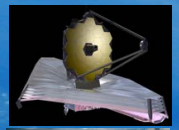
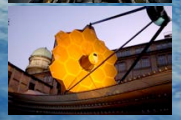
JWST is an international partnership between NASA, ESA and the CSA.

JWST status and scientific timeline
NIRSpec exoplanet GTO program

Pierre Ferruit (ESA JWST project scientist)

"PlanetS JWST workshop"
Bern – 09 May 2017



Contents of the presentation

Acknowledgements

Many elements of this presentation are based on existing presentations prepared by other members of the JWST project, the instrument teams and STScI.

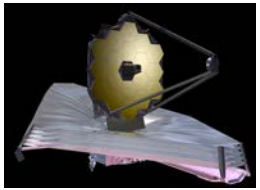
A lot of material used in this presentation is coming from from STScI's JWST web sites (main resources for getting information):

https://jwst.stsci.edu/ (main site)

https://jwst-docs.stsci.edu/ (documentation site, work in progress)

Introduction

JWST will be one of the "great observatories" of the next decade.



Joint mission between NASA, ESA and CSA.

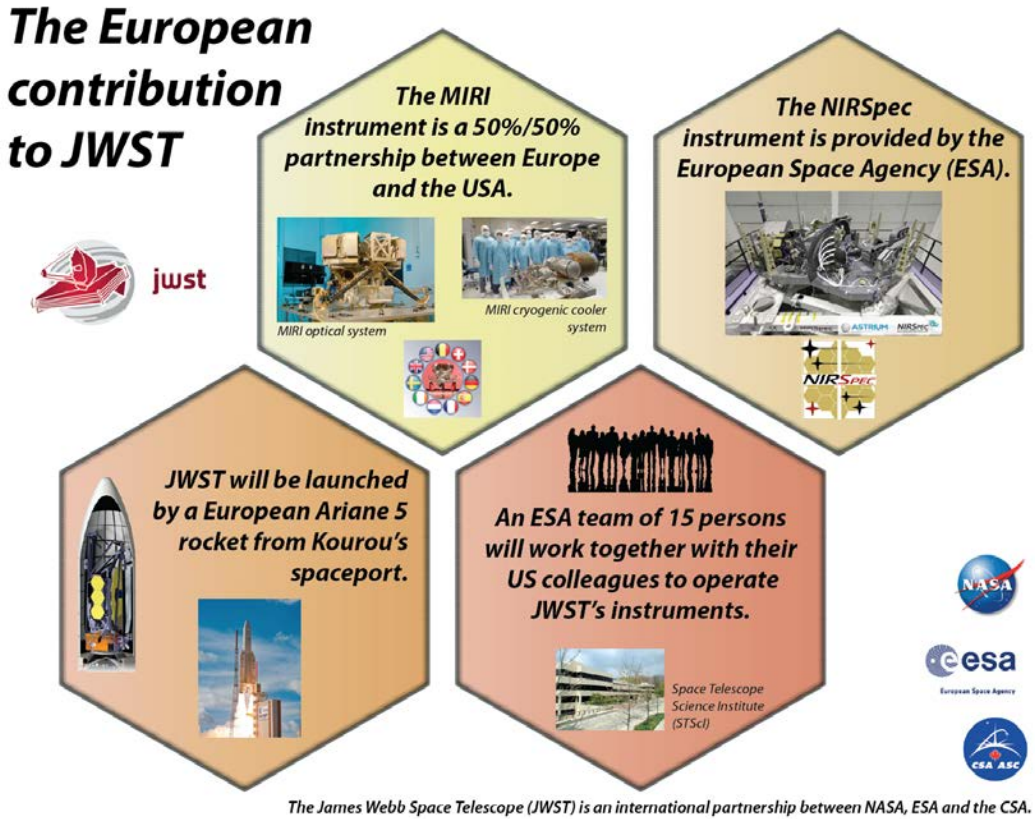
- *High-priority endeavor for the associated astrophysical communities.*

Setup similar to the HST one.

- *Over the duration of the mission, at least 15% of the total JWST observing time goes to ESA member states applicants.*

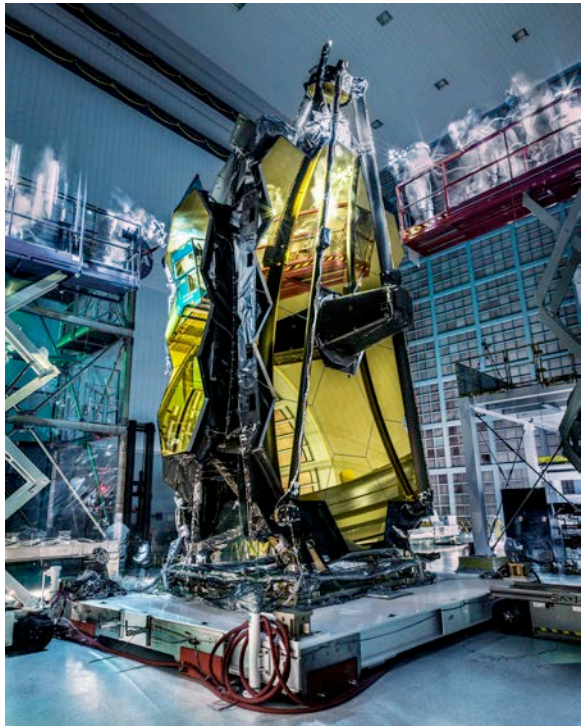
To be launched in October 2018 for a minimum mission duration of 5 years (10-year goal).

