Integrated Science Instrument Module Status

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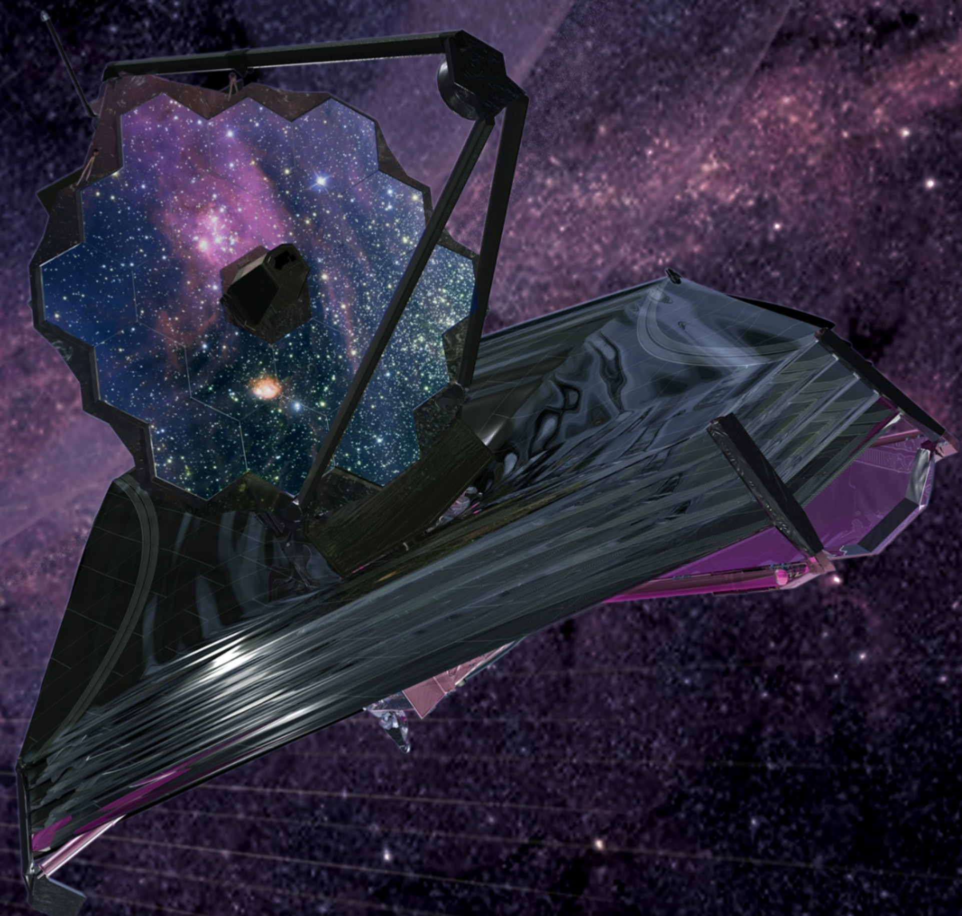
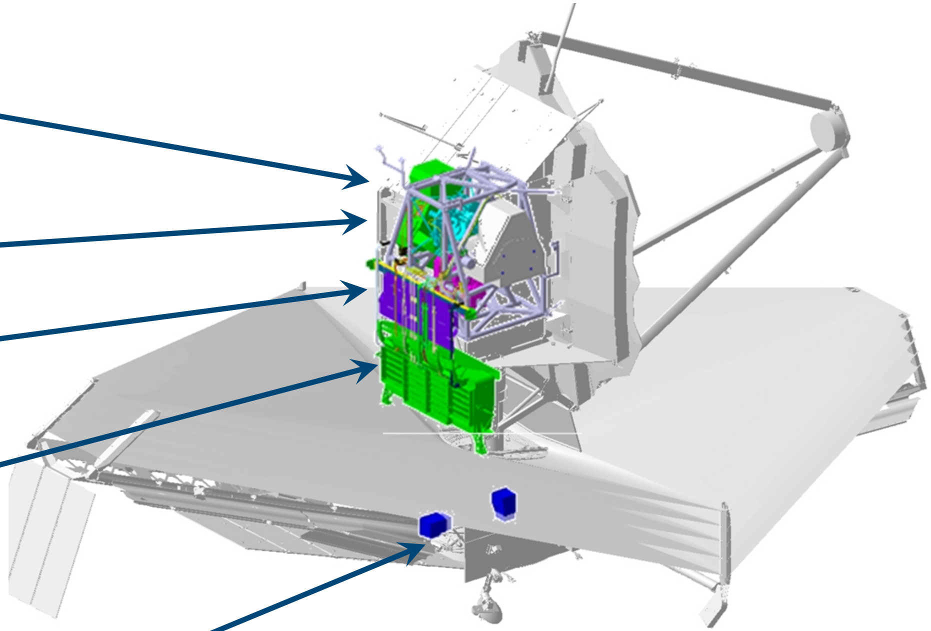
17 July 2013

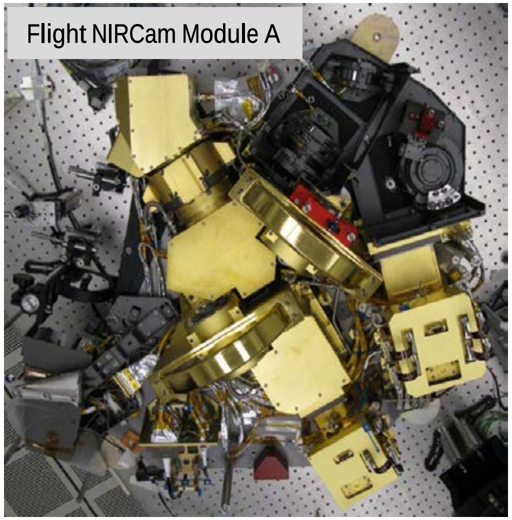


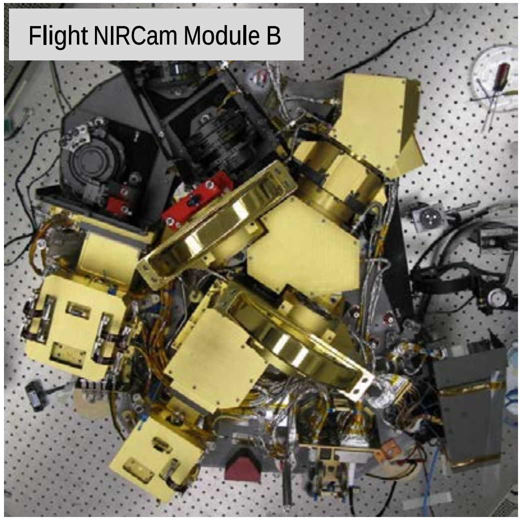
The Integrated Science Instrument Module (ISIM) is the science instrument payload of the JWST

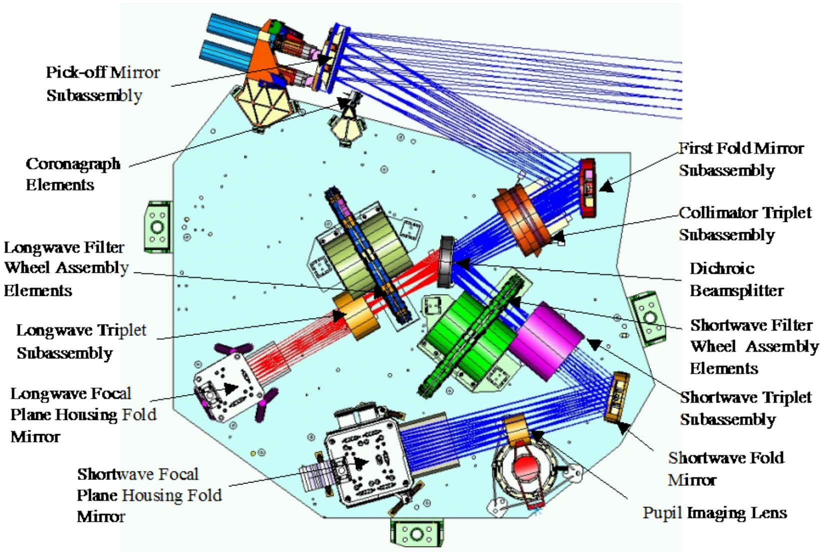
- ISIM is one of three elements that together make up the JWST space vehicle
  - Approximately 1.4 metric tons, ~20% of JWST by mass
  - Completed its Critical Design Review during 2009 and is currently in integration and test
- The ISIM system consists of:
  - Four science instruments
    - Complete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

