# The Incredible Journey of the James Webb Space Telescope

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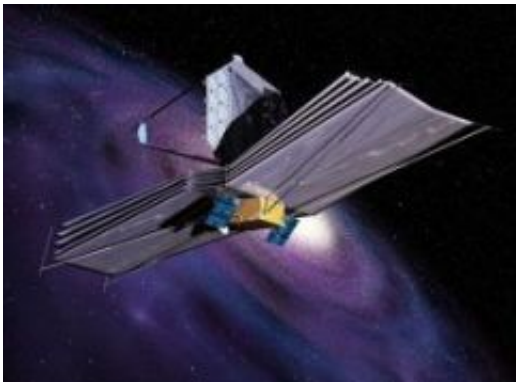

The James Webb Space Telescope, an artist's concept. Credit: ESA.

The James Webb Space Telescope, targeted for launch in 2013, is already taking an incredible journey right here on Earth. It's zigzagging up, down, and across the US to be "spit and polished" to perfection for its lofty space mission.

"To find the first stars and galaxies that formed in the early universe, which are millions and even billions of light years away, the Webb telescope mirror has to be wickedly smooth," says Jeff Kegley of NASA's Marshall Space Flight Center.

To get ready for space, the 18 mirror segments that will ultimately form the Webb telescope's huge primary mirror are trucked from pit stop to pit stop in tandem cross-country for careful processing and polishing.

They visit seven different states, some several times.

During the long odyssey, every precaution is taken for their protection. How many years of bad luck would you have if you broke one of these mirrors?

"That's something we don't talk about," laughs Helen Cole, also of Marshall. "But seriously, we do have three spare segments, so no problem there."

Let's trace a mirror segment's Earthly journey from rough start to "wickedly smooth," and finally to union with its 17 siblings to form a 6.5 meter (21 ½ foot) wide whole with a total area of 25 square-meters (almost 30 square yards).

The story begins in a Utah beryllium mine. Beryllium is one of the lightest of all metals, and the "stuff" of the telescope's mirrors.

Technicians in Ohio sift and purify the gritty beryllium powder from Utah into an extremely uniform optical grade especially for the Webb mirror. Then they pour the powder in a big, flat can, apply heat and pressure, and pump out the residual gas to create a large slab called a mirror billet. They bathe the billet in acid to burn off any stainless steel stuck to the billet when the can is removed. Next they split the billet in half Oreo-cookie-style to form two mirror blanks (no cream!). These mirror blanks are the largest ever produced in beryllium.

Workers in Alabama machine the back of each blank into a honeycomb structure to make the blanks lighter without reducing stiffness. The machined ribs are less than 1 millimeter thick -- almost paper cut thin!

"This precision machining/etching removes 92 percent of a blank's mass," says Lee Feinberg of the Goddard Space Flight Center. "Mass is

critical in launching space missions."

Next, a California company grinds and polishes the segments to a very smooth and exact shape and optically tests them at room temperature.

But the Webb telescope will not operate in room temperature. Not only will this telescope mirror be "wickedly smooth," it will also be wickedly cold in space. Because it is an infrared telescope, the JWST is designed to pick up the heat of faint, awesomely distant stars and galaxies. To do that it has to be kept extremely cold. It will operate in space at about -238 deg Celsius (-396 deg Fahrenheit, 35K).

"The extreme cold may cause the telescope's structures and mirrors to change shape, so testing has to be done here on Earth under similar, hyper-cold conditions," says Cole.

This super-cold testing is done in Alabama. The Marshall Space Flight Center's X-ray & Cryogenic Facility has a vacuum chamber that can simulate the incredibly cold conditions of space. Testing in this chamber reveals even the tiniest distortions that happen to the mirror segments in the cold. The tests provide precise data that specifies the exact repolishing to be done to compensate ahead of time for distortions likely to occur in space.

Once the mirror segments are polished to precision, gold is evaporated over them, forming a very thin coating on the smooth mirror surface.

"This gold coating is highly reflective over all the wavelengths of the Webb telescope, from visible to mid-infrared," says Feinberg.

All 18 segments finally meet at Goddard Space Flight Center. Here, they're mounted on structures that will ultimately hold them in place and let them perform as if they were part of a single giant hexagonal mirror.

(The mirror structure will be folded with its shield origami style when it's time to fit in a rocket.) Next the telescope is fully assembled and attached to the instrument module, and the whole kit and caboodle is acoustic and vibration tested.

Final cryogenic testing takes place at Johnson Space Center, in the same vacuum chamber that tested the Apollo lunar lander.

The telescope is integrated with the spacecraft and sunshield at Northrop Grumman in California. It will lift-off from Kourou, French Guiana, on an Ariane 5 rocket.

Are we there yet? Almost. Only 930,000 more miles to go....

Source: by Dauna Coulter, Science@NASA