
NASA
Jet Propulsion Laboratory
California Institute of Technology
Thomas Zurbuchen
ight Director

1
00:00:02,268 --> 00:00:05,038
[dramatic music]

2
00:00:38,438 --> 00:00:40,573
- Hello everyone,
I'm Gay Yee Hill,

3
00:00:40,573 --> 00:00:43,443
and welcome to NASA's Jet
Propulsion Laboratory.

4
00:00:43,443 --> 00:00:45,845
After two decades in space,

5
00:00:45,845 --> 00:00:48,114
the Cassini
spacecraft has reached

6
00:00:48,114 --> 00:00:50,316
the end of its
journey at Saturn.

7
00:00:50,316 --> 00:00:52,719
Earlier this morning,
the spacecraft made

8
00:00:52,719 --> 00:00:55,088
its final approach
to the giant planet,

9
00:00:55,088 --> 00:00:57,991
and plunged into Saturn's
upper atmosphere,

10
00:00:57,991 --> 00:01:00,760
ending this
extraordinary mission.

11
00:01:00,760 --> 00:01:03,730

But due to the time it
takes for radio signals

12
00:01:03,730 --> 00:01:06,499
to travel almost a billion miles

13
00:01:06,499 --> 00:01:08,701
between the ringed
planet and Earth,

14
00:01:08,701 --> 00:01:11,504
the team won't have
confirmation that the mission

15
00:01:11,504 --> 00:01:15,675
has ended until they see
Cassini's signal drop away.

16
00:01:17,110 --> 00:01:19,312
The Deep Space Network is
monitoring Cassini's signal.

17
00:01:19,312 --> 00:01:22,549
As you can see on
this DSN Now display,

18
00:01:22,549 --> 00:01:26,286
it's being tracked by a
70-meter-wide antenna,

19
00:01:26,286 --> 00:01:29,222
Antenna 43, in
Canberra, Australia.

20
00:01:31,491 --> 00:01:33,726
Here's a live picture
of the control room

21
00:01:33,726 --> 00:01:35,495
on the other side of the world.

22
00:01:35,495 --> 00:01:37,564
The DSN team in
Australia is keeping

23
00:01:37,564 --> 00:01:41,134
a watchful eye on Cassini's
final transmission.

24
00:01:41,134 --> 00:01:44,804
Meanwhile, it is four
AM here in California.

25
00:01:46,306 --> 00:01:49,943
The sun is not up yet and more
than 1500 Cassini scientists,

26
00:01:51,144 --> 00:01:53,546
engineers, alumni,
friends, and family

27
00:01:53,546 --> 00:01:55,515
have gathered for this moment.

28
00:01:55,515 --> 00:01:59,219
The flight team is in the
Cassini Mission Control Area.

29
00:01:59,219 --> 00:02:03,323
Others have gathered in von
Karman Auditorium here at JPL,

30
00:02:04,491 --> 00:02:07,827
and still more are at
CalTech in Pasadena.

31
00:02:09,295 --> 00:02:12,165
Folks wanted to be together
to share this final moment.

32
00:02:13,333 --> 00:02:15,468
This is a vigil, but
also a celebration

33
00:02:15,468 --> 00:02:17,871
of a remarkable mission.

34
00:02:17,871 --> 00:02:21,441
This is the last hour
of the last chapter

35
00:02:21,441 --> 00:02:23,610
of Cassini's grand finale.

36
00:02:26,646 --> 00:02:29,482
[dramatic music]

37
00:02:30,416 --> 00:02:33,453
- [Narrator] A lone explorer.

38
00:02:33,453 --> 00:02:37,123
On a mission to reveal
the grandeur of Saturn,

39
00:02:37,123 --> 00:02:38,791
its rings and moons.

40
00:02:44,297 --> 00:02:48,168
After 20 years in space,
NASA's Cassini spacecraft

41
00:02:48,168 --> 00:02:50,069
is running out of fuel.

42
00:02:51,905 --> 00:02:54,908
And so, to protect
moons of Saturn

43

00:02:54,908 --> 00:02:58,578
that could have conditions
suitable for life,

44
00:02:58,578 --> 00:03:00,747
a spectacular end
has been planned

45
00:03:00,747 --> 00:03:04,083
for this long-lived
traveler from Earth.

46
00:03:06,986 --> 00:03:10,490
- [Announcer] Five,
four, three, two, one.

47
00:03:11,958 --> 00:03:14,794
And lift-off of the
Cassini spacecraft

48
00:03:14,794 --> 00:03:17,397
on a billion-mile
trek to Saturn.

49
00:03:17,397 --> 00:03:19,365
We have cleared the tower.

50
00:03:19,365 --> 00:03:20,967
Pitch program is in.

51
00:03:20,967 --> 00:03:22,468
Roll program is in.

52
00:03:23,803 --> 00:03:26,739
- [Narrator] In 2004,
following a seven-year journey

53
00:03:26,739 --> 00:03:30,210
through the solar system,
Cassini arrived at Saturn.

54
00:03:31,344 --> 00:03:32,612
- [Announcer] The
SOI burn attitude are

55
00:03:32,612 --> 00:03:34,948
pointing position, and
light up the rockets.

56
00:03:34,948 --> 00:03:38,218
- [Narrator] The spacecraft
carried a passenger,

57
00:03:38,218 --> 00:03:40,386
the European Huygens Probe,

58
00:03:40,386 --> 00:03:43,289
the first human-made
object to land on a world

59
00:03:43,289 --> 00:03:45,892
in the distant
outer solar system.

60
00:03:45,892 --> 00:03:48,828
- [Announcer] The Huygens
arrival on Saturn's moon, Titan.

61
00:03:48,828 --> 00:03:50,730
- [Narrator] For over a decade,

62
00:03:50,730 --> 00:03:53,399
Cassini has shared
the wonders of Saturn

63
00:03:53,399 --> 00:03:55,768
and its family of icy moons,

64
00:03:55,768 --> 00:03:58,071

taking us to astounding worlds

65
00:03:58,071 --> 00:04:01,608
where methane rivers
run to a methane sea,

66
00:04:01,608 --> 00:04:05,778
where jets of ice and
gas are blasting material

67
00:04:06,980 --> 00:04:08,881
into space from a
liquid water ocean

68
00:04:08,881 --> 00:04:12,452
that might harbor the
ingredients for life.

69
00:04:13,853 --> 00:04:17,824
And Saturn, a giant world
ruled by raging storms

70
00:04:18,858 --> 00:04:21,561
and delicate
harmonies of gravity.

71
00:04:24,864 --> 00:04:28,534
Now, Cassini has one
last daring assignment.

72
00:04:37,277 --> 00:04:41,281
Cassini's grand finale
is a brand-new adventure.

73
00:04:44,751 --> 00:04:48,321
As it repeatedly braves
this unexplored region,

74
00:04:48,321 --> 00:04:51,557
Cassini seeks new insights

about the origins of the rings

75
00:04:51,557 --> 00:04:54,627
and the nature of the
planet's interior,

76
00:04:54,627 --> 00:04:57,463
closer to Saturn
than ever before.

77
00:05:04,570 --> 00:05:08,741
On the final orbit, Cassini
will plunge into Saturn,

78
00:05:09,876 --> 00:05:13,212
fighting to keep its
antenna pointed at Earth

79
00:05:13,212 --> 00:05:15,648
as it transmits its farewell.

80
00:05:17,850 --> 00:05:21,254
In the skies of Saturn,
the journey ends,

81
00:05:25,024 --> 00:05:28,761
as Cassini becomes part
of the planet itself.

82
00:05:53,486 --> 00:05:57,156
- Okay, let's do the
numbers, the Cassini numbers.

83
00:05:57,156 --> 00:05:59,225
The mission has traveled nearly

84
00:05:59,225 --> 00:06:01,794
five billion miles since launch,

85

00:06:01,794 --> 00:06:04,297
executed 2.5 million commands,

86
00:06:05,698 --> 00:06:09,635
taken 453,000-plus images,
discovered six moons,

87
00:06:11,838 --> 00:06:15,375
published nearly
4,000 science papers,

88
00:06:15,375 --> 00:06:17,243
and it's not done.

89
00:06:17,243 --> 00:06:21,414
Cassini is sending home data
right now, right to the end.

90
00:06:22,281 --> 00:06:23,750
Let's take a look now and talk

91
00:06:23,750 --> 00:06:26,486
to Cassini program manager
Earl Maize about this.

92
00:06:26,486 --> 00:06:30,323
After a lineup like that,
you have to be impressed.

93
00:06:30,323 --> 00:06:31,557
- We are impressed.

94
00:06:31,557 --> 00:06:33,760
It's very impressive,
and we're very proud

95
00:06:33,760 --> 00:06:35,595
of what we've been
able to accomplish

96
00:06:35,595 --> 00:06:37,764
over the last 13 years at
Saturn, it's just been awesome.

97
00:06:37,764 --> 00:06:39,799
- So a lot of people
are asking, then,

98
00:06:39,799 --> 00:06:42,268
why must we end this
mission this way?

99
00:06:42,268 --> 00:06:45,571
- Well really, if you think
about it a little bit,

100
00:06:45,571 --> 00:06:48,007
you'll find out we
didn't have any choice.

101
00:06:48,007 --> 00:06:52,145
Cassini must be disposed
of properly at some point.

102
00:06:52,145 --> 00:06:54,313
There are international
treaties that require

103
00:06:54,313 --> 00:06:56,282
that we can't just leave
a derelict spacecraft

104
00:06:56,282 --> 00:06:58,084
in orbit around a
planet like Saturn,

105
00:06:58,084 --> 00:06:59,519
which has prebiotic moons.

106

00:06:59,519 --> 00:07:01,621
So we've got to do
something about it.

107
00:07:01,621 --> 00:07:03,990
We could have sent
Cassini away from Saturn,

108
00:07:03,990 --> 00:07:07,493
but Saturn was so
compelling, so exciting,

109
00:07:08,628 --> 00:07:10,563
and the mission that
we finally came up with

110
00:07:10,563 --> 00:07:14,333
is so rich scientifically
that we just couldn't,

111
00:07:14,333 --> 00:07:17,970
we had to finish up at
Saturn, not someplace else.

112
00:07:17,970 --> 00:07:21,307
So the mission really started
about seven years ago.

113
00:07:21,307 --> 00:07:23,309
We've been on this
path to actually end up

114
00:07:23,309 --> 00:07:25,778
right where we are, right
now, in less than an hour.

115
00:07:25,778 --> 00:07:28,080
- So, let's talk about
what's about to happen

116

00:07:28,080 --> 00:07:31,818
and kind of walk viewers
through what to expect.

117
00:07:31,818 --> 00:07:35,087
But let's start with Monday
and the kiss goodbye.

118
00:07:35,087 --> 00:07:36,556
Can we talk about that?

119
00:07:36,556 --> 00:07:38,424
- Can we bring up
this first graphic?

120
00:07:38,424 --> 00:07:39,826
Let's see what we got here.

121
00:07:39,826 --> 00:07:43,362
So this is the last
22 orbits of Saturn.

122
00:07:43,362 --> 00:07:46,032
And every one of them is
going between the rings

123
00:07:46,032 --> 00:07:49,669
and Saturn, absolutely
unexplored territory,

124
00:07:49,669 --> 00:07:51,938
fantastic science every time.

125
00:07:51,938 --> 00:07:54,006
And what's been also
happening is that

126
00:07:54,006 --> 00:07:56,476
that out there
further away is Titan,

127
00:07:56,476 --> 00:07:58,377
and every now and
then, Titan comes by,

128
00:07:58,377 --> 00:08:00,480
and you're gonna see
it come by for one last

129
00:08:00,480 --> 00:08:02,748
final kiss goodbye, that was it.

130
00:08:02,748 --> 00:08:04,450
It was very quick.

131
00:08:04,450 --> 00:08:06,085
You have to, don't blink.

132
00:08:06,085 --> 00:08:08,721
What happened on Monday
was that Titan came by

133
00:08:08,721 --> 00:08:11,123
and gave Cassini one
last little nudge.

134
00:08:11,123 --> 00:08:13,793
Took away a few 10ths
of meters per second,

135
00:08:13,793 --> 00:08:16,863
slowed us down just
enough so that our entry

136
00:08:16,863 --> 00:08:19,165
into Saturn in just
a few minutes now

137
00:08:19,165 --> 00:08:20,766

is absolutely inevitable.

138
00:08:20,766 --> 00:08:24,036
- So, Cassini's
fate is just sealed.

139
00:08:24,036 --> 00:08:25,738
- Sealed, absolutely done.

140
00:08:25,738 --> 00:08:27,874
There was, wasn't much we
could've done about it before

141
00:08:27,874 --> 00:08:29,976
because this thing
had been so wired in,

142
00:08:29,976 --> 00:08:31,477
but after that Titan fly by,

143
00:08:31,477 --> 00:08:33,279
there is absolutely
nothing we can do.

144
00:08:33,279 --> 00:08:35,481
- So, step us through
what has happened

145
00:08:35,481 --> 00:08:39,218
over this last week then,
getting ready for this moment.

146
00:08:39,218 --> 00:08:41,721
- Okay well, because
Cassini's still

147
00:08:41,721 --> 00:08:44,423
a science machine, really
most of what we've been doing

148
00:08:44,423 --> 00:08:46,058
is still gathering more science.

149
00:08:46,058 --> 00:08:47,927
And so, if you look at
this graphic up here,

150
00:08:47,927 --> 00:08:50,229
we saw, there's the
Titan, the kiss goodbye

151
00:08:50,229 --> 00:08:53,299
on September 11th, and then
we turn right back around

152
00:08:53,299 --> 00:08:56,569
after flying by Titan,
getting a lot of Titan,

153
00:08:56,569 --> 00:08:58,371
we turned around, played
all that data back,

154
00:08:58,371 --> 00:09:00,139
it's on the monitors
on these displays,

155
00:09:00,139 --> 00:09:01,641
you can see those.

156
00:09:01,641 --> 00:09:03,242
Played back all of
the data from Titan,

157
00:09:03,242 --> 00:09:05,278
got confused with the
north of the lakes

158
00:09:05,278 --> 00:09:07,680

and the clouds again,
then Cassini turned

159
00:09:07,680 --> 00:09:11,517
back around again for its final
set of science observations.

160
00:09:11,517 --> 00:09:13,486
And we actually did a
little bit of science

161
00:09:13,486 --> 00:09:16,055
and a little bit
of just nostalgia.

162
00:09:16,055 --> 00:09:17,957
We took our last
picture of Enceladus,

163
00:09:17,957 --> 00:09:19,392
our last picture of Titan,

164
00:09:19,392 --> 00:09:22,395
our last picture of
the rings and planet,

165
00:09:22,395 --> 00:09:25,264
and we want to more
look at the propellers

166
00:09:25,264 --> 00:09:28,200
and Peggy, the little
moon we discovered

167
00:09:28,200 --> 00:09:29,402
out in the A ring.

168
00:09:29,402 --> 00:09:30,903
So there's a little
bit of science,

169
00:09:30,903 --> 00:09:33,739
a little bit of just kind
of last memento photos,

170
00:09:33,739 --> 00:09:35,541
and those all got played back,

171
00:09:35,541 --> 00:09:38,277
beginning yesterday
afternoon, about 2:45.

172
00:09:38,277 --> 00:09:40,646
Cassini turned back for
final call to Earth,

173
00:09:40,646 --> 00:09:42,281
played all those data back.

174
00:09:42,281 --> 00:09:44,183
They're also available
on real time display.

