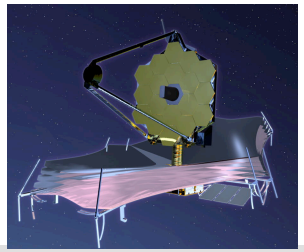




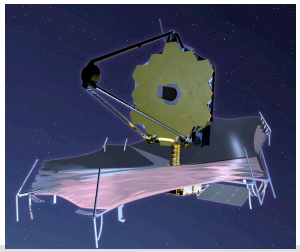




HST observations in preparation of JWST

M. Stiavelli

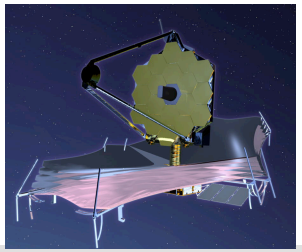
STScI



Summary:

- JWST and its status
- HST-JWST comparison
- Implications for HST surveys
- Observing with JWST

James Webb Space Telescope: Overview

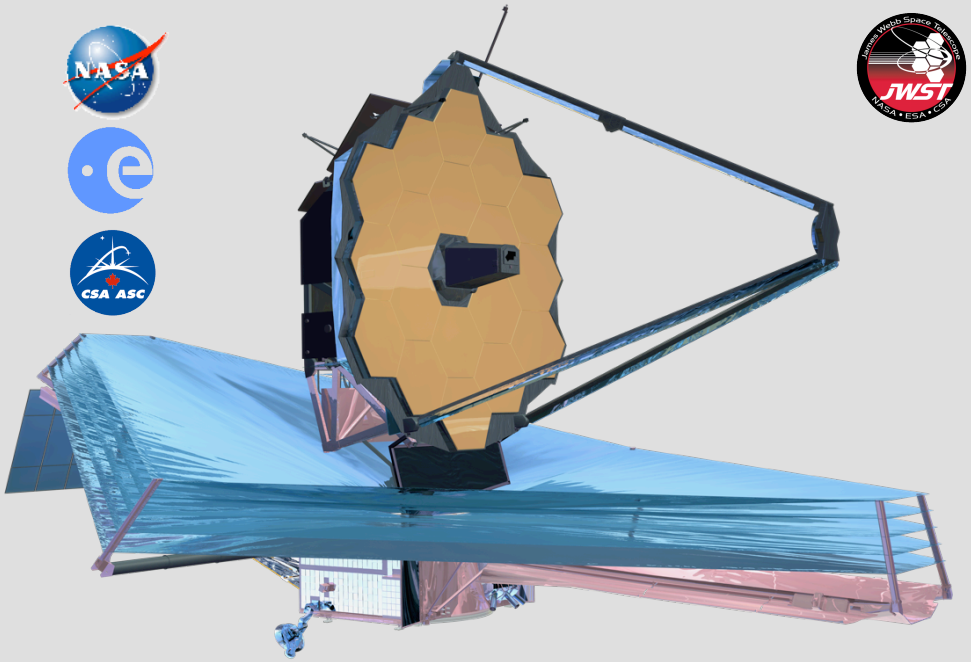


Organization

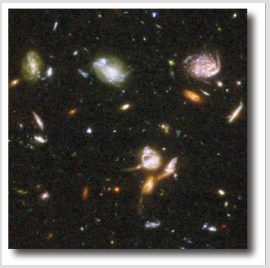
- **Mission Lead**: Goddard Space Flight Center
- Project Scientist: Dr John Mather (Nobel Laureate)
- **International collaboration**: ESA & CSA
- **Prime Contractor**: Northrop Grumman Space Technology
- **Instruments**:
  - Near Infrared Camera (NIRCam) – Univ. of Arizona
  - Near Infrared Spectrograph (NIRSpec) – ESA
  - Mid-Infrared Instrument (MIRI) – JPL/ESA
  - Fine Guidance Sensor (FGS) – CSA
- **Operations**: Space Telescope Science Institute

Description

- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch June 2013 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)

