AbSciCon 2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:13,310 --> 00:00:09,310
[Applause]

3
00:00:15,440 --> 00:00:13,320
I'm gonna talk about our just a very new

4
00:00:17,210 --> 00:00:15,450
project called Europa STI where we're

5
00:00:19,460 --> 00:00:17,220
investigating tethered and free space

6
00:00:21,320 --> 00:00:19,470
communication techniques for sending

7
00:00:25,130 --> 00:00:21,330
signals through the ice for a nice ocean

8
00:00:27,260 --> 00:00:25,140
probe at Europa um so there was a study

9
00:00:30,620 --> 00:00:27,270
that was done about our Europe a tunnel

10
00:00:33,889 --> 00:00:30,630
bot mission concept by NASA folks and

11
00:00:37,220 --> 00:00:33,899
some other folks at Hopkins and Illinois

12
00:00:38,840 --> 00:00:37,230
and Idaho National Laboratory and the

13
00:00:41,390 --> 00:00:38,850

technical objective for this type of

14
00:00:43,460 --> 00:00:41,400
mission is to achieve ice penetration

15
00:00:45,320 --> 00:00:43,470
into the ocean on an ocean ice ocean

16
00:00:47,750 --> 00:00:45,330
world particularly we're looking at

17
00:00:48,710 --> 00:00:47,760
Europa and we needed to do this in about

18
00:00:50,990 --> 00:00:48,720
three years

19
00:00:53,210 --> 00:00:51,000
reach a depth we considered 20

20
00:00:56,420 --> 00:00:53,220
kilometers to be our achievable depth

21
00:00:58,100 --> 00:00:56,430
there in about three years and/or if we

22
00:01:00,140 --> 00:00:58,110
determined that there was a water pocket

23
00:01:02,180 --> 00:01:00,150
within the ice shell at about a four

24
00:01:05,420 --> 00:01:02,190
kilometer say depth that we could maybe

25
00:01:06,859 --> 00:01:05,430
determine had connection to the ocean so

26
00:01:09,140 --> 00:01:06,869
it's being fed by the ocean that might

27
00:01:11,989 --> 00:01:09,150
also be an objective a place that we

28
00:01:13,940 --> 00:01:11,999
could achieve our objectives which for

29
00:01:16,700 --> 00:01:13,950
science are to look for signs of life

30
00:01:18,529 --> 00:01:16,710
and so the science objectives closely

31
00:01:20,569 --> 00:01:18,539
followed those of the Europa SDT report

32
00:01:22,669 --> 00:01:20,579
where we would search for evidence of

33
00:01:24,859 --> 00:01:22,679
life at Europa we would assess the

34
00:01:26,480 --> 00:01:24,869
habitability of Europa via these in situ

35
00:01:29,179 --> 00:01:26,490
techniques which are uniquely available

36
00:01:32,539 --> 00:01:29,189
for this concept for the tunnel bot and

37
00:01:35,059 --> 00:01:32,549
then characterize those properties also

38
00:01:35,989 --> 00:01:35,069

that were the environmental

39
00:01:39,730 --> 00:01:35,999
characteristics that would either

40
00:01:42,340 --> 00:01:39,740
support or maybe not so support our

41
00:01:45,529 --> 00:01:42,350
detection of biosignatures

42
00:01:48,429 --> 00:01:45,539
so here is the structure of Europa and

43
00:01:51,410 --> 00:01:48,439
as you can see it's a very interesting

44
00:01:52,969 --> 00:01:51,420
world we have as time mentioned that's

45
00:01:55,480 --> 00:01:52,979
basically three layers that you wrote

46
00:01:57,620 --> 00:01:55,490
but we have the theater thick

47
00:02:00,019 --> 00:01:57,630
potentially thick ice layer at the top

48
00:02:01,910 --> 00:02:00,029
which is a brittle upper layer in a more

49
00:02:04,219 --> 00:02:01,920
ductile lower layer and then the ocean

50
00:02:06,379 --> 00:02:04,229
beneath and we don't really fully

51
00:02:07,969 --> 00:02:06,389
understand yet on what this structure is

52
00:02:09,889 --> 00:02:07,979
like how thick is that brittle layer

53
00:02:12,440 --> 00:02:09,899
compared to the ductile layer how thick

54
00:02:15,590 --> 00:02:12,450
