
Google+
1:24 PM
John Mather
JWST Senior Project Scientist

1
00:00:09,260 --> 00:00:06,860
hello and welcome to this NASA google+

2
00:00:12,140 --> 00:00:09,270
hangout for the agency's James Webb

3
00:00:14,209 --> 00:00:12,150
Space Telescope I'm JD Harrington public

4
00:00:15,740 --> 00:00:14,219
affairs officer for NASA's astrophysics

5
00:00:17,810 --> 00:00:15,750
division and the science Mission

6
00:00:20,660 --> 00:00:17,820
Directorate NASA headquarters in

7
00:00:22,970 --> 00:00:20,670
Washington DC we have five panelists

8
00:00:25,280 --> 00:00:22,980
joining us today actually they're

9
00:00:27,680 --> 00:00:25,290
engineers scientists the net folks that

10
00:00:30,140 --> 00:00:27,690
will discuss the program status how the

11
00:00:32,600 --> 00:00:30,150
tennis court size spacecraft will work

12
00:00:34,790 --> 00:00:32,610
explain its science objectives and for

13
00:00:37,430 --> 00:00:34,800

lunch and basically just highlight how

14
00:00:39,099 --> 00:00:37,440
will impact the world just like its

15
00:00:41,989 --> 00:00:39,109
predecessor the Hubble Space Telescope

16
00:00:44,239 --> 00:00:41,999
you can also ask question right here on

17
00:00:47,569 --> 00:00:44,249
google plus and via twitter using

18
00:00:50,840 --> 00:00:47,579
hashtag cast nasa let's introduce the

19
00:00:53,180 --> 00:00:50,850
panelists we have first Jeff Yoder the

20
00:00:57,529 --> 00:00:53,190
program director at nasa headquarters in

21
00:01:00,410 --> 00:00:57,539
washington DC actually have eric smith

22
00:01:02,959 --> 00:01:00,420
deputy program director and also program

23
00:01:07,460 --> 00:01:02,969
scientist also at nasa headquarters here

24
00:01:09,290 --> 00:01:07,470
in DC John Mather the JWST project

25
00:01:13,460 --> 00:01:09,300
scientist at NASA Goddard Space Flight

26
00:01:16,010 --> 00:01:13,470
Center at greenbelt maryland amber stron

27
00:01:17,750 --> 00:01:16,020
the estradas an astrophysicist and

28
00:01:20,240 --> 00:01:17,760
deputy project scientist for

29
00:01:22,460 --> 00:01:20,250
communications and outreach at NASA

30
00:01:26,000 --> 00:01:22,470
Goddard Space Flight Center that's also

31
00:01:28,370 --> 00:01:26,010
a green belt and we also have Jon Aaron

32
00:01:30,680 --> 00:01:28,380
Burr chief engineer at my butt at

33
00:01:33,860 --> 00:01:30,690
Northrop Grumman aerospace systems in

34
00:01:36,920 --> 00:01:33,870
redondo beach california and with that

35
00:01:38,330 --> 00:01:36,930
I'd like to start off the panelist here

36
00:01:40,670 --> 00:01:38,340
to give them a chance to discuss their

37
00:01:44,540 --> 00:01:40,680
perspectives on the web well start with

38
00:01:46,510 --> 00:01:44,550

Jeff Jeff thanks jay king i want to

39
00:03:07,810 --> 00:01:46,520
thank everybody from you're just begging

40
00:03:15,530 --> 00:03:09,800
this is a unique and interesting

41
00:03:26,810 --> 00:03:15,540
perspective of the mission engine for

42
00:03:29,780 --> 00:03:26,820
exploration efforts run challenging hey

43
00:03:44,199 --> 00:03:29,790
JW's teen since the replay is on trying

44
00:03:48,770 --> 00:03:44,209
technically schedule reserve and from a

45
00:04:02,090 --> 00:03:48,780
perspective every minute in 2011 we have

46
00:04:24,460 --> 00:04:02,100
13 months of Canaan to me meet our

47
00:04:24,470 --> 00:04:35,439
dr. out

48
00:04:41,600 --> 00:04:39,260
yes hi I wanted to describe for you the

49
00:04:44,300 --> 00:04:41,610
main scientific motivations for this new

50
00:04:46,100 --> 00:04:44,310
telescope when we built the Hubble Space

51
00:04:49,070 --> 00:04:46,110
Telescope and we got it up and working

52
00:04:50,960 --> 00:04:49,080
and then repaired it we found that there

53
00:04:54,379 --> 00:04:50,970
were some pretty spectacular surprises

54
00:04:55,969 --> 00:04:54,389
in the universe number one galaxies were

55
00:04:57,980 --> 00:04:55,979
not formed at all like people had

56
00:05:00,770 --> 00:04:57,990
predicted in fact we found that they

57
00:05:04,370 --> 00:05:00,780
were found far earlier in time farther

58
00:05:06,290 --> 00:05:04,380
away from us has so far away in time and

59
00:05:08,899 --> 00:05:06,300
space that we wouldn't be able to see

60
00:05:11,300 --> 00:05:08,909
them in their formation process even

61
00:05:13,640 --> 00:05:11,310
with the great Hubble telescope because

62
00:05:15,800 --> 00:05:13,650
they're so far away so faint and they're

63
00:05:17,749 --> 00:05:15,810

in wavelengths are so far shifted into

64
00:05:19,219 --> 00:05:17,759
the intra read that we could see right

65
00:05:22,339 --> 00:05:19,229
away that we would need a new telescope

66
00:05:25,129 --> 00:05:22,349
of a different kind to be able to extend

67
00:05:27,050 --> 00:05:25,139
the Hubble discoveries then as time went

68
00:05:29,270 --> 00:05:27,060
along we also discovered a few of more

69
00:05:31,580 --> 00:05:29,280
amazing things we discovered that

70
00:05:33,950 --> 00:05:31,590
there's cosmic dark energy and cosmic

71
00:05:38,170 --> 00:05:33,960
dark matter in great abundance out there

72
00:05:40,820 --> 00:05:38,180
and great mysteries to be resolved so

73
00:05:42,560 --> 00:05:40,830
then even after that then we discovered

74
00:05:44,570 --> 00:05:42,570
that there are actually thousands of

75
00:05:46,760 --> 00:05:44,580
planets around other stars that could be

76
00:05:49,459 --> 00:05:46,770
studied by something called the transit

77
00:05:52,700 --> 00:05:49,469
technique and a few have even had images

78
00:05:54,110 --> 00:05:52,710
taken by the Hubble telescope so that we

79
00:05:56,719 --> 00:05:54,120
know that they're out there and they're

80
00:05:58,909 --> 00:05:56,729
worthy of great effort to study them

81
00:06:02,570 --> 00:05:58,919
because some of them are even a little

82
00:06:04,070 --> 00:06:02,580
bit like Earth so we have four major

83
00:06:05,930 --> 00:06:04,080
scientific areas that we think

84
00:06:08,480 --> 00:06:05,940
scientists will pursue with the new

85
00:06:11,870 --> 00:06:08,490
telescope one is what is the first thing

86
00:06:13,850 --> 00:06:11,880
that happened after the after the early

87
00:06:15,680 --> 00:06:13,860
universe what were the first things that

88
00:06:18,559 --> 00:06:15,690

turned on whether the first stars and

89
00:06:20,420 --> 00:06:18,569
galaxies like second question is how do

90
00:06:23,540 --> 00:06:20,430
the galaxies like the Milky Way where we

91
00:06:25,959 --> 00:06:23,550
live grow up were they formed from small

92
00:06:28,640 --> 00:06:25,969
a little things that started off

93
00:06:31,129 --> 00:06:28,650
separate and joined together or were

94
00:06:33,409 --> 00:06:31,139
they form from some primordial very

95
00:06:35,379 --> 00:06:33,419
large structure which nucleated the

96
00:06:38,589 --> 00:06:35,389
formation of a whole galaxy at once

97
00:06:41,659 --> 00:06:38,599
third question is how our stars and

98
00:06:42,590 --> 00:06:41,669
planetary systems born right here in the

99
00:06:44,810 --> 00:06:42,600
Milky Way we know

100
00:06:47,870 --> 00:06:44,820
that there are typically several stars

101
00:06:49,310 --> 00:06:47,880
born per year and we imagine that if we

102
00:06:50,930 --> 00:06:49,320
could see that happening we would learn

103
00:06:54,740 --> 00:06:50,940
something about the formation of our own

104
00:06:56,360 --> 00:06:54,750
solar system finally a a major area

105
00:06:58,580 --> 00:06:56,370
which we didn't know we could pursue in

106
00:07:00,320 --> 00:06:58,590
the beginning was how does planetary

107
00:07:04,460 --> 00:07:00,330
systems evolve with time how do they

108
00:07:07,190 --> 00:07:04,470
change because there clearly are not

109
00:07:09,400 --> 00:07:07,200
constant so here in our own solar system

110
00:07:11,960 --> 00:07:09,410
we can study the planets that we have

111
00:07:15,020 --> 00:07:11,970
even the dwarf planets that what used to

112
00:07:17,960 --> 00:07:15,030
be called Pluto is now Pluto the dwarf

113
00:07:19,760 --> 00:07:17,970

planet but it has many many cousins in

114
00:07:22,400 --> 00:07:19,770
the outer solar system that are as large

115
00:07:25,520 --> 00:07:22,410
and as interesting but haven't mostly

116
00:07:27,290 --> 00:07:25,530
been discovered so studying all of the

117
00:07:28,930 --> 00:07:27,300
residue from the formation of our own

118
00:07:32,000 --> 00:07:28,940
solar system will help us learn about

119
00:07:33,950 --> 00:07:32,010
how the earth was formed I would became

120
00:07:36,860 --> 00:07:33,960
possible for life to exist here on earth

121
00:07:39,050 --> 00:07:36,870
through the delivery of carbon and water

122
00:07:41,330 --> 00:07:39,060
so that we could have life here on the

123
00:07:43,070 --> 00:07:41,340
surface of the earth and we're extremely

124
00:07:45,170 --> 00:07:43,080
lucky now we'll be able to demonstrate

125
00:07:47,360 --> 00:07:45,180
that some of the planet's seen around

126
00:07:49,580 --> 00:07:47,370
other stars are a little bit like Earth

127
00:07:51,560 --> 00:07:49,590
possibly even we would know that they

128
00:07:54,080 --> 00:07:51,570
have a notion that which we would learn

129
00:07:56,240 --> 00:07:54,090
from discovering water vapor in their

130
00:07:58,810 --> 00:07:56,250
atmospheres so these are the four

131
00:08:02,720 --> 00:07:58,820
primary motivations that people have for

132
00:08:05,390 --> 00:08:02,730
building and using the telescope but of

133
00:08:07,760 --> 00:08:05,400
course we're very interested as well in

134
00:08:09,890 --> 00:08:07,770
the surprises that will occur for the

135
00:08:12,290 --> 00:08:09,900
Hubble Space Telescope at least half of

136
00:08:15,710 --> 00:08:12,300
its great measurements have been big

137
00:08:16,910 --> 00:08:15,720
surprises and for instance discovering

138
00:08:18,860 --> 00:08:16,920

that there's a black hole in the middle

139
00:08:20,930 --> 00:08:18,870
of almost every galaxy was a big

140
00:08:23,930 --> 00:08:20,940
surprise and it required the power of

141
00:08:26,570 --> 00:08:23,940
how to do it so this is the four areas

142
00:08:33,620 --> 00:08:26,580
that people expect to pursue and and

143
00:08:35,330 --> 00:08:33,630
many more will be tried all right now

144
00:08:40,070 --> 00:08:35,340
we're going to go to Eric Smith all

145
00:08:41,390 --> 00:08:40,080
right I thanks JD well so uh Jon Mannah

146
00:08:42,860 --> 00:08:41,400
just told you about some of the

147
00:08:45,320 --> 00:08:42,870
incredible science that we're going to

148
00:08:47,740 --> 00:08:45,330
