
10
SPACE STATION RESEARCH:
TOP TEN RESULTS

1
00:00:02,919 --> 00:00:06,319
[Music]

2
00:00:06,319 --> 00:00:19,960
>> This is NASA TV.

3
00:00:19,960 --> 00:00:23,359
[Music]

4
00:00:23,359 --> 00:00:28,580
>> There have been hundreds of science experiments
and technology research projects onboard the

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00:00:28,580 --> 00:00:34,280
International Space Station since the first
modules of that station were launched 15 years

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00:00:34,280 --> 00:00:35,280
ago.

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00:00:35,280 --> 00:00:40,159
The research has covered things like human
life sciences, in order to find out how being

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00:00:40,159 --> 00:00:44,909
in that environment impacts people, and to
find out ways to mitigate the negative effects

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00:00:44,909 --> 00:00:51,289
of that, as well as research in biology and
physical sciences, and astronomical sciences

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00:00:51,289 --> 00:00:57,190
and technology development, and research to
support future human exploration beyond low

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00:00:57,190 --> 00:00:58,449
earth orbit.

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00:00:58,449 --> 00:01:02,229
And much of this has been done with an eye
toward how what we've learned in space can

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00:01:02,229 --> 00:01:05,650
be applied to help people here on earth.

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00:01:05,650 --> 00:01:09,829
For a recent international conference, the
International Space Station Chief Scientist,

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00:01:09,829 --> 00:01:14,370
Dr. Julie Robinson, was asked to put together
a list of the top 10 research results from

16
00:01:14,370 --> 00:01:18,130
the space station, and she joins us today
to talk about some of those.

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00:01:18,130 --> 00:01:25,259
Julie, give us a brief reminder of the criteria
that you used when you thought about all that's

18
00:01:25,259 --> 00:01:30,579
been done onboard the station in these years,
to try to decide which were the top 10 results.

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00:01:30,579 --> 00:01:31,579
>> Sure.

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00:01:31,579 --> 00:01:36,609
You know, I took all, I have these great lists,
in my head at least, of all the wonderful

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00:01:36,609 --> 00:01:39,090
things that the space station has accomplished.

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00:01:39,090 --> 00:01:44,840
And I, I set aside all the engineering achievements,

I set aside all the advancements in international

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00:01:44,840 --> 00:01:48,799
relations and how we work with other countries
in space, set that aside.

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00:01:48,799 --> 00:01:55,021
I set aside all the spinoffs where a new technology
has led to life-saving devices on earth, and

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00:01:55,021 --> 00:01:58,960
I just focused on the research results from
the research that we've been doing over the

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00:01:58,960 --> 00:01:59,960
last 15 years.

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00:01:59,960 --> 00:02:05,840
I looked at those results for examples where
either it was, you know, a significant scientific

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00:02:05,840 --> 00:02:11,220
publication in a major journal, or where it
was, had a very direct connection, right back

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00:02:11,220 --> 00:02:13,989
to people's lives on earth, and I really drew
from those.

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00:02:13,989 --> 00:02:18,760
I also used inputs from some of my colleagues,
and, but, of course, the list was painful

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00:02:18,760 --> 00:02:22,909
to develop, because there are many more than
10 outstanding research results that have

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00:02:22,909 --> 00:02:23,909
come from the space station.

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00:02:23,909 --> 00:02:28,040
But I, but I was forced to limit myself to
10, so I did.

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00:02:28,040 --> 00:02:30,200
>> And there are more, but we'll, we'll talk
about those 10 here.

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00:02:30,200 --> 00:02:35,750
And a lot of times when we talk about the
science research onboard the station, we have

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00:02:35,750 --> 00:02:40,980
a tendency to think about the, the things
that we see astronauts and cosmonauts working

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00:02:40,980 --> 00:02:45,209
on, but I want you to repeat something that
I've heard you talk about before, and, and

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00:02:45,209 --> 00:02:51,879
that's that we do a disservice to the overall
thing, if we neglect all of the, some of the

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00:02:51,879 --> 00:02:55,269
things that go on that really don't have human
crew member involvement.

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00:02:55,269 --> 00:02:56,269
>> Right.

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00:02:56,269 --> 00:02:59,830
We actually design experiments to have as
little crew involvement as needed, so we can

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00:02:59,830 --> 00:03:02,640
do as many things at one time as we possibly
can.

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00:03:02,640 --> 00:03:07,650
A great example of that is the Alpha Magnetic Spectrometer, it takes, literally, no crew

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00:03:07,650 --> 00:03:08,650
time.

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00:03:08,650 --> 00:03:10,200
Maybe once a year they reboot the computer.

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00:03:10,200 --> 00:03:18,079
But it has collected over 20 billion observations of galactic cosmic rays since it went up in

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00:03:18,079 --> 00:03:19,079
2011.

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00:03:19,079 --> 00:03:20,980
And it had significant papers that came out this year.

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00:03:20,980 --> 00:03:24,860
The most significant papers from that experiment are definitely yet to come.

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00:03:24,860 --> 00:03:29,470
And, so, even when the crew's asleep, there's a huge amount of science data coming down.

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00:03:29,470 --> 00:03:34,280
>> Well it's not, of course, to say that the human crew doesn't play a role, and number

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00:03:34,280 --> 00:03:37,340
5 on the top 10 list, is just one example of that.

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00:03:37,340 --> 00:03:42,530
Number 5 is pathway for bacterial pathogens to become virulent.

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00:03:42,530 --> 00:03:47,920
Now this was a result that was supported by
the crew members, but, I believe the investigation

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00:03:47,920 --> 00:03:52,760
actually grew out of a concern for the health
of the crew on space, in space.

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00:03:52,760 --> 00:03:53,760
>> That's right.

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00:03:53,760 --> 00:03:57,040
When we've done some studies of crew members
health, one of the things we found is crew

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00:03:57,040 --> 00:03:59,060
member's immune function is disrupted.

