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December
15-16,
2016

JWST DMS Overview

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JWST Data Management System Basic Functions

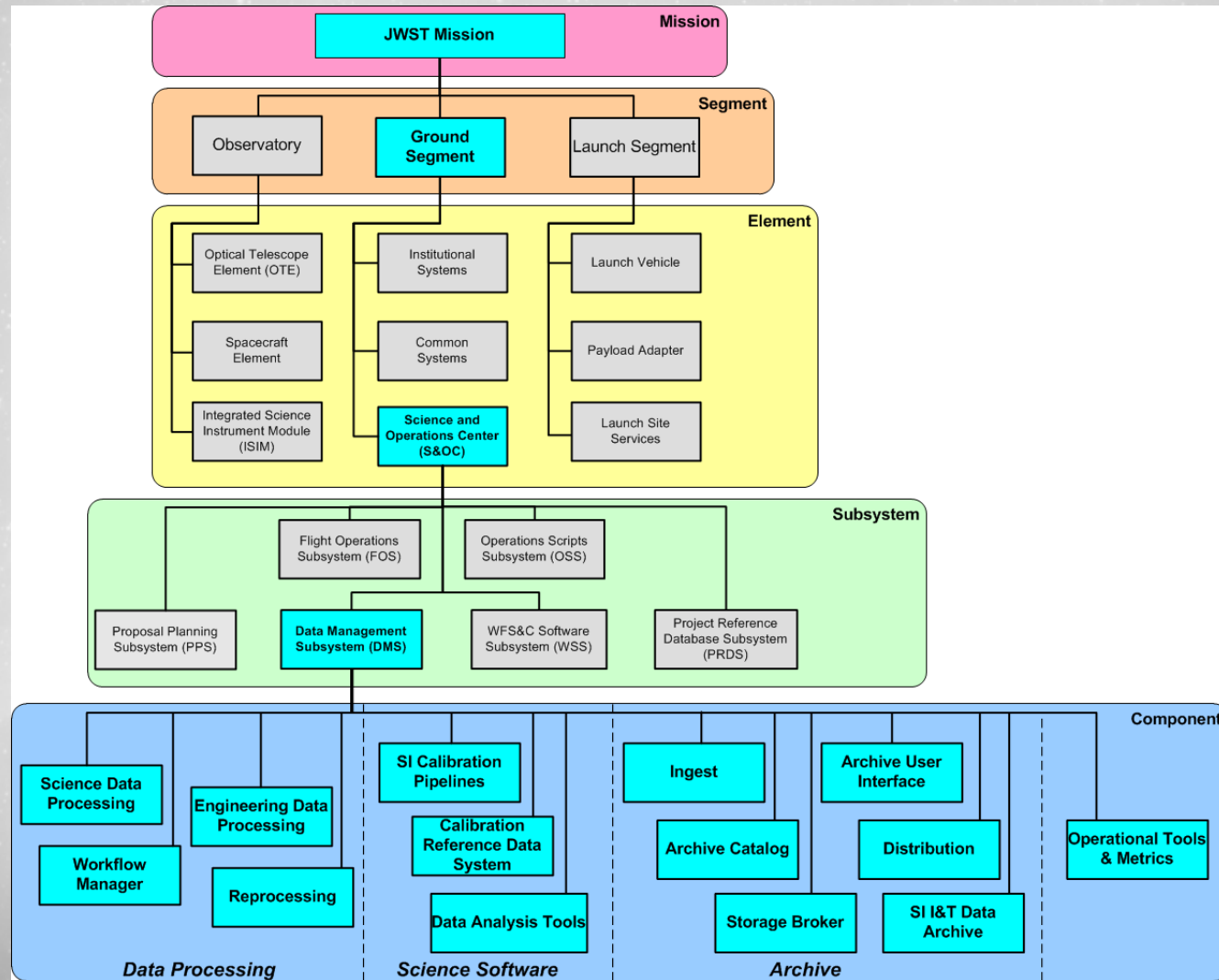
- Receipt of science and engineering telemetry data
- Reformatting, quality checking, and calibration processing needed to generate data for the archive
- Reprocessing due to software and reference data updates
- Archiving the data
- User search interfaces and access tools
- Distributing the data
- User analysis tools
- Contributed data products support (High Level Science Products)
- Storage, display and distribution of calibrated engineering data
- Support for instrument reference data



