

1
00:00:05,299 --> 00:00:09,719
hello everybody and welcome to this

2
00:00:07,620 --> 00:00:12,330
week's special James Webb Space

3
00:00:09,718 --> 00:00:13,798
Telescope edition of our Hubble hangout

4
00:00:12,330 --> 00:00:15,689
this week we're going to be talking

5
00:00:13,798 --> 00:00:17,698
about our recent milestone that was

6
00:00:15,689 --> 00:00:20,339
reached in the building of the James

7
00:00:17,699 --> 00:00:23,010
Webb Space Telescope or JWST for short

8
00:00:20,339 --> 00:00:25,198
as I love to call it and we have people

9
00:00:23,010 --> 00:00:26,460
both from Northrop Grumman and Goddard

10
00:00:25,199 --> 00:00:28,859
Space Flight Center to help out and give

11
00:00:26,460 --> 00:00:32,039
us some background and to talk about

12
00:00:28,859 --> 00:00:33,859
this latest test this latest test

13
00:00:32,039 --> 00:00:37,379
milestone you may recall back in

14
00:00:33,859 --> 00:00:39,750
something back in the summer in their

15
00:00:37,380 --> 00:00:41,520
facilities in California the the folks

16
00:00:39,750 --> 00:00:45,000
at Northrop Grumman have for the first

17
00:00:41,520 --> 00:00:47,640
time fully deployed the Sun shield which

18
00:00:45,000 --> 00:00:49,200
will be on the orbiting spacecraft we're

19
00:00:47,640 --> 00:00:50,250
going to talk about that test we're

20
00:00:49,200 --> 00:00:52,050
going to talk about what the Sun shield

21
00:00:50,250 --> 00:00:53,670
is and we'll talk about the overall

22
00:00:52,049 --> 00:00:55,738
deployment of the James Webb Space

23
00:00:53,670 --> 00:00:57,090
Telescope as well but before I do that

24
00:00:55,738 --> 00:00:59,189
and before I also get to the

25
00:00:57,090 --> 00:01:00,660
introductions of everybody here let me

26
00:00:59,189 --> 00:01:02,789
tell you how you can interact with us if

27
00:01:00,659 --> 00:01:06,060
you have questions about the jada the

28
00:01:02,789 --> 00:01:09,150
JWST or the deployment or anything about

29

00:01:06,060 --> 00:01:10,978
what it may do at science we hope that

30
00:01:09,150 --> 00:01:13,290
you will interact with us by either

31
00:01:10,978 --> 00:01:15,929
using the easiest way is to use the Q&A

32
00:01:13,290 --> 00:01:18,479
app that's either both on YouTube and

33
00:01:15,930 --> 00:01:21,750
Google+ another very easy way to do it

34
00:01:18,478 --> 00:01:25,019
is to comment on the event page on

35
00:01:21,750 --> 00:01:26,640
Google+ and the YouTube events video

36
00:01:25,019 --> 00:01:28,890
page itself because I'm monitoring all

37
00:01:26,640 --> 00:01:31,650
of that also we hope you will tweet at

38
00:01:28,890 --> 00:01:34,739
us using the Hubble hangout hashtag you

39
00:01:31,650 --> 00:01:36,478
can also use JWST we're mom we're doing

40
00:01:34,739 --> 00:01:38,640
both of those as well so please tweet

41
00:01:36,478 --> 00:01:41,519
ask your questions and your give us your

42
00:01:38,640 --> 00:01:44,399
comments and we will use them later on

43
00:01:41,519 --> 00:01:46,199

I'm very excited about today because for

44

00:01:44,399 --> 00:01:48,329

the first time in a long time I've got

45

00:01:46,200 --> 00:01:50,640

my old friend dr. Alberto Conti

46

00:01:48,328 --> 00:01:53,279

hello Alberto hey Tony it's great to be

47

00:01:50,640 --> 00:02:04,379

here again a long time indeed used to be

48

00:01:53,280 --> 00:02:07,590

an astronomer here are you still an

49

00:02:04,379 --> 00:02:09,840

astronomer yeah I do I might a little

50

00:02:07,590 --> 00:02:11,819

weird but I still I'm a silly

51

00:02:09,840 --> 00:02:13,620

astrophysicist here Northrop Grumman

52

00:02:11,818 --> 00:02:15,359

I'm the innovation manager for business

53

00:02:13,620 --> 00:02:17,849

development so I work on to the bestia

54

00:02:15,360 --> 00:02:21,510

and the things are perhaps in the future

55

00:02:17,848 --> 00:02:23,878

after Jetta misty oh good and also with

56

00:02:21,509 --> 00:02:25,639

us is the chief engineer for from

57

00:02:23,878 --> 00:02:27,810

northrup-grumman who worked on the JWST

58
00:02:25,639 --> 00:02:28,889
jonathan Ehrenberg hi Jonathan it's

59
00:02:27,810 --> 00:02:30,299
really good to see him for the first or

60
00:02:28,889 --> 00:02:33,839
for the first time in our hangout

61
00:02:30,299 --> 00:02:36,170
nice to be here good also we and he's

62
00:02:33,840 --> 00:02:39,840
back with us dr. mark clapping he's the

63
00:02:36,169 --> 00:02:41,578
he is the program manager for the James

64
00:02:39,840 --> 00:02:42,959
Webb Space Telescope at no I'm sorry

65
00:02:41,579 --> 00:02:44,849
you're not your program manager you're

66
00:02:42,959 --> 00:02:46,950
the Observatory project scientist for

67
00:02:44,848 --> 00:02:49,169
the James Webb Space Telescope at net

68
00:02:46,949 --> 00:02:53,729
NOAA NASA Goddard hi mark welcome back

69
00:02:49,169 --> 00:02:56,429
all right thanks okay so and also Scott

70
00:02:53,729 --> 00:03:00,328
driving the internet I mean the

71
00:02:56,430 --> 00:03:02,430
Internet's so I will be tweeting all

72
00:03:00,329 --> 00:03:03,329
over Hubble hangout and I know that NASA

73
00:03:02,430 --> 00:03:05,400
social

74
00:03:03,329 --> 00:03:07,049
and NASA official has been I'm already

75
00:03:05,400 --> 00:03:08,908
seeing some tweets going out so I wanted

76
00:03:07,049 --> 00:03:11,549
to be seeing you guys tweet and we'll be

77
00:03:08,908 --> 00:03:15,269
trying to gather all those questions and

78
00:03:11,549 --> 00:03:17,099
comments up so let's go ahead and get

79
00:03:15,269 --> 00:03:21,120
started so the James Webb Space

80
00:03:17,098 --> 00:03:22,828
Telescope is being built right now as we

81
00:03:21,120 --> 00:03:26,099
speak in a lot of different places it's

82
00:03:22,829 --> 00:03:27,449
being assembled in in at NASA Goddard

83
00:03:26,098 --> 00:03:29,189
but it's being built in many different

84
00:03:27,449 --> 00:03:29,579
facilities one of which is Northrop

85
00:03:29,189 --> 00:03:32,669
Grumman

86

00:03:29,579 --> 00:03:34,319
and it is the successor to the to the

87
00:03:32,669 --> 00:03:35,340
Hubble Space Telescope if you haven't

88
00:03:34,318 --> 00:03:36,899
heard about it by now

89
00:03:35,340 --> 00:03:39,150
you will certainly be hearing more about

90
00:03:36,900 --> 00:03:43,310
it in the future it's scheduled for

91
00:03:39,150 --> 00:03:45,419
launch when Alberto 2018 October 2018

92
00:03:43,310 --> 00:03:47,639
2018 we'll talk a little bit more about

93
00:03:45,419 --> 00:03:49,260
the details of the schedule of how

94
00:03:47,639 --> 00:03:51,209
things are going with it and everything

95
00:03:49,259 --> 00:03:53,189
else but we really want to talk about a

96
00:03:51,209 --> 00:03:55,949
really exciting thing that happened last

97
00:03:53,189 --> 00:03:58,799
summer where they for the first time

98
00:03:55,949 --> 00:04:01,650
there with it would be bigger the folks

99
00:03:58,799 --> 00:04:03,870
at Northrop Grumman have tested the it's

100
00:04:01,650 --> 00:04:05,789

fully deployed a heat shield which will

101

00:04:03,870 --> 00:04:09,090

protect the instruments on the

102

00:04:05,789 --> 00:04:10,739

spacecraft itself and I guess in order

103

00:04:09,090 --> 00:04:11,969

to give some people an idea of what

104

00:04:10,739 --> 00:04:13,829

we're talking about for those who have

105

00:04:11,969 --> 00:04:18,529

never seen it before we have an

106

00:04:13,829 --> 00:04:21,629

animation of what will happen once the

107

00:04:18,529 --> 00:04:23,819

once the observatory is in space once

108

00:04:21,629 --> 00:04:25,259

it's in orbit and I tell you it's

109

00:04:23,819 --> 00:04:28,230

amazing what's going to happen here

110

00:04:25,259 --> 00:04:30,120

this is the it when you fully understand

111

00:04:28,230 --> 00:04:34,050

all the stuff that's gonna happen after

112

00:04:30,120 --> 00:04:36,209

the spacecraft gets into space just

113

00:04:34,050 --> 00:04:38,009

blows me away every time I see it so

114

00:04:36,209 --> 00:04:40,139

John I think what I'd like you to do if

115
00:04:38,009 --> 00:04:41,699
you don't mind is we have an animation

116
00:04:40,139 --> 00:04:42,839
here of the deployment sequence can you

117
00:04:41,699 --> 00:04:44,670
step us through it just a little bit

118
00:04:42,839 --> 00:04:47,359
what's gonna happen to JWST once it

119
00:04:44,670 --> 00:04:50,930
launches sure what you just saw was

120
00:04:47,360 --> 00:04:54,180
separation from our launch vehicle and

121
00:04:50,930 --> 00:04:57,389
stabilization and unfolding of the solar

122
00:04:54,180 --> 00:05:00,300
array if you watch along the bottom it

123
00:04:57,389 --> 00:05:03,269
shows our position away from Earth and

124
00:05:00,300 --> 00:05:08,430
as you can see we're passing the moon

125
00:05:03,269 --> 00:05:10,680
and still quite stowed we can have a

126
00:05:08,430 --> 00:05:13,259
couple of mid-course Corrections to add

127
00:05:10,680 --> 00:05:15,750
the necessary energy to achieve our

128
00:05:13,259 --> 00:05:18,589
orbit and the Blue Dot and we just left

129
00:05:15,750 --> 00:05:24,389
behind is the manned altitude record

130
00:05:18,589 --> 00:05:28,079
currently held by Apollo 13 the Sun

131
00:05:24,389 --> 00:05:31,110
shield begins to deploy by opening the

132
00:05:28,079 --> 00:05:33,659
aft and forward palettes and the

133
00:05:31,110 --> 00:05:36,720
telescope which would snug down for

134
00:05:33,660 --> 00:05:40,290
launch moves away about four feet from

135
00:05:36,720 --> 00:05:42,780
the Sun shield and what you see is the

136
00:05:40,290 --> 00:05:47,129
various covers that protect the

137
00:05:42,779 --> 00:05:50,279
membranes unfolding and the structure

138
00:05:47,129 --> 00:05:53,189
the mid moons as we call them pressing

139
00:05:50,279 --> 00:05:57,179
out there like a great big old-fashioned

140
00:05:53,189 --> 00:06:00,300
car antenna and then after a suitable

141
00:05:57,180 --> 00:06:03,720
waiting period we reel in the cables in

142
00:06:00,300 --> 00:06:10,740
tension the Sun shield pulling it to its

143

00:06:03,720 --> 00:06:13,170
full orientation once that's done as

144
00:06:10,740 --> 00:06:15,360
you're going to see in just a second the

145
00:06:13,170 --> 00:06:19,259
telescope begins to deploy the secondary

146
00:06:15,360 --> 00:06:20,759
mirror mount the aft radiator to allow

147
00:06:19,259 --> 00:06:24,060
the instruments to vent their heat to

148
00:06:20,759 --> 00:06:27,060
space and then finally the wings and

149
00:06:24,060 --> 00:06:30,839
this is completed roughly about a

150
00:06:27,060 --> 00:06:32,579
million kilometres or 600,000 miles and

151
00:06:30,839 --> 00:06:34,500
if you guys you can see in the upper

152
00:06:32,579 --> 00:06:36,659
part of the screen to sort of the

153
00:06:34,500 --> 00:06:37,649
elapsed time we're in day 29 and this

154
00:06:36,660 --> 00:06:40,949
animation

155
00:06:37,649 --> 00:06:43,709
so a month after launch this thing is

156
00:06:40,949 --> 00:06:47,250
going to be going through its paces and

157
00:06:43,709 --> 00:06:50,039

to become fully deployed and it's

158

00:06:47,250 --> 00:06:51,449

pointed in its spot at the I2 point and

159

00:06:50,040 --> 00:06:53,870

we'll talk about what that is in just a

160

00:06:51,449 --> 00:06:56,490

minute so I don't know if you guys fully

161

00:06:53,870 --> 00:07:00,810

got that I mean we they had they crammed

162

00:06:56,490 --> 00:07:03,030

this whole gigantic Observatory into the

163

00:07:00,810 --> 00:07:04,829

rocket and the engineering challenge one

164

00:07:03,029 --> 00:07:06,299

of the biggest ones they've ever they've

165

00:07:04,829 --> 00:07:08,939

ever had to solve I think was how are

166

00:07:06,300 --> 00:07:10,680

they gonna get something that has the

167

00:07:08,939 --> 00:07:13,469

shape of the James Webb Space Telescope

168

00:07:10,680 --> 00:07:15,569

into a rocket and out to to where it

169

00:07:13,470 --> 00:07:20,760

needs to be and you just saw the plan

170

00:07:15,569 --> 00:07:24,240

for it John the so the who was

171

00:07:20,759 --> 00:07:25,500

responsible for this this design was er

172
00:07:24,240 --> 00:07:28,620
it was our group of people team of

173
00:07:25,500 --> 00:07:31,829
people that became there's a was a very

174
00:07:28,620 --> 00:07:33,538
large team of people that studied it in

175
00:07:31,829 --> 00:07:37,759
the early phases and came up with the

176
00:07:33,538 --> 00:07:42,209
architecture passively cooled large

177
00:07:37,759 --> 00:07:45,180
beryllium mirror telescope and then the

178
