



Ames Research Center

1
00:00:01,000 --> 00:00:04,000
[music playing]

2
00:00:16,800 --> 00:00:18,866
- SO, WELCOME TO THE 75th
ANNIVERSARY

3
00:00:18,866 --> 00:00:20,700
OF NASA AMES
RESEARCH CENTER,

4
00:00:20,700 --> 00:00:23,733
AND THE DIRECTORS COLLOQUIA
SUMMER SERIES.

5
00:00:23,733 --> 00:00:27,500
THE MOON, WE SEE IT EVERY DAY
WHEN WE LOOK UP,

6
00:00:27,500 --> 00:00:28,966
IS OUR NEAREST NEIGHBOR,

7
00:00:28,966 --> 00:00:31,633
YET WE KNOW SO LITTLE.

8
00:00:31,633 --> 00:00:35,000
THE MOON IS AN INTEGRAL PART
OF WHO WE ARE

9
00:00:35,000 --> 00:00:38,433
AND WHAT CREATED US.

10
00:00:38,433 --> 00:00:43,366
NASA AMES HAS HAD
A FEW MISSIONS TO THE MOON.

11
00:00:43,366 --> 00:00:46,800
BUT WHEN YOU LOOK AT MISSIONS
AS A WHOLE,

12
00:00:46,800 --> 00:00:48,200
NASA-BASED MISSIONS,

13
00:00:48,200 --> 00:00:50,366
THERE IS A SCIENCE GOAL
TO IT.

14
00:00:50,366 --> 00:00:54,933
BUT TO ACHIEVE THAT SCIENCE GOAL
REQUIRES A WHOLE TEAM.

15
00:00:54,933 --> 00:00:58,766
A TEAM OF ENGINEERS,
A TEAM OF SCIENTISTS,

16
00:00:58,766 --> 00:01:01,133
AND TEAM OF ACCOUNTANTS.

17
00:01:01,133 --> 00:01:04,833
TEAM OF EDUCATIONAL OUTREACH.

18
00:01:04,833 --> 00:01:07,200
IT TAKES A WHOLE TEAM.

19
00:01:07,200 --> 00:01:09,266
BESIDES THE SCIENCE,

20
00:01:09,266 --> 00:01:12,800
WE ALSO PUSH THE ENVELOPE
OF THE TECHNOLOGY THAT IS NEEDED

21
00:01:12,800 --> 00:01:15,466
TO DO SPACE MISSIONS.

22
00:01:15,466 --> 00:01:21,333
THOSE TECHNOLOGIES ALSO ADVANCED
OUR ABILITY HERE ON EARTH.

23

00:01:23,800 --> 00:01:25,133

TODAY'S TALK,

24

00:01:25,133 --> 00:01:28,266

ENTITLED "SKIMMING THE LUNAR
SURFACE FOR SCIENCE:

25

00:01:28,266 --> 00:01:30,766

THE LADEE MISSION,"

26

00:01:30,766 --> 00:01:33,933

WILL BE GIVEN
BY BRIAN LEWIS.

27

00:01:33,933 --> 00:01:37,433

BRIAN LEWIS
IS A SYSTEM ENGINEER

28

00:01:37,433 --> 00:01:40,000

HERE AT NASA AMES
RESEARCH CENTER.

29

00:01:40,000 --> 00:01:42,566

HE IS CURRENTLY THE LEAD
SYSTEM ENGINEER

30

00:01:42,566 --> 00:01:44,566

FOR THE BIOSENTINEL PROJECT,

31

00:01:44,566 --> 00:01:48,633

AND PREVIOUSLY ACTED AS
THE SPACECRAFT SYSTEM ENGINEER

32

00:01:48,633 --> 00:01:53,300

AND THE SPACECRAFT MANAGER
ON THE LADEE PROJECT.

33

00:01:53,300 --> 00:01:57,633

HE HOLDS A BACHELORS OF SCIENCE

AND A MASTERS OF SCIENCE

34

00:01:57,633 --> 00:02:00,700
IN MECHANICAL ENGINEERING
FROM UTAH STATE UNIVERSITY,

35

00:02:00,700 --> 00:02:05,600
WITH A FOCUS ON THERMAL SYSTEMS
ENGINEERING.

36

00:02:05,600 --> 00:02:09,566
HE HAS BEEN INVOLVED WITH
SPACECRAFT SYSTEM ENGINEERINGS

37

00:02:09,566 --> 00:02:11,633
FOR OVER 14 YEARS.

38

00:02:11,633 --> 00:02:14,866
PLEASE JOIN ME IN WELCOMING
BRIAN LEWIS.

39

00:02:14,866 --> 00:02:17,066
[applause]

40

00:02:22,733 --> 00:02:24,166
- ALL RIGHT, THANK YOU ALL
VERY MUCH.

41

00:02:24,166 --> 00:02:25,666
IT'S AN HONOR
TO BE HERE TODAY.

42

00:02:25,666 --> 00:02:27,366
IT IS A LITTLE BIT
INTIMIDATING

43

00:02:27,366 --> 00:02:29,000
BEING PLACED BETWEEN
ROBERT ZUBRIN

44

00:02:29,000 --> 00:02:31,133

AND TRYING TO LEAD IN
FOR RUSTY SCHWEICKART,

45

00:02:31,133 --> 00:02:33,400

BUT I'LL DO MY BEST AND TRY TO
GIVE YOU SOME INTERESTING THINGS

46

00:02:33,400 --> 00:02:36,466

THAT WE LEARNED WHILE TESTING,
LAUNCHING AND FLYING LADEE.

47

00:02:36,466 --> 00:02:38,033

LIKE JACOB SAID,

48

00:02:38,033 --> 00:02:40,000

I WAS THE SPACECRAFT SYSTEMS
ENGINEER FOR A LITTLE BIT,

49

00:02:40,000 --> 00:02:41,600

AND THEN MY LAST ROLE
IN THE PROJECT

50

00:02:41,600 --> 00:02:43,866

WAS AS THE SPACECRAFT MANAGER
ON THE PROJECT.

