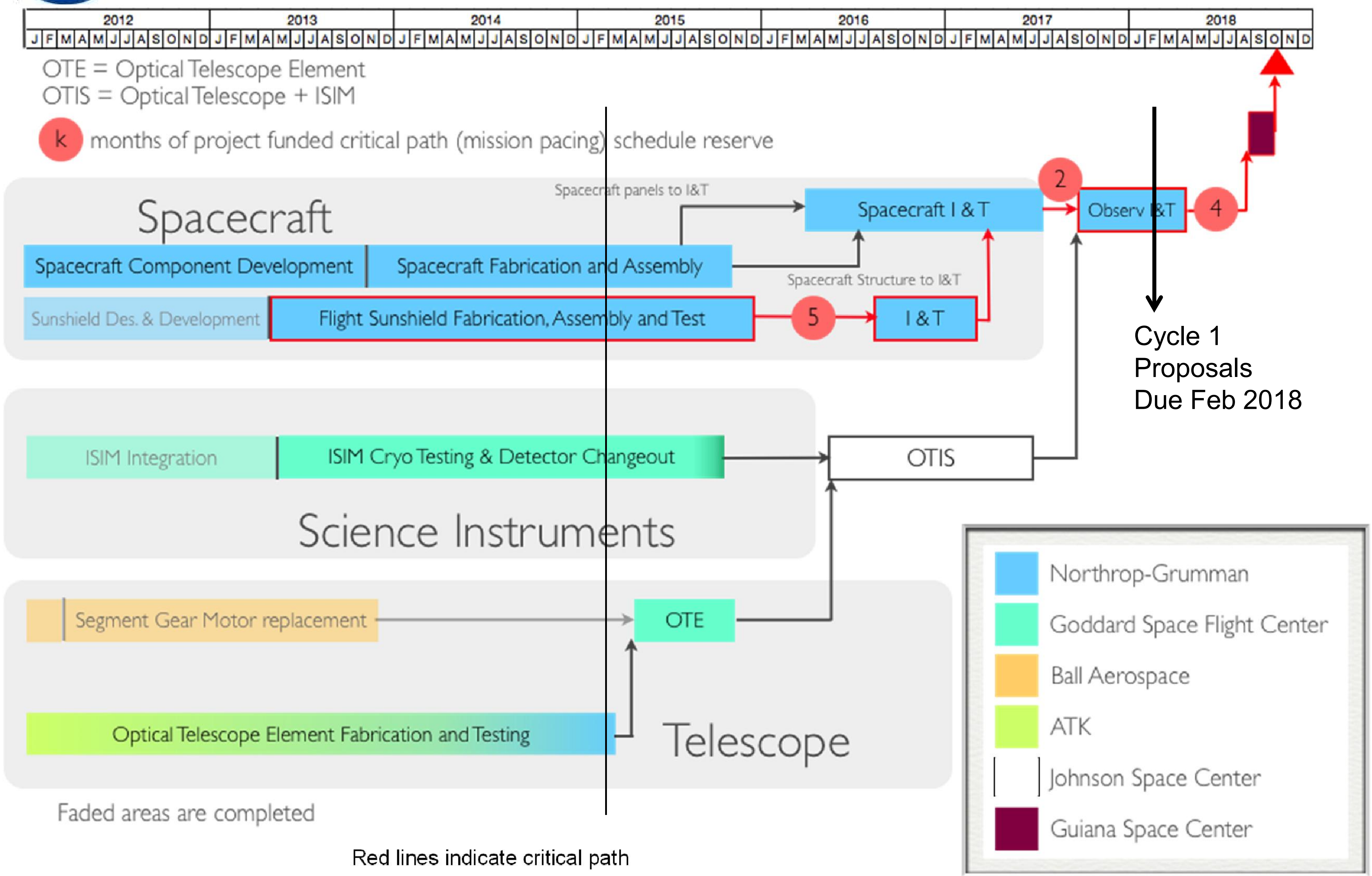
Fine Steering Mirror

Rear side view of mirrors showing relative size



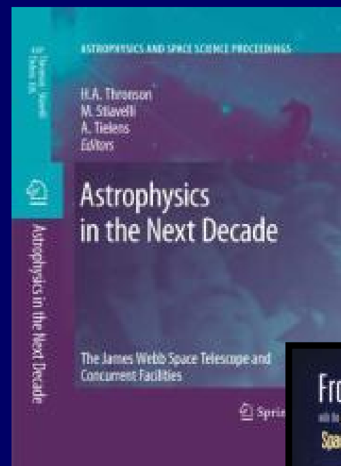


JWST Simplified Schedule



Want to Learn More about JWST?

Gardner et al. 2006,
Space Science Reviews, 123/4, 485
http://jwst.nasa.gov/scientists.html



2007 Conference
Proceedings
Read on-line

2011 Conference
Presentations
