
NASA
SILICON
VALLEY
LIVE
NASA
SILICON
VALLEY
AMES RESEARCH CENTER

1
00:00:19,060 --> 00:00:16,680
[Music]

2
00:00:21,520 --> 00:00:19,070
what's up everybody you are watching

3
00:00:25,269 --> 00:00:21,530
NASA in Silicon Valley live for November

4
00:00:28,840 --> 00:00:25,279
15th 2018 I am your host Matt Buffington

5
00:00:31,750 --> 00:00:28,850
and joining me as the co-host for the

6
00:00:36,130 --> 00:00:31,760
first time ever is NASA's very own

7
00:00:38,650 --> 00:00:36,140
Tiffany Blake people who haven't seen

8
00:00:45,610 --> 00:00:38,660
your byline on nasa.gov she's very

9
00:00:48,670 --> 00:00:45,620
famous well I work in the Office of

10
00:00:50,560 --> 00:00:48,680
Communications here at NASA Ames and I

11
00:00:52,540 --> 00:00:50,570
cover all of our taken engineering

12
00:00:55,450 --> 00:00:52,550
projects as well as some of our mission

13
00:00:56,910 --> 00:00:55,460

activities and so really I just help our

14
00:00:59,229 --> 00:00:56,920
people tell their story pretty much

15
00:01:01,030 --> 00:00:59,239
awesome that's exciting

16
00:01:04,210 --> 00:01:01,040
thank you speaking of cool people that

17
00:01:06,219 --> 00:01:04,220
you talk to yes we have we have here

18
00:01:07,060 --> 00:01:06,229
Robin Beck and Paul rozanski here

19
00:01:09,190 --> 00:01:07,070
joining us today

20
00:01:11,950 --> 00:01:09,200
you guys tell us about yourselves what

21
00:01:15,010 --> 00:01:11,960
you do here at Ames um well my name is

22
00:01:18,370 --> 00:01:15,020
Robin Beck and I'm a mechanical engineer

23
00:01:21,250 --> 00:01:18,380
from local schools I grew up here went

24
00:01:24,670 --> 00:01:21,260
to Santa Clara to Stanford so on I work

25
00:01:27,850 --> 00:01:24,680
on heat shield materials so anything to

26
00:01:34,800 --> 00:01:27,860
keep a spacecraft cool how fortuitous

27
00:01:40,630 --> 00:01:38,590
my name is Paul Sinskey I am an engineer

28
00:01:43,540 --> 00:01:40,640
currently a project manager out here at

29
00:01:46,660 --> 00:01:43,550
Ames working in a group that designs

30
00:01:48,490 --> 00:01:46,670
heat shields does all kinds of design

31
00:01:49,930 --> 00:01:48,500
and technology development and I'm

32
00:01:52,210 --> 00:01:49,940
looking forward to telling you a little

33
00:01:53,950 --> 00:01:52,220
bit about my latest project see Paul if

34
00:01:56,140 --> 00:01:53,960
you didn't know Paul is also super

35
00:01:58,780 --> 00:01:56,150
famous we had like an old Facebook live

36
00:02:00,160 --> 00:01:58,790
from about like a year or so ago that he

37
00:02:01,450 --> 00:02:00,170
talked about a whole bunch about it

38
00:02:03,370 --> 00:02:01,460

Keats shields and give us a tour of the

39
00:02:06,040 --> 00:02:03,380
arc jet and Robin did a podcast episode

40
00:02:07,690 --> 00:02:06,050
awhile back - I did Paul did another

41
00:02:15,580 --> 00:02:07,700
podcast episode that's in the hand

42
00:02:18,369 --> 00:02:15,590
that'll be released sometimes we did not

43
00:02:20,110 --> 00:02:18,379
forget you Paul but folks if you didn't

44
00:02:22,869 --> 00:02:20,120
know this is NASA in Silicon Valley live

45
00:02:24,849 --> 00:02:22,879
it is a conversational show out of

46
00:02:26,470 --> 00:02:24,859
NASA's Ames Research Center here in

47
00:02:28,690 --> 00:02:26,480
Silicon Valley where we talk to the

48
00:02:31,390 --> 00:02:28,700
various researchers scientists engineer

49
00:02:33,190 --> 00:02:31,400
and all-around cool people at NASA so if

50
00:02:36,520 --> 00:02:33,200
you like that we are gonna we are live

51
00:02:38,860 --> 00:02:36,530
on Twitch on YouTube Facebook periscope

52
00:02:40,420 --> 00:02:38,870
everywhere that you can think of but if

53
00:02:42,580 --> 00:02:40,430
you want to participate in the chat you

54
00:02:44,110 --> 00:02:42,590
want to send Robin and impulse some

55
00:02:47,050 --> 00:02:44,120
questions then you need to go to

56
00:02:49,089 --> 00:02:47,060
twitch.tv slash NASA if you're sitting

57
00:02:51,400 --> 00:02:49,099
on Facebook or YouTube go back to

58
00:02:53,350 --> 00:02:51,410
twitch.tv slash NASA send us all your

59
00:02:55,839 --> 00:02:53,360
questions in if you want to talk to us

60
00:02:57,009 --> 00:02:55,849
live if you can't catch us live that is

61
00:02:59,380 --> 00:02:57,019
no big deal

62
00:03:01,180 --> 00:02:59,390
we are also will be up on Facebook

63
00:03:03,699 --> 00:03:01,190

YouTube after the fact and on demand

64
00:03:05,680 --> 00:03:03,709
will also be on for our audio listeners

65
00:03:08,740 --> 00:03:05,690
will be on podcast services throughout

66
00:03:11,199 --> 00:03:08,750
the solar system and beyond but as

67
00:03:13,449 --> 00:03:11,209
promised we're all about heat shields so

68
00:03:14,740 --> 00:03:13,459
I guess we'll just start through the

69
00:03:17,110 --> 00:03:14,750
basic thing for people who may be

70
00:03:18,640 --> 00:03:17,120
watching who have no idea what a heat

71
00:03:22,449 --> 00:03:18,650
shield is let's just kind of go generic

72
00:03:25,170 --> 00:03:22,459
like what is a heat shield right well if

73
00:03:29,920 --> 00:03:25,180
you have

74
00:03:33,430 --> 00:03:29,930
like a prop in front and you're going to

75
00:03:35,620 --> 00:03:33,440
enter into a planet or a planet or back

76
00:03:37,330 --> 00:03:35,630
to earth that has an atmosphere it's

77
00:03:39,220 --> 00:03:37,340
going to be traveling really fast and

78
00:03:40,780 --> 00:03:39,230
it's gonna get really really hot in the

79
00:03:43,210 --> 00:03:40,790
front it's going to get pretty toasty on

80
00:03:44,979 --> 00:03:43,220
the back as well so you want to protect

81
00:03:48,960 --> 00:03:44,989
the material you want to protect the

82
00:03:53,530 --> 00:03:48,970
structure with heat shield materials

83
00:03:57,190 --> 00:03:53,540
shields from he was lieutenant materials

84
00:04:01,080 --> 00:03:57,200
would you use to to you know shield such

85
00:04:04,390 --> 00:04:01,090
heat and well eat it really depends on

86
00:04:08,710 --> 00:04:04,400
how fast you're going how how big you

87
00:04:10,599 --> 00:04:08,720
are what the atmosphere is so there are

88
00:04:18,940 --> 00:04:10,609

a lot of examples I brought I brought

89
00:04:21,009 --> 00:04:18,950
props if you want to see some there's a

90
00:04:29,710 --> 00:04:21,019
lot of little particulates that I'd

91
00:04:30,850 --> 00:04:29,720
rather not have go get in my through a

92
00:04:32,140 --> 00:04:30,860
whole bunch of the different like

93
00:04:34,990 --> 00:04:32,150
products you got some really cool stuff

94
00:04:36,370 --> 00:04:35,000
that you're gonna check out this is real

95
00:04:42,420 --> 00:04:36,380
science yeah

96
00:04:46,260 --> 00:04:42,430
yes the material that flew on Apollo

97
00:04:48,640 --> 00:04:46,270
okay so and it also flew on the first

98
00:04:51,160 --> 00:04:48,650
experimental flight for Orion so learn

99
00:04:52,150 --> 00:04:51,170
our new vehicle and so we have a bunch

100
00:04:54,100 --> 00:04:52,160
of people I'm sure you can tell us what

101
00:04:56,860 --> 00:04:54,110
people are going carbon fiber carbon

102
00:05:02,410 --> 00:04:56,870
fiber no rhino Ranger and gets Berserker

103
00:05:04,720 --> 00:05:02,420
more armor we're saying that no but if

104
00:05:06,610 --> 00:05:04,730
you look up close it is a honeycomb

105
00:05:08,320 --> 00:05:06,620
based material so the honeycomb gets

106
00:05:10,990 --> 00:05:08,330
bonded onto the heat shield and then

107
00:05:13,480 --> 00:05:11,000
this stuff gets put in each cell

108
00:05:15,460 --> 00:05:13,490
individually wow that's so that's how

109
00:05:18,310 --> 00:05:15,470
this meant what this material is and

110
00:05:21,280 --> 00:05:18,320
this can withstand heating easily up to

111
00:05:22,540 --> 00:05:21,290
a thousand watts per square centimeter

112
00:05:24,100 --> 00:05:22,550
oh wow

113
00:05:26,680 --> 00:05:24,110

this you know this flew and came back

114
00:05:30,730 --> 00:05:26,690
from the moon so and we get some pretty

115
00:05:36,280 --> 00:05:30,740
high heating then and so that's a that's

116
00:05:40,590 --> 00:05:36,290
one that is very capable okay okay what

117
00:05:42,880 --> 00:05:40,600
you got next yeah if we go back to

118
00:05:45,820 --> 00:05:42,890
lighter heating come back in the earth

119
00:05:48,580 --> 00:05:45,830
we have shuttle tile material so and

120
00:05:54,220 --> 00:05:48,590
this is a coated shuttle top very very

121
00:05:57,580 --> 00:05:54,230
lightweight because it really is a

122
00:05:59,110 --> 00:05:57,590
foamed glass type material so that's

123
00:06:01,750 --> 00:05:59,120
really what it looks like it's a very

124
00:06:04,690 --> 00:06:01,760
very low density the coating is so that

125
00:06:06,460 --> 00:06:04,700
you get yuri radiates the heat rather

126
00:06:09,670 --> 00:06:06,470
than have it all coming to the surface

127
00:06:12,610 --> 00:06:09,680
because it turns out that when you have

128
00:06:14,380 --> 00:06:12,620
radiation something that's white tends

129
00:06:17,830 --> 00:06:14,390
to absorb it something that's black

130
00:06:20,530 --> 00:06:17,840
tends to get it right so this will help

131
00:06:23,140 --> 00:06:20,540
that he'd go away from the surface but

132
00:06:25,120 --> 00:06:23,150
it's very very useful in low heating

133
00:06:28,570 --> 00:06:25,130
conditions in keeping your structure

134
00:06:31,300 --> 00:06:28,580
cool excellent so we have a bunch of

135
00:06:33,280 --> 00:06:31,310
people the chats going nuts okay a lot

136
00:06:36,280 --> 00:06:33,290
of that's so cool interesting that's the

137
00:06:38,080 --> 00:06:36,290
man of all zero my buddy over in the

138
00:06:40,330 --> 00:06:38,090

chat nice guy Dewey was asking what are

139
00:06:42,430 --> 00:06:40,340
major challenges faced in designing a

140
00:06:43,360 --> 00:06:42,440
reusable heat shield because most of

141
00:06:46,480 --> 00:06:43,370
this stuff you're looking at is like

142
00:06:49,380 --> 00:06:46,490
it's a one-time use right shuttle

143
00:06:58,330 --> 00:06:49,390
material the dialogue right

144
00:07:00,040 --> 00:06:58,340
because their ablative talking about a

145
00:07:03,190 --> 00:07:00,050
blade of like you can't talk about heat

146
00:07:04,660 --> 00:07:03,200
shields without saying ablative so we're

147
00:07:07,450 --> 00:07:04,670
gonna just come out like so let's talk

148
00:07:09,640 --> 00:07:07,460
about ablative what does that mean okay

149
00:07:12,040 --> 00:07:09,650
most people don't I don't know what that

150
00:07:16,360 --> 00:07:12,050
is well we can we can turn shuttle tile

151
00:07:19,600 --> 00:07:16,370
into an ablator but you have a rigid or

152
00:07:21,670 --> 00:07:19,610
a flexible substrate that gets

153
00:07:25,810 --> 00:07:21,680
impregnated with the resin and that

154
00:07:28,990 --> 00:07:25,820
resin decomposes when it gets hot and it

155
00:07:30,910 --> 00:07:29,000
