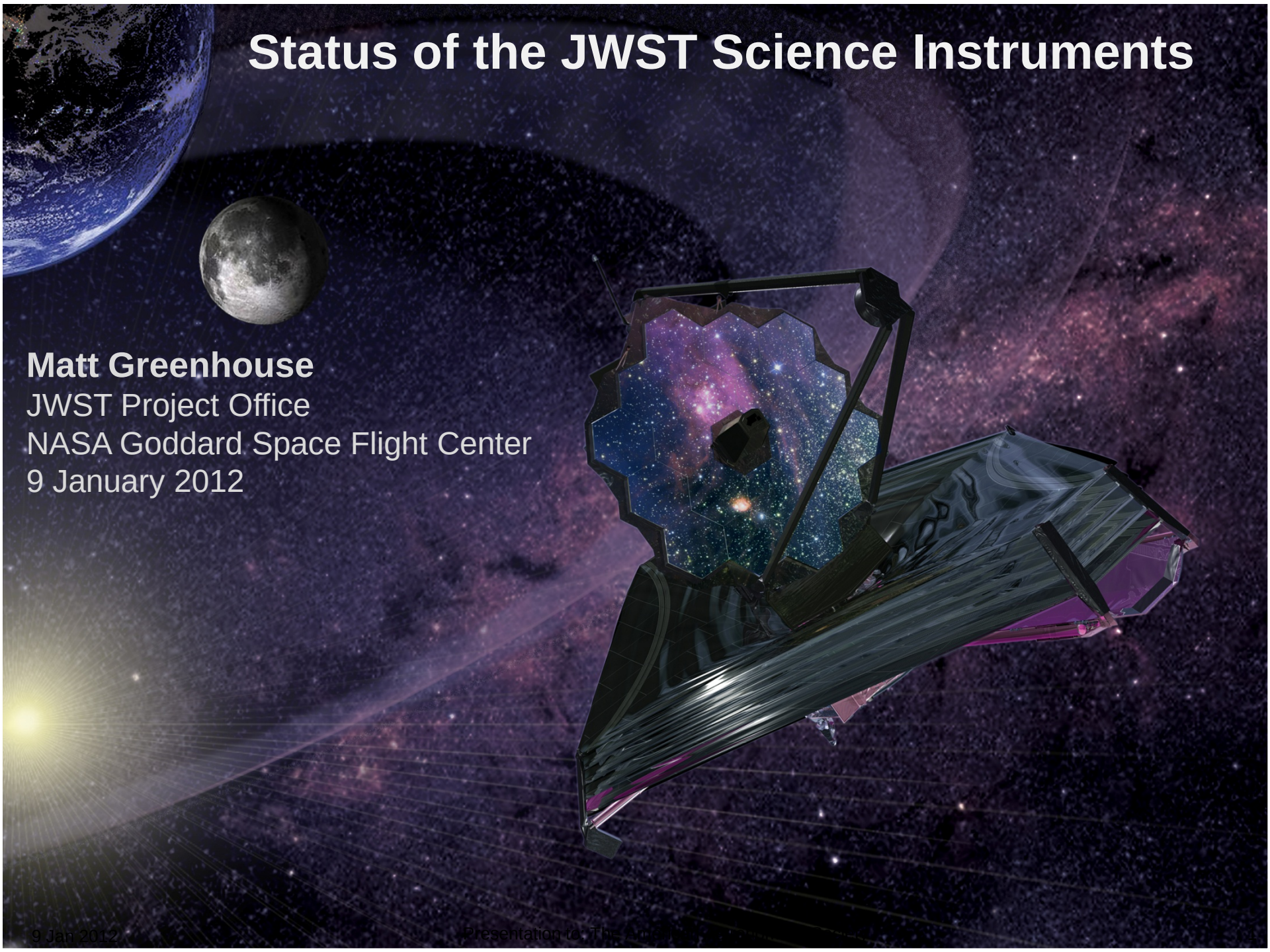
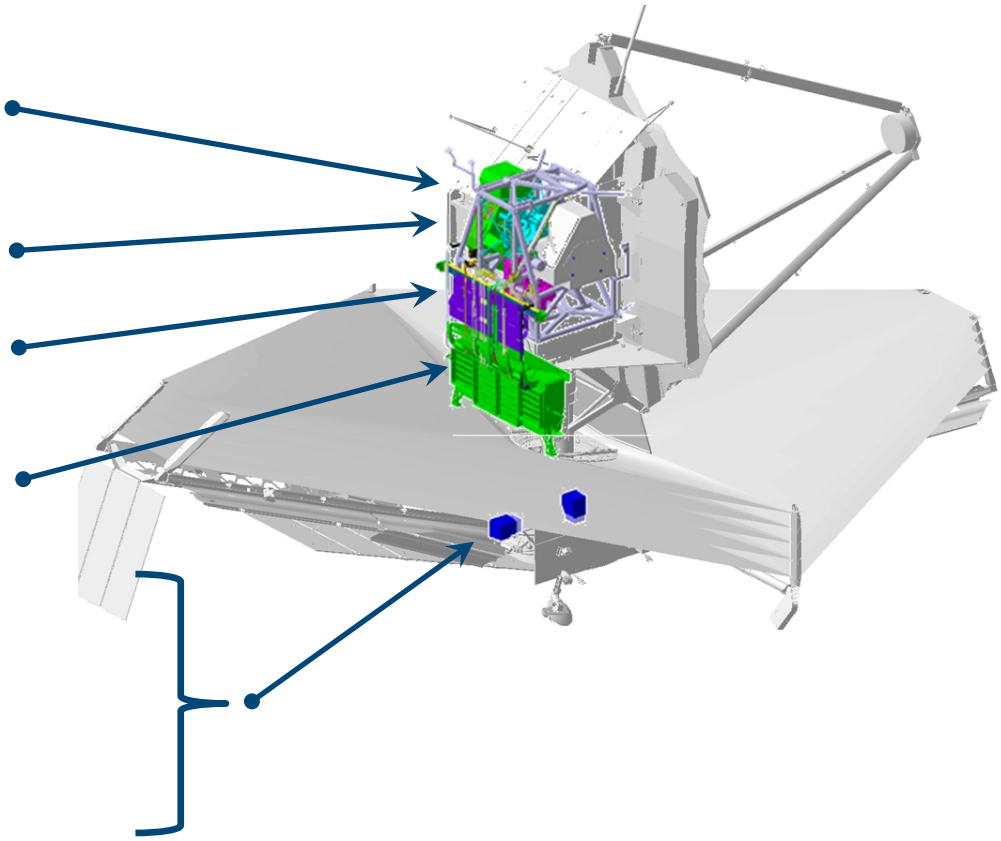
Status of the JWST Science Instruments



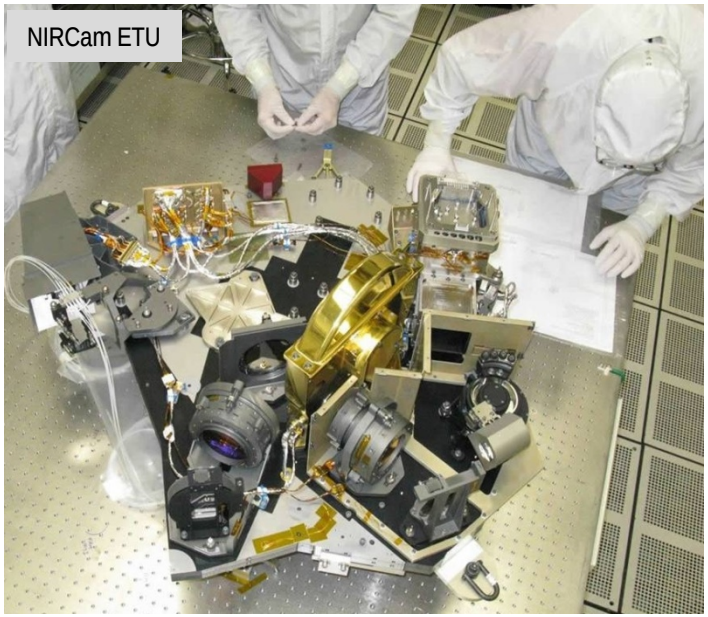
Matt Greenhouse
JWST Project Office
NASA Goddard Space Flight Center
9 January 2012

