1
00:00:07,220 --> 00:00:05,360
we're back out of the East test area for

2
00:00:09,410 --> 00:00:07,230
one of the newer facilities here at

3
00:00:11,360 --> 00:00:09,420
Marshall it's a new part of the impact

4
00:00:14,240 --> 00:00:11,370
testing facility this is the outdoor

5
00:00:16,010 --> 00:00:14,250
range we've got some very large guns

6
00:00:17,660 --> 00:00:16,020
we're joined by Andy Fincham with

7
00:00:18,620 --> 00:00:17,670
impacts testing I guess any first thing

8
00:00:20,720 --> 00:00:18,630
could you tell us a little bit about

9
00:00:23,810 --> 00:00:20,730
exactly what impact testing is well what

10
00:00:26,120 --> 00:00:23,820
we've been doing for years at impact

11
00:00:29,050 --> 00:00:26,130
testing is trying to understand how

12
00:00:31,460 --> 00:00:29,060
materials perform mainly hyper velocity

13
00:00:34,130 --> 00:00:31,470

micro meteoroids orbal to be that sort

14
00:00:36,380 --> 00:00:34,140
of thing what after return to flight and

15
00:00:37,610 --> 00:00:36,390
lost Colombian trying to get a better

16
00:00:39,319 --> 00:00:37,620
understanding of how the materials

17
00:00:43,610 --> 00:00:39,329
perform at lower velocities on the scent

18
00:00:45,950 --> 00:00:43,620
at the launch pad these allow us to go

19
00:00:47,750 --> 00:00:45,960
from a few hundred feet per second to a

20
00:00:51,319 --> 00:00:47,760
few thousand feet per second up to say

21
00:00:54,139 --> 00:00:51,329
rifle velocity and that's the first

22
00:00:55,580 --> 00:00:54,149
couple minutes of flight we got to

23
00:00:57,229 --> 00:00:55,590
characterize and better understand how

24
00:01:00,590 --> 00:00:57,239
our materials that were using on flight

25
00:01:01,970 --> 00:01:00,600
can resist impact and that's that's what

26
00:01:03,979 --> 00:01:01,980
we that's all that's all we're doing

27
00:01:06,890 --> 00:01:03,989
here supporting return to flight

28
00:01:09,410 --> 00:01:06,900
understanding launch debris use the

29
00:01:12,590 --> 00:01:09,420
larger gun same thing to understand

30
00:01:15,260 --> 00:01:12,600
characterize ice foam impacts blader

31
00:01:18,230 --> 00:01:15,270
impacts anything that can hit the

32
00:01:20,179 --> 00:01:18,240
vehicle we can shoot it and simulate an

33
00:01:21,800 --> 00:01:20,189
impact of it now the three different

34
00:01:24,170 --> 00:01:21,810
areas that involve impacts testing this

35
00:01:26,120 --> 00:01:24,180
is called the ballistic area and it's at

36
00:01:27,740 --> 00:01:26,130
an outdoor range I mean the guns

37
00:01:28,850 --> 00:01:27,750
themselves are housed indoors but

38
00:01:31,940 --> 00:01:28,860

obviously there's a target downrange

39
00:01:34,280 --> 00:01:31,950
great why is that well the idea here is

40
00:01:36,380 --> 00:01:34,290
that we are able to shoot a full-scale

41
00:01:39,920 --> 00:01:36,390
hardware if need be we can we can bring

42
00:01:41,510 --> 00:01:39,930
in a huge test panel cryogenics high

43
00:01:43,340 --> 00:01:41,520
pressure since we're out in the test

44
00:01:46,310 --> 00:01:43,350
area this whole areas consider hazards

45
00:01:48,050 --> 00:01:46,320
operations so we can set out the panel

46
00:01:50,240 --> 00:01:48,060
out there suit it if it blows up and

47
00:01:52,969 --> 00:01:50,250
nobody's hurt where we're in our own

48
00:01:55,069 --> 00:01:52,979
little area basalt protected and and

49
00:01:57,950 --> 00:01:55,079
that's ultimately the difference between

50
00:02:00,050 --> 00:01:57,960