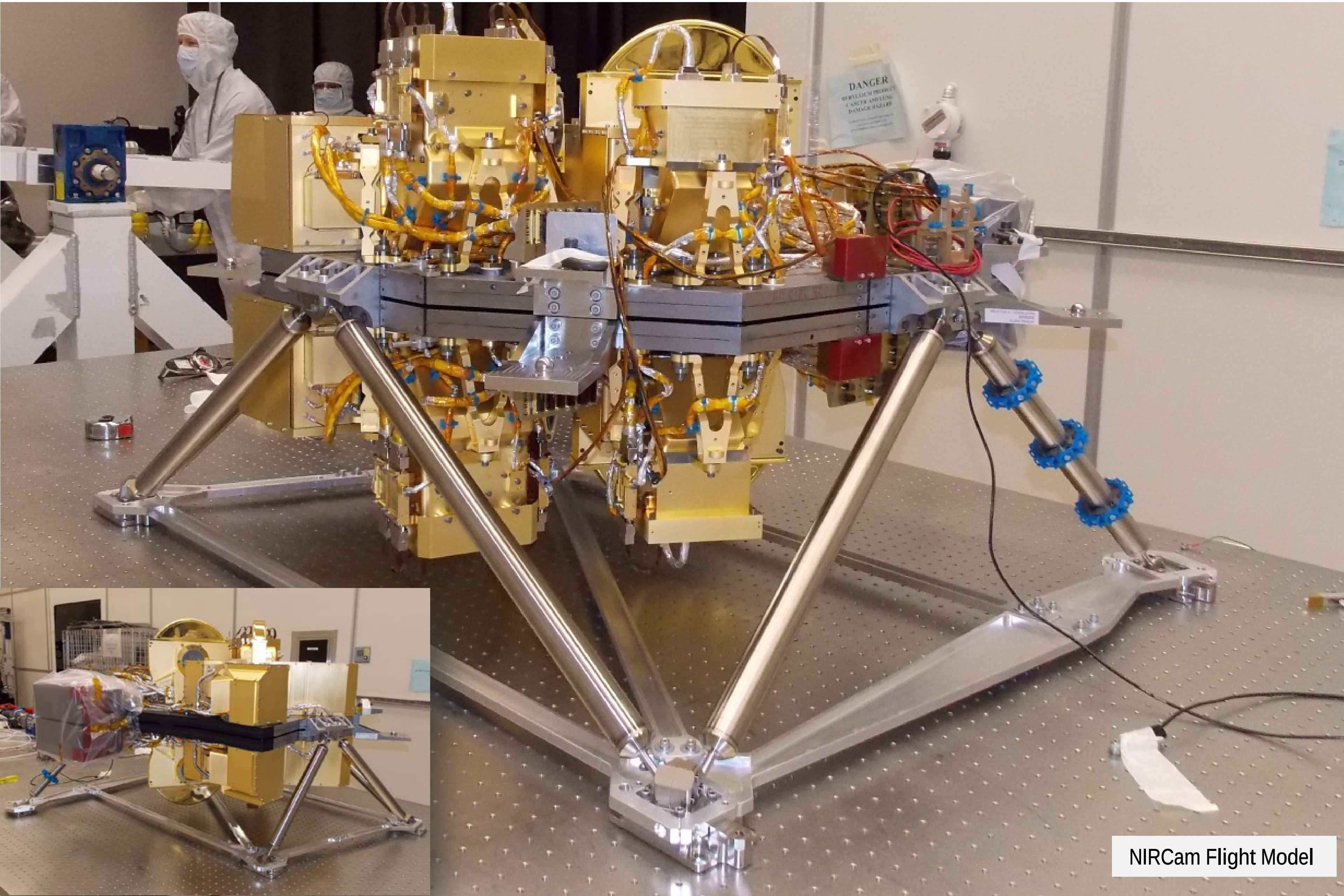




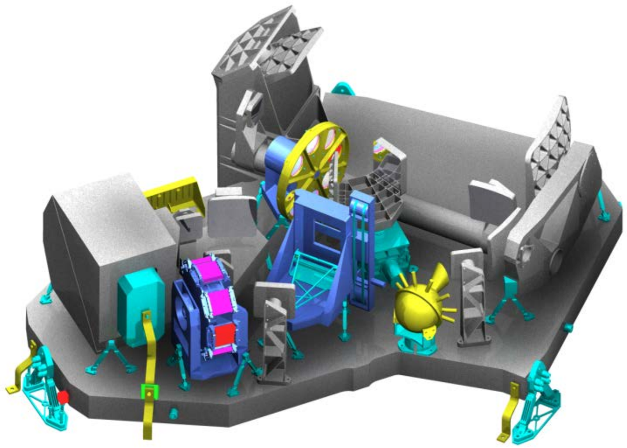


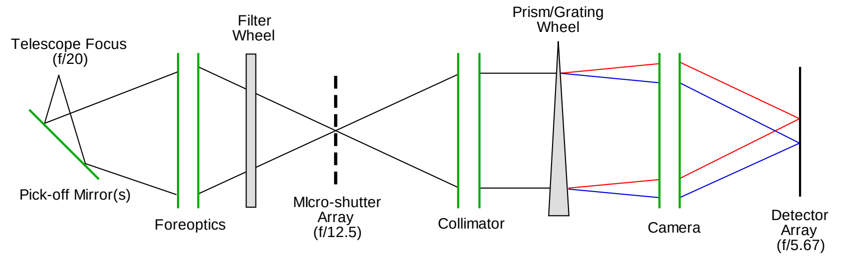
- Developed by the University of Arizona with Lockheed Martin ATC
  - Operating wavelength: 0.6 – 5.0 microns
  - Spectral resolution: 4, 10, 100 (filters + grism), coronagraph
  - Field of view: 2.2 x 4.4 arc minutes
  - Angular resolution (1 pixel): 32 mas < 2.3 microns, 65 mas > 2.4 microns
  - Detector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

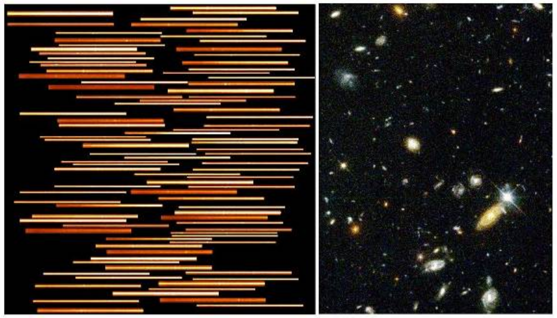
NIRCam will arrive at GSFC during July 2013

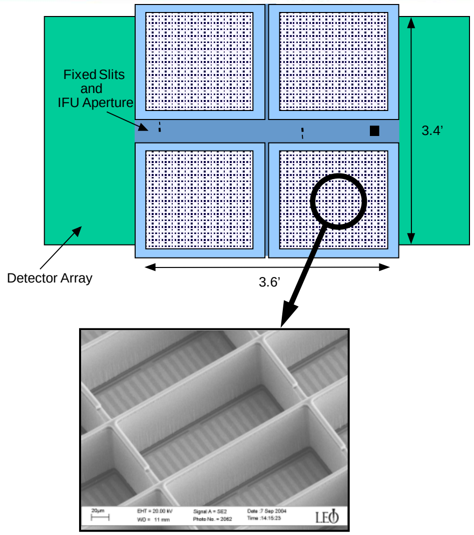


The NIRSpec will acquire near-infrared spectra of up to 100 objects in a single exposure



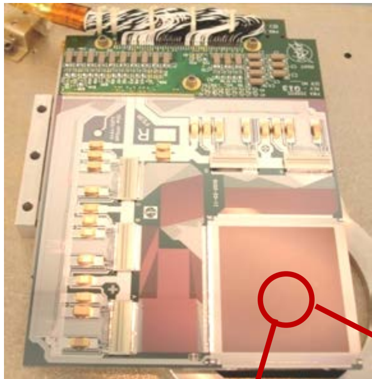


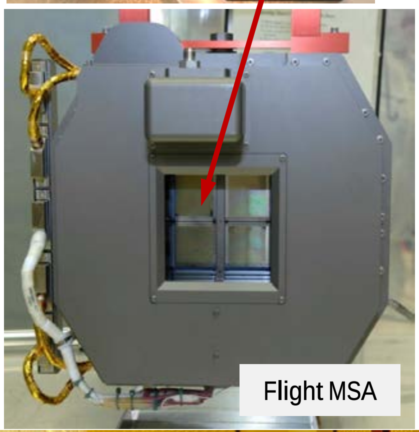


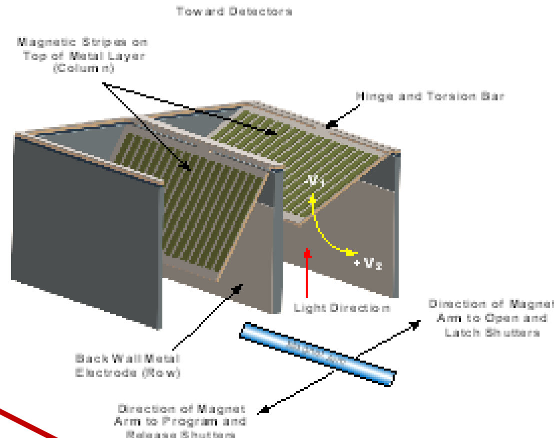


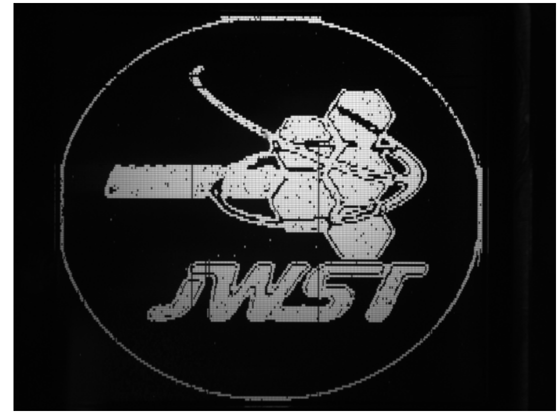
- Developed by the European Space Technology Center (ESTEC) with Astrium and Goddard Space Flight Center
  - Operating wavelength: 0.6 – 5.0 microns
  - Spectral resolution: 100, 1000, 3000
  - Field of view: 3.4 x 3.4 arc minutes
    - Aperture control:
      - Programmable micro-shutters, 250,000 pixels
      - 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