175
00:09:44,183 --> 00:09:46,519
About one o'clock this morning,

176
00:09:46,519 --> 00:09:48,654
all that data was
down on the ground.

177
00:09:48,654 --> 00:09:50,890
Cassini then rigged
herself up for,

178
00:09:50,890 --> 00:09:54,193
if we go back to that
timeline just for a moment.

179
00:09:54,193 --> 00:09:56,729

Can we go back one, yeah.
- Go back one, there you go.

180
00:09:56,729 --> 00:10:00,633
So September 15th and 137
down there, that last plot,

181
00:10:00,633 --> 00:10:04,370
we actually figured ourselves
into a real-time Saturn probe.

182
00:10:04,370 --> 00:10:06,072
Everything that comes into the

183
00:10:06,072 --> 00:10:08,374
spacecraft goes right back out.

184
00:10:08,374 --> 00:10:10,710
So there's no delay, or as
little delay as we could make,

185
00:10:10,710 --> 00:10:12,578
so that we actually can
become an atmospheric

186
00:10:12,578 --> 00:10:14,747
sampling mission as
we go into the planet.

187
00:10:14,747 --> 00:10:18,918
And then of course at 4:55
AM, that's give or take a few

188
00:10:20,453 --> 00:10:22,622
seconds on that,
we'll be entering into
Saturn's atmosphere.

189
00:10:22,622 --> 00:10:24,790
- And let's advance

to the next display.

190
00:10:24,790 --> 00:10:28,060
This is what's going to be
happening within the last hour.

191
00:10:28,060 --> 00:10:31,030
- That's exactly right, we
came in over the North Pole,

192
00:10:31,030 --> 00:10:34,000
just a little bit east
from that perspective.

193
00:10:34,000 --> 00:10:37,036
Actually that looks west
here, but a little bit over

194
00:10:37,036 --> 00:10:39,639
the North Pole, just before
four o'clock this morning,

195
00:10:39,639 --> 00:10:41,440
we were 60 degrees
north, and as you

196
00:10:41,440 --> 00:10:43,609
can see, that descent
is very rapid.

197
00:10:43,609 --> 00:10:46,412
In 20 minutes from now or so
we'll be at 50 degrees north.

198
00:10:46,412 --> 00:10:49,582
Then 12 minutes later
40, and we'll be slowly,

199
00:10:49,582 --> 00:10:51,951
not slowly, very

rapidly increasing.

200
00:10:51,951 --> 00:10:55,087
The 10 degree north
latitude impact point

201
00:10:55,087 --> 00:10:57,690
is just about where
we're gonna finish up.

202
00:10:57,690 --> 00:11:01,560
And it's gonna happen about
5:05 this morning local time.

203
00:11:01,560 --> 00:11:03,529
- And the last 90 seconds.

204
00:11:03,529 --> 00:11:06,232
- The last 90 seconds,
this is really

205
00:11:06,232 --> 00:11:07,767
where it's all
gonna be happening.

206
00:11:07,767 --> 00:11:09,769
Cassini's not gonna
even really notice

207
00:11:09,769 --> 00:11:12,705
Saturn until the
last 90 seconds.

208
00:11:12,705 --> 00:11:14,907
Because it's in free fall
around the gravitational body,

209
00:11:14,907 --> 00:11:18,010
it's just doing its thing
and playing our thing.

210
00:11:18,010 --> 00:11:21,447
But between 70 and 60 seconds
out from final impact,

211
00:11:21,447 --> 00:11:23,549
it will start to
notice the atmosphere,

212
00:11:23,549 --> 00:11:25,451
and you can see in
this graphic the very

213
00:11:25,451 --> 00:11:28,020
tenuous atmosphere
starting to experience.

214
00:11:28,020 --> 00:11:30,256
Now Cassini's been fighting
in that atmosphere before.

215
00:11:30,256 --> 00:11:31,791
As a matter of fact for the last

216
00:11:31,791 --> 00:11:33,826
five revs we've been doing that.

217
00:11:33,826 --> 00:11:35,628
And it's done very well.

218
00:11:35,628 --> 00:11:38,297
But this time, because
we're gonna go in so deep,

219
00:11:38,297 --> 00:11:39,999
there's not a chance that it can

220
00:11:39,999 --> 00:11:41,767
fight to hold onto

the atmosphere.

221
00:11:41,767 --> 00:11:44,003
That atmosphere where
we've been fighting so far

222
00:11:44,003 --> 00:11:47,673
is about the same density
as the atmosphere that

223
00:11:47,673 --> 00:11:50,843
the International Space Station
experiences here on Earth.

224
00:11:50,843 --> 00:11:54,413
Very thin, but we're going
very very fast. [laughs]

225
00:11:54,413 --> 00:11:58,017
- Alright, and we have the
animation from the video early.

226
00:11:58,017 --> 00:12:00,453
It sort of helps us envision.
- Okay.

227
00:12:00,453 --> 00:12:02,988
- [Gay] Although it might
be painful to watch.

228
00:12:02,988 --> 00:12:05,224
- Well it's
actually, what's your

229
00:12:05,224 --> 00:12:06,759
watching is valued spacecraft.

230
00:12:06,759 --> 00:12:09,495
So you can see the thrusters
coming out the back

231
00:12:09,495 --> 00:12:11,530
as it starts to
encounter the atmosphere.

232
00:12:11,530 --> 00:12:13,165
Those are small thrusters.

233
00:12:13,165 --> 00:12:16,602
They just aren't built to
fight the kind of torques.

234
00:12:16,602 --> 00:12:19,672
And by the way, that's
the antennae still trying

235
00:12:19,672 --> 00:12:21,607
to point at the Earth,
those thrusters just aren't

236
00:12:21,607 --> 00:12:24,276
built to handle the kind
of atmospheric torque

237
00:12:24,276 --> 00:12:26,245
and drag that Cassini's
gonna experience.

238
00:12:26,245 --> 00:12:29,215
But for about a minute,
Cassini will hang on,

239
00:12:29,215 --> 00:12:31,183
will be sampling the atmosphere,

240
00:12:31,183 --> 00:12:33,519
we'll be sending the data
back as quickly as we can,

241

00:12:33,519 --> 00:12:36,489
and then finally of course,
it's gonna lose the battle

242
00:12:36,489 --> 00:12:39,925
and within the next minute
will be completely and totally

243
00:12:39,925 --> 00:12:43,496
vaporized, becoming part of
the planet it went to explore.

244
00:12:43,496 --> 00:12:44,797
- [Gay] Just as planned.

245
00:12:44,797 --> 00:12:46,565
- As planned, just
exactly the way

246
00:12:46,565 --> 00:12:48,300
we've always had it to be.

247
00:12:48,300 --> 00:12:51,237
- And so for the team,
it is bittersweet.

248
00:12:51,237 --> 00:12:55,407
I mean it is sad, but there's
tremendous energy here.

249
00:12:56,041 --> 00:12:57,243
- There is.

250
00:12:57,243 --> 00:12:59,378
I think we're excited,
because this is

251
00:12:59,378 --> 00:13:01,680
exactly the way we
always planned this.

252
00:13:01,680 --> 00:13:03,916
It's sad that we're
losing, you know,

253
00:13:03,916 --> 00:13:06,118
an incredible discovery
machine, that's a loss.

254
00:13:06,118 --> 00:13:08,320
But it was always in the plans.

255
00:13:08,320 --> 00:13:11,457
And now it's working exactly
the way we set it out.

256
00:13:11,457 --> 00:13:13,926
The images we've seen
from the last few revs

257
00:13:13,926 --> 00:13:15,694
and the science we've had from

258
00:13:15,694 --> 00:13:17,797
this entire approximal orbit
has just been phenomenal.

259
00:13:17,797 --> 00:13:21,100
So the real sense here is
just, alright, we got it.

260
00:13:21,100 --> 00:13:22,501
- You have, you have.
- We have.

261
00:13:22,501 --> 00:13:24,303
- What a wonderful tour.
- Alright, thank you.

262

00:13:24,303 --> 00:13:26,605
- Alright, well thanks
so much for joining us.

263
00:13:26,605 --> 00:13:28,240
I'll let you back in the room,

264
00:13:28,240 --> 00:13:29,842
I know you wanna
be back in there.

265
00:13:29,842 --> 00:13:31,977
Alright, thanks Earl.
- I do, thanks.

266
00:13:31,977 --> 00:13:34,647
- Meanwhile, DSN 43 in Australia

267
00:13:34,647 --> 00:13:37,616
is the antenna locked
on Cassini's signal.

268
00:13:37,616 --> 00:13:40,352
And let's check
the update display.

269
00:13:40,352 --> 00:13:43,622
The expected loss of
signal is 4:55 AM.

270
00:13:45,591 --> 00:13:49,161
And that is about 41
minutes away from now.

271
00:13:56,001 --> 00:13:58,237
- We've managed to inspire

272
00:13:58,237 --> 00:14:00,506
a younger generation
of scientists.

273
00:14:00,506 --> 00:14:04,476
And they will continue
after this is over and after

274
00:14:04,476 --> 00:14:08,647
the original investigators
are gone to march on for

275
00:14:10,015 --> 00:14:13,252
their own challenges for
future spacecraft exploration.

276
00:14:17,890 --> 00:14:20,359
- Let's look back to
what inspired the mission

277
00:14:20,359 --> 00:14:22,995
and the day Cassini
arrived at Saturn,

278
00:14:22,995 --> 00:14:26,565
the Cassini-Huygens Mission
was a joint effort of NASA,

279
00:14:26,565 --> 00:14:30,169
the European Space Agency,
and the Italian Space Agency.

280
00:14:30,169 --> 00:14:33,739
It was conceived after the
Voyager flybys of Saturn,

281
00:14:33,739 --> 00:14:37,176
and scientists
all over the world

282
00:14:37,176 --> 00:14:39,612
insisted they had to go back.

283
00:14:47,953 --> 00:14:49,922
- Hello, this is Arthur Clark,

284
00:14:49,922 --> 00:14:53,859
joining you from my home
in Colombo, Sri Lanka.

285
00:14:56,262 --> 00:14:59,398
Thanks to the World Wide
Web, I've been following

286
00:14:59,398 --> 00:15:03,202
the progress of
Cassini-Huygens from the time

287
00:15:03,202 --> 00:15:06,038
it was launched
several years ago.

288
00:15:06,038 --> 00:15:10,209
As you know, I have more than
a passing interest in Saturn.

289
00:15:11,777 --> 00:15:13,846
So I'm going to keep my fingers

290
00:15:13,846 --> 00:15:17,416
crossed with what
Cassini discovers.

291
00:15:17,416 --> 00:15:21,420
And who know, one day
our survival on Earth

292
00:15:21,420 --> 00:15:24,857
may depend on what we
discover out there.

293
00:15:54,887 --> 00:15:56,889

- [Radio Operator]
Flight's going up.

294
00:15:56,889 --> 00:15:58,991
- [Co-Radio Operator]
Go ahead in flight com.

295
00:15:58,991 --> 00:16:01,593
- [Radio Operator] The
downloader has flattened out.

296
00:16:01,593 --> 00:16:05,664
[people applauding and cheering]

297
00:16:09,335 --> 00:16:11,437
- Okay, we have
burn complete here

298
00:16:11,437 --> 00:16:14,173
for the SOI orbit
insertion burn.

299
00:16:17,843 --> 00:16:20,446
- From Saturn's strong
gravity pulling it in.

300
00:16:20,446 --> 00:16:23,282
SOI burn attitude or
pointing direction

301
00:16:23,282 --> 00:16:26,151
and will help to
acquire a signal

302
00:16:26,151 --> 00:16:29,989
before that turn
actually completes.

303
00:16:29,989 --> 00:16:33,025
- Now the voice you heard

announcing the arrival

304
00:16:33,025 --> 00:16:36,562
of Saturn June 30th,
2004 was the voice

305
00:16:36,562 --> 00:16:39,531
of Cassini propulsion
engineer Todd Barber.

306
00:16:39,531 --> 00:16:43,469
Todd served as the
team's commentator
and Todd is back today

307
00:16:43,469 --> 00:16:46,271
once again serving as
our team commentator

308
00:16:46,271 --> 00:16:50,442
in the same mission control
room for a much different event.

309
00:16:51,643 --> 00:16:52,878
How does it feel,
Todd, to be here?

310
00:16:52,878 --> 00:16:54,780
- Hi Gay, well it's
great to be back.

311
00:16:54,780 --> 00:16:57,850
It's kind of cruel
to age 13 years

312
00:16:57,850 --> 00:16:59,852
in two seconds and
have to watch that.

313
00:16:59,852 --> 00:17:03,689

But what a demonstration of
the longevity of this mission.

314
00:17:03,689 --> 00:17:06,258
As you and I sat there
in 2004, we never

315
00:17:06,258 --> 00:17:09,862
dreamt we'd be here
in 2017 still talking

316
00:17:09,862 --> 00:17:12,664
about Cassini and
collecting science data.

317
00:17:12,664 --> 00:17:14,666
So I'm just thrilled to be here,

318
00:17:14,666 --> 00:17:18,170
even having aged
some years since SOI.

319
00:17:18,170 --> 00:17:21,440
- Todd, very quickly, we're a
couple of minutes behind here,

320
00:17:21,440 --> 00:17:24,676
explain qto us why the
team has gathered here

321
00:17:24,676 --> 00:17:28,647
even though you had told
me that the spacecraft

322
00:17:28,647 --> 00:17:32,818
met its fate probably about
3:30, 3:30 Pacific time,

323
00:17:34,787 --> 00:17:38,257
out at Saturn, but yet the

team is waiting here now

324
00:17:38,257 --> 00:17:41,026
and holding vigil, why is that?

325
00:17:41,026 --> 00:17:43,395
- Well, it's that pesky
Albert Einstein and his speed

326
00:17:43,395 --> 00:17:46,698
of light speed limit,
186,000 miles per second

327
00:17:46,698 --> 00:17:48,534
or 300,000 kilometers
per second.

328
00:17:48,534 --> 00:17:51,003
So Saturn is about an
hour and 23 minutes

329
00:17:51,003 --> 00:17:53,906
away from us right now,
one way light time.

330
00:17:53,906 --> 00:17:56,308
I'm a big sports nut, I
tape a lot of games in DVR,

331
00:17:56,308 --> 00:17:59,044
and the game is still exciting
if you don't know the result

332
00:17:59,044 --> 00:18:01,547
and you haven't seen it, and
no one's seen the Cassini

333
00:18:01,547 --> 00:18:04,516
last bits of science come
back from Saturn yet.

334
00:18:04,516 --> 00:18:06,819
It's just about
to cross the orbit

335
00:18:06,819 --> 00:18:09,488
of Jupiter, there's our graphic.

336
00:18:09,488 --> 00:18:13,158
And of course Jupiter's a
little different position,

337
00:18:13,158 --> 00:18:16,829
so any denizens of the solar
system at Jupiter or Mars,

338
00:18:16,829 --> 00:18:20,532
they'll know Cassini's
fate and last bit of data

339
00:18:20,532 --> 00:18:22,301
before we will on Earth.

340
00:18:22,301 --> 00:18:23,936
So we're holding vigil here.

341
00:18:23,936 --> 00:18:28,107
We also have this display, kind
of like gauges in your car.

342
00:18:29,575 --> 00:18:32,377
This is the speed notice,
it's 63,000 miles per hour

343
00:18:32,377 --> 00:18:36,215
and climbing as we descend
into Saturn's gravity well.