51

00:02:43,866 --> 00:02:47,666

SO I WAS, LIKE JACOB SAID,
FOCUSED MOSTLY ON MAKING SURE

52

00:02:47,666 --> 00:02:50,000

THAT THE TECHNOLOGIES
THAT GOT OUR SCIENCE INSTRUMENTS

53

00:02:50,000 --> 00:02:52,866

INTO ORBIT WORKED TOGETHER WHEN
THEY WERE ALL BROUGHT TOGETHER.

54

00:02:52,866 --> 00:02:56,100
AS A LITTLE BIT OF AN INTRO TO
THE LADEE MISSION ITSELF,

55
00:02:56,100 --> 00:02:57,633
THE OBJECTIVES
OF THE LADEE MISSION

56
00:02:57,633 --> 00:02:59,333
WERE TO MEASURE
THE LUNAR DUST

57
00:02:59,333 --> 00:03:01,700
AND EXAMINE THE LUNAR
ATMOSPHERE.

58
00:03:01,700 --> 00:03:04,000
THE LADEE MISSION
WAS ORIGINALLY AWARDED

59
00:03:04,000 --> 00:03:05,800
BACK WHEN WE WERE
STILL ON A PATH

60
00:03:05,800 --> 00:03:07,300
TO BEING PLACING ASTRONAUTS
ON THE MOON,

61
00:03:07,300 --> 00:03:10,100
AND THE SCIENCE RATIONALE
WAS TO TRY TO CHARACTERIZE

62
00:03:10,100 --> 00:03:12,500
THAT THIN EXOSPHERE
AROUND THE MOON

63
00:03:12,500 --> 00:03:16,600
BEFORE WE LANDED ASTRONAUTS
THERE, AND LANDED ROVERS,

64

00:03:16,600 --> 00:03:18,000
AND STARTED BUILDING BASES,

65

00:03:18,000 --> 00:03:19,333
AND STARTED DISTURBING
THAT ATMOSPHERE.

66

00:03:19,333 --> 00:03:21,333
SO WE KNOW WHAT IT WAS
IN A PRISTINE CONDITION.

67

00:03:21,333 --> 00:03:24,900
AS YOU ALL KNOW,
WE ARE NOW ON A PATH

68

00:03:24,900 --> 00:03:27,033
ON PLACING ASTRONAUTS
ONTO ASTEROIDS,

69

00:03:27,033 --> 00:03:29,166
WITH THE GOAL OF GETTING THEM
TOWARD MARS.

70

00:03:29,166 --> 00:03:30,833
BUT A LOT OF THE RESEARCH
THAT WE LEARNED

71

00:03:30,833 --> 00:03:32,233
AND A LOT OF THE SCIENCE DATA
THAT WE TOOK

72

00:03:32,233 --> 00:03:34,066
ON THE LADEE MISSION
WILL HELP US UNDERSTAND

73

00:03:34,066 --> 00:03:35,933
WHAT WE'RE DOING ON THAT PATH
THERE AS WELL.

74

00:03:35,933 --> 00:03:38,233

SO IT--IT--THE SCIENCE
THAT WE COLLECTED

75

00:03:38,233 --> 00:03:39,700
IS STILL VERY USEFUL.

76

00:03:39,700 --> 00:03:42,333
SOME OF THE KEY PARAMETERS:
LADEE ITSELF WAS LAUNCHED

77

00:03:42,333 --> 00:03:45,733
IN LATE SEPTEMBER
OR EARLY SEPTEMBER OF LAST YEAR.

78

00:03:45,733 --> 00:03:47,533
AND THEN IT IMPACTED
WITH THE MOON

79

00:03:47,533 --> 00:03:50,333
IN ABOUT THE MIDDLE OF APRIL
OF THIS YEAR ITSELF.

80

00:03:50,333 --> 00:03:52,600
THE SPACECRAFT ITSELF
IS A SMALL EXPLORER.

81

00:03:52,600 --> 00:03:54,233
IT WAS ABOUT 300 KILOGRAMS.

82

00:03:54,233 --> 00:03:55,933
IT WAS AN ENHANCED CLASS D.

83

00:03:55,933 --> 00:03:57,900
THE SPACECRAFT WAS ITSELF
PROVIDED

84

00:03:57,900 --> 00:04:00,333
BY AMES RESEARCH CENTER,
AND THE SPACECRAFT INSTRUMENTS

85

00:04:00,333 --> 00:04:02,833

WERE MANAGED BY GODDARD
SPACE FLIGHT CENTER.

86

00:04:02,833 --> 00:04:06,033

BUT WHILE THOSE ARE SAID,
THAT'S NOT THE WHOLE STORY.

87

00:04:06,033 --> 00:04:08,066

IN THE END, WE TOTTED UP
ALL OF THE CONTRIBUTIONS

88

00:04:08,066 --> 00:04:09,266

FROM THE DIFFERENT
NASA CENTERS

89

00:04:09,266 --> 00:04:10,633

AND A LOT OF OUR PARTNERS.

90

00:04:10,633 --> 00:04:12,433

AND EIGHT OF THE TEN
NASA CENTERS

91

00:04:12,433 --> 00:04:13,800

CONTRIBUTED DIRECTLY
TO THE SUCCESS

92

00:04:13,800 --> 00:04:16,033

OF THE LADEE MISSION,
AS WELL AS PROVIDING--

93

00:04:16,033 --> 00:04:19,400

NUMEROUS SMALL COMPANIES
PROVIDING TECHNOLOGIES

94

00:04:19,400 --> 00:04:21,700

THAT MADE THE MISSION
A SUCCESS.

