



1  
00:00:11,089 --> 00:00:06,860  
NASA's Jet Propulsion Laboratory

2  
00:00:13,520 --> 00:00:11,099  
presents the von Karman lecture a series

3  
00:00:16,220 --> 00:00:13,530  
of talks by scientists and engineers who

4  
00:00:18,610 --> 00:00:16,230  
are exploring our planet our solar

5  
00:00:27,320 --> 00:00:18,620  
system and all lies beyond

6  
00:00:32,700 --> 00:00:30,390  
hey everybody welcome to our monthly

7  
00:00:34,950 --> 00:00:32,710  
series of public talks and discussions

8  
00:00:37,970 --> 00:00:34,960  
from NASA's Jet Propulsion Laboratory

9  
00:00:40,920 --> 00:00:37,980  
here in California I'm Preston dykes

10  
00:00:43,080 --> 00:00:40,930  
well this month we are super excited

11  
00:00:46,049 --> 00:00:43,090  
because we are getting ready for an epic

12  
00:00:49,410 --> 00:00:46,059  
journey to the red planet so buckle up

13  
00:00:51,960 --> 00:00:49,420

because we're going to Mars now for this

14

00:00:54,360 --> 00:00:51,970

show we have two speakers to share how

15

00:00:56,939 --> 00:00:54,370

they're helping to make NASA's next Mars

16

00:00:59,579 --> 00:00:56,949

rover mission a reality now if you're

17

00:01:01,950 --> 00:00:59,589

watching live on YouTube or Facebook you

18

00:01:03,719 --> 00:01:01,960

can submit questions via the chat and

19

00:01:07,020 --> 00:01:03,729

we'll work in some of those questions

20

00:01:08,969 --> 00:01:07,030

into the show as we go and so to help us

21

00:01:11,940 --> 00:01:08,979

with that I am really grateful to have

22

00:01:15,740 --> 00:01:11,950

my colleague from the NASA Mars public

23

00:01:19,230 --> 00:01:15,750

engagement team Sarah marcotte hey Sarah

24

00:01:21,120 --> 00:01:19,240

hey there Preston so it's going to be my

25

00:01:23,039 --> 00:01:21,130

role to take those questions from

26  
00:01:26,160 --> 00:01:23,049  
YouTube and Facebook so keep them coming

27  
00:01:28,440 --> 00:01:26,170  
if you happen to lose the chat window

28  
00:01:29,780 --> 00:01:28,450  
just refresh your browser and it should

29  
00:01:32,430 --> 00:01:29,790  
appear again

30  
00:01:33,480 --> 00:01:32,440  
all right thanks Sarah I'm glad to have

31  
00:01:35,220 --> 00:01:33,490  
your help

32  
00:01:37,860 --> 00:01:35,230  
so a quick program note that we found

33  
00:01:39,030 --> 00:01:37,870  
just in the pre-show check out for Rav

34  
00:01:41,040 --> 00:01:39,040  
that we're having a little trouble with

35  
00:01:42,840 --> 00:01:41,050  
the internet connectivity for our first

36  
00:01:44,610 --> 00:01:42,850  
speaker so we'll we'll hope for the best

37  
00:01:46,560 --> 00:01:44,620  
there and and and roll with that and we

38  
00:01:48,660 --> 00:01:46,570

hope you'll just hang in with us hang in

39

00:01:51,000 --> 00:01:48,670

there with us as we work through that

40

00:01:54,990 --> 00:01:51,010

but hopefully everything will be fine

41

00:01:57,600 --> 00:01:55,000

well NASA's Mars 2020 mission is

42

00:02:00,660 --> 00:01:57,610

targeting a launch date of July 20th

43

00:02:03,510 --> 00:02:00,670

from Cape Canaveral in Florida and on

44

00:02:06,150 --> 00:02:03,520

board that Atlas five rocket will be the

45

00:02:09,180 --> 00:02:06,160

perseverance rover it's the latest in

46

00:02:11,550 --> 00:02:09,190

NASA's a line of robotic explorers to

47

00:02:13,830 --> 00:02:11,560

Rove the Red Planet extending our senses

48

00:02:17,699 --> 00:02:13,840

and our presence to the surface of Mars

49

00:02:20,070 --> 00:02:17,709

and so Sarah your team is working on a

50

00:02:21,780 --> 00:02:20,080

bunch of ways for people to follow along

51  
00:02:24,930 --> 00:02:21,790  
with the mission both in the run-up to

52  
00:02:27,470 --> 00:02:24,940  
launch and on the journey to Mars so

53  
00:02:30,869 --> 00:02:27,480  
tell us what you've been up to

54  
00:02:33,720 --> 00:02:30,879  
sure so I wanted to tell everyone where

55  
00:02:36,179 --> 00:02:33,730  
our one-stop-shop for resources to watch

56  
00:02:39,750 --> 00:02:36,189  
this launch will be it's our website

57  
00:02:42,179 --> 00:02:39,760  
which as Mars [nasa.gov](http://nasa.gov) slash Mara

