AbSciCon 2019

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

2
00:00:12,410 --> 00:00:09,130
[Applause]

3
00:00:15,260 --> 00:00:12,420
all right thank you so my name is Joey

4
00:00:16,700 --> 00:00:15,270
Sparta I'm from honeybee robotics I'm

5
00:00:19,400 --> 00:00:16,710
gonna be talking about sampling the

6
00:00:22,280 --> 00:00:19,410
ocean world so we had a few talks

7
00:00:24,859 --> 00:00:22,290
already about drilling down through icy

8
00:00:27,560 --> 00:00:24,869
crusts and getting deep into the surface

9
00:00:29,900 --> 00:00:27,570
I'm gonna be focusing on sort of

10
00:00:35,720 --> 00:00:29,910
sampling the top layer of these icy

11
00:00:37,040 --> 00:00:35,730
moons so I'll talk about the ocean

12
00:00:40,310 --> 00:00:37,050
worlds in general and what it might take

13
00:00:42,049 --> 00:00:40,320

to sample at the top layer and sort of

14
00:00:43,430 --> 00:00:42,059
what the scientific priority is and

15
00:00:45,439 --> 00:00:43,440
maybe some engineering challenges that

16
00:00:48,549 --> 00:00:45,449
sort of drive the sampling system design

17
00:00:51,410 --> 00:00:48,559
itself then I'm going to go into the

18
00:00:54,110 --> 00:00:51,420
what I'm calling the ISS this is the

19
00:00:56,090 --> 00:00:54,120
actual sampling system that we've put

20
00:01:00,259 --> 00:00:56,100
together for the dragonfly new frontiers

21
00:01:04,549 --> 00:01:00,269
mission so my colleague ty Costa and

22
00:01:07,219 --> 00:01:04,559
myself were basically started on this

23
00:01:10,399 --> 00:01:07,229
project last January and we have been

24
00:01:12,410 --> 00:01:10,409
developing just about every day working

25
00:01:14,209 --> 00:01:12,420
on this sampling system so pretty

26
00:01:17,380 --> 00:01:14,219
fitting that we're here today and we

27
00:01:21,560 --> 00:01:17,390
have an announcement coming today that

28
00:01:22,910 --> 00:01:21,570
we're very much anxious and waiting then

29
00:01:24,859 --> 00:01:22,920
I'm just gonna touch on how you can use

30
00:01:26,719 --> 00:01:24,869
this for any other ocean world so this

31
00:01:28,520 --> 00:01:26,729
obviously for the dragonfly mission is

32
00:01:31,179 --> 00:01:28,530
for Titan which has an atmosphere and

33
00:01:35,810 --> 00:01:31,189
then I'll touch on how you can use this

34
00:01:38,270 --> 00:01:35,820
for airless ocean worlds so ocean worlds

35
00:01:40,639 --> 00:01:38,280
in general way out in the solar system

36
00:01:42,469 --> 00:01:40,649
around gas giants you have radiation you

37
00:01:45,440 --> 00:01:42,479
have extremely cold temperatures you

38
00:01:48,260 --> 00:01:45,450

have low gravity and these make for some

39
00:01:52,010 --> 00:01:48,270
serious challenges for sampling in

40
00:01:53,510 --> 00:01:52,020
general the search for life takes us

41
00:01:55,459 --> 00:01:53,520
below the surface so that's why we're

42
00:01:57,859 --> 00:01:55,469
drilling down as you're all everyone in

43
00:02:01,520 --> 00:01:57,869
this room is probably aware but when you

44
00:02:03,139 --> 00:02:01,530
start drilling down and then once you

45
00:02:05,260 --> 00:02:03,149
want to actually take that sample and

46
00:02:07,760 --> 00:02:05,270
analyze it with an instrument you've got

47
00:02:09,859 --> 00:02:07,770
your instruments are probably in your in

48
00:02:11,480 --> 00:02:09,869
your spacecraft in the warm area so

49
00:02:14,480 --> 00:02:11,490
you've got to get this material from the

50
