AbSciCon 2019

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

2
00:00:11,890 --> 00:00:08,709
[Applause]

3
00:00:14,109 --> 00:00:11,900
I want to talk about the work that we're

4
00:00:16,359 --> 00:00:14,119
doing at the space sciences lab at

5
00:00:17,800 --> 00:00:16,369
Berkeley on microfluidic detection this

6
00:00:21,400 --> 00:00:17,810
is the first time I've been at this

7
00:00:23,050 --> 00:00:21,410
meeting but you should realize that I've

8
00:00:24,659 --> 00:00:23,060
been working in the microphone micro

9
00:00:27,370 --> 00:00:24,669
fluidics area for about twenty years

10
00:00:29,799 --> 00:00:27,380
mostly on genomics and high sensitivity

11
00:00:32,520 --> 00:00:29,809
and litical detection and then I

12
00:00:35,880 --> 00:00:32,530
connected up with Jeff bada with the EXO

13
00:00:38,889 --> 00:00:35,890

Mars mission and the URI instrument and

14
00:00:41,619 --> 00:00:38,899
got into this direction which is a lot

15
00:00:44,590 --> 00:00:41,629
of fun my collaborators are Anna

16
00:00:47,500 --> 00:00:44,600
Butterworth and at the space sciences

17
00:00:49,829 --> 00:00:47,510
lab at Berkeley James knew and Laura

18
00:00:53,020 --> 00:00:49,839
cast out postdocs and Mattin goals our

19
00:00:56,139 --> 00:00:53,030
we're working with John Q Kim at Texas

20
00:00:58,930 --> 00:00:56,149
Tech on the micro fluidics and the micro

21
00:01:01,209 --> 00:00:58,940
processing fluid motion the impact work

22
00:01:03,549 --> 00:01:01,219
that feeds into the EO a is being done

23
00:01:05,560 --> 00:01:03,559
at the impact group at Kent and we're

24
00:01:08,469 --> 00:01:05,570
also collaborating with Amanda Stockton

25
00:01:13,480 --> 00:01:08,479
at Georgia Tech now the basic idea is

26
00:01:16,440 --> 00:01:13,490
there a pointer on this thing this looks

27
00:01:22,360 --> 00:01:20,590
okay the basic idea is a core

28
00:01:26,440 --> 00:01:22,370
microfluidic analyser you've heard about

29
00:01:29,500 --> 00:01:26,450
seee before this is integrated into

30
00:01:31,150 --> 00:01:29,510
these components that basically enable

31
00:01:33,520 --> 00:01:31,160
us to do high sensitivity organic

32
00:01:35,560 --> 00:01:33,530
analysis and their variety of inputs in

33
00:01:38,290 --> 00:01:35,570
case Enceladus you have particles coming

34
00:01:40,210 --> 00:01:38,300
into a plume capture system for the Moab

35
00:01:43,120 --> 00:01:40,220
application which could be landed on

36
00:01:45,970 --> 00:01:43,130
Enceladus or Europa you have a sample

37
00:01:48,460 --> 00:01:45,980
funnel you've heard this all before the

38
00:01:51,940 --> 00:01:48,470

with our hundred picomolar sensitivity

39
00:01:54,810 --> 00:01:51,950
we meet the detection requirements that

40
00:01:59,080 --> 00:01:54,820
came of the science definition team and

41
00:02:00,700 --> 00:01:59,090
but for Enceladus it gets a little

42
00:02:02,830 --> 00:02:00,710
trickier because instead of getting one

43
00:02:06,670 --> 00:02:02,840
gram of material you're only getting a

44
00:02:09,040 --> 00:02:06,680
few attends to hundreds of micrograms so

45
00:02:12,070 --> 00:02:09,050
we've been doing a lot of work figuring

46
00:02:14,170 --> 00:02:12,080
out the capture process and organic

47
00:02:17,320 --> 00:02:14,180
survival and so far basically in terms

48
00:02:19,059 --> 00:02:17,330
of defining mission feasibility it looks

49
00:02:20,260 --> 00:02:19,069
like we get significant organic capture

50
00:02:22,930 --> 00:02:20,270
and survival up to about three

51
00:02:26,290 --> 00:02:22,940
kilometer per second impacts and a

52
00:02:29,830 --> 00:02:26,300