00:07:42,209 --> 00:07:47,399
design has significantly matured over

179
00:07:45,180 --> 00:07:57,560
the last few years as it went from

180
00:07:47,399 --> 00:07:59,819
concept I well the sunshield in some way

181
00:07:57,560 --> 00:08:01,199
okay part of you cut out there I'm not

182
00:07:59,819 --> 00:08:02,639
sure it was

183
00:08:01,199 --> 00:08:03,659
we caught the light we didn't catch the

184
00:08:02,639 --> 00:08:04,740
last part of that but hopefully we'll

185
00:08:03,660 --> 00:08:07,470
get we'll be able to fill in the details

186
00:08:04,740 --> 00:08:09,360
a little bit later so this the Sun shall

187
00:08:07,470 --> 00:08:11,070
let's let's talk about the Sun shield

188
00:08:09,360 --> 00:08:13,949
itself a little bit um Kelly I don't

189
00:08:11,069 --> 00:08:16,168
know if you can go into one of the

190
00:08:13,949 --> 00:08:19,050
images or maybe the the animation where

191
00:08:16,168 --> 00:08:20,519
it was fully what where the Sun shield

192
00:08:19,050 --> 00:08:23,310
was deployed can you go to one of those

193
00:08:20,519 --> 00:08:24,990
spots there what's the Sun shield

194
00:08:23,310 --> 00:08:30,449
supposed to do what's it what's its

195
00:08:24,990 --> 00:08:34,168
purpose the Sun shield purpose is very

196
00:08:30,449 --> 00:08:37,050
simple it makes a nice dark shadow that

197
00:08:34,168 --> 00:08:38,929
the telescope lives in and it allows the

198
00:08:37,049 --> 00:08:42,658
telescope to radiate its heat to space

199
00:08:38,929 --> 00:08:45,208
to achieve the operating very cold

200

00:08:42,658 --> 00:08:48,328
temperatures that the telescope needs to

201
00:08:45,208 --> 00:08:51,208
be able to see our targets so basically

202
00:08:48,328 --> 00:08:51,719
it's a very high-tech parasol alright so

203
00:08:51,208 --> 00:08:53,309
remember

204
00:08:51,720 --> 00:08:56,040
if I can interject here for a second

205
00:08:53,309 --> 00:08:58,349
remember that we build a telescope you

206
00:08:56,039 --> 00:09:00,480
know to satisfy our our science

207
00:08:58,350 --> 00:09:03,240
curiosity if you will and web in order

208
00:09:00,480 --> 00:09:04,860
to do his job needs to be extremely cold

209
00:09:03,240 --> 00:09:07,438
because it's an infrared telescope and

210
00:09:04,860 --> 00:09:09,169
so in order to do that and to make it in

211
00:09:07,438 --> 00:09:11,759
such a way that you don't have

212
00:09:09,169 --> 00:09:14,219
Expendables like for example gas cooling

213
00:09:11,759 --> 00:09:17,490
or so we made into a passive telescope

214
00:09:14,220 --> 00:09:19,379

and so the this Sun shield as as John

215

00:09:17,490 --> 00:09:21,180

just mentioned is basically that it's a

216

00:09:19,379 --> 00:09:25,019

it's a it's something that produces a

217

00:09:21,179 --> 00:09:27,419

very very peculiar and very predictable

218

00:09:25,019 --> 00:09:30,299

shade in which the scope and all its

219

00:09:27,419 --> 00:09:34,099

electronics set okay so Kelly has a nice

220

00:09:30,299 --> 00:09:38,028

image of it up now what's it made of

221

00:09:34,100 --> 00:09:41,550

John is made of a plastic called captain

222

00:09:38,028 --> 00:09:43,769

the individual layers the top four

223

00:09:41,549 --> 00:09:46,078

layers that you can see are one

224

00:09:43,769 --> 00:09:47,730

thousandth of an inch thick and the

225

00:09:46,078 --> 00:09:50,519

bottom layer is two thousandth of an

226

00:09:47,730 --> 00:09:54,209

inch thick if you speak metric that's 25

227

00:09:50,519 --> 00:09:57,120

microns and 50 microns roughly the size

228

00:09:54,208 --> 00:09:59,818

of a width of a hair and the coatings

229
00:09:57,120 --> 00:10:02,100
that you see here are aluminum and the

230
00:09:59,818 --> 00:10:04,740
bottoms of layers one and two are coated

231
00:10:02,100 --> 00:10:08,720
with the element silicon so they're very

232
00:10:04,740 --> 00:10:11,430
very thin they're much thinner than the

233
00:10:08,720 --> 00:10:14,250
snack bag that you ate your potato chips

234
00:10:11,429 --> 00:10:17,758
out of at lunch but it's a very similar

235
00:10:14,250 --> 00:10:19,980
kind of material so guys I'm sleeve it

236
00:10:17,759 --> 00:10:21,379
already how do you know I ate chips at

237
00:10:19,980 --> 00:10:24,480
lunch

238
00:10:21,379 --> 00:10:31,438
yes it's an advanced telescope Scott it

239
00:10:24,480 --> 00:10:32,759
really is so presumably this stuff is

240
00:10:31,438 --> 00:10:36,230
also very well you're very lightweight

241
00:10:32,759 --> 00:10:39,209
correct I mean yes it's extremely

242
00:10:36,230 --> 00:10:42,899
lightweight are you worried at all about

243
00:10:39,208 --> 00:10:46,919
ripping or tearing once it's I mean how

244
00:10:42,899 --> 00:10:49,919
strong is this stuff Lizzie we do stress

245
00:10:46,919 --> 00:10:51,360
test it on the ground to make sure that

246
00:10:49,919 --> 00:10:54,539
it's been made properly

247
00:10:51,360 --> 00:10:56,370
there are ripstop features so that if a

248
00:10:54,539 --> 00:11:00,480
rip does occur it doesn't propagate

249
00:10:56,370 --> 00:11:04,198
across the entire sun shield and we've

250
00:11:00,480 --> 00:11:05,590
also had tested it in the laboratory for

251
00:11:04,198 --> 00:11:08,109
micrometeorite

252
00:11:05,590 --> 00:11:13,149
to understand how that affects the

253
00:11:08,110 --> 00:11:18,009
mechanical integrity so you know we have

254
00:11:13,149 --> 00:11:19,419
thought about it in the design we we

255
00:11:18,009 --> 00:11:21,519
worry about it to the point where we

256
00:11:19,419 --> 00:11:23,889
mitigate that concern inside the design

257

00:11:21,519 --> 00:11:25,269
I may be way off here and forget I'm

258
00:11:23,889 --> 00:11:28,659
certain you'll correct me if I'm wrong

259
00:11:25,269 --> 00:11:30,100
but the captain is that the same stuff

260
00:11:28,659 --> 00:11:31,719
they used in the around the Apollo

261
00:11:30,100 --> 00:11:34,870
module or the lunar modules or is that

262
00:11:31,720 --> 00:11:37,750
something else this is very commonly

263
00:11:34,870 --> 00:11:39,039
used insulation material so this is

264
00:11:37,750 --> 00:11:40,509
pretty old stuff and I mean it's been

265
00:11:39,039 --> 00:11:43,028
around a while as far as the technology

266
00:11:40,509 --> 00:11:45,850
of the material the materials

267
00:11:43,028 --> 00:11:47,230
okay you mentioned micrometeorites how

268
00:11:45,850 --> 00:11:49,540
well didn't you tested it against that

269
00:11:47,230 --> 00:11:52,769
how how do they do I mean are they gonna

270
00:11:49,539 --> 00:11:55,149
they're gonna stand up let's see the

271
00:11:52,769 --> 00:11:59,278

micrometeorites will penetrate the sun

272

00:11:55,149 --> 00:12:02,559

shield those those expected values with

273

00:11:59,278 --> 00:12:07,689

considerable conservatism is part of the

274

00:12:02,559 --> 00:12:11,289

budget so for the properties that define

275

00:12:07,690 --> 00:12:14,290

how well is sun shield works we

276

00:12:11,289 --> 00:12:15,669

calculate a budget if you will and all

277

00:12:14,289 --> 00:12:18,370

of the things that degrade those

278

00:12:15,669 --> 00:12:22,029

properties one of those is homes from

279

00:12:18,370 --> 00:12:23,860

micrometeorites that's in our budget so

280

00:12:22,029 --> 00:12:27,279

we have convinced ourselves that even

281

00:12:23,860 --> 00:12:30,879

with what do you mean budget though it's

282

00:12:27,279 --> 00:12:34,329

just like the allowable yes we have to

283

00:12:30,879 --> 00:12:37,740

have a certain amount of reflectivity

284

00:12:34,330 --> 00:12:40,750

and we're allowed a certain amount of

285

00:12:37,740 --> 00:12:42,909

transmission from one layer to the next

286
00:12:40,750 --> 00:12:45,370
if we have a hole in it say from

287
00:12:42,909 --> 00:12:49,629
micrometeorite that increases the

288
00:12:45,370 --> 00:12:52,509
transmission so we analyze for the

289
00:12:49,629 --> 00:12:54,720
thermal performance given a certain set

290
00:12:52,509 --> 00:12:58,899
of material properties reflectance

291
00:12:54,720 --> 00:13:01,959
absorptance transmissions emissivity etc

292
00:12:58,899 --> 00:13:05,019
and we degrade these by introducing the

293
00:13:01,958 --> 00:13:08,169
effects of the holes contamination and

294
00:13:05,019 --> 00:13:10,990
other things and convince ourselves at

295
00:13:08,169 --> 00:13:15,219
the end of life we meet our requirements

296
00:13:10,990 --> 00:13:17,589
so that's how understanding go ahead

297
00:13:15,220 --> 00:13:19,000
Alberto no I would say this also goes to

298
00:13:17,589 --> 00:13:22,270
the fact that you know people

299
00:13:19,000 --> 00:13:23,700
asked why five layers are not 35 you

300
00:13:22,269 --> 00:13:27,669
read my mind

301
00:13:23,700 --> 00:13:29,500
that's what we do here yes so but they

302
00:13:27,669 --> 00:13:32,079
should know the issue is as John just

303
00:13:29,500 --> 00:13:33,970
mentioned you know and you know in order

304
00:13:32,080 --> 00:13:35,470
to satisfy those science requirements

305
00:13:33,970 --> 00:13:38,050
you have to model you know how your

306
00:13:35,470 --> 00:13:40,440
spacecraft behaves and so five layers is

307
00:13:38,049 --> 00:13:43,659
a compromise on you know in terms of

308
00:13:40,440 --> 00:13:44,890
being able to match those those those

309
00:13:43,659 --> 00:13:47,860
requirements the other thing that we

310
00:13:44,889 --> 00:13:50,649
should mention is that it you know the

311
00:13:47,860 --> 00:13:52,480
the sunshade this star the part of the

312
00:13:50,649 --> 00:13:54,220
essential that faces the Sun is going to

313
00:13:52,480 --> 00:13:56,409
get extremely hot so this is tremendous

314

00:13:54,220 --> 00:13:58,990
gradient that goes from the hot side to

315
00:13:56,409 --> 00:14:02,409
the cold side of Abajo door 600 degrees

316
00:13:58,990 --> 00:14:04,240
or so and what can what gets Kotter

317
00:14:02,409 --> 00:14:07,089
Kelly can one of you put up an image

318
00:14:04,240 --> 00:14:12,399
showing these layers so we can have it

319
00:14:07,090 --> 00:14:13,899
up while he's talking yeah just one from

320
00:14:12,399 --> 00:14:16,350
it when viewed from the side or

321
00:14:13,899 --> 00:14:16,350
something like that

322
00:14:17,700 --> 00:14:22,330
also I'm saying is you know so it this

323
00:14:20,080 --> 00:14:24,310
is part of whatever it really means to

324
00:14:22,330 --> 00:14:25,810
to build a spacecraft and Observatory

325
00:14:24,309 --> 00:14:28,239
this complex which is you have to do

326
00:14:25,809 --> 00:14:30,609
extremely sophisticated model II to

327
00:14:28,240 --> 00:14:32,049
understand not only in the environment

328
00:14:30,610 --> 00:14:34,000

that the telescope would be in in terms

329

00:14:32,049 --> 00:14:35,799

of temperature for example but the

330

00:14:34,000 --> 00:14:37,809

environment in terms on micrometeorites

331

00:14:35,799 --> 00:14:39,250

and we have a lot of telescopes and a

332

00:14:37,809 --> 00:14:41,588

lot of spacecrafts that have been

333

00:14:39,250 --> 00:14:42,970

orbiting I2 for some time so we we

334

00:14:41,589 --> 00:14:44,440

started to understand that environment

335

00:14:42,970 --> 00:14:46,269

better and better and so our models get

336

00:14:44,440 --> 00:14:48,520

better and better but as John mentioned

337

00:14:46,269 --> 00:14:51,370

you know that all these five layers are

338

00:14:48,519 --> 00:14:53,289

so the minimum innum um required to

339

00:14:51,370 --> 00:14:56,019

satisfy those those requirement take

340

00:14:53,289 --> 00:15:00,279

into account you know for the fact that

341

00:14:56,019 --> 00:15:04,319

we will be struck by micrometeorites we

342

00:15:00,279 --> 00:15:06,939

will have you know a certain amount of

343
00:15:04,320 --> 00:15:09,490
quite a bit of heat you know on the on

344
00:15:06,940 --> 00:15:12,030
the on the on the front layer if you

345
00:15:09,490 --> 00:15:15,240
will wonder faces the Sun and how they

346
00:15:12,029 --> 00:15:17,470
heat dissipates so it's a very complex

347
00:15:15,240 --> 00:15:19,899
set of requirements that you have to

348
00:15:17,470 --> 00:15:21,460
fold into a complex modelling that you

349
00:15:19,899 --> 00:15:23,439
have to do and I think the team and John

350
00:15:21,460 --> 00:15:25,810
and this couple with a scientist which

351
00:15:23,440 --> 00:15:27,339
are perhaps the users at the end you

352
00:15:25,809 --> 00:15:29,529
know those that are actually requiring

353
00:15:27,339 --> 00:15:31,570
what it is good enough for me to do my

354
