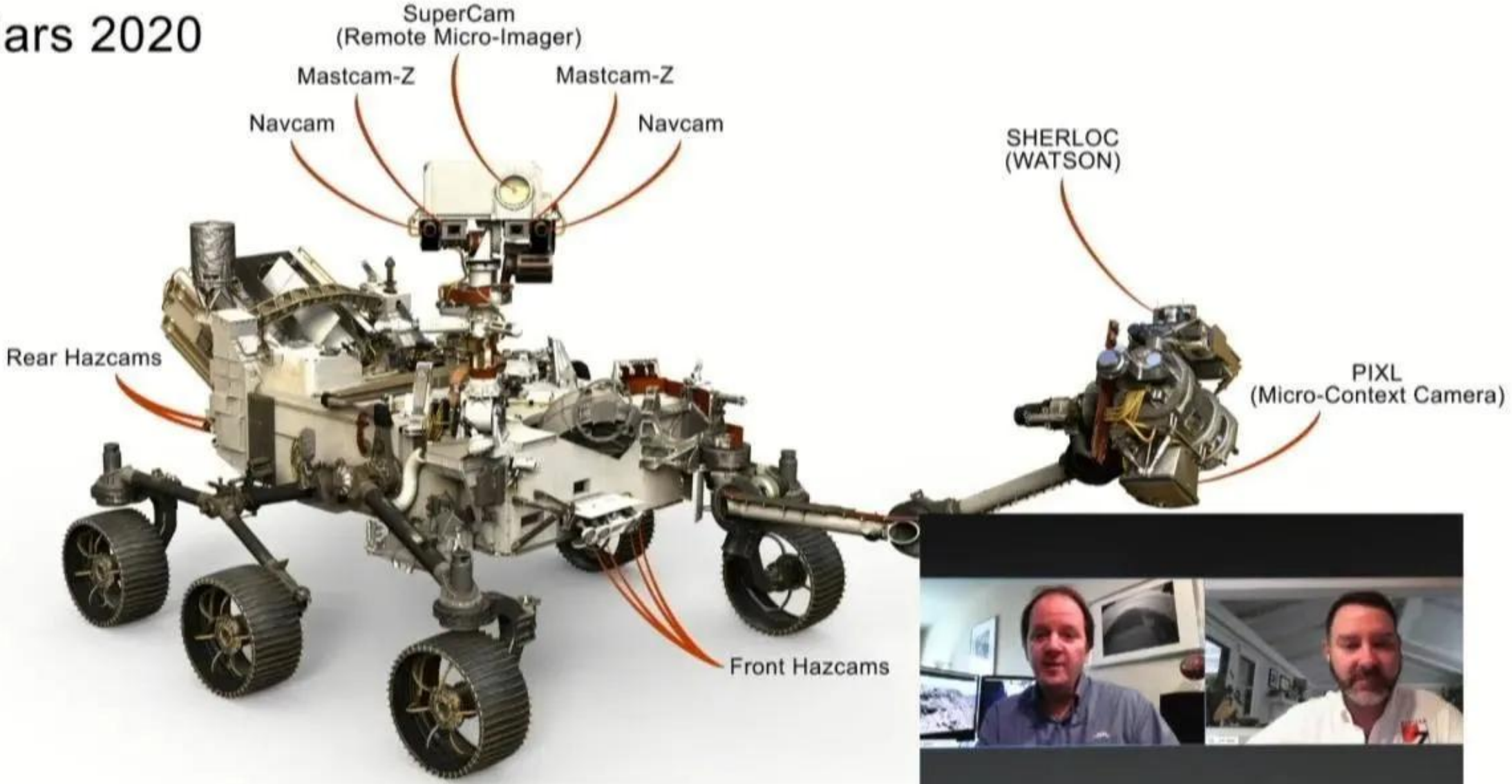
Mars 2020


SuperCam
(Remote Micro-Imager)
Mastcam-Z
Mastcam-Z
Navcam
Navcam
SHERLOC
(WATSON)
Rear Hazcams
PIXL
(Micro-Context Camera)
Front Hazcams

1
00:00:50,260 --> 00:00:41,720
[Music]

2
00:00:50,270 --> 00:00:54,160
[Applause]

3
00:00:54,170 --> 00:01:06,030
[Music]

