1
00:00:15,339 --> 00:00:20,140
From the Johns Hopkins Applied Physics Laboratory
in Laurel, Maryland, welcome to the NASA New

2
00:00:20,140 --> 00:00:21,980
Horizons Mission Countdown to Pluto.

3
00:00:21,980 --> 00:00:26,099
I'm Mike Buckley from APL Communications and
Public Affairs coming to you from Pluto's

4
00:00:26,099 --> 00:00:32,090
doorstep as we countdown to New Horizons historic
flight to the Pluto system on July 14th.

5
00:00:32,090 --> 00:00:35,500
We're four weeks from the Pluto flyby; just
under a month.

6
00:00:35,500 --> 00:00:40,390
New Horizons itself is now just about 20 million
miles from Pluto, closer than Earth and Venus

7
00:00:40,390 --> 00:00:41,820
at their closest point.

8
00:00:41,820 --> 00:00:49,550
And after nine years and 3 billion miles,
it really feels like 2015 is the year of Pluto.

9
00:00:49,550 --> 00:00:53,380
There's a mysterious zone far out in our solar
system.

10
00:00:53,380 --> 00:01:00,150
It's a region of ice worlds; some solitary,
some with moons.

11
00:01:00,150 --> 00:01:09,460

Their names may be unfamiliar; Eris, Makemake,
Haumea, but they hold clues to all our origins.

12
00:01:09,460 --> 00:01:14,939
And the first of these worlds and the one
we'll reach in 2015 is the king of the Kuiper

13
00:01:14,939 --> 00:01:18,000
Belt, Pluto.

14
00:01:18,000 --> 00:01:24,469
The long journey of NASA's New Horizon's mission
began in 2006 aboard America's biggest, baddest

15
00:01:24,469 --> 00:01:27,740
rocket, tricked out with every conceivable
booster.

16
00:01:27,740 --> 00:01:32,520
We built a very light spacecraft and bought
a very large launch vehicle and the combination

17
00:01:32,520 --> 00:01:33,520
is ferocious.

18
00:01:33,520 --> 00:01:40,159
But, in some sense, it all began in 1930 with
Clyde Tombaugh, 24-years-old and fresh off

19
00:01:40,159 --> 00:01:46,100
a farm in Kansas, but willing to spend long
hours scanning star fields to find the moving

20
00:01:46,100 --> 00:01:47,499
point of light.

21
00:01:47,499 --> 00:01:49,859
Humanities first glimpse of Pluto.

22

00:01:49,859 --> 00:01:55,979
The dream of actually getting to Pluto began
with a six-year-old boy in love with science

23
00:01:55,979 --> 00:02:01,499
who grew up to lead a team of brilliant researchers
and engineers with dogged persistence through

24
00:02:01,499 --> 00:02:05,590
decades of planning and building and testing.

25
00:02:05,590 --> 00:02:08,929
A race against time just to get to the launch
pad.

26
00:02:08,929 --> 00:02:14,310
Exploring the outer solar system, because
it's so far, takes a lot of time.

27
00:02:14,310 --> 00:02:19,849
It requires a lot of patience, a lot of dedication,
a lot of perseverance, but it's a frontier.

28
00:02:19,849 --> 00:02:25,150
Assuming all goes well at Pluto, NASA may
choose to extend the adventure further out

29
00:02:25,150 --> 00:02:29,269
into the Kuiper Belt, the solar system's mysterious
third zone.

30
00:02:29,269 --> 00:02:33,439
This is maybe the one chance in my lifetime
that we're going to get a spacecraft out there

31
00:02:33,439 --> 00:02:36,860
and look up close at one of these Kuiper Belt
objects.

32
00:02:36,860 --> 00:02:37,860

December 6, 2014--.

33
00:02:37,860 --> 00:02:39,269
--It is time to wake up.

34
00:02:39,269 --> 00:02:40,269
[Unintelligible--].

35
00:02:40,269 --> 00:02:45,489
--New Horizons wakes up for the last time
from hibernation.

36
00:02:45,489 --> 00:02:51,790
New Horizons is speeding towards Pluto at
a phenomenal rate and we can't wait for it

37
00:02:51,790 --> 00:02:52,909
to get there.

38
00:02:52,909 --> 00:02:57,530
January 27, 2015, six months of approach science
begins.

39
00:02:57,530 --> 00:03:06,780
July 14, 2015, New Horizons' long journey,
3 billion miles, nine years in flight, and

40
00:03:06,780 --> 00:03:13,310
85 years of speculation about Pluto climaxes
in one day of close approach and flyby.

41
00:03:13,310 --> 00:03:15,319
Yeah, we're around in third day.

42
00:03:15,319 --> 00:03:16,670
So, we're headed out.

43
00:03:16,670 --> 00:03:20,810
The dream, the adventure, the promise of discovery.

44
00:03:20,810 --> 00:03:27,689
That's what makes 2015 the year of Pluto.

45
00:03:27,689 --> 00:03:29,250
That was a look at the year of Pluto.

46
00:03:29,250 --> 00:03:33,480
The story of New Horizons is now running on
the mission website and NASA TV.

47
00:03:33,480 --> 00:03:38,939
And now, let's get an operations update.

48
00:03:38,939 --> 00:03:46,629
Now, the year of Pluto covers the New Horizons
team as they prepare us for this summer's

49
00:03:46,629 --> 00:03:47,629
flyby.

50
00:03:47,629 --> 00:03:51,389
And a familiar name in that video is mission
operations manager, Alice Bowman.

51
00:03:51,389 --> 00:03:53,129
Alice, thanks for joining us.

52
00:03:53,129 --> 00:03:54,599
Hi, Mike.