is the overall ice shell are there water

55
00:02:17,900 --> 00:02:15,600
pockets within the ice how briny are

56
00:02:20,550 --> 00:02:17,910
some of these layers and these are all

57
00:02:23,130 --> 00:02:20,560
challenges then for a potential mission

58
00:02:24,690 --> 00:02:23,140
this potential architecture of getting

59
00:02:27,510 --> 00:02:24,700
through the ice down to the ocean

60
00:02:29,460 --> 00:02:27,520
sampling on our way trying to understand

61
00:02:32,010 --> 00:02:29,470
this environment the most thermally and

62
00:02:34,470 --> 00:02:32,020
mechanically as we design this type of

63
00:02:36,210 --> 00:02:34,480

mission to achieve our goals so that our

64
00:02:38,760 --> 00:02:36,220
project is I'm really focused on that

65
00:02:40,680 --> 00:02:38,770
portion behind the tunnel bot so how do

66
00:02:42,660 --> 00:02:40,690
we transfer that information that very

67
00:02:45,540 --> 00:02:42,670
important information from this

68
00:02:48,030 --> 00:02:45,550
subsurface probe to the landed portion

69
00:02:51,090 --> 00:02:48,040
that then sends our fantastic science

70
00:02:53,280 --> 00:02:51,100
data back to earth and so a couple

71
00:02:55,350 --> 00:02:53,290
strategies have been thought about where

72
00:02:58,050 --> 00:02:55,360
we're considering a communication tether

73
00:03:00,060 --> 00:02:58,060
and then also these repeaters on where

74
00:03:03,300 --> 00:03:00,070
you may be using a free three space type

75
00:03:05,490 --> 00:03:03,310
of communication to where because of

76
00:03:07,800 --> 00:03:05,500
these challenges within a rope as ice

77
00:03:09,690 --> 00:03:07,810
shell the tether may not be the most

78
00:03:11,699 --> 00:03:09,700
robust to all of these challenges and so

79
00:03:14,610 --> 00:03:11,709
if you had a repeater that could

80
00:03:16,920 --> 00:03:14,620
potentially jump across that break in

81
00:03:19,050 --> 00:03:16,930
your tether you could continue to send

82
00:03:21,300 --> 00:03:19,060
your information up to the land landed

83
00:03:23,040 --> 00:03:21,310
portion and so some of these challenges

84
00:03:25,039 --> 00:03:23,050
on we see evidence of this all over the

85
00:03:27,840 --> 00:03:25,049
surface you wrote but many faults

86
00:03:29,610 --> 00:03:27,850
evidence of you know subsumption

87
00:03:31,770 --> 00:03:29,620
activity potentially where you have

88
00:03:34,380 --> 00:03:31,780

convergent boundaries on Pascha possibly

89
00:03:36,960 --> 00:03:34,390
pushing material beneath the surface and

90
00:03:39,660 --> 00:03:36,970
then divergent boundaries strike-slip

91
00:03:42,449 --> 00:03:39,670
type of boundaries faults happening

92
00:03:43,680 --> 00:03:42,459
there so can a tether you know that is

93
00:03:46,080 --> 00:03:43,690
thin enough right like we also have to

94
00:03:47,610 --> 00:03:46,090
consider mass for these missions and is

95
00:03:50,220 --> 00:03:47,620
it thin enough to spool out for a whole

96
00:03:52,020 --> 00:03:50,230
20 kilometres while still being somewhat

97
00:03:54,840 --> 00:03:52,030
robust to the potential activity within

98
00:03:57,330 --> 00:03:54,850
Europa's ice shell and you know if so or

99
00:04:00,539 --> 00:03:57,340
if not under what conditions are these

100
00:04:02,280 --> 00:04:00,549
viable options if the tethers not you

101
00:04:03,780 --> 00:04:02,290
know doable in all the environments of

102
00:04:04,380 --> 00:04:03,790
europe as ice shell what other options

103
00:04:06,210 --> 00:04:04,390
you have

104
00:04:09,030 --> 00:04:06,220
could you use free space communications

105
00:04:11,069 --> 00:04:09,040
to provide alternative techniques and so

106
00:04:12,810 --> 00:04:11,079
