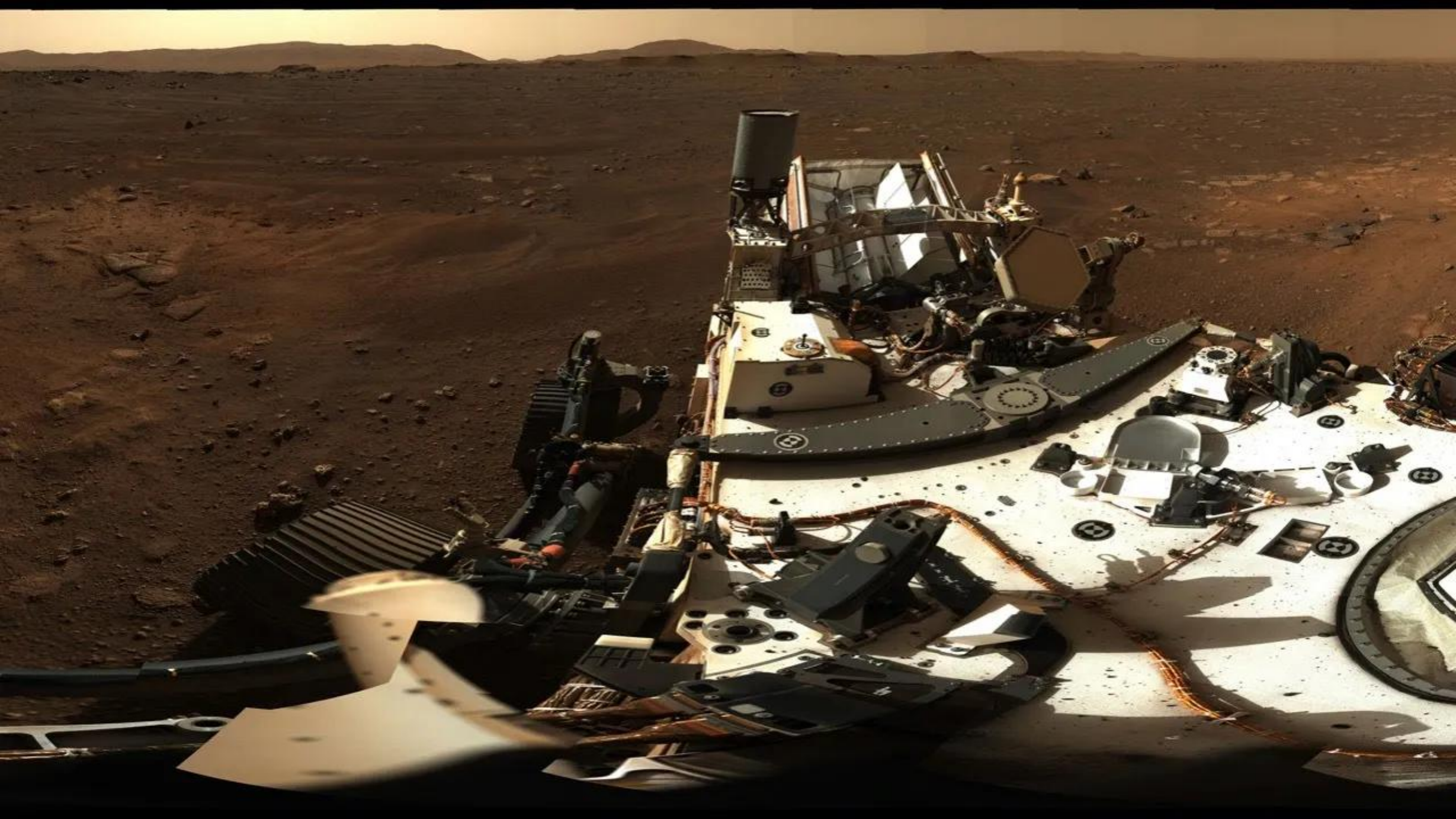

1
00:00:22,060 --> 00:01:01,910
[Music]

