JWST Science and best practices

Massimo Stiavelli, Jason Kalirai, Klaus Pontoppidan

ROE, July 5th, 2016

Space Telescope Science Institute

STScI Operations Flow

Proposal Preparation

PPS

Proposal Selection

Science Planning

Operations Scheduling

Flight Operations

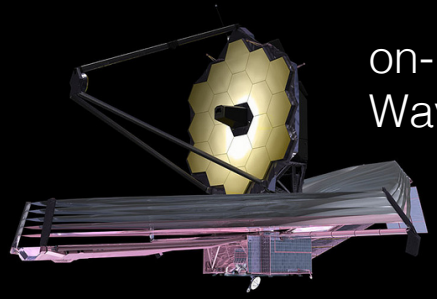
FOS

DMS

Data Processing and User Tools

Data Archiving

on-board scripts (OSS)
Wavefront sensing (WFSC)



Education and Public Outreach

S&OC Sub-systems overview

S&OC & Subsystem Status						
Subsystem	**Build**	**Development completion date**	**I&T completion date**	**Status**	**% of requirements delivered to date**	**% of requirements verified to date**
Data Management Subsystem (DMS)	5	October 2015	May 2016	I&T completed	73%	36%
	6	May 2016	December 2016	Development completed		
	7*	December 2016	April 2017			
	7.1	November 2017	February 2018			
Proposal Planning Subsystem (PPS)	12	October 2015	April 2016	I&T completed	92%	65%
	13	April 2016	October 2016	Development completed		
	14*	December 2016	February 2017			
	15	November 2017	February 2018			
Wavefront Sensing & Control (WFS&C) Software Subsystem	5.1	March 2016	May 2016	Development completed	100%	96%
	6*	January 2017	May 2017			
	6.1	December 2017	February 2018			
Flight Operations Subsystem (FOS)	5	March 2016	July 2016	Completed site acceptance test	58%	53%
	6	February 2017	July 2017	Under development		
	6.1*	August 2017	December 2017			
Operations Scripts Subsystem (OSS)	5	May 2016	September 2016	In Level 1 Certification	73% Level 2 certified	58% Level 3 certified
	6*	March 2017	August 2017			
Project Reference Database Subsystem (PRDS)	4.10*	November 15	November 15	Latest Sustaining Engineering release	100%	100%

*** Supports Launch**

Aligning the telescope

OTE Commissioning Simulation End to End

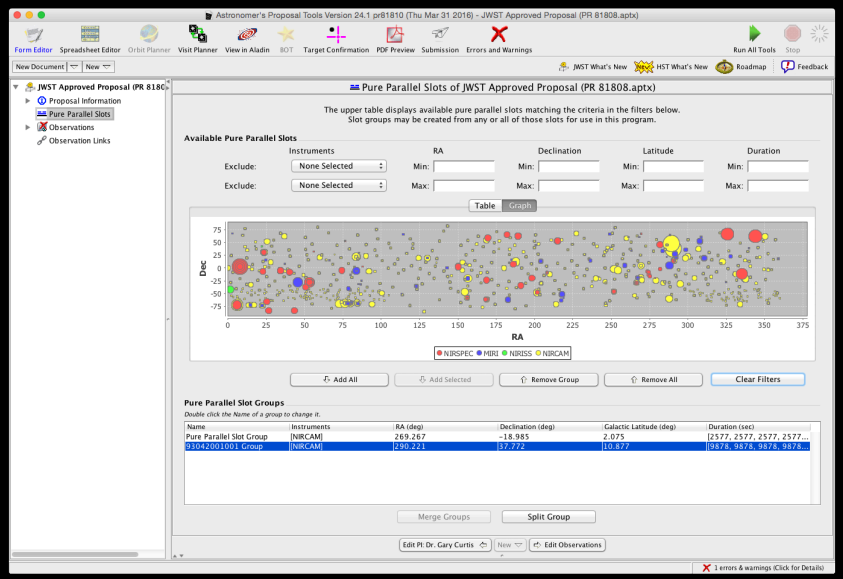
- Following delivery by BATC of their Integrated Telescope Model (ITM) and associated tools, STScI performed our first complete simulation of OTE commissioning.

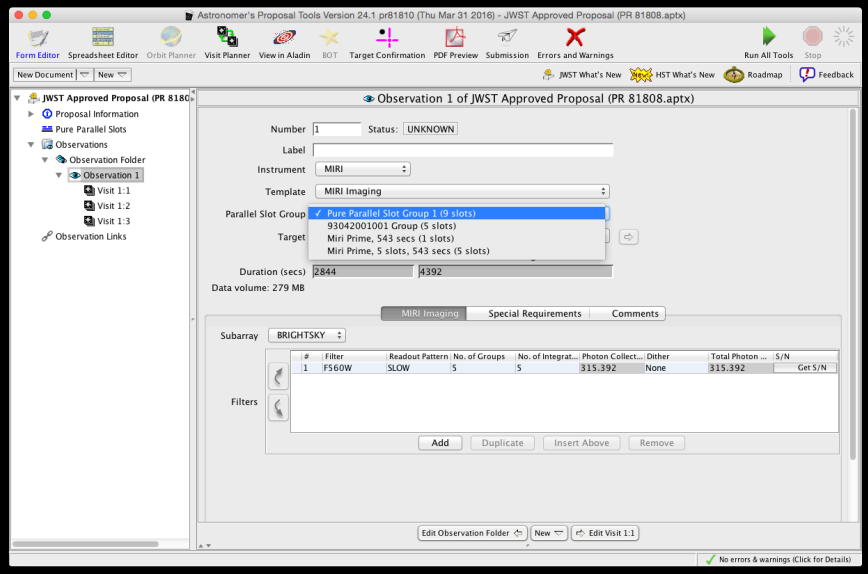
Mission Operations Center

- JWST operations will be conducted from the MOC at STScI. The backup ops center (bMOC) will be located at GSFC.

