

Europa Mission News

May 26, 2015 11 a.m. PT (2 p.m. ET, 1800 UTC)



Jet Propulsion Laboratory
California Institute of Technology

#askNASA

1
00:00:12,150 --> 00:00:10,310
good afternoon my name is felicia chao

2
00:00:14,310 --> 00:00:12,160
with the office of communications and

3
00:00:16,150 --> 00:00:14,320
welcome to nasa headquarters

4
00:00:18,230 --> 00:00:16,160
nasa has selected science instruments

5
00:00:20,070 --> 00:00:18,240
for the europa mission as part of our

6
00:00:22,310 --> 00:00:20,080
commitment to explore the solar system

7
00:00:24,150 --> 00:00:22,320
and beyond to understand the workings of

8
00:00:25,429 --> 00:00:24,160
the universe and search for life among

9
00:00:27,429 --> 00:00:25,439
the stars

10
00:00:29,189 --> 00:00:27,439
we will have brief presentations from

11
00:00:31,029 --> 00:00:29,199
our panelists then we will take

12
00:00:33,110 --> 00:00:31,039
questions from the audience the phone

13
00:00:35,350 --> 00:00:33,120

lines and social media

14

00:00:39,430 --> 00:00:35,360

to ask a question using social media

15

00:00:42,389 --> 00:00:39,440

please use the hashtag ask nasa

16

00:00:45,510 --> 00:00:42,399

today's participants are kurt nieber

17

00:00:47,750 --> 00:00:45,520

europa program scientist

18

00:00:50,869 --> 00:00:47,760

jim green director of the planetary

19

00:00:55,270 --> 00:00:52,950

and to officially start us off here is

20

00:00:58,150 --> 00:00:55,280

john grunsfeld associate administrator

21

00:01:00,549 --> 00:00:58,160

for the science mission directorate john

22

00:01:03,110 --> 00:01:00,559

thank you very much felicia

23

00:01:06,070 --> 00:01:03,120

we're on our way to europa

24

00:01:07,510 --> 00:01:06,080

our mission is to innovate

25

00:01:08,870 --> 00:01:07,520

explore

26

00:01:10,710 --> 00:01:08,880

discover

27

00:01:12,630 --> 00:01:10,720

and inspire

28

00:01:14,710 --> 00:01:12,640

we're trying to answer the big questions

29

00:01:17,590 --> 00:01:14,720

where did we come from where are we

30

00:01:19,429 --> 00:01:17,600

going and are we alone

31

00:01:22,149 --> 00:01:19,439

these we translate into science

32

00:01:26,149 --> 00:01:24,630

ever since the 11 flybys by the galileo

33

00:01:28,070 --> 00:01:26,159

mission more than a decade ago we've

34

00:01:29,350 --> 00:01:28,080

been intrigued by this amazing moon of

35

00:01:31,910 --> 00:01:29,360

jupiter

36

00:01:33,590 --> 00:01:31,920

it's about the same size as our own moon

37

00:01:35,109 --> 00:01:33,600

and scientists have scrutinized these

38

00:01:37,030 --> 00:01:35,119

images

39

00:01:39,190 --> 00:01:37,040

to incredible detail

40

00:01:41,990 --> 00:01:39,200

and determined that europa harbors a

41

00:01:42,870 --> 00:01:42,000

deep salty ocean below a thick mantle of

42

00:01:45,510 --> 00:01:42,880

ice

43

00:01:47,910 --> 00:01:45,520

the images show a cracked even tortured

44

00:01:51,109 --> 00:01:47,920

surface

45

00:01:54,870 --> 00:01:51,119

i've just lost my notes

46

00:01:59,270 --> 00:01:57,350

one of the amazing features of europa is

47

00:02:01,510 --> 00:01:59,280

that we see very few craters indicating

48

00:02:03,670 --> 00:02:01,520

it's a very young surface something is

49

00:02:05,910 --> 00:02:03,680

causing it to be turned over

50

00:02:07,030 --> 00:02:05,920

the age is perhaps only about 50 million

51
00:02:08,949 --> 00:02:07,040
years

52
00:02:11,750 --> 00:02:08,959
tidal forces from jupiter must be

53
00:02:13,990 --> 00:02:11,760
causing some dynamics that result in the

54
00:02:15,589 --> 00:02:14,000
surface being in contact with that

55
00:02:17,910 --> 00:02:15,599
undersea ocean

56
00:02:19,910 --> 00:02:17,920
recently observations from the hubble

57
00:02:21,510 --> 00:02:19,920
space telescope you know i had to get

58
00:02:24,150 --> 00:02:21,520
hubble in there somehow

59
00:02:25,350 --> 00:02:24,160
detect what may be plumes of water

60
00:02:27,589 --> 00:02:25,360
shooting out

61
00:02:29,430 --> 00:02:27,599
from under the surface of europa this

62
00:02:31,510 --> 00:02:29,440
may be part of the mechanism that helps

63
00:02:33,990 --> 00:02:31,520

resurface europa

64

00:02:36,710 --> 00:02:34,000

europa is just one of many icy moons in

65

00:02:38,710 --> 00:02:36,720

our solar system that are likely sites

66

00:02:41,430 --> 00:02:38,720

of subsurface oceans

67

00:02:43,430 --> 00:02:41,440

for europa that ocean may have been in

68

00:02:45,830 --> 00:02:43,440

existence for billions of years since

69

00:02:48,229 --> 00:02:45,840

the creation of the solar system

70

00:02:50,710 --> 00:02:48,239

in that ocean of course is water salty

71

00:02:53,190 --> 00:02:50,720

water organics and likely sources of

72

00:02:54,550 --> 00:02:53,200

heat such as undersea vents that we see

73

00:02:56,309 --> 00:02:54,560

here on earth

74

00:02:58,150 --> 00:02:56,319

all of those components

75

00:03:00,790 --> 00:02:58,160

are the kind of contributors that we

76

00:03:03,350 --> 00:03:00,800

believe are necessary ingredients

77

00:03:05,350 --> 00:03:03,360

for life to emerge

78

00:03:07,030 --> 00:03:05,360

the instruments we're announcing today

79

00:03:09,509 --> 00:03:07,040

are the result of investments we've made

80

00:03:12,229 --> 00:03:09,519

over the last few years in technology to

81

00:03:13,670 --> 00:03:12,239

help interrogate the ic bodies in our

82

00:03:15,110 --> 00:03:13,680

solar system

83

00:03:17,030 --> 00:03:15,120

the complement of instruments we've

84

00:03:19,270 --> 00:03:17,040

selected are compelling

85

00:03:21,750 --> 00:03:19,280

and will result in a mission that is

86

00:03:24,070 --> 00:03:21,760

every bit as impressive in my opinion is

87

00:03:26,070 --> 00:03:24,080

the cassini mission to saturn or the

88

00:03:27,589 --> 00:03:26,080

previous galileo mission to jupiter and

89

00:03:29,190 --> 00:03:27,599

its moons

90

00:03:30,869 --> 00:03:29,200

the mission design is still being

91

00:03:32,149 --> 00:03:30,879

studied but we wanted to get a head

92

00:03:34,309 --> 00:03:32,159

start on the instruments as they're

93

00:03:36,070 --> 00:03:34,319

often the long poles on the development

94

00:03:37,750 --> 00:03:36,080

of something as complex as a mission to

95

00:03:39,509 --> 00:03:37,760

europa

96

00:03:41,350 --> 00:03:39,519

jim green will cover the science in some

97

00:03:43,190 --> 00:03:41,360

detail and kurt will go over the

98

00:03:45,270 --> 00:03:43,200

instruments we've selected i'm

99

00:03:47,110 --> 00:03:45,280

incredibly excited about this big step

100

00:03:49,190 --> 00:03:47,120

forward and our quest to learn more

101
00:03:51,270 --> 00:03:49,200
about our solar system and the search

102
00:03:53,750 --> 00:03:51,280
for life beyond earth

103
00:03:55,990 --> 00:03:53,760
with some editorial license let me quote

104
00:03:57,990 --> 00:03:56,000
john f kennedy from 1961 on the

105
00:04:00,710 --> 00:03:58,000
exploration of space

106
00:04:02,949 --> 00:04:00,720
this is the new ocean and i believe the

107
00:04:05,589 --> 00:04:02,959
united states must sail on it and be in

108
00:04:07,910 --> 00:04:05,599
a position second to none

109
00:04:08,789 --> 00:04:07,920
europa here we come

110
00:04:10,309 --> 00:04:08,799
jim

111
00:04:13,270 --> 00:04:10,319
thank you very much john

112
00:04:14,949 --> 00:04:13,280
yeah europa is just such a fabulous moon

113
00:04:15,910 --> 00:04:14,959

of jupiter

114

00:04:18,069 --> 00:04:15,920

in fact

115

00:04:20,469 --> 00:04:18,079

much of what john described can be seen

116

00:04:22,069 --> 00:04:20,479

in our very first graphic of this

117

00:04:25,830 --> 00:04:22,079

beautiful moon

118

00:04:29,030 --> 00:04:25,840

so as you can see very few craters it

119

00:04:30,950 --> 00:04:29,040

has these brown areas or what we call a

120

00:04:32,629 --> 00:04:30,960

brown gun for the lack of really

121

00:04:35,510 --> 00:04:32,639

knowledge of what they are

122

00:04:38,870 --> 00:04:35,520

and and in addition to that the brown

123

00:04:41,270 --> 00:04:38,880

also illustrates the cracks in the moon

124

00:04:43,990 --> 00:04:41,280

where we believe the subsurface ocean

125

00:04:46,870 --> 00:04:44,000

must be communicating with the surface

126

00:04:48,469 --> 00:04:46,880

so this is indeed a fabulous body as

127

00:04:50,310 --> 00:04:48,479

john mentioned we've been studying it

128

00:04:53,110 --> 00:04:50,320

for a number of years

129

00:04:55,909 --> 00:04:53,120

with only a few passes by the galileo

130

00:04:57,430 --> 00:04:55,919

spacecraft which was orbiting jupiter

131

00:04:59,189 --> 00:04:57,440

in the 90s

132

00:05:01,110 --> 00:04:59,199

and so ever since then we've been

133

00:05:03,909 --> 00:05:01,120

intrigued by this body

134

00:05:06,629 --> 00:05:03,919

now europa was first discovered by

135

00:05:08,870 --> 00:05:06,639

galileo in 1610

136

00:05:11,189 --> 00:05:08,880

he never had the eyes that we currently

137

00:05:13,430 --> 00:05:11,199

have in looking and seeing this moon

138

00:05:14,629 --> 00:05:13,440

from the galileo spacecraft named after

139

00:05:17,909 --> 00:05:14,639

him

140

00:05:20,629 --> 00:05:17,919

now we are in the pursuit of trying to

141

00:05:23,189 --> 00:05:20,639

understand how thick that ice shell is

142

00:05:26,230 --> 00:05:23,199

we know that there's an undercrossed

143

00:05:28,550 --> 00:05:26,240

ocean and in fact that ocean might be

144

00:05:30,870 --> 00:05:28,560

significant in terms of having more than

145

00:05:31,830 --> 00:05:30,880

twice the water that we have on this

146

00:05:34,230 --> 00:05:31,840

planet

147

00:05:37,430 --> 00:05:34,240

and after 5 billion years with

148

00:05:39,990 --> 00:05:37,440

conditions like that indeed it could be

149

00:05:41,670 --> 00:05:40,000

a very habitable place if life indeed

150

00:05:43,749 --> 00:05:41,680

started on that body

151

00:05:46,469 --> 00:05:43,759

many billions of years ago

152

00:05:49,590 --> 00:05:46,479

so what's underneath that ice crust

153

00:05:51,990 --> 00:05:49,600

well we can only imagine but we have i

154

00:05:54,150 --> 00:05:52,000

think some really good ideas and plenty

155

00:05:56,550 --> 00:05:54,160

of evidence to indicate that what i'm

156

00:06:00,150 --> 00:05:56,560

going to tell you about next is true if

157

00:06:03,270 --> 00:06:00,160

i can have my second graphic

158

00:06:08,790 --> 00:06:03,280

in this particular graphic what we see

159

00:06:11,990 --> 00:06:08,800

is the moon io and and and europa uh in

160

00:06:14,390 --> 00:06:12,000

the back background we believe something

161

00:06:16,070 --> 00:06:14,400

like the surface of io must be at the

162

00:06:20,870 --> 00:06:16,080

bottom of the ocean

163

00:06:23,350 --> 00:06:20,880

uh in europa so this is really exciting

164

00:06:25,350 --> 00:06:23,360

io is suffering the same tidal forces

165

