
NASA LIVE
OSIRIS-REx
ASTEROID SAMPLE COLLECTION ATTEMPT

1
00:04:37,189 --> 00:04:34,710
over 200 million miles away from earth

2
00:04:39,749 --> 00:04:37,199
osiris-rex is preparing for nasa's most

3
00:04:40,710 --> 00:04:39,759
ambitious sample return since the apollo

4
00:04:42,629 --> 00:04:40,720
program

5
00:04:44,950 --> 00:04:42,639
after months of detailed analysis of

6
00:04:46,950 --> 00:04:44,960
bender's terrain the team selected the

7
00:04:49,350 --> 00:04:46,960
nightingale crater as the sample site

8
00:04:51,430 --> 00:04:49,360
for the mission osiris-rex will need to

9
00:04:53,909 --> 00:04:51,440
carefully dodge rocky hazards as it

10
00:04:54,830 --> 00:04:53,919
descends to a space no larger than a few

11
00:04:57,189 --> 00:04:54,840
parking

12
00:04:59,430 --> 00:04:57,199
spots this spacecraft has mapped the

13
00:05:01,830 --> 00:04:59,440

terrain in high resolution

14
00:05:09,110 --> 00:05:01,840
capturing a stunning catalog of images

15
00:05:12,790 --> 00:05:10,390
and now

16
00:05:16,710 --> 00:05:12,800
we are ready to target site manager to

17
00:05:21,110 --> 00:05:18,950
in the dark voids of the solar system

18
00:05:22,830 --> 00:05:21,120
drifting in between the familiar planets

19
00:05:25,430 --> 00:05:22,840
and their families of moons are the

20
00:05:28,310 --> 00:05:25,440
asteroids there may be a million perhaps

21
00:05:30,870 --> 00:05:28,320
two million of these cold dark rocks

22
00:05:31,830 --> 00:05:30,880
but these small worlds are anything but

23
00:05:33,749 --> 00:05:31,840
dull

24
00:05:35,189 --> 00:05:33,759
in fact some of them are time capsules

25
00:05:38,070 --> 00:05:35,199
from the very beginning of the solar

26
00:05:39,909 --> 00:05:38,080
system unaltered for billions of years

27
00:05:42,070 --> 00:05:39,919
and in fact the clues to how everything

28
00:05:43,909 --> 00:05:42,080
around us began from the formation of

29
00:05:45,670 --> 00:05:43,919
the planets to the beginning of life

30
00:05:48,550 --> 00:05:45,680
itself may be locked up in these

31
00:05:51,189 --> 00:05:48,560
asteroids and tonight a spacecraft from

32
00:05:53,749 --> 00:05:51,199
earth is going to touch one bring back a

33
00:05:56,469 --> 00:05:53,759
sample and prepare the long journey back

34
00:05:58,469 --> 00:05:56,479
to earth where we can analyze it

35
00:06:00,070 --> 00:05:58,479
welcome everyone i'm michelle fowler

36
00:06:01,749 --> 00:06:00,080
from nasa's goddard space flight center

37
00:06:02,950 --> 00:06:01,759
and thank you for joining us i'm

38
00:06:04,550 --> 00:06:02,960

speaking to you live from the mission

39
00:06:06,710 --> 00:06:04,560
support area at the lockheed martin

40
00:06:08,710 --> 00:06:06,720
space lockheed martin space in littleton

41
00:06:10,390 --> 00:06:08,720
colorado as you can see i'm struggling

42
00:06:11,990 --> 00:06:10,400
with my mask here a little bit we're

43
00:06:14,230 --> 00:06:12,000
here to follow the sample collection for

44
00:06:16,390 --> 00:06:14,240
nasa's osiris-rex mission this is an

45
00:06:17,670 --> 00:06:16,400
operation referred to appropriately as

46
00:06:19,350 --> 00:06:17,680
tag

47
00:06:21,590 --> 00:06:19,360
now remember that this is a historic

48
00:06:23,830 --> 00:06:21,600
event today's endeavor will be the first

49
00:06:25,990 --> 00:06:23,840
time the space agency has ever touched

50
00:06:28,870 --> 00:06:26,000
the surface of an asteroid collecting a

51
00:06:31,110 --> 00:06:28,880
sample of this pristine ancient material

52
00:06:32,390 --> 00:06:31,120
a scientific treasure far more precious

53
00:06:33,670 --> 00:06:32,400
than gold

54
00:06:34,950 --> 00:06:33,680
joining me throughout the show will be

55
00:06:37,110 --> 00:06:34,960
the principal investigator of the

56
00:06:38,790 --> 00:06:37,120
osiris-rex mission dante loretta welcome

57
00:06:41,110 --> 00:06:38,800
dante thank you michelle it's really

58
00:06:43,029 --> 00:06:41,120
great to be here today i'm a professor

59
00:06:44,870 --> 00:06:43,039
at the university of arizona and i have

60
00:06:47,110 --> 00:06:44,880
the honor and the privilege of leading

61
00:06:49,670 --> 00:06:47,120
this amazing mission for nasa and really

62
00:06:51,430 --> 00:06:49,680
for the world that's pretty amazing so

63
00:06:54,390 --> 00:06:51,440

now the main event is happening in about

64
00:06:56,150 --> 00:06:54,400
an hour and uh you we actually uh um

65
00:06:58,230 --> 00:06:56,160
this is called tag can you explain to us

66
00:07:00,390 --> 00:06:58,240
a bit why it's called tag yeah we today

67
00:07:02,150 --> 00:07:00,400
we're tagging an asteroid and tag is an

68
00:07:04,150 --> 00:07:02,160
acronym that describes our sample

69
00:07:06,469 --> 00:07:04,160
collection strategy we're going to send

70
00:07:08,469 --> 00:07:06,479
the spacecraft down for a short duration

71
00:07:10,469 --> 00:07:08,479
contact with the asteroid surface

72
00:07:13,749 --> 00:07:10,479
anywhere between five and maybe as long

73
00:07:16,629 --> 00:07:13,759
as 15 seconds so we call it a touch and

74
00:07:18,230 --> 00:07:16,639
go or tag an asteroid it actually is

75
00:07:20,150 --> 00:07:18,240
almost sort of like a quick touch of tag

76
00:07:22,230 --> 00:07:20,160
it's a very great good way of putting it

77
00:07:23,589 --> 00:07:22,240
exactly yeah absolutely so there's lots

78
00:07:25,029 --> 00:07:23,599
of asteroids out there we talked about

79
00:07:26,950 --> 00:07:25,039
the fact that there are a couple million

80
00:07:29,110 --> 00:07:26,960
so why have we selected this particular

81
00:07:31,350 --> 00:07:29,120
one to sample yeah the target of our

82
00:07:32,790 --> 00:07:31,360
mission is called asteroid bennu and

83
00:07:34,390 --> 00:07:32,800
when we were designing the mission we

84
00:07:36,070 --> 00:07:34,400
had to consider both engineering

85
00:07:37,909 --> 00:07:36,080
constraints and of course our science

86
00:07:40,230 --> 00:07:37,919
objectives and when we looked at the

87
00:07:41,830 --> 00:07:40,240
capabilities of our spacecraft we knew

88
00:07:44,469 --> 00:07:41,840

we needed to go what was to what was

89
00:07:46,070 --> 00:07:44,479
called a near-earth asteroid so we're

90
00:07:47,909 --> 00:07:46,080
basically looking at its orbital

91
00:07:50,390 --> 00:07:47,919
properties and its location within the

92
00:07:52,390 --> 00:07:50,400
solar system we needed an object whose

93
00:07:54,390 --> 00:07:52,400
orbit was pretty similar to the earth so

94
00:07:56,150 --> 00:07:54,400
that we could launch off of our planet

95
00:07:58,309 --> 00:07:56,160
rendezvous and spend some time at the

96
00:08:00,550 --> 00:07:58,319
asteroid and then leave and bring this

97
00:08:02,230 --> 00:08:00,560
precious scientific cargo back to earth

98
00:08:04,070 --> 00:08:02,240
absolutely and then from the science

99
00:08:05,670 --> 00:08:04,080
perspective we're really answering some

100
00:08:07,909 --> 00:08:05,680
fundamental questions

101
00:08:10,550 --> 00:08:07,919
why are we here why is earth a habitable

102
00:08:12,710 --> 00:08:10,560
planet how did the origin of life occur

103
00:08:15,110 --> 00:08:12,720
so we wanted an asteroid that we thought

104
00:08:17,589 --> 00:08:15,120
was rich in water that may have brought

105
00:08:19,830 --> 00:08:17,599
the oceans to our planet and also rich

106
00:08:22,070 --> 00:08:19,840
in carbon we're looking for the organic

107
00:08:23,990 --> 00:08:22,080
seeds of life that may have led to

108
00:08:26,150 --> 00:08:24,000
evolution as we know it today and this

109
00:08:27,990 --> 00:08:26,160
is really an amazing point our

110
00:08:29,430 --> 00:08:28,000
connection to these asteroids so what

111
00:08:31,510 --> 00:08:29,440
you're saying is that some of the

112
00:08:33,430 --> 00:08:31,520
organic compounds in my body some of the

113
00:08:35,190 --> 00:08:33,440

water in my body right now may

114
00:08:36,949 --> 00:08:35,200
originally have come from asteroids

115
00:08:39,670 --> 00:08:36,959
almost certainly the earth was accreted

116
00:08:41,909 --> 00:08:39,680
from these asteroids bennu is a remnant

117
00:08:43,990 --> 00:08:41,919
that survived that process but it's the

118
00:08:45,590 --> 00:08:44,000
geologic history of our solar system

119
00:08:47,509 --> 00:08:45,600
that's locked inside this body

120
00:08:49,430 --> 00:08:47,519
absolutely now there are many other

121
00:08:50,550 --> 00:08:49,440
asteroids like bennu in the solar system

122
00:08:51,750 --> 00:08:50,560
and of course there are some that are

123
00:08:53,590 --> 00:08:51,760
even larger

124
00:08:55,590 --> 00:08:53,600
over the last decades we believe we have

125
00:08:58,230 --> 00:08:55,600
found nearly all of the potentially

126
00:09:00,710 --> 00:08:58,240
dangerous ones

127
00:09:02,630 --> 00:09:00,720
overex natural feature tracking system

128
00:09:08,230 --> 00:09:02,640
has resumed processing

129
00:09:11,350 --> 00:09:09,910
so getting back to my point

130
00:09:13,509 --> 00:09:11,360
we know there are others out there that

131
00:09:15,910 --> 00:09:13,519
we have not yet detected you know in

132
00:09:17,590 --> 00:09:15,920
fact just this past august a truck-sized

133
00:09:19,590 --> 00:09:17,600
asteroid missed the earth by less than

134
00:09:20,790 --> 00:09:19,600
two thousand miles and nobody even knew

135
00:09:23,670 --> 00:09:20,800
it was headed our way until it already

136
00:09:25,430 --> 00:09:23,680
passed us by so for our survival it's

137
00:09:27,350 --> 00:09:25,440
essential that we understand what's out

138
00:09:28,790 --> 00:09:27,360

there in our environment in space and

139
00:09:30,949 --> 00:09:28,800
this is one of the main objectives of

140
00:09:33,030 --> 00:09:30,959
the osiris-rex mission we'd like to go

141
00:09:35,590 --> 00:09:33,040
out and meet bennu before something like

142
00:09:37,030 --> 00:09:35,600
bennu comes and meets all of us so dante

143
00:09:38,470 --> 00:09:37,040
what can you tell us about this idea of

144
00:09:40,630 --> 00:09:38,480
planetary defense

145
00:09:43,030 --> 00:09:40,640
so as a result of bennu having this

146
00:09:44,949 --> 00:09:43,040
optimal orbit for sample return it also

147
00:09:46,389 --> 00:09:44,959
is what we call a potentially hazardous

148
00:09:48,389 --> 00:09:46,399
asteroid

149
00:09:49,990 --> 00:09:48,399
because its orbit literally does cross

150
00:09:52,470 --> 00:09:50,000
the orbit of the earth and there's a

151
00:09:54,470 --> 00:09:52,480
probability about 150 years in the

152
00:09:57,269 --> 00:09:54,480
future that bennu may in fact impact our

153
00:09:59,990 --> 00:09:57,279
planet creating a natural disaster so

154
00:10:02,230 --> 00:10:00,000
osiris-rex is really trying to study

155
00:10:04,069 --> 00:10:02,240
venue's orbit very precisely

156
00:10:05,990 --> 00:10:04,079
we know that sunlight actually

157
00:10:07,829 --> 00:10:06,000
influences the trajectory of these small

158
00:10:09,670 --> 00:10:07,839
asteroids and we're studying that

159
00:10:12,630 --> 00:10:09,680
phenomena how it interacts with the

160
00:10:15,110 --> 00:10:12,640
asteroid surface and ultimately how it's

161
00:10:17,269 --> 00:10:15,120
going to allow us to assess the impact

162
00:10:19,509 --> 00:10:17,279
risk that bennu poses to the earth

163
00:10:21,030 --> 00:10:19,519

absolutely so the idea of planetary

164
00:10:23,110 --> 00:10:21,040
defense isn't just an intellectual

165
00:10:25,110 --> 00:10:23,120
exercise it's something that nasa takes

166
00:10:26,949 --> 00:10:25,120
very seriously a little later in the

167
00:10:28,310 --> 00:10:26,959
broadcast we're going to talk with some

168
00:10:31,190 --> 00:10:28,320
people but more about protecting the

169
00:10:33,269 --> 00:10:31,200
planet from surprise visitors from space

170
00:10:34,710 --> 00:10:33,279
so back to bennu we have a lot of

171
00:10:36,790 --> 00:10:34,720
exciting stuff to share with you about

172
00:10:39,190 --> 00:10:36,800
this tag operation from how it works to

173
00:10:40,870 --> 00:10:39,200
why this overall mission matters so much

174
00:10:42,870 --> 00:10:40,880
and you can be part of this too by

175
00:10:44,630 --> 00:10:42,880
joining us on our social media platforms

176
00:10:46,790 --> 00:10:44,640
i'd like to introduce james trailey at

177
00:10:48,389 --> 00:10:46,800
our social media desk james yeah thanks

178
00:10:50,230 --> 00:10:48,399
michelle my name is james trailey and

179
00:10:52,550 --> 00:10:50,240
i'm a producer at nasa guider space

180
00:10:54,310 --> 00:10:52,560
flight center and today i'm joining you

181
00:10:56,230 --> 00:10:54,320
on social media to share the excitement

182
00:10:57,750 --> 00:10:56,240
of the osiris-rex mission and this

183
00:10:59,990 --> 00:10:57,760
incredible sample collection event at

184
00:11:02,389 --> 00:11:00,000
asteroid venue to join us today you can

185
00:11:04,470 --> 00:11:02,399
use the hashtag to bennu and back on

186
00:11:05,670 --> 00:11:04,480
instagram facebook and twitter to join

187
00:11:07,269 --> 00:11:05,680
the conversation and share the

188
00:11:08,790 --> 00:11:07,279

excitement with all of us here

189
00:11:11,350 --> 00:11:08,800
you can also follow the missions twitter

190
00:11:13,430 --> 00:11:11,360
account at osiris-rex for live updates

191
00:11:15,110 --> 00:11:13,440
as we make our tag attempt we actually

192
00:11:17,590 --> 00:11:15,120
have a poll going on at this twitter

193
00:11:19,190 --> 00:11:17,600
right now but we're asking you how much

194
00:11:20,630 --> 00:11:19,200
sample do you think osiris-rex will pick

195
00:11:22,069 --> 00:11:20,640
up at venue today

196
00:11:24,150 --> 00:11:22,079
i'll check back in with you in a little

197
00:11:25,670 --> 00:11:24,160
bit for the results but for now back to

198
00:11:27,990 --> 00:11:25,680
you michelle

199
00:11:30,230 --> 00:11:28,000
thanks james okay so right behind me is

200
00:11:32,389 --> 00:11:30,240
the msa the mission support area for

201
00:11:34,470 --> 00:11:32,399
osiris-rex and today it is filled with

202
00:11:36,069 --> 00:11:34,480
very excited people the scientists

203
00:11:37,430 --> 00:11:36,079
engineers and technical specialists

204
00:11:39,430 --> 00:11:37,440
who've worked on this mission in some

205
00:11:41,269 --> 00:11:39,440
cases for more than a decade

206
00:11:42,550 --> 00:11:41,279
so back there is gary napier from

207
00:11:44,550 --> 00:11:42,560
lockheed martin he's right in the middle

208
00:11:46,550 --> 00:11:44,560
of it all right so uh gary what's the

209
00:11:48,230 --> 00:11:46,560
feeling in the room

210
00:11:49,910 --> 00:11:48,240
michelle like you said i am just right

211
00:11:51,509 --> 00:11:49,920
behind you about 20 feet we're here in

212
00:11:54,310 --> 00:11:51,519
the larger locking martin mission

213
00:11:56,550 --> 00:11:54,320

support area where we're operating six

214
00:11:59,030 --> 00:11:56,560
of nasa's spacecraft around the solar

215
00:12:01,710 --> 00:11:59,040
system four of them at mars one of them

216
00:12:04,069 --> 00:12:01,720
at jupiter and this one right here

217
00:12:06,870 --> 00:12:04,079
osiris-rex we're gonna take you into the

218
00:12:08,470 --> 00:12:06,880
operations center here at osiris-rex

219
00:12:10,069 --> 00:12:08,480
this is where the flight team is right

220
00:12:11,190 --> 00:12:10,079
now

221
00:12:12,710 --> 00:12:11,200
the um

222
00:12:14,870 --> 00:12:12,720
controllers are already on board we've

223
00:12:16,310 --> 00:12:14,880
heard some good call outs right now in a

224
00:12:17,750 --> 00:12:16,320
little while we're going to come in here

225
00:12:19,430 --> 00:12:17,760
and talk to some of them and see how

226
00:12:21,750 --> 00:12:19,440
things are going it's looking really

227
00:12:23,910 --> 00:12:21,760
good right now back to you michelle

228
00:12:25,110 --> 00:12:23,920
thanks gary so i think right now we have

229
00:12:26,550 --> 00:12:25,120
to acknowledge something that this is a

230
00:12:27,910 --> 00:12:26,560
bit of an unusual broadcast we're

231
00:12:29,430 --> 00:12:27,920
dealing with some pretty big challenges

232
00:12:31,670 --> 00:12:29,440
tonight because we're doing this all in

233
00:12:33,269 --> 00:12:31,680
the midst of a pandemic so you'll notice

234
00:12:34,790 --> 00:12:33,279
that i'm wearing a mask i've certainly

235
00:12:36,710 --> 00:12:34,800
never hosted an event wearing a mask

236
00:12:37,829 --> 00:12:36,720
before forgive me if i struggled with a

237
00:12:39,829 --> 00:12:37,839
little bit tonight make sure that it's

238
00:12:40,870 --> 00:12:39,839

in the right position and when we

239
00:12:42,470 --> 00:12:40,880
interview people you'll notice that

240
00:12:44,870 --> 00:12:42,480
we'll be standing farther away than

241
00:12:46,710 --> 00:12:44,880
normal and also i'm gonna stay right

242
00:12:48,069 --> 00:12:46,720
here uh you normally i might be back in

243
00:12:49,670 --> 00:12:48,079
the mission support area but i'm not

244
00:12:50,710 --> 00:12:49,680
allowed to go back there i'm isolated

245
00:12:52,550 --> 00:12:50,720
from them

246
00:12:54,470 --> 00:12:52,560
so it's amazing that with the incredible

247
00:12:55,750 --> 00:12:54,480
operation going on at bennu tonight and

248
00:12:57,829 --> 00:12:55,760
the people all around me who've been

249
00:12:59,670 --> 00:12:57,839
working on this for years to make this a

250
00:13:01,590 --> 00:12:59,680
success we still have to deal with the

251
00:13:03,590 --> 00:13:01,600
challenges of covid19

252
00:13:05,590 --> 00:13:03,600
and so you know tonight our attention is

253
00:13:08,069 --> 00:13:05,600
going to be on this wonderful event

254
00:13:09,750 --> 00:13:08,079
actually sampling an asteroid and you

255
00:13:11,509 --> 00:13:09,760
know that's incredibly adventurous it's

256
00:13:13,190 --> 00:13:11,519
very happy but we're going to remember

257
00:13:15,750 --> 00:13:13,200
to actually take care of each other we

258
00:13:17,509 --> 00:13:15,760
can't forget that so please bear with us

259
00:13:18,829 --> 00:13:17,519
today as we are working with our masks

260
00:13:22,150 --> 00:13:18,839
and trying to do this the best way we

261
00:13:23,829 --> 00:13:22,160
can okay so uh dante uh give us a chance

262
00:13:25,190 --> 00:13:23,839
now give us sort of an idea about how

263
00:13:27,990 --> 00:13:25,200

the engineers back there are actually

264
00:13:29,670 --> 00:13:28,000
flying osiris-rex so it's important to

265
00:13:31,509 --> 00:13:29,680
understand that the spacecraft is

266
00:13:33,910 --> 00:13:31,519
actually literally on the other side of

267
00:13:36,389 --> 00:13:33,920
the solar system over 200 million miles

268
00:13:38,150 --> 00:13:36,399
away from the earth so any signal that

269
00:13:39,670 --> 00:13:38,160
we were to transmit here would take over

270
00:13:41,990 --> 00:13:39,680
18 and a half minutes to reach the

271
00:13:43,590 --> 00:13:42,000
spacecraft so when we get these signals

272
00:13:45,829 --> 00:13:43,600
back we're actually seeing things that

273
00:13:47,590 --> 00:13:45,839
happened in the past at the asteroid as

274
00:13:49,590 --> 00:13:47,600
a result we have to have a very smart

275
00:13:51,590 --> 00:13:49,600
spacecraft it has to make its own

276
00:13:54,550 --> 00:13:51,600
guidance calculations and make its own

277
00:13:56,470 --> 00:13:54,560
decisions and in fact instead of getting

278
00:13:59,110 --> 00:13:56,480
high data back we're only getting a very

279
00:14:01,269 --> 00:13:59,120
low data rate what we call breadcrumbs

280
00:14:03,430 --> 00:14:01,279
just key pieces of information from the

281
00:14:06,389 --> 00:14:03,440
spacecraft that tell us when key events

282
00:14:08,870 --> 00:14:06,399
have taken place in the tag sequence

283
00:14:13,990 --> 00:14:08,880
rex has processed its next image

284
00:14:16,710 --> 00:14:15,509
so that's an example of the kind of

285
00:14:18,389 --> 00:14:16,720
information that we're getting back from

286
00:14:19,750 --> 00:14:18,399
the spacecraft it's got its onboard

287
00:14:20,949 --> 00:14:19,760
natural feature tracking system which

288
00:14:23,350 --> 00:14:20,959

we're going to hear a lot more about

289
00:14:26,150 --> 00:14:23,360
today absolutely yeah

290
00:14:27,910 --> 00:14:26,160
all right so i guess after that we are

291
00:14:30,150 --> 00:14:27,920
dealing with um you know actually the

292
00:14:31,509 --> 00:14:30,160
tag event itself but i understand that

293
00:14:33,110 --> 00:14:31,519
we're not going to be able to see images

294
00:14:34,949 --> 00:14:33,120
tonight in real time that we have to

295
00:14:37,030 --> 00:14:34,959
wait a while why is that

296
00:14:38,710 --> 00:14:37,040
uh the images take a lot of data to

297
00:14:39,990 --> 00:14:38,720
bring back to the space uh bring back

298
00:14:41,350 --> 00:14:40,000
from the spacecraft to the earth and

299
00:14:43,590 --> 00:14:41,360
since we're on that low data rate what

300
00:14:45,829 --> 00:14:43,600
we're using today is this real-time

301
00:14:47,350 --> 00:14:45,839
simulation that we've put together so

302
00:14:48,470 --> 00:14:47,360
what we're seeing here and we'll be

303
00:14:51,269 --> 00:14:48,480
referring to this throughout the

304
00:14:53,670 --> 00:14:51,279
broadcast tonight uh this isn't any kind

305
00:14:55,910 --> 00:14:53,680
of real information from outer space

306
00:14:58,389 --> 00:14:55,920
this is uh what we expect the spacecraft

307
00:15:00,629 --> 00:14:58,399
to be doing so it'll let us know when

308
00:15:02,069 --> 00:15:00,639
key events are programmed to take place

309
00:15:04,629 --> 00:15:02,079
on the spacecraft and to be received

310
00:15:05,990 --> 00:15:04,639
back on earth uh there may be some lags

311
00:15:07,910 --> 00:15:06,000
in communication but this is going to

312
00:15:09,990 --> 00:15:07,920
really help us visualize what's actually

313
00:15:11,590 --> 00:15:10,000

happening at asteroid bennu

314
00:15:12,550 --> 00:15:11,600
so when will we expect those those first

315
00:15:13,750 --> 00:15:12,560
images

316
00:15:15,430 --> 00:15:13,760
uh so

317
00:15:17,189 --> 00:15:15,440
everything's going to play out at this

318
00:15:19,110 --> 00:15:17,199
very low data rate through most of the

319
00:15:20,710 --> 00:15:19,120
broadcast today and then the spacecraft

320
00:15:22,629 --> 00:15:20,720
has to back away from the asteroid

321
00:15:24,629 --> 00:15:22,639
surface it has to cool off it has to get

322
00:15:26,310 --> 00:15:24,639
back on its solar arrays and then it's

323
00:15:28,389 --> 00:15:26,320
going to turn that high gain antenna to

324
00:15:30,389 --> 00:15:28,399
the earth this evening and we expect

325
00:15:31,670 --> 00:15:30,399
images to be coming in overnight and we

326
00:15:33,670 --> 00:15:31,680
hope to have some great information for

327
00:15:34,949 --> 00:15:33,680
everybody by tomorrow

328
00:15:37,350 --> 00:15:34,959
i'm really looking forward to those

329
00:15:39,430 --> 00:15:37,360
images people around the world are so at

330
00:15:41,269 --> 00:15:39,440
this point the spacecraft has left its

331
00:15:43,110 --> 00:15:41,279
home orbit and it's on its way to the

332
00:15:44,710 --> 00:15:43,120
sample site and every minute now we're

333
00:15:46,870 --> 00:15:44,720
drawing near to that moment when

334
00:15:48,230 --> 00:15:46,880
osiris-rex touches the surface of bennu

335
00:15:50,629 --> 00:15:48,240
so while we're waiting let's check in

336
00:15:52,629 --> 00:15:50,639
with james at our social media desk yeah

337
00:15:54,710 --> 00:15:52,639
thanks michelle so a few days ago we

338
00:15:56,230 --> 00:15:54,720

actually hosted a reddit ama with a few

339
00:15:58,389 --> 00:15:56,240
of our scientists and got a lot of

340
00:16:00,310 --> 00:15:58,399
fantastic questions we wanted to recap a

341
00:16:02,310 --> 00:16:00,320
couple of them for you right now

342
00:16:04,230 --> 00:16:02,320
so our first question asks how is it

343
00:16:06,230 --> 00:16:04,240
possible to map such a tiny speckle in

344
00:16:07,430 --> 00:16:06,240
the sky do you have any detailed images

345
00:16:09,110 --> 00:16:07,440
that you can share

346
00:16:10,629 --> 00:16:09,120
do you really see the landing site or is

347
00:16:12,710 --> 00:16:10,639
it all based on measurements of some

348
00:16:15,269 --> 00:16:12,720
weird properties and calculations

349
00:16:17,110 --> 00:16:15,279
so yes our first observation of bennu

350
00:16:19,189 --> 00:16:17,120
actually came from right here on earth

351
00:16:20,150 --> 00:16:19,199
from the arecibo observatory in puerto

352
00:16:22,150 --> 00:16:20,160
rico

353
00:16:23,829 --> 00:16:22,160
this huge radio telescope gave us a

354
00:16:26,069 --> 00:16:23,839
basic understanding of the rough shape

355
00:16:27,749 --> 00:16:26,079
of bennu this kind of strange top like

356
00:16:30,230 --> 00:16:27,759
shape that you see right here

357
00:16:32,069 --> 00:16:30,240
as osiris-rex was actually out in space

358
00:16:34,389 --> 00:16:32,079
and began making its approach closer and

359
00:16:35,670 --> 00:16:34,399
closer to the asteroid it used its suite

360
00:16:37,509 --> 00:16:35,680
of on-board camera instruments to

361
00:16:39,670 --> 00:16:37,519
actually image the surface in increasing

362
00:16:41,990 --> 00:16:39,680
detail bender green detail from just a

363
00:16:43,749 --> 00:16:42,000

few tiny pixels on our screen to this

364
00:16:46,150 --> 00:16:43,759
super high resolution world that you see

365
00:16:47,590 --> 00:16:46,160
right here littered with giant rugged

366
00:16:50,550 --> 00:16:47,600
boulders

367
00:16:52,069 --> 00:16:50,560
another question from reddit is asking

368
00:16:54,710 --> 00:16:52,079
us

369
00:16:56,470 --> 00:16:54,720
see here as it loads in yes so would it

370
00:16:58,310 --> 00:16:56,480
have been feasible to have a robotic arm

371
00:16:59,990 --> 00:16:58,320
pick up a rock would a single rock have

372
00:17:02,470 --> 00:17:00,000
been better than a hundred tiny grains

373
00:17:04,549 --> 00:17:02,480
of sand or ice so the team had

374
00:17:07,510 --> 00:17:04,559
originally designed osiris-rex to sample

375
00:17:09,350 --> 00:17:07,520
on a nice flat sandy-like surface but as

376
00:17:11,429 --> 00:17:09,360
you just saw bennu is not at all like

377
00:17:13,510 --> 00:17:11,439
that it's super rugged and filled with

378
00:17:14,870 --> 00:17:13,520
giant boulders so the team had to work

379
00:17:16,870 --> 00:17:14,880
with what we had designed for which was

380
00:17:18,789 --> 00:17:16,880
that flat sandy surface

381
00:17:19,990 --> 00:17:18,799
if you were to try to sample on a rock

382
00:17:22,309 --> 00:17:20,000
that actually presents a number of

383
00:17:23,750 --> 00:17:22,319
challenges of its own for example if we

384
00:17:25,029 --> 00:17:23,760
were to pick up a rock it might actually

385
00:17:26,710 --> 00:17:25,039
just crumble away and we wouldn't

386
00:17:28,390 --> 00:17:26,720
actually get a sample out of it

387
00:17:30,710 --> 00:17:28,400
also some of these rocks might actually

388
00:17:32,150 --> 00:17:30,720

be a bit too stuck to the surface and if

389
00:17:33,510 --> 00:17:32,160
we were to try to pry those loose they

390
00:17:35,190 --> 00:17:33,520
might not actually budge and we won't

391
00:17:37,029 --> 00:17:35,200
actually even get a sample

392
00:17:38,630 --> 00:17:37,039
so these are all things that the team

393
00:17:40,549 --> 00:17:38,640
has to consider when designing something

394
00:17:42,150 --> 00:17:40,559
that's going to be operating millions

395
00:17:45,750 --> 00:17:42,160
upon millions of miles away from us here

396
00:17:47,190 --> 00:17:45,760
on earth so for now back to you michelle

397
00:17:48,310 --> 00:17:47,200
thanks james we'll be back to you more

398
00:17:49,909 --> 00:17:48,320
for later

399
00:17:51,909 --> 00:17:49,919
okay now i have been a star wars fan

400
00:17:53,909 --> 00:17:51,919
nearly all my life and uh in one movie

401
00:17:56,230 --> 00:17:53,919
darth vader said rather famously that

402
00:17:57,909 --> 00:17:56,240
asteroids do not concern me but that is

403
00:17:59,350 --> 00:17:57,919
certainly not true for us this evening

404
00:18:00,710 --> 00:17:59,360
we are all about asteroids here at the

405
00:18:03,110 --> 00:18:00,720
mission support area in littleton

406
00:18:04,630 --> 00:18:03,120
colorado and we are bringing you live

407
00:18:06,950 --> 00:18:04,640
coverage of our attempt to collect a

408
00:18:08,789 --> 00:18:06,960
sample from the asteroid better

409
00:18:11,110 --> 00:18:08,799
now osiris-rex is a one-of-a-kind

410
00:18:12,710 --> 00:18:11,120
spacecraft with an extraordinary team of

411
00:18:14,870 --> 00:18:12,720
engineers and scientists charting

412
00:18:17,110 --> 00:18:14,880
unexplored places it was launched on

413
00:18:19,909 --> 00:18:17,120

september 8 2016.

