1
00:00:09,110 --> 00:00:07,269
good afternoon once again this is the

2
00:00:11,430 --> 00:00:09,120
mission science briefing for the

3
00:00:13,830 --> 00:00:11,440
radiation belt storm probes

4
00:00:16,630 --> 00:00:13,840
and here to talk about the mission

5
00:00:21,109 --> 00:00:16,640
is mona kessel the rbsp program

6
00:00:26,710 --> 00:00:23,990
nikki fox the rbsp deputy project

7
00:00:30,870 --> 00:00:26,720
scientist from the johns hopkins applied

8
00:00:39,110 --> 00:00:33,830
harlan spence principal investigator

9
00:00:45,750 --> 00:00:41,350
craig kletzing principal investigator

10
00:00:50,150 --> 00:00:48,389
and lou lanzarati principal investigator

11
00:00:51,670 --> 00:00:50,160
from the new jersey institute of

12
00:00:54,229 --> 00:00:51,680
technology

13
00:00:56,389 --> 00:00:54,239

and we'll begin first with mona kessel

14
00:00:59,990 --> 00:00:56,399
our program scientist

15
00:01:02,790 --> 00:01:00,000
thank you george so i want to start with

16
00:01:04,710 --> 00:01:02,800
answering a couple of simple questions

17
00:01:08,149 --> 00:01:04,720
and if i could see my first graphic

18
00:01:10,230 --> 00:01:08,159
please i want to show a cutaway model

19
00:01:12,149 --> 00:01:10,240
of the radiation belts now you've seen

20
00:01:14,550 --> 00:01:12,159
this before because this is our logo

21
00:01:17,990 --> 00:01:14,560
it's been up on a lot of things the two

22
00:01:20,149 --> 00:01:18,000
bright red areas are the radiation belts

23
00:01:21,670 --> 00:01:20,159
you can see that they are encircling

24
00:01:23,590 --> 00:01:21,680
earth and if you can imagine them

25
00:01:25,749 --> 00:01:23,600
wrapping around what they look like is a

26
00:01:29,190 --> 00:01:25,759
couple of donut shaped

27
00:01:31,749 --> 00:01:29,200
regions and these regions are full of

28
00:01:33,670 --> 00:01:31,759
very high energy particles and they're

29
00:01:37,350 --> 00:01:33,680
in these regions because they're trapped

30
00:01:40,950 --> 00:01:37,360
by earth's magnetic field they exist

31
00:01:43,350 --> 00:01:40,960
from about 650 miles above the surface

32
00:01:46,550 --> 00:01:43,360
and they go out that's the inner belt it

33
00:01:49,270 --> 00:01:46,560
goes out to about 8 000 miles and then

34
00:01:52,630 --> 00:01:49,280
the outer belt starts about 12 000 goes

35
00:01:55,429 --> 00:01:52,640
out to about 25 000. now that's in a

36
00:01:57,670 --> 00:01:55,439
normal situation but when we get solar

37
00:01:59,190 --> 00:01:57,680
storms and we've heard about some solar

38
00:02:01,590 --> 00:01:59,200

storms when we get those then the

39
00:02:03,910 --> 00:02:01,600
radiation belts can expand in fact quite

40
00:02:04,910 --> 00:02:03,920
a bit the inner belt can come down as

41
00:02:08,469 --> 00:02:04,920
close as

42
00:02:12,229 --> 00:02:08,479
125 miles above the surface of the earth

43
00:02:14,710 --> 00:02:12,239
and that means that the international

44
00:02:17,430 --> 00:02:14,720
space station crosses through it and

45
00:02:19,030 --> 00:02:17,440
other low orbiting satellites and the

46
00:02:21,030 --> 00:02:19,040
outer belt does the same thing it

47
00:02:22,949 --> 00:02:21,040
expands outward and that means that

48
00:02:24,630 --> 00:02:22,959
geosynchronous satellites that are there

49
00:02:27,830 --> 00:02:24,640
and there are about 300 of them out

50
00:02:30,229 --> 00:02:27,840
there those are also then encompassed by

51
00:02:32,630 --> 00:02:30,239
the radiation belts so these belts

52
00:02:34,790 --> 00:02:32,640
provide some hazard to the assets that

53
00:02:36,710 --> 00:02:34,800
are out there but now having said that i

54
00:02:39,430 --> 00:02:36,720
want to take you back in time back to

55
00:02:41,910 --> 00:02:39,440
the 1950s to the dawn of the space age

56
00:02:45,030 --> 00:02:41,920
because the radiation belts were the

57
00:02:47,990 --> 00:02:45,040
very first discovery of the space age

58
00:02:49,990 --> 00:02:48,000
and if i can get the next picture please

59
00:02:52,790 --> 00:02:50,000
then i'm showing a picture of four of

60
00:02:55,030 --> 00:02:52,800
the pioneering scientists of the time

61
00:02:57,750 --> 00:02:55,040
starting left to right carl mcelwain

62
00:02:58,550 --> 00:02:57,760
james van allen george ludwig and ernie

63
00:03:00,949 --> 00:02:58,560

ray

64
00:03:02,550 --> 00:03:00,959
so these four men were instrumental in a

65
00:03:04,710 --> 00:03:02,560
lot of the early science and in

66
00:03:07,830 --> 00:03:04,720
particular van allen second from the

67
00:03:09,190 --> 00:03:07,840
left he was lecturing widely around the

68
00:03:11,270 --> 00:03:09,200
country he was trying to get people

69
00:03:13,910 --> 00:03:11,280
interested in science doing science in

70
00:03:16,790 --> 00:03:13,920
space in particular because he he wanted

71
00:03:18,550 --> 00:03:16,800
to study cosmic rays and the few

72
00:03:21,589 --> 00:03:18,560
sounding rocket missions that had gone

73
00:03:23,190 --> 00:03:21,599
before they went up they'd be above the

74
00:03:24,949 --> 00:03:23,200
atmosphere for a few seconds and then

75
00:03:27,990 --> 00:03:24,959
they come back down so a satellite would

76
00:03:30,710 --> 00:03:28,000
provide so much more information and so

77
00:03:33,110 --> 00:03:30,720
he teamed up with george ludwig to build

78
00:03:35,750 --> 00:03:33,120
the instrument a simple geiger counter

79
00:03:36,869 --> 00:03:35,760
and with pickering and von braun

80
00:03:39,030 --> 00:03:36,879
which

81
00:03:41,750 --> 00:03:39,040
if you see the next one you can we can

82
00:03:43,750 --> 00:03:41,760
look at a picture of them this is at the

83
00:03:46,630 --> 00:03:43,760
press conference after their successful

84
00:03:49,910 --> 00:03:46,640
launch they put the rocket up it

85
00:03:52,789 --> 00:03:49,920
launched in 1958 and it was a success

86
00:03:54,309 --> 00:03:52,799
and an important event around the around

87
00:03:57,190 --> 00:03:54,319
the whole world international and

88
00:03:58,789 --> 00:03:57,200

national significance so as soon as they

89
00:04:00,550 --> 00:03:58,799
got that data back they started

90
00:04:02,070 --> 00:04:00,560
analyzing it and at the same time

91
00:04:04,789 --> 00:04:02,080
they're preparing explore two and

92
00:04:07,270 --> 00:04:04,799
explorer three for launch and those went

93
00:04:08,869 --> 00:04:07,280
up soon afterwards but as they're

94
00:04:11,429 --> 00:04:08,879
looking at that data

95
00:04:13,910 --> 00:04:11,439
it's it's perplexing because there are

96
00:04:14,949 --> 00:04:13,920
no counts in some regions so why was

97
00:04:16,949 --> 00:04:14,959
that

98
00:04:18,469 --> 00:04:16,959
it was it was confusing we didn't know

99
00:04:21,110 --> 00:04:18,479
why and so

100
00:04:22,150 --> 00:04:21,120
they go into the lab and they start to

101
00:04:24,070 --> 00:04:22,160
look at it

102
00:04:26,870 --> 00:04:24,080
carl mcelwain in particular he's in

103
00:04:29,510 --> 00:04:26,880
there he's he's bombarding the counter

104
00:04:32,790 --> 00:04:29,520
with te with charged particles and he

105
00:04:34,870 --> 00:04:32,800
finds that 25 000 counts per second and

106
00:04:37,670 --> 00:04:34,880
he gets that many in there then indeed

107
00:04:40,070 --> 00:04:37,680
the geiger counter shows zero so now

108
00:04:42,310 --> 00:04:40,080
there's a different question because now

109
00:04:44,469 --> 00:04:42,320
it's a case of okay we have lots of

110
00:04:46,310 --> 00:04:44,479
counts we have a thousand times more

111
00:04:48,150 --> 00:04:46,320
than the cosmic rays that we had

112
00:04:50,230 --> 00:04:48,160
estimated that we have

113
00:04:52,230 --> 00:04:50,240

so there were more

114
00:04:54,230 --> 00:04:52,240
rockets that went up there were in fact

115
00:04:56,870 --> 00:04:54,240
in a period of 15 months there were

116
00:05:00,150 --> 00:04:56,880
about nine that went up so explore four

117
00:05:02,550 --> 00:05:00,160
and pioneer three they went further out

118
00:05:05,510 --> 00:05:02,560
and they were able to see the outer belt

119
00:05:07,189 --> 00:05:05,520
so they started analyzing the the four

120
00:05:09,590 --> 00:05:07,199
that i showed you the picture of they're

121
00:05:11,670 --> 00:05:09,600
analyzing the data and they're trying to

122
00:05:14,870 --> 00:05:11,680
to put it by latitude longitude and

123
00:05:17,029 --> 00:05:14,880
altitude and they draw a map and if you

124
00:05:19,110 --> 00:05:17,039
can see the next slide you can see that

125
00:05:20,870 --> 00:05:19,120
a picture on the left hand side of the

126
00:05:23,029 --> 00:05:20,880
map they drew and you can see that this

127
00:05:26,230 --> 00:05:23,039
is an early picture of the radiation

128
00:05:28,230 --> 00:05:26,240
belts and van allen had deduced that

129
00:05:31,430 --> 00:05:28,240
there was trapped particle there and

130
00:05:33,270 --> 00:05:31,440
this discovery of the of the magnetic

131
00:05:35,110 --> 00:05:33,280
trapped radiation got him on the cover

132
00:05:37,670 --> 00:05:35,120
of time magazine

133
00:05:40,070 --> 00:05:37,680
so later satellites as you've heard a

134
00:05:42,390 --> 00:05:40,080
little bit of crests and one called

135
00:05:44,150 --> 00:05:42,400
sampex which i want to show a picture

136
00:05:46,950 --> 00:05:44,160
actually a movie of sampex now if we

137
00:05:49,670 --> 00:05:46,960
could show that shows how dynamic the

138
00:05:51,909 --> 00:05:49,680

area was we had no idea back in the 50s

139
00:05:54,629 --> 00:05:51,919
that it would be this dynamic you can

140
00:05:56,150 --> 00:05:54,639
see the red regions again they represent

141
00:05:58,790 --> 00:05:56,160
areas where there are lots of charged

142
00:06:01,110 --> 00:05:58,800
particles you can see at lots of times

143
00:06:03,189 --> 00:06:01,120
that there are two distinct areas these

144
00:06:05,430 --> 00:06:03,199
are the two belts but sometimes the

145
00:06:07,350 --> 00:06:05,440
outer region almost goes away

146
00:06:09,430 --> 00:06:07,360
and then sometimes it almost fills in

147
00:06:12,230 --> 00:06:09,440
the whole region so what we have is a

148
00:06:14,070 --> 00:06:12,240
very very dynamic situation and with

149
00:06:16,550 --> 00:06:14,080
only the one satellite either in the

150
00:06:19,189 --> 00:06:16,560
case of sampecs or in the case of crests

151
00:06:22,550 --> 00:06:19,199
they couldn't figure out and unravel

152
00:06:24,390 --> 00:06:22,560
what was really going on up here why why

153
00:06:27,430 --> 00:06:24,400
sometimes it's extreme and sometimes

154
00:06:29,189 --> 00:06:27,440
it's not that's a job for rbsp so what

155
00:06:31,110 --> 00:06:29,199
we have here is a kind of weather and

156
00:06:33,430 --> 00:06:31,120
we've talked about this before it's

157
00:06:35,990 --> 00:06:33,440
something we call space weather and if

158
00:06:36,950 --> 00:06:36,000
you show the next graphic then you can

159
00:06:38,469 --> 00:06:36,960
see

160
00:06:41,110 --> 00:06:38,479
a picture of things that we've already

161
00:06:44,070 --> 00:06:41,120
mentioned before single event upsets

162
00:06:47,990 --> 00:06:44,080
charging discharging solar panels can be

163
00:06:50,390 --> 00:06:48,000

degraded when on orbit so we have we

164
00:06:52,790 --> 00:06:50,400
have these these weather

165
00:06:54,710 --> 00:06:52,800
assets or these satellites that are

166
00:06:57,430 --> 00:06:54,720
really affected by what's happening in

167
00:06:59,589 --> 00:06:57,440
space weather and we are very dependent

168
00:07:02,790 --> 00:06:59,599
on our assets in space so this becomes

169
00:07:04,870 --> 00:07:02,800
more important rbsp will address one

170
00:07:07,110 --> 00:07:04,880
area of this it will look at what's

171
00:07:09,670 --> 00:07:07,120
going on off with the satellites and

172
00:07:11,510 --> 00:07:09,680
assess the damage that's um well not the

173
00:07:13,589 --> 00:07:11,520
damage to individual satellites but the

174
00:07:14,550 --> 00:07:13,599
measurements that could cause that

175
00:07:16,790 --> 00:07:14,560
so

176
00:07:18,710 --> 00:07:16,800
we are going to with rbsp both

177
00:07:21,510 --> 00:07:18,720
