
AbSciCon
2019

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

2
00:00:12,470 --> 00:00:09,130
[Applause]

3
00:00:13,879 --> 00:00:12,480
hello good afternoon everyone my name is

4
00:00:15,770 --> 00:00:13,889
Leslie from NASA Ames Research Center

5
00:00:17,740 --> 00:00:15,780
I'm a chemical engineer over there

6
00:00:20,179 --> 00:00:17,750
working as a Mission Support Engineer

7
00:00:22,190 --> 00:00:20,189
today I wanted to talk about splice our

8
00:00:24,740 --> 00:00:22,200
sample processor to enable the search

9
00:00:26,109 --> 00:00:24,750
for life on icy worlds specifically what

10
00:00:29,560 --> 00:00:26,119
we're gonna be talking about is a

11
00:00:32,299 --> 00:00:29,570
microfluidic front-end to interface with

12
00:00:34,010 --> 00:00:32,309
capillary electrophoresis or mass spec

13
00:00:37,280 --> 00:00:34,020

or a number of different analytical

14
00:00:39,350 --> 00:00:37,290
instruments it's specific to processing

15
00:00:41,960 --> 00:00:39,360
samples and from ocean worlds and

16
00:00:44,030 --> 00:00:41,970
solidus in Europa we had to we have

17
00:00:45,829 --> 00:00:44,040
multiple configurations first place some

18
00:00:49,579 --> 00:00:45,839
for a plume sampling some Firth Lander

19
00:00:51,229 --> 00:00:49,589
sampling in which case each of our each

20
00:00:52,910 --> 00:00:51,239
of our sample requirements were

21
00:00:54,500 --> 00:00:52,920
different but specifically we're looking

22
00:00:56,450 --> 00:00:54,510
at doing biomarker detection

23
00:00:59,899 --> 00:00:56,460
habitability characterization and

24
00:01:02,000 --> 00:00:59,909
building on our previous previous Mars

25
00:01:03,460 --> 00:01:02,010
missions Viking and Phoenix which

26
00:01:07,070 --> 00:01:03,470
utilize some of these same types of

27
00:01:08,480 --> 00:01:07,080
characterization techniques so an

28
00:01:11,180 --> 00:01:08,490
overview of what we're trying to

29
00:01:12,770 --> 00:01:11,190
accomplish on these missions we're

30
00:01:14,870 --> 00:01:12,780
looking at doing automated sample

31
00:01:17,539 --> 00:01:14,880
handling of some very dilute low

32
00:01:19,490 --> 00:01:17,549
concentration samples so we have a some

33
00:01:22,010 --> 00:01:19,500
sort of sample collector and a fluidics

34
00:01:24,319 --> 00:01:22,020
processor that interfaces to end up to a

35
00:01:26,870 --> 00:01:24,329
giant and analytical instrument suite

36
00:01:28,459 --> 00:01:26,880
so for a flukes processor we need to do

37
00:01:31,120 --> 00:01:28,469
a number of things including extracting

38
00:01:34,039 --> 00:01:31,130

the solution and sampling out particles

39
00:01:36,499 --> 00:01:34,049
degassing adjusting ionic strength or

40
00:01:39,109 --> 00:01:36,509
removing ions adjusting pH adjusting

41
00:01:40,849 --> 00:01:39,119
polarity and eventually just delivering

42
00:01:45,349 --> 00:01:40,859
to the number of instruments that we are

43
00:01:46,849 --> 00:01:45,359
interfaced with so in order to

44
00:01:49,249 --> 00:01:46,859
accomplish this we went through a

45
00:01:51,620 --> 00:01:49,259
process of starting with component level

46
00:01:52,940 --> 00:01:51,630
testing we had an idea of the things

47
00:01:55,160 --> 00:01:52,950
that we needed to accomplish and we

48
00:01:57,289 --> 00:01:55,170
started by miniaturizing these into

49
00:01:59,239 --> 00:01:57,299
smaller component pieces that we could

50
00:02:01,130 --> 00:01:59,249
test individually so shown here you have

51
00:02:03,200 --> 00:02:01,140
some bubble traps check valves dry

52
00:02:05,510 --> 00:02:03,210
reagent storage precision metering pumps

53
00:02:09,249 --> 00:02:05,520
and a concentrator that's used to all

54
00:02:13,880 --> 00:02:09,259
processes samples in different ways

55
00:02:15,680 --> 00:02:13,890
after analyzing the capabilities of

56
00:02:18,350 --> 00:02:15,690
these instruments we then integrated