do with this telescope but perhaps the

149
00:08:50,150 --> 00:08:47,750
most important property of any telescope

150
00:08:52,970 --> 00:08:50,160
astronomical telescope is its ability to

151
00:08:54,829 --> 00:08:52,980
collect light and in the case of web its

152
00:08:56,360 --> 00:08:54,839
infrared light that we want to be

153
00:08:58,430 --> 00:08:56,370
collecting and detect

154
00:09:01,040 --> 00:08:58,440
thing because of the redshifted light

155
00:09:03,769 --> 00:09:01,050
from the early universe and the ability

156
00:09:05,840 --> 00:09:03,779
infrared lights ability to penetrate the

157
00:09:08,329 --> 00:09:05,850
dust clouds where stars and planets are

158
00:09:09,769 --> 00:09:08,339
forming within our own galaxy so for

159
00:09:12,650 --> 00:09:09,779
those science goals that we've just

160
00:09:16,220 --> 00:09:12,660
heard about we need a mirror in space

161
00:09:18,380 --> 00:09:16,230
bigger than any mirror has ever been

162
00:09:22,100 --> 00:09:18,390
flown before in space larger than Hubble

163
00:09:24,590 --> 00:09:22,110

and in fact so large that it's bigger

164
00:09:27,920 --> 00:09:24,600
than any rocket that we would use to

165
00:09:30,140 --> 00:09:27,930
launch it into space so we have to build

166
00:09:31,910 --> 00:09:30,150
an infrared optimized telescope that's

167
00:09:34,040 --> 00:09:31,920
bigger than the rocket it fits into so

168
00:09:37,310 --> 00:09:34,050
that means we have to have a folding or

169
00:09:38,930 --> 00:09:37,320
articulated telescope another important

170
00:09:40,400 --> 00:09:38,940
point about this telescope because it's

171
00:09:43,040 --> 00:09:40,410
going to be looking in the infrared is

172
00:09:44,990 --> 00:09:43,050
that it needs to be very cold because

173
00:09:48,740 --> 00:09:45,000
it's detecting heat radiation after all

174
00:09:50,840 --> 00:09:48,750
so web the instruments the detecting

175
00:09:54,110 --> 00:09:50,850
part of web will be just 40 degrees

176
00:09:56,660 --> 00:09:54,120
above absolute zero and when you're that

177
00:09:58,820 --> 00:09:56,670
cold the material properties how things

178
00:10:01,820 --> 00:09:58,830
behave how they banned how they shake

179
00:10:04,010 --> 00:10:01,830
how they move changes completely from

180
00:10:06,079 --> 00:10:04,020
your experience so you're going to have

181
00:10:08,210 --> 00:10:06,089
to build the telescope it looks like any

182
00:10:10,940 --> 00:10:08,220
other in a way that behaves in a very

183
00:10:13,310 --> 00:10:10,950
non intuitive sense if I can have a

184
00:10:15,680 --> 00:10:13,320
graphic up on the screen here to show

185
00:10:19,010 --> 00:10:15,690
you what the design of web looks like

186
00:10:21,380 --> 00:10:19,020
maybe this will help to explain why it's

187
00:10:22,640 --> 00:10:21,390
so different from any other telescope

188
00:10:24,230 --> 00:10:22,650

now most people when you think of a

189
00:10:26,210 --> 00:10:24,240
telescope you think of it too right

190
00:10:29,329 --> 00:10:26,220
astronomers looking through a tube in

191
00:10:32,810 --> 00:10:29,339
some fashion and on the graphic you can

192
00:10:34,579 --> 00:10:32,820
see two of the tube type telescopes that

193
00:10:35,960 --> 00:10:34,589
people might be familiar with the Hubble

194
00:10:38,150 --> 00:10:35,970
Space Telescope which folks have heard

195
00:10:39,920 --> 00:10:38,160
of and the Spitzer Space Telescope which

196
00:10:42,320 --> 00:10:39,930
is maybe not quite as household a name

197
00:10:45,980 --> 00:10:42,330
but it's an infrared telescope that NASA

198
00:10:47,990 --> 00:10:45,990
is using today in many ways web is the

199
00:10:50,449 --> 00:10:48,000
offspring of these two telescopes it

200
00:10:53,329 --> 00:10:50,459
will have this much larger mirror that

201
00:10:55,460 --> 00:10:53,339
you see up there on the right-hand part

202
00:10:57,620 --> 00:10:55,470
of the picture looking off to the right

203
00:11:00,530 --> 00:10:57,630
and light will come in from the right

204
00:11:02,390 --> 00:11:00,540
hit that primary mirror bounced off a

205
00:11:05,030 --> 00:11:02,400
little secondary mirror sticking out on

206
00:11:06,890 --> 00:11:05,040
the tower or back through the cone into

207
00:11:08,900 --> 00:11:06,900
the science instruments behind and

208
00:11:11,750 --> 00:11:08,910
that's where all the detection

209
00:11:14,210 --> 00:11:11,760
of a light comes and then it is sent

210
00:11:16,280 --> 00:11:14,220
down to astronomers here on earth where

211
00:11:18,770 --> 00:11:16,290
they will begin the exciting task of

212
00:11:21,260 --> 00:11:18,780
unraveling with these signals mean and i

213
00:11:25,310 --> 00:11:21,270

think but will do next is turn it over

214
00:11:26,390 --> 00:11:25,320
to Amber strong and she can tell us a

215
00:11:27,920 --> 00:11:26,400
little bit about what they're going to

216
00:11:32,690 --> 00:11:27,930
be doing with those data when they come

217
00:11:35,630 --> 00:11:32,700
down sure hi so I am an astrophysicist

218
00:11:37,640 --> 00:11:35,640
here at NASA my job is to study star

219
00:11:40,130 --> 00:11:37,650
formation in distant galaxies usually

220
00:11:43,040 --> 00:11:40,140
mainly the Hubble Space Telescope and so

221
00:11:45,470 --> 00:11:43,050
in a really real sense this telescope is

222
00:11:47,450 --> 00:11:45,480
the future of astronomy will be able to

223
00:11:49,340 --> 00:11:47,460
use this telescope to answer these big

224
00:11:52,190 --> 00:11:49,350
sign it's questions that how we'll just

225
00:11:54,170 --> 00:11:52,200
can't quite answer so in that sense I am

226
00:11:55,850 --> 00:11:54,180
a future user of this observatory I'm

227
00:11:57,530 --> 00:11:55,860
really exciting about the great things

228
00:11:59,600 --> 00:11:57,540
we're going to learn which dr. Mathers

229
00:12:02,780 --> 00:11:59,610
already talked about some and then my

230
00:12:04,340 --> 00:12:02,790
other job kind of on the project is I do

231
00:12:06,860 --> 00:12:04,350
communications and outreach for the

232
00:12:09,470 --> 00:12:06,870
program so part of my job is to to get

233
00:12:11,090 --> 00:12:09,480
the the news about the telescope out to

234
00:12:13,400 --> 00:12:11,100
the public and to get people excited

235
00:12:15,980 --> 00:12:13,410
about the this awesome telescope the

236
00:12:18,410 --> 00:12:15,990
rebuilding and that's really am that's a

237
00:12:20,540 --> 00:12:18,420
fun part of my job it's easy to do but

238
00:12:22,880 --> 00:12:20,550

because this telescope is really easy to

239
00:12:24,830 --> 00:12:22,890
get excited about this is Hubble two

240
00:12:27,440 --> 00:12:24,840
point oh we're building this telescope

241
00:12:28,850 --> 00:12:27,450
again to answer those big questions in

242
00:12:31,250 --> 00:12:28,860
astronomy this will be the biggest

243
00:12:32,870 --> 00:12:31,260
telescope ever put into space and we're

244
00:12:35,150 --> 00:12:32,880
building it to answer the biggest

245
00:12:37,190 --> 00:12:35,160
science questions of our day in the

246
00:12:43,840 --> 00:12:37,200
terms of astronomy the lots of exciting

247
00:12:45,800 --> 00:12:43,850
things that we have planned um again the

248
00:12:48,320 --> 00:12:45,810
inspiration I think that were able to

249
00:12:52,490 --> 00:12:48,330
gain from big bold missions like this is

250
00:12:54,080 --> 00:12:52,500
a huge part of what NASA dies and we're

251
00:12:55,220 --> 00:12:54,090
just really excited about about all the

252
00:12:57,680 --> 00:12:55,230
things that we have planned for this

253
00:13:00,320 --> 00:12:57,690
telescope both ended the scientific

254
00:13:02,030 --> 00:13:00,330
sense about what will learn and also the

255
00:13:04,550 --> 00:13:02,040
engineering behind this telescope is

256
00:13:06,410 --> 00:13:04,560
incredible so I believe we'll pass it on

257
00:13:07,790 --> 00:13:06,420
now and and hear a little bit more about

258
00:13:19,710 --> 00:13:07,800
the engineering and some of the people

259
00:13:28,000 --> 00:13:23,050
hi JD thank you very much I hope

260
00:13:29,829 --> 00:13:28,010
everybody can hear me up I'm John

261
00:13:33,130 --> 00:13:29,839
ehrenberg I'm the chief engineer for

262
00:13:35,949 --> 00:13:33,140
Northrop Grumman and I'm happy to be

263
00:13:40,060 --> 00:13:35,959

here today sharing great program with

264
00:13:42,960 --> 00:13:40,070
you it's a true challenge the

265
00:13:46,199 --> 00:13:42,970
engineering job of a lifetime to build

266
00:13:49,180 --> 00:13:46,209
jwst we've had many years of steady

267
00:13:51,750 --> 00:13:49,190
technical progress we've recently

268
00:13:55,960 --> 00:13:51,760
completed all the optics for the flight

269
00:14:00,910 --> 00:13:55,970
optical system the primary can I be

270
00:14:03,069 --> 00:14:00,920
heard primary secondary and tertiary

271
00:14:05,949 --> 00:14:03,079
mirrors are all finished and are in the

272
00:14:08,980 --> 00:14:05,959
process of being delivered the structure

273
00:14:12,850 --> 00:14:08,990
it's going to old the mirrors up is

274
00:14:14,380 --> 00:14:12,860
nearing completion the wings that hold

275
00:14:18,579 --> 00:14:14,390
the deployable sections of the mirror

276
00:14:20,250 --> 00:14:18,589
are complete and being tested and the

277
00:14:22,930 --> 00:14:20,260
spacecraft has actually be done

278
00:14:26,170 --> 00:14:22,940
fabrication so we've had a lot of

279
00:14:27,699 --> 00:14:26,180
progress as jeff has said we as

280
00:14:30,910 --> 00:14:27,709
engineers are looking forward to

281
00:14:35,230 --> 00:14:30,920
building this great observatory for the

282
00:14:39,939 --> 00:14:35,240
astronomers Don amber Eric and the world

283
00:14:47,199 --> 00:14:39,949
at large so I look forward to your

284
00:14:50,550 --> 00:14:47,209
questions all right thank you once again

285
00:14:53,170 --> 00:14:50,560
it's against it like a question that we

286
00:14:57,130 --> 00:14:53,180
finished fingers why should we shoot as

287
00:15:00,880 --> 00:14:57,140
well or you can leave a message a fav

288
00:15:04,030 --> 00:15:00,890

ayer keroh going to twitter our first

289
00:15:06,699 --> 00:15:04,040
question comes from a group here what're

290
00:15:10,150 --> 00:15:06,709
you over the web we decode the mystery

291
00:15:17,530 --> 00:15:10,160
game the birth of our galaxy ops and I

292
00:15:20,500 --> 00:15:17,540
guess I prefer John matter well how did

293
00:15:23,139 --> 00:15:20,510
our galaxy form we have a theory we have

294
00:15:25,870 --> 00:15:23,149