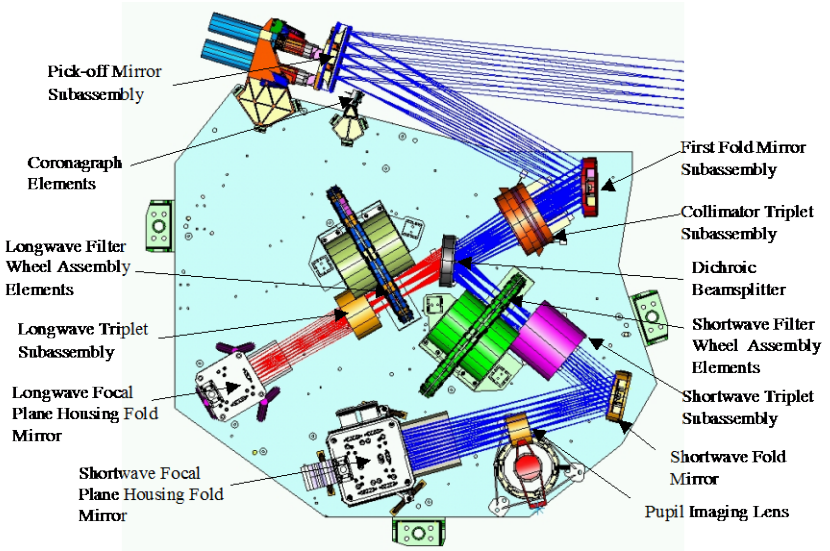
The Integrated Science Instrument Module (ISIM) is the science instrument payload of the JWST

- ISIM is one of three elements that together make up the JWST space vehicle
  - Approximately 1.4 metric tons, ~20% of JWST by mass
  - Completed its Critical Design Review during 2009 and is currently in integration and test
- The ISIM system consists of:
  - Four science instruments
    - NIRCam, NIRSpec, MIRI, FGS
  - Nine instrument support systems:
    - Optical metering structure system
    - Electrical Harness System
    - Harness Radiator System
    - ISIM electronics compartment
    - ISIM Remote Services Unit
    - Cryogenic Thermal Control System
    - Command and Data Handling System
    - Flight Software System
    - Operations Scripts System



NIRCam will provide the deepest near-infrared images ever and will identify primeval galaxy targets for the NIRSpec

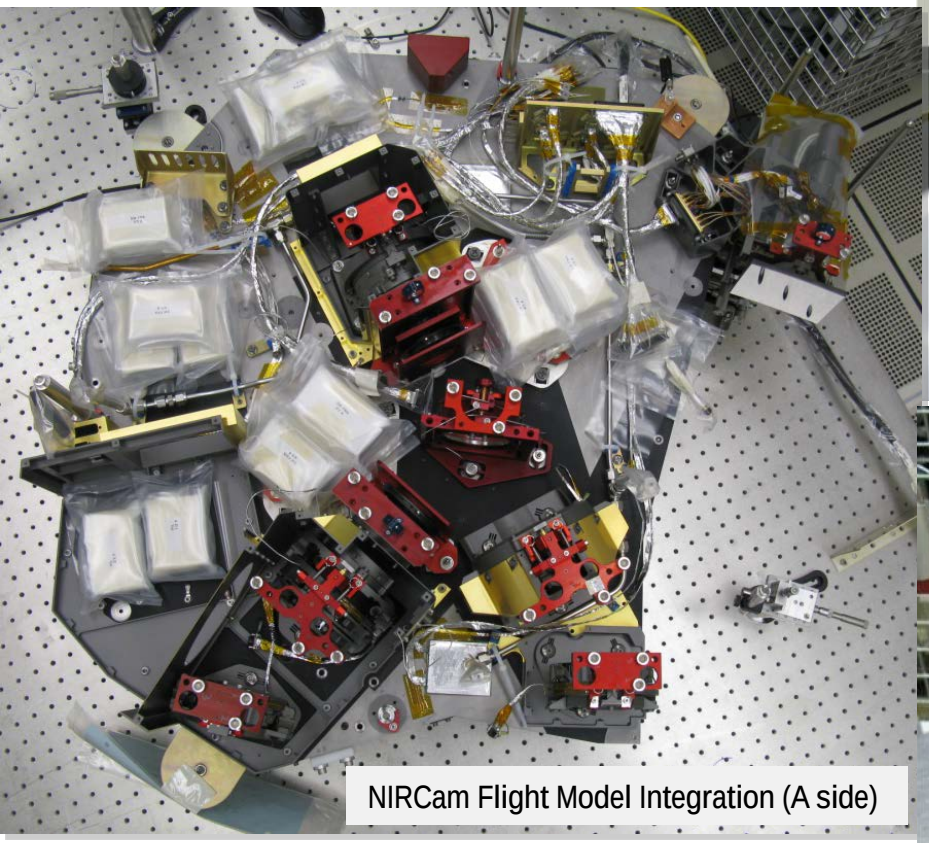




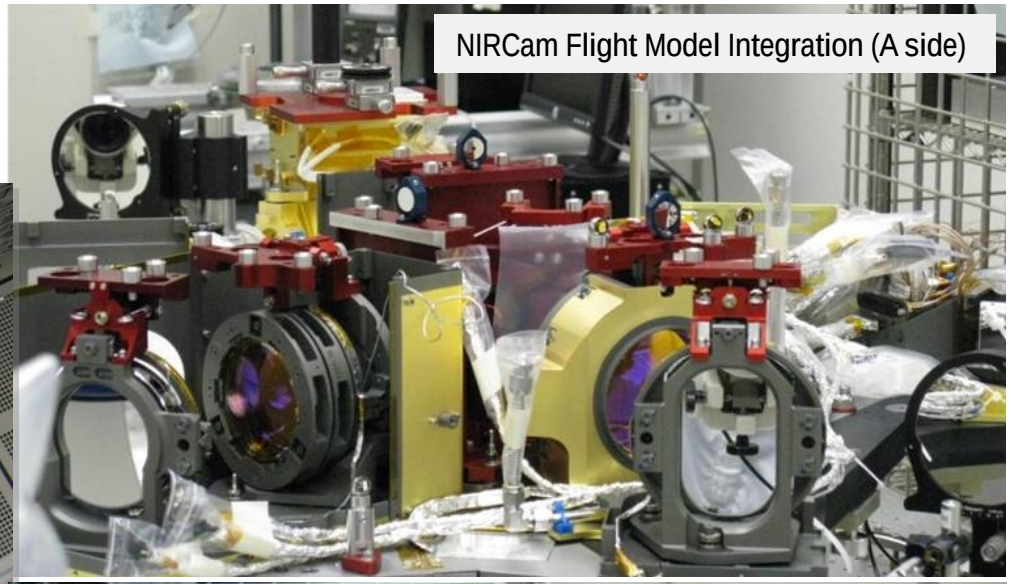
- Developed by the University of Arizona with Lockheed Martin ATC
  - Operating wavelength: 0.6 – 5.0 microns
  - Spectral resolution: 4, 10, 100 (filters + grism), coronagraph
  - Field of view: 2.2 x 4.4 arc minutes
  - Angular resolution (1 pixel): 32 mas < 2.3 microns, 65 mas > 2.4 microns
  - Detector type: HgCdTe, 2048 x 2048 pixel format, 10 detectors, 40 K passive cooling
  - Refractive optics, Beryllium structure
- Supports telescope wavefront sensing