00:02:18,170 --> 00:02:14,490
subsurface into the spacecraft and in a

51
00:02:19,970 --> 00:02:18,180
low gravity environment you may end up

52
00:02:21,949 --> 00:02:19,980
dealing with some really sticky nasty

53
00:02:24,349 --> 00:02:21,959
material especially on

54
00:02:27,949 --> 00:02:24,359
where you have organics and potential

55
00:02:30,500 --> 00:02:27,959
wet sticky like sand particles and other

56
00:02:32,569 --> 00:02:30,510
things so essentially we started on this

57
00:02:34,970 --> 00:02:32,579
project and working with Ralph Lorenz

58
00:02:39,080 --> 00:02:34,980
and he handed us a whole bunch of nasty

59
00:02:42,020 --> 00:02:39,090
sticky simulants like sand and oil and

60
00:02:44,000 --> 00:02:42,030
wheat flour and just really nasty stuff

61
00:02:46,849 --> 00:02:44,010
and he said try to figure out how to how

62
00:02:50,300 --> 00:02:46,859
to transport this stuff with using

63
00:02:52,459 --> 00:02:50,310

pneumatics using gas and so when we

64
00:02:55,369 --> 00:02:52,469
designed this system we we thought of

65
00:02:57,860 --> 00:02:55,379
four sort of steps or strategies and how

66
00:02:59,869 --> 00:02:57,870
we might sample first obviously

67
00:03:02,629 --> 00:02:59,879
excavating the surface so we use a drill

68
00:03:04,369 --> 00:03:02,639
to get into the subsurface and then we

69
00:03:06,679 --> 00:03:04,379
transfer that material into the

70
00:03:08,990 --> 00:03:06,689
spacecraft and while we do the transfer

71
00:03:11,899 --> 00:03:09,000
we focus on minimizing crosstalk or

72
00:03:14,119 --> 00:03:11,909
cross-contamination as well as heat

73
00:03:15,979 --> 00:03:14,129
transfer so heat transfer if we're

74
00:03:18,110 --> 00:03:15,989
putting heat into the sample especially

75
00:03:21,709 --> 00:03:18,120
on these icy moons we're risking losing

76
00:03:24,289 --> 00:03:21,719
volatiles are there important signals in

77
00:03:25,789 --> 00:03:24,299
our aspects of the sample and then

78
00:03:28,039 --> 00:03:25,799
crosstalk we want to make sure that

79
00:03:29,899 --> 00:03:28,049
we're having a clean system that you

80
00:03:33,110 --> 00:03:29,909
know as we go from sample site to sample

81
00:03:36,080 --> 00:03:33,120
site we're not mixing our signal and so

82
00:03:39,619 --> 00:03:36,090
for this integrated sampling system we

83
00:03:41,719 --> 00:03:39,629
were delivering to two modes of one mass

84
00:03:43,640 --> 00:03:41,729
spectrometer we have a laser desorption

85
00:03:47,479 --> 00:03:43,650
and a gas chromatograph so do you see

86
00:03:49,309 --> 00:03:47,489
this and in LB ms and it's pretty small

87
00:03:52,309 --> 00:03:49,319
volumes less than a milliliter and

88
00:03:54,409 --> 00:03:52,319

pretty fine particles and so like I said

89
00:03:56,030 --> 00:03:54,419
excavating we use a rotary percussive

90
00:03:58,369 --> 00:03:56,040
drill drilling is something that

91
00:04:00,800 --> 00:03:58,379
honeybee has a lot of has done a lot of

92
00:04:02,629 --> 00:04:00,810
work with in the past I mean sort of the

93
00:04:04,610 --> 00:04:02,639
new technology part of this was the

94
00:04:06,740 --> 00:04:04,620
pneumatic transport so using gas to

95
00:04:10,610 --> 00:04:06,750
actually carry sample from the ground to

96
00:04:12,830 --> 00:04:10,620
the spacecraft and form a heat transfer

97
00:04:15,289 --> 00:04:12,840
standpoint pneumatics are great we can

98
00:04:19,789 --> 00:04:15,299
use the cold ambient gas that's already

