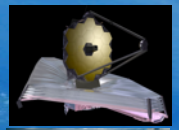
JWST is an international partnership between NASA, ESA and the CSA.

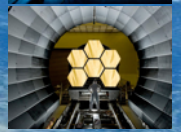
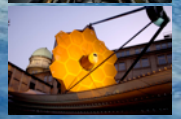
More and more branded as “Webb”.

The JWST mission – overview

Pierre Ferruit (ESA JWST project scientist)

JWST IAC workshop – G01 proposal planning
12-14 February 2018



Acknowledgements

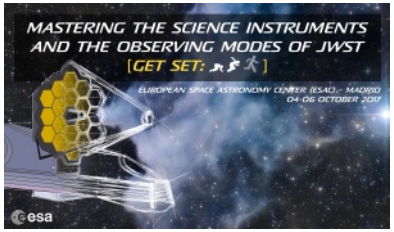
All along this presentation you will see results from work conducted by a large number of teams in Europe, USA and Canada.

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

In particular, it makes an extensive use of presentations given during recent JWST training workshops in Europe and in the US:

https://www.cosmos.esa.int/web/jwst-2017-esac/

https://jwst.stsci.edu/news-events/events/events-area/stsci-events-listing-container/jwst-proposal-and-planning-workshop-1?mwc=-1



Contents of the presentation

Overview of the JWST (the mission, European contribution)

Mission status (launch date, a few words about the path to launch)

- For detailed hardware integration and status information, see talk by Begonia Vila.

JWST's observatory and instruments (main elements, instruments)

- For detailed information on the observing modes, see talk by Massimo Roberto.

Non-GO cycle 1 programs (GTO, DD ERS)

- For detailed information on the GO call and its timeline, see talk by Marco Sirianni.

A few words about the EROs and the JSTUC

JWST's orbit (orbit specificities, visibility and orientations of objects)

Conclusion

The JWST mission in one slide…

JWST is a NASA flagship mission and is a partnership between NASA, ESA and the Canadian Space Agency.

- It is a general purpose near and mid-infrared observatory.
- It will be the largest visible or infrared astronomical telescope ever flown.
- It will be observing objects ranging from planets and bodies of our Solar System to some of the most distant galaxies.
- It is scheduled for launch in 2019.

The JWST mission - Introduction

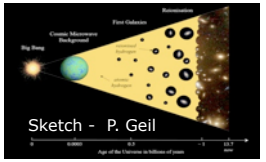
Four (very) broad science themes:

The end of the dark ages: first light and reionisation.

The assembly of galaxies.

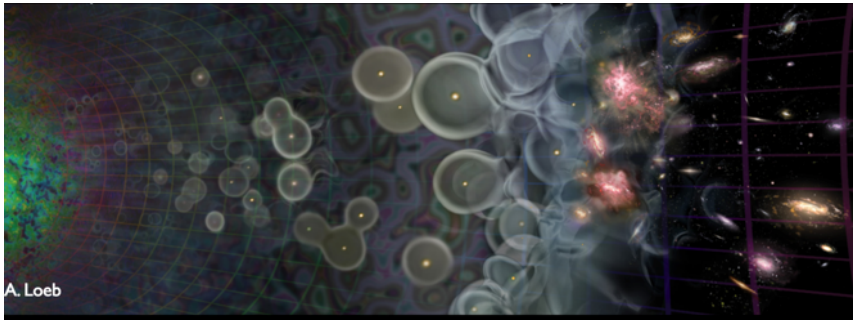
The birth of stars and proto-planetary systems.

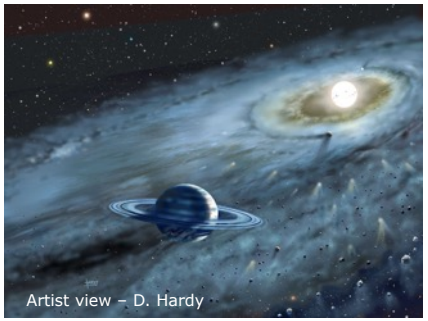
Planetary systems (including our Solar System) and the origin of life.

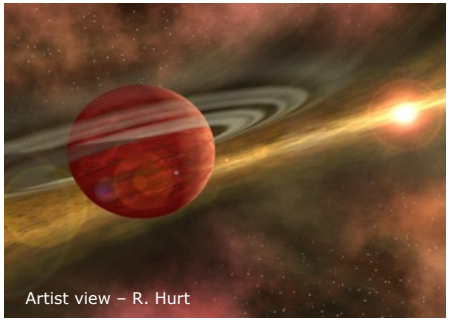


See Gardner et al., 2006, Space Science Reviews,123, 485

The JWST mission - Introduction







Yearly calls for proposals that will be peer-reviewed by a time allocation committee.

Following a scheme similar to the one used for the Hubble Space Telescope (HST).

See Gardner et al., 2006, Space Science Reviews,123, 485

The JWST mission - Introduction

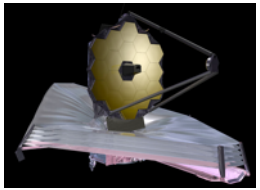
As already stated, JWST is a partnership between NASA, ESA and CSA.

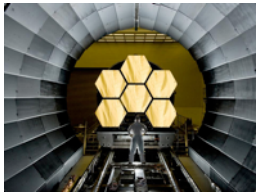
ESA (and CSA) have been present since the very early phases of the mission.

- *They were invited to join the project in 1997 at a time when the telescope was still called the "Next Generation Space Telescope" (NGST).*
- *The contribution of Europe to the mission gets consolidated around 2000.*

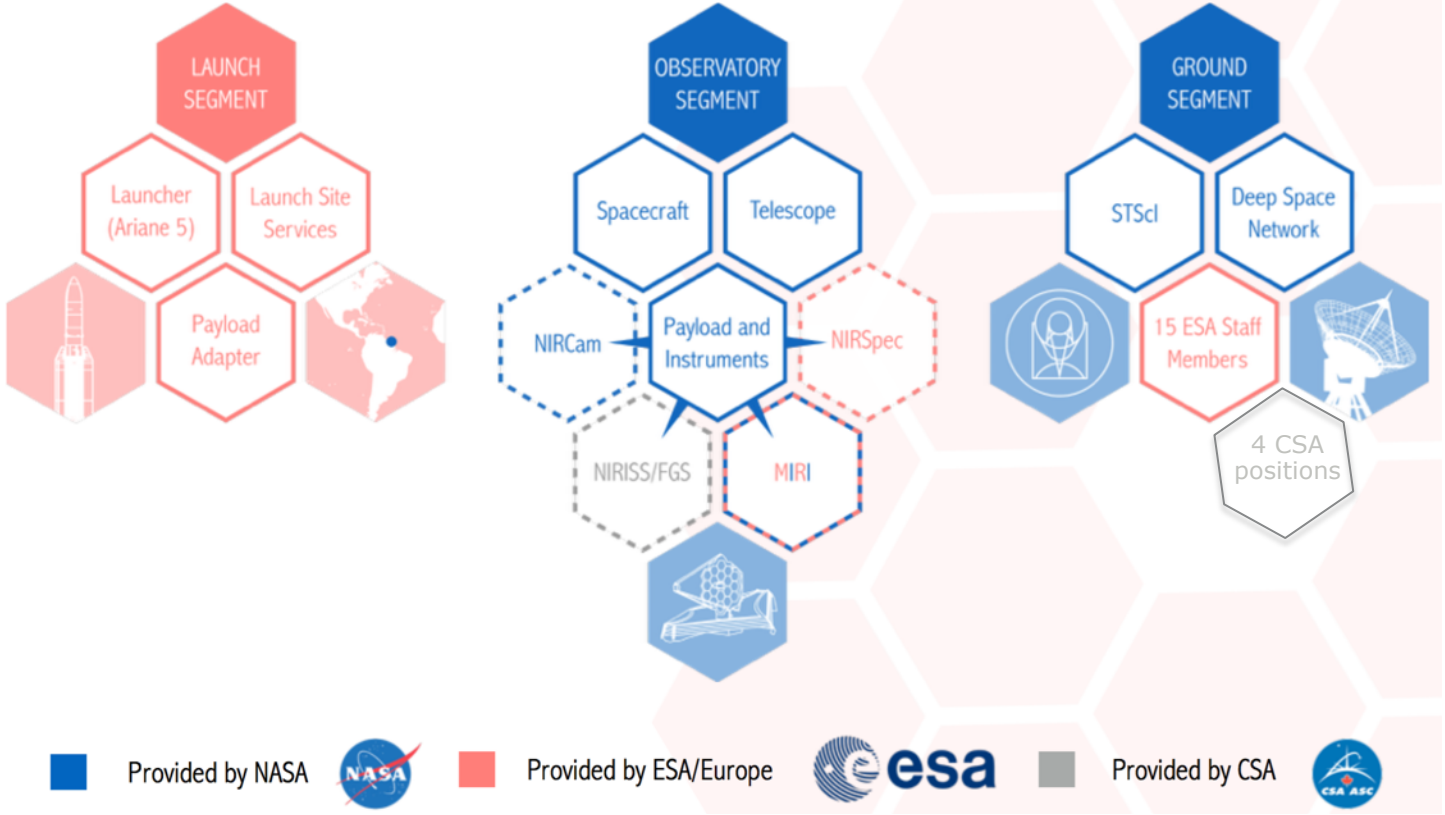
In return for this contribution, ESA shall obtain a portion of the observing time on JWST that will be no less than 15% of the observing time on average over the lifetime of the mission.