4
00:01:09,990 --> 00:01:08,400
hey welcome back again for another NASA

5
00:01:12,030 --> 00:01:10,000
at home spaceport series episode I'm

6
00:01:15,330 --> 00:01:12,040
Joshua Santora coming to you live from

7
00:01:17,070 --> 00:01:15,340
the Kennedy Space Center sort of as most

8
00:01:18,600 --> 00:01:17,080
of our agency and a lot of America I'm

9
00:01:21,030 --> 00:01:18,610
working from home still being really

10
00:01:23,550 --> 00:01:21,040
productive as is an incredible amount of

11
00:01:24,480 --> 00:01:23,560
number of men and women for agency we

12
00:01:26,730 --> 00:01:24,490
want to introduce you to a couple

13
00:01:29,310 --> 00:01:26,740

gentlemen who are helping to launch the

14
00:01:31,950 --> 00:01:29,320
next Mars rover in just a minute so

15
00:01:35,190 --> 00:01:31,960
we're talking about this bad boy this is

16
00:01:37,110 --> 00:01:35,200
Mars 2020 recently named perseverance so

17
00:01:38,790 --> 00:01:37,120
we're excited for that excited for the

18
00:01:41,430 --> 00:01:38,800
name perseverance certainly that is a

19
00:01:43,620 --> 00:01:41,440
message that resonates with almost all

20
00:01:45,450 --> 00:01:43,630
of us today and as we talk about the

21
00:01:47,609 --> 00:01:45,460
spaceport series looking at the Kennedy

22
00:01:49,230 --> 00:01:47,619
Space Center we are honing in for our

23
00:01:51,510 --> 00:01:49,240
world on the launch services program

24
00:01:53,640 --> 00:01:51,520
they are managing the launch for

25
00:01:56,700 --> 00:01:53,650
perseverance here in just a few months

26
00:01:58,499 --> 00:01:56,710
so that's what's going on today please

27
00:02:00,510 --> 00:01:58,509
make sure to check out all the NASA at

28
00:02:02,040 --> 00:02:00,520
home material and especially make sure

29
00:02:03,990 --> 00:02:02,050
to send us your questions now on the

30
00:02:05,370 --> 00:02:04,000
chat window and let us know what you

31
00:02:06,960 --> 00:02:05,380
want to see in future episodes we're

32
00:02:08,400 --> 00:02:06,970
doing some planning for the future and

33
00:02:10,770 --> 00:02:08,410
would love to know what you'd like to

34
00:02:12,780 --> 00:02:10,780
hear but let's go ahead and jump right

35
00:02:14,460 --> 00:02:12,790
in here I want to bring on our two

36
00:02:16,080 --> 00:02:14,470
guests this this morning or afternoon

37
00:02:20,370 --> 00:02:16,090
depending upon where you're coming from

38
00:02:22,610 --> 00:02:20,380

first up on the the left there we've got

39
00:02:25,259 --> 00:02:22,620
Justin is it Mackey

40
00:02:26,850 --> 00:02:25,269
Justin Becky yeah Maggie sorry I'm not

41
00:02:29,100 --> 00:02:26,860
as good with left Nate or last names I

42
00:02:32,160 --> 00:02:29,110
need to work on that and then also we

43
00:02:34,380 --> 00:02:32,170
have Jim Bell Jim thanks for joining us

44
00:02:36,600 --> 00:02:34,390
you got that pronunciation right thank

45
00:02:40,320 --> 00:02:36,610
you perfect know that

46
00:02:43,380 --> 00:02:40,330
so hey so I want to quickly mention the

47
00:02:45,240 --> 00:02:43,390
fact that we're talking about a job

48
00:02:49,170 --> 00:02:45,250
title I just throw up I'm dealing with

49
00:02:50,789 --> 00:02:49,180
Mars 2020 and imaging but your full job

50
00:02:53,490 --> 00:02:50,799
titles we could not fit on screen

51
00:02:54,960 --> 00:02:53,500
together and I want to give you guys a

52
00:02:57,479 --> 00:02:54,970
chance to explain what you do because it

53
00:02:59,610 --> 00:02:57,489
is amazing and impressive and I'm a big

54
00:03:01,590 --> 00:02:59,620
fan just of the the work of exploring

55
00:03:01,979 --> 00:03:01,600
but I want to just let you guys take it

56
00:03:03,660 --> 00:03:01,989
away

57
00:03:05,250 --> 00:03:03,670
tell us about what you do and what does

58
00:03:08,870 --> 00:03:05,260
it mean to be an imaging scientist or a

59
00:03:12,660 --> 00:03:08,880
principal investigator for mastcam Z

60
00:03:14,460 --> 00:03:12,670
ahead Justin okay so I'm Justin Maki I

61
00:03:18,199 --> 00:03:14,470
am the imaging scientist for the Mars

62
00:03:19,770 --> 00:03:18,209
2020 Rover among my several types I also

63
00:03:24,150 --> 00:03:19,780

do

64
00:03:26,670 --> 00:03:24,160
engineer for the project and I'm also

65
00:03:30,120 --> 00:03:26,680
domestic MZ deputy PRI working with Jim

66
00:03:31,590 --> 00:03:30,130
so as part of my job both Jim and I

67
00:03:34,890 --> 00:03:31,600
we've been working on Mars rover

68
00:03:38,340 --> 00:03:34,900
missions for a long time over 20 years

69
00:03:40,080 --> 00:03:38,350
and I've been doing a lot of the design

70
00:03:43,290 --> 00:03:40,090
and development of the imaging systems

71
00:03:46,650 --> 00:03:43,300
or the Rovers so that includes camera

72
00:03:48,990 --> 00:03:46,660
designs and specifications the system

73
00:03:51,660 --> 00:03:49,000
the imaging system which involves all

74
00:03:54,330 --> 00:03:51,670
software the processes the data and then

75
00:03:56,729 --> 00:03:54,340
on the rover itself and then processing

76
00:03:58,710 --> 00:03:56,739
the images on the ground so it's kind of

77
00:04:00,449 --> 00:03:58,720
a catch-all title but I work a lot with

78
00:04:01,650 --> 00:04:00,459
the science team I have a background of

79
00:04:03,270 --> 00:04:01,660
science and engineering

80
00:04:05,550 --> 00:04:03,280
so I do do a little bit of both and

81
00:04:07,260 --> 00:04:05,560
basically put the systems together and

82
00:04:12,420 --> 00:04:07,270
test it out and then do operations with

83
00:04:14,010 --> 00:04:12,430
the cameras on the server bars awesome