95

00:04:21,700 --> 00:04:23,233
THE INSTRUMENTS WE'VE FLOWN

96
00:04:23,233 --> 00:04:24,600
I'LL TALK A LITTLE BIT
MORE ABOUT LATER,

97
00:04:24,600 --> 00:04:26,133
BUT THERE WERE THREE
PRIMARY INSTRUMENTS ON THERE:

98
00:04:26,133 --> 00:04:27,766
A NEUTRAL MASS SPECTROMETER,

99
00:04:27,766 --> 00:04:29,866
AN ULTRAVIOLET AND VISIBLE
SPECTROMETER,

100
00:04:29,866 --> 00:04:31,666
AND A LUNAR DUST EXPLORER.

101
00:04:31,666 --> 00:04:33,866
THOSE WERE ALL MEANT
TO CHARACTERIZE THE EXOSPHERE

102
00:04:33,866 --> 00:04:35,233
AROUND THE MOON ITSELF.

103
00:04:35,233 --> 00:04:37,433
AND THERE WAS A TECHNOLOGY
DEMONSTRATION PAYLOAD,

104
00:04:37,433 --> 00:04:39,800
AND THAT PAYLOAD WAS A LUNAR
LASERCOMM TERMINAL.

105
00:04:39,800 --> 00:04:42,233
WE WERE TRYING TO DEMONSTRATE
THE VIABILITY

106
00:04:42,233 --> 00:04:44,000
OF LASER-BASED COMMUNICATIONS

107
00:04:44,000 --> 00:04:46,233
FROM BEYOND LOW EARTH ORBIT
FOR THE FIRST TIME EVER.

108
00:04:46,233 --> 00:04:49,866
AND THEN THE--AS ANOTHER FIRST,
THE MISSION ITSELF WAS LAUNCHED

109
00:04:49,866 --> 00:04:52,000
OFF OF A MINOTAUR V
LAUNCH VEHICLE

110
00:04:52,000 --> 00:04:55,333
OUT OF WALLOPS FLIGHT FACILITY
IN WEST--EASTERN VIRGINIA.

111
00:04:55,333 --> 00:04:57,200
THIS IS THE FIRST FLIGHT
OF THE MINOTAUR V,

112
00:04:57,200 --> 00:04:58,666
AND WE HAD A LITTLE BIT
OF BIRTHING PAINS

113
00:04:58,666 --> 00:04:59,866
WITH THAT AS WELL.

114
00:04:59,866 --> 00:05:01,366
I WON'T TALK TOO MUCH
ABOUT THEM,

115
00:05:01,366 --> 00:05:03,133
BUT THERE WERE A LOT OF FIRSTS
THAT WE DID WITH LADEE,

116
00:05:03,133 --> 00:05:06,300

EVEN THOUGH IT WAS
A LOW-COST MISSION.

117
00:05:06,300 --> 00:05:08,300
IN TERMS OF SCIENCE
OBJECTIVES,

118
00:05:08,300 --> 00:05:09,866
I TALKED A LITTLE BIT
ABOUT THESE BEFORE.

119
00:05:09,866 --> 00:05:11,466
WE WERE TRYING TO DETERMINE
THE COMPOSITION

120
00:05:11,466 --> 00:05:13,900
OF THE LUNAR ATMOSPHERE
IN AN UNDISTURBED STATE,

121
00:05:13,900 --> 00:05:16,233
SINCE WE HADN'T LANDED ANYTHING
THERE FOR QUITE SOME TIME.

122
00:05:16,233 --> 00:05:18,700
WE THOUGHT THIS WOULD BE IN A
RELATIVELY PRISTINE ENVIRONMENT.

123
00:05:18,700 --> 00:05:21,033
AND THEN WE WANTED TO
CHARACTERIZE THAT ENVIRONMENT

124
00:05:21,033 --> 00:05:23,133
AND MEASURE ITS SPATIAL
AND THERMAL

125
00:05:23,133 --> 00:05:24,700
AND TEMPORAL VARIABILITY,

126
00:05:24,700 --> 00:05:27,400
AND THE IMPACTS THAT DIFFERENT

THINGS LIKE THE SOLAR WIND,

127

00:05:27,400 --> 00:05:28,933

THE EARTH'S MAGNETOSPHERE,

128

00:05:28,933 --> 00:05:31,433

IMPACTS FROM METEOROIDS
OR ASTEROIDS WOULD HAVE

129

00:05:31,433 --> 00:05:33,066

ON THE LUNAR ATMOSPHERE
AS WELL.

130

00:05:33,066 --> 00:05:35,033

AND ONE OF THE REASONS
THAT WE WANTED TO DO THAT

131

00:05:35,033 --> 00:05:37,166

WAS THAT WE WERE ABLE TO TAKE
THE SCIENCE WE LEARNED THERE

132

00:05:37,166 --> 00:05:40,100

AND APPLY IT TO OTHER SMALL
BODIES AROUND THE SOLAR SYSTEM.

133

00:05:40,100 --> 00:05:42,900

PLACES LIKE MERCURY,
THE MOONS OF MARS,

134

00:05:42,900 --> 00:05:44,933

THE MOONS OF JUPITER,
SMALL ASTEROIDS.

135

00:05:44,933 --> 00:05:47,733

ALL OF THESE TYPES OF BODIES
AROUND THE SOLAR SYSTEM

136

00:05:47,733 --> 00:05:50,100

ARE SURROUNDED BY THIN
EXOSPHERES,

137

00:05:50,100 --> 00:05:51,800
MUCH LIKE THE MOON HAS.

138

00:05:51,800 --> 00:05:54,366
AND SO WHAT WE LEARN
FROM THIS MISSION,

139

00:05:54,366 --> 00:05:56,433
WE'LL BE ABLE TO USE
TO CHARACTERIZE

140

00:05:56,433 --> 00:06:00,166
AND INFORM OUR OPERATIONS AROUND
THOSE BODIES IN THE FUTURE.

