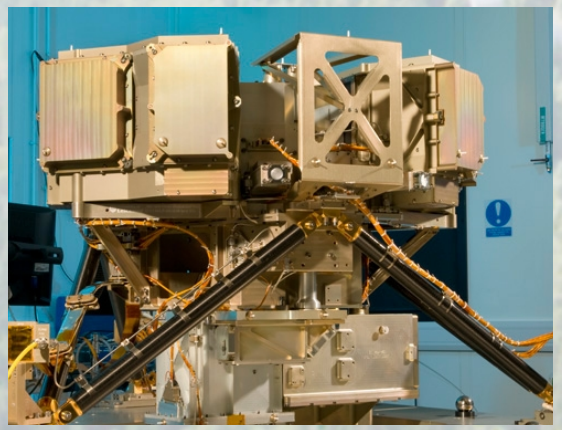
Max Planck Institute for Astronomy, Heidelberg

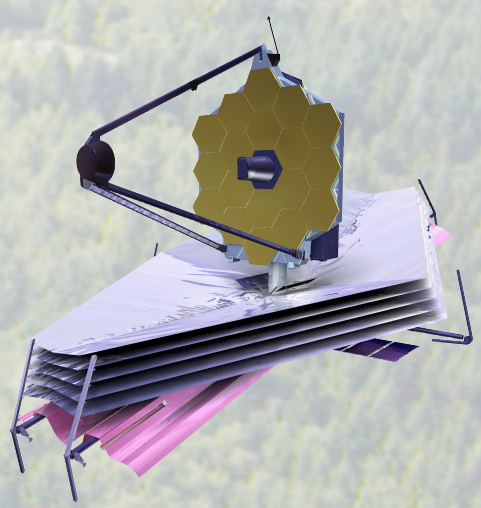
The Mid-Infrared Instrument (MIRI) aboard the James Webb Space Telescope