Science Parallels

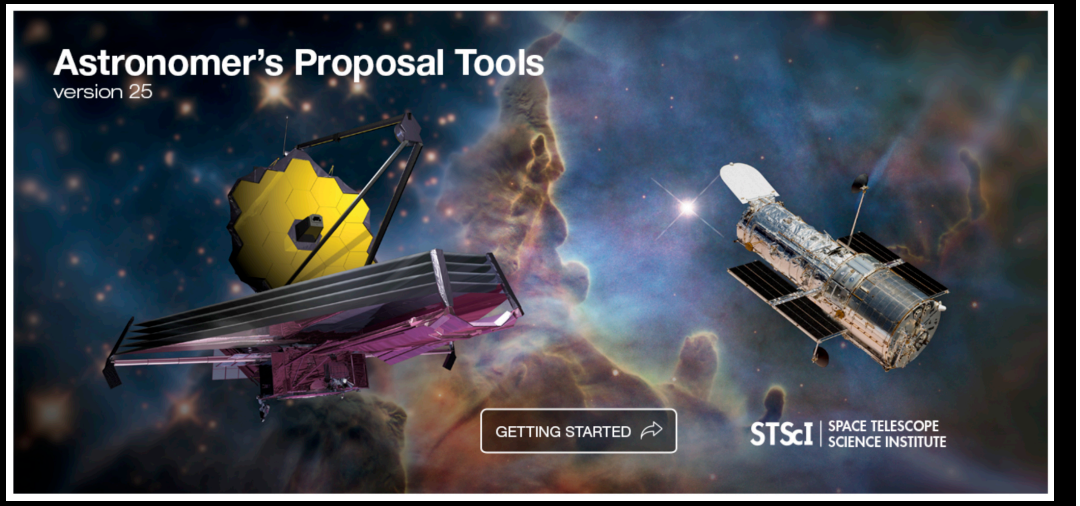
- Parallel science:
  - Cycle 1 will include pure-parallel (= manually crafted) support for all science modes that make sense to be used in parallel
  - Will include coordinated parallel (= joint coordinated template) support for 3-4 parallel combinations. (NIRCam Imaging-MIRI Imaging, NIRCam Imaging-NIRISS WFSS, MIRI Imaging-NIRISS WFSS and possibly NIRCam Imaging-NIRSpec MSA)
  - Additional coordinated parallels will be supported in Cycle 2.



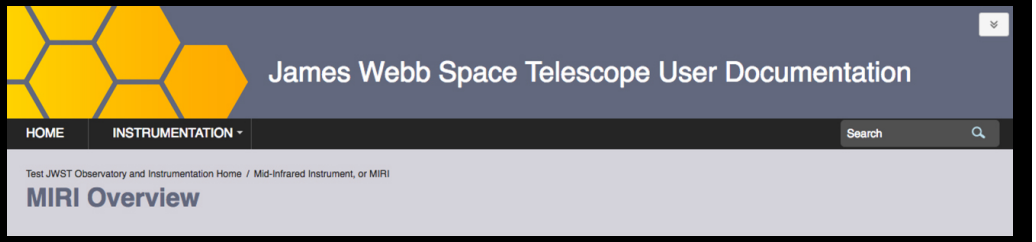


JWST User Tools Highlights

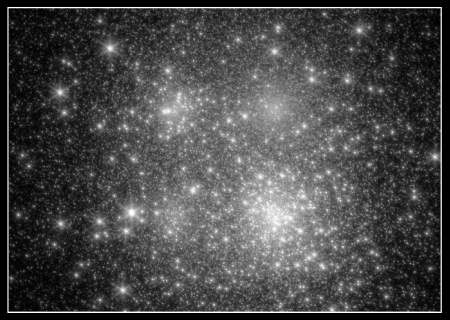
- Astronomer's proposal tool (APT)
  - Smart overhead accounting
  - New visibility tools
  - New JWST graphics
- Exposure time calculator (ETC)
  - All science modes complete
  - First release for WFIRST
  - Quantitative verification in review
  - Package being prepared for release
- Data simulators
  - STIPS imaging modes to be released
- Calibration pipelines
  - New plan with better prioritization and workflows
- User documentation (JDOX)
  - Wikipedia-style integrated web documentation
  - First batch of instrument and background articles in review
- Data analysis tools
  - Many new applications, including spectroscopic viewer, multi-object and IFU tools



