



HUBBLE

hangouts

James Webb Space Telescope Update:
Sunshield Deployment Test

Thursday October 2, 2014, 3pm EDT 7pm GMT

1
00:00:09,709 --> 00:00:07,610
hello everybody and welcome to this

2
00:00:12,320 --> 00:00:09,719
week's special James Webb Space

3
00:00:13,789 --> 00:00:12,330
Telescope edition of our Hubble hangout

4
00:00:15,680 --> 00:00:13,799
this week we're going to be talking

5
00:00:17,689 --> 00:00:15,690
about our recent milestone that was

6
00:00:20,330 --> 00:00:17,699
reached in the building of the James

7
00:00:23,000 --> 00:00:20,340
Webb Space Telescope or JWST for short

8
00:00:25,189 --> 00:00:23,010
as I love to call it and we have people

9
00:00:26,450 --> 00:00:25,199
both from Northrop Grumman and Goddard

10
00:00:28,849 --> 00:00:26,460
Space Flight Center to help out and give

11
00:00:32,030 --> 00:00:28,859
us some background and to talk about

12
00:00:33,850 --> 00:00:32,040
this latest test this latest test

13
00:00:37,370 --> 00:00:33,860

milestone you may recall back in

14

00:00:39,740 --> 00:00:37,380

something back in the summer in their

15

00:00:41,510 --> 00:00:39,750

facilities in California the the folks

16

00:00:44,990 --> 00:00:41,520

at Northrop Grumman have for the first

17

00:00:47,630 --> 00:00:45,000

time fully deployed the Sun shield which

18

00:00:49,190 --> 00:00:47,640

will be on the orbiting spacecraft we're

19

00:00:50,240 --> 00:00:49,200

going to talk about that test we're

20

00:00:52,040 --> 00:00:50,250

going to talk about what the Sun shield

21

00:00:53,660 --> 00:00:52,050

is and we'll talk about the overall

22

00:00:55,729 --> 00:00:53,670

deployment of the James Webb Space

23

00:00:57,080 --> 00:00:55,739

Telescope as well but before I do that

24

00:00:59,180 --> 00:00:57,090

and before I also get to the

25

00:01:00,650 --> 00:00:59,190

introductions of everybody here let me

26
00:01:02,779 --> 00:01:00,660
tell you how you can interact with us if

27
00:01:06,050 --> 00:01:02,789
you have questions about the jada the

28
00:01:09,140 --> 00:01:06,060
JWST or the deployment or anything about

29
00:01:10,969 --> 00:01:09,150
what it may do at science we hope that

30
00:01:13,280 --> 00:01:10,979
you will interact with us by either

31
00:01:15,920 --> 00:01:13,290
using the easiest way is to use the Q&A

32
00:01:18,469 --> 00:01:15,930
app that's either both on YouTube and

33
00:01:21,740 --> 00:01:18,479
Google+ another very easy way to do it

34
00:01:25,010 --> 00:01:21,750
is to comment on the event page on

35
00:01:26,630 --> 00:01:25,020
Google+ and the YouTube events video

36
00:01:28,880 --> 00:01:26,640
page itself because I'm monitoring all

37
00:01:31,640 --> 00:01:28,890
of that also we hope you will tweet at

38
00:01:34,730 --> 00:01:31,650

us using the Hubble hangout hashtag you

39
00:01:36,469 --> 00:01:34,740
can also use JWST we're mom we're doing

40
00:01:38,630 --> 00:01:36,479
both of those as well so please tweet

41
00:01:41,510 --> 00:01:38,640
ask your questions and your give us your

42
00:01:44,389 --> 00:01:41,520
comments and we will use them later on

43
00:01:46,190 --> 00:01:44,399
I'm very excited about today because for

44
00:01:48,319 --> 00:01:46,200
the first time in a long time I've got

45
00:01:50,630 --> 00:01:48,329
my old friend dr. Alberto Conti

46
00:01:53,270 --> 00:01:50,640
hello Alberto hey Tony it's great to be

47
00:02:04,370 --> 00:01:53,280
here again a long time indeed used to be

48
00:02:07,580 --> 00:02:04,380
an astronomer here are you still an

49
00:02:09,830 --> 00:02:07,590
astronomer yeah I do I might a little

50
00:02:11,809 --> 00:02:09,840
weird but I still I'm a silly

51
00:02:13,610 --> 00:02:11,819
astrophysicist here Northrop Grumman

52
00:02:15,350 --> 00:02:13,620
I'm the innovation manager for business

53
00:02:17,839 --> 00:02:15,360
development so I work on to the bestia

54
00:02:21,500 --> 00:02:17,849
and the things are perhaps in the future

55
00:02:23,869 --> 00:02:21,510
after Jetta misty oh good and also with

56
00:02:25,630 --> 00:02:23,879
us is the chief engineer for from

57
00:02:27,800 --> 00:02:25,640
northrup-grumman who worked on the JWST

58
00:02:28,880 --> 00:02:27,810
jonathan Ehrenberg hi Jonathan it's

59
00:02:30,289 --> 00:02:28,890
really good to see him for the first or

60
00:02:33,830 --> 00:02:30,299
for the first time in our hangout

61
00:02:36,160 --> 00:02:33,840
nice to be here good also we and he's

62
00:02:39,830 --> 00:02:36,170
back with us dr. mark clapping he's the

63
00:02:41,569 --> 00:02:39,840

he is the program manager for the James

64

00:02:42,949 --> 00:02:41,579

Webb Space Telescope at no I'm sorry

65

00:02:44,839 --> 00:02:42,959

you're not your program manager you're

66

00:02:46,940 --> 00:02:44,849

the Observatory project scientist for

67

00:02:49,160 --> 00:02:46,950

the James Webb Space Telescope at net

68

00:02:53,720 --> 00:02:49,170

NOAA NASA Goddard hi mark welcome back

69

00:02:56,420 --> 00:02:53,730

all right thanks okay so and also Scott

70

00:03:00,319 --> 00:02:56,430

driving the internet I mean the

71

00:03:02,420 --> 00:03:00,329

Internet's so I will be tweeting all

72

00:03:03,319 --> 00:03:02,430

over Hubble hangout and I know that NASA

73

00:03:05,390 --> 00:03:03,329

social

74

00:03:07,039 --> 00:03:05,400

and NASA official has been I'm already

75

00:03:08,899 --> 00:03:07,049

seeing some tweets going out so I wanted

76
00:03:11,539 --> 00:03:08,909
to be seeing you guys tweet and we'll be

77
00:03:15,259 --> 00:03:11,549
trying to gather all those questions and

78
00:03:17,089 --> 00:03:15,269
comments up so let's go ahead and get

79
00:03:21,110 --> 00:03:17,099
started so the James Webb Space

80
00:03:22,819 --> 00:03:21,120
Telescope is being built right now as we

81
00:03:26,089 --> 00:03:22,829
speak in a lot of different places it's

82
00:03:27,439 --> 00:03:26,099
being assembled in in at NASA Goddard

83
00:03:29,180 --> 00:03:27,449
but it's being built in many different

84
00:03:29,569 --> 00:03:29,190
facilities one of which is Northrop

85
00:03:32,659 --> 00:03:29,579
Grumman

86
00:03:34,309 --> 00:03:32,669
and it is the successor to the to the

87
00:03:35,330 --> 00:03:34,319
Hubble Space Telescope if you haven't

88
00:03:36,890 --> 00:03:35,340

heard about it by now

89

00:03:39,140 --> 00:03:36,900

you will certainly be hearing more about

90

00:03:43,300 --> 00:03:39,150

it in the future it's scheduled for

91

00:03:45,409 --> 00:03:43,310

launch when Alberto 2018 October 2018

92

00:03:47,629 --> 00:03:45,419

2018 we'll talk a little bit more about

93

00:03:49,250 --> 00:03:47,639

the details of the schedule of how

94

00:03:51,199 --> 00:03:49,260

things are going with it and everything

95

00:03:53,180 --> 00:03:51,209

else but we really want to talk about a

96

00:03:55,939 --> 00:03:53,190

really exciting thing that happened last

97

00:03:58,789 --> 00:03:55,949

summer where they for the first time

98

00:04:01,640 --> 00:03:58,799

there with it would be bigger the folks

99

00:04:03,860 --> 00:04:01,650

at Northrop Grumman have tested the it's

100

00:04:05,780 --> 00:04:03,870

fully deployed a heat shield which will

101
00:04:09,080 --> 00:04:05,790
protect the instruments on the

102
00:04:10,729 --> 00:04:09,090
spacecraft itself and I guess in order

103
00:04:11,960 --> 00:04:10,739
to give some people an idea of what

104
00:04:13,819 --> 00:04:11,970
we're talking about for those who have

105
00:04:18,520 --> 00:04:13,829
never seen it before we have an

106
00:04:21,620 --> 00:04:18,530
animation of what will happen once the

107
00:04:23,810 --> 00:04:21,630
once the observatory is in space once

108
00:04:25,250 --> 00:04:23,820
it's in orbit and I tell you it's

109
00:04:28,220 --> 00:04:25,260
amazing what's going to happen here

110
00:04:30,110 --> 00:04:28,230
this is the it when you fully understand

111
00:04:34,040 --> 00:04:30,120
all the stuff that's gonna happen after

112
00:04:36,200 --> 00:04:34,050
the spacecraft gets into space just

113
00:04:38,000 --> 00:04:36,210

blows me away every time I see it so

114

00:04:40,130 --> 00:04:38,010

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

115

00:04:41,690 --> 00:04:40,140

you don't mind is we have an animation

116

00:04:42,830 --> 00:04:41,700

here of the deployment sequence can you

117

00:04:44,660 --> 00:04:42,840

step us through it just a little bit

118

00:04:47,350 --> 00:04:44,670

what's gonna happen to JWST once it

119

00:04:50,920 --> 00:04:47,360

launches sure what you just saw was

120

00:04:54,170 --> 00:04:50,930

separation from our launch vehicle and

121

00:04:57,380 --> 00:04:54,180

stabilization and unfolding of the solar

122

00:05:00,290 --> 00:04:57,390

array if you watch along the bottom it

123

00:05:03,260 --> 00:05:00,300

shows our position away from Earth and

124

00:05:08,420 --> 00:05:03,270

as you can see we're passing the moon

125

00:05:10,670 --> 00:05:08,430

and still quite stowed we can have a

126
00:05:13,250 --> 00:05:10,680
couple of mid-course Corrections to add

127
00:05:15,740 --> 00:05:13,260
the necessary energy to achieve our

128
00:05:18,580 --> 00:05:15,750
orbit and the Blue Dot and we just left

129
00:05:24,380 --> 00:05:18,590
behind is the manned altitude record

130
00:05:28,070 --> 00:05:24,390
currently held by Apollo 13 the Sun

131
00:05:31,100 --> 00:05:28,080
shield begins to deploy by opening the

132
00:05:33,650 --> 00:05:31,110
aft and forward palettes and the

133
00:05:36,710 --> 00:05:33,660
telescope which would snug down for

134
00:05:40,280 --> 00:05:36,720
launch moves away about four feet from

135
00:05:42,770 --> 00:05:40,290
the Sun shield and what you see is the

136
00:05:47,120 --> 00:05:42,780
various covers that protect the

137
00:05:50,270 --> 00:05:47,130
membranes unfolding and the structure

138
00:05:53,180 --> 00:05:50,280

the mid moons as we call them pressing

139

00:05:57,170 --> 00:05:53,190

out there like a great big old-fashioned

140

00:06:00,290 --> 00:05:57,180

car antenna and then after a suitable

141

00:06:03,710 --> 00:06:00,300

waiting period we reel in the cables in

142

00:06:10,730 --> 00:06:03,720

tension the Sun shield pulling it to its

143

00:06:13,160 --> 00:06:10,740

full orientation once that's done as

144

00:06:15,350 --> 00:06:13,170

you're going to see in just a second the

145

00:06:19,250 --> 00:06:15,360

telescope begins to deploy the secondary

146

00:06:20,750 --> 00:06:19,260

mirror mount the aft radiator to allow

147

00:06:24,050 --> 00:06:20,760

the instruments to vent their heat to

148

00:06:27,050 --> 00:06:24,060

space and then finally the wings and

149

00:06:30,830 --> 00:06:27,060

this is completed roughly about a

150

00:06:32,570 --> 00:06:30,840

million kilometres or 600,000 miles and

151
00:06:34,490 --> 00:06:32,580
if you guys you can see in the upper

152
00:06:36,650 --> 00:06:34,500
part of the screen to sort of the

153
00:06:37,640 --> 00:06:36,660
elapsed time we're in day 29 and this

154
00:06:40,939 --> 00:06:37,650
animation

155
00:06:43,700 --> 00:06:40,949
so a month after launch this thing is

156
00:06:47,240 --> 00:06:43,710
going to be going through its paces and

157
00:06:50,030 --> 00:06:47,250
to become fully deployed and it's

158
00:06:51,439 --> 00:06:50,040
pointed in its spot at the I2 point and

159
00:06:53,860 --> 00:06:51,449
we'll talk about what that is in just a

160
00:06:56,480 --> 00:06:53,870
minute so I don't know if you guys fully

161
00:07:00,800 --> 00:06:56,490
got that I mean we they had they crammed

162
00:07:03,020 --> 00:07:00,810
this whole gigantic Observatory into the

163
00:07:04,820 --> 00:07:03,030

rocket and the engineering challenge one

164

00:07:06,290 --> 00:07:04,830

of the biggest ones they've ever they've

165

00:07:08,930 --> 00:07:06,300

ever had to solve I think was how are

166

00:07:10,670 --> 00:07:08,940

they gonna get something that has the

167

00:07:13,460 --> 00:07:10,680

shape of the James Webb Space Telescope

168

00:07:15,560 --> 00:07:13,470

into a rocket and out to to where it

169

00:07:20,750 --> 00:07:15,570

needs to be and you just saw the plan

170

00:07:24,230 --> 00:07:20,760

for it John the so the who was

171

00:07:25,490 --> 00:07:24,240

responsible for this this design was er

172

00:07:28,610 --> 00:07:25,500

it was our group of people team of

173

00:07:31,820 --> 00:07:28,620

people that became there's a was a very

174

00:07:33,529 --> 00:07:31,830

large team of people that studied it in

175

00:07:37,750 --> 00:07:33,539

the early phases and came up with the

176

00:07:42,200 --> 00:07:37,760

architecture passively cooled large

