The Footsteps of VOYAGER

1
00:00:00,436 --> 00:00:03,519
(rocket blasting)

2
00:00:04,502 --> 00:00:07,040
- [Narrator] After the race to the moon

3
00:00:07,040 --> 00:00:10,603
the United States charts a new
future with a new spacecraft.

4
00:00:12,420 --> 00:00:14,940
And a robotic mission to Jupiter

5
00:00:14,940 --> 00:00:17,610
struggles to get off the ground.

6
00:00:17,610 --> 00:00:19,710
- [John] We started
tearing this thing apart

7
00:00:19,710 --> 00:00:22,500
and really began to find the warts on it.

8
00:00:22,500 --> 00:00:23,430
- [Narrator] Meanwhile

9
00:00:23,430 --> 00:00:25,610
another spacecraft attempts to complete

10
00:00:25,610 --> 00:00:28,960
the first reconnaissance
of the outer planets.

11
00:00:28,960 --> 00:00:30,730
- [Torrence] The initial
calculation showed

12
00:00:30,730 --> 00:00:32,820

that we were going to be in great danger

13
00:00:32,820 --> 00:00:34,680
of getting really fuzzy pictures

14
00:00:34,680 --> 00:00:37,650
if we didn't do something
to the spacecraft.

15
00:00:37,650 --> 00:00:40,883
- ISS wide angle electronics is off.

16
00:00:40,883 --> 00:00:43,497
(faint speaking)
replacement heater is off.

17
00:00:43,497 --> 00:00:45,090
- [William] And at close encounter

18
00:00:45,090 --> 00:00:47,770
we would all be holding our breaths.

19
00:00:47,770 --> 00:00:50,680
You can't believe how exciting that was.

20
00:00:50,680 --> 00:00:53,610
- [Ed] The images that
were returned this morning

21
00:00:53,610 --> 00:00:57,361
revealed a world unlike any
of the others that we've seen.

22
00:00:57,361 --> 00:01:00,790
(people exclaiming)
(people applauding)

23
00:01:00,790 --> 00:01:03,300
- [Narrator] Yet even

in the midst of triumph

24
00:01:03,300 --> 00:01:07,253
the future of planetary
exploration seems in doubt.

25
00:01:08,790 --> 00:01:10,050
- [Female Speaker] I'm
kind of having a hard time

26
00:01:10,050 --> 00:01:11,540
reconciling all this to know

27
00:01:11,540 --> 00:01:14,240
what the next generation's
going to be doing in space.

28
00:01:16,110 --> 00:01:18,800
- [Narrator] The Footsteps of Voyager

29
00:01:18,800 --> 00:01:22,359
JPL and the beginnings of the Space Age.

30
00:01:22,359 --> 00:01:23,192
Next.

31
00:01:31,115 --> 00:01:33,782
(light music)

32
00:01:39,639 --> 00:01:43,697
■ I was strolling on the Moon one day ■

33
00:01:43,697 --> 00:01:47,430
■ In the merry, merry month of December ■

34
00:01:47,430 --> 00:01:48,704
- May, May!

35

00:01:48,704 --> 00:01:51,003
May is the month this year.
- May, that's right.

36
00:01:51,003 --> 00:01:53,918
- [Narrator] In December of 1972

37
00:01:53,918 --> 00:01:56,546
Apollo 17 astronauts Harrison Schmitt

38
00:01:56,546 --> 00:02:00,419
and Gene Cernan took the
last steps on the Moon.

39
00:02:00,419 --> 00:02:01,896
■ Da, da, da, da, da, da, da ■

40
00:02:01,896 --> 00:02:03,911
■ Dee, da, dee ■

41
00:02:03,911 --> 00:02:06,948
- Okay, Bob.
■ Da, da, da, da, da, dee ■

42
00:02:08,890 --> 00:02:09,930
Let me tell you, Bob.

43
00:02:09,930 --> 00:02:12,410
This flag is a beautiful picture.

44
00:02:12,410 --> 00:02:13,450
That's beautiful.

45
00:02:13,450 --> 00:02:15,880
This has gotta be one of the
most proud moments of my life.

46
00:02:15,880 --> 00:02:16,723
I guarantee you.

47
00:02:18,660 --> 00:02:21,540
- [Narrator] NASA had
hoped for more missions.

48
00:02:21,540 --> 00:02:23,520
But the race against the Soviet Union

49
00:02:23,520 --> 00:02:25,653
to be the first to the Moon had been won.

50
00:02:26,500 --> 00:02:29,593
America's priorities
were turning elsewhere.

51
00:02:30,617 --> 00:02:32,867
- [Gene] This is Gene
and I'm on the surface.

52
00:02:34,782 --> 00:02:38,532
And as I take man's last
step from the surface

53
00:02:39,455 --> 00:02:43,600
I'd like to just let what I
believe history will record

54
00:02:45,110 --> 00:02:48,480
that America's challenge of today

55
00:02:49,654 --> 00:02:53,563
has forged man's destiny of tomorrow.

56
00:02:55,330 --> 00:02:57,887
Godspeed the crew of Apollo 17.

57
00:03:01,011 --> 00:03:04,594
(intense orchestral music)

58
00:03:07,550 --> 00:03:09,530
- [Narrator] Long before this moment

59
00:03:09,530 --> 00:03:11,630
NASA was charting a new future

60
00:03:11,630 --> 00:03:14,303
with a very different kind of spacecraft.

61
00:03:18,670 --> 00:03:22,263
One with wings that could
glide back to a runway.

62
00:03:25,510 --> 00:03:27,840
The Shuttle, as it came to be known,

63
00:03:27,840 --> 00:03:31,030
could be reused over and over again

64
00:03:31,030 --> 00:03:33,983
to ferry astronauts and cargo into space.

65
00:03:37,180 --> 00:03:41,460
Early designs envisioned an
enormous rocket flown by pilots

66
00:03:41,460 --> 00:03:43,510
that would launch the Shuttle into orbit.

67
00:03:44,760 --> 00:03:47,630
This extraordinary concept
was as unaffordable

68
00:03:47,630 --> 00:03:50,240
as it was unrealistic.

69
00:03:50,240 --> 00:03:53,423
The final design was severely scaled back.

70
00:03:55,120 --> 00:03:57,823
What did not change were expectations.

71
00:04:00,710 --> 00:04:03,710
Proponents promised that
with this winged orbiter

72
00:04:03,710 --> 00:04:07,010
access to space would
become routine commutes.

73
00:04:07,010 --> 00:04:10,133
The Shuttle was to be cheaper and safer.

74
00:04:12,030 --> 00:04:14,080
But to make the economic model work

75
00:04:14,080 --> 00:04:16,593
meant abandoning expendable rockets.

76
00:04:17,560 --> 00:04:21,140
The Shuttle's manifest
was to carry all cargo

77
00:04:21,140 --> 00:04:23,201
for NASA, commercial companies,

78
00:04:23,201 --> 00:04:26,293
and even defense and
intelligence agencies.

79
00:04:27,200 --> 00:04:31,670
But the Shuttle's reach went
only as far as low earth orbit.

80
00:04:31,670 --> 00:04:35,323
And that was not good news for
exploring the solar system.

81
00:04:36,680 --> 00:04:38,470
- This was threatening the
whole planetary program.

82
00:04:38,470 --> 00:04:41,090
But in this monopoly craze

83
00:04:41,090 --> 00:04:42,230
NASA said, no,

84
00:04:42,230 --> 00:04:44,740
you can't just buy regular launch vehicles

85
00:04:44,740 --> 00:04:46,150
that were available.

86
00:04:46,150 --> 00:04:46,983
We're gonna liquidate those.

87
00:04:46,983 --> 00:04:48,673
We're gonna force them to close.

88
00:04:49,950 --> 00:04:53,440
- [Narrator] Bruce Murray was
often out of step with NASA.

89
00:04:53,440 --> 00:04:56,200
But he viewed the policy
of a Shuttle monopoly

90
00:04:56,200 --> 00:04:59,650
as a threat to the entire space agency.

91
00:04:59,650 --> 00:05:00,720
- And so there were two issues.

92
00:05:00,720 --> 00:05:02,120

One was my programmatic view

93
00:05:02,120 --> 00:05:03,810
that this was a crazy thing to do,

94
00:05:03,810 --> 00:05:05,539
and would, by the way,

95
00:05:05,539 --> 00:05:06,950
kill the planetary program,

96
00:05:06,950 --> 00:05:08,250
which it did for a decade.

97
00:05:09,160 --> 00:05:13,140
But more generally, it
would destroy the agency.

98
00:05:13,140 --> 00:05:14,530
So the agency that had been able

99
00:05:14,530 --> 00:05:16,830
to do extraordinary things like Apollo

100
00:05:16,830 --> 00:05:19,270
was going to consciously transform itself

101
00:05:19,270 --> 00:05:22,728
to running a space transportation system

102
00:05:22,728 --> 00:05:25,410
because it had gained a monopoly.

103
00:05:25,410 --> 00:05:29,148
This was dreadfully wrong on both grounds.

104
00:05:29,148 --> 00:05:32,231
(rocket launching)

105
00:05:37,343 --> 00:05:39,540
- [Narrator] Murray's
criticisms were hard to see

106
00:05:39,540 --> 00:05:40,983
when the Shuttle first flew.

107
00:05:42,420 --> 00:05:45,420
The Shuttle not only looked
like a space age vehicle,

108
00:05:45,420 --> 00:05:48,794
it impressively performed like one.

109
00:05:48,794 --> 00:05:51,627
(people cheering)

110
00:05:52,620 --> 00:05:54,430
And Murray's opinions did nothing

111
00:05:54,430 --> 00:05:57,410
to discourage an
enterprising group of JPLers

112
00:05:57,410 --> 00:06:00,350
from trying to hitch
a ride on the Shuttle.

113
00:06:00,350 --> 00:06:03,410
The team's leader was Charles Elachi.

114
00:06:03,410 --> 00:06:06,853
And he pitched a series of
radar science experiments.

115
00:06:08,010 --> 00:06:10,640
- And basically, it's a
configuration of it at launch.

116
00:06:10,640 --> 00:06:12,540
It will be configured in this arrangement.

117
00:06:12,540 --> 00:06:13,863
Once we get in orbit

118
00:06:13,863 --> 00:06:16,470
then the antenna panels will be opened

119
00:06:16,470 --> 00:06:18,400
which will take about
twenty minute operation

120
00:06:18,400 --> 00:06:19,533
to open the antennas.

121
00:06:21,670 --> 00:06:24,570
- [Narrator] NASA said
yes to the proposal.

122
00:06:24,570 --> 00:06:26,550
And the second flight carried on board

123
00:06:26,550 --> 00:06:28,950
the Shuttle Imaging Radar A,

124
00:06:28,950 --> 00:06:31,843
the first in a series of radar payloads.

125
00:06:32,880 --> 00:06:33,713
- [Male Speaker] Okay, Sally.

126
00:06:33,713 --> 00:06:35,020
We've got the arm secured right now.

127
00:06:35,020 --> 00:06:37,474
We're just getting ready

to activate the SIR-A.

128
00:06:37,474 --> 00:06:38,420
We've got the power on

129
00:06:38,420 --> 00:06:41,121
and we're getting ready to turn it on.

