
HUBBLE
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HUBBLE
hangouts
Hubble Hangouts Live at AAS 225
Starshade Update
Monday, Jan 4, 2014, 1:30pm PST, 9:30 UT, 10:30 CET

1
00:00:10,669 --> 00:00:07,430
let me know when you see alive Hubble

2
00:00:14,089 --> 00:00:10,679
hang out and help hello everybody and

3
00:00:16,070 --> 00:00:14,099
welcome to the 225th meeting of the

4
00:00:17,390 --> 00:00:16,080
american astronomical society my name is

5
00:00:19,400 --> 00:00:17,400
Tony Darnell I work at the Space

6
00:00:21,200 --> 00:00:19,410
Telescope Science Institute and we are

7
00:00:23,480 --> 00:00:21,210
here at the northrop grumman booth in

8
00:00:26,179 --> 00:00:23,490
the exhibit hall to talk about a really

9
00:00:29,089 --> 00:00:26,189
cool project called star shape and with

10
00:00:30,830 --> 00:00:29,099
me as I again after a long time is my

11
00:00:32,150 --> 00:00:30,840
old friend Alberto continent this

12
00:00:33,290 --> 00:00:32,160
awkward thing going with the microphone

13
00:00:34,880 --> 00:00:33,300

I'm going to have to give it back and

14
00:00:36,920 --> 00:00:34,890
forth to him in a min i'm going to let

15
00:00:38,720 --> 00:00:36,930
him speak to us but first interact with

16
00:00:42,170 --> 00:00:38,730
us send us questions talk to us on

17
00:00:43,670 --> 00:00:42,180
Twitter Facebook and G+ as well as the

18
00:00:45,680 --> 00:00:43,680
YouTube page from which this is being

19
00:00:47,389 --> 00:00:45,690
broadcast this is on our Hubble site

20
00:00:49,459 --> 00:00:47,399
channel we're looking at your comments

21
00:00:51,529 --> 00:00:49,469
if you use the hashtag Hubble hang out

22
00:00:54,910 --> 00:00:51,539
we will see that on Twitter and I've got

23
00:00:57,319 --> 00:00:54,920
lots of people looking up for those of

24
00:00:59,660 --> 00:00:57,329
tweets from you as well as the comments

25
00:01:01,279 --> 00:00:59,670
on g+ and facebook so ask us questions

26
00:01:02,569 --> 00:01:01,289
about starshade we're gonna you don't

27
00:01:04,219 --> 00:01:02,579
know what it is we're going to find out

28
00:01:05,119 --> 00:01:04,229
so I got I got people here from Northrop

29
00:01:08,149 --> 00:01:05,129
Grumman to tell us but before I

30
00:01:10,670 --> 00:01:08,159
introduce them Alberto it's good to see

31
00:01:12,920 --> 00:01:10,680
you again after do this which is a lock

32
00:01:15,020 --> 00:01:12,930
what is it I have to wait to respond to

33
00:01:16,100 --> 00:01:15,030
you it's good to see you again we

34
00:01:19,070 --> 00:01:16,110
haven't be we haven't seen each other

35
00:01:20,690 --> 00:01:19,080
for quite some time actually here and so

36
00:01:23,539 --> 00:01:20,700
this is actually routine for us so we

37
00:01:24,620 --> 00:01:23,549
should do this often the old days so

38
00:01:25,820 --> 00:01:24,630

we're going to do this I wanted to

39
00:01:28,010 --> 00:01:25,830
mention we can do this throughout the

40
00:01:29,870 --> 00:01:28,020
week so you're going to do it half and

41
00:01:31,670 --> 00:01:29,880
half at the North three booths and half

42
00:01:32,899 --> 00:01:31,680
at the space let's go booth which is

43
00:01:34,399 --> 00:01:32,909
fantastic so we're going to talk about

44
00:01:36,170 --> 00:01:34,409
lots of topic start is just the

45
00:01:37,520 --> 00:01:36,180
first one we have great people here for

46
00:01:40,580 --> 00:01:37,530
a new program to tell you exactly what

47
00:01:43,700 --> 00:01:40,590
they are and well they leave it up to

48
00:01:45,230 --> 00:01:43,710
you let's let's get it on so I'm glad so

49
00:01:46,370 --> 00:01:45,240
you tell people what you're doing a

50
00:01:47,960 --> 00:01:46,380
northrop though i don't think people

51
00:01:50,120 --> 00:01:47,970
know what you do you left this institute

52
00:01:51,859 --> 00:01:50,130
to do what are you doing now little

53
00:01:53,990 --> 00:01:51,869
strange title i'm an innovation manager

54
00:01:55,550 --> 00:01:54,000
for civil air and spaces so i work in

55
00:01:58,340 --> 00:01:55,560
the business development organization so

56
00:01:59,630 --> 00:01:58,350
i have in my portfolio things like jwst

57
00:02:01,370 --> 00:01:59,640
which I support I can continue to

58
00:02:03,319 --> 00:02:01,380
support but also things like we're going

59
00:02:05,330 --> 00:02:03,329
to talk about today star shades and

60
00:02:07,130 --> 00:02:05,340
maybe next generation flagship so it's a

61
00:02:10,249 --> 00:02:07,140
very very trusting job very very hectic

62
00:02:12,680 --> 00:02:10,259
and it's love it yeah well we miss you

63
00:02:13,710 --> 00:02:12,690

at the Institute that's for sure so okay

64
00:02:15,780 --> 00:02:13,720
let's get to let's get to the

65
00:02:17,250 --> 00:02:15,790
just get to the me oh one more thing if

66
00:02:18,840 --> 00:02:17,260
you want to keep track of where we're

67
00:02:20,340 --> 00:02:18,850
going on what what hangouts are coming

68
00:02:21,990 --> 00:02:20,350
next the best way to do that is to

69
00:02:24,540 --> 00:02:22,000
follow our Facebook page Hubble

70
00:02:27,960 --> 00:02:24,550
telescope also follow Hubble NASA Hubble

71
00:02:29,910 --> 00:02:27,970
he'll be tweeting on that as well as I'd

72
00:02:30,960 --> 00:02:29,920
be posting the events on google+ so

73
00:02:32,850 --> 00:02:30,970
that's how you're going to know which

74
00:02:34,230 --> 00:02:32,860
hangouts are coming up next all the ones

75
00:02:35,700 --> 00:02:34,240
for today are already posted we have a

76
00:02:38,280 --> 00:02:35,710
whole nother slew of them planned

77
00:02:39,690 --> 00:02:38,290
tomorrow so ok let me get to our guests

78
00:02:41,610 --> 00:02:39,700
I have with me an astronomer from

79
00:02:44,520 --> 00:02:41,620
Northrop Grumman his his name's Ron

80
00:02:46,620 --> 00:02:44,530
politan I had to look at your I'm so bad

81
00:02:47,790 --> 00:02:46,630
at names he is an astronomer at Northrop

82
00:02:49,920 --> 00:02:47,800
Grumman welcome so I tell us a little

83
00:02:52,020 --> 00:02:49,930
about what you're doing I'm the science

84
00:02:54,270 --> 00:02:52,030
manager for Northrop Grumman and with

85
00:02:55,920 --> 00:02:54,280
regard to star shades I've been there

86
00:02:57,570 --> 00:02:55,930
since the beginning when about 10 years

87
00:02:59,610 --> 00:02:57,580
ago when the concept first came into

88
00:03:01,620 --> 00:02:59,620

being we did some stuff with the

89
00:03:03,690 --> 00:03:01,630
university of colorado and what resulted

90
00:03:05,940 --> 00:03:03,700
from that was this concept of a star

91
00:03:07,410 --> 00:03:05,950
shade awesome and also with me and Steve

92
00:03:09,570 --> 00:03:07,420
Warrick he's an engineer building the

93
00:03:10,740 --> 00:03:09,580
thing I see hey how you doing tell us a

94
00:03:12,030 --> 00:03:10,750
little about what what you're doing so

95
00:03:14,460 --> 00:03:12,040
most of what we're doing at the moment

96
00:03:17,490 --> 00:03:14,470
is testing the optics of the starshade

97
00:03:19,770 --> 00:03:17,500
seeing how the starshade does what it's

98
00:03:21,420 --> 00:03:19,780
supposed to do which is to block out the

99
00:03:24,600 --> 00:03:21,430
light of a star so that we can see the

100
00:03:26,610 --> 00:03:24,610
light from a planet an exoplanet well

101
00:03:27,750 --> 00:03:26,620
welcome to both of you from to our to

102
00:03:28,650 --> 00:03:27,760
our Hubble hang on I appreciate this

103
00:03:31,080 --> 00:03:28,660
even though we're talking about

104
00:03:33,030 --> 00:03:31,090
starshade it is it is in fact the hub

105
00:03:34,140 --> 00:03:33,040
will hang out so so Ron let me get back

106
00:03:35,940 --> 00:03:34,150
to you a little bit tell us tell

107
00:03:37,620 --> 00:03:35,950
everybody what this thing is what are

108
00:03:39,390 --> 00:03:37,630
you doing what is starshade and what are

109
00:03:42,030 --> 00:03:39,400
you hoping to accomplish with it only

110
00:03:43,550 --> 00:03:42,040
the big issue with seeing exoplanets

111
00:03:46,410 --> 00:03:43,560
these are planets that are round stars

112
00:03:47,940 --> 00:03:46,420
outside the solar system planets are

113
00:03:49,710 --> 00:03:47,950

very faint stars very bright so

114
00:03:51,690 --> 00:03:49,720
astronomers have been struggling for a

115
00:03:53,670 --> 00:03:51,700
long time with how to suppress that

116
00:03:56,400 --> 00:03:53,680
starlight and then see the planets

117
00:03:58,229 --> 00:03:56,410
around it about 10 years ago we came up

118
00:03:59,130 --> 00:03:58,239
with this concept for something that's

119
00:04:01,350 --> 00:03:59,140
very different from the traditional

120
00:04:04,530 --> 00:04:01,360
approach which is to build an instrument

121
00:04:06,420 --> 00:04:04,540
and put it inside the telescope and get

122
00:04:08,430 --> 00:04:06,430
rid of the Starlight through some sort

123
00:04:10,580 --> 00:04:08,440
of internal thing this is a device

124
00:04:13,770 --> 00:04:10,590
that's fairly large but it flies outside

125
00:04:17,190 --> 00:04:13,780
the telescope and it blocks the light

126
00:04:18,900 --> 00:04:17,200
from entering the telescope and allows

127
00:04:20,670 --> 00:04:18,910
the planet to come through unencumbered

128
00:04:22,620 --> 00:04:20,680
so it's sort of like putting your thumb

129
00:04:24,220 --> 00:04:22,630
in front of a bright light to block out

130
00:04:26,080 --> 00:04:24,230
the light so you can see what around it

131
00:04:30,880 --> 00:04:26,090
so yes like that and so this is just a

132
00:04:34,390 --> 00:04:30,890
very special unusually shaped thumb I'll

133
00:04:36,370 --> 00:04:34,400
say looks like a daisy with petals and

134
00:04:39,190 --> 00:04:36,380
such and that's a mathematical design

135
00:04:41,410 --> 00:04:39,200
that allows this this spot that it

136
00:04:43,420 --> 00:04:41,420
creates to be very very deep and very

137
00:04:45,160 --> 00:04:43,430
dark and so think of it as a traveling