uses a lot of the energy to decompose

156
00:07:33,250 --> 00:07:30,920
which is great because using that energy

157
00:07:36,820 --> 00:07:33,260
keeps the energy from conducting to the

158
00:07:40,120 --> 00:07:36,830
to the structure so it also interacts

159
00:07:42,850 --> 00:07:40,130
with the the boundary layer which is

160
00:07:44,860 --> 00:07:42,860
what's heating up the surface and makes

161
00:07:47,140 --> 00:07:44,870
it a little thicker which reduces the

162
00:07:49,030 --> 00:07:47,150
heating the fact that it's creating

163
00:07:51,610 --> 00:07:49,040

gases blows through the char layer

164
00:07:55,870 --> 00:07:51,620
that's left there and itself cools so

165
00:07:58,270 --> 00:07:55,880
it's a really efficient way of keeping

166
00:08:00,730 --> 00:07:58,280
your your spacecraft cool the problem is

167
00:08:03,100 --> 00:08:00,740
is that it is changing state and other

168
00:08:05,620 --> 00:08:03,110
than making it super super thick and

169
00:08:07,240 --> 00:08:05,630
then shaving off the Charlier and

170
00:08:11,470 --> 00:08:07,250
getting back to virgin material each

171
00:08:13,690 --> 00:08:11,480
time it's really not reusable and there

172
00:08:18,190 --> 00:08:13,700
are there are some companies that are

173
00:08:22,380 --> 00:08:18,200
looking at reusing a pika like material

174
00:08:29,260 --> 00:08:26,350
okay so this material was invented here

175
00:08:33,010 --> 00:08:29,270
as a matter of fact and it's based on a

176
00:08:35,560 --> 00:08:33,020
rigid carbon structure so that's really

177
00:08:37,870 --> 00:08:35,570
tough right and it gets impregnated with

178
00:08:39,719 --> 00:08:37,880
a resin okay okay so pika stands for a

179
00:08:43,150 --> 00:08:39,729
phenolic impregnated carbon ablator

180
00:08:46,810 --> 00:08:43,160
carbon the yellow is phenolic turns it

181
00:08:48,550 --> 00:08:46,820
this kind of color so this is have to

182
00:08:52,780 --> 00:08:48,560
jump into phenolic what does that mean

183
00:08:55,240 --> 00:08:52,790
but not like is a resin like silicone is

184
00:08:57,430 --> 00:08:55,250
a resin which we also yes but phenolic

185
00:09:01,750 --> 00:08:57,440
is a very very good resin because it

186
00:09:04,660 --> 00:09:01,760
uses up a lot of energy to decompose so

187
00:09:07,510 --> 00:09:04,670
is great this material in tile form flew

188
00:09:12,660 --> 00:09:07,520

on MSL which delivered curiosity

189
00:09:17,230 --> 00:09:12,670
it also will fly on Mars 2020 the next

190
00:09:20,560 --> 00:09:17,240
Rover to Mars it flew in single piece on

191
00:09:23,620 --> 00:09:20,570
Stardust and it's flying right now on

192
00:09:25,060 --> 00:09:23,630
osiris-rex in a single mouse so as we

193
00:09:26,710 --> 00:09:25,070
were practicing and rehearsing this I

194
00:09:27,910 --> 00:09:26,720
kept saying that the chat was gonna go

195
00:09:44,470 --> 00:09:27,920
nuts with pika-pika

196
00:09:46,960 --> 00:09:44,480
so Anthony is that it's a great ablator

197
00:09:48,820 --> 00:09:46,970
the bad news is it's very very brittle

198
00:09:53,130 --> 00:09:48,830
that makes it a little bit difficult to

199
00:09:56,440 --> 00:09:53,140
design with sorry we've been working on

200
00:10:02,230 --> 00:09:56,450
an advanced version of that so this is

201
00:10:06,040 --> 00:10:02,240
new material that is based on carbon

202
00:10:08,230 --> 00:10:06,050
felt which is flexible okay see so we

203
00:10:11,320 --> 00:10:08,240
take that now once we impregnate it with

204
00:10:14,770 --> 00:10:11,330
about the same recipe it becomes rigid

205
00:10:17,050 --> 00:10:14,780
it's not going anywhere but we can mold

206
00:10:19,810 --> 00:10:17,060
it before we impregnate we take this

207
00:10:22,600 --> 00:10:19,820
felt we mold it and then we wait and so

208
00:10:26,200 --> 00:10:22,610
we get the best properties everywhere

209
00:10:30,640 --> 00:10:26,210
rather than just along certain lines of

210
00:10:32,790 --> 00:10:30,650
it tile and so it it's near net shape we

211
00:10:35,140 --> 00:10:32,800
can you can see we can machine it and

212
00:10:38,050 --> 00:10:35,150
machine plugs out of it all kinds of

213
00:10:40,660 --> 00:10:38,060

stuff so then the even better news is

214
00:10:42,670 --> 00:10:40,670
that it's even more thermally efficient

215
00:10:44,890 --> 00:10:42,680
than pika is it weighs about the same

216
00:10:46,960 --> 00:10:44,900
very lightweight weighs about the same

217
00:10:48,820 --> 00:10:46,970
but it's it's even better than pika a

218
00:10:52,350 --> 00:10:48,830
couple shout out so from pumpkin pie

219
00:10:56,230 --> 00:10:52,360
we're seeing you dude this is epic

220
00:10:58,210 --> 00:10:56,240
mister heat shield girl is just a big

221
00:11:00,970 --> 00:10:58,220
old pika so a lot of shoutouts for that

222
00:11:03,790 --> 00:11:00,980
stuff and then I'll say just I saw one

223
00:11:05,110 --> 00:11:03,800
that came in from X Z Tron was just

224
00:11:10,000 --> 00:11:05,120
saying it's like is it structurally

225
00:11:13,450 --> 00:11:10,010
bonded not chemically yes it is bonded

226
00:11:16,079 --> 00:11:13,460
with an adhesive to a structure so this

227
00:11:20,489 --> 00:11:16,089
it makes it more

228
00:11:23,910 --> 00:11:20,499
which the the last one you just showed

229
00:11:25,799 --> 00:11:23,920
up it's more efficient it's more vision

230
00:11:29,220 --> 00:11:25,809
because of its well we can make bigger

231
00:11:33,299 --> 00:11:29,230
tiles right and we also can bond

232
00:11:35,309 --> 00:11:33,309
directly to an aeroshell where in some

233
00:11:38,519 --> 00:11:35,319
cases pika

234
00:11:39,989 --> 00:11:38,529
might need strain isolation pad which is

235
00:11:43,999 --> 00:11:39,999
what they put under shuttle tiles they

236
00:11:48,660 --> 00:11:44,009
put a strain isolation pad behind the

237
00:11:51,479 --> 00:11:48,670
thermal protection material and it's it

238
00:11:53,160 --> 00:11:51,489

is more compliant so that that's one of

239
00:11:55,410 --> 00:11:53,170
the benefits of the conformal that we

240
00:11:58,199 --> 00:11:55,420
call it conformal pika because it is

241
00:11:59,759 --> 00:11:58,209
more compliant and this is one of the

242
00:12:02,489 --> 00:11:59,769
crazy things as we've been talking about

243
00:12:04,139 --> 00:12:02,499
this of you know ablation and then these

244
00:12:06,210 --> 00:12:04,149
heat shields because it's like you're

245
00:12:08,369 --> 00:12:06,220
building these out of material but it's

246
00:12:10,769 --> 00:12:08,379
also like you pick the properties that

247
00:12:16,439 --> 00:12:10,779
you expect them to not really burn up

248
00:12:18,960 --> 00:12:16,449
but it's like they go away they get

249
00:12:22,259 --> 00:12:18,970
thinner so that is hard it's by design

250
00:12:24,449 --> 00:12:22,269
absolutely absolutely and what you do is

251
00:12:26,819 --> 00:12:24,459
you protect the structure so you design

252
00:12:28,799 --> 00:12:26,829
it so that you know the temperature at

253
00:12:32,009 --> 00:12:28,809
the bond line doesn't get too hot right

254
00:12:33,809 --> 00:12:32,019
you don't overheat your structure so we

255
00:12:36,780 --> 00:12:33,819
understand we can model these kinds of

256
00:12:39,509 --> 00:12:36,790
materials and we understand how they

257
00:12:40,499 --> 00:12:39,519
behave and so that's that's how we use

258
00:12:51,929 --> 00:12:40,509
them it's amazing

259
00:13:02,340 --> 00:12:51,939
it's from our latest yes okay our latest

260
00:13:06,059 --> 00:13:02,350
material and this material is a I'm

261
00:13:09,419 --> 00:13:06,069
gonna set it down a 3d woven material so

262
00:13:11,489 --> 00:13:09,429
you imagine a large loom like you're you

263
00:13:13,710 --> 00:13:11,499

know making cloth but this is making

264
00:13:17,729 --> 00:13:13,720
cloth in three dimensions and we can

265
00:13:21,090 --> 00:13:17,739
take advantage of having a high higher

266
00:13:24,030 --> 00:13:21,100
conductivity higher density higher

267
00:13:28,050 --> 00:13:24,040
capability ablative layer receipt

268
00:13:30,270 --> 00:13:28,060
receipt receding layer sorry over

269
00:13:31,860 --> 00:13:30,280
an insulating layer and it's all

270
00:13:33,960 --> 00:13:31,870
integral we don't have to worry about

271
00:13:36,450 --> 00:13:33,970
how do we hold the two layers together

272
00:13:38,790 --> 00:13:36,460
you know we looked at it but they're

273
00:13:40,970 --> 00:13:38,800
woven together layer by layer so we

274
00:13:43,620 --> 00:13:40,980
don't we don't get any inner laminar

275
00:13:46,620 --> 00:13:43,630
separation where we you would in a tape

276
00:13:50,460 --> 00:13:46,630
wrap type carbon phenolic heat shield so

277
00:13:52,170 --> 00:13:50,470
and it's it's tailorable for how thick

278
00:13:54,690 --> 00:13:52,180
you make the insulation how thick you

279
00:13:56,940 --> 00:13:54,700
make the recession layer and what the

280
00:13:59,780 --> 00:13:56,950
densities are so it's a very very cool

281
00:14:03,360 --> 00:13:59,790
material but this is for very high

282
00:14:05,100 --> 00:14:03,370
intensity environments not you wouldn't

283
00:14:08,190 --> 00:14:05,110
use this going to Mars you don't know it

284
00:14:09,930 --> 00:14:08,200
but I do need it going to places like

285
00:14:12,090 --> 00:14:09,940
Venus if you're doing a very sharp

286
00:14:14,430 --> 00:14:12,100
direct entry we got a couple of

287
00:14:17,640 --> 00:14:14,440
questions of like the like I got here

288
00:14:19,290 --> 00:14:17,650

what's up with the gloves that's several

289
00:14:23,730 --> 00:14:19,300
comments on the gloves and the gloves

290
00:14:24,150 --> 00:14:23,740
and so talk about why you're wearing the

291
00:14:27,990 --> 00:14:24,160
gloves

292
00:14:30,390 --> 00:14:28,000
well like pika is has a lot of why

293
00:14:36,360 --> 00:14:30,400
should see I get yellow on myself and on

294
00:14:38,640 --> 00:14:36,370
the table the phenolic comes out carbon

295
00:14:42,030 --> 00:14:38,650
fibers in the felt and there's carbon

296
00:14:43,710 --> 00:14:42,040
fibers in that rigid substrate so I kind

297
00:14:46,230 --> 00:14:43,720
of don't want it sticking in my fingers

298
00:14:55,440 --> 00:14:46,240
or I don't want to touch my face after

299
00:14:57,530 --> 00:14:55,450
after you know is you know with all

300
00:15:00,030 --> 00:14:57,540
these materials I mean the temperature

301
00:15:02,880 --> 00:15:00,040
gradient that it sees across the

302
00:15:05,130 --> 00:15:02,890
thickness I mean so on the hot side that

303
00:15:07,710 --> 00:15:05,140
surface can be seeing like several

304
00:15:10,320 --> 00:15:07,720
thousand degrees but just a half an inch

305
00:15:11,940 --> 00:15:10,330
or an inch away it's at just a few

306
00:15:13,530 --> 00:15:11,950
hundred degrees I mean that's that's

307
00:15:15,840 --> 00:15:13,540
what's really amazing about all these

