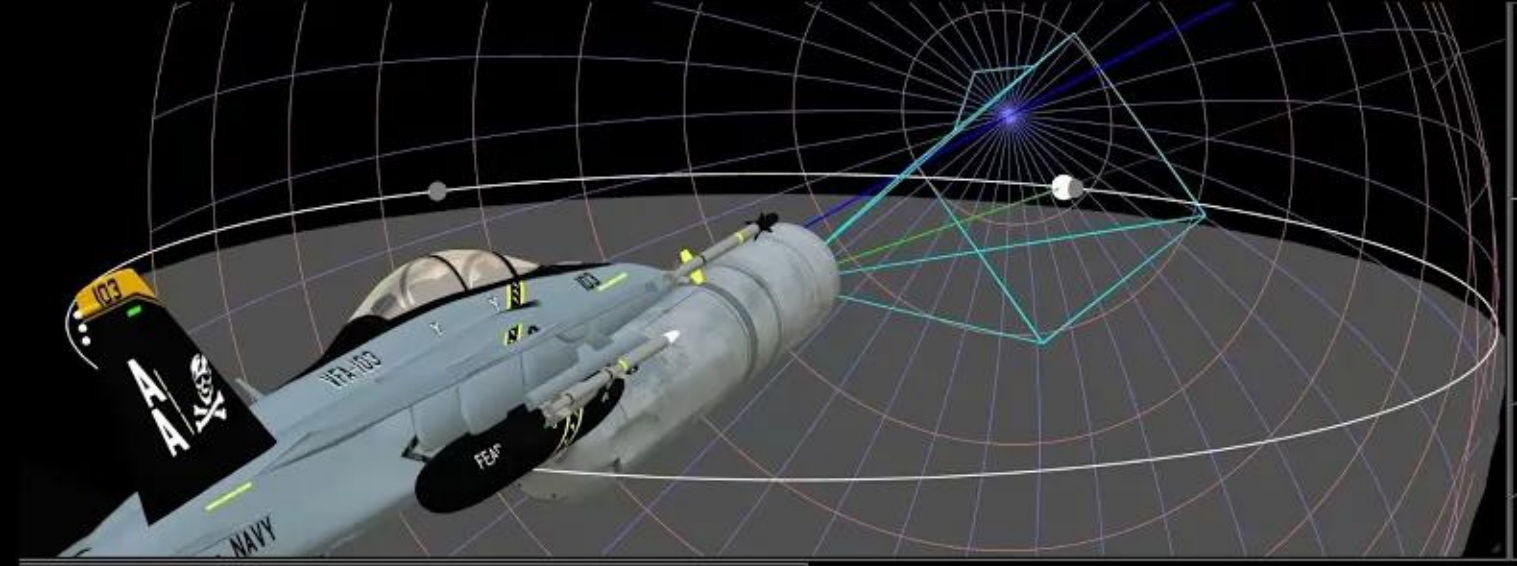
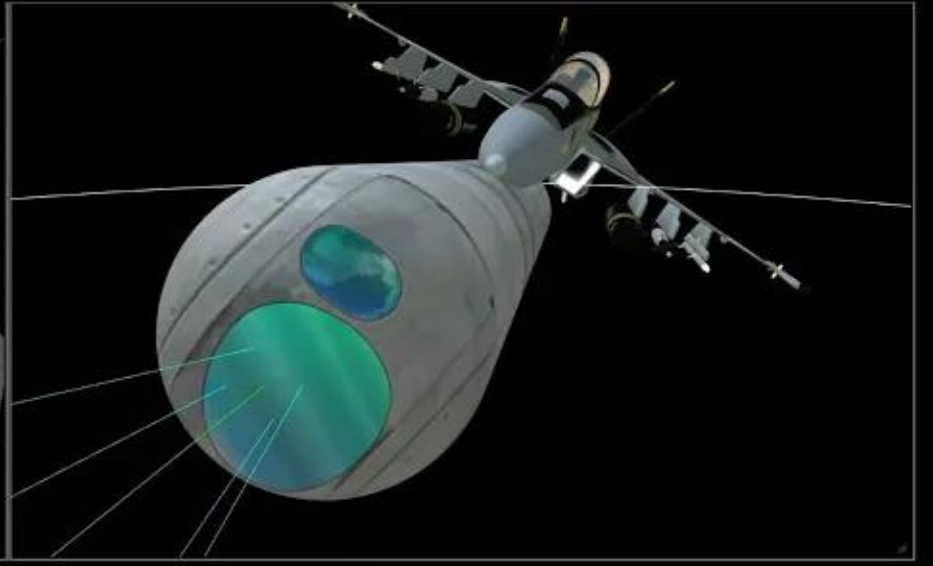
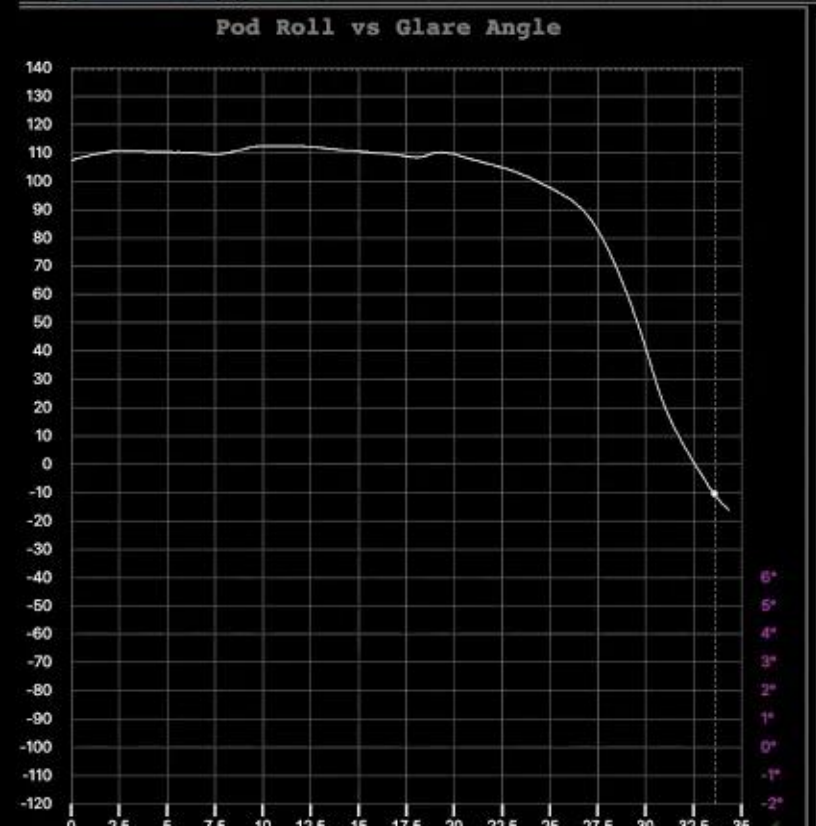
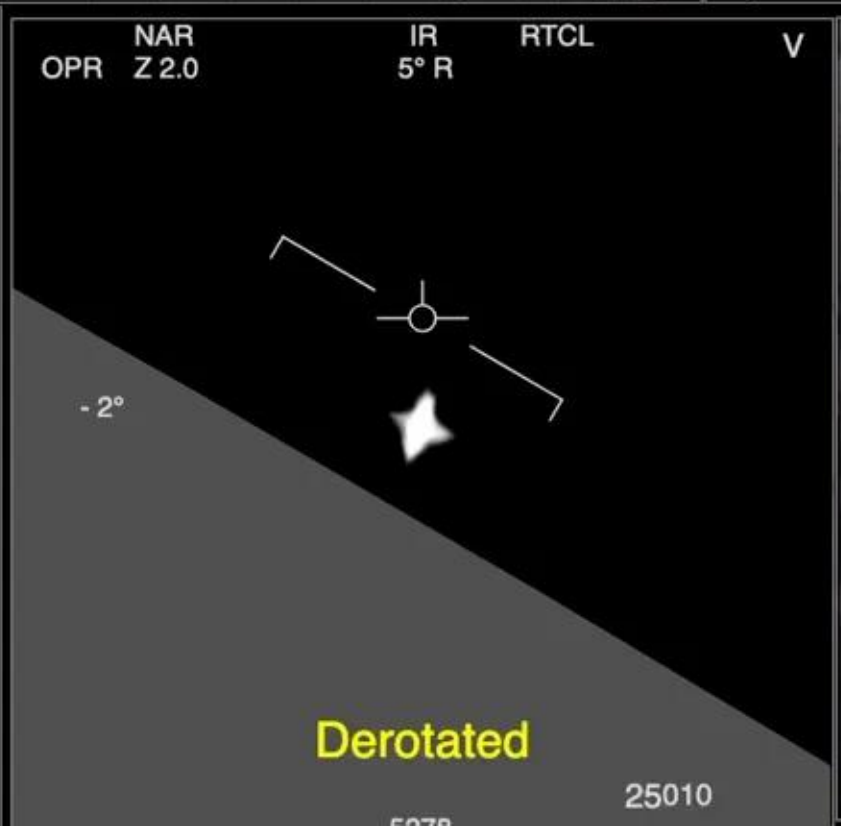