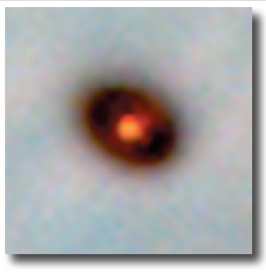


JWST Science Themes



End of the dark ages: First light and reionization

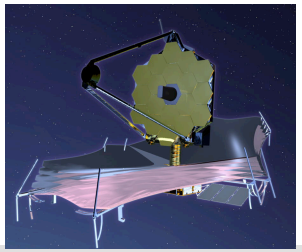
The assembly of galaxies

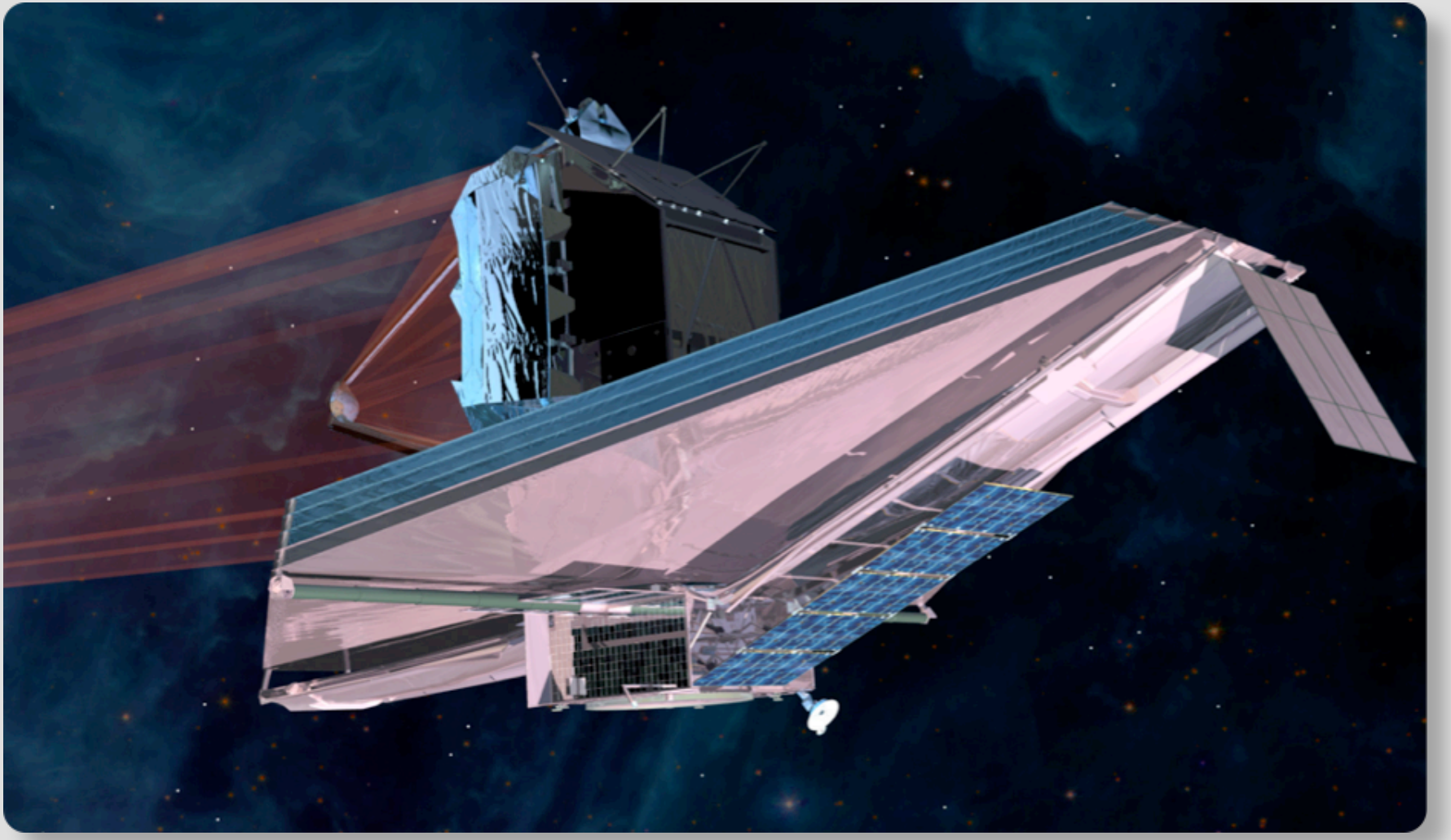


Birth of stars and proto-planetary systems

Planetary systems and the origin of life

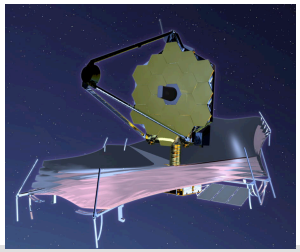
New Solar Array: Single Tail Dragger



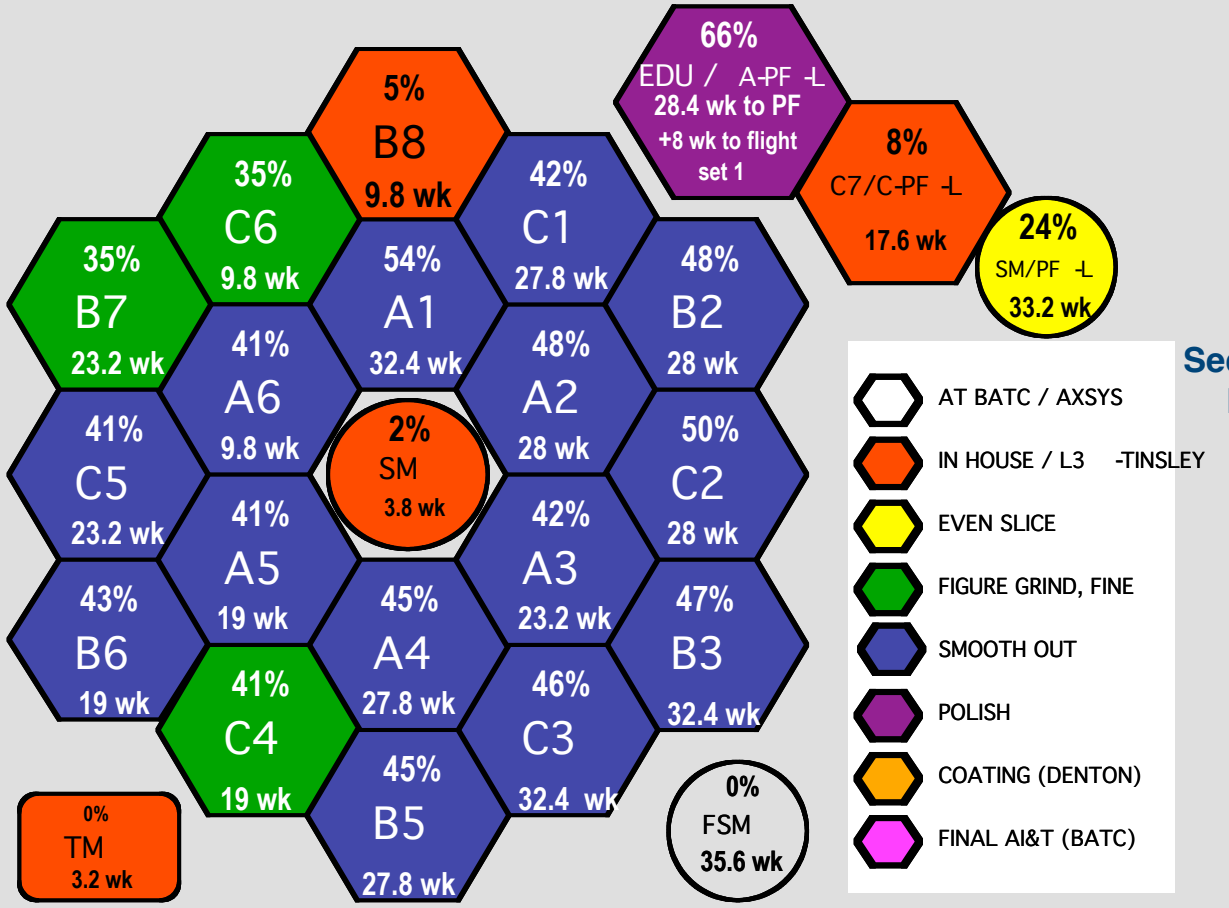


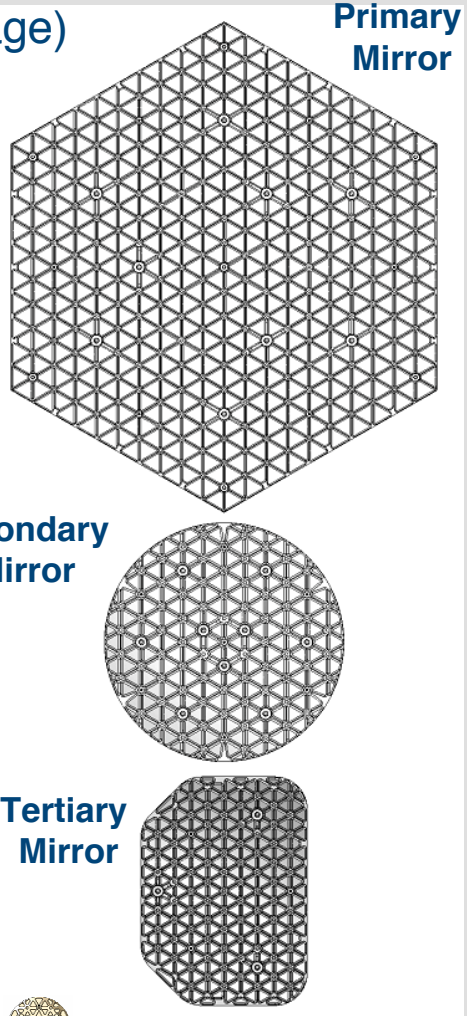
BRUSH WELLMAN has completed all JWST Primary, Secondary and Tertiary mirror blanks

JWST Mirror Development on Schedule

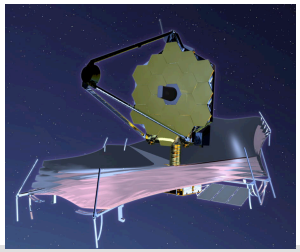


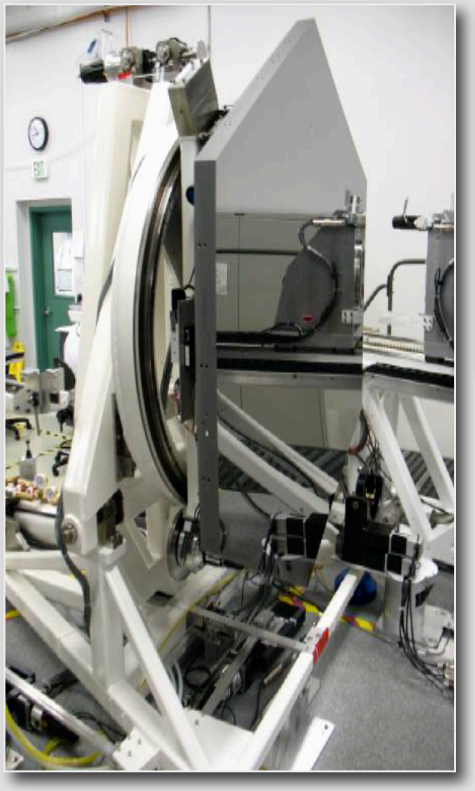
- Flight PM/SM segments are all being figured at Tinsley (3rd Stage)
- Tertiary and Fine Steering mirror ready for delivery to Tinsley