we're exploring this with our our

107
00:04:14,580 --> 00:04:12,820
project we have folks from the Woods

108
00:04:18,630 --> 00:04:14,590
Hole Oceanographic Institute have been

109
00:04:21,180 --> 00:04:18,640
doing sub-option within the ocean sub

110
00:04:22,680 --> 00:04:21,190
ice subsea ice type of exploration where

111
00:04:24,840 --> 00:04:22,690
they have been using tethers for their

112
00:04:26,460 --> 00:04:24,850
submersibles for some years so we're

113
00:04:27,510 --> 00:04:26,470

starting out with these types of tethers

114
00:04:30,089 --> 00:04:27,520
that have been proven in these

115
00:04:32,190 --> 00:04:30,099
environments which allow on the

116
00:04:33,220 --> 00:04:32,200
submersibles to move around sort of

117
00:04:35,200 --> 00:04:33,230
independent of

118
00:04:36,790 --> 00:04:35,210
the ship is located it can move around

119
00:04:37,990 --> 00:04:36,800
and do exploration of the seafloor and

120
00:04:39,520 --> 00:04:38,000
find those really interesting

121
00:04:41,080 --> 00:04:39,530
hydrothermal vents that we know are

122
00:04:42,580 --> 00:04:41,090
happening there and so we're starting

123
00:04:45,070 --> 00:04:42,590
with those tethers on we have

124
00:04:47,440 --> 00:04:45,080
particularly picked out four types of

125
00:04:48,970 --> 00:04:47,450
tethers here that we will arm explore

126
00:04:50,770 --> 00:04:48,980
for their robustness particularly to

127
00:04:52,330 --> 00:04:50,780
shear motion as we expect there to be

128
00:04:55,420 --> 00:04:52,340
that to be happening that I'm at the

129
00:04:59,530 --> 00:04:55,430
faults and we're gonna explore some

130
00:05:01,330 --> 00:04:59,540
tethers that are more armored for to be

131
00:05:02,860 --> 00:05:01,340
potentially robust and doing the

132
00:05:05,710 --> 00:05:02,870
comparison then for how heavy they are

133
00:05:07,720 --> 00:05:05,720
and how you know much that would require

134
00:05:11,160 --> 00:05:07,730
four masts for a spaceflight and we're

135
00:05:12,880 --> 00:05:11,170
also looking at thinner copper ribbons

136
00:05:15,010 --> 00:05:12,890
potentially they're low-temperature

137
00:05:17,170 --> 00:05:15,020
ductility may prolong their survival in

138
00:05:18,160 --> 00:05:17,180

these environments and they're also they

139
00:05:20,830 --> 00:05:18,170
also have the potential that we could

140
00:05:22,090 --> 00:05:20,840
maybe heat them and that would have

141
00:05:25,060 --> 00:05:22,100
relieved some of the stress that may be

142
00:05:26,200 --> 00:05:25,070
acting upon them in the ice shell and so

143
00:05:28,000 --> 00:05:26,210
how are we going to do this well first

144
00:05:30,490 --> 00:05:28,010
we we want to think a lot about the ice

145
00:05:32,890 --> 00:05:30,500
that they're going to be inside of and

146
00:05:35,140 --> 00:05:32,900
and and really explore those parameters

147
00:05:37,510 --> 00:05:35,150
I'm thinking about grain size porosity

148
00:05:39,040 --> 00:05:37,520
and also potential impurities within the

149
00:05:41,800 --> 00:05:39,050
ice both composition different

150
00:05:43,540 --> 00:05:41,810
compositions as well as brines you know

151
00:05:45,790 --> 00:05:43,550
different amounts of brines and these

152
00:05:47,170 --> 00:05:45,800
compositions and incorporate those into

153
00:05:48,790 --> 00:05:47,180
the ice that we built so that we can

154
00:05:51,520 --> 00:05:48,800
really get a good understanding of how

155
00:05:54,220 --> 00:05:51,530
the ice mechanics changes with those

156
00:05:56,830 --> 00:05:54,230
changes in composition thinking about

157
00:05:59,020 --> 00:05:56,840
where the ice grain boundaries and those

158