00:15:29,529 --> 00:15:32,818
science are collaborating on a daily

355
00:15:31,570 --> 00:15:34,528
basis to actually make sure

356
00:15:32,818 --> 00:15:36,478
you do satisfy those requirements and

357
00:15:34,528 --> 00:15:39,088
that's why I think the test that we're

358
00:15:36,479 --> 00:15:39,959
going to show in a few minutes is was

359
00:15:39,089 --> 00:15:41,999
critical for this

360
00:15:39,958 --> 00:15:44,878
okay so I've heard this thing called a

361
00:15:41,999 --> 00:15:48,869
big giant radiator where the each of the

362
00:15:44,879 --> 00:15:50,159
five layers actually do a can you

363
00:15:48,869 --> 00:15:52,079
describe what they mean by that John

364
00:15:50,159 --> 00:15:53,399
what is it you know what it why the five

365
00:15:52,078 --> 00:15:57,508
layers and what does it do you think

366
00:15:53,399 --> 00:16:00,058
dissipation so what happens is the

367
00:15:57,509 --> 00:16:03,329
sunlight strikes the first layer the

368
00:16:00,058 --> 00:16:05,938
closest to the Sun layer one a lot of

369
00:16:03,328 --> 00:16:09,208
that heat is reflected some of it is

370
00:16:05,938 --> 00:16:12,149
absorbed and its remit addictions both

371

00:16:09,208 --> 00:16:14,878
up the stack and back at the Sun just

372
00:16:12,149 --> 00:16:19,499
about has a nice picture up now yeah and

373
00:16:14,879 --> 00:16:22,199
that he that now is leaving layer one

374
00:16:19,499 --> 00:16:25,139
and going to see layer two most of that

375
00:16:22,198 --> 00:16:26,878
gets reflected and that what you can't

376
00:16:25,139 --> 00:16:30,028
see in these pictures because it's hard

377
00:16:26,879 --> 00:16:32,639
to see is there's a very small opening

378
00:16:30,028 --> 00:16:36,688
angle so that so that the layers

379
00:16:32,639 --> 00:16:40,139
actually form tiny V's allowing the

380
00:16:36,688 --> 00:16:43,048
reflected heat to essentially walk out

381
00:16:40,139 --> 00:16:47,009
or reflect out and exit through space

382
00:16:43,048 --> 00:16:49,139
and with every successive layer most of

383
00:16:47,009 --> 00:16:52,019
the incident radiation is reflected a

384
00:16:49,139 --> 00:16:54,959
tiny fraction is absorbed and with each

385
00:16:52,019 --> 00:16:59,038

layer the temperature goes down starting

386

00:16:54,958 --> 00:17:00,958
as Alberto said at about 90 Celsius

387

00:16:59,038 --> 00:17:03,509
almost the temperature of boiling water

388

00:17:00,958 --> 00:17:06,359
and when we get to the top it's almost

389

00:17:03,509 --> 00:17:09,509
the temperature that's cold enough to

390

00:17:06,359 --> 00:17:11,398
liquefy nitrogen so that's that spot

391

00:17:09,509 --> 00:17:13,528
where the in the image that Scott is

392

00:17:11,398 --> 00:17:16,859
showing where these guys are currently

393

00:17:13,528 --> 00:17:18,838
standing is that the coldest spot that

394

00:17:16,859 --> 00:17:24,708
should actually in the center believe it

395

00:17:18,838 --> 00:17:24,708
or not that's the warmest spot huh

396

00:17:27,199 --> 00:17:31,259
those guys are standing that's the

397

00:17:29,128 --> 00:17:43,019
warmest spot that tells me yes because

398

00:17:31,259 --> 00:17:45,179
the spacecraft is underneath it okay the

399

00:17:43,019 --> 00:17:46,589
tower the cables everything that

400
00:17:45,179 --> 00:17:48,870
connects the hot side to the cold

401
00:17:46,589 --> 00:17:51,480
side comes through the sunshield at that

402
00:17:48,869 --> 00:17:53,819
position and we call that the core and

403
00:17:51,480 --> 00:17:55,470
the core is the warmest part of the

404
00:17:53,819 --> 00:17:57,928
sunshield got it

405
00:17:55,470 --> 00:17:59,130
okay dr. Martin clapping I want to get

406
00:17:57,929 --> 00:18:01,019
you into this real quick I want to ask

407
00:17:59,130 --> 00:18:03,150
you why can you tell us a little bit

408
00:18:01,019 --> 00:18:05,940
about why this thing needs to be so cold

409
00:18:03,150 --> 00:18:08,820
what is the reason for getting getting

410
00:18:05,940 --> 00:18:10,590
the temperature down so low well the

411
00:18:08,819 --> 00:18:13,349
reason is because this is an infrared

412
00:18:10,589 --> 00:18:17,009
telescope and infrared as we all know is

413
00:18:13,349 --> 00:18:19,288
heat radiation and the science goes to

414
00:18:17,009 --> 00:18:22,849
this telescope to span a broad range of

415
00:18:19,288 --> 00:18:25,349
infrared astronomy ranging from looking

416
00:18:22,849 --> 00:18:28,319
trying to take images of the very first

417
00:18:25,349 --> 00:18:30,869
galaxies that formed in the universe to

418
00:18:28,319 --> 00:18:33,298
understanding the nature of the

419
00:18:30,869 --> 00:18:35,609
atmospheres of exoplanets so we have a

420
00:18:33,298 --> 00:18:38,700
broad range of science that requires

421
00:18:35,609 --> 00:18:41,788
very high positions infrared

422
00:18:38,700 --> 00:18:44,548
measurements and if we're to do that

423
00:18:41,788 --> 00:18:46,528
then we need to cool the telescope so

424
00:18:44,548 --> 00:18:48,778
that we're actually imaging the sources

425
00:18:46,528 --> 00:18:51,329
in the universe that he wants to study

426
00:18:48,778 --> 00:18:53,278
and not just looking at a big thermal

427
00:18:51,329 --> 00:18:55,918
background caused by the telescope

428

00:18:53,278 --> 00:19:00,119
itself the way you do that is you get

429
00:18:55,919 --> 00:19:02,788
your telescope instrument temperature so

430
00:19:00,119 --> 00:19:04,589
that you're able to essentially image

431
00:19:02,788 --> 00:19:06,629
the infrared radiation coming from the

432
00:19:04,589 --> 00:19:09,089
universe and not as boring thermal

433
00:19:06,630 --> 00:19:12,000
signature so we're calling the

434
00:19:09,089 --> 00:19:15,119
telescopes and the instruments to

435
00:19:12,000 --> 00:19:17,940
something like 40 Kelvin which is 40

436
00:19:15,119 --> 00:19:20,308
degrees above absolute zero and that's

437
00:19:17,940 --> 00:19:22,710
the reason we need the Sun shield now

438
00:19:20,308 --> 00:19:25,759
all of the infrared telescopes we've

439
00:19:22,710 --> 00:19:27,929
flown up to now have relied on

440
00:19:25,759 --> 00:19:30,450
essentially a big dustbin of liquid

441
00:19:27,929 --> 00:19:32,850
helium to keep them cold and that's fine

442
00:19:30,450 --> 00:19:35,730

but as as you go through the life in the

443

00:19:32,849 --> 00:19:38,158
mission that helium burns out so you end

444

00:19:35,730 --> 00:19:40,230
up with a red or to be near short

445

00:19:38,159 --> 00:19:42,840
lifetime for your mission a couple years

446

00:19:40,230 --> 00:19:45,329
and that helium is burnt up and you no

447

00:19:42,839 --> 00:19:48,269
longer have a telescope it's very

448

00:19:45,329 --> 00:19:50,609
exciting we met that sort of happened to

449

00:19:48,269 --> 00:19:52,500
Spitzer right that has happened to

450

00:19:50,609 --> 00:19:54,808
Spencer and Spitz around now in what's

451

00:19:52,500 --> 00:19:56,849
called its war mission phase it happened

452

00:19:54,808 --> 00:19:58,558
to Herschel so both of these oceans

453

00:19:56,849 --> 00:20:00,009
reach the end of their specified

454

00:19:58,558 --> 00:20:02,220
lifetime and

455

00:20:00,009 --> 00:20:04,690
you know ran out of hide sorry helium

456

00:20:02,220 --> 00:20:06,910
the what we're doing here is we're using

457
00:20:04,690 --> 00:20:09,460
the Sun shield to do what we call

458
00:20:06,910 --> 00:20:12,250
passive cooling that means that we can

459
00:20:09,460 --> 00:20:15,970
operate JWST is that facility

460
00:20:12,250 --> 00:20:18,759
Observatory totally for up to 10 year

461
00:20:15,970 --> 00:20:21,279
lifetime and be able to do some infrared

462
00:20:18,759 --> 00:20:24,400
science so that's why we have the Sun

463
00:20:21,279 --> 00:20:26,980
shield we have some real challenges

464
00:20:24,400 --> 00:20:29,140
trying to do this science so to in for

465
00:20:26,980 --> 00:20:31,120
instance to image the you know very

466
00:20:29,140 --> 00:20:33,190
first galaxies that formed in universe

467
00:20:31,119 --> 00:20:35,919
we need a very large mirror which is why

468
00:20:33,190 --> 00:20:37,990
today wsd provides you need to gather

469
00:20:35,920 --> 00:20:41,019
image in the infrared because most of

470
00:20:37,990 --> 00:20:43,120
the light from these objects is Doppler

471
00:20:41,019 --> 00:20:45,549
shifted into the infrared part of the

472
00:20:43,119 --> 00:20:48,549
electromagnetic spectrum and we also

473
00:20:45,549 --> 00:20:51,190
need angular resolution and so we go to

474
00:20:48,549 --> 00:20:53,139
very large cryogenic telescope and that

475
00:20:51,190 --> 00:20:55,509
allows us to do this identifiers

476
00:20:53,140 --> 00:20:57,670
great alright thank you very much so

477
00:20:55,509 --> 00:21:01,470
let's get to the test before too much

478
00:20:57,670 --> 00:21:04,810
time goes by so last summer you guys

479
00:21:01,470 --> 00:21:08,710
Alberto and Jonathan you uh you guys

480
00:21:04,809 --> 00:21:11,529
pulled this thing out huh you guys so

481
00:21:08,710 --> 00:21:13,420
describe the test to us what where this

482
00:21:11,529 --> 00:21:14,740
is their actual now this is the actual

483
00:21:13,420 --> 00:21:18,310
Sun shield this is the one that's going

484
00:21:14,740 --> 00:21:20,079
up into space this is not it this is not

485

00:21:18,309 --> 00:21:25,480
it this is a this is a development

486
00:21:20,079 --> 00:21:27,939
article okay it's so it's typical of how

487
00:21:25,480 --> 00:21:30,880
we build these things we build test

488
00:21:27,940 --> 00:21:33,309
articles and engineering models and as

489
00:21:30,880 --> 00:21:36,100
we gradually increase our knowledge and

490
00:21:33,309 --> 00:21:38,529
we're sure how the system is going to

491
00:21:36,099 --> 00:21:43,000
behave then we begin to experiment on

492
00:21:38,529 --> 00:21:46,000
the flight hardware very gently so that

493
00:21:43,000 --> 00:21:52,180
we're sure that it's it's not been loved

494
00:21:46,000 --> 00:21:53,859
to death if you will on the ground sorry

495
00:21:52,180 --> 00:22:00,009
your telescope working it's been lovely

496
00:21:53,859 --> 00:22:02,439
too much and so these membranes serve

497
00:22:00,009 --> 00:22:05,490
many purposes in the development of the

498
00:22:02,440 --> 00:22:07,950
Sun shield their first purpose was to

499
00:22:05,490 --> 00:22:11,740

essentially pathfinding to prove out the

500

00:22:07,950 --> 00:22:13,930

manufacturing processes I happen to be

501

00:22:11,740 --> 00:22:17,920

sitting in Huntsville Alabama

502

00:22:13,930 --> 00:22:19,900

at the membrane manufacturers today for

503

00:22:17,920 --> 00:22:23,440

a meeting on another subject

504

00:22:19,900 --> 00:22:26,350

Jayda BST related but these membranes

505

00:22:23,440 --> 00:22:27,940

were made to start the pathfinding

506

00:22:26,349 --> 00:22:31,899

process to prove that we can manufacture

507

00:22:27,940 --> 00:22:36,720

them and then we also learned how to

508

00:22:31,900 --> 00:22:39,509

handle fold and stow them and ultimately

509

00:22:36,720 --> 00:22:43,900

when they were secured for launch

510

00:22:39,509 --> 00:22:49,329

release the locks and prove that they

511

00:22:43,900 --> 00:22:52,780

would unfold without snagging on

512

00:22:49,329 --> 00:22:55,319

anything at the unit so previously

513

00:22:52,779 --> 00:22:58,539

single layers had been deployed

514
00:22:55,319 --> 00:23:01,599
different pieces the core the various

515
00:22:58,539 --> 00:23:06,190
folding had been tested and so this was

516
00:23:01,599 --> 00:23:08,799
a little bit like a symphony where each

517
00:23:06,190 --> 00:23:10,960
of the different pieces was a section of

518
00:23:08,799 --> 00:23:13,928
the orchestra and we finally got the

519
00:23:10,960 --> 00:23:15,730
band all together to to play that that

520
00:23:13,929 --> 00:23:17,620
one symphony which was the deployment

521
00:23:15,730 --> 00:23:19,299
okay yeah you we got you guys have sent

522
00:23:17,619 --> 00:23:21,939
us some really nice time lapses Kelly if

523
00:23:19,299 --> 00:23:24,129
you can show us those going on of the

524
00:23:21,940 --> 00:23:25,690
actual test itself now you brought up an

525
00:23:24,130 --> 00:23:28,510
interesting point with this not being

526
00:23:25,690 --> 00:23:31,570
the actual deployment heat shield that

527
00:23:28,509 --> 00:23:38,710
will be deployed not this video Kelly

528
00:23:31,569 --> 00:23:46,529
sorry no such challenge although she

529
00:23:38,710 --> 00:23:50,679
goes sorry I've got it up on my girl

530
00:23:46,529 --> 00:23:52,058