NAVY
FEAR




Pod Roll vs Glare Angle
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
6°
5°
4°
3°
2°
1°
0°
-1°
-2°


NAR
OPR Z 2.0
IR
5° R
RTCL
V
- 2°
Derotated
25010


NAR
OPR Z 2.0
IR
5° R
RTCL
V
TACT
- 2°
LST
1688
1688
LTD/R
G1
25010
DCLTR
5318A

1
00:00:04,630 --> 00:00:02,869
in this video i'm going to demonstrate

2
00:00:06,710 --> 00:00:04,640
four observables

3
00:00:08,870 --> 00:00:06,720
four things that you can verify yourself

4
00:00:11,669 --> 00:00:08,880
that demonstrate that the gimbal ufo

5
00:00:13,910 --> 00:00:11,679
video almost certainly shows a glare

6
00:00:15,669 --> 00:00:13,920
that hides the actual object

7
00:00:19,429 --> 00:00:15,679
and that the shape of the glare is only

8
00:00:22,550 --> 00:00:19,439
rotating because the camera is rotating

9
00:00:23,590 --> 00:00:22,560
briefly the four observables are

10
00:00:25,670 --> 00:00:23,600
one

11
00:00:27,990 --> 00:00:25,680
no rotation when banking

12
00:00:30,790 --> 00:00:28,000
the shape does not rotate when the jet

13
00:00:32,150 --> 00:00:30,800

banks everything else rotates the shape

14
00:00:33,350 --> 00:00:32,160
does not

15
00:00:35,670 --> 00:00:33,360
two

16
00:00:37,670 --> 00:00:35,680
bumps before rotation

17
00:00:39,510 --> 00:00:37,680
when the shape does rotate there's a

18
00:00:42,069 --> 00:00:39,520
bump right at the start sometimes a

19
00:00:43,190 --> 00:00:42,079
fraction of a second before

20
00:00:45,029 --> 00:00:43,200
three

21
00:00:46,869 --> 00:00:45,039
rotating patterns

22
00:00:48,630 --> 00:00:46,879
when the shape rotates there's a

23
00:00:51,350 --> 00:00:48,640
matching rotation of light patterns

24
00:00:52,470 --> 00:00:51,360
across the entire image

25
00:00:54,950 --> 00:00:52,480
four

26
00:00:57,029 --> 00:00:54,960
derotation matches

27
00:00:59,830 --> 00:00:57,039
the rotation of the shape matches

28
00:01:02,229 --> 00:00:59,840
exactly the amount of d rotation needed

29
00:01:04,630 --> 00:01:02,239
for tracking the target

30
00:01:06,230 --> 00:01:04,640
the first three are simple observations

31
00:01:08,310 --> 00:01:06,240
they don't need any math to see their

32
00:01:09,910 --> 00:01:08,320
implications just an understanding of

33
00:01:12,390 --> 00:01:09,920
the camera system

34
00:01:14,469 --> 00:01:12,400
the last one does require math but i can

35
00:01:15,910 --> 00:01:14,479
also demonstrate it with a simulation so

36
00:01:19,749 --> 00:01:15,920
you can see the math matches the

37
00:01:24,230 --> 00:01:22,070
before we get into the four observables

38
00:01:26,070 --> 00:01:24,240

we need to understand what is going on

39
00:01:27,910 --> 00:01:26,080
what are we looking at and how is it

40
00:01:30,870 --> 00:01:27,920
filmed

41
00:01:33,030 --> 00:01:30,880
the gimbal ufo video is the poster child

42
00:01:34,950 --> 00:01:33,040
of modern ufo videos

43
00:01:37,510 --> 00:01:34,960
it is the most interesting of the three

44
00:01:39,990 --> 00:01:37,520
videos taken by navy pilots

45
00:01:42,550 --> 00:01:40,000
it appears to show a source-shaped

46
00:01:45,190 --> 00:01:42,560
object skimming over the clouds

47
00:01:47,510 --> 00:01:45,200
the object seems to slow down and turn

48
00:01:49,429 --> 00:01:47,520
on its end in a way that appears to defy

49
00:01:51,830 --> 00:01:49,439
aerodynamics

50
00:01:53,510 --> 00:01:51,840
it's the only navy video that seems to

51
00:01:54,550 --> 00:01:53,520
show good evidence of advanced

52
00:01:56,230 --> 00:01:54,560
technology

53
00:01:57,749 --> 00:01:56,240
and so it's very important to people

54
00:02:01,429 --> 00:01:57,759
making the case that is of

55
00:02:04,709 --> 00:02:03,350
here i'm only going to make the case

56
00:02:06,830 --> 00:02:04,719
that what we are looking at is a

57
00:02:09,350 --> 00:02:06,840
rotating glare that hides the actual

58
00:02:11,350 --> 00:02:09,360
object this does not mean it's not some

59
00:02:13,830 --> 00:02:11,360
really interesting object that's still

60
00:02:15,510 --> 00:02:13,840
unknown unidentified

61
00:02:17,830 --> 00:02:15,520
i'm not going to address the audio that

62
00:02:19,750 --> 00:02:17,840
describes a fleet of them or what's

63
00:02:22,390 --> 00:02:19,760

actually going on in the wider context

64
00:02:24,229 --> 00:02:22,400
of military planes in a training range

65
00:02:25,350 --> 00:02:24,239
just the rotating glare part of the

66
00:02:26,790 --> 00:02:25,360
puzzle

67
00:02:29,430 --> 00:02:26,800
i'm also not going to address the

68
00:02:31,830 --> 00:02:29,440
location and the path of the object that

69
00:02:34,150 --> 00:02:31,840
is i believe being answered by the work

70
00:02:36,550 --> 00:02:34,160
of edward currant who was built upon the

71
00:02:38,790 --> 00:02:36,560
analysis of various people to extract

72
00:02:40,710 --> 00:02:38,800
the flight information of the jet and to

73
00:02:43,110 --> 00:02:40,720
build a variety of 3d models that

74
00:02:45,190 --> 00:02:43,120
replicate the video it turns out several

75
00:02:47,509 --> 00:02:45,200
solutions fit but the simplest was found

76
00:02:50,229 --> 00:02:47,519