these guns along with the velocity all

51
00:02:01,310 --> 00:02:00,060
the other guns are within a building so

52
00:02:03,620 --> 00:02:01,320
we're sort of limited with the other

53
00:02:06,840 --> 00:02:03,630
with the size of the target

54
00:02:08,609 --> 00:02:06,850
we can you know I mean you know up to up

55
00:02:10,020 --> 00:02:08,619
to full size hardware if we need to

56
00:02:12,420 --> 00:02:10,030
input an external tank out there and

57
00:02:13,979 --> 00:02:12,430
shoot it if we needed to we're not going

58
00:02:15,540 --> 00:02:13,989
to shoot at anything that large today

59
00:02:17,430 --> 00:02:15,550
but let's go ahead and fire one of these

60
00:02:19,650 --> 00:02:17,440
all right what is a fascinating they're

61
00:02:22,229 --> 00:02:19,660
not your traditional revolvers and

62
00:02:24,180 --> 00:02:22,239
rifles are there no now these instead of

63
00:02:26,370 --> 00:02:24,190

using gunpowder these use helium is the

64
00:02:28,589 --> 00:02:26,380
propellant an advantage there is is that

65
00:02:30,990 --> 00:02:28,599
we can actually dial in the pressure

66
00:02:34,259 --> 00:02:31,000
that we want to get the velocity that we

67
00:02:36,180 --> 00:02:34,269
need so let's do it all right what's

68
00:02:37,920 --> 00:02:36,190
what's is this Oregon parachute the

69
00:02:40,530 --> 00:02:37,930
small what we call the small ballistic

70
00:02:42,720 --> 00:02:40,540
gun we're currently doing return to

71
00:02:45,030 --> 00:02:42,730
flight work with this shooting a very

72
00:02:47,220 --> 00:02:45,040
small projectiles into place to

73
00:02:50,970 --> 00:02:47,230
characterize those materials on launch

74
00:02:52,140 --> 00:02:50,980
and and so we'll just do a quick shot in

75
00:03:05,230 --> 00:02:52,150
this to show you what it's all about

76
00:03:09,940 --> 00:03:07,630
what we're shooting into for this test

77
00:03:11,290 --> 00:03:09,950
is a half-inch thick steel plate that's

78
00:03:13,690 --> 00:03:11,300
instrumented with three accelerometers

79
00:03:15,970 --> 00:03:13,700
and a load cell at each of the four

80
00:03:18,040 --> 00:03:15,980
corners so that the guys that are doing

81
00:03:20,230 --> 00:03:18,050
all the computer modeling can take the

82
00:03:22,480 --> 00:03:20,240
impact data plug it into their models

83
00:03:25,060 --> 00:03:22,490
and make sure that it that the that

84
00:03:27,300 --> 00:03:25,070
their models agree with actual impact of

85
00:03:31,949 --> 00:03:30,150
okay Andy so the gun is loaded and ready

86
00:03:33,360 --> 00:03:31,959
to go it's pressurized what are we going

87
00:03:36,449 --> 00:03:33,370
to shoot what we're going to shoot is a

88
00:03:38,339 --> 00:03:36,459

sample of EA 934 it's an epoxy that's

89
00:03:41,070 --> 00:03:38,349
found all over the launch pad and we're

90
00:03:43,740 --> 00:03:41,080
doing this to simulate launch debris as

91
00:03:46,110 --> 00:03:43,750
if that might be hitting the shuttle on

92
00:03:47,910 --> 00:03:46,120
its way all right correct okay i'll let

93
00:03:49,949 --> 00:03:47,920
you go to it then i have to be out here

94
00:03:51,570 --> 00:03:49,959
right ok it's in there with these safety

95
00:03:54,710 --> 00:03:51,580
rationale standing here either I won't

96
00:04:07,390 --> 00:03:54,720
be out okay great come on up to five

97
00:04:11,199 --> 00:04:10,059
I saw Andy we just shot the gun and you

98
00:04:13,479 --> 00:04:11,209
just recover the pieces of the

99
00:04:15,460 --> 00:04:13,489
