STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

JWST Science & Operations Center

Nikole K. Lewis

September 14th, 2017

STScI S&OC Operations Flow

Proposal Preparation

Proposal Planning Subsystem (PPS)

Proposal Selection

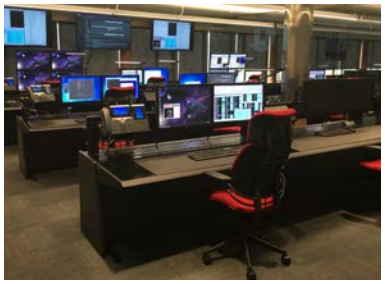
Science Planning

Operations Scheduling

Flight Operations

Data Processing and User Tools

Data Archiving



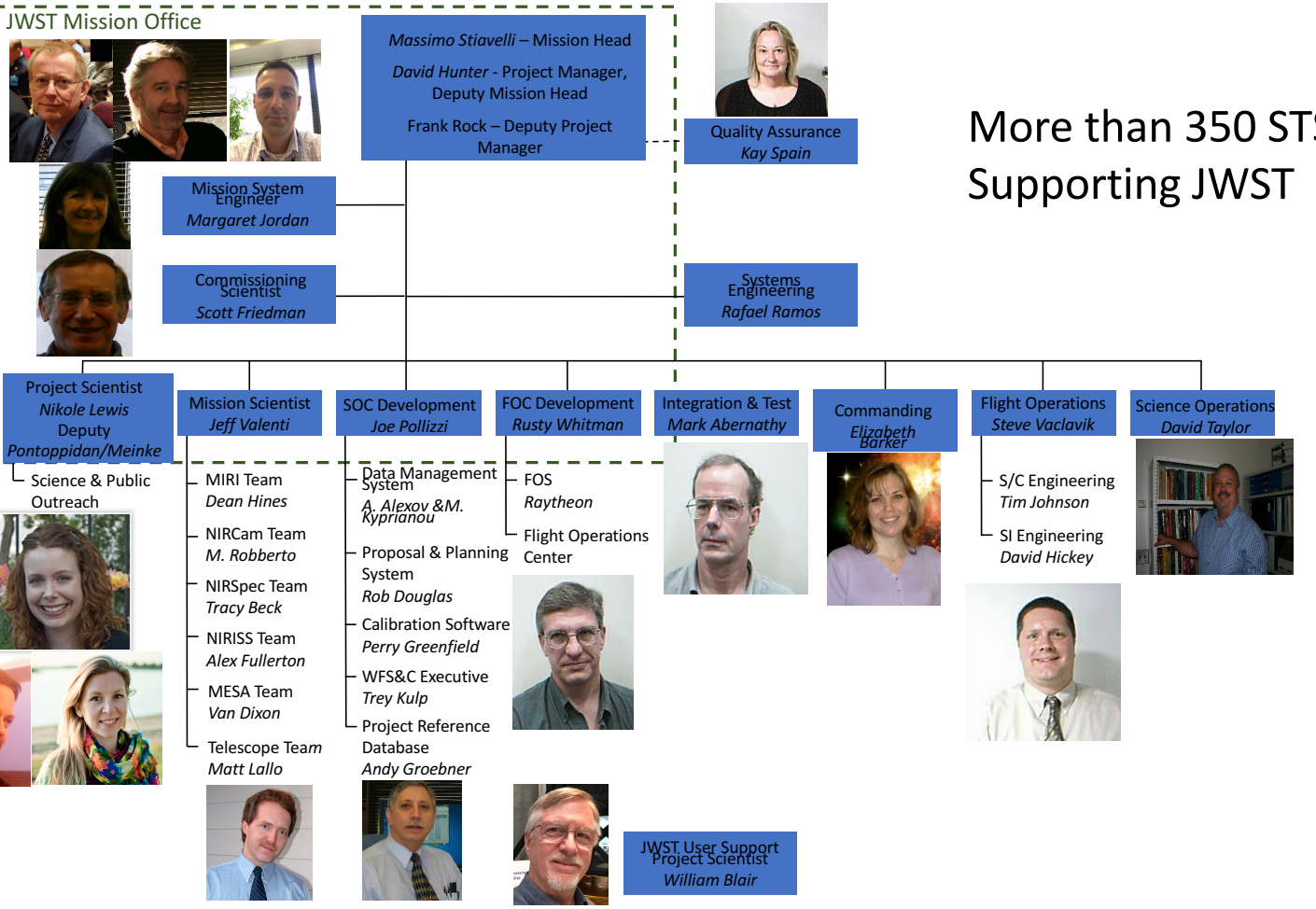
On-Board Script Subsystem (OSS)
Wavefront Sensing & Control (WFSC)

Flight Operations Subsystem (FOS)

Data Management Subsystem (DMS)

Science Community and Public Outreach

STScI JWST Mission Organization



More than 350 STScI Staff Supporting JWST

STScI Systems & Science Systems Engineering

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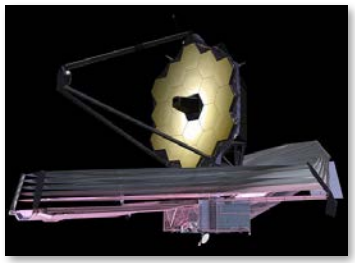


Operations Scripts Subsystems (OSS)

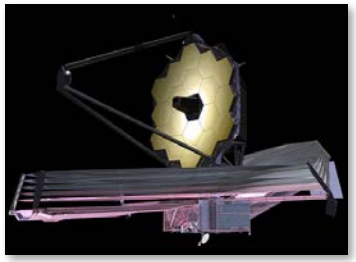
Overarching Subsystems
Project Reference Database Subsystem (PRDS)

Other Subsystems
Grants Management Subsystem (GMS)

Riccardo Giacconi –

"… the purpose of building Hubble had to do with the study of our Universe. For this reason we had developed a methodology which we called a science systems engineering approach to guide us in developing the necessary hardware and software tools to carry out our operations from end to end."

Proposal Planning Subsystem



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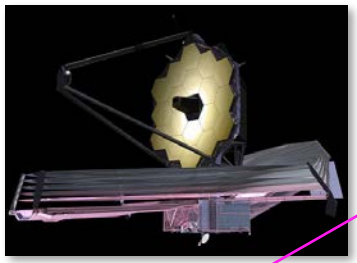
Data Management Subsystem (DMS)

The Proposal and Planning Subsystem
- Provides tools for preparing proposals
- Schedules when to best execute proposals
- Builds the visits and creates the Operations Plan to upload to the Observatory

Operations Script Subsystem



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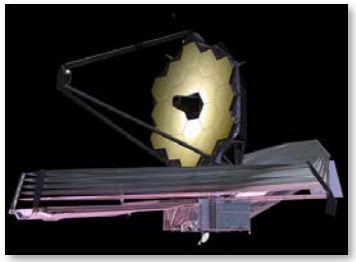
The On-Board Scripts execute the Operation Plan
- Coordinate the low level on-board operations
- Event-driven methodology

Project Reference Data Subsystem



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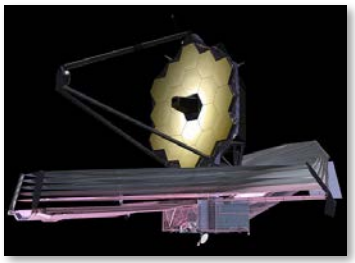
The Project Reference Database is the repository of configuration-controlled data for the observatory operation

Flight Operations Subsystem



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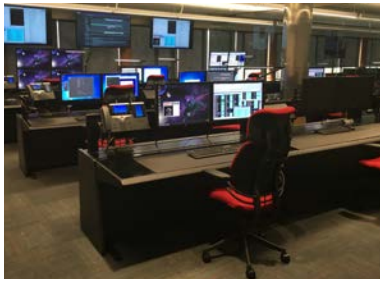
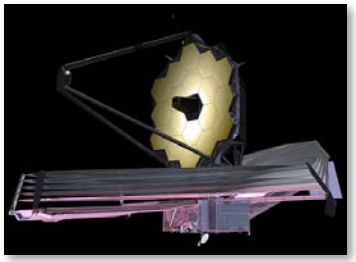


The Flight Operations Subsystem controls all communications with the spacecraft, uploads commands, observations plans and associated data, downloads telemetry and science data