by modeling another jet about 30 miles

77
00:02:52,150 --> 00:02:50,239
away flying away and a bit to the left

78
00:02:55,110 --> 00:02:52,160
i'll include links to his videos and the

79
00:02:57,190 --> 00:02:55,120
discussion thread in the description

80
00:02:59,270 --> 00:02:57,200
before we get to the four observables no

81
00:03:01,030 --> 00:02:59,280
banking rotation bumps rotating patterns

82
00:03:03,270 --> 00:03:01,040
and the d rotation match

83
00:03:05,430 --> 00:03:03,280
we need to understand the camera which

84
00:03:08,790 --> 00:03:05,440
in this case is an aptlyer system on a

85
00:03:10,470 --> 00:03:08,800
us navy fa-18 it's a targeting pod made

86
00:03:12,470 --> 00:03:10,480
by raytheon

87
00:03:13,750 --> 00:03:12,480
we're looking at an infrared image

88
00:03:15,990 --> 00:03:13,760

showing heat

89
00:03:18,070 --> 00:03:16,000
the object in the middle shows up as hot

90
00:03:19,910 --> 00:03:18,080
there's an aura around it that looks

91
00:03:21,430 --> 00:03:19,920
colder but that's just an artifact of

92
00:03:23,830 --> 00:03:21,440
thermal imaging

93
00:03:25,110 --> 00:03:23,840
what we are interested in is this saucer

94
00:03:26,949 --> 00:03:25,120
shape

95
00:03:29,750 --> 00:03:26,959
we know they are zoomed in an incredible

96
00:03:31,990 --> 00:03:29,760
amount it's in narrow mode with a two

97
00:03:33,830 --> 00:03:32,000
times additional zoom so the camera is

98
00:03:36,229 --> 00:03:33,840
only showing about a third of a degree

99
00:03:37,910 --> 00:03:36,239
of the sky to put that into perspective

100
00:03:40,550 --> 00:03:37,920
go out and look at the moon which is

101
00:03:43,110 --> 00:03:40,560
half a degree across imagine a square

102
00:03:44,949 --> 00:03:43,120
about two-thirds that size that's what

103
00:03:46,869 --> 00:03:44,959
the camera is looking at

104
00:03:49,509 --> 00:03:46,879
so we know that when the pilot says is

105
00:03:51,589 --> 00:03:49,519
rotated he's just looking at the screen

106
00:03:53,110 --> 00:03:51,599
the exact same thing we are looking at

107
00:03:55,030 --> 00:03:53,120
it would be too small to see with a

108
00:03:57,670 --> 00:03:55,040
naked eye because it's several miles

109
00:04:00,070 --> 00:03:57,680
away the camera is mounted on a two-axis

110
00:04:02,470 --> 00:04:00,080
gimbal system this might be a clue as

111
00:04:04,470 --> 00:04:02,480
the official navy title for the video is

112
00:04:06,070 --> 00:04:04,480
gimbal which might indicate that the

113
00:04:07,190 --> 00:04:06,080

gimbal system has something to do with

114
00:04:08,789 --> 00:04:07,200
it

115
00:04:11,270 --> 00:04:08,799
gimbal's system just means that there

116
00:04:13,270 --> 00:04:11,280
are two or more rotation axes where

117
00:04:15,670 --> 00:04:13,280
rotating one axis changes the

118
00:04:17,749 --> 00:04:15,680
orientation of the other

119
00:04:19,430 --> 00:04:17,759
with the app flare camera there's roll

120
00:04:21,830 --> 00:04:19,440
where the front part of the pod rotates

121
00:04:23,830 --> 00:04:21,840
along an axis parallel to the bore sight

122
00:04:26,950 --> 00:04:23,840
and pitch where the ball at the front of

123
00:04:29,990 --> 00:04:26,960
the pod rotates around another axis

124
00:04:32,550 --> 00:04:30,000
the roll rotation affects the pitch axis

125
00:04:34,870 --> 00:04:32,560
so initially pitches up and down but if

126
00:04:37,189 --> 00:04:34,880
the pod rolls 90 degrees and the pitch

127
00:04:39,270 --> 00:04:37,199
axis is now vertical and pitch is

128
00:04:40,790 --> 00:04:39,280
actually left and right

129
00:04:42,950 --> 00:04:40,800
to track a target

130
00:04:44,870 --> 00:04:42,960
the pod uses a combination of pitch and

131
00:04:46,230 --> 00:04:44,880
roll to make the line of sight point at

132
00:04:48,390 --> 00:04:46,240
the target

133
00:04:50,390 --> 00:04:48,400
roll by itself will just move the line

134
00:04:51,990 --> 00:04:50,400
of sight in a circle which is not that

135
00:04:54,230 --> 00:04:52,000
useful for tracking

136
00:04:57,030 --> 00:04:54,240
pitch by itself will move the line of

137
00:04:59,590 --> 00:04:57,040
sight along a line this line sometimes

138
00:05:01,670 --> 00:04:59,600

coincides with a target but usually you

139
00:05:05,029 --> 00:05:01,680
have to use both the pod roll and the

140
00:05:06,790 --> 00:05:05,039
pod pitch together

141
00:05:09,110 --> 00:05:06,800
in the gimbal video we are tracking a

142
00:05:10,390 --> 00:05:09,120
target that starts out at 54 degrees to

143
00:05:12,870 --> 00:05:10,400
the left of the jet

144
00:05:14,710 --> 00:05:12,880
and ends up seven degrees to the right

145
00:05:16,790 --> 00:05:14,720
this is largely because the jet is

146
00:05:19,189 --> 00:05:16,800
banked and turned to the left bringing

147
00:05:21,350 --> 00:05:19,199
the target around in front of it

148
00:05:24,070 --> 00:05:21,360
the movement relative to the clouds is

149
00:05:25,830 --> 00:05:24,080
parallax and it slows down as we line up

150
00:05:27,749 --> 00:05:25,840
with a target but does not stop

151
00:05:29,510 --> 00:05:27,759
indicating the target has some movement