130
00:06:41,121 --> 00:06:44,440
- [Sally Ride] Okay, sounds good.

131
00:06:44,440 --> 00:06:45,780
- [Narrator] The radar experiments

132
00:06:45,780 --> 00:06:47,830
demonstrated how the Shuttle could be used

133
00:06:47,830 --> 00:06:50,440
to better understand our own planet.

134
00:06:50,440 --> 00:06:53,570
But for spacecraft
destined beyond Earth orbit

135
00:06:53,570 --> 00:06:55,820
the Shuttle's limitations
would be crippling.

136
00:07:00,858 --> 00:07:04,858
(deliberative orchestral music)

137
00:07:12,050 --> 00:07:13,550
Jupiter.

138
00:07:13,550 --> 00:07:17,273
Only the Sun is larger than
the fifth planet from our star.

139

00:07:18,680 --> 00:07:20,610
It is two and a half times the mass

140
00:07:20,610 --> 00:07:23,583
of all the other planets in
our solar system combined.

141
00:07:25,190 --> 00:07:27,150
The Pioneer and Voyager missions

142
00:07:27,150 --> 00:07:30,393
had provided the first flyby
glimpses of this giant.

143
00:07:32,340 --> 00:07:34,983
The next step was to send an orbiter.

144
00:07:36,030 --> 00:07:36,930
- There was something called

145
00:07:36,930 --> 00:07:40,060
the Jupiter Orbiter with Probe, JOP.

146
00:07:40,060 --> 00:07:43,882
And the science team was consisted only of

147
00:07:43,882 --> 00:07:47,020
fields and particle people
and atmospheric people.

148
00:07:47,020 --> 00:07:48,710
And they wanted to build a probe

149
00:07:48,710 --> 00:07:50,930
that would go into the
atmosphere of Jupiter

150
00:07:50,930 --> 00:07:53,483
and the simplest spacecraft

to carry it there

151
00:07:53,483 --> 00:07:55,280
would have just be a spinning spacecraft.

152
00:07:55,280 --> 00:07:57,080
And you could slap some
fields and particles

153
00:07:57,080 --> 00:07:58,550
on the spinning spacecraft,

154
00:07:58,550 --> 00:07:59,600
and you had a winner.

155
00:08:02,250 --> 00:08:04,100
- [Narrator] Not everyone thought so.

156
00:08:05,100 --> 00:08:06,680
Other scientists were clamoring

157
00:08:06,680 --> 00:08:09,463
for different instruments and a camera.

158
00:08:10,410 --> 00:08:12,400
And that posed a dilemma.

159
00:08:12,400 --> 00:08:15,430
Taking images requires a steady platform

160
00:08:15,430 --> 00:08:17,400
while measuring magnetic fields

161
00:08:17,400 --> 00:08:19,923
calls for a spinning spacecraft.

162
00:08:21,580 --> 00:08:24,300
To solve these conflicting requirements,

163
00:08:24,300 --> 00:08:28,093
NASA assigned the project to JPL in 1975.

164
00:08:29,020 --> 00:08:31,470
The result was Galileo,

165
00:08:31,470 --> 00:08:33,110
a novel engineering design

166
00:08:33,110 --> 00:08:36,953
featuring both spinning
and stable platforms.

167
00:08:37,980 --> 00:08:41,320
- That quickly escalated
into a really major,

168
00:08:41,320 --> 00:08:42,800
major big design.

169
00:08:42,800 --> 00:08:45,160
Big cost change, big mass change.

170
00:08:45,160 --> 00:08:47,760
We started tearing this thing apart

171
00:08:47,760 --> 00:08:50,640
and really began to find the warts on it

172
00:08:50,640 --> 00:08:53,230
and, you know, attack them one by one.

173
00:08:53,230 --> 00:08:56,060
But the spacecraft got bigger

174
00:08:56,060 --> 00:08:58,073
and more complex as a result of that.

175
00:09:00,370 --> 00:09:02,460
- [Narrator] Galileo
also had the challenge

176
00:09:02,460 --> 00:09:04,440
of being the first planetary mission

177
00:09:04,440 --> 00:09:07,200
assigned for deployment by the Shuttle.

178
00:09:07,200 --> 00:09:09,510
But to travel beyond Earth orbit

179
00:09:09,510 --> 00:09:12,573
would require strapping on
a second booster rocket.

180
00:09:13,800 --> 00:09:16,840
There were two boosters
from which to choose.

181
00:09:16,840 --> 00:09:17,913
One was the Centaur.

182
00:09:19,122 --> 00:09:21,820
- The problem with a
Centaur is it's liquid fuel.

183
00:09:21,820 --> 00:09:24,270
If there's any kind of
leak of the liquid fuel

184
00:09:24,270 --> 00:09:25,310
into the Shuttle bay

185
00:09:25,310 --> 00:09:26,970
while they're trying to
get this thing up in orbit

186
00:09:26,970 --> 00:09:29,450
it could be potentially catastrophic.

187
00:09:29,450 --> 00:09:30,793
A very volatile fuel.

188
00:09:31,870 --> 00:09:35,250
- [Narrator] The Centaur
was seen as a dangerous risk

189
00:09:35,250 --> 00:09:37,527
and NASA ruled out its use.

190
00:09:37,527 --> 00:09:40,390
- And they were right,
it was nuts to do that.

191
00:09:40,390 --> 00:09:41,820
It was not safe.

192
00:09:41,820 --> 00:09:42,970
So, cancel that.

193
00:09:42,970 --> 00:09:45,100
And the only other thing we have

194
00:09:45,100 --> 00:09:49,350
is a solid fuel rocket called the IUS,

195
00:09:49,350 --> 00:09:52,243
which is actually an Air
Force rocket developed.

196
00:09:53,080 --> 00:09:54,270
And you can use that.

197
00:09:54,270 --> 00:09:55,970

But that won't get you to Jupiter!

198
00:09:57,130 --> 00:09:59,390
- [Narrator] That was
because the IUS booster

199
00:09:59,390 --> 00:10:01,550
was still on the drawing boards

200
00:10:01,550 --> 00:10:04,120
and it was not powerful enough.

201
00:10:04,120 --> 00:10:06,280
To use this booster also required

202
00:10:06,280 --> 00:10:08,523
a gravity assist around Mars.

203
00:10:09,430 --> 00:10:11,360
The launch dates slipped a year

204
00:10:11,360 --> 00:10:15,143
resulting in the first in a
long list of budget increases.

205
00:10:17,760 --> 00:10:20,300
Then it was realized
that Galileo was heavier

206
00:10:20,300 --> 00:10:22,830
than the Shuttle could safely lift.

207
00:10:22,830 --> 00:10:25,073
More powerful engines had to be built.

208
00:10:27,250 --> 00:10:29,210
NASA next directed JPL

209

00:10:29,210 --> 00:10:32,050
to explore dividing the mission in two:

210
00:10:32,050 --> 00:10:33,400
launching the spacecraft

211
00:10:33,400 --> 00:10:36,460
and the probe on separate
Shuttle missions.

212
00:10:36,460 --> 00:10:38,123
That plan was scrapped, too.

213
00:10:39,060 --> 00:10:41,653
Galileo was again delayed.

214
00:10:44,100 --> 00:10:45,560
- There's this kind of back and forth.

215
00:10:45,560 --> 00:10:48,060
And every time the JPL engineers

216
00:10:48,060 --> 00:10:50,010
are kind of back to the drawing board

217
00:10:50,010 --> 00:10:54,793
accommodating different
payload specifications,

218
00:10:55,640 --> 00:10:57,810
different trajectories
they can accomplish,

219
00:10:57,810 --> 00:10:59,370
every time, they have
to redesign the mission,

220
00:10:59,370 --> 00:11:01,170
and it's just a major headache here.

221
00:11:02,540 --> 00:11:05,793
- [Narrator] Galileo also became
a political lightning rod.

222
00:11:06,800 --> 00:11:10,050
And now engineering
decisions were being debated

223
00:11:10,050 --> 00:11:11,733
on the floor of the House.

224
00:11:13,430 --> 00:11:14,263
- Earlier this year

225
00:11:14,263 --> 00:11:16,560
we passed a NASA authorization bill

226
00:11:16,560 --> 00:11:18,590
overwhelmingly in this House

227
00:11:18,590 --> 00:11:20,767
that said that we would go with the IUS.

228
00:11:21,870 --> 00:11:23,960
Now, you can vote any way you want to.

229
00:11:23,960 --> 00:11:25,670
I have no vested interest.

230
00:11:25,670 --> 00:11:28,710
- The problem here is
that you have a vehicle

231
00:11:28,710 --> 00:11:32,570
that will get Galileo into
a geosynchronous orbit.

232

00:11:32,570 --> 00:11:34,560
It may be launched probably a year later,

233
00:11:34,560 --> 00:11:38,090
but as compared to the
IUS and the kick stage,

234
00:11:38,090 --> 00:11:39,893
it will get there a year earlier.

235
00:11:41,910 --> 00:11:44,220
- [Narrator] The booster
dispute finally came to an end

236
00:11:44,220 --> 00:11:47,770
when President Ronald
Reagan signed a bill in 1982

237
00:11:47,770 --> 00:11:52,543
that by law ordered NASA to
use the liquid fuel booster.

238
00:11:53,500 --> 00:11:57,210
Galileo's launch date was
delayed for yet another year,

239
00:11:57,210 --> 00:12:00,011
but at least there was now a path forward.

240
00:12:00,011 --> 00:12:01,810
(camera shuttering)

241
00:12:01,810 --> 00:12:03,493
Or so it seemed.

242
00:12:08,573 --> 00:12:12,323
(deliberative ambient music)

243
00:12:16,930 --> 00:12:19,200

Galileo survived.

244
00:12:19,200 --> 00:12:20,603
Bruce Murray did not.

245
00:12:22,100 --> 00:12:25,490
In trying to keep JPL
planetary missions alive

246
00:12:25,490 --> 00:12:28,423
he had burned one
Washington bridge too many.

247
00:12:30,120 --> 00:12:32,573
- It's a real pleasure to be here.

248
00:12:33,610 --> 00:12:36,382
We at last have a Director.

249
00:12:36,382 --> 00:12:38,860
And it turns out he's
a pretty good Director

250
00:12:38,860 --> 00:12:40,940
as far as I'm concerned.

251
00:12:40,940 --> 00:12:45,525
A man I'm proud to call my
friend is Dr. Lew Allen.

252
00:12:45,525 --> 00:12:47,740
(people applauding)

253
00:12:47,740 --> 00:12:50,620
- [Narrator] Lew Allen was a
four-star Air Force general

254
00:12:50,620 --> 00:12:53,480
with a PhD in nuclear physics.

255
00:12:53,480 --> 00:12:57,470
His resume included stints as
deputy director of the CIA,

256
00:12:57,470 --> 00:13:00,300
director of the National Security Agency,

257
00:13:00,300 --> 00:13:02,920
director of the National
Reconnaissance Office,

258
00:13:02,920 --> 00:13:05,440
commander of Air Force Systems Command,

259
00:13:05,440 --> 00:13:08,280
and Air Force Chief of Staff.