satellites will be broadcasting space

178
00:07:23,670 --> 00:07:21,520
weather data 24 7 whenever they're not

179
00:07:26,629 --> 00:07:23,680
doing science data and that data will be

180
00:07:28,950 --> 00:07:26,639
collected by ground stations on in the

181
00:07:32,469 --> 00:07:28,960
u.s and also around the world and if you

182
00:07:34,309 --> 00:07:32,479
could show my final graphic this is a

183
00:07:36,230 --> 00:07:34,319
ground station that was built by the

184
00:07:39,350 --> 00:07:36,240
korea astronomy and space science

185
00:07:41,430 --> 00:07:39,360
institute especially to capture rbsp

186
00:07:43,670 --> 00:07:41,440
data and so they're one of our partners

187
00:07:45,909 --> 00:07:43,680
we have other partners around the world

188
00:07:49,189 --> 00:07:45,919

and with with these ground stations and

189
00:07:50,790 --> 00:07:49,199
their help we rbsp will be able to

190
00:07:53,270 --> 00:07:50,800
predict

191
00:07:54,790 --> 00:07:53,280
the extremes and the dynamic conditions

192
00:07:57,350 --> 00:07:54,800
of space weather

193
00:08:00,230 --> 00:07:57,360
and that with that george thank you mona

194
00:08:01,990 --> 00:08:00,240
and now to nikki fox the rbsp deputy

195
00:08:04,070 --> 00:08:02,000
project scientist from the applied

196
00:08:07,029 --> 00:08:04,080
physics laboratory thank you george

197
00:08:09,189 --> 00:08:07,039
so um mona's just done a really nice job

198
00:08:11,589 --> 00:08:09,199
of explaining where the radiation belts

199
00:08:12,950 --> 00:08:11,599
are and and how we know that they are

200
00:08:15,189 --> 00:08:12,960
changing

201
00:08:17,110 --> 00:08:15,199
the the difficult thing for us to work

202
00:08:18,950 --> 00:08:17,120
out is why they're changing why they

203
00:08:21,430 --> 00:08:18,960
change different times to seemingly

204
00:08:24,150 --> 00:08:21,440
similar drivers um we know that

205
00:08:27,430 --> 00:08:24,160
variations in the sun create strong

206
00:08:30,150 --> 00:08:27,440
geomagnetic storms here at earth

207
00:08:32,709 --> 00:08:30,160
and but what we don't understand is how

208
00:08:34,709 --> 00:08:32,719
we really truly respond to them

209
00:08:36,949 --> 00:08:34,719
the earth responds to what's coming from

210
00:08:39,589 --> 00:08:36,959
the sun so we say if the sun sneezes the

211
00:08:41,829 --> 00:08:39,599
earth catches a cold and if we could run

212
00:08:43,350 --> 00:08:41,839
my first movie please what you can see

213
00:08:45,430 --> 00:08:43,360

here is kind of some of the symptoms of

214
00:08:46,870 --> 00:08:45,440
the cold you're looking at the radiation

215
00:08:48,470 --> 00:08:46,880
belts and how are they how they're

216
00:08:50,310 --> 00:08:48,480
responding to the sun

217
00:08:52,150 --> 00:08:50,320
the uh the red and green dots that you

218
00:08:53,590 --> 00:08:52,160
can see kind of zipping in and out there

219
00:08:55,910 --> 00:08:53,600
are actually representing the two

220
00:08:57,430 --> 00:08:55,920
spacecraft and you can see them cutting

221
00:08:59,110 --> 00:08:57,440
first through the inner belt and then

222
00:09:01,430 --> 00:08:59,120
going out through the outer belt in a

223
00:09:03,430 --> 00:09:01,440
nice highly elliptical orbit here's the

224
00:09:06,310 --> 00:09:03,440
storm that's just hit the trace at the

225
00:09:07,750 --> 00:09:06,320
top there is giving you an idea of when

226
00:09:09,030 --> 00:09:07,760
you see that big dip the storm has

227
00:09:11,350 --> 00:09:09,040
arrived and you can see that the

228
00:09:14,949 --> 00:09:11,360
radiation belts respond very very

229
00:09:17,590 --> 00:09:14,959
strongly to the arrival of that storm

230
00:09:20,070 --> 00:09:17,600
these this movie is available on the

231
00:09:22,070 --> 00:09:20,080
rbsp and the nasa websites and if you do

232
00:09:23,990 --> 00:09:22,080
watch it in its entirety you'll see that

233
00:09:26,389 --> 00:09:24,000
the response to the two different storm

234
00:09:27,509 --> 00:09:26,399
events is actually quite different thank

235
00:09:33,430 --> 00:09:27,519
you

236
00:09:35,509 --> 00:09:33,440
coming from the sun and the radiation

237
00:09:37,990 --> 00:09:35,519
belts pump up they get much larger in

238
00:09:40,150 --> 00:09:38,000

size and much larger in energy other

239
00:09:41,910 --> 00:09:40,160
times they actually shrink and almost go

240
00:09:44,389 --> 00:09:41,920
away and then there are times when the

241
00:09:46,630 --> 00:09:44,399
radiation belts seem to not know that

242
00:09:48,829 --> 00:09:46,640
anything has happened so if we can go to

243
00:09:51,670 --> 00:09:48,839
the next slide please

244
00:09:53,590 --> 00:09:51,680
um when it comes to radiation belts we

245
00:09:56,550 --> 00:09:53,600
are not alone uh

246
00:09:58,949 --> 00:09:56,560
all of the large magnetized planets in

247
00:10:02,069 --> 00:09:58,959
our solar system have radiation bulk

248
00:10:04,870 --> 00:10:02,079
structures so jupiter saturn uranus

249
00:10:07,590 --> 00:10:04,880
neptune all have radiation regions very

250
00:10:09,190 --> 00:10:07,600
similar to to what we see at earth and

251
00:10:11,509 --> 00:10:09,200
the processes that are causing these

252
00:10:13,590 --> 00:10:11,519
radiation belts are the same

253
00:10:15,110 --> 00:10:13,600
at the other planets as they are for us

254
00:10:17,030 --> 00:10:15,120
if you look at the graphic the bottom

255
00:10:19,829 --> 00:10:17,040
two panels represent the earth and also

256
00:10:22,230 --> 00:10:19,839
the radiation regions at jupiter so we

257
00:10:24,949 --> 00:10:22,240
know fundamental particle acceleration

258
00:10:27,670 --> 00:10:24,959
is going on at each of these planets it

259
00:10:30,310 --> 00:10:27,680
is also going on the same processes that

260
00:10:32,630 --> 00:10:30,320
cause acceleration in the solar wind and

261
00:10:35,030 --> 00:10:32,640
also more than um

262
00:10:37,670 --> 00:10:35,040
6 000 light years away that are causing

263
00:10:40,389 --> 00:10:37,680

the crab nebula to glow in x-rays it's

264
00:10:41,910 --> 00:10:40,399
all fundamental particle acceleration so

265
00:10:43,910 --> 00:10:41,920
i always like to describe the mission as

266
00:10:47,430 --> 00:10:43,920
a fundamental science mission that has

267
00:10:49,430 --> 00:10:47,440
really strong practical applications

268
00:10:51,430 --> 00:10:49,440
so we know what processes are going on

269
00:10:54,069 --> 00:10:51,440
in the radiation belts we know it's

270
00:10:55,590 --> 00:10:54,079
almost like having a building making a

271
00:10:58,069 --> 00:10:55,600
cake you know all the ingredients but

272
00:11:00,790 --> 00:10:58,079
you're not quite sure of the proportions

273
00:11:03,430 --> 00:11:00,800
of each piece in each given storm

274
00:11:05,509 --> 00:11:03,440
sometimes one process is far great is

275
00:11:07,670 --> 00:11:05,519
far more dominant than another and that

276
00:11:11,110 --> 00:11:07,680
is obviously causing the radiation belts

277
00:11:13,829 --> 00:11:11,120
to um respond differently to seemingly

278
00:11:17,509 --> 00:11:13,839
similar things coming from the sun

279
00:11:18,949 --> 00:11:17,519
if we go back to uh the the um

280
00:11:22,069 --> 00:11:18,959
movie please

281
00:11:24,310 --> 00:11:22,079
so rbsp was designed to answer the

282
00:11:26,389 --> 00:11:24,320
questions of how these radiation belts

283
00:11:29,190 --> 00:11:26,399
are responding we do that by really

284
00:11:31,430 --> 00:11:29,200
looking at three different areas one why

285
00:11:33,829 --> 00:11:31,440
the radiation belts are pumping up or

286
00:11:36,069 --> 00:11:33,839
increasing one why the particles are

287
00:11:38,230 --> 00:11:36,079
lost from them because they do return to

288
00:11:40,870 --> 00:11:38,240

their pre-storm states

289
00:11:42,470 --> 00:11:40,880
and then how the ring current which uh

290
00:11:44,150 --> 00:11:42,480
harlan will be talking about more in a

291
00:11:45,030 --> 00:11:44,160
moment how that

292
00:11:46,630 --> 00:11:45,040
is

293
00:11:48,790 --> 00:11:46,640
associated with the radiation belt

294
00:11:49,750 --> 00:11:48,800
changes and how one is affecting the

295
00:11:52,629 --> 00:11:49,760
other

296
00:11:53,590 --> 00:11:52,639
so we have two spacecraft that um are on

297
00:11:56,389 --> 00:11:53,600
orbit

298
00:11:58,389 --> 00:11:56,399
the reason we need two is uh not just

299
00:12:00,069 --> 00:11:58,399
because it's better than one but

300
00:12:01,910 --> 00:12:00,079
actually because we they really are

301
00:12:03,990 --> 00:12:01,920
doing a job at looking at these

302
00:12:05,670 --> 00:12:04,000
different processes trying to find out

303
00:12:07,750 --> 00:12:05,680
whether they're changing in time or

304
00:12:10,310 --> 00:12:07,760
whether they're changing in space so if

305
00:12:11,990 --> 00:12:10,320
you imagine sitting on a life raft in

306
00:12:14,150 --> 00:12:12,000
the ocean and you suddenly go down and

307
00:12:15,509 --> 00:12:14,160
come up again you don't know very much

308
00:12:17,030 --> 00:12:15,519
about what caused you to go down and

309
00:12:18,790 --> 00:12:17,040
come up if you have a friend that is

310
00:12:20,790 --> 00:12:18,800
sitting on a life raft a little little

311
00:12:22,230 --> 00:12:20,800
way away you can say well do we both go

312
00:12:24,550 --> 00:12:22,240
down and up at the same time in which

313
00:12:26,470 --> 00:12:24,560

it's a big scale feature like a tsunami

314
00:12:29,110 --> 00:12:26,480
did one of us go down and then the other

315
00:12:31,430 --> 00:12:29,120
one it how how far apart did we see that

316
00:12:33,350 --> 00:12:31,440
feature did it grow did it shrink and

317
00:12:35,269 --> 00:12:33,360
you can really start to look at the

318
00:12:38,069 --> 00:12:35,279
global dynamics of what's happening in

319
00:12:39,430 --> 00:12:38,079
the radiation belts so that's why why we

320
00:12:41,190 --> 00:12:39,440
have two

321
00:12:43,350 --> 00:12:41,200
we do have them lapping so that

322
00:12:46,150 --> 00:12:43,360
sometimes they're very close together

323
00:12:48,629 --> 00:12:46,160
they can be as close as 100 miles apart

324
00:12:50,629 --> 00:12:48,639
and other times they're separated

325
00:12:55,110 --> 00:12:50,639
by a distance of about three earth

326
00:12:56,710 --> 00:12:55,120
diameters so about 23 000 24 000 miles

327
00:12:58,150 --> 00:12:56,720
so that's allowing one to be in the

328
00:13:00,230 --> 00:12:58,160
inner belt while the other is in the

329
00:13:02,230 --> 00:13:00,240
outer belt so that you can you know do

330
00:13:03,990 --> 00:13:02,240
sort of cause an effect see if the inner

331
00:13:07,350 --> 00:13:04,000
belt is responding to the changes in the

332
00:13:10,069 --> 00:13:07,360
outer belt also um the the highly

333
00:13:12,069 --> 00:13:10,079
elliptical orbit uh does allow us to cut

334
00:13:15,509 --> 00:13:12,079
through the heart of both the inner and

335
00:13:18,069 --> 00:13:15,519
the outer radiation belt um

336
00:13:20,230 --> 00:13:18,079
the uh why why do you have to get up at

337
00:13:21,590 --> 00:13:20,240
408 in the morning

338
00:13:23,190 --> 00:13:21,600

it's not just because the weather is

339
00:13:25,269 --> 00:13:23,200
likely to be better at that time in

340
00:13:26,629 --> 00:13:25,279
florida it was actually chosen very

341
00:13:29,110 --> 00:13:26,639
specifically

342
00:13:31,350 --> 00:13:29,120
to allow us to get the highest possible

343
00:13:33,430 --> 00:13:31,360
science return from the mission

344
00:13:35,430 --> 00:13:33,440
when we want when we start the the

345
00:13:37,670 --> 00:13:35,440
mission we want the the point that is

346
00:13:40,310 --> 00:13:37,680
furthest from the earth or the apogee to

347
00:13:43,030 --> 00:13:40,320
be at local dawn and then as the

348
00:13:45,590 --> 00:13:43,040
two-year mission uh continues that point

349
00:13:48,470 --> 00:13:45,600
actually walks all the way around so it

350
00:13:50,949 --> 00:13:48,480
will go to every single local region it

351
00:13:53,430 --> 00:13:50,959
will take us two years to do a full

352
00:13:54,870 --> 00:13:53,440