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JWST Mission Hierarchy for DMS





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DMS Requirements Component Definitions (14)

Architectural partition	DMS Component	Acronym
Data processing	Science data processing	SDP
	Engineering data processing	EDP
	Workflow Manager	WFM
	Reprocessing	REPRO
Science Software	SI calibration pipelines	CAL
	Calibration Reference Data System	CRDS
	Data analysis tools	DA
Archive	Ingest	ING
	Archive Catalog	AC
	Storage Broker	SB
	Distribution	DIST
	Archive User Interface	AUI
	SI I&T Data Archive	SID
Operational Tools	Operational tools and metrics	OPS



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DMS Primary Interface Context

S&OC



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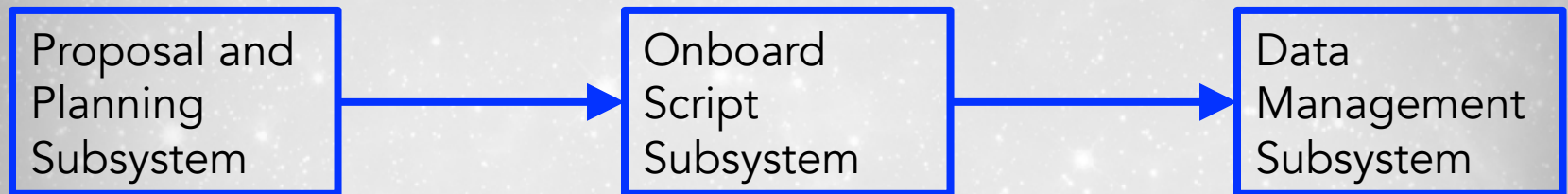
Science & Operations Center Dataflow



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Flow of a program through the system