- *Again, following the same scheme than the one successfully applied to HST.*





The European participation to JWST



Important and visible participation involving ESA as well as European institutes and industry.

Credit for the figure:
Nora Lützgendorf

The European participation to JWST

Credit: Arianespace - ESA

JWST will be launched by an Ariane 5 ECA rocket for the spaceport of Kourou in French Guyana.

Folded JWST in an Ariane 5 fairing.

The European participation to JWST

NIRSpec - Near Infrared Spectrograph

MODES

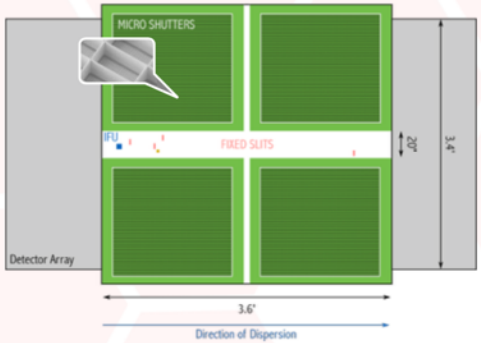
Fixed Slits (FS):
➡ Single sources, bright stars

Multi-Object spectroscopy (MOS):
➡ Rich fields, extended targets

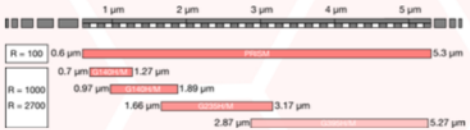
Integral Field Spectroscopy (IFS):
➡ Sources with few arcsec extent

Bright Object Time Series (BOTS):
➡ Exoplanets

FIELD OF VIEW

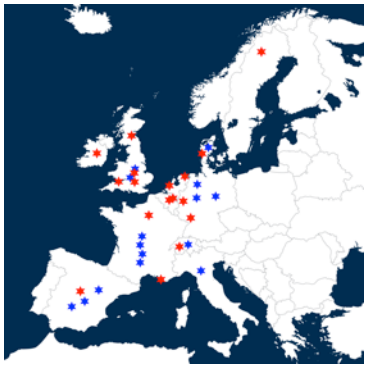


WAVELENGTH COVERAGE



NIRSpec was built by a consortium of European industrial company for ESA with contributions from NASA.

Consortium led by Airbus Defence and Space.



A truly European endeavor.
Blue = NIRSpec
Red = MIRI

Credit G. Wright

Credit for the figure: Nora Lützgendorf

The European participation to JWST

MIRI - Mid Infrared Instrument

MODES

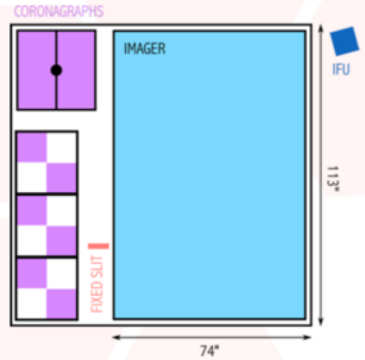
Imaging:
➡ Rich fields, extended targets

Coronagraphic Imaging:
➡ Exoplanets

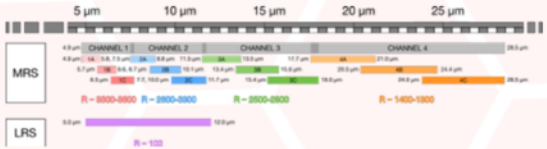
Low-resolution Spectroscopy (LRS):
➡ Sparse fields, single objects

Medium-resolution Spectroscopy (MRS):
➡ Sources with few arcsec extent

FIELD OF VIEW

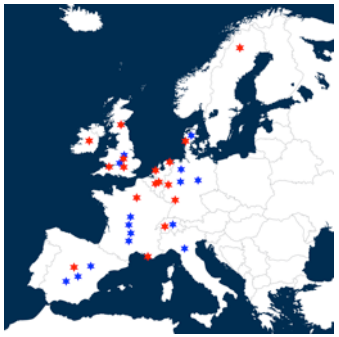


WAVELENGTH COVERAGE



The MIRI optical system was built by a consortium of nationally funded European institutes led by G. Wright.

Its detectors and MIRI's cryogenic cooler system were provided by NASA JPL.

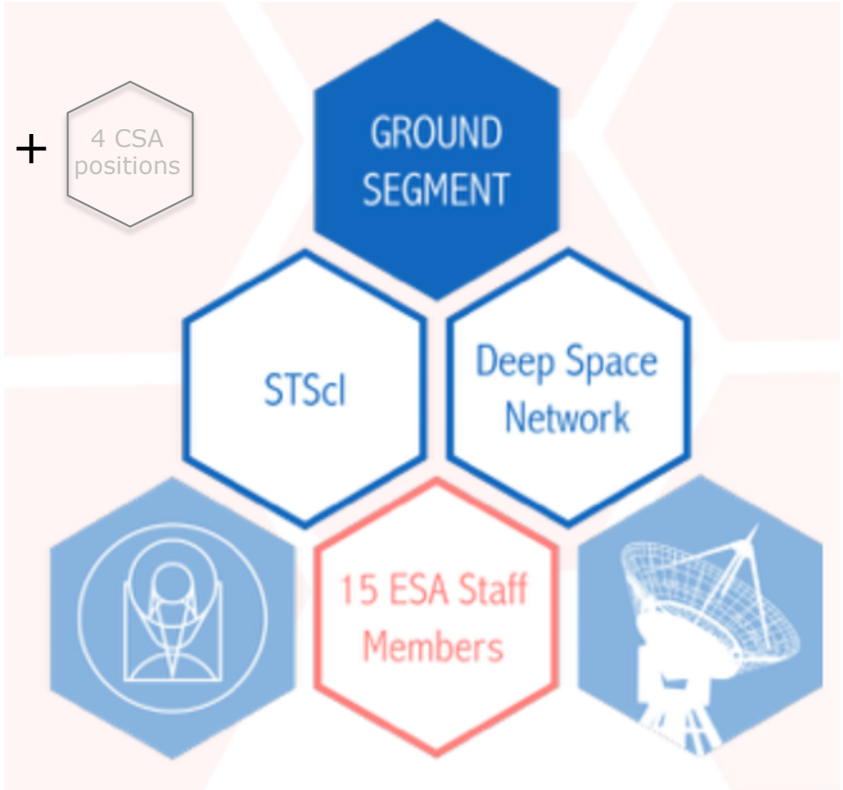


A truly European endeavor.
Blue = NIRSpec
Red = MIRI

Credit G. Wright

Credit for the figure: Nora Lützgendorf

The European participation to JWST



A team of ESA operation scientists and engineers is also working alongside their US colleagues at STScI.

The ESA scientific operation team is led by Marco Sirianni (SCI-O) and will include a total of 15 scientists and engineers by the time JWST is launched.

Credit for the figure: Nora Lützgendorf

JWST launching in 2019

Since 2011, the mission had remained on schedule and on cost.

In 2017, NASA took a detailed look at the remaining integration and testing steps.

The conclusion of this schedule assessment was that some activities were taking or would take longer than initially planned and this led to move JWST's launch date.

JWST launch date is now in Spring 2019

(formal 90-day launch period covering end-March to end-June)

Another schedule review is currently on-going at NASA.

JWST launching in 2019

The delays are not driven by concerns with the hardware or with the expected performances of the observatory.

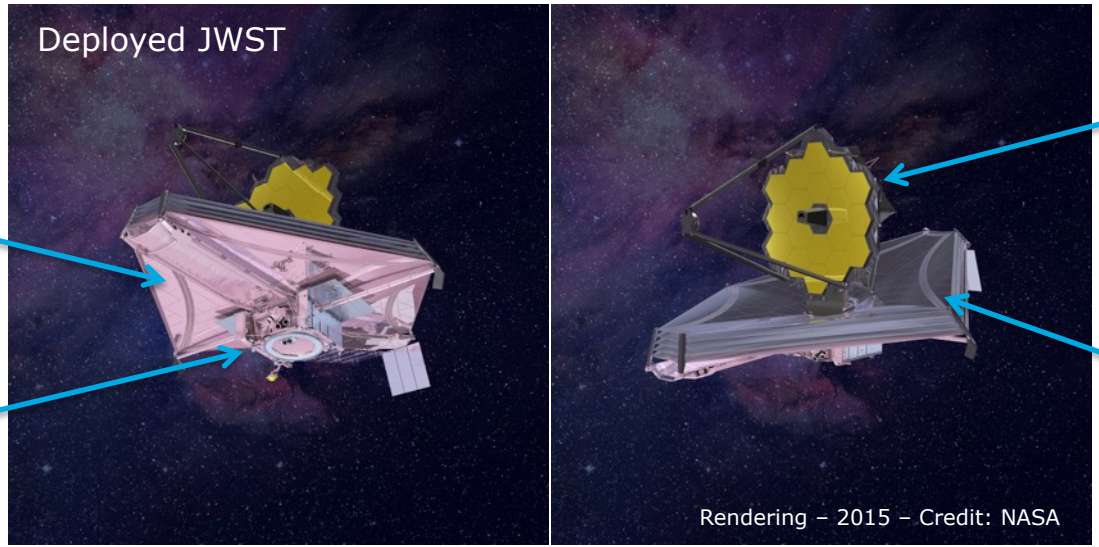
➔ All tests and measurements so far indicate that JWST remains the amazingly powerful observatory that we all expect it to be!