57
00:02:19,640 --> 00:02:18,360
them into a number of manifolds and so

58
00:02:20,910 --> 00:02:19,650
here you can see that what we've

59
00:02:22,800 --> 00:02:20,920
accomplished is

60
00:02:25,230 --> 00:02:22,810
development of microfluidic manifolds

61
00:02:27,660 --> 00:02:25,240
that behave like fused multi-layer

62
00:02:30,449 --> 00:02:27,670
monoliths so there's a number of cut

63
00:02:32,430 --> 00:02:30,459

channels down to 250 microliters or up

64
00:02:35,750 --> 00:02:32,440
to one milliliter or approximately in

65
00:02:38,520 --> 00:02:35,760
diameter that run through these channels

66
00:02:42,570 --> 00:02:38,530
or that run through these manifolds to

67
00:02:44,699 --> 00:02:42,580
handle either 2 micro liter or larger

68
00:02:49,770 --> 00:02:44,709
milliliter size samples from these

69
00:02:54,300 --> 00:02:49,780
missions so splice 1.0 was the original

70
00:02:56,729 --> 00:02:54,310
og mandible that we we established and

71
00:03:02,190 --> 00:02:56,739
this was made for MCA and a connection

72
00:03:03,650 --> 00:03:02,200
to a micro with chemical lab I am and so

73
00:03:07,620 --> 00:03:03,660
you see a number of the components there

74
00:03:10,800 --> 00:03:07,630
this then increased in complexity when

75
00:03:14,310 --> 00:03:10,810
we developed splice MS and here the big

76
00:03:18,240 --> 00:03:14,320
thing being the the connection to the

77
00:03:21,210 --> 00:03:18,250
mass spectrometer and then finally into

78
00:03:22,880 --> 00:03:21,220
splice 2.0 which collected 2 which

79
00:03:25,830 --> 00:03:22,890
connects to a micro capillary

80
00:03:28,140 --> 00:03:25,840
electrophoresis instrument a micro what

81
00:03:31,500 --> 00:03:28,150
chemistry lab as well as a mass

82
00:03:33,690 --> 00:03:31,510
spectroscopy suite so in the case of all

83
00:03:35,370 --> 00:03:33,700
of these manifolds and each of these

84
00:03:37,050 --> 00:03:35,380
components were again tested

85
00:03:39,780 --> 00:03:37,060
individually and then integrated into

86
00:03:41,550 --> 00:03:39,790
one full suite that takes samples and

87
00:03:44,789 --> 00:03:41,560
allows them to be processed and

88
00:03:48,180 --> 00:03:44,799

delivered to multiple instruments in a

89
00:03:49,020 --> 00:03:48,190
lot of the cases we're working or in all

90
00:03:51,780 --> 00:03:49,030
of these manifolds

91
00:03:53,280 --> 00:03:51,790
we are working with flight heritage 50

92
00:03:55,199 --> 00:03:53,290
micro liter pumps and solenoid valves

93
00:03:57,449 --> 00:03:55,209
and the integration of these manifolds

94
00:03:59,190 --> 00:03:57,459
is down on the scale of inches so each

95
00:04:02,729 --> 00:03:59,200
one of these manifolds is about 5 inches

96
00:04:06,930 --> 00:04:02,739
by 5 inches and it's a weight is only

97
00:04:08,789 --> 00:04:06,940
about half of a kilogram so previous

98
00:04:11,250 --> 00:04:08,799
talks have kind of talked about some of

99
00:04:14,160 --> 00:04:11,260
these capabilities that we have but one

100
00:04:16,289 --> 00:04:14,170
of them is to go and connect to a sample

101
00:04:17,909 --> 00:04:16,299
collector and to wet out that sample

102
00:04:20,099 --> 00:04:17,919
collector and then retrieve all of the

103
00:04:22,290 --> 00:04:20,109
particles from that collector to move

104
00:04:24,150 --> 00:04:22,300
into the manifold with that we also have

105
00:04:27,680 --> 00:04:24,160
the ability to concentrate these

106
00:04:30,060 --> 00:04:27,690
particles on the order of 5 X

107
00:04:31,839 --> 00:04:30,070
concentration from 35 microliters down

108
00:04:35,949 --> 00:04:31,849
to 7 microliters within a 20 minute

109
00:04:37,139 --> 00:04:35,959
span and as well as a number of other

110
00:04:40,949 --> 00:04:37,149
autonomous

111
00:04:43,480 --> 00:04:40,959
processes so specifically with the

112
00:04:46,989 --> 00:04:43,490