a story which we get from computer

295
00:15:28,180 --> 00:15:25,880
simulations we have mapped the early

296
00:15:31,150 --> 00:15:28,190
universe with the cosmic microwave back

297
00:15:33,610 --> 00:15:31,160
radiation radiation we saw that it has

298
00:15:37,720 --> 00:15:33,620
hot and cold spots in it and we predict

299
00:15:39,970 --> 00:15:37,730
that gravitation acting on those regions

300
00:15:41,380 --> 00:15:39,980
will be able to pull material back from

301
00:15:44,560 --> 00:15:41,390
the expansion and cause it to collapse

302
00:15:46,480 --> 00:15:44,570
back down into objects so prediction is

303
00:15:49,240 --> 00:15:46,490
that the objects that form first will be

304
00:15:51,280 --> 00:15:49,250
small and that they will be continually

305
00:15:54,430 --> 00:15:51,290
colliding with each other and merging

306
00:15:56,590 --> 00:15:54,440
together to make a larger galaxy so if

307
00:15:58,390 --> 00:15:56,600
this story is correct then our Milky Way

308
00:16:00,160 --> 00:15:58,400
was made of thousands or tens of

309
00:16:02,890 --> 00:16:00,170
thousands of small objects that came

310
00:16:05,620 --> 00:16:02,900
together through the force of gravity so

311
00:16:07,000 --> 00:16:05,630
how would we know if this is true we

312
00:16:09,160 --> 00:16:07,010
can't just believe a computer simulation

313
00:16:13,480 --> 00:16:09,170

have to go look and see with the

314
00:16:14,830 --> 00:16:13,490
telescope as far back as we can so we

315
00:16:16,570 --> 00:16:14,840
take pictures of the most distant

316
00:16:18,760 --> 00:16:16,580
universe and we have already discovered

317
00:16:20,740 --> 00:16:18,770
that the early galaxies the ones that

318
00:16:23,230 --> 00:16:20,750
are that we see very far away because

319
00:16:25,810 --> 00:16:23,240
we're looking back at time as we look

320
00:16:29,080 --> 00:16:25,820
for our way those galaxies are small and

321
00:16:31,150 --> 00:16:29,090
irregular in shape but they formed much

322
00:16:34,300 --> 00:16:31,160
earlier than people had expected a few

323
00:16:36,550 --> 00:16:34,310
decades ago so our job now is to observe

324
00:16:39,700 --> 00:16:36,560
them as close to the earliest moments of

325
00:16:41,710 --> 00:16:39,710
universe as we can that takes this giant

326
00:16:43,870 --> 00:16:41,720
intra read telescope because these

327
00:16:49,150 --> 00:16:43,880
objects are small and they're going away

328
00:16:51,640 --> 00:16:49,160
from us very rapidly alright thanks John

329
00:16:56,950 --> 00:16:51,650
we have a question here I guess would go

330
00:16:58,560 --> 00:16:56,960
toward to Eric Smith once we launch jwst

331
00:17:00,640 --> 00:16:58,570
how long do we expect it to actually

332
00:17:11,250 --> 00:17:00,650
live or how long we'll be able to pull

333
00:17:17,800 --> 00:17:15,970
thanks JD the mission has what's called

334
00:17:19,329 --> 00:17:17,810
a five year design life time so that

335
00:17:22,590 --> 00:17:19,339
sort of dictates the type of quality

336
00:17:25,120 --> 00:17:22,600
parts you want to use but we we have a

337
00:17:27,429 --> 00:17:25,130
fuel tank on board which we use to do

338
00:17:29,740 --> 00:17:27,439

station keeping that will be sized for

339
00:17:31,900 --> 00:17:29,750
about 10 years of life so the mission

340
00:17:33,970 --> 00:17:31,910
will last sometime between five and ten

341
00:17:38,480 --> 00:17:33,980
years once it reaches its orbit and

342
00:17:40,760 --> 00:17:38,490
begins operating okay

343
00:17:42,470 --> 00:17:40,770
next question is I'm going to throw this

344
00:17:44,960 --> 00:17:42,480
to you amber I'm not sure if you'll know

345
00:17:47,270 --> 00:17:44,970
it might need to go to John out in

346
00:17:50,930 --> 00:17:47,280
California but what's the power source

347
00:17:55,299 --> 00:17:50,940
for jwst once we get it up in the open

348
00:17:59,570 --> 00:17:55,309
space John why don't you take this one

349
00:18:01,700 --> 00:17:59,580
the power source is solar power we have

350
00:18:04,250 --> 00:18:01,710
we're electrically powered we're very

351
00:18:07,730 --> 00:18:04,260
close to the Sun we're only a million

352
00:18:20,570 --> 00:18:07,740
miles away so conventional solar power

353
00:18:21,980 --> 00:18:20,580
will work just fine okay we're about the

354
00:18:29,240 --> 00:18:21,990
same distance from the Sun as the earth

355
00:18:30,470 --> 00:18:29,250
is ok but let's talk a little bit about

356
00:18:34,190 --> 00:18:30,480
the data that we're going to pull down

357
00:18:36,140 --> 00:18:34,200
from jwst what is the data come down at

358
00:18:39,880 --> 00:18:36,150
where is it stored and who's able to use

359
00:18:43,669 --> 00:18:39,890
it amber why don't you take that one

360
00:18:46,820 --> 00:18:43,679
well when once jdc is in space it will

361
00:18:50,930 --> 00:18:46,830
operate in a manner similar to Hubble so

362
00:18:53,990 --> 00:18:50,940
um in as far as who who gets to use the

363
00:18:55,760 --> 00:18:54,000

data every year astronomers from around

364
00:18:58,669 --> 00:18:55,770
the world get together and proposed

365
00:19:00,500 --> 00:18:58,679
their best ideas on and that's how we

366
00:19:02,840 --> 00:19:00,510
decide who gets to use Hubble and who

367
00:19:05,240 --> 00:19:02,850
gets to observe with Hubble so that same

368
00:19:06,710 --> 00:19:05,250
same method will apply for Jade reust

369
00:19:08,810 --> 00:19:06,720
that's one of the really great things

370
00:19:10,940 --> 00:19:08,820
about these big NASA telescope TSA's in

371
00:19:12,860 --> 00:19:10,950
a sense they're open source you know the

372
00:19:15,080 --> 00:19:12,870
people with the best ideas get to use

373
00:19:17,000 --> 00:19:15,090
the telescopes and then once the data is

374
00:19:19,250 --> 00:19:17,010
taken the data is public anyone in the

375
00:19:23,299 --> 00:19:19,260
world can go in and download Hubble data

376
00:19:25,760 --> 00:19:23,309
and that will be the same with jwst now

377
00:19:28,400 --> 00:19:25,770
is there a reservation time we're only

378
00:19:30,440 --> 00:19:28,410
JWT engineers or scientists can use the

379
00:19:31,910 --> 00:19:30,450
data or another way to put it is how

380
00:19:36,500 --> 00:19:31,920
long before that dad will be available

381
00:19:37,790 --> 00:19:36,510
to say foreign foreign scientists so I

382
00:19:39,950 --> 00:19:37,800
think there are different prepare

383
00:19:41,419 --> 00:19:39,960
proprietary times for different sorts of

384
00:19:46,220 --> 00:19:41,429
programs Eric might be able to answer

385
00:19:47,480 --> 00:19:46,230
that a bit better sure amber the way

386
00:19:49,730 --> 00:19:47,490
that it's going to work for web is

387
00:19:51,810 --> 00:19:49,740
similar to Hubble so there's what's

388
00:19:53,790 --> 00:19:51,820

called a period of exclusive use

389
00:19:55,890 --> 00:19:53,800
when the data come down those scientists

390
00:19:58,920 --> 00:19:55,900
who proposed the idea yet more or less

391
00:20:01,200 --> 00:19:58,930
first crack at it for about a year

392
00:20:03,510 --> 00:20:01,210
twelve month period but what many

393
00:20:05,910 --> 00:20:03,520
astronomers are doing in their proposals

394
00:20:08,400 --> 00:20:05,920
is just waving that proprietary period

395
00:20:09,750 --> 00:20:08,410
so the actual time from when it comes

396
00:20:11,640 --> 00:20:09,760
down from the telescope to when the

397
00:20:14,490 --> 00:20:11,650
public can get it varies but it's never

398
00:20:16,200 --> 00:20:14,500
more than 12 months and foreign

399
00:20:20,670 --> 00:20:16,210
scientists have the same rights as US

400
00:20:22,830 --> 00:20:20,680
scientists thanks Eric Jeff I know we

401
00:20:27,570 --> 00:20:22,840
had some initial audio problems from

402
00:20:30,000 --> 00:20:27,580
listening to you in your initial pitch

403
00:20:32,280 --> 00:20:30,010
but uh here's a question for you our

404
00:20:35,250 --> 00:20:32,290
budget constraints going to delay the

405
00:21:22,860 --> 00:20:35,260
launch of JWST you'll be launching in

406
00:21:24,300 --> 00:21:22,870
October 2018 for some reason we're still

407
00:21:27,330 --> 00:21:24,310
having some audio problems with your

408
00:21:30,120 --> 00:21:27,340
microphone there but we'll have somebody

409
00:21:32,190 --> 00:21:30,130
up to try and get that fixed Eric I

410
00:21:34,650 --> 00:21:32,200
think this is going to come to you can

411
00:21:39,150 --> 00:21:34,660
you give us a background real quick on

412
00:21:42,960 --> 00:21:39,160
how jwst JWST is going to unfold after

413
00:21:45,750 --> 00:21:42,970

it gets to the Lagrange point sure it

414
00:21:48,090 --> 00:21:45,760
actually unfolds before it gets out of

415
00:21:51,330 --> 00:21:48,100
the garage point John arenberg mentioned

416
00:21:53,520 --> 00:21:51,340
this as after we launched and as it's on

417
00:21:55,440 --> 00:21:53,530
its way out to the second Lagrange point

418
00:21:57,510 --> 00:21:55,450
which is four times farther from the

419
00:22:01,590 --> 00:21:57,520
earth and the moon is it actually does

420
00:22:04,580 --> 00:22:01,600
all its deployment of sort of when it's

421
00:22:06,590 --> 00:22:04,590
getting around the moon so

422
00:22:09,019 --> 00:22:06,600
if if you wanted a more detailed

423
00:22:10,940 --> 00:22:09,029
description of the actual deployment

424
00:22:14,419 --> 00:22:10,950
timeline I think John ehrenberg would be

425
00:22:17,659 --> 00:22:14,429
the person to address that question hey

426
00:22:20,390 --> 00:22:17,669
John to me about that sure I'd be happy

427
00:22:21,799 --> 00:22:20,400
to our first deployment occurs about two

428
00:22:24,049 --> 00:22:21,809
minutes after we separate from the

429
00:22:26,299 --> 00:22:24,059
launcher and that's the solar array that

430
00:22:28,399 --> 00:22:26,309
I was mentioning before so that we have

431
00:22:32,269 --> 00:22:28,409
power to continue and after about three

432
00:22:36,019 --> 00:22:32,279
days the large pallets that contain the

433
00:22:41,620 --> 00:22:36,029
sunshield deploy that is they move down

434
00:22:45,769 --> 00:22:41,630
to their flight composition push out the

435
00:22:48,940 --> 00:22:45,779
sides of the sunshield deploy the

436
00:22:52,460 --> 00:22:48,950
telescope but comes up on its tower up

437
00:22:54,860 --> 00:22:52,470
and then the wings and secondary deploy

438
00:22:57,889 --> 00:22:54,870

this is completed about two weeks after

439
00:23:01,460 --> 00:22:57,899
launch allowing the telescope too cool

440
00:23:04,760 --> 00:23:01,470