WaveFront Software Subsystem



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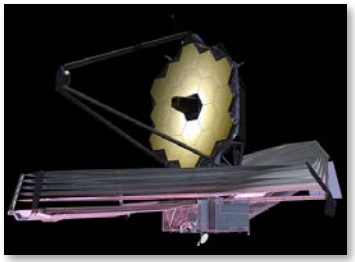
The Wavefront Sensing and Control Software is used to monitor the JWST mirror and to periodically adjust its shape

The subsystem incorporates software developed by STScI with software developed by Ball

Data Management Subsystem



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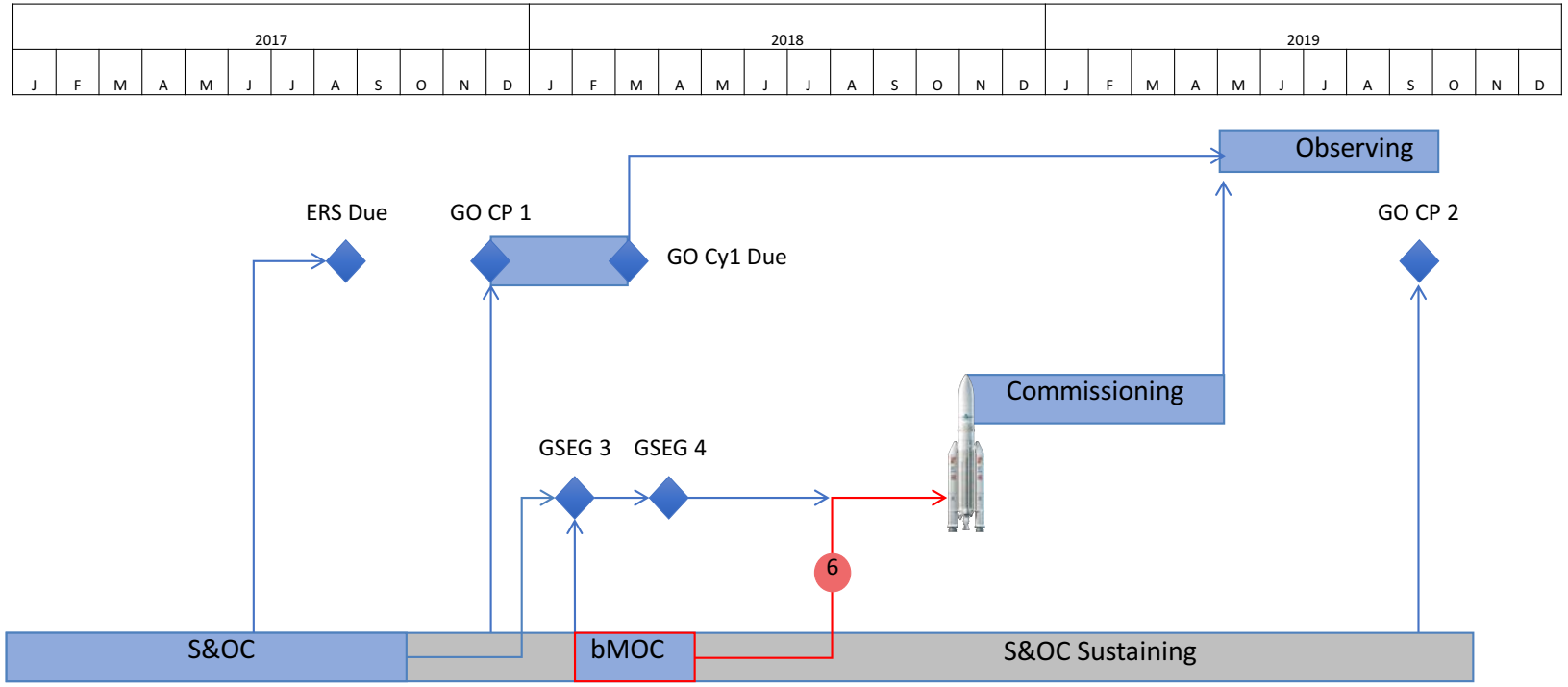
Data Management Subsystem (DMS)

The Data Management Subsystem
- Organizes and formats the down-linked data
- Processes and calibrates data to generate the science products
- Archives the data
- Distributes the data to PIs and to the community once they become public
- Provides tools to assist with analysis of the data

JWST S&OC Simplified schedule



k months of funded critical path schedule reserve

S&OC Subsystems 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)	7*	December 2016	June 2017	Completed I&T	89%	80%
	7.1	November 2017	February 2018	In Development		
Proposal Planning Subsystem (PPS)	14*	December 2016	June 2017	Completed I&T	97%	91%
	14.1	June 2017	December 2017	Completed Development		
	14.2	October 2017	January 2018	In Development		
Wavefront Sensing & Control (WFS&C) Software Subsystem	6.1*, **	September 2017	February 2018	In Development	97%	97%
Flight Operations Subsystem (FOS)	6.1*	November 2017	December 2017	In Development	83%	80%
Operations Scripts Subsystem (OSS)	6	March 2017	November 2017	In Level 2 Certification Testing	73% Level 2 certified	58% Level 3 certified
	7*	October 2017	March 2018	In Development		
Project Reference Database Subsystem (PRDS)	4.13	April 2017	April 2017		100%	100%
	4.14*	May 2017	May 2017	Latest Sustaining Engineering Release		

*Supports Launch

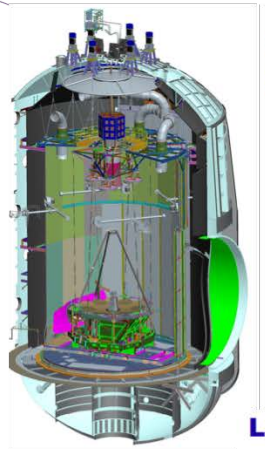
** Reflects the addition of 5 new approved Cryo-Cooler Tuning requirements

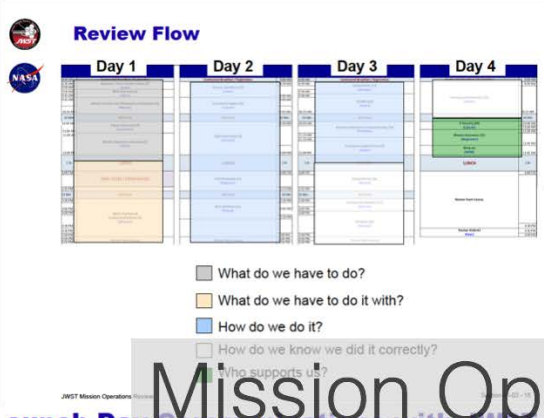
S&OC FY17 Milestones

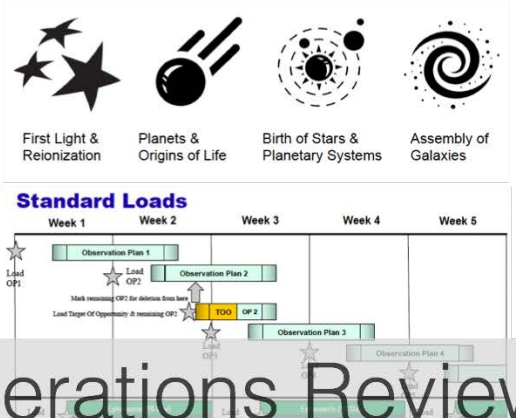
- Science & Operations Center Release 1 (due November 2016)*
- PPS build 14 supporting launch (due January 2017)
- WFS&C build 6 supporting launch (due February 2017)*
- FOS build 6 supporting pre-launch (due March 2017)*
- GSEG1 testing communications and data handling (due July 2017)
- Mission Operations Review (due May 2017)
- OSS build 6 supporting launch (due June 2017)*
- Call for Proposal Early Release Science (due June 2017)
- FOT Ops readiness exercise 2 (due July 2017)