sweep of all of the radiation region and

353
00:13:57,110 --> 00:13:54,880
the most important thing is it will

354
00:13:59,990 --> 00:13:57,120
allow us to do the the dawn to the

355
00:14:01,430 --> 00:14:00,000
midnight sweep twice in that two years

356
00:14:03,750 --> 00:14:01,440
and that is where

357
00:14:04,550 --> 00:14:03,760
certainly it's one of the most dynamic

358
00:14:08,310 --> 00:14:04,560
uh

359
00:14:11,110 --> 00:14:08,320
that's where everyone's very interested

360
00:14:13,509 --> 00:14:11,120
in so that will be sampled twice

361
00:14:15,750 --> 00:14:13,519
the other big new capability that we

362
00:14:18,310 --> 00:14:15,760
have are just the wonderful science

363
00:14:21,269 --> 00:14:18,320

instruments that we fly the spacecraft

364
00:14:23,750 --> 00:14:21,279
are identical um so we can do really

365
00:14:26,069 --> 00:14:23,760
good collaborating uh measurements

366
00:14:27,670 --> 00:14:26,079
between the two spacecraft we have

367
00:14:30,230 --> 00:14:27,680
suites of instruments that measure the

368
00:14:31,670 --> 00:14:30,240
particles the full spectrum of energies

369
00:14:35,030 --> 00:14:31,680
right the way down from the cold dense

370
00:14:37,350 --> 00:14:35,040
plasma up to the very very high energy

371
00:14:39,590 --> 00:14:37,360
uh protons in the inner belt

372
00:14:41,350 --> 00:14:39,600
which we're very grateful to uh the

373
00:14:43,670 --> 00:14:41,360
national reconnaissance office for

374
00:14:45,430 --> 00:14:43,680
teaming with us and providing a detector

375
00:14:47,189 --> 00:14:45,440
that really is focusing on that inner

376
00:14:48,470 --> 00:14:47,199
belt which has increased the science

377
00:14:50,550 --> 00:14:48,480
that we can do

378
00:14:52,710 --> 00:14:50,560
we also have instruments that measure uh

379
00:14:55,910 --> 00:14:52,720
the magnetic and the electric fields

380
00:14:57,110 --> 00:14:55,920
around the earth so i'm pleased that i

381
00:14:58,870 --> 00:14:57,120
don't have to go into that anymore

382
00:15:00,710 --> 00:14:58,880
because we have our experts here so

383
00:15:02,470 --> 00:15:00,720
george that's enough from me all right

384
00:15:04,870 --> 00:15:02,480
thank you nikki

385
00:15:06,710 --> 00:15:04,880
our next scientist is harlan spence who

386
00:15:09,189 --> 00:15:06,720
was the principal investigator from the

387
00:15:11,750 --> 00:15:09,199
university of new hampshire harlan

388
00:15:14,710 --> 00:15:11,760

thank you george it's truly my delight

389
00:15:16,310 --> 00:15:14,720
to be here after working on this mission

390
00:15:19,030 --> 00:15:16,320
to its roots uh

391
00:15:19,990 --> 00:15:19,040
far back to actually the late 90s in my

392
00:15:22,230 --> 00:15:20,000
case

393
00:15:23,430 --> 00:15:22,240
to be on the cusp of a launch is truly

394
00:15:27,269 --> 00:15:23,440
exciting

395
00:15:29,509 --> 00:15:27,279
going after a long-standing set of

396
00:15:31,670 --> 00:15:29,519
mysteries in the radiation belt with

397
00:15:33,189 --> 00:15:31,680
instrumentation that will

398
00:15:35,749 --> 00:15:33,199
be fundamentally i believe

399
00:15:37,590 --> 00:15:35,759
transformational and allow us to make

400
00:15:39,189 --> 00:15:37,600
answer old questions but also to make

401
00:15:42,310 --> 00:15:39,199
new discoveries

402
00:15:45,350 --> 00:15:42,320
if i could have the first slide please

403
00:15:47,590 --> 00:15:45,360
this is a model of the spacecraft and if

404
00:15:49,670 --> 00:15:47,600
you could add the instruments now i'd

405
00:15:52,629 --> 00:15:49,680
like to talk to you about the particle

406
00:15:54,310 --> 00:15:52,639
instruments that are on the rbsp

407
00:15:55,430 --> 00:15:54,320
spacecraft

408
00:15:57,189 --> 00:15:55,440
there are

409
00:15:59,509 --> 00:15:57,199
eight different instruments per

410
00:16:02,550 --> 00:15:59,519
spacecraft and we need eight because

411
00:16:04,470 --> 00:16:02,560
we're measuring across this huge energy

412
00:16:07,030 --> 00:16:04,480
range that nikki mentioned from

413
00:16:08,949 --> 00:16:07,040

particles that are very very low energy

414
00:16:12,069 --> 00:16:08,959
in our units we talk about going down to

415
00:16:14,230 --> 00:16:12,079
one electron volt very low energy to

416
00:16:17,670 --> 00:16:14,240
particles that are moving near the speed

417
00:16:19,829 --> 00:16:17,680
of light at billions of electron volts

418
00:16:21,829 --> 00:16:19,839
huge energy range we have to cover in

419
00:16:24,470 --> 00:16:21,839
addition we're looking at different

420
00:16:27,670 --> 00:16:24,480
species we're looking at protons

421
00:16:29,829 --> 00:16:27,680
electrons helium and oxygen ions

422
00:16:31,430 --> 00:16:29,839
so we have a suite of instruments and

423
00:16:32,230 --> 00:16:31,440
several suites of instruments there are

424
00:16:34,550 --> 00:16:32,240
eight

425
00:16:37,030 --> 00:16:34,560
individual instruments per spacecraft in

426
00:16:39,590 --> 00:16:37,040
three different investigations

427
00:16:41,189 --> 00:16:39,600
the first investigation is called ect

428
00:16:43,590 --> 00:16:41,199
that stands for energetic particle

429
00:16:45,829 --> 00:16:43,600
composition and thermal plasma and there

430
00:16:47,269 --> 00:16:45,839
are three different flavors of ect

431
00:16:48,550 --> 00:16:47,279
instruments that you can see there one

432
00:16:50,949 --> 00:16:48,560
is called hope

433
00:16:53,509 --> 00:16:50,959
one is called and that stands for helium

434
00:16:55,670 --> 00:16:53,519
oxygen protons and electrons

435
00:16:57,670 --> 00:16:55,680
the second is called mag ice and that

436
00:16:58,949 --> 00:16:57,680
stands for magnetic electron ion

437
00:17:01,110 --> 00:16:58,959
spectrometer

438
00:17:03,030 --> 00:17:01,120

and at the highest energy range uh

439
00:17:04,949 --> 00:17:03,040
there's the the last of the ect

440
00:17:07,189 --> 00:17:04,959
instruments is called rept that stands

441
00:17:08,949 --> 00:17:07,199
for relativistic electron and proton

442
00:17:11,110 --> 00:17:08,959
telescope

443
00:17:12,949 --> 00:17:11,120
also on the sp each spacecraft is an

444
00:17:15,350 --> 00:17:12,959
instrument called rb spice that's the

445
00:17:17,750 --> 00:17:15,360
radiation belt storm probes ion

446
00:17:20,309 --> 00:17:17,760
composition experiment and that

447
00:17:23,750 --> 00:17:20,319
instrument is looking at

448
00:17:25,270 --> 00:17:23,760
of the ions that create the ring current

449
00:17:27,590 --> 00:17:25,280
the last instrument is the one that

450
00:17:29,990 --> 00:17:27,600
nikki referred to from the nro that's

451
00:17:32,549 --> 00:17:30,000
called rps and that's the relativistic

452
00:17:34,710 --> 00:17:32,559
proton spectrometer i'll talk a little

453
00:17:37,190 --> 00:17:34,720
bit more about these later on in terms

454
00:17:40,230 --> 00:17:37,200
of what science they will accomplish

455
00:17:41,590 --> 00:17:40,240
next i'd like to to move on to

456
00:17:43,190 --> 00:17:41,600
talk about some of the challenges we

457
00:17:45,510 --> 00:17:43,200
have with these instruments

458
00:17:47,190 --> 00:17:45,520
this is a incredibly harsh radiation

459
00:17:48,950 --> 00:17:47,200
environment and we're trying to make

460
00:17:50,630 --> 00:17:48,960
these detailed measurements across the

461
00:17:52,150 --> 00:17:50,640
energy range and across the different

462
00:17:53,909 --> 00:17:52,160
species of particles that we need to

463
00:17:55,909 --> 00:17:53,919

answer the science questions but we're

464
00:17:57,990 --> 00:17:55,919
doing that in the presence of this just

465
00:17:59,990 --> 00:17:58,000
penetrating radiation

466
00:18:01,590 --> 00:18:00,000
so we have fantastic instruments that

467
00:18:03,510 --> 00:18:01,600
are designed to do that one of the

468
00:18:06,070 --> 00:18:03,520
things we have to do in addition to the

469
00:18:08,310 --> 00:18:06,080
energy and species is to understand the

470
00:18:09,750 --> 00:18:08,320
directionality of the ins of the arrival

471
00:18:11,590 --> 00:18:09,760
of the particles into the instruments

472
00:18:13,430 --> 00:18:11,600
and if i could have uh the next slide

473
00:18:15,110 --> 00:18:13,440
please

474
00:18:16,789 --> 00:18:15,120
just a quick lesson

475
00:18:18,230 --> 00:18:16,799
charged particles in the presence of a

476
00:18:20,150 --> 00:18:18,240
magnetic field

477
00:18:22,070 --> 00:18:20,160
have different motions there's a from

478
00:18:24,470 --> 00:18:22,080
left to right a gyro motion the particle

479
00:18:26,150 --> 00:18:24,480
will spiral around gyrate around a

480
00:18:31,590 --> 00:18:26,160
magnetic field

481
00:18:33,990 --> 00:18:31,600
narrowing at different locations they

482
00:18:36,310 --> 00:18:34,000
can bounce between these reflection

483
00:18:37,510 --> 00:18:36,320
points and then lastly they can drift

484
00:18:40,150 --> 00:18:37,520
across the field line so we have

485
00:18:41,190 --> 00:18:40,160
gyration around bounce along and drift

486
00:18:43,430 --> 00:18:41,200
across

487
00:18:45,029 --> 00:18:43,440
in the next slide here's how those

488
00:18:47,350 --> 00:18:45,039

motions are

489
00:18:49,110 --> 00:18:47,360
realized in earth's magnetic field so

490
00:18:51,270 --> 00:18:49,120
now you can see the earth you can see a

491
00:18:53,110 --> 00:18:51,280
green colored magnetic field line

492
00:18:55,430 --> 00:18:53,120
through the radiation belt and you can

493
00:18:57,510 --> 00:18:55,440
see this complicated trajectory

494
00:18:59,750 --> 00:18:57,520
in that one dimension

495
00:19:01,350 --> 00:18:59,760
you can also see uh near the equator of

496
00:19:03,590 --> 00:19:01,360
the earth the directions of how the

497
00:19:05,510 --> 00:19:03,600
different particle species drift across

498
00:19:08,230 --> 00:19:05,520
the magnetic field line

499
00:19:10,549 --> 00:19:08,240
the next movie will bring this to life

500
00:19:12,549 --> 00:19:10,559
it's kind of hard to see it in

501
00:19:14,630 --> 00:19:12,559
two dimensions but if i could have this

502
00:19:17,270 --> 00:19:14,640
movie which shows a particle now

503
00:19:19,350 --> 00:19:17,280
gyrating along this blue now magnetic

504
00:19:20,950 --> 00:19:19,360
field line and as we pan back

505
00:19:23,110 --> 00:19:20,960
you can see that it's traveling along a

506
00:19:24,870 --> 00:19:23,120
magnetic field line

507
00:19:26,470 --> 00:19:24,880
and as it gets closer to the planet

508
00:19:29,190 --> 00:19:26,480
those field lines are bunching together

509
00:19:31,029 --> 00:19:29,200
and it will reflect it will bounce back

510
00:19:32,549 --> 00:19:31,039
but in reality it's in three dimensions

511
00:19:33,909 --> 00:19:32,559
we're now looking from the north pole

512
00:19:36,230 --> 00:19:33,919
and you can see that that particle is

513
00:19:38,470 --> 00:19:36,240

drifting around the earth while it's

514
00:19:39,990 --> 00:19:38,480
doing this complicated motion it's sort

515
00:19:41,510 --> 00:19:40,000
of like rubbing your stomach and patting

516
00:19:43,669 --> 00:19:41,520
your head it's got all these motions

517
00:19:45,190 --> 00:19:43,679
going on at the same time that was one

518
00:19:47,110 --> 00:19:45,200
particle but now take trillions and

519
00:19:49,510 --> 00:19:47,120
trillions and trillions of them they

520
00:19:51,750 --> 00:19:49,520
fill the radiation belt all moving in

521
00:19:53,430 --> 00:19:51,760
these complicated directions part of our

522
00:19:55,029 --> 00:19:53,440
job is to make those measurements of the

523
00:19:56,630 --> 00:19:55,039
directionality

524
00:19:59,270 --> 00:19:56,640
why do we measure them

525
00:20:01,270 --> 00:19:59,280
to me a key element we've heard before

526
00:20:03,590 --> 00:20:01,280
in terms of space weather

527
00:20:06,549 --> 00:20:03,600
is that killer killer electrons are

528
00:20:08,549 --> 00:20:06,559
space weathers villains they are

529
00:20:10,149 --> 00:20:08,559
fantastic things to observe from from

530
00:20:12,470 --> 00:20:10,159
the point of view of the physics there's

531
00:20:14,070 --> 00:20:12,480
this cosmic accelerator literally above

532
00:20:15,830 --> 00:20:14,080