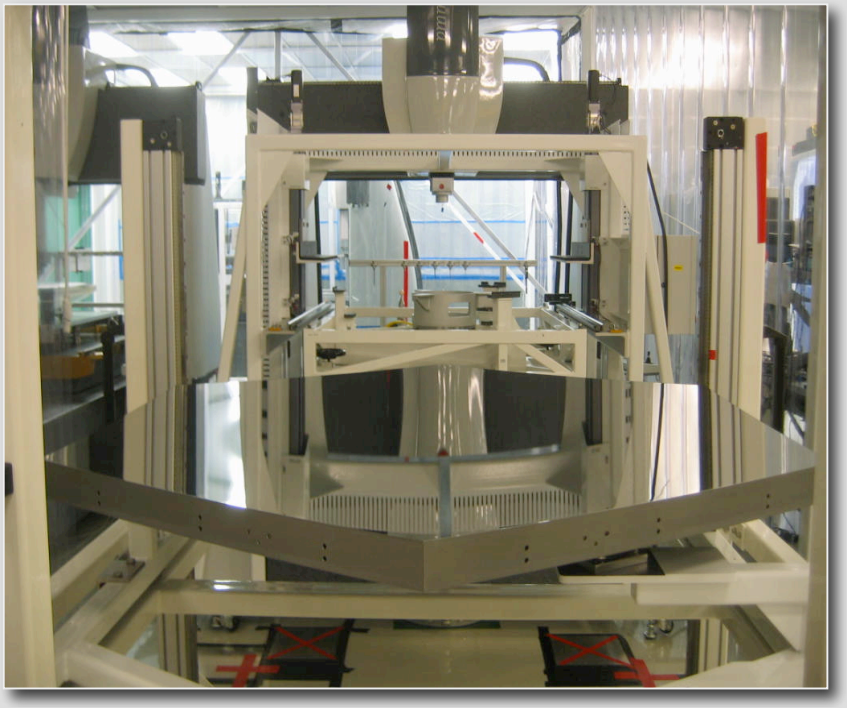




EDU Mirror - Figuring Process Pathfinder

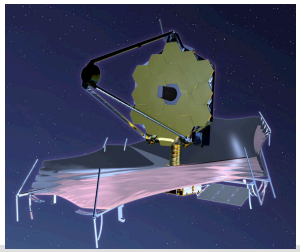


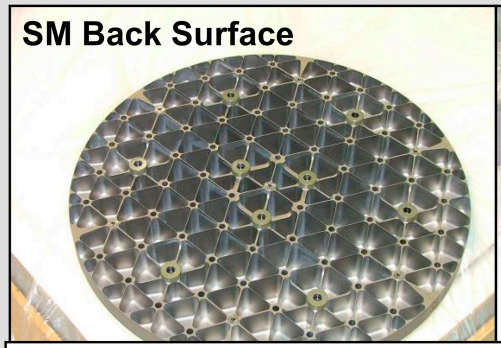


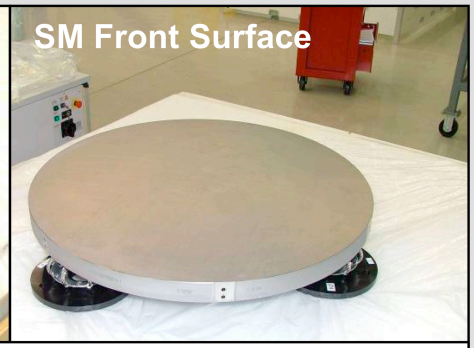


- EDU mirror is on schedule for completion of fine polishing in a few months
  - Next step is cryo-polish
- EDU is providing fine-tuning of the figuring process for flight mirrors

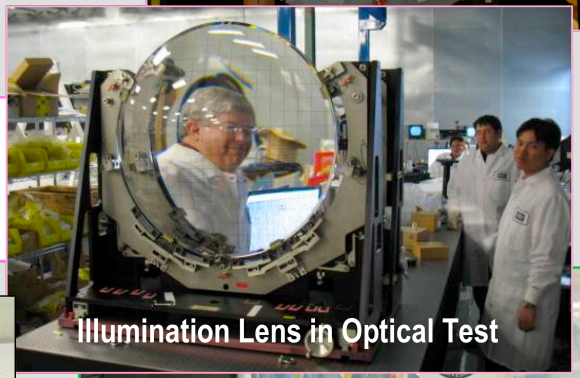
JWST Secondary Mirror on Schedule



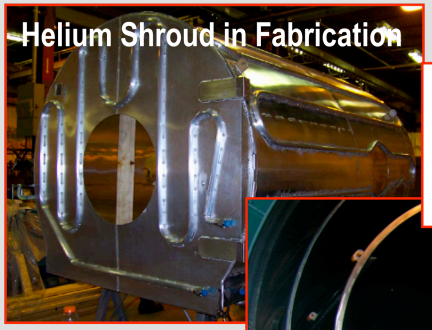




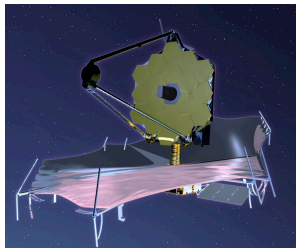
SM Pathfinder Light and Flight segments have completed machining at Axsys Technologies. Processing is beginning at Tinsley Laboratories.