slower is a bit better that means in one

53
00:02:32,170 --> 00:02:29,840
pass you get an interesting result of

54
00:02:33,730 --> 00:02:32,180
forty part per billion detective 'ti but

55
00:02:35,860 --> 00:02:33,740
probably not enough for life detection

56
00:02:38,170 --> 00:02:35,870
but with ten passes you get into a

57
00:02:39,610 --> 00:02:38,180
regime where that would be actually

58
00:02:44,710 --> 00:02:39,620
quite interesting

59
00:02:47,260 --> 00:02:44,720
now the basic concept of this I'll go

60
00:02:49,480 --> 00:02:47,270
through quickly is looking for bio

61
00:02:52,150 --> 00:02:49,490
focusing and amplification of molecular

62
00:02:54,550 --> 00:02:52,160
complexity caused by life that

63
00:02:57,520 --> 00:02:54,560

amplification can be fatty acid chain

64
00:03:00,400 --> 00:02:57,530
lake variation and chirality amino acid

65
00:03:05,140 --> 00:03:00,410
focusing and so on but the big point

66
00:03:07,210 --> 00:03:05,150
about this is that molecular analysis is

67
00:03:09,610 --> 00:03:07,220
highly leveraged because for example on

68
00:03:12,160 --> 00:03:09,620
earth bacterial cell gives you a billion

69
00:03:14,950 --> 00:03:12,170
readout mechanisms such as amino acids

70
00:03:17,080 --> 00:03:14,960
so there's a ten to the nine gain when

71
00:03:19,480 --> 00:03:17,090
you look at the molecular components of

72
00:03:21,220 --> 00:03:19,490
a cell so the idea is to label those

73
00:03:23,020 --> 00:03:21,230
biosignature molecules and to do

74
00:03:24,699 --> 00:03:23,030
functional group specific fluorescent

75
00:03:27,640 --> 00:03:24,709
dyes so we segregate the molecular

76
00:03:30,760 --> 00:03:27,650
population and then go on to electro

77
00:03:32,740 --> 00:03:30,770
phoretic analysis now a little heritage

78
00:03:34,660 --> 00:03:32,750
this was first developed at the

79
00:03:36,750 --> 00:03:34,670
prototype stage in our group by Jim

80
00:03:40,420 --> 00:03:36,760
Shearer some fifteen years ago

81
00:03:42,310 --> 00:03:40,430
confocal detection a stack of wafers two

82
00:03:43,960 --> 00:03:42,320
pieces of glass here that define the

83
00:03:46,090 --> 00:03:43,970
capillary electrophoresis channel and

84
00:03:49,060 --> 00:03:46,100
micro fluidics I'll tell you about for

85
00:03:51,310 --> 00:03:49,070
manipulating things on the chip at a

86
00:03:52,630 --> 00:03:51,320
very low volume confocal laser

87
00:03:55,720 --> 00:03:52,640
fluorescence gets you a hundred

88
00:03:57,550 --> 00:03:55,730

picomolar sensitivity and the basic

89
00:03:59,770 --> 00:03:57,560
point is if you can't you know if you

90
00:04:02,500 --> 00:03:59,780
don't see it it doesn't matter so high

91
00:04:06,210 --> 00:04:02,510
sensitivity is really critical in this

92
00:04:10,030 --> 00:04:06,220
game now a key part of this is the

93
00:04:12,640 --> 00:04:10,040
manipulation of the fluids and back in

94
00:04:14,440 --> 00:04:12,650
2003 we'll Grover my group invented

95
00:04:16,810 --> 00:04:14,450
these pneumatic valves where you apply a

96
00:04:19,900 --> 00:04:16,820
pneumatic pressure to essentially open a

97
00:04:21,760 --> 00:04:19,910
deformable membrane to open a valve or

98
00:04:24,940 --> 00:04:21,770
close it these are normally closed

99
00:04:26,770 --> 00:04:24,950
valves you can gain three together to

100
00:04:28,930 --> 00:04:26,780
make a pump as was described early in

101
00:04:30,430 --> 00:04:28,940
the conference and we invented it we

102
00:04:31,690 --> 00:04:30,440
patented it's actually part of a

103
00:04:34,300 --> 00:04:31,700
commercial product so

104
00:04:36,310 --> 00:04:34,310