177

00:07:45,170 --> 00:07:42,210

beryllium mirror telescope and then the

178

00:07:47,390 --> 00:07:45,180

design has significantly matured over

179

00:07:57,550 --> 00:07:47,400

the last few years as it went from

180

00:07:59,810 --> 00:07:57,560

concept I well the sunshield in some way

181

00:08:01,190 --> 00:07:59,820

okay part of you cut out there I'm not

182

00:08:02,629 --> 00:08:01,200

sure it was

183

00:08:03,650 --> 00:08:02,639

we caught the light we didn't catch the

184

00:08:04,730 --> 00:08:03,660

last part of that but hopefully we'll

185

00:08:07,460 --> 00:08:04,740

get we'll be able to fill in the details

186

00:08:09,350 --> 00:08:07,470

a little bit later so this the Sun shall

187

00:08:11,060 --> 00:08:09,360

let's let's talk about the Sun shield

188

00:08:13,939 --> 00:08:11,070

itself a little bit um Kelly I don't

189

00:08:16,159 --> 00:08:13,949

know if you can go into one of the

190

00:08:19,040 --> 00:08:16,169

images or maybe the the animation where

191

00:08:20,510 --> 00:08:19,050

it was fully what where the Sun shield

192

00:08:23,300 --> 00:08:20,520

was deployed can you go to one of those

193

00:08:24,980 --> 00:08:23,310

spots there what's the Sun shield

194

00:08:30,439 --> 00:08:24,990

supposed to do what's it what's its

195

00:08:34,159 --> 00:08:30,449

purpose the Sun shield purpose is very

196

00:08:37,040 --> 00:08:34,169

simple it makes a nice dark shadow that

197

00:08:38,920 --> 00:08:37,050

the telescope lives in and it allows the

198

00:08:42,649 --> 00:08:38,930

telescope to radiate its heat to space

199

00:08:45,199 --> 00:08:42,659

to achieve the operating very cold

200

00:08:48,319 --> 00:08:45,209

temperatures that the telescope needs to

201
00:08:51,199 --> 00:08:48,329
be able to see our targets so basically

202
00:08:51,710 --> 00:08:51,209
it's a very high-tech parasol alright so

203
00:08:53,300 --> 00:08:51,720
remember

204
00:08:56,030 --> 00:08:53,310
if I can interject here for a second

205
00:08:58,340 --> 00:08:56,040
remember that we build a telescope you

206
00:09:00,470 --> 00:08:58,350
know to satisfy our our science

207
00:09:03,230 --> 00:09:00,480
curiosity if you will and web in order

208
00:09:04,850 --> 00:09:03,240
to do his job needs to be extremely cold

209
00:09:07,429 --> 00:09:04,860
because it's an infrared telescope and

210
00:09:09,160 --> 00:09:07,439
so in order to do that and to make it in

211
00:09:11,749 --> 00:09:09,170
such a way that you don't have

212
00:09:14,210 --> 00:09:11,759
Expendables like for example gas cooling

213
00:09:17,480 --> 00:09:14,220

or so we made into a passive telescope

214

00:09:19,369 --> 00:09:17,490

and so the this Sun shield as as John

215

00:09:21,170 --> 00:09:19,379

just mentioned is basically that it's a

216

00:09:25,009 --> 00:09:21,180

it's a it's something that produces a

217

00:09:27,410 --> 00:09:25,019

very very peculiar and very predictable

218

00:09:30,290 --> 00:09:27,420

shade in which the scope and all its

219

00:09:34,090 --> 00:09:30,300

electronics set okay so Kelly has a nice

220

00:09:38,019 --> 00:09:34,100

image of it up now what's it made of

221

00:09:41,540 --> 00:09:38,029

John is made of a plastic called captain

222

00:09:43,759 --> 00:09:41,550

the individual layers the top four

223

00:09:46,069 --> 00:09:43,769

layers that you can see are one

224

00:09:47,720 --> 00:09:46,079

thousandth of an inch thick and the

225

00:09:50,509 --> 00:09:47,730

bottom layer is two thousandth of an

226

00:09:54,199 --> 00:09:50,519

inch thick if you speak metric that's 25

227

00:09:57,110 --> 00:09:54,209

microns and 50 microns roughly the size

228

00:09:59,809 --> 00:09:57,120

of a width of a hair and the coatings

229

00:10:02,090 --> 00:09:59,819

that you see here are aluminum and the

230

00:10:04,730 --> 00:10:02,100

bottoms of layers one and two are coated

231

00:10:08,710 --> 00:10:04,740

with the element silicon so they're very

232

00:10:11,420 --> 00:10:08,720

very thin they're much thinner than the

233

00:10:14,240 --> 00:10:11,430

snack bag that you ate your potato chips

234

00:10:17,749 --> 00:10:14,250

out of at lunch but it's a very similar

235

00:10:19,970 --> 00:10:17,759

kind of material so guys I'm sleeve it

236

00:10:21,369 --> 00:10:19,980

already how do you know I ate chips at

237

00:10:24,470 --> 00:10:21,379

lunch

238

00:10:31,429 --> 00:10:24,480

yes it's an advanced telescope Scott it

239

00:10:32,749 --> 00:10:31,439

really is so presumably this stuff is

240

00:10:36,220 --> 00:10:32,759

also very well you're very lightweight

241

00:10:39,199 --> 00:10:36,230

correct I mean yes it's extremely

242

00:10:42,889 --> 00:10:39,209

lightweight are you worried at all about

243

00:10:46,910 --> 00:10:42,899

ripping or tearing once it's I mean how

244

00:10:49,910 --> 00:10:46,920

strong is this stuff Lizzie we do stress

245

00:10:51,350 --> 00:10:49,920

test it on the ground to make sure that

246

00:10:54,530 --> 00:10:51,360

it's been made properly

247

00:10:56,360 --> 00:10:54,540

there are ripstop features so that if a

248

00:11:00,470 --> 00:10:56,370

rip does occur it doesn't propagate

249

00:11:04,189 --> 00:11:00,480

across the entire sun shield and we've

250

00:11:05,580 --> 00:11:04,199

also had tested it in the laboratory for

251

00:11:08,100 --> 00:11:05,590

micrometeorite

252

00:11:13,140 --> 00:11:08,110

to understand how that affects the

253

00:11:18,000 --> 00:11:13,150

mechanical integrity so you know we have

254

00:11:19,410 --> 00:11:18,010

thought about it in the design we we

255

00:11:21,510 --> 00:11:19,420

worry about it to the point where we

256

00:11:23,880 --> 00:11:21,520

mitigate that concern inside the design

257

00:11:25,260 --> 00:11:23,890

I may be way off here and forget I'm

258

00:11:28,650 --> 00:11:25,270

certain you'll correct me if I'm wrong

259

00:11:30,090 --> 00:11:28,660

but the captain is that the same stuff

260

00:11:31,710 --> 00:11:30,100

they used in the around the Apollo

261

00:11:34,860 --> 00:11:31,720

module or the lunar modules or is that

262

00:11:37,740 --> 00:11:34,870

something else this is very commonly

263

00:11:39,030 --> 00:11:37,750

used insulation material so this is

264

00:11:40,500 --> 00:11:39,040

pretty old stuff and I mean it's been

265

00:11:43,019 --> 00:11:40,510

around a while as far as the technology

266

00:11:45,840 --> 00:11:43,029

of the material the materials

267

00:11:47,220 --> 00:11:45,850

okay you mentioned micrometeorites how

268

00:11:49,530 --> 00:11:47,230

well didn't you tested it against that

269

00:11:52,760 --> 00:11:49,540

how how do they do I mean are they gonna

270

00:11:55,140 --> 00:11:52,770

they're gonna stand up let's see the

271

00:11:59,269 --> 00:11:55,150

micrometeorites will penetrate the sun

272

00:12:02,550 --> 00:11:59,279

shield those those expected values with

273

00:12:07,680 --> 00:12:02,560

considerable conservatism is part of the

274

00:12:11,280 --> 00:12:07,690

budget so for the properties that define

275

00:12:14,280 --> 00:12:11,290

how well is sun shield works we

276

00:12:15,660 --> 00:12:14,290

calculate a budget if you will and all

277

00:12:18,360 --> 00:12:15,670

of the things that degrade those

278

00:12:22,020 --> 00:12:18,370

properties one of those is homes from

279

00:12:23,850 --> 00:12:22,030

micrometeorites that's in our budget so

280

00:12:27,270 --> 00:12:23,860

we have convinced ourselves that even

281

00:12:30,870 --> 00:12:27,280

with what do you mean budget though it's

282

00:12:34,320 --> 00:12:30,880

just like the allowable yes we have to

283

00:12:37,730 --> 00:12:34,330

have a certain amount of reflectivity

284

00:12:40,740 --> 00:12:37,740

and we're allowed a certain amount of

285

00:12:42,900 --> 00:12:40,750

transmission from one layer to the next

286

00:12:45,360 --> 00:12:42,910

if we have a hole in it say from

287

00:12:49,620 --> 00:12:45,370

micrometeorite that increases the

288

00:12:52,500 --> 00:12:49,630

transmission so we analyze for the

289

00:12:54,710 --> 00:12:52,510

thermal performance given a certain set

290

00:12:58,890 --> 00:12:54,720

of material properties reflectance

291

00:13:01,949 --> 00:12:58,900

absorptance transmissions emissivity etc

292

00:13:05,010 --> 00:13:01,959

and we degrade these by introducing the

293

00:13:08,160 --> 00:13:05,020

effects of the holes contamination and

294

00:13:10,980 --> 00:13:08,170

other things and convince ourselves at

295

00:13:15,210 --> 00:13:10,990

the end of life we meet our requirements

296

00:13:17,579 --> 00:13:15,220

so that's how understanding go ahead

297

00:13:18,990 --> 00:13:17,589

Alberto no I would say this also goes to

298

00:13:22,260 --> 00:13:19,000

the fact that you know people

299

00:13:23,690 --> 00:13:22,270

asked why five layers are not 35 you

300

00:13:27,660 --> 00:13:23,700

read my mind

301

00:13:29,490 --> 00:13:27,670

that's what we do here yes so but they

302

00:13:32,070 --> 00:13:29,500

should know the issue is as John just

303

00:13:33,960 --> 00:13:32,080

mentioned you know and you know in order

304

00:13:35,460 --> 00:13:33,970

to satisfy those science requirements

305

00:13:38,040 --> 00:13:35,470

you have to model you know how your

306

00:13:40,430 --> 00:13:38,050

spacecraft behaves and so five layers is

307

00:13:43,650 --> 00:13:40,440

a compromise on you know in terms of

308

00:13:44,880 --> 00:13:43,660

being able to match those those those

309

00:13:47,850 --> 00:13:44,890

requirements the other thing that we

310

00:13:50,640 --> 00:13:47,860

should mention is that it you know the

311

00:13:52,470 --> 00:13:50,650

the sunshade this star the part of the

312

00:13:54,210 --> 00:13:52,480

essential that faces the Sun is going to

313

00:13:56,400 --> 00:13:54,220

get extremely hot so this is tremendous

314

00:13:58,980 --> 00:13:56,410

gradient that goes from the hot side to

315

00:14:02,400 --> 00:13:58,990

the cold side of Abajo door 600 degrees

316

00:14:04,230 --> 00:14:02,410

or so and what can what gets Kotter

317

00:14:07,080 --> 00:14:04,240

Kelly can one of you put up an image

318

00:14:12,390 --> 00:14:07,090

showing these layers so we can have it

319

00:14:13,890 --> 00:14:12,400

up while he's talking yeah just one from

320

00:14:17,690 --> 00:14:13,900

it when viewed from the side or

321

00:14:22,320 --> 00:14:20,070

also I'm saying is you know so it this

322

00:14:24,300 --> 00:14:22,330

is part of whatever it really means to

323

00:14:25,800 --> 00:14:24,310

to build a spacecraft and Observatory

324

00:14:28,230 --> 00:14:25,810

this complex which is you have to do

325

00:14:30,600 --> 00:14:28,240

extremely sophisticated model II to

326

00:14:32,040 --> 00:14:30,610

understand not only in the environment

327

00:14:33,990 --> 00:14:32,050

that the telescope would be in in terms

328

00:14:35,790 --> 00:14:34,000

of temperature for example but the

329

00:14:37,800 --> 00:14:35,800

environment in terms on micrometeorites

330

00:14:39,240 --> 00:14:37,810

and we have a lot of telescopes and a

331

00:14:41,579 --> 00:14:39,250

lot of spacecrafts that have been

332

00:14:42,960 --> 00:14:41,589

orbiting I2 for some time so we we

333

00:14:44,430 --> 00:14:42,970

started to understand that environment

334

00:14:46,260 --> 00:14:44,440

better and better and so our models get

335

00:14:48,510 --> 00:14:46,270

better and better but as John mentioned

336

00:14:51,360 --> 00:14:48,520

you know that all these five layers are

337

00:14:53,280 --> 00:14:51,370

so the minimum innum um required to

338

00:14:56,010 --> 00:14:53,290

satisfy those those requirement take

339

00:15:00,270 --> 00:14:56,020

into account you know for the fact that

340

00:15:04,310 --> 00:15:00,280

we will be struck by micrometeorites we

341

00:15:06,930 --> 00:15:04,320

will have you know a certain amount of

342

00:15:09,480 --> 00:15:06,940

quite a bit of heat you know on the on

343

00:15:12,020 --> 00:15:09,490

the on the on the front layer if you

344

00:15:15,230 --> 00:15:12,030

will wonder faces the Sun and how they

345

00:15:17,460 --> 00:15:15,240

heat dissipates so it's a very complex

346

00:15:19,890 --> 00:15:17,470

set of requirements that you have to

347

00:15:21,450 --> 00:15:19,900

fold into a complex modelling that you

348

00:15:23,430 --> 00:15:21,460

have to do and I think the team and John

349

00:15:25,800 --> 00:15:23,440

and this couple with a scientist which

350

00:15:27,329 --> 00:15:25,810

are perhaps the users at the end you