okay so these yes I I see people

531
00:23:50,679 --> 00:23:54,059
physically pulling them out describe

532
00:23:52,058 --> 00:23:59,619
what we're looking at now Jonathan's so

533
00:23:54,058 --> 00:24:03,129
what you're seeing is the deployment of

534
00:23:59,619 --> 00:24:06,428
the Sun shield the mainly the mid booms

535
00:24:03,130 --> 00:24:09,040
pressing out and what you're seeing now

536
00:24:06,429 --> 00:24:11,259
is the tensioning of the individual

537
00:24:09,039 --> 00:24:14,019
membranes the reeling in of the cables

538
00:24:11,259 --> 00:24:16,569
that pull them from their initial

539
00:24:14,019 --> 00:24:18,670
position on deployment to their final

540
00:24:16,569 --> 00:24:20,649
position that is pulling them into those

541
00:24:18,670 --> 00:24:21,840
these that I told you about earlier

542

00:24:20,650 --> 00:24:25,140
right

543
00:24:21,839 --> 00:24:27,928
and that's are an absolutely necessary

544
00:24:25,140 --> 00:24:33,669
part of getting the Sun shield

545
00:24:27,929 --> 00:24:37,000
so the main objective of this test was

546
00:24:33,669 --> 00:24:40,538
to prove to ourselves that we know how

547
00:24:37,000 --> 00:24:43,058
to secure the membranes for launch and

548
00:24:40,538 --> 00:24:45,190
that once they're in that position that

549
00:24:43,058 --> 00:24:49,119
they will unfold without snagging and

550
00:24:45,190 --> 00:24:50,470
assume the correct final positions okay

551
00:24:49,119 --> 00:24:52,028
I'm seeing a lot of people doing a lot

552
00:24:50,470 --> 00:24:58,149
of pulling presumably they won't be out

553
00:24:52,028 --> 00:25:05,288
there I totally want to be one of those

554
00:24:58,148 --> 00:25:09,009
people that go out here here you go what

555
00:25:05,288 --> 00:25:12,190
you see actually there were were really

556
00:25:09,009 --> 00:25:14,890

13 principle people seven engineers

557

00:25:12,190 --> 00:25:16,990

technicians or vice versa that were

558

00:25:14,890 --> 00:25:19,830

really responsible for that test and

559

00:25:16,990 --> 00:25:24,099

because it was such an interesting and

560

00:25:19,829 --> 00:25:28,439

importantly test there were a few times

561

00:25:24,099 --> 00:25:32,918

more people that wanted to get real-time

562

00:25:28,440 --> 00:25:35,080

so they got to that lucky 13 got to do a

563

00:25:32,919 --> 00:25:37,679

very important job in front of maybe a

564

00:25:35,079 --> 00:25:42,099

hundred onlookers and so there were

565

00:25:37,679 --> 00:25:45,460

video crews myself Marc Alberto and any

566

00:25:42,099 --> 00:25:48,069

number of people that were interested

567

00:25:45,460 --> 00:25:50,610

but not specifically assigned to the

568

00:25:48,069 --> 00:25:53,109

test team that's why it looks like

569

00:25:50,609 --> 00:25:55,389

there's an awful lot of people around it

570

00:25:53,109 --> 00:25:58,000

because quite frankly there are a lot of

571
00:25:55,390 --> 00:26:00,820
people around it so this test taught you

572
00:25:58,000 --> 00:26:02,740
that you know how to fold them properly

573
00:26:00,819 --> 00:26:06,730
for launch and that they will in fact

574
00:26:02,740 --> 00:26:10,179
unfold properly once they're ready to be

575
00:26:06,730 --> 00:26:12,099
deployed yes anything else anything else

576
00:26:10,179 --> 00:26:13,778
that you learned that you maybe you

577
00:26:12,099 --> 00:26:14,439
hadn't expected or were there any

578
00:26:13,778 --> 00:26:17,528
surprises

579
00:26:14,440 --> 00:26:21,130
let's see actually it went amazingly

580
00:26:17,528 --> 00:26:23,859
smoothly it's testimony to the many

581
00:26:21,130 --> 00:26:25,690
hundreds of man years that the team

582
00:26:23,859 --> 00:26:30,548
sunshield has put in to get ready for

583
00:26:25,690 --> 00:26:33,009
this point you know some of the things

584
00:26:30,548 --> 00:26:35,528
and Mark and I are particularly

585
00:26:33,009 --> 00:26:40,869
interested in was the behavior of

586
00:26:35,528 --> 00:26:43,119
membranes at the edges there actually

587
00:26:40,869 --> 00:26:46,750
you know very elegant behavior if you

588
00:26:43,119 --> 00:26:49,239
stand at the right point you can see all

589
00:26:46,750 --> 00:26:52,720
the way to the core indicating that the

590
00:26:49,240 --> 00:26:55,720
heat can easily exit the stack on orbit

591
00:26:52,720 --> 00:26:57,220
so I think all the surprises at least

592
00:26:55,720 --> 00:27:00,759
that I got personally were all quite

593
00:26:57,220 --> 00:27:02,259
good out of the test how about you

594
00:27:00,759 --> 00:27:04,269
Alberto were you were you pleasantly

595
00:27:02,259 --> 00:27:05,769
were you happy with the result I was

596
00:27:04,269 --> 00:27:07,450
actually it was very very surprised it

597
00:27:05,769 --> 00:27:10,808
was the first time again we did all five

598
00:27:07,450 --> 00:27:15,308
layers as John mentioned and he was a

599

00:27:10,808 --> 00:27:17,769
very complex sort of routine you know

600
00:27:15,308 --> 00:27:20,139
falling you know falling back to the I'm

601
00:27:17,769 --> 00:27:22,599
going back to the to the orchestra

602
00:27:20,140 --> 00:27:24,670
example that John brought up it was a

603
00:27:22,599 --> 00:27:26,889
very very nice liam well choreographed

604
00:27:24,670 --> 00:27:28,360
event that actually took place very well

605
00:27:26,890 --> 00:27:29,740
but the thing I wanted to mention is

606
00:27:28,359 --> 00:27:31,808
that we learned that they we know how to

607
00:27:29,740 --> 00:27:34,029
fold that we know how to unfold them and

608
00:27:31,808 --> 00:27:36,910
they unfold unfold without breaking

609
00:27:34,029 --> 00:27:38,470
without tearing without snagging or

610
00:27:36,910 --> 00:27:41,170
anything but it the same thing at the

611
00:27:38,470 --> 00:27:42,579
same time it's critical that at the end

612
00:27:41,170 --> 00:27:44,500
with the attention properly they

613
00:27:42,579 --> 00:27:46,720

maintain the shape that gives us the

614

00:27:44,500 --> 00:27:48,220

property that we want for the task up to

615

00:27:46,720 --> 00:27:50,350

operate and I think that was also a key

616

00:27:48,220 --> 00:27:52,480

part of the test and actually that went

617

00:27:50,349 --> 00:27:54,549

that weren't remarkably well as well

618

00:27:52,480 --> 00:27:58,960

mark clamping you have any comments on

619

00:27:54,549 --> 00:28:01,839

the test yeah I was like John very happy

620

00:27:58,960 --> 00:28:05,470

and very pleased at that it if executed

621

00:28:01,839 --> 00:28:08,740

with in a very few sort of very minor

622

00:28:05,470 --> 00:28:10,269

hiccups everything went as planned we

623

00:28:08,740 --> 00:28:14,410

were very happy with the way it worked

624

00:28:10,269 --> 00:28:15,879

and as you've already heard this is just

625

00:28:14,410 --> 00:28:18,340

that you know the first step in a

626

00:28:15,880 --> 00:28:22,179

sequence of these tests is we you know

627

00:28:18,339 --> 00:28:24,279

add complexity to the deployment test to

628
00:28:22,179 --> 00:28:25,990
get to the simulation of what it's

629
00:28:24,279 --> 00:28:27,509
actually going to be like when we do the

630
00:28:25,990 --> 00:28:30,130
on-orbit

631
00:28:27,509 --> 00:28:32,140
deployment so when you start up this

632
00:28:30,130 --> 00:28:33,760
well with the first step going so well

633
00:28:32,140 --> 00:28:35,500
it's always good to know that you're

634
00:28:33,759 --> 00:28:37,509
going to be able to move forward through

635
00:28:35,500 --> 00:28:40,359
the rest of your test sequences later on

636
00:28:37,509 --> 00:28:42,579
in the year without too much problem so

637
00:28:40,359 --> 00:28:45,789
yeah I was I was very happy with the way

638
00:28:42,579 --> 00:28:47,230
it executed I know that we know that the

639
00:28:45,789 --> 00:28:49,659
answer to the question of how many

640
00:28:47,230 --> 00:28:53,470
aerospace engineers does it take to do

641
00:28:49,660 --> 00:28:54,519
space origami this is a 13 and may be

642
00:28:53,470 --> 00:28:55,900
parts

643
00:28:54,519 --> 00:28:58,150
that questions finally been answered

644
00:28:55,900 --> 00:29:00,580
I've been wondering that for a long time

645
00:28:58,150 --> 00:29:03,460
thirteen folks were the ones that

646
00:29:00,579 --> 00:29:06,369
actually were responsible for the

647
00:29:03,460 --> 00:29:09,190
execution of the test team sunshield was

648
00:29:06,369 --> 00:29:11,259
considerably larger so I would answer

649
00:29:09,190 --> 00:29:17,650
that the number of engineers it takes

650
00:29:11,259 --> 00:29:18,609
two to do origami as all of them so

651
00:29:17,650 --> 00:29:20,980
actually I want to mention something

652
00:29:18,609 --> 00:29:24,609
else that perhaps some of the viewers

653
00:29:20,980 --> 00:29:26,319
that saw the deployment of the test my

654
00:29:24,609 --> 00:29:27,909
wonder you know it's like okay so you're

655
00:29:26,319 --> 00:29:30,099
testing this on the ground

656

00:29:27,910 --> 00:29:31,660
nevermind the hundreds of people are

657
00:29:30,099 --> 00:29:33,279
going around at 13 Engineers are

658
00:29:31,660 --> 00:29:36,009
physically executing for the for the

659
00:29:33,279 --> 00:29:38,259
much larger team but wait a second you

660
00:29:36,009 --> 00:29:41,200
know this is in gravity so how do you

661
00:29:38,259 --> 00:29:43,210
compensate for the effect of gravity on

662
00:29:41,200 --> 00:29:46,720
on planet earth when you're not gonna

663
00:29:43,210 --> 00:29:48,279
have any gravity on you know in orbit as

664
00:29:46,720 --> 00:29:50,110
you deploy and that's a key question

665
00:29:48,279 --> 00:29:52,690
because it takes some moments it took

666
00:29:50,109 --> 00:29:55,029
some thought yes it took some thought

667
00:29:52,690 --> 00:29:57,759
the reason that you see those large

668
00:29:55,029 --> 00:30:00,579
pieces of plastic underneath the

669
00:29:57,759 --> 00:30:03,039
membranes is essentially a first-order

670
00:30:00,579 --> 00:30:06,839

simulation of where the membranes will

671

00:30:03,039 --> 00:30:10,930

be in flight if you didn't have those

672

00:30:06,839 --> 00:30:15,639

plastic sheets there it would droop and

673

00:30:10,930 --> 00:30:19,029

perhaps giving us a false problem but

674

00:30:15,640 --> 00:30:21,190

you also don't see is the many hours and

675

00:30:19,029 --> 00:30:25,029

hours of analysis the reason I said all

676

00:30:21,190 --> 00:30:27,549

of them is because basically every

677

00:30:25,029 --> 00:30:31,720

aspect of the sunshield and indeed the

678

00:30:27,549 --> 00:30:33,549

observatory is is watched over by by

679

00:30:31,720 --> 00:30:35,920

teams of engineers that are assigned to

680

00:30:33,549 --> 00:30:38,619

each aspect all of them have to work

681

00:30:35,920 --> 00:30:41,740

together for the team to be successful

682

00:30:38,619 --> 00:30:47,769

so my my good comment of all of them

683

00:30:41,740 --> 00:30:51,849

actually I meant all of them but you

684

00:30:47,769 --> 00:30:55,089

know we also have looked at and have run

685
00:30:51,849 --> 00:30:58,419
tests in the very same room to convince

686
00:30:55,089 --> 00:31:00,939
ourselves that in zero-g when the when

687
00:30:58,420 --> 00:31:04,000
the membranes will billow up they also

688
00:31:00,940 --> 00:31:06,250
don't run into the telescope or other

689
00:31:04,000 --> 00:31:08,259
structure that wasn't included in this

690
00:31:06,250 --> 00:31:09,789
test so

691
00:31:08,259 --> 00:31:11,650
we try to think through very very

692
00:31:09,789 --> 00:31:12,970
carefully you know what are the

693
00:31:11,650 --> 00:31:16,180
differences between our test environment

694
00:31:12,970 --> 00:31:20,440
our deployment environment do our test

695
00:31:16,180 --> 00:31:22,060
conditions do our analysis cover it it

696
00:31:20,440 --> 00:31:27,460
can be quite an involved set of

697
00:31:22,059 --> 00:31:30,309
questions we have pretty clever and

698
00:31:27,460 --> 00:31:33,309
experienced customers that that also

699

00:31:30,309 --> 00:31:38,589

review our review our analysis which

700

00:31:33,309 --> 00:31:40,329

makes it challenging good well I'm sure

701

00:31:38,589 --> 00:31:42,399

this is the first of many tests and

702

00:31:40,329 --> 00:31:43,990

Alberto brought up a a good good

703

00:31:42,400 --> 00:31:46,450

question and I wanted to ask about this

704

00:31:43,990 --> 00:31:48,160

so you're right we have gravity on earth

705

00:31:46,450 --> 00:31:50,440

you're testing on earth you're going to

706

00:31:48,160 --> 00:31:52,120

