
Americans in Space
Where we're going
225,000,000 miles
Deep Spa
Human journeys
and discovery t
into space th

1
00:03:15,339 --> 00:03:11,770
our life okay good morning and welcome

2
00:03:17,890 --> 00:03:15,349
to the morning session of the asteroid

3
00:03:22,780 --> 00:03:17,900
deflection demonstrations idea synthesis

4
00:03:24,399 --> 00:03:22,790
discussion we've got not a full crowd

5
00:03:25,869 --> 00:03:24,409
this morning in the house not as much as

6
00:03:28,059 --> 00:03:25,879
we had yesterday afternoon but hopefully

7
00:03:31,270 --> 00:03:28,069
folks will trickle in as we get started

8
00:03:34,949 --> 00:03:31,280
here again my name is Dan Maz Nick from

9
00:03:38,470 --> 00:03:34,959
from NASA Langley Research Center my

10
00:03:42,129 --> 00:03:38,480
co-chair here is Paul able from Johnson

11
00:03:44,559 --> 00:03:42,139
Space Center Paul's actually filling in

12
00:03:47,800 --> 00:03:44,569
for Pat troutman back at Langley who had

13
00:03:50,129 --> 00:03:47,810

to go home for some family matters Pat

14
00:03:53,640 --> 00:03:50,139
may be actually on the line this morning

15
00:03:57,849 --> 00:03:53,650
to participate in the discussion as well

16
00:03:59,830 --> 00:03:57,859
so what we had yesterday just a recap

17
00:04:02,770 --> 00:03:59,840
and I'm going to step up to the podium

18
00:04:04,390 --> 00:04:02,780
in just a few minutes to UM to kind of

19
00:04:09,750 --> 00:04:04,400
facilitate the discussion here this

20
00:04:13,750 --> 00:04:09,760
morning we had 13 presentations that

21
00:04:16,539 --> 00:04:13,760
were all very very well done and again I

22
00:04:17,979 --> 00:04:16,549
appreciate the presenters adhering to

23
00:04:22,390 --> 00:04:17,989
the time constraints I think the

24
00:04:25,210 --> 00:04:22,400
sessions session went very smoothly what

25
00:04:26,770 --> 00:04:25,220
we what we what I did last night was I

26
00:04:28,330 --> 00:04:26,780
kind of pulled together a summary that

27
00:04:30,159 --> 00:04:28,340
would be using in the plenary session

28
00:04:32,170 --> 00:04:30,169
and I kind of view this as kind of a

29
00:04:33,960 --> 00:04:32,180
working session will edit charts real

30
00:04:36,100 --> 00:04:33,970
time because that plenary happens at

31
00:04:40,120 --> 00:04:36,110
ten-fifteen I believe I think we have a

32
00:04:41,980 --> 00:04:40,130
15 minute break so we'll go you know a

33
00:04:43,450 --> 00:04:41,990
few minutes before 10 probably few

34
00:04:46,300 --> 00:04:43,460
minutes to clean up charts if I need to

35
00:04:47,950 --> 00:04:46,310
at the end but we've got the whole two

36
00:04:49,600 --> 00:04:47,960
hours here for discussion if we finish

37
00:04:50,950 --> 00:04:49,610
early and we have nothing more to say

38
00:04:52,779 --> 00:04:50,960

and nothing more to contribute them will

39
00:04:57,939 --> 00:04:52,789
have a little bit of free time before

40
00:05:00,700 --> 00:04:57,949
the plenary session um so first of all I

41
00:05:04,540 --> 00:05:00,710
guess maybe I can ask is is Pat troutman

42
00:05:07,270 --> 00:05:04,550
on the line can he respond no oh we

43
00:05:10,469 --> 00:05:07,280
don't have any telecon ah did not

44
00:05:13,180 --> 00:05:10,479
realize that okay so we're going to go

45
00:05:15,850 --> 00:05:13,190
modern old-fashioned and if there

46
00:05:18,460 --> 00:05:15,860
besides using the the twitter feed that

47
00:05:22,030 --> 00:05:18,470
Jonathan bowie's is mana

48
00:05:23,950 --> 00:05:22,040
terrain I will have my my cell phone for

49
00:05:27,550 --> 00:05:23,960
a text message if there's anything that

50
00:05:32,500 --> 00:05:27,560
needs to be said this morning from

51
00:05:35,800 --> 00:05:32,510
outside so please use the protect plush

52
00:05:37,420 --> 00:05:35,810
tag protect planet on Twitter and I

53
00:05:40,960 --> 00:05:37,430
think there is a is there a link on the

54
00:05:43,330 --> 00:05:40,970
website too are they on the ustream

55
00:05:44,830 --> 00:05:43,340
there is a communications method on the

56
00:05:47,620 --> 00:05:44,840
ustream if you don't have a twitter

57
00:05:49,240 --> 00:05:47,630
there's a chat function there so you can

58
00:05:53,680 --> 00:05:49,250
use either those and you can get there

59
00:06:00,220 --> 00:05:53,690
by going to ww nasa gov asteroid

60
00:06:02,080 --> 00:06:00,230
workshop all one word okay so um Paul do

61
00:06:03,790 --> 00:06:02,090
you have any overall general comments

62
00:06:05,410 --> 00:06:03,800
from from yesterday session no I thought

63
00:06:08,110 --> 00:06:05,420

it was a very good session very dynamic

64
00:06:09,340 --> 00:06:08,120
good feedback and so hopefully we'll

65
00:06:10,840 --> 00:06:09,350
have a little bit further discussion

66
00:06:13,750 --> 00:06:10,850
round of the charts and then continue

67
00:06:14,800 --> 00:06:13,760
forward okay so what I'm going to do is

68
00:06:17,260 --> 00:06:14,810
I'm going to go and step up to the

69
00:06:25,080 --> 00:06:17,270
podium and we've got microphones in the

70
00:06:29,590 --> 00:06:27,040
definitely need to be by the microphone

71
00:06:31,840 --> 00:06:29,600
so the folks online can hear so what I'd

72
00:06:33,820 --> 00:06:31,850
like to do I'm going to not go into

73
00:06:35,500 --> 00:06:33,830
slideshow mode well let me go to slide

74
00:06:46,020 --> 00:06:35,510
show mode to start but then we'll

75
00:06:46,030 --> 00:08:28,850
you

76
00:08:34,069 --> 00:08:31,070
a subsequent kinetic impact of an

77
00:08:38,000 --> 00:08:34,079
incoming large asteroid used the thrust

78
00:08:39,199 --> 00:08:38,010
to push an asteroid that should probably

79
00:08:42,139 --> 00:08:39,209
say and I'll fix up some grammar

80
00:08:44,480 --> 00:08:42,149
justjust still miss some things that's

81
00:08:45,980 --> 00:08:44,490
basically ion beam deflection I might

82
00:08:47,600 --> 00:08:45,990
put that let me actually let me pop out

83
00:08:55,009 --> 00:08:47,610
and do it right now because otherwise

84
00:08:57,560 --> 00:08:55,019
we'll forget and and again if folks do

85
00:08:59,300 --> 00:08:57,570