141

00:06:00,166 --> 00:06:02,900
THE SCIENCE PAYLOAD, AS I TALKED
A LITTLE BIT ABOUT BEFORE,

142

00:06:02,900 --> 00:06:04,566
YOU CAN SEE THERE
ON THE TOP LEFT.

143

00:06:04,566 --> 00:06:05,900
THERE'S A NEUTRAL MASS
SPECTROMETER.

144

00:06:05,900 --> 00:06:07,966
THAT WAS PROVIDED
BY GODDARD SPACE FLIGHT CENTER.

145

00:06:07,966 --> 00:06:10,733
MEASURED A LOT OF THE
ATMOSPHERIC CONSTITUENTS

146

00:06:10,733 --> 00:06:11,900
AROUND THE MOON.

147

00:06:11,900 --> 00:06:13,633
MOST OF THEM WERE NOBLE GASES,
AS YOU CAN SEE.

148
00:06:13,633 --> 00:06:15,600
ARGON, HELIUM, NEON,
THINGS LIKE THAT.

149
00:06:15,600 --> 00:06:18,533
BUT THEY WERE ABLE TO PICK UP
AND CHARACTERIZE

150
00:06:18,533 --> 00:06:20,933
A HANDFUL OF OTHER GASES
AS WELL.

151
00:06:20,933 --> 00:06:22,933
THERE WAS AN ULTRAVIOLET
AND VISIBLE SPECTROMETER,

152
00:06:22,933 --> 00:06:24,633
THAT WAS PROVIDED
BY DR. TONY COLAPRETE

153
00:06:24,633 --> 00:06:26,266
HERE AT NASA AMES
RESEARCH CENTER,

154
00:06:26,266 --> 00:06:28,933
AND A LOT OF THE TEAM I'VE SEEN
FILTERING IN HERE AS WELL.

155
00:06:28,933 --> 00:06:33,533
THAT SPECTROMETER WORKS
TO CHARACTERIZE THE SPECIES

156
00:06:33,533 --> 00:06:37,200
OF ELEMENTS THAT WE SEE
IN THE EXOSPHERIC DUST.

157

00:06:37,200 --> 00:06:39,533
WHETHER THEY'RE THINGS LIKE
SODIUM OR POTASSIUM,

158
00:06:39,533 --> 00:06:42,366
OR OTHER ELEMENTS
UP IN THE ATMOSPHERE THERE.

159
00:06:42,366 --> 00:06:45,100
AND IT'S DONE BY MEASURING
EITHER THE EMISSIONS

160
00:06:45,100 --> 00:06:46,833
OR THE TRANSMITTED LIGHT
COMING THROUGH THE SUN

161
00:06:46,833 --> 00:06:49,566
THAT IS THEN ATTENUATED
BY THE LUNAR DUST.

162
00:06:49,566 --> 00:06:52,066
AND THEN LASTLY, THERE WAS
A LUNAR DUST EXPERIMENT

163
00:06:52,066 --> 00:06:53,500
THAT MEASURED IN SITU DUST.

164
00:06:53,500 --> 00:06:54,766
IT WAS ACTUALLY CHARACTERIZING

165
00:06:54,766 --> 00:06:56,133
THE IMPACTS
OF THE DUST PARTICLES

166
00:06:56,133 --> 00:06:57,366
AS LADEE FLEW AROUND.

167
00:06:57,366 --> 00:06:58,800
AND THOSE ARE
THE MAJOR ELEMENTS

168

00:06:58,800 --> 00:07:01,000

THAT CHARACTERIZE THE
ATMOSPHERE--GOT THE SCIENCE.

169

00:07:01,000 --> 00:07:02,366

AND I'LL HAVE
A FEW CHARTS LATER

170

00:07:02,366 --> 00:07:03,800

THAT'LL TALK A LITTLE BIT
ABOUT THAT.

171

00:07:03,800 --> 00:07:06,333

OUR LASERCOMM PAYLOAD,
YOU CAN SEE HERE,

172

00:07:06,333 --> 00:07:09,266

WAS MOUNTED ON THE SIDE
OF THE LADEE SPACECRAFT.

173

00:07:09,266 --> 00:07:11,133

THERE WERE A COUPLE
OF INTERNAL INSTRUMENTS AS WELL,

174

00:07:11,133 --> 00:07:13,300

OR INTERNAL COMPONENTS
OF THAT.

175

00:07:13,300 --> 00:07:16,200

THIS WAS, AS I SAID,
A TECH DEMO.

176

00:07:16,200 --> 00:07:17,700

THEY WEREN'T REALLY SURE
WHETHER THIS WOULD WORK.

177

00:07:17,700 --> 00:07:19,333

AND WE THOUGHT THAT WE WOULD
HAVE TO TAKE A SIGNIFICANT

178

00:07:19,333 --> 00:07:21,100

AMOUNT OF TIME MAKING IT WORK,

179

00:07:21,100 --> 00:07:23,700

SPEND A LOT OF TIME TRYING
TO SYNC UP THE TRANSMITTER

180

00:07:23,700 --> 00:07:25,833

AND ITS GROUND STATION.

181

00:07:25,833 --> 00:07:28,400

AS IT TURNED OUT,
WE WERE ABLE TO ACQUIRE WITH IT

182

00:07:28,400 --> 00:07:30,100

ON ALMOST THE FIRST TRY
THAT WE HAD.

183

00:07:30,100 --> 00:07:32,366

AND BY THE END OF THE MISSION,
THEY WERE ABLE TO ACHIEVE

184

00:07:32,366 --> 00:07:34,833

OVER 600-MEGABIT-PER-SECOND
DOWNLINK

185

00:07:34,833 --> 00:07:37,100

AND ABOUT 20-MEGABIT-PER-SECOND
UPLINK FROM THE GROUND.