our heads that's taking these particles

533
00:20:17,990 --> 00:20:15,840
and bringing them near to the speed of

534
00:20:19,590 --> 00:20:18,000
light but they also can inflict damage

535
00:20:21,830 --> 00:20:19,600
that we've heard about

536
00:20:25,590 --> 00:20:21,840
so one of the primary measurements we'll

537
00:20:28,070 --> 00:20:25,600
make with the rbsp mission are these

538
00:20:30,230 --> 00:20:28,080

relativistic electrons in the outer

539
00:20:32,789 --> 00:20:30,240
radiation belt that are at this very

540
00:20:34,710 --> 00:20:32,799
very high energy we do that with the mag

541
00:20:35,909 --> 00:20:34,720
ice and the rept instruments that i

542
00:20:37,669 --> 00:20:35,919
talked about

543
00:20:40,149 --> 00:20:37,679
in the inner belt

544
00:20:42,470 --> 00:20:40,159
we have trap populations of the

545
00:20:44,789 --> 00:20:42,480
relativistic protons and these have been

546
00:20:47,190 --> 00:20:44,799
very poorly explored in the past and

547
00:20:49,830 --> 00:20:47,200
that's where the rps instrument

548
00:20:52,149 --> 00:20:49,840
will be flourishing i'd like to go to

549
00:20:53,909 --> 00:20:52,159
the next movie if i would

550
00:20:56,789 --> 00:20:53,919
and talk a little bit about what the

551
00:20:59,110 --> 00:20:56,799
lower energy plasma particles do this is

552
00:21:00,870 --> 00:20:59,120
a movie from the image spacecraft of a

553
00:21:03,110 --> 00:21:00,880
region called the ring current and here

554
00:21:05,750 --> 00:21:03,120
we're using a technique of remotely

555
00:21:07,430 --> 00:21:05,760
sensing that from a spacecraft far away

556
00:21:09,909 --> 00:21:07,440
the region that you see illuminated is

557
00:21:12,230 --> 00:21:09,919
co-located with the radiation belt and

558
00:21:14,710 --> 00:21:12,240
this region is bristling with electrical

559
00:21:17,750 --> 00:21:14,720
currents that disturb inflate and

560
00:21:19,110 --> 00:21:17,760
deflate the magnetic fields that control

561
00:21:21,029 --> 00:21:19,120
how these

562
00:21:23,909 --> 00:21:21,039
very energetic particles in the outer

563
00:21:25,590 --> 00:21:23,919

zone are operating so we need not only

564
00:21:27,590 --> 00:21:25,600
to measure the high energy particles but

565
00:21:29,590 --> 00:21:27,600
also the medium and low energy particles

566
00:21:32,710 --> 00:21:29,600
that's the medium within which the

567
00:21:35,190 --> 00:21:32,720
radiation belts exist

568
00:21:36,950 --> 00:21:35,200
lastly i'd like to show a movie that

569
00:21:37,990 --> 00:21:36,960
essentially is the baby pictures of our

570
00:21:41,430 --> 00:21:38,000
instruments

571
00:21:43,270 --> 00:21:41,440
and if you could cue that role

572
00:21:45,430 --> 00:21:43,280
it shows the different instruments as

573
00:21:47,830 --> 00:21:45,440
they were coming to the spacecraft

574
00:21:50,070 --> 00:21:47,840
here's the mag ice instrument they all

575
00:21:52,710 --> 00:21:50,080
have you'll see single apertures and

576
00:21:55,110 --> 00:21:52,720
they go on to the spacecraft in

577
00:21:57,669 --> 00:21:55,120
specific locations as that first visual

578
00:21:59,190 --> 00:21:57,679
showed but i also told you that we need

579
00:22:01,190 --> 00:21:59,200
to be able to see particles as they

580
00:22:02,950 --> 00:22:01,200
arrive from all directions

581
00:22:05,990 --> 00:22:02,960
this is where the spacecraft spin that

582
00:22:09,510 --> 00:22:06,000
you heard about is critically important

583
00:22:11,590 --> 00:22:09,520
the spacecraft's spin rate is

584
00:22:13,990 --> 00:22:11,600
five roughly five rpm so that means

585
00:22:15,750 --> 00:22:14,000
every 12 seconds as these apertures that

586
00:22:18,549 --> 00:22:15,760
are fixed locations on the spacecraft

587
00:22:21,029 --> 00:22:18,559
spin around we map out the sky and are

588
00:22:23,270 --> 00:22:21,039

able to build up this comprehensive

589
00:22:24,230 --> 00:22:23,280
picture of particle motion needed to

590
00:22:26,710 --> 00:22:24,240
answer

591
00:22:28,149 --> 00:22:26,720
the fundamental uh questions that become

592
00:22:30,710 --> 00:22:28,159
practical

593
00:22:33,190 --> 00:22:30,720
so i would just conclude by saying that

594
00:22:35,350 --> 00:22:33,200
rbsp in a sense will be going right to

595
00:22:37,909 --> 00:22:35,360
the scene of the crime to watch the

596
00:22:39,590 --> 00:22:37,919
radiation belt particles in action

597
00:22:41,350 --> 00:22:39,600
along with their accomplishment

598
00:22:43,029 --> 00:22:41,360
accomplices what is it that accelerates

599
00:22:44,630 --> 00:22:43,039
these particles it's the electric and

600
00:22:46,149 --> 00:22:44,640
magnetic fields that exist and are

601
00:22:48,070 --> 00:22:46,159
co-located that determine their

602
00:22:50,390 --> 00:22:48,080
quote-unquote bad behavior

603
00:22:52,950 --> 00:22:50,400
so uh many scientists have worked hard

604
00:22:54,630 --> 00:22:52,960
and long to get us to this point

605
00:22:55,990 --> 00:22:54,640
we're very grateful for the teams that

606
00:22:57,110 --> 00:22:56,000
have built these particle instruments

607
00:22:57,990 --> 00:22:57,120
that are um

608
00:23:00,630 --> 00:22:58,000
will

609
00:23:02,950 --> 00:23:00,640
are outstanding and like never before in

610
00:23:05,029 --> 00:23:02,960
two two locations it will be fantastic

611
00:23:07,830 --> 00:23:05,039
the science team stands ready we're

612
00:23:09,110 --> 00:23:07,840
eager anticipating and uh very excited

613
00:23:11,029 --> 00:23:09,120

about the launch

614
00:23:13,110 --> 00:23:11,039
thank you george thank you harlan

615
00:23:15,350 --> 00:23:13,120
our next presentation will be from craig

616
00:23:17,830 --> 00:23:15,360
cletzing the principal investigator from

617
00:23:19,029 --> 00:23:17,840
the university of iowa greg

618
00:23:20,470 --> 00:23:19,039
so as harlan has mentioned we've all

619
00:23:22,549 --> 00:23:20,480
been working on this for quite a while

620
00:23:24,470 --> 00:23:22,559
now we proposed oh

621
00:23:26,310 --> 00:23:24,480
more than half a decade ago and let me

622
00:23:27,669 --> 00:23:26,320
see more than we are stoked to get this

623
00:23:28,950 --> 00:23:27,679
launched

624
00:23:30,710 --> 00:23:28,960
what i want to talk to you about are the

625
00:23:31,510 --> 00:23:30,720
electric and magnetic field measurements

626
00:23:32,950 --> 00:23:31,520
that we're going to make on the

627
00:23:34,630 --> 00:23:32,960
spacecraft

628
00:23:37,110 --> 00:23:34,640
there are two investigations there's the

629
00:23:39,750 --> 00:23:37,120
electric field and waves investigation

630
00:23:41,510 --> 00:23:39,760
or efw we always use acronyms and then

631
00:23:43,269 --> 00:23:41,520
there's the electric and magnetic field

632
00:23:44,230 --> 00:23:43,279
instrument street suite and integrated

633
00:23:46,390 --> 00:23:44,240
science

634
00:23:48,390 --> 00:23:46,400
or emphasis and those are the two sets

635
00:23:50,470 --> 00:23:48,400
of investigations that will look at the

636
00:23:51,990 --> 00:23:50,480
electric and magnetic fields so if i

637
00:23:53,909 --> 00:23:52,000
take the spacecraft model here i can

638
00:23:55,990 --> 00:23:53,919

show you the sensors that we use for the

639
00:23:58,549 --> 00:23:56,000
electric and magnetic fields we have two

640
00:24:00,230 --> 00:23:58,559
sets of sensors on the ends of the booms

641
00:24:01,830 --> 00:24:00,240
this is our search coil sensor it looks

642
00:24:03,029 --> 00:24:01,840
like sort of three sticks at right

643
00:24:05,190 --> 00:24:03,039
angles to each other we have the

644
00:24:06,789 --> 00:24:05,200
magnetometer sensor up here then you'll

645
00:24:08,630 --> 00:24:06,799
see here are some wire booms that come

646
00:24:10,390 --> 00:24:08,640
out the spacecraft actually spins along

647
00:24:11,990 --> 00:24:10,400
this axis

648
00:24:13,909 --> 00:24:12,000
and um

649
00:24:15,909 --> 00:24:13,919
and so these come out and then we also

650
00:24:17,350 --> 00:24:15,919
have booms that go along the spacecraft

651
00:24:18,870 --> 00:24:17,360
spin axis as well and there's a slide

652
00:24:20,870 --> 00:24:18,880
here which shows the labels of each of

653
00:24:22,710 --> 00:24:20,880
these various different

654
00:24:24,149 --> 00:24:22,720
sensors as they come out and so all

655
00:24:25,590 --> 00:24:24,159
these sensors go together to give us a

656
00:24:27,750 --> 00:24:25,600
clear picture of the electric and

657
00:24:29,269 --> 00:24:27,760
magnetic fields now you might say why do

658
00:24:30,710 --> 00:24:29,279
we care about the electric and magnetic

659
00:24:32,549 --> 00:24:30,720
fields well it turns out they're

660
00:24:34,149 --> 00:24:32,559
critical for

661
00:24:35,750 --> 00:24:34,159
the acceleration of the particles as

662
00:24:37,830 --> 00:24:35,760
what pumps up the radiation belts and

663
00:24:39,190 --> 00:24:37,840

makes them bigger and stronger but

664
00:24:40,950 --> 00:24:39,200
they're also important for what causes

665
00:24:43,029 --> 00:24:40,960
the radiation belts to decrease they can

666
00:24:44,549 --> 00:24:43,039
cause particles to get scattered so they

667
00:24:47,269 --> 00:24:44,559
hit the atmosphere and are lost and

668
00:24:48,710 --> 00:24:47,279
never come back and so by measuring

669
00:24:50,470 --> 00:24:48,720
these fields we have the other half of

670
00:24:51,909 --> 00:24:50,480
the puzzle we have the particles as

671
00:24:54,310 --> 00:24:51,919
harlan's described and then we have the

672
00:24:56,470 --> 00:24:54,320
fields that cause them to to change

673
00:24:57,830 --> 00:24:56,480
their behavior now we measure over a

674
00:24:59,029 --> 00:24:57,840
wide range there's a lot of different

675
00:25:00,950 --> 00:24:59,039
kinds of phenomena that we want to

676
00:25:03,110 --> 00:25:00,960
measure with the field measurements from

677
00:25:04,870 --> 00:25:03,120
very low frequency very slowly varying

678
00:25:06,390 --> 00:25:04,880
things up to things as high as hundreds

679
00:25:07,350 --> 00:25:06,400
of kilohertz

680
00:25:08,789 --> 00:25:07,360
and

681
00:25:10,230 --> 00:25:08,799
we need to measure across all these

682
00:25:12,870 --> 00:25:10,240
ranges and that's what the instruments

683
00:25:14,390 --> 00:25:12,880
cover now interestingly enough many of

684
00:25:16,630 --> 00:25:14,400
the important waves that we're going to

685
00:25:18,149 --> 00:25:16,640
measure are actually in the audio range

686
00:25:20,310 --> 00:25:18,159
of the same range as human hearing

687
00:25:22,230 --> 00:25:20,320
they're radio waves but you can actually

688
00:25:23,669 --> 00:25:22,240

play them and listen to them and they

689
00:25:29,669 --> 00:25:23,679
make a sound and so we can listen to a

690
00:25:34,789 --> 00:25:32,710
so this is the noise of space uh this is

691
00:25:35,990 --> 00:25:34,799
a phenomena called chorus and that's

692
00:25:37,750 --> 00:25:36,000
because if you'll notice it sounds sort

693
00:25:38,789 --> 00:25:37,760
of like a chorus of birds early in the

694
00:25:40,870 --> 00:25:38,799
morning you know when they start

695
00:25:42,390 --> 00:25:40,880
chirping as the sun comes up and that

696
00:25:44,230 --> 00:25:42,400
was actually why this phenomenon was

697
00:25:46,390 --> 00:25:44,240
named chorus people uh measured this

698
00:25:47,909 --> 00:25:46,400
early on and said ah that kind of sounds

699
00:25:49,590 --> 00:25:47,919
like birds and so this is one of the key

700
00:25:51,830 --> 00:25:49,600
wave modes that we're going to measure

701
00:25:53,510 --> 00:25:51,840
to try to understand uh what's going on

702
00:25:55,110 --> 00:25:53,520
now as i said there's a zoo of different

703
00:25:57,669 --> 00:25:55,120
waves so we have a slide that sort of

704
00:25:58,710 --> 00:25:57,679
shows the various different waves here

705
00:26:00,070 --> 00:25:58,720
and you can see there are all these

706
00:26:01,269 --> 00:26:00,080
different locations i won't go into the

707
00:26:03,029 --> 00:26:01,279
details of what all these different

708
00:26:04,549 --> 00:26:03,039
waves are but i think one of the cool

709
00:26:06,710 --> 00:26:04,559
things about the radiation belt storm