see any thing that's kind of a working

86
00:09:04,420 --> 00:08:59,310
session please let me know when

87
00:09:09,110 --> 00:09:06,949
typical I am being shepherding an ion

88
00:09:14,530 --> 00:09:09,120

beam deflection I think we've used ion

89
00:09:17,389 --> 00:09:14,540
beam deflection for the majority of it

90
00:09:18,949 --> 00:09:17,399
low-cost kinetic impactor and again this

91
00:09:21,610 --> 00:09:18,959
is probably only applicable at the end

92
00:09:23,930 --> 00:09:21,620
of the pickup Iraq mission approach

93
00:09:27,110 --> 00:09:23,940
enhanced gravity tractor with local mass

94
00:09:29,720 --> 00:09:27,120
augmentation using solar energy for

95
00:09:33,290 --> 00:09:29,730
vaporizing material for pulse of

96
00:09:35,540 --> 00:09:33,300
propulsion looking at a swarm of small

97
00:09:36,889 --> 00:09:35,550
satellites attached to a stir a 2d spin

98
00:09:40,069 --> 00:09:36,899
and redirect it that was one of the

99
00:09:42,230 --> 00:09:40,079
presentations we had yesterday and any

100
00:09:43,970 --> 00:09:42,240
applicable proposal spanning all areas

101
00:09:45,740 --> 00:09:43,980
of the mission envelope that support

102
00:09:48,199 --> 00:09:45,750
asteroid deflection that's kind of a

103
00:09:57,470 --> 00:09:48,209
rewording there go ahead well yeah come

104
00:10:01,160 --> 00:09:57,480
on up okay it's a ion beam not iron be a

105
00:10:03,259 --> 00:10:01,170
leggy can someone please go get me a cup

106
00:10:07,819 --> 00:10:03,269
of coffee this morning I want to see an

107
00:10:10,100 --> 00:10:07,829
eye on beef um I'm not keen on impulsive

108
00:10:12,800 --> 00:10:10,110
propulsion it's a steady state okay um

109
00:10:14,810 --> 00:10:12,810
impulsive to me implies you know how

110
00:10:21,290 --> 00:10:14,820
about just was election deflection yeah

111
00:10:27,390 --> 00:10:24,960
yeah maybe that's not good either you

112
00:10:34,410 --> 00:10:27,400
know yeah low thrust sounds okay clash

113
00:10:37,820 --> 00:10:34,420

yeah I want to imply that it's going to

114
00:10:41,070 --> 00:10:37,830
take a period of time steady state and

115
00:10:43,230 --> 00:10:41,080
continuous continuous deflection okay

116
00:10:44,460 --> 00:10:43,240
how about low thrust because that's what

117
00:10:48,050 --> 00:10:44,470
you are going to end up generating less

118
00:10:50,250 --> 00:10:48,060
we have the most enormous solar rays in

119
00:10:52,080 --> 00:10:50,260
imaginable well then that brings a point

120
00:10:53,640 --> 00:10:52,090
to the last chart you had low thrust

121
00:10:54,960 --> 00:10:53,650
concepts and then you had gravity

122
00:10:57,120 --> 00:10:54,970
tractor are you trying to apply it

123
00:11:00,060 --> 00:10:57,130
gravity tractor is extremely low thrust

124
00:11:02,430 --> 00:11:00,070
because that is a good implication there

125
00:11:04,110 --> 00:11:02,440
but you had those two broken out on the

126
00:11:07,620 --> 00:11:04,120
previous chart yeah they will that that

127
00:11:09,270 --> 00:11:07,630
came from headquarters so I'm not going

128
00:11:10,890 --> 00:11:09,280
to mess with that chart that's how that

129
00:11:19,080 --> 00:11:10,900
that's I mean literally that's what the

130
00:11:24,090 --> 00:11:19,090
RF I said so yes it was Oh thrust really

131
00:11:27,330 --> 00:11:24,100
conveys much my bro yeah not kinetic

132
00:11:34,030 --> 00:11:27,340
impactor dharna or nuclear so nuclear is

133
00:11:46,280 --> 00:11:43,370
yeah the other certainly yeah how about

134
00:11:49,220 --> 00:11:46,290
let's just say for deflection rob is

135
00:11:51,139 --> 00:11:49,230
that okay Brian's making the good point

136
00:11:56,030 --> 00:11:51,149
is you know there's different classes of

137
00:12:00,500 --> 00:11:56,040
low thrust and in order to not go into

138
00:12:02,240 --> 00:12:00,510

that Valley week okay if filming thinks

139
00:12:08,210 --> 00:12:02,250
of a better word to qualify that we can

140
00:12:13,160 --> 00:12:08,220
always go back okay no that's that's

141
00:12:15,590 --> 00:12:13,170
good and end up saving here as we go so

142
00:12:19,040 --> 00:12:15,600
and I know all the presenters aren't

143
00:12:21,320 --> 00:12:19,050
here this morning but what I tried to do

144
00:12:23,030 --> 00:12:21,330
what we try to do last night was we were

145
00:12:25,370 --> 00:12:23,040
asked to provide just a summary of this

146
00:12:28,280 --> 00:12:25,380
the sessions and so I tried to capture

147
00:12:31,389 --> 00:12:28,290
the the salient main point of each

148
00:12:33,560 --> 00:12:31,399
presentation if the presenters are here

149
00:12:38,060 --> 00:12:33,570
you could flip through these real quick

150
00:12:39,470 --> 00:12:38,070
and you look at them and comment and I

151
00:12:41,720 --> 00:12:39,480
don't know that I want to go ahead and

152
00:12:48,590 --> 00:12:41,730
read these but but basically the first

153
00:12:51,490 --> 00:12:48,600
three were we're specific companies

154
00:12:53,510 --> 00:12:51,500
approaches to the entire mission

155
00:12:56,210 --> 00:12:53,520
basically each of them advocating the

156
00:12:58,610 --> 00:12:56,220
use of their their boss or some

157
00:13:05,690 --> 00:12:58,620
derivative of their bus or some parts

158
00:13:08,510 --> 00:13:05,700
that could be made up and so I know

159
00:13:12,160 --> 00:13:08,520
let's see who's who's in the room here

160
00:13:15,170 --> 00:13:12,170
Howard's in the room like is not 0

161
00:13:25,120 --> 00:13:15,180
Andy's here well yeah Thank You Annie

162
00:13:32,600 --> 00:13:30,890
the right here but you just came in base

163
00:13:35,510 --> 00:13:32,610

basically for the plenary session they

164
00:13:38,480 --> 00:13:35,520
want a very brief synopsis um you know

165
00:13:40,940 --> 00:13:38,490
one a one sentence to sentence summary

166
00:13:43,400 --> 00:13:40,950
of each of each presentation okay well I

167
00:13:45,530 --> 00:13:43,410
if we talked about something that was

168
00:13:47,000 --> 00:13:45,540
beyond what was actually written did you

169
00:13:49,880 --> 00:13:47,010
want to include that too or do you just