projectile right what happens is that

100
00:04:18,129 --> 00:04:15,470
we've learned all the modelers have told

101
00:04:20,439 --> 00:04:18,139
us and we've learned by test that the

102
00:04:21,969 --> 00:04:20,449
material will mount fracture below 400

103
00:04:23,499 --> 00:04:21,979
feet per second but if we see it right

104
00:04:25,659 --> 00:04:23,509
over 400 feet per second it will break

105
00:04:27,460 --> 00:04:25,669
into two big chunks and the faster we go

106
00:04:28,810 --> 00:04:27,470
the smaller the chunks are imagine

107
00:04:30,580 --> 00:04:28,820
sometimes it's hard to find those chunks

108
00:04:33,400 --> 00:04:30,590
it's very difficult I got a thousand

109
00:04:35,620 --> 00:04:33,410
square feet to look for these Chinese we

110
00:04:37,629 --> 00:04:35,630
moved indoors to building 46 12 here in

111
00:04:39,370 --> 00:04:37,639
Marshall and the original impact testing

112
00:04:40,510 --> 00:04:39,380
facility where we're joined by Mary

113
00:04:42,490 --> 00:04:40,520

whole matter is going to tell us about

114
00:04:43,990 --> 00:04:42,500
the largest and the oldest yet we have

115
00:04:45,939 --> 00:04:44,000
here in Marshall yes that's correct miss

116
00:04:47,850 --> 00:04:45,949
burns over 90 feet long and this is the

117
00:04:49,810 --> 00:04:47,860
hyper velocity to stage light gas gun

118
00:04:52,060 --> 00:04:49,820
this one was actually brought here in

119
00:04:53,500 --> 00:04:52,070
nearly 60 s and it was used for various

120
00:04:55,390 --> 00:04:53,510
testing including Space Station

121
00:04:56,860 --> 00:04:55,400
excellent well why don't walk us through

122
00:04:58,990 --> 00:04:56,870
some of different parts of it here sure

123
00:05:00,279 --> 00:04:59,000
can do that at the end down here you

124
00:05:02,680 --> 00:05:00,289
have your breach area this is your

125
00:05:04,089 --> 00:05:02,690
action end so where your powder goes you

126
00:05:06,790 --> 00:05:04,099
have a piston the white thing you see

127
00:05:08,740 --> 00:05:06,800
there and once you fire this gun and

128
00:05:10,300 --> 00:05:08,750
blows the powder which moves your piston

129
00:05:12,960 --> 00:05:10,310
and compresses your gas hits the light

130
00:05:15,969 --> 00:05:12,970
gas guns hydrogen that's in this gun

131
00:05:18,520 --> 00:05:15,979
it's compressed in this area until it

132
00:05:20,260 --> 00:05:18,530
reaches a certain PSI level and it blows

133
00:05:22,899 --> 00:05:20,270
a disc which gives us a certain velocity

134
00:05:25,390 --> 00:05:22,909
and lose your projectile much like a

135
00:05:28,899 --> 00:05:25,400
bullet has a jacket around it moves that

136
00:05:30,700 --> 00:05:28,909
down this barrel and your jacket is

137
00:05:32,589 --> 00:05:30,710
stripped away and you have just a

138
00:05:37,120 --> 00:05:32,599

project Holland free flight from here on

139
00:05:39,310 --> 00:05:37,130
out it moves down a flight to here and

140
00:05:41,230 --> 00:05:39,320
it goes all the way down till it gets to

141
00:05:43,300 --> 00:05:41,240
this area where your target will be

142
00:05:45,700 --> 00:05:43,310
sitting this is where the impact happens

143
00:05:46,899 --> 00:05:45,710
if you have very large targets we can

144
00:05:49,000 --> 00:05:46,909
put them in our very large chamber

145
00:05:51,460 --> 00:05:49,010
that's a big tank right right and all

146
00:05:53,800 --> 00:05:51,470
this is evacuated just like space all

147
00:05:55,899 --> 00:05:53,810
