
PAO

1
00:00:05,910 --> 00:00:03,590
we're talking this morning uh here with

2
00:00:09,350 --> 00:00:05,920
vic cooley he is the lead increment

3
00:00:11,030 --> 00:00:09,360
scientist for expeditions 33 and 34. vic

4
00:00:13,430 --> 00:00:11,040
i appreciate the

5
00:00:14,390 --> 00:00:13,440
hanging with us as we've waited to find

6
00:00:16,310 --> 00:00:14,400
out

7
00:00:18,230 --> 00:00:16,320
when this is going to happen let's start

8
00:00:20,230 --> 00:00:18,240
by getting you to explain

9
00:00:22,230 --> 00:00:20,240
what this small satellite deployer

10
00:00:24,070 --> 00:00:22,240
demonstration is all about

11
00:00:26,230 --> 00:00:24,080
well thank you pat

12
00:00:27,589 --> 00:00:26,240
good morning to you yes it's a pretty

13
00:00:29,109 --> 00:00:27,599

exciting day to be here in the flight

14
00:00:30,630 --> 00:00:29,119
control room

15
00:00:32,870 --> 00:00:30,640
the demonstration of the small set

16
00:00:35,110 --> 00:00:32,880
deployment system is all about adding

17
00:00:36,470 --> 00:00:35,120
yet one more capability to our wonderful

18
00:00:38,630 --> 00:00:36,480
space station

19
00:00:40,549 --> 00:00:38,640
you know the the small sad otherwise

20
00:00:43,110 --> 00:00:40,559
known as cubesat that design was

21
00:00:44,950 --> 00:00:43,120
actually engineered by cal poly back in

22
00:00:47,990 --> 00:00:44,960
1999

23
00:00:50,229 --> 00:00:48,000
and it included a deployer now jaxa has

24
00:00:51,910 --> 00:00:50,239
has modified that slightly and has

25
00:00:53,189 --> 00:00:51,920
launched it to the space station on the

26
00:00:55,350 --> 00:00:53,199
htv

27
00:00:57,750 --> 00:00:55,360
vehicle earlier this summer

28
00:00:59,910 --> 00:00:57,760
and now there are five satellites there

29
00:01:02,069 --> 00:00:59,920
and they will be ejected when we get to

30
00:01:04,630 --> 00:01:02,079
this activity which is now probably

31
00:01:06,550 --> 00:01:04,640
postponed because of the atv situation

32
00:01:08,950 --> 00:01:06,560
and the dam

33
00:01:11,750 --> 00:01:08,960
but it is to demonstrate that capability

34
00:01:12,870 --> 00:01:11,760
from a permanently manned uh orbiting

35
00:01:14,870 --> 00:01:12,880
vehicle

36
00:01:16,710 --> 00:01:14,880
so far these satellites have been

37
00:01:19,030 --> 00:01:16,720
ejected from

38
00:01:21,350 --> 00:01:19,040

non-manned vehicles which are

39
00:01:23,670 --> 00:01:21,360
very expensive to launch and the whole

40
00:01:25,270 --> 00:01:23,680
idea is about lowering cost

41
00:01:28,550 --> 00:01:25,280
if we can lower the cost by these

42
00:01:31,830 --> 00:01:28,560
payloads being a secondary payload on a

43
00:01:33,749 --> 00:01:31,840
rocket or in this case on the htv which

44
00:01:35,910 --> 00:01:33,759
is already carrying cargo to the space

45
00:01:38,390 --> 00:01:35,920
station then that makes it even lower

46
00:01:42,069 --> 00:01:38,400
cost for these small sats to be deployed

47
00:01:44,230 --> 00:01:42,079
so it is a matter of of expense as well

48
00:01:46,149 --> 00:01:44,240
as the efficacy of deploying them you

49
00:01:48,230 --> 00:01:46,159
don't have to have a dedicated rocket to

50
00:01:51,109 --> 00:01:48,240
launch what's really a small payload

51
00:01:53,109 --> 00:01:51,119
that's correct and uh you know we

52
00:01:55,270 --> 00:01:53,119
we want to continue lowering the cost as

53
00:01:57,830 --> 00:01:55,280
much as possible the the cost was

54
00:01:59,429 --> 00:01:57,840
lowered substantially just by having