for approximately two months and allow

441
00:23:07,460 --> 00:23:04,770
it to be able to take data at that point

442
00:23:09,830 --> 00:23:07,470
the wavefront sensing begins in the

443
00:23:11,600 --> 00:23:09,840
final stage of the deployment or the

444
00:23:14,570 --> 00:23:11,610
alignment of the primary mirror and

445
00:23:18,200 --> 00:23:14,580
secondary mirror is undertaken giving us

446
00:23:21,950 --> 00:23:18,210
an operational telescope if people want

447
00:23:24,409 --> 00:23:21,960
to see a better animated view of all the

448
00:23:26,810 --> 00:23:24,419
details I refer you to the deployment

449
00:23:33,440 --> 00:23:26,820
video that you can find on the official

450
00:23:37,070 --> 00:23:33,450
jwst website thanks Jonathan so I think

451
00:23:40,730 --> 00:23:37,080
this next question to John matter can

452
00:23:43,639 --> 00:23:40,740
you tell us why we didn't develop the

453
00:23:47,330 --> 00:23:43,649
web for servicing like we did originally

454
00:23:48,769 --> 00:23:47,340
with Hubble yes of course that was the

455
00:23:51,769 --> 00:23:48,779
very first question our team had to

456
00:23:53,630 --> 00:23:51,779
consider because we knew that Hubble was

457
00:23:56,419 --> 00:23:53,640
a successful project because of

458
00:23:58,340 --> 00:23:56,429
servicing however we were not able to

459
00:24:01,190 --> 00:23:58,350
find a place to put the telescope that

460
00:24:03,590 --> 00:24:01,200
could enable it to be cold anywhere that

461
00:24:05,389 --> 00:24:03,600
the astronauts could reach it so the

462
00:24:06,980 --> 00:24:05,399
telescope has to be cold so that it can

463
00:24:08,750 --> 00:24:06,990

observe the injury red light that we've

464
00:24:10,940 --> 00:24:08,760
never been able to observe before and

465
00:24:13,220 --> 00:24:10,950
there's no place close to earth where we

466
00:24:15,980 --> 00:24:13,230
can go where we can arrange for that so

467
00:24:18,259 --> 00:24:15,990
the first closest place we could go was

468
00:24:20,029 --> 00:24:18,269
this place we have chosen the Thunder

469
00:24:23,509 --> 00:24:20,039
Lagrange point a million miles farther

470
00:24:25,310 --> 00:24:23,519
out the Sun than we are so a million

471
00:24:27,859 --> 00:24:25,320
miles is farther than the astronauts can

472
00:24:31,699 --> 00:24:27,869
go right today so that's why it's not

473
00:24:33,769 --> 00:24:31,709
designed for servicing if the technology

474
00:24:36,680 --> 00:24:33,779
continues to progress then robotic

475
00:24:38,329 --> 00:24:36,690
servicing will probably be available but

476
00:24:40,489 --> 00:24:38,339
we have not designed it to be able to

477
00:24:46,789 --> 00:24:40,499
use that no user serviceable parts

478
00:24:48,829 --> 00:24:46,799
inside thanks John Jonathan we're going

479
00:24:51,499 --> 00:24:48,839
to go back to you a lots been said about

480
00:24:53,930 --> 00:24:51,509
the technological innovation doing it

481
00:24:56,749 --> 00:24:53,940
well can you explain what that we even

482
00:25:00,379 --> 00:24:56,759
give us an example of that sure I'd be

483
00:25:01,549 --> 00:25:00,389
happy to in fact my first job on JWST

484
00:25:04,279 --> 00:25:01,559
was developing one of those new

485
00:25:06,409 --> 00:25:04,289
technologies back prior to the

486
00:25:08,930 --> 00:25:06,419
preliminary design review when we had to

487
00:25:11,509 --> 00:25:08,940
be confirmed as a mission there were ten

488
00:25:15,440 --> 00:25:11,519

identified technologies that needed to

489
00:25:18,349 --> 00:25:15,450
be proven to outside experts to be ready

490
00:25:22,879 --> 00:25:18,359
to enable us to build the web a one of

491
00:25:26,329 --> 00:25:22,889
those backplane and I was the test

492
00:25:31,339 --> 00:25:26,339
conductor that brand the test we took a

493
00:25:34,039 --> 00:25:31,349
sixth section 6 of the backplane and put

494
00:25:37,609 --> 00:25:34,049
it into a test chamber and showed but it

495
00:25:40,849 --> 00:25:37,619
would perform deforming only a few

496
00:25:43,369 --> 00:25:40,859
nanometers per Kelvin and meeting our

497
00:25:46,609 --> 00:25:43,379
requirements so we did a number of

498
00:25:49,489 --> 00:25:46,619
technology developments areas and the

499
00:25:51,829 --> 00:25:49,499
detector electronics materials to build

500
00:25:55,909 --> 00:25:51,839
the telescope the mirrors themselves on

501
00:25:57,579 --> 00:25:55,919
that was completed about 2007 so a

502
00:26:00,799 --> 00:25:57,589
number of technologies were developed

503
00:26:02,299 --> 00:26:00,809
unlike previous missions there was a

504
00:26:07,419 --> 00:26:02,309
large investment in this program up

505
00:26:11,269 --> 00:26:07,429
front thanks Jonathan next question is

506
00:26:13,639 --> 00:26:11,279
once the web is in orbit propulsion

507
00:26:16,669 --> 00:26:13,649
systems will use it will be used to

508
00:26:18,859 --> 00:26:16,679
maneuver to maneuver the spacecraft to

509
00:26:22,089 --> 00:26:18,869
actually look at objects in space Eric

510
00:26:26,690 --> 00:26:22,099
we're going to send this one to you okay

511
00:26:28,009 --> 00:26:26,700
when the web is a on orbit out at l2 it

512
00:26:30,919 --> 00:26:28,019
doesn't actually sit there it orbits the

513
00:26:32,000 --> 00:26:30,929

point it will use reaction wheels and

514
00:26:33,890 --> 00:26:32,010
gyroscopes just

515
00:26:37,340 --> 00:26:33,900
like the Hubble Space Telescope does to

516
00:26:38,930 --> 00:26:37,350
control its pointing and over time it

517
00:26:40,400 --> 00:26:38,940
will use that fuel that I mentioned

518
00:26:42,530 --> 00:26:40,410
earlier to do what's called

519
00:26:45,110 --> 00:26:42,540
station-keeping to keep it in this orbit

520
00:26:47,350 --> 00:26:45,120
around l2 but it will have these

521
00:26:50,960 --> 00:26:47,360
spinning flywheels you can think of a

522
00:26:53,780 --> 00:26:50,970
think of them that way six of those and

523
00:26:56,840 --> 00:26:53,790
as you move and change their rates of

524
00:26:58,700 --> 00:26:56,850
speed the telescope up you know reacts

525
00:27:00,710 --> 00:26:58,710
opposite to that the equal and opposite

526
00:27:03,560 --> 00:27:00,720
force and so that's how you point and

527
00:27:05,600 --> 00:27:03,570
control it once the telescope is looking

528
00:27:07,340 --> 00:27:05,610
at a particular target then we use an

529
00:27:09,860 --> 00:27:07,350
instrument called a fine guidance sensor

530
00:27:14,150 --> 00:27:09,870
which was given to us by the Canadian

531
00:27:16,760 --> 00:27:14,160
Space Agency and it will lock JWST or

532
00:27:18,560 --> 00:27:16,770
web on to a particular star and then

533
00:27:21,080 --> 00:27:18,570
these reaction wheels will keep that

534
00:27:22,990 --> 00:27:21,090
star steady allowing the other science

535
00:27:27,500 --> 00:27:23,000
instruments to collect their data

536
00:27:31,040 --> 00:27:27,510
obviously this this question is going to

537
00:27:34,030 --> 00:27:31,050
be targeted toward John Mather how will

538
00:27:37,670 --> 00:27:34,040

other telescopes on earth or like on

539
00:27:39,620 --> 00:27:37,680
mukhiya mauna kea overlapped the

540
00:27:42,530 --> 00:27:39,630
capabilities of the James Webb Space

541
00:27:44,420 --> 00:27:42,540
Telescope but we've designed our

542
00:27:45,800 --> 00:27:44,430
Observatory to be complementary to

543
00:27:47,780 --> 00:27:45,810
everything that we knew that could be

544
00:27:49,640 --> 00:27:47,790
accomplished on the ground there's no

545
00:27:51,380 --> 00:27:49,650
point in putting a great effort to put a

546
00:27:53,240 --> 00:27:51,390
telescope in space if somebody could do

547
00:27:54,620 --> 00:27:53,250
it as well or better on the ground

548
00:27:58,280 --> 00:27:54,630
because it's always cheaper to do it on

549
00:28:00,170 --> 00:27:58,290
the ground if you can so our telescope

550
00:28:01,610 --> 00:28:00,180
the James Webb telescope is built to

551
00:28:04,120 --> 00:28:01,620
observe it into red wavelengths that

552
00:28:06,650 --> 00:28:04,130
really can't be seen from the ground

553
00:28:09,050 --> 00:28:06,660
because the telescope on the ground will

554
00:28:10,640 --> 00:28:09,060
glow and emit it's only a red light or

555
00:28:13,820 --> 00:28:10,650
because the atmosphere is opaque it

556
00:28:15,440 --> 00:28:13,830
stops the light from coming in so for

557
00:28:17,570 --> 00:28:15,450
both reasons we've designed our

558
00:28:19,340 --> 00:28:17,580
Observatory to do those particular

559
00:28:21,980 --> 00:28:19,350
features that are difficult from the

560
00:28:24,170 --> 00:28:21,990
ground on the other hand some things can

561
00:28:26,090 --> 00:28:24,180
be done on the ground as the great Keck

562
00:28:28,520 --> 00:28:26,100
telescope has been complimentary to the

563
00:28:30,050 --> 00:28:28,530

564
00:28:32,900 --> 00:28:30,060
with each one can be followed up with

565
00:28:36,110 --> 00:28:32,910
the other one so we expect the similar

566
00:28:38,990 --> 00:28:36,120
features to in the future as you know

567
00:28:40,520 --> 00:28:39,000
we're building hoping to build some very

568
00:28:44,390 --> 00:28:40,530
very much larger telescopes on the

569
00:28:45,470 --> 00:28:44,400
ground maybe 20 30 40 meters in size

570
00:28:48,049 --> 00:28:45,480
there in

571
00:28:51,860 --> 00:28:48,059
of them are in progress already that's

572
00:28:53,840 --> 00:28:51,870
to say 60 80 100 feet across so much

573
00:28:57,980 --> 00:28:53,850
larger than the James Webb telescope

574
00:28:59,750 --> 00:28:57,990
even so as those telescopes are built

575
00:29:01,580 --> 00:28:59,760
and come online we certainly expect them

576
00:29:02,630 --> 00:29:01,590
to be used to follow up the discoveries

577
00:29:06,890 --> 00:29:02,640
that are made with the James Webb

578
00:29:08,090 --> 00:29:06,900
telescope alright thanks John amber

579
00:29:11,240 --> 00:29:08,100
we're going to send this question to you

580
00:29:14,350 --> 00:29:11,250
will there be any real-time image

581
00:29:18,560 --> 00:29:14,360
website capabilities with the James Webb

582
00:29:21,140 --> 00:29:18,570
12 top any real-time imaging

583
00:29:25,659 --> 00:29:21,150
capabilities well again the way we will

584
00:29:28,039 --> 00:29:25,669
use this telescope will be by selecting

585
00:29:31,190 --> 00:29:28,049
proposals that were written in event in

586
00:29:34,610 --> 00:29:31,200
advance to look at the most the most

587
00:29:37,370 --> 00:29:34,620
cool things in the universe so um there

588
00:29:39,409 --> 00:29:37,380