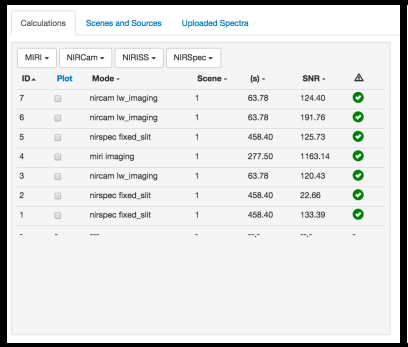
JDOX

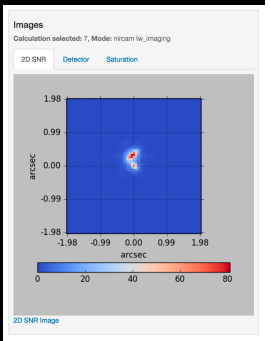


JWST Simulator



JWST ETC





JWST User Tools Highlights

See talk by Susan Kassin

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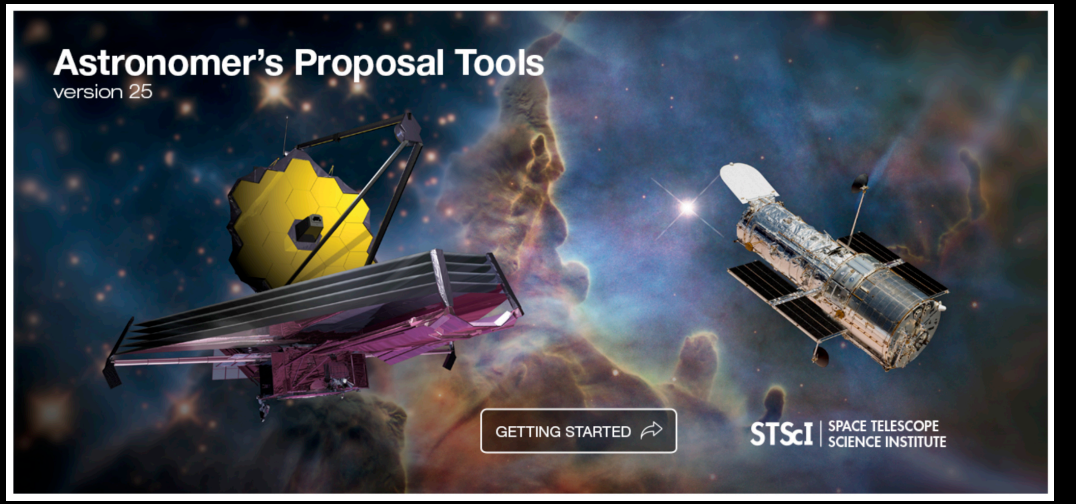
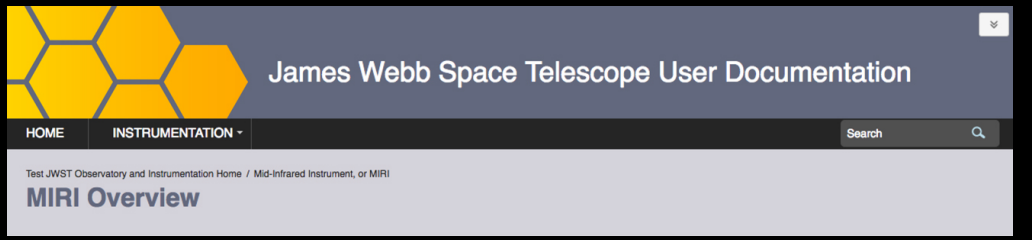
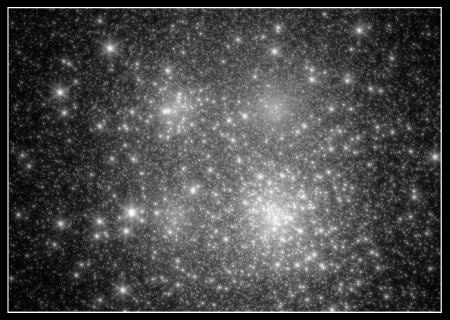