260
00:13:08,280 --> 00:13:10,300
- My space experience in the Air Force

261
00:13:10,300 --> 00:13:12,630
was almost entirely associated

262
00:13:12,630 --> 00:13:14,410
with the National Reconnaissance Office.

263
00:13:14,410 --> 00:13:19,060
These reconnaissance missions
were of course different

264
00:13:19,060 --> 00:13:21,590
than planetary missions,

265
00:13:21,590 --> 00:13:23,580
but they weren't all that different.

266
00:13:23,580 --> 00:13:28,000

So coming to JPL was
not a tremendous shock

267
00:13:28,000 --> 00:13:30,690
in the sense that it was
a continuation really

268
00:13:30,690 --> 00:13:33,440
of the kind of work that I'd
been doing for many years.

269
00:13:35,010 --> 00:13:38,000
- [Narrator] Whereas Murray
had meant to shake things up,

270
00:13:38,000 --> 00:13:40,663
Allen's demeanor was calm and reassuring.

271
00:13:42,180 --> 00:13:46,080
- We who did not contribute
to those accomplishments,

272
00:13:46,080 --> 00:13:49,530
but who have admired the
work of this laboratory,

273
00:13:49,530 --> 00:13:51,100
envy you.

274
00:13:51,100 --> 00:13:55,143
And I consider it an honor
to be able to join you now.

275
00:13:56,280 --> 00:13:57,590
- [Narrator] But there were concerns

276
00:13:57,590 --> 00:14:01,170
about how Allen's military
background would be perceived,

277
00:14:01,170 --> 00:14:05,890
especially by Caltech,
which manages JPL for NASA.

278
00:14:05,890 --> 00:14:08,590
- They were extremely
self-conscious about the perception

279
00:14:08,590 --> 00:14:10,810
that they were bringing
in this military general

280
00:14:10,810 --> 00:14:14,560
just when the lab was going
to be ramping up defense work,

281
00:14:14,560 --> 00:14:15,850
and this perception that well now

282
00:14:15,850 --> 00:14:19,523
JPL was just becoming basically
a de facto military lab.

283
00:14:20,990 --> 00:14:23,210
- [Narrator] Caltech
President Marvin Goldberger

284
00:14:23,210 --> 00:14:27,530
instructed JPL to play down
his military background.

285
00:14:27,530 --> 00:14:29,550
He was also worried that the news media

286
00:14:29,550 --> 00:14:31,075
might view a general's arrival

287
00:14:31,075 --> 00:14:33,460
as signaling a dramatic change

288
00:14:33,460 --> 00:14:37,620
and NASA's capitulation to
the militarization of space.

289
00:14:37,620 --> 00:14:40,290
Goldberger declared there
was to be no forsaking

290
00:14:40,290 --> 00:14:43,640
the civilian space
emphasis for a military one

291
00:14:43,640 --> 00:14:47,863
or an open R&D facility
for a classified one.

292
00:14:49,550 --> 00:14:51,630
- So they worked hard to
counter that perception.

293
00:14:51,630 --> 00:14:54,960
One way they did that was
by referring to Lew Allen

294
00:14:54,960 --> 00:14:57,540
not as General Allen, but as Dr. Allen,

295
00:14:57,540 --> 00:14:59,410
because he did have a
PhD in nuclear physics.

296
00:14:59,410 --> 00:15:01,513
He did have scientific credentials.

297
00:15:03,040 --> 00:15:04,650
- [Narrator] Before Allen's arrival

298
00:15:04,650 --> 00:15:07,140

NASA's leadership had instructed JPL

299
00:15:07,140 --> 00:15:09,260
to take on work for the Pentagon

300
00:15:09,260 --> 00:15:10,783
and the lab had complied.

301
00:15:12,610 --> 00:15:15,970
One involved the Strategic
Defense Initiative.

302
00:15:15,970 --> 00:15:18,180
JPL's role was to find ways

303
00:15:18,180 --> 00:15:20,350
of tracking the path of incoming missiles

304
00:15:20,350 --> 00:15:23,350
that were to be destroyed by lasers.

305
00:15:23,350 --> 00:15:25,850
Another project was underway for the Army,

306
00:15:25,850 --> 00:15:28,510
an attempt to sort and
analyze for commanders

307
00:15:28,510 --> 00:15:30,700
fast-moving and complicated events

308
00:15:30,700 --> 00:15:32,883
taking place on the battlefield.

309
00:15:34,220 --> 00:15:37,010
- That situation was so
challenging to the Army

310

00:15:37,890 --> 00:15:39,530
that in some desperation

311
00:15:39,530 --> 00:15:43,550
they turned to JPL because they
believed we were good enough

312
00:15:43,550 --> 00:15:46,900
and tough enough to make
a breakthrough of sorts

313
00:15:46,900 --> 00:15:48,253
in this particular area.

314
00:15:49,790 --> 00:15:52,160
- [Narrator] But Dr. Allen's main interest

315
00:15:52,160 --> 00:15:55,000
was now space exploration.

316
00:15:55,000 --> 00:15:57,360
And early on, he announced that JPL

317
00:15:57,360 --> 00:16:00,490
would be actually
reducing military projects

318
00:16:00,490 --> 00:16:03,550
to no more than 20% of its workload.

319
00:16:03,550 --> 00:16:05,290
And he articulated a policy

320
00:16:05,290 --> 00:16:07,560
restricting the type of defense activities

321
00:16:07,560 --> 00:16:10,853
the lab would take on
and what it would avoid.

322
00:16:13,550 --> 00:16:16,330
- We should view the
defense work in this way,

323
00:16:16,330 --> 00:16:19,360
that the JPL role should be early,

324
00:16:19,360 --> 00:16:20,890
that we make our contributions

325
00:16:20,890 --> 00:16:22,530
on the front edge of technology

326
00:16:22,530 --> 00:16:25,120
and phase out then of the programs

327
00:16:25,120 --> 00:16:27,223
just as quickly as we can.

328
00:16:28,680 --> 00:16:30,750
- [Narrator] This policy
about military work

329
00:16:30,750 --> 00:16:32,910
coincided with a shift in Washington

330
00:16:32,910 --> 00:16:35,850
in favor of new planetary missions.

331
00:16:35,850 --> 00:16:39,180
Soon, Allen would have
the best of worries:

332
00:16:39,180 --> 00:16:41,883
more work than the lab knew how to handle.

333
00:16:43,210 --> 00:16:45,450

- So our problems quickly
shifted to the fact

334
00:16:45,450 --> 00:16:48,184
that we were outgrowing our facilities.

335
00:16:48,184 --> 00:16:50,720
(people applauding)

336
00:16:50,720 --> 00:16:52,150
So we tried different techniques

337
00:16:52,150 --> 00:16:56,310
for restricting the size of the workforce.

338
00:16:56,310 --> 00:16:58,340
None of them worked. (laughing)

339
00:16:58,340 --> 00:17:00,780
The people at JPL who
were out seeking the work

340
00:17:00,780 --> 00:17:02,580
were far too inventive

341
00:17:02,580 --> 00:17:07,040
to be influenced via a broad policy idea

342
00:17:07,040 --> 00:17:08,580
that one shouldn't grow.

343
00:17:08,580 --> 00:17:10,493
And so we continued to grow.

344
00:17:12,890 --> 00:17:15,840
- [Narrator] Earth science
had been one growth area.

345

00:17:15,840 --> 00:17:17,590
Another was astronomy.

346
00:17:17,590 --> 00:17:19,050
The lab had played a vital role

347
00:17:19,050 --> 00:17:21,913
in the first infrared
space telescope mission.

348
00:17:23,020 --> 00:17:26,420
And now, JPL was busy
building the workhorse camera

349
00:17:26,420 --> 00:17:29,343
for the much anticipated
Hubble Space Telescope.

350
00:17:30,680 --> 00:17:33,430
A radar mission to Venus was underway.

351
00:17:33,430 --> 00:17:35,993
So was an orbiter to circle Mars.

352
00:17:37,460 --> 00:17:40,660
There was even good news about Galileo.

353
00:17:40,660 --> 00:17:41,920
It was being packed up

354
00:17:41,920 --> 00:17:45,133
and shipped by truck convoy
across the country to Florida.

355
00:17:47,340 --> 00:17:50,303
The spacecraft's next scheduled
stop was the launch pad.

356
00:17:51,440 --> 00:17:54,393

Then, it would finally
be on its way to Jupiter.

357
00:17:55,790 --> 00:17:58,510
But as Galileo made its way to the Cape

358
00:17:58,510 --> 00:18:02,030
another spacecraft
already far beyond Jupiter

359
00:18:02,030 --> 00:18:03,913
was about to make history.

360
00:18:04,832 --> 00:18:07,832
(vehicles whirring)

361
00:18:11,345 --> 00:18:15,345
(deliberative orchestral music)

362
00:18:20,370 --> 00:18:23,070
After triumphs at Jupiter and Saturn

363
00:18:23,070 --> 00:18:26,700
Voyager 2 was closing in
on the first encounter ever

364
00:18:26,700 --> 00:18:29,653
with the ice giant planet Uranus.

365
00:18:33,660 --> 00:18:37,173
Voyager's journey to this point
had taken over eight years.

366
00:18:41,610 --> 00:18:43,780
And the wear and tear of a billion miles

367
00:18:43,780 --> 00:18:45,013
was beginning to show.

368
00:18:46,730 --> 00:18:49,300
The scan platform that
moved Voyager's camera

369
00:18:49,300 --> 00:18:50,703
was prone to seizing up.

370
00:18:53,770 --> 00:18:56,030
Transmitting instructions
to the spacecraft

371
00:18:56,030 --> 00:18:57,970
was an elaborate chore

372
00:18:57,970 --> 00:19:01,100
as the primary receiver
was no longer functioning

373
00:19:01,100 --> 00:19:03,663
and the backup was only partially working.

374
00:19:05,540 --> 00:19:08,763
Getting a signal back from
Voyager was a challenge, too.

375
00:19:10,050 --> 00:19:13,513
One-way transmission time
now took three hours.

376
00:19:14,700 --> 00:19:17,840
- The extension of the
mission to Uranus and Neptune

377
00:19:17,840 --> 00:19:22,227
I think highlights really one
of the unsung heroes of JPL

378
00:19:22,227 --> 00:19:24,513
and that was the Deep Space Network.

379
00:19:26,810 --> 00:19:29,610
- [Narrator] The Deep Space
Network is a group of antennas

380
00:19:29,610 --> 00:19:33,600
arrayed in three strategic
locations around the globe.

381
00:19:33,600 --> 00:19:36,650
This is the essential link
for tracking and communicating

382
00:19:36,650 --> 00:19:39,823
with all of NASA's
interplanetary spacecraft.

383
00:19:42,150 --> 00:19:43,700
- Those encounters at Uranus and Neptune

384
00:19:43,700 --> 00:19:44,680
would have been impossible

385
00:19:44,680 --> 00:19:46,297
without what the Deep Space Network,

386
00:19:46,297 --> 00:19:49,910
the DSN, did to get that data back.

387
00:19:49,910 --> 00:19:50,743
When you think about it,

388
00:19:50,743 --> 00:19:52,790
you've got the Voyager radio transmitter

389
00:19:52,790 --> 00:19:54,980
powered at about 23 watts,

390

00:19:54,980 --> 00:19:58,310
which is about the power of
your refrigerator light bulb.