it really will be by a detailed process

589
00:29:41,659 --> 00:29:39,419
in order to pick out the right things to

590
00:29:43,400 --> 00:29:41,669
observe with this telescope so in terms

591
00:29:46,520 --> 00:29:43,410
of real time there won't be quite as

592
00:29:48,530 --> 00:29:46,530
much of that but as soon as these on big

593
00:29:50,930 --> 00:29:48,540
discoveries are made with web which we

594
00:29:53,360 --> 00:29:50,940
know will happen we will have a similar

595
00:29:55,730 --> 00:29:53,370
process of press releases and it will be

596
00:29:58,190 --> 00:29:55,740
active on social media so all of these

597
00:30:00,530 --> 00:29:58,200
things as soon as those results start to

598
00:30:04,990 --> 00:30:00,540
come out then we will we will definitely

599
00:30:07,220 --> 00:30:05,000
get them out to the public thanks amber

600
00:30:11,960 --> 00:30:07,230
one of the questions we have I'm going

601
00:30:13,940 --> 00:30:11,970
to send this to eric is how big are the

602
00:30:15,950 --> 00:30:13,950
mirrors going to be on the James Webb

603
00:30:17,960 --> 00:30:15,960
Space Telescope I know that they're

604
00:30:20,390 --> 00:30:17,970
going to be pretty large and the

605
00:30:22,789 --> 00:30:20,400
tolerances to be able to fold them and

606
00:30:24,230 --> 00:30:22,799
get them into the end of the rocket

607
00:30:27,710 --> 00:30:24,240
that's going to launch it into space is

608
00:30:30,970 --> 00:30:27,720
really really tight can you can give us

609
00:30:32,930 --> 00:30:30,980
a brief description of that sure the

610
00:30:35,630 --> 00:30:32,940
diameter if you will of course it's a

611
00:30:39,710 --> 00:30:35,640
two hexagon but the the diameter of the

612
00:30:42,530 --> 00:30:39,720
primary mirror is 21 and a half feet six

613
00:30:45,470 --> 00:30:42,540

and a half meters a Hubble is 2.4 meters

614
00:30:48,919 --> 00:30:45,480
just for a sense of comparison it's made

615
00:30:51,620 --> 00:30:48,929
up of 18 hexagonal segments each of

616
00:30:56,390 --> 00:30:51,630
those segments themselves are just a

617
00:30:58,610 --> 00:30:56,400
little under two meters in size and of

618
00:30:59,389 --> 00:30:58,620
course you want your mirror to be a nice

619
00:31:01,999 --> 00:30:59,399
and

620
00:31:04,219 --> 00:31:02,009
smooth across across its surface to give

621
00:31:08,089 --> 00:31:04,229
you those good sharp images and if you

622
00:31:09,499 --> 00:31:08,099
were to take the telescope mirror for

623
00:31:11,479 --> 00:31:09,509
James Webb Space Telescope make it as

624
00:31:13,219 --> 00:31:11,489
big as the United States so sort of you

625
00:31:16,399 --> 00:31:13,229
know imagine the mirror that large and

626
00:31:19,219 --> 00:31:16,409
the biggest ripples you would have in

627
00:31:20,719 --> 00:31:19,229
that sort of the mountains in the the

628
00:31:23,629 --> 00:31:20,729
country made up of the James Webb Space

629
00:31:26,029 --> 00:31:23,639
Telescope primary mirror would be less

630
00:31:28,549 --> 00:31:26,039
than three inches tall so that gives you

631
00:31:31,159 --> 00:31:28,559
some indication of how flat the the

632
00:31:36,829 --> 00:31:31,169
mirrors are and it's like I say 21 and a

633
00:31:38,779 --> 00:31:36,839
half feet across thanks Eric Jonathan

634
00:31:41,539 --> 00:31:38,789
can you tell us a little bit going back

635
00:31:43,849 --> 00:31:41,549
to these tolerances that when you're

636
00:31:48,680 --> 00:31:43,859
talking about stuff and tolerances to

637
00:31:51,079 --> 00:31:48,690
get a get the a capella scopes into

638
00:31:52,729 --> 00:31:51,089

Veronica well won't you have friends

639
00:31:55,450 --> 00:31:52,739
with vibration renew your code is

640
00:31:58,639 --> 00:31:55,460
actually a tantric awful watch manager

641
00:32:00,229 --> 00:31:58,649
let's see what vibration is a normal

642
00:32:03,159 --> 00:32:00,239
problem we have to deal with in

643
00:32:07,999 --> 00:32:03,169
designing satellites all of the mirrors

644
00:32:11,799 --> 00:32:08,009
are restrained for launch so called sin

645
00:32:14,119 --> 00:32:11,809
in a snubbed position I alluded to

646
00:32:16,820 --> 00:32:14,129
technology development one of the early

647
00:32:18,739 --> 00:32:16,830
technology developments that was related

648
00:32:23,149 --> 00:32:18,749
to the mirrors was proving that our

649
00:32:25,190 --> 00:32:23,159
mirror design would sustain survive just

650
00:32:27,859 --> 00:32:25,200
such large vibrations so we took a

651
00:32:30,889 --> 00:32:27,869
mirror blank or early in the in the

652
00:32:33,320 --> 00:32:30,899
program and subjected it to launch

653
00:32:36,200 --> 00:32:33,330
vibrations and prove that it maintained

654
00:32:39,259 --> 00:32:36,210
its shape so yes that is a serious

655
00:32:41,389 --> 00:32:39,269
concern it was addressed very early and

656
00:32:44,839 --> 00:32:41,399
that risk was retired about five years

657
00:32:46,909 --> 00:32:44,849
ago and as you can see if I could catch

658
00:32:49,909 --> 00:32:46,919
something I've seen and I think it may

659
00:32:51,799 --> 00:32:49,919
be visible on the Jedi VST website there

660
00:32:53,810 --> 00:32:51,809
might be some little videos of one of

661
00:32:55,369 --> 00:32:53,820
those mirror segments undergoing that

662
00:32:56,599 --> 00:32:55,379
violent shaking and I can tell you as an

663
00:32:58,909 --> 00:32:56,609

astronomer it's absolutely frightening

664
00:33:04,310 --> 00:32:58,919
to see that thing shake like that but

665
00:33:07,310 --> 00:33:04,320
it's gratifying to see it survive thanks

666
00:33:08,719 --> 00:33:07,320
Eric let's go to the next question here

667
00:33:10,190 --> 00:33:08,729
and once again if you'd like to ask a

668
00:33:12,770 --> 00:33:10,200
question you can do so right here on

669
00:33:16,790 --> 00:33:12,780
google+ or you can send

670
00:33:24,430 --> 00:33:16,800
question via Twitter to the hashtag ask

671
00:33:26,990 --> 00:33:24,440
NASA well the question is how will jwst

672
00:33:29,570 --> 00:33:27,000
observations help to better understand

673
00:33:32,240 --> 00:33:29,580
black holes John Mather we're going to

674
00:33:34,250 --> 00:33:32,250
go to you with this one okay well James

675
00:33:37,070 --> 00:33:34,260
Webb telescope will be observing the

676
00:33:39,590 --> 00:33:37,080
history of by hole formation by

677
00:33:43,610 --> 00:33:39,600
observing early galaxies to see where

678
00:33:44,930 --> 00:33:43,620
the black hole is a curve first so the

679
00:33:48,340 --> 00:33:44,940
way of course that we observed like

680
00:33:51,200 --> 00:33:48,350
holes is is by watching things fall in a

681
00:33:54,170 --> 00:33:51,210
black hole by definition is something

682
00:33:56,300 --> 00:33:54,180
where nothing can come out so what it

683
00:33:59,270 --> 00:33:56,310
does is it has extremely strong gravity

684
00:34:02,180 --> 00:33:59,280
and if a piece of material a gaseous

685
00:34:04,040 --> 00:34:02,190
cloud or a star or a planet were to fall

686
00:34:05,570 --> 00:34:04,050
in it would be compressed to a very high

687
00:34:07,640 --> 00:34:05,580
density and raised to a very high

688
00:34:09,950 --> 00:34:07,650

temperature and capable of transmitting

689
00:34:13,310 --> 00:34:09,960
very large amounts of power either

690
00:34:16,820 --> 00:34:13,320
x-rays or radio or it's red so that we

691
00:34:18,830 --> 00:34:16,830
can see them so that's our job is to see

692
00:34:20,840 --> 00:34:18,840
the history of that happening the big

693
00:34:23,889 --> 00:34:20,850
question for astronomers is which came

694
00:34:26,960 --> 00:34:23,899
first the the Galaxy or the black hole

695
00:34:28,610 --> 00:34:26,970
now that we see them today all the

696
00:34:30,649 --> 00:34:28,620
galaxies have at least one big black

697
00:34:33,260 --> 00:34:30,659
hole in the middle but we don't think

698
00:34:34,850 --> 00:34:33,270
the black holes started out big they

699
00:34:38,480 --> 00:34:34,860
probably started out small and then

700
00:34:40,580 --> 00:34:38,490
somehow grew by absorbing material so

701
00:34:43,010 --> 00:34:40,590
this is something to to be learned by

702
00:34:45,169 --> 00:34:43,020
observing we've got many stories from

703
00:34:47,090 --> 00:34:45,179
theoretical calculations but very

704
00:34:51,980 --> 00:34:47,100
difficult to explain the actual history

705
00:34:54,669 --> 00:34:51,990
that we've seen thanks John right now I

706
00:34:57,170 --> 00:34:54,679
think I hope we've got a jeff's

707
00:35:01,190 --> 00:34:57,180
microphone situation fixed but this

708
00:35:04,100 --> 00:35:01,200
question goes out to you a Jeff why is

709
00:35:07,070 --> 00:35:04,110
it taking so long to build and launch

710
00:35:08,420 --> 00:35:07,080
the web I mean we've we've delayed it a

711
00:35:11,720 --> 00:35:08,430
couple years ago and now we're looking

712
00:35:14,180 --> 00:35:11,730
at 2018 so that's still a good four

713
00:35:21,200 --> 00:35:14,190

years away almost five years so if you

714
00:36:00,890 --> 00:35:50,630
as in operating in temperatures we've

715
00:36:07,150 --> 00:36:00,900
never operated what you call the

716
00:36:19,990 --> 00:36:07,160
technologies I need to test technologies

717
00:36:32,300 --> 00:36:30,280
exercise all right John first I mean uh

718
00:36:35,930 --> 00:36:32,310
Jeff for some reason we're not able to

719
00:36:39,980 --> 00:36:35,940
get your audio cleared so we'll keep

720
00:36:41,690 --> 00:36:39,990
trying here's a great question and I'd

721
00:36:45,260 --> 00:36:41,700
like to go back to Jonathan with this

722
00:36:48,380 --> 00:36:45,270
one if we can jonathan is jwh doing

723
00:36:54,079 --> 00:36:48,390
dangerous really change the look very

724
00:36:56,240 --> 00:36:54,089
very let's see and we're not at risk for

725
00:36:59,450 --> 00:36:56,250
being hit by space debris our orbit is

726
00:37:01,490 --> 00:36:59,460
considerably above the typical low Earth

727
00:37:04,040 --> 00:37:01,500
orbit or even the geosynchronous orbit

728
00:37:08,170 --> 00:37:04,050
where lots of debris from previous space

729
00:37:10,730 --> 00:37:08,180
flights are but they are subject to

730
00:37:14,359 --> 00:37:10,740
micro meteoroids that are part of the

731
00:37:17,599 --> 00:37:14,369
inter planetary environment and one of

732
00:37:19,670 --> 00:37:17,609
the key jobs of the engineers like

733
00:37:23,510 --> 00:37:19,680
myself and all the members of the team

734
00:37:28,550 --> 00:37:23,520
is to design a system that is capable of

735