170
00:13:52,670 --> 00:13:49,890
what was written in the paper you put

171
00:13:55,460 --> 00:13:52,680
well because I did mention that we have

172
00:13:58,610 --> 00:13:55,470
we have our our system is adaptable to

173
00:14:00,170 --> 00:13:58,620
doing a ion beam as well because we have

174
00:14:02,840 --> 00:14:00,180
electric thrust okay now that's a good

175
00:14:06,260 --> 00:14:02,850
push in both directions yeah and you

176
00:14:07,340 --> 00:14:06,270
kind of mentioned electrostatic track

177
00:14:09,290 --> 00:14:07,350
Tareen but there really wasn't a

178
00:14:14,090 --> 00:14:09,300
discussion about that about that yeah um

179
00:14:15,920 --> 00:14:14,100
and so actually I did mention that

180
00:14:17,780 --> 00:14:15,930
Coulomb forces are larger than the

181
00:14:20,840 --> 00:14:17,790
gravitational forces so if you put a

182
00:14:23,120 --> 00:14:20,850
charge on the thing on the on the body

183
00:14:25,970 --> 00:14:23,130
right you could manipulate it we also

184
00:14:27,590 --> 00:14:25,980
also in the satellite business charge

185
00:14:29,600 --> 00:14:27,600
control on the spacecraft is very

186
00:14:32,270 --> 00:14:29,610
important so we'd be applying any

187
00:14:33,710 --> 00:14:32,280
background there to the electrostatic

188
00:14:37,570 --> 00:14:33,720

tracked ring so that's all I said about

189
00:14:39,290 --> 00:14:37,580
that boy yeah you can push yeah and the

190
00:14:40,970 --> 00:14:39,300
electricity that's true the

191
00:14:44,920 --> 00:14:40,980
electrostatic track turing is push as

192
00:14:49,280 --> 00:14:44,930
well as pull and gravity tractor expose

193
00:14:51,590 --> 00:14:49,290
inb ms push only physical principles

194
00:14:53,030 --> 00:14:51,600
there right I don't know if we need to

195
00:14:54,410 --> 00:14:53,040
get down to that now you don't level of

196
00:14:55,730 --> 00:14:54,420
detail and it might want to keep that in

197
00:14:57,380 --> 00:14:55,740
the back here so I'll just I'll just

198
00:14:59,570 --> 00:14:57,390
have a sentence there about ion beam

199
00:15:01,730 --> 00:14:59,580
deflection could be accommodated yeah

200
00:15:04,160 --> 00:15:01,740
and and what could be performed maybe a

201
00:15:06,200 --> 00:15:04,170
better word it could be performed you

202
00:15:07,910 --> 00:15:06,210
might want to test it with our system

203
00:15:10,250 --> 00:15:07,920
before we did the gravity tractor ring

204
00:15:13,790 --> 00:15:10,260
for example that's that's what I said

205
00:15:18,920 --> 00:15:13,800
yesterday okay um to test have out to

206
00:15:24,780 --> 00:15:22,680
okay the other thing that I said at the

207
00:15:27,420 --> 00:15:24,790
end of this session 2 is that you make

208
00:15:29,130 --> 00:15:27,430
you can also combine I think something

209
00:15:31,980 --> 00:15:29,140
to think about is combining techniques

210
00:15:34,950 --> 00:15:31,990
I've got that yeah yeah ok then I think

211
00:15:37,290 --> 00:15:34,960
I'm done okay Scherzer type of Howard

212
00:15:43,740 --> 00:15:37,300
can you go to the mic yeah yoga please

213
00:15:56,410 --> 00:15:43,750

thank you yeah Northrop is ROP not ruv

214
00:16:01,379 --> 00:15:59,740
yeah yeah I mean do you want to put

215
00:16:04,629 --> 00:16:01,389
parenthetically derived from astromaster

216
00:16:06,509 --> 00:16:04,639
okay yeah I had that in there originally

217
00:16:10,329 --> 00:16:06,519
and then I thought probably good enough

218
00:16:18,220 --> 00:16:10,339
but if folks are you know obviously more

219
00:16:31,689 --> 00:16:18,230
familiar with that astro a mesh thank

220
00:16:40,780 --> 00:16:37,960
alright the next slide bong we is here

221
00:16:43,379 --> 00:16:40,790
can take a look at that Jeff Landis is

222
00:16:48,579 --> 00:16:43,389
not so we can all look at it and see if

223
00:16:50,259 --> 00:16:48,589
if I summarized it sufficiently there or

224
00:16:53,079 --> 00:16:50,269
if he is there we can't hear them so if

225
00:17:01,109 --> 00:16:53,089
he's online i guess maybe he can tweet

226
00:17:04,779 --> 00:17:03,460
okay and again this is you know they've

227
00:17:09,579 --> 00:17:04,789
got the abstracts they got the

228
00:17:19,400 --> 00:17:09,589
presentations is just a synopsis of the

229
00:17:29,180 --> 00:17:22,260
okay and again I thought those were two

230
00:17:31,830 --> 00:17:29,190
very good interesting ideas you know I'm

231
00:17:34,080 --> 00:17:31,840
since we don't know a lot about 2000s 33

232
00:17:36,510 --> 00:17:34,090
44 it's hard to to make definitive

233
00:17:39,990 --> 00:17:36,520
decisions but but if it is a

234
00:17:42,300 --> 00:17:40,000
carbonaceous object you know it's it

235
00:17:44,630 --> 00:17:42,310
certainly is a very accessible source of

236
00:17:46,920 --> 00:17:44,640
resources as well as a human mission

237
00:17:49,830 --> 00:17:46,930
target whether or not bringing that

238
00:17:51,960 --> 00:17:49,840

close to the Earth's vicinity because of

239
00:17:59,940 --> 00:17:51,970
its size that may start to you know

240
00:18:02,280 --> 00:17:59,950
invoke some consternation by folks yeah

241
00:18:04,770 --> 00:18:02,290
yeah that's that's just the issue again

242
00:18:07,740 --> 00:18:04,780
with the redirect mission you know a big

243
00:18:10,890 --> 00:18:07,750
driver was to keep it small so that it

244
00:18:12,540 --> 00:18:10,900
was not a threat of any sort of entry so

245
00:18:13,980 --> 00:18:12,550
that might start to violate that go

246
00:18:16,680 --> 00:18:13,990
ahead Brian I want to comment on the

247
00:18:18,810 --> 00:18:16,690
land of summary it calls the l4 and l5

248
00:18:20,660 --> 00:18:18,820
points stable but in fact they are not

249
00:18:22,770 --> 00:18:20,670
stable because when you introduce the

250
00:18:24,840 --> 00:18:22,780
perturbation the periodic forcing

251
00:18:26,760 --> 00:18:24,850
function of the Sun the solar tidal

252
00:18:30,030 --> 00:18:26,770
influence in the rotating reference

253
00:18:31,620 --> 00:18:30,040
frame you find that a particle placed

254
00:18:34,380 --> 00:18:31,630