308
00:15:18,210 --> 00:15:15,850
materials it's a very very steep

309
00:15:20,760 --> 00:15:18,220
gradient they're insulating materials a

310
00:15:22,620 --> 00:15:20,770
very steep gradient through then thermal

311
00:15:24,450 --> 00:15:22,630
gradient through them you know we have

312
00:15:26,010 --> 00:15:24,460
to protect that structure and that

313
00:15:29,100 --> 00:15:26,020

structure could be something like

314
00:15:30,900 --> 00:15:29,110
aluminum a lot of tip motor it can also

315
00:15:33,810 --> 00:15:30,910
be a composite I mean there's a lot of

316
00:15:35,850 --> 00:15:33,820
limitations now how hot this back wall

317
00:15:37,710 --> 00:15:35,860
is and what happens with this materials

318
00:15:40,380 --> 00:15:37,720
it's very similar to pica in that or

319
00:15:41,010 --> 00:15:40,390
indica similar to a conformal pica in

320
00:15:44,550 --> 00:15:41,020
that

321
00:15:47,100 --> 00:15:44,560
we take the woven structure and we mold

322
00:15:49,830 --> 00:15:47,110
it so this was flat when it was woven

323
00:15:53,640 --> 00:15:49,840
and we put it over a mold because it is

324
00:15:55,950 --> 00:15:53,650
it's yak but its stiff but it is cloth

325
00:15:58,620 --> 00:15:55,960
and then we impregnate it so it's a near

326
00:16:02,250 --> 00:15:58,630
net shape now this has been machined but

327
00:16:04,140 --> 00:16:02,260
this is a near net shape these are woven

328
00:16:10,530 --> 00:16:04,150
materials and it's kind of like well is

329
00:16:13,940 --> 00:16:10,540
this like a big mechanical loom is it's

330
00:16:23,220 --> 00:16:17,670
there's a company in Pennsylvania that

331
00:16:26,270 --> 00:16:23,230
is weaving for us and they have they've

332
00:16:31,260 --> 00:16:26,280
been they started out weaving ribbons

333
00:16:33,180 --> 00:16:31,270
okay ribbons for hats and they now yeah

334
00:16:35,580 --> 00:16:33,190
they're weaving heatseal say we

335
00:16:37,770 --> 00:16:35,590
protective materials and other stuff too

336
00:16:39,510 --> 00:16:37,780
but yeah they're weaving stuff that's

337
00:16:42,570 --> 00:16:39,520
going to space Wow Wow

338
00:16:43,980 --> 00:16:42,580

so I have a question basically we need

339
00:16:46,950 --> 00:16:43,990
different heat shows for definitions

340
00:16:48,810 --> 00:16:46,960
right so say I was going to Mars I was

341
00:16:51,120 --> 00:16:48,820
going to earth like what kinds of

342
00:16:53,250 --> 00:16:51,130
different heat shows what I used you

343
00:16:56,310 --> 00:16:53,260
know to be in to earth or to land on

344
00:16:59,240 --> 00:16:56,320
Mars right well the Apollo type material

345
00:17:02,580 --> 00:16:59,250
the AB coat that I showed would be

346
00:17:04,260 --> 00:17:02,590
easily coming back from the moon going

347
00:17:09,210 --> 00:17:04,270
into the Earth's atmosphere you don't

348
00:17:12,210 --> 00:17:09,220
need it to go to Mars pica is perfect

349
00:17:14,610 --> 00:17:12,220
it's even a little better than it needs

350
00:17:17,160 --> 00:17:14,620
to be you know to go to Mars because the

351
00:17:19,320 --> 00:17:17,170
heating there are peak heating there on

352
00:17:21,270 --> 00:17:19,330
our heat shields is about 200 watts per

353
00:17:24,000 --> 00:17:21,280
square per square centimetre coming back

354
00:17:26,490 --> 00:17:24,010
from the moon we're over 66 hundred to a

355
00:17:30,260 --> 00:17:26,500
thousand watts per square centimeter

356
00:17:32,490 --> 00:17:30,270
going to Venus we can be as high as five

357
00:17:34,380 --> 00:17:32,500
thousand watts per square centimeter

358
00:17:37,080 --> 00:17:34,390
maybe even higher than that we need

359
00:17:38,760 --> 00:17:37,090
things like heat so it really depends on

360
00:17:41,070 --> 00:17:38,770
what your atmosphere is and and the

361
00:17:43,920 --> 00:17:41,080
whole reason with all that is you don't

362
00:17:46,830 --> 00:17:43,930
want to carry every ounce every kilogram

363
00:17:48,780 --> 00:17:46,840

is noise so you don't want your heat

364
00:17:51,390 --> 00:17:48,790
sealed away anymore than it has to

365
00:17:53,280 --> 00:17:51,400
because that's taking away mass that you

366
00:17:54,259 --> 00:17:53,290
can be doing science or something else

367
00:17:57,409 --> 00:17:54,269
right your halo

368
00:17:58,879 --> 00:17:57,419
it gets reduced along that line of like

369
00:18:00,680 --> 00:17:58,889
Venus and especially for Mars you have

370
00:18:02,899 --> 00:18:00,690
two questions one came from a man called

371
00:18:05,539 --> 00:18:02,909
Steve for how more advanced is the heat

372
00:18:09,229 --> 00:18:05,549
shield for new Rover for Mars 2020 and

373
00:18:10,789 --> 00:18:09,239
similarly mr. heat shield girl said Mars

374
00:18:14,570 --> 00:18:10,799
2020 heat shield is the same as

375
00:18:17,239 --> 00:18:14,580
curiosity heat shield I think it is

376
00:18:19,699 --> 00:18:17,249
exactly the same and so we've just been

377
00:18:23,359 --> 00:18:19,709
making pika we start there machining the

378
00:18:25,940 --> 00:18:23,369
tiles we are to save money didn't want

379
00:18:29,959 --> 00:18:25,950
to redesign right so you wanted to use

380
00:18:32,839 --> 00:18:29,969
as much of the design from from MSL

381
00:18:34,369 --> 00:18:32,849
which delivered curiosity he wanted to

382
00:18:38,779 --> 00:18:34,379
use the same design as much as you could

383
00:18:41,629 --> 00:18:38,789
possible so there are 27 different tile

384
00:18:42,919 --> 00:18:41,639
designs on that heat shield so you

385
00:18:47,449 --> 00:18:42,929
didn't want to have to start over and

386
00:18:49,849 --> 00:18:47,459
redesign there are 113 tiles on the heat

387
00:18:53,180 --> 00:18:49,859
shield so if you had to figure out a new

388
00:18:56,419 --> 00:18:53,190

tile layout and and change the thickness

389
00:19:00,409 --> 00:18:56,429
for example in which we definitely could

390
00:19:02,749 --> 00:19:00,419
it's very heavily over designed but it

391
00:19:04,969 --> 00:19:02,759
didn't make sense cost wise to spend

392
00:19:06,529 --> 00:19:04,979
that money to do that again and so I

393
00:19:08,899 --> 00:19:06,539
want to come on over to one of the

394
00:19:10,639 --> 00:19:08,909
questions from Rai oranger is asking and

395
00:19:11,749 --> 00:19:10,649
this is a pivot to we can't talk about

396
00:19:15,799 --> 00:19:11,759
heat shield without talking about the

397
00:19:18,049 --> 00:19:15,809
arc jet how are heat shields materials

398
00:19:24,829 --> 00:19:18,059
tested and can you replicate temps in a

399
00:19:27,259 --> 00:19:24,839
lab that are seen in production well the

400
00:19:29,599 --> 00:19:27,269
arc jet is is an incredible facility and

401
00:19:33,139 --> 00:19:29,609
sort of the easiest way to explain it is

402
00:19:36,199 --> 00:19:33,149
think of a wind tunnel mm-hmm that has

403
00:19:38,180 --> 00:19:36,209
is it's reservoir a tank that gets

404
00:19:40,940 --> 00:19:38,190
filled with high pressure high

405
00:19:43,699 --> 00:19:40,950
temperature gas they blast literally a

406
00:19:45,919 --> 00:19:43,709
lightning bolt through it to energize it

407
00:19:48,319 --> 00:19:45,929
and give it that much more energy and

408
00:19:49,549 --> 00:19:48,329
then they just open up a nozzle at one

409
00:19:52,239 --> 00:19:49,559
end and this high-temperature

410
00:19:55,519 --> 00:19:52,249
high-pressure gas just goes blasting out

411
00:19:58,129 --> 00:19:55,529
Mach 5 Mach 7 it flows over your test

412
00:20:00,109 --> 00:19:58,139
article and they take all this energy

413
00:20:03,709 --> 00:20:00,119

all this electricity that can literally

414
00:20:05,989 --> 00:20:03,719
power a small town and all that energy

415
00:20:08,029 --> 00:20:05,999
gets concentrated into a small test I

416
00:20:08,430 --> 00:20:08,039
mean it gives you an idea of just what

417
00:20:11,160 --> 00:20:08,440
type of

418
00:20:16,230 --> 00:20:11,170
environments these materials have to be

419
00:20:18,420 --> 00:20:16,240
designed for simulates the environment

420
00:20:21,780 --> 00:20:18,430
entry into it we tend to catch me into

421
00:20:24,870 --> 00:20:21,790
an right we tend to test in air however

422
00:20:27,420 --> 00:20:24,880
we can get the right heating rates and

423
00:20:29,750 --> 00:20:27,430
we can get the right pressures if we

424
00:20:33,240 --> 00:20:29,760
need to we can get the right shear Oh

425
00:20:36,750 --> 00:20:33,250
cheer like what if shear is the friction

426
00:20:38,280 --> 00:20:36,760
the flow over okay so I have a I have an

427
00:20:40,920 --> 00:20:38,290
arc jet specimen let's go for it

428
00:20:48,300 --> 00:20:40,930
I think I think we actually bow I think

429
00:20:52,580 --> 00:20:48,310
we have a clip of this specimen going

430
00:20:56,430 --> 00:20:52,590
into the facility yeah so this is a

431
00:20:59,220 --> 00:20:56,440
sphere cone this is the heating at the

432
00:21:00,960 --> 00:20:59,230
nose on this test article is 700 watts

433
00:21:03,600 --> 00:21:00,970
per square centimeter the flow is coming

434
00:21:06,480 --> 00:21:03,610
from the job blowing over it right and

435
00:21:08,490 --> 00:21:06,490
on the flank on the conical part of it

436
00:21:11,400 --> 00:21:08,500
the heating is 400 watts per square

437
00:21:13,620 --> 00:21:11,410
centimeter and then the shear around

438
00:21:18,270 --> 00:21:13,630

near the shoulder near the backside the

439
00:21:21,030 --> 00:21:18,280
back end of this is 400 Pascal's which

440
00:21:25,380 --> 00:21:21,040
is a lot it's similar to what we would

441
00:21:27,180 --> 00:21:25,390
see on Mars 2020 and MSL so we were

442
00:21:28,860 --> 00:21:27,190
looking for a test article design that

443
00:21:30,690 --> 00:21:28,870
could do that now and I was gonna say

444
00:21:32,580 --> 00:21:30,700
that footage that we saw this test

445
00:21:35,670 --> 00:21:32,590
article that is the exact same cow and

446
00:21:39,000 --> 00:21:35,680
this test article actually was testing

447
00:21:41,760 --> 00:21:39,010
we have pika on here and we have the

448
00:21:43,560 --> 00:21:41,770
conformal pika with seams and gaps so we

449
00:21:45,150 --> 00:21:43,570
were looking at you know could we put

450
00:21:47,190 --> 00:21:45,160
the material right up next to it without

451
00:21:50,940 --> 00:21:47,200
needing to design for gaps and it turns

452
00:21:53,010 --> 00:21:50,950
out yes we could and we also were

453
00:21:55,050 --> 00:21:53,020
comparing the recession's of how much

454
00:21:58,170 --> 00:21:55,060
thickness we lost we were comparing the

455
00:21:59,520 --> 00:21:58,180
recession to that of pika and it's very

456
00:22:02,790 --> 00:21:59,530
very comparable it's about the same

457
00:22:05,610 --> 00:22:02,800
density and very comfortable recession

458
00:22:09,420 --> 00:22:05,620
the best news was that the temperature

459
00:22:11,100 --> 00:22:09,430
rise at the bond line was half of what