00:06:27,029 --> 00:06:25,360

europa is although

166

00:06:29,430 --> 00:06:27,039

several orders of magnitude more

167

00:06:31,590 --> 00:06:29,440

extensive because it's so close

168

00:06:33,029 --> 00:06:31,600

to the planet jupiter

169

00:06:35,270 --> 00:06:33,039

now these

170

00:06:37,590 --> 00:06:35,280

hydrothermal vents

171

00:06:41,990 --> 00:06:37,600

really must represent the volcanoes that

172

00:06:44,309 --> 00:06:42,000

we see on io if indeed europa has

173

00:06:45,350 --> 00:06:44,319

an ocean that that

174

00:06:48,230 --> 00:06:45,360

is

175

00:06:50,230 --> 00:06:48,240

straddling the entire body the

176
00:06:52,309 --> 00:06:50,240
hydrothermal vents that you see in these

177
00:06:55,029 --> 00:06:52,319
insets down at the bottom of the image

178
00:06:57,110 --> 00:06:55,039
are really our own from from our earth

179
00:06:59,029 --> 00:06:57,120
and we know that they're full of life

180
00:07:00,950 --> 00:06:59,039
they bring up nutrients

181
00:07:03,430 --> 00:07:00,960
and those nutrients circulate through

182
00:07:05,510 --> 00:07:03,440
the ocean so how do we know there are

183
00:07:07,510 --> 00:07:05,520
hydrothermal vents there

184
00:07:09,110 --> 00:07:07,520
in my next graphic

185
00:07:11,270 --> 00:07:09,120
we believe there's some really good

186
00:07:13,589 --> 00:07:11,280
indications of that

187
00:07:15,670 --> 00:07:13,599
so at the very bottom of this graphic we

188
00:07:16,870 --> 00:07:15,680

see what a hydrothermal vent might look

189

00:07:20,950 --> 00:07:16,880

like

190

00:07:23,909 --> 00:07:20,960

that we have

191

00:07:26,790 --> 00:07:23,919

on io must be at the bottom of the ocean

192

00:07:29,589 --> 00:07:26,800

this is causing the water to be heated

193

00:07:31,990 --> 00:07:29,599

massive circulation going on and in fact

194

00:07:34,870 --> 00:07:32,000

that heat must actually go all the way

195

00:07:36,710 --> 00:07:34,880

up to the crust itself

196

00:07:39,350 --> 00:07:36,720

now we don't really know how thick the

197

00:07:40,710 --> 00:07:39,360

crust is we believe it's on the order of

198

00:07:42,550 --> 00:07:40,720

sometimes

199

00:07:44,790 --> 00:07:42,560

10 kilometers

200

00:07:47,270 --> 00:07:44,800

but in actuality it may be only a few

201
00:07:49,589 --> 00:07:47,280
kilometers in spots and in fact we

202
00:07:52,790 --> 00:07:49,599
believe the cracks may open and close

203
00:07:54,550 --> 00:07:52,800
based on tidal forces forcing water back

204
00:07:55,510 --> 00:07:54,560
out onto the surface

205
00:07:57,670 --> 00:07:55,520
so

206
00:08:00,550 --> 00:07:57,680
as we see here in this particular

207
00:08:02,550 --> 00:08:00,560
graphic that heat is transferred to the

208
00:08:05,510 --> 00:08:02,560
top of the ice shell

209
00:08:08,070 --> 00:08:05,520
the ocean may be as deep as a thousand

210
00:08:11,430 --> 00:08:08,080
or sorry a hundred kilometers

211
00:08:14,390 --> 00:08:11,440
so if i have the next graphic please

212
00:08:17,110 --> 00:08:14,400
here we see the very top of the uh the

213
00:08:19,110 --> 00:08:17,120

surface the ice crust and what we see in

214

00:08:20,070 --> 00:08:19,120

the center is what we call a chaos

215

00:08:22,469 --> 00:08:20,080

region

216

00:08:25,110 --> 00:08:22,479

we believe there's good indication that

217

00:08:27,510 --> 00:08:25,120

right below this chaos region is some of

218

00:08:29,990 --> 00:08:27,520

these hydrothermal vents it's very

219

00:08:33,110 --> 00:08:30,000

consistent with our model of

220

00:08:35,670 --> 00:08:33,120

of the ocean being heated from below

221

00:08:37,829 --> 00:08:35,680

and breaking up the ice and in the cold

222

00:08:40,709 --> 00:08:37,839

environment that the surface of europa

223

00:08:43,750 --> 00:08:40,719

has experienced then ice is over and

224

00:08:45,829 --> 00:08:43,760

produces these chaos patterns we also

225

00:08:47,990 --> 00:08:45,839

see the discoloration

226

00:08:51,590 --> 00:08:48,000

of these particular areas indicating

227

00:08:54,470 --> 00:08:51,600

that there may be organics or nutrients

228

00:08:56,389 --> 00:08:54,480

that that is sulfur certainly that is

229

00:08:59,509 --> 00:08:56,399

filling these regions

230

00:09:03,030 --> 00:08:59,519

and the discoloration is showing us

231

00:09:05,910 --> 00:09:03,040

now on the lower panel on the on the

232

00:09:07,990 --> 00:09:05,920

right side is an is another process we

233

00:09:09,190 --> 00:09:08,000

also believe is going on this is called

234

00:09:10,470 --> 00:09:09,200

subduction

235

00:09:12,790 --> 00:09:10,480

this is where

236

00:09:16,310 --> 00:09:12,800

at a particular crack there may be one

237

00:09:17,910 --> 00:09:16,320

plate that's moving under another plate

238

00:09:19,590 --> 00:09:17,920

uh also

239

00:09:20,470 --> 00:09:19,600

producing heat

240

00:09:24,070 --> 00:09:20,480

and

241

00:09:26,070 --> 00:09:24,080

possibly being able to produce plumes

242

00:09:28,470 --> 00:09:26,080

now as you see in the upper right corner

243

00:09:30,550 --> 00:09:28,480

as john mentioned this is indeed

244

00:09:33,750 --> 00:09:30,560

taken from hubble data we've got

245

00:09:36,550 --> 00:09:33,760

indication uh that there are uh plumes

246

00:09:39,269 --> 00:09:36,560

uh at europa and hubble has been

247

00:09:41,990 --> 00:09:39,279

observing europa now for a significant

248

00:09:43,829 --> 00:09:42,000

period of time in search of

249

00:09:45,110 --> 00:09:43,839

what are the reasons that these plumes

250

00:09:47,110 --> 00:09:45,120

are occurring

251
00:09:49,990 --> 00:09:47,120
so this is indeed a tremendously

252
00:09:52,230 --> 00:09:50,000
exciting opportunity a time for us and

253
00:09:53,590 --> 00:09:52,240
what i'd like to do now is switch to a

254
00:09:55,269 --> 00:09:53,600
little movie

255
00:09:58,310 --> 00:09:55,279
as john mentioned

256
00:09:59,990 --> 00:09:58,320
we've started the process of announcing

257
00:10:03,509 --> 00:10:00,000
our instruments for

258
00:10:06,150 --> 00:10:03,519
a multiple flyby mission of europa

259
00:10:08,550 --> 00:10:06,160
this particular movie once we get her

260
00:10:11,350 --> 00:10:08,560
started shows our our

261
00:10:14,230 --> 00:10:11,360
concept of our spacecraft

262
00:10:17,590 --> 00:10:14,240
flying by europa it's actually orbiting

263
00:10:19,110 --> 00:10:17,600

jupiter we find that multiple flybys

264

00:10:21,990 --> 00:10:19,120

can allow us

265

00:10:24,710 --> 00:10:22,000

to get a complete picture of europa

266

00:10:26,630 --> 00:10:24,720

uh after many flybys also the

267

00:10:27,829 --> 00:10:26,640

opportunity of flying through one of the

268

00:10:29,350 --> 00:10:27,839

plumes

269

00:10:32,150 --> 00:10:29,360

so the instruments that we're going to

270

00:10:34,389 --> 00:10:32,160

talk about today indeed set the stage

271

00:10:37,269 --> 00:10:34,399

for what europa looks like

272

00:10:38,069 --> 00:10:37,279

in great detail on its surface it tells

273

00:10:43,350 --> 00:10:38,079

us

274

00:10:45,430 --> 00:10:43,360

perhaps how the under

275

00:10:46,790 --> 00:10:45,440

ice crust ocean is communicating with

276

00:10:49,829 --> 00:10:46,800

the surface

277

00:10:51,990 --> 00:10:49,839

through these plumes and allows us to

278

00:10:54,230 --> 00:10:52,000

make these kind of detailed measurements

279

00:10:56,790 --> 00:10:54,240

over a long period of time

280

00:10:58,150 --> 00:10:56,800

and so to understand what we've selected

281

00:11:00,710 --> 00:10:58,160

and to talk about each of the

282

00:11:03,590 --> 00:11:00,720

instruments let me turn it over to kurt

283

00:11:06,389 --> 00:11:03,600

nieber kurt thanks jim

284

00:11:07,750 --> 00:11:06,399

we received 33 proposals from people

285

00:11:09,590 --> 00:11:07,760

interested in building instruments for

286

00:11:11,509 --> 00:11:09,600

this mission and today we're announcing

287

00:11:13,030 --> 00:11:11,519

the selection of nine of those to fly on

288

00:11:14,470 --> 00:11:13,040

the spacecraft that we eventually send

289

00:11:15,670 --> 00:11:14,480

to europa

290

00:11:18,310 --> 00:11:15,680

all of these

291

00:11:20,470 --> 00:11:18,320

instruments are designed to increase our

292

00:11:22,069 --> 00:11:20,480

rather limited knowledge of europa and

293

00:11:24,870 --> 00:11:22,079

they're doing that by helping us probe

294

00:11:26,870 --> 00:11:24,880

the big question which is is europa

295

00:11:28,949 --> 00:11:26,880

habitable that's a very difficult

296

00:11:31,670 --> 00:11:28,959

question to answer and these instruments

297

00:11:32,949 --> 00:11:31,680

all pursue a different aspect of that

298

00:11:34,230 --> 00:11:32,959

big question

299

00:11:35,190 --> 00:11:34,240

so if i could have the first slide

300

00:11:37,430 --> 00:11:35,200

please

301

00:11:39,190 --> 00:11:37,440

the first two instruments that we'll be

302

00:11:42,069 --> 00:11:39,200

talking about today are magnetometer and

303

00:11:44,150 --> 00:11:42,079

a series of three faraday cups these are

304

00:11:46,710 --> 00:11:44,160

rather small and straightforward

305

00:11:48,790 --> 00:11:46,720

instruments that provide a very powerful

306

00:11:50,470 --> 00:11:48,800

and useful data set

307

00:11:52,069 --> 00:11:50,480

what they allow us to do by measuring

308

00:11:54,230 --> 00:11:52,079

the magnetic field and the plasma

309

00:11:55,350 --> 00:11:54,240

environment of europa in exquisite

310

00:11:57,190 --> 00:11:55,360

detail

311

00:12:00,069 --> 00:11:57,200

means that we can essentially take an

312

00:12:03,110 --> 00:12:00,079

mri of the interior structure of europa

313

00:12:05,350 --> 00:12:03,120

without actually accessing it

314

00:12:07,190 --> 00:12:05,360

what they can do if you look at the

315

00:12:09,110 --> 00:12:07,200

the part of the lower right that very

316

00:12:11,350 --> 00:12:09,120

complex diagram what that indicates is

317

00:12:13,269 --> 00:12:11,360

that if we're very clever

318

00:12:15,030 --> 00:12:13,279

and when and where we take those

319

00:12:17,990 --> 00:12:15,040

measurements what we can actually do as

320

00:12:22,069 --> 00:12:18,000

we fly by europa is figure out how deep

321

00:12:23,829 --> 00:12:22,079

that global ocean is and how salty it is

322

00:12:25,590 --> 00:12:23,839

and we can do all of that without

323

00:12:28,230 --> 00:12:25,600

actually cracking open the crust and

324

00:12:30,230 --> 00:12:28,240

dipping our instruments into the ocean

325

00:12:33,509 --> 00:12:30,240

just as a doctor can see what's going on

326

00:12:35,750 --> 00:12:33,519

inside your body by using an mri

327

00:12:37,110 --> 00:12:35,760

next slide please

328

00:12:39,190 --> 00:12:37,120

the next instrument i want to talk about

329

00:12:41,590 --> 00:12:39,200

is a special camera we call an infrared

330

00:12:44,629 --> 00:12:41,600