- Proposal tool
- Program constraints
- Planning
- Scheduling
- Observation plan

- Observation plan executive

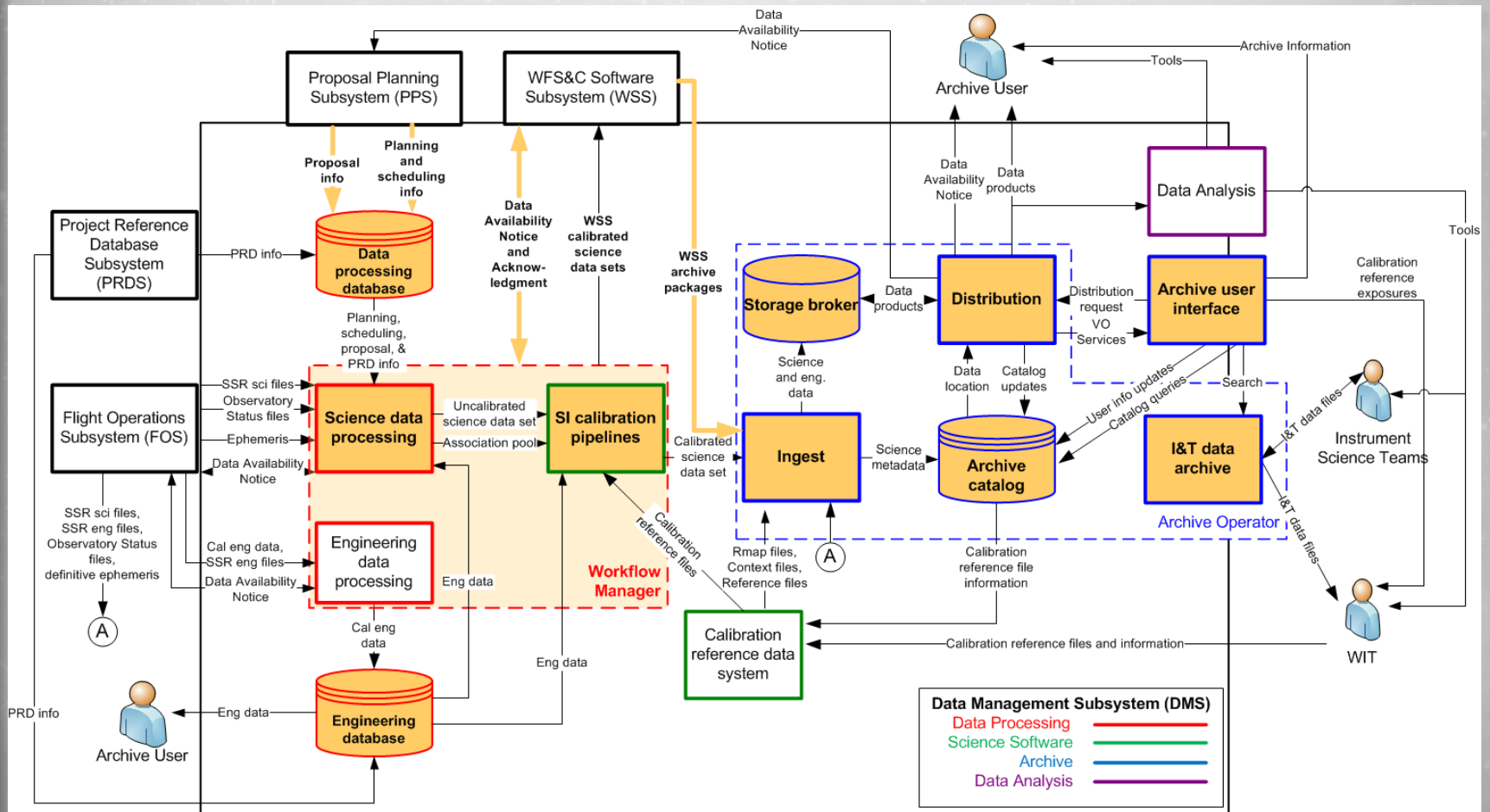