152
00:05:31,270 --> 00:05:29,520
to the left

153
00:05:33,830 --> 00:05:31,280
what we are interested in here is the

154
00:05:35,909 --> 00:05:33,840
apparent rotation

155
00:05:37,990 --> 00:05:35,919
the discussion and the simulation is all

156
00:05:40,230 --> 00:05:38,000
in terms of angles which are all either

157
00:05:42,390 --> 00:05:40,240
shown on the screen or derived from data

158
00:05:43,990 --> 00:05:42,400
on the screen and are independent of the

159
00:05:46,070 --> 00:05:44,000
actual distance to the object and its

160
00:05:48,310 --> 00:05:46,080
speed

161
00:05:50,710 --> 00:05:48,320
as the object is tracked from 54 left to

162
00:05:53,270 --> 00:05:50,720
seven right it stays at a constant minus

163
00:05:55,110 --> 00:05:53,280

two degrees i.e two degrees below

164
00:05:56,790 --> 00:05:55,120
horizontal

165
00:05:58,950 --> 00:05:56,800
in the simulator this is shown with a

166
00:06:00,950 --> 00:05:58,960
white dot

167
00:06:03,270 --> 00:06:00,960
moving the target across the range of

168
00:06:05,670 --> 00:06:03,280
angles shows how the pod needs to modify

169
00:06:07,590 --> 00:06:05,680
its pitch and roll to track the target

170
00:06:09,350 --> 00:06:07,600
the graph here shows the roll angle of

171
00:06:11,029 --> 00:06:09,360
the pot in a simple configuration with

172
00:06:13,110 --> 00:06:11,039
the jet horizontal

173
00:06:15,670 --> 00:06:13,120
it starts out with a part rolled about

174
00:06:17,830 --> 00:06:15,680
90 degrees clockwise initially most of

175
00:06:19,430 --> 00:06:17,840
the pod movement is pitch but as the

176
00:06:21,909 --> 00:06:19,440
target gets closer to being straight

177
00:06:23,590 --> 00:06:21,919
ahead the pod is forced to turn more and

178
00:06:25,670 --> 00:06:23,600
there's a very rapid role as it crosses

179
00:06:29,110 --> 00:06:25,680
straight ahead and it ends up rolled

180
00:06:31,110 --> 00:06:29,120
about 70 degrees counterclockwise

181
00:06:33,110 --> 00:06:31,120
it helps to see why if we turn on a view

182
00:06:34,790 --> 00:06:33,120
that shows the roll rings in red and the

183
00:06:37,270 --> 00:06:34,800
pitch lines in blue

184
00:06:39,270 --> 00:06:37,280
pitch can only go along a blue line

185
00:06:41,110 --> 00:06:39,280
which is about all you need at the start

186
00:06:42,950 --> 00:06:41,120
but towards the center the pitch lines

187
00:06:47,029 --> 00:06:42,960
become perpendicular to where we want to

188
00:06:49,350 --> 00:06:47,039

go so we have to rely on roll instead

189
00:06:51,110 --> 00:06:49,360
the jet is actually back to the left

190
00:06:53,029 --> 00:06:51,120
which just changes the initial roll

191
00:06:55,189 --> 00:06:53,039
angle as it still has to roll the same

192
00:06:57,749 --> 00:06:55,199
amount so the curve is the same just

193
00:06:59,749 --> 00:06:57,759
shift it up

194
00:07:01,749 --> 00:06:59,759
now if we look at the video the bank

195
00:07:04,309 --> 00:07:01,759
angle of the plane shown relative to the

196
00:07:06,309 --> 00:07:04,319
artificial horizon is not constant it

197
00:07:09,189 --> 00:07:06,319
changes bank angle to the left four

198
00:07:11,110 --> 00:07:09,199
times and to the right once

199
00:07:12,950 --> 00:07:11,120
we can extract that data from the video

200
00:07:14,390 --> 00:07:12,960
with motion tracking and add it to the

201
00:07:15,749 --> 00:07:14,400
simulation

202
00:07:18,070 --> 00:07:15,759
the banking to the left

203
00:07:20,550 --> 00:07:18,080
counter-clockwise actually means that

204
00:07:21,510 --> 00:07:20,560
the pod needs to rotate counterclockwise

205
00:07:23,110 --> 00:07:21,520
less

206
00:07:25,510 --> 00:07:23,120
this makes the curve a bit more

207
00:07:28,870 --> 00:07:25,520
irregular but it keeps it in a narrower

208
00:07:33,189 --> 00:07:31,110
as well as banking the jet has to pitch

209
00:07:34,629 --> 00:07:33,199
up a bit in flight to maintain an angle

210
00:07:37,749 --> 00:07:34,639
of attack

211
00:07:39,510 --> 00:07:37,759
we use a base pitch of 3.6 degrees which

212
00:07:43,189 --> 00:07:39,520
is in line with the values given in the

213
00:07:45,670 --> 00:07:43,199

f 18 ops manual for 25 000 feet

214
00:07:48,550 --> 00:07:45,680
this value is also scaled up by the bank

215
00:07:50,230 --> 00:07:48,560
angle to account for loss of lift

216
00:07:51,990 --> 00:07:50,240
the interesting thing about pitching up

217
00:07:53,830 --> 00:07:52,000
the plane is that it flattens out the

218
00:07:55,350 --> 00:07:53,840
curve of the roll needed to track the

219
00:07:58,070 --> 00:07:55,360
target

220
00:08:00,390 --> 00:07:58,080
the combination of banking and pitching

221
00:08:02,790 --> 00:08:00,400
reduces the required total roll by about

222
00:08:04,710 --> 00:08:02,800
30 degrees

223
00:08:07,029 --> 00:08:04,720
so now we've got a nice model of exactly

224
00:08:09,510 --> 00:08:07,039
how the pod should rotate and pitch to

225
00:08:11,430 --> 00:08:09,520
track a target from 54 left to seven

226
00:08:12,950 --> 00:08:11,440
right whilst correctly accounting for

227
00:08:15,350 --> 00:08:12,960