84
00:04:18,000 --> 00:04:14,020
okay I'll go next

85
00:04:19,830 --> 00:04:18,010
so I'm Jim Bell I'm a professor at

86
00:04:23,690 --> 00:04:19,840
Arizona State University in the school

87
00:04:26,100 --> 00:04:23,700
of Earth space exploration I'm the

88
00:04:27,719 --> 00:04:26,110

president of the Planetary Society if we

89
00:04:29,640 --> 00:04:27,729
have any Planetary Society members out

90
00:04:33,180 --> 00:04:29,650
there great organization that promotes

91
00:04:35,430 --> 00:04:33,190
planetary exploration and education and

92
00:04:37,350 --> 00:04:35,440
I'm the principal investigator for the

93
00:04:39,719 --> 00:04:37,360
mastcam Zee camera system which we'll

94
00:04:42,090 --> 00:04:39,729
talk a lot more about that's on the 2020

95
00:04:44,310 --> 00:04:42,100
perseverance Rover so I work a lot with

96
00:04:46,140 --> 00:04:44,320
engineers worked with Justin as we said

97
00:04:48,780 --> 00:04:46,150
for 20 years going back to Mars

98
00:04:54,030 --> 00:04:48,790
Pathfinder spirit opportunity curiosity

99
00:04:56,010 --> 00:04:54,040
other other missions and my job is as

100
00:04:57,480 --> 00:04:56,020
the leader of the camera teams who try

101
00:05:00,990 --> 00:04:57,490
to integrate the science that we're

102
00:05:04,890 --> 00:05:01,000
trying to do geology a little bit of

103
00:05:07,560 --> 00:05:04,900
mineralogy some atmospheric science and

104
00:05:09,450 --> 00:05:07,570
also to help make sure the cameras can

105
00:05:11,370 --> 00:05:09,460
support all the engineering activities

106
00:05:13,560 --> 00:05:11,380
that are going on while driving arm

107
00:05:15,420 --> 00:05:13,570
placement things that that we'll talk a

108
00:05:17,640 --> 00:05:15,430
little bit more about here so we have a

109
00:05:20,700 --> 00:05:17,650
big team that's composed of a number of

110
00:05:23,070 --> 00:05:20,710
scientists other faculty members people

111
00:05:25,010 --> 00:05:23,080
at national laboratories students

112
00:05:28,140 --> 00:05:25,020
graduate students undergraduate students

113
00:05:31,290 --> 00:05:28,150

and that the nask MZ team is part of a

114
00:05:33,060 --> 00:05:31,300
larger science team overall for the

115
00:05:33,300 --> 00:05:33,070
rover and the science team is part of

116
00:05:35,160 --> 00:05:33,310
the

117
00:05:38,520 --> 00:05:35,170
sort of engineering team that includes

118
00:05:39,900 --> 00:05:38,530
the launch folks that at KSC and many

119
00:05:43,080 --> 00:05:39,910
others around the country around the

120
00:05:44,550 --> 00:05:43,090
world so it's it's just it's a lot of

121
00:05:47,490 --> 00:05:44,560
fun it's it's going to be a great great

122
00:05:48,750 --> 00:05:47,500
mission so let's jump right in here

123
00:05:50,730 --> 00:05:48,760
we're talking about imaging today

124
00:05:51,930 --> 00:05:50,740
obviously with the rover and it's

125
00:05:54,510 --> 00:05:51,940
something that people may not consider

126
00:05:56,100 --> 00:05:54,520
right away but tell me a little bit

127
00:05:57,780 --> 00:05:56,110
about what do we mean when we say

128
00:06:01,440 --> 00:05:57,790
imaging how many cameras are we talking

129
00:06:04,680 --> 00:06:01,450
about and what are they doing okay well

130
00:06:07,560 --> 00:06:04,690
so the 2020 perseverance forever has 23

131
00:06:09,600 --> 00:06:07,570
cameras on on it which is the MoMA the

132
00:06:12,060 --> 00:06:09,610
most that we've ever flown the MSL

133
00:06:13,920 --> 00:06:12,070
curiosity rover had 17 which was the

134
00:06:17,790 --> 00:06:13,930
high-water mark at that point but now we

135
00:06:20,670 --> 00:06:17,800
have 23 and of those 23 cameras about 16

136
00:06:22,890 --> 00:06:20,680
of them are for engineering purposes and

137
00:06:24,930 --> 00:06:22,900
there's the diagram there showing a lot

138
00:06:26,940 --> 00:06:24,940

of the cameras that we have one of the

139
00:06:29,040 --> 00:06:26,950
big changes with this mission is that we

140
00:06:31,080 --> 00:06:29,050
have a next-generation engineering

141
00:06:33,710 --> 00:06:31,090
camera imaging system so those of you

142
00:06:35,940 --> 00:06:33,720
that know about MSL the Curiosity rover

143
00:06:38,250 --> 00:06:35,950
we have black and white cameras on that

144
00:06:40,290 --> 00:06:38,260
Rover for doing River navigation and

145
00:06:42,390 --> 00:06:40,300
drive designation things like that drive

146
00:06:44,550 --> 00:06:42,400
planning this time around and those are

147
00:06:46,920 --> 00:06:44,560
one megapixels on curiosity this time

148
00:06:50,490 --> 00:06:46,930
around we have 20 megapixel color

149
00:06:52,290 --> 00:06:50,500
cameras which are quite impressive in

150
00:06:55,440 --> 00:06:52,300
terms of their capabilities we've now

151
00:06:57,000 --> 00:06:55,450
taken some modern detectors we've

152
00:06:58,830 --> 00:06:57,010
incorporated them into the designs so

153
00:07:00,240 --> 00:06:58,840
that'll be a big change from previous

154
00:07:02,460 --> 00:07:00,250
missions but we will be having these

155
00:07:03,900 --> 00:07:02,470
high-resolution color photos of the

156
00:07:06,180 --> 00:07:03,910
landscape coming from the engineering

157
00:07:08,240 --> 00:07:06,190
cameras in addition to that we're going

158
00:07:10,770 --> 00:07:08,250
to have some high-speed video cameras

159
00:07:12,960 --> 00:07:10,780
recording the EDL entry descent and

160
00:07:14,730 --> 00:07:12,970
landing phase so we're gonna have

161
00:07:17,160 --> 00:07:14,740
cameras pointing to the parachute which

162
00:07:20,490 --> 00:07:17,170