138
00:04:46,330 --> 00:04:45,170

dark spot okay well that's a really

139
00:04:47,890 --> 00:04:46,340
interesting concept I mean a lot of

140
00:04:50,620 --> 00:04:47,900
times I know what you're saying about

141
00:04:52,270 --> 00:04:50,630
sometimes they have telescope tubes or

142
00:04:54,370 --> 00:04:52,280
optical assemblies we'll put something

143
00:04:56,320 --> 00:04:54,380
called in a culture in the light path to

144
00:04:58,090 --> 00:04:56,330
kind of block out just a little disk

145
00:04:59,800 --> 00:04:58,100
usually it's a cone shape or something

146
00:05:01,800 --> 00:04:59,810
like that it just sort of blocks out the

147
00:05:04,210 --> 00:05:01,810
bright spot of this the bright star

148
00:05:05,410 --> 00:05:04,220
solar telescopes have these all over the

149
00:05:07,030 --> 00:05:05,420
place to block out the disk of the Sun

150
00:05:10,510 --> 00:05:07,040
so they can see the limb and also the

151
00:05:12,430 --> 00:05:10,520
solar corona so the stars because is it

152
00:05:14,620 --> 00:05:12,440
because the stars are so far away that

153
00:05:17,890 --> 00:05:14,630
the planets are I mean you can still

154
00:05:19,570 --> 00:05:17,900
resolve even at say dozens of

155
00:05:20,650 --> 00:05:19,580
light-years planets that might be an

156
00:05:23,020 --> 00:05:20,660
orbit around a star with the light

157
00:05:24,760 --> 00:05:23,030
blocked yes I mean the big issue and it

158
00:05:28,930 --> 00:05:24,770
is a hard thing to do it's basically

159
00:05:31,120 --> 00:05:28,940
like trying to image a firefly a few

160
00:05:34,720 --> 00:05:31,130
centimeters from a searchlight so it is

161
00:05:36,430 --> 00:05:34,730
a very very difficult thing to do but

162
00:05:38,380 --> 00:05:36,440
yes with a large enough telescope and

163
00:05:40,000 --> 00:05:38,390

with something that could block out this

164
00:05:42,340 --> 00:05:40,010
light the plants are going to be

165
00:05:43,870 --> 00:05:42,350
observable so Steve let me get you in on

166
00:05:46,270 --> 00:05:43,880
this so have we started building it yet

167
00:05:48,310 --> 00:05:46,280
and no way it not the space version at

168
00:05:50,410 --> 00:05:48,320
least we've been we've been doing some

169
00:05:53,260 --> 00:05:50,420
testing on the ground and what we're

170
00:05:55,180 --> 00:05:53,270
doing there is we're taking a light

171
00:05:56,560 --> 00:05:55,190
source out to the desert we got a nice

172
00:05:58,840 --> 00:05:56,570
picture here there's a light source

173
00:06:04,120 --> 00:05:58,850
overruns head over there telescope in

174
00:06:05,470 --> 00:06:04,130
here and what we're doing is is is we're

175
00:06:08,470 --> 00:06:05,480
using this bright light source to

176
00:06:10,000 --> 00:06:08,480
simulate a a star and we've got some

177
00:06:12,190 --> 00:06:10,010
other little light sources that simulate

178
00:06:14,950 --> 00:06:12,200
in the planet we put a star shade which

179
00:06:17,140 --> 00:06:14,960
is you know about that big a one-percent

180
00:06:19,900 --> 00:06:17,150
scale starshade something like that in

181
00:06:22,240 --> 00:06:19,910
between the bright source and the and

182
00:06:24,010 --> 00:06:22,250
the telescope and and we're checking our

183
00:06:26,350 --> 00:06:24,020
imaging with that and we're showing that

184
00:06:29,140 --> 00:06:26,360
the computer models that we have for how

185
00:06:31,660 --> 00:06:29,150
the optics we'll work our are very

186
00:06:33,100 --> 00:06:31,670
similar to what we're able to to collect

187
00:06:36,040 --> 00:06:33,110
the images we were able to collect in

188
00:06:37,360 --> 00:06:36,050

the desert ok so so we've got a

189
00:06:40,480 --> 00:06:37,370
proof-of-concept essentially

190
00:06:42,460 --> 00:06:40,490
already built yes absolutely so and one

191
00:06:44,110 --> 00:06:42,470
of the things with the sausage was as

192
00:06:46,750 --> 00:06:44,120
Ron mentioned the the very specific

193
00:06:49,390 --> 00:06:46,760
shape of it and we're trying to suppress

194
00:06:51,280 --> 00:06:49,400
the Starlight to 10 to the 10 and that's

195
00:06:53,170 --> 00:06:51,290
a really difficult number ten to the six

196
00:06:55,719 --> 00:06:53,180
would be relatively easy 10 to the 10

197
00:06:57,790 --> 00:06:55,729
gets really quite hard so there's a lot

198
00:06:59,980 --> 00:06:57,800
of questions about whether the model is

199
00:07:02,379 --> 00:06:59,990
is going to be accurate the optical

200
00:07:04,240 --> 00:07:02,389
model is accurate at that level so and

201
00:07:06,790 --> 00:07:04,250
there's some possible different shapes

202
00:07:08,260 --> 00:07:06,800
you can use there's the issue of when

203
00:07:10,629 --> 00:07:08,270
you build this thing and you fly it in

204
00:07:12,760 --> 00:07:10,639
space can you control the shape to the

205
00:07:14,170 --> 00:07:12,770
the accuracy you need so we've been

206
00:07:15,670 --> 00:07:14,180
doing some testing with what happens

207
00:07:18,159 --> 00:07:15,680
when the the shape isn't quite perfect

208
00:07:20,620 --> 00:07:18,169
and and you start distorting the shape

209
00:07:22,659 --> 00:07:20,630
does that affect the results are you're

210
00:07:24,370 --> 00:07:22,669
going to be able to get so you tested

211
00:07:25,779 --> 00:07:24,380
this on the ground and you said it works

212
00:07:28,270 --> 00:07:25,789
were you able to see anything and you

213
00:07:29,710 --> 00:07:28,280

pee on any planet so when we're testing

214
00:07:33,640 --> 00:07:29,720
on the ground we're looking at these

215
00:07:36,820 --> 00:07:33,650
LEDs and so what we were simulating a

216
00:07:40,270 --> 00:07:36,830
system it's not it's not it's not a it's

217
00:07:41,920 --> 00:07:40,280
not quite the right scale for what you

218
00:07:43,240 --> 00:07:41,930
would be looking at yeah I misunderstood

219
00:07:45,219 --> 00:07:43,250
what you said about the test day okay

220
00:07:47,950 --> 00:07:45,229
your door you were using LEDs to do that

221
00:07:50,170 --> 00:07:47,960
not actual stars correct yeah yeah so

222
00:07:52,900 --> 00:07:50,180
okay so I didn't hear that part

223
00:07:55,120 --> 00:07:52,910
certainly we saw the LEDs like we

224
00:07:57,100 --> 00:07:55,130
expected to see them so the whole point

225
00:07:58,300 --> 00:07:57,110
here is because this is a new concept

226
00:08:00,070 --> 00:07:58,310
this is something that hasn't been

227
00:08:02,110 --> 00:08:00,080
around for generations it's something

228
00:08:04,210 --> 00:08:02,120
that really came into being on two

229
00:08:06,700 --> 00:08:04,220
thousand four and five there's a lot of

230
00:08:09,400 --> 00:08:06,710
basic understanding that we need until

231
00:08:11,430 --> 00:08:09,410
these tests in the desert that Steve

232
00:08:14,620 --> 00:08:11,440
talked about are essential to start

233
00:08:16,210 --> 00:08:14,630
saying if we model this this is what we

234
00:08:17,980 --> 00:08:16,220
think we should see and then we go out

235
00:08:19,510 --> 00:08:17,990
and empirically see is this what we see

236
00:08:21,250 --> 00:08:19,520
and then through those sorts of things

237
00:08:24,100 --> 00:08:21,260
like Steve said with putting in

238
00:08:25,870 --> 00:08:24,110

artificial distortions if I can put in a

239
00:08:27,820 --> 00:08:25,880
distortion and predict what I'm going to

240
00:08:29,589 --> 00:08:27,830
see then obviously I know more about

241
00:08:31,240 --> 00:08:29,599
this and if I put in something I get

242
00:08:33,310 --> 00:08:31,250
something completely different and so

243
00:08:35,589 --> 00:08:33,320
this is a very methodical process to go

244
00:08:38,469 --> 00:08:35,599
through and understand this optic

245
00:08:40,360 --> 00:08:38,479
because it is an optic and how performs

246
00:08:42,339 --> 00:08:40,370
what are the things that are tight

247
00:08:44,380 --> 00:08:42,349
tolerances what are the things that are

248
00:08:46,660 --> 00:08:44,390
not very much oh and here we go this is

249
00:08:49,150 --> 00:08:46,670
this is we have a model thank you this

250
00:08:51,430 --> 00:08:49,160
is what they look like in general

251
00:08:53,619 --> 00:08:51,440
as I was going to just reiterate one

252
00:08:55,329 --> 00:08:53,629
thing as Steve will show you in a second

253
00:08:57,009 --> 00:08:55,339
describe the starshade I want to go back

254
00:08:58,660 --> 00:08:57,019
to what the size of the problem really

255
00:09:00,509 --> 00:08:58,670
is what are we trying to do right you're

256
00:09:04,240 --> 00:09:00,519
trying to find an earth-like planet

257
00:09:06,069 --> 00:09:04,250
around a star okay and the planet is 10

258
00:09:08,499 --> 00:09:06,079
billion times fainter than the parent

259
00:09:11,769 --> 00:09:08,509
star so you're putting your your thumb

260
00:09:13,360 --> 00:09:11,779
up there on top of it so in virtually on

261
00:09:15,460 --> 00:09:13,370
top of its of the very little separation

262
00:09:17,470 --> 00:09:15,470
so that's the heart of problem and so

263
00:09:20,619 --> 00:09:17,480

the shape is actually very meaningful so

264
00:09:22,119 --> 00:09:20,629
I'm gonna it's very pretty I like it

265
00:09:23,800 --> 00:09:22,129
yeah but it's all black you need to add

266
00:09:27,460 --> 00:09:23,810
colors and maybe a little smiley face on

267
00:09:28,389 --> 00:09:27,470
there and that'll be all right tell us a

268
00:09:30,699 --> 00:09:28,399
little bit more about what you hold out

269
00:09:32,710 --> 00:09:30,709
okay so what I'm holding here is in one

270
00:09:34,240 --> 00:09:32,720
of the samples that we we test in the

271
00:09:36,910 --> 00:09:34,250
desert and and and as I mentioned

272
00:09:38,949 --> 00:09:36,920
earlier this shape is is critical to

273
00:09:41,769 --> 00:09:38,959
reach in that kind of suppression that

274
00:09:44,769 --> 00:09:41,779
we were looking for and we also have

275