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00:03:59,060 --> 00:04:02,640
So, we would actually expect them to get sick
more often than they do, they're also incredibly

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00:04:02,640 --> 00:04:07,159
healthy people and so that may be part of
why they don't, and there was some ground-based

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00:04:07,159 --> 00:04:13,469
data that suggested some kinds of bacteria
might be, be more able to grow in space.

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00:04:13,469 --> 00:04:19,170
So, originally, our human research program
funded a study of salmonella bacteria in space,

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00:04:19,170 --> 00:04:24,230
those are bacteria that cause foodborne illness,
you know, a lot of people around the country

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00:04:24,230 --> 00:04:28,130
have had salmonella, it's, also it kills people
all around the world.

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00:04:28,130 --> 00:04:32,090
You get that foodborne illness and if, if
you don't have access to hospital care and

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00:04:32,090 --> 00:04:35,340
get a severe case, you know, people can definitely
die of salmonella food poisoning.

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00:04:35,340 --> 00:04:39,720
The, and so, originally it was funded by NASA's
Human Research Program, because they were

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00:04:39,720 --> 00:04:44,270
worried about if a few salmonella got into
the food supply, say on a mission to Mars,

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00:04:44,270 --> 00:04:47,940
it could become a life-threatening event,
and, and you could lose, you know, it becomes

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00:04:47,940 --> 00:04:49,840
a risk to losing the mission.

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00:04:49,840 --> 00:04:56,960
So, they funded a study to test the bacterial
growth of salmonella in space, and echoing

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00:04:56,960 --> 00:05:01,770
the ground analog studies that had been done
ahead of time, when, when those bacteria were

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00:05:01,770 --> 00:05:07,740
grown in space, brought back home and infected
in an animal model, the, they were much more

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00:05:07,740 --> 00:05:13,600

pathogenic, they were much more able to cause
illness, and so that was a really significant

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00:05:13,600 --> 00:05:18,100
result, it was published in the proceedings
of the National Academy of Sciences, and what

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00:05:18,100 --> 00:05:22,200
was most important about it scientifically,
was not just that they became more able to

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00:05:22,200 --> 00:05:28,380
cause illness, it was that scientists were
able to determine the genes that had turned

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00:05:28,380 --> 00:05:30,770
off, on, to cause that to happen.

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00:05:30,770 --> 00:05:36,370
So it was a new genetic pathway for causing
illness that had not been identified before.

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00:05:36,370 --> 00:05:43,260
>> Did the bacteria even stronger, or more
capable of causing illness in that environment

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00:05:43,260 --> 00:05:44,720
than it would have been on earth?

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00:05:44,720 --> 00:05:45,720
>> Right.

83
00:05:45,720 --> 00:05:46,720
Right.

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00:05:46,720 --> 00:05:51,440
And by understanding that pathway that opens
up the knowledge to go in and intervene.

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00:05:51,440 --> 00:05:55,910
So that opens up the possibility of either
figuring out some kind of treatment, that

86
00:05:55,910 --> 00:06:00,230
if somebody has salmonella could help, help
them get better quicker, or even potentially

87
00:06:00,230 --> 00:06:04,620
finding a way to have a vaccine, where if
somebody could be inoculated and be more resistant

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00:06:04,620 --> 00:06:05,960
to salmonella.

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00:06:05,960 --> 00:06:08,200
So those early results were quite compelling.

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00:06:08,200 --> 00:06:11,800
They had to be followed up, so they were repeated
in a follow-on study.

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00:06:11,800 --> 00:06:15,510
Scientists started changing the media that
they were growing in to see if they could

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00:06:15,510 --> 00:06:20,680
show that that pathway was really important
and those results came back significant more

93
00:06:20,680 --> 00:06:21,740
published.

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00:06:21,740 --> 00:06:27,260
So then the, the research teams kind of split
up into a number of different groups who have

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00:06:27,260 --> 00:06:31,030
been looking at ways to advance that further.

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00:06:31,030 --> 00:06:35,140
So there's one team at the Arizona State University
Bio-Design Institute, and they're looking

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00:06:35,140 --> 00:06:40,840
at ways to take that knowledge and transfer
it to the development of other kinds of vaccines.

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00:06:40,840 --> 00:06:46,510
So if, so, for example, that university has
a vaccine in development for pneumonia, and

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00:06:46,510 --> 00:06:50,990
they're interested in seeing if they can use
a combination of salmonella and the pneumonia

100
00:06:50,990 --> 00:06:53,270
together to find a vaccine that might be more
effective.

101
00:06:53,270 --> 00:06:57,890
It might help, especially older people who
don't respond really well to the current pneumonia

102
00:06:57,890 --> 00:06:59,280
vaccines.

103
00:06:59,280 --> 00:07:03,510
A separate team, which was a commercially-funded
team, called Astrogenetics, flew a number

104
00:07:03,510 --> 00:07:06,400
of additional on-orbit studies.

105
00:07:06,400 --> 00:07:12,710
They tried flying a, a small roundworm called
C. elegans, it's often used as a model for

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00:07:12,710 --> 00:07:16,240

higher organisms to, and, and it gets infected
by salmonella as well.

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00:07:16,240 --> 00:07:19,620
So they tried flying that model to really
understand the mechanisms, see if they could

108
00:07:19,620 --> 00:07:20,970
hone in on a vaccine.

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00:07:20,970 --> 00:07:25,860
And right now, all of that future work hasn't
come to, to fruition yet.

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00:07:25,860 --> 00:07:28,110
It, science takes some time.