autonomous development we've developed

113
00:04:49,929 --> 00:04:46,999

flight hardware to control all of our

114
00:04:53,260 --> 00:04:49,939
valves pumps etc to actually move these

115
00:04:55,659 --> 00:04:53,270
samples where they need to go so some

116
00:04:57,489 --> 00:04:55,669
routine functionality I'm we have dry

117
00:04:59,469 --> 00:04:57,499
reagent storage on board as well as

118
00:05:01,869 --> 00:04:59,479
bubble mitigation and pressure and

119
00:05:03,489 --> 00:05:01,879
temperature sensing when I say routine

120
00:05:04,839 --> 00:05:03,499
functionality I mean these aren't things

121
00:05:06,459 --> 00:05:04,849
that are specialized but they are very

122
00:05:07,629 --> 00:05:06,469
incredibly necessary for the sample

123
00:05:10,480 --> 00:05:07,639
handling that we're trying to accomplish

124
00:05:12,939 --> 00:05:10,490
out on Enceladus Europa deep space

125
00:05:17,019 --> 00:05:12,949
missions dry reagent storage of course

126
00:05:18,399 --> 00:05:17,029
it's very very powerful to have to

127
00:05:22,480 --> 00:05:18,409
reduce your volumes inside of the

128
00:05:25,299 --> 00:05:22,490
instrument eye as well as to have good

129
00:05:27,879 --> 00:05:25,309
control of concentrations within your

130
00:05:29,259 --> 00:05:27,889
manifold bubble mitigation we've had a

131
00:05:32,259 --> 00:05:29,269
number of types of bubble traps which

132
00:05:35,589 --> 00:05:32,269
we've all proved to work before but the

133
00:05:37,389 --> 00:05:35,599
the nice improvement in slice 2.0 that

134
00:05:38,799 --> 00:05:37,399
other manifolds haven't had is the

135
00:05:41,170 --> 00:05:38,809
integrated pressure and temperature

136
00:05:45,399 --> 00:05:41,180
sensing with the use of Honeywell

137
00:05:47,589 --> 00:05:45,409
pressure sensors shown there so with dry

138
00:05:50,499 --> 00:05:47,599

region storage what we've done is we've

139
00:05:52,869 --> 00:05:50,509
taken these porous polymer monoliths and

140
00:05:54,429 --> 00:05:52,879
actually dehydrated reagents onto the

141
00:05:56,350 --> 00:05:54,439
monoliths and found that with

142
00:05:58,029 --> 00:05:56,360
rehydration we can generally get back

143
00:05:59,889 --> 00:05:58,039
about 90 percent of what we have put

144
00:06:02,379 --> 00:05:59,899
onto the monolith to use for other

145
00:06:04,179 --> 00:06:02,389
processes so we have a characterize

146
00:06:07,629 --> 00:06:04,189
reconstitution of dry reagents from

147
00:06:09,309 --> 00:06:07,639
absorbance measurements by using and but

148
00:06:11,739 --> 00:06:09,319
we have characterized by using a single

149
00:06:13,659 --> 00:06:11,749
point detector which takes absorbance

150
00:06:15,100 --> 00:06:13,669
measurements so then see what's coming

151
00:06:19,659 --> 00:06:15,110
off of the monoliths that we can

152
00:06:21,759 --> 00:06:19,669
characterize and use so important to

153
00:06:23,739 --> 00:06:21,769
this was the concentration control what

154
00:06:26,409 --> 00:06:23,749
often happens with the dry reagent

155
00:06:28,629 --> 00:06:26,419
storage is that as the reagent is

156
00:06:30,790 --> 00:06:28,639
rehydrating especially if the kinetics

157
00:06:33,369 --> 00:06:30,800
or the reagent are very quick you get a

158
00:06:36,040 --> 00:06:33,379
very high concentration front and a very

159
00:06:37,570 --> 00:06:36,050
low concentration tail so if you look

160
00:06:39,430 --> 00:06:37,580
this concentration right here you can

161
00:06:41,409 --> 00:06:39,440
see that on a normal on a regular

162
00:06:43,089 --> 00:06:41,419
rehydration you start up with the

163
00:06:44,980 --> 00:06:43,099

concentration that's at or above a

164
00:06:48,490 --> 00:06:44,990
hundred percent that drops down to zero

165
00:06:52,420 --> 00:06:48,500
but in the case of staining staining

166
00:06:53,980 --> 00:06:52,430
cells staying any sort of materials that