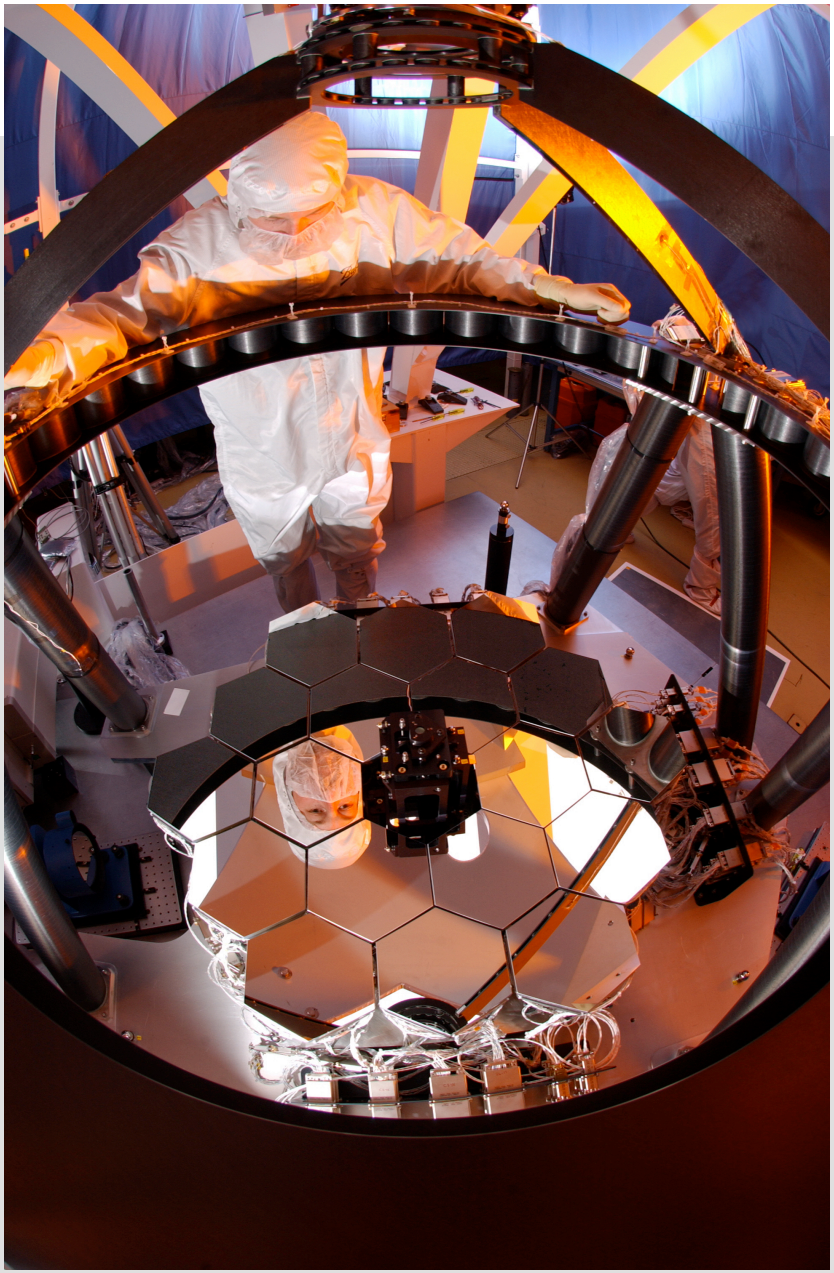


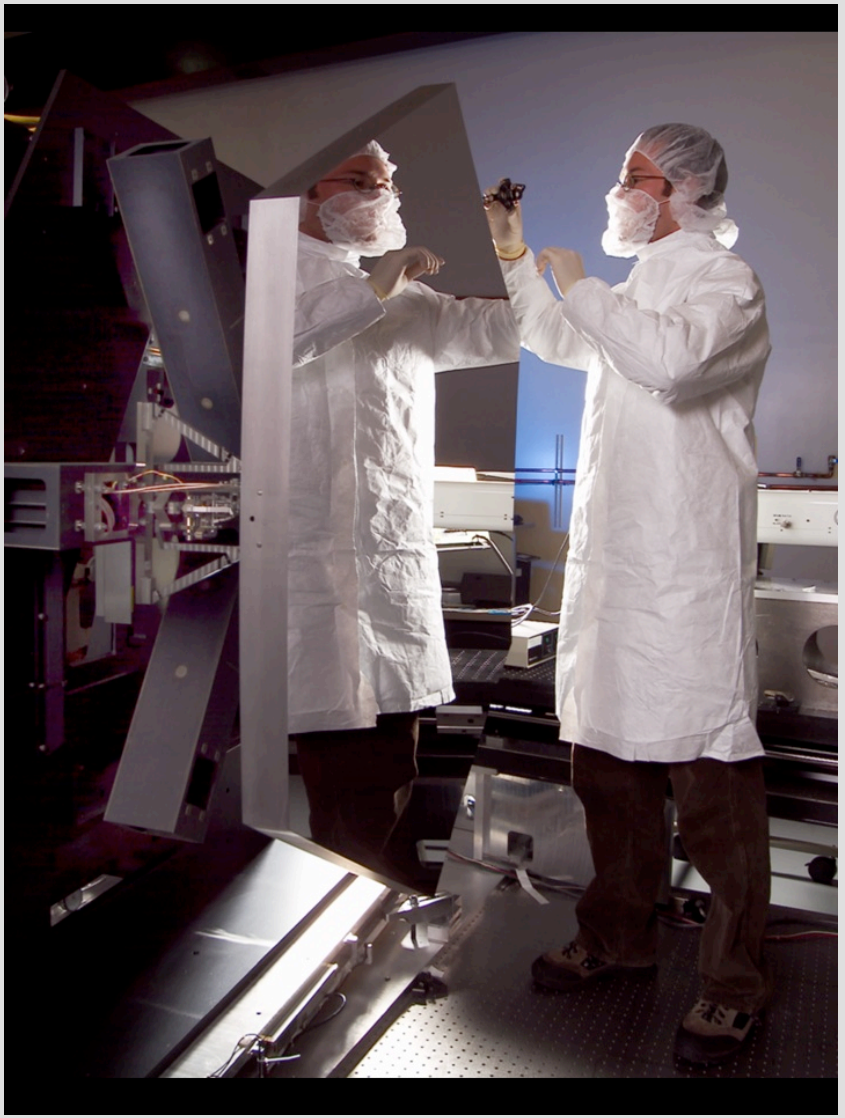
The Aspheric Test Plate Lens and Illumination Lens is nearing completion at Tinsley Laboratories.



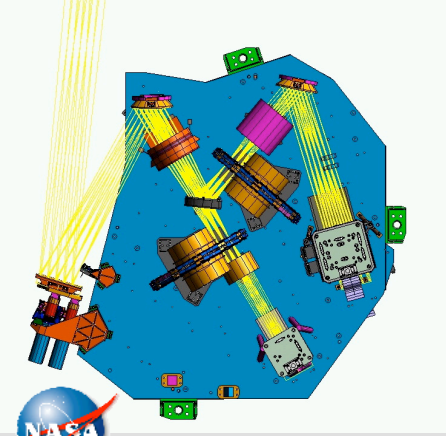
The helium shroud and regeneration system has been delivered to BATC and tested down to 6K.







Instrumentation



Arizona: Marcia Rieke PI

Lockheed-Martin & Rockwell

- NIRCam, 0.6 to 5.0 micron:
  - 2.3 x 4.5 arcmin FOV
  - Broad & narrow-band imaging
- NIRSpec, 0.6 to 5.0 micron
  - 3.4 x 3.4 arcmin FOV
  - Micro-shutter, IFU, slits
  - R~100, 1000, 3000

TFI, 1.6 to 4.8 micron

- 2.2 x 2.2 arcmin FOV
- R~100 narrow-band imaging

MIRI, 5.0 to 27.0 micron

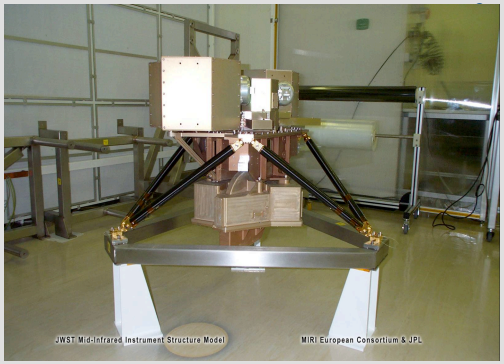
- 1.4 x 1.9 arcmin FOV imaging
- 3 arcsec IFU at R~3000