the motion of the jet

228
00:08:17,589 --> 00:08:15,360
so what about this glare

229
00:08:19,270 --> 00:08:17,599
a problem with rolling the camera or in

230
00:08:22,710 --> 00:08:19,280
the case of the apflier what is known as

231
00:08:25,350 --> 00:08:22,720
the a vocal four optics the front bit is

232
00:08:26,710 --> 00:08:25,360
that it also rolls the image

233
00:08:28,230 --> 00:08:26,720
for example

234
00:08:30,550 --> 00:08:28,240
if we're looking to the left then the

235
00:08:31,510 --> 00:08:30,560
camera is rotated clockwise nearly 90

236
00:08:33,269 --> 00:08:31,520
degrees

237
00:08:35,509 --> 00:08:33,279
see the little triangle here in the view

238
00:08:36,389 --> 00:08:35,519

pyramid or frustum that indicates the

239
00:08:38,310 --> 00:08:36,399
top

240
00:08:40,070 --> 00:08:38,320
the clockwise rotation of the camera

241
00:08:41,909 --> 00:08:40,080
means the image is rotated

242
00:08:44,070 --> 00:08:41,919
counterclockwise

243
00:08:45,590 --> 00:08:44,080
here's the pod side view compare it to

244
00:08:48,389 --> 00:08:45,600
what's in the box

245
00:08:50,870 --> 00:08:48,399
at the end of the view frustum

246
00:08:52,870 --> 00:08:50,880
now we don't want this rotation we want

247
00:08:54,870 --> 00:08:52,880
the horizon in the display to look like

248
00:08:57,190 --> 00:08:54,880
the horizon out the window

249
00:08:59,990 --> 00:08:57,200
so the app flare includes an internal

250
00:09:01,750 --> 00:09:00,000
device called a d row short for d

251
00:09:03,910 --> 00:09:01,760
rotation

252
00:09:07,350 --> 00:09:03,920
that just takes the entire image and

253
00:09:09,350 --> 00:09:07,360
rotates it back to the correct angle

254
00:09:11,110 --> 00:09:09,360
we see this explicitly in video from

255
00:09:13,110 --> 00:09:11,120
other targeting pods

256
00:09:14,870 --> 00:09:13,120
when you rotate an image that's the same

257
00:09:16,870 --> 00:09:14,880
size as the screen then you get black

258
00:09:19,750 --> 00:09:16,880
regions and you can see the rotating

259
00:09:21,110 --> 00:09:19,760
rectangle that's the original image

260
00:09:23,829 --> 00:09:21,120
notice here you don't see the black

261
00:09:25,829 --> 00:09:23,839
regions when zoomed in

262
00:09:27,590 --> 00:09:25,839
something else you see in this video is

263
00:09:32,710 --> 00:09:27,600

glare

264
00:09:35,030 --> 00:09:32,720
radiation that spills out around a

265
00:09:37,430 --> 00:09:35,040
bright or hot object

266
00:09:39,430 --> 00:09:37,440
this is often just a circular or oval

267
00:09:41,590 --> 00:09:39,440
shape but can also have spikes in

268
00:09:43,670 --> 00:09:41,600
various directions these spikes can be

269
00:09:45,350 --> 00:09:43,680
long or short and the shape of the glare

270
00:09:47,030 --> 00:09:45,360
can be unrelated to the shape of the

271
00:09:49,430 --> 00:09:47,040
plane

272
00:09:52,389 --> 00:09:49,440
in this video there's a burning car very

273
00:09:54,310 --> 00:09:52,399
hot and a large diffraction spike

274
00:09:56,150 --> 00:09:54,320
you see the spike rotate dramatically

275
00:09:58,949 --> 00:09:56,160
here and at one point we see the message

276
00:10:00,389 --> 00:09:58,959
gimbal gimbal roll pop up on screen

277
00:10:03,269 --> 00:10:00,399
before a major correction and glare

278
00:10:08,069 --> 00:10:05,750
earlier in the video we see the rotation

279
00:10:09,990 --> 00:10:08,079
of a smaller glare it's not as dramatic

280
00:10:11,670 --> 00:10:10,000
but it is rotating

281
00:10:14,470 --> 00:10:11,680
then we zoom out letting us see the

282
00:10:16,389 --> 00:10:14,480
original frame before d rotation

283
00:10:22,550 --> 00:10:16,399
notice that the glare rotates at the

284
00:10:27,110 --> 00:10:24,949
this is because glare orientation is

285
00:10:28,949 --> 00:10:27,120
relative to the camera

286
00:10:31,509 --> 00:10:28,959
rotate the camera and the background

287
00:10:33,350 --> 00:10:31,519
will rotate but the glare angle will

288
00:10:36,470 --> 00:10:33,360

remain unchanged

289
00:10:38,389 --> 00:10:36,480
you can see this with glare in an iphone

290
00:10:40,949 --> 00:10:38,399
and look at the pod's eye view here with

291
00:10:44,150 --> 00:10:40,959
a glare added the orientation of the

292
00:10:47,030 --> 00:10:44,160
glare does not change

293
00:10:50,870 --> 00:10:47,040
so what eventually ends up on screen

294
00:10:53,430 --> 00:10:50,880
is the pod's eye view derotated

295
00:10:56,550 --> 00:10:53,440
since the d row d rotates the entire

296
00:10:59,110 --> 00:10:56,560
image and the background has rotated but

297
00:11:01,750 --> 00:10:59,120
the glare is fixed to the camera

298
00:11:07,110 --> 00:11:01,760
then the end result is the background

299
00:11:11,190 --> 00:11:09,110
it's important to remember the d row

300
00:11:13,590 --> 00:11:11,200
isn't responsible for the glare rotating

301
00:11:16,310 --> 00:11:13,600
independently of the background the d

302
00:11:18,710 --> 00:11:16,320
row affects the entire image the same

303
00:11:21,269 --> 00:11:18,720
the separation of glare and background

304
00:11:23,670 --> 00:11:21,279