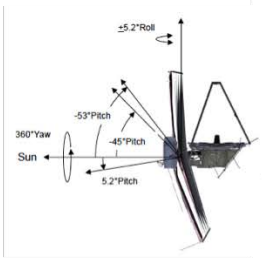
* Completed early

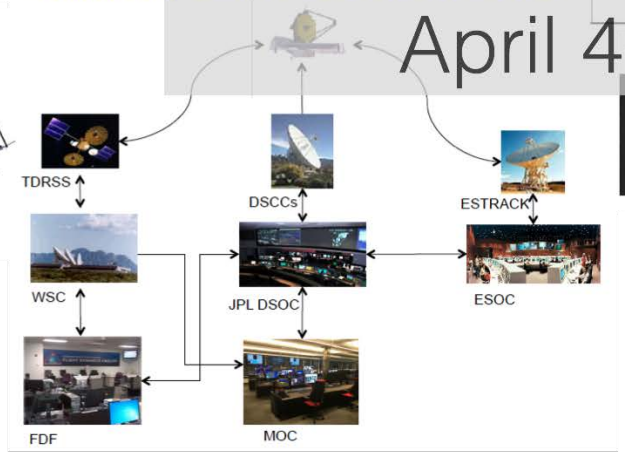
Mission Operations Review

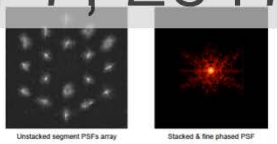


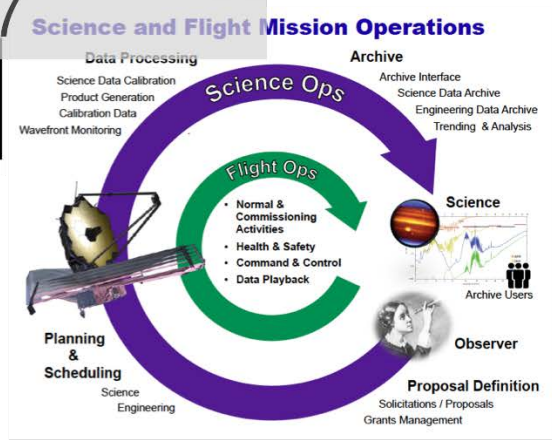






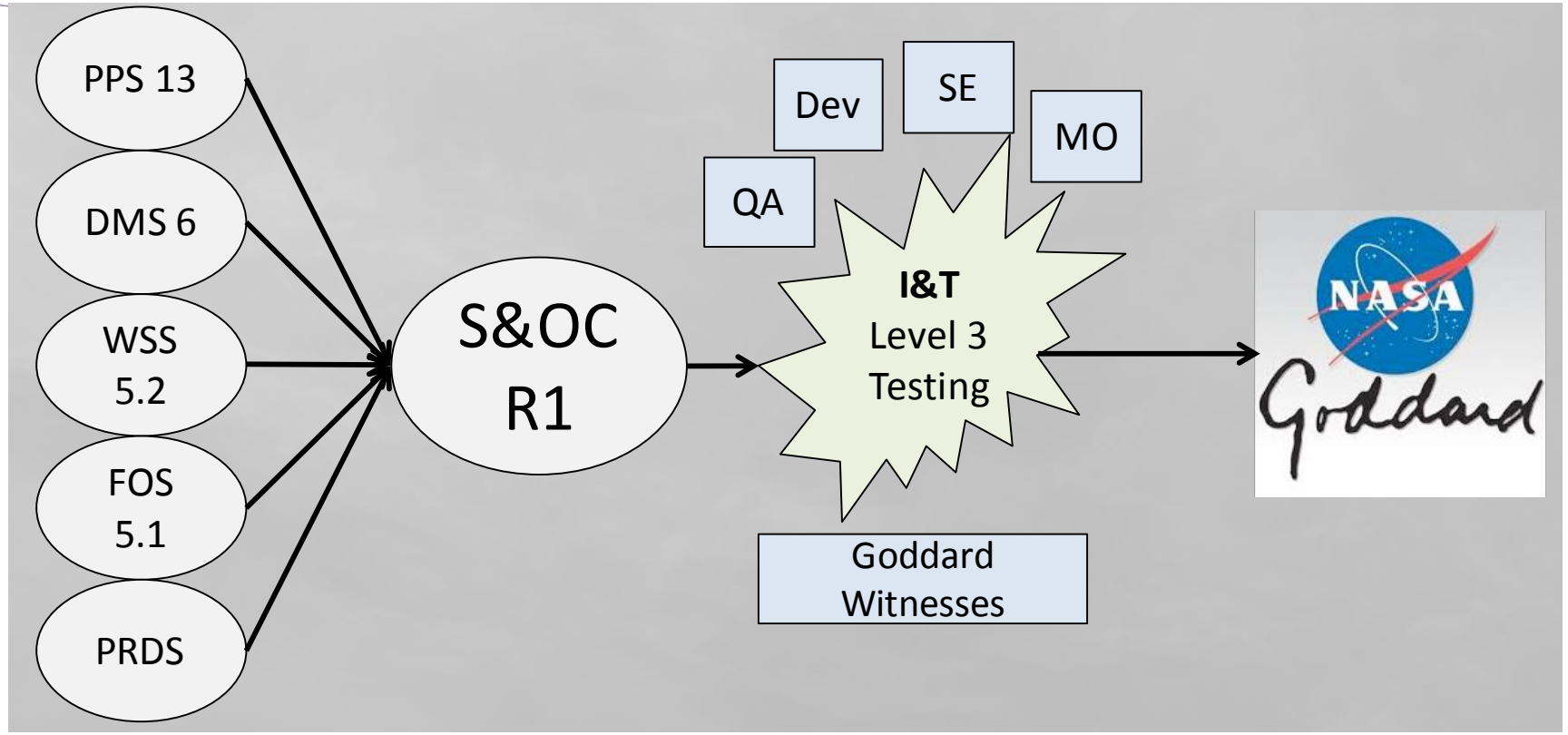






Mission Operations Review
April 4-7, 2017

S&OC Release 1



Recent End-to-End Testing with Observatory Test Bed (OTB) Simulator Approaching Readiness for JWST Launch

Subsystem Highlights

Flight Operations System

- Build 6 being used for Operational Readiness Tests, GSEG tests, and tests with the Engineering Model Test Bed and the Observatory Test Bed
- Backup Mission Operations Center is in development and has completed factory qualification testing at Raytheon
- Successfully tested Flight Operations Subsystem communication from STScI to JWST spacecraft at Northrop Grumman over ground network and Deep Space Network and space network RF link

Proposal and Planning System

- APT v25.1 and ETC v1.1 (from PPS 14.1) made available on June 1 to the GTO's and DD ERS proposers for preparing and submitting their proposals
- Focus on completing support for updated timing models, dithered and other associated observations, and performance
- Build 14.2 slated for November 2017 – to close off remaining functionality and to support GO's with their proposal preparation

WFS&C Software Subsystem

- Build 6 supported OTIS Center of Curvature tests at GSFC
- Support OTIS testing at JSC