we'll be able to do take pictures of the

163
00:07:22,170 --> 00:07:20,500

parachute of expanding deploying and

164
00:07:26,100 --> 00:07:22,180
then we'll have cameras that are looking

165
00:07:27,750 --> 00:07:26,110
down at the rover on the road we're

166
00:07:29,580 --> 00:07:27,760
looking up at the sky crane as it's

167
00:07:31,050 --> 00:07:29,590
coming down and then two more cameras

168
00:07:33,420 --> 00:07:31,060
looking down on the ground so a lot more

169
00:07:35,460 --> 00:07:33,430
cameras a lot going on there engineering

170
00:07:37,470 --> 00:07:35,470
wise and then on the science side we

171
00:07:39,090 --> 00:07:37,480
also have improved capabilities for the

172
00:07:41,280 --> 00:07:39,100
cameras as well we have two cameras or

173
00:07:43,830 --> 00:07:41,290
three cameras on the arm which would do

174
00:07:45,960 --> 00:07:43,840
high-resolution close-up photos and then

175
00:07:47,010 --> 00:07:45,970
up on the mast even you get the highest

176
00:07:48,960 --> 00:07:47,020
resolution camera

177
00:07:50,640 --> 00:07:48,970
of all we go to the mass MZ cameras and

178
00:07:52,350 --> 00:07:50,650
that's the Jim and I are working on what

179
00:07:53,730 --> 00:07:52,360
Jim is the pi/4 and Jim can talk about

180
00:07:55,550 --> 00:07:53,740
the mass KMZ cameras which are also

181
00:07:58,589 --> 00:07:55,560
improved over the last time

182
00:08:01,469 --> 00:07:58,599
yeah thanks Justin it's it really is an

183
00:08:03,960 --> 00:08:01,479
impressive collection of cameras and

184
00:08:05,760 --> 00:08:03,970
I'll just point out in case people don't

185
00:08:09,719 --> 00:08:05,770
know there's a couple of microphones on

186
00:08:11,730 --> 00:08:09,729
the rover as well so assuming we land

187
00:08:13,830 --> 00:08:11,740
safely we'll be able to integrate some

188
00:08:15,740 --> 00:08:13,840

of that video at the sound and it should

189
00:08:24,689 --> 00:08:15,750
be really really spectacular

190
00:08:26,430 --> 00:08:24,699
that's the mast when you say microphones

191
00:08:28,439 --> 00:08:26,440
that's also a really interesting point

192
00:08:29,550 --> 00:08:28,449
that people don't think about are we is

193
00:08:32,430 --> 00:08:29,560
this the first time we're sending

194
00:08:33,959 --> 00:08:32,440
microphones to Mars well it's not the

195
00:08:36,000 --> 00:08:33,969
first time we're sending them that had

196
00:08:38,550 --> 00:08:36,010
been attempted previously they haven't

197
00:08:40,949 --> 00:08:38,560
worked so well hopefully this will be

198
00:08:42,930 --> 00:08:40,959
the first successful time the Planetary

199
00:08:44,670 --> 00:08:42,940
Society has been involved in previous

200
00:08:46,319 --> 00:08:44,680
attempts and we're hoping the whole

201
00:08:49,620 --> 00:08:46,329
project is hoping to share these sounds

202
00:08:51,000 --> 00:08:49,630
at Mars but everybody awesome so I

203
00:08:54,329 --> 00:08:51,010
didn't mean to cut you off I just want

204
00:08:56,160 --> 00:08:54,339
to know it's really important but to go

205
00:08:58,230 --> 00:08:56,170
back to the the mass Kenzie's the camp

206
00:09:00,720 --> 00:08:58,240
that the two main science cameras up on

207
00:09:04,740 --> 00:09:00,730
the top of the mast there they're very

208
00:09:06,840 --> 00:09:04,750
much very similar to the cameras on the

209
00:09:09,150 --> 00:09:06,850
Curiosity rover there they're sort of

210
00:09:11,550 --> 00:09:09,160
evolutionary from from those cameras a

211
00:09:13,170 --> 00:09:11,560
curiosity has one wide-angle camera that

212
00:09:15,060 --> 00:09:13,180
can see the landscape and one angle on

213
00:09:17,430 --> 00:09:15,070

telephoto camera that can kind of zoom

214
00:09:18,900 --> 00:09:17,440
in so kind of a little bit of myopic

215
00:09:22,010 --> 00:09:18,910
vision makes it difficult not impossible

216
00:09:24,240 --> 00:09:22,020
but difficult to get stereo so the the

217
00:09:26,340 --> 00:09:24,250
innovation that we're adding now with

218
00:09:28,769 --> 00:09:26,350
with perseverance in mask MZ is that

219
00:09:30,540 --> 00:09:28,779
each camera is a zoom camera so they can

220
00:09:33,569 --> 00:09:30,550
go from both wide-angle give us a

221
00:09:36,949 --> 00:09:33,579
wide-angle stereo view to both telephoto

222
00:09:38,730 --> 00:09:36,959
zooming and really close at the Rovers

223
00:09:40,829 --> 00:09:38,740
landscape brightens frontcourt the

224
00:09:43,530 --> 00:09:40,839
distant horizon and we'll be able to

225
00:09:47,040 --> 00:09:43,540
have matched focal length to be able to

226
00:09:49,980 --> 00:09:47,050
make 3d stereo anywhere we look and so

227
00:09:53,430 --> 00:09:49,990
we're anticipating doing a lot more 3d

228
00:09:55,560 --> 00:09:53,440
kind of topographic reconstructions

229
00:09:57,930 --> 00:09:55,570
digital terrain models you know

230
00:09:59,730 --> 00:09:57,940
simulated flyovers of the landscape and

231
00:10:00,690 --> 00:09:59,740
that kind of stuff at the highest

232
00:10:04,110 --> 00:10:00,700
resolution

233
00:10:05,280 --> 00:10:04,120
Kimsey office so I want to want to ask

234
00:10:07,770 --> 00:10:05,290
that question kind of thinking about

235
00:10:09,840 --> 00:10:07,780
curiosity obviously being on Mars

236
00:10:12,810 --> 00:10:09,850
already exploring and just people's

237
00:10:15,030 --> 00:10:12,820
general interest how what should people

238
00:10:16,920 --> 00:10:15,040

expect to see obviously we've seen some

239
00:10:19,320 --> 00:10:16,930
really cool things come from curiosity

240
00:10:21,870 --> 00:10:19,330