391
00:19:58,310 --> 00:20:00,480
And we're trying to pick up
that signal here on Earth

392
00:20:00,480 --> 00:20:03,460
from well over a billion miles away.

393
00:20:03,460 --> 00:20:06,510
And picking out that
very tiny little signal

394
00:20:06,510 --> 00:20:08,880
from that vast background of outer space

395
00:20:08,880 --> 00:20:11,880
is really a remarkable achievement,
when you think about it.

396
00:20:18,460 --> 00:20:20,220
- [Narrator] Plotting Voyager's encounter

397
00:20:20,220 --> 00:20:21,623
was another challenge.

398
00:20:23,100 --> 00:20:26,030
That was because compared
to the rest of the planets,

399
00:20:26,030 --> 00:20:28,270
Uranus is flipped on its side,

400
00:20:28,270 --> 00:20:31,923
caused perhaps by a
gigantic collision long ago.

401

00:20:34,630 --> 00:20:37,210
- Uranus was a real planning challenge.

402
00:20:37,210 --> 00:20:40,980
And the reason why is
one, we only get one shot;

403
00:20:40,980 --> 00:20:44,770
and two, Uranus is kind
of turned up on its edge.

404
00:20:44,770 --> 00:20:48,960
And we're now instead of seeing
the moons in kind of a plane

405
00:20:48,960 --> 00:20:50,270
where you can fly through this plane

406
00:20:50,270 --> 00:20:51,760
and get one after the other,

407
00:20:51,760 --> 00:20:53,160
we're looking at a bullseye.

408
00:20:55,520 --> 00:20:57,700
- [Narrator] That meant
that the flyby of Uranus

409
00:20:57,700 --> 00:21:01,133
and its moons and rings would
occur nearly simultaneously.

410
00:21:03,085 --> 00:21:06,600
Coping with so much to see in
such a short period of time

411
00:21:06,600 --> 00:21:08,750
would make this the most intense

412

00:21:08,750 --> 00:21:10,973
of all the Voyager encounters.

413
00:21:13,210 --> 00:21:16,520
- You're given this pulse
of data no one's ever seen.

414
00:21:16,520 --> 00:21:17,740
And you get it all at once.

415
00:21:17,740 --> 00:21:18,850
You get high resolution.

416
00:21:18,850 --> 00:21:19,990
It comes up very, very quickly

417
00:21:19,990 --> 00:21:21,150
because these moons are small

418
00:21:21,150 --> 00:21:24,230
and you're flying by it at large velocity.

419
00:21:24,230 --> 00:21:25,570
So in a blink of an eye

420
00:21:25,570 --> 00:21:27,890
basically you go from a
very low resolution image

421
00:21:27,890 --> 00:21:29,670
to in your face high resolution,

422
00:21:29,670 --> 00:21:30,713
and then gone again.

423
00:21:34,900 --> 00:21:37,800
- You're gonna go by every
satellite in the same hour.

424
00:21:37,800 --> 00:21:41,040
It presented kind of an extreme version

425
00:21:41,040 --> 00:21:43,610
of the scientific competition
between different targets.

426
00:21:43,610 --> 00:21:46,670
Everybody wanted to look
in different directions.

427
00:21:46,670 --> 00:21:49,210
- [Narrator] As he had
done at Jupiter and Saturn

428
00:21:49,210 --> 00:21:52,580
Project Scientist Ed Stone
listened to the arguments,

429
00:21:52,580 --> 00:21:55,963
sought consensus, and then made decisions.

430
00:21:56,960 --> 00:21:57,930
- I would take a poll.

431
00:21:57,930 --> 00:22:00,030
But it was not literally a vote in a sense

432
00:22:00,030 --> 00:22:00,910
because I didn't feel

433
00:22:00,910 --> 00:22:03,620
that the science should
be decided by vote.

434
00:22:03,620 --> 00:22:06,393
It really had to be decided on its value.

435

00:22:08,080 --> 00:22:09,610
And that had to be something

436
00:22:09,610 --> 00:22:11,643
that ultimately the group understood.

437
00:22:12,730 --> 00:22:15,350
In some cases, I had to make
a decision where in fact

438
00:22:15,350 --> 00:22:17,610
it was really weighing
two different objectives.

439
00:22:17,610 --> 00:22:19,343
And it was a judgment call.

440
00:22:21,600 --> 00:22:22,520
- [Narrator] The biggest worry

441
00:22:22,520 --> 00:22:25,570
was whether anything could be seen at all.

442
00:22:25,570 --> 00:22:27,710
Anyone who has ever used a camera knows

443
00:22:27,710 --> 00:22:29,239
that taking a picture in focus

444
00:22:29,239 --> 00:22:32,503
requires a steady hand and ample light.

445
00:22:34,300 --> 00:22:38,100
Voyager was moving at over
30,000 miles per hour.

446
00:22:38,100 --> 00:22:43,100
And sunlight at Uranus is 400
times fainter than at Earth.

447
00:22:44,390 --> 00:22:47,363
- One half of Uranus in fact,
was not even in sunlight.

448
00:22:48,460 --> 00:22:50,310
The initial calculation showed

449
00:22:50,310 --> 00:22:52,140
that we were going to be in great danger

450
00:22:52,140 --> 00:22:53,840
of getting really fuzzy pictures

451
00:22:53,840 --> 00:22:56,883
of practically everything
if we didn't do something.

452
00:22:57,740 --> 00:23:00,600
And so we actually did some
re-engineering on the spacecraft

453
00:23:00,600 --> 00:23:03,576
with the help of the engineering teams.

454
00:23:03,576 --> 00:23:06,975
(people chattering)

455
00:23:06,975 --> 00:23:08,090
- It ended at 0623.

456
00:23:09,480 --> 00:23:11,833
- We called it our anti-smear campaign.

457
00:23:12,940 --> 00:23:16,790
We basically improved our
camera platform in flight

458

00:23:16,790 --> 00:23:18,933
by remotely changing how we operated it.

459
00:23:23,310 --> 00:23:25,730
- [Narrator] Scientists could
also thank the navigators

460
00:23:25,730 --> 00:23:27,483
for their astounding precision.

461
00:23:32,040 --> 00:23:34,940
Voyager would arrive just a single minute

462
00:23:34,940 --> 00:23:37,010
off the predicted schedule,

463
00:23:37,010 --> 00:23:40,433
a schedule calculated five years before.

464
00:23:42,010 --> 00:23:43,660
Now came the mad rush

465
00:23:43,660 --> 00:23:48,300
to squeeze close to 100
measurements into just a few hours.

466
00:23:48,300 --> 00:23:49,404
- Off.

467
00:23:49,404 --> 00:23:51,124
(faint speaking) is off.

468
00:23:51,124 --> 00:23:52,830
There are no temperatures in alarm.

469
00:23:52,830 --> 00:23:54,410
All items are as expected.

470

00:23:54,410 --> 00:23:55,337
Temperature (faint speaking).

471
00:23:58,100 --> 00:24:01,860
- We were bringing our
sleeping bags to our offices

472
00:24:01,860 --> 00:24:04,700
and sleeping overnight
so that we could be there

473
00:24:04,700 --> 00:24:07,150
and not miss any of the great discoveries

474
00:24:07,150 --> 00:24:09,890
that were occurring on a regular basis.

475
00:24:09,890 --> 00:24:12,130
Even though we couldn't
predict what they were,

476
00:24:12,130 --> 00:24:14,980
we knew that there were going
to be some great surprises.

477
00:24:15,852 --> 00:24:19,185
(intense ambient music)

478
00:24:37,700 --> 00:24:39,490
- [Narrator] The initial surprise though

479
00:24:39,490 --> 00:24:41,453
was the lack of a surprise.

480
00:24:43,790 --> 00:24:47,400
- We thought we'd see bands
and other colorful things

481
00:24:47,400 --> 00:24:49,660

like we had seen at Jupiter and Saturn.

482
00:24:49,660 --> 00:24:52,043
And Uranus presented to us a blank face.

483
00:24:55,860 --> 00:24:58,310
- [Narrator] That first
impression was deceiving.

484
00:24:59,760 --> 00:25:02,290
Uranus turned out to be the coldest planet

485
00:25:02,290 --> 00:25:04,160
in the solar system.

486
00:25:04,160 --> 00:25:06,640
Here, winds blow more than twice the speed

487
00:25:06,640 --> 00:25:08,073
of hurricanes on earth.

488
00:25:09,420 --> 00:25:12,790
Another surprise was the
planet's magnetic field.

489
00:25:12,790 --> 00:25:15,710
The poles here reside near the equator,

490
00:25:15,710 --> 00:25:18,003
twisting and turning like a corkscrew.

491
00:25:21,140 --> 00:25:23,130
And to everyone's delight

492
00:25:23,130 --> 00:25:27,593
two new narrow rings and 10
tiny new moons were discovered.

493

00:25:29,150 --> 00:25:33,050
The biggest surprise though
was the tiny moon Miranda.

494
00:25:33,050 --> 00:25:34,750
- Larry, I've heard you refer to this

495
00:25:34,750 --> 00:25:37,780
as probably the most exotic
body in the solar system.

496
00:25:37,780 --> 00:25:40,580
- Well, I think exotic
is an understatement.

497
00:25:40,580 --> 00:25:43,710
Miranda surpassed our
wildest expectations.

498
00:25:43,710 --> 00:25:46,853
No one possibly imagined what
we were going to find here.

499
00:25:50,840 --> 00:25:53,350
- Miranda just looked incredible.

500
00:25:53,350 --> 00:25:54,970
The amount of detailed structure,

501
00:25:54,970 --> 00:25:56,510
it looked like someone had

502
00:25:56,510 --> 00:25:58,420
just maybe like a clay or something,

503
00:25:58,420 --> 00:25:59,560
sort of squeezed on it

504
00:25:59,560 --> 00:26:02,523

and given it all these
different shapes and patterns.

505
00:26:04,160 --> 00:26:08,965
- Miranda was another one of
these weird jigsaw puzzles

506
00:26:08,965 --> 00:26:12,740
of two or three different types of terrain

507
00:26:12,740 --> 00:26:16,666
that looked like you just
painted them on the surface

508
00:26:16,666 --> 00:26:19,400
and then ripped apart the images

509
00:26:19,400 --> 00:26:21,850
and then put them together
in some haphazard way.

510
00:26:24,080 --> 00:26:26,090
- [Linda] It was clear that
something had happened.

511
00:26:26,090 --> 00:26:29,360
Some kind of activity had changed it

512
00:26:29,360 --> 00:26:30,910
from when it originally formed.

513
00:26:32,374 --> 00:26:34,730
- [Rich] It was probably hit
with something very large,

514
00:26:34,730 --> 00:26:36,990
which actually disrupted
it, broke it apart.

515

00:26:36,990 --> 00:26:40,910
So you now have a big chunk of
rock and a big chunk of ice.

516
00:26:40,910 --> 00:26:42,810
And these big chunks came together,

517
00:26:42,810 --> 00:26:44,710
which created these peculiar terrains.

518
00:26:49,010 --> 00:26:51,010
- [Narrator] This first
ever visit to Uranus

519
00:26:51,010 --> 00:26:53,730
provided a bounty of discoveries.