710
00:26:07,909 --> 00:26:06,720
probes is you'll see the two bigger dots

711
00:26:09,029 --> 00:26:07,919
there that label where the two

712
00:26:10,870 --> 00:26:09,039
spacecraft could be when they're

713
00:26:13,110 --> 00:26:10,880

separated along the orbit and one of the

714
00:26:14,950 --> 00:26:13,120
things we fundamentally do not know is

715
00:26:16,950 --> 00:26:14,960
if one kind of wave is happening in one

716
00:26:18,710 --> 00:26:16,960
place is the same as the same or a

717
00:26:20,630 --> 00:26:18,720
different wave happening elsewhere does

718
00:26:21,909 --> 00:26:20,640
one lead the other or follow the other

719
00:26:23,669 --> 00:26:21,919
does one happen and the other doesn't

720
00:26:25,430 --> 00:26:23,679
happen at all we don't know so this will

721
00:26:27,590 --> 00:26:25,440
be the first time that we've got two

722
00:26:28,950 --> 00:26:27,600
spacecraft with the same instruments so

723
00:26:30,070 --> 00:26:28,960
that we can actually start to figure out

724
00:26:32,070 --> 00:26:30,080
these kinds of questions it's

725
00:26:33,669 --> 00:26:32,080
tremendously exciting to get this kind

726
00:26:34,870 --> 00:26:33,679
of data and put this together and

727
00:26:37,110 --> 00:26:34,880
understand something that we've just

728
00:26:38,870 --> 00:26:37,120
never seen before now when you're making

729
00:26:40,070 --> 00:26:38,880
field measurements you have to worry

730
00:26:41,990 --> 00:26:40,080
about making sure that what you're

731
00:26:43,430 --> 00:26:42,000
measuring is what's in space and not

732
00:26:44,950 --> 00:26:43,440
anything coming from the spacecraft and

733
00:26:46,950 --> 00:26:44,960
that's why we put things out on these

734
00:26:48,789 --> 00:26:46,960
various different booms here and so we

735
00:26:50,310 --> 00:26:48,799
have to check that that stuff works and

736
00:26:52,390 --> 00:26:50,320
so we have a little video clip here of

737
00:26:54,470 --> 00:26:52,400
us checking the deployment of one of the

738
00:26:55,830 --> 00:26:54,480

emphasis sensors that comes out and we

739
00:26:57,750 --> 00:26:55,840
do this what we call a gene negated

740
00:26:59,990 --> 00:26:57,760
deploy and that's where we do the

741
00:27:01,190 --> 00:27:00,000
appropriate things to simulate the fact

742
00:27:02,470 --> 00:27:01,200
that when the boom comes out it's going

743
00:27:04,630 --> 00:27:02,480
to be in space and it won't be

744
00:27:06,710 --> 00:27:04,640
experiencing the effects of gravity

745
00:27:08,470 --> 00:27:06,720
and that test went quite well i should

746
00:27:09,830 --> 00:27:08,480
say of course

747
00:27:12,149 --> 00:27:09,840
you know doing it you've got all this

748
00:27:13,350 --> 00:27:12,159
apparatus to put the

749
00:27:14,870 --> 00:27:13,360
negate the effects of the earth's

750
00:27:16,470 --> 00:27:14,880
gravity so it's actually much more

751
00:27:18,070 --> 00:27:16,480
exciting or much more elegant i should

752
00:27:20,149 --> 00:27:18,080
say to see this in space and so we have

753
00:27:22,310 --> 00:27:20,159
an animation here that shows what that

754
00:27:23,990 --> 00:27:22,320
looks like when they deploy in space and

755
00:27:25,430 --> 00:27:24,000
so you'll see one of the spacecraft sort

756
00:27:27,909 --> 00:27:25,440
of come up here and first the solar

757
00:27:29,350 --> 00:27:27,919
panels come out

758
00:27:31,830 --> 00:27:29,360
and then a little while later you'll see

759
00:27:34,389 --> 00:27:31,840
the the booms come out with the the

760
00:27:35,750 --> 00:27:34,399
emphasis sensors on the end of them

761
00:27:37,909 --> 00:27:35,760
i think this looks a little nicer than

762
00:27:41,269 --> 00:27:37,919
the test but we do the test so that this

763
00:27:42,710 --> 00:27:41,279

happens the way you actually see it here

764
00:27:43,909 --> 00:27:42,720
and so we're really looking forward to

765
00:27:46,149 --> 00:27:43,919
get that going

766
00:27:49,110 --> 00:27:46,159
now

767
00:27:50,389 --> 00:27:49,120
when we do these things we check

768
00:27:52,070 --> 00:27:50,399
everything out make sure everything's

769
00:27:54,070 --> 00:27:52,080
working just fine but we also want to

770
00:27:56,310 --> 00:27:54,080
make sure that the spacecraft

771
00:27:58,549 --> 00:27:56,320
doesn't produce a signature that we see

772
00:27:59,990 --> 00:27:58,559
on our various instruments we say

773
00:28:01,350 --> 00:28:00,000
sometimes we only hear the noise of

774
00:28:03,430 --> 00:28:01,360
space rather than the noise of the

775
00:28:04,549 --> 00:28:03,440
spacecraft and so one of the tests that

776
00:28:06,470 --> 00:28:04,559
we do is we want to make sure that the

777
00:28:07,510 --> 00:28:06,480
magnetic field i mean anything that has

778
00:28:09,110 --> 00:28:07,520
metal and it's going to have some

779
00:28:10,710 --> 00:28:09,120
magnetic field but we do our very best

780
00:28:12,549 --> 00:28:10,720
to minimize that so we want to make sure

781
00:28:14,549 --> 00:28:12,559
the magnetic field of the spacecraft

782
00:28:15,909 --> 00:28:14,559
doesn't show up in our sensors but this

783
00:28:17,669 --> 00:28:15,919
is a tough problem because you're trying

784
00:28:19,669 --> 00:28:17,679
to measure the requirement is that it

785
00:28:21,029 --> 00:28:19,679
has to have one ten thousandth of the

786
00:28:23,430 --> 00:28:21,039
earth's field on the surface of the

787
00:28:25,110 --> 00:28:23,440
earth is what you have to have uh to

788
00:28:26,789 --> 00:28:25,120

meet the requirements to be quiet enough

789
00:28:28,389 --> 00:28:26,799
and so how do you do that well what we

790
00:28:30,310 --> 00:28:28,399
do and i'll show you this clip here is

791
00:28:32,070 --> 00:28:30,320
what we call the swing test what we do

792
00:28:33,430 --> 00:28:32,080
is we take the spacecraft and we hang it

793
00:28:35,029 --> 00:28:33,440
from a big cable you don't see a

794
00:28:37,430 --> 00:28:35,039
spacecraft hanging from a string that

795
00:28:38,230 --> 00:28:37,440
often you pull it back but what we can

796
00:28:39,669 --> 00:28:38,240
see when we measure with the

797
00:28:41,750 --> 00:28:39,679
magnetometer is the part that's

798
00:28:43,269 --> 00:28:41,760
oscillating back and forth has to be due

799
00:28:45,029 --> 00:28:43,279
to the spacecraft it can't come from

800
00:28:46,470 --> 00:28:45,039
anything else and so that way we can

801
00:28:48,230 --> 00:28:46,480
verify that we have a nice clean

802
00:28:49,990 --> 00:28:48,240
spacecraft and everything's doing what

803
00:28:51,510 --> 00:28:50,000
we want it to and in fact we do have a

804
00:28:53,750 --> 00:28:51,520
very clean spacecraft probably one of

805
00:28:54,470 --> 00:28:53,760
the cleanest spacecraft flown

806
00:28:56,230 --> 00:28:54,480
and

807
00:28:58,389 --> 00:28:56,240
finally i'd like to talk about electric

808
00:29:01,590 --> 00:28:58,399
fields now those are even more sensitive

809
00:29:03,190 --> 00:29:01,600
to spacecraft induced effects and so we

810
00:29:04,470 --> 00:29:03,200
want to get the electric field sensors

811
00:29:06,230 --> 00:29:04,480
as far away as we can from the

812
00:29:08,789 --> 00:29:06,240
spacecraft so we let them out on wire

813
00:29:11,190 --> 00:29:08,799

booms that go out a long way in fact the

814
00:29:13,029 --> 00:29:11,200
tip to tip from one end of one probe to

815
00:29:14,789 --> 00:29:13,039
the other is longer than a football

816
00:29:16,310 --> 00:29:14,799
field and those go out along what we

817
00:29:17,269 --> 00:29:16,320
call the spin plane that's the plane in

818
00:29:19,590 --> 00:29:17,279
which the

819
00:29:21,110 --> 00:29:19,600
spacecraft is spinning now you can't do

820
00:29:22,310 --> 00:29:21,120
that though along the spin axis because

821
00:29:24,710 --> 00:29:22,320
there's nothing to pull it out no

822
00:29:27,029 --> 00:29:24,720
centripetal force so there a stacer boom

823
00:29:28,630 --> 00:29:27,039
is used and they go out along the spin

824
00:29:29,750 --> 00:29:28,640
axis to get them as far away as you can

825
00:29:32,230 --> 00:29:29,760
and there's a little clip here that

826
00:29:36,070 --> 00:29:32,240
shows the way the stacers

827
00:29:37,669 --> 00:29:36,080
pop and then the booms extend out along

828
00:29:39,269 --> 00:29:37,679
the spin axes of the spacecraft as you

829
00:29:40,710 --> 00:29:39,279
can see

830
00:29:42,710 --> 00:29:40,720
and so with that we get these

831
00:29:44,070 --> 00:29:42,720
measurements uh we get them away from

832
00:29:46,630 --> 00:29:44,080
the spacecraft we get nice quiet

833
00:29:48,389 --> 00:29:46,640
measurements and that will be measuring

834
00:29:50,149 --> 00:29:48,399
the noise of space rather than the noise

835
00:29:51,669 --> 00:29:50,159
of the spacecraft so we're all very

836
00:29:54,070 --> 00:29:51,679
excited uh we're here you know we've

837
00:29:55,830 --> 00:29:54,080
been working on this for a long time and

838
00:29:57,110 --> 00:29:55,840

it's time to get this in space and get

839
00:29:58,710 --> 00:29:57,120
going

840
00:30:01,110 --> 00:29:58,720
thank you craig

841
00:30:03,430 --> 00:30:01,120
and our last presentation is from lou

842
00:30:05,190 --> 00:30:03,440
lanzarotti the principal investigator

843
00:30:08,549 --> 00:30:05,200
from the new jersey institute of

844
00:30:11,350 --> 00:30:08,559
technology thank you very much well the

845
00:30:13,190 --> 00:30:11,360
rbsp mission is back to the future for

846
00:30:15,190 --> 00:30:13,200
me

847
00:30:16,549 --> 00:30:15,200
it provides an unprecedented opportunity

848
00:30:17,830 --> 00:30:16,559
to arrive at important new

849
00:30:19,029 --> 00:30:17,840
understandings of earth space

850
00:30:21,190 --> 00:30:19,039
environment

851
00:30:22,870 --> 00:30:21,200
this was the exact motivation that

852
00:30:26,549 --> 00:30:22,880
attracted me to this field of research

853
00:30:28,389 --> 00:30:26,559
nearly 50 50 years ago

854
00:30:29,990 --> 00:30:28,399
as the last mission of my career i'm

855
00:30:31,750 --> 00:30:30,000
excited to be able to investigate

856
00:30:33,430 --> 00:30:31,760
earth's radiation belts with

857
00:30:35,269 --> 00:30:33,440
state-of-the-art instrumentation flying

858
00:30:37,029 --> 00:30:35,279
within the belts themselves

859
00:30:39,590 --> 00:30:37,039
seeking answers about fundamental

860
00:30:41,590 --> 00:30:39,600
processes in earth space environment

861
00:30:43,510 --> 00:30:41,600
again the same same kind of questions

862
00:30:45,669 --> 00:30:43,520
that motivated me to join

863
00:30:47,269 --> 00:30:45,679

uh bell laboratories in the space

864
00:30:50,230 --> 00:30:47,279
program nearly 50 years ago as i

865
00:30:52,149 --> 00:30:50,240
indicated i began my career first first

866
00:30:54,310 --> 00:30:52,159
view graph there i began my career at

867
00:30:56,310 --> 00:30:54,320
bell labs in 1965

868
00:30:58,470 --> 00:30:56,320
to work on data analysis from the first

869
00:30:59,590 --> 00:30:58,480
active communication satellite telstar

870
00:31:01,110 --> 00:30:59,600
one

871
00:31:02,630 --> 00:31:01,120
and on the design and building of a

872
00:31:04,630 --> 00:31:02,640
radiation detector instrument for the

873
00:31:07,110 --> 00:31:04,640
first nasa test communication satellite

874
00:31:09,110 --> 00:31:07,120
a geosynchronous orbit ats-1 which we'll

875
00:31:11,269 --> 00:31:09,120
come back to

876
00:31:13,909 --> 00:31:11,279
second slide unfortunately telstar only

877
00:31:15,669 --> 00:31:13,919
operated for approximately eight months

878
00:31:17,509 --> 00:31:15,679
in its low earth orbit

879
00:31:19,830 --> 00:31:17,519
before it was seriously damaged by

880
00:31:21,430 --> 00:31:19,840
massive influxes of radiation

881
00:31:23,190 --> 00:31:21,440
some natural

882
00:31:25,430 --> 00:31:23,200
from the van allen radiation belts and

883
00:31:27,590 --> 00:31:25,440
some man-made from atmospheric nuclear

884
00:31:29,990 --> 00:31:27,600
testing that occurred on the day prior

885
00:31:31,269 --> 00:31:30,000
to the launch of telstar

886
00:31:34,789 --> 00:31:31,279
on july

887
00:31:36,789 --> 00:31:34,799
9th 1962.