53
00:03:54,599 --> 00:03:57,430
Let's just start first by telling people--I
mean, this is a big team.

54
00:03:57,430 --> 00:03:59,340
What does a mission operations manager do?

55

00:03:59,340 --> 00:04:03,799
Well, the mission operations manager manages
the mission operations team.

56
00:04:03,799 --> 00:04:10,040
We have about 20 people on the mission ops
team and they're composed of planners.

57
00:04:10,040 --> 00:04:15,909
And they're the people that are responsible
for building the command sets, testing, verify

58
00:04:15,909 --> 00:04:18,170
them before they go to the spacecraft.

59
00:04:18,170 --> 00:04:23,890
And also, ensuring that those commands do
what the scientists want the instruments to

60
00:04:23,890 --> 00:04:28,580
do and what the subsystem engineers need to
have their subsystems be doing to support

61
00:04:28,580 --> 00:04:30,600
this incredible encounter.

62
00:04:30,600 --> 00:04:32,870
We also have flight controllers.

63
00:04:32,870 --> 00:04:37,920
They're the people that sit what we call in
the command pit and they watch the data come

64
00:04:37,920 --> 00:04:44,800
in from the spacecraft, monitoring for any
kind of off-nominal or abnormal conditions.

65
00:04:44,800 --> 00:04:48,800
They're also responsible for sending commands
to the spacecraft.

66
00:04:48,800 --> 00:04:50,449
Those are commands that tell the spacecraft
what to do.

67
00:04:50,449 --> 00:04:51,449
Yes.

68
00:04:51,449 --> 00:04:52,449
As it happens.

69
00:04:52,449 --> 00:04:53,449
Yes.

70
00:04:53,449 --> 00:04:54,449
Okay.

71
00:04:54,449 --> 00:04:56,490
So, you're doing a lot of communications with
New Horizons, but for something that's 3 billion

72
00:04:56,490 --> 00:05:01,060
miles away, that has to present some special
challenges of its own.

73
00:05:01,060 --> 00:05:02,720
Yes, it certainly does.

74
00:05:02,720 --> 00:05:07,060
It's much different than communicating with
a spacecraft that's in orbit around Earth.

75
00:05:07,060 --> 00:05:12,389
For one thing, we have to account for the
amount of time it takes for the data coming

76
00:05:12,389 --> 00:05:14,699
from the spacecraft to reach Earth.

77
00:05:14,699 --> 00:05:21,699
So, we have to send that data from the spacecraft
a little less than four and a half hours before

78
00:05:21,699 --> 00:05:26,180
we're ready to receive it on the ground with
the deep space antenna.

79
00:05:26,180 --> 00:05:31,251
Likewise, when we want to send information
or commands to the spacecraft, we have to

80
00:05:31,251 --> 00:05:37,110
send them to the point in space where that
spacecraft will be a little less than four

81
00:05:37,110 --> 00:05:38,830
and a half hours later.

82
00:05:38,830 --> 00:05:44,910
So, the spacecraft may be here when we start
to send those commands, but we're actually

83
00:05:44,910 --> 00:05:47,520
sending those commands to this point.

84
00:05:47,520 --> 00:05:53,199
And as those commands travel through space,
that spacecraft will come down and will intersect

85
00:05:53,199 --> 00:05:54,960
and will receive the commands from Earth.

86
00:05:54,960 --> 00:05:55,960
Okay.

87
00:05:55,960 --> 00:05:57,430
So, this is, like, a deep space forward pass.

88
00:05:57,430 --> 00:05:59,509
I mean, you really have to make sure the receiver
is in the right spot.

89
00:05:59,509 --> 00:06:01,430
You've got to get it there to get those commands.

90
00:06:01,430 --> 00:06:05,289
So, they're--you know, it's also something
interesting, too, about this is that the team

91
00:06:05,289 --> 00:06:08,949
seems, you know, with that communication,
you kind of have to pick your spots in a way,

92
00:06:08,949 --> 00:06:13,530
too, because if I understand, the spacecraft
can't communicate, it can't send data back

93
00:06:13,530 --> 00:06:17,300
or receive it when it's collecting data, say,
if it's focused on the Pluto system.

94
00:06:17,300 --> 00:06:19,400
So, how does the team work that out?

95
00:06:19,400 --> 00:06:20,520
Yes, that's very true.

96
00:06:20,520 --> 00:06:27,110
One of the things that we did to ensure that
the spacecraft gets to the Pluto system healthy

97
00:06:27,110 --> 00:06:28,810
was to minimize moving parts.

98
00:06:28,810 --> 00:06:33,919
And so, we have this gigantic antenna on the
spacecraft, but it's fixed.

99
00:06:33,919 --> 00:06:39,710
So, in order--and those instruments on board
the spacecraft are co-aligned with that antenna.

100
00:06:39,710 --> 00:06:46,409
So, in order to take data of the Pluto system,
you have to point that spacecraft to those

101
00:06:46,409 --> 00:06:50,919
objects that you're taking images of or collecting
data on.

102
00:06:50,919 --> 00:06:56,680
And when you want to communicate with Earth,
you have to turn those instruments away from

103
00:06:56,680 --> 00:06:59,400
their data taking and point to Earth.

104
00:06:59,400 --> 00:07:07,789
So, what we do is because the science team
wants to maximize observations of Pluto, they

105
00:07:07,789 --> 00:07:14,050
have specific times where they're observing
and all those other times, we will point that

106
00:07:14,050 --> 00:07:16,330
spacecraft to Earth and send data.

107
00:07:16,330 --> 00:07:21,050
Likewise, we'll be able to send commands when
the antenna is pointed to Earth.

108
00:07:21,050 --> 00:07:22,250
Take your chances when you get them.