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00:07:28,110 --> 00:07:32,660
But the reason I called out this result, first
of all, because it was such a significant

112
00:07:32,660 --> 00:07:36,740
advancement in its own right, in terms of,
that you would study bacteria in space and

113
00:07:36,740 --> 00:07:40,220
that you could really learn something novel
about bacteria by studying them in space,

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00:07:40,220 --> 00:07:45,360
and it's definitely, that knowledge is now
tumbling around in the scientific community

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00:07:45,360 --> 00:07:49,270
and people are seeking the different ways
to take that and leverage it to make something

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00:07:49,270 --> 00:07:56,510
that's, that's really good for, for improving
health on earth, and now, just recently, you

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00:07:56,510 --> 00:07:59,590
know, there's been additional work that's
been started to see about taking that knowledge

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00:07:59,590 --> 00:08:03,840
and really turning it into a vaccine by a
university that's very good at developing

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00:08:03,840 --> 00:08:05,550
vaccines and has done that in the past.

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00:08:05,550 --> 00:08:10,310
So, it takes time, but I'm really, I, I think
just watching the development of this case,

121
00:08:10,310 --> 00:08:13,090
over the last years has been really great.

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00:08:13,090 --> 00:08:18,060
>> The next result on our list, includes one
of the biggest numbers that's associated with,

123
00:08:18,060 --> 00:08:20,360
with anything here.

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00:08:20,360 --> 00:08:26,300
Number 4 on the list is 43 million students,
and counting.

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00:08:26,300 --> 00:08:30,960
You're talking, you're counting, figuring
43 million students have been involved, in

126
00:08:30,960 --> 00:08:34,960
some way, with space station educational endeavors.

127
00:08:34,960 --> 00:08:40,409
And I liked to get you to try to flesh that

out, start with some examples of, of students

128
00:08:40,409 --> 00:08:44,729
who have actually had their own experiments
fly in space.

129
00:08:44,729 --> 00:08:45,800
>> That's right.

130
00:08:45,800 --> 00:08:51,160
Google, YouTube had a contest where they,
students from all around the world proposed

131
00:08:51,160 --> 00:08:52,980
what experiment, what they would do in the
space station.

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00:08:52,980 --> 00:08:58,160
It was a huge contest, they had to post YouTube
videos of what they would like to do and why,

133
00:08:58,160 --> 00:09:02,670
and then the two winners of that contest both
had their experiments carried out by the astronauts

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00:09:02,670 --> 00:09:06,629
last year, one of them will be publishing
those results in the Scientific Journal.

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00:09:06,629 --> 00:09:11,389
It's, it's really amazing to see what students
can do when they're offered access to such

136
00:09:11,389 --> 00:09:12,389
an innovative platform.

137
00:09:12,389 --> 00:09:18,800
>> Are there, are there other similar projects,
where, where kids are flying their own experiments?

138
00:09:18,800 --> 00:09:24,360
>> Another area, which is amazing, is through
the, the NanoRack System, students are able

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00:09:24,360 --> 00:09:29,060
to fly, basically small, contained packages
and, and send those up to the space station.

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00:09:29,060 --> 00:09:32,269
There are schools that actually raise the
money every year for their science fair projects,

141
00:09:32,269 --> 00:09:33,699
to go to the space station.

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00:09:33,699 --> 00:09:37,610
We don't pay them to do that at NASA, but
the, but the schools through NanoRacks and

143
00:09:37,610 --> 00:09:41,589
through CASIS, the Center for the Advancement
of Science in Space, can actually take advantage

144
00:09:41,589 --> 00:09:43,710
of that opportunity to use ISS.

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00:09:43,710 --> 00:09:49,650
>> And, and to, to stop there, for just a
moment, CASIS is an organization that's designed

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00:09:49,650 --> 00:09:55,180
to help, not just students, but a lot of,
of other people outside of NASA, take advantage

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00:09:55,180 --> 00:09:56,649
of, of this laboratory.

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00:09:56,649 --> 00:09:57,649
>> Right.

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00:09:57,649 --> 00:10:02,920
CASIS works with other government agencies,
like NIH or, or NOA, or the National Science

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00:10:02,920 --> 00:10:08,160
Foundation, they also work with the private
sector, commercial companies, FARMA, industrial

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00:10:08,160 --> 00:10:12,819
companies, materials companies, and then also
education organizations and non-profits, to

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00:10:12,819 --> 00:10:17,350
help the taxpayer, all of us, get absolutely
everything we can out of the space station,

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00:10:17,350 --> 00:10:21,600
to facilitate all those groups having access
and to do innovative things.

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00:10:21,600 --> 00:10:25,589
>> In terms of the way the station's touching
students, there are other ways that students

155
00:10:25,589 --> 00:10:29,009
are involved without flying their own experiments,
as such.

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00:10:29,009 --> 00:10:33,490
What are, what are some of the other projects
or experiments that they're involved in?

157
00:10:33,490 --> 00:10:38,839
>> Yeah, we've had about 1.7 million students
that have done something we call inquiry-base

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00:10:38,839 --> 00:10:42,790
learning, and that means the student's were
looking at, or learning about an experiment

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00:10:42,790 --> 00:10:46,699
that was going on on the space station and
doing a parallel experiment in their classroom

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00:10:46,699 --> 00:10:47,699
on the ground.

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00:10:47,699 --> 00:10:50,829
They were developing their own hypotheses,
testing what would happen, and really doing

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00:10:50,829 --> 00:10:55,140
real science, and that's been shown, inquiry-based
learning has been shown to be one of the most

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00:10:55,140 --> 00:10:59,689
fundamental things that changes a student's
interest in math and science, because they

164
00:10:59,689 --> 00:11:04,459
really start asking their own questions, not
just memorizing terms or looking at equations,

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00:11:04,459 --> 00:11:08,649
but really asking questions and answering
them, so that, that's incredibly influential

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00:11:08,649 --> 00:11:12,810
in our nation, to have that many students
involved in space experiments.