- Data processing
- Science software
- Archive



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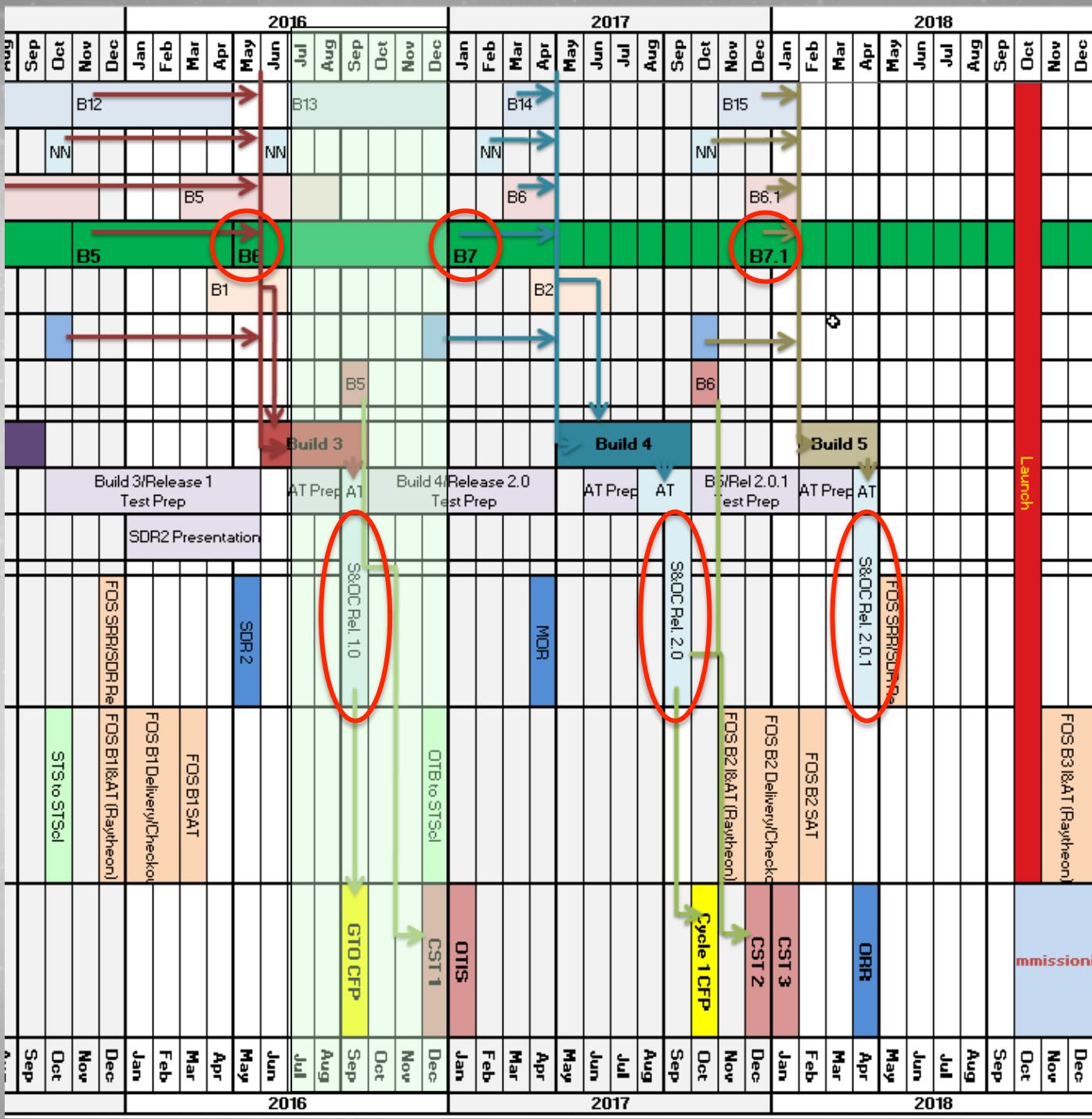
DMS Dataflow