exactly one of those points will be

255
00:18:36,990 --> 00:18:34,390
driven out within about six months yeah

256
00:18:39,780 --> 00:18:37,000
so you want to say Kwazii stable enough

257
00:18:41,640 --> 00:18:39,790
that there may be I don't really exactly

258
00:18:46,860 --> 00:18:41,650
use the word stable maybe he did again

259
00:18:48,810 --> 00:18:46,870
how about 30 minutes yeah yeah I mean it

260
00:18:50,310 --> 00:18:48,820
right if you if you have active control

261
00:18:54,630 --> 00:18:50,320
you can keep things there indefinitely

262
00:18:56,810 --> 00:18:54,640
right and animal right right and and

263
00:19:01,230 --> 00:18:56,820

minimally compared to the unstable

264
00:19:04,560 --> 00:19:01,240
LaGrant the truly unparallel at one l1

265
00:19:08,060 --> 00:19:04,570
l2 too yeah i thought four and five were

266
00:19:11,100 --> 00:19:08,070
stable orbiting the point i mean you are

267
00:19:14,040 --> 00:19:11,110
I've seen several things on this so i

268
00:19:18,030 --> 00:19:14,050
liked it i think one two and three are

269
00:19:19,770 --> 00:19:18,040
in a saddle point yeah but for a fiver

270
00:19:22,410 --> 00:19:19,780
unstable if you look at the gist the

271
00:19:25,140 --> 00:19:22,420
potential well but there's been numerous

272
00:19:26,230 --> 00:19:25,150
models that have these uh these objects

273
00:19:33,940 --> 00:19:26,240
orbiting

274
00:19:37,990 --> 00:19:33,950
oh right uh right i mean there are

275
00:19:40,690 --> 00:19:38,000
putting it at the point not as good as

276
00:19:47,440 --> 00:19:40,700
some orbits that is true but none of the

277
00:19:49,120 --> 00:19:47,450
orbits are stable in the one can you go

278
00:19:50,320 --> 00:19:49,130
to the mic if you're going to join in

279
00:19:52,120 --> 00:19:50,330
the conversation with people online can

280
00:19:54,340 --> 00:19:52,130
hear ya I've heard both stories on this

281
00:19:55,870 --> 00:19:54,350
so the only thing is for asteroids is an

282
00:19:57,580 --> 00:19:55,880
example there are simulations that

283
00:20:00,640 --> 00:19:57,590
demonstrate that asteroids primordial

284
00:20:02,770 --> 00:20:00,650
asteroids could be in the vicinity of

285
00:20:04,720 --> 00:20:02,780
the garage the triangular Lagrange

286
00:20:07,980 --> 00:20:04,730
points on the order of the age of the

287
00:20:10,330 --> 00:20:07,990
solar system at son no for the earth

288
00:20:18,240 --> 00:20:10,340

yeah that's pretty new Mahalo for

289
00:20:22,090 --> 00:20:18,250
instance so they are stable but hey dear

290
00:20:24,190 --> 00:20:22,100
yes i'm a top- management okay yeah can

291
00:20:25,570 --> 00:20:24,200
we probably this is going down in the

292
00:20:28,270 --> 00:20:25,580
weeds a little too much I think for this

293
00:20:30,460 --> 00:20:28,280
conversation so let's try and keep it to

294
00:20:33,130 --> 00:20:30,470
the point at hand yeah i recommend

295
00:20:37,090 --> 00:20:33,140
potentially stable l4 l5 points leave it

296
00:20:38,740 --> 00:20:37,100
at that I would just let's just leave it

297
00:20:44,710 --> 00:20:38,750
at out of that I don't worry about that

298
00:20:48,760 --> 00:20:44,720
you do go to the microphone please yeah

299
00:20:50,380 --> 00:20:48,770
just so everybody can hear as you going

300
00:20:53,440 --> 00:20:50,390
through these are you sort of going to

301
00:20:57,010 --> 00:20:53,450
collect themes that came up over and

302
00:21:00,760 --> 00:20:57,020
over like one thing that we heard was in

303
00:21:03,910 --> 00:21:00,770
orbit you know doing drought gravity

304
00:21:06,160 --> 00:21:03,920
tracking in in in the velocity vector

305
00:21:09,100 --> 00:21:06,170
was the preferred approach I think three

306
00:21:10,770 --> 00:21:09,110
speakers said that okay yeah what's this

307
00:21:13,510 --> 00:21:10,780
just a summary what we're going to do is

308
00:21:15,280 --> 00:21:13,520
we've got some additional slides that we

309
00:21:16,780 --> 00:21:15,290
can we can address that if I didn't call

310
00:21:18,669 --> 00:21:16,790
it out already i think that actually is

311
00:21:22,330 --> 00:21:18,679
appointed in i didn't capture that we

312
00:21:24,280 --> 00:21:22,340
didn't capture okay we move on to the

313
00:21:28,120 --> 00:21:24,290

next slide up now stand one more on Jeff

314
00:21:29,440 --> 00:21:28,130
Landis's the defense against is kind of

315
00:21:30,780 --> 00:21:29,450
vague you might want to say exactly how

316
00:21:33,270 --> 00:21:30,790
it would defend I think

317
00:21:35,130 --> 00:21:33,280
his intent was to drive it into an

318
00:21:36,990 --> 00:21:35,140
incoming asteroid but just as it stands

319
00:21:44,220 --> 00:21:37,000
it doesn't really capture the the key

320
00:21:52,950 --> 00:21:44,230
point is that cool enough good enough

321
00:21:55,320 --> 00:21:52,960
for me okay yeah again it's not clear

322
00:21:56,700 --> 00:21:55,330
you know it's it's basically the what I

323
00:21:59,070 --> 00:21:56,710
call the Superman effect putting

324
00:22:01,830 --> 00:21:59,080
Superman in front of the Train you know

325
00:22:04,230 --> 00:22:01,840
can Superman just stand there or does he

326
00:22:06,840 --> 00:22:04,240
have to to get a head of steam up on it

327
00:22:09,630 --> 00:22:06,850
all depends so depends on the the target

328
00:22:13,110 --> 00:22:09,640
and the availability of trajectories so

329
00:22:16,320 --> 00:22:13,120
I think that's probably good enough josh

330
00:22:20,580 --> 00:22:16,330
is said he was going to run a little bit

331
00:22:22,440 --> 00:22:20,590
late we can come back and let him look

332
00:22:26,760 --> 00:22:22,450
at that yeah cuz he I just had breakfast

333
00:22:30,900 --> 00:22:26,770
with him he's not in the room okay and

334
00:22:36,180 --> 00:22:30,910
then John Brophy I think John had to

335
00:22:37,590 --> 00:22:36,190
leave as well yeah so Brian maybe you

336
00:22:40,380 --> 00:22:37,600
can look at that real quick it is being

337
00:22:45,760 --> 00:22:40,390
here I I was awake last night when I was

338
00:22:45,770 --> 00:22:50,030