00:37:31,070 --> 00:37:28,560
surviving in that environment so we have

736
00:37:34,999 --> 00:37:31,080
as part of again the technology

737
00:37:37,289 --> 00:37:35,009
development that we talked about earlier

738
00:37:40,650 --> 00:37:37,299

elements of the sunshield in the mirrors

739
00:37:43,140 --> 00:37:40,660
the hypervelocity impacts and included

740
00:37:45,930 --> 00:37:43,150
those degradation 'he's in the design

741
00:37:49,109 --> 00:37:45,940
that is the design is a little bit more

742
00:37:51,630 --> 00:37:49,119
robust than it would have to be in the

743
00:37:54,989 --> 00:37:51,640
absence of this micrometeorite

744
00:37:57,839 --> 00:37:54,999
environment so the answer is we will be

745
00:38:00,329 --> 00:37:57,849
struck typically these micro meteorites

746
00:38:02,880 --> 00:38:00,339
are very very small but they have a lot

747
00:38:05,670 --> 00:38:02,890
of energy and their impacts on the

748
00:38:10,079 --> 00:38:05,680
system have been calculated and included

749
00:38:12,809 --> 00:38:10,089
in the design Thank You Jonathan well

750
00:38:16,680 --> 00:38:12,819
like to ask question of amber here that

751
00:38:20,640 --> 00:38:16,690
just came in who or what was the James

752
00:38:23,039 --> 00:38:20,650
Webb actually named after so James Webb

753
00:38:25,829 --> 00:38:23,049
was the administrator of NASA the leader

754
00:38:28,739 --> 00:38:25,839
of NASA during the development of the

755
00:38:31,229 --> 00:38:28,749
Apollo program so James Webb was largely

756
00:38:33,509 --> 00:38:31,239
responsible for helping us to get humans

757
00:38:36,630 --> 00:38:33,519
to walk on the moon which is pretty

758
00:38:38,729 --> 00:38:36,640
great obviously a very worthy thing for

759
00:38:41,370 --> 00:38:38,739
a telescope to be named after but in

760
00:38:43,410 --> 00:38:41,380
addition to that James Webb was the

761
00:38:46,019 --> 00:38:43,420
first person to say that in addition to

762
00:38:48,120 --> 00:38:46,029
sending rockets to space we also need to

763
00:38:50,160 --> 00:38:48,130

be doing science so he was a very big

764
00:38:52,079 --> 00:38:50,170
advocate for science early on in the

765
00:38:54,209 --> 00:38:52,089
early days of NASA so we thought that

766
00:38:57,719 --> 00:38:54,219
would be a really good person to name

767
00:39:00,450 --> 00:38:57,729
this awesome new telescope after sounds

768
00:39:04,039 --> 00:39:00,460
good it was a good choice as well here's

769
00:39:07,170 --> 00:39:04,049
a programming question for Eric Smith

770
00:39:10,380 --> 00:39:07,180
unfortunately we can't get hold of jeff

771
00:39:12,809 --> 00:39:10,390
right now but it takes so long for these

772
00:39:15,479 --> 00:39:12,819
telescopes to go through design and

773
00:39:17,160 --> 00:39:15,489
development and we've been involved with

774
00:39:21,150 --> 00:39:17,170
this one now for quite a number of years

775
00:39:25,109 --> 00:39:21,160
is jwst successor I'm the drawing board

776
00:39:27,839 --> 00:39:25,119
right now yes in fact the astronomical

777
00:39:29,519 --> 00:39:27,849
community is always thinking not only

778
00:39:31,319 --> 00:39:29,529
about the telescope's they have today

779
00:39:34,349 --> 00:39:31,329
but the telescopes they want to have in

780
00:39:37,109 --> 00:39:34,359
the future and they go through a process

781
00:39:39,299 --> 00:39:37,119
every ten years where they decide as a

782
00:39:45,209 --> 00:39:39,309
community how do we want to prioritize

783
00:39:47,610 --> 00:39:45,219
what to do next for our field and jwst

784
00:39:48,960 --> 00:39:47,620
was one of those top choices

785
00:39:51,300 --> 00:39:48,970
in one of those surveys and its

786
00:39:53,490 --> 00:39:51,310
continuing on and in the most recently

787
00:39:55,950 --> 00:39:53,500
concluded survey in 2010 they've already

788
00:39:58,770 --> 00:39:55,960

picked the type of mission they want to

789
00:40:00,480 --> 00:39:58,780
do next to follow after the Webb

790
00:40:02,820 --> 00:40:00,490
telescope and this would be a telescope

791
00:40:06,510 --> 00:40:02,830
that focuses on the the mystery of dark

792
00:40:08,760 --> 00:40:06,520
energy and so while web is looking at

793
00:40:12,000 --> 00:40:08,770
you know particular problems with early

794
00:40:13,800 --> 00:40:12,010
galaxies and exoplanets the mission that

795
00:40:16,410 --> 00:40:13,810
folks are thinking about coming down the

796
00:40:19,380 --> 00:40:16,420
line would be one that is focused on a

797
00:40:21,450 --> 00:40:19,390
dark energy as an exoplanets and surveys

798
00:40:26,850 --> 00:40:21,460
so yep we're always thinking about what

799
00:40:28,500 --> 00:40:26,860
comes next so good every thnx here's a

800
00:40:30,780 --> 00:40:28,510
question probably Eric you need to take

801
00:40:35,760 --> 00:40:30,790
as well are there any military

802
00:40:38,520 --> 00:40:35,770
applications for jwst the JWST is

803
00:40:42,300 --> 00:40:38,530
designed to look out into the cosmos

804
00:40:44,070 --> 00:40:42,310
look for very faint signals so this is

805
00:40:46,320 --> 00:40:44,080
not the type of telescope that would

806
00:40:48,300 --> 00:40:46,330
really see any useful military

807
00:40:49,860 --> 00:40:48,310
application unless of course we were

808
00:40:54,170 --> 00:40:49,870
able to detect Klingons or Romulans

809
00:40:59,430 --> 00:40:54,180
approaching solar system thanks Eric

810
00:41:01,500 --> 00:40:59,440
John Mather can you tell us about the

811
00:41:04,380 --> 00:41:01,510
goal of observing how planetary systems

812
00:41:07,430 --> 00:41:04,390
change over time what kind of changes

813
00:41:10,230 --> 00:41:07,440

are you expecting to observe with jwst

814
00:41:12,660 --> 00:41:10,240
okay well most planetary systems don't

815
00:41:15,630 --> 00:41:12,670
change very rapidly except that the

816
00:41:18,120 --> 00:41:15,640
planets go around the center so however

817
00:41:19,860 --> 00:41:18,130
when we are able to find the young

818
00:41:22,440 --> 00:41:19,870
planetary systems in the process of

819
00:41:24,840 --> 00:41:22,450
formation we expect those changes to be

820
00:41:27,150 --> 00:41:24,850
much more rapid so for instance there's

821
00:41:29,340 --> 00:41:27,160
ones planetary system called beta

822
00:41:31,770 --> 00:41:29,350
Pictoris where it seems that comets are

823
00:41:34,590 --> 00:41:31,780
falling into the central star quite

824
00:41:37,590 --> 00:41:34,600
frequently because we see changes of the

825
00:41:39,690 --> 00:41:37,600
of the light coming from that start that

826
00:41:42,510 --> 00:41:39,700
have the traces of the heavier elements

827
00:41:45,000 --> 00:41:42,520
that would be in a comet so that's one

828
00:41:47,730 --> 00:41:45,010
where we can see the other thing that we

829
00:41:49,850 --> 00:41:47,740
can do is to look at different planetary

830
00:41:52,490 --> 00:41:49,860
systems and see how they appear

831
00:41:54,900 --> 00:41:52,500
depending on how old they are and

832
00:41:57,480 --> 00:41:54,910
depending on what kind of star they're

833
00:41:59,850 --> 00:41:57,490
orbiting around and so so far it appears

834
00:42:01,450 --> 00:41:59,860
that the solar system is not common in

835
00:42:03,490 --> 00:42:01,460
its configuration that

836
00:42:05,410 --> 00:42:03,500
most of the planetary systems we've been

837
00:42:08,290 --> 00:42:05,420
able to find are not the same as our

838
00:42:10,180 --> 00:42:08,300

solar system now partly that's because

839
00:42:13,839 --> 00:42:10,190
it's easier to find certain kinds and

840
00:42:15,550 --> 00:42:13,849
others and planetary systems with large

841
00:42:19,390 --> 00:42:15,560
planets are clearly easier to find than

842
00:42:21,099 --> 00:42:19,400
those with small planets so we study

843
00:42:23,170 --> 00:42:21,109
what we can find and try to make a

844
00:42:26,680 --> 00:42:23,180
consistent story that explains

845
00:42:28,630 --> 00:42:26,690
everything that we see ranging from our

846
00:42:32,440 --> 00:42:28,640
ideas and our observations of young

847
00:42:34,390 --> 00:42:32,450
planetary systems so planetary systems

848
00:42:37,089 --> 00:42:34,400
that still have a lot of dust in them

849
00:42:38,890 --> 00:42:37,099
left over from the first moment to very

850
00:42:41,200 --> 00:42:38,900
old planetary systems that have no dust

851
00:42:43,359 --> 00:42:41,210
left at all of course one of the reasons

852
00:42:45,310 --> 00:42:43,369
for studying these things is this way is

853
00:42:47,470 --> 00:42:45,320
to see whether there are any candidates

854
00:42:49,930 --> 00:42:47,480
for direct observations for a future

855
00:42:53,440 --> 00:42:49,940
generation of telescopes we've designed

856
00:42:55,030 --> 00:42:53,450
and thinking about planetary systems for

857
00:42:57,700 --> 00:42:55,040
a long time something called the

858
00:43:00,820 --> 00:42:57,710
terrestrial planet finder was conceived

859
00:43:02,170 --> 00:43:00,830
well over ten years ago as a number of

860
00:43:04,570 --> 00:43:02,180
different choices that can be

861
00:43:06,730 --> 00:43:04,580
implemented to observe earth-like

862
00:43:09,780 --> 00:43:06,740
planets orbiting sun-like star is quite

863
00:43:14,500 --> 00:43:09,790

directly but it's a difficult project

864
00:43:15,880 --> 00:43:14,510
alright thanks John uh Jonathan I think

865
00:43:18,730 --> 00:43:15,890
this question is going to you it seems

866
00:43:21,490 --> 00:43:18,740
to be engineering related what is the

867
00:43:25,510 --> 00:43:21,500
maximum exposure time to share today was

868
00:43:29,050 --> 00:43:25,520
creaking services target before noise we

869
00:43:34,630 --> 00:43:29,060
change a column for the detection let's

870
00:43:36,880 --> 00:43:34,640
see our length is limited by how long we

871
00:43:38,980 --> 00:43:36,890
can point at a single object we're

872
00:43:43,030 --> 00:43:38,990
capable of pointing at a simple object

873
00:43:45,400 --> 00:43:43,040
for ten days that's by design the Sun

874
00:43:48,820 --> 00:43:45,410
shield is designed to take ten degrees

875
00:43:51,339 --> 00:43:48,830
of role as we go around the Sun the the

876
00:43:53,410 --> 00:43:51,349
noise really is a limitation of the

877
00:43:55,960 --> 00:43:53,420
faintness of the target and the

878
00:43:58,630 --> 00:43:55,970
temperature of the telescope and the

879
00:44:01,390 --> 00:43:58,640
detectors and so it's really not a

880
00:44:03,460 --> 00:44:01,400
length of exposure issue it's really

881
00:44:06,339 --> 00:44:03,470