00:09:45,939 --> 00:09:44,779
just as shown how it worked tested with

276
00:09:48,100 --> 00:09:45,949
a dish because it's about the same size

277
00:09:50,170 --> 00:09:48,110
but for completely circular and what we

278
00:09:53,019 --> 00:09:50,180
see with the disc is that you get as we

279
00:09:55,600 --> 00:09:53,029
expected a bright ring of diffracted

280
00:09:57,790 --> 00:09:55,610
light from the from the main LED coming

281
00:09:59,259 --> 00:09:57,800
around there and that's just natural

282
00:10:00,309 --> 00:09:59,269
behavior of light going through anything

283
00:10:01,870 --> 00:10:00,319
what tell us a little bit about a

284
00:10:04,600 --> 00:10:01,880
fraction so different' is the way that

285
00:10:06,730 --> 00:10:04,610
land light bends around or in fact any

286
00:10:08,230 --> 00:10:06,740
wave then bends around the surface in

287
00:10:11,410 --> 00:10:08,240
this case we're talking about light and

288
00:10:12,910 --> 00:10:11,420

when we've got a surface that is is at

289
00:10:15,069 --> 00:10:12,920
right angles to the light beam then it

290
00:10:16,600 --> 00:10:15,079
will bend around it what's going on here

291
00:10:18,999 --> 00:10:16,610
is we're getting that same diffraction

292
00:10:22,360 --> 00:10:19,009
but with this this petal shape we're

293
00:10:24,069 --> 00:10:22,370
canceling out the diffraction rings so

294
00:10:27,220 --> 00:10:24,079
that we wind up with a much a little

295
00:10:28,900 --> 00:10:27,230
lower so that we can sit where we get

296
00:10:31,569 --> 00:10:28,910
we're canceling out the diffraction from

297
00:10:33,519 --> 00:10:31,579
different radii along a pebble so that

298
00:10:35,530 --> 00:10:33,529
we get a much darker spot than we would

299
00:10:36,999 --> 00:10:35,540
with just a disc that was out in front

300
00:10:38,290 --> 00:10:37,009
of so it was just one of the beauties of

301
00:10:40,829 --> 00:10:38,300
science that it turned out to be the

302
00:10:43,600 --> 00:10:40,839
shape it did that that's exactly right

303
00:10:44,620 --> 00:10:43,610
okay so triangle shape yeah so the

304
00:10:45,699 --> 00:10:44,630
differentially she's talking about if

305
00:10:47,650 --> 00:10:45,709
you ever look at a star through a

306
00:10:50,019 --> 00:10:47,660
telescope and the secondary mirror

307
00:10:51,309 --> 00:10:50,029
sometimes you can see little rings that

308
00:10:52,389 --> 00:10:51,319
they come around and that's what they're

309
00:10:54,549 --> 00:10:52,399
talking about canceling it now and that

310
00:10:56,530 --> 00:10:54,559
can prevent you from seeing really close

311
00:10:58,179 --> 00:10:56,540
planets right near the star so you want

312
00:11:00,879 --> 00:10:58,189
to get rid of that as much as you can so

313
00:11:03,280 --> 00:11:00,889

run why space can we do this on the

314
00:11:05,350 --> 00:11:03,290
ground I mean the problem will start

315
00:11:07,420 --> 00:11:05,360
is that while it's a very efficient way

316
00:11:10,389 --> 00:11:07,430
to operate it's a very large baseline

317
00:11:11,650 --> 00:11:10,399
and so even in our desert test what do

318
00:11:14,530 --> 00:11:11,660
you mean long long baseline I the

319
00:11:17,889 --> 00:11:14,540
distance between other telescope and the

320
00:11:20,199 --> 00:11:17,899
starshade has to be very large compared

321
00:11:22,180 --> 00:11:20,209
to the size of either so for example in

322
00:11:24,189 --> 00:11:22,190
the desert it's a couple of kilometers

323
00:11:26,110 --> 00:11:24,199
different distance between the starshade

324
00:11:27,579 --> 00:11:26,120
and the camera so this was sitting a

325
00:11:29,199 --> 00:11:27,589
couple of kilometers away from the

326
00:11:30,579 --> 00:11:29,209
telescope you were testing right and so

327
00:11:32,110 --> 00:11:30,589
in space because we're dealing with

328
00:11:34,960 --> 00:11:32,120
bigger telescopes and bigger things

329
00:11:38,170 --> 00:11:34,970
you're talking about a 30 to 60 meter

330
00:11:40,240 --> 00:11:38,180
diameter starshade tens of thousands of

331
00:11:42,189 --> 00:11:40,250
kilometers in front of a telescope so

332
00:11:44,650 --> 00:11:42,199
it's a very long arm that is holding

333
00:11:46,660 --> 00:11:44,660
that thumb and so they're they're

334
00:11:49,780 --> 00:11:46,670
independent they're they're traveling

335
00:11:51,430 --> 00:11:49,790
together so its formation flying but one

336
00:11:53,499 --> 00:11:51,440
that's relatively straightforward and

337
00:11:56,259 --> 00:11:53,509
that's what allows us to have the really

338
00:11:59,050 --> 00:11:56,269

small spot so we can cover the star but

339
00:12:00,999 --> 00:11:59,060
not cover the planet ok so we haven't

340
00:12:03,069 --> 00:12:01,009
you've tested it but we haven't actually

341
00:12:05,769 --> 00:12:03,079
started building this yet correct known

342
00:12:08,290 --> 00:12:05,779
as a space mission no I mean it's pretty

343
00:12:10,860 --> 00:12:08,300
critical that we know exactly how this

344
00:12:14,439 --> 00:12:10,870
works before we go spending you know

345
00:12:16,600 --> 00:12:14,449
government money so this is but we have

346
00:12:18,519 --> 00:12:16,610
begun testing components because in

347
00:12:21,430 --> 00:12:18,529
parallel to the desert test with their

348
00:12:23,170 --> 00:12:21,440
testing the optics are we and people at

349
00:12:25,329 --> 00:12:23,180
JPL and other people in community are

350
00:12:27,129 --> 00:12:25,339
testing other aspects of this how would

351
00:12:29,350 --> 00:12:27,139
we build it how would we deploy it what

352
00:12:31,629 --> 00:12:29,360
materials should be involved so those

353
00:12:33,220 --> 00:12:31,639
are going on in parallel they're not at

354
00:12:36,430 --> 00:12:33,230
the level right now where we would be

355
00:12:37,990 --> 00:12:36,440
using space equivalent hardware but it's

356
00:12:41,680 --> 00:12:38,000
the first stages like with the optical

357
00:12:43,540 --> 00:12:41,690
testing of testing how in some number of

358
00:12:45,910 --> 00:12:43,550
years will we actually build this to fly

359
00:12:48,879 --> 00:12:45,920
in space I wanted to go back to what

360
00:12:52,059 --> 00:12:48,889
something that Rhonda said which is not

361
00:12:56,050 --> 00:12:52,069
only the distance between here is

362
00:12:57,910 --> 00:12:56,060
telephone that's right that's right so

363
00:12:59,290 --> 00:12:57,920

not only the distance between the

364
00:13:01,120 --> 00:12:59,300
telescope in the starshade has to be

365
00:13:02,319 --> 00:13:01,130
over 10,000 you know thousands of

366
00:13:04,059 --> 00:13:02,329
kilometers to ten thousands of

367
00:13:05,740 --> 00:13:04,069
kilometers but I should they shape the

368
00:13:07,329 --> 00:13:05,750
size of the starshade is also relevant

369
00:13:09,100 --> 00:13:07,339
you know so you know this is not these

370
00:13:11,800 --> 00:13:09,110
are not this is a clear model it's very

371
00:13:14,439 --> 00:13:11,810
small so maybe you know both you and Stu

372
00:13:16,000 --> 00:13:14,449
can tell give us an idea of how big you

373
00:13:17,180 --> 00:13:16,010
know with the task of B it was sorry

374
00:13:20,150 --> 00:13:17,190
with the starshade have to

375
00:13:22,580 --> 00:13:20,160
in order to act as this famous thumb

376
00:13:24,260 --> 00:13:22,590
yeah and also this is this is kind of

377
00:13:25,610 --> 00:13:24,270
solid material you're not going to make

378
00:13:28,880 --> 00:13:25,620
it out of solid material I don't think

379
00:13:30,820 --> 00:13:28,890
either right so now i'm at the right now

380
00:13:33,980 --> 00:13:30,830
we're looking at is something that is a

381
00:13:35,810 --> 00:13:33,990
membrane suspended between some sort of

382
00:13:36,830 --> 00:13:35,820
structure but that's part of what we're

383
00:13:38,950 --> 00:13:36,840
looking at is how we would go about

384
00:13:41,660 --> 00:13:38,960
doing this anything like the jwst

385
00:13:42,800 --> 00:13:41,670
essentials something very similar be sun

386
00:13:44,450 --> 00:13:42,810
shield and what are the one of the

387
00:13:45,710 --> 00:13:44,460
interesting aspects of this is that one

388
00:13:47,750 --> 00:13:45,720

of the cast we will be doing over the

389
00:13:49,820 --> 00:13:47,760
next couple years is if i have a

390
00:13:50,990 --> 00:13:49,830
membrane it's really light and therefore

391
00:13:54,560 --> 00:13:51,000
this thing doesn't have to weigh as much

392
00:13:57,170 --> 00:13:54,570
but um how transparent is it because

393
00:13:58,760 --> 00:13:57,180
even though you know if i look at a

394
00:14:01,460 --> 00:13:58,770
piece of mylar or whatever they would

395
00:14:03,770 --> 00:14:01,470
use it seems opaque as scheme said we're

396
00:14:06,770 --> 00:14:03,780
talking about one part in 10 to the 10

397
00:14:08,330 --> 00:14:06,780
billion oh no we need to make sure that

398
00:14:09,680 --> 00:14:08,340
it's actually opaque to that level so

399
00:14:15,650 --> 00:14:09,690
there's lots of interesting tests are

400
00:14:16,850 --> 00:14:15,660
going on okay so um Alberto I ok so so

401
00:14:17,750 --> 00:14:16,860
let's go back to the size of this so

402
00:14:19,730 --> 00:14:17,760
tell us a little about how big these

403
00:14:21,740 --> 00:14:19,740
things going to be so in the space

404
00:14:24,290 --> 00:14:21,750
application we've looked at everything

405
00:14:26,360 --> 00:14:24,300
from 30 metres up to about 80 meters and

406
00:14:27,910 --> 00:14:26,370
it depends very much on the telescope

407
00:14:30,140 --> 00:14:27,920
that you're working with the other

408
00:14:31,460 --> 00:14:30,150
obvious problem that you've got is there

409
00:14:33,230 --> 00:14:31,470
aren't many photons coming from the

410
00:14:35,540 --> 00:14:33,240
planets that we're trying to observe so

411
00:14:37,220 --> 00:14:35,550
you really want to get a large

412
00:14:38,780 --> 00:14:37,230