167
00:11:12,810 --> 00:11:17,560
Then, the other millions of students that,
that I talked about, to make that 43 million,

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00:11:17,560 --> 00:11:23,189
those students have mostly participated in
a variety of other investigations, or other

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00:11:23,189 --> 00:11:28,499
activities where they could watch astronauts,
videos of astronauts demonstrating things,

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00:11:28,499 --> 00:11:32,519
showing Newton's laws of motion, for example,
there are, are great videos and curriculums

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00:11:32,519 --> 00:11:37,379
out there using those different tools, teacher's
use those in their classrooms, just grab them

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00:11:37,379 --> 00:11:41,529
and show a little byte, really encouraged
the students, they'll hear it from an astronaut

173
00:11:41,529 --> 00:11:43,920
in a little different way than they hear it
from their regular teacher.

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00:11:43,920 --> 00:11:48,291
>> And, and there's a lot of different kinds
of experiments that, over the years, station

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00:11:48,291 --> 00:11:53,120
crew members have participated in to do that,
sometimes they even get a chance to talk directly

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00:11:53,120 --> 00:11:54,120
to students.

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00:11:54,120 --> 00:11:55,350
>> That's right.

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00:11:55,350 --> 00:11:57,240
Students talk to astronauts in two ways.

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00:11:57,240 --> 00:12:02,709
One is is there's a whole ham radio organization

that volunteers the ARIS [phonetic] organization.

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00:12:02,709 --> 00:12:06,660
They volunteer to connect the astronauts and
do the connections on the ground so that the

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00:12:06,660 --> 00:12:10,029
astronauts who are sort of in the evenings
on the space station, after their work day

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00:12:10,029 --> 00:12:14,629
is over, if they want to make a contact, they
can talk to a, a classroom back on earth and

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00:12:14,629 --> 00:12:18,751
the classrooms get prepared, ask questions
about the science that they're doing, ask

184
00:12:18,751 --> 00:12:21,830
questions about what it's like to live and
work in space.

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00:12:21,830 --> 00:12:26,870
Another thing, we have our education downlinks,
where schools can be set up, in a school assembly,

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00:12:26,870 --> 00:12:31,019
the astronaut comes on the television loop,
the students can ask questions, they'll have

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00:12:31,019 --> 00:12:34,430
contests at school to decide which are the
good questions and students get to ask them

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00:12:34,430 --> 00:12:35,620
and the astronaut answers them.

189
00:12:35,620 --> 00:12:41,389
There are really great opportunities for students
to learn about space and to really understand

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00:12:41,389 --> 00:12:43,800
how important a part of our future it really
is.

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00:12:43,800 --> 00:12:48,110
>> And there are, I, I know, particularly,
some other things, like the SPHERES experiments,

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00:12:48,110 --> 00:12:54,059
or the EarthKAM investigation, where there
are millions of people who've been involved

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00:12:54,059 --> 00:12:55,059
in some way.

194
00:12:55,059 --> 00:12:56,059
>> Oh yeah.

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00:12:56,059 --> 00:12:59,930
And Sally Ride EarthKAM is, is one of the
longest-running education activities we've,

196
00:12:59,930 --> 00:13:01,050
we've had on the space station.

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00:13:01,050 --> 00:13:04,550
Middle school students control a camera that's
mounted in the window.

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00:13:04,550 --> 00:13:08,949
They learn about the earth, they develop the
files to tell the camera when to take pictures.

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00:13:08,949 --> 00:13:10,259
Students at U.C.

200
00:13:10,259 --> 00:13:13,959
San Diego run a little mission control center

to put those together and control the camera

201
00:13:13,959 --> 00:13:17,000
on the space station, and we actually have
some.

202
00:13:17,000 --> 00:13:21,999
A flight controller, in mission control today,
who was an EarthKAM student early in her career.

203
00:13:21,999 --> 00:13:24,389
So these are really influential activities.

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00:13:24,389 --> 00:13:28,370
>> Our next result on the list is something
that I always think of as kind of a science

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00:13:28,370 --> 00:13:31,069
fiction-y characteristic to it.

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00:13:31,069 --> 00:13:34,449
Number three, dark matter is still out there.

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00:13:34,449 --> 00:13:40,790
Because it wasn't that long ago that dark
matter was something in, in science fiction.

208
00:13:40,790 --> 00:13:47,470
A, as you described it in the blog, give me
the non-astrophysicist version of, of what

209
00:13:47,470 --> 00:13:48,470
we're talking about.

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00:13:48,470 --> 00:13:49,470
What is dark matter?

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00:13:49,470 --> 00:13:53,819
>> Yeah, so I'm definitely not an astrophysicist,

so I have a, have a genuine biologist viewpoint

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00:13:53,819 --> 00:13:54,819
of astrophysics.

213
00:13:54,819 --> 00:13:58,379
>> Maybe give the journalist viewpoint, which
is even simpler.

214
00:13:58,379 --> 00:14:02,339
>> [Laughing] So, you know, basically, if
you add up, if you do all the math and you

215
00:14:02,339 --> 00:14:06,009
add up everything in the universe, there's
a whole bunch of mass out there that we can't

216
00:14:06,009 --> 00:14:07,009
see.

217
00:14:07,009 --> 00:14:11,249
And there are different theories for what
that might be, but the best theory is the

218
00:14:11,249 --> 00:14:12,249
theory of dark matter.

219
00:14:12,249 --> 00:14:16,059
That there's a bunch of matter that is not
reflecting or glowing in any way and so we

220
00:14:16,059 --> 00:14:17,410
just can't see it.

221
00:14:17,410 --> 00:14:21,629
It's not, you know, whereas we can see stars,
you know, those of evidence of matter out

222
00:14:21,629 --> 00:14:22,850

there.

223
00:14:22,850 --> 00:14:28,990
So, that requires a set of theoretical processes
that haven't really been measured, and that,

224
00:14:28,990 --> 00:14:32,879
one of the things that boils out of that theory
is if there was dark matter that makes sense

225
00:14:32,879 --> 00:14:36,790
to the physics we know today, those particles,
every now and then, should bump into each

226
00:14:36,790 --> 00:14:41,949
other, and annihilate each other, and that
would produce positrons.