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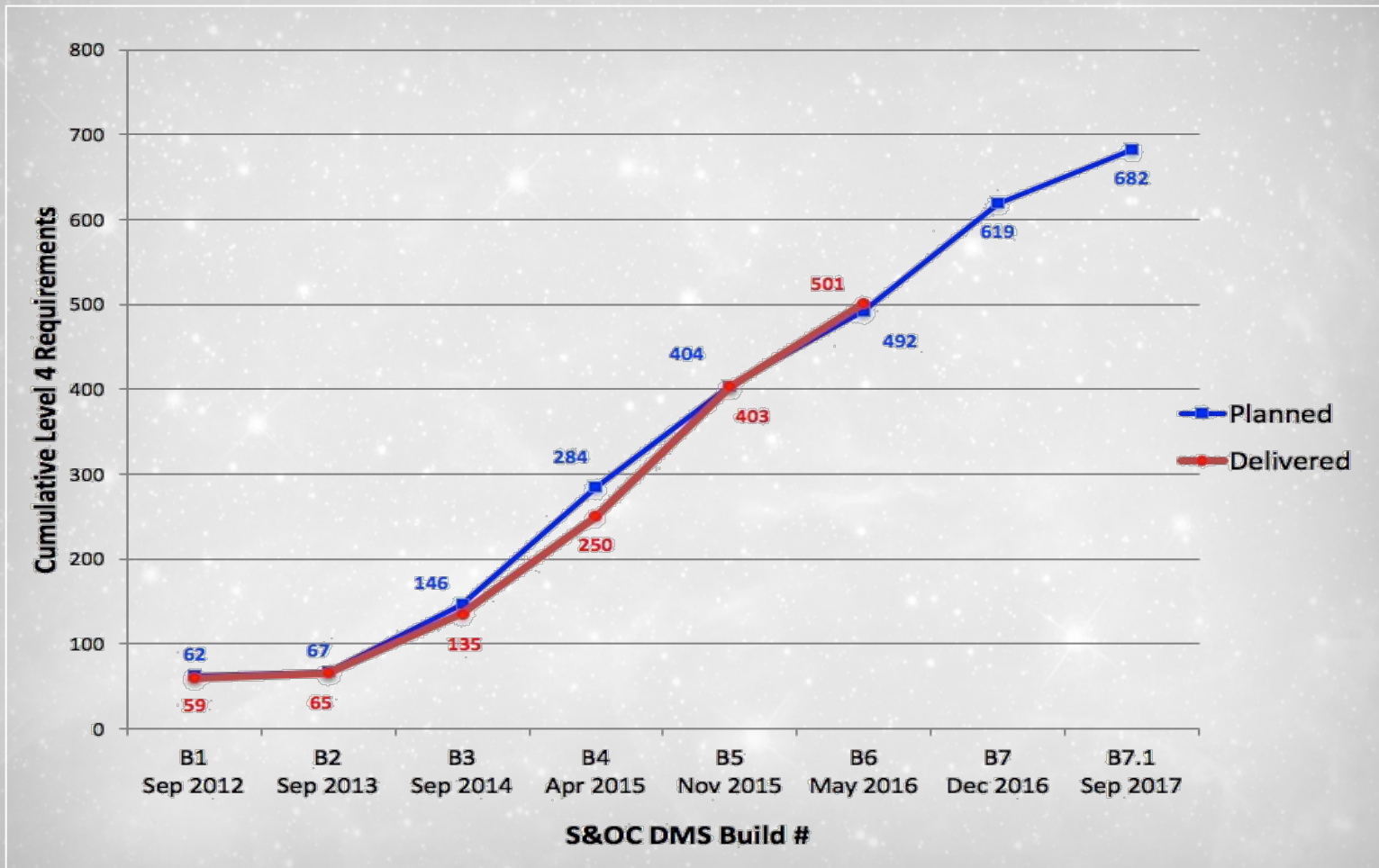
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DMS S&OC Build Plan