and video on-line at STScI

White Papers:

Solar System Objects
Dark Energy
Transiting Planets
Coronagraphy
Planetary Systems
Stellar Pops
Star Formation
Galaxy Assembly
First Light
Astrobiology
Scientific Capabilities
Observation Planning

Science White Papers
http://www.stsci.edu/jwst/science/whitepapers/

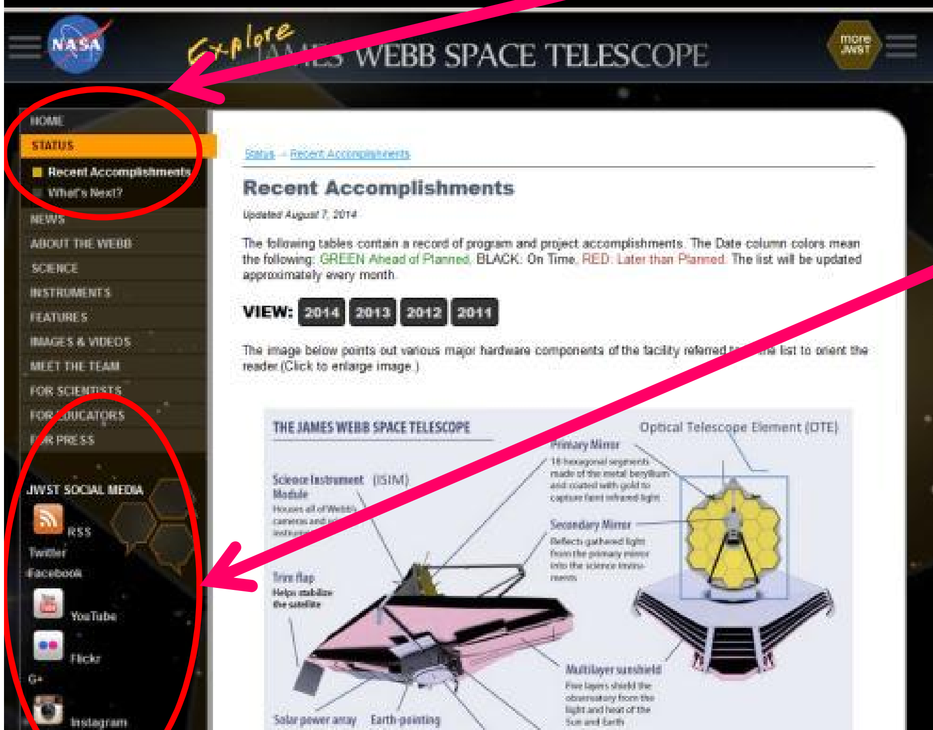
Annual Sessions at AAS, DPS and SPIE meetings