spectrometer but this camera doesn't

331

00:12:46,949 --> 00:12:44,639

take pictures of the surface instead it

332

00:12:49,030 --> 00:12:46,959

acquires something we call spectra which

333

00:12:51,430 --> 00:12:49,040

are those squiggly lines you see on the

334

00:12:54,230 --> 00:12:51,440

right hand side in the logo

335

00:12:56,310 --> 00:12:54,240

spectra are very beautiful things

336

00:12:58,150 --> 00:12:56,320

because they're not random squiggly

337

00:13:00,230 --> 00:12:58,160

lines they're actually unique

338

00:13:02,069 --> 00:13:00,240

fingerprints that can tell us what

339

00:13:03,350 --> 00:13:02,079

materials are on or on the surface of

340

00:13:05,269 --> 00:13:03,360

europa

341

00:13:08,230 --> 00:13:05,279

so if we know that a certain material

342

00:13:10,389 --> 00:13:08,240

say table salt has a squiggly line of a

343

00:13:12,470 --> 00:13:10,399

certain shape a fingerprint of a certain

344

00:13:14,230 --> 00:13:12,480

shape and then we and then this

345

00:13:15,350 --> 00:13:14,240

instrument shows us that fingerprint on

346

00:13:17,269 --> 00:13:15,360

europa

347

00:13:19,269 --> 00:13:17,279

what we then know is that table salt

348

00:13:21,509 --> 00:13:19,279

exists on europa

349

00:13:24,870 --> 00:13:21,519

and by cataloging the entire surface we

350

00:13:27,030 --> 00:13:24,880

can get a near global map of the stuff

351
00:13:29,509 --> 00:13:27,040
that populates europa's surface we can

352
00:13:31,670 --> 00:13:29,519
know what it is made out of and we can

353
00:13:33,190 --> 00:13:31,680
do that for almost the entire surface

354
00:13:35,590 --> 00:13:33,200
now the reason that's important is

355
00:13:37,110 --> 00:13:35,600
because of that brownish gunk that jim

356
00:13:39,590 --> 00:13:37,120
mentioned and that is our

357
00:13:42,230 --> 00:13:39,600
state-of-the-art term for it brown gunk

358
00:13:44,550 --> 00:13:42,240
because we don't know what it is we have

359
00:13:46,790 --> 00:13:44,560
a lot of educated guesses

360
00:13:49,829 --> 00:13:46,800
but they're just that they're guesses we

361
00:13:52,069 --> 00:13:49,839
need actual data to be able to nail this

362
00:13:53,590 --> 00:13:52,079
material down and this material is

363
00:13:54,949 --> 00:13:53,600

important because as you see in the

364

00:13:57,350 --> 00:13:54,959

middle picture

365

00:14:00,230 --> 00:13:57,360

there that brownish gunk

366

00:14:03,269 --> 00:14:00,240

is associated with the absolute newest

367

00:14:05,030 --> 00:14:03,279

youngest areas on europa's surface

368

00:14:07,829 --> 00:14:05,040

these are areas where we think that

369

00:14:10,150 --> 00:14:07,839

water is erupting onto the surface just

370

00:14:11,430 --> 00:14:10,160

like lava erupts onto the surface of

371

00:14:14,069 --> 00:14:11,440

earth

372

00:14:15,750 --> 00:14:14,079

and this brownish gunk is what is being

373

00:14:18,470 --> 00:14:15,760

carried in that water so if we can

374

00:14:20,629 --> 00:14:18,480

determine what that brown gunk is

375

00:14:23,350 --> 00:14:20,639

we can then understand what is in the

376

00:14:25,189 --> 00:14:23,360

water what's in the oceans of europa and

377

00:14:27,189 --> 00:14:25,199

that is an incredibly important question

378

00:14:30,389 --> 00:14:27,199

to answer if we're trying to figure out

379

00:14:32,069 --> 00:14:30,399

if this place is habitable next slide

380

00:14:33,910 --> 00:14:32,079

please

381

00:14:35,910 --> 00:14:33,920

so the next instrument is actually is a

382

00:14:38,389 --> 00:14:35,920

camera and it's actually a set of two

383

00:14:40,949 --> 00:14:38,399

cameras there is a wide angle camera

384

00:14:43,350 --> 00:14:40,959

that provides large images of relatively

385

00:14:45,269 --> 00:14:43,360

low resolution of the surface and those

386

00:14:47,670 --> 00:14:45,279

images are in color and then there's a

387

00:14:49,590 --> 00:14:47,680

narrow angle camera that provides very

388

00:14:51,910 --> 00:14:49,600

high resolution images

389

00:14:52,949 --> 00:14:51,920

this is really a critical instrument for

390

00:14:54,710 --> 00:14:52,959

this mission

391

00:14:57,350 --> 00:14:54,720

because the best pictures we have of

392

00:14:59,750 --> 00:14:57,360

europa are from galileo the mission that

393

00:15:02,069 --> 00:14:59,760

that john mentioned and galileo was a

394

00:15:04,150 --> 00:15:02,079

truly phenomenal mission and is the

395

00:15:06,470 --> 00:15:04,160

mission that that revealed to us that

396

00:15:08,629 --> 00:15:06,480

there's a global ocean on europa

397

00:15:09,350 --> 00:15:08,639

but we often overlook the simple fact

398

00:15:11,590 --> 00:15:09,360

that

399

00:15:12,470 --> 00:15:11,600

galileo only flew by europa about 11

400

00:15:14,790 --> 00:15:12,480

times

401
00:15:17,990 --> 00:15:14,800
it did not get a lot of pictures of

402
00:15:21,910 --> 00:15:19,990
when you sum all those pictures up we've

403
00:15:24,710 --> 00:15:21,920
only seen about 10 percent of the

404
00:15:27,030 --> 00:15:24,720
surface of europa at a resolution of 200

405
00:15:29,430 --> 00:15:27,040
meters or better that means that there

406
00:15:31,189 --> 00:15:29,440
is a lot of terrain that we don't really

407
00:15:33,990 --> 00:15:31,199
have good pictures of

408
00:15:36,069 --> 00:15:34,000
but we have spent the past 15 years

409
00:15:38,949 --> 00:15:36,079
pouring over those small number of

410
00:15:41,750 --> 00:15:38,959
pictures over and over again for two

411
00:15:43,430 --> 00:15:41,760
reasons first of all because they're the

412
00:15:45,509 --> 00:15:43,440
only pictures we have

413
00:15:47,509 --> 00:15:45,519

and second of all because they're such

414

00:15:49,670 --> 00:15:47,519

fascinating pictures and you see

415

00:15:51,350 --> 00:15:49,680

examples of some of those on this slide

416

00:15:53,670 --> 00:15:51,360

in the center you see a picture of an

417

00:15:56,069 --> 00:15:53,680

area that that looks like a cracked up

418

00:15:58,550 --> 00:15:56,079

jigsaw puzzle we see regions on europa

419

00:16:00,870 --> 00:15:58,560

where there are huge blocks tens of

420

00:16:02,470 --> 00:16:00,880

kilometers across that look like

421

00:16:04,629 --> 00:16:02,480

icebergs that have been melted out and

422

00:16:06,069 --> 00:16:04,639

have rotated and shifted and you can

423

00:16:08,629 --> 00:16:06,079

actually look at this picture and you

424

00:16:10,389 --> 00:16:08,639

can reassemble that jigsaw puzzle and

425

00:16:12,629 --> 00:16:10,399

put those pieces back together but

426

00:16:14,310 --> 00:16:12,639

something caused them to shift

427

00:16:17,430 --> 00:16:14,320

we also see in the lower left hand

428

00:16:19,030 --> 00:16:17,440

corner icebergs that are kilometers high

429

00:16:21,030 --> 00:16:19,040

with sheer with

430

00:16:22,389 --> 00:16:21,040

sheer vertical cliffs

431

00:16:24,629 --> 00:16:22,399

and then in the upper right corner you

432

00:16:26,870 --> 00:16:24,639

see these odd ridges that are ubiquitous

433

00:16:29,189 --> 00:16:26,880

on europa they are everywhere

434

00:16:31,430 --> 00:16:29,199

and they look remarkably similar to the

435

00:16:33,670 --> 00:16:31,440

mid-ocean spread spreading ridges we see

436

00:16:36,389 --> 00:16:33,680

on earth where these are ridges that are

437

00:16:38,230 --> 00:16:36,399

pulling apart from one another as in

438

00:16:41,030 --> 00:16:38,240

this case water could be erupting from

439

00:16:42,710 --> 00:16:41,040

below and pushing the crust apart

440

00:16:44,710 --> 00:16:42,720

these are the things we've seen just by

441

00:16:46,949 --> 00:16:44,720

looking at 10 percent

442

00:16:49,829 --> 00:16:46,959

of the surface of europa the instrument

443

00:16:51,990 --> 00:16:49,839

we selected today will cover almost 90

444

00:16:53,189 --> 00:16:52,000

percent of the surface at 50 meter

445

00:16:55,110 --> 00:16:53,199

resolution

446

00:16:57,110 --> 00:16:55,120

and if we've seen such amazing things on

447

00:16:59,269 --> 00:16:57,120

only 10 percent of the surface it's hard

448

00:17:01,269 --> 00:16:59,279

to even imagine the amazing things we'll

449

00:17:02,949 --> 00:17:01,279

see when we look at the rest of europa

450

00:17:04,789 --> 00:17:02,959

at even better res

451
00:17:08,150 --> 00:17:04,799
even better resolution

452
00:17:12,069 --> 00:17:10,150
as john mentioned we think europa has a

453
00:17:14,390 --> 00:17:12,079
very young surface because there aren't

454
00:17:16,470 --> 00:17:14,400
a lot of craters on the surface and if

455
00:17:18,549 --> 00:17:16,480
it's young that means it must be very

456
00:17:20,069 --> 00:17:18,559
active something is causing that surface

457
00:17:21,590 --> 00:17:20,079
to renew itself

458
00:17:23,669 --> 00:17:21,600
the next two instruments help us

459
00:17:26,150 --> 00:17:23,679
investigate that activity something is

460
00:17:28,789 --> 00:17:26,160
causing the surface of europa to turn

461
00:17:30,470 --> 00:17:28,799
over to generate new surface

462
00:17:32,470 --> 00:17:30,480
what the ice penetrating radar on the

463
00:17:34,390 --> 00:17:32,480

left here does is allow us to see

464

00:17:37,110 --> 00:17:34,400

underneath the surface of europa we can

465

00:17:38,950 --> 00:17:37,120

actually probe it in three dimensions

466

00:17:40,950 --> 00:17:38,960

it allows us to see the structure in the

467

00:17:43,190 --> 00:17:40,960

layers of the ice underneath see how

468

00:17:44,390 --> 00:17:43,200

those layers have shifted and bent and

469

00:17:45,990 --> 00:17:44,400

twisted

470

00:17:48,549 --> 00:17:46,000

and what that means is we can see how

471

00:17:51,270 --> 00:17:48,559

they're oriented and get a better idea

472

00:17:53,270 --> 00:17:51,280

of how they have changed through time

473

00:17:55,590 --> 00:17:53,280

this radar is also very good at

474

00:17:57,909 --> 00:17:55,600

detecting subsurface water

475

00:18:00,470 --> 00:17:57,919

recently we we have strong evidence that

476

00:18:02,789 --> 00:18:00,480

there are lakes underneath the ice crust

477

00:18:06,630 --> 00:18:02,799

on europa just as we have found over the

478

00:18:08,710 --> 00:18:06,640

past decade or so in antarctica on earth

479

00:18:10,630 --> 00:18:08,720

and we think these lakes are incredibly

480

00:18:12,710 --> 00:18:10,640

common on europa

481

00:18:15,190 --> 00:18:12,720

this radar will be able to identify

482

00:18:17,909 --> 00:18:15,200

those lakes tell us where they are how

483

00:18:19,350 --> 00:18:17,919

big they are how much water they contain

484

00:18:21,350 --> 00:18:19,360

and this is important because these

485

00:18:22,310 --> 00:18:21,360

lakes are likely very close to the

486

00:18:24,950 --> 00:18:22,320

surface

487

00:18:26,310 --> 00:18:24,960

which makes them easier to study

488

00:18:28,710 --> 00:18:26,320

the other instrument you see on this