58  
00:02:44,880 --> 00:02:42,189  
20:20 now that is where everything you

59  
00:02:47,460 --> 00:02:44,890  
need to watch this launch will be

60  
00:02:50,160 --> 00:02:47,470  
located now on this website we have a

61  
00:02:52,259 --> 00:02:50,170  
page called our launch toolkit and it's

62  
00:02:54,509 --> 00:02:52,269  
just that it is a toolkit that gives you

63  
00:02:56,640 --> 00:02:54,519

all the tools you need to watch the

64

00:02:59,009 --> 00:02:56,650

launch whether you can actually join us

65

00:03:01,830 --> 00:02:59,019

at Kennedy Space Center in Florida or

66

00:03:04,949 --> 00:03:01,840

you'll be watching online like I will

67

00:03:06,240 --> 00:03:04,959

now I do want to mention that in the

68

00:03:07,890 --> 00:03:06,250

next few weeks leading up to launch

69

00:03:10,380 --> 00:03:07,900

we're going to be releasing several new

70

00:03:12,899 --> 00:03:10,390

experiences so it's pretty important to

71

00:03:15,630 --> 00:03:12,909

check our social channels and to check

72

00:03:18,059 --> 00:03:15,640

the website again as we release things

73

00:03:22,680 --> 00:03:18,069

in the weeks leading up to our July 20

74

00:03:24,180 --> 00:03:22,690

launch all right well thanks thanks a

75

00:03:26,099 --> 00:03:24,190

lot Sarah and sounds great

76

00:03:31,199 --> 00:03:26,109

so just remember to follow @nasa

77

00:03:34,110 --> 00:03:31,209

persevere on Twitter and Facebook so it

78

00:03:37,229 --> 00:03:34,120

is always an exciting time when we head

79

00:03:39,089 --> 00:03:37,239

off to Mars with a new mission and over

80

00:03:41,729 --> 00:03:39,099

the years we've built up some experience

81

00:03:42,390 --> 00:03:41,739

in landing and operating spacecraft on

82

00:03:46,470 --> 00:03:42,400

the Red Planet

83

00:03:49,830 --> 00:03:46,480

but it's really complicated really hard

84

00:03:53,580 --> 00:03:49,840

and it takes a lot of people to working

85

00:03:55,229 --> 00:03:53,590

together to make it happen so now in the

86

00:03:56,849 --> 00:03:55,239

run-up to launch we tend to place a lot

87

00:03:57,240 --> 00:03:56,859

of focus on the engineering side of

88

00:03:59,640 --> 00:03:57,250

things

89

00:04:02,039 --> 00:03:59,650  
for obvious reasons but of course

90

00:04:04,650 --> 00:04:02,049  
there's also a large team of scientists

91

00:04:07,319 --> 00:04:04,660  
involved from the beginning who really

92

00:04:09,809 --> 00:04:07,329  
helped to shape what the mission becomes

93

00:04:11,640 --> 00:04:09,819  
everything from what science questions

94

00:04:14,939 --> 00:04:11,650  
will the rover investigate to where

95

00:04:16,830 --> 00:04:14,949  
should we land and so our first speaker

96

00:04:19,560 --> 00:04:16,840  
is one of those scientists on the Mars

97

00:04:21,659 --> 00:04:19,570  
2020 mission dr. Brian E Horgan is a

98

00:04:23,790 --> 00:04:21,669  
co-investigator on the rover's camera

99

00:04:30,839 --> 00:04:23,800  
team and a professor at Purdue

100

00:04:32,550 --> 00:04:30,849  
University in Indiana so hey Brian hey

101  
00:04:36,600 --> 00:04:32,560  
how's it going I'm so happy to be here

102  
00:04:40,469 --> 00:04:36,610  
and great thanks so much so now you're a

103  
00:04:41,750 --> 00:04:40,479  
planetary scientist right first of all

104  
00:04:47,930 --> 00:04:41,760  
what does that mean and how do you

105  
00:04:53,100 --> 00:04:51,390  
so appliances basically any kind of

106  
00:04:55,980 --> 00:04:53,110  
science you can imagine everything

107  
00:04:58,230 --> 00:04:55,990  
from biology to chemistry to geology

108  
00:05:00,150 --> 00:04:58,240  
physics to study the planets in our

109  
00:05:03,300 --> 00:05:00,160  
solar system to try to understand the

110  
00:05:06,360 --> 00:05:03,310  
history everything from you know what

111  
00:05:07,890 --> 00:05:06,370  
kind did they ever support or really

112  
00:05:10,830 --> 00:05:07,900  
it's a pretty fun job as we get to do a

113  
00:05:13,080 --> 00:05:10,840

lot but yeah so what I do personally is

114

00:05:15,270 --> 00:05:13,090

I actually do planetary geology so I use

115

00:05:18,030 --> 00:05:15,280

mostly images and other data from

116

00:05:20,250 --> 00:05:18,040

satellites in orbit around planets as

117

00:05:22,980 --> 00:05:20,260

well as Rovers on the ground to try to

118

00:05:25,530 --> 00:05:22,990

understand the past geology of planets

119

00:05:27,120 --> 00:05:25,540

like Mars and the moon and also back

120

00:05:31,200 --> 00:05:27,130

here on earth working in the field in

121

00:05:33,420 --> 00:05:31,210

the lab cool and how did you come to be

122

00:05:37,590 --> 00:05:33,430

part of the Mars 2020 mission you know

123

00:05:44,910 --> 00:05:37,600

how does one come to be a Mars rover

124

00:05:46,800 --> 00:05:44,920

scientist well the way one says I'm

125

00:05:48,570 --> 00:05:46,810

going to send this Rover to Mars JPL is

126

00:05:50,310 --> 00:05:48,580

going to build it now we're going to

127

00:05:52,080 --> 00:05:50,320

reach out to the science community to

128

00:05:54,720 --> 00:05:52,090

compete for instruments they're going to

129

00:05:57,240 --> 00:05:54,730

go on board and so back in 2014 I

130

00:05:59,370 --> 00:05:57,250

believe we had a competitive grant

131

00:06:01,050 --> 00:05:59,380

competition basically where we all all

132

00:06:02,820 --> 00:06:01,060

the scientists got together and you know

133

00:06:04,350 --> 00:06:02,830

split up into teams and developed

134

00:06:06,120 --> 00:06:04,360

instruments that would help address the

135

00:06:07,740 --> 00:06:06,130

big science questions that we wanted to

136

00:06:09,330 --> 00:06:07,750

answer with this Rover proposed those

137

00:06:10,320 --> 00:06:09,340

instruments and then NASA selected

138

00:06:12,120 --> 00:06:10,330

they're really the ones I thought were

139

00:06:13,890 --> 00:06:12,130

the most would be the best for answering

140

00:06:15,600 --> 00:06:13,900

those questions and so I was lucky

141

00:06:17,850 --> 00:06:15,610

enough to be on the camera team that was

142

00:06:19,200 --> 00:06:17,860

proposed and we were selected and now

143

00:06:23,070 --> 00:06:19,210

we're going to Mars and we're really

144

00:06:25,170 --> 00:06:23,080

excited well tell us about the

145

00:06:27,030 --> 00:06:25,180

perseverance Rover I mean what are the

146

00:06:30,330 --> 00:06:27,040

key things that people need to know

147

00:06:33,260 --> 00:06:30,340

about this particular Rover so this

148

00:06:35,250 --> 00:06:33,270

Rover is what I like to call a robotic

149

00:06:37,830 --> 00:06:35,260

astrobiologists so this Rover the cold

150

00:06:40,470 --> 00:06:37,840

goal of the mission is to try to look

151  
00:06:42,510 --> 00:06:40,480  
for signs of ancient life on Mars now

152  
00:06:44,160 --> 00:06:42,520  
that's a really big deal you might have

153  
00:06:46,020 --> 00:06:44,170  
heard a lot in the media about you know

154  
00:06:47,700 --> 00:06:46,030  
looking for water on Mars and finding

155  
00:06:49,050 --> 00:06:47,710  
water on Mars and that's what we've been

156  
00:06:51,360 --> 00:06:49,060  
doing for a long time we've been trying

157  
00:06:53,970 --> 00:06:51,370  
to understand you know what was ancient

158  
00:06:55,620 --> 00:06:53,980  
Mars like was it ever earth-like so it's

159  
00:06:57,930 --> 00:06:55,630  
really been this big build-up all the

160  
00:07:00,150 --> 00:06:57,940  
way from the Pathfinder Rover back in

161  
00:07:02,550 --> 00:07:00,160  
the 90s to the Spirit and Opportunity

162  
00:07:04,920 --> 00:07:02,560  
Rovers back in the early two-thousands

163  
00:07:06,429 --> 00:07:04,930

those were sort of a robot geology

164

00:07:09,429 --> 00:07:06,439

disent landed on Mars

165

00:07:13,089 --> 00:07:09,439

trying to look for signs of that ancient

166

00:07:15,249 --> 00:07:13,099

water Mars was Mars ever earth-like and

167

00:07:17,080 --> 00:07:15,259

then I was followed up by the Curiosity

168

00:07:19,059 --> 00:07:17,090

rover which is still roaming Mars today

169

00:07:22,089 --> 00:07:19,069

Gale Crater which was trying to

170

00:07:24,070 --> 00:07:22,099

understand what their not more watery

171

00:07:26,260 --> 00:07:24,080

ancient environments on Mars could have

172

00:07:29,379 --> 00:07:26,270

actually supported life if they were

173

00:07:31,629 --> 00:07:29,389

habitable environments now that we've

174

00:07:33,850 --> 00:07:31,639

done all of that you know the Rovers and

175

00:07:36,010 --> 00:07:33,860

we've also had satellites orbit around

176

00:07:38,679 --> 00:07:36,020

Mars trying to understand what the

177

00:07:40,209 --> 00:07:38,689

history was it you weren't even for a

178

00:07:42,820 --> 00:07:40,219

little green men running around we're

179

00:07:44,649 --> 00:07:42,830

looking for signs of ancient microbes

180

00:07:46,629 --> 00:07:44,659

that might have once lived on Mars and

181

00:07:48,580 --> 00:07:46,639

it turns out it's really really tough to

182

00:07:50,499 --> 00:07:48,590

find signs of microbial life in the

183

00:07:52,480 --> 00:07:50,509

geologic record it's even hard here on

184

00:07:54,640 --> 00:07:52,490

earth but we think we know enough now do

185

00:07:56,860 --> 00:07:54,650

we have a really great landing site that

186

00:07:59,170 --> 00:07:56,870

we can we can go to to look for these

187

00:08:01,329 --> 00:07:59,180

ancient signs of life if you bring up a

188

00:08:03,399 --> 00:08:01,339

graphic one you can see a shot of what

189

00:08:03,850 --> 00:08:03,409

Mars 2020 we think will look like on the

190

00:08:06,640 --> 00:08:03,860

ground

191

00:08:09,459 --> 00:08:06,650

it's artist's rendition the rover

192

00:08:10,929 --> 00:08:09,469

investigating some rocks on Mars this is

193

00:08:12,459 --> 00:08:10,939

lower hope we're gonna be doing well

194

00:08:14,110 --> 00:08:12,469

hope we are roving around the site we'll

195

00:08:15,999 --> 00:08:14,120

talk about a little later Jezreel crater

196

00:08:17,559 --> 00:08:16,009

trying to understand the geologic

197

00:08:19,119 --> 00:08:17,569

history of the site as well as you know

198

00:08:24,450 --> 00:08:19,129

looking for these what we call bio

199

00:08:27,159 --> 00:08:24,460

signatures if you go to some graphic -

200

00:08:28,629 --> 00:08:27,169

so here's where the rover was until

201  
00:08:30,670 --> 00:08:28,639  
recently this is actually we call it a

202  
00:08:32,769 --> 00:08:30,680  
high bay at JPL it's where the rover was

203  
00:08:34,659 --> 00:08:32,779  
assembled and you can see this photo is

204  
00:08:37,569 --> 00:08:34,669  
actually of the rover taking its baby

205  
00:08:39,130 --> 00:08:37,579  
steps back in December of last year now

206  
00:08:41,889 --> 00:08:39,140  
it's been shipped off to the Cape and

207  
00:08:43,860 --> 00:08:41,899  
it's reading getting ready to get loaded

208  
00:08:46,150 --> 00:08:43,870  
onto the rocket which is really exciting

209  
00:08:47,560 --> 00:08:46,160  
they go to graphic three you can see

210  
00:08:49,389 --> 00:08:47,570  
some of the really great instruments

211  
00:08:51,100 --> 00:08:49,399  
that are on board the rover because

212  
00:08:54,069 --> 00:08:51,110  
really you know the rover itself it's

213  
00:08:55,329 --> 00:08:54,079

this amazing chassis as amazing robots

214

00:08:57,519 --> 00:08:55,339

going to do all this great work but it's

215

00:08:59,380 --> 00:08:57,529

this the instruments that really are

216

00:09:01,600 --> 00:08:59,390

what the river is about and this Rover

217

00:09:03,009 --> 00:09:01,610

really is an astrobiologist we have all

218

00:09:04,990 --> 00:09:03,019

kinds of amazing instruments on board

219

00:09:07,780 --> 00:09:05,000

that we're going to be doing things like

220

00:09:10,600 --> 00:09:07,790

looking for traces of organics at the

221

00:09:12,530 --> 00:09:10,610

millimeter/submillimeter scale we're

222

00:09:15,019 --> 00:09:12,540

going to be looking for evidence

223

00:09:16,639 --> 00:09:15,029

you know textural bio signatures all

224

00:09:18,560 --> 00:09:16,649

kinds of interesting things like that

225

00:09:21,800 --> 00:09:18,570

with our really heavy-duty kind of

226

00:09:23,300 --> 00:09:21,810

microscopic payload a lot of microscopes

227

00:09:27,230 --> 00:09:23,310

you can see are actually out on the end

228

00:09:33,259 --> 00:09:27,240

of that seven long arm and just for

229

00:09:35,569 --> 00:09:33,269

reference that are on the end weighs

230

00:09:38,180 --> 00:09:35,579

about as much as a lawn mower and are

231

00:09:40,519 --> 00:09:38,190

able to place it with a millimeter

232

00:09:43,579 --> 00:09:40,529

precision which is really incredible but

233

00:09:45,319 --> 00:09:43,589

that's really the workhorse is the

234

00:09:48,019 --> 00:09:45,329

instruments out on the armature these

235

00:09:51,350 --> 00:09:48,029

amazing microscopic instrument second

236

00:09:54,110 --> 00:09:51,360

map organics and minerals and chemistry

237

00:09:59,300 --> 00:09:54,120

at this very fine scale to help us look

238

00:10:00,980 --> 00:09:59,310

for this Rover you can see just how

