
Juno
Mission to Jupiter
The giant planet story...
NASA

1
00:00:03,030 --> 00:00:01,510
again trent perato public affairs

2
00:00:04,950 --> 00:00:03,040
officer with nasa science mission

3
00:00:06,710 --> 00:00:04,960
directorate in washington dc like to

4
00:00:07,990 --> 00:00:06,720
welcome the tweeps here back to the tent

5
00:00:10,230 --> 00:00:08,000
for the juno tweetup and i'd like to

6
00:00:11,990 --> 00:00:10,240
welcome all of you joining us online

7
00:00:14,310 --> 00:00:12,000
virtually for the conversation again you

8
00:00:14,910 --> 00:00:14,320
can follow what's happening on twitter

9
00:00:17,349 --> 00:00:14,920
at

10
00:00:19,189 --> 00:00:17,359
twitter.com slash nasa tweetup and

11
00:00:21,109 --> 00:00:19,199
please follow the hashtags

12
00:00:23,349 --> 00:00:21,119
nasatweetup and

13
00:00:25,429 --> 00:00:23,359

juno we have an exciting program for you

14
00:00:26,950 --> 00:00:25,439
today we're really excited to have a

15
00:00:29,349 --> 00:00:26,960
number of brilliant speakers doing

16
00:00:30,630 --> 00:00:29,359
amazing things in our solar system and

17
00:00:32,549 --> 00:00:30,640
it's we're going to cap it all off for

18
00:00:34,229 --> 00:00:32,559
the launch tomorrow hopefully of the

19
00:00:36,069 --> 00:00:34,239
jupiter spacecraft i'm sorry the juno

20
00:00:37,750 --> 00:00:36,079
spacecraft to jupiter

21
00:00:39,990 --> 00:00:37,760
so we have a packed agenda you only get

22
00:00:41,670 --> 00:00:40,000
to see this once juno going to jupiter

23
00:00:43,510 --> 00:00:41,680
so get ready to drink from the fire hose

24
00:00:46,229 --> 00:00:43,520
because we have a very exciting and

25
00:00:48,229 --> 00:00:46,239
jam-packed program for you today

26
00:00:50,630 --> 00:00:48,239
um you know a lot of people ask us who

27
00:00:52,549 --> 00:00:50,640
all is involved in the social media side

28
00:00:54,869 --> 00:00:52,559
of nasa there are a few of us you've met

29
00:00:56,950 --> 00:00:54,879
most of us in this tent but we feel like

30
00:00:59,510 --> 00:00:56,960
it includes all of you too i mean it's

31
00:01:01,270 --> 00:00:59,520
your space program it's a real pleasure

32
00:01:03,430 --> 00:01:01,280
and it's an honor to bring such a

33
00:01:04,950 --> 00:01:03,440
diverse group of people together here

34
00:01:06,390 --> 00:01:04,960
and online and a big shout out to all

35
00:01:07,750 --> 00:01:06,400
the tweets who've joined us before for

36
00:01:10,230 --> 00:01:07,760
tweetups and we know that you're out

37
00:01:11,990 --> 00:01:10,240
there so a big hello from us

38
00:01:14,310 --> 00:01:12,000

this is an ongoing conversation but it's

39
00:01:15,910 --> 00:01:14,320
a thriving dynamic community with nasa

40
00:01:17,190 --> 00:01:15,920
tweet up and it's fun for us to watch

41
00:01:18,390 --> 00:01:17,200
the conversation develop and we just

42
00:01:19,749 --> 00:01:18,400
want to thank you all for helping us

43
00:01:21,910 --> 00:01:19,759
tell the story of this remarkable

44
00:01:23,990 --> 00:01:21,920
spacecraft this amazingly beautiful

45
00:01:25,590 --> 00:01:24,000
mission and all the cool things that

46
00:01:27,350 --> 00:01:25,600
we're going to discover because of it

47
00:01:29,350 --> 00:01:27,360
about jupiter and about the history of

48
00:01:31,429 --> 00:01:29,360
our solar system

49
00:01:33,510 --> 00:01:31,439
so with that i just wanted to introduce

50
00:01:34,950 --> 00:01:33,520
again uh stephanie sherholtz who's nasa

51
00:01:36,149 --> 00:01:34,960
social media manager tell us a little

52
00:01:41,030 --> 00:01:36,159
bit more about that and then we'll get

53
00:01:44,389 --> 00:01:42,630
thank you trent

54
00:01:46,389 --> 00:01:44,399
uh thank you all for being here and

55
00:01:48,630 --> 00:01:46,399
making your way here it's a great honor

56
00:01:50,630 --> 00:01:48,640
that you guys traveled from all over

57
00:01:52,630 --> 00:01:50,640
from all over the world we have people

58
00:01:54,710 --> 00:01:52,640
here from six different countries and

59
00:01:56,789 --> 00:01:54,720
from 28 different u.s states plus the

60
00:01:58,950 --> 00:01:56,799
district of columbia and that's just

61
00:02:00,709 --> 00:01:58,960
great that you guys are getting it out

62
00:02:02,709 --> 00:02:00,719
to your communities the places that you

63
00:02:04,550 --> 00:02:02,719

live the people that you interact with

64
00:02:06,950 --> 00:02:04,560
and sharing what you're experiencing

65
00:02:08,550 --> 00:02:06,960
here today we can't invite everybody who

66
00:02:10,070 --> 00:02:08,560
registered so it's great that you can

67
00:02:11,190 --> 00:02:10,080
share your experience with everybody

68
00:02:13,750 --> 00:02:11,200
else

69
00:02:16,070 --> 00:02:13,760
this is the 23rd nasa tweet up we're

70
00:02:17,030 --> 00:02:16,080
very proud of what this has become and

71
00:02:20,550 --> 00:02:17,040
how

72
00:02:23,510 --> 00:02:20,560
your enthusiasm for this event and for

73
00:02:26,470 --> 00:02:23,520
experiencing nasa in a very real way has

74
00:02:28,470 --> 00:02:26,480
uh led to more and more tweet ups every

75
00:02:29,670 --> 00:02:28,480
single one we think we don't know if

76
00:02:32,949 --> 00:02:29,680
we're going to be able to hold another

77
00:02:35,030 --> 00:02:32,959
tweet up and you all are so enthusiastic

78
00:02:37,110 --> 00:02:35,040
that we find a way to make it happen and

79
00:02:39,270 --> 00:02:37,120
we're so thrilled that we can do that we

80
00:02:41,350 --> 00:02:39,280
that we have great support at nasa for

81
00:02:43,190 --> 00:02:41,360
engaging on social media and for um

82
00:02:45,509 --> 00:02:43,200
bringing you out to experience these

83
00:02:48,309 --> 00:02:45,519
these types of events and launches and

84
00:02:51,030 --> 00:02:48,319
and nasa centers you know there are 10

85
00:02:52,630 --> 00:02:51,040
nasa centers across the country and

86
00:02:54,229 --> 00:02:52,640
there's a lot that you can experience

87
00:02:56,229 --> 00:02:54,239
with nasa

88
00:02:58,149 --> 00:02:56,239

we're very active

89
00:02:59,270 --> 00:02:58,159
and so thank you for being a part of the

90
00:03:00,949 --> 00:02:59,280
community

91
00:03:03,030 --> 00:03:00,959
you are now

92
00:03:04,790 --> 00:03:03,040
now we have more than 2 000 people who

93
00:03:07,430 --> 00:03:04,800
have attended different nasa tweet-up

94
00:03:09,589 --> 00:03:07,440
events so you're part of a big community

95
00:03:11,589 --> 00:03:09,599
and a big family and even more who've

96
00:03:13,990 --> 00:03:11,599
registered online who haven't yet been

97
00:03:16,869 --> 00:03:14,000
selected but who probably will be

98
00:03:19,190 --> 00:03:16,879
someday hopefully and

99
00:03:21,430 --> 00:03:19,200
you all can it's your community you own

100
00:03:23,910 --> 00:03:21,440
it you can create it uh there's a

101
00:03:24,750 --> 00:03:23,920
wikipedia page that you guys made

102
00:03:27,350 --> 00:03:24,760
there's

103
00:03:29,190 --> 00:03:27,360
nasatweet.com which is a wiki page that

104
00:03:30,470 --> 00:03:29,200
you created which is all sorts of good

105
00:03:32,470 --> 00:03:30,480
information

106
00:03:34,470 --> 00:03:32,480
really just if you're a space geek so

107
00:03:36,789 --> 00:03:34,480
you know you don't have to be a space

108
00:03:38,869 --> 00:03:36,799
geek or a die hard space fan to come to

109
00:03:40,070 --> 00:03:38,879
a nasa tweet up but we hope you are when

110
00:03:42,949 --> 00:03:40,080
you leave

111
00:03:44,789 --> 00:03:42,959
thank you we have a great program really

112
00:03:51,910 --> 00:03:44,799
great speakers and we hope that you have

113
00:03:55,990 --> 00:03:53,670

thanks stephanie uh just a little

114
00:03:57,670 --> 00:03:56,000
context quickly uh stephanie mentioned

115
00:03:59,589 --> 00:03:57,680
the nasa centers nasa's broken out into

116
00:04:01,910 --> 00:03:59,599
four mission directorates as well space

117
00:04:03,190 --> 00:04:01,920
operations aeronautics exploration

118
00:04:05,750 --> 00:04:03,200
systems and science so you're going to

119
00:04:07,270 --> 00:04:05,760
be hearing people from science that work

120
00:04:08,550 --> 00:04:07,280
with and through the science mission

121
00:04:11,350 --> 00:04:08,560
directorate that's broken out into four

122
00:04:13,270 --> 00:04:11,360
divisions uh that is earth science

123
00:04:14,630 --> 00:04:13,280
heliophysics study of our sun

124
00:04:17,189 --> 00:04:14,640
planetary and you're going to be hearing

125
00:04:18,789 --> 00:04:17,199
from people who work with the planetary

126
00:04:20,229 --> 00:04:18,799
division today and astrophysics

127
00:04:21,270 --> 00:04:20,239
everything beyond our solar system on

128
00:04:22,710 --> 00:04:21,280
the public affairs officer for

129
00:04:24,790 --> 00:04:22,720
astrophysics you have any questions

130
00:04:26,310 --> 00:04:24,800
during the tweet i'd be happy to answer

131
00:04:29,030 --> 00:04:26,320
them about those missions

132
00:04:30,790 --> 00:04:29,040
our first speaker is the deputy director

133
00:04:33,110 --> 00:04:30,800
of the planetary science division at

134
00:04:35,030 --> 00:04:33,120
nasa headquarters he is responsible for

135
00:04:36,790 --> 00:04:35,040
the day-to-day program management of the

136
00:04:38,950 --> 00:04:36,800
missions which is the cost the schedule

137
00:04:40,870 --> 00:04:38,960
the technical performance on every

138
00:04:43,350 --> 00:04:40,880

planetary mission that's conducting

139
00:04:44,629 --> 00:04:43,360
outstanding and astounding science and

140
00:04:47,590 --> 00:04:44,639
making the new discoveries that just

141
00:04:48,950 --> 00:04:47,600
keep us all in awe uh and on a personal

142
00:04:50,550 --> 00:04:48,960
note this wouldn't have been possible

143
00:04:51,990 --> 00:04:50,560
without him and it's you know the fact

144
00:04:53,749 --> 00:04:52,000
that we're all here is due in large part

145
00:05:03,670 --> 00:04:53,759
to his support so with that let me

146
00:05:07,350 --> 00:05:05,029
i think stephanie took off with the

147
00:05:10,550 --> 00:05:07,360
handheld mic

148
00:05:12,390 --> 00:05:10,560
because i i don't like being tied here

149
00:05:15,909 --> 00:05:12,400
uh indeed

150
00:05:17,830 --> 00:05:15,919
the the tweet up in planetary science oh

151
00:05:20,230 --> 00:05:17,840
thanks stephanie appreciate that

152
00:05:22,550 --> 00:05:20,240
the tweet up in planetary science was

153
00:05:25,510 --> 00:05:22,560
kind of an unheard of thing

154
00:05:27,189 --> 00:05:25,520
and uh i'd been sort of watching it

155
00:05:29,510 --> 00:05:27,199
and trying to figure out what was going

156
00:05:31,909 --> 00:05:29,520
on with social media ever since uh mars

157
00:05:33,670 --> 00:05:31,919
phoenix landed

158
00:05:36,310 --> 00:05:33,680
and um

159
00:05:37,749 --> 00:05:36,320
when we got to uh when we got to

160
00:05:39,909 --> 00:05:37,759
figuring out what we were going to do

161
00:05:42,550 --> 00:05:39,919
for guest stops for juno somebody on

162
00:05:45,510 --> 00:05:42,560
twitter i forget exactly whom it was

163
00:05:48,070 --> 00:05:45,520

asked me to uh

164
00:05:49,749 --> 00:05:48,080
consider holding a tweet up for juno

165
00:05:51,430 --> 00:05:49,759
so we did a little investigation and

166
00:05:53,830 --> 00:05:51,440
stephanie came by and talked to us about

167
00:05:55,749 --> 00:05:53,840
what they've been doing on sts for that

168
00:05:57,430 --> 00:05:55,759
and we found out that

169
00:05:59,270 --> 00:05:57,440
that it was really quite an easy thing

170
00:06:01,350 --> 00:05:59,280
to pull together because the community

171
00:06:02,150 --> 00:06:01,360
really self-energizes

172
00:06:14,230 --> 00:06:02,160
and

173
00:06:18,870 --> 00:06:15,990
i think stephanie might have fainted at

174
00:06:23,029 --> 00:06:20,790
because uh you know in just a month's

175
00:06:25,990 --> 00:06:23,039
time we're going to be back here again

176
00:06:28,710 --> 00:06:26,000
with 150 of your colleagues

177
00:06:30,390 --> 00:06:28,720
uh tweeting about the moon and the

178
00:06:31,830 --> 00:06:30,400
fantastic things we have going on at the

179
00:06:33,270 --> 00:06:31,840
moon

180
00:06:35,590 --> 00:06:33,280
i had

181
00:06:37,670 --> 00:06:35,600
been thinking about what to say and so i

182
00:06:42,629 --> 00:06:37,680
asked stephanie how many slides do i get

183
00:06:45,029 --> 00:06:43,990
and so

184
00:06:47,990 --> 00:06:45,039
um

185
00:06:50,790 --> 00:06:48,000
i have no prepared remarks

186
00:06:53,430 --> 00:06:50,800
other than to say it's just a fantastic

187
00:06:54,230 --> 00:06:53,440
opportunity or a fantastic time to be

188
00:06:56,870 --> 00:06:54,240

here

189
00:06:58,629 --> 00:06:56,880
juno has been 10 years in the making

190
00:07:00,629 --> 00:06:58,639
it's going to take another five years to

191
00:07:03,909 --> 00:07:00,639
get to jupiter and then as steve will

192
00:07:06,469 --> 00:07:03,919
tell you later on the science starts

193
00:07:08,710 --> 00:07:06,479
so it's a it's been a long haul for j

194
00:07:10,629 --> 00:07:08,720
for juno i just came from watching the

195
00:07:11,749 --> 00:07:10,639
rocket roll out got to walk in front of

196
00:07:14,469 --> 00:07:11,759
it it was

197
00:07:18,790 --> 00:07:16,629
way cool it's an incredible machine the

198
00:07:20,950 --> 00:07:18,800
atlas v

199
00:07:23,670 --> 00:07:20,960
and it marks the start of what we've

200
00:07:25,670 --> 00:07:23,680
been terming the launch phase of the

201
00:07:27,830 --> 00:07:25,680
year of the solar system

202
00:07:30,629 --> 00:07:27,840
the year the solar system started about

203
00:07:33,029 --> 00:07:30,639
a year ago when we realized that we had

204
00:07:36,870 --> 00:07:33,039
about nine events

205
00:07:39,189 --> 00:07:36,880
all stacked up inside 26 months

206
00:07:41,189 --> 00:07:39,199
26 months is a martian year hence the

207
00:07:42,230 --> 00:07:41,199
year of the solar system

208
00:07:45,110 --> 00:07:42,240
and

209
00:07:48,950 --> 00:07:45,120
it has been an incredible ride that

210
00:07:51,189 --> 00:07:48,960
started in november with the flyby of

211
00:07:52,629 --> 00:07:51,199
the epoxy spacecraft with the comet

212
00:07:54,950 --> 00:07:52,639
hartley ii

213
00:07:56,710 --> 00:07:54,960

we found out amazing things about comets

214
00:07:59,350 --> 00:07:56,720
that we didn't expect that we would find

215
00:08:01,029 --> 00:07:59,360
out we returned to the comet temple 1

216
00:08:01,909 --> 00:08:01,039
the one that deep impact knocked a hole

217
00:08:03,830 --> 00:08:01,919
into

218
00:08:05,909 --> 00:08:03,840
and tried to peer down inside the crater

219
00:08:07,670 --> 00:08:05,919
that we thought we made

220
00:08:10,390 --> 00:08:07,680
and remapped the back side of it since

221
00:08:13,029 --> 00:08:10,400
we didn't get that data the first time

222
00:08:15,350 --> 00:08:13,039
for the first time ever we put a

223
00:08:17,909 --> 00:08:15,360
spacecraft into orbit around the planet

224
00:08:20,150 --> 00:08:17,919
mercury and for the next year or two we

225
00:08:23,350 --> 00:08:20,160
will unlock some of the secrets of that

226
00:08:29,189 --> 00:08:26,309
and then um just two three weeks ago the

227
00:08:32,630 --> 00:08:29,199
dawn spacecraft

228
00:08:34,790 --> 00:08:32,640
uh got into orbit around the asteroid

229
00:08:37,909 --> 00:08:34,800
vesta and the some of the images if you

230
00:08:39,909 --> 00:08:37,919
haven't seen them are just stunning

231
00:08:41,509 --> 00:08:39,919
trying it's gonna keep planetary

232
00:08:43,269 --> 00:08:41,519
scientists busy for a long time

233
00:08:44,870 --> 00:08:43,279
especially geologists trying to figure

234
00:08:47,030 --> 00:08:44,880
out what was going on

235
00:08:49,190 --> 00:08:47,040
when that body was formed and what does

236
00:08:51,910 --> 00:08:49,200
it mean for the rest of the asteroids

237
00:08:54,389 --> 00:08:51,920
that we might explore in the future

238
00:08:56,949 --> 00:08:54,399

but this is the launch phase so

239
00:08:59,670 --> 00:08:56,959
now juno launches and then grail and

240
00:09:01,829 --> 00:08:59,680
then msl and then we have a little bit

241
00:09:04,230 --> 00:09:01,839
of a hiatus and then msl lands about

242
00:09:05,509 --> 00:09:04,240
this time next year

243
00:09:07,269 --> 00:09:05,519
and we're just

244
00:09:08,550 --> 00:09:07,279
outrageously happy

245
00:09:11,590 --> 00:09:08,560
that we're here

246
00:09:13,910 --> 00:09:11,600
we're on schedule we're on cost which is

247
00:09:15,829 --> 00:09:13,920
one of my biggest worries

248
00:09:17,190 --> 00:09:15,839
and most of all we haven't compromised

249
00:09:22,230 --> 00:09:17,200
the science

250
00:09:24,150 --> 00:09:22,240
understand our place in the universe and

251
00:09:26,790 --> 00:09:24,160
that's a big challenge

252
00:09:29,269 --> 00:09:26,800
and every time we begin to to ask a

253
00:09:30,870 --> 00:09:29,279
question and answer a question we have

254
00:09:33,030 --> 00:09:30,880
more questions that's what the

255
00:09:34,790 --> 00:09:33,040
scientific process is all about and

256
00:09:37,110 --> 00:09:34,800
that's one of the reasons why we do what

257
00:09:38,310 --> 00:09:37,120
we do because we're searching for our

258
00:09:40,949 --> 00:09:38,320
own place

259
00:09:42,389 --> 00:09:40,959
in the universe i think i'll stop

260
00:09:44,550 --> 00:09:42,399
talking

261
00:09:46,310 --> 00:09:44,560
and just answer questions if that's okay

262
00:09:47,829 --> 00:09:46,320
do i have time stephanie

263
00:09:50,949 --> 00:09:47,839

to answer questions

264
00:09:53,190 --> 00:09:50,959
yes certainly okay so are there

265
00:09:55,030 --> 00:09:53,200
questions raise your hand jason and i

266
00:09:57,190 --> 00:09:55,040
have microphones we'll come around no

267
00:09:59,750 --> 00:09:57,200
question so we have i have a question

268
00:10:01,509 --> 00:09:59,760
are we gonna launch tomorrow oh

269
00:10:03,750 --> 00:10:01,519
good question

270
00:10:08,150 --> 00:10:03,760
anybody got a friend named emily are

271
00:10:12,710 --> 00:10:09,509
so

272
00:10:14,310 --> 00:10:12,720
we decided this morning at 6 30 to go

273
00:10:16,550 --> 00:10:14,320
ahead and roll the rocket out to the

274
00:10:18,150 --> 00:10:16,560
launch pad

275
00:10:20,790 --> 00:10:18,160
so that we could be ready to launch

276
00:10:25,670 --> 00:10:23,190
the next the next decision point

277
00:10:27,750 --> 00:10:25,680
is 6 30 tomorrow morning when we decide

278
00:10:29,030 --> 00:10:27,760
whether or not to start the terminal

279
00:10:31,430 --> 00:10:29,040
count

280
00:10:33,670 --> 00:10:31,440
that will be based on the status of the

281
00:10:38,470 --> 00:10:33,680
weather and a number of other things

282
00:10:41,910 --> 00:10:39,509
okay

283
00:10:45,110 --> 00:10:41,920
anyway the countdown starts after we

284
00:10:47,110 --> 00:10:45,120
make a decision at 6 30 tomorrow morning

285
00:10:49,190 --> 00:10:47,120
in the middle of that countdown

286
00:10:51,030 --> 00:10:49,200
at about 9 45

287
00:10:53,590 --> 00:10:51,040
we'll make a decision about whether or

288
00:10:57,110 --> 00:10:53,600

not to load cryo

289
00:10:59,829 --> 00:10:57,120
when the cryogen gets loaded

290
00:11:03,190 --> 00:10:59,839
if there's a scrub it takes about

291
00:11:05,030 --> 00:11:03,200
26 hours before the rocket could return

292
00:11:06,870 --> 00:11:05,040
to the safety of the vertical

293
00:11:09,269 --> 00:11:06,880
integration facility

294
00:11:11,269 --> 00:11:09,279
so the real issue is not is the weather

295
00:11:12,230 --> 00:11:11,279
going to be good enough tomorrow to

296
00:11:14,630 --> 00:11:12,240
launch

297
00:11:16,310 --> 00:11:14,640
the real issue is after we load cryo

298
00:11:18,470 --> 00:11:16,320
will the weather be good enough that we

299
00:11:21,269 --> 00:11:18,480
could return the spacecraft

300
00:11:22,870 --> 00:11:21,279
to the vertical integration facility and

301
00:11:24,230 --> 00:11:22,880
that's really the big decision that we

302
00:11:25,590 --> 00:11:24,240
have ahead of us

303
00:11:27,829 --> 00:11:25,600
right now

304
00:11:35,110 --> 00:11:27,839
i'm proud to report that everything

305
00:11:39,350 --> 00:11:37,670
with the one caveat that emily just

306
00:11:40,790 --> 00:11:39,360
won't make up her mind on where she

307
00:11:43,910 --> 00:11:40,800
wants to go

308
00:11:46,069 --> 00:11:43,920
so we'll see how that goes but uh it's

309
00:11:48,790 --> 00:11:46,079
going to be a fantastic launch it's this

310
00:11:51,590 --> 00:11:48,800
like i i've told people in the past this

311
00:11:54,550 --> 00:11:51,600
is the largest of the atlas 5 family

312
00:11:55,350 --> 00:11:54,560
it's the atlas 5 551 that means it's got

313
00:11:57,350 --> 00:11:55,360

these

314
00:11:59,190 --> 00:11:57,360
five enormous

315
00:12:00,790 --> 00:11:59,200
solid rocket boosters strapped to the

316
00:12:01,990 --> 00:12:00,800
sides of it

317
00:12:04,470 --> 00:12:02,000
and um

318
00:12:05,990 --> 00:12:04,480
it's going to jump off the pad i you

319
00:12:08,310 --> 00:12:06,000
probably some of you probably seen atlas

320
00:12:09,829 --> 00:12:08,320
5's before but you've not seen this one

321
00:12:11,829 --> 00:12:09,839
unless you were at the new horizons

322
00:12:13,829 --> 00:12:11,839
launch because this is only the second

323
00:12:16,389 --> 00:12:13,839
one in history to fly

324
00:12:18,629 --> 00:12:16,399
so any other questions so you're going

325
00:12:20,949 --> 00:12:18,639
to tweet at 6 30 tomorrow morning

326
00:12:26,949 --> 00:12:20,959
whether we're

327
00:12:31,590 --> 00:12:29,670
well we'll see i i will i i will tell

328
00:12:33,829 --> 00:12:31,600
you that i will definitely

329
00:12:36,790 --> 00:12:33,839
if there's something to tweet i'll i'll

330
00:12:41,750 --> 00:12:36,800
put a notice out awesome

331
00:12:45,910 --> 00:12:42,949
oh there we go

332
00:12:47,829 --> 00:12:45,920
hi nasa jim i'm dave

333
00:12:49,910 --> 00:12:47,839
um so it seems like to me there ought to

334
00:12:52,310 --> 00:12:49,920
be a rocket load of data coming back

335
00:12:54,870 --> 00:12:52,320
from all this what happens to that data

336
00:12:56,629 --> 00:12:54,880
where does it go who uses it

337
00:12:59,190 --> 00:12:56,639
how are we going to solve all our world

338
00:13:00,870 --> 00:12:59,200

problems so the data the data the data

339
00:13:03,509 --> 00:13:00,880
that comes back

340
00:13:05,590 --> 00:13:03,519
um it takes first off the light time

341
00:13:07,750 --> 00:13:05,600
lots of people ask what's the light time

342
00:13:09,670 --> 00:13:07,760
how long does the data transit from

343
00:13:11,590 --> 00:13:09,680
jupiter back to the earth it's about 48

344
00:13:14,230 --> 00:13:11,600
minutes depending upon where we are in

345
00:13:16,629 --> 00:13:14,240
the year but every bit of data that

346
00:13:18,710 --> 00:13:16,639
comes back from for planetary science

347
00:13:21,590 --> 00:13:18,720
goes into something called the planetary

348
00:13:24,389 --> 00:13:21,600
data system which you could google right

349
00:13:26,470 --> 00:13:24,399
now and has open access

350
00:13:28,629 --> 00:13:26,480
you could go to the planetary data

351
00:13:31,350 --> 00:13:28,639
system and pull up the

352
00:13:33,110 --> 00:13:31,360
data that's been formatted and loaded

353
00:13:35,430 --> 00:13:33,120
into the pds

354
00:13:37,509 --> 00:13:35,440
will you find the latest images of vesta

355
00:13:40,870 --> 00:13:37,519
there no

356
00:13:43,670 --> 00:13:40,880
will you find the the latest mro image

357
00:13:45,750 --> 00:13:43,680
there no it lags about six months and

358
00:13:48,710 --> 00:13:45,760
the reason that they that they lag about

359
00:13:51,750 --> 00:13:48,720
six months is so that they can

360
00:13:53,590 --> 00:13:51,760
calibrate the data and validate that

361
00:13:55,509 --> 00:13:53,600
they've actually got the formatting

362
00:13:58,470 --> 00:13:55,519
right and the captions correct and that

363
00:14:00,069 --> 00:13:58,480

sort of thing because then it is public

364
00:14:03,509 --> 00:14:00,079
and it goes out and we just don't

365
00:14:05,110 --> 00:14:03,519
control how it's used so

366
00:14:07,350 --> 00:14:05,120
open data

367
00:14:09,030 --> 00:14:07,360
do um who's directing questions not me

368
00:14:10,470 --> 00:14:09,040
right right question on the left over

369
00:14:12,470 --> 00:14:10,480
there good

370
00:14:14,470 --> 00:14:12,480
earlier you were speaking about how

371
00:14:16,150 --> 00:14:14,480
questions drive science and how we're

372
00:14:17,990 --> 00:14:16,160
always trying to find more answers to

373
00:14:19,509 --> 00:14:18,000
those questions and things and it occurs

374
00:14:21,430 --> 00:14:19,519
to me that for those of us who don't you

375
00:14:23,350 --> 00:14:21,440
know launch rockets for a living the

376
00:14:25,110 --> 00:14:23,360
idea of a rocket scientist is usually

377
00:14:26,310 --> 00:14:25,120
held up as a cliche for somebody who has

378
00:14:27,990 --> 00:14:26,320
all the answers to these really

379
00:14:29,430 --> 00:14:28,000
difficult questions i was just wondering

380
00:14:31,910 --> 00:14:29,440
if you could speak to

381
00:14:35,110 --> 00:14:31,920
the idea of certainty in a mission like

382
00:14:36,629 --> 00:14:35,120
juno how how where's the balance between

383
00:14:38,069 --> 00:14:36,639
what we know is going to work and what

384
00:14:39,750 --> 00:14:38,079
we don't know we're going to find in

385
00:14:41,590 --> 00:14:39,760