NIRCam is on schedule for delivery during 2012

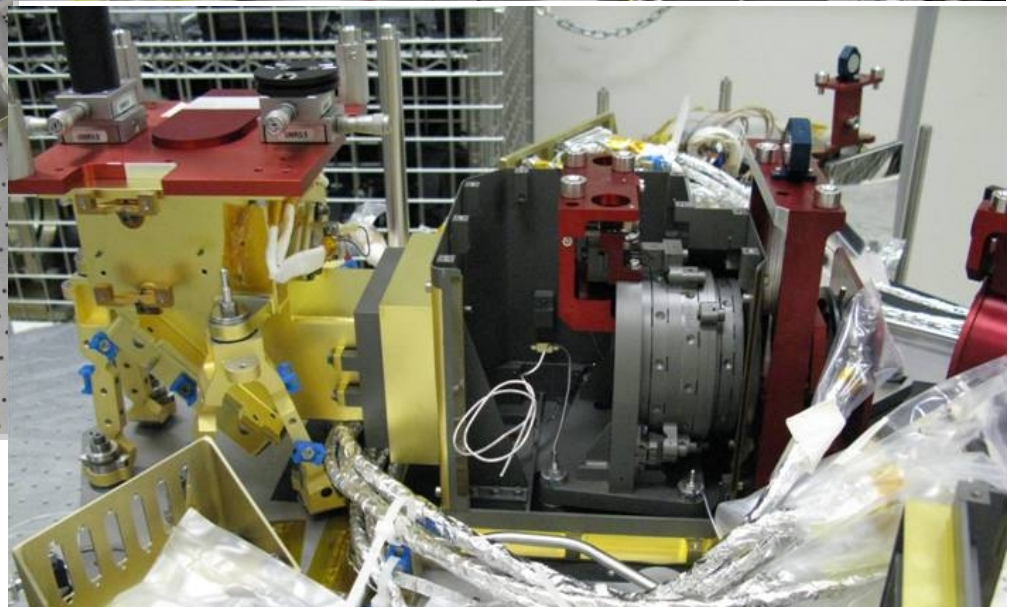
Flight model cryo-vacuum testing begins during March



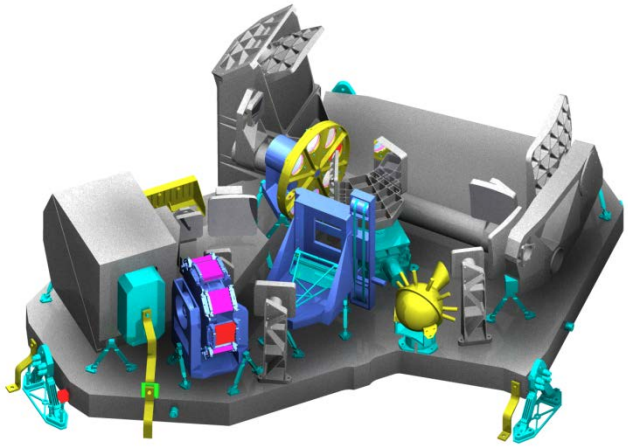
NIRCam Flight Model Integration (A side)

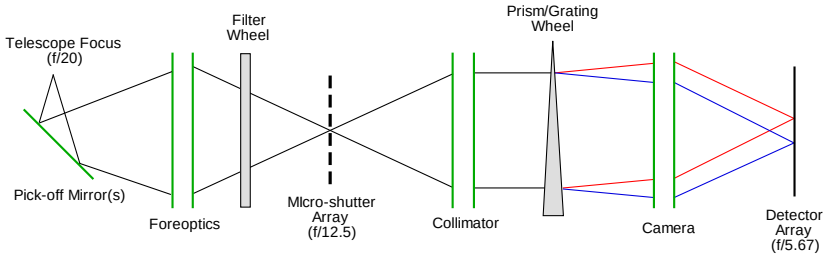


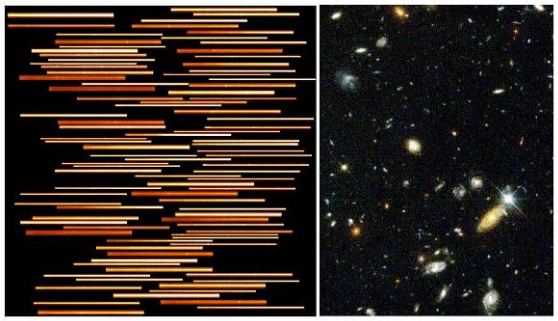
NIRCam Flight Model Integration (A side)

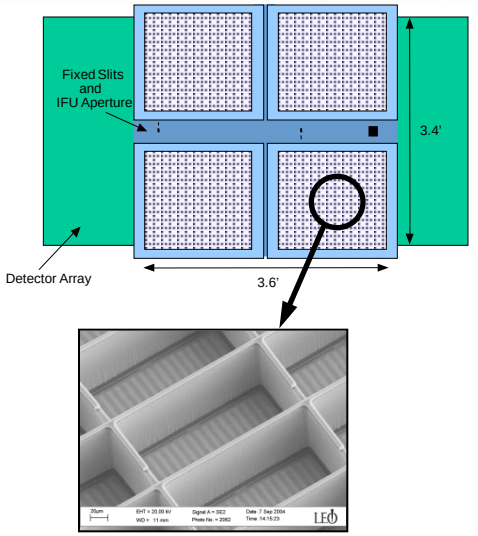


The NIRSpec will acquire near-infrared spectra of up to 100 objects in a single exposure