Subsystem Highlights

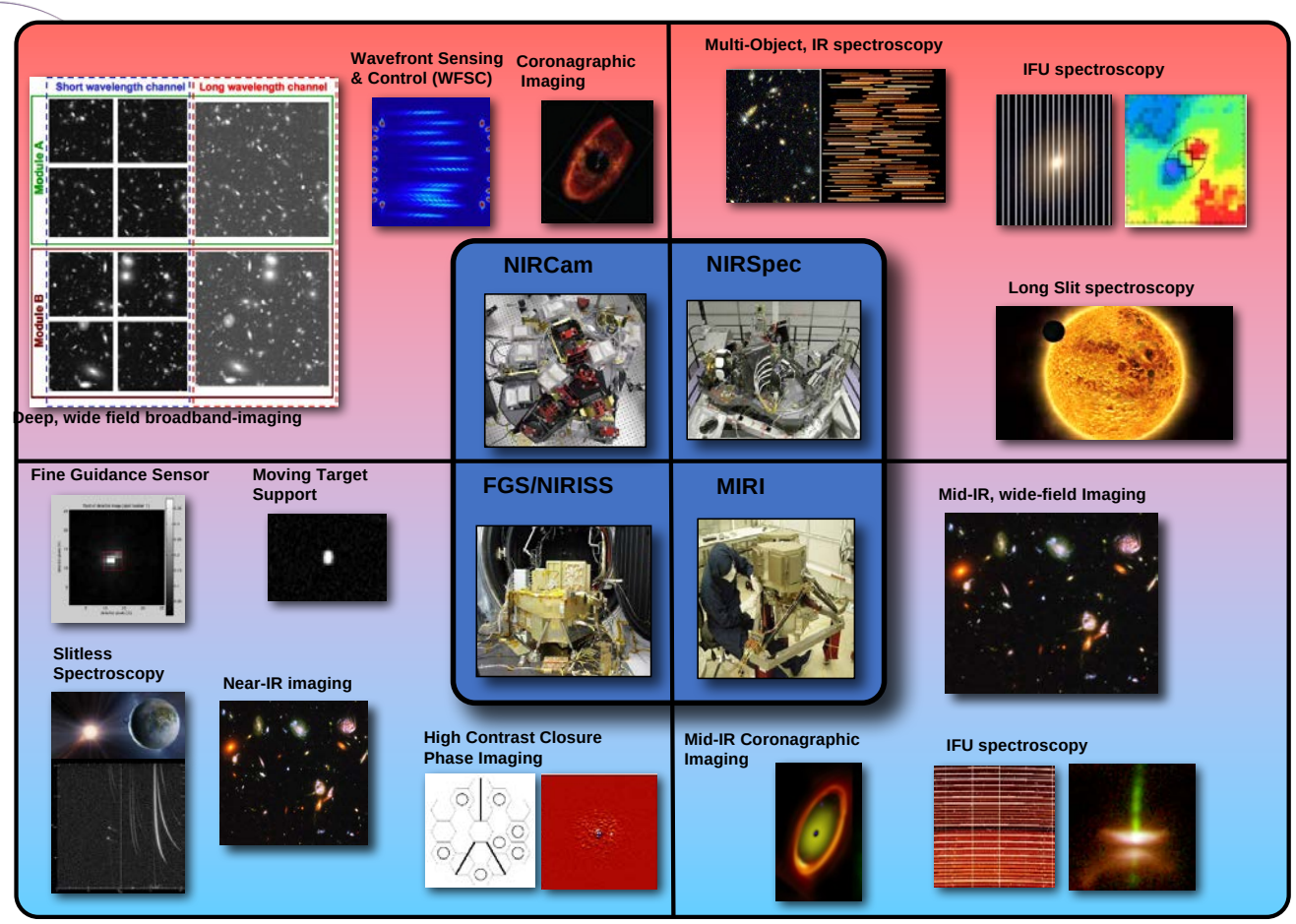
Data Management Subsystem

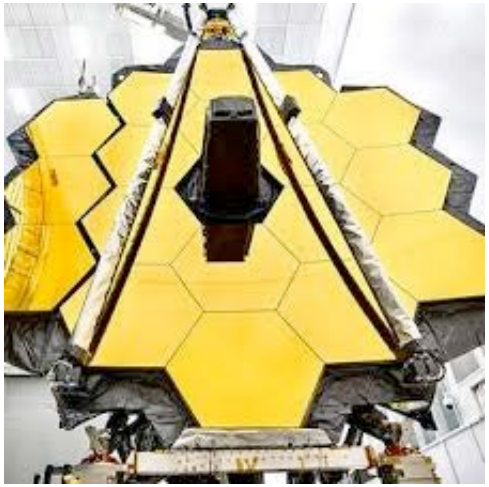
- Build 6 will be used to process data taken from OTIS/JSC testing
- Build 7.1 (due November 2017) will add additional level 3 data processing and archive distribution support
- Challenge is acquiring flight like data to validate testing DMS

Operations Script Subsystem

- Build 5 is being used with OTIS/JSC testing
- Build 6 (now in test) supports Target Acquisitions, dithering, and moving targets

STScI Instrument and Telescope Teams





Telescope/Optics Support

Optics team is composed of scientists & engineers experienced in design and control of optical systems, I&T of instrument and telescope optics, and in-flight maintenance of telescope optical performance

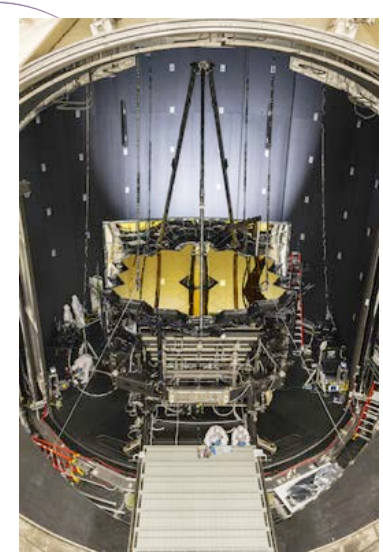
Progress:

- Providing optics expertise to development and testing of sub-systems
- Participating in development of hardware simulators for ground tests
- Participated in planning and staffing of ground tests for optics & instruments
- Finalizing plans for commissioning of the primary mirror segments

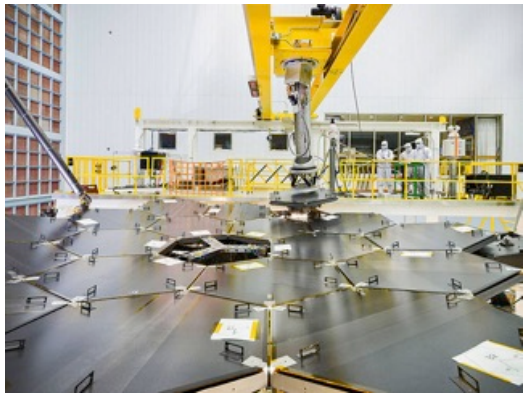
Work Remaining:

- Provide optics support to system development & ground tests
- Build additional experience required to support mission in flight

Telescope/Optics Support Highlights



JSC test chamber



Optics integration

- Most of the STScI Optics staff are participating in the JSC OTIS test as Test Conductors, subject matter experts, quick-look analyst and WSS operators
- Supported “Shadow mode” test in which the JSC data were processed by the WFS&C subsystem and operators in the MOC at STScI
- Generating flight-ready proposals for the OTE commissioning activities
- Assisting astronomy community members to plan coronagraphic observations
- Supported mirror control software tests and mirror environmental tests (End of 2016)

Science Instrument Support

Instrument scientists, engineers, and analysts with relevant expertise:

- Instrument development, commissioning, operations, and calibration.
- Astronomical observations, data analysis, and scientific research.

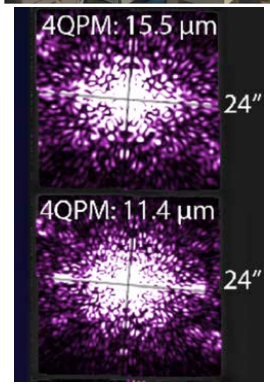
Accomplishments:

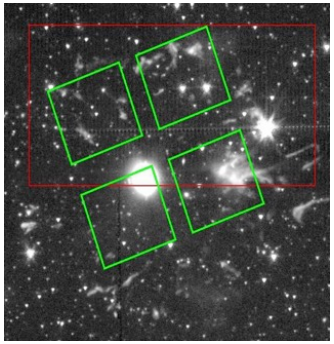
- Supported successful instrument and observatory ground tests.
- Supported development of science and operations center software systems.
- Generated or gathered calibration reference data to support launch.
- Provided documentation, training, and support for user community.

Remaining Tasks (as planned):

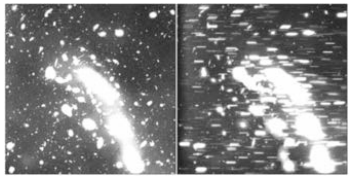
- Validate flight build of science and operations center software systems.
- Finalize commissioning program and in-flight calibration plan.
- Provide user support for Cycle 1 proposal process.
- Perform technical reviews of approved observing programs.
- Complete development of core set of data analysis tools.

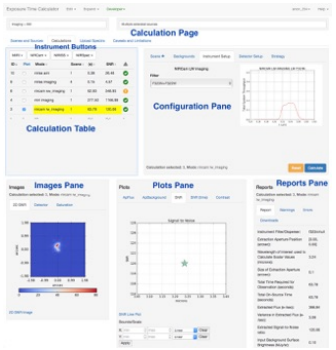
Science Instrument Support Highlights

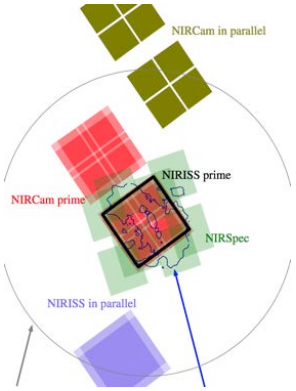




- Measured detector characteristics and performance in detector lab.
- Developed observing strategies for high-precision modes, e.g., exoplanet transits and coronagraphy.
- Gathered necessary calibration data with other observatories.
- Specified algorithms for data calibration pipeline.
- Developed innovative 3D exposure time calculator.
- Specified observing templates for parallel observations with multiple instruments.