DMS S&OC Build



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DMS S&OC Subsystem Builds

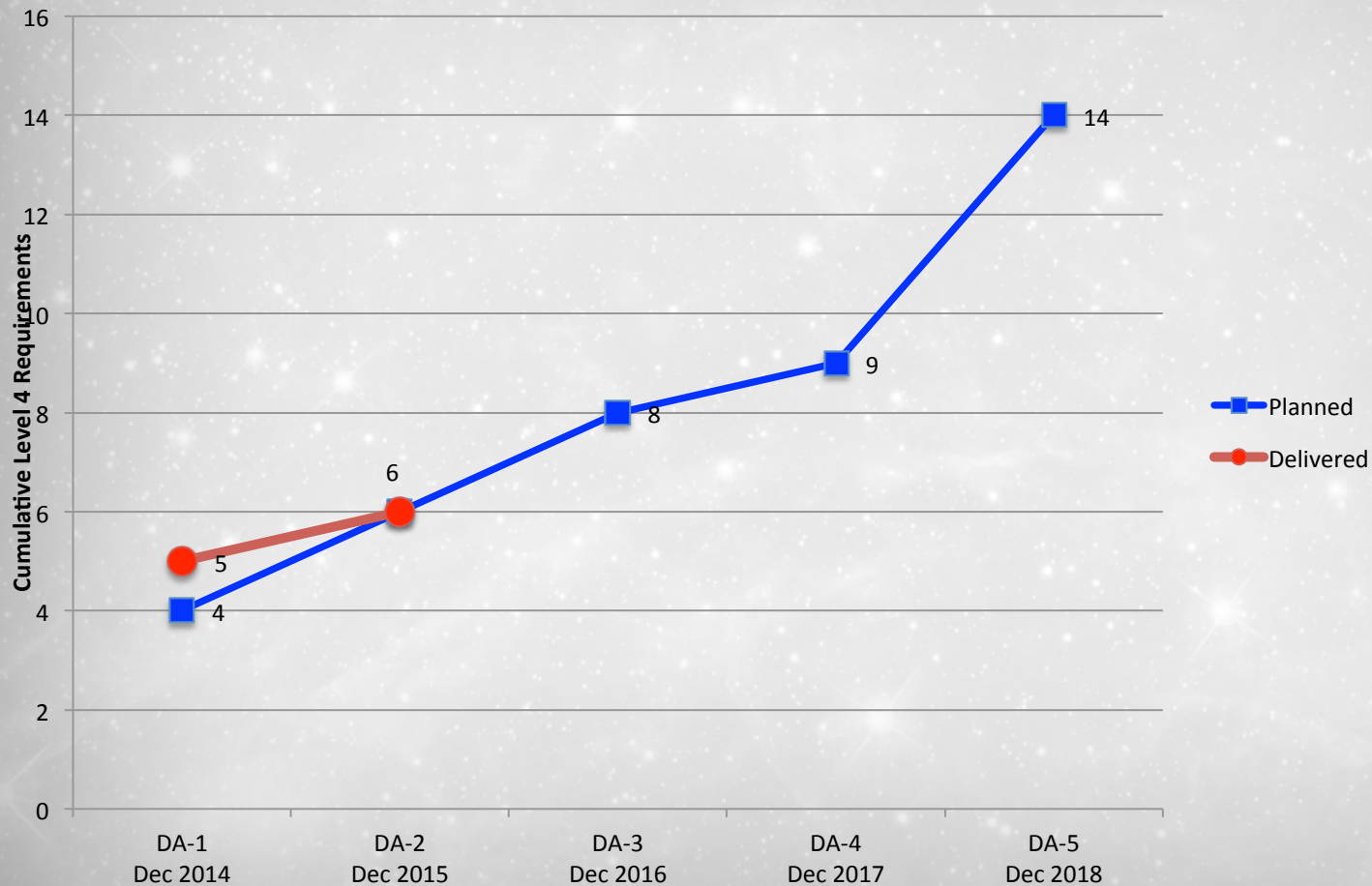
Build ID	Build Description	Components Function	Delivery to I&T	Level 4 Requirements	Status
4	DMS I&T	SDP FGS, Archive Infrastructure, CAL- Coronagraphic Pipeline, S&OC Interface Prelim PPS/PRD/WSS	Apr-15	115 completed 250 cumulative	In I&T, used for S&OC Build 2, I&T wrapping up
5	DMS S&OC Integration, Prelim OPS	SDP partial modes Level 2, CRDS Commit, Baseline for Archive Operations, Baseline Level 3 Spectrographic Pipeline	Nov-15	153 completed 403 cumulative	In I&T
6	DMS S&OC Integration	Baseline Archive Access, Level-3 Spectrographic Pipeline, user support and baseline calibration SI algorithms	May-16	98 completed 501 cumulative	Completed Development, integrated with DMS components and S&OC subsystems; handing over to I&T
7	DMS S&OC Flight Release	S&OC DMS: mission readiness, science user support and remaining baseline SI calibration algorithms	Dec-16	127 planned 619 cumulative	Completing B7 development and documentation for software delivery
7.1	DMS Flight Readiness	DMS patch release, remaining mission fulfillment capabilities	Aug-17	63 planned (687 cumulative / *682)	



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DMS Data Analysis Build Plan





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DMS Data Analysis Builds

Build ID	Build Description	Components Function	Supported Mission Systems	Delivery Target Date	Level 4 Requirements	Status
DA-1	Data Analysis Build 1	Basic infrastructure, visualize 1D, 2D and 3D data	Science Users	December 2014	4 cumulative	Delivered to I&T, verified
DA-2	Data Analysis Build 2	ASDF, GWCS, glue, spectral viewer/fitting, image geometric tools, etc.	Science Users	December 2015	6 cumulative	Delivered to I&T 12/24/15, in verification
DA-3	Data Analysis Build 3	PSF Kernel matching/fitting, initial release of 1-D, MOS and 3D tool	Science Users	December 2016	8 cumulative	Completing B7 development and documentation for software delivery
DA-4	Data Analysis Build 4	GRISM Analysis/ visualization, time series	Science Users	December 2017	9 cumulative	
DA-5	Data Analysis Build 5	3d Spectral Modeling tools, multi instrument spectral combine tools	Science Users	December 2018	14 cumulative	



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JWST DMS Accomplishments in 2016