888
00:31:38,710 --> 00:31:36,799

the bell labs team that designed and

889
00:31:40,070 --> 00:31:38,720
built and launched the telstar satellite

890
00:31:42,149 --> 00:31:40,080
did not have a clear picture of the

891
00:31:43,430 --> 00:31:42,159
space environment above our planet at

892
00:31:45,029 --> 00:31:43,440
that time

893
00:31:47,909 --> 00:31:45,039
second third slide

894
00:31:49,909 --> 00:31:47,919
before the launch of ats-1 nasa's ats-1

895
00:31:51,509 --> 00:31:49,919
in 1966

896
00:31:53,909 --> 00:31:51,519
which i participated in building an

897
00:31:56,230 --> 00:31:53,919
instrument up for and analyzed much

898
00:31:57,990 --> 00:31:56,240
extensively the data from the radiation

899
00:32:00,070 --> 00:31:58,000
environment at geosynchronous altitude

900
00:32:01,990 --> 00:32:00,080
where all of our modern communication

901
00:32:03,669 --> 00:32:02,000
satellites operate was completely

902
00:32:06,070 --> 00:32:03,679
unknown no measurements had been made

903
00:32:06,870 --> 00:32:06,080
there at that time

904
00:32:09,350 --> 00:32:06,880
next

905
00:32:12,230 --> 00:32:09,360
fourth slide there bern blake who's a

906
00:32:15,029 --> 00:32:12,240
member of the rbsp ect

907
00:32:17,509 --> 00:32:15,039
team instrument team was also a young

908
00:32:19,110 --> 00:32:17,519
physicist who had an instrument also on

909
00:32:20,310 --> 00:32:19,120
ats-1

910
00:32:23,110 --> 00:32:20,320
he and i

911
00:32:25,269 --> 00:32:23,120
are the two rbsp investigators who are

912
00:32:27,509 --> 00:32:25,279
from the very early days of exploration

913
00:32:30,710 --> 00:32:27,519

of earth space environment and that are

914
00:32:32,230 --> 00:32:30,720
back to the future as i indicated

915
00:32:34,630 --> 00:32:32,240
50 years ago

916
00:32:36,470 --> 00:32:34,640
50 years later we understand much more

917
00:32:38,549 --> 00:32:36,480
about the hazards posed by highly

918
00:32:40,710 --> 00:32:38,559
charged particles in the radiation belt

919
00:32:42,870 --> 00:32:40,720
but the fundamental processes that drive

920
00:32:45,029 --> 00:32:42,880
and shape the belts are still poorly

921
00:32:47,190 --> 00:32:45,039
understood as we've heard several times

922
00:32:49,269 --> 00:32:47,200
today

923
00:32:50,789 --> 00:32:49,279
nearly 40 years ago a colleague and i

924
00:32:53,830 --> 00:32:50,799
mike schultz

925
00:32:56,149 --> 00:32:53,840
wrote this textbook on radiation belts

926
00:32:58,310 --> 00:32:56,159
particle diffusion and radiation belts

927
00:33:01,190 --> 00:32:58,320
this was the theory of radiation belts

928
00:33:03,590 --> 00:33:01,200
it's been the theory to today

929
00:33:06,789 --> 00:33:03,600
data from rbsp is finally going to prove

930
00:33:08,310 --> 00:33:06,799
this textbook correct

931
00:33:09,750 --> 00:33:08,320
i expect however we're going to find

932
00:33:11,590 --> 00:33:09,760
some surprises

933
00:33:13,190 --> 00:33:11,600
and maybe we'll if we have the energy

934
00:33:14,549 --> 00:33:13,200
maybe we'll have to revise it i don't

935
00:33:15,830 --> 00:33:14,559
know we've been asked to revise it

936
00:33:17,750 --> 00:33:15,840
several times

937
00:33:20,310 --> 00:33:17,760
we'll see

938
00:33:22,549 --> 00:33:20,320

these mysteries of the

939
00:33:24,549 --> 00:33:22,559
radiation belts and as we described here

940
00:33:26,470 --> 00:33:24,559
40 years ago less than slightly less

941
00:33:27,990 --> 00:33:26,480
than 40 years ago are the focus of our

942
00:33:29,669 --> 00:33:28,000
mission as we've talked about and i'm

943
00:33:30,630 --> 00:33:29,679
pleased to be able to be associated with

944
00:33:33,029 --> 00:33:30,640
it

945
00:33:35,430 --> 00:33:33,039
modern societies and i've spent much my

946
00:33:36,789 --> 00:33:35,440
career involved with applications of

947
00:33:38,789 --> 00:33:36,799
radiation belt research and

948
00:33:40,630 --> 00:33:38,799
communications and thanks modern modern

949
00:33:43,029 --> 00:33:40,640
societies dependence on satellites and

950
00:33:45,190 --> 00:33:43,039
other space-based technologies that must

951
00:33:46,710 --> 00:33:45,200
operate in the belts makes the research

952
00:33:49,990 --> 00:33:46,720
and understanding that will come from

953
00:33:51,590 --> 00:33:50,000
rbsp's data invaluable to building

954
00:33:53,909 --> 00:33:51,600
better protected satellites in the

955
00:33:56,710 --> 00:33:53,919
future for communications

956
00:33:58,789 --> 00:33:56,720
for navigation for remote sensing

957
00:34:01,269 --> 00:33:58,799
and importantly for national security

958
00:34:03,590 --> 00:34:01,279
thank you very much thank you lou

959
00:34:05,269 --> 00:34:03,600
and we're ready now to take questions

960
00:34:07,190 --> 00:34:05,279
please give the name your name and

961
00:34:09,190 --> 00:34:07,200
affiliation when the microphone comes to

962
00:34:10,950 --> 00:34:09,200
you we'll start with marcia marcia done

963
00:34:13,349 --> 00:34:10,960

associated press with a few questions

964
00:34:15,349 --> 00:34:13,359
i'm not sure who to direct this to um i

965
00:34:16,550 --> 00:34:15,359
previously previously asked and i'll ask

966
00:34:18,470 --> 00:34:16,560
again um

967
00:34:20,470 --> 00:34:18,480
you know it's been more than 50 years

968
00:34:22,310 --> 00:34:20,480
since the valley now you know the van

969
00:34:24,710 --> 00:34:22,320
allen belts were discovered

970
00:34:26,389 --> 00:34:24,720
why why take so long to to get to this

971
00:34:28,710 --> 00:34:26,399
point is there any is it because it's

972
00:34:31,510 --> 00:34:28,720
such a challenge complicated

973
00:34:34,149 --> 00:34:31,520
and if somebody could just sort of

974
00:34:36,230 --> 00:34:34,159
compare that original explorer one with

975
00:34:38,389 --> 00:34:36,240
which it's going to be flying in a

976
00:34:40,069 --> 00:34:38,399
couple days

977
00:34:42,069 --> 00:34:40,079
i can maybe speak to the

978
00:34:43,270 --> 00:34:42,079
particle aspect of it maybe colleagues

979
00:34:45,430 --> 00:34:43,280
can add

980
00:34:48,389 --> 00:34:45,440
to it we have

981
00:34:49,829 --> 00:34:48,399
modern microelectronic technologies now

982
00:34:52,230 --> 00:34:49,839
that were the envy would have been the

983
00:34:54,069 --> 00:34:52,240
envy of the early explorers the ability

984
00:34:56,470 --> 00:34:54,079
to pack

985
00:34:59,349 --> 00:34:56,480
highly sophisticated and

986
00:35:02,630 --> 00:34:59,359
capable instruments into a very small

987
00:35:04,390 --> 00:35:02,640
volume and small amount of mass

988
00:35:07,349 --> 00:35:04,400

allows us to do things

989
00:35:09,670 --> 00:35:07,359
even now than better than when we first

990
00:35:11,990 --> 00:35:09,680
proposed the mission so the advances

991
00:35:13,589 --> 00:35:12,000
even in the last five years have been

992
00:35:14,710 --> 00:35:13,599
highly enabling in terms of the kind of

993
00:35:16,390 --> 00:35:14,720
measurements

994
00:35:17,829 --> 00:35:16,400
and a particular challenge as i

995
00:35:20,150 --> 00:35:17,839
mentioned with the particle instruments

996
00:35:21,990 --> 00:35:20,160
is being able to cleanly distinguish the

997
00:35:23,349 --> 00:35:22,000
particle that you're going after

998
00:35:24,790 --> 00:35:23,359
against the

999
00:35:27,030 --> 00:35:24,800
spurious signals you get from the

1000
00:35:29,030 --> 00:35:27,040
penetrating radiation and the

1001
00:35:31,270 --> 00:35:29,040
sophistication of the instrumentation

1002
00:35:34,630 --> 00:35:31,280
again is enabled by this

1003
00:35:36,630 --> 00:35:34,640
advance in terms of the electronics

1004
00:35:38,069 --> 00:35:36,640
maybe i could comment on sort of why is

1005
00:35:40,310 --> 00:35:38,079
it taking a while and i think part of

1006
00:35:42,230 --> 00:35:40,320
the answer is is that we didn't know the

1007
00:35:45,109 --> 00:35:42,240
radiation belts were as interesting as

1008
00:35:47,109 --> 00:35:45,119
they've turned out to be for a long time

1009
00:35:48,870 --> 00:35:47,119
initial measurements for mate lew wrote

1010
00:35:50,790 --> 00:35:48,880
the book and okay we think we have a

1011
00:35:53,270 --> 00:35:50,800
pretty good idea until submissions flew

1012
00:35:54,230 --> 00:35:53,280
about 20 years ago so two decades and

1013
00:35:56,310 --> 00:35:54,240

said

1014
00:35:58,710 --> 00:35:56,320
we looked at that data and it's a little

1015
00:36:00,310 --> 00:35:58,720
more complicated than we thought it was

1016
00:36:02,310 --> 00:36:00,320
but it takes a while to put together a

1017
00:36:03,829 --> 00:36:02,320
mission and those missions didn't have a

1018
00:36:05,349 --> 00:36:03,839
very complete set of instruments they

1019
00:36:07,349 --> 00:36:05,359
had particle measurements and some

1020
00:36:09,589 --> 00:36:07,359
limited field measurements but not what

1021
00:36:11,190 --> 00:36:09,599
you need to do the job correctly and so

1022
00:36:12,550 --> 00:36:11,200
people started working towards this but

1023
00:36:13,670 --> 00:36:12,560
it takes a while to put a mission like

1024
00:36:15,190 --> 00:36:13,680
this together

1025
00:36:16,630 --> 00:36:15,200
and this is a phenomenal set of

1026
00:36:18,150 --> 00:36:16,640
instruments this is the best that's ever

1027
00:36:20,230 --> 00:36:18,160
been flown in the radiation belts and

1028
00:36:23,109 --> 00:36:20,240
we'll make tremendous advances

1029
00:36:25,430 --> 00:36:23,119
and in addition to that we now have two

1030
00:36:27,109 --> 00:36:25,440
satellites that's a very important part

1031
00:36:29,589 --> 00:36:27,119
of this because

1032
00:36:32,230 --> 00:36:29,599
with only one you only know what's going

1033
00:36:34,390 --> 00:36:32,240
on right there at that time what's

1034
00:36:36,150 --> 00:36:34,400
coming across and as nikki described

1035
00:36:38,069 --> 00:36:36,160
already when you have two and especially

1036
00:36:40,550 --> 00:36:38,079
we're going to vary the separation

1037
00:36:42,310 --> 00:36:40,560
distances all along the orbit and

1038
00:36:44,630 --> 00:36:42,320

throughout the mission and so we're

1039
00:36:46,470 --> 00:36:44,640
going to get a feeling for you know okay

1040
00:36:48,550 --> 00:36:46,480
we see it here we don't see it right

1041
00:36:50,310 --> 00:36:48,560
here we see it here we don't see it

1042
00:36:51,910 --> 00:36:50,320
right here but maybe we see something

1043
00:36:54,150 --> 00:36:51,920
over here so

1044
00:36:56,630 --> 00:36:54,160
that whole picture will be built up by

1045
00:36:58,870 --> 00:36:56,640
the variations in the separation

1046
00:37:00,630 --> 00:36:58,880
distances and of course whatever comes

1047
00:37:02,390 --> 00:37:00,640
at us from the sun

1048
00:37:03,910 --> 00:37:02,400
yeah and just just to maybe add to that

1049
00:37:05,829 --> 00:37:03,920
um because i thought somebody else would

1050
00:37:07,270 --> 00:37:05,839
say this but they didn't so i'll say we

1051
00:37:08,950 --> 00:37:07,280
actually now know the questions that we

1052
00:37:10,630 --> 00:37:08,960
want to answer

1053
00:37:12,150 --> 00:37:10,640
so when you know when they were first

1054
00:37:13,910 --> 00:37:12,160
discovered as craig said we thought they

1055
00:37:15,510 --> 00:37:13,920
were just two very stable

1056
00:37:18,870 --> 00:37:15,520
bands of radiation

1057
00:37:20,710 --> 00:37:18,880
in 1991 the air force nasa cress

1058
00:37:22,390 --> 00:37:20,720
spacecraft really showed

1059
00:37:24,310 --> 00:37:22,400
started to show how dynamic they were

1060
00:37:26,230 --> 00:37:24,320
with the discovery of a new belt when a

1061
00:37:28,230 --> 00:37:26,240
big shot came through and suddenly the

1062
00:37:31,270 --> 00:37:28,240
the the gap that should be empty was now

1063
00:37:33,270 --> 00:37:31,280

full um sam pecks picked up and then

1064
00:37:35,910 --> 00:37:33,280
it's actually still working today

1065
00:37:37,829 --> 00:37:35,920
although sadly will um re-enter very

1066
00:37:40,150 --> 00:37:37,839
soon

1067
00:37:42,069 --> 00:37:40,160
was able to really track just how that

1068
00:37:44,150 --> 00:37:42,079
dynamics has changed over 20 you know

1069
00:37:45,910 --> 00:37:44,160
looking at 20 years and also other

1070
00:37:48,069 --> 00:37:45,920
missions that maybe aren't designed to

1071
00:37:50,550 --> 00:37:48,079
look at radiation belts have returned

1072
00:37:52,710 --> 00:37:50,560
really really high quality data that

1073
00:37:54,550 --> 00:37:52,720
when you add to other data sources have

1074
00:37:57,510 --> 00:37:54,560
given us a lot of information and have

1075
00:38:01,030 --> 00:37:57,520
really helped us over the 11 years since

1076
00:38:03,829 --> 00:38:01,040
we did get together in september of 2001

1077
00:38:05,270 --> 00:38:03,839
um to start doing the mission it took a

1078
00:38:06,550 --> 00:38:05,280
number of years to really hone the

1079
00:38:08,790 --> 00:38:06,560
questions

1080
00:38:10,470 --> 00:38:08,800
get the right observations choose the

1081
00:38:12,230 --> 00:38:10,480
right instruments and have the right

1082
00:38:13,829 --> 00:38:12,240
technology in the right place to do the

1083
00:38:15,670 --> 00:38:13,839
do the mission now

1084
00:38:17,670 --> 00:38:15,680
you could just a quick follow is there

1085
00:38:22,470 --> 00:38:17,680
anything on board or in the mission plan