460
00:22:13,470 --> 00:22:11,110
the temperature rise at the bond line

461
00:22:16,410 --> 00:22:13,480
behind the regular the standard pika so

462
00:22:17,790 --> 00:22:16,420
behind the conformal pika it's much more

463
00:22:20,310 --> 00:22:17,800

thermally efficient because the

464
00:22:21,629 --> 00:22:20,320
conductivity is so much lower so I think

465
00:22:23,219 --> 00:22:21,639
Paul you told us what is you

466
00:22:28,619 --> 00:22:23,229
today that that's what you guys want to

467
00:22:31,199 --> 00:22:28,629
see after you have a test right well you

468
00:22:34,680 --> 00:22:31,209
do have pictures of Warren and after

469
00:22:37,079 --> 00:22:34,690
that test article and so if there's

470
00:22:38,579 --> 00:22:37,089
there it was yellow original that's the

471
00:22:40,409 --> 00:22:38,589
original and what you're looking at is

472
00:22:42,810 --> 00:22:40,419
the conformal the nose is a actually

473
00:22:45,569 --> 00:22:42,820
pika and then one quadrant which you're

474
00:22:49,499 --> 00:22:45,579
not seeing here but then after it looks

475
00:22:53,459 --> 00:22:49,509
like black and that's what that's the

476
00:22:55,139 --> 00:22:53,469
same test article so right so in such a

477
00:22:57,239 --> 00:22:55,149
shape slightly you can tell the nose

478
00:23:00,209 --> 00:22:57,249
blunted up because some of the material

479
00:23:01,619 --> 00:23:00,219
went away but it's charred and turned to

480
00:23:03,329 --> 00:23:01,629
carbon and there's and there's not a

481
00:23:09,169 --> 00:23:03,339
whole lot of in between in these tests

482
00:23:16,969 --> 00:23:11,669
literally within fraction of a second

483
00:23:20,940 --> 00:23:19,289
surprised not on this material but we

484
00:23:24,569 --> 00:23:20,950
had some surprise tests on some

485
00:23:26,519 --> 00:23:24,579
materials in in areas in heating rates

486
00:23:29,639 --> 00:23:26,529
that we didn't expect to see problems

487
00:23:32,459 --> 00:23:29,649
and we had material absolutely disappear

488
00:23:33,959 --> 00:23:32,469

in four seconds shouldn't have so well

489
00:23:36,659 --> 00:23:33,969
and also just to give people some

490
00:23:38,699 --> 00:23:36,669
perspective I mean if that same test

491
00:23:43,409 --> 00:23:38,709
article was just a the same piece of

492
00:23:44,669 --> 00:23:43,419
aluminum in a fraction of a second and

493
00:23:45,810 --> 00:23:44,679
write the whole thing would be gone I

494
00:23:48,329 --> 00:23:45,820
mean I just gives you an idea of just

495
00:23:50,369 --> 00:23:48,339
the the energy and the temperatures that

496
00:23:54,690 --> 00:23:50,379
it sees sorry the surface temperatures

497
00:23:57,599 --> 00:23:54,700
here were between three and four

498
00:23:59,069 --> 00:23:57,609
thousand Fahrenheit so at the nose over

499
00:24:00,449 --> 00:23:59,079
four thousand Fahrenheit and on the

500
00:24:02,489 --> 00:24:00,459
flank it was at three thousand

501
00:24:09,989 --> 00:24:02,499
Fahrenheit so you might as well be

502
00:24:11,849 --> 00:24:09,999
walking on the Sun but it's pretty darn

503
00:24:14,190 --> 00:24:11,859
hard yep and how long are you guys

504
00:24:16,349 --> 00:24:14,200
testing and that one was in for thirty

505
00:24:18,690 --> 00:24:16,359
seconds ah okay a lot of them just

506
00:24:21,149 --> 00:24:18,700
depends on on the trajectory how it's

507
00:24:22,859 --> 00:24:21,159
gonna fly at its destination planet then

508
00:24:24,810 --> 00:24:22,869
right we were trying to match the heat

509
00:24:28,229 --> 00:24:24,820
load which is heating rate times the

510
00:24:30,509 --> 00:24:28,239
time so as we went to lower heating

511
00:24:33,779 --> 00:24:30,519
rates we went to longer longer times oh

512
00:24:35,130 --> 00:24:33,789
I see the chat is going completely nuts

513
00:24:37,680 --> 00:24:35,140

we got a shout out too

514
00:24:40,230 --> 00:24:37,690
arcjet team this is from gr underscore a

515
00:24:43,110 --> 00:24:40,240
b get a couple questions one that i just

516
00:24:45,110 --> 00:24:43,120
saw through go live this is fourth and

517
00:24:48,030 --> 00:24:45,120
inches one it said something similar to

518
00:24:50,490 --> 00:24:48,040
the same thing that another person asked

519
00:24:54,630 --> 00:24:50,500
about the heat panels on Parker Solar

520
00:24:56,700 --> 00:24:54,640
Probe is that is that the same thing I

521
00:24:58,680 --> 00:24:56,710
mean they are protecting their it's a

522
00:25:01,140 --> 00:24:58,690
carbon carbon material it's all carbon

523
00:25:02,640 --> 00:25:01,150
and it's so it can take very very high

524
00:25:04,500 --> 00:25:02,650
energy and has insulation on the

525
00:25:06,270 --> 00:25:04,510
backside so that what's behind it

526
00:25:08,940 --> 00:25:06,280
doesn't get too hot and that's a pure

527
00:25:10,980 --> 00:25:08,950
radiative heating separation right right

528
00:25:12,840 --> 00:25:10,990
and so also another person who jumped in

529
00:25:15,270 --> 00:25:12,850
the chat with Scott Manley one of our

530
00:25:17,040 --> 00:25:15,280
co-hosts last time we did one of the

531
00:25:19,530 --> 00:25:17,050
shows a couple episodes back he was

532
00:25:20,250 --> 00:25:19,540
asking and welcome back Scott nice to

533
00:25:22,320 --> 00:25:20,260
see you

534
00:25:24,990 --> 00:25:22,330
can you tell us about the most extreme

535
00:25:32,490 --> 00:25:25,000
heat shield NASA ever made like the

536
00:25:34,230 --> 00:25:32,500
Jupiter atmosphere Pro yeah that was a

537
00:25:37,280 --> 00:25:34,240
mission that flew into Jupiter and

538
00:25:39,810 --> 00:25:37,290

Jupiter is a hydrogen helium atmosphere

539
00:25:43,040 --> 00:25:39,820
so back in the day they literally had an

540
00:25:46,800 --> 00:25:43,050
arc jet that used hydrogen helium right

541
00:25:50,310 --> 00:25:46,810
and they had to blast so much energy

542
00:25:51,660 --> 00:25:50,320
that they were able to not only get the

543
00:25:54,060 --> 00:25:51,670
convective heating but the radiative

544
00:25:57,390 --> 00:25:54,070
heating that you would see at the high

545
00:26:07,850 --> 00:25:57,400
speed so entry into Jupiter is is this

546
00:26:09,660 --> 00:26:07,860
outlier that's fun it's really really

547
00:26:11,850 --> 00:26:09,670
facility was up and running I think in

548
00:26:13,590 --> 00:26:11,860
the 70s and in the 80s they did the

549
00:26:16,740 --> 00:26:13,600
final designs on the heat shield but

550
00:26:18,810 --> 00:26:16,750
that was a probe where half of the entry

551
00:26:22,220 --> 00:26:18,820
mass half of the probe mass going in to

552
00:26:25,200 --> 00:26:22,230
Jupiter was all heat shield right and

553
00:26:26,820 --> 00:26:25,210
they actually because they did some

554
00:26:29,910 --> 00:26:26,830
measurements but they came pretty darn

555
00:26:31,080 --> 00:26:29,920
close to losing it with some of the

556
00:26:34,020 --> 00:26:31,090
measurements because they were able to

557
00:26:35,430 --> 00:26:34,030
tell in certain places on it how far it

558
00:26:37,350 --> 00:26:35,440
recessed and they were a couple places

559
00:26:39,360 --> 00:26:37,360
where they realized there wasn't a whole

560
00:26:41,220 --> 00:26:39,370
lot left after it finished the heating

561
00:26:43,440 --> 00:26:41,230
poles right and it was the opposite of

562
00:26:44,940 --> 00:26:43,450
what they expected nose receded less

563
00:26:47,940 --> 00:26:44,950

than they expected which is the highest

564
00:26:49,760 --> 00:26:47,950
heating and the flank receded almost all

565
00:26:52,080 --> 00:26:49,770
the way through why

566
00:26:55,910 --> 00:26:52,090
I'm gonna jump in because somebody the

567
00:27:00,390 --> 00:26:58,710
it's what kind of fibers are used what

568
00:27:05,880 --> 00:27:00,400
kind of properties do the resins have

569
00:27:11,070 --> 00:27:05,890
and how are they manufactured most of

570
00:27:14,340 --> 00:27:11,080
the fibers well those are carbon fibers

571
00:27:17,700 --> 00:27:14,350
rayon based carbon fibers and phenolic

572
00:27:23,460 --> 00:27:17,710
there is a phenolic resin which they use

573
00:27:25,650 --> 00:27:23,470
I think actually great pads too so you

574
00:27:28,110 --> 00:27:25,660
know it's a common resin it's it's so

575
00:27:34,280 --> 00:27:28,120
but and how do they manufacture with

576
00:27:39,180 --> 00:27:37,620
what kind of density you want and and

577
00:27:41,310 --> 00:27:39,190
what kind of properties you want they

578
00:27:43,800 --> 00:27:41,320
say re-entry into Earth is different

579
00:27:55,440 --> 00:27:43,810
from entry into Mars or Venus that's

580
00:27:58,080 --> 00:27:55,450
right oh man this chat isn't saying

581
00:28:01,740 --> 00:27:58,090
there's so much stuff going on so uh let

582
00:28:03,300 --> 00:28:01,750
me jump to let's say okay hi NASA does

583
00:28:05,160 --> 00:28:03,310
the shape or angle of the heat shield

584
00:28:09,000 --> 00:28:05,170
affect how thick it has to be

585
00:28:12,930 --> 00:28:09,010
that's from Brad yes it does it affects

586
00:28:17,370 --> 00:28:12,940
the heat heating profile and so um we've

587
00:28:20,070 --> 00:28:17,380
typically flown to Mars with that 70

588
00:28:22,140 --> 00:28:20,080

degrees for your cone which is what MSL

589
00:28:24,570 --> 00:28:22,150
and Viking I mean everything that's one

590
00:28:29,460 --> 00:28:24,580
Mars I think has been a 70 degrees fear

591
00:28:34,080 --> 00:28:29,470
cone a blunt body the Venus we flew 45

592
00:28:36,270 --> 00:28:34,090
degrees fear cones and it it it

593
00:28:39,030 --> 00:28:36,280
definitely affects what the heating on

594
00:28:40,230 --> 00:28:39,040
the material is and the thickness is

595
00:28:42,330 --> 00:28:40,240
dependent on what the heating on the

596
00:28:49,110 --> 00:28:42,340
material is it's funny cuz I feel like

597
00:28:50,340 --> 00:28:49,120
we could sit here and talk came in from

598
00:28:52,290 --> 00:28:50,350
Raj 2017

599
00:28:53,280 --> 00:28:52,300
what about inflatable heat shields and I

600
00:28:54,510 --> 00:28:53,290
thought that might be a good transition

601
00:28:57,190 --> 00:28:54,520
to some of the other stuff and I'm also

602
00:29:04,370 --> 00:28:57,200
looking at Tiffany who

603
00:29:05,750 --> 00:29:04,380
that we need to talk about tell me well

604
00:29:07,880 --> 00:29:05,760
I mean we've been talking about a lot by

605
00:29:10,700 --> 00:29:07,890
March 2 and so I know the agency we're

606
00:29:12,799 --> 00:29:10,710
all excited about insite landing in a

607
00:29:15,230 --> 00:29:12,809
couple of weeks yeah scheduled for

608
00:29:20,890 --> 00:29:15,240
Monday November 26 which happens to be

609
00:29:26,290 --> 00:29:20,900
Cyber Monday but it is landing at

610
00:29:28,790 --> 00:29:26,300
basically lunchtime it's 11:47 a.m. Pt

611
00:29:32,540 --> 00:29:28,800
you know grab your lunch and then watch

612
00:29:33,890 --> 00:29:32,550