99
00:04:21,589 --> 00:04:19,799
on Titan and so basically this the heat

100
00:04:24,260 --> 00:04:21,599
transfer is mitigated by the fact that

101
00:04:25,820 --> 00:04:24,270
were operating in the environment and we

102
00:04:27,439 --> 00:04:25,830
have designed our mechanisms to actually

103
00:04:29,029 --> 00:04:27,449
operate out the ambient temperature and

104
00:04:31,570 --> 00:04:29,039
so there really isn't much temperature

105
00:04:34,100 --> 00:04:31,580
gradient throughout the entire system

106
00:04:34,810 --> 00:04:34,110
additionally it's extremely quick we use

107
00:04:38,290 --> 00:04:34,820
a very high

108
00:04:39,970 --> 00:04:38,300
air speed so like from the time we pull

109
00:04:42,790 --> 00:04:39,980
the material out of the ground it's in a

110
00:04:45,190 --> 00:04:42,800
sample cup in less than a tenth of a

111
00:04:47,620 --> 00:04:45,200
second so it's extremely fast and it is

112
00:04:49,540 --> 00:04:47,630
extremely robust and the fact that the

113
00:04:51,940 --> 00:04:49,550

air speed that we generate is so fast

114
00:04:55,240 --> 00:04:51,950
means that it's self-cleaning and so we

115
00:04:57,480 --> 00:04:55,250
don't end up with clogs or sticky like

116
00:05:00,160 --> 00:04:57,490
materials sticking to surfaces or other

117
00:05:01,540 --> 00:05:00,170
like robotic arms or scoops or other

118
00:05:04,480 --> 00:05:01,550
things like that it's just a very clean

119
00:05:06,340 --> 00:05:04,490
system and it's an analogous to like the

120
00:05:08,290 --> 00:05:06,350
medical industry the pharmaceutical

121
00:05:10,000 --> 00:05:08,300
industry where they transport medicines

122
00:05:11,530 --> 00:05:10,010
and powders and things like that they

123
00:05:13,570 --> 00:05:11,540
don't want cross talk they don't want

124
00:05:16,630 --> 00:05:13,580
you know they want very fine metered

125
00:05:19,480 --> 00:05:16,640
control of fine material and that's

126
00:05:24,250 --> 00:05:19,490
exactly what we're after on this mission

127
00:05:25,510 --> 00:05:24,260
and sampling in general so here's a

128
00:05:27,670 --> 00:05:25,520
little diagram that shows what I'm

129
00:05:30,460 --> 00:05:27,680
talking about we've got a drill on the

130
00:05:32,530 --> 00:05:30,470
leg of the lander and this is a rotary

131
00:05:35,770 --> 00:05:32,540
percussive drill and then we put a

132
00:05:39,160 --> 00:05:35,780
pneumatic transport system which can be

133
00:05:40,840 --> 00:05:39,170
adapted to icing ones that don't have an

134
00:05:44,140 --> 00:05:40,850
atmosphere which is the later part of

135
00:05:46,330 --> 00:05:44,150
this talk so for the Dragonfly mission

136
00:05:49,000 --> 00:05:46,340
for tighten like I said it has a nice

137
00:05:51,760 --> 00:05:49,010
thick atmosphere so we can basically do

138
00:05:53,410 --> 00:05:51,770

what we do here on earth those of you

139
00:05:55,180 --> 00:05:53,420
who have worked in a wood shop when

140
00:05:57,430 --> 00:05:55,190
you're cutting wood and you're done

141
00:05:59,950 --> 00:05:57,440
cutting you might take a shop vacuum and

142
00:06:01,510 --> 00:05:59,960
just suction up all the cuttings that's

143
00:06:04,210 --> 00:06:01,520
exactly what we're doing on dragonfly

144
00:06:06,760 --> 00:06:04,220
we're drilling into the ground and then

145
00:06:08,830 --> 00:06:06,770
we're using a blower which has a

146
00:06:11,560 --> 00:06:08,840
impeller that we spent at a high speed

