SCIENCE: JAMES WEBB SPACE TELESCOPE (JWST)

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017	BTC	Total
FY 2013 President's Budget Request	2,992.1	476.8	518.6	627.6	659.1	646.6	621.6	571.1	1,649.5	8,762.9

JAMES WEBB SPACE TELESCOPE

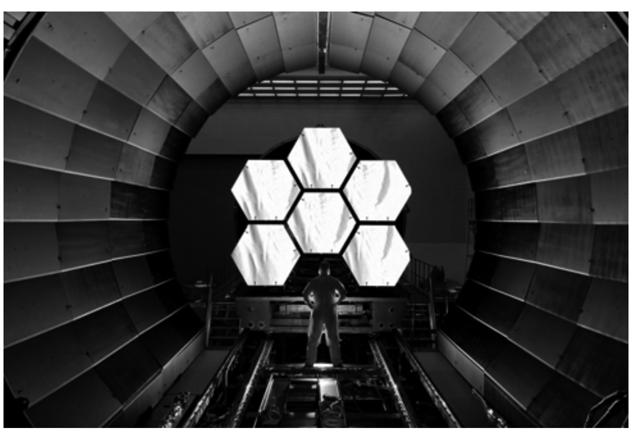
JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	2013	Notional FY 2014	FY 2015	FY 2016	FY 2017	BTC	Total
FY 2013 President's Budget Request	**2,992.1**	**476.8**	**518.6**	**627.6**	**659.1**	**646.6**	**621.6**	**571.1**	**1,649.5**	**8,762.9**
2012 MPAR Project Cost Estimate	**3,013.7**	**515.3**	**530.6**	**627.6**	**659.1**	**646.6**	**621.6**	**571.1**	**1,649.5**	**8,835.0**
Formulation	1,800.1	--	--		--	--	--	--	--	1,800.1
Development/ Implementation	1,213.6	515.3	530.6	627.6	659.1	646.6	621.6	571.1	812.5	6,198.0
Operations/ Close-out	--	--	--		--	--	--	--	837.0	837.0
Change From FY 2012 Estimate		--	--	**109.0**						
Percent Change From FY 2012 Estimate		--	--	**21.0%**						

Note: *These pages fulfill the Congressional requirement under 51 USC 30104 (c)(2) for a Baseline Report on the new baseline for JWST. Under subsection (c)(2)(E), the JWST Program Director at NASA Headquarters has primary responsibility for overseeing the JWST Program. The 2012 MPAR Project Cost Estimate includes $72.1 million for Construction of Facilities (CoF) funds in FY 2010 to FY 2012 which are budgeted in the CECR account. The life cycle cost (including CoF funds) is $8.835 billion.*



The first six flight-ready James Webb Space Telescope primary mirror segments are prepped to begin final cryogenic testing at MSFC. A total of 18 segments will form the telescope's primary mirror for space observations. Engineers began final cryogenic testing to confirm that the mirrors will respond as expected to the extreme temperatures of space prior to integration into the telescope's permanent housing structure.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA has rebaselined JWST project, making significant changes in the management in 2011, in response to the poor cost and schedule performance and the recommendations of the Independent Comprehensive Review Panel (ICRP) report (http://www.ngst.nasa.gov/resources/JamesWebbSpaceTelescopeIndependentComprehensiveReviewPanelReport.pdf). As a result of the rebaseline, the launch date moved from 2014 to 2018, and the development cost increased from $2.581 to $6.198 billion. The new Headquarters-based program office worked closely with the project office, senior NASA managers, and stakeholders to improve project management. Communications have greatly improved between Headquarters, Centers, and contractors, particularly at

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

senior management levels. There now is open and honest dialogue, quick identification of issues, and agreement on fixes.

The program office commissioned an in-depth, independent analysis of alternatives, which was completed in April 2011. The analysis indicated that the baseline JWST design was still the best value to achieve the primary scientific objectives of the mission. The Agency completed a replan of the JWST cost and schedule baseline on September 23, 2011, and sent the revised cost and schedule requirements, along with the analysis of alternatives, to Congress on October 24, 2011, in a breach report pursuant to Section 103 of the NASA Authorization Act of 2005 (P.L. 109-155): Baselines and Cost Controls.

The FY 2013 President's Budget Request officially establishes a new baseline for JWST (as shown in the Budget Summary table above) consistent with direction in NASA's FY 2012 appropriation to cap JWST formulation and development costs at $8.0 billion. The rebaselined budget supports an October 2018 launch date with adequate cost and schedule margin, consistent with the ICRP recommendation.

