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00:00:13,099 --> 00:00:17,699
The James Webb Space Telescope will be launched into the extreme cold of space

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00:00:17,699 --> 00:00:22,289
To deal with these harsh environments, engineers of the observatory used special

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00:00:22,289 --> 00:00:27,299
materials to build it. Well, one of the instruments, NIRSPEC, or Near Infrared Spectrograph,

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00:00:27,300 --> 00:00:31,000
used silicon carbide. What exactly is silicon carbide?

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00:00:31,000 --> 00:00:36,509
We're here at Astrium, in Ottobrunn, Germany to find out. So, Guenther, I guess this is silicon carbide.

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00:00:36,509 --> 00:00:42,589
What's so special about it? Guenther Kling/Astrium: It's two times stiff than steel and five times stiff than

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00:00:42,590 --> 00:00:47,250
aluminum. Silicon carbide is a ceramic material and it offers outstanding

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00:00:47,250 --> 00:00:53,000
properties to fulfill the mission of NIRSPEC. So ceramic... like porcelain?

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00:00:53,000 --> 00:00:58,939
Yeah, in principal, yes. It's a lightweight design, you see. The material offers high stability.

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00:00:58,939 --> 00:01:02,500
The optics stays aligned and that is very important for this mission.

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00:01:02,500 --> 00:01:07,000
I can show you this piece within NIRSPEC when we are in the cleanroom.

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00:01:07,000 --> 00:01:13,430

Mary, do you recognize the piece of silicon carbide I have shown outside? Oh yeah, that bar right there.

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00:01:13,430 --> 00:01:17,979

It is part of an optical element on NIRSPEC. What parts are silicon carbide?

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00:01:17,978 --> 00:01:23,000

every gray-colored item you see here is made out of silicon carbide.

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00:01:23,000 --> 00:01:27,000

It's representing 75% of the structure you see.

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00:01:27,000 --> 00:01:28,659

Do you guys does actually make silicon carbide?

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00:01:28,659 --> 00:01:33,109

We don't manufacture it here. Boostec in France are manufacturing these pieces out of silicon carbide.

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00:01:35,000 --> 00:01:37,000

Hi Michael. Michel Bougoin/Space Projects Manager - Boostec: Hello, Mary.

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00:01:37,000 --> 00:01:40,608

Guenther from Astrium told us that you guys make the

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00:01:41,000 --> 00:01:45,280

parts for NIRSPEC out of silicon carbide. What exactly is silicon carbide?

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00:01:46,000 --> 00:01:51,000

Silicon carbide is a synthetic material made from the chemical reaction

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00:01:51,000 --> 00:01:53,039

at high temperature of silica sand and carbon.

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00:01:53,039 --> 00:01:56,000

Can I touch it? Yes.

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00:01:57,000 --> 00:02:02,539

Kinda looks like a meteorite.. Now, is this is stuff that NIRSPEC is made of then?

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00:02:03,000 --> 00:02:09,030

No. In fact for NIRSPEC, we have to crush this into fine powder

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00:02:09,030 --> 00:02:14,000
like this one. Typically one micron in grain size.

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00:02:14,000 --> 00:02:16,500
So, is this the stuff then that goes into making NIRSPEC?

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00:02:16,500 --> 00:02:21,128
Not yet. There is a further step where we press this powder into blocks

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00:02:22,000 --> 00:02:27,189
We have just got the blank for NIRSPEC base plate. I will show it to you now.

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00:02:28,099 --> 00:02:34,000
This material is still very brittle and it feels like chalk or chocolate.

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00:02:34,000 --> 00:02:38,000
It can be break by hand like that. It can be easily machined because the material is soft.

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00:02:38,000 --> 00:02:43,000
Guenther told us that this is going to be a ceramic. Is it a ceramic now?

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00:02:43,000 --> 00:02:47,000
No it is not yet a ceramic. It will become a ceramic after being sintered.

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00:02:47,000 --> 00:02:49,000
And sintered means what?

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00:02:49,000 --> 00:02:55,000
Sintering involves a treatment at high temperature, typically more than 2,000 degrees Celsius.

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00:02:56,000 --> 00:03:00,000
What is interesting here is that you can see that it is machined very quickly.

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00:03:00,000 --> 00:03:02,000
This just gives him a flat surface to work with?

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00:03:03,000 --> 00:03:05,500
He has to get a flat surface and also the good thickness.

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00:03:07,000 --> 00:03:13,000

We have seen the pressed block and afterwards, we have to machine it.... And to machine it, it's done with milling machines.

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00:03:13,000 --> 00:03:15,000

And you're using these programs to program the machine?

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00:03:15,500 --> 00:03:20,069

Yes, we are simulating the program of the big base plate of NIRSPEC.

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00:03:21,699 --> 00:03:27,000

Once we put the part in the milling machine, we start green machining.

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00:03:27,000 --> 00:03:31,000

It is here that we shape the part. This will take roughly two weeks.

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00:03:31,000 --> 00:03:33,000

Where do we go after this?

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00:03:33,000 --> 00:03:36,568

The part will be sintered in order to transform the compact of powder into the ceramic.

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00:03:38,000 --> 00:03:40,000

What's he doing now?

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00:03:40,000 --> 00:03:42,568

He's preparing the measurement of this part with this coordinate measuring machine.

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00:03:44,000 --> 00:03:46,909

He will measure the flatness of this area here.

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00:03:46,909 --> 00:03:49,000

How precise to his measurements have to be?

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00:03:49,000 --> 00:03:51,000

Precise in the range of a few micrometers.

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00:03:52,650 --> 00:03:55,000

In one millimeter, you have one thousand micrometers.

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00:03:56,000 --> 00:03:59,000
Here is non-destructive inspection of the parts.

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00:03:59,000 --> 00:04:01,000
We first spray the dye penetrant,

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00:04:02,000 --> 00:04:06,000
then we rinse it off, then we dry it

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00:04:06,000 --> 00:04:10,000
and we inspect it in the darkroom under UV light

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00:04:11,000 --> 00:04:13,000
and if we have cracks in the part,

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00:04:13,000 --> 00:04:15,500
we are able to see them with this technique.

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00:04:16,500 --> 00:04:18,500
For space applications, we do not tolerate any crack.

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00:04:19,000 --> 00:04:22,918
If we have a small one, we will remove it by grinding. We are able to do that.

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00:04:25,000 --> 00:04:29,000
The UV allows us seeing the cracks and the big holes.

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00:04:29,500 --> 00:04:32,000
here, we are looking for very small holes.

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00:04:32,000 --> 00:04:35,000
And this is on top of the process we just saw with the UV light.

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00:04:35,000 --> 00:04:37,550
What's he preparing to do now?

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00:04:37,550 --> 00:04:42,000
This laser scanning head allows us to make 3D model very quickly

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00:04:42,000 --> 00:04:45,000
and to compare the real model with the theoretical one.

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00:04:47,000 --> 00:04:49,000

You have here some NIRSPEC samples.

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00:04:49,000 --> 00:04:56,000

You have NIRSPEC mirror, flat mirror, structure part of NIRSPEC, which have been sintered.

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00:04:56,000 --> 00:04:58,000

And now you can touch it, the material is not brittle.

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00:04:59,000 --> 00:05:03,000

While silicon carbide is used the build space telescopes like Webb

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00:05:04,000 --> 00:05:06,959

its unique properties are valuable for things right here on Earth

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00:05:06,959 --> 00:05:10,000

like the water pump in
your car.

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00:05:11,699 --> 00:05:13,589

Thanks for joining us for this edition of Behind the Webb.