Introduction



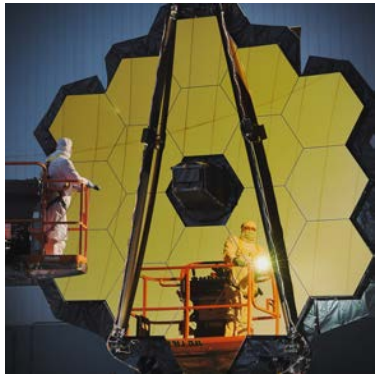
The James Webb Space Telescope (JWST) is an international partnership between NASA, ESA and the CSA.

Status

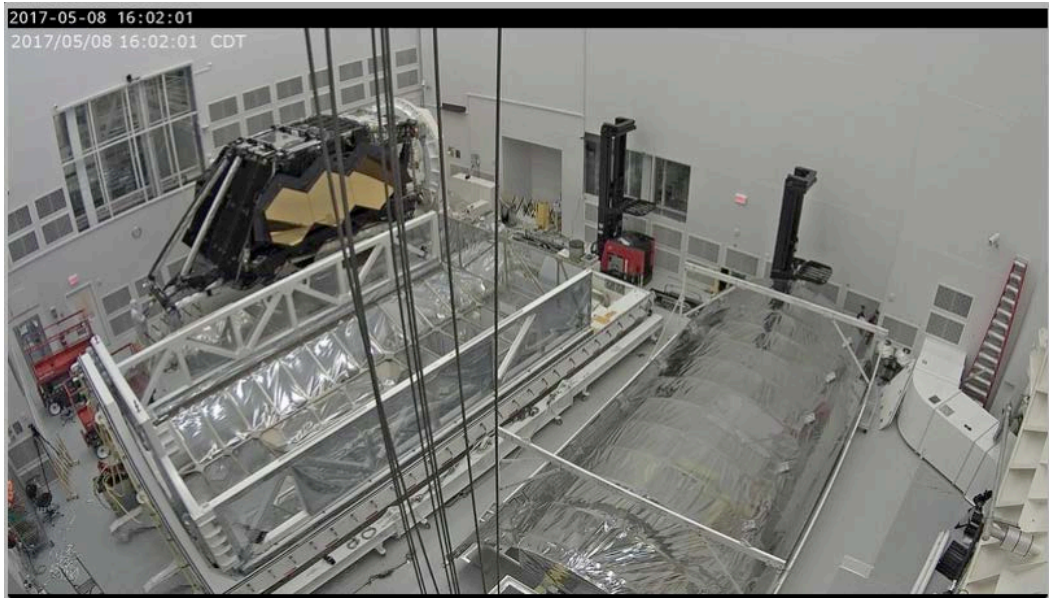


Credits: NASA/Chris Gunn

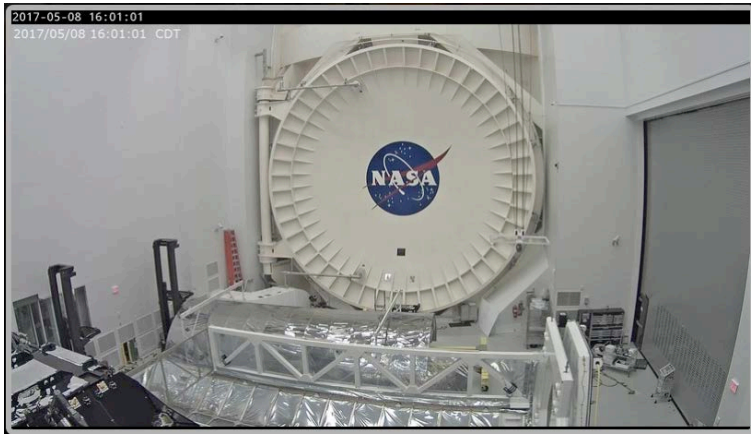
JWST's payload module (telescope + instruments = OTIS) just arrived to NASA's Johnson Space Center