that sort of thing how does that play

386
00:14:43,910 --> 00:14:41,600
out in these missions well i don't know

387
00:14:45,590 --> 00:14:43,920
if i'll answer your question but i

388
00:14:47,670 --> 00:14:45,600

certainly brings up a lot of thoughts in

389
00:14:50,310 --> 00:14:47,680
my mind there are three major questions

390
00:14:51,910 --> 00:14:50,320
that planetary science and indeed most

391
00:14:53,910 --> 00:14:51,920
of nasa science

392
00:14:57,430 --> 00:14:53,920
seeks to answer

393
00:15:00,310 --> 00:14:57,440
the first is how do we get here

394
00:15:02,949 --> 00:15:00,320
and the second is where are we going and

395
00:15:04,629 --> 00:15:02,959
the third is are we alone

396
00:15:06,389 --> 00:15:04,639
and frankly

397
00:15:08,470 --> 00:15:06,399
everything that we do in planetary

398
00:15:09,910 --> 00:15:08,480
science is driven by one of those

399
00:15:11,350 --> 00:15:09,920
questions

400
00:15:12,870 --> 00:15:11,360
one of the really interesting things is

401
00:15:15,269 --> 00:15:12,880
you know you start breaking it down you

402
00:15:16,470 --> 00:15:15,279
say okay well are we alone what does

403
00:15:18,550 --> 00:15:16,480
that mean

404
00:15:21,189 --> 00:15:18,560
are there amino acids elsewhere in the

405
00:15:22,870 --> 00:15:21,199
solar system turns out the answer is yes

406
00:15:25,509 --> 00:15:22,880
what is going on with the methane on

407
00:15:28,550 --> 00:15:25,519
mars and why does what does titan have

408
00:15:30,230 --> 00:15:28,560
so much methane it's it rains methane

409
00:15:32,550 --> 00:15:30,240
instead of water there and why does

410
00:15:35,509 --> 00:15:32,560
europa have so much water when it's

411
00:15:38,470 --> 00:15:35,519
embedded in this radiation belt

412
00:15:41,430 --> 00:15:38,480
these are questions that scientists

413
00:15:42,470 --> 00:15:41,440

like steve levin like scott bolton

414
00:15:43,910 --> 00:15:42,480
ask

415
00:15:45,189 --> 00:15:43,920
and answer

416
00:15:47,350 --> 00:15:45,199
and then

417
00:15:48,870 --> 00:15:47,360
generate more questions

418
00:15:51,350 --> 00:15:48,880
in the search

419
00:15:52,870 --> 00:15:51,360
to find out

420
00:15:55,670 --> 00:15:52,880
how do we get here

421
00:15:58,150 --> 00:15:55,680
where are we going and are we alone

422
00:16:00,230 --> 00:15:58,160
really our place in the universe

423
00:16:03,509 --> 00:16:00,240
one of the really interesting quotes i i

424
00:16:05,829 --> 00:16:03,519
love is neil degrasse tyson was being

425
00:16:08,389 --> 00:16:05,839
interviewed by um

426
00:16:09,749 --> 00:16:08,399
jon stewart on the daily show and he

427
00:16:11,910 --> 00:16:09,759
said you know that's the problem with

428
00:16:15,030 --> 00:16:11,920
all you scientists is you got too many

429
00:16:18,949 --> 00:16:17,269
and neil degrasse tyson said no that's

430
00:16:21,509 --> 00:16:18,959
the seduction

431
00:16:22,629 --> 00:16:21,519
and he's absolutely right

432
00:16:25,189 --> 00:16:22,639
learning

433
00:16:27,430 --> 00:16:25,199
about something causes you to want to

434
00:16:29,990 --> 00:16:27,440
learn more about something

435
00:16:32,870 --> 00:16:30,000
and that's really the mode that we're in

436
00:16:35,430 --> 00:16:32,880
and i'm hopeful that that inspires

437
00:16:38,150 --> 00:16:35,440
a younger generation to move into

438
00:16:39,590 --> 00:16:38,160

science and math and technology so that

439
00:16:42,710 --> 00:16:39,600
in the future

440
00:16:46,550 --> 00:16:42,720
we will have a space aware an active

441
00:16:52,069 --> 00:16:50,150
next question is over here on the right

442
00:16:53,749 --> 00:16:52,079
barbara buckner b buckner

443
00:16:54,629 --> 00:16:53,759
how close do you think we are to the 10

444
00:16:56,069 --> 00:16:54,639
000

445
00:16:57,269 --> 00:16:56,079
oh

446
00:17:01,110 --> 00:16:57,279
how close

447
00:17:03,590 --> 00:17:02,550
150

448
00:17:05,189 --> 00:17:03,600
is that the

449
00:17:09,270 --> 00:17:05,199
how many you think are attending or is

450
00:17:12,549 --> 00:17:11,189
i already told somebody so you guys over

451
00:17:15,909 --> 00:17:12,559
there at uh

452
00:17:16,789 --> 00:17:15,919
at tim's table you can't answer

453
00:17:19,829 --> 00:17:16,799
so

454
00:17:24,069 --> 00:17:19,839
here's the way it breaks down

455
00:17:27,750 --> 00:17:24,079
there are 3 000 invited vips that will

456
00:17:33,990 --> 00:17:31,590
delaware north will sell 2 000 tickets

457
00:17:35,590 --> 00:17:34,000
for people that will also go to banana

458
00:17:37,750 --> 00:17:35,600
creek

459
00:17:39,909 --> 00:17:37,760
those are all confirmed

460
00:17:42,390 --> 00:17:39,919
there are 150 tweets

461
00:17:45,669 --> 00:17:42,400
there are 300 people that will

462
00:17:47,990 --> 00:17:45,679
be in osb2

463
00:17:50,549 --> 00:17:48,000

there's going to be 1 600 people at the

464
00:17:52,630 --> 00:17:50,559
turn basin

465
00:17:55,110 --> 00:17:52,640
if you total all that together

466
00:17:56,390 --> 00:17:55,120
get somewhere in the neighborhood and i

467
00:17:58,070 --> 00:17:56,400
somebody would have to do the math for

468
00:18:01,590 --> 00:17:58,080
me um

469
00:18:03,990 --> 00:18:01,600
six to eight thousand there are close to

470
00:18:04,710 --> 00:18:04,000
two thousand more people

471
00:18:07,270 --> 00:18:04,720
that

472
00:18:09,350 --> 00:18:07,280
will be watching the launch outside the

473
00:18:13,110 --> 00:18:09,360
gate of kennedy space center

474
00:18:15,270 --> 00:18:13,120
and so we believe that we will break the

475
00:18:17,750 --> 00:18:15,280
10 000 mark

476
00:18:19,510 --> 00:18:17,760
that's what the guest operations

477
00:18:21,669 --> 00:18:19,520
director reported at the launch

478
00:18:22,710 --> 00:18:21,679
readiness review on

479
00:18:28,230 --> 00:18:22,720
yesterday

480
00:18:33,270 --> 00:18:30,789
so i i thought on my way over i might

481
00:18:34,230 --> 00:18:33,280
tell the story about how juno 10k came

482
00:18:37,029 --> 00:18:34,240
about

483
00:18:40,150 --> 00:18:37,039
but i before i do that i i thought

484
00:18:43,029 --> 00:18:40,160
i i really need to thank you all

485
00:18:44,870 --> 00:18:43,039
for making that happen because without

486
00:18:46,870 --> 00:18:44,880
social media we would not have been able

487
00:18:49,750 --> 00:18:46,880
to do as well as we did

488
00:18:51,990 --> 00:18:49,760

uh in terms of raising the awareness

489
00:18:54,390 --> 00:18:52,000
of expendable launch

490
00:18:56,070 --> 00:18:54,400
vehicles their launches

491
00:18:57,190 --> 00:18:56,080
and uh and the missions that they

492
00:18:59,110 --> 00:18:57,200
support

493
00:19:00,549 --> 00:18:59,120
so do i have time for the story or

494
00:19:02,710 --> 00:19:00,559
stephanie are you

495
00:19:05,110 --> 00:19:02,720
all right

496
00:19:06,470 --> 00:19:05,120
uh about a year ago i was in a meeting a

497
00:19:09,590 --> 00:19:06,480
budget meeting

498
00:19:11,669 --> 00:19:09,600
with charlie bolden and ed weiler and ed

499
00:19:13,750 --> 00:19:11,679
weiler was making a presentation and his

500
00:19:15,990 --> 00:19:13,760
comment was

501
00:19:17,750 --> 00:19:16,000
inside of four months

502
00:19:19,750 --> 00:19:17,760
planetary science division will launch

503
00:19:21,830 --> 00:19:19,760
four and a half billion dollars worth of

504
00:19:24,549 --> 00:19:21,840
hardware into space by the way that's

505
00:19:26,630 --> 00:19:24,559
what starts tomorrow

506
00:19:29,830 --> 00:19:26,640
and charlie just about came out of his

507
00:19:31,430 --> 00:19:29,840
chair and he said we need to find a way

508
00:19:34,870 --> 00:19:31,440
to engage

509
00:19:38,230 --> 00:19:34,880
the guest operations and the community

510
00:19:41,029 --> 00:19:38,240
down at kennedy space center to embrace

511
00:19:42,470 --> 00:19:41,039
expendable launch vehicles

512
00:19:44,070 --> 00:19:42,480
and everybody went yeah yeah that's a

513
00:19:46,150 --> 00:19:44,080

really good idea i mean we'll send them

514
00:19:48,870 --> 00:19:46,160
a little bit more money

515
00:19:50,070 --> 00:19:48,880
about three months ago it was may

516
00:19:51,909 --> 00:19:50,080
i was

517
00:19:53,430 --> 00:19:51,919
in an elevator you know they always tell

518
00:19:54,630 --> 00:19:53,440
you you should have your elevator speech

519
00:19:56,390 --> 00:19:54,640
ready

520
00:19:59,029 --> 00:19:56,400
well i had been rehearsed

521
00:20:00,870 --> 00:19:59,039
and i was in an elevator with charlie

522
00:20:03,110 --> 00:20:00,880
and i said you know

523
00:20:05,029 --> 00:20:03,120
juno is the first launch after the last

524
00:20:07,190 --> 00:20:05,039
shuttle

525
00:20:09,350 --> 00:20:07,200
and i said

526
00:20:12,149 --> 00:20:09,360
we normally invite 300 to a thousand

527
00:20:14,310 --> 00:20:12,159
people to a a rocket launch

528
00:20:15,510 --> 00:20:14,320
but you guys on the human space flight

529
00:20:17,270 --> 00:20:15,520
side

530
00:20:19,190 --> 00:20:17,280
you'll get

531
00:20:21,430 --> 00:20:19,200
hundreds of thousands or you know in the

532
00:20:22,950 --> 00:20:21,440
case of sts-135 was it close to a

533
00:20:25,190 --> 00:20:22,960
million

534
00:20:27,190 --> 00:20:25,200
um out for a launch

535
00:20:30,149 --> 00:20:27,200
i said wouldn't it be cool

536
00:20:32,549 --> 00:20:30,159
if we could get and i in in the moment

537
00:20:34,390 --> 00:20:32,559
made up a number wouldn't it be cool if

538
00:20:35,830 --> 00:20:34,400

we could get 10 000 people out to the

539
00:20:38,230 --> 00:20:35,840
juno launch

540
00:20:39,909 --> 00:20:38,240
and he said that's a great idea and then

541
00:20:44,310 --> 00:20:39,919
i immediately backed off and i said well

542
00:20:47,190 --> 00:20:46,310
and he said yes but if you don't try you

543
00:20:49,190 --> 00:20:47,200
won't

544
00:20:50,950 --> 00:20:49,200
and so that's how

545
00:20:53,430 --> 00:20:50,960
we got the support

546
00:20:55,590 --> 00:20:53,440
not only for juno 10k but for the juno

547
00:20:57,350 --> 00:20:55,600
tweet up and for the grail tweet up and

548
00:21:00,230 --> 00:20:57,360
for the msl tweet up

549
00:21:03,430 --> 00:21:00,240
and so we are going to set similar goals

550
00:21:08,230 --> 00:21:03,440
for grail and msl

551
00:21:13,830 --> 00:21:10,950
i'm not so sure i don't know about grail

552
00:21:16,630 --> 00:21:13,840
but we won't know if we don't try

553
00:21:18,390 --> 00:21:16,640
so that's where we're at and just on

554
00:21:20,710 --> 00:21:18,400
that note you know jim's a great guy to

555
00:21:24,950 --> 00:21:20,720
ask questions about grail and msl too

556
00:21:27,270 --> 00:21:24,960
because he's a all over planetary guy

557
00:21:29,510 --> 00:21:27,280
hi jim i'm morris jones from los angeles

558
00:21:31,270 --> 00:21:29,520
on twitter mojo la

559
00:21:32,549 --> 00:21:31,280
and i have a i don't know if this

560
00:21:34,710 --> 00:21:32,559
question is in your wheelhouse or not

561
00:21:37,590 --> 00:21:34,720
but i grew up watching

562
00:21:38,630 --> 00:21:37,600
as a rocket geek watching mercury gemini

563
00:21:40,950 --> 00:21:38,640

apollo

564
00:21:43,270 --> 00:21:40,960
and i know that um

565
00:21:45,590 --> 00:21:43,280
after the first two mercury redstone

566
00:21:49,270 --> 00:21:45,600
missions uh john glenn and all the

567
00:21:51,750 --> 00:21:49,280
others rode on a rocket called an atlas

568
00:21:54,870 --> 00:21:51,760
and i wonder if you could tell me if

569
00:21:56,870 --> 00:21:54,880
there's some tie between the atlas that

570
00:21:59,830 --> 00:21:56,880
that that he rode and the rockets that

571
00:22:02,390 --> 00:21:59,840
we call atlas now you know um i really

572
00:22:04,710 --> 00:22:02,400
can't answer that question uh i know we

573
00:22:07,029 --> 00:22:04,720
were talking about it just yesterday and

574
00:22:08,789 --> 00:22:07,039
frankly i can't remember the answer but

575
00:22:10,710 --> 00:22:08,799
there will be a ula person here right

576
00:22:12,710 --> 00:22:10,720
stephanie

577
00:22:15,270 --> 00:22:12,720
come talk to us tomorrow so if you could

578
00:22:17,750 --> 00:22:15,280
hold hold that question that is a very

579
00:22:21,669 --> 00:22:17,760
good question or you could tweet at ula

580
00:22:21,679 --> 00:22:25,590
so next question over here on the right

581
00:22:30,630 --> 00:22:27,750
hi my name is emily carney and i'm out

582
00:22:32,070 --> 00:22:30,640
of st petersburg florida um i have a

583
00:22:34,950 --> 00:22:32,080
question it's more of an engineering

584
00:22:37,029 --> 00:22:34,960
question i know uh previous space probes

585
00:22:38,870 --> 00:22:37,039
in the past like pioneer and voyager

586
00:22:41,590 --> 00:22:38,880
from those families they used a

587
00:22:44,230 --> 00:22:41,600
radioisotope thermoelectric generators

588
00:22:46,470 --> 00:22:44,240

to power themselves or rtgs

589
00:22:48,630 --> 00:22:46,480
i know juno is a departure because it

590
00:22:50,630 --> 00:22:48,640
employs solar panels

591
00:22:52,870 --> 00:22:50,640
what was the motivation behind using

592
00:22:54,149 --> 00:22:52,880
that and why basically

593
00:22:56,549 --> 00:22:54,159
you're asking the right guy that

594
00:22:59,750 --> 00:22:56,559
question too

595
00:23:02,470 --> 00:22:59,760
so rtgs is also in my portfolio as well

596
00:23:05,270 --> 00:23:02,480
as the plutonium that powers them

597
00:23:07,909 --> 00:23:05,280
it's a very expensive prospect to fly a

598
00:23:09,350 --> 00:23:07,919
radio isotope thermoelectric generator

599
00:23:11,750 --> 00:23:09,360
or it's

600
00:23:17,270 --> 00:23:11,760
its new cousin something called an

601
00:23:22,070 --> 00:23:18,870
i don't even want to quote numbers it's

602
00:23:24,470 --> 00:23:22,080
just very expensive and so you only ever

603
00:23:27,350 --> 00:23:24,480
use it when you're going someplace

604
00:23:29,110 --> 00:23:27,360
you're absolutely certain you can't use

605
00:23:33,669 --> 00:23:29,120
solar rays

606
00:23:36,230 --> 00:23:33,679
and so juno really pushed the edge

607
00:23:39,110 --> 00:23:36,240
we'd not ever been to jupiter before on

608
00:23:40,149 --> 00:23:39,120
solar rays we may not ever go back to

609
00:23:42,950 --> 00:23:40,159
jupiter

610
00:23:45,430 --> 00:23:42,960
on solar arrays the judo the juno

611
00:23:47,909 --> 00:23:45,440
mission and its orbit design is just so

612
00:23:51,029 --> 00:23:47,919
very highly optimized that you could

613
00:23:53,350 --> 00:23:51,039

make solar rays work it did come at a

614
00:23:56,230 --> 00:23:53,360
cost though we invested quite a lot of

615
00:23:58,710 --> 00:23:56,240
money in making solar arrays work that

616
00:24:00,710 --> 00:23:58,720
that far out in space there's an effect

617
00:24:03,909 --> 00:24:00,720
called lilt low intensity low

618
00:24:04,710 --> 00:24:03,919
temperature that causes the solar rays

619
00:24:06,789 --> 00:24:04,720
to

620
00:24:07,990 --> 00:24:06,799
not function the way they would closer

621
00:24:09,590 --> 00:24:08,000
into earth

622
00:24:11,110 --> 00:24:09,600
and so we spent a lot of technology

623
00:24:12,630 --> 00:24:11,120
dollars trying to make sure that we

624
00:24:14,870 --> 00:24:12,640
understood those effects so that the

625
00:24:16,310 --> 00:24:14,880
mission would be successful

626
00:24:18,789 --> 00:24:16,320
the solar arrays on

627
00:24:20,870 --> 00:24:18,799
juno they come out right

628
00:24:23,750 --> 00:24:20,880
six minutes after we separate from the

629
00:24:24,789 --> 00:24:23,760
launch vehicle in shadow and so as we

630
00:24:27,190 --> 00:24:24,799
emerge

631
00:24:29,350 --> 00:24:27,200
from the eclipse of the uh of the earth

632
00:24:31,269 --> 00:24:29,360
they'll be illuminated by the sun

633
00:24:34,070 --> 00:24:31,279
they'll be full on the sun

634
00:24:35,350 --> 00:24:34,080
they put out about 12 000 watts while

635
00:24:38,390 --> 00:24:35,360
they're here at earth

636
00:24:40,549 --> 00:24:38,400
but during its five-year voyage

637
00:24:41,590 --> 00:24:40,559
the sun gets dimmer and dimmer and

638
00:24:42,630 --> 00:24:41,600

dimmer

639
00:24:44,549 --> 00:24:42,640
such that

640
00:24:47,430 --> 00:24:44,559
by the time you get out to

641
00:24:50,870 --> 00:24:47,440
uh to jupiter

642
00:24:54,149 --> 00:24:50,880
it's only putting out 400 watts

643
00:24:57,750 --> 00:24:54,159
and 200 of those 400 watts

644
00:25:00,710 --> 00:24:57,760
are used to keep the spacecraft warm

645
00:25:04,470 --> 00:25:00,720
so the whole juno mission

646
00:25:06,149 --> 00:25:04,480
is running on basically two light bulbs

647
00:25:08,470 --> 00:25:06,159
so

648
00:25:10,710 --> 00:25:08,480
all right do we have time for one more

649
00:25:12,710 --> 00:25:10,720
hi jim my name is jason major i'm a

650
00:25:13,669 --> 00:25:12,720
space blogger for lights in the dark dot

651
00:25:14,789 --> 00:25:13,679
com

652
00:25:16,870 --> 00:25:14,799
and

653
00:25:19,830 --> 00:25:16,880
once juno launches it's going to take

654
00:25:23,590 --> 00:25:19,840
five years for it to arrive at jupiter

655
00:25:25,990 --> 00:25:23,600
in july 2016. um when would we start to

656
00:25:27,750 --> 00:25:26,000
actually see images coming in from juno

657
00:25:30,149 --> 00:25:27,760
will it be when it when it establishes

658
00:25:31,750 --> 00:25:30,159
orbit or will we get a a sneak peek as

659
00:25:34,230 --> 00:25:31,760
it's approaching i'll tell you what i'm

660
00:25:37,190 --> 00:25:34,240
going to let steve when steve levin gets

661
00:25:38,710 --> 00:25:37,200
up and talks okay i'll i'll let you poke

662
00:25:41,190 --> 00:25:38,720
at him about that

663
00:25:43,430 --> 00:25:41,200

my our intention is that as soon as

664
00:25:44,549 --> 00:25:43,440
images are available we start taking

665
00:25:46,870 --> 00:25:44,559
them

666
00:25:47,750 --> 00:25:46,880
as long as the spacecraft is safe and

667
00:25:49,430 --> 00:25:47,760
and then

668
00:25:51,190 --> 00:25:49,440
soon thereafter we make them as public

669
00:25:51,909 --> 00:25:51,200
as we possibly can

670
00:25:54,390 --> 00:25:51,919
but

671
00:25:55,669 --> 00:25:54,400
a lot of that depends upon the way the

672
00:25:57,590 --> 00:25:55,679
science

673
00:25:59,269 --> 00:25:57,600
architecture is

674
00:26:01,669 --> 00:25:59,279
is set up right

675
00:26:03,909 --> 00:26:01,679
for the mission so juno's primary

676
00:26:06,789 --> 00:26:03,919
mission is not to take pictures

677
00:26:09,510 --> 00:26:06,799
it's to look into the clouds and measure

678
00:26:11,669 --> 00:26:09,520
the magnetic fields once that data comes

679
00:26:13,269 --> 00:26:11,679
back there's some processing that they

680
00:26:14,789 --> 00:26:13,279
have to do before they can say here's

681
00:26:16,149 --> 00:26:14,799
what we're seeing in the clouds of

682
00:26:18,230 --> 00:26:16,159
jupiter or here

683
00:26:19,750 --> 00:26:18,240
here's what the magnetic field at

684
00:26:21,590 --> 00:26:19,760
jupiter looks like

685
00:26:23,750 --> 00:26:21,600
there is a camera on board it's an

686
00:26:25,669 --> 00:26:23,760
educational public outreach camera and

687
00:26:27,909 --> 00:26:25,679
i'm not exactly sure how it's targeted

688
00:26:30,390 --> 00:26:27,919

but i'm sure steve will tell us right

689
00:26:33,029 --> 00:26:30,400
and also mike ravine will be talking to

690
00:26:34,789 --> 00:26:33,039
us tomorrow morning about junocam

691
00:26:36,390 --> 00:26:34,799
perfect yeah

692
00:26:38,549 --> 00:26:36,400
to pass around

693
00:26:40,630 --> 00:26:38,559
excellent fantastic

694
00:26:42,230 --> 00:26:40,640
so one more question one more question

695
00:26:43,750 --> 00:26:42,240
and then i'm done questions over here in

696
00:26:46,230 --> 00:26:43,760
the back okay

697
00:26:47,909 --> 00:26:46,240
hi uh john stockton and i have a

698
00:26:50,549 --> 00:26:47,919
question that's not so much science and

699
00:26:51,909 --> 00:26:50,559
more just your personal opinion um you

700
00:26:54,549 --> 00:26:51,919
alluded earlier to how you know the

701
00:26:57,510 --> 00:26:54,559
public is in love with mars so msl is

702
00:26:59,190 --> 00:26:57,520
clearly the the public favorite um

703
00:27:01,190 --> 00:26:59,200
but what is your personal favorite we've

704
00:27:03,830 --> 00:27:01,200
got missions to asteroids

705
00:27:06,630 --> 00:27:03,840
and the moon and

706
00:27:07,669 --> 00:27:06,640
this cutting out jupiter and mars you

707
00:27:09,430 --> 00:27:07,679
know we've got all these missions what

708
00:27:12,070 --> 00:27:09,440
is your personal favorite into this so

709
00:27:18,230 --> 00:27:12,080
my my mother you always used to say i

710
00:27:23,990 --> 00:27:21,269
what excites me is not necessarily the

711
00:27:25,350 --> 00:27:24,000
individual missions but the fact that we

712
00:27:27,510 --> 00:27:25,360
can begin to

713
00:27:28,950 --> 00:27:27,520

uh further our

714
00:27:31,669 --> 00:27:28,960
understanding

715
00:27:34,230 --> 00:27:31,679
of where we're at in the universe

716
00:27:36,630 --> 00:27:34,240
that we can begin to start looking to

717
00:27:38,870 --> 00:27:36,640
see if we actually are alone in fact jim

718
00:27:40,549 --> 00:27:38,880
green my boss and i have a steak dinner

719
00:27:42,389 --> 00:27:40,559
bet on the results

720
00:27:44,789 --> 00:27:42,399
of msl

721
00:27:47,029 --> 00:27:44,799
and the classification of the isotope of

722
00:27:49,350 --> 00:27:47,039
the methane that we might measure once

723
00:27:52,230 --> 00:27:49,360
we land msl on the surface of mars

724
00:27:53,029 --> 00:27:52,240
that's a little detailed

725
00:27:59,029 --> 00:27:53,039
but

726
00:28:00,070 --> 00:27:59,039
not there ever was life on mars

727
00:28:01,350 --> 00:28:00,080
so

728
00:28:03,350 --> 00:28:01,360
i think that's it right trent i'm

729
00:28:05,110 --> 00:28:03,360
getting the hook one quick question if

730
00:28:06,470 --> 00:28:05,120
you can do 20 to 30 seconds on why

731
00:28:08,630 --> 00:28:06,480
methane is important you brought it up a

732
00:28:10,310 --> 00:28:08,640
couple times it's tantalizing as an

733
00:28:12,710 --> 00:28:10,320
answer

734
00:28:14,630 --> 00:28:12,720
well methane is a complex

735
00:28:17,430 --> 00:28:14,640
organic compound

736
00:28:20,789 --> 00:28:17,440
and it forms in one of two ways it

737
00:28:22,950 --> 00:28:20,799
either comes from geologic activity

738
00:28:24,549 --> 00:28:22,960

water flowing across magma across

739
00:28:26,230 --> 00:28:24,559
certain kinds of minerals you know you

740
00:28:28,070 --> 00:28:26,240
get methane out of volcanoes and that

741
00:28:30,870 --> 00:28:28,080
sort of thing

742
00:28:32,149 --> 00:28:30,880
or it comes from life either decaying

743
00:28:35,029 --> 00:28:32,159
life or

744
00:28:36,549 --> 00:28:35,039
excrement you know like cows

745
00:28:39,430 --> 00:28:36,559
so

746
00:28:40,389 --> 00:28:39,440
what we've seen on mars

747
00:28:43,669 --> 00:28:40,399
is

748
00:28:45,269 --> 00:28:43,679
methane clouds that come and go with the

749
00:28:47,590 --> 00:28:45,279
seasons

750
00:28:50,230 --> 00:28:47,600
why is that we're not sure where is it

751
00:28:52,710 --> 00:28:50,240
coming from we don't know

752
00:28:56,710 --> 00:28:52,720
we're pretty sure there's no

753
00:29:00,310 --> 00:28:56,720
geologic activity on mars

754
00:29:05,590 --> 00:29:00,320
maybe there's cows on mars

755
00:29:11,430 --> 00:29:08,710
so the the bottom line the bottom line

756
00:29:13,510 --> 00:29:11,440
is it's an indicator of life maybe and

757
00:29:14,310 --> 00:29:13,520
that's why it's important to us

758
00:29:16,230 --> 00:29:14,320
so

759
00:29:17,990 --> 00:29:16,240
with that i've got one thing i want to

760
00:29:20,870 --> 00:29:18,000
do before i stand down stephanie would

761
00:29:22,310 --> 00:29:20,880
you come up here please

762
00:29:24,549 --> 00:29:22,320
stephanie

763
00:29:27,350 --> 00:29:24,559

took on the challenge

764
00:29:29,669 --> 00:29:27,360
of bringing up uh a tweet up from

765
00:29:30,870 --> 00:29:29,679
scratch not not just one tweet up but

766
00:29:33,590 --> 00:29:30,880
three

767
00:29:35,830 --> 00:29:33,600
and so this is a personal gift

768
00:29:36,630 --> 00:29:35,840
from jim green and myself to say thank

769
00:29:40,630 --> 00:29:36,640
you

770
00:29:43,830 --> 00:29:40,640
and what it is is an artist concept

771
00:29:50,710 --> 00:29:43,840
a black blown glass of jupiter

772
00:29:50,720 --> 00:29:56,389
thank you

773
00:29:56,399 --> 00:30:05,750
let's hear it for at nasa gym everybody

774
00:30:10,149 --> 00:30:07,750
okay we're pleased to introduce our next

775
00:30:12,549 --> 00:30:10,159
speaker he is the juno principal

776
00:30:14,149 --> 00:30:12,559
investigator he is the director of the

777
00:30:15,750 --> 00:30:14,159
space science department at the

778
00:30:17,269 --> 00:30:15,760
southwest research institute in san

779
00:30:18,950 --> 00:30:17,279
antonio texas

780
00:30:20,230 --> 00:30:18,960
and all that means he leads the

781
00:30:22,070 --> 00:30:20,240
international science team that's

782
00:30:24,470 --> 00:30:22,080
seeking to unmask the mysteries that lie

783
00:30:39,590 --> 00:30:24,480
beneath jupiter's clouds that let me

784
00:30:45,029 --> 00:30:41,029
well thank you

785
00:30:48,710 --> 00:30:45,039
uh for being here it's really exciting

786
00:30:51,750 --> 00:30:48,720
just one day away from the launch

787
00:30:55,350 --> 00:30:51,760
juno will launch off to jupiter

788
00:30:56,789 --> 00:30:55,360

it arrives in 2016.