109
00:07:22,250 --> 00:07:23,250

Your opportunity--.

110
00:07:23,250 --> 00:07:24,250
--Exactly--.

111
00:07:24,250 --> 00:07:25,250
--Is to get that when it happens.

112
00:07:25,250 --> 00:07:26,250
That's a busy spacecraft and a lot of activity.

113
00:07:26,250 --> 00:07:31,189
So, I'm thinking as we're getting close to
flyby, your team has to be pretty busy, too.

114
00:07:31,189 --> 00:07:33,580
Tell us a little bit about what's been going
on in the last week or so with the operations

115
00:07:33,580 --> 00:07:34,580
team.

116
00:07:34,580 --> 00:07:35,580
Sure.

117
00:07:35,580 --> 00:07:37,319
We have a lot of things going on in mission
operations.

118
00:07:37,319 --> 00:07:43,680
We have four different command sequences in
development spanning from about two weeks

119
00:07:43,680 --> 00:07:47,569
in the future through six days after closest
approach.

120
00:07:47,569 --> 00:07:54,060
So, we're testing, verifying, building all

those command sets, getting them ready for

121
00:07:54,060 --> 00:07:57,830
uplink to the spacecraft or having critical
design reviews, et cetera.

122
00:07:57,830 --> 00:08:03,800
We're also watching all the activities that
happen on board the spacecraft that we planned

123
00:08:03,800 --> 00:08:05,919
about six weeks ago.

124
00:08:05,919 --> 00:08:10,550
And these things include monitoring to make
sure that everything's going like we expect

125
00:08:10,550 --> 00:08:11,680
it to go.

126
00:08:11,680 --> 00:08:19,010
We're bringing back down a lot of data; light
curve data, air glow data, plasma data.

127
00:08:19,010 --> 00:08:23,599
We're also bringing down optical navigation
data and this is data that the navigation

128
00:08:23,599 --> 00:08:29,110
and mission design teams are going to use
to determine whether or not or when we need

129
00:08:29,110 --> 00:08:31,419
to do trajectory correction maneuvers.

130
00:08:31,419 --> 00:08:33,909
Just to make sure, too, that the spacecraft
is on course, right?

131

00:08:33,909 --> 00:08:37,120
That it's going to get to its aim point at
the right time near Pluto to see if you have

132
00:08:37,120 --> 00:08:39,060
to change or make those moves.

133
00:08:39,060 --> 00:08:40,060
Definitely.

134
00:08:40,060 --> 00:08:41,500
So, how are things on board?

135
00:08:41,500 --> 00:08:42,500
Spacecraft is healthy?

136
00:08:42,500 --> 00:08:43,500
Things are looking good?

137
00:08:43,500 --> 00:08:46,520
The spacecraft is great and the team is ready.

138
00:08:46,520 --> 00:08:47,520
All right.

139
00:08:47,520 --> 00:08:48,520
Thanks, Alice.

140
00:08:48,520 --> 00:08:49,520
Sure.

141
00:08:49,520 --> 00:08:58,630
And now, for a science update.

142
00:08:58,630 --> 00:09:03,030
To talk science is Cathy Olkin, a deputy project
scientist for New Horizons.

143

00:09:03,030 --> 00:09:04,850
Cathy, thanks for joining us.

144
00:09:04,850 --> 00:09:06,230
Thanks for having me.

145
00:09:06,230 --> 00:09:07,330
Let's just start first here.

146
00:09:07,330 --> 00:09:11,370
What's--explain a little bit about the role
of a deputy project scientist on New Horizons.

147
00:09:11,370 --> 00:09:15,760
I have a number of different responsibilities
on the New Horizons mission.

148
00:09:15,760 --> 00:09:18,380
I help with the Pluto encounter planning.

149
00:09:18,380 --> 00:09:23,020
I also review the sequences for the Ralph
instrument to make sure that everything we're

150
00:09:23,020 --> 00:09:27,380
going to send up to the spacecraft executes
as we expect it so that we can get the best

151
00:09:27,380 --> 00:09:28,560
science return.

152
00:09:28,560 --> 00:09:31,480
What kind of science data has New Horizons
taken now?

153
00:09:31,480 --> 00:09:33,480
I mean, we're kind of approach, we're looking
in.

154

00:09:33,480 --> 00:09:36,980
What kind of data is it gathering on the system,
even from far enough away?

155
00:09:36,980 --> 00:09:39,010
So, we're getting lots of interesting data
right now.

156
00:09:39,010 --> 00:09:41,560
We're getting data with the LORRI instrument.

157
00:09:41,560 --> 00:09:44,650
We're getting interesting maps of the surface.

158
00:09:44,650 --> 00:09:46,080
We're getting hazard data.

159
00:09:46,080 --> 00:09:51,340
We're getting color images with the Ralph
instrument and plasma information from the

160
00:09:51,340 --> 00:09:53,780
plasma suite swap and PEPSSI.

161
00:09:53,780 --> 00:09:57,420
You mentioned LORRI, too, and we have some
new images that just came out from LORRI,

162
00:09:57,420 --> 00:09:58,420
too.

163
00:09:58,420 --> 00:09:59,420
What's the--take us through some of those.

164
00:09:59,420 --> 00:10:00,420
What are we seeing in those pictures?

165
00:10:00,420 --> 00:10:01,770
Yeah, this is getting really exciting.

166
00:10:01,770 --> 00:10:04,580
Here, you can see four different faces of
Pluto.

167
00:10:04,580 --> 00:10:07,410
We have four different images taken with the
LORRI camera.

168
00:10:07,410 --> 00:10:12,640
And you can see down at the bottom here, these
dark--this dark region of Pluto.