be you will be performing tests in the

707

00:31:50,440 --> 00:31:54,430

future that sort of compensate for this

708

00:31:52,119 --> 00:31:56,799

right and right oh yeah and how will you

709

00:31:54,430 --> 00:31:58,630

do that let's see we do it lots of

710

00:31:56,799 --> 00:32:03,099

different ways maybe now's a good chance

711

00:31:58,630 --> 00:32:06,220

to show the secondary error video ok

712

00:32:03,099 --> 00:32:08,289

Kelly before yeah because we have the

713

00:32:06,220 --> 00:32:09,759
same issues there and Jon I want to talk

714
00:32:08,289 --> 00:32:13,509
about that as well yeah there's a really

715
00:32:09,759 --> 00:32:16,319
good example what you're looking at here

716
00:32:13,509 --> 00:32:21,000
is you're looking down from the top and

717
00:32:16,319 --> 00:32:25,119
as you see the mirrored mirror

718
00:32:21,000 --> 00:32:27,460
structure the tripod itself deploy it's

719
00:32:25,119 --> 00:32:30,159
being deployed by the by the engineering

720
00:32:27,460 --> 00:32:33,069
model of the motor that will do it in

721
00:32:30,160 --> 00:32:36,480
flight and if we can hold it right let's

722
00:32:33,069 --> 00:32:43,389
see let's go back end of the video I

723
00:32:36,480 --> 00:32:45,220
want to show you what one item here go

724
00:32:43,390 --> 00:32:48,120
to the end of the video yeah go to the

725
00:32:45,220 --> 00:32:50,860
end of the video and hold that Kelly I

726
00:32:48,119 --> 00:32:53,349
know we're asking a lot here yeah this

727
00:32:50,859 --> 00:32:54,549

is pretty hard yeah I see all the people

728

00:32:53,349 --> 00:32:55,839

that were in the Sun shield they're

729

00:32:54,549 --> 00:32:58,089

still in there right they're gonna be

730

00:32:55,839 --> 00:33:00,509

all out there helping out yeah

731

00:32:58,089 --> 00:33:00,509

absolutely

732

00:33:00,990 --> 00:33:12,960

ok whether it's rather it's resolved the

733

00:33:13,140 --> 00:33:20,509

yeah the secondary mirror mount that you

734

00:33:16,750 --> 00:33:23,828

see ok right there

735

00:33:20,509 --> 00:33:26,828

keep keep going it's right at the end

736

00:33:23,828 --> 00:33:26,828

okay

737

00:33:27,489 --> 00:33:34,009

it's actually quite hard to see but

738

00:33:31,729 --> 00:33:36,528

there's actually a table at the end of

739

00:33:34,009 --> 00:33:42,679

the tripod where the secondary mirror

740

00:33:36,528 --> 00:33:46,519

will be and what let see stop it right

741

00:33:42,679 --> 00:33:51,499

there there you go so if you look on the

742
00:33:46,519 --> 00:33:54,979
top actually one little if you look very

743
00:33:51,499 --> 00:33:56,419
carefully at the secondary mirror mount

744
00:33:54,979 --> 00:33:58,788
that the idea of the structure that

745
00:33:56,419 --> 00:34:02,749
holds the mirror you'll see a cable

746
00:33:58,788 --> 00:34:07,338
assembly that's pulling up and I filling

747
00:34:02,749 --> 00:34:10,179
up with the weight of the tripod to

748
00:34:07,338 --> 00:34:14,000
essentially make the tripod weightless

749
00:34:10,179 --> 00:34:16,789
to prove that the motor can drive it in

750
00:34:14,000 --> 00:34:21,699
space okay so you got cable so this is a

751
00:34:16,789 --> 00:34:24,950
very concrete example of offloading and

752
00:34:21,699 --> 00:34:28,358
how we do that and perform the test and

753
00:34:24,949 --> 00:34:31,068
not make the test too easy or too hard

754
00:34:28,358 --> 00:34:34,250
is one of the engineering challenges

755
00:34:31,068 --> 00:34:36,168
faced by the deployment team well

756
00:34:34,250 --> 00:34:37,818
Alberto I have a suggestion for you to

757
00:34:36,168 --> 00:34:39,318
put in your innovation group instead of

758
00:34:37,818 --> 00:34:42,219
using cables and pulleys to simulate

759
00:34:39,318 --> 00:34:45,048
anti-gravity make an antigravity machine

760
00:34:42,219 --> 00:34:47,058
we're working on a and and so that we

761
00:34:45,048 --> 00:34:53,259
could just cancel out all gravity on in

762
00:34:47,059 --> 00:34:55,669
the in the surrounding area technology

763
00:34:53,259 --> 00:35:00,889
calling the elevator just cut the cables

764
00:34:55,668 --> 00:35:02,449
we got those thank you gravity then

765
00:35:00,889 --> 00:35:04,759
we've already figured out dark matter at

766
00:35:02,449 --> 00:35:12,739
that point so we can just get it all

767
00:35:04,759 --> 00:35:15,019
done in one fell swoop so you can see as

768
00:35:12,739 --> 00:35:17,419
we do these different tests you can take

769
00:35:15,018 --> 00:35:20,389
that video we saw at the beginning sort

770

00:35:17,420 --> 00:35:22,789
of cartoon you magic of the deployment

771
00:35:20,389 --> 00:35:24,679
the animation it slowly testing each of

772
00:35:22,789 --> 00:35:27,019
those pieces so that the time we fly

773
00:35:24,679 --> 00:35:28,940
will have done all of these tests on the

774
00:35:27,018 --> 00:35:32,118
ground multiple times and negatives

775
00:35:28,940 --> 00:35:33,920
confident so there it says well execute

776
00:35:32,119 --> 00:35:34,280
once you're on orbit that's a great

777
00:35:33,920 --> 00:35:35,539
point

778
00:35:34,280 --> 00:35:37,519
glad you brought this up because Alberto

779
00:35:35,539 --> 00:35:38,929
and I talked to I believe it was Scott

780
00:35:37,519 --> 00:35:41,199
Willoughby back in the double-a s last

781
00:35:38,929 --> 00:35:45,440
January and he gave us some really good

782
00:35:41,199 --> 00:35:47,299
insight into how hardware becomes space

783
00:35:45,440 --> 00:35:50,030
qualified it can you give us some idea

784
00:35:47,300 --> 00:35:51,830

of what that means I mean I mean we've

785

00:35:50,030 --> 00:35:54,590

Johnathan's talked touched on this a

786

00:35:51,829 --> 00:35:56,090

little bit we build this one sort of

787

00:35:54,590 --> 00:35:58,760

market it's on a mock-up but it's a

788

00:35:56,090 --> 00:36:00,230

version of the dislike lineman hinge

789

00:35:58,760 --> 00:36:04,070

feel but it's not the one that's gonna

790

00:36:00,230 --> 00:36:09,260

fly give us some sense of how this stuff

791

00:36:04,070 --> 00:36:12,170

is is tested on the way to space so in

792

00:36:09,260 --> 00:36:14,480

order to go to space the every piece of

793

00:36:12,170 --> 00:36:16,639

hardware has to be able to survive the

794

00:36:14,480 --> 00:36:18,590

environment in which it will be working

795

00:36:16,639 --> 00:36:20,719

in once it's in space and the

796

00:36:18,590 --> 00:36:24,470

environment that it will see during

797

00:36:20,719 --> 00:36:27,409

launch as it goes into space so just

798

00:36:24,469 --> 00:36:30,019

take an example the hole with JWST once

799
00:36:27,409 --> 00:36:32,299
it's been stowed will have to go through

800
00:36:30,019 --> 00:36:34,119
an environmental testing which means

801
00:36:32,300 --> 00:36:37,670
that we will put it on a shaker table

802
00:36:34,119 --> 00:36:40,789
simulate launch all of the materials

803
00:36:37,670 --> 00:36:43,240
that go into JWST of had to be tested

804
00:36:40,789 --> 00:36:45,739
and verified or validated that they can

805
00:36:43,239 --> 00:36:47,959
meet all of the extremes of temperature

806
00:36:45,739 --> 00:36:49,969
that our models predict that they will

807
00:36:47,960 --> 00:36:51,470
need to see so we have all the

808
00:36:49,969 --> 00:36:53,209
temperatures that they will see during

809
00:36:51,469 --> 00:36:55,309
launch and then the temperatures they

810
00:36:53,210 --> 00:36:57,170
will see once they pull down the

811
00:36:55,309 --> 00:36:59,750
cryogenic temperatures some of these

812
00:36:57,170 --> 00:37:03,050
pieces are Hardware see very large

813
00:36:59,750 --> 00:37:05,570
extremes of temperature and so we have

814
00:37:03,050 --> 00:37:07,610
to test for all of those and then you

815
00:37:05,570 --> 00:37:10,460
also have the quality assurance aspect

816
00:37:07,610 --> 00:37:12,590
where you know people have to keep you

817
00:37:10,460 --> 00:37:14,539
know very solid paper work on how the

818
00:37:12,590 --> 00:37:16,760
piece of hardware was made it has to be

819
00:37:14,539 --> 00:37:18,559
tested signed off though there's the

820
00:37:16,760 --> 00:37:20,180
whole sort of oversight process of

821
00:37:18,559 --> 00:37:22,639
actually putting something together and

822
00:37:20,179 --> 00:37:24,949
doing the testing in the lab or at the

823
00:37:22,639 --> 00:37:27,049
company that's building that and that's

824
00:37:24,949 --> 00:37:28,669
true for every single nut and bolt and

825
00:37:27,050 --> 00:37:29,990
anything that goes on this Observatory

826
00:37:28,670 --> 00:37:32,269
right it has to be spaced what's called

827

00:37:29,989 --> 00:37:34,609
space qualified open I'm getting that

828
00:37:32,269 --> 00:37:37,190
correct and the reason is that you can't

829
00:37:34,610 --> 00:37:39,349
go up and fix it later on so you have to

830
00:37:37,190 --> 00:37:41,420
test and make sure that everything works

831
00:37:39,349 --> 00:37:43,519
on the ground the way it's meant to and

832
00:37:41,420 --> 00:37:47,000
not just as a set of individual

833
00:37:43,519 --> 00:37:47,940
components actually a question from

834
00:37:47,000 --> 00:37:49,920
Trotter regarding

835
00:37:47,940 --> 00:37:54,088
- let me go and show this up here real

836
00:37:49,920 --> 00:37:57,358
quick this is from one thing mom in aria

837
00:37:54,088 --> 00:37:59,730
I apologize if I mispronounce that says

838
00:37:57,358 --> 00:38:03,119
that for the sunshield deploy test did

839
00:37:59,730 --> 00:38:05,579
you and how did you measure the deployed

840
00:38:03,119 --> 00:38:07,530
shape so is there a reason why that

841
00:38:05,579 --> 00:38:10,470

shape came into being and how do you

842

00:38:07,530 --> 00:38:14,130

guys measure to make sure that that was

843

00:38:10,469 --> 00:38:18,239

the nominal the nominal shape when it

844

00:38:14,130 --> 00:38:21,750

was fully deployed well who are you

845

00:38:18,239 --> 00:38:29,729

asking you to Trump the panel so I have

846

00:38:21,750 --> 00:38:38,400

an innovation scientist on my fan tact

847

00:38:29,730 --> 00:38:42,298

you onto the shape is determined by by

848

00:38:38,400 --> 00:38:44,880

analysis which one gives us the Koopman

849

00:38:42,298 --> 00:38:46,980

that we need and allows the packaging

850

00:38:44,880 --> 00:38:52,980

that we have to have to get it stowed

851

00:38:46,980 --> 00:38:56,250

and launched and deployed we do measure

852

00:38:52,980 --> 00:38:58,409

each of the membranes by themselves the

853

00:38:56,250 --> 00:39:01,309

template membranes were measured by a

854

00:38:58,409 --> 00:39:05,808

variety of techniques laser trackers

855

00:39:01,309 --> 00:39:08,548

laser radars called lidar z' and other

856
00:39:05,809 --> 00:39:10,079
instruments of that ilk to show that

857
00:39:08,548 --> 00:39:12,599
they had the correct three-dimensional

858
00:39:10,079 --> 00:39:15,150
shape so the shape is determined by

859
00:39:12,599 --> 00:39:17,099
analysis it gives us the thermal and

860
00:39:15,150 --> 00:39:21,180
optical performance that we require and

861
00:39:17,099 --> 00:39:25,859
then when the the membranes are made

862
00:39:21,179 --> 00:39:28,139
there they are measured and then at that

863
00:39:25,858 --> 00:39:31,019
system level we simply verified that the

864
00:39:28,139 --> 00:39:33,739
pull points the corners of the membranes

865
00:39:31,019 --> 00:39:36,150
were in the proper the proper position

866
00:39:33,739 --> 00:39:38,519
okay so we do have a lot of great

867
00:39:36,150 --> 00:39:39,869
comments and questions also on Twitter

868
00:39:38,519 --> 00:39:41,639
thank you guys for using Twitter I

869
00:39:39,869 --> 00:39:43,170
appreciate it but before I get to our

870
00:39:41,639 --> 00:39:46,650
and I promise I'll get to as many as I

871
00:39:43,170 --> 00:39:49,528
can I want to ask mark how you were

872
00:39:46,650 --> 00:39:51,298
talking about the qualifying space

873
00:39:49,528 --> 00:39:52,920
hardware what it takes to make sure that

874
00:39:51,298 --> 00:39:55,889
it seems it has to work right the first

875
00:39:52,920 --> 00:39:58,710
time you as the observatory project

876
00:39:55,889 --> 00:40:01,348
scientist akkad er how how confident are

877
00:39:58,710 --> 00:40:04,349
you that all of this is going to work as

878
00:40:01,349 --> 00:40:05,430
and or as designed are you pretty are

879
00:40:04,349 --> 00:40:08,489
you pretty confident based on what

880
00:40:05,429 --> 00:40:11,190
you're seeing so far absolutely I'm very

881