Silvia Scheithauer

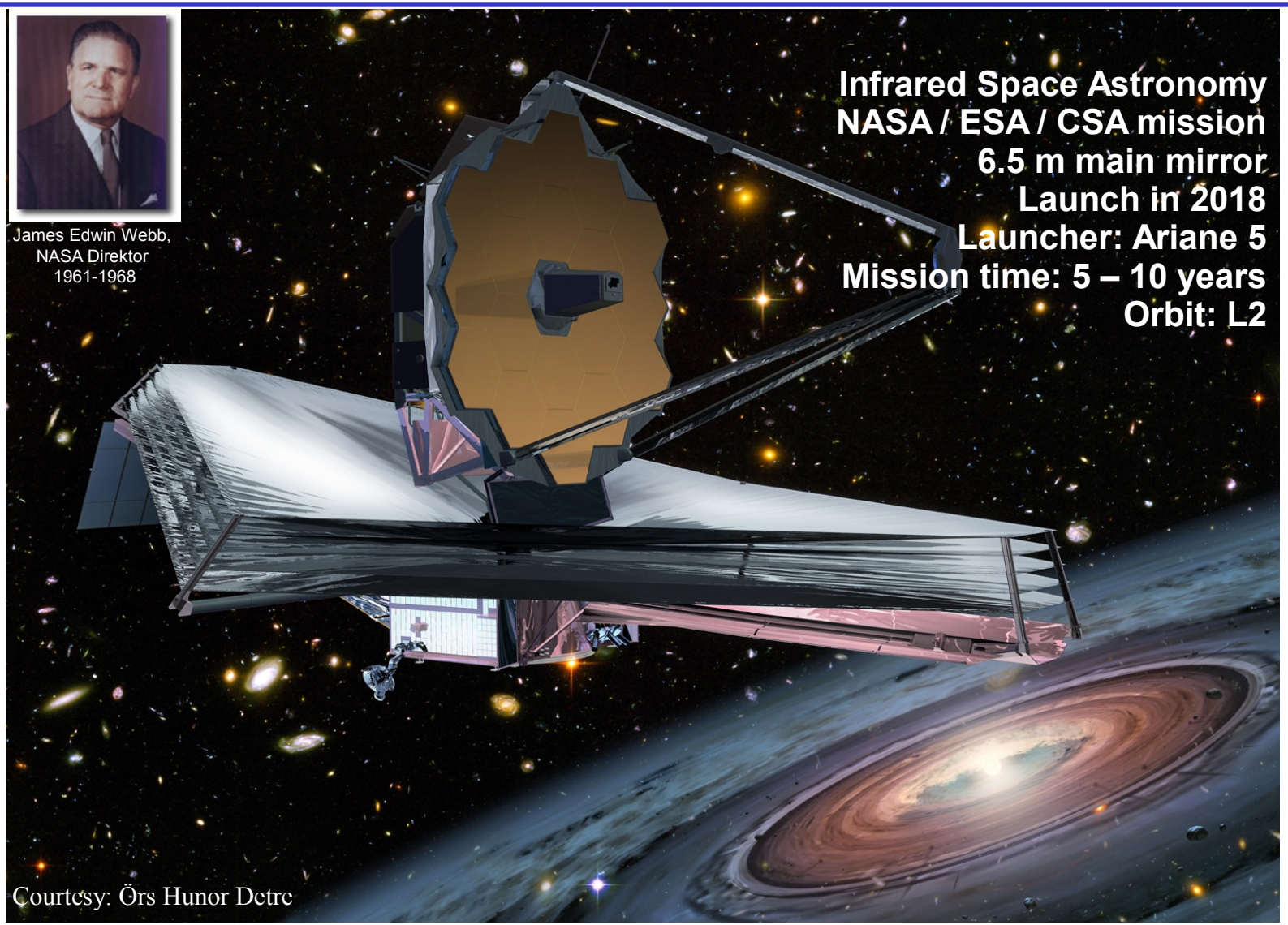
MIRI team at MPIA

European MIRI test team





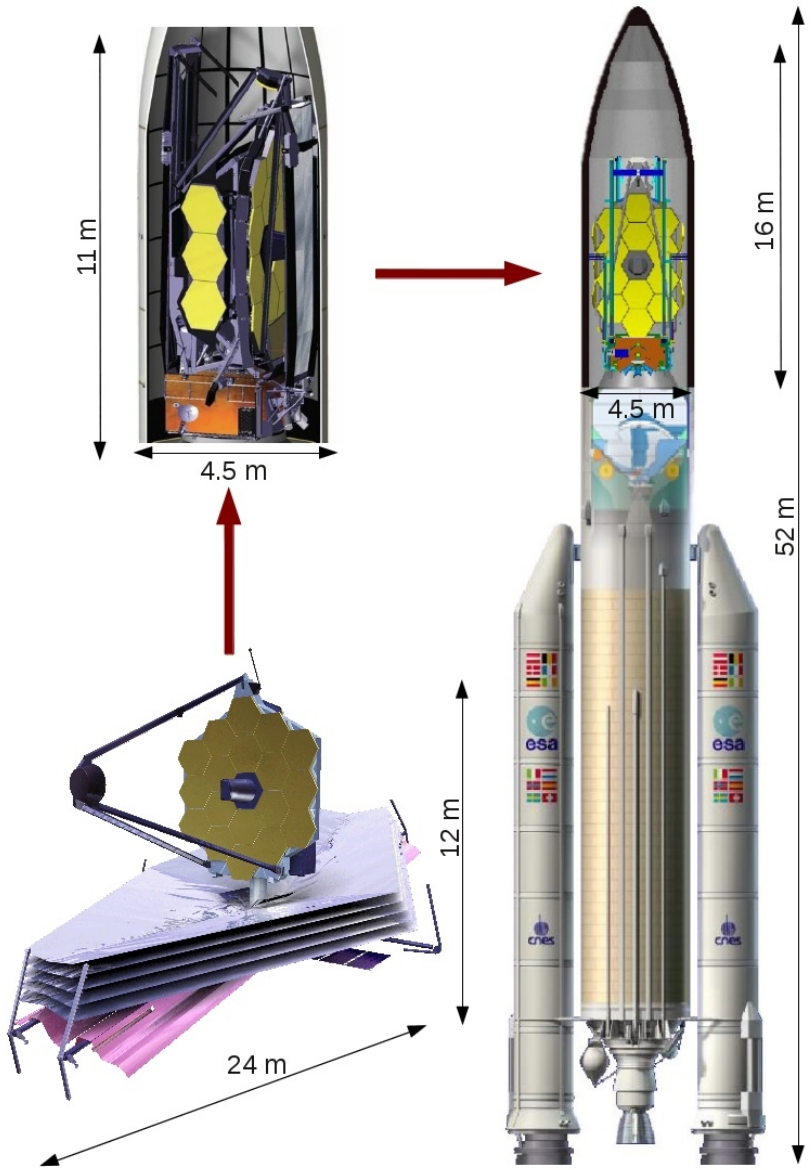
James Webb Space Telescope (JWST)