167
00:06:55,719 --> 00:06:53,990
we want with fluorescent tags and things

168
00:06:58,689 --> 00:06:55,729
you really want a uniform concentration

169
00:07:02,409 --> 00:06:58,699
that you can deliver to those samples to

170
00:07:04,170 --> 00:07:02,419
be able to get the best to be able to

171
00:07:07,659 --> 00:07:04,180
get the best fluorescence or the best

172
00:07:08,649 --> 00:07:07,669
analysis of your samples and so the way

173
00:07:10,839 --> 00:07:08,659
that we've done this is we've actually

174
00:07:13,350 --> 00:07:10,849
developed a method for concentration

175
00:07:15,909 --> 00:07:13,360
control by dilution additi so we use

176
00:07:18,309 --> 00:07:15,919
irregular water dosing to take the

177
00:07:19,869 --> 00:07:18,319
enriched flood front and turn it into a

178
00:07:24,180 --> 00:07:19,879
uniform concentration that we can

179
00:07:27,550 --> 00:07:24,190
deliver to your sample so another

180
00:07:31,149 --> 00:07:27,560
another another use that we have found

181
00:07:32,409 --> 00:07:31,159
and which in the case of dry reagent

182
00:07:34,270 --> 00:07:32,419
storage is something that we have to

183
00:07:35,950 --> 00:07:34,280
have but in the case of air gap

184
00:07:38,320 --> 00:07:35,960
generation this is a feature that we do

185
00:07:41,290 --> 00:07:38,330
we determined after the fact to be

186
00:07:44,050 --> 00:07:41,300
useful for a process so ergo generation

187
00:07:45,339 --> 00:07:44,060
is using our bubble traps reverse of the

188
00:07:47,559 --> 00:07:45,349

way that they were meant to be used

189
00:07:50,019 --> 00:07:47,569
so rather than capturing bubbles you are

190
00:07:51,999 --> 00:07:50,029
now creating bubbles to create electric

191
00:07:54,159 --> 00:07:52,009
isolation or could who create electrical

192
00:07:56,110 --> 00:07:54,169
resistance inside of the manifold so in

193
00:07:58,959 --> 00:07:56,120
the case of mass spec and there's high

194
00:08:01,029 --> 00:07:58,969
voltage systems up to 20 kV that are

195
00:08:02,980 --> 00:08:01,039
being employed in order to analyze the

196
00:08:06,100 --> 00:08:02,990
sample and one of the concerns is then

197
00:08:08,170 --> 00:08:06,110
worrying about the electrical components

198
00:08:10,930 --> 00:08:08,180
that are on the manifold and so by

199
00:08:14,350 --> 00:08:10,940
having a secondary protection against

200
00:08:17,499 --> 00:08:14,360
those types of those types of voltage

201
00:08:20,019 --> 00:08:17,509
output systems and we're helping prevent

202
00:08:24,219 --> 00:08:20,029
you know mitigating risks basically

203
00:08:26,200 --> 00:08:24,229
within our manifolds so the nice thing

204
00:08:27,879 --> 00:08:26,210
about this air gap generation that we we

205
00:08:31,149 --> 00:08:27,889
learned was that it didn't matter how

206
00:08:33,159 --> 00:08:31,159
fast we created these air bubbles or how

207
00:08:34,930 --> 00:08:33,169
slow or how fast we dispense them for

208
00:08:38,110 --> 00:08:34,940
that matter we could get very very

209
00:08:40,029 --> 00:08:38,120
consistent output for the displacement

210
00:08:42,430 --> 00:08:40,039
that we wanted so if we pulled 5

211
00:08:43,240 --> 00:08:42,440
microliters it didn't matter whether it

212
00:08:45,460 --> 00:08:43,250
was up

213
00:08:46,780 --> 00:08:45,470

50 microliters per second or 0.2 micro

214
00:08:48,850 --> 00:08:46,790
liters per second we were always getting

215
00:08:53,800 --> 00:08:48,860
a 5 micro liter bubble that we could use

216
00:08:56,680 --> 00:08:53,810
for that secondary production so the

217
00:08:59,050 --> 00:08:56,690
nice part is that in the in more recent

218
00:09:01,330 --> 00:08:59,060
times the sensor development and contact

219
00:09:05,260 --> 00:09:01,340
diocese specifically for sample

220
00:09:07,930 --> 00:09:05,270
characterization and contact eysies have

221