55
00:02:02,069 --> 00:01:59,439
this design that we've had over the last

56
00:02:03,429 --> 00:02:02,079
10 years and and many small sats have

57
00:02:04,950 --> 00:02:03,439
already been launched that way from

58
00:02:06,469 --> 00:02:04,960
unmanned vehicles

59
00:02:08,389 --> 00:02:06,479
we would like to have that capability

60
00:02:10,469 --> 00:02:08,399
from the space station also it's

61
00:02:12,949 --> 00:02:10,479
possible to conceive that you might want

62
00:02:15,510 --> 00:02:12,959
to have satellites ready to go that

63
00:02:17,670 --> 00:02:15,520

needed some kind of tweaking or

64
00:02:19,589 --> 00:02:17,680
adjustment before you launched them they

65
00:02:21,350 --> 00:02:19,599
could be positioned on the space station

66
00:02:22,869 --> 00:02:21,360
and then that adjustments mechanical

67
00:02:25,110 --> 00:02:22,879
adjustments could be made by the crew

68
00:02:27,030 --> 00:02:25,120
members before they launch them for such

69
00:02:28,309 --> 00:02:27,040
dedicated purposes as

70
00:02:29,510 --> 00:02:28,319
as as

71
00:02:32,949 --> 00:02:29,520
monitoring

72
00:02:34,790 --> 00:02:32,959
disasters or other natural events

73
00:02:36,630 --> 00:02:34,800
i'll talk about some of these satellites

74
00:02:38,150 --> 00:02:36,640
later in their monitoring capabilities

75
00:02:39,990 --> 00:02:38,160
and is that what the crew members have

76
00:02:41,990 --> 00:02:40,000
been doing making those preparations

77
00:02:43,830 --> 00:02:42,000
those those adjustments to it

78
00:02:45,430 --> 00:02:43,840
oh no they haven't adjusted any of these

79
00:02:47,190 --> 00:02:45,440
satellites so we're just in the early

80
00:02:48,869 --> 00:02:47,200
stages of demonstrating that these

81
00:02:51,110 --> 00:02:48,879
satellites can actually be launched from

82
00:02:53,509 --> 00:02:51,120
the space station with this japanese

83
00:02:55,589 --> 00:02:53,519
ssod the small satellite orbital

84
00:02:57,430 --> 00:02:55,599
deployer okay we saw a piece of

85
00:02:59,509 --> 00:02:57,440
animation here while you were speaking a

86
00:03:01,190 --> 00:02:59,519
minute ago that i'm hoping we can get

87
00:03:03,110 --> 00:03:01,200
set up to run again because i want to

88
00:03:06,070 --> 00:03:03,120

ask you if you can talk us through the

89
00:03:07,589 --> 00:03:06,080
deployment procedure and tell me how the

90
00:03:09,750 --> 00:03:07,599
the crew and the flight controllers on

91
00:03:11,509 --> 00:03:09,760
the ground are going to work to to

92
00:03:13,589 --> 00:03:11,519
actually set these satellites out into

93
00:03:15,430 --> 00:03:13,599
orbit well first let me talk about the

94
00:03:18,070 --> 00:03:15,440
jim airlock and the gem remote

95
00:03:20,630 --> 00:03:18,080
manipulator system or jim rms the gem is

96
00:03:22,949 --> 00:03:20,640
the japanese experiment module it has an

97
00:03:25,110 --> 00:03:22,959
air lock which allows the crew to

98
00:03:26,949 --> 00:03:25,120
position

99
00:03:28,550 --> 00:03:26,959
in this case the satellite deployer in

100
00:03:30,390 --> 00:03:28,560
the air lock when it's and this is

101
00:03:33,190 --> 00:03:30,400
connected and open to the pressurized

102
00:03:35,910 --> 00:03:33,200
environment then they close the hatch

103
00:03:38,550 --> 00:03:35,920
behind the satellite deployer and then

104
00:03:39,670 --> 00:03:38,560
they can depressurize that air lock such

105
00:03:40,470 --> 00:03:39,680
that now

106
00:03:47,509 --> 00:03:40,480