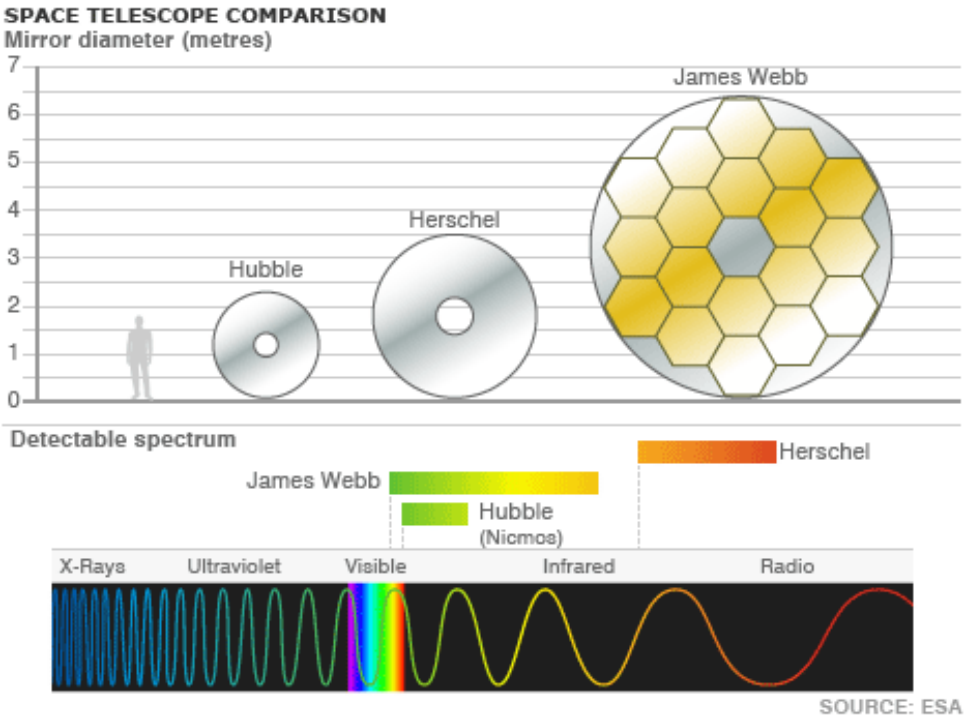


JWST 1:1 model

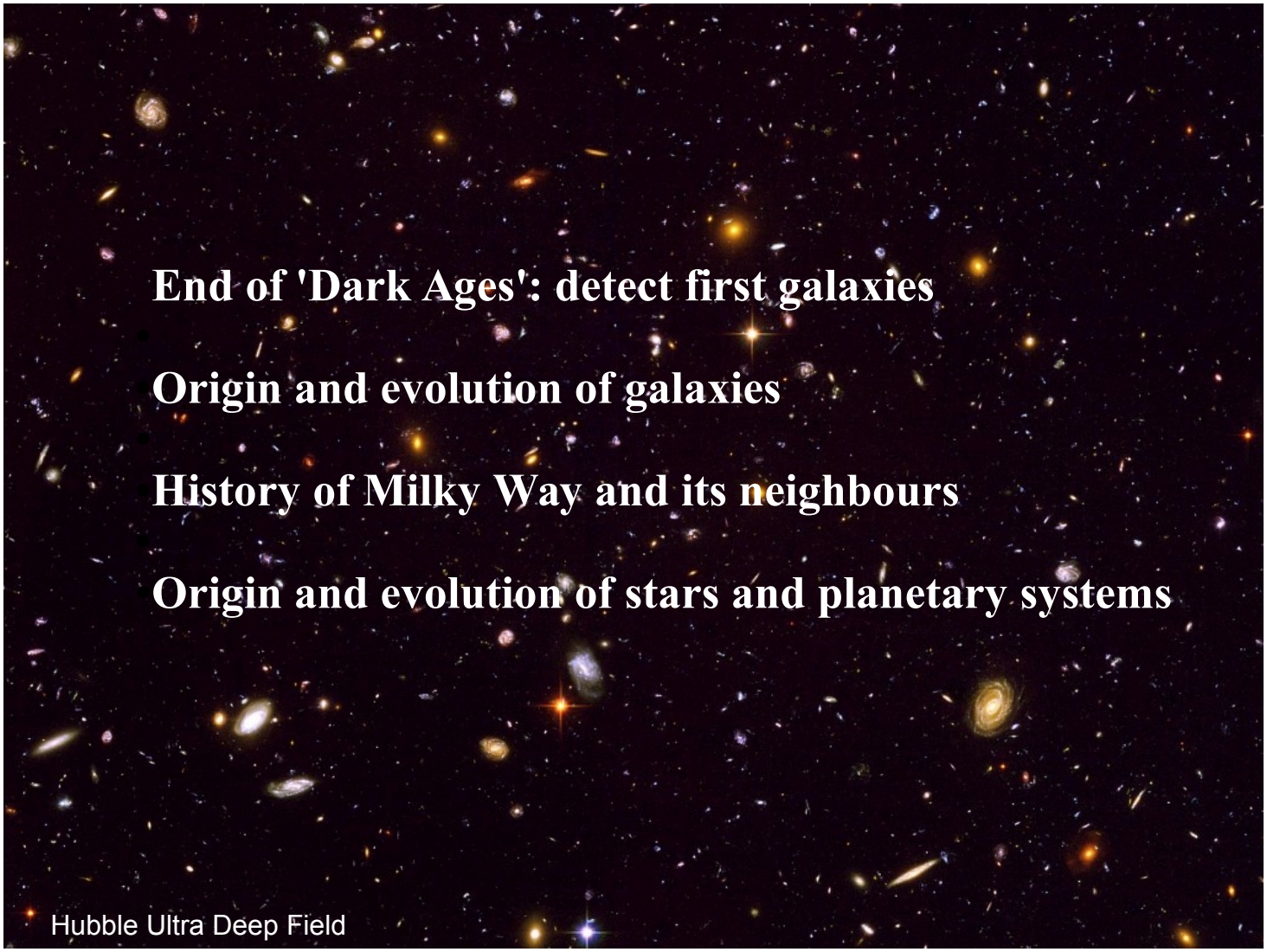
JWST partners workshop, 2008, Munich

JWST – Dimensions



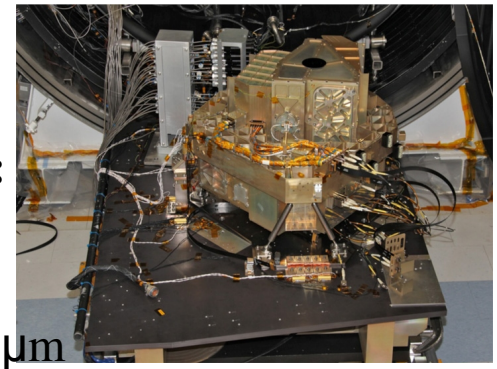


JWST Overall Science Goals

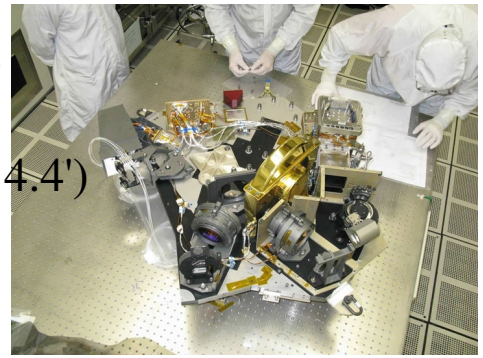


JWST Scientific Instruments

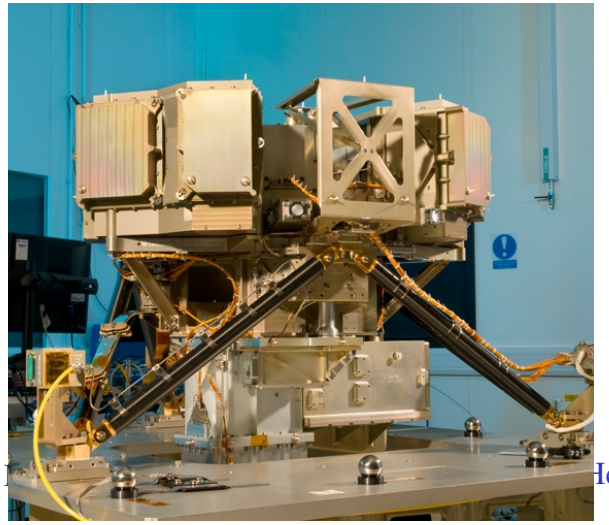
Fine Guidance System / NIR Imager and Slit Spectrograph (NIRISS):
near-IR tunable filter imaging capability (2.3' x 2.3', R~100), λ ~ 1.5 – 5 μm



Near-IR-Camera (NIRCam):
wide-field (2.2' x 4.4') near-IR camera
λ ~ 0.6 – 5 μm



Mid-IR-Instrument (MIRI):
combined mid-IR-camera (1.4' x 1.9') and spectrograph (R~100, ~1000-3000)
λ ~ 5 – 28 μm