344
00:18:36,215 --> 00:18:39,551

And on the right side is the
distance from the cloud tops,

345
00:18:39,551 --> 00:18:41,753
and that's just shrinking,
it's gonna head down

346
00:18:41,753 --> 00:18:45,924
over the next 37 minutes
until we meet those cloud tops

347
00:18:47,292 --> 00:18:49,361
and say goodbye to our beautiful
spacecraft out at Saturn.

348
00:18:49,361 --> 00:18:51,396
- And Todd, help us understand

349
00:18:51,396 --> 00:18:53,632
how the team will
be monitoring this.

350
00:18:53,632 --> 00:18:57,569
- Yes, we've got a few ways,
there's a display from,

351
00:18:57,569 --> 00:19:00,205
well here's our radio signal.

352
00:19:00,205 --> 00:19:04,209
So this is the carrier
frequency, and what
I like to point

353
00:19:04,209 --> 00:19:08,280
out here, the peak
in the middle, this
is like the loudness

354
00:19:08,280 --> 00:19:12,451

or the signal strength, and
at the Cassini frequency that

355
00:19:13,886 --> 00:19:16,388
it's talking, we have two
displays by the way, X band

356
00:19:16,388 --> 00:19:18,924
and S band, those are just two
different radio frequencies.

357
00:19:18,924 --> 00:19:21,393
So if you think in your
car radio of tuning

358
00:19:21,393 --> 00:19:23,795
to different frequencies,
that's like moving

359
00:19:23,795 --> 00:19:26,265
along the X axis there,
the horizontal axis.

360
00:19:26,265 --> 00:19:28,834
And we're getting a nice
big strong booming signal

361
00:19:28,834 --> 00:19:30,936
from Cassini on both those axes.

362
00:19:30,936 --> 00:19:35,107
But as we come into
the atmosphere and
turn away from Earth,

363
00:19:36,542 --> 00:19:38,844
our thrusters can't keep
anymore with the torques,

364
00:19:38,844 --> 00:19:40,946

those will flat line and that's

365
00:19:40,946 --> 00:19:43,549
when we say goodbye to Cassini.

366
00:19:43,549 --> 00:19:46,585
However, the key is to
keep the data coming

367
00:19:46,585 --> 00:19:49,254
down to Earth and
get those precious

368
00:19:49,254 --> 00:19:52,491
last few bits of science
data from Saturn.

369
00:19:52,491 --> 00:19:56,495
Our first sniff of the
upper Saturn atmosphere.

370
00:19:56,495 --> 00:19:58,230
And boy we're excited for that.

371
00:19:58,230 --> 00:19:59,932
- Alright, well thanks Todd,

372
00:19:59,932 --> 00:20:01,900
we will check back
with you later.

373
00:20:01,900 --> 00:20:04,703
And one of the signals
Todd showed you is

374
00:20:04,703 --> 00:20:07,372
part of a computer
visualization tool

375

00:20:07,372 --> 00:20:09,741
we call Eyes on
the Solar System.

376
00:20:09,741 --> 00:20:13,212
This JPL computer simulation
software is based on real data

377
00:20:13,212 --> 00:20:16,081
from missions and is
something you can download

378
00:20:16,081 --> 00:20:20,252
onto your own computer and use
to follow along this morning.

379
00:20:21,587 --> 00:20:24,623
Just go to eyes.nasa.gov,
download the app,

380
00:20:25,490 --> 00:20:27,192
and click on Cassini's Tour.

381
00:20:29,228 --> 00:20:32,297
Here are two family
photos we'd like to share.

382
00:20:32,297 --> 00:20:36,301
The top one was taken
on June 21st, 2017.

383
00:20:36,301 --> 00:20:38,804
It's the Cassini
team and alumni,

384
00:20:38,804 --> 00:20:41,773
and they filled the
staircase on the mall here.

385
00:20:41,773 --> 00:20:43,809

Most of them are engineers.

386
00:20:43,809 --> 00:20:47,579
On the bottom photo, and this
one was just taken just a few

387
00:20:47,579 --> 00:20:51,717
days ago, it's the science
team, and they were at Cal Tech.

388
00:20:51,717 --> 00:20:54,720
The team includes scientists
from all over the world.

389
00:20:54,720 --> 00:20:57,289
Over the years thousands
of people have worked

390
00:20:57,289 --> 00:21:00,359
on this mission, in fact there
are so many members of the

391
00:21:00,359 --> 00:21:04,363
Cassini family, we couldn't
fit all of them here at JPL.

392
00:21:04,363 --> 00:21:07,599
It's why there's a big
crowd at Beckman Auditorium

393
00:21:07,599 --> 00:21:10,802
at Cal Tech in Pasadena,
and that is where Cassini

394
00:21:10,802 --> 00:21:13,905
science team member
Morgan Cable is right now.

395
00:21:13,905 --> 00:21:16,742
Morgan, what is

it like out there?

396
00:21:18,710 --> 00:21:21,380
- Hi Gay, well here at Cal Tech,

397
00:21:22,547 --> 00:21:24,549
you can hear it
behind me, right?

398
00:21:24,549 --> 00:21:26,184
This is a historic moment,

399
00:21:26,184 --> 00:21:28,487
and I think the
mood reflects that.

400
00:21:28,487 --> 00:21:31,123
But it's also like
a family reunion.

401
00:21:31,123 --> 00:21:34,393
We're here with our other
fellow Cassini members

402
00:21:34,393 --> 00:21:37,896
where same people we
haven't seen in a long time

403
00:21:37,896 --> 00:21:41,233
for some cases, and
it's just been wonderful

404
00:21:41,233 --> 00:21:44,636
to share these memories,
to revel in the excitement.

405
00:21:44,636 --> 00:21:46,505
This is a celebration of an

406

00:21:46,505 --> 00:21:50,409
amazing mission and
an incredible legacy.

407
00:21:50,409 --> 00:21:51,877
- Morgan,

408
00:21:51,877 --> 00:21:53,812
you're one of the scientists.
- So back to you at JPL.

409
00:21:53,812 --> 00:21:56,315
- You're one of the
scientists out there.

410
00:21:56,315 --> 00:22:00,218
I mean for you, you're
probably being very reflective.

411
00:22:00,218 --> 00:22:04,323
What was one of the highlights
for you this mission?

412
00:22:05,691 --> 00:22:09,061
- For me personally, the
discoveries at Enceladus have

413
00:22:09,061 --> 00:22:12,798
really revolutionized our view
of where we might find life

414
00:22:12,798 --> 00:22:15,667
or at least the conditions
suitable for life

415
00:22:15,667 --> 00:22:18,737
in not only our solar
system, but the universe.

416
00:22:18,737 --> 00:22:21,873

We've learned now that there
are places where liquid water

417
00:22:21,873 --> 00:22:25,344
and the other ingredients for
life as we know it to exist,

418
00:22:25,344 --> 00:22:29,047
chemistry and energy, exist
in places like Enceladus.

419
00:22:29,047 --> 00:22:31,450
And that's thanks to
the Cassini mission,

420
00:22:31,450 --> 00:22:34,820
which flew through the plume
of Enceladus multiple times.

421
00:22:34,820 --> 00:22:38,623
This means that life may not
only exist in the habitable

422
00:22:38,623 --> 00:22:42,060
zone around other stars,
but now we can start to look

423
00:22:42,060 --> 00:22:44,996
for places like Enceladus
or Europa elsewhere

424
00:22:44,996 --> 00:22:47,999
in the universe and
extend our search to try

425
00:22:47,999 --> 00:22:51,870
to find that amazing discovery
of life somewhere else.

426
00:22:51,870 --> 00:22:54,272

- Alright, well we
will be checking

427
00:22:54,272 --> 00:22:56,908
back with you, Morgan,
later on the show.

428
00:22:56,908 --> 00:22:58,276
Thanks for that report.

429
00:22:58,276 --> 00:23:00,779
It is about 23
minutes past the hour.

430
00:23:00,779 --> 00:23:03,682
You're watching live coverage
marking the final moments

431
00:23:03,682 --> 00:23:07,119
of Cassini on NASA TV,
the Deep Space Network

432
00:23:07,119 --> 00:23:09,554
is awaiting the loss of
signal from the spacecraft

433
00:23:09,554 --> 00:23:12,691
from DSN antenna
43 in Australia.

434
00:23:12,691 --> 00:23:16,395
And let's go to Cassini's
final hour display.

435
00:23:16,395 --> 00:23:19,631
At this point the
spacecraft has sent us data

436
00:23:19,631 --> 00:23:23,702
from about the 50 degree

north latitude mark.

437
00:23:23,702 --> 00:23:26,872
And loss of signal
should be coming

438
00:23:26,872 --> 00:23:29,040
about 32 minutes from now.

439
00:23:33,512 --> 00:23:36,248
[dramatic music]

440
00:24:33,171 --> 00:24:35,907
Beautiful images from Cassini.

441
00:24:35,907 --> 00:24:37,876
The Cassini-Huygens'
mission made

442
00:24:37,876 --> 00:24:39,811
so many historic discoveries.

443
00:24:39,811 --> 00:24:41,713
Think about it, the
Huygens probe sent

444
00:24:41,713 --> 00:24:44,115
back details of an
alien world on Titan,

445
00:24:44,115 --> 00:24:47,185
a world that appears to
be very similar to Earth.

446
00:24:47,185 --> 00:24:49,654
It found jets
spraying water, ice,

447
00:24:49,654 --> 00:24:52,324

and organics from the
south pole of Enceladus,

448
00:24:52,324 --> 00:24:55,894
revealing an interior ocean
where there could be life.

449
00:24:55,894 --> 00:24:59,564
Over and over again, the mission
revealed scientific wonders

450
00:24:59,564 --> 00:25:02,234
about Saturn, its
rings and moons,

451
00:25:02,234 --> 00:25:06,238
and it hasn't stopped,
at least not yet.

452
00:25:06,238 --> 00:25:09,608
With me now is Cassini project
scientist Linda Spilker.

453
00:25:09,608 --> 00:25:12,310
This mission was
determined to send

454
00:25:12,310 --> 00:25:15,113
down science right
down to the very end.

455
00:25:15,113 --> 00:25:18,016
- That's right Gay, to
the very last second.

456
00:25:18,016 --> 00:25:21,853
- So Earl told us just a little
while ago that overnight,

457
00:25:21,853 --> 00:25:25,757

the spacecraft sent back
the last picture show,

458
00:25:27,926 --> 00:25:31,096
it's been called, can you
describe what those are?

459
00:25:31,096 --> 00:25:33,765
- Okay, well let's go to the
very first image, image A.

460
00:25:33,765 --> 00:25:36,334
As part of the last picture
show the first thing we did

461
00:25:36,334 --> 00:25:39,571
is we made a color mosaic,
and these are just a couple

462
00:25:39,571 --> 00:25:42,541
of pictures from that mosaic,
we'll stitch those together

463
00:25:42,541 --> 00:25:45,343
and have a beautiful
image of Saturn

464
00:25:45,343 --> 00:25:47,412
plus the rings
for the last time.

465
00:25:47,412 --> 00:25:51,182
We go to image C, that's
a movie of Enceladus

466
00:25:51,182 --> 00:25:55,353
actually setting behind
the limb of Saturn.

467
00:25:56,521 --> 00:25:58,356

- [Gay] And explain to
me how the team decided

468
00:25:58,356 --> 00:26:01,426
to come up with this
imagery and this selection.

469
00:26:01,426 --> 00:26:04,162
- Well, there's a lot of
science in these images,

470
00:26:04,162 --> 00:26:06,798
so we wanted to do science,
oh there's Enceladus,

471
00:26:06,798 --> 00:26:09,200
setting behind the
lumament of Saturn.

472
00:26:09,200 --> 00:26:11,136
So we're saying
goodbye to Enceladus,

473
00:26:11,136 --> 00:26:14,205
and taking a last look
at that particular world.

474
00:26:14,205 --> 00:26:16,775
And so we wanted to
sorta do a survey,

475
00:26:16,775 --> 00:26:18,710
look at each of
these key targets,

476
00:26:18,710 --> 00:26:21,846
collect picture postcards
for our Cassini scrapbook.

477
00:26:21,846 --> 00:26:23,782

So these will be
the last pictures

478
00:26:23,782 --> 00:26:25,684
that we'll put in our scrapbook.

479
00:26:25,684 --> 00:26:29,321
If we look at image E, that's
a true color image of Titan.

480
00:26:29,321 --> 00:26:32,090
And you can see the
lakes up in the north.

481
00:26:32,090 --> 00:26:36,061
Image F shows this in false
color, there's a UV filter

482
00:26:36,061 --> 00:26:39,497
as part of image F and
the lakes really pop out.

483
00:26:39,497 --> 00:26:43,401
And you can also see that bluish
haze at the edge of Titan.

484
00:26:43,401 --> 00:26:46,004
You know, Titan has this
thick nitrogen atmosphere.

485
00:26:46,004 --> 00:26:48,940
And we also took some
pictures of the rings, Gay,

486
00:26:48,940 --> 00:26:51,309
if we go to image
G, we're looking

487
00:26:51,309 --> 00:26:54,045
for propellers in

this particular image.

488
00:26:54,045 --> 00:26:57,382
You can just see a hint
of it above that dark gap.

489
00:26:57,382 --> 00:27:00,251
If we go to image
H, that's a blowup,

490
00:27:00,251 --> 00:27:03,622
and see that little
two-armed propellor,

491
00:27:03,622 --> 00:27:06,291
it's that little bright feature
just above the dark gap.

492
00:27:06,291 --> 00:27:08,860
There's a collection of
ring particles that are

493
00:27:08,860 --> 00:27:10,962
large enough that are trying
to open their own gap,

494
00:27:10,962 --> 00:27:14,032
and they create what looks
like an airplane propellor.

495
00:27:14,032 --> 00:27:17,035
And they have fun
names of aviators.

496
00:27:17,035 --> 00:27:20,805
If we go to image I as
part of the sequence,

497
00:27:20,805 --> 00:27:24,376
we're looking at the

tiny moon Daphnis,

498
00:27:24,376 --> 00:27:26,344
that's the Keeler
Gap, and you can see

499
00:27:26,344 --> 00:27:28,246
those crinkly edges
along the gap.

500
00:27:28,246 --> 00:27:31,816
That's created by Daphnis,
a wake as it goes through

501
00:27:31,816 --> 00:27:35,253
that system, and you can see
the beautiful density waves,

502
00:27:35,253 --> 00:27:38,123
the interaction between the
rings and the satellites also

503
00:27:38,123 --> 00:27:42,293
as those bright features in our
last look at the propellors.

504
00:27:43,028 --> 00:27:44,996
And finally image J.

505
00:27:44,996 --> 00:27:47,799
This is an image looking
at Saturn in a place

506
00:27:47,799 --> 00:27:51,970
where Cassini will be entering,
so one of our last views,

507
00:27:53,071 --> 00:27:55,040
our very last
pictures, of Saturn.

508
00:27:55,040 --> 00:27:56,841
And you can think of Cassini

509
00:27:56,841 --> 00:27:58,977
as basically running a marathon.

510
00:27:58,977 --> 00:28:00,812
For 13 years we've been running

511
00:28:00,812 --> 00:28:03,415
a marathon of
scientific discovery.

512
00:28:03,415 --> 00:28:05,583
And we're on the last lap.

513
00:28:05,583 --> 00:28:08,019
And so we're here today to cheer

514
00:28:08,019 --> 00:28:10,722
as Cassini finishes that race.

515
00:28:10,722 --> 00:28:14,893
- Now many of these images
and what the spacecraft

516
00:28:16,327 --> 00:28:19,230
will be doing right now, all
of this is unknown territory.