rotation has already happened

305
00:11:25,829 --> 00:11:23,680
all the d-row is doing is rotating the

306
00:11:27,509 --> 00:11:25,839
entire image to put the horizon in the

307
00:11:29,430 --> 00:11:27,519
right place

308
00:11:31,910 --> 00:11:29,440
so now we've got a simulation of how a

309
00:11:33,829 --> 00:11:31,920
glare would behave with these angles we

310
00:11:36,230 --> 00:11:33,839
can see it already looks fairly similar

311
00:11:39,509 --> 00:11:36,240
to the actual video rotating the same

312
00:11:41,750 --> 00:11:39,519
amount and at about the same times

313
00:11:43,750 --> 00:11:41,760

there are a couple of differences

314
00:11:45,670 --> 00:11:43,760
in the simulation with the early rolls

315
00:11:48,150 --> 00:11:45,680
of the jet we see little rotations of

316
00:11:49,509 --> 00:11:48,160
the glare as the pod roll adjusts to the

317
00:11:52,150 --> 00:11:49,519
perfect angle

318
00:11:55,190 --> 00:11:52,160
but in the real video the target remains

319
00:11:57,190 --> 00:11:55,200
fixed in place for the first 20 seconds

320
00:11:59,350 --> 00:11:57,200
and then when the target makes these big

321
00:12:01,670 --> 00:11:59,360
rotations they happen in steps in the

322
00:12:04,949 --> 00:12:01,680
real video but in the simulation is a

323
00:12:08,470 --> 00:12:06,710
to understand this we need to understand

324
00:12:10,629 --> 00:12:08,480
the inner workings of the app layer

325
00:12:11,990 --> 00:12:10,639
there's the two big external gimbals the

326
00:12:14,470 --> 00:12:12,000
pitch and roll

327
00:12:16,470 --> 00:12:14,480
but there are also one or two additional

328
00:12:18,550 --> 00:12:16,480
internal gimbals that can steer the line

329
00:12:20,389 --> 00:12:18,560
of sight with mirrors

330
00:12:22,550 --> 00:12:20,399
these can be used to steer the line of

331
00:12:25,110 --> 00:12:22,560
sight without using roll

332
00:12:27,750 --> 00:12:25,120
they are used to avoid gimbal lock near

333
00:12:29,750 --> 00:12:27,760
what is called the gimbal singularity

334
00:12:31,269 --> 00:12:29,760
but could also be used for a variety of

335
00:12:32,949 --> 00:12:31,279
other situations

336
00:12:35,430 --> 00:12:32,959
they are described in various patterns

337
00:12:37,750 --> 00:12:35,440
from raytheon we don't know the exact

338
00:12:39,350 --> 00:12:37,760

configuration or how exactly they were

339
00:12:40,629 --> 00:12:39,360
programmed to operate at the time of

340
00:12:42,550 --> 00:12:40,639
this video

341
00:12:44,310 --> 00:12:42,560
but we do know they are commonly used

342
00:12:46,870 --> 00:12:44,320
and they give the camera about five

343
00:12:49,829 --> 00:12:46,880
degrees of flex where you can keep on

344
00:12:51,990 --> 00:12:49,839
target with the internal gimbals even if

345
00:12:53,910 --> 00:12:52,000
the external gimbals are a bit off i

346
00:12:56,230 --> 00:12:53,920
suspect what's going on is that it's

347
00:12:59,110 --> 00:12:56,240
trying to minimize use of role to

348
00:13:01,030 --> 00:12:59,120
prevent loss of target lock as well as

349
00:13:03,269 --> 00:13:01,040
optimally positioning the system for

350
00:13:05,430 --> 00:13:03,279
likely future movements

351
00:13:07,829 --> 00:13:05,440
this is discussed a bit in the patents

352
00:13:10,389 --> 00:13:07,839
saying that the role axis may require

353
00:13:12,710 --> 00:13:10,399
significant power and is not fast or

354
00:13:14,150 --> 00:13:12,720
agile and may not be particularly

355
00:13:16,310 --> 00:13:14,160
accurate

356
00:13:18,230 --> 00:13:16,320
so using the role axis only for short

357
00:13:19,750 --> 00:13:18,240
periods of time makes sense if there's

358
00:13:23,269 --> 00:13:19,760
another system that can take up the

359
00:13:27,750 --> 00:13:25,430
how much slack is needed

360
00:13:29,829 --> 00:13:27,760
well we can take the angle of the glare

361
00:13:31,910 --> 00:13:29,839
in the video extracted with image

362
00:13:34,389 --> 00:13:31,920
processing techniques and de-noise with

363
00:13:37,030 --> 00:13:34,399

keyframing we can then use that in the

364
00:13:38,870 --> 00:13:37,040
simulation to directly control the roll

365
00:13:41,110 --> 00:13:38,880
angle of the pod

366
00:13:47,030 --> 00:13:41,120
this is the green line in the graph and

367
00:13:50,150 --> 00:13:48,870
so now at last we can get to our four

368
00:13:51,110 --> 00:13:50,160
observables

369
00:13:53,910 --> 00:13:51,120
first

370
00:13:55,750 --> 00:13:53,920
no rotation while banking

371
00:13:58,230 --> 00:13:55,760
the simplest explanation for why there

372
00:14:00,550 --> 00:13:58,240
is no rotation in the first 20 seconds

373
00:14:01,430 --> 00:14:00,560
is because the pod is avoiding using

374
00:14:03,430 --> 00:14:01,440
roll

375
00:14:06,150 --> 00:14:03,440
if we look at the angular distance

376
00:14:08,150 --> 00:14:06,160
between the white dot the target

377
00:14:10,550 --> 00:14:08,160
and the green dot the line of sight

378
00:14:13,910 --> 00:14:10,560
driven by the glare angle then they stay

379
00:14:16,389 --> 00:14:13,920
very close actually within 2.2 degrees

380