414
00:18:22,549 --> 00:18:19,919
the vehicle has traveled over 2.2

415
00:18:24,470 --> 00:18:22,559
billion miles on a complex route to

416
00:18:27,590 --> 00:18:24,480
reach bennu it's scheduled to deliver

417
00:18:29,590 --> 00:18:27,600
its precious cargo back to earth in 2023

418
00:18:32,789 --> 00:18:29,600
so now let's take a closer look at

419
00:18:37,750 --> 00:18:35,510
over 200 million miles away from earth

420
00:18:39,350 --> 00:18:37,760
nasa's osiris-rex spacecraft is

421
00:18:43,270 --> 00:18:39,360
preparing for an ambitious sample

422
00:18:44,870 --> 00:18:43,280
collection attempt at asteroid bennu

423
00:18:46,310 --> 00:18:44,880
before it makes its approach to the

424
00:18:48,070 --> 00:18:46,320
rocky surface

425
00:18:50,070 --> 00:18:48,080
let's take a look back at some of the

426
00:18:51,510 --> 00:18:50,080
incredible firsts for this mission which

427
00:18:54,230 --> 00:18:51,520
almost seemed like something out of a

428
00:18:56,470 --> 00:18:54,240
hollywood movie

429
00:18:58,310 --> 00:18:56,480
this is the first asteroid sample return

430
00:19:00,470 --> 00:18:58,320
mission for nasa and it could be the

431
00:19:02,390 --> 00:19:00,480
largest return from space since the

432
00:19:03,830 --> 00:19:02,400
apollo astronauts brought moon samples

433
00:19:05,510 --> 00:19:03,840
back to earth

434
00:19:08,070 --> 00:19:05,520
while getting set to grab a sample

435
00:19:09,590 --> 00:19:08,080
osiris-rex has said not one but two

436
00:19:11,909 --> 00:19:09,600
guinness world records

437
00:19:14,630 --> 00:19:11,919
its first for the smallest ever body

438
00:19:17,270 --> 00:19:14,640

orbited and its second for the closest

439
00:19:19,190 --> 00:19:17,280
weapon of a spacecraft this tight orbit

440
00:19:21,830 --> 00:19:19,200
has brought the spacecraft so close to

441
00:19:24,150 --> 00:19:21,840
bennu that osiris-rex's on-board cameras

442
00:19:26,070 --> 00:19:24,160
and laser altimeter have been able to

443
00:19:28,789 --> 00:19:26,080
image and characterize the asteroid

444
00:19:29,909 --> 00:19:28,799
surface and shape better than earth our

445
00:19:34,630 --> 00:19:29,919
own moon

446
00:19:39,270 --> 00:19:37,110
osiris-rex says image bennu down to

447
00:19:41,350 --> 00:19:39,280
centimeter per pixel resolution

448
00:19:45,430 --> 00:19:41,360
providing us with an unprecedented view

449
00:19:48,549 --> 00:19:45,440
into this rocky and boulder-filled world

450
00:19:50,549 --> 00:19:48,559
with 28 onboard thrusters osiris-rex is

451
00:19:52,150 --> 00:19:50,559
one of the most maneuverable spacecrafts

452
00:19:54,710 --> 00:19:52,160
this allows it to carefully and

453
00:19:56,390 --> 00:19:54,720
precisely descend to a spot on bennu

454
00:19:57,510 --> 00:19:56,400
that is no larger than a few parking

455
00:19:58,710 --> 00:19:57,520
spaces

456
00:20:01,190 --> 00:19:58,720
there have certainly been some

457
00:20:03,110 --> 00:20:01,200
unexpected twists along the way however

458
00:20:04,950 --> 00:20:03,120
osiris-rex is capitalized on these

459
00:20:07,830 --> 00:20:04,960
moments right after arriving at the

460
00:20:09,830 --> 00:20:07,840
asteroid osiris-rex imaged rocky ejecta

461
00:20:11,270 --> 00:20:09,840
that has been bursting off bennett this

462
00:20:13,190 --> 00:20:11,280
is the first time we have been able to

463
00:20:15,669 --> 00:20:13,200

observe the entire life cycle of a

464
00:20:17,590 --> 00:20:15,679
natural satellite ejecting off an object

465
00:20:18,870 --> 00:20:17,600
entering into orbit and returning back

466
00:20:20,789 --> 00:20:18,880
to the surface

467
00:20:23,029 --> 00:20:20,799
because of bennu's extremely rocky

468
00:20:25,029 --> 00:20:23,039
surface the team needed to adapt the

469
00:20:26,789 --> 00:20:25,039
spacecraft's navigation method to an

470
00:20:29,190 --> 00:20:26,799
optical approach known as natural

471
00:20:30,870 --> 00:20:29,200
feature tracking or nft this is the

472
00:20:33,510 --> 00:20:30,880
first time this approach has been used

473
00:20:35,510 --> 00:20:33,520
in space and it will allow osiris-rex to

474
00:20:37,830 --> 00:20:35,520
steer itself down to collect a sample

475
00:20:40,230 --> 00:20:37,840
from bennu

476
00:20:42,470 --> 00:20:40,240
and now osiris-rex is looking to set

477
00:20:44,070 --> 00:20:42,480
another first for nasa

478
00:20:54,310 --> 00:20:44,080
successfully collect a sample of an

479
00:20:57,909 --> 00:20:56,310
welcome back if you're just joining us

480
00:20:59,590 --> 00:20:57,919
i'm michelle thawler from nasa's goddard

481
00:21:01,590 --> 00:20:59,600
space flight center and with me is dante

482
00:21:03,590 --> 00:21:01,600
loretta from the university of arizona

483
00:21:05,750 --> 00:21:03,600
and you are here with us on a historic

484
00:21:07,430 --> 00:21:05,760
evening it will be nasa's first sample

485
00:21:09,430 --> 00:21:07,440
return from an asteroid the attempt to

486
00:21:11,029 --> 00:21:09,440
actually sample the asteroid bennu the

487
00:21:13,110 --> 00:21:11,039
spacecraft osiris-rex is descending

488
00:21:15,029 --> 00:21:13,120

toward bennu right now to take a sample

489
00:21:16,470 --> 00:21:15,039
and return it back to earth

490
00:21:17,909 --> 00:21:16,480
so dante let's talk more about this

491
00:21:20,070 --> 00:21:17,919
real-time simulation that we're looking

492
00:21:21,590 --> 00:21:20,080
at yeah it's been an exciting day

493
00:21:23,590 --> 00:21:21,600
already michelle we're well over three

494
00:21:25,750 --> 00:21:23,600
hours into the tag sequence which is the

495
00:21:27,590 --> 00:21:25,760
pre-programmed uh set of commands that

496
00:21:29,669 --> 00:21:27,600
are already on the spacecraft

497
00:21:31,669 --> 00:21:29,679
earlier we departed our orbit around the

498
00:21:34,149 --> 00:21:31,679
asteroid so we're flying over the sunlit

499
00:21:35,830 --> 00:21:34,159
side of the asteroid taking images for

500
00:21:37,909 --> 00:21:35,840
the onboard guidance system called

501
00:21:39,750 --> 00:21:37,919
natural feature tracking a couple other

502
00:21:41,590 --> 00:21:39,760
key events that have taken place already

503
00:21:44,470 --> 00:21:41,600
is the spacecraft has deployed its

504
00:21:46,549 --> 00:21:44,480
robotic tag sam sampling arm so the arm

505
00:21:48,789 --> 00:21:46,559
is ready in position to collect that

506
00:21:50,470 --> 00:21:48,799
sample and we've turned on and started

507
00:21:52,549 --> 00:21:50,480
collecting science data from one of our

508
00:21:54,870 --> 00:21:52,559
science instruments the otis thermal

509
00:21:56,789 --> 00:21:54,880
emission spectrometer the spacecraft has

510
00:21:58,870 --> 00:21:56,799
already moved into its second natural

511
00:22:01,110 --> 00:21:58,880
feature tracking attitude and is getting

512
00:22:03,350 --> 00:22:01,120
on board positional updates as we speak

513
00:22:05,110 --> 00:22:03,360

and i can tell you everything is going

514
00:22:07,270 --> 00:22:05,120
exactly according to plan right now it

515
00:22:09,590 --> 00:22:07,280
looks really good oh it's an exciting

516
00:22:11,590 --> 00:22:09,600
day so osiris-rex has traveled more than

517
00:22:13,830 --> 00:22:11,600
two and a half years as it navigated its

518
00:22:15,350 --> 00:22:13,840
way to this delicate orbit around bennu

519
00:22:17,350 --> 00:22:15,360
and once there it began mapping the

520
00:22:18,630 --> 00:22:17,360
surface one of the many tasks it in the

521
00:22:20,470 --> 00:22:18,640
engineering team had been conducting

522
00:22:22,230 --> 00:22:20,480
since it arrived and there have been

523
00:22:24,470 --> 00:22:22,240
some challenges and surprises too

524
00:22:26,390 --> 00:22:24,480
correct absolutely i can tell you

525
00:22:28,149 --> 00:22:26,400
already the science return from

526
00:22:29,909 --> 00:22:28,159
osiris-rex has been phenomenal and

527
00:22:31,750 --> 00:22:29,919
rewritten a lot of things about what we

528
00:22:33,350 --> 00:22:31,760
know about asteroids i'm going to talk

529
00:22:34,470 --> 00:22:33,360
really about three of some of the most

530
00:22:37,029 --> 00:22:34,480
interesting

531
00:22:38,630 --> 00:22:37,039
results for me first off we learned

532
00:22:40,470 --> 00:22:38,640
literally about one week after getting

533
00:22:43,590 --> 00:22:40,480
into orbit that bennu is what we call an

534
00:22:45,750 --> 00:22:43,600
active asteroid it is ejecting particles

535
00:22:47,830 --> 00:22:45,760
from its surface these particles are

536
00:22:49,350 --> 00:22:47,840
coming off at relatively low velocities

537
00:22:52,390 --> 00:22:49,360
for the most part they're actually going

538
00:22:54,070 --> 00:22:52,400

into orbit spiraling around the asteroid

539
00:22:56,149 --> 00:22:54,080
providing some excellent science

540
00:22:57,990 --> 00:22:56,159
allowing us to map out the gravity field

541
00:23:01,190 --> 00:22:58,000
of this small body at an unprecedented

542
00:23:02,870 --> 00:23:01,200
detail way beyond what we expected to do

543
00:23:04,230 --> 00:23:02,880
the other thing that we saw right away

544
00:23:06,789 --> 00:23:04,240
as we were approaching is that there was

545
00:23:08,230 --> 00:23:06,799
some a generally dark black surface as

546
00:23:09,990 --> 00:23:08,240
expected but there are these really

547
00:23:12,230 --> 00:23:10,000
bright boulders that were shining like

548
00:23:13,750 --> 00:23:12,240
beacons to us and as we trained our

549
00:23:15,830 --> 00:23:13,760
science instruments on there and

550
00:23:17,510 --> 00:23:15,840
characterized their mineralogy we were

551
00:23:19,990 --> 00:23:17,520
actually able to link them to another

552
00:23:21,750 --> 00:23:20,000
asteroid called vesta one of the largest

553
00:23:23,270 --> 00:23:21,760
asteroids in the solar system and

554
00:23:25,110 --> 00:23:23,280
actually the target of nasa's dawn

555
00:23:27,029 --> 00:23:25,120
spacecraft which did a phenomenal job

556
00:23:28,390 --> 00:23:27,039
characterizing this target and this just

557
00:23:30,870 --> 00:23:28,400
shows that these asteroids are

558
00:23:32,630 --> 00:23:30,880
exchanging pieces back and forth as they

559
00:23:34,630 --> 00:23:32,640
collide into each other and shoot their

560
00:23:37,110 --> 00:23:34,640
particles off into space

561
00:23:44,230 --> 00:23:37,120
over has processed its next image

562
00:23:48,310 --> 00:23:46,149
and i would say uh back to the science

563
00:23:49,909 --> 00:23:48,320

the final result that that really is

564
00:23:51,990 --> 00:23:49,919
important from this mission is we did

565
00:23:53,830 --> 00:23:52,000
expect this asteroid to look sandy and

566
00:23:55,430 --> 00:23:53,840
beach like and that was based on the

567
00:23:57,750 --> 00:23:55,440
thermal properties as determined from

568
00:23:59,830 --> 00:23:57,760
telescopic observations from earth and

569
00:24:02,070 --> 00:23:59,840
we got there and we used the otis and

570
00:24:04,710 --> 00:24:02,080
our ovir spectrometer to map and produce

571
00:24:06,950 --> 00:24:04,720
a thermal inertia characterization of

572
00:24:09,190 --> 00:24:06,960
the entire surface and everything turned

573
00:24:10,870 --> 00:24:09,200
itself upside down based on our models

574
00:24:12,789 --> 00:24:10,880
the areas that we thought would be

575
00:24:14,310 --> 00:24:12,799
beach-like based on thermal properties

576
00:24:16,230 --> 00:24:14,320
turned out to be the largest boulders on

577
00:24:17,990 --> 00:24:16,240
the asteroid surface and the more

578
00:24:19,669 --> 00:24:18,000
fine-grained regions turned turned out

579
00:24:21,590 --> 00:24:19,679
to have what we call this higher thermal

580
00:24:23,830 --> 00:24:21,600
inertia completely opposite of

581
00:24:25,909 --> 00:24:23,840
everything we expected propagating a lot

582
00:24:27,269 --> 00:24:25,919
of great science as a result and so when

583
00:24:29,269 --> 00:24:27,279
you mention that there are these bright

584
00:24:31,269 --> 00:24:29,279
rocks from vesta does that that means

585
00:24:32,710 --> 00:24:31,279
that bennu was once in the asteroid belt

586
00:24:34,789 --> 00:24:32,720
between mars and jupiter that's right

587
00:24:36,950 --> 00:24:34,799
bennu is currently a near-earth asteroid

588
00:24:38,870 --> 00:24:36,960

but it has it's a recent wanderer into

589
00:24:41,190 --> 00:24:38,880
the inner solar system we actually think

590
00:24:42,870 --> 00:24:41,200
it's uh fragments of a much larger

591
00:24:45,830 --> 00:24:42,880
asteroid that was catastrophically

592
00:24:47,830 --> 00:24:45,840
disrupted maybe a billion years ago wow

593
00:24:49,350 --> 00:24:47,840
that is so cool thank you so much

594
00:24:51,190 --> 00:24:49,360
okay now as challenging as it is

595
00:24:52,630 --> 00:24:51,200
actually getting to bennu capturing a

596
00:24:54,950 --> 00:24:52,640
sample of the asteroid is something else

597
00:24:57,350 --> 00:24:54,960
entirely and the team needed to develop

598
00:24:58,549 --> 00:24:57,360
this remarkable system the osiris-rex

599
00:25:00,630 --> 00:24:58,559
mission has been in development for

600
00:25:02,310 --> 00:25:00,640
almost 20 years with the engineers and

601
00:25:03,990 --> 00:25:02,320
scientists developing new technologies

602
00:25:06,070 --> 00:25:04,000
and strategies to accomplish something

603
00:25:07,909 --> 00:25:06,080
that's honestly never been done before

604
00:25:09,750 --> 00:25:07,919
and this is particularly challenging

605
00:25:11,750 --> 00:25:09,760
because bennu has such a weak gravity

606
00:25:13,830 --> 00:25:11,760
field so when you think about going into

607
00:25:15,909 --> 00:25:13,840
orbit around something how do you orbit

608
00:25:17,510 --> 00:25:15,919
something where the gravity can't grab

609
00:25:19,830 --> 00:25:17,520
you and actually push you into orbit

610
00:25:21,510 --> 00:25:19,840
it's all about flying the spacecraft

611
00:25:23,990 --> 00:25:21,520
it's also very difficult to take a

612
00:25:25,830 --> 00:25:24,000
sample in a very low gravity environment

613
00:25:27,029 --> 00:25:25,840

so thankfully we have the mastermind

614
00:25:28,710 --> 00:25:27,039
behind the device that's going to take

615
00:25:30,710 --> 00:25:28,720
the sample tonight lockheed martin's

616
00:25:32,549 --> 00:25:30,720
beau beerhouse welcome beau thank you

617
00:25:34,390 --> 00:25:32,559
michelle it's great to be here

618
00:25:35,830 --> 00:25:34,400
okay so let's talk a bit about why

619
00:25:37,830 --> 00:25:35,840
working in this low gravity environment

620
00:25:39,350 --> 00:25:37,840
makes it tough to get a sample because

621
00:25:41,029 --> 00:25:39,360
you might think sort of at first you

622
00:25:43,269 --> 00:25:41,039
could just take like a robotic claw a

623
00:25:44,230 --> 00:25:43,279
robotic arm and scoop something up but

624
00:25:46,230 --> 00:25:44,240
that's not going to work in these

625
00:25:48,230 --> 00:25:46,240
conditions that's exactly right the

626
00:25:49,909 --> 00:25:48,240
microgravity of bennu provides a

627
00:25:51,750 --> 00:25:49,919
challenge of sampling that we don't

628
00:25:53,510 --> 00:25:51,760
normally face on earth

629
00:25:55,590 --> 00:25:53,520
you can imagine trying to use a shovel

630
00:25:57,510 --> 00:25:55,600
or a scoop on earth and the ground

631
00:25:58,870 --> 00:25:57,520
pushes against you but the gravity keeps

632
00:26:00,470 --> 00:25:58,880
you on the ground

633
00:26:02,789 --> 00:26:00,480
on bennu the surface gravity is

634
00:26:04,470 --> 00:26:02,799
thousands of times lower than on earth

635
00:26:06,070 --> 00:26:04,480
so if you pushed a shovel or a scoop

636
00:26:08,390 --> 00:26:06,080
into the ground you'd push yourself

637
00:26:09,990 --> 00:26:08,400
right off the surface so we had to come

638
00:26:12,630 --> 00:26:10,000

up with a technique that worked within

639
00:26:14,230 --> 00:26:12,640
this very low gravity we also had the

640
00:26:16,630 --> 00:26:14,240
challenge of uncertainty of the

641
00:26:18,710 --> 00:26:16,640
mechanical properties of the surface

642
00:26:20,149 --> 00:26:18,720
and both of those things made landing a

643
00:26:21,990 --> 00:26:20,159
challenge we wouldn't know how to

644
00:26:24,070 --> 00:26:22,000
grapple particularly well in this

645
00:26:25,269 --> 00:26:24,080
material so we had to come up with a

646
00:26:27,269 --> 00:26:25,279
technique that worked in the

647
00:26:29,430 --> 00:26:27,279
microgravity environment and that could

648
00:26:31,029 --> 00:26:29,440
work in this tag architecture this touch

649
00:26:32,470 --> 00:26:31,039
and go architecture of just a few

650
00:26:33,669 --> 00:26:32,480
seconds long

651
00:26:35,350 --> 00:26:33,679
now i understand you have brought some

652
00:26:36,310 --> 00:26:35,360
models with you both of the spacecraft

653
00:26:37,750 --> 00:26:36,320
and of the instrument that will be

654
00:26:39,750 --> 00:26:37,760
taking samples so show us what you've

655
00:26:41,990 --> 00:26:39,760
got here that's exactly right so this is

656
00:26:43,830 --> 00:26:42,000
a scale model of the spacecraft

657
00:26:46,070 --> 00:26:43,840
the arm is extended in the sampling

658
00:26:48,230 --> 00:26:46,080
position

659
00:26:50,710 --> 00:26:48,240
part way down the arm you can see three

660
00:26:52,789 --> 00:26:50,720
gas bottles we'll use one of them today

661
00:26:55,110 --> 00:26:52,799
this has high pressure nitrogen gas

662
00:26:56,870 --> 00:26:55,120
which passes down the arm into the tag

663
00:26:59,990 --> 00:26:56,880

sam head itself

664
00:27:01,990 --> 00:27:00,000
and here i have actually a full scale

665
00:27:05,110 --> 00:27:02,000
tag sam it's actually a device that we

666
00:27:06,870 --> 00:27:05,120
used for collection testing on earth

667
00:27:08,470 --> 00:27:06,880
the gas comes down i don't have the

668
00:27:10,230 --> 00:27:08,480
tubing here to show you but the gas

669
00:27:12,549 --> 00:27:10,240
comes down to the center of the tag sam

670
00:27:15,029 --> 00:27:12,559
is split into two and passes underneath

671
00:27:17,029 --> 00:27:15,039
the head there is now a high pressure

672
00:27:19,590 --> 00:27:17,039
bubble of gas underneath the head that

673
00:27:22,310 --> 00:27:19,600
is mobilizing material much like wind

674
00:27:23,990 --> 00:27:22,320
blows dirt on a dusty day on the earth

675
00:27:24,950 --> 00:27:24,000
and we're surrounded by the vacuum of

676
00:27:26,789 --> 00:27:24,960
space

677
00:27:28,630 --> 00:27:26,799
so the gas is there's a high pressure

678
00:27:30,870 --> 00:27:28,640
gas underneath tag sam and it will

679
00:27:33,029 --> 00:27:30,880
escape into the low pressure environment

680
00:27:35,029 --> 00:27:33,039
of the vacuum of space surrounding it

681
00:27:36,789 --> 00:27:35,039
and it does so through this screen

682
00:27:39,350 --> 00:27:36,799
around the entire perimeter of the tag

683
00:27:41,750 --> 00:27:39,360
sam head itself but while the gas can

684
00:27:43,269 --> 00:27:41,760
escape the screen traps the material

685
00:27:44,470 --> 00:27:43,279
safely inside

686
00:27:46,070 --> 00:27:44,480
it's one of these sort of brilliant

687
00:27:47,430 --> 00:27:46,080
things about engineering for space is to

688
00:27:48,870 --> 00:27:47,440

have things that are really really

689
00:27:50,870 --> 00:27:48,880
rigorously built and they can't break

690
00:27:52,389 --> 00:27:50,880
easily and so there aren't even any

691
00:27:54,710 --> 00:27:52,399
moving parts here and you're using the

692
00:27:56,389 --> 00:27:54,720
vacuum of space itself to provide the

693
00:27:57,750 --> 00:27:56,399
pressure to collect the sample that's

694
00:28:00,470 --> 00:27:57,760
exactly right when we were first

695
00:28:01,990 --> 00:28:00,480
designing this device many years ago we

696
00:28:04,070 --> 00:28:02,000
were thinking we wanted to keep it as

697
00:28:05,909 --> 00:28:04,080
simple and as robust and as full proof

698
00:28:07,990 --> 00:28:05,919