Status



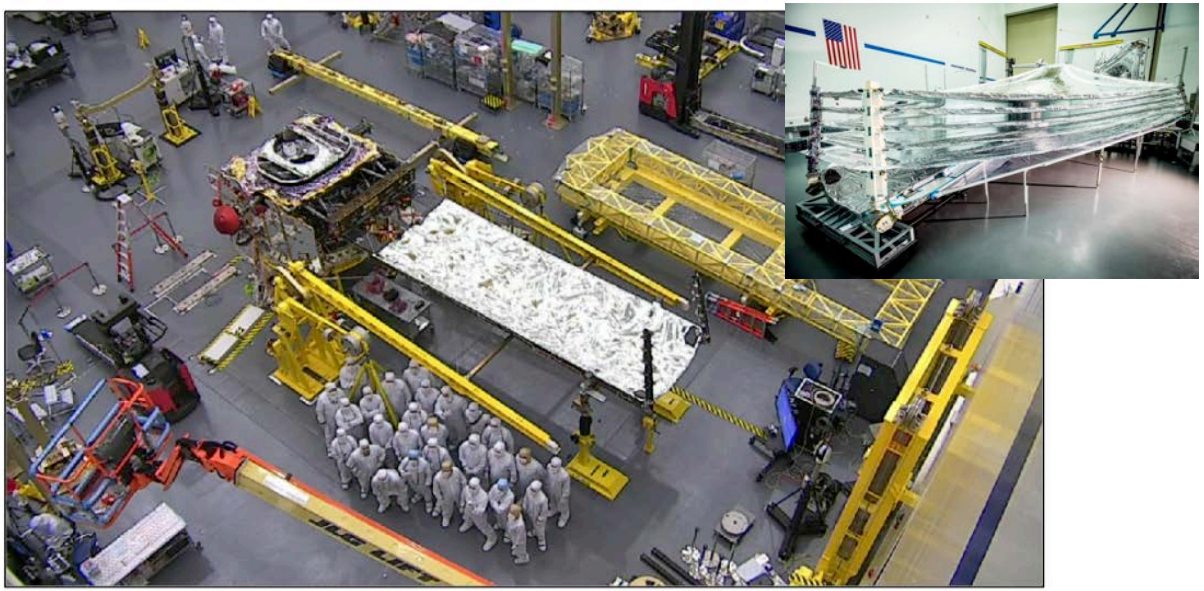
Web cam: https://jwst.nasa.gov/

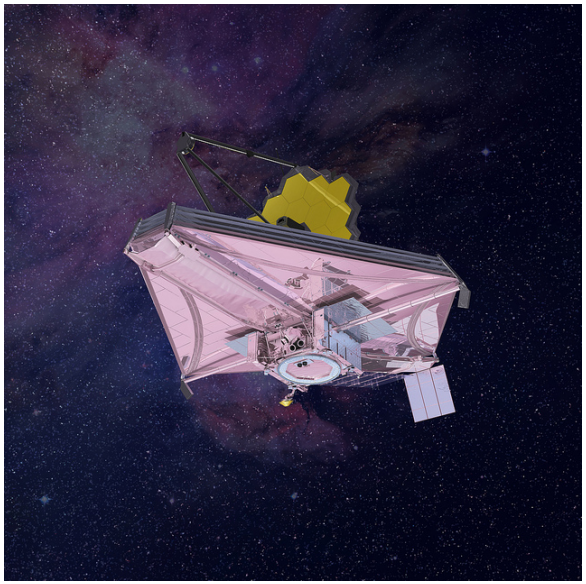


OTIS is being unpacked in the clean room in front of the giant thermal-vacuum chamber at JSC

Status

In parallel, the integration of the spacecraft and the sunshield continues at Northrop-Grumman's premises in California.





Forward Sunshield Unitized Pallet Structure Attached to the Spacecraft Bus (Northrop Grumman)

Status

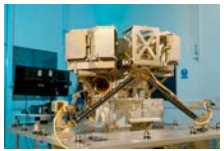
JWST has made tremendous progress and the launch is now in sight but we still have a lot of work in front of us.

JWST is on track for a launch in October 2018.

JWST capabilities – instrument suite

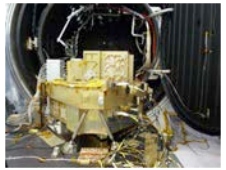
NIRCam = Near-InfraRed Camera - PI: M. Rieke

Developed under the responsibility of the University of Arizona.



MIRI = Mid-InfraRed Instrument - PIs: G. Wright and G. Rieke

50/50 partnership between a nationally funded consortium of European institutes (MIRI EC) + ESA and NASA/JPL.



NIRISS = Near-infrared Imager and Slit-less Spectrograph

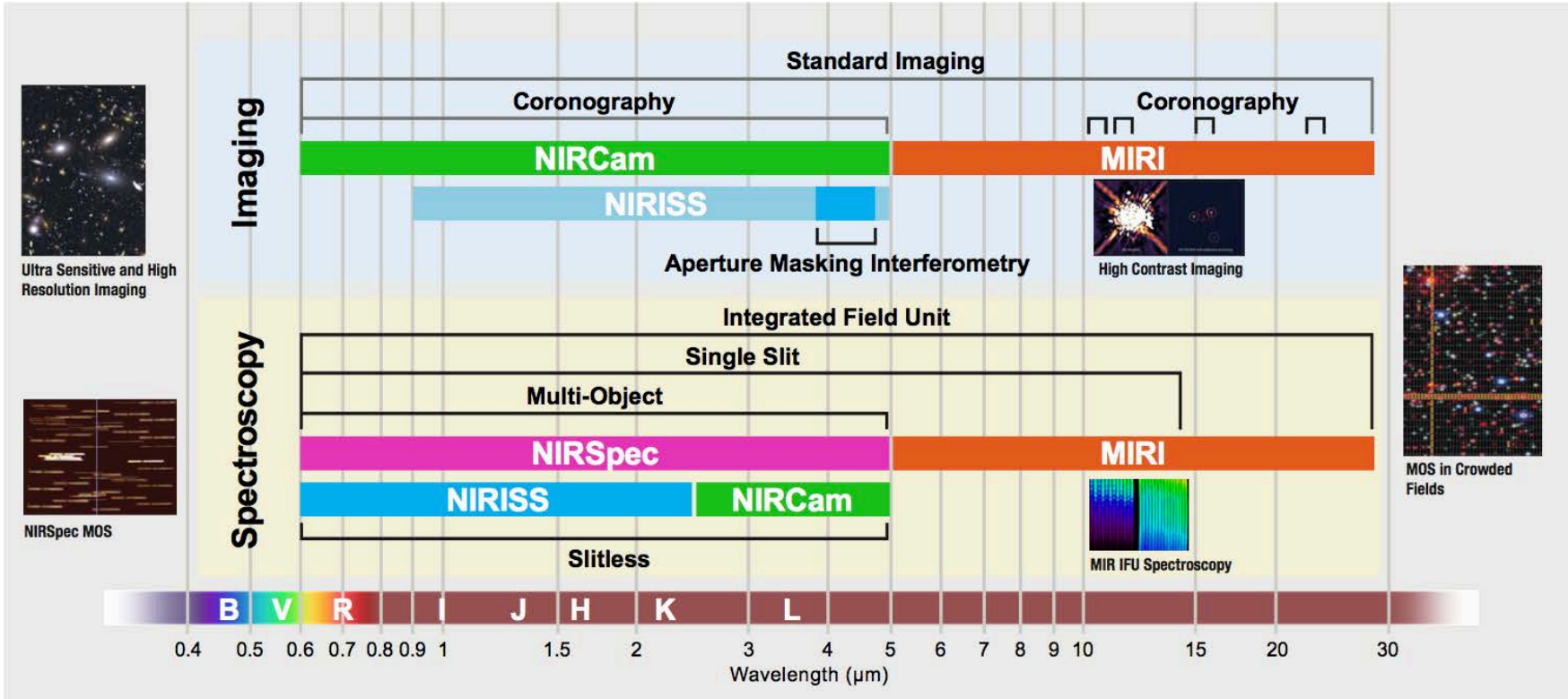
FGS = Fine Guidance Sensor - PIs: R. Doyon & C. Willott