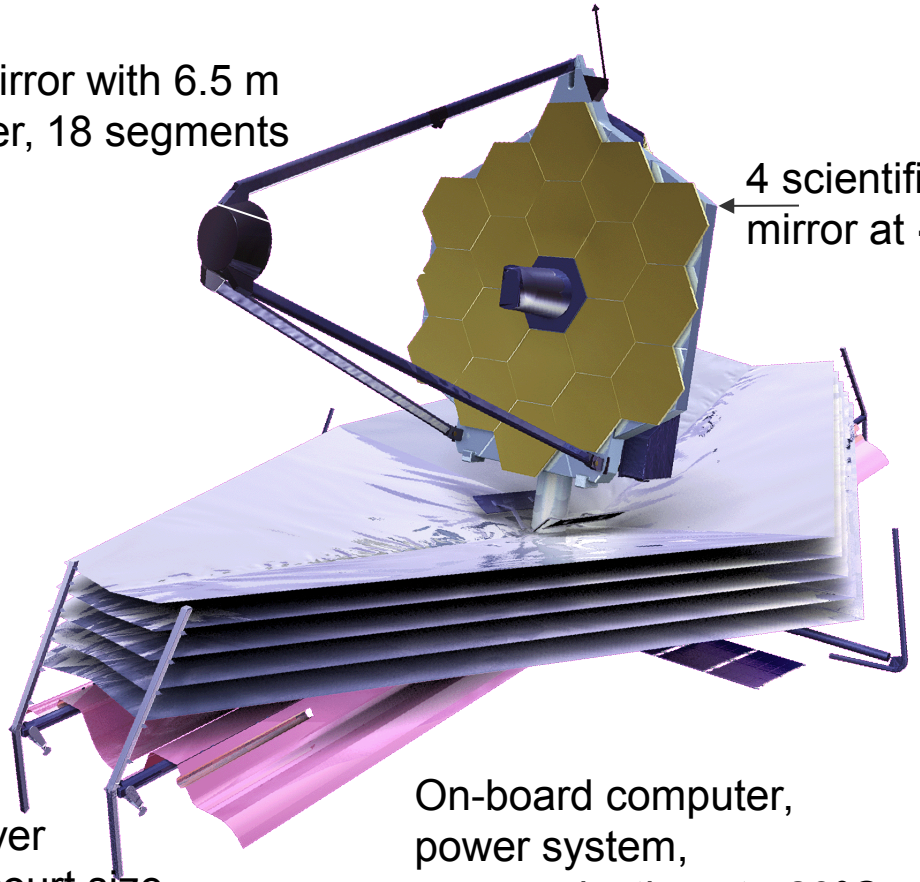


Near-IR-Spectrograph (NIRSpec):
wide-field (3.5' x 3.5') multi-object near IR spectrometer (R~100, ~1000, ~300)
λ ~ 0.6 – 5 μm

JWST Cooling Strategy

main mirror with 6.5 m diameter, 18 segments

4 scientific instruments behind mirror at **-230°C**



Orbit:
1.5 millionen km away from Earth (Lagrange Point 2)
'empty' space at -270°C

Key technology: 5-layer sun-shield of tennis court size

Passive cooling from +20°C to -230°C

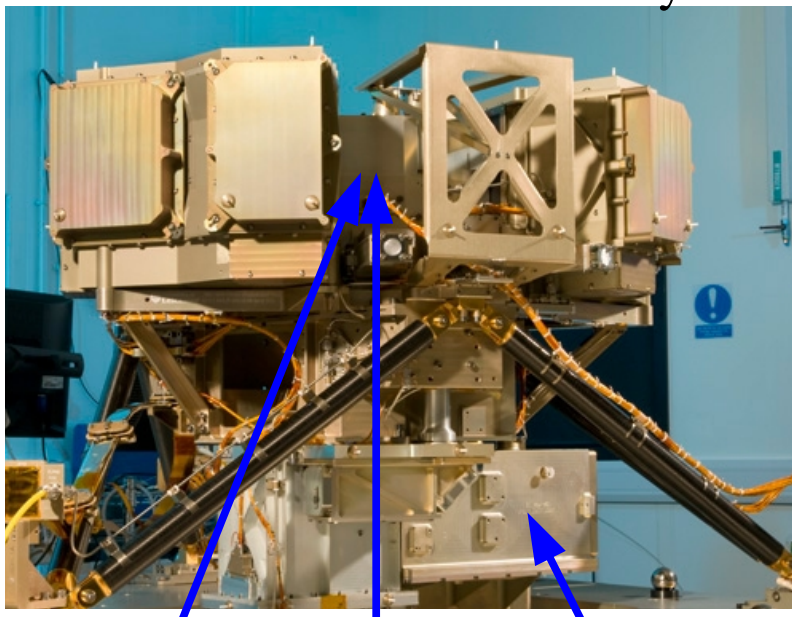
On-board computer, power system, communication at **+20°C**

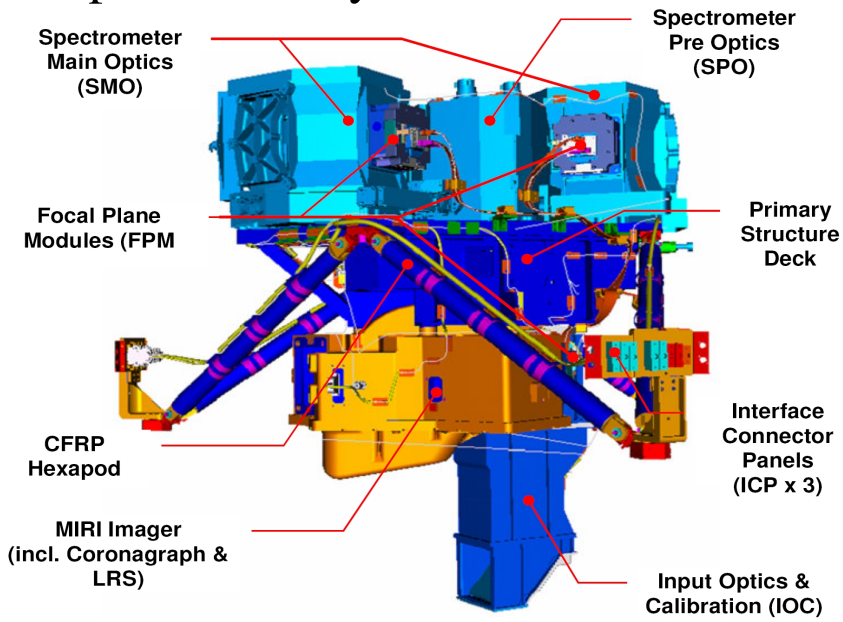
NIR instruments are fine with passive cooling

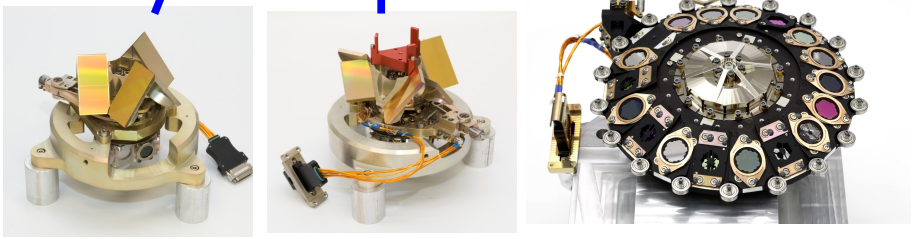
MIRI needs additional cryo-cooler to work at 6 K

The MIRI Instrument

MIRI has been developed by scientific institutions from 10 European countries and NASA / JPL and built by European space industry.