2
00:01:05,590 --> 00:01:03,910
i'm marina jurica with nasa's jet

3
00:01:08,310 --> 00:01:05,600
propulsion laboratory in southern

4
00:01:11,109 --> 00:01:08,320
california after landing on mars last

5
00:01:13,429 --> 00:01:11,119
week nasa's perseverance rover took its

6
00:01:15,990 --> 00:01:13,439
first look around we are getting an

7
00:01:18,469 --> 00:01:16,000
initial look at just how powerful the

8
00:01:20,630 --> 00:01:18,479
cameras on board the rover are from the

9
00:01:23,429 --> 00:01:20,640
never before seen entry descent and

10
00:01:25,990 --> 00:01:23,439
landing video to the mass cam z camera

11
00:01:27,630 --> 00:01:26,000
system capturing a panorama of the

12
00:01:30,310 --> 00:01:27,640
landscape in

13
00:01:32,950 --> 00:01:30,320

unprecedented detail we have been able

14
00:01:36,230 --> 00:01:32,960
to see the surface of mars as never

15
00:01:40,069 --> 00:01:36,240
before the perseverance rover has 19

16
00:01:42,069 --> 00:01:40,079
cameras on board ready to explore today

17
00:01:44,230 --> 00:01:42,079
i am joined by a team of experts who

18
00:01:46,310 --> 00:01:44,240
will be using the mass cam z camera

19
00:01:48,469 --> 00:01:46,320
system throughout the mission and they

20
00:01:51,590 --> 00:01:48,479
will show us the highest resolution

21
00:01:52,870 --> 00:01:51,600
shots of the red planet yet in a moment

22
00:01:54,550 --> 00:01:52,880
if you are joining along in the

23
00:01:56,870 --> 00:01:54,560
conversation would like to ask one of

24
00:01:59,030 --> 00:01:56,880
the scientists or engineers a question

25
00:02:01,830 --> 00:01:59,040
you can pop it into the social feed you

26
00:02:04,709 --> 00:02:01,840
are using with the hashtag countdown to

27
00:02:07,350 --> 00:02:04,719
mars joining me today is jim bell the

28
00:02:09,350 --> 00:02:07,360
principal investigator for the masscam z

29
00:02:12,070 --> 00:02:09,360
instrument

30
00:02:14,550 --> 00:02:12,080
elsa jensen of mayland space science

31
00:02:18,229 --> 00:02:14,560
systems who leads operations for sending

32
00:02:21,430 --> 00:02:18,239
commands to the mass cam z instrument

33
00:02:23,750 --> 00:02:21,440
kiarten kink of the neil bohr institute

34
00:02:25,670 --> 00:02:23,760
of the university of copenhagen who led

35
00:02:28,309 --> 00:02:25,680
the design and construction of mass cam

36
00:02:30,630 --> 00:02:28,319
z's calibration targets which are used

37
00:02:32,309 --> 00:02:30,640
to tune the instrument settings thank

38
00:02:33,830 --> 00:02:32,319

you so much for joining me here today

39
00:02:35,190 --> 00:02:33,840
guys

40
00:02:37,589 --> 00:02:35,200
great to be here marina thanks for

41
00:02:39,589 --> 00:02:37,599
having us yes thanks for having us

42
00:02:41,830 --> 00:02:39,599
thanks for having us

43
00:02:44,390 --> 00:02:41,840
now jim we spoke before landing on your

44
00:02:46,470 --> 00:02:44,400
anticipation for the camera shots you

45
00:02:48,390 --> 00:02:46,480
would be getting is it living up to what

46
00:02:50,869 --> 00:02:48,400
you dreamed it would be

47
00:02:51,670 --> 00:02:50,879
oh my gosh

48
00:02:54,070 --> 00:02:51,680
oh

49
00:02:56,070 --> 00:02:54,080
i mean remember when we talked about it

50
00:02:58,149 --> 00:02:56,080
and we were trying to make predictions

51
00:03:01,030 --> 00:02:58,159
and i made a crazy prediction this is

52
00:03:03,030 --> 00:03:01,040
going to be a feast for the eyes right

53
00:03:04,390 --> 00:03:03,040
all these incredible cameras

54
00:03:05,910 --> 00:03:04,400
uh you know

55
00:03:08,070 --> 00:03:05,920
you mentioned the 19 on the rover if you

56
00:03:10,309 --> 00:03:08,080
count the ones on the descent stage if

57
00:03:12,949 --> 00:03:10,319
you count the ones on the helicopter you

58
00:03:16,229 --> 00:03:12,959
know we're talking about 25 cameras on

59
00:03:18,710 --> 00:03:16,239
this rover just unbelievable image rich

60
00:03:21,030 --> 00:03:18,720
and i think we were all blown away by

61
00:03:23,750 --> 00:03:21,040
the videos right by those incredible the

62
00:03:26,149 --> 00:03:23,760
parachute and the thing and the stuff

63
00:03:28,390 --> 00:03:26,159

and it's like what it's just really hard

64
00:03:30,789 --> 00:03:28,400
to believe that all that worked even

65
00:03:33,589 --> 00:03:30,799
though many of us kind of knew

66
00:03:35,750 --> 00:03:33,599
intellectually what to expect uh

67
00:03:37,589 --> 00:03:35,760
emotionally it was like we were blown

68
00:03:39,430 --> 00:03:37,599
out of the water it was incredible and

69
00:03:41,750 --> 00:03:39,440
and a lot of us are having on the mass

70
00:03:42,869 --> 00:03:41,760
cams etm are having the same experience

71
00:03:45,509 --> 00:03:42,879
with the pictures we're taking with

72
00:03:47,350 --> 00:03:45,519
these zoom cameras

73
00:03:50,949 --> 00:03:47,360
absolutely breathtaking i think

74
00:03:52,949 --> 00:03:50,959
everybody around the globe has just been

75
00:03:54,789 --> 00:03:52,959
so inspired by it all now you mentioned

76
00:03:57,910 --> 00:03:54,799
that the first images you ever saw of

77
00:03:59,350 --> 00:03:57,920
mars were from the viking landers now

78
00:04:01,270 --> 00:03:59,360
how does that compare with what you're

79
00:04:02,949 --> 00:04:01,280
seeing now

80
00:04:04,869 --> 00:04:02,959
yeah so you know the

81
00:04:06,030 --> 00:04:04,879
the first successful landing on mars

82
00:04:07,670 --> 00:04:06,040
back in

83
00:04:10,070 --> 00:04:07,680
1976

84
00:04:11,750 --> 00:04:10,080
and the two viking landers one and two

85
00:04:14,710 --> 00:04:11,760
set down on the surface

86
00:04:17,509 --> 00:04:14,720
and very different camera systems than

87
00:04:19,030 --> 00:04:17,519
we use today but for the time they were

88
00:04:21,430 --> 00:04:19,040

you know designed and built in the early

89
00:04:22,230 --> 00:04:21,440
1970s they were just incredibly cutting

90
00:04:24,150 --> 00:04:22,240
edge

91
00:04:27,510 --> 00:04:24,160
incredibly state of the art

92
00:04:29,990 --> 00:04:27,520
but also very very simple compared to

93
00:04:32,550 --> 00:04:30,000
today's cameras the viking cameras had

94
00:04:34,070 --> 00:04:32,560
uh basically single detectors and they

95
00:04:35,749 --> 00:04:34,080
were scanned

96
00:04:38,070 --> 00:04:35,759
up and down and then moving along the

97
00:04:40,550 --> 00:04:38,080
side kind of like a fax machine almost

98
00:04:43,110 --> 00:04:40,560
and so i remember being a kid watching

99
00:04:44,710 --> 00:04:43,120
on the nightly news the first pictures

100
00:04:50,070 --> 00:04:44,720
coming down from mars and they were

101
00:04:54,390 --> 00:04:51,749
you know and it was like watching paint

102
00:04:56,469 --> 00:04:54,400
drip down the wall and little bit at a

103
00:04:58,790 --> 00:04:56,479
time and it took hours you know and and

104
00:05:00,710 --> 00:04:58,800
you see oh there's the foot pad you know

105
00:05:02,790 --> 00:05:00,720
it was incredibly exciting of course the

106
00:05:05,110 --> 00:05:02,800
first time we got down onto mars

107
00:05:08,469 --> 00:05:05,120
nowadays we're used to digital cameras

108
00:05:10,710 --> 00:05:08,479
and our cell phones or dls dslrs uh

109
00:05:13,510 --> 00:05:10,720
we're used to big arrays of pixels

110
00:05:15,990 --> 00:05:13,520
megapixel arrays and so you know mass

111
00:05:17,909 --> 00:05:16,000
cam z is is a two megapixel camera which

112
00:05:19,909 --> 00:05:17,919
is pretty good for space there are

113
00:05:23,270 --> 00:05:19,919

higher megapixel cameras on this rover

114
00:05:24,550 --> 00:05:23,280
but for us it does the job uh and its

115
00:05:26,629 --> 00:05:24,560
resolution

116
00:05:27,670 --> 00:05:26,639
it varies because of course we go wide

117
00:05:30,230 --> 00:05:27,680
angle

118
00:05:32,070 --> 00:05:30,240
all the way to telephoto in stereo with

119
00:05:34,390 --> 00:05:32,080
those two eyes here you're seeing in

120
00:05:36,950 --> 00:05:34,400
this next graphic the two eyes of mass

121
00:05:38,390 --> 00:05:36,960
cam z up on the mast and that mass can

122
00:05:41,430 --> 00:05:38,400
let us move around

123
00:05:43,110 --> 00:05:41,440
360 degrees up and down

124
00:05:44,950 --> 00:05:43,120
and that's how we build

125
00:05:47,270 --> 00:05:44,960
uh panoramas and you'll you'll hear more

126
00:05:49,189 --> 00:05:47,280
about that from from elsa

127
00:05:51,029 --> 00:05:49,199
at the widest setting we got about two

128
00:05:52,469 --> 00:05:51,039
and a half times better resolution than

129
00:05:54,629 --> 00:05:52,479
those viking cameras and at the

130
00:05:55,990 --> 00:05:54,639
telephoto setting we get about 10 times

131
00:05:58,230 --> 00:05:56,000
better resolution

132
00:06:01,270 --> 00:05:58,240
than those viking cameras so those are a

133
00:06:03,110 --> 00:06:01,280
great start to the legacy of of imaging

134
00:06:06,309 --> 00:06:03,120
on mars that we're

135
00:06:08,390 --> 00:06:06,319
we're picking up with this mission

136
00:06:10,629 --> 00:06:08,400
and what an amazing opportunity jim for

137
00:06:11,909 --> 00:06:10,639
you to be able to watch that growth this

138
00:06:14,150 --> 00:06:11,919

is your fifth

139
00:06:16,550 --> 00:06:14,160
mars landing and to be able to watch

140
00:06:18,150 --> 00:06:16,560
just exponentially uh how these cameras

141
00:06:19,830 --> 00:06:18,160
have gotten better and better so what

142
00:06:21,830 --> 00:06:19,840
kind of advice do you have for the

143
00:06:23,830 --> 00:06:21,840
future scientists and engineers watching

144
00:06:25,670 --> 00:06:23,840
today on what they will bring perhaps to

145
00:06:28,870 --> 00:06:25,680
the table coming up

146
00:06:30,870 --> 00:06:28,880
yeah you know uh we've got a lot of uh

147
00:06:33,909 --> 00:06:30,880
uh young young people and early career

148
00:06:36,070 --> 00:06:33,919
people here at asu uh working with us

149
00:06:37,749 --> 00:06:36,080
faculty staff students we have i'm in

150
00:06:40,390 --> 00:06:37,759
the mission operations center for mass

151
00:06:41,270 --> 00:06:40,400
camzy here at asu on the tempe campus

152
00:06:42,950 --> 00:06:41,280
and

153
00:06:44,629 --> 00:06:42,960
so we do a lot of the processing here

154
00:06:46,790 --> 00:06:44,639
and i think what's happening is you know

155
00:06:49,029 --> 00:06:46,800
these students we work with and others

156
00:06:51,430 --> 00:06:49,039
they're seeing the future of deep space

157
00:06:54,150 --> 00:06:51,440
imaging these video cameras with these

158
00:06:56,309 --> 00:06:54,160
higher and higher megapixel capabilities

159
00:06:59,029 --> 00:06:56,319
with more infrastructure out in the

160
00:07:01,189 --> 00:06:59,039
solar system to get the data back you

161
00:07:03,350 --> 00:07:01,199
know we we can talk about bandwidth and

162
00:07:05,510 --> 00:07:03,360
how you know we can take

163
00:07:07,270 --> 00:07:05,520

megapixels and movies and all kinds of

164
00:07:09,990 --> 00:07:07,280
stuff but we don't have high speed

165
00:07:12,870 --> 00:07:10,000
internet to mars right we have basically

166
00:07:14,710 --> 00:07:12,880
the equivalent of old style dial up so

167
00:07:16,629 --> 00:07:14,720
that's a you know advancing that

168
00:07:18,790 --> 00:07:16,639
frontier we're seeing incredible

169
00:07:20,870 --> 00:07:18,800
improvements in our mission compared to

170
00:07:23,029 --> 00:07:20,880
previous ones and how we can get all

171
00:07:25,110 --> 00:07:23,039
those pixels into the tiny straw of

172
00:07:26,629 --> 00:07:25,120
bandwidth getting back to the earth

173
00:07:29,189 --> 00:07:26,639
so i think that's just going to continue

174
00:07:30,469 --> 00:07:29,199
to improve and will continue to send

175
00:07:31,510 --> 00:07:30,479
amazing missions out there and the

176
00:07:33,749 --> 00:07:31,520
instruments are going to get more and

177
00:07:35,670 --> 00:07:33,759
more sophisticated basically following

178
00:07:37,350 --> 00:07:35,680
the you know consumer electronics and

179
00:07:38,309 --> 00:07:37,360
all the great amazing things that are

180
00:07:43,270 --> 00:07:38,319
happening

181
00:07:48,550 --> 00:07:45,510
so much to look forward to as we look

182
00:07:50,150 --> 00:07:48,560
into the future and speaking of that you

183
00:07:51,830 --> 00:07:50,160
said it's been a feast for the eyes i

184
00:07:54,629 --> 00:07:51,840
don't think we could ever get enough of

185
00:07:59,830 --> 00:07:54,639
that so moving over to elsa elsa how do

186
00:08:00,790 --> 00:07:59,840
we actually take these pictures on mars

187
00:08:03,189 --> 00:08:00,800
um

188
00:08:05,270 --> 00:08:03,199

you know it's it's amazing actually we

189
00:08:07,589 --> 00:08:05,280
started two years ago and if i could

190
00:08:09,990 --> 00:08:07,599
have the mosaic

191
00:08:11,510 --> 00:08:10,000
image number three

192
00:08:14,629 --> 00:08:11,520
number three please

193
00:08:17,189 --> 00:08:14,639
it it actually from start to finish to

194
00:08:19,909 --> 00:08:17,199
take a picture like this in the box is

195
00:08:21,670 --> 00:08:19,919
about two years it's taken a core team

196
00:08:24,469 --> 00:08:21,680
of six people

197
00:08:26,469 --> 00:08:24,479
um starting two years ago to plan test

198
00:08:29,589 --> 00:08:26,479
and execute

199
00:08:31,189 --> 00:08:29,599
over 5 000 command parameters that go

200
00:08:32,149 --> 00:08:31,199
into this image

201
00:08:33,190 --> 00:08:32,159
um

202
00:08:34,070 --> 00:08:33,200
and

203
00:08:38,389 --> 00:08:34,080
we

204
00:08:40,310 --> 00:08:38,399
landing which in mars time mars mission

205
00:08:42,709 --> 00:08:40,320
time is just a blink of an eye you know

206
00:08:46,070 --> 00:08:42,719
you land and we already have to execute

207
00:08:47,829 --> 00:08:46,080
it so we had to start a long time ago

208
00:08:49,350 --> 00:08:47,839
you know it's um

209
00:08:51,990 --> 00:08:49,360
funny because

210
00:08:53,110 --> 00:08:52,000
when you take a parent like this on mars

211
00:08:55,750 --> 00:08:53,120
you you think you know it's very

212
00:08:57,750 --> 00:08:55,760
technical and it is but it's in some

213
00:09:00,150 --> 00:08:57,760

ways the same as when you have your

214
00:09:01,269 --> 00:09:00,160
smartphone because what you need to do

215
00:09:02,310 --> 00:09:01,279
is you have to look in the right

216
00:09:04,070 --> 00:09:02,320
direction

217
00:09:06,870 --> 00:09:04,080
and you have to get the focus right and

218
00:09:09,430 --> 00:09:06,880
that's really what we focus on um

219
00:09:12,630 --> 00:09:09,440
when we're taking these images

220
00:09:14,750 --> 00:09:12,640
we're millions of miles away though our

221
00:09:18,470 --> 00:09:14,760
selfie stick if you will is

222
00:09:19,190 --> 00:09:18,480
150 million miles long

223
00:09:21,829 --> 00:09:19,200
so

224
00:09:23,670 --> 00:09:21,839
when we take the pictures we can't just

225
00:09:26,070 --> 00:09:23,680
go out and do it and when we press the

226
00:09:28,230 --> 00:09:26,080
shutter button hey take a picture