169
00:10:12,640 --> 00:10:14,760
So, this is really interesting.

170
00:10:14,760 --> 00:10:18,090
We've always known that Pluto has dark and
bright regions, but now we're starting to

171
00:10:18,090 --> 00:10:25,010
see how large they are, where they're exactly
located, what shape they take, and it's very

172
00:10:25,010 --> 00:10:27,980
fascinating that we see this level of detail.

173
00:10:27,980 --> 00:10:32,270
So, we're getting closer and closer, it's
getting harder and harder for Pluto to hold

174
00:10:32,270 --> 00:10:33,650
on to its secrets.

175
00:10:33,650 --> 00:10:34,650
Most definitely.

176
00:10:34,650 --> 00:10:35,830
It really is.

177
00:10:35,830 --> 00:10:38,640
So, what observations are planned over the
next week or so?

178
00:10:38,640 --> 00:10:41,960
We have a lot of exciting things coming up
this week.

179
00:10:41,960 --> 00:10:46,880
We have the first observations in the infrared
with Pluto and Karen from New Horizons.

180
00:10:46,880 --> 00:10:49,170
So, I'm really looking forward to that.

181
00:10:49,170 --> 00:10:55,670
We also have a series of daily color images
that we'll be taking of Pluto and Sharon to

182
00:10:55,670 --> 00:10:58,720
cover a whole rotational phase of Pluto.

183
00:10:58,720 --> 00:11:00,920
And we have LORRI images continuing.

184
00:11:00,920 --> 00:11:01,920
Right.

185
00:11:01,920 --> 00:11:02,920
So--.

186
00:11:02,920 --> 00:11:03,920
--Okay.

187
00:11:03,920 --> 00:11:04,920
Well, thanks, Cathy.

188

00:11:04,920 --> 00:11:05,920
Thank you.

189
00:11:05,920 --> 00:11:09,150
Of course, all of this leads up to the flyby
on July 14th when New Horizons makes observations

190
00:11:09,150 --> 00:11:14,280
of Pluto and its moons as it zips through
the system at more than 30,000 miles an hour.

191
00:11:14,280 --> 00:11:18,150
Now, let's take a look at what New Horizons
will be doing as it passes Pluto, besides

192
00:11:18,150 --> 00:11:24,050
making history.

193
00:11:24,050 --> 00:11:31,690
So, July 14th is going to be really exciting.

194
00:11:31,690 --> 00:11:34,779
We have observations planned with our whole
suite of instruments.

195
00:11:34,779 --> 00:11:38,740
Things really begin to heat up at about three
hours before closest approach.

196
00:11:38,740 --> 00:11:45,500
As we're flying by, if my hand is Pluto, the
spacecraft will flyby and it will scan the

197
00:11:45,500 --> 00:11:50,180
LISA instrument across the surface of Pluto
to build up a spectral image of what the surface

198
00:11:50,180 --> 00:11:51,200
looks like.

199
00:11:51,200 --> 00:11:58,080
Then as we get around--toward Pluto's terminator,
we take our very long high resolution scans

200
00:11:58,080 --> 00:12:04,080
in black and white, which means that we can
use the very wide field and thick.

201
00:12:04,080 --> 00:12:07,390
And at the same time, use the narrow field
LORRI.

202
00:12:07,390 --> 00:12:15,110
So, we get 5,000 pixels across Pluto, about
half a kilometer resolution at closest approach.

203
00:12:15,110 --> 00:12:21,950
At the same time, we have this very skitty
[sp] inset of the LORRI field of view and

204
00:12:21,950 --> 00:12:25,230
only about 100 meters per pixel.

205
00:12:25,230 --> 00:12:30,060
So, we take our LORRI images, one after the
other, these overlapping images.

206
00:12:30,060 --> 00:12:37,230
So, what it looks like is this big plate of
Pluto and the skinny little noodle of LORRI

207
00:12:37,230 --> 00:12:38,450
running across the middle.

208
00:12:38,450 --> 00:12:44,030
At this point, we are, for the first time
in humanities history, behind Pluto, taking

209
00:12:44,030 --> 00:12:45,940

pictures back on the far side.

210
00:12:45,940 --> 00:12:50,570
The Alice instrument will be doing a solar
occultation, which is watching the sun set

211
00:12:50,570 --> 00:12:51,640
behind Pluto.

212
00:12:51,640 --> 00:12:56,580
The deep space network will be transmitting
a signal and that signal will be picked up

213
00:12:56,580 --> 00:13:02,440
by the antenna and it'll be changed by the
atmosphere of Pluto that it has to go through

214
00:13:02,440 --> 00:13:04,790
and that's how we probe Pluto's atmosphere.

215
00:13:04,790 --> 00:13:07,790
The pressure and temperature right near the
surface.

216
00:13:07,790 --> 00:13:11,010
July 14th is the apex of what we've been working
for.

217
00:13:11,010 --> 00:13:16,000
We launched more than nine years ago and ever
since then, we've been trying to shepherd

218
00:13:16,000 --> 00:13:18,730
the spacecraft safely across the solar system.

219
00:13:18,730 --> 00:13:24,250
As spacecraft goes, New Horizons is a very
small team, but still we've been working on

220

00:13:24,250 --> 00:13:26,830
this for over a decade.

221
00:13:26,830 --> 00:13:33,530
And you add it all up and it's about 2.5 million
work hours to get ourselves to Pluto.

222
00:13:33,530 --> 00:13:38,770
We can't wait to get to Pluto and to July
14th and see what the surface looks like.

223
00:13:38,770 --> 00:13:42,710
We're ready to go and it's show time.