as possible we didn't want any

699
00:28:10,950 --> 00:28:08,000
mechanisms we didn't want any electrical

700
00:28:13,430 --> 00:28:10,960
devices the entire collection is driven

701
00:28:15,269 --> 00:28:13,440
by the dynamics of the gas itself so

702
00:28:17,510 --> 00:28:15,279
once the gas is released from the bottle

703
00:28:20,070 --> 00:28:17,520
and travels down the arm the gas does

704
00:28:21,110 --> 00:28:20,080
all the work that's so cool so what size

705
00:28:22,230 --> 00:28:21,120
particles are we talking about

706
00:28:24,310 --> 00:28:22,240
collecting here

707
00:28:26,149 --> 00:28:24,320
well tag sam is designed to collect two

708
00:28:28,710 --> 00:28:26,159
centimeter particles and i have some

709
00:28:30,950 --> 00:28:28,720
examples here to show you so this is a

710
00:28:33,269 --> 00:28:30,960
two centimeter sphere it's about the

711
00:28:35,430 --> 00:28:33,279
same diameter as a nickel

712
00:28:37,430 --> 00:28:35,440
but of course most geologic materials

713
00:28:39,510 --> 00:28:37,440

aren't actually perfect spheres most

714
00:28:40,470 --> 00:28:39,520
geologic materials are irregularly

715
00:28:43,350 --> 00:28:40,480
shaped

716
00:28:47,590 --> 00:28:43,360
orex has processed its next image

717
00:28:49,430 --> 00:28:47,600
position uncertainty is 0.5 meters

718
00:28:51,830 --> 00:28:49,440
that is fantastic

719
00:28:53,669 --> 00:28:51,840
excellent

720
00:28:55,669 --> 00:28:53,679
so we're going where we need to go to

721
00:28:58,070 --> 00:28:55,679
get this material

722
00:28:59,510 --> 00:28:58,080
so most geologic material is irregularly

723
00:29:01,430 --> 00:28:59,520
shaped so this

724
00:29:03,190 --> 00:29:01,440
rock is actually about four centimeters

725
00:29:04,789 --> 00:29:03,200
long in its longest dimension but we

726
00:29:06,870 --> 00:29:04,799
were still able to collect this in a

727
00:29:08,470 --> 00:29:06,880
test on earth and that's because even

728
00:29:10,789 --> 00:29:08,480
though it's four centimeters in this

729
00:29:12,230 --> 00:29:10,799
dimension you can see that it's much

730
00:29:14,389 --> 00:29:12,240
less than two centimeters in that

731
00:29:15,750 --> 00:29:14,399
dimension or even two centimeters in the

732
00:29:17,990 --> 00:29:15,760
other dimension

733
00:29:20,070 --> 00:29:18,000
so while we're limited in in one

734
00:29:22,389 --> 00:29:20,080
direction for two centimeters as long as

735
00:29:24,310 --> 00:29:22,399
the other two directions are less we can

736
00:29:26,549 --> 00:29:24,320
actually collect uh much larger

737
00:29:28,070 --> 00:29:26,559
particles into the tag sam head itself

738
00:29:29,510 --> 00:29:28,080

well excellent so i understand we have

739
00:29:30,549 --> 00:29:29,520
some animations queued up to give us a

740
00:29:34,630 --> 00:29:30,559
sense of what's going to happen in the

741
00:29:38,230 --> 00:29:36,070
so what you're seeing is the spacecraft

742
00:29:40,389 --> 00:29:38,240
descending at a leisurely 10 centimeters

743
00:29:42,230 --> 00:29:40,399
per second to the surface 15 times

744
00:29:44,710 --> 00:29:42,240
slower than walking speed

745
00:29:46,870 --> 00:29:44,720
it contacts the spacecraft senses

746
00:29:49,269 --> 00:29:46,880
contact and fires the gas

747
00:29:50,789 --> 00:29:49,279
the gas mobilizes material underneath

748
00:29:53,029 --> 00:29:50,799
the tag sam head

749
00:29:54,389 --> 00:29:53,039
that gas escapes into the vacuum of

750
00:29:56,389 --> 00:29:54,399
space through the perimeter and

751
00:29:58,870 --> 00:29:56,399
materials collected inside the tag sam

752
00:30:00,710 --> 00:29:58,880
head the spacecraft fires its thrusters

753
00:30:02,950 --> 00:30:00,720
and backs safely away from the surface

754
00:30:04,310 --> 00:30:02,960
of the asteroid

755
00:30:05,590 --> 00:30:04,320
well thank you for the tutorial though i

756
00:30:06,870 --> 00:30:05,600
mean clearly the science community is

757
00:30:08,789 --> 00:30:06,880
going to be very excited to study

758
00:30:10,549 --> 00:30:08,799
whatever tag sam collects so thank you

759
00:30:11,669 --> 00:30:10,559
so much thank you it's wonderful to be

760
00:30:13,269 --> 00:30:11,679
here

761
00:30:14,870 --> 00:30:13,279
okay well speaking of all the important

762
00:30:16,950 --> 00:30:14,880
tag the thing that's happening in less

763
00:30:18,389 --> 00:30:16,960

than an hour uh right now before we get

764
00:30:20,070 --> 00:30:18,399
any later it would be a good time for us

765
00:30:21,430 --> 00:30:20,080
to get a tour of the nerve center here

766
00:30:22,389 --> 00:30:21,440
at lockheed martin space in littleton

767
00:30:23,990 --> 00:30:22,399
colorado

768
00:30:26,710 --> 00:30:24,000
right behind me is the mission support

769
00:30:28,070 --> 00:30:26,720
area or msa and that's where osiris-rex

770
00:30:29,990 --> 00:30:28,080
team members are keeping an eye on the

771
00:30:32,389 --> 00:30:30,000
spacecraft right now so let's send it

772
00:30:33,750 --> 00:30:32,399
over to gary what's going on gary

773
00:30:35,510 --> 00:30:33,760
so as i showed you earlier we're just

774
00:30:37,510 --> 00:30:35,520
around the corner from you this is the

775
00:30:38,710 --> 00:30:37,520
heart of the tag operations and we

776
00:30:40,070 --> 00:30:38,720
thought this would actually be a really

777
00:30:40,950 --> 00:30:40,080
good time to kind of check in with the

778
00:30:42,789 --> 00:30:40,960
team

779
00:30:45,110 --> 00:30:42,799
see how things are going and the best

780
00:30:47,510 --> 00:30:45,120
person to do that is joining me and this

781
00:30:49,350 --> 00:30:47,520
is sandy friend she's the osiris-rex

782
00:30:50,470 --> 00:30:49,360
operations manager here at lockheed

783
00:30:52,630 --> 00:30:50,480
martin so

784
00:30:54,630 --> 00:30:52,640
sandy thanks for joining us

785
00:30:56,389 --> 00:30:54,640
how's the team doing oh the team is

786
00:30:58,230 --> 00:30:56,399
great we have been here on consoles

787
00:31:01,350 --> 00:30:58,240
since six o'clock this morning setting

788
00:31:03,509 --> 00:31:01,360

the final commands getting ready for tag

789
00:31:05,190 --> 00:31:03,519
really cool i know there's like 40

790
00:31:06,630 --> 00:31:05,200
people on your overall flight team but

791
00:31:07,590 --> 00:31:06,640
it seems like there's about 20 of them

792
00:31:08,950 --> 00:31:07,600
here

793
00:31:10,470 --> 00:31:08,960
right now maybe kind of give us a little

794
00:31:12,310 --> 00:31:10,480
idea of who some of these folks are and

795
00:31:14,389 --> 00:31:12,320
what they're doing yeah absolutely so

796
00:31:16,149 --> 00:31:14,399
this is the amazing orex team you can

797
00:31:17,190 --> 00:31:16,159
see all of our subsystems here on

798
00:31:19,190 --> 00:31:17,200
console

799
00:31:20,950 --> 00:31:19,200
monitoring their telemetry like you

800
00:31:23,190 --> 00:31:20,960
mentioned we can't have everybody in

801
00:31:24,789 --> 00:31:23,200
here we do have many team members

802
00:31:27,110 --> 00:31:24,799
supporting from other conference rooms

803
00:31:28,310 --> 00:31:27,120
in the building and some even from home

804
00:31:30,070 --> 00:31:28,320
so let's talk about a couple of the

805
00:31:31,669 --> 00:31:30,080
positions we have in the room

806
00:31:32,789 --> 00:31:31,679
in the back corner over there is dale

807
00:31:34,870 --> 00:31:32,799
howe

808
00:31:36,630 --> 00:31:34,880
dale is our tag phase lead you've been

809
00:31:39,269 --> 00:31:36,640
hearing his voice calling out events as

810
00:31:41,029 --> 00:31:39,279
they complete on board the spacecraft

811
00:31:43,990 --> 00:31:41,039
here in the center area we have curtis

812
00:31:46,470 --> 00:31:44,000
miller curtis is our nft lead

813
00:31:48,149 --> 00:31:46,480

he is watching natural feature tracking

814
00:31:50,950 --> 00:31:48,159
and that is how we are navigating to the

815
00:31:52,950 --> 00:31:50,960
surface of benny today so he is watching

816
00:31:55,029 --> 00:31:52,960
how nft is performing how many features

817
00:31:55,990 --> 00:31:55,039
we're matching and how that system is

818
00:31:57,750 --> 00:31:56,000
working

819
00:31:59,190 --> 00:31:57,760
so i know natural feature trekking like

820
00:32:00,549 --> 00:31:59,200
you're saying is kind of keeping an eye

821
00:32:01,750 --> 00:32:00,559
on telling us where we're going and i

822
00:32:03,590 --> 00:32:01,760
know we're going to get into that a

823
00:32:05,430 --> 00:32:03,600
little bit later in the show

824
00:32:07,509 --> 00:32:05,440
but also it's important just to stay in

825
00:32:09,830 --> 00:32:07,519
communications with the spacecraft so

826
00:32:11,830 --> 00:32:09,840
what what about comms yeah absolutely so

827
00:32:14,470 --> 00:32:11,840
right behind me here is sierra gonzalez

828
00:32:16,149 --> 00:32:14,480
she's our real time operator or ace

829
00:32:18,070 --> 00:32:16,159
she is working with our deep space

830
00:32:20,549 --> 00:32:18,080
network partners currently we're on a

831
00:32:23,110 --> 00:32:20,559
station in goldstone and in canberra

832
00:32:25,430 --> 00:32:23,120
making sure we maintain our calm link

833
00:32:27,110 --> 00:32:25,440
and our com link is only 40 bits per

834
00:32:28,789 --> 00:32:27,120
second so we're just bringing down that

835
00:32:30,710 --> 00:32:28,799
key information but sierra's here to

836
00:32:33,029 --> 00:32:30,720
make sure we keep that link going and

837
00:32:35,430 --> 00:32:33,039
our station operator is informed

838
00:32:37,509 --> 00:32:35,440

and right next to her is estelle church

839
00:32:39,509 --> 00:32:37,519
and estelle is our systems coordinator

840
00:32:41,430 --> 00:32:39,519
for this event she's built all the

841
00:32:43,190 --> 00:32:41,440
command products that are executing

842
00:32:44,950 --> 00:32:43,200
she's keeping an eye on how everything

843
00:32:46,789 --> 00:32:44,960
is progressing on board the spacecraft

844
00:32:48,630 --> 00:32:46,799
talking to all of our sub-systems here

845
00:32:50,470 --> 00:32:48,640
in the room and making sure things are

846
00:32:52,149 --> 00:32:50,480
going just as planned

847
00:32:54,070 --> 00:32:52,159
very good i know you yourself have

848
00:32:55,110 --> 00:32:54,080
actually been on this um project for

849
00:32:56,389 --> 00:32:55,120
quite a while we've been back to

850
00:32:58,470 --> 00:32:56,399
development

851
00:33:01,269 --> 00:32:58,480
how are you feeling tonight

852
00:33:02,630 --> 00:33:01,279
no actually i'm excited um i feel like

853
00:33:04,470 --> 00:33:02,640
we've done everything we can to make

854
00:33:06,070 --> 00:33:04,480
this successful and i've been on this

855
00:33:07,909 --> 00:33:06,080
mission for seven years so i've watched

856
00:33:09,509 --> 00:33:07,919
it go from a spacecraft on paper to

857
00:33:11,669 --> 00:33:09,519
being built in our high day

858
00:33:13,269 --> 00:33:11,679
to launch and everything here and yeah

859
00:33:15,029 --> 00:33:13,279
i'm excited my kids are excited this

860
00:33:16,789 --> 00:33:15,039
morning and we are ready

861
00:33:18,310 --> 00:33:16,799
right on that's so fantastic so we're

862
00:33:20,470 --> 00:33:18,320
going to let you guys get back to it i

863
00:33:22,950 --> 00:33:20,480

know we don't want to interrupt too much

864
00:33:24,950 --> 00:33:22,960
sandy thank you so much for joining us

865
00:33:26,789 --> 00:33:24,960
and i know that uh folks around the

866
00:33:28,630 --> 00:33:26,799
world are paying attention to this right

867
00:33:30,870 --> 00:33:28,640
now we're seeing a ton of social media

868
00:33:32,470 --> 00:33:30,880
coming in so let's go over to james on

869
00:33:34,549 --> 00:33:32,480
the social media desk and see what some

870
00:33:36,230 --> 00:33:34,559
of those conversations are about

871
00:33:37,509 --> 00:33:36,240
yeah thanks gary it's awesome to see the

872
00:33:38,950 --> 00:33:37,519
team over there in the msa you can

873
00:33:40,149 --> 00:33:38,960
really feel the energy in the room

874
00:33:41,990 --> 00:33:40,159
especially after every call out from

875
00:33:44,710 --> 00:33:42,000
dale and

876
00:33:46,789 --> 00:33:44,720
to the tag attitude the third and final

877
00:33:48,549 --> 00:33:46,799
natural feature tracking attitude all

878
00:33:50,389 --> 00:33:48,559
right so we're inching ever so closer

879
00:33:52,710 --> 00:33:50,399
down to the surface of bennu but today

880
00:33:54,470 --> 00:33:52,720
we also want to hear from you so you can

881
00:33:56,549 --> 00:33:54,480
check in on live updates at our twitter

882
00:33:58,470 --> 00:33:56,559
account at osiris-rex or using that

883
00:34:00,789 --> 00:33:58,480
hashtag to venue and back across social

884
00:34:02,149 --> 00:34:00,799
media to get in on the conversation

885
00:34:04,230 --> 00:34:02,159
in the meantime a question i had when i

886
00:34:05,830 --> 00:34:04,240
first started covering the mission is

887
00:34:07,590 --> 00:34:05,840
how do you even begin to prepare for a

888
00:34:09,510 --> 00:34:07,600

mission of this scale i mean when i

889
00:34:10,629 --> 00:34:09,520
first heard about osiris-rex it really

890
00:34:13,829 --> 00:34:10,639
seemed like something out of a big

891
00:34:15,270 --> 00:34:13,839
budget movie but this is a reality we're

892
00:34:17,190 --> 00:34:15,280
actually going to be trying to sample on

893
00:34:19,510 --> 00:34:17,200
an asteroid to put things into

894
00:34:22,550 --> 00:34:19,520
perspective for you bennu is about the

895
00:34:24,389 --> 00:34:22,560
size of the empire state building that's

896
00:34:25,750 --> 00:34:24,399
really small for an object and makes it

897
00:34:27,430 --> 00:34:25,760
exceptionally challenging for us to

898
00:34:28,230 --> 00:34:27,440
orbit something with such a weak gravity

899
00:34:29,589 --> 00:34:28,240
field

900
00:34:32,470 --> 00:34:29,599
and that sample site we're going for

901
00:34:34,550 --> 00:34:32,480
today nightingale it's just a few meters

902
00:34:36,310 --> 00:34:34,560
in width which is about the size of a

903
00:34:38,310 --> 00:34:36,320
few parking spaces

904
00:34:39,829 --> 00:34:38,320
so just take a step back for a second

905
00:34:41,669 --> 00:34:39,839
and put yourself in the shoes of some of

906
00:34:44,069 --> 00:34:41,679
those engineers on this mission and

907
00:34:47,270 --> 00:34:44,079
imagine trying to park a spacecraft on

908
00:34:49,669 --> 00:34:47,280
an asteroid 200 million miles away and a

909
00:34:51,589 --> 00:34:49,679
space no larger than a few parking spots

910
00:34:53,990 --> 00:34:51,599
as if parallel parking on an asteroid

911
00:34:56,310 --> 00:34:54,000
isn't hard enough imagine also trying to

912
00:34:57,589 --> 00:34:56,320
dodge hazards like rocky boulders and

913
00:34:59,589 --> 00:34:57,599

all kinds of things as you're making

914
00:35:01,270 --> 00:34:59,599
your descent down to collect a sample

915
00:35:02,710 --> 00:35:01,280
and on top of that the team has actually

916
00:35:04,630 --> 00:35:02,720
programmed the spacecraft to steer

917
00:35:06,150 --> 00:35:04,640
itself down to the surface

918
00:35:07,510 --> 00:35:06,160
it's it's truly incredible this mission

919
00:35:09,030 --> 00:35:07,520
and all the foresight that went into it

920
00:35:10,150 --> 00:35:09,040
really blows my mind

921
00:35:11,750 --> 00:35:10,160
we actually have a couple questions

922
00:35:13,109 --> 00:35:11,760
coming in from twitter and a lot of

923
00:35:14,870 --> 00:35:13,119
people are actually asking about our

924
00:35:17,270 --> 00:35:14,880
fuel usage for the mission

925
00:35:19,270 --> 00:35:17,280
this one question is asking how does the

926
00:35:21,750 --> 00:35:19,280
craft have enough fuel to return back to

927
00:35:24,069 --> 00:35:21,760
earth from the asteroid so we're looking

928
00:35:25,829 --> 00:35:24,079
to bring that symbol back in 2023 and

929
00:35:27,510 --> 00:35:25,839
osiris-rex is thrusters are actually

930
00:35:29,430 --> 00:35:27,520
powered by hydrazine which is stored in

931
00:35:30,870 --> 00:35:29,440
a container on the spacecraft we're

932
00:35:32,630 --> 00:35:30,880
tapping into a little bit of that fuel

933
00:35:35,270 --> 00:35:32,640
today on the order of maybe tens of

934
00:35:37,349 --> 00:35:35,280
grams not a lot because as you remember

935
00:35:38,950 --> 00:35:37,359
bennu has this microgravity environment

936
00:35:40,550 --> 00:35:38,960
and it just requires a little bit of

937
00:35:42,069 --> 00:35:40,560
thrust to kick us in the right direction

938
00:35:44,150 --> 00:35:42,079

to collect the sample

939
00:35:45,510 --> 00:35:44,160
that return trip back to earth that's a

940
00:35:48,150 --> 00:35:45,520
bit of a different story we're going to

941
00:35:49,750 --> 00:35:48,160
be using a lot more fuel for that but

942
00:35:51,349 --> 00:35:49,760
don't worry the team has thought way

943
00:35:54,470 --> 00:35:51,359
ahead and has packed more than enough

944
00:35:56,150 --> 00:35:54,480
fuel to get us back here safely in 2023

945
00:35:57,910 --> 00:35:56,160
but there's a lot more to come and i'll

946
00:35:59,829 --> 00:35:57,920
check back in with you in just a minute

947
00:36:01,589 --> 00:35:59,839
back to you michelle

948
00:36:02,950 --> 00:36:01,599
thank you james okay so let's take a

949
00:36:04,150 --> 00:36:02,960
quick look at the simulation to see

950
00:36:05,670 --> 00:36:04,160
where we are

951
00:36:08,630 --> 00:36:05,680
as you notice with the simulation the

952
00:36:11,030 --> 00:36:08,640
spacecraft has its arm extended now and

953
00:36:12,310 --> 00:36:11,040
is on a slow path toward the surface so

954
00:36:14,150 --> 00:36:12,320
as we get closer to the moment of

955
00:36:16,470 --> 00:36:14,160
contact the drama starts to happen in

956
00:36:18,630 --> 00:36:16,480
slow motion and this is to maximize

957
00:36:20,069 --> 00:36:18,640
precision and minimize unintentional

958
00:36:24,550 --> 00:36:20,079
surprises

959
00:36:25,910 --> 00:36:24,560
big aspect of the osiris-rex mission

960
00:36:27,910 --> 00:36:25,920
that's all about preparing for the

961
00:36:29,910 --> 00:36:27,920
unexpected and joining us to discuss

962
00:36:32,150 --> 00:36:29,920
this is nasa planetary science division

963
00:36:33,430 --> 00:36:32,160

director lori glaze now

964
00:36:34,630 --> 00:36:33,440
laura you have kind of a dramatic

965
00:36:36,230 --> 00:36:34,640
specialty

966
00:36:38,230 --> 00:36:36,240
and a responsibility that comes with

967
00:36:41,109 --> 00:36:38,240
your position at nasa you actually worry

968
00:36:41,990 --> 00:36:41,119
about things like planetary protection

969
00:36:43,190 --> 00:36:42,000
yes

970
00:36:44,870 --> 00:36:43,200
planetary protection or planetary

971
00:36:46,790 --> 00:36:44,880
defenses

972
00:36:48,230 --> 00:36:46,800
defending our planet from potential

973
00:36:49,990 --> 00:36:48,240
impacts and

974
00:36:51,589 --> 00:36:50,000
bennu is in a special class and i think

975
00:36:52,390 --> 00:36:51,599
dante spoke about this a little earlier

976
00:36:54,550 --> 00:36:52,400
that

977
00:36:57,670 --> 00:36:54,560
bennu is actually a near-earth object or

978
00:37:00,310 --> 00:36:57,680
a neo um and a neo or near-earth object

979
00:37:02,550 --> 00:37:00,320
um is an asteroid or a comet that orbits

980
00:37:05,270 --> 00:37:02,560
the sun much like our planets do uh but

981
00:37:07,270 --> 00:37:05,280
they're slightly unusual

982
00:37:09,510 --> 00:37:07,280
overex has reached the third and final

983
00:37:11,829 --> 00:37:09,520
natural feature tracking attitude the

984
00:37:13,190 --> 00:37:11,839
spacecraft will hold this fixed attitude

985
00:37:15,510 --> 00:37:13,200
until tagged

986
00:37:18,310 --> 00:37:15,520
excellent great news

987
00:37:20,790 --> 00:37:18,320
so back to neos yes so neos are somewhat

988
00:37:23,109 --> 00:37:20,800

unusual in that their orbits bring them

989
00:37:25,109 --> 00:37:23,119
within the vicinity of earth's orbit um