489

00:18:30,630 --> 00:18:28,720

slide is what we call the thermal imager

490

00:18:32,630 --> 00:18:30,640

this is our heat detector

491

00:18:34,150 --> 00:18:32,640

this is important because if there's

492

00:18:37,350 --> 00:18:34,160

activity going on on the surface of

493

00:18:38,310 --> 00:18:37,360

europa that activity is associated with

494

00:18:40,310 --> 00:18:38,320

heat

495

00:18:42,549 --> 00:18:40,320

that's what's powering the engine that's

496

00:18:44,549 --> 00:18:42,559

going that's operating here

497

00:18:46,150 --> 00:18:44,559

so finding the relatively hot spots can

498

00:18:48,950 --> 00:18:46,160

help us understand where and how

499

00:18:51,750 --> 00:18:48,960

europa's surface is active

500

00:18:54,950 --> 00:18:51,760

hot spots being a fairly relative term

501
00:18:56,710 --> 00:18:54,960
europa surface is about minus 160

502
00:18:58,549 --> 00:18:56,720
degrees celsius

503
00:19:00,789 --> 00:18:58,559
we're looking for areas that that are

504
00:19:03,190 --> 00:19:00,799
just a couple of degrees warmer than

505
00:19:05,270 --> 00:19:03,200
that so we're still talking very frigid

506
00:19:07,270 --> 00:19:05,280
temperatures so this is an incredibly

507
00:19:09,110 --> 00:19:07,280
sensitive instrument

508
00:19:11,190 --> 00:19:09,120
but conversely

509
00:19:13,110 --> 00:19:11,200
there might be areas on europa such as

510
00:19:16,470 --> 00:19:13,120
where plumes are erupting or where

511
00:19:18,870 --> 00:19:16,480
there's active eruptions of water

512
00:19:21,510 --> 00:19:18,880
that might be 100 or even 150 degrees

513
00:19:23,350 --> 00:19:21,520

warmer than that and this instrument

514

00:19:24,470 --> 00:19:23,360

will do a very good job of pinpointing

515

00:19:26,470 --> 00:19:24,480

those regions

516

00:19:28,150 --> 00:19:26,480

some of which could be very small and

517

00:19:30,230 --> 00:19:28,160

that's what you see in that simulated

518

00:19:31,430 --> 00:19:30,240

image on the lower right hand corner

519

00:19:34,310 --> 00:19:31,440

that's an image of one of those

520

00:19:35,750 --> 00:19:34,320

spreading ridges that we see on europa

521

00:19:38,310 --> 00:19:35,760

along with what we think could be the

522

00:19:40,549 --> 00:19:38,320

heat signature the thermal signature as

523

00:19:42,310 --> 00:19:40,559

it erupts new material onto the surface

524

00:19:44,310 --> 00:19:42,320

and this thermal imager will be able to

525

00:19:46,470 --> 00:19:44,320

spot that activity

526

00:19:48,950 --> 00:19:46,480

very precisely

527

00:19:51,270 --> 00:19:48,960

next slide please

528

00:19:53,510 --> 00:19:51,280

next we come to our next two instruments

529

00:19:55,990 --> 00:19:53,520

that are composition instruments these

530

00:19:58,630 --> 00:19:56,000

provide very detailed information on the

531

00:20:00,549 --> 00:19:58,640

composition of europa using a different

532

00:20:02,390 --> 00:20:00,559

technique than the infrared spectrometer

533

00:20:04,390 --> 00:20:02,400

i already mentioned

534

00:20:06,630 --> 00:20:04,400

the infrared spectrometer is

535

00:20:08,150 --> 00:20:06,640

looking at the entire surface of europa

536

00:20:10,549 --> 00:20:08,160

but what these instruments do is they

537

00:20:12,630 --> 00:20:10,559

actually ingest samples of europa that

538

00:20:14,310 --> 00:20:12,640

have been blasted into space and

539

00:20:15,830 --> 00:20:14,320

directly measure them

540

00:20:17,750 --> 00:20:15,840

the first one in the top left-hand

541

00:20:20,070 --> 00:20:17,760

corner is called mass specs

542

00:20:22,150 --> 00:20:20,080

and what this does is essentially sample

543

00:20:26,789 --> 00:20:22,160

the atmosphere of europa

544

00:20:28,950 --> 00:20:26,799

is really a misnomer europa's doesn't

545

00:20:31,350 --> 00:20:28,960

have an atmosphere it's it's a vacuum so

546

00:20:33,190 --> 00:20:31,360

the materials we see around europa are

547

00:20:35,110 --> 00:20:33,200

actually materials from the surface that

548

00:20:37,909 --> 00:20:35,120

have been lofted into space

549

00:20:40,549 --> 00:20:37,919

and what this instrument does is analyze

550

00:20:41,990 --> 00:20:40,559

the composition of those surface samples

551
00:20:44,390 --> 00:20:42,000
those gases

552
00:20:46,830 --> 00:20:44,400
to an incredibly precise degree better

553
00:20:49,430 --> 00:20:46,840
than we ever have with any other

554
00:20:51,270 --> 00:20:49,440
mission similarly the second instrument

555
00:20:53,430 --> 00:20:51,280
called suda does about the same thing

556
00:20:55,909 --> 00:20:53,440
but instead of working with gases

557
00:20:58,230 --> 00:20:55,919
it's working with dust it is working

558
00:21:00,230 --> 00:20:58,240
with very small particulates of rock and

559
00:21:02,230 --> 00:21:00,240
ice that have been blasted off the

560
00:21:04,149 --> 00:21:02,240
surface of europa and lofted up to where

561
00:21:05,830 --> 00:21:04,159
the spacecraft is at

562
00:21:07,590 --> 00:21:05,840
and working together with these two

563
00:21:10,549 --> 00:21:07,600

instruments can do is measure the

564

00:21:13,350 --> 00:21:10,559

surface composition of europa without

565

00:21:15,990 --> 00:21:13,360

actually having to land on europa which

566

00:21:18,310 --> 00:21:16,000

is a very powerful technique for us but

567

00:21:20,470 --> 00:21:18,320

the real power of these two instruments

568

00:21:23,270 --> 00:21:20,480

is shown in the center picture here

569

00:21:25,029 --> 00:21:23,280

which is a diagram uh denoting some of

570

00:21:27,110 --> 00:21:25,039

the chemistry that occurs on the

571

00:21:28,070 --> 00:21:27,120

hydrothermal vents on earth's ocean

572

00:21:29,750 --> 00:21:28,080

floor

573

00:21:31,909 --> 00:21:29,760

with these two instruments what we can

574

00:21:33,430 --> 00:21:31,919

do is when samples from down there are

575

00:21:35,350 --> 00:21:33,440

lofted to the surface and brought to the

576
00:21:37,029 --> 00:21:35,360
spacecraft these instruments are

577
00:21:39,510 --> 00:21:37,039
powerful enough

578
00:21:41,909 --> 00:21:39,520
and precise enough that they can

579
00:21:43,669 --> 00:21:41,919
actually from orbit

580
00:21:46,390 --> 00:21:43,679
teach us about the chemistry happening

581
00:21:48,230 --> 00:21:46,400
at the bottom of europa's ocean

582
00:21:49,430 --> 00:21:48,240
without actually having to dive into

583
00:21:50,789 --> 00:21:49,440
that ocean

584
00:21:52,630 --> 00:21:50,799
these are techniques that we've used

585
00:21:54,950 --> 00:21:52,640
very successfully on the cassini mission

586
00:21:57,270 --> 00:21:54,960
to understand enceladus and its ocean

587
00:21:59,669 --> 00:21:57,280
and its plumes the instruments that

588
00:22:01,830 --> 00:21:59,679

we'll be taking on to europa are several

589

00:22:04,950 --> 00:22:01,840

generations more advanced

590

00:22:07,909 --> 00:22:04,960

than what we have on the cassini mission

591

00:22:12,630 --> 00:22:10,070

and finally we have our plume hunter an

592

00:22:15,190 --> 00:22:12,640

ultraviolet spectrograph this is an

593

00:22:17,590 --> 00:22:15,200

instrument that is specifically designed

594

00:22:19,110 --> 00:22:17,600

to find the plumes that that we recently

595

00:22:19,830 --> 00:22:19,120

discovered and that we're so interested

596

00:22:25,750 --> 00:22:19,840

in

597

00:22:27,590 --> 00:22:25,760

about the plumes but this is the

598

00:22:29,270 --> 00:22:27,600

instrument that specifically is designed

599

00:22:31,669 --> 00:22:29,280

to hunt them down

600

00:22:33,750 --> 00:22:31,679

and tell us where they're at

601
00:22:35,830 --> 00:22:33,760
this instrument uses the same technique

602
00:22:38,149 --> 00:22:35,840
that the hubble space telescope used to

603
00:22:40,230 --> 00:22:38,159
first find evidence of these plumes and

604
00:22:42,630 --> 00:22:40,240
as we are flying both near and far from

605
00:22:45,430 --> 00:22:42,640
europa it will identify where those

606
00:22:48,070 --> 00:22:45,440
plumes are how active they are what kind

607
00:22:50,149 --> 00:22:48,080
of materials they are spewing into space

608
00:22:52,070 --> 00:22:50,159
and how they vary with time because as

609
00:22:54,149 --> 00:22:52,080
john mentioned we're already seeing

610
00:22:57,190 --> 00:22:54,159
evidence that these plumes change with

611
00:22:59,430 --> 00:22:57,200
time they start they stop they move they

612
00:23:01,510 --> 00:22:59,440
start up again the dynamics of these

613
00:23:03,909 --> 00:23:01,520

plumes are very complicated and we don't

614

00:23:06,549 --> 00:23:03,919

understand them yet so bringing along an

615

00:23:08,390 --> 00:23:06,559

instrument that can observe those plumes

616

00:23:10,630 --> 00:23:08,400

and give us an understanding as to where

617

00:23:12,630 --> 00:23:10,640

and why they pop up is incredibly

618

00:23:14,630 --> 00:23:12,640

valuable

619

00:23:16,310 --> 00:23:14,640

next slide please

620

00:23:17,510 --> 00:23:16,320

so this is a very wonderful set of

621

00:23:19,510 --> 00:23:17,520

instruments

622

00:23:23,190 --> 00:23:19,520

but recall that the big question that

623

00:23:25,190 --> 00:23:23,200

this mission needs to answer is europa

624

00:23:27,750 --> 00:23:25,200

habitable

625

00:23:28,710 --> 00:23:27,760

posing big questions like that is very

626
00:23:30,470 --> 00:23:28,720
easy

627
00:23:32,630 --> 00:23:30,480
but answering them is much more

628
00:23:35,029 --> 00:23:32,640
difficult so what we need to do to

629
00:23:37,110 --> 00:23:35,039
answer that big question is europa

630
00:23:39,750 --> 00:23:37,120
habitable is break it apart into more

631
00:23:41,270 --> 00:23:39,760
manual manageable chunks into smaller

632
00:23:42,630 --> 00:23:41,280
questions that we can answer

633
00:23:44,870 --> 00:23:42,640
definitively

634
00:23:46,390 --> 00:23:44,880
and those are the questions listed here

635
00:23:47,830 --> 00:23:46,400
these are the questions that the next

636
00:23:50,230 --> 00:23:47,840
mission to europa

637
00:23:52,710 --> 00:23:50,240
must answer because once we have

638
00:23:55,190 --> 00:23:52,720

definitive answers to these questions we

639

00:23:58,149 --> 00:23:55,200

can then attack the bigger question of

640

00:24:00,390 --> 00:23:58,159

is europa habitable so once we know how

641

00:24:01,350 --> 00:24:00,400

deep and salty that ocean is we can get

642

00:24:02,710 --> 00:24:01,360

a better understanding about

643

00:24:05,110 --> 00:24:02,720

habitability

644

00:24:06,710 --> 00:24:05,120

once we know how thick the ice shell is

645

00:24:08,950 --> 00:24:06,720

and to what extent it communicates with

646

00:24:10,789 --> 00:24:08,960

that ocean and brings material up to the

647

00:24:12,950 --> 00:24:10,799

surface of material back down into the

648

00:24:15,190 --> 00:24:12,960

water we can have a better understanding

649

00:24:17,110 --> 00:24:15,200