517
00:28:20,331 --> 00:28:22,000
The spacecraft has
never been here before.

518
00:28:22,000 --> 00:28:24,469
- That's right, we're
flying into Saturn.

519
00:28:24,469 --> 00:28:26,938
We're deeper than we've
ever flown before.

520
00:28:26,938 --> 00:28:29,507
We have eight of our
scientific instruments on.

521
00:28:29,507 --> 00:28:31,476
They key instrument is the ion

522
00:28:31,476 --> 00:28:33,411
and neutral mass spectrometer.

523
00:28:33,411 --> 00:28:36,448
Basically coming in
we've oriented the
instrument to sample

524
00:28:36,448 --> 00:28:39,150
the atmosphere of Saturn,
which it's doing right now,

525
00:28:39,150 --> 00:28:42,120
deeper and deeper, until
in the very final second

526
00:28:42,120 --> 00:28:44,389
as Cassini fights
to hold attitude,

527
00:28:44,389 --> 00:28:48,593
it'll send back those last
very valuable packets of data.

528
00:28:49,728 --> 00:28:51,930
And who knows how
many PhD theses might

529

00:28:51,930 --> 00:28:55,667
be in just those
final seconds of data.

530
00:28:55,667 --> 00:28:59,237
- Right, we will have
scientists and students

531
00:28:59,237 --> 00:29:02,774
poring over this data for
decades to come, probably.

532
00:29:02,774 --> 00:29:05,477
- Right, and looking at the
hydrogen to helium ratio

533
00:29:05,477 --> 00:29:07,879
to help us understand
how Saturn formed,

534
00:29:07,879 --> 00:29:10,782
how Saturn's evolving,
and who knows what

535
00:29:10,782 --> 00:29:13,318
else we'll see as we
go into the atmosphere.

536
00:29:13,318 --> 00:29:15,887
- What great science
leaves still ahead.

537
00:29:15,887 --> 00:29:18,523
Alright, well Linda,
thanks for joining us.

538
00:29:18,523 --> 00:29:20,225
- [Linda] Yeah, glad to be here.

539
00:29:20,225 --> 00:29:23,061

- You're watching live
coverage of Cassini's

540
00:29:23,061 --> 00:29:25,663
final hour from the Jet
Propulsion Laboratory.

541
00:29:25,663 --> 00:29:28,299
JPL is a NASA center in
La Canada Flintridge,

542
00:29:28,299 --> 00:29:30,502
and Pasadena, California,
and managed by

543
00:29:30,502 --> 00:29:32,904
the California
Institute of Technology.

544
00:29:32,904 --> 00:29:37,008
Let's check out our
display, we are now about

545
00:29:37,008 --> 00:29:41,179
just a little under 26 minutes
from the end of mission.

546
00:29:46,117 --> 00:29:48,686
[upbeat music]

547
00:30:06,938 --> 00:30:10,008
- Well, the Cassini team
considers itself a family.

548
00:30:10,008 --> 00:30:13,711
A team that works together
and plays together.

549
00:30:13,711 --> 00:30:15,780
And here is one example.

550
00:30:15,780 --> 00:30:19,617
The Cassini Virtual Singers,
they have a knack for

551
00:30:19,617 --> 00:30:23,788
putting a Cassini spin on
just about any showtune.

552
00:30:25,690 --> 00:30:28,793
And I saw Todd
Barber in that group.

553
00:30:28,793 --> 00:30:32,197
Todd, it is a very
close-knit group,

554
00:30:32,197 --> 00:30:34,632
and a multi-generational group.

555
00:30:34,632 --> 00:30:37,969
I mean some people have
spent their entire careers

556
00:30:37,969 --> 00:30:40,138
on this mission,
and others are just

557
00:30:40,138 --> 00:30:43,274
starting their
careers on Cassini.

558
00:30:43,274 --> 00:30:46,177
Todd Barber is standing by
with one of the younger members

559
00:30:46,177 --> 00:30:49,614
of team, Guidance and
Control Engineer Joni Stupak,

560
00:30:49,614 --> 00:30:52,917
who started her career
with Cassini, right?

561
00:30:52,917 --> 00:30:56,020
- Yes, that's right, and I've
been on since before launch,

562
00:30:56,020 --> 00:30:57,822
but it's so wonderful to have

563
00:30:57,822 --> 00:30:59,424
young engineers
join the project.

564
00:30:59,424 --> 00:31:02,527
Welcome Joni, and Joni
is an attitude control

565
00:31:02,527 --> 00:31:04,963
engineer on the project,
and can you explain

566
00:31:04,963 --> 00:31:06,764
what that means to our viewers?

567
00:31:06,764 --> 00:31:08,233
- Sure, absolutely.

568
00:31:08,233 --> 00:31:10,368
So I and my team are in charge

569
00:31:10,368 --> 00:31:13,004
of the orientation
of the spacecraft.

570
00:31:13,004 --> 00:31:15,940
So we point all of the
cameras the antenna.

571
00:31:15,940 --> 00:31:18,576
- That's great, and
you have a particularly

572
00:31:18,576 --> 00:31:20,612
important role this
evening, right?

573
00:31:20,612 --> 00:31:22,513
Or this morning, I
guess I should say.

574
00:31:22,513 --> 00:31:25,216
- Absolutely, so as Earl
and Linda both alluded to,

575
00:31:25,216 --> 00:31:29,254
we want to get every last
possible second of information,

576
00:31:29,254 --> 00:31:31,322
which means our antenna
needs to be pointed

577
00:31:31,322 --> 00:31:33,791
towards Earth for as
long as we possibly can.

578
00:31:33,791 --> 00:31:35,426
As we enter into the atmosphere,

579
00:31:35,426 --> 00:31:37,495
Saturn is gonna start
trying to tug us away.

580
00:31:37,495 --> 00:31:39,564
So we wanna hold
the antenna steady

581
00:31:39,564 --> 00:31:41,532
as we possibly can
for that whole time.

582
00:31:41,532 --> 00:31:42,767
- [Todd] And how do you do that?

583
00:31:42,767 --> 00:31:44,235
- We have little
engines or thrusters

584
00:31:44,235 --> 00:31:46,204
that we use to hold us steady.

585
00:31:46,204 --> 00:31:49,874
- [Todd] Wonderful, and
basically we will lose

586
00:31:49,874 --> 00:31:52,377
the battle with Saturn's
atmosphere, though.

587
00:31:52,377 --> 00:31:54,045
- [Joni] We will, and if
we go to the graphic here,

588
00:31:54,045 --> 00:31:56,748
we see the thrusters
firing as we try

589
00:31:56,748 --> 00:31:59,684
and hold that antenna
for as long as we can.

590
00:31:59,684 --> 00:32:01,853
And that will last for
only about a minute,

591
00:32:01,853 --> 00:32:03,888

until the thrusters
are finally overwhelmed

592
00:32:03,888 --> 00:32:05,823
and we can no longer
point the antenna.

593
00:32:05,823 --> 00:32:07,625
- Wow, that's amazing.

594
00:32:07,625 --> 00:32:10,094
But those precious
seconds of science data

595
00:32:10,094 --> 00:32:13,932
are worth every thruster
pulse we put on the--

596
00:32:13,932 --> 00:32:15,700
- Every second, yeah.

597
00:32:16,834 --> 00:32:18,803
We're learning all about
Saturn's atmosphere

598
00:32:18,803 --> 00:32:21,105
with all the instruments
we can as we go in.

599
00:32:21,105 --> 00:32:22,540
- So yeah.
- That's good.

600
00:32:22,540 --> 00:32:24,075
- We wanna point
as long as we can.

601
00:32:24,075 --> 00:32:26,244
- [Todd] So you started
your career on this mission,

602
00:32:26,244 --> 00:32:28,379
how are you feeling
tonight, knowing we have

603
00:32:28,379 --> 00:32:30,248
to say goodbye to our
beautiful spacecraft?

604
00:32:30,248 --> 00:32:31,849
- It's definitely bittersweet,
yeah, I started my career,

605
00:32:31,849 --> 00:32:34,953
I was in high school when
Cassini arrived at Saturn.

606
00:32:34,953 --> 00:32:38,189
So you know, it's really
exciting and I'm really

607
00:32:38,189 --> 00:32:40,692
proud to have worked
on such, you know,

608
00:32:40,692 --> 00:32:42,894
incredible mission, part
of such a wonderful family.

609
00:32:42,894 --> 00:32:45,029
But it's gonna be sad, you
know, I'm used to checking how

610
00:32:45,029 --> 00:32:47,799
the spacecraft is feeling
every morning and things like

611
00:32:47,799 --> 00:32:50,568
that, so it'll be a little
sad to not have that anymore.

612
00:32:50,568 --> 00:32:52,470
- [Todd] I definitely
agree there,

613
00:32:52,470 --> 00:32:54,205
and we're so grateful
for your contributions

614
00:32:54,205 --> 00:32:56,274
and all the young
engineers on the project.

615
00:32:56,274 --> 00:32:57,575
As well as the
veterans that have been

616
00:32:57,575 --> 00:32:59,310
around since launch,
thank you Joni.

617
00:32:59,310 --> 00:33:00,378
- What'll you be able to
do without the veterans?

618
00:33:00,378 --> 00:33:01,546
[both laugh]

619
00:33:01,546 --> 00:33:03,348
- We got a few tricks
up our sleeves.

620
00:33:03,348 --> 00:33:06,918
So if we can head back to
the radio science display

621
00:33:06,918 --> 00:33:08,419
and check and see,

622

00:33:09,988 --> 00:33:14,158
still looking good, so we have
a strong X and S band signal.

623
00:33:15,326 --> 00:33:17,795
So as Earl mentioned,
our fate is sealed,

624
00:33:17,795 --> 00:33:21,132
we've met our planetary
protection requirement.

625
00:33:21,132 --> 00:33:23,601
We know we're gonna impact
Saturn and take care of that.

626
00:33:23,601 --> 00:33:25,470
The next thing that's
important is to hold

627
00:33:25,470 --> 00:33:27,438
that signal as long
as possible and get

628
00:33:27,438 --> 00:33:30,508
every last precious
bit of science data.

629
00:33:30,508 --> 00:33:32,877
So so far so good,
Gay, back to you.

630
00:33:32,877 --> 00:33:34,812
- Thanks Todd, thanks Joni.

631
00:33:34,812 --> 00:33:37,315
It is about 33
minutes past the hour

632
00:33:37,315 --> 00:33:41,486

and the estimated time of loss
of signal is 4:55 AM Pacific.

633
00:33:46,090 --> 00:33:48,860
[dramatic music]

634
00:34:45,316 --> 00:34:47,785
The Cassini-Huygens
mission has been

635
00:34:47,785 --> 00:34:51,055
an epic adventure around
the Saturn system.

636
00:34:51,055 --> 00:34:55,226
It has sent home mountains of
science data, stunning images.

637
00:34:56,294 --> 00:34:58,296
The spacecraft
performed beautifully.

638
00:34:58,296 --> 00:35:01,999
The mission fulfilled
its goals and then some.

639
00:35:01,999 --> 00:35:06,170
Members say they couldn't
have asked for anything more.

640
00:35:07,572 --> 00:35:10,308
[dramatic music]

641
00:35:14,979 --> 00:35:17,815
- [Radio Operator] This
is Titan launch control.

642
00:35:17,815 --> 00:35:20,051
- [Man] All systems are go.

643
00:35:28,826 --> 00:35:32,063
- I've worked on the Cassini
project for almost 30 years.

644
00:35:32,063 --> 00:35:34,899
And that's an
entire Saturn orbit.

645
00:35:36,134 --> 00:35:39,704
- The beauty of
Cassini is the design.

646
00:35:39,704 --> 00:35:43,441
It's the largest outer planetary
spacecraft every built.

647
00:35:43,441 --> 00:35:45,510
12 different instruments.

648
00:35:45,510 --> 00:35:49,413
The Huygens probe, built by
the European Space Agency.

649
00:35:49,413 --> 00:35:52,016
It's just a monumental machine.

650
00:35:55,586 --> 00:35:57,588
- [Man] Three, two, one,

651
00:35:58,789 --> 00:36:01,058
and liftoff of the
Cassini spacecraft

652
00:36:01,058 --> 00:36:03,828
on a billion mile
trip to Saturn.

653
00:36:22,780 --> 00:36:26,617
- We turned the Cassini cameras

down to look at the rings,

654
00:36:26,617 --> 00:36:30,354
revealing them in a way we
had never seen them before.

655
00:36:30,354 --> 00:36:32,790
I remember coming back to
JPL early in the morning

656
00:36:32,790 --> 00:36:34,892
just so I could be there.

657
00:36:36,861 --> 00:36:40,798
And watch those pictures
one by one come down.

658
00:36:40,798 --> 00:36:43,100
And I felt like I could
almost reach out and touch

659
00:36:43,100 --> 00:36:45,770
the rings that were right there.

660
00:36:53,377 --> 00:36:55,780
- We had been collaborating
with the Europeans

661
00:36:55,780 --> 00:36:58,082
ever since launch to
make sure that we had

662
00:36:58,082 --> 00:37:00,451
everything right for Huygens.

663
00:37:02,920 --> 00:37:05,556
The Huygens probe was
dropped onto Titan.

664

00:37:05,556 --> 00:37:08,559
These are images from
billion miles away

665
00:37:08,559 --> 00:37:10,561
on the surface of Titan.

666
00:37:12,029 --> 00:37:14,699
They're boulders, there were
pebbles, in a dry lake bed.

667
00:37:14,699 --> 00:37:18,769
And I still get goosebumps
just talking about it.

668
00:37:21,339 --> 00:37:24,008
- Looking back at what
we were planning to do

669
00:37:24,008 --> 00:37:27,778
in those first four years,
we've gone so far beyond that.

670
00:37:27,778 --> 00:37:30,681
- We remapped our
investigations to concentrate

671
00:37:30,681 --> 00:37:33,751
on the questions
that Cassini raised.

672
00:37:35,620 --> 00:37:37,922
- Two of our instruments
actually sampled

673
00:37:37,922 --> 00:37:41,292
the plume of Enceladus
as we flew through.

674
00:37:41,292 --> 00:37:43,761

Tasting the gas,
measuring the particles,

675
00:37:43,761 --> 00:37:46,497
in a way that we hadn't planned.

676
00:37:46,497 --> 00:37:48,766
Cassini has changed the paradigm

677
00:37:48,766 --> 00:37:50,935
of where we might look for life.

678
00:37:50,935 --> 00:37:53,704
That will be one
of her legacies.

679
00:37:55,273 --> 00:37:57,842
- 13 years of exploring Saturn.

680
00:37:57,842 --> 00:38:00,845
It really is just
an awesome mission.

681
00:38:12,256 --> 00:38:14,058
- Alright, well
joining me now is

682
00:38:14,058 --> 00:38:17,495
NASA Director of Planetary
Science Jim Greene.

683
00:38:17,495 --> 00:38:20,998
Some of Cassini's
greatest accomplishments

684
00:38:20,998 --> 00:38:24,168
came as big surprises,
didn't they?

685

00:38:24,168 --> 00:38:26,103
- They did, absolutely.

686
00:38:26,103 --> 00:38:28,072
You know, one of the
ones that's pretty

687
00:38:28,072 --> 00:38:30,107
spectacular obviously
is Enceladus.

688
00:38:30,107 --> 00:38:33,077
Now you may not really
understand the importance

689
00:38:33,077 --> 00:38:37,248
of having a spacecraft with
all kinds of instruments,

690
00:38:38,683 --> 00:38:41,152
including magnetometers and
plasma weight instruments.