239

00:10:02,740 --> 00:10:00,990

similar they really are I mean they're

240

00:10:04,819 --> 00:10:02,750

very they basically have the same

241

00:10:06,290 --> 00:10:04,829

chassis they had the same kind of

242

00:10:08,509 --> 00:10:06,300

overall design but they are very

243

00:10:11,269 --> 00:10:08,519

different now the Curiosity rover is

244

00:10:12,889 --> 00:10:11,279

basically a roving geology laboratory it

245

00:10:14,480 --> 00:10:12,899

has an incredible suite of instruments

246

00:10:16,160 --> 00:10:14,490

and designed to look at the the

247

00:10:18,110 --> 00:10:16,170

chemistry of the rocks the mineralogy

248

00:10:19,460 --> 00:10:18,120

the rocks because that's where that the

249

00:10:20,900 --> 00:10:19,470

signs of that ancient Hannibal

250

00:10:23,449 --> 00:10:20,910

environment are trapped is within the

251  
00:10:26,420 --> 00:10:23,459  
kind of details of the things that make

252  
00:10:30,680 --> 00:10:26,430  
up the rocks again with March my point

253  
00:10:32,720 --> 00:10:30,690  
we're really looking for ancient biology

254  
00:10:34,340 --> 00:10:32,730  
so has a very different suite of

255  
00:10:35,870 --> 00:10:34,350  
instruments do they look really similar

256  
00:10:39,889 --> 00:10:35,880  
they're going to be doing really

257  
00:10:43,129 --> 00:10:39,899  
different things on the ground gotcha

258  
00:10:45,559 --> 00:10:43,139  
well it is a remarkable looking piece of

259  
00:10:48,740 --> 00:10:45,569  
machinery I think it's a good time for

260  
00:10:50,240 --> 00:10:48,750  
us to go to Sarah for our first question

261  
00:10:55,340 --> 00:10:50,250  
from the audience Sarah what do you got

262  
00:10:57,920 --> 00:10:55,350  
for Briony sure well I saw some

263  
00:11:00,079 --> 00:10:57,930

questions come in and they were related

264

00:11:03,680 --> 00:11:00,089

very nicely to what Briony was talking

265

00:11:06,019 --> 00:11:03,690

about so tan on Facebook asks how our

266

00:11:08,120 --> 00:11:06,029

perseverance is duties so what is going

267

00:11:09,949 --> 00:11:08,130

to do on the surface of Mars different

268

00:11:11,720 --> 00:11:09,959

from curiosity and you talked a little

269

00:11:14,120 --> 00:11:11,730

bit about how the rover's look very

270

00:11:28,470 --> 00:11:14,130

similar but what are how are the tasks

271

00:11:32,559 --> 00:11:30,790

that's a great question actually it's a

272

00:11:34,090 --> 00:11:32,569

great opportunity to talk about sample

273

00:11:35,290 --> 00:11:34,100

caching because that's one of the big

274

00:11:37,509 --> 00:11:35,300

things that this worker is going to do

275

00:11:40,059 --> 00:11:37,519

is not just you know do this complete

276

00:11:41,949 --> 00:11:40,069

science investigation on the ground with

277

00:11:44,410 --> 00:11:41,959

the rocks in there we're also going to

278

00:11:46,239 --> 00:11:44,420

be selecting samples that we're going to

279

00:11:47,710 --> 00:11:46,249

eventually bring back to earth and so

280

00:11:49,299 --> 00:11:47,720

the way that's gonna work we'll be

281

00:11:51,489 --> 00:11:49,309

selecting this kind of pencil-sized

282

00:11:54,730 --> 00:11:51,499

drill samples of rock that the rover

283

00:11:56,079 --> 00:11:54,740

will doing a lot of the kind of mineral

284

00:11:58,179 --> 00:11:56,089

Hema story and triangle rocks are made

285

00:11:59,799 --> 00:11:58,189

of but what's really exciting book 2020

286

00:12:01,929 --> 00:11:59,809

we're actually going to be sampling

287

00:12:03,519 --> 00:12:01,939

those rocks to bring back to earth to

288

00:12:04,689 --> 00:12:03,529

look at in our labs back here on earth

289

00:12:06,129 --> 00:12:04,699

and the reason we're doing that is

290

00:12:08,470 --> 00:12:06,139

because if we really want to know

291

00:12:10,600 --> 00:12:08,480

whether or not there are signs of life

292

00:12:12,429 --> 00:12:10,610

trapped in those rocks we have to look

293

00:12:14,379 --> 00:12:12,439

at them with extremely you know just the

294

00:12:16,299 --> 00:12:14,389

best instrumentation possible with the

295

00:12:17,559 --> 00:12:16,309

best you know electron microscopes and

296

00:12:18,939 --> 00:12:17,569

things that we have back here on earth

297

00:12:21,189 --> 00:12:18,949

to try to figure that out it's really

298

00:12:22,900 --> 00:12:21,199

hard to do that kind of work as well as

299

00:12:24,400 --> 00:12:22,910

we would like to to confirm whether or

300

00:12:26,829 --> 00:12:24,410

not there was ever inch in life there on

301

00:12:27,939 --> 00:12:26,839

Mars with the rover and so that's the

302

00:12:30,489 --> 00:12:27,949

next step so we're going to be

303

00:12:32,379 --> 00:12:30,499

collecting those samples and then later

304

00:12:33,939 --> 00:12:32,389

there's going to be a series of missions

305

00:12:37,419 --> 00:12:33,949

that will help bring those samples back

306

00:12:39,970 --> 00:12:37,429

it's a pretty tough job not only you

307

00:12:41,860 --> 00:12:39,980

know so 2020 perseverance rover's going

308

00:12:43,629 --> 00:12:41,870

to be collecting the samples and you

309

00:12:45,850 --> 00:12:43,639

know documenting them and we'll help us

310

00:12:49,389 --> 00:12:45,860

decide which ones to bring back but then

311

00:12:51,160 --> 00:12:49,399

we have to land another rover on the

312

00:12:54,040 --> 00:12:51,170

ground that'll go get those samples

313

00:12:55,629 --> 00:12:54,050

it'll have to bring those samples back

314

00:12:58,389 --> 00:12:55,639

to a launch platform

315

00:13:00,730 --> 00:12:58,399

it'll have to load those samples into a

316

00:13:02,619 --> 00:13:00,740

rocket which will then lift off the

317

00:13:04,569 --> 00:13:02,629

launch platform blast into orbit

318

00:13:07,030 --> 00:13:04,579

rendezvous with the satellite that it

319

00:13:08,980 --> 00:13:07,040

will pick up the samples and eventually

320

00:13:10,749 --> 00:13:08,990

make it back there at the landowner so

321

00:13:12,610 --> 00:13:10,759

it's really really tough it's a lot of

322

00:13:14,889 --> 00:13:12,620

steps we have to go but we're starting

323

00:13:16,989 --> 00:13:14,899

to work on it NASA and the European

324

00:13:18,460 --> 00:13:16,999

Space Agency have actually already

325

00:13:20,439 --> 00:13:18,470

started working on this and putting

326

00:13:21,999 --> 00:13:20,449

money toward this and developing joint

327

00:13:23,769 --> 00:13:22,009

that admissions it'll make this happen

328

00:13:25,199 --> 00:13:23,779

so we're really excited that you know

329

00:13:27,039 --> 00:13:25,209

not only are we doing this great

330

00:13:28,960 --> 00:13:27,049

astrobiology on the ground with the

331

00:13:30,639 --> 00:13:28,970

rover we're also going to be helping

332

00:13:34,210 --> 00:13:30,649

bring back some of the most exciting

333

00:13:36,280 --> 00:13:34,220

sample to ever return from space so

334

00:13:38,079 --> 00:13:36,290

Brian II you you've mentioned a word a

335

00:13:39,710 --> 00:13:38,089

couple of times that I wanted to ask you

336

00:13:41,929 --> 00:13:39,720

to delve into a little bit

337

00:13:45,319 --> 00:13:41,939

more deeply you mentioned bio signatures

338

00:13:48,470 --> 00:13:45,329

so what are bio signatures and how can

339

00:13:50,960 --> 00:13:48,480

they help you understand today whether

340

00:13:58,850 --> 00:13:50,970

Mars had life three or four billion

341

00:14:00,319 --> 00:13:58,860

years ago that's a great question so if

342

00:14:01,610 --> 00:14:00,329

you go to graphic five we have some

343

00:14:03,619 --> 00:14:01,620

nicely what these things are

344

00:14:06,410 --> 00:14:03,629

so bio signatures are being a lot less

345

00:14:07,460 --> 00:14:06,420

and it could be due to life and so

346

00:14:08,929 --> 00:14:07,470

there's a lot of different things that

347

00:14:10,910 --> 00:14:08,939

could be it could be things like you

348

00:14:12,740 --> 00:14:10,920

know chemical signatures isotopes or a

349

00:14:14,540 --> 00:14:12,750

really common one you know life gets

350

00:14:15,920 --> 00:14:14,550

them there and really messes with their

351

00:14:17,809 --> 00:14:15,930

the different kinds of chemicals that

352

00:14:20,150 --> 00:14:17,819

are left behind it could be you know

353

00:14:21,860 --> 00:14:20,160

nice really obvious things like in that

354

00:14:24,139 --> 00:14:21,870

middle left that's what we call a

355

00:14:26,449 --> 00:14:24,149

stromatolite that's a nice textural bio

356

00:14:28,340 --> 00:14:26,459

signature that was created by microbial

357

00:14:30,499 --> 00:14:28,350

mats on the shores of an ancient lake

358

00:14:31,910 --> 00:14:30,509

that kind of helps cement these minerals

359

00:14:33,379 --> 00:14:31,920

together and create this really kind of

360

00:14:35,420 --> 00:14:33,389

it looks it looks a lie right this kind

361

00:14:37,069 --> 00:14:35,430

of life light texture it could be a lot

362

00:14:38,629 --> 00:14:37,079

of different things micro fossils are a

363

00:14:40,400 --> 00:14:38,639

great example even things like a

364

00:14:42,470 --> 00:14:40,410

dinosaur bone is technically a bio

365

00:14:44,240 --> 00:14:42,480

signature so but the difference is you

366

00:14:45,559 --> 00:14:44,250

know we wouldn't find a dinosaur bone on

367

00:14:48,350 --> 00:14:45,569

Mars but of course we're really looking

368

00:14:49,939 --> 00:14:48,360

for are these microbial bio signatures

369

00:14:51,199 --> 00:14:49,949

and so that's why even though you know

370

00:14:54,019 --> 00:14:51,209

we're going to do as much as we can to

371

00:14:55,280 --> 00:14:54,029

characterize organics and textures and

372

00:14:57,019 --> 00:14:55,290

all of these things that we think could

373

00:14:58,910 --> 00:14:57,029

help us indicate where bio signatures

374

00:15:00,590 --> 00:14:58,920

could be on Mars ultimately we'll have

375

00:15:02,269 --> 00:15:00,600

to bring these samples back to earth to

376

00:15:04,699 --> 00:15:02,279

confirm whether or not that's true so

377

00:15:06,019 --> 00:15:04,709

even if we find say that amazing rock on

378

00:15:07,329 --> 00:15:06,029

the left of the stromatolite which we

379

00:15:09,799 --> 00:15:07,339

hope we might find in our landing site

380

00:15:11,059 --> 00:15:09,809

that would be great we still have to

381

00:15:12,559 --> 00:15:11,069

bring it back to earth to confirm

382

00:15:18,199 --> 00:15:12,569

whether or not that was actually created

383

00:15:21,079 --> 00:15:18,209

by microbes Wow and before we go too

384

00:15:23,329 --> 00:15:21,089

much farther Sarah I wanted to ask you

385

00:15:28,400 --> 00:15:23,339

you to mention this that perseverance

386

00:15:31,280 --> 00:15:28,410

has a helicopter too right yes it does

387

00:15:33,769 --> 00:15:31,290

indeedy it's got a helicopter riding on

388

00:15:37,040 --> 00:15:33,779

the belly of the perseverance Rover the

389

00:15:40,369 --> 00:15:37,050

helicopters name is ingenuity and in the

390

00:15:42,799 --> 00:15:40,379

first few weeks or months of the surface

391

00:15:45,340 --> 00:15:42,809

operations of perseverance so we're

392

00:15:48,439 --> 00:15:45,350

talking sometime in the spring of 2021

393

00:15:51,410 --> 00:15:48,449

that helicopter ingenuity may

394

00:15:52,040 --> 00:15:51,420

demonstrate the first powered flight on

395

00:15:55,759 --> 00:15:52,050

another

396

00:15:58,490 --> 00:15:55,769

in it how cool is that that is super

397

00:15:59,600 --> 00:15:58,500

cool and and so I wanted to mention the

398

00:16:01,250 --> 00:15:59,610

helicopter because I think a lot of

399

00:16:03,740 --> 00:16:01,260

people are becoming aware that there's a

400

00:16:05,540 --> 00:16:03,750

there's the helicopter on this thick

401  
00:16:07,310 --> 00:16:05,550  
going with this thing but Brian II does

402  
00:16:10,400 --> 00:16:07,320  
that play into the science of the

403  
00:16:11,960 --> 00:16:10,410  
mission we're opening yeah I mean so the

404  
00:16:14,480 --> 00:16:11,970  
helicopter it's technically it's a

405  
00:16:16,370 --> 00:16:14,490  
technology demonstration so you know the

406  
00:16:17,690 --> 00:16:16,380  
basic thing has to do is show that we

407  
00:16:19,430 --> 00:16:17,700  
like serious said that we can have we

408  
00:16:21,290 --> 00:16:19,440  
can actually operate powered flight on

409  
00:16:23,120 --> 00:16:21,300  
Mars we can operate a helicopter on Mars

410  
00:16:25,579 --> 00:16:23,130  
so we're hoping you know the helicopter

411  
00:16:27,920 --> 00:16:25,589  
has cameras on board and we're really

412  
00:16:30,800 --> 00:16:27,930  
hoping you know what this helicopter

413  
00:16:32,750 --> 00:16:30,810

future missions like this will do this

414

00:16:34,850 --> 00:16:32,760

help kind of bridge the gap between our

415

00:16:37,040 --> 00:16:34,860

really incredible images we have from

416

00:16:38,509 --> 00:16:37,050

satellites and orbit what we see it can

417

00:16:40,280 --> 00:16:38,519

see from the rover on the ground you

418

00:16:42,019 --> 00:16:40,290

know just like drones here on earth kind

419

00:16:44,120 --> 00:16:42,029