of whether or not europa is habitable

650

00:24:19,750 --> 00:24:17,120

once we understand how active the ice

651
00:24:21,430 --> 00:24:19,760
shell is and how it is behaving with

652
00:24:23,190 --> 00:24:21,440
time we can better understand

653
00:24:24,789 --> 00:24:23,200
habitability

654
00:24:27,830 --> 00:24:24,799
and once we understand what that

655
00:24:29,830 --> 00:24:27,840
ubiquitous brown gunk is

656
00:24:32,630 --> 00:24:29,840
we can understand what one of the direct

657
00:24:34,149 --> 00:24:32,640
components of that ocean is

658
00:24:36,630 --> 00:24:34,159
all of these things feed into that

659
00:24:38,310 --> 00:24:36,640
habitability question and finally one of

660
00:24:40,310 --> 00:24:38,320
the most recent questions that we've

661
00:24:41,669 --> 00:24:40,320
begun struggling to answer is where are

662
00:24:43,190 --> 00:24:41,679
those plumes

663
00:24:45,269 --> 00:24:43,200

what's in them

664

00:24:48,070 --> 00:24:45,279

are they really coming are they really

665

00:24:50,789 --> 00:24:48,080

delivering samples of the ocean to us in

666

00:24:53,110 --> 00:24:50,799

space that we can easily access

667

00:24:54,789 --> 00:24:53,120

and if that's the case how can we get at

668

00:24:56,070 --> 00:24:54,799

them and what kind of measurements can

669

00:24:58,390 --> 00:24:56,080

we take on them

670

00:25:00,789 --> 00:24:58,400

this payload will answer all of these

671

00:25:02,230 --> 00:25:00,799

questions and help us take great strides

672

00:25:06,310 --> 00:25:02,240

forward in understanding the

673

00:25:11,430 --> 00:25:08,950

thank you kurt now let's go into the q a

674

00:25:13,430 --> 00:25:11,440

session if you'd like to ask a question

675

00:25:14,390 --> 00:25:13,440

using social media please use the

676
00:25:17,510 --> 00:25:14,400
hashtag

677
00:25:21,029 --> 00:25:19,430
so before we take questions from social

678
00:25:26,390 --> 00:25:21,039
media let's see if there are any

679
00:25:32,710 --> 00:25:28,390
okay please wait for the mic and say

680
00:25:36,870 --> 00:25:36,149
uh my name's katie hi

681
00:25:40,549 --> 00:25:36,880
so

682
00:25:41,510 --> 00:25:40,559
if you were able to detect any form of

683
00:25:43,269 --> 00:25:41,520
life

684
00:25:47,590 --> 00:25:43,279
what would be the next steps that you

685
00:25:47,600 --> 00:25:52,390
okay i would immediately retire

686
00:25:55,909 --> 00:25:53,350
that's a

687
00:25:57,909 --> 00:25:55,919
i've been telling everyone that you know

688
00:26:00,230 --> 00:25:57,919

answering that big question is is there

689

00:26:01,510 --> 00:26:00,240

life in the universe really starts

690

00:26:02,870 --> 00:26:01,520

uh from

691

00:26:05,110 --> 00:26:02,880

understanding if there's life in the

692

00:26:07,190 --> 00:26:05,120

solar system europa is one of those

693

00:26:09,590 --> 00:26:07,200

critical areas where we believe the

694

00:26:10,789 --> 00:26:09,600

environment is just

695

00:26:13,510 --> 00:26:10,799

perfect

696

00:26:15,430 --> 00:26:13,520

for potential development of life and

697

00:26:17,110 --> 00:26:15,440

and so this mission will

698

00:26:19,830 --> 00:26:17,120

be that step

699

00:26:22,870 --> 00:26:19,840

that helps us understand the environment

700

00:26:25,430 --> 00:26:22,880

and and hopefully give us an indication

701
00:26:27,590 --> 00:26:25,440
how habitable the environment could be

702
00:26:29,190 --> 00:26:27,600
if we do find life or indications of

703
00:26:31,830 --> 00:26:29,200
life

704
00:26:34,390 --> 00:26:31,840
that will be an enormous

705
00:26:36,470 --> 00:26:34,400
step forward in our understanding of of

706
00:26:38,390 --> 00:26:36,480
our place in the universe

707
00:26:40,310 --> 00:26:38,400
if there's life in the solar system and

708
00:26:41,590 --> 00:26:40,320
in europa in particular it must be

709
00:26:43,909 --> 00:26:41,600
everywhere

710
00:26:45,190 --> 00:26:43,919
in in our galaxy and perhaps even in the

711
00:26:47,830 --> 00:26:45,200
universe

712
00:26:50,230 --> 00:26:47,840
so uh understanding the these questions

713
00:26:52,310 --> 00:26:50,240

are important because they have uh you

714

00:26:53,430 --> 00:26:52,320

know really a

715

00:26:54,950 --> 00:26:53,440

major

716

00:26:56,630 --> 00:26:54,960

implication to

717

00:26:59,190 --> 00:26:56,640

to our understanding of our place in the

718

00:27:02,789 --> 00:26:59,200

solar system and in the universe

719

00:27:05,190 --> 00:27:02,799

um hello uh nathan ross and um

720

00:27:06,789 --> 00:27:05,200

you mentioned chaos regions and uh could

721

00:27:07,590 --> 00:27:06,799

you go into a little more detail on

722

00:27:10,950 --> 00:27:07,600

those

723

00:27:14,470 --> 00:27:10,960

graphic where we saw a place on the

724

00:27:18,230 --> 00:27:14,480

surface of europa as a chaos region

725

00:27:20,630 --> 00:27:18,240

it's uh my um uh third graphic uh sorry

726

00:27:23,269 --> 00:27:20,640

yes third graphic there what we're

727

00:27:26,470 --> 00:27:23,279

seeing we believe what's underneath that

728

00:27:29,029 --> 00:27:26,480

chaos region perhaps a

729

00:27:31,750 --> 00:27:29,039

melted lake region

730

00:27:35,510 --> 00:27:31,760

and below that it's being heated by

731

00:27:38,149 --> 00:27:35,520

perhaps a hydrothermal vent at a depth

732

00:27:40,470 --> 00:27:38,159

that we don't really know depends on how

733

00:27:41,269 --> 00:27:40,480

hot the thermal vent is and how close it

734

00:27:43,909 --> 00:27:41,279

is

735

00:27:44,870 --> 00:27:43,919

uh to the to the ice crust

736

00:27:46,789 --> 00:27:44,880

and so

737

00:27:49,190 --> 00:27:46,799

as kurt mentioned one of the instruments

738

00:27:51,269 --> 00:27:49,200

which is an ice penetrating radar

739

00:27:53,750 --> 00:27:51,279

we want to target these regions we want

740

00:27:56,230 --> 00:27:53,760

to fly over we want to see these broken

741

00:27:58,630 --> 00:27:56,240

up ice

742

00:28:01,190 --> 00:27:58,640

sheets if you will creating these chaos

743

00:28:03,110 --> 00:28:01,200

regions and see indeed if there's a

744

00:28:05,510 --> 00:28:03,120

perhaps uh they're very thin perhaps

745

00:28:07,430 --> 00:28:05,520

there's a lake underneath it perhaps uh

746

00:28:10,630 --> 00:28:07,440

either they're completely open to the

747

00:28:14,389 --> 00:28:10,640

ocean below or maybe there's a bottom to

748

00:28:17,430 --> 00:28:14,399

them so um uh in this graphic it uh it

749

00:28:22,470 --> 00:28:17,440

proposes a an under ice

750

00:28:26,789 --> 00:28:25,110

thanks jim let's go to the phone lines

751
00:28:28,789 --> 00:28:26,799
and then social media

752
00:28:31,510 --> 00:28:28,799
first on the line we have irene klotz

753
00:28:33,909 --> 00:28:31,520
from reuters irene

754
00:28:36,870 --> 00:28:33,919
hi thanks very much i have several

755
00:28:39,029 --> 00:28:36,880
questions um the first is jim if you can

756
00:28:41,269 --> 00:28:39,039
maybe just give us an overview of the

757
00:28:43,909 --> 00:28:41,279
funding for the europa mission both

758
00:28:46,230 --> 00:28:43,919
nasa's request and the very much more

759
00:28:48,149 --> 00:28:46,240
money that congress seems to be

760
00:28:49,909 --> 00:28:48,159
interested in putting toward it and the

761
00:28:52,470 --> 00:28:49,919
time frame for

762
00:28:54,789 --> 00:28:52,480
for launching and the status of the

763
00:28:56,789 --> 00:28:54,799

proposal to put a lander on it

764

00:28:59,990 --> 00:28:56,799

and also if you could give us a little

765

00:29:01,990 --> 00:29:00,000

rundown of how much these uh the nine

766

00:29:03,750 --> 00:29:02,000

instruments plus the technology

767

00:29:06,310 --> 00:29:03,760

demonstration the one the attempt one

768

00:29:09,830 --> 00:29:06,320

that right now is inflated for the

769

00:29:11,590 --> 00:29:09,840

orbiter or the clipper um how much nasa

770

00:29:12,549 --> 00:29:11,600

is going to be spending on all those

771

00:29:14,310 --> 00:29:12,559

things

772

00:29:16,549 --> 00:29:14,320

okay so let me see if i can go through

773

00:29:19,750 --> 00:29:16,559

all of those and and pass off a few to

774

00:29:21,029 --> 00:29:19,760

um uh to my colleagues here

775

00:29:24,070 --> 00:29:21,039

um

776

00:29:24,830 --> 00:29:24,080

one of your first questions indeed uh

777

00:29:28,149 --> 00:29:24,840

was

778

00:29:29,990 --> 00:29:28,159

um what about the mission itself as we

779

00:29:32,710 --> 00:29:30,000

announced in february when the president

780

00:29:35,510 --> 00:29:32,720

delivered his budget to congress we have

781

00:29:38,710 --> 00:29:35,520

indeed a projected budget

782

00:29:41,190 --> 00:29:38,720

for the europa mission uh out over uh

783

00:29:43,590 --> 00:29:41,200

the five-year projected budget that the

784

00:29:46,549 --> 00:29:43,600

president provides this is a tremendous

785

00:29:49,350 --> 00:29:46,559

opportunity for us to really get serious

786

00:29:51,430 --> 00:29:49,360

complete our initial studies and move

787

00:29:53,430 --> 00:29:51,440

the mission into what we call

788

00:29:55,990 --> 00:29:53,440

uh formulation

789

00:29:58,149 --> 00:29:56,000

so it's not only

790

00:30:00,070 --> 00:29:58,159

important to know that we're moving

791

00:30:02,389 --> 00:30:00,080

towards that the instrument selection is

792

00:30:04,630 --> 00:30:02,399

the start of that process

793

00:30:06,710 --> 00:30:04,640

but our plans are to

794

00:30:08,950 --> 00:30:06,720

have this key decision point of starting

795

00:30:10,389 --> 00:30:08,960

the formulation before the end of this

796

00:30:12,789 --> 00:30:10,399

fiscal year

797

00:30:15,269 --> 00:30:12,799

now how much is the total mission cost i

798

00:30:16,230 --> 00:30:15,279

think is was your next

799

00:30:17,430 --> 00:30:16,240

question

800

00:30:19,909 --> 00:30:17,440

we have

801
00:30:22,310 --> 00:30:19,919
uh some mission concepts some basic

802
00:30:23,750 --> 00:30:22,320
mission concepts that we are exploring

803
00:30:25,510 --> 00:30:23,760
in great detail

804
00:30:27,350 --> 00:30:25,520
uh that

805
00:30:29,350 --> 00:30:27,360
mean that the mission perhaps is on the

806
00:30:31,190 --> 00:30:29,360
order of two billion dollars without the

807
00:30:32,870 --> 00:30:31,200
launch vehicle in that in that

808
00:30:35,190 --> 00:30:32,880
neighborhood

809
00:30:37,350 --> 00:30:35,200
but what's important to understand is

810
00:30:39,110 --> 00:30:37,360
now that we've made the selection of the

811
00:30:40,710 --> 00:30:39,120
instruments we're going to begin the

812
00:30:43,590 --> 00:30:40,720
accommodations

813
00:30:45,750 --> 00:30:43,600

uh on our mission concept we're going to

814

00:30:48,389 --> 00:30:45,760

move the whole

815

00:30:51,269 --> 00:30:48,399

activity into formulation and get really

816

00:30:53,110 --> 00:30:51,279

serious about all aspects of the mission

817

00:30:55,590 --> 00:30:53,120