providing work over

339
00:22:59,600 --> 00:22:53,600
yeah okay I think I cut that out of his

340
00:23:04,100 --> 00:22:59,610
one of his slides so all right and Scott

341
00:23:07,070 --> 00:23:04,110
I got Scott's not here right now so I

342
00:23:08,120 --> 00:23:07,080
try to summarize folks can the audience

343
00:23:10,880 --> 00:23:08,130
could look at that real quick and see if

344
00:23:13,760 --> 00:23:10,890
did it okay I know Paul looked at these

345
00:23:18,590 --> 00:23:13,770
last night so what's more eyes are

346
00:23:22,460 --> 00:23:18,600
always good that's at least what was

347
00:23:26,750 --> 00:23:22,470
advocated in his paper and his

348
00:23:31,940 --> 00:23:26,760
presentation ok so is Rob Rob here I'll

349
00:23:36,620 --> 00:23:31,950
be lost Rob text is a little bit smaller

350
00:23:41,150 --> 00:23:36,630
here and on can kind of look through

351
00:23:44,540 --> 00:23:41,160
these Rob yours is kind of short and

352
00:23:52,480 --> 00:23:44,550
sweet I I thought it captured it all but

353
00:23:52,490 --> 00:23:59,110
and others little black

354
00:24:07,730 --> 00:24:03,040
just change text color fur forget Steve

355
00:24:12,590 --> 00:24:07,740
and then Jonathan is Jonathan here now

356
00:24:14,510 --> 00:24:12,600
Oh Jonathan was virtual thank you but I

357
00:24:19,370 --> 00:24:14,520
think I captured in Jonathan's all of

358
00:24:24,200 --> 00:24:19,380
the different spacecraft mechanisms that

359
00:24:26,030 --> 00:24:24,210
they were that he addressed so regarding

360
00:24:29,330 --> 00:24:26,040
on the on the I think was the second

361
00:24:31,370 --> 00:24:29,340
slide you had the remark that the

362
00:24:33,980 --> 00:24:31,380
kinetic impactor would only be relevant

363
00:24:38,450 --> 00:24:33,990

for the following pick up a bolder

364
00:24:39,830 --> 00:24:38,460
approach which get to the question that

365
00:24:41,270 --> 00:24:39,840
I brought up yesterday I think somebody

366
00:24:45,770 --> 00:24:41,280
else brought up yesterday as well is

367
00:24:48,440 --> 00:24:45,780
whether or not the Grand Challenge is a

368
00:24:51,670 --> 00:24:48,450
large program that includes the asteroid

369
00:24:54,770 --> 00:24:51,680
retrieval mission as an element right or

370
00:24:57,020 --> 00:24:54,780
as the RFI is written right now one

371
00:24:58,700 --> 00:24:57,030
might unfortunately get the sort of

372
00:25:01,490 --> 00:24:58,710
cynical perspective that the Grand

373
00:25:07,100 --> 00:25:01,500
Challenge is just a vehicle for the

374
00:25:09,440 --> 00:25:07,110
asteroid retrieval mission so and you

375
00:25:11,720 --> 00:25:09,450
look at that there are fights the

376
00:25:14,000 --> 00:25:11,730
implication is that the only way to do a

377
00:25:18,920 --> 00:25:14,010
deflection demonstration under this

378
00:25:23,840 --> 00:25:18,930
program is with the ARV yeah so Steve I

379
00:25:26,900 --> 00:25:23,850
think the intent was to use the asteroid

380
00:25:28,460 --> 00:25:26,910
redirect mission so again if everybody

381
00:25:31,900 --> 00:25:28,470
remembers how its laid out we have the

382
00:25:34,820 --> 00:25:31,910
asteroid initiative this this big

383
00:25:36,890 --> 00:25:34,830
nebulous thing and inside of that is the

384
00:25:40,580 --> 00:25:36,900
asteroid redirect mission which includes

385
00:25:41,870 --> 00:25:40,590
both the crew and the the robotic

386
00:25:44,060 --> 00:25:41,880
mission as well as the observation

387
00:25:47,000 --> 00:25:44,070
program and then we've got the grant

388
00:25:49,310 --> 00:25:47,010

challenge which includes basically

389
00:25:51,020 --> 00:25:49,320
planetary defense or mitigation

390
00:25:53,720 --> 00:25:51,030
approaches is what it's usually put on

391
00:25:56,510 --> 00:25:53,730
their stakeholder stuff and then and

392
00:25:58,660 --> 00:25:56,520
then also is the observation program and

393
00:26:01,400 --> 00:25:58,670
what's the fourth thing on the bottom

394
00:26:04,910 --> 00:26:01,410
there's one thing in the middle but um

395
00:26:07,960 --> 00:26:04,920
but so it's the overlap so originally as

396
00:26:10,700 --> 00:26:07,970
the asteroid initiative was was

397
00:26:11,250 --> 00:26:10,710
formulated the planetary defense part of

398
00:26:21,960 --> 00:26:11,260
it

399
00:26:25,730 --> 00:26:21,970
was to utilize the asteroid redirect

400
00:26:29,340 --> 00:26:25,740
robotic mission as a demonstration

401
00:26:32,040 --> 00:26:29,350
platform for planetary defense that

402
00:26:36,660 --> 00:26:32,050
being said certainly it's kept under the

403
00:26:40,410 --> 00:26:36,670
grand challenge so it's not just so this

404
00:26:43,500 --> 00:26:40,420
call for ideas is less related to the

405
00:26:47,010 --> 00:26:43,510
grand challenge and more related to the

406
00:26:51,060 --> 00:26:47,020
asteroid redirect mission for planetary

407
00:26:52,380 --> 00:26:51,070
defense so so so I know that's idea

408
00:26:55,650 --> 00:26:52,390
actually I think that's an unfortunate

409
00:26:57,780 --> 00:26:55,660
narrowing of the scope of the of the

410
00:27:00,300 --> 00:26:57,790
call for ideas which I noticed as soon

411
00:27:04,770 --> 00:27:00,310
as I read this several months ago right

412
00:27:09,000 --> 00:27:04,780
um and I think that as chairs you have

413
00:27:10,800 --> 00:27:09,010

some opportunity to whether it's as an

414
00:27:13,260 --> 00:27:10,810
ancillary information to enlarge the

415
00:27:15,720 --> 00:27:13,270
scope of the summary like to capture

416
00:27:17,850 --> 00:27:15,730
things like this so for instance in your

417
00:27:20,600 --> 00:27:17,860
in the next slide you say that the canal

418
00:27:23,730 --> 00:27:20,610
across Connecticut impacted

419
00:27:25,770 --> 00:27:23,740
demonstration is really only applicable

420
00:27:30,210 --> 00:27:25,780
at the end of the pic of pick up a rock

421
00:27:33,210 --> 00:27:30,220
mission but I guess strictly reading the

422
00:27:36,600 --> 00:27:33,220
wording of the RFI that's that's true

423
00:27:38,310 --> 00:27:36,610
but I don't think it's true in a larger