the

107
00:03:50,309 --> 00:03:47,519
gem rms and

108
00:03:52,470 --> 00:03:50,319
and then uh positioned for deployment so

109
00:03:54,309 --> 00:03:52,480
if to to recap that the the crew members

110
00:03:56,949 --> 00:03:54,319
have the satellites inside the station

111
00:03:59,670 --> 00:03:56,959
but they attach it to this slide and

112
00:04:02,949 --> 00:03:59,680
through the air lock presented outside

113
00:04:05,190 --> 00:04:02,959

so that the japanese robotic arm can

114
00:04:07,429 --> 00:04:05,200
grab it and begin to manipulate put

115
00:04:10,070 --> 00:04:07,439
these out to be deployed yes and that's

116
00:04:13,509 --> 00:04:10,080
a it's it's a choreographed sequence of

117
00:04:15,910 --> 00:04:13,519
steps between the ground and aki hoshide

118
00:04:20,069 --> 00:04:15,920
on the space station so there's uh the

119
00:04:21,590 --> 00:04:20,079
way it starts out is uh aki will

120
00:04:23,909 --> 00:04:21,600
uh

121
00:04:26,550 --> 00:04:23,919
position the satellites on the table

122
00:04:27,350 --> 00:04:26,560
and he will then close the hatch such

123
00:04:30,390 --> 00:04:27,360
that

124
00:04:32,469 --> 00:04:30,400
the uh the satellites are now in the

125
00:04:34,390 --> 00:04:32,479
uh airlock and the hatch is closed on

126
00:04:36,390 --> 00:04:34,400
the inside he will then command uh the

127
00:04:38,390 --> 00:04:36,400
airlock to be depressed

128
00:04:39,990 --> 00:04:38,400
and he will open the hatch on the

129
00:04:41,749 --> 00:04:40,000
outside of the airlock and this is all

130
00:04:43,030 --> 00:04:41,759
by commanding he's not physically doing

131
00:04:45,110 --> 00:04:43,040
this himself

132
00:04:46,870 --> 00:04:45,120
and he will then command the table to

133
00:04:49,670 --> 00:04:46,880
slide out

134
00:04:52,230 --> 00:04:49,680
and now it's out in the vacuum of space

135
00:04:54,469 --> 00:04:52,240
and the ground will then command the gem

136
00:04:55,749 --> 00:04:54,479
rms a remote manipulator system much

137
00:04:57,990 --> 00:04:55,759
like our

138
00:04:59,590 --> 00:04:58,000

space station arm which but the space

139
00:05:00,870 --> 00:04:59,600
station arm is much bigger this is a

140
00:05:02,469 --> 00:05:00,880
smaller arm

141
00:05:04,710 --> 00:05:02,479
just on the gym section just for

142
00:05:07,670 --> 00:05:04,720
handling external payloads

143
00:05:09,830 --> 00:05:07,680
so the ground uh sipsy control

144
00:05:13,430 --> 00:05:09,840
at the jackson control center in scuba

145
00:05:14,629 --> 00:05:13,440
near tokyo will command the gym arm to

146
00:05:16,469 --> 00:05:14,639
grapple

147
00:05:18,629 --> 00:05:16,479
the extended

148
00:05:19,590 --> 00:05:18,639
slide table with the satellite deployer

149
00:05:22,310 --> 00:05:19,600
on it

150
00:05:25,029 --> 00:05:22,320
aki will then release the lock that

151
00:05:28,870 --> 00:05:25,039
holds the multi-purpose experiment

152
00:05:31,510 --> 00:05:28,880
platform or mpap on onto the slide table

153
00:05:33,909 --> 00:05:31,520
and then the rms is now it's being

154
00:05:35,029 --> 00:05:33,919
commanded from the ground it extracts

155
00:05:36,310 --> 00:05:35,039
that

156
00:05:39,670 --> 00:05:36,320
uh

157
00:05:42,469 --> 00:05:39,680
deployer from the the airlock slide

158
00:05:45,430 --> 00:05:42,479
table now at this point aki

159
00:05:49,270 --> 00:05:45,440
uh retracts the table into the airlock

160
00:05:52,230 --> 00:05:49,280
and the gem rms then moves to the deploy