186

00:07:37,100 --> 00:07:38,733

THIS IS ORDERS
OF MAGNITUDE

187

00:07:38,733 --> 00:07:40,500

BEYOND WHAT WE'VE BEEN
ABLE TO DO

188

00:07:40,500 --> 00:07:43,433
WITH RF-BASED COMMUNICATIONS
IN THAT REGIME.

189
00:07:43,433 --> 00:07:45,300
THE GODDARD TEAM
THAT WORKED ON THAT

190
00:07:45,300 --> 00:07:48,000
WITH MIT LINCOLN LABS
IS NOW WORKING ON TRYING

191
00:07:48,000 --> 00:07:52,566
TO DO ANOTHER DEMONSTRATION OFF
THE INTERNATIONAL SPACE STATION,

192
00:07:52,566 --> 00:07:55,100
WHERE THEY CAN PUSH THESE SPEEDS
INTO GIGABIT-TYPE--

193
00:07:55,100 --> 00:07:56,966
GIGABIT-PER-SECOND-TYPE SPEEDS.

194
00:07:56,966 --> 00:07:58,266
BUT THE NICE THING
THAT YOU CAN SEE

195
00:07:58,266 --> 00:08:00,166
IS THAT WE WERE ABLE TO DO FULLY
AUTONOMOUS LOCKUP,

196
00:08:00,166 --> 00:08:01,833
AND WE WERE ABLE
TO DO STREAMING VIDEO.

197
00:08:01,833 --> 00:08:03,100
THAT MIGHT NOT SEEM
LIKE A LOT,

198
00:08:03,100 --> 00:08:04,666

BUT WHEN WE'RE SENDING
ASTRONAUTS OUT

199

00:08:04,666 --> 00:08:06,333
TO DEEP-SPACE ENVIRONMENTS,

200

00:08:06,333 --> 00:08:09,200
BEING ABLE TO ALLOW THEM
TO MAINTAIN LINKS WITH EARTH,

201

00:08:09,200 --> 00:08:11,700
LINKS WITH THEIR FAMILIES,
LINKS WITH PEOPLE HERE,

202

00:08:11,700 --> 00:08:14,266
IS A MAJOR PART ON BEING ABLE
TO ALLOW THEM TO OPERATE

203

00:08:14,266 --> 00:08:15,933
IN THE SPACE FLIGHT ENVIRONMENT
FOR THAT LONG.

204

00:08:15,933 --> 00:08:18,000
SO BEING ABLE TO DEMONSTRATE
THESE TYPE OF CAPABILITIES

205

00:08:18,000 --> 00:08:21,833
IS A HUGE BENEFIT
FOR EXTENDING ASTRONAUTS

206

00:08:21,833 --> 00:08:24,100
INTO THAT DEEP-SPACE REGIME.

207

00:08:24,100 --> 00:08:26,300
IN TERMS OF THE FLIGHT SYSTEM
OVERVIEW,

208

00:08:26,300 --> 00:08:29,033
I HAVE A NICE
LITTLE MODEL HERE.

209

00:08:29,033 --> 00:08:30,333

I THINK A FEW PEOPLE--

210

00:08:30,333 --> 00:08:31,700

JIM CANNON PROBABLY
REMEMBERS THIS.

211

00:08:31,700 --> 00:08:34,433

BUTLER HINE, A FEW OF
THE LADEE FOLKS IN HERE.

212

00:08:34,433 --> 00:08:36,166

THIS WAS WHAT LADEE
LOOKED LIKE

213

00:08:36,166 --> 00:08:37,966

PROBABLY ABOUT FIVE YEARS AGO
OR SO.

214

00:08:37,966 --> 00:08:39,333

AND THEN ON THE SCREEN HERE
YOU CAN SEE

215

00:08:39,333 --> 00:08:41,100

WHAT LADEE LOOKED LIKE RIGHT
BEFORE LAUNCHING.

216

00:08:41,100 --> 00:08:43,233

AND SO YOU CAN SEE
HOW IT CHANGED A LITTLE BIT.

217

00:08:43,233 --> 00:08:45,066

IT USED TO BE THREE MODULES.

218

00:08:45,066 --> 00:08:47,333

ENDED UP BEING FOUR
WHEN WE ACTUALLY FLEW IT.

219

00:08:47,333 --> 00:08:50,733
THERE WAS A NICE THERMAL
RADIATOR ON THE TOP PANEL

220
00:08:50,733 --> 00:08:52,266
OF THE SPACECRAFT THAT WE WERE
TRYING TO KEEP OPEN

221
00:08:52,266 --> 00:08:56,033
SO WE COULD REJECT AS MUCH HEAT
TO THE ENVIRONMENT AS WE COULD.

222
00:08:56,033 --> 00:08:58,000
AND YOU CAN SEE,
IN THE END,

223
00:08:58,000 --> 00:08:59,733
WE HAD TO COVER UP
A LOT OF THAT RADIATOR

224
00:08:59,733 --> 00:09:02,133
WITH THINGS LIKE STAR TRACKER
BAFFLES, AND HARNESS,

225
00:09:02,133 --> 00:09:03,933
AND OTHER DEVICES.

226
00:09:03,933 --> 00:09:06,333
THERE'S A PART OF THE EVOLUTION
THAT WE GO THROUGH

227
00:09:06,333 --> 00:09:08,233
IN TERMS OF A SYSTEM
ENGINEERING PROCESS.

228
00:09:08,233 --> 00:09:10,800
WHEN WE STARTED OUT
PUTTING THE DESIGN TOGETHER,

229
00:09:10,800 --> 00:09:12,833

WE HAD OUR BEST ESTIMATES,
OUR BEST GUESSES

230

00:09:12,833 --> 00:09:14,766

AT WHAT THE MISSION
WOULD REQUIRE.