MPIA hardware contributions: wheel mechanisms

3 Si:As detector arrays at ~ 6 K

Imaging

Low Resolution Spectroscopy (prism)

Coronography

Medium Resolution Spectroscopy (IFU)

MIRI Capabilities

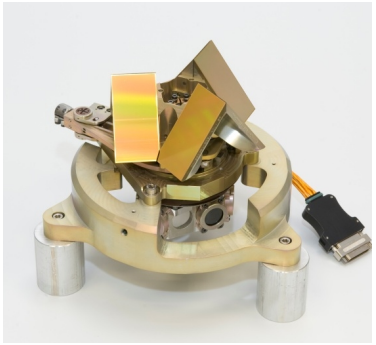
MIRI combines:

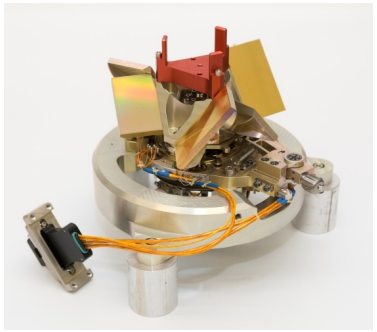
- Imaging, low and moderate resolution spectroscopy and coronography
- Extremely high sensitivity levels:
  - Factor 3000 better imaging sensitivity w.r.t. 8m ground-based telescopes
  - Factor 1000 better for moderate resolution (R~3000) spectroscopy
  - Factor 50 better than Spitzer for 5-12μm range (MIRI LRS)
- Subarcsec angular resolution
- Space advantages: stability, no atmospheric interferences

This makes MIRI ideal for studying:

- Imaging exoplanets
- Transit and eclipse spectroscopy of exoplanets
- Star and planet formation
- Determining star formation rates and mass growth in galaxies
- Characterising youngest massive galaxies

MIRI Hardware Contributions from MPIA





Dichroic grating wheels for spectrometer unit

2001-2010: Development, test and qualification of filter and dichroic-grating wheels; support of flight model assembly and testing