351
00:15:29,520 --> 00:15:27,339
know those that are actually requiring

352
00:15:31,560 --> 00:15:29,530
what it is good enough for me to do my

353
00:15:32,809 --> 00:15:31,570
science are collaborating on a daily

354
00:15:34,519 --> 00:15:32,819
basis to actually make sure

355
00:15:36,469 --> 00:15:34,529
you do satisfy those requirements and

356
00:15:39,079 --> 00:15:36,479
that's why I think the test that we're

357
00:15:39,949 --> 00:15:39,089
going to show in a few minutes is was

358
00:15:41,989 --> 00:15:39,959
critical for this

359
00:15:44,869 --> 00:15:41,999
okay so I've heard this thing called a

360
00:15:48,859 --> 00:15:44,879
big giant radiator where the each of the

361
00:15:50,150 --> 00:15:48,869
five layers actually do a can you

362
00:15:52,069 --> 00:15:50,160
describe what they mean by that John

363
00:15:53,389 --> 00:15:52,079

what is it you know what it why the five

364

00:15:57,499 --> 00:15:53,399

layers and what does it do you think

365

00:16:00,049 --> 00:15:57,509

dissipation so what happens is the

366

00:16:03,319 --> 00:16:00,059

sunlight strikes the first layer the

367

00:16:05,929 --> 00:16:03,329

closest to the Sun layer one a lot of

368

00:16:09,199 --> 00:16:05,939

that heat is reflected some of it is

369

00:16:12,139 --> 00:16:09,209

absorbed and its remit addictions both

370

00:16:14,869 --> 00:16:12,149

up the stack and back at the Sun just

371

00:16:19,489 --> 00:16:14,879

about has a nice picture up now yeah and

372

00:16:22,189 --> 00:16:19,499

that he that now is leaving layer one

373

00:16:25,129 --> 00:16:22,199

and going to see layer two most of that

374

00:16:26,869 --> 00:16:25,139

gets reflected and that what you can't

375

00:16:30,019 --> 00:16:26,879

see in these pictures because it's hard

376

00:16:32,629 --> 00:16:30,029

to see is there's a very small opening

377

00:16:36,679 --> 00:16:32,639

angle so that so that the layers

378

00:16:40,129 --> 00:16:36,689

actually form tiny V's allowing the

379

00:16:43,039 --> 00:16:40,139

reflected heat to essentially walk out

380

00:16:46,999 --> 00:16:43,049

or reflect out and exit through space

381

00:16:49,129 --> 00:16:47,009

and with every successive layer most of

382

00:16:52,009 --> 00:16:49,139

the incident radiation is reflected a

383

00:16:54,949 --> 00:16:52,019

tiny fraction is absorbed and with each

384

00:16:59,029 --> 00:16:54,959

layer the temperature goes down starting

385

00:17:00,949 --> 00:16:59,039

as Alberto said at about 90 Celsius

386

00:17:03,499 --> 00:17:00,959

almost the temperature of boiling water

387

00:17:06,350 --> 00:17:03,509

and when we get to the top it's almost

388

00:17:09,499 --> 00:17:06,360

the temperature that's cold enough to

389

00:17:11,389 --> 00:17:09,509

liquefy nitrogen so that's that spot

390

00:17:13,519 --> 00:17:11,399

where the in the image that Scott is

391

00:17:16,850 --> 00:17:13,529

showing where these guys are currently

392

00:17:18,829 --> 00:17:16,860

standing is that the coldest spot that

393

00:17:27,189 --> 00:17:18,839

should actually in the center believe it

394

00:17:31,249 --> 00:17:29,119

those guys are standing that's the

395

00:17:43,009 --> 00:17:31,259

warmest spot that tells me yes because

396

00:17:45,169 --> 00:17:43,019

the spacecraft is underneath it okay the

397

00:17:46,580 --> 00:17:45,179

tower the cables everything that

398

00:17:48,860 --> 00:17:46,590

connects the hot side to the cold

399

00:17:51,470 --> 00:17:48,870

side comes through the sunshield at that

400

00:17:53,810 --> 00:17:51,480

position and we call that the core and

401
00:17:55,460 --> 00:17:53,820
the core is the warmest part of the

402
00:17:57,919 --> 00:17:55,470
sunshield got it

403
00:17:59,120 --> 00:17:57,929
okay dr. Martin clapping I want to get

404
00:18:01,010 --> 00:17:59,130
you into this real quick I want to ask

405
00:18:03,140 --> 00:18:01,020
you why can you tell us a little bit

406
00:18:05,930 --> 00:18:03,150
about why this thing needs to be so cold

407
00:18:08,810 --> 00:18:05,940
what is the reason for getting getting

408
00:18:10,580 --> 00:18:08,820
the temperature down so low well the

409
00:18:13,340 --> 00:18:10,590
reason is because this is an infrared

410
00:18:17,000 --> 00:18:13,350
telescope and infrared as we all know is

411
00:18:19,279 --> 00:18:17,010
heat radiation and the science goes to

412
00:18:22,840 --> 00:18:19,289
this telescope to span a broad range of

413
00:18:25,340 --> 00:18:22,850

infrared astronomy ranging from looking

414

00:18:28,310 --> 00:18:25,350

trying to take images of the very first

415

00:18:30,860 --> 00:18:28,320

galaxies that formed in the universe to

416

00:18:33,289 --> 00:18:30,870

understanding the nature of the

417

00:18:35,600 --> 00:18:33,299

atmospheres of exoplanets so we have a

418

00:18:38,690 --> 00:18:35,610

broad range of science that requires

419

00:18:41,779 --> 00:18:38,700

very high positions infrared

420

00:18:44,539 --> 00:18:41,789

measurements and if we're to do that

421

00:18:46,519 --> 00:18:44,549

then we need to cool the telescope so

422

00:18:48,769 --> 00:18:46,529

that we're actually imaging the sources

423

00:18:51,320 --> 00:18:48,779

in the universe that he wants to study

424

00:18:53,269 --> 00:18:51,330

and not just looking at a big thermal

425

00:18:55,909 --> 00:18:53,279

background caused by the telescope

426

00:19:00,110 --> 00:18:55,919

itself the way you do that is you get

427

00:19:02,779 --> 00:19:00,120

your telescope instrument temperature so

428

00:19:04,580 --> 00:19:02,789

that you're able to essentially image

429

00:19:06,620 --> 00:19:04,590

the infrared radiation coming from the

430

00:19:09,080 --> 00:19:06,630

universe and not as boring thermal

431

00:19:11,990 --> 00:19:09,090

signature so we're calling the

432

00:19:15,110 --> 00:19:12,000

telescopes and the instruments to

433

00:19:17,930 --> 00:19:15,120

something like 40 Kelvin which is 40

434

00:19:20,299 --> 00:19:17,940

degrees above absolute zero and that's

435

00:19:22,700 --> 00:19:20,309

the reason we need the Sun shield now

436

00:19:25,750 --> 00:19:22,710

all of the infrared telescopes we've

437

00:19:27,919 --> 00:19:25,760

flown up to now have relied on

438

00:19:30,440 --> 00:19:27,929

essentially a big dustbin of liquid

439

00:19:32,840 --> 00:19:30,450

helium to keep them cold and that's fine

440

00:19:35,720 --> 00:19:32,850

but as as you go through the life in the

441

00:19:38,149 --> 00:19:35,730

mission that helium burns out so you end

442

00:19:40,220 --> 00:19:38,159

up with a red or to be near short

443

00:19:42,830 --> 00:19:40,230

lifetime for your mission a couple years

444

00:19:45,320 --> 00:19:42,840

and that helium is burnt up and you no

445

00:19:48,260 --> 00:19:45,330

longer have a telescope it's very

446

00:19:50,600 --> 00:19:48,270

exciting we met that sort of happened to

447

00:19:52,490 --> 00:19:50,610

Spitzer right that has happened to

448

00:19:54,799 --> 00:19:52,500

Spencer and Spitz around now in what's

449

00:19:56,840 --> 00:19:54,809

called its war mission phase it happened

450

00:19:58,549 --> 00:19:56,850

to Herschel so both of these oceans

451
00:20:00,000 --> 00:19:58,559
reach the end of their specified

452
00:20:02,210 --> 00:20:00,010
lifetime and

453
00:20:04,680 --> 00:20:02,220
you know ran out of hide sorry helium

454
00:20:06,900 --> 00:20:04,690
the what we're doing here is we're using

455
00:20:09,450 --> 00:20:06,910
the Sun shield to do what we call

456
00:20:12,240 --> 00:20:09,460
passive cooling that means that we can

457
00:20:15,960 --> 00:20:12,250
operate JWST is that facility

458
00:20:18,750 --> 00:20:15,970
Observatory totally for up to 10 year

459
00:20:21,270 --> 00:20:18,760
lifetime and be able to do some infrared

460
00:20:24,390 --> 00:20:21,280
science so that's why we have the Sun

461
00:20:26,970 --> 00:20:24,400
shield we have some real challenges

462
00:20:29,130 --> 00:20:26,980
trying to do this science so to in for

463
00:20:31,110 --> 00:20:29,140

instance to image the you know very

464

00:20:33,180 --> 00:20:31,120

first galaxies that formed in universe

465

00:20:35,910 --> 00:20:33,190

we need a very large mirror which is why

466

00:20:37,980 --> 00:20:35,920

today wsd provides you need to gather

467

00:20:41,010 --> 00:20:37,990

image in the infrared because most of

468

00:20:43,110 --> 00:20:41,020

the light from these objects is Doppler

469

00:20:45,540 --> 00:20:43,120

shifted into the infrared part of the

470

00:20:48,540 --> 00:20:45,550

electromagnetic spectrum and we also

471

00:20:51,180 --> 00:20:48,550

need angular resolution and so we go to

472

00:20:53,130 --> 00:20:51,190

very large cryogenic telescope and that

473

00:20:55,500 --> 00:20:53,140

allows us to do this identifiers

474

00:20:57,660 --> 00:20:55,510

great alright thank you very much so

475

00:21:01,460 --> 00:20:57,670

let's get to the test before too much

476
00:21:04,800 --> 00:21:01,470
time goes by so last summer you guys

477
00:21:08,700 --> 00:21:04,810
Alberto and Jonathan you uh you guys

478
00:21:11,520 --> 00:21:08,710
pulled this thing out huh you guys so

479
00:21:13,410 --> 00:21:11,530
describe the test to us what where this

480
00:21:14,730 --> 00:21:13,420
is their actual now this is the actual

481
00:21:18,300 --> 00:21:14,740
Sun shield this is the one that's going

482
00:21:20,070 --> 00:21:18,310
up into space this is not it this is not

483
00:21:25,470 --> 00:21:20,080
it this is a this is a development

484
00:21:27,930 --> 00:21:25,480
article okay it's so it's typical of how

485
00:21:30,870 --> 00:21:27,940
we build these things we build test

486
00:21:33,300 --> 00:21:30,880
articles and engineering models and as

487
00:21:36,090 --> 00:21:33,310
we gradually increase our knowledge and

488
00:21:38,520 --> 00:21:36,100

we're sure how the system is going to

489

00:21:42,990 --> 00:21:38,530

behave then we begin to experiment on

490

00:21:45,990 --> 00:21:43,000

the flight hardware very gently so that

491

00:21:52,170 --> 00:21:46,000

we're sure that it's it's not been loved

492

00:21:53,850 --> 00:21:52,180

to death if you will on the ground sorry

493

00:22:00,000 --> 00:21:53,860

your telescope working it's been lovely

494

00:22:02,430 --> 00:22:00,010

too much and so these membranes serve

495

00:22:05,480 --> 00:22:02,440

many purposes in the development of the

496

00:22:07,940 --> 00:22:05,490

Sun shield their first purpose was to

497

00:22:11,730 --> 00:22:07,950

essentially pathfinding to prove out the

498

00:22:13,920 --> 00:22:11,740

manufacturing processes I happen to be

499

00:22:17,910 --> 00:22:13,930

sitting in Huntsville Alabama

500

00:22:19,890 --> 00:22:17,920

at the membrane manufacturers today for

501
00:22:23,430 --> 00:22:19,900
a meeting on another subject

502
00:22:26,340 --> 00:22:23,440
Jayda BST related but these membranes

503
00:22:27,930 --> 00:22:26,350
were made to start the pathfinding

504
00:22:31,890 --> 00:22:27,940
process to prove that we can manufacture

505
00:22:36,710 --> 00:22:31,900
them and then we also learned how to

506
00:22:39,500 --> 00:22:36,720
handle fold and stow them and ultimately

507
00:22:43,890 --> 00:22:39,510
when they were secured for launch

508
00:22:49,320 --> 00:22:43,900
release the locks and prove that they

509
00:22:52,770 --> 00:22:49,330
would unfold without snagging on

510
00:22:55,310 --> 00:22:52,780
anything at the unit so previously

511
00:22:58,530 --> 00:22:55,320
single layers had been deployed

512
00:23:01,590 --> 00:22:58,540
different pieces the core the various

513
00:23:06,180 --> 00:23:01,600

folding had been tested and so this was

514

00:23:08,790 --> 00:23:06,190

a little bit like a symphony where each

515

00:23:10,950 --> 00:23:08,800

of the different pieces was a section of

516

00:23:13,919 --> 00:23:10,960

the orchestra and we finally got the

517

00:23:15,720 --> 00:23:13,929

band all together to to play that that

518

00:23:17,610 --> 00:23:15,730

one symphony which was the deployment

519

00:23:19,290 --> 00:23:17,620

okay yeah you we got you guys have sent

520

00:23:21,930 --> 00:23:19,300

us some really nice time lapses Kelly if

521

00:23:24,120 --> 00:23:21,940

you can show us those going on of the

522

00:23:25,680 --> 00:23:24,130

actual test itself now you brought up an

523

00:23:28,500 --> 00:23:25,690

interesting point with this not being

524

00:23:31,560 --> 00:23:28,510

the actual deployment heat shield that

525

00:23:38,700 --> 00:23:31,570

will be deployed not this video Kelly

