More than 350 STScI Staff Supporting JWST
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

- Proposal Preparation
- Proposal Selection
- Science Planning
- Operations Scheduling

Proposal Planning Subsystem (PPS)

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
The On-Board Scripts execute the Operation Plan
- Coordinate the low level on-board operations
- Event-driven methodology
The Project Reference Database is the repository of configuration-controlled data for the observatory operation.
The Flight Operations Subsystem controls all communications with the spacecraft, uploads commands, observations plans and associated data, downloads telemetry and science data.
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.
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

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th></th>
<th>2018</th>
<th></th>
<th>2019</th>
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<tr>
<td>ERS Due</td>
<td></td>
<td>GO CP 1</td>
<td></td>
<td>GO Cy1 Due</td>
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<td>GSEG 3</td>
<td></td>
<td>GSEG 4</td>
<td></td>
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<td>bMOC</td>
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<tr>
<td>S&amp;OC</td>
<td></td>
<td>S&amp;OC Sustaining</td>
<td></td>
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</table>

*months of funded critical path schedule reserve*
## S&OC Subsystems Overview

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Build</th>
<th>Development completion date</th>
<th>I&amp;T completion date</th>
<th>Status</th>
<th>% of requirements delivered to date</th>
<th>% of requirements verified to date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management Subsystem (DMS)</td>
<td>7*</td>
<td>December 2016</td>
<td>June 2017</td>
<td>Completed I&amp;T</td>
<td>89%</td>
<td>80%</td>
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<tr>
<td></td>
<td>7.1</td>
<td>November 2017</td>
<td>February 2018</td>
<td>In Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposal Planning Subsystem (PPS)</td>
<td>14*</td>
<td>December 2016</td>
<td>June 2017</td>
<td>Completed I&amp;T</td>
<td>97%</td>
<td>91%</td>
</tr>
<tr>
<td></td>
<td>14.1</td>
<td>June 2017</td>
<td>December 2017</td>
<td>Completed Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14.2</td>
<td>October 2017</td>
<td>January 2018</td>
<td>In Development</td>
<td></td>
<td></td>
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<tr>
<td>Wavefront Sensing &amp; Control (WFS&amp;C) Software Subsystem</td>
<td>6.1*, **</td>
<td>September 2017</td>
<td>February 2018</td>
<td>In Development</td>
<td>97%</td>
<td>97%</td>
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<tr>
<td>Flight Operations Subsystem (FOS)</td>
<td>6.1*</td>
<td>November 2017</td>
<td>December 2017</td>
<td>In Development</td>
<td>83%</td>
<td>80%</td>
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<tr>
<td>Operations Scripts Subsystem (OSS)</td>
<td>6</td>
<td>March 2017</td>
<td>November 2017</td>
<td>In Level 2 Certification Testing</td>
<td>73% Level 2 certified</td>
<td>58% Level 3 certified</td>
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<tr>
<td></td>
<td>7*</td>
<td>October 2017</td>
<td>March 2018</td>
<td>In Development</td>
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<tr>
<td>Project Reference Database Subsystem (PRDS)</td>
<td>4.13</td>
<td>April 2017</td>
<td>April 2017</td>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
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</table>

*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)
- 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
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
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

- 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

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

1. Your Brilliant Idea
2. Learn more about *Webb* Capabilities.
3. Webb Performance Estimation Tools
4. Submit Your Brilliant Proposal and Hope for Best
5. Plan Your Observations/Write Proposal
6. Celebrate and Wait For Observations
7. Observations Processed by *Webb* Pipeline
8. Data Reduction, Analysis, and Interpretation = Brilliant Paper
9. Processed Data Delivered to MAST Archive
Instrument Capabilities

Space Based MOS

Mid IR IFUs

Near IR IFUs

Moving Target Support

Science Capabilities

Ultra Sensitive and High Resolution Imaging

Single Object and Wide-Field Slitless Spectroscopy

Bright Object Modes

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

Welcome to the James Webb Space Telescope Help Desk

Proposal Planning Toolbox

And Much More!
The *Webb* Pipeline Architecture

- **CALDETECTOR1**
- **CALIMAGE2**
- **CALSPEC2**
- **CALIMAGE3**
- **CALCORON3**
- **CALAMI3**
- **CALTSO3**
- **CALSPEC3**

**ARCHIVE**

**MAST**

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

Large Scale Exhibitions and Local Events:

STAR app – JWST model fully deployable!
EXPANDING THE FRONTIERS OF SPACE ASTRONOMY