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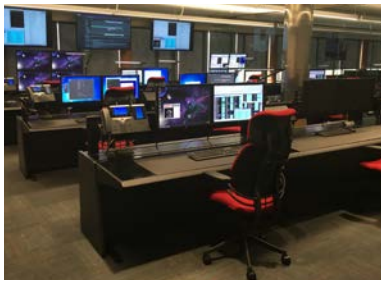

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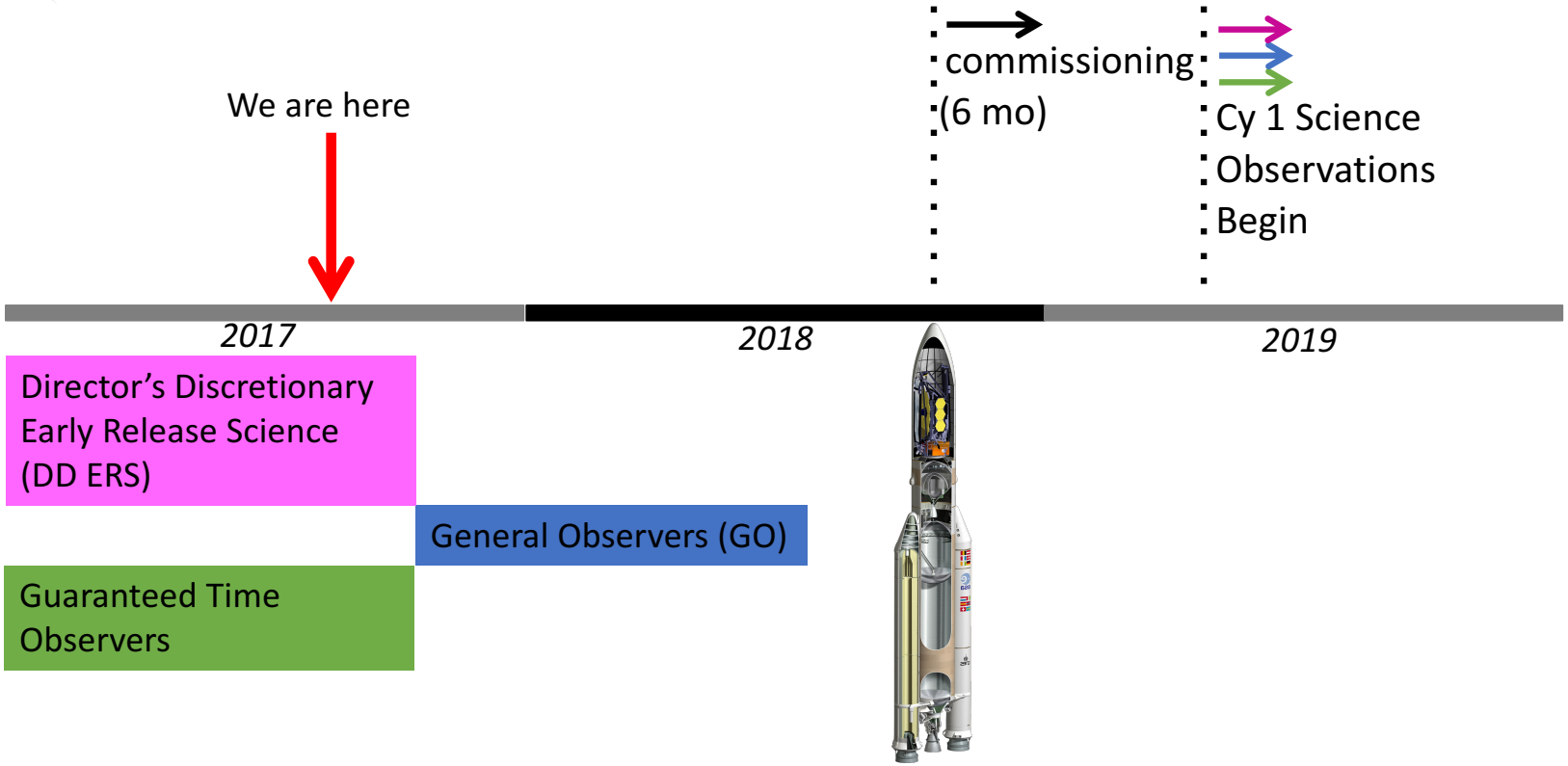
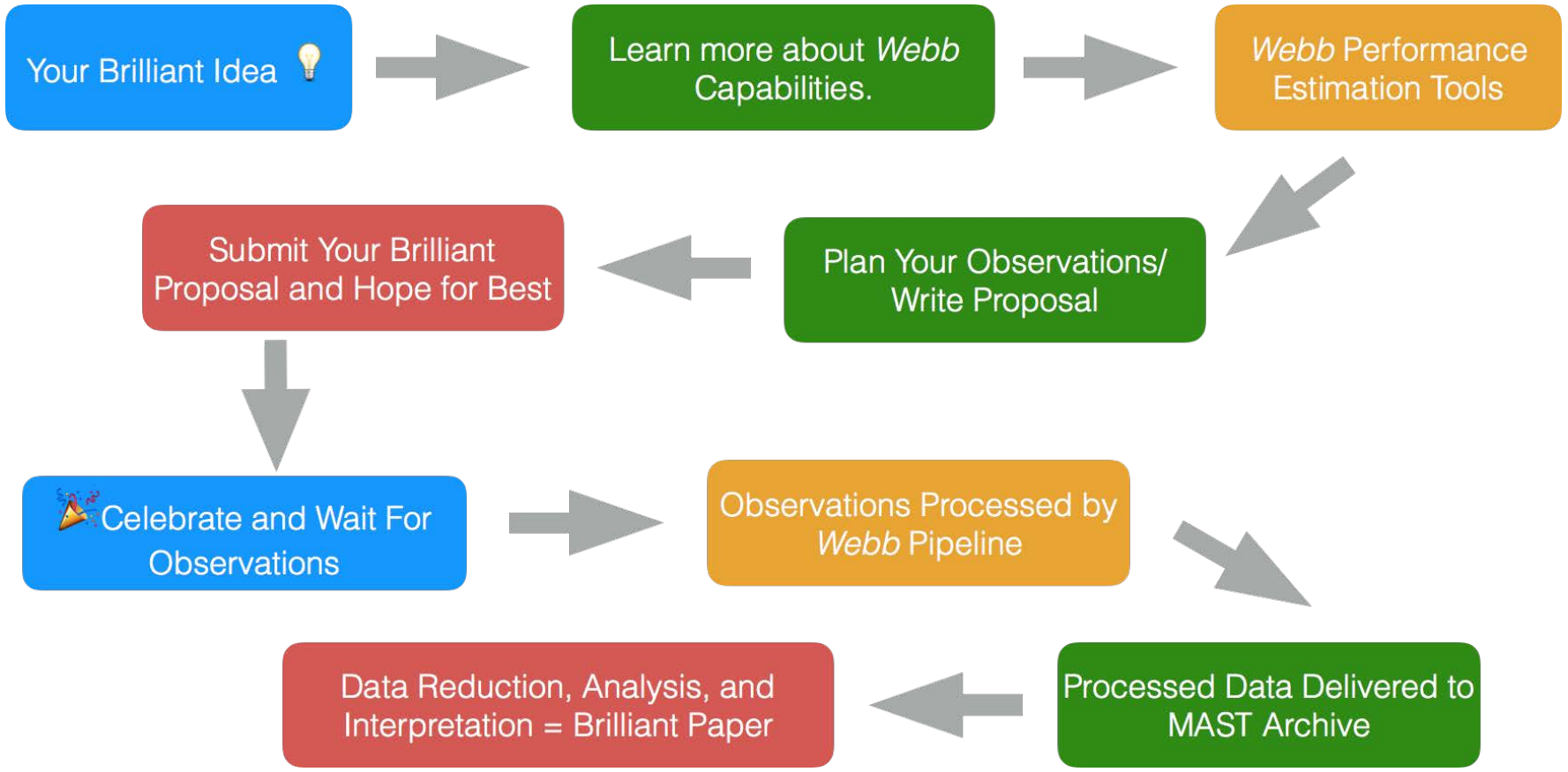
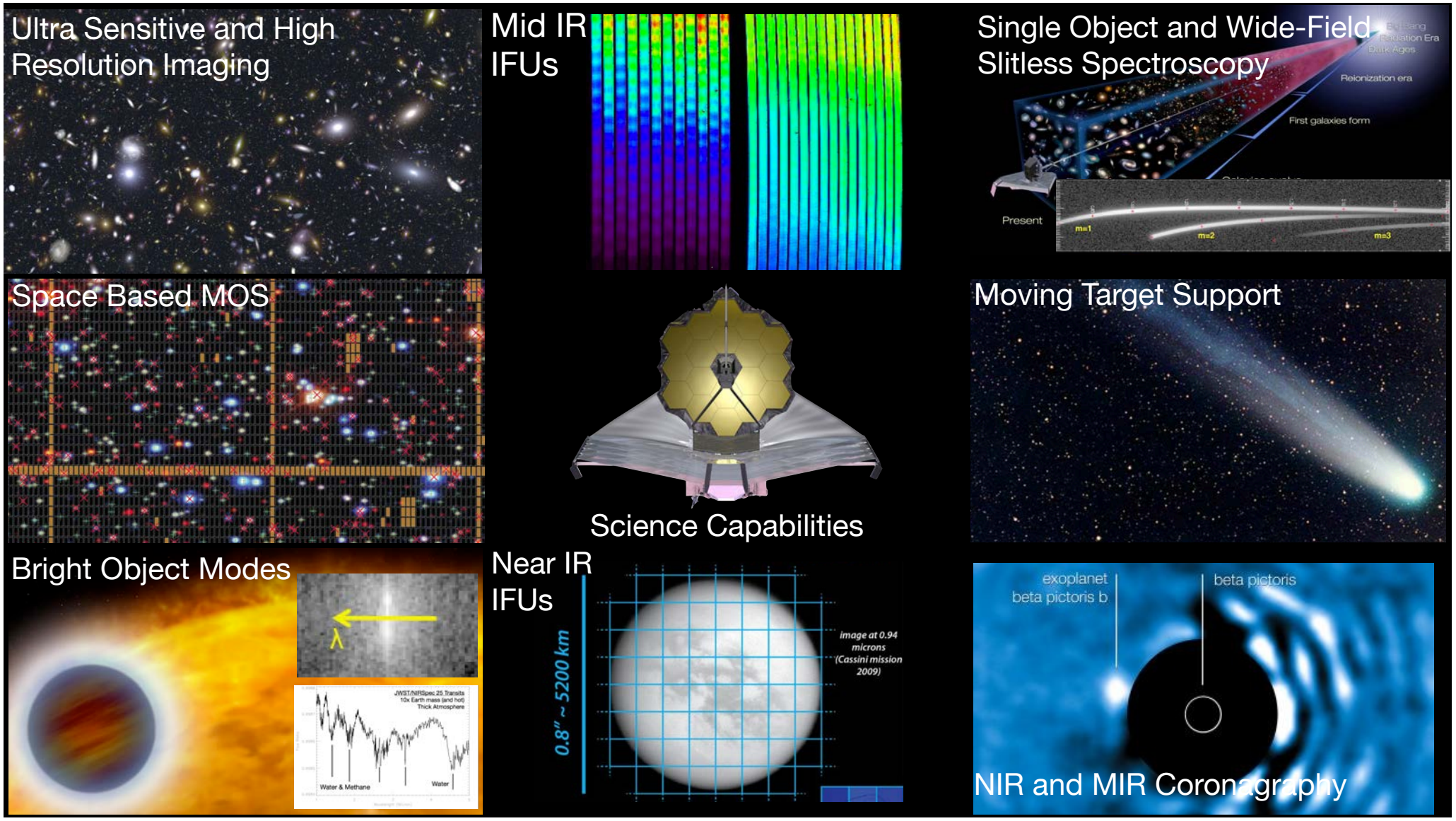
JWST Science Timeline