Provided by the Canadian Space Agency.

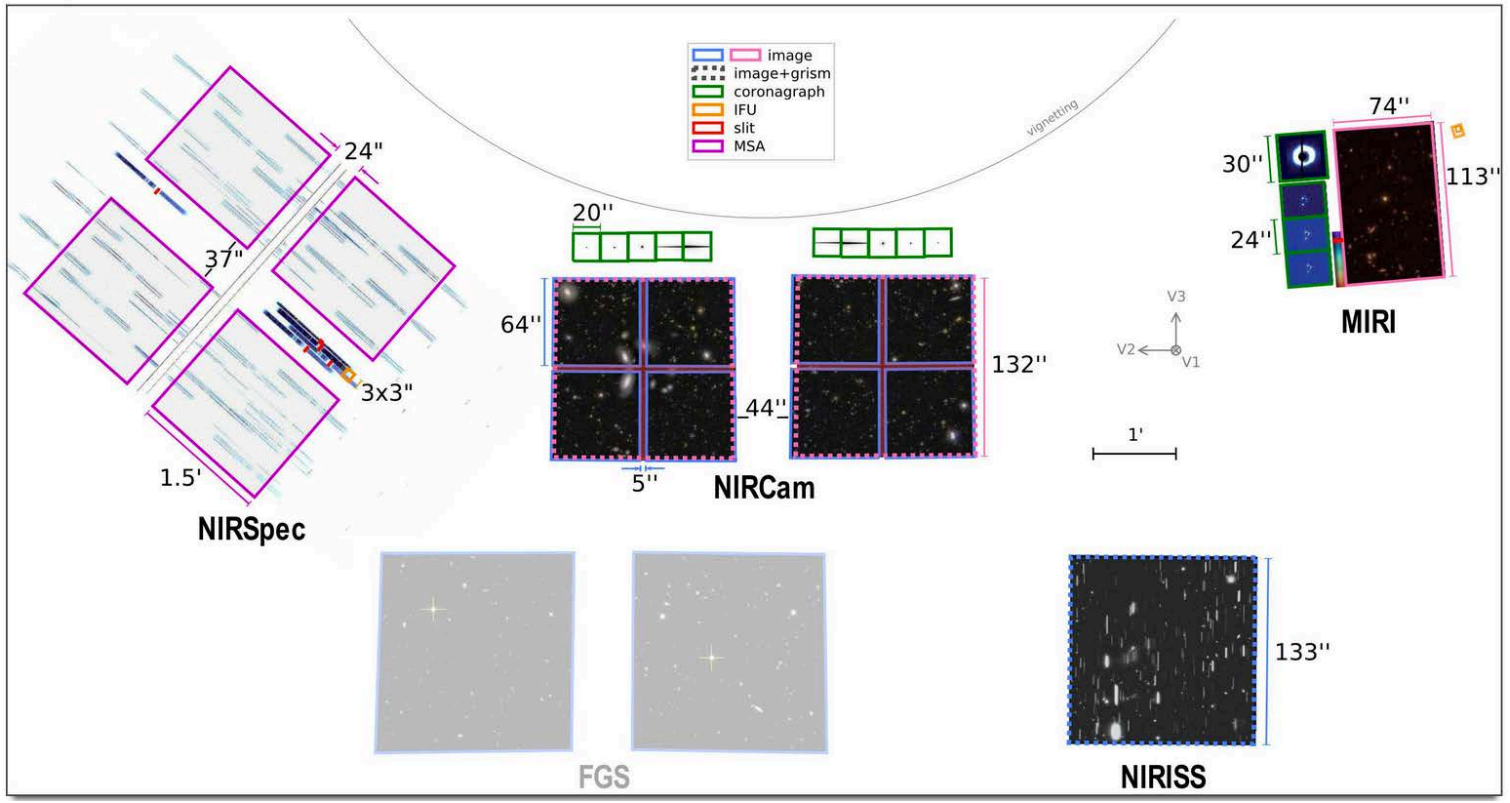
NIRSpec = Near-infrared Spectrograph

Provided by the European Space Agency. Built for ESA by an industrial consortium led by Airbus Defence and Space.

JWST capabilities

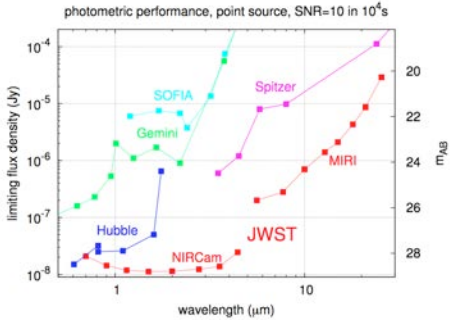


JWST capabilities



JWST capabilities (imaging)

Instrument	Wavelength (in microns)	Pixel scale (in mas/pixel)	Field of view (arcmin x arcmin)
NIRCam	0.6-2.3	32	2.2′ x 4.4′
NIRCam	2.4-5.0	65	2.2′ x 4.4′
NIRISS	0.9-5.0	65	2.2′ x 2.2′
MIRI	5.0-28	110	1.3′ x 1.7′



NIRCam: Simultaneous imaging of the same field of view in the short and long wavelength channels.