Coronagraphy

- NIRCam, TFI & MIRI

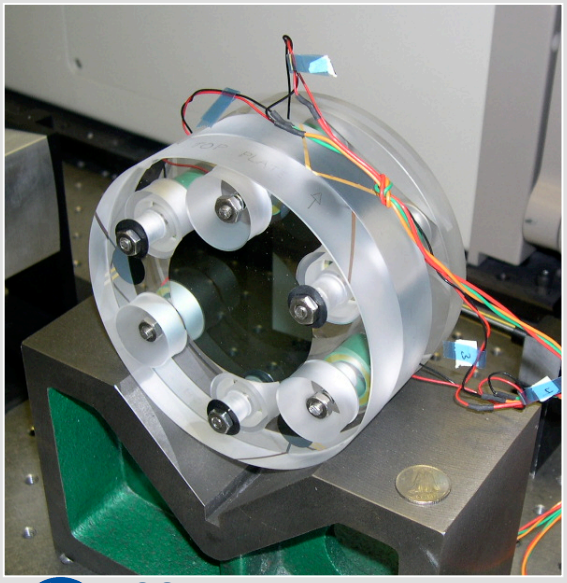
ESA: Peter Jakobsen

EADS Astrium & GSFC



George Rieke & Gillian Wright

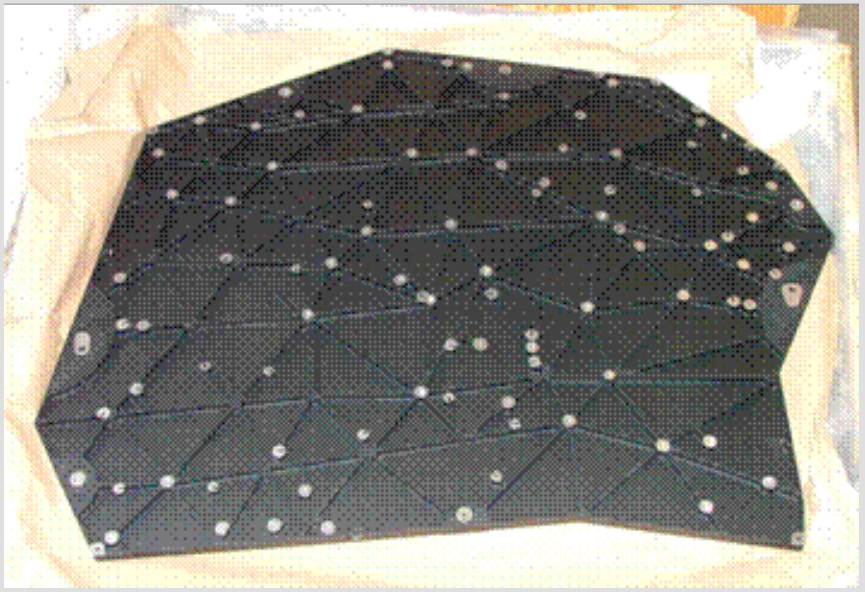
JPL and European Consortium



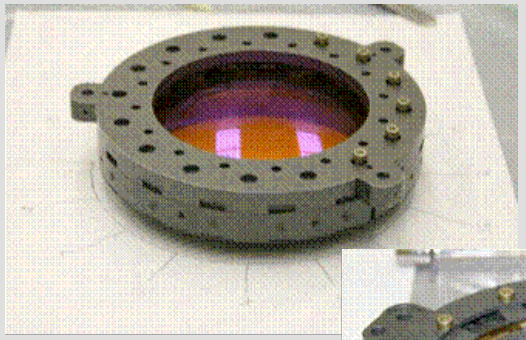
CSA: Rene Doyon

COM DEV

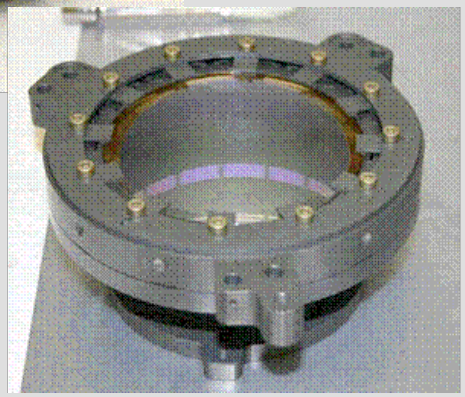
NIRCam ETU Hardware in Fabrication



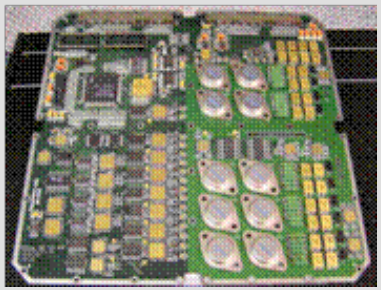
Bench panel after anodizing



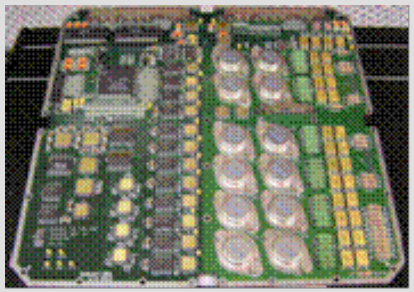
ZnSe
Collimator



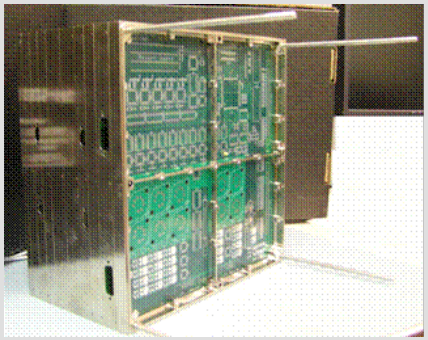
BaF_2
Camera

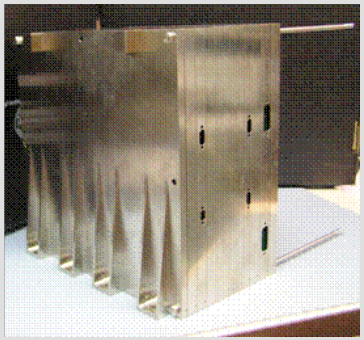


Filter Wheel Drive Board



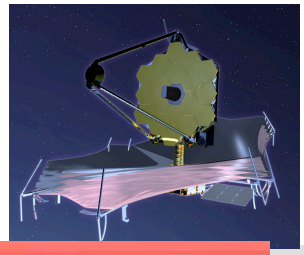
Focus Mech Drive Board



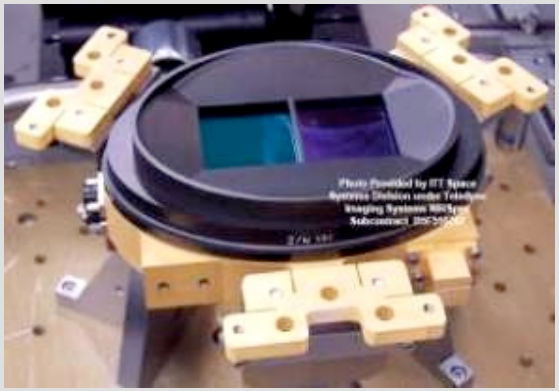


Instrument Control Electronics

NIRSpec ETU/Qual Model Hardware



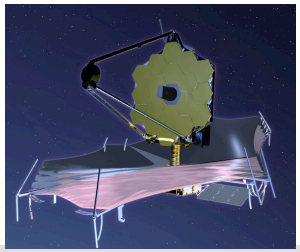
Fore Optics

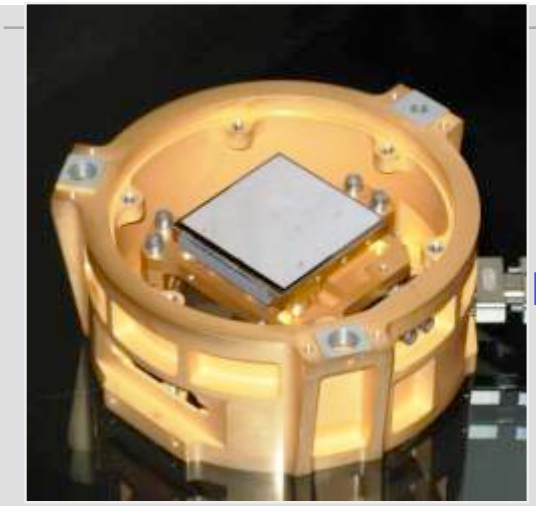