JWST is a very complex mission and the decision from NASA shows that they are not cutting corners. The focus is on making sure the telescope and the spacecraft have been carefully integrated and thoroughly tested by the time they launch.

The path to launch

At this stage of the integration, all JWST elements have been integrated in two big sub-systems:

- **The telescope and its instruments (this sub-system is called OTIS).**
- **The spacecraft and the sun-shield.**



The path to launch

Remaining I&T Activities*

Science Payload

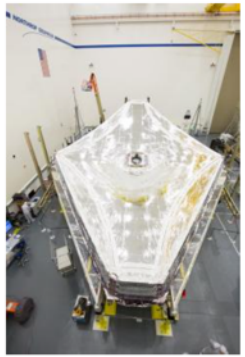
- OTIS Deployments at NGAS
  (secondary mirror & ISIM radiator)

Spacecraft Element

- Thruster re-installation
- Acoustics, vibe, and thermal vacuum tests
- Post-Environmental deployment & stow

$\int(\text{Observatory})dt$

- Pre-environmental Observatory deployments
- Observatory fold & stow
- Observatory system (electrical) test
- Observatory vibration, acoustics tests
- Observatory deployment
- Observatory stow for launch
- Observatory final system test



*Top-level tasks to go. Many activities are associated with each of these steps

Although the last two years have seen tremendous progress with JWST taking shape (see presentation by B. Vila), very important steps are still ahead of us.

Presentation: SWG monthly teleconference – E. Smith NASA HQ

A few words about commissioning.

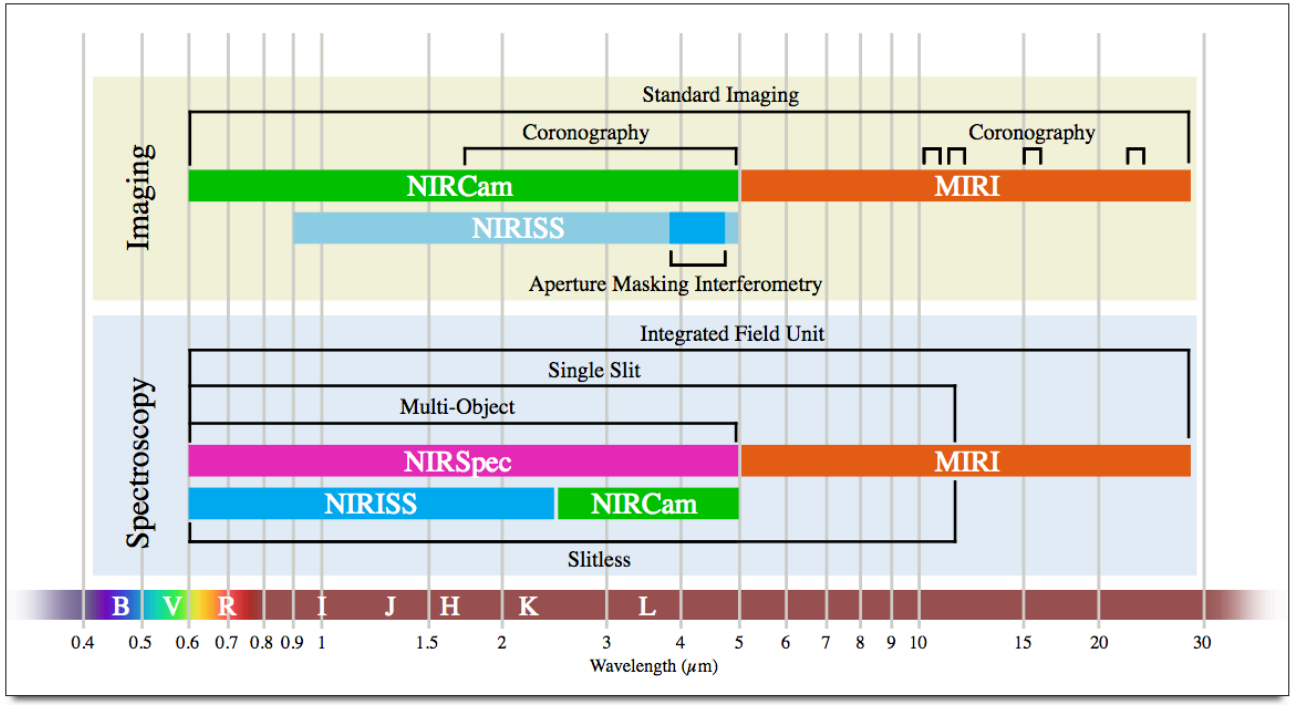
JWST has a 6-month commissioning period, which includes the time needed to reach the L2 point around which it will orbit.

- Deploying the observatory: approximately from launch (L) to L+3w.
- Traveling to L2: approximately from L to L+1m.
- A complex commissioning for a large cryogenic, deployable telescope with a segmented mirror that will need to be phased once in orbit.
- Telescope phased and aligned at around L+4m.

Observatory ready for science at L+6 (Fall 2019).

For more details, see the presentation to JWST's users committee in September 2017:
https://jwst.stsci.edu/files/live/sites/jwst/files/home/events/_documents/jstuc-0917-commissioning-friedman.pdf

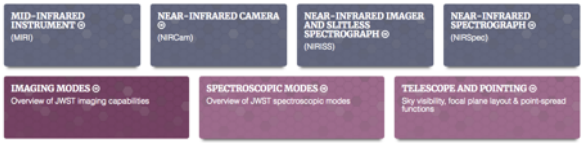
JWST capabilities



Credit: STScI

Entry point:

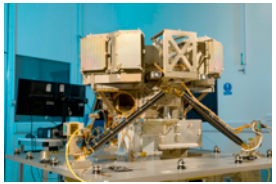
https://jwst.stsci.edu/instrumentation/



A very powerful and versatile observatory.

See presentation by Massimo Roberto.

JWST's instrument suite



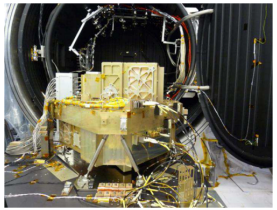
MIRI = Mid-InfraRed Instrument

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

PIs: G. Wright and G. Rieke

NIRSpec = Near-infrared Spectrograph

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

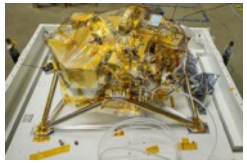


NIRISS = Near-infrared Imager and Slit-less Spectrograph

FGS = Fine Guidance Sensor

Provided by the Canadian Space Agency.

PIs: R. Doyon & C. Willott



NIRCam = Near-InfraRed Camera

Developed under the responsibility of the University of Arizona.

PI: M. Rieke

Scientific timeline

Although launch is planned in ~1.5 years the preparation of JWST's first cycle of observations (cycle 1) has already started.

Navigating JWST's acronym jungle:

- GO = general observers = scientists from the community
- GTO = guaranteed time observers = instrument team members and interdisciplinary scientists who have been granted a fixed amount of JWST time in return for their work for the mission.
- DDT = director's discretionary time = 10% of JWST's time managed by the director of the scientific operation center (STScI)
- ERS = Early Release Science = DDT initiative of ~500 hours set up to provide early access to JWST's data to the community as well as high-level data products and tools.
- EROs = Early Release Observations = NOT science observations, targeting the general public and aiming at showcasing the "debut" of JWST.

GTO programs

Total of ~3800 hours in cycle 1

Proposals submitted in April 2017 and first APT files submitted in July and November 2017.

Consolidated programs submitted on the 31st of January 2018 with the official cycle-1 call APT version.

To be updated to account for the contents of the latest submission

Name	GTO description	Hours requested
Heidi Hammel	Interdisciplinary scientist	106 hrs
Simon Lilly	Interdisciplinary scientist	112
Jonathan Lunine	Interdisciplinary scientist	100
Mark McCaughrean	Interdisciplinary scientist	40
Massimo Stiavelli	Interdisciplinary scientist	78
Rogier Windhorst	Interdisciplinary scientist	110
Gillian Wright	European MIRI Team PI	430
George Rieke	US MIRI Team PI	155
Marcia Rieke	NIRCam Team PI	905
René Doyon	NIRISS Team PI	448
Pierre Ferruit	NIRSpec Team PI	865
Matt Mountain	Telescope Scientist	192
Christine Chen	US MIRI Science Team	12
Scott Friedman	US MIRI Science Team	12
Karl Gordon	US MIRI Science Team	12
Tom Greene	US MIRI Science Team	60
Dean Hines	US MIRI Science Team	10
Margaret Meixner	US MIRI Science Team	57
Alberto Noriega Crespo	US MIRI Science Team	12
Mike Ressler	US MIRI Science Team	60
		3775 hrs

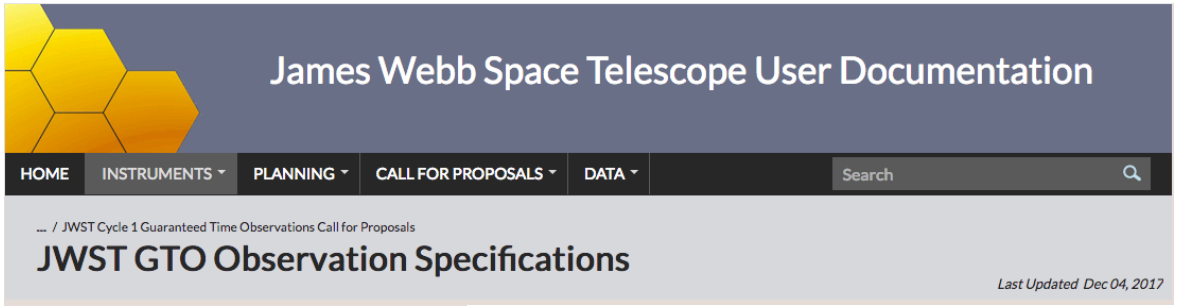
Table extracted from a presentation by N. Reid(STScI) – 11 December 2017

GTO programs

Large variety of programs.