990
00:37:26,390 --> 00:37:25,119
the technical definition of an a neo is

991
00:37:29,190 --> 00:37:26,400
something that comes within about 30

992
00:37:30,550 --> 00:37:29,200
million miles of earth's orbit um and

993
00:37:33,349 --> 00:37:30,560
asteroids actually come close to the

994
00:37:35,109 --> 00:37:33,359
earth all the time one or two per week

995
00:37:37,030 --> 00:37:35,119
actually pass in between the earth and

996
00:37:38,950 --> 00:37:37,040
the moon but most of those are really

997
00:37:41,270 --> 00:37:38,960
small and not dangerous

998
00:37:42,630 --> 00:37:41,280
but asteroids of a much bigger size that

999
00:37:44,630 --> 00:37:42,640
could actually do damage to the earth's

1000
00:37:46,230 --> 00:37:44,640
surface if they were to impact and they

1001
00:37:48,230 --> 00:37:46,240
can pass by earth closer than the moon

1002
00:37:51,030 --> 00:37:48,240
about once per month and that's why it's

1003
00:37:53,109 --> 00:37:51,040
really important for us to find them

1004
00:37:55,510 --> 00:37:53,119
as early as possible so we can track

1005
00:37:57,910 --> 00:37:55,520
their orbits study their characteristics

1006
00:38:00,150 --> 00:37:57,920
and if necessary we can mitigate a

1007
00:38:01,990 --> 00:38:00,160
potential future impact threat and

1008
00:38:03,829 --> 00:38:02,000
that's where a mission that we're

1009
00:38:06,230 --> 00:38:03,839
building now called the double asteroid

1010
00:38:06,870 --> 00:38:06,240
redirection test that's where dart comes

1011
00:38:15,670 --> 00:38:06,880
in

1012
00:38:17,270 --> 00:38:15,680
technique that could be used one day to

1013
00:38:20,069 --> 00:38:17,280

help us mitigate a future potential

1014
00:38:22,230 --> 00:38:20,079
impact threat by bumping an asteroid

1015
00:38:24,150 --> 00:38:22,240
ever slow slightly on a that's on a

1016
00:38:25,750 --> 00:38:24,160
completion course with our planet into a

1017
00:38:27,510 --> 00:38:25,760
slightly different orbit so it misses

1018
00:38:29,270 --> 00:38:27,520
earth just a little bit is all you need

1019
00:38:31,109 --> 00:38:29,280
just a tiny bit

1020
00:38:32,790 --> 00:38:31,119
so i mean that is really exciting now i

1021
00:38:34,230 --> 00:38:32,800
also understand that not all of the

1022
00:38:36,069 --> 00:38:34,240
asteroids in the solar system are the

1023
00:38:37,910 --> 00:38:36,079
same there are different sorts and nasa

1024
00:38:39,670 --> 00:38:37,920
has some upcoming missions to study

1025
00:38:41,030 --> 00:38:39,680
these different kinds of asteroids so

1026
00:38:42,710 --> 00:38:41,040
tell us a bit more about that please

1027
00:38:44,870 --> 00:38:42,720
absolutely yeah we know that the

1028
00:38:47,109 --> 00:38:44,880
majority of our asteroids are found in

1029
00:38:49,030 --> 00:38:47,119
the main asteroid belt between mars and

1030
00:38:51,349 --> 00:38:49,040
jupiter and in fact we have a mission

1031
00:38:53,510 --> 00:38:51,359
that's going to launch in 2022 it's

1032
00:38:55,430 --> 00:38:53,520
called psyche uh it's going to visit one

1033
00:38:57,670 --> 00:38:55,440
of the the biggest asteroids in the

1034
00:38:58,870 --> 00:38:57,680
asteroid belt that's actually called 16

1035
00:39:00,630 --> 00:38:58,880
psyche

1036
00:39:03,750 --> 00:39:00,640
and this mission is going to arrive in

1037
00:39:05,589 --> 00:39:03,760
early 2026 and help us better understand

1038
00:39:07,829 --> 00:39:05,599

um if this asteroid is potentially

1039
00:39:10,390 --> 00:39:07,839
actually the core of a planet-sized

1040
00:39:12,550 --> 00:39:10,400
object we also have other types of

1041
00:39:14,790 --> 00:39:12,560
asteroids called trojans that are

1042
00:39:17,190 --> 00:39:14,800
clustered in two groups that lead and

1043
00:39:19,030 --> 00:39:17,200
trail in jupiter's orbit due to a

1044
00:39:21,670 --> 00:39:19,040
balancing act of the pull of both

1045
00:39:23,270 --> 00:39:21,680
jupiter's and the sun's gravity on them

1046
00:39:25,109 --> 00:39:23,280
nasa has a mission to those trojan

1047
00:39:27,430 --> 00:39:25,119
asteroids called lucy it's going to

1048
00:39:29,430 --> 00:39:27,440
launch next year next fall about a year

1049
00:39:31,589 --> 00:39:29,440
from now and it's going to go visit

1050
00:39:33,190 --> 00:39:31,599
several of these trojan asteroids

1051
00:39:35,349 --> 00:39:33,200
we have a new mission

1052
00:39:37,510 --> 00:39:35,359
called janus and we selected this

1053
00:39:39,990 --> 00:39:37,520
mission through our simplex

1054
00:39:41,510 --> 00:39:40,000
small mission program line

1055
00:39:43,910 --> 00:39:41,520
this mission is going to send actually

1056
00:39:45,109 --> 00:39:43,920
two small spacecraft very small

1057
00:39:47,990 --> 00:39:45,119
spacecraft

1058
00:39:49,670 --> 00:39:48,000
to two binary asteroid systems and help

1059
00:39:51,430 --> 00:39:49,680
us understand what it is that makes

1060
00:39:53,829 --> 00:39:51,440
these binary asteroid systems different

1061
00:39:55,030 --> 00:39:53,839
from one another and so studying this

1062
00:39:56,870 --> 00:39:55,040
full breadth

1063
00:39:58,790 --> 00:39:56,880

of these diverse small worlds will

1064
00:40:00,710 --> 00:39:58,800
continue to help us fill up the

1065
00:40:02,790 --> 00:40:00,720
knowledge gaps of how our solar system

1066
00:40:03,990 --> 00:40:02,800
actually formed and evolved over time

1067
00:40:05,510 --> 00:40:04,000
so it seems without these missions

1068
00:40:07,589 --> 00:40:05,520
coming up we're sort of in a golden age

1069
00:40:09,270 --> 00:40:07,599
of asteroid exploration but then there's

1070
00:40:11,190 --> 00:40:09,280
this other aspect of the osiris-rex

1071
00:40:12,630 --> 00:40:11,200
mission which is the sample return and

1072
00:40:14,390 --> 00:40:12,640
it turns out that we're also beginning

1073
00:40:16,710 --> 00:40:14,400
this golden age of sample return to it

1074
00:40:18,710 --> 00:40:16,720
and not just asteroids you're absolutely

1075
00:40:19,990 --> 00:40:18,720
right and we're really excited about all

1076
00:40:21,589 --> 00:40:20,000
these samples because they're so

1077
00:40:23,589 --> 00:40:21,599
precious precious and there's so much

1078
00:40:26,550 --> 00:40:23,599
science we can do with them in addition

1079
00:40:28,470 --> 00:40:26,560
to osiris-rex we're also partnering with

1080
00:40:30,710 --> 00:40:28,480
the japanese space agency on their

1081
00:40:32,390 --> 00:40:30,720
mission called hayabusa ii which is

1082
00:40:34,470 --> 00:40:32,400
actually already on its way back

1083
00:40:35,750 --> 00:40:34,480
bringing a sample from ryugu they're

1084
00:40:38,309 --> 00:40:35,760
going to be coming back to earth in

1085
00:40:40,309 --> 00:40:38,319
december we're also partnering with

1086
00:40:42,069 --> 00:40:40,319
japanese space agency on another mission

1087
00:40:43,750 --> 00:40:42,079
of theirs that's going to return a

1088
00:40:47,190 --> 00:40:43,760

sample from phobos which is one of the

1089
00:40:49,190 --> 00:40:47,200
two moons of mars and then finally at

1090
00:40:51,589 --> 00:40:49,200
the end of this decade we're going to

1091
00:40:53,109 --> 00:40:51,599
send a mission to mars to retrieve the

1092
00:40:55,829 --> 00:40:53,119
samples that are collected by the

1093
00:40:59,030 --> 00:40:55,839
perseverance rover which is really truly

1094
00:41:01,030 --> 00:40:59,040
our first astrobiology mission from nasa

1095
00:41:04,069 --> 00:41:01,040
and it's focused on looking for finding

1096
00:41:06,790 --> 00:41:04,079
potential life ancient life on mars so

1097
00:41:08,550 --> 00:41:06,800
sample of return is really important uh

1098
00:41:10,950 --> 00:41:08,560
because it allows us to study these

1099
00:41:13,190 --> 00:41:10,960
pristine samples back here on earth

1100
00:41:15,190 --> 00:41:13,200
we can then take advantage of our room

1101
00:41:17,030 --> 00:41:15,200
size laboratories

1102
00:41:19,349 --> 00:41:17,040
all of this ops

1103
00:41:21,670 --> 00:41:19,359
orex has begun moving the solar arrays

1104
00:41:23,750 --> 00:41:21,680
to the y-wing configuration to avoid

1105
00:41:25,030 --> 00:41:23,760
possible contact with the surface during

1106
00:41:27,430 --> 00:41:25,040
tag

1107
00:41:29,190 --> 00:41:27,440
great news moving right along

1108
00:41:30,950 --> 00:41:29,200
so when we bring the samples back this

1109
00:41:32,710 --> 00:41:30,960
allows us to use all of the laboratory

1110
00:41:34,230 --> 00:41:32,720
capabilities that we have here on earth

1111
00:41:35,829 --> 00:41:34,240
we can use the full suite of the

1112
00:41:37,430 --> 00:41:35,839
scientific instruments that we have at

1113
00:41:39,510 --> 00:41:37,440

our disposal to help us better

1114
00:41:41,030 --> 00:41:39,520
understand the sample their compositions

1115
00:41:42,150 --> 00:41:41,040
and the history of the body from which

1116
00:41:43,990 --> 00:41:42,160
they came

1117
00:41:46,150 --> 00:41:44,000
and also having the samples back here on

1118
00:41:48,550 --> 00:41:46,160
earth allows us to preserve them for

1119
00:41:50,550 --> 00:41:48,560
future generations to come and allows

1120
00:41:52,870 --> 00:41:50,560
their future explorers to analyze the

1121
00:41:54,870 --> 00:41:52,880
samples using techniques and instruments

1122
00:41:56,309 --> 00:41:54,880
that haven't been invented and to ask

1123
00:41:57,829 --> 00:41:56,319
questions that we don't even know to ask

1124
00:41:59,430 --> 00:41:57,839
yet

1125
00:42:01,109 --> 00:41:59,440
that is just so cool i mean your life is

1126
00:42:02,150 --> 00:42:01,119
all about how we navigate unknowns this

1127
00:42:03,750 --> 00:42:02,160
is something that's happening in real

1128
00:42:04,870 --> 00:42:03,760
time around us tonight so it's

1129
00:42:07,030 --> 00:42:04,880
reassuring to know that there's an

1130
00:42:08,230 --> 00:42:07,040
organized plan that you're in charge of

1131
00:42:10,630 --> 00:42:08,240
to help take some of the uncertainties

1132
00:42:12,230 --> 00:42:10,640
out of at least one dramatic category

1133
00:42:13,670 --> 00:42:12,240
so lori glease thank you for joining us

1134
00:42:15,589 --> 00:42:13,680
this evening so good to see you thank

1135
00:42:18,150 --> 00:42:15,599
you so much for having me i just want to

1136
00:42:21,109 --> 00:42:18,160
add that it's been fantastic to watch

1137
00:42:23,030 --> 00:42:21,119
the osiris-rex mission um so far and i'm

1138
00:42:23,990 --> 00:42:23,040

really really excited for what's ahead

1139
00:42:26,390 --> 00:42:24,000
tonight and i want to say

1140
00:42:28,470 --> 00:42:26,400
congratulations to the entire team thank

1141
00:42:31,349 --> 00:42:28,480
you so much thank you

1142
00:42:32,950 --> 00:42:31,359
now asteroids are not easily navigated

1143
00:42:34,950 --> 00:42:32,960
they're hard to see they have low

1144
00:42:36,390 --> 00:42:34,960
gravity fields they're dark and rocky

1145
00:42:38,150 --> 00:42:36,400
and traveling around the solar system

1146
00:42:39,670 --> 00:42:38,160
where everything is moving rarely means

1147
00:42:41,109 --> 00:42:39,680
traveling in a straight line

1148
00:42:42,790 --> 00:42:41,119
let's take a look at some of the big

1149
00:42:46,870 --> 00:42:42,800
challenges the team has faced to get to

1150
00:42:50,230 --> 00:42:48,630
as we started to approach bennu from a

1151
00:42:52,309 --> 00:42:50,240
distance and it started to fill up the

1152
00:42:53,829 --> 00:42:52,319
camera field of view it looked exactly

1153
00:42:55,270 --> 00:42:53,839
like we thought it would with a few

1154
00:42:58,069 --> 00:42:55,280
boulders sticking out but as we got

1155
00:42:59,910 --> 00:42:58,079
closer we expected to see a very sandy

1156
00:43:02,069 --> 00:42:59,920
surface with maybe a few boulders here

1157
00:43:04,069 --> 00:43:02,079
and there and what we saw is

1158
00:43:06,470 --> 00:43:04,079
very little sand and we saw these

1159
00:43:09,589 --> 00:43:06,480
mountains we saw boulders we saw rocks

1160
00:43:11,829 --> 00:43:09,599
and we saw very few areas that had this

1161
00:43:18,870 --> 00:43:11,839
sandy surface that we were expecting and

1162
00:43:23,030 --> 00:43:21,270
we have never done this before

1163
00:43:24,870 --> 00:43:23,040

we're actually going to collect a sample

1164
00:43:27,750 --> 00:43:24,880
and bring it back down to earth for

1165
00:43:29,829 --> 00:43:27,760
further examination by scientists

1166
00:43:31,270 --> 00:43:29,839
in order to achieve that objective the

1167
00:43:33,109 --> 00:43:31,280
osiris-rex spacecraft has been

1168
00:43:35,109 --> 00:43:33,119
navigating around bennu for about the

1169
00:43:36,150 --> 00:43:35,119
last two years studying it in great

1170
00:43:38,150 --> 00:43:36,160
detail

1171
00:43:40,790 --> 00:43:38,160
and also overcoming a number of

1172
00:43:43,270 --> 00:43:40,800
challenges that venue has presented we

1173
00:43:45,910 --> 00:43:43,280
were looking for locations on bennu that

1174
00:43:47,910 --> 00:43:45,920
were 50 meters in diameter relatively

1175
00:43:49,910 --> 00:43:47,920
flat and covered with fine grained

1176
00:43:51,990 --> 00:43:49,920
material and by fine grain material i

1177
00:43:53,829 --> 00:43:52,000
mean stuff that's the size of a dime or

1178
00:43:55,829 --> 00:43:53,839
smaller we realized that there were no

1179
00:43:57,589 --> 00:43:55,839
sites on bennu that even came close to

1180
00:43:59,510 --> 00:43:57,599
meeting this criteria everywhere we

1181
00:44:01,430 --> 00:43:59,520
looked was too small and covered with

1182
00:44:03,270 --> 00:44:01,440
boulders so we actually had to fly a

1183
00:44:05,829 --> 00:44:03,280
number of additional close passes over

1184
00:44:09,190 --> 00:44:05,839
the asteroid and rethink our entire plan

1185
00:44:11,030 --> 00:44:09,200
for grabbing the sample

1186
00:44:13,190 --> 00:44:11,040
after the additional observations of

1187
00:44:15,190 --> 00:44:13,200
bennu we had to down select to four

1188
00:44:17,510 --> 00:44:15,200

sites and then go back and survey those

1189
00:44:19,990 --> 00:44:17,520
sites even further to select the final

1190
00:44:21,990 --> 00:44:20,000
primary sample site my first impression

1191
00:44:24,230 --> 00:44:22,000
of nightingale is that's the last place

1192
00:44:26,710 --> 00:44:24,240
i wanted to go but as we started looking

1193
00:44:28,790 --> 00:44:26,720
at other sites we saw that one this is

1194
00:44:32,150 --> 00:44:28,800
probably one of the most sample both

1195
00:44:33,829 --> 00:44:32,160
sites and two we were over performing in

1196
00:44:35,829 --> 00:44:33,839
our navigation capability and our

1197
00:44:37,430 --> 00:44:35,839
ability to contact

1198
00:44:39,270 --> 00:44:37,440
natural feature tracking works a lot

1199
00:44:41,910 --> 00:44:39,280
like the human mind in that we pick up

1200
00:44:43,510 --> 00:44:41,920
landmarks along the way as we descend we

1201
00:44:45,109 --> 00:44:43,520
look at features on the ground we

1202
00:44:47,109 --> 00:44:45,119
program the computer to recognize

1203
00:44:49,190 --> 00:44:47,119
certain features it takes a picture says

1204
00:44:50,870 --> 00:44:49,200
this feature is not where i expected it

1205
00:44:53,109 --> 00:44:50,880
to be it's a little bit off to the side

1206
00:44:54,790 --> 00:44:53,119
updates its position based on where it's

1207
00:44:57,670 --> 00:44:54,800
pointed and where that feature shows up

1208
00:45:01,030 --> 00:44:57,680
in the camera position

1209
00:45:02,470 --> 00:45:01,040
the tag event is our touch and go event

1210
00:45:04,710 --> 00:45:02,480
which is where we'll actually be

1211
00:45:06,230 --> 00:45:04,720
retrieving the sample from asteroid

1212
00:45:07,670 --> 00:45:06,240
bennu we start with a series of

1213
00:45:09,510 --> 00:45:07,680

maneuvers one of them being the

1214
00:45:11,589 --> 00:45:09,520
checkpoint burn which is where we'll

1215
00:45:14,390 --> 00:45:11,599
actually check our position velocity in

1216
00:45:16,950 --> 00:45:14,400
relation to the sample site and then the

1217
00:45:18,790 --> 00:45:16,960
match point burn about 10 minutes later

1218
00:45:20,550 --> 00:45:18,800
we'll zero out our horizontal velocity

1219
00:45:22,630 --> 00:45:20,560
relative to the surface and then about

1220
00:45:24,950 --> 00:45:22,640
10 minutes after that we make contact

1221
00:45:27,510 --> 00:45:24,960
with the tag sam fire the gas bottle and

1222
00:45:29,750 --> 00:45:27,520
then back away and we hope to get at

1223
00:45:31,990 --> 00:45:29,760
least 60 grams of sample and then we'll

1224
00:45:33,349 --> 00:45:32,000
be able to store that and bring it back

1225
00:45:34,790 --> 00:45:33,359
down to earth but there are several

1226
00:45:36,230 --> 00:45:34,800
things that could go wrong and we also

1227
00:45:38,150 --> 00:45:36,240
have to be prepared that we won't be

1228
00:45:39,270 --> 00:45:38,160
successful on our first try at

1229
00:45:41,750 --> 00:45:39,280
nightingale

1230
00:45:43,750 --> 00:45:41,760
we don't only get one shot at tag we

1231
00:45:45,190 --> 00:45:43,760
actually have three nitrogen bottles on

1232
00:45:47,510 --> 00:45:45,200
board the spacecraft so we can

1233
00:45:49,990 --> 00:45:47,520
potentially do three tag attempts if

1234
00:45:51,750 --> 00:45:50,000
needed we go through several what-if

1235
00:45:54,069 --> 00:45:51,760
scenarios and this is how we actually

1236
00:45:55,510 --> 00:45:54,079
prepare for a lot of our contingencies

1237
00:45:57,510 --> 00:45:55,520
so we've had to look all around the

1238
00:45:59,190 --> 00:45:57,520

surface and identify the rocks and

1239
00:46:01,990 --> 00:45:59,200
boulders that if the spacecraft were to

1240
00:46:04,309 --> 00:46:02,000
tip over up to 25 degrees it could come

1241
00:46:06,390 --> 00:46:04,319
into contact and be damaged we had to

1242
00:46:07,829 --> 00:46:06,400
develop a hazard map which we program

1243
00:46:09,750 --> 00:46:07,839
into the computer and says if you're

1244
00:46:11,990 --> 00:46:09,760
getting too close to those hazards we'll

1245
00:46:13,670 --> 00:46:12,000
do a wave off we'll back away from the

1246
00:46:15,270 --> 00:46:13,680
asteroid we'll come back and do this

1247
00:46:17,430 --> 00:46:15,280
another day everything might work

1248
00:46:19,750 --> 00:46:17,440
perfectly we come down we touch the

1249
00:46:22,790 --> 00:46:19,760
surface just where we want to we fire

1250
00:46:25,589 --> 00:46:22,800
the gas bottle but the area we contact

1251
00:46:28,230 --> 00:46:25,599
is covered in large rocks

1252
00:46:30,069 --> 00:46:28,240
those rocks would prevent any fine grain

1253
00:46:32,550 --> 00:46:30,079
material from being stirred up and

1254
00:46:34,790 --> 00:46:32,560
captured in the tag sam head

1255
00:46:36,309 --> 00:46:34,800
another similar scenario is if the tag

1256
00:46:38,470 --> 00:46:36,319
sam were to touch on the edge of a

1257
00:46:40,390 --> 00:46:38,480
boulder and become tipped up in that

1258
00:46:42,550 --> 00:46:40,400
case when the gas bottle fires much of

1259
00:46:44,309 --> 00:46:42,560
that gas escapes out the side not

1260
00:46:46,309 --> 00:46:44,319
churning up the material that we want to

1261
00:46:48,150 --> 00:46:46,319
capture the day of tag is going to be

1262
00:46:50,470 --> 00:46:48,160
really exciting but the excitement for

1263
00:46:53,349 --> 00:46:50,480

our team doesn't end there we have to

1264
00:46:55,349 --> 00:46:53,359
verify that we have a proper sample

1265
00:46:56,790 --> 00:46:55,359
first we're going to image the tag sam

1266
00:46:57,990 --> 00:46:56,800
head by sticking in front of one of the

1267
00:46:59,670 --> 00:46:58,000
cameras then we're going to do a

1268
00:47:01,190 --> 00:46:59,680
maneuver called the sample mass

1269
00:47:03,349 --> 00:47:01,200
measurement in which we stick out the

1270
00:47:04,870 --> 00:47:03,359
arm and we spin the spacecraft in order

1271
00:47:06,550 --> 00:47:04,880