424
00:27:39,990 --> 00:27:38,320
sense of the grand challenge so I think

425
00:27:41,550 --> 00:27:40,000
right somehow that should be captured

426
00:27:44,010 --> 00:27:41,560
and what's captured it's going to catch

427
00:27:46,170 --> 00:27:44,020
right here I think that's part of what

428
00:27:48,090 --> 00:27:46,180
was captured in some of the other slides

429
00:27:49,650 --> 00:27:48,100
if you go on to this yeah when we get to

430
00:27:53,190 --> 00:27:49,660
the end but yet to the SD makes a good

431
00:28:01,410 --> 00:27:53,200
point is setting the tone on how to word

432
00:28:17,630 --> 00:28:07,980
but is definitely applicable yeah I get

433
00:28:25,690 --> 00:28:17,640
it to mitigation approaches for the

434
00:28:34,659 --> 00:28:30,490
it's all right Steve I mean I think it's

435
00:28:40,710 --> 00:28:34,669
actually applicable you know I it could

436
00:28:47,740 --> 00:28:43,899
yeah I'm in this area see there's

437
00:28:50,310 --> 00:28:47,750
distinction here is because this this

438
00:28:53,379 --> 00:28:50,320

concept of this cosmic billiards is

439
00:28:56,110 --> 00:28:53,389
kinetic impactor on a grand scale but

440
00:28:57,759 --> 00:28:56,120
it's using the ARV as that kinetic

441
00:29:00,220 --> 00:28:57,769
impactor a couple of presentations talk

442
00:29:03,490 --> 00:29:00,230
about this this low-cost impactor is

443
00:29:06,190 --> 00:29:03,500
something like Isis or some el cross

444
00:29:07,810 --> 00:29:06,200
derived or other spacecraft so there's a

445
00:29:09,549 --> 00:29:07,820
there's a difference because when we got

446
00:29:11,799 --> 00:29:09,559
the proposals there there were these

447
00:29:24,250 --> 00:29:11,809
groupings and that's why we group them

448
00:29:26,100 --> 00:29:24,260
into these areas well okay so yeah right

449
00:29:28,779 --> 00:29:26,110
move we'll go that way Everett there's

450
00:29:30,460 --> 00:29:28,789
we keep adding letters to the acronyms

451
00:29:32,049 --> 00:29:30,470
left and right although I was trying to

452
00:29:33,820 --> 00:29:32,059
think about whether it should be even

453
00:29:37,600 --> 00:29:33,830
strong I mean you could say that in

454
00:29:42,820 --> 00:29:37,610
general kinetic impactors are a key

455
00:29:45,159 --> 00:29:42,830
element in any mitigation toolbox two

456
00:29:46,600 --> 00:29:45,169
techniques or something I mean that it's

457
00:29:48,279 --> 00:29:46,610
hard to imagine if we really had a

458
00:29:50,529 --> 00:29:48,289
problem that we wouldn't you know

459
00:29:52,269 --> 00:29:50,539
seriously seriously consider doing an

460
00:29:54,370 --> 00:29:52,279
impactor and so getting some sort of

461
00:29:59,500 --> 00:29:54,380
demonstration out there I don't know I

462
00:30:07,460 --> 00:29:59,510
just about this key but where did you

463
00:30:11,029 --> 00:30:09,409

we'll be all right key element

464
00:30:14,060 --> 00:30:11,039
applicable to mitigation approaches for

465
00:30:16,880 --> 00:30:14,070
the grand challenge but probably only

466
00:30:20,690 --> 00:30:16,890
applicable to the at the end of the

467
00:30:23,870 --> 00:30:20,700
pickup erotic mission for the arm does

468
00:30:26,240 --> 00:30:23,880
that does that turn it around and make

469
00:30:29,330 --> 00:30:26,250
it a little bit stronger and again this

470
00:30:30,380 --> 00:30:29,340
is a consensus of of our group so there

471
00:30:32,600 --> 00:30:30,390
might be people outside of this group

472
00:30:34,490 --> 00:30:32,610
that disagree but when it be more

473
00:30:36,200 --> 00:30:34,500
appropriate to just say that it's only

474
00:30:38,390 --> 00:30:36,210
applicable for the pick up a rock

475
00:30:40,340 --> 00:30:38,400
mission because it's not applicable at

476
00:30:41,539 --> 00:30:40,350
all to the other mission and the way

477
00:30:45,440 --> 00:30:41,549
that's where it it doesn't exactly

478
00:30:47,510 --> 00:30:45,450
convey that yeah so yeah I think I think

479
00:30:49,220 --> 00:30:47,520
that's true I i I'd like to sometimes

480
00:30:53,149 --> 00:30:49,230
use weasel words because when you get in

481
00:30:55,580 --> 00:30:53,159
definitive stuff it um you get in

482
00:30:57,590 --> 00:30:55,590
trouble but okay maybe you could find a

483
00:30:58,940 --> 00:30:57,600
I think that's all over the satellite

484
00:31:01,460 --> 00:30:58,950
and hit the satellite or something but

485
00:31:02,960 --> 00:31:01,470
that seems like yeah well you can

486
00:31:05,090 --> 00:31:02,970
there's been this thought that you could

487
00:31:07,640 --> 00:31:05,100
go somewhere else on the way and if you

488
00:31:10,010 --> 00:31:07,650

have enough time then sure we probably

489
00:31:12,740 --> 00:31:10,020
don't have that much time than principle

490
00:31:13,789 --> 00:31:12,750
you could do to reduce right right so

491
00:31:15,440 --> 00:31:13,799
that actually that's that's the good

492
00:31:20,870 --> 00:31:15,450
point that's probably why probably why I

493
00:31:22,730 --> 00:31:20,880
put probably there there are some some

494
00:31:27,250 --> 00:31:22,740
situations that we view that we've

495
00:31:30,500 --> 00:31:27,260
considered but their likelihood is small

496
00:31:36,799 --> 00:31:30,510
so what that what that would mean is

497
00:31:38,090 --> 00:31:36,809
that well let me give you example that's

498
00:31:41,779 --> 00:31:38,100
actually Tim that's not the one because

499
00:31:47,029 --> 00:31:41,789
you would still be doing the kinetic

500
00:31:52,250 --> 00:31:47,039
impact with the ARV no no use the

501
00:31:54,770 --> 00:31:52,260
microphone so so there's the end of

502
00:31:56,930 --> 00:31:54,780
mission ARV impact prank scenario but

503
00:31:58,159 --> 00:31:56,940
that's kind of not very interesting

504
00:32:01,100 --> 00:31:58,169
because you still have to observe it

505
00:32:03,799 --> 00:32:01,110
with somebody else oh okay so this would

506
00:32:05,149 --> 00:32:03,809
be the idea that that you know you don't

507
00:32:07,760 --> 00:32:05,159
care if you get back to the earth until

508
00:32:09,169 --> 00:32:07,770