you know NASA TV but you know when it's

613
00:29:40,430 --> 00:29:33,900

actually guys can you talk a little bit

614
00:29:46,760 --> 00:29:40,440
about insight and a couple weeks the

615
00:29:49,040 --> 00:29:46,770
thermal protection material is on the

616
00:29:50,990 --> 00:29:49,050
heat shield and the heat shield is

617
00:29:54,440 --> 00:29:51,000
thicker than this this material is also

618
00:29:56,390 --> 00:29:54,450
the back shell for MSL and Mars 2020 at

619
00:30:02,690 --> 00:29:56,400
about that thickness we heat the front

620
00:30:05,419 --> 00:30:02,700
and the back like half the size it's not

621
00:30:09,080 --> 00:30:05,429
the size it's not going in as hot and or

622
00:30:11,510 --> 00:30:09,090
as fast it's lighter weight and so this

623
00:30:14,650 --> 00:30:11,520
material is perfectly designed it's

624
00:30:15,799 --> 00:30:14,660
what's always flown to Mars on our US

625
00:30:19,280 --> 00:30:15,809
spacecraft

626
00:30:22,340 --> 00:30:19,290
except for MSL so the MSL was so large a

627
00:30:26,180 --> 00:30:22,350
myself you love acronyms Mars Science

628
00:30:28,610 --> 00:30:26,190
Laboratory and that curiosity so Mars

629
00:30:30,830 --> 00:30:28,620
2020 is coming it will also have this

630
00:30:32,330 --> 00:30:30,840
material in the back shell and pica on

631
00:30:34,910 --> 00:30:32,340
the heat shield because of the

632
00:30:37,430 --> 00:30:34,920
environment so and so what's insights

633
00:30:40,669 --> 00:30:37,440
mission what will the lander be doing on

634
00:30:44,710 --> 00:30:40,679
Mars the lander will be measuring the

635
00:30:52,000 --> 00:30:44,720
temperature through the thickness of the

636
00:30:54,680 --> 00:30:52,010
shell and it will also be measuring

637
00:30:58,160 --> 00:30:54,690
seismic activity so there's a thermal

638
00:31:03,620 --> 00:30:58,170

probe that'll go down about five six

639
00:31:05,480 --> 00:31:03,630
meters so 16 17 feet or so and there's a

640
00:31:07,970 --> 00:31:05,490
seismometer that'll sit on the surface

641
00:31:10,040 --> 00:31:07,980
and we'll measure marsquakes Mars quake

642
00:31:10,640 --> 00:31:10,050
so I think we have a clip here right of

643
00:31:14,420 --> 00:31:10,650
the show

644
00:31:16,280 --> 00:31:14,430
right yeah there we go so that it's

645
00:31:18,710 --> 00:31:16,290
right now it's got the cruise stage so

646
00:31:20,570 --> 00:31:18,720
that's been let go and now that you have

647
00:31:22,460 --> 00:31:20,580
the entry vehicle kind of looks like our

648
00:31:25,400 --> 00:31:22,470
little model there now it's getting very

649
00:31:28,250 --> 00:31:25,410
hot on the front but also that wake is

650
00:31:31,480 --> 00:31:28,260
radiating to the back shell and so we

651
00:31:34,760 --> 00:31:31,490
have to protect it as well and then

652
00:31:38,180 --> 00:31:34,770
eventually we slow down enough that we

653
00:31:40,640 --> 00:31:38,190
will pop a chute to slow it down the

654
00:31:46,460 --> 00:31:40,650
rest of the way or nearly the rest of

655
00:31:48,470 --> 00:31:46,470
the way so as soon as we pop the chute

656
00:31:50,960 --> 00:31:48,480
soon after that heat show gets dropped

657
00:31:54,320 --> 00:31:50,970
because we really want to deploy this

658
00:31:56,480 --> 00:31:54,330
Lander so the feet come out then it'll

659
00:31:59,660 --> 00:31:56,490
drop out of the backshell and that will

660
00:32:01,850 --> 00:31:59,670
kind of fly away and the row of the

661
00:32:05,180 --> 00:32:01,860
lander itself will propel itself

662
00:32:10,340 --> 00:32:05,190
downward are you use propulsion opposite

663
00:32:11,900 --> 00:32:10,350

direction to slow itself down insight

664
00:32:17,000 --> 00:32:11,910
doesn't move correct cuz you said Lander

665
00:32:20,990 --> 00:32:17,010
not exactly there's no wheels so this is

666
00:32:24,050 --> 00:32:21,000
because it lands near the poles and it

667
00:32:25,970 --> 00:32:24,060
doesn't have to move it is powered by

668
00:32:30,710 --> 00:32:25,980
solar power it's not nuclear-powered

669
00:32:32,990 --> 00:32:30,720
like curiosity is and so it it will sit

670
00:32:36,230 --> 00:32:33,000
there and it has a two-year mission so

671
00:32:38,750 --> 00:32:36,240
and gathering data they do expect they

672
00:32:42,440 --> 00:32:38,760
they know that Mars gets hit a lot with

673
00:32:46,820 --> 00:32:42,450
asteroids and and foreign bodies and so

674
00:32:49,730 --> 00:32:46,830
those the seismic equipment should be

675
00:32:52,100 --> 00:32:49,740
able to measure the impacts as well so

676
00:32:58,820 --> 00:32:52,110
sadly tip oh GU underscore that was not

677
00:33:05,450 --> 00:32:58,830
live footage footage of some of the fun

678
00:33:07,310 --> 00:33:05,460
stuff that Paul's been working you know

679
00:33:09,410 --> 00:33:07,320
for more information about insight you

680
00:33:11,690 --> 00:33:09,420
can go to Mars that NASA does slash

681
00:33:16,970 --> 00:33:11,700
insight and make sure you tune in on the

682
00:33:18,590 --> 00:33:16,980
26th to see that exciting land and not

683
00:33:20,180 --> 00:33:18,600
also throw out a reminder for posts for

684
00:33:22,730 --> 00:33:20,190
folks who are watching if you're

685
00:33:23,910 --> 00:33:22,740
watching on Facebook YouTube twitch we

686
00:33:25,110 --> 00:33:23,920
we are we are alive

687
00:33:26,490 --> 00:33:25,120
right now but if you want to participate

688
00:33:29,550 --> 00:33:26,500

live on the chat you need to go to

689
00:33:31,440 --> 00:33:29,560
twitch.tv slash NASA we have a ton of

690
00:33:32,730 --> 00:33:31,450
questions coming in and you're in luck

691
00:33:35,010 --> 00:33:32,740
because about the last 10 minutes we're

692
00:33:36,990 --> 00:33:35,020
gonna spend doing rapid-fire questions

693
00:33:38,550 --> 00:33:37,000
we're not there yet and we're gonna try

694
00:33:40,500 --> 00:33:38,560
to hit as many of these as humanly

695
00:33:43,890 --> 00:33:40,510
possible because there's so much going

696
00:33:45,630 --> 00:33:43,900
on in there but go for it so we know

697
00:33:48,330 --> 00:33:45,640
that he's show development continues to

698
00:33:50,040 --> 00:33:48,340
evolve right and so I know Paul you have

699
00:33:53,280 --> 00:33:50,050
you're working on a project that really

700
00:33:55,080 --> 00:33:53,290
dives into next generation heat shields

701
00:33:57,180 --> 00:33:55,090
and game changing technologies so tell

702
00:33:57,750 --> 00:33:57,190
us a little bit about adept what's the

703
00:34:02,750 --> 00:33:57,760
depth

704
00:34:09,570 --> 00:34:06,810
adaptable deployable entry and placement

705
00:34:11,340 --> 00:34:09,580
technology so that's a mouthful and the

706
00:34:12,930 --> 00:34:11,350
way we try to describe it is up to now

707
00:34:14,400 --> 00:34:12,940
what we've been talking about our heat

708
00:34:17,850 --> 00:34:14,410
shields that we call rigid heat shield

709
00:34:20,640 --> 00:34:17,860
so it's a solid structure able to take

710
00:34:22,020 --> 00:34:20,650
high temperatures but it's rigid so with

711
00:34:24,810 --> 00:34:22,030
what you launch is what enters the

712
00:34:28,200 --> 00:34:24,820
planet and what we have seen is there's

713
00:34:31,680 --> 00:34:28,210

a lot of missions out there that could

714
00:34:34,560 --> 00:34:31,690
do more if they could be launched with a

715
00:34:37,860 --> 00:34:34,570
heat shield that opened up to even

716
00:34:40,020 --> 00:34:37,870
bigger sizes and right now what's

717
00:34:42,360 --> 00:34:40,030
limiting the size of our heat shields is

718
00:34:45,390 --> 00:34:42,370
the rocket that carries him so if there

719
00:34:48,350 --> 00:34:45,400
was a way to make a heat shield that

720
00:34:50,580 --> 00:34:48,360
could fold up or stow and then open up

721
00:34:53,159 --> 00:34:50,590
once it's free and clear of the rocket

722
00:34:56,070 --> 00:34:53,169
we could do more things go to do more

723
00:34:58,050 --> 00:34:56,080
science so that's that's what it did

724
00:34:59,940 --> 00:34:58,060
think of a heat shield that works like

725
00:35:02,610 --> 00:34:59,950
an umbrella well I got something I can

726
00:35:08,130 --> 00:35:02,620
show you - yes show us please clear the

727
00:35:10,260 --> 00:35:08,140
decks here yeah and folks might have

728
00:35:13,080 --> 00:35:10,270
recognized what Paul's gonna show out if

729
00:35:14,040 --> 00:35:13,090
he watched our Halloween episode yeah

730
00:35:18,710 --> 00:35:14,050
Mary

731
00:35:29,090 --> 00:35:22,120
super famous and

732
00:35:33,290 --> 00:35:29,100
we all have to do things like that yeah

733
00:35:37,250 --> 00:35:33,300
so this is an umbrella it literally can

734
00:35:39,610 --> 00:35:37,260
has its the underneath there we go

735
00:35:43,850 --> 00:35:39,620
it's got ribs and struts underneath it

736
00:35:46,280 --> 00:35:43,860
this is a flexible carbon fabric this is

737
00:35:48,590 --> 00:35:46,290
sort of related to the woven material

738
00:35:51,800 --> 00:35:48,600

Robyn was showing but this is not

739
00:35:55,670 --> 00:35:51,810
impregnated it is just four to eight

740
00:35:57,860 --> 00:35:55,680
layers of carbon fabric woven three

741
00:35:59,680 --> 00:35:57,870
dimensionally so when this does get

742
00:36:03,200 --> 00:35:59,690
glowing hot and I think we're gonna show

743
00:36:05,300 --> 00:36:03,210
some video of this maybe when we test

744
00:36:08,930 --> 00:36:05,310
this in the heat shield or in our Jets

745
00:36:11,830 --> 00:36:08,940
glows red hot survives for one to two

746
00:36:14,930 --> 00:36:11,840
minutes now what we're seeing here is

747
00:36:18,410 --> 00:36:14,940
the same size is just under a meter

748
00:36:20,810 --> 00:36:18,420
diameter this is a heat shield that we

749
00:36:27,530 --> 00:36:20,820
flew on a sounding rocket a few months

750
00:36:29,260 --> 00:36:27,540
back a good friend das Valdez is sit in

751
00:36:31,160 --> 00:36:29,270
the chance to hide us how's it going

752
00:36:33,350 --> 00:36:31,170
there's a video game I told you guys

753
00:36:35,150 --> 00:36:33,360
about called Kerbal space program but he

754
00:36:36,860 --> 00:36:35,160
was saying that like in Kerbal you can

755
00:36:52,040 --> 00:36:36,870
actually do you that there's an adept in

756
00:37:00,800 --> 00:36:52,050
there there's like deployable like this

757
00:37:01,930 --> 00:37:00,810
is launched it's pretty hard spray the

758
00:37:06,050 --> 00:37:01,940
rub

759
00:37:15,450 --> 00:37:13,410
and then it is deployed it's deployed in

760
00:37:17,640 --> 00:37:15,460
space so it doesn't have to do anything

761
00:37:18,330 --> 00:37:17,650
really fast right it can deploy slowly

762
00:37:21,360 --> 00:37:18,340
yep

763
00:37:23,670 --> 00:37:21,370

in the EXO atmosphere so awesome but an

764
00:37:25,620 --> 00:37:23,680
awesome idea now we did have a question

765
00:37:28,440 --> 00:37:25,630
of someone about inflatables and there

766