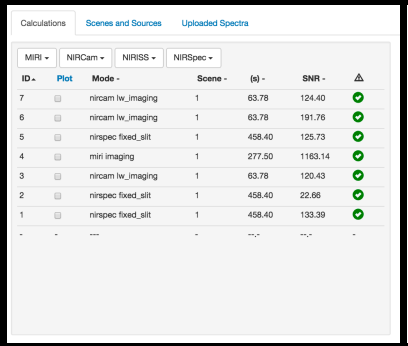
JDOX

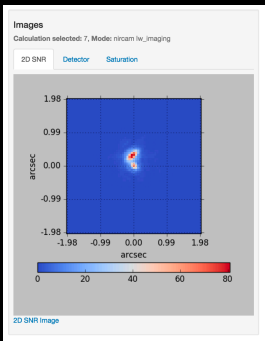


JWST Simulator

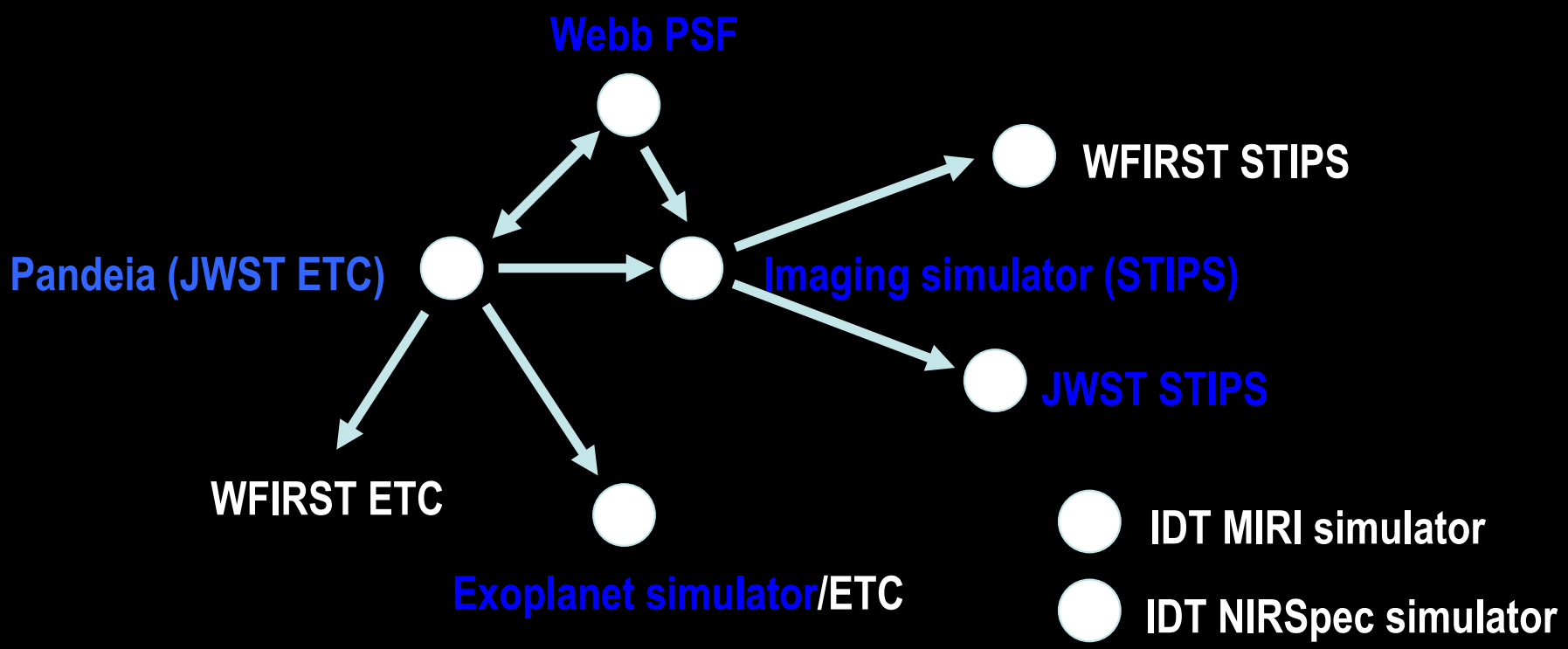


JWST ETC

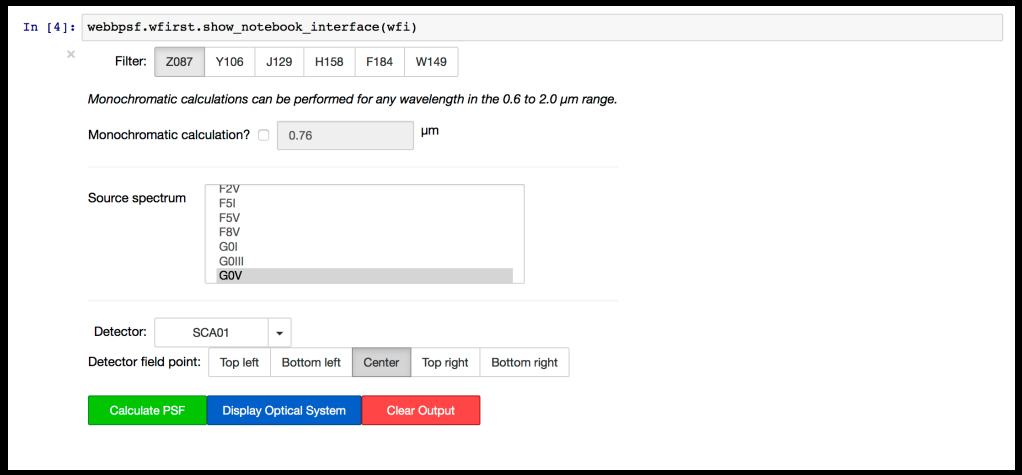




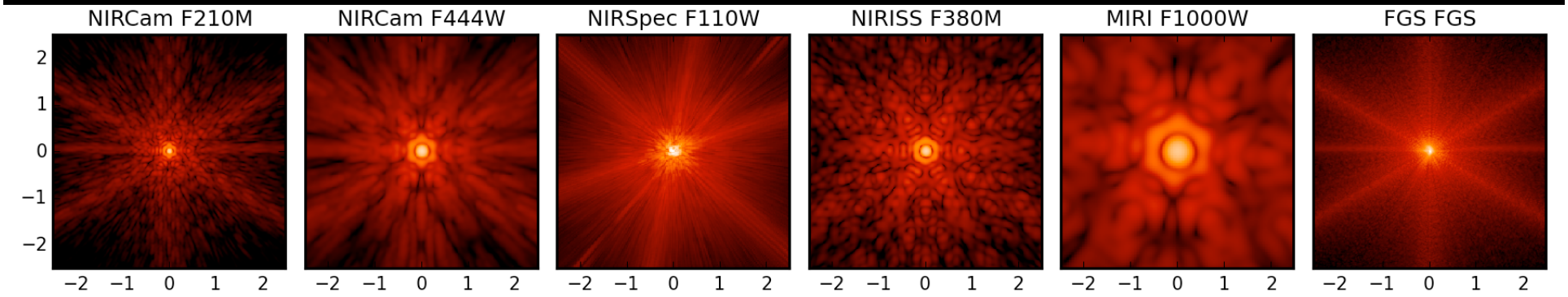
Relations between simulator tools



WebbPSF

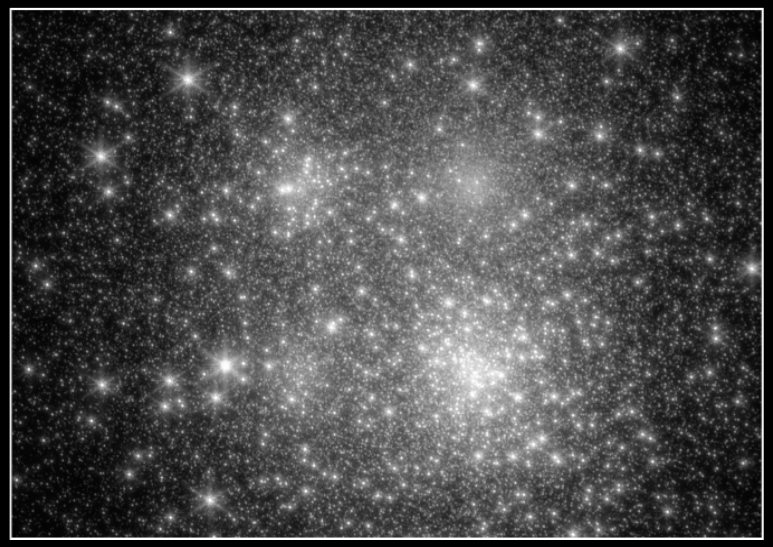


Status: Released. In active use.
Current version: 0.4.1
Hosted on: http://pythonhosted.org/webbpsf
WFIRST interface on: http://www.stsci.edu/wfirst/software/wfirst-tools-server



Space Telescope Image Project Simulator (STIPS)

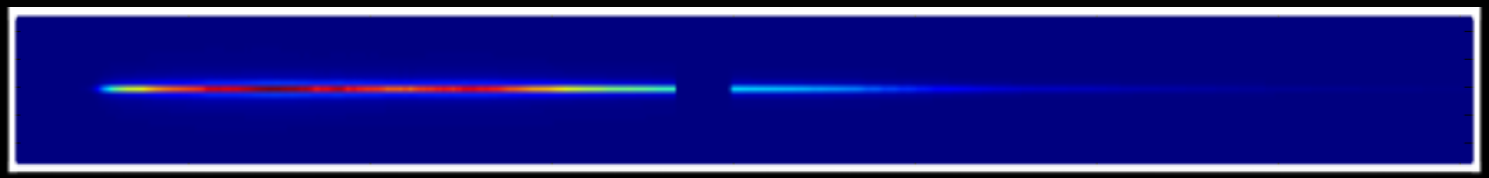
JWST Simulator



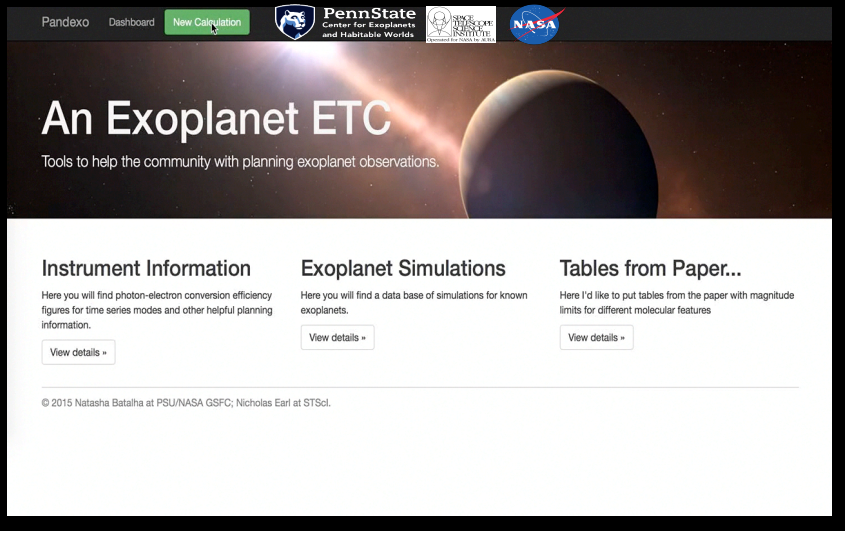
- **Current version 0.6**
- **Complex observing sequences, dithers, and simulated data products.**
- **Web tool**
- **Includes JWST imaging modes**
- **Different astrophysical models: stellar populations, galaxy populations**
- **Full FOV, WebbPSFs, Pandeia throughputs**
- **Initial release in summer 2016, along with WFIRST STIPS.**
- **Likely on jwstwebsim.stsci.edu**