526
00:23:46,520 --> 00:23:38,710
sorry no such challenge although she

527
00:23:50,669 --> 00:23:46,530
goes sorry I've got it up on my girl

528
00:23:52,049 --> 00:23:50,679
okay so these yes I I see people

529
00:23:54,049 --> 00:23:52,059
physically pulling them out describe

530
00:23:59,610 --> 00:23:54,059
what we're looking at now Jonathan's so

531
00:24:03,120 --> 00:23:59,620
what you're seeing is the deployment of

532
00:24:06,419 --> 00:24:03,130
the Sun shield the mainly the mid booms

533
00:24:09,030 --> 00:24:06,429
pressing out and what you're seeing now

534
00:24:11,250 --> 00:24:09,040
is the tensioning of the individual

535
00:24:14,010 --> 00:24:11,260
membranes the reeling in of the cables

536
00:24:16,560 --> 00:24:14,020
that pull them from their initial

537
00:24:18,660 --> 00:24:16,570
position on deployment to their final

538
00:24:20,640 --> 00:24:18,670

position that is pulling them into those

539

00:24:21,830 --> 00:24:20,650

these that I told you about earlier

540

00:24:25,130 --> 00:24:21,840

right

541

00:24:27,919 --> 00:24:25,140

and that's are an absolutely necessary

542

00:24:33,659 --> 00:24:27,929

part of getting the Sun shield

543

00:24:36,990 --> 00:24:33,669

so the main objective of this test was

544

00:24:40,529 --> 00:24:37,000

to prove to ourselves that we know how

545

00:24:43,049 --> 00:24:40,539

to secure the membranes for launch and

546

00:24:45,180 --> 00:24:43,059

that once they're in that position that

547

00:24:49,110 --> 00:24:45,190

they will unfold without snagging and

548

00:24:50,460 --> 00:24:49,120

assume the correct final positions okay

549

00:24:52,019 --> 00:24:50,470

I'm seeing a lot of people doing a lot

550

00:24:58,139 --> 00:24:52,029

of pulling presumably they won't be out

551
00:25:05,279 --> 00:24:58,149
there I totally want to be one of those

552
00:25:09,000 --> 00:25:05,289
people that go out here here you go what

553
00:25:12,180 --> 00:25:09,010
you see actually there were were really

554
00:25:14,880 --> 00:25:12,190
13 principle people seven engineers

555
00:25:16,980 --> 00:25:14,890
technicians or vice versa that were

556
00:25:19,820 --> 00:25:16,990
really responsible for that test and

557
00:25:24,090 --> 00:25:19,830
because it was such an interesting and

558
00:25:28,430 --> 00:25:24,100
importantly test there were a few times

559
00:25:32,909 --> 00:25:28,440
more people that wanted to get real-time

560
00:25:35,070 --> 00:25:32,919
so they got to that lucky 13 got to do a

561
00:25:37,669 --> 00:25:35,080
very important job in front of maybe a

562
00:25:42,090 --> 00:25:37,679
hundred onlookers and so there were

563
00:25:45,450 --> 00:25:42,100

video crews myself Marc Alberto and any

564

00:25:48,060 --> 00:25:45,460

number of people that were interested

565

00:25:50,600 --> 00:25:48,070

but not specifically assigned to the

566

00:25:53,100 --> 00:25:50,610

test team that's why it looks like

567

00:25:55,380 --> 00:25:53,110

there's an awful lot of people around it

568

00:25:57,990 --> 00:25:55,390

because quite frankly there are a lot of

569

00:26:00,810 --> 00:25:58,000

people around it so this test taught you

570

00:26:02,730 --> 00:26:00,820

that you know how to fold them properly

571

00:26:06,720 --> 00:26:02,740

for launch and that they will in fact

572

00:26:10,169 --> 00:26:06,730

unfold properly once they're ready to be

573

00:26:12,090 --> 00:26:10,179

deployed yes anything else anything else

574

00:26:13,769 --> 00:26:12,100

that you learned that you maybe you

575

00:26:14,430 --> 00:26:13,779

hadn't expected or were there any

576
00:26:17,519 --> 00:26:14,440
surprises

577
00:26:21,120 --> 00:26:17,529
let's see actually it went amazingly

578
00:26:23,850 --> 00:26:21,130
smoothly it's testimony to the many

579
00:26:25,680 --> 00:26:23,860
hundreds of man years that the team

580
00:26:30,539 --> 00:26:25,690
sunshield has put in to get ready for

581
00:26:33,000 --> 00:26:30,549
this point you know some of the things

582
00:26:35,519 --> 00:26:33,010
and Mark and I are particularly

583
00:26:40,860 --> 00:26:35,529
interested in was the behavior of

584
00:26:43,110 --> 00:26:40,870
membranes at the edges there actually

585
00:26:46,740 --> 00:26:43,120
you know very elegant behavior if you

586
00:26:49,230 --> 00:26:46,750
stand at the right point you can see all

587
00:26:52,710 --> 00:26:49,240
the way to the core indicating that the

588
00:26:55,710 --> 00:26:52,720

heat can easily exit the stack on orbit

589

00:26:57,210 --> 00:26:55,720

so I think all the surprises at least

590

00:27:00,750 --> 00:26:57,220

that I got personally were all quite

591

00:27:02,250 --> 00:27:00,760

good out of the test how about you

592

00:27:04,260 --> 00:27:02,260

Alberto were you were you pleasantly

593

00:27:05,760 --> 00:27:04,270

were you happy with the result I was

594

00:27:07,440 --> 00:27:05,770

actually it was very very surprised it

595

00:27:10,799 --> 00:27:07,450

was the first time again we did all five

596

00:27:15,299 --> 00:27:10,809

layers as John mentioned and he was a

597

00:27:17,760 --> 00:27:15,309

very complex sort of routine you know

598

00:27:20,130 --> 00:27:17,770

falling you know falling back to the I'm

599

00:27:22,590 --> 00:27:20,140

going back to the to the orchestra

600

00:27:24,660 --> 00:27:22,600

example that John brought up it was a

601
00:27:26,880 --> 00:27:24,670
very very nice liam well choreographed

602
00:27:28,350 --> 00:27:26,890
event that actually took place very well

603
00:27:29,730 --> 00:27:28,360
but the thing I wanted to mention is

604
00:27:31,799 --> 00:27:29,740
that we learned that they we know how to

605
00:27:34,020 --> 00:27:31,809
fold that we know how to unfold them and

606
00:27:36,900 --> 00:27:34,030
they unfold unfold without breaking

607
00:27:38,460 --> 00:27:36,910
without tearing without snagging or

608
00:27:41,160 --> 00:27:38,470
anything but it the same thing at the

609
00:27:42,570 --> 00:27:41,170
same time it's critical that at the end

610
00:27:44,490 --> 00:27:42,580
with the attention properly they

611
00:27:46,710 --> 00:27:44,500
maintain the shape that gives us the

612
00:27:48,210 --> 00:27:46,720
property that we want for the task up to

613
00:27:50,340 --> 00:27:48,220

operate and I think that was also a key

614

00:27:52,470 --> 00:27:50,350

part of the test and actually that went

615

00:27:54,540 --> 00:27:52,480

that weren't remarkably well as well

616

00:27:58,950 --> 00:27:54,550

mark clamping you have any comments on

617

00:28:01,830 --> 00:27:58,960

the test yeah I was like John very happy

618

00:28:05,460 --> 00:28:01,840

and very pleased at that it if executed

619

00:28:08,730 --> 00:28:05,470

with in a very few sort of very minor

620

00:28:10,260 --> 00:28:08,740

hiccups everything went as planned we

621

00:28:14,400 --> 00:28:10,270

were very happy with the way it worked

622

00:28:15,870 --> 00:28:14,410

and as you've already heard this is just

623

00:28:18,330 --> 00:28:15,880

that you know the first step in a

624

00:28:22,169 --> 00:28:18,340

sequence of these tests is we you know

625

00:28:24,270 --> 00:28:22,179

add complexity to the deployment test to

626

00:28:25,980 --> 00:28:24,280

get to the simulation of what it's

627

00:28:27,500 --> 00:28:25,990

actually going to be like when we do the

628

00:28:30,120 --> 00:28:27,510

on-orbit

629

00:28:32,130 --> 00:28:30,130

deployment so when you start up this

630

00:28:33,750 --> 00:28:32,140

well with the first step going so well

631

00:28:35,490 --> 00:28:33,760

it's always good to know that you're

632

00:28:37,500 --> 00:28:35,500

going to be able to move forward through

633

00:28:40,350 --> 00:28:37,510

the rest of your test sequences later on

634

00:28:42,570 --> 00:28:40,360

in the year without too much problem so

635

00:28:45,780 --> 00:28:42,580

yeah I was I was very happy with the way

636

00:28:47,220 --> 00:28:45,790

it executed I know that we know that the

637

00:28:49,650 --> 00:28:47,230

answer to the question of how many

638

00:28:53,460 --> 00:28:49,660

aerospace engineers does it take to do

639

00:28:54,510 --> 00:28:53,470

space origami this is a 13 and may be

640

00:28:55,890 --> 00:28:54,520

parts

641

00:28:58,140 --> 00:28:55,900

that questions finally been answered

642

00:29:00,570 --> 00:28:58,150

I've been wondering that for a long time

643

00:29:03,450 --> 00:29:00,580

thirteen folks were the ones that

644

00:29:06,360 --> 00:29:03,460

actually were responsible for the

645

00:29:09,180 --> 00:29:06,370

execution of the test team sunshield was

646

00:29:11,250 --> 00:29:09,190

considerably larger so I would answer

647

00:29:17,640 --> 00:29:11,260

that the number of engineers it takes

648

00:29:18,600 --> 00:29:17,650

two to do origami as all of them so

649

00:29:20,970 --> 00:29:18,610

actually I want to mention something

650

00:29:24,600 --> 00:29:20,980

else that perhaps some of the viewers

651
00:29:26,310 --> 00:29:24,610
that saw the deployment of the test my

652
00:29:27,900 --> 00:29:26,320
wonder you know it's like okay so you're

653
00:29:30,090 --> 00:29:27,910
testing this on the ground

654
00:29:31,650 --> 00:29:30,100
nevermind the hundreds of people are

655
00:29:33,270 --> 00:29:31,660
going around at 13 Engineers are

656
00:29:36,000 --> 00:29:33,280
physically executing for the for the

657
00:29:38,250 --> 00:29:36,010
much larger team but wait a second you

658
00:29:41,190 --> 00:29:38,260
know this is in gravity so how do you

659
00:29:43,200 --> 00:29:41,200
compensate for the effect of gravity on

660
00:29:46,710 --> 00:29:43,210
on planet earth when you're not gonna

661
00:29:48,270 --> 00:29:46,720
have any gravity on you know in orbit as

662
00:29:50,100 --> 00:29:48,280
you deploy and that's a key question

663
00:29:52,680 --> 00:29:50,110

because it takes some moments it took

664

00:29:55,020 --> 00:29:52,690

some thought yes it took some thought

665

00:29:57,750 --> 00:29:55,030

the reason that you see those large

666

00:30:00,570 --> 00:29:57,760

pieces of plastic underneath the

667

00:30:03,030 --> 00:30:00,580

membranes is essentially a first-order

668

00:30:06,830 --> 00:30:03,040

simulation of where the membranes will

669

00:30:10,920 --> 00:30:06,840

be in flight if you didn't have those

670

00:30:15,630 --> 00:30:10,930

plastic sheets there it would droop and

671

00:30:19,020 --> 00:30:15,640

perhaps giving us a false problem but

672

00:30:21,180 --> 00:30:19,030

you also don't see is the many hours and

673

00:30:25,020 --> 00:30:21,190

hours of analysis the reason I said all

674

00:30:27,540 --> 00:30:25,030

of them is because basically every

675

00:30:31,710 --> 00:30:27,550

aspect of the sunshield and indeed the

676

00:30:33,540 --> 00:30:31,720

observatory is is watched over by by

677

00:30:35,910 --> 00:30:33,550

teams of engineers that are assigned to

678

00:30:38,610 --> 00:30:35,920

each aspect all of them have to work

679

00:30:41,730 --> 00:30:38,620

together for the team to be successful

680

00:30:47,760 --> 00:30:41,740

so my my good comment of all of them

681

00:30:51,840 --> 00:30:47,770

actually I meant all of them but you

682

00:30:55,080 --> 00:30:51,850

know we also have looked at and have run

683

00:30:58,410 --> 00:30:55,090

tests in the very same room to convince

684

00:31:00,930 --> 00:30:58,420

ourselves that in zero-g when the when

685

00:31:03,990 --> 00:31:00,940

the membranes will billow up they also

686

00:31:06,240 --> 00:31:04,000

don't run into the telescope or other

687

00:31:08,250 --> 00:31:06,250

structure that wasn't included in this

688

00:31:09,780 --> 00:31:08,260

test so

689

00:31:11,640 --> 00:31:09,790

we try to think through very very

690

00:31:12,960 --> 00:31:11,650

carefully you know what are the

691

00:31:16,170 --> 00:31:12,970

differences between our test environment

692

00:31:20,430 --> 00:31:16,180

our deployment environment do our test

693

00:31:22,050 --> 00:31:20,440

conditions do our analysis cover it it

694

00:31:27,450 --> 00:31:22,060

can be quite an involved set of

695

00:31:30,300 --> 00:31:27,460

questions we have pretty clever and

696

00:31:33,300 --> 00:31:30,310

experienced customers that that also

697

00:31:38,580 --> 00:31:33,310

review our review our analysis which

698

00:31:40,320 --> 00:31:38,590

makes it challenging good well I'm sure

699

00:31:42,390 --> 00:31:40,330

this is the first of many tests and

700

00:31:43,980 --> 00:31:42,400

Alberto brought up a a good good

701
00:31:46,440 --> 00:31:43,990
question and I wanted to ask about this

