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NASA's troubled US$8-billion Hubble successor is back on track

After setbacks, delays and cost overruns that almost led to its cancellation, the telescope should be able to meet its 2018 launch date.

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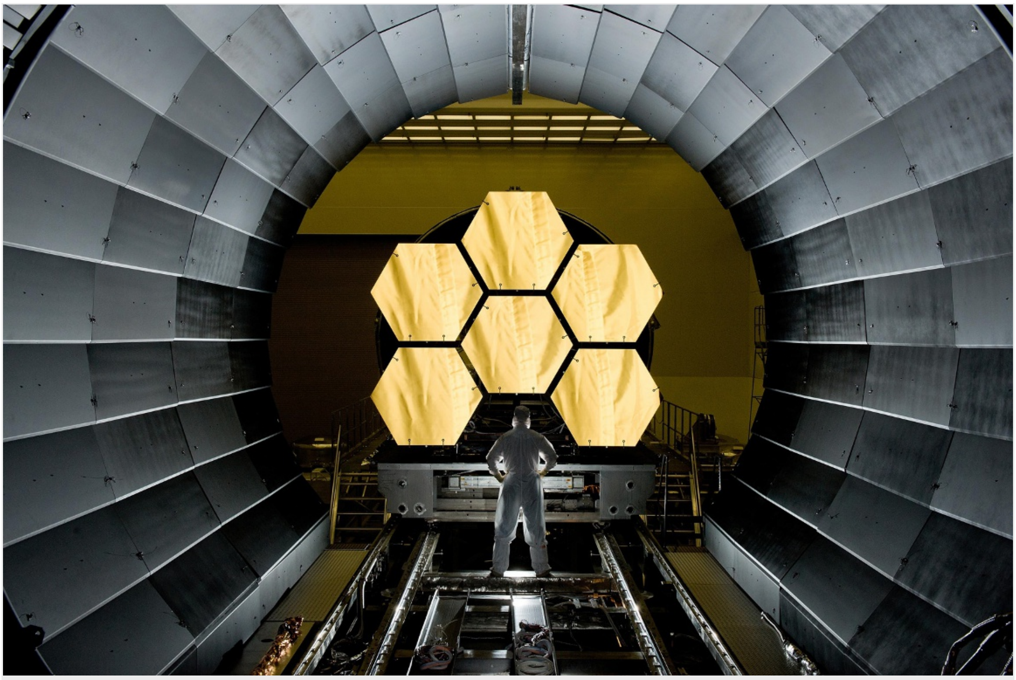

NASA/MSFC/David Higginbotham

The first six flight-ready segments of the James Webb Space Telescope's primary mirror in cryogenic testing at NASA's Marshall Space Flight Center.

The Hubble Space Telescope is still operating, but its successor is already waiting in the wings. The James Webb Space Telescope (JWST) will be the largest observatory ever sent to space, and one of the most complex instruments ever built. After running seriously over budget and behind schedule until 2011, the project is now on track and heading into an eventful year of assembly and tests in preparation for its 2018 launch.

All four of the JWST's main science instruments are built and have been shipped to the NASA Goddard Space Flight Center in Greenbelt, Maryland, to be combined into one unit, called the Integrated Science Instrument Module. Last month the telescope passed its final design milestone — the critical design review — where all of the plans for design, construction and testing of the observatory were approved. "Ninety-seven percent of the mass of the telescope is either built or on the way," Eric Smith, JWST deputy program director at NASA Headquarters in Washington DC, said during a January press tour of Goddard. "Now [that] we've got the science instruments, we're going to start manufacturing the telescope."

What Hubble observes in optical light, James Webb is designed to see in infrared — the long-wavelength band where ancient, extremely distant stars and galaxies shine. Because the universe is expanding, the farther away an object is from Earth, the faster it appears to recede. Its light, in turn, will appear redder because of a phenomenon known as the Doppler shift that causes its wavelength to stretch, or move toward the red end of the spectrum. Thus, James Webb should be able to glimpse cosmic wonders so far away they are nearly as old as the universe itself. "It's all about: How did we get here?" said JWST senior project scientist John Mather. "Where did our atoms come from in the beginning? Every one of us is made of exploded stars. How are stars born?"

These grand questions have forced NASA to take on grand engineering challenges. The observatory must operate at extremely cold temperatures below 50 kelvins (–223 °C) to avoid contamination from

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infrared light in the form of heat radiation. Such radiation comes from Earth as well as the sun and moon, all of which must all be blocked from the telescope's field of view by a giant visor called a multilayer sunshield. To keep those three bodies always at its back, James Webb will orbit at a stable point called Lagrangian point 2 (L2), a million miles from Earth and much farther than Hubble or most other satellites. The telescope's housing had to be built from a new type of composite graphite material that can withstand the extreme changes in temperature it will undergo moving from Earth to L2.

In addition to being red, the sights targeted by James Webb will be very faint, necessitating giant optics with seven times the light-collecting area of Hubble's primary mirror. The JWST's mirror will be 6.5 metres wide and made of 18 hexagonal-shaped segments that can be folded up like leaves of a drop-leaf table to fit inside the cone of a rocket for launch. The mirror must then unfurl after liftoff and open into the correct configuration so that each segment locks into place — no easy feat. The tennis court-size sunshield, too, will be tightly tucked in for launch and must unwrap once in orbit. "We designed something that doesn't fit into a rocket" without folding, says Scott Willoughby, JWST Program at Northrop Grumman Aerospace Systems, NASA's primary contractor for the mission. "That made it complex."

Some of the complexity seems to have been underestimated in the early 2000s, when the telescope was initially expected to cost under US$2 billion and launch around 2010. After budget overruns and schedule slips caused fed-up lawmakers to threaten cancellation of the project in 2011, NASA came up with a new plan to launch the JWST in 2018 for $8.7 billion. Since then, the project has been proceeding on schedule and within its (quadrupled) budget. "The JWST is on track until the next problem, and given what they are trying to do, the next problem is just around the corner," says Roger Handberg, a space policy expert at the University of Central Florida. "Cutting edge is still cutting edge." The budget for James Webb now takes up about half of NASA's astrophysics allotment each year, prompting nicknames like "the telescope that ate astronomy." "The money question is a question we have to ask ourselves as a country," JWST Deputy Project Scientist Amber Straughn said at Goddard in January. "Is it worth it? I think Webb will be worth it many times over."

Although James Webb has already cleared many of its biggest design and construction hurdles, the next four years until launch will feature stringent testing of every component to make sure they can withstand the rigors of launch and the coldness and vacuum of space. The coming years will also see the observatory's separate elements finally combined and working together. "It's not the home stretch but maybe we've got bases loaded," Willoughby says. "It's at a phase now where to me it's the part of the program I love the most, because it's real. Everyday when you get up, you're working on hardware."

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