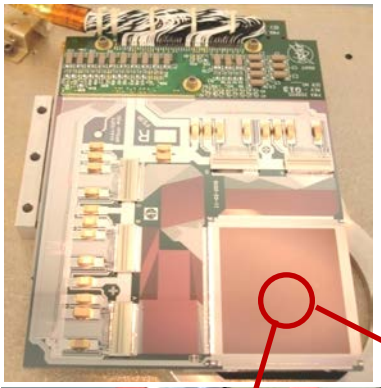


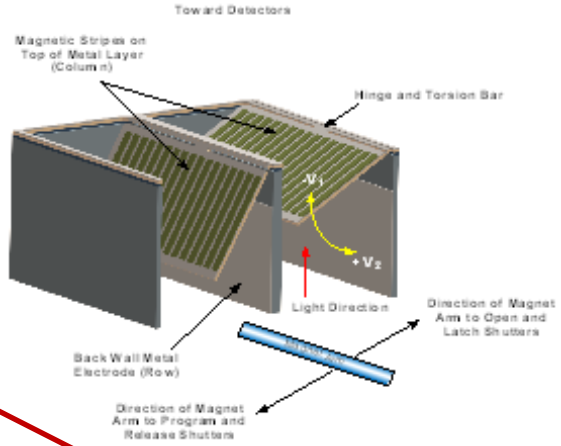


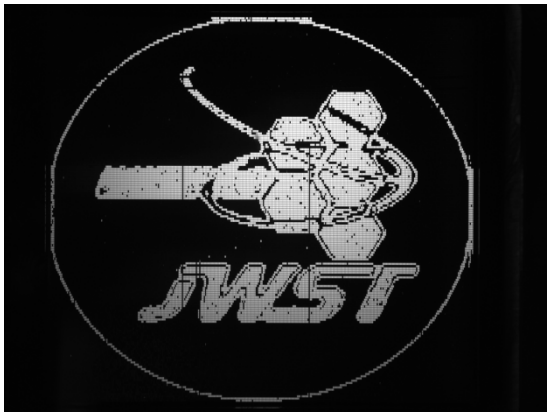


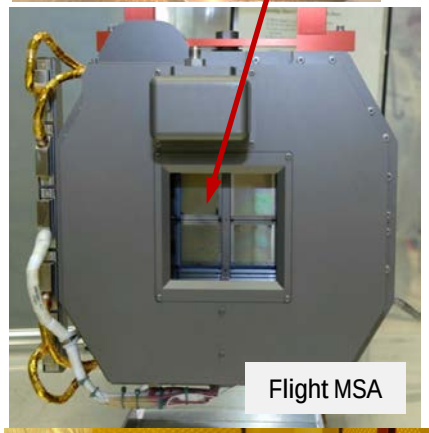
- Developed by the European Space Technology Center (ESTEC) with Astrium and Goddard Space Flight Center
  - Operating wavelength: 0.6 – 5.0 microns
  - Spectral resolution: 100, 1000, 3000
  - Field of view: 3.4 x 3.4 arc minutes
    - Aperture control:
      - Programmable micro-shutters, 250,000 pixels
      - Fixed long slits & transit spectroscopy aperture
      - Image slicer (IFU) 3x3 arc sec
  - Detector type: HgCdTe, 2048 x 2048 format, 2 detectors, 37 K passive cooling
  - Reflective optics, Silicon Carbide structure and optics

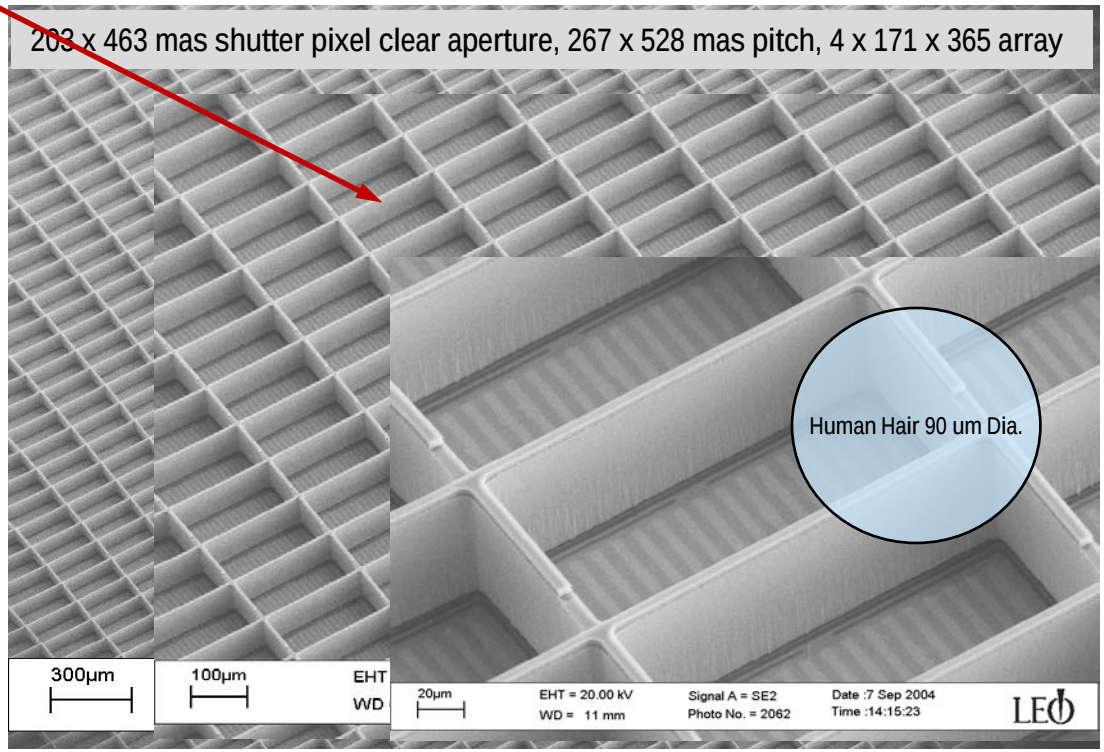
Aperture control: 250,000 programmable micro-shutters System flight qualified and delivered to ESA June 2010





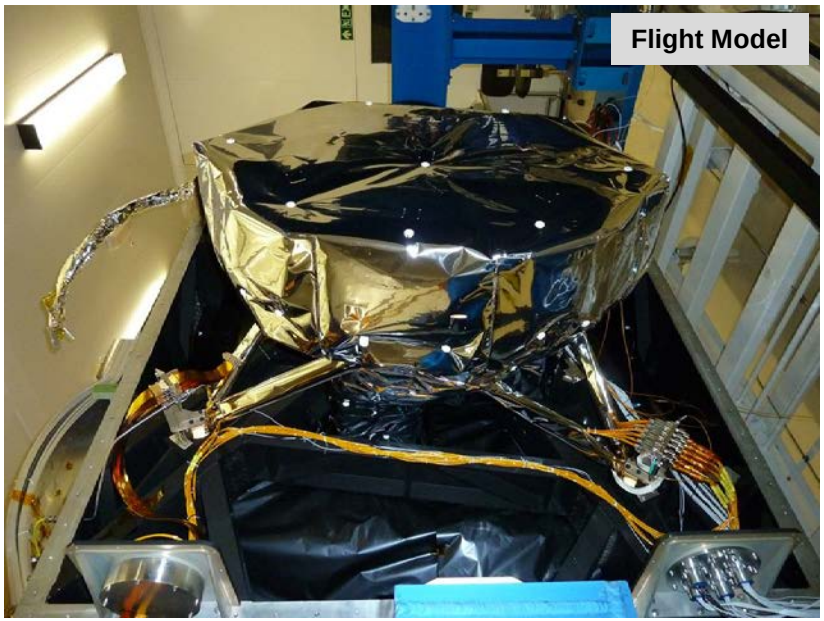






NIRSpec delivery expected during early 2013

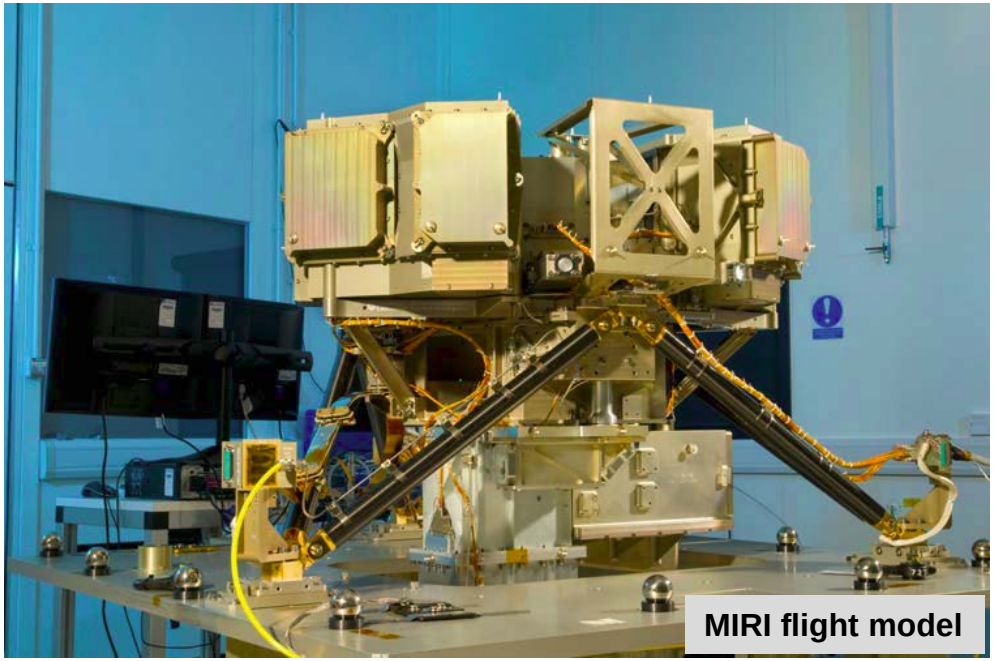
The MIRI instrument will characterize circumstellar debris disks, extra-solar planets, and the evolutionary state of high redshift galaxies