227
00:09:29,269 --> 00:09:28,240
it takes a day for the signal to get to

228
00:09:32,150 --> 00:09:29,279
mars

229
00:09:34,230 --> 00:09:32,160
and it takes another day before we get

230
00:09:37,829 --> 00:09:34,240
the images back so we have that

231
00:09:41,829 --> 00:09:37,839
challenge of time and space if you will

232
00:09:43,350 --> 00:09:41,839
um so how do we how do we do that then

233
00:09:46,949 --> 00:09:43,360
um

234
00:09:49,350 --> 00:09:46,959
doing this for a long time we've

235
00:09:51,750 --> 00:09:49,360
actually been imaging um

236
00:09:54,070 --> 00:09:51,760
for eight years with curiosity with the

237
00:09:57,590 --> 00:09:54,080
mast cam and that has led to

238
00:10:00,230 --> 00:09:57,600

a ton of experience we use our

239
00:10:01,350 --> 00:10:00,240
intuition and then we have computer

240
00:10:03,110 --> 00:10:01,360
tools

241
00:10:05,910 --> 00:10:03,120
and um

242
00:10:09,350 --> 00:10:05,920
as we put all these things together we

243
00:10:10,870 --> 00:10:09,360
we make a draft do we test it we get

244
00:10:13,190 --> 00:10:10,880
results some of them work some of them

245
00:10:16,310 --> 00:10:13,200
and don't and then we test again

246
00:10:18,550 --> 00:10:16,320
so i wanted to um introduce one of the

247
00:10:20,550 --> 00:10:18,560
most important tools that we've used in

248
00:10:23,110 --> 00:10:20,560
creating mosaics which is the command

249
00:10:24,949 --> 00:10:23,120
visualization tool called viewpoint it

250
00:10:29,030 --> 00:10:24,959
was developed by one of our team members

251
00:10:31,030 --> 00:10:29,040
john proton and it provides us with

252
00:10:33,509 --> 00:10:31,040
a way to visualize

253
00:10:36,230 --> 00:10:33,519
as if we were on mars looking at the

254
00:10:38,630 --> 00:10:36,240
mars images behind it and the computer

255
00:10:41,829 --> 00:10:38,640
uh model of the rover

256
00:10:45,030 --> 00:10:41,839
and then we can lay down footprints

257
00:10:47,190 --> 00:10:45,040
and that's a great way to pretend that

258
00:10:49,030 --> 00:10:47,200
we've that we're right there with mass

259
00:10:50,710 --> 00:10:49,040
cam as you saw the pictures before we're

260
00:10:51,829 --> 00:10:50,720
right there with mast cam taking the

261
00:10:53,269 --> 00:10:51,839
images

262
00:10:56,389 --> 00:10:53,279
um

263
00:10:57,190 --> 00:10:56,399

and be able to visualize that

264
00:11:00,630 --> 00:10:57,200
so

265
00:11:03,190 --> 00:11:00,640
if i could have the next picture please

266
00:11:05,829 --> 00:11:03,200
thank you you see here the frames see

267
00:11:07,269 --> 00:11:05,839
all the red squares the red rectangles

268
00:11:08,870 --> 00:11:07,279
that's actually the footprints that

269
00:11:12,389 --> 00:11:08,880
we've laid down

270
00:11:14,150 --> 00:11:12,399
um for this mosaic and there's 142 total

271
00:11:16,230 --> 00:11:14,160
like i mentioned before there's fifth

272
00:11:18,790 --> 00:11:16,240
over 5000 commands

273
00:11:21,110 --> 00:11:18,800
for all together to take these 142

274
00:11:24,310 --> 00:11:21,120
images that we stitched together

275
00:11:26,310 --> 00:11:24,320
now in this case we didn't land on mars

276
00:11:28,949 --> 00:11:26,320
before we took this right we had to plan

277
00:11:32,389 --> 00:11:28,959
it in the blind so

278
00:11:34,069 --> 00:11:32,399
we had to um start with our information

279
00:11:35,430 --> 00:11:34,079
that we had available which was from

280
00:11:38,630 --> 00:11:35,440
curiosity

281
00:11:40,790 --> 00:11:38,640
so two years ago um two of our office

282
00:11:43,269 --> 00:11:40,800
engineers at the time jason van beek and

283
00:11:45,430 --> 00:11:43,279
tex kobachky put together kind of a

284
00:11:47,430 --> 00:11:45,440
draft and then

285
00:11:49,430 --> 00:11:47,440
that sequence we took into testing with

286
00:11:52,790 --> 00:11:49,440
the thermal vacuum chamber

287
00:11:56,470 --> 00:11:52,800
um which is house size so imagine a

288
00:11:58,230 --> 00:11:56,480

small house that is in mars conditions

289
00:12:00,790 --> 00:11:58,240
with the temperatures fluctuating about

290
00:12:03,030 --> 00:12:00,800
100 degrees between day and night

291
00:12:05,750 --> 00:12:03,040
and also some of the air pumped out for

292
00:12:07,030 --> 00:12:05,760
vacuum and we tested in there

293
00:12:09,350 --> 00:12:07,040
and then

294
00:12:11,269 --> 00:12:09,360
we also got special permission to

295
00:12:14,150 --> 00:12:11,279
execute this

296
00:12:16,389 --> 00:12:14,160
sequence at kennedy space center

297
00:12:18,150 --> 00:12:16,399
and that was important because of the

298
00:12:19,829 --> 00:12:18,160
focus

299
00:12:21,910 --> 00:12:19,839
we could get the landscape pretty well

300
00:12:24,870 --> 00:12:21,920
from curiosity

301
00:12:26,949 --> 00:12:24,880
but we also needed information on how to

302
00:12:28,870 --> 00:12:26,959
focus on the various details of the

303
00:12:31,190 --> 00:12:28,880
perseverance rover deck because that's

304
00:12:34,790 --> 00:12:31,200
different than curiosity

305
00:12:36,150 --> 00:12:34,800
so uh we got that in the bag um and

306
00:12:38,150 --> 00:12:36,160
thank goodness because that's what

307
00:12:41,910 --> 00:12:38,160
allowed us to put the sequence together

308
00:12:44,870 --> 00:12:41,920
all all of it in um in one sequence we

309
00:12:47,509 --> 00:12:44,880
sent it up two weeks before we actually

310
00:12:50,310 --> 00:12:47,519
landed on mars

311
00:12:52,230 --> 00:12:50,320
we do that to ensure that um

312
00:12:54,310 --> 00:12:52,240
as a mitigation case the communication

313
00:12:56,949 --> 00:12:54,320

errors right after we land it was all

314
00:12:58,949 --> 00:12:56,959
fine but in case we would have it on

315
00:13:00,069 --> 00:12:58,959
board already and ready to execute when

316
00:13:01,910 --> 00:13:00,079
we landed

317
00:13:04,790 --> 00:13:01,920
so that's part of the the

318
00:13:07,430 --> 00:13:04,800
thorough testing that we do um when

319
00:13:11,829 --> 00:13:07,440
we're preparing to go to mars

320
00:13:14,069 --> 00:13:11,839
so i got finally um with all of that we

321
00:13:17,190 --> 00:13:14,079
had our cognizant engineer mike kaplan

322
00:13:19,990 --> 00:13:17,200
here at msq we had ops engineers tex and

323
00:13:23,269 --> 00:13:20,000
angela and chris and myself we checked

324
00:13:25,350 --> 00:13:23,279
and reject and then we were ready to fly

325
00:13:27,990 --> 00:13:25,360
so if i could have the next

326
00:13:30,550 --> 00:13:28,000
the next image please here's how we laid

327
00:13:31,829 --> 00:13:30,560
out the panorama you see how we start at

328
00:13:33,910 --> 00:13:31,839
the horizon

329
00:13:37,030 --> 00:13:33,920
where imagine being on the mast you're

330
00:13:39,829 --> 00:13:37,040
looking one way and then looking next

331
00:13:41,430 --> 00:13:39,839
down then down we go as we take the

332
00:13:44,710 --> 00:13:41,440
panorama

333
00:13:46,550 --> 00:13:44,720
and building up tile by tile

334
00:13:49,509 --> 00:13:46,560
from the horizon and all the way down to

335
00:13:51,829 --> 00:13:49,519
the rover deck 142 different frames you

336
00:13:54,310 --> 00:13:51,839
can see we have focus on the hardware on

337
00:13:55,990 --> 00:13:54,320
the landscape and it's all put together

338
00:13:57,030 --> 00:13:56,000

into one sequence

339
00:13:59,590 --> 00:13:57,040
so

340
00:14:01,829 --> 00:13:59,600
it's great to be here today our team is

341
00:14:04,150 --> 00:14:01,839
loving being on mars we're taking

342
00:14:06,150 --> 00:14:04,160
already hundreds and hundreds of images

343
00:14:07,990 --> 00:14:06,160
with this camera and we're going to take

344
00:14:10,069 --> 00:14:08,000
thousands tens if not hundreds of

345
00:14:11,910 --> 00:14:10,079
thousands in the future we're so happy

346
00:14:13,509 --> 00:14:11,920
to be here from male and space science

347
00:14:15,750 --> 00:14:13,519
systems and

348
00:14:18,790 --> 00:14:15,760
love working with jim and asu thank you

349
00:14:19,670 --> 00:14:18,800
for having us come along to mars again

350
00:14:22,069 --> 00:14:19,680
and

351
00:14:23,829 --> 00:14:22,079
we just cannot wait to get

352
00:14:25,269 --> 00:14:23,839
going with this camera

353
00:14:26,629 --> 00:14:25,279
thank you

354
00:14:28,870 --> 00:14:26,639
awesome

355
00:14:31,030 --> 00:14:28,880
thank you so much elsa such great

356
00:14:33,829 --> 00:14:31,040
information and that was such an

357
00:14:36,790 --> 00:14:33,839
incredible animation there as well and

358
00:14:39,990 --> 00:14:36,800
it obviously takes a village to get all

359
00:14:42,470 --> 00:14:40,000
of these images processed and put out to

360
00:14:45,110 --> 00:14:42,480
the public and kiarten what's a

361
00:14:47,829 --> 00:14:45,120
calibration target and why do you

362
00:14:50,310 --> 00:14:47,839
actually need one

363
00:14:52,150 --> 00:14:50,320

so all scientific instruments basically

364
00:14:52,949 --> 00:14:52,160
need some sort of calibration you need

365
00:14:58,710 --> 00:14:52,959
to

366
00:15:00,230 --> 00:14:58,720
some standard something that you know

367
00:15:01,590 --> 00:15:00,240
really well you need to make sure

368
00:15:03,110 --> 00:15:01,600
exactly how

369
00:15:05,269 --> 00:15:03,120
the readings of your instrument

370
00:15:07,269 --> 00:15:05,279
translate to things in the real world

371
00:15:09,750 --> 00:15:07,279
and we went through a lot of pre-flight

372
00:15:11,430 --> 00:15:09,760
calibration a lot of activities to to

373
00:15:12,949 --> 00:15:11,440
image lamps and

374
00:15:14,870 --> 00:15:12,959
and and

375
00:15:16,790 --> 00:15:14,880
dot patterns and other things with the

376
00:15:18,949 --> 00:15:16,800
cameras to make sure that we understood

377
00:15:20,470 --> 00:15:18,959
these instruments really well

378
00:15:22,230 --> 00:15:20,480
and a lot of the instruments also have

379
00:15:24,550 --> 00:15:22,240
calibration targets

380
00:15:26,230 --> 00:15:24,560
on board the rover that they can visit

381
00:15:27,509 --> 00:15:26,240
and we have a calibration target that we

382
00:15:29,990 --> 00:15:27,519
can image

383
00:15:31,590 --> 00:15:30,000
to check that things are still operating

384
00:15:33,749 --> 00:15:31,600
as they should but our calibration

385
00:15:36,069 --> 00:15:33,759
target actually kind of has a purpose

386
00:15:38,389 --> 00:15:36,079
that goes a little bit beyond that

387
00:15:40,790 --> 00:15:38,399
and the reason is the mass can see is a

388
00:15:43,030 --> 00:15:40,800

color camera of course it it acquires

389
00:15:45,269 --> 00:15:43,040
color images in red green and blue but

390
00:15:47,670 --> 00:15:45,279
it also has a whole set of

391
00:15:49,110 --> 00:15:47,680
of a special optical filters of what we

392
00:15:52,550 --> 00:15:49,120
call narrow band filters that are

393
00:15:54,870 --> 00:15:52,560
basically filters that image at sort of

394
00:15:57,590 --> 00:15:54,880
tightly around us a single frequency a

395
00:15:59,829 --> 00:15:57,600
wavelength of light um and we have 11

396
00:16:01,670 --> 00:15:59,839
different of them from a little bit into

397
00:16:03,269 --> 00:16:01,680
the ultraviolet a little bit out into

398
00:16:05,430 --> 00:16:03,279
the infrared

399
00:16:08,310 --> 00:16:05,440
and with all of these different

400
00:16:11,269 --> 00:16:08,320
14 11 narrow and and three red green and

401
00:16:13,990 --> 00:16:11,279
blue with all these 14 color bands and

402
00:16:16,470 --> 00:16:14,000
we can we can make some some color

403
00:16:19,350 --> 00:16:16,480
images that allow us to go a little bit

404
00:16:22,069 --> 00:16:19,360
beyond human vision and and tease out

405
00:16:24,710 --> 00:16:22,079
differences in the terrain tell one rock

406
00:16:25,749 --> 00:16:24,720
from another or tell that two rocks are

407
00:16:26,870 --> 00:16:25,759
similar

408
00:16:30,550 --> 00:16:26,880
um

409
00:16:33,110 --> 00:16:30,560
or tell layering in in a cliff phase or

410
00:16:34,949 --> 00:16:33,120
or or what have you and also on things

411
00:16:37,509 --> 00:16:34,959
that might not be visible to the to the

412
00:16:39,509 --> 00:16:37,519
human eye to standard red green and blue

413
00:16:42,310 --> 00:16:39,519

um but

414
00:16:44,470 --> 00:16:42,320
when you look at at a rock on mars or a

415
00:16:46,069 --> 00:16:44,480
rock on earth or anything

416
00:16:47,670 --> 00:16:46,079
you're seeing a color that's a

417
00:16:49,749 --> 00:16:47,680
combination of

418
00:16:51,350 --> 00:16:49,759
the color of the light and the color are

419
00:16:54,150 --> 00:16:51,360
the thing the rock

420
00:16:56,949 --> 00:16:54,160
and so you know you know if you light

421
00:16:58,790 --> 00:16:56,959
shine red light on a on a on something

422
00:17:00,150 --> 00:16:58,800
it looks red and you shine blue light on

423
00:17:02,629 --> 00:17:00,160
it it looks blue

424
00:17:04,390 --> 00:17:02,639
and on mars the illumination will change

425
00:17:05,990 --> 00:17:04,400
like it does on earth you know the sun

426
00:17:07,110 --> 00:17:06,000
may be high in the sky maybe low in the

427
00:17:09,270 --> 00:17:07,120
sky

428
00:17:11,750 --> 00:17:09,280
if the atmosphere may be dusty it may be

429
00:17:13,429 --> 00:17:11,760
not so dusty so it will change over time

430
00:17:15,750 --> 00:17:13,439
and it can change on fairly short time

431
00:17:17,350 --> 00:17:15,760
scales and it's kind of hard to model

432
00:17:19,429 --> 00:17:17,360
um

433
00:17:21,590 --> 00:17:19,439
and uh so for that we use the

434
00:17:23,669 --> 00:17:21,600
calibration target and can i get slide

435
00:17:24,710 --> 00:17:23,679
number number seven at the calibration

436
00:17:27,750 --> 00:17:24,720
target

437
00:17:31,430 --> 00:17:27,760
um so that's a uh just a a little

438
00:17:34,230 --> 00:17:31,440

aluminum plate with uh some patches uh

439
00:17:36,390 --> 00:17:34,240
ceramic patches in four colors and four

440
00:17:37,669 --> 00:17:36,400
gray scales and four rings and the same

441
00:17:39,990 --> 00:17:37,679
gray scales

442
00:17:41,990 --> 00:17:40,000
and and these are our colors and gray

443
00:17:43,190 --> 00:17:42,000
scales that we had we characterized

444
00:17:45,830 --> 00:17:43,200
super well

445
00:17:48,150 --> 00:17:45,840
before we flew to mars so we know

446
00:17:50,470 --> 00:17:48,160
exactly how they reflect light and so so

447
00:17:52,230 --> 00:17:50,480
imaging this with the camera

448
00:17:54,150 --> 00:17:52,240
allows the camera actually to measure

449
00:17:55,270 --> 00:17:54,160
the illumination measure the light that

450
00:17:56,870 --> 00:17:55,280
comes in

451
00:17:59,190 --> 00:17:56,880
and then we take a picture of mars and

452
00:18:01,830 --> 00:17:59,200
then we can use that information to

453
00:18:03,909 --> 00:18:01,840
basically divide out that illumination

454
00:18:06,230 --> 00:18:03,919
and we can then convert the image of

455
00:18:07,909 --> 00:18:06,240