789
00:30:58,950 --> 00:30:56,799
so

790
00:31:03,029 --> 00:30:58,960
why are we going there

791
00:31:06,870 --> 00:31:05,190
questions really fundamental questions

792
00:31:09,509 --> 00:31:06,880
is what we're after

793
00:31:13,269 --> 00:31:09,519
who are we

794
00:31:15,830 --> 00:31:13,279
how'd we get here where are we going

795
00:31:17,430 --> 00:31:15,840
what happened how did we find ourselves

796
00:31:19,590 --> 00:31:17,440
on the earth where did the earth come

797
00:31:22,389 --> 00:31:19,600
from where did life come from

798
00:31:24,950 --> 00:31:22,399
these are questions that are

799
00:31:26,549 --> 00:31:24,960
addressed by all of the nasa missions

800
00:31:27,590 --> 00:31:26,559
not just juno

801
00:31:29,029 --> 00:31:27,600
each one

802
00:31:30,230 --> 00:31:29,039
provides some unique piece of

803
00:31:32,310 --> 00:31:30,240
information

804
00:31:34,070 --> 00:31:32,320
that helps us understand nature helps us

805
00:31:35,750 --> 00:31:34,080
understand ourselves

806
00:31:38,149 --> 00:31:35,760
looking out at the universe trying to

807
00:31:42,149 --> 00:31:38,159
figure out how we fit in

808
00:31:44,230 --> 00:31:42,159
how does the earth work how do we work

809
00:31:47,750 --> 00:31:44,240
so juno each mission has a unique

810
00:31:49,509 --> 00:31:47,760
contribution juno has one as well

811
00:31:51,909 --> 00:31:49,519
we're going to jupiter because it's the

812
00:31:53,350 --> 00:31:51,919
largest of all the planets

813
00:31:55,430 --> 00:31:53,360

so

814
00:31:58,070 --> 00:31:55,440
after the sun formed

815
00:32:02,549 --> 00:31:58,080
there were leftovers

816
00:32:07,350 --> 00:32:04,070
saturn got the next

817
00:32:09,830 --> 00:32:07,360
biggest chunk uranus neptune etc

818
00:32:12,870 --> 00:32:09,840
the really tiny scraps

819
00:32:16,549 --> 00:32:14,230
so we're trying to figure out what

820
00:32:17,590 --> 00:32:16,559
happened there jupiter because it's so

821
00:32:20,389 --> 00:32:17,600
massive

822
00:32:22,389 --> 00:32:20,399
has held on to its original material we

823
00:32:24,710 --> 00:32:22,399
lost most of ours at earth we don't

824
00:32:26,149 --> 00:32:24,720
really know our own history very well

825
00:32:28,070 --> 00:32:26,159
because we are

826
00:32:29,909 --> 00:32:28,080
have a powerful enough gravity field to

827
00:32:32,789 --> 00:32:29,919
hold on to the material whereas jupiter

828
00:32:36,070 --> 00:32:32,799
is pretty much the same as when it first

829
00:32:38,549 --> 00:32:36,080
formed i mean it's got lots of dynamics

830
00:32:42,149 --> 00:32:38,559
the magnetosphere in the atmosphere

831
00:32:43,509 --> 00:32:42,159
buzzing around and stuff but

832
00:32:45,669 --> 00:32:43,519
it's pretty much held onto its

833
00:32:48,149 --> 00:32:45,679
composition and we know this because

834
00:32:50,070 --> 00:32:48,159
it's mostly hydrogen helium

835
00:32:51,110 --> 00:32:50,080
in fact the sun is mostly hydrogen and

836
00:32:53,029 --> 00:32:51,120
helium

837
00:32:55,350 --> 00:32:53,039
the interstellar clouds that we see that

838
00:32:56,630 --> 00:32:55,360

we think make stars are mostly hydrogen

839
00:32:58,630 --> 00:32:56,640
and helium

840
00:33:00,630 --> 00:32:58,640
the whole universe is mostly hydrogen

841
00:33:02,870 --> 00:33:00,640
and helium

842
00:33:07,430 --> 00:33:02,880
so there's this other stuff

843
00:33:10,870 --> 00:33:09,509
think of your chemistry table when

844
00:33:12,870 --> 00:33:10,880
you're in school

845
00:33:15,909 --> 00:33:12,880
so you got hydrogen and helium the two

846
00:33:17,509 --> 00:33:15,919
lightest elements the next ones

847
00:33:19,909 --> 00:33:17,519
in fact all of them

848
00:33:22,310 --> 00:33:19,919
are just the heavy elements

849
00:33:27,190 --> 00:33:22,320
the carbon the nitrogen the sulfur the

850
00:33:31,350 --> 00:33:29,590
so somehow and they're just traces in

851
00:33:33,269 --> 00:33:31,360
the universe it's mostly still this

852
00:33:35,750 --> 00:33:33,279
hydrogen and helium stuff so somehow

853
00:33:38,389 --> 00:33:35,760
when jupiter forms

854
00:33:41,269 --> 00:33:38,399
it gets a little bit more of these heavy

855
00:33:43,750 --> 00:33:41,279
elements than the sun does

856
00:33:45,669 --> 00:33:43,760
so the sun gets formed jupiter's almost

857
00:33:47,509 --> 00:33:45,679
just like it

858
00:33:50,149 --> 00:33:47,519
but it's got a little more more of these

859
00:33:52,630 --> 00:33:50,159
heavy elements we call it an enrichment

860
00:33:54,710 --> 00:33:52,640
we don't know how that happened we know

861
00:33:55,990 --> 00:33:54,720
that it's enriched in carbon and

862
00:33:57,990 --> 00:33:56,000
nitrogen

863
00:33:59,350 --> 00:33:58,000

and sulfur in fact galio probe went in

864
00:34:01,269 --> 00:33:59,360
and we know that it's enriched by all

865
00:34:03,350 --> 00:34:01,279
these things about factor of three or

866
00:34:05,830 --> 00:34:03,360
four with respect to the percentage of

867
00:34:07,430 --> 00:34:05,840
hydrogen in it compared to the sun we

868
00:34:10,710 --> 00:34:07,440
don't know how that happened we're

869
00:34:13,349 --> 00:34:10,720
missing one of the key pieces oxygen

870
00:34:15,349 --> 00:34:13,359
which is tied up in water

871
00:34:17,349 --> 00:34:15,359
oxygen is the third most abundant

872
00:34:19,510 --> 00:34:17,359
element in the universe so we're missing

873
00:34:22,310 --> 00:34:19,520
the next biggest piece

874
00:34:25,669 --> 00:34:22,320
it's fundamental to us we know we search

875
00:34:27,109 --> 00:34:25,679
for life looking for liquid water

876
00:34:29,750 --> 00:34:27,119
but it's fundamental in the universe

877
00:34:32,389 --> 00:34:29,760
it's probably the most common molecule

878
00:34:35,190 --> 00:34:32,399
i mean multi-element molecule apart from

879
00:34:37,430 --> 00:34:35,200
h2 two hydrogens two hydrogens and

880
00:34:39,669 --> 00:34:37,440
oxygen make water so we're trying to

881
00:34:41,109 --> 00:34:39,679
figure out this history

882
00:34:43,349 --> 00:34:41,119
we're trying to figure out where we came

883
00:34:45,829 --> 00:34:43,359
from that the uh the stuff that

884
00:34:47,990 --> 00:34:45,839
jupiter's enriched in is the stuff we're

885
00:34:50,310 --> 00:34:48,000
made out of

886
00:34:52,470 --> 00:34:50,320
so understanding the history of these

887
00:34:55,109 --> 00:34:52,480
volatiles across the early solar system

888
00:34:56,629 --> 00:34:55,119

comes back and leads to us somehow

889
00:34:59,030 --> 00:34:56,639
not just the earth and the terrestrial

890
00:35:00,550 --> 00:34:59,040
planets but life itself we don't know

891
00:35:03,349 --> 00:35:00,560
the history of these elements we don't

892
00:35:05,589 --> 00:35:03,359
know the history of oxygen so what juno

893
00:35:07,109 --> 00:35:05,599
is doing is it's going back to jupiter

894
00:35:10,069 --> 00:35:07,119
because it's the biggest and it's got

895
00:35:12,870 --> 00:35:10,079
this record for us it's going to get the

896
00:35:14,310 --> 00:35:12,880
oxygen abundance by measuring water deep

897
00:35:16,069 --> 00:35:14,320
in the atmosphere

898
00:35:17,109 --> 00:35:16,079
something the galileo probe wasn't able

899
00:35:19,190 --> 00:35:17,119
to get

900
00:35:20,950 --> 00:35:19,200
even though it worked perfectly well it

901
00:35:22,710 --> 00:35:20,960
went into some weird spot or at least

902
00:35:23,910 --> 00:35:22,720
some scientists believe it went into a

903
00:35:26,470 --> 00:35:23,920
weird spot

904
00:35:28,870 --> 00:35:26,480
and the oxygen was deep down and so it

905
00:35:31,589 --> 00:35:28,880
never really got the measurement

906
00:35:32,870 --> 00:35:31,599
of course though maybe the scientists

907
00:35:34,710 --> 00:35:32,880
are wrong and maybe that's the way

908
00:35:36,710 --> 00:35:34,720
jupiter really is

909
00:35:38,390 --> 00:35:36,720
so juno will find out whether that was a

910
00:35:40,470 --> 00:35:38,400
weird spot or whether

911
00:35:42,790 --> 00:35:40,480
jupiter's all over like that

912
00:35:45,030 --> 00:35:42,800
if it turns out it wasn't a weird spot

913
00:35:48,390 --> 00:35:45,040

that galileo probe went in and jupiter

914
00:35:50,310 --> 00:35:48,400
is actually depleted in oxygen then we

915
00:35:52,150 --> 00:35:50,320
actually have no real understanding of

916
00:35:54,069 --> 00:35:52,160
how the solar system is made or how any

917
00:35:55,750 --> 00:35:54,079
planet gets made and the scientists are

918
00:35:57,270 --> 00:35:55,760
going to have to go back to square one

919
00:35:59,270 --> 00:35:57,280
come up with some explanation of what

920
00:36:00,230 --> 00:35:59,280
happened to the oxygen because we don't

921
00:36:02,710 --> 00:36:00,240
know

922
00:36:05,270 --> 00:36:02,720
if it's got a lot of oxygen it may help

923
00:36:07,510 --> 00:36:05,280
us understand where jupiter's formed

924
00:36:09,990 --> 00:36:07,520
farther out maybe out at uranus and

925
00:36:12,069 --> 00:36:10,000
neptune's distance and migrates in

926
00:36:14,230 --> 00:36:12,079
or maybe it's formed near these are

927
00:36:16,710 --> 00:36:14,240
things that are tied to how much water

928
00:36:18,790 --> 00:36:16,720
we we find in jupiter

929
00:36:20,390 --> 00:36:18,800
what else does juno do juno goes into

930
00:36:22,710 --> 00:36:20,400
this polar orbit

931
00:36:25,270 --> 00:36:22,720
a very special polar orbit

932
00:36:27,910 --> 00:36:25,280
going right over the poles and very

933
00:36:30,950 --> 00:36:27,920
close to the planet 5 000 kilometers

934
00:36:33,430 --> 00:36:30,960
above the cloud tops

935
00:36:35,430 --> 00:36:33,440
so that's pretty much skimming the cloud

936
00:36:37,109 --> 00:36:35,440
tops we do that because we want to

937
00:36:39,829 --> 00:36:37,119
measure the gravity and the magnetic

938
00:36:41,910 --> 00:36:39,839

field very

939
00:36:44,390 --> 00:36:41,920
the gravity field tells us how the mass

940
00:36:46,790 --> 00:36:44,400
is distributed inside the planet so when

941
00:36:48,790 --> 00:36:46,800
we start to put together the ingredient

942
00:36:50,630 --> 00:36:48,800
list we also have sort of the structure

943
00:36:53,910 --> 00:36:50,640
of jupiter to put together into that

944
00:36:55,349 --> 00:36:53,920
model of how it forms it's our example

945
00:36:57,430 --> 00:36:55,359
it must have been the first planet that

946
00:36:58,790 --> 00:36:57,440
formed it got most of the leftovers how

947
00:37:00,870 --> 00:36:58,800
did that happen

948
00:37:03,190 --> 00:37:00,880
how did it get enriched does it have a

949
00:37:05,030 --> 00:37:03,200
core in the middle is there a core of

950
00:37:07,270 --> 00:37:05,040
heavy elements in the center we don't

951
00:37:09,750 --> 00:37:07,280
know juno will help us constrain that

952
00:37:11,829 --> 00:37:09,760
that core of heavy elements may be

953
00:37:13,109 --> 00:37:11,839
something that's kind of like the the

954
00:37:14,950 --> 00:37:13,119
rocks or the

955
00:37:16,470 --> 00:37:14,960
the ground that we're used to but of

956
00:37:17,990 --> 00:37:16,480
course it's in the middle of jupiter

957
00:37:19,670 --> 00:37:18,000
under incredible pressure so it's not

958
00:37:21,430 --> 00:37:19,680
going to look like a rock like we know

959
00:37:23,270 --> 00:37:21,440
of

960
00:37:26,710 --> 00:37:23,280
it may not have any core

961
00:37:28,790 --> 00:37:26,720
it may just be gas getting more and more

962
00:37:30,950 --> 00:37:28,800
uh pressure you know and going through a

963
00:37:32,150 --> 00:37:30,960

transition we know part way down the

964
00:37:36,630 --> 00:37:32,160
hydrogen

965
00:37:39,109 --> 00:37:36,640
like a fluid

966
00:37:41,190 --> 00:37:39,119
somewhere deep in that layer

967
00:37:43,510 --> 00:37:41,200
that's already a weird substance

968
00:37:45,510 --> 00:37:43,520
somewhere deep in that layer a magnetic

969
00:37:48,310 --> 00:37:45,520
field gets generated

970
00:37:49,990 --> 00:37:48,320
that magnetic field is the most powerful

971
00:37:52,470 --> 00:37:50,000
of all the planetary magnetic fields in

972
00:37:53,270 --> 00:37:52,480
the entire solar system we want to study

973
00:37:54,790 --> 00:37:53,280
that

974
00:37:56,470 --> 00:37:54,800
we want to understand how magnetic

975
00:37:58,470 --> 00:37:56,480
fields in general get

976
00:38:00,390 --> 00:37:58,480
developed there's a theory out there

977
00:38:02,470 --> 00:38:00,400
called the dynamo theory that says how

978
00:38:04,470 --> 00:38:02,480
the earth's magnetic field gets created

979
00:38:05,829 --> 00:38:04,480
but it doesn't work perfectly well we

980
00:38:07,430 --> 00:38:05,839
need there's a lot of things we still

981
00:38:10,550 --> 00:38:07,440
need to learn about it

982
00:38:11,990 --> 00:38:10,560
jupiter offers a comparative study and

983
00:38:13,910 --> 00:38:12,000
even better

984
00:38:15,990 --> 00:38:13,920
it's a little it's transparent down to

985
00:38:17,750 --> 00:38:16,000
that metallic hydrogen whereas the earth

986
00:38:20,230 --> 00:38:17,760
when we look at our magnetic field has a

987
00:38:24,470 --> 00:38:20,240
permanent magnetized crust blocking our

988
00:38:28,150 --> 00:38:24,480

view down to where the core is

989
00:38:30,310 --> 00:38:28,160
what else do we do we go over the poles

990
00:38:32,470 --> 00:38:30,320
and we're perfectly situated to study

991
00:38:34,069 --> 00:38:32,480
the polar magnetosphere and the aurora

992
00:38:35,589 --> 00:38:34,079
the northern lights

993
00:38:36,630 --> 00:38:35,599
of course there's northern and southern

994
00:38:37,910 --> 00:38:36,640
lights

995
00:38:39,990 --> 00:38:37,920
we're in the north so we always call

996
00:38:41,589 --> 00:38:40,000
them the northern lights

997
00:38:44,390 --> 00:38:41,599
i've never asked in australia but they

998
00:38:46,470 --> 00:38:44,400
may call them the southern lights

999
00:38:47,829 --> 00:38:46,480
but anyway so we go right over the poles

1000
00:38:49,670 --> 00:38:47,839
we've got a whole bunch of instruments

1001
00:38:51,349 --> 00:38:49,680
that are going to study those aurora and

1002
00:38:53,109 --> 00:38:51,359
look at the particles going up and down

1003
00:38:54,870 --> 00:38:53,119
the magnetic field lines creating those

1004
00:38:56,550 --> 00:38:54,880
aurora that will help us understand

1005
00:38:59,270 --> 00:38:56,560
jupiter's aurora which we don't really

1006
00:39:00,870 --> 00:38:59,280
understand very well yet

1007
00:39:03,030 --> 00:39:00,880
but we'll also compare that back to

1008
00:39:04,950 --> 00:39:03,040
earth and saturn and start to put

1009
00:39:07,190 --> 00:39:04,960
together the picture of how aurora and

1010
00:39:08,870 --> 00:39:07,200
polar magnetospheres work these are

1011
00:39:11,670 --> 00:39:08,880
pretty important to us that

1012
00:39:13,270 --> 00:39:11,680
magnetosphere around jupiter is huge but

1013
00:39:14,390 --> 00:39:13,280

the magnetosphere around the earth sort

1014
00:39:15,910 --> 00:39:14,400
of shields us

1015
00:39:17,589 --> 00:39:15,920
so that's a very

1016
00:39:19,910 --> 00:39:17,599
key thing to understand the physics

1017
00:39:22,310 --> 00:39:19,920
behind that and of course one of the key

1018
00:39:25,190 --> 00:39:22,320
things that scientists do in order to

1019
00:39:27,030 --> 00:39:25,200
learn is comparative study

1020
00:39:29,190 --> 00:39:27,040
so comparing the different planets is

1021
00:39:30,870 --> 00:39:29,200
what allows us to learn how the planets

1022
00:39:33,109 --> 00:39:30,880
work you look for similarities

1023
00:39:34,710 --> 00:39:33,119
differences and you try to sort out how

1024
00:39:36,870 --> 00:39:34,720
nature works

1025
00:39:39,030 --> 00:39:36,880
so we learn about ourselves by studying

1026
00:39:41,990 --> 00:39:39,040
jupiter but we also learn about jupiter

1027
00:39:44,710 --> 00:39:42,000
we also use that as our example of giant

1028
00:39:46,630 --> 00:39:44,720
planets around other stars we're now

1029
00:39:49,670 --> 00:39:46,640
being getting to the point where we can

1030
00:39:51,750 --> 00:39:49,680
detect other solar systems

1031
00:39:54,230 --> 00:39:51,760
we we have to understand the role that

1032
00:39:56,470 --> 00:39:54,240
these giant planets played in creating

1033
00:39:59,190 --> 00:39:56,480
these solar systems and so jupiter is

1034
00:40:01,430 --> 00:39:59,200
our key to doing that

1035
00:40:03,510 --> 00:40:01,440
so so i'm just giving you a quick

1036
00:40:07,910 --> 00:40:03,520
overview of the science for juno and

1037
00:40:07,920 --> 00:40:16,950
i don't know hey robin mike's for coming

1038
00:40:21,829 --> 00:40:19,829

uh donald schwartz escobel

1039
00:40:24,390 --> 00:40:21,839
uh my question is there was mention in

1040
00:40:26,470 --> 00:40:24,400
the impress kit that the reason that

1041
00:40:27,750 --> 00:40:26,480
jupiter is not a sun is because of its

1042
00:40:30,309 --> 00:40:27,760
mass

1043
00:40:32,870 --> 00:40:30,319
now how large would it be

1044
00:40:34,950 --> 00:40:32,880
and is it possible that that should we

1045
00:40:36,630 --> 00:40:34,960
need it could we start it up again i'm

1046
00:40:39,109 --> 00:40:36,640
sorry what was the last part could we

1047
00:40:40,710 --> 00:40:39,119
start jupiter up again without having to

1048
00:40:41,750 --> 00:40:40,720
be a mess and having to be an alternate

1049
00:40:44,630 --> 00:40:41,760
son

1050
00:40:46,309 --> 00:40:44,640
take us in

1051
00:40:47,829 --> 00:40:46,319
so what about jupiter could that be the

1052
00:40:49,109 --> 00:40:47,839
b plan

1053
00:40:50,550 --> 00:40:49,119
so uh

1054
00:40:55,430 --> 00:40:50,560
are you thinking it's not warm enough

1055
00:41:00,390 --> 00:40:58,550
because i'm pretty hot but anyway um

1056
00:41:02,550 --> 00:41:00,400
that's a good question so

1057
00:41:04,470 --> 00:41:02,560
i i've read some of the same stuff and

1058
00:41:06,470 --> 00:41:04,480
and my understanding is that if jupiter

1059
00:41:09,030 --> 00:41:06,480
was about 80 times as massive and that's

1060
00:41:10,630 --> 00:41:09,040
what i recall i may not be completely

1061
00:41:12,470 --> 00:41:10,640
correct on this but about 80 times as

1062
00:41:15,430 --> 00:41:12,480
massive then it would have been massive

1063
00:41:17,990 --> 00:41:15,440

enough to ignite the nuclear fusion

1064
00:41:21,349 --> 00:41:18,000
furnace inside which is what sort of

1065
00:41:23,109 --> 00:41:21,359
creates a star right and i think at this

1066
00:41:25,030 --> 00:41:23,119
point there's no way for it to be

1067
00:41:26,950 --> 00:41:25,040
to get 80 times more massive because

1068
00:41:28,309 --> 00:41:26,960
most of that extra if i took all the

1069
00:41:30,790 --> 00:41:28,319
rest of the source and put it in there

1070
00:41:32,470 --> 00:41:30,800
it still wouldn't be big enough

1071
00:41:34,630 --> 00:41:32,480
so um

1072
00:41:36,710 --> 00:41:34,640
now the thing that i'm not sure of about

1073
00:41:39,109 --> 00:41:36,720
that 80 times is that there are many

1074
00:41:41,190 --> 00:41:39,119
kinds of stars

1075
00:41:42,870 --> 00:41:41,200
and i don't know if the 80 times is to

1076
00:41:44,950 --> 00:41:42,880
match our star

1077
00:41:47,910 --> 00:41:44,960
or it is to match

1078
00:41:49,589 --> 00:41:47,920
the smallest known star so it's possible

1079
00:41:50,950 --> 00:41:49,599
that jupiter missed being a star by

1080
00:41:52,950 --> 00:41:50,960
something else but i those the

1081
00:41:54,790 --> 00:41:52,960
astrophysicists that calculated that and

1082
00:41:57,190 --> 00:41:54,800
i'm not familiar with that calculation

1083
00:42:00,710 --> 00:41:57,200
directly is um i think that was the

1084
00:42:01,990 --> 00:42:00,720
minimum mass to get the fusion going

1085
00:42:04,150 --> 00:42:02,000
so i don't think there's any way to

1086
00:42:07,270 --> 00:42:04,160
change that but that's basically what it

1087
00:42:08,630 --> 00:42:07,280
is but jupiter is still cooling from its

1088
00:42:10,790 --> 00:42:08,640

formation

1089
00:42:13,190 --> 00:42:10,800
and so it's hotter inside than outside

1090
00:42:14,950 --> 00:42:13,200
it's glowing we use that in order to get

1091
00:42:16,950 --> 00:42:14,960
our water abundance

1092
00:42:19,030 --> 00:42:16,960
we basically listen

1093
00:42:20,550 --> 00:42:19,040
inside the planet with our microwave

1094
00:42:22,550 --> 00:42:20,560
radiometers

1095
00:42:24,309 --> 00:42:22,560
so we're basically just receiving what's

1096
00:42:26,870 --> 00:42:24,319
called black body radiation we're just

1097
00:42:28,950 --> 00:42:26,880
looking at the thermal glow from jupiter

1098
00:42:31,270 --> 00:42:28,960
glowing and we look at it with different

1099
00:42:32,870 --> 00:42:31,280
wavelengths so you and i all of us if we

1100
00:42:35,670 --> 00:42:32,880
looked in infrared cameras we'd be

1101
00:42:37,910 --> 00:42:35,680
glowing jupiter's not as hot as us so

1102
00:42:39,430 --> 00:42:37,920
it's glowing in radio so that's what

1103
00:42:40,870 --> 00:42:39,440
we're doing we're looking microwave

1104
00:42:43,190 --> 00:42:40,880
basically the same kind of stuff that

1105
00:42:45,750 --> 00:42:43,200
your microwave oven works off of we're

1106
00:42:48,309 --> 00:42:45,760
watching this glow

1107
00:42:50,950 --> 00:42:48,319
and we have different wavelengths some

1108
00:42:52,150 --> 00:42:50,960
are or more or less opaque

1109
00:42:54,630 --> 00:42:52,160
to water

1110
00:42:57,190 --> 00:42:54,640
so things that are more transparent to

1111
00:42:59,510 --> 00:42:57,200
the water the longer wavelengths get the

1112
00:43:01,829 --> 00:42:59,520
glow from deeper down

1113
00:43:04,230 --> 00:43:01,839

and the stuff that is really opaque to

1114
00:43:06,550 --> 00:43:04,240
water just gets blocked right away in

1115
00:43:07,910 --> 00:43:06,560
the and we see the glow from the top and

1116
00:43:09,349 --> 00:43:07,920
that's really the trick to the water

1117
00:43:10,710 --> 00:43:09,359
abundance i know that didn't tie to your

1118
00:43:12,950 --> 00:43:10,720
question but i thought i'd take that

1119
00:43:27,349 --> 00:43:12,960
opportunity to explain it did i get you

1120
00:43:31,109 --> 00:43:29,030
so you're really looking way off in the

1121
00:43:33,510 --> 00:43:31,119
future and wondering when our star burns

1122
00:43:36,069 --> 00:43:33,520
out could we ignite jupiter

1123
00:43:38,390 --> 00:43:36,079
so i think the answer is no

1124
00:43:40,870 --> 00:43:38,400
and it's so far off i i don't think you

1125
00:43:42,870 --> 00:43:40,880
should lose sleep so

1126
00:43:44,630 --> 00:43:42,880
arthur c clarke was wrong that's what

1127
00:43:48,790 --> 00:43:44,640
you're saying uh one question over here

1128
00:43:54,470 --> 00:43:50,870
as you are probably aware there's a

1129
00:43:57,030 --> 00:43:54,480
device on juno called jedi

1130
00:43:58,870 --> 00:43:57,040
uh who came up with that name and how

1131
00:44:01,349 --> 00:43:58,880
long did it come up how long did it take

1132
00:44:04,230 --> 00:44:01,359
for them to come up with that

1133
00:44:06,470 --> 00:44:04,240
so that that is the um

1134
00:44:08,790 --> 00:44:06,480
the energetic particle detector built

1135
00:44:11,430 --> 00:44:08,800
out of apl applied physics lab which is

1136
00:44:14,470 --> 00:44:11,440
part of john hopkins university

1137
00:44:15,910 --> 00:44:14,480
that name was hotly contested it turns

1138
00:44:18,790 --> 00:44:15,920

out

1139
00:44:20,150 --> 00:44:18,800
and the reason was is that before there

1140
00:44:23,270 --> 00:44:20,160
was a juno

1141
00:44:25,670 --> 00:44:23,280
before we made juno we we were proposing

1142
00:44:28,309 --> 00:44:25,680
looking at other concepts and one of

1143
00:44:30,630 --> 00:44:28,319
them was called jazzy that was sort of a

1144
00:44:33,109 --> 00:44:30,640
mission that i'd put together before we

1145
00:44:35,190 --> 00:44:33,119
put together the juno concept

1146
00:44:37,109 --> 00:44:35,200
and it did pretty much the same kind of

1147
00:44:38,790 --> 00:44:37,119
thing but it was just flying past

1148
00:44:40,550 --> 00:44:38,800
jupiter instead of going into orbit so

1149
00:44:43,109 --> 00:44:40,560
it didn't do as much

1150
00:44:46,630 --> 00:44:43,119
and there was a plasma instrument plasma

1151
00:44:47,990 --> 00:44:46,640
is the low energy particles

1152
00:44:50,069 --> 00:44:48,000
and then there's you can have high

1153
00:44:51,109 --> 00:44:50,079
energy particles both are needed to be

1154
00:44:53,510 --> 00:44:51,119
measured but you need different

1155
00:44:55,349 --> 00:44:53,520
instruments so the low energy particles

1156
00:44:57,430 --> 00:44:55,359
was being built by a friend of mine at

1157
00:44:59,670 --> 00:44:57,440
southwest research institute and he

1158
00:45:02,069 --> 00:44:59,680
named his instrument jedi

1159
00:45:04,950 --> 00:45:02,079
on the old mission

1160
00:45:08,710 --> 00:45:04,960
then we dissolve that proposal that

1161
00:45:10,550 --> 00:45:08,720
concept and we and we started juno

1162
00:45:11,589 --> 00:45:10,560
and before he could announce his name

1163
00:45:14,069 --> 00:45:11,599

again

1164
00:45:16,150 --> 00:45:14,079
the guys at apl said we're naming our

1165
00:45:18,710 --> 00:45:16,160
instrument jedi

1166
00:45:20,710 --> 00:45:18,720
and um i think the name i don't know the

1167
00:45:23,190 --> 00:45:20,720
exact person that thought of the name

1168
00:45:24,470 --> 00:45:23,200
but i i i give the credit to a guy named

1169
00:45:26,230 --> 00:45:24,480
barry mock

1170
00:45:29,589 --> 00:45:26,240
but it may have been somebody that was

1171
00:45:33,750 --> 00:45:31,270
thanks scott uh we'll take one more

1172
00:45:39,430 --> 00:45:33,760
question and

1173
00:45:44,309 --> 00:45:41,750
okay so besides the hardware working and

1174
00:45:47,109 --> 00:45:44,319
getting delivered to jupiter

1175
00:45:49,910 --> 00:45:47,119
what are the top two mission success

1176
00:45:55,190 --> 00:45:49,920
criteria for juno

1177
00:46:00,230 --> 00:45:58,230
okay so i i i i get a free pass that i'm

1178
00:46:02,470 --> 00:46:00,240
already at jupiter

1179
00:46:04,870 --> 00:46:02,480
and i'm everything's working

1180
00:46:07,030 --> 00:46:04,880
okay so for the science mission the two

1181
00:46:08,550 --> 00:46:07,040
most imp there's three

1182
00:46:10,069 --> 00:46:08,560
or the three there's three most

1183
00:46:11,190 --> 00:46:10,079
important measurements that we really

1184
00:46:13,670 --> 00:46:11,200
want to get

1185
00:46:15,190 --> 00:46:13,680
we want them all of course but just to

1186
00:46:16,950 --> 00:46:15,200
to uh