1086
00:38:26,230 --> 00:38:23,910
well we're not allowed to put things on

1087
00:38:32,069 --> 00:38:26,240
the spacecraft that aren't fully blessed

1088
00:38:37,109 --> 00:38:34,870

uh james dean with floor today um miss

1089
00:38:39,270 --> 00:38:37,119
miss kessel perhaps uh since you're

1090
00:38:40,310 --> 00:38:39,280
talking about broadcasting 24 7 i just

1091
00:38:42,150 --> 00:38:40,320
wondered if you might be able to make

1092
00:38:43,750 --> 00:38:42,160
any kind of analogy to

1093
00:38:45,829 --> 00:38:43,760
you know the modern media world in

1094
00:38:47,829 --> 00:38:45,839
general and kind of what this these

1095
00:38:50,630 --> 00:38:47,839
spacecraft will provide

1096
00:38:52,550 --> 00:38:50,640
uh yeah i was sort of like a 24 7 cable

1097
00:38:54,870 --> 00:38:52,560
channel or something compared to the uh

1098
00:38:57,670 --> 00:38:54,880
the van allen day

1099
00:38:59,670 --> 00:38:57,680
okay so we will be broadcasting data 24

1100
00:39:02,790 --> 00:38:59,680
7 we will pick it up from ground

1101
00:39:05,430 --> 00:39:02,800
stations around the world within about

1102
00:39:08,150 --> 00:39:05,440
12 minutes that data will be out there

1103
00:39:10,470 --> 00:39:08,160
available to the public so

1104
00:39:12,230 --> 00:39:10,480
just seeing the the kind of data that

1105
00:39:14,150 --> 00:39:12,240
first comes back the very low level

1106
00:39:16,230 --> 00:39:14,160
products that probably won't tell you

1107
00:39:18,790 --> 00:39:16,240
that much but we're also going to put

1108
00:39:22,150 --> 00:39:18,800
that into models so that we will be able

1109
00:39:23,829 --> 00:39:22,160
to show a picture in three dimensions

1110
00:39:27,190 --> 00:39:23,839
that's going to be similar to what i was

1111
00:39:28,630 --> 00:39:27,200
showing before of the dynamic changes

1112
00:39:30,870 --> 00:39:28,640
we're going to be able to put that kind

1113
00:39:32,470 --> 00:39:30,880

of picture out there within minutes but

1114
00:39:34,950 --> 00:39:32,480
that's not going to happen on the day

1115
00:39:37,430 --> 00:39:34,960
one that we launched because we're we're

1116
00:39:40,470 --> 00:39:37,440
actually assimilating that data into

1117
00:39:42,630 --> 00:39:40,480
models and so that product will be

1118
00:39:44,630 --> 00:39:42,640
available fairly soon i would think but

1119
00:39:46,950 --> 00:39:44,640
then on an ongoing basis it will be

1120
00:39:47,750 --> 00:39:46,960
available every 12 minutes or so so just

1121
00:39:50,310 --> 00:39:47,760
like

1122
00:39:52,790 --> 00:39:50,320
you see sometimes with with soho and i

1123
00:39:53,589 --> 00:39:52,800
think i think sdo also pictures of the

1124
00:39:55,990 --> 00:39:53,599
sun

1125
00:39:57,670 --> 00:39:56,000
then this minute the next minute or five

1126
00:39:59,430 --> 00:39:57,680
minutes however often the cadence is

1127
00:40:01,109 --> 00:39:59,440
that they take the pictures and it's out

1128
00:40:03,109 --> 00:40:01,119
there available to the media these

1129
00:40:06,470 --> 00:40:03,119
products will be available it will be

1130
00:40:09,670 --> 00:40:07,510
any further questions you have a

1131
00:40:10,870 --> 00:40:09,680
follow-up james

1132
00:40:12,230 --> 00:40:10,880
yeah um

1133
00:40:13,910 --> 00:40:12,240
could you just

1134
00:40:16,230 --> 00:40:13,920
address again if if there's a problem

1135
00:40:18,790 --> 00:40:16,240
with one spacecraft how much does that

1136
00:40:20,470 --> 00:40:18,800
limit you and and i wasn't sure i guess

1137
00:40:21,829 --> 00:40:20,480
if i understand carly these

1138
00:40:23,190 --> 00:40:21,839

they're not communicating with each

1139
00:40:25,430 --> 00:40:23,200
other correct they're just uh

1140
00:40:26,710 --> 00:40:25,440
independently

1141
00:40:27,510 --> 00:40:26,720
that's right speaking of

1142
00:40:28,950 --> 00:40:27,520
today

1143
00:40:31,190 --> 00:40:28,960
they don't um communicate with one

1144
00:40:33,510 --> 00:40:31,200
another on orbit all the data are

1145
00:40:36,069 --> 00:40:33,520
downlinked and then uh you know we we do

1146
00:40:37,750 --> 00:40:36,079
the the collaboration between the two

1147
00:40:40,069 --> 00:40:37,760
spacecraft or coordination between the

1148
00:40:41,030 --> 00:40:40,079
data sets on the ground

1149
00:40:42,630 --> 00:40:41,040
if

1150
00:40:43,670 --> 00:40:42,640
we we are

1151
00:40:45,349 --> 00:40:43,680
our

1152
00:40:47,829 --> 00:40:45,359
mission success is to have both

1153
00:40:49,430 --> 00:40:47,839
spacecraft operating for one year

1154
00:40:51,910 --> 00:40:49,440
if one does

1155
00:40:53,510 --> 00:40:51,920
sadly something happens to it then we

1156
00:40:55,670 --> 00:40:53,520
can still do an awful lot with one

1157
00:40:57,589 --> 00:40:55,680
spacecraft um

1158
00:40:59,190 --> 00:40:57,599
the the really fabulous thing about the

1159
00:41:01,030 --> 00:40:59,200
mission is having two and being able to

1160
00:41:02,550 --> 00:41:01,040
do these multi-point measurements but as

1161
00:41:04,390 --> 00:41:02,560
my colleagues have really stressed the

1162
00:41:06,710 --> 00:41:04,400
actual instrumentation on board these

1163
00:41:09,589 --> 00:41:06,720

spacecraft is so high-tech and so

1164
00:41:11,750 --> 00:41:09,599
cutting-edge that even with one we would

1165
00:41:12,950 --> 00:41:11,760
still we're still stepping through all

1166
00:41:14,630 --> 00:41:12,960
of the the

1167
00:41:16,150 --> 00:41:14,640
regions of the radiation belt still

1168
00:41:17,910 --> 00:41:16,160
cutting through all the most important

1169
00:41:19,750 --> 00:41:17,920
regions and still taking the best

1170
00:41:21,990 --> 00:41:19,760
fidelity measurements we've taken yet

1171
00:41:24,230 --> 00:41:22,000
even with just one platform although we

1172
00:41:28,470 --> 00:41:24,240
do anticipate that they will both work

1173
00:41:29,910 --> 00:41:28,480
we have we have tested them extensively

1174
00:41:33,109 --> 00:41:29,920
and through on lots of different

1175
00:41:34,950 --> 00:41:33,119
conditions and it is our

1176
00:41:36,630 --> 00:41:34,960
we do believe that we will have them

1177
00:41:38,390 --> 00:41:36,640
both and that they will operate and

1178
00:41:40,950 --> 00:41:38,400
possibly even past two years i was going

1179
00:41:45,030 --> 00:41:40,960
to say that yes maybe even possible

1180
00:41:47,430 --> 00:41:45,040
very very armor-plated spacecraft

1181
00:41:50,150 --> 00:41:47,440
on the line now we have irene klotz from

1182
00:41:52,710 --> 00:41:50,160
reuters so irene

1183
00:41:54,309 --> 00:41:52,720
hi george thanks very much um i have a

1184
00:41:55,910 --> 00:41:54,319
couple questions the first is and i'm

1185
00:41:57,349 --> 00:41:55,920
not sure who'd be best to answer this

1186
00:41:59,910 --> 00:41:57,359
but i was wondering if there's going to

1187
00:42:02,790 --> 00:41:59,920
be any collaborative studies with

1188
00:42:04,870 --> 00:42:02,800

anything um at

1189
00:42:07,109 --> 00:42:04,880
the cassini spacecraft or

1190
00:42:09,349 --> 00:42:07,119
any other spacecraft that are looking at

1191
00:42:11,430 --> 00:42:09,359
radiation belts and radiation

1192
00:42:14,230 --> 00:42:11,440
environments around other planets in the

1193
00:42:18,710 --> 00:42:16,630
we don't we don't have any collaborative

1194
00:42:22,230 --> 00:42:18,720
efforts with that at the moment however

1195
00:42:24,790 --> 00:42:22,240
we do with other uh missions the themis

1196
00:42:27,750 --> 00:42:24,800
mission that's currently operating

1197
00:42:30,309 --> 00:42:27,760
uh they we have members from both teams

1198
00:42:32,390 --> 00:42:30,319
that that come together and we have

1199
00:42:34,950 --> 00:42:32,400
discussed possible collaborations with

1200
00:42:37,829 --> 00:42:34,960
them and there's also a balloon mission

1201
00:42:40,950 --> 00:42:37,839
that's part of lws that was going to

1202
00:42:43,750 --> 00:42:40,960
send 20 balloons up into space from

1203
00:42:45,589 --> 00:42:43,760
antarctica and that will happen in

1204
00:42:49,670 --> 00:42:45,599
january of

1205
00:42:51,510 --> 00:42:49,680
of next year so 2013 and while those are

1206
00:42:54,470 --> 00:42:51,520
up there we will be able to measure

1207
00:42:56,950 --> 00:42:54,480
precipitating electrons

1208
00:42:59,829 --> 00:42:56,960
so we will be able to see that while

1209
00:43:02,150 --> 00:42:59,839
we're measuring in situ in the radiation

1210
00:43:04,230 --> 00:43:02,160
belt so we're really excited about that

1211
00:43:06,069 --> 00:43:04,240
collaboration so that one and the one

1212
00:43:08,470 --> 00:43:06,079
with them us and probably also we'll do

1213
00:43:11,510 --> 00:43:08,480

things with cluster which is primarily

1214
00:43:14,150 --> 00:43:11,520
an isa mission but we have some u.s

1215
00:43:16,870 --> 00:43:14,160
participation so we have been talking to

1216
00:43:18,790 --> 00:43:16,880
other people ground-based assets and and

1217
00:43:20,870 --> 00:43:18,800
various other things but we don't think

1218
00:43:23,109 --> 00:43:20,880
we have anything particular oh okay

1219
00:43:25,829 --> 00:43:23,119
nikki knows that we do so here we are we

1220
00:43:27,349 --> 00:43:25,839
are actually going to have um a like a

1221
00:43:29,349 --> 00:43:27,359
it's going to be very quick because it

1222
00:43:31,670 --> 00:43:29,359
flies by very fast but we are going to

1223
00:43:33,349 --> 00:43:31,680
have a coordinated campaign with juno

1224
00:43:36,630 --> 00:43:33,359
when that comes through the

1225
00:43:37,990 --> 00:43:36,640
magnetosphere next year um they will be

1226
00:43:39,430 --> 00:43:38,000
actually we'll be doing some cross

1227
00:43:41,030 --> 00:43:39,440
calibrations with their instruments

1228
00:43:43,190 --> 00:43:41,040
looking at the radiation they measure in

1229
00:43:45,510 --> 00:43:43,200
our magnetosphere and then the radiation

1230
00:43:47,430 --> 00:43:45,520
that they measure at jupiter so that is

1231
00:43:49,190 --> 00:43:47,440
it it's quick because man it's moving

1232
00:43:52,069 --> 00:43:49,200
fast but um it will be

1233
00:43:55,430 --> 00:43:52,079
it we will get two cuts as it comes past

1234
00:43:57,829 --> 00:43:55,440
and through the earth's magnetosphere so

1235
00:44:01,670 --> 00:43:57,839
um thanks and uh maybe for for uh dr

1236
00:44:04,550 --> 00:44:01,680
lanzerati hi um i wanted to know if um

1237
00:44:07,109 --> 00:44:04,560
why why was it not suspected before the

1238
00:44:08,630 --> 00:44:07,119

the launch of telstar that earth would

1239
00:44:10,950 --> 00:44:08,640
have something like

1240
00:44:11,990 --> 00:44:10,960
radiation belts since i believe it was

1241
00:44:14,150 --> 00:44:12,000
known that

1242
00:44:15,990 --> 00:44:14,160
the the planet had a magnetic field

1243
00:44:18,230 --> 00:44:16,000
already if you could maybe explain a

1244
00:44:20,550 --> 00:44:18,240
little bit about

1245
00:44:25,349 --> 00:44:22,870
what causes the radiation belts and and

1246
00:44:27,510 --> 00:44:25,359
why its initial discovery came as a

1247
00:44:29,750 --> 00:44:27,520
surprise thanks

1248
00:44:32,309 --> 00:44:29,760
irene that's uh that's that's a long

1249
00:44:34,829 --> 00:44:32,319
long history as you probably are aware

1250
00:44:38,150 --> 00:44:34,839
to some extent

1251
00:44:40,790 --> 00:44:38,160
um when uh john pierce actually uh

1252
00:44:42,950 --> 00:44:40,800
arthur clark proposed a satellite in a

1253
00:44:45,109 --> 00:44:42,960
in a uh certainly after the second world

1254
00:44:46,950 --> 00:44:45,119
war geosynchronous altitude it was a

1255
00:44:49,430 --> 00:44:46,960
science fiction kind of thing but john

1256
00:44:52,230 --> 00:44:49,440
pierce at bell laboratories uh proposed

1257
00:44:55,990 --> 00:44:52,240
the echo uh reflection uh satellite

1258
00:44:59,109 --> 00:44:56,000
which was launched in 1960 with nasa

1259
00:45:00,390 --> 00:44:59,119
and then john pierce in about 1954

1260
00:45:01,829 --> 00:45:00,400
had proposed an active

1261
00:45:02,950 --> 00:45:01,839
telecommunications satellite and that

1262
00:45:05,589 --> 00:45:02,960
was before the discovery of the

1263
00:45:07,270 --> 00:45:05,599

radiation belts so i i think it's quite

1264
00:45:09,270 --> 00:45:07,280
fair to say and it is fair to say and

1265
00:45:11,510 --> 00:45:09,280
knowing and knowing him a little

1266
00:45:12,710 --> 00:45:11,520
somewhat uh we overlapped a little bit

1267
00:45:15,750 --> 00:45:12,720
to labs

1268
00:45:17,910 --> 00:45:15,760
before he retired and went to caltech um

1269
00:45:19,829 --> 00:45:17,920
there was no no expectation that the

1270
00:45:22,150 --> 00:45:19,839
earth space environment was not anything

1271
00:45:23,750 --> 00:45:22,160
but benign cosmic rays had been

1272
00:45:25,750 --> 00:45:23,760
discovered about 50 years prior to the

1273
00:45:27,349 --> 00:45:25,760
van allen radiation belts actually 100

1274
00:45:30,950 --> 00:45:27,359
year anniversary of the discovery of

1275
00:45:33,990 --> 00:45:30,960
cosmic rays is just this year where

1276
00:45:36,069 --> 00:45:34,000
dr hess over in in austria flew his

1277
00:45:40,510 --> 00:45:36,079
balloons uh with him in them and

1278
00:45:42,150 --> 00:45:40,520
discovered cosmic rays in july august uh

1279
00:45:44,150 --> 00:45:42,160
1912.