227
00:14:41,949 --> 00:14:44,720
So positrons are little positive particles,
you can think about them as.

228
00:14:44,720 --> 00:14:49,670
>> As evidence of this collision, which is
evidence of their existence.

229
00:14:49,670 --> 00:14:50,670
>> Right.

230
00:14:50,670 --> 00:14:51,670
Right.

231
00:14:51,670 --> 00:14:55,329
Now there's some other things that produce
positrons, out there, that we understand,

232
00:14:55,329 --> 00:14:59,270
astronomical sources that we can measure and
we understand, and so what physicists have

233
00:14:59,270 --> 00:15:05,050
been focusing on to understand whether dark
matter is out there, is looking at the positrons

234
00:15:05,050 --> 00:15:09,019
they can measure that are coming from the
universe all around.

235
00:15:09,019 --> 00:15:13,939
So the Alpha-Magnetic Spectrometer is the
most sophisticated tool we've ever had for

236
00:15:13,939 --> 00:15:19,240
measuring the galactic cosmic rays, including
positrons that I talked about, and, as I mentioned,

237
00:15:19,240 --> 00:15:25,339
they've had over 20 billion observations now,
that's a lot of data to sift through.

238
00:15:25,339 --> 00:15:30,170
They published in the, in the early spring,
they published their first publication, physical

239
00:15:30,170 --> 00:15:34,350
review letters, and in that they looked just
at the positron data that they had, not at

240
00:15:34,350 --> 00:15:41,670
all the other particles, and they looked only
at the energies from 0 to 300 gigaelectronvolts.

241
00:15:41,670 --> 00:15:49,689
Now the instrument goes from 300 to 1,000
gigaelectronvolts, or 1 teravolt, teraelectronvolt,

242
00:15:49,689 --> 00:15:53,911
that data's rarer, those are higher energy
particles, so that's still data to come, but

243
00:15:53,911 --> 00:15:58,309
up to 300, that's, the, that's the data that
other instruments have occasionally able to

244
00:15:58,309 --> 00:16:01,010
measure, instruments like [inaudible].

245
00:16:01,010 --> 00:16:06,329
So what AMS did, because it's, it's got so
much statistical power from getting all these

246
00:16:06,329 --> 00:16:10,129
observations, is when they publish their data,
it's the best data that science has ever had,

247
00:16:10,129 --> 00:16:13,449
on how many positrons there are in the universe,
and where they're coming from and what their

248
00:16:13,449 --> 00:16:14,449
energies are.

249
00:16:14,449 --> 00:16:18,490
>> And it's getting all this data because
it's up on the space station, it's there all

250
00:16:18,490 --> 00:16:19,490
the time.

251
00:16:19,490 --> 00:16:20,490
>> Right.

252
00:16:20,490 --> 00:16:21,490
Right.

253
00:16:21,490 --> 00:16:22,490
This is an enormous magnet.

254

00:16:22,490 --> 00:16:26,540
The magnet is, you know, essentially the size
of a small house.

255
00:16:26,540 --> 00:16:31,949
And, and so this, this enormous magnet up
there is collecting these, measuring the direction

256
00:16:31,949 --> 00:16:37,110
they're coming, measuring their masses, measuring
their energies, and what Nobel laureate, Dr.

257
00:16:37,110 --> 00:16:43,290
Sam Ting and his team of over 350 collaborators,
were able to publish early in the year is

258
00:16:43,290 --> 00:16:48,600
basically they showed that with all of this
data, there are way too many positrons in

259
00:16:48,600 --> 00:16:49,899
the universe.

260
00:16:49,899 --> 00:16:53,920
That they're not explained by all those other
processes that are well-known in astronomy.

261
00:16:53,920 --> 00:16:59,029
There are a lot of high energy positrons that
just aren't explained by any other phenomenon.

262
00:16:59,029 --> 00:17:02,869
So the careful astrophysicists, you know,
they're not going to say that's evidence of

263
00:17:02,869 --> 00:17:07,240
dark matter, because you can't prove something
by just measuring there's too much of something.

264
00:17:07,240 --> 00:17:08,810

>> But it, but it must be something.

265
00:17:08,810 --> 00:17:12,901
>> But it means there's something there, and
that something is not explained by all the

266
00:17:12,901 --> 00:17:17,339
other theories, it's not explained by looking
at pulsars and looking at, at, you know, all

267
00:17:17,339 --> 00:17:22,900
the other processes that we see going on in
the universe, so it support for all of the,

268
00:17:22,900 --> 00:17:25,209
the theories about what dark matter and dark
energy are.

269
00:17:25,209 --> 00:17:28,820
>> Yeah, there, it's coming from somewhere,
something has caused it.

270
00:17:28,820 --> 00:17:34,180
And this, this is a great example of the International
Space Station as a science platform.

271
00:17:34,180 --> 00:17:40,650
There are other things like, similar to the
AMS, that are using the station as a, a place

272
00:17:40,650 --> 00:17:43,050
to be in order to gather this information.

273
00:17:43,050 --> 00:17:44,050
>> Right.

274
00:17:44,050 --> 00:17:47,800
Professor Ting put, put the AMS on the space
station just because we have these amazing

275
00:17:47,800 --> 00:17:51,790
solar rays, all this power, all this data,
it would have required building an enormous

276
00:17:51,790 --> 00:17:55,740
satellite, much bigger than any satellites
we ever built for astronomy, in order to support

277
00:17:55,740 --> 00:17:58,800
this large magnet, and space station was the
perfect place to do it.

278
00:17:58,800 --> 00:18:03,190
>> And there are other investigations that
are, are taking advantage of the same, the

279
00:18:03,190 --> 00:18:04,190
same perch.