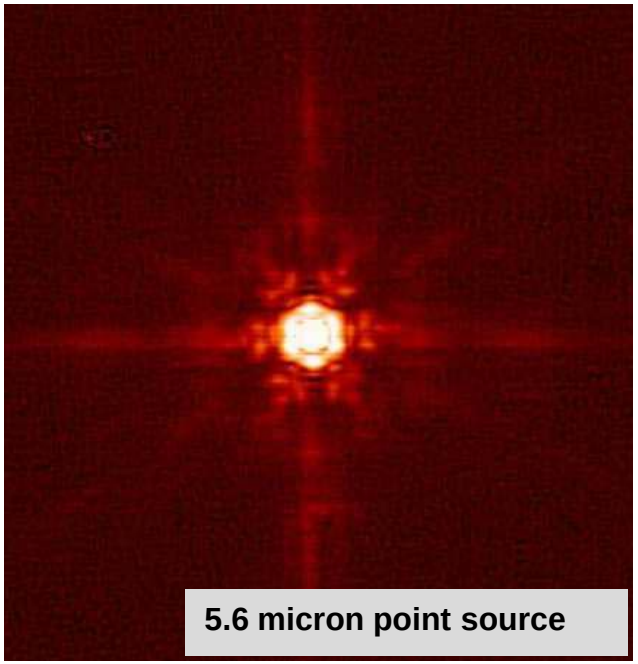


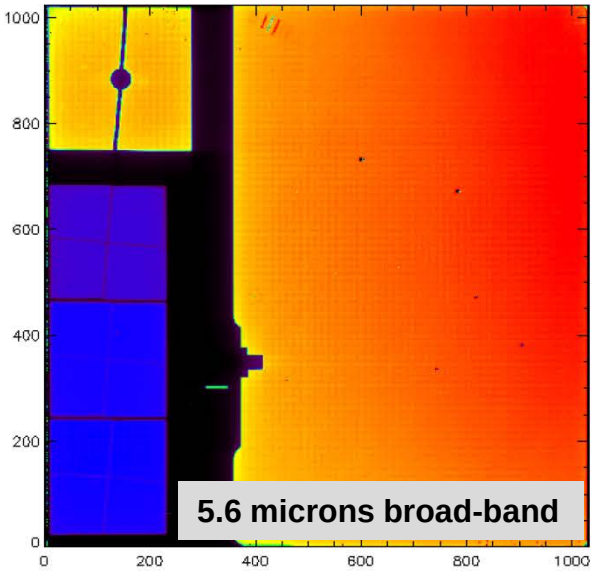
- Developed by a consortium of 10 European countries and NASA/JPL
  - Operating wavelength: 5 - 29 microns
  - Spectral resolution: 5, 100, 2000
  - Broad-band imagery: 1.9 x 1.4 arc minutes FOV
  - Coronagraphic imagery
  - Spectroscopy:
    - R100 long slit spectroscopy 5 x 0.2 arc sec
    - R2000 spectroscopy 3.5 x 3.5 and 7 x 7 arc sec FOV integral field units
  - Detector type: Si:As, 1024 x 1024 pixel format, 3 detectors, 7 K cryo-cooler
  - Reflective optics, Aluminum structure and optics

Flight unit cryo-vacuum testing completed during July 2011

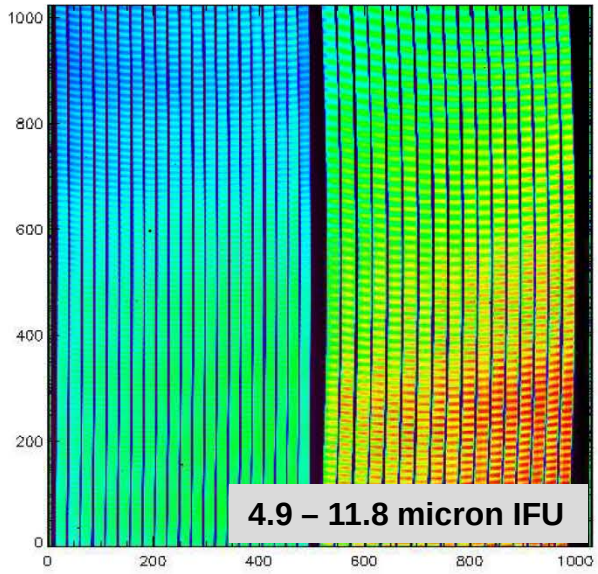
MIRI is on schedule for delivery during 2012


MIRI flight model

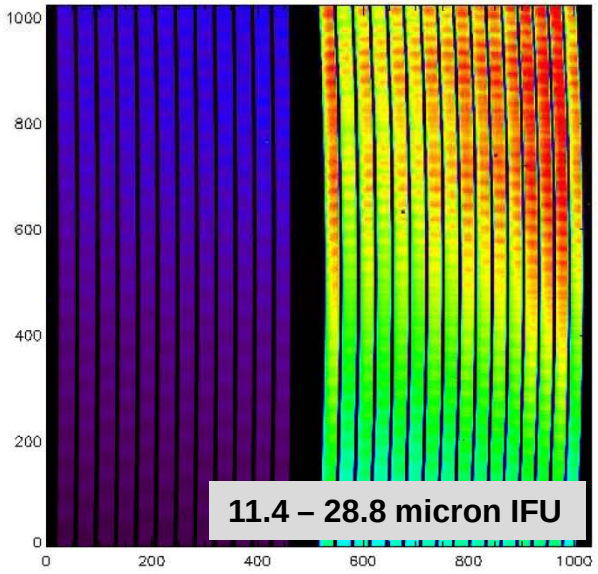

5.6 micron point source



5.6 microns broad-band

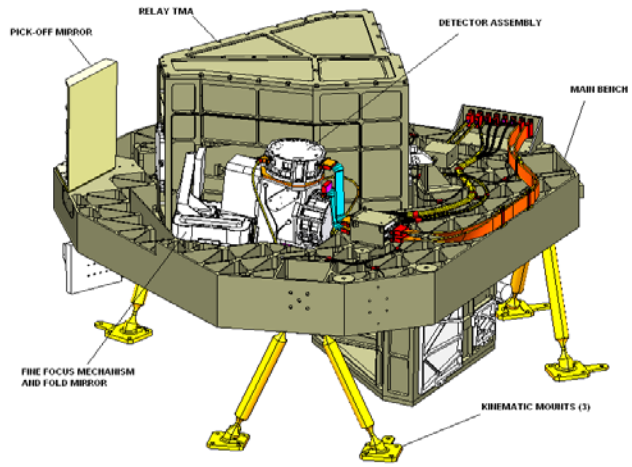


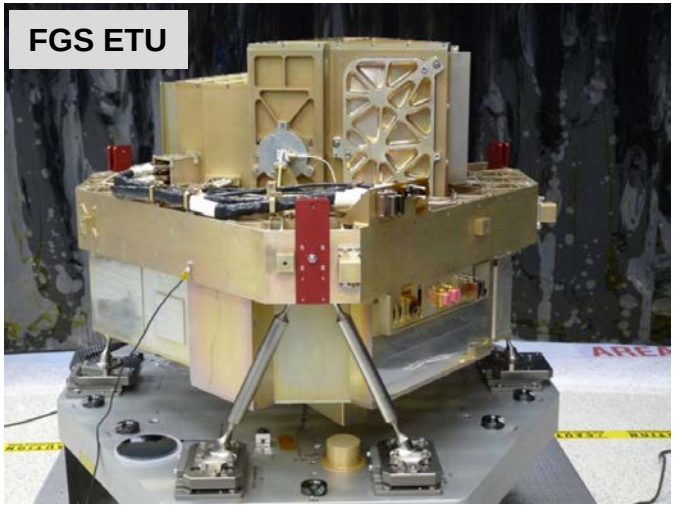
4.9 – 11.8 micron IFU



11.4 – 28.8 micron IFU

The FGS-Guider and -NIRISS provide telescope pointing control imagery & slitless spectroscopy for Ly-α galaxy surveys and extra-solar planet transits