520
00:26:53,730 --> 00:26:57,200
And NASA saw the encounter
as an excellent backdrop

521
00:26:57,200 --> 00:26:58,810
to underscore to the press

522
00:26:58,810 --> 00:27:03,810
that 1986 was the agency's
year of space science.

523
00:27:04,310 --> 00:27:05,143
- Thanks, Jim.

524
00:27:05,143 --> 00:27:06,970
It's been a real pleasure
and a thrill for me

525
00:27:06,970 --> 00:27:09,060
as I'm sure it's been for all of you.

526
00:27:09,060 --> 00:27:11,920

It's been a brilliant
scientific achievement.

527
00:27:11,920 --> 00:27:14,310
- [Narrator] But the plan backfired.

528
00:27:14,310 --> 00:27:17,170
These reporters were almost to a person

529
00:27:17,170 --> 00:27:20,420
unabashed supporters of
exploring the planets.

530
00:27:20,420 --> 00:27:21,890
And the answer to one question

531
00:27:21,890 --> 00:27:24,370
had the effect of waving a red flag

532
00:27:24,370 --> 00:27:27,520
in front of a herd of disgruntled bulls.

533
00:27:27,520 --> 00:27:29,410
- This is pretty much the
whole ball game, isn't it?

534
00:27:29,410 --> 00:27:31,930
None of us in this room are
ever going to see anything else

535
00:27:31,930 --> 00:27:35,018
of any real consequence coming
back from Uranus, are we?

536
00:27:35,018 --> 00:27:36,220
- As I just mentioned,

537
00:27:36,220 --> 00:27:37,220
it is very likely

538
00:27:37,220 --> 00:27:41,000
that there will not be
another mission to Uranus

539
00:27:42,190 --> 00:27:43,573
for a couple of centuries.

540
00:27:45,440 --> 00:27:47,240
And so this is it.

541
00:27:47,240 --> 00:27:49,380
- To what extent is the
fact that the United States

542
00:27:49,380 --> 00:27:52,100
does not have its own Halley mission

543
00:27:52,100 --> 00:27:54,850
a loss of face or a step backwards

544
00:27:54,850 --> 00:27:56,670
in terms of keeping the United States

545
00:27:56,670 --> 00:27:58,490
preeminent in space technology?

546
00:27:58,490 --> 00:28:03,410
- What follow up plans you
have for the follow up stars?

547
00:28:03,410 --> 00:28:05,540
- I'm a kind of having a hard
time reconciling all this

548
00:28:05,540 --> 00:28:07,160
to know what the next generation's

549

00:28:07,160 --> 00:28:08,820
going to be doing in space.

550
00:28:08,820 --> 00:28:10,830
- What assurance can you really offer

551
00:28:10,830 --> 00:28:13,070
that the United States
is going to continue

552
00:28:13,070 --> 00:28:15,400
to pursue planetary science

553
00:28:15,400 --> 00:28:17,290
and that when we see
international missions,

554
00:28:17,290 --> 00:28:20,800
it won't be international
without the United States?

555
00:28:20,800 --> 00:28:21,633
- [Male Speaker] Final question,

556
00:28:21,633 --> 00:28:23,290
Kelly Beatty, Sky and Telescope.

557
00:28:23,290 --> 00:28:25,050
- Dr. Edelson did a meeting

558
00:28:25,050 --> 00:28:27,470
of planetary scientists in October.

559
00:28:27,470 --> 00:28:30,450
Dr. Allen stated that planetary science

560
00:28:30,450 --> 00:28:33,000
does not seem to be highly
regarded within NASA.

561
00:28:33,000 --> 00:28:35,050
Would you like to comment on that please?

562
00:28:35,943 --> 00:28:38,440
(laughing)

563
00:28:38,440 --> 00:28:39,440
- [Lew] Dr. Edelson?

564
00:28:41,410 --> 00:28:43,525
- Gosh, I didn't make that statement.

565
00:28:43,525 --> 00:28:44,358
- [Male Speaker] I don't think so, sir.

566
00:28:44,358 --> 00:28:46,020
- Maybe you oughta ask Dr.
Allen to comment on it.

567
00:28:46,020 --> 00:28:48,713
- [Male Speaker] I didn't
write it down. (laughing)

568
00:28:49,730 --> 00:28:51,870
- We do need to continue
planetary exploration.

569
00:28:51,870 --> 00:28:56,158
There are things which are
terribly important left to do.

570
00:28:56,158 --> 00:28:59,740
And it should compete
in scientific importance

571
00:28:59,740 --> 00:29:01,410
with other important things

572
00:29:01,410 --> 00:29:03,460
such as the great observatories.

573
00:29:03,460 --> 00:29:05,550
- And ladies and gentlemen,
our time is fleeting.

574
00:29:05,550 --> 00:29:08,700
Thank you very much,
Dr. Edelson, Dr. Allen.

575
00:29:08,700 --> 00:29:10,740
We'd like to remind you
that at 10 o'clock--

576
00:29:10,740 --> 00:29:13,550
- [Narrator] The rush to get
off the stage was telling.

577
00:29:13,550 --> 00:29:16,393
Expectations were far
greater than funding.

578
00:29:17,440 --> 00:29:19,580
And in contrast to Voyager

579
00:29:19,580 --> 00:29:23,240
the Shuttle program was not
living up to its billing.

580
00:29:23,240 --> 00:29:26,210
Access to space had not become routine,

581
00:29:26,210 --> 00:29:28,193
cheaper, or safer.

582
00:29:33,870 --> 00:29:36,460
Two days after the
Voyager press conference

583
00:29:36,460 --> 00:29:39,280
scientists at JPL paused
to watch the launch

584
00:29:39,280 --> 00:29:41,023
of the next Shuttle flight.

585
00:29:43,740 --> 00:29:48,740
- We were meeting in our daily
science discussion meeting

586
00:29:49,030 --> 00:29:51,330
and we'd had them through the weekends

587
00:29:51,330 --> 00:29:52,866
during that time period.

588
00:29:52,866 --> 00:29:56,330
And we had just finished discussing

589
00:29:56,330 --> 00:29:57,700
what we were going to talk about

590
00:29:57,700 --> 00:29:59,503
in the press conference that day.

591
00:30:00,350 --> 00:30:04,263
And it was time for the launch
of the Challenger Shuttle.

592
00:30:06,470 --> 00:30:10,120
And so we had the television
set there in the room

593
00:30:10,120 --> 00:30:15,120
and we broke our meeting up
just in time to watch that.

594
00:30:15,970 --> 00:30:20,860
- [Male Speaker] T minus
10, nine, eight, seven, six.

595
00:30:20,860 --> 00:30:23,060
We have main engine start.

596
00:30:23,060 --> 00:30:26,418
Four, three, two, one.

597
00:30:26,418 --> 00:30:28,203
And lift off.

598
00:30:28,203 --> 00:30:31,550
Lift off of the 25th
Space Shuttle mission.

599
00:30:31,550 --> 00:30:33,213
And it has cleared the tower.

600
00:30:34,201 --> 00:30:37,368
(faint radio chatter)

601
00:30:39,773 --> 00:30:42,750
- And we were pleased that
it got off the ground.

602
00:30:42,750 --> 00:30:46,190
And then suddenly, we
saw this bright flash

603
00:30:46,190 --> 00:30:49,433
and trails of material going
in different directions.

604
00:30:50,360 --> 00:30:53,120
And it slowly dawned on us

605

00:30:53,120 --> 00:30:56,720
that the Challenger had
actually blown apart.

606
00:30:56,720 --> 00:30:57,553
- [Male Speaker] Flight controllers

607
00:30:57,553 --> 00:30:59,560
here looking very
carefully at the situation.

608
00:31:00,980 --> 00:31:02,633
Obviously, a major malfunction.

609
00:31:05,400 --> 00:31:07,283
- [Ellis] It was a tremendous shock.

610
00:31:08,130 --> 00:31:09,833
- [Male Speaker] We have no downlink.

611
00:31:12,510 --> 00:31:14,770
- We had two TV monitors up;

612
00:31:14,770 --> 00:31:18,720
one that was streaming the
pictures of Uranus coming back

613
00:31:20,210 --> 00:31:23,580
and the second with the
repeats of the explosions

614
00:31:23,580 --> 00:31:24,563
at the Challenger.

615
00:31:25,630 --> 00:31:27,413
So hard to watch those.

616
00:31:28,990 --> 00:31:31,100
Success... tremendous success with Voyager

617
00:31:31,100 --> 00:31:34,463
versus the heartbreak of what
happened with Challenger.

618
00:31:37,415 --> 00:31:40,665
(somber ambient music)

619
00:31:55,610 --> 00:31:58,000
- [Narrator] The loss of
Challenger and its crew of seven

620
00:31:58,000 --> 00:32:00,210
was a major shock to the nation

621
00:32:00,210 --> 00:32:02,423
and an enormous setback for NASA.

622
00:32:04,360 --> 00:32:06,750
All Shuttle flights were grounded.

623
00:32:06,750 --> 00:32:09,960
With no Shuttle and no
available expendable rockets

624
00:32:09,960 --> 00:32:13,893
there was no doorway into
space for the United States.

625
00:32:17,810 --> 00:32:21,263
Galileo was wrapped up and
transported back to Pasadena.

626
00:32:23,050 --> 00:32:24,950
Other missions to Venus, Saturn,

627
00:32:24,950 --> 00:32:27,473
and Mars were placed on hold.

628
00:32:28,840 --> 00:32:30,940
- All of you recall, I'm sure,

629
00:32:30,940 --> 00:32:34,543
that 1986 was to be the
year of space science.

630
00:32:35,820 --> 00:32:40,820
It began magnificently with
Voyager's encounter with Uranus.

631
00:32:41,250 --> 00:32:42,290
But of course

632
00:32:42,290 --> 00:32:46,510
the year of space science was
brought to a tragic conclusion

633
00:32:46,510 --> 00:32:49,763
when the Challenger accident
occurred so early in the year.

634
00:32:51,000 --> 00:32:56,000
We are overall looking at a
substantial period of stand down

635
00:32:57,090 --> 00:33:00,060
in the achievement of
space science information

636
00:33:00,060 --> 00:33:02,943
from the exploration of the solar system.

637
00:33:04,740 --> 00:33:07,540
Satellite programs will
have to go into storage

638
00:33:07,540 --> 00:33:09,919
for a substantial period of time.

639
00:33:09,919 --> 00:33:12,586
(door thudding)

640
00:33:21,754 --> 00:33:25,254
(somber orchestral music)

641
00:33:30,150 --> 00:33:31,810
- [Narrator] As NASA's Shuttle program

642
00:33:31,810 --> 00:33:34,660
worked to recover from
the loss of Challenger,

643
00:33:34,660 --> 00:33:37,080
Voyager 2 continued on its journey

644
00:33:37,080 --> 00:33:39,093
and final planetary encounter.

645
00:33:41,053 --> 00:33:42,970
(people chattering)

646
00:33:42,970 --> 00:33:45,660
- Three, two, one.

647
00:33:45,660 --> 00:33:47,310
Just about a million miles left

648
00:33:47,310 --> 00:33:49,550
to travel for the robot Voyager spacecraft

649
00:33:49,550 --> 00:33:51,480
to the last planet in the solar system,

650
00:33:51,480 --> 00:33:53,200
its close approach to Neptune.