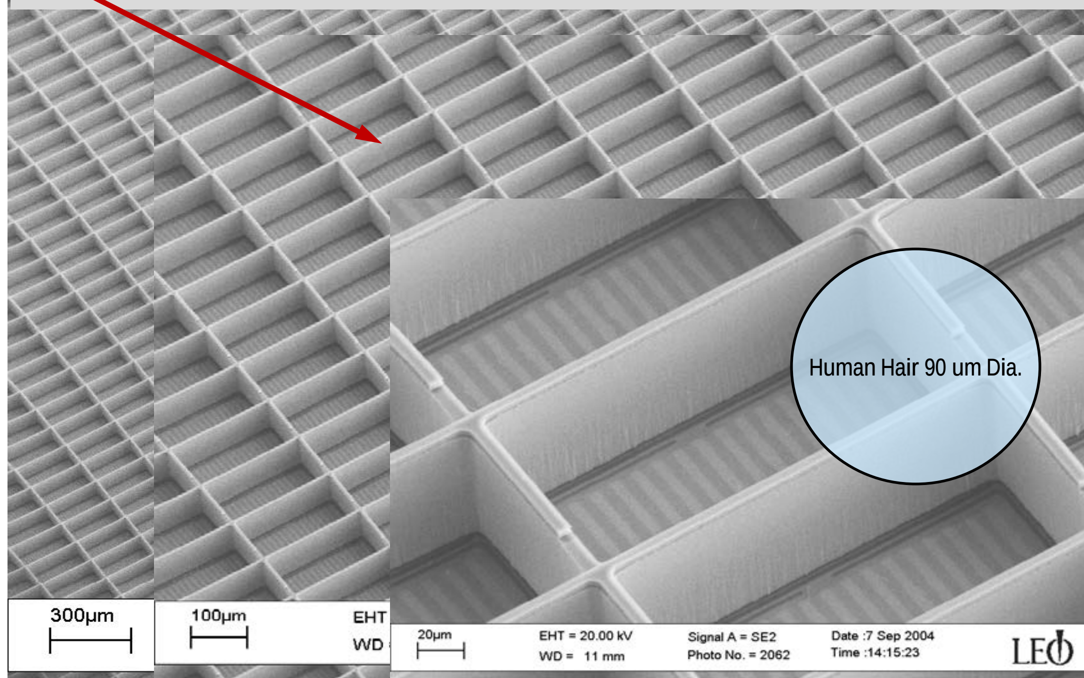






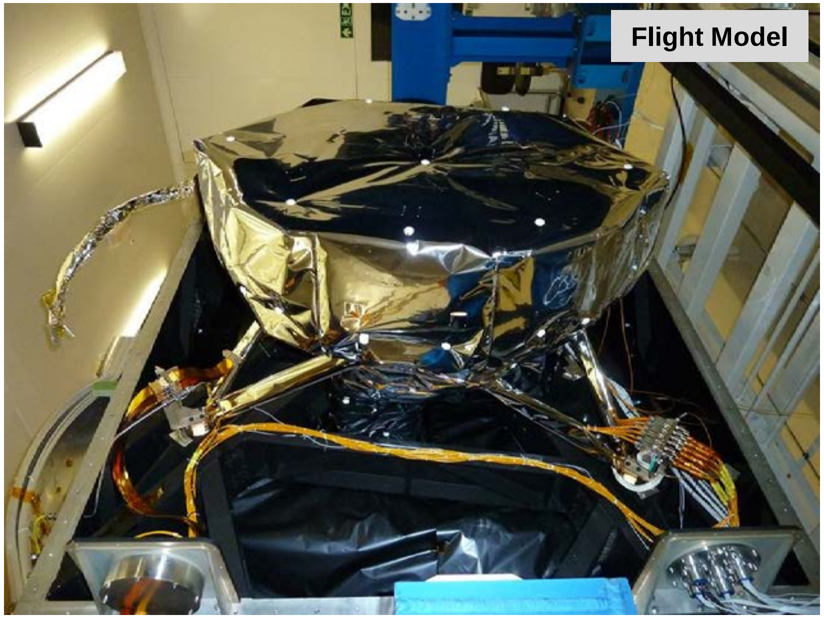


203 x 463 mas shutter pixel clear aperture, 267 x 528 mas pitch, 4 x 171 x 365 array



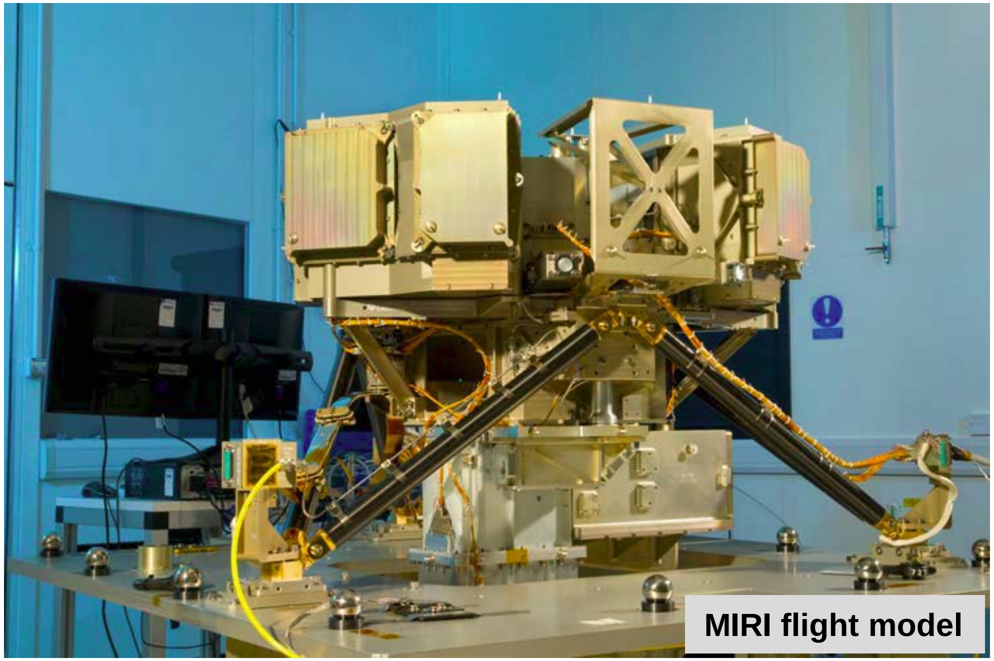
NIRSpec delivery is expected during September 2013

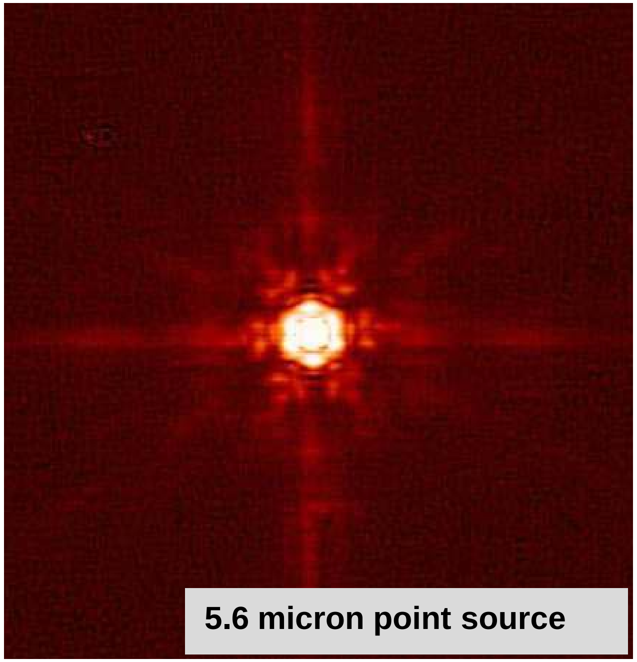
The MIRI instrument will characterize circumstellar debris disks, extra-solar planets, and the evolutionary state of high redshift galaxies