1187
00:46:19,430 --> 00:46:16,960
probably the highest level science goals

1188
00:46:22,230 --> 00:46:19,440

are the water abundance inside jupiter

1189
00:46:25,030 --> 00:46:22,240
the global water abundance so we we look

1190
00:46:25,750 --> 00:46:25,040
at many different places to get that

1191
00:46:35,510 --> 00:46:25,760
the

1192
00:46:38,150 --> 00:46:35,520
important measurements to discriminate

1193
00:46:39,349 --> 00:46:38,160
among theories of how planets are made

1194
00:46:41,750 --> 00:46:39,359
we're going out we're trying to figure

1195
00:46:43,510 --> 00:46:41,760
out the recipe for planets so those are

1196
00:46:45,430 --> 00:46:43,520
the two pieces of information that are

1197
00:46:47,430 --> 00:46:45,440
probably the most important

1198
00:46:49,990 --> 00:46:47,440
to help us in in discriminating among

1199
00:46:51,750 --> 00:46:50,000
theories on that the third

1200
00:46:52,870 --> 00:46:51,760
most important measurement that's

1201
00:46:55,030 --> 00:46:52,880
probably equal with these is the

1202
00:46:56,950 --> 00:46:55,040
magnetic field

1203
00:46:58,630 --> 00:46:56,960
and and that's because it all ties into

1204
00:47:01,030 --> 00:46:58,640
the internal structure of how jupiter's

1205
00:47:03,670 --> 00:47:01,040
built the internal structure

1206
00:47:05,349 --> 00:47:03,680
meaning the internal magnetic field and

1207
00:47:06,870 --> 00:47:05,359
that's why we go so close so i would say

1208
00:47:09,349 --> 00:47:06,880
that those three measurements are the

1209
00:47:12,150 --> 00:47:09,359
three most important now we have

1210
00:47:14,470 --> 00:47:12,160
official success criteria

1211
00:47:16,470 --> 00:47:14,480
that deal with um

1212
00:47:19,430 --> 00:47:16,480
being able to obtain

1213
00:47:21,990 --> 00:47:19,440

four data sets out of five

1214
00:47:23,430 --> 00:47:22,000
data sets that we collect so we want to

1215
00:47:26,069 --> 00:47:23,440
do a little bit better than what i just

1216
00:47:33,030 --> 00:47:28,549
okay thanks very much scott appreciate

1217
00:47:33,040 --> 00:47:42,549
thank you

1218
00:47:47,030 --> 00:47:45,270
okay please introduce our next speaker

1219
00:47:48,150 --> 00:47:47,040
this is

1220
00:47:50,230 --> 00:47:48,160
excuse me

1221
00:47:52,790 --> 00:47:50,240
the juno project scientist at the jet

1222
00:47:54,630 --> 00:47:52,800
propulsion lab steve levin

1223
00:47:56,549 --> 00:47:54,640
when we see jupiter we see this i mean

1224
00:47:59,190 --> 00:47:56,559
we see these remarkable images we see

1225
00:48:01,109 --> 00:47:59,200
the big spot we see something incredible

1226
00:48:02,870 --> 00:48:01,119
i i think steve would be fair to say

1227
00:48:05,589 --> 00:48:02,880
sees not only that but the magnetic

1228
00:48:06,710 --> 00:48:05,599
fields and the synchrotron emissions and

1229
00:48:08,230 --> 00:48:06,720
everything that tells us such an

1230
00:48:09,430 --> 00:48:08,240
incredible story about this iconic

1231
00:48:11,829 --> 00:48:09,440
planet so it's a pleasure to have you

1232
00:48:19,349 --> 00:48:11,839
here dr steve levin

1233
00:48:22,950 --> 00:48:21,510
well i'll hold this one it's easier so

1234
00:48:24,390 --> 00:48:22,960
um

1235
00:48:25,430 --> 00:48:24,400
basically what i want to do is answer

1236
00:48:26,390 --> 00:48:25,440
questions

1237
00:48:27,990 --> 00:48:26,400
and

1238
00:48:30,069 --> 00:48:28,000

first i'll i'll tell you just enough so

1239
00:48:31,510 --> 00:48:30,079
you know what to ask questions about

1240
00:48:32,710 --> 00:48:31,520
and

1241
00:48:34,230 --> 00:48:32,720
the first

1242
00:48:36,549 --> 00:48:34,240
description of that is you can ask me

1243
00:48:37,990 --> 00:48:36,559
anything because i've learned how to say

1244
00:48:40,549 --> 00:48:38,000
i don't know

1245
00:48:42,549 --> 00:48:40,559
or i don't want to tell you

1246
00:48:44,470 --> 00:48:42,559
so ask me anything you want but what it

1247
00:48:46,470 --> 00:48:44,480
would make sense to ask me about is the

1248
00:48:48,950 --> 00:48:46,480
science on juno

1249
00:48:51,030 --> 00:48:48,960
and i'll tell you i also um one of my

1250
00:48:52,790 --> 00:48:51,040
main jobs i like to think of it as

1251
00:48:54,390 --> 00:48:52,800
translating science to engineering and

1252
00:48:56,549 --> 00:48:54,400
translating engineering to science i

1253
00:48:58,230 --> 00:48:56,559
kind of help do the interface between

1254
00:49:00,390 --> 00:48:58,240
the engineering team and the science

1255
00:49:02,390 --> 00:49:00,400
team a lot so you could ask me about

1256
00:49:03,910 --> 00:49:02,400
that too if you want i'm sure

1257
00:49:05,030 --> 00:49:03,920
after what scott said there's plenty of

1258
00:49:06,549 --> 00:49:05,040
questions

1259
00:49:08,309 --> 00:49:06,559
so why don't we yeah

1260
00:49:10,470 --> 00:49:08,319
okay oh my gosh i gotta wait for the mic

1261
00:49:12,549 --> 00:49:10,480
huh

1262
00:49:13,910 --> 00:49:12,559
i asked this question of jim before and

1263
00:49:16,870 --> 00:49:13,920

um i

1264
00:49:20,150 --> 00:49:16,880
i know the camera aboard juno is a he

1265
00:49:23,430 --> 00:49:20,160
said a public outreach camera um but

1266
00:49:26,710 --> 00:49:23,440
obviously with with all that we've been

1267
00:49:30,230 --> 00:49:26,720
waiting for to get to jupiter uh in 2016

1268
00:49:32,549 --> 00:49:30,240
what type of images can we expect um

1269
00:49:34,309 --> 00:49:32,559
from the juno spacecraft obviously it's

1270
00:49:36,870 --> 00:49:34,319
going to be very close to jupiter so so

1271
00:49:38,230 --> 00:49:36,880
first of all i want to um make sure i

1272
00:49:39,510 --> 00:49:38,240
make the point because it's important to

1273
00:49:41,510 --> 00:49:39,520
me at least

1274
00:49:42,870 --> 00:49:41,520
we get a lot more information back than

1275
00:49:44,950 --> 00:49:42,880
just images

1276
00:49:45,910 --> 00:49:44,960
so um everybody when you do a space

1277
00:49:47,430 --> 00:49:45,920
mission one of the things everybody

1278
00:49:48,950 --> 00:49:47,440
wants to see is the pictures and i

1279
00:49:50,950 --> 00:49:48,960
understand that we're used to looking at

1280
00:49:52,470 --> 00:49:50,960
pictures but we have a lot of ways of

1281
00:49:55,109 --> 00:49:52,480
looking at jupiter and pictures are only

1282
00:49:56,230 --> 00:49:55,119
one piece of it having said that junocam

1283
00:49:57,190 --> 00:49:56,240
is going to take some really cool

1284
00:50:00,470 --> 00:49:57,200
pictures

1285
00:50:03,510 --> 00:50:00,480
so what's what's going to happen is is

1286
00:50:05,109 --> 00:50:03,520
junocam is sized and aimed at at taking

1287
00:50:07,030 --> 00:50:05,119
pictures of the poles

1288
00:50:09,589 --> 00:50:07,040

we haven't had a spacecraft come

1289
00:50:11,750 --> 00:50:09,599
anywhere close to jupiter over the poles

1290
00:50:13,670 --> 00:50:11,760
so if you go look at

1291
00:50:15,190 --> 00:50:13,680
images we have of jupiter some people

1292
00:50:17,430 --> 00:50:15,200
put together you know a montage or

1293
00:50:19,190 --> 00:50:17,440
whatever and make a a globe of jupiter

1294
00:50:21,030 --> 00:50:19,200
we have one over there or whatever and

1295
00:50:23,030 --> 00:50:21,040
you look at the north and south poles

1296
00:50:24,069 --> 00:50:23,040
they're kind of blurry or blank

1297
00:50:26,230 --> 00:50:24,079
that's because we don't have any good

1298
00:50:27,990 --> 00:50:26,240
images of them we're going to fly juno

1299
00:50:30,870 --> 00:50:28,000
is going to fly right over the poles

1300
00:50:33,670 --> 00:50:30,880
junocam has a big wide 50-something

1301
00:50:35,589 --> 00:50:33,680
degree field of view designed so that

1302
00:50:37,589 --> 00:50:35,599
when we come over the pole

1303
00:50:39,589 --> 00:50:37,599
really close it'll get a really nice

1304
00:50:41,910 --> 00:50:39,599
image what we're going to do with that

1305
00:50:44,470 --> 00:50:41,920
is we're going to

1306
00:50:46,150 --> 00:50:44,480
between now and 2016 when it gets there

1307
00:50:47,990 --> 00:50:46,160
set something up so the public can have

1308
00:50:49,670 --> 00:50:48,000
lots of input on which pictures we take

1309
00:50:52,309 --> 00:50:49,680
because you can't you know the camera

1310
00:50:53,750 --> 00:50:52,319
can't continuously take pictures both

1311
00:50:56,150 --> 00:50:53,760
because it needs some time in between

1312
00:50:57,670 --> 00:50:56,160
for the camera and because you'll have

1313
00:50:59,670 --> 00:50:57,680

limited data link all the way from

1314
00:51:01,670 --> 00:50:59,680
jupiter so we'll have to make decisions

1315
00:51:03,670 --> 00:51:01,680
about which pictures to take and we'll

1316
00:51:05,589 --> 00:51:03,680
get the public involved with that

1317
00:51:07,030 --> 00:51:05,599
and then when the raw data come down you

1318
00:51:09,190 --> 00:51:07,040
have to take that data and turn it into

1319
00:51:11,589 --> 00:51:09,200
good quality images and stitch things

1320
00:51:13,349 --> 00:51:11,599
together and stuff like that and we'll

1321
00:51:14,069 --> 00:51:13,359
let the public get involved with that as

1322
00:51:15,990 --> 00:51:14,079
well

1323
00:51:17,670 --> 00:51:16,000
so not only will it take really cool

1324
00:51:20,829 --> 00:51:17,680
pictures but there'll be an opportunity

1325
00:51:23,270 --> 00:51:20,839
to play with it it should be really

1326
00:51:24,870 --> 00:51:23,280
fun don't know who's got i'll let

1327
00:51:26,710 --> 00:51:24,880
whoever's got the mic should be choosing

1328
00:51:28,470 --> 00:51:26,720
whose questions yeah uh kind of an

1329
00:51:31,109 --> 00:51:28,480
engineering question could you comment

1330
00:51:32,309 --> 00:51:31,119
all on the uh how the solar panels are

1331
00:51:34,870 --> 00:51:32,319
being protected from jupiter's

1332
00:51:37,030 --> 00:51:34,880
electromagnetic fields

1333
00:51:38,470 --> 00:51:37,040
panels protected from the radiation is

1334
00:51:39,750 --> 00:51:38,480
that what you're asking

1335
00:51:41,030 --> 00:51:39,760
um

1336
00:51:42,390 --> 00:51:41,040
well the short answer is they're not

1337
00:51:43,190 --> 00:51:42,400
that protected

1338
00:51:47,910 --> 00:51:43,200

um

1339
00:51:49,270 --> 00:51:47,920
they've got a thin layer of uh cover

1340
00:51:50,870 --> 00:51:49,280
glass on them

1341
00:51:52,950 --> 00:51:50,880
they

1342
00:51:55,510 --> 00:51:52,960
we've done lots of tests to understand

1343
00:51:57,589 --> 00:51:55,520
how they will behave in the radiation

1344
00:51:59,750 --> 00:51:57,599
belts and how much degradation they'll

1345
00:52:01,670 --> 00:51:59,760
take over time and so forth so we

1346
00:52:03,510 --> 00:52:01,680
calculate how much power we're going to

1347
00:52:05,510 --> 00:52:03,520
lose and make sure that we've got enough

1348
00:52:07,109 --> 00:52:05,520
extra solar panels so that by the end of

1349
00:52:09,030 --> 00:52:07,119
the mission we still still have enough

1350
00:52:10,549 --> 00:52:09,040
power

1351
00:52:11,750 --> 00:52:10,559
you have to worry not just about the

1352
00:52:14,630 --> 00:52:11,760
radiation

1353
00:52:16,470 --> 00:52:14,640
but it's the low intensity and low

1354
00:52:18,390 --> 00:52:16,480
temperature as well

1355
00:52:19,670 --> 00:52:18,400
solar cells behave differently at lower

1356
00:52:20,790 --> 00:52:19,680
temperatures than they do at room

1357
00:52:22,390 --> 00:52:20,800
temperature

1358
00:52:24,069 --> 00:52:22,400
and they are

1359
00:52:25,589 --> 00:52:24,079
behave differently in low intensity if

1360
00:52:27,349 --> 00:52:25,599
the light's not as bright you obviously

1361
00:52:29,270 --> 00:52:27,359
get less power but the efficiency

1362
00:52:31,030 --> 00:52:29,280
changes too so we have solar panels

1363
00:52:33,430 --> 00:52:31,040

we're intending to handle that we've

1364
00:52:34,950 --> 00:52:33,440
done a lot of tests with them to try to

1365
00:52:36,390 --> 00:52:34,960
understand what the radiation will do to

1366
00:52:38,150 --> 00:52:36,400
them how they'll behave in low intensity

1367
00:52:40,230 --> 00:52:38,160
and low temperature and of course we

1368
00:52:41,510 --> 00:52:40,240
select the solar cells a bit too you

1369
00:52:42,950 --> 00:52:41,520
know you don't just go down to the store

1370
00:52:46,790 --> 00:52:42,960
buy a zillion solar cells and put them

1371
00:52:49,589 --> 00:52:46,800
on the arrays um you you go to obviously

1372
00:52:51,270 --> 00:52:49,599
lockheed did this they go to their their

1373
00:52:53,349 --> 00:52:51,280
subcontractors who can give them the

1374
00:52:55,030 --> 00:52:53,359
best solar cells and then they screen

1375
00:52:57,030 --> 00:52:55,040
them so you look through them and you

1376
00:52:58,790 --> 00:52:57,040
come up with tests to test the solar

1377
00:53:00,470 --> 00:52:58,800
cell to see how it's going to behave in

1378
00:53:02,390 --> 00:53:00,480
low intensity low temperature and

1379
00:53:05,910 --> 00:53:02,400
radiation and choose the best ones to

1380
00:53:10,069 --> 00:53:09,030
and i'm i'm looking for nasa is made up

1381
00:53:12,549 --> 00:53:10,079
of

1382
00:53:14,470 --> 00:53:12,559
amazing people that perform magic i mean

1383
00:53:16,630 --> 00:53:14,480
you guys just you know you do things

1384
00:53:19,349 --> 00:53:16,640
that nobody would ever think of but

1385
00:53:20,870 --> 00:53:19,359
at some point a decision has to be made

1386
00:53:23,829 --> 00:53:20,880
and this isn't really a juno question

1387
00:53:25,750 --> 00:53:23,839
this is kind of a spacecraft question at

1388
00:53:26,790 --> 00:53:25,760

some point a decision has to be made to

1389
00:53:28,390 --> 00:53:26,800
figure out

1390
00:53:30,230 --> 00:53:28,400
what we're going to take

1391
00:53:31,589 --> 00:53:30,240
and when you know the question the the

1392
00:53:33,829 --> 00:53:31,599
point came up earlier that you're when

1393
00:53:37,270 --> 00:53:33,839
you get to juno we're going to have 200

1394
00:53:40,470 --> 00:53:37,280
watts of power to use so

1395
00:53:42,950 --> 00:53:40,480
how do we decide what experiments

1396
00:53:44,790 --> 00:53:42,960
are are carried along and what missions

1397
00:53:46,710 --> 00:53:44,800
i mean is is there some kind of a an

1398
00:53:48,790 --> 00:53:46,720
engineering death match where people say

1399
00:53:51,430 --> 00:53:48,800
my idea is better and you know how do we

1400
00:53:54,390 --> 00:53:51,440
decide what goes to get the best bang

1401
00:53:56,230 --> 00:53:54,400
for the buck okay so i'll give you the

1402
00:53:59,190 --> 00:53:56,240
really short answer first and then i'll

1403
00:54:01,430 --> 00:53:59,200
explain okay so the really short answer

1404
00:54:02,630 --> 00:54:01,440
to a question like that is scott bolton

1405
00:54:04,710 --> 00:54:02,640
decides

1406
00:54:06,549 --> 00:54:04,720
okay but the longer answer he doesn't

1407
00:54:08,549 --> 00:54:06,559
just do that in a vacuum and make it up

1408
00:54:10,950 --> 00:54:08,559
we have a team and generally we get a

1409
00:54:13,510 --> 00:54:10,960
decision like that by consensus what

1410
00:54:15,829 --> 00:54:13,520
happens is very early on in the process

1411
00:54:17,510 --> 00:54:15,839
when we're working on the proposal

1412
00:54:19,190 --> 00:54:17,520
right we looked at what science we're

1413
00:54:21,270 --> 00:54:19,200

trying to do what nasa has said they're

1414
00:54:22,870 --> 00:54:21,280
interested in based on the decadal

1415
00:54:24,710 --> 00:54:22,880
survey and other scientists coming up

1416
00:54:26,549 --> 00:54:24,720
with what are the important questions

1417
00:54:28,390 --> 00:54:26,559
what we think we can do

1418
00:54:29,910 --> 00:54:28,400
how much power we expect to have how

1419
00:54:31,910 --> 00:54:29,920
much of all the other resources we

1420
00:54:34,470 --> 00:54:31,920
expect to have and we try to work it out

1421
00:54:35,910 --> 00:54:34,480
and get investigators involved and yeah

1422
00:54:37,270 --> 00:54:35,920
you can build an instrument a lot like

1423
00:54:38,710 --> 00:54:37,280
this one and if we do this too it'll

1424
00:54:40,950 --> 00:54:38,720
have a little less power and or if you

1425
00:54:43,030 --> 00:54:40,960
do that you can add a little more there

1426
00:54:44,630 --> 00:54:43,040
you work that out as a team

1427
00:54:46,309 --> 00:54:44,640
and come to a

1428
00:54:47,510 --> 00:54:46,319
consensus about what things are in the

1429
00:54:48,390 --> 00:54:47,520
proposal

1430
00:54:50,710 --> 00:54:48,400
then

1431
00:54:52,549 --> 00:54:50,720
after we got selected we made a few

1432
00:54:56,069 --> 00:54:52,559
changes as other things came up for

1433
00:54:57,990 --> 00:54:56,079
example um the italians weren't quite

1434
00:54:59,750 --> 00:54:58,000
able at the time of the proposal to

1435
00:55:01,430 --> 00:54:59,760
contribute an infrared

1436
00:55:03,589 --> 00:55:01,440
immagerian spectrometer but not very

1437
00:55:05,109 --> 00:55:03,599
long after the proposal they said yeah

1438
00:55:07,910 --> 00:55:05,119

we've got the funding on our side we can

1439
00:55:09,670 --> 00:55:07,920
do this and so we had a discussion

1440
00:55:11,270 --> 00:55:09,680
within the team about can we afford to

1441
00:55:12,710 --> 00:55:11,280
add them because even though they were

1442
00:55:14,789 --> 00:55:12,720
going to supply it we didn't have to pay

1443
00:55:17,109 --> 00:55:14,799
the money for it we still have to pay

1444
00:55:18,950 --> 00:55:17,119
resources on the spacecraft to supp to

1445
00:55:20,549 --> 00:55:18,960
supply it with power and a

1446
00:55:23,430 --> 00:55:20,559
place to put it and radiation shielding

1447
00:55:25,430 --> 00:55:23,440
and all that stuff right so obviously

1448
00:55:26,950 --> 00:55:25,440
it's on board the science team and

1449
00:55:28,710 --> 00:55:26,960
everybody else concluded this is really

1450
00:55:30,230 --> 00:55:28,720
worth it this is a great instrument so

1451
00:55:32,789 --> 00:55:30,240
we added it in

1452
00:55:34,870 --> 00:55:32,799
that kind of thing happens for all kinds

1453
00:55:36,789 --> 00:55:34,880
of decisions big ones like adding or

1454
00:55:39,430 --> 00:55:36,799
subtracting an instrument

1455
00:55:40,950 --> 00:55:39,440
little ones like um you know do you can

1456
00:55:43,510 --> 00:55:40,960
you put an extra cable for this thing

1457
00:55:45,750 --> 00:55:43,520
and have it be dual sided and and have a

1458
00:55:46,789 --> 00:55:45,760
little redundancy on it or

1459
00:55:48,390 --> 00:55:46,799
there were a couple of times where we

1460
00:55:51,109 --> 00:55:48,400
made the solar panels bigger and we had

1461
00:55:53,349 --> 00:55:51,119
a big internal discussion about the pros

1462
00:55:54,230 --> 00:55:53,359
and cons of making the solar panels

1463
00:55:55,829 --> 00:55:54,240

bigger

1464
00:55:58,309 --> 00:55:55,839
that kind of stuff those are called

1465
00:55:59,910 --> 00:55:58,319
engineering trade studies

1466
00:56:01,990 --> 00:55:59,920
generally speaking

1467
00:56:04,309 --> 00:56:02,000
what happens is that's handled by the

1468
00:56:06,630 --> 00:56:04,319
project system engineering team so it's

1469
00:56:09,109 --> 00:56:06,640
mostly the engineers who work out

1470
00:56:11,030 --> 00:56:09,119
what you can do and what you can't do

1471
00:56:12,789 --> 00:56:11,040
and the pros and cons and they come to

1472
00:56:14,870 --> 00:56:12,799
the science team and say how important

1473
00:56:17,589 --> 00:56:14,880
is the science you get from this and

1474
00:56:19,510 --> 00:56:17,599
they lay it all out for the team

1475
00:56:23,430 --> 00:56:19,520
we try to arrive at a consensus and if

1476
00:56:24,870 --> 00:56:23,440
there isn't a consensus scott decides

1477
00:56:28,150 --> 00:56:24,880
so we got time for two more questions

1478
00:56:29,109 --> 00:56:28,160
one of them's right here oh man already

1479
00:56:31,270 --> 00:56:29,119
hello

1480
00:56:33,190 --> 00:56:31,280
my name is lisa johnson and i happen to

1481
00:56:35,430 --> 00:56:33,200
be working on a satellite that's going

1482
00:56:37,190 --> 00:56:35,440
to be uh trying to dissipate some of the

1483
00:56:38,950 --> 00:56:37,200
high energy particles that we have here

1484
00:56:42,230 --> 00:56:38,960
in the earth's atmosphere so i was

1485
00:56:43,829 --> 00:56:42,240
curious about jupiter's auroras and how

1486
00:56:45,829 --> 00:56:43,839
do they compare to the earth because the

1487
00:56:47,829 --> 00:56:45,839
earth much closer to the sun we have a

1488
00:56:49,270 --> 00:56:47,839

lot of the solar wind particles that get

1489
00:56:50,309 --> 00:56:49,280
in that cause the great auroras that we

1490
00:56:52,150 --> 00:56:50,319
have here

1491
00:56:53,910 --> 00:56:52,160
jupiter is much farther away and it also

1492
00:56:55,910 --> 00:56:53,920
doesn't have the human contribution so

1493
00:56:57,190 --> 00:56:55,920
i'm curious what we will see on jupiter

1494
00:56:59,589 --> 00:56:57,200
and what data we're going to be

1495
00:57:00,870 --> 00:56:59,599
measuring so um

1496
00:57:02,630 --> 00:57:00,880
first of all that sounds like a really

1497
00:57:03,910 --> 00:57:02,640
cool experiment

1498
00:57:06,470 --> 00:57:03,920
but

1499
00:57:07,670 --> 00:57:06,480
the way you have to picture this is the

1500
00:57:09,510 --> 00:57:07,680
aurora

1501
00:57:11,270 --> 00:57:09,520
and here's fran baginal who is the

1502
00:57:13,670 --> 00:57:11,280
person who should answer this question

1503
00:57:16,230 --> 00:57:13,680
you want to just come do this

1504
00:57:17,670 --> 00:57:16,240
i could give you a great answer but but

1505
00:57:20,390 --> 00:57:17,680
graham is like the world's expert on

1506
00:57:21,190 --> 00:57:20,400
this okay

1507
00:57:22,950 --> 00:57:21,200
so

1508
00:57:24,230 --> 00:57:22,960
indeed uh we're going to be measuring

1509
00:57:26,950 --> 00:57:24,240
the aurora

1510
00:57:29,270 --> 00:57:26,960
and but not just looking down on the

1511
00:57:32,710 --> 00:57:29,280
aurora with um

1512
00:57:34,470 --> 00:57:32,720
the uvs and with um

1513
00:57:36,309 --> 00:57:34,480

duram and looking at the radiation of

1514
00:57:39,190 --> 00:57:36,319
the uv radiation and the infrared

1515
00:57:40,470 --> 00:57:39,200
radiation that comes from the atmosphere

1516
00:57:41,990 --> 00:57:40,480
but we're also going to be looking at

1517
00:57:44,630 --> 00:57:42,000
the particles

1518
00:57:46,710 --> 00:57:44,640
that are causing that radiation that so

1519
00:57:49,589 --> 00:57:46,720
we got a problem with radiation we we

1520
00:57:50,630 --> 00:57:49,599
sorted out radiation and radiation okay

1521
00:57:51,910 --> 00:57:50,640
so

1522
00:57:54,710 --> 00:57:51,920
we have to get

1523
00:57:56,789 --> 00:57:54,720
sort out photons which is the uv

1524
00:57:58,390 --> 00:57:56,799
particles coming out and the infrared

1525
00:58:01,270 --> 00:57:58,400
particles coming out

1526
00:58:04,230 --> 00:58:01,280
and the electrons and protons which

1527
00:58:07,910 --> 00:58:04,240
bombard the atmosphere and generate that

1528
00:58:09,430 --> 00:58:07,920
light to come out okay so uh infrared

1529
00:58:12,470 --> 00:58:09,440
and uv

1530
00:58:13,829 --> 00:58:12,480
light come out that we detect with jiram

1531
00:58:16,789 --> 00:58:13,839
and uvs

1532
00:58:18,549 --> 00:58:16,799
and that'll show us what the aurora are

1533
00:58:20,950 --> 00:58:18,559
um but also

1534
00:58:23,430 --> 00:58:20,960
we will be carrying two instruments that

1535
00:58:26,150 --> 00:58:23,440
carry measure the

1536
00:58:28,230 --> 00:58:26,160
energetic particles the jedi and jade

1537
00:58:29,589 --> 00:58:28,240
instruments that are the particles that

1538
00:58:31,750 --> 00:58:29,599

are coming in and bombarding the

1539
00:58:35,270 --> 00:58:31,760
atmosphere

1540
00:58:37,990 --> 00:58:35,280
and then on top of that we have waves

1541
00:58:39,510 --> 00:58:38,000
which measures uh electric fields and i

1542
00:58:41,750 --> 00:58:39,520
get my hands go like this because i'm

1543
00:58:44,230 --> 00:58:41,760
thinking wiggling fields right you know

1544
00:58:46,630 --> 00:58:44,240
so uh electric fields and magnetic

1545
00:58:49,270 --> 00:58:46,640
fields mag doing the magnetic fields so

1546
00:58:50,630 --> 00:58:49,280
what we think is happening is that

1547
00:58:53,990 --> 00:58:50,640
we have

1548
00:58:56,950 --> 00:58:54,000
waves in literally electromagnetic waves

1549
00:58:58,789 --> 00:58:56,960
at fairly low frequencies compared with

1550
00:59:01,190 --> 00:58:58,799
light waves

1551
00:59:03,589 --> 00:59:01,200
that scatter particles accelerate

1552
00:59:05,990 --> 00:59:03,599
particles and we think that the

1553
00:59:08,630 --> 00:59:06,000
then those accelerated particles come

1554
00:59:10,710 --> 00:59:08,640
bombarding into the atmosphere excite

1555
00:59:13,990 --> 00:59:10,720
the uh atoms and molecules in the

1556
00:59:17,270 --> 00:59:14,000
atmosphere of jupiter that then glow

1557
00:59:20,309 --> 00:59:17,280
with this infrared and uh uv radiation

1558
00:59:21,750 --> 00:59:20,319
so in some ways it's almost exactly the

1559
00:59:23,910 --> 00:59:21,760
same as the northern lights with the

1560
00:59:27,270 --> 00:59:23,920
earth where we have the same sort of

1561
00:59:29,829 --> 00:59:27,280
processes going on in the northern poles

1562
00:59:32,470 --> 00:59:29,839
and the southern poles uh producing that

1563
00:59:34,150 --> 00:59:32,480

process what we don't know and this is

1564
00:59:36,390 --> 00:59:34,160
the big difference between the earth and

1565
00:59:38,789 --> 00:59:36,400
jupiter is where

1566
00:59:41,270 --> 00:59:38,799
that acceleration process happens that

1567
00:59:44,470 --> 00:59:41,280
excites those electrons that bombard the

1568
00:59:47,589 --> 00:59:44,480
atmosphere and what are the causes

1569
00:59:48,309 --> 00:59:47,599
because with with the earth we know that

1570
00:59:52,789 --> 00:59:48,319
the

1571
00:59:54,950 --> 00:59:52,799
magnetic field wheels it about makes it

1572
00:59:56,950 --> 00:59:54,960
shake and that's what causes the

1573
00:59:58,789 --> 00:59:56,960
particles to be accelerated and then

1574
01:00:00,230 --> 00:59:58,799
ultimately hit

1575
01:00:03,190 --> 01:00:00,240
the earth's atmosphere to make the

1576
01:00:06,230 --> 01:00:03,200
aurora and so the earth's aurora very

1577
01:00:08,549 --> 01:00:06,240
strongly depends on what's going on on

1578
01:00:10,150 --> 01:00:08,559
the sun and what comes from the sun and

1579
01:00:12,870 --> 01:00:10,160