00:37:31,530 --> 00:37:28,450
yeah we do have a very similar approach

767
00:37:33,810 --> 00:37:31,540
for an inflatable so it's a general

768
00:37:35,610 --> 00:37:33,820
deployable heat shield other what it's

769
00:37:39,990 --> 00:37:35,620
it's inflated and so there are large

770
00:37:41,880 --> 00:37:40,000
towards that are being built in Southern

771
00:37:43,650 --> 00:37:41,890
California that gets stacked up with

772
00:37:47,040 --> 00:37:43,660
thermal protection materials on the

773
00:37:50,100 --> 00:37:47,050
outside and they can straight even

774
00:37:53,730 --> 00:37:50,110
smaller and then have all kinds of

775
00:38:01,500 --> 00:37:53,740
devices and gas generators to deploy

776
00:38:04,320 --> 00:38:01,510
them right Paul that's right your first

777
00:38:06,960 --> 00:38:04,330
test flight for a dip right it was just

778
00:38:09,150 --> 00:38:06,970
about the same size this is like I said

779
00:38:11,340 --> 00:38:09,160
just under a meter in diameter that

780
00:38:13,950 --> 00:38:11,350
here's the rock goes up into a rocket

781
00:38:16,580 --> 00:38:13,960
with a 10-inch diameter tube and get

782
00:38:19,470 --> 00:38:16,590
ready for some cool GoPro footage

783
00:38:20,940 --> 00:38:19,480
there's a launch and it's within 10

784
00:38:24,450 --> 00:38:20,950
seconds it's already leaving the

785
00:38:26,730 --> 00:38:24,460
atmosphere and within a minute it's up

786
00:38:30,060 --> 00:38:26,740
at about a hundred kilometers up and

787
00:38:31,890 --> 00:38:30,070
then went there we're just reaching our

788
00:38:34,020 --> 00:38:31,900

maximum altitude of around 120

789
00:38:37,070 --> 00:38:34,030
kilometers we've opened up and now with

790
00:38:39,450 --> 00:38:37,080
a GoPro camera onboard is that curvature

791
00:38:41,430 --> 00:38:39,460
confirming that we opened us that was

792
00:38:44,640 --> 00:38:41,440
one of our major objectives of the test

793
00:38:46,490 --> 00:38:44,650
was to show that we can deploy and now

794
00:38:49,400 --> 00:38:46,500
as we're descending into the atmosphere

795
00:38:52,830 --> 00:38:49,410
we got all these instruments recording

796
00:38:56,790 --> 00:38:52,840
how it's the the aerodynamic stability

797
00:38:59,100 --> 00:38:56,800
its flight attitude rates all this good

798
00:39:01,830 --> 00:38:59,110
information that we're now still poring

799
00:39:03,720 --> 00:39:01,840
over and and deciphering and it was

800
00:39:10,470 --> 00:39:03,730
supposed to be spinning right I mean it

801
00:39:12,960 --> 00:39:10,480
was spun out of the rocket oh yes how

802
00:39:16,760 --> 00:39:12,970
long did it take to you know get from

803
00:39:18,630 --> 00:39:16,770
the start to your first flight test oh

804
00:39:20,580 --> 00:39:18,640
we've been working

805
00:39:23,730 --> 00:39:20,590
the Adept project has been active now

806
00:39:26,880 --> 00:39:23,740
for at least six or seven years the last

807
00:39:29,160 --> 00:39:26,890
two years I'd say we were hard at work

808
00:39:31,140 --> 00:39:29,170
on the sounding rocket flight tests up

809
00:39:33,960 --> 00:39:31,150
to then we had been doing a bunch of

810
00:39:36,450 --> 00:39:33,970
ground tests we've gone in wind tunnels

811
00:39:38,910 --> 00:39:36,460
we've gone in the arc Jets we've done

812
00:39:41,660 --> 00:39:38,920
all different kinds of tests to try to

813
00:39:44,910 --> 00:39:41,670

understand and and make sure we're

814
00:39:47,280 --> 00:39:44,920
confident in how this new heat shield

815
00:39:50,250 --> 00:39:47,290
can perform but then ultimately like

816
00:39:52,170 --> 00:39:50,260
with a lot of things that go into space

817
00:39:54,990 --> 00:39:52,180
people will only believe it when it

818
00:39:56,670 --> 00:39:55,000
flies in space so that's that was part

819
00:39:59,970 --> 00:39:56,680
of our purpose of this flight test then

820
00:40:01,800 --> 00:39:59,980
it and it did what we wanted to do and

821
00:40:04,650 --> 00:40:01,810
then we're hoping down the road to even

822
00:40:06,330 --> 00:40:04,660
do some more adventurous flight tests

823
00:40:07,350 --> 00:40:06,340
coming in from orbit to where we'll

824
00:40:10,080 --> 00:40:07,360
actually see

825
00:40:12,180 --> 00:40:10,090
heating that you'll see at an actual

826
00:40:14,520 --> 00:40:12,190
mission and that's how we're really get

827
00:40:16,370 --> 00:40:14,530
higher confidence in this those like the

828
00:40:19,470 --> 00:40:16,380
next steps for a depth we hope so

829
00:40:19,800 --> 00:40:19,480
absolutely I know when I was there with

830
00:40:23,100 --> 00:40:19,810
you guys

831
00:40:25,770 --> 00:40:23,110
just seeing the team together you know

832
00:40:27,990 --> 00:40:25,780
prepping getting you know adept into

833
00:40:29,070 --> 00:40:28,000
like it stowed into the rocket and

834
00:40:30,240 --> 00:40:29,080
things like that I can't believe it's

835
00:40:36,060 --> 00:40:30,250
like really in the rocket but when you

836
00:40:37,920 --> 00:40:36,070
see it like it's so you get to see the

837
00:40:39,450 --> 00:40:37,930
team and he has a really great team and

838
00:40:41,070 --> 00:40:39,460

just like their interactions and just

839
00:40:46,920 --> 00:40:41,080
how they finally got to like their first

840
00:40:49,020 --> 00:40:46,930
flight test it's really really cool when

841
00:40:51,450 --> 00:40:49,030
you guys were retrieving Adept

842
00:40:53,940 --> 00:40:51,460
after the test they just like everybody

843
00:40:59,640 --> 00:40:53,950
jumped into an SUV and drove ah there

844
00:41:02,310 --> 00:40:59,650
were almost skid marks and this is at

845
00:41:05,310 --> 00:41:02,320
White Sands Missile Range it's an army

846
00:41:07,710 --> 00:41:05,320
base and they had all kinds of other

847
00:41:09,780 --> 00:41:07,720
activities going on that same day and so

848
00:41:12,360 --> 00:41:09,790
the recovery crew was in the helicopter

849
00:41:14,400 --> 00:41:12,370
was you know coming and going all over

850
00:41:16,320 --> 00:41:14,410
they couldn't tell us exactly when they

851
00:41:18,510 --> 00:41:16,330
were gonna come to do our part of the

852
00:41:21,180 --> 00:41:18,520
mission and so they said just be ready

853
00:41:23,790 --> 00:41:21,190
at any time and so sure enough four

854
00:41:25,730 --> 00:41:23,800
hours later get a knock on the door you

855
00:41:32,180 --> 00:41:25,740
guys got three minutes get up doctor

856
00:41:32,190 --> 00:41:39,559
we have some really cool footage of Paul

857
00:41:44,279 --> 00:41:42,210
so the test is how about how long

858
00:41:47,450 --> 00:41:44,289
well it takes only about 15 minutes from

859
00:41:52,589 --> 00:41:47,460
launch to coming back down on the ground

860
00:41:53,009 --> 00:41:52,599
yeah very relieved very happy there the

861
00:41:55,079 --> 00:41:53,019
Adept

862
00:41:56,700 --> 00:41:55,089
took a hard landing we were expecting

863
00:41:59,640 --> 00:41:56,710

that and so that was the container we

864
00:42:03,210 --> 00:41:59,650
put it in and the team is still working

865
00:42:04,979 --> 00:42:03,220
on we've recovered all the data from it

866
00:42:09,420 --> 00:42:04,989
it stored all the data on board on these

867
00:42:11,969 --> 00:42:09,430
little memory boards and we probably got

868
00:42:14,370 --> 00:42:11,979
a few more months worth of deciphering

869
00:42:16,559 --> 00:42:14,380
and analysis to go one question they

870
00:42:18,870 --> 00:42:16,569
came in this is from Celine you hear

871
00:42:28,549 --> 00:42:18,880
this is seriously seriously though can

872
00:42:33,450 --> 00:42:30,690
you'd have to probably talk to the

873
00:42:36,809 --> 00:42:33,460
manufacturer and see what they want to

874
00:42:38,999 --> 00:42:36,819
charge you know I mean it's it's very

875
00:42:42,029 --> 00:42:39,009
specialized I mean it's it's for

876
00:42:43,769 --> 00:42:42,039
high-temperature use but it's very

877
00:42:45,239 --> 00:42:43,779
durable very rugged and that's what

878
00:42:50,219 --> 00:42:45,249
makes it exciting as a heat shield

879
00:42:51,930 --> 00:42:50,229
material because it can take a lot so

880
00:42:53,249 --> 00:42:51,940
okay let me jump on to some of these

881
00:42:56,660 --> 00:42:53,259
chat questions we are gonna do a rapid

882
00:42:58,799 --> 00:42:56,670
fire towards the end but let's go into

883
00:43:00,900 --> 00:42:58,809
alright what sort of properties would

884
00:43:02,609 --> 00:43:00,910
the rocket need to support that kind of

885
00:43:08,099 --> 00:43:02,619
dynamic heat shield as opposed to a

886
00:43:13,380 --> 00:43:08,109
rigid one no difference I mean you know

887
00:43:16,259 --> 00:43:13,390
I think the nice thing about it is is

888
00:43:18,180 --> 00:43:16,269

that you can take the same payload in a

889
00:43:20,609 --> 00:43:18,190
much smaller rocket because now you're

890
00:43:22,200 --> 00:43:20,619
not dominated by this huge heat shield a

891
00:43:24,539 --> 00:43:22,210
rigid heat shield now we can all fold up

892
00:43:26,309 --> 00:43:24,549
around your payload so you know a shout

893
00:43:31,799 --> 00:43:26,319
out that was Herald with an H I forgot

894
00:43:33,839 --> 00:43:31,809
to give it as it gets bigger it's not

895
00:43:36,930 --> 00:43:33,849
necessarily gonna be any lighter right

896
00:43:39,329 --> 00:43:36,940
then then the current heat shield the

897
00:43:41,579 --> 00:43:39,339
with all the structure and and the cloth

898
00:43:42,990 --> 00:43:41,589
the cloth is not you know no really

899
00:43:45,840 --> 00:43:43,000
lightweight either so I'm

900
00:43:49,400 --> 00:43:45,850
it's not so much weight its volume and

901
00:43:52,920 --> 00:43:49,410
you can you know you can put much more

902
00:43:55,620 --> 00:43:52,930
volume in and have it open it to

903
00:43:58,590 --> 00:43:55,630
something so much larger than what we're

904
00:44:01,170 --> 00:43:58,600
using for March 2020 and we're really

905
00:44:03,510 --> 00:44:01,180
getting to the limits there with a four

906
00:44:09,870 --> 00:44:03,520
and a half meter heat shield on what can

907
00:44:11,820 --> 00:44:09,880
fit in our fairings so anyone else think

908
00:44:44,700 --> 00:44:11,830
the pole there should be a Paul action

909
00:44:48,780 --> 00:44:44,710
figure it was pretty fun to design

910
00:44:54,420 --> 00:44:48,790
develop and install this unit well you

911
00:44:55,920 --> 00:44:54,430
know it does a small team that that was

912
00:44:59,460 --> 00:44:55,930
working on sr1

913
00:45:01,860 --> 00:44:59,470

but we probably on total say roughly a

914
00:45:04,470 --> 00:45:01,870
dozen people more or less full-time

915
00:45:07,080 --> 00:45:04,480
working it over over a year or two okay

916
00:45:08,820 --> 00:45:07,090
just for that for this test the design

917
00:45:12,270 --> 00:45:08,830
the preliminary designs over the last

918
00:45:14,810 --> 00:45:12,280
few years is oh you know yeah a lot of

919
00:45:19,020 --> 00:45:14,820