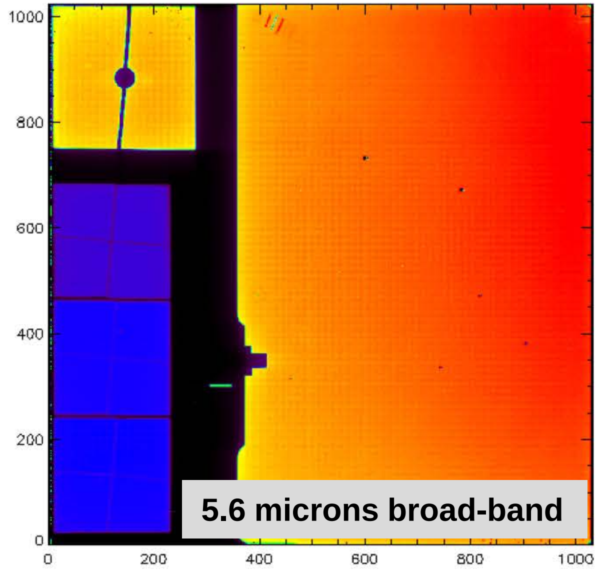


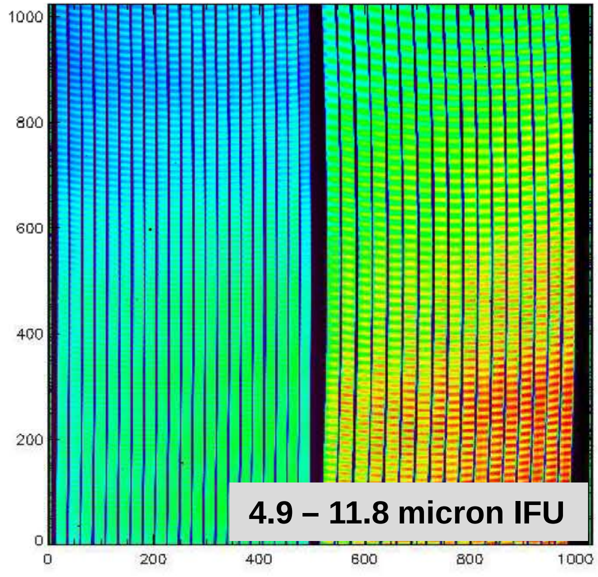
- Developed by a consortium of 10 European countries and NASA/JPL
  - Operating wavelength: 5 - 29 microns
  - Spectral resolution: 5, 100, 2000
  - Broad-band imagery: 1.9 x 1.4 arc minutes FOV
  - Coronagraphic imagery
  - Spectroscopy:
    - R100 long slit spectroscopy 5 x 0.2 arc sec
    - R2000 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

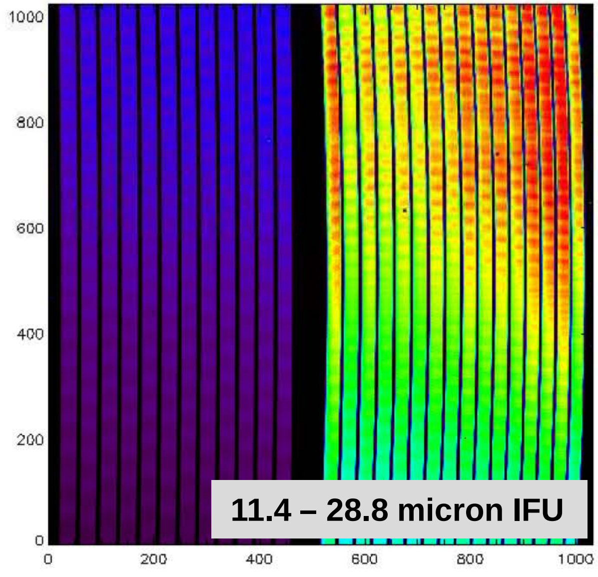
MIRI was delivered to ISIM I&T during May 2012



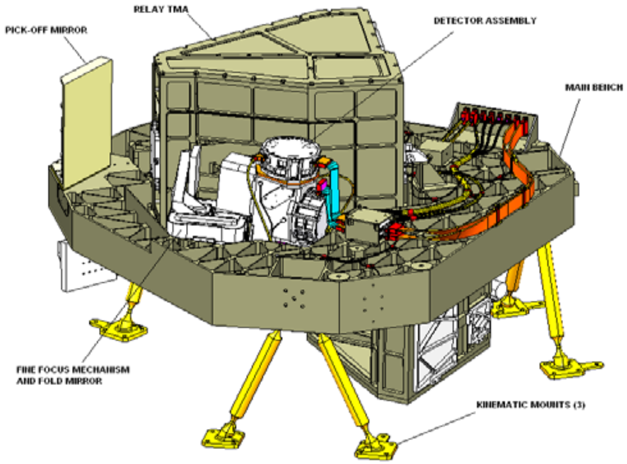


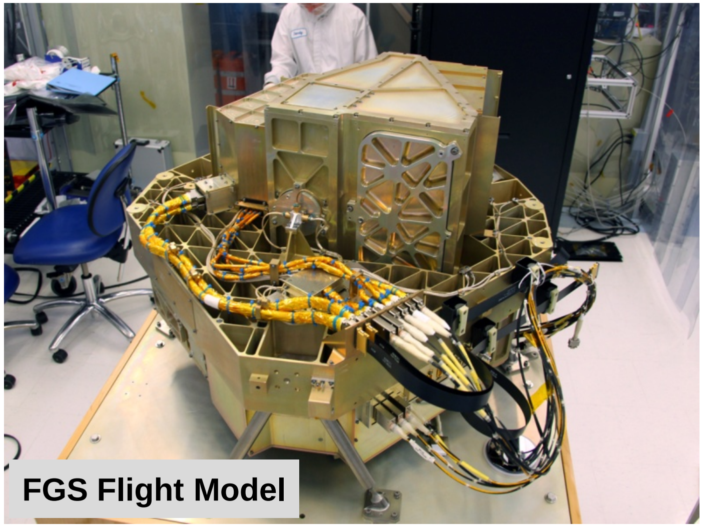






The FGS-Guider and -NIRISS provide telescope pointing control imagery & slitless spectroscopy for Ly-α galaxy surveys and extra-solar planet transits





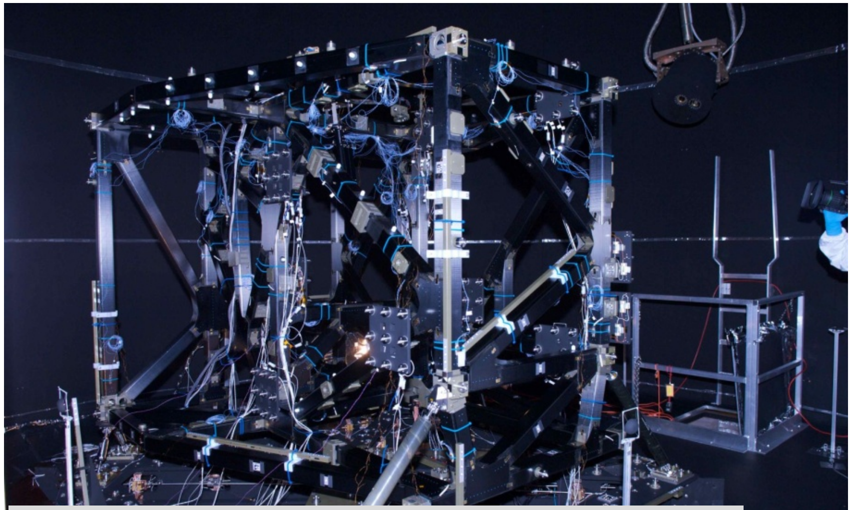
- Developed by the Canadian Space Agency with ComDev
  - Broad-band guider (0.6 – 5 microns)
  - Field of view: 2.3 x 2.3 arc minutes
  - Science imagery:
    - Slitless spectroscopic imagery (grism)
      - R ~ 150, 0.8 – 2.25 microns optimized for Ly alpha galaxy surveys
      - R ~ 700, 0.7 – 2.5 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

FGS was delivered to ISIM I&T during July 2012

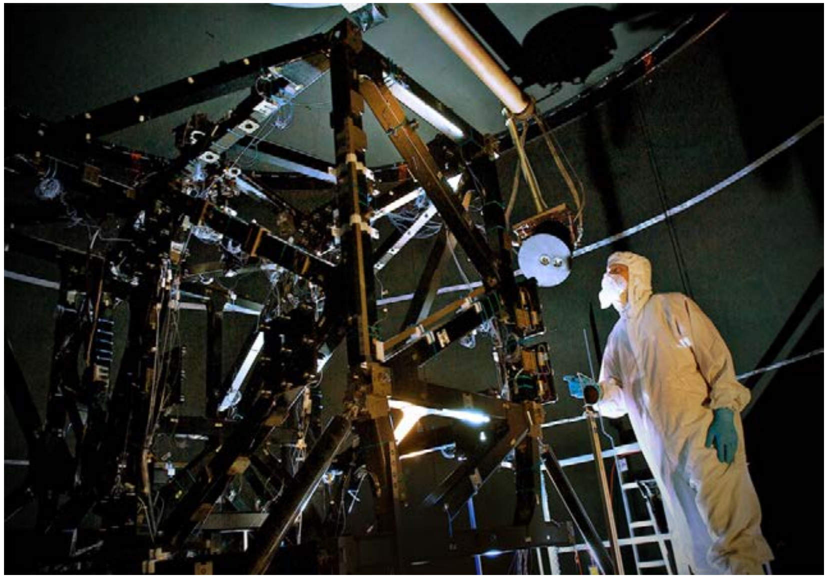
The ISIM structure has been qualified for ambient and cryogenic strength, cryogenic dimensional repeatability and distortion

- Carbon-fiber/cyanate-ester composite material
  - Primary launch-load bearing structure (warm launch)
  - High precision optical requirements
- Key dimensional requirements for thermal cycling (300 to 30 K) verified to better than 25 micron precision
  - Repeatability: 80 microns
  - Distortion: 500 microns
- Cryogenic and ambient strength proof test and modal survey completed