hits the earth

1580
01:00:15,990 --> 01:00:12,880
now with jupiter the magnetic field is

1581
01:00:19,990 --> 01:00:16,000
so strong that it holds off the solar

1582
01:00:22,309 --> 01:00:20,000
wind for a long way okay so at earth

1583
01:00:24,230 --> 01:00:22,319
towards the sun the solar wind

1584
01:00:26,630 --> 01:00:24,240
in the solar wind direction the earth's

1585
01:00:28,789 --> 01:00:26,640
magnetic field extends for about 10

1586
01:00:30,549 --> 01:00:28,799
times the radius of the earth so you

1587
01:00:32,470 --> 01:00:30,559
think of the earth and then something 10

1588
01:00:34,390 --> 01:00:32,480

times bigger that's the size of the

1589
01:00:36,950 --> 01:00:34,400
magnetosphere of the earth

1590
01:00:38,950 --> 01:00:36,960
with jupiter and remember that jupiter

1591
01:00:40,950 --> 01:00:38,960
is 10 times the size of the earth so you

1592
01:00:42,789 --> 01:00:40,960
could put the magnetosphere inside the

1593
01:00:44,950 --> 01:00:42,799
planet jupiter

1594
01:00:46,150 --> 01:00:44,960
the earth's magnesium within the planet

1595
01:00:50,069 --> 01:00:46,160
jupiter

1596
01:00:52,150 --> 01:00:50,079
times

1597
01:00:54,150 --> 01:00:52,160
the size of jupiter that's just in the

1598
01:00:56,230 --> 01:00:54,160
direction towards the sun in the

1599
01:00:58,309 --> 01:00:56,240
direction away from the sun it goes past

1600
01:00:59,430 --> 01:00:58,319
the orbit of saturn so this is a vast

1601
01:01:01,750 --> 01:00:59,440
region

1602
01:01:04,390 --> 01:01:01,760
so the processes are very different

1603
01:01:06,710 --> 01:01:04,400
it's not affected by the solar wind

1604
01:01:09,589 --> 01:01:06,720
it it behaves on its own due to what's

1605
01:01:12,230 --> 01:01:09,599
going on inside

1606
01:01:15,750 --> 01:01:12,240
so has anybody talked about eo and that

1607
01:01:17,109 --> 01:01:15,760
pesky little moon eo on what eo is doing

1608
01:01:21,109 --> 01:01:17,119
he won't

1609
01:01:24,309 --> 01:01:22,150
anyway

1610
01:01:26,150 --> 01:01:24,319
we can talk about pesky little eel later

1611
01:01:27,990 --> 01:01:26,160
she was asked about the size too the

1612
01:01:29,109 --> 01:01:28,000
aurora and jupiter being so much bigger

1613
01:01:30,870 --> 01:01:29,119

right i think we haven't really talked

1614
01:01:32,630 --> 01:01:30,880
about why they're bigger

1615
01:01:35,030 --> 01:01:32,640
uh when you say bigger do you mean

1616
01:01:37,510 --> 01:01:35,040
bigger as in spatially bigger or covers

1617
01:01:39,670 --> 01:01:37,520
more of the planets it's about the same

1618
01:01:42,470 --> 01:01:39,680
size on the planet if you were to draw

1619
01:01:44,710 --> 01:01:42,480
just a sphere and draw where the

1620
01:01:45,910 --> 01:01:44,720
aurora are for jupiter and where they

1621
01:01:46,950 --> 01:01:45,920
are for the earth they're not all that

1622
01:01:48,390 --> 01:01:46,960
different

1623
01:01:54,069 --> 01:01:48,400
about the same

1624
01:01:58,549 --> 01:01:55,670
i promise i'll give up the mic again

1625
01:02:00,870 --> 01:01:58,559
when i when they make me

1626
01:02:03,510 --> 01:02:00,880
question for you back here

1627
01:02:06,390 --> 01:02:03,520
yes okay it's a slightly

1628
01:02:10,470 --> 01:02:06,400
slightly less technical question where

1629
01:02:13,589 --> 01:02:12,069
am i am i allowed to mention commercial

1630
01:02:16,950 --> 01:02:13,599
companies um

1631
01:02:18,870 --> 01:02:16,960
we it turns out land lands end will do

1632
01:02:20,710 --> 01:02:18,880
they have like a business

1633
01:02:22,150 --> 01:02:20,720
uh corporate

1634
01:02:23,510 --> 01:02:22,160
section or something and if you give

1635
01:02:25,190 --> 01:02:23,520
them a logo

1636
01:02:27,750 --> 01:02:25,200
they'll make shirts

1637
01:02:29,990 --> 01:02:27,760
so um scott got this stuff and gave it

1638
01:02:31,589 --> 01:02:30,000

to them and then team members can just

1639
01:02:33,109 --> 01:02:31,599
call them up and say you know number

1640
01:02:37,109 --> 01:02:33,119
whatever i want logo number whatever on

1641
01:02:39,029 --> 01:02:37,119
my shirt and i have about 10 of these

1642
01:02:43,029 --> 01:02:39,039
but we're gonna do juno glitter tattoos

1643
01:02:57,109 --> 01:02:44,789
thank you steve really appreciate your

1644
01:03:01,750 --> 01:02:59,750
okay so for our last tweet up

1645
01:03:03,670 --> 01:03:01,760
the big challenge is it nearly turned

1646
01:03:05,109 --> 01:03:03,680
into space woodstock outside with the

1647
01:03:06,630 --> 01:03:05,119
rain and the mud

1648
01:03:08,950 --> 01:03:06,640
and i think our bonding experience is

1649
01:03:10,230 --> 01:03:08,960
going to be florida and august and i

1650
01:03:13,589 --> 01:03:10,240
know it's getting warm on this side of

1651
01:03:14,390 --> 01:03:13,599
the tent especially because the sun is

1652
01:03:18,630 --> 01:03:14,400
so

1653
01:03:20,390 --> 01:03:18,640
water find one of us in a blue badge let

1654
01:03:21,510 --> 01:03:20,400
us know that side of the tent because

1655
01:03:23,109 --> 01:03:21,520
it's a little more out of the sun is a

1656
01:03:24,230 --> 01:03:23,119
little cooler so if you need to stand up

1657
01:03:26,230 --> 01:03:24,240
go over there stand by the air

1658
01:03:27,829 --> 01:03:26,240
conditioners i understand we're gonna

1659
01:03:29,510 --> 01:03:27,839
keep moving along if you guys are still

1660
01:03:31,750 --> 01:03:29,520
in it with us

1661
01:03:34,150 --> 01:03:31,760
all right all right fantastic

1662
01:03:36,470 --> 01:03:34,160
so it's my pleasure to introduce three

1663
01:03:37,990 --> 01:03:36,480

of the juno science team members that

1664
01:03:39,430 --> 01:03:38,000
are going to be working deep down in

1665
01:03:41,349 --> 01:03:39,440
some of the scientific discoveries that

1666
01:03:43,430 --> 01:03:41,359
you know is going to enable and they are

1667
01:03:45,270 --> 01:03:43,440
toby owen professor of astronomy at the

1668
01:03:47,109 --> 01:03:45,280
university of hawaii

1669
01:03:49,829 --> 01:03:47,119
fran baganal who you all just met she's

1670
01:03:51,270 --> 01:03:49,839
professor of astro yeah please no fran

1671
01:03:52,870 --> 01:03:51,280
absolutely

1672
01:03:54,630 --> 01:03:52,880
professor of astrophysical and planetary

1673
01:03:56,950 --> 01:03:54,640
sciences and faculty associate of the

1674
01:03:59,270 --> 01:03:56,960
laboratory of atmospheric and space

1675
01:04:00,710 --> 01:03:59,280
physics at the university of colorado

1676
01:04:03,750 --> 01:04:00,720
and paul boulder

1677
01:04:05,990 --> 01:04:03,760
and dave stevenson the george van osdol

1678
01:04:07,430 --> 01:04:06,000
professor of planetary science at

1679
01:04:18,710 --> 01:04:07,440
caltech

1680
01:04:20,950 --> 01:04:19,990
so we're going to share the microphone

1681
01:04:22,150 --> 01:04:20,960
for now and i'll try to get you the

1682
01:04:23,029 --> 01:04:22,160
other two let's go whoever wants to

1683
01:04:26,150 --> 01:04:23,039
speak

1684
01:04:30,549 --> 01:04:27,670
you've already heard what i'm interested

1685
01:04:35,510 --> 01:04:30,559
in i'm going to hand the phone over to

1686
01:04:39,829 --> 01:04:37,510
so for me this

1687
01:04:42,470 --> 01:04:39,839
mission is very exciting in some

1688
01:04:43,750 --> 01:04:42,480

respects a culmination of a career

1689
01:04:46,309 --> 01:04:43,760
because

1690
01:04:47,670 --> 01:04:46,319
40 years ago when i was a student at

1691
01:04:50,390 --> 01:04:47,680
cornell

1692
01:04:54,630 --> 01:04:50,400
i embarked on a thesis the title of

1693
01:04:56,309 --> 01:04:54,640
which was the interior of jupiter

1694
01:04:58,309 --> 01:04:56,319
and now finally we're going to find out

1695
01:04:59,990 --> 01:04:58,319
the truth

1696
01:05:03,510 --> 01:05:00,000
but it's too late for them to take away

1697
01:05:08,390 --> 01:05:07,109
a planet is like a book or a movie

1698
01:05:10,309 --> 01:05:08,400
it tells a story

1699
01:05:12,549 --> 01:05:10,319
it has a plot

1700
01:05:14,309 --> 01:05:12,559
and

1701
01:05:15,430 --> 01:05:14,319
in particular

1702
01:05:18,870 --> 01:05:15,440
it

1703
01:05:20,470 --> 01:05:18,880
tells you something about history

1704
01:05:23,270 --> 01:05:20,480
when you look at a planet you're not

1705
01:05:25,750 --> 01:05:23,280
just looking at the way it behaves now

1706
01:05:28,630 --> 01:05:25,760
you're looking at the outcome

1707
01:05:30,309 --> 01:05:28,640
of an evolution over the age of the

1708
01:05:31,829 --> 01:05:30,319
solar system four and a half billion

1709
01:05:35,589 --> 01:05:31,839
years

1710
01:05:38,150 --> 01:05:35,599
and particularly in the case of jupiter

1711
01:05:40,950 --> 01:05:38,160
you are seeing

1712
01:05:42,789 --> 01:05:40,960
information about how

1713
01:05:45,829 --> 01:05:42,799

the planet formed

1714
01:05:48,470 --> 01:05:45,839
and how it has evolved

1715
01:05:50,630 --> 01:05:48,480
and jupiter is the 800 pound gorilla in

1716
01:05:52,549 --> 01:05:50,640
the solar system it

1717
01:05:56,870 --> 01:05:52,559
has affected

1718
01:05:59,510 --> 01:05:56,880
the architecture of our planetary system

1719
01:06:00,630 --> 01:05:59,520
it has even affected

1720
01:06:03,190 --> 01:06:00,640
earth

1721
01:06:05,190 --> 01:06:03,200
the water that i hope you're drinking

1722
01:06:07,510 --> 01:06:05,200
very likely came

1723
01:06:10,309 --> 01:06:07,520
from a region near jupiter

1724
01:06:12,789 --> 01:06:10,319
and the way in which it was delivered

1725
01:06:14,150 --> 01:06:12,799
is affected by the way in which jupiter

1726
01:06:15,670 --> 01:06:14,160
is formed

1727
01:06:16,950 --> 01:06:15,680
and that

1728
01:06:19,190 --> 01:06:16,960
process

1729
01:06:20,470 --> 01:06:19,200
of formation

1730
01:06:22,950 --> 01:06:20,480
is

1731
01:06:24,549 --> 01:06:22,960
there as a memory in the internal

1732
01:06:26,950 --> 01:06:24,559
structure

1733
01:06:29,430 --> 01:06:26,960
one of the central questions of the juno

1734
01:06:30,309 --> 01:06:29,440
mission is to understand whether there

1735
01:06:32,789 --> 01:06:30,319
is

1736
01:06:35,829 --> 01:06:32,799
a central concentration of heavy

1737
01:06:36,710 --> 01:06:35,839
elements that scott bolton talked about

1738
01:06:38,789 --> 01:06:36,720

uh

1739
01:06:39,829 --> 01:06:38,799
material that on earth would make up a

1740
01:06:41,270 --> 01:06:39,839
rock

1741
01:06:43,589 --> 01:06:41,280
maybe ice

1742
01:06:46,710 --> 01:06:43,599
the amount of that material

1743
01:06:47,589 --> 01:06:46,720
the way in which it's distributed

1744
01:06:50,870 --> 01:06:47,599
is

1745
01:06:53,109 --> 01:06:50,880
a legacy of the formation process

1746
01:06:53,829 --> 01:06:53,119
of the planet

1747
01:06:58,230 --> 01:06:53,839
so

1748
01:07:00,870 --> 01:06:58,240
the place you look

1749
01:07:02,630 --> 01:07:00,880
to understand these processes is jupiter

1750
01:07:05,910 --> 01:07:02,640
because jupiter is the most massive

1751
01:07:07,349 --> 01:07:05,920
planet you might also say uh let's look

1752
01:07:10,950 --> 01:07:07,359
at the earth and people do look at the

1753
01:07:12,069 --> 01:07:10,960
earth but the nature of earth itself is

1754
01:07:12,950 --> 01:07:12,079
affected

1755
01:07:15,910 --> 01:07:12,960
by

1756
01:07:18,230 --> 01:07:15,920
uh the structure

1757
01:07:19,190 --> 01:07:18,240
of jupiter

1758
01:07:21,910 --> 01:07:19,200
so

1759
01:07:23,349 --> 01:07:21,920
the exciting thing about this mission is

1760
01:07:24,390 --> 01:07:23,359
that it will

1761
01:07:26,470 --> 01:07:24,400
bring

1762
01:07:27,829 --> 01:07:26,480
three important things that scott bolton

1763
01:07:30,789 --> 01:07:27,839

mentioned

1764
01:07:32,470 --> 01:07:30,799
to bear on this question water water is

1765
01:07:34,470 --> 01:07:32,480
extremely important toby will say

1766
01:07:36,309 --> 01:07:34,480
something about that as well

1767
01:07:38,870 --> 01:07:36,319
the amount of water

1768
01:07:40,829 --> 01:07:38,880
the origin of that water

1769
01:07:44,230 --> 01:07:40,839
is is of central importance for

1770
01:07:45,910 --> 01:07:44,240
understanding the nature of jupiter

1771
01:07:47,349 --> 01:07:45,920
the gravity field which will tell us

1772
01:07:48,549 --> 01:07:47,359
something about how the materials are

1773
01:07:50,309 --> 01:07:48,559
distributed

1774
01:07:52,390 --> 01:07:50,319
and the magnetic field

1775
01:07:55,589 --> 01:07:52,400
now i want to say a few more words about

1776
01:07:57,589 --> 01:07:55,599
the gravity field of the magnetic field

1777
01:07:59,829 --> 01:07:57,599
the the gravity field of course is

1778
01:08:01,990 --> 01:07:59,839
determined by

1779
01:08:04,470 --> 01:08:02,000
looking at the trajectory of the

1780
01:08:05,910 --> 01:08:04,480
spacecraft which will be slightly

1781
01:08:06,870 --> 01:08:05,920
disturbed

1782
01:08:09,190 --> 01:08:06,880
by

1783
01:08:12,150 --> 01:08:09,200
the distribution of mass within the

1784
01:08:14,630 --> 01:08:12,160
planet as it goes around in its orbit

1785
01:08:16,789 --> 01:08:14,640
the the orbit will be ever so slightly

1786
01:08:19,590 --> 01:08:16,799
modified and that will show up in the

1787
01:08:22,229 --> 01:08:19,600
doppler signal that comes back to earth

1788
01:08:23,349 --> 01:08:22,239

and in addition to learning

1789
01:08:24,550 --> 01:08:23,359
about

1790
01:08:27,269 --> 01:08:24,560
the

1791
01:08:29,910 --> 01:08:27,279
central concentration of matter

1792
01:08:31,669 --> 01:08:29,920
the gravity field has the exciting

1793
01:08:33,590 --> 01:08:31,679
prospect of telling us about some

1794
01:08:34,709 --> 01:08:33,600
aspects of the outer part of the planet

1795
01:08:35,669 --> 01:08:34,719
as well

1796
01:08:38,390 --> 01:08:35,679
it may

1797
01:08:42,149 --> 01:08:38,400
amazingly enough actually tell us

1798
01:08:43,990 --> 01:08:42,159
something about the nature of the winds

1799
01:08:48,950 --> 01:08:44,000
on jupiter

1800
01:08:50,789 --> 01:08:48,960
zonal winds

1801
01:08:52,229 --> 01:08:50,799
there's an equatorial jet and more

1802
01:08:53,669 --> 01:08:52,239
complicated structure at higher

1803
01:08:55,349 --> 01:08:53,679
latitudes

1804
01:08:57,749 --> 01:08:55,359
and those winds

1805
01:08:58,950 --> 01:08:57,759
change the shape

1806
01:09:02,070 --> 01:08:58,960
of jupiter

1807
01:09:03,910 --> 01:09:02,080
and thereby change the gravity field and

1808
01:09:06,470 --> 01:09:03,920
we hope to pick that up and that will be

1809
01:09:08,950 --> 01:09:06,480
exciting because there's a possibility

1810
01:09:11,510 --> 01:09:08,960
of learning about the depth to which

1811
01:09:13,510 --> 01:09:11,520
those flows extend at the moment that's

1812
01:09:15,829 --> 01:09:13,520
a total mystery

1813
01:09:17,590 --> 01:09:15,839

with the magnetic field as scott bolden

1814
01:09:20,870 --> 01:09:17,600
mentioned

1815
01:09:23,110 --> 01:09:20,880
there is the prospect of learning about

1816
01:09:25,590 --> 01:09:23,120
the nature of how magnetic fields

1817
01:09:28,070 --> 01:09:25,600
generated within planets to a greater

1818
01:09:30,709 --> 01:09:28,080
extent even than earth

1819
01:09:32,630 --> 01:09:30,719
because on earth we have the problem

1820
01:09:36,070 --> 01:09:32,640
that the measurements we make at earth's

1821
01:09:39,590 --> 01:09:36,080
surface or in space are affected by the

1822
01:09:43,510 --> 01:09:39,600
presence of magnetization in the crust

1823
01:09:45,829 --> 01:09:43,520
jupiter has no crust it has a region of

1824
01:09:48,229 --> 01:09:45,839
metallic conduction that extends out to

1825
01:09:51,269 --> 01:09:48,239
perhaps 80 percent of the radius of the

1826
01:09:53,990 --> 01:09:51,279
planet and within that fluid

1827
01:09:56,310 --> 01:09:54,000
the field is being generated by a dynamo

1828
01:09:59,910 --> 01:09:56,320
process like that in earth's core we

1829
01:10:01,910 --> 01:09:59,920
would like to understand uh that process

1830
01:10:03,510 --> 01:10:01,920
better

1831
01:10:06,229 --> 01:10:03,520
now

1832
01:10:08,709 --> 01:10:06,239
i want finally to make a general comment

1833
01:10:10,790 --> 01:10:08,719
about planetary exploration people often

1834
01:10:14,229 --> 01:10:10,800
say well what's the most important thing

1835
01:10:16,709 --> 01:10:14,239
that a mission is going to do

1836
01:10:18,870 --> 01:10:16,719
and my answer to that question is the

1837
01:10:20,950 --> 01:10:18,880
most important thing is the things we

1838
01:10:23,990 --> 01:10:20,960

cannot predict

1839
01:10:26,149 --> 01:10:24,000
for indeed if you look back at previous

1840
01:10:28,149 --> 01:10:26,159
missions if you look back at what

1841
01:10:30,310 --> 01:10:28,159
voyager did

1842
01:10:32,070 --> 01:10:30,320
arguably the most successful mission

1843
01:10:33,990 --> 01:10:32,080
ever the outer solar system two

1844
01:10:35,669 --> 01:10:34,000
spacecraft or if you look at what

1845
01:10:39,350 --> 01:10:35,679
galileo did or if you look at what

1846
01:10:41,750 --> 01:10:39,360
cassini is doing the most important most

1847
01:10:44,709 --> 01:10:41,760
exciting things that came out of those

1848
01:10:45,910 --> 01:10:44,719
missions were the things that we did not

1849
01:10:48,070 --> 01:10:45,920
predict

1850
01:10:50,149 --> 01:10:48,080
and i think that will be the case which

1851
01:10:51,510 --> 01:10:50,159
you know as well the most exciting

1852
01:10:54,709 --> 01:10:51,520
things that will come out of this

1853
01:10:59,030 --> 01:10:54,719
mission are the things that i

1854
01:11:02,229 --> 01:10:59,040
and nobody else on the team can predict

1855
01:11:03,669 --> 01:11:02,239
let me uh toby

1856
01:11:06,149 --> 01:11:03,679
you want to talk for a while maybe you

1857
01:11:08,229 --> 01:11:06,159
want to answer questions or

1858
01:11:10,709 --> 01:11:08,239
we could do questions as a group or i

1859
01:11:13,669 --> 01:11:10,719
could answer questions right now yes

1860
01:11:14,950 --> 01:11:13,679
any questions

1861
01:11:17,270 --> 01:11:14,960
okay we got a question over here on your

1862
01:11:21,350 --> 01:11:19,590
um hi i'm kat robinson from tucson

1863
01:11:23,750 --> 01:11:21,360

arizona i have kind of a question for

1864
01:11:25,510 --> 01:11:23,760
all of you i think one thing that's been

1865
01:11:26,950 --> 01:11:25,520
mentioned several times here is the

1866
01:11:28,870 --> 01:11:26,960
important of getting the younger

1867
01:11:31,590 --> 01:11:28,880
generation invested in space and space

1868
01:11:33,350 --> 01:11:31,600
exploration so just wondering what was

1869
01:11:35,590 --> 01:11:33,360
it that got each of you hooked into

1870
01:11:38,550 --> 01:11:35,600
space and what led you to be on this

1871
01:11:42,950 --> 01:11:40,870
in my personal case i went to cornell

1872
01:11:45,270 --> 01:11:42,960
and i went there intending to be a

1873
01:11:47,510 --> 01:11:45,280
theoretical physicist in fact my phd is

1874
01:11:50,470 --> 01:11:47,520
in theoretical physics but i did take a

1875
01:11:52,630 --> 01:11:50,480
course from carl sagan uh and and he was

1876
01:11:55,030 --> 01:11:52,640
an important influence there were other

1877
01:11:56,149 --> 01:11:55,040
influences as well but it was to be

1878
01:12:00,470 --> 01:11:56,159
frank

1879
01:12:04,790 --> 01:12:01,830
okay next question is going to be here

1880
01:12:09,430 --> 01:12:07,510
hi uh maurice jones from los angeles uh

1881
01:12:12,070 --> 01:12:09,440
over the past few years we've had the

1882
01:12:13,270 --> 01:12:12,080
serendipitous opportunity to see jupiter

1883
01:12:16,390 --> 01:12:13,280
get whacked

1884
01:12:17,990 --> 01:12:16,400
by uh asteroids or comets and we've seen

1885
01:12:21,669 --> 01:12:18,000
those scar impacts and what i wanted to

1886
01:12:24,149 --> 01:12:21,679
know is if those uh if those events as

1887
01:12:26,229 --> 01:12:24,159
unpredicted as they were or we saw

1888
01:12:28,229 --> 01:12:26,239

shoemaker lee becoming

1889
01:12:30,070 --> 01:12:28,239
if what those might have contributed to

1890
01:12:33,270 --> 01:12:30,080
what we know about the interior of

1891
01:12:39,430 --> 01:12:36,870
it turns out that in the impact

1892
01:12:42,550 --> 01:12:39,440
of shoemaker levy

1893
01:12:44,550 --> 01:12:42,560
the material that was excited was very

1894
01:12:46,390 --> 01:12:44,560
close to the surface of the planet very

1895
01:12:49,189 --> 01:12:46,400
close to the region that we can observe

1896
01:12:51,110 --> 01:12:49,199
from earth and so although some of us

1897
01:12:52,470 --> 01:12:51,120
thought that you would learn about the

1898
01:12:55,590 --> 01:12:52,480
interior

1899
01:12:58,390 --> 01:12:55,600
fact unfortunately those impacts did not

1900
01:13:00,550 --> 01:12:58,400
tell us about that it did tell us

1901
01:13:02,950 --> 01:13:00,560
some important things about

1902
01:13:03,750 --> 01:13:02,960
waves in the atmosphere

1903
01:13:06,149 --> 01:13:03,760
and

1904
01:13:16,070 --> 01:13:06,159
so some important things about what

1905
01:13:19,910 --> 01:13:18,630
hi elissa frankel washington dc

1906
01:13:21,430 --> 01:13:19,920
um i know there's a lot that we don't

1907
01:13:24,390 --> 01:13:21,440
know yet not that we're hoping to find

1908
01:13:27,110 --> 01:13:24,400
out in five years about this whole

1909
01:13:28,790 --> 01:13:27,120
core of jupiter um but what did you

1910
01:13:29,510 --> 01:13:28,800
write about in your thesis concerning

1911
01:13:30,950 --> 01:13:29,520
that

1912
01:13:35,590 --> 01:13:30,960
what what did you write about in your

1913
01:13:39,910 --> 01:13:37,669

in my thesis work

1914
01:13:41,669 --> 01:13:39,920
the main thing i actually looked at was

1915
01:13:42,550 --> 01:13:41,679
the question of whether there is helium

1916
01:13:43,750 --> 01:13:42,560
brain

1917
01:13:45,750 --> 01:13:43,760
in jupiter

1918
01:13:47,830 --> 01:13:45,760
and it now seems likely that the answer

1919
01:13:49,910 --> 01:13:47,840
is yes

1920
01:13:52,950 --> 01:13:49,920
and and that has been an exciting

1921
01:13:55,750 --> 01:13:52,960
outcome over over many years

1922
01:13:58,709 --> 01:13:55,760
because it turns out that that

1923
01:14:01,110 --> 01:13:58,719
process of forming droplets deep down

1924
01:14:04,790 --> 01:14:01,120
inside jupiter also affects

1925
01:14:07,669 --> 01:14:04,800
other noble gases especially neon

1926
01:14:10,550 --> 01:14:07,679
and it it may also be an important

1927
01:14:12,229 --> 01:14:10,560
energy source for the heat that comes

1928
01:14:19,189 --> 01:14:12,239
out of saturn

1929
01:14:19,199 --> 01:14:24,470
we got a question here in the back

1930
01:14:27,510 --> 01:14:26,550
hi my name is bj price i'm from orlando

1931
01:14:29,750 --> 01:14:27,520
florida

1932
01:14:31,669 --> 01:14:29,760
i wanted to ask you about what's it like

1933
01:14:34,149 --> 01:14:31,679
to work on a project that's so long in

1934
01:14:36,470 --> 01:14:34,159
the making and so long from

1935
01:14:38,630 --> 01:14:36,480
10 years to to develop another six years

1936
01:14:40,550 --> 01:14:38,640
before you're going to see any data

1937
01:14:43,189 --> 01:14:40,560
it's a it's an incredible investment of

1938
01:14:44,709 --> 01:14:43,199

time just to get your experiments to

1939
01:14:46,390 --> 01:14:44,719
work and to get some data back what's it

1940
01:14:49,750 --> 01:14:46,400
like working on an experiment of that

1941
01:14:52,149 --> 01:14:50,630
you know

1942
01:14:54,070 --> 01:14:52,159
there's an interesting thing about that

1943
01:14:57,030 --> 01:14:54,080
very long time scale when i first got

1944
01:14:58,070 --> 01:14:57,040
involved in this mission i had a mindset

1945
01:14:59,669 --> 01:14:58,080
that

1946
01:15:01,590 --> 01:14:59,679
i didn't want to be involved in missions

1947
01:15:04,870 --> 01:15:01,600
i was just happily

1948
01:15:06,790 --> 01:15:04,880
sitting in my ivory tower doing science

1949
01:15:09,030 --> 01:15:06,800
but i have found involvement in the

1950
01:15:10,470 --> 01:15:09,040
mission even over this very long period

1951
01:15:12,470 --> 01:15:10,480
of time

1952
01:15:15,110 --> 01:15:12,480
an extremely fruitful

1953
01:15:19,110 --> 01:15:15,120
stimulation for learning about new

1954
01:15:20,550 --> 01:15:19,120
science and so in fact even though

1955
01:15:23,430 --> 01:15:20,560
data are not going to come back until

1956
01:15:26,070 --> 01:15:23,440
2016 i can assure you we will be working

1957
01:15:27,110 --> 01:15:26,080
hard during that intervening period to

1958
01:15:29,030 --> 01:15:27,120
prepare

1959
01:15:32,070 --> 01:15:29,040
for the results of course some of the

1960
01:15:35,350 --> 01:15:32,080
results will be unexpected as i said um

1961
01:15:36,870 --> 01:15:35,360
but but the the there's it's not as if

1962
01:15:39,990 --> 01:15:36,880
we're sitting around twiddling our

1963
01:15:43,430 --> 01:15:41,430

we have a question here on your right

1964
01:15:45,750 --> 01:15:43,440
folks

1965
01:15:47,750 --> 01:15:45,760
i have to say that that juno takes a

1966
01:15:49,830 --> 01:15:47,760
long time but it's nothing like as long

1967
01:15:51,590 --> 01:15:49,840
as new horizons

1968
01:15:53,990 --> 01:15:51,600
he started working on the pluto mission

1969
01:15:57,189 --> 01:15:54,000
in 1989

1970
01:15:59,669 --> 01:15:57,199
for juneau and uh which we're only

1971
01:16:03,510 --> 01:15:59,679
halfway there and we launched uh in

1972
01:16:05,270 --> 01:16:03,520
2006. so you know

1973
01:16:07,110 --> 01:16:05,280
there are there are long missions a lot

1974
01:16:09,430 --> 01:16:07,120
really long missions

1975
01:16:11,510 --> 01:16:09,440
similarly voyager i started working on

1976
01:16:15,430 --> 01:16:11,520
voyager as a graduate student

1977
01:16:18,390 --> 01:16:15,440
and uh you know it went to uh duke went

1978
01:16:20,950 --> 01:16:18,400
past jupiter in 79 and and uh

1979
01:16:24,149 --> 01:16:20,960
finally went past neptune in in 89 is

1980
01:16:25,350 --> 01:16:24,159
still going so yeah there's

1981
01:16:27,750 --> 01:16:25,360
there's there's missions and there's

1982
01:16:29,430 --> 01:16:27,760
missions and uh we'll also as we did

1983
01:16:32,149 --> 01:16:29,440
with new horizons take some data along

1984
01:16:34,630 --> 01:16:32,159
the way to test out the instruments

1985
01:16:36,390 --> 01:16:34,640
uh and we'll prepare and be ready for

1986
01:16:38,470 --> 01:16:36,400
when we get there well one of the key

1987
01:16:41,030 --> 01:16:38,480
things that we do have to do is to

1988
01:16:43,990 --> 01:16:41,040

document what we're doing very carefully