there was recently a giant panorama that

241
00:10:24,150 --> 00:10:21,880
was I think it's one of like the largest

242
00:10:26,340 --> 00:10:24,160
pixel images ever we've seen the

243
00:10:28,590 --> 00:10:26,350
beautiful unselfie images that it took

244
00:10:30,300 --> 00:10:28,600
with its robotic arm and out there so

245
00:10:33,300 --> 00:10:30,310
what are people gonna get a chance to

246
00:10:34,980 --> 00:10:33,310
see that they've never seen before well

247
00:10:36,570 --> 00:10:34,990
I think certainly we'll be doing a lot

248
00:10:38,160 --> 00:10:36,580
of that same kind of stuff and we should

249
00:10:40,950 --> 00:10:38,170
show some pictures of some of the

250
00:10:43,800 --> 00:10:40,960
equipment testing that allows do that

251
00:10:46,650 --> 00:10:43,810
kind of stuff as well but I think the

252
00:10:48,630 --> 00:10:46,660
big here's there's a nice shot of one of

253
00:10:50,550 --> 00:10:48,640
the masks NZ big booth in masks NZ

254
00:10:53,310 --> 00:10:50,560
cameras and just for scale it's hard to

255
00:10:55,890 --> 00:10:53,320
tell the scale it's sort of like maybe

256
00:10:57,870 --> 00:10:55,900
about the size of a can of tennis balls

257
00:11:01,080 --> 00:10:57,880
that you would you know take open some

258
00:11:03,440 --> 00:11:01,090
new tennis balls about that size and and

259
00:11:07,440 --> 00:11:03,450
all the zoom capability is inside the

260
00:11:09,480 --> 00:11:07,450
gold cylinder there but I think it's

261
00:11:11,310 --> 00:11:09,490
gonna be a combination of things that'll

262
00:11:13,590 --> 00:11:11,320
be new that the 3d capabilities

263
00:11:16,620 --> 00:11:13,600

certainly the high resolution capability

264
00:11:18,560 --> 00:11:16,630
that Justin mentioned or the for the

265
00:11:23,550 --> 00:11:18,570
engineering cameras and maybe we could

266
00:11:26,100 --> 00:11:23,560
show some of the lab testing data and

267
00:11:28,290 --> 00:11:26,110
Justin can talk about how we were able

268
00:11:30,870 --> 00:11:28,300
to do the work ahead of time to make

269
00:11:33,180 --> 00:11:30,880
sure we get there was really good 3d

270
00:11:34,860 --> 00:11:33,190
views yeah I can talk about that a

271
00:11:37,830 --> 00:11:34,870
little bit so the cameras that we put on

272
00:11:39,990 --> 00:11:37,840
the rotors are they're not like your

273
00:11:42,390 --> 00:11:40,000
cameras on your iPhone or the cameras

274
00:11:43,650 --> 00:11:42,400
that you buy in the store and one of the

275
00:11:45,750 --> 00:11:43,660
reasons is is because these are very

276
00:11:48,450 --> 00:11:45,760
carefully calibrated because they're

277
00:11:51,390 --> 00:11:48,460
scientific instruments basically that we

278
00:11:53,280 --> 00:11:51,400
use to measure the sizes and distances

279
00:11:55,920 --> 00:11:53,290
of things so that requires a very

280
00:11:57,690 --> 00:11:55,930
careful calibration to understand when

281
00:12:00,330 --> 00:11:57,700
we do see an image how we can interpret

282
00:12:01,980 --> 00:12:00,340
the scale we can do the stereo data that

283
00:12:03,480 --> 00:12:01,990
Jim was mentioning you have a left

284
00:12:05,760 --> 00:12:03,490
camera and a right camera and then you

285
00:12:08,490 --> 00:12:05,770
take picture from each and then you can

286
00:12:10,230 --> 00:12:08,500
basically project raids out into 3d

287
00:12:12,810 --> 00:12:10,240
space and intersect those rays it's

288
00:12:14,610 --> 00:12:12,820

called triangulation and that's that's a

289
00:12:16,170 --> 00:12:14,620
technique that we use right

290
00:12:18,810 --> 00:12:16,180
say the same thing our eyes and brain

291
00:12:21,630 --> 00:12:18,820
are doing all the time yes exactly in

292
00:12:24,570 --> 00:12:21,640
fact it's very similar in fact humans

293
00:12:27,300 --> 00:12:24,580
are extremely good at doing image

294
00:12:28,950 --> 00:12:27,310
processing just average person can

295
00:12:30,570 --> 00:12:28,960
interpret thousands of objects and the

296
00:12:32,580 --> 00:12:30,580
distances without even thinking about it

297
00:12:34,650 --> 00:12:32,590
it's actually kind of amazing so we have

298
00:12:37,050 --> 00:12:34,660
to do implement that same capability on

299
00:12:39,330 --> 00:12:37,060
the rover it's called machine vision or

300
00:12:40,560 --> 00:12:39,340
robotic vision and it's actually it

301
00:12:42,660 --> 00:12:40,570
takes a fair amount of processing power

302
00:12:44,310 --> 00:12:42,670
to do that and if you I don't know if we

303
00:12:46,020 --> 00:12:44,320
can show the pictures of the calibration

304
00:12:47,670 --> 00:12:46,030
but it requires a lot of careful

305
00:12:49,020 --> 00:12:47,680
calibration in the laboratory and

306
00:12:51,180 --> 00:12:49,030
there's a picture of some of our team

307
00:12:53,040 --> 00:12:51,190
members there from smz that's a

308
00:12:54,840 --> 00:12:53,050
radiometric calibration picture there we

309
00:12:56,490 --> 00:12:54,850
also also have to measure the ability of

310
00:12:58,020 --> 00:12:56,500
the cameras to detect light and how

311
00:13:00,180 --> 00:12:58,030
sensitive it is so that when we see

312
00:13:01,950 --> 00:13:00,190
certain spectral signatures were able to

313
00:13:04,230 --> 00:13:01,960

interpret that so you get the colors

314
00:13:05,730 --> 00:13:04,240
right exactly yes and give colors right

315
00:13:08,010 --> 00:13:05,740
which is very important as everybody

316
00:13:10,440 --> 00:13:08,020
knows because everyone's used to it now

317
00:13:11,760 --> 00:13:10,450
their cameras that they purchased you

318