231

00:09:14,766 --> 00:09:16,000

WE PLACED THOSE
INSTRUMENTS DOWN,

232

00:09:16,000 --> 00:09:17,500

AND AS THE DESIGN EVOLVED,

233

00:09:17,500 --> 00:09:20,300

WE WERE ABLE TO GO THROUGH AND
FIND ALL THE SUPPORTING HARDWARE

234

00:09:20,300 --> 00:09:21,633

THAT WE HAD MISSED
IN THE FIRST TIME,

235

00:09:21,633 --> 00:09:23,200

OR THE FIRST CUT THAT WE'D DONE
THROUGH THE DESIGN.

236

00:09:23,200 --> 00:09:25,233

AND SO YOU CAN SEE
KIND OF AN EVOLUTION

237

00:09:25,233 --> 00:09:27,366

AS THE DESIGN PROGRESSES THERE.

238

00:09:27,366 --> 00:09:30,766

THE SPACECRAFT ITSELF
HAS AN ALL-COMPOSITE STRUCTURE.

239

00:09:30,766 --> 00:09:32,566

IT'S A COMPOSITE
FACESHEETS

240

00:09:32,566 --> 00:09:35,166
WITH AN ALUMINUM
HONEYCOMB CORE IN IT.

241

00:09:35,166 --> 00:09:37,100
AND SEE HERE WE HAVE

242

00:09:37,100 --> 00:09:38,533
A SINGLE-STAGE
BIPROPELLANT SYSTEM,

243

00:09:38,533 --> 00:09:39,933
AND I'LL TALK
A LITTLE BIT LATER

244

00:09:39,933 --> 00:09:41,500
ABOUT SOME OF THE CHALLENGES
THAT WE HAD IN INTEGRATING THAT.

245

00:09:41,500 --> 00:09:42,933
THEY'RE ALL BODY-MOUNTED
SOLAR ARRAYS.

246

00:09:42,933 --> 00:09:44,466
WE DIDN'T DEPLOY
ANY SOLAR ARRAYS.

247

00:09:44,466 --> 00:09:47,433
AND THAT WAS DONE TO REDUCE
RISK, KEEP OUR COSTS DOWN.

248

00:09:47,433 --> 00:09:49,866
WE HAD ABOUT A 24-AMP-HOUR
LITHIUM ION BATTERY.

249

00:09:49,866 --> 00:09:51,400
IT'S A FAIRLY
STANDARD BATTERY.

250

00:09:51,400 --> 00:09:53,966

THEY ACTUALLY MAKE THOSE OUT OF
THE SMALL DOUBLE-A-TYPE CELLS

251

00:09:53,966 --> 00:09:56,766

THAT YOU WOULD FIND
IN MOST STORES AROUND.

252

00:09:56,766 --> 00:09:58,400

AND THEN THEY PUT A LOT
OF BATTERY CHARGE PROTECTION,

253

00:09:58,400 --> 00:09:59,933

AND OTHER CIRCUITS
AROUND IT

254

00:09:59,933 --> 00:10:02,866

TO KEEP THE BATTERY WORKING
FUNCTIONALLY AND WORKING WELL

255

00:10:02,866 --> 00:10:04,366

OVER THE LIFE
OF OUR MISSION.

256

00:10:04,366 --> 00:10:06,633

WE HAD AN S-BAND
COMMUNICATION SYSTEM

257

00:10:06,633 --> 00:10:08,000

THAT WOULD ALLOW US TO,
YOU KNOW,

258

00:10:08,000 --> 00:10:10,633

PUSH ABOUT 128 KILOBITS
PER SECOND DOWN FROM THE MOON,

259

00:10:10,633 --> 00:10:12,100

AND ABOUT TWO KILOBITS
PER SECOND UP.

260

00:10:12,100 --> 00:10:15,033

AND IN THAT STATEMENT ALONE,
YOU CAN SEE THE DIFFERENCE

261

00:10:15,033 --> 00:10:17,066

IN WHAT NORMAL RF SYSTEMS

262

00:10:17,066 --> 00:10:19,100

AND LASER OPTICAL SYSTEMS
CAN PROVIDE.

263

00:10:19,100 --> 00:10:22,000

THEIR ORDERS OF THOUSANDS OF
ORDERS OF MAGNITUDE DIFFERENCE

264

00:10:22,000 --> 00:10:23,500

IN THE AMOUNT OF DATA
THAT WE CAN GET BACK.

265

00:10:23,500 --> 00:10:25,666

AND THAT DIRECTLY HELPS
OUR ASTRONAUTS,

266

00:10:25,666 --> 00:10:27,233

AND IT ALSO
HELPS OUR SCIENCE.

267

00:10:27,233 --> 00:10:29,566

WE WERE LIMITED IN THE NUMBER
OF SCIENCE OBSERVATIONS

268

00:10:29,566 --> 00:10:31,700

THAT WE COULD TAKE BY THE AMOUNT
THAT WE COULD TRANSMIT BACK.

269

00:10:31,700 --> 00:10:34,866

IF WE'D HAVE BEEN ABLE
TO USE THAT LASERCOMM SYSTEM

270

00:10:34,866 --> 00:10:36,133
FOR THE LIFE OF THE MISSION,

271
00:10:36,133 --> 00:10:37,966
WE'D HAVE BEEN ABLE TO RETURN
A LOT MORE DATA.

272
00:10:37,966 --> 00:10:41,066
AND THAT'S SOMETHING WE LOOK
FORWARD TO USING IN THE FUTURE.

273
00:10:41,066 --> 00:10:45,033
SO THAT'S A KIND OF A SUMMARY
OF THE SYSTEM ITSELF.

274
00:10:45,033 --> 00:10:47,600
THE SYSTEM WAS ABOUT 130--
OR ABOUT 300 KILOGRAMS,

275
00:10:47,600 --> 00:10:49,733
AND ABOUT 134 KILOGRAMS
OF PROPELLANT

276
00:10:49,733 --> 00:10:52,233
WHEN WE FINALLY
LAUNCHED IT.