collecting area you make the telescope

413
00:14:41,120 --> 00:14:38,790

larger than the starshade has to be

414
00:14:43,760 --> 00:14:41,130
larger to be able to give the dark spot

415
00:14:48,380 --> 00:14:43,770
that surrounds the entire optics of your

416
00:14:51,170 --> 00:14:48,390
telescope so there's lots of discussion

417
00:14:52,490 --> 00:14:51,180
here / over the last weekend and I'm

418
00:14:55,130 --> 00:14:52,500
sure there will be further discussion

419
00:14:56,900 --> 00:14:55,140
about the next generation telescope the

420
00:14:58,460 --> 00:14:56,910
next next generation tal scale the one

421
00:15:01,430 --> 00:14:58,470
after James Webb and how big that will

422
00:15:03,079 --> 00:15:01,440
be if you've got a 8 meter optic or 10

423
00:15:06,230 --> 00:15:03,089
millimeter optic then the starshade

424
00:15:09,050 --> 00:15:06,240
should be around 80 meters diameter to

425
00:15:10,310 --> 00:15:09,060
be 80 meters 10 spot yeah we're going to

426
00:15:11,990 --> 00:15:10,320
have a hangout on the future of space

427
00:15:13,220 --> 00:15:12,000
telescopes to later this week I think so

428
00:15:15,890 --> 00:15:13,230
we'll how about we'll talk about that as

429
00:15:18,380 --> 00:15:15,900
well so does the telescope have to be

430
00:15:19,280 --> 00:15:18,390
built to your building the starshade now

431
00:15:20,960 --> 00:15:19,290
you're gonna be able to build in

432
00:15:22,730 --> 00:15:20,970
different sizes depending on you said

433
00:15:24,260 --> 00:15:22,740
the telescope that is used with but if I

434
00:15:26,000 --> 00:15:24,270
want to use a star shade on my telescope

435
00:15:27,620 --> 00:15:26,010
do I have to design my telescope to

436
00:15:29,480 --> 00:15:27,630
specifically be compatible with this is

437
00:15:30,370 --> 00:15:29,490
a require for example a certain field of

438
00:15:32,410 --> 00:15:30,380

view

439
00:15:35,590 --> 00:15:32,420
no really no I mean it will work with

440
00:15:36,700 --> 00:15:35,600
practically any generic Space Telescope

441
00:15:39,310 --> 00:15:36,710
because you know there's lots of those

442
00:15:41,200 --> 00:15:39,320
lying around but I'm gonna launch a CA

443
00:15:44,200 --> 00:15:41,210
that's what I'm gonna do you see a dura

444
00:15:46,270 --> 00:15:44,210
lx200 yeah yeah so it should work with

445
00:15:48,730 --> 00:15:46,280
practically any space telescope the only

446
00:15:50,050 --> 00:15:48,740
caveat to that is you need to know where

447
00:15:51,490 --> 00:15:50,060
the two things are you need to know

448
00:15:53,590 --> 00:15:51,500
where your star shape you've got to line

449
00:15:55,000 --> 00:15:53,600
them up yeah you're gonna line them up

450
00:15:56,200 --> 00:15:55,010
you're gonna know where your / it

451
00:15:58,720 --> 00:15:56,210
spacecraft is you're going to know where

452
00:16:01,210 --> 00:15:58,730
your telescope is so it's it the benefit

453
00:16:03,070 --> 00:16:01,220
is having a beacon on on your telescope

454
00:16:04,870 --> 00:16:03,080
so that you can you can detect where you

455
00:16:05,950 --> 00:16:04,880
are relative to each other oh that's an

456
00:16:08,770 --> 00:16:05,960
interesting point so how would that work

457
00:16:10,780 --> 00:16:08,780
Ronnie you got okay aspect of this is

458
00:16:12,970 --> 00:16:10,790
that um as I said this is a traveling

459
00:16:15,520 --> 00:16:12,980
bare spot that dark spot has a diameter

460
00:16:17,560 --> 00:16:15,530
so you also have to match your telescope

461
00:16:19,240 --> 00:16:17,570
that it needs to sit inside the dark

462
00:16:21,910 --> 00:16:19,250
spot we aren't really care where in the

463
00:16:24,700 --> 00:16:21,920

dark spot but if I have a dark spot that

464
00:16:26,110 --> 00:16:24,710
is let's say five meters across and I

465
00:16:27,700 --> 00:16:26,120
have a 10-meter telescope that's not

466
00:16:28,780 --> 00:16:27,710
going to help so I do got to keep these

467
00:16:30,310 --> 00:16:28,790
things in mind when I build my tell

468
00:16:33,040 --> 00:16:30,320
that's the only thing that it does

469
00:16:35,170 --> 00:16:33,050
require is that the telescope has to fit

470
00:16:37,960 --> 00:16:35,180
inside of our spot okay and adjust this

471
00:16:39,880 --> 00:16:37,970
to be the size that it's needed so if

472
00:16:41,740 --> 00:16:39,890
you have a four meter telescope I can

473
00:16:43,930 --> 00:16:41,750
give you a five or six meters shadow or

474
00:16:45,610 --> 00:16:43,940
if you have a 10 meter one I can give

475
00:16:48,460 --> 00:16:45,620
you a bigger one but that's that's where

476
00:16:49,870 --> 00:16:48,470
the scaling size comes in okay so you

477
00:16:51,910 --> 00:16:49,880
said it's a movable dark spot how do I

478
00:16:54,190 --> 00:16:51,920
move this thing it operates with

479
00:16:56,680 --> 00:16:54,200
propulsion more likely than not electric

480
00:17:00,700 --> 00:16:56,690
propulsion and I move it around the side

481
00:17:03,250 --> 00:17:00,710
to align services yeah like what like

482
00:17:06,550 --> 00:17:03,260
Rosetta right there well I Rosetta or

483
00:17:08,260 --> 00:17:06,560
dawn and must rely so those sorts of

484
00:17:10,000 --> 00:17:08,270
things so existing technology so you got

485
00:17:12,280 --> 00:17:10,010
to be patient to point this thing right

486
00:17:13,090 --> 00:17:12,290
i mean if you want to you want to end

487
00:17:14,829 --> 00:17:13,100
you're going to have to somehow

488
00:17:15,939 --> 00:17:14,839

coordinate that with your telescope it's

489
00:17:18,970 --> 00:17:15,949
going to have to all be linked together

490
00:17:21,250 --> 00:17:18,980
you're going to have to write and and

491
00:17:22,480 --> 00:17:21,260
you're going to need to be I want to now

492
00:17:24,939 --> 00:17:22,490
and look over here this part of this guy

493
00:17:26,500 --> 00:17:24,949
is going to take a while right and we

494
00:17:28,810 --> 00:17:26,510
look at essentially for traveling

495
00:17:30,220 --> 00:17:28,820
salesman problem is that we have a bunch

496
00:17:32,710 --> 00:17:30,230
of stars on sky that we want to look at

497
00:17:35,380 --> 00:17:32,720
and we can go from one to the next in

498
00:17:36,910 --> 00:17:35,390
some plan and then therefore optimize

499
00:17:38,740 --> 00:17:36,920
the time the nice thing about starshade

500
00:17:40,870 --> 00:17:38,750
since it doesn't require any special

501
00:17:41,830 --> 00:17:40,880
anything on the telescope that in

502
00:17:43,180 --> 00:17:41,840
between those

503
00:17:45,549 --> 00:17:43,190
listening the telescope can be doing

504
00:17:47,320 --> 00:17:45,559
other astrophysics so it's not one of

505
00:17:50,019 --> 00:17:47,330
these things where I'm dedicated to do

506
00:17:53,470 --> 00:17:50,029
this the throughput of the starshade is

507
00:17:55,960 --> 00:17:53,480
very high so when I do finally align I

508
00:17:57,850 --> 00:17:55,970
can get my data very quickly and then

509
00:18:01,210 --> 00:17:57,860
how that move on to the next one and so

510
00:18:04,390 --> 00:18:01,220
it becomes basically how energetic of an

511
00:18:06,130 --> 00:18:04,400
ion propulsion system you have and how

512
00:18:08,470 --> 00:18:06,140
far you are away and sort of stuff but

513
00:18:09,909 --> 00:18:08,480

what very doable and very much within

514
00:18:12,100 --> 00:18:09,919
giving you the right number of stars

515
00:18:13,779 --> 00:18:12,110
people would want to survey and that's

516
00:18:14,769 --> 00:18:13,789
awesome so see I don't know if this is

517
00:18:16,510 --> 00:18:14,779
your expertise enough I'd like to ask

518
00:18:17,799 --> 00:18:16,520
you a bit more about this ion drive key

519
00:18:21,220 --> 00:18:17,809
tell us what they're like how they work

520
00:18:24,820 --> 00:18:21,230
and so not my area of expertise but and

521
00:18:26,740 --> 00:18:24,830
you you are basically driving xenon gas

522
00:18:28,539 --> 00:18:26,750
out of the back of the thrusters and on

523
00:18:31,630 --> 00:18:28,549
Zenon depending on where which side is

524
00:18:35,950 --> 00:18:31,640
Atlantic Zenon Zenon Zenon alcoholism

525
00:18:37,450 --> 00:18:35,960
and and and that's you using electric

526
00:18:39,460 --> 00:18:37,460
propulsion to do that so you're

527
00:18:43,299 --> 00:18:39,470
basically charging the particles and

528
00:18:46,029 --> 00:18:43,309
using the charge between two plates to

529
00:18:48,460 --> 00:18:46,039
pull the the Zen on out the back of the

530
00:18:49,840 --> 00:18:48,470
thruster so is that the limiting factor

531
00:18:51,610 --> 00:18:49,850
of the lifetime of the starshade is how

532
00:18:54,960 --> 00:18:51,620
much gas you put in it that would

533
00:18:57,130 --> 00:18:54,970
definitely be part of it and it they

534
00:19:00,159 --> 00:18:57,140
because you were only able to look at

535
00:19:01,840 --> 00:19:00,169
planets and you've got a limit of how

536
00:19:03,279 --> 00:19:01,850
close you can look to the start because

537
00:19:05,169 --> 00:19:03,289
you know that's the size of the dark

538
00:19:07,120 --> 00:19:05,179

spot and we're talking of the order of

539
00:19:08,980 --> 00:19:07,130
100 milli arcseconds something like that

540
00:19:10,899 --> 00:19:08,990
maybe 60 milliseconds something like

541
00:19:13,720 --> 00:19:10,909
that so what that means is when you're

542
00:19:15,700 --> 00:19:13,730
looking for habitable zones you're only

543
00:19:18,639 --> 00:19:15,710
able to look at the nearest 200 or so

544
00:19:19,960 --> 00:19:18,649
stars may be 500 stars because once you

545
00:19:22,659 --> 00:19:19,970
start looking at stars that are further

546
00:19:24,220 --> 00:19:22,669
away than that then then the annular

547
00:19:27,340 --> 00:19:24,230
separation between the habitable zone

548
00:19:30,760 --> 00:19:27,350
and the and the and the star starts to

549
00:19:32,919 --> 00:19:30,770
be too small so yes it does have a

550