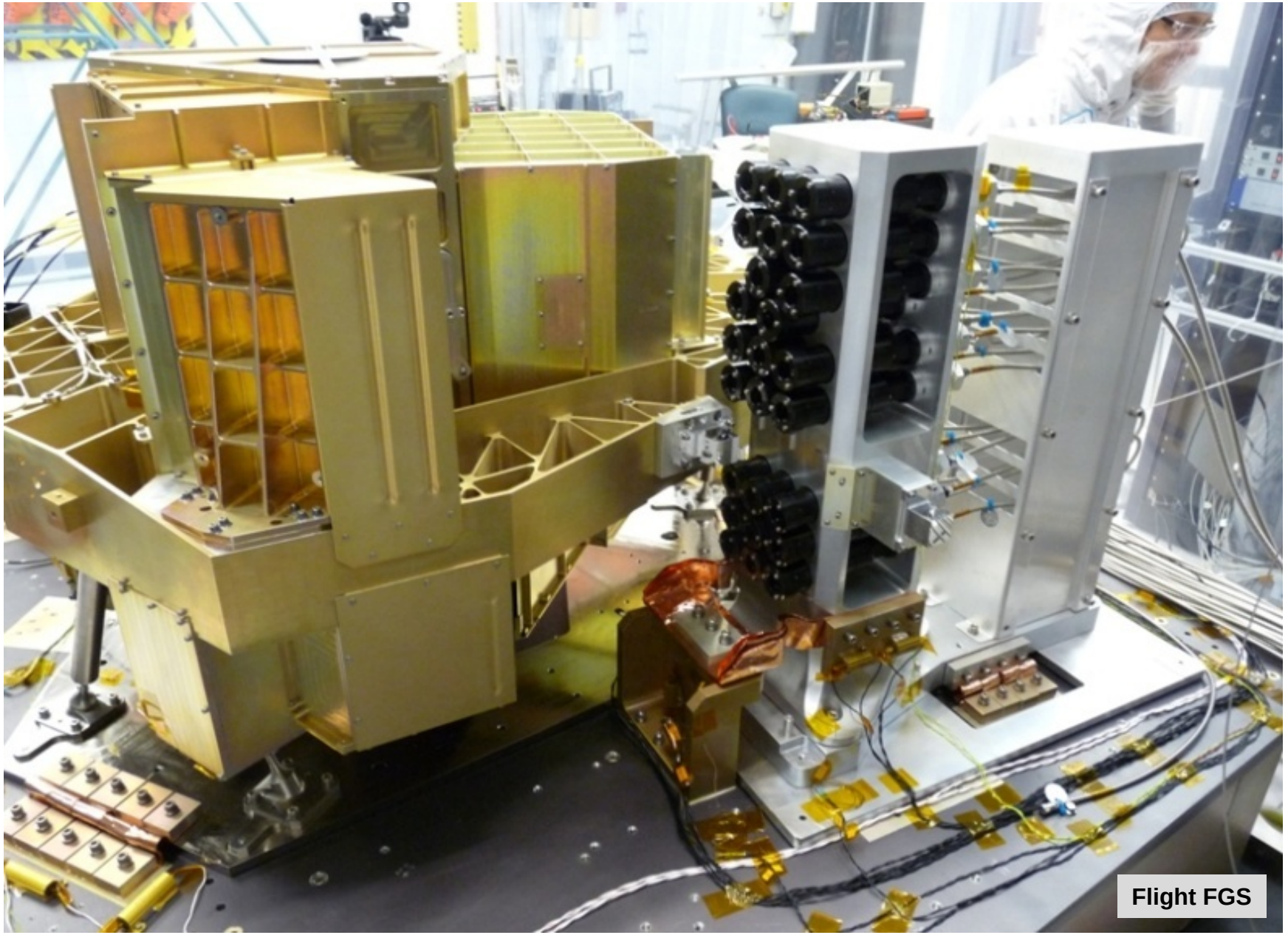




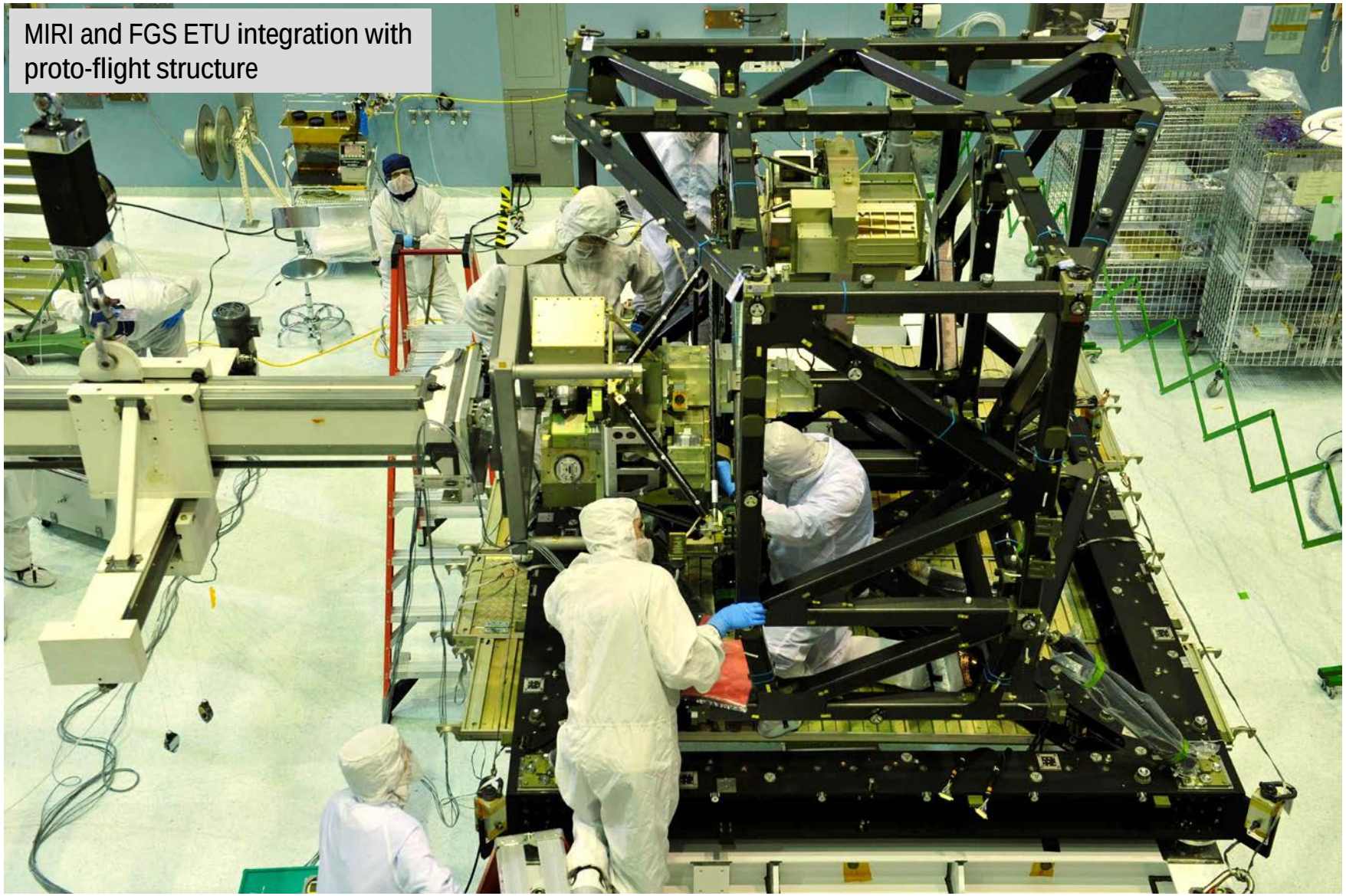
- Developed by the Canadian Space Agency with ComDev
  - Broad-band guider (0.6 – 5 microns)
  - Field of view: 2.3 x 2.3 arc minutes
  - Science imagery:
    - Slitless spectroscopic imagery (grism)
      - R ~ 150, 0.8 – 2.25 microns optimized for Ly alpha galaxy surveys
      - R ~ 700, 0.7 – 2.5 microns optimized for exoplanet transit spectroscopy
    - Sparse aperture interferometric imaging (7 aperture NRM) 3.8, 4.3, and 4.8 microns
  - Angular resolution (1 pixel): 68 mas
  - Detector type: HgCdTe, 2048 x 2048 pixel format, 3 detectors
  - Reflective optics, Aluminum structure and optics