691
00:38:41,152 --> 00:38:44,655
But it really discovered
the plumes by magnetometer.

692
00:38:44,655 --> 00:38:48,659
And so as the spacecraft
was doing a flyby,

693
00:38:48,659 --> 00:38:51,595
what was happening
is the plumes were

694
00:38:51,595 --> 00:38:55,032
being blasted out of
the tiger stripes.

695
00:38:55,032 --> 00:38:57,301

They were being
ionized and they were

696
00:38:57,301 --> 00:38:59,270
loading down the
field, dragging it by.

697
00:38:59,270 --> 00:39:01,505
And so the magnetometer
saw the wave

698
00:39:01,505 --> 00:39:04,675
of the field in a place
that they hadn't expected.

699
00:39:04,675 --> 00:39:06,544
And that gave a
hint that something

700
00:39:06,544 --> 00:39:08,446
was going on and it
needed to be looked at.

701
00:39:08,446 --> 00:39:11,682
And so then the next pass
they came up with the idea,

702
00:39:11,682 --> 00:39:13,718
well let's look at
it in back light.

703
00:39:13,718 --> 00:39:15,820
And wow, there were the plumes.

704
00:39:15,820 --> 00:39:19,657
And that started then
a series of new orbits,

705
00:39:19,657 --> 00:39:23,060
new trajectories, to try to go

through and taste the plumes

706
00:39:23,060 --> 00:39:24,829
and get even more details about

707
00:39:24,829 --> 00:39:27,098
what's happening at Enceladus.

708
00:39:27,098 --> 00:39:30,334
- And how does this
discovery sort of change

709
00:39:30,334 --> 00:39:34,305
the way we look for life
in the solar system?

710
00:39:34,305 --> 00:39:38,476
- Well, this is really
a calling, if you will,

711
00:39:39,643 --> 00:39:41,445
of hey, you're gonna
have to come back.

712
00:39:41,445 --> 00:39:45,449
Because there's several
things we know about life.

713
00:39:45,449 --> 00:39:48,619
One, it metabolizes, that
means it takes in a liquid,

714
00:39:48,619 --> 00:39:51,622
it then uses that
to extract energy

715
00:39:51,622 --> 00:39:54,325
and then the liquid is
used to extract the waste.

716
00:39:54,325 --> 00:39:58,262
But then it evolves, and
then it also reproduces.

717
00:39:58,262 --> 00:40:01,065
Well I can't measure any of
those from our spacecraft

718
00:40:01,065 --> 00:40:03,134
other than going
after the water.

719
00:40:03,134 --> 00:40:05,870
So once we see an
area that has water,

720
00:40:05,870 --> 00:40:08,639
then we know it
has a possibility

721
00:40:08,639 --> 00:40:11,175
of being a habitable
environment.

722
00:40:11,175 --> 00:40:14,278
- And transitioning to
the other big story,

723
00:40:14,278 --> 00:40:18,115
also from Cassini, is
another moon, Titan.

724
00:40:18,115 --> 00:40:19,483
- Oh yeah, Titan.

725
00:40:19,483 --> 00:40:21,552
What a beautiful moon this is.

726
00:40:21,552 --> 00:40:23,954

You know, it's bigger
than the planet Mercury.

727
00:40:23,954 --> 00:40:26,690
Its atmosphere is actually
a significant one.

728
00:40:26,690 --> 00:40:29,660
It's twice the pressure
that we have here on Earth.

729
00:40:29,660 --> 00:40:32,930
It's similar in the sense
that it has a lot of nitrogen.

730
00:40:32,930 --> 00:40:34,765
In fact it's
dominated by nitrogen.

731
00:40:34,765 --> 00:40:37,435
But it also has
liquid on its surface,

732
00:40:37,435 --> 00:40:39,470
which we know now is methane.

733
00:40:39,470 --> 00:40:43,641
And there's a hydrological
cycle of evaporation,

734
00:40:44,842 --> 00:40:47,144
transport, rain,
and then new lakes

735
00:40:47,144 --> 00:40:49,580
are forming in other
locations on the moon.

736
00:40:49,580 --> 00:40:51,882
- And that's an

incredible science legacy,

737
00:40:51,882 --> 00:40:55,853
but Titan also helped us with
an engineering legacy as well.

738
00:40:55,853 --> 00:40:57,288
- Oh, absolutely.

739
00:40:57,288 --> 00:41:00,825
The concept of using
Titan to do lunar,

740
00:41:00,825 --> 00:41:03,227
or to do gravity
assist swing bys

741
00:41:03,227 --> 00:41:06,330
that then enable the
spacecraft to get

742
00:41:06,330 --> 00:41:09,500
into different orbits
is a fabulous concept.

743
00:41:09,500 --> 00:41:12,570
Because while we're
doing that, you know,

744
00:41:12,570 --> 00:41:14,872
and here's the Koosh
ball, as we say,

745
00:41:14,872 --> 00:41:16,574
all these spectacular flybys

746
00:41:16,574 --> 00:41:18,976
allow us to look
at Titan in detail.

747
00:41:18,976 --> 00:41:22,813
So from multiple flybys
we can get a global view

748
00:41:22,813 --> 00:41:26,684
of that moon, and we're
using that same concept

749
00:41:26,684 --> 00:41:30,855
at Jupiter with another
moon called Europa.

750
00:41:31,722 --> 00:41:33,624
- Alright, well before we go,

751
00:41:33,624 --> 00:41:36,293
I wanted to bring up the e-book.

752
00:41:36,293 --> 00:41:39,463
Because one of the
most fantastic things

753
00:41:39,463 --> 00:41:41,932
about this mission
has been the imagery,

754
00:41:41,932 --> 00:41:43,901
could you tell us a
little bit about that?

755
00:41:43,901 --> 00:41:46,971
- Well you know, we
really needed to make sure

756
00:41:46,971 --> 00:41:51,141
that we had wonderfully
described and beautifully

757
00:41:52,309 --> 00:41:55,479

set images that were
accessible to everyone.

758
00:41:56,814 --> 00:42:00,351
And after you know,
450,000 plus images,

759
00:42:00,351 --> 00:42:03,487
it's so hard to pick, but
you know, we were able

760
00:42:03,487 --> 00:42:07,658
to go back in, get 100
beautiful images or more,

761
00:42:07,658 --> 00:42:09,894
and videos and all kinds of--

762
00:42:09,894 --> 00:42:11,762
- And there's a link.
- Yeah.

763
00:42:11,762 --> 00:42:13,731
- [Gay] Where if
you want to get it,

764
00:42:13,731 --> 00:42:16,767
you can download it
off the internet.

765
00:42:16,767 --> 00:42:18,769
- [Jim] Nasa.gov/ebooks.

766
00:42:18,769 --> 00:42:21,605
- Alright, well Jim,
thanks for joining us.

767
00:42:21,605 --> 00:42:23,908
Thanks for taking time for us.
- Oh, my pleasure.

768
00:42:23,908 --> 00:42:26,210
- And I know you wanna get
back into that control room.

769
00:42:26,210 --> 00:42:27,378
- [Jim] Absolutely.

770
00:42:27,378 --> 00:42:30,014
- Thank you.
- Thank you.

771
00:42:30,014 --> 00:42:32,783
[dramatic music]

772
00:44:35,272 --> 00:44:38,042
- Well we are a little
over 10 minutes away

773
00:44:38,042 --> 00:44:40,878
from the loss of signal,
so we will be focusing

774
00:44:40,878 --> 00:44:44,048
our attention to the
control room very soon now.

775
00:44:44,048 --> 00:44:46,750
But before we do,
let's take a moment

776
00:44:46,750 --> 00:44:49,319
to chat with JPL
director Mike Watkins.

777
00:44:49,319 --> 00:44:52,222
So Mike, how are you feeling?

778
00:44:52,222 --> 00:44:53,757

- Well first good morning.

779
00:44:53,757 --> 00:44:55,459
- [Gay] [laughs] Yes,
very early morning.

780
00:44:55,459 --> 00:44:56,894
- We always tend to do
these events somehow

781
00:44:56,894 --> 00:44:58,395
at three in the morning
or five in the morning.

782
00:44:58,395 --> 00:45:00,164
- [Gay] Why do they do that?

783
00:45:00,164 --> 00:45:01,865
- But you know, it's
kind of a bittersweet

784
00:45:01,865 --> 00:45:03,467
event for all of us I think.

785
00:45:03,467 --> 00:45:05,703
For me personally it's
more sweet than bitter,

786
00:45:05,703 --> 00:45:08,472
because Cassini's been
such a fantastic mission.

787
00:45:08,472 --> 00:45:11,075
But I think you know, one of
the important things about

788
00:45:11,075 --> 00:45:13,744
these events is to celebrate
the incredible hard work,

789
00:45:13,744 --> 00:45:15,679
the decades of hard
work of the team that

790
00:45:15,679 --> 00:45:18,082
designed, built, and
operated Cassini.

791
00:45:18,082 --> 00:45:20,250
And that's really, right,
the heart of the spacecraft

792
00:45:20,250 --> 00:45:22,352
is really the people
that worked on it,

793
00:45:22,352 --> 00:45:24,154
the people that have
been operating it.

794
00:45:24,154 --> 00:45:25,923
And this is a great
time to celebrate

795
00:45:25,923 --> 00:45:28,192
that level of dedication,
that devotion.

796
00:45:28,192 --> 00:45:30,661
To work on something
for 10, 20, 30 years,

797
00:45:30,661 --> 00:45:34,398
that's sorta unparalleled
in human history.

798
00:45:34,398 --> 00:45:36,433
- So how do you
think Cassini will

799
00:45:36,433 --> 00:45:39,369
be remembered in
the science books?

800
00:45:39,369 --> 00:45:41,905
- Well I'd say most
of the science books,

801
00:45:41,905 --> 00:45:43,707
most of what we have
in science books

802
00:45:43,707 --> 00:45:45,275
about Saturn come from Cassini.

803
00:45:45,275 --> 00:45:46,543
- [Gay] Right.

804
00:45:46,543 --> 00:45:47,811
- Right, so it will
be long remembered.

805
00:45:47,811 --> 00:45:49,279
I mean you look at
almost everything

806
00:45:49,279 --> 00:45:50,981
we know came from
Cassini about Saturn.

807
00:45:50,981 --> 00:45:53,016
But you know, I think one
of the greatest legacies

808
00:45:53,016 --> 00:45:55,319
of a mission is not just
the scientific discoveries

809
00:45:55,319 --> 00:45:57,221

it makes and what
you learn about,

810
00:45:57,221 --> 00:45:59,323
but the fact that you
make discoveries that

811
00:45:59,323 --> 00:46:01,358
are so compelling that
you have to go back.

812
00:46:01,358 --> 00:46:03,861
And that's really part of
what the end of Cassini sweet

813
00:46:03,861 --> 00:46:05,929
is that the discoveries are so

814
00:46:05,929 --> 00:46:07,898
compelling that we
have to go back.

815
00:46:07,898 --> 00:46:10,400
We will go back and fly through
the geysers of Enceladus

816
00:46:10,400 --> 00:46:12,469
and we'll go back
and look at Titan,

817
00:46:12,469 --> 00:46:16,340
because the Cassini findings,
they're just groundbreaking.

818
00:46:16,340 --> 00:46:19,843
- But the way missions
are, one mission

819
00:46:19,843 --> 00:46:23,447
sort of sets the footsteps

for the next mission.

820
00:46:23,447 --> 00:46:27,484
So what's coming up
next after Cassini?

821
00:46:27,484 --> 00:46:30,120
- So one of the things
we've learned about

822
00:46:30,120 --> 00:46:32,756
the outer solar system is
how much water is there.

823
00:46:32,756 --> 00:46:34,825
So we used to think that
most of the water was here

824
00:46:34,825 --> 00:46:37,194
in the inner solar system,
here on Earth for example,

825
00:46:37,194 --> 00:46:38,996
habitable zone, Goldilocks Zone

826
00:46:38,996 --> 00:46:41,799
between Venus and
Mars where we are.

827
00:46:41,799 --> 00:46:43,700
We now realize
that there's a lot

828
00:46:43,700 --> 00:46:45,235
of water in the
outer solar system.

829
00:46:45,235 --> 00:46:47,871
So Europa for example,
the moon of Jupiter.

830
00:46:47,871 --> 00:46:49,573
Enceladus.

831
00:46:49,573 --> 00:46:51,475
And I think what you
see compelling about
the outer planets

832
00:46:51,475 --> 00:46:52,910
is to go back and look at those

833
00:46:52,910 --> 00:46:54,411
ocean worlds in great detail.

834
00:46:54,411 --> 00:46:57,014
Fly through the geysers, try
to drill down through the ice,

835
00:46:57,014 --> 00:46:58,916
take a look at the
composition of the ice.

836
00:46:58,916 --> 00:47:01,819
And as Jim Green noted, you
know, are these habitable

837
00:47:01,819 --> 00:47:04,021
places, are these places
where there could be life?

838
00:47:04,021 --> 00:47:06,523
And so we here at JPL and
NASA, we have plans to go back

839
00:47:06,523 --> 00:47:09,393
to many of these ocean
worlds, as many as we can.

840

00:47:09,393 --> 00:47:12,963
The next one up is a
multiple flyby of Europa,

841
00:47:12,963 --> 00:47:15,999
we call it Europa Clipper,
where we'll be in orbit

842
00:47:15,999 --> 00:47:18,202
around Jupiter and fly
by Europa 40 or 50 times

843
00:47:18,202 --> 00:47:21,071
and taking a very close
look at that ocean

844
00:47:21,071 --> 00:47:23,607
from above the ice, of course,

845
00:47:23,607 --> 00:47:25,542
and the composition of the ice.

846
00:47:25,542 --> 00:47:28,345
And then later we'll make our
way to the other ocean worlds.

847
00:47:28,345 --> 00:47:30,414
- Ocean worlds are the things

848
00:47:30,414 --> 00:47:32,316
to look at right now, it seems.

849
00:47:32,316 --> 00:47:33,517
- Absolutely.

850
00:47:33,517 --> 00:47:35,285
You know, the search
for life is one

851

00:47:35,285 --> 00:47:37,955
of the compelling
threads for NASA and for

852
00:47:37,955 --> 00:47:40,257
the science mission
directorate and for JPL.

853
00:47:40,257 --> 00:47:42,292
We're looking for life
in our solar system

854
00:47:42,292 --> 00:47:44,094
and of course we're looking
for life outside the

855
00:47:44,094 --> 00:47:46,163
solar system, we're looking for
exoplanets and other Earths.

856
00:47:46,163 --> 00:47:47,898
But the ocean worlds look like

857
00:47:47,898 --> 00:47:49,399
an incredibly compelling target.

858
00:47:49,399 --> 00:47:52,035
- Alright, well thank
you so much, Mike,

859
00:47:52,035 --> 00:47:54,104
for coming by and joining us.

860
00:47:54,104 --> 00:47:56,573
I know all the guys
wanna get back in there,

861
00:47:56,573 --> 00:47:58,041
in the control room.
- Absolutely.

862
00:47:58,041 --> 00:47:59,376
- And be there for the moment.

863
00:47:59,376 --> 00:48:00,644
- 'Til the last few minutes.

864
00:48:00,644 --> 00:48:02,179
- Alright, thank you so much.
- Thanks Gay.

865
00:48:02,179 --> 00:48:04,915
- You're watching live coverage
of Cassini's final hour

866
00:48:04,915 --> 00:48:07,017
from NASA's Jet
Propulsion Laboratory.