a thermal Fisher right now it was

105
00:04:40,030 --> 00:04:36,320
actually quite successful and enables

106
00:04:41,530 --> 00:04:40,040
doing quite a few interesting things now

107
00:04:44,080 --> 00:04:41,540
illustrating this functional group

108
00:04:46,030 --> 00:04:44,090
specific labeling if you take carboxylic

109
00:04:48,130 --> 00:04:46,040
acids and hit them with cascade blue you

110
00:04:50,380 --> 00:04:48,140
can light those up selectively here's an

111
00:04:52,420 --> 00:04:50,390
example from a hobby Batcave this is a

112
00:04:54,750 --> 00:04:52,430
my air in my life when I was doing field

113
00:04:57,130 --> 00:04:54,760

trials so it's a very high sensitivity

114
00:04:59,020 --> 00:04:57,140
apparatus everybody else you try to

115
00:05:00,190 --> 00:04:59,030
analyze bat I bet you can't do it

116
00:05:02,650 --> 00:05:00,200
okay

117
00:05:05,050 --> 00:05:02,660
we can also label aldehydes and ketones

118
00:05:07,240 --> 00:05:05,060
this is my most famous paper where we

119
00:05:09,040 --> 00:05:07,250
actually analyze various wines from the

120
00:05:12,970 --> 00:05:09,050
California industry got the highest

121
00:05:14,920 --> 00:05:12,980
citation of any paper I ever did you can

122
00:05:17,020 --> 00:05:14,930
also of course label amines and amino

123
00:05:19,600 --> 00:05:17,030
acids this is a separation about 50

124
00:05:21,970 --> 00:05:19,610
different components which is just a

125
00:05:23,980 --> 00:05:21,980
standard but basically like everybody

126
00:05:26,290 --> 00:05:23,990
else we went to the Atacama Desert

127
00:05:28,450 --> 00:05:26,300
we ran subcritical a supercritical water

128
00:05:30,160 --> 00:05:28,460
extraction we did an analysis we saw

129
00:05:32,740 --> 00:05:30,170
part per billion detective attea saw

130
00:05:34,960 --> 00:05:32,750
chirality Atacama Desert and notice that

131
00:05:38,170 --> 00:05:34,970
was published in 2007 so we did this

132
00:05:41,140 --> 00:05:38,180
like over ten years ago okay so that's

133
00:05:43,420 --> 00:05:41,150
the end of my prototype instrument field

134
00:05:45,370 --> 00:05:43,430
trials life and I said I'm done with

135
00:05:46,990 --> 00:05:45,380
this I'm going to focus on making flight

136
00:05:49,750 --> 00:05:47,000
instruments that are basically

137
00:05:52,120 --> 00:05:49,760
specifically designed in their in their

138
00:05:53,950 --> 00:05:52,130

physical layout I and the material as

139
00:05:56,920 --> 00:05:53,960
you put it and everything else so we

140
00:06:00,820 --> 00:05:56,930
transform directly to flight with these

141
00:06:02,800 --> 00:06:00,830
technologies so that's how it fits

142
00:06:07,450 --> 00:06:02,810
together there's this core organic

143
00:06:09,040 --> 00:06:07,460
analyzer the Moab thing which is IC to

144
00:06:12,220 --> 00:06:09,050
funding has just started there's a

145
00:06:14,380 --> 00:06:12,230
component which is accommodation now

146
00:06:16,960 --> 00:06:14,390
that we have specific science goals that

147
00:06:18,820 --> 00:06:16,970
came up with the SDT we have you know

148
00:06:20,860 --> 00:06:18,830
specific target concentrations and

149
00:06:24,280 --> 00:06:20,870
separations we want to do or get going

150
00:06:26,560 --> 00:06:24,290
on that and the sample input this sample

151
00:06:28,390 --> 00:06:26,570
input is a funnel it is purely sort of

152
00:06:30,160 --> 00:06:28,400
notional because we just had the meeting

153
00:06:31,690 --> 00:06:30,170
with the academy's guys to figure out

154
00:06:33,670 --> 00:06:31,700
what the nature of that sample tourette

155
00:06:35,700 --> 00:06:33,680