147
00:06:13,810 --> 00:06:11,570
and generate a low pressure basically

148
00:06:16,630 --> 00:06:13,820
suctions the atmosphere in through a

149
00:06:18,700 --> 00:06:16,640
nozzle that's called a pickup foot right

150
00:06:20,590 --> 00:06:18,710
here by the drill bit and it basically

151
00:06:24,970 --> 00:06:20,600
lifts the particles up and carries them

152
00:06:26,950 --> 00:06:24,980
down de tubing in our case we've

153
00:06:29,500 --> 00:06:26,960
actually made this even cleaner by

154
00:06:32,020 --> 00:06:29,510
diluting the flow so for every one

155
00:06:34,780 --> 00:06:32,030
milliliter of sample that we carry we're

156
00:06:37,270 --> 00:06:34,790
carrying ten thousand milliliters of gas

157
00:06:38,710 --> 00:06:37,280
with it so it's extremely diluted it's

158
00:06:41,610 --> 00:06:38,720
extremely clean

159
00:06:44,080 --> 00:06:41,620
we pretty much never had a clog in

160
00:06:45,920 --> 00:06:44,090
hundreds of tests that we did I'm since

161
00:06:48,920 --> 00:06:45,930
extremely robust

162
00:06:52,730 --> 00:06:48,930
I also mentioned diverter valves we came

163
00:06:55,610 --> 00:06:52,740

up with this component that we added to

164
00:06:57,529 --> 00:06:55,620
the system which allows us to basically

165
00:06:59,990 --> 00:06:57,539
have multiple drills and have multiple

166
00:07:02,600 --> 00:07:00,000
blowers for redundancy as well as like

167
00:07:04,700 --> 00:07:02,610
drill site diversity so if there's if

168
00:07:06,020 --> 00:07:04,710
you land in a spot and you find

169
00:07:07,580 --> 00:07:06,030
something interesting on your left side

170
00:07:10,730 --> 00:07:07,590
you can also sample on the right side

171
00:07:13,969 --> 00:07:10,740
and see and compare you could also have

172
00:07:16,550 --> 00:07:13,979
like redundant drills like you could

173
00:07:18,650 --> 00:07:16,560
have multiple drills in case one fails

174
00:07:20,719 --> 00:07:18,660
and you could even have multiple

175
00:07:22,610 --> 00:07:20,729
scientific instruments or interfaces so

176
00:07:24,260 --> 00:07:22,620
if you you know want to have them well

177
00:07:25,640 --> 00:07:24,270
if you sample something it looks

178
00:07:28,219 --> 00:07:25,650
interesting maybe you want to hit it

179
00:07:32,480 --> 00:07:28,229
with ldms and then the next time you

180
00:07:35,210 --> 00:07:32,490
might do a GCMs and i'll just mention

181
00:07:41,029 --> 00:07:35,220
that this valve we tested successfully

182
00:07:43,870 --> 00:07:41,039
in in cryogenic environment so here's

183
00:07:48,260 --> 00:07:43,880
the CONOPS deploy the drill from the leg

184
00:07:51,170 --> 00:07:48,270
start drilling generate some sample turn

185
00:07:53,360 --> 00:07:51,180
on the blower will generate some gas

186
00:07:55,939 --> 00:07:53,370
flow it'll pick up the sample carry it

187
00:07:57,890 --> 00:07:55,949
down the stream drawn the tubing here

188
00:07:59,570 --> 00:07:57,900

and then we have a sample cup that ty

189
00:08:01,969 --> 00:07:59,580
actually gave a talk on Monday about

190
00:08:05,570 --> 00:08:01,979
which has been designed to basically

191
00:08:07,640 --> 00:08:05,580
extract the particles from the gas well

192
00:08:09,379 --> 00:08:07,650
and then we just dumped the rest of the

193
00:08:11,779 --> 00:08:09,389
we dumped the rest of the sample

194
00:08:15,910 --> 00:08:11,789
overboard so here's a video from our

195
00:08:15,920 --> 00:08:19,330
[Music]