Flight model cryo-vacuum testing currently underway

FGS is on schedule for delivery during 2012

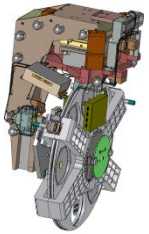


Integration of engineering model science instruments with the flight ISIM structure is proceeding well

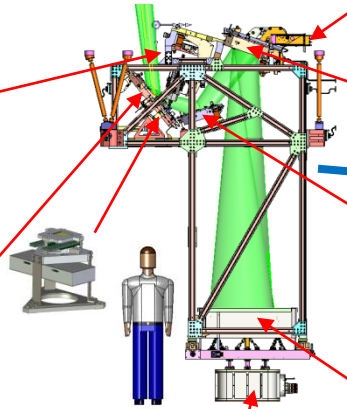


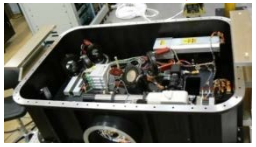
ISIM will be tested at ~35 K in a space environment simulation chamber using a telescope simulator (OSIM)

He shroud installation and test completed July 09

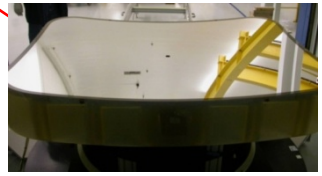


Fold Mirror 3 Tip/Tilt Gimbal Assembly

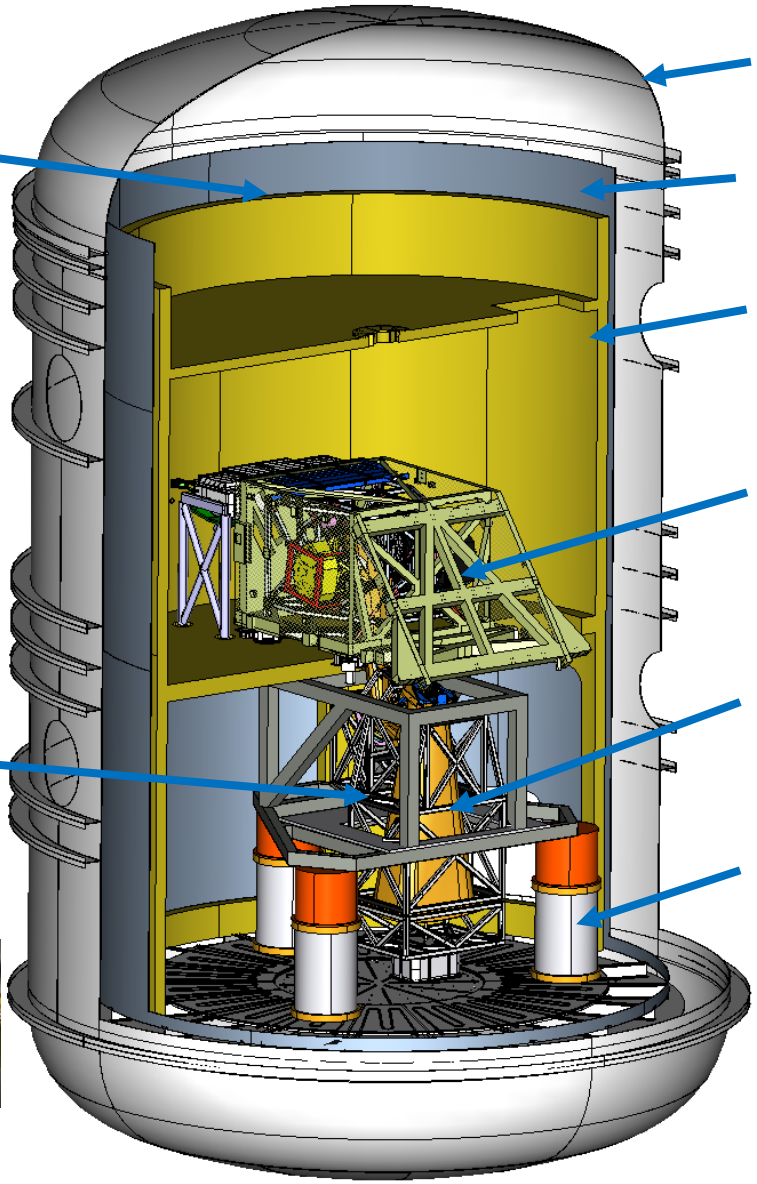




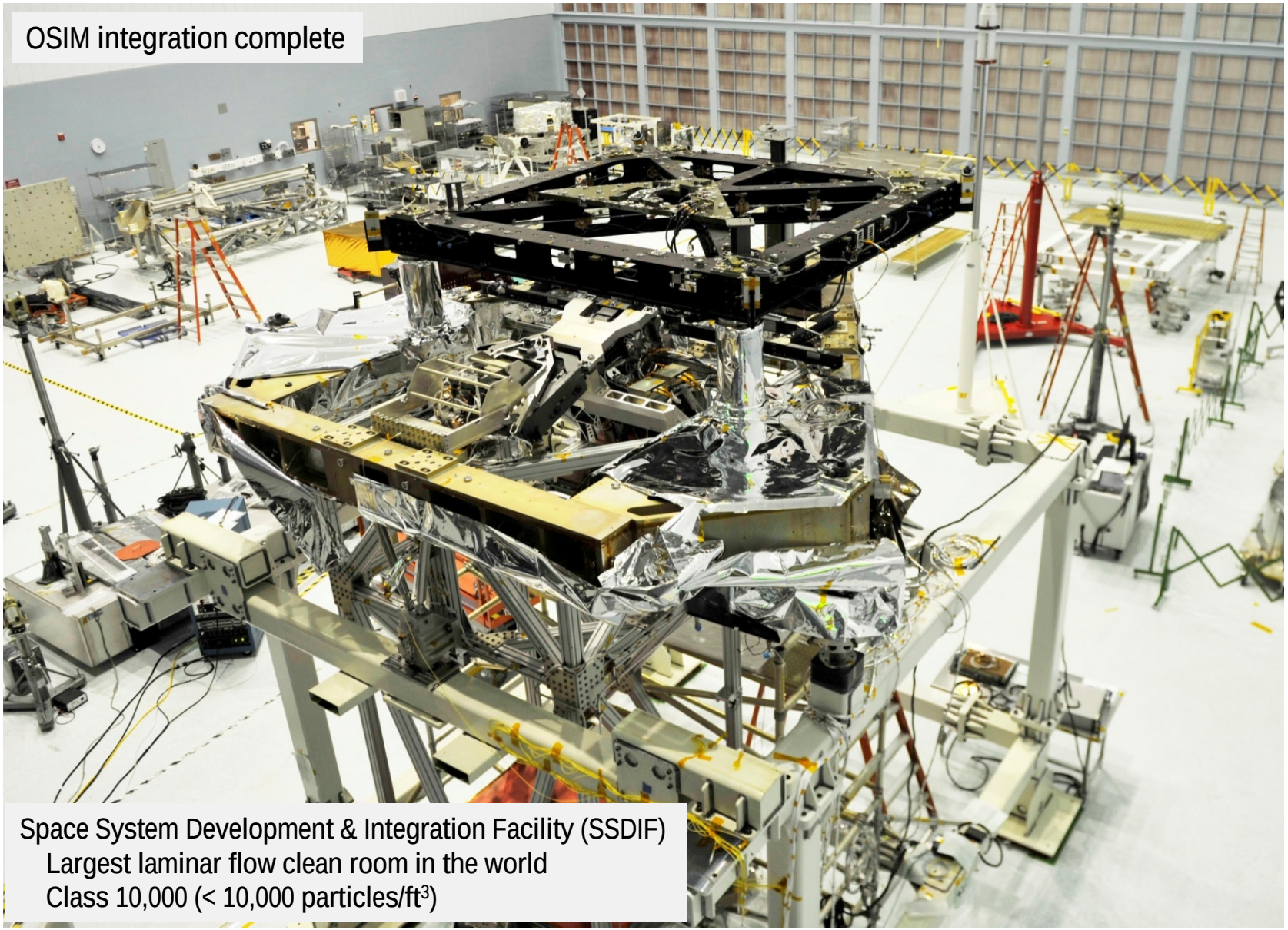
Alignment Diagnostic Module



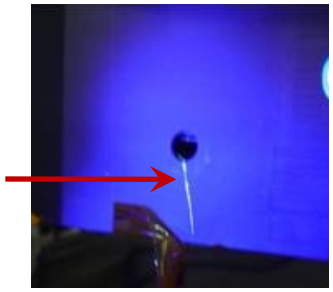
OSIM Primary Mirror



The telescope simulator is on schedule for cryo-vac certification during 2012



ISIM technical issues as of January 2012

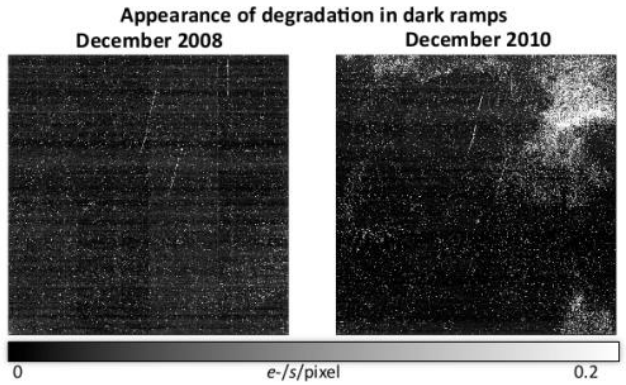


NIRSpec bench crack:

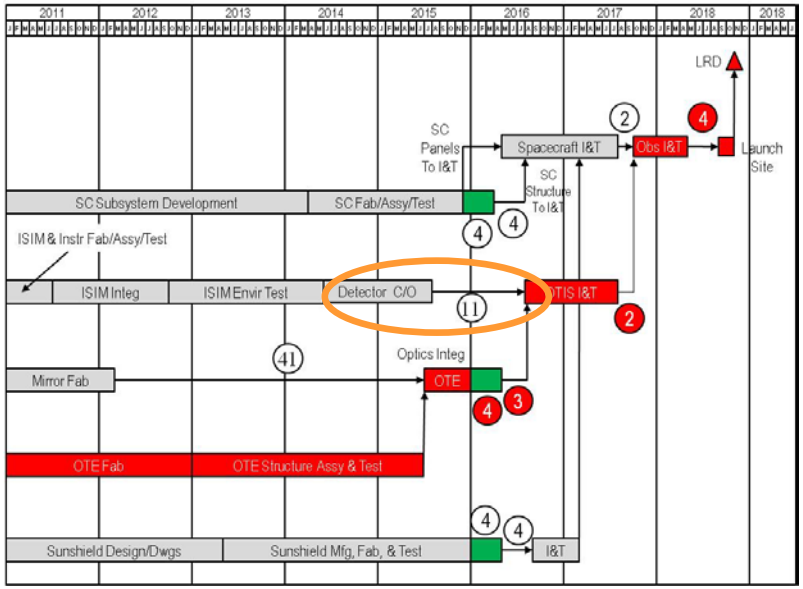
- Root causes determined; Integration procedure revised to avoid
- Installing flight spare bench
- Puts NIRSpec on ISIM critical path but not expected to delay ISIM delivery

HgCdTe detector degradation:

- Root cause determined; new design undergoing flight qualification