transport is going to be but it will

156
00:06:39,190 --> 00:06:35,710
obviously be introduction of solid

157
00:06:41,350 --> 00:06:39,200
filtration and generating fluids so what

158
00:06:44,440 --> 00:06:41,360
is the state of the core analyzer that's

159
00:06:45,399 --> 00:06:44,450
outlined here and I'll go through it the

160
00:06:47,559 --> 00:06:45,409
basic point here

161
00:06:51,009 --> 00:06:47,569
first there's a macro fluidic system

162
00:06:53,169 --> 00:06:51,019
that's been designed by the engineers at

163
00:06:56,350 --> 00:06:53,179

JPL and I should point a point out here

164
00:06:59,290 --> 00:06:56,360
that my focus here isn't on making very

165
00:07:00,729 --> 00:06:59,300
simple very robust technology I TR L

166
00:07:03,279 --> 00:07:00,739
that is designed by people who have

167
00:07:04,809 --> 00:07:03,289
built flight instruments before we want

168
00:07:06,969 --> 00:07:04,819
a simple we're going to integrate it we

169
00:07:09,429 --> 00:07:06,979
want a totally autonomous and we want to

170
00:07:14,559 --> 00:07:09,439
do one thing really well and have low

171
00:07:16,719 --> 00:07:14,569
risk so the macro fluidics is shown here

172
00:07:18,699 --> 00:07:16,729
where we have the gas reservoirs

173
00:07:21,969 --> 00:07:18,709
pneumatics and water storage chambers

174
00:07:24,040 --> 00:07:21,979
that's in green in this CAD design and

175
00:07:27,819 --> 00:07:24,050
you can see the hard components that we

176
00:07:29,769 --> 00:07:27,829
fabricated here the chip that I'll go

177
00:07:32,169 --> 00:07:29,779
into in more detail is contained in this

178
00:07:34,569 --> 00:07:32,179
orange structure and here's a picture of

179
00:07:37,659 --> 00:07:34,579
the chip in the prototype fabricated

180
00:07:40,419 --> 00:07:37,669
chamber there's also a confocal

181
00:07:42,999 --> 00:07:40,429
detection system so on at purple that

182
00:07:46,629 --> 00:07:43,009
fits in here and now I'm going to go

183
00:07:49,119 --> 00:07:46,639
through all these various components now

184
00:07:50,739 --> 00:07:49,129
an important part about this is sort of

185
00:07:53,049 --> 00:07:50,749
the transfer function this is what we

186
00:07:55,629 --> 00:07:53,059
cook so to level one requirements how do

187
00:07:58,600 --> 00:07:55,639
you get from you know one gram of

188
00:08:00,999 --> 00:07:58,610

material with 0.1 ppb organics all the

189
00:08:03,219 --> 00:08:01,009
way through to 100 picomolar detection

190
00:08:05,169 --> 00:08:03,229
at our detection system and this shows

191
00:08:06,519 --> 00:08:05,179
that a transfer function I think in the

192
00:08:08,290 --> 00:08:06,529
interest of time I'm not going to read

193
00:08:10,600 --> 00:08:08,300
all these numbers to show you that it

194
00:08:12,999 --> 00:08:10,610
exists and we've worked it out in a part

195
00:08:14,919 --> 00:08:13,009
part about this for others is that after

196
00:08:17,409 --> 00:08:14,929
we get roughly one milliliter of

197
00:08:19,299 --> 00:08:17,419
dissolved and filtered material we

198
00:08:21,069 --> 00:08:19,309
really only need 100 microliters of this

199
00:08:23,469 --> 00:08:21,079
so most likely there's about 900

200
00:08:26,350 --> 00:08:23,479
microliters that can go to other

201
00:08:28,179 --> 00:08:26,360
instruments and these results allow us

202
00:08:29,919 --> 00:08:28,189
to meet all the science goals that are

203
00:08:35,199 --> 00:08:29,929
defined by the science definition team

204
00:08:37,749 --> 00:08:35,209
for Europa now so here is image of the

205
00:08:39,519 --> 00:08:37,759
chips we're not making this wafer you