IR space group

Design department

Electronic workshop

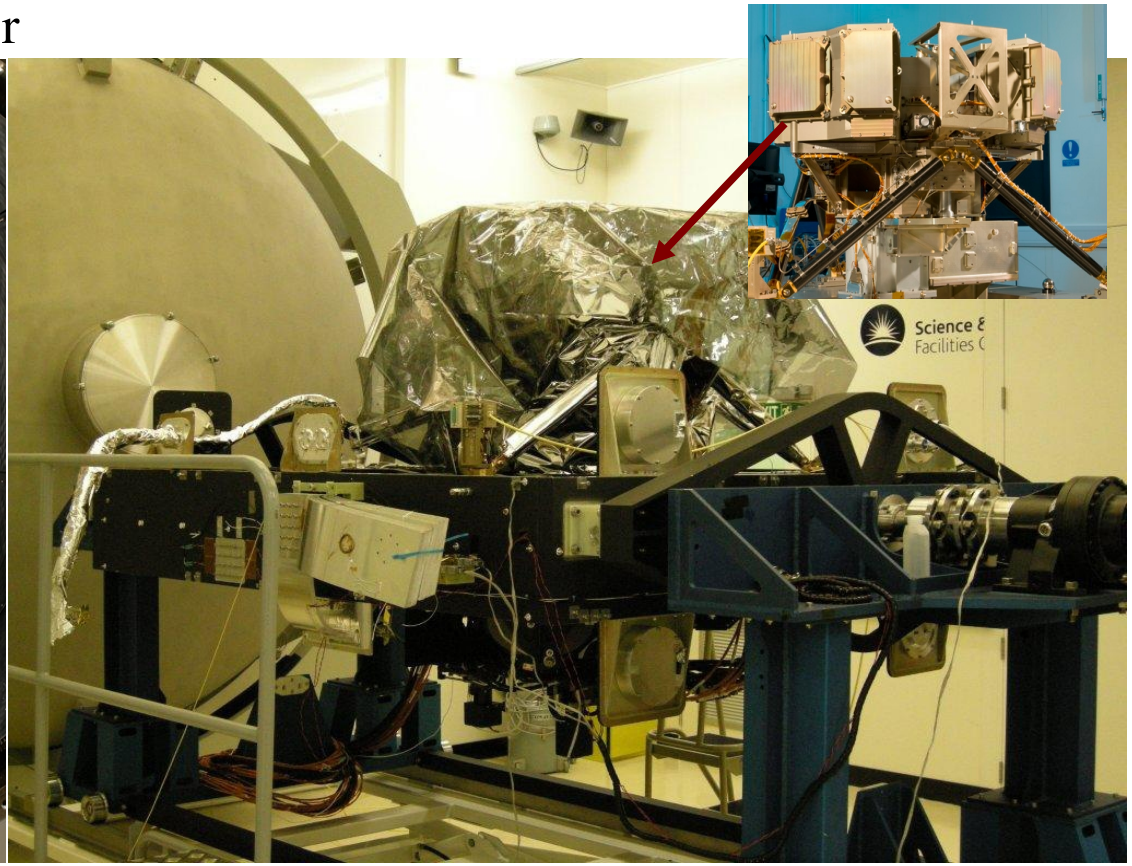
Mechanical workshop

Filter wheel for imager

Flight model assembly and testing at Zeiss Oberkochen

MIRI Assembly & Performance Testing

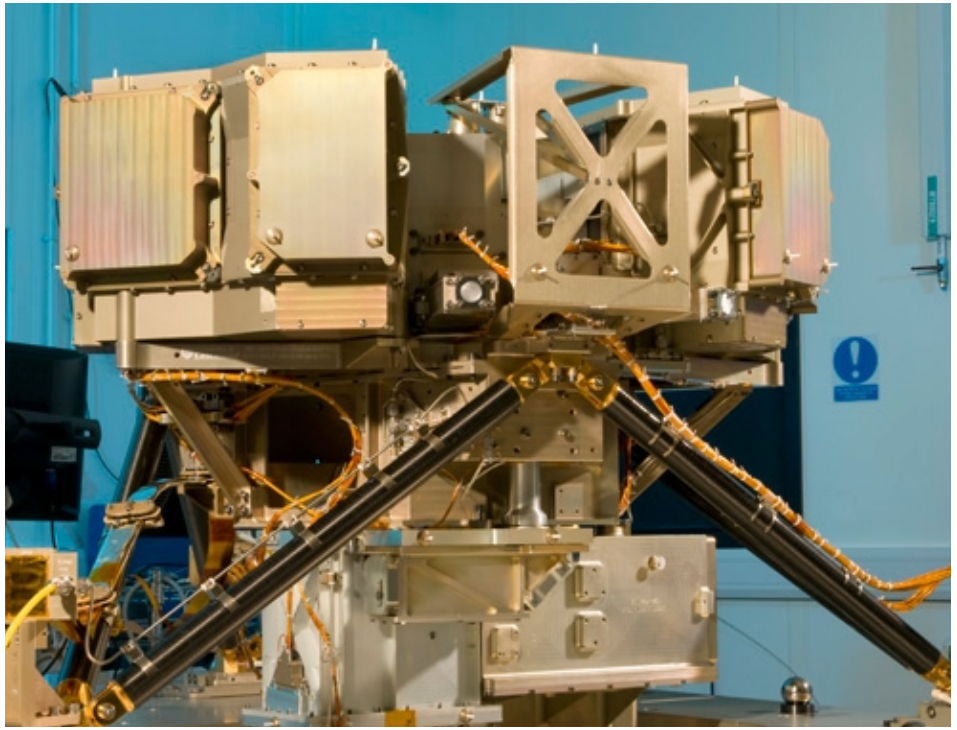
2010: completion of full MIRI instrument at RAL (Rutherford Appleton Laboratory), UK
Testing in 2011: functional, thermal, shaker;
113 days of performance testing by the MIRI Test Team in thermal chamber with telescope simulator