224
00:13:42,710 --> 00:13:48,950
Now, of course, to get great data, you need
a great spacecraft and New Horizons carries

225
00:13:48,950 --> 00:13:51,930
a range of tools and capabilities for its
mission to Pluto.

226
00:13:51,930 --> 00:13:56,370
Now, joining me for a look at the spacecraft
is mission systems engineer Chris Hersman

227
00:13:56,370 --> 00:13:59,910
from the applied physics laboratory where
New Horizons was designed and built.

228
00:13:59,910 --> 00:14:01,360
So, Chris, thanks for joining us.

229
00:14:01,360 --> 00:14:02,940
Well, thanks, Mike, for inviting me.

230
00:14:02,940 --> 00:14:05,270
It's a pleasure to be here.

231

00:14:05,270 --> 00:14:08,080
It obviously takes a team to build something
like New Horizons.

232
00:14:08,080 --> 00:14:12,550
So, maybe tell us a bit about the mission
systems engineer's role on the spacecraft

233
00:14:12,550 --> 00:14:13,550
team.

234
00:14:13,550 --> 00:14:14,550
Oh, thanks.

235
00:14:14,550 --> 00:14:19,850
So, the mission system engineer is the lead
technical person on the project.

236
00:14:19,850 --> 00:14:25,440
But, he can't do his job without his expert--team
of experts in the fields.

237
00:14:25,440 --> 00:14:30,830
I was the spacecraft system engineer during
the development and I had about 10 leads,

238
00:14:30,830 --> 00:14:33,430
one for each of the subsystems on the spacecraft.

239
00:14:33,430 --> 00:14:38,500
I had the power system lead, the propulsion
system lead, the thermal system lead, communications,

240
00:14:38,500 --> 00:14:40,510
commanded day to day handling.

241
00:14:40,510 --> 00:14:45,760
All of those people together--and if I've
left out any, I'm sorry.

242
00:14:45,760 --> 00:14:52,200
But, all of those subsystems together, they
really--you know, they're the experts and

243
00:14:52,200 --> 00:14:54,630
they're the ones who actually make it happen.

244
00:14:54,630 --> 00:15:00,410
And I was responsible for the interfaces between
the subsystems and between the systems and

245
00:15:00,410 --> 00:15:02,010
the instruments.

246
00:15:02,010 --> 00:15:07,030
And then now that I've taken over the role
as mission system engineer, I'm also responsible

247
00:15:07,030 --> 00:15:10,480
for the ground system, the instruments, and
that as well.

248
00:15:10,480 --> 00:15:15,690
But, again, it's the technical experts and
the leads that really make it happen and pull

249
00:15:15,690 --> 00:15:16,690
it all together.

250
00:15:16,690 --> 00:15:18,300
And, you know, it's--obviously, it's been
working.

251
00:15:18,300 --> 00:15:22,830
You know, over nine and a half years in space,
over 3 billion miles to get there.

252
00:15:22,830 --> 00:15:28,150
So, I guess how do you design something, okay,

not just to go so far, but really to go where

253
00:15:28,150 --> 00:15:30,010
no other spacecraft has really gone before?

254
00:15:30,010 --> 00:15:31,010
Mm-hmm.

255
00:15:31,010 --> 00:15:36,750
Yeah, we started with the power source because
we really had to use the radio isotope thermal

256
00:15:36,750 --> 00:15:41,870
electric generator because there's no--not
enough sunlight to really power it--anything

257
00:15:41,870 --> 00:15:42,940
out of Pluto.

258
00:15:42,940 --> 00:15:47,080
So, given that, it only has about 200 watts
of power when we get to Pluto.

259
00:15:47,080 --> 00:15:52,350
So, we had to design into every subsystem
ways to cut power and to shave a few watts

260
00:15:52,350 --> 00:15:55,570
here and there to get under that 200 watt
limit.

261
00:15:55,570 --> 00:16:01,370
And we managed to do it with developments
like the digital receiver, which we built

262
00:16:01,370 --> 00:16:02,370
here at APL.

263
00:16:02,370 --> 00:16:04,300

That was an enabling technology.

264
00:16:04,300 --> 00:16:09,560
We also have sophisticated thermal control
that would allow us to operate at Pluto without

265
00:16:09,560 --> 00:16:11,720
any electric heaters.

266
00:16:11,720 --> 00:16:15,350
We actually reuse some of the waste heat on
the power source.

267
00:16:15,350 --> 00:16:22,630
We also have a software controlled algorithm
that keeps the level of power inside the spacecraft

268
00:16:22,630 --> 00:16:25,440
to maintain the constant temperature.

269
00:16:25,440 --> 00:16:31,330
And right now, the spacecraft is approximately
room temperature on the inside when outside

270
00:16:31,330 --> 00:16:35,110
it's almost a couple of hundred degrees below
zero Celsius.

271
00:16:35,110 --> 00:16:39,360
I mean, so, the idea that it--I mean, just
by operating it, it keeps itself warm.

272
00:16:39,360 --> 00:16:42,690
The electronics and the boxes and everything,
as they're moving, that keeps the spacecraft

273
00:16:42,690 --> 00:16:43,690
warm.

274

00:16:43,690 --> 00:16:44,690
That's right.

275
00:16:44,690 --> 00:16:47,550
Just like the way your laptop gets warm, all
the boxes inside, they get warm, and then

276
00:16:47,550 --> 00:16:52,890
they keep a tight thermos bottle design on
the spacecraft to keep that heat inside.

277
00:16:52,890 --> 00:16:57,170
And there are also some components that actually
want to be cold and they are actually put

278
00:16:57,170 --> 00:17:01,030
outside of that thermos bottle.

279
00:17:01,030 --> 00:17:06,740
And then they actually try to minimize the
exchange of heat between the various isolated

280
00:17:06,740 --> 00:17:11,069
components from the ones that are inside that
need to stay at room temperature.