we won't really have a detailed

818

00:30:58,230 --> 00:30:55,600

understanding of what that cost profile

819

00:30:59,909 --> 00:30:58,240

is until we are further along in the

820

00:31:02,149 --> 00:30:59,919

process

821

00:31:03,590 --> 00:31:02,159

and so to another one of your questions

822

00:31:10,070 --> 00:31:03,600

is

823

00:31:12,230 --> 00:31:10,080

what have we selected um uh uh costing

824

00:31:14,310 --> 00:31:12,240

and for that let me turn it over to uh

825

00:31:16,870 --> 00:31:14,320

kurt nieber to give you an idea of the

826

00:31:18,870 --> 00:31:16,880

of the cost on the instruments

827

00:31:20,710 --> 00:31:18,880

so over the next year or so we'll be

828

00:31:23,110 --> 00:31:20,720

spending about 10 million dollars total

829

00:31:25,990 --> 00:31:23,120

on the instruments and over the next

830

00:31:28,230 --> 00:31:26,000

three years it comes to uh about 100

831

00:31:30,070 --> 00:31:28,240

million about 100 110 million dollars

832

00:31:31,590 --> 00:31:30,080

total on the instruments that'll get us

833

00:31:33,750 --> 00:31:31,600

to the point where we reach a key

834

00:31:35,029 --> 00:31:33,760

decision point where we decide if we're

835

00:31:37,029 --> 00:31:35,039

going to continue on with the

836

00:31:39,509 --> 00:31:37,039

instruments if some of them are no

837

00:31:41,590 --> 00:31:39,519

longer ready uh and need and we need to

838

00:31:43,509 --> 00:31:41,600

revisit them but in about three years

839

00:31:48,310 --> 00:31:43,519

we'll be ready to to commit to that the

840

00:31:51,669 --> 00:31:50,230

okay we'll take one more question from

841

00:31:52,789 --> 00:31:51,679

the phone lines before going to social

842

00:31:56,230 --> 00:31:52,799

media

843

00:31:58,389 --> 00:31:56,240

next we have jeff faust from space news

844

00:32:00,230 --> 00:31:58,399

jeff

845

00:32:02,389 --> 00:32:00,240

hi um sort of a related question to

846

00:32:04,549 --> 00:32:02,399

irene this one sort of on the schedule

847

00:32:06,549 --> 00:32:04,559

the house is pushing a fairly aggressive

848

00:32:09,990 --> 00:32:06,559

schedule in its appropriations bill

849

00:32:12,630 --> 00:32:10,000

seeking to launch europa mission by 2022

850

00:32:14,789 --> 00:32:12,640

is it reasonable that these instruments

851
00:32:19,110 --> 00:32:14,799
selected today would be ready for flight

852
00:32:23,110 --> 00:32:20,950
given the schedules that the instruments

853
00:32:25,669 --> 00:32:23,120
provided us and the time they need

854
00:32:28,149 --> 00:32:25,679
they could be ready in the early 2020s

855
00:32:29,990 --> 00:32:28,159
but that's also dependent upon how much

856
00:32:33,509 --> 00:32:30,000
money is in the budget for us to give

857
00:32:37,750 --> 00:32:35,430
okay we'll take one more question from

858
00:32:40,389 --> 00:32:37,760
the phone lines this is from mike wall

859
00:32:44,149 --> 00:32:40,399
of space.com

860
00:32:47,269 --> 00:32:45,590
um well

861
00:32:49,909 --> 00:32:47,279
yeah hi guys thanks for actually doing

862
00:32:51,669 --> 00:32:49,919
this um so so there are no explicit

863
00:32:53,269 --> 00:32:51,679

light detection instruments on this

864

00:32:55,509 --> 00:32:53,279

mission right are the i mean could any

865

00:32:57,909 --> 00:32:55,519

of these instruments theoretically find

866

00:33:00,389 --> 00:32:57,919

find some signs of

867

00:33:02,710 --> 00:33:00,399

like damn alien life if if any does

868

00:33:04,710 --> 00:33:02,720

exist on europa and if that's the case

869

00:33:08,870 --> 00:33:04,720

what what sorts of things could it be

870

00:33:13,269 --> 00:33:11,110

well actually that's a great question

871

00:33:15,669 --> 00:33:13,279

and the short answer is

872

00:33:18,070 --> 00:33:15,679

they could find indications of life but

873

00:33:19,909 --> 00:33:18,080

as you said they're not life detectors

874

00:33:21,350 --> 00:33:19,919

and in discussing this question over the

875

00:33:23,190 --> 00:33:21,360

past several months

876

00:33:24,470 --> 00:33:23,200

what became clear is

877

00:33:26,230 --> 00:33:24,480

we don't have

878

00:33:28,310 --> 00:33:26,240

a life detector

879

00:33:30,149 --> 00:33:28,320

we currently don't even have consensus

880

00:33:32,710 --> 00:33:30,159

among the scientific community as to

881

00:33:34,789 --> 00:33:32,720

what we would measure that would tell

882

00:33:36,870 --> 00:33:34,799

everybody with confidence this thing

883

00:33:37,750 --> 00:33:36,880

you're looking at it is alive

884

00:33:39,669 --> 00:33:37,760

so

885

00:33:41,590 --> 00:33:39,679

building a life detector is incredibly

886

00:33:43,590 --> 00:33:41,600

difficult we're not really sure how to

887

00:33:46,230 --> 00:33:43,600

go about building it yet

888

00:33:48,230 --> 00:33:46,240

but it's something that has received

889

00:33:50,230 --> 00:33:48,240

renewed interest and vigor lately

890

00:33:51,909 --> 00:33:50,240

because of the europa mission so that's

891

00:33:54,470 --> 00:33:51,919

something that we're going to be poking

892

00:33:56,470 --> 00:33:54,480

into a lot more aggressively in the near

893

00:33:59,430 --> 00:33:56,480

future

894

00:34:02,470 --> 00:33:59,440

thank thanks kurt uh next question we

895

00:34:04,789 --> 00:34:02,480

have is from ken cramer of uni universe

896

00:34:06,870 --> 00:34:04,799

today

897

00:34:08,950 --> 00:34:06,880

hi thank you for taking my question and

898

00:34:10,869 --> 00:34:08,960

uh doing this briefing i have a few

899

00:34:12,470 --> 00:34:10,879

questions about um the science

900

00:34:14,550 --> 00:34:12,480

instruments one

901
00:34:16,230 --> 00:34:14,560
i wonder depending on the budget uh

902
00:34:18,149 --> 00:34:16,240
could you add more

903
00:34:19,829 --> 00:34:18,159
i'm also wondering on the mass spec can

904
00:34:23,190 --> 00:34:19,839
you talk a little bit about what's the

905
00:34:25,669 --> 00:34:23,200
mass range that it uh can detect uh

906
00:34:29,190 --> 00:34:25,679
uh is there a chiral analyzer that might

907
00:34:31,669 --> 00:34:29,200
be aboard and about the flybys how how

908
00:34:35,190 --> 00:34:31,679
how many do you expect to accomplish and

909
00:34:36,710 --> 00:34:35,200
how long would they be thank you

910
00:34:38,950 --> 00:34:36,720
the issue with the number of instruments

911
00:34:40,550 --> 00:34:38,960
isn't so much money it's real estate

912
00:34:43,109 --> 00:34:40,560
available on the spacecraft you you've

913
00:34:45,190 --> 00:34:43,119

got to have room to bolt them onto onto

914

00:34:47,109 --> 00:34:45,200

the spacecraft you have to have the mass

915

00:34:48,790 --> 00:34:47,119

available to fit them onto the launch

916

00:34:50,710 --> 00:34:48,800

vehicle and you've got to have the power

917

00:34:51,909 --> 00:34:50,720

available to turn them on

918

00:34:53,909 --> 00:34:51,919

so it's

919

00:34:55,909 --> 00:34:53,919

those are the primary considerations

920

00:34:57,750 --> 00:34:55,919

that that drive the size of the payload

921

00:34:59,910 --> 00:34:57,760

as opposed to the cost

922

00:35:01,670 --> 00:34:59,920

you asked about the mass spectrometer

923

00:35:04,550 --> 00:35:01,680

this mass spectrometer that the mass

924

00:35:07,030 --> 00:35:04,560

range is from one to a thousand daltons

925

00:35:09,750 --> 00:35:07,040

uh to give you an idea the cassini mass

926

00:35:11,430 --> 00:35:09,760

spectrometer is between 50 and 100

927

00:35:13,510 --> 00:35:11,440

daltons depending on what mode you have

928

00:35:15,829 --> 00:35:13,520

it operating in and the mass resolution

929

00:35:17,430 --> 00:35:15,839

of this mass spectrometer is also

930

00:35:19,910 --> 00:35:17,440

phenomenal

931

00:35:22,390 --> 00:35:19,920

so it's an incredibly capable mass

932

00:35:24,950 --> 00:35:22,400

spectrometer uh and then your last

933

00:35:26,390 --> 00:35:24,960

question i'm sorry what what was your

934

00:35:27,910 --> 00:35:26,400

last question

935

00:35:29,910 --> 00:35:27,920

analyzer and

936

00:35:30,790 --> 00:35:29,920

also about the flybys how many you'd be

937

00:35:32,790 --> 00:35:30,800

doing

938

00:35:34,870 --> 00:35:32,800

we don't have the ability to detect

939

00:35:37,190 --> 00:35:34,880

chirality with the map with the payload

940

00:35:39,910 --> 00:35:37,200

we selected and right now the baseline

941

00:35:42,630 --> 00:35:39,920

mission we're looking at about 45 flybys

942

00:35:47,510 --> 00:35:45,190

great thanks kurt now let's go take some

943

00:35:49,349 --> 00:35:47,520

questions from social media here is

944

00:35:51,190 --> 00:35:49,359

jason townsend from our social media

945

00:35:53,750 --> 00:35:51,200

team so what kind of questions are we

946

00:35:55,349 --> 00:35:53,760

getting on social media today jason

947

00:35:57,109 --> 00:35:55,359

we're getting a wide variety here uh

948

00:35:59,270 --> 00:35:57,119

following up on the last question here

949

00:36:01,270 --> 00:35:59,280

casey dreyer asks how does the

950

00:36:02,870 --> 00:36:01,280

resolution of the mass spec instrument

951
00:36:05,109 --> 00:36:02,880
actually compare to the mass spec on

952
00:36:10,790 --> 00:36:05,119
cassini and what could you detect that

953
00:36:14,550 --> 00:36:12,710
i won't bore you with the numbers the

954
00:36:16,790 --> 00:36:14,560
the the comparison to the resolution of

955
00:36:19,510 --> 00:36:16,800
the mass spec for cassini is that

956
00:36:21,589 --> 00:36:19,520
there's really not much of a comparison

957
00:36:23,829 --> 00:36:21,599
the the mass spectrometer on cassini was

958
00:36:26,310 --> 00:36:23,839
excellent from when it was built which

959
00:36:28,390 --> 00:36:26,320
was the early 1990s the mass

960
00:36:31,190 --> 00:36:28,400
spectrometer that we selected today is

961
00:36:33,109 --> 00:36:31,200
very advanced and it has benefited from

962
00:36:35,750 --> 00:36:33,119
a significant investment from nasa over

963
00:36:38,069 --> 00:36:35,760

the past four years as well so the mass

964

00:36:39,589 --> 00:36:38,079

spectrometer mass resolution

965

00:36:42,950 --> 00:36:39,599

for what we selected

966

00:36:46,950 --> 00:36:42,960

blows everything else out of the water

967

00:36:51,270 --> 00:36:48,790

wonderful next question next question

968

00:36:52,790 --> 00:36:51,280

comes from jason major who asks uh what

969

00:36:54,710 --> 00:36:52,800

is the anticipated launch date for

970

00:36:58,950 --> 00:36:54,720

europa mission how long would the trip

971

00:37:03,349 --> 00:37:00,950

so right now um

972

00:37:05,430 --> 00:37:03,359

once we move it into formulation

973

00:37:08,069 --> 00:37:05,440

uh we expect it to be launched in the

974

00:37:10,870 --> 00:37:08,079

2020s uh whether it's

975

00:37:13,430 --> 00:37:10,880

mid or a little early or a little later

976
00:37:15,430 --> 00:37:13,440
needs to be worked out based on

977