PROJECT PURPOSE

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is the scientific and technological successor to the Hubble Space Telescope, extending Hubble's discoveries by looking into the infrared spectrum. The infrared spectrum is where the highly red-shifted early universe must be observed, where astronomical objects like protostars and protoplanetary disks strongly emit infrared light and where dust obscures shorter wavelengths.

The four main science goals are to:

- Search for the first galaxies or luminous objects formed after the Big Bang;
- Determine how galaxies evolved from their formation until now;
- Observe the formation of stars from the first stages to the formation of planetary systems; and
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

While Hubble has greatly improved knowledge about distant objects, its infrared coverage is limited. Light from distant galaxies is redshifted by the expansion of the universe into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, with more light-collecting area than Hubble and near to mid-infrared-optimized instruments, JWST will be able to observe things farther away, as their light has taken longer to reach the Earth. JWST will effectively be looking even further back in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

The telescope will launch from Kourou, French Guiana, on an ESA-supplied Ariane 5 rocket. Its operational location is the Lagrange 2 point, which is about a million miles from Earth.

For more information, please see http://www.jwst.nasa.gov.

PROJECT PARAMETERS

JWST is an infrared optimized observatory that will be used to conduct imaging and spectrographic observations in the 0.6 to 27 microns wavelength range and will be 100 times more sensitive than Hubble. The 6.5-meter primary mirror consists of 18 actively controlled segments that (along with the rest of the telescope optics and instruments) are passively cooled to about 40 Kelvin by a large multilayer sunshield the size of a tennis court. JWST will operate in deep space about 1 million miles from Earth.

JWST's instruments include the Near Infrared Camera (NIRCam), Near Infrared Spectrograph (NIRSpec), Mid Infrared Instrument (MIRI), and the Fine Guidance Sensor (FGS).

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to charge coupled devices found in ordinary digital cameras. In addition to a science instrument, NIRCam is a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view per exposure. It provides medium-resolution spectroscopy over a wavelength range from 0.6 to 5 micrometers. The instrument employs a micro-electromechanical system microshutter array for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 to 28 micrometers and has three arsenic-doped silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for MIRI is seven degrees above absolute zero, which is possible through an on-board cooling system.

FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both guide star acquisition and fine pointing. The sensor operates over a wavelength range of 1 to 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95 percent probability of acquiring a guide star for any valid pointing direction. The FGS tunable filter camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 to 4.9 micrometers, via a near infrared imager and slitless spectrograph that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

In addition to rebaselining the program's cost and schedule, the JWST project made significant technical progress in the past year:

- As of December 2011, all mirror fabrication has been completed, including thermal vacuum testing, and the primary, secondary, and tertiary mirror systems which meet the highly exacting cryogenic optical surface specifications;
- Fabrication of the flight backplane structure that holds the primary mirror segments continued, and the center section neared completion;
- Integrated Science Instrument Module (ISIM) integration and testing is underway, with multiple hardware elements delivered, and science instrument deliveries to GSFC to begin in spring 2012;
- The project successfully completed testing a one-third-scale sunshield, and full-scale engineering development units are being delivered and tested in Huntsville, AL;
- All sunshield material for test units and for flight layers has been delivered;
- The project continues to mature the spacecraft design and many components have completed the Critical Design Review (CDR); the project has made progress on or completed engineering model development of other components;
- The flight solid state recorder is complete;
- Northrop Grumman Aerospace Systems (NGAS) delivered the flight software to GSFC.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, JWST plans to:

- Begin assembly of the Optical Telescope Element (OTE) backplane support fixture;
- Hold the sunshield manufacturing readiness review to determine if the procedures developed during the construction of the template sunshields are valid and ready to be used to construct the flight sunshield;
- Conduct the ISIM pre-environmental review to certify that the ISIM and integrated instruments are ready to enter into the thermal vacuum testing; and
- Complete build 2.4 for the ground segment software (common command and telemetry system).

JAMES WEBB SPACE TELESCOPE (JWST)

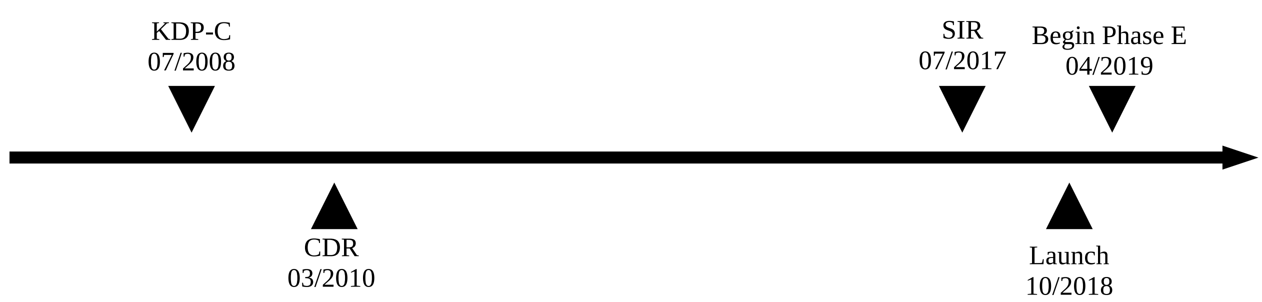
Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

JWST will launch in October 2018 to begin a five-year prime mission. The following timeline shows the development agreement schedule per the rebaseline plan.