00:06:00,820 --> 00:05:59,030
those impurities happen within between

159
00:06:02,950 --> 00:06:00,830
the grain boundaries and how that

160
00:06:04,870 --> 00:06:02,960
affects just the loads that are placed

161
00:06:07,990 --> 00:06:04,880
on the ice and then subsequently the

162
00:06:09,580 --> 00:06:08,000
tether you know how that affects the the

163
00:06:12,910 --> 00:06:09,590

transfer of the loads to the tether and

164
00:06:15,160 --> 00:06:12,920
how it just all behaves together and of

165
00:06:17,560 --> 00:06:15,170
course we picked out these certain

166
00:06:19,120 --> 00:06:17,570
impurities and and things from

167
00:06:22,600 --> 00:06:19,130
observations that have been done of

168
00:06:25,570 --> 00:06:22,610
Europa finding both on hydro of sulfuric

169
00:06:28,120 --> 00:06:25,580
acid water Frost and hydrated salts

170
00:06:30,790 --> 00:06:28,130
potentially from the ice the ocean and

171
00:06:32,920 --> 00:06:30,800
rock interactions that's happening um so

172
00:06:35,070 --> 00:06:32,930
here's the really cool testing apparatus

173
00:06:37,710 --> 00:06:35,080
pun intended that they had

174
00:06:39,240 --> 00:06:37,720
at a lamont-doherty Earth Observatory so

175
00:06:40,559 --> 00:06:39,250
we're again pairing with Woods Hole

176
00:06:41,939 --> 00:06:40,569
Oceanographic Institute with their

177
00:06:44,100 --> 00:06:41,949
tethers we're freezing their tethers

178
00:06:46,559 --> 00:06:44,110
into these ice blocks and then this this

179
00:06:48,210 --> 00:06:46,569
apparatus is loading apparatus can place

180
00:06:50,520 --> 00:06:48,220
the loads the shearing loads that we

181
00:06:53,939 --> 00:06:50,530
want to explore on our tethers and this

182
00:06:56,730 --> 00:06:53,949
is on the testing you know to our test

183
00:06:58,320 --> 00:06:56,740
setup is based on the concrete so they

184
00:07:00,300 --> 00:06:58,330
do the same kind of tests for concrete

185
00:07:01,619 --> 00:07:00,310
where they have the rebars going through

186
00:07:03,059 --> 00:07:01,629
the concrete and they do these shearing

187
00:07:04,649 --> 00:07:03,069
tests to understand their their

188
00:07:06,480 --> 00:07:04,659

mechanical strengths so we're going to

189
00:07:08,219 --> 00:07:06,490
doing very similar tests I'm exploring

190
00:07:10,709 --> 00:07:08,229
temperatures and then the velocities of

191
00:07:15,089 --> 00:07:10,719
these like potential strike-slip like

192
00:07:17,700 --> 00:07:15,099
fault shearing armloads and then as we

193
00:07:19,140 --> 00:07:17,710
move forward past this so again this is

194
00:07:21,899 --> 00:07:19,150
just some some of the work we've only

195
00:07:23,399 --> 00:07:21,909
done very initially past this we want to

196
00:07:25,290 --> 00:07:23,409
also then consider these other

197
00:07:27,420 --> 00:07:25,300
strategies for communications just in

198
00:07:29,939 --> 00:07:27,430
the case of where the tethers may not be

199
00:07:32,459 --> 00:07:29,949
the most robust so these additional

200
00:07:33,930 --> 00:07:32,469
strategies will include radio frequency

201
00:07:36,390 --> 00:07:33,940
and other free space communication

202
00:07:39,120 --> 00:07:36,400
techniques and we're interested in these

203
00:07:41,370 --> 00:07:39,130
also to understand how they behave and

204
00:07:44,670 --> 00:07:41,380
the different regimes within the thermal

205
00:07:46,620 --> 00:07:44,680
mechanical layering and Europa would

206
00:07:48,360 --> 00:07:46,630
they potentially be most applicable when

207
00:07:49,800 --> 00:07:48,370
certain regimes in the ice shell where's

208
00:07:51,360 --> 00:07:49,810
the tether maybe most applicable and

209
00:07:54,209 --> 00:07:51,370