More than one order of magnitude sensitivity improvement in some bands.

Extremely powerful observatory, a lot of discovery space.

JWST capabilities (spectroscopy)

	Instrument	Type	Wavelength (microns)	Spectral resolution	Field of view	
Direct spectroscopy	NIRISS	SLITLESS	1.0-2.5	~150	2.2′ x 2.2′	
	NIRCam	SLITLESS	2.4-5.0	~2000	2.2′ x 2.2′	
	NIRSpec	MOS	0.6-5.3	100/1000/[2700]	9 square arcmin.	
	NIRSpec	IFU	0.6-5.3	100/1000/2700	3″ x 3″	
	MIRI	IFU	5.0-28.8	2000-3500	>3″ x >3.9″	
	NIRSpec	SLIT	0.6-5.0	100/1000/2700	Single object	P.-O. Lagage
Transits	MIRI	SLIT/SLITLESS	5.0-10.0	60-140	Single object	
	NIRSpec	APERTURE	0.6-5.3	100/1000/2700	Single object	L. Nielsen
	NIRISS	SLITLESS	0.6-2.5	700	Single object	M. Meyer

Take-home message: in JWST, spectroscopy comes in many different flavors…

JWST capabilities (coronagraphy & AMI)

Instrument	Wavelength (in microns)	Pixel scale (in mas/pixel)	Field of view	Type
NIRCam	0.6-2.3	32	20” x 20”	Lyot
NIRCam	2.4-5.0	65	20” x 20”	Lyot
NIRISS	3.8-4.8	65	0.1-0.5”	Aperture masking interferometry
MIRI	10.65	110	24” x 24”	4QPM
MIRI	11.4	110	24” x 24”	4QPM
MIRI	15.5	110	24” x 24”	4QPM
MIRI	23	110	30” x 30”	Lyot

Direct imaging

See talks by P.-O. Lagage and M. Meyer

Variety of modes spread over the complete wavelength range of JWST.

Scientific timeline – cycle 1

JWST launch in October 2018

After launch, JWST will deploy (duration ~2-3 weeks) as it cruises toward the Lagrange 2 (L2) point.

It will take it ~1 months to reach the vicinity of the L2 point around which it will orbit (halo orbit).

The commissioning should be completed 6 months after launch, i.e. in April 2019.

Cycle 1 is scheduled to start in April-May 2019.

- Scientific observations will start as soon as possible, mode per mode.
- Full calibration will be achieved progressively during cycle 1.

Scientific timeline – cycle 1 calls

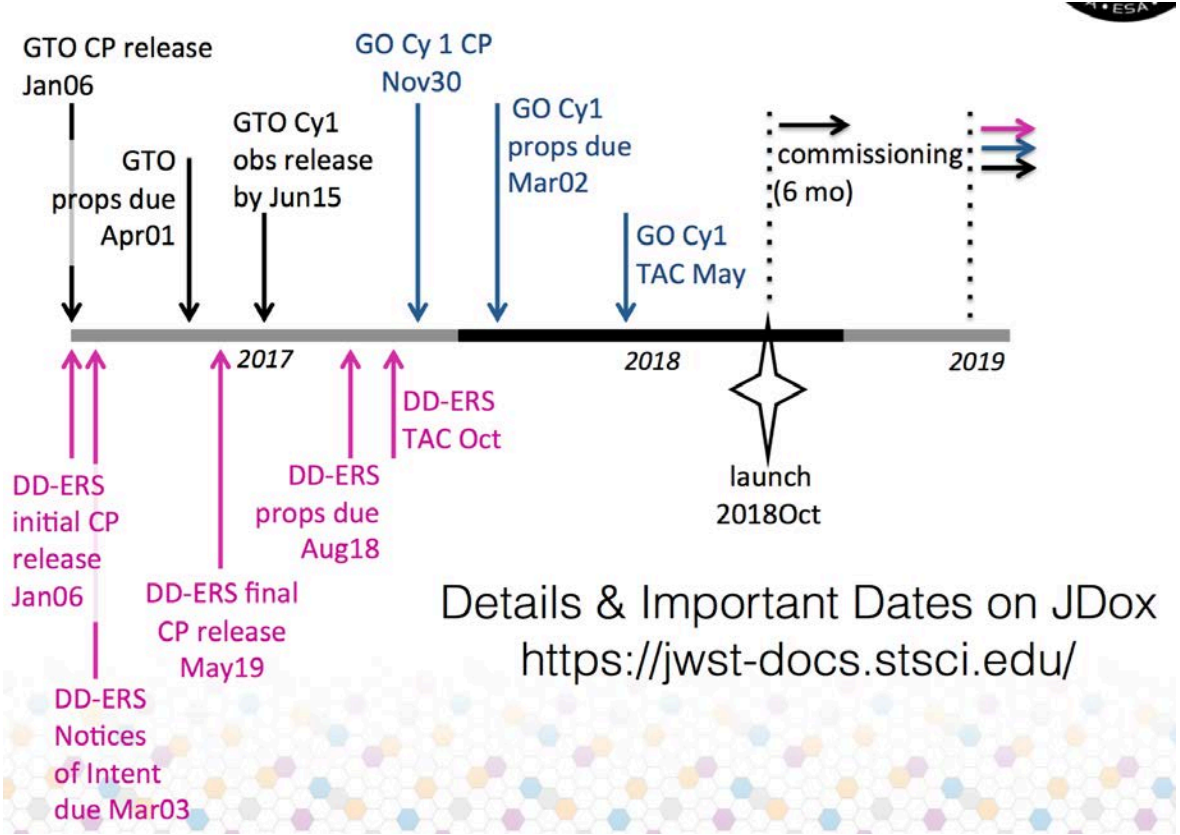
The first JWST cycle-1 calls have been issued!!!