people working and designers and an

920
00:45:21,030 --> 00:45:19,030
analysts and you know people for doing

921
00:45:22,650 --> 00:45:21,040
all the instrumentation mm-hmm I think

922
00:45:24,180 --> 00:45:22,660
Paul you mentioned to me that it took a

923
00:45:27,120 --> 00:45:24,190
long time just to get the fabric right

924
00:45:28,710 --> 00:45:27,130
to find the material that you needed the

925
00:45:31,230 --> 00:45:28,720
first couple of years all we were

926
00:45:33,750 --> 00:45:31,240
worrying about was how to weave the

927
00:45:35,670 --> 00:45:33,760
fabric and how the layers would get set

928
00:45:38,310 --> 00:45:35,680
up we weren't even sure that was gonna

929
00:45:40,950 --> 00:45:38,320
work and and so we had to prove to

930
00:45:43,800 --> 00:45:40,960
ourselves that fabric could take the

931
00:45:45,240 --> 00:45:43,810
loads because it's that's that's what's

932
00:45:46,800 --> 00:45:45,250
a little different of this than even a

933
00:45:49,470 --> 00:45:46,810
rigid is now you have this fabric that's

934
00:45:51,780 --> 00:45:49,480
being pulled while it's glowing at 3,000

935
00:45:53,910 --> 00:45:51,790
degrees Fahrenheit so it's it's got its

936
00:45:54,540 --> 00:45:53,920
work cut out for it a quick reminder to

937
00:45:56,190 --> 00:45:54,550
the folks

938
00:45:58,770 --> 00:45:56,200

we're gonna do rapid-fire in the next a

939
00:46:00,600 --> 00:45:58,780
little bit but we're at twitch TV / NASA

940
00:46:03,060 --> 00:46:00,610
if you have any questions jump into the

941
00:46:05,100 --> 00:46:03,070
chat now to add those like our friend

942
00:46:07,020 --> 00:46:05,110
Jennifer who's put in a couple of

943
00:46:09,150 --> 00:46:07,030
questions over and over and she was the

944
00:46:11,160 --> 00:46:09,160
latest one was are these heat shields

945
00:46:20,000 --> 00:46:11,170
tested in vacuums and evidently I think

946
00:46:27,900 --> 00:46:26,430
universe you can control what kind of

947
00:46:31,590 --> 00:46:27,910
environments you want to test the arc

948
00:46:35,730 --> 00:46:31,600
jet typically is tested yeah usually we

949
00:46:38,820 --> 00:46:35,740
test in very low pressure in vacuum we

950
00:46:41,820 --> 00:46:38,830
don't get heat we get radiant heating oh

951
00:46:43,470 --> 00:46:41,830
it's not very hot we get solar right as

952
00:46:46,650 --> 00:46:43,480
we're going through space so we do have

953
00:46:49,110 --> 00:46:46,660
to design our spacecraft for that this

954
00:46:53,310 --> 00:46:49,120
heating from the Sun as it's traveling

955
00:46:55,740 --> 00:46:53,320
there is no longer a vacuum exactly you

956
00:46:58,590 --> 00:46:55,750
know it is low pressure okay we do test

957
00:47:01,890 --> 00:46:58,600
at we do pull put it into a vacuum

958
00:47:04,020 --> 00:47:01,900
chamber and then slow flow the gasses

959
00:47:06,300 --> 00:47:04,030
over it and that helps the gas to expand

960
00:47:07,500 --> 00:47:06,310
and to get to the right pressure right

961
00:47:10,590 --> 00:47:07,510
through the nozzle goes through the

962
00:47:13,770 --> 00:47:10,600
nozzle and expands and goes over our our

963
00:47:16,050 --> 00:47:13,780

test article so I know when we went to

964
00:47:17,610 --> 00:47:16,060
twitchcon those last couple weekends ago

965
00:47:19,230 --> 00:47:17,620
and I know that several people would be

966
00:47:20,880 --> 00:47:19,240
interested and you know if you've seen

967
00:47:22,820 --> 00:47:20,890
the YouTube show where they do the

968
00:47:25,020 --> 00:47:22,830
hydraulic press where they crush things

969
00:47:32,880 --> 00:47:25,030
imagine a show where we just put things

970
00:47:35,220 --> 00:47:32,890
in the arc jet when we were working MSL

971
00:47:44,610 --> 00:47:35,230
one of our guys wanted to make a meat

972
00:47:47,040 --> 00:47:44,620
shield you know you could only do him a

973
00:47:50,670 --> 00:47:47,050
really short time but you know was Kobe

974
00:47:53,700 --> 00:47:50,680
beef different from American beef and

975
00:47:57,210 --> 00:47:53,710
pork and stuff so we did have one person

976
00:47:58,830 --> 00:47:57,220
who wanted to test a meat shield a shout

977
00:48:00,750 --> 00:47:58,840
at the space master you asked before

978
00:48:02,340 --> 00:48:00,760
like how do i watch this show live you

979
00:48:04,380 --> 00:48:02,350
are watching this show live right at

980
00:48:05,940 --> 00:48:04,390
this moment he also gave a shout out to

981
00:48:07,260 --> 00:48:05,950
Gary Jordan who's over at Johnson

982
00:48:07,710 --> 00:48:07,270
because he says that he's friends with

983
00:48:11,070 --> 00:48:07,720
Gary

984
00:48:13,830 --> 00:48:11,080
Johnson but we're going to keep going to

985
00:48:16,500 --> 00:48:13,840
a couple more questions and I'm gonna

986
00:48:18,150 --> 00:48:16,510
look at can such a sheet can such a

987
00:48:20,550 --> 00:48:18,160
shield cover objects with irregular

988
00:48:23,700 --> 00:48:20,560

shapes like a decommissioned satellite

989
00:48:25,500 --> 00:48:23,710
that's from Bob keys I don't know

990
00:48:26,490 --> 00:48:25,510
well what kind of crazy shapes you're

991
00:48:29,580 --> 00:48:26,500
looking for heat shields or for the most

992
00:48:31,920 --> 00:48:29,590
part well that's about what the depth is

993
00:48:34,470 --> 00:48:31,930
as recovering satellites small sets

994
00:48:36,300 --> 00:48:34,480
right instead of just having them burn

995
00:48:39,210 --> 00:48:36,310
up in as they come into the atmosphere

996
00:48:41,130 --> 00:48:39,220
actually recovery so or from shuttle

997
00:48:44,250 --> 00:48:41,140
settings Nutt shuttles from space

998
00:48:47,160 --> 00:48:44,260
station doing down mass right sending

999
00:48:49,410 --> 00:48:47,170
experiments down and so they're looking

1000
00:48:52,410 --> 00:48:49,420
at things that that start small and can

1001
00:48:54,089 --> 00:48:52,420
deploy outside of the space station so

1002
00:48:56,670 --> 00:48:54,099
they don't take up as much space but

1003
00:48:59,190 --> 00:48:56,680
they could they send down experiments

1004
00:49:03,960 --> 00:48:59,200
right and be able to recover them fast

1005
00:49:06,390 --> 00:49:03,970
enough to look at the the data so and

1006
00:49:10,410 --> 00:49:06,400
and they are you know we we look at

1007
00:49:13,500 --> 00:49:10,420
these as for small sets as well for

1008
00:49:16,980 --> 00:49:13,510
small satellites to enter atmospheres

1009
00:49:19,740 --> 00:49:16,990
and then to go into orbit around them

1010
00:49:23,010 --> 00:49:19,750
and so when questions for Paul that came

1011
00:49:24,270 --> 00:49:23,020
in from cats loved Mars I mean we just

1012
00:49:25,829 --> 00:49:24,280
kind of brushed over it we showed the

1013
00:49:27,900 --> 00:49:25,839

sounding rocket and so cats love Mars

1014
00:49:32,700 --> 00:49:27,910
was asking what is the sounding rocket

1015
00:49:36,390 --> 00:49:32,710
so well I think generally a sounding

1016
00:49:38,970 --> 00:49:36,400
rocket is where it just goes literally

1017
00:49:42,540 --> 00:49:38,980
up and then it comes back down so it

1018
00:49:44,790 --> 00:49:42,550
doesn't have the umph that bigger

1019
00:49:47,490 --> 00:49:44,800
rockets have that would put a payload

1020
00:49:49,170 --> 00:49:47,500
into orbit and so sounding rocket I

1021
00:49:51,390 --> 00:49:49,180
think goes back to the days when they

1022
00:49:53,520 --> 00:49:51,400
were just trying to study the atmosphere

1023
00:49:55,230 --> 00:49:53,530
so they would just send instruments sort

1024
00:49:57,390 --> 00:49:55,240
of straight up and they would measure

1025
00:49:59,510 --> 00:49:57,400
some at some altitude take some

1026
00:50:01,500 --> 00:49:59,520
measurements but then come back down

1027
00:50:07,349 --> 00:50:01,510
Tiffani's if you wanna hit before we go

1028
00:50:08,970 --> 00:50:07,359
to the audio for a bill and Dave over in

1029
00:50:10,859 --> 00:50:08,980
our control room guys are you guys ready

1030
00:50:24,880 --> 00:50:10,869
to rock and roll for some rapid fire I'm

1031
00:50:24,890 --> 00:50:30,820
we were not gonna waste that animation

1032
00:50:35,060 --> 00:50:32,840
practicing rapid-fire sometimes

1033
00:50:36,740 --> 00:50:35,070
rapid-fire isn't so rapid yes we're

1034
00:50:38,360 --> 00:50:36,750
gonna try and I'm gonna grab some of the

1035
00:50:40,700 --> 00:50:38,370
later the latest ones and kind of move

1036
00:50:42,320 --> 00:50:40,710
our way up okay what part of the heat

1037
00:50:44,290 --> 00:50:42,330
shield gets hottest that's from Tom Beck

1038
00:50:46,340 --> 00:50:44,300

Oh usually it's this part right up here

1039
00:50:48,110 --> 00:50:46,350
stagnation we call that the stagnation

1040
00:50:50,210 --> 00:50:48,120
point all right

1041
00:50:52,700 --> 00:50:50,220
is there an estimation of how much money

1042
00:50:54,830 --> 00:50:52,710
is worth investigating in more research

1043
00:50:58,040 --> 00:50:54,840
and material costs to lose one kilogram

1044
00:51:01,550 --> 00:50:58,050
of weight that's from O's app fits one

1045
00:51:05,240 --> 00:51:01,560
kilogram not so much but um you know

1046
00:51:07,730 --> 00:51:05,250
half the TPS weight definitely and again

1047
00:51:10,340 --> 00:51:07,740
it it depends on where you're going on

1048
00:51:13,520 --> 00:51:10,350
what kind of heat shield you need and on

1049
00:51:16,670 --> 00:51:13,530
how how heavy it will actually be and so

1050
00:51:20,300 --> 00:51:16,680
I'm what material is the disk on top for

1051
00:51:21,440 --> 00:51:20,310
a dense oh well what we're looking at

1052
00:51:23,690 --> 00:51:21,450
for this guy right here this is

1053
00:51:25,520 --> 00:51:23,700
literally stainless steel and this is

1054
00:51:27,620 --> 00:51:25,530
some 3d printed plastic because this is

1055
00:51:30,170 --> 00:51:27,630
a demo model but what flew for us our

1056
00:51:32,420 --> 00:51:30,180
one was a metal nose and we got away

1057
00:51:34,670 --> 00:51:32,430
with that because we only flew to mach 3

1058
00:51:39,590 --> 00:51:34,680
so we didn't see real aero thermal

1059
00:51:41,660 --> 00:51:39,600
heating only Mach 3 whatever yeah for

1060
00:51:49,100 --> 00:51:41,670
planetary entry they're actually looking

1061
00:51:51,950 --> 00:51:49,110
at flying with conformal pica yep don't

1062
00:51:53,990 --> 00:51:51,960
let me down so are there any other

1063
00:51:56,230 --> 00:51:54,000

cooling systems that work with the heat

1064
00:51:59,450 --> 00:51:56,240
shield for a depth this is star molds

1065
00:52:01,460 --> 00:51:59,460
cooling systems well we've looked at I

1066
00:52:04,190 --> 00:52:01,470
mean one of the challenges with with

1067
00:52:06,440 --> 00:52:04,200
this is the fabric gets red hot and

1068
00:52:08,300 --> 00:52:06,450
that's great because it's carbon

1069
00:52:10,430 --> 00:52:08,310
material that holds together what you

1070
00:52:12,230 --> 00:52:10,440