Exoplanet Simulator (PANDEXO)

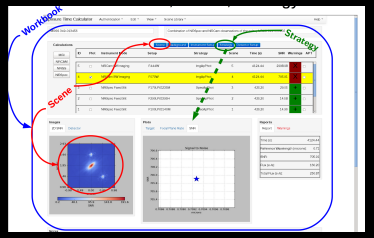
- **Developed by Natasha Batalha (Penn State) + Avi Mandell, Nick Earl, Jason Kalirai, Klaus Pontoppidan**
- **Uses Pandeia (ETC) as the instrument model (will always be synchronized with the best-known instrument performance).**
- **Simulates transit spectroscopy.**
- **Advanced web tool.**
- **Due for public release soon after the ETC engine release**



While PANDEXO is not directly relevant to the extragalactic community it is an example of a partnership with non-STScI groups. Similar things could be possible for other specific science areas.



User tools timeline



ETC Engine release (verification)

ETC WebApp flight release

Beta

ERS deadline

Cycle 1 Call for Proposals

Launch!

2016 2017 2018 2019

227th AAS

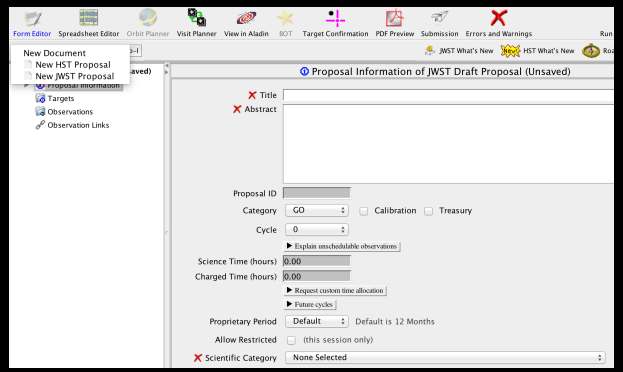
Exoplanet simulator release

STIPS Release

First User Doc release

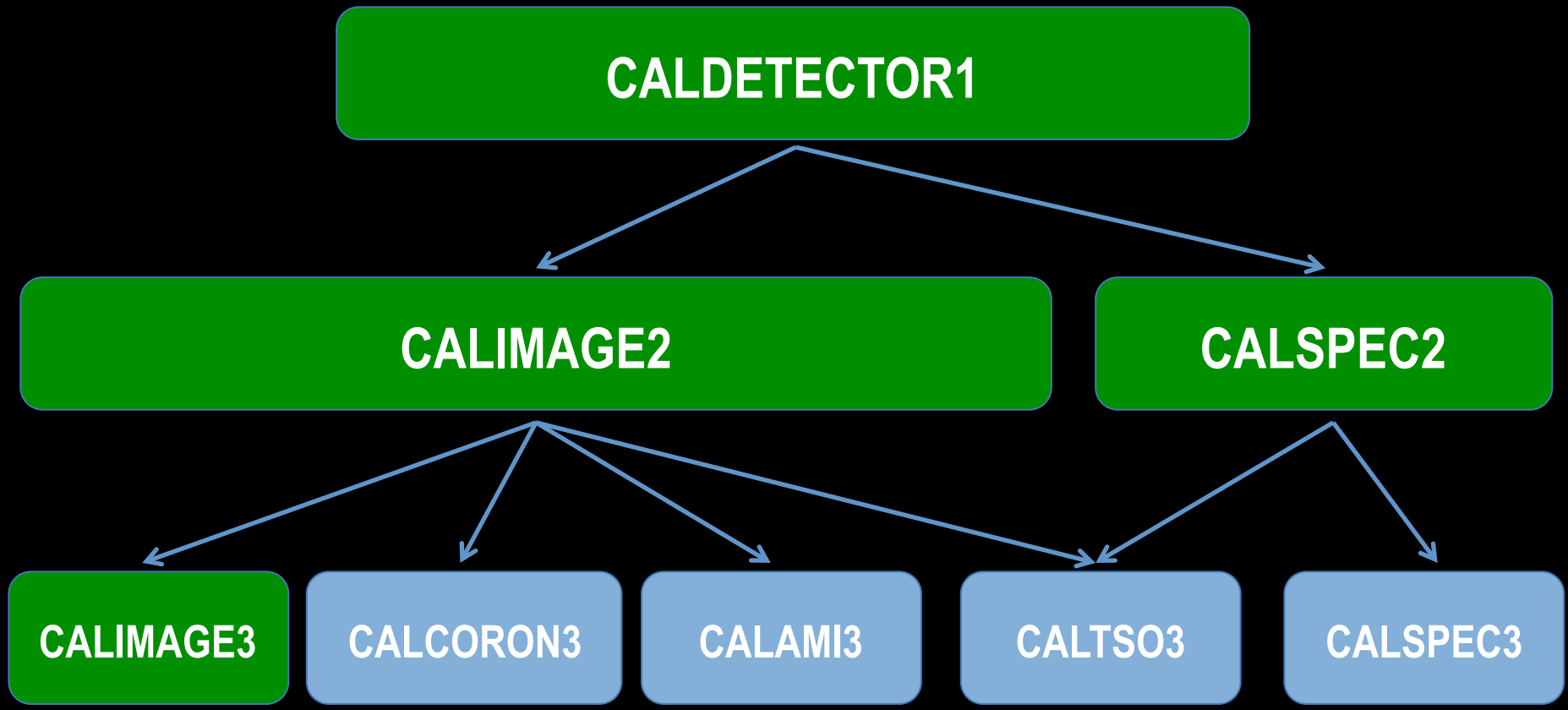
APT flight release

Cycle 1 deadline



Pipeline

Green boxes: Data management subsystem (DMS) build 6 – completed and under testing
Light blue boxes: DMS build 7 – under development