1280
00:45:45,510 --> 00:45:44,160
um but other than cosmic rays there was

1281
00:45:46,870 --> 00:45:45,520
no reason to expect the earth space

1282
00:45:49,829 --> 00:45:46,880
environment wasn't benign and in fact

1283
00:45:52,710 --> 00:45:49,839
the physics text that i used in 1956

1284
00:45:53,910 --> 00:45:52,720
1957 and i've shown this at other talks

1285
00:45:56,150 --> 00:45:53,920
that i've given

1286
00:45:58,470 --> 00:45:56,160
showed the earth's magnetic field with

1287
00:46:00,950 --> 00:45:58,480
just nothing out there except for the

1288
00:46:02,790 --> 00:46:00,960

stars and the sun and i've shown that in

1289
00:46:05,430 --> 00:46:02,800
the past to show what we really didn't

1290
00:46:06,950 --> 00:46:05,440
know fifty years ago and so then van

1291
00:46:10,309 --> 00:46:06,960
allen's discovery the van allen

1292
00:46:11,349 --> 00:46:10,319
radiation belt did did put some surprise

1293
00:46:17,109 --> 00:46:11,359
into the

1294
00:46:18,069 --> 00:46:17,119
built they did take into account some of

1295
00:46:25,829 --> 00:46:18,079
the

1296
00:46:30,950 --> 00:46:25,839
transistors

1297
00:46:32,550 --> 00:46:30,960
and as a fact a matter of fact our ats-1

1298
00:46:34,710 --> 00:46:32,560
instruments were built with just

1299
00:46:37,030 --> 00:46:34,720
discrete transistors soldered together

1300
00:46:39,270 --> 00:46:37,040
with very limited memory there were no

1301
00:46:40,790 --> 00:46:39,280
ics at integrated circuits at that time

1302
00:46:44,069 --> 00:46:40,800
and they were all transistors put

1303
00:46:47,430 --> 00:46:44,079
together to make your to make your uh uh

1304
00:46:50,550 --> 00:46:47,440
uh memory ch memory uh devices and all

1305
00:46:52,309 --> 00:46:50,560
and so one had very limited uh radiation

1306
00:46:54,870 --> 00:46:52,319
there was no radiation hardness of these

1307
00:46:58,550 --> 00:46:54,880
transistors for telstar and in fact at

1308
00:47:01,030 --> 00:46:58,560
att flew uh flew some uh transistors

1309
00:47:03,670 --> 00:47:01,040
that they used as radiation monitors in

1310
00:47:05,670 --> 00:47:03,680
order to monitor the the van allen belts

1311
00:47:08,390 --> 00:47:05,680
at telstar altitudes to get a better

1312
00:47:09,829 --> 00:47:08,400
idea but they didn't but the the

1313
00:47:11,829 --> 00:47:09,839

expectation was a satellite would

1314
00:47:14,550 --> 00:47:11,839
probably last longer than it actually

1315
00:47:18,430 --> 00:47:14,560
did but the data were so poor by that

1316
00:47:23,030 --> 00:47:18,440
time 1962 and during the design in 1961

1317
00:47:25,670 --> 00:47:23,040
1962 that there was just no way to uh to

1318
00:47:28,950 --> 00:47:25,680
harden in the same sense that we use

1319
00:47:30,630 --> 00:47:28,960
today uh that that spacecraft as a

1320
00:47:32,549 --> 00:47:30,640
matter of fact it was just the 50th if i

1321
00:47:34,470 --> 00:47:32,559
can advertise here for a moment and

1322
00:47:35,670 --> 00:47:34,480
allow me to go on if i might for a

1323
00:47:37,349 --> 00:47:35,680
moment

1324
00:47:39,190 --> 00:47:37,359
it was just the 50th anniversary of the

1325
00:47:41,589 --> 00:47:39,200
launch of telestar held last month at

1326
00:47:43,430 --> 00:47:41,599
bell laboratories in new jersey several

1327
00:47:45,990 --> 00:47:43,440
of us were asked to give talks there

1328
00:47:47,990 --> 00:47:46,000
there's a video a youtube video talking

1329
00:47:50,150 --> 00:47:48,000
about that event which is quite

1330
00:47:51,510 --> 00:47:50,160
interesting to look at walter brown at

1331
00:47:53,270 --> 00:47:51,520
that time who hired me at bell

1332
00:47:55,670 --> 00:47:53,280
laboratories to do radiation belt

1333
00:47:56,630 --> 00:47:55,680
research as a matter of fact uh gave a

1334
00:47:58,790 --> 00:47:56,640
talk

1335
00:48:00,790 --> 00:47:58,800
uh on his instruments on his little

1336
00:48:03,190 --> 00:48:00,800
transistors that he flew on telstar to

1337
00:48:05,109 --> 00:48:03,200
measure the radiation environment and

1338
00:48:06,710 --> 00:48:05,119

some of that data is still used today

1339
00:48:08,870 --> 00:48:06,720
and then i followed him talking about

1340
00:48:11,349 --> 00:48:08,880
space weather and how it's important for

1341
00:48:12,390 --> 00:48:11,359
communications to today so alcatel

1342
00:48:14,390 --> 00:48:12,400
lucent

1343
00:48:17,190 --> 00:48:14,400
while no longer building spacecraft is

1344
00:48:19,750 --> 00:48:17,200
still involved and interested in this in

1345
00:48:21,990 --> 00:48:19,760
this field of of endeavor and research

1346
00:48:23,109 --> 00:48:22,000
as can be evidenced by the anniversary

1347
00:48:25,270 --> 00:48:23,119
that they held and people that they

1348
00:48:27,670 --> 00:48:25,280
asked to come and give talks back

1349
00:48:30,309 --> 00:48:27,680
from their prior staff

1350
00:48:32,710 --> 00:48:30,319
did that help a little bit irene um yes

1351
00:48:35,510 --> 00:48:32,720
that does but um i also was wondering if

1352
00:48:37,510 --> 00:48:35,520
there's i know this is a a huge question

1353
00:48:40,069 --> 00:48:37,520
as well but could somebody just give

1354
00:48:42,230 --> 00:48:40,079
kind of a basic science explanation of

1355
00:48:44,390 --> 00:48:42,240
why earth and the other planets that

1356
00:48:45,829 --> 00:48:44,400
have magnetic fields have radiation

1357
00:48:47,190 --> 00:48:45,839
belts

1358
00:48:49,109 --> 00:48:47,200
that's a very good question i don't

1359
00:48:50,790 --> 00:48:49,119
think we really understand very well

1360
00:48:52,870 --> 00:48:50,800
mike schultz and i talked about a little

1361
00:48:55,270 --> 00:48:52,880
bit in our book here and my colleagues

1362
00:48:57,430 --> 00:48:55,280
who've done a lot of theory also we have

1363
00:48:59,030 --> 00:48:57,440

all these very low energy particles in

1364
00:48:59,910 --> 00:48:59,040
the solar wind that are coming out from

1365
00:49:11,270 --> 00:48:59,920
the

1366
00:49:12,549 --> 00:49:11,280
but it's really poorly very poorly

1367
00:49:14,069 --> 00:49:12,559
understood and that's the whole prime

1368
00:49:15,990 --> 00:49:14,079
purpose of this mission

1369
00:49:19,270 --> 00:49:16,000
i i should point out one thing i did

1370
00:49:23,109 --> 00:49:19,280
forget was back in about 19

1371
00:49:25,109 --> 00:49:23,119
about 1954 55 time frame which was uh

1372
00:49:27,589 --> 00:49:25,119
when uh john pierce was talking about

1373
00:49:29,430 --> 00:49:27,599
telstar and and low earth orbiting

1374
00:49:30,950 --> 00:49:29,440
active communication satellites there

1375
00:49:32,710 --> 00:49:30,960
was a chat there was a professor at the

1376
00:49:36,069 --> 00:49:32,720
university of maryland named f fred

1377
00:49:38,390 --> 00:49:36,079
singer fred singer still is as active in

1378
00:49:41,510 --> 00:49:38,400
certain areas of his of research even

1379
00:49:42,309 --> 00:49:41,520
today he's close to 90 years old uh i

1380
00:49:44,390 --> 00:49:42,319
think

1381
00:49:47,510 --> 00:49:44,400
mid 80s anyway

1382
00:49:49,430 --> 00:49:47,520
and and he he he did some calculations

1383
00:49:51,349 --> 00:49:49,440
where he showed that if you put it put

1384
00:49:53,349 --> 00:49:51,359
some particles into something like a

1385
00:49:55,109 --> 00:49:53,359
magnetosphere there was no such

1386
00:49:57,030 --> 00:49:55,119
magnetosphere at the time but into a

1387
00:49:58,870 --> 00:49:57,040
dipole feel like the earth had you could

1388
00:50:01,430 --> 00:49:58,880

probably trap them

1389
00:50:03,990 --> 00:50:01,440
but his paper was sort of an obscure one

1390
00:50:06,309 --> 00:50:04,000
in american geophysical union abstracts

1391
00:50:08,470 --> 00:50:06,319
somewhere and and he never talked about

1392
00:50:10,549 --> 00:50:08,480
how you could highly populate them but

1393
00:50:13,030 --> 00:50:10,559
he did talk about they could be trapping

1394
00:50:15,990 --> 00:50:13,040
and so there was some research at that

1395
00:50:18,309 --> 00:50:16,000
time and speculation and discussion but

1396
00:50:19,589 --> 00:50:18,319
nothing intense and we really still

1397
00:50:20,950 --> 00:50:19,599
don't know how these low energy

1398
00:50:22,950 --> 00:50:20,960
particles in the solar wind get in the

1399
00:50:25,030 --> 00:50:22,960
magnetosphere and accelerated and

1400
00:50:26,630 --> 00:50:25,040
decelerated and how they populate that's

1401
00:50:28,230 --> 00:50:26,640
the whole point of this mission

1402
00:50:30,470 --> 00:50:28,240
if i could maybe just add on onto that

1403
00:50:31,990 --> 00:50:30,480
lady um the thing that really is making

1404
00:50:33,270 --> 00:50:32,000
it different for the planets that have

1405
00:50:35,670 --> 00:50:33,280
them and the planets that don't have

1406
00:50:37,910 --> 00:50:35,680
them is the strong magnetic field so we

1407
00:50:39,990 --> 00:50:37,920
know that it is the the magnetic field

1408
00:50:41,510 --> 00:50:40,000
at those planets that is trapping the

1409
00:50:44,710 --> 00:50:41,520
radiation

1410
00:50:46,710 --> 00:50:44,720
already inside the magnetosphere our

1411
00:50:49,030 --> 00:50:46,720
magnetosphere itself does a tremendous

1412
00:50:51,109 --> 00:50:49,040
job of of protecting us from the

1413
00:50:52,710 --> 00:50:51,119

particles that are in the solar wind so

1414
00:50:54,710 --> 00:50:52,720
a lot of the particles are already

1415
00:50:56,630 --> 00:50:54,720
living in the magnetosphere and get

1416
00:50:59,510 --> 00:50:56,640
injected and trapped and i think that

1417
00:51:01,589 --> 00:50:59,520
that release shows why harlan and craig

1418
00:51:04,309 --> 00:51:01,599
both stressed how important it is not

1419
00:51:06,150 --> 00:51:04,319
just to meant to measure the particles

1420
00:51:08,710 --> 00:51:06,160
but also to measure those magnetic and

1421
00:51:10,950 --> 00:51:08,720
electric fields because without those we

1422
00:51:12,390 --> 00:51:10,960
wouldn't have the radiation regions that

1423
00:51:14,150 --> 00:51:12,400
we see

1424
00:51:17,190 --> 00:51:14,160
can i follow on

1425
00:51:18,950 --> 00:51:17,200
am i taking too much time so

1426
00:51:20,710 --> 00:51:18,960
one more question okay

1427
00:51:22,150 --> 00:51:20,720
you could you go ahead and make a brief

1428
00:51:24,230 --> 00:51:22,160
point and we'll then we'll take one

1429
00:51:27,270 --> 00:51:24,240
final question well on the point

1430
00:51:29,109 --> 00:51:27,280
waves on on the nasa satellite ats-3

1431
00:51:30,950 --> 00:51:29,119
we flew a wave instrument

1432
00:51:32,549 --> 00:51:30,960
to measure whistlers

1433
00:51:35,430 --> 00:51:32,559
it wasn't a very successful instrument

1434
00:51:37,910 --> 00:51:35,440
at all and it was what what did it get

1435
00:51:39,829 --> 00:51:37,920
looking back now the history is that we

1436
00:51:41,430 --> 00:51:39,839
just didn't know anything about the

1437
00:51:43,589 --> 00:51:41,440
waves that could affect these particles

1438
00:51:45,670 --> 00:51:43,599

at that time it was very primitive

1439
00:51:47,349 --> 00:51:45,680
understanding which shows the importance

1440
00:51:50,549 --> 00:51:47,359
of the kind of sophisticated instruments

1441
00:51:52,549 --> 00:51:50,559
that we're able to do now the comparison

1442
00:51:54,470 --> 00:51:52,559
okay we'll come back here for one final

1443
00:51:57,270 --> 00:51:54,480
question hi uh christopher hill from the

1444
00:51:59,430 --> 00:51:57,280
avion newspaper i just wondered how the

1445
00:52:01,990 --> 00:51:59,440
data from this mission will be used to

1446
00:52:03,589 --> 00:52:02,000
protect future spacecraft or satellites

1447
00:52:04,950 --> 00:52:03,599
that may be traveling through this

1448
00:52:06,710 --> 00:52:04,960
region

1449
00:52:09,670 --> 00:52:06,720
a number of different ways that the easy

1450
00:52:11,589 --> 00:52:09,680
answer to that is to really do a far far

1451
00:52:13,589 --> 00:52:11,599
better job of modeling the environment

1452
00:52:15,589 --> 00:52:13,599
in which they'll have to live and work

1453
00:52:17,829 --> 00:52:15,599
um there are sort of and it's two sides

1454
00:52:19,589 --> 00:52:17,839
of the coin um you don't want to send

1455
00:52:22,150 --> 00:52:19,599
something up that is not adequately

1456
00:52:24,470 --> 00:52:22,160
shielded and it either you know gets

1457
00:52:27,109 --> 00:52:24,480
crippled by a space weather event or its

1458
00:52:29,270 --> 00:52:27,119
lifetime is dramatically decreased by

1459
00:52:32,870 --> 00:52:29,280
say solar panel damage

1460
00:52:34,230 --> 00:52:32,880
um the same token you don't want to over

1461
00:52:36,470 --> 00:52:34,240
engineer something you don't want to

1462
00:52:38,150 --> 00:52:36,480
launch a battleship when you know a

1463
00:52:40,710 --> 00:52:38,160

dinghy would have done

1464
00:52:42,630 --> 00:52:40,720
so you don't want to be really it costs

1465
00:52:44,549 --> 00:52:42,640
a lot more to launch a lot more to build

1466
00:52:46,870 --> 00:52:44,559
a lot more to maintain

1467
00:52:48,630 --> 00:52:46,880
so you want to be able to engineer the

1468
00:52:50,230 --> 00:52:48,640
design of the spacecraft so that you

1469
00:52:52,630 --> 00:52:50,240
really are putting the right amount of

1470
00:52:54,790 --> 00:52:52,640
shielding for the right region and also

1471
00:52:56,950 --> 00:52:54,800
to have a very good um

1472
00:52:58,950 --> 00:52:56,960
prediction of how long those spacecraft

1473
00:53:00,950 --> 00:52:58,960
will last because again you don't want

1474
00:53:02,710 --> 00:53:00,960
to if you've got operational spacecraft

1475
00:53:04,630 --> 00:53:02,720
you don't want to not launch something

1476
00:53:06,630 --> 00:53:04,640
quick enough and have a gap but you also

1477
00:53:09,109 --> 00:53:06,640
don't want to launch it too soon and

1478
00:53:10,150 --> 00:53:09,119
have you know on orbit storage well you

1479
00:53:13,109 --> 00:53:10,160
know you could have you could have

1480
00:53:15,109 --> 00:53:13,119
waited two years so by having the really

1481
00:53:17,030 --> 00:53:15,119
accurate models of the environment

1482
00:53:19,270 --> 00:53:17,040
through which they will travel will

1483
00:53:21,349 --> 00:53:19,280
really dramatically improve the design

1484
00:53:22,390 --> 00:53:21,359
of spacecraft

1485
00:53:26,950 --> 00:53:22,400
the models

1486
00:53:29,109 --> 00:53:26,960
are about 30 years old

1487
00:53:30,710 --> 00:53:29,119
this we can really use an upgrade to

1488
00:53:33,030 --> 00:53:30,720

those models for future design and

1489
00:53:35,910 --> 00:53:33,040
engineering purposes they're almost as

1490
00:53:38,309 --> 00:53:35,920
old as lou himself

1491
00:53:40,230 --> 00:53:38,319
thank you nikki

1492
00:53:42,950 --> 00:53:40,240
in addition to the design models we also

1493
00:53:45,750 --> 00:53:42,960
have a physics-based models that the

1494
00:53:47,430 --> 00:53:45,760
rbsp data will really provide

1495
00:53:49,750 --> 00:53:47,440
critically important information that's

1496
00:53:52,710 --> 00:53:49,760
needed to deliver better predictive

1497
00:53:54,710 --> 00:53:52,720
models and as we build up extreme events

1498
00:53:56,390 --> 00:53:54,720
we'll understand the range of the kind

1499
00:53:58,470 --> 00:53:56,400
of events that we need to shield against

1500
00:54:00,870 --> 00:53:58,480
as well right a good good chunk of the

1501
00:54:02,309 --> 00:54:00,880
models now are sort of empirical models

1502
00:54:04,069 --> 00:54:02,319
and getting to this where you actually

1503
00:54:05,829 --> 00:54:04,079
understand what's happening

1504
00:54:07,270 --> 00:54:05,839
allows you to do better predictions and

1505
00:54:08,870 --> 00:54:07,280
of course the other aspect is our space

1506
00:54:10,470 --> 00:54:08,880
weather broadcast and there are the

1507
00:54:11,990 --> 00:54:10,480
modelers are now thinking about how can

1508
00:54:13,750 --> 00:54:12,000
i be pulling this data that's coming

1509
00:54:15,270 --> 00:54:13,760
down all the time so that we can at

1510
00:54:16,870 --> 00:54:15,280
least do you know maybe only at this

1511
00:54:18,309 --> 00:54:16,880
point an hour or two in the future but

1512
00:54:21,589 --> 00:54:18,319
that's still more preparation than we

1513
00:54:26,069 --> 00:54:23,829

all right that will conclude our

1514
00:54:28,150 --> 00:54:26,079
briefing uh one programming note as far

1515
00:54:30,230 --> 00:54:28,160
as launch coverage the start time is

1516
00:54:32,870 --> 00:54:30,240
unchanged for launch on

1517
00:54:35,750 --> 00:54:32,880
uh friday august the 24th our nasa tv

1518
00:54:39,589 --> 00:54:35,760
coverage will start at 1 30 a.m eastern

1519
00:54:41,510 --> 00:54:39,599
time for a launch at 407 a.m