October 2015 JWST Conference at ESTEC in The Netherlands

Latest News

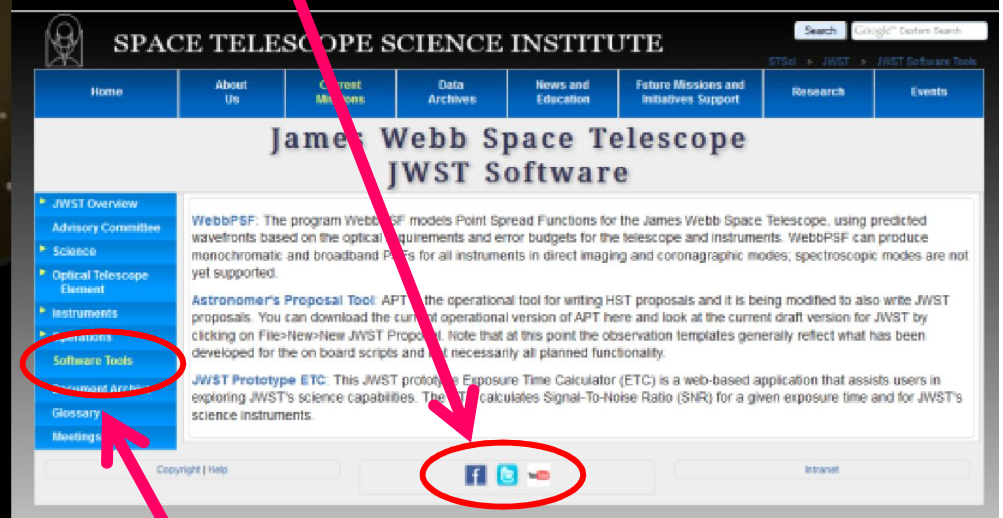
jwst.nasa.gov

Project Milestones
updated monthly



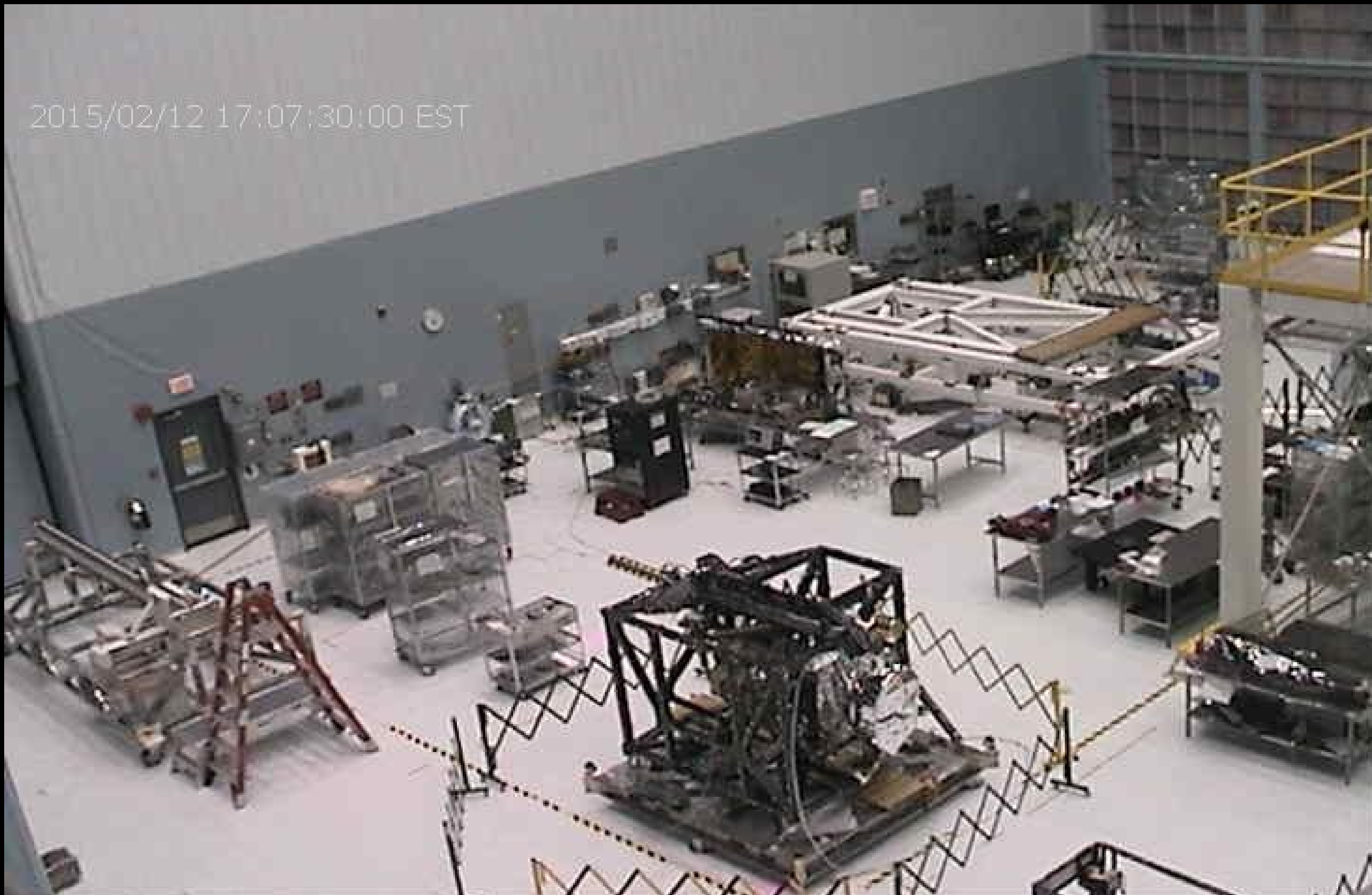
Social Media

www.stsci.edu/jwst



Astronomy Software Tools
ETC, PSF, APT

Webbcam

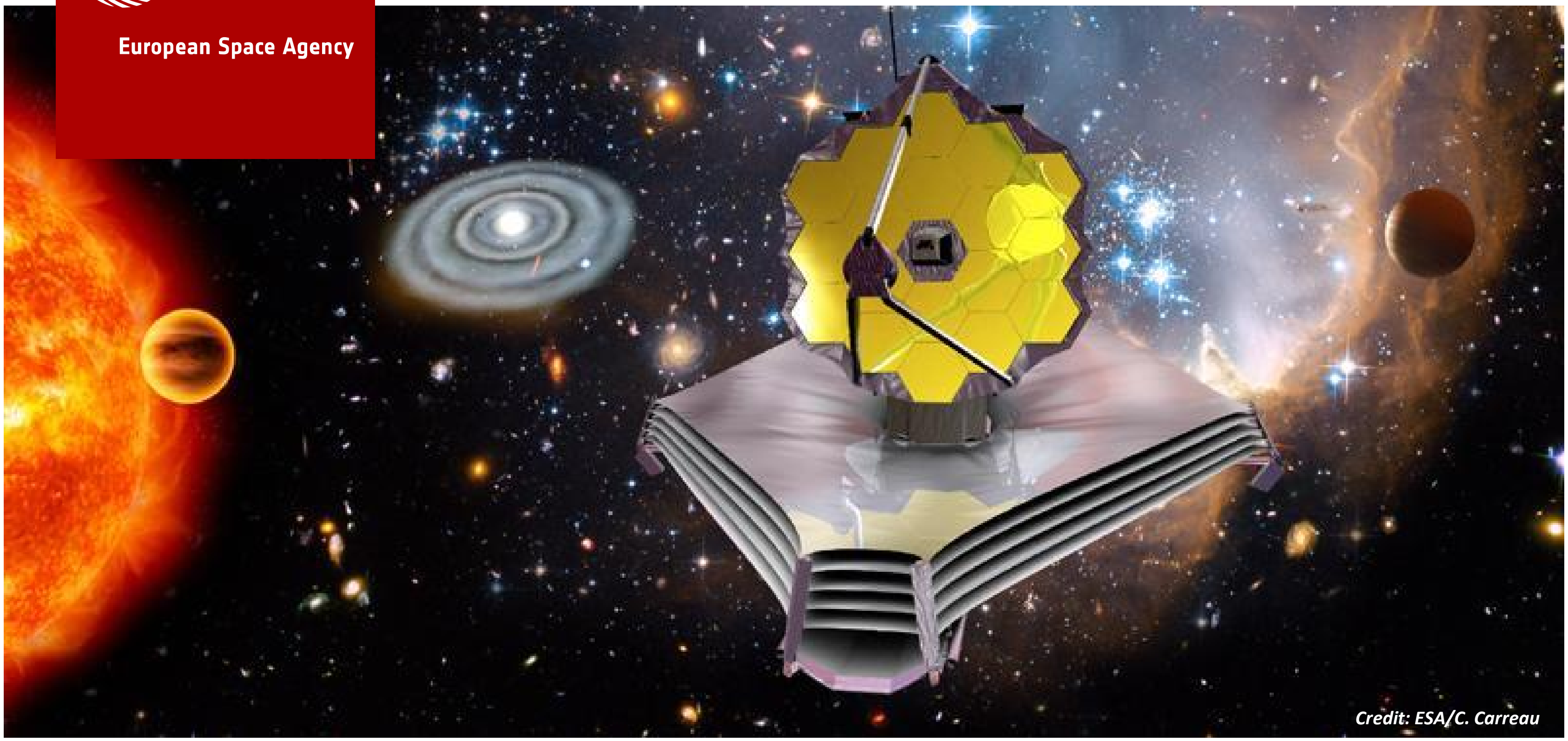


Live update every 60 seconds http://jwst.nasa.gov/webcam.html.

European Space Agency

“Exploring the Universe with JWST”

49th ESLAB symposium



ESA/ESTEC

October 12-16 2015

Noordwijk, The Netherlands

An international conference dedicated to the presentation and discussion of future scientific research that will be enabled by the James Webb Space Telescope.

