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00:00:13,439 --> 00:00:18,089  
At the Johnson Space Center in Houston, Texas...  
you can walk along a Saturn V rocket that

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00:00:18,089 --> 00:00:22,859  
was designed to help humans get to the moon.  
But now, this center is helping NASA prepare

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00:00:22,859 --> 00:00:28,019  
for our next great adventure in astronomy:  
a telescope what will look way past the moon

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00:00:28,019 --> 00:00:31,528  
out to the universe's farthest horizons.

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00:00:31,528 --> 00:00:36,000  
Here is the vacuum chamber that was used to  
test spacecraft during the Apollo era, so

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00:00:36,000 --> 00:00:38,689  
Lee, I understand it's being used for the  
James Webb Space Telescope, too?

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00:00:38,689 --> 00:00:40,538  
Lee Feinberg/JWST Optical Telescope Element  
Manager: Yes, this is where we will be doing

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00:00:40,539 --> 00:00:45,579  
the full-scale test of the James Webb Space  
Telescope, including the telescope and the

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00:00:45,579 --> 00:00:50,070  
instruments, and we're going to be doing  
optical testing and thermal testing of those

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00:00:50,070 --> 00:00:50,820  
components.

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00:00:50,820 --> 00:00:55,488  
We've seen tests before but this is like  
the largest scale that we've done so far

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00:00:55,488 --> 00:00:56,248  
on Webb, right?

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00:00:56,249 --> 00:01:00,409  
Yeah, in fact, it's probably the largest optical test that NASA has ever done and that's

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00:01:00,408 --> 00:01:03,350  
because Webb is the largest space telescope we've ever built. So we're going to be

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00:01:03,350 --> 00:01:07,500  
testing the full primary mirror, which is 6 1/2 meters in diameter ... And we're going

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00:01:07,500 --> 00:01:10,120  
to be testing the whole telescope and the instruments with it.

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00:01:10,120 --> 00:01:14,890  
So before we get in there, give us a preview of what's been done to prepare for this

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00:01:14,890 --> 00:01:15,859  
test right now.

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00:01:15,859 --> 00:01:19,340  
Well, first of all, this is the first test where we actually have flight hardware. It's

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00:01:19,340 --> 00:01:24,260  
the Aft Optics System which is part of the telescope itself. We've put the Aft Optics

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00:01:24,260 --> 00:01:28,469  
System onto the Pathfinder telescope, which is a model of the telescope and includes primary

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00:01:28,469 --> 00:01:33,659  
mirror segments on it. We then put that Pathfinder telescope with the Aft Optics system onto

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00:01:33,659 --> 00:01:37,539  
a large structure and a rail system that allowed us to put it in the chamber.

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00:01:37,540 --> 00:01:40,790  
So, what's the real purpose of the test?

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00:01:40,790 --> 00:01:44,630  
We're going to be cooling the telescope  
down and we're going to be making sure that

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00:01:44,629 --> 00:01:49,659  
all of the mirrors are aligned the way they're  
supposed to be and also that the system as

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00:01:49,659 --> 00:01:54,280  
a telescope really works the way we expect  
at the very cold temperatures that it'll

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00:01:54,280 --> 00:01:57,799  
be at in space. It looks like they're all  
set up for the tests, so let's get out of

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00:01:57,799 --> 00:01:59,539  
the chamber now.

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00:01:59,540 --> 00:02:04,270  
Now they're going to be closing the chamber  
door. The liquid nitrogen is used to cool

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00:02:04,269 --> 00:02:09,049  
the inside of the vacuum shell to about 70  
degrees above absolute zero. But inside of

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00:02:09,050 --> 00:02:13,330  
that is a helium shell. The helium shell is  
what cools us to even colder temperatures

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00:02:13,330 --> 00:02:16,030  
to the 30 to 50 degrees above absolute zero.

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00:02:16,030 --> 00:02:19,180  
We're now well into the optical testing.

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00:02:19,180 --> 00:02:21,090  
So what do you mean by optical testing?

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00:02:21,090 --> 00:02:24,789  
We actually put light through the entire telescope  
chain, including the tertiary mirror and the

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00:02:24,789 --> 00:02:25,620

fine steering mirror.

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00:02:25,620 --> 00:02:30,009

Do you want to see some of the images from light that's going through the entire telescope?

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00:02:30,009 --> 00:02:30,689

Oh yeah!

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00:02:30,689 --> 00:02:32,409

Let me show you that.

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00:02:32,409 --> 00:02:36,340

We actually simulate what looks like little stars running through the entire end-to-end

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00:02:36,340 --> 00:02:41,159

telescope and um, by looking at how these stars go through focus, we can understand what the

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00:02:41,159 --> 00:02:43,000

telescope is doing.

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00:02:43,000 --> 00:02:47,259

So that's how you test the end-to-end telescope through the full light path. How about the

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00:02:47,259 --> 00:02:49,000

primary mirror alone?

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00:02:49,000 --> 00:02:53,919

We use special test equipment that lets us test the primary mirror just by itself and

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00:02:53,919 --> 00:02:57,899

by doing that, we can determine the alignment of each of the mirror segments individually,

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00:02:57,900 --> 00:03:02,209

but also how they relate to each other and make sure that they are aligned properly.

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00:03:02,209 --> 00:03:06,860

When we have the full telescope, we'll have 18 of these hexagons. The pathfinder only

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00:03:06,860 --> 00:03:11,420

has two mirror segments but it's enough to really let us practice all the things we

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00:03:11,419 --> 00:03:13,799

need to practice in terms of the testing and the alignment.

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00:03:13,800 --> 00:03:16,860

The images look like they have fingerprints on them?

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00:03:16,860 --> 00:03:21,750

Yeah, those fingerprints are really just contour maps ... kind of like taking slices through

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00:03:21,750 --> 00:03:25,979

a mountain. As we tilt the mirrors around, the contour maps tell us how much the mirrors

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00:03:25,979 --> 00:03:29,869

are tilted and we use that information as we align the primary mirror.

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00:03:29,870 --> 00:03:34,240

What's the deal with this dark line right here, through one of the primary mirror segments?

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00:03:34,240 --> 00:03:39,170

Yes, so that is just a shadow from the big strut that holds the secondary mirror. Remember

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00:03:39,169 --> 00:03:43,509

the secondary mirror's on a tripod and so the light that is hitting the mirrors is actually

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00:03:43,509 --> 00:03:47,419

going and it's casting a shadow from that strut. And what we're trying to do is align

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00:03:47,419 --> 00:03:50,750

the mirrors to create essentially a single mirror.

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00:03:50,750 --> 00:03:55,090

Ok, so we're finishing up the test. And what we're doing is sort of reversing the

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00:03:55,090 --> 00:03:59,860

process of getting it in. We have to be very careful with all of the sensitive hardware,

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00:03:59,860 --> 00:04:01,340

including flight hardware, that we're removing.

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00:04:01,340 --> 00:04:06,150

Well, thanks, Lee, for your time and letting us see what the first large-scale test on

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00:04:06,150 --> 00:04:07,390

James Webb has been like.

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00:04:07,389 --> 00:04:09,289

You're very welcome.

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00:04:09,289 --> 00:04:14,030

The Aft Optics System has been removed from the test setup and will be joining other flight

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00:04:14,030 --> 00:04:19,348

hardware for more testing at NASA's Goddard Space Flight Center in Greenbelt, MD. Thanks

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00:04:19,348 --> 00:04:21,968

for joining us for this edition of Behind the Webb.