00:13:14,250 --> 00:13:11,770
know that smartphone cameras are very

319
00:13:15,780 --> 00:13:14,260
good at color keep it very good color

320
00:13:17,550 --> 00:13:15,790
capabilities there's a lot of work that

321
00:13:19,860 --> 00:13:17,560
goes behind that that you don't see when

322
00:13:21,630 --> 00:13:19,870
you turn on your smartphone so this is

323
00:13:23,310 --> 00:13:21,640
sort of a behind-the-scenes look at what

324
00:13:24,900 --> 00:13:23,320
we have to do to get the cameras ready

325
00:13:27,360 --> 00:13:24,910
and here's a picture of a geometric

326
00:13:28,800 --> 00:13:27,370
target which is the way that we do the

327
00:13:31,320 --> 00:13:28,810
calibration I talked about where it's a

328
00:13:33,450 --> 00:13:31,330
very careful geometric every single

329
00:13:35,880 --> 00:13:33,460
pixel in an image we know exactly where

330
00:13:38,780 --> 00:13:35,890
that pixel points and so if we have a 2

331
00:13:41,100 --> 00:13:38,790
megapixel camera we have two million

332
00:13:42,450 --> 00:13:41,110
vectors that tell us where all those

333
00:13:43,860 --> 00:13:42,460
pixels are pointing to and in the case

334
00:13:46,290 --> 00:13:43,870
of the engineering cameras we have 20

335
00:13:47,820 --> 00:13:46,300
million vectors per camera so it was a

336
00:13:51,570 --> 00:13:47,830
lot of careful calibration I think the

337
00:13:52,860 --> 00:13:51,580
next photo shows the see what the next

338
00:13:55,770 --> 00:13:52,870

one is I think yeah there we go there's

339
00:13:57,660 --> 00:13:55,780
another target there we are we also have

340
00:13:59,610 --> 00:13:57,670
to measure the capability of the focus

341
00:14:00,960 --> 00:13:59,620
on the sharpness of the canvas with mass

342
00:14:01,830 --> 00:14:00,970
Kimsey that's especially important

343
00:14:05,280 --> 00:14:01,840
because it's one of our highest

344
00:14:07,320 --> 00:14:05,290
resolution imagers that we have and then

345
00:14:09,000 --> 00:14:07,330
when the Rovers all get or the cameras

346
00:14:12,410 --> 00:14:09,010
all get delivered to the rover I think

347
00:14:14,520 --> 00:14:12,420
the next photo that we have shows the

348
00:14:16,920 --> 00:14:14,530
alignment measurements that we do I'm

349
00:14:18,540 --> 00:14:16,930
sorry there's another photo that's hard

350
00:14:21,750 --> 00:14:18,550
work for they where they finished all

351
00:14:23,160 --> 00:14:21,760
the wiring harnesses yeah yeah and you

352
00:14:24,930 --> 00:14:23,170
can imagine there's a lot of wires that

353
00:14:26,460 --> 00:14:24,940
have to be all check and double-check

354
00:14:28,240 --> 00:14:26,470
this and that's what that photo is I

355
00:14:29,680 --> 00:14:28,250
think the next picture is

356
00:14:31,660 --> 00:14:29,690
picture where the cameras are now

357
00:14:34,120 --> 00:14:31,670
mounted on the rover itself and we're

358
00:14:40,000 --> 00:14:34,130
taking a picture of a target which for

359
00:14:41,890 --> 00:14:40,010
us is sort of the sign that there you go

360
00:14:44,410 --> 00:14:41,900
there's still there's the crystal so

361
00:14:45,910 --> 00:14:44,420
this picture here is a sign that we're

362
00:14:47,290 --> 00:14:45,920
approaching the end of our integration

363
00:14:48,430 --> 00:14:47,300

phase but that means that all the

364
00:14:50,410 --> 00:14:48,440
cameras have been mounted on the rover

365
00:14:52,420 --> 00:14:50,420
and we put one of these geometric

366
00:14:55,720 --> 00:14:52,430
targets down on the floor and then we

367
00:14:56,890 --> 00:14:55,730
take require images of those that target

368
00:14:59,050 --> 00:14:56,900
I'm not sure if you can make it out in

369
00:15:02,400 --> 00:14:59,060
the webcast but that target contains

370
00:15:06,610 --> 00:15:02,410
that particular target contains 40 by 40

371
00:15:08,140 --> 00:15:06,620
dot 1600 dots on it and we measure the

372
00:15:10,000 --> 00:15:08,150
position of all those dots in the real

373
00:15:12,160 --> 00:15:10,010
world which we call the real-world 3d

374
00:15:13,720 --> 00:15:12,170
space and then we map that back into the

375
00:15:15,370 --> 00:15:13,730
two-dimensional space of the cameras and

376
00:15:16,630 --> 00:15:15,380
all the cameras are a majority of

377
00:15:18,130 --> 00:15:16,640
cameras on the rover

378
00:15:21,280 --> 00:15:18,140
look at that target and then we know

379
00:15:24,490 --> 00:15:21,290
exactly how everything is aligned so

380
00:15:25,750 --> 00:15:24,500
really excited about this we're really

381
00:15:27,220 --> 00:15:25,760
excited at the mission we're excited

382
00:15:29,200 --> 00:15:27,230
about the new capabilities on all the

383
00:15:30,250 --> 00:15:29,210
cameras especially mass cams Eve Jim and

384
00:15:32,740 --> 00:15:30,260
I have been working on her for many

385
00:15:33,790 --> 00:15:32,750
years now and I don't know if Jim you

386
00:15:35,380 --> 00:15:33,800
want to talk a little bit more about

387
00:15:37,000 --> 00:15:35,390
masks um see and it may be just that

388
00:15:39,850 --> 00:15:37,010

Josh didn't Joshua can you show that

389
00:15:44,710 --> 00:15:39,860
that zoom animation this is some data

390
00:15:48,250 --> 00:15:44,720
that we took with the mask m-z system a

391
00:15:49,720 --> 00:15:48,260
lot of laboratory window of the the

392
00:15:52,960 --> 00:15:49,730
colleagues that we work with that male

393
00:15:54,490 --> 00:15:52,970
and space science systems in the

394
00:15:57,670 --> 00:15:54,500
cleanroom they look out the window of

395
00:16:00,820 --> 00:15:57,680
the cleanroom and and we're able to zoom