867
00:48:07,017 --> 00:48:09,920
JPL is located in La Canada
Flintridge and Pasadena,

868
00:48:09,920 --> 00:48:13,056
and managed by the California
Institute of Technology.

869
00:48:13,056 --> 00:48:16,760
Let's take a look at
our last hour display.

870
00:48:16,760 --> 00:48:19,763
Our display shows
that we are just over

871
00:48:19,763 --> 00:48:23,967
seven minutes away from
the end of mission.

872

00:48:25,335 --> 00:48:28,338
And it's now traveling
about 75,000 miles per hour.

873
00:48:32,042 --> 00:48:36,213
So Cassini is traveling rapidly
towards its end of mission.

874
00:48:43,287 --> 00:48:46,523
- For all the beauty and the
exotic features that we found,

875
00:48:46,523 --> 00:48:49,326
those are places that
startle and amaze,

876
00:48:49,326 --> 00:48:51,361
but not a place
where you can live.

877
00:48:51,361 --> 00:48:54,598
And I think it gives
you a perspective on

878
00:48:54,598 --> 00:48:58,068
the Earth and what a
wonderful place it is,

879
00:48:58,068 --> 00:49:01,672
and more impetus to
perhaps take care of it.

880
00:49:05,275 --> 00:49:07,244
- We are getting close to time,

881
00:49:07,244 --> 00:49:10,047
and the time when we
should lose that signal.

882
00:49:10,047 --> 00:49:14,151

Folks are watching the radio
science display right now,

883
00:49:14,151 --> 00:49:17,955
so let's go to Todd and
Joni in Mission Control.

884
00:49:17,955 --> 00:49:21,091
- Hi Gay, well six minutes to
go 'til we're six feet under.

885
00:49:21,091 --> 00:49:24,661
So it's gonna be hard
to say goodbye here.

886
00:49:24,661 --> 00:49:28,332
Radio display still looks
great as we just saw onscreen.

887
00:49:28,332 --> 00:49:30,033
Mission Control.

888
00:49:30,033 --> 00:49:34,204
I hear a lot of buzz in the
room about the thruster cycles,

889
00:49:35,605 --> 00:49:37,975
'cause the thrusters are
firing, we're still outside

890
00:49:37,975 --> 00:49:40,811
the atmosphere, and they're
just keeping dead bands,

891
00:49:40,811 --> 00:49:44,481
keeping that pointed on
Earth as long as possible.

892
00:49:44,481 --> 00:49:47,017
So things aren't too crazy yet,

893
00:49:47,017 --> 00:49:50,120
but once we hit that atmosphere
things happen super fast.

894
00:49:50,120 --> 00:49:52,823
So let's look around the room.

895
00:49:52,823 --> 00:49:56,026
- [Man] Is nominal,
we're in low rate mode

896
00:49:56,026 --> 00:49:58,762
and we're waiting for
high rate mode transition.

897
00:49:58,762 --> 00:50:01,398
- Okay, thank you.
- So that was indication--

898
00:50:01,398 --> 00:50:04,101
- [Lead Operator]
ACS fault protection.

899
00:50:04,101 --> 00:50:05,869
- [ACS Operator] Go
ahead system lead.

900
00:50:05,869 --> 00:50:07,404
- [Lead Operator] Just gonna get

901
00:50:07,404 --> 00:50:08,872
a quick set system
status please.

902
00:50:08,872 --> 00:50:10,540
- [ACS Operator] ACS fault
protection is nominal.

903

00:50:10,540 --> 00:50:12,009
- [Lead Operator]
Copy, thank you.

904
00:50:12,009 --> 00:50:13,510
Thermal systems lead.

905
00:50:13,510 --> 00:50:15,345
- [Thermal Operator] Thermal
devices subsystem is nominal.

906
00:50:15,345 --> 00:50:16,880
- [Lead Operator]
Copy, thank you.

907
00:50:16,880 --> 00:50:18,715
Power systems lead.

908
00:50:18,715 --> 00:50:20,784
- [Power Operator]
Power system is nominal.

909
00:50:20,784 --> 00:50:22,319
- [Lead Operator]
Copy, thank you.

910
00:50:22,319 --> 00:50:23,954
System fault
protection system lead.

911
00:50:23,954 --> 00:50:25,922
- [Fault Protection Operator]
System fault protection

912
00:50:25,922 --> 00:50:28,158
is nominal, no fault
protection activity.

913
00:50:28,158 --> 00:50:29,593
- [Lead Operator]

Copy, thank you.

914
00:50:29,593 --> 00:50:31,094
CES systems lead.

915
00:50:31,094 --> 00:50:32,929
- [CES Operator] CES is nominal,

916
00:50:32,929 --> 00:50:34,865
we have two frames buffered.

917
00:50:34,865 --> 00:50:36,400
- [Lead Operator]
Copy, thank you.

918
00:50:36,400 --> 00:50:38,835
Telecom systems lead.

919
00:50:38,835 --> 00:50:42,039
- [Telecom Operator]
Telecom is now good, SNG.

920
00:50:42,039 --> 00:50:44,508
- [Lead Operator]
Copy, thank you.

921
00:50:44,508 --> 00:50:46,243
Radio science system state.

922
00:50:46,243 --> 00:50:48,478
- [Radio Science Operator]
Radio is science is nominal.

923
00:50:48,478 --> 00:50:49,980
Two and was for power nominal,

924
00:50:49,980 --> 00:50:53,950
the residual frequency
is starting to increase.

925
00:50:53,950 --> 00:50:56,219
- [Lead Operator]
Copy, thank you.

926
00:50:56,219 --> 00:50:58,255
Propulsion Systems lead.

927
00:50:58,255 --> 00:51:00,924
- [Propulsion Operator]
Pressures and temperatures

928
00:51:00,924 --> 00:51:03,060
are nominal,
propulsion is nominal.

929
00:51:03,060 --> 00:51:04,928
- [Lead Operator]
Okay, thank you.

930
00:51:04,928 --> 00:51:06,596
Mission planning systems lead.

931
00:51:06,596 --> 00:51:08,598
- [Planning Operator]
Mission planning is nominal.

932
00:51:08,598 --> 00:51:10,133
- [Lead Operator]
Copy, thank you.

933
00:51:10,133 --> 00:51:12,436
Side turn systems lead,
everything is nominal.

934
00:51:12,436 --> 00:51:14,237
- [Woman] Copy.

935
00:51:14,237 --> 00:51:17,140

- [Radio Operator]
And days copies.

936
00:51:18,575 --> 00:51:20,744
- [Lead Operator] Thank you ace.

937
00:51:20,744 --> 00:51:23,814
- [Joni] So what we just heard
was the room going around

938
00:51:23,814 --> 00:51:26,516
and checking all of the
subsystems, so so far,

939
00:51:26,516 --> 00:51:30,287
all of the subsystems are
nominal, about four minutes,

940
00:51:30,287 --> 00:51:32,956
3 1/2 to four minutes
away from the end.

941
00:51:32,956 --> 00:51:35,092
- [Todd] Joni, I heard
a comment that we went

942
00:51:35,092 --> 00:51:37,928
from low rate to high
rate control, can
you comment on that?

943
00:51:37,928 --> 00:51:41,398
- [Joni] Sure, so we have our
computer that's controlling

944
00:51:41,398 --> 00:51:44,067
our pointing has different
modes and it's smart enough

945
00:51:44,067 --> 00:51:46,436

to know when we start having
to fight a little harder.

946
00:51:46,436 --> 00:51:49,206
So we heard that the
computer acknowledged

947
00:51:49,206 --> 00:51:51,408
that we start having
to fight a little bit.

948
00:51:51,408 --> 00:51:53,243
- [Todd] Okay, thanks.

949
00:51:56,146 --> 00:51:58,515
We were remarking
earlier, it's incredible,

950
00:51:58,515 --> 00:52:01,785
this entire spacecraft
runs on 600 watts of power.

951
00:52:01,785 --> 00:52:03,053
How much power is that?

952
00:52:03,053 --> 00:52:04,688
- [Joni] Yeah, about
half a hair dryer.

953
00:52:04,688 --> 00:52:06,289
- Wow.
- It's all we got right now.

954
00:52:06,289 --> 00:52:07,824
[both laugh]

955
00:52:07,824 --> 00:52:09,559
- [Todd] I won't even
talk about how little fuel

956
00:52:09,559 --> 00:52:12,429
we have left, it's about
1% plus or minus 2%.

957
00:52:12,429 --> 00:52:14,231
[Joni laughs]
So that's one reason

958
00:52:14,231 --> 00:52:18,001
we're heading into
Saturn's atmosphere today.

959
00:52:19,936 --> 00:52:21,938
Under three minutes now.

960
00:52:37,821 --> 00:52:39,456
We should definitely emphasize

961
00:52:39,456 --> 00:52:41,091
we don't know exactly
when we'll lose signal.

962
00:52:41,091 --> 00:52:42,626
It depends on the
Saturn atmosphere

963
00:52:42,626 --> 00:52:44,828
and how well the
thrusters fight.

964
00:52:44,828 --> 00:52:45,996
So stay tuned.

965
00:52:48,832 --> 00:52:51,234
Radio signal looks wonderful.

966
00:52:52,469 --> 00:52:54,571
X band and S band, two
different radio bands,

967
00:52:54,571 --> 00:52:56,306
still getting the
signal from Cassini.

968
00:52:56,306 --> 00:52:58,008
- [Joni] And we're approaching

969
00:52:58,008 --> 00:53:01,444
about 10 degrees north
latitude on Saturn.

970
00:53:05,949 --> 00:53:08,552
3000 miles from the cloud tops.

971
00:53:10,020 --> 00:53:13,123
- [Todd] I remember saying we
were gonna hit the atmosphere

972
00:53:13,123 --> 00:53:17,294
about 77,000 miles an hours,
I see we're close, so.

973
00:53:20,864 --> 00:53:22,966
Two minutes and counting.

974
00:53:32,342 --> 00:53:34,277
- [Joni] Oh, we're
starting to exit the--

975
00:53:34,277 --> 00:53:36,746
- [ACS Operator]
Systems, this is ACS one.

976
00:53:36,746 --> 00:53:38,481
- [Lead Operator] Go ahead ACS.

977
00:53:38,481 --> 00:53:40,350
- [ACS Operator] We're

still waiting for transition

978
00:53:40,350 --> 00:53:41,885
to high rate mode, but it
looks like we're gonna start

979
00:53:41,885 --> 00:53:45,388
accumulating thruster on
time at a higher rate now.

980
00:53:45,388 --> 00:53:49,559
And our attitude controller
is starting to be more active.

981
00:53:51,294 --> 00:53:53,997
- [Lead Operator] Copy.

982
00:53:53,997 --> 00:53:55,298
- [Todd] That means we're just

983
00:53:55,298 --> 00:53:56,800
starting to sense the
atmosphere, right?

984
00:53:56,800 --> 00:53:58,768
- [Joni] Yep, we can start
seeing the spacecraft

985
00:53:58,768 --> 00:54:00,403
starting the lose the
battle with the atmosphere.

986
00:54:00,403 --> 00:54:01,805
- [ACS Operator]
This is ACS one,

987
00:54:01,805 --> 00:54:04,374
we just had the transition
to high rate mode.

988
00:54:04,374 --> 00:54:06,776
And with this we're gonna
start seeing thruster

989
00:54:06,776 --> 00:54:09,946
on time accumulating
very quickly and the
dead band is gonna

990
00:54:09,946 --> 00:54:14,117
clamp down to .52 millirad
and we are in the atmosphere.

991
00:54:15,619 --> 00:54:17,787
- [Lead Operator]
Copy, thank you.

992
00:54:17,787 --> 00:54:19,589
- [Todd] We're actually one
minute to loss of signal.

993
00:54:19,589 --> 00:54:21,191
- [Nav Operator]
Systems, this is nav.

994
00:54:21,191 --> 00:54:22,659
- [Lead Operator] Go ahead, Nav.

995
00:54:22,659 --> 00:54:25,695
- [Nav Operator] We can
confirm what ACS just told you.

996
00:54:25,695 --> 00:54:28,531
- [Lead Operator]
Copy, thank you.

997
00:54:30,367 --> 00:54:32,769
- [Joni] We're just
starting to see

998
00:54:32,769 --> 00:54:35,538
the thrusters fire
more and more.

999
00:54:41,444 --> 00:54:43,046
Yeah, it really is.

1000
00:54:45,715 --> 00:54:49,719
- [Todd] Radio signal
still holding, 30 seconds.

1001
00:54:52,355 --> 00:54:54,057
- [Planning Operator] Systems
lead, missions planning.

1002
00:54:54,057 --> 00:54:55,959
- [Lead Operator] Go
ahead, mission planning.

1003
00:54:55,959 --> 00:54:57,761
- [Planning Operator]
Spacecraft has just crossed

1004
00:54:57,761 --> 00:55:00,764
10 degrees north latitude,
altitude 1000 miles.

1005
00:55:00,764 --> 00:55:04,167
- [Lead Operator]
Copy, thank you.

1006
00:55:04,167 --> 00:55:07,804
- [ACS Operator]
Systems, ACS one.

1007
00:55:07,804 --> 00:55:09,439
- [Lead Operator] Go ahead.

1008
00:55:09,439 --> 00:55:11,775

- [ACS Operator] With the
additional thruster on time,

1009
00:55:11,775 --> 00:55:15,945
we're gonna also see the
dead bands start rising up.

1010
00:55:27,290 --> 00:55:30,126
- [Todd] We crossed
our zero time.

1011
00:55:51,715 --> 00:55:53,216
- [Radio Science] Flight
director, radio science.

1012
00:55:53,216 --> 00:55:54,918
- [Flight Director] Go
ahead, flight director.

1013
00:55:54,918 --> 00:55:56,553
- [Radio Science] We
have loss of signal

1014
00:55:56,553 --> 00:55:59,155
at X-ray band and sierra band.

1015
00:56:26,583 --> 00:56:29,586
- [Flight Director] Project
manager, flight director.

1016
00:56:29,586 --> 00:56:30,954
- [Project Manager] Go ahead.

1017
00:56:30,954 --> 00:56:32,422
- [Flight Director]
Okay, we call loss

1018
00:56:32,422 --> 00:56:34,824
of signal, loss of X band at,

1019
00:56:45,502 --> 00:56:48,171
we call loss of signal at 115546

1020
00:56:49,572 --> 00:56:53,410
for the S band, that would
be the end of the spacecraft.

1021
00:56:54,711 --> 00:56:57,580
- Project manager on FSO cord.

1022
00:56:57,580 --> 00:57:00,216
Maybe a trickle
of telemetry left,

1023
00:57:00,216 --> 00:57:04,354
but just heard the signal
from the spacecraft just go on

1024
00:57:05,755 --> 00:57:08,958
and within the next 45 seconds
so will be the spacecraft.

1025
00:57:10,126 --> 00:57:11,895
I hope you're all
as deeply proud

1026
00:57:13,730 --> 00:57:16,332
of this amazing accomplishment.

1027
00:57:16,332 --> 00:57:18,368
Congratulations to you all.

1028
00:57:18,368 --> 00:57:20,570
This has been an
incredible mission,

1029
00:57:20,570 --> 00:57:24,541
an incredible spacecraft, and
you're all an incredible team.

1030
00:57:24,541 --> 00:57:27,444
I'm gonna call this
the end of mission.

1031
00:57:27,444 --> 00:57:29,779
Project manager off the net.