Life-cycle of your observations with *Webb*




Ultra Sensitive and High Resolution Imaging
Mid IR IFUs
Single Object and Wide-Field Slitless Spectroscopy
Reionization era
First galaxies form
Present
m=1
m=2
m=3
Space Based MOS
Moving Target Support
Science Capabilities
Bright Object Modes
λ
JWST/NIRSpec 25 Transits
10x Earth mass (and hot)
Thick Atmosphere
Water & Methane
Water
Near IR IFUs
0.8" ~ 5200 km
image at 0.94 microns (Cassini mission 2009)
exoplanet beta pictoris b
beta pictoris
NIR and MIR Coronagraphy

JWST Documentation (JDox)

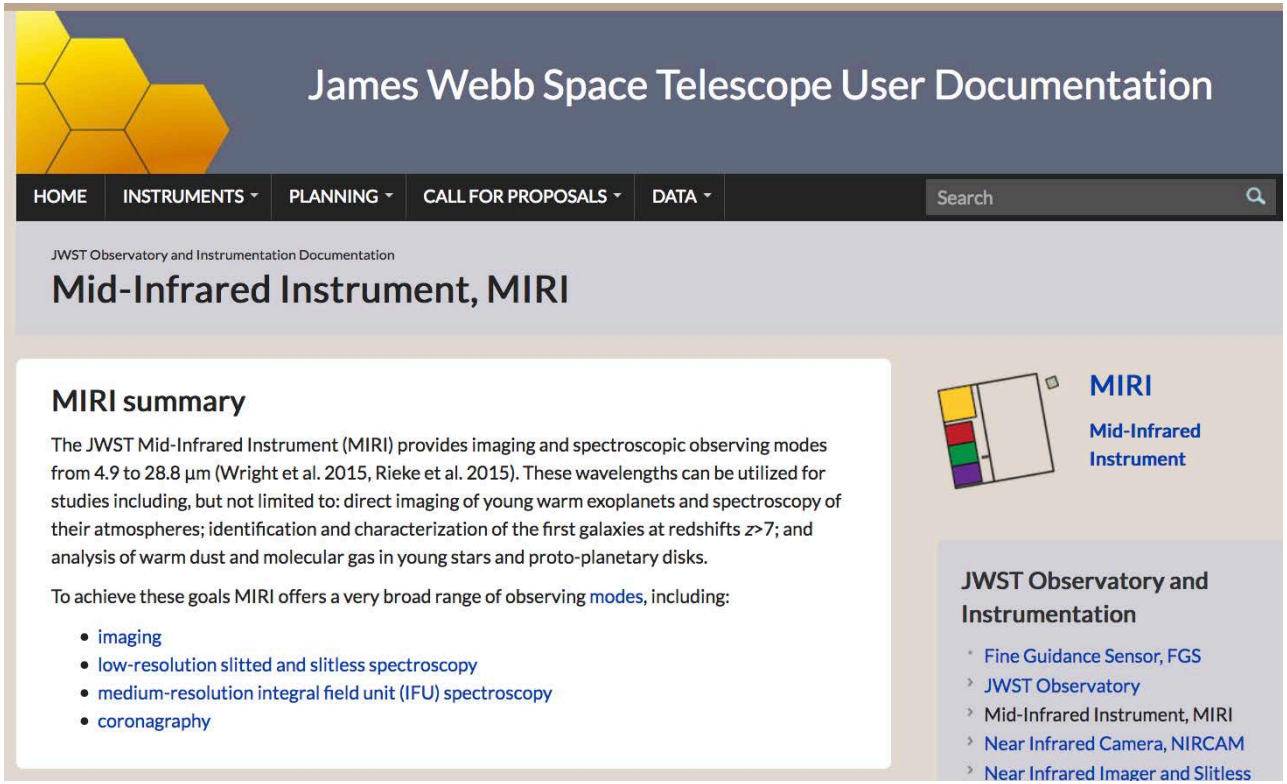
A New Paradigm for JWST User Documentation

New documentation system: “Every page is page one”
- Short articles
- Self-contained, one-level information
- Hyperlinked network rather than monolithic handbook

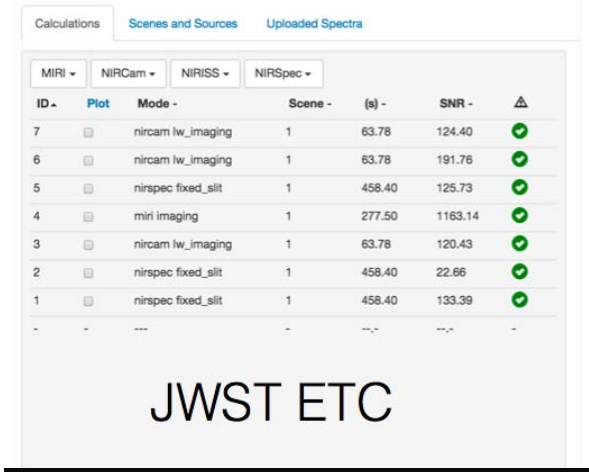
Think Wikipedia (but it’s not a wiki)