Details can be found on STScI's web site:

https://jwst-docs.stsci.edu/display/JSP/JWST+GTO+Observation+Specifications



[Extra-solar planets] [Brown Dwarfs] [Protostars, Protostellar Disks, and Young Stellar Objects] [Debris Disks and Photodissociation Regions] [Star Clusters, Star Formation Regions, Planetary Nebulae, and Galactic Transients] [Targeted Galaxies] [Clusters of Galaxies] [High-redshift Quasars and Galaxy Assembly] [Deep Fields] [Related Links]

Scientific timeline

Although launch is planned in ~1.5 years the preparation of JWST's first cycle of observations (cycle 1) has already started.

See talk by Marco Sirianni for more details on the scientific timeline.

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- ERS = Early Release Science = DDT initiative of ~500 hours set up to provide early access to JWST's data to the community as well as high-level data products and tools.

DD ERS programs

Context

STScI Director Ken Sembach will allocate up to 500 hours of Director's Discretionary time for Early Release Science (DD-ERS) to

- *accelerate the diffusion of JWST know-how, and*
- *expand early opportunities for the community to gain experience with JWST data and scientific analysis.*

Early resources are allocated to support up to 15 teams. Proposals will be selected in research areas spanning the science themes of JWST :

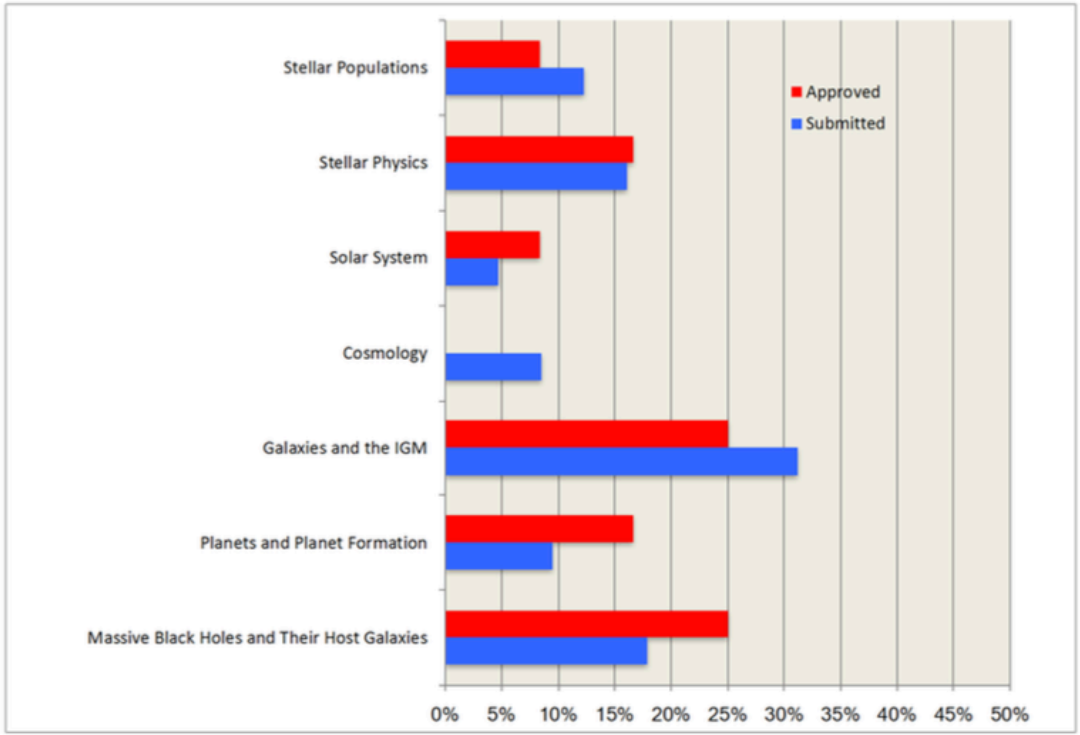
A multi-disciplinary committee of experts will recommend a suite of proposals that both fulfills the goals of the DD-ERS and makes optimal use of the available time for observation and funding.
All data will be available immediately with no exclusive access period.

DD ERS programs

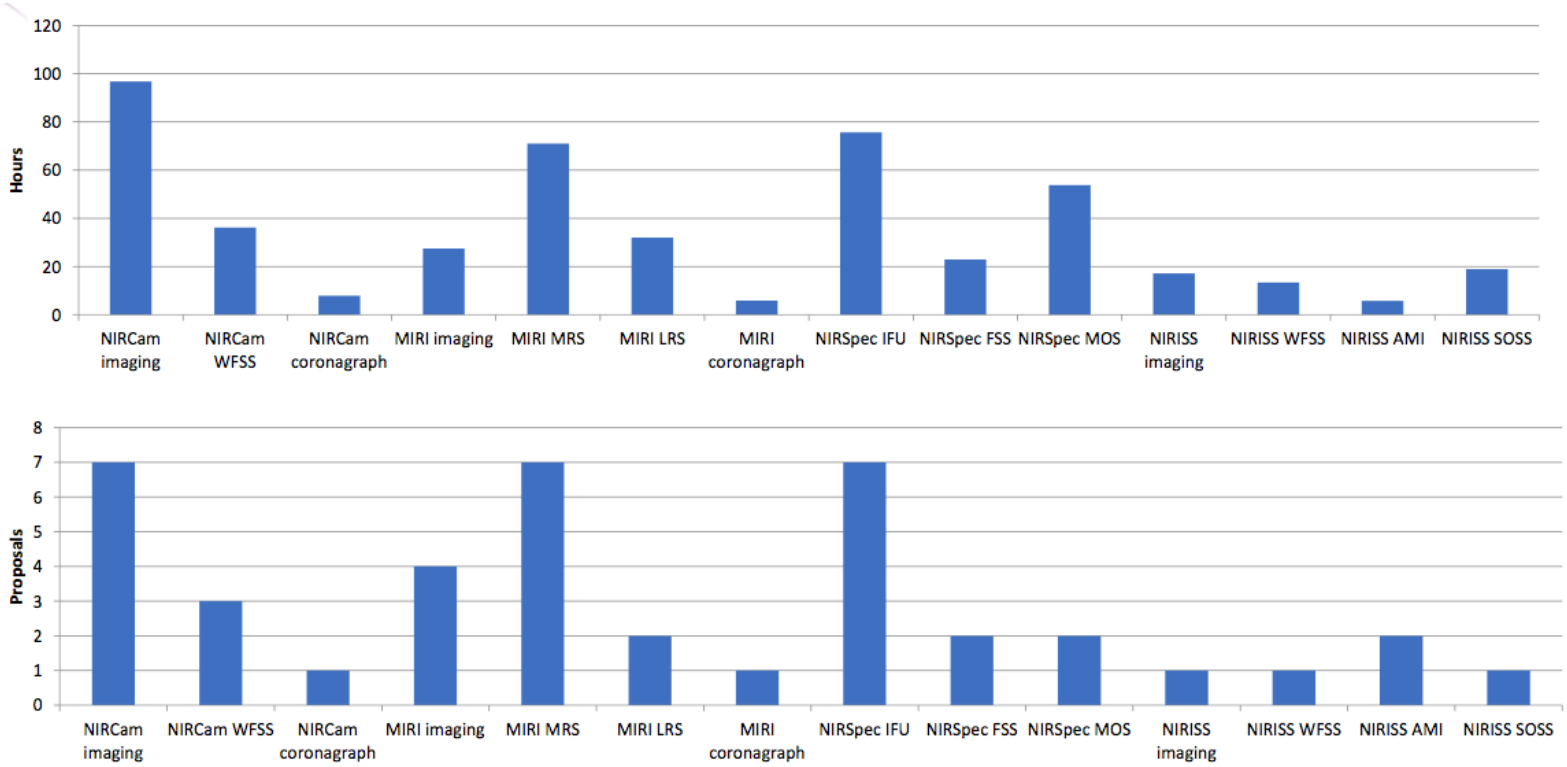
106 proposals were received by the 18th of August submission deadline

The ERS time allocation committee met on the 9th and 10th of October.

13 proposals have been selected for a total of ~460 hours of telescope time.