651
00:33:53,200 --> 00:33:54,660
Scientists are eagerly awaiting

652
00:33:54,660 --> 00:33:57,360
the closeup pictures of
Neptune and its moon Triton.

653
00:33:57,360 --> 00:33:58,930
And Project Scientist Ed Stone

654
00:33:58,930 --> 00:34:01,083
says they'll be looking
for more moons too.

655
00:34:06,370 --> 00:34:09,560
- Neptune, 30 times as far
from the Sun as the Earth,

656
00:34:09,560 --> 00:34:12,613
very cold, very remote
edge of the solar system.

657
00:34:14,820 --> 00:34:16,580
- [Narrator] Neptune is so far away

658
00:34:16,580 --> 00:34:18,923
that it cannot be seen with the naked eye.

659
00:34:20,180 --> 00:34:23,403
It was discovered only through
mathematical calculations.

660
00:34:25,090 --> 00:34:28,060
This was the best
telescope image of Neptune

661
00:34:28,060 --> 00:34:29,460
before Voyager 2.

662
00:34:32,310 --> 00:34:34,233
- It's very, very dark at Neptune.

663
00:34:35,300 --> 00:34:37,570
We knew that there were rings at Neptune.

664
00:34:37,570 --> 00:34:42,570
The rings themselves were
half the brightness of soot.

665
00:34:43,340 --> 00:34:46,100
Seen against a jet black background

666
00:34:46,100 --> 00:34:48,160
with sunlight which is 1,000 times dimmer

667
00:34:48,160 --> 00:34:49,770
than it is on Earth.

668
00:34:49,770 --> 00:34:51,923
So you've got everything
going against you.

669
00:34:53,730 --> 00:34:54,563
- [Narrator] Once again

670
00:34:54,563 --> 00:34:57,900
Voyager had to be
retooled by remote control

671
00:34:57,900 --> 00:35:01,243
to have any hope of
getting back usable images.

672
00:35:02,560 --> 00:35:04,520
- If the spacecraft is
doing what it normally does,

673

00:35:04,520 --> 00:35:07,020
which is to slowly weave, bob around it,

674
00:35:07,020 --> 00:35:08,540
it rotates around like this,

675
00:35:08,540 --> 00:35:10,290
you're just gonna smear everything.

676
00:35:16,930 --> 00:35:19,740
- And so we had to go into
the attitude control system

677
00:35:19,740 --> 00:35:22,500
and come up with very
clever software changes

678
00:35:22,500 --> 00:35:24,943
to allow the spacecraft
to stay very stable.

679
00:35:30,820 --> 00:35:33,770
- [Narrator] More advances in
data compression were needed.

680
00:35:35,090 --> 00:35:38,670
A global array of antennas
had to be lashed together

681
00:35:38,670 --> 00:35:41,463
and Voyager itself was
requiring attention.

682
00:35:42,710 --> 00:35:44,441
- The spacecraft has
encountered its problems.

683
00:35:44,441 --> 00:35:47,370
It's a deaf in one ear essentially,

684
00:35:47,370 --> 00:35:48,203
one of the receivers.

685
00:35:48,203 --> 00:35:50,070
It's tone deaf in the other ear.

686
00:35:50,070 --> 00:35:53,022
It's got an arthritic scan platform.

687
00:35:53,022 --> 00:35:55,850
It's hung up on us several times.

688
00:35:55,850 --> 00:35:57,460
It's got memory lapses.

689
00:35:57,460 --> 00:35:58,310
It's got other, you know,

690
00:35:58,310 --> 00:36:00,230
the kinds of things you can associate

691
00:36:00,230 --> 00:36:02,900
with degradation, with age.

692
00:36:02,900 --> 00:36:04,870
But nevertheless, it's got a personality

693
00:36:04,870 --> 00:36:06,653
and it's also got a brain.

694
00:36:10,400 --> 00:36:12,690
- [Narrator] And that
brain had already noted

695
00:36:12,690 --> 00:36:14,713
a massive swirling storm,

696

00:36:16,640 --> 00:36:19,453
previously unknown moons and ring arcs.

697
00:36:21,130 --> 00:36:22,510
These were early signs

698
00:36:22,510 --> 00:36:25,163
that Neptune would not be a bland world.

699
00:36:27,050 --> 00:36:28,820
- It was kind of an amazing encounter.

700
00:36:28,820 --> 00:36:31,810
I'm still not exactly
sure why it happened,

701
00:36:31,810 --> 00:36:35,323
but it was a huge public affairs success.

702
00:36:36,720 --> 00:36:37,750
- [Narrator] With each encounter

703
00:36:37,750 --> 00:36:40,100
Voyager became better known.

704
00:36:40,100 --> 00:36:43,840
And scientists and engineers
were more media savvy.

705
00:36:43,840 --> 00:36:46,655
Some were even doubling
up as news anchors.

706
00:36:46,655 --> 00:36:47,488
- We'll do the opening.
- Yeah.

707
00:36:47,488 --> 00:36:48,613
- We come to you.

- Right.

708
00:36:48,613 --> 00:36:50,080
- You say a few words.

709
00:36:50,080 --> 00:36:52,692
We say let's have examples
of star occultations.

710
00:36:52,692 --> 00:36:53,525
- The Neptune encounter.

711
00:36:53,525 --> 00:36:55,300
I got to be the host of the PBS show

712
00:36:55,300 --> 00:36:56,980
called Neptune All Night.

713
00:36:56,980 --> 00:36:59,640
It was four hours of sitting there

714
00:36:59,640 --> 00:37:01,100
in front of the TV monitor

715
00:37:01,100 --> 00:37:02,530
for people who wanted to stay up all night

716
00:37:02,530 --> 00:37:03,990
for the encounter.

717
00:37:03,990 --> 00:37:06,559
- Three, two, one.

718
00:37:06,559 --> 00:37:07,392
Roll the opening.

719
00:37:07,392 --> 00:37:08,483
- Opening rolling.

720
00:37:09,760 --> 00:37:10,840
- [Narrator] Another anchor

721
00:37:10,840 --> 00:37:13,493
was a young engineer named Suzanne Dodd.

722
00:37:14,410 --> 00:37:17,250
- With us this morning,
we have Dr. Jay Holberg.

723
00:37:17,250 --> 00:37:18,190
I just got asked.

724
00:37:18,190 --> 00:37:23,190
I think JPL was looking
for a young female engineer

725
00:37:23,540 --> 00:37:25,905
who knew something about
the Voyager project

726
00:37:25,905 --> 00:37:27,823
and what Voyager was gonna do.

727
00:37:29,060 --> 00:37:30,970
- [Narrator] Dodd joined the Voyager team

728
00:37:30,970 --> 00:37:32,840
right out of college.

729
00:37:32,840 --> 00:37:34,840
She had moved up the ranks

730
00:37:34,840 --> 00:37:37,080
and was now responsible for the commands

731
00:37:37,080 --> 00:37:38,230

that would have Voyager

732
00:37:38,230 --> 00:37:41,173
executing a daredevil fly by of Neptune.

733
00:37:42,445 --> 00:37:45,680
- I thought, okay, my career
is kinda riding on this one

734
00:37:45,680 --> 00:37:48,110
'cause I built the
closest approach sequence.

735
00:37:48,110 --> 00:37:53,110
And if it goes wrong,
it could be my fault.

736
00:37:55,980 --> 00:37:58,720
- [Narrator] A sense
of drama was everywhere

737
00:37:58,720 --> 00:38:01,600
and journalists and writers
from all over the world

738
00:38:01,600 --> 00:38:04,880
were converging to be a part
of what was being called

739
00:38:04,880 --> 00:38:06,243
the last picture show.

740
00:38:08,680 --> 00:38:09,630
- It was like a reunion.

741
00:38:09,630 --> 00:38:10,890
I mean, they came out here

742
00:38:10,890 --> 00:38:14,400

and they melded with the scientists.

743
00:38:14,400 --> 00:38:16,360
The scientists had a great time.

744
00:38:16,360 --> 00:38:18,720
They got a lot of good press coverage.

745
00:38:18,720 --> 00:38:19,903
It was a festival.

746
00:38:21,050 --> 00:38:24,430
- [Narrator] And at
times, a feeding frenzy.

747
00:38:24,430 --> 00:38:26,640
No one knew that better than a Dutch-born,

748
00:38:26,640 --> 00:38:31,230
sleep deprived JPLer named
Jurrie van der Woude.

749
00:38:31,230 --> 00:38:35,200
It was his job to provide
the always on deadline press

750
00:38:35,200 --> 00:38:36,370
with the latest images

751
00:38:36,370 --> 00:38:39,720
that were coming quite
literally off the printing press

752
00:38:39,720 --> 00:38:41,713
in this era before the internet.

753
00:38:42,600 --> 00:38:43,433
- In those days

754
00:38:43,433 --> 00:38:44,820
as soon as they saw you come in

755
00:38:44,820 --> 00:38:47,060
with the boxes with photographs

756
00:38:47,060 --> 00:38:49,820
was everybody had a deadline.

757
00:38:49,820 --> 00:38:54,750
And it was exactly 15 seconds
from the moment they saw you.

758
00:38:54,750 --> 00:38:55,583
Okay.

759
00:38:55,583 --> 00:38:57,190
Just before you leave here, come by,

760
00:38:57,190 --> 00:38:59,770
and I will get you a bunch
of photographs to take home.

761
00:38:59,770 --> 00:39:00,603
All right?

762
00:39:00,603 --> 00:39:02,270
- Thank you.
- Fantastic.

763
00:39:02,270 --> 00:39:03,800
Then I had to turn around,

764
00:39:03,800 --> 00:39:05,640
go to the photo lab,

765
00:39:05,640 --> 00:39:09,400
and see what was coming in

as far as data is concerned,

766
00:39:09,400 --> 00:39:11,270
see how it was processed.

767
00:39:11,270 --> 00:39:13,416
Then have 600 to 800

768
00:39:13,416 --> 00:39:17,060
of those individual photographs printed,

769
00:39:17,060 --> 00:39:20,370
of each stacks of photographs that high.

770
00:39:20,370 --> 00:39:22,750
That had to happen through the night.

771
00:39:22,750 --> 00:39:26,000
But I had to stay there
to get captions written,

772
00:39:26,000 --> 00:39:29,583
and printed, and glued on the
back of each of the prints.

773
00:39:31,580 --> 00:39:33,213
Three weeks, I saw no bed.

774
00:39:40,170 --> 00:39:44,490
But boy, I wouldn't have
missed a second of those days.

775
00:39:44,490 --> 00:39:46,423
There's no way you can describe,

776
00:39:47,960 --> 00:39:49,780
or I cannot,

777

00:39:49,780 --> 00:39:54,780
the feeling when you look at
a planet for the first time

778
00:39:56,260 --> 00:39:58,450
in the history of our species.

779
00:39:58,450 --> 00:40:00,003
Nobody else has seen it.

780
00:40:05,653 --> 00:40:06,890
- It's kinda interesting.

781
00:40:06,890 --> 00:40:08,780
Beautiful pictures frequently are the ones

782
00:40:08,780 --> 00:40:11,162
that also have a lot of
scientific content in them.