DMS Build 6.0

- What's in it?
  - CALDETECTOR1: Various modifications including support for NIRSpec IRS^2 readout mode
  - CALSPEC2: Individual exposures from most spectroscopic modes are processed from counts s^{-1} to absolute flux and wavelength units; supports associations of nodded/ chopped exposures for background subtraction
  - CALIMAGE3: Multiple exposures from the direct-imaging modes are combined into a single image.
    - Refine relative WCS
    - Background matching
    - Outlier detection
    - Image combination
    - Generate source catalog

DMS Build 7.0

- What's planned?
  - CALSPEC2: NIRCam and NIRISS Wide-Field Slitless Spectroscopy (WFSS) modes
  - CALCORON3: Multiple exposures from the coronagraphic modes
  - CALAMI3: Multiple exposures from NIRISS Aperture Masking Interferometry
  - CALTSO3: Individual exposures taken in Time Series Observation (TSO) mode (images or spectra)
  - CALSPEC3: Multiple exposures combined into a data cube and/or extracted spectra

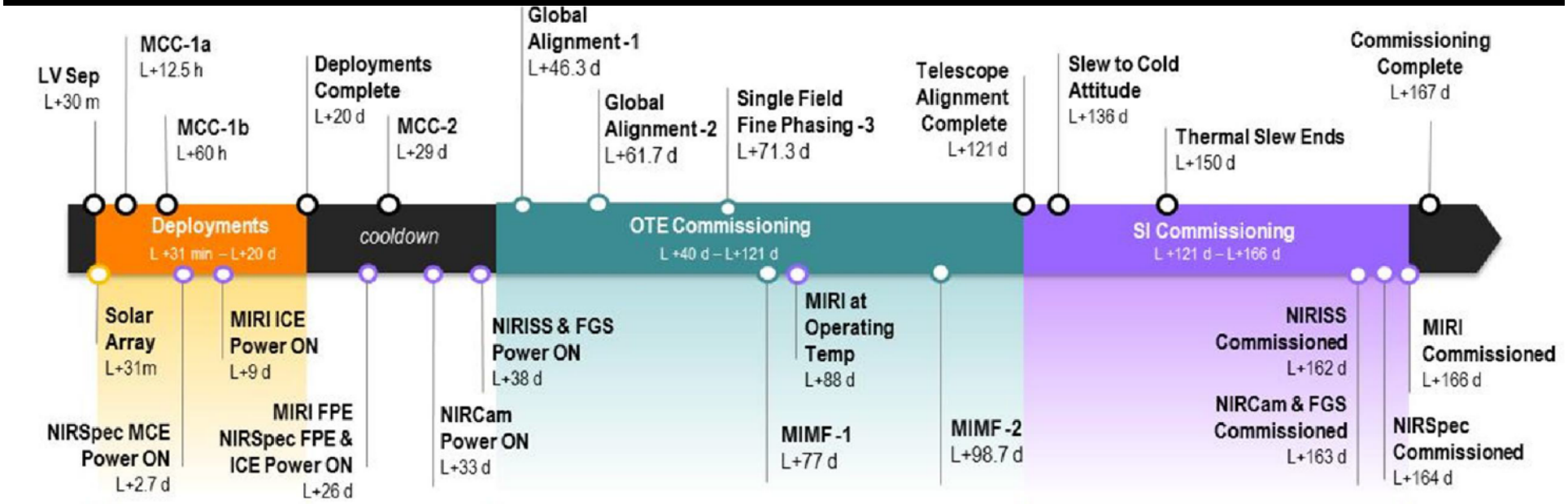
- **GOAL: scientifically valid pipeline for all modes**

DMS Build 7.1+

- Optimal Versions of
  - CALDETECTOR1: error handling, linearity correction, persistence correction, jump detection, slope fitting
  - CALIMAGE2: telescope emission subtraction
  - CALSPEC2: NIRSpec MSA imprint subtraction and flat fields
  - CALIMAGE3: self-calibration
  - CALCORON3: PSF library, background matching, ancillary science products
  - CALAMI3: image reconstruction
  - CALSPEC3: self-calibration, optimal extraction

Commissioning

- Soon after launch the spacecraft is controlled from the MOC at STScI
- Deployments will occur during the first 3 weeks after launch
- Cooldown of JWST will take an additional 2.5 weeks.
- OTE commissioning will take almost 3 months (see earlier video)
- Commissioning of the science instruments will start 4 months after launch and is completed in 1.5 months.
- 0.5 months are held on reserve to the nominal start of Cycle 1 science in April 2019