196
00:08:24,620 --> 00:08:21,920
so we're spinning up the blower here and

197
00:08:26,149 --> 00:08:24,630
generating our gas flow and then we're

198
00:08:28,040 --> 00:08:26,159
going to start drilling so we're

199
00:08:29,810 --> 00:08:28,050
rotating and we're also hammering into

200
00:08:32,269 --> 00:08:29,820
the ground to basically break the

201
00:08:33,620 --> 00:08:32,279
material into very fine dust and then

202
00:08:35,420 --> 00:08:33,630
this is our pickup foot which is

203
00:08:37,839 --> 00:08:35,430
basically suctioning material every time

204
00:08:40,219 --> 00:08:37,849
that drill that spins all the way up

205
00:08:45,260 --> 00:08:40,229
through the system up here where it's

206
00:08:47,540 --> 00:08:45,270
basically captured by this cup and this

207
00:08:49,130 --> 00:08:47,550
cup fills reliably reliably we fill it

208
00:08:51,230 --> 00:08:49,140
up pretty much every time with every

209
00:08:53,060 --> 00:08:51,240
simulant that we've tested so I

210
00:08:56,590 --> 00:08:53,070
mentioned earlier the sand oil the wheat

211
00:08:58,950 --> 00:08:56,600
flour all that basically the stressing

212
00:09:02,280 --> 00:08:58,960
materials that you could try to

213
00:09:06,630 --> 00:09:02,290

defeat the system with it's never it's

214
00:09:11,000 --> 00:09:06,640
been successful each time we tested it

215
00:09:13,590 --> 00:09:11,010
had 94 Kelvin and nitrogen gas so

216
00:09:15,210 --> 00:09:13,600
basically as close as we could get to

217
00:09:18,920 --> 00:09:15,220
the Titan environment without building a

218
00:09:21,570 --> 00:09:18,930
entire Titan chamber with pressure and

219
00:09:24,840 --> 00:09:21,580
we were successful we tested it with

220
00:09:28,829 --> 00:09:24,850
water ice ammonia water ice wax and sand

221
00:09:32,940 --> 00:09:28,839
so various actual Titan ice analogs and

222
00:09:34,980 --> 00:09:32,950
we filled our sample cup every time then

223
00:09:36,870 --> 00:09:34,990
the last part here is talking about how

224
00:09:40,160 --> 00:09:36,880
could you use this for Europa Enceladus

225
00:09:43,070 --> 00:09:40,170
any really small body with it with uh

226
00:09:45,210 --> 00:09:43,080
with just vacuum with no atmosphere so

227
00:09:47,610 --> 00:09:45,220
we've been working on this too at

228
00:09:50,040 --> 00:09:47,620
honeybee I'm so you basically need to

229
00:09:53,850 --> 00:09:50,050
supply your own gas so you carry a gas

230
00:09:56,220 --> 00:09:53,860
tank on board and then you essentially

231
00:09:59,639 --> 00:09:56,230
replace the pick up nozzle with a

232
00:10:01,050 --> 00:09:59,649
manifold here and that allows you to

233
00:10:04,470 --> 00:10:01,060
seal against the surface and actually

234
00:10:05,820 --> 00:10:04,480
pick material right off of the ground so

235
00:10:07,500 --> 00:10:05,830
here's a close-up of what that looks

236
00:10:09,960 --> 00:10:07,510
like you have a drill that's gonna come

237
00:10:11,940 --> 00:10:09,970
down pull material out of the go out of

238
00:10:17,340 --> 00:10:11,950

the hole and then you're gonna inject

239
00:10:21,240 --> 00:10:17,350
gas which blows the sample downstream so

240
00:10:26,010 --> 00:10:21,250
CONOPS deploy your drill come down here

241
00:10:29,160 --> 00:10:26,020
into the manifold generate sample inject

242
00:10:32,190 --> 00:10:29,170
gas and you're gonna blow your gas into

243