other regimes trying to really

210
00:07:56,610 --> 00:07:54,219
understand that and we will further

211
00:07:58,140 --> 00:07:56,620
explore this through modeling efforts

212
00:08:00,269 --> 00:07:58,150
just of the Europa's ice shell itself

213
00:08:02,129 --> 00:08:00,279

we're going to take into account on

214
00:08:04,559 --> 00:08:02,139
fault movements do fracture mechanics

215
00:08:06,240 --> 00:08:04,569
modeling consider tidal forcing and

216
00:08:09,149 --> 00:08:06,250
thermal mechanical characteristics of

217
00:08:11,100 --> 00:08:09,159
the ice shell blitz viscosities and then

218
00:08:14,010 --> 00:08:11,110
also one interesting thing that we've

219
00:08:15,839 --> 00:08:14,020
been thinking about is as so our cry

220
00:08:17,459 --> 00:08:15,849
about you know melts its way this is a

221
00:08:19,290 --> 00:08:17,469
concept that we have is melting this way

222
00:08:21,390 --> 00:08:19,300
so your water is refreezing behind you

223
00:08:23,670 --> 00:08:21,400
sort of in this column you know is that

224
00:08:25,379 --> 00:08:23,680
refreezing ice going to be similar to

225
00:08:26,519 --> 00:08:25,389
the surrounding ice that you've just

226
00:08:28,529 --> 00:08:26,529
passed through or is it going to

227
00:08:30,420 --> 00:08:28,539
refreeze in a different way changing

228
00:08:32,279 --> 00:08:30,430
that compositional layering potentially

229
00:08:34,439 --> 00:08:32,289
and how would that then affect your

230
00:08:36,600 --> 00:08:34,449
tether that's within that column of ice

231
00:08:38,909 --> 00:08:36,610
behind you that's been refrozen as well

232
00:08:41,730 --> 00:08:38,919
as the RF or you know free space

233
00:08:43,740 --> 00:08:41,740
communication repeaters that have been

234
00:08:45,180 --> 00:08:43,750
frozen and behind you as well so we're

235
00:08:47,450 --> 00:08:45,190
going to be doing further modeling to

236
00:08:49,280 --> 00:08:47,460
understand that and that's going

237
00:08:50,870 --> 00:08:49,290
done by folks at John Hopkins Applied

238
00:08:54,320 --> 00:08:50,880

Physics lab Southwest Research Institute

239
00:08:56,300 --> 00:08:54,330
and we have University of Southern Maine

240
00:08:57,980 --> 00:08:56,310
and we're going to be continuing just to

241
00:09:01,730 --> 00:08:57,990
explore those and try to understand

242
00:09:03,530 --> 00:09:01,740
where in Europa's ice shell can we you

243
00:09:05,090 --> 00:09:03,540
know have this strategy of communication

244
00:09:07,280 --> 00:09:05,100
like where best is the tether gonna be

245
00:09:09,680 --> 00:09:07,290
from you know doing the best for us with

246
00:09:11,180 --> 00:09:09,690
a higher probably data rate transfer but

247
00:09:13,490 --> 00:09:11,190
then when we need a repeater you know

248
00:09:16,190 --> 00:09:13,500
can it also be robust in certain regimes

249
00:09:18,200 --> 00:09:16,200
um that we can depend on those so in

250
00:09:19,910 --> 00:09:18,210
summary our project the Europa SDI

251
00:09:21,500 --> 00:09:19,920
project is going to characterize the

252
00:09:23,840 --> 00:09:21,510
deployment capability and mechanical

253
00:09:26,180 --> 00:09:23,850
strength of these multiple tethers in

254
00:09:27,710 --> 00:09:26,190
the laboratory sent us situation where

255
00:09:30,200 --> 00:09:27,720
we are simulating Europa light

256
00:09:31,370 --> 00:09:30,210
conditions will do a lot of modeling to

257
00:09:32,960 --> 00:09:31,380
understand the thermal mechanical

258
00:09:35,300 --> 00:09:32,970
environmental hazards that are possible

259
00:09:38,420 --> 00:09:35,310
within Europe as ice shell and on that

260
00:09:40,580 --> 00:09:38,430
kappa tote could be potential risks to