mars to what we call a reflectance

456
00:18:09,830 --> 00:18:07,919
calibrated image and that's an image

457
00:18:10,950 --> 00:18:09,840
that shows the

458
00:18:13,669 --> 00:18:10,960
um

459
00:18:14,470 --> 00:18:13,679
the inherent color of the rocks and the

460
00:18:16,390 --> 00:18:14,480
soil

461
00:18:17,990 --> 00:18:16,400
how they reflect light rather than the

462
00:18:20,549 --> 00:18:18,000
illumination and that way you can

463
00:18:22,950 --> 00:18:20,559

compare them to images you took 10 days

464
00:18:24,950 --> 00:18:22,960
back when the atmosphere was dustier or

465
00:18:27,590 --> 00:18:24,960
image you have of a rock in your

466
00:18:30,390 --> 00:18:27,600
laboratory or or whatever and that helps

467
00:18:32,470 --> 00:18:30,400
the the science team use the camera to

468
00:18:34,150 --> 00:18:32,480
pick out interesting targets

469
00:18:35,909 --> 00:18:34,160
and so on if you if you give me the next

470
00:18:37,830 --> 00:18:35,919
slide um

471
00:18:40,230 --> 00:18:37,840
is that it's a close-up of this

472
00:18:42,870 --> 00:18:40,240
calibration target um and we're going to

473
00:18:46,070 --> 00:18:42,880
be imaging it a lot and so we added some

474
00:18:47,510 --> 00:18:46,080
some decorations and a little model

475
00:18:49,590 --> 00:18:47,520
to it

476
00:18:51,430 --> 00:18:49,600
and it's just been an amazing journey

477
00:18:54,549 --> 00:18:51,440
seeing it for the first time on the

478
00:18:56,789 --> 00:18:54,559
surface of mars was amazing i'm sitting

479
00:18:58,789 --> 00:18:56,799
here and it's 10 p.m in in central

480
00:19:00,789 --> 00:18:58,799
copenhagen in the nilsport institute i'm

481
00:19:02,470 --> 00:19:00,799
actually sitting in millsport's old

482
00:19:04,630 --> 00:19:02,480
office he was one of the fathers of

483
00:19:07,270 --> 00:19:04,640
modern physics and they let me sit in

484
00:19:10,150 --> 00:19:07,280
his office they left it preserved since

485
00:19:12,310 --> 00:19:10,160
he passed away in 62. um

486
00:19:14,230 --> 00:19:12,320
and and everybody here that has worked

487
00:19:16,310 --> 00:19:14,240
on this project are have just been so

488
00:19:18,070 --> 00:19:16,320

excited to be able to contribute to this

489
00:19:20,870 --> 00:19:18,080
amazing mission and be a part of this

490
00:19:25,029 --> 00:19:23,590
carotene amazing information here and i

491
00:19:26,630 --> 00:19:25,039
actually have a social media question

492
00:19:28,950 --> 00:19:26,640
that's coming in that really pertains to

493
00:19:31,430 --> 00:19:28,960
what you were just talking about joshua

494
00:19:33,590 --> 00:19:31,440
becomes on twitter says this is really

495
00:19:36,390 --> 00:19:33,600
incredible to see i'm sure we all think

496
00:19:40,710 --> 00:19:36,400
that now are these photos artificially

497
00:19:44,470 --> 00:19:43,029
no i mean i don't i know jim if you want

498
00:19:46,470 --> 00:19:44,480
to

499
00:19:48,710 --> 00:19:46,480
well sure

500
00:19:50,470 --> 00:19:48,720
carton pointed out that we've got all

501
00:19:51,830 --> 00:19:50,480
these different color filters and when

502
00:19:54,390 --> 00:19:51,840
we take

503
00:19:56,789 --> 00:19:54,400
pictures like this panorama in red green

504
00:19:58,710 --> 00:19:56,799
blue then it's sim can simulate what we

505
00:20:01,110 --> 00:19:58,720
see with our own eyes but

506
00:20:02,470 --> 00:20:01,120
if we use the filters that are a little

507
00:20:04,070 --> 00:20:02,480
in the ultraviolet or a little in the

508
00:20:06,310 --> 00:20:04,080
infrared beyond

509
00:20:07,909 --> 00:20:06,320
i call it superhuman mass kinsey has

510
00:20:09,669 --> 00:20:07,919
superhuman vision

511
00:20:11,590 --> 00:20:09,679
um then we can't look at them in red

512
00:20:12,390 --> 00:20:11,600
green blues so we have to false color

513
00:20:13,909 --> 00:20:12,400

them

514
00:20:15,590 --> 00:20:13,919
kind of like a lot of the pictures you

515
00:20:17,669 --> 00:20:15,600
see from the hubble space telescope

516
00:20:19,590 --> 00:20:17,679
they're taken outside of human normal

517
00:20:20,390 --> 00:20:19,600
vision and they're false colored

518
00:20:21,190 --> 00:20:20,400
and so

519
00:20:23,110 --> 00:20:21,200
uh

520
00:20:24,710 --> 00:20:23,120
you're you'll start seeing once we start

521
00:20:26,710 --> 00:20:24,720
using those filters

522
00:20:29,350 --> 00:20:26,720
and i know curtin's going to do a great

523
00:20:32,549 --> 00:20:29,360
job calibrating them you'll start seeing

524
00:20:34,390 --> 00:20:32,559
these kind of andy warhol garish views

525
00:20:37,110 --> 00:20:34,400
of mars that don't look like what we see

526
00:20:39,590 --> 00:20:37,120
it with our eyes but that look

527
00:20:42,310 --> 00:20:39,600
just like what mascanzi can see with its

528
00:20:43,909 --> 00:20:42,320
superhuman eyes and like kyrton said

529
00:20:46,950 --> 00:20:43,919
that gives us some

530
00:20:48,549 --> 00:20:46,960
sensitivity to different kinds of

531
00:20:51,669 --> 00:20:48,559
rocks and minerals and just color

532
00:20:54,149 --> 00:20:51,679
variations and i think of us as

533
00:20:56,230 --> 00:20:54,159
using the cameras kind of to do triage

534
00:20:58,149 --> 00:20:56,240
you know we we can sweep this these

535
00:20:59,990 --> 00:20:58,159
fields of view across the whole scene

536
00:21:02,870 --> 00:21:00,000
with the navigation cameras the hazard

537
00:21:05,669 --> 00:21:02,880
cameras and mass cam z and we're using

538
00:21:06,789 --> 00:21:05,679

color differences as a proxy for well

539
00:21:08,070 --> 00:21:06,799
maybe there's a really interesting

540
00:21:10,070 --> 00:21:08,080
chemistry there maybe there's

541
00:21:12,070 --> 00:21:10,080
interesting minerals there maybe there's

542
00:21:14,149 --> 00:21:12,080
an interesting texture and and we'll

543
00:21:15,510 --> 00:21:14,159
drive over and use all the arm

544
00:21:17,830 --> 00:21:15,520
instruments that we'll be seeing and

545
00:21:19,590 --> 00:21:17,840
hearing a lot about in the weeks to come

546
00:21:22,950 --> 00:21:19,600
use those to get

547
00:21:26,870 --> 00:21:22,960
the much more detailed information

548
00:21:29,350 --> 00:21:26,880
and i know jim you made an incredible

549
00:21:33,029 --> 00:21:29,360
storyboard with your teammates and it

550
00:21:33,909 --> 00:21:33,039
really shows truly how this camera can

551
00:21:35,029 --> 00:21:33,919
zoom

552
00:21:36,630 --> 00:21:35,039
you want to take a little tour through

553
00:21:38,310 --> 00:21:36,640
this should we do that yeah let's do it

554
00:21:40,310 --> 00:21:38,320
let's do it all right well so we're

555
00:21:42,630 --> 00:21:40,320
going to start this is the full

556
00:21:44,070 --> 00:21:42,640
version of the panorama 360 degrees it

557
00:21:46,070 --> 00:21:44,080
connects on the left and the right you

558
00:21:47,270 --> 00:21:46,080
could wrap it around

559
00:21:49,510 --> 00:21:47,280
and it goes

560
00:21:51,350 --> 00:21:49,520
right down to looking at our feet

561
00:21:53,750 --> 00:21:51,360
out to the horizon and a little bit of

562
00:21:54,950 --> 00:21:53,760
the sky as well so go ahead and and zoom

563
00:21:56,710 --> 00:21:54,960

to the first

564
00:21:58,710 --> 00:21:56,720
region here we're going to zoom in on

565
00:22:01,669 --> 00:21:58,720
this panorama all the way behind the

566
00:22:03,510 --> 00:22:01,679
rover this is looking to the north a

567
00:22:05,590 --> 00:22:03,520
little bit northwest

568
00:22:07,990 --> 00:22:05,600
and you can see a couple of different

569
00:22:10,149 --> 00:22:08,000
ridges there's a near ridge closer to us

570
00:22:13,029 --> 00:22:10,159
and then there's those far mountains

571
00:22:13,990 --> 00:22:13,039
the near ridge closest to us is the the

572
00:22:16,870 --> 00:22:14,000
front

573
00:22:19,350 --> 00:22:16,880
edge of the delta the jezreel crater

574
00:22:21,350 --> 00:22:19,360
delta that brought us to this site that

575
00:22:22,870 --> 00:22:21,360
brought this rover to this place and

576
00:22:24,630 --> 00:22:22,880
that we're going to eventually drive

577
00:22:27,510 --> 00:22:24,640
over to beyond that those distant

578
00:22:29,029 --> 00:22:27,520
mountains are the the rim of jezreel

579
00:22:31,029 --> 00:22:29,039
crater you know jethro has a big hole in

580
00:22:32,310 --> 00:22:31,039
the ground it has these mountainous

581
00:22:35,510 --> 00:22:32,320
uh uh

582
00:22:38,070 --> 00:22:35,520
circular uh rim of of uh mountains that

583
00:22:39,750 --> 00:22:38,080
surround us and and we're seeing them

584
00:22:41,350 --> 00:22:39,760
all on the edges of this

585
00:22:42,710 --> 00:22:41,360
this panorama so those are pretty far

586
00:22:44,870 --> 00:22:42,720
away those are three four or five

587
00:22:46,870 --> 00:22:44,880
kilometers away in the distance but the

588
00:22:48,549 --> 00:22:46,880

delta itself is only about two

589
00:22:51,190 --> 00:22:48,559
kilometers a little under a mile and a

590
00:22:53,750 --> 00:22:51,200
half or so away so it's relatively close

591
00:22:56,149 --> 00:22:53,760
the engineers got us in a beautiful spot

592
00:22:58,070 --> 00:22:56,159
and uh let's let's zoom back out and

593
00:23:00,470 --> 00:22:58,080
just look at a couple of the features a

594
00:23:02,149 --> 00:23:00,480
number of the science uh folks on our

595
00:23:04,070 --> 00:23:02,159
team have been looking at these

596
00:23:06,070 --> 00:23:04,080
different areas and zooming in and

597
00:23:08,230 --> 00:23:06,080
trying to do some instant science and

598
00:23:10,230 --> 00:23:08,240
analysis and let's go to the first

599
00:23:12,710 --> 00:23:10,240
zoomed in region here

600
00:23:17,029 --> 00:23:14,950
uh you're transported uh you can see the

601
00:23:18,470 --> 00:23:17,039
resolution of the panorama right we you

602
00:23:20,549 --> 00:23:18,480
know we keep going in there and it's

603
00:23:23,669 --> 00:23:20,559
like wow look at this detail

604
00:23:26,310 --> 00:23:23,679
this is uh just a a blocky hill we think

605
00:23:29,510 --> 00:23:26,320
is a separated remnant maybe of the

606
00:23:31,350 --> 00:23:29,520
original delta uh maybe the delta was

607
00:23:33,750 --> 00:23:31,360
much larger and it's been eroded away

608
00:23:34,950 --> 00:23:33,760
but leaving these little blocky remnants

609
00:23:36,789 --> 00:23:34,960
behind

610
00:23:38,470 --> 00:23:36,799
we see you know some evidence that it

611
00:23:40,950 --> 00:23:38,480
might be more resistive

612
00:23:42,070 --> 00:23:40,960
on its top this is obviously our first

613
00:23:43,430 --> 00:23:42,080

look at it

614
00:23:46,230 --> 00:23:43,440
we're going to be getting much higher

615
00:23:48,870 --> 00:23:46,240
resolution data this is our widest angle

616
00:23:50,950 --> 00:23:48,880
zoom so our lowest resolution almost on

617
00:23:53,430 --> 00:23:50,960
the camera so we're starting to

618
00:23:55,669 --> 00:23:53,440
telephoto in to these now over the

619
00:23:56,950 --> 00:23:55,679
coming days and weeks and we'll get much

620
00:23:58,710 --> 00:23:56,960
more detail and then of course to get

621
00:24:00,789 --> 00:23:58,720
even more detail we'll drive over there

622
00:24:02,310 --> 00:24:00,799
or somewhere near there we'll get closer

623
00:24:05,029 --> 00:24:02,320
to these features let's go to the next

624
00:24:09,110 --> 00:24:05,039
one so zoom back out

625
00:24:11,590 --> 00:24:09,120
and get a get a sense of again the

626
00:24:12,950 --> 00:24:11,600
the wide scale right now let's zoom into

627
00:24:16,630 --> 00:24:12,960
the next one i think this is going to be

628
00:24:19,029 --> 00:24:16,640
another part of the delta this is uh

629
00:24:22,070 --> 00:24:19,039
farther uh towards the north

630
00:24:24,230 --> 00:24:22,080
and and west part of the delta see some

631
00:24:26,789 --> 00:24:24,240
again this blocky kind of top to it

632
00:24:27,750 --> 00:24:26,799
there's the faint hints of some layering

633
00:24:29,830 --> 00:24:27,760
in here

634
00:24:31,350 --> 00:24:29,840
uh maybe you know we would expect that

635
00:24:32,470 --> 00:24:31,360
from what we've seen from orbit and from

636
00:24:34,310 --> 00:24:32,480
what we know about

637
00:24:35,669 --> 00:24:34,320
deltas but it's really kind of a tease

638
00:24:38,070 --> 00:24:35,679

because we of course want better

639
00:24:40,070 --> 00:24:38,080
resolution and lots of folks thinking

640
00:24:42,950 --> 00:24:40,080
about what what could be going on here

641
00:24:44,710 --> 00:24:42,960
lots of sort of geologic comparisons to

642
00:24:46,870 --> 00:24:44,720
what's going on in deltas and other

643
00:24:48,310 --> 00:24:46,880
places on the earth let's zoom out and

644
00:24:49,510 --> 00:24:48,320
look at some other features that are

645
00:24:50,710 --> 00:24:49,520
really close

646
00:24:52,789 --> 00:24:50,720
by

647
00:24:54,710 --> 00:24:52,799
some individual rocks and other rocky

648
00:24:56,789 --> 00:24:54,720
regions we'll go to the next one

649
00:24:58,710 --> 00:24:56,799
i think this is going to go to yeah this

650
00:25:01,110 --> 00:24:58,720
is an area pretty close

651
00:25:03,269 --> 00:25:01,120
to the rover that's uh

652
00:25:05,590 --> 00:25:03,279
been scoured by the retro rockets coming

653
00:25:08,149 --> 00:25:05,600
down and and delivering the rover on the

654
00:25:10,549 --> 00:25:08,159
sky crane so some of the dust and soil

655
00:25:12,789 --> 00:25:10,559
has been scoured away exposing these

656
00:25:15,669 --> 00:25:12,799
rocks with some some layers that white

657
00:25:17,750 --> 00:25:15,679
rock in there is about a half a meter

658
00:25:19,269 --> 00:25:17,760
across or about a foot and a half across

659
00:25:20,549 --> 00:25:19,279
for scale

660
00:25:21,750 --> 00:25:20,559
and

661
00:25:23,909 --> 00:25:21,760
interesting

662
00:25:25,350 --> 00:25:23,919
features and textures on it we don't

663
00:25:28,789 --> 00:25:25,360

know whether these are volcanic

664
00:25:30,470 --> 00:25:28,799
sedimentary some combination of them

665
00:25:32,470 --> 00:25:30,480
we don't have chemical and mineral data

666
00:25:34,870 --> 00:25:32,480
yet but again the cameras are helping us

667
00:25:36,870 --> 00:25:34,880
triage and identify the places where we

668
00:25:38,390 --> 00:25:36,880
want to get those detailed

669
00:25:40,230 --> 00:25:38,400
chemical and mineral measurements let's

670
00:25:42,870 --> 00:25:40,240
zoom out and go to the next one got two

671
00:25:45,110 --> 00:25:42,880
more here to zoom in on i love how it

672
00:25:48,230 --> 00:25:45,120
you just you get a real sense of the

673
00:25:51,269 --> 00:25:48,240
resolution uh on this uh panorama here

674
00:25:54,230 --> 00:25:51,279
we go we're going to another interesting

675
00:25:55,590 --> 00:25:54,240
weird little rock this one is also about

676
00:25:57,590 --> 00:25:55,600
half a meter

677
00:26:00,630 --> 00:25:57,600
across about a foot and a half

678
00:26:03,029 --> 00:26:00,640
across and uh it is uh informally been