00:19:35,380 --> 00:19:32,929
lifetime at that lifetime is is based on

551
00:19:37,060 --> 00:19:35,390
fuel but your point would be that to

552
00:19:39,279 --> 00:19:37,070
design a mission that can in its

553
00:19:41,380 --> 00:19:39,289
lifetime get round the stars that that

554
00:19:44,860 --> 00:19:41,390
you give you the best chance of finding

555
00:19:46,870 --> 00:19:44,870
you know a earth-like planet in you know

556
00:19:50,529 --> 00:19:46,880
in our neighborhood ok he said habitable

557
00:19:52,490 --> 00:19:50,539
zone hey how little zone this is what

558
00:19:56,060 --> 00:19:52,500
has become sort of the

559
00:19:58,400 --> 00:19:56,070
standard measure and it's it's consider

560
00:20:00,830 --> 00:19:58,410
we believe that water is essential for

561
00:20:03,050 --> 00:20:00,840
life so the habitable zone is basically

562
00:20:05,030 --> 00:20:03,060
the area around a star where liquid

563
00:20:07,640 --> 00:20:05,040

water can exist on the surface of a

564
00:20:10,100 --> 00:20:07,650
planet so if you go too close to the Sun

565
00:20:12,050 --> 00:20:10,110
it gets real hot you evaporate all your

566
00:20:13,970 --> 00:20:12,060
water so you get things like a Mercury

567
00:20:16,640 --> 00:20:13,980
and Venus if you go too far from the Sun

568
00:20:18,800 --> 00:20:16,650
you get ice freezing of water freezing

569
00:20:20,750 --> 00:20:18,810
out and you get Mars and then Jupiter

570
00:20:23,390 --> 00:20:20,760
and beyond so there is a narrow region

571
00:20:24,920 --> 00:20:23,400
around every star in which the

572
00:20:26,570 --> 00:20:24,930
temperature is just right so it's also

573
00:20:29,060 --> 00:20:26,580
called the Goldilocks zone where it's

574
00:20:31,040 --> 00:20:29,070
not unfortunately it's not too cold it's

575
00:20:32,600 --> 00:20:31,050
just right and so that's what people are

576
00:20:34,010 --> 00:20:32,610
looking for yes and we've talked at

577
00:20:35,600 --> 00:20:34,020
length about why liquid water is

578
00:20:37,040 --> 00:20:35,610
important you may not think it's all

579
00:20:38,810 --> 00:20:37,050
that big a deal but liquid water is

580
00:20:40,400 --> 00:20:38,820
where we start because we know at least

581
00:20:43,100 --> 00:20:40,410
in the one spot where we know there is

582
00:20:44,480 --> 00:20:43,110
life it is vital so he looks may as well

583
00:20:46,160 --> 00:20:44,490
look for what we know works so that's

584
00:20:47,750 --> 00:20:46,170
why liquid liquid water has been so

585
00:20:49,430 --> 00:20:47,760
important in our search for life ishan

586
00:20:54,650 --> 00:20:49,440
says he's got some social media stuff

587
00:21:01,010 --> 00:20:54,660
going to tell us Daniel and Sato of

588
00:21:03,530 --> 00:21:01,020

Google+ wants to know how do you get the

589
00:21:04,550 --> 00:21:03,540
starshade and the telescope to orbit in

590
00:21:06,920 --> 00:21:04,560
sync when they're thousands of

591
00:21:09,290 --> 00:21:06,930
kilometers apart who wants that one and

592
00:21:11,840 --> 00:21:09,300
great question and you can't do that

593
00:21:13,940 --> 00:21:11,850
around us so your your your options are

594
00:21:16,340 --> 00:21:13,950
that you go to l2 which is where the

595
00:21:18,470 --> 00:21:16,350
James Webb Space Telescope is going a

596
00:21:20,630 --> 00:21:18,480
lot of other things it seems yeah and a

597
00:21:24,710 --> 00:21:20,640
lot of other things so then it so L 2

598
00:21:27,170 --> 00:21:24,720
that is a gravitational saddle that is

599
00:21:29,330 --> 00:21:27,180
in line with the the Sun and the earth

600
00:21:31,970 --> 00:21:29,340
and it's about a million miles beyond

601
00:21:33,830 --> 00:21:31,980
the Earth from the Sun and the gravity

602
00:21:37,250 --> 00:21:33,840
area there is pretty flat and so you

603
00:21:39,140 --> 00:21:37,260
your gravity difference between what's

604
00:21:41,420 --> 00:21:39,150
affecting the starshade spacecraft and

605
00:21:44,180 --> 00:21:41,430
your telescope spacecraft is very minor

606
00:21:46,370 --> 00:21:44,190
so you don't need that much fuel to hold

607
00:21:48,110 --> 00:21:46,380
the position between the two there's

608
00:21:49,760 --> 00:21:48,120
other options as well earth trailing

609
00:21:52,310 --> 00:21:49,770
orbits or if leading orbits would also

610
00:21:53,450 --> 00:21:52,320
give you a way of doing that really good

611
00:21:54,710 --> 00:21:53,460
question I was going to ask him myself

612
00:21:57,080 --> 00:21:54,720
but you got to it you got another winner

613
00:21:58,340 --> 00:21:57,090

is that it for now okay so keep keep on

614
00:22:02,900 --> 00:21:58,350
coming guys we're monitoring we got it

615
00:22:05,900 --> 00:22:02,910
we got you covered so I guess I get so

616
00:22:06,310 --> 00:22:05,910
the but we're in the planning stages now

617
00:22:08,590 --> 00:22:06,320
is

618
00:22:10,299 --> 00:22:08,600
they're some kind of and a presumably

619
00:22:12,549 --> 00:22:10,309
Northrop Grumman is building this thing

620
00:22:14,080 --> 00:22:12,559
for space at some point is there

621
00:22:17,190 --> 00:22:14,090
anything we're waiting on to get make

622
00:22:20,289 --> 00:22:17,200
further progress on this or is it is it

623
00:22:22,180 --> 00:22:20,299
I guess it's what what's what are we

624
00:22:24,730 --> 00:22:22,190
ready to move to the next phase we are

625
00:22:27,009 --> 00:22:24,740
moving to the next phase so the desert

626
00:22:29,129 --> 00:22:27,019
tests that we are in the process of

627
00:22:32,169 --> 00:22:29,139
doing and they're still more to do are

628
00:22:33,850 --> 00:22:32,179
establishing the optical properties so

629
00:22:35,110 --> 00:22:33,860
it's under we're understanding now what

630
00:22:37,659 --> 00:22:35,120
our tolerances are we're getting

631
00:22:39,970 --> 00:22:37,669
empirical measures of theoretical

632
00:22:41,950 --> 00:22:39,980
calculations so we're combining that so

633
00:22:44,110 --> 00:22:41,960
we understand how it works would it

634
00:22:45,490 --> 00:22:44,120
what's needed to make it work what kind

635
00:22:47,019 --> 00:22:45,500
of tolerances we need on the thing that

636
00:22:48,519 --> 00:22:47,029
we're going to build as i said in

637
00:22:50,470 --> 00:22:48,529
parallel we're also trying to look at

638
00:22:52,930 --> 00:22:50,480

how we would deploy this how we would

639
00:22:54,549 --> 00:22:52,940
fit this into a fairing so all those are

640
00:22:56,950 --> 00:22:54,559
starting to converge and so over the

641
00:23:00,310 --> 00:22:56,960
next few years we will learn more about

642
00:23:01,720 --> 00:23:00,320
this our understanding will grow and at

643
00:23:03,999 --> 00:23:01,730
some point hopefully within a couple of

644
00:23:06,519 --> 00:23:04,009
years we will be ready to do some sort

645
00:23:10,409 --> 00:23:06,529
of demo test or something of that nature

646
00:23:12,999 --> 00:23:10,419
to go to the next stage so this is a

647
00:23:15,220 --> 00:23:13,009
broad reach project right now because

648
00:23:17,470 --> 00:23:15,230
we're looking at how it works optically

649
00:23:19,330 --> 00:23:17,480
how it works mechanically what are some

650
00:23:21,580 --> 00:23:19,340
of the issues as for the question from

651
00:23:23,560 --> 00:23:21,590
there what orbits we should go into what

652
00:23:25,720 --> 00:23:23,570
those constraints put on things so all

653
00:23:27,399 --> 00:23:25,730
those things need to be looked at and so

654
00:23:28,960 --> 00:23:27,409
it's a lot of work to do but it's coming

655
00:23:30,369 --> 00:23:28,970
together very nicely and we would hope

656
00:23:33,279 --> 00:23:30,379
in a few years to be ready to start

657
00:23:35,740 --> 00:23:33,289
looking at a space-based at least test

658
00:23:37,180 --> 00:23:35,750
if not the demo okay so in a couple

659
00:23:38,440 --> 00:23:37,190
years we might be testing anybody want

660
00:23:40,840 --> 00:23:38,450
to prognosticate when this thing is

661
00:23:43,950 --> 00:23:40,850
going to be in norway in orbit come on

662
00:23:46,210 --> 00:23:43,960
that's really up to NASA and the

663
00:23:47,980 --> 00:23:46,220

halliwell what's this is your good

664
00:23:49,840 --> 00:23:47,990
support for NASA on this project yes

665
00:23:51,940 --> 00:23:49,850
very good and so nASA has been very

666
00:23:54,369 --> 00:23:51,950
helpful from the very early days on

667
00:23:56,919 --> 00:23:54,379
NASA's been involved in the discussion

668
00:23:59,139 --> 00:23:56,929
are the some of the demonstrations of

669
00:24:01,869 --> 00:23:59,149
how the deployment works were done at

670
00:24:04,210 --> 00:24:01,879
JPL with Norfolk support stuff so NASA

671
00:24:06,490 --> 00:24:04,220
is very key to this very important and

672
00:24:08,320 --> 00:24:06,500
supplied both great intellectual

673
00:24:09,730 --> 00:24:08,330
property but also the resources and the

674
00:24:12,220 --> 00:24:09,740
facilities to do some of the stuff the

675
00:24:14,019 --> 00:24:12,230
the starshade itself doesn't seem like

676
00:24:15,399 --> 00:24:14,029
it's that expensive to make I mean

677
00:24:16,779 --> 00:24:15,409
compared to some of the other things

678
00:24:18,820 --> 00:24:16,789
that go up into space this might be a

679
00:24:19,389 --> 00:24:18,830
pretty economical thing to build right

680
00:24:20,889 --> 00:24:19,399
well

681
00:24:22,359 --> 00:24:20,899
a lot of that depends on what we find

682
00:24:24,430 --> 00:24:22,369
over the next few years I mean we are

683
00:24:26,349 --> 00:24:24,440
looking at tolerances and other sorts of

684
00:24:28,719 --> 00:24:26,359
things we hope it will be very

685
00:24:30,789 --> 00:24:28,729
affordable at this stage it's probably a

686
00:24:32,440 --> 00:24:30,799
little early to say absolutely but you

687
00:24:34,419 --> 00:24:32,450
know yes indeed well we think this is a

688
00:24:36,759 --> 00:24:34,429

very good way to go forward we think