00:09:10,210 --> 00:09:07,940
a bad rap sometimes for being very

222
00:09:11,860 --> 00:09:10,220
finicky um and I think this is something

223
00:09:14,560 --> 00:09:11,870
that needs to do continue to be

224
00:09:16,510 --> 00:09:14,570
developed as time goes on but what we've

225
00:09:19,260 --> 00:09:16,520
done is we've actually developed or what

226
00:09:21,910 --> 00:09:19,270
we found is that we can get pretty

227
00:09:22,870 --> 00:09:21,920
consistent results from our excitation

228
00:09:24,640 --> 00:09:22,880
and our occurrence when we're taking

229
00:09:29,440 --> 00:09:24,650
conductivity measurements so

230
00:09:31,960 --> 00:09:29,450
specifically below saturation a lot of

231
00:09:33,430 --> 00:09:31,970
our we're able to take good measurements

232
00:09:34,720 --> 00:09:33,440
on conductivity to make relative

233
00:09:37,840 --> 00:09:34,730
assumptions about what's happening

234
00:09:39,790 --> 00:09:37,850
inside I'm more development needs to be

235
00:09:41,050 --> 00:09:39,800
done on this but one of the special

236
00:09:42,550 --> 00:09:41,060
features has been the compact form

237
00:09:44,740 --> 00:09:42,560
factor development where we've started

238
00:09:49,630 --> 00:09:44,750

including multiple electrodes inside of

239
00:09:52,960 --> 00:09:49,640
small diameter fittings so overall this

240
00:09:55,980 --> 00:09:52,970
project has been sort of a maturation of

241
00:09:57,940 --> 00:09:55,990
technologies and a furthering of

242
00:10:00,640 --> 00:09:57,950
elements that we knew that worked before

243
00:10:04,180 --> 00:10:00,650
but combined together to be able to move

244
00:10:07,240 --> 00:10:04,190
this into an autonomous out IC world

245
00:10:08,680 --> 00:10:07,250
situation and so in the process of

246
00:10:11,440 --> 00:10:08,690
making these three manifolds what we've

247
00:10:13,090 --> 00:10:11,450
seen is a reducing that reduction in

248
00:10:16,030 --> 00:10:13,100
dead volume you know reduction in power

249
00:10:18,790 --> 00:10:16,040
requirements improvement of the features

250
00:10:20,680 --> 00:10:18,800
that we had need to be onto there the

251
00:10:23,079 --> 00:10:20,690
increase in capabilities for temperature

252
00:10:24,730 --> 00:10:23,089
monitoring as well as the increased

253
00:10:28,660 --> 00:10:24,740
capabilities for dry reagent storage and

254
00:10:31,180 --> 00:10:28,670
then the potential for IAC monitoring so

255
00:10:33,490 --> 00:10:31,190
overall we have increasing experimental

256
00:10:35,350 --> 00:10:33,500
capability and we have a transferable

257
00:10:37,540 --> 00:10:35,360
technology development that could be

258
00:10:40,060 --> 00:10:37,550
useful for any IC world mission let

259
00:10:41,740 --> 00:10:40,070
alone any habitability characterization

260
00:10:46,340 --> 00:10:41,750
mission that might be interested in any

261
00:10:51,269 --> 00:10:49,470
so special thanks to your team Leah I

262
00:10:52,530 --> 00:10:51,279
think Richard point is here today and

263
00:10:55,280 --> 00:10:52,540

he'll be giving a talk later this week

264
00:10:58,440 --> 00:10:55,290
and this was funded in part by NASA for

265
00:11:01,949 --> 00:10:58,450
constantly coltec program I am for more

266
00:11:20,460 --> 00:11:01,959
information you can go to Tony Rico list

267
00:11:28,240 --> 00:11:24,070
can your ph probe measure the ph of a

268
00:11:30,310 --> 00:11:28,250
sample that's a few microliters yes

269
00:11:33,520 --> 00:11:30,320
depending on what you mean by a few

270
00:11:35,620 --> 00:11:33,530
microliters and the tendency of the

271
00:11:37,840 --> 00:11:35,630
micro flow redesign is to use very very

272
00:11:39,730 --> 00:11:37,850
small ICS and to use very very small

273
00:11:42,070 --> 00:11:39,740
channels and so if your miniaturizing

274
00:11:50,140 --> 00:11:42,080
everything that is what we're aiming to