MIRI leaves Europe

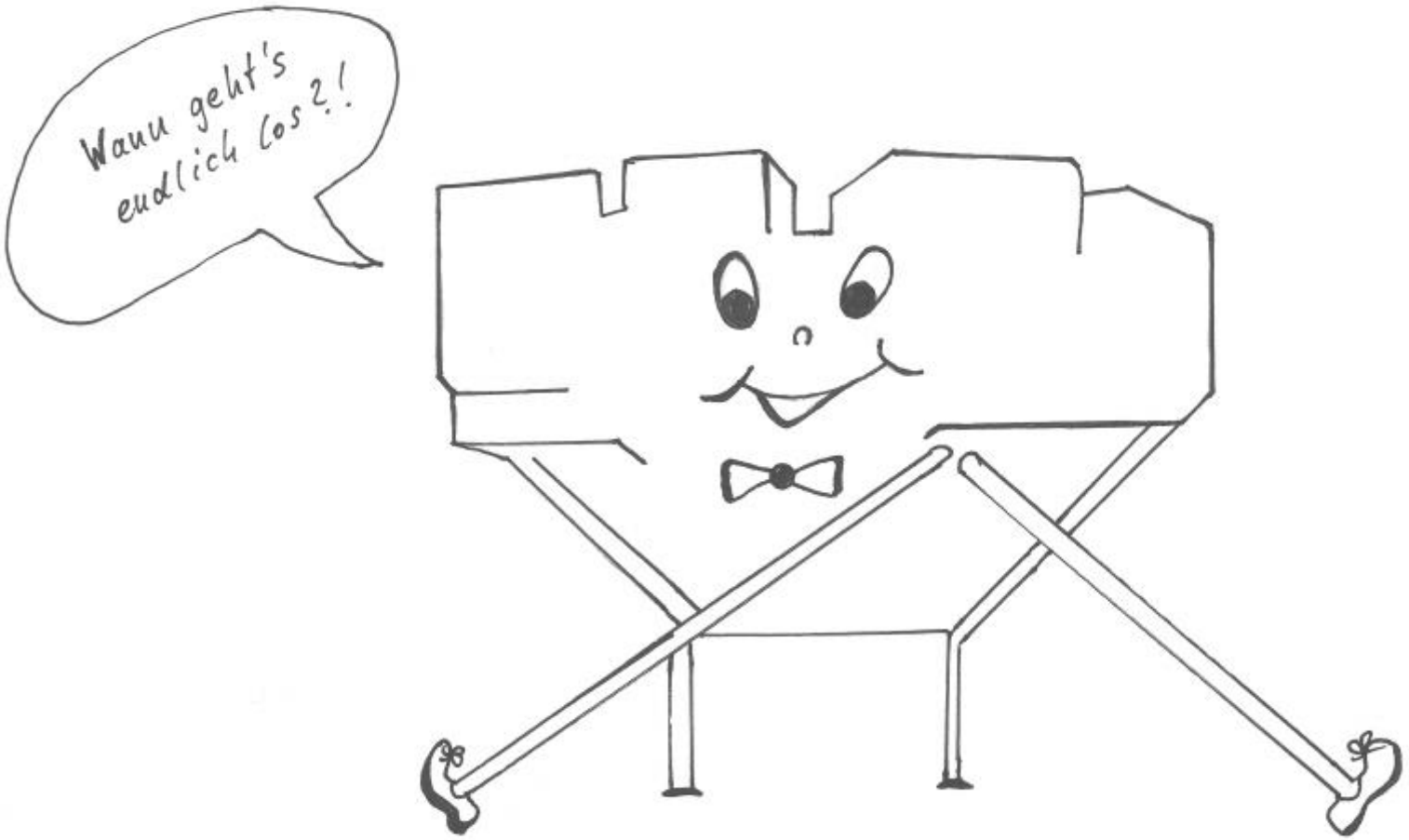
9 May 2012

MIRI is the first of the science instruments to be delivered to NASA

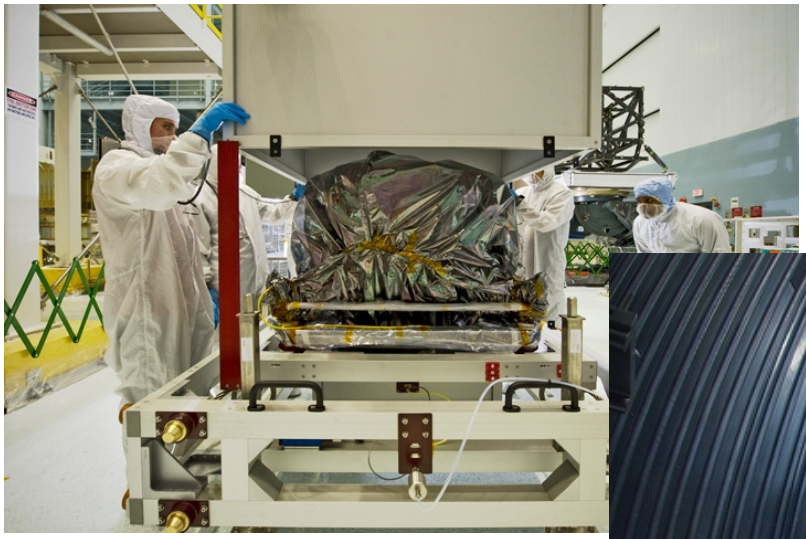


European Consortium stays responsible for MIRI till end of commissioning (6 month after launch)

MIRI at NASA 2012



MIRI testing at NASA



2012: arrival at Goddard Space Flight Center (GSFC), Maryland; inspections, functional testing

2013: several month for first cryo-vacuum test campaign in cryo-chamber at GSFC (only MIRI and FGS)

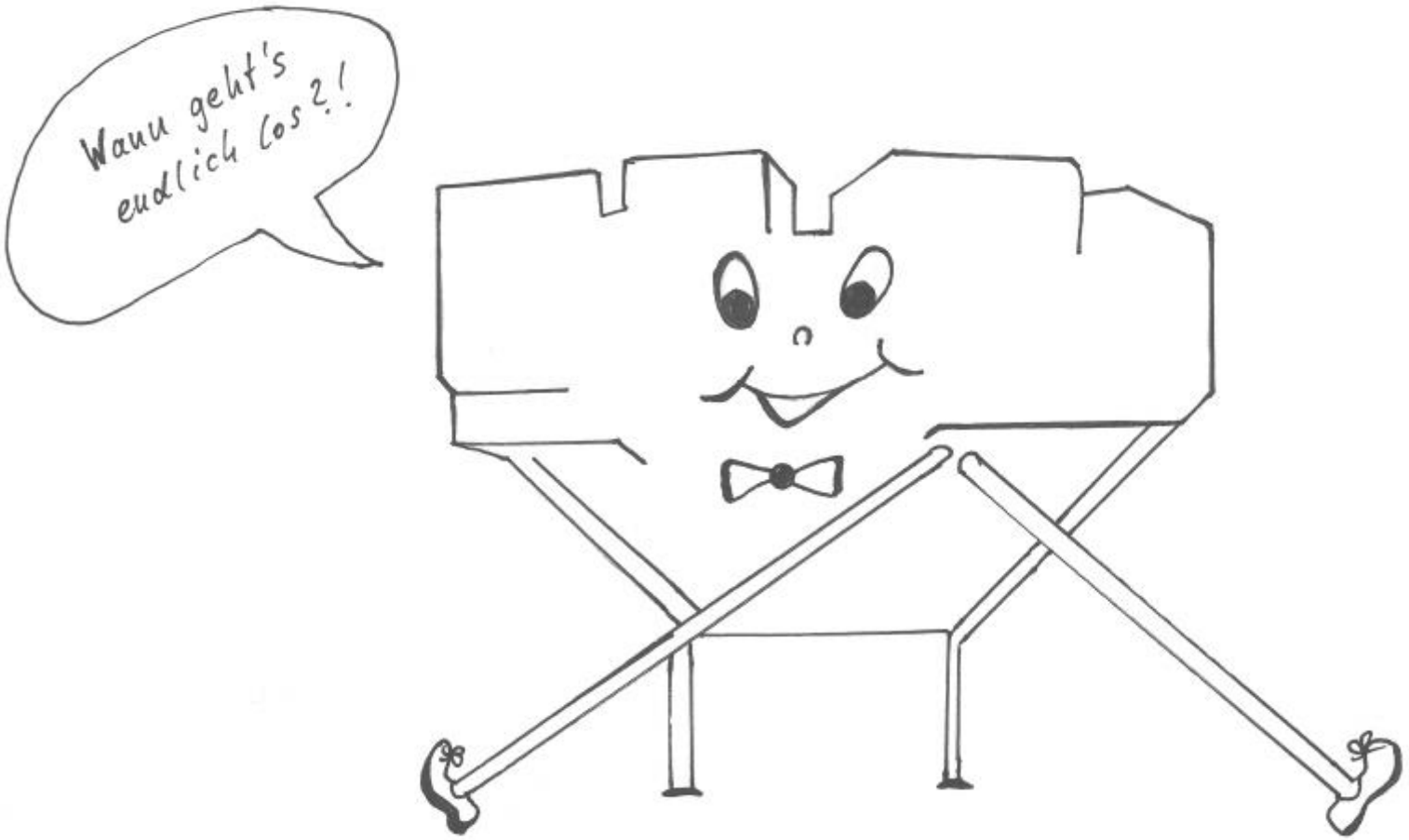
All activities supported by European MIRI Test Team

MIRI testing at NASA

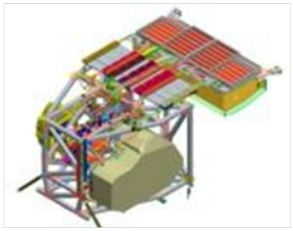
June-Nov 2014: 2nd cryo vacuum testing including all 4 scientific instruments integrated in the science instrument structure (ISIM)