689
00:24:38,619 --> 00:24:36,769
this may be one of the better ways to

690
00:24:42,369 --> 00:24:38,629
find out if there's life outside the

691
00:24:43,930 --> 00:24:42,379
solar system no oh okay he took the

692
00:24:45,999 --> 00:24:43,940
words out of your mouth did he okay cool

693
00:24:47,649 --> 00:24:46,009
well I'd say to me what worries me are

694
00:24:49,629 --> 00:24:47,659
the space telescopes themselves I don't

695
00:24:51,639 --> 00:24:49,639
know of a lot other than say W first and

696
00:24:52,899 --> 00:24:51,649
maybe something else down the road we

697
00:24:54,430 --> 00:24:52,909
got to start now thinking about the

698
00:24:56,469 --> 00:24:54,440
you're building star shades but we got

699
00:24:57,909 --> 00:24:56,479
telescopes to build to use these things

700
00:24:59,889 --> 00:24:57,919
that kind of worries me a little bit i'm

701
00:25:01,539 --> 00:24:59,899
not sure i guess the one other aspect of

702
00:25:03,219 --> 00:25:01,549
this than the other big advantage of a

703
00:25:05,889 --> 00:25:03,229
star shade is since it's a an

704
00:25:07,899 --> 00:25:05,899
independent operator it's an external

705
00:25:09,039 --> 00:25:07,909
occult for an external coronagraph it

706
00:25:11,529 --> 00:25:09,049
can actually operate with multiple

707
00:25:13,690 --> 00:25:11,539
telescopes so if we had three or four

708
00:25:15,430 --> 00:25:13,700
telescopes at l2 right now in principle

709
00:25:18,579 --> 00:25:15,440
we could operate a star shape with each

710
00:25:20,619 --> 00:25:18,589
one so you know one could look at using

711
00:25:22,269 --> 00:25:20,629
telescope number one to do one thing and

712
00:25:24,099 --> 00:25:22,279
tell us what number two to do nothing we

713
00:25:26,649 --> 00:25:24,109

just need to then move the starshade in

714
00:25:31,180 --> 00:25:26,659
line with Ulster well what about jada

715
00:25:33,279 --> 00:25:31,190
beastie certainly one good in principle

716
00:25:36,009 --> 00:25:33,289
do that as Steve said I mean the one big

717
00:25:38,079 --> 00:25:36,019
issue with this is the easiest way to

718
00:25:39,849 --> 00:25:38,089
align the choose to put a beacon on on

719
00:25:42,070 --> 00:25:39,859
the telescope so I know where the

720
00:25:43,479 --> 00:25:42,080
telescope is or if I'm a star shade and

721
00:25:45,519 --> 00:25:43,489
it's the telescope knows what the

722
00:25:46,959 --> 00:25:45,529
starshade is that both those there then

723
00:25:48,639 --> 00:25:46,969
it becomes really easy right now there's

724
00:25:50,999 --> 00:25:48,649
no beach in on Jane flow Alberta you

725
00:25:53,169 --> 00:25:51,009
need to add that as a feature on JWST

726
00:25:54,369 --> 00:25:53,179
yeah that would be interesting feature I

727
00:25:57,099 --> 00:25:54,379
don't think is in the plan but it will

728
00:26:00,669 --> 00:25:57,109
be an interesting feature so but we want

729
00:26:01,839 --> 00:26:00,679
to see I mean it's generally we look at

730
00:26:03,249 --> 00:26:01,849
yeah but remember this is a piece was

731
00:26:05,289 --> 00:26:03,259
built to look at spectra for exoplanets

732
00:26:06,519 --> 00:26:05,299
rye and so I think it's a kind of

733
00:26:08,169 --> 00:26:06,529
different kind of absorbing right that

734
00:26:09,940 --> 00:26:08,179
you want to do in terms of in terms of

735
00:26:12,039 --> 00:26:09,950
what you want to get out right and sorry

736
00:26:14,139 --> 00:26:12,049
I talks is not going to look at you know

737
00:26:15,879 --> 00:26:14,149
I don't generously denial resolution to

738
00:26:16,930 --> 00:26:15,889

look at earth-sized planets rice you're

739
00:26:18,940 --> 00:26:16,940
going to look at hot Jupiters for

740
00:26:20,899 --> 00:26:18,950
example right so ishan do you have

741
00:26:26,899 --> 00:26:20,909
anything for me

742
00:26:29,089 --> 00:26:26,909
golf addict 75 youtube how small of a

743
00:26:31,849 --> 00:26:29,099
planet will be able to image who wants

744
00:26:33,979 --> 00:26:31,859
that one and the issue is that's

745
00:26:35,539 --> 00:26:33,989
depending on how big of a telescope as

746
00:26:37,940 --> 00:26:35,549
the resolving power of the telescope

747
00:26:41,149 --> 00:26:37,950
primary and how I'm these planets are

748
00:26:42,710 --> 00:26:41,159
faint so but with a big telescope and a

749
00:26:44,419 --> 00:26:42,720
suitable starshade one should be able to

750
00:26:47,389 --> 00:26:44,429
image earth or smaller planets so

751
00:26:49,039 --> 00:26:47,399
earth-sized are smaller and but you are

752
00:26:51,409 --> 00:26:49,049
limited by how close you can get correct

753
00:26:54,139 --> 00:26:51,419
a pen that's correct so yeah if you

754
00:26:56,779 --> 00:26:54,149
there's a in a working angle 65 million

755
00:26:58,759 --> 00:26:56,789
seconds probably about right and so and

756
00:27:01,310 --> 00:26:58,769
then it depends your Goldilocks zone

757
00:27:03,019 --> 00:27:01,320
depends on the brightness of the star

758
00:27:05,359 --> 00:27:03,029
you know the type of star you're looking

759
00:27:07,940 --> 00:27:05,369
at so I certainly on some of them like

760
00:27:10,820 --> 00:27:07,950
the M Dwarfs that area may be too far in

761
00:27:13,219 --> 00:27:10,830
for a star shade to to be able to work

762
00:27:15,710 --> 00:27:13,229
but stars that are like our own star

763
00:27:17,389 --> 00:27:15,720

then then yeah absolutely there's 200

764
00:27:20,690 --> 00:27:17,399
plus targets that we could go after with

765
00:27:22,369 --> 00:27:20,700
this okay i just want and you know that

766
00:27:23,779 --> 00:27:22,379
there's a lot of interest from NASA from

767
00:27:25,999 --> 00:27:23,789
lots of other folks to actually look at

768
00:27:27,799 --> 00:27:26,009
planet that size right the have water in

769
00:27:29,419 --> 00:27:27,809
the Goldilocks zone so i think is not a

770
00:27:31,399 --> 00:27:29,429
surprising answer that we want to aim

771
00:27:32,539 --> 00:27:31,409
you know for a 10 to 12 meter telescope

772
00:27:34,190 --> 00:27:32,549
for example in the future of the

773
00:27:37,639 --> 00:27:34,200
jeddah-based e to those kind of planets

774
00:27:39,499 --> 00:27:37,649
right anything else you Sean okay so I

775
00:27:40,639 --> 00:27:39,509
want to get to a little bit about so I'm

776
00:27:41,659 --> 00:27:40,649
gonna go that's a little bit about

777
00:27:43,009 --> 00:27:41,669
starshade I want to thank you guys for

778
00:27:43,909 --> 00:27:43,019
giving us an update on that but I want

779
00:27:46,099 --> 00:27:43,919
to talk a little bit about Northrop

780
00:27:47,359 --> 00:27:46,109
Grumman and why you guys are doing this

781
00:27:49,879 --> 00:27:47,369
and we were talking to him last night

782
00:27:51,830 --> 00:27:49,889
Ron about how early career scientists

783
00:27:54,739 --> 00:27:51,840
when they're coming out of graduate

784
00:27:55,580 --> 00:27:54,749
school and maybe going into postdoc we

785
00:27:57,769 --> 00:27:55,590
were talking about how what how

786
00:27:59,389 --> 00:27:57,779
competitive that is but actually there's

787
00:28:01,159 --> 00:27:59,399
other career paths you've both chosen

788
00:28:02,839 --> 00:28:01,169

industry or at least you're working at

789
00:28:04,159 --> 00:28:02,849
northrop grumman can you talk a little

790
00:28:06,019 --> 00:28:04,169
bit about the opportunities that might

791
00:28:07,310 --> 00:28:06,029
be available to younger people and I'm

792
00:28:10,369 --> 00:28:07,320
gonna let Steve go first in an ID code

793
00:28:11,779 --> 00:28:10,379
are you okay I mean just maybe the ideas

794
00:28:14,029 --> 00:28:11,789
i think to let people know that is it

795
00:28:17,089 --> 00:28:14,039
not always about academia no absolutely

796
00:28:19,489 --> 00:28:17,099
not and our our team the team that said

797
00:28:23,180 --> 00:28:19,499
that works for wrong I believe we've got

798
00:28:26,779 --> 00:28:23,190
what four for astronomy PhDs on the team

799
00:28:28,869 --> 00:28:26,789
and Alberto's one right you got an abuse

800
00:28:31,840 --> 00:28:28,879
running they all you got on their team

801
00:28:33,850 --> 00:28:31,850
that was revoked right

802
00:28:36,039 --> 00:28:33,860
yeah so I mean that doesn't mean you're

803
00:28:38,650 --> 00:28:36,049
necessarily doing astronomy you're doing

804
00:28:40,659 --> 00:28:38,660
engineering or interface to to a

805
00:28:42,310 --> 00:28:40,669
customer like James Webb obviously the

806
00:28:44,830 --> 00:28:42,320
for James Webb there are hundreds of

807
00:28:46,630 --> 00:28:44,840
scientists who are the customers for the

808
00:28:48,850 --> 00:28:46,640
James Webb Space Telescope so and

809
00:28:50,770 --> 00:28:48,860
something that that astronomers working

810
00:28:52,779 --> 00:28:50,780
at Northrop Grumman have done is is be

811
00:28:55,150 --> 00:28:52,789
the interface to those people speak the

812
00:28:56,440 --> 00:28:55,160
science language and learn a little bit

813
00:28:59,110 --> 00:28:56,450

of engineering and speak to the

814
00:29:01,539 --> 00:28:59,120
engineers to and be that bridge so that

815
00:29:04,360 --> 00:29:01,549
that us as engineers can understand

816
00:29:06,419 --> 00:29:04,370
properly what we're trying to do so how

817
00:29:10,060 --> 00:29:06,429
would it compare do you think Ron with

818
00:29:12,279 --> 00:29:10,070
with academia versus working in a

819
00:29:13,960 --> 00:29:12,289
company well it turns out i can give you

820
00:29:16,510 --> 00:29:13,970
a unique perspective on that I ask you

821
00:29:19,120 --> 00:29:16,520
that ah the first third of my career I

822
00:29:22,180 --> 00:29:19,130
was an academic you know doing basic

823
00:29:23,710 --> 00:29:22,190
research publishing papers I then joined

824
00:29:25,270 --> 00:29:23,720
NASA and in the middle third of my

825
00:29:26,110 --> 00:29:25,280
career I was a NASA civil servant

826
00:29:29,649 --> 00:29:26,120