1989
01:16:46,390 --> 01:16:44,000
and train uh young people to be

1990
01:16:48,709 --> 01:16:46,400
ready so we have to anticipate the fact

1991
01:16:50,149 --> 01:16:48,719
that there will be turnover in personnel

1992
01:16:52,390 --> 01:16:50,159
between the beginning and the end of the

1993
01:16:53,510 --> 01:16:52,400
mission yeah good point

1994
01:16:55,830 --> 01:16:53,520
okay we have a question here on the

1995
01:17:00,149 --> 01:16:58,390
hello laurel ann whitlock from orlando i

1996
01:17:01,830 --> 01:17:00,159
was just wondering i believe it's 33

1997
01:17:04,950 --> 01:17:01,840
orbits that juno is going to make is

1998
01:17:07,189 --> 01:17:04,960
that the right number uh

1999
01:17:10,630 --> 01:17:07,199
if all goes well the spacecraft will

2000
01:17:13,270 --> 01:17:10,640
make 33 orbits it'll pass jupiter 33

2001
01:17:15,990 --> 01:17:13,280
times yes why is that the number that

2002
01:17:18,709 --> 01:17:16,000
they're going for well um it has to do

2003
01:17:20,790 --> 01:17:18,719
with those pesky radiation belts because

2004
01:17:23,430 --> 01:17:20,800
what happens is um

2005
01:17:25,270 --> 01:17:23,440
the orbit starts off very nice and

2006
01:17:27,990 --> 01:17:25,280
elliptical with going pretty much

2007
01:17:30,070 --> 01:17:28,000
crossing the equator out at 40 times

2008
01:17:31,110 --> 01:17:30,080
jupiter's radius and then skimming over

2009
01:17:33,110 --> 01:17:31,120
the clouds

2010
01:17:35,990 --> 01:17:33,120
and then what happens because of the

2011
01:17:38,470 --> 01:17:36,000
fact that jupiter isn't perfectly round

2012
01:17:39,510 --> 01:17:38,480
it's fat in its equator because of the

2013
01:17:41,990 --> 01:17:39,520

spin

2014
01:17:44,790 --> 01:17:42,000
what that does is it makes the orbit um

2015
01:17:47,910 --> 01:17:44,800
begin to process so it goes from being

2016
01:17:49,669 --> 01:17:47,920
oriented in the equator to dipping down

2017
01:17:52,070 --> 01:17:49,679
and then that means that this part of

2018
01:17:53,830 --> 01:17:52,080
the orbit begins to dip into those

2019
01:17:56,630 --> 01:17:53,840
radiation belts that are very close to

2020
01:17:58,870 --> 01:17:56,640
the planet so we have a sense of

2021
01:18:00,630 --> 01:17:58,880
how long it will the spacecraft can

2022
01:18:02,709 --> 01:18:00,640
realistically survive without being

2023
01:18:05,830 --> 01:18:02,719
attacked by those radiation belts the

2024
01:18:07,669 --> 01:18:05,840
instruments being affected and so um we

2025
01:18:09,990 --> 01:18:07,679
anticipate that at some point we'll have

2026
01:18:11,510 --> 01:18:10,000
to send it into jupiter and the point of

2027
01:18:13,830 --> 01:18:11,520
course is we have to send it into

2028
01:18:15,430 --> 01:18:13,840
jupiter so that it doesn't hit europa

2029
01:18:18,630 --> 01:18:15,440
and you all know why we mustn't hit

2030
01:18:26,229 --> 01:18:20,070
okay we're gonna do a quick mic switch

2031
01:18:26,239 --> 01:18:30,709
next question's back here in the back

2032
01:18:34,709 --> 01:18:32,310
hi uh tony rice from raleigh north

2033
01:18:36,550 --> 01:18:34,719
carolina i had a question i was hoping

2034
01:18:38,149 --> 01:18:36,560
for anybody up there could you compare

2035
01:18:39,669 --> 01:18:38,159
and contrast the kind of science that

2036
01:18:42,470 --> 01:18:39,679
you're expecting to get

2037
01:18:43,510 --> 01:18:42,480
both on orbit versus during that d orbit

2038
01:18:48,550 --> 01:18:43,520

what are you expecting to get during

2039
01:18:53,750 --> 01:18:51,510
during the d orbit um

2040
01:18:55,510 --> 01:18:53,760
will happen very quickly so basically

2041
01:18:57,590 --> 01:18:55,520
it'll be exactly the same as the other

2042
01:19:00,229 --> 01:18:57,600
orbits but

2043
01:19:01,430 --> 01:19:00,239
dive into the clouds and into the planet

2044
01:19:02,870 --> 01:19:01,440
i don't know how much data we're

2045
01:19:04,950 --> 01:19:02,880
actually going to get we will keep the

2046
01:19:07,510 --> 01:19:04,960
particle data and the magnetic field

2047
01:19:08,550 --> 01:19:07,520
data going instruments going but i don't

2048
01:19:11,590 --> 01:19:08,560
think we're going to get anything

2049
01:19:12,790 --> 01:19:11,600
particularly new um compared with the

2050
01:19:15,590 --> 01:19:12,800
ones that were

2051
01:19:16,709 --> 01:19:15,600
just not hitting the planet as it were

2052
01:19:19,030 --> 01:19:16,719
um so

2053
01:19:20,550 --> 01:19:19,040
we just want to get there get into orbit

2054
01:19:21,350 --> 01:19:20,560
get a few orbits and then we'll worry

2055
01:19:24,070 --> 01:19:21,360
about

2056
01:19:29,750 --> 01:19:26,149
who knows it may be that the radiation

2057
01:19:31,669 --> 01:19:29,760
is not as bad and we can last longer

2058
01:19:34,149 --> 01:19:31,679
we got new batteries now so hopefully

2059
01:19:35,990 --> 01:19:34,159
it'll stop cutting out

2060
01:19:37,750 --> 01:19:36,000
hi i'm stephanie lee from minneapolis

2061
01:19:39,590 --> 01:19:37,760
minnesota and i'm just curious what

2062
01:19:41,830 --> 01:19:39,600
happens from launch when it goes

2063
01:19:43,510 --> 01:19:41,840

successful on to jupiter you said you

2064
01:19:44,950 --> 01:19:43,520
test some of the machines but what else

2065
01:19:48,310 --> 01:19:44,960
happens

2066
01:19:49,510 --> 01:19:48,320
um well we have to do some maneuvers so

2067
01:19:51,430 --> 01:19:49,520
um

2068
01:19:53,110 --> 01:19:51,440
we have to uh first of all we have to

2069
01:19:54,470 --> 01:19:53,120
get it out of earth orbit and so we're

2070
01:19:57,030 --> 01:19:54,480
going to do that by

2071
01:19:59,030 --> 01:19:57,040
firing uh one of the um the rocket will

2072
01:20:01,030 --> 01:19:59,040
get us out of orbit then we go out and

2073
01:20:02,550 --> 01:20:01,040
we go out past the asteroid belt and

2074
01:20:03,430 --> 01:20:02,560
come back again and rendezvous with

2075
01:20:06,149 --> 01:20:03,440
earth

2076
01:20:08,229 --> 01:20:06,159
and we use that primarily to get a a

2077
01:20:09,990 --> 01:20:08,239
kick a gravity kick that will get us to

2078
01:20:11,110 --> 01:20:10,000
jupiter faster

2079
01:20:13,750 --> 01:20:11,120
but the other

2080
01:20:15,189 --> 01:20:13,760
purpose um is that we're going to

2081
01:20:17,110 --> 01:20:15,199
sneakily

2082
01:20:19,189 --> 01:20:17,120
jan chodes isn't here right the project

2083
01:20:20,550 --> 01:20:19,199
manager oh she is

2084
01:20:22,550 --> 01:20:20,560
so we're going to test out the

2085
01:20:24,870 --> 01:20:22,560
instruments by doing a little science

2086
01:20:28,470 --> 01:20:24,880
along the way

2087
01:20:30,310 --> 01:20:28,480
so as we fly by uh earth we'll turn on

2088
01:20:33,350 --> 01:20:30,320

the instruments uh we'll take some

2089
01:20:34,950 --> 01:20:33,360
pictures we'll test out the various

2090
01:20:36,070 --> 01:20:34,960
modes of operation

2091
01:20:37,910 --> 01:20:36,080
and

2092
01:20:40,870 --> 01:20:37,920
we'll make some measurements along the

2093
01:20:43,189 --> 01:20:40,880
way and then once we go past

2094
01:20:45,030 --> 01:20:43,199
earth we leave after that gravity kick

2095
01:20:46,870 --> 01:20:45,040
we'll do you know along the way we'll

2096
01:20:47,910 --> 01:20:46,880
see we'll check we're on we're going in

2097
01:20:50,550 --> 01:20:47,920
the right direction and we're getting

2098
01:20:52,950 --> 01:20:50,560
there everything's okay um and then as

2099
01:20:55,110 --> 01:20:52,960
we approach jupiter we'll begin to make

2100
01:20:57,430 --> 01:20:55,120
a whole bunch of observations

2101
01:21:00,470 --> 01:20:57,440
anticipating getting an idea of how

2102
01:21:03,030 --> 01:21:00,480
jupiter's behaving um we'll be using the

2103
01:21:04,629 --> 01:21:03,040
uvs and the gram to do that as well as

2104
01:21:06,870 --> 01:21:04,639
the particle instruments the wave

2105
01:21:09,590 --> 01:21:06,880
instruments and the magnetic field

2106
01:21:12,149 --> 01:21:09,600
and for me it just happens to provide a

2107
01:21:14,629 --> 01:21:12,159
really exciting opportunity because that

2108
01:21:16,870 --> 01:21:14,639
capture orbit which is a very long orbit

2109
01:21:19,669 --> 01:21:16,880
which will be on the dawn side of

2110
01:21:21,590 --> 01:21:19,679
jupiter's magnetosphere will measure

2111
01:21:24,149 --> 01:21:21,600
the magnetosphere responding to the

2112
01:21:26,790 --> 01:21:24,159
solar wind so the magnetosphere goes in

2113
01:21:29,270 --> 01:21:26,800

and out by about a factor of two due to

2114
01:21:31,590 --> 01:21:29,280
the solar wind going by and we'll be out

2115
01:21:33,430 --> 01:21:31,600
there measuring that effect and looking

2116
01:21:35,430 --> 01:21:33,440
at the aurora at the same time so it's

2117
01:21:37,590 --> 01:21:35,440
actually a unique opportunity and then

2118
01:21:40,310 --> 01:21:37,600
we get into captured into close orbit

2119
01:21:41,669 --> 01:21:40,320
and do all the regular science orbits

2120
01:21:44,070 --> 01:21:41,679
okay another question in the back on the

2121
01:21:46,310 --> 01:21:44,080
left here

2122
01:21:48,229 --> 01:21:46,320
hi uh sean cowan from hicksville ohio

2123
01:21:50,229 --> 01:21:48,239
yes you all know it's a real town

2124
01:21:52,310 --> 01:21:50,239
uh question is now that we've had a

2125
01:21:54,149 --> 01:21:52,320
chance to kind of all of us collectively

2126
01:21:54,950 --> 01:21:54,159
be in the social media fishbowl if you

2127
01:21:57,030 --> 01:21:54,960
will

2128
01:21:59,189 --> 01:21:57,040
how do you feel social media has

2129
01:22:01,830 --> 01:21:59,199
impacted your particular mission with

2130
01:22:03,990 --> 01:22:01,840
having this juno tweet up uh and then

2131
01:22:05,750 --> 01:22:04,000
social media in general a second part

2132
01:22:08,870 --> 01:22:05,760
would be how do you feel it may

2133
01:22:10,629 --> 01:22:08,880
impact future missions coming out

2134
01:22:12,390 --> 01:22:10,639
well

2135
01:22:14,070 --> 01:22:12,400
to be honest with you very few in the

2136
01:22:17,910 --> 01:22:14,080
science team

2137
01:22:20,629 --> 01:22:17,920
tweet i've never tweeted in my life okay

2138
01:22:22,709 --> 01:22:20,639

i barely use a cell phone and i suspect

2139
01:22:24,870 --> 01:22:22,719
we're all a bit that way

2140
01:22:27,030 --> 01:22:24,880
but what i think is extremely exciting

2141
01:22:28,870 --> 01:22:27,040
is that you're all here

2142
01:22:30,629 --> 01:22:28,880
we haven't we didn't have this with new

2143
01:22:31,750 --> 01:22:30,639
horizons we didn't have this with other

2144
01:22:33,830 --> 01:22:31,760
missions that i was involved we

2145
01:22:35,990 --> 01:22:33,840
certainly didn't have this with voyager

2146
01:22:38,550 --> 01:22:36,000
so i think this is fantastic

2147
01:22:40,149 --> 01:22:38,560
radio shows were all very good tv was

2148
01:22:42,229 --> 01:22:40,159
all very good but this is a way in which

2149
01:22:43,750 --> 01:22:42,239
it's getting out there quick and fast

2150
01:22:45,350 --> 01:22:43,760
you know if i need some information

2151
01:22:47,750 --> 01:22:45,360
about the juno mission

2152
01:22:49,189 --> 01:22:47,760
i go to youtube i have to say because i

2153
01:22:51,270 --> 01:22:49,199
know it's there

2154
01:22:52,550 --> 01:22:51,280
um so i think it is making a difference

2155
01:22:54,470 --> 01:22:52,560
now it's making a big difference for

2156
01:22:56,950 --> 01:22:54,480
teaching and i we all teach we're the

2157
01:22:58,709 --> 01:22:56,960
three of us here are all teachers and we

2158
01:23:01,110 --> 01:22:58,719
teach the university and it's making a

2159
01:23:02,790 --> 01:23:01,120
huge difference we can get access to

2160
01:23:04,550 --> 01:23:02,800
materials and we can get it out and get

2161
01:23:06,550 --> 01:23:04,560
it at the students

2162
01:23:08,790 --> 01:23:06,560
but i also have to say it's been kind of

2163
01:23:09,910 --> 01:23:08,800

interesting i uh took some pictures of

2164
01:23:11,430 --> 01:23:09,920
you all

2165
01:23:15,189 --> 01:23:11,440
because um

2166
01:23:18,070 --> 01:23:15,199
this is a bit like one of my classrooms

2167
01:23:19,510 --> 01:23:18,080
and um there's a huge debate amongst us

2168
01:23:22,070 --> 01:23:19,520
teachers

2169
01:23:24,470 --> 01:23:22,080
why do we bother to be here

2170
01:23:27,510 --> 01:23:24,480
if you guys are all out there doing your

2171
01:23:29,510 --> 01:23:27,520
stuff out there and so um

2172
01:23:32,149 --> 01:23:29,520
there's an interesting question about

2173
01:23:33,110 --> 01:23:32,159
where we're going in terms of use of

2174
01:23:35,030 --> 01:23:33,120
this

2175
01:23:37,270 --> 01:23:35,040
and what worries me i'll be quite honest

2176
01:23:39,830 --> 01:23:37,280
with you is attention span

2177
01:23:41,750 --> 01:23:39,840
and i worry about deep thinking and deep

2178
01:23:43,110 --> 01:23:41,760
reading and deep understanding and

2179
01:23:46,229 --> 01:23:43,120
absorption

2180
01:23:47,430 --> 01:23:46,239
and if things move a bit too fast quick

2181
01:23:49,270 --> 01:23:47,440
and furious

2182
01:23:51,189 --> 01:23:49,280
you don't get that deep thinking that

2183
01:23:52,229 --> 01:23:51,199
you need to struggle through a difficult

2184
01:23:54,790 --> 01:23:52,239
problem

2185
01:23:56,310 --> 01:23:54,800
like doing the math to understand one of

2186
01:23:58,790 --> 01:23:56,320
dave's papers

2187
01:24:01,830 --> 01:23:58,800
um you know so

2188
01:24:04,229 --> 01:24:01,840

uh there's good and bad

2189
01:24:08,070 --> 01:24:04,239
basically really good

2190
01:24:08,080 --> 01:24:11,510
do i start now

2191
01:24:15,030 --> 01:24:14,229
twitter doesn't affect my life actually

2192
01:24:16,470 --> 01:24:15,040
um

2193
01:24:18,629 --> 01:24:16,480
the trouble with having such good

2194
01:24:19,510 --> 01:24:18,639
speakers is that when you're at the tail

2195
01:24:20,390 --> 01:24:19,520
of the pro

2196
01:24:21,669 --> 01:24:20,400
the

2197
01:24:23,910 --> 01:24:21,679
proceedings

2198
01:24:26,149 --> 01:24:23,920
there's not too much left to say okay

2199
01:24:27,510 --> 01:24:26,159
but i'll try to decorate uh what people

2200
01:24:29,590 --> 01:24:27,520
have said before

2201
01:24:30,950 --> 01:24:29,600
so let me start with nasa jim who was

2202
01:24:32,550 --> 01:24:30,960
totally brilliant

2203
01:24:34,550 --> 01:24:32,560
and say something about methane because

2204
01:24:36,550 --> 01:24:34,560
i'm involved in that experiment

2205
01:24:38,390 --> 01:24:36,560
and so i'm worried about what the

2206
01:24:39,669 --> 01:24:38,400
results are going to mean

2207
01:24:42,709 --> 01:24:39,679
first of all

2208
01:24:47,350 --> 01:24:42,719
methane from cows comes from burps

2209
01:24:49,910 --> 01:24:48,870
second thing is which is even less

2210
01:24:51,990 --> 01:24:49,920
romantic

2211
01:24:53,830 --> 01:24:52,000
a lot of methane on earth is generated

2212
01:24:55,990 --> 01:24:53,840
by rice paddies

2213
01:24:57,990 --> 01:24:56,000

because the bacteria that make let make

2214
01:24:59,030 --> 01:24:58,000
methane love to live on the roots of

2215
01:24:59,990 --> 01:24:59,040
rice

2216
01:25:02,310 --> 01:25:00,000
so

2217
01:25:04,870 --> 01:25:02,320
as the need in the world

2218
01:25:07,430 --> 01:25:04,880
increases for more food we're going to

2219
01:25:09,350 --> 01:25:07,440
get more methane okay kind of a sobering

2220
01:25:12,550 --> 01:25:09,360
concept

2221
01:25:14,870 --> 01:25:12,560
let's see now we get to oh one more

2222
01:25:16,870 --> 01:25:14,880
thing about nasa jim he talked about

2223
01:25:19,189 --> 01:25:16,880
what nasa was doing and he left out one

2224
01:25:21,430 --> 01:25:19,199
thing that's kind of dear to my heart

2225
01:25:22,390 --> 01:25:21,440
and that's the cassini huygens mission

2226
01:25:24,310 --> 01:25:22,400
okay

2227
01:25:25,669 --> 01:25:24,320
i'd like you to think for a minute

2228
01:25:27,110 --> 01:25:25,679
because we tend to take all these things

2229
01:25:27,910 --> 01:25:27,120
for granted

2230
01:25:32,310 --> 01:25:27,920
that

2231
01:25:34,870 --> 01:25:32,320
let's put the united states together

2232
01:25:36,070 --> 01:25:34,880
with europe about 16 countries

2233
01:25:38,550 --> 01:25:36,080
got together

2234
01:25:41,910 --> 01:25:38,560
we sent a probe and an orbiter to the

2235
01:25:45,189 --> 01:25:41,920
saturn system we deployed a probe to the

2236
01:25:46,790 --> 01:25:45,199
surface of one of saturn's satellites

2237
01:25:49,350 --> 01:25:46,800
okay that's something that doesn't

2238
01:25:51,350 --> 01:25:49,360

happen every day and yet people are sort

2239
01:25:52,870 --> 01:25:51,360
of forgetting about it already which is

2240
01:25:54,709 --> 01:25:52,880
part of the problem with progress i

2241
01:25:56,790 --> 01:25:54,719
guess anyway that mission is still going

2242
01:25:58,470 --> 01:25:56,800
strong and still producing data and we

2243
01:26:00,790 --> 01:25:58,480
love it a lot

2244
01:26:03,669 --> 01:26:00,800
okay we come to scott bolton and now i

2245
01:26:06,629 --> 01:26:03,679
can tell you how the mission got started

2246
01:26:08,870 --> 01:26:06,639
it got started in a jpl cafeteria

2247
01:26:10,790 --> 01:26:08,880
where i was innocently eating lunch

2248
01:26:14,390 --> 01:26:10,800
and scott came over with this brilliant

2249
01:26:16,149 --> 01:26:14,400
idea of having a probe in a polar orbit

2250
01:26:18,470 --> 01:26:16,159
around jupiter which would give a much

2251
01:26:20,870 --> 01:26:18,480
better or much different view of the

2252
01:26:23,590 --> 01:26:20,880
magnetosphere than we'd ever have before

2253
01:26:24,870 --> 01:26:23,600
and he asked me is there anything else

2254
01:26:28,310 --> 01:26:24,880
we could do with the probe in that

2255
01:26:30,390 --> 01:26:28,320
situation and i said oxygen because i

2256
01:26:32,229 --> 01:26:30,400
just come off the galileo probe and as

2257
01:26:34,390 --> 01:26:32,239
scott told you we hadn't been able to

2258
01:26:36,310 --> 01:26:34,400
measure the oxygen we saw a little bit

2259
01:26:37,910 --> 01:26:36,320
of water vapor in the upper atmosphere

2260
01:26:40,229 --> 01:26:37,920
but and so we know there was oxygen

2261
01:26:42,310 --> 01:26:40,239
there oxygen there but we didn't get the

2262
01:26:44,310 --> 01:26:42,320
global abundance of oxygen because

2263
01:26:46,149 --> 01:26:44,320

that's tied up with hydrogen and water

2264
01:26:48,310 --> 01:26:46,159
and that's very low in the atmosphere

2265
01:26:49,910 --> 01:26:48,320
below the clouds that we could see

2266
01:26:52,390 --> 01:26:49,920
and below the region that the probe

2267
01:26:53,270 --> 01:26:52,400
could get to so that was a big missing

2268
01:26:55,110 --> 01:26:53,280
link

2269
01:26:57,030 --> 01:26:55,120
okay

2270
01:26:57,910 --> 01:26:57,040
and uh what else

2271
01:27:00,629 --> 01:26:57,920
um

2272
01:27:02,870 --> 01:27:00,639
anyway it worked and here we are and

2273
01:27:05,669 --> 01:27:02,880
it's a wonderful mission and let me just

2274
01:27:07,750 --> 01:27:05,679
say a few words again about these great

2275
01:27:09,030 --> 01:27:07,760
ideas that uh fran was just talking

2276
01:27:11,350 --> 01:27:09,040
about

2277
01:27:13,510 --> 01:27:11,360
you can imagine our ancient ancestors

2278
01:27:16,709 --> 01:27:13,520
sitting out standing out on the lawn

2279
01:27:18,709 --> 01:27:16,719
here on the savannah let's say

2280
01:27:20,790 --> 01:27:18,719
they're looking into each other's eyes

2281
01:27:22,229 --> 01:27:20,800
they're looking up at the night sky

2282
01:27:24,310 --> 01:27:22,239
and they're thinking

2283
01:27:25,590 --> 01:27:24,320
what is all this about

2284
01:27:28,310 --> 01:27:25,600
and one of the things they're thinking

2285
01:27:30,070 --> 01:27:28,320
of course is how did we get here and

2286
01:27:32,310 --> 01:27:30,080
another thing is

2287
01:27:34,550 --> 01:27:32,320
what's going on out there is there some

2288
01:27:37,030 --> 01:27:34,560

connection between us and out there and

2289
01:27:38,709 --> 01:27:37,040
mind you this was before nasa

2290
01:27:41,590 --> 01:27:38,719
okay they had these ideas they had these

2291
01:27:47,590 --> 01:27:44,229
and before tweet yes

2292
01:27:50,470 --> 01:27:47,600
actually quite a bit before tweet

2293
01:27:53,270 --> 01:27:50,480
okay so um where do we go from there

2294
01:27:55,189 --> 01:27:53,280
well these ideas are so deep and so

2295
01:27:57,590 --> 01:27:55,199
profound that they have actually

2296
01:27:58,390 --> 01:27:57,600
influenced a lot of what goes on on the

2297
01:28:01,430 --> 01:27:58,400
earth

2298
01:28:03,510 --> 01:28:01,440
they have influenced religions okay all

2299
01:28:05,590 --> 01:28:03,520
over the planet it's an important part

2300
01:28:06,709 --> 01:28:05,600
of almost every religion

2301
01:28:09,270 --> 01:28:06,719
secondly

2302
01:28:10,790 --> 01:28:09,280
they have influenced art music

2303
01:28:12,950 --> 01:28:10,800
literature

2304
01:28:15,270 --> 01:28:12,960
and thirdly they lead to a lot of

2305
01:28:17,110 --> 01:28:15,280
wonderful arguments among scientists as

2306
01:28:18,470 --> 01:28:17,120
to what the hell is going on that's

2307
01:28:20,470 --> 01:28:18,480
another question by the way a deep

2308
01:28:21,750 --> 01:28:20,480
question which people have had since the

2309
01:28:23,510 --> 01:28:21,760
very beginning

2310
01:28:25,270 --> 01:28:23,520
still going on

2311
01:28:27,910 --> 01:28:25,280
all right so what's

2312
01:28:30,070 --> 01:28:27,920
really happening oh i forget these

2313
01:28:31,990 --> 01:28:30,080

gentlemen and ladies

2314
01:28:34,310 --> 01:28:32,000
i should decorate them too

2315
01:28:36,310 --> 01:28:34,320
this guy is very hard to decorate so let

2316
01:28:39,350 --> 01:28:36,320
me just decorate him the way people get

2317
01:28:41,350 --> 01:28:39,360
decorated in washington by the president

2318
01:28:42,870 --> 01:28:41,360
in addition to 4k showing that there was

2319
01:28:44,790 --> 01:28:42,880
helium rain

2320
01:28:47,510 --> 01:28:44,800
on jupiter

2321
01:28:49,510 --> 01:28:47,520
he figured out this brilliant idea

2322
01:28:51,510 --> 01:28:49,520
that neon which had been missing we

2323
01:28:54,550 --> 01:28:51,520
haven't been able to connect to to see

2324
01:28:57,189 --> 01:28:54,560
it with uh the probe it was what we saw

2325
01:28:59,430 --> 01:28:57,199
it sorry but it was very depleted

2326
01:29:01,830 --> 01:28:59,440
why why was it depleted

2327
01:29:04,470 --> 01:29:01,840
dave figured out that the helium sorry

2328
01:29:07,590 --> 01:29:04,480
the night the neon too many elements the

2329
01:29:10,229 --> 01:29:07,600
neon was dissolving in the helium rain

2330
01:29:13,510 --> 01:29:10,239
and getting down inside that was a that

2331
01:29:16,229 --> 01:29:13,520
was a stroke that was a very nice stroke

2332
01:29:17,750 --> 01:29:16,239
i have a smaller decoration for fran

2333
01:29:19,590 --> 01:29:17,760
sorry for that

2334
01:29:22,070 --> 01:29:19,600
i was giving a lecture

2335
01:29:24,310 --> 01:29:22,080
at the agu one one time

2336
01:29:25,910 --> 01:29:24,320
and i couldn't get the av to work it

2337
01:29:27,750 --> 01:29:25,920
just wouldn't work

2338
01:29:30,550 --> 01:29:27,760

fran got up from the audience came up

2339
01:29:31,350 --> 01:29:30,560
there pushed one button it worked

2340
01:29:33,910 --> 01:29:31,360
which

2341
01:29:40,950 --> 01:29:33,920
the moral is when you're in trouble ask

2342
01:29:43,750 --> 01:29:42,550
can we make this the last few seconds if

2343
01:29:45,189 --> 01:29:43,760
we could our next speakers are on a

2344
01:29:47,270 --> 01:29:45,199
tight schedule

2345
01:29:48,229 --> 01:29:47,280
i got a few seconds uh yeah if we could

2346
01:29:49,669 --> 01:29:48,239
we could

2347
01:29:52,229 --> 01:29:49,679
apologize okay

2348
01:29:55,350 --> 01:29:52,239
uh oxygen is a really good thing uh it

2349
01:29:57,830 --> 01:29:55,360
tells us about uh whether or not jupiter

2350
01:30:00,709 --> 01:29:57,840
migrated we can we can actually deduce

2351
01:30:02,629 --> 01:30:00,719
that it tells us about a very important

2352
01:30:04,310 --> 01:30:02,639
element for building interior models we

2353
01:30:05,669 --> 01:30:04,320
need it we don't have it

2354
01:30:08,070 --> 01:30:05,679
and you're all breathing it which is

2355
01:30:10,310 --> 01:30:08,080
kind of nice but here

2356
01:30:12,310 --> 01:30:10,320
mind you it's produced by green plants

2357
01:30:14,870 --> 01:30:12,320
okay it didn't get here from outer space

2358
01:30:16,870 --> 01:30:14,880
so be friends with your green plants we

2359
01:30:17,910 --> 01:30:16,880
need them

2360
01:30:19,189 --> 01:30:17,920
okay

2361
01:30:24,149 --> 01:30:19,199
so let's hear it for our planetary

2362
01:30:27,189 --> 01:30:25,669
sorry to have to cut that short i hope

2363
01:30:28,390 --> 01:30:27,199

you're able to stick around a little bit

2364
01:30:30,149 --> 01:30:28,400
and see if any of the tweeps have some

2365
01:30:40,550 --> 01:30:30,159
more questions for you here in the back

2366
01:30:43,510 --> 01:30:42,310
okay so i'd like to introduce our next

2367
01:30:45,430 --> 01:30:43,520
speakers

2368
01:30:47,990 --> 01:30:45,440
when i ask my colleagues at

2369
01:30:49,910 --> 01:30:48,000
jpl how to explain how the juno proposal

2370
01:30:51,189 --> 01:30:49,920
manager and the general project manager

2371
01:30:52,629 --> 01:30:51,199
fit into the story they said that's this

2372
01:30:54,870 --> 01:30:52,639
is an easy one

2373
01:30:55,990 --> 01:30:54,880
because steve matuzik is the grandfather

2374
01:30:58,229 --> 01:30:56,000
of juno

2375
01:31:00,070 --> 01:30:58,239
and jan chodes is the superhuman ceo of

2376
01:31:01,430 --> 01:31:00,080
the mission so you get an idea in

2377
01:31:03,270 --> 01:31:01,440
someone's head it comes down to paper

2378
01:31:05,350 --> 01:31:03,280
these two help make it happen so with

2379
01:31:06,870 --> 01:31:05,360
that steve matuzik the genome proposal

2380
01:31:13,270 --> 01:31:06,880
manager and jan showed us the juno

2381
01:31:17,510 --> 01:31:15,430
volunteered to hold this for me for

2382
01:31:20,790 --> 01:31:17,520
minutes can

2383
01:31:25,750 --> 01:31:22,149
i'll get back to you in a little bit

2384
01:31:29,830 --> 01:31:28,149
so i wanted to talk about uh some of the

2385
01:31:31,830 --> 01:31:29,840
early days

2386
01:31:33,830 --> 01:31:31,840
we started working on the proposal in

2387
01:31:35,669 --> 01:31:33,840
2003.