kind of targets to use while we have

148
00:05:57,790 --> 00:05:55,909
several if you'd like to look at them so

149
00:05:58,839 --> 00:05:57,800
this is one of the targets that you got

150
00:06:00,459 --> 00:05:58,849
shot in

151
00:06:02,859 --> 00:06:00,469
looks a little bit like styrofoam but

152
00:06:04,480 --> 00:06:02,869
it's obviously not what is this right

153
00:06:06,089 --> 00:06:04,490
this is an aluminum foam it was a

154
00:06:07,989 --> 00:06:06,099
concept that we used several years ago

155
00:06:09,879 --> 00:06:07,999
we look for things that are a good

156
00:06:11,919 --> 00:06:09,889
energy absorber and this happened to be

157
00:06:13,779 --> 00:06:11,929
a very good example of that you see

158
00:06:16,239 --> 00:06:13,789
where the projectile actually hit here

159
00:06:17,889 --> 00:06:16,249
and if you turn it over you can see

160
00:06:19,570 --> 00:06:17,899
where it did not penetrate the back

161
00:06:21,159 --> 00:06:19,580
surface never made it through it helped

162
00:06:23,079 --> 00:06:21,169
vessels are traveling seven kilometres a

163
00:06:25,299 --> 00:06:23,089

second unbelievable what about this one

164
00:06:29,619 --> 00:06:25,309
better this is also a good example and

165
00:06:31,989 --> 00:06:29,629
we use a whipple shield which means we

166
00:06:33,549 --> 00:06:31,999
have several different layers in here we

167
00:06:35,439 --> 00:06:33,559
have a first layer that's a sacrificial

168
00:06:38,230 --> 00:06:35,449
layer and then we have different layers

169
00:06:40,480 --> 00:06:38,240
or even materials depending on what what

170
00:06:42,100 --> 00:06:40,490
the customer wants and this would be an

171
00:06:44,799 --> 00:06:42,110
example of your interior wall of your

172
00:06:46,209 --> 00:06:44,809
spacecraft so if a projectile comes in

173
00:06:48,279 --> 00:06:46,219
at seven kilometers a second it breaks

174
00:06:49,389 --> 00:06:48,289
up and all these different layers or

175
00:06:51,399 --> 00:06:49,399
materials that happen to be in the

176
00:06:52,959 --> 00:06:51,409
middle absorb all that energy and didn't

177
00:06:55,389 --> 00:06:52,969
all out kind of trait the back law if

178
00:06:57,309 --> 00:06:55,399
you look in between you can see that and

179
00:06:59,679 --> 00:06:57,319
what about the big one right here the

180
00:07:02,409 --> 00:06:59,689
big one here was actually the firt one

181
00:07:03,909 --> 00:07:02,419
of the first ones that was shot many

182
00:07:06,009 --> 00:07:03,919
many years ago when Space Station

183
00:07:08,619 --> 00:07:06,019
freedom first started and you can see

184
00:07:10,540 --> 00:07:08,629
the very large hole that was made with a

185
00:07:12,549 --> 00:07:10,550
projectile even smaller than what i have

186
00:07:14,619 --> 00:07:12,559
here and how fast was traveling to make

187
00:07:16,449 --> 00:07:14,629
that size of a whole that's a usual

188
00:07:18,009 --> 00:07:16,459

right that's a very large hole that was

189
00:07:21,309 --> 00:07:18,019
going just almost seven kilometers a

190
00:07:24,759 --> 00:07:21,319
second you have to understand to this

191
00:07:27,009 --> 00:07:24,769
one had fabric and materials in front of

192
00:07:29,169 --> 00:07:27,019
it but they obviously were not a very

193
00:07:30,969 --> 00:07:29,179
good energy absorber well do we have

194
00:07:32,619 --> 00:07:30,979
these guys here to test it there exactly

195
00:07:35,649 --> 00:07:32,629
now you have another gun here that

196
00:07:37,419 --> 00:07:35,659