Focal Plane Assembly

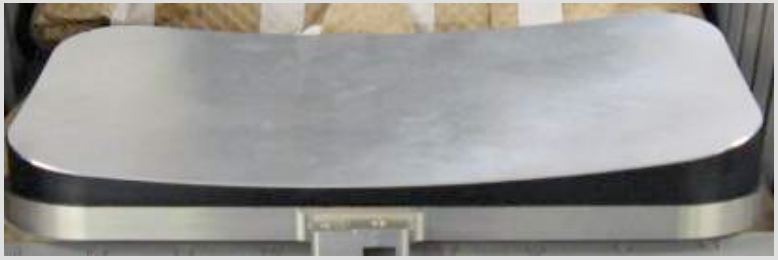
Optical Bench

FGS ETU/Flight Hardware in Fabrication



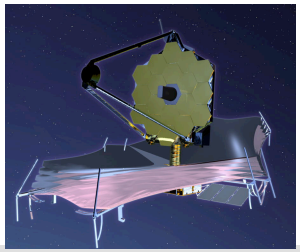


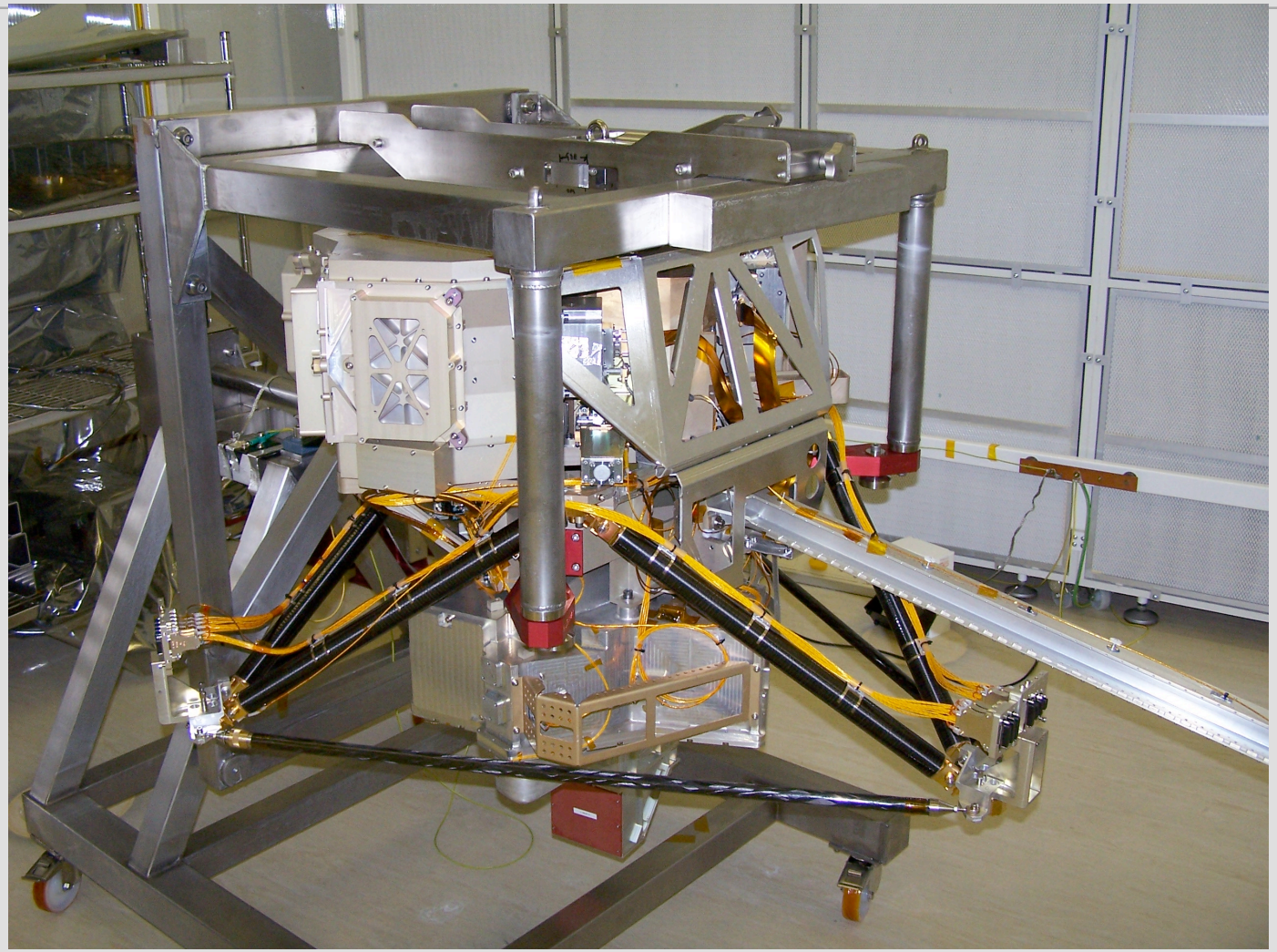
Demo Unit
Focal Plane



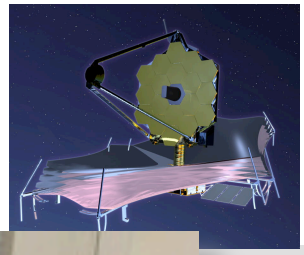
Primary Mirror Blank

MIRI Verification Model in Test

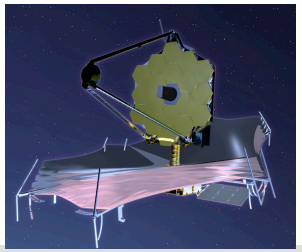


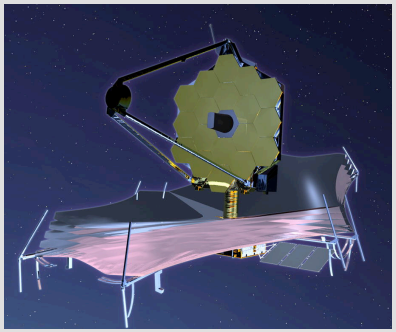


Sunshield: full scale membrane test



Operations





JWST at L2

Ka S

DSN

THE ASTROPHYSICAL JOURNAL

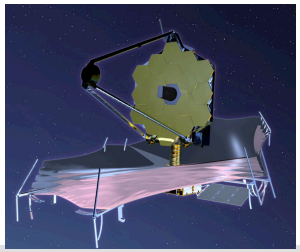
- STScI has been designated as Science Operations Center
- GO, Legacy/Treasury and GTO programs similar to HST

Astronomer

STScI

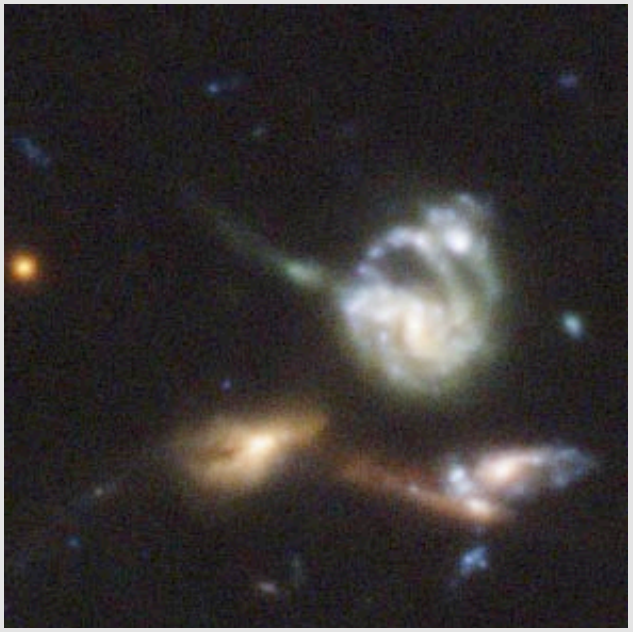
TAC

HST vs JWST



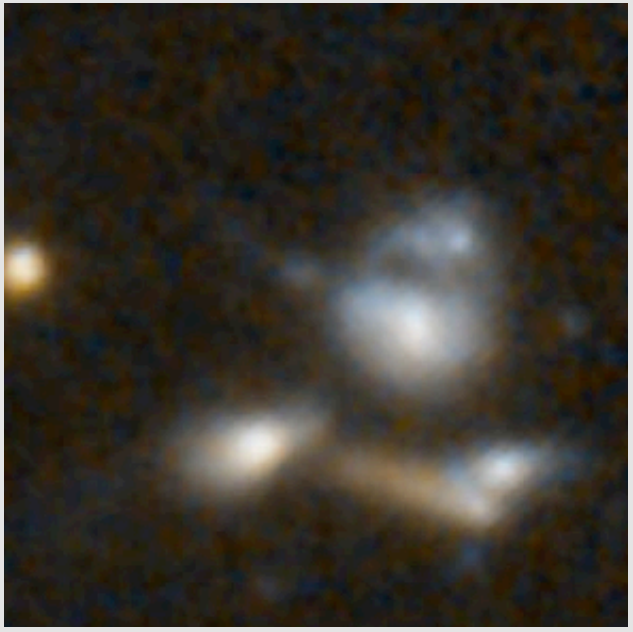
- JWST is capable of high angular resolution imaging (similarly to HST but extended to the near-IR)