for us to decide if we've collected

1272
00:47:08,790 --> 00:47:06,560
enough mass to be able to stow the

1273
00:47:11,190 --> 00:47:08,800
sample and return home or if we have to

1274
00:47:12,309 --> 00:47:11,200
try again this is the culmination of a

1275
00:47:13,829 --> 00:47:12,319
lot of work it's probably one of the

1276
00:47:15,510 --> 00:47:13,839
most exciting missions that i've worked

1277
00:47:17,670 --> 00:47:15,520
on it is really exciting to know that

1278
00:47:19,510 --> 00:47:17,680
we're finally going to be able to

1279
00:47:21,270 --> 00:47:19,520
touch the surface of the asteroid and

1280
00:47:22,950 --> 00:47:21,280
collect the sample to return back to

1281
00:47:24,790 --> 00:47:22,960
earth

1282
00:47:26,470 --> 00:47:24,800
so step back for a moment and realize

1283
00:47:29,030 --> 00:47:26,480
that tonight's events are exceedingly

1284
00:47:30,790 --> 00:47:29,040
rare and historic humanity has only

1285
00:47:32,309 --> 00:47:30,800
landed on a few different bodies in the

1286
00:47:34,230 --> 00:47:32,319
solar system and actually retrieving a

1287
00:47:35,910 --> 00:47:34,240
sample is even more rare

1288
00:47:37,670 --> 00:47:35,920

so luckily with me tonight are some of

1289
00:47:39,190 --> 00:47:37,680
the people that know better than anybody

1290
00:47:41,750 --> 00:47:39,200
with all the challenges that it took to

1291
00:47:43,589 --> 00:47:41,760
get here so let me introduce mike moreau

1292
00:47:44,950 --> 00:47:43,599
mike is the osiris-rex deputy project

1293
00:47:47,109 --> 00:47:44,960
manager at the goddard space flight

1294
00:47:49,910 --> 00:47:47,119
center and coralie adam is tag

1295
00:47:51,510 --> 00:47:49,920
navigation manager at kinetics aerospace

1296
00:47:53,589 --> 00:47:51,520
so welcome mike and coralie how you guys

1297
00:47:55,109 --> 00:47:53,599
doing so excited

1298
00:47:56,549 --> 00:47:55,119
for less than a half hour from tag now

1299
00:47:57,910 --> 00:47:56,559
yeah you could feel the energy all

1300
00:47:59,190 --> 00:47:57,920
building so i should mention at this

1301
00:48:01,190 --> 00:47:59,200
point that it's possible you've been

1302
00:48:02,549 --> 00:48:01,200
hearing this before cheers from the msa

1303
00:48:03,670 --> 00:48:02,559
so can you give us a sense what's going

1304
00:48:05,990 --> 00:48:03,680
on right now

1305
00:48:07,750 --> 00:48:06,000
yeah so every few minutes a navigation

1306
00:48:09,589 --> 00:48:07,760
camera image is taken by the spacecraft

1307
00:48:11,670 --> 00:48:09,599
of the surface below and it's sent to

1308
00:48:14,069 --> 00:48:11,680
the natural feature tracking system and

1309
00:48:16,630 --> 00:48:14,079
that system identifies features in the

1310
00:48:17,829 --> 00:48:16,640
image and sends a signal back to earth

1311
00:48:19,510 --> 00:48:17,839
that

1312
00:48:23,670 --> 00:48:19,520
it was successful

1313
00:48:25,190 --> 00:48:23,680

the mission uncertainty is 0.5 meters

1314
00:48:26,630 --> 00:48:25,200
and the team celebrates

1315
00:48:28,630 --> 00:48:26,640
it tells us we're on track to our next

1316
00:48:30,790 --> 00:48:28,640
target and on track to tag

1317
00:48:31,910 --> 00:48:30,800
absolutely so now clearly there's a lot

1318
00:48:33,670 --> 00:48:31,920
to talk about in terms of the mission

1319
00:48:35,510 --> 00:48:33,680
but once again you had to do all of this

1320
00:48:37,109 --> 00:48:35,520
in the midst of this covet 19 pandemic

1321
00:48:38,710 --> 00:48:37,119
so were there any mission expectations

1322
00:48:41,109 --> 00:48:38,720
that changed how did you deal with that

1323
00:48:43,109 --> 00:48:41,119
yeah for sure i mean as the whole world

1324
00:48:45,589 --> 00:48:43,119
was coming to grips with the pandemic in

1325
00:48:47,430 --> 00:48:45,599
the march time frame this team was in

1326
00:48:48,549 --> 00:48:47,440
the midst of preparing for our first tag

1327
00:48:52,309 --> 00:48:48,559
rehearsal

1328
00:48:54,710 --> 00:48:52,319
the spacecraft only 65 meters above the

1329
00:48:56,230 --> 00:48:54,720
surface so we had to rethink the entire

1330
00:48:58,549 --> 00:48:56,240
way in which we were going to do that

1331
00:49:00,309 --> 00:48:58,559
rehearsal with only a skeleton crew here

1332
00:49:02,069 --> 00:49:00,319
in the building and with many of our

1333
00:49:03,990 --> 00:49:02,079
team members remote as sandy mentioned

1334
00:49:05,589 --> 00:49:04,000
before today we have people literally

1335
00:49:07,190 --> 00:49:05,599
all over the building monitoring also at

1336
00:49:08,790 --> 00:49:07,200
goddard space flight center and at the

1337
00:49:10,710 --> 00:49:08,800
university of arizona

1338
00:49:12,150 --> 00:49:10,720

watching this event today but thankfully

1339
00:49:13,510 --> 00:49:12,160
we got through checkpoint rehearsal in

1340
00:49:15,190 --> 00:49:13,520
april and match point rehearsal in

1341
00:49:16,549 --> 00:49:15,200
august and all the special

1342
00:49:18,309 --> 00:49:16,559
considerations they're still going on

1343
00:49:20,309 --> 00:49:18,319
around us today right yeah i mean you

1344
00:49:22,549 --> 00:49:20,319
could see people spaced out in the msa

1345
00:49:25,349 --> 00:49:22,559
when you're over there and um you know

1346
00:49:26,950 --> 00:49:25,359
we we had more time to prepare for tag

1347
00:49:28,710 --> 00:49:26,960
in order to accommodate that and get

1348
00:49:31,109 --> 00:49:28,720
everyone into the building here today so

1349
00:49:32,950 --> 00:49:31,119
i'm just incredibly proud of our team uh

1350
00:49:35,109 --> 00:49:32,960
for you know their efforts to keep the

1351
00:49:36,470 --> 00:49:35,119
project on track for tag in spite of all

1352
00:49:38,710 --> 00:49:36,480
of these challenges

1353
00:49:39,990 --> 00:49:38,720
absolutely so i know nasa is a famous

1354
00:49:42,069 --> 00:49:40,000
for having to deal with unexpected

1355
00:49:43,750 --> 00:49:42,079
situations and this covet 19 thing is

1356
00:49:45,030 --> 00:49:43,760
kind of a different flavor of unexpected

1357
00:49:47,190 --> 00:49:45,040
situations

1358
00:49:49,109 --> 00:49:47,200
we're gonna deal about that okay so now

1359
00:49:50,710 --> 00:49:49,119
let's talk more about the challenges of

1360
00:49:52,790 --> 00:49:50,720
tag that we introduced in the video

1361
00:49:54,309 --> 00:49:52,800
segment so corelli right so you saw

1362
00:49:55,990 --> 00:49:54,319
you've seen that nightingale site is an

1363
00:49:58,230 --> 00:49:56,000

extremely challenging spot to navigate

1364
00:49:59,829 --> 00:49:58,240
into there's boulders all around it um

1365
00:50:01,829 --> 00:49:59,839
this is totally different than how we

1366
00:50:04,549 --> 00:50:01,839
originally designed the system uh to

1367
00:50:06,630 --> 00:50:04,559
target a 50 meter diameter area

1368
00:50:08,870 --> 00:50:06,640
nightingale is 10 times smaller than

1369
00:50:11,430 --> 00:50:08,880
that so it required the whole team to

1370
00:50:13,510 --> 00:50:11,440
rethink how to safely navigate into this

1371
00:50:15,349 --> 00:50:13,520
context of the surface and we had to

1372
00:50:17,589 --> 00:50:15,359
come up with some new ideas yeah so the

1373
00:50:21,030 --> 00:50:17,599
original navigation approach used lidar

1374
00:50:22,630 --> 00:50:21,040
or laser based navigation uh to take us

1375
00:50:24,309 --> 00:50:22,640
to the nightingale crater but when we

1376
00:50:25,990 --> 00:50:24,319
saw what bennu looked like we realized

1377
00:50:27,910 --> 00:50:26,000
we had to switch to a vision-based

1378
00:50:29,270 --> 00:50:27,920
approach and that's the nft system that

1379
00:50:31,670 --> 00:50:29,280
you've been hearing about

1380
00:50:33,510 --> 00:50:31,680
yeah so the kinetics navigation team has

1381
00:50:35,190 --> 00:50:33,520
spent the last two years

1382
00:50:37,430 --> 00:50:35,200
learning how to navigate around venue

1383
00:50:39,190 --> 00:50:37,440
using optical navigation techniques uh

1384
00:50:41,270 --> 00:50:39,200
very similar to what nft is doing on

1385
00:50:42,790 --> 00:50:41,280
board the spacecraft today so kinetics

1386
00:50:45,750 --> 00:50:42,800
worked with scientists and the lockheed

1387
00:50:49,270 --> 00:50:47,270
not the surface of that rex has

1388
00:50:54,630 --> 00:50:49,280

processed its next image

1389
00:50:56,710 --> 00:50:54,640
position uncertainty is 0.5 meters

1390
00:50:58,390 --> 00:50:56,720
so we mapped the surface of venue to

1391
00:51:00,150 --> 00:50:58,400
unprecedented resolution of two

1392
00:51:01,910 --> 00:51:00,160
centimeters per pixel which is better

1393
00:51:03,670 --> 00:51:01,920
than what we've done on our own earth

1394
00:51:05,910 --> 00:51:03,680
and moon um

1395
00:51:07,990 --> 00:51:05,920
so it was a huge herculean effort to get

1396
00:51:09,750 --> 00:51:08,000
to this point where we're comfortable

1397
00:51:12,309 --> 00:51:09,760
handing the maps and the keys over to

1398
00:51:15,109 --> 00:51:12,319
the spacecraft to get us down into this

1399
00:51:16,790 --> 00:51:15,119
small site today absolutely

1400
00:51:18,790 --> 00:51:16,800
so i guess right now it's time to say

1401
00:51:21,349 --> 00:51:18,800
goodbye to you guys the best of luck for

1402
00:51:23,190 --> 00:51:21,359
today i'm really excited and it's it's

1403
00:51:25,910 --> 00:51:23,200
great to be with uh with you guys thank

1404
00:51:27,109 --> 00:51:25,920
you michelle yeah well so right now um i

1405
00:51:29,349 --> 00:51:27,119
think probably the best thing to do is

1406
00:51:30,950 --> 00:51:29,359
to check in with gary napier so um i

1407
00:51:32,870 --> 00:51:30,960
guess we're gonna go back and uh and see

1408
00:51:35,990 --> 00:51:32,880
how things are going back there so to

1409
00:51:40,630 --> 00:51:37,829
so things are going really good right

1410
00:51:49,109 --> 00:51:40,640
now michelle we're actually going to uh

1411
00:51:54,150 --> 00:51:52,150
thanks for joining us heather hi gary

1412
00:51:55,910 --> 00:51:54,160
so what's really interesting heather is

1413
00:51:57,430 --> 00:51:55,920

that you actually feel that you know

1414
00:51:59,510 --> 00:51:57,440
long missions like this are really

1415
00:52:01,510 --> 00:51:59,520
important i mean you you go from design

1416
00:52:03,349 --> 00:52:01,520
to build but operations is really quite

1417
00:52:05,270 --> 00:52:03,359
a while that it's actually really

1418
00:52:06,710 --> 00:52:05,280
important to involve that next

1419
00:52:08,630 --> 00:52:06,720
generation and kind of bring that

1420
00:52:10,470 --> 00:52:08,640
generation up correct talk to us a

1421
00:52:11,910 --> 00:52:10,480
little bit about that absolutely gary

1422
00:52:13,510 --> 00:52:11,920
you're right um

1423
00:52:15,109 --> 00:52:13,520
all the way back from when we started uh

1424
00:52:18,309 --> 00:52:15,119
planning this mission of cyrus trucks we

1425
00:52:20,470 --> 00:52:18,319
recognize it's a long duration mission

1426
00:52:21,349 --> 00:52:20,480
and although that presents challenges

1427
00:52:23,510 --> 00:52:21,359
for

1428
00:52:25,829 --> 00:52:23,520
retaining your key personnel we actually

1429
00:52:28,710 --> 00:52:25,839
took it as an opportunity to use this

1430
00:52:29,990 --> 00:52:28,720
mission to train our next generation of

1431
00:52:31,109 --> 00:52:30,000
students

1432
00:52:33,030 --> 00:52:31,119
and science

1433
00:52:35,349 --> 00:52:33,040
engineers and scientists

1434
00:52:37,910 --> 00:52:35,359
a good example is we had uh one of our

1435
00:52:39,990 --> 00:52:37,920
science uh instruments is called rexus

1436
00:52:42,309 --> 00:52:40,000
it's an x-ray spectrometer built by a

1437
00:52:44,710 --> 00:52:42,319
team of students at mit and harvard so

1438
00:52:46,950 --> 00:52:44,720

real hands-on that's really interesting

1439
00:52:48,549 --> 00:52:46,960
i mean i understand you also have some

1440
00:52:51,109 --> 00:52:48,559
folks that actually were students and

1441
00:52:52,870 --> 00:52:51,119
came onto the team later yeah so being

1442
00:52:55,109 --> 00:52:52,880
at the university of arizona on a pi led

1443
00:52:56,870 --> 00:52:55,119
mission we have had hundreds of

1444
00:52:59,030 --> 00:52:56,880
undergraduate and graduate students

1445
00:53:02,470 --> 00:52:59,040
working on this mission over the course

1446
00:53:03,990 --> 00:53:02,480
of the last decade and two of our uh

1447
00:53:06,549 --> 00:53:04,000
students that start off with students

1448
00:53:08,069 --> 00:53:06,559
are actually two of our uh

1449
00:53:09,750 --> 00:53:08,079
navigation team members that's dan

1450
00:53:12,309 --> 00:53:09,760
whitman and eric tsar wow they're on

1451
00:53:14,710 --> 00:53:12,319
they're on console right now

1452
00:53:16,549 --> 00:53:14,720
yeah they are at this time nfc has

1453
00:53:17,910 --> 00:53:16,559
computed the checkpoint and match point

1454
00:53:19,910 --> 00:53:17,920
burn updates

1455
00:53:22,470 --> 00:53:19,920
the correct for errors in the trajectory

1456
00:53:25,109 --> 00:53:22,480
accumulated since orbit departure

1457
00:53:26,870 --> 00:53:25,119
checkpoint burn in two minutes

1458
00:53:27,990 --> 00:53:26,880
so checkpoint turn in two minutes we're

1459
00:53:30,309 --> 00:53:28,000
going to

1460
00:53:31,829 --> 00:53:30,319
throw it back over to michelle because i

1461
00:53:34,150 --> 00:53:31,839
know this is an important update for her

1462
00:53:35,990 --> 00:53:34,160
so michelle thanks back over to you

1463
00:53:38,390 --> 00:53:36,000

thank you thanks gary

1464
00:53:40,630 --> 00:53:38,400
absolutely so dante tell us what this

1465
00:53:42,549 --> 00:53:40,640
important milestone checkpoint means

1466
00:53:43,990 --> 00:53:42,559
this is a really important uh part of

1467
00:53:45,589 --> 00:53:44,000
the mission right now so we've been

1468
00:53:48,630 --> 00:53:45,599
hearing about natural feature tracking

1469
00:53:50,790 --> 00:53:48,640
and how it's processing these images

1470
00:53:54,870 --> 00:53:50,800
overx has processed its next image

1471
00:53:56,230 --> 00:53:54,880
position uncertainty is 0.46 meters

1472
00:53:58,630 --> 00:53:56,240
right so what it's doing with that

1473
00:54:00,549 --> 00:53:58,640
information is it's calculating uh how

1474
00:54:02,630 --> 00:54:00,559
it's going to fire its thrusters for

1475
00:54:04,309 --> 00:54:02,640
this checkpoint when we left orbit we

1476
00:54:05,670 --> 00:54:04,319
were on a trajectory that would take us

1477
00:54:07,510 --> 00:54:05,680
over the

1478
00:54:09,190 --> 00:54:07,520
surface of the asteroid and if nothing

1479
00:54:12,069 --> 00:54:09,200
else happened we would safely fly past

1480
00:54:13,750 --> 00:54:12,079
bennu once we fire the thrusters for the

1481
00:54:15,270 --> 00:54:13,760
checkpoint maneuver we're actually going

1482
00:54:16,710 --> 00:54:15,280
to start descending down towards the

1483
00:54:19,510 --> 00:54:16,720
asteroid surface so this means we're

1484
00:54:21,270 --> 00:54:19,520
going to be on our way to make contact

1485
00:54:23,030 --> 00:54:21,280
so natural feature tracking has been

1486
00:54:25,670 --> 00:54:23,040
doing nothing but calculating this

1487
00:54:26,870 --> 00:54:25,680
maneuver since we started taking images

1488
00:54:28,470 --> 00:54:26,880

so this is one of the big deals this is

1489
00:54:30,950 --> 00:54:28,480
one of the the big milestones coming up

1490
00:54:32,390 --> 00:54:30,960
this is huge yeah absolutely i know that

1491
00:54:34,230 --> 00:54:32,400
as we look at the simulation there's an

1492
00:54:35,589 --> 00:54:34,240
interesting configuration the spacecraft

1493
00:54:37,270 --> 00:54:35,599
isn't oh i see the thrusters firing

1494
00:54:38,630 --> 00:54:37,280
that's right you can see we would expect

1495
00:54:39,990 --> 00:54:38,640
right now on the spacecraft the

1496
00:54:41,990 --> 00:54:40,000
thrusters to be firing so we're going to

1497
00:54:43,589 --> 00:54:42,000
be paying close attention to dale howell

1498
00:54:45,030 --> 00:54:43,599
to let us know we've gotten telemetry

1499
00:54:48,710 --> 00:54:45,040
back to telling us that maneuver has

1500
00:54:51,910 --> 00:54:50,069
in the meantime if you want to tell us a

1501
00:54:53,750 --> 00:54:51,920
bit about the configuration it's in go

1502
00:54:55,109 --> 00:54:53,760
ahead yeah we heard dale call out

1503
00:54:56,710 --> 00:54:55,119
earlier that the spacecraft was in the

1504
00:54:58,470 --> 00:54:56,720
y-wing configuration there we just

1505
00:55:00,309 --> 00:54:58,480
reconfigured the solar arrays to get

1506
00:55:02,069 --> 00:55:00,319
them up away from the asteroid surface

1507
00:55:03,829 --> 00:55:02,079
basically to protect their active areas

1508
00:55:06,069 --> 00:55:03,839
from any dust loading that might be

1509
00:55:07,750 --> 00:55:06,079
kicked up during the tag event it's

1510
00:55:10,069 --> 00:55:07,760
another excellent star wars reference

1511
00:55:11,829 --> 00:55:10,079
that's right always

1512
00:55:13,829 --> 00:55:11,839
you can also see here in the simulation

1513
00:55:15,670 --> 00:55:13,839

the nightingale sample site now down in

1514
00:55:17,030 --> 00:55:15,680
the lower corner here this is our target

1515
00:55:18,870 --> 00:55:17,040
this is what we're trying to get into

1516
00:55:20,710 --> 00:55:18,880
with that spacecraft so it looks like

1517
00:55:23,270 --> 00:55:20,720
there's a lot of boulders around that

1518
00:55:25,109 --> 00:55:23,280
yeah as we've said uh generally the

1519
00:55:27,030 --> 00:55:25,119
surface of venue is rough and rugged and

1520
00:55:28,789 --> 00:55:27,040
covered with boulders nightingale really

1521
00:55:31,990 --> 00:55:28,799
does stand out as a pretty unique

1522
00:55:34,309 --> 00:55:32,000
interesting area on the surface

1523
00:55:35,829 --> 00:55:34,319
how you doing doing pretty good paying

1524
00:55:37,349 --> 00:55:35,839
close attention to that call out wait

1525
00:55:38,710 --> 00:55:37,359
for dale to tell us that checkpoint has

1526
00:55:40,549 --> 00:55:38,720
occurred absolutely so what we're

1527
00:55:42,789 --> 00:55:40,559
waiting for right now is the call out

1528
00:55:44,789 --> 00:55:42,799
the checkpoint has occurred and the uh

1529
00:55:47,589 --> 00:55:44,799
the osiris-rex spacecraft has begun its

1530
00:55:49,990 --> 00:55:47,599
descent towards the asteroid surface

1531
00:55:51,349 --> 00:55:50,000
right any time now

1532
00:55:54,230 --> 00:55:51,359
and it's probably worth mentioning forex

1533
00:55:56,390 --> 00:55:54,240
msa on orex ops checkpoint burn has

1534
00:55:58,230 --> 00:55:56,400
completed

1535
00:56:00,710 --> 00:55:58,240
okay we're heading down towards the

1536
00:56:04,150 --> 00:56:00,720
asteroid surface at this point

1537
00:56:08,390 --> 00:56:05,750
ah wow

1538
00:56:10,390 --> 00:56:08,400

okay well you know i guess um the next

1539
00:56:12,390 --> 00:56:10,400
thing that comes up is uh is going to be

1540
00:56:14,309 --> 00:56:12,400
this match point maneuver so that's the

1541
00:56:16,150 --> 00:56:14,319
next big milestone for us that's right

1542
00:56:17,910 --> 00:56:16,160
so we've got one more firing of

1543
00:56:19,349 --> 00:56:17,920
thrusters with the spacecraft to get us

1544
00:56:21,670 --> 00:56:19,359
lined up for the sample acquisition

1545
00:56:23,430 --> 00:56:21,680
event we call that the match point uh

1546
00:56:25,030 --> 00:56:23,440
because what we're doing there currently

1547
00:56:26,710 --> 00:56:25,040
as we're flying over the asteroid

1548
00:56:28,870 --> 00:56:26,720
surface in fact it's the asteroid

1549
00:56:30,470 --> 00:56:28,880
surface that's rotating underneath us

1550
00:56:31,990 --> 00:56:30,480
and when we fire thrusters for match

1551
00:56:33,750 --> 00:56:32,000
point we're doing that to match that

1552
00:56:36,150 --> 00:56:33,760
rotational velocity so that the

1553
00:56:38,230 --> 00:56:36,160
spacecraft becomes station keeping

1554
00:56:40,230 --> 00:56:38,240