working at the Goddard Space Flight

827
00:29:31,270 --> 00:29:29,659
Center and then I got a call one day

828
00:29:33,220 --> 00:29:31,280
from someone saying you ever think of

829
00:29:34,779 --> 00:29:33,230
working in industry and so the last

830
00:29:36,909 --> 00:29:34,789
third of my career is now in industry

831
00:29:39,310 --> 00:29:36,919
and so I think one of the things that

832
00:29:43,720 --> 00:29:39,320
that I think star shades illustrates is

833
00:29:45,159 --> 00:29:43,730
the ability of comp i combined science

834
00:29:47,020 --> 00:29:45,169
and engineering team to sell the

835
00:29:50,320 --> 00:29:47,030
problems one of the things that we went

836
00:29:52,570 --> 00:29:50,330
from over 10 years we went from

837
00:29:55,299 --> 00:29:52,580
literally the laughable fringe the first

838
00:29:56,710 --> 00:29:55,309

time we presented this paper on star

839
00:29:58,720 --> 00:29:56,720
shades we were actually laughed at

840
00:30:00,279 --> 00:29:58,730
because this is a chuckle to now one of

841
00:30:01,840 --> 00:30:00,289
the baseline architectures and the

842
00:30:04,360 --> 00:30:01,850
reason we were able to do that in such a

843
00:30:06,340 --> 00:30:04,370
short amount of time is we had a really

844
00:30:08,649 --> 00:30:06,350
nice integrated science and engineering

845
00:30:10,270 --> 00:30:08,659
team scientists contribute to scientists

846
00:30:12,250 --> 00:30:10,280
the engineers pretty contribute the

847
00:30:14,260 --> 00:30:12,260
engineering and that combination of

848
00:30:15,970 --> 00:30:14,270
those two disciplines really allowed us

849
00:30:18,130 --> 00:30:15,980
to solve problems far faster than

850
00:30:20,860 --> 00:30:18,140
anybody ever thought we would solve so

851
00:30:23,230 --> 00:30:20,870
that's really the key I think to success

852
00:30:26,409 --> 00:30:23,240
four star shades is the ability of an

853
00:30:28,600 --> 00:30:26,419
industry government and academia team

854
00:30:30,070 --> 00:30:28,610
working together arm and arm to go

855
00:30:32,140 --> 00:30:30,080
forward and that's really been

856
00:30:34,000 --> 00:30:32,150
beneficial on really got us through a

857
00:30:35,440 --> 00:30:34,010
lot of problems very quickly okay so

858
00:30:36,700 --> 00:30:35,450
Alberto you're in that Club to how about

859
00:30:39,580 --> 00:30:36,710
you give us comments on that I

860
00:30:41,140 --> 00:30:39,590
completely agree with but what both well

861
00:30:43,390 --> 00:30:41,150
these guys actually said because it's

862
00:30:44,259 --> 00:30:43,400
it's absolutely true so I just came from

863
00:30:46,539 --> 00:30:44,269

a panel

864
00:30:48,219 --> 00:30:46,549
call Korea's one on one when I gave my

865
00:30:49,899 --> 00:30:48,229
perspective about exactly about this way

866
00:30:52,869 --> 00:30:49,909
and so exactly along the lines of what

867
00:30:54,879 --> 00:30:52,879
well lon and Ron and Steve actually said

868
00:30:57,419 --> 00:30:54,889
but one other thing i want to add is

869
00:30:59,919 --> 00:30:57,429
also that sometimes that they need for

870
00:31:01,419 --> 00:30:59,929
talking to engineers in the language

871
00:31:02,739 --> 00:31:01,429
they can understand it translate those

872
00:31:04,449 --> 00:31:02,749
requirements are from science for

873
00:31:05,829 --> 00:31:04,459
example into engineer requirements

874
00:31:07,449 --> 00:31:05,839
something that really is some time is

875
00:31:08,919 --> 00:31:07,459
missing so if you don't have that your

876
00:31:10,869 --> 00:31:08,929
project would not really go very well

877
00:31:13,449 --> 00:31:10,879
and so people like like Steve you know

878
00:31:15,219 --> 00:31:13,459
people like like like Ron are those

879
00:31:16,869 --> 00:31:15,229
they're mediators if you will a

880
00:31:18,099 --> 00:31:16,879
translator right they translate some

881
00:31:19,419 --> 00:31:18,109
requirements are come from us to visit

882
00:31:21,069 --> 00:31:19,429
what is the science that you want to

883
00:31:22,749 --> 00:31:21,079
implement so this is how you actually

884
00:31:24,639 --> 00:31:22,759
build this and then they argue for a

885
00:31:25,629 --> 00:31:24,649
while and then it compromised and

886
00:31:28,449 --> 00:31:25,639
actually that's part of the team and

887
00:31:30,879 --> 00:31:28,459
successful team actually is a team that

888
00:31:31,989 --> 00:31:30,889

can draw from the sensor comments

889
00:31:33,489 --> 00:31:31,999
understand how you implement those

890
00:31:35,379 --> 00:31:33,499
requirements while pushing the

891
00:31:37,089 --> 00:31:35,389
engineering at the limit you know we do

892
00:31:38,709 --> 00:31:37,099
this every level jeddah-based e but it's

893
00:31:40,389 --> 00:31:38,719
a it's a very successful thing that we

894
00:31:43,149 --> 00:31:40,399
do and i think actually there's a is a

895
00:31:45,519 --> 00:31:43,159
great partnership that has to be had you

896
00:31:47,379 --> 00:31:45,529
know in in between industry academia and

897
00:31:49,089 --> 00:31:47,389
an engineering just because of this yeah

898
00:31:50,259 --> 00:31:49,099
i just want to make that point because i

899
00:31:52,029 --> 00:31:50,269
know a lot of people think there's

900
00:31:53,560 --> 00:31:52,039
really only one path in science an

901
00:31:55,029 --> 00:31:53,570
astronomy they did you know that you go

902
00:31:56,379 --> 00:31:55,039
to graduate are your undergrad degree

903
00:31:58,119 --> 00:31:56,389
you get a graduate degree you get your

904
00:31:59,499 --> 00:31:58,129
post off you do the postdoc work and

905
00:32:00,999 --> 00:31:59,509
then you hopefully get a job as a

906
00:32:03,789 --> 00:32:01,009
tenured professor at some point but that

907
00:32:05,169 --> 00:32:03,799
is a highly competitive and a difficult

908
00:32:06,759 --> 00:32:05,179
way to go and it's not also the only way

909
00:32:08,859 --> 00:32:06,769
to go yeah and that's the point i really

910
00:32:11,889 --> 00:32:08,869
wanted to make the other aspect of that

911
00:32:13,419 --> 00:32:11,899
is um in academia when I was there there

912
00:32:15,699 --> 00:32:13,429
were some very compelling problems I'm

913
00:32:18,399 --> 00:32:15,709

really stimulating mentally stimulating

914
00:32:20,529 --> 00:32:18,409
intellectually you know worthwhile

915
00:32:21,969 --> 00:32:20,539
things that i did when i joined the

916
00:32:23,889 --> 00:32:21,979
government there are also things there

917
00:32:25,569 --> 00:32:23,899
and now in industry there's also equally

918
00:32:27,339 --> 00:32:25,579
no equal number of compelling things to

919
00:32:29,440 --> 00:32:27,349
do so so the real thing is you want to

920
00:32:31,469 --> 00:32:29,450
work on something where you have the

921
00:32:34,060 --> 00:32:31,479
ability to contribute where you have

922
00:32:36,339 --> 00:32:34,070
some contribution to something important

923
00:32:37,839 --> 00:32:36,349
and at least from my career i was able

924
00:32:39,729 --> 00:32:37,849
to do that as an academic i was able to

925
00:32:42,669 --> 00:32:39,739
do that as a civil servant and able to

926
00:32:43,839 --> 00:32:42,679
do that as a member of industry i just

927
00:32:45,369 --> 00:32:43,849
want to add one thing which is the

928
00:32:46,749 --> 00:32:45,379
reason why people are like they say

929
00:32:48,579 --> 00:32:46,759
astronomers for example a companies like

930
00:32:50,560 --> 00:32:48,589
a northrop grumman is because their

931
00:32:52,149 --> 00:32:50,570
skills are in problem solving they've

932
00:32:53,440 --> 00:32:52,159
been given a problem that no one else

933
00:32:55,149 --> 00:32:53,450
has seen before and they can actually

934
00:32:56,499 --> 00:32:55,159
walk it through right it's the same

935
00:32:57,640 --> 00:32:56,509
thing for engineers that right engineers

936
00:32:59,350 --> 00:32:57,650
i can solve you know

937
00:33:01,150 --> 00:32:59,360
it's all very very very hard problems

938
00:33:03,190 --> 00:33:01,160

and they're hard not because of the

939
00:33:05,260 --> 00:33:03,200
specialty there you know which the

940
00:33:06,400 --> 00:33:05,270
thesis with you know the idea that my

941
00:33:08,140 --> 00:33:06,410
thesis in you know a numerical

942
00:33:10,240 --> 00:33:08,150
simulations you know what maybe it's not

943
00:33:12,460 --> 00:33:10,250
gonna be very useful but we have a way

944
00:33:14,680 --> 00:33:12,470
to approach problems that is not common

945
00:33:16,240 --> 00:33:14,690
and that's actually what's worth you

946
00:33:17,590 --> 00:33:16,250
know money and and and works to a

947
00:33:19,180 --> 00:33:17,600
company what's also why a lot of

948
00:33:21,220 --> 00:33:19,190
physicists go into finance to I mean

949
00:33:22,450 --> 00:33:21,230
they solve problems using they're using

950
00:33:27,610 --> 00:33:22,460
their skill set you Sean do you have

951
00:33:31,960 --> 00:33:27,620
another one to n Ram samurai two

952
00:33:37,090 --> 00:33:31,970
questions on YouTube how long can the

953
00:33:38,350 --> 00:33:37,100
starshade be kept in space and can you

954
00:33:39,670 --> 00:33:38,360
get all good we didn't we didn't cover

955
00:33:40,930 --> 00:33:39,680
that a good one and can you give us a

956
00:33:42,790 --> 00:33:40,940
good a simple explanation of how you

957
00:33:46,720 --> 00:33:42,800
unfurl atlas what was the first one

958
00:33:49,900 --> 00:33:46,730
again i forgot how long his face is

959
00:33:51,700 --> 00:33:49,910
saying space he wants that so how long

960
00:33:54,460 --> 00:33:51,710
it stays in space p only driven by the

961
00:33:55,960 --> 00:33:54,470
the fuel the thrusters the size of the

962
00:33:58,270 --> 00:33:55,970
tank that you're able to take with you

963
00:34:00,580 --> 00:33:58,280

we would expect to make a mission that

964
00:34:02,980 --> 00:34:00,590
was five years or maybe a little longer

965
00:34:04,450 --> 00:34:02,990