HST/ACS
Viz



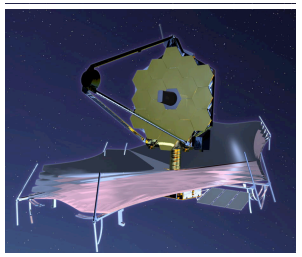
JWST/NIRCam
Viz

HST/NICMOS
J H

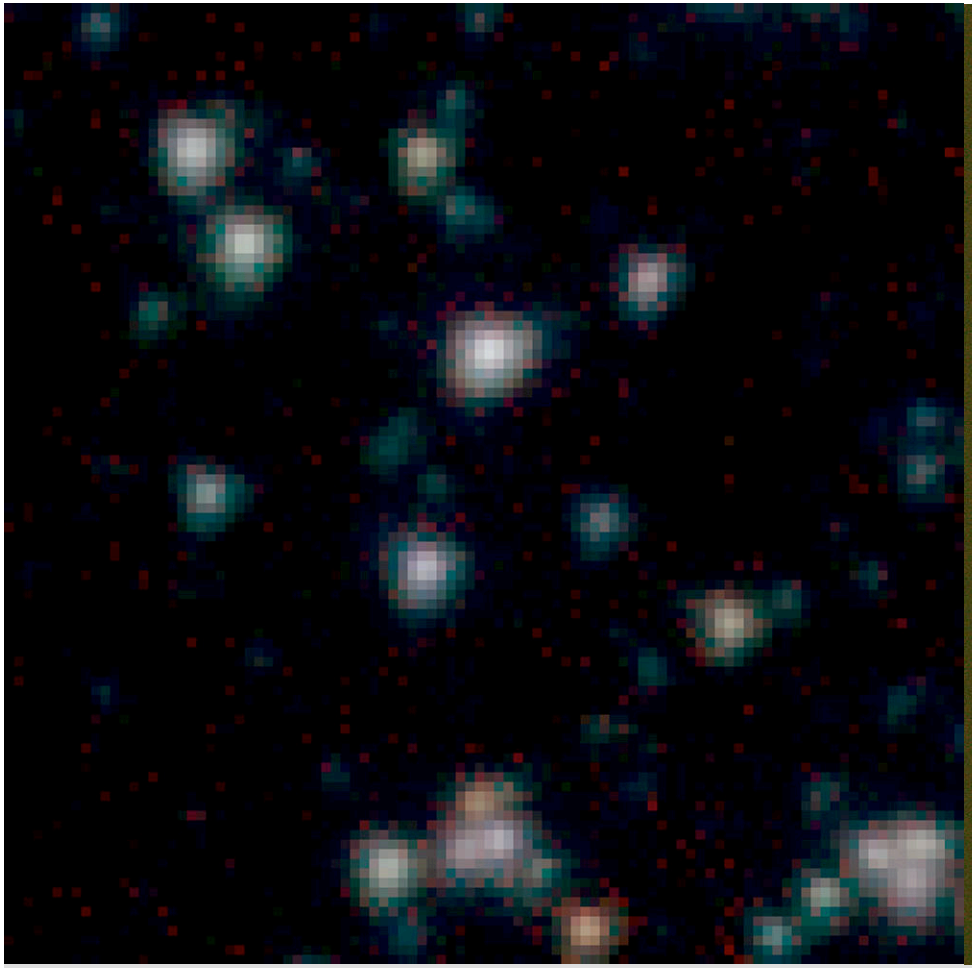


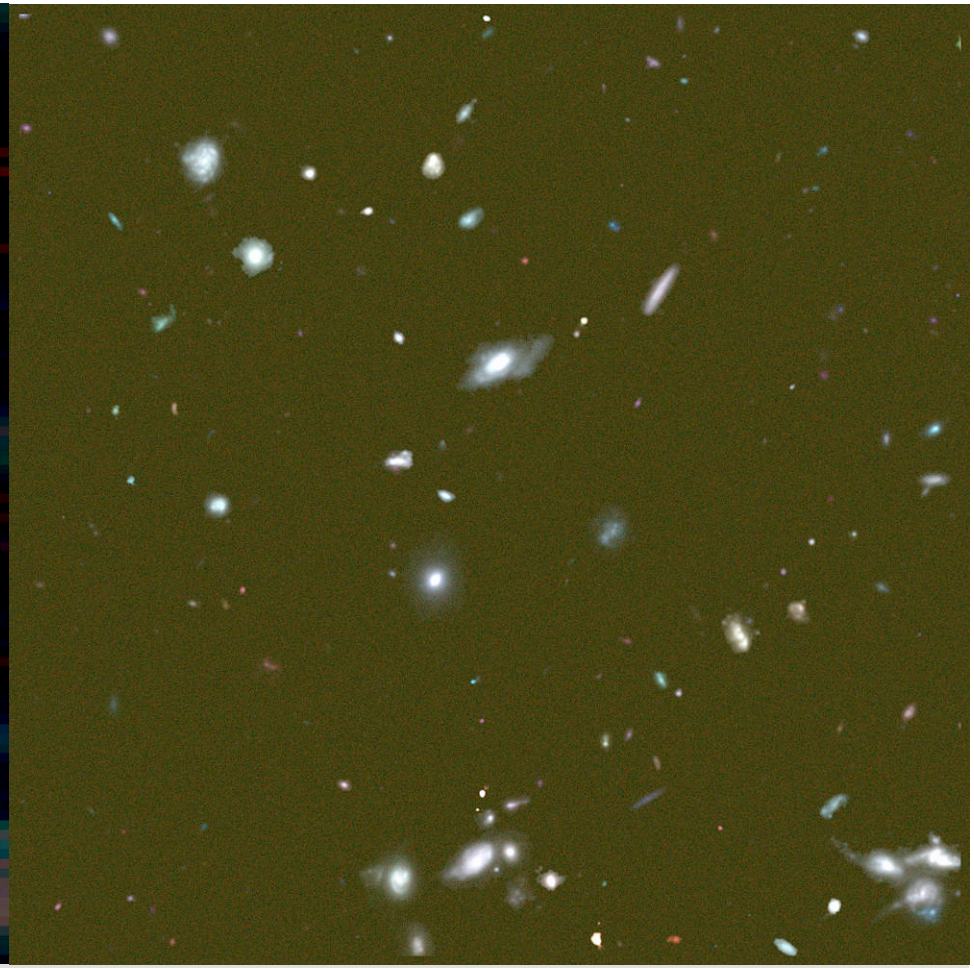
JWST/NIRCam
J H

JWST-Spitzer image comparison



1'x1' region in the UDF – 3.5 to 5.8 μm



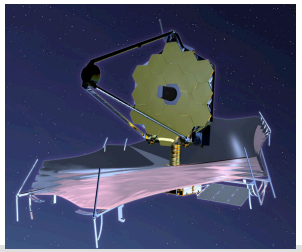


Spitzer, 25 hour per band (GOODS)

JWST, 1000s per band (simulated)

JWST can take a spectrum of everything that Spitzer can image

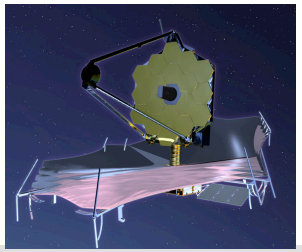
HST vs JWST



- ✓ JWST is capable of high angular resolution imaging (similarly to HST but extended to the near-IR)
- ✓ JWST has a rich complement of coronographs
- ✓ JWST is significantly more sensitive than HST (and Spitzer)

- JWST cannot take images at wavelengths below the V band
  - ➢ for UV, B band, and possible V band need to use HST
- JWST cannot take spectra at resolving power > 3000
- JWST cannot take spectra at wavelengths below ~ 8000Å
- JWST has no astrometric instrument similar to HST-FGS
- JWST has no polarizers

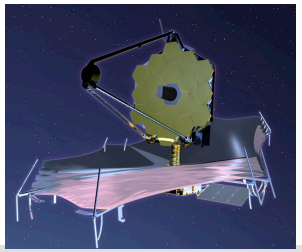
Implications for HST surveys



For projets requiring UV, visible data it is important to make sure that the needed data will be obtained with HST as it is unsure that there will be a long overlap with both HST and JWST available to the community: JWST will be launched five years after the next (last) HST servicing mission. Different fields may well have different requirements, e.g.

- High-z high latitude surveys
- Nearby galaxies
- Galactic globular clusters
- Galactic star forming regions

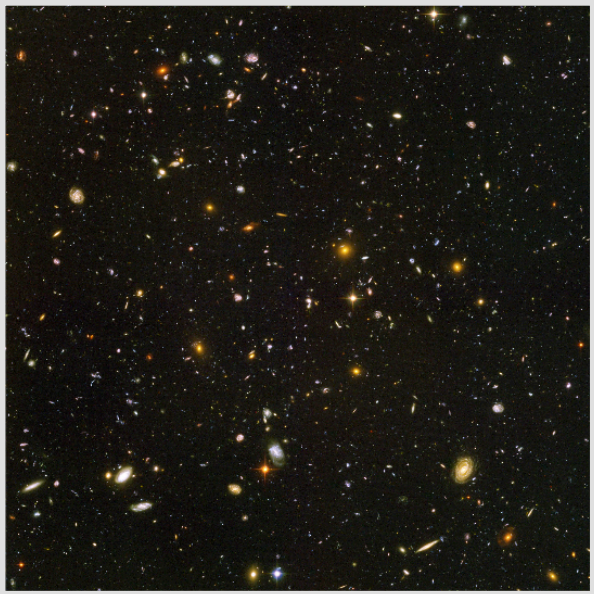
High-z Surveys



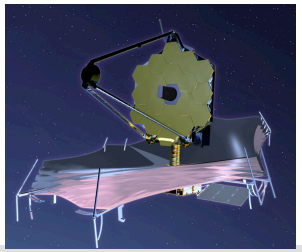
Lyman-break searches for high-z galaxies may require deep UV and B-band data to rule-out possible low-redshift interlopers especially when the objects are too faint for spectroscopic follow-up.

Several fields with deep B-band coverage are already available: e.g. HUDF (Beckwith et al. 2006), UDF05 (Oesch et al. 2006), GOODS (Giavalisco et al. 2004).

The main concern is that galaxies at $z>7$ are rare and a wider area than that presently available might be needed. Hopefully we will know more thanks to WFC3.



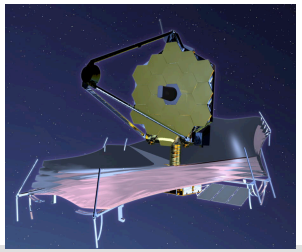
High-z Surveys - cont'd



Searches for SNae with JWST will naturally focus on the North ecliptic pole which is the best area in the JWST northern Continuous Viewing Zone (CVZ) for galactic surveys. Therefore, this might be the most likely location for new extragalactic surveys as deep exposures would be obtained as a byproduct of a SN search and followup program.

To turn these into useful fields for high-z work it would be desireable to obtain HST data in the B (and possibly UV) in these areas.

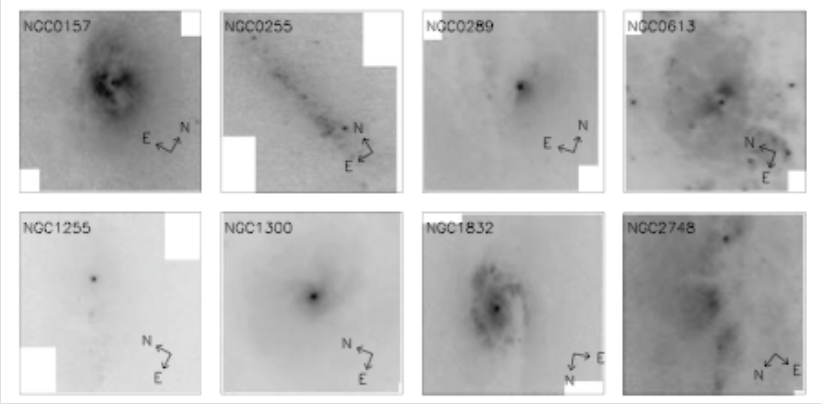
Galaxy Surveys



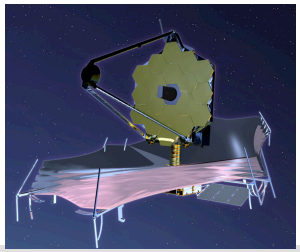
Many hundreds of nearby galaxies have been imaged by HST. Unfortunately, this has been done by a variety of programs using a variety of filters and non uniform selection criteria. For instance the largest HST surveys of nearby galaxies were carried out in snapshot mode and do not generally include B-band exposures or UV data.