280
00:18:04,190 --> 00:18:10,890
>> Yeah, we'll have another astrophysics payload
going up called CREAM, looking at, at other

281
00:18:10,890 --> 00:18:14,880
aspects of cosmic rays and, of course, the
earth science instruments, there are dozens

282
00:18:14,880 --> 00:18:18,500
of those either going up soon or being planned.

283
00:18:18,500 --> 00:18:24,010
It's really becoming a key platform for both
looking at space and looking down at earth.

284
00:18:24,010 --> 00:18:27,960
>> Next on the list is something that's grown
out of one of the biggest machines on the

285
00:18:27,960 --> 00:18:29,280

space station.

286
00:18:29,280 --> 00:18:32,880
Number 2 is robotic-assist for brain surgery.

287
00:18:32,880 --> 00:18:37,460
In this case, the result is, is thanks to
a lot of work that was on the ground to create

288
00:18:37,460 --> 00:18:41,990
a spinoff from critical station hardware,
that was developed by one of the stations

289
00:18:41,990 --> 00:18:43,210
international partners.

290
00:18:43,210 --> 00:18:44,210
>> That's right.

291
00:18:44,210 --> 00:18:47,960
And I said I didn't include spinoffs, so I
have to tell you why I did include this one,

292
00:18:47,960 --> 00:18:51,960
and that's because it wasn't really, it's
not like you could just take the technology

293
00:18:51,960 --> 00:18:56,660
from the space station and use it on people's
brains, it took a lot of research in between

294
00:18:56,660 --> 00:18:58,620
there, it took a lot of science in between
there to get it.

295
00:18:58,620 --> 00:18:59,620
>> Not a direct.

296
00:18:59,620 --> 00:19:01,890

>> It was not a direct spinoff from the space station.

297
00:19:01,890 --> 00:19:07,610
But, you know, the Canadarm and the Dexter, which is the, the fingers, essentially, of

298
00:19:07,610 --> 00:19:11,650
the Canadarm, were developed by the Canadian Space Agency, it's their major contribution

299
00:19:11,650 --> 00:19:16,630
to ISS, and our Canadian colleagues have extraordinary capabilities in robotics.

300
00:19:16,630 --> 00:19:21,680
The MDA, the company that designed that for the space station, in space hardening and

301
00:19:21,680 --> 00:19:26,840
developing reliability that was suitable for doing things like assembling a space station,

302
00:19:26,840 --> 00:19:33,000
or carrying an astronaut in space, once you do that, you have really pushed your technology

303
00:19:33,000 --> 00:19:34,580
in robotics.

304
00:19:34,580 --> 00:19:40,420
And you've also had to have technology that was resistant to, to radiation that was resistant

305
00:19:40,420 --> 00:19:42,180
to that harsh environment of space.

306
00:19:42,180 --> 00:19:47,190
So what they wound up with in minute, once they miniaturized it, was a robotic arm that

307
00:19:47,190 --> 00:19:52,920
could be used inside an MRI machine, successfully,
in that magnetic field.

308
00:19:52,920 --> 00:19:56,990
And now, of course, it's very small, and it
can be controlled by a neurosurgeon and it's

309
00:19:56,990 --> 00:19:59,910
more stable than the human hand can ever be.

310
00:19:59,910 --> 00:20:04,210
And that's enabled neurosurgeries and some
surgeries patients where there was no surgeon

311
00:20:04,210 --> 00:20:09,920
who could try to do the surgery, to remove
a tumor or to remove other problems, and they

312
00:20:09,920 --> 00:20:15,010
just published, in the Scientific Journal,
just two weeks, or two months ago, the results

313
00:20:15,010 --> 00:20:16,530
of their first 35 patients.

314
00:20:16,530 --> 00:20:19,380
The patient outcomes, where they've actually
followed them, not that they've recovered

315
00:20:19,380 --> 00:20:20,380
from the surgery.

316
00:20:20,380 --> 00:20:24,540
Those, those are reports about people who
are alive today because of the space station.

317
00:20:24,540 --> 00:20:26,870

>> And this is a thing called NeuroArm.

318
00:20:26,870 --> 00:20:27,870
>> Right.

319
00:20:27,870 --> 00:20:29,450
It's called the NeuroArm.

320
00:20:29,450 --> 00:20:33,060
>> Can you give me the, the quick version
of how this helps a surgeon.

321
00:20:33,060 --> 00:20:37,370
I mean, is it a thing that they hold that
has a scalpel on it?

322
00:20:37,370 --> 00:20:43,180
So the, so essentially, you know, the robotic
mechanism, they control it with some triggers

323
00:20:43,180 --> 00:20:48,110
and some controls here, and they're able to,
you know, they do what they need to with their

324
00:20:48,110 --> 00:20:52,401
hands, and then they're able to come in and
just excise a little tumor while the MRI is

325
00:20:52,401 --> 00:20:55,610
on so that they can get the position just
exact.

326
00:20:55,610 --> 00:20:56,710
And that's how it works.

327
00:20:56,710 --> 00:21:00,420
>> And it's the, the, the fineness of, of
it.

328

00:21:00,420 --> 00:21:05,100
It's ability to, to keep in one place that's important, because when you're working in

329
00:21:05,100 --> 00:21:07,430
the brain, there are areas you don't want to go.

330
00:21:07,430 --> 00:21:08,430
>> Right.

331
00:21:08,430 --> 00:21:09,430
Right.

332
00:21:09,430 --> 00:21:11,800
It's that fineness of control and then being able to do it in the MRI so you have the image

333
00:21:11,800 --> 00:21:14,680
to help you get just that one, precise place.

334
00:21:14,680 --> 00:21:18,700
>> Because anybody, anybody who's had an MRI knows about how you have to make sure you

335
00:21:18,700 --> 00:21:20,670
don't even have anything metal on you.

336
00:21:20,670 --> 00:21:21,670
>> That's right.

337
00:21:21,670 --> 00:21:22,670
>> As the patient.