161
00:05:55,990 --> 00:05:52,240
position for the satellites the deploy

162
00:05:58,870 --> 00:05:56,000
position is pointed 45 degrees away from

163
00:06:00,870 --> 00:05:58,880

nader and retrograde such that it won't

164
00:06:03,670 --> 00:06:00,880
interfere with the space station after

165
00:06:05,430 --> 00:06:03,680
the satellites are released

166
00:06:07,110 --> 00:06:05,440
what is it that these satellites are

167
00:06:09,270 --> 00:06:07,120
going to do uh

168
00:06:10,950 --> 00:06:09,280
you said there are five satellites uh in

169
00:06:13,510 --> 00:06:10,960
in general what's the mission of these

170
00:06:14,710 --> 00:06:13,520
uh satellites once they're deployed well

171
00:06:16,950 --> 00:06:14,720
let me talk a little bit about the

172
00:06:19,189 --> 00:06:16,960
satellites first as i mentioned this

173
00:06:20,710 --> 00:06:19,199
satellite design has been a standard for

174
00:06:23,270 --> 00:06:20,720
over 10 years now

175
00:06:25,510 --> 00:06:23,280
and they are 10 centimeter cubes

176
00:06:27,590 --> 00:06:25,520
weighing no more than 1.2 kilograms or

177
00:06:29,670 --> 00:06:27,600
about three pounds

178
00:06:31,350 --> 00:06:29,680
so in this particular case there are

179
00:06:33,350 --> 00:06:31,360
five of these satellites

180
00:06:35,670 --> 00:06:33,360
one of them is actually two of those 10

181
00:06:38,150 --> 00:06:35,680
centimeter cubic units

182
00:06:40,150 --> 00:06:38,160
each of the there are two

183
00:06:43,430 --> 00:06:40,160
shoots or jim

184
00:06:46,469 --> 00:06:43,440
satellite deployers and three of the 10

185
00:06:48,550 --> 00:06:46,479
centimeter cubes can fit in each chute

186
00:06:50,550 --> 00:06:48,560
the first deployment will be done by aki

187
00:06:52,790 --> 00:06:50,560
the second deployment will be done by by

188
00:06:55,589 --> 00:06:52,800

the sipsy ground control but in this

189
00:06:56,870 --> 00:06:55,599
case uh the five satellites consist of

190
00:06:58,070 --> 00:06:56,880
uh

191
00:07:00,950 --> 00:06:58,080
all of them

192
00:07:03,749 --> 00:07:00,960
uh with one exception were designed and

193
00:07:05,749 --> 00:07:03,759
built by students at universities

194
00:07:07,510 --> 00:07:05,759
one of them was built by san jose state

195
00:07:09,589 --> 00:07:07,520
university

196
00:07:10,629 --> 00:07:09,599
and that's called tech ed sat

197
00:07:12,070 --> 00:07:10,639
and

198
00:07:14,550 --> 00:07:12,080
it will

199
00:07:17,270 --> 00:07:14,560
need to refer to my notes here

200
00:07:19,510 --> 00:07:17,280
it transmits elapsed time temperature

201
00:07:21,270 --> 00:07:19,520
voltage and current and any error

202
00:07:23,350 --> 00:07:21,280
messages that have and that the

203
00:07:26,390 --> 00:07:23,360
microprocessor has encountered over a

204
00:07:28,950 --> 00:07:26,400
ham radio all of these satellites have

205
00:07:30,790 --> 00:07:28,960
solar panels on them to produce power

206
00:07:33,430 --> 00:07:30,800
and they all transmit signals of some

207
00:07:36,550 --> 00:07:33,440
sort in this case ham radio signals

208
00:07:38,790 --> 00:07:36,560
another satellite which is

209
00:07:41,270 --> 00:07:38,800
provided by the company called nanorax

210
00:07:43,350 --> 00:07:41,280
who in turn goes out and gathers

211
00:07:45,189 --> 00:07:43,360
customers who want to launch small

212
00:07:47,189 --> 00:07:45,199
satellites in this case their customer

213
00:07:48,629 --> 00:07:47,199

is a vietnamese university