2388
01:31:36,950 --> 01:31:35,679

one of the big things we had to decide

2389
01:31:39,270 --> 01:31:36,960
at the beginning

2390
01:31:41,110 --> 01:31:39,280
was of course everybody knows that juno

2391
01:31:43,350 --> 01:31:41,120
spins

2392
01:31:47,270 --> 01:31:43,360
and we had to say well

2393
01:31:48,709 --> 01:31:47,280
um which way is it going to spin

2394
01:31:51,669 --> 01:31:48,719
and we

2395
01:31:53,270 --> 01:31:51,679
we scratched our heads and said well

2396
01:31:55,430 --> 01:31:53,280
i don't know maybe it should spin this

2397
01:31:56,790 --> 01:31:55,440
way and half the team said that and the

2398
01:31:58,950 --> 01:31:56,800
other half the team said well no i think

2399
01:32:00,629 --> 01:31:58,960
it should spin this way

2400
01:32:02,550 --> 01:32:00,639
so we scratched our heads some more and

2401
01:32:04,709 --> 01:32:02,560
finally we came up with the reason for

2402
01:32:07,590 --> 01:32:04,719
the way it's going to spin so

2403
01:32:09,669 --> 01:32:07,600
if if you're facing the solar rays it's

2404
01:32:11,830 --> 01:32:09,679
spinning this way and the reason we do

2405
01:32:13,430 --> 01:32:11,840
that is because we actually get a few

2406
01:32:15,270 --> 01:32:13,440
more measurements

2407
01:32:16,470 --> 01:32:15,280
at jupiter and every measurement is

2408
01:32:19,669 --> 01:32:16,480
important

2409
01:32:21,590 --> 01:32:19,679
so that's the reason we spin that way um

2410
01:32:23,189 --> 01:32:21,600
another question i oh i forgot to

2411
01:32:24,629 --> 01:32:23,199
mention to everybody i'm the one to

2412
01:32:27,910 --> 01:32:24,639
blame

2413
01:32:29,750 --> 01:32:27,920

for why we're launching in august so

2414
01:32:31,189 --> 01:32:29,760
i'm sorry about that

2415
01:32:34,229 --> 01:32:31,199
we have to launch in august to get to

2416
01:32:35,510 --> 01:32:34,239
jupiter the reason for that is that we

2417
01:32:37,030 --> 01:32:35,520
launch of course and then we do a

2418
01:32:38,629 --> 01:32:37,040
two-year loop

2419
01:32:40,149 --> 01:32:38,639
and come back to the earth again and

2420
01:32:41,510 --> 01:32:40,159
people again they scratch their heads

2421
01:32:43,189 --> 01:32:41,520
and say well why do you come back to the

2422
01:32:44,470 --> 01:32:43,199
earth again don't you want to get out to

2423
01:32:45,750 --> 01:32:44,480
jupiter

2424
01:32:46,629 --> 01:32:45,760
we have to come back to the earth

2425
01:32:48,149 --> 01:32:46,639
because

2426
01:32:50,149 --> 01:32:48,159
i'm borrowing

2427
01:32:52,629 --> 01:32:50,159
ever so little bit of energy from the

2428
01:32:56,390 --> 01:32:52,639
earth so that we can get out to jupiter

2429
01:32:57,990 --> 01:32:56,400
we went on on the atlas 5-51

2430
01:32:59,990 --> 01:32:58,000
and we that's how we were able to fit

2431
01:33:01,750 --> 01:33:00,000
the mission onto that launch vehicle is

2432
01:33:04,950 --> 01:33:01,760
is do gravity assisted earth and get out

2433
01:33:06,070 --> 01:33:04,960
to jupiter in in five years

2434
01:33:12,470 --> 01:33:06,080
um

2435
01:33:14,629 --> 01:33:12,480
when you're spinning how do you point

2436
01:33:16,390 --> 01:33:14,639
because everybody knows when you

2437
01:33:18,390 --> 01:33:16,400
have a bicycle wheel and it's spinning

2438
01:33:21,270 --> 01:33:18,400

and you try and move it

2439
01:33:24,070 --> 01:33:21,280
it's not easy to move sometimes and so

2440
01:33:26,310 --> 01:33:24,080
how do you how do you point it is

2441
01:33:27,830 --> 01:33:26,320
well the answer is we don't need to

2442
01:33:32,070 --> 01:33:27,840
point it

2443
01:33:33,830 --> 01:33:32,080
as things are spinning around and you've

2444
01:33:35,350 --> 01:33:33,840
you've seen all the science instruments

2445
01:33:36,390 --> 01:33:35,360
that are on the side

2446
01:33:38,390 --> 01:33:36,400
well

2447
01:33:40,229 --> 01:33:38,400
they they go by and they see jupiter

2448
01:33:42,470 --> 01:33:40,239
once every revolution and so we don't

2449
01:33:44,950 --> 01:33:42,480
need to point the spacecraft and so it

2450
01:33:46,629 --> 01:33:44,960
can spin and stay it's very stable out

2451
01:33:48,390 --> 01:33:46,639
in space it just

2452
01:33:50,870 --> 01:33:48,400
it floats along and doesn't really have

2453
01:33:54,790 --> 01:33:50,880
to do much uh on its way out to jupiter

2454
01:33:58,550 --> 01:33:56,149
and the last thing i'm going to talk

2455
01:34:00,629 --> 01:33:58,560
about here before i hand it over to jan

2456
01:34:02,790 --> 01:34:00,639
and then i'll come back up probably here

2457
01:34:04,709 --> 01:34:02,800
to answer a few questions too is

2458
01:34:06,550 --> 01:34:04,719
um

2459
01:34:08,550 --> 01:34:06,560
fran i think talked about it when she

2460
01:34:11,189 --> 01:34:08,560
was up here she said she loved that huge

2461
01:34:14,310 --> 01:34:11,199
orbit that we go into initially

2462
01:34:16,709 --> 01:34:14,320
and uh why do we have to go into huge

2463
01:34:20,229 --> 01:34:16,719

orbit like that 107 day orbit i mean we

2464
01:34:22,709 --> 01:34:20,239
get to jupiter we fire the engine and

2465
01:34:25,110 --> 01:34:22,719
why do we go into such a big orbit well

2466
01:34:27,030 --> 01:34:25,120
the answer to that is in the original

2467
01:34:29,189 --> 01:34:27,040
proposal we did not do that we went

2468
01:34:30,310 --> 01:34:29,199
straight into the 11 day orbit

2469
01:34:32,790 --> 01:34:30,320
and then

2470
01:34:34,470 --> 01:34:32,800
we needed to figure out how to reduce

2471
01:34:36,149 --> 01:34:34,480
some of the mass and so i scratched my

2472
01:34:38,470 --> 01:34:36,159
head and i said ah

2473
01:34:40,149 --> 01:34:38,480
if we go into a big orbit

2474
01:34:42,149 --> 01:34:40,159
we're going to use less propellant so we

2475
01:34:43,990 --> 01:34:42,159
go into a big huge orbit and then we get

2476
01:34:46,229 --> 01:34:44,000
down to our final orbit

2477
01:34:48,070 --> 01:34:46,239
after that one big orbit so that's again

2478
01:34:49,270 --> 01:34:48,080
saves some more propellant and gets and

2479
01:34:50,950 --> 01:34:49,280
gets more

2480
01:34:52,470 --> 01:34:50,960
instruments and measurements back from

2481
01:34:53,750 --> 01:34:52,480
jupiter so

2482
01:34:57,990 --> 01:34:53,760
i'll stay up here and i'm going to tag

2483
01:35:01,430 --> 01:34:59,590
thanks steve

2484
01:35:04,070 --> 01:35:01,440
uh it's great to be here today welcome

2485
01:35:10,790 --> 01:35:04,080
to uh the juno launch we're planning on

2486
01:35:15,830 --> 01:35:14,229
um this morning at 6 30 we met um over

2487
01:35:18,310 --> 01:35:15,840
in the atlas space flight operations

2488
01:35:19,910 --> 01:35:18,320

center and got yet another weather

2489
01:35:22,550 --> 01:35:19,920
weather briefing to decide whether or

2490
01:35:24,870 --> 01:35:22,560
not to roll out today and um of course

2491
01:35:27,189 --> 01:35:24,880
emily is being very fickle

2492
01:35:29,430 --> 01:35:27,199
not very easily predicted what is going

2493
01:35:31,430 --> 01:35:29,440
to happen with this tropical storm but

2494
01:35:34,070 --> 01:35:31,440
the weather folks put their heads

2495
01:35:36,070 --> 01:35:34,080
together and decided that yes we can

2496
01:35:38,790 --> 01:35:36,080
roll out today and we'll have another

2497
01:35:40,629 --> 01:35:38,800
meeting uh 6 a.m tomorrow morning to

2498
01:35:42,790 --> 01:35:40,639
decide whether we can go for the launch

2499
01:35:45,430 --> 01:35:42,800
opportunity tomorrow we'd like to have

2500
01:35:47,510 --> 01:35:45,440
opportunities both friday and saturday

2501
01:35:49,910 --> 01:35:47,520
so we'll just keep track of emily

2502
01:35:52,149 --> 01:35:49,920
it's traveling more westerly than they

2503
01:35:54,550 --> 01:35:52,159
originally anticipated has not made its

2504
01:35:56,229 --> 01:35:54,560
turn north we we really wanted it to

2505
01:35:58,070 --> 01:35:56,239
turn north earlier so it would stay to

2506
01:35:59,590 --> 01:35:58,080
the east of the peninsula but right now

2507
01:36:00,950 --> 01:35:59,600
everything looks good for an opportunity

2508
01:36:01,830 --> 01:36:00,960
tomorrow

2509
01:36:03,189 --> 01:36:01,840
and

2510
01:36:05,669 --> 01:36:03,199
noting the time i think it's a little

2511
01:36:08,070 --> 01:36:05,679
afternoon now and our launch window

2512
01:36:15,189 --> 01:36:08,080
tomorrow opens at 11 34 a.m so we're

2513
01:36:20,870 --> 01:36:18,149

we have a 69-minute window tomorrow to

2514
01:36:23,030 --> 01:36:20,880
attempt and we have a 22-day launch

2515
01:36:24,870 --> 01:36:23,040
period as i'm sure you all know with

2516
01:36:26,229 --> 01:36:24,880
daily windows up to about 90 minutes

2517
01:36:28,229 --> 01:36:26,239
most days

2518
01:36:30,229 --> 01:36:28,239
right now the spacecraft is in its

2519
01:36:32,310 --> 01:36:30,239
stowed configuration on top of the space

2520
01:36:34,950 --> 01:36:32,320
on top of the rocket so unlike this

2521
01:36:36,870 --> 01:36:34,960
model here that shows the beautiful rays

2522
01:36:38,550 --> 01:36:36,880
deployed it's it's um they're all folded

2523
01:36:40,310 --> 01:36:38,560
up against the spacecraft uh the

2524
01:36:42,470 --> 01:36:40,320
spacecraft is about 11 and a half feet

2525
01:36:44,470 --> 01:36:42,480
high about 11 and a half feet across but

2526
01:36:46,550 --> 01:36:44,480
if you did a circumference of a diameter

2527
01:36:48,149 --> 01:36:46,560
of a circle uh from the tip of the mag

2528
01:36:50,709 --> 01:36:48,159
boom all the way around it's it's about

2529
01:36:54,229 --> 01:36:50,719
80 feet across so it really is a large

2530
01:36:56,550 --> 01:36:54,239
uh spacecraft with the wings deployed

2531
01:36:58,310 --> 01:36:56,560
so everything's ready to go we're ready

2532
01:37:00,149 --> 01:36:58,320
the rocket's ready the weather is

2533
01:37:05,669 --> 01:37:00,159
looking good and

2534
01:37:09,109 --> 01:37:07,830
so um yeah i can only stay for a few

2535
01:37:10,950 --> 01:37:09,119
more minutes so i'd be happy to take

2536
01:37:13,030 --> 01:37:10,960
some questions before uh turning it back

2537
01:37:15,030 --> 01:37:13,040
over to steve if there's anything that

2538
01:37:19,109 --> 01:37:15,040

you'd like to know yeah

2539
01:37:22,870 --> 01:37:21,030
hi jan i'll ask the non-science question

2540
01:37:24,709 --> 01:37:22,880
here as i know there's a couple project

2541
01:37:26,390 --> 01:37:24,719
managers in the room from a project

2542
01:37:28,310 --> 01:37:26,400
management perspective on a very large

2543
01:37:29,910 --> 01:37:28,320
project like this what are some of the

2544
01:37:32,390 --> 01:37:29,920
challenges you faced over the past

2545
01:37:33,750 --> 01:37:32,400
couple years

2546
01:37:36,310 --> 01:37:33,760
well um

2547
01:37:37,910 --> 01:37:36,320
on a large project as any large team you

2548
01:37:39,510 --> 01:37:37,920
want to make sure that you have really

2549
01:37:42,790 --> 01:37:39,520
good uh team

2550
01:37:45,430 --> 01:37:42,800
communication and and and team um

2551
01:37:47,270 --> 01:37:45,440
division of responsibilities and esprit

2552
01:37:48,950 --> 01:37:47,280
de corps i mean you want to work you

2553
01:37:52,070 --> 01:37:48,960
want to one of the things i take the

2554
01:37:53,669 --> 01:37:52,080
most pleasure in is seeing a team evolve

2555
01:37:55,830 --> 01:37:53,679
so that everyone understands their roles

2556
01:37:57,350 --> 01:37:55,840
and responsibilities each person knows

2557
01:37:58,790 --> 01:37:57,360
what they need to take care of who their

2558
01:38:01,109 --> 01:37:58,800
interfaces are

2559
01:38:03,430 --> 01:38:01,119
they work harmoniously

2560
01:38:04,709 --> 01:38:03,440
mutual respect and integrity are

2561
01:38:07,109 --> 01:38:04,719
important because you want to make sure

2562
01:38:08,870 --> 01:38:07,119
that when you run into a problem you can

2563
01:38:11,109 --> 01:38:08,880

debate the pros and cons in a

2564
01:38:13,510 --> 01:38:11,119
non-emotional fashion and make sure that

2565
01:38:17,990 --> 01:38:13,520
you make the right decision for the best

2566
01:38:24,870 --> 01:38:21,109
anything else any questions on this side

2567
01:38:29,430 --> 01:38:27,109
because because this is a tweet up

2568
01:38:31,189 --> 01:38:29,440
i feel i'd be amiss if i didn't direct a

2569
01:38:33,590 --> 01:38:31,199
question towards you from somebody i

2570
01:38:35,910 --> 01:38:33,600
follow on twitter chris astro

2571
01:38:37,430 --> 01:38:35,920
and he'd like to know if uh can you

2572
01:38:38,629 --> 01:38:37,440
please extend the mission for more than

2573
01:38:40,950 --> 01:38:38,639
just a year

2574
01:38:42,870 --> 01:38:40,960
just you know just take a little longer

2575
01:38:44,870 --> 01:38:42,880
well that's actually a better question

2576
01:38:46,870 --> 01:38:44,880
for steve from a mission design

2577
01:38:48,470 --> 01:38:46,880
perspective but

2578
01:38:50,950 --> 01:38:48,480
any other questions for me from a

2579
01:38:54,550 --> 01:38:50,960
project management perspective the

2580
01:38:57,189 --> 01:38:54,560
boring management budget schedule

2581
01:38:59,030 --> 01:38:57,199
side of things we are on schedule and on

2582
01:39:02,070 --> 01:38:59,040
budget so that's a tribute to the

2583
01:39:04,629 --> 01:39:02,080
extended juno team

2584
01:39:07,109 --> 01:39:04,639
one question here in the back

2585
01:39:09,270 --> 01:39:07,119
on that topic a lot of nasa projects

2586
01:39:11,270 --> 01:39:09,280
have had a tendency to get really far

2587
01:39:13,030 --> 01:39:11,280
off of budget so how is juno different

2588
01:39:15,830 --> 01:39:13,040

than say

2589
01:39:17,910 --> 01:39:15,840
james webb or the space shuttle or mars

2590
01:39:19,750 --> 01:39:17,920
science laboratory well we are on

2591
01:39:21,669 --> 01:39:19,760
schedule and on budget we have a total

2592
01:39:23,750 --> 01:39:21,679
budget of 1.1 billion and we're coming

2593
01:39:26,629 --> 01:39:23,760
in a little bit under that

2594
01:39:29,910 --> 01:39:26,639
thanks to the great teamwork and

2595
01:39:31,750 --> 01:39:29,920
focus from everyone across the nation

2596
01:39:34,310 --> 01:39:31,760
and the world we have international

2597
01:39:36,550 --> 01:39:34,320
partnerships as well it takes everyone

2598
01:39:38,310 --> 01:39:36,560
doing the right technical job

2599
01:39:40,070 --> 01:39:38,320
and being sensitive to

2600
01:39:45,189 --> 01:39:40,080
the technical scope the schedule and the

2601
01:39:50,070 --> 01:39:46,629
questions one

2602
01:39:53,669 --> 01:39:51,830
yeah hi my name is patrick cavanaugh i

2603
01:39:55,910 --> 01:39:53,679
was just wondering how you got involved

2604
01:39:58,390 --> 01:39:55,920
with nasa originally and how you rose to

2605
01:40:00,790 --> 01:39:58,400
be at the position you're at now leading

2606
01:40:03,830 --> 01:40:00,800
um project manager for this mission well

2607
01:40:07,189 --> 01:40:03,840
i i joined the jet propulsion laboratory

2608
01:40:10,149 --> 01:40:07,199
in 1980 so i've been there over 31 years

2609
01:40:11,830 --> 01:40:10,159
when i was in i'm actually canadian

2610
01:40:14,229 --> 01:40:11,840
i went to university of toronto any

2611
01:40:16,550 --> 01:40:14,239
canadians here all right toronto

2612
01:40:18,149 --> 01:40:16,560
university of toronto um aerospace

2613
01:40:20,390 --> 01:40:18,159

engineering bachelor's and master's

2614
01:40:21,750 --> 01:40:20,400
degrees and i uh the space side of

2615
01:40:23,990 --> 01:40:21,760
aerospace engineering appealed to me the

2616
01:40:26,470 --> 01:40:24,000
math and physics

2617
01:40:28,229 --> 01:40:26,480
predictability appealed to me in high

2618
01:40:31,830 --> 01:40:28,239
school and college

2619
01:40:33,590 --> 01:40:31,840
and and so when i was applying for a job

2620
01:40:35,750 --> 01:40:33,600
it's serendipitous and timing is

2621
01:40:37,510 --> 01:40:35,760
everything and there were i was able to

2622
01:40:39,990 --> 01:40:37,520
get a visa that allowed me to come and

2623
01:40:41,990 --> 01:40:40,000
work at jpl and join the galileo mission

2624
01:40:43,510 --> 01:40:42,000
so i worked on the galileo mission

2625
01:40:44,870 --> 01:40:43,520
attitude and articulation control

2626
01:40:47,750 --> 01:40:44,880
subsystem

2627
01:40:49,270 --> 01:40:47,760
from 1980 uh through galileo's launch i

2628
01:40:52,629 --> 01:40:49,280
ended up as a technical manager of that

2629
01:40:55,830 --> 01:40:52,639
subsystem but really i think that

2630
01:40:58,229 --> 01:40:55,840
i i enjoy the technical topic of

2631
01:41:00,070 --> 01:40:58,239
aerospace and space exploration but my

2632
01:41:01,430 --> 01:41:00,080
personal strengths are more in

2633
01:41:03,590 --> 01:41:01,440
planning

2634
01:41:04,790 --> 01:41:03,600
coordination management scheduling

2635
01:41:06,629 --> 01:41:04,800
budget

2636
01:41:09,430 --> 01:41:06,639
that sort of thing organizing

2637
01:41:11,109 --> 01:41:09,440
anticipating problems you know early so

2638
01:41:12,870 --> 01:41:11,119

you can work them out when they're small

2639
01:41:14,950 --> 01:41:12,880
so i think i naturally gravitated to be

2640
01:41:16,709 --> 01:41:14,960
more a technical manager than staying in

2641
01:41:21,030 --> 01:41:16,719
the pure technical field and jpl has

2642
01:41:24,790 --> 01:41:22,790
thanks very much i gotta run back and do

2643
01:41:25,750 --> 01:41:24,800
another guest briefing thank you very

2644
01:41:32,229 --> 01:41:25,760
much

2645
01:41:35,669 --> 01:41:34,390
okay i remembered your question

2646
01:41:37,109 --> 01:41:35,679
um

2647
01:41:39,750 --> 01:41:37,119
question the question i'll just repeat

2648
01:41:42,470 --> 01:41:39,760
it so people uh question is why

2649
01:41:43,830 --> 01:41:42,480
why not extend juno's mission

2650
01:41:45,270 --> 01:41:43,840
well the

2651
01:41:47,669 --> 01:41:45,280
the short answer i'll give the short

2652
01:41:50,709 --> 01:41:47,679
answer the long answer the short answer

2653
01:41:53,270 --> 01:41:50,719
is that that jupiter course has

2654
01:41:55,750 --> 01:41:53,280
very high radiation field

2655
01:41:57,109 --> 01:41:55,760
and as we go along

2656
01:41:58,709 --> 01:41:57,119
in the mission

2657
01:42:00,390 --> 01:41:58,719
the orbit

2658
01:42:02,470 --> 01:42:00,400
i'm actually going to have to maybe you

2659
01:42:04,550 --> 01:42:02,480
can stand up and hold the globe

2660
01:42:07,510 --> 01:42:04,560
like right about there thank you

2661
01:42:10,310 --> 01:42:07,520
you can help answer your own question

2662
01:42:12,790 --> 01:42:10,320
okay so if if we're

2663
01:42:19,430 --> 01:42:12,800

if you're facing jupiter like this

2664
01:42:23,669 --> 01:42:21,830
okay so we're coming in like that

2665
01:42:25,590 --> 01:42:23,679
excellent

2666
01:42:27,189 --> 01:42:25,600
3d animation

2667
01:42:28,870 --> 01:42:27,199
and and then

2668
01:42:30,310 --> 01:42:28,880
well that's the big orbit and then we

2669
01:42:31,590 --> 01:42:30,320
then we go in and we get into the

2670
01:42:33,830 --> 01:42:31,600
smaller orbit

2671
01:42:36,390 --> 01:42:33,840
now we're in

2672
01:42:38,070 --> 01:42:36,400
now the orbit though jupiter

2673
01:42:40,070 --> 01:42:38,080
every time we go by

2674
01:42:41,510 --> 01:42:40,080
jupiter's torquing the orbit down like

2675
01:42:43,750 --> 01:42:41,520
this so

2676
01:42:45,350 --> 01:42:43,760
it starts getting more and more down and

2677
01:42:47,590 --> 01:42:45,360
we start getting more and more radiation

2678
01:42:49,990 --> 01:42:47,600
as the mission goes along so by the time

2679
01:42:51,189 --> 01:42:50,000
we get to the 33rd orbit

2680
01:42:52,790 --> 01:42:51,199
we're getting

2681
01:42:54,470 --> 01:42:52,800
pretty big doses of radiation and we

2682
01:42:57,030 --> 01:42:54,480
want to make sure that we can control

2683
01:42:59,669 --> 01:42:57,040
the spacecraft so that we can put it

2684
01:43:03,990 --> 01:42:59,679
into jupiter at the end you can do the

2685
01:43:04,000 --> 01:43:07,990
it goes in

2686
01:43:13,910 --> 01:43:09,669
and

2687
01:43:16,149 --> 01:43:13,920
everything's going great you could go

2688
01:43:18,310 --> 01:43:16,159

maybe an orbit or two more but that's

2689
01:43:21,109 --> 01:43:18,320
about it because the radiation just gets

2690
01:43:23,750 --> 01:43:21,119
to be so intense

2691
01:43:25,830 --> 01:43:23,760
okay uh i wanted to add

2692
01:43:27,669 --> 01:43:25,840
about my background too because i've

2693
01:43:29,910 --> 01:43:27,679
i've been i've actually been following

2694
01:43:31,669 --> 01:43:29,920
some of the tweets uh on here because i

2695
01:43:34,070 --> 01:43:31,679
have a twitter account i don't i don't

2696
01:43:35,590 --> 01:43:34,080
tweet very often but um

2697
01:43:37,350 --> 01:43:35,600
one one of the things i've seen is

2698
01:43:39,270 --> 01:43:37,360
people who said yeah i want to work at

2699
01:43:40,950 --> 01:43:39,280
nasa they're they're in college now

2700
01:43:43,189 --> 01:43:40,960
they're about to graduate or

2701
01:43:45,189 --> 01:43:43,199
i wanted to say that's what i did i went

2702
01:43:46,310 --> 01:43:45,199
to university colorado boulder and i

2703
01:43:48,310 --> 01:43:46,320
said

2704
01:43:50,790 --> 01:43:48,320
i want to work for nasa

2705
01:43:52,229 --> 01:43:50,800
and i just i was just persistent i just

2706
01:43:55,590 --> 01:43:52,239
said i'm gonna do that i got a job at

2707
01:43:59,189 --> 01:43:55,600
jpl i worked on the voyager mission

2708
01:44:01,030 --> 01:43:59,199
when i was uh 25 years old i flew by the

2709
01:44:03,030 --> 01:44:01,040
planet neptune and now we're going to

2710
01:44:05,109 --> 01:44:03,040
jupiter those kind of dreams they can

2711
01:44:07,510 --> 01:44:05,119
happen i mean you just

2712
01:44:09,750 --> 01:44:07,520
you set your mind to it study the right

2713
01:44:11,030 --> 01:44:09,760

stuff and it happens

2714
01:44:12,629 --> 01:44:11,040
um

2715
01:44:15,109 --> 01:44:12,639
what i what i started out doing was

2716
01:44:16,870 --> 01:44:15,119
orbital mechanics and that's how i know

2717
01:44:19,430 --> 01:44:16,880
how to get out to jupiter and plan that

2718
01:44:21,590 --> 01:44:19,440
kind of stuff and once we're at jupiter

2719
01:44:23,669 --> 01:44:21,600
let's see uh there was i think there was

2720
01:44:26,870 --> 01:44:23,679
a another question let me talk a little

2721
01:44:28,870 --> 01:44:26,880
bit about the orbit now i wasn't totally

2722
01:44:30,950 --> 01:44:28,880
honest when i said that we don't have to

2723
01:44:33,669 --> 01:44:30,960
point the spacecraft we actually

2724
01:44:35,830 --> 01:44:33,679
have to point the spacecraft only twice

2725
01:44:38,149 --> 01:44:35,840
so um

2726
01:44:40,149 --> 01:44:38,159
i'm going to borrow the globe again

2727
01:44:41,430 --> 01:44:40,159
sorry to

2728
01:44:43,189 --> 01:44:41,440
okay so

2729
01:44:45,350 --> 01:44:43,199
if we're coming in like this there's

2730
01:44:47,510 --> 01:44:45,360
you've heard of the microwave radiometer

2731
01:44:49,669 --> 01:44:47,520
it comes in and it needs to be parallel

2732
01:44:52,470 --> 01:44:49,679
with jupiter so that's one of our type

2733
01:44:54,629 --> 01:44:52,480
orbit types and the other type is when

2734
01:44:56,550 --> 01:44:54,639
we're going up very close to the planet

2735
01:44:57,830 --> 01:44:56,560
we do a gravity science because we get

2736
01:45:00,709 --> 01:44:57,840
within

2737
01:45:02,950 --> 01:45:00,719
about 3 000 miles 5000 kilometers of the

2738
01:45:04,950 --> 01:45:02,960

cloud tops there and so we're going to

2739
01:45:07,270 --> 01:45:04,960
get all the measurements are going to be

2740
01:45:09,590 --> 01:45:07,280
awesome when we're that close

2741
01:45:11,350 --> 01:45:09,600
and when we're in that way we we point

2742
01:45:13,430 --> 01:45:11,360
the high gain antenna at the earth so we

2743
01:45:15,750 --> 01:45:13,440
can do the gravity science the deep

2744
01:45:17,750 --> 01:45:15,760
space network actually the biggest

2745
01:45:19,030 --> 01:45:17,760
instrument on juno

2746
01:45:21,109 --> 01:45:19,040
involves

2747
01:45:23,270 --> 01:45:21,119
the high gain antenna and the telecom

2748
01:45:25,590 --> 01:45:23,280
subsystem and

2749
01:45:27,430 --> 01:45:25,600
the deep space network antennas here on

2750
01:45:29,430 --> 01:45:27,440
earth at goldstone and that's the whole

2751
01:45:31,590 --> 01:45:29,440
instrument it takes it takes the whole

2752
01:45:33,590 --> 01:45:31,600
array there to to sense down to one

2753
01:45:35,990 --> 01:45:33,600
millimeter per second the gravity

2754
01:45:40,390 --> 01:45:36,000
science as we're going by there uh later

2755
01:45:43,910 --> 01:45:41,990
oh yeah that's way less that's about

2756
01:45:45,669 --> 01:45:43,920
that's about the distance that i flew

2757
01:45:47,750 --> 01:45:45,679
flying here from la

2758
01:45:49,189 --> 01:45:47,760
uh above the cloud tops

2759
01:45:51,830 --> 01:45:49,199
so i'm going to pause for a second and

2760
01:45:54,310 --> 01:45:51,840
take some questions um

2761
01:45:55,669 --> 01:45:54,320
thanks to the glo thanks to 3d animators

2762
01:45:57,189 --> 01:45:55,679
too that was really cool i want to do

2763
01:45:58,550 --> 01:45:57,199

that again sometime

2764
01:46:00,310 --> 01:45:58,560
that was awesome we've got a question

2765
01:46:02,310 --> 01:46:00,320
right here okay

2766
01:46:04,629 --> 01:46:02,320
yeah your great 3d animation brought to

2767
01:46:08,149 --> 01:46:04,639
the mind a question for me when you do

2768
01:46:10,390 --> 01:46:08,159
deorbit uh are you targeting a specific

2769
01:46:13,590 --> 01:46:10,400
uh hemisphere up northern pole southern

2770
01:46:16,790 --> 01:46:13,600
pole equator and would the inclination

2771
01:46:19,990 --> 01:46:16,800
or the orbital mechanics be right for uh

2772
01:46:24,229 --> 01:46:20,000
visualization from earth

2773
01:46:27,750 --> 01:46:24,239
i'm gonna have to do a quick

2774
01:46:30,149 --> 01:46:27,760
3d inside my head i

2775
01:46:32,310 --> 01:46:30,159
well for the first part of it is it's

2776
01:46:34,229 --> 01:46:32,320
going to come in around up here around

2777
01:46:36,149 --> 01:46:34,239
the pole there's no choice since the

2778
01:46:37,669 --> 01:46:36,159
orbit since the orbit goes like this and

2779
01:46:39,270 --> 01:46:37,679
we do the maneuver

2780
01:46:40,070 --> 01:46:39,280
out here to the deorbit maneuver it's

2781
01:46:42,470 --> 01:46:40,080
gonna

2782
01:46:44,870 --> 01:46:42,480
make the burn and then come in and go in

2783
01:46:46,870 --> 01:46:44,880
the northern hemisphere i i think it's

2784
01:46:49,510 --> 01:46:46,880
so small

2785
01:46:51,030 --> 01:46:49,520
the juno spacecraft is big but compared

2786
01:46:53,510 --> 01:46:51,040
to jupiter it's so small i don't think

2787
01:46:54,870 --> 01:46:53,520
we can see it i i'm that's just a guess

2788
01:46:56,629 --> 01:46:54,880

on my part

2789
01:46:57,990 --> 01:46:56,639
um i'd i'll have to go back that

2790
01:47:00,310 --> 01:46:58,000
actually put a thought in my head so i'm

2791
01:47:02,390 --> 01:47:00,320
going to go back and see if i don't

2792
01:47:04,149 --> 01:47:02,400
think we can but

2793
01:47:06,149 --> 01:47:04,159
good that's a good question

2794
01:47:07,669 --> 01:47:06,159
i'm going to check that out

2795
01:47:09,430 --> 01:47:07,679
if we can't see it i certainly want to

2796
01:47:11,350 --> 01:47:09,440
see that

2797
01:47:13,590 --> 01:47:11,360
steve we have a question here or a

2798
01:47:16,149 --> 01:47:13,600
comment back right this way right

2799
01:47:17,990 --> 01:47:16,159
speaker speaker

2800
01:47:20,629 --> 01:47:18,000
okay uh for those of you who aren't

2801
01:47:22,390 --> 01:47:20,639
rocket scientists okay if you get up at

2802
01:47:24,629 --> 01:47:22,400
five o'clock in the morning

2803
01:47:27,030 --> 01:47:24,639
you can see our target right up here

2804
01:47:29,189 --> 01:47:27,040
overhead okay in the eastern sky

2805
01:47:31,030 --> 01:47:29,199
so take a look and if you've got seven

2806
01:47:32,550 --> 01:47:31,040
by fifty binoculars

2807
01:47:34,709 --> 01:47:32,560
and you can hold them steady you've got

2808
01:47:36,470 --> 01:47:34,719
tripods even better you can see the

2809
01:47:38,870 --> 01:47:36,480
moons of jupiter in the same way that

2810
01:47:40,070 --> 01:47:38,880
galileo did when he discovered them so i

2811
01:47:42,390 --> 01:47:40,080
recommend it

2812
01:47:44,070 --> 01:47:42,400
yeah it's a it's an awesome sight i look

2813
01:47:46,310 --> 01:47:44,080

through it through my telescope all the

2814
01:47:50,149 --> 01:47:46,320
time

2815
01:47:50,159 --> 01:47:53,510
got one out here in the middle

2816
01:47:57,350 --> 01:47:55,510
hi i'm warren levine

2817
01:47:59,189 --> 01:47:57,360
um

2818
01:48:00,310 --> 01:47:59,199
being that you went to

2819
01:48:02,390 --> 01:48:00,320
boulder

2820
01:48:03,750 --> 01:48:02,400
uh and since you're

2821
01:48:05,750 --> 01:48:03,760
you know since you're in the profession

2822
01:48:07,590 --> 01:48:05,760
you are in did you ever enter a flying

2823
01:48:09,669 --> 01:48:07,600
machine into that annual race they've

2824
01:48:11,590 --> 01:48:09,679
got oh

2825
01:48:13,189 --> 01:48:11,600
no i've observed it a lot but i never

2826
01:48:14,870 --> 01:48:13,199
entered a machine there

2827
01:48:16,550 --> 01:48:14,880
perhaps i should sometimes that would be

2828
01:48:19,030 --> 01:48:16,560
that would be interesting yeah

2829
01:48:21,109 --> 01:48:19,040
that'd be really cool

2830
01:48:24,950 --> 01:48:21,119
okay time for one last question who

2831
01:48:28,629 --> 01:48:26,790
a lot of the speakers have talked about

2832
01:48:30,229 --> 01:48:28,639
all of the data that's coming in and i

2833
01:48:32,229 --> 01:48:30,239
understand from a scientific perspective

2834
01:48:34,310 --> 01:48:32,239
how useful it is but on the team have

2835
01:48:36,229 --> 01:48:34,320
you thought at all about how to use that

2836
01:48:39,030 --> 01:48:36,239
data in a way that the public can

2837
01:48:40,470 --> 01:48:39,040
understand visualizations or something

2838
01:48:42,709 --> 01:48:40,480

that goes beyond just the pictures that

2839
01:48:44,470 --> 01:48:42,719
are coming back from junocam i guess i'm

2840
01:48:46,550 --> 01:48:44,480
thinking of how data is really difficult

2841
01:48:48,550 --> 01:48:46,560
for people to get so how do you help the

2842
01:48:50,950 --> 01:48:48,560
public get it in order to make them care

2843
01:48:52,390 --> 01:48:50,960
about planetary missions like this i'm

2844
01:48:54,229 --> 01:48:52,400
i'm going to take a crack at that and

2845
01:48:57,270 --> 01:48:54,239
then i'm going to turn it over to

2846
01:48:59,030 --> 01:48:57,280
probably to fran and some others but the

2847
01:49:01,270 --> 01:48:59,040
answer is yes there are going to be a

2848
01:49:03,109 --> 01:49:01,280
lot of visualizations coming out because

2849
01:49:05,910 --> 01:49:03,119
when i when i first started working on

2850
01:49:07,030 --> 01:49:05,920
juno all the there's there's junocam

2851
01:49:09,109 --> 01:49:07,040
which is the visible camera but

2852
01:49:12,229 --> 01:49:09,119
everything else magnetometer gravity

2853
01:49:15,030 --> 01:49:12,239
science plasma particles

2854
01:49:17,189 --> 01:49:15,040
your eyes can't see that and so juno is

2855
01:49:19,030 --> 01:49:17,199
seeing it in different ways and there's

2856
01:49:20,550 --> 01:49:19,040
there's a lot of planning going into how

2857
01:49:23,350 --> 01:49:20,560
to put all those things together and

2858
01:49:25,589 --> 01:49:23,360
make them understandable even to the

2859
01:49:30,870 --> 01:49:25,599
science team and to everyone else too

2860
01:49:35,430 --> 01:49:33,189
juno is a little different from

2861
01:49:37,350 --> 01:49:35,440
the other big missions like galileo and

2862
01:49:39,510 --> 01:49:37,360
some extent cassini because it doesn't

2863
01:49:41,910 --> 01:49:39,520

last that long so we have to be ready

2864
01:49:43,830 --> 01:49:41,920
when we get there to analyze the data so

2865
01:49:45,669 --> 01:49:43,840
right now i'm training a couple of

2866
01:49:47,750 --> 01:49:45,679
undergraduates and two graduate students

2867
01:49:48,790 --> 01:49:47,760
to learn how to analyze the particle

2868
01:49:51,109 --> 01:49:48,800
data

2869
01:49:53,030 --> 01:49:51,119
so we've got visualization tools ready

2870
01:49:54,790 --> 01:49:53,040
to get those data out we're also going

2871
01:49:57,430 --> 01:49:54,800
to meet as a team next week and one of

2872
01:49:59,030 --> 01:49:57,440
the top priorities of the magnetospheric

2873
01:50:00,390 --> 01:49:59,040
group is to put together how do we put

2874
01:50:01,510 --> 01:50:00,400
all the data together and make them

2875
01:50:05,430 --> 01:50:01,520
available

2876
01:50:09,830 --> 01:50:05,440
people to look at

2877
01:50:11,990 --> 01:50:09,840
just as these the national space weather

2878
01:50:13,430 --> 01:50:12,000
center which is in boulder colorado at

2879
01:50:15,589 --> 01:50:13,440
the noaa

2880
01:50:18,229 --> 01:50:15,599
center there they put out space weather

2881
01:50:19,669 --> 01:50:18,239
for the earth so the the magnetic field

2882
01:50:21,270 --> 01:50:19,679
and the energetic particles that

2883
01:50:23,669 --> 01:50:21,280
generate the earth's aurora you can go

2884
01:50:25,830 --> 01:50:23,679
see them generated by nasa and other

2885
01:50:27,430 --> 01:50:25,840
spacecraft you can just go onto their

2886
01:50:29,189 --> 01:50:27,440
website and see what's happening now in

2887
01:50:31,910 --> 01:50:29,199
space weather we want to do the same

2888
01:50:35,109 --> 01:50:31,920

with juno uh jupiter's weather using

2889
01:50:37,430 --> 01:50:35,119
juno so you'll be able to look at the uh

2890
01:50:39,990 --> 01:50:37,440
juno space weather jupiter space weather

2891
01:50:42,790 --> 01:50:40,000
same way so this is the new way of doing

2892
01:50:44,709 --> 01:50:42,800
business just like twitter we're growing

2893
01:50:48,950 --> 01:50:44,719
up finally and making it available to

2894
01:50:48,960 --> 01:50:51,510
okay

2895
01:50:56,550 --> 01:50:53,109
we can do

2896
01:50:57,830 --> 01:50:56,560
see our next speaker hydrating over

2897
01:50:59,030 --> 01:50:57,840
there which is a very good idea and i

2898
01:51:01,589 --> 01:50:59,040
encourage everyone to keep doing the

2899
01:51:04,709 --> 01:51:01,599
same so how about one quick question

2900
01:51:08,790 --> 01:51:06,870
hi don schwartz uh

2901
01:51:11,109 --> 01:51:08,800
the question is it keeps on coming up

2902
01:51:13,430 --> 01:51:11,119
about the duration and the lifetimes of

2903
01:51:15,990 --> 01:51:13,440
the people involved in the long projects

2904
01:51:18,070 --> 01:51:16,000
well is there a way

2905
01:51:20,870 --> 01:51:18,080
short of using gravity assist that we

2906
01:51:22,390 --> 01:51:20,880
can bypass gravity assist and how fast

2907
01:51:24,629 --> 01:51:22,400
would the actually the spacecraft have

2908
01:51:26,870 --> 01:51:24,639
to go substantially cut down the time of

2909
01:51:29,430 --> 01:51:26,880
these missions

2910
01:51:30,950 --> 01:51:29,440
the the wave well let me use juno as an

2911
01:51:32,790 --> 01:51:30,960
example

2912
01:51:34,550 --> 01:51:32,800
in in the early days we looked at could

2913
01:51:37,430 --> 01:51:34,560

we go direct and that would take three

2914
01:51:40,070 --> 01:51:37,440
years to get to jupiter and so it comes

2915
01:51:41,510 --> 01:51:40,080
down to a bigger launch vehicle for less

2916
01:51:43,750 --> 01:51:41,520
you know if if we had bigger launch

2917
01:51:46,709 --> 01:51:43,760
vehicle for the same price

2918
01:51:51,030 --> 01:51:48,870
oh like solar electric propulsion and

2919
01:51:53,350 --> 01:51:51,040
those kind uh for this kind of mission

2920
01:51:55,350 --> 01:51:53,360
it didn't it doesn't really help that

2921
01:51:57,189 --> 01:51:55,360
like i mean the dawn spacecraft is now

2922
01:51:58,629 --> 01:51:57,199
at vesta and it's orbiting and that's

2923
01:51:59,990 --> 01:51:58,639
the reason it got there is a solar

2924
01:52:02,310 --> 01:52:00,000
electric propulsion

2925
01:52:03,669 --> 01:52:02,320