00:40:08,489 --> 00:40:14,220
confident as the observer to project

882
00:40:11,190 --> 00:40:17,130
scientist I have to be involved in in

883
00:40:14,219 --> 00:40:21,139
all of these processes as John will tell

884

00:40:17,130 --> 00:40:24,420
you so I go out to Northrup on a regular

885
00:40:21,139 --> 00:40:26,338
basis and sittings meetings where we

886
00:40:24,420 --> 00:40:28,920
discuss how this work is going to get

887
00:40:26,338 --> 00:40:30,449
done then see it in the reviews when

888
00:40:28,920 --> 00:40:33,568
we've done the work and we're looking at

889
00:40:30,449 --> 00:40:35,969
the results and you know basically I

890
00:40:33,568 --> 00:40:37,909
participate in all aspects of this and I

891
00:40:35,969 --> 00:40:40,588
went out to see the Sun shield deployed

892
00:40:37,909 --> 00:40:43,139
because you know that is something that

893
00:40:40,588 --> 00:40:45,268
everybody asks about and of course as a

894
00:40:43,139 --> 00:40:47,909
scientist I'm very concerned about how

895
00:40:45,268 --> 00:40:50,639
it deploys because it's not just getting

896
00:40:47,909 --> 00:40:53,068
it out that's important but also how it

897
00:40:50,639 --> 00:40:54,659
comes out well each of the layers are

898
00:40:53,068 --> 00:40:56,608

aligned with respect to each other has

899

00:40:54,659 --> 00:40:59,098

you know big impact on the science so

900

00:40:56,608 --> 00:41:01,469

I'm clearly very interested in aspects

901

00:40:59,099 --> 00:41:04,979

ideas so yes I'm very confident because

902

00:41:01,469 --> 00:41:07,528

I stay very tuned in to what John and

903

00:41:04,978 --> 00:41:10,169

Alberto and the engineers out at

904

00:41:07,528 --> 00:41:11,579

Northrop are doing so that I understand

905

00:41:10,170 --> 00:41:13,619

what they're doing and how it's being

906

00:41:11,579 --> 00:41:15,989

done and understand what the challenges

907

00:41:13,619 --> 00:41:18,269

are and how we're addressing it great

908

00:41:15,989 --> 00:41:20,249

I'm glad to hear that now on a related

909

00:41:18,268 --> 00:41:22,288

note and let's take a little bit step

910

00:41:20,248 --> 00:41:24,028

back to the bigger picture for just a

911

00:41:22,289 --> 00:41:25,710

moment and look at the mission as a

912

00:41:24,028 --> 00:41:26,849

whole and how the the observatory is

913
00:41:25,710 --> 00:41:28,978
coming together can you give us the

914
00:41:26,849 --> 00:41:31,170
status an update on our things are

915
00:41:28,978 --> 00:41:33,088
things going on schedule or is there any

916
00:41:31,170 --> 00:41:37,309
any red flags how were how are things

917
00:41:33,088 --> 00:41:37,308
going with the observatory as a whole

918
00:41:38,568 --> 00:41:42,329
okay

919
00:41:39,929 --> 00:41:43,919
I let me just speak to a couple of

920
00:41:42,329 --> 00:41:46,318
things we're doing here at Goddard and

921
00:41:43,920 --> 00:41:46,680
then John can speak okay that sounds

922
00:41:46,318 --> 00:41:49,739
great

923
00:41:46,679 --> 00:41:52,078
so one of the big milestones that we're

924
00:41:49,739 --> 00:41:54,599
just in the process of reaching the

925
00:41:52,079 --> 00:41:58,200
Goddard is something called C v2 and

926
00:41:54,599 --> 00:41:59,849
this is a thermal vacuum test that

927
00:41:58,199 --> 00:42:01,798
cryogenic temperatures of the four

928
00:41:59,849 --> 00:42:04,588
instruments we're doing three of these

929
00:42:01,798 --> 00:42:06,478
we are just finishing up the second one

930
00:42:04,588 --> 00:42:08,460
now so for the last couple of months

931
00:42:06,478 --> 00:42:11,429
we've been operating the four flight

932
00:42:08,460 --> 00:42:14,190
instruments the ones that will fly met

933
00:42:11,429 --> 00:42:16,440
mounted in there

934
00:42:14,190 --> 00:42:17,999
skeleton if you like that we call the

935
00:42:16,440 --> 00:42:20,190
icing or the integrated science

936
00:42:17,998 --> 00:42:22,889
instrument module and they have been

937
00:42:20,190 --> 00:42:24,568
operated in a big chamber we've done our

938
00:42:22,889 --> 00:42:26,129
instrument to instrument alignments

939
00:42:24,568 --> 00:42:28,829
check the performance of each of the

940
00:42:26,130 --> 00:42:31,680
instruments and we just finished that

941

00:42:28,829 --> 00:42:33,239
process recently and we're now in the

942
00:42:31,679 --> 00:42:35,009
process of starting to warm those

943
00:42:33,239 --> 00:42:38,130
instruments back up so that was the

944
00:42:35,009 --> 00:42:40,318
second of three tests and that way and

945
00:42:38,130 --> 00:42:42,059
that's going on at garden right now yeah

946
00:42:40,318 --> 00:42:45,239
it's actually just finishing up right

947
00:42:42,059 --> 00:42:48,720
and you can see the challenges I have

948
00:42:45,239 --> 00:42:52,619
doing this interview in a green building

949
00:42:48,719 --> 00:42:54,929
where the lights keep going out no

950
00:42:52,619 --> 00:42:56,818
you're saving energy that's good the

951
00:42:54,929 --> 00:42:58,409
bottom line is that we're we're doing

952
00:42:56,818 --> 00:43:00,929
really well we're on schedule we're

953
00:42:58,409 --> 00:43:03,629
their instrument testing the other big

954
00:43:00,929 --> 00:43:07,679
activity we have here is that we have a

955
00:43:03,630 --> 00:43:10,039

flight spare backplane which is what the

956

00:43:07,679 --> 00:43:12,778

mirrors mount to the center section and

957

00:43:10,039 --> 00:43:15,239

we've actually mounted two flights pair

958

00:43:12,778 --> 00:43:17,809

mirrors on that and that structures get

959

00:43:15,239 --> 00:43:20,068

being ready to be shipped down to Texas

960

00:43:17,809 --> 00:43:22,229

towards the end of the year so that we

961

00:43:20,068 --> 00:43:24,719

can put it in the big chamber in Texas

962

00:43:22,228 --> 00:43:26,818

at the Johnson Space Center early next

963

00:43:24,719 --> 00:43:29,309

year and start doing testing that will

964

00:43:26,818 --> 00:43:31,048

allow us to make sure we understand that

965

00:43:29,309 --> 00:43:33,778

all our test Hardware in that chamber

966

00:43:31,048 --> 00:43:36,778

works in preparation for when we send

967

00:43:33,778 --> 00:43:39,358

the final telescope down in 2017 for its

968

00:43:36,778 --> 00:43:41,009

end-to-end cryo optical test but that's

969

00:43:39,358 --> 00:43:43,018

what's going on at Goddard and I hand

970
00:43:41,009 --> 00:43:44,460
over to John okay John go ahead watch

971
00:43:43,018 --> 00:43:47,129
give us a quick update on how things run

972
00:43:44,460 --> 00:43:52,670
on your end in short we're really quite

973
00:43:47,130 --> 00:43:55,140
firing all cylinders at Northrop we have

974
00:43:52,670 --> 00:43:57,028
accepted the flight structure that's

975
00:43:55,139 --> 00:44:00,690
going to hold the mirrors and our

976
00:43:57,028 --> 00:44:04,228
attaching the wings that hold the three

977
00:44:00,690 --> 00:44:05,880
sets of primary mirror elements that

978
00:44:04,228 --> 00:44:10,108
fold back that you saw in the deployment

979
00:44:05,880 --> 00:44:12,838
video we're in the process of building

980
00:44:10,108 --> 00:44:17,848
the spacecraft structure which is moving

981
00:44:12,838 --> 00:44:20,518
along a pace flight boxes on electronics

982
00:44:17,849 --> 00:44:24,180
are being received the main structure

983
00:44:20,518 --> 00:44:26,248
the sunshield is in is in build and we

984
00:44:24,179 --> 00:44:26,849
just have the test readiness review to

985
00:44:26,248 --> 00:44:30,719
measure

986
00:44:26,849 --> 00:44:33,360
the second plague membrane here at next

987
00:44:30,719 --> 00:44:38,689
oven we concluded that yesterday so

988
00:44:33,360 --> 00:44:41,280
basically all of the hardware for the

989
00:44:38,690 --> 00:44:45,000
Northrop side everything that's not the

990
00:44:41,280 --> 00:44:48,510
Isum is in some level of manufacture or

991
00:44:45,000 --> 00:44:51,840
assembly and so it's very exciting at

992
00:44:48,510 --> 00:44:53,010
this point in the program awesome and I

993
00:44:51,840 --> 00:44:54,900
want to underscore one thing I think

994
00:44:53,010 --> 00:44:56,340
both mark and Jonathan brought up which

995
00:44:54,900 --> 00:44:58,380
is the fact that at some point just

996
00:44:56,340 --> 00:45:00,390
because you test the sunshield

997
00:44:58,380 --> 00:45:01,470
separately and the mirrors separately

998

00:45:00,389 --> 00:45:04,079
doesn't mean that they're gonna work as

999
00:45:01,469 --> 00:45:05,639
a system well and so what Mark was

1000
00:45:04,079 --> 00:45:08,069
mentioned is that at some point it will

1001
00:45:05,639 --> 00:45:10,769
be a end-to-end testing of their all

1002
00:45:08,070 --> 00:45:12,360
observatory and so that's extremely

1003
00:45:10,769 --> 00:45:14,070
important because just because you test

1004
00:45:12,360 --> 00:45:16,940
you know under these conditions you know

1005
00:45:14,070 --> 00:45:18,420
from launch to deployment to actual

1006
00:45:16,940 --> 00:45:20,490
commissioning and then through

1007
00:45:18,420 --> 00:45:22,349
operations it doesn't you know if you

1008
00:45:20,489 --> 00:45:25,469
test a separate system it does not

1009
00:45:22,349 --> 00:45:26,730
really follow through logically that it

1010
00:45:25,469 --> 00:45:28,980
will work together very well and so I

1011
00:45:26,730 --> 00:45:30,690
think all these tests are getting large

1012
00:45:28,980 --> 00:45:32,159

and large in complexity in the sense

1013

00:45:30,690 --> 00:45:34,050

that you adding and adding things

1014

00:45:32,159 --> 00:45:35,219

together and this is actually the name

1015

00:45:34,050 --> 00:45:36,870

of the game for this telescope because

1016

00:45:35,219 --> 00:45:39,059

it's so it's so complex but at the same

1017

00:45:36,869 --> 00:45:40,529

time so beautiful to watch I know this

1018

00:45:39,059 --> 00:45:42,690

is great I'm very excited I'm glad

1019

00:45:40,530 --> 00:45:44,340

things are still on track we have gotten

1020

00:45:42,690 --> 00:45:46,050

a lot of comments and questions let me

1021

00:45:44,340 --> 00:45:48,150

try to get to some of them now this is

1022

00:45:46,050 --> 00:45:50,960

from the QA AB Michael joban is asking

1023

00:45:48,150 --> 00:45:54,090

now when Mike Massimino was removing

1024

00:45:50,960 --> 00:45:55,829

captain on HST it fell apart when he

1025

00:45:54,090 --> 00:45:58,200

touched it and made a mess the Sun

1026

00:45:55,829 --> 00:46:00,480

degraded it so is that okay

1027
00:45:58,199 --> 00:46:02,819
don't see yeah there's a couple of

1028
00:46:00,480 --> 00:46:05,490
things that are different the Hubble's

1029
00:46:02,820 --> 00:46:08,309
in a very low orbit it's actually still

1030
00:46:05,489 --> 00:46:13,379
in the the sensible atmosphere if you

1031
00:46:08,309 --> 00:46:15,869
will and so the captain on the Hubble

1032
00:46:13,380 --> 00:46:17,430
faces a very different environment the

1033
00:46:15,869 --> 00:46:22,699
low Earth environment is much more

1034
00:46:17,429 --> 00:46:29,190
hostile to us than the I2 environment

1035
00:46:22,699 --> 00:46:32,399
that being said the the captain in Sun

1036
00:46:29,190 --> 00:46:35,309
shield material development was one of

1037
00:46:32,400 --> 00:46:37,650
the ten early technologies that needed

1038
00:46:35,309 --> 00:46:40,289
to be developed and demonstrated prior

1039
00:46:37,650 --> 00:46:43,920
to confirmation of JWST so

1040
00:46:40,289 --> 00:46:46,590
the actual design of that flight

1041
00:46:43,920 --> 00:46:51,599
material saw extensive environmental

1042
00:46:46,590 --> 00:46:54,840
testing about a decade ago to prove its

1043
00:46:51,599 --> 00:46:58,289
its flight worthiness so it's all what's

1044
00:46:54,840 --> 00:47:01,110
life question and again we answered that

1045
00:46:58,289 --> 00:47:04,259
question by by testing and retiring that

1046
00:47:01,110 --> 00:47:07,769
risk right basically you're saying that

1047
00:47:04,260 --> 00:47:10,340
it's the the amount of atmosphere that

1048
00:47:07,769 --> 00:47:12,929
Hubble is going through that slowly

1049
00:47:10,340 --> 00:47:15,269
degrading it because of friction over

1050
00:47:12,929 --> 00:47:16,769
that long period of time that that James

1051
00:47:15,269 --> 00:47:19,530
Webb won't be dealing with since is

1052
00:47:16,769 --> 00:47:21,449
going to be out the I2 point correct we

1053
00:47:19,530 --> 00:47:25,260
don't have the concern over atomic

1054
00:47:21,449 --> 00:47:27,269
oxygen which is you know extremely

1055

00:47:25,260 --> 00:47:29,880
corrosive both kinetically and

1056
00:47:27,269 --> 00:47:32,460