about a brightness and temperature issue

882
00:44:08,950 --> 00:44:06,349
with the system but ten days is the

883
00:44:11,410 --> 00:44:08,960
longest we can look at a single target

884
00:44:13,570 --> 00:44:11,420
without repointing but the astronomers

885
00:44:15,250 --> 00:44:13,580
are very adept at piecing together these

886
00:44:18,610 --> 00:44:15,260
exposures in making

887
00:44:21,550 --> 00:44:18,620
many multi-million second exposures so

888
00:44:24,160 --> 00:44:21,560

there really is no limit except how much

889
00:44:29,350 --> 00:44:24,170
of the telescope's lifetime they want to

890
00:44:31,290 --> 00:44:29,360
dedicate to a single target amber this

891
00:44:35,830 --> 00:44:31,300
one's coming to you can you tell us how

892
00:44:37,750 --> 00:44:35,840
NASA goes about deciding which targets

893
00:44:40,420 --> 00:44:37,760
to actually target I mean what's the

894
00:45:00,220 --> 00:44:40,430
process for developing our target list

895
00:45:06,970 --> 00:45:00,230
so to speak so are you muted ever lost

896
00:45:08,830 --> 00:45:06,980
audio here amber we're not hearing you

897
00:45:13,540 --> 00:45:08,840
never we're not hearing you are you

898
00:45:14,620 --> 00:45:13,550
muted oh well we'll come back to you

899
00:45:17,740 --> 00:45:14,630
here in just a moment we'll give you a

900
00:45:19,980 --> 00:45:17,750
chance Eric this one this question is

901
00:45:23,500 --> 00:45:19,990
going to come back to you then if we can

902
00:45:25,720 --> 00:45:23,510
what happens to JWST after the

903
00:45:27,250 --> 00:45:25,730
instruments no longer work we'll just go

904
00:45:31,720 --> 00:45:27,260
in the graveyard around the Sun so to

905
00:45:34,330 --> 00:45:31,730
speak well NASA has to have their called

906
00:45:37,180 --> 00:45:34,340
disposal plans for anything that it puts

907
00:45:39,670 --> 00:45:37,190
up there now of course because web is a

908
00:45:41,920 --> 00:45:39,680
million miles away from the earth it's

909
00:45:43,540 --> 00:45:41,930
not the same type of disposal plan that

910
00:45:44,830 --> 00:45:43,550
you have to have for a satellite that's

911
00:45:48,790 --> 00:45:44,840
a near-earth orbit and would eventually

912
00:45:52,000 --> 00:45:48,800
come back into the atmosphere so this

913
00:45:54,220 --> 00:45:52,010

will stay in a solar orbit just like the

914
00:45:56,080 --> 00:45:54,230
earth going around the Sun for hundreds

915
00:45:57,730 --> 00:45:56,090
and hundreds of years until some culture

916
00:46:00,010 --> 00:45:57,740
in the future is able to go out there

917
00:46:03,670 --> 00:46:00,020
and capture it and bring it back and put

918
00:46:05,920 --> 00:46:03,680
it in a space museum somewhere sounds

919
00:46:09,610 --> 00:46:05,930
good John Mather we're going to target

920
00:46:13,030 --> 00:46:09,620
this question to you as you know the

921
00:46:15,130 --> 00:46:13,040
kepler space telescope has been staring

922
00:46:17,590 --> 00:46:15,140
at a lot of stars and has been finding a

923
00:46:22,000 --> 00:46:17,600
lot of planet candidates i can you tell

924
00:46:25,270 --> 00:46:22,010
us how jwst wants up will determine the

925
00:46:27,070 --> 00:46:25,280
atmosphere for these different planets

926
00:46:27,920 --> 00:46:27,080
to help us determine whether there's a

927
00:46:30,800 --> 00:46:27,930
possibility of

928
00:46:33,050 --> 00:46:30,810
on them yes sure well the way that the

929
00:46:35,060 --> 00:46:33,060
Kepler mission discovers planets is to

930
00:46:37,940 --> 00:46:35,070
stare in about a hundred thousand stars

931
00:46:40,610 --> 00:46:37,950
in the constellation of Cygnus all year

932
00:46:43,610 --> 00:46:40,620
long and once in a while a planet will

933
00:46:47,030 --> 00:46:43,620
go between us and the and the star so it

934
00:46:48,470 --> 00:46:47,040
will block some starlight and the subtle

935
00:46:50,450 --> 00:46:48,480
thing is that some of the star light

936
00:46:52,640 --> 00:46:50,460
passes through the planetary atmosphere

937
00:46:55,010 --> 00:46:52,650
on its way to the telescope now the

938
00:46:56,690 --> 00:46:55,020

Kepler mission doesn't have any special

939
00:46:58,970 --> 00:46:56,700
ways to analyze that light that went

940
00:47:01,190 --> 00:46:58,980
through the atmosphere of the planet but

941
00:47:03,530 --> 00:47:01,200
the James Webb telescope does we have

942
00:47:05,660 --> 00:47:03,540
something called a spectrometer so we

943
00:47:07,700 --> 00:47:05,670
spread the light out into a rainbow and

944
00:47:10,520 --> 00:47:07,710
we're able to recognize the particular

945
00:47:13,010 --> 00:47:10,530
changes that are due to the molecules in

946
00:47:14,510 --> 00:47:13,020
the atmosphere of those planets now most

947
00:47:17,600 --> 00:47:14,520
of the planets that are discovered by

948
00:47:20,570 --> 00:47:17,610
the Kepler mission are kind of far away

949
00:47:22,430 --> 00:47:20,580
and not very bright so we're also very

950
00:47:26,810 --> 00:47:22,440
eager to see other ones that are closer

951
00:47:28,850 --> 00:47:26,820
up so you might our audience might not

952
00:47:30,500 --> 00:47:28,860
know that a net mission has been

953
00:47:34,310 --> 00:47:30,510
selected for further study called the

954
00:47:36,500 --> 00:47:34,320
test tes s and it will be looking for

955
00:47:39,410 --> 00:47:36,510
the brightest nearby stars that also

956
00:47:41,840 --> 00:47:39,420
have planets that do this transiting

957
00:47:43,640 --> 00:47:41,850
phenomenon so when we know where to look

958
00:47:45,980 --> 00:47:43,650
and when to look the James Webb

959
00:47:47,270 --> 00:47:45,990
telescope will be able to tell the

960
00:47:50,450 --> 00:47:47,280
chemical constituents of those

961
00:47:52,250 --> 00:47:50,460
atmospheres so that's the ideal case is

962
00:47:54,680 --> 00:47:52,260
to have the nearest brightest objects

963
00:47:59,180 --> 00:47:54,690

and web is designed to be able to do

964
00:48:01,130 --> 00:47:59,190
that thanks John Jonathan we're going to

965
00:48:04,580 --> 00:48:01,140
go to you here's the another engineering

966
00:48:07,610 --> 00:48:04,590
type question how do you go walk signing

967
00:48:08,690 --> 00:48:07,620
or two more mega machine you can today w

968
00:48:13,330 --> 00:48:08,700
wife's clues what are the procedures

969
00:48:16,190 --> 00:48:13,340
interesting the procedures involve

970
00:48:18,710 --> 00:48:16,200
studying the studying the giant problem

971
00:48:21,370 --> 00:48:18,720
understanding what our customers the end

972
00:48:23,270 --> 00:48:21,380
users our astronomers want and

973
00:48:26,540 --> 00:48:23,280
decomposing it into smaller problems

974
00:48:28,760 --> 00:48:26,550
that can be solved this is a a little

975
00:48:30,800 --> 00:48:28,770
bit like the answer to the problem is

976
00:48:33,560 --> 00:48:30,810
how do you eat an elephant and the

977
00:48:36,800 --> 00:48:33,570
answer is one bite at a time so we

978
00:48:38,900 --> 00:48:36,810
divide the system into components and

979
00:48:41,780 --> 00:48:38,910
elements and they go into subsystems and

980
00:48:44,990 --> 00:48:41,790
components and assemblies

981
00:48:46,640 --> 00:48:45,000
and flowing down the requirements is one

982
00:48:49,430 --> 00:48:46,650
of the chief jobs of the systems

983
00:48:52,220 --> 00:48:49,440
engineers like myself and then verifying

984
00:48:54,350 --> 00:48:52,230
that that job has been done correctly

985
00:48:56,870 --> 00:48:54,360
and that when the system comes back

986
00:48:59,480 --> 00:48:56,880
together it's going to work is basically

987
00:49:02,360 --> 00:48:59,490
what I do all day so there are a number

988
00:49:08,030 --> 00:49:02,370

of people devoted early in the program

989
00:49:11,060 --> 00:49:08,040
to decomposing the problem is solvable

990
00:49:13,130 --> 00:49:11,070
provable answers and that they're

991
00:49:16,190 --> 00:49:13,140
connected in a logical fashion to give

992
00:49:18,470 --> 00:49:16,200
us a system that works and then as we

993
00:49:21,230 --> 00:49:18,480
come back up and build it we verify it

994
00:49:23,300 --> 00:49:21,240
so we like to think of it as a V and

995
00:49:25,670 --> 00:49:23,310
we're climbing up the the upside of the

996
00:49:26,840 --> 00:49:25,680
V proving that we've built the system

997
00:49:29,270 --> 00:49:26,850
that's going to work and give the

998
00:49:34,760 --> 00:49:29,280
astronomers the performance that we all

999
00:49:36,260 --> 00:49:34,770
want to deliver thanks Jonathan one of

1000
00:49:38,560 --> 00:49:36,270
the questions we got here that just came

1001
00:49:41,450 --> 00:49:38,570
in probably going to go to Eric Smith

1002
00:49:43,580 --> 00:49:41,460
and once again recopy recapping what

1003
00:49:45,380 --> 00:49:43,590
Jeff told us at the very beginning that

1004
00:49:49,430 --> 00:49:45,390
we had some minor problems with audio

1005
00:49:52,610 --> 00:49:49,440
wise JW tia is on cost is on budget is

1006
00:49:55,190 --> 00:49:52,620
on schedule but the question is what is

1007
00:49:58,550 --> 00:49:55,200
the exact cost of the entire JWST

1008
00:50:02,360 --> 00:49:58,560
program and the question is is it really

1009
00:50:05,840 --> 00:50:02,370
worth the investment Eric okay so the

1010
00:50:08,690 --> 00:50:05,850
cost to build or develop web and launch

1011
00:50:11,450 --> 00:50:08,700
it is eight billion dollars and then

1012
00:50:14,480 --> 00:50:11,460
there will be money used to operate it

1013
00:50:18,350 --> 00:50:14,490

after that and you can look that number

1014
00:50:21,140 --> 00:50:18,360
up and it's about 8.8 billion dollars to

1015
00:50:23,090 --> 00:50:21,150
build and operate web for five years if

1016
00:50:24,500 --> 00:50:23,100
it operates longer it obviously costs

1017
00:50:26,630 --> 00:50:24,510
more to operate because you're operating

1018
00:50:30,170 --> 00:50:26,640
it longer and so then the question comes

1019
00:50:32,360 --> 00:50:30,180
to the worth of a mission like this of

1020
00:50:34,040 --> 00:50:32,370
course because I've devoted much of my

1021
00:50:37,220 --> 00:50:34,050
career to working on this I clearly

1022
00:50:40,760 --> 00:50:37,230
believe that this is worth that this is

1023
00:50:43,760 --> 00:50:40,770
pushing a humankind's knowledge of the

1024
00:50:46,100 --> 00:50:43,770
universe this is doing things making

1025
00:50:47,870 --> 00:50:46,110
ourselves better not only as a country

1026
00:50:50,930 --> 00:50:47,880
through the knowledge we gained through

1027
00:50:53,720 --> 00:50:50,940