essentially over that nightingale sample

1555
00:56:41,829 --> 00:56:40,240
site absolutely

1556
00:56:43,990 --> 00:56:41,839
all right so i think we have a little

1557
00:56:45,670 --> 00:56:44,000
bit time now to turn to our social media

1558
00:56:47,670 --> 00:56:45,680
desk so uh james what's going on in

1559
00:56:48,870 --> 00:56:47,680
social media yeah michelle it's super

1560
00:56:50,710 --> 00:56:48,880
exciting you just heard that checkpoint

1561
00:56:52,549 --> 00:56:50,720
burn confirmed we are now just very very

1562
00:56:53,990 --> 00:56:52,559
close down to the surface of nightingale

1563
00:56:55,270 --> 00:56:54,000

and you guys have been really excited

1564
00:56:57,349 --> 00:56:55,280
over on social media too with that

1565
00:56:59,030 --> 00:56:57,359
hashtag to bennu and back lots of great

1566
00:57:00,549 --> 00:56:59,040
messages rolling in here someone's

1567
00:57:02,870 --> 00:57:00,559
really excited for our little robot

1568
00:57:04,150 --> 00:57:02,880
friend to go rock hunting on the surface

1569
00:57:05,829 --> 00:57:04,160
we had someone who actually attended our

1570
00:57:07,829 --> 00:57:05,839
launch back in a couple years ago cape

1571
00:57:09,510 --> 00:57:07,839
canaveral and are now watching the

1572
00:57:11,270 --> 00:57:09,520
broadcast live with us today excited for

1573
00:57:12,309 --> 00:57:11,280
that sample collection event we have

1574
00:57:14,150 --> 00:57:12,319
philip who kind of puts it in

1575
00:57:15,990 --> 00:57:14,160
perspective for us here who says this is

1576
00:57:18,630 --> 00:57:16,000
amazing and extremely difficult in so

1577
00:57:19,990 --> 00:57:18,640
many ways venues orbit spin inclination

1578
00:57:21,990 --> 00:57:20,000
the orbital mechanics of this long

1579
00:57:23,510 --> 00:57:22,000
mission are just astounding i can only

1580
00:57:25,750 --> 00:57:23,520
imagine how many orbit simulations have

1581
00:57:27,750 --> 00:57:25,760
been made here on earth it really is a

1582
00:57:29,670 --> 00:57:27,760
crazy mission and we also have our

1583
00:57:32,789 --> 00:57:29,680
animal friends our pets cheering us on

1584
00:57:35,109 --> 00:57:32,799
here as well bennu is rough from uh this

1585
00:57:37,030 --> 00:57:35,119
couple of our pets here really excited

1586
00:57:38,870 --> 00:57:37,040
so we're now just minutes away from that

1587
00:57:41,109 --> 00:57:38,880
match point burn and for that i'll take

1588
00:57:42,950 --> 00:57:41,119

it back to you michelle okay excellent

1589
00:57:44,470 --> 00:57:42,960
so you know just a few minutes ago dante

1590
00:57:47,109 --> 00:57:44,480
you were saying that this landing site

1591
00:57:48,630 --> 00:57:47,119
is sort of a unique area on the asteroid

1592
00:57:50,950 --> 00:57:48,640
tell us about this site

1593
00:57:53,270 --> 00:57:50,960
yeah uh we spent an enormous amount of

1594
00:57:54,710 --> 00:57:53,280
effort uh selecting the area on this

1595
00:57:57,109 --> 00:57:54,720
asteroid surface where we wanted to get

1596
00:57:58,630 --> 00:57:57,119
the sample from and we kind of divided

1597
00:58:00,710 --> 00:57:58,640
our analysis up into four different

1598
00:58:03,270 --> 00:58:00,720
categories first we were looking at the

1599
00:58:05,109 --> 00:58:03,280
deliverability and this was a real

1600
00:58:06,870 --> 00:58:05,119
challenge because as we've seen earlier

1601
00:58:09,510 --> 00:58:06,880
in the broadcast the original guidance

1602
00:58:10,950 --> 00:58:09,520
accuracy was 25 meter radius and we're

1603
00:58:13,190 --> 00:58:10,960
trying to get into an area that's 10

1604
00:58:15,349 --> 00:58:13,200
percent of that size we have solved that

1605
00:58:17,589 --> 00:58:15,359
problem with our amazing natural feature

1606
00:58:19,190 --> 00:58:17,599
tracking solution and as we've heard

1607
00:58:20,789 --> 00:58:19,200
that's worked really well and it has

1608
00:58:22,470 --> 00:58:20,799
updated its checkpoint and its match

1609
00:58:24,470 --> 00:58:22,480
point maneuvers on board based on that

1610
00:58:26,150 --> 00:58:24,480
information that gets you down to the

1611
00:58:27,670 --> 00:58:26,160
surface of the asteroid so the next

1612
00:58:30,150 --> 00:58:27,680
thing that we have to worry about is

1613
00:58:31,910 --> 00:58:30,160

maintaining spacecraft safety

1614
00:58:33,349 --> 00:58:31,920
there's a lot of hazards on this

1615
00:58:35,910 --> 00:58:33,359
asteroid surface things that could

1616
00:58:38,069 --> 00:58:35,920
damage a critical component and we

1617
00:58:39,910 --> 00:58:38,079
decided to focus safety on the things

1618
00:58:41,349 --> 00:58:39,920
that were needed to get the sample back

1619
00:58:42,710 --> 00:58:41,359
to the earth so there were certain

1620
00:58:44,309 --> 00:58:42,720
things we could lose at this point in

1621
00:58:45,670 --> 00:58:44,319
the mission if they didn't fulfill that

1622
00:58:47,990 --> 00:58:45,680
objective

1623
00:58:49,670 --> 00:58:48,000
we still have some upcoming major

1624
00:58:51,990 --> 00:58:49,680
milestones that help us maintain that

1625
00:58:53,829 --> 00:58:52,000
spacecraft safety now natural feature

1626
00:58:56,069 --> 00:58:53,839
tracking is going to be switching over

1627
00:58:58,309 --> 00:58:56,079
to calculating the contact point on the

1628
00:59:00,549 --> 00:58:58,319
asteroid surface and it has a piece of

1629
00:59:02,630 --> 00:59:00,559
software on board called the hazard map

1630
00:59:04,870 --> 00:59:02,640
it's actually determining is the

1631
00:59:07,910 --> 00:59:04,880
location that i'm going to touch down on

1632
00:59:10,230 --> 00:59:07,920
safe a green area on that hazard map or

1633
00:59:12,230 --> 00:59:10,240
is it potentially hazardous a red area

1634
00:59:14,789 --> 00:59:12,240
on that hazard map so as we get closer

1635
00:59:16,470 --> 00:59:14,799
to the asteroid surface a key moment is

1636
00:59:18,549 --> 00:59:16,480
the five meter crossing that's when the

1637
00:59:20,630 --> 00:59:18,559
spacecraft makes that decision do i

1638
00:59:22,789 --> 00:59:20,640

continue down to collect the sample or

1639
00:59:23,829 --> 00:59:22,799
do i back away and live to tag another

1640
00:59:25,510 --> 00:59:23,839
day

1641
00:59:27,030 --> 00:59:25,520
after that you've got down there your

1642
00:59:28,789 --> 00:59:27,040
spacecraft is safe there's got to be

1643
00:59:30,630 --> 00:59:28,799
something for you to pick up earlier in

1644
00:59:32,710 --> 00:59:30,640
the broadcast beau beerhouse showed us

1645
00:59:34,950 --> 00:59:32,720
the size of particles that tag sam could

1646
00:59:36,870 --> 00:59:34,960
actually collect so we had to map the

1647
00:59:39,030 --> 00:59:36,880
nightingale area and other potential

1648
00:59:41,430 --> 00:59:39,040
sample sites well below that two

1649
00:59:44,470 --> 00:59:41,440
centimeter resolution and in fact we got

1650
00:59:46,950 --> 00:59:44,480
3.5 millimeters per pixel

1651
00:59:49,109 --> 00:59:46,960
all over the the nightingale sample site

1652
00:59:51,910 --> 00:59:49,119
and we were really excited to see lots

1653
00:59:53,430 --> 00:59:51,920
of particles uh of that size and of

1654
00:59:54,870 --> 00:59:53,440
course the final

1655
00:59:57,190 --> 00:59:54,880
parameter that we were looking at was

1656
00:59:59,270 --> 00:59:57,200
the scientific value and i can tell you

1657
01:00:01,190 --> 00:59:59,280
the good news is any sample from bennu

1658
01:00:03,430 --> 01:00:01,200
is scientifically valuable we've seen

1659
01:00:05,750 --> 01:00:03,440
these hydrated clay minerals we've seen

1660
01:00:07,349 --> 01:00:05,760
organic molecules carbon bearing

1661
01:00:09,349 --> 01:00:07,359
minerals all over the surface of the

1662
01:00:11,030 --> 01:00:09,359
asteroid exactly the kind of material

1663
01:00:12,870 --> 01:00:11,040

that we're hoping to bring home

1664
01:00:13,990 --> 01:00:12,880
so i understand the next big milestone

1665
01:00:15,750 --> 01:00:14,000
we're looking for here is something

1666
01:00:17,670 --> 01:00:15,760
called match point that's right so what

1667
01:00:19,910 --> 01:00:17,680
happens at match point uh match point is

1668
01:00:23,190 --> 01:00:19,920
the final maneuver that the spacecraft

1669
01:00:25,750 --> 01:00:23,200
uh performs by firing its thrusters and

1670
01:00:27,430 --> 01:00:25,760
that's where we become

1671
01:00:29,430 --> 01:00:27,440
centered over the nightingale sample

1672
01:00:31,109 --> 01:00:29,440
site and begin that final descent down

1673
01:00:33,109 --> 01:00:31,119
to the asteroid surface and the

1674
01:00:35,990 --> 01:00:33,119
spacecraft is solely focused on its

1675
01:00:37,270 --> 01:00:36,000
safety calculation and the decision on

1676
01:00:39,510 --> 01:00:37,280
whether or not it's going to proceed

1677
01:00:40,870 --> 01:00:39,520
down to collect that sample

1678
01:00:42,630 --> 01:00:40,880
of course the amazing thing about match

1679
01:00:44,870 --> 01:00:42,640
point is that the asteroid itself is

1680
01:00:46,630 --> 01:00:44,880
actually rotating so when we go to match

1681
01:00:48,470 --> 01:00:46,640
point the spacecraft has to match the

1682
01:00:50,470 --> 01:00:48,480
rotation of the asteroid so it comes

1683
01:00:52,870 --> 01:00:50,480
directly down onto it that's right so

1684
01:00:55,670 --> 01:00:52,880
how fast has been rotating venue has a

1685
01:00:57,750 --> 01:00:55,680
rotation period of 4.3 hours so that's

1686
01:00:59,190 --> 01:00:57,760
basically the length of the day on on

1687
01:01:01,109 --> 01:00:59,200
the asteroid on earth the rotation

1688
01:01:03,190 --> 01:01:01,119

period is 24 hours which is why a day on

1689
01:01:03,910 --> 01:01:03,200
earth is 24 hours long

1690
01:01:06,150 --> 01:01:03,920
so

1691
01:01:08,549 --> 01:01:06,160
that translates because benny's a pretty

1692
01:01:10,390 --> 01:01:08,559
small object as we've seen 500 meters or

1693
01:01:12,390 --> 01:01:10,400
about the same size as the empire state

1694
01:01:14,950 --> 01:01:12,400
building at the equator the surface is

1695
01:01:16,630 --> 01:01:14,960
moving at 10 centimeters per second and

1696
01:01:18,630 --> 01:01:16,640
actually gets slower and slower as you

1697
01:01:20,630 --> 01:01:18,640
go to higher latitudes by the time you

1698
01:01:22,390 --> 01:01:20,640
get to the north pole it's zero

1699
01:01:24,069 --> 01:01:22,400
nightingale is pretty far north so it's

1700
01:01:26,069 --> 01:01:24,079
actually much lower than 10 centimeters

1701
01:01:28,950 --> 01:01:26,079
per second and that just kind of shows

1702
01:01:31,030 --> 01:01:28,960
you the delicate precision nature of

1703
01:01:33,910 --> 01:01:31,040
this mission you know we've got to get

1704
01:01:35,910 --> 01:01:33,920
very low thrust maneuvers very delicate

1705
01:01:37,670 --> 01:01:35,920
very slow approach to the asteroid

1706
01:01:39,190 --> 01:01:37,680
surface everything kind of happens in

1707
01:01:41,430 --> 01:01:39,200
slow motion when you're operating in a

1708
01:01:43,349 --> 01:01:41,440
microgravity environment like bennu so

1709
01:01:45,430 --> 01:01:43,359
what's the next critical milestone after

1710
01:01:47,910 --> 01:01:45,440
match point uh after match point we're

1711
01:01:49,589 --> 01:01:47,920
going to be looking for the uh natural

1712
01:01:51,670 --> 01:01:49,599
feature tracking system coming back

1713
01:01:54,470 --> 01:01:51,680

online taking those images and

1714
01:01:56,710 --> 01:01:54,480
additional correlations and precision on

1715
01:01:58,230 --> 01:01:56,720
its knowledge of its position and we

1716
01:01:59,829 --> 01:01:58,240
might expect it to actually jump up

1717
01:02:01,510 --> 01:01:59,839
we've been hearing natural feature

1718
01:02:04,470 --> 01:02:01,520
tracking uncertainties on the order of

1719
01:02:05,829 --> 01:02:04,480
half a meter it may go up a little bit

1720
01:02:08,069 --> 01:02:05,839
on our

1721
01:02:09,750 --> 01:02:08,079
4x natural feature tracking system has

1722
01:02:12,789 --> 01:02:09,760
resumed processing

1723
01:02:14,789 --> 01:02:12,799
position uncertainty is 1.6 meters so

1724
01:02:16,150 --> 01:02:14,799
you can see there we went back to 1.6

1725
01:02:18,230 --> 01:02:16,160
meters that's because we went through

1726
01:02:19,829 --> 01:02:18,240
the checkpoint maneuver so whenever you

1727
01:02:22,470 --> 01:02:19,839
impart a thrust like that it adds

1728
01:02:23,589 --> 01:02:22,480
uncertainty into the system uh and we're

1729
01:02:25,670 --> 01:02:23,599
seeing that with the natural feature

1730
01:02:28,069 --> 01:02:25,680
tracking system right now

1731
01:02:29,430 --> 01:02:28,079
that is so exciting okay so let's we're

1732
01:02:31,430 --> 01:02:29,440
going to introduce actually the

1733
01:02:32,789 --> 01:02:31,440
associate administrator of nasa dr

1734
01:02:34,470 --> 01:02:32,799
thomas bookend thomas thank you for

1735
01:02:36,390 --> 01:02:34,480
joining us so glad to be here with all

1736
01:02:38,230 --> 01:02:36,400
of you it's an exciting time thomas

1737
01:02:39,589 --> 01:02:38,240
happy birthday thank you that's right

1738
01:02:41,430 --> 01:02:39,599

yesterday is his birthday yeah that's

1739
01:02:43,270 --> 01:02:41,440
right happy birthday so you know i guess

1740
01:02:44,870 --> 01:02:43,280
um you know

1741
01:02:46,470 --> 01:02:44,880
everybody here is aiming for this point

1742
01:02:48,150 --> 01:02:46,480
in time called

1743
01:02:49,829 --> 01:02:48,160
this tag sam but it turns out that there

1744
01:02:51,029 --> 01:02:49,839
have been a lot of friends a lot of

1745
01:02:53,750 --> 01:02:51,039
colleagues that have helped get us to

1746
01:02:55,750 --> 01:02:53,760
this moment so you know who's been along

1747
01:02:57,750 --> 01:02:55,760
with us on this journey well look i mean

1748
01:02:59,270 --> 01:02:57,760
there's a number of of course domestic

1749
01:03:00,710 --> 01:02:59,280
partners many of them around here you

1750
01:03:02,470 --> 01:03:00,720
talk to some of them but there's also

1751
01:03:04,710 --> 01:03:02,480
international partners and the canadian

1752
01:03:06,150 --> 01:03:04,720
space agency provided the laser

1753
01:03:08,069 --> 01:03:06,160
altimeter which is an important

1754
01:03:10,390 --> 01:03:08,079
instrument here and of course we have a

1755
01:03:11,910 --> 01:03:10,400
partnership with jaxa uh what we we're

1756
01:03:15,029 --> 01:03:11,920
going to do is actually share the

1757
01:03:17,029 --> 01:03:15,039
samples from ryuko from hayabusa to with

1758
01:03:18,870 --> 01:03:17,039
uh sorry threx once it's back for

1759
01:03:20,950 --> 01:03:18,880
maximum science and that's really what

1760
01:03:22,870 --> 01:03:20,960
international partnerships are about

1761
01:03:24,230 --> 01:03:22,880
so this is a big mission for nasa but it

1762
01:03:25,990 --> 01:03:24,240
turns out that there are many different

1763
01:03:27,750 --> 01:03:26,000

kinds of partners in a mission like this

1764
01:03:29,510 --> 01:03:27,760
give us a sense of the range of partners

1765
01:03:30,950 --> 01:03:29,520
that we have well look i mean it starts

1766
01:03:33,349 --> 01:03:30,960
with the university of arizona that's

1767
01:03:35,589 --> 01:03:33,359
where the leadership is and uh with you

1768
01:03:36,950 --> 01:03:35,599
there and your entire team but nasa

1769
01:03:39,109 --> 01:03:36,960
goddard space flight center is a

1770
01:03:41,029 --> 01:03:39,119
critical partner with uh managing of

1771
01:03:43,510 --> 01:03:41,039
course uh especially also working with

1772
01:03:45,430 --> 01:03:43,520
lockheed martin who really you know with

1773
01:03:47,589 --> 01:03:45,440
that team deserves a lot of credit and

1774
01:03:48,950 --> 01:03:47,599
kinetics which was already introduced as

1775
01:03:51,349 --> 01:03:48,960
well as many others you know if you

1776
01:03:53,270 --> 01:03:51,359
really look so often missions like that

1777
01:03:56,069 --> 01:03:53,280
touch many many states around the united

1778
01:03:57,750 --> 01:03:56,079
states absolutely so um thomas bookend

1779
01:03:59,109 --> 01:03:57,760
thank you for joining us and we will see

1780
01:04:02,309 --> 01:03:59,119
you later on in the program how do you

1781
01:04:04,630 --> 01:04:02,319
feel man i'm pretty excited this is the

1782
01:04:06,470 --> 01:04:04,640
final like 10 12 minutes here for

1783
01:04:08,630 --> 01:04:06,480
contact i feel really good the teams in

1784
01:04:10,470 --> 01:04:08,640
high spirits as you and i talked about

1785
01:04:12,630 --> 01:04:10,480
earlier this week we have done

1786
01:04:15,190 --> 01:04:12,640
everything possible to make this today a

1787
01:04:16,789 --> 01:04:15,200
success exactly right and you know your

1788
01:04:18,710 --> 01:04:16,799

your mind is already out there and the

1789
01:04:20,710 --> 01:04:18,720
spacecraft is already on the way out in

1790
01:04:22,309 --> 01:04:20,720
real time can you imagine that right

1791
01:04:23,990 --> 01:04:22,319
it's good actually to point out whatever

1792
01:04:25,670 --> 01:04:24,000
has happened with tag has already

1793
01:04:27,750 --> 01:04:25,680
happened we're well past that 18 and a

1794
01:04:29,910 --> 01:04:27,760
half minute one-way lifetime absolutely

1795
01:04:30,950 --> 01:04:29,920
hey congrats let's continue doing this

1796
01:04:32,150 --> 01:04:30,960
yeah we'll see you later thank you

1797
01:04:35,109 --> 01:04:32,160
thomas

1798
01:04:36,470 --> 01:04:35,119
oh wow okay so we're coming up i know on

1799
01:04:38,789 --> 01:04:36,480
the uh the critical point of match

1800
01:04:41,829 --> 01:04:38,799
points so um at what point will we know

1801
01:04:44,309 --> 01:04:41,839
that we know we really have a sample

1802
01:04:45,670 --> 01:04:44,319
that's a great question uh we we're not

1803
01:04:47,670 --> 01:04:45,680
exactly sure what's going to happen

1804
01:04:49,589 --> 01:04:47,680
right away we'll know if we made contact

1805
01:04:51,829 --> 01:04:49,599
with the asteroid surface today we'll

1806
01:04:53,589 --> 01:04:51,839
know if the gas bottle fired

1807
01:04:55,430 --> 01:04:53,599
and we know that we bat safely away from

1808
01:04:57,990 --> 01:04:55,440
the asteroid but we actually have a lot

1809
01:04:59,589 --> 01:04:58,000
of work to do over the next week or so

1810
01:05:01,349 --> 01:04:59,599
we'll take a look at the images that we

1811
01:05:03,109 --> 01:05:01,359
were acquired during contact with the

1812
01:05:06,470 --> 01:05:03,119
asteroid surface and then we'll go into

1813
01:05:08,950 --> 01:05:06,480

a different imaging campaign uh

1814
01:05:10,789 --> 01:05:08,960
we're about 30 seconds so uh we're going

1815
01:05:14,309 --> 01:05:10,799
to keep our ears open for that critical

1816
01:05:17,029 --> 01:05:14,319
call out from dale uh works msa on rxops

1817
01:05:19,750 --> 01:05:17,039
orex has processed its next image

1818
01:05:21,109 --> 01:05:19,760
position uncertainty is one meter all

1819
01:05:23,510 --> 01:05:21,119
right we're back down to a meter

1820
01:05:26,710 --> 01:05:23,520
positional uncertainty that's great news

1821
01:05:28,549 --> 01:05:26,720
uh so back to sample verification um we

1822
01:05:29,990 --> 01:05:28,559
will after we're well away from the

1823
01:05:32,069 --> 01:05:30,000
asteroid and everything has kind of

1824
01:05:33,750 --> 01:05:32,079
settled down we have that robotic arm

1825
01:05:35,910 --> 01:05:33,760
we're actually going to use that to put

1826
01:05:37,670 --> 01:05:35,920
the tag sam head into the field of view

1827
01:05:39,349 --> 01:05:37,680
of samcam

1828
01:05:40,630 --> 01:05:39,359
and we can look not only at the top of

1829
01:05:41,910 --> 01:05:40,640
the sampler head like we're going to get

1830
01:05:43,670 --> 01:05:41,920
with the images today but we can

1831
01:05:46,630 --> 01:05:43,680
actually turn it around and we can look

1832
01:05:48,630 --> 01:05:46,640
at the base of tag sam we have in

1833