chemically right and so it does have the

1057
00:47:29,880 --> 00:47:34,170
tendency to degrade materials in a

1058
00:47:32,460 --> 00:47:37,610
different way in low-earth orbit than it

1059
00:47:34,170 --> 00:47:39,440
does in essentially interplanetary

1060
00:47:37,610 --> 00:47:42,809
environment that we're gonna live it

1061
00:47:39,440 --> 00:47:44,670
okay Judy Schmidt also on the Q&A app hi

1062
00:47:42,809 --> 00:47:46,469
Judy asked a really good question and

1063
00:47:44,670 --> 00:47:48,090
I'm gonna use it also as a segue into

1064
00:47:46,469 --> 00:47:49,919
the I2 point discussion a little bit

1065
00:47:48,090 --> 00:47:51,870
she's asking is there any place in the

1066
00:47:49,920 --> 00:47:54,630
solar system where an infrared telescope

1067
00:47:51,869 --> 00:47:57,449
could be placed and not have to rely on

1068
00:47:54,630 --> 00:47:59,280
coolant and Sun shields to maintain its

1069
00:47:57,449 --> 00:48:02,279

effectiveness is there anywhere we can

1070

00:47:59,280 --> 00:48:04,470

go but we don't need these things let's

1071

00:48:02,280 --> 00:48:07,860

see yeah I'll take I'll take a crack at

1072

00:48:04,469 --> 00:48:10,559

it and and and Mark may have a few other

1073

00:48:07,860 --> 00:48:14,130

ideas but basically what we need to do

1074

00:48:10,559 --> 00:48:15,750

is get our telescope into a cold

1075

00:48:14,130 --> 00:48:18,030

environment we're bringing that with us

1076

00:48:15,750 --> 00:48:21,690

that's the Sun shield and we want it to

1077

00:48:18,030 --> 00:48:24,780

be steady which is one of the positive

1078

00:48:21,690 --> 00:48:26,730

attributes of the L2 orbit in principle

1079

00:48:24,780 --> 00:48:29,310

we could locate that infrared telescope

1080

00:48:26,730 --> 00:48:35,340

a very far away very far away from the

1081

00:48:29,309 --> 00:48:38,130

Sun and a way away from its heating the

1082

00:48:35,340 --> 00:48:40,860

sun's heat the problem with that is we

1083

00:48:38,130 --> 00:48:42,900

then have no power or very little power

1084
00:48:40,860 --> 00:48:46,530
or have to take a very large battery or

1085
00:48:42,900 --> 00:48:52,440
radioisotope thermoelectric

1086
00:48:46,530 --> 00:48:53,930
a we're not very far away from us earth

1087
00:48:52,440 --> 00:48:57,289
on earth and we have to

1088
00:48:53,929 --> 00:49:00,679
the data home so the orbit that we were

1089
00:48:57,289 --> 00:49:03,230
chosen is a balance between a stable

1090
00:49:00,679 --> 00:49:04,848
orbit close to home so we can get the

1091
00:49:03,230 --> 00:49:08,179
massive amounts of data we're going to

1092
00:49:04,849 --> 00:49:09,680
take home in a safe way and the ability

1093
00:49:08,179 --> 00:49:11,989
to stay out of the earth and moon

1094
00:49:09,679 --> 00:49:14,449
shadows giving us a stable environment

1095
00:49:11,989 --> 00:49:18,259
so in some respects it's kind of the

1096
00:49:14,449 --> 00:49:19,549
Goldilocks place yeah the best let's

1097
00:49:18,260 --> 00:49:21,349
well let's talk a little more about the

1098
00:49:19,550 --> 00:49:23,359
El Topo Alberto can you describe what

1099
00:49:21,349 --> 00:49:25,970
the l2 point is and why we're going

1100
00:49:23,358 --> 00:49:28,369
there so we're going there for it for

1101
00:49:25,969 --> 00:49:31,818
actually for all the reasons that the

1102
00:49:28,369 --> 00:49:33,650
John just just mentioned we want to

1103
00:49:31,818 --> 00:49:36,909
sorry we want to we want to face the

1104
00:49:33,650 --> 00:49:40,369
moon the moon earth system all the time

1105
00:49:36,909 --> 00:49:42,170
okay we are going to do that and that

1106
00:49:40,369 --> 00:49:43,579
provides us with power because the Sun

1107
00:49:42,170 --> 00:49:45,710
is also in the same direction

1108
00:49:43,579 --> 00:49:47,780
that provides us with line-of-sight you

1109
00:49:45,710 --> 00:49:50,269
know to earth that is great if you want

1110
00:49:47,780 --> 00:49:52,510
to beam down information and this is

1111
00:49:50,269 --> 00:49:55,460
jazz John describe it it's basically a

1112

00:49:52,510 --> 00:49:57,349
sort of a it's not really a point it's

1113
00:49:55,460 --> 00:49:59,510
you know because I think what I would

1114
00:49:57,349 --> 00:50:01,039
like to notice if folks take a look at

1115
00:49:59,510 --> 00:50:04,010
the deployment video at the very end

1116
00:50:01,039 --> 00:50:08,329
where after the 29 days after the month

1117
00:50:04,010 --> 00:50:10,430
where that the deployment takes there's

1118
00:50:08,329 --> 00:50:12,470
a very large you see this orbit which is

1119
00:50:10,429 --> 00:50:13,879
a very large orbit at the very end which

1120
00:50:12,469 --> 00:50:15,439
is an orbit that is larger than the

1121
00:50:13,880 --> 00:50:18,789
distance from us to the moon really it's

1122
00:50:15,440 --> 00:50:22,159
a it's a 800,000 by 500,000 ellipse

1123
00:50:18,789 --> 00:50:24,469
kilometers ellipse and so it's a it's a

1124
00:50:22,159 --> 00:50:27,048
we are around the point you know where

1125
00:50:24,469 --> 00:50:29,389
we are able to there we go if you show

1126
00:50:27,048 --> 00:50:30,920

the deployment at the very very end that

1127

00:50:29,389 --> 00:50:35,179

you might be able to see those lines

1128

00:50:30,920 --> 00:50:38,000

represent the size to scale of the orbit

1129

00:50:35,179 --> 00:50:40,759

around the second lagrangian point that

1130

00:50:38,000 --> 00:50:42,289

web will take and so you see that you

1131

00:50:40,760 --> 00:50:43,549

know we see the distance from the earth

1132

00:50:42,289 --> 00:50:47,630

to the moon and if you you know if you

1133

00:50:43,548 --> 00:50:50,269

keep it running Kelly you see that at

1134

00:50:47,630 --> 00:50:51,650

the very end before it disappears so you

1135

00:50:50,269 --> 00:50:53,900

can probably pause it whenever you have

1136

00:50:51,650 --> 00:50:56,660

those those lines are showing up in in

1137

00:50:53,900 --> 00:50:58,068

in a few seconds so those those lines

1138

00:50:56,659 --> 00:50:59,868

are present the size of the orbit of

1139

00:50:58,068 --> 00:51:02,750

jadibooti around that point so it's

1140

00:50:59,869 --> 00:51:05,329

really not at I2 it's in orbit around I2

1141
00:51:02,750 --> 00:51:07,250
and that orbit provides again a very

1142
00:51:05,329 --> 00:51:07,880
stable point for power a very stable

1143
00:51:07,250 --> 00:51:11,000
point

1144
00:51:07,880 --> 00:51:14,509
or data handling you know in terms of in

1145
00:51:11,000 --> 00:51:16,989
terms of beaming down the wonderful day

1146
00:51:14,509 --> 00:51:20,088
that we're gonna get in 2019 yeah it's

1147
00:51:16,989 --> 00:51:24,288
it's worth stating very quickly that

1148
00:51:20,088 --> 00:51:27,619
once JWST has launched in the early

1149
00:51:24,289 --> 00:51:30,890
morning of its launch day it's never in

1150
00:51:27,619 --> 00:51:32,930
shadow we have no eclipses on this orbit

1151
00:51:30,889 --> 00:51:36,288
we're never in the Earth or the moon

1152
00:51:32,929 --> 00:51:38,480
shadow at any point in our trajectory so

1153
00:51:36,289 --> 00:51:40,579
mark wanted to say something yeah I was

1154
00:51:38,480 --> 00:51:43,490
gonna say that the one other magic thing

1155
00:51:40,579 --> 00:51:46,430
about I2 is that we get 24/7 science

1156
00:51:43,489 --> 00:51:48,679
operation exactly yes I mean slowing

1157
00:51:46,429 --> 00:51:50,929
from one object to the next unlike Cobo

1158
00:51:48,679 --> 00:51:53,419
of course which in its low Earth orbit

1159
00:51:50,929 --> 00:51:57,288
has to go around the earth and you know

1160
00:51:53,420 --> 00:51:58,730
we go 45 minutes around the bright part

1161
00:51:57,289 --> 00:52:01,099
of the Earth's and then we get 45

1162
00:51:58,730 --> 00:52:03,559
minutes for science around the dark so

1163
00:52:01,099 --> 00:52:05,088
that I2 we just get to do science all

1164
00:52:03,559 --> 00:52:09,349
the time and it's just gonna be very

1165
00:52:05,088 --> 00:52:11,509
important or doing some of the exoplanet

1166
00:52:09,349 --> 00:52:13,579
science of people are proposing now

1167
00:52:11,509 --> 00:52:16,190
where you may have to spend it quite a

1168
00:52:13,579 --> 00:52:21,170
long time staring at one object glad you

1169

00:52:16,190 --> 00:52:22,670
brought up exoplanet on YouTube and as

1170
00:52:21,170 --> 00:52:25,940
we as we've heard one of the science

1171
00:52:22,670 --> 00:52:28,099
goals of JWST will be to help us

1172
00:52:25,940 --> 00:52:30,318
understand exoplanets a lot more in

1173
00:52:28,099 --> 00:52:33,950
their atmospheres and he is asking how

1174
00:52:30,318 --> 00:52:36,139
small and will an exoplanet will jws TV

1175
00:52:33,949 --> 00:52:39,078
be able to resolve or can you answer

1176
00:52:36,139 --> 00:52:41,929
that one sorry did you say to resolve

1177
00:52:39,079 --> 00:52:45,190
yeah that's a key question that's a key

1178
00:52:41,929 --> 00:52:49,368
maybe we should talk about resolve me a

1179
00:52:45,190 --> 00:52:53,210
wst will be able to I guess the word I

1180
00:52:49,369 --> 00:52:57,130
would use is the image exoplanets and

1181
00:52:53,210 --> 00:53:00,259
sort of gas giant class maybe down to

1182
00:52:57,130 --> 00:53:02,509
some some of the larger Neptune's and

1183
00:53:00,259 --> 00:53:05,599

this is because we really weren't

1184

00:53:02,509 --> 00:53:09,380
designed to take direct images of

1185

00:53:05,599 --> 00:53:12,079
planets and there are a lot of things

1186

00:53:09,380 --> 00:53:14,358
that go into question of how you do that

1187

00:53:12,079 --> 00:53:16,190
but the bottom line is that you you're

1188

00:53:14,358 --> 00:53:18,230
trying to look at very faint objects

1189

00:53:16,190 --> 00:53:20,000
next very bright objects so you have to

1190

00:53:18,230 --> 00:53:21,860
use an instrument called a coronagraph

1191

00:53:20,000 --> 00:53:26,420
and on Jade

1192

00:53:21,860 --> 00:53:28,220
UST some of the coronagraphs can do

1193

00:53:26,420 --> 00:53:30,170
these kind of observations but you can't

1194

00:53:28,219 --> 00:53:32,359
see in so close that you could for

1195

00:53:30,170 --> 00:53:34,760
instance see an earth-sized planet so

1196

00:53:32,360 --> 00:53:36,860
you can see or the big jupiter-sized

1197

00:53:34,760 --> 00:53:39,500
planets you know the gas giants further

1198
00:53:36,860 --> 00:53:40,300
out that's good enough for me I'd be

1199
00:53:39,500 --> 00:53:43,510
happy with that

1200
00:53:40,300 --> 00:53:46,490
Michael Maxie also on YouTube is asking

1201
00:53:43,510 --> 00:53:48,590
how durable are the optics maybe this

1202
00:53:46,489 --> 00:53:51,679
was for you Jonathan how durable are the

1203
00:53:48,590 --> 00:53:54,710
optics - meteor impacts and how hard

1204
00:53:51,679 --> 00:53:55,759
easy is in-flight maintenance all that

1205
00:53:54,710 --> 00:54:04,099
last part of the question is an easy

1206
00:53:55,760 --> 00:54:06,440
thing to ask with the second question

1207
00:54:04,099 --> 00:54:09,469
because maintenance is not part of our

1208
00:54:06,440 --> 00:54:14,710
our mission so write the telephone does

1209
00:54:09,469 --> 00:54:17,589
not require servicing to meet his life

1210
00:54:14,710 --> 00:54:19,820
requirement and working backwards

1211
00:54:17,590 --> 00:54:22,850
earlier in the conversation when I

1212
00:54:19,820 --> 00:54:25,700
discussed micro meteorite impacts

1213
00:54:22,849 --> 00:54:30,920
hypervelocity testing that was conducted

1214
00:54:25,699 --> 00:54:34,659
on the membranes we similarly did those

1215
00:54:30,920 --> 00:54:40,220
kinds of tests on the beryllium mirrors

1216
00:54:34,659 --> 00:54:43,339
to understand how those projectiles

1217
00:54:40,219 --> 00:54:46,429
interact whether they bounce off when

1218
00:54:43,340 --> 00:54:49,780
they crater or what they do and so as a

1219
00:54:46,429 --> 00:54:52,159
result again in the budget that

1220
00:54:49,780 --> 00:54:55,390
determines the optical figure of the

1221
00:54:52,159 --> 00:54:59,809
mirror there is an entry for

1222
00:54:55,389 --> 00:55:03,139
micrometeoroid degradation and the

1223
00:54:59,809 --> 00:55:05,659
budget which mark has reviewed with me

1224
00:55:03,139 --> 00:55:09,500
on many occasions those shows that we be

1225
00:55:05,659 --> 00:55:11,469
are way front or our optical figure you

1226

00:55:09,500 --> 00:55:13,460
know well past the five year lifetime

1227
00:55:11,469 --> 00:55:15,429
including the effects of the micro

1228
00:55:13,460 --> 00:55:17,990
meteoroids that's very good

1229
00:55:15,429 --> 00:55:20,089