679
00:26:06,470 --> 00:26:03,039
called the harbor seal

680
00:26:08,470 --> 00:26:06,480
and it is a highly eroded probably wind

681
00:26:11,990 --> 00:26:08,480
carved rock and we've seen rocks like

682
00:26:13,590 --> 00:26:12,000
this at other mars landing sites

683
00:26:17,269 --> 00:26:13,600
these rocks have been exposed to the

684
00:26:19,269 --> 00:26:17,279
winds of mars for billions of years and

685
00:26:20,149 --> 00:26:19,279
you'd think that the sand grains you

686
00:26:21,590 --> 00:26:20,159
know

687
00:26:24,230 --> 00:26:21,600
gently moving across the surface

688
00:26:27,029 --> 00:26:24,240

wouldn't do much erosion but if you let

689
00:26:28,950 --> 00:26:27,039
them do that work for two three billion

690
00:26:31,510 --> 00:26:28,960
years

691
00:26:32,710 --> 00:26:31,520
you can create these just fantastic uh

692
00:26:34,630 --> 00:26:32,720
forms

693
00:26:36,870 --> 00:26:34,640
uh in the rocks these are these are

694
00:26:38,870 --> 00:26:36,880
called ventefacts on the earth and we do

695
00:26:40,310 --> 00:26:38,880
see these kind of wind carved features

696
00:26:41,510 --> 00:26:40,320
we think they're wind car features at

697
00:26:43,029 --> 00:26:41,520
least we need to get over and take a

698
00:26:45,110 --> 00:26:43,039
closer look and get the high resolution

699
00:26:46,789 --> 00:26:45,120
on it to know uh

700
00:26:48,630 --> 00:26:46,799
better and even

701
00:26:49,750 --> 00:26:48,640
more we'll zoom out and zoom back into

702
00:26:51,590 --> 00:26:49,760
one more

703
00:26:54,149 --> 00:26:51,600
and these i think are

704
00:26:57,590 --> 00:26:54,159
this area which is uh going to be to the

705
00:26:58,870 --> 00:26:57,600
to the right here is even more enigmatic

706
00:27:01,510 --> 00:26:58,880
and some of the most interesting stuff

707
00:27:02,870 --> 00:27:01,520
we're looking at these are light-toned

708
00:27:05,190 --> 00:27:02,880
uh pitted

709
00:27:07,430 --> 00:27:05,200
rocks that again

710
00:27:10,310 --> 00:27:07,440
part of the dust and soil that was

711
00:27:12,710 --> 00:27:10,320
covering them has been blown away by the

712
00:27:14,950 --> 00:27:12,720
uh by the retro rockets hopefully you've

713
00:27:15,990 --> 00:27:14,960

all seen that crate movie about the the

714
00:27:18,389 --> 00:27:16,000
crazy

715
00:27:20,070 --> 00:27:18,399
structures and the winds moving when the

716
00:27:22,950 --> 00:27:20,080
retro rockets came down almost like it

717
00:27:24,630 --> 00:27:22,960
was alive just phenomenal stuff so this

718
00:27:27,350 --> 00:27:24,640
was all has all been kind of cleared off

719
00:27:30,149 --> 00:27:27,360
a little bit and you know are these

720
00:27:32,310 --> 00:27:30,159
volcanic rocks are these carbonate rocks

721
00:27:33,430 --> 00:27:32,320
are these some something else uh you

722
00:27:35,190 --> 00:27:33,440
know they have

723
00:27:37,110 --> 00:27:35,200
coatings on them we don't know we don't

724
00:27:38,549 --> 00:27:37,120
have any chemical data or mineral data

725
00:27:40,549 --> 00:27:38,559
on them yet but boy they're certainly

726
00:27:42,310 --> 00:27:40,559
interesting and part of the story about

727
00:27:45,110 --> 00:27:42,320
what's going on here is

728
00:27:46,950 --> 00:27:45,120
is is going to be told when we get more

729
00:27:49,110 --> 00:27:46,960
detailed information

730
00:27:50,789 --> 00:27:49,120
on these these rocks and some of the

731
00:27:52,710 --> 00:27:50,799
other materials in this area so let's

732
00:27:55,430 --> 00:27:52,720
zoom back out again

733
00:27:57,669 --> 00:27:55,440
and uh this just gives you a flavor for

734
00:28:00,470 --> 00:27:57,679
what you can do in exploring this

735
00:28:02,789 --> 00:28:00,480
panorama on your own the

736
00:28:05,590 --> 00:28:02,799
nasa photojournal site has released the

737
00:28:07,590 --> 00:28:05,600
full resolution tiff file if you want to

738
00:28:10,230 --> 00:28:07,600

download that it'll take a little while

739
00:28:12,230 --> 00:28:10,240
650 megabytes or so but you want to

740
00:28:14,310 --> 00:28:12,240
wallpaper your bathroom with mars that's

741
00:28:16,149 --> 00:28:14,320
the file to use highest possible

742
00:28:17,750 --> 00:28:16,159
resolution and there are many of us on

743
00:28:20,070 --> 00:28:17,760
the team are just giddy and spending

744
00:28:23,029 --> 00:28:20,080
hours just pouring through this and

745
00:28:24,710 --> 00:28:23,039
place to place it's a lot of fun

746
00:28:26,789 --> 00:28:24,720
we've been waiting we've been spending

747
00:28:31,430 --> 00:28:26,799
years

748
00:28:33,909 --> 00:28:31,440
this site in satellite images from orbit

749
00:28:36,789 --> 00:28:33,919
that are like you know 25 centimeter per

750
00:28:38,470 --> 00:28:36,799
pixel which is amazing from orbit but

751
00:28:41,029 --> 00:28:38,480
you know getting down on the ground and

752
00:28:43,909 --> 00:28:41,039
being able to you know pretty much maybe

753
00:28:45,590 --> 00:28:43,919
soon know what this all is and puzzle

754
00:28:46,789 --> 00:28:45,600
out the story is this just super

755
00:28:50,149 --> 00:28:46,799
exciting

756
00:28:51,990 --> 00:28:50,159
and i'm sure that's a general reaction

757
00:28:54,549 --> 00:28:52,000
from your entire team i mean we're

758
00:28:58,549 --> 00:28:54,559
taking a zoom

759
00:29:01,110 --> 00:28:58,559
tour of the red planet and that just

760
00:29:03,029 --> 00:29:01,120
incredible detail i don't think a lot of

761
00:29:04,710 --> 00:29:03,039
us ever thought in our lifetime to

762
00:29:06,870 --> 00:29:04,720
expect

763
00:29:08,470 --> 00:29:06,880

yeah it's pretty spectacular and and

764
00:29:11,110 --> 00:29:08,480
more is coming

765
00:29:12,870 --> 00:29:11,120
remember this is our lowest resolution

766
00:29:17,510 --> 00:29:12,880
panorama

767
00:29:19,110 --> 00:29:17,520
we will get three times this resolution

768
00:29:21,350 --> 00:29:19,120
and we're starting to get three times

769
00:29:22,789 --> 00:29:21,360
this resolution on selected targets in

770
00:29:24,789 --> 00:29:22,799
the field

771
00:29:26,230 --> 00:29:24,799
and we'll pick that up in earnest once

772
00:29:27,590 --> 00:29:26,240
we come back from the software

773
00:29:29,350 --> 00:29:27,600
transition that's going on now we're

774
00:29:30,789 --> 00:29:29,360
going from the cruise software to the

775
00:29:32,149 --> 00:29:30,799
surface flight software that takes

776
00:29:34,549 --> 00:29:32,159
several days

777
00:29:36,870 --> 00:29:34,559
and so once that process is done we'll

778
00:29:38,789 --> 00:29:36,880
get back to characterizing our cameras

779
00:29:40,389 --> 00:29:38,799
the other instruments will do that they

780
00:29:41,990 --> 00:29:40,399
need to do their calibration their

781
00:29:43,590 --> 00:29:42,000
characterizations

782
00:29:47,590 --> 00:29:43,600
so the whole rover is just sort of

783
00:29:49,430 --> 00:29:47,600
slowly coming alive slowly turning on as

784
00:29:51,430 --> 00:29:49,440
the engineers check out system after

785
00:29:53,269 --> 00:29:51,440
system we're very lucky to have been

786
00:29:54,789 --> 00:29:53,279
turned on and starting our checkouts

787
00:29:56,789 --> 00:29:54,799
very early

788
00:29:58,230 --> 00:29:56,799

and uh and getting all this great stuff

789
00:29:59,990 --> 00:29:58,240
out very quickly

790
00:30:01,590 --> 00:30:00,000
to the public including the raw images

791
00:30:03,990 --> 00:30:01,600
that went into this panorama which had

792
00:30:06,870 --> 00:30:04,000
been released on the

793
00:30:09,269 --> 00:30:06,880
jpl public jpl nasa raw images public

794
00:30:12,070 --> 00:30:09,279
website

795
00:30:14,630 --> 00:30:12,080
and as you might imagine we've got so

796
00:30:16,070 --> 00:30:14,640
many people joining us today on social

797
00:30:17,909 --> 00:30:16,080
media and if you want to have your

798
00:30:20,549 --> 00:30:17,919
questions answered remember to use the

799
00:30:22,630 --> 00:30:20,559
hashtag countdown to mars so let's get

800
00:30:25,350 --> 00:30:22,640
to a few of your questions out there

801
00:30:28,630 --> 00:30:25,360
we've got a lot of them a youtube viewer

802
00:30:31,590 --> 00:30:28,640
asks are the mass cam z pictures used

803
00:30:33,269 --> 00:30:31,600
for stereo vision 3d mapping of the

804
00:30:34,310 --> 00:30:33,279
surface

805
00:30:36,870 --> 00:30:34,320
yes

806
00:30:39,269 --> 00:30:36,880
that is a major major goal of what we

807
00:30:42,710 --> 00:30:39,279
want to do and it's an advancement

808
00:30:44,710 --> 00:30:42,720
that we're able to make over um the mass

809
00:30:46,549 --> 00:30:44,720
cams on curiosity which elsa and her

810
00:30:49,669 --> 00:30:46,559
team at male and space science systems

811
00:30:52,549 --> 00:30:49,679
operate still every day

812
00:30:55,510 --> 00:30:52,559
000 odd mars days after landing back in

813
00:30:57,269 --> 00:30:55,520

2012 so that those cameras which fit on

814
00:31:00,389 --> 00:30:57,279
the same mast we have a copy of that

815
00:31:03,190 --> 00:31:00,399
mast on on perseverance those cameras uh

816
00:31:04,870 --> 00:31:03,200
have one wide angle left eye and one

817
00:31:06,310 --> 00:31:04,880
telephoto right eye and they take

818
00:31:07,750 --> 00:31:06,320
spectacular pictures they're just

819
00:31:09,350 --> 00:31:07,760
amazing you've seen the pictures from

820
00:31:11,990 --> 00:31:09,360
curiosity

821
00:31:13,909 --> 00:31:12,000
the the problem in quotes problem is

822
00:31:16,470 --> 00:31:13,919
it's hard to do stereo you know you have

823
00:31:18,470 --> 00:31:16,480
to do stereo at the the wide angle

824
00:31:20,149 --> 00:31:18,480
scale so it's low resolution stereo

825
00:31:21,909 --> 00:31:20,159
compared to the telephoto lens and it's

826
00:31:24,230 --> 00:31:21,919
just cumbersome to do it and you need a

827
00:31:27,350 --> 00:31:24,240
lot of telephoto images to fill it and

828
00:31:30,310 --> 00:31:27,360
so it's just not as easy and common to

829
00:31:32,470 --> 00:31:30,320
do 3d stereo with the mast cams on

830
00:31:35,590 --> 00:31:32,480
curiosity so the innovation that we

831
00:31:37,669 --> 00:31:35,600
brought with our partners at ms cube did

832
00:31:39,909 --> 00:31:37,679
was to design this zoom system so we

833
00:31:42,230 --> 00:31:39,919
could do stereo at the wide angle like

834
00:31:45,029 --> 00:31:42,240
we've got here and then all the way to

835
00:31:46,870 --> 00:31:45,039
telephoto so there's a right eye this is

836
00:31:49,590 --> 00:31:46,880
the left eye this panorama you're seeing

837
00:31:51,509 --> 00:31:49,600
here of of mask mz there's a right eye

838
00:31:52,950 --> 00:31:51,519

version of this that's much of it is

839
00:31:55,110 --> 00:31:52,960
still on the rover we're trying to get

840
00:31:57,029 --> 00:31:55,120
it down as quickly as we can

841
00:31:58,950 --> 00:31:57,039
and once we get all the right eye data

842
00:32:00,630 --> 00:31:58,960
down we'll take the left and the right

843
00:32:02,310 --> 00:32:00,640
and we're going to get a beautiful

844
00:32:04,950 --> 00:32:02,320
stereo

845
00:32:06,630 --> 00:32:04,960
view of this terrain at that scale and

846
00:32:08,389 --> 00:32:06,640
we'll be doing that left right at all of

847
00:32:11,669 --> 00:32:08,399
our zoom positions for everything that

848
00:32:13,909 --> 00:32:11,679
we do and we use that stereo information

849
00:32:15,430 --> 00:32:13,919
not just for science and the geology and

850
00:32:17,590 --> 00:32:15,440
the topography

851
00:32:20,070 --> 00:32:17,600
but to help our engineering friends and

852
00:32:22,389 --> 00:32:20,080
colleagues who are driving the rover who

853
00:32:25,990 --> 00:32:22,399
need that stereo vision to do hazard

854
00:32:28,389 --> 00:32:26,000
avoidance and traverse planning to guide

855
00:32:30,630 --> 00:32:28,399
our friends on the helicopter team who

856
00:32:31,750 --> 00:32:30,640
are trying to find a safe landing site

857
00:32:33,430 --> 00:32:31,760
uh

858
00:32:35,430 --> 00:32:33,440
take off and landing site for the for

859
00:32:38,230 --> 00:32:35,440
the helicopter they they need stereo

860
00:32:40,310 --> 00:32:38,240
data so mask mz can help with that to

861
00:32:42,149 --> 00:32:40,320
guide our folks our friends putting the

862
00:32:44,149 --> 00:32:42,159
arm down and the drill down onto the

863
00:32:46,230 --> 00:32:44,159

surface they need stereo data they can

864
00:32:47,909 --> 00:32:46,240
get it from the nav cams at lower

865
00:32:50,630 --> 00:32:47,919
resolution we can give them even better

866
00:32:52,789 --> 00:32:50,640
stereo data with the mass cam zs so

867
00:32:55,110 --> 00:32:52,799
doing that kind of stereo is

868
00:32:56,630 --> 00:32:55,120
a hundred percent part of our our goal

869
00:32:58,950 --> 00:32:56,640
and we're going to put a lot of those

870
00:33:02,070 --> 00:32:58,960
great stereo products out for the public

871
00:33:07,430 --> 00:33:04,310
great jim another technical question

872
00:33:09,029 --> 00:33:07,440
from facebook iraquali asks what is the

873
00:33:11,110 --> 00:33:09,039
transfer weight

874
00:33:15,430 --> 00:33:11,120
rate excuse me bandwidth and speed of

875
00:33:20,070 --> 00:33:16,870
oh my gosh do you happen to know that

876
00:33:23,350 --> 00:33:21,029
well

877
00:33:26,549 --> 00:33:23,360
i i don't happen to know the number but

878
00:33:27,990 --> 00:33:26,559
one thing that is um an interesting

879
00:33:29,830 --> 00:33:28,000
number that i just heard the other day

880
00:33:31,269 --> 00:33:29,840
which is you know we start really low

881
00:33:33,269 --> 00:33:31,279
because we have to make sure everything

882
00:33:35,509 --> 00:33:33,279
is working so you start on your really

883
00:33:38,149 --> 00:33:35,519
safe antennas that have lower

884
00:33:39,909 --> 00:33:38,159
transfer rates so that's how we started

885
00:33:42,710 --> 00:33:39,919
and we couldn't get very much up or down

886
00:33:44,389 --> 00:33:42,720
that's also why we had to put our first

887
00:33:46,870 --> 00:33:44,399
four days of commands on the rover

888
00:33:48,789 --> 00:33:46,880

beforehand because we're really starting

889
00:33:50,470 --> 00:33:48,799
out we we wouldn't be able to send it

890
00:33:53,350 --> 00:33:50,480
all up in the beginning on these really

891
00:33:55,590 --> 00:33:53,360
low rate antennas but very quickly on

892
00:33:57,509 --> 00:33:55,600
this mission after we landed everything

893
00:34:00,149 --> 00:33:57,519
was a-okay and they upped their

894
00:34:02,310 --> 00:34:00,159
transmission rates very quickly and i

895
00:34:04,710 --> 00:34:02,320
just heard one of the mission managers

896
00:34:06,870 --> 00:34:04,720
yesterday tell us that

897
00:34:09,829 --> 00:34:06,880
at this point in the mission comparing

898
00:34:11,909 --> 00:34:09,839
perseverance to curiosity we have about

899
00:34:13,750 --> 00:34:11,919
10 times the amount of data coming down

900
00:34:16,550 --> 00:34:13,760