261
00:09:42,410 --> 00:09:40,590
our communication techniques and then

262
00:09:45,350 --> 00:09:42,420
we'll evaluate the system performance of

263
00:09:47,540 --> 00:09:45,360

these free space communication

264
00:09:49,520 --> 00:09:47,550
strategies to further our understanding

265
00:09:51,110 --> 00:09:49,530
of where we want to employ certain

266
00:09:54,350 --> 00:09:51,120
techniques where we want to have you

267
00:09:56,360 --> 00:09:54,360
know a reliability on these as we as we

268
00:09:59,030 --> 00:09:56,370
want to go down and explore your roses

269
00:10:01,190 --> 00:09:59,040
your robust ocean so I'm just like to

270
00:10:03,320 --> 00:10:01,200
thank everyone for their time and thanks

271
00:10:03,710 --> 00:10:03,330
to all my colleagues um as we push

272
00:10:05,840 --> 00:10:03,720
forward

273
00:10:13,240 --> 00:10:05,850
onward to your row position so thank you

274
00:10:15,470 --> 00:10:13,250
so we have time for a couple questions

275
00:10:17,360 --> 00:10:15,480
it just occurred to me that there's an

276
00:10:23,270 --> 00:10:17,370
experiment in Antarctica called ice cube

277
00:10:24,590 --> 00:10:23,280
they have 50 to 2.8 kilometer setups

278
00:10:27,350 --> 00:10:24,600
have you talked to them and gotten

279
00:10:28,610 --> 00:10:27,360
lessons learned from so um my colleague

280
00:10:30,260 --> 00:10:28,620
Ralph Lorenz he's kind of more the

281
00:10:31,940 --> 00:10:30,270
expert on history cuz but he definitely

282
00:10:35,180 --> 00:10:31,950
we've we've definitely are considering

283
00:10:36,530 --> 00:10:35,190
that and what they've done to build upon

284
00:10:40,820 --> 00:10:36,540
their their knowledge that they gained

285
00:10:45,560 --> 00:10:40,830
there yes thank you I said a question

286
00:10:47,420 --> 00:10:45,570
about how the ice changes like either

287
00:10:50,060 --> 00:10:47,430
the radio frequency or the acoustics for

288
00:10:53,060 --> 00:10:50,070

the repeater mechanism like if you have

289
00:10:54,660 --> 00:10:53,070
to consider the geometry value sentence

290
00:10:56,640 --> 00:10:54,670
how

291
00:10:59,010 --> 00:10:56,650
change your signal that kind of thing do

292
00:11:01,020 --> 00:10:59,020
you mean like one if a fault happens and

293
00:11:03,660 --> 00:11:01,030
you have a fault happens or just from

294
00:11:06,150 --> 00:11:03,670
refreezing or whatever other mechanical

295
00:11:07,740 --> 00:11:06,160
changes so I think this is these are the

296
00:11:10,020 --> 00:11:07,750
kinds of things that we'll be exploring

297
00:11:11,910 --> 00:11:10,030
like we we understand that like with

298
00:11:13,610 --> 00:11:11,920
with depth you know wrote Europa's ice

299
00:11:16,020 --> 00:11:13,620
shell is gonna change with fracture

300
00:11:17,940 --> 00:11:16,030
current you know fracture motion

301
00:11:20,550 --> 00:11:17,950
happening things are gonna and this is

302
00:11:22,020 --> 00:11:20,560
exactly what we want to explore to try

303
00:11:24,510 --> 00:11:22,030
to understand how robust are they to

304
00:11:26,520 --> 00:11:24,520
these this type of activity how that

305
00:11:27,480 --> 00:11:26,530
would it change our signal oh and the

306
00:11:30,150 --> 00:11:27,490
other thing I didn't mention is we

307
00:11:32,550 --> 00:11:30,160
really want to constrain the attenuation

308
00:11:33,990 --> 00:11:32,560
of the signal as it moves apart because

309
00:11:35,910 --> 00:11:34,000
you need to understand like how often

310
00:11:38,190 --> 00:11:35,920
you need to drop these these repeaters

311
00:11:40,170 --> 00:11:38,200
off behind you you know how far can your

312
00:11:42,480 --> 00:11:40,180
signal transfer across if you have a