206
00:08:41,290 --> 00:08:39,529
can see the separation channel it is the

207
00:08:43,119 --> 00:08:41,300
cross and the separation a lot you've

208
00:08:44,499 --> 00:08:43,129
heard a lot of talks about this so I

209
00:08:46,600 --> 00:08:44,509
won't go through the details

210
00:08:48,670 --> 00:08:46,610
these are fabricated in the Nano lab at

211
00:08:51,280 --> 00:08:48,680
Berkley on 100 millimeter wafers it's

212
00:08:53,019 --> 00:08:51,290
two pieces of glass one surface is

213
00:08:55,509 --> 00:08:53,029

etched there then the thermally fused

214
00:08:56,850 --> 00:08:55,519
together this channel format 15

215
00:08:59,940 --> 00:08:56,860
centimeters long there

216
00:09:02,340 --> 00:08:59,950
100 by 30 micron cross-section channels

217
00:09:04,050 --> 00:09:02,350
we're using two channels because you

218
00:09:06,090 --> 00:09:04,060
know if you get to Europa and one of

219
00:09:07,940 --> 00:09:06,100
them clogs you're kind of screwed so

220
00:09:09,960 --> 00:09:07,950
we're doing redone two redundant

221
00:09:12,990 --> 00:09:09,970
separation channels and detection

222
00:09:14,430 --> 00:09:13,000
systems and you get these very fast

223
00:09:17,579 --> 00:09:14,440
separations that have already been

224
00:09:20,400 --> 00:09:17,589
talked about the main point is that you

225
00:09:22,350 --> 00:09:20,410
know you can make these things you can

226
00:09:25,199 --> 00:09:22,360
carry them around in your suitcase Kevin

227
00:09:27,449 --> 00:09:25,209
can look at you know this is very robust

228
00:09:29,310 --> 00:09:27,459
solid technology and what you have to

229
00:09:32,280 --> 00:09:29,320
remember is what I just showed you has

230
00:09:34,380 --> 00:09:32,290
the C II system it has all the valves it

231
00:09:36,389 --> 00:09:34,390
has all the fluidic processing there are

232
00:09:38,880 --> 00:09:36,399
no external Swagelok connectors of

233
00:09:40,650 --> 00:09:38,890
tubing it's just a chunk of stuff that

234
00:09:41,430 --> 00:09:40,660
you can pass around okay it's very

235
00:09:45,480 --> 00:09:41,440
robust

236
00:09:48,329 --> 00:09:45,490
so the fluidic system that I just handed

237
00:09:51,139 --> 00:09:48,339
to Kevin is what we call a programmable

238
00:09:54,210 --> 00:09:51,149

microfluidic analyzer this is made by

239
00:09:56,850 --> 00:09:54,220
jungkook Kim at Texas Tech and if you go

240
00:09:58,440 --> 00:09:56,860
around this these circumferential inputs

241
00:10:00,180 --> 00:09:58,450
are the pneumatic inputs those are

242
00:10:02,370 --> 00:10:00,190
indicated in blue so here there are four

243
00:10:04,550 --> 00:10:02,380
inputs that control these valves that

244
00:10:08,310 --> 00:10:04,560
control the filling of the C II system

245
00:10:09,930 --> 00:10:08,320
these ganged inputs control the central

246
00:10:12,090 --> 00:10:09,940
processor this is essentially a

247
00:10:14,579 --> 00:10:12,100
programmable automaton that allows you

248
00:10:17,490 --> 00:10:14,589
to route fluids to any point that was

249
00:10:19,759 --> 00:10:17,500
invented by will Grover in my group and

250
00:10:23,189 --> 00:10:19,769
this is an array of sample storage

251
00:10:26,130 --> 00:10:23,199
reservoirs the sample is pumped to the

252
00:10:29,759 --> 00:10:26,140
reservoirs by that macro fluidic system

253
00:10:32,519 --> 00:10:29,769
and then we use these three valve pumps

254
00:10:35,280 --> 00:10:32,529
to move fluids around and mix the sample

255
00:10:40,860 --> 00:10:35,290
with the reagents and get a reaction and

256
00:10:44,699 --> 00:10:40,870
I showed you the CAD here's a picture of

257
