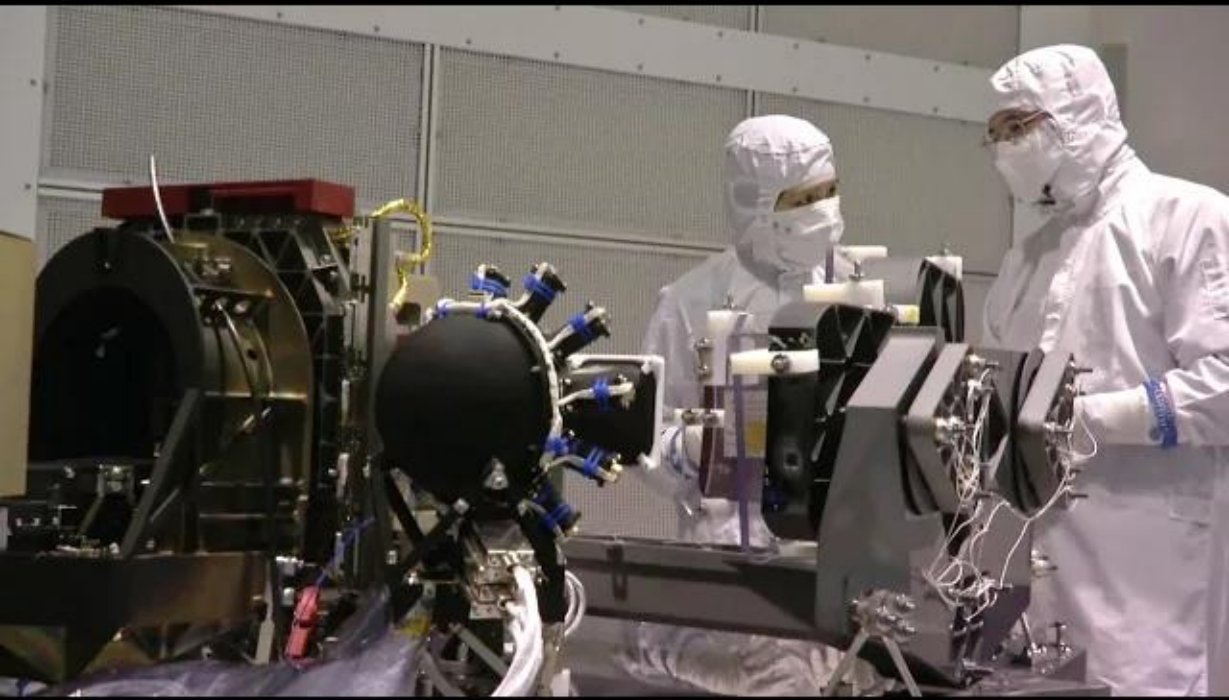

1
00:00:13,100 --> 00:00:17,700
The James Webb Space Telescope will be
launched into the extreme cold of space

2
00:00:17,700 --> 00:00:22,290
To deal with these harsh environments,
engineers of the observatory used special

3
00:00:22,290 --> 00:00:27,300
materials to build it. Well, one of the
instruments, NIRSPEC, or Near Infrared Spectrograph,

4
00:00:27,300 --> 00:00:31,000
used silicon carbide. What
exactly is silicon carbide?

5
00:00:31,000 --> 00:00:36,510
We're here at Astrium, in Ottobrunn, Germany to find out.
So, Guenther, I guess this is silicon carbide.

6
00:00:36,510 --> 00:00:42,590
What's so special about it? Guenther Kling/Astrium: It's two times
stiff than steel and five times stiff than

7
00:00:42,590 --> 00:00:47,250
aluminum. Silicon carbide is a ceramic
material and it offers outstanding

8
00:00:47,250 --> 00:00:53,000
properties to fulfill the mission of NIRSPEC. So ceramic... like porcelain?

9
00:00:53,000 --> 00:00:58,940
Yeah, in principal, yes. It's a lightweight design, you see. The
material offers high stability.

10
00:00:58,940 --> 00:01:02,500
The optics stays aligned and that is very
important for this mission.

11

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

12
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.

13
00:01:13,430 --> 00:01:17,979
It is part of an optical element on NIRSPEC. What parts are silicon carbide?

14
00:01:17,979 --> 00:01:23,000
every gray-colored item you see here is made out of silicon
carbide.

15
00:01:23,000 --> 00:01:27,000
It's representing 75% of the structure you see.

16
00:01:27,000 --> 00:01:28,659
Do you guys does actually make silicon carbide?

17
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.

18
00:01:35,000 --> 00:01:37,000
Hi Michael. Michel Bougoin/Space Projects Manager - Boostec: Hello, Mary.

19
00:01:37,000 --> 00:01:40,609
Guenther from Astrium told us that you guys make the

20
00:01:41,000 --> 00:01:45,280
parts for NIRSPEC out of
silicon carbide. What exactly is silicon carbide?