281
00:17:11,069 --> 00:17:12,069
Okay.

282
00:17:12,069 --> 00:17:15,459
So, Chris, why don't you--take us for a tour
around the New Horizons spacecraft.

283
00:17:15,459 --> 00:17:16,669
Oh, I'd love to.

284
00:17:16,669 --> 00:17:22,709
Here is the New Horizons spacecraft, which
shows a triangular shape, which is used to

285
00:17:22,709 --> 00:17:24,089
balance the spacecraft.

286
00:17:24,089 --> 00:17:27,309
The size of this is about the size of a grand
piano.

287
00:17:27,309 --> 00:17:33,279
And what we did is we position all the instruments
in the view that you see here pointing in

288
00:17:33,279 --> 00:17:39,280
the direction opposite of the power source,
which is this black curling iron type object

289
00:17:39,280 --> 00:17:40,960
over to the right.

290
00:17:40,960 --> 00:17:47,110
So, we put that actually out further because
it generates heat and it also generates radiation

291
00:17:47,110 --> 00:17:48,950
that could affect the electronics.

292
00:17:48,950 --> 00:17:54,210
So, in general, we put all the sensitive electronics
on this side of the spacecraft, the left side,

293
00:17:54,210 --> 00:17:58,410
and put the power source on the right side
and that provides two things.

294
00:17:58,410 --> 00:17:59,970
It provides distance between the two.

295
00:17:59,970 --> 00:18:03,269
It also provides balance for the spinning
mode of the spacecraft.

296
00:18:03,269 --> 00:18:07,780
And we have a spinning mode and that's one
of the things that helps us get through this

297
00:18:07,780 --> 00:18:13,850
long duration mission because when we spin
the spacecraft, it doesn't take any fuel to

298
00:18:13,850 --> 00:18:15,539
maintain the pointing.

299
00:18:15,539 --> 00:18:20,620
And then we can put it into a hibernation
mode where we turn most of the electronics

300
00:18:20,620 --> 00:18:26,350
off, which let's those electronics last longer
and it's just--it all ties together into the

301
00:18:26,350 --> 00:18:28,899
operational mode that we use for the spacecraft.

302
00:18:28,899 --> 00:18:34,759
So, if we move down to the first instrument
that I'd like to show you, it's the ultraviolet

303
00:18:34,759 --> 00:18:35,759
instrument.

304
00:18:35,759 --> 00:18:36,759
It's called Alice.

305
00:18:36,759 --> 00:18:40,899
So, the Alice instrument shown here is the
ultraviolet instrument and it will measure

306
00:18:40,899 --> 00:18:46,830
air glow in the atmosphere as well as taking

occultation measurements as the spacecraft

307
00:18:46,830 --> 00:18:49,879
traverses into the shadow of Pluto.

308
00:18:49,879 --> 00:18:57,529
And simultaneous with that ultraviolet measurement,
they'll also make a radio science measurement

309
00:18:57,529 --> 00:19:02,830
from signals that are transmitted from the
Earth at the same time as it's traversing

310
00:19:02,830 --> 00:19:04,139
into the shadow of Pluto.

311
00:19:04,139 --> 00:19:08,049
And then the next instrument I'd like to talk
about is the Ralph instrument.

312
00:19:08,049 --> 00:19:15,570
This has the ultraviolet and visible imaging
that's used at the closest distances to get

313
00:19:15,570 --> 00:19:18,830
the full view and the composition mapping.

314
00:19:18,830 --> 00:19:23,820
They use the infrared part of the instrument
to determine the surface composition.

315
00:19:23,820 --> 00:19:29,370
And like I said, the Alice instrument was
measuring the atmospheric composition.

316
00:19:29,370 --> 00:19:34,700
So, if we move on to the other side of the
spacecraft, you'll see that radio isotope

317

00:19:34,700 --> 00:19:36,269
thermal electric generator.

318
00:19:36,269 --> 00:19:43,250
And this is connected to the spacecraft through
a pyramid shape and that pyramid was actually

319
00:19:43,250 --> 00:19:47,570
altered during the design to minimize the
amount of additional weight that you would

320
00:19:47,570 --> 00:19:49,610
have to put on the spacecraft to balance it.

321
00:19:49,610 --> 00:19:55,370
So, we could adjust the design of that pyramid
in a shape so that it could move it further

322
00:19:55,370 --> 00:19:57,929
away or closer or up or down.

323
00:19:57,929 --> 00:20:05,759
And then we set that--once we built that pyramid
shape and then installed that right on the

324
00:20:05,759 --> 00:20:06,759
launch pad.

325
00:20:06,759 --> 00:20:12,509
You'll also notice the heat shield, which
is the gold octagon shaped object between

326
00:20:12,509 --> 00:20:18,890
the power source and the spacecraft and that's
designed to minimize the amount of heat that

327
00:20:18,890 --> 00:20:23,880
would be coupled to the instruments to adjust
to cause noise in the instruments.

328
00:20:23,880 --> 00:20:28,510
But, there is actually a tailored opening
inside of the spacecraft that allows some

329
00:20:28,510 --> 00:20:31,919
heat to come through and keep the inside of
the spacecraft warm.

330
00:20:31,919 --> 00:20:36,880
So, now, moving up to the high gain antenna,
you can see here there's actually an assembly

331
00:20:36,880 --> 00:20:38,169
of multiple antennas.

332
00:20:38,169 --> 00:20:43,470
At the very end is a low gain antenna and
that was used at launch and it can see half

333
00:20:43,470 --> 00:20:46,080
of the sphere from the spacecraft.