783
00:40:11,162 --> 00:40:13,412
(laughing)

784
00:40:15,100 --> 00:40:17,220
- We've been in the
observatory phase for months,

785
00:40:17,220 --> 00:40:21,700
seeing Neptune as slowly
growing from a dot

786
00:40:21,700 --> 00:40:25,740
to something filling the
television screen and more.

787
00:40:25,740 --> 00:40:30,740
Neptune itself is a
beautiful austere blue world.

788

00:40:32,270 --> 00:40:37,170
We are looking at a
world of clouds and gas.

789
00:40:37,170 --> 00:40:39,870
The surface, if any, is far below.

790
00:40:39,870 --> 00:40:42,561
We have no idea what's deep down there.

791
00:40:42,561 --> 00:40:46,906
(people exclaiming)
(people applauding)

792
00:40:46,906 --> 00:40:48,380
- And at close encounter

793
00:40:48,380 --> 00:40:52,650
we would all be in von
Karman holding our breaths.

794
00:40:52,650 --> 00:40:54,920
And you'd get these incredible pictures

795
00:40:54,920 --> 00:40:56,350
which nobody had ever seen before.

796
00:40:56,350 --> 00:40:59,940
And you'd sit there and
you'd say, oh my god!

797
00:40:59,940 --> 00:41:02,453
You can't believe how exciting that was.

798
00:41:03,420 --> 00:41:05,480
- [Narrator] As Neptune's dark spot

799
00:41:05,480 --> 00:41:08,460
the size of the Earth

came more into focus,

800
00:41:08,460 --> 00:41:10,613
other features became apparent too.

801
00:41:11,520 --> 00:41:14,990
Just below the dark spot was
a group of streaking clouds

802
00:41:14,990 --> 00:41:19,170
circling Neptune so fast
they were named Scooter.

803
00:41:19,170 --> 00:41:23,230
Here winds blow over 1,200 miles per hour,

804
00:41:23,230 --> 00:41:25,453
the fastest in the solar system.

805
00:41:27,820 --> 00:41:31,140
Voyager was moving fast
too and flying low,

806
00:41:31,140 --> 00:41:33,903
skimming just above the
cloud tops of Neptune.

807
00:41:34,899 --> 00:41:37,840
(intense ambient music)

808
00:41:37,840 --> 00:41:40,020
Then the gravitational force of the planet

809
00:41:40,020 --> 00:41:44,450
bent the spacecraft downwards
towards the final fly by.

810
00:41:44,450 --> 00:41:47,740
Scientists who were accustomed

to extraordinary sights

811
00:41:47,740 --> 00:41:51,813
were still amazed by what they
saw at Neptune's moon Triton.

812
00:41:53,580 --> 00:41:56,920
- Last night was certainly
a night to be remembered.

813
00:41:56,920 --> 00:41:58,720
I think it's the most exciting night

814
00:41:58,720 --> 00:42:01,360
that I can remember from
any of the encounters

815
00:42:01,360 --> 00:42:02,600
that we've had with Voyager,

816
00:42:02,600 --> 00:42:04,690
and there have been some exciting nights.

817
00:42:04,690 --> 00:42:05,910
Without a question

818
00:42:05,910 --> 00:42:08,870
the images that were returned this morning

819
00:42:08,870 --> 00:42:12,473
revealed a world unlike any
of the others that we've seen.

820
00:42:17,371 --> 00:42:19,430
- It seemed like a lot of these flybys

821
00:42:19,430 --> 00:42:21,360
often happened in the middle of the night

822
00:42:21,360 --> 00:42:23,493
or early morning hours.

823
00:42:23,493 --> 00:42:26,813
It seemed like that and
Triton was one of those.

824
00:42:26,813 --> 00:42:29,813
(people chattering)

825
00:42:31,780 --> 00:42:33,714
- Well, it's like all of those things.

826
00:42:33,714 --> 00:42:36,840
Voyager put all the things
that seemed before as strange

827
00:42:36,840 --> 00:42:39,050
and put it in one place again.

828
00:42:39,050 --> 00:42:41,040
- I think for me, one of the highlights,

829
00:42:41,040 --> 00:42:43,190
to see those early pictures come back

830
00:42:43,190 --> 00:42:45,960
and people pointing at
the screen and saying,

831
00:42:45,960 --> 00:42:47,530
what do you think that means

832
00:42:47,530 --> 00:42:49,693
or what do you think is going on?

833
00:42:50,830 --> 00:42:52,040
- [Ed] What is it?

834
00:42:52,040 --> 00:42:54,053
- It's a crocodile of the solar system.

835
00:42:54,053 --> 00:42:56,303
(laughing)

836
00:42:58,537 --> 00:42:59,370
- Beautiful.

837
00:42:59,370 --> 00:43:00,683
- Oh, there are craters there.

838
00:43:02,910 --> 00:43:04,260
- [Narrator] What Voyager saw

839
00:43:04,260 --> 00:43:07,750
was a frigid world of rock and ice.

840
00:43:07,750 --> 00:43:09,620
- And it also had a very thin atmosphere.

841
00:43:09,620 --> 00:43:12,380
And the atmosphere had these
cloud structures in it,

842
00:43:12,380 --> 00:43:15,623
these very, very thin narrow clouds.

843
00:43:16,950 --> 00:43:18,153
You guys see a limb haze?

844
00:43:21,724 --> 00:43:22,570
I think that's a wind streak.

845
00:43:22,570 --> 00:43:23,581
- [Brad] Oh, they are wind streaks.

846
00:43:23,581 --> 00:43:24,530
No question about it.

847
00:43:24,530 --> 00:43:25,363
- How can you have a wind streak

848
00:43:25,363 --> 00:43:27,040
with such a tenuous atmosphere though?

849
00:43:27,040 --> 00:43:28,626
- You get the winds to blow.

850
00:43:28,626 --> 00:43:29,459
- To follow the migrations?

851
00:43:29,459 --> 00:43:30,292
You had to blow very hard.

852
00:43:30,292 --> 00:43:31,440
- If you get the winds blow fast enough.

853
00:43:31,440 --> 00:43:34,146
- Yeah, but did you calculate
how fast it's gotta blow

854
00:43:34,146 --> 00:43:35,620
in a (faint speaking) atmosphere?

855
00:43:35,620 --> 00:43:37,570
- Obviously, it knows how fast to blow

856
00:43:37,570 --> 00:43:40,793
because it's certainly
streaking that material out.

857
00:43:44,010 --> 00:43:49,010
- Triton had a very,
very peculiar surface.

858
00:43:49,040 --> 00:43:50,420
Very few craters.

859
00:43:50,420 --> 00:43:53,740
Very odd, chaotic looking terrain.

860
00:43:53,740 --> 00:43:55,380
Very disturbed.

861
00:43:55,380 --> 00:43:58,220
There are areas that look
very resurfaced, right?

862
00:43:58,220 --> 00:43:59,840
I mean, craterless.

863
00:44:02,260 --> 00:44:05,220
- [Narrator] Here perhaps
is the most diverse terrain

864
00:44:05,220 --> 00:44:07,123
in the entire solar system.

865
00:44:08,430 --> 00:44:10,800
Triton's surface has few craters,

866
00:44:10,800 --> 00:44:13,750
which suggests that
unlike the moon itself,

867
00:44:13,750 --> 00:44:16,813
the surface is for some
reason relatively young.

868
00:44:17,820 --> 00:44:20,190
A smudge on one of Voyager's images

869

00:44:20,190 --> 00:44:22,980
so small as to almost go unnoticed

870
00:44:22,980 --> 00:44:25,820
provided a clue as to why.

871
00:44:25,820 --> 00:44:28,010
- We saw these vents of things.

872
00:44:28,010 --> 00:44:31,100
And the thing is only like 20
degrees above absolute zero.

873
00:44:31,100 --> 00:44:33,130
I mean, it's one of the
coldest things there is.

874
00:44:33,130 --> 00:44:35,633
And it's got things erupting on it.

875
00:44:37,930 --> 00:44:40,470
- [Narrator] And though
these smudges were faint

876
00:44:40,470 --> 00:44:42,813
the implications were spectacular.

877
00:44:44,978 --> 00:44:48,311
(intense ambient music)

878
00:44:52,870 --> 00:44:54,630
These were erupting geysers

879
00:44:55,540 --> 00:44:58,615
shooting out material miles into space.

880
00:44:58,615 --> 00:45:01,532
(intense rumbling)

881
00:45:03,760 --> 00:45:07,770
In other places, there were
lava-like flows of ice,

882
00:45:07,770 --> 00:45:10,950
all of it believed caused
by volcanic processes

883
00:45:10,950 --> 00:45:12,993
underneath Triton's surface.

884
00:45:15,150 --> 00:45:18,700
- A world at the very, very
edge of the solar system.

885
00:45:18,700 --> 00:45:20,290
Frozen.

886
00:45:20,290 --> 00:45:22,770
We thought it would be
completely geologically dead.

887
00:45:22,770 --> 00:45:24,920
And it turns out to be
geologically active.

888
00:45:26,430 --> 00:45:27,730
That was a great surprise.

889
00:45:33,570 --> 00:45:37,335
- I think we were all just
overwhelmed with the experience

890
00:45:37,335 --> 00:45:38,168
that it had been.

891
00:45:38,168 --> 00:45:40,110
I mean this, for everybody,
I think, on the Voyager team

892
00:45:40,110 --> 00:45:42,133
had been the journey of a lifetime.

893
00:45:43,060 --> 00:45:45,330
There's no doubt that
the wealth of discovery

894
00:45:45,330 --> 00:45:47,330
from this mission had never been matched

895
00:45:47,330 --> 00:45:48,380
by any other mission.

896
00:45:49,970 --> 00:45:52,640
Voyager discovered the
diversity of the solar system

897
00:45:52,640 --> 00:45:55,940
which really told us that
the solar system is alive.

898
00:45:55,940 --> 00:45:58,730
The objects in the solar
system have evolved

899
00:45:58,730 --> 00:46:00,740
and are continuing to evolve.

900
00:46:00,740 --> 00:46:02,350
And I think for a science team

901
00:46:02,350 --> 00:46:04,290
that was a unique experience

902
00:46:04,290 --> 00:46:06,414
which will be the highlight
for many of the careers

903
00:46:06,414 --> 00:46:08,283
of the Voyager scientists.

904
00:46:11,320 --> 00:46:13,180
- I think we should just
have a show of hands

905
00:46:13,180 --> 00:46:16,613
who's here from that 1972 imaging team?

906
00:46:16,613 --> 00:46:19,640
(people laughing)
One!

907
00:46:19,640 --> 00:46:21,230
- I think it was very sad

908
00:46:21,230 --> 00:46:22,510
for some of the people on the project

909
00:46:22,510 --> 00:46:25,620
who had been there for all four encounters

910
00:46:25,620 --> 00:46:28,650
and really had had their whole life

911
00:46:28,650 --> 00:46:31,360
revolve around these four encounters.

912
00:46:31,360 --> 00:46:32,457
They had their

913
00:46:32,457 --> 00:46:35,220
plan their children in between encounters.

914
00:46:35,220 --> 00:46:36,100
And you know,

915
00:46:36,100 --> 00:46:38,900
you could watch your family
grow by the different years.