DD ERS programs



DD ERS programs

The Transiting Exoplanet Community Early Release Science Program	**PI:** Natalie Batalha (NASA Ames Research Center) **CoPIs:** Jacob Bean (University of Chicago) and Kevin Stevenson (Space Telescope Science Institute)
High Contrast Imaging of Exoplanets and Exoplanetary Systems with JWST	**PI:** Sasha Hinkley (University of Exeter) **CoPIs:** Andrew Skemer (University of California - Santa Cruz) and Beth Biller (University of Edinburgh)
ERS observations of the Jovian System as a Demonstration of JWST's Capabilities for Solar System Science	**PI:** Imke de Pater (University of California - Berkeley)

Planets & Origins of Life

Birth of Stars & Protoplanetary Systems

Q-3D: Imaging Spectroscopy of Quasar Hosts with JWST Analyzed with a Powerful New PSF Decomposition and Spectral Analysis Package	**PI:** Dominika Wylezalek (European Southern Observatory - Germany) **CoPIs:** Sylvain Veilleux (University of Maryland) and Nadia Zakamska (Johns Hopkins University)
Nuclear Dynamics of a Nearby Seyfert with NIRSpec Integral Field Spectroscopy	**PI:** Misty Bentz (Georgia State University Research Foundation)

Assembly of Galaxies

https://jwst.stsci.edu/news-events/news/News%20items/selections-made-for-the-jwst-directors-discretionary-early-release-science-program

Slide from a presentation by N. Reid(STScI) – 11 December 2017

DD ERS programs

Radiative Feedback from Massive Stars as Traced by Multiband Imaging and Spectroscopic Mosaics	**PI:** Olivier Berne (Universite Toulouse) **CoPIs:** Emilie Habart (Institut d'Astrophysique Spatiale) and Els Peeters (University of Western Ontario)
IceAge: Chemical Evolution of Ices during Star Formation	**PI:** Melissa McClure (Universiteit van Amsterdam) **CoPIs:** Adwin Boogert (University of Hawaii) and Harold Linnartz (Universiteit Leiden)
Establishing Extreme Dynamic Range with JWST: Decoding Smoke Sig Program ID 1349 - Lau f a Wolf-Rayet Binary	**PI:** Ryan Lau (California Institute of Technology)
The Resolved Stellar Populations Early Release Science Program	**PI:** Daniel Weisz (University of California - Berkeley)

Birth of Stars & Protoplanetary Systems

Assembly of Galaxies

A JWST Study of the Starburst-AGN Connection in Merging LIRGs	**PI:** Lee Armus (California Institute of Technology)
TEMPLATES: Targeting Extremely Magnified Panchromatic Lensed Arcs and Their Extended Star Formation	**PI:** Jane Rigby (NASA Goddard Space Flight Center) **CoPI:** Joaquin Vieira (University of Illinois)
The Cosmic Evolution Early Release Science (CEERS) Survey	**PI:** Steven Finkelstein (University of Texas at Austin)
Through the Looking GLASS: A JWST Exploration of Galaxy Formation and Evolution from Cosmic Dawn to Present Day	**PI:** Tommaso Treu (University of California - Los Angeles)

First Light & Reionization

https://jwst.stsci.edu/news-events/news/News%20items/selections-made-for-the-jwst-directors-discretionary-early-release-science-program

Slide from a presentation by N. Reid(STScI) – 11 December 2017

Early Release Observations (EROs)

Call for ideas released in October 2017.

- This is becoming slightly late to submit ideas but not yet too late…
- Beware, you will NOT receive any feedback or acknowledgment.

E-mail to:
ero@stsci.edu

The James Webb Space Telescope (JWST) Early Release Observations (ERO) will be among the first images and spectra taken during the commissioning of the observatory after its launch, now planned for the second quarter of 2019. They represent JWST's debut to the world and are intended to have immediate and dramatic appeal for a broad audience.

The JWST ERO Committee welcomes the collective expertise of the astronomical community and invites suggestions for ERO observations. We are looking for observations that will showcase JWST's instruments and scientific capabilities. The data will become public when the ERO products are released at the end of commissioning. Your input, while appreciated, will not be formally acknowledged, and there will be no grant funding or pre-release access to the data. However, your input will be a valued contribution to JWST's mission!

The ERO Committee

Kathryn Flanagan (STScI) – Coordination Scientist

Elena Sabbi (STScI) – Executive Secretary

Michael Balogh (U of Waterloo / CSA)

Jonathan Gardner (GSFC)

Hashima Hasan (NASA HQ)

Zolt Levay (STScI)

Antonella Nota (ESA/STScI)

JWST's users committee = JSTUC

The JSTUC was started this year:

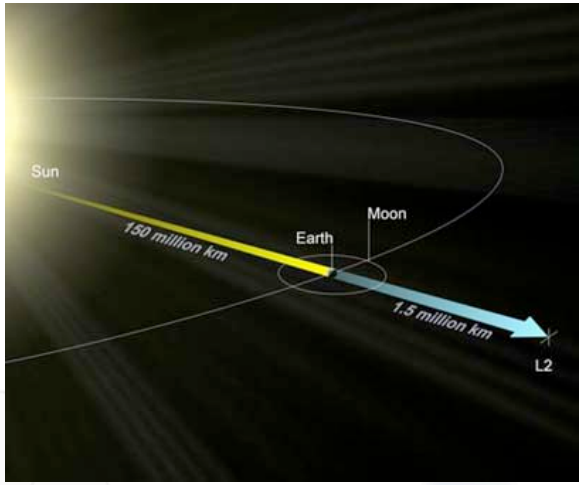
- 17 members in total, drawn from the astronomical community and with instrument teams representation. It is chaired by James Bullock (Univ. California, Irvine).
- It will meet approximately every 6 months.

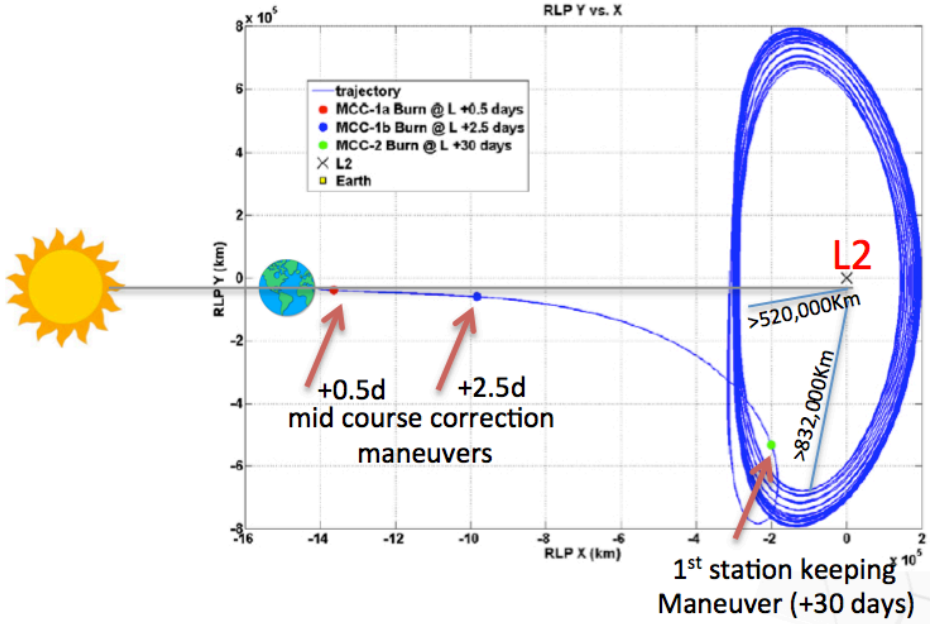
It includes representatives from ESA member states selected in coordination with ESA:

- Community: Laura Pentericci (INAF) and Johan Richard (Lyon University).
- Instruments: Stéphane Charlot (NIRSpec), Alistair Glasse (MIRI, observer).
- ESA observers: Antonella Nota & Pierre Ferruit.

More details: https://jwst.stsci.edu/science-planning/user-committees/jwst-users-committee-jstuc