than that that would be designed mission

966
00:34:06,640 --> 00:34:04,460
right we talked about a little bit with

967
00:34:10,840 --> 00:34:06,650
with the gas for their for the electrons

968
00:34:11,830 --> 00:34:10,850
right unfurling it okay so and there

969
00:34:14,110 --> 00:34:11,840
were a couple of ways we can do this

970
00:34:15,880 --> 00:34:14,120
obviously i'm feeling is a critical

971
00:34:18,130 --> 00:34:15,890
problem you're talking about making

972
00:34:20,649 --> 00:34:18,140
something in space that is 50 60 70

973
00:34:22,690 --> 00:34:20,659
meters across and rocking for rocket

974
00:34:25,000 --> 00:34:22,700
ferrin's at the moment though are five

975
00:34:27,669 --> 00:34:25,010
meters across or if you use the space

976
00:34:29,649 --> 00:34:27,679
you know the SLS rocket there may be a

977
00:34:31,780 --> 00:34:29,659
little larger so you need to win full

978
00:34:33,780 --> 00:34:31,790
the the starshade when you get on orbit

979
00:34:36,639 --> 00:34:33,790
a couple of ways of doing that we got

980
00:34:40,020 --> 00:34:36,649
some technology that was used for and

981
00:34:43,450 --> 00:34:40,030
still is used for unfolding

982
00:34:45,099 --> 00:34:43,460
antennas mesh antennas in space and that

983
00:34:50,470 --> 00:34:45,109
kind of its called a perimeter truss

984
00:34:53,500 --> 00:34:50,480
design and it expands with a ring of of

985
00:34:55,659 --> 00:34:53,510
struts around the edge so all the struts

986
00:34:56,889 --> 00:34:55,669
are wrapped up in 2 into 1 cor and as

987
00:34:59,620 --> 00:34:56,899
you drive them out of these struts

988
00:35:02,020 --> 00:34:59,630

expand out into a ring that forms the

989
00:35:04,180 --> 00:35:02,030
center of a star shade deployable design

990
00:35:06,849 --> 00:35:04,190
then then what we have is the pedals

991
00:35:09,040 --> 00:35:06,859
attach the edge of that perimeter trust

992
00:35:11,620 --> 00:35:09,050
that our star vertical and as they as

993
00:35:14,440 --> 00:35:11,630
the trust pushes out they rotate to to

994
00:35:17,109 --> 00:35:14,450
be flat so that's that's probably the

995
00:35:19,750 --> 00:35:17,119
easiest way to describe a deployment at

996
00:35:21,760 --> 00:35:19,760
the moment and presumably that would

997
00:35:24,310 --> 00:35:21,770
take a long time alright if you look on

998
00:35:26,980 --> 00:35:24,320
youtube and look for star shades and

999
00:35:30,099 --> 00:35:26,990
deployment you will see a about a third

1000
00:35:33,790 --> 00:35:30,109
scale demonstration that was done last

1001
00:35:36,190 --> 00:35:33,800
year I think and so you should be able

1002
00:35:38,440 --> 00:35:36,200
to watch it it's on a number of YouTube

1003
00:35:40,210 --> 00:35:38,450
sites so just look for starshade

1004
00:35:42,520 --> 00:35:40,220
deployment on YouTube and you'll find a

1005
00:35:43,870 --> 00:35:42,530
demo you'll find a video I'm glad you

1006
00:35:45,160 --> 00:35:43,880
mentioned that thing and the next thing

1007
00:35:47,079 --> 00:35:45,170
you can actually see there's actually a

1008
00:35:48,640 --> 00:35:47,089
video of a deployment of JPL put

1009
00:35:50,260 --> 00:35:48,650
together i think the full you know

1010
00:35:51,460 --> 00:35:50,270
address rendition but it's actually nice

1011
00:35:57,370 --> 00:35:51,470
it gives you an idea of a Hollywood

1012
00:35:59,380 --> 00:35:57,380
unfurl you know a artist simulation and

1013
00:36:02,410 --> 00:35:59,390

some real demonstrations this gets back

1014
00:36:04,660 --> 00:36:02,420
to your earlier comment about moving

1015
00:36:06,430 --> 00:36:04,670
forward this now has gotten to the point

1016
00:36:07,960 --> 00:36:06,440
where we have a little bit of hardware

1017
00:36:09,760 --> 00:36:07,970
being demonstrated and we're moving

1018
00:36:11,920 --> 00:36:09,770
forward and parallel with the desert us

1019
00:36:13,900 --> 00:36:11,930
awesome so yeah well unfortunately folks

1020
00:36:14,829 --> 00:36:13,910
this is not a hangout on air like we're

1021
00:36:16,300 --> 00:36:14,839
used to doing we don't have the

1022
00:36:18,069 --> 00:36:16,310
technology to share our screens here

1023
00:36:20,520 --> 00:36:18,079
we're just streaming live from one one

1024
00:36:23,109 --> 00:36:20,530
spot so definitely go to youtube and

1025
00:36:24,339 --> 00:36:23,119
look up starshade and all kinds of

1026
00:36:25,660 --> 00:36:24,349
animations will come up and you'll be

1027
00:36:27,400 --> 00:36:25,670
able to see this deployment I'm glad we

1028
00:36:35,979 --> 00:36:27,410
brought that up you have anything else I

1029
00:36:43,789 --> 00:36:38,029
you know what I think he should just

1030
00:36:45,709 --> 00:36:43,799
read it we've heard that NASA is the key

1031
00:36:47,420 --> 00:36:45,719
to the starshade moving forward what is

1032
00:36:54,289 --> 00:36:47,430
Northrop Grumman role in development of

1033
00:36:56,660 --> 00:36:54,299
the starshade um we are an aerospace

1034
00:37:00,349 --> 00:36:56,670
industry so we have built demonstrations

1035
00:37:03,920 --> 00:37:00,359
of some of the hardware we are looking

1036
00:37:06,249 --> 00:37:03,930
at the engineering aspects of this to go

1037
00:37:10,880 --> 00:37:06,259
forward as I said this is an integrated

1038
00:37:12,679 --> 00:37:10,890

Northrop NASA academic team so it's kind

1039
00:37:14,479 --> 00:37:12,689
of hard to draw a dividing line as to

1040
00:37:16,549 --> 00:37:14,489
what NASA is doing and what we're doing

1041
00:37:19,130 --> 00:37:16,559
and what academia are doing we're all in

1042
00:37:22,009 --> 00:37:19,140
this as an integrated team and everybody

1043
00:37:24,620 --> 00:37:22,019
has contributed some aspect of both the

1044
00:37:26,120 --> 00:37:24,630
optimal performance the deployment and

1045
00:37:28,130 --> 00:37:26,130
this sort of stuff so it's not

1046
00:37:32,509 --> 00:37:28,140
partitioned in that similar way we are a

1047
00:37:33,829 --> 00:37:32,519
single team so elberta you in it I just

1048
00:37:35,809 --> 00:37:33,839
want to add you know part of a core

1049
00:37:36,769 --> 00:37:35,819
mission is to enhance discovery right so

1050
00:37:38,299 --> 00:37:36,779
that's how we do it we do it with

1051
00:37:40,339 --> 00:37:38,309
jeddah-based a for example we do it in

1052
00:37:42,189 --> 00:37:40,349
many areas of science and starshade it

1053
00:37:44,359 --> 00:37:42,199
just will be another example how we

1054
00:37:46,400 --> 00:37:44,369
fulfill that promise you know they'll

1055
00:37:48,739 --> 00:37:46,410
find an exoplanet for example in the

1056
00:37:53,929 --> 00:37:48,749
future all right is there anything else

1057
00:37:56,120 --> 00:37:53,939
you saw Mary becker on youtube wants to

1058
00:37:59,569 --> 00:37:56,130
know starshade will work four stars out

1059
00:38:03,979 --> 00:37:59,579
to what distance from us to what

1060
00:38:07,279 --> 00:38:03,989
distance from us Oh somewhat of a fuzzy

1061
00:38:08,689 --> 00:38:07,289
question is on the damage yeah I mean

1062
00:38:11,630 --> 00:38:08,699
you know it basically is how big which

1063
00:38:14,269 --> 00:38:11,640

all soaped you want to go for um when

1064
00:38:15,799 --> 00:38:14,279
you get much beyond about a about a

1065
00:38:18,650 --> 00:38:15,809
hundred parsecs it gets really really

1066
00:38:21,049 --> 00:38:18,660
tough the habitable zone just becomes

1067
00:38:22,620 --> 00:38:21,059
really close for all stars and so

1068
00:38:26,249 --> 00:38:22,630
something within

1069
00:38:27,450 --> 00:38:26,259
um you know 20 to 50 light-years is

1070
00:38:29,720 --> 00:38:27,460
probably going to be fairly straight

1071
00:38:33,799 --> 00:38:29,730
forward over the next decade or two

1072
00:38:36,029 --> 00:38:33,809
beyond that it's a lot sent to depend on

1073
00:38:37,980 --> 00:38:36,039
how big of a telescope you want to build

1074
00:38:39,990 --> 00:38:37,990
and how big of a starter you want to put

1075
00:38:42,809 --> 00:38:40,000
with it okay awesome but will sample

1076
00:38:45,749 --> 00:38:42,819
enough space to have a high probability

1077
00:38:48,420 --> 00:38:45,759
of saying does life exist outside

1078
00:38:51,539 --> 00:38:48,430
sources there you go so that's a good

1079
00:38:53,279 --> 00:38:51,549
question um so I guess way is that

1080
00:38:54,839 --> 00:38:53,289
everything there each other okay I guess

1081
00:38:56,069 --> 00:38:54,849
we'll go ahead and let you guys have one

1082
00:38:58,140 --> 00:38:56,079
when I address something that we haven't

1083
00:38:59,309 --> 00:38:58,150
talked about I guess we'll sort of will

1084
00:39:00,630 --> 00:38:59,319
sort of close it there yeah I've worked

1085
00:39:02,069 --> 00:39:00,640
out you have anything you wanna add ok

1086
00:39:04,109 --> 00:39:02,079
all right folks well that's it for our

1087
00:39:07,620 --> 00:39:04,119
first hangout from the double-a s the

1088
00:39:10,890 --> 00:39:07,630

225 I'll be joining me come back what

1089
00:39:13,079 --> 00:39:10,900
time is it in about an hour about about

1090
00:39:15,120 --> 00:39:13,089
about another little over an hour I'll

1091
00:39:19,079 --> 00:39:15,130
be setting up at three-thirty pacific

1092
00:39:20,930 --> 00:39:19,089
standard time to talk about the 25th

1093
00:39:23,339 --> 00:39:20,940
anniversary Hubble 25th anniversary

1094
00:39:25,109 --> 00:39:23,349
image release it's coming out in about

1095
00:39:26,220 --> 00:39:25,119
five minutes so we'll have carol

1096
00:39:28,049 --> 00:39:26,230
christian zolta bay and a few other

1097
00:39:31,259 --> 00:39:28,059
people at the Institute to talk about

1098
00:39:33,269 --> 00:39:31,269
that image we hope you'll you will also

1099
00:39:35,069 --> 00:39:33,279
leave us comments and questions and on

1100
00:39:37,230 --> 00:39:35,079
behalf of the folks here at northrop

1101
00:39:40,289 --> 00:39:37,240
grumman Steve and Enron and Alberto