this is putting up another question

1230
00:55:17,989 --> 00:55:21,679
that's related I don't mean to cut you

1231
00:55:20,090 --> 00:55:22,670
off but this is actually in line with

1232
00:55:21,679 --> 00:55:24,919
what you're talking about

1233
00:55:22,670 --> 00:55:27,590
where this where Jeremy Topolsky is

1234
00:55:24,920 --> 00:55:28,849
asking about the estimated lifetime of

1235
00:55:27,590 --> 00:55:30,410
this budget that you're talking about

1236
00:55:28,849 --> 00:55:32,239
how long is it supposed to last you're

1237
00:55:30,409 --> 00:55:34,250
saying you're designing and for the

1238
00:55:32,239 --> 00:55:36,679
five-year mission but it's

1239
00:55:34,250 --> 00:55:39,199
that's right we have a requirement meant

1240
00:55:36,679 --> 00:55:41,868

to last for four five at least five

1241
00:55:39,199 --> 00:55:45,769
years you know typically the way you

1242
00:55:41,869 --> 00:55:48,980
prove that a system will last five years

1243
00:55:45,769 --> 00:55:51,920
is by assuming basically everything go

1244
00:55:48,980 --> 00:55:54,079
wrong can go wrong and will go wrong and

1245
00:55:51,920 --> 00:55:56,570
that you still meet the lifetime

1246
00:55:54,079 --> 00:55:59,900
requirement and so in a more nominal

1247
00:55:56,570 --> 00:56:03,680
case you get a much longer life time for

1248
00:55:59,900 --> 00:56:06,170
JWST the consumable item the thing that

1249
00:56:03,679 --> 00:56:09,469
will be life limiting is our fuel not

1250
00:56:06,170 --> 00:56:11,750
the performance of the optics right yeah

1251
00:56:09,469 --> 00:56:13,368
so as well let's talk about the fuel

1252
00:56:11,750 --> 00:56:17,239
we'll just a little bit what's it for

1253
00:56:13,369 --> 00:56:20,480
well how much fuel will that have we

1254
00:56:17,239 --> 00:56:22,848
have a requirement to have five years

1255
00:56:20,480 --> 00:56:24,619
worth of mission fuel again this is

1256
00:56:22,849 --> 00:56:29,000
sized in an extremely conservative

1257
00:56:24,619 --> 00:56:31,160
manner we do have we will be loading

1258
00:56:29,000 --> 00:56:34,429
excuse me their requirement for 10 years

1259
00:56:31,159 --> 00:56:37,489
of fuel there is still room in the tank

1260
00:56:34,429 --> 00:56:41,029
so if we have extra mass to spend we'll

1261
00:56:37,489 --> 00:56:43,009
fill up the tanks again with a more

1262
00:56:41,030 --> 00:56:44,869
nominal case we should far exceed that

1263
00:56:43,010 --> 00:56:46,250
five-year life okay great I'm sorry I'm

1264
00:56:44,869 --> 00:56:46,880
rushing but there's so many I want to

1265
00:56:46,250 --> 00:56:48,739
get to

1266
00:56:46,880 --> 00:56:51,440
Alberto this one's this one's for you

1267
00:56:48,739 --> 00:56:54,529
please compare real thing 1905 on

1268
00:56:51,440 --> 00:57:01,190
YouTube please compare the changeable

1269
00:56:54,530 --> 00:57:03,800
oh okay as big as a school bus as big as

1270
00:57:01,190 --> 00:57:06,920
a tennis court Hubble is a visible

1271
00:57:03,800 --> 00:57:09,170
telescope which has given us actually 25

1272
00:57:06,920 --> 00:57:12,470
years of a spectacular images next year

1273
00:57:09,170 --> 00:57:14,960
next April of spectacular images as

1274
00:57:12,469 --> 00:57:18,348
revolutionize science and rewritten

1275
00:57:14,960 --> 00:57:20,690
textbooks I might add Webb will do that

1276
00:57:18,349 --> 00:57:23,450
wait a little longer but it's also a not

1277
00:57:20,690 --> 00:57:24,710
a optical telescope is not a visible

1278
00:57:23,449 --> 00:57:28,608
light telescope it's an infrared

1279
00:57:24,710 --> 00:57:32,059
infrared telescope the web wait I am not

1280
00:57:28,608 --> 00:57:38,449
done I know I'm just yeah once you get

1281
00:57:32,059 --> 00:57:40,429
him talking as Mark is Mark mentioned

1282
00:57:38,449 --> 00:57:41,960
also as Mark mentioned also we want to

1283

00:57:40,429 --> 00:57:45,230
image things are very very faint and

1284
00:57:41,960 --> 00:57:47,539
very far away or both actually and so we

1285
00:57:45,230 --> 00:57:49,250
need a larger aperture so we are about

1286
00:57:47,539 --> 00:57:51,800
twenty-one feet or six and a half meters

1287
00:57:49,250 --> 00:57:54,530
versus a two point four meter of the of

1288
00:57:51,800 --> 00:57:56,240
the Hubble Space Telescope the orbits

1289
00:57:54,530 --> 00:58:00,050
are very different as we talked about

1290
00:57:56,239 --> 00:58:01,879
the Hubble is in low-earth orbit it goes

1291
00:58:00,050 --> 00:58:04,340
around the earth about in ninety minutes

1292
00:58:01,880 --> 00:58:08,030
or so we are going a million miles away

1293
00:58:04,340 --> 00:58:11,000
or 1 billion sorry

1294
00:58:08,030 --> 00:58:13,280
1 million kilometres away from Earth at

1295
00:58:11,000 --> 00:58:14,989
this second round jump point so it's a

1296
00:58:13,280 --> 00:58:17,330
very very different one and actually I

1297
00:58:14,989 --> 00:58:19,189

would say that Webb Reid does not even

1298

00:58:17,329 --> 00:58:20,659

look like it like you your grandfather's

1299

00:58:19,190 --> 00:58:22,400

telescope so to speak as you as you look

1300

00:58:20,659 --> 00:58:25,579

at it we have to expose the optics

1301

00:58:22,400 --> 00:58:28,490

basically in order to satisfy the

1302

00:58:25,579 --> 00:58:29,599

requirements for folding and/or getting

1303

00:58:28,489 --> 00:58:32,929

the science done for such a large

1304

00:58:29,599 --> 00:58:35,690

optical telescope in for a telescope ok

1305

00:58:32,929 --> 00:58:38,539

I'm gonna have a Scott if you do up a

1306

00:58:35,690 --> 00:58:39,619

couple of Twitter ones for me because I

1307

00:58:38,539 --> 00:58:40,759

know there's a lot of things happening

1308

00:58:39,619 --> 00:58:42,500

on Twitter and you can share the screen

1309

00:58:40,760 --> 00:58:45,170

on that really good let me get Adams

1310

00:58:42,500 --> 00:58:46,849

synergies question out on the QA app

1311

00:58:45,170 --> 00:58:49,460

which i think is a good one to ask you

1312
00:58:46,849 --> 00:58:52,489
guys with such a complex deployment of

1313
00:58:49,460 --> 00:58:54,980
JWST is it stressful putting it all

1314
00:58:52,489 --> 00:59:02,899
together anyone had any bad dreams yet

1315
00:58:54,980 --> 00:59:04,340
about it all going I was going to say

1316
00:59:02,900 --> 00:59:06,230
that all I will say to John when the

1317
00:59:04,340 --> 00:59:15,140
program started has all these hair and

1318
00:59:06,230 --> 00:59:18,559
all these yes absolutely it's it's

1319
00:59:15,139 --> 00:59:21,469
stressful but it's a good kind of stress

1320
00:59:18,559 --> 00:59:24,880
everybody who's working the team is very

1321
00:59:21,469 --> 00:59:30,559
dedicated and the the stress is a

1322
00:59:24,880 --> 00:59:33,289
productive one in that ensures that

1323
00:59:30,559 --> 00:59:37,579
everybody checks and double-checks so

1324
00:59:33,289 --> 00:59:40,400
yes absolutely it's stressful but for

1325
00:59:37,579 --> 00:59:42,559
those of us on the team you know we all

1326
00:59:40,400 --> 00:59:48,400
have had to give us the ball we want to

1327
00:59:42,559 --> 00:59:51,380
make that shot so absolutely it is but

1328
00:59:48,400 --> 00:59:52,670
very hard to get in this position yes

1329
00:59:51,380 --> 00:59:54,740
and according to mark things are going

1330
00:59:52,670 --> 00:59:56,180
quite well so great job guys I'm really

1331
00:59:54,739 --> 00:59:57,229
I think I'm really excited

1332
00:59:56,179 --> 00:59:59,179
go ahead Albert who you want to comment

1333
00:59:57,230 --> 01:00:00,590
no I was gonna say that even must be I

1334
00:59:59,179 --> 01:00:01,399
was gonna ask mark actually it must be

1335
01:00:00,590 --> 01:00:03,050
stressful for him

1336
01:00:01,400 --> 01:00:04,730
as well as the scientists and because it

1337
01:00:03,050 --> 01:00:06,200
is for me for example because there's

1338
01:00:04,730 --> 01:00:07,519
always this tension between engineering

1339
01:00:06,199 --> 01:00:09,769
requirements and scientific requirements

1340

01:00:07,519 --> 01:00:11,780
that has to go on and on and on and so

1341
01:00:09,769 --> 01:00:13,880
you give up this much and you get back

1342
01:00:11,780 --> 01:00:14,900
this other much so the stress for the

1343
01:00:13,880 --> 01:00:15,980
scientist is a little different than

1344
01:00:14,900 --> 01:00:16,490
bill and telescope but it's very

1345
01:00:15,980 --> 01:00:17,690
stressful

1346
01:00:16,489 --> 01:00:21,859
I think the stress for the scientists

1347
01:00:17,690 --> 01:00:22,970
will increase tenfold after after the

1348
01:00:21,860 --> 01:00:25,970
telescope is actually becomes

1349
01:00:22,969 --> 01:00:29,089
operational to see actually what how how

1350
01:00:25,969 --> 01:00:33,619
will how it will really operate and what

1351
01:00:29,090 --> 01:00:34,970
what it will deliver great okay so Scott

1352
01:00:33,619 --> 01:00:38,750
do you have anything from Twitter thank

1353
01:00:34,969 --> 01:00:40,279
you guys by the way hang out Hubble hang

1354
01:00:38,750 --> 01:00:44,769

on hashtag is really doing well so thank

1355

01:00:40,280 --> 01:00:44,769

you guys he say three times fast

1356

01:00:46,730 --> 01:00:50,809

who's master physicists from Columbia I

1357

01:00:48,949 --> 01:00:53,449

was responding to one of the tweets out

1358

01:00:50,809 --> 01:00:54,860

there that with NASA what telescope my

1359

01:00:53,449 --> 01:00:57,319

scope wants to science all the time

1360

01:00:54,860 --> 01:00:57,680

science all the time science all the

1361

01:00:57,320 --> 01:01:01,010

time

1362

01:00:57,679 --> 01:01:03,139

Oh anything Scott just looks for excuses

1363

01:01:01,010 --> 01:01:05,720

to sing hey it's what I do

1364

01:01:03,139 --> 01:01:09,429

that's why I Drive the Internet I join

1365

01:01:05,719 --> 01:01:11,719

what your hands to go with it um

1366

01:01:09,429 --> 01:01:13,789

Alessandro Barsanti says I can't wait to

1367

01:01:11,719 --> 01:01:16,039

understand exoplanets more with NASA

1368

01:01:13,789 --> 01:01:18,590

Webb telescope can we break it down into

1369
01:01:16,039 --> 01:01:21,259
six words so I don't know if you guys

1370
01:01:18,590 --> 01:01:23,780
are familiar with six words it's trying

1371
01:01:21,260 --> 01:01:26,090
to break down a concept my attempt at it

1372
01:01:23,780 --> 01:01:28,570
was might find other Earth's out there

1373
01:01:26,090 --> 01:01:32,600
do you guys want to give a try at

1374
01:01:28,570 --> 01:01:35,360
exoplanets in six words exoplanet at six

1375
01:01:32,599 --> 01:01:42,400
words so you didn't know you'd be tested

1376
01:01:35,360 --> 01:01:42,400
it yeah I can 13's we might understand

1377
01:01:42,849 --> 01:01:58,190
now there we go awesome and there yeah

1378
01:01:56,480 --> 01:02:00,260
there's been a lot of great activity

1379
01:01:58,190 --> 01:02:02,570
with the Hubble hangout hashtag from all

1380
01:02:00,260 --> 01:02:04,400
over the place questions and comments

1381
01:02:02,570 --> 01:02:05,539
you guys have been awesome yeah thank

1382
01:02:04,400 --> 01:02:06,730
you guys for getting on Twitter we

1383
01:02:05,539 --> 01:02:09,289
appreciate it it's usually been the

1384
01:02:06,730 --> 01:02:11,869
you've been the the light spot in our

1385
01:02:09,289 --> 01:02:14,869
conversation with you guys also lots of

1386
01:02:11,869 --> 01:02:15,349
comments and questions on the various so

1387
01:02:14,869 --> 01:02:17,239
social for me

1388
01:02:15,349 --> 01:02:18,619
channels I was looking at unfortunately

1389
01:02:17,239 --> 01:02:20,539
we're out of time and I have to let

1390
01:02:18,619 --> 01:02:21,769
these guys go you guys gonna come back

1391
01:02:20,539 --> 01:02:26,360
and give us another update in the future

1392
01:02:21,769 --> 01:02:27,860
oh yeah till 2018 I know well I just saw

1393
01:02:26,360 --> 01:02:31,360
the next test right Jonathan um if

1394
01:02:27,860 --> 01:02:33,559
you're gonna be like my damn artists

1395
01:02:31,360 --> 01:02:37,579
mark was sometimes a Goddard you're

1396
01:02:33,559 --> 01:02:38,480
gonna let us do a hangout right people I

1397

01:02:37,579 --> 01:02:40,099
mean I got to tell you this is

1398
01:02:38,480 --> 01:02:42,170
generating a lot of interest this is one

1399
01:02:40,099 --> 01:02:43,819
of the most viewed hangouts we've done

1400
01:02:42,170 --> 01:02:48,829
so far so I want to thank you all very

1401
01:02:43,820 --> 01:02:54,700
much and I guess we'll stop there that's

1402
01:02:48,829 --> 01:02:57,819
it for this week space say watching and

1403
01:02:54,699 --> 01:02:57,819
looking up