702
00:31:48,150 --> 00:31:46,450
so you're right we have gravity on earth

703
00:31:50,430 --> 00:31:48,160
you're testing on earth you're going to

704
00:31:52,110 --> 00:31:50,440
be you will be performing tests in the

705
00:31:54,420 --> 00:31:52,120
future that sort of compensate for this

706
00:31:56,790 --> 00:31:54,430
right and right oh yeah and how will you

707
00:31:58,620 --> 00:31:56,800
do that let's see we do it lots of

708
00:32:03,090 --> 00:31:58,630
different ways maybe now's a good chance

709
00:32:06,210 --> 00:32:03,100
to show the secondary error video ok

710
00:32:08,280 --> 00:32:06,220
Kelly before yeah because we have the

711
00:32:09,750 --> 00:32:08,290
same issues there and Jon I want to talk

712
00:32:13,500 --> 00:32:09,760
about that as well yeah there's a really

713
00:32:16,310 --> 00:32:13,510

good example what you're looking at here

714

00:32:20,990 --> 00:32:16,320

is you're looking down from the top and

715

00:32:25,110 --> 00:32:21,000

as you see the mirrored mirror

716

00:32:27,450 --> 00:32:25,120

structure the tripod itself deploy it's

717

00:32:30,150 --> 00:32:27,460

being deployed by the by the engineering

718

00:32:33,060 --> 00:32:30,160

model of the motor that will do it in

719

00:32:36,470 --> 00:32:33,070

flight and if we can hold it right let's

720

00:32:43,380 --> 00:32:36,480

see let's go back end of the video I

721

00:32:45,210 --> 00:32:43,390

want to show you what one item here go

722

00:32:48,110 --> 00:32:45,220

to the end of the video yeah go to the

723

00:32:50,850 --> 00:32:48,120

end of the video and hold that Kelly I

724

00:32:53,340 --> 00:32:50,860

know we're asking a lot here yeah this

725

00:32:54,540 --> 00:32:53,350

is pretty hard yeah I see all the people

726

00:32:55,830 --> 00:32:54,550

that were in the Sun shield they're

727

00:32:58,080 --> 00:32:55,840

still in there right they're gonna be

728

00:33:00,980 --> 00:32:58,090

all out there helping out yeah

729

00:33:00,990 --> 00:33:13,130

ok whether it's rather it's resolved the

730

00:33:20,499 --> 00:33:16,740

yeah the secondary mirror mount that you

731

00:33:23,819 --> 00:33:20,509

see ok right there

732

00:33:27,479 --> 00:33:23,829

keep keep going it's right at the end

733

00:33:33,999 --> 00:33:31,719

it's actually quite hard to see but

734

00:33:36,519 --> 00:33:34,009

there's actually a table at the end of

735

00:33:42,669 --> 00:33:36,529

the tripod where the secondary mirror

736

00:33:46,509 --> 00:33:42,679

will be and what let see stop it right

737

00:33:51,489 --> 00:33:46,519

there there you go so if you look on the

738

00:33:54,969 --> 00:33:51,499

top actually one little if you look very

739

00:33:56,409 --> 00:33:54,979

carefully at the secondary mirror mount

740

00:33:58,779 --> 00:33:56,419

that the idea of the structure that

741

00:34:02,739 --> 00:33:58,789

holds the mirror you'll see a cable

742

00:34:07,329 --> 00:34:02,749

assembly that's pulling up and I filling

743

00:34:10,169 --> 00:34:07,339

up with the weight of the tripod to

744

00:34:13,990 --> 00:34:10,179

essentially make the tripod weightless

745

00:34:16,779 --> 00:34:14,000

to prove that the motor can drive it in

746

00:34:21,690 --> 00:34:16,789

space okay so you got cable so this is a

747

00:34:24,940 --> 00:34:21,700

very concrete example of offloading and

748

00:34:28,349 --> 00:34:24,950

how we do that and perform the test and

749

00:34:31,059 --> 00:34:28,359

not make the test too easy or too hard

750

00:34:34,240 --> 00:34:31,069

is one of the engineering challenges

751
00:34:36,159 --> 00:34:34,250
faced by the deployment team well

752
00:34:37,809 --> 00:34:36,169
Alberto I have a suggestion for you to

753
00:34:39,309 --> 00:34:37,819
put in your innovation group instead of

754
00:34:42,210 --> 00:34:39,319
using cables and pulleys to simulate

755
00:34:45,039 --> 00:34:42,220
anti-gravity make an antigravity machine

756
00:34:47,049 --> 00:34:45,049
we're working on a and and so that we

757
00:34:53,249 --> 00:34:47,059
could just cancel out all gravity on in

758
00:34:55,659 --> 00:34:53,259
the in the surrounding area technology

759
00:35:00,880 --> 00:34:55,669
calling the elevator just cut the cables

760
00:35:02,440 --> 00:35:00,890
we got those thank you gravity then

761
00:35:04,749 --> 00:35:02,450
we've already figured out dark matter at

762
00:35:12,730 --> 00:35:04,759
that point so we can just get it all

763
00:35:15,009 --> 00:35:12,740

done in one fell swoop so you can see as

764

00:35:17,410 --> 00:35:15,019

we do these different tests you can take

765

00:35:20,380 --> 00:35:17,420

that video we saw at the beginning sort

766

00:35:22,779 --> 00:35:20,390

of cartoon you magic of the deployment

767

00:35:24,670 --> 00:35:22,789

the animation it slowly testing each of

768

00:35:27,009 --> 00:35:24,680

those pieces so that the time we fly

769

00:35:28,930 --> 00:35:27,019

will have done all of these tests on the

770

00:35:32,109 --> 00:35:28,940

ground multiple times and negatives

771

00:35:33,910 --> 00:35:32,119

confident so there it says well execute

772

00:35:34,270 --> 00:35:33,920

once you're on orbit that's a great

773

00:35:35,530 --> 00:35:34,280

point

774

00:35:37,510 --> 00:35:35,540

glad you brought this up because Alberto

775

00:35:38,920 --> 00:35:37,520

and I talked to I believe it was Scott

776

00:35:41,190 --> 00:35:38,930

Willoughby back in the double-a s last

777

00:35:45,430 --> 00:35:41,200

January and he gave us some really good

778

00:35:47,290 --> 00:35:45,440

insight into how hardware becomes space

779

00:35:50,020 --> 00:35:47,300

qualified it can you give us some idea

780

00:35:51,820 --> 00:35:50,030

of what that means I mean I mean we've

781

00:35:54,580 --> 00:35:51,830

Johnathan's talked touched on this a

782

00:35:56,080 --> 00:35:54,590

little bit we build this one sort of

783

00:35:58,750 --> 00:35:56,090

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

784

00:36:00,220 --> 00:35:58,760

version of the dislike lineman hinge

785

00:36:04,060 --> 00:36:00,230

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

786

00:36:09,250 --> 00:36:04,070

fly give us some sense of how this stuff

787

00:36:12,160 --> 00:36:09,260

is is tested on the way to space so in

788

00:36:14,470 --> 00:36:12,170

order to go to space the every piece of

789

00:36:16,630 --> 00:36:14,480

hardware has to be able to survive the

790

00:36:18,580 --> 00:36:16,640

environment in which it will be working

791

00:36:20,710 --> 00:36:18,590

in once it's in space and the

792

00:36:24,460 --> 00:36:20,720

environment that it will see during

793

00:36:27,400 --> 00:36:24,470

launch as it goes into space so just

794

00:36:30,010 --> 00:36:27,410

take an example the hole with JWST once

795

00:36:32,290 --> 00:36:30,020

it's been stowed will have to go through

796

00:36:34,110 --> 00:36:32,300

an environmental testing which means

797

00:36:37,660 --> 00:36:34,120

that we will put it on a shaker table

798

00:36:40,780 --> 00:36:37,670

simulate launch all of the materials

799

00:36:43,230 --> 00:36:40,790

that go into JWST of had to be tested

800

00:36:45,730 --> 00:36:43,240

and verified or validated that they can

801
00:36:47,950 --> 00:36:45,740
meet all of the extremes of temperature

802
00:36:49,960 --> 00:36:47,960
that our models predict that they will

803
00:36:51,460 --> 00:36:49,970
need to see so we have all the

804
00:36:53,200 --> 00:36:51,470
temperatures that they will see during

805
00:36:55,300 --> 00:36:53,210
launch and then the temperatures they

806
00:36:57,160 --> 00:36:55,310
will see once they pull down the

807
00:36:59,740 --> 00:36:57,170
cryogenic temperatures some of these

808
00:37:03,040 --> 00:36:59,750
pieces are Hardware see very large

809
00:37:05,560 --> 00:37:03,050
extremes of temperature and so we have

810
00:37:07,600 --> 00:37:05,570
to test for all of those and then you

811
00:37:10,450 --> 00:37:07,610
also have the quality assurance aspect

812
00:37:12,580 --> 00:37:10,460
where you know people have to keep you

813
00:37:14,530 --> 00:37:12,590

know very solid paper work on how the

814

00:37:16,750 --> 00:37:14,540

piece of hardware was made it has to be

815

00:37:18,550 --> 00:37:16,760

tested signed off though there's the

816

00:37:20,170 --> 00:37:18,560

whole sort of oversight process of

817

00:37:22,630 --> 00:37:20,180

actually putting something together and

818

00:37:24,940 --> 00:37:22,640

doing the testing in the lab or at the

819

00:37:27,040 --> 00:37:24,950

company that's building that and that's

820

00:37:28,660 --> 00:37:27,050

true for every single nut and bolt and

821

00:37:29,980 --> 00:37:28,670

anything that goes on this Observatory

822

00:37:32,260 --> 00:37:29,990

right it has to be spaced what's called

823

00:37:34,600 --> 00:37:32,270

space qualified open I'm getting that

824

00:37:37,180 --> 00:37:34,610

correct and the reason is that you can't

825

00:37:39,340 --> 00:37:37,190

go up and fix it later on so you have to

826
00:37:41,410 --> 00:37:39,350
test and make sure that everything works

827
00:37:43,510 --> 00:37:41,420
on the ground the way it's meant to and

828
00:37:46,990 --> 00:37:43,520
not just as a set of individual

829
00:37:47,930 --> 00:37:47,000
components actually a question from

830
00:37:49,910 --> 00:37:47,940
Trotter regarding

831
00:37:54,079 --> 00:37:49,920
- let me go and show this up here real

832
00:37:57,349 --> 00:37:54,089
quick this is from one thing mom in aria

833
00:37:59,720 --> 00:37:57,359
I apologize if I mispronounce that says

834
00:38:03,109 --> 00:37:59,730
that for the sunshield deploy test did

835
00:38:05,569 --> 00:38:03,119
you and how did you measure the deployed

836
00:38:07,520 --> 00:38:05,579
shape so is there a reason why that

837
00:38:10,460 --> 00:38:07,530
shape came into being and how do you

838
00:38:14,120 --> 00:38:10,470

guys measure to make sure that that was

839

00:38:18,230 --> 00:38:14,130

the nominal the nominal shape when it

840

00:38:21,740 --> 00:38:18,240

was fully deployed well who are you

841

00:38:29,720 --> 00:38:21,750

asking you to Trump the panel so I have

842

00:38:38,390 --> 00:38:29,730

an innovation scientist on my fan tact

843

00:38:42,289 --> 00:38:38,400

you onto the shape is determined by by

844

00:38:44,870 --> 00:38:42,299

analysis which one gives us the Koopman

845

00:38:46,970 --> 00:38:44,880

that we need and allows the packaging

846

00:38:52,970 --> 00:38:46,980

that we have to have to get it stowed

847

00:38:56,240 --> 00:38:52,980

and launched and deployed we do measure

848

00:38:58,400 --> 00:38:56,250

each of the membranes by themselves the

849

00:39:01,299 --> 00:38:58,410

template membranes were measured by a

850

00:39:05,799 --> 00:39:01,309

variety of techniques laser trackers

851

00:39:08,539 --> 00:39:05,809

laser radars called lidar z' and other

852

00:39:10,069 --> 00:39:08,549

instruments of that ilk to show that

853

00:39:12,589 --> 00:39:10,079

they had the correct three-dimensional

854

00:39:15,140 --> 00:39:12,599

shape so the shape is determined by

855

00:39:17,089 --> 00:39:15,150

analysis it gives us the thermal and

856

00:39:21,170 --> 00:39:17,099

optical performance that we require and

857

00:39:25,849 --> 00:39:21,180

then when the the membranes are made

858

00:39:28,130 --> 00:39:25,859

there they are measured and then at that

859

00:39:31,010 --> 00:39:28,140

system level we simply verified that the

860

00:39:33,730 --> 00:39:31,020

pull points the corners of the membranes

861

00:39:36,140 --> 00:39:33,740

were in the proper the proper position

862

00:39:38,510 --> 00:39:36,150

okay so we do have a lot of great

863

00:39:39,859 --> 00:39:38,520

comments and questions also on Twitter

864

00:39:41,630 --> 00:39:39,869

thank you guys for using Twitter I

865

00:39:43,160 --> 00:39:41,640

appreciate it but before I get to our

866

00:39:46,640 --> 00:39:43,170

and I promise I'll get to as many as I

867

00:39:49,519 --> 00:39:46,650

can I want to ask mark how you were

868

00:39:51,289 --> 00:39:49,529

talking about the qualifying space

869

00:39:52,910 --> 00:39:51,299

hardware what it takes to make sure that

870

00:39:55,880 --> 00:39:52,920

it seems it has to work right the first

871

00:39:58,700 --> 00:39:55,890

time you as the observatory project

872

00:40:01,339 --> 00:39:58,710

scientist akkad er how how confident are

873

00:40:04,339 --> 00:40:01,349

you that all of this is going to work as

874

00:40:05,420 --> 00:40:04,349

and or as designed are you pretty are