JWST's orbit



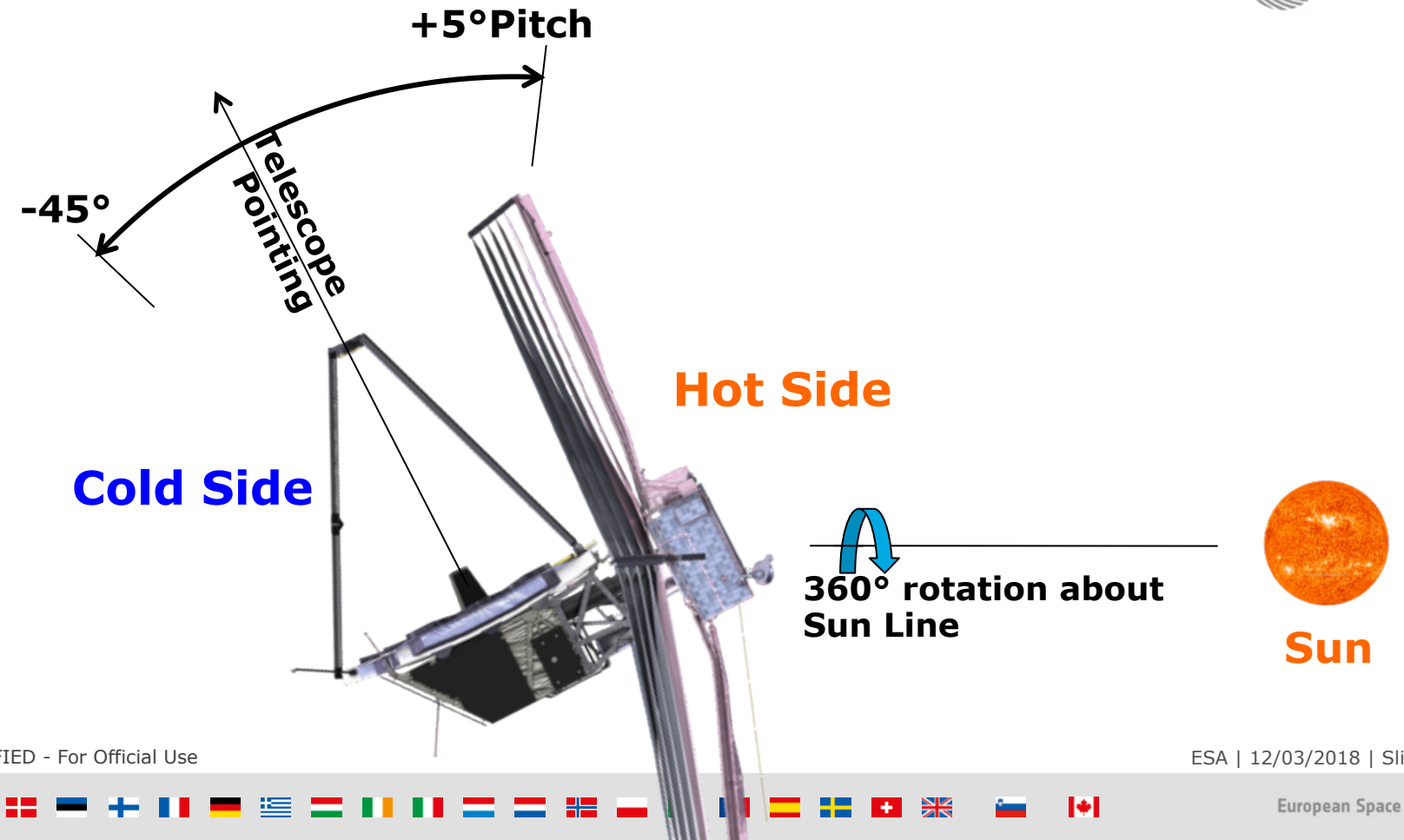


Halo orbit period is ~ 6 months

Final details on the orbit depend on launch window

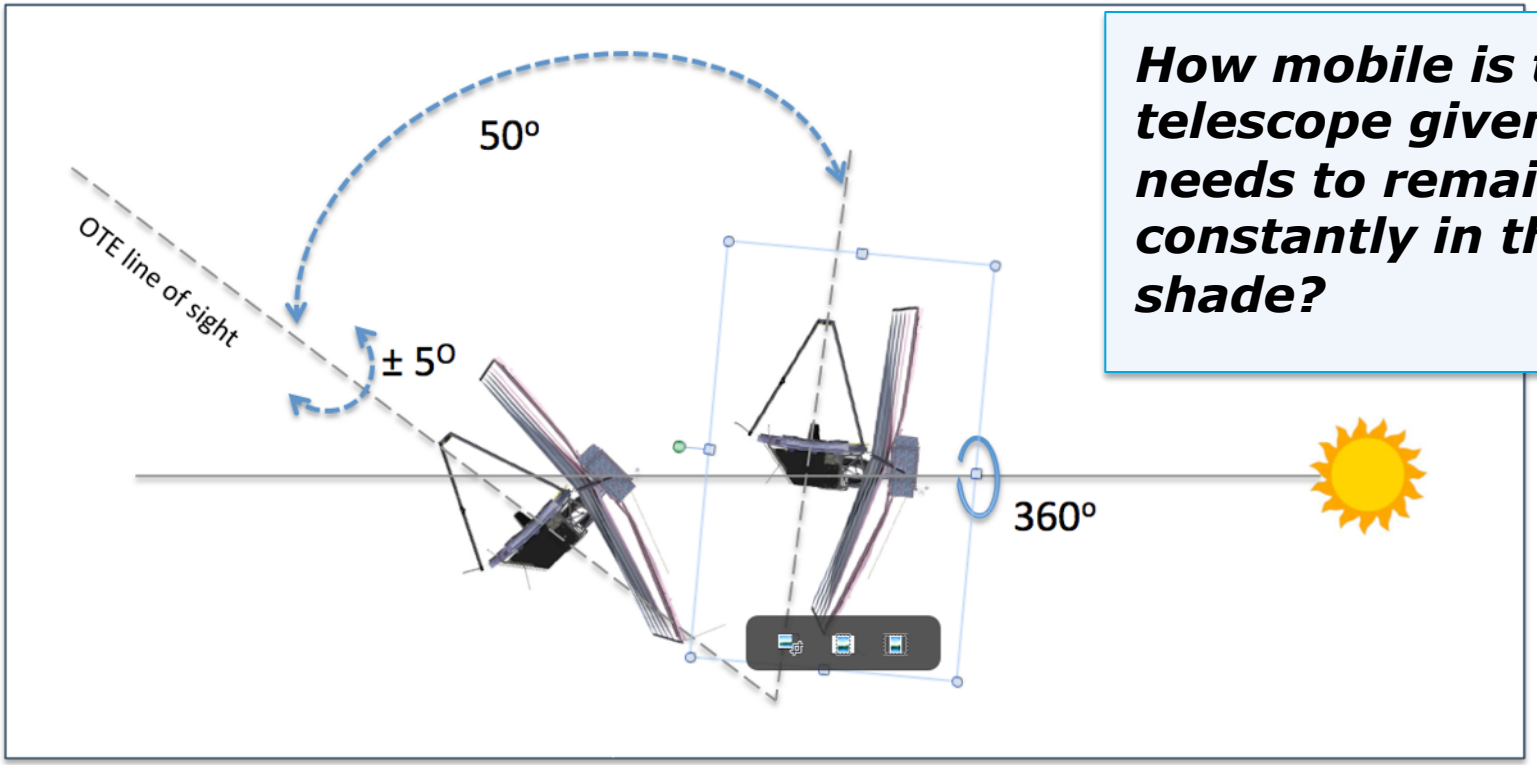
L2 "halo" orbit, keeping the Sun, the Earth and the Moon on the same side of the sunshield.

JWST's field of regard



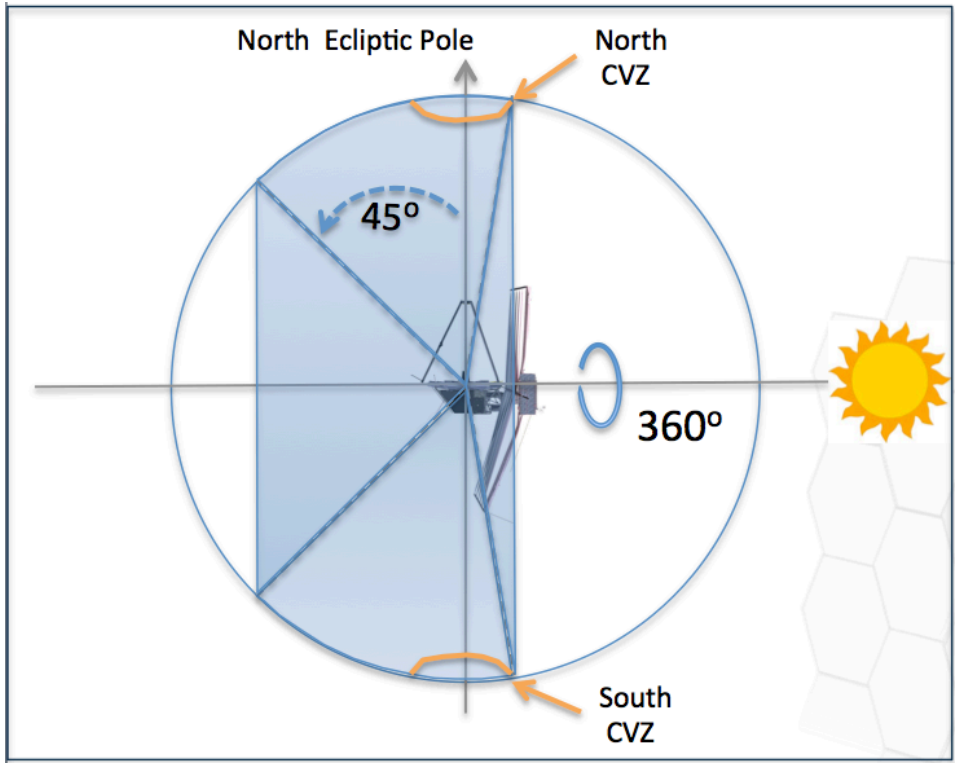
Credit figure: G. Sonneborn

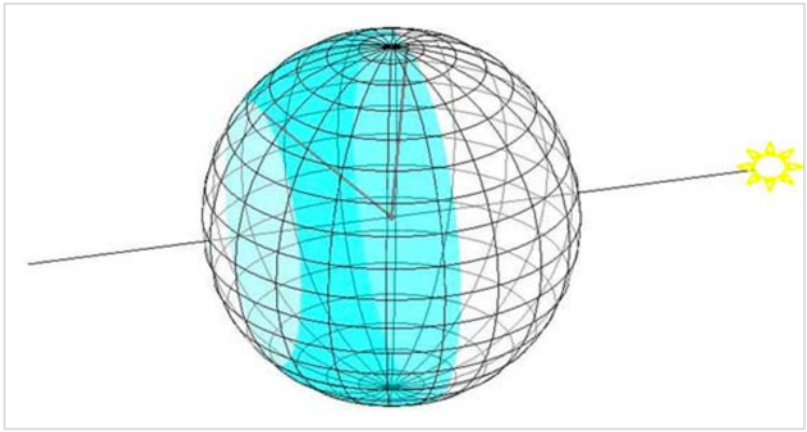
JWST's field of regard



How mobile is the telescope given that it needs to remain constantly in the shade?