277
00:10:52,233 --> 00:10:54,700
AND SO WE GET INTO, NOW,
BUTLER HINE,

278
00:10:54,700 --> 00:10:56,033
THE PROJECT MANAGER
FOR THE MISSION,

279
00:10:56,033 --> 00:10:57,466
CAME AND GAVE A TALK
LAST YEAR.

280
00:10:57,466 --> 00:10:59,766

THAT WAS JUST BEFORE WE'D
STARTED TO DO MOST OF THIS WORK,

281

00:10:59,766 --> 00:11:02,400
AND SHIPPED IT OFF TO WALLOPS
AND LAUNCHED IT.

282

00:11:02,400 --> 00:11:04,466
AS WE CAN SEE HERE, HERE'S THE
ROUTE THAT WE ACTUALLY TOOK

283

00:11:04,466 --> 00:11:07,533
WHEN WE WERE SHIPPING LADEE FROM
AMES RESEARCH CENTER

284

00:11:07,533 --> 00:11:09,000
OUT TO WALLOPS
FLIGHT FACILITY.

285

00:11:09,000 --> 00:11:11,700
WE STARTED OUT HERE AND WE
PACKED IT ONTO A NICE CONVOY.

286

00:11:11,700 --> 00:11:14,200
YOU CAN SEE WE HAVE A LARGE
TRUCK THERE IN THE CENTER,

287

00:11:14,200 --> 00:11:15,566
AND A LEAD CAR,
AND A FOLLOW CAR.

288

00:11:15,566 --> 00:11:17,033
AND WE HAD ABOUT FIVE OR SIX
OF THE PEOPLE

289

00:11:17,033 --> 00:11:19,000
FROM THE LADEE PROJECT ITSELF.

290

00:11:19,000 --> 00:11:21,133
WE HAD SOME PEOPLE

FROM AMES PROTECTIVE SERVICES.

291

00:11:21,133 --> 00:11:22,900

WE HAD Q.A. PEOPLE
TRAVELING WITH IT

292

00:11:22,900 --> 00:11:25,933

TO MAKE SURE THAT WHAT WAS GOING
ON WAS IN ACCORDANCE.

293

00:11:25,933 --> 00:11:28,366

AND WE ACTUALLY HAD A COUPLE
OF NICE PEOPLE THAT VOLUNTEERED

294

00:11:28,366 --> 00:11:31,866

FROM THE CENTER TO DRIVE ALONG
WITH THE VEHICLE ITSELF,

295

00:11:31,866 --> 00:11:34,033

JUST BECAUSE THE TEAM ITSELF
HAD A LOT OF OTHER WORK TO DO.

296

00:11:34,033 --> 00:11:36,000

I THINK YVONNE CAGLE
AND DANA LYNCH,

297

00:11:36,000 --> 00:11:38,500

AND MAYBE A FEW OTHERS
HAD MADE THE TRIP OUT WITH US.

298

00:11:38,500 --> 00:11:41,100

A LOT OF THE PEOPLE
THAT ACTUALLY MADE THAT TRIP

299

00:11:41,100 --> 00:11:42,766

WERE YOUNGER PEOPLE
WHO HAD BEEN ON THE PROJECT,

300

00:11:42,766 --> 00:11:44,833

BUT HAD BEEN WORKING REALLY HARD

AND DID IT THERE.

301

00:11:44,833 --> 00:11:48,133
SO ONE OF THE THINGS, ANOTHER
KEY NOTE THAT YOU'LL SEE

302

00:11:48,133 --> 00:11:49,633
IN GOING THROUGH THIS,

303

00:11:49,633 --> 00:11:52,866
IS THAT EVEN IF YOU'RE YOUNG
AND STARTING OUT

304

00:11:52,866 --> 00:11:55,133
IN A NEW ENTRY
TO THE AMES SYSTEM,

305

00:11:55,133 --> 00:11:58,000
YOU'RE GIVEN THE OPPORTUNITY
TO PROVE YOURSELF

306

00:11:58,000 --> 00:12:00,733
AND DO A LOT OF THINGS
THAT ACTUALLY MAKE MAJOR IMPACTS

307

00:12:00,733 --> 00:12:01,966
ON THESE PROJECTS.

308

00:12:01,966 --> 00:12:03,333
YOU DON'T HAVE TO WAIT
FOR 20 YEARS

309

00:12:03,333 --> 00:12:04,566
BEFORE YOU CAN DO SOMETHING

310

00:12:04,566 --> 00:12:06,000
THAT'S ACTUALLY GOING
TO FLY IN SPACE.

311

00:12:06,000 --> 00:12:08,233
YOU HAVE A CHANCE TO DO THAT
FROM COMING IN.

312
00:12:08,233 --> 00:12:11,166
AFTER WE'D GOTTEN THE SYSTEM
ALL PACKED UP AND READY TO GO,

313
00:12:11,166 --> 00:12:12,900
WE TOOK ONE LAST PICTURE.

314
00:12:12,900 --> 00:12:14,966
AND THIS WAS SEEN AS A VERY
AUSPICIOUS OMEN,

315
00:12:14,966 --> 00:12:17,300
BECAUSE YOU CAN SEE THERE
IN THE THING--

316
00:12:17,300 --> 00:12:20,233
TOP CENTER OF IT,
YOU CAN SEE THE MOON.

317
00:12:20,233 --> 00:12:21,666
AND THERE YOU CAN
SEE OUR DESTINATION

318
00:12:21,666 --> 00:12:23,066
RIGHT AS WE'RE STARTING OUT
OUR JOURNEY,

319
00:12:23,066 --> 00:12:24,433
AND SEE WHERE
WE'RE SHIPPING TO.

320
00:12:24,433 --> 00:12:26,733
AND THIS WAS SEEN AS A GREAT
OMEN FOR THE TRIP ITSELF.