334
00:20:46,080 --> 00:20:49,950
And there's another one on the other side
to give full coverage from all angles of the

335
00:20:49,950 --> 00:20:50,950
spacecraft.

336
00:20:50,950 --> 00:20:54,270
That allowed us, from the ground, to talk
to the spacecraft no matter which direction

337
00:20:54,270 --> 00:20:55,840
it was pointing.

338
00:20:55,840 --> 00:20:59,140
Then, in the middle there, is a smaller dish.

339
00:20:59,140 --> 00:21:03,450
That's our medium gain antenna and we use
that for beacon modes and also for emergency

340
00:21:03,450 --> 00:21:07,730
modes to have a wider beam width than the
high gain antenna.

341
00:21:07,730 --> 00:21:13,450
And that's very important for communicating
during the hibernation period.

342
00:21:13,450 --> 00:21:19,429
Then, the high gain antenna, that's the one
we use for the radio science and the high

343
00:21:19,429 --> 00:21:24,169
data downlink of the science data after Pluto.

344
00:21:24,169 --> 00:21:29,830
So, moving over to the particles and plasma
instrument, you see here the solar wind and

345
00:21:29,830 --> 00:21:30,830
Pluto instrument.

346
00:21:30,830 --> 00:21:36,259
The swap instrument can make measurements
on the atmosphere even when the optical instruments

347
00:21:36,259 --> 00:21:38,620
are taking images of Pluto.

348
00:21:38,620 --> 00:21:43,510
And we keep those instruments on throughout
the encounter so that they can measure.

349
00:21:43,510 --> 00:21:47,330
And there's actually an interaction between

the solar wind and Pluto's atmosphere that

350
00:21:47,330 --> 00:21:50,889
creates a bow [sp] shock and that's one of
the critical measurements that this instrument

351
00:21:50,889 --> 00:21:51,990
will make.

352
00:21:51,990 --> 00:21:55,580
There's also an energetic particles instrument,
which is shown here.

353
00:21:55,580 --> 00:22:01,360
It also has a fan shaped aperture and it measures
the energetic particles, but it doesn't actually

354
00:22:01,360 --> 00:22:02,360
want to see the sun.

355
00:22:02,360 --> 00:22:07,090
It wants to see the ions that may be coming
off at high velocity.

356
00:22:07,090 --> 00:22:13,070
And it measures the mass and the time of flight
of those particles, and by there, it can determine

357
00:22:13,070 --> 00:22:15,510
the elemental composition.

358
00:22:15,510 --> 00:22:19,820
And then if we move around to the backside
of the spacecraft here, you can see the long

359
00:22:19,820 --> 00:22:20,820
range imager.

360
00:22:20,820 --> 00:22:28,789

And this is about a third of a meter in the
aperture and it takes the images for optical

361
00:22:28,789 --> 00:22:35,399
navigation and also it'll take small high
resolution images while the other Ralph instrument

362
00:22:35,399 --> 00:22:38,700
is taking larger maps of the surface.

363
00:22:38,700 --> 00:22:46,139
And we also have underneath the spacecraft
a student dust measurement counter that will

364
00:22:46,139 --> 00:22:51,150
count the impacts of dust particles from the
region around Pluto.

365
00:22:51,150 --> 00:22:55,650
And then moving over to some of these other
cameras, this is the star camera and it's

366
00:22:55,650 --> 00:22:57,289
an interesting set of cameras.

367
00:22:57,289 --> 00:22:58,399
There's actually two.

368
00:22:58,399 --> 00:23:03,860
We only need one, but we have two for redundancy
and the star camera has two modes of operation.

369
00:23:03,860 --> 00:23:06,779
It'll operate in a spinning mode or a three
axis mode.

370
00:23:06,779 --> 00:23:13,009
And that was very important for our hibernation
period as well, to have some attitude knowledge

371
00:23:13,009 --> 00:23:17,039
while we're traversing in a spinning mode.

372
00:23:17,039 --> 00:23:20,700
Now, when you say three axis, that's when
the spacecraft is actually configured almost

373
00:23:20,700 --> 00:23:22,840
still in--to move around the tech data.

374
00:23:22,840 --> 00:23:23,840
That's correct.

375
00:23:23,840 --> 00:23:27,880
When we take images, we're in a three axis
mode and that's important.

376
00:23:27,880 --> 00:23:30,179
Otherwise, all the images would be blurred.

377
00:23:30,179 --> 00:23:34,910
When we're in a spinning mode, we don't take
image data, but we can still take the particles

378
00:23:34,910 --> 00:23:35,910
and plasma data.

379
00:23:35,910 --> 00:23:38,910
We can also take the student dust counter
measurements.

380
00:23:38,910 --> 00:23:43,279
So, moving on over here to the sun sensor.

381
00:23:43,279 --> 00:23:49,270
Just in case the star tracker has a problem
and it can't get a lock on the stars and we

382

00:23:49,270 --> 00:23:54,259
need to go to a safe mode, we keep on board
a sun sensor so that we can point to the sun.

383
00:23:54,259 --> 00:23:57,779
Even if we don't know what day it is, if we
don't know anything else, we can always point

384
00:23:57,779 --> 00:24:02,309
to the sun and we know that we'll be able
to get commands in through the medium gain

385
00:24:02,309 --> 00:24:03,309
antenna.

386
00:24:03,309 --> 00:24:06,710
And you know, that far out, too, I mean, if
you're just pointing at the sun, Earth is

387
00:24:06,710 --> 00:24:07,710
nearby.

388
00:24:07,710 --> 00:24:08,710
That's correct.

389
00:24:08,710 --> 00:24:09,710
Just be able to do that.

390
00:24:09,710 --> 00:24:11,580
It's only--it's very close in the region of
the sky.