21
00:01:46,000 --> 00:01:51,000
Silicon carbide is a synthetic material made
from the chemical reaction

22
00:01:51,000 --> 00:01:53,039

at high temperature of silica sand and carbon.

23
00:01:53,039 --> 00:01:56,000
Can I touch it? Yes.

24
00:01:57,000 --> 00:02:02,539
Kinda looks like a meteorite.. Now, is
this is stuff that NIRSPEC is made of then?

25
00:02:03,000 --> 00:02:09,030
No. In fact for NIRSPEC, we have
to crush this into fine powder

26
00:02:09,030 --> 00:02:14,000
like this one. Typically one micron in
grain size.

27
00:02:14,000 --> 00:02:16,500
So, is this the stuff then that goes into making NIRSPEC?

28
00:02:16,500 --> 00:02:21,129
Not yet. There
is a further step where we press this powder into blocks

29
00:02:22,000 --> 00:02:27,190
We have just got the
blank for NIRSPEC base plate. I will show it to you now.

30
00:02:28,100 --> 00:02:34,000
This material is still very brittle and it feels like chalk or chocolate.

31
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.

32
00:02:38,000 --> 00:02:43,000
Guenther told us that this is going to be a ceramic. Is it a ceramic now?

33
00:02:43,000 --> 00:02:47,000
No it is not yet a ceramic. It will become a ceramic after being sintered.

34
00:02:47,000 --> 00:02:49,000
And sintered means what?

35
00:02:49,000 --> 00:02:55,000
Sintering involves a treatment at high temperature, typically more than 2,000 degrees Celsius.

36
00:02:56,000 --> 00:03:00,000
What is interesting here is that you can see that it is machined very quickly.

37
00:03:00,000 --> 00:03:02,000
This just gives him a flat surface to work with?

38
00:03:03,000 --> 00:03:05,500
He has to get a flat surface and also the good thickness.

39
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 mil

40
00:03:13,000 --> 00:03:15,000
And you're using these programs to program the machine?

41
00:03:15,500 --> 00:03:20,070
Yes, we are simulating the program of the big base plate of NIRSPEC.

42
00:03:21,700 --> 00:03:27,000
Once we put the part in the milling machine, we
start green machining.

43
00:03:27,000 --> 00:03:31,000
It is here that we shape the part. This will take roughly two weeks.

44
00:03:31,000 --> 00:03:33,000
Where do we go after this?

45
00:03:33,000 --> 00:03:36,569
The part will be sintered in order to transform the compact of powder into the ceramic.

46
00:03:38,000 --> 00:03:40,000
What's he doing now?

47
00:03:40,000 --> 00:03:42,569
He’s preparing the measurement of this part with this coordinate measuring machine.

48
00:03:44,000 --> 00:03:46,910
He will measure the flatness of this area here.

49
00:03:46,910 --> 00:03:49,000
How precise to his measurements have to
be?

50
00:03:49,000 --> 00:03:51,000
Precise in the range of a few micrometers.

51
00:03:52,650 --> 00:03:55,000
In one millimeter, you have one thousand micrometers.

52
00:03:56,000 --> 00:03:59,000
Here is non-destructive inspection of the parts.

53
00:03:59,000 --> 00:04:01,000
We first spray the dye penetrant,

54
00:04:02,000 --> 00:04:06,000
then we rinse it off, then we dry it

55
00:04:06,000 --> 00:04:10,000
and we inspect it in the darkroom under UV light

56
00:04:11,000 --> 00:04:13,000
and if we have cracks in the part,

57
00:04:13,000 --> 00:04:15,500
we are able to see them with this technique.

58

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

59
00:04:19,000 --> 00:04:22,919
If we have a small one, we will remove it by grinding. We are able to do that.

60
00:04:25,000 --> 00:04:29,000
The UV allows us seeing the cracks and the big holes.

61
00:04:29,500 --> 00:04:32,000
here, we are looking for very small holes.

62
00:04:32,000 --> 00:04:35,000
And this is on top of the process we just saw with the UV light.

63
00:04:35,000 --> 00:04:37,550
What’s he preparing to do now?

64
00:04:37,550 --> 00:04:42,000
This laser scanning head allows us to make 3D model very quickly

65
00:04:42,000 --> 00:04:45,000
and to compare the real model with the theoretical one.

66
00:04:47,000 --> 00:04:49,000
You have here some NIRSPEC samples.

67
00:04:49,000 --> 00:04:56,000
You have NIRSPEC mirror, flat mirror, structure part of NIRSPEC, which have been sintered.

68
00:04:56,000 --> 00:04:58,000
And now you can touch it, the material is not brittle.

69
00:04:59,000 --> 00:05:03,000
While silicon carbide is used the build space telescopes like Webb

70
00:05:04,000 --> 00:05:06,960
its unique properties are valuable for things right here on Earth