1032
00:57:31,448 --> 00:57:34,184
[people applaud]

1033
00:58:14,757 --> 00:58:17,527
[dramatic music]

1034
01:00:35,798 --> 01:00:39,969
[people talking
amongst themselves]

1035
01:01:18,274 --> 01:01:21,310
- So just a short time
ago, Julie Webster,

1036
01:01:21,310 --> 01:01:25,481
the space operations team
manager and program manger

1037
01:01:26,883 --> 01:01:29,619
Earl Maize called it the
end of mission for Cassini.

1038
01:01:29,619 --> 01:01:32,522
It came at about
4:55 as predicted.

1039
01:01:33,690 --> 01:01:36,426
Let's go now to
Beckman Auditorium

1040
01:01:36,426 --> 01:01:38,461

and check in with Morgan Cable,

1041
01:01:38,461 --> 01:01:41,030
she is with Cassini
interdisciplinary

1042
01:01:41,030 --> 01:01:43,433
scientist Jonathan Lunine,

1043
01:01:43,433 --> 01:01:45,301
to find out how the scientists

1044
01:01:45,301 --> 01:01:47,804
are doing and the team
is doing down there.

1045
01:01:47,804 --> 01:01:50,506
The mission is certainly
not over for them,

1046
01:01:50,506 --> 01:01:53,242
because now there
will be tons of data

1047
01:01:53,242 --> 01:01:55,545
for them to be poring over.

1048
01:01:55,545 --> 01:01:56,379
Moran?

1049
01:01:59,849 --> 01:02:01,751
- That's a very good point, Gay.

1050
01:02:01,751 --> 01:02:05,455
There's gonna be lots of data
to analyze for years to come.

1051
01:02:05,455 --> 01:02:08,691
Jonathan, how are you

feeling right now?

1052
01:02:08,691 --> 01:02:11,894
- I'm actually breathing again.

1053
01:02:11,894 --> 01:02:15,698
And I feel sad, but we
felt sad the whole week.

1054
01:02:15,698 --> 01:02:17,900
We knew this was
going to happen.

1055
01:02:17,900 --> 01:02:20,670
And Cassini performed exactly
as she was supposed to,

1056
01:02:20,670 --> 01:02:22,605
and I'll be there's
some terrific data

1057
01:02:22,605 --> 01:02:25,074
on the ground now about
Saturn's atmosphere.

1058
01:02:25,074 --> 01:02:27,310
- I'll bet you're right.

1059
01:02:27,310 --> 01:02:30,713
What was your favorite
memory of Cassini?

1060
01:02:32,081 --> 01:02:35,051
Or share a story, just
anything that comes to mind.

1061
01:02:35,051 --> 01:02:39,222
- My two favorite moments were
both having to do with Titan.

1062
01:02:40,089 --> 01:02:42,258
One was seeing the seas of Titan

1063
01:02:42,258 --> 01:02:45,261
for the first time from
the radar on Cassini.

1064
01:02:45,261 --> 01:02:47,730
And the other was
seeing the surface

1065
01:02:47,730 --> 01:02:49,665
of Titan from the
Huygen's probe.

1066
01:02:49,665 --> 01:02:53,836
Sitting with 30 other people
in a trailer in the middle

1067
01:02:55,304 --> 01:02:56,939
of Germany in the middle of
winter, it was cold and dark.

1068
01:02:56,939 --> 01:02:59,108
And there were
the first pictures

1069
01:02:59,108 --> 01:03:02,378
of gullies on the surface
of an alien world.

1070
01:03:02,378 --> 01:03:04,847
- That had to just
blow your mind.

1071
01:03:04,847 --> 01:03:07,884
- It did, I was screaming,
so was everyone else.

1072

01:03:07,884 --> 01:03:11,320
- Well I think the mood's been
a little bit more somber now,

1073
01:03:11,320 --> 01:03:13,689
but there was applause
right near the end.

1074
01:03:13,689 --> 01:03:17,226
I think this is a
celebration of Cassini's life

1075
01:03:17,226 --> 01:03:20,563
and Cassini's legacy
and we should talk

1076
01:03:20,563 --> 01:03:22,598
a little bit about the future.

1077
01:03:22,598 --> 01:03:25,835
What do you see next
for the Saturn system?

1078
01:03:25,835 --> 01:03:29,205
- Well, what I would
like to see next

1079
01:03:29,205 --> 01:03:31,707
for the Saturn system is
that we go back there.

1080
01:03:31,707 --> 01:03:34,443
There's so many things
that Cassini has given us

1081
01:03:34,443 --> 01:03:36,813
in terms of a legacy to explore.

1082
01:03:36,813 --> 01:03:39,315
Enceladus and the

possibility of life.

1083
01:03:39,315 --> 01:03:43,486
Titan and its amazing lakes
and seas and hydrologic cycle.

1084
01:03:44,654 --> 01:03:47,256
Saturn and the rings
and the mysteries

1085
01:03:47,256 --> 01:03:49,392
of what lies beneath the clouds.

1086
01:03:49,392 --> 01:03:51,194
There's an awful
lot that Cassini

1087
01:03:51,194 --> 01:03:55,064
has said to us, we must
go back and explore.

1088
01:03:55,064 --> 01:03:57,433
- Yeah, there's a lot left
to do in the Saturn system

1089
01:03:57,433 --> 01:04:00,536
and elsewhere in the
solar system as well.

1090
01:04:00,536 --> 01:04:04,440
Well this has been an
international mission

1091
01:04:04,440 --> 01:04:07,610
and an intergenerational
mission, right,

1092
01:04:07,610 --> 01:04:09,979
it's been such a joy
for someone like me

1093
01:04:09,979 --> 01:04:12,882
to be able to be mentored
by veterans like you.

1094
01:04:12,882 --> 01:04:17,053
In terms of following on
Cassini's legacy and mentoring

1095
01:04:18,187 --> 01:04:21,190
the next generation,
what do you see in terms

1096
01:04:21,190 --> 01:04:23,826
of next missions coming
up, being able to bring

1097
01:04:23,826 --> 01:04:26,829
in the next generation of
scientists and engineers?

1098
01:04:26,829 --> 01:04:29,966
- First of all, I'm
very very confident

1099
01:04:29,966 --> 01:04:32,969
and optimistic about
the next generation,

1100
01:04:32,969 --> 01:04:35,705
because I can see that the
experts are here already.

1101
01:04:35,705 --> 01:04:38,174
So we will be well
served in the future.

1102
01:04:38,174 --> 01:04:41,611
Of course, NASA is
going back to Europa

1103
01:04:41,611 --> 01:04:44,814
with the Europa Clipper,
which is very exciting.

1104
01:04:44,814 --> 01:04:47,149
And the Europeans are
doing JUICE to the other

1105
01:04:47,149 --> 01:04:50,386
Galilean moons and there are
number of concepts out there

1106
01:04:50,386 --> 01:04:54,557
for going back to Enceladus
and Titan and to Saturn.

1107
01:04:55,725 --> 01:04:57,526
We don't know if any
of those are going

1108
01:04:57,526 --> 01:05:00,129
to happen in the next
few years but we'll see.

1109
01:05:00,129 --> 01:05:02,732
There are lots of ideas,
the important point is that

1110
01:05:02,732 --> 01:05:05,568
Cassini has gotta be
a jumping off point

1111
01:05:05,568 --> 01:05:09,672
to even more exciting
exploratory missions.

1112
01:05:09,672 --> 01:05:11,974
We can't let it
stop at this point,

1113
01:05:11,974 --> 01:05:13,609
we have to keep going on.

1114
01:05:13,609 --> 01:05:15,211
We will in the Jupiter system.

1115
01:05:15,211 --> 01:05:16,679
We need to go back to Saturn,

1116
01:05:16,679 --> 01:05:18,381
we need to go to
Uranus and Neptune.

1117
01:05:18,381 --> 01:05:20,116
We need to do the whole
outer solar system.

1118
01:05:20,116 --> 01:05:22,318
- We need to, the outer planets.

1119
01:05:22,318 --> 01:05:24,620
I think one of the amazing
things that Cassini

1120
01:05:24,620 --> 01:05:28,124
has shown us is that it's
not a boring cold place.

1121
01:05:28,124 --> 01:05:31,460
It's dynamic, it's
so incredibly varied.

1122
01:05:31,460 --> 01:05:34,664
Just the differences in
the moons of Saturn alone.

1123
01:05:34,664 --> 01:05:37,700
It inspires us to wanna

go back and to learn more.

1124
01:05:37,700 --> 01:05:41,904
- Yeah, you know, 40 years
ago, Voyager One was launched.

1125
01:05:43,072 --> 01:05:45,441
And it was Voyager
One and Two that

1126
01:05:45,441 --> 01:05:47,576
broke open the outer
solar system for us,

1127
01:05:47,576 --> 01:05:51,747
told us that this was not
a cold dead gray place.

1128
01:05:53,182 --> 01:05:55,184
And then Galileo and Cassini
followed on and showed us

1129
01:05:55,184 --> 01:05:59,021
what really amazing things
are going on in those systems

1130
01:05:59,021 --> 01:06:02,158
and that there might in fact
be places for life to exist

1131
01:06:02,158 --> 01:06:05,194
in Europa and
Enceladus and Titan.

1132
01:06:05,194 --> 01:06:08,898
And I have a poem I wanna read
to you as well at some point.

1133
01:06:08,898 --> 01:06:10,199
Is this a good time?

1134
01:06:10,199 --> 01:06:11,667
- I think it's a great time.

1135
01:06:11,667 --> 01:06:14,403
- Okay, you know a lot has been
said about Cassini already,

1136
01:06:14,403 --> 01:06:18,307
and the end of the mission,
but I think that the best

1137
01:06:18,307 --> 01:06:22,411
I could to do leave for
me, leave this celebration

1138
01:06:22,411 --> 01:06:25,414
of Cassini's end is to
read a bit of a poem

1139
01:06:25,414 --> 01:06:27,883
by Swinburne, On
the Verge, which was

1140
01:06:27,883 --> 01:06:30,353
a nautical poem about
death and dying.

1141
01:06:30,353 --> 01:06:34,156
Death, sailing on the sea
as a metaphor for death.

1142
01:06:34,156 --> 01:06:37,226
And so I'm gonna read
the last few lines of it.

1143
01:06:37,226 --> 01:06:40,463
And I've changed one of the
words, it'll be obvious.

1144
01:06:40,463 --> 01:06:43,532
Ah but here Cassini's
heart leaps,

1145
01:06:43,532 --> 01:06:47,103
yearning toward the gloom
with venturous glee.

1146
01:06:47,103 --> 01:06:50,806
Though her pilot eye
behold nor bay nor harbor,

1147
01:06:50,806 --> 01:06:54,710
rock nor shoal, from the
shore that hath no shore

1148
01:06:54,710 --> 01:06:57,213
beyond it set in all the sea.

1149
01:06:57,213 --> 01:06:59,315
- That's beautiful.

1150
01:06:59,315 --> 01:07:01,150
You had to do that, didn't you?

1151
01:07:01,150 --> 01:07:02,718
- I did, sorry about that.

1152
01:07:02,718 --> 01:07:04,620
- Thank you Johnathan
for everything.

1153
01:07:04,620 --> 01:07:07,189
- Well Morgan, the
future is in your hands

1154
01:07:07,189 --> 01:07:10,259
and the hands of your
generation, and this was

1155
01:07:10,259 --> 01:07:12,828
a moment of transition,
it was not the end.

1156
01:07:12,828 --> 01:07:15,765
And so let's go forth
and explore the solar
system together.

1157
01:07:15,765 --> 01:07:16,999
- Alright.

1158
01:07:16,999 --> 01:07:20,136
- That's a beautiful sentiment.

1159
01:07:20,136 --> 01:07:22,938
Well with me now is NASA
Associate Administrator

1160
01:07:22,938 --> 01:07:25,107
for Science Thomas Zurbuchen.

1161
01:07:25,107 --> 01:07:27,376
Dr. Zurbuchen, what
was your reaction

1162
01:07:27,376 --> 01:07:29,345
being in that control room?

1163
01:07:29,345 --> 01:07:32,014
- I was just
overwhelmed with just

1164
01:07:32,014 --> 01:07:35,084
understanding how
professional this team is.

1165
01:07:35,084 --> 01:07:37,119

You know, like during
the entire time

1166
01:07:37,119 --> 01:07:38,921
this was clearly
emotional for everybody.

1167
01:07:38,921 --> 01:07:41,724
The lucky peanuts were there,
but there are lot of Kleenex,

1168
01:07:41,724 --> 01:07:43,692
and there's a lot
of use of Kleenex.

1169
01:07:43,692 --> 01:07:46,929
But everybody was so
professional to the very end,

1170
01:07:46,929 --> 01:07:49,565
and I just saw it happening,
you know, it went so fast.

1171
01:07:49,565 --> 01:07:51,967
You know, somebody
was shouting out, ah,

1172
01:07:51,967 --> 01:07:54,804
we're struggling with Z
axis, and oh, it's gone.

1173
01:07:54,804 --> 01:07:58,374
And I just saw that team holding
together 'til the very end.

1174
01:07:58,374 --> 01:08:01,143
Just really it's all about
teamwork with this mission,

1175
01:08:01,143 --> 01:08:02,978

and it showed in
the last seconds.

1176
01:08:02,978 --> 01:08:04,213
- It truly did.

1177
01:08:04,213 --> 01:08:05,815
And your feelings about this,

1178
01:08:05,815 --> 01:08:08,951
what sort of legacy do you
think this mission leaves?

1179
01:08:08,951 --> 01:08:11,454
- You know, I really
do think it rewrote

1180
01:08:11,454 --> 01:08:14,457
not only what we know about
the outer solar system,

1181
01:08:14,457 --> 01:08:17,293
but how we think as
humans about ourselves.

1182
01:08:17,293 --> 01:08:20,262
You know, these worlds
that it found we never knew

1183
01:08:20,262 --> 01:08:24,433
were there are changing how
we think about life itself.

1184
01:08:25,501 --> 01:08:27,136
And so for me,
that's why it's truly

1185
01:08:27,136 --> 01:08:30,172
a civilization-scale
mission, one that will

1186
01:08:30,172 --> 01:08:33,042
stand out among other
missions anywhere.

1187
01:08:33,042 --> 01:08:36,512
- And how will it
impact future ideas

1188
01:08:36,512 --> 01:08:40,583
and future missions
as we plan new things?

1189
01:08:40,583 --> 01:08:43,052
- You know, some of the
hardest questions to answer

1190
01:08:43,052 --> 01:08:46,055
are questions like is
there life out there?

1191
01:08:46,055 --> 01:08:49,859
And this mission really
has redefined that.

1192
01:08:49,859 --> 01:08:52,294
It will affect how we
think about that question.

1193
01:08:52,294 --> 01:08:54,763
So of course we're tackling
that at NASA with a multitude

1194
01:08:54,763 --> 01:08:57,166
of missions, looking at
Mars, trying to bring

1195
01:08:57,166 --> 01:08:59,735
samples back, but also
looking at Europa,

1196
01:08:59,735 --> 01:09:01,604
looking at these
outer ocean worlds

1197
01:09:01,604 --> 01:09:05,040
and finding these worlds
all over the universe,

1198
01:09:05,040 --> 01:09:07,676
all over our galaxy,
every, you know.

1199
01:09:07,676 --> 01:09:10,079
There's thousands
of these exoplanets

1200
01:09:10,079 --> 01:09:14,250
and you know, Saturn-like,
Jupiter-like kind of exoplanets

1201
01:09:15,117 --> 01:09:16,552
that we're discovering and we're

1202
01:09:16,552 --> 01:09:19,121
thinking about in
a totally new way.