00:14:18,710 --> 00:14:16,399
over the first 20 seconds

381
00:14:20,550 --> 00:14:18,720
with 5 degrees of flex from the internal

382
00:14:22,949 --> 00:14:20,560
gimbals there's no need for the slight

383
00:14:25,509 --> 00:14:22,959
corrections we'd need with just the two

384
00:14:28,470 --> 00:14:25,519
external gimbals

385
00:14:31,030 --> 00:14:28,480
however if this actually was a real

386
00:14:32,629 --> 00:14:31,040
object 10 miles away and this was its

387
00:14:34,949 --> 00:14:32,639
actual shape

388
00:14:36,870 --> 00:14:34,959

then when the plane banks the entire

389
00:14:38,949 --> 00:14:36,880
scene should rotate

390
00:14:41,110 --> 00:14:38,959
so if this was a real source of shaped

391
00:14:44,389 --> 00:14:41,120
craft then it should also rotate with

392
00:14:46,470 --> 00:14:44,399
the horizon instead it's fixed for the

393
00:14:48,870 --> 00:14:46,480
first 20 seconds

394
00:14:50,870 --> 00:14:48,880
while it's at a fixed angle the horizon

395
00:14:52,870 --> 00:14:50,880
both the artificial horizon and the real

396
00:14:56,069 --> 00:14:52,880
one indicated by the clouds and the dark

397
00:14:58,949 --> 00:14:56,079
band above them rotates 12 degrees in

398
00:15:01,350 --> 00:14:58,959
three steps over those first 20 seconds

399
00:15:03,269 --> 00:15:01,360
this is probably the most significant of

400
00:15:04,949 --> 00:15:03,279
the four observables you can see it

401
00:15:07,269 --> 00:15:04,959
simply by looking at the first 20

402
00:15:09,990 --> 00:15:07,279
seconds of the video scrub back and

403
00:15:11,750 --> 00:15:10,000
forth see the horizon rotate but the

404
00:15:14,069 --> 00:15:11,760
object does not

405
00:15:16,150 --> 00:15:14,079
either something 10 plus miles away is

406
00:15:18,150 --> 00:15:16,160
precisely mirroring the exact small

407
00:15:19,110 --> 00:15:18,160
changes in the bank angle of a random

408
00:15:23,590 --> 00:15:19,120
jet

409
00:15:27,829 --> 00:15:26,069
the second observable is bumps before

410
00:15:30,310 --> 00:15:27,839
rotation

411
00:15:32,710 --> 00:15:30,320
whenever the target rotates we see just

412
00:15:33,749 --> 00:15:32,720
before this a little bump of the entire

413
00:15:36,069 --> 00:15:33,759

scene

414
00:15:38,710 --> 00:15:36,079
this can be seen in the original video

415
00:15:41,430 --> 00:15:38,720
but it's clearer if we use opencv to

416
00:15:43,269 --> 00:15:41,440
calculate a velocity field for the video

417
00:15:45,670 --> 00:15:43,279
we see the motion of the clouds shift up

418
00:15:47,030 --> 00:15:45,680
a bit with the bump before the rotation

419
00:15:49,269 --> 00:15:47,040
starts

420
00:15:51,110 --> 00:15:49,279
this means that there's a camera motion

421
00:15:52,470 --> 00:15:51,120
just before the object's apparent

422
00:15:54,310 --> 00:15:52,480
rotation

423
00:15:56,470 --> 00:15:54,320
so either the object is zapping the

424
00:15:58,870 --> 00:15:56,480
plane with energy from 10 miles away

425
00:16:01,509 --> 00:15:58,880
just before it decides to rotate

426
00:16:03,670 --> 00:16:01,519
or it's an artifact of the camera

427
00:16:04,710 --> 00:16:03,680
the third observable is rotating

428
00:16:07,749 --> 00:16:04,720
patterns

429
00:16:09,590 --> 00:16:07,759
when the object the glare rotates we

430
00:16:11,749 --> 00:16:09,600
also see patterns of light in the

431
00:16:13,670 --> 00:16:11,759
background of the image rotate

432
00:16:14,870 --> 00:16:13,680
this is easier to see if you cover the

433
00:16:18,629 --> 00:16:14,880
glare

434
00:16:19,829 --> 00:16:18,639
rotation even when the jet is not

435
00:16:22,150 --> 00:16:19,839
banking

436
00:16:24,550 --> 00:16:22,160
this can really only be explained as an

437
00:16:26,629 --> 00:16:24,560
artifact of the camera

438
00:16:28,870 --> 00:16:26,639

finally there's the incredible

439
00:16:31,269 --> 00:16:28,880
synchronicity between the calculated

440
00:16:32,870 --> 00:16:31,279
roll the white line and the roll that's

441
00:16:35,110 --> 00:16:32,880
simply the same as the angle of the

442
00:16:37,030 --> 00:16:35,120
glare the green line

443
00:16:39,910 --> 00:16:37,040
for the first 20 seconds they are within

444
00:16:43,430 --> 00:16:39,920
about 2 degrees no need to adjust but at

445
00:16:46,629 --> 00:16:43,440
about 23 seconds we get over 2.5 degrees

446
00:16:49,030 --> 00:16:46,639
away and there's a small roll to correct

447
00:16:51,910 --> 00:16:49,040
this happens again at 26 seconds and

448
00:16:54,230 --> 00:16:51,920
then at 28.5 seconds it happens again

449
00:16:56,389 --> 00:16:54,240
but this time before the correction ends

450
00:16:57,430 --> 00:16:56,399
there's a roll of the jet in a clockwise

451
00:16:59,590 --> 00:16:57,440
direction

452
00:17:01,670 --> 00:16:59,600
which means the pod needs to rotate more

453
00:17:04,069 --> 00:17:01,680
in the counterclockwise direction so we

454
00:17:05,350 --> 00:17:04,079
get this long correction until the jet

455
00:17:06,789 --> 00:17:05,360
stops banking

456
00:17:08,710 --> 00:17:06,799
then there's one more correction like

457
00:17:10,069 --> 00:17:08,720