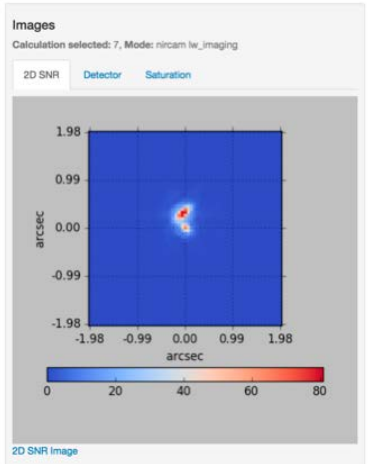
Multiple conceptual spaces: Background articles, planning cookbooks, science policy, engineering specs

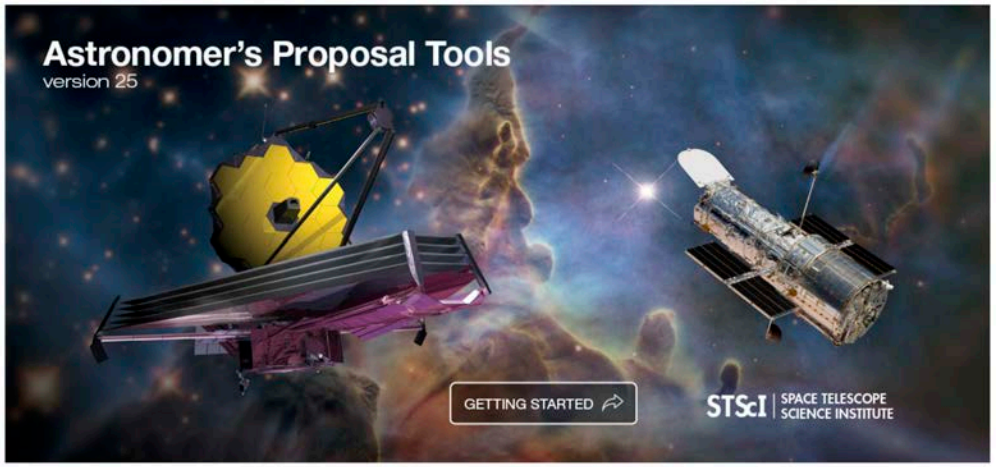
Incremental releases (as articles are written and reviewed), beginning with instruments, APT, ETC articles



JWST Proposal Planning Tools

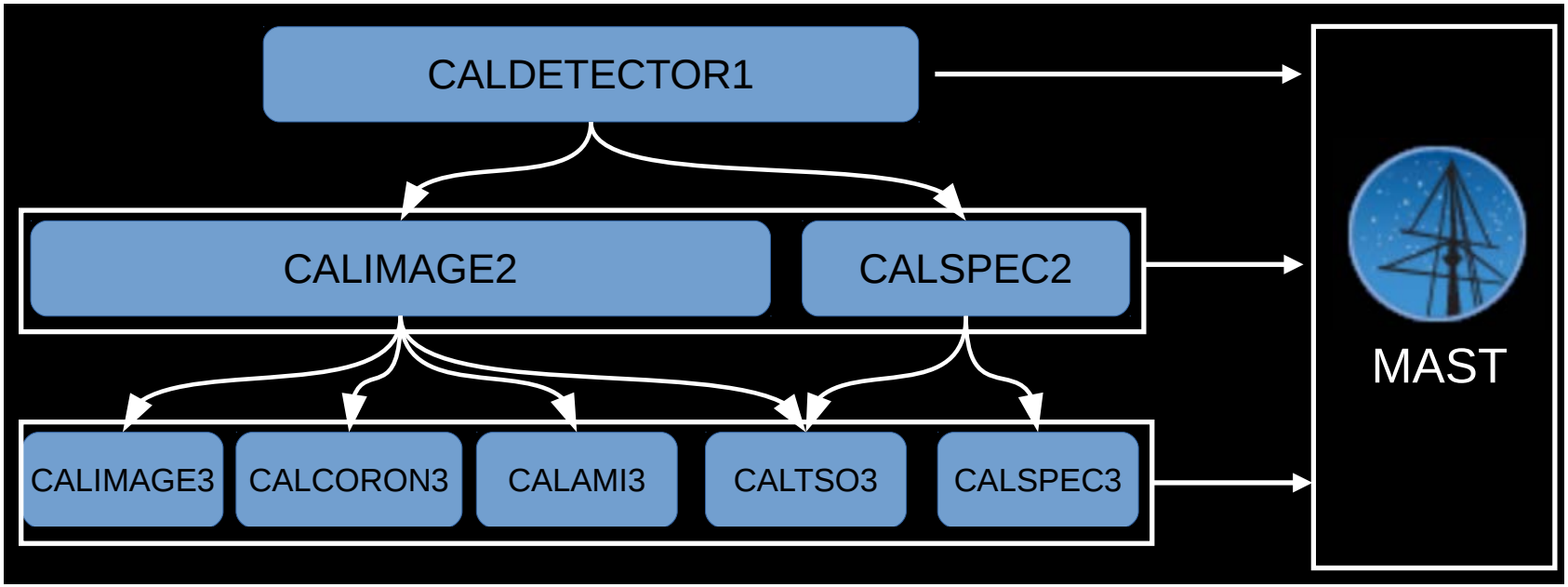






And Much More!

The *Webb* Pipeline Architecture



Written in python, based on astropy

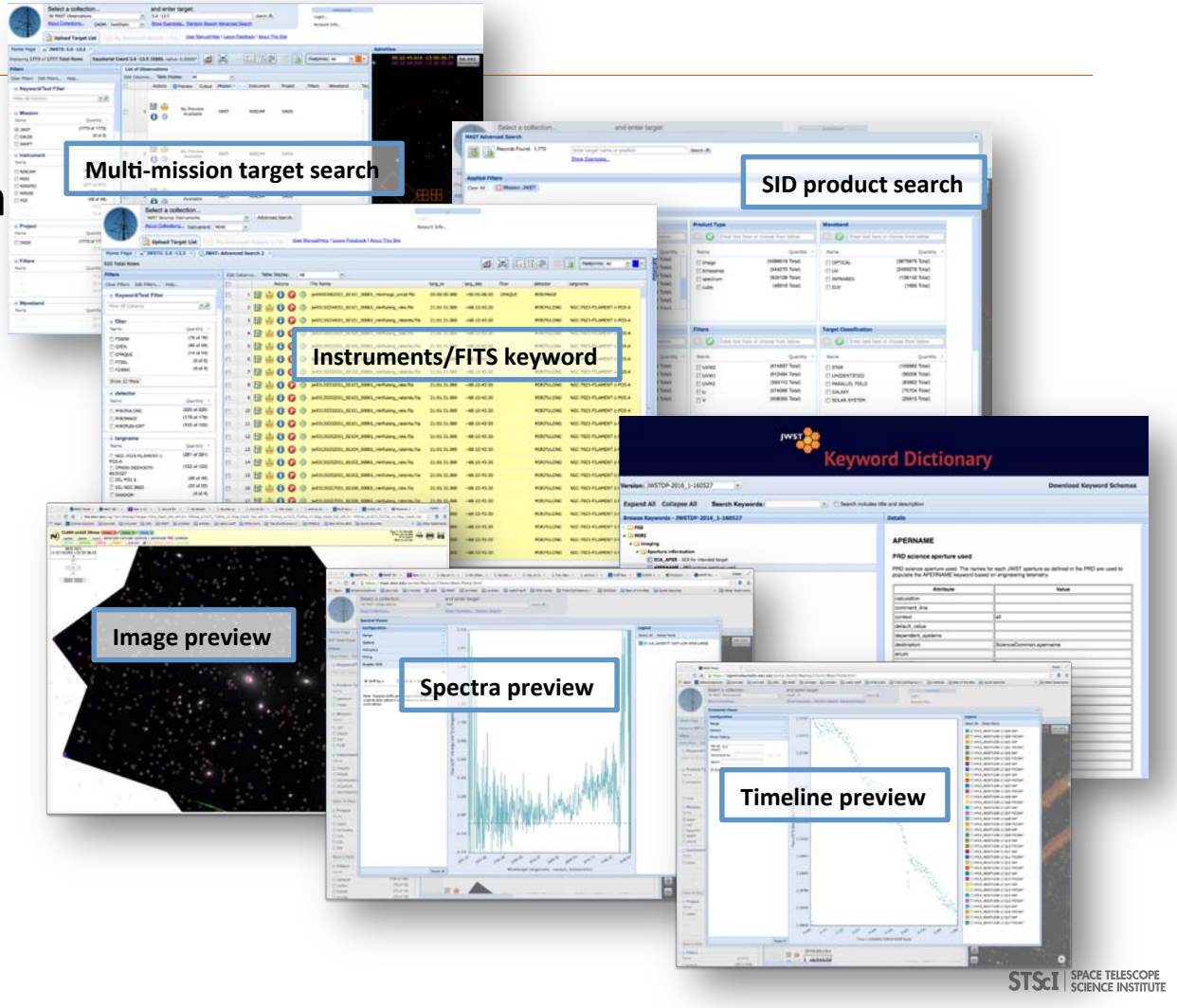
Users can replace specific modules

Will be freely available (github)