of help you get context where you are

420

00:16:46,130 --> 00:16:44,130

you're great for mapping or great for

421

00:16:47,630 --> 00:16:46,140

doing geology and science too we're

422

00:16:49,970 --> 00:16:47,640

hoping the drone but the helicopter

423

00:16:51,199 --> 00:16:49,980

ingenuity will help us with that in our

424

00:16:52,940 --> 00:16:51,209

landing site will help us kind of

425

00:16:55,579 --> 00:16:52,950

understand context where the rover is

426

00:16:57,319 --> 00:16:55,589

help us make really cool 3d maps of

427

00:17:00,350 --> 00:16:57,329

where we are all kinds of great look

428

00:17:01,790 --> 00:17:00,360

done well you you may you gave me a

429

00:17:04,909 --> 00:17:01,800

perfect bridge to my next question

430

00:17:07,669 --> 00:17:04,919

because you work on the team that is

431

00:17:10,460 --> 00:17:07,679

going to take all the incredible images

432

00:17:12,559 --> 00:17:10,470

of Mars with perseverance so tell us

433

00:17:15,669 --> 00:17:12,569

about the cameras uh how will they be

434

00:17:18,620 --> 00:17:15,679

similar to or different from curiosity

435

00:17:21,199 --> 00:17:18,630

yeah so I'm on the mass candy team that

436

00:17:23,840 --> 00:17:21,209

stands for mast camera zoom so we had

437

00:17:25,309 --> 00:17:23,850

mass cams on curiosity and you know they

438

00:17:27,079 --> 00:17:25,319

worked really well it's really you know

439

00:17:29,360 --> 00:17:27,089

almost all the really beautiful color

440

00:17:30,890 --> 00:17:29,370

and big mosaics and things that you see

441

00:17:33,890 --> 00:17:30,900

from the Curiosity rover those are

442

00:17:35,930 --> 00:17:33,900

almost all taken by the mass cam cameras

443

00:17:38,419 --> 00:17:35,940

so we're gonna stand something fairly

444

00:17:40,850 --> 00:17:38,429

similar to Mars mask and Z is pretty

445

00:17:43,610 --> 00:17:40,860

similar to mass cam except for we have

446

00:17:45,770 --> 00:17:43,620

better zoom capabilities with mass cam

447

00:17:47,419 --> 00:17:45,780

we actually had the eyes were so I stuck

448

00:17:49,520 --> 00:17:47,429

sumed in one with stucco zoomed out on

449

00:17:51,380 --> 00:17:49,530

purpose to make you think simple we have

450

00:17:52,490 --> 00:17:51,390

the ability to zoom them independently

451

00:17:54,440 --> 00:17:52,500

now which is going to be really great

452

00:17:57,470 --> 00:17:54,450

we're gonna have a beautiful

453

00:17:59,840 --> 00:17:57,480

you know 3d mosaics we can make with the

454

00:18:01,669 --> 00:17:59,850

two eyes we're going to be able to no

455

00:18:03,290 --> 00:18:01,679

but I actually work on is mineralogy we

456

00:18:05,210 --> 00:18:03,300

can actually do some really simple

457

00:18:05,600 --> 00:18:05,220

spectroscopy looking at the wavelength

458

00:18:08,060 --> 00:18:05,610

that

459

00:18:10,190 --> 00:18:08,070

of light coming off of rocks to help

460

00:18:11,600 --> 00:18:10,200

identify their mineral fingerprints

461

00:18:13,489 --> 00:18:11,610

we're going to be able to do that look

462

00:18:15,499 --> 00:18:13,499

at the beautiful colors and all of that

463

00:18:21,950 --> 00:18:15,509

with these cameras it really kind of the

464

00:18:25,220 --> 00:18:21,960

geology workhorses of the mission really

465

00:18:26,600 --> 00:18:25,230

nice graphic oh yeah sorry we have a

466

00:18:28,639 --> 00:18:26,610

great if you go to graphic seven you can

467

00:18:30,560 --> 00:18:28,649

actually see the mastcam the high bay

468

00:18:32,570 --> 00:18:30,570

JPL so there you can see this is the

469

00:18:34,489 --> 00:18:32,580

head of person go the big kind of goal

470

00:18:36,680 --> 00:18:34,499

at the top that's actually a port for a

471

00:18:38,899 --> 00:18:36,690

laser that's for the the super cam a

472

00:18:40,669 --> 00:18:38,909

laser instrument which does Raman

473

00:18:42,649 --> 00:18:40,679

spectroscopy and laser-induced breakdown

474

00:18:43,879 --> 00:18:42,659

spectroscopy so basically zapping the

475

00:18:45,859 --> 00:18:43,889

rocks to see what they're made of and

476

00:18:47,690 --> 00:18:45,869

then below that the two big rectangles

477

00:18:49,460 --> 00:18:47,700

that that's the mask and Aziz the two

478

00:18:51,440 --> 00:18:49,470

eyes and the reason we have two is so we

479

00:18:52,849 --> 00:18:51,450

can actually do stereo imaging just like

480

00:18:54,649 --> 00:18:52,859

you know you have depth perception with

481

00:18:56,659 --> 00:18:54,659

your eyes because you have to the mask

482

00:18:58,099 --> 00:18:56,669

and aziz are able to give us depth

483

00:19:01,430 --> 00:18:58,109

perception with the rovers we can

484

00:19:03,499 --> 00:19:01,440

actually make things like 3d maps very

485

00:19:05,269 --> 00:19:03,509

cool well I think it's time to go back

486

00:19:09,529 --> 00:19:05,279

to Sarah for another question from our

487

00:19:12,440 --> 00:19:09,539

live audience Sarah what do you got sure

488

00:19:16,220 --> 00:19:12,450

so Doug Oh on YouTube is wondering about

489

00:19:19,669 --> 00:19:16,230

how do you prevent biological pollution

490

00:19:21,379 --> 00:19:19,679

or maybe doggo means contamination from

491

00:19:23,389 --> 00:19:21,389

the rover on Mars

492

00:19:26,269 --> 00:19:23,399

I hear there's some sort of field called

493

00:19:29,869 --> 00:19:26,279

planetary protection can you speak about

494

00:19:31,460 --> 00:19:29,879

that at all yeah so planetary protection

495

00:19:33,200 --> 00:19:31,470

is something NASA takes very seriously

496

00:19:35,419 --> 00:19:33,210

so what does that mean well music want

497

00:19:37,580 --> 00:19:35,429

to protect all of the planets I mean to

498

00:19:39,499 --> 00:19:37,590

both Earth and Mars from each other and

499

00:19:41,389 --> 00:19:39,509

so that means we want to make sure that

500

00:19:43,249 --> 00:19:41,399

we don't bring anything dangerous back

501  
00:19:45,200 --> 00:19:43,259  
here to earth so you know when we bring

502  
00:19:46,519 --> 00:19:45,210  
samples back even from places like the

503  
00:19:48,619 --> 00:19:46,529  
moon or you don't expect there to be

504  
00:19:50,330 --> 00:19:48,629  
much life or comets we make sure

505  
00:19:52,789 --> 00:19:50,340  
everything is quarantined that it's you

506  
00:19:54,049 --> 00:19:52,799  
know if we can sterilize it so you bring

507  
00:19:55,430 --> 00:19:54,059  
things moving these samples back from

508  
00:19:56,749 --> 00:19:55,440  
Mars and one of the first thing you have

509  
00:19:58,700 --> 00:19:56,759  
to do is make sure that they're not

510  
00:20:00,049 --> 00:19:58,710  
inhabited with modern life and that

511  
00:20:01,580 --> 00:20:00,059  
obviously would be interesting for

512  
00:20:03,590 --> 00:20:01,590  
science but also really important for

513  
00:20:04,789 --> 00:20:03,600

making sure we protect our planet but it

514

00:20:06,859 --> 00:20:04,799

goes the other way too we want to make

515

00:20:09,200 --> 00:20:06,869

sure we protect Mars from all of the

516

00:20:11,029 --> 00:20:09,210

bugs you know microbes in the center are

517

00:20:12,440 --> 00:20:11,039

crawling around on earth and so one of

518

00:20:14,869 --> 00:20:12,450

the things we try to do is make sure the

519

00:20:16,879 --> 00:20:14,879

rover itself is not quite sterile

520

00:20:17,450 --> 00:20:16,889

basically but as clean as we can get it

521

00:20:19,130 --> 00:20:17,460

while not

522

00:20:21,080 --> 00:20:19,140

managing the instruments all of every

523

00:20:23,419 --> 00:20:21,090

single piece of hardware on the rover is

524

00:20:24,769 --> 00:20:23,429

carefully cleaned and documented you

525

00:20:26,960 --> 00:20:24,779

know as it's taken apart and put back

526  
00:20:29,029 --> 00:20:26,970  
together so that we don't we try to

527  
00:20:31,580 --> 00:20:29,039  
bring as few bugs with us as possible to

528  
00:20:32,570 --> 00:20:31,590  
Mars partly to protect an ecosystem we

529  
00:20:34,460 --> 00:20:32,580  
want to make sure we don't you know

530  
00:20:35,840 --> 00:20:34,470  
overpower anything that's living there

531  
00:20:37,730 --> 00:20:35,850  
today because we don't know right there

532  
00:20:40,130 --> 00:20:37,740  
might be little bugs living it either in

533  
00:20:41,510 --> 00:20:40,140  
the subsurface or you know near the

534  
00:20:43,940 --> 00:20:41,520  
polar caps or something like that on

535  
00:20:45,919 --> 00:20:43,950  
Mars we're not sure but also so that you

536  
00:20:48,200 --> 00:20:45,929  
know if we go there and we see signs of

537  
00:20:49,549 --> 00:20:48,210  
life we can tell that for sure it's not

538  
00:20:52,010 --> 00:20:49,559

from Earth right that we know it's

539

00:20:53,840 --> 00:20:52,020

actually native Martian life if we go

540

00:20:55,159 --> 00:20:53,850

and contaminate the whole planet you

541

00:20:56,419 --> 00:20:55,169

know there's some ethics questions there

542

00:20:58,340 --> 00:20:56,429

but also it just makes it a lot harder

543

00:21:00,110 --> 00:20:58,350

for us to tell what's going on so that's

544

00:21:01,460 --> 00:21:00,120

actual office that exists at NASA we

545

00:21:03,740 --> 00:21:01,470

have an officer of planetary protection

546

00:21:07,070 --> 00:21:03,750

and they try to make sure that we do the

547

00:21:08,510 --> 00:21:07,080

right thing yet another cool job title

548

00:21:11,000 --> 00:21:08,520

at NASA planetary protection officer

549

00:21:13,130 --> 00:21:11,010

among many cool job titles Mars rover

550

00:21:16,730 --> 00:21:13,140

scientist is super cool

551  
00:21:19,760 --> 00:21:16,740  
so great question thank you you were

552  
00:21:21,590 --> 00:21:19,770  
involved though Briony in the selection

553  
00:21:23,060 --> 00:21:21,600  
of the landing site as one of the

554  
00:21:25,700 --> 00:21:23,070  
science team members of jezero crater

555  
00:21:29,330 --> 00:21:25,710  
tell us about that process what was that

556  
00:21:31,549 --> 00:21:29,340  
like yeah so why do you so do you take

557  
00:21:33,620 --> 00:21:31,559  
the one place on Mars that you're going

558  
00:21:35,570 --> 00:21:33,630  
to collect maybe the only samples you

559  
00:21:36,799 --> 00:21:35,580  
ever get back from the planet it's a

560  
00:21:39,200 --> 00:21:36,809  
tough question right if you had to pick

561  
00:21:40,760 --> 00:21:39,210  
one place on earth to pick you know a

562  
00:21:42,680 --> 00:21:40,770  
bunch of rock samples to tell you about

563  
00:21:44,090 --> 00:21:42,690

the entire geologic history of the earth

564

00:21:46,310 --> 00:21:44,100

where would you go well that's really

565

00:21:47,510 --> 00:21:46,320

hard so this is a hard question so you

566

00:21:49,070 --> 00:21:47,520

know NASA likes to be as open as

567

00:21:51,260 --> 00:21:49,080

possible so the way this was done was

568

00:21:53,510 --> 00:21:51,270

that NASA play an open call to the whole

569

00:21:55,220 --> 00:21:53,520

science community and really anybody to

570

00:21:57,260 --> 00:21:55,230

propose landing sites and we started out

571

00:21:59,180 --> 00:21:57,270

with I think 60 different landing sites

572

00:22:01,220 --> 00:21:59,190

proposed on Mars for this mission and

573

00:22:03,260 --> 00:22:01,230

gradually over hearing about five years

574

00:22:05,299 --> 00:22:03,270

and big community meetings we got

575

00:22:07,100 --> 00:22:05,309

together and argued about it gradually

576

00:22:08,810 --> 00:22:07,110

narrowed it down to just a just three

577

00:22:11,720 --> 00:22:08,820

sites and eventually down to jezero

578

00:22:13,279 --> 00:22:11,730

crater so the how do you choose a

579

00:22:15,200 --> 00:22:13,289

landing site like that well for one

580

00:22:16,850 --> 00:22:15,210

thing this is an astrobiology mission we

581

00:22:19,430 --> 00:22:16,860

want to try to go somewhere that has a

582

00:22:21,649 --> 00:22:19,440

good chance of preserving those ancient

583

00:22:22,970 --> 00:22:21,659

microbial bio signatures there's a

584

00:22:25,190 --> 00:22:22,980

couple different places you could go to

585

00:22:30,350 --> 00:22:25,200

do that but we decided to go ancient

586

00:22:31,110 --> 00:22:30,360

lake on Mars cool all right well I mean

587

00:22:33,660 --> 00:22:31,120

it's

588

00:22:37,320 --> 00:22:33,670

60 down to one it must have been kind of

589

00:22:40,590 --> 00:22:37,330

a kind of our choice what I wanted to

590

00:22:42,000 --> 00:22:40,600

ask you in addition to just about some

591

00:22:43,170 --> 00:22:42,010

of the other things that you've done as

592

00:22:45,810 --> 00:22:43,180

a member of the science team and kind of

593

00:22:47,310 --> 00:22:45,820

making this mission what it is in

594

00:22:48,450 --> 00:22:47,320

addition to the landing site what are

595

00:22:50,790 --> 00:22:48,460

some of the other things that you and

596

00:22:55,830 --> 00:22:50,800

the other science team members have had

597

00:22:57,210 --> 00:22:55,840

to work on together along the way yeah

598

00:22:58,740 --> 00:22:57,220

so there's a couple of things I mean

599

00:23:00,330 --> 00:22:58,750