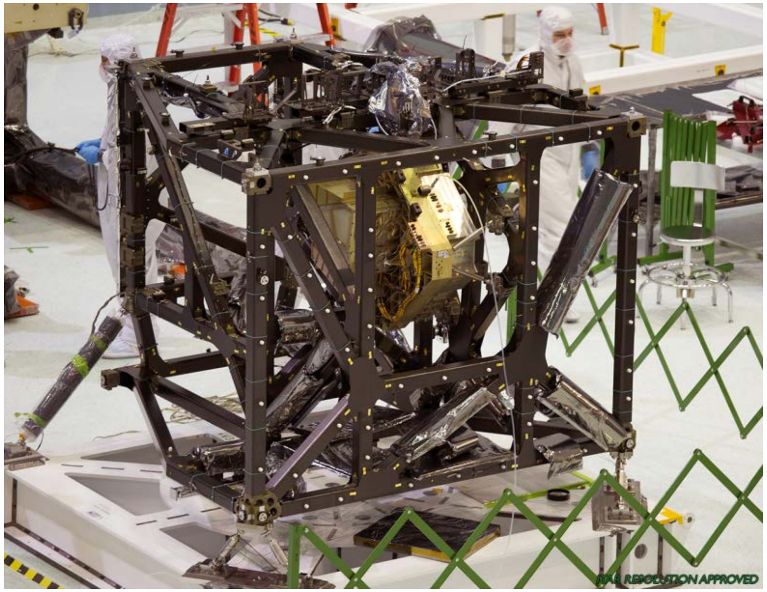
ISIM flight structure ambient temp strength testing

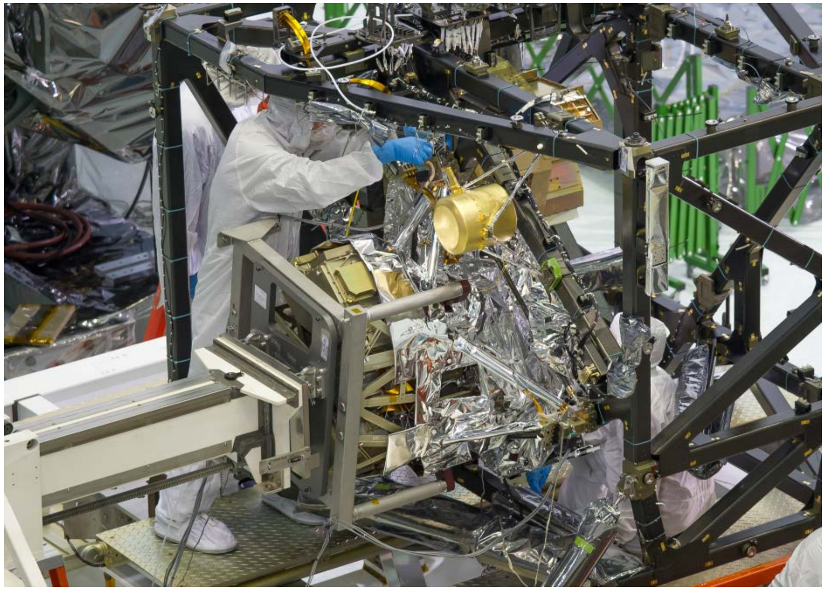


ISIM flight structure cryogenic photogrammetry testing



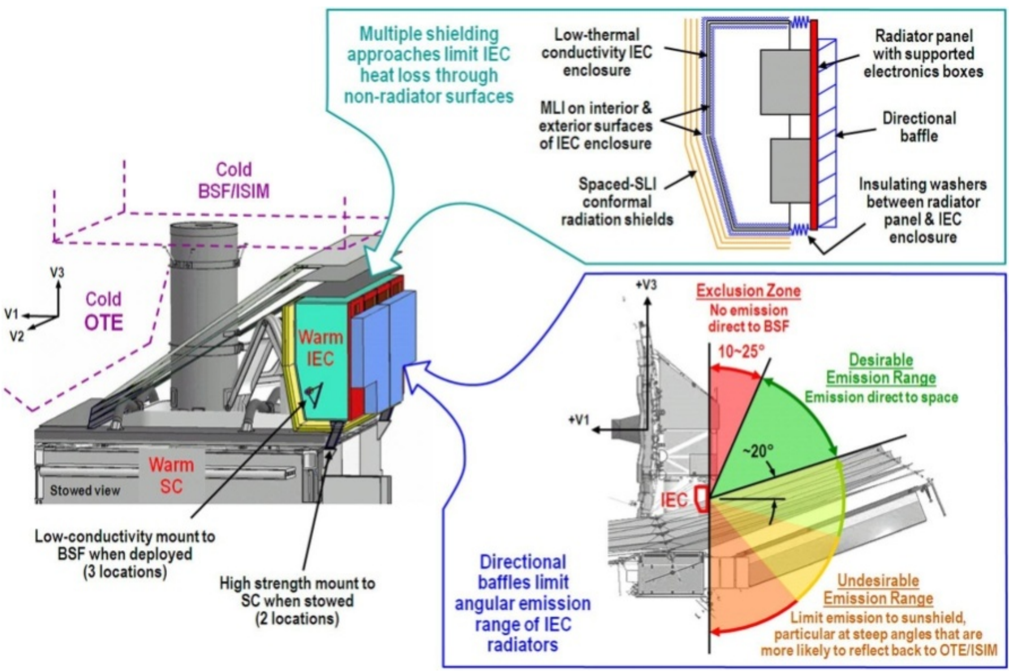
Integration of FGS, NIRISS, and MIRI sensors with the ISIM structure has been completed

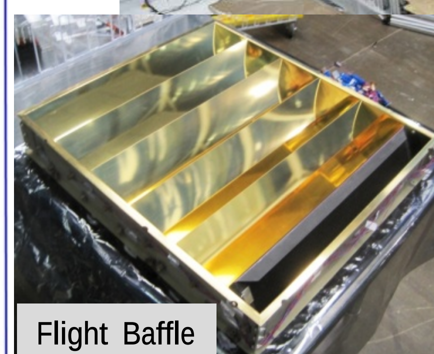




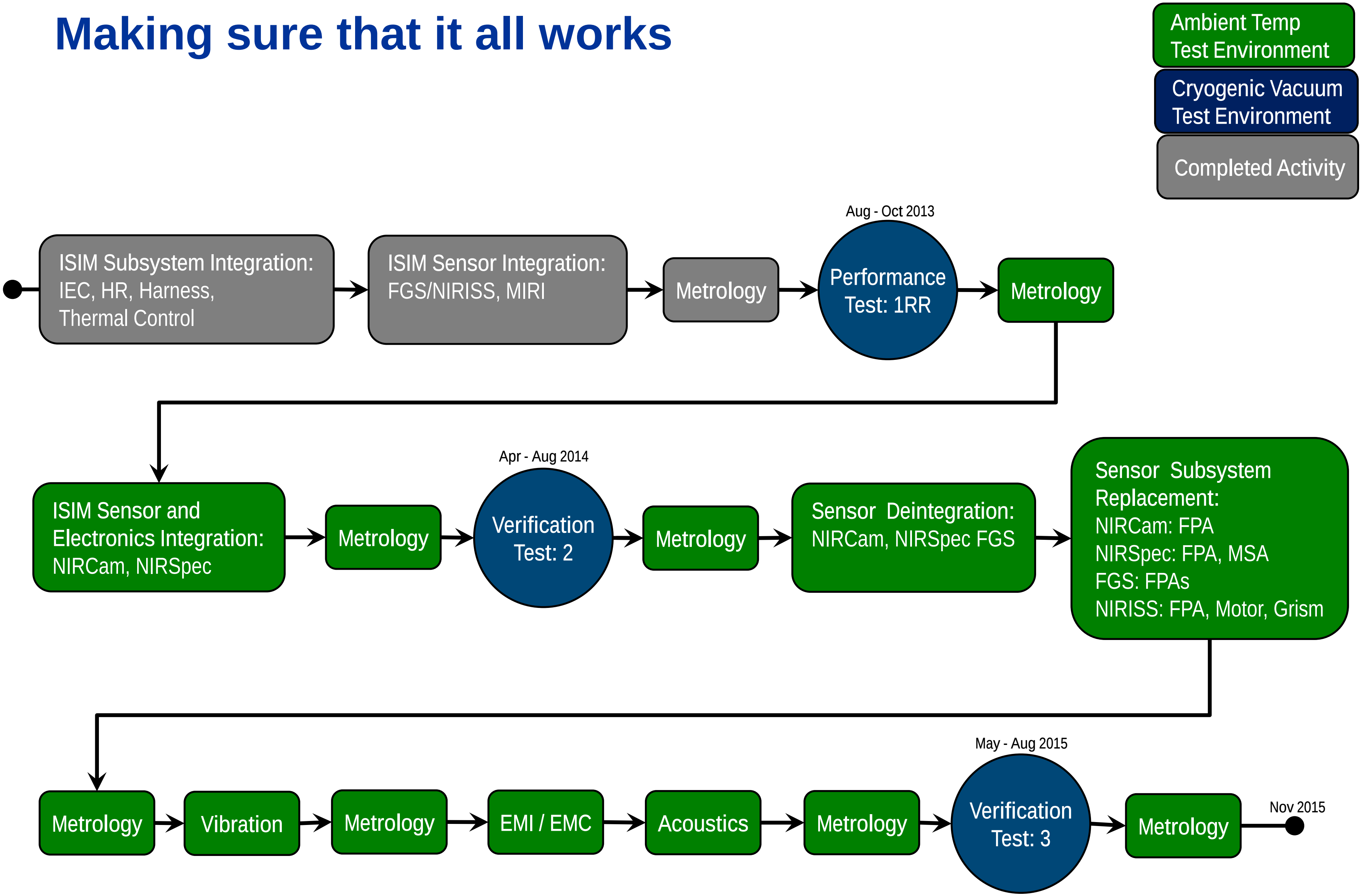
ISIM Electronics Compartment (IEC) and Harness Radiator (HR) address one of the most difficult engineering challenges of the JWST