I imagine that a legacy HST survey of nearby galaxies selected in some uniform criterion and including U and B band images would be highly desireable. Unfortunately, the TAC tends not to agree with me on this…

Scarlata et al. 2004

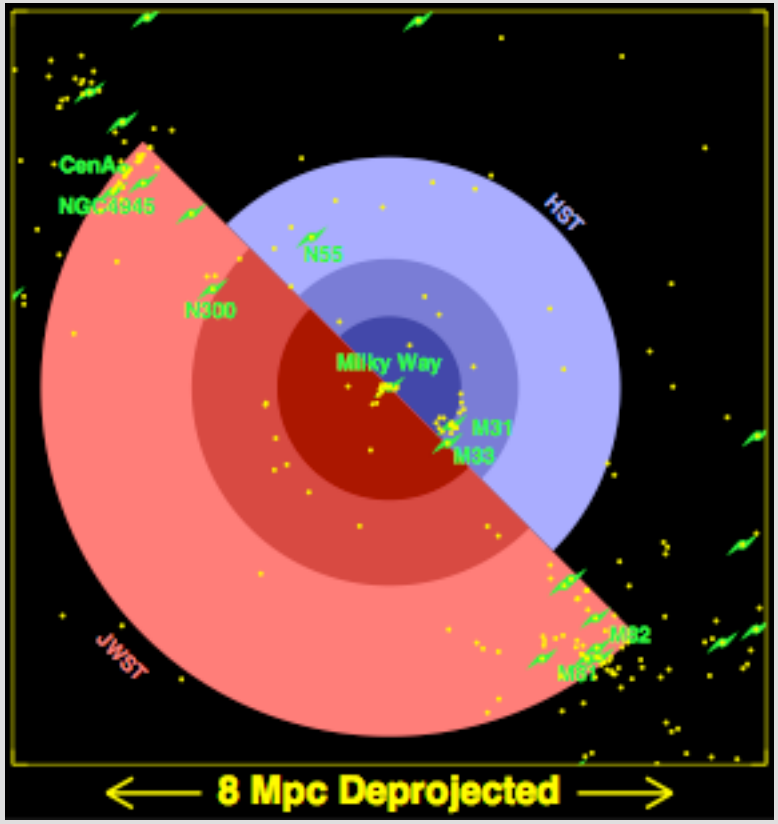


Galaxy Surveys - cont'd



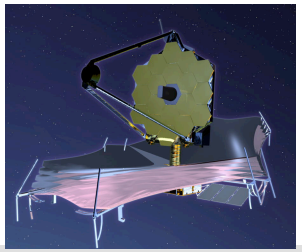
For galaxies close enough to be resolved in stars JWST will also be quite powerful.

The figure (by T. Brown) depicts the volumes where HST (blue) and JWST (red) can reach 0.5 mag below the turnoff with exposure times of 10,100 and 1000 hours. Ensuring deep U and B band images for these objects would complete the JWST data.



The LMC is in the JWST southern CVZ and will also be a very natural target requiring matching data.

Galactic Globular Clusters



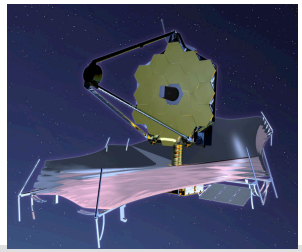
Many globular clusters have been already imaged by HST but we should make sure that HST images in the B band (if not the near-UV) are available for all galactic globular clusters not seen through high obscuration areas.

For nearby GCs JWST should be able to observe the WD cooling sequence down to its termination. It might be useful to have imaging of "matching" depth in the blue.

Cluster (1)	Distance (kpc)	AV (mag)	F070W/F090W Truncation	Exp Time (hours) (2)
NGC 104 (47 Tuc)	4.5	0.13	30.1/30.3	24
NGC 5139 (Omega Cen)	5.3	0.38	30.6/30.8	59
NGC 6656 (M22)	3.2	1.09	30.0/30.1	18
NGC 6752	4.0	0.13	29.8/30.1	15
NGC 6809	5.3	0.26	30.5/30.8	55
NGC 6838	4.0	0.80	30.3/30.4	31

Courtesy of H. Richer

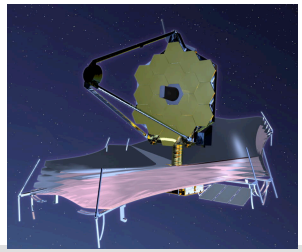
Galactic Starforming regions



Galactic star forming regions will be one of the prime targets for JWST. The mid-IR sensitivity and angular resolution of JWST should enable detailed studies of protostars and of the stellar IMF.

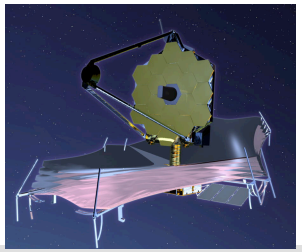
Any blue and near-UV data needed for these study will need to be obtained before hand with HST.

Observing with JWST

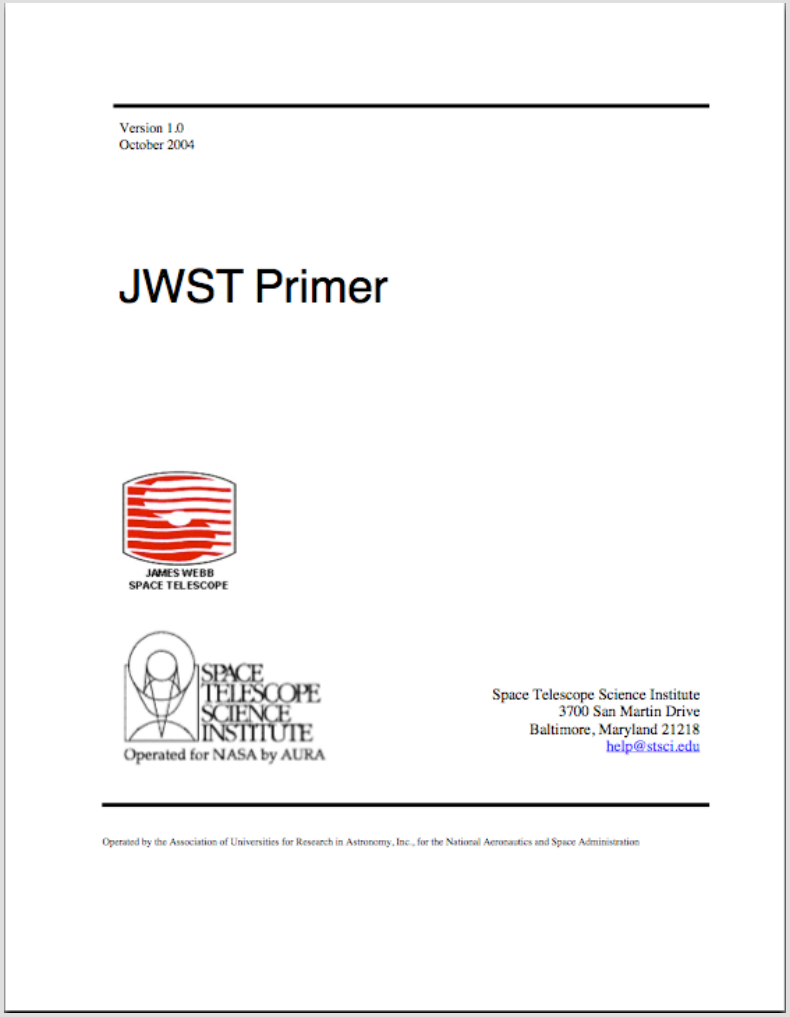


- JWST will have reduced capabilities to observe off its nominal roll angle compared to HST. This limits the maximum time at a given orientation and the visibility of a target in the year. Moreover, angular momentum balance considerations might reduce the maximum time at a given orientation even further.
- CVZ targets will be the only ones for which generic orientations will be possible. The JWST CVZ is observable throughout the year.
- For large mosaics where one needs a large amount of time on target and a constrained orientation, CVZ might be almost unavoidable (e.g. COSMOS on JWST might be possible only in the CVZ).

How to know more about JWST



- Website at STScI includes links to documents including the JWST primer, a mini-handbook for JWST. This is still mostly valid even though not updated since 2004. We would consider updating it more frequently if there is interest in the community.
- Email JWSTinfo@stsci.edu



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JWST Primer

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