first off we're still working on the

600

00:23:01,530 --> 00:23:00,340

landing site so I'm a little more detail

601  
00:23:03,330 --> 00:23:01,540  
what we're actually going to see crater

602  
00:23:06,240 --> 00:23:03,340  
if you'd like to hear that and to bring

603  
00:23:09,480 --> 00:23:06,250  
out Big Eight you'll see a topographic

604  
00:23:11,820 --> 00:23:09,490  
map of jezero crater and so jezero here

605  
00:23:13,980 --> 00:23:11,830  
you can see so in these this topographic

606  
00:23:15,990 --> 00:23:13,990  
map blue is low and yellow is high and

607  
00:23:17,550 --> 00:23:16,000  
so you can see the crater itself without

608  
00:23:18,930 --> 00:23:17,560  
all that blue indicating the floor of

609  
00:23:21,420 --> 00:23:18,940  
the crater and the rim surrounding it

610  
00:23:23,880 --> 00:23:21,430  
and what's really unique about des Rose

611  
00:23:25,620 --> 00:23:23,890  
you can see on the left this channel

612  
00:23:27,570 --> 00:23:25,630  
leaping into the crater and another one

613  
00:23:29,610 --> 00:23:27,580

getting out on the upper right and those

614

00:23:31,620 --> 00:23:29,620

are actually the ancient rivers that are

615

00:23:33,210 --> 00:23:31,630

have been carved into the bedrock in

616

00:23:36,030 --> 00:23:33,220

through the rim into the rim and

617

00:23:40,080 --> 00:23:36,040

actually created in jezero crater so if

618

00:23:42,750 --> 00:23:40,090

you go to the next graphic 9 let's do a

619

00:23:44,730 --> 00:23:42,760

nice map of the crater so what we're

620

00:23:47,820 --> 00:23:44,740

looking at here so the gray the

621

00:23:49,530 --> 00:23:47,830

grayscale background that's just a black

622

00:23:51,180 --> 00:23:49,540

and white imagery from our satellites in

623

00:23:53,280 --> 00:23:51,190

orbit and the colors that are on top of

624

00:23:55,020 --> 00:23:53,290

that are colors from one of our

625

00:23:57,090 --> 00:23:55,030

spectrometers in orbit the cruising

626  
00:23:58,380 --> 00:23:57,100  
imaging spectrometer and the colors are

627  
00:24:00,450 --> 00:23:58,390  
telling us about different the

628  
00:24:03,390 --> 00:24:00,460  
composition of sand so if for example

629  
00:24:05,100 --> 00:24:03,400  
here Green is indicating carbonate rocks

630  
00:24:07,350 --> 00:24:05,110  
with carbonate minerals and red is

631  
00:24:08,490 --> 00:24:07,360  
telling us about olivine minerals so all

632  
00:24:10,800 --> 00:24:08,500  
of you is one of the most common

633  
00:24:13,380 --> 00:24:10,810  
minerals in basalts and basaltic lava

634  
00:24:15,270 --> 00:24:13,390  
whereas carbonate is a mineral that

635  
00:24:16,980 --> 00:24:15,280  
forms due to interview with waters you

636  
00:24:18,810 --> 00:24:16,990  
can already kind of get a sense of why

637  
00:24:20,310 --> 00:24:18,820  
we're excited about this location the

638  
00:24:22,410 --> 00:24:20,320

bullish thing in this image is this

639

00:24:24,810 --> 00:24:22,420

giant sort of fan-shaped feature that's

640

00:24:27,120 --> 00:24:24,820

actually an ancient River Delta on Mars

641

00:24:28,800 --> 00:24:27,130

this is a place where that river that's

642

00:24:30,990 --> 00:24:28,810

coming in from the upper-left floated

643

00:24:32,250 --> 00:24:31,000

into the crater I created a lake and

644

00:24:34,170 --> 00:24:32,260

then dumped all the sediment was

645

00:24:35,670 --> 00:24:34,180

carrying out into this big River Delta

646

00:24:37,890 --> 00:24:35,680

just like the mouth of the Mississippi

647

00:24:39,330 --> 00:24:37,900

River somewhere like that on earth we

648

00:24:41,160 --> 00:24:39,340

get these big Delta's forming where

649

00:24:42,930 --> 00:24:41,170

rivers flow into lakes that's what we're

650

00:24:43,630 --> 00:24:42,940

seeing here and so you can actually see

651  
00:24:45,820 --> 00:24:43,640  
the landing site

652  
00:24:47,500 --> 00:24:45,830  
the actual landing ellipse itself on top

653  
00:24:49,810 --> 00:24:47,510  
of that and so hopefully somewhere in

654  
00:24:52,690 --> 00:24:49,820  
the middle of that circle either on the

655  
00:24:54,400 --> 00:24:52,700  
Delta or just right next to it so this

656  
00:24:56,200 --> 00:24:54,410  
landing today it's exciting because we

657  
00:24:58,140 --> 00:24:56,210  
have you know really clear evidence of

658  
00:25:00,670 --> 00:24:58,150  
this ancient lake exist that we had

659  
00:25:02,650 --> 00:25:00,680  
persistent liquid water for a long

660  
00:25:04,630 --> 00:25:02,660  
enough time to create this ancient Delta

661  
00:25:06,460 --> 00:25:04,640  
to have water flow into the crater

662  
00:25:07,990 --> 00:25:06,470  
creating a lake and then overflow out

663  
00:25:11,020 --> 00:25:08,000

the other side to create that outflow

664

00:25:12,940 --> 00:25:11,030

channel we saw and not only that we see

665

00:25:15,610 --> 00:25:12,950

lots of cool mineral mineralogical

666

00:25:17,350 --> 00:25:15,620

evidence for water here too so those

667

00:25:19,240 --> 00:25:17,360

those green rocks you can see in this

668

00:25:21,850 --> 00:25:19,250

color image those are the carbonates so

669

00:25:23,260 --> 00:25:21,860

carbonates form in water and in this

670

00:25:24,490 --> 00:25:23,270

case we think that some of the

671

00:25:26,920 --> 00:25:24,500

carbonates here in particularly that

672

00:25:29,170 --> 00:25:26,930

kind of green ring behind the Delta

673

00:25:31,240 --> 00:25:29,180

might have actually formed at the shores

674

00:25:33,370 --> 00:25:31,250

of this ancient lake and that's really

675

00:25:34,660 --> 00:25:33,380

exciting because that's exactly the kind

676  
00:25:37,750 --> 00:25:34,670  
of place you would go to look for

677  
00:25:39,580 --> 00:25:37,760  
microbial bio signatures and a lake on

678  
00:25:42,220 --> 00:25:39,590  
earth in fact there are plenty of places

679  
00:25:43,870 --> 00:25:42,230  
where in this kind of Lake that's making

680  
00:25:45,940 --> 00:25:43,880  
carbonate kind of we imagine kind of

681  
00:25:48,820 --> 00:25:45,950  
white carbonates and on the edge of the

682  
00:25:50,050 --> 00:25:48,830  
lake we see microbial mats growing all

683  
00:25:52,390 --> 00:25:50,060  
along the lake shore creating

684  
00:25:54,850 --> 00:25:52,400  
stromatolites like we saw in the bio

685  
00:25:56,710 --> 00:25:54,860  
signatures graphic sort of these rocks

686  
00:25:58,870 --> 00:25:56,720  
that are created from layers and layers

687  
00:26:00,910 --> 00:25:58,880  
and layers of microbes trapping the

688  
00:26:02,230 --> 00:26:00,920

minerals in this case carbonates that's

689

00:26:04,420 --> 00:26:02,240

how we're hoping we're going to find

690

00:26:06,160 --> 00:26:04,430

we're hoping that we'll be able to study

691

00:26:08,110 --> 00:26:06,170

the the carbonates that are perhaps

692

00:26:09,790 --> 00:26:08,120

formed on the shore of an ancient lake

693

00:26:11,920 --> 00:26:09,800

we're hoping we'll be able to study the

694

00:26:13,810 --> 00:26:11,930

muds at the bottom of this ancient Delta

695

00:26:15,250 --> 00:26:13,820

the muds at the bottom of the ancient

696

00:26:17,170 --> 00:26:15,260

delts are also great for trapping

697

00:26:19,540 --> 00:26:17,180

organics and other bio signatures and so

698

00:26:20,920 --> 00:26:19,550

between the minerals in the Delta and

699

00:26:22,810 --> 00:26:20,930

the whole kind of geology of this site

700

00:26:24,880 --> 00:26:22,820

we think it's one of the best places on

701  
00:26:27,190 --> 00:26:24,890  
Mars to go look for microbial bio

702  
00:26:29,470 --> 00:26:27,200  
signatures so you can there's a lot of

703  
00:26:31,600 --> 00:26:29,480  
work on the team yeah to try to

704  
00:26:33,790 --> 00:26:31,610  
understand how we're going to explore

705  
00:26:36,340 --> 00:26:33,800  
this site so you bring up graphic 11 you

706  
00:26:38,320 --> 00:26:36,350  
can see one idea that we're about a year

707  
00:26:40,570 --> 00:26:38,330  
ago for what a traverse through this

708  
00:26:41,860 --> 00:26:40,580  
landing site might look like so of

709  
00:26:44,260 --> 00:26:41,870  
course we don't know where we're gonna

710  
00:26:45,730 --> 00:26:44,270  
land so we have kind of two ideas if we

711  
00:26:47,290 --> 00:26:45,740  
land on the left side or the right side

712  
00:26:48,550 --> 00:26:47,300  
of the crater what are some of the cool

713  
00:26:50,470 --> 00:26:48,560

places we're going to be able to go

714

00:26:53,770 --> 00:26:50,480

explore and in particular get samples

715

00:26:56,029 --> 00:26:53,780

from for eventual Mars sample return so

716

00:26:57,470 --> 00:26:56,039

we're hoping to explore the Delta

717

00:26:59,539 --> 00:26:57,480

sort of all the different parts of

718

00:27:02,149 --> 00:26:59,549

adults that we see evidence for river

719

00:27:04,100 --> 00:27:02,159

channels and you know muds and all kinds

720

00:27:06,470 --> 00:27:04,110

of different environments that used to

721

00:27:08,330 --> 00:27:06,480

exist along this ancient lake make sure

722

00:27:10,279 --> 00:27:08,340

then eventually up into the crater rim

723

00:27:12,860 --> 00:27:10,289

as well or we see science for ancient

724

00:27:15,200 --> 00:27:12,870

hydrothermal systems that could have

725

00:27:17,180 --> 00:27:15,210

also helped preserve signs of life and

726

00:27:19,789 --> 00:27:17,190

those sort of warm habitable

727

00:27:22,370 --> 00:27:19,799

environments the other cool thing we've

728

00:27:24,259 --> 00:27:22,380

been doing on the team is trying to

729

00:27:25,909 --> 00:27:24,269

learn how to do operations with this

730

00:27:28,190 --> 00:27:25,919

Rover so how do we actually run the

731

00:27:30,230 --> 00:27:28,200

rover everyday as a team so if you go to

732

00:27:33,139 --> 00:27:30,240

slide I go to a graphic 12 you can see

733

00:27:36,169 --> 00:27:33,149

an example of a simulated rover mission

734

00:27:38,060 --> 00:27:36,179

out in the desert of Utah so one of the

735

00:27:39,820 --> 00:27:38,070

ways that we sort of practice running a

736

00:27:42,019 --> 00:27:39,830

rover is we actually create a fake

737

00:27:45,230 --> 00:27:42,029

people and instruments that run around

738

00:27:47,000 --> 00:27:45,240

in the desert and take data for us and

739

00:27:49,370 --> 00:27:47,010

they send it back to the team who treats

740

00:27:52,519 --> 00:27:49,380

it like data from Mars and puts together

741

00:27:54,080 --> 00:27:52,529

plan science plans engineering plans for

742

00:27:56,330 --> 00:27:54,090

investigating this site and looking

743

00:27:58,490 --> 00:27:56,340

forward bio signatures at you know what

744

00:28:00,560 --> 00:27:58,500

we call a Mars analog site on earth so a

745

00:28:02,930 --> 00:28:00,570

site that has characteristics that are

746

00:28:05,539 --> 00:28:02,940

similar to Mars in some way this was

747

00:28:07,100 --> 00:28:05,549

also an ancient ancient Lake muds

748

00:28:10,000 --> 00:28:07,110

ancient Lake deposits that were looking

749

00:28:12,710 --> 00:28:10,010

at here in this image that we were

750

00:28:17,600 --> 00:28:12,720

pretending to explore with our people

751  
00:28:19,850 --> 00:28:17,610  
powered Rover very cool I mean you guys

752  
00:28:21,740 --> 00:28:19,860  
and so clearly there's a group building

753  
00:28:24,230 --> 00:28:21,750  
the rover but there's a group of big

754  
00:28:26,750 --> 00:28:24,240  
people figuring out what to do with it

755  
00:28:28,879 --> 00:28:26,760  
and what what where to send it and how

756  
00:28:32,450 --> 00:28:28,889  
to operate it so that's a it's a really

757  
00:28:34,820 --> 00:28:32,460  
exciting time and I think that's about

758  
00:28:37,669 --> 00:28:34,830  
all the time we have for talking with

759  
00:28:39,590 --> 00:28:37,679  
you right now Briony but we really want

760  
00:28:41,240 --> 00:28:39,600  
to wish you and your scientific

761  
00:28:43,970 --> 00:28:41,250  
colleagues on the mission the best for

762  
00:28:50,200 --> 00:28:43,980  
launch landing and roving on mars and

763  
00:28:52,850 --> 00:28:50,210

thanks for being here with us all right

764

00:28:54,110 --> 00:28:52,860

all right so and I think there's a

765

00:28:56,389 --> 00:28:54,120

little bit of a lag thank you to

766

00:28:58,940 --> 00:28:56,399

everybody for for hanging in there with

767

00:29:00,649 --> 00:28:58,950

us but I was you know connection stayed

768

00:29:02,539 --> 00:29:00,659

right right with us so we got to hear

769

00:29:07,129 --> 00:29:02,549

from her the whole time so hey that's a

770

00:29:08,560 --> 00:29:07,139

win well so earlier I mentioned the

771

00:29:11,680 --> 00:29:08,570

engineering side of

772

00:29:15,399 --> 00:29:11,690

making a Mars rover which involves a lot

773

00:29:18,820 --> 00:29:15,409

of testing and before we meet our second

774

00:29:22,330 --> 00:29:18,830

speaker we have a short video that shows

775

00:29:23,940 --> 00:29:22,340

a behind-the-scenes peek at the building

776

00:29:27,370 --> 00:29:23,950

and testing of the Mars 2020 Rover

777

00:29:56,910 --> 00:29:27,380

perseverance take a look

778

00:29:56,920 --> 00:30:52,950

[Music]