- **The IEC accommodates 11 warm electronics boxes that must reside on the cryogenic side of the sunshield close to the science instruments**
  - Rejects ~220 W of power to space in a controlled beam pattern to achieve required observatory thermal balance and avoid thermal stray light
  - Radiator beam pattern and thermal balance verified in unit-level test
- **The HR provides passive cooling for ~2,700 wires that run between the cryogenic science instruments and their warm electronics (~ 2 meters).**
  - Reduces conductive harness heat load to 95 mW



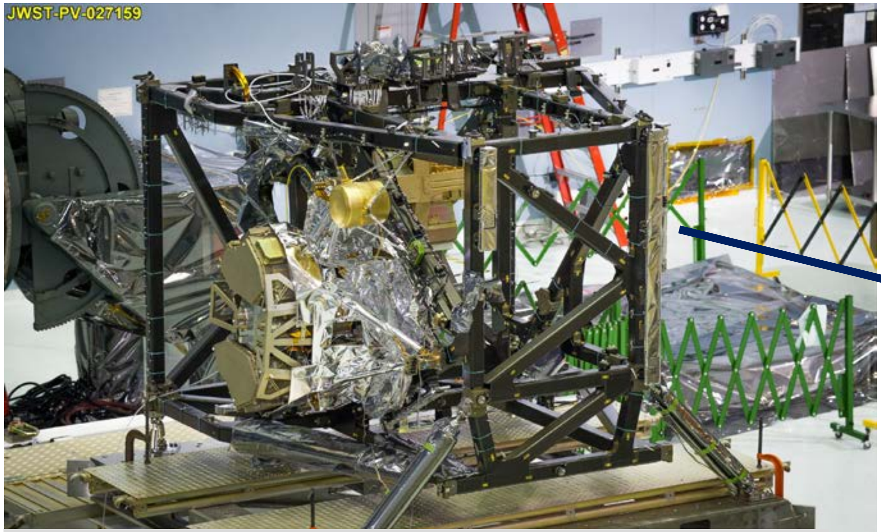


Making sure that it all works

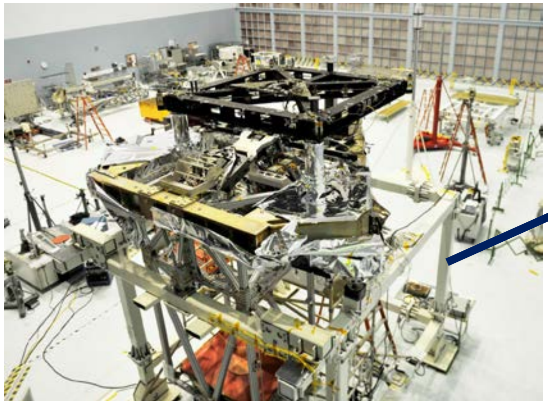


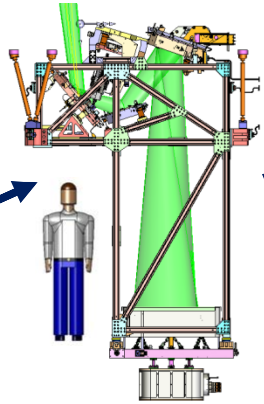
ISIM will be tested at ~35 K in the GSFC SES chamber using a cryogenic telescope simulator (OSIM)

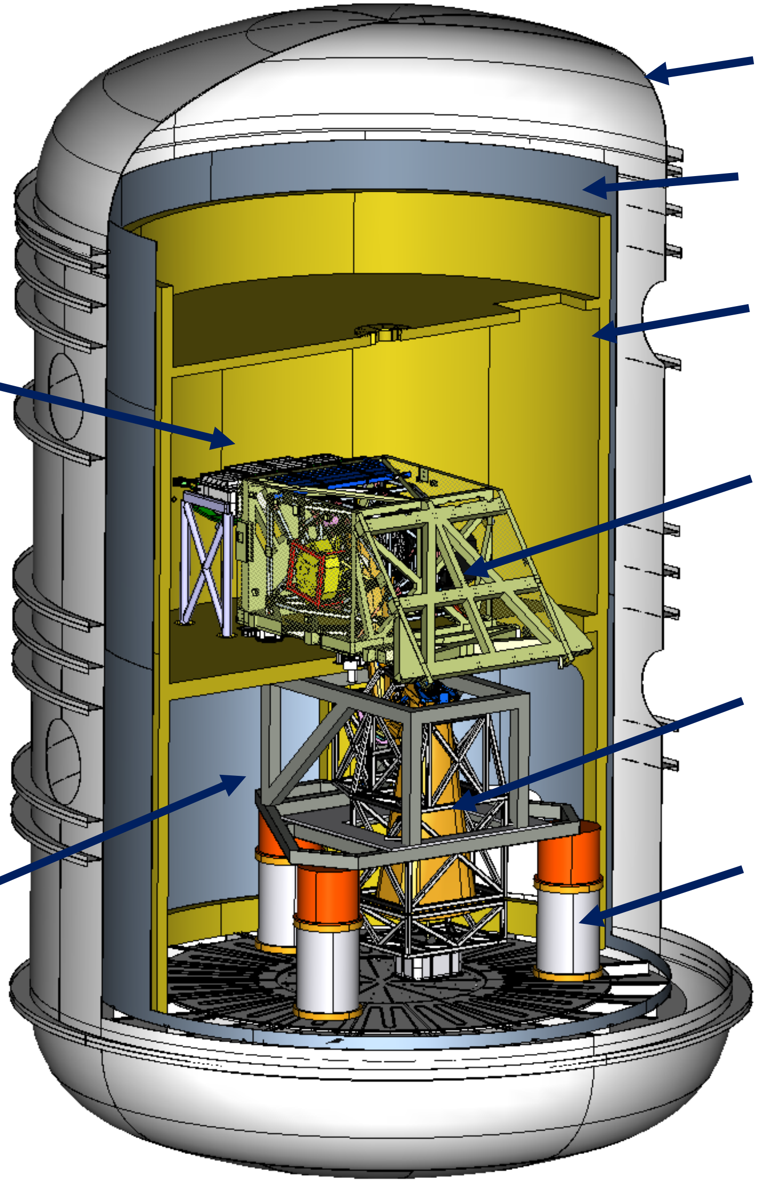
First of 3 SES test cycles of the flight ISIM begins during August 2013



MIRI and FGS integrated with the flight ISIM structure

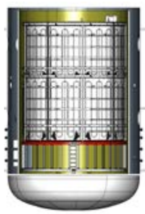
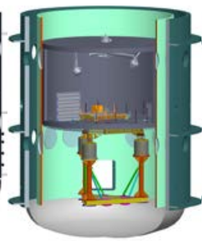
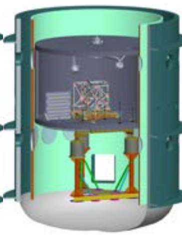
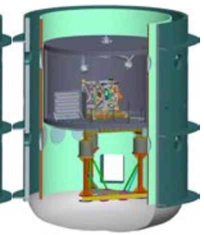
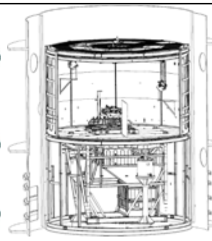
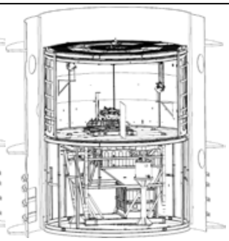
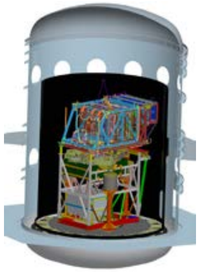






The upcoming ISIM CV-1RR test is the culmination of 5 years of test facility development for it

Test Items – Test Exposure of Items in <u>SES Testing</u> prior to Cryo-Vacuum Test