for going out to jupiter we're going so

2926
01:52:05,750 --> 01:52:03,679
fast

2927
01:52:07,350 --> 01:52:05,760
anyway to get out there that solar

2928
01:52:09,189 --> 01:52:07,360
electric propulsion didn't really help

2929
01:52:12,229 --> 01:52:09,199
us but we looked at that early on to see

2930
01:52:14,709 --> 01:52:12,239
if it would help so

2931
01:52:16,950 --> 01:52:14,719
some like solar i'm a big fan of

2932
01:52:18,550 --> 01:52:16,960
electric propulsion so and that really

2933
01:52:20,310 --> 01:52:18,560
works for

2934
01:52:21,830 --> 01:52:20,320
rendezvousing with asteroids and things

2935
01:52:23,510 --> 01:52:21,840
that don't have much mass but jupiter

2936
01:52:25,350 --> 01:52:23,520
has so much mass

2937
01:52:27,030 --> 01:52:25,360
that we're using that to our advantage

2938
01:52:29,109 --> 01:52:27,040

when we get there so it's helping us

2939
01:52:30,629 --> 01:52:29,119
stop and and get into orbit and things

2940
01:52:32,629 --> 01:52:30,639
like that so

2941
01:52:40,709 --> 01:52:32,639
good question

2942
01:52:40,719 --> 01:52:51,189
thank you

2943
01:52:55,270 --> 01:52:53,669
okay we're coming to a close just about

2944
01:52:58,629 --> 01:52:55,280
on the speaking portion our final

2945
01:53:00,870 --> 01:52:58,639
speaker today is chris brocius he is the

2946
01:53:02,550 --> 01:53:00,880
chief systems engineer for juno for

2947
01:53:03,430 --> 01:53:02,560
lockheed martin and he can tell you a

2948
01:53:05,350 --> 01:53:03,440
little bit from an engineering

2949
01:53:06,870 --> 01:53:05,360
perspective how the heck this remarkable

2950
01:53:10,149 --> 01:53:06,880
spacecraft came together and how they

2951
01:53:12,709 --> 01:53:10,159
built it with that chris

2952
01:53:14,149 --> 01:53:12,719
thank you very much

2953
01:53:16,149 --> 01:53:14,159
this is this is really a great

2954
01:53:18,149 --> 01:53:16,159
opportunity i want to share some some

2955
01:53:19,669 --> 01:53:18,159
interesting facts engineering hopefully

2956
01:53:21,750 --> 01:53:19,679
you guys are interested in how we put

2957
01:53:24,790 --> 01:53:21,760
the spacecraft together and what it's

2958
01:53:26,950 --> 01:53:24,800
made of and and how it all works

2959
01:53:28,550 --> 01:53:26,960
the spacecraft was born in denver at the

2960
01:53:30,870 --> 01:53:28,560
lockheed martin facility that's where we

2961
01:53:35,430 --> 01:53:30,880
build all of our planetaries

2962
01:53:38,629 --> 01:53:36,950
we've all seen how big these solar

2963
01:53:39,990 --> 01:53:38,639

arrays are right

2964
01:53:43,270 --> 01:53:40,000
there's 18

2965
01:53:44,629 --> 01:53:43,280
600 solar cells on there

2966
01:53:46,629 --> 01:53:44,639
and i have one here if you want to take

2967
01:53:48,550 --> 01:53:46,639
a look at it it is a very high

2968
01:53:49,430 --> 01:53:48,560
efficiency cell it's a triple junction

2969
01:53:51,189 --> 01:53:49,440
cell

2970
01:53:53,589 --> 01:53:51,199
and we actually had

2971
01:53:55,109 --> 01:53:53,599
almost twice as many of these things

2972
01:53:56,629 --> 01:53:55,119
built so we could cherry pick them to

2973
01:53:58,070 --> 01:53:56,639
get the very best performance for this

2974
01:54:00,310 --> 01:53:58,080
mission

2975
01:54:03,189 --> 01:54:00,320
you guys might have heard that

2976
01:54:05,750 --> 01:54:03,199
out at jupiter the sun isn't very bright

2977
01:54:07,510 --> 01:54:05,760
and the solar arrays produce about 450

2978
01:54:08,390 --> 01:54:07,520
watts normally over the course of the

2979
01:54:09,990 --> 01:54:08,400
mission

2980
01:54:11,910 --> 01:54:10,000
that won't even run a hair dryer you

2981
01:54:13,669 --> 01:54:11,920
know that won't even power those lights

2982
01:54:15,030 --> 01:54:13,679
over there so we had to design the

2983
01:54:16,950 --> 01:54:15,040
mission to be very electrically

2984
01:54:19,030 --> 01:54:16,960
efficient we needed the most efficient

2985
01:54:21,350 --> 01:54:19,040
solar cells we could

2986
01:54:24,550 --> 01:54:21,360
conversely those big arrays here at

2987
01:54:26,070 --> 01:54:24,560
earth they produce almost 19 000 watts

2988
01:54:27,910 --> 01:54:26,080

that could power a couple of houses

2989
01:54:30,870 --> 01:54:27,920
easily so you kind of get a perspective

2990
01:54:31,910 --> 01:54:30,880
of the of the change that uh juno goes

2991
01:54:33,830 --> 01:54:31,920
through

2992
01:54:35,830 --> 01:54:33,840
we also had to design the power system

2993
01:54:37,430 --> 01:54:35,840
so that when it's close to earth we're

2994
01:54:39,030 --> 01:54:37,440
not generating that much power because

2995
01:54:41,430 --> 01:54:39,040
that would blow the batteries to pieces

2996
01:54:42,950 --> 01:54:41,440
it would fry the all the electronics so

2997
01:54:45,270 --> 01:54:42,960
we had to make it very smart and very

2998
01:54:47,589 --> 01:54:45,280
sophisticated so it knows where it is

2999
01:54:52,470 --> 01:54:47,599
with respect to the sun and it knows how

3000
01:54:55,030 --> 01:54:54,229
another thing that's really interesting

3001
01:54:57,109 --> 01:54:55,040
about

3002
01:54:59,030 --> 01:54:57,119
this particular spacecraft

3003
01:55:01,030 --> 01:54:59,040
is this block underneath the high gain

3004
01:55:02,550 --> 01:55:01,040
antenna here called the vault

3005
01:55:04,229 --> 01:55:02,560
you guys have heard about what a

3006
01:55:06,149 --> 01:55:04,239
wonderful place jupiter is and all the

3007
01:55:08,070 --> 01:55:06,159
secrets that are there but i'll tell you

3008
01:55:11,109 --> 01:55:08,080
from an engineering perspective it's

3009
01:55:13,430 --> 01:55:11,119
also really nasty the radiation is just

3010
01:55:15,030 --> 01:55:13,440
unbelievable it's a it's a unique

3011
01:55:17,589 --> 01:55:15,040
radiation field

3012
01:55:18,470 --> 01:55:17,599
mostly dominated by electrons

3013
01:55:20,470 --> 01:55:18,480

and it

3014
01:55:22,149 --> 01:55:20,480
posed some very interesting engineering

3015
01:55:23,910 --> 01:55:22,159
challenges for us because we had to

3016
01:55:25,510 --> 01:55:23,920
figure out how to shield all the

3017
01:55:27,270 --> 01:55:25,520
electronics in there

3018
01:55:28,709 --> 01:55:27,280
so they would survive that steve talked

3019
01:55:29,589 --> 01:55:28,719
a little bit about how at the end of the

3020
01:55:31,910 --> 01:55:29,599
mission

3021
01:55:34,870 --> 01:55:31,920
we've accumulated as much radiation as

3022
01:55:36,149 --> 01:55:34,880
we can tolerate that is absolutely true

3023
01:55:39,270 --> 01:55:36,159
the vault

3024
01:55:40,709 --> 01:55:39,280
as it stands right now

3025
01:55:41,910 --> 01:55:40,719
is made out of this material here

3026
01:55:45,189 --> 01:55:41,920
titanium

3027
01:55:47,669 --> 01:55:45,199
this because it's got some excellent

3028
01:55:49,910 --> 01:55:47,679
shielding characteristics

3029
01:55:52,149 --> 01:55:49,920
the uh the vault is very much tailored

3030
01:55:53,589 --> 01:55:52,159
because we are so weight conscious some

3031
01:55:55,430 --> 01:55:53,599
of the panels are a quarter of an inch

3032
01:55:57,350 --> 01:55:55,440
thick other ones are half an inch thick

3033
01:56:00,709 --> 01:55:57,360
depending on what's around them and will

3034
01:56:03,430 --> 01:56:00,719
take advantage of shielding but overall

3035
01:56:04,709 --> 01:56:03,440
the vault produces about a factor of

3036
01:56:07,109 --> 01:56:04,719
4000

3037
01:56:08,550 --> 01:56:07,119
in radiation reduction so it does an

3038
01:56:12,790 --> 01:56:08,560

outstanding job of protecting our

3039
01:56:16,229 --> 01:56:14,629
we originally back in the days when

3040
01:56:17,510 --> 01:56:16,239
steve was working the proposal had

3041
01:56:19,430 --> 01:56:17,520
thought that we were going to use a

3042
01:56:20,790 --> 01:56:19,440
material

3043
01:56:24,950 --> 01:56:20,800
tantalum

3044
01:56:27,589 --> 01:56:24,960
vault very much like this material here

3045
01:56:30,229 --> 01:56:27,599
tungsten it's very dense very heavy also

3046
01:56:31,990 --> 01:56:30,239
has some nice characteristics but we

3047
01:56:33,030 --> 01:56:32,000
realized when we started designing and

3048
01:56:35,750 --> 01:56:33,040
figuring out how we're going to build

3049
01:56:37,109 --> 01:56:35,760
the vault that it's hard to glue things

3050
01:56:39,990 --> 01:56:37,119
to tantalum

3051
01:56:41,910 --> 01:56:40,000
we can't do that very well and in the

3052
01:56:44,390 --> 01:56:41,920
nasty environment a space where it's hot

3053
01:56:45,990 --> 01:56:44,400
and it's cold and vacuum we don't we

3054
01:56:48,470 --> 01:56:46,000
didn't have any qualified processes that

3055
01:56:50,310 --> 01:56:48,480
we could trust to use that material

3056
01:56:53,669 --> 01:56:50,320
so right before our critical design

3057
01:56:55,109 --> 01:56:53,679
review we switched to titanium which is

3058
01:56:56,950 --> 01:56:55,119
one of our favorite materials we know

3059
01:56:58,229 --> 01:56:56,960
how to use it it added a little bit of

3060
01:57:03,430 --> 01:56:58,239
weight overall but it was the right

3061
01:57:06,350 --> 01:57:05,270
the spacecraft is big you've heard about

3062
01:57:09,589 --> 01:57:06,360
it it's

3063
01:57:12,709 --> 01:57:09,599

3625 kilograms about 2 000 kilograms of

3064
01:57:14,470 --> 01:57:12,719
fuel that's about 500 gallons of

3065
01:57:16,229 --> 01:57:14,480
propellants total

3066
01:57:17,669 --> 01:57:16,239
for those of you that are interested

3067
01:57:19,510 --> 01:57:17,679
about the environment and things like

3068
01:57:22,550 --> 01:57:19,520
that we have figured out our miles per

3069
01:57:25,109 --> 01:57:22,560
gallon on juno it's almost 3.8 million

3070
01:57:26,870 --> 01:57:25,119
miles per gallon

3071
01:57:30,149 --> 01:57:26,880
so well it's pretty good for a hybrid

3072
01:57:34,149 --> 01:57:32,390
and then finally the last thing that was

3073
01:57:36,550 --> 01:57:34,159
very challenging about this radiation

3074
01:57:39,189 --> 01:57:36,560
field it's uh it's definitely one of the

3075
01:57:41,350 --> 01:57:39,199
most strongest engineering nemesis you

3076
01:57:43,030 --> 01:57:41,360
can think of is it because it's electron

3077
01:57:46,070 --> 01:57:43,040
species dominated

3078
01:57:48,310 --> 01:57:46,080
it acts a lot like people do with wool

3079
01:57:49,350 --> 01:57:48,320
socks on running across a carpet in the

3080
01:57:52,550 --> 01:57:49,360
wintertime

3081
01:57:55,030 --> 01:57:52,560
it generates a ton of static electricity

3082
01:57:56,950 --> 01:57:55,040
in fact it generates so much electricity

3083
01:57:58,790 --> 01:57:56,960
that if we didn't do something we could

3084
01:58:01,510 --> 01:57:58,800
get tens of thousands of volts of

3085
01:58:03,109 --> 01:58:01,520
discharge within the spacecraft itself

3086
01:58:04,950 --> 01:58:03,119
all the dielectric materials the

3087
01:58:07,910 --> 01:58:04,960
materials that don't conduct

3088
01:58:09,750 --> 01:58:07,920

electricity the electrons lodge in there

3089
01:58:11,350 --> 01:58:09,760
and they stay in there but they don't

3090
01:58:13,669 --> 01:58:11,360
like to stay in there once they get too

3091
01:58:15,910 --> 01:58:13,679
crowded and they discharge like a static

3092
01:58:17,510 --> 01:58:15,920
shock like you get in the winter time

3093
01:58:19,830 --> 01:58:17,520
we couldn't tolerate that so we had to

3094
01:58:22,070 --> 01:58:19,840
design and build the spacecraft to give

3095
01:58:24,310 --> 01:58:22,080
a path to everything for those electrons

3096
01:58:26,950 --> 01:58:24,320
to escape so we couldn't get that type

3097
01:58:28,709 --> 01:58:26,960
of potential and that turned out to be a

3098
01:58:30,790 --> 01:58:28,719
big engineering challenge

3099
01:58:32,470 --> 01:58:30,800
the the the atlo folks that actually

3100
01:58:34,229 --> 01:58:32,480
built the vehicle they hated us because

3101
01:58:36,629 --> 01:58:34,239
we made them run ground wires all over

3102
01:58:38,790 --> 01:58:36,639
the place and shielding and use special

3103
01:58:40,310 --> 01:58:38,800
compounds that are conductive

3104
01:58:43,830 --> 01:58:40,320
we actually are using

3105
01:58:45,750 --> 01:58:43,840
carbon nanotubes to cloak to coat the

3106
01:58:47,109 --> 01:58:45,760
thruster towers here

3107
01:58:48,149 --> 01:58:47,119
that turns out to be an excellent

3108
01:58:51,270 --> 01:58:48,159
material for that because it's

3109
01:58:53,430 --> 01:58:51,280
conductive it's very strong and

3110
01:58:54,950 --> 01:58:53,440
it turned out to be very nice so we

3111
01:58:57,669 --> 01:58:54,960
actually have some state-of-the-art

3112
01:58:59,910 --> 01:58:57,679
technology in there as well

3113
01:59:01,669 --> 01:58:59,920

do you guys have any questions

3114
01:59:06,709 --> 01:59:01,679
yes

3115
01:59:10,149 --> 01:59:08,629
sound is one first

3116
01:59:12,070 --> 01:59:10,159
you mentioned the vault gives a four

3117
01:59:13,990 --> 01:59:12,080
thousand times attenuation of the

3118
01:59:17,189 --> 01:59:14,000
radiation and my question is first of

3119
01:59:17,910 --> 01:59:17,199
all is that enough and secondly how do

3120
01:59:20,709 --> 01:59:17,920
you

3121
01:59:22,310 --> 01:59:20,719
simulate that environment for testing ah

3122
01:59:24,709 --> 01:59:22,320
that good question

3123
01:59:26,550 --> 01:59:24,719
first off yes it's in us it's enough you

3124
01:59:29,189 --> 01:59:26,560
know engineers by nature are very

3125
01:59:31,510 --> 01:59:29,199
conservative and we never like to to uh

3126
01:59:33,830 --> 01:59:31,520
to cut it right on the edge so we have a

3127
01:59:35,990 --> 01:59:33,840
radiation design margin of two

3128
01:59:38,229 --> 01:59:36,000
so we actually only need a factor of two

3129
01:59:39,589 --> 01:59:38,239
thousand based on the components that

3130
01:59:41,350 --> 01:59:39,599
are in there

3131
01:59:43,990 --> 01:59:41,360
to simulate and test that is very

3132
01:59:47,030 --> 01:59:44,000
difficult uh we have not put the vault

3133
01:59:48,390 --> 01:59:47,040
in a in a chamber and bombed it to see

3134
01:59:50,709 --> 01:59:48,400
what comes in on the other side that's

3135
01:59:53,270 --> 01:59:50,719
all done analytically

3136
01:59:55,189 --> 01:59:53,280
we do test all the individual components

3137
01:59:56,950 --> 01:59:55,199
though representative samples lot

3138
01:59:58,470 --> 01:59:56,960

accepting test of radiation so we know

3139
02:00:00,470 --> 01:59:58,480
what pieces can tolerate

3140
02:00:02,149 --> 02:00:00,480
so we know how sensitive they are and

3141
02:00:04,790 --> 02:00:02,159
then we've used some very sophisticated

3142
02:00:07,350 --> 02:00:04,800
computer modeling tools to simulate

3143
02:00:08,950 --> 02:00:07,360
the jovian radiation its impact on the

3144
02:00:11,350 --> 02:00:08,960
vault what gets through and what that

3145
02:00:12,790 --> 02:00:11,360
does to the individual pieces so that's

3146
02:00:14,149 --> 02:00:12,800
that's how that's done excellent

3147
02:00:15,830 --> 02:00:14,159
question

3148
02:00:18,390 --> 02:00:15,840
chris while we're taking q a did you

3149
02:00:19,669 --> 02:00:18,400
want to pass the samples around there's

3150
02:00:22,629 --> 02:00:19,679
a way that people can see them

3151
02:00:24,390 --> 02:00:22,639
absolutely we'll give you a hand

3152
02:00:26,790 --> 02:00:24,400
here's a solar array

3153
02:00:29,189 --> 02:00:26,800
i do need that back

3154
02:00:31,510 --> 02:00:29,199
please

3155
02:00:33,270 --> 02:00:31,520
and then here is some tungsten aluminum

3156
02:00:34,310 --> 02:00:33,280
and titanium

3157
02:00:36,229 --> 02:00:34,320
again

3158
02:00:37,750 --> 02:00:36,239
aluminum and titanium are pretty common

3159
02:00:39,030 --> 02:00:37,760
for spacecraft the tungsten is a little

3160
02:00:45,109 --> 02:00:39,040
bit different it's very close to

3161
02:00:49,270 --> 02:00:46,709
yes

3162
02:00:50,950 --> 02:00:49,280
hi um i've actually got a question from

3163
02:00:53,430 --> 02:00:50,960

one of my twitter followers who i

3164
02:00:55,830 --> 02:00:53,440
moderate some ustreams with um he wants

3165
02:00:57,589 --> 02:00:55,840
to know how many of the solar cells you

3166
02:00:59,430 --> 02:00:57,599
lose during the mission and the types of

3167
02:01:01,189 --> 02:00:59,440
failures failures you'll see and if it

3168
02:01:02,550 --> 02:01:01,199
hits anything on the way

3169
02:01:03,910 --> 02:01:02,560
we're expecting to lose somewhere

3170
02:01:04,950 --> 02:01:03,920
between five and ten percent of the

3171
02:01:07,030 --> 02:01:04,960
cells

3172
02:01:09,430 --> 02:01:07,040
some of them just die because of age and

3173
02:01:11,350 --> 02:01:09,440
attrition we have cherry picked them to

3174
02:01:13,270 --> 02:01:11,360
try to get the very best ones

3175
02:01:16,070 --> 02:01:13,280
we also lose a few to what's called

3176
02:01:18,149 --> 02:01:16,080
micrometeoroids the little bits of dust

3177
02:01:20,470 --> 02:01:18,159
that are in interstellar space

3178
02:01:23,109 --> 02:01:20,480
and those things actually can impact the

3179
02:01:25,430 --> 02:01:23,119
glass and etch the glass and

3180
02:01:26,950 --> 02:01:25,440
lose the cell that way we may also take

3181
02:01:27,830 --> 02:01:26,960
a break in one of the wires by one of

3182
02:01:30,629 --> 02:01:27,840
these

3183
02:01:32,470 --> 02:01:30,639
micrometeoroids so we do plan to lose

3184
02:01:35,109 --> 02:01:32,480
some solar cells

3185
02:01:37,109 --> 02:01:35,119
we do provide extra power capability

3186
02:01:39,270 --> 02:01:37,119
for that eventuality so that after we

3187
02:01:41,669 --> 02:01:39,280
have lost the cells we're going to we

3188
02:01:44,070 --> 02:01:41,679

can still get the mission done

3189
02:01:46,550 --> 02:01:44,080
question here in the back yes

3190
02:01:48,950 --> 02:01:46,560
uh space rated uh electronics tend to be

3191
02:01:50,950 --> 02:01:48,960
pretty old so like what is the power

3192
02:01:53,109 --> 02:01:50,960
levels of the computers on here like

3193
02:01:54,550 --> 02:01:53,119
compared to you know a modern personal

3194
02:01:56,229 --> 02:01:54,560
computer kind of thing

3195
02:01:58,870 --> 02:01:56,239
actually our flight computers are very

3196
02:02:00,629 --> 02:01:58,880
modern they're power pc based it's uh

3197
02:02:03,189 --> 02:02:00,639
it's a radiation hard chip called the

3198
02:02:06,310 --> 02:02:03,199
rad 750 and it's very comparable to

3199
02:02:09,030 --> 02:02:06,320
what's in a mac right now the overall

3200
02:02:11,750 --> 02:02:09,040
flight computers uh use about 30 watts

3201
02:02:14,149 --> 02:02:11,760
of power each one so they're not you

3202
02:02:15,430 --> 02:02:14,159
know overly constrained we actually do

3203
02:02:17,830 --> 02:02:15,440
have a lot of state-of-the-art

3204
02:02:18,790 --> 02:02:17,840
electronics in there now for a couple of

3205
02:02:21,189 --> 02:02:18,800
reasons

3206
02:02:22,870 --> 02:02:21,199
one the uh we need the radiation

3207
02:02:24,629 --> 02:02:22,880
tolerance and and

3208
02:02:26,709 --> 02:02:24,639
you need you need that for this mission

3209
02:02:28,070 --> 02:02:26,719
more than anything else and two because

3210
02:02:29,830 --> 02:02:28,080
the mission is so long we need high

3211
02:02:32,149 --> 02:02:29,840
reliability parts we need to make sure

3212
02:02:35,430 --> 02:02:32,159
these things are going to last and not

3213
02:02:37,750 --> 02:02:35,440

fail before the end of the mission

3214
02:02:39,270 --> 02:02:37,760
question here on the side

3215
02:02:40,390 --> 02:02:39,280
yes

3216
02:02:42,709 --> 02:02:40,400
uh what

3217
02:02:44,550 --> 02:02:42,719
what what is the

3218
02:02:45,750 --> 02:02:44,560
what kind of fail safes have been put

3219
02:02:46,470 --> 02:02:45,760
into

3220
02:02:50,550 --> 02:02:46,480
the

3221
02:02:52,229 --> 02:02:50,560
something catastrophic goes wrong i mean

3222
02:02:53,990 --> 02:02:52,239
we had problems with the mars rovers

3223
02:02:55,910 --> 02:02:54,000
where it basically just went to sleep

3224
02:02:57,350 --> 02:02:55,920
and we kind of like hoped that you know

3225
02:02:59,189 --> 02:02:57,360
something would the system would

3226
02:03:01,109 --> 02:02:59,199
basically restart itself i mean if we

3227
02:03:03,350 --> 02:03:01,119
completely lose everything

3228
02:03:05,030 --> 02:03:03,360
and juno vanishes

3229
02:03:10,629 --> 02:03:05,040
what is it going to do to become

3230
02:03:14,790 --> 02:03:13,109
that's an excellent question

3231
02:03:15,910 --> 02:03:14,800
this spacecraft is designed to take care

3232
02:03:18,790 --> 02:03:15,920
of itself

3233
02:03:20,629 --> 02:03:18,800
it's it's almost self-aware um it's not

3234
02:03:23,109 --> 02:03:20,639
got artificial intelligence on it but it

3235
02:03:25,910 --> 02:03:23,119
does constantly monitor its health its

3236
02:03:28,149 --> 02:03:25,920
status we have whole pieces of software

3237
02:03:29,910 --> 02:03:28,159
and whole whole chips that do nothing

3238
02:03:31,990 --> 02:03:29,920

but make sure that the spacecraft is

3239
02:03:33,350 --> 02:03:32,000
okay and that everything is working the

3240
02:03:35,109 --> 02:03:33,360
way it's supposed to

3241
02:03:37,030 --> 02:03:35,119
it is what we call

3242
02:03:39,830 --> 02:03:37,040
dual string design so it has two

3243
02:03:42,070 --> 02:03:39,840
complete sets of avionics the sensors

3244
02:03:45,270 --> 02:03:42,080
are cross-strapped so computer a can

3245
02:03:46,470 --> 02:03:45,280
talk to this the star camera a or b same

3246
02:03:48,629 --> 02:03:46,480
thing with the inertial measurement

3247
02:03:50,709 --> 02:03:48,639
units everything's cross strap so that

3248
02:03:52,550 --> 02:03:50,719
if you have an issue

3249
02:03:54,629 --> 02:03:52,560
the computer who is currently running

3250
02:03:57,270 --> 02:03:54,639
can talk to all the other components on

3251
02:03:59,189 --> 02:03:57,280
the spacecraft we also have a pretty

3252
02:04:01,990 --> 02:03:59,199
neat setup that has been evolving for

3253
02:04:04,229 --> 02:04:02,000
our planetary spacecraft back from mro

3254
02:04:06,229 --> 02:04:04,239
all the way back to the magellan days

3255
02:04:08,069 --> 02:04:06,239
where if one computer gets in trouble

3256
02:04:09,990 --> 02:04:08,079
the system is designed to take that

3257
02:04:11,510 --> 02:04:10,000
computer off and bring the other one up

3258
02:04:13,910 --> 02:04:11,520
and the other one comes up in what's

3259
02:04:15,990 --> 02:04:13,920
called safe mode and that's a very happy

3260
02:04:18,550 --> 02:04:16,000
place for the spacecraft where it just

3261
02:04:20,229 --> 02:04:18,560
sits there it goes to a minimum power it

3262
02:04:22,550 --> 02:04:20,239
points to the sun to make sure that it's

3263
02:04:24,310 --> 02:04:22,560

got lots of power available and it waits

3264
02:04:26,310 --> 02:04:24,320
for the ground to come in and figure it

3265
02:04:28,310 --> 02:04:26,320
out and that's really important for this

3266
02:04:29,510 --> 02:04:28,320
mission because if something does happen

3267
02:04:31,830 --> 02:04:29,520
at jupiter

3268
02:04:33,350 --> 02:04:31,840
it takes the spacecraft an hour

3269
02:04:34,950 --> 02:04:33,360
for that information to get back to

3270
02:04:36,550 --> 02:04:34,960
earth because of the one-way lifetime

3271
02:04:38,390 --> 02:04:36,560
we're that far away you just can't get

3272
02:04:40,229 --> 02:04:38,400
your head around how far that is

3273
02:04:42,229 --> 02:04:40,239
so when the ground sees a problem it'll

3274
02:04:44,790 --> 02:04:42,239
take the ground guys probably a few

3275
02:04:46,790 --> 02:04:44,800
hours at best to figure out what to do

3276
02:04:48,149 --> 02:04:46,800
and they send some commands up there's

3277
02:04:49,510 --> 02:04:48,159
another hour just to get back to the

3278
02:04:50,950 --> 02:04:49,520
spacecraft

3279
02:04:52,709 --> 02:04:50,960
by that time

3280
02:04:54,229 --> 02:04:52,719
the spacecraft could have been long dead

3281
02:04:56,390 --> 02:04:54,239
and that's something that we we don't

3282
02:04:58,149 --> 02:04:56,400
want so we've purposely designed this

3283
02:05:00,390 --> 02:04:58,159
thing to take care of itself giving it

3284
02:05:02,069 --> 02:05:00,400
lots of redundancy and the the

3285
02:05:04,470 --> 02:05:02,079
fail-safes that it can jump to the other

3286
02:05:05,830 --> 02:05:04,480
side if necessary

3287
02:05:07,589 --> 02:05:05,840
let me pause see if there are any

3288
02:05:09,910 --> 02:05:07,599

questions on that side nope we got one

3289
02:05:12,149 --> 02:05:09,920
right here yep

3290
02:05:13,830 --> 02:05:12,159
hey uh how much uh and what kind of

3291
02:05:15,910 --> 02:05:13,840
engineering data is sent back at a

3292
02:05:17,510 --> 02:05:15,920
regular basis and is it constantly sent

3293
02:05:20,310 --> 02:05:17,520
back is it sent back in

3294
02:05:22,709 --> 02:05:20,320
packets every couple of hours the answer

3295
02:05:25,510 --> 02:05:22,719
is yes yes and yes

3296
02:05:27,510 --> 02:05:25,520
we have almost 30 000 individual

3297
02:05:29,430 --> 02:05:27,520
telemetry parameters that can beam back

3298
02:05:31,910 --> 02:05:29,440
from the spacecraft we monitor

3299
02:05:34,390 --> 02:05:31,920
everything from temperatures at at the

3300
02:05:35,990 --> 02:05:34,400
end of the instrument boom to how much

3301
02:05:38,229 --> 02:05:36,000
utilization is being used by the

3302
02:05:40,310 --> 02:05:38,239
computer at the time to the individual

3303
02:05:42,310 --> 02:05:40,320
states on the battery cells

3304
02:05:44,149 --> 02:05:42,320
there's a pretty sophisticated system

3305
02:05:45,350 --> 02:05:44,159
inside which takes all of these

3306
02:05:47,270 --> 02:05:45,360
measurements

3307
02:05:49,270 --> 02:05:47,280
and beams them back at specific

3308
02:05:51,270 --> 02:05:49,280
intervals and specific frequencies some

3309
02:05:53,109 --> 02:05:51,280
things were much more interested

3310
02:05:55,270 --> 02:05:53,119
than other things because they change

3311
02:05:56,950 --> 02:05:55,280
slower or perhaps it's more important

3312
02:05:58,470 --> 02:05:56,960
temperatures generally come back once a

3313
02:05:59,910 --> 02:05:58,480

minute because temperatures just don't

3314
02:06:01,430 --> 02:05:59,920
change that fast

3315
02:06:02,950 --> 02:06:01,440
during the middle of a burn you're

3316
02:06:04,870 --> 02:06:02,960
really interested in delta v that's

3317
02:06:07,270 --> 02:06:04,880
being accumulated we'll send that back

3318
02:06:09,030 --> 02:06:07,280
at 100 millisecond intervals so it

3319
02:06:11,270 --> 02:06:09,040
really depends on what part of the

3320
02:06:13,270 --> 02:06:11,280
mission is what's going on and what

3321
02:06:14,629 --> 02:06:13,280
instrumentation is important

3322
02:06:16,550 --> 02:06:14,639
the telemetry system is also

3323
02:06:17,910 --> 02:06:16,560
programmable so if we see something we

3324
02:06:20,149 --> 02:06:17,920
learn something about the spacecraft

3325
02:06:22,310 --> 02:06:20,159
while it's in flight we can change when

3326
02:06:24,069 --> 02:06:22,320
information comes back we can change how

3327
02:06:26,229 --> 02:06:24,079
fast it comes back in case we need to

3328
02:06:28,830 --> 02:06:26,239
look at something or something else or

3329
02:06:31,669 --> 02:06:28,840
something more frequently so it's very

3330
02:06:37,430 --> 02:06:31,679
flexible okay question here in the back

3331
02:06:43,270 --> 02:06:41,030
oh sorry hi um i have a question about

3332
02:06:45,510 --> 02:06:43,280
um we all are kind of aware of the rich

3333
02:06:47,030 --> 02:06:45,520
history that nasa possesses with space

3334
02:06:48,629 --> 02:06:47,040
probes from

3335
02:06:51,990 --> 02:06:48,639
pioneer

3336
02:06:53,589 --> 02:06:52,000
to a voyager to the more modern missions

3337
02:06:55,109 --> 02:06:53,599
is there anything specific you can think

3338
02:06:57,910 --> 02:06:55,119

of that you may have learned from

3339
02:06:59,750 --> 02:06:57,920
previous missions to jupiter that you

3340
02:07:04,550 --> 02:06:59,760
can apply to

3341
02:07:07,990 --> 02:07:06,310
the easiest one of course is galileo

3342
02:07:10,470 --> 02:07:08,000
because galileo gave us some very good

3343
02:07:12,709 --> 02:07:10,480
radiation data about the planet it

3344
02:07:14,470 --> 02:07:12,719
didn't get as close as juno is going to

3345
02:07:15,910 --> 02:07:14,480
get but it gave us an excellent idea of

3346
02:07:17,430 --> 02:07:15,920
what to expect when we get there

3347
02:07:18,709 --> 02:07:17,440
radiation wise

3348
02:07:22,069 --> 02:07:18,719
some of the other missions that we've

3349
02:07:24,149 --> 02:07:22,079
flown odyssey mro stardust we've

3350
02:07:26,069 --> 02:07:24,159
incorporated numerous lessons learned

3351
02:07:27,510 --> 02:07:26,079
from them everything from the type of

3352
02:07:29,830 --> 02:07:27,520
battery we use we're now using a

3353
02:07:31,589 --> 02:07:29,840
lithium-ion battery on this as opposed

3354
02:07:33,030 --> 02:07:31,599
to nicads which were used back on

3355
02:07:35,430 --> 02:07:33,040
magellan and

3356
02:07:37,669 --> 02:07:35,440
in the old days if you will

3357
02:07:39,990 --> 02:07:37,679
computer software that's constantly

3358
02:07:42,870 --> 02:07:40,000
evolving we've been evolving essentially

3359
02:07:45,510 --> 02:07:42,880
the same core set of software from again

3360
02:07:47,350 --> 02:07:45,520
the old days of magellan if you will all

3361
02:07:49,830 --> 02:07:47,360
the way through up and into this bird

3362
02:07:51,750 --> 02:07:49,840
now and and the stuff that is in juno

3363
02:07:53,510 --> 02:07:51,760

now is being

3364
02:07:55,910 --> 02:07:53,520
constantly involved lessons learned for

3365
02:07:57,910 --> 02:07:55,920
the next missions coming up such as

3366
02:07:59,430 --> 02:07:57,920
maven as an example

3367
02:08:01,109 --> 02:07:59,440
the grail spacecraft that are going to

3368
02:08:03,189 --> 02:08:01,119
launch about a month after we do we

3369
02:08:05,189 --> 02:08:03,199
share a lot of common software with them

3370
02:08:07,109 --> 02:08:05,199
as well so yeah we're always trying to

3371
02:08:09,910 --> 02:08:07,119
learn from the missions that have gone

3372
02:08:11,910 --> 02:08:09,920
in the past and how to fit that into the

3373
02:08:13,669 --> 02:08:11,920
spacecraft especially the the lessons

3374
02:08:18,470 --> 02:08:13,679
learned when when things don't go so

3375
02:08:18,480 --> 02:08:23,589
okay question over here in the middle

3376
02:08:27,910 --> 02:08:25,350
hi um

3377
02:08:29,990 --> 02:08:27,920
in terms of engineering the spacecraft

3378
02:08:32,069 --> 02:08:30,000
what did you expect to be the most

3379
02:08:34,069 --> 02:08:32,079
challenging aspect of it did that

3380
02:08:36,229 --> 02:08:34,079
actually turn out to be the

3381
02:08:38,629 --> 02:08:36,239
the biggest challenge and how did you

3382
02:08:40,870 --> 02:08:38,639
handle it

3383
02:08:42,870 --> 02:08:40,880
wow there's so many of them

3384
02:08:44,709 --> 02:08:42,880
um

3385
02:08:45,990 --> 02:08:44,719
one of the the biggest things that we

3386
02:08:48,149 --> 02:08:46,000
started

3387
02:08:49,109 --> 02:08:48,159
looking at right away was back in phase

3388
02:08:51,270 --> 02:08:49,119

b

3389
02:08:53,189 --> 02:08:51,280
right on the side of the spacecraft here

3390
02:08:55,189 --> 02:08:53,199
on the upper deck we have these two

3391
02:08:56,390 --> 02:08:55,199
cameras they're called stellar reference

3392
02:08:58,790 --> 02:08:56,400
units

3393
02:09:01,030 --> 02:08:58,800
and their whole objective is to figure

3394
02:09:03,669 --> 02:09:01,040
out where we're pointed in in space and

3395
02:09:05,270 --> 02:09:03,679
they do that by looking at the stars as

3396
02:09:06,550 --> 02:09:05,280
we're spinning by

3397
02:09:08,149 --> 02:09:06,560
and we can figure out where we're

3398
02:09:10,149 --> 02:09:08,159
pointed in time based on the star

3399
02:09:11,910 --> 02:09:10,159
pattern that we're looking at

3400
02:09:13,669 --> 02:09:11,920
to make that work for a spinner is a lot

3401
02:09:14,470 --> 02:09:13,679
more complicated than making it work for

3402
02:09:48,229 --> 02:09:14,480
a

3403
02:09:49,750 --> 02:09:48,239
while the whole screen is moving while

3404
02:09:51,510 --> 02:09:49,760
all these stars are streaming by so we

3405
02:09:53,990 --> 02:09:51,520
could actually identify real stars as

3406
02:09:55,990 --> 02:09:54,000
opposed to the noise so we could come up

3407
02:09:57,750 --> 02:09:56,000
with our attitude solutions so we knew

3408
02:09:59,350 --> 02:09:57,760
exactly where we were pointed

3409
02:10:00,950 --> 02:09:59,360
and of course that's critical to folks

3410
02:10:03,910 --> 02:10:00,960
like the magnetometer that are trying to

3411
02:10:05,669 --> 02:10:03,920
map the magnetic field very accurately

3412
02:10:07,750 --> 02:10:05,679
that turned out to be one of the hardest

3413
02:10:09,750 --> 02:10:07,760

initial challenges and thankfully i'm

3414
02:10:11,910 --> 02:10:09,760
able to report that it's it's actually

3415
02:10:13,510 --> 02:10:11,920
working very well and we expect the star

3416
02:10:15,270 --> 02:10:13,520
cameras to have better performance than

3417
02:10:18,709 --> 02:10:15,280
their requirements because it was worked

3418
02:10:21,430 --> 02:10:18,719
so hard so that was good

3419
02:10:26,550 --> 02:10:21,440
chris let's do one more if you can sure

3420
02:10:32,629 --> 02:10:29,430
being that jupiter is so reflective uh

3421
02:10:35,350 --> 02:10:32,639
will juno be able to gather light

3422
02:10:37,990 --> 02:10:35,360
uh for its solar panels and use that

3423
02:10:40,390 --> 02:10:38,000
electricity no um

3424
02:10:42,310 --> 02:10:40,400
we're actually pointed in such a way

3425
02:10:43,350 --> 02:10:42,320
that the solar panels aren't pointed at

3426
02:10:45,109 --> 02:10:43,360
jupiter

3427
02:10:47,109 --> 02:10:45,119
there is some albedo effects and again

3428
02:10:48,790 --> 02:10:47,119
they do affect the optical experiments

3429
02:10:50,229 --> 02:10:48,800
and they do affect the the star cameras

3430
02:10:52,550 --> 02:10:50,239
but because we're spinning we're not

3431
02:10:54,870 --> 02:10:52,560
always looking at at jupiter but for the

3432
02:10:57,430 --> 02:10:54,880
most part if you're the sun

3433
02:10:59,030 --> 02:10:57,440
the spacecraft is pointed like this at

3434
02:11:01,189 --> 02:10:59,040
the sun at the earth almost the whole

3435
02:11:03,990 --> 02:11:01,199
time and it goes around the planet

3436
02:11:07,750 --> 02:11:05,270
and it's always pointed in that

3437
02:11:10,950 --> 02:11:07,760
direction so it never stares at the at

3438
02:11:12,709 --> 02:11:10,960

the planet per se okay let's have a big

3439
02:11:24,550 --> 02:11:12,719
round of applause for chris ferocious

3440
02:11:28,229 --> 02:11:26,470
samples

3441
02:11:35,510 --> 02:11:28,239
or chris please find chris you've got

3442
02:11:39,030 --> 02:11:36,950
so that's going to wrap it for today's

3443
02:11:40,709 --> 02:11:39,040
speaking portion of the

3444
02:11:42,390 --> 02:11:40,719
live webcast event we want to thank

3445
02:11:43,669 --> 02:11:42,400
everyone for being here with us big

3446
02:11:51,750 --> 02:11:43,679
thanks to all our speakers if we could

3447
02:11:55,189 --> 02:11:53,189
and thanks to everyone who joined us at

3448
02:11:57,030 --> 02:11:55,199
home uh we encourage you to keep

3449
02:11:59,270 --> 02:11:57,040
continuing the conversation with us at

3450
02:12:00,550 --> 02:11:59,280
www.twitter.com

3451
02:12:02,790 --> 02:12:00,560
forward slash

3452
02:12:04,790 --> 02:12:02,800
nasa tweet up following the nasa tweet

3453
02:12:05,990 --> 02:12:04,800
up hashtag as well as juno and we hope

3454
02:12:07,910 --> 02:12:06,000
you'll be watching with us tomorrow

3455
02:12:10,470 --> 02:12:07,920
we're all excited about seeing a launch

3456
02:12:12,550 --> 02:12:10,480
the window opens at 11 34 eastern

3457
02:12:14,870 --> 02:12:12,560
tomorrow august 5th so we hope you'll be

3458
02:12:16,069 --> 02:12:14,880
uh watching along with us on nasa.gov

3459
02:12:17,589 --> 02:12:16,079
and if everybody in the tech could just