779

00:30:57,909 --> 00:30:55,720

one of the things I loved about that

780

00:31:00,280 --> 00:30:57,919

video is that you get a real sense of

781

00:31:03,220 --> 00:31:00,290

the human scale of the mission not and

782

00:31:04,780 --> 00:31:03,230

not only the physical size of the rover

783

00:31:07,030 --> 00:31:04,790

which is it's a big piece of machinery

784

00:31:09,909 --> 00:31:07,040

but a feel for all the hard-working

785

00:31:13,390 --> 00:31:09,919

humans who are behind the effort to put

786

00:31:15,520 --> 00:31:13,400

it on Mars and as part of that effort we

787

00:31:19,480 --> 00:31:15,530

have these very special places at NASA

788

00:31:21,400 --> 00:31:19,490

JPL that we call test beds and our next

789

00:31:23,140 --> 00:31:21,410

speaker is one of the humans who's

790

00:31:24,610 --> 00:31:23,150

helping to get perseverance ready for

791

00:31:26,140 --> 00:31:24,620

its mission and a couple of these test

792

00:31:28,900 --> 00:31:26,150

beds are his responsibility

793

00:31:31,270 --> 00:31:28,910

so our mentor ian is a mechanical

794

00:31:33,460 --> 00:31:31,280

engineer at JPL and he serves as the

795

00:31:37,390 --> 00:31:33,470

lead for what we call the system testbed

796

00:31:40,570 --> 00:31:37,400

for the Mars 2020 mission hey Armand hi

797

00:31:44,409 --> 00:31:40,580

Preston well tell us about your job at

798

00:31:47,350 --> 00:31:44,419

JPL what do you do yeah so I'm the

799

00:31:49,990 --> 00:31:47,360

testbed lead for the Mars 2020 system

800

00:31:51,940 --> 00:31:50,000

testbed and that's a very special place

801  
00:31:54,430 --> 00:31:51,950  
where we get to test everything from

802  
00:31:56,200 --> 00:31:54,440  
low-level ones and zeros moving around

803  
00:31:58,840 --> 00:31:56,210  
on our computer all the way up to really

804  
00:32:00,850 --> 00:31:58,850  
complicated behaviors like is the rover

805  
00:32:03,610 --> 00:32:00,860  
able to intelligently navigate on the

806  
00:32:08,140 --> 00:32:03,620  
surface of Mars or are we going to be

807  
00:32:10,690 --> 00:32:08,150  
able to land on the surface and and

808  
00:32:13,090 --> 00:32:10,700  
everything in between so it's a really

809  
00:32:18,130 --> 00:32:13,100  
special lab with a lot of exciting

810  
00:32:20,740 --> 00:32:18,140  
hardware and and testing that we do to

811  
00:32:22,120 --> 00:32:20,750  
cover all the different gamut of things

812  
00:32:22,860 --> 00:32:22,130  
we need to prove to be able to pull off

813  
00:32:26,260 --> 00:32:22,870

a mission like this

814

00:32:28,390 --> 00:32:26,270

yeah it's incredibly just a mind-numbing

815

00:32:31,570 --> 00:32:28,400

League mind-bendingly I should say

816

00:32:33,430 --> 00:32:31,580

complex stuff but you are not a rover

817

00:32:36,310 --> 00:32:33,440

newbie you worked on curiosity as well

818

00:32:38,560 --> 00:32:36,320

right well maybe you still do that's

819

00:32:40,480 --> 00:32:38,570

right no I did I worked on the curiosity

820

00:32:42,730 --> 00:32:40,490

mission first I was working as a

821

00:32:45,370 --> 00:32:42,740

mechanical engineer working on the

822

00:32:47,200 --> 00:32:45,380

actuators that drive the wheels and the

823

00:32:49,830 --> 00:32:47,210

robotic arm and all those things and

824

00:32:53,470 --> 00:32:49,840

then I worked in the testbed on the

825

00:32:55,270 --> 00:32:53,480

entry descent landing system and and now

826

00:32:58,030 --> 00:32:55,280

I'm running the lab where we're doing

827

00:32:58,840 --> 00:32:58,040

most of that testing all right well I

828

00:33:00,880 --> 00:32:58,850

asked assume

829

00:33:03,550 --> 00:33:00,890

our question to Briony earlier but I

830

00:33:05,800 --> 00:33:03,560

want to ask you as well how does one get

831

00:33:08,230 --> 00:33:05,810

to be an engineer who tests robots that

832

00:33:11,950 --> 00:33:08,240

fly to Mars how do you come to have this

833

00:33:14,290 --> 00:33:11,960

kind of job so I'm a mechanical engineer

834

00:33:16,150 --> 00:33:14,300

and also I have a degree in mechanical

835

00:33:18,520 --> 00:33:16,160

engineering and aerospace engineering

836

00:33:21,640 --> 00:33:18,530

and I've loved robots in space ever

837

00:33:23,140 --> 00:33:21,650

since I was a little kid and I knew from

838

00:33:24,670 --> 00:33:23,150

very early on that I wanted to do

839

00:33:26,620 --> 00:33:24,680

something with both of those there

840

00:33:28,950 --> 00:33:26,630

aren't that many jobs where you get to

841

00:33:32,170 --> 00:33:28,960

do that and so JPL was kind of a natural

842

00:33:33,970 --> 00:33:32,180

fit for me when I was in school I worked

843

00:33:36,090 --> 00:33:33,980

on these little things called cubes hats

844

00:33:38,470 --> 00:33:36,100

which were two tiny little satellites

845

00:33:40,650 --> 00:33:38,480

and I made a lot of connections that way

846

00:33:43,960 --> 00:33:40,660

and I did an internship here at NASA JPL

847

00:33:50,140 --> 00:33:43,970

fell in love and after I graduated I I

848

00:33:52,510 --> 00:33:50,150

applied now what is a testbed what do we

849

00:33:55,510 --> 00:33:52,520

mean by that at JPL specifically and

850

00:33:56,860 --> 00:33:55,520

what are they used for so test beds are

851  
00:33:58,990 --> 00:33:56,870  
really common in the engineering field

852  
00:34:00,430 --> 00:33:59,000  
what it means is it's a place where you

853  
00:34:04,600 --> 00:34:00,440  
can test something that you're building

854  
00:34:07,360 --> 00:34:04,610  
and these go anywhere from really low

855  
00:34:09,400 --> 00:34:07,370  
level things like computers or motors

856  
00:34:10,930 --> 00:34:09,410  
all the way up to what we call the

857  
00:34:13,360 --> 00:34:10,940  
system test beds which is a pretty

858  
00:34:16,420 --> 00:34:13,370  
unique thing that we do at JPL where we

859  
00:34:19,420 --> 00:34:16,430  
have basically all of the hardware all

860  
00:34:21,220 --> 00:34:19,430  
of the equipment and and all the parts

861  
00:34:23,980 --> 00:34:21,230  
that would go into the rover and the

862  
00:34:27,550 --> 00:34:23,990  
spacecraft all connected together and we

863  
00:34:30,550 --> 00:34:27,560

test them all as one one venue one test

864

00:34:31,780 --> 00:34:30,560

fit and so we can do things where we

865

00:34:34,330 --> 00:34:31,790

have things that interact together

866

00:34:35,770 --> 00:34:34,340

there's about 50 computers on the

867

00:34:36,940 --> 00:34:35,780

perseverance over they all have to

868

00:34:39,160 --> 00:34:36,950

talk to each other they all have to

869

00:34:41,110 --> 00:34:39,170

communicate that's really complicated

870

00:34:42,520 --> 00:34:41,120

and takes a lot of work to prove that

871

00:34:45,730 --> 00:34:42,530

all of that is going to work properly

872

00:34:49,410 --> 00:34:45,740

and so those are the types of things

873

00:34:52,180 --> 00:34:49,420

that we do in these system test beds

874

00:34:55,510 --> 00:34:52,190

okay that's it sounds like a very busy

875

00:34:56,710 --> 00:34:55,520

place why don't we go to Sara for our

876

00:35:00,760 --> 00:34:56,720

first question from our live audience

877

00:35:02,980 --> 00:35:00,770

for you Sara what he got for Arman sure

878

00:35:06,160 --> 00:35:02,990

well I'm so glad that you asked Arman

879

00:35:07,720 --> 00:35:06,170

how it is that he became a mechanical

880

00:35:09,240 --> 00:35:07,730

engineer at JPL because we had a

881

00:35:11,250 --> 00:35:09,250

question related to that

882

00:35:13,920 --> 00:35:11,260

on Facebook wanted to know if

883

00:35:15,840 --> 00:35:13,930

entry-level mechanical engineers are

884

00:35:17,790 --> 00:35:15,850

able to work on some some of these

885

00:35:20,490 --> 00:35:17,800

missions and I think I can answer that

886

00:35:22,980 --> 00:35:20,500

yes entry-level people can work do this

887

00:35:25,440 --> 00:35:22,990

important work and also lots of interns

888

00:35:26,780 --> 00:35:25,450

and JPL interns have had significant

889

00:35:29,520 --> 00:35:26,790

roles on our missions

890

00:35:32,910 --> 00:35:29,530

however the question I do want to ask

891

00:35:35,040 --> 00:35:32,920

Arman is from Rocky on YouTube he's

892

00:35:37,530 --> 00:35:35,050

wondering about the wheels how the

893

00:35:40,770 --> 00:35:37,540

wheels of perseverance were redesigned

894

00:35:42,660 --> 00:35:40,780

and how will these wheels resist some of

895

00:35:46,610 --> 00:35:42,670

the wear and tear issues that the

896

00:35:50,190 --> 00:35:46,620

Curiosity rover face in Gale Crater

897

00:35:51,810 --> 00:35:50,200

that's a great question so one of the

898

00:35:54,180 --> 00:35:51,820

test beds is something we call the

899

00:35:57,990 --> 00:35:54,190

vehicle system test bed and that's where

900

00:35:59,640 --> 00:35:58,000

we assembled basically as Preston likes

901  
00:36:03,150 --> 00:35:59,650  
to call it a stunt double of the real

902  
00:36:04,830 --> 00:36:03,160  
Rover and it is a complete Rover

903  
00:36:06,720 --> 00:36:04,840  
basically exactly what we're going to be

904  
00:36:08,550 --> 00:36:06,730  
flying but it's something that stays

905  
00:36:10,890 --> 00:36:08,560  
here on earth and we can test with it

906  
00:36:12,750 --> 00:36:10,900  
and one of the one of the places we do

907  
00:36:15,420 --> 00:36:12,760  
this testing is called the Mars yard if

908  
00:36:19,500 --> 00:36:15,430  
you bring up graphic 22 you can see a

909  
00:36:22,320 --> 00:36:19,510  
picture of that this is basically a big

910  
00:36:25,230 --> 00:36:22,330  
lot we have on the JPL campus it's like

911  
00:36:26,760 --> 00:36:25,240  
a playground for Mars rovers we have all

912  
00:36:29,580 --> 00:36:26,770  
sorts of dirt that we can push around

913  
00:36:30,990 --> 00:36:29,590

with tractors make Hills and of

914

00:36:33,210 --> 00:36:31,000

different grades and different materials

915

00:36:36,000 --> 00:36:33,220

we have rocks that we can place as

916

00:36:38,040 --> 00:36:36,010

obstacles and and for the rover to

917

00:36:40,500 --> 00:36:38,050

navigate around and we do a lot of our

918

00:36:42,540 --> 00:36:40,510

testing here and one of the things we

919

00:36:44,430 --> 00:36:42,550

found with the Curiosity rover is the

920

00:36:47,210 --> 00:36:44,440

wheels are designed to be really

921

00:36:50,250 --> 00:36:47,220

lightweight and strong but we definitely

922

00:36:52,290 --> 00:36:50,260

underestimated the sharpness and the

923

00:36:54,510 --> 00:36:52,300

hardness of the rocks on the surface at

924

00:36:56,190 --> 00:36:54,520

some spots and so we started getting

925

00:36:58,380 --> 00:36:56,200

holes in these rocks like Swiss cheese

926  
00:37:00,180 --> 00:36:58,390  
after a while and you know curiosity's

927  
00:37:01,920 --> 00:37:00,190  
been on Mars for a long time now and so

928  
00:37:04,050 --> 00:37:01,930  
the wheels still work they work great

929  
00:37:06,330 --> 00:37:04,060  
but but they are starting to get worn

930  
00:37:07,820 --> 00:37:06,340  
out so there was a big redesign effort

931  
00:37:11,970 --> 00:37:07,830  
that was done for the perseverance

932  
00:37:14,160 --> 00:37:11,980  
mission and and one of the things we

933  
00:37:15,930 --> 00:37:14,170  
used other than trying a bunch of

934  
00:37:19,680 --> 00:37:15,940  
different tread patterns and thicknesses

935  
00:37:22,080 --> 00:37:19,690  
and materials we pull up picture 17 we

936  
00:37:23,820 --> 00:37:22,090  
have this rover that's also

937  
00:37:26,100 --> 00:37:23,830  
test but not assistant testbed but this

938  
00:37:29,190 --> 00:37:26,110

one's called the Scarecrow and what this

939

00:37:31,110 --> 00:37:29,200

is used for is practicing driving around

940

00:37:33,240 --> 00:37:31,120

including understanding the wear on the

941

00:37:34,830 --> 00:37:33,250

wheels and the reason it looks like this

942

00:37:37,650 --> 00:37:34,840

and the reason we call it the Scarecrow

943

00:37:41,220 --> 00:37:37,660

is because it has no brain but it is not

944

00:37:43,530 --> 00:37:41,230

the complicated vstb that I'm talking

945

00:37:47,070 --> 00:37:43,540

about that we're currently building it's

946

00:37:49,790 --> 00:37:47,080

a much simpler Rover but it behaves like

947

00:37:52,170 --> 00:37:49,800

what the real Rover will on Mars so

948

00:37:54,000 --> 00:37:52,180

gravity is different on earth versus on

949

00:37:55,710 --> 00:37:54,010

Mars it's about three eighths of what it

950

00:37:59,700 --> 00:37:55,720

is on earth everything is much lighter

951  
00:38:01,830 --> 00:37:59,710  
there so if we drove around our V STD on

952  
00:38:03,750 --> 00:38:01,840  
in this Mars yard it's not really gonna

953  
00:38:07,230 --> 00:38:03,760  
perform the same way as the real Rover

954  
00:38:09,420 --> 00:38:07,240  
will this is much lighter the mobility

955  
00:38:11,610 --> 00:38:09,430  
system is stiffer and overbuilt so it

956  
00:38:13,620 --> 00:38:11,620  
acts a lot more like the real Rover

957  
00:38:16,320 --> 00:38:13,630  
below Mars and so this is some of the

958  
00:38:18,000 --> 00:38:16,330  
testing that we've done to end up with

959  
00:38:21,540 --> 00:38:18,010  
the the wheel design that we have for

960  
00:38:23,520 --> 00:38:21,550  
this mission I've been here four years

961  
00:38:24,750 --> 00:38:23,530  
and I still think it's super cool that

962  
00:38:28,320 --> 00:38:24,760  
we have a place called the Mars yard

963  
00:38:31,050 --> 00:38:28,330

this just is so neat and just to clarify

964

00:38:33,770 --> 00:38:31,060

I think you said it but vstb answer it's

965

00:38:38,190 --> 00:38:33,780

a vehicle system testbed that's right

966

00:38:40,440 --> 00:38:38,200

okay so that's that's one important

967

00:38:42,330 --> 00:38:40,450

testbed but there are several others at

968

00:38:45,240 --> 00:38:42,340

NASA JPL for the work that you're

969

00:38:47,910 --> 00:38:45,250

involved in right that's correct we have

970

00:38:50,490 --> 00:38:47,920

a couple other test beds that we use for

971

00:38:52,920 --> 00:38:50,500

all of the other type of testing so

972

00:38:54,900 --> 00:38:52,930

whereas the vehicle system test that

973

00:38:57,800 --> 00:38:54,910

focuses on things like driving and

974

00:39:00,570 --> 00:38:57,810

eventually on drilling core samples and

975

00:39:03,240 --> 00:39:00,580

all of those types of surface related

976  
00:39:05,190 --> 00:39:03,250  
things testing out instruments we have

977  
00:39:07,020 --> 00:39:05,200  
another test testbed called the mission

978  
00:39:09,390 --> 00:39:07,030  
system testbed that's much more focused

979  
00:39:13,020 --> 00:39:09,400  
on getting to Mars so we have all of the

980  
00:39:15,660 --> 00:39:13,030  
hardware from the computers to the power

981  
00:39:18,060 --> 00:39:15,670  
assemblies and the sensors that we're

982  
00:39:20,930 --> 00:39:18,070  
going to use to navigate to Mars and

983  
00:39:24,030 --> 00:39:20,940  
then pull off the landing on Mars and