01:05:51,109 --> 01:05:48,640
addition to the gas stimulation we have

1834
01:05:52,470 --> 01:05:51,119
contact pads simply by making contact

1835
01:05:54,390 --> 01:05:52,480
with the asteroid surface we think we

1836
01:05:56,470 --> 01:05:54,400
can pick up fine grained particles less

1837
01:05:57,589 --> 01:05:56,480
than a millimeter or so but basically

1838
01:06:00,390 --> 01:05:57,599

we're going to be looking for any

1839
01:06:02,470 --> 01:06:00,400
evidence of asteroid material on or

1840
01:06:03,670 --> 01:06:02,480
inside the tag sam

1841
01:06:04,870 --> 01:06:03,680
now obviously you don't want to go all

1842
01:06:07,270 --> 01:06:04,880
the way back

1843
01:06:08,630 --> 01:06:07,280
on over x ops match point burn is

1844
01:06:10,470 --> 01:06:08,640
complete

1845
01:06:12,150 --> 01:06:10,480
all right

1846
01:06:14,309 --> 01:06:12,160
we're heading down we've got about 10

1847
01:06:16,470 --> 01:06:14,319
minutes uh before contact with the

1848
01:06:17,589 --> 01:06:16,480
asteroid surface oh wow so i was about

1849
01:06:19,990 --> 01:06:17,599
to say so obviously you don't want to

1850
01:06:21,349 --> 01:06:20,000
head back to earth with not much samples

1851
01:06:23,270 --> 01:06:21,359
how do you know how much sample you

1852
01:06:25,109 --> 01:06:23,280
actually got there's an incredibly

1853
01:06:27,029 --> 01:06:25,119
clever physics experiment that the team

1854
01:06:28,150 --> 01:06:27,039
has designed here called the sample mass

1855
01:06:29,349 --> 01:06:28,160
measurement

1856
01:06:31,589 --> 01:06:29,359
so what we're going to do is we're going

1857
01:06:33,589 --> 01:06:31,599
to place the spacecraft arm out to the

1858
01:06:35,190 --> 01:06:33,599
side of the spacecraft so when it's in

1859
01:06:37,670 --> 01:06:35,200
uh sampling configuration it's actually

1860
01:06:39,270 --> 01:06:37,680
pointed above for this we put it out in

1861
01:06:41,430 --> 01:06:39,280
the other direction and we kind of spin

1862
01:06:43,029 --> 01:06:41,440
the entire spacecraft around and we're

1863
01:06:45,589 --> 01:06:43,039

measuring a property called the moment

1864
01:06:47,990 --> 01:06:45,599
of inertia we have actually already done

1865
01:06:49,990 --> 01:06:48,000
this uh prior to initiating the tag

1866
01:06:51,829 --> 01:06:50,000
sequence today so we know what that

1867
01:06:53,670 --> 01:06:51,839
property is when the tag sam head is

1868
01:06:55,829 --> 01:06:53,680
empty now we're going to be able to do

1869
01:06:57,829 --> 01:06:55,839
it hopefully when it's full of asteroid

1870
01:07:00,470 --> 01:06:57,839
regolith so we're only looking for a

1871
01:07:02,150 --> 01:07:00,480
small differences in this property as a

1872
01:07:03,910 --> 01:07:02,160
result of this experiment and the

1873
01:07:06,630 --> 01:07:03,920
precision just like everything on this

1874
01:07:08,789 --> 01:07:06,640
program is phenomenal we're talking tens

1875
01:07:10,549 --> 01:07:08,799
of grams of precision on a measurement

1876
01:07:11,829 --> 01:07:10,559
on a spacecraft hundreds of millions of

1877
01:07:14,069 --> 01:07:11,839
miles away

1878
01:07:16,549 --> 01:07:14,079
that just picked up this asteroid sample

1879
01:07:19,750 --> 01:07:16,559
the minimum that we're looking for is 60

1880
01:07:21,670 --> 01:07:19,760
grams or excuse me

1881
01:07:23,190 --> 01:07:21,680
attitude control system has transitioned

1882
01:07:25,029 --> 01:07:23,200
to touch and go mode

1883
01:07:27,510 --> 01:07:25,039
right spacecraft's getting ready to make

1884
01:07:29,510 --> 01:07:27,520
contact with the asteroid surface here

1885
01:07:31,589 --> 01:07:29,520
so uh the sample mass measurement will

1886
01:07:34,069 --> 01:07:31,599
tell us if we have 60 grams or more of

1887
01:07:36,069 --> 01:07:34,079
material and that'll happen on saturday

1888
01:07:37,670 --> 01:07:36,079

uh later this week excellent

1889
01:07:38,789 --> 01:07:37,680
okay dante this is it you know the

1890
01:07:40,470 --> 01:07:38,799
engines have given us a push in the

1891
01:07:42,710 --> 01:07:40,480
right direction and osiris-rex is on

1892
01:07:43,910 --> 01:07:42,720
course to make touchdown on an asteroid

1893
01:07:46,150 --> 01:07:43,920
so we're going to listen to the flight

1894
01:07:47,589 --> 01:07:46,160
controller calls from msa but before we

1895
01:07:49,029 --> 01:07:47,599
actually touch the surface it's a great

1896
01:07:51,109 --> 01:07:49,039
time to visit our social media desk

1897
01:07:52,309 --> 01:07:51,119
again so james what's going on yeah

1898
01:07:53,510 --> 01:07:52,319
thanks michelle so you've been hearing

1899
01:07:55,589 --> 01:07:53,520
those call-outs from dale over the

1900
01:07:57,430 --> 01:07:55,599
loudspeakers about those nft images

1901
01:07:58,789 --> 01:07:57,440
processing it'd be awesome to actually

1902
01:08:00,309 --> 01:07:58,799
grab a camera and make the trek out to

1903
01:08:01,190 --> 01:08:00,319
bennu to photograph it up close in

1904
01:08:02,789 --> 01:08:01,200
person

1905
01:08:04,470 --> 01:08:02,799
but you know as we've mentioned bennu is

1906
01:08:06,630 --> 01:08:04,480
a little bit far away from us right now

1907
01:08:08,309 --> 01:08:06,640
on the order of 200 million miles away

1908
01:08:10,710 --> 01:08:08,319
but don't worry here's something

1909
01:08:12,549 --> 01:08:10,720
osiris-rex can deliver to you right now

1910
01:08:14,069 --> 01:08:12,559
from the comfort of your own home if

1911
01:08:16,630 --> 01:08:14,079
you're on instagram you can head over to

1912
01:08:18,309 --> 01:08:16,640
at nasa solar system we have two ar

1913
01:08:20,149 --> 01:08:18,319

filters that you can use on your social

1914
01:08:21,749 --> 01:08:20,159
media stories this first one is called

1915
01:08:23,749 --> 01:08:21,759
osiris-rex in you and features

1916
01:08:24,709 --> 01:08:23,759
osiris-rex playing tag with bennu around

1917
01:08:26,470 --> 01:08:24,719
your head

1918
01:08:28,550 --> 01:08:26,480
the second one is called to bennu and

1919
01:08:31,110 --> 01:08:28,560
back it allows you to place an asteroid

1920
01:08:32,550 --> 01:08:31,120
wherever you are at home at school bring

1921
01:08:33,829 --> 01:08:32,560
an asteroid with you

1922
01:08:35,189 --> 01:08:33,839
so i understand we actually have a

1923
01:08:37,510 --> 01:08:35,199
question coming in from instagram from

1924
01:08:39,669 --> 01:08:37,520
mauricio who asks how do you manage the

1925
01:08:40,950 --> 01:08:39,679
force back from touching down i mean the

1926
01:08:42,630 --> 01:08:40,960
moment the spacecraft touches the

1927
01:08:44,470 --> 01:08:42,640
surface it should experience a similar

1928
01:08:46,550 --> 01:08:44,480
force in the opposite direction how do

1929
01:08:47,829 --> 01:08:46,560
you manage that well thanks mauricio so

1930
01:08:49,990 --> 01:08:47,839
the team actually thought ahead for this

1931
01:08:51,749 --> 01:08:50,000
one when designing that sample arm they

1932
01:08:53,110 --> 01:08:51,759
actually added a spring-like mechanism

1933
01:08:55,669 --> 01:08:53,120
to it that you could think of a bit like

1934
01:08:58,070 --> 01:08:55,679
a pogo stick if that sample arm were

1935
01:08:59,990 --> 01:08:58,080
rigid when contacting bennu it would

1936
01:09:01,910 --> 01:09:00,000
stop its downward motion and when firing

1937
01:09:03,110 --> 01:09:01,920
the gas bottle to stir up a sample we

1938
01:09:04,470 --> 01:09:03,120

would just kick right back off into

1939
01:09:06,870 --> 01:09:04,480
space as beau bierhouse had mentioned

1940
01:09:08,309 --> 01:09:06,880
earlier but since we have that spring

1941
01:09:10,309 --> 01:09:08,319
you can think of it like a pogo sample

1942
01:09:11,749 --> 01:09:10,319
site yeah we are collecting tons of

1943
01:09:13,110 --> 01:09:11,759
images right now but we simply don't

1944
01:09:14,470 --> 01:09:13,120
have the data rate to get them back to

1945
01:09:16,070 --> 01:09:14,480
the earth in real time so they're just

1946
01:09:17,510 --> 01:09:16,080
getting banked into the spacecraft's

1947
01:09:19,189 --> 01:09:17,520
memory and we're going to start looking

1948
01:09:21,110 --> 01:09:19,199
at those later tonight and have them

1949
01:09:23,030 --> 01:09:21,120
available for everybody tomorrow morning

1950
01:09:24,870 --> 01:09:23,040
so this is just a simulation of the

1951
01:09:27,430 --> 01:09:24,880
field of view of the sam cam the

1952
01:09:30,309 --> 01:09:27,440
sampling camera part of our ocams camera

1953
01:09:31,590 --> 01:09:30,319
suite it has a clear shot of the tag sam

1954
01:09:33,510 --> 01:09:31,600
collector right in the middle of its

1955
01:09:36,229 --> 01:09:33,520
field of view you can actually see the

1956
01:09:38,550 --> 01:09:36,239
lower end of the tag sam arm here over x

1957
01:09:41,430 --> 01:09:38,560
msa on over exhaust

1958
01:09:43,749 --> 01:09:41,440
or x is descending below 25 meters okay

1959
01:09:45,910 --> 01:09:43,759
we're getting really close uh i want to

1960
01:09:47,349 --> 01:09:45,920
remind you it's the five meter crossing

1961
01:09:49,510 --> 01:09:47,359
that's the really critical one we're

1962
01:09:51,910 --> 01:09:49,520
only a couple minutes away from that

1963
01:09:53,269 --> 01:09:51,920

so the spacecraft has one key decision

1964
01:09:54,790 --> 01:09:53,279
left to make

1965
01:09:57,510 --> 01:09:54,800
it's calculating right now the

1966
01:09:59,590 --> 01:09:57,520
probability that it's going to come down

1967
01:10:02,229 --> 01:09:59,600
either on a hazardous area as we defined

1968
01:10:04,630 --> 01:10:02,239
on that hazard map or in a safe area so

1969
01:10:06,390 --> 01:10:04,640
we may at five meters the spacecraft may

1970
01:10:08,390 --> 01:10:06,400
decide that it's hazardous and it's

1971
01:10:10,709 --> 01:10:08,400
going to back away allowing us to live

1972
01:10:13,110 --> 01:10:10,719
the tag another day so to me

1973
01:10:15,270 --> 01:10:13,120
uh all my senses are on that call out

1974
01:10:16,870 --> 01:10:15,280
right now i really want to hear that we

1975
01:10:18,709 --> 01:10:16,880
are go for tag so that's just a couple

1976
01:10:20,709 --> 01:10:18,719
minutes away here and of course remember

1977
01:10:22,149 --> 01:10:20,719
that that was planned for that yeah

1978
01:10:23,510 --> 01:10:22,159
it has to know it's safe otherwise it's

1979
01:10:25,110 --> 01:10:23,520
going to back up and try again another

1980
01:10:26,950 --> 01:10:25,120
time that's really how we solve the

1981
01:10:28,790 --> 01:10:26,960
amazing challenges that this asteroid

1982
01:10:30,550 --> 01:10:28,800
surface presented to us you can see here

1983
01:10:32,470 --> 01:10:30,560
that this is a pretty daunting terrain

1984
01:10:34,149 --> 01:10:32,480
that we're coming down here uh there's

1985
01:10:36,310 --> 01:10:34,159
giant boulders all around the

1986
01:10:38,630 --> 01:10:36,320
nightingale site even some large rocks

1987
01:10:40,950 --> 01:10:38,640
inside the crater that we do not think

1988
01:10:42,630 --> 01:10:40,960

the spacecraft would survive at least

1989
01:10:44,390 --> 01:10:42,640
with the ability to return back to earth

1990
01:10:46,790 --> 01:10:44,400
if it made contact

1991
01:10:49,910 --> 01:10:46,800
so it is there to protect itself first

1992
01:10:51,350 --> 01:10:49,920
and foremost safety is always first

1993
01:10:53,110 --> 01:10:51,360
but we're feeling pretty good

1994
01:10:54,310 --> 01:10:53,120
everything's gone really well today so i

1995
01:10:56,790 --> 01:10:54,320
would say

1996
01:10:58,470 --> 01:10:56,800
things are looking great for for a tag

1997
01:11:00,149 --> 01:10:58,480
but of course the spacecraft is the one

1998
01:11:01,669 --> 01:11:00,159
that gets to make that decision it's

1999
01:11:03,270 --> 01:11:01,679
just amazing we've been rehearsing this

2000
01:11:05,510 --> 01:11:03,280
event you know all week long all the

2001
01:11:07,110 --> 01:11:05,520
different mission calls and milestones

2002
01:11:08,790 --> 01:11:07,120
but then to actually be here tonight and

2003
01:11:10,830 --> 01:11:08,800
realize that this is going on 200

2004
01:11:13,590 --> 01:11:10,840
million miles away that's right

2005
01:11:14,870 --> 01:11:13,600
yeah i'm pretty excited

2006
01:11:16,229 --> 01:11:14,880
so i mean there were obviously a lot of

2007
01:11:19,830 --> 01:11:16,239
firsts in this mission

2008
01:11:22,070 --> 01:11:19,840
msa on rxops orex has processed its next

2009
01:11:26,229 --> 01:11:22,080
message

2010
01:11:29,510 --> 01:11:26,239
position uncertainty is 0.5 meters

2011
01:11:33,590 --> 01:11:29,520
predicted tag lateral offset is 1.7

2012
01:11:36,070 --> 01:11:33,600
meters hazard probability is 0

2013
01:11:38,630 --> 01:11:36,080

ag lateral velocity

2014
01:11:42,229 --> 01:11:38,640
is 0

2015
01:11:44,149 --> 01:11:42,239
0.2 millimeters per second

2016
01:11:47,189 --> 01:11:44,159
vertical velocity

2017
01:11:49,270 --> 01:11:47,199
is 10.2 centimeters per second

2018
01:11:51,270 --> 01:11:49,280
that sounded really good yes so it

2019
01:11:53,590 --> 01:11:51,280
sounds like the hazard map calculation

2020
01:11:55,830 --> 01:11:53,600
looks really good if that we're coming

2021
01:11:57,910 --> 01:11:55,840
down in a green area we're going to make

2022
01:11:59,910 --> 01:11:57,920
contact with the asteroid surface

2023
01:12:01,910 --> 01:11:59,920
ah well remember how historic this this

2024
01:12:04,470 --> 01:12:01,920
is nasa's first mission to retrieve a

2025
01:12:06,310 --> 01:12:04,480
sample from an asteroid a pristine part

2026
01:12:08,070 --> 01:12:06,320
of the solar system just look at that

2027
01:12:09,750 --> 01:12:08,080
animation now so we're looking at i'm

2028
01:12:11,830 --> 01:12:09,760
looking at the team i think

2029
01:12:13,430 --> 01:12:11,840
i think we can see everybody is laser

2030
01:12:18,870 --> 01:12:13,440
focused on what the spacecraft's going

2031
01:12:22,950 --> 01:12:20,310
but those calls were really great that

2032
01:12:24,229 --> 01:12:22,960
was great news from dale yeah

2033
01:12:33,750 --> 01:12:24,239
even more accurate than we hoped for in

2034
01:12:38,229 --> 01:12:37,030
everybody seems happy yeah

2035
01:12:40,229 --> 01:12:38,239
so i guess you know there were obviously

2036
01:12:41,669 --> 01:12:40,239
a lot of firsts in this mission and

2037
01:12:43,270 --> 01:12:41,679
there was a time when you said you know

2038
01:12:44,470 --> 01:12:43,280

a lot of what-ifs basically you know i

2039
01:12:47,110 --> 01:12:44,480
mean what if we could actually send a

2040
01:12:48,790 --> 01:12:47,120
spacecraft to an asteroid what if we

2041
01:12:51,110 --> 01:12:48,800
really could bring back a sample of the

2042
01:12:52,149 --> 01:12:51,120
solar system from billions of years ago

2043
01:12:54,229 --> 01:12:52,159
do you remember where you were when

2044
01:12:57,189 --> 01:12:54,239
those those what if there's msa on orex

2045
01:12:59,950 --> 01:12:57,199
ops orex has descended below the five

2046
01:13:09,580 --> 01:12:59,960
meter mark the hazard map is go for

2047
01:13:22,630 --> 01:13:11,350
[Applause]

2048
01:13:26,709 --> 01:13:25,270
oh my gosh um we're there folks that was

2049
01:13:28,310 --> 01:13:26,719
amazing i mean i don't know if you saw

2050
01:13:30,070 --> 01:13:28,320
the team here but they just kind of blew

2051
01:13:30,870 --> 01:13:30,080
up they went from being steely eye to

2052
01:13:33,270 --> 01:13:30,880
like

2053
01:13:35,870 --> 01:13:33,280
celebrating the super bowl so um

2054
01:13:37,910 --> 01:13:35,880
so it's all good this is amazing so

2055
01:13:40,070 --> 01:13:37,920
congratulations everybody i know that

2056
01:13:41,990 --> 01:13:40,080
dante and dr brooking are right here and

2057
01:13:44,870 --> 01:13:42,000
dante you somehow got over here pretty

2058
01:13:49,830 --> 01:13:47,510
congratulations how you guys feeling

2059
01:13:52,870 --> 01:13:49,840
uh transcendental i mean i can't believe

2060
01:13:55,510 --> 01:13:52,880
we actually pulled this off

2061
01:13:57,590 --> 01:13:55,520
but i am so excited about the team hey

2062
01:14:00,149 --> 01:13:57,600
he might just bring up something please

2063
01:14:01,590 --> 01:14:00,159

our friend mike drake is with us right

2064
01:14:03,430 --> 01:14:01,600
now that's right now who came up with

2065
01:14:05,110 --> 01:14:03,440
the mission at the beginning and uh

2066
01:14:06,870 --> 01:14:05,120
we're thinking of him he's no longer on

2067
01:14:09,270 --> 01:14:06,880
earth but i i feel him right here i

2068
01:14:10,630 --> 01:14:09,280
agree he's with us today and i know he's

2069
01:14:11,990 --> 01:14:10,640
incredibly proud of this team and

2070
01:14:13,110 --> 01:14:12,000
everything we have accomplished this is

2071
01:14:14,790 --> 01:14:13,120
history

2072
01:14:16,390 --> 01:14:14,800
uh it's amazing

2073
01:14:18,310 --> 01:14:16,400
i can barely speak you know i'm like

2074
01:14:20,630 --> 01:14:18,320
shaking how about you

2075
01:14:22,310 --> 01:14:20,640
absolutely

2076
01:14:23,830 --> 01:14:22,320
it's almost hard to process everything

2077
01:14:26,630 --> 01:14:23,840
that's happening right now it's it's

2078
01:14:28,630 --> 01:14:26,640
overwhelming pride in this team and

2079
01:14:29,590 --> 01:14:28,640
everything we've done to get here uh i

2080
01:14:30,630 --> 01:14:29,600
couldn't

2081
01:14:32,470 --> 01:14:30,640
uh

2082
01:14:38,790 --> 01:14:32,480
really have anything better to say about

2083
01:14:43,510 --> 01:14:41,430
oh rex msa on norwreck top

2084
01:14:46,950 --> 01:14:43,520
sample collection is complete and the

2085
01:14:47,260 --> 01:14:46,960
back away burn has executed

2086
01:14:50,150 --> 01:14:47,270
all right

2087
01:14:51,830 --> 01:14:50,160
[Music]

2088
01:14:52,210 --> 01:14:51,840

[Applause]

2089
01:14:54,550 --> 01:14:52,220
now

2090
01:14:56,070 --> 01:14:54,560
[Applause]

2091
01:14:57,830 --> 01:14:56,080
dante that was actually a really

2092
01:14:59,590 --> 01:14:57,840
important call we were celebrating on

2093
01:15:01,590 --> 01:14:59,600
the tag that was actually probably even

2094
01:15:03,990 --> 01:15:01,600
more important called why is that

2095
01:15:06,630 --> 01:15:04,000
the pyro bottles fired so tag sam

2096
01:15:08,149 --> 01:15:06,640
operated the back away thruster is fired

2097
01:15:10,310 --> 01:15:08,159
so we're safely moving away from the

2098
01:15:12,550 --> 01:15:10,320
asteroid surface the spacecraft did

2099
01:15:13,590 --> 01:15:12,560
everything it was supposed to do

2100
01:15:15,270 --> 01:15:13,600
so

2101
01:15:17,750 --> 01:15:15,280
we did it we tagged the surface of the

2102
01:15:19,189 --> 01:15:17,760
asteroid and it's up to bennu now to see

2103
01:15:21,430 --> 01:15:19,199
how the event went

2104
01:15:23,910 --> 01:15:21,440
what does this mean to nasa oh i mean

2105
01:15:25,830 --> 01:15:23,920
this is key key mouse out of this now

2106
01:15:27,990 --> 01:15:25,840
it's a few days right to figure out how

2107
01:15:30,709 --> 01:15:28,000
much we caught off this amazing example

2108
01:15:33,350 --> 01:15:30,719
that's right thinking about for decades

2109
01:15:35,330 --> 01:15:33,360
but uh i think this is just i'm so proud

2110
01:15:41,910 --> 01:15:35,340
of this team hey

2111
01:15:44,229 --> 01:15:41,920
[Applause]

2112
01:15:48,229 --> 01:15:44,239
oh my goodness

2113
01:15:50,229 --> 01:15:48,239

well i gotta tell you this this has been

2114
01:15:51,750 --> 01:15:50,239
a fantastic day a fantastic journey

2115
01:15:53,350 --> 01:15:51,760
we're so proud of both of you for being

2116
01:15:55,030 --> 01:15:53,360
here and supporting that team we're

2117
01:15:56,550 --> 01:15:55,040
going to get back over to the stage and

2118
01:15:58,950 --> 01:15:56,560
michelle but

2119
01:16:00,470 --> 01:15:58,960
some really good news so

2120
01:16:02,870 --> 01:16:00,480
back to you michelle thank you

2121
01:16:04,070 --> 01:16:02,880
[Music]