00:37:16,790 --> 00:37:15,440
a much firmer cost estimate and a

978
00:37:19,349 --> 00:37:16,800
profile

979
00:37:21,750 --> 00:37:19,359
that would support it that's

980
00:37:23,670 --> 00:37:21,760
what formulation is all about is putting

981
00:37:25,670 --> 00:37:23,680
all those resources together and getting

982
00:37:28,310 --> 00:37:25,680
serious about a major design as we move

983
00:37:32,230 --> 00:37:29,829
all right this next question comes from

984
00:37:33,829 --> 00:37:32,240
twitter user bradley who asks what drove

985
00:37:35,670 --> 00:37:33,839
the decision to go straight to a nine

986
00:37:41,030 --> 00:37:35,680
instrument mission complement and skip a

987
00:37:44,870 --> 00:37:42,950
originally we we had considered doing

988
00:37:46,470 --> 00:37:44,880

what we call a two-step process which

989

00:37:48,390 --> 00:37:46,480

means that if you're going to fly one

990

00:37:50,550 --> 00:37:48,400

camera you select

991

00:37:52,470 --> 00:37:50,560

two or three or four of them and you

992

00:37:54,870 --> 00:37:52,480

give them some money and some time to do

993

00:37:57,030 --> 00:37:54,880

some work to reduce their risk address

994

00:37:58,790 --> 00:37:57,040

their technical challenges uh what we

995

00:38:00,630 --> 00:37:58,800

found when we reviewed these proposals

996

00:38:02,550 --> 00:38:00,640

though is that in every category of

997

00:38:04,870 --> 00:38:02,560

instrument we wanted to fly

998

00:38:06,550 --> 00:38:04,880

there was one that was ready to go now

999

00:38:08,710 --> 00:38:06,560

and in fact in most cases there were

1000

00:38:11,030 --> 00:38:08,720

more than one that were ready to go now

1001
00:38:12,710 --> 00:38:11,040
so we didn't have any instruments that

1002
00:38:14,710 --> 00:38:12,720
that needed additional work we had

1003
00:38:16,710 --> 00:38:14,720
instruments that were ready to move into

1004
00:38:18,550 --> 00:38:16,720
formulation right now with a high degree

1005
00:38:20,790 --> 00:38:18,560
of confidence that they would be ready

1006
00:38:22,630 --> 00:38:20,800
for flight in the 2020s

1007
00:38:24,550 --> 00:38:22,640
i think part of that is because we did

1008
00:38:26,230 --> 00:38:24,560
invest over the past few years in a

1009
00:38:28,790 --> 00:38:26,240
technology program

1010
00:38:31,750 --> 00:38:28,800
for ic worlds to be ready for this next

1011
00:38:33,270 --> 00:38:31,760
step and we found that in fact that has

1012
00:38:37,109 --> 00:38:33,280
been highly valuable and has allowed us

1013
00:38:42,150 --> 00:38:39,190

wonderful next question comes from the

1014

00:38:43,990 --> 00:38:42,160

ustream user sergio who asks is laser

1015

00:38:46,230 --> 00:38:44,000

communications going to be used in this

1016

00:38:51,109 --> 00:38:46,240

mission

1017

00:38:54,150 --> 00:38:51,119

utilize laser communication

1018

00:38:57,109 --> 00:38:54,160

that would be deep space optical com

1019

00:38:58,069 --> 00:38:57,119

really deep we've tested it from here to

1020

00:38:59,750 --> 00:38:58,079

the moon

1021

00:39:01,990 --> 00:38:59,760

we haven't even tested deep space

1022

00:39:04,710 --> 00:39:02,000

optical comp from here to mars

1023

00:39:07,109 --> 00:39:04,720

and of course uh jupiter is uh you know

1024

00:39:09,829 --> 00:39:07,119

at five astronomical units away where

1025

00:39:11,990 --> 00:39:09,839

the earth is uh one astronomical unit

1026

00:39:14,870 --> 00:39:12,000

away and so um

1027

00:39:17,670 --> 00:39:14,880

we have a lot of work to do to be able

1028

00:39:20,870 --> 00:39:17,680

to utilize optical communication for

1029

00:39:22,069 --> 00:39:20,880

these outer planet missions but uh that

1030

00:39:24,470 --> 00:39:22,079

is a

1031

00:39:26,630 --> 00:39:24,480

a wonderful set of technologies we would

1032

00:39:30,069 --> 00:39:26,640

love to have in our hands today

1033

00:39:32,310 --> 00:39:30,079

uh and and um space technology is indeed

1034

00:39:33,750 --> 00:39:32,320

um uh mission directorate is indeed

1035

00:39:36,069 --> 00:39:33,760

working with us to invest in this

1036

00:39:39,030 --> 00:39:36,079

particular area but the next stop will

1037

00:39:41,190 --> 00:39:39,040

probably be mars instead of europa for

1038

00:39:42,870 --> 00:39:41,200

deep space optical com

1039

00:39:45,109 --> 00:39:42,880

one of the challenges to keep in mind

1040

00:39:46,710 --> 00:39:45,119

when when we go to europa is that

1041

00:39:48,870 --> 00:39:46,720

jupiter's magnetic field is an

1042

00:39:50,630 --> 00:39:48,880

accelerator of charged particles it's

1043

00:39:52,870 --> 00:39:50,640

kind of like the sun itself there's a

1044

00:39:55,670 --> 00:39:52,880

jupiter wind and so the radiation

1045

00:39:58,150 --> 00:39:55,680

environment at jupiter is fierce and so

1046

00:39:59,910 --> 00:39:58,160

as we look at the technologies

1047

00:40:02,470 --> 00:39:59,920

to support the mission we want to take

1048

00:40:04,230 --> 00:40:02,480

low risk on the spacecraft so that we

1049

00:40:06,390 --> 00:40:04,240

can put most of our effort into the

1050

00:40:07,910 --> 00:40:06,400

instruments which also have to survive

1051
00:40:09,589 --> 00:40:07,920
in that high radiation environment so

1052
00:40:12,390 --> 00:40:09,599
laser comet is probably a little bit

1053
00:40:14,710 --> 00:40:12,400
early for europa

1054
00:40:16,150 --> 00:40:14,720
thanks uh let's take two questions from

1055
00:40:17,430 --> 00:40:16,160
the phone lines before going back to

1056
00:40:20,470 --> 00:40:17,440
social media

1057
00:40:24,870 --> 00:40:20,480
the first question we have is from mike

1058
00:40:26,470 --> 00:40:24,880
del fiore from popular mechanics mike

1059
00:40:28,390 --> 00:40:26,480
hi thanks for taking my question i just

1060
00:40:30,710 --> 00:40:28,400
wanted to follow up on the the mission

1061
00:40:31,990 --> 00:40:30,720
duration the length and you mentioned 45

1062
00:40:33,270 --> 00:40:32,000
flybys

1063
00:40:34,630 --> 00:40:33,280

and someone else would ask the question

1064

00:40:35,910 --> 00:40:34,640

how long it might take so i was

1065

00:40:37,829 --> 00:40:35,920

interested in that i'm also interested

1066

00:40:40,150 --> 00:40:37,839

in where the instruments are being built

1067

00:40:42,790 --> 00:40:40,160

and when when they will start being

1068

00:40:47,589 --> 00:40:44,630

well mission duration once we get to

1069

00:40:48,630 --> 00:40:47,599

jupiter we'll spend about two and a half

1070

00:40:51,589 --> 00:40:48,640

years

1071

00:40:53,990 --> 00:40:51,599

doing those 45 flybys so at the fastest

1072

00:40:55,670 --> 00:40:54,000

pace we have a flyby about every two to

1073

00:40:57,030 --> 00:40:55,680

two to three weeks

1074

00:40:59,990 --> 00:40:57,040

in terms of where the instruments are

1075

00:41:01,910 --> 00:41:00,000

being built it runs the gamut it spans

1076
00:41:04,390 --> 00:41:01,920
the country we have instruments being

1077
00:41:06,790 --> 00:41:04,400
built on the west coast at nasa's at

1078
00:41:09,510 --> 00:41:06,800
nasa centers we have instruments being

1079
00:41:11,589 --> 00:41:09,520
built in in university labs we have

1080
00:41:14,150 --> 00:41:11,599
instruments being built in

1081
00:41:16,550 --> 00:41:14,160
in federal and federal research labs as

1082
00:41:17,910 --> 00:41:16,560
well so it's it really spans spans the

1083
00:41:20,069 --> 00:41:17,920
country

1084
00:41:22,870 --> 00:41:20,079
when will they be built as far as i'm

1085
00:41:24,630 --> 00:41:22,880
concerned they start tomorrow

1086
00:41:27,030 --> 00:41:24,640
and they're going to be working very

1087
00:41:29,030 --> 00:41:27,040
hard every single day until we get this

1088
00:41:30,390 --> 00:41:29,040

mission to the launch pad and then they

1089

00:41:31,670 --> 00:41:30,400

will actually start working harder

1090

00:41:33,990 --> 00:41:31,680

because then we need to start flying

1091

00:41:35,670 --> 00:41:34,000

these instruments and operating them you

1092

00:41:37,190 --> 00:41:35,680

know one of the things to understand

1093

00:41:39,750 --> 00:41:37,200

about the mission

1094

00:41:40,870 --> 00:41:39,760

architecture is the the multiple flyby

1095

00:41:42,950 --> 00:41:40,880

concept

1096

00:41:44,790 --> 00:41:42,960

you know this particular mission that

1097

00:41:47,829 --> 00:41:44,800

we're moving towards to stay out of the

1098

00:41:50,790 --> 00:41:47,839

radiation belt and only be in it as we

1099

00:41:53,349 --> 00:41:50,800

need to in in in taking extensive data

1100

00:41:54,710 --> 00:41:53,359

about europa actually orbits jupiter

1101

00:41:57,510 --> 00:41:54,720

itself

1102

00:41:59,910 --> 00:41:57,520

and so as it flies by it it takes a

1103

00:42:02,309 --> 00:41:59,920

massive amount of data and then as it

1104

00:42:05,190 --> 00:42:02,319

moves out of the radiation belt and is

1105

00:42:08,150 --> 00:42:05,200

clear it then begins to send that data

1106

00:42:11,589 --> 00:42:08,160

back in full resolution now this is

1107

00:42:13,990 --> 00:42:11,599

really a spectacular way of managing the

1108

00:42:15,910 --> 00:42:14,000

data it allows the scientists to get all

1109

00:42:18,150 --> 00:42:15,920

the details to really tease out

1110

00:42:19,589 --> 00:42:18,160

everything that we want to it also

1111

00:42:22,150 --> 00:42:19,599

allows our

1112

00:42:24,630 --> 00:42:22,160

plume chasers so to speak to really

1113

00:42:27,349 --> 00:42:24,640

continue to look at europa and find

1114

00:42:29,270 --> 00:42:27,359

potential plumes that on the next pass

1115

00:42:32,870 --> 00:42:29,280

we could we could potentially fly

1116

00:42:36,710 --> 00:42:32,880

through so um the architecture is uh is

1117

00:42:39,190 --> 00:42:36,720

set such that we maximize that time uh

1118

00:42:41,430 --> 00:42:39,200

when we're away from europa uh by

1119

00:42:44,390 --> 00:42:41,440

getting set up and aligning ourselves

1120

00:42:48,230 --> 00:42:44,400

again uh for the next flyby uh to

1121

00:42:49,750 --> 00:42:48,240

maximize the science that we want to do

1122

00:42:50,950 --> 00:42:49,760

thanks jim uh we'll take one more

1123

00:42:52,630 --> 00:42:50,960

question from the phone lines before

1124

00:42:56,470 --> 00:42:52,640

going to social media

1125

00:42:57,910 --> 00:42:56,480

um this is irene klotz from reuters

1126

00:42:59,670 --> 00:42:57,920

thanks um

1127

00:43:02,390 --> 00:42:59,680

could you maybe elaborate a little bit

1128

00:43:05,349 --> 00:43:02,400

on what uh you would consider

1129

00:43:07,829 --> 00:43:05,359

indications of life um with the suite of

1130

00:43:10,470 --> 00:43:07,839

instruments that were selected what

1131

00:43:12,790 --> 00:43:10,480

sorts of things uh might be indicative

1132

00:43:14,870 --> 00:43:12,800

of life and also

1133

00:43:17,190 --> 00:43:14,880

is there room aboard the spacecraft for

1134