every day that we did eight years ago

901
00:34:18,470 --> 00:34:16,560
when we landed and that's thanks to

902
00:34:20,389 --> 00:34:18,480
the systems working really well and also

903
00:34:23,109 --> 00:34:20,399
that we have more orbiters more assets

904
00:34:25,349 --> 00:34:23,119
at mars that can relay out data for us

905
00:34:27,349 --> 00:34:25,359
and get all this data down otherwise we

906
00:34:29,030 --> 00:34:27,359
would not have had this much data down

907
00:34:30,310 --> 00:34:29,040
already

908
00:34:32,230 --> 00:34:30,320
so

909
00:34:34,629 --> 00:34:32,240
i think the numbers are in the hundreds

910
00:34:35,430 --> 00:34:34,639
of kilobits per second

911
00:34:37,270 --> 00:34:35,440
uh

912
00:34:39,190 --> 00:34:37,280
i think that's we can go to the mega

913
00:34:41,030 --> 00:34:39,200

yeah we can

914
00:34:43,109 --> 00:34:41,040
yeah yeah

915
00:34:45,750 --> 00:34:43,119
and christopher has a follow-up to that

916
00:34:48,629 --> 00:34:45,760
question on facebook as well how much

917
00:34:52,069 --> 00:34:48,639
longer does it take to receive mass cam

918
00:34:53,349 --> 00:34:52,079
z data due to the larger data sets

919
00:34:54,550 --> 00:34:53,359
um

920
00:34:56,230 --> 00:34:54,560
yeah that's a good that's a great

921
00:34:58,710 --> 00:34:56,240
question that's a great question and

922
00:35:01,190 --> 00:34:58,720
it's it's a little complicated because

923
00:35:02,550 --> 00:35:01,200
um we're not in real time contact with

924
00:35:04,390 --> 00:35:02,560
the rover

925
00:35:05,829 --> 00:35:04,400
you know when elsa said it takes a day

926
00:35:07,430 --> 00:35:05,839
to get the commands there in a day to

927
00:35:08,950 --> 00:35:07,440
get back it's not because it's a day at

928
00:35:11,510 --> 00:35:08,960
the speed of light it's because it's a

929
00:35:14,230 --> 00:35:11,520
day on our work calendar

930
00:35:15,510 --> 00:35:14,240
right it's because we communicate

931
00:35:17,910 --> 00:35:15,520
we send

932
00:35:19,670 --> 00:35:17,920
the commands up to the rover once per

933
00:35:21,510 --> 00:35:19,680
approximately once per birthday once per

934
00:35:22,710 --> 00:35:21,520
mars day in the morning when the rover

935
00:35:24,150 --> 00:35:22,720
wakes up

936
00:35:25,910 --> 00:35:24,160
first thing it does it listens hey

937
00:35:28,710 --> 00:35:25,920
eric's going to call me with my to-do

938
00:35:30,870 --> 00:35:28,720

list today and radio that up the deep

939
00:35:32,630 --> 00:35:30,880
space network that nasa runs

940
00:35:34,069 --> 00:35:32,640
gets its command list

941
00:35:35,670 --> 00:35:34,079
and then we're out of contact with it

942
00:35:36,950 --> 00:35:35,680
and it's just executing all those

943
00:35:39,510 --> 00:35:36,960
commands

944
00:35:41,430 --> 00:35:39,520
take these pictures test that instrument

945
00:35:43,349 --> 00:35:41,440
turn on this heater

946
00:35:45,589 --> 00:35:43,359
wiggle the wheels drive two meters

947
00:35:47,430 --> 00:35:45,599
forward whatever it's just a long to do

948
00:35:48,710 --> 00:35:47,440
list with time stamps it's doing it on

949
00:35:50,950 --> 00:35:48,720
its own

950
00:35:52,790 --> 00:35:50,960
and then near the end of its day one of

951
00:35:55,270 --> 00:35:52,800
the orbiters nasa or the european

952
00:35:57,349 --> 00:35:55,280
orbiter comes overhead and rover relays

953
00:35:59,109 --> 00:35:57,359
its results back

954
00:36:00,550 --> 00:35:59,119
through that orbiter and then back to

955
00:36:01,829 --> 00:36:00,560
the earth and sometimes it comes very

956
00:36:03,190 --> 00:36:01,839
quickly sometimes there's a little bit

957
00:36:04,790 --> 00:36:03,200
of a delay

958
00:36:07,829 --> 00:36:04,800
but the end result is we're really

959
00:36:09,670 --> 00:36:07,839
getting a big pile of data once a day

960
00:36:10,950 --> 00:36:09,680
maybe twice a day

961
00:36:12,710 --> 00:36:10,960
sometimes in the middle of the mars

962
00:36:14,230 --> 00:36:12,720
night we get one of those orbiter passes

963
00:36:15,829 --> 00:36:14,240

as well

964
00:36:17,270 --> 00:36:15,839
and so it's it's not we're not

965
00:36:18,710 --> 00:36:17,280
joysticking we're not in real time

966
00:36:19,510 --> 00:36:18,720
contact

967
00:36:20,710 --> 00:36:19,520
but

968
00:36:21,589 --> 00:36:20,720
at least in the first part of this

969
00:36:23,750 --> 00:36:21,599
mission

970
00:36:25,430 --> 00:36:23,760
almost all those bits of ones and zeros

971
00:36:27,750 --> 00:36:25,440
coming back to us have been images the

972
00:36:30,310 --> 00:36:27,760
videos that you saw these spectacular

973
00:36:32,790 --> 00:36:30,320
panoramas lots of engineering data and

974
00:36:35,829 --> 00:36:32,800
telemetry but but the imaging data is

975
00:36:39,030 --> 00:36:35,839
the vast majority of that stream of

976
00:36:45,670 --> 00:36:41,109
all right let's turn to the freezing

977
00:36:48,710 --> 00:36:45,680
cold nights of mars taran on facebook

978
00:36:51,349 --> 00:36:48,720
asks will perseverance send in a night

979
00:36:53,030 --> 00:36:51,359
landscape shot

980
00:36:54,630 --> 00:36:53,040
um

981
00:36:57,349 --> 00:36:54,640
well

982
00:36:59,349 --> 00:36:57,359
yeah yeah absolutely

983
00:37:01,990 --> 00:36:59,359
what i what i really encourage people to

984
00:37:05,030 --> 00:37:02,000
do is imagine that you're the camera on

985
00:37:08,150 --> 00:37:05,040
mars because our mass is up and actually

986
00:37:09,829 --> 00:37:08,160
the mass is that about six feet so as we

987
00:37:12,069 --> 00:37:09,839
look around it's almost like you're

988
00:37:15,510 --> 00:37:12,079

standing there yourself looking around

989
00:37:18,310 --> 00:37:15,520
and they are visible cameras um

990
00:37:20,150 --> 00:37:18,320
they're primarily in the same wavelength

991
00:37:21,910 --> 00:37:20,160
that you can see with your eyes and so

992
00:37:24,550 --> 00:37:21,920
if you're there at night on mars how

993
00:37:27,109 --> 00:37:24,560
much could you see well it's really dark

994
00:37:28,069 --> 00:37:27,119
so we can't see a whole lot and that's

995
00:37:29,829 --> 00:37:28,079
that's

996
00:37:32,310 --> 00:37:29,839
where we're at we're not going to take

997
00:37:33,190 --> 00:37:32,320
images at night for that reason

998
00:37:36,310 --> 00:37:33,200
um

999
00:37:37,990 --> 00:37:36,320
and also because it's extremely cold i

1000
00:37:40,390 --> 00:37:38,000
mean i was just looking at temperatures

1001
00:37:42,790 --> 00:37:40,400
the other day we get down to minus 80

1002
00:37:44,790 --> 00:37:42,800
degrees celsius on our cameras

1003
00:37:47,270 --> 00:37:44,800
and we do have heaters on board we use

1004
00:37:49,270 --> 00:37:47,280
them even in the morning or later in the

1005
00:37:50,710 --> 00:37:49,280
afternoon if we need when we need to we

1006
00:37:52,950 --> 00:37:50,720
use the heaters

1007
00:37:54,230 --> 00:37:52,960
but that much energy to heat us up that

1008
00:37:55,910 --> 00:37:54,240
much in the middle of the night that

1009
00:37:57,829 --> 00:37:55,920
would just be prohibitive

1010
00:37:59,750 --> 00:37:57,839
so you've got two things against you got

1011
00:38:01,190 --> 00:37:59,760
no light and you got too cold of a

1012
00:38:03,910 --> 00:38:01,200
temperature

1013
00:38:05,750 --> 00:38:03,920

so we generally don't do it except for a

1014
00:38:07,670 --> 00:38:05,760
few um

1015
00:38:09,270 --> 00:38:07,680
a few occasions when we might be looking

1016
00:38:11,910 --> 00:38:09,280
up into the sky

1017
00:38:14,150 --> 00:38:11,920
and um doing that at night time but we

1018
00:38:15,829 --> 00:38:14,160
do have to set it up beforehand again we

1019
00:38:18,550 --> 00:38:15,839
don't want to heat everything up it's

1020
00:38:21,030 --> 00:38:18,560
the cameras it's the mask the

1021
00:38:22,790 --> 00:38:21,040
massive mask that you saw that has to be

1022
00:38:24,950 --> 00:38:22,800
heated as well so you want to set it up

1023
00:38:26,950 --> 00:38:24,960
beforehand so all you have to do is open

1024
00:38:29,990 --> 00:38:26,960
the shutter to take the image

1025
00:38:32,470 --> 00:38:30,000
and then be done with your job

1026
00:38:34,310 --> 00:38:32,480
i'll i'll just add that you know you're

1027
00:38:35,030 --> 00:38:34,320
absolute that's a great description elsa

1028
00:38:36,710 --> 00:38:35,040
and

1029
00:38:38,790 --> 00:38:36,720
um you know the

1030
00:38:40,390 --> 00:38:38,800
science goals of our mission are are

1031
00:38:42,630 --> 00:38:40,400
focused on

1032
00:38:45,349 --> 00:38:42,640
geology mineralogy chemistry also

1033
00:38:47,109 --> 00:38:45,359
atmospheric science typically daytime

1034
00:38:48,470 --> 00:38:47,119
but the weather station the meta weather

1035
00:38:49,910 --> 00:38:48,480
station will be measuring nighttime

1036
00:38:51,510 --> 00:38:49,920
temperatures and pressures and all that

1037
00:38:53,910 --> 00:38:51,520
kind of stuff so

1038
00:38:55,910 --> 00:38:53,920

for imaging it's difficult at night

1039
00:38:57,990 --> 00:38:55,920
these are these are cameras not

1040
00:38:58,870 --> 00:38:58,000
telescopes right it's not like taking

1041
00:39:00,630 --> 00:38:58,880
your

1042
00:39:03,109 --> 00:39:00,640
big light bucket telescope out in the

1043
00:39:04,870 --> 00:39:03,119
yard and collecting faint signals these

1044
00:39:06,310 --> 00:39:04,880
are just cameras so

1045
00:39:08,470 --> 00:39:06,320
you know if you just point and shoot

1046
00:39:10,470 --> 00:39:08,480
with your iphone or your android phone

1047
00:39:12,310 --> 00:39:10,480
it's it's hard to get deep space

1048
00:39:14,710 --> 00:39:12,320
astrophotography kind of data out of

1049
00:39:17,589 --> 00:39:14,720
that so we can see bright stars we can

1050
00:39:19,030 --> 00:39:17,599
see phobos and demos the moons of mars

1051
00:39:20,550 --> 00:39:19,040
and we'll do some of that science we'll

1052
00:39:22,310 --> 00:39:20,560
do some of that nighttime science it

1053
00:39:24,230 --> 00:39:22,320
helps us understand the atmosphere and

1054
00:39:26,790 --> 00:39:24,240
the moons themselves

1055
00:39:28,950 --> 00:39:26,800
and it's sort of great bonus science if

1056
00:39:31,030 --> 00:39:28,960
we have the power to run the heaters if

1057
00:39:33,670 --> 00:39:31,040
we have the power to run the cameras

1058
00:39:35,430 --> 00:39:33,680
uh if there's scientific questions and

1059
00:39:38,550 --> 00:39:35,440
scientific interests that we can direct

1060
00:39:40,710 --> 00:39:38,560
at it we'll do that and we'll also i i

1061
00:39:44,470 --> 00:39:40,720
predict i mean nothing is formally

1062
00:39:46,390 --> 00:39:44,480
planned but i predict we will do some

1063
00:39:48,069 --> 00:39:46,400

relatively fun kind of things like take

1064
00:39:49,829 --> 00:39:48,079
some pictures of the earth

1065
00:39:52,230 --> 00:39:49,839
you know take this has been done on

1066
00:39:54,390 --> 00:39:52,240
previous rover and lander missions

1067
00:39:56,470 --> 00:39:54,400
uh we will take one you know these are

1068
00:39:58,069 --> 00:39:56,480
the ultimate selfies right everybody on

1069
00:40:00,790 --> 00:39:58,079
the earth and that one

1070
00:40:02,790 --> 00:40:00,800
pale blue dot in the sky and so we'll

1071
00:40:04,790 --> 00:40:02,800
probably do some sort of fun stuff like

1072
00:40:07,430 --> 00:40:04,800
that too

1073
00:40:10,150 --> 00:40:07,440
and speaking of atmospheric science

1074
00:40:13,589 --> 00:40:10,160
glenn on facebook asks does condensation

1075
00:40:15,109 --> 00:40:13,599
form at night on mars

1076
00:40:17,109 --> 00:40:15,119
kjaert is the physicist so he should

1077
00:40:20,550 --> 00:40:17,119
take that question

1078
00:40:22,230 --> 00:40:20,560
well it happens um probably not that

1079
00:40:23,510 --> 00:40:22,240
much here because we're close to the

1080
00:40:25,349 --> 00:40:23,520
equator

1081
00:40:27,190 --> 00:40:25,359
and there's not that much moisture

1082
00:40:28,870 --> 00:40:27,200
there's actually some pretty amazing

1083
00:40:31,030 --> 00:40:28,880
images from biking

1084
00:40:32,309 --> 00:40:31,040
with frost on the ground

1085
00:40:34,069 --> 00:40:32,319
um so

1086
00:40:36,550 --> 00:40:34,079
it happens but it will be frost

1087
00:40:38,470 --> 00:40:36,560
conditions condensating because the uh

1088
00:40:39,349 --> 00:40:38,480

the atmosphere is so thin

1089
00:40:40,230 --> 00:40:39,359
that

1090
00:40:42,870 --> 00:40:40,240
when

1091
00:40:43,910 --> 00:40:42,880
that the water can can be a gas or it

1092
00:40:46,950 --> 00:40:43,920
can be

1093
00:40:49,190 --> 00:40:46,960
ice a frost but it cannot be liquid

1094
00:40:50,630 --> 00:40:49,200
and so it will go to frost on the ground

1095
00:40:52,630 --> 00:40:50,640
and then it will go straight back up in

1096
00:40:54,870 --> 00:40:52,640
the atmosphere but you can get like

1097
00:40:56,790 --> 00:40:54,880
especially if you're not on the equator

1098
00:40:59,589 --> 00:40:56,800
or close to the equator like we are you

1099
00:41:03,190 --> 00:40:59,599
can get like a frosty morning that

1100
00:41:08,630 --> 00:41:05,589
and rachel on facebook asks how do you

1101
00:41:11,349 --> 00:41:08,640
deal with dust on the lenses

1102
00:41:12,710 --> 00:41:11,359
well that's a great question uh i get i

1103
00:41:14,470 --> 00:41:12,720
get that question every single time

1104
00:41:15,349 --> 00:41:14,480
that's that's a wonderful question

1105
00:41:16,950 --> 00:41:15,359
um

1106
00:41:19,670 --> 00:41:16,960
we actually uh

1107
00:41:23,030 --> 00:41:19,680
we don't do a lot about it actually we

1108
00:41:25,430 --> 00:41:23,040
mitigate mitigate we we prevent uh dust

1109
00:41:27,270 --> 00:41:25,440
from collecting on the lens by pointing

1110
00:41:29,190 --> 00:41:27,280
the cameras down when we're not using

1111
00:41:30,390 --> 00:41:29,200
them that that end of the mass we just

1112
00:41:32,790 --> 00:41:30,400
point it down

1113
00:41:34,150 --> 00:41:32,800

and uh that that prevents the dust it's

1114
00:41:36,309 --> 00:41:34,160
always falling gently out of the

1115
00:41:37,670 --> 00:41:36,319
atmosphere from collecting on our lenses

1116
00:41:39,750 --> 00:41:37,680
but we know that dust is going to

1117
00:41:41,829 --> 00:41:39,760
collect on our lenses when when we're

1118
00:41:43,750 --> 00:41:41,839
imaging and especially up at the sky and

1119
00:41:44,630 --> 00:41:43,760
all that and we can't point down all the

1120
00:41:45,990 --> 00:41:44,640
time

1121
00:41:47,910 --> 00:41:46,000
and we don't have any little wiper

1122
00:41:51,589 --> 00:41:47,920
blades or anything like that no way to

1123
00:41:53,750 --> 00:41:51,599
no covers to to protect them so we just

1124
00:41:55,829 --> 00:41:53,760
we know that the lenses are going to get

1125
00:41:59,190 --> 00:41:55,839
a little bit dusty over time

1126
00:42:01,750 --> 00:41:59,200
and uh and sort of two things uh one if

1127
00:42:04,150 --> 00:42:01,760
anybody who wears glasses i wear glasses