the light 2020s and you still launch

509
00:32:11,000 --> 00:32:09,179
early enough to go rendezvous right

510
00:32:12,350 --> 00:32:11,010
somebody somebody comes in and wax it

511
00:32:14,000 --> 00:32:12,360
you play all the games with it then you

512
00:32:18,629 --> 00:32:14,010
go on and grab a small rock and bring it

513
00:32:24,249 --> 00:32:22,210

or or another another one could be at

514
00:32:27,310 --> 00:32:24,259
end of mission for the find a small one

515
00:32:30,659 --> 00:32:27,320
or grab a small one would be to come

516
00:32:33,639 --> 00:32:30,669
back out of cislunar space and then

517
00:32:36,899 --> 00:32:33,649
maybe we have this you know the concept

518
00:32:39,310 --> 00:32:36,909
is that we may repurpose the SEP system

519
00:32:42,789 --> 00:32:39,320
the instruments are an issue because

520
00:32:46,539 --> 00:32:42,799
they're basically now covered by the by

521
00:32:48,940 --> 00:32:46,549
the asteroid but they're so let's leave

522
00:32:50,230 --> 00:32:48,950
it it probably that's always put weasel

523
00:32:51,639 --> 00:32:50,240
words because creative engineers can

524
00:32:53,950 --> 00:32:51,649
come up with some way of doing something

525
00:32:57,129 --> 00:32:53,960
that we can't think of right now in the

526
00:32:59,470 --> 00:32:57,139
room go to Brian I you know the term key

527
00:33:01,629 --> 00:32:59,480
element I just like to point out that

528
00:33:04,720 --> 00:33:01,639
kinetic impactors are really hard to do

529
00:33:07,029 --> 00:33:04,730
well because the Delta V tends not to be

530
00:33:08,710 --> 00:33:07,039
along the direction of motion and cross

531
00:33:10,600 --> 00:33:08,720
track motion as we heard many times

532
00:33:14,080 --> 00:33:10,610
yesterday you know it's not very helpful

533
00:33:15,759 --> 00:33:14,090
so well but that's totally true as the

534
00:33:17,470 --> 00:33:15,769
well it's not necessarily true but

535
00:33:19,600 --> 00:33:17,480
unless you go out and go round Jupiter

536
00:33:22,230 --> 00:33:19,610
and get into a retrograde orbit it's

537
00:33:25,629 --> 00:33:22,240
very hard to get extremely high

538
00:33:29,169 --> 00:33:25,639

velocities a long track compared to the

539
00:33:33,070 --> 00:33:29,179
ion beam deflector you mean by extremely

540
00:33:35,710 --> 00:33:33,080
high but if you look yes okay well okay

541
00:33:37,840 --> 00:33:35,720
well let me okay okay good good finish

542
00:33:39,850 --> 00:33:37,850
under the shell finish the point which

543
00:33:42,789 --> 00:33:39,860
is that the ion beam deflection as

544
00:33:44,440 --> 00:33:42,799
brophy I think said yesterday well you

545
00:33:46,239 --> 00:33:44,450
know gives you like 30 kilometers a

546
00:33:48,700 --> 00:33:46,249
second with essentially all of your

547
00:33:50,680 --> 00:33:48,710
propellant load right and and you do

548
00:33:52,359 --> 00:33:50,690
give up this factor of two that you have

549
00:33:54,070 --> 00:33:52,369
a beam that shines on the asteroid you

550
00:33:56,859 --> 00:33:54,080
have another beam that shines out into

551
00:33:59,619 --> 00:33:56,869
space so that is a penalty but when you

552
00:34:01,659 --> 00:33:59,629
look at the difficulty of getting an

553
00:34:05,289 --> 00:34:01,669
equivalent velocity you know 30

554
00:34:08,020 --> 00:34:05,299
kilometers a second down track relative

555
00:34:10,329 --> 00:34:08,030
velocity so now Tim and you and the

556
00:34:12,369 --> 00:34:10,339
other dynamics guys and tell me that you

557
00:34:14,559 --> 00:34:12,379
have a way to get 30 kilometers a second

558
00:34:18,700 --> 00:34:14,569
cup down track can I feel that real

559
00:34:20,770 --> 00:34:18,710
quick okay so there's a key element with

560
00:34:23,230 --> 00:34:20,780
respect to all of these these slow

561
00:34:26,710 --> 00:34:23,240
acting techniques and that's warning

562
00:34:29,540 --> 00:34:26,720
time if we have a very short warning

563
00:34:32,750 --> 00:34:29,550

time event those fall off to take

564
00:34:34,900 --> 00:34:32,760
as long we showed us additionally when

565
00:34:37,580 --> 00:34:34,910
you get very close to the time of impact

566
00:34:40,250 --> 00:34:37,590
directing that that change in velocity

567
00:34:42,650 --> 00:34:40,260
of momentum along the the velocity

568
00:34:44,450 --> 00:34:42,660
Direction is not necessarily and in

569
00:34:47,230 --> 00:34:44,460
general is not the way you want to do it

570
00:34:50,120 --> 00:34:47,240
there are particular out-of-plane

571
00:34:52,160 --> 00:34:50,130
impacts that you would want to do for a

572
00:34:54,740 --> 00:34:52,170
very short warning time where you're not

573
00:34:56,570 --> 00:34:54,750
worried about changing the the orbital

574
00:34:58,550 --> 00:34:56,580
elements you're really worried about our

575
00:35:00,050 --> 00:34:58,560
the long-term propagation orbital

576
00:35:01,760 --> 00:35:00,060
elements you're really worried about

577
00:35:06,550 --> 00:35:01,770
getting the dang thing from hitting the

578
00:35:15,200 --> 00:35:10,280
use the microphone guys please thanks

579
00:35:18,110 --> 00:35:15,210
Bob the the I mean I'm being reflection

580
00:35:20,810 --> 00:35:18,120
thing is something that that is new

581
00:35:23,150 --> 00:35:20,820
enough that it isn't well established in

582
00:35:25,370 --> 00:35:23,160
our Bob and I think that some of what

583
00:35:27,980 --> 00:35:25,380
you say is correct but it's also true

584
00:35:29,330 --> 00:35:27,990
that that you know you have to

585
00:35:32,360 --> 00:35:29,340
rendezvous first and you have to have

586
00:35:34,460 --> 00:35:32,370
enough time to do the stuff and so so I

587
00:35:36,230 --> 00:35:34,470
think that you know maybe maybe key

588
00:35:40,040 --> 00:35:36,240

element is too strong maybe important

589
00:35:41,660 --> 00:35:40,050
element is more or I don't know about I

590
00:35:45,920 --> 00:35:41,670
take your point you hear some of what

591
00:35:47,810 --> 00:35:45,930
you say is true it's all true I think we

592
00:35:50,780 --> 00:35:47,820
have to close our discussion yeah I