396
00:16:02,680 --> 00:16:00,830
on to some some houses off in a distant

397
00:16:04,150 --> 00:16:02,690
distant Ridge and those houses are about

398
00:16:07,300 --> 00:16:04,160
a kilometer away so you can see the

399
00:16:10,480 --> 00:16:07,310
wide-angle capability to the telephoto

400
00:16:12,250 --> 00:16:10,490
capability of the cameras so we'll

401
00:16:14,290 --> 00:16:12,260
really be able to zoom in on the world

402
00:16:16,630 --> 00:16:14,300
of course the world will be Mars the

403
00:16:18,520 --> 00:16:16,640
world will be jezero crater this amazing

404
00:16:20,410 --> 00:16:18,530
landing site where there's a delta

405
00:16:24,000 --> 00:16:20,420
that's coming down from the inner rim

406
00:16:26,140 --> 00:16:24,010
and there was a leak in a shallow water

407
00:16:28,540 --> 00:16:26,150
environment and we can see interesting

408
00:16:30,700 --> 00:16:28,550
mineral signatures from orbit and first

409
00:16:32,200 --> 00:16:30,710
we're going to try to find out if we can

410
00:16:34,840 --> 00:16:32,210
find more evidence about the past

411
00:16:37,300 --> 00:16:34,850
habitability in the past evidence for

412
00:16:39,160 --> 00:16:37,310
life on Mars so we're super excited

413
00:16:40,760 --> 00:16:39,170

about this mission yes there's a

414
00:16:43,699 --> 00:16:40,770
question from social

415
00:16:45,380 --> 00:16:43,709
to ask how fast will it take for the

416
00:16:47,480 --> 00:16:45,390
images to get back to earth

417
00:16:49,490 --> 00:16:47,490
so obviously we've got several months of

418
00:16:50,690 --> 00:16:49,500
flight there but once we land how long

419
00:16:54,620 --> 00:16:50,700
shall we start getting these beautiful

420
00:16:57,800 --> 00:16:54,630
images back to earth well I can take

421
00:16:59,329 --> 00:16:57,810
that one Jim when we land just like

422
00:17:02,150 --> 00:16:59,339
dynamic so we take we actually acquire

423
00:17:04,640 --> 00:17:02,160
some images right after we walk from the

424
00:17:05,780 --> 00:17:04,650
has camp so those are the cameras that I

425
00:17:07,490 --> 00:17:05,790
don't know if we have the picture of it

426
00:17:09,500 --> 00:17:07,500
but there they're mounted to the rover

427
00:17:11,419 --> 00:17:09,510
body-fixed mounted and they're kind of

428
00:17:12,910 --> 00:17:11,429
on the underside and so we'll get

429
00:17:15,650 --> 00:17:12,920
pictures from those cameras right away

430
00:17:18,590 --> 00:17:15,660
super wide angle we have a very wide

431
00:17:20,270 --> 00:17:18,600
angle fisheye lenses over 130 degree

432
00:17:22,150 --> 00:17:20,280
field of view so they will catch you

433
00:17:24,230 --> 00:17:22,160
know the area right around the river

434
00:17:25,819 --> 00:17:24,240
depending on the links

435
00:17:26,809 --> 00:17:25,829
those could come down right away or

436
00:17:28,910 --> 00:17:26,819
they're come down in the first

437
00:17:30,820 --> 00:17:28,920
communications past after landing which

438
00:17:33,440 --> 00:17:30,830

would be within you know a couple hours

439
00:17:34,820 --> 00:17:33,450
so those would be the first pictures the

440
00:17:36,799 --> 00:17:34,830
covers on those cameras will likely

441
00:17:39,260 --> 00:17:36,809
they'll still be deployed and there will

442
00:17:41,540 --> 00:17:39,270
likely be debris on the covers so they

443
00:17:42,830 --> 00:17:41,550
may may be a little dirty as you've seen

444
00:17:45,200 --> 00:17:42,840
on some of our other land previous

445
00:17:48,260 --> 00:17:45,210
landings those images would be the first

446
00:17:50,240 --> 00:17:48,270
ones and then within a day or two or a

447
00:17:53,290 --> 00:17:50,250
saw I'll call the Martian days assault

448
00:17:56,330 --> 00:17:53,300
the rover master deploys that's that

449
00:17:57,710 --> 00:17:56,340
that white a mastiff deploys up like

450
00:18:00,410 --> 00:17:57,720
this and can point the cameras around

451
00:18:01,850 --> 00:18:00,420
like that down on deploy and then we'll

452
00:18:03,380 --> 00:18:01,860
start to get our full-color panorama

453
00:18:04,520 --> 00:18:03,390
from the surface so to be within a day

454
00:18:06,500 --> 00:18:04,530
or two we should have some really nice

455
00:18:09,260 --> 00:18:06,510
color pictures from this remark and and

456
00:18:11,570 --> 00:18:09,270
then we'll go into this mode of you know

457
00:18:13,669 --> 00:18:11,580
every every morning the earth will

458
00:18:16,040 --> 00:18:13,679
communicate a set of commands to the

459
00:18:17,540 --> 00:18:16,050
rover the rubber will go off and execute

460
00:18:19,820 --> 00:18:17,550
those commands and when one of the

461
00:18:21,650 --> 00:18:19,830
orbiters NASA orbiters passes overhead

462
00:18:24,919 --> 00:18:21,660
or or the European orbiter passes

463
00:18:27,919 --> 00:18:24,929

overhead relay the data back and back to

464
00:18:29,720 --> 00:18:27,929
the earth so some days we'll get a few

465
00:18:31,370 --> 00:18:29,730
images some days we'll get hundreds of

466
00:18:33,830 --> 00:18:31,380
images just depends on whether we're

467
00:18:35,960 --> 00:18:33,840
doing a Big Ben some days we'll get

468
00:18:37,940 --> 00:18:35,970
other kinds of data from the many other

469
00:18:39,860 --> 00:18:37,950
instruments that the robots carrying

470
00:18:42,440 --> 00:18:39,870
including this so-called squiggly line

471
00:18:45,320 --> 00:18:42,450
instruments so it'll be a mixture of all

472
00:18:47,169 --> 00:18:45,330
that data coming back daily and of

473
00:18:49,700 --> 00:18:47,179
course the team at least for the first

474