1128
00:42:05,589 --> 00:42:04,160
for contacts but i also wear glasses you

1129
00:42:07,109 --> 00:42:05,599
take your glasses off and just look at

1130
00:42:09,030 --> 00:42:07,119
them elsa look at your glasses they're

1131
00:42:10,390 --> 00:42:09,040
probably kind of filthy dirty right

1132
00:42:12,069 --> 00:42:10,400
they've got dust all over them and

1133
00:42:13,349 --> 00:42:12,079
specks and hair

1134
00:42:15,910 --> 00:42:13,359
but you put them on and you can still

1135
00:42:18,710 --> 00:42:15,920
see through them right and it's it's not

1136
00:42:20,870 --> 00:42:18,720
that bad you get a little bit of dust um

1137
00:42:22,790 --> 00:42:20,880
and so we can live with that and if it

1138
00:42:24,710 --> 00:42:22,800

does get a little thicker we can correct

1139
00:42:26,630 --> 00:42:24,720
for that with our calibration that

1140
00:42:29,430 --> 00:42:26,640
curtain and others are working on

1141
00:42:31,109 --> 00:42:29,440
and secondly what we've discovered

1142
00:42:33,109 --> 00:42:31,119
in previous missions

1143
00:42:35,030 --> 00:42:33,119
is that once in a while the winds of

1144
00:42:36,710 --> 00:42:35,040
mars come and they

1145
00:42:38,870 --> 00:42:36,720
blow the dust off

1146
00:42:40,710 --> 00:42:38,880
off the deck of the rover off the

1147
00:42:42,630 --> 00:42:40,720
calibration targets

1148
00:42:45,349 --> 00:42:42,640
off the lenses

1149
00:42:46,550 --> 00:42:45,359
and uh so mars has been actually pretty

1150
00:42:48,950 --> 00:42:46,560
helpful

1151
00:42:50,470 --> 00:42:48,960
in past missions and keeping our our

1152
00:42:51,349 --> 00:42:50,480
lenses clean but

1153
00:42:57,270 --> 00:42:51,359
our

1154
00:42:59,109 --> 00:42:57,280
and just point them down

1155
00:43:00,230 --> 00:42:59,119
i'll add a little something to that

1156
00:43:03,030 --> 00:43:00,240
because

1157
00:43:05,109 --> 00:43:03,040
exactly this reason of the dust is why

1158
00:43:07,750 --> 00:43:05,119
we had to get going really quickly

1159
00:43:09,990 --> 00:43:07,760
without imaging we wanted to take images

1160
00:43:12,230 --> 00:43:10,000
as soon as we could of a clean rover

1161
00:43:14,230 --> 00:43:12,240
deck well as curtin can attest to it

1162
00:43:16,550 --> 00:43:14,240
wasn't entirely clean because you know

1163
00:43:18,550 --> 00:43:16,560

all the dust that was kicked up but

1164
00:43:21,750 --> 00:43:18,560
specifically for carton and the other

1165
00:43:24,630 --> 00:43:21,760
scientists um on our team jim being

1166
00:43:27,030 --> 00:43:24,640
another um big proponent of this we

1167
00:43:29,910 --> 00:43:27,040
wanted to look at the deck as as cleanly

1168
00:43:31,990 --> 00:43:29,920
as we could so we can compare that to

1169
00:43:33,430 --> 00:43:32,000
all the data that comes after and that

1170
00:43:35,990 --> 00:43:33,440
was one of the big reasons we were

1171
00:43:38,069 --> 00:43:36,000
allowed to image as early as we did and

1172
00:43:41,030 --> 00:43:38,079
in fact even the day before we imaged

1173
00:43:43,030 --> 00:43:41,040
this one we took um

1174
00:43:46,069 --> 00:43:43,040
we took a huge amount of calibration

1175
00:43:47,990 --> 00:43:46,079
target data and um that was really so

1176
00:43:49,270 --> 00:43:48,000
that the calibration could compare to

1177
00:43:51,589 --> 00:43:49,280
that for the rest of the mission and

1178
00:43:53,510 --> 00:43:51,599
we'll continue to do that and monitor

1179
00:43:55,270 --> 00:43:53,520
you know take images on a regular basis

1180
00:43:56,870 --> 00:43:55,280
to monitor the dust

1181
00:43:57,670 --> 00:43:56,880
that's accumulating

1182
00:44:01,109 --> 00:43:57,680
and

1183
00:44:02,309 --> 00:44:01,119
there's some special places on the cal

1184
00:44:04,630 --> 00:44:02,319
target that

1185
00:44:09,829 --> 00:44:04,640
deals with dust

1186
00:44:13,589 --> 00:44:11,510
so it's obviously a problem for the

1187
00:44:16,230 --> 00:44:13,599
calibration target too that and that is

1188
00:44:19,829 --> 00:44:16,240

always facing upwards and dust will

1189
00:44:21,349 --> 00:44:19,839
drizzle on them no um sliding the the

1190
00:44:24,230 --> 00:44:21,359
major slide

1191
00:44:26,309 --> 00:44:24,240
um so they get they will gradually get

1192
00:44:28,390 --> 00:44:26,319
dusty and sometimes the dust will get

1193
00:44:31,109 --> 00:44:28,400
blown off a little bit and they will get

1194
00:44:33,030 --> 00:44:31,119
that's the one um and actually right at

1195
00:44:35,349 --> 00:44:33,040
landing there's a bunch of dust that

1196
00:44:37,270 --> 00:44:35,359
gets kicked up by the rockets right we

1197
00:44:39,349 --> 00:44:37,280
wanted to image it right after landings

1198
00:44:41,270 --> 00:44:39,359
as quickly as possible that's the the

1199
00:44:43,190 --> 00:44:41,280
cleanest it's ever going to be

1200
00:44:46,150 --> 00:44:43,200
um but it has these you can see how the

1201
00:44:47,750 --> 00:44:46,160
dust just rings around the patches

1202
00:44:49,670 --> 00:44:47,760
and that's because we build in these

1203
00:44:51,670 --> 00:44:49,680
very strong

1204
00:44:53,750 --> 00:44:51,680
hollow cylinder magnets that are sitting

1205
00:44:56,230 --> 00:44:53,760
right underneath those surfaces and they

1206
00:44:58,550 --> 00:44:56,240
attract the dust to where the magnet is

1207
00:45:00,950 --> 00:44:58,560
but in the middle the magnet is not

1208
00:45:03,270 --> 00:45:00,960
and that area is kept fairly clean of

1209
00:45:05,430 --> 00:45:03,280
dust and that will work also for the

1210
00:45:07,670 --> 00:45:05,440
dust in the martian atmosphere it works

1211
00:45:09,750 --> 00:45:07,680
because there's iron in the dust both in

1212
00:45:12,150 --> 00:45:09,760
this dust and in the dust that comes

1213
00:45:13,829 --> 00:45:12,160

drizzling down from the atmosphere so

1214
00:45:16,710 --> 00:45:13,839
those magnets are going to keep those

1215
00:45:18,550 --> 00:45:16,720
little areas pretty much clean of dust

1216
00:45:20,230 --> 00:45:18,560
and those colors are going to be like

1217
00:45:22,950 --> 00:45:20,240
they were in the lab when we measured

1218
00:45:24,230 --> 00:45:22,960
them and and we're going to be trusting

1219
00:45:26,230 --> 00:45:24,240
them still

1220
00:45:27,910 --> 00:45:26,240
but another thing is that

1221
00:45:29,910 --> 00:45:27,920
on other parts of the calibration target

1222
00:45:31,349 --> 00:45:29,920
it will gradually get dusty and we will

1223
00:45:34,069 --> 00:45:31,359
be able to monitor that and that's

1224
00:45:37,430 --> 00:45:34,079
actually kind of a little extra um

1225
00:45:38,870 --> 00:45:37,440
a piece of of a meteorological data

1226
00:45:40,870 --> 00:45:38,880
because we can sort of tell when the

1227
00:45:42,630 --> 00:45:40,880
dust is falling and when it gets blown

1228
00:45:44,069 --> 00:45:42,640
off and it's like a seasonal thing on

1229
00:45:46,390 --> 00:45:44,079
mars

1230
00:45:49,349 --> 00:45:46,400
i'll i'll mention that uh

1231
00:45:50,230 --> 00:45:49,359
kyoton wrote a great uh blog piece on

1232
00:45:51,750 --> 00:45:50,240
our

1233
00:45:54,069 --> 00:45:51,760
public website in marina we'll give you

1234
00:45:56,630 --> 00:45:54,079
the address at the end all about this

1235
00:45:58,630 --> 00:45:56,640
target and all about the magnets and

1236
00:46:01,510 --> 00:45:58,640
that why the colors were chosen and the

1237
00:46:03,589 --> 00:46:01,520
little messages and and vignettes and

1238
00:46:04,710 --> 00:46:03,599

all that and the the sort of

1239
00:46:07,349 --> 00:46:04,720
uh

1240
00:46:09,190 --> 00:46:07,359
artistic elements that we were able to

1241
00:46:11,109 --> 00:46:09,200
put on this with help from the planetary

1242
00:46:13,510 --> 00:46:11,119
society and mark hilverda who's an

1243
00:46:15,829 --> 00:46:13,520
artist who works with with the society

1244
00:46:18,390 --> 00:46:15,839
and a small group of us on the team so

1245
00:46:21,589 --> 00:46:18,400
encourage folks to check out curtin's uh

1246
00:46:24,069 --> 00:46:21,599
article that's on our website

1247
00:46:25,829 --> 00:46:24,079
and speaking of that for kiarten j.e

1248
00:46:27,990 --> 00:46:25,839
bruce on twitter wants to know where he

1249
00:46:31,030 --> 00:46:28,000
can get his hands on one of those

1250
00:46:33,349 --> 00:46:31,040
sundials and can you tell us more about

1251
00:46:35,349 --> 00:46:33,359
the sundial

1252
00:46:38,069 --> 00:46:35,359
maybe i should start a company and just

1253
00:46:41,990 --> 00:46:40,470
we have a few spears when you send an

1254
00:46:43,829 --> 00:46:42,000
instrument you have to build a flight

1255
00:46:45,990 --> 00:46:43,839
spear in case something goes wrong with

1256
00:46:47,829 --> 00:46:46,000
the instrument before you launch so we

1257
00:46:50,470 --> 00:46:47,839
actually have two flight spears they're

1258
00:46:51,270 --> 00:46:50,480
not paseo and we have a few extra sort

1259
00:46:53,270 --> 00:46:51,280
of

1260
00:46:55,030 --> 00:46:53,280
test units

1261
00:46:56,630 --> 00:46:55,040
but it's only a little handful and

1262
00:46:58,630 --> 00:46:56,640
they'll probably wind up in museums

1263
00:47:01,270 --> 00:46:58,640

where you might be able to see him tim

1264
00:47:03,670 --> 00:47:01,280
has a 3d printed version there and we we

1265
00:47:05,510 --> 00:47:03,680
do we do have 3d print files that maybe

1266
00:47:07,349 --> 00:47:05,520
we'll put out at some point we should

1267
00:47:09,270 --> 00:47:07,359
put the 3d print files on our public

1268
00:47:11,109 --> 00:47:09,280
website if you're willing to do yeah we

1269
00:47:12,550 --> 00:47:11,119
could do that yeah sure absolutely this

1270
00:47:15,430 --> 00:47:12,560
just gives you a sense of scale this is

1271
00:47:17,990 --> 00:47:15,440
full size yep so yeah there it is and we

1272
00:47:20,309 --> 00:47:18,000
did have uh you mentioned museums we had

1273
00:47:22,630 --> 00:47:20,319
the the flight spare for the spirit and

1274
00:47:26,150 --> 00:47:22,640
opportunity cal target was on display in

1275
00:47:29,910 --> 00:47:28,470
special exhibits about those rovers so

1276
00:47:31,190 --> 00:47:29,920
lots of people put their eyes on that

1277
00:47:34,230 --> 00:47:31,200
one

1278
00:47:36,230 --> 00:47:34,240
yeah i remember i went there jim and i i

1279
00:47:38,710 --> 00:47:36,240
wrote that i i just came back from

1280
00:47:40,309 --> 00:47:38,720
standing in the in the in the august

1281
00:47:42,549 --> 00:47:40,319
presence of the

1282
00:47:44,390 --> 00:47:42,559
of the apollo 11 command module and you

1283
00:47:46,549 --> 00:47:44,400
wrote back how about the august presence

1284
00:47:48,390 --> 00:47:46,559
of the spear

1285
00:47:50,549 --> 00:47:48,400
pancan celtic

1286
00:47:53,589 --> 00:47:50,559
yes and i said that was a flight spear

1287
00:47:56,870 --> 00:47:53,599
it wasn't the flight culture

1288
00:47:58,630 --> 00:47:56,880

anyway well as a meteorologist we

1289
00:48:00,470 --> 00:47:58,640
as a meteorologist we're getting tons of

1290
00:48:02,790 --> 00:48:00,480
weather questions so i'm really excited

1291
00:48:04,870 --> 00:48:02,800
about that everyone is very excited

1292
00:48:07,190 --> 00:48:04,880
talking about the weather on mars on

1293
00:48:10,390 --> 00:48:07,200
social media this afternoon chopra on

1294
00:48:12,470 --> 00:48:10,400
facebook asks any storms expected there

1295
00:48:16,309 --> 00:48:12,480
and how do you manage them and how would

1296
00:48:23,589 --> 00:48:19,349
yeah i mean we don't manage the weather

1297
00:48:26,710 --> 00:48:23,599
do not manage it uh absolutely uh but uh

1298
00:48:28,950 --> 00:48:26,720
you know the the the great thing about

1299
00:48:31,829 --> 00:48:28,960
the fact that we've had 60 years of

1300
00:48:34,710 --> 00:48:31,839
exploring mars with flybys orbiters

1301
00:48:37,190 --> 00:48:34,720
landers and rovers is that we really

1302
00:48:39,750 --> 00:48:37,200
know a lot about the weather and it is

1303
00:48:41,910 --> 00:48:39,760
very repeatable from year to year not

1304
00:48:43,670 --> 00:48:41,920
precisely some years are different some

1305
00:48:45,270 --> 00:48:43,680
years have these big dust storms that

1306
00:48:47,430 --> 00:48:45,280
cover the whole planet we don't really

1307
00:48:50,230 --> 00:48:47,440
understand why those form forms some

1308
00:48:52,390 --> 00:48:50,240
years not others but in general you know

1309
00:48:54,390 --> 00:48:52,400
everywhere on mars has a dusty season

1310
00:48:56,390 --> 00:48:54,400
and a less dusty season and there's

1311
00:48:58,870 --> 00:48:56,400
always small dust storms

1312
00:49:00,549 --> 00:48:58,880
all the time and sometimes it's cloudy

1313
00:49:02,150 --> 00:49:00,559

and with water ice clouds and sometimes

1314
00:49:04,549 --> 00:49:02,160
it's not but we understand a lot about

1315
00:49:06,710 --> 00:49:04,559
those patterns from these previous

1316
00:49:08,790 --> 00:49:06,720
missions and so you know we landed at a

1317
00:49:11,990 --> 00:49:08,800
time that's not a particularly

1318
00:49:14,069 --> 00:49:12,000
problematic for dust storms but there

1319
00:49:15,990 --> 00:49:14,079
will come a time when there will be

1320
00:49:18,309 --> 00:49:16,000
more of an issue for dust it's not so

1321
00:49:20,470 --> 00:49:18,319
much of a concern for perseverance and

1322
00:49:22,630 --> 00:49:20,480
curiosity nuclear-powered rovers as

1323
00:49:25,510 --> 00:49:22,640
opposed to the solar-powered rovers

1324
00:49:27,990 --> 00:49:25,520
spirit opportunity and solar-powered

1325
00:49:30,230 --> 00:49:28,000
missions like insight

1326
00:49:32,870 --> 00:49:30,240
you know that ultimately it was mars

1327
00:49:34,710 --> 00:49:32,880
dust and dust storms that killed

1328
00:49:37,190 --> 00:49:34,720
both spirit and opportunity because of

1329
00:49:40,150 --> 00:49:37,200
the dust settling on those solar panels

1330
00:49:43,030 --> 00:49:40,160
and the dust darkening the sky uh and

1331
00:49:44,230 --> 00:49:43,040
cutting off their solar power uh so we

1332
00:49:45,510 --> 00:49:44,240
we care about the way it changes

1333
00:49:47,990 --> 00:49:45,520
temperatures we care about the way it

1334
00:49:50,630 --> 00:49:48,000
could mess up our lenses

1335
00:49:52,630 --> 00:49:50,640
uh so we do follow it and track it and

1336
00:49:54,470 --> 00:49:52,640
pay attention to it but

1337
00:49:55,750 --> 00:49:54,480
honestly we mostly care about it

1338
00:49:57,510 --> 00:49:55,760

scientifically because it's a really

1339
00:49:58,950 --> 00:49:57,520
interesting part of the weather

1340
00:50:00,870 --> 00:49:58,960
and we're trying to learn as much as we

1341
00:50:01,750 --> 00:50:00,880
can about the weather on mars so that

1342
00:50:03,670 --> 00:50:01,760
once

1343
00:50:05,589 --> 00:50:03,680
future astronauts and settlers go there

1344
00:50:07,589 --> 00:50:05,599
within the next few decades

1345
00:50:09,589 --> 00:50:07,599
they'll have a really good understanding