- JWST guaranteed time observer (GTO) call for proposals.
  - https://jwst-docs.stsci.edu/display/JSP/JWST+Cycle+1+Guaranteed+Time+Observations+Call+for+Proposals
- Call for (mandatory) notice of intents for the Early Release Science (ERS) programs.
  - https://jwst-docs.stsci.edu/display/JSP/JWST+Director%27s+Discretionary+Early+Release+Science+Call+for+Proposals

The call for general observers (GOs) is planned for November 2017.

- After the GTO proposals are known and the ERS proposals selected.

Scientific timeline - full



From a presentation by N. Lewis (STScI)

Scientific timeline – Getting ready

Special session "Preparing the JWST era" at the EWASS 2017.

- Focusing on learning from the GTO proposals (transferring experience). Work in progress to consolidate the program.

Second JWST ESAC workshop "Mastering the science instruments and of the observing modes of JWST [get set]" at ESAC (4-6 October 2017).

- Following the successful [on your mark] 2016 edition.

Workshop "Planning Solar System Observations with JWST" in ESTEC (13-15 December 2017).

- Mirroring a similar US workshop planned for November.

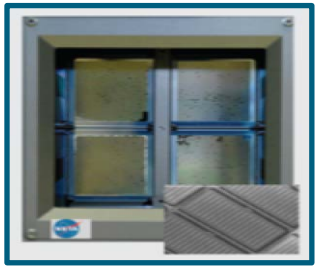
List of events in the USA, Europe and Canada maintained by STScI:

https://jwst.stsci.edu/news-events/events

Studying transiting exoplanets with NIRSpec

JWST NIRSpec

MOS



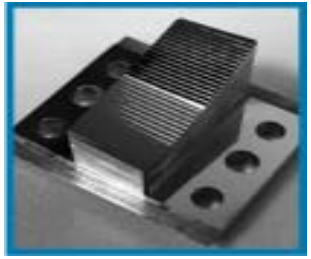
Multi-object spectroscopy

Field of view: 9 square arc minutes.

Apertures: 0.2”-wide, ~1/4 of a million micro-shutters.

Spectral resolution: ~100, ~1000, [~2700 (with partial truncation of the spectra)]

IFS



Integral-field spectroscopy

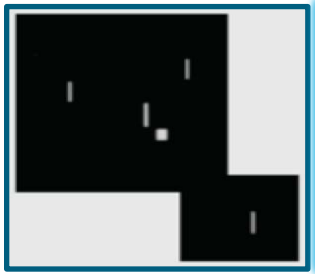
Field of view: 3” x 3”

Spaxel size: 0.1” x 0.1” (900 spaxels)

Spectral resolution: ~100, ~1000 and ~2700.

Cannot be used at the same time than the MOS.

FS/BOTS

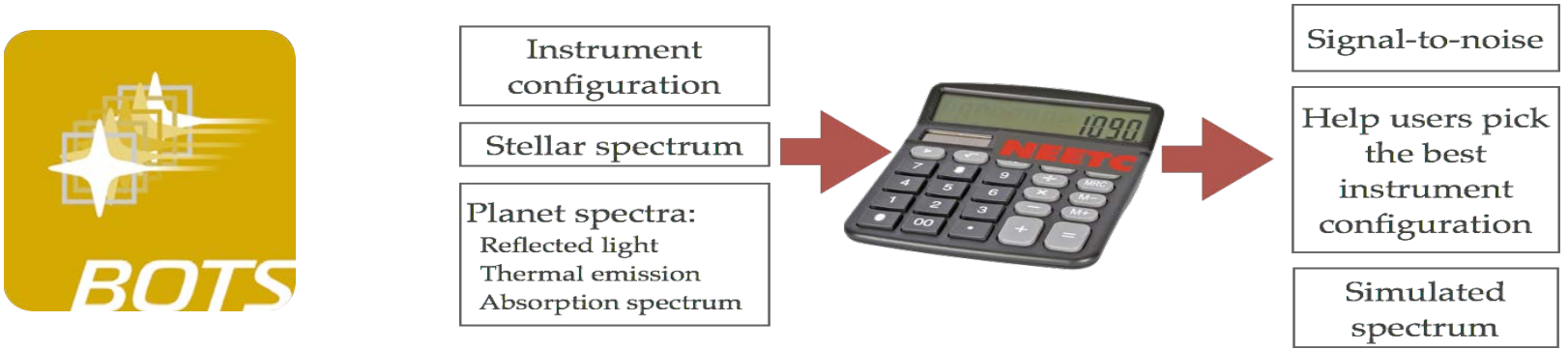


Slit and time series spectroscopy

Apertures: 0.2” and 0.4”-wide slits and ***one square 1.6”x1.6” aperture for time-series spectroscopy (exoplanets typically; optimisation for bright targets).***

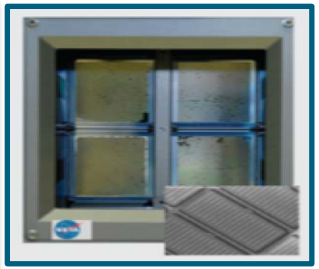
Spectral resolution: ~100, ~1000 and ~2700.