1203
01:09:19,121 --> 01:09:23,292
- And so the thought is people
are clamoring to go back.

1204
01:09:24,160 --> 01:09:25,694
Will that be difficult to do,

1205
01:09:25,694 --> 01:09:29,598
to be able to envision another
mission to these places soon?

1206

01:09:30,866 --> 01:09:33,402
- It's always very
difficult, right, to do this.

1207
01:09:33,402 --> 01:09:35,871
Because these
machines are so hard.

1208
01:09:35,871 --> 01:09:39,575
To go back and for example take
the next step on Enceladus,

1209
01:09:39,575 --> 01:09:43,045
we wanna really think
what that will take.

1210
01:09:43,045 --> 01:09:45,214
Now there's great ideas
already out there.

1211
01:09:45,214 --> 01:09:47,616
And perhaps some of these
ideas will come to fruition

1212
01:09:47,616 --> 01:09:49,919
relatively early, I
don't know, but you know,

1213
01:09:49,919 --> 01:09:52,221
we wanna really start
thinking about this

1214
01:09:52,221 --> 01:09:54,857
and start talking about it
in the science community.

1215
01:09:54,857 --> 01:09:58,561
We're all waiting for
current stem to really start,

1216

01:09:58,561 --> 01:10:01,096
you know, making
plans so we can create

1217
01:10:01,096 --> 01:10:04,300
a consensus as to what
direction we wanna go at.

1218
01:10:04,300 --> 01:10:05,868
Yes we wanna really go back.

1219
01:10:05,868 --> 01:10:07,603
This is such a wonderful system,

1220
01:10:07,603 --> 01:10:09,305
we don't wanna leave it alone.

1221
01:10:09,305 --> 01:10:10,839
- Right, and such
a beautiful one.

1222
01:10:10,839 --> 01:10:12,641
And it's affected
so many people.

1223
01:10:12,641 --> 01:10:14,777
Dr. Zurbuchen, thank you so much

1224
01:10:14,777 --> 01:10:16,912
for sharing this moment with us.

1225
01:10:16,912 --> 01:10:18,881
A very special one.
- Thanks to you.

1226
01:10:18,881 --> 01:10:21,016
- Alright.
- Thanks to the team.

1227

01:10:21,016 --> 01:10:24,186
- Well the Cassini-Huygens
team was a multi-international

1228
01:10:24,186 --> 01:10:27,756
team and in just a few
moments from now we will

1229
01:10:27,756 --> 01:10:31,427
be speaking to
members of ESA and ASI

1230
01:10:31,427 --> 01:10:34,763
about their feelings
about this mission.

1231
01:10:38,100 --> 01:10:40,836
[dramatic music]

1232
01:12:40,622 --> 01:12:43,525
As we told you earlier,
Cassini-Huygens was

1233
01:12:43,525 --> 01:12:47,129
a multi-national endeavor
from the very very start.

1234
01:12:47,129 --> 01:12:48,997
A partnership between NASA,

1235
01:12:48,997 --> 01:12:52,968
the European Space Agency,
and the Italian Space Agency.

1236
01:12:52,968 --> 01:12:56,839
This is an equally proud
moment for ESA and ASI,

1237
01:12:56,839 --> 01:13:00,109
and the ESA director of

science, Alvaro Gimenez,

1238
01:13:00,109 --> 01:13:03,479
joins us, and the president
of ASI, Roberto Battiston

1239
01:13:03,479 --> 01:13:06,949
are here to share
this historic moment.

1240
01:13:06,949 --> 01:13:08,984
Thank you so much for coming.

1241
01:13:08,984 --> 01:13:11,653
Was this something
that you decided

1242
01:13:11,653 --> 01:13:13,956
you couldn't miss
it for the world?

1243
01:13:13,956 --> 01:13:16,091
- Of course we couldn't miss it,

1244
01:13:16,091 --> 01:13:18,827
because we knew this
moment was gonna come.

1245
01:13:18,827 --> 01:13:21,730
It's a little bit sad,
because we wanted to delay it

1246
01:13:21,730 --> 01:13:24,633
as much as possible and get
as much science as possible.

1247
01:13:24,633 --> 01:13:26,201
But we knew it was coming.

1248

01:13:26,201 --> 01:13:30,372
In that sense it's sad, but
it's also very nice to see that

1249
01:13:31,807 --> 01:13:34,743
we have opened the possibility
for the future science also.

1250
01:13:35,611 --> 01:13:37,679
And for the scientist to work

1251
01:13:37,679 --> 01:13:40,916
on the data that
Cassini has collected.

1252
01:13:40,916 --> 01:13:44,420
But also as an example
and I think we have

1253
01:13:44,420 --> 01:13:48,357
to build on this
cooperation between the US

1254
01:13:48,357 --> 01:13:51,427
and Europe in ambitious
missions like this.

1255
01:13:51,427 --> 01:13:54,096
We are very proud of
having worked together

1256
01:13:54,096 --> 01:13:57,833
and we have to make sure
that we continue this way,

1257
01:13:57,833 --> 01:14:00,869
because together we
can do much better.

1258
01:14:00,869 --> 01:14:02,805

- And much more--
- Than separate.

1259
01:14:02,805 --> 01:14:04,540
- And Roberto, your feelings.

1260
01:14:04,540 --> 01:14:06,642
I mean to be a part of this.

1261
01:14:06,642 --> 01:14:08,944
- It is a very
historical moment,

1262
01:14:08,944 --> 01:14:11,246
and being part of that is really

1263
01:14:11,246 --> 01:14:14,116
something very
emotionally intense.

1264
01:14:14,116 --> 01:14:17,085
I was not there 20 years
ago when this started,

1265
01:14:17,085 --> 01:14:19,721
but I know the story of all
my friend and colleagues.

1266
01:14:19,721 --> 01:14:23,225
And Cassini demonstrated
we can do that.

1267
01:14:23,225 --> 01:14:26,795
We can create the conditions
for the international

1268
01:14:26,795 --> 01:14:29,465
collaboration, the mission
was operated 20 years.

1269
01:14:29,465 --> 01:14:31,767
We can learn an inter amount
of things for the future

1270
01:14:31,767 --> 01:14:34,603
is one step gigantic
step toward the future.

1271
01:14:34,603 --> 01:14:37,573
And really we should hope
this is not the last one,

1272
01:14:37,573 --> 01:14:40,042
that this is the only the
first one in a series.

1273
01:14:40,042 --> 01:14:43,378
- Were you surprised at how
long this mission has lasted?

1274
01:14:43,378 --> 01:14:45,981
And the amount of information

1275
01:14:45,981 --> 01:14:49,485
and science that it
has brought back?

1276
01:14:49,485 --> 01:14:52,654
- Not so much about the length,

1277
01:14:52,654 --> 01:14:54,590
I think we all dreamt about it.

1278
01:14:54,590 --> 01:14:58,760
But the discoveries and what
we have found in the Cassini

1279
01:15:00,462 --> 01:15:03,465
system, in the Saturn

system, are simply amazing.

1280
01:15:03,465 --> 01:15:05,801
We were surprised by that.

1281
01:15:05,801 --> 01:15:09,905
- And ESA's role with
Huygens and working on Titan.

1282
01:15:09,905 --> 01:15:13,842
I mean, what was the
high points for you?

1283
01:15:13,842 --> 01:15:17,212
- Well for me, Huygens
was getting to Titan.

1284
01:15:17,212 --> 01:15:20,048
We landed there in 2005.

1285
01:15:20,048 --> 01:15:21,683
But the whole purpose was to

1286
01:15:21,683 --> 01:15:23,652
understand the
atmosphere of Titan.

1287
01:15:23,652 --> 01:15:25,287
To analyze the atmosphere,

1288
01:15:25,287 --> 01:15:27,589
which is a pretty
exotic atmosphere,

1289
01:15:27,589 --> 01:15:30,926
full of nitrogen and methane
and those kind of elements,

1290
01:15:30,926 --> 01:15:35,097

which is what we thought that
these bodies outside the outer

1291
01:15:36,498 --> 01:15:39,668
part of the solar system were
before life could appear.

1292
01:15:41,003 --> 01:15:43,205
And we wanted to analyze that.

1293
01:15:43,205 --> 01:15:46,074
But then we found that
we could even land.

1294
01:15:46,074 --> 01:15:48,577
When the mission was designed,

1295
01:15:48,577 --> 01:15:51,113
we didn't know how
the surface was.

1296
01:15:51,113 --> 01:15:55,317
We didn't know if it was going
to sink or land or whatever.

1297
01:15:56,718 --> 01:15:58,186
- And it was alive for
some time when it landed.

1298
01:15:58,186 --> 01:16:00,222
- And it was alive,
and that was amazing,

1299
01:16:00,222 --> 01:16:03,225
because also we could see
first this was the furthest

1300
01:16:03,225 --> 01:16:06,862
away landing every of
a human made probe.

1301
01:16:06,862 --> 01:16:11,033
But also we found a landscape
totally unexpected of Titan.

1302
01:16:14,503 --> 01:16:17,205
Something similar
to Earth actually.

1303
01:16:17,205 --> 01:16:18,740
- [Gay] Very.

1304
01:16:18,740 --> 01:16:22,477
- With lakes and rivers and
mountains and very filming,

1305
01:16:23,845 --> 01:16:26,315
but with a totally different
chemical composition.

1306
01:16:26,315 --> 01:16:27,783
Totally different world.

1307
01:16:27,783 --> 01:16:31,587
And with the cycles of
methane rather than water.

1308
01:16:31,587 --> 01:16:35,757
But it is so interesting,
it's so attractive I guess.

1309
01:16:37,159 --> 01:16:39,928
- But looking at it, it does
look very very familiar.

1310
01:16:39,928 --> 01:16:41,930
And Roberto, let's talk about

1311
01:16:41,930 --> 01:16:45,200

ASI's role and the
high gain antenna.

1312
01:16:45,200 --> 01:16:49,371
So often the project relied
on the high gain antenna

1313
01:16:50,539 --> 01:16:53,141
as protection for the
rest of the spacecraft,

1314
01:16:53,141 --> 01:16:56,645
was that something
that was planned

1315
01:16:56,645 --> 01:17:00,749
and you thought this is
a way to use the antenna?

1316
01:17:01,617 --> 01:17:02,884
- This antenna is amazing.

1317
01:17:02,884 --> 01:17:04,419
It's probably the
most sophisticated

1318
01:17:04,419 --> 01:17:06,455
antenna ever built
for a space mission.

1319
01:17:06,455 --> 01:17:09,558
Receiving and transmitting a
field four different bands at

1320
01:17:09,558 --> 01:17:12,995
the same time, operating for
20 years, almost 20 years ago.

1321
01:17:12,995 --> 01:17:16,031
So that was at the core of

it, but indeed you're right.

1322
01:17:16,031 --> 01:17:18,100
That was designed to be as

1323
01:17:18,100 --> 01:17:20,135
a passive thermal
protection system.

1324
01:17:20,135 --> 01:17:22,204
Going into Venus
this was shielding

1325
01:17:22,204 --> 01:17:26,108
the satellite from the
intense solar radiation.

1326
01:17:27,409 --> 01:17:30,746
And getting into the
Saturn environment,

1327
01:17:30,746 --> 01:17:33,582
it was shielding again
the micrometeorite.

1328
01:17:33,582 --> 01:17:36,885
Basically measuring by the
vibration on the antenna itself

1329
01:17:36,885 --> 01:17:39,788
the amount of micrometeorite
it was hitting

1330
01:17:39,788 --> 01:17:43,191
and to use that as a
protection when entering

1331
01:17:43,191 --> 01:17:47,362
in certain location like
the space between the Uranus

1332
01:17:48,797 --> 01:17:52,367
and the Saturn planet, which
was unknown, totally unknown.

1333
01:17:53,235 --> 01:17:55,370
And I think this is amazing.

1334
01:17:55,370 --> 01:17:58,573
Such a sophisticated
instrument we use a thermal

1335
01:17:58,573 --> 01:18:02,210
shield call, as
micrometeorite shield indeed.

1336
01:18:02,210 --> 01:18:06,214
- And Cassini was such
a well-made machine

1337
01:18:06,214 --> 01:18:10,385
and served so well, I
think in its entire flight

1338
01:18:11,787 --> 01:18:14,956
it had only safed I think
three times and that was all.

1339
01:18:16,425 --> 01:18:19,594
But could not have done it
without both ASI and ESA.

1340
01:18:21,029 --> 01:18:23,131
And we are so pleased that
you are here and joining us.

1341
01:18:23,131 --> 01:18:25,834
- These are the kind of
stories about space mission

1342
01:18:25,834 --> 01:18:30,005
that should be told,
because the fact it was most

1343
01:18:31,173 --> 01:18:33,108
perfectly designed
without trouble

1344
01:18:33,108 --> 01:18:36,078
is a tremendous giant
bonds that should be known.

1345
01:18:36,078 --> 01:18:37,479
- Right.

1346
01:18:37,479 --> 01:18:40,115
Well thank you again for
coming out and being with us on

1347
01:18:40,115 --> 01:18:42,484
this very very special day.
- Thank you.

1348
01:18:42,484 --> 01:18:43,318
- Alright.

1349
01:18:48,056 --> 01:18:50,726
[relaxed music]

1350
01:21:07,762 --> 01:21:11,733
And that video you just saw
was called Cassini Inspires.

1351
01:21:11,733 --> 01:21:15,470
It was made up of images that
the public, you, sent in using

1352
01:21:15,470 --> 01:21:19,641
some of Cassini's raw images

as well as your own artwork.

1353
01:21:20,375 --> 01:21:21,610
Thank you so much.

1354
01:21:21,610 --> 01:21:23,645
Well that wraps it up from here.

1355
01:21:23,645 --> 01:21:27,082
A bittersweet for the Cassini
team, but we can't help

1356
01:21:27,082 --> 01:21:30,418
but feel proud of the
fantastic people that made

1357
01:21:30,418 --> 01:21:34,589
these accomplishments
possible these last 20 years.

1358
01:21:35,457 --> 01:21:37,092
And about an hour from now,

1359
01:21:37,092 --> 01:21:40,095
at 6:30 AM Pacific,
9:30 AM Eastern,

1360
01:21:41,496 --> 01:21:44,666
there will be a news briefing
on Cassini's grand finale.

1361
01:21:44,666 --> 01:21:47,602
It will be live on NASA
TV and also streamed.

1362
01:21:47,602 --> 01:21:50,572
And for more information
about the mission,

1363

01:21:50,572 --> 01:21:53,909
you can check out the URLs
you see on the screen.

1364
01:21:53,909 --> 01:21:56,211
And a little bit earlier,

1365
01:21:56,211 --> 01:21:59,014
Jim Green told you
about the e-books.

1366
01:21:59,014 --> 01:22:01,549
Some of the most memorable gifts

1367
01:22:01,549 --> 01:22:04,419
from Cassini are those
specactular images.

1368
01:22:04,419 --> 01:22:07,622
An e-book of these stunning
images has been made,

1369
01:22:07,622 --> 01:22:09,524
and you can find it by going

1370
01:22:09,524 --> 01:22:12,928
to that link you
see on the screen.

1371
01:22:12,928 --> 01:22:15,964
Well finally before
we go, a parting look

1372
01:22:15,964 --> 01:22:19,968
at the DSN now image, the
display you see there.

1373
01:22:21,436 --> 01:22:25,507
Antenna 43, that's the one
in Australia, is now dark.

1374
01:22:27,075 --> 01:22:30,578
Communication with the
spacecraft is now silent.