1346
00:50:11,190 --> 00:50:09,599
of what to expect and when at different

1347
00:50:13,349 --> 00:50:11,200
times a year

1348
00:50:14,790 --> 00:50:13,359
elsa

1349
00:50:16,870 --> 00:50:14,800
and then there's also a little story

1350
00:50:19,589 --> 00:50:16,880
about how we captured some sand in the

1351
00:50:21,829 --> 00:50:19,599
uh cameras with curiosity

1352
00:50:24,230 --> 00:50:21,839
that gave us a nice lesson learned for

1353
00:50:26,390 --> 00:50:24,240
for this mission so what happened was

1354
00:50:27,510 --> 00:50:26,400
during dust storms on mars

1355
00:50:30,870 --> 00:50:27,520
um

1356
00:50:33,589 --> 00:50:30,880
sand with deposit we have these long

1357
00:50:35,910 --> 00:50:33,599
lens covers that keep straight light

1358
00:50:37,270 --> 00:50:35,920
from coming into our images

1359
00:50:39,589 --> 00:50:37,280
well they're also really good at

1360
00:50:41,190 --> 00:50:39,599
trapping small saints small small

1361
00:50:42,230 --> 00:50:41,200
amounts of sand

1362
00:50:44,230 --> 00:50:42,240
and

1363
00:50:46,470 --> 00:50:44,240

we didn't even think about this

1364
00:50:48,790 --> 00:50:46,480
um until one day

1365
00:50:50,950 --> 00:50:48,800
when we were looking up at the skies we

1366
00:50:52,790 --> 00:50:50,960
talked about and we take images you know

1367
00:50:55,430 --> 00:50:52,800
at different angles to look at the

1368
00:50:57,589 --> 00:50:55,440
atmosphere and we notice there's some

1369
00:50:58,790 --> 00:50:57,599
there seems to be something off there's

1370
00:50:59,910 --> 00:50:58,800
definitely something off in these

1371
00:51:01,349 --> 00:50:59,920
measurements

1372
00:51:03,829 --> 00:51:01,359
and we looked into it further and we

1373
00:51:05,430 --> 00:51:03,839
compared you know over time how did this

1374
00:51:08,950 --> 00:51:05,440
exhibit itself

1375
00:51:10,790 --> 00:51:08,960
and uh mark lemon who's one of our most

1376
00:51:13,270 --> 00:51:10,800
prominent atmospheric scientists looked

1377
00:51:15,030 --> 00:51:13,280
at his data as well and we realized

1378
00:51:16,630 --> 00:51:15,040
there's something in front there is

1379
00:51:19,270 --> 00:51:16,640
absolutely something in front so we took

1380
00:51:21,990 --> 00:51:19,280
some experiments um and we determined

1381
00:51:25,030 --> 00:51:22,000
that yes indeed when you go up and when

1382
00:51:27,829 --> 00:51:25,040
you go down it looks different just very

1383
00:51:31,030 --> 00:51:29,430
proof really

1384
00:51:33,190 --> 00:51:31,040
a strong indicator as we say in the

1385
00:51:35,270 --> 00:51:33,200
scientific world

1386
00:51:36,950 --> 00:51:35,280
that we have stand inside the lenses

1387
00:51:39,190 --> 00:51:36,960
well you can't just go up there and sort

1388
00:51:40,390 --> 00:51:39,200

of shake it out right that that's not

1389
00:51:43,190 --> 00:51:40,400
how it works

1390
00:51:46,790 --> 00:51:43,200
um so we still have a little of it um

1391
00:51:49,430 --> 00:51:46,800
inside the the covers on curiosity and

1392
00:51:50,470 --> 00:51:49,440
what we learned from that was on these

1393
00:51:52,950 --> 00:51:50,480
cameras

1394
00:51:55,430 --> 00:51:52,960
we drilled a little tiny hole in the

1395
00:51:57,670 --> 00:51:55,440
enclosure so that if we do get sand

1396
00:52:00,390 --> 00:51:57,680
inside this time it will trickle out on

1397
00:52:02,390 --> 00:52:00,400
its own and we won't have this problem

1398
00:52:04,549 --> 00:52:02,400
yep little drain holes

1399
00:52:06,870 --> 00:52:04,559
good lesson from curiosity it's actually

1400
00:52:08,710 --> 00:52:06,880
kind of amazing that little sand grains

1401
00:52:10,309 --> 00:52:08,720
are hopping across the surface and

1402
00:52:11,910 --> 00:52:10,319
bouncing up

1403
00:52:14,790 --> 00:52:11,920
six feet

1404
00:52:16,309 --> 00:52:14,800
and going into the front of our

1405
00:52:17,910 --> 00:52:16,319
the lenses are set back a little bit

1406
00:52:19,910 --> 00:52:17,920
there's like a sun shade and a baffle so

1407
00:52:22,150 --> 00:52:19,920
there's a little bit of volume there

1408
00:52:23,430 --> 00:52:22,160
and on curiosity they're hopping up in

1409
00:52:25,109 --> 00:52:23,440
there getting in there it's totally

1410
00:52:27,910 --> 00:52:25,119
surprising

1411
00:52:30,230 --> 00:52:27,920
okay like the storms are not

1412
00:52:32,309 --> 00:52:30,240
the storms you know the winds can be

1413
00:52:34,069 --> 00:52:32,319

high speed but the atmosphere is so thin

1414
00:52:35,910 --> 00:52:34,079
that the power in them is not very high

1415
00:52:37,990 --> 00:52:35,920
it's not like it's going to jiggle the

1416
00:52:40,069 --> 00:52:38,000
rover or tip it over or anything like

1417
00:52:41,990 --> 00:52:40,079
that but it can still move sand and

1418
00:52:43,750 --> 00:52:42,000
obviously dust but but it's kind of

1419
00:52:46,630 --> 00:52:43,760
surprising how much it can move sand

1420
00:52:48,630 --> 00:52:46,640
even though it's such a thin atmosphere

1421
00:52:50,950 --> 00:52:48,640
yeah it's like that carved rock you know

1422
00:52:52,950 --> 00:52:50,960
how long it took to do that you know

1423
00:52:55,030 --> 00:52:52,960
that a lot of people have seen the movie

1424
00:52:56,710 --> 00:52:55,040
the martian and there's that scene in

1425
00:52:57,510 --> 00:52:56,720
the beginning with this violent storm

1426
00:52:59,910 --> 00:52:57,520
you know

1427
00:53:01,589 --> 00:52:59,920
i mean it's it's a dramatic and fun

1428
00:53:03,430 --> 00:53:01,599
scene but it's science fiction i mean

1429
00:53:05,589 --> 00:53:03,440
it's nothing like that i mean the wind

1430
00:53:08,230 --> 00:53:05,599
speeds can be very high but it would be

1431
00:53:09,190 --> 00:53:08,240
like somebody blowing up you know

1432
00:53:11,510 --> 00:53:09,200
feathers

1433
00:53:12,470 --> 00:53:11,520
by you they would feel just so light

1434
00:53:13,829 --> 00:53:12,480
it's so

1435
00:53:16,549 --> 00:53:13,839
thin

1436
00:53:18,870 --> 00:53:16,559
but it moves sand and dust very

1437
00:53:20,630 --> 00:53:18,880
efficiently

1438
00:53:23,030 --> 00:53:20,640

and you're constantly looking towards

1439
00:53:24,630 --> 00:53:23,040
the future and so dbl on twitch asked

1440
00:53:26,150 --> 00:53:24,640
what changes have you made to the rover

1441
00:53:28,790 --> 00:53:26,160
design to better suit the conditions of

1442
00:53:30,790 --> 00:53:28,800
mars which i think elsa just answered

1443
00:53:33,190 --> 00:53:30,800
with adding those holes so that you are

1444
00:53:35,910 --> 00:53:33,200
able to to get that dust off so we'll

1445
00:53:37,990 --> 00:53:35,920
move on to harry on twitter who's asking

1446
00:53:39,910 --> 00:53:38,000
could you please describe the software

1447
00:53:43,190 --> 00:53:39,920
you're using to stitch together that

1448
00:53:45,829 --> 00:53:43,200
panorama is it custom software developed

1449
00:53:48,710 --> 00:53:45,839
in-house or using commercial software

1450
00:53:52,549 --> 00:53:48,720
like lightroom or photoshop if custom

1451
00:53:57,109 --> 00:53:55,430
great question yeah do you want to start

1452
00:53:58,950 --> 00:53:57,119
gym or you want me to take it

1453
00:54:01,190 --> 00:53:58,960
oh you start and i'll finish

1454
00:54:02,950 --> 00:54:01,200
okay sounds great so can we have that

1455
00:54:05,109 --> 00:54:02,960
picture again with the frames on it it

1456
00:54:08,150 --> 00:54:05,119
was a second

1457
00:54:11,589 --> 00:54:08,160
i think it was number five yes perfect

1458
00:54:14,069 --> 00:54:11,599
that is such a great depiction of

1459
00:54:16,549 --> 00:54:14,079
what my life what our team's life looks

1460
00:54:18,230 --> 00:54:16,559
like um on a daily basis

1461
00:54:20,150 --> 00:54:18,240
this is homegrown software as i

1462
00:54:21,510 --> 00:54:20,160
mentioned before john proton wrote it he

1463
00:54:22,710 --> 00:54:21,520

was actually

1464
00:54:25,430 --> 00:54:22,720
um

1465
00:54:27,589 --> 00:54:25,440
way back on murr going back now almost

1466
00:54:29,910 --> 00:54:27,599
20 years he was one of the operators

1467
00:54:32,230 --> 00:54:29,920
that would do commanding and then

1468
00:54:33,990 --> 00:54:32,240
realized at one point you know what i

1469
00:54:35,990 --> 00:54:34,000
can do this software much better than

1470
00:54:37,270 --> 00:54:36,000
anything that's commercially available

1471
00:54:39,270 --> 00:54:37,280
anything that people have thought of

1472
00:54:41,510 --> 00:54:39,280
because he did the job and then he took

1473
00:54:43,589 --> 00:54:41,520
his software programming skills put the

1474
00:54:46,630 --> 00:54:43,599
two together and came up with this tool

1475
00:54:49,510 --> 00:54:46,640
and it it truly is um

1476
00:54:50,549 --> 00:54:49,520
the only uh software of its kind on this

1477
00:54:53,990 --> 00:54:50,559
planet

1478
00:54:57,109 --> 00:54:54,000
so it's specifically customized for um

1479
00:54:59,829 --> 00:54:57,119
visualizing imaging and

1480
00:55:01,430 --> 00:54:59,839
this is just one way of um looking at it

1481
00:55:04,230 --> 00:55:01,440
but there's a lot of details that goes

1482
00:55:06,630 --> 00:55:04,240
into it that's at our fingertips um

1483
00:55:09,030 --> 00:55:06,640
the distances to each

1484
00:55:11,430 --> 00:55:09,040
part of the image what the focus would

1485
00:55:13,910 --> 00:55:11,440
be that would correspond to it there's

1486
00:55:16,150 --> 00:55:13,920
just a tremendous amount of um power

1487
00:55:18,630 --> 00:55:16,160
behind it so we're extremely grateful to

1488
00:55:20,870 --> 00:55:18,640

have this and in fact it's thanks to jim

1489
00:55:23,349 --> 00:55:20,880
working on pan cam with john and then we

1490
00:55:25,349 --> 00:55:23,359
did a beta version for um

1491
00:55:28,309 --> 00:55:25,359
mass cam on msl that we've been running

1492
00:55:30,870 --> 00:55:28,319
now for years all of it with the thought

1493
00:55:34,349 --> 00:55:30,880
that we would get this tool for this

1494
00:55:37,589 --> 00:55:34,359
mission with these cameras and it is

1495
00:55:39,670 --> 00:55:37,599
spectacularly paid off it is exactly i

1496
00:55:41,829 --> 00:55:39,680
mean it's more than i could even imagine

1497
00:55:44,789 --> 00:55:41,839
you know um chris and i were talking the

1498
00:55:46,390 --> 00:55:44,799
other day one of my ops engineers and he

1499
00:55:48,230 --> 00:55:46,400
was just laughing he's like i cannot

1500
00:55:49,829 --> 00:55:48,240
believe this piece of software i don't i

1501
00:55:51,670 --> 00:55:49,839
don't even know everything to do with it

1502
00:55:54,390 --> 00:55:51,680
yet i can't wait till we can explore it

1503
00:55:55,589 --> 00:55:54,400
more and we all feel like that it's it's

1504
00:55:57,750 --> 00:55:55,599
amazing

1505
00:56:00,630 --> 00:55:57,760
so it's a it's there's a lot of custom

1506
00:56:02,470 --> 00:56:00,640
homegrown software but we also do

1507
00:56:05,109 --> 00:56:02,480
occasionally use photoshop or those

1508
00:56:07,109 --> 00:56:05,119
kinds of commercial tools uh to to

1509
00:56:10,710 --> 00:56:07,119
finish some of the processing and

1510
00:56:14,630 --> 00:56:12,069
and like

1511
00:56:16,230 --> 00:56:14,640
oh sorry go ahead go ahead yeah i wanted

1512
00:56:19,670 --> 00:56:16,240
to finish up on the question the

1513
00:56:20,789 --> 00:56:19,680

operating systems um we really use all

1514
00:56:23,270 --> 00:56:20,799
kinds

1515
00:56:25,270 --> 00:56:23,280
we're using

1516
00:56:28,230 --> 00:56:25,280
some of my team runs on macs we also

1517
00:56:29,430 --> 00:56:28,240
have some dells we use linux

1518
00:56:31,829 --> 00:56:29,440
and

1519
00:56:34,150 --> 00:56:31,839
just throughout we are

1520
00:56:35,510 --> 00:56:34,160
a team of hundreds of scientists and

1521
00:56:37,670 --> 00:56:35,520
engineers if you count them all up

1522
00:56:41,030 --> 00:56:37,680
there's probably thousands and we use

1523
00:56:42,710 --> 00:56:41,040
all kinds of of um tools

1524
00:56:44,470 --> 00:56:42,720
make them all work together our tools

1525
00:56:46,470 --> 00:56:44,480
that we run for the mission

1526
00:56:50,069 --> 00:56:46,480
that all of us run have to run on all

1527
00:56:52,150 --> 00:56:50,079
those um you know well-known platforms

1528
00:56:56,870 --> 00:56:52,160
yep and there's all kinds of programming

1529
00:56:59,109 --> 00:56:56,880
in c python matlab idl i got some old

1530
00:57:00,069 --> 00:56:59,119
fortran stuff that i can still use you

1531
00:57:02,150 --> 00:57:00,079
know it's

1532
00:57:04,710 --> 00:57:02,160
it's it's a it's a real

1533
00:57:09,109 --> 00:57:04,720
wide array of programming

1534
00:57:10,950 --> 00:57:09,119
it's a village and thank you so much for

1535
00:57:13,270 --> 00:57:10,960
everyone's questions out there on social

1536
00:57:14,630 --> 00:57:13,280
media so many of you joined us today and

1537
00:57:15,990 --> 00:57:14,640
we'll try to answer some of your

1538
00:57:18,069 --> 00:57:16,000

questions as we progress through the

1539
00:57:20,789 --> 00:57:18,079
rest of the day and tomorrow but thank

1540
00:57:23,510 --> 00:57:20,799
you most of all to jim elsa and kiarten

1541
00:57:25,510 --> 00:57:23,520
for joining me this afternoon

1542
00:57:27,750 --> 00:57:25,520
it's been a lot of fun and we just have

1543
00:57:28,789 --> 00:57:27,760
to thank all of our teammates

1544
00:57:34,309 --> 00:57:28,799
on the

1545
00:57:35,910 --> 00:57:34,319
team the nasa jpl team the folks who

1546
00:57:38,230 --> 00:57:35,920
built the rocket the folks who got

1547
00:57:40,630 --> 00:57:38,240
through kova to get us to the launch pad

1548
00:57:41,589 --> 00:57:40,640
i mean what an incredible team thousands

1549
00:57:43,589 --> 00:57:41,599
of people

1550
00:57:44,630 --> 00:57:43,599
involved in ultimately getting to this

1551
00:57:48,470 --> 00:57:44,640
kind of

1552
00:57:51,430 --> 00:57:48,480
yeah

1553
00:57:53,349 --> 00:57:51,440
thanks for having me thanks so much

1554
00:57:55,030 --> 00:57:53,359
yes thanks for having us

1555
00:57:57,589 --> 00:57:55,040
oh thank you so much we can't wait to

1556
00:58:00,470 --> 00:57:57,599
see the rest of the panoramas now for

1557
00:58:03,030 --> 00:58:00,480
the latest on the mission follow at nasa

1558
00:58:05,430 --> 00:58:03,040
persevere on both twitter and facebook

1559
00:58:10,630 --> 00:58:05,440
and you can also take a deeper dive at

1560
00:58:15,030 --> 00:58:12,870
perseverance and as jim mentioned

1561
00:58:17,910 --> 00:58:15,040
there's lots of information about the

1562
00:58:22,390 --> 00:58:17,920
mass cam z instrument on the website

1563
00:58:28,710 --> 00:58:25,270

and the very latest images can be found

1564
00:58:36,870 --> 00:58:33,349
mars 2020 slash multimedia slash raw

1565
00:58:39,270 --> 00:58:36,880
hyphen images a lot of great feasts for

1566
00:58:40,789 --> 00:58:39,280
the eyes as jim likes to put it now

1567
00:59:18,000 --> 00:58:40,799
thanks so much for watching this