want to do though is be careful with

1071
00:52:13,520 --> 00:52:12,240
things underneath it that are also going

1072
00:52:16,010 --> 00:52:13,530
to get hot just because they're close to

1073
00:52:18,050 --> 00:52:16,020
the fabric so we've looked at insulating

1074
00:52:19,580 --> 00:52:18,060
materials that can go underneath the

1075
00:52:21,980 --> 00:52:19,590
ribs sort of between the ribs and the

1076
00:52:24,740 --> 00:52:21,990
fabric to help keep that heat away and

1077
00:52:26,220 --> 00:52:24,750
then also on the payload itself some

1078
00:52:28,349 --> 00:52:26,230
sort of blanket on the payload

1079
00:52:30,690 --> 00:52:28,359
a bit from getting radiantly heated from

1080
00:52:32,670 --> 00:52:30,700
the backside of the carbon alright some

1081
00:52:35,550 --> 00:52:32,680
are coming in I have old questions and

1082
00:52:37,320 --> 00:52:35,560
we have new oh my gosh what is the

1083
00:52:39,120 --> 00:52:37,330
multi-layer insulation made of that's

1084
00:52:41,460 --> 00:52:39,130
our buddy nice guy Dewey again

1085
00:52:44,310 --> 00:52:41,470
well the multi-layer it is and it's

1086
00:52:47,640 --> 00:52:44,320
different yarns and the outer layers of

1087
00:52:50,490 --> 00:52:47,650
carbon it's all carbon yarn and the

1088
00:52:52,440 --> 00:52:50,500

inner layer is an insulating yarn okay

1089
00:53:02,849 --> 00:52:52,450
so um can the heat shield ever get too

1090
00:53:05,609 --> 00:53:02,859
hot that's G dog 16 absolutely right and

1091
00:53:07,650 --> 00:53:05,619
some of the materials the insight

1092
00:53:09,599 --> 00:53:07,660
material for example when you get it too

1093
00:53:11,370 --> 00:53:09,609
hot it melts it turn you get glass

1094
00:53:13,830 --> 00:53:11,380
there's a lot of glass in it and it'll

1095
00:53:15,990 --> 00:53:13,840
melt and flow and collapse and get you

1096
00:53:23,220 --> 00:53:16,000
thin and you know it's you don't really

1097
00:53:27,470 --> 00:53:23,230
want a heat shield that drips Slayer X

1098
00:53:32,280 --> 00:53:30,480
it's more of a single-use I mean most of

1099
00:53:33,720 --> 00:53:32,290
the missions we envision it going to

1100
00:53:36,590 --> 00:53:33,730
another planet that most of those are

1101
00:53:38,490 --> 00:53:36,600
one-way trips so we tend to design

1102
00:53:40,410 --> 00:53:38,500
single-use okay

1103
00:53:43,470 --> 00:53:40,420
there's the fabric after reentry stay

1104
00:53:46,380 --> 00:53:43,480
flexible that's from Chris ah that's a

1105
00:53:48,690 --> 00:53:46,390
good question it's will still be

1106
00:53:51,330 --> 00:53:48,700
somewhat I mean when it's deployed its

1107
00:53:53,190 --> 00:53:51,340
we actually wanted to be as close to a

1108
00:53:56,180 --> 00:53:53,200
rigid heat shield and not be flexible

1109
00:54:00,750 --> 00:53:56,190
because we wanted to have that very

1110
00:54:02,280 --> 00:54:00,760
predictable shape okay so the material

1111
00:54:03,510 --> 00:54:02,290
afterwards I guess if we took it off of

1112
00:54:06,599 --> 00:54:03,520
their ribs and everything it would

1113
00:54:08,370 --> 00:54:06,609

probably still be flexible but it's a

1114
00:54:10,650 --> 00:54:08,380
little bit stiffer as you heat the

1115
00:54:13,230 --> 00:54:10,660
carbon it'll get a little stiffer so M

1116
00:54:17,370 --> 00:54:13,240
gallon as asking does the Adept fabric

1117
00:54:21,270 --> 00:54:17,380
oblate during reentry it does we do see

1118
00:54:23,550 --> 00:54:21,280
layer loss the carbon now it doesn't

1119
00:54:25,260 --> 00:54:23,560
there's no paralyzing going on because

1120
00:54:27,930 --> 00:54:25,270
there's nothing that infiltrated but

1121
00:54:31,109 --> 00:54:27,940
what happens is the carbon oxidizes

1122
00:54:33,450 --> 00:54:31,119
that's the primary mode at which layers

1123
00:54:35,640 --> 00:54:33,460
go away and we we knew that was going to

1124
00:54:38,220 --> 00:54:35,650
happen and that's why we have to do a

1125
00:54:38,779 --> 00:54:38,230
special weave so that don't get holes

1126
00:54:45,949 --> 00:54:38,789
right

1127
00:54:47,359 --> 00:54:45,959
the layers how many layers are gonna go

1128
00:54:49,609 --> 00:54:47,369
away and then you have structural layers

1129
00:54:57,909 --> 00:54:49,619
below that no and we saw tests early on

1130
00:55:02,449 --> 00:55:00,349
question from Tom it asks what past

1131
00:55:03,829 --> 00:55:02,459
programs Apollo Space Shuttle have

1132
00:55:06,079 --> 00:55:03,839
carried over to what you're designing

1133
00:55:11,329 --> 00:55:06,089
now obviously everything kind of build

1134
00:55:14,809 --> 00:55:11,339
on well Apollo Orion now the the

1135
00:55:18,229 --> 00:55:14,819
honeycomb in in a riot in the aapko

1136
00:55:21,579 --> 00:55:18,239
material coat material was it flew on

1137
00:55:24,079 --> 00:55:21,589
the first experimental flight for Orion

1138
00:55:25,699 --> 00:55:24,089

for the future flights they're flying

1139
00:55:28,159 --> 00:55:25,709
that same material but without the

1140
00:55:30,859 --> 00:55:28,169
honeycomb so it's now molded into blocks

1141
00:55:33,049 --> 00:55:30,869
and machined and bonded on to the

1142
00:55:35,390 --> 00:55:33,059
structure we talked a little bit about

1143
00:55:37,219 --> 00:55:35,400
this this is from Timbo do the sides of

1144
00:55:38,679 --> 00:55:37,229
the spacecraft need heat protection too

1145
00:55:42,529 --> 00:55:38,689
we talked a little bit yes absolutely

1146
00:55:45,409 --> 00:55:42,539
and in fact we talked about for MSL and

1147
00:55:48,169 --> 00:55:45,419
for Mars 2020 the material that's the

1148
00:55:50,479 --> 00:55:48,179
heat shield material for insight is on

1149
00:55:56,329 --> 00:55:50,489
the back shell to protect the back shell

1150
00:55:58,669 --> 00:55:56,339
of the bigger heavier faster missions so

1151
00:56:01,759 --> 00:55:58,679
they they we definitely have to protect

1152
00:56:04,189 --> 00:56:01,769
that okay the heat shields okay somebody

1153
00:56:14,779 --> 00:56:04,199
is saying the heat shield i weld on go

1154
00:56:16,519 --> 00:56:14,789
on jets and are made of tea from

1155
00:56:18,079 --> 00:56:16,529
Mitchell Pro Mitchell knows what he's

1156
00:56:19,339 --> 00:56:18,089
talking about and he's asking what's the

1157
00:56:21,409 --> 00:56:19,349
reason your heat shields are made of

1158
00:56:23,269 --> 00:56:21,419
carbon like carbon over your titanium oh

1159
00:56:25,969 --> 00:56:23,279
well I mean titanium great

1160
00:56:28,640 --> 00:56:25,979
high-temperature metal but it just

1161
00:56:30,199 --> 00:56:28,650
wouldn't survive these type of extreme

1162
00:56:34,630 --> 00:56:30,209
environments that we're seeing area it

1163
00:56:41,929 --> 00:56:38,719

the supersonic jets they get worm in

1164
00:56:44,870 --> 00:56:41,939
titanium would be enough but they these

1165
00:56:46,759 --> 00:56:44,880
get hot a rapid fire is getting rapid as

1166
00:56:50,449 --> 00:56:46,769
we're about like two minutes left

1167
00:56:52,020 --> 00:56:50,459
it's Kay's Lee is or Keck KLC is asking

1168
00:56:53,820 --> 00:56:52,030
what temperatures can it protect up to

1169
00:56:56,330 --> 00:56:53,830
so what are your maximum temperatures

1170
00:57:01,260 --> 00:56:56,340
are we thinking of here it depends on

1171
00:57:06,180 --> 00:57:01,270
the material and we carbon can go easily

1172
00:57:11,100 --> 00:57:06,190
above 3000 Kelvin so let's see 40

1173
00:57:15,000 --> 00:57:11,110
I'm sorry 4500 for our well over 4000 so

1174
00:57:17,220 --> 00:57:15,010
it will get very hot you get to a point

1175
00:57:21,420 --> 00:57:17,230
where it stops oxidizing and it just

1176
00:57:24,410 --> 00:57:21,430
starts going off as carbon so it starts

1177
00:57:27,630 --> 00:57:24,420
subliming but it can get very very hot

1178
00:57:29,430 --> 00:57:27,640
other materials can't get that hot if

1179
00:57:35,180 --> 00:57:29,440
they get above you know the glassy

1180
00:57:37,860 --> 00:57:35,190
materials get above about 1600 Celsius

1181
00:57:39,000 --> 00:57:37,870
2000 2500 Fahrenheit so if we can hit up

1182
00:57:40,740 --> 00:57:39,010
one more question this is for

1183
00:57:42,720 --> 00:57:40,750
four-year-old Elly before we go into the

1184
00:57:46,140 --> 00:57:42,730
outdoor Natalie how much cooler is it

1185
00:57:50,130 --> 00:57:46,150
underneath the umbrella than on top then

1186
00:57:51,960 --> 00:57:50,140
I got one minute to go it's still pretty

1187
00:57:53,910 --> 00:57:51,970
warm on the up on the back side of this

1188
00:57:55,680 --> 00:57:53,920

so that's we have to pay attention to

1189
00:57:57,900 --> 00:57:55,690
that not as hot as the front side but

1190
00:58:01,800 --> 00:57:57,910
still it's you wouldn't want to touch it

1191
00:58:04,770 --> 00:58:01,810
on the back the point is to protect

1192
00:58:07,080 --> 00:58:04,780
what's inside right but folks this is

1193
00:58:09,150 --> 00:58:07,090
all the time that we have we got to wrap

1194
00:58:10,980 --> 00:58:09,160
things up this has been NASA in Silicon

1195
00:58:12,900 --> 00:58:10,990
Valley live it is a conversational show

1196
00:58:14,100 --> 00:58:12,910
out of NASA's Ames Research Center in

1197
00:58:16,260 --> 00:58:14,110
Silicon Valley where we talked to the

1198
00:58:18,360 --> 00:58:16,270
various scientists researchers engineers

1199
00:58:20,580 --> 00:58:18,370
and all-around cool people here at NASA

1200
00:58:23,550 --> 00:58:20,590
and if you like that we are on twitch

1201
00:58:25,950 --> 00:58:23,560
YouTube Facebook periscope and once the

1202
00:58:27,390 --> 00:58:25,960
show is over we will have on-demand

1203
00:58:28,380 --> 00:58:27,400
video so if you couldn't catch us live

1204
00:58:30,090 --> 00:58:28,390
don't worry about it

1205
00:58:31,650 --> 00:58:30,100
go on to on-demand will be able to watch

1206
00:58:36,540 --> 00:58:31,660
that there including next week up on

1207
00:58:36,990 --> 00:58:36,550
NASA TV thank you so much everybody for

1208
00:58:38,880 --> 00:58:37,000
coming

1209
00:58:40,620 --> 00:58:38,890
this has been a super fun show and like

1210
00:58:42,030 --> 00:58:40,630
what we're looking at next well no not

1211
00:58:44,190 --> 00:58:42,040
next week cuz it's gonna be Thanksgiving

1212
00:58:46,680 --> 00:58:44,200
and I ain't gonna be here but a huge

1213
00:58:48,090 --> 00:58:46,690

thanks to our guests a huge thanks to

1214
00:58:50,040 --> 00:58:48,100
the twitch chat for everything you guys

1215
00:58:51,960 --> 00:58:50,050
are doing we'll be back on December 6

1216
00:58:53,490 --> 00:58:51,970
when we talk about Sofia the world's

1217
00:58:55,260 --> 00:58:53,500
largest flying Observatory in the

1218
00:58:57,870 --> 00:58:55,270
history of airborne astronomy and I am

1219
00:58:59,070 --> 00:58:57,880
way past her out Joe until then thank

1220
00:58:59,780 --> 00:58:59,080
you for coming everybody we'll see you