- Compliance with original performance requirements demonstrated in test
- Qualification program on schedule to complete during June
- Replacement of existing detectors will not delay ISIM delivery



Parameter	Unit	NIRCam Req.	Improved H2RGs H2RG-"A"	H2RG-"B"
Transimpedance gain[1]	μV/e^-	none	4.46	4.49
QE @ 800 nm	%	none	82	83
QE @ 1000 nm	%	none	89	81
QE @ 1230 nm	%	none	81	78
QE @ 2000 nm[2]	%	≥80%	81	81
Median dark current[3]	e^-/s	<0.01	0.009	0.004
Median read noise per CDS	e^- rms	<21	9.48	10.07
Median total noise[4]	e^- rms	<9	6.5	5.1
Well capacity	e^-	>60,000	97,400	97,800
Crosstalk	%	none	0.8	0.8
Residual image (latency - 2nd read)	%	<0.1	0.07	0.08



Learn more at:

www.jwst.nasa.gov

http://webbtelescope.org/webb_telescope/progress_report/

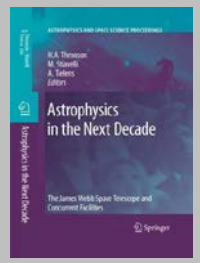
Watch the JWST being built at:

www.jwst.nasa.gov/webcam.html

Read about JWST science mission objectives at:

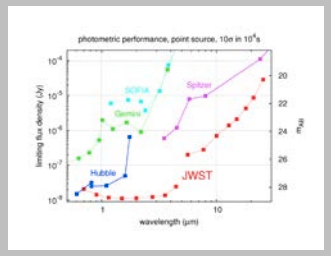
http://www.jwst.nasa.gov/science.html

http://www.stsci.edu/jwst/science/whitepapers/



Explore your science objectives with the JWST exposure time calculator:

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



Interact with the JWST Science Working Group:

http://www.jwst.nasa.gov/workinggroup.html