338
00:21:22,670 --> 00:21:25,940
Now they're talking about taking the whole instrument inside that environment.

339
00:21:25,940 --> 00:21:26,940

>> Right.

340
00:21:26,940 --> 00:21:30,890
>> So it, it's not exactly directly a doctor's arm, but it is something that they control.

341
00:21:30,890 --> 00:21:32,070
>> That they're controlling, right.

342
00:21:32,070 --> 00:21:33,730
>> And it's saving lives in surgery.

343
00:21:33,730 --> 00:21:34,730
>> That's right.

344
00:21:34,730 --> 00:21:38,070
>> And it's also leading to some other research too, right?

345
00:21:38,070 --> 00:21:43,490
>> Well, so, you know, the, the, you get this feedback then, whenever you develop a new

346
00:21:43,490 --> 00:21:47,460
technology,, you bring it back to the ground, then you could bring those technologies back

347
00:21:47,460 --> 00:21:48,460
into space.

348
00:21:48,460 --> 00:21:51,790
So there's a back and forth as we make those technology advancements, and that's definitely,

349
00:21:51,790 --> 00:21:53,290
definitely what's going on with robotics.

350
00:21:53,290 --> 00:21:56,110
>> That's leading to those other things.

351
00:21:56,110 --> 00:21:59,410
Benefits on earth is, is something that we
always like to talk about, and that's certainly

352
00:21:59,410 --> 00:22:00,410
one of them.

353
00:22:00,410 --> 00:22:05,240
The benefit on earth that's associated with
the final item on the list is pretty apparent.

354
00:22:05,240 --> 00:22:10,900
The number one result, from the International
Space Station research, is new targeted methods

355
00:22:10,900 --> 00:22:18,420
of chemotherapy drug delivery with clinical
breast cancer trials now in development.

356
00:22:18,420 --> 00:22:19,420
Is that all?

357
00:22:19,420 --> 00:22:21,360
Are you just, just changing the way we treat
cancer?

358
00:22:21,360 --> 00:22:23,490
>> Well, cancer is not a thing.

359
00:22:23,490 --> 00:22:28,200
So, so we cannot cure it [laughing] and, and
nobody can cure it on earth, and nobody can

360
00:22:28,200 --> 00:22:29,440
cure it in space.

361
00:22:29,440 --> 00:22:35,940
But what we can do is take biomedical advancements

and find ways to use that special environment

362
00:22:35,940 --> 00:22:40,110
of space to advance our knowledge and, and
find an application that can really help patients

363
00:22:40,110 --> 00:22:45,920
on earth, and so, the way that this worked,
very early in ISS, back in Expedition 5, we

364
00:22:45,920 --> 00:22:52,690
had an experiment called MEPS, Microencapsulation
of Particles in Space, and it, the, the basic

365
00:22:52,690 --> 00:22:57,280
idea was that if you could make the right
kind of little balloon, and this is almost

366
00:22:57,280 --> 00:22:59,470
at that nanoscale we were talking about in
the beginning.

367
00:22:59,470 --> 00:23:04,331
If you can make the right kind of little balloon,
then you could put a, a cancer treatment drug

368
00:23:04,331 --> 00:23:08,720
inside of that and it would target, based
on the properties of the balloon, it would

369
00:23:08,720 --> 00:23:10,810
sort of target the target tissues.

370
00:23:10,810 --> 00:23:11,810
For example...

371
00:23:11,810 --> 00:23:13,000
>> To carry the drug to a particular.

372

00:23:13,000 --> 00:23:15,350
>> To carry the drug to the tumor, for example.

373
00:23:15,350 --> 00:23:20,420
And, and folks work on that because, you know,
cancer treatment drugs have so many horrible

374
00:23:20,420 --> 00:23:24,860
side effects, and they have their side effects
when they're hitting organs that don't have

375
00:23:24,860 --> 00:23:28,960
cancer, and so you want to find things about
those micro-balloons that will have them tend

376
00:23:28,960 --> 00:23:35,450
to want to go based on, you know, there molecular
traction, or based on their, the physiology,

377
00:23:35,450 --> 00:23:38,340
or based on a variety of things, you want
them to kind of go where the tumor is and

378
00:23:38,340 --> 00:23:39,940
not go other places.

379
00:23:39,940 --> 00:23:46,581
So, scientists thought that if you took convection,
that mixing that I talked about before, out

380
00:23:46,581 --> 00:23:50,910
of the equation, that you might be able to
get those little micro-balloons to self-assemble

381
00:23:50,910 --> 00:23:51,960
in space.

382
00:23:51,960 --> 00:23:55,030
And that those micro-balloons would have a
set of properties that nobody had been able

383
00:23:55,030 --> 00:23:56,570
to make on earth.

384
00:23:56,570 --> 00:23:59,380
So this, the scientists proved that they could
do it in space.

385
00:23:59,380 --> 00:24:03,510
Right after that, the Columbia accident happened,
and, but they had their results, and they

386
00:24:03,510 --> 00:24:05,520
couldn't fly in space again right away.

387
00:24:05,520 --> 00:24:10,010
So they came home and they sharpened their
pencils, and they spent five years developing

388
00:24:10,010 --> 00:24:14,400
a piece of equipment that could mimic space
enough to make those same micro-balloons on

389
00:24:14,400 --> 00:24:15,400
earth.

390
00:24:15,400 --> 00:24:18,429
>> So, I mean, in order to manufacture it
here instead of there?

391
00:24:18,429 --> 00:24:19,429
>> Right.

392
00:24:19,429 --> 00:24:23,040
Because you want to be able to make those
in clinically-relevant quantities in nice,

393
00:24:23,040 --> 00:24:27,960
clean, aseptic environments, so you have something

you're really willing to inject into patients.