875

00:40:08,479 --> 00:40:05,430

you pretty confident based on what

876

00:40:11,180 --> 00:40:08,489

you're seeing so far absolutely I'm very

877

00:40:14,210 --> 00:40:11,190

confident as the observer to project

878

00:40:17,120 --> 00:40:14,220

scientist I have to be involved in in

879

00:40:21,130 --> 00:40:17,130

all of these processes as John will tell

880

00:40:24,410 --> 00:40:21,140

you so I go out to Northrup on a regular

881

00:40:26,329 --> 00:40:24,420

basis and sittings meetings where we

882

00:40:28,910 --> 00:40:26,339

discuss how this work is going to get

883

00:40:30,440 --> 00:40:28,920

done then see it in the reviews when

884

00:40:33,559 --> 00:40:30,450

we've done the work and we're looking at

885

00:40:35,960 --> 00:40:33,569

the results and you know basically I

886

00:40:37,900 --> 00:40:35,970

participate in all aspects of this and I

887

00:40:40,579 --> 00:40:37,910

went out to see the Sun shield deployed

888

00:40:43,130 --> 00:40:40,589

because you know that is something that

889

00:40:45,259 --> 00:40:43,140

everybody asks about and of course as a

890

00:40:47,900 --> 00:40:45,269

scientist I'm very concerned about how

891

00:40:50,630 --> 00:40:47,910

it deploys because it's not just getting

892

00:40:53,059 --> 00:40:50,640

it out that's important but also how it

893

00:40:54,650 --> 00:40:53,069

comes out well each of the layers are

894

00:40:56,599 --> 00:40:54,660

aligned with respect to each other has

895

00:40:59,089 --> 00:40:56,609

you know big impact on the science so

896

00:41:01,460 --> 00:40:59,099

I'm clearly very interested in aspects

897

00:41:04,969 --> 00:41:01,470

ideas so yes I'm very confident because

898

00:41:07,519 --> 00:41:04,979

I stay very tuned in to what John and

899

00:41:10,160 --> 00:41:07,529

Alberto and the engineers out at

900

00:41:11,569 --> 00:41:10,170

Northrop are doing so that I understand

901
00:41:13,609 --> 00:41:11,579
what they're doing and how it's being

902
00:41:15,979 --> 00:41:13,619
done and understand what the challenges

903
00:41:18,259 --> 00:41:15,989
are and how we're addressing it great

904
00:41:20,239 --> 00:41:18,269
I'm glad to hear that now on a related

905
00:41:22,279 --> 00:41:20,249
note and let's take a little bit step

906
00:41:24,019 --> 00:41:22,289
back to the bigger picture for just a

907
00:41:25,700 --> 00:41:24,029
moment and look at the mission as a

908
00:41:26,839 --> 00:41:25,710
whole and how the the observatory is

909
00:41:28,969 --> 00:41:26,849
coming together can you give us the

910
00:41:31,160 --> 00:41:28,979
status an update on our things are

911
00:41:33,079 --> 00:41:31,170
things going on schedule or is there any

912
00:41:38,559 --> 00:41:33,089
any red flags how were how are things

913
00:41:42,319 --> 00:41:39,920

okay

914

00:41:43,910 --> 00:41:42,329

I let me just speak to a couple of

915

00:41:46,309 --> 00:41:43,920

things we're doing here at Goddard and

916

00:41:46,670 --> 00:41:46,319

then John can speak okay that sounds

917

00:41:49,729 --> 00:41:46,680

great

918

00:41:52,069 --> 00:41:49,739

so one of the big milestones that we're

919

00:41:54,589 --> 00:41:52,079

just in the process of reaching the

920

00:41:58,190 --> 00:41:54,599

Goddard is something called C v2 and

921

00:41:59,839 --> 00:41:58,200

this is a thermal vacuum test that

922

00:42:01,789 --> 00:41:59,849

cryogenic temperatures of the four

923

00:42:04,579 --> 00:42:01,799

instruments we're doing three of these

924

00:42:06,469 --> 00:42:04,589

we are just finishing up the second one

925

00:42:08,450 --> 00:42:06,479

now so for the last couple of months

926

00:42:11,420 --> 00:42:08,460

we've been operating the four flight

927

00:42:14,180 --> 00:42:11,430

instruments the ones that will fly met

928

00:42:16,430 --> 00:42:14,190

mounted in there

929

00:42:17,989 --> 00:42:16,440

skeleton if you like that we call the

930

00:42:20,180 --> 00:42:17,999

icing or the integrated science

931

00:42:22,880 --> 00:42:20,190

instrument module and they have been

932

00:42:24,559 --> 00:42:22,890

operated in a big chamber we've done our

933

00:42:26,120 --> 00:42:24,569

instrument to instrument alignments

934

00:42:28,819 --> 00:42:26,130

check the performance of each of the

935

00:42:31,670 --> 00:42:28,829

instruments and we just finished that

936

00:42:33,229 --> 00:42:31,680

process recently and we're now in the

937

00:42:34,999 --> 00:42:33,239

process of starting to warm those

938

00:42:38,120 --> 00:42:35,009

instruments back up so that was the

939

00:42:40,309 --> 00:42:38,130

second of three tests and that way and

940

00:42:42,049 --> 00:42:40,319

that's going on at garden right now yeah

941

00:42:45,229 --> 00:42:42,059

it's actually just finishing up right

942

00:42:48,710 --> 00:42:45,239

and you can see the challenges I have

943

00:42:52,609 --> 00:42:48,720

doing this interview in a green building

944

00:42:54,920 --> 00:42:52,619

where the lights keep going out no

945

00:42:56,809 --> 00:42:54,930

you're saving energy that's good the

946

00:42:58,400 --> 00:42:56,819

bottom line is that we're we're doing

947

00:43:00,920 --> 00:42:58,410

really well we're on schedule we're

948

00:43:03,620 --> 00:43:00,930

their instrument testing the other big

949

00:43:07,670 --> 00:43:03,630

activity we have here is that we have a

950

00:43:10,029 --> 00:43:07,680

flight spare backplane which is what the

951
00:43:12,769 --> 00:43:10,039
mirrors mount to the center section and

952
00:43:15,229 --> 00:43:12,779
we've actually mounted two flights pair

953
00:43:17,799 --> 00:43:15,239
mirrors on that and that structures get

954
00:43:20,059 --> 00:43:17,809
being ready to be shipped down to Texas

955
00:43:22,219 --> 00:43:20,069
towards the end of the year so that we

956
00:43:24,709 --> 00:43:22,229
can put it in the big chamber in Texas

957
00:43:26,809 --> 00:43:24,719
at the Johnson Space Center early next

958
00:43:29,299 --> 00:43:26,819
year and start doing testing that will

959
00:43:31,039 --> 00:43:29,309
allow us to make sure we understand that

960
00:43:33,769 --> 00:43:31,049
all our test Hardware in that chamber

961
00:43:36,769 --> 00:43:33,779
works in preparation for when we send

962
00:43:39,349 --> 00:43:36,779
the final telescope down in 2017 for its

963
00:43:40,999 --> 00:43:39,359

end-to-end cryo optical test but that's

964

00:43:43,009 --> 00:43:41,009

what's going on at Goddard and I hand

965

00:43:44,450 --> 00:43:43,019

over to John okay John go ahead watch

966

00:43:47,120 --> 00:43:44,460

give us a quick update on how things run

967

00:43:52,660 --> 00:43:47,130

on your end in short we're really quite

968

00:43:55,130 --> 00:43:52,670

firing all cylinders at Northrop we have

969

00:43:57,019 --> 00:43:55,140

accepted the flight structure that's

970

00:44:00,680 --> 00:43:57,029

going to hold the mirrors and our

971

00:44:04,219 --> 00:44:00,690

attaching the wings that hold the three

972

00:44:05,870 --> 00:44:04,229

sets of primary mirror elements that

973

00:44:10,099 --> 00:44:05,880

fold back that you saw in the deployment

974

00:44:12,829 --> 00:44:10,109

video we're in the process of building

975

00:44:17,839 --> 00:44:12,839

the spacecraft structure which is moving

976
00:44:20,509 --> 00:44:17,849
along a pace flight boxes on electronics

977
00:44:24,170 --> 00:44:20,519
are being received the main structure

978
00:44:26,239 --> 00:44:24,180
the sunshield is in is in build and we

979
00:44:26,840 --> 00:44:26,249
just have the test readiness review to

980
00:44:30,710 --> 00:44:26,850
measure

981
00:44:33,350 --> 00:44:30,720
the second plague membrane here at next

982
00:44:38,680 --> 00:44:33,360
oven we concluded that yesterday so

983
00:44:41,270 --> 00:44:38,690
basically all of the hardware for the

984
00:44:44,990 --> 00:44:41,280
Northrop side everything that's not the

985
00:44:48,500 --> 00:44:45,000
Isum is in some level of manufacture or

986
00:44:51,830 --> 00:44:48,510
assembly and so it's very exciting at

987
00:44:53,000 --> 00:44:51,840
this point in the program awesome and I

988
00:44:54,890 --> 00:44:53,010

want to underscore one thing I think

989

00:44:56,330 --> 00:44:54,900

both mark and Jonathan brought up which

990

00:44:58,370 --> 00:44:56,340

is the fact that at some point just

991

00:45:00,380 --> 00:44:58,380

because you test the sunshield

992

00:45:01,460 --> 00:45:00,390

separately and the mirrors separately

993

00:45:04,070 --> 00:45:01,470

doesn't mean that they're gonna work as

994

00:45:05,630 --> 00:45:04,080

a system well and so what Mark was

995

00:45:08,060 --> 00:45:05,640

mentioned is that at some point it will

996

00:45:10,760 --> 00:45:08,070

be a end-to-end testing of their all

997

00:45:12,350 --> 00:45:10,770

observatory and so that's extremely

998

00:45:14,060 --> 00:45:12,360

important because just because you test

999

00:45:16,930 --> 00:45:14,070

you know under these conditions you know

1000

00:45:18,410 --> 00:45:16,940

from launch to deployment to actual

1001
00:45:20,480 --> 00:45:18,420
commissioning and then through

1002
00:45:22,340 --> 00:45:20,490
operations it doesn't you know if you

1003
00:45:25,460 --> 00:45:22,350
test a separate system it does not

1004
00:45:26,720 --> 00:45:25,470
really follow through logically that it

1005
00:45:28,970 --> 00:45:26,730
will work together very well and so I

1006
00:45:30,680 --> 00:45:28,980
think all these tests are getting large

1007
00:45:32,150 --> 00:45:30,690
and large in complexity in the sense

1008
00:45:34,040 --> 00:45:32,160
that you adding and adding things

1009
00:45:35,210 --> 00:45:34,050
together and this is actually the name

1010
00:45:36,860 --> 00:45:35,220
of the game for this telescope because

1011
00:45:39,050 --> 00:45:36,870
it's so it's so complex but at the same

1012
00:45:40,520 --> 00:45:39,060
time so beautiful to watch I know this

1013
00:45:42,680 --> 00:45:40,530

is great I'm very excited I'm glad

1014

00:45:44,330 --> 00:45:42,690

things are still on track we have gotten

1015

00:45:46,040 --> 00:45:44,340

a lot of comments and questions let me

1016

00:45:48,140 --> 00:45:46,050

try to get to some of them now this is

1017

00:45:50,950 --> 00:45:48,150

from the QA AB Michael joban is asking

1018

00:45:54,080 --> 00:45:50,960

now when Mike Massimino was removing

1019

00:45:55,820 --> 00:45:54,090

captain on HST it fell apart when he

1020

00:45:58,190 --> 00:45:55,830

touched it and made a mess the Sun

1021

00:46:00,470 --> 00:45:58,200

degraded it so is that okay

1022

00:46:02,810 --> 00:46:00,480

don't see yeah there's a couple of

1023

00:46:05,480 --> 00:46:02,820

things that are different the Hubble's

1024

00:46:08,300 --> 00:46:05,490

in a very low orbit it's actually still

1025

00:46:13,370 --> 00:46:08,310

in the the sensible atmosphere if you

1026
00:46:15,860 --> 00:46:13,380
will and so the captain on the Hubble

1027
00:46:17,420 --> 00:46:15,870
faces a very different environment the

1028
00:46:22,690 --> 00:46:17,430
low Earth environment is much more

1029
00:46:29,180 --> 00:46:22,700
hostile to us than the I2 environment

1030
00:46:32,390 --> 00:46:29,190
that being said the the captain in Sun

1031
00:46:35,300 --> 00:46:32,400
shield material development was one of

1032
00:46:37,640 --> 00:46:35,310
the ten early technologies that needed

1033
00:46:40,280 --> 00:46:37,650
to be developed and demonstrated prior

1034
00:46:43,910 --> 00:46:40,290
to confirmation of JWST so

1035
00:46:46,580 --> 00:46:43,920
the actual design of that flight

1036
00:46:51,590 --> 00:46:46,590
material saw extensive environmental

1037
00:46:54,830 --> 00:46:51,600
testing about a decade ago to prove its

1038
00:46:58,280 --> 00:46:54,840

its flight worthiness so it's all what's

1039

00:47:01,100 --> 00:46:58,290

life question and again we answered that

1040

00:47:04,250 --> 00:47:01,110

question by by testing and retiring that

1041

00:47:07,760 --> 00:47:04,260

risk right basically you're saying that

1042

00:47:10,330 --> 00:47:07,770

it's the the amount of atmosphere that

1043

00:47:12,920 --> 00:47:10,340

Hubble is going through that slowly

1044

00:47:15,260 --> 00:47:12,930

degrading it because of friction over

1045

00:47:16,760 --> 00:47:15,270

that long period of time that that James

1046

00:47:19,520 --> 00:47:16,770

Webb won't be dealing with since is

1047

00:47:21,440 --> 00:47:19,530

going to be out the I2 point correct we

1048

00:47:25,250 --> 00:47:21,450

don't have the concern over atomic

1049

00:47:27,260 --> 00:47:25,260