that's a lot shorter yes we have a small

197
00:07:39,009 --> 00:07:37,429
gun it does exactly the same thing but

198
00:07:42,159 --> 00:07:39,019
she's very small projectiles let's go

199
00:07:44,409 --> 00:07:42,169
take a look at it ok so this gun is

200
00:07:45,790 --> 00:07:44,419
essentially a smaller version of the big

201
00:07:47,619 --> 00:07:45,800
one you have here yes that's correct

202
00:07:50,529 --> 00:07:47,629
this is a very small to station light

203
00:07:53,109 --> 00:07:50,539
gas gun it simulates micrometeor debris

204
00:07:54,490 --> 00:07:53,119
and we shoot one millimeter projectiles

205
00:07:56,290 --> 00:07:54,500
and smaller

206
00:07:58,420 --> 00:07:56,300
really small one but like the size of a

207
00:08:00,370 --> 00:07:58,430
grain of salt maybe yes this one has a

208
00:08:02,650 --> 00:08:00,380
real trigger too yes it's a fun gun to

209
00:08:04,990 --> 00:08:02,660
shoot thanks for letting us into the

210
00:08:06,550 --> 00:08:05,000
indoor test ranges over here no problem

211
00:08:08,080 --> 00:08:06,560
we have one more we have a water gun if

212
00:08:11,350 --> 00:08:08,090
you want to go look at that water gun

213
00:08:13,120 --> 00:08:11,360

yes that's right okay so Mary brought us

214
00:08:14,980 --> 00:08:13,130
back out to the east test area to visit

215
00:08:16,840 --> 00:08:14,990
the third lab of the impact testing

216
00:08:18,550 --> 00:08:16,850
facility and talked to Whitney hubs when

217
00:08:19,720 --> 00:08:18,560
you're going to show us this water gun

218
00:08:23,800 --> 00:08:19,730
and that's what you call me the water

219
00:08:28,000 --> 00:08:23,810
cannon actually this is a rain impact

220
00:08:31,480 --> 00:08:28,010
testing facility I will shoot your

221
00:08:35,980 --> 00:08:31,490
sample which is infrared window into a

222
00:08:37,600 --> 00:08:35,990
single raindrop at a nun velocity and we

223
00:08:40,390 --> 00:08:37,610
determined the damage on the materials

224
00:08:42,820 --> 00:08:40,400
also your Nazi shooting water then no

225
00:08:44,890 --> 00:08:42,830
just a single raindrop ok so the

226
00:08:46,510 --> 00:08:44,900
raindrop Falls and the sample hits it

227
00:08:50,410 --> 00:08:46,520
great then you find out the effect it

228
00:08:54,100 --> 00:08:50,420
has right ok the rain post is a serious

229
00:08:56,860 --> 00:08:54,110
threat to missiles to aircraft

230
00:08:59,079 --> 00:08:56,870
components spacecraft components like

231
00:09:00,850 --> 00:08:59,089
you know we're going to create a new

232
00:09:02,910 --> 00:09:00,860
vehicle and we're going to need to test

233
00:09:05,320 --> 00:09:02,920
for that in adverse weather conditions

234
00:09:07,060 --> 00:09:05,330
so really that section is right here but

235
00:09:08,680 --> 00:09:07,070
but why the long barrel which itself

236
00:09:11,770 --> 00:09:08,690
that way that actually is just a slow

237
00:09:13,870 --> 00:09:11,780
the sample down after it's been impacted

238
00:09:17,260 --> 00:09:13,880

by the raindrop where we don't do damage

239
00:09:27,519 --> 00:09:17,270
to the sample alright do is you sure

240
00:09:31,310 --> 00:09:29,900
those are the typical kinds of guns were

241
00:09:32,690 --> 00:09:31,320
used to saying but some pretty cool

242
00:09:34,610 --> 00:09:32,700
stuff that's right and that x-ray

243
00:09:36,200 --> 00:09:34,620
facility in the electron microscope both

244
00:09:37,640 --> 00:09:36,210
a couple of great capabilities that we