394
00:24:27,960 --> 00:24:32,170
And so once that was approved, now they've
been refining techniques for how they would

395
00:24:32,170 --> 00:24:38,430
use that, that microencapsulation technology,
both to target, target tumors that are scheduled

396
00:24:38,430 --> 00:24:42,850
for ablation so that the ablation technologies
only affect the tumor and affect the surrounding

397
00:24:42,850 --> 00:24:44,360
tissues less, less.

398
00:24:44,360 --> 00:24:46,590
And also to deliver chemotherapy treatments.

399
00:24:46,590 --> 00:24:51,570
In some rodent models, they had real effectiveness
in treating tumors, sometimes 14 times more

400
00:24:51,570 --> 00:24:56,070
effective than the chemotherapy drug alone,
but they have not yet made it to human clinical

401
00:24:56,070 --> 00:24:57,070
trials.

402
00:24:57,070 --> 00:25:02,610
They just received some funding to do the
next stage of development so that they would

403
00:25:02,610 --> 00:25:07,410
be ready to start clinical trials very soon,
and they already have the protocols in place,

404

00:25:07,410 --> 00:25:11,670
that they could even do those at MD Anderson Cancer Center, but these things just take

405
00:25:11,670 --> 00:25:12,670
a little bit of time.

406
00:25:12,670 --> 00:25:16,070
And one of the reasons I, I put them on my top 10 list, I hadn't been talking about them

407
00:25:16,070 --> 00:25:19,860
for awhile, but they moved on, you know, I talked about them for awhile when they got

408
00:25:19,860 --> 00:25:24,310
the patent, and I thought here comes the FDA trials, and then nothing happened and nothing

409
00:25:24,310 --> 00:25:28,340
happened, because at each stage of this process, scientists have to raise money, they have

410
00:25:28,340 --> 00:25:29,790
to, to find the support.

411
00:25:29,790 --> 00:25:33,980
They have to answer the questions of regulators, and that's why I picked them as number one.

412
00:25:33,980 --> 00:25:38,140
Because just that determination, that these investigators have had, to keep taking that

413
00:25:38,140 --> 00:25:42,690
knowledge that came from space and overcoming each barrier when they couldn't keep flying

414
00:25:42,690 --> 00:25:45,600
to space, they figured out how to make it,

make it on the ground.

415
00:25:45,600 --> 00:25:47,910
When they figured it out how to make it on
the ground, now they're figuring out how to

416
00:25:47,910 --> 00:25:52,430
answer all the regulator's questions and then
keep moving that forward, it takes real dedication

417
00:25:52,430 --> 00:25:56,370
to take our space results and, and make them
save lives, and it's amazing.

418
00:25:56,370 --> 00:25:58,270
It's going to be amazing if this one pays
off.

419
00:25:58,270 --> 00:25:59,270
>> These are great.

420
00:25:59,270 --> 00:26:04,420
Is there anything that's going on in the station
now that has potential to be on next year's

421
00:26:04,420 --> 00:26:05,420
list?

422
00:26:05,420 --> 00:26:09,760
>> Well, you know, if I, if I had done the
list on a different day, I might have picked

423
00:26:09,760 --> 00:26:10,760
other things.

424
00:26:10,760 --> 00:26:17,050
I, I didn't talk about some of our great spinoffs,
for example, you know, right after the, the

425

00:26:17,050 --> 00:26:21,390
horrible hurricane in the Philippines, the
water treatment system that we developed for

426
00:26:21,390 --> 00:26:26,270
the space station, is, has been deployed over
the last 10 years now, all over the world,

427
00:26:26,270 --> 00:26:30,360
because it really works in disaster regions,
and, and that saves thousands of lives, prevented

428
00:26:30,360 --> 00:26:34,960
lots of cholera, and it, it was deployed right
out to the Philippines right after the, the

429
00:26:34,960 --> 00:26:36,750
hurricane came through.

430
00:26:36,750 --> 00:26:43,770
Also, you know, women in rural areas around
the world, from the far Arctic to Brazil and

431
00:26:43,770 --> 00:26:48,650
Kenya are having the opportunity to have the
ultrasound technology that we developed for

432
00:26:48,650 --> 00:26:53,780
astronauts to, to be used to help them screen
pregnancies so they can get to a hospital

433
00:26:53,780 --> 00:26:57,670
before they go into labor and have a complication
and that's credited with saving thousands

434
00:26:57,670 --> 00:26:58,670
of lives.

435
00:26:58,670 --> 00:27:01,770
There's a non-profit organization now that

is doing nothing but testing how to spread

436
00:27:01,770 --> 00:27:05,180
that technology around the world, working
with the World Health Organization.

437
00:27:05,180 --> 00:27:06,520
>> These are all very exciting.

438
00:27:06,520 --> 00:27:09,800
Thank you for, for helping us understand it
better.

439
00:27:09,800 --> 00:27:13,180
Julie Robinson is the International Space
Station's Chief Scientist.

440
00:27:13,180 --> 00:27:18,650
And you can read Julie's blog, A Lab Aloft,
online at blogs.nasa.gov.

441
00:27:18,650 --> 00:27:26,650
You can also follow along on Twitter at ISS_research,
and on Facebook, at facebook.com/iss.

442
00:27:26,650 --> 00:27:30,610
You can also see the station as its orbiting
above the earth when it passes above your

443
00:27:30,610 --> 00:27:35,860
location, you can find out where that is by
checking out our site, spotthestation.nasa.gov.

444
00:27:35,860 --> 00:27:40,110
I'll remind you too that you can keep up with
the mission onboard the International Space

445
00:27:40,110 --> 00:27:45,630
Station daily, here on NASA TV and online
at nasa.gov, by watching our space station

446
00:27:45,630 --> 00:27:47,370
live program, weekdays at 10 a.m.

447
00:27:47,370 --> 00:27:48,370
Central time.

448
00:27:48,370 --> 00:27:53,590
And you can catch up on the week's activities
every Friday by checking out nasa.gov for