214
00:07:50,869 --> 00:07:48,639
and that the students from that

215
00:07:53,589 --> 00:07:50,879
university have designed a satellite

216
00:07:56,309 --> 00:07:53,599
that will take images of the earth

217
00:07:58,790 --> 00:07:56,319
and possibly capture images of and be

218
00:08:02,070 --> 00:07:58,800
able to do ship tracking detect forest

219
00:08:03,909 --> 00:08:02,080
fires and do atmospheric research

220
00:08:07,749 --> 00:08:03,919
the other three satellites were designed

221
00:08:09,830 --> 00:08:07,759
by japanese students or or companies and

222
00:08:12,869 --> 00:08:09,840
one of them that is very interesting is

223
00:08:16,230 --> 00:08:12,879
uh is the fitsat this satellite actually

224
00:08:18,070 --> 00:08:16,240
has leds on it that flash very brightly

225
00:08:19,670 --> 00:08:18,080
but flashing is the key here because

226
00:08:21,990 --> 00:08:19,680
they're not on continuously they don't

227
00:08:25,029 --> 00:08:22,000
consume that much power but when they

228
00:08:27,990 --> 00:08:25,039
are on their their uh

229
00:08:30,390 --> 00:08:28,000
uh very bright so bright that you might

230
00:08:31,830 --> 00:08:30,400
be able to see them from ground sites uh

231
00:08:34,149 --> 00:08:31,840
within japan

232
00:08:37,509 --> 00:08:34,159
they're they're described as 100 watts

233
00:08:38,630 --> 00:08:37,519
of leds now a watt is a is a an amount

234
00:08:41,029 --> 00:08:38,640
of uh

235
00:08:42,790 --> 00:08:41,039
energy per time unit so since they're

236
00:08:45,110 --> 00:08:42,800
flashing you really have to take out the

237
00:08:47,110 --> 00:08:45,120
time aspect of it but they're they're

238
00:08:49,190 --> 00:08:47,120

extremely bright if you know how bright

239
00:08:50,150 --> 00:08:49,200
leds can be compared to regular light

240
00:08:54,070 --> 00:08:50,160
bulbs

241
00:08:56,870 --> 00:08:54,080
uh the second satellite from the uh

242
00:08:58,949 --> 00:08:56,880
from jaxa or from the japanese side

243
00:09:00,949 --> 00:08:58,959
is that the one that's actually twice as

244
00:09:03,670 --> 00:09:00,959
big as any of the others it's a two unit

245
00:09:06,310 --> 00:09:03,680
satellite and it transmits earth images

246
00:09:09,670 --> 00:09:06,320
taken with a fisheye lens

247
00:09:11,990 --> 00:09:09,680
uh and the the last satellite from the

248
00:09:15,430 --> 00:09:12,000
jackson side takes infrared pictures of

249
00:09:17,269 --> 00:09:15,440
the earth and transmits those to ground

250
00:09:19,750 --> 00:09:17,279
it's all it could be uh interesting to

251
00:09:21,269 --> 00:09:19,760
see when it when it happens

252
00:09:22,870 --> 00:09:21,279
as we mentioned the

253
00:09:25,990 --> 00:09:22,880
plan was that the satellites were going

254
00:09:28,150 --> 00:09:26,000
to be deployed tomorrow morning possibly

255
00:09:30,470 --> 00:09:28,160
about this time

256
00:09:34,389 --> 00:09:30,480
that plan is probably going to change as

257
00:09:36,470 --> 00:09:34,399
a result of the atv not undocking as

258
00:09:38,230 --> 00:09:36,480
well as a planning for a possible

259
00:09:41,030 --> 00:09:38,240
conjunction uh

260
00:09:42,949 --> 00:09:41,040
but uh it's it's another interesting

261
00:09:45,590 --> 00:09:42,959
scientific aspect of what's going on

262
00:09:47,990 --> 00:09:45,600
very briefly can give me a sense of what

263
00:09:50,389 --> 00:09:48,000

we can look forward to in science during

264
00:09:52,470 --> 00:09:50,399
expedition 33 and 34.