593
00:35:53,300 --> 00:35:50,790
wanna help I agree that it is a key

594
00:35:56,000 --> 00:35:53,310
element so kinetic impactor technology

595
00:35:58,580 --> 00:35:56,010
is the key element is a key element it's

596
00:36:01,940 --> 00:35:58,590
a crucial element for any measure we are

597
00:36:03,890 --> 00:36:01,950
not arguing whether gravity tractor ion

598
00:36:05,750 --> 00:36:03,900
beam is better than kinetic impactor

599
00:36:13,250 --> 00:36:05,760
well yet we should not be wasting our

600
00:36:17,180 --> 00:36:13,260
time on talking that is ok we we will

601
00:36:22,190 --> 00:36:17,190
have Jeff Landis calling in ok so yeah

602
00:36:26,420 --> 00:36:22,200
oh yeah just we can here you go son the

603
00:36:30,230 --> 00:36:26,430
factual area actually work so then

604
00:36:32,870 --> 00:36:30,240
yesterday but a lot of problems alright

605
00:36:35,460 --> 00:36:32,880
yeah sorry i've been listening for the

606
00:36:40,859 --> 00:36:35,470
last half hour trying to get through

607
00:36:43,320 --> 00:36:40,869
I thanks are very confusing here to see

608
00:36:47,730 --> 00:36:43,330
you very much about 15 seconds behind oh

609
00:36:52,560 --> 00:36:47,740
yes we probably still have that delay so

610
00:36:54,150 --> 00:36:52,570
so Jeff whoops what's your comment as as

611
00:36:56,940 --> 00:36:54,160
you come into the session here and I'll

612
00:36:58,560 --> 00:36:56,950
slowly flip through charts that's going

613
00:37:04,470 --> 00:36:58,570

to be unfortunate for the focus on line

614
00:37:07,290 --> 00:37:04,480
if we're flipping around oh yeah I have

615
00:37:12,870 --> 00:37:07,300
some comments a little bit on the

616
00:37:15,030 --> 00:37:12,880
earlier earlier ideas but I think mostly

617
00:37:18,570 --> 00:37:15,040
you've sort of moved on to other things

618
00:37:20,310 --> 00:37:18,580
so maybe I should just to justify on

619
00:37:22,950 --> 00:37:20,320
here on welcome tomorrow we'll see did

620
00:37:24,540 --> 00:37:22,960
you Jeff do you have any specific

621
00:37:28,950 --> 00:37:24,550
comments that you'd like to make anyway

622
00:37:31,260 --> 00:37:28,960
as basically as your is your concept

623
00:37:34,589 --> 00:37:31,270
well represented I'm trying to fight it

624
00:37:38,940 --> 00:37:34,599
but i think it is adequately represented

625
00:37:41,310 --> 00:37:38,950
i make him I should have family tweets

626
00:37:43,950 --> 00:37:41,320
it the wording about saying going to the

627
00:37:46,170 --> 00:37:43,960
disabled Lagrange points us obviously

628
00:37:48,150 --> 00:37:46,180
you don't just park in the stable

629
00:37:54,500 --> 00:37:48,160
Lagrange point service Android just

630
00:37:58,710 --> 00:37:54,510
windows to sort of a interplanetary

631
00:38:03,510 --> 00:37:58,720
slingshot between I transferred her face

632
00:38:06,480 --> 00:38:03,520
and and interplanetary space okay so in

633
00:38:09,450 --> 00:38:06,490
the interest of time I think we okay

634
00:38:15,180 --> 00:38:09,460
with that last slide onto kinetic

635
00:38:17,730 --> 00:38:15,190
impactor yeah I think we're fine steve

636
00:38:23,640 --> 00:38:17,740
carell facing disease I'm very dubious

637
00:38:26,370 --> 00:38:23,650
about the gravity tractor idea that's an

638
00:38:28,349 --> 00:38:26,380

awfully weak force that you're you're

639
00:38:32,099 --> 00:38:28,359
using their i'm not sure why people are

640
00:38:35,430 --> 00:38:32,109
taking that variably well again jeff i

641
00:38:37,320 --> 00:38:35,440
think i think the the new approach to

642
00:38:39,349 --> 00:38:37,330
the gravity tractor is this enhanced

643
00:38:44,670 --> 00:38:39,359
gravity tractor with mass augmentation

644
00:38:46,990 --> 00:38:44,680
that really changes the the effective

645
00:38:49,360 --> 00:38:47,000
time period of that approach and poss

646
00:38:51,850 --> 00:38:49,370
he makes it valuable for certain types

647
00:38:55,060 --> 00:38:51,860
of deflection opportunities and again in

648
00:38:56,620 --> 00:38:55,070
paleontology problem and it became

649
00:38:58,450 --> 00:38:56,630
substantial is josh hawkins showed

650
00:39:01,450 --> 00:38:58,460
yesterday you can't really run to vote

651
00:39:03,820 --> 00:39:01,460
with and land on asteroids suit again

652
00:39:10,210 --> 00:39:03,830
just it seems to be solving a problem

653
00:39:13,110 --> 00:39:10,220
that arguably doesn't even exist we

654
00:39:17,170 --> 00:39:13,120
don't know can you explain it just Oh

655
00:39:19,330 --> 00:39:17,180
itself in the problem how do you affect

656
00:39:22,570 --> 00:39:19,340
an asteroid without actually touching

657
00:39:26,260 --> 00:39:22,580
the asteroid and then we'll wipe why

658
00:39:29,710 --> 00:39:26,270
bother you if they an argument that says

659
00:39:36,130 --> 00:39:29,720
it is so hard to land on that droid move

660
00:39:38,920 --> 00:39:36,140
an asteroid portion after I've or you

661
00:39:40,540 --> 00:39:38,930
know even piece in an average that we

662
00:39:43,120 --> 00:39:40,550
have to be able to do these without

663
00:39:45,550 --> 00:39:43,130

touching it and I just don't think that

664
00:39:47,710 --> 00:39:45,560
that's true I don't think there's a good

665
00:39:49,990 --> 00:39:47,720
argument that says that you have to move

666
00:39:52,510 --> 00:39:50,000
an asteroid without actually being in

667
00:39:55,660 --> 00:39:52,520
contact with them yeah it's not that you

668
00:39:57,700 --> 00:39:55,670
have to it's just one option and and the

669
00:39:59,590 --> 00:39:57,710
issue is if you if you provide a

670
00:40:02,380 --> 00:39:59,600
continuous force that continuous

671
00:40:05,350 --> 00:40:02,390
touching then you're subject to the

672
00:40:07,900 --> 00:40:05,360
rotational period and the motion of the

673
00:40:11,710 --> 00:40:07,910
asteroid to apply the the Delta V in the

674
00:40:14,170 --> 00:40:11,720
right direction so but i think i'm not

675
00:40:17,620 --> 00:40:14,180
sure that that is a problem even if you

676
00:40:19,630 --> 00:40:17,630
can't be rotate an asteroid but if you