oxygen which is you know extremely

1050

00:47:29,870 --> 00:47:27,270

corrosive both kinetically and

1051
00:47:32,450 --> 00:47:29,880
chemically right and so it does have the

1052
00:47:34,160 --> 00:47:32,460
tendency to degrade materials in a

1053
00:47:37,600 --> 00:47:34,170
different way in low-earth orbit than it

1054
00:47:39,430 --> 00:47:37,610
does in essentially interplanetary

1055
00:47:42,800 --> 00:47:39,440
environment that we're gonna live it

1056
00:47:44,660 --> 00:47:42,810
okay Judy Schmidt also on the Q&A app hi

1057
00:47:46,460 --> 00:47:44,670
Judy asked a really good question and

1058
00:47:48,080 --> 00:47:46,470
I'm gonna use it also as a segue into

1059
00:47:49,910 --> 00:47:48,090
the I2 point discussion a little bit

1060
00:47:51,860 --> 00:47:49,920
she's asking is there any place in the

1061
00:47:54,620 --> 00:47:51,870
solar system where an infrared telescope

1062
00:47:57,440 --> 00:47:54,630
could be placed and not have to rely on

1063
00:47:59,270 --> 00:47:57,450

coolant and Sun shields to maintain its

1064

00:48:02,270 --> 00:47:59,280

effectiveness is there anywhere we can

1065

00:48:04,460 --> 00:48:02,280

go but we don't need these things let's

1066

00:48:07,850 --> 00:48:04,470

see yeah I'll take I'll take a crack at

1067

00:48:10,550 --> 00:48:07,860

it and and and Mark may have a few other

1068

00:48:14,120 --> 00:48:10,560

ideas but basically what we need to do

1069

00:48:15,740 --> 00:48:14,130

is get our telescope into a cold

1070

00:48:18,020 --> 00:48:15,750

environment we're bringing that with us

1071

00:48:21,680 --> 00:48:18,030

that's the Sun shield and we want it to

1072

00:48:24,770 --> 00:48:21,690

be steady which is one of the positive

1073

00:48:26,720 --> 00:48:24,780

attributes of the I2 orbit in principle

1074

00:48:29,300 --> 00:48:26,730

we could locate that infrared telescope

1075

00:48:35,330 --> 00:48:29,310

a very far away very far away from the

1076

00:48:38,120 --> 00:48:35,340

Sun and a way away from its heating the

1077

00:48:40,850 --> 00:48:38,130

sun's heat the problem with that is we

1078

00:48:42,890 --> 00:48:40,860

then have no power or very little power

1079

00:48:46,520 --> 00:48:42,900

or have to take a very large battery or

1080

00:48:52,430 --> 00:48:46,530

radioisotope thermoelectric

1081

00:48:53,920 --> 00:48:52,440

a we're not very far away from us earth

1082

00:48:57,280 --> 00:48:53,930

on earth and we have to

1083

00:49:00,670 --> 00:48:57,290

the data home so the orbit that we were

1084

00:49:03,220 --> 00:49:00,680

chosen is a balance between a stable

1085

00:49:04,839 --> 00:49:03,230

orbit close to home so we can get the

1086

00:49:08,170 --> 00:49:04,849

massive amounts of data we're going to

1087

00:49:09,670 --> 00:49:08,180

take home in a safe way and the ability

1088

00:49:11,980 --> 00:49:09,680

to stay out of the earth and moon

1089

00:49:14,440 --> 00:49:11,990

shadows giving us a stable environment

1090

00:49:18,250 --> 00:49:14,450

so in some respects it's kind of the

1091

00:49:19,540 --> 00:49:18,260

Goldilocks place yeah the best let's

1092

00:49:21,339 --> 00:49:19,550

well let's talk a little more about the

1093

00:49:23,349 --> 00:49:21,349

El Topo Alberto can you describe what

1094

00:49:25,960 --> 00:49:23,359

the L2 point is and why we're going

1095

00:49:28,359 --> 00:49:25,970

there so we're going there for it for

1096

00:49:31,809 --> 00:49:28,369

actually for all the reasons that the

1097

00:49:33,640 --> 00:49:31,819

John just just mentioned we want to

1098

00:49:36,900 --> 00:49:33,650

sorry we want to we want to face the

1099

00:49:40,359 --> 00:49:36,910

moon the moon earth system all the time

1100

00:49:42,160 --> 00:49:40,369

okay we are going to do that and that

1101
00:49:43,569 --> 00:49:42,170
provides us with power because the Sun

1102
00:49:45,700 --> 00:49:43,579
is also in the same direction

1103
00:49:47,770 --> 00:49:45,710
that provides us with line-of-sight you

1104
00:49:50,260 --> 00:49:47,780
know to earth that is great if you want

1105
00:49:52,500 --> 00:49:50,270
to beam down information and this is

1106
00:49:55,450 --> 00:49:52,510
jazz John describe it it's basically a

1107
00:49:57,339 --> 00:49:55,460
sort of a it's not really a point it's

1108
00:49:59,500 --> 00:49:57,349
you know because I think what I would

1109
00:50:01,030 --> 00:49:59,510
like to notice if folks take a look at

1110
00:50:04,000 --> 00:50:01,040
the deployment video at the very end

1111
00:50:08,319 --> 00:50:04,010
where after the 29 days after the month

1112
00:50:10,420 --> 00:50:08,329
where that the deployment takes there's

1113
00:50:12,460 --> 00:50:10,430

a very large you see this orbit which is

1114

00:50:13,870 --> 00:50:12,470

a very large orbit at the very end which

1115

00:50:15,430 --> 00:50:13,880

is an orbit that is larger than the

1116

00:50:18,780 --> 00:50:15,440

distance from us to the moon really it's

1117

00:50:22,150 --> 00:50:18,790

a it's a 800,000 by 500,000 ellipse

1118

00:50:24,460 --> 00:50:22,160

kilometers ellipse and so it's a it's a

1119

00:50:27,039 --> 00:50:24,470

we are around the point you know where

1120

00:50:29,380 --> 00:50:27,049

we are able to there we go if you show

1121

00:50:30,910 --> 00:50:29,390

the deployment at the very very end that

1122

00:50:35,170 --> 00:50:30,920

you might be able to see those lines

1123

00:50:37,990 --> 00:50:35,180

represent the size to scale of the orbit

1124

00:50:40,750 --> 00:50:38,000

around the second lagrangian point that

1125

00:50:42,280 --> 00:50:40,760

web will take and so you see that you

1126
00:50:43,539 --> 00:50:42,290
know we see the distance from the earth

1127
00:50:47,620 --> 00:50:43,549
to the moon and if you you know if you

1128
00:50:50,260 --> 00:50:47,630
keep it running Kelly you see that at

1129
00:50:51,640 --> 00:50:50,270
the very end before it disappears so you

1130
00:50:53,890 --> 00:50:51,650
can probably pause it whenever you have

1131
00:50:56,650 --> 00:50:53,900
those those lines are showing up in in

1132
00:50:58,059 --> 00:50:56,660
in a few seconds so those those lines

1133
00:50:59,859 --> 00:50:58,069
are present the size of the orbit of

1134
00:51:02,740 --> 00:50:59,869
jadibooti around that point so it's

1135
00:51:05,319 --> 00:51:02,750
really not at L2 it's in orbit around L2

1136
00:51:07,240 --> 00:51:05,329
and that orbit provides again a very

1137
00:51:07,870 --> 00:51:07,250
stable point for power a very stable

1138
00:51:10,990 --> 00:51:07,880

point

1139

00:51:14,499 --> 00:51:11,000

or data handling you know in terms of in

1140

00:51:16,980 --> 00:51:14,509

terms of beaming down the wonderful day

1141

00:51:20,079 --> 00:51:16,990

that we're gonna get in 2019 yeah it's

1142

00:51:24,279 --> 00:51:20,089

it's worth stating very quickly that

1143

00:51:27,609 --> 00:51:24,289

once JWST has launched in the early

1144

00:51:30,880 --> 00:51:27,619

morning of its launch day it's never in

1145

00:51:32,920 --> 00:51:30,890

shadow we have no eclipses on this orbit

1146

00:51:36,279 --> 00:51:32,930

we're never in the Earth or the moon

1147

00:51:38,470 --> 00:51:36,289

shadow at any point in our trajectory so

1148

00:51:40,569 --> 00:51:38,480

mark wanted to say something yeah I was

1149

00:51:43,480 --> 00:51:40,579

gonna say that the one other magic thing

1150

00:51:46,420 --> 00:51:43,490

about I2 is that we get 24/7 science

1151
00:51:48,670 --> 00:51:46,430
operation exactly yes I mean slowing

1152
00:51:50,920 --> 00:51:48,680
from one object to the next unlike Cobo

1153
00:51:53,410 --> 00:51:50,930
of course which in its low Earth orbit

1154
00:51:57,279 --> 00:51:53,420
has to go around the earth and you know

1155
00:51:58,720 --> 00:51:57,289
we go 45 minutes around the bright part

1156
00:52:01,089 --> 00:51:58,730
of the Earth's and then we get 45

1157
00:52:03,549 --> 00:52:01,099
minutes for science around the dark so

1158
00:52:05,079 --> 00:52:03,559
that I2 we just get to do science all

1159
00:52:09,339 --> 00:52:05,089
the time and it's just gonna be very

1160
00:52:11,499 --> 00:52:09,349
important or doing some of the exoplanet

1161
00:52:13,569 --> 00:52:11,509
science of people are proposing now

1162
00:52:16,180 --> 00:52:13,579
where you may have to spend it quite a

1163
00:52:21,160 --> 00:52:16,190

long time staring at one object glad you

1164

00:52:22,660 --> 00:52:21,170

brought up exoplanet on YouTube and as

1165

00:52:25,930 --> 00:52:22,670

we as we've heard one of the science

1166

00:52:28,089 --> 00:52:25,940

goals of JWST will be to help us

1167

00:52:30,309 --> 00:52:28,099

understand exoplanets a lot more in

1168

00:52:33,940 --> 00:52:30,319

their atmospheres and he is asking how

1169

00:52:36,130 --> 00:52:33,950

small and will an exoplanet will jws TV

1170

00:52:39,069 --> 00:52:36,140

be able to resolve or can you answer

1171

00:52:41,920 --> 00:52:39,079

that one sorry did you say to resolve

1172

00:52:45,180 --> 00:52:41,930

yeah that's a key question that's a key

1173

00:52:49,359 --> 00:52:45,190

maybe we should talk about resolve me a

1174

00:52:53,200 --> 00:52:49,369

wst will be able to I guess the word I

1175

00:52:57,120 --> 00:52:53,210

would use is the image exoplanets and

1176

00:53:00,249 --> 00:52:57,130

sort of gas giant class maybe down to

1177

00:53:02,499 --> 00:53:00,259

some some of the larger Neptune's and

1178

00:53:05,589 --> 00:53:02,509

this is because we really weren't

1179

00:53:09,370 --> 00:53:05,599

designed to take direct images of

1180

00:53:12,069 --> 00:53:09,380

planets and there are a lot of things

1181

00:53:14,349 --> 00:53:12,079

that go into question of how you do that

1182

00:53:16,180 --> 00:53:14,359

but the bottom line is that you you're

1183

00:53:18,220 --> 00:53:16,190

trying to look at very faint objects

1184

00:53:19,990 --> 00:53:18,230

next very bright objects so you have to

1185

00:53:21,850 --> 00:53:20,000

use an instrument called a coronagraph

1186

00:53:26,410 --> 00:53:21,860

and on Jade

1187

00:53:28,210 --> 00:53:26,420

UST some of the coronagraphs can do

1188

00:53:30,160 --> 00:53:28,220

these kind of observations but you can't

1189

00:53:32,350 --> 00:53:30,170

see in so close that you could for

1190

00:53:34,750 --> 00:53:32,360

instance see an earth-sized planet so

1191

00:53:36,850 --> 00:53:34,760

you can see or the big jupiter-sized

1192

00:53:39,490 --> 00:53:36,860

planets you know the gas giants further

1193

00:53:40,290 --> 00:53:39,500

out that's good enough for me I'd be

1194

00:53:43,500 --> 00:53:40,300

happy with that

1195

00:53:46,480 --> 00:53:43,510

Michael Maxie also on YouTube is asking

1196

00:53:48,580 --> 00:53:46,490

how durable are the optics maybe this

1197

00:53:51,670 --> 00:53:48,590

was for you Jonathan how durable are the

1198

00:53:54,700 --> 00:53:51,680

optics - meteor impacts and how hard

1199

00:53:55,750 --> 00:53:54,710

easy is in-flight maintenance all that

1200

00:54:04,090 --> 00:53:55,760

last part of the question is an easy

1201
00:54:06,430 --> 00:54:04,100
thing to ask with the second question

1202
00:54:09,460 --> 00:54:06,440
because maintenance is not part of our

1203
00:54:14,700 --> 00:54:09,470
our mission so write the telephone does

1204
00:54:17,580 --> 00:54:14,710
not require servicing to meet his life

1205
00:54:19,810 --> 00:54:17,590
requirement and working backwards

1206
00:54:22,840 --> 00:54:19,820
earlier in the conversation when I

1207
00:54:25,690 --> 00:54:22,850
discussed micro meteorite impacts

1208
00:54:30,910 --> 00:54:25,700
hypervelocity testing that was conducted

1209
00:54:34,650 --> 00:54:30,920
on the membranes we similarly did those

1210
00:54:40,210 --> 00:54:34,660
kinds of tests on the beryllium mirrors

1211
00:54:43,330 --> 00:54:40,220
to understand how those projectiles

1212
00:54:46,420 --> 00:54:43,340
interact whether they bounce off when

1213
00:54:49,770 --> 00:54:46,430

they crater or what they do and so as a

1214

00:54:52,150 --> 00:54:49,780

result again in the budget that

1215

00:54:55,380 --> 00:54:52,160

determines the optical figure of the

1216

00:54:59,800 --> 00:54:55,390

mirror there is an entry for

1217

00:55:03,130 --> 00:54:59,810

micrometeoroid degradation and the

1218

00:55:05,650 --> 00:55:03,140

budget which mark has reviewed with me

1219

00:55:09,490 --> 00:55:05,660

on many occasions those shows that we be

1220

00:55:11,460 --> 00:55:09,500

are way front or our optical figure you

1221

00:55:13,450 --> 00:55:11,470

know well past the five year lifetime

1222