REGISTRATION AND ABSTRACTS OPEN IN MARCH 2015

http://congrexprojects.com/15a02

From Jackie Flaherty


WISE & The James Webb Space Telescope
NASA
Jonathan P. Gardner
NASA's Goddard Space Flight Center
http://jwst.nasa.gov
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JWST **Imaging** Modes

Mode	Instrument	Wavelength (microns)	Pixel Scale (arcsec)	Field of View
Imaging	NIRCam	0.6 – 2.3	0.032	2.2 x 4.4′
	NIRCam	2.4 – 5.0	0.065	2.2 x 4.4′
	NIRISS	0.9 – 5.0	0.065	2.2 x 2.2′
	MIRI	5.0 – 28	0.11	1.23 x 1.88′
Aperture Mask Interferometry	NIRISS	3.8 – 4.8	0.065	2.2 x 2.2′
Coronography	NIRCam	0.6 – 2.3	0.032	20 x 20″
	NIRCam	2.4 – 5.0	0.065	20 x 20″
	MIRI	10.65	0.11	24 x 24″
	MIRI	11.4	0.11	24 x 24″
	MIRI	15.5	0.11	24 x 24″
	MIRI	23	0.11	30 x 30″

JWST **Spectroscopy** Modes

Mode	Instrument	Wavelength (microns)	Resolving Power (λ/Δλ)	Field of View
Slitless Spectroscopy	NIRISS	1.0 – 2.5	150	2.2 x 2.2′
	NIRISS	0.6 – 2.5	700	single object
	NIRCam	2.4 – 5.0	2000	2.2 x 2.2′
Multi-Object Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.4 x 3.4′ with 250k 0.2 x 0.5″ microshutters
Single Slit Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	slits with 0.4 x 3.8″ 0.2 x 3.3″ 1.6 x 1.6″
	MIRI	5.0 – ~14.0	~100 at 7.5 microns	0.6 x 5.5″ slit
IFU Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.0 x 3.0″
	MIRI	5.0 – 7.7	3500	3.0 x 3.9″
	MIRI	7.7 – 11.9	2800	3.5 x 4.4″
	MIRI	11.9 – 18.3	2700	5.2 x 6.2″
	MIRI	18.3 – 28.8	2200	6.7 x 7.7″