00:10:34,280 --> 00:10:32,200
the pneumatic tubing just like we do on

244
00:10:38,130 --> 00:10:34,290
the dragonfly

245
00:10:39,660 --> 00:10:38,140
so we brought this into the vacuum we

246
00:10:41,900 --> 00:10:39,670
have it pretty tall vacuum chamber and

247
00:10:44,569 --> 00:10:41,910
honeybee so we were able to fit some

248
00:10:47,940 --> 00:10:44,579
full-scale hardware and basically

249
00:10:51,500 --> 00:10:47,950
recreate different planetary surfaces

250
00:10:55,230 --> 00:10:51,510
and different like textures and and

251
00:10:59,910 --> 00:10:55,240
simulants and so we were successful

252
00:11:03,720 --> 00:10:59,920
every time with this - we tested sandy

253
00:11:06,449 --> 00:11:03,730
surfaces lunar simulants perhaps a

254
00:11:09,720 --> 00:11:06,459
powder surface if you're on a comet but

255
00:11:10,700 --> 00:11:09,730
not Caesar a rocky surface such as an

256
00:11:14,510 --> 00:11:10,710
asteroid

257
00:11:15,650 --> 00:11:14,520
and various other things so I think it's

258
00:11:16,880 --> 00:11:15,660
really cool I mean I think this is

259
00:11:19,700 --> 00:11:16,890
something that you could probably use

260
00:11:22,130 --> 00:11:19,710
with success on most ocean worlds I mean

261
00:11:25,730 --> 00:11:22,140
right now it seems very promising the

262
00:11:28,580 --> 00:11:25,740
pneumatics are the pneumatic transfer

263
00:11:30,590 --> 00:11:28,590

aspect of this to me is really like the

264
00:11:32,570 --> 00:11:30,600
critical technology that enables it and

265
00:11:34,910 --> 00:11:32,580
I think it's a really clean robust thing

266
00:11:38,600 --> 00:11:34,920
that works well for that for the

267
00:11:40,130 --> 00:11:38,610
application so that's it we also did had

268
00:11:42,290 --> 00:11:40,140
a cold tech grant so I wanted to thank

269
00:11:46,880 --> 00:11:42,300
NASA for that as well as the dragonfly

270
00:11:54,260 --> 00:11:46,890
team and I appreciate your attention so

271
00:12:01,240 --> 00:11:54,270
if there's any questions I think we have

272
00:12:06,590 --> 00:12:03,950
Steve ruff ASU I'm curious about the

273
00:12:09,230 --> 00:12:06,600
blower on the dragonfly implementation

274
00:12:13,150 --> 00:12:09,240
if what's the RPMs on that that's about

275
00:12:16,820 --> 00:12:13,160
15,000 15,000 15,000 5-0 yeah it's fast

276
00:12:19,610 --> 00:12:16,830
real fast is that can you control that

277
00:12:22,310 --> 00:12:19,620
is there any benefit to be able to slow

278
00:12:24,380 --> 00:12:22,320
down or maybe increase it even yeah so

279
00:12:25,940 --> 00:12:24,390
we already able to control it and there

280
00:12:29,840 --> 00:12:25,950
is a benefit to slowing it down for

281
00:12:32,690 --> 00:12:29,850
example you can run it at a lower speed

282
00:12:34,580 --> 00:12:32,700
to basically have a lower gas flow rate

283
00:12:36,740 --> 00:12:34,590
before you sample which allows you to

284
00:12:38,780 --> 00:12:36,750
sort of draw in the atmospheric air and

285
00:12:40,610 --> 00:12:38,790
sort of pre cool everything throughout

286
00:12:45,140 --> 00:12:40,620
the system um so that's something we've

287
00:12:46,580 --> 00:12:45,150
tested and it works well but for the

288
00:12:48,410 --> 00:12:46,590

testing that we've done we've just been

289
00:12:50,450 --> 00:12:48,420
running this thing to the maximum that

290
00:12:52,550 --> 00:12:50,460
we can because we found in our testing