00:55:15,420 --> 00:55:13,460

including the effects of the micro

1223

00:55:17,980 --> 00:55:15,430

meteoroids that's very good

1224

00:55:20,080 --> 00:55:17,990

this is putting up another question

1225

00:55:21,670 --> 00:55:20,090

that's related I don't mean to cut you

1226

00:55:22,660 --> 00:55:21,680

off but this is actually in line with

1227

00:55:24,910 --> 00:55:22,670

what you're talking about

1228

00:55:27,580 --> 00:55:24,920

where this where Jeremy Topolsky is

1229

00:55:28,840 --> 00:55:27,590

asking about the estimated lifetime of

1230

00:55:30,400 --> 00:55:28,850

this budget that you're talking about

1231

00:55:32,230 --> 00:55:30,410

how long is it supposed to last you're

1232

00:55:34,240 --> 00:55:32,240

saying you're designing and for the

1233

00:55:36,670 --> 00:55:34,250

five-year mission but it's

1234

00:55:39,190 --> 00:55:36,680

that's right we have a requirement meant

1235

00:55:41,859 --> 00:55:39,200

to last for four five at least five

1236

00:55:45,760 --> 00:55:41,869

years you know typically the way you

1237

00:55:48,970 --> 00:55:45,770

prove that a system will last five years

1238

00:55:51,910 --> 00:55:48,980

is by assuming basically everything go

1239

00:55:54,070 --> 00:55:51,920

wrong can go wrong and will go wrong and

1240

00:55:56,560 --> 00:55:54,080

that you still meet the lifetime

1241

00:55:59,890 --> 00:55:56,570

requirement and so in a more nominal

1242

00:56:03,670 --> 00:55:59,900

case you get a much longer life time for

1243

00:56:06,160 --> 00:56:03,680

JWST the consumable item the thing that

1244

00:56:09,460 --> 00:56:06,170

will be life limiting is our fuel not

1245

00:56:11,740 --> 00:56:09,470

the performance of the optics right yeah

1246

00:56:13,359 --> 00:56:11,750

so as well let's talk about the fuel

1247

00:56:17,230 --> 00:56:13,369

we'll just a little bit what's it for

1248

00:56:20,470 --> 00:56:17,240

well how much fuel will that have we

1249

00:56:22,839 --> 00:56:20,480

have a requirement to have five years

1250

00:56:24,609 --> 00:56:22,849

worth of mission fuel again this is

1251
00:56:28,990 --> 00:56:24,619
sized in an extremely conservative

1252
00:56:31,150 --> 00:56:29,000
manner we do have we will be loading

1253
00:56:34,420 --> 00:56:31,160
excuse me their requirement for 10 years

1254
00:56:37,480 --> 00:56:34,430
of fuel there is still room in the tank

1255
00:56:41,020 --> 00:56:37,490
so if we have extra mass to spend we'll

1256
00:56:43,000 --> 00:56:41,030
fill up the tanks again with a more

1257
00:56:44,859 --> 00:56:43,010
nominal case we should far exceed that

1258
00:56:46,240 --> 00:56:44,869
five-year life okay great I'm sorry I'm

1259
00:56:46,870 --> 00:56:46,250
rushing but there's so many I want to

1260
00:56:48,730 --> 00:56:46,880
get to

1261
00:56:51,430 --> 00:56:48,740
Alberto this one's this one's for you

1262
00:56:54,520 --> 00:56:51,440
please compare real thing 1905 on

1263
00:57:01,180 --> 00:56:54,530

YouTube please compare the changeable

1264

00:57:03,790 --> 00:57:01,190

oh okay as big as a school bus as big as

1265

00:57:06,910 --> 00:57:03,800

a tennis court Hubble is a visible

1266

00:57:09,160 --> 00:57:06,920

telescope which has given us actually 25

1267

00:57:12,460 --> 00:57:09,170

years of a spectacular images next year

1268

00:57:14,950 --> 00:57:12,470

next April of spectacular images as

1269

00:57:18,339 --> 00:57:14,960

revolutionize science and rewritten

1270

00:57:20,680 --> 00:57:18,349

textbooks I might add Webb will do that

1271

00:57:23,440 --> 00:57:20,690

wait a little longer but it's also a not

1272

00:57:24,700 --> 00:57:23,450

a optical telescope is not a visible

1273

00:57:28,599 --> 00:57:24,710

light telescope it's an infrared

1274

00:57:32,050 --> 00:57:28,609

infrared telescope the web wait I am not

1275

00:57:38,440 --> 00:57:32,060

done I know I'm just yeah once you get

1276

00:57:40,420 --> 00:57:38,450

him talking as Mark is Mark mentioned

1277

00:57:41,950 --> 00:57:40,430

also as Mark mentioned also we want to

1278

00:57:45,220 --> 00:57:41,960

image things are very very faint and

1279

00:57:47,530 --> 00:57:45,230

very far away or both actually and so we

1280

00:57:49,240 --> 00:57:47,540

need a larger aperture so we are about

1281

00:57:51,790 --> 00:57:49,250

twenty-one feet or six and a half meters

1282

00:57:54,520 --> 00:57:51,800

versus a two point four meter of the of

1283

00:57:56,230 --> 00:57:54,530

the Hubble Space Telescope the orbits

1284

00:58:00,040 --> 00:57:56,240

are very different as we talked about

1285

00:58:01,870 --> 00:58:00,050

the Hubble is in low-earth orbit it goes

1286

00:58:04,330 --> 00:58:01,880

around the earth about in ninety minutes

1287

00:58:08,020 --> 00:58:04,340

or so we are going a million miles away

1288

00:58:10,990 --> 00:58:08,030

or 1 billion sorry

1289

00:58:13,270 --> 00:58:11,000

1 million kilometres away from Earth at

1290

00:58:14,980 --> 00:58:13,280

this second round jump point so it's a

1291

00:58:17,320 --> 00:58:14,990

very very different one and actually I

1292

00:58:19,180 --> 00:58:17,330

would say that Webb Reid does not even

1293

00:58:20,650 --> 00:58:19,190

look like it like you your grandfather's

1294

00:58:22,390 --> 00:58:20,660

telescope so to speak as you as you look

1295

00:58:25,570 --> 00:58:22,400

at it we have to expose the optics

1296

00:58:28,480 --> 00:58:25,580

basically in order to satisfy the

1297

00:58:29,590 --> 00:58:28,490

requirements for folding and/or getting

1298

00:58:32,920 --> 00:58:29,600

the science done for such a large

1299

00:58:35,680 --> 00:58:32,930

optical telescope in for a telescope ok

1300

00:58:38,530 --> 00:58:35,690

I'm gonna have a Scott if you do up a

1301
00:58:39,610 --> 00:58:38,540
couple of Twitter ones for me because I

1302
00:58:40,750 --> 00:58:39,620
know there's a lot of things happening

1303
00:58:42,490 --> 00:58:40,760
on Twitter and you can share the screen

1304
00:58:45,160 --> 00:58:42,500
on that really good let me get Adams

1305
00:58:46,840 --> 00:58:45,170
synergies question out on the QA app

1306
00:58:49,450 --> 00:58:46,850
which i think is a good one to ask you

1307
00:58:52,480 --> 00:58:49,460
guys with such a complex deployment of

1308
00:58:54,970 --> 00:58:52,490
JWST is it stressful putting it all

1309
00:59:02,890 --> 00:58:54,980
together anyone had any bad dreams yet

1310
00:59:04,330 --> 00:59:02,900
about it all going I was going to say

1311
00:59:06,220 --> 00:59:04,340
that all I will say to John when the

1312
00:59:15,130 --> 00:59:06,230
program started has all these hair and

1313
00:59:18,550 --> 00:59:15,140

all these yes absolutely it's it's

1314

00:59:21,460 --> 00:59:18,560

stressful but it's a good kind of stress

1315

00:59:24,870 --> 00:59:21,470

everybody who's working the team is very

1316

00:59:30,550 --> 00:59:24,880

dedicated and the the stress is a

1317

00:59:33,280 --> 00:59:30,560

productive one in that ensures that

1318

00:59:37,570 --> 00:59:33,290

everybody checks and double-checks so

1319

00:59:40,390 --> 00:59:37,580

yes absolutely it's stressful but for

1320

00:59:42,550 --> 00:59:40,400

those of us on the team you know we all

1321

00:59:48,390 --> 00:59:42,560

have had to give us the ball we want to

1322

00:59:51,370 --> 00:59:48,400

make that shot so absolutely it is but

1323

00:59:52,660 --> 00:59:51,380

very hard to get in this position yes

1324

00:59:54,730 --> 00:59:52,670

and according to mark things are going

1325

00:59:56,170 --> 00:59:54,740

quite well so great job guys I'm really

1326

00:59:57,220 --> 00:59:56,180

I think I'm really excited

1327

00:59:59,170 --> 00:59:57,230

go ahead Albert who you want to comment

1328

01:00:00,580 --> 00:59:59,180

no I was gonna say that even must be I

1329

01:00:01,390 --> 01:00:00,590

was gonna ask mark actually it must be

1330

01:00:03,040 --> 01:00:01,400

stressful for him

1331

01:00:04,720 --> 01:00:03,050

as well as the scientists and because it

1332

01:00:06,190 --> 01:00:04,730

is for me for example because there's

1333

01:00:07,510 --> 01:00:06,200

always this tension between engineering

1334

01:00:09,760 --> 01:00:07,520

requirements and scientific requirements

1335

01:00:11,770 --> 01:00:09,770

that has to go on and on and on and so

1336

01:00:13,870 --> 01:00:11,780

you give up this much and you get back

1337

01:00:14,890 --> 01:00:13,880

this other much so the stress for the

1338

01:00:15,970 --> 01:00:14,900

scientist is a little different than

1339

01:00:16,480 --> 01:00:15,980

bill and telescope but it's very

1340

01:00:17,680 --> 01:00:16,490

stressful

1341

01:00:21,850 --> 01:00:17,690

I think the stress for the scientists

1342

01:00:22,960 --> 01:00:21,860

will increase tenfold after after the

1343

01:00:25,960 --> 01:00:22,970

telescope is actually becomes

1344

01:00:29,080 --> 01:00:25,970

operational to see actually what how how

1345

01:00:33,610 --> 01:00:29,090

will how it will really operate and what

1346

01:00:34,960 --> 01:00:33,620

what it will deliver great okay so Scott

1347

01:00:38,740 --> 01:00:34,970

do you have anything from Twitter thank

1348

01:00:40,270 --> 01:00:38,750

you guys by the way hang out Hubble hang

1349

01:00:46,720 --> 01:00:40,280

on hashtag is really doing well so thank

1350

01:00:50,800 --> 01:00:48,940

who's master physicists from Columbia I

1351
01:00:53,440 --> 01:00:50,810
was responding to one of the tweets out

1352
01:00:54,850 --> 01:00:53,450
there that with NASA what telescope my

1353
01:00:57,310 --> 01:00:54,860
scope wants to science all the time

1354
01:00:57,670 --> 01:00:57,320
science all the time science all the

1355
01:01:01,000 --> 01:00:57,680
time

1356
01:01:03,130 --> 01:01:01,010
Oh anything Scott just looks for excuses

1357
01:01:05,710 --> 01:01:03,140
to sing hey it's what I do

1358
01:01:09,420 --> 01:01:05,720
that's why I Drive the Internet I join

1359
01:01:11,710 --> 01:01:09,430
what your hands to go with it um

1360
01:01:13,780 --> 01:01:11,720
Alessandro Barsanti says I can't wait to

1361
01:01:16,030 --> 01:01:13,790
understand exoplanets more with NASA

1362
01:01:18,580 --> 01:01:16,040
Webb telescope can we break it down into

1363
01:01:21,250 --> 01:01:18,590

six words so I don't know if you guys

1364

01:01:23,770 --> 01:01:21,260

are familiar with six words it's trying

1365

01:01:26,080 --> 01:01:23,780

to break down a concept my attempt at it

1366

01:01:28,560 --> 01:01:26,090

was might find other Earth's out there

1367

01:01:32,590 --> 01:01:28,570

do you guys want to give a try at

1368

01:01:35,350 --> 01:01:32,600

exoplanets in six words exoplanet at six

1369

01:01:42,840 --> 01:01:35,360

words so you didn't know you'd be tested

1370

01:01:58,180 --> 01:01:56,470

now there we go awesome and there yeah

1371

01:02:00,250 --> 01:01:58,190

there's been a lot of great activity

1372

01:02:02,560 --> 01:02:00,260

with the Hubble hangout hashtag from all

1373

01:02:04,390 --> 01:02:02,570

over the place questions and comments

1374

01:02:05,530 --> 01:02:04,400

you guys have been awesome yeah thank

1375

01:02:06,720 --> 01:02:05,540

you guys for getting on Twitter we

1376

01:02:09,280 --> 01:02:06,730

appreciate it it's usually been the

1377

01:02:11,860 --> 01:02:09,290

you've been the the light spot in our

1378

01:02:14,860 --> 01:02:11,870

conversation with you guys also lots of

1379

01:02:15,340 --> 01:02:14,870

comments and questions on the various so

1380

01:02:17,230 --> 01:02:15,350

social for me

1381

01:02:18,610 --> 01:02:17,240

channels I was looking at unfortunately

1382

01:02:20,530 --> 01:02:18,620

we're out of time and I have to let

1383

01:02:21,760 --> 01:02:20,540

these guys go you guys gonna come back

1384

01:02:26,350 --> 01:02:21,770

and give us another update in the future

1385

01:02:27,850 --> 01:02:26,360

oh yeah till 2018 I know well I just saw

1386

01:02:31,350 --> 01:02:27,860

the next test right Jonathan um if

1387

01:02:33,550 --> 01:02:31,360

you're gonna be like my damn artists

1388

01:02:37,570 --> 01:02:33,560

mark was sometimes a Goddard you're

1389

01:02:38,470 --> 01:02:37,580

gonna let us do a hangout right people I

1390

01:02:40,090 --> 01:02:38,480

mean I got to tell you this is

1391

01:02:42,160 --> 01:02:40,100

generating a lot of interest this is one

1392

01:02:43,810 --> 01:02:42,170

of the most viewed hangouts we've done

1393

01:02:48,820 --> 01:02:43,820

so far so I want to thank you all very

1394

01:02:54,690 --> 01:02:48,830

much and I guess we'll stop there that's