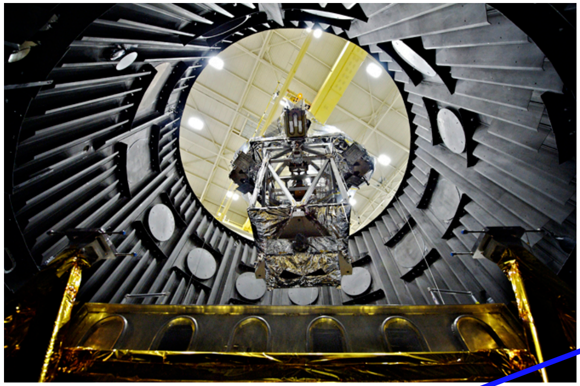
Tests	 He Shroud Acceptance Test (-03) **COMPLETE 2008**	 Chamber Certification Test (-01) **COMPLETE March 2010**	 ISIM Structure Cryoset Test **COMPLETE May 2010**	 ISIM Structure Cryo-Proof Test **COMPLETE Nov 2010**	 OSIM Cryo-Cal Test 1 **COMPLETE Aug 2012**	 OSIM Cryo-Cal Test 2 **COMPLETE May 2013**	 ISIM Element Cryo-Vacuum Tests (3 tests planned)
Items in Test	He Shroud (-03)	He Shroud (-01) Lower GESHA Upper GESHA GIS ITP Photogrammetry Fabreeka VIS* MIRI MLI Expmnt Bolometers	He Shroud (-01) Lower GESHA Upper GESHA GIS ITP / MATF Photogrammetry Fabreeka VIS* MIRI MLI Expmnt Bolometers <u>Flight Structure</u> IATF	He Shroud (-01) Lower GESHA Upper GESHA GIS ITP Photogrammetry Fabreeka VIS* Radiometer <u>Flight Structure</u> IATF	He Shroud (-01) Lower GESHA Upper GESHA GIS ITP / MATF Photogrammetry Fabreeka VIS OSIM Baffle OSIM OSIM Shroud BIA SIF/Shroud Support Frame	Not in Previous SES Tests	He Shroud (-01) Lower/Upper GESHA, GIS ITP/ MATF Fabreeka VIS <u>Flight Structure</u> IATF OSIM OSIM Shroud SIF/Shroud Support Frame **<u>Science Instruments (SI)#</u>** **<u>Flight Harness</u>** **<u>Flight Heat Straps</u>** **<u>MIRI Cryo-Cooler#</u>** **MCA** **SIF & Interfaces to Frame** **Surrogate TMS** **<u>IEC</u> w/ Shroud /LN2 Panel** **<u>Harness Radiator</u>** **HR Shroud**
Cycles	1 cycle to 15K B/O to 70C	1 cycle to 15K 1 cycle to 30K B/O to 50C	1 cycle to 39K 1 cycle to 28K B/O to 40C	1 cycle to 28K	1 cycle to 30K (BIA) 1 cycle of OSIM to 100K		CV1: 1 cycle to 43K CV2: 1 cycle to 37K + 43K CV3: 1 cycle to 37K + 43K

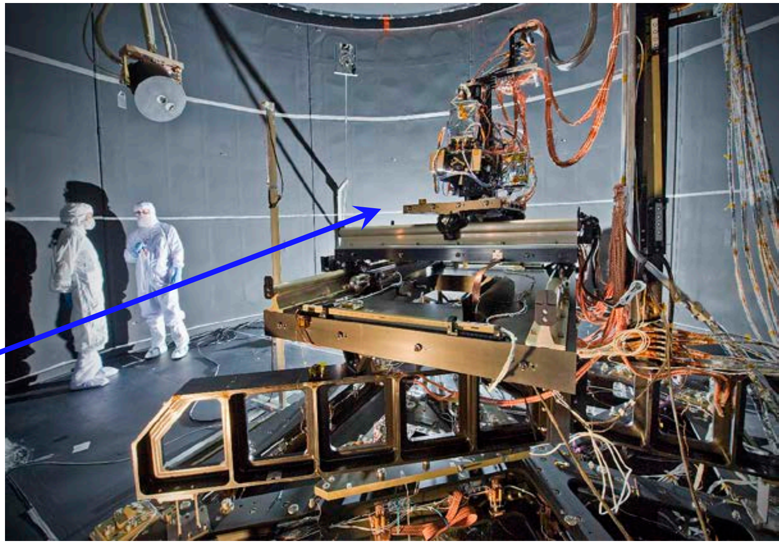
* - caveat; Fabreeka's were not energized in these tests

- caveat; NIRSpec, NIRCam are not in CV1, and Cryo cColer CHA ETU used in CV 1 test.

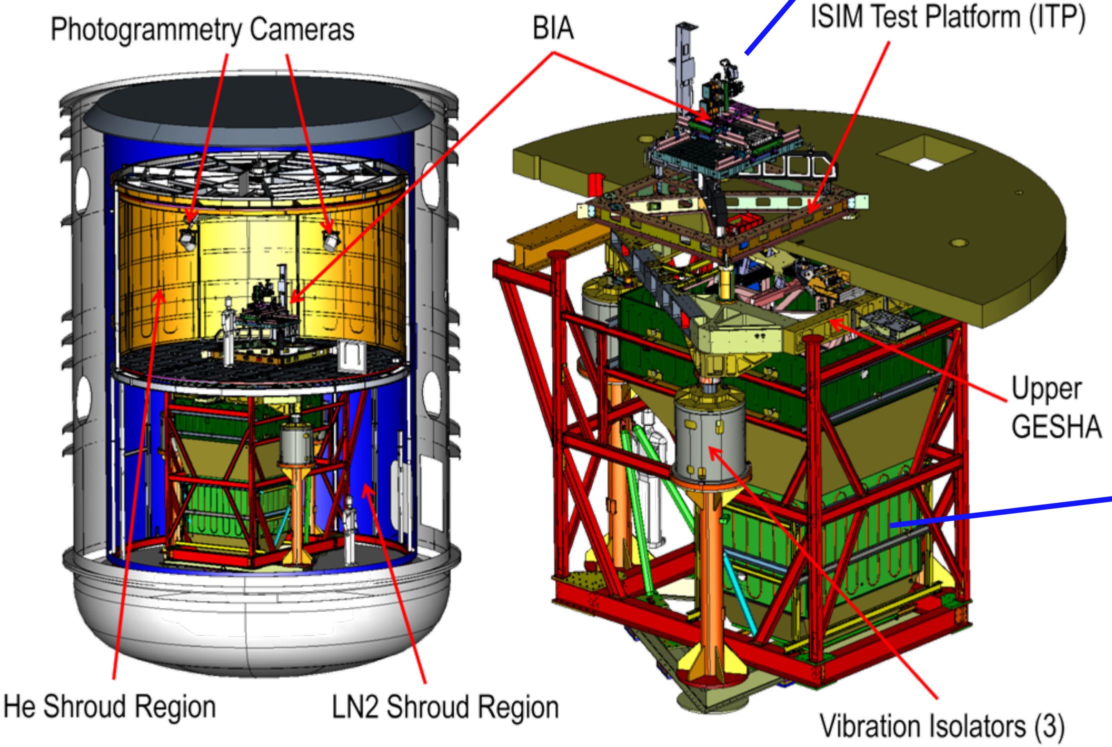
<u>Underlined</u> items indicate flight articles

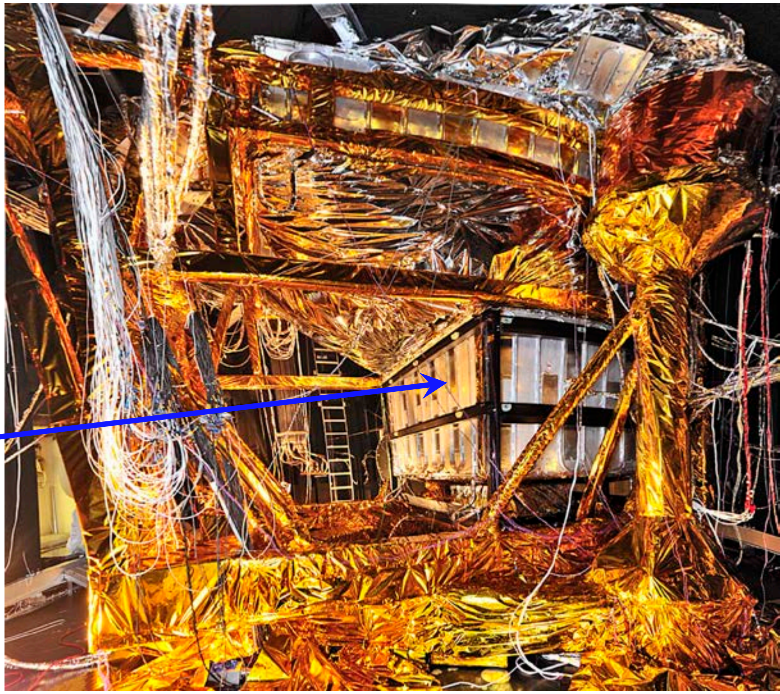
OSIM-1 test configuration in SES chamber: June 2012