Sept 2015 – Jan 2016: 3rd cryo vacuum testing: MIRI will have improved detector readout electronics by then

MIRI at NASA 2016



Spacecraft Assembly and Testing



ISIM I&T
Completes 2015

OTE/ISIM TESTING
Cryo Optics Test
Completes 2017

I&T Responsibility

	Execution	Facility
GSFC		
JSC	N/A	
NGAS		
ITT		
ESA / Arianespace		

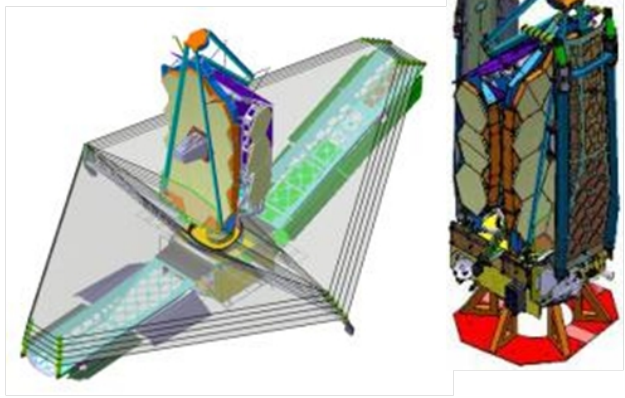
OTE Structure I&T
Completes 2015

OTE I&T
Completes 2015

OTE Pathfinder Structure
Completed 2014

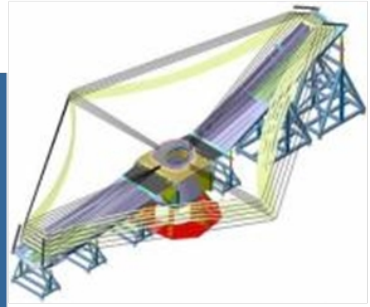
Pathfinder Optics Integration
Completed 2014

Pathfinder Cryo Optics & Thermal Tests
Completes 2016



Observatory EM Test Bed (EMTB)
Completes 2015

Propulsion Module I&T
Completes 2015



Spacecraft Panel I&T
Completes 2016

Sunshield Pathfinders (EPF/IVA)
Completed

Sunshield I&T
Completes 2017

Spacecraft Element I&T
Completes 2017

Complete Observatory I&T
Completes 2018

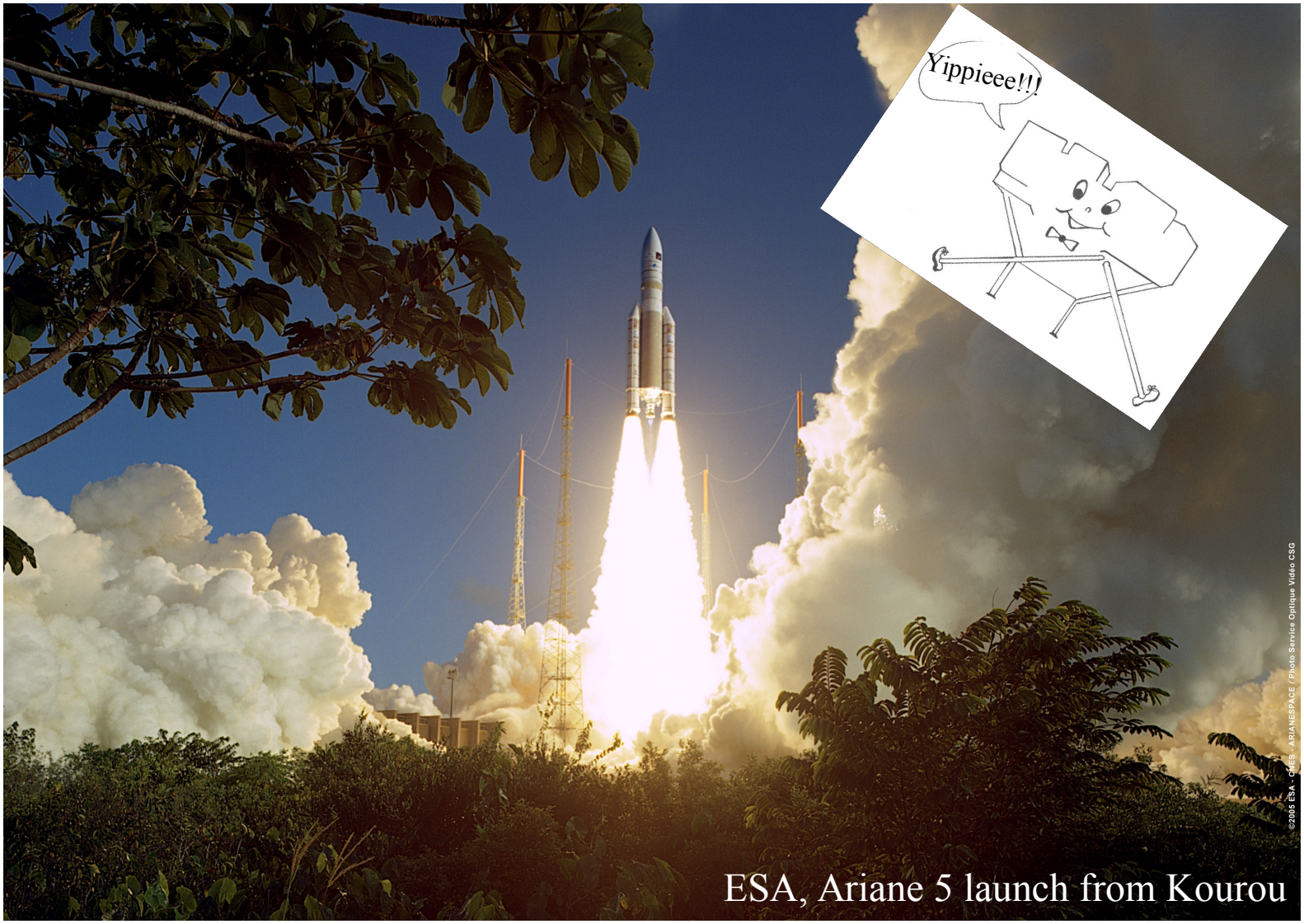
Launch Site I&T

LV Integ

Completes 2018

Oct. 2018

JWST Launch in 2018



The End – Beginning of Science