00:18:53,180 --> 00:18:49,710
three three months or so will be living

475
00:18:54,409 --> 00:18:53,190
on Mars time at at JPL with our time

476
00:18:55,669 --> 00:18:54,419
slowly

477
00:18:57,859 --> 00:18:55,679
shifting through the earth day because

478
00:19:00,919 --> 00:18:57,869
the Mars days was 40 minutes longer than

479
00:19:02,749 --> 00:19:00,929
the earth day so it'll be crazy it'll be

480
00:19:03,799 --> 00:19:02,759
wonderful and really exciting and we're

481
00:19:05,450 --> 00:19:03,809
really looking forward to sharing it

482
00:19:07,190 --> 00:19:05,460
will be awesome

483
00:19:09,289 --> 00:19:07,200
well gentlemen Jim Justin preciate you

484
00:19:10,519 --> 00:19:09,299
both good luck to both of you obviously

485
00:19:12,529 --> 00:19:10,529
we're super excited to see this thing

486
00:19:14,210 --> 00:19:12,539
fly and then before you know it we'll be

487
00:19:18,889 --> 00:19:14,220
on Mars once again with a brand new

488
00:19:20,570 --> 00:19:18,899

Rover and bringing images yeah watching

489
00:19:22,489 --> 00:19:20,580
and watching mid-july February

490
00:19:24,409 --> 00:19:22,499
eighteenth 2021 landing it's gonna be

491
00:19:29,259 --> 00:19:24,419
exciting be there mark your calendar all

492
00:19:31,039 --> 00:19:29,269
right thanks guys thanks all right so

493
00:19:32,629 --> 00:19:31,049
thank you so much for those that

494
00:19:34,009 --> 00:19:32,639
submitted questions and are watching

495
00:19:36,379 --> 00:19:34,019
online please feel free to continue so

496
00:19:37,489 --> 00:19:36,389
many questions also be sure to let us

497
00:19:39,830 --> 00:19:37,499
know what you'd like to see on future

498
00:19:42,739 --> 00:19:39,840
episodes want to hit a couple other

499
00:19:45,710 --> 00:19:42,749
topics like I normally do specifically I

500
00:19:48,200 --> 00:19:45,720
want to hit on this at home so lots more

501
00:19:50,739 --> 00:19:48,210
products besides our spaceport series

502
00:19:53,899 --> 00:19:50,749
here so you can go to the website NASA

503
00:19:55,489 --> 00:19:53,909
nasa.gov slash NASA at home and check

504
00:19:57,229 --> 00:19:55,499
out all that's there so highlighting a

505
00:19:59,060 --> 00:19:57,239
couple specific thing or one specific

506
00:20:01,369 --> 00:19:59,070
thing today inside the videos section

507
00:20:03,529 --> 00:20:01,379
there's some really cool Ultra High

508
00:20:05,029 --> 00:20:03,539
Definition video content you can go look

509
00:20:06,710 --> 00:20:05,039
at specifically there's this really

510
00:20:07,820 --> 00:20:06,720
awesome video talking about how we are

511
00:20:10,249 --> 00:20:07,830
going to the moon

512
00:20:12,739 --> 00:20:10,259
it's a 4k feature basically looking at

513
00:20:13,759 --> 00:20:12,749

one big world on the moon we're going

514
00:20:15,109 --> 00:20:13,769
back to the moon and how we're doing

515
00:20:16,909 --> 00:20:15,119
that through the Artemis program there

516
00:20:19,299 --> 00:20:16,919
so super exciting to see that all

517
00:20:22,639 --> 00:20:19,309
playing out also want to highlight a few

518
00:20:25,310 --> 00:20:22,649
social media things for you specifically

519
00:20:27,109 --> 00:20:25,320
we've got some some exciting things

520
00:20:29,299 --> 00:20:27,119
happening this past week we had a huge

521
00:20:31,549 --> 00:20:29,309
announcement getting ready to assign

522
00:20:33,649 --> 00:20:31,559
some flights for science to be done in

523
00:20:35,180 --> 00:20:33,659
advance of sustainable presence on the

524
00:20:37,340 --> 00:20:35,190
moon we're hoping to have boots on the

525
00:20:40,279 --> 00:20:37,350
moon first woman the next man 2024 and

526
00:20:42,710 --> 00:20:40,289
then sustainable presence 2028 that is

527
00:20:43,930 --> 00:20:42,720
the target and we are headed there full

528
00:20:46,639 --> 00:20:43,940
steam ahead

529
00:20:49,879 --> 00:20:46,649
next up we wanted to say goodbye to the

530
00:20:52,009 --> 00:20:49,889
Dragon 1 it completed its final cargo

531
00:20:53,570 --> 00:20:52,019
resupply mission Dragon 2 will be coming

532
00:20:56,810 --> 00:20:53,580
online later this year we're excited for

533
00:20:59,370 --> 00:20:56,820
that but certainly another page turned

534
00:21:00,870 --> 00:20:59,380
on the history books an exciting one

535
00:21:02,630 --> 00:21:00,880
one and a very productive one at that

536
00:21:04,950 --> 00:21:02,640
and then last but certainly not least

537
00:21:08,150 --> 00:21:04,960
this is the week that we celebrate

538
00:21:11,550 --> 00:21:08,160

Apollo 13 and a successful failure of

539
00:21:13,560 --> 00:21:11,560
finding out what NASA is really made of

540
00:21:15,360 --> 00:21:13,570
that famous line failure is not an

541
00:21:17,190 --> 00:21:15,370
option that is what we certainly lived

542
00:21:19,380 --> 00:21:17,200
by in that moment and we are proud to

543
00:21:21,600 --> 00:21:19,390
say that we all those men came home

544
00:21:23,400 --> 00:21:21,610
safely so cool history there there's

545
00:21:24,990 --> 00:21:23,410
lots of things on TV today lots of

546
00:21:26,970 --> 00:21:25,000
things online you can find there mr.

547
00:21:28,440 --> 00:21:26,980
Brian son or administrator getting a

548
00:21:30,570 --> 00:21:28,450
shout out to a documentary that was done

549
00:21:32,400 --> 00:21:30,580
on bringing those guys home safely

550
00:21:35,010 --> 00:21:32,410
that's gonna do all for us here today

551
00:21:37,290 --> 00:21:35,020
for from the Kennedy Space Center sort

552
00:21:39,210 --> 00:21:37,300
of I'm Josh with Santora we'll see you