Development Milestones	Rebaseline Date	FY 2013 PB Request Date
KDP-C	Jul-08	Jul-08
CDR	Mar-10	Mar-10
SIR	Jul-17	Jul-17
Launch	Oct-18	Oct-18
Begin Phase E	Apr-19	Apr-19
End of Prime Mission	Apr-24	Apr-24

Project Schedule



JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Development Cost and Schedule

This document establishes the new baseline for JWST as follows:

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2012	6197.9	66	2012	6197.9	0	LRD	Oct-18	Oct-18	0

The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost. For the new JWST baseline, the associated cost confidence level is significantly higher than the 80% recommended by the ICRP.

DEVELOPMENT COST DETAILS (IN $M)

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Change from Base Year Estimate ($M)
TOTAL:	**6197.9**	**6197.9**	**0**
Aircraft/Spacecraft	2955.0	2955.0	0
Payloads	695.1	695.1	0
Systems I&T	288.4	288.4	0
Launch Vehicle	0.9	0.9	0
Ground Systems	652.3	652.3	0
Science/Technology	42.7	42.7	0
Other Direct Project Costs	1563.5	1563.5	0

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Project Management & Commitments

GSFC is responsible for JWST project management.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Observatory	Provider: NGAS and GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Includes OTE, spacecraft, sunshield, observatory assembly integration and testing, and commissioning. The observatory shall be designed for at least a five-year lifetime. NGAS has the lead for the OTE, sunshield, spacecraft bus, and selected assembly, integration, and testing activities.	Same	Same
Mission management and system engineering	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Includes management of all technical aspects of mission development, and system engineering of all components	Same	Same
Integrated Science Instrument Module (ISIM)	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Contains the science instruments and FGS. Provides structural, thermal, power, command and data handling resources to the science instruments and FGS.	Same	Same
Near Infrared Camera (NIRCam) Instrument	Provider: University of Arizona, Lockheed Martin Project Management: GSFC NASA Center: GSFC Cost Share: None	Optimized for finding first light sources, and operating over the wavelength range 0.6 to 5 microns.	Same	Same
Near Infrared Spectrometer (NIRSpec)	Provider: ESA Project Management: ESA NASA Center: None Cost Share: ESA	Operating over the wavelength range 0.6 to 5 microns with three observing modes.	Same	Same

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Mid-Infrared Instrument (MIRI)	Provider: ESA, University of Arizona, JPL Project Management: GSFC NASA Center: JPL, ARC Cost Share: ESA	Operating over the wavelength range 5 to 27 microns, providing imaging, coronagraphy, and spectroscopy.	Same	Same
Fine Guidance Sensor (FGS)	Provider: CSA Project Management: CSA NASA Center: None Cost Share: CSA	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same	Same
Launch vehicle and launch operations	Provider: ESA Project Management: ESA NASA Center: None Cost Share: ESA	Ariane 5 Evolution Cryotechnique – Type A	Same	Same
Ground control systems and science operations and control center	Provider: Space Telescope Science Institute (STScI) Project Management: GSFC NASA Center: None Cost Share: None	Mission operations and science operations center	Same	Same

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The double pass auto-collimating flat test cannot work to sufficiently tight performance consistent with the error budgets, Then: the level 2 imaging requirements cannot be verified	Test Assessment Team , SRB, and Test Design Review recommendations being implemented. New plan includes earlier checkout, more efficient testing. Baseline now includes checkout of all optical ground support equipment as part of OSGE 1 and 2 tests at JSC.
If: The thermal balance test fails to meet success criteria, Then: disassembly, rework, and a re-test will be required	Test Assessment Team recommendations being implemented to reduce risk of test via second core test, Pathfinder thermal testing, cooler end-to-end test. Risk reduction pathfinder thermal test objectives have been established.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

All major contracts have been awarded.