265
00:09:54,389 --> 00:09:52,480
well um in the near term i noticed you

266
00:09:56,310 --> 00:09:54,399
were talking about the spacex dragon

267
00:09:58,230 --> 00:09:56,320
vehicle docking soon

268
00:10:01,269 --> 00:09:58,240
there are two experiments coming up on

269
00:10:04,069 --> 00:10:01,279
that vehicle uh one is called micro six

270
00:10:07,190 --> 00:10:04,079
this looks at the uh the yeast fungus

271
00:10:09,590 --> 00:10:07,200
also known as the thrush uh

272
00:10:10,550 --> 00:10:09,600
fungus which people can get in their

273
00:10:12,870 --> 00:10:10,560
mouths

274
00:10:14,630 --> 00:10:12,880
uh it turns out that the yeast fungus is

275
00:10:17,269 --> 00:10:14,640
actually present on all of our bodies

276
00:10:19,750 --> 00:10:17,279
it's an opportunistic pathogen it's just

277
00:10:21,269 --> 00:10:19,760
waiting for a chance to flourish when a

278
00:10:23,910 --> 00:10:21,279
person's immune system becomes

279
00:10:26,230 --> 00:10:23,920
compromised and we know from

280
00:10:29,590 --> 00:10:26,240
from other studies that astronauts

281
00:10:32,389 --> 00:10:29,600
immune system just because they're uh

282
00:10:33,990 --> 00:10:32,399
out of their natural environment and in

283
00:10:36,230 --> 00:10:34,000
a microgravity environment their immune

284
00:10:38,630 --> 00:10:36,240
system does become compromised

285
00:10:40,710 --> 00:10:38,640
so there is you can understand that

286
00:10:42,630 --> 00:10:40,720
there would be a very serious health

287
00:10:44,389 --> 00:10:42,640
risk the yeast

288
00:10:46,630 --> 00:10:44,399

infections

289
00:10:48,310 --> 00:10:46,640
in this case so this experiment actually

290
00:10:50,389 --> 00:10:48,320
grows yeast in the microgravity

291
00:10:52,150 --> 00:10:50,399
environment and looks at the genetic

292
00:10:54,310 --> 00:10:52,160
changes that happen

293
00:10:56,150 --> 00:10:54,320
uh with that yeast growing uh in a

294
00:10:58,630 --> 00:10:56,160
microgravity environment

295
00:11:00,150 --> 00:10:58,640
another uh sorti experiment as we call

296
00:11:02,630 --> 00:11:00,160
it which will go up on the spacex

297
00:11:05,509 --> 00:11:02,640
vehicle and come down approximately 25

298
00:11:06,710 --> 00:11:05,519
or 30 days later on the same vehicle

299
00:11:08,870 --> 00:11:06,720
looks at

300
00:11:10,630 --> 00:11:08,880
plants and their resistance against

301
00:11:12,790 --> 00:11:10,640
gravity on the earth

302
00:11:14,790 --> 00:11:12,800
it turns out this experiment is called

303
00:11:17,750 --> 00:11:14,800
resist tubule

304
00:11:19,590 --> 00:11:17,760
and the the act of resisting

305
00:11:22,150 --> 00:11:19,600
the pull of gravity and being able to

306
00:11:23,590 --> 00:11:22,160
hold itself up is where the resistance

307
00:11:26,630 --> 00:11:23,600
come from

308
00:11:29,750 --> 00:11:26,640
the tubule refers to

309
00:11:31,590 --> 00:11:29,760
structures inside plant cells that give

310
00:11:34,150 --> 00:11:31,600
those cells their strength so that they

311
00:11:35,829 --> 00:11:34,160
can resist gravity so there are earth

312
00:11:37,990 --> 00:11:35,839
applications as well as space

313
00:11:40,790 --> 00:11:38,000

applications for this experiment on

314
00:11:42,949 --> 00:11:40,800
earth a plant can spend up to 50 percent

315
00:11:45,829 --> 00:11:42,959
of the energy it acquires from the sun

316
00:11:47,910 --> 00:11:45,839
just resisting gravity but as we

317
00:11:49,990 --> 00:11:47,920
continue to use genetically modified

318
00:11:51,990 --> 00:11:50,000
organisms for our food

319
00:11:53,910 --> 00:11:52,000
plants may not need to spend that much

320
00:11:55,670 --> 00:11:53,920
energy resistant gravity because they

321
00:11:58,230 --> 00:11:55,680
change their shape and so forth but they

322
00:12:01,110 --> 00:11:58,240
still may grow these these structures to

323
00:12:03,350 --> 00:12:01,120
resist gravity so if we can control how

324
00:12:05,269 --> 00:12:03,360
much energy the plant puts in resisting

325
00:12:07,670 --> 00:12:05,279
gravity we might be able to increase

326
00:12:10,550 --> 00:12:07,680
food production for plants on earth

327
00:12:12,870 --> 00:12:10,560
in space obviously for long duration

328
00:12:14,470 --> 00:12:12,880
trips it it would be very desirable to

329
00:12:16,310 --> 00:12:14,480
be able to for the astronauts to grow

330
00:12:18,710 --> 00:12:16,320
their own food in space and that it has

331
00:12:20,389 --> 00:12:18,720
space applications also that's great we

332
00:12:21,750 --> 00:12:20,399
look forward to seeing all that vic

333
00:12:23,670 --> 00:12:21,760
thanks for coming this morning

334
00:12:26,069 --> 00:12:23,680
appreciate it cooley is the lead