2122
01:16:05,750 --> 01:16:04,080
this is one of those moments we're all

2123
01:16:07,590 --> 01:16:05,760
aware of proven 19 because i want the

2124
01:16:08,950 --> 01:16:07,600
hugs and the high fives and everything

2125
01:16:11,110 --> 01:16:08,960
but we're all going to keep each other

2126
01:16:12,470 --> 01:16:11,120
safe there are lots of super excited

2127
01:16:13,669 --> 01:16:12,480
people all over who want to share in

2128
01:16:15,270 --> 01:16:13,679
this moment and share their

2129
01:16:16,790 --> 01:16:15,280
congratulations

2130
01:16:18,470 --> 01:16:16,800
so let's take a moment to hear a few

2131
01:16:20,310 --> 01:16:18,480
words from three institutional leaders

2132
01:16:21,990 --> 01:16:20,320
who couldn't be here tonight but they're

2133
01:16:24,790 --> 01:16:22,000
cheering on the team on behalf of so

2134
01:16:26,950 --> 01:16:24,800
many supporters

2135
01:16:29,590 --> 01:16:26,960
hi everyone dennis anderson goddard

2136
01:16:32,470 --> 01:16:29,600
center director i am just so excited

2137
01:16:34,470 --> 01:16:32,480
that osiris-rex is collect is collecting

2138
01:16:39,350 --> 01:16:34,480

a sample from the surface of banana the

2139
01:16:42,709 --> 01:16:40,950
back to earth we're obviously going to

2140
01:16:44,950 --> 01:16:42,719
be that's completed a great event

2141
01:16:47,189 --> 01:16:44,960
microwave entire mission but i gotta

2142
01:16:49,430 --> 01:16:47,199
congratulate you and your team

2143
01:16:52,149 --> 01:16:49,440
your project management skills as a pi

2144
01:16:54,229 --> 01:16:52,159
just just superb rich the operations

2145
01:16:56,070 --> 01:16:54,239
team for getting us to where we are and

2146
01:16:58,630 --> 01:16:56,080
lisa lisa callahan for the awesome

2147
01:17:00,790 --> 01:16:58,640
lockheed martin team uh in getting

2148
01:17:03,189 --> 01:17:00,800
osiris-rex to where we are

2149
01:17:07,510 --> 01:17:03,199
and building a great spacecraft and

2150
01:17:10,229 --> 01:17:07,520
returning it to earth go cyrus rex

2151
01:17:12,390 --> 01:17:10,239
today's an exciting day as osiris-rex

2152
01:17:13,990 --> 01:17:12,400
begins its descent to bennu

2153
01:17:16,709 --> 01:17:14,000
the nation is looking forward to the

2154
01:17:18,470 --> 01:17:16,719
news of a successful tag event

2155
01:17:20,310 --> 01:17:18,480
osiris-rex team members have been

2156
01:17:23,189 --> 01:17:20,320
working on this project for more than a

2157
01:17:26,310 --> 01:17:23,199
decade and the work being done is hard

2158
01:17:28,070 --> 01:17:26,320
and it's complicated and it's necessary

2159
01:17:30,149 --> 01:17:28,080
understanding the makeup of bennu will

2160
01:17:32,149 --> 01:17:30,159
help us better understand our universe

2161
01:17:33,830 --> 01:17:32,159
and how to protect our most important

2162
01:17:35,110 --> 01:17:33,840
asset in space

2163
01:17:36,790 --> 01:17:35,120

earth

2164
01:17:39,350 --> 01:17:36,800
i want to wish the best of luck to the

2165
01:17:41,030 --> 01:17:39,360
entire osiris-rex team including our

2166
01:17:43,750 --> 01:17:41,040
partners at the nasa goddard space

2167
01:17:45,830 --> 01:17:43,760
flight center the university of arizona

2168
01:17:49,030 --> 01:17:45,840
and especially the mission operators and

2169
01:17:51,910 --> 01:17:49,040
engineers right here at lockheed martin

2170
01:17:53,990 --> 01:17:51,920
go orex

2171
01:17:55,590 --> 01:17:54,000
the university of arizona is incredibly

2172
01:17:57,189 --> 01:17:55,600
proud of its long tradition of

2173
01:17:59,550 --> 01:17:57,199
excellence and leadership in space

2174
01:18:01,510 --> 01:17:59,560
exploration i'm thrilled to see the

2175
01:18:04,070 --> 01:18:01,520
osiris-rex's missions achievements

2176
01:18:06,149 --> 01:18:04,080
carried this tradition forward today

2177
01:18:08,390 --> 01:18:06,159
with nasa lockheed martin and all of our

2178
01:18:10,149 --> 01:18:08,400
incredible partners congratulations to

2179
01:18:12,390 --> 01:18:10,159
all of the osiris-rex mission team

2180
01:18:14,870 --> 01:18:12,400
members you have shown the world how our

2181
01:18:17,110 --> 01:18:14,880
determination creativity and talent can

2182
01:18:19,350 --> 01:18:17,120
advance the capabilities of our entire

2183
01:18:21,110 --> 01:18:19,360
nation and i can't wait for the amazing

2184
01:18:23,830 --> 01:18:21,120
science we will see with the sample

2185
01:18:26,149 --> 01:18:23,840
return in 2023

2186
01:18:29,030 --> 01:18:26,159
okay well we are here live after some

2187
01:18:30,390 --> 01:18:29,040
excellent news i'm here with an exultant

2188
01:18:32,229 --> 01:18:30,400

tomte loretta from the university of

2189
01:18:34,229 --> 01:18:32,239
arizona so one more time for our

2190
01:18:36,310 --> 01:18:34,239
audience out there explain when we know

2191
01:18:37,830 --> 01:18:36,320
we'll have a sample

2192
01:18:40,229 --> 01:18:37,840
a little overwhelmed right now michelle

2193
01:18:41,990 --> 01:18:40,239
i have to say it's been pretty intense

2194
01:18:44,070 --> 01:18:42,000
several minutes here

2195
01:18:45,910 --> 01:18:44,080
i can tell you that everything went

2196
01:18:47,350 --> 01:18:45,920
just exactly perfect

2197
01:18:48,149 --> 01:18:47,360
which is kind of the hallmark of this

2198
01:18:49,990 --> 01:18:48,159
team

2199
01:18:52,709 --> 01:18:50,000
we have consistently

2200
01:18:54,630 --> 01:18:52,719
beaten expectations over and over again

2201
01:18:56,709 --> 01:18:54,640
we have overcome the amazing challenges

2202
01:18:58,470 --> 01:18:56,719
that this asteroid has thrown at us and

2203
01:19:00,070 --> 01:18:58,480
the spacecraft appears to have operated

2204
01:19:02,470 --> 01:19:00,080
flawlessly

2205
01:19:04,229 --> 01:19:02,480
we made it down to the asteroid surface

2206
01:19:06,950 --> 01:19:04,239
we were in contact

2207
01:19:08,229 --> 01:19:06,960
the gas bottles fired

2208
01:19:09,750 --> 01:19:08,239
we don't know how long we were in

2209
01:19:11,669 --> 01:19:09,760
contact with yet that's uh some

2210
01:19:12,870 --> 01:19:11,679
reconstructed uh information that we're

2211
01:19:14,790 --> 01:19:12,880
gonna have to put together over the next

2212
01:19:16,550 --> 01:19:14,800
few hours as the data come in

2213
01:19:18,229 --> 01:19:16,560

uh we backed away successfully from the

2214
01:19:21,110 --> 01:19:18,239
asteroid surface

2215
01:19:22,630 --> 01:19:21,120
the team is exuberant back there uh

2216
01:19:24,870 --> 01:19:22,640
emotions are high

2217
01:19:26,149 --> 01:19:24,880
everybody is really proud

2218
01:19:28,630 --> 01:19:26,159
and

2219
01:19:30,870 --> 01:19:28,640
we have some work to do to determine how

2220
01:19:32,310 --> 01:19:30,880
much sample that we have collected

2221
01:19:35,189 --> 01:19:32,320
uh the next thing that i'm going to be

2222
01:19:37,189 --> 01:19:35,199
looking for is once the spacecraft cools

2223
01:19:38,950 --> 01:19:37,199
off it probably got pretty warm as it

2224
01:19:40,709 --> 01:19:38,960
approached the asteroid surface so it

2225
01:19:42,790 --> 01:19:40,719
needs to get rid of some of that excess

2226
01:19:45,590 --> 01:19:42,800
heat it's got to get those solar rays

2227
01:19:47,430 --> 01:19:45,600
back onto the sun and get power positive

2228
01:19:48,709 --> 01:19:47,440
once it's stabilized it's going to point

2229
01:19:49,750 --> 01:19:48,719
that high gain antenna at the earth

2230
01:19:50,550 --> 01:19:49,760
we're going to start bringing that data

2231
01:19:52,790 --> 01:19:50,560
back

2232
01:19:54,149 --> 01:19:52,800
and those sam cam images are going to

2233
01:19:55,350 --> 01:19:54,159
tell us an enormous amount of

2234
01:19:56,470 --> 01:19:55,360
information about how the events of

2235
01:19:58,310 --> 01:19:56,480
today went

2236
01:20:00,470 --> 01:19:58,320
we're going to be looking at a whole

2237
01:20:01,830 --> 01:20:00,480
series of images as we descended down to

2238
01:20:04,149 --> 01:20:01,840

the surface

2239
01:20:05,590 --> 01:20:04,159
made contact fired that gas bottle and i

2240
01:20:06,709 --> 01:20:05,600
really want to know how that surface

2241
01:20:08,629 --> 01:20:06,719
responded

2242
01:20:10,950 --> 01:20:08,639
we haven't done this before

2243
01:20:12,470 --> 01:20:10,960
so this is a new territory for us and

2244
01:20:14,629 --> 01:20:12,480
the whole science team i know is really

2245
01:20:15,990 --> 01:20:14,639
looking forward to that information

2246
01:20:18,709 --> 01:20:16,000
for one thing it'll tell us the

2247
01:20:21,189 --> 01:20:18,719
likelihood of sample collection kind of

2248
01:20:23,270 --> 01:20:21,199
a probabilistic assessment

2249
01:20:24,709 --> 01:20:23,280
probably a lot of uh science that comes

2250
01:20:25,910 --> 01:20:24,719
out of that as well yeah well listen i

2251
01:20:27,590 --> 01:20:25,920
know you want to be back there with your

2252
01:20:29,510 --> 01:20:27,600
team it's going to be a long hopefully

2253
01:20:31,510 --> 01:20:29,520
happy night for all of you as more data

2254
01:20:33,350 --> 01:20:31,520
comes in thank you so much it's been

2255
01:20:35,189 --> 01:20:33,360
such an honor to be with you thank you

2256
01:20:37,510 --> 01:20:35,199
thank you everybody for for a great

2257
01:20:40,310 --> 01:20:37,520
evening and uh kudos to this team it's

2258
01:20:42,629 --> 01:20:40,320
it's an amazing experience and history

2259
01:20:43,990 --> 01:20:42,639
was made tonight absolutely so you know

2260
01:20:45,830 --> 01:20:44,000
what we're going to do now is actually

2261
01:20:47,350 --> 01:20:45,840
take a closer look at this beautiful

2262
01:20:48,870 --> 01:20:47,360
terrain that we've actually sampled

2263
01:20:50,790 --> 01:20:48,880

we've identified over a million

2264
01:20:52,790 --> 01:20:50,800
asteroids in the solar system but

2265
01:20:54,870 --> 01:20:52,800
remember bennu is what's called a neo a

2266
01:20:56,470 --> 01:20:54,880
near-earth asteroid so instead of

2267
01:20:58,390 --> 01:20:56,480
orbiting in the main asteroid belt

2268
01:21:00,629 --> 01:20:58,400
between mars and jupiter it has an orbit

2269
01:21:02,149 --> 01:21:00,639
fairly similar to our own planet earth

2270
01:21:04,229 --> 01:21:02,159
and it not only gets our attention

2271
01:21:05,590 --> 01:21:04,239
because it's so close to earth but also

2272
01:21:07,350 --> 01:21:05,600
because we believe it may be one of the

2273
01:21:09,189 --> 01:21:07,360
older bodies in the solar system with a

2274
01:21:11,350 --> 01:21:09,199
wealth of information about how the

2275
01:21:13,189 --> 01:21:11,360
solar system and life began

2276
01:21:15,110 --> 01:21:13,199
let's take a closer look at the subject

2277
01:21:22,160 --> 01:21:15,120
of all of this activity all this joy

2278
01:21:26,390 --> 01:21:23,270
[Music]

2279
01:21:30,310 --> 01:21:26,400
in december 2018 after traveling for two

2280
01:21:33,110 --> 01:21:30,320
years 101 days and over 1.2 billion

2281
01:21:35,270 --> 01:21:33,120
miles nasa's osiris-rex spacecraft

2282
01:21:37,270 --> 01:21:35,280
arrived at its target near-earth

2283
01:21:39,590 --> 01:21:37,280
asteroid bennu

2284
01:21:41,590 --> 01:21:39,600
osiris-rex is the first mission to

2285
01:21:44,149 --> 01:21:41,600
explore this primitive remnant from the

2286
01:21:46,470 --> 01:21:44,159
origins of the solar system designed to

2287
01:21:48,310 --> 01:21:46,480
study the asteroid and return a sample

2288
01:21:51,189 --> 01:21:48,320

to earth

2289
01:21:53,590 --> 01:21:51,199
bennu is a dark diminutive world roughly

2290
01:21:55,430 --> 01:21:53,600
the height of a skyscraper and now the

2291
01:21:56,790 --> 01:21:55,440
smallest body to be orbited by a

2292
01:21:59,110 --> 01:21:56,800
spacecraft

2293
01:22:01,669 --> 01:21:59,120
prior to arrival it was known to have

2294
01:22:04,310 --> 01:22:01,679
low thermal inertia a characteristic of

2295
01:22:07,110 --> 01:22:04,320
fine-grained materials like sand

2296
01:22:09,030 --> 01:22:07,120
an infrared spectrometer on osiris-rex

2297
01:22:11,189 --> 01:22:09,040
confirmed this property leading

2298
01:22:12,790 --> 01:22:11,199
scientists to expect a predominantly

2299
01:22:14,950 --> 01:22:12,800
smooth surface

2300
01:22:17,270 --> 01:22:14,960
but the first close-up views of bennu

2301
01:22:19,189 --> 01:22:17,280
delivered a major surprise

2302
01:22:21,189 --> 01:22:19,199
in exquisite detail the mission's

2303
01:22:24,310 --> 01:22:21,199
cameras revealed an unrelenting

2304
01:22:26,950 --> 01:22:24,320
rockscape dominated by boulders by

2305
01:22:29,189 --> 01:22:26,960
combining these images from osiris-rex

2306
01:22:31,189 --> 01:22:29,199
with its laser altimetry data we can

2307
01:22:32,709 --> 01:22:31,199
take a tour of bennu's remarkable

2308
01:22:35,510 --> 01:22:32,719
terrain

2309
01:22:37,430 --> 01:22:35,520
the first stop is simrack saxon

2310
01:22:39,990 --> 01:22:37,440
this prominent boulder defines the

2311
01:22:42,709 --> 01:22:40,000
asteroids prime meridian and serves as

2312
01:22:45,110 --> 01:22:42,719
the basis of its coordinate system

2313
01:22:47,189 --> 01:22:45,120

in persian mythology the simrac is a

2314
01:22:49,189 --> 01:22:47,199
large and benevolent bird and the

2315
01:22:52,310 --> 01:22:49,199
possessor of all knowledge

2316
01:22:54,790 --> 01:22:52,320
saxum is latin for stone to the

2317
01:22:55,750 --> 01:22:54,800
northeast lies the largest boulder on

2318
01:22:58,229 --> 01:22:55,760
venue

2319
01:23:00,629 --> 01:22:58,239
measuring over 300 feet in length rock

2320
01:23:02,070 --> 01:23:00,639
saxon is a colossus longer than a

2321
01:23:05,030 --> 01:23:02,080
football field

2322
01:23:07,350 --> 01:23:05,040
it is also rich in a type of iron oxide

2323
01:23:09,830 --> 01:23:07,360
called magnetite which was used by

2324
01:23:11,189 --> 01:23:09,840
mariners as an early form of magnetic

2325
01:23:13,750 --> 01:23:11,199
compass

2326
01:23:16,149 --> 01:23:13,760
in arab folklore the rock is an enormous

2327
01:23:18,790 --> 01:23:16,159
bird of prey that can clasp elephants in

2328
01:23:22,310 --> 01:23:18,800
its talons as well as stranded sailors

2329
01:23:24,550 --> 01:23:22,320
like the hero sinbad

2330
01:23:27,830 --> 01:23:24,560
continuing northeast over the equatorial

2331
01:23:29,590 --> 01:23:27,840
ridge we arrive at gargoyle saxon

2332
01:23:31,910 --> 01:23:29,600
this striking boulder is among the

2333
01:23:33,590 --> 01:23:31,920
darkest on venue though it clutches a

2334
01:23:35,910 --> 01:23:33,600
much brighter rock that is about the

2335
01:23:38,470 --> 01:23:35,920
size of a person

2336
01:23:40,629 --> 01:23:38,480
in medieval legend gargoyles are dragon

2337
01:23:43,110 --> 01:23:40,639
like winged monsters that can breathe

2338
01:23:45,189 --> 01:23:43,120

fire and that guard cathedrals from evil

2339
01:23:47,510 --> 01:23:45,199
spirits

2340
01:23:48,629 --> 01:23:47,520
our next destination takes us far to the

2341
01:23:50,629 --> 01:23:48,639
east

2342
01:23:53,110 --> 01:23:50,639
at the northern end of a small crater

2343
01:23:55,590 --> 01:23:53,120
lies a sippidy saxon a comparatively

2344
01:23:57,030 --> 01:23:55,600
bright boulder measuring about 33 feet

2345
01:23:59,590 --> 01:23:57,040
in diameter

2346
01:24:01,750 --> 01:23:59,600
oscipide saxon is located near one of

2347
01:24:04,550 --> 01:24:01,760
three sites where bennu ejected small

2348
01:24:06,629 --> 01:24:04,560
particles into space in early 2019

2349
01:24:07,830 --> 01:24:06,639
displaying its dynamic and evolving

2350
01:24:10,550 --> 01:24:07,840
nature

2351
01:24:13,030 --> 01:24:10,560
in greek mythology osipity is one of the

2352
01:24:15,590 --> 01:24:13,040
three harpies the half-maiden half-bird

2353
01:24:21,830 --> 01:24:15,600
personifications of storm winds would

2354
01:24:27,430 --> 01:24:24,629
in the creation stories of ancient egypt

2355
01:24:29,350 --> 01:24:27,440
the universe began as a formless endless

2356
01:24:31,750 --> 01:24:29,360
expanse of water

2357
01:24:34,390 --> 01:24:31,760
from this primordial sea arose the

2358
01:24:36,550 --> 01:24:34,400
primordial mound ben ben

2359
01:24:38,870 --> 01:24:36,560
it was upon this rock that the god

2360
01:24:41,270 --> 01:24:38,880
autumn settled in the form of the bennu

2361
01:24:42,790 --> 01:24:41,280
bird and sent forth the call that shaped

2362
01:24:44,870 --> 01:24:42,800
creation

2363
01:24:47,350 --> 01:24:44,880

the story of ben ben harkens to the

2364
01:24:49,110 --> 01:24:47,360
mounds of fertile silt that once emerged

2365
01:24:51,750 --> 01:24:49,120
from the receding flood waters of the

2366
01:24:54,310 --> 01:24:51,760
nile and it provides a fitting namesake

2367
01:24:57,430 --> 01:24:54,320
for the tallest boulder on bennu

2368
01:24:59,590 --> 01:24:57,440
protruding by over 70 feet benben saxon

2369
01:25:01,030 --> 01:24:59,600
is so tall that it was first detected

2370
01:25:03,189 --> 01:25:01,040
from earth

2371
01:25:05,350 --> 01:25:03,199
now we can appreciate this monumental

2372
01:25:08,950 --> 01:25:05,360
feature in detail using data from

2373
01:25:13,350 --> 01:25:11,430
the final stop on our tour is a cluster

2374
01:25:15,750 --> 01:25:13,360
of exceptionally bright boulders

2375
01:25:17,669 --> 01:25:15,760
scattered across the southern hemisphere

2376
01:25:20,470 --> 01:25:17,679
they bear the spectral fingerprint of

2377
01:25:23,189 --> 01:25:20,480
pyroxene a mineral found in igneous rock

2378
01:25:25,590 --> 01:25:23,199
that is unlikely to have formed on bennu

2379
01:25:27,750 --> 01:25:25,600
these boulders most likely originated on

2380
01:25:29,669 --> 01:25:27,760
the large asteroid vesta and were

2381
01:25:32,870 --> 01:25:29,679
delivered to bennu's parent body through

2382
01:25:35,430 --> 01:25:32,880
meteoroid impacts

2383
01:25:37,750 --> 01:25:35,440
although it is small in size asteroid

2384
01:25:40,550 --> 01:25:37,760
bennu has proved to be a fascinating

2385
01:25:43,030 --> 01:25:40,560
world abundant in geographic features

2386
01:25:45,669 --> 01:25:43,040
that have defied our expectations

2387
01:25:48,390 --> 01:25:45,679
thanks to osiris-rex we can now explore

2388
01:25:50,950 --> 01:25:48,400

bennu to uncover its composition its

2389
01:26:04,629 --> 01:25:50,960
evolution and its ancient memories from

2390
01:26:07,830 --> 01:26:06,310
if everything has gone right tonight a

2391
01:26:10,149 --> 01:26:07,840
little bit of bennu will be coming back

2392
01:26:11,910 --> 01:26:10,159
to earth in 2023.

2393
01:26:14,149 --> 01:26:11,920
so let's get one last visit with our

2394
01:26:15,830 --> 01:26:14,159
social media desk james what's going on

2395
01:26:17,270 --> 01:26:15,840
yeah michelle i've got goosebumps i

2396
01:26:19,270 --> 01:26:17,280
really can't even begin to fathom that

2397
01:26:20,870 --> 01:26:19,280
we just tagged and collected a sample

2398
01:26:22,470 --> 01:26:20,880
from this asteroid 200 million miles

2399
01:26:24,149 --> 01:26:22,480
away i know i'm going to want to relive

2400
01:26:26,070 --> 01:26:24,159
the events that just unfolded tonight

2401
01:26:27,750 --> 01:26:26,080
i'm sure you will as well so once again

2402
01:26:29,830 --> 01:26:27,760
if you have that 360 video up on our

2403
01:26:31,270 --> 01:26:29,840
nasa goddard youtube page go check it

2404
01:26:32,950 --> 01:26:31,280
out put yourself right where the action

2405
01:26:34,950 --> 01:26:32,960
just happened a couple minutes ago it's

2406
01:26:36,229 --> 01:26:34,960
truly mind-blowing stuff i also want to

2407
01:26:37,270 --> 01:26:36,239
check back in with that twitter poll

2408
01:26:39,350 --> 01:26:37,280
that we put out at the beginning of the

2409
01:26:41,350 --> 01:26:39,360
broadcast and we're asking you how much

2410
01:26:43,430 --> 01:26:41,360
material you think we just got from

2411
01:26:45,189 --> 01:26:43,440
asteroid bennu so remember we're looking

2412
01:26:47,189 --> 01:26:45,199
for at least 60 grams but that sample

2413
01:26:50,229 --> 01:26:47,199

container can hold up to two kilograms

2414
01:26:52,470 --> 01:26:50,239
so you guys are saying that a candy bar

2415
01:26:54,070 --> 01:26:52,480
size of sample i like the optimism let's

2416
01:26:55,750 --> 01:26:54,080
hope we actually pack that container to

2417
01:26:58,310 --> 01:26:55,760
the max and bring all the sample back

2418
01:27:00,310 --> 01:26:58,320
home but any sample we get back is truly

2419
01:27:01,990 --> 01:27:00,320
magical and will help us learn more

2420
01:27:04,790 --> 01:27:02,000
about the solar system and our origins

2421
01:27:05,990 --> 01:27:04,800
here so keep at us on the hashtag to

2422
01:27:07,430 --> 01:27:06,000
bendu and back we're excited to keep

2423
01:27:08,870 --> 01:27:07,440
this conversation going as we look to

2424
01:27:12,149 --> 01:27:08,880
bring that sample all the way back from

2425
01:27:14,550 --> 01:27:12,159
bennu here to earth in 2023. so back to

2426
01:27:16,070 --> 01:27:14,560
you michelle

2427
01:27:17,830 --> 01:27:16,080
this is one of these evenings where it's

2428
01:27:19,669 --> 01:27:17,840
such a privilege and a pleasure to be

2429
01:27:21,430 --> 01:27:19,679
working for nasa and for the idea of

2430
01:27:23,270 --> 01:27:21,440
scientific exploration

2431
01:27:25,030 --> 01:27:23,280
so what we've been doing all evening is

2432
01:27:27,189 --> 01:27:25,040
seeing the joy seeing these people that

2433
01:27:28,790 --> 01:27:27,199
have worked on this for decades but you

2434
01:27:30,790 --> 01:27:28,800
have to remember there's a real reason

2435
01:27:32,390 --> 01:27:30,800
we're going to look at these asteroids

2436
01:27:34,390 --> 01:27:32,400
we think we actually might be coming

2437
01:27:36,070 --> 01:27:34,400
back with a baby picture of what the

2438
01:27:39,110 --> 01:27:36,080

solar system was like of what our

2439
01:27:41,030 --> 01:27:39,120
chemistry was like billions of years ago

2440
01:27:43,430 --> 01:27:41,040
we're looking for our own origins out

2441
01:27:45,350 --> 01:27:43,440
there and that's why we've gone so far

2442
01:27:46,709 --> 01:27:45,360
to bring a bit of venue back this has

2443
01:27:49,189 --> 01:27:46,719
been an incredible evening the

2444
01:27:50,790 --> 01:27:49,199
adrenaline is slowly beginning to slowly

2445
01:27:52,709 --> 01:27:50,800
go down and there's going to be a lot of

2446
01:27:54,149 --> 01:27:52,719
celebration and a lot of work in the

2447
01:27:55,990 --> 01:27:54,159
coming hours

2448
01:27:57,990 --> 01:27:56,000
so from lockheed martin space here in