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James Webb Space Telescope

System Description

The James Webb Space Telescope is the highest priority large space mission in astronomy. Webb will study every phase in the history of our universe, ranging from the luminous glows of the first stars that formed after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own solar system.

Northrop Grumman Aerospace Systems is the prime contractor on the team that will design, build, integrate and test the Webb telescope. The Observatory is composed of the optical telescope, an Integrated Science Instrument Module (ISIM), a sunshield and spacecraft.

- The optical telescope includes a large, segmented primary mirror that will deploy on orbit, unfolding to approximately 6.5 meters in diameter. The primary mirror is composed of 18 hexagonal segments, each of which is individually controlled. The segments are aligned on orbit and will be sensitive to light in the near- and mid-infrared spectrum.

- The ISIM, built by NASA's Goddard Space Flight Center, contains instruments provided by NASA, and international and university partners. The four science instruments are: a near-infrared camera, a near–infrared spectrograph, a mid-infrared instrument and a fine guidance sensor with a near-infrared imager/spectrograph.

- The spacecraft element is dominated by a deployable sunshield the size of a tennis court that will allow passive cooling of the telescope and instruments to their cryogenic operating temperatures of around 45 Kelvin (nearly - 400 degrees Fahrenheit). The spacecraft will have a propulsion system with enough capacity to support up to 10 years of operational lifetime.

Webb will be launched via an Ariane 5 expendable launch vehicle provided by the European Space Agency into an orbit at the L2 Lagrange point a million miles from Earth. On orbit, Webb will look far beyond the reach of current telescopes, observing objects in the near- and mid-

infrared region of the electromagnetic spectrum (radiation with wavelength of 0.6 to 28 microns). Its mirror will have more than six times the light-gathering capabilities of the Hubble Space Telescope.

Customer

● NASA's Goddard Space Flight Center, Greenbelt, Md. Goddard is managing Webb with contributions from a number of academic, international and industrial partners.

Contract Details

● Contract awarded in September 2002 to a Northrop Grumman Aerospace Systems-led team that includes Ball Aerospace & Technologies Corp., ITT and ATK.

--Northrop Grumman is the prime contractor and is leading the overall system design and integration effort; Ball is developing the telescope, with a special emphasis on the optical elements; ITT is the integration and test lead for the optical telescope; Alliant Techsystems (ATK) provides the telescope's composite structures.

Contract Requirements

● Design, develop, build, integrate, test and perform on-orbit commissioning of the Webb observatory.

Current Component Status

- All the flight mirrors for the telescope have been finished. The last primary mirror segment was polished by L-3 Tinsley in June, 2011. The second set of six flight mirrors will complete cryotest at Marshall Space Flight Center in September 2011. The third and last set of six flight mirrors will finish their cryotest by the end of the year.

- The sunshield enters a new test phase September 2011, when shape-testing on full-size test membranes in a fully simulated flight configuration will begin by teammate NeXolve. Test engineers will use a high precision laser radar tool to measure each layer every few inches at room temperature and pressure, creating a 3-D map or picture of the surface. The map will be compared to computer models to see if the material behaved as the model predicted.

- The flight sunshield alignment table has been completed and hole-punching will begin on all five test membranes in early 2012, interspersed with fit checks on a full-size telescope mock-up. Flight sunshield alignment is expected to begin in mid-2013.

- Bonding on the center section of the flight backplane, which supports the primary mirror segments, is 60 percent complete. The pathfinder backplane, a practice model, has been completed by ATK and delivered to Northrop Grumman in April, 2011.

- A two-story thermal facsimile of the telescope's central region and a 1/3 scale sunshield model both successfully passed thermal vacuum tests.

Ten new technologies were developed for the Webb telescope and have passed a technology readiness evaluation for operation in a space environment. They include near- and mid-infrared detectors, sunshield materials, lightweight cryogenic mirrors, microshutter arrays, cryogenic detector readout application-specific integrated circuits, cryogenic heat switches, a large precision cryogenic structure, a cryocooler for the mid-infrared instrument, and wavefront sensing and control.

Background: Humankind has always been fascinated by the question of how the universe formed, how life began, and whether there is life outside of our own planet and our solar system. From measurements at all wavelengths, astronomers have a fairly good understanding of what the observable universe is like today and what it was like in the recent past (when the universe was several billion years old). They are also fairly confident of what the universe was like when it was quite young (less than about 1 million years old) based upon observation of the cosmic microwave background and an understanding of high-energy particle physics. But there is a period of time after the Big Bang about which very little is known, a period that is critically important in the history of the universe. Webb will gather clues about the universe when it was a few hundred million to a few billion years old and the first structures such as stars and galaxies began to form. The Webb telescope has four mission goals:

- 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 collapse of gas clouds to the formation of planetary systems
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems

Northrop Grumman and its team have demonstrated experience in developing spacecraft for NASA's most challenging space science missions. Northrop Grumman, Ball and ITT have collectively played significant roles on all four of NASA's Great Observatories: Gamma Ray Observatory, Chandra X-Ray Observatory, Hubble Space Telescope and Spitzer Space Telescope.

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August 2011