00:10:48,150 --> 00:10:44,709
the device and here's the device so

258
00:10:50,130 --> 00:10:48,160
we've gone all the way okay so these

259
00:10:53,759 --> 00:10:50,140
systems are very nice we're currently

260
00:10:56,069 --> 00:10:53,769
integrating that chip into this manifold

261
00:10:57,720 --> 00:10:56,079
this is a circular manifold it has the

262
00:10:59,250 --> 00:10:57,730
solenoids the connection being the

263
00:11:01,800 --> 00:10:59,260

solenoids are controlling pressure and

264
00:11:04,319 --> 00:11:01,810
vacuum that go into the chip and control

265
00:11:05,850 --> 00:11:04,329
the valves so it's a nice compact

266
00:11:06,420 --> 00:11:05,860
structure that's really no bigger than

267
00:11:08,910 --> 00:11:06,430
100

268
00:11:12,389 --> 00:11:08,920
millimeter diameter wafer you can see

269
00:11:14,130 --> 00:11:12,399
the high voltage inputs that come in the

270
00:11:16,740 --> 00:11:14,140
chip is covered so we have an ambient

271
00:11:18,269 --> 00:11:16,750
pressure over it over the any fluids

272
00:11:20,150 --> 00:11:18,279
that are exposed so we don't have to

273
00:11:22,920 --> 00:11:20,160
deal with evaporation and

274
00:11:24,780 --> 00:11:22,930
electrochemical breakdown the valve

275
00:11:26,579 --> 00:11:24,790
manifold and all of that has been

276
00:11:28,920 --> 00:11:26,589
assembled here we're using pigtails to

277
00:11:31,230 --> 00:11:28,930
connect the circuit board up to the

278
00:11:33,960 --> 00:11:31,240
manifold but it can be also directly

279
00:11:35,460 --> 00:11:33,970
soldered in place and all of this makes

280
00:11:37,829 --> 00:11:35,470
up what we call a technology

281
00:11:40,170 --> 00:11:37,839
demonstration unit which is being has

282
00:11:42,420 --> 00:11:40,180
actually just been assembled in our lab

283
00:11:44,670 --> 00:11:42,430
and is now undergoing functional testing

284
00:11:47,910 --> 00:11:44,680
and I point out this is all designed by

285
00:11:49,800 --> 00:11:47,920
the engineers at space sciences lab this

286
00:11:51,750 --> 00:11:49,810
is the format that will fly every

287
00:11:54,530 --> 00:11:51,760
component we're putting in here every

288
00:11:57,389 --> 00:11:54,540

design is designed to be flyable flyable

289
00:11:59,010 --> 00:11:57,399
material a component that has flight

290
00:12:03,090 --> 00:11:59,020
heritage or a component that has a

291
00:12:05,699 --> 00:12:03,100
pathway to flight so the overall

292
00:12:07,920 --> 00:12:05,709
structure of this is shown here this is

293
00:12:09,449 --> 00:12:07,930
the AOA tdu assembly of course we just

294
00:12:10,920 --> 00:12:09,459
got Moab mommy so we haven't built

295
00:12:14,250 --> 00:12:10,930
anything with it yet so this is really

296
00:12:16,199 --> 00:12:14,260
an outline of the eoa here's the cat of

297
00:12:17,460 --> 00:12:16,209
the system the power supplies are

298
00:12:19,590 --> 00:12:17,470
conventional because they didn't get

299
00:12:22,860 --> 00:12:19,600
money to build those the chips going in

300
00:12:23,519 --> 00:12:22,870
there here's the manifold the macro

301
00:12:25,800 --> 00:12:23,529
fluidics

302
00:12:28,230 --> 00:12:25,810
there's the confocal detection system

303
00:12:29,850 --> 00:12:28,240
and for eoa of course there's a particle

304
00:12:31,800 --> 00:12:29,860
capture system but the patents pending

305
00:12:33,300 --> 00:12:31,810
on that structure so I can't show it to

306
00:12:35,220 --> 00:12:33,310
you we'll probably talk more about how

307
00:12:38,460 --> 00:12:35,230
you achieve those detection

308
00:12:43,340 --> 00:12:38,470
sensitivities for eroded enceladus