- Delivered JWST DMS Build 6 “B6” (5/2016)
 - Staged and configured 15 DMS servers in the C-string to host DMS B6
 - Included development efforts for Level 2 image and spectral calibration algorithms
 - Included Level 3 association development for image and started work on spectral associations
 - Integrated and tested DMS components prior to I&T delivery; also, tested with other S&OC subsystems
 - Implemented generation of WFS&C Level 2b exposures and the transfer of those products to WSS
 - Implemented data retrieval of recorded engineering to FOS and archive packages distribution to WSS
- Delivered JWST S&OC Release 1 with DMS Build 6 and Data Analysis Build 2 “DA-2” (9/2016)
 - Reviewed S&OC Release 1 test procedures targeting Level 3 requirement verification
 - Participated in the execution of test dry runs and supported government witness tests
 - Tested interface utilizing DAN transfer protocol with FOS, PPS and WSS utilizing DAN servers as will exist in the operational environment
 - Assisted I&T in operational-like data transfers between FOS and DMS for recorded engineering and science SSR data
 - Prepared and delivered DMS B6 and DA-2 software products and documentation to be included in the S&OC Release 1 deliverables
- Delivering JWST DMS Build 7 “B7” and DA Build 3 “DA-3” (12/2016)
 - Staged and configured 16 DMS servers in the D-String to host DMS B7
 - Completed almost all development efforts for Level 2 image and spectral calibration algorithms
 - Included basic Level 3 association development for image and spectra
 - DMS and ITSD wrote a technical report on a short term Safestore solution for DMS in lieu of the current generation of SafeStore solutions reaching end of life and as new technology is just becoming available



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What's coming for JWST DMS in 2017?

- JWST DMS Build 7.1 (final NASA deliverable with completed requirements) [11/2017]
 - 68 requirements across all components, with more emphasis on the Associations/ Distribution/AUI/Operational Tools
 - 7 requirements with International Partners will likely be deferred until there is an MoU and work agreements
- S&OC Release 2 Witness Testing and Delivery to NASA with DMS Build 7 and Data Analysis Build 3 [9/2017]
- JWST Server Environment ramp up for JWST Operations
 - Currently maintain 2 sets of 16 servers, which encompass a “String” per Build:
 - B7 String in Development
 - B6 String in Integration & Test (I&T)
 - Will need to create and maintain 2 additional Strings (16 servers each):
 - JWST Operations
 - I&T patching/build migration procedures
 - This process will need to encompass MAST as an entity for Operations, rather than a separate isolated server set for String testing
- DMS needs to support data curation and major instrument tests scheduled throughout **2017**: OTB (Observatory Test Bed simulator), OTIS (Integrated Optical Telescope/Instrument Science Module), OSS B6 Certification
 - Needed for S&OC end to end data processing for DMS
 - Needed for Associations
 - Needed for requirement verification of modes and functionality across entire DMS



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JWST DMS “Science” Instrument Calibration Pipeline (CAL)

Stage 1	CALDETECTOR1					
Stage 2	CALIMAGE2			CALSPEC2		
Stage 3	CALIMAGE3	CALCORON3	CALAMI3	CALTSO3	CALSPEC3	CALTSO3

B7

B7.1

Pipeline

- The pipeline is split into 3 stages, with each stage becoming increasingly more specific to the type of observations.
- The algorithms for each step in each pipeline stage are split into “baseline” and “optimal” versions.
 - **Baseline “Vanilla”**
 - The vanilla algorithms for each step should produce reduced data that is ready for science
 - These algorithms should at least be the minimum required for science and to pass verification
 - These are the algorithms to be implemented in a resource restricted environment
 - **Optimal “Chocolate”**
 - The optimal algorithms for each step would produce the best possible data for science
 - In the case of unlimited resources, these would be the algorithms that we would use
 - At some fundamental level, these algorithms represent what the pipeline will look like 10+ years after the launch of JWST
 - It is expected that the optimal versions of the algorithms will be updated multiple times as we learn more about the instruments and telescope.