JWST's field of regard

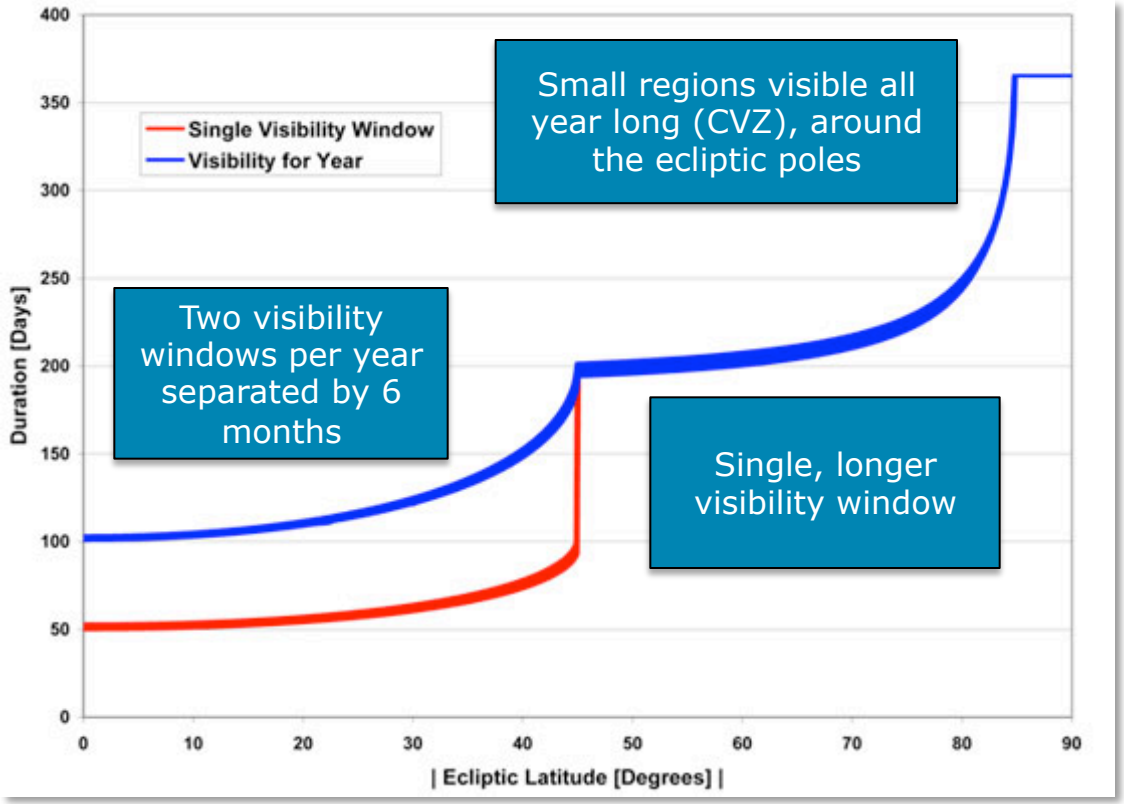




~39% of full sky observable at any time.

100% sky coverage over 6 months.

JWST's visibility constraints

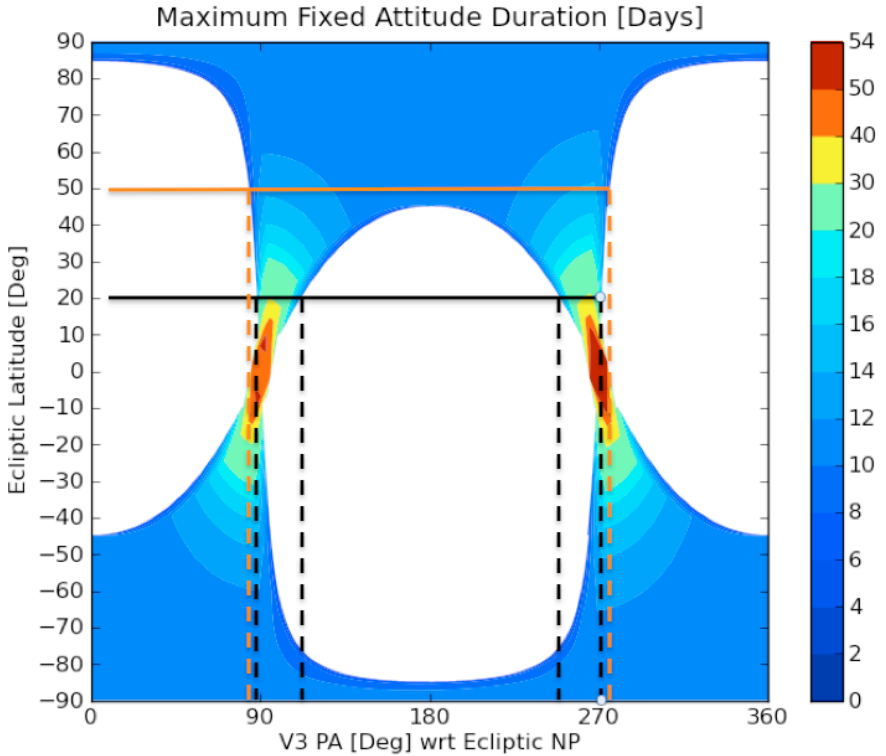


3 different categories:

- Always visible.
- Single, long visibility window.
- Two ~50-day visibility windows per year.

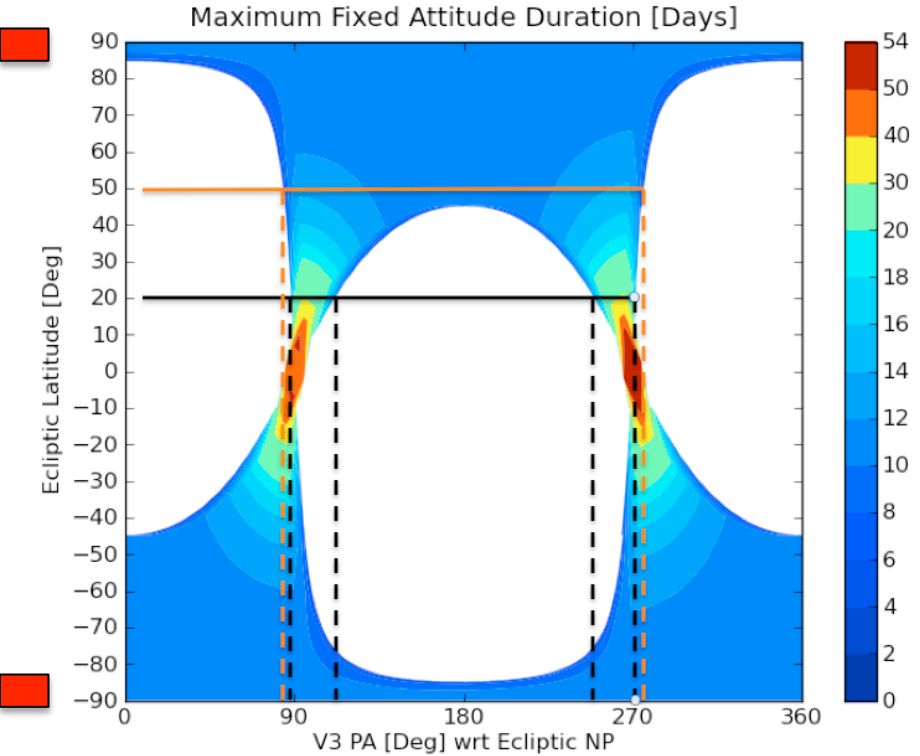
Main driver: ecliptic latitude of the object.

JWST's visibility and orientation constraints



It is important to understand that the visibility constraints go hand-in-hand with some orientation constraints.

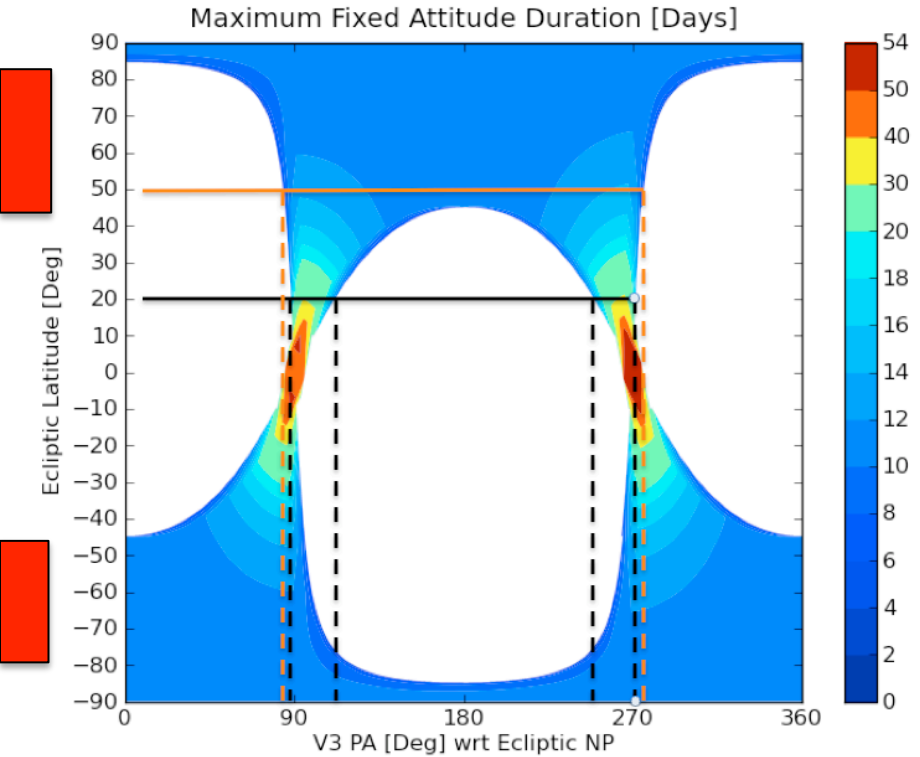
JWST's visibility and orientation constraints