309
00:12:47,130 --> 00:12:43,350
impacts probably at aju in december so

310
00:12:49,079 --> 00:12:47,140
last slide the Berkeley Space Sciences

311
00:12:50,930 --> 00:12:49,089
lab is really pioneering the fabrication

312
00:12:53,850 --> 00:12:50,940
of these microfluidic instruments

313
00:12:56,160 --> 00:12:53,860

characterizing organic biomarkers

314
00:12:58,980 --> 00:12:56,170
I think functional group specific

315
00:13:01,199 --> 00:12:58,990
labeling really enables you to segregate

316
00:13:03,990 --> 00:13:01,209
the market or population and is very

317
00:13:05,790 --> 00:13:04,000
agnostic it's not just amino acids

318
00:13:08,880 --> 00:13:05,800
basically any molecule that shows up

319
00:13:11,370 --> 00:13:08,890
with aldehyde ketone amine or carboxylic

320
00:13:14,069 --> 00:13:11,380
acid whatever whatever life gives us our

321
00:13:16,110 --> 00:13:14,079
life doesn't give us we can label it and

322
00:13:19,170 --> 00:13:16,120
we can segregate it and we can detect it

323
00:13:20,210 --> 00:13:19,180
with high sensitivity and we expect to

324
00:13:22,580 --> 00:13:20,220
be at Tierra

325
00:13:25,670 --> 00:13:22,590
six with a clear pathway to seven by

326
00:13:28,070 --> 00:13:25,680
basically somewhere between 20 21 and 20

327
00:13:30,020 --> 00:13:28,080
22 which unfortunately now looks like it

328
00:13:31,670 --> 00:13:30,030
might be early but we'll see what

329
00:13:40,990 --> 00:13:31,680
happens okay so thank you very much

330
00:13:48,230 --> 00:13:45,800
frank post buck fu berlin so i can the

331
00:13:48,890 --> 00:13:48,240
system handle salt saturated prawns does

332
00:13:50,870 --> 00:13:48,900
that matter

333
00:13:53,900 --> 00:13:50,880
kenny hander what can the system salt

334
00:13:55,820 --> 00:13:53,910
saturated brines yes we were the first

335
00:13:57,650 --> 00:13:55,830
to show that you could handle such rated

336
00:14:01,310 --> 00:13:57,660
brian we actually got samples from the

337
00:14:04,160 --> 00:14:01,320
saline valley in death valley and the

338
00:14:06,590 --> 00:14:04,170

way you do that is there's there's two

339
00:14:08,990 --> 00:14:06,600
solutions one that zach mentioned

340
00:14:11,900 --> 00:14:09,000
already was dilution but the key part

341
00:14:14,150 --> 00:14:11,910
about that is there's there's two key

342
00:14:15,710 --> 00:14:14,160
points one is you make sure you pick a

343
00:14:18,680 --> 00:14:15,720
buffer which has sufficient buffer

344
00:14:20,840 --> 00:14:18,690
capacity to deal with any high or low pH

345
00:14:23,120 --> 00:14:20,850
we did ryo-san Rio Tinto samples to I

346
00:14:26,000 --> 00:14:23,130
can send you a reference for a paper on

347
00:14:28,190 --> 00:14:26,010
this but you know the key the killer is

348
00:14:30,710 --> 00:14:28,200
if you dilute you the sensitivity and

349
00:14:33,290 --> 00:14:30,720
that's why we developed these Pacific

350
00:14:34,760 --> 00:14:33,300
blue reagents which actually got us by a

351
00:14:36,950 --> 00:14:34,770
factor of a hundred times better

352
00:14:39,590 --> 00:14:36,960
sensitivity than the earlier work we did

353
00:14:41,270 --> 00:14:39,600
when we are working with Jeff so it you

354
00:14:43,340 --> 00:14:41,280
the basic point is if you have super

355
00:14:46,070 --> 00:14:43,350
high sensitivity you can use you can

356
00:14:47,870 --> 00:14:46,080
trade that sensitivity to solve problems

357
00:14:49,760 --> 00:14:47,880
and you've described one of the problems

358
00:14:54,890 --> 00:14:49,770
that we solved with that exploiting that

359
00:14:59,890 --> 00:14:54,900
sensitivity excellent