Element	Vendor/Provider	Location
Science and Operations Center	Space Telescope Science Institute (STScI)	Baltimore, MD
NIRCam	University of Arizona; Lockheed Martin	Tucson, AZ Palo Alto, CA
Observatory	NGAS Ball Aerospace ITT Alliant Techsystems	Redondo Beach, CA Boulder, CO Rochester, NY Edina, MN
Near Infrared Detectors	Teledyne Imaging Systems	Camarillo, CA

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board (SRB)	Apr-10	Critical Design Review. SRB found that mission design is mature and recommended a more in depth review of the integration and testing plan.	N/A
Quality	Test Assessment Team	Aug-10	Evaluate the JWST plans for integration and testing. Team recommended several changes to test plan. See full report at http://www.jwst.nasa.gov/publications.html.	N/A
Other	Independent Comprehensive Review Panel	Oct-10	ICRP was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, and estimate the minimum cost to launch JWST, along with the associated launch date and budget profile, including adequate reserves. The report made 22 recommendations covering several areas of management and performance.	N/A
Other	Aerospace Corp	Apr-11	Analysis of alternatives. The analysis indicated that the baseline JWST design was still the best value to achieve the primary scientific objectives of the mission.	N/A
Other	SRB	May-11	Review proposed rebaselined project technical, cost, and schedule plans and made recommendations to Agency.	N/A
Performance	SRB	N/A	Replan assessment review	Jun-12
Performance	SRB	N/A	Spacecraft Critical Design Review	Jun-14
Performance	SRB	N/A	Systems Integration Review	Jul-17
Performance	SRB	N/A	Flight Readiness Review	Sep-18

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

CORRECTIVE ACTION PLAN AS REQUIRED BY SECTION 1203 OF NASA 2010 AUTHORIZATION ACT

JWST is an infrared observatory being built to study and answer fundamental astrophysical questions ranging from the formation and structure of the universe to the origin of planetary systems and the origins of life. Thousands of individual scientists and multiple international teams of astronomers will use this scientific successor to the Hubble Space Telescope and the Spitzer Space Telescope to conduct imaging and spectroscopic observations.

In accordance with Section 103 of the NASA Authorization Act of 2005 (P.L. 109-155), NASA informed Congress by letters dated October 28, 2010, April 21, 2011, and October 24, 2011, that JWST had experienced a significant cost overrun and schedule delay. NASA has worked aggressively to address the root causes of the overrun and delays and has rebaselined the project with an executable budget and schedule. NASA's April 21, 2011, letter transmitted the final report of the Independent Comprehensive Review Panel (ICRP). NASA's detailed response to the ICRP included recommendations to correct past problems, reduce the risk of future cost growth and schedule delays, and improve JWST performance.

At the time the April 21, 2011 letter was submitted, NASA was in the midst of a rigorous, comprehensive, bottom-up review of JWST, as recommended by ICRP, and had not completed the revised cost and schedule estimates or the analysis of impacts and alternatives, as required by Section 103(d)(1)(C), and Section 103(d)(2) of P.L. 109-155. These have been completed and outlined in the enclosures to the October 24, 2011, letter. In addition, NASA completed the bottom-up review and finalized the revised cost and schedule baseline for JWST. The FY 2013 President's Budget Request constitutes NASA's new baseline for JWST. The current projected JWST launch readiness date is October 2018, the development cost estimate is $6.198 billion, and the life cycle cost estimate is $8.835 billion. The revised JWST cost and schedule incorporates 13 months of schedule reserve within the planned funding for development.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

2010 Issues	Corrective Action Plan
Issue 1: Cost and schedule overrun Current Status: Revised cost and schedule baseline has been approved by the Agency and sent to Congress. Subsequent to the submission of the revised baseline to Congress, Congress approved the FY 2012 NASA appropriation and included the funding required to support the revised development cost and schedule baseline, and included language capping JWST formulation and development costs at $8 billion.	Programmatic: NASA revised the program management structure, with the creation of a NASA Headquarters program office reporting programmatically to the NASA Associate Administrator. NASA also increased visibility and communication at both the Agency and Center levels. Technical: No action required. Cost: Bottom-up review resulted in a revised life cycle cost estimate of $8.835 billion. This estimate is consistent with the 66 percent joint confidence level with a cost confidence level that is significantly higher than the 80 percent recommended by the ICRP. Schedule: Bottom-up review resulted in a revised development schedule, with launch in October 2018. The revised schedule incorporates 13 months of funded schedule reserve.
Issue 2: Testing concerns Current Status: Findings from the Independent Test Assessment Team have been incorporated into the plans for testing within the JWST integration and test phase and within the revised development cost and schedule baseline.	To address testing concerns from the mission CDR, NASA chartered an independent Test Assessment Team to conduct a review of plans for environmental and functional testing. The findings of this review have now been incorporated into the plans for testing within the JWST integration and test phase and the revised development cost and schedule baseline.