984  
00:39:25,410 --> 00:39:24,040  
the interesting thing there is we in

985  
00:39:27,660 --> 00:39:25,420  
addition to having all of that hardware

986  
00:39:30,510 --> 00:39:27,670  
we also have all of these what we call

987  
00:39:32,690 --> 00:39:30,520  
simulation support equipment so that

988  
00:39:35,880 --> 00:39:32,700

hardware which is all sitting on a bench

989

00:39:37,920 --> 00:39:35,890

is not very useful if you're

990

00:39:39,660 --> 00:39:37,930

star scanners pointed at a wall and her

991

00:39:41,250 --> 00:39:39,670

cameras are pointed at a wall and you

992

00:39:42,900 --> 00:39:41,260

know you're not you're measuring the

993

00:39:44,430 --> 00:39:42,910

gravity of Earth instead of what you're

994

00:39:46,440 --> 00:39:44,440

measuring as you're entering the

995

00:39:49,470 --> 00:39:46,450

atmosphere so we have all of these

996

00:39:51,779 --> 00:39:49,480

simulations running that pretend to be

997

00:39:53,309 --> 00:39:51,789

those environments and all of those

998

00:39:55,920 --> 00:39:53,319

simulations are connected to the

999

00:39:57,420 --> 00:39:55,930

hardware so we can do things like do

1000

00:39:59,789 --> 00:39:57,430

trial runs of entry descent landing

1001  
00:40:01,289 --> 00:39:59,799  
where we have a gravity model and an

1002  
00:40:02,910 --> 00:40:01,299  
atmosphere model and all these things

1003  
00:40:04,620 --> 00:40:02,920  
that are keeping track of the

1004  
00:40:06,539 --> 00:40:04,630  
theoretical position of this spacecraft

1005  
00:40:08,460 --> 00:40:06,549  
as it's coming into the atmosphere and

1006  
00:40:10,349 --> 00:40:08,470  
then feeding that information back into

1007  
00:40:12,630 --> 00:40:10,359  
the sensors so the star scanner will

1008  
00:40:14,220 --> 00:40:12,640  
actually see the stars that we think it

1009  
00:40:17,099 --> 00:40:14,230  
will see when it's on its way there or

1010  
00:40:19,170 --> 00:40:17,109  
the landing radar will actually get

1011  
00:40:20,700 --> 00:40:19,180  
radio waves as if it's seeing the

1012  
00:40:23,099 --> 00:40:20,710  
surface of Mars but really is just

1013  
00:40:25,140 --> 00:40:23,109

coming out of a rack of computers and so

1014

00:40:27,870 --> 00:40:25,150

not only can we test the computers that

1015

00:40:29,730 --> 00:40:27,880

are enabling all this to happen but

1016

00:40:32,250 --> 00:40:29,740

we're also testing those computers

1017

00:40:34,950 --> 00:40:32,260

talking to the sensors that are going to

1018

00:40:36,539 --> 00:40:34,960

be enabling this mission and so that's

1019

00:40:39,089 --> 00:40:36,549

what makes these system test beds very

1020

00:40:41,220 --> 00:40:39,099

special is that we have everything there

1021

00:40:44,279 --> 00:40:41,230

and we have all of these simulations

1022

00:40:45,779 --> 00:40:44,289

that let us make the hardware pretend

1023

00:40:48,509 --> 00:40:45,789

like it's any at any point in the

1024

00:40:49,920 --> 00:40:48,519

mission and we do hundreds and thousands

1025

00:40:52,410 --> 00:40:49,930

of different tests and different

1026

00:40:54,029 --> 00:40:52,420

varieties of iterations of those tests

1027

00:40:57,990 --> 00:40:54,039

to make sure we understand how it's

1028

00:40:59,609 --> 00:40:58,000

going to behave and can I just poke at

1029

00:41:02,130 --> 00:40:59,619

that a little bit more I thought it was

1030

00:41:05,160 --> 00:41:02,140

when we first talked about your work a

1031

00:41:07,259 --> 00:41:05,170

few weeks ago I thought it's fascinating

1032

00:41:09,569 --> 00:41:07,269

that you're able to use use these

1033

00:41:12,480 --> 00:41:09,579

systems as sort of like flight

1034

00:41:14,430 --> 00:41:12,490

simulators Mars rover addition for the

1035

00:41:16,980 --> 00:41:14,440

team as well right you can do

1036

00:41:19,859 --> 00:41:16,990

simulations for your your team and the

1037

00:41:22,440 --> 00:41:19,869

the operations folks and how they're

1038

00:41:24,839 --> 00:41:22,450

going to how they're going to operate

1039

00:41:27,329 --> 00:41:24,849

the mission but you can also do

1040

00:41:29,759 --> 00:41:27,339

simulations for them to kind of run run

1041

00:41:30,630 --> 00:41:29,769

the team through their paces right sure

1042

00:41:33,480 --> 00:41:30,640

absolutely

1043

00:41:35,670 --> 00:41:33,490

as we heard in bryony's section there's

1044

00:41:37,769 --> 00:41:35,680

a lot of planning that happens to get

1045

00:41:39,930 --> 00:41:37,779

the team ready for these missions there

1046

00:41:42,420 --> 00:41:39,940

it's just a really complicated machine

1047

00:41:43,799 --> 00:41:42,430

and learning how to operate it and and

1048

00:41:45,509 --> 00:41:43,809

planning out what it's going to do today

1049

00:41:47,670 --> 00:41:45,519

day to day it's very complicated

1050

00:41:48,420 --> 00:41:47,680

so one of the things we do with these

1051  
00:41:52,050 --> 00:41:48,430  
test beds

1052  
00:41:53,820 --> 00:41:52,060  
is we have the operations team that's in

1053  
00:41:55,350 --> 00:41:53,830  
the building they're gonna be in when

1054  
00:41:57,120 --> 00:41:55,360  
they're running the mission

1055  
00:42:00,060 --> 00:41:57,130  
like for example launch we're preparing

1056  
00:42:03,810 --> 00:42:00,070  
for coming up soon and landing and other

1057  
00:42:06,060 --> 00:42:03,820  
key activities and we use the test beds

1058  
00:42:09,150 --> 00:42:06,070  
to simulate the real spacecraft so that

1059  
00:42:10,740 --> 00:42:09,160  
testbed the the ops team is flying that

1060  
00:42:12,480 --> 00:42:10,750  
testbed instead of the real thing

1061  
00:42:14,220 --> 00:42:12,490  
from their point of view it looks very

1062  
00:42:16,230 --> 00:42:14,230  
similar in fact in some ways it looks

1063  
00:42:18,570 --> 00:42:16,240

identical and so we can do things like

1064

00:42:20,700 --> 00:42:18,580

practice their decision making ability

1065

00:42:22,050 --> 00:42:20,710

we can do things like practice timing of

1066

00:42:23,820 --> 00:42:22,060

different events that are going to

1067

00:42:26,310 --> 00:42:23,830

happen sending commands and getting

1068

00:42:28,980 --> 00:42:26,320

telemetry back and and we even do off

1069

00:42:30,570 --> 00:42:28,990

nominal operational readiness test where

1070

00:42:32,400 --> 00:42:30,580

we have a whole team that's just

1071

00:42:34,440 --> 00:42:32,410

creating problems for the ops team to

1072

00:42:36,360 --> 00:42:34,450

solve they don't know what they are and

1073

00:42:37,740 --> 00:42:36,370

we have to make it seem like something

1074

00:42:40,710 --> 00:42:37,750

went wrong and they have to figure out

1075

00:42:45,180 --> 00:42:40,720

how to how to fix it so so it's a very

1076

00:42:47,310 --> 00:42:45,190

valuable resource for us very cool so

1077

00:42:49,350 --> 00:42:47,320

Sara I think we have another question

1078

00:42:51,470 --> 00:42:49,360

from our live audience forearm and why

1079

00:42:55,470 --> 00:42:51,480

don't you go ahead

1080

00:42:58,170 --> 00:42:55,480

sure Manesh on YouTube is wondering what

1081

00:43:00,450 --> 00:42:58,180

the biggest challenges are to designing

1082

00:43:03,060 --> 00:43:00,460

a vehicle that can function on a foreign

1083

00:43:04,950 --> 00:43:03,070

planet so maybe you can speak to the

1084

00:43:09,630 --> 00:43:04,960

conditions on Mars that these Rovers

1085

00:43:12,660 --> 00:43:09,640

have to face sure there are a lot of

1086

00:43:14,340 --> 00:43:12,670

different challenges and every planet in

1087

00:43:16,650 --> 00:43:14,350

the solar system has its own unique set

1088

00:43:19,080 --> 00:43:16,660

of challenges so what what I'm saying

1089

00:43:20,460 --> 00:43:19,090

will apply to Mars but you know there's

1090

00:43:22,020 --> 00:43:20,470

a whole other set of challenges for

1091

00:43:23,880 --> 00:43:22,030

other missions that are going to moons

1092

00:43:26,700 --> 00:43:23,890

of Jupiter and other places in the solar

1093

00:43:29,310 --> 00:43:26,710

system but one of the things some things

1094

00:43:31,590 --> 00:43:29,320

are universal obviously you don't have

1095

00:43:34,200 --> 00:43:31,600

air and even on the surface of Mars we

1096

00:43:35,700 --> 00:43:34,210

only have an atmosphere that's 1% as

1097

00:43:37,980 --> 00:43:35,710

thick as what we have on earth so

1098

00:43:39,630 --> 00:43:37,990

there's almost no air you don't really

1099

00:43:41,760 --> 00:43:39,640

think about it but air moves a lot of

1100

00:43:43,890 --> 00:43:41,770

heat and so getting heat out of your

1101  
00:43:46,680 --> 00:43:43,900  
electronics and out of your computers

1102  
00:43:48,480 --> 00:43:46,690  
can be trickier so we have pumps that

1103  
00:43:51,660 --> 00:43:48,490  
actually pump fluid through the rover to

1104  
00:43:54,510 --> 00:43:51,670  
cool it down and things like that also

1105  
00:43:57,660 --> 00:43:54,520  
the dust on Mars is very fine

1106  
00:44:01,020 --> 00:43:57,670  
it gets in everything and so all our

1107  
00:44:01,590 --> 00:44:01,030  
gear boxes and and motors and all those

1108  
00:44:02,880 --> 00:44:01,600  
things that

1109  
00:44:05,610 --> 00:44:02,890  
need to move and do all these

1110  
00:44:07,500 --> 00:44:05,620  
complicated activities need to be

1111  
00:44:10,140 --> 00:44:07,510  
designed to be able to withstand that

1112  
00:44:11,670 --> 00:44:10,150  
and along with that temperature Mars

1113  
00:44:15,510 --> 00:44:11,680

gets really really cold and really

1114

00:44:18,510 --> 00:44:15,520

really hot - none of us would survive

1115

00:44:20,070 --> 00:44:18,520

even a minute on the surface so we have

1116

00:44:22,830 --> 00:44:20,080

to design all of this hardware to be

1117

00:44:24,680 --> 00:44:22,840

able to work things like lubricants like

1118

00:44:27,330 --> 00:44:24,690

the oil you put in your car would freeze

1119

00:44:29,550 --> 00:44:27,340

at night on Mars and so we have to

1120

00:44:32,100 --> 00:44:29,560

develop special lubricants to use in the

1121

00:44:34,080 --> 00:44:32,110

gearboxes so there's all these unique

1122

00:44:36,030 --> 00:44:34,090

challenges radiation another one of them

1123

00:44:38,790 --> 00:44:36,040

your cell phone would last maybe a day

1124

00:44:41,400 --> 00:44:38,800

up there we have to design all these

1125

00:44:43,110 --> 00:44:41,410

computers to withstand radiation so

1126

00:44:45,390 --> 00:44:43,120

there are a lot of unique challenges to

1127

00:44:47,160 --> 00:44:45,400

designing something that works in space

1128

00:44:48,720 --> 00:44:47,170

or works on another planet but I think

1129

00:44:54,660 --> 00:44:48,730

that's one of the funnest parts of being

1130

00:44:56,610 --> 00:44:54,670

an engineer working in this field and

1131

00:44:59,940 --> 00:44:56,620

Sarah you had another follow-up question

1132

00:45:01,530 --> 00:44:59,950

to go with that you know well it wasn't

1133

00:45:03,420 --> 00:45:01,540

exactly a follow-up question but it's a

1134

00:45:05,070 --> 00:45:03,430

question I've heard a lot before and I

1135

00:45:07,980 --> 00:45:05,080

thought perhaps Armen could answer it

1136

00:45:10,080 --> 00:45:07,990

it's a common one so it's high flyer and

1137

00:45:12,060 --> 00:45:10,090

YouTube is wondering how fast the

1138

00:45:16,920 --> 00:45:12,070

perseverance Wilbur will be able to move

1139

00:45:18,930 --> 00:45:16,930

on Mars so that's a really good question

1140

00:45:21,060 --> 00:45:18,940

and if you when things get back to

1141

00:45:22,800 --> 00:45:21,070

normal if you come and visit JPL on one

1142

00:45:24,960 --> 00:45:22,810

of the tours you'll see you might see

1143

00:45:27,960 --> 00:45:24,970

this rover driving around into Mars yard

1144

00:45:30,750 --> 00:45:27,970

our test rover and as you notice in some

1145

00:45:34,050 --> 00:45:30,760

of these videos everything is sped up so

1146

00:45:36,930 --> 00:45:34,060

everything is done really slowly I think

1147

00:45:39,060 --> 00:45:36,940

on Mars Science Lab I'm reaching back so

1148

00:45:40,800 --> 00:45:39,070

if I get this wrong don't hold it

1149

00:45:43,350 --> 00:45:40,810

against me but I think we were driving

1150

00:45:45,720 --> 00:45:43,360

about a hundred feet or so a day and I

1151

00:45:47,190 --> 00:45:45,730

think we're expecting to double that it

1152

00:45:50,820 --> 00:45:47,200

doesn't seem like a lot but you have to

1153

00:45:53,400 --> 00:45:50,830

factor in that the rover has to do all

1154

00:45:57,320 --> 00:45:53,410

this autonomously meaning we have no

1155

00:45:59,850 --> 00:45:57,330

intervention it takes it can take

1156

00:46:01,650 --> 00:45:59,860

between 14 minutes to half an hour just

1157

00:46:03,690 --> 00:46:01,660

to get a signal to Mars and then the

1158

00:46:05,070 --> 00:46:03,700

same amount of time to come back so we

1159

00:46:07,140 --> 00:46:05,080

can't drive this thing like a

1160

00:46:09,150 --> 00:46:07,150

remote-control car it has to take

1161

00:46:11,400 --> 00:46:09,160

pictures of its surroundings it has to

1162

00:46:13,140 --> 00:46:11,410

process those images and create 3d maps

1163

00:46:15,029 --> 00:46:13,150

of where all the hazards are

1164

00:46:16,859 --> 00:46:15,039

all the rocks all the cliffs all of that

1165

00:46:20,160 --> 00:46:16,869

stuff it has to decide what the best

1166

00:46:22,289 --> 00:46:20,170

path forward is and then it has to drive

1167

00:46:26,279 --> 00:46:22,299

and stop and do that all over again so

1168

00:46:27,720 --> 00:46:26,289

to improve the driving performance one

1169

00:46:30,029 --> 00:46:27,730

of the things we did was add a whole

1170

00:46:31,920 --> 00:46:30,039

nother computer which is called the

1171

00:46:34,380 --> 00:46:31,930

vision compute element it's basically a

1172

00:46:37,109 --> 00:46:34,390

really powerful graphics card it's going

1173

00:46:38,609 --> 00:46:37,119

to process those images for us and we'll

1174

00:46:41,670 --> 00:46:38,619

be able to drive much much faster than

1175

00:46:46,849 --> 00:46:41,680

or cover much more distance than we did

1176

00:46:52,440 --> 00:46:46,859

on the curiosity mission you know

1177

00:46:56,250 --> 00:46:52,450

getting speeding not likely not by our

1178

00:46:58,440 --> 00:46:56,260

standards but you know we don't we don't

1179

00:47:00,059 --> 00:46:58,450

have to do things quickly either we

1180

00:47:03,170 --> 00:47:00,069

don't really get a chance to go and fix

1181

00:47:05,940 --> 00:47:03,180

stuff if we get it wrong so we get to

1182

00:47:08,339 --> 00:47:05,950

command this thing once a day usually

1183

00:47:10,500 --> 00:47:08,349

and we get telemetry back once a day and

1184

00:47:14,039 --> 00:47:10,510

so we have plenty of time to do things

1185

00:47:15,599 --> 00:47:14,049

nice and slow patience is a virtue all

1186

00:47:20,549 --> 00:47:15,609

right let's not get any speeding tickets

1187

00:47:22,589 --> 00:47:20,559