916
00:46:40,160 --> 00:46:40,993
- Here's to Kennedy.

917
00:46:40,993 --> 00:46:42,756
We couldn't have done it without her!

918
00:46:42,756 --> 00:46:44,250
(people cheering)

919
00:46:44,250 --> 00:46:46,700
- So not only are you sort of done

920
00:46:46,700 --> 00:46:48,650
with the science aspect of the mission,

921
00:46:48,650 --> 00:46:51,570
but you're really losing
your friends and your family

922
00:46:51,570 --> 00:46:54,913
as they go out and start
working on other projects.

923
00:46:57,000 --> 00:46:58,570
- If I really think about what's happened

924
00:46:58,570 --> 00:47:00,440
in the last few days,

925
00:47:00,440 --> 00:47:02,000
it's intellectually

926
00:47:02,000 --> 00:47:05,560
perhaps one of the most

stimulating times in my life.

927
00:47:05,560 --> 00:47:08,280
Emotionally, it's one of the saddest.

928
00:47:08,280 --> 00:47:09,580
I've been here... For the last 10 years

929
00:47:09,580 --> 00:47:10,600
I've worked on this mission,

930
00:47:10,600 --> 00:47:13,910
always anticipated one
encounter after the next,

931
00:47:13,910 --> 00:47:15,680
realizing they'd be fantastic,

932
00:47:15,680 --> 00:47:18,423
realizing that there'd be
things totally unexpected.

933
00:47:19,570 --> 00:47:21,060
And it's over.

934
00:47:21,060 --> 00:47:22,230
We've done it.

935
00:47:22,230 --> 00:47:24,500
We've finished the first reconnaissance

936
00:47:24,500 --> 00:47:25,820
of the entire solar system.

937
00:47:25,820 --> 00:47:27,320
We've rewritten the textbooks.

938
00:47:29,040 --> 00:47:30,947

What do you do next, you know?

939
00:47:35,870 --> 00:47:38,983
- [Narrator] The adventures
of the Voyagers were not over.

940
00:47:40,120 --> 00:47:42,740
In 1990, Voyager 1,

941
00:47:42,740 --> 00:47:45,980
over three and a half billion
miles away from its home,

942
00:47:45,980 --> 00:47:47,703
snapped these images.

943
00:47:49,490 --> 00:47:53,060
This first ever family
portrait of the solar system

944
00:47:53,060 --> 00:47:55,423
was the idea of scientist Carl Sagan.

945
00:47:58,570 --> 00:48:01,210
- [Child] Hello from the
children of planet Earth.

946
00:48:01,210 --> 00:48:02,940
- Sagan also led the team

947
00:48:02,940 --> 00:48:05,183
that designed Voyager's Golden Record.

948
00:48:06,110 --> 00:48:07,420
It is a greeting card

949
00:48:07,420 --> 00:48:10,440
containing sights and
sounds of our planet,

950
00:48:10,440 --> 00:48:13,990
should one day somewhere
in interstellar space

951
00:48:13,990 --> 00:48:16,830
a wayfarer were to stumble
upon the spacecraft

952
00:48:16,830 --> 00:48:20,253
and wonder who had sent
it on its adventure.

953
00:48:22,610 --> 00:48:24,150
A member of the record team

954
00:48:24,150 --> 00:48:27,445
and later Sagan's wife was Ann Druyan.

955
00:48:27,445 --> 00:48:30,267
Together, they wrote
this excerpted passage

956
00:48:30,267 --> 00:48:32,683
about our pale blue dot.

957
00:48:36,587 --> 00:48:38,410
(soft piano music)

958
00:48:38,410 --> 00:48:40,193
- Consider again that dot.

959
00:48:41,740 --> 00:48:42,693
That's home.

960
00:48:43,640 --> 00:48:44,633
That's us.

961

00:48:46,000 --> 00:48:48,340
On it, everyone you love.

962
00:48:48,340 --> 00:48:49,563
Everyone you know.

963
00:48:51,020 --> 00:48:52,780
Everyone you ever heard of.

964
00:48:52,780 --> 00:48:56,703
Every human being who ever
was lived out their lives.

965
00:48:58,420 --> 00:49:00,400
Our planet is a lonely speck

966
00:49:00,400 --> 00:49:02,803
in the great enveloping cosmic dark.

967
00:49:05,320 --> 00:49:08,210
In our obscurity, in all this vastness,

968
00:49:08,210 --> 00:49:11,610
there is no hint that help
will come from elsewhere

969
00:49:11,610 --> 00:49:13,543
to save us from ourselves.

970
00:49:14,410 --> 00:49:17,503
For the moment, the Earth
is where we make our stand.

971
00:49:18,750 --> 00:49:21,370
It underscores our responsibility

972
00:49:22,640 --> 00:49:24,710
to deal more kindly with one another

973
00:49:25,690 --> 00:49:30,133
and to preserve and
cherish the pale blue dot,

974
00:49:31,050 --> 00:49:33,873
the only home we've ever known.

975
00:49:38,384 --> 00:49:40,920
(people applauding)

976
00:49:40,920 --> 00:49:43,920
(upbeat rock music)

977
00:49:52,670 --> 00:49:54,010
- [Narrator] At the end of the encounter

978
00:49:54,010 --> 00:49:55,810
at Neptune and Triton

979
00:49:55,810 --> 00:49:58,340
a celebration organized by Carl Sagan

980
00:49:58,340 --> 00:50:01,993
and the Planetary Society
was held on JPL's mall.

981
00:50:03,290 --> 00:50:05,330
The evening featured a surprise appearance

982
00:50:05,330 --> 00:50:07,373
by rock and roll great Chuck Berry.

983
00:50:08,250 --> 00:50:10,610
It was a fitting choice as Berry's music

984
00:50:10,610 --> 00:50:13,630
was now sailing outward toward the stars

985
00:50:13,630 --> 00:50:15,803
aboard Voyager's Golden Record.

986
00:50:17,710 --> 00:50:20,403
That was only one of many
reasons to celebrate.

987
00:50:26,510 --> 00:50:28,143
The Shuttle was flying again.

988
00:50:29,120 --> 00:50:31,620
Three months before the Neptune encounter

989
00:50:31,620 --> 00:50:35,600
the Shuttle Atlantis had
deployed JPL's Magellan.

990
00:50:35,600 --> 00:50:37,460
This spacecraft used radar

991
00:50:37,460 --> 00:50:39,883
to map the surface of Venus in 3D.

992
00:50:40,890 --> 00:50:44,530
It was a natural follow-on
to the pioneering experiments

993
00:50:44,530 --> 00:50:47,603
JPL had flown on the
Shuttle's early flights.

994
00:50:50,150 --> 00:50:53,230
Five months after Magellan's deployment

995
00:50:53,230 --> 00:50:57,293
Galileo was also deployed and
sent on its way to Jupiter.

996

00:50:58,530 --> 00:51:00,790
Magellan and Galileo were two

997
00:51:00,790 --> 00:51:03,390
of only three planetary spacecraft

998
00:51:03,390 --> 00:51:05,483
ever carried aloft by the Shuttle.

999
00:51:08,260 --> 00:51:10,893
Lew Allen retired in 1991.

1000
00:51:12,641 --> 00:51:15,950
He used this skit to help say his goodbye,

1001
00:51:15,950 --> 00:51:18,543
riding off into the sunset with his wife.

1002
00:51:20,700 --> 00:51:22,533
Allen died in 2010.

1003
00:51:25,490 --> 00:51:28,313
Ed Stone became the new sheriff in town.

1004
00:51:29,640 --> 00:51:33,150
Even while serving as
JPL's director for a decade

1005
00:51:33,150 --> 00:51:36,303
he continued on as
Voyager's chief scientist.

1006
00:51:37,450 --> 00:51:39,500
In 2013, Stone,

1007
00:51:39,500 --> 00:51:43,170
still the only chief scientist
Voyager has ever had,

1008
00:51:43,170 --> 00:51:47,690
announced that Voyager 1 had
reached interstellar space,

1009
00:51:47,690 --> 00:51:49,893
the region between the stars.

1010
00:51:50,750 --> 00:51:52,800
This historic event happened

1011
00:51:52,800 --> 00:51:56,300
during the watch of Voyager's
10th project manager

1012
00:51:56,300 --> 00:51:57,563
Suzanne Dodd.

1013
00:51:59,860 --> 00:52:02,230
All this was still ahead.

1014
00:52:02,230 --> 00:52:05,300
But on this evening of
the Neptune celebration

1015
00:52:05,300 --> 00:52:09,320
before Chuck Berry struck
the first note on his guitar,

1016
00:52:09,320 --> 00:52:12,500
Carl Sagan addressed the assembled crowd

1017
00:52:12,500 --> 00:52:17,500
with words that are as fitting
today as they were in 1989.

1018
00:52:20,900 --> 00:52:24,700
- [Carl] Every human culture
has rites of passage.

1019
00:52:24,700 --> 00:52:27,650
They mark the transition from
one stage of life to another.

1020
00:52:28,600 --> 00:52:30,770
We are gathered here to celebrate

1021
00:52:30,770 --> 00:52:33,143
Voyager's right of passage.

1022
00:52:34,740 --> 00:52:39,200
A machine designed, built,
and operated right here at JPL

1023
00:52:39,200 --> 00:52:42,830
has broken free of the Sun's gravity,

1024
00:52:42,830 --> 00:52:45,890
explored most of the
worlds of the solar system,

1025
00:52:45,890 --> 00:52:47,580
and is now on its way

1026
00:52:47,580 --> 00:52:51,563
to the great dark ocean
of interstellar space.

1027
00:52:53,270 --> 00:52:56,433
The men and women responsible
are gathered here.

1028
00:52:57,330 --> 00:53:00,310
They are heroes of human accomplishment.

1029
00:53:00,310 --> 00:53:03,113
Their deeds will be remembered
in the history books.

1030
00:53:04,750 --> 00:53:06,890
Our remote descendants may live

1031
00:53:06,890 --> 00:53:09,943
on some of the worlds first
revealed to us by Voyager.

1032
00:53:10,990 --> 00:53:14,700
If so, those descendants
will look back upon us

1033
00:53:14,700 --> 00:53:17,273
as we look on Christopher Columbus.

1034
00:53:19,480 --> 00:53:22,180
Voyager reminds us of the rarity

1035
00:53:22,180 --> 00:53:25,730
and preciousness of what our planet holds,

1036
00:53:25,730 --> 00:53:28,773
of our responsibility to
preserve life on Earth.

1037
00:53:30,100 --> 00:53:32,620
If we are capable of such grand,

1038
00:53:32,620 --> 00:53:35,070
long-term, benign, visionary,

1039
00:53:35,070 --> 00:53:38,230
high technology endeavors as Voyager,

1040
00:53:38,230 --> 00:53:41,100
can we not use our technological gifts

1041
00:53:41,100 --> 00:53:44,463
and long-term vision to

put this planet right?

1042
00:53:46,180 --> 00:53:48,090
To take care of one another,

1043
00:53:48,090 --> 00:53:49,870
to cherish the Earth,

1044
00:53:49,870 --> 00:53:54,870
and bravely, to venture forth
in the footsteps of Voyager

1045
00:53:55,160 --> 00:53:57,377
to the planets and the stars.