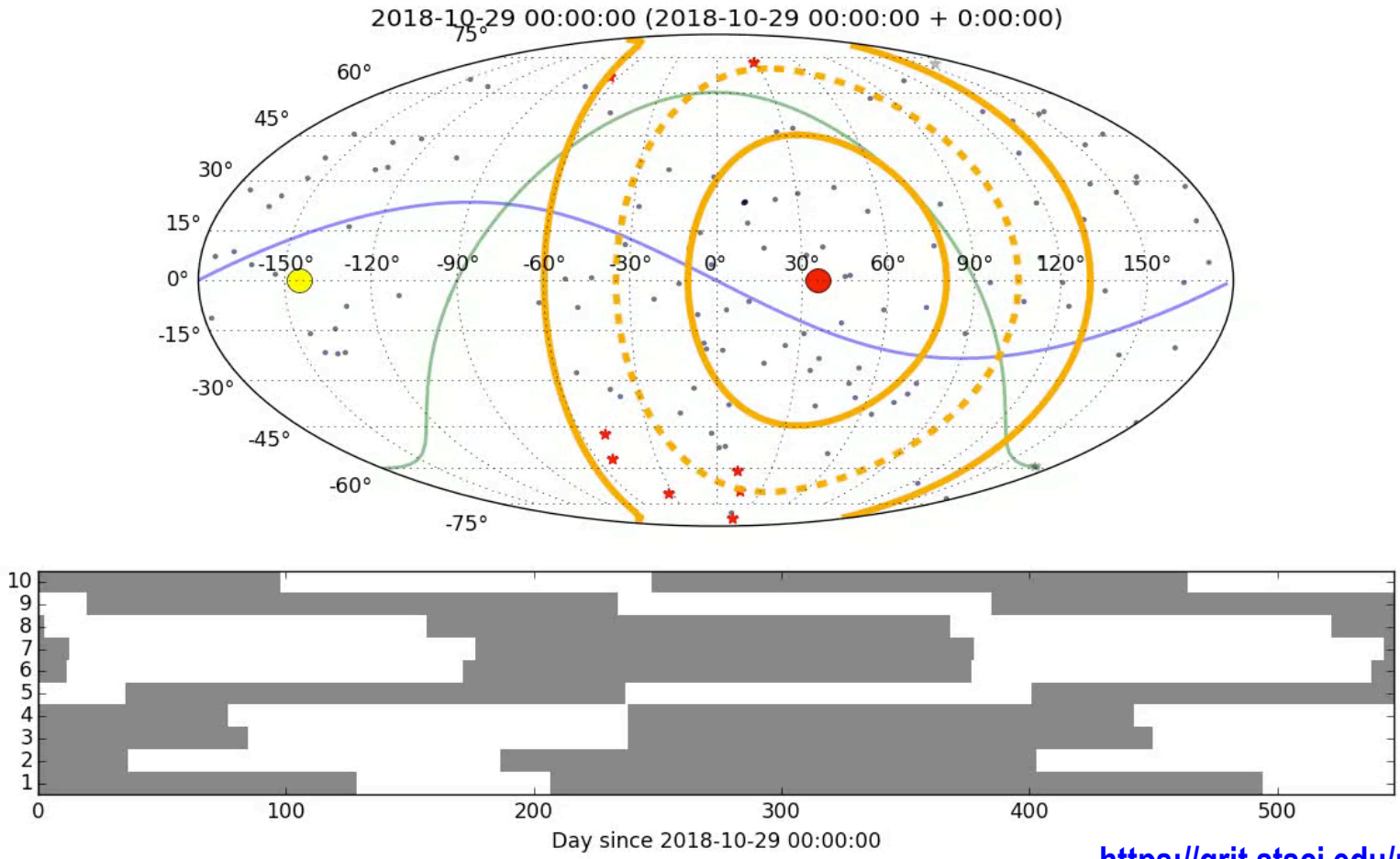
Commissioning

- 6 months process including deployments, cooldown, OTE alignment, verification of the instruments functionality
- Obtaining an-orbit calibration data is not a goal of commissioning.
  - One should expect that the first observers receiving data in Cycle 1 will have only ground-cal available

Commissioning

OTE Commissioning activity proposal implementation

- Began work producing flight-ready APT programs for all commissioning activities
- Early commissioning target selection of isolated bright stars, with candidates being screened via database checks and survey archive images.



https://grit.stsci.edu/ntz/jwstvz

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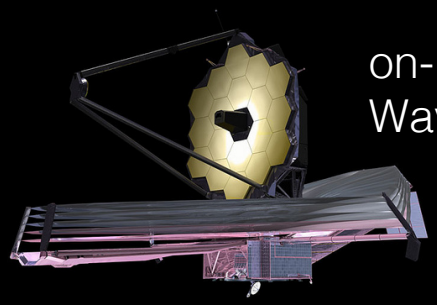

on-board scripts (OSS)
Wavefront sensing (WFSC)

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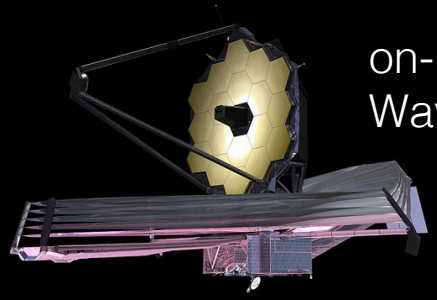
Calibration proposals

Content of Cycle 1 calibration will be informed by approved proposals but will be carried out throughout the cycle

Operations Scheduling



on-board scripts (OSS)
Wavefront sensing (WFSC)

Approved proposals will include TOO with 2-days activation

Flight Operations

FOS

DMS

Orbit maintenance

Wavefront maintenance

Data Processing and User Tools

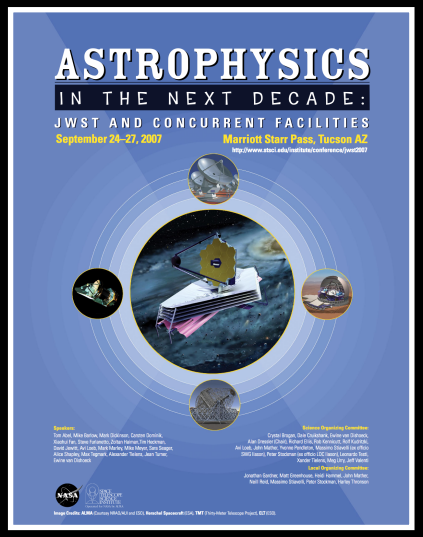
Data Archiving

We expect orbit maintenance burns every 21 days and the need to adjust the OTE at a similar cadence. Wavefront is sensed every 2 days.

What's next?

- We are planning to complete all development and testing needed to support launch in October 2017 (one year ahead of launch).
- The remaining year is available for contingency, improvements in software usability and algorithms, and developing additional capabilities requested after our scheduled was baselined.
- Developments occurring after October 2017 will likely not be available for Cycle 1 but this depends on the specific subsystem and on various factors. The safe assumption is to assume that they will be ready for Cycle 2.