on Mars so Arman you also told me about

1188

00:47:25,710 --> 00:47:22,599

a thing that you guys do called

1189

00:47:27,920 --> 00:47:25,720

shadowing supporting the operations team

1190

00:47:31,789 --> 00:47:27,930

right can you tell us what that is

1191

00:47:34,410 --> 00:47:31,799

sure shadowing what we refer to as

1192

00:47:37,019 --> 00:47:34,420

mirroring or following along with what

1193

00:47:38,730 --> 00:47:37,029

the real spacecraft is doing we're

1194

00:47:40,500 --> 00:47:38,740

getting ready to do that for launch in a

1195

00:47:44,190 --> 00:47:40,510

few weeks here in about a month here and

1196

00:47:46,710 --> 00:47:44,200

and so the idea there is that the

1197

00:47:48,269 --> 00:47:46,720

twofold one we all want any surprises

1198

00:47:50,220 --> 00:47:48,279

with any commands we send to the

1199

00:47:53,400 --> 00:47:50,230

spacecraft we want to know that whatever

1200

00:47:55,079 --> 00:47:53,410

we send we've tried out in these test

1201  
00:47:56,819 --> 00:47:55,089  
beds and we know how the system is going

1202  
00:47:59,940 --> 00:47:56,829  
to behave and that everything's going to

1203  
00:48:01,680 --> 00:47:59,950  
work the way we expect so in one sense

1204  
00:48:02,849 --> 00:48:01,690  
we'll send commands here before we send

1205  
00:48:04,410 --> 00:48:02,859  
them in real-life make sure they're

1206  
00:48:07,410 --> 00:48:04,420  
doing what we what we think they should

1207  
00:48:10,200 --> 00:48:07,420  
and then the other hand we want to be

1208  
00:48:13,140 --> 00:48:10,210  
ready to debug any problems that might

1209  
00:48:15,930 --> 00:48:13,150  
come up let's say we get up in space and

1210  
00:48:18,059 --> 00:48:15,940  
we don't see any stars or we aren't in

1211  
00:48:19,769 --> 00:48:18,069  
the right orientation exactly or

1212  
00:48:22,829 --> 00:48:19,779  
something is not working right or a

1213  
00:48:25,140 --> 00:48:22,839

computer resets we don't want to spend

1214

00:48:26,850 --> 00:48:25,150

hours getting the testbed set up to be

1215

00:48:29,520 --> 00:48:26,860

able to debug that problem

1216

00:48:31,260 --> 00:48:29,530

so we're following along in lockstep

1217

00:48:32,640 --> 00:48:31,270

with the real mission and as soon as

1218

00:48:34,890 --> 00:48:32,650

something happens we have a team ready

1219

00:48:38,790 --> 00:48:34,900

to go that can just jump in and start

1220

00:48:41,190 --> 00:48:38,800

working those anomalies I thought that

1221

00:48:42,600 --> 00:48:41,200

was a particularly neat capability that

1222

00:48:45,750 --> 00:48:42,610

you you don't you don't want to waste

1223

00:48:48,200 --> 00:48:45,760

the time spinning up to get ready to to

1224

00:48:51,150 --> 00:48:48,210

figure out what to do you're ready to go

1225

00:48:53,220 --> 00:48:51,160

can you talk a little bit about some of

1226

00:48:55,290 --> 00:48:53,230

the activities that that you and your

1227

00:48:57,720 --> 00:48:55,300

team have done in in preparation for

1228

00:48:59,250 --> 00:48:57,730

Mars 2020 you talked about some of the

1229

00:49:01,440 --> 00:48:59,260

capabilities in these different test

1230

00:49:03,360 --> 00:49:01,450

beds but but so many specific things

1231

00:49:04,770 --> 00:49:03,370

that you guys have have done while

1232

00:49:08,850 --> 00:49:04,780

you're preparing for the mission or

1233

00:49:10,980 --> 00:49:08,860

testing it out yeah I think the two big

1234

00:49:12,690 --> 00:49:10,990

ones right now or we're building the the

1235

00:49:14,940 --> 00:49:12,700

vehicle system testbed that I talked

1236

00:49:16,680 --> 00:49:14,950

about so that's going to be the stunt

1237

00:49:19,230 --> 00:49:16,690

double of the rover and we're having

1238

00:49:21,870 --> 00:49:19,240

that come online later this year that's

1239

00:49:23,880 --> 00:49:21,880

a huge effort obviously it's in many

1240

00:49:25,590 --> 00:49:23,890

ways just as complicated as a real Rover

1241

00:49:27,180 --> 00:49:25,600

we don't have to take the same

1242

00:49:29,910 --> 00:49:27,190

cleanliness precautions and things like

1243

00:49:32,400 --> 00:49:29,920

that but it's still complicated and then

1244

00:49:35,490 --> 00:49:32,410

the operational readiness test I talked

1245

00:49:37,200 --> 00:49:35,500

about the anomalous one where we were

1246

00:49:39,570 --> 00:49:37,210

throwing problems at the operations team

1247

00:49:42,090 --> 00:49:39,580

that was a big milestone to show that

1248

00:49:44,240 --> 00:49:42,100

our infrastructure and our team and our

1249

00:49:46,890 --> 00:49:44,250

management is all ready to react and and

1250

00:49:50,970 --> 00:49:46,900

take on any challenges that we might we

1251  
00:49:52,970 --> 00:49:50,980  
might be faced with I have no doubt that

1252  
00:49:55,350 --> 00:49:52,980  
you guys will be will be ready to go

1253  
00:49:57,960 --> 00:49:55,360  
Sarah we have time for a couple more

1254  
00:50:02,550 --> 00:49:57,970  
audience questions what do you got from

1255  
00:50:06,270 --> 00:50:02,560  
from Facebook and YouTube for us sure

1256  
00:50:10,110 --> 00:50:06,280  
let's see we have this one from ask NASA

1257  
00:50:12,150 --> 00:50:10,120  
I think this is Astro Boy who is

1258  
00:50:15,330 --> 00:50:12,160  
wondering how long this Mars mission

1259  
00:50:17,910 --> 00:50:15,340  
will last does it last until the rover

1260  
00:50:18,960 --> 00:50:17,920  
collects all its samples and the data or

1261  
00:50:24,530 --> 00:50:18,970  
does it keep going

1262  
00:50:29,700 --> 00:50:28,170  
like so we like to keep our robberies

1263  
00:50:31,320 --> 00:50:29,710

going as long as possible you know the

1264

00:50:33,480 --> 00:50:31,330

opportunity Rover was supposed to last

1265

00:50:36,480 --> 00:50:33,490

90 days ended up lasting more than 11

1266

00:50:38,910 --> 00:50:36,490

years because of the amazing engineer

1267

00:50:39,980 --> 00:50:38,920

engineering work done at JPL so this

1268

00:50:41,660 --> 00:50:39,990

Rover

1269

00:50:43,430 --> 00:50:41,670

you know actually both the Curiosity

1270

00:50:45,349 --> 00:50:43,440

rover and the perseverance rover do you

1271

00:50:47,960 --> 00:50:45,359

have sort of a limited life because they

1272

00:50:50,710 --> 00:50:47,970

are actually nuclear-powered they run

1273

00:50:52,970 --> 00:50:50,720

using a radio thermal generator an RTG

1274

00:50:55,099 --> 00:50:52,980

basically with the radioactive decay of

1275

00:50:56,900 --> 00:50:55,109

reactive materials on the inside that

1276

00:50:59,180 --> 00:50:56,910

drives a heat engine which drives

1277

00:51:01,789 --> 00:50:59,190

electricity for the for the Rovers and

1278

00:51:03,769 --> 00:51:01,799

you know those materials decay over time

1279

00:51:06,559 --> 00:51:03,779

so eventually you actually do run out of

1280

00:51:08,240 --> 00:51:06,569

energy for the Curiosity rover or we're

1281

00:51:09,980 --> 00:51:08,250

hoping it'll keep going for at least

1282

00:51:11,509 --> 00:51:09,990

another three or four years and we're

1283

00:51:13,670 --> 00:51:11,519

hoping perseverance will last just as

1284

00:51:16,400 --> 00:51:13,680

long so we're hoping we'll get you know

1285

00:51:18,109 --> 00:51:16,410

we have to last a Mars year but we're

1286

00:51:19,700 --> 00:51:18,119

hoping we'll get a lot more of that from

1287

00:51:21,799 --> 00:51:19,710

the rover we're actually hoping we'll

1288

00:51:23,870 --> 00:51:21,809

get to drive out of jezero crater on to

1289

00:51:25,970 --> 00:51:23,880

the surrounding areas around which

1290

00:51:31,759 --> 00:51:25,980

there's lots of even even better geology

1291

00:51:33,890 --> 00:51:31,769

beyond the crater itself yeah we're not

1292

00:51:36,349 --> 00:51:33,900

gonna pull the plug on this thing so as

1293

00:51:42,410 --> 00:51:36,359

long as it's working we plan to keep

1294

00:51:46,279 --> 00:51:42,420

driving it alright Sarah you got another

1295

00:51:47,440 --> 00:51:46,289

question for up for for Armen didn't I

1296

00:51:51,230 --> 00:51:47,450

do I do

1297

00:51:53,509 --> 00:51:51,240

Ben you mean on Facebook is asking so

1298

00:51:56,870 --> 00:51:53,519

which systems on the rover have

1299

00:51:59,019 --> 00:51:56,880

redundancy to improve reliability sounds

1300

00:52:02,720 --> 00:51:59,029

like kind of a good engineering question

1301

00:52:03,980 --> 00:52:02,730

that is a great question and if anyone's

1302

00:52:06,319 --> 00:52:03,990

wondering what we're done in C means it

1303

00:52:10,190 --> 00:52:06,329

just means backups we have backups for

1304

00:52:13,160 --> 00:52:10,200

almost everything so we have yep we have

1305

00:52:16,400 --> 00:52:13,170

backup plans and backup hardware we have

1306

00:52:18,740 --> 00:52:16,410

two computers on on the rover

1307

00:52:21,380 --> 00:52:18,750

they both are equally capable of doing

1308

00:52:24,140 --> 00:52:21,390

the job we only need one so if we ever

1309

00:52:26,650 --> 00:52:24,150

have a problem we can swap that we also

1310

00:52:29,269 --> 00:52:26,660

have backups for a lot of the power

1311

00:52:30,950 --> 00:52:29,279

hardware that will turn devices on and

1312

00:52:32,569 --> 00:52:30,960

off and collect all sorts of information

1313

00:52:34,249 --> 00:52:32,579

about the health of the rover like

1314

00:52:35,450 --> 00:52:34,259

temperatures and voltages and things

1315

00:52:38,990 --> 00:52:35,460

like that

1316

00:52:40,910 --> 00:52:39,000

we have backups of some sensors like we

1317

00:52:43,759 --> 00:52:40,920

have an inertial measurement unit that

1318

00:52:47,269 --> 00:52:43,769

can measure the like the compass in your

1319

00:52:49,309 --> 00:52:47,279

iPhone or smartphone and measure the

1320

00:52:52,249 --> 00:52:49,319

orientation of the rover and so we have

1321

00:52:53,050 --> 00:52:52,259

two of those and a lot of the

1322

00:52:55,030 --> 00:52:53,060

instruments have

1323

00:52:57,190 --> 00:52:55,040

an A and a beast died so we can talk to

1324

00:52:59,260 --> 00:52:57,200

them from either computer so there's

1325

00:53:02,380 --> 00:52:59,270

there's a lot of redundancy all over the

1326

00:53:05,410 --> 00:53:02,390

system and and that's part of why these

1327

00:53:07,600 --> 00:53:05,420

test campaigns are so thorough and takes

1328

00:53:09,610 --> 00:53:07,610

so much time and effort because all that

1329

00:53:11,260 --> 00:53:09,620

redundancy is complicated and and the

1330

00:53:14,950 --> 00:53:11,270

interactions are complicated and we test

1331

00:53:17,680 --> 00:53:14,960

all of it yeah our Armen I want to jump

1332

00:53:19,780 --> 00:53:17,690

in and kind of wrap up with you by

1333

00:53:23,170 --> 00:53:19,790

asking something I kind of missed or

1334

00:53:25,570 --> 00:53:23,180

earlier in our talk was that the testing

1335

00:53:27,520 --> 00:53:25,580

is a really important part of our

1336

00:53:29,650 --> 00:53:27,530

culture at NASA JPL it's something that

1337

00:53:32,470 --> 00:53:29,660

we do we believe very strongly in

1338

00:53:34,180 --> 00:53:32,480

testing testing testing why is it so

1339

00:53:35,380 --> 00:53:34,190

important and why is it such a big part

1340

00:53:40,930 --> 00:53:35,390

of our work

1341

00:53:42,790 --> 00:53:40,940

I think testing is really important for

1342

00:53:44,440 --> 00:53:42,800

the aerospace field in general

1343

00:53:47,770 --> 00:53:44,450

especially anything leaving this planet

1344

00:53:50,200 --> 00:53:47,780

because it's not like other devices that

1345

00:53:53,080 --> 00:53:50,210

are engineered to work here you can't go

1346

00:53:54,760 --> 00:53:53,090

and fix something if it breaks you can't

1347

00:53:56,800 --> 00:53:54,770

go and improve something if you didn't

1348

00:53:58,750 --> 00:53:56,810

design it well enough we have to plan

1349

00:54:00,700 --> 00:53:58,760

for every contingency we spend a lot of

1350

00:54:02,770 --> 00:54:00,710

time understanding the environment that

1351

00:54:05,530 --> 00:54:02,780

this Rover has to operate in and

1352

00:54:08,080 --> 00:54:05,540

spacecraft has to operate in and we do

1353

00:54:10,480 --> 00:54:08,090

our best to design something that will

1354

00:54:12,070 --> 00:54:10,490

will work in that environment but you

1355

00:54:13,990 --> 00:54:12,080

don't really know until you test it and

1356

00:54:16,240 --> 00:54:14,000

the level of testing that we go through

1357

00:54:18,550 --> 00:54:16,250

I think is extraordinary and I think

1358

00:54:20,770 --> 00:54:18,560

that's a big reason why why we've been

1359

00:54:22,660 --> 00:54:20,780

as successful as we have been because

1360

00:54:24,580 --> 00:54:22,670

everything gets tested like I said from

1361

00:54:26,380 --> 00:54:24,590

the lowest level down to like the parts

1362

00:54:28,150 --> 00:54:26,390

the microchips on the board's all the

1363

00:54:30,450 --> 00:54:28,160

way up to the entire rover and the

1364

00:54:32,830 --> 00:54:30,460

spacecraft all as one assembly so

1365

00:54:36,460 --> 00:54:32,840

testing is a huge part of the culture at

1366

00:54:37,570 --> 00:54:36,470

JPL and NASA alright yeah it's it's

1367

00:54:40,680 --> 00:54:37,580

definitely something that's that's a

1368

00:54:43,900 --> 00:54:40,690

very important to the way we do our work

1369

00:54:46,240 --> 00:54:43,910

well that is about all the time we have

1370

00:54:48,340 --> 00:54:46,250

to talk with you Armin thank you so much

1371

00:54:51,510 --> 00:54:48,350

for joining us and really good luck to

1372

00:54:54,310 --> 00:54:51,520

you and the team thank you

1373

00:54:56,950 --> 00:54:54,320

alright well again we want to thank

1374

00:55:00,010 --> 00:54:56,960

Briony Horgan and Armin Torian for being

1375

00:55:02,320 --> 00:55:00,020

with us we'll all be watching with a lot

1376

00:55:05,380 --> 00:55:02,330

of excitement when that rocket lifts off

1377

00:55:08,050 --> 00:55:05,390

month and thank you to Sarah market for

1378

00:55:09,640 --> 00:55:08,060

sharing our audience questions and of

1379

00:55:12,280 --> 00:55:09,650

course thank you all of you for watching

1380

00:55:14,860 --> 00:55:12,290

and submitting those questions glad we

1381

00:55:17,170 --> 00:55:14,870

could get to some of those now again if

1382

00:55:19,450 --> 00:55:17,180

you are looking for resources from NASA

1383

00:55:23,110 --> 00:55:19,460

regarding the Mars 2020 mission you can

1384

00:55:26,380 --> 00:55:23,120

go to Mars [nasa.gov](https://nasa.gov) slash Mars 2020 and

1385

00:55:29,410 --> 00:55:26,390

follow at NASA persevere on Facebook and

1386

00:55:31,330 --> 00:55:29,420

Twitter that's all for this month but we

1387

00:55:36,040 --> 00:55:31,340

hope you'll join us next month as we

1388

00:55:38,710 --> 00:55:36,050

pivot our focus to Venus will ask is it

1389

00:55:41,740 --> 00:55:38,720

Earth's evil twin or maybe just under

1390

00:55:45,430 --> 00:55:41,750

misunderstood you'll have to tune in to