Case #1: CVZ

- ***Always visible but the orientation changes constantly (fixing the orientation is equivalent to fixing when to observe).***
- ***Can only use the roll (+/- 5 degrees) to keep the orientation constant and this corresponds to a little bit more than 10 days (i.e. a given orientation is only available for ~10 days).***
- ***All orientations possible.***

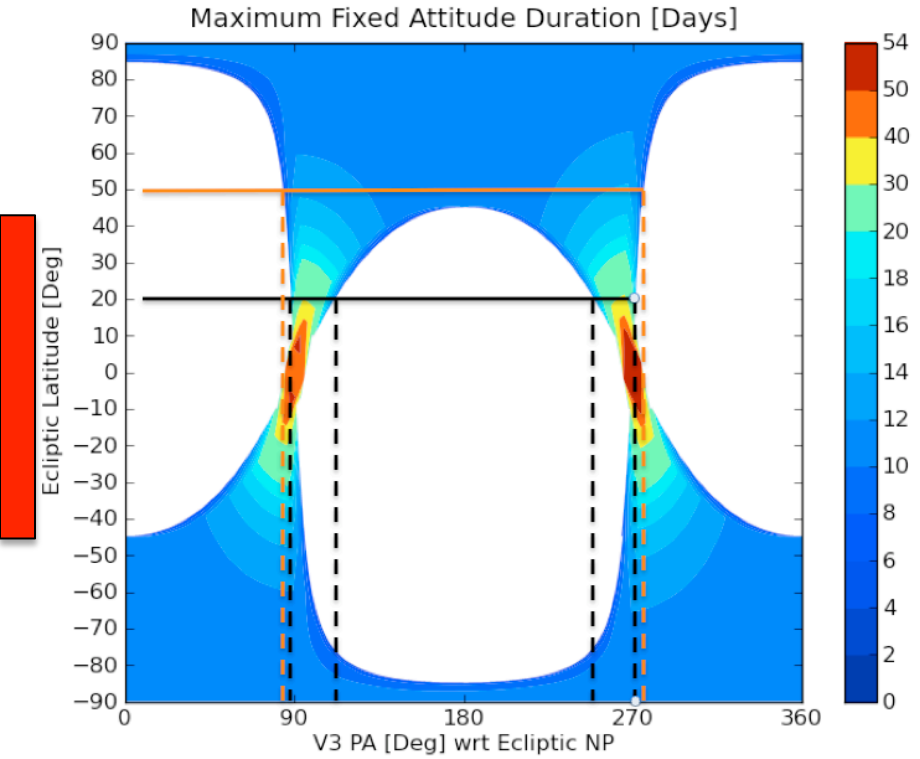
JWST's visibility and orientation constraints



Case #2: single visibility window

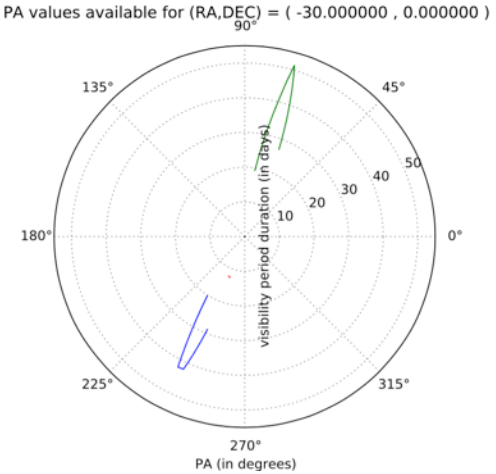
- ***Relatively similar to CVZ, constraining the orientation is equivalent to constraining the scheduling.***
- ***A given orientation is available for a limited time.***
- ***Limited range of orientations available.***

JWST's visibility constraints

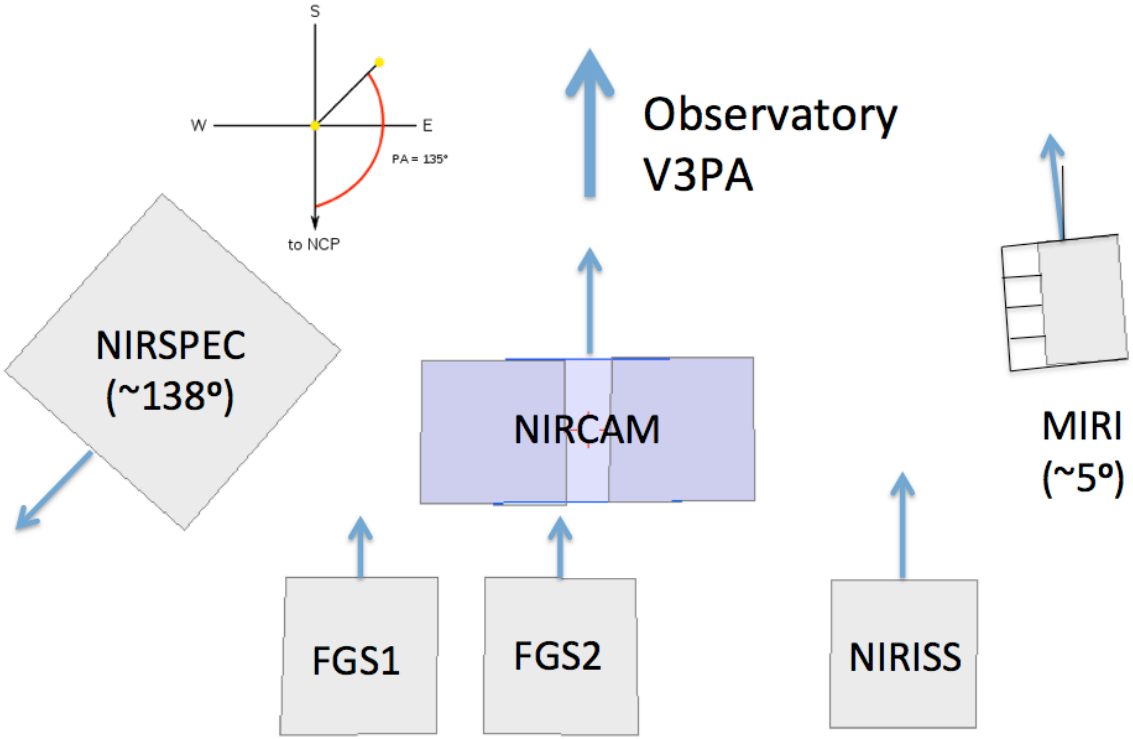


Case #3: 2 visibility periods (low ecliptic angle)

- ***Very little choice of orientation.***
- ***Can keep a given angle for a long time…***



Beware of the PA forest…



V3PA = reference PA for the observatory

= position angle (PA) of the V3 axis eastward relative to ecliptic north pole when projected onto the sky

APA = reference PA for a given instrument

= what an observer wants to know when preparing an observation with a given instrument.

JWST's general target visibility tool

Allows to compute the visibility periods for an object together with the V3PA and APA angles.

- *Simple command-line Python script distributed by STScI (see documentation site for instructions on how to install it).*
- Basic input: RA and DEC of the target.

Returns tabulated data (visibility and angles as a function of time) as well as basic plots.

Documentation:

https://jwst-docs.stsci.edu/display/JPP/JWST+General+Target+Visibility+Tool+Help

JWST's coronagraphy visibility tool

A more sophisticated tool responding to the more complex needs of coronagraphy.

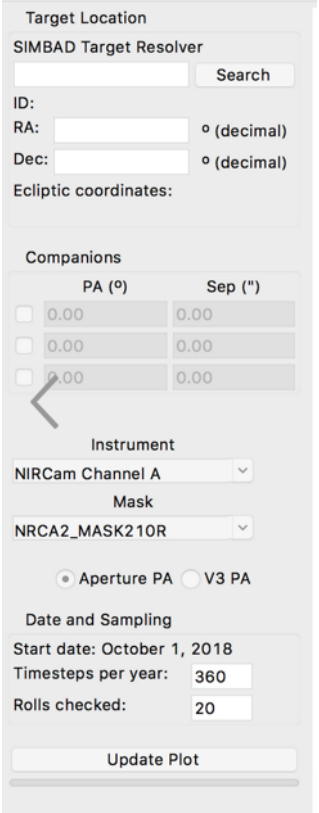
- *Tool with a GUI distributed by STScI (see documentation site for instructions on how to install it).*
- Basic input: RA and DEC of the target.

Allows to specify the target & companion(s) coordinates and configurations as well as the instrumental configuration.

In returns, shows the visibility information and the position / orientations with respect to the coronagraph.

Documentation:

https://jwst-docs.stsci.edu/display/JPP/JWST+Coronagraphic+Visibility+Tool+Help



Conclusion

A launch date that has shifted to Spring 2019 but JWST is in good shape. Schedule remains under scrutiny.

We still have a lot of work ahead of us, first to get it to the launch pad and then to get it ready for science.

The scientific preparation of the mission is in full swing.

Thanks for your attention and have a good workshop!