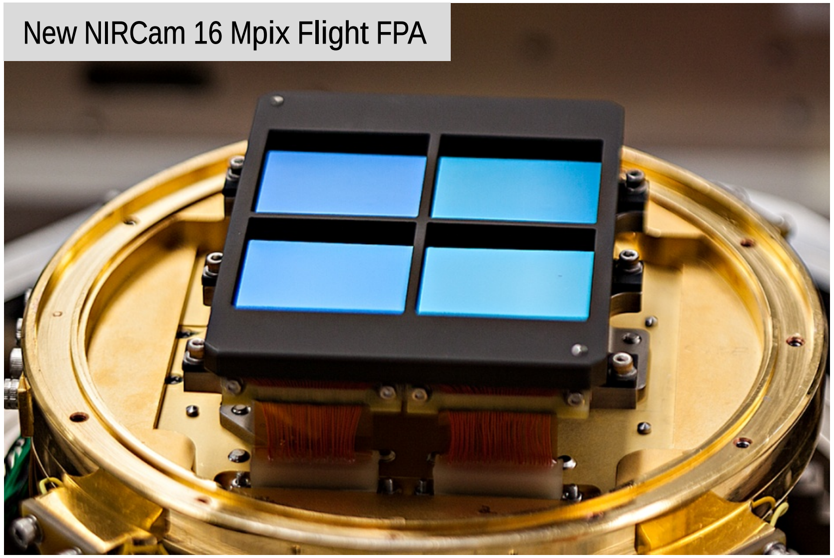
OSIM cryo-vac test configuration

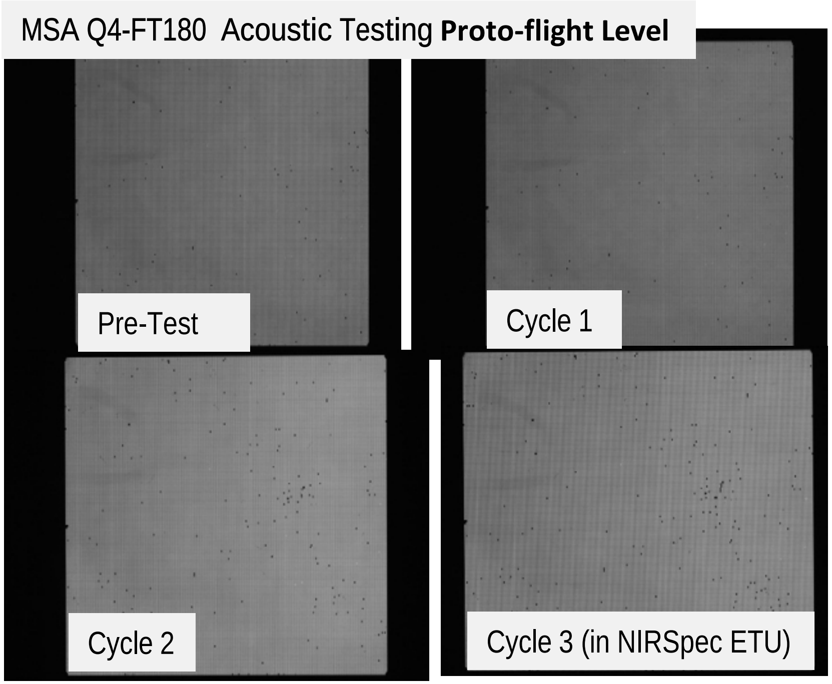




Sensor subsystem re-work proceeding on schedule

- Near-Infrared detectors
  - Degradation of original flight detectors necessitates remanufacture
    - Root cause determined and corrected; new design qualified through test
  - Production of new units on schedule for replacement prior to ISIM CV-3; NIRCam units currently on schedule for replacement prior to CV-2
- NIRSpec MSA
  - Flight unit out of spec due to damage sustained during acoustic testing
    - Root cause of unexpected acoustic susceptibility determined and corrected on flight spare unit which is in manufacturing
      - Resiliency to flight acoustic loads proven through test
  - Plan to install flight spare MSA prior to ISIM CV-3





Learn more at:

www.jwst.nasa.gov

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

Watch the JWST being built at:

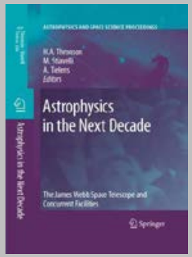
Click Video

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 observing time estimator:

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

Interact with the JWST Science Working Group:

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

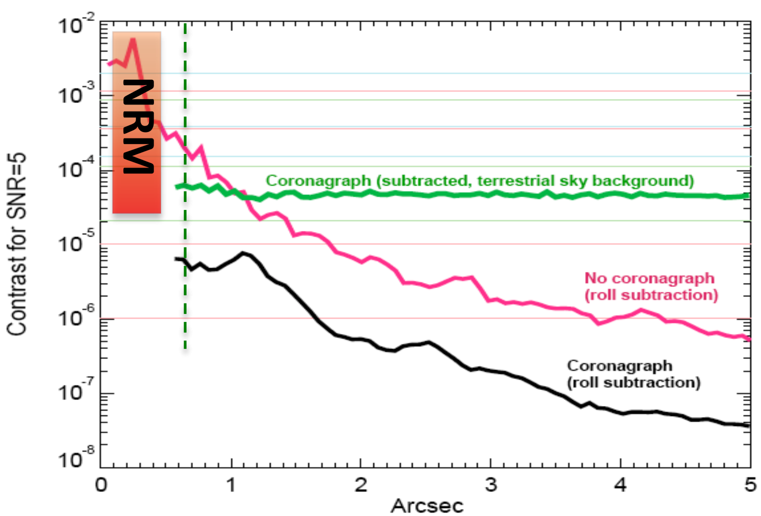
Supplemental Slides

The NIRISS includes an Aperture Masking Interferometry (AMI) mode that enables moderate contrast imagery at an inner working angle of λ/2D

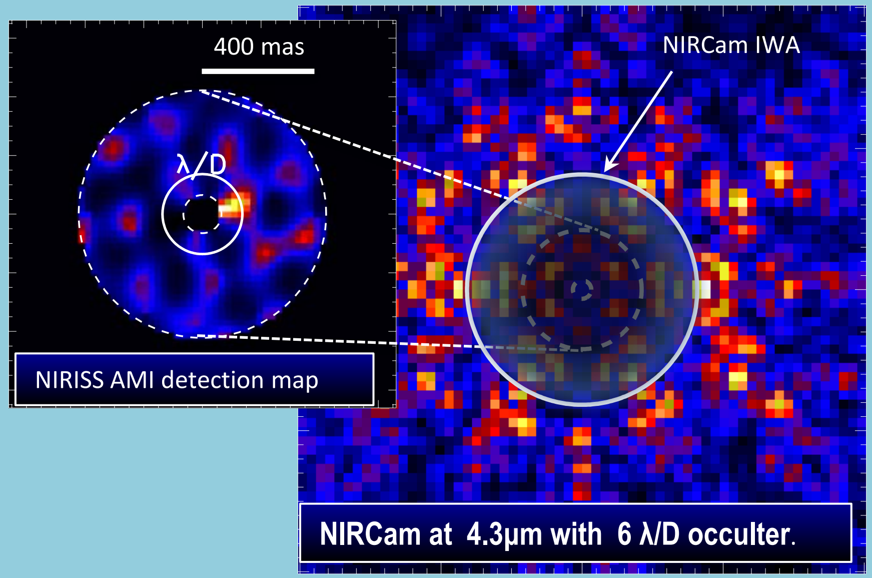
Available in 3 broad-band filters: 3.8, 4.3, 4.8 um over which NIRISS is Nyquist sampled

Yields 10-12 magnitudes of point source contrast over a 70-500 mas annulus

NIRCam coronagraphy limited to an inner working angle of approximately 600 mas



NIRISS & NIRCam IWA and contrast



Simulated companion above has contrast of 10 mag at a separation of 130 mas

Equivalent to a 1-2 M_{Jup} planet at ~1 AU of a 50 Myr-old M0V dwarf at a distance of 10 pc from the Sun.

Above simulation corresponds to approximately 3 hours of observing time

CV-1RR Objectives

- **Primary:**
  - Demonstrate that the test configuration, which includes large amounts of new GSE, is able to support the test requirements of the ISIM verification program (identify any necessary fixes to hardware before CV2)
  - By dry-running critical test procedures, learn how to most efficiently formulate and execute them and to analyze the results (identify any necessary improvements to procedures before CV2)
  - Demonstrate that the cryo-vacuum test setup provides adequate thermal control and stability through an entire cryogenic cycle (cool down, plateau at ISIM operating temperature, warm up) and supports the capability of performing a thermal balance test
  - Demonstrate operation of the MIRI, FGS, and NIRISS (hereafter “SIs”)with ISIM systems at temperature (basic performance, timing, noise)
  - Demonstrate the management of the hardware from a contamination control standpoint
  - Demonstrate the viability of the test setup for performing optical testing in terms of the jitter environment and stray light backgrounds
  - Explore the interaction of the OSIM and the SI’s such that pointing, fluxes, and exposures can be planned and configured efficiently for performing optical verification in subsequent tests
- **Secondary:**
  - Verify the cryo-cooler 6.2K heat load. This will be done by measuring the heat load to the J-T cooler
  - By dry-running optical tests, provide an initial confirmation of key optical performance parameters, such as the six degree-of-freedom alignment of the SI’s, retiring the very low risk of any fundamental metrology problem in the OSIM or SI buildup
  - Take the opportunity to perform critical SI-level verifications for NIRISS (never before operated end-to-end in its current optical configuration) and MIRI (detector regression testing to close out the sensitivity non-compliance investigation)
  - By dry-running tests, provide a firm basis for planning and estimating the required time for the verification tests of CV2&3
  - Train all test personnel in the logistics of test execution (communications, decision processes, roles and responsibilities) and analysis