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CALIMAGE2 Pipeline Steps

Step	Vanilla	Build	Optimal	Build	NIRCam	NIRISS	FGS	MIRI	NIRSpec	All TA
Input	Uncalibrated slope images for all integrations and exposures									
GWCS Information	DECIDED Details	5	VANILLA		X	X	X	X	X	X
Background Subtraction	DECIDED Details	7			X	X		X	X	
Telescope Emission Subtraction	NOT DONE		IN PROGRESS Details	7.1				X		
Flat Field Correction	DECIDED Details	5	VANILLA		X	X	X	X	X	X
Flux Calibration	DECIDED Details	5	VANILLA		X	X	X	X		
Rectify 2D Image	DECIDED Details	5/6	VANILLA		X	X	X	X	X	X
Output	Calibrated slope images for all integrations and exposures									



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CALSPEC2 Pipeline Steps

Step	Baseline	Build	Optimal	Build	NIRCam	NIRSpec			NIRISS		MIRI			
					Slitless	MSA	IFU	Fixed Slit	SOSS	WFSS	LRS	MRS	TSO	
Input	Uncalibrated slope images for all integrations and exposures													
Background Subtraction	DECIDED Details	6/7	VANILLA		X	X	X	X	X	X	X			
Imprint Subtraction	DECIDED Details	6	IN PROGRESS Details	7.1		X	X							
MSA Failed Open Flagging	DECIDED Details	6	VANILLA			X	X							
WCS Information	DECIDED Details	6/7	VANILLA		X	X	X	X	X	X	X	X	X	X
Subwindow Extraction	DECIDED Details	6/7	VANILLA		X	X		X	X	X				
Flat Field Correction	DECIDED Details	5/6	IN PROGRESS Details	7.1	X	X	X	X	X	X	X	X	X	X
Stray Light Subtraction	DECIDED Details	5/7	VANILLA									X	X	
Fringing Removal	DECIDED Details	5	VANILLA										X	
Path-Loss Correction	DECIDED Details	7	VANILLA			X	X	X	X			X		
Flux Calibration	DECIDED Details	5/6	VANILLA		X	X	X	X	X	X	X	X	X	X
Recified 2D/3D Product	DECIDED Details	7	VANILLA		X	X	X	X	X	X	X	X	X	X
Output	Calibrated slope images for all integrations and exposures													



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JWST DMS CAL Pipeline Deliveries

- **Functionality through B7 (Commissioning)**
 - Completed almost all [baseline](#) development efforts for Level 2 image and spectral calibration algorithms
 - Delayed CAL development to Build 7.1:
 - Wide-Field Slitless Spectroscopy (WFSS) mode observations for NIRCam and NIRISS
 - Correction for the latent signal from earlier exposures or integrations
 - Propagation of random and systematic uncertainties through each calibration step
 - Correct for emission from the telescope
- **Functionality through B7.1 (Flight)**
 - Complete remaining [baseline](#) development for all Level 2 image and spectral calibration algorithms
 - Completing the “Delayed” list from above
 - Complete development for Level 3 (Associations) image and spectral calibration algorithms
 - Complete all Associations requirements (higher level data products)
 - Initial delivery of [optimal](#) pipeline updates to former baseline algorithms
- **Functionality B7.2+ (Flight+)**
 - Follow up delivery of [optimal](#) pipeline updates to former baseline algorithms



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JWST DMS Pipeline will Produce Automated High-Level Science Products (Level 3)!

- Unlike for HST, JWST has automated pipeline processing to create Level 3 science data products (extremely complex)
- Pipeline requires all input observations to be complete (“an Association”/ grouping of related files)
- Level 3 products include: mosaics, catalogs, combined spectra, IFU data cubes, AMI, time-series, extracted spectra, etc.
 - NIRCam catalogs needed for NIRSpec MSA use
- Roll combined, PSF subtracted coronagraphic images
- Archive users can rerun and customize the calibration pipeline
- Data analysis tools will be integrated with astropy, GLUE, Ginga
 - Development with domain experts in “sprints”
 - Visualization, model fitting, PSF tools, geometry
 - Mode-specific tools, source extraction, and more