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## **James Webb Space Telescope (JWST)**

### **System Description**

The James Webb Space Telescope (JWST) is a new, space-based telescope that will be the premier space observatory for astronomers in the coming decade. JWST 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 Space Technology is leading a team that will design, build, integrate and test the Observatory. The Observatory is composed of an Optical Telescope Element (OTE), an Integrated Science Instrument Module (ISIM), and a spacecraft element (spacecraft and sunshield).

- The OTE 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 individually controllable to align the primary mirror on orbit and will be sensitive to light from 0.6 to 27 micrometers.
- The ISIM, built by NASA's Goddard Space Flight Center and international and university partners, contains four science instruments: a near-infrared (IR) camera, a near-IR multi-object spectrograph, a mid-IR instrument and a tunable filter-imager.
- 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 below zero on the Fahrenheit scale). The spacecraft provides standard electrical, mechanical, communications and control devices. In addition, it will have a propulsion system that provides mid-course correction in transfer trajectory, inserts JWST into its final orbit and maintains that orbit for up to 10 years of operational lifetime.

JWST will be launched in 2014 from an Ariane 5 expendable launch vehicle provided by the European Space Agency into an orbit at the L2 Lagrange point some 940,000 miles from Earth. On orbit, JWST will look far beyond the reach of current telescopes, observing objects in the near- and mid-IR region of

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the electromagnetic spectrum (radiation with wavelength of 0.6 to 27 microns). Its mirror will have about six times the light-gathering capabilities of the Hubble Space Telescope.

### **Customer**

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

### **Contract Details**

- Contract awarded in September 2002 to Northrop Grumman Space Technology-led team that includes Ball Aerospace & Technologies Corp. and ITT.
  - Northrop Grumman is the prime contractor and is leading the overall system design and integration effort; Ball is developing the JWST telescope, with a special emphasis on the optical elements; ITT is the integration and test lead for the optical telescope.

### **Contract Requirements**

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

### **Current Component Status**

Ten new technologies developed for JWST were certified to have achieved Technology Readiness Level 6 (TRL 6) in April 2007. TRL 6 means prototypes of the technologies were successfully tested in a relevant environment simulating space and are mature enough to include on the telescope's upcoming mission. The actual hardware and software that will fly on the telescope now can be engineered from working prototypes.

The technologies include near- and mid-IR 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-IR instrument, and wavefront sensing and control.

**Background:** Man has always been fascinated by the question of how the universe formed, how life formed, and whether there is life outside of our own planet and our own solar system. Astronomers have a fairly good understanding of what the universe is like today and what it was like in the recent past (when the universe was several billion years old) from observations at all wavelengths. They are also fairly confident of what the universe was like when it was quite young (less than about 1 million years

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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.

JWST 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. JWST 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 stages 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, GRO, Chandra, Hubble and Spitzer.

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