00:43:18,309 --> 00:43:17,200

all nine of these instruments to fly or

1135

00:43:21,109 --> 00:43:18,319

would some

1136

00:43:23,349 --> 00:43:21,119

need to be eliminated for for mass

1137

00:43:25,670 --> 00:43:23,359

purposes

1138

00:43:27,109 --> 00:43:25,680

i'll take your easier question first yes

1139

00:43:29,190 --> 00:43:27,119

there's room on the spacecraft for all

1140

00:43:31,349 --> 00:43:29,200

nine instruments that we've selected

1141

00:43:33,430 --> 00:43:31,359

that was one of the the criteria that we

1142

00:43:35,430 --> 00:43:33,440

looked at when we made the selections

1143

00:43:37,349 --> 00:43:35,440

your first question about what are some

1144

00:43:39,190 --> 00:43:37,359

of the possible signs of life we might

1145

00:43:42,630 --> 00:43:39,200

be able to to detect

1146

00:43:44,550 --> 00:43:42,640

is a very difficult question uh

1147

00:43:46,550 --> 00:43:44,560

because we're not sure what those signs

1148

00:43:48,710 --> 00:43:46,560

would be i mean it would be wonderful if

1149

00:43:50,470 --> 00:43:48,720

we would see chlorophyll like you see in

1150

00:43:52,230 --> 00:43:50,480

earth plants but we're not going to see

1151
00:43:54,630 --> 00:43:52,240
chlorophyll mother nature is not going

1152
00:43:56,710 --> 00:43:54,640
to be that kind to us it would be great

1153
00:43:58,630 --> 00:43:56,720
if we would see fossilized bones

1154
00:44:00,150 --> 00:43:58,640
sticking up out of the surface that's

1155
00:44:02,150 --> 00:44:00,160
not going to happen mother nature is not

1156
00:44:05,109 --> 00:44:02,160
going to be that kind to us finding

1157
00:44:07,750 --> 00:44:05,119
evidence of life is very nuanced it's

1158
00:44:10,069 --> 00:44:07,760
very delicate it's very difficult to do

1159
00:44:13,589 --> 00:44:10,079
even if you go out to a lake or earth's

1160
00:44:16,230 --> 00:44:13,599
ocean and grab up a scoop of water

1161
00:44:19,109 --> 00:44:16,240
signs of life don't immediately jump out

1162
00:44:21,109 --> 00:44:19,119
at you so it's it's going to take some

1163
00:44:23,589 --> 00:44:21,119

very smart people sitting around working

1164

00:44:25,270 --> 00:44:23,599

together over the next few years

1165

00:44:27,109 --> 00:44:25,280

to build upon the work that has already

1166

00:44:29,510 --> 00:44:27,119

been done to help educate us in this

1167

00:44:33,589 --> 00:44:31,190

thank you now let's take a few questions

1168

00:44:35,510 --> 00:44:33,599

from social media jason

1169

00:44:37,190 --> 00:44:35,520

sure twitter user dave asks are there

1170

00:44:39,030 --> 00:44:37,200

any instruments from this payload that

1171

00:44:42,790 --> 00:44:39,040

could work with instruments from issa's

1172

00:44:47,190 --> 00:44:44,550

yes there are in fact the the

1173

00:44:48,950 --> 00:44:47,200

ultraviolet instrument that we selected

1174

00:44:50,870 --> 00:44:48,960

is a contribution that nasa is also

1175

00:44:53,030 --> 00:44:50,880

making to the to the juice payload

1176

00:44:54,950 --> 00:44:53,040

they're very similar instruments

1177

00:44:57,030 --> 00:44:54,960

so there is overlap among both of the

1178

00:44:58,950 --> 00:44:57,040

payloads so they complement one one

1179

00:45:00,870 --> 00:44:58,960

another strongly but i think it's

1180

00:45:03,190 --> 00:45:00,880

important to keep in mind that the

1181

00:45:05,270 --> 00:45:03,200

juice mission that is putting together

1182

00:45:06,950 --> 00:45:05,280

its focus really is on ganymede and to a

1183

00:45:09,829 --> 00:45:06,960

lesser extent close to they're only

1184

00:45:11,430 --> 00:45:09,839

flying by europa twice

1185

00:45:13,829 --> 00:45:11,440

because of of the nature of their

1186

00:45:16,829 --> 00:45:13,839

mission design we'll be flying by europa

1187

00:45:22,309 --> 00:45:19,430

more wonderful this next question comes

1188

00:45:23,829 --> 00:45:22,319

from uh dr leo here who asks what kind

1189

00:45:26,309 --> 00:45:23,839

of propulsion and craft will take the

1190

00:45:28,550 --> 00:45:26,319

instruments mentioned to europa

1191

00:45:30,550 --> 00:45:28,560

and additionally uh twitter user crow

1192

00:45:34,710 --> 00:45:30,560

asks what will be the power source for

1193

00:45:37,430 --> 00:45:36,390

the spacecraft will be solar powered so

1194

00:45:40,390 --> 00:45:37,440

we're going to have

1195

00:45:41,990 --> 00:45:40,400

solar panels on this on this mission

1196

00:45:45,430 --> 00:45:42,000

just like we do for the juno mission

1197

00:45:47,109 --> 00:45:45,440

which will reach jupiter in about a year

1198

00:45:49,109 --> 00:45:47,119

in terms of the type of spacecraft it

1199

00:45:51,030 --> 00:45:49,119

will be chemical propulsion so pretty

1200

00:45:53,510 --> 00:45:51,040

standard propulsion systems that nasa

1201
00:45:55,109 --> 00:45:53,520
uses for the majority of its science

1202
00:45:56,870 --> 00:45:55,119
missions

1203
00:45:58,829 --> 00:45:56,880
we will burn the engine hard we'll burn

1204
00:46:01,589 --> 00:45:58,839
it hot and we'll get there as fast as we

1205
00:46:03,670 --> 00:46:01,599
can wonderful this next question comes

1206
00:46:05,829 --> 00:46:03,680
from twitter user ryan who asks is

1207
00:46:07,349 --> 00:46:05,839
anything actually landing and if so will

1208
00:46:09,910 --> 00:46:07,359
it be able to send a probe into the

1209
00:46:14,710 --> 00:46:13,030
so uh at this stage

1210
00:46:16,950 --> 00:46:14,720
we are

1211
00:46:19,829 --> 00:46:16,960
doing some studies and very elementary

1212
00:46:22,150 --> 00:46:19,839
studies about land admissions

1213
00:46:25,190 --> 00:46:22,160

you know in planetary science we make a

1214

00:46:28,470 --> 00:46:25,200

very uh important progression of fly by

1215

00:46:31,270 --> 00:46:28,480

orbit land rove and then return samples

1216

00:46:33,670 --> 00:46:31,280

and we do that in a very deliberate way

1217

00:46:36,150 --> 00:46:33,680

and although galileo gave us the

1218

00:46:39,190 --> 00:46:36,160

tantalizing glimpses of what europa was

1219

00:46:41,750 --> 00:46:39,200

is like the multiple flybys of europa

1220

00:46:43,990 --> 00:46:41,760

will give us the orbital view will give

1221

00:46:46,150 --> 00:46:44,000

us a global understanding

1222

00:46:48,710 --> 00:46:46,160

to be able to get down to the surface is

1223

00:46:51,270 --> 00:46:48,720

a huge step after that

1224

00:46:53,990 --> 00:46:51,280

but we don't really know uh

1225

00:46:56,870 --> 00:46:54,000

in any detail about

1226

00:46:58,309 --> 00:46:56,880

how hard it is to land on a very

1227

00:47:00,950 --> 00:46:58,319

corrugated

1228

00:47:03,109 --> 00:47:00,960

surface or where we would need to go

1229

00:47:05,430 --> 00:47:03,119

we have an extensive amount of research

1230

00:47:07,349 --> 00:47:05,440

to be able to do in that particular area

1231

00:47:09,109 --> 00:47:07,359

and although we're studying that at the

1232

00:47:11,109 --> 00:47:09,119

moment the results of those studies

1233

00:47:12,870 --> 00:47:11,119

won't really be known to us until later

1234

00:47:14,390 --> 00:47:12,880

on this year

1235

00:47:16,950 --> 00:47:14,400

and i think it's important to keep in

1236

00:47:18,470 --> 00:47:16,960

mind i mentioned that galileo gave us a

1237

00:47:19,990 --> 00:47:18,480

limited amount of pictures of the

1238

00:47:21,910 --> 00:47:20,000

surface of europa

1239

00:47:23,750 --> 00:47:21,920

we actually don't know what the surface

1240

00:47:25,829 --> 00:47:23,760

of europa looks like at the scale of

1241

00:47:28,230 --> 00:47:25,839

this table at the scale of a lander if

1242

00:47:30,150 --> 00:47:28,240

it's smooth if it's incredibly rough if

1243

00:47:31,910 --> 00:47:30,160

it's full of spikes

1244

00:47:33,030 --> 00:47:31,920

without knowing what the surface even

1245

00:47:35,349 --> 00:47:33,040

looks like

1246

00:47:37,109 --> 00:47:35,359

it's difficult to design a lander that

1247

00:47:38,630 --> 00:47:37,119

that could survive so that's something

1248

00:47:40,150 --> 00:47:38,640

that we have to take into account as

1249

00:47:44,710 --> 00:47:40,160

well

1250

00:47:46,309 --> 00:47:44,720

user uh haman asks here will there be

1251

00:47:48,950 --> 00:47:46,319

any robotic mission to europa in the

1252

00:47:51,190 --> 00:47:48,960

future to explore life if any uh or any

1253

00:47:53,430 --> 00:47:51,200

of the liquid ocean beneath the solid

1254

00:47:55,829 --> 00:47:53,440

icy surface

1255

00:47:58,950 --> 00:47:55,839

yeah it would be great to think that the

1256

00:48:01,190 --> 00:47:58,960

results from this particular mission

1257

00:48:03,270 --> 00:48:01,200

would lead in the next decade to some

1258

00:48:05,270 --> 00:48:03,280

new and exciting concepts about

1259

00:48:07,190 --> 00:48:05,280

potentially getting underneath the ice

1260

00:48:09,430 --> 00:48:07,200

shell

1261

00:48:12,230 --> 00:48:09,440

once again we need to really make those

1262

00:48:14,630 --> 00:48:12,240

steps methodical steps and scientific

1263

00:48:16,710 --> 00:48:14,640

understanding to determine indeed if

1264

00:48:19,109 --> 00:48:16,720

this body

1265

00:48:20,950 --> 00:48:19,119

can be

1266

00:48:23,670 --> 00:48:20,960

penetrated in a way to be able to get

1267

00:48:26,230 --> 00:48:23,680

under the ice shell but that's indeed in

1268

00:48:27,829 --> 00:48:26,240

the distant future

1269

00:48:29,829 --> 00:48:27,839

wonderful last question here comes from

1270

00:48:31,750 --> 00:48:29,839

jason major who asks would this europa

1271

00:48:37,829 --> 00:48:31,760

mission be able to acquire data on other

1272

00:48:43,109 --> 00:48:40,309

it it can the these instruments are

1273

00:48:45,030 --> 00:48:43,119

fairly versatile they're

1274

00:48:46,790 --> 00:48:45,040

they're very much designed to operate on

1275

00:48:48,390 --> 00:48:46,800

that flyby mode that jim mentioned

1276

00:48:51,589 --> 00:48:48,400

because this is this is the multiple

1277

00:48:54,630 --> 00:48:51,599

flyby mission the mf mission uh

1278

00:48:56,309 --> 00:48:54,640

but if we choose to point the spacecraft

1279

00:48:57,910 --> 00:48:56,319

at other targets like ganymede or

1280

00:49:01,190 --> 00:48:57,920

callisto these instruments would work

1281

00:49:04,950 --> 00:49:02,790

okay and that's all the time we have

1282

00:49:07,829 --> 00:49:04,960

left for today keep those questions

1283

00:49:09,510 --> 00:49:07,839

coming with the hashtag asknasa

1284

00:49:14,790 --> 00:49:09,520

all the information you've heard today

1285

00:49:18,710 --> 00:49:16,950

europa news

1286

00:49:29,030 --> 00:49:18,720

thank you all and all the panelists for

1287

00:49:47,910 --> 00:49:30,630

hi i'm neil degrasse tyson and you're

1288

00:49:52,309 --> 00:49:50,069

from solar trek

1289

00:49:55,750 --> 00:49:52,319

to future tech

1290

00:49:59,030 --> 00:49:55,760

from undersea and hst