the technology we invent to do something

1028
00:50:55,640 --> 00:50:53,730
like this so these kinds of investments

1029
00:50:57,890 --> 00:50:55,650
in things that make us back

1030
00:51:02,450 --> 00:50:57,900
as a people i think are definitely worth

1031
00:51:04,850 --> 00:51:02,460
it thanks Eric good answer we're going

1032
00:51:07,610 --> 00:51:04,860
to try to go back to Amber real quick we

1033
00:51:09,290 --> 00:51:07,620
know that the web is going to be a

1034
00:51:11,390 --> 00:51:09,300
replacement for the Hubble Space

1035
00:51:13,820 --> 00:51:11,400
Telescope but could it also be

1036
00:51:15,530 --> 00:51:13,830
considered a replacement for the Spitzer

1037
00:51:18,610 --> 00:51:15,540
Space Telescope because they have the

1038
00:51:22,010 --> 00:51:18,620

same they study the same metric or

1039
00:51:25,040 --> 00:51:22,020
electromagnetic spectrum so first of all

1040
00:51:28,610 --> 00:51:25,050
can you hear me I can hear you very good

1041
00:51:31,520 --> 00:51:28,620
okay so um well we say here at NASA that

1042
00:51:34,370 --> 00:51:31,530
that the James Webb Space Telescope is a

1043
00:51:36,140 --> 00:51:34,380
successor to both Hubble and Spitzer so

1044
00:51:37,880 --> 00:51:36,150
the fact is is that is it it's a

1045
00:51:40,460 --> 00:51:37,890
successor to Hubble in the sense that

1046
00:51:44,290 --> 00:51:40,470
you know we've learned so much about our

1047
00:51:46,460 --> 00:51:44,300
universe from Hubble Hubble's completely

1048
00:51:48,620 --> 00:51:46,470
revolutionized our understanding of the

1049
00:51:50,450 --> 00:51:48,630
universe in many key ways and we expect

1050
00:51:53,570 --> 00:51:50,460
that this big bold mission of James Webb

1051
00:51:55,250 --> 00:51:53,580
will will allow us to continue that that

1052
00:51:57,080 --> 00:51:55,260
kind of effort to really answer those

1053
00:51:58,790 --> 00:51:57,090
biggest wrong any questions so it's a

1054
00:52:00,890 --> 00:51:58,800
successor to hobble in that sense and

1055
00:52:03,560 --> 00:52:00,900
it's definitely also a successor to the

1056
00:52:06,260 --> 00:52:03,570
Spitzer Space Telescope in the sense of

1057
00:52:07,910 --> 00:52:06,270
the kind of light that will study with

1058
00:52:10,640 --> 00:52:07,920
the James Webb Space Telescope which is

1059
00:52:13,040 --> 00:52:10,650
of course infrared so in that sense it's

1060
00:52:14,960 --> 00:52:13,050
kind of jwst will be the best of both

1061
00:52:18,800 --> 00:52:14,970
worlds as far as Hubble and Spitzer is

1062
00:52:21,740 --> 00:52:18,810
concerned thanks amber John Mather this

1063
00:52:25,310 --> 00:52:21,750

question goes to you why are the mirrors

1064
00:52:28,640 --> 00:52:25,320
on web gold-plated and how thick is this

1065
00:52:31,070 --> 00:52:28,650
gold plating the mirrors are cold plated

1066
00:52:33,830 --> 00:52:31,080
because we make them out of beryllium

1067
00:52:36,500 --> 00:52:33,840
and beryllium is not as good a reflector

1068
00:52:38,240 --> 00:52:36,510
for infrared light as other things so

1069
00:52:41,570 --> 00:52:38,250
goal is the best material that we can

1070
00:52:44,150 --> 00:52:41,580
get for for covering the mirrors it's

1071
00:52:45,920 --> 00:52:44,160
ideal for two reasons one is that it's

1072
00:52:48,070 --> 00:52:45,930
the best reflector and another one is

1073
00:52:50,330 --> 00:52:48,080
that it doesn't tarnish or get old

1074
00:52:54,620 --> 00:52:50,340
sitting around here on the ground for

1075
00:52:56,840 --> 00:52:54,630
the period of time that it takes so the

1076
00:52:59,720 --> 00:52:56,850
way that we do it is to coat the memory

1077
00:53:03,020 --> 00:52:59,730
is extremely thinly with gold the amount

1078
00:53:05,630 --> 00:53:03,030
of gold that it takes is less than what

1079
00:53:07,430 --> 00:53:05,640
is in a typical person's wedding ring so

1080
00:53:08,229 --> 00:53:07,440
it's an extremely small amount of gold

1081
00:53:11,619 --> 00:53:08,239
it's very very

1082
00:53:16,629 --> 00:53:11,629
thin but it's just the right amount for

1083
00:53:20,499 --> 00:53:16,639
this purpose thanks John Jonathan

1084
00:53:22,629 --> 00:53:20,509
question for you we've already targeted

1085
00:53:25,179 --> 00:53:22,639
you have a lifespan educators to the

1086
00:53:30,429 --> 00:53:25,189
visual do you want to launch but do we

1087
00:53:32,859 --> 00:53:30,439
expect an offense to go bad unhand fuel

1088
00:53:34,959 --> 00:53:32,869

a coolant or fills you to run out before

1089
00:53:38,649 --> 00:53:34,969
here in which much how's it going to me

1090
00:53:41,169 --> 00:53:38,659
and its efficiency ah let's see the

1091
00:53:44,459 --> 00:53:41,179
entire thermal design for the

1092
00:53:46,659 --> 00:53:44,469
observatory is passive there are no

1093
00:53:48,669 --> 00:53:46,669
refrigerants there are no cryogenic

1094
00:53:50,499 --> 00:53:48,679
there are four Spitzer although the

1095
00:53:54,399 --> 00:53:50,509
mid-infrared instrument is cooled by a

1096
00:53:58,329 --> 00:53:54,409
closed loop refrigerator so the issue is

1097
00:54:02,229 --> 00:53:58,339
not one of losing a crosman and losing

1098
00:54:04,659 --> 00:54:02,239
thermal control our one main consumable

1099
00:54:06,819 --> 00:54:04,669
is our propellant which we need to use

1100
00:54:09,759 --> 00:54:06,829
to manage our momentum and do

1101
00:54:12,219 --> 00:54:09,769
station-keeping if we eat that and

1102
00:54:15,429 --> 00:54:12,229
husband it well we will extend our

1103
00:54:17,259 --> 00:54:15,439
lifetime but the instruments will not be

1104
00:54:21,849 --> 00:54:17,269
the life limiting element on the

1105
00:54:24,059 --> 00:54:21,859
observatory all right and we're going to

1106
00:54:26,919 --> 00:54:24,069
come back to do for this question I know

1107
00:54:30,999 --> 00:54:26,929
jwc is giving us towards a project which

1108
00:54:32,619 --> 00:54:31,009
is isn't just making me introduce what

1109
00:54:37,659 --> 00:54:32,629
could the child has many partners do we

1110
00:54:40,809 --> 00:54:37,669
have a national partners okay sure this

1111
00:54:42,789 --> 00:54:40,819
and any undertaking like this in science

1112
00:54:44,619 --> 00:54:42,799
anymore is usually always international

1113
00:54:48,249 --> 00:54:44,629

and most science missions here at NASA

1114
00:54:50,559 --> 00:54:48,259
are web has partnerships with the

1115
00:54:53,559 --> 00:54:50,569
Canadian Space Agency and the European

1116
00:54:55,659 --> 00:54:53,569
Space Agency as well as what we call the

1117
00:54:57,249 --> 00:54:55,669
European consortium countries that came

1118
00:54:58,709 --> 00:54:57,259
together to provide the mid-infrared

1119
00:55:02,019 --> 00:54:58,719
instrument that you just heard Johnathan

1120
00:55:03,729 --> 00:55:02,029
ehrenberg referred to so all the

1121
00:55:05,919 --> 00:55:03,739
countries that are in ISA and I've lost

1122
00:55:08,289 --> 00:55:05,929
count whether there's 21 countries in

1123
00:55:10,689 --> 00:55:08,299
the European Space Agency right now and

1124
00:55:12,849 --> 00:55:10,699
that the Canadian Space Agency are

1125
00:55:15,189 --> 00:55:12,859
partnered with us so we have partners in

1126
00:55:16,959 --> 00:55:15,199
virtually everybody in Europe and just

1127
00:55:19,689 --> 00:55:16,969
across the border and they are providing

1128
00:55:21,279 --> 00:55:19,699
key expertise not only in the form of

1129
00:55:22,180 --> 00:55:21,289
hardware science instruments that

1130
00:55:23,830 --> 00:55:22,190
they've given us

1131
00:55:26,080 --> 00:55:23,840
but they will be involved at the Space

1132
00:55:28,000 --> 00:55:26,090
Telescope Science Institute afterwards

1133
00:55:31,540 --> 00:55:28,010
with astronomers working there and

1134
00:55:33,250 --> 00:55:31,550
operating those instance thanks Derek

1135
00:55:34,540 --> 00:55:33,260
and we're coming up on the top of the

1136
00:55:35,650 --> 00:55:34,550
hour we're going to have to close down I

1137
00:55:38,290 --> 00:55:35,660
think we've got time for one more

1138
00:55:40,360 --> 00:55:38,300

question and John Mathers I'm going to

1139
00:55:43,360 --> 00:55:40,370
take this to you can you tell us exactly

1140
00:55:46,390 --> 00:55:43,370
when we expect JWST to launch and we're

1141
00:55:49,390 --> 00:55:46,400
launched from we're planning on about

1142
00:55:52,420 --> 00:55:49,400
October 2018 so about five and a half

1143
00:55:55,060 --> 00:55:52,430
years from today and we're watching it

1144
00:55:58,000 --> 00:55:55,070
from kourou which is in French Guiana on

1145
00:56:00,100 --> 00:55:58,010
the equator in South America and that's

1146
00:56:02,620 --> 00:56:00,110
chosen because that's the lunch site for

1147
00:56:05,260 --> 00:56:02,630
thief arion space which is a commercial

1148
00:56:07,510 --> 00:56:05,270
organization in in Europe that builds

1149
00:56:09,040 --> 00:56:07,520
these rockets and the rocket is one of

1150
00:56:11,830 --> 00:56:09,050
the contributions of the European Space

1151
00:56:13,270 --> 00:56:11,840
Agency to this partnership so it's a

1152
00:56:15,640 --> 00:56:13,280
little too soon to buy your plane ticket

1153
00:56:17,980 --> 00:56:15,650
to the watch date but we're pretty sure

1154
00:56:20,140 --> 00:56:17,990
that we can do it there at about that

1155
00:56:22,810 --> 00:56:20,150
time so thanks to a congressional

1156
00:56:25,030 --> 00:56:22,820
approval of the budget we're continuing

1157
00:56:28,780 --> 00:56:25,040
at full tilt two to the schedule that

1158
00:56:31,600 --> 00:56:28,790
we've announced so that's what our plan

1159
00:56:34,180 --> 00:56:31,610
is then six months after its launch then

1160
00:56:38,260 --> 00:56:34,190
we get to good start genuine scientific

1161
00:56:40,270 --> 00:56:38,270
observations sounds good John thank you

1162
00:56:41,950 --> 00:56:40,280
very much and unfortunately that's going

1163
00:56:44,020 --> 00:56:41,960

to have to do it for our time today and

1164
00:56:46,300 --> 00:56:44,030
there's a Google+ Hangout on the James

1165
00:56:48,550 --> 00:56:46,310
Webb Space Telescope I'd like to thank

1166
00:56:49,960 --> 00:56:48,560
our panelists today for their time if

1167
00:56:51,970 --> 00:56:49,970
you'd like more information about the

1168
00:57:05,140 --> 00:56:51,980
Webb telescope you can join us on the

1169
00:57:08,310 --> 00:57:05,150
web at www.nasa.gov or on any of our

1170
00:57:11,280 --> 00:57:08,320
mini social media sites such as flickr

1171
00:57:14,440 --> 00:57:11,290
facebook twitter youtube and of course