the others and finally we end just

458
00:17:12,390 --> 00:17:10,079
before another correction would be

459
00:17:14,390 --> 00:17:12,400
needed

460
00:17:17,429 --> 00:17:14,400
so if this isn't a glare then we've got

461
00:17:19,029 --> 00:17:17,439
an object over 10 miles away probably 30

462
00:17:20,949 --> 00:17:19,039
that somehow rotates when the jet

463
00:17:22,949 --> 00:17:20,959

rotates so it stays fixed in the

464
00:17:25,110 --> 00:17:22,959
camera's frame it's an object that

465
00:17:27,750 --> 00:17:25,120
somehow bumps the camera before it

466
00:17:29,430 --> 00:17:27,760
rotates from 10 plus miles away

467
00:17:31,590 --> 00:17:29,440
it's an object that somehow projects

468
00:17:32,470 --> 00:17:31,600
rotating light patterns that rotate with

469
00:17:34,390 --> 00:17:32,480
it

470
00:17:36,630 --> 00:17:34,400
is an object that rotates in a way that

471
00:17:38,870 --> 00:17:36,640
matches exactly the amount needed to

472
00:17:40,710 --> 00:17:38,880
stay within three degrees of a gimbal

473
00:17:42,310 --> 00:17:40,720
system tracking the target while

474
00:17:44,630 --> 00:17:42,320
minimizing roll

475
00:17:46,950 --> 00:17:44,640
but just from this one plane at this

476
00:17:48,150 --> 00:17:46,960
pitch and this bank angle

477
00:17:49,669 --> 00:17:48,160
or

478
00:17:52,070 --> 00:17:49,679
it's a glare

479
00:18:00,070 --> 00:17:52,080
rotating because of the gimbal system in

480
00:18:03,909 --> 00:18:02,230
this isn't fudging the numbers or mental

481
00:18:05,909 --> 00:18:03,919
gymnastics

482
00:18:07,710 --> 00:18:05,919
this is an open source simulation that

483
00:18:09,270 --> 00:18:07,720
you can try yourself it's at

484
00:18:10,230 --> 00:18:09,280
metabunk.org

485
00:18:12,310 --> 00:18:10,240
gimbal

486
00:18:15,110 --> 00:18:12,320
the data was all extracted from the navy

487
00:18:16,870 --> 00:18:15,120
videos and you can verify that

488
00:18:19,110 --> 00:18:16,880

there's extensive discussion threads on

489
00:18:20,710 --> 00:18:19,120
metabunk about all of this where i

490
00:18:22,390 --> 00:18:20,720
discuss what i'm showing here and you

491
00:18:24,789 --> 00:18:22,400
can see the process of discovery and

492
00:18:26,630 --> 00:18:24,799
figuring stuff out

493
00:18:28,950 --> 00:18:26,640
this isn't just me

494
00:18:31,270 --> 00:18:28,960
lots of people have done similar work

495
00:18:33,350 --> 00:18:31,280
the lack of rotation was brought up by a

496
00:18:35,029 --> 00:18:33,360
twitter user called reality seeker and

497
00:18:37,590 --> 00:18:35,039
was probably noticed by others before

498
00:18:40,310 --> 00:18:37,600
that the role of aircraft pitch was

499
00:18:41,909 --> 00:18:40,320
raised by metabunk user marcus who also

500
00:18:43,830 --> 00:18:41,919
extracted the glare angle and

501
00:18:45,270 --> 00:18:43,840
demonstrated the close match with

502
00:18:47,750 --> 00:18:45,280
expected raw

503
00:18:49,669 --> 00:18:47,760
other people have done similarly

504
00:18:51,830 --> 00:18:49,679
there were also additional discussions i

505
00:18:54,230 --> 00:18:51,840
don't have time to get into like how the

506
00:18:57,110 --> 00:18:54,240
relationship between the steering q dot

507
00:18:59,990 --> 00:18:57,120
and the azimuth verifies the 3.6 degrees

508
00:19:02,310 --> 00:19:00,000
pitch angle many people have helped many

509
00:19:04,630 --> 00:19:02,320
people agree

510
00:19:06,310 --> 00:19:04,640
i know this won't convince everyone but

511
00:19:08,789 --> 00:19:06,320
i hope it will help people understand

512
00:19:12,470 --> 00:19:08,799
the rotating glare hypothesis and why

513
00:19:13,750 --> 00:19:12,480

it's such a good fit for the data

514
00:19:15,909 --> 00:19:13,760
if you've made it all the way through

515
00:19:17,990 --> 00:19:15,919
this video and still have questions then

516
00:19:19,430 --> 00:19:18,000
i'd be happy to discuss them i'd also be

517
00:19:21,830 --> 00:19:19,440
happy to demonstrate all of this with

518
00:19:24,549 --> 00:19:21,840
the simulator over a zoom meeting live

519
00:19:26,470 --> 00:19:24,559
on youtube if you'd like

520
00:19:28,789 --> 00:19:26,480
finally i know there's a question about

521
00:19:30,710 --> 00:19:28,799
if raytheon's patents describe usage of

522
00:19:32,950 --> 00:19:30,720
the internal gimbals in this matter to

523
00:19:34,710 --> 00:19:32,960
give the arbitrary flex

524
00:19:36,549 --> 00:19:34,720
they don't exactly but they don't

525
00:19:38,710 --> 00:19:36,559
preclude it

526
00:19:40,630 --> 00:19:38,720
the hardware isn't an issue it's just a

527
00:19:43,110 --> 00:19:40,640
different algorithm and we don't know

528
00:19:44,549 --> 00:19:43,120
which highly classified algorithm was in

529
00:19:46,950 --> 00:19:44,559
use that day

530
00:19:48,630 --> 00:19:46,960
i asked the patent holder about this and

531
00:19:50,310 --> 00:19:48,640
he said he was only authorized to

532
00:19:52,470 --> 00:19:50,320
comment about what was in the public

533
00:19:55,029 --> 00:19:52,480
patents

534
00:19:58,070 --> 00:19:55,039
but we do know that this shape looks and