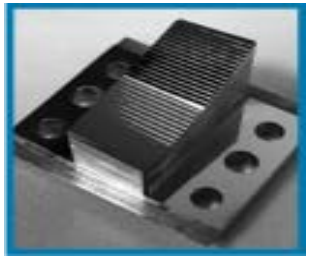
See talk by Louise Nielsen

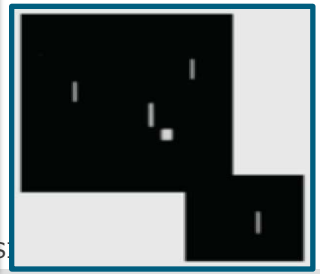


Studying transiting exoplanets with NIRSpec

JWST NIRSpec







If you want to know more about JWST and NIRSpec capabilities:

NIRSpec: T. Böker, N. Lützgendorf, S. Birkmann

http://www.cosmos.esa.int/web/jwst-2016-esac

Bright Object Transit Spectroscopy

How optimistic are we that we can reach this "noise floor"?

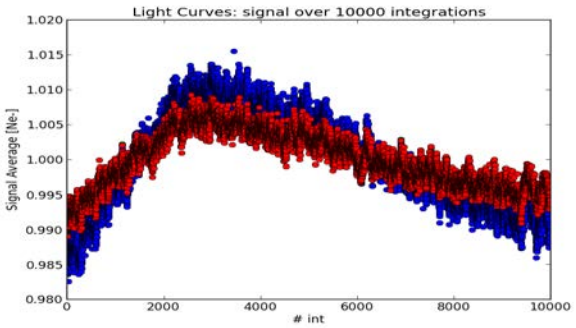
- Good signs coming from other observatories (e.g. HST).
- Working to gain even more confidence using test data.

But only in-orbit data will tell us what is our limit.

- And expecting to get better and better as time goes on and our understanding of the instruments increases.

Sanity check - Looking at test data processed with very basic algorithms.

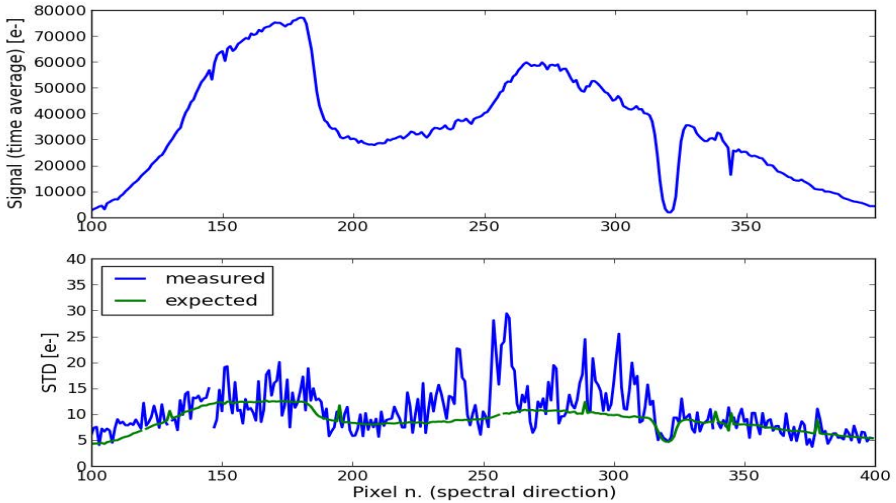
- Amazing light source for most of the instrument tests but definitely not for this one (flickering and jittering source). → main limiting factor

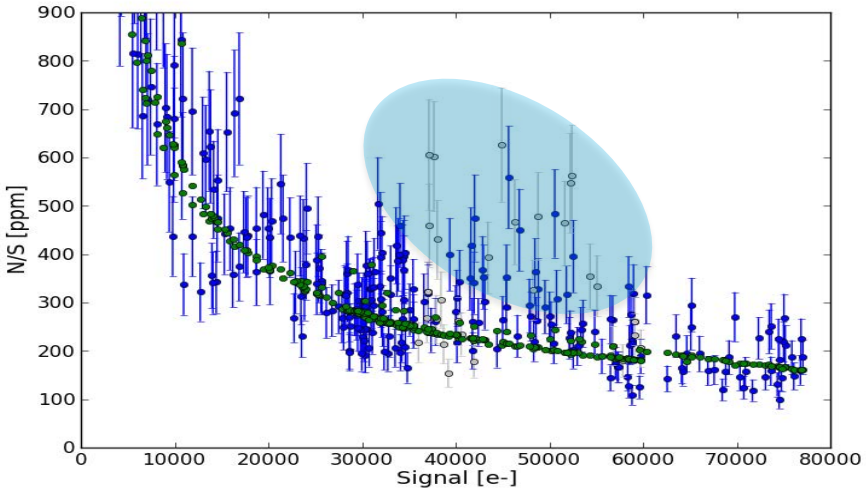


Bright Object Transit Spectroscopy

Work by G. Giardino

- Total of 9000 usable integrations.
- Standard deviation over 15 bins of 600 integrations (4.5-minutes bins)