Users can rerun all or part of pipeline

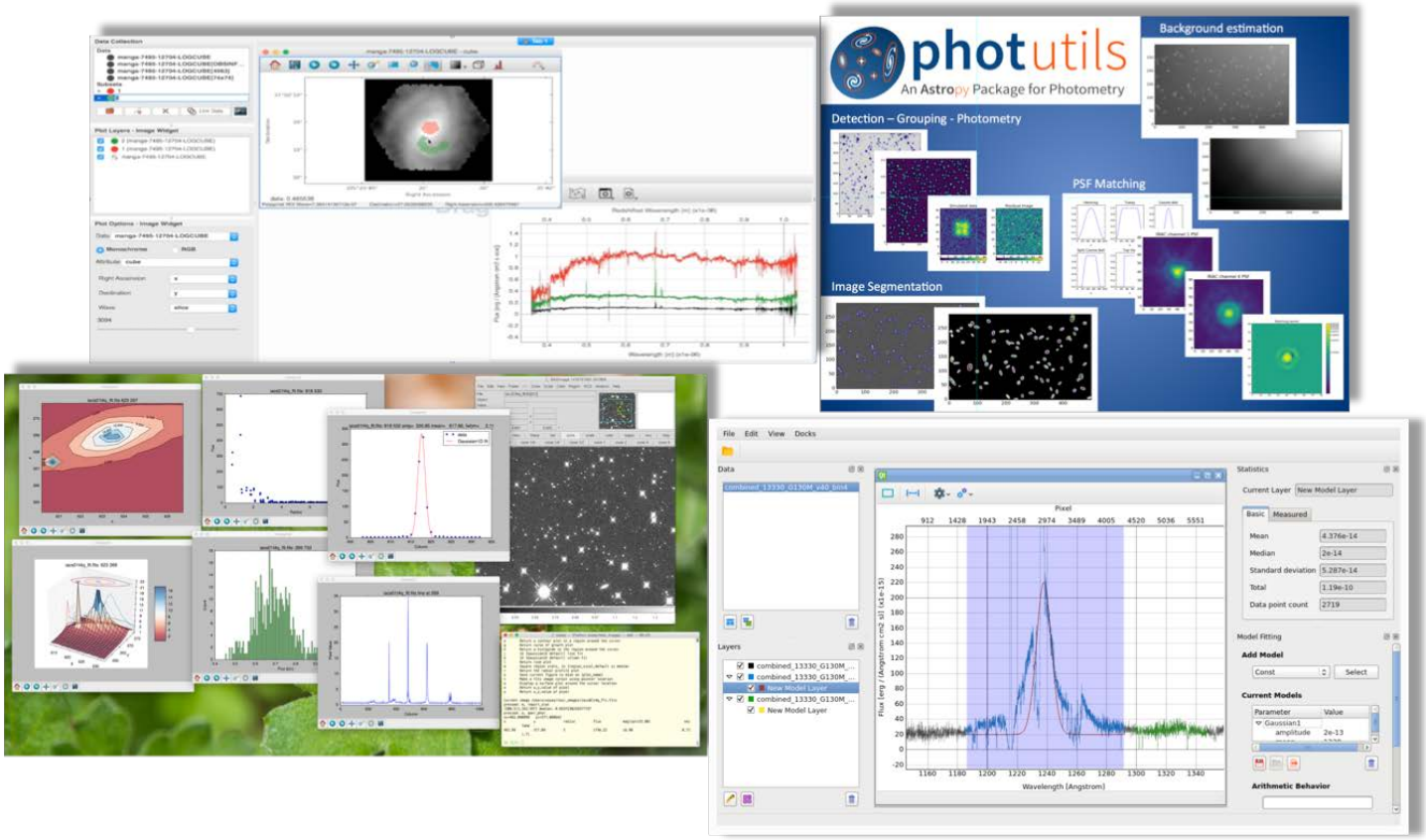
The MAST Archive

- Common Archive Observation Model (CAOM)
- JWST-specific views
- Distribution (URL & Curl-scripts)
- Subscription Service
- High Level Science Products (HLSP)
- Digital Object Identifier (DOI): Linking Data to Papers



JWST Data Analysis Tools

- Flexible, Modular tools
- In Python
- Supporting JWST data structures
- Simple installation



STScI S&OC Operations Flow

Proposal Preparation

Proposal Planning Subsystem (PPS)

Proposal Selection

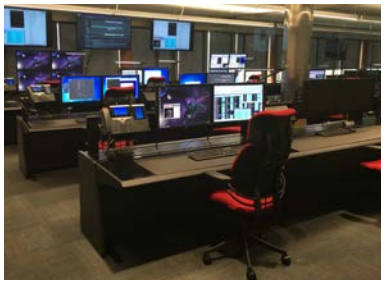
Science Planning

Operations Scheduling

Flight Operations

Data Processing and User Tools

Data Archiving



On-Board Script Subsystem (OSS)
Wavefront Sensing & Control (WFSC)

Flight Operations Subsystem (FOS)

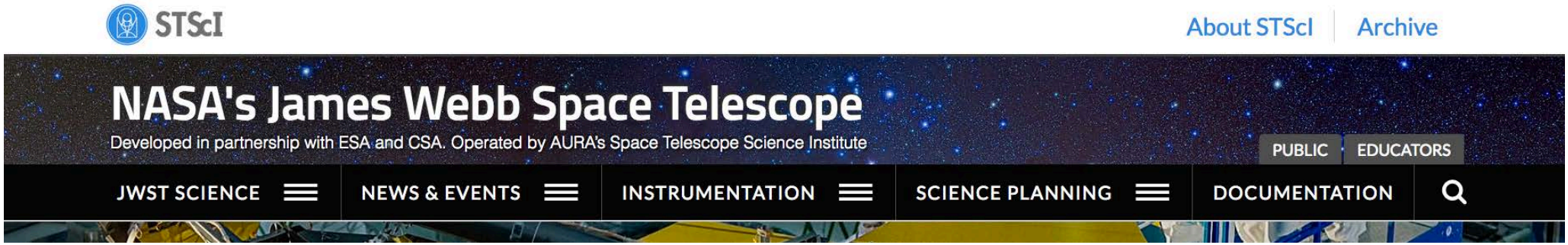
Data Management Subsystem (DMS)

Science Community and Public Outreach

JWST Astronomical Community Outreach

Activities include

- AAS support (winter+summer 2017)
  - JWST town hall, including release of user tools & DD ERS NOI call release
  - Hands-on workshops & ask-an-expert sessions
  - Meeting-in-a-meeting on GTO programs
- Series of data analysis + proposal planning workshops (STScI, Pasadena, Venice, ...)
- For Scientists Website (@JWSTObserver)
- Community lectures



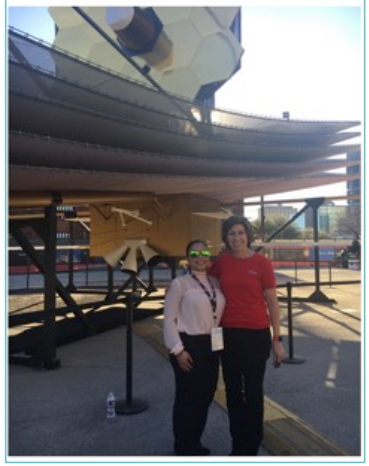
JWST Public Outreach

Emerging Tech to engage new audiences

Bmore VR exhibition
-virtually explore JWST at L2

STAR app – JWST model fully deployable!

Large Scale Exhibitions and Local Events:




EXPANDING THE FRONTIERS OF SPACE ASTRONOMY