391
00:24:11,580 --> 00:24:12,809
And that was why we designed this.

392
00:24:12,809 --> 00:24:16,970
We didn't need it for power, but we do want
it for the ability to communicate.

393

00:24:16,970 --> 00:24:20,880
So, if we lose the time on board, we can always
point to the sun.

394
00:24:20,880 --> 00:24:25,919
So, we define that as the lowest level of
safe mode for the spacecraft in case it loses

395
00:24:25,919 --> 00:24:29,129
track of time or doesn't know where the Earth
is.

396
00:24:29,129 --> 00:24:30,860
It can't find the Earth.

397
00:24:30,860 --> 00:24:34,740
So, that's the tour of the New Horizons spacecraft.

398
00:24:34,740 --> 00:24:38,980
I mean, it looks--it sounds like the design
has proved itself out so far, right?

399
00:24:38,980 --> 00:24:44,879
I mean, nine years in space, 3 billion miles
and it's still working and working well.

400
00:24:44,879 --> 00:24:47,320
It has a job to do at Pluto.

401
00:24:47,320 --> 00:24:48,320
Right.

402
00:24:48,320 --> 00:24:52,480
And it may have a job to do deeper in the
Kuiper Belt with NASA's okay.

403
00:24:52,480 --> 00:24:54,640
Just how long could the spacecraft go?

404

00:24:54,640 --> 00:24:55,640
How long could it last?

405
00:24:55,640 --> 00:24:59,869
So, the thing--if everything all goes well,
we've done some estimates on the amount of

406
00:24:59,869 --> 00:25:02,990
power that we can have at the Kuiper Belt.

407
00:25:02,990 --> 00:25:06,200
And our Kuiper Belt looks like we'll have
about 12 watts less.

408
00:25:06,200 --> 00:25:08,059
So, we actually have to budget.

409
00:25:08,059 --> 00:25:09,750
What can't we save in power?

410
00:25:09,750 --> 00:25:12,539
And we've already come up with strategies
for that.

411
00:25:12,539 --> 00:25:15,220
And then we said how far do you think we can
go?

412
00:25:15,220 --> 00:25:17,840
How low can we go in power and still keep
operating?

413
00:25:17,840 --> 00:25:23,419
And we've made a conservative estimate on
what we could do for a mission beyond the

414
00:25:23,419 --> 00:25:24,980
Kuiper Belt.

415

00:25:24,980 --> 00:25:30,499
And there are a lot of interesting interactions
between the heliosphere and what's beyond

416
00:25:30,499 --> 00:25:31,499
that.

417
00:25:31,499 --> 00:25:32,649
And so, we'd like to get there.

418
00:25:32,649 --> 00:25:37,679
And it looks like we can make it until the
mid 2030s at least.

419
00:25:37,679 --> 00:25:40,330
Assuming nothing goes wrong and we're all
superstitious.

420
00:25:40,330 --> 00:25:41,590
Knock on wood.

421
00:25:41,590 --> 00:25:50,280
But, yeah, it looks like 2030 is--a mid 2030s
is where we're predicting we could at least,

422
00:25:50,280 --> 00:25:54,220
you know, conservatively get to with the power
that we have on board.

423
00:25:54,220 --> 00:25:56,999
Oh, this has always been a mission of patience
to begin with, right?

424
00:25:56,999 --> 00:25:57,999
Right.

425
00:25:57,999 --> 00:25:58,999
So, a few more years after this.

426

00:25:58,999 --> 00:25:59,999
So, all right.

427
00:25:59,999 --> 00:26:00,999
Well, thanks, Chris.

428
00:26:00,999 --> 00:26:01,999
Oh.

429
00:26:01,999 --> 00:26:02,999
It's--thank you, Michael.

430
00:26:02,999 --> 00:26:06,570
Out on the fringes of the solar system where
New Horizons will encounter Pluto, sunlight

431
00:26:06,570 --> 00:26:08,399
is much weaker than it is here on Earth.

432
00:26:08,399 --> 00:26:10,549
But, it isn't completely dark.

433
00:26:10,549 --> 00:26:13,540
In fact, it's a big brighter than you might
expect.

434
00:26:13,540 --> 00:26:18,059
For just a moment near dawn and dusk each
day, the illumination on Earth matches that

435
00:26:18,059 --> 00:26:21,360
of noon on Pluto and we call this Pluto time.

436
00:26:21,360 --> 00:26:26,299
And NASA recently introduced a web program
that allows you to find Pluto time in your

437
00:26:26,299 --> 00:26:27,299
area.

438
00:26:27,299 --> 00:26:30,850
You start by plugging your coordinates into
the map and then find out when it's Pluto

439
00:26:30,850 --> 00:26:32,980
time in your area.

440
00:26:32,980 --> 00:26:36,799
Take a picture during your local Pluto time
and share it to social media with the hash

441
00:26:36,799 --> 00:26:38,799
tag Pluto time.

442
00:26:38,799 --> 00:26:42,649
NASA will highlight some of the most interesting
shots from around the world.

443
00:26:42,649 --> 00:26:48,490
Next month, after New Horizons makes its historic
flight past Pluto on July 14th, we'll combine

444
00:26:48,490 --> 00:26:53,179
as many submitted images as we can into a
mosaic image of Pluto and its moons.

445
00:26:53,179 --> 00:26:55,150
That's pretty cool.

446
00:26:55,150 --> 00:26:59,379
So, that's the latest from NASA's New Horizons
mission on Pluto's doorstep.

447
00:26:59,379 --> 00:27:03,860
Twenty-eight days and 20 million miles to
go until the flyby, the countdown to Pluto

448
00:27:03,860 --> 00:27:04,980

continues.