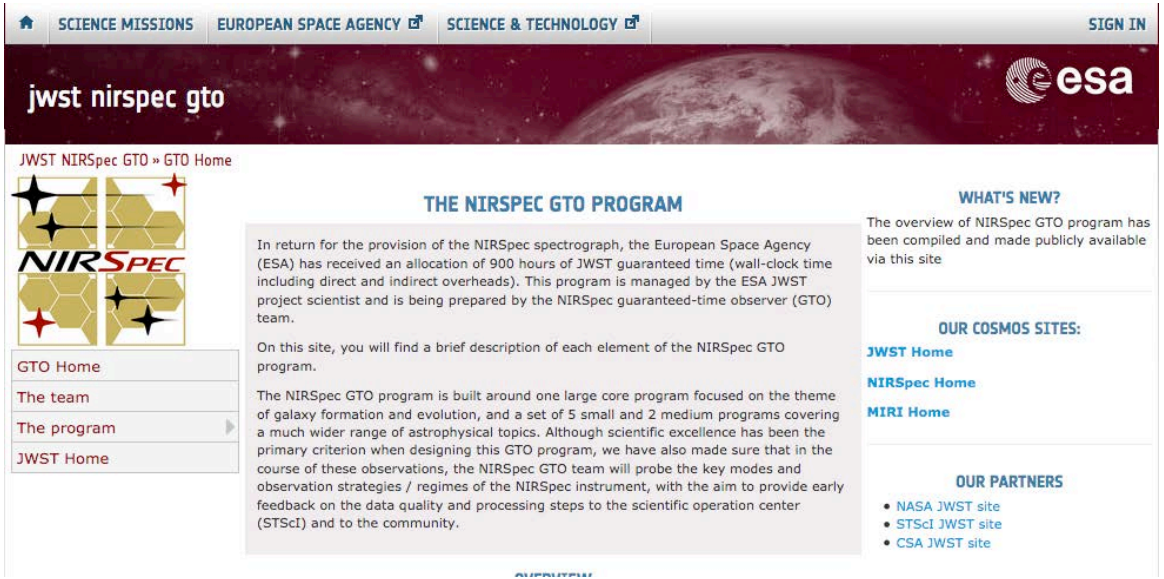


Results consistent with the noise floor down to a few hundreds of ppms.
Limited by the test setup…

NIRSpec GTO program

A description of the various elements of the NIRSpec GTO program can be found on-line:

- https://www.cosmos.esa.int/web/jwst-nirspec-gto



NIRSpec GTO program - transits

A 50-hour program led by S. Birkmann (ESA) and J. Valenti (STScI) on transiting exoplanets and made of 3 blocks:

- attempting to detect molecular features in a super-Earth by taking spectra over the 2.9-5.2 micron wavelength range;
- obtaining a full phase curve of a hot Jupiter over the complete JWST near-infrared wavelength range (0.6-5.3 micron) using the PRISM (i.e. the low spectral resolution configuration);
- taking a first NIRSpec look at the diversity of giant planets through a case study of two planets in the 2.9-5.2 micron range.

NIRSpec GTO program - transits

Observations and targets:

LHS 1140b (GJ 3053b)	1 primary eclipse in the G395H/F290LP configuration. Observation duration of ~7 hours. Targeted ppm level: TBD.
WASP-43b	1 full phase curve observation in the PRISM/CLEAR configuration. Observation duration of ~27 hours. Targeted ppm level: TBD.
WASP-107b	1 primary eclipse in the G395H/F290LP configuration. Observation duration of ~9 hours. Targeted ppm level: TBD.
WASP-80b	1 secondary eclipse in the G395H/F290LP configuration. Observation duration of ~7 hours. Targeted ppm level: TBD.

CAUTION: the list of targets and observing strategies provided in this document is not yet frozen and is subject to change between now and the official publication of the JWST GTO target lists by NASA and STScI.

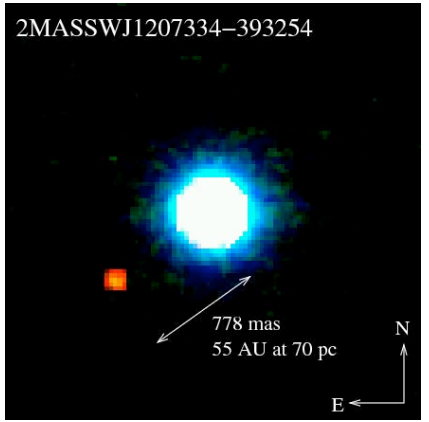
NIRSpec GTO program – direct spectroscopy

A short 6-hour pilot program led by S. Birkmann (ESA) aiming at obtaining a direct spectrum of an exoplanet with NIRSpec IFU.

- demonstration of the capabilities of the NIRSpec IFU for the spectroscopic studies of faint targets located at several tenths of an arcsecond from a bright point source (~0.8-1 arcsecond);
- target young and massive enough so that internal heat yields thermal emission detectable by NIRSpec at 5 μm (T > 500 K);
- collaboration with the MIRI EC GTO team (see talk P.-O. Lagage); see also talk by M. Meyer as this mode is also used by the NIRCam GTO team.

NIRSpec GTO program – direct spectroscopy

VLT/NACO deep image of the TWA brown dwarf 2M1207 and its 5 MJup companion at 41 AU obtained in Ks-band with the S27 camera (Chauvin et al. 2004)



Observations and targets:

TWA 27 (2M1207)	Spatially dithered IFU observations using the G140H/F100LP, G235H/F170LP, and G395H/F290LP configurations, providing 1.0 to 5.2 micron wavelength coverage with high (~2700) spectral resolution. Total on-source exposure times are approximately 2100 seconds per configuration.
2MASSW J1205527-385451 (reference star)	Identical observation of a nearby isolated star of a similar brightness and spectral type as the exoplanet host star.

CAUTION: the list of targets and observing strategies provided in this document is not yet frozen and is subject to change between now and the official publication of the JWST GTO target lists by NASA and STScI.

Conclusion

Launch in October 2018 (stable) and we can now say we launch next year!

Some pilot studies as part of NIRSpec GTO but there is plenty of room for ERS and GO programs!

Thanks for your attention