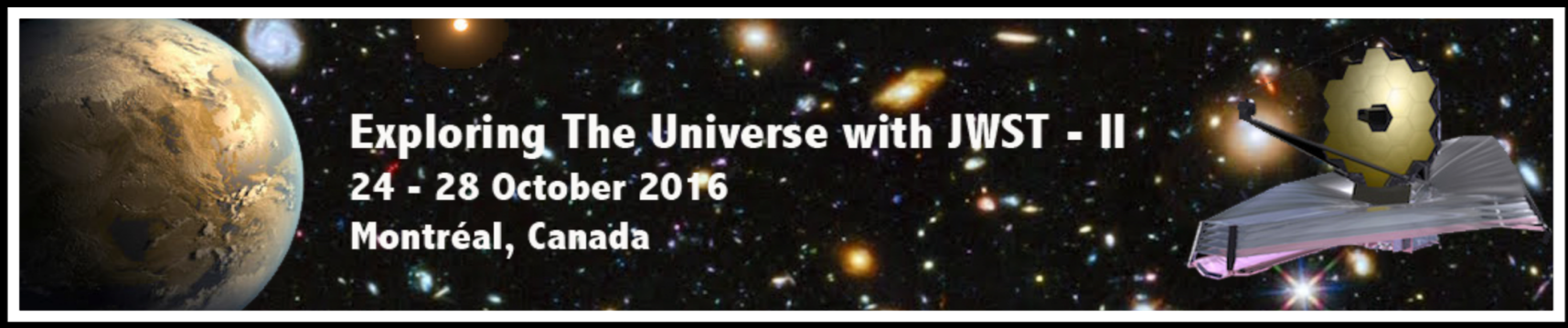
Oct 2016: Exploring the Universe with JWST II



Sept 2007 (Tucson)

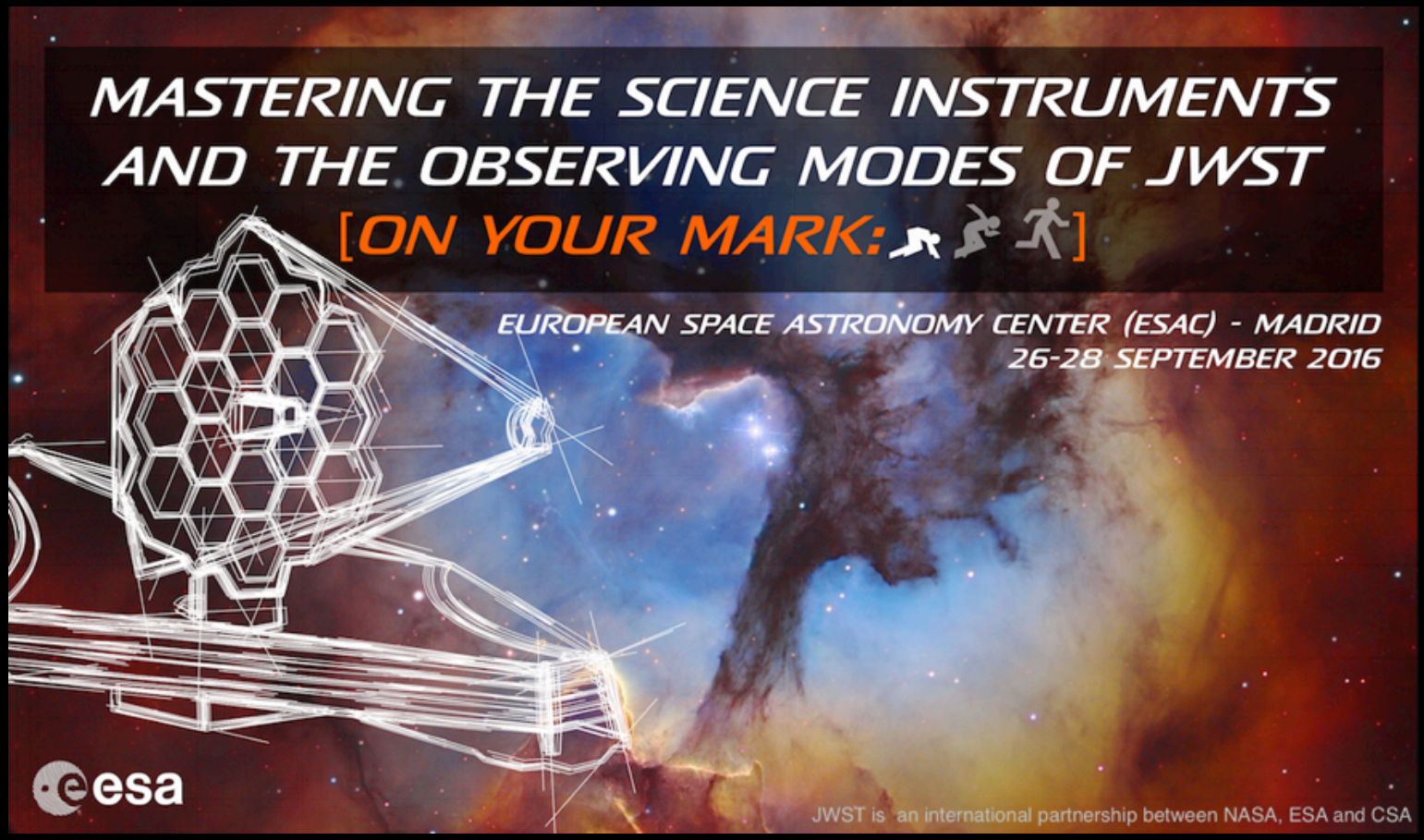
Jun 2011 (STScI)

Oct 2015 (ESTEC)



Coming this Fall - http://craq-astro.ca/jwst2016/

ESAC 2016 JWST Workshop



September 26-28th, 2016 @ ESAC Madrid
Website coming soon!

Science with the Hubble and James Webb Space Telescopes

March 20-24th, 2017 @ Venice
Website coming soon!

Upcoming JWST Science Meetings and Preparation Workshops

Major International Science Conferences (~Annually)

October 24-28, 2016 in Montreal; Exploring the Universe with JWST II
March 20-24, 2017 in Venice; HST + JWST Conference

Topical Science Meetings

2-3 day workshops on major JWST science themes will be organized at STScI throughout 2016-2018
- meetings will include a component to introduce users to software and systems

User Training

September 26-28, ESAC, Madrid: Mastering the science instruments and the observing modes of JWST
Annual workshops at STScI and AAS on JWST data analysis tools - next November 8-11, 2016.
2017 - workshops on JWST planning tools (ETCs, simulators)
2017-2018 - workshops on APT, single stream, documentation
Annual workshops in Europe on JWST capabilities, proposal tools, and data analysis tools

JWST "Community Days" (Coming Soon)

Open call to US institutions to host hands-on JWST 1-2 workshops (w/ optional science meeting)
- ERS program planning, JWST modes and flight capabilities, observing techniques, etc.

***All meeting/workshops at STScI will have significant remote connectivity**