321
00:12:26,733 --> 00:12:28,766

AND AS WE WERE
DRIVING ALONG,

322

00:12:28,766 --> 00:12:30,566

YOU CAN SEE THAT OUR
PHOTOGRAPHER ALONG THE WAY

323

00:12:30,566 --> 00:12:32,500

DECIDED WHERE WE WANTED
TO DOCUMENT THE TRIP.

324

00:12:32,500 --> 00:12:35,600

AND YOU CAN SEE US CROSSING OVER
INTO THE STATE OF ARIZONA THERE.

325

00:12:35,600 --> 00:12:37,533

I DIDN'T INCLUDE
A PICTURE OF IT,

326

00:12:37,533 --> 00:12:39,500

BUT, YOU KNOW, A FEW HOURS
AFTER STARTING OFF,

327

00:12:39,500 --> 00:12:41,066

OUR TEAM RAN INTO
A SMALL PROBLEM

328

00:12:41,066 --> 00:12:42,600

WHERE ONE OF OUR
AIR CONDITIONING UNITS

329

00:12:42,600 --> 00:12:44,300

STARTED THROWING UP
AN ERROR.

330

00:12:44,300 --> 00:12:47,133

AND THEY DIDN'T WANT TO CONTINUE
IF WE WEREN'T CONDITIONED,

331

00:12:47,133 --> 00:12:50,033

AND HAD CLEAN AIR AND COOL AIR
IN THE VEHICLE.

332

00:12:50,033 --> 00:12:52,866
SO WE ACTUALLY HAD TO STOP
AT DRYDEN FLIGHT FACILITY,

333

00:12:52,866 --> 00:12:56,100
AND TAKE--AND STOP
AND REPAIR THAT UNIT.

334

00:12:56,100 --> 00:12:57,366
LUCKILY, IT TURNED OUT
TO BE A WIRE

335

00:12:57,366 --> 00:12:58,666
THAT HAD KIND OF
VIBRATED LOOSE,

336

00:12:58,666 --> 00:13:00,500
AND THEY WERE ABLE TO REPAIR
THAT FAIRLY QUICKLY

337

00:13:00,500 --> 00:13:01,966
AND CONTINUE ON THEIR WAY.

338

00:13:01,966 --> 00:13:04,166
BUT IT SPEAKS TO THE CHALLENGES
THAT YOU SEE

339

00:13:04,166 --> 00:13:05,933
THAT YOU DIDN'T REALLY PLAN FOR
OR EXPECT.

340

00:13:05,933 --> 00:13:07,433
BUT ALL THE THINGS
THAT YOU HAVE TO KIND OF HAVE

341

00:13:07,433 --> 00:13:09,133
A CONTINGENCY PLAN

IN PLACE FOR.

342

00:13:09,133 --> 00:13:12,533
CONTINUING ON, YOU CAN SEE
THAT THE MOON IN THE BACKGROUND

343

00:13:12,533 --> 00:13:14,766
WITH LADEE TRAVELING
BECAME A FREQUENT FOCUS

344

00:13:14,766 --> 00:13:19,333
OF THE PICTURES THAT OUR
DOCUMENTER DECIDED TO FOCUS ON.

345

00:13:19,333 --> 00:13:23,133
THIS WAS AS WE WERE CROSSING
OVER FROM NEW MEXICO INTO TEXAS.

346

00:13:23,133 --> 00:13:25,000
AND THEN YOU CAN SEE HERE
THEM PULLING IN

347

00:13:25,000 --> 00:13:28,066
ON THEIR LAST--ON THEIR MIDWAY
STOP INTO AMARILLO, TEXAS.

348

00:13:28,066 --> 00:13:30,100
THAT WAS WHERE THE TEAM STOPPED
ABOUT HALFWAY THROUGH

349

00:13:30,100 --> 00:13:32,566
AND TOOK ABOUT A HALF A DAY
OR A DAY BREAK

350

00:13:32,566 --> 00:13:34,500
IN THE MIDDLE
OF THEIR DRIVING.

351

00:13:34,500 --> 00:13:37,066
AND, AGAIN, YOU CAN SEE

LADEE

352

00:13:37,066 --> 00:13:38,600
WITH THE MOON UP IN THE--

353

00:13:38,600 --> 00:13:41,233
I THINK OUR VIDEOGRAPHER
WAS BECOMING A BIT OF A LUNATIC

354

00:13:41,233 --> 00:13:42,733
AT THIS POINT.

355

00:13:42,733 --> 00:13:44,500
AND THAT'S THE LAST
REALLY HORRENDOUS PUN

356

00:13:44,500 --> 00:13:46,133
THAT YOU'LL GET FOR THE DAY.

357

00:13:46,133 --> 00:13:48,300
CONTINUING ON,
AFTER WE LEFT...

358

00:13:48,300 --> 00:13:49,500
I'LL GO BACK ONE.

359

00:13:49,500 --> 00:13:51,733
ONE OF THE ITEMS
THAT WE WERE CONCERNED ABOUT:

360

00:13:51,733 --> 00:13:53,766
AS WE WERE COMING
INTO AMARILLO, TEXAS,

361

00:13:53,766 --> 00:13:55,800
ABOUT FOUR OR FIVE DAYS
PRIOR THERE WAS A--

362

00:13:55,800 --> 00:13:57,766

A STRING OF VERY LARGE
TORNADOES

363

00:13:57,766 --> 00:13:59,600
THAT HAD PASSED THROUGH
OKLAHOMA CITY.

364

00:13:59,600 --> 00:14:01,833
SOME OF YOU MAY REMEMBER
FROM LAST YEAR.

365

00:14:01,833 --> 00:14:03,200
THERE WAS A LOT OF DESTRUCTION,

366

00:14:03,200 --> 00:14:04,566
THERE WAS A LOT OF PEOPLE
THAT HAD LOST HOUSES.

367

00:14:04,566 --> 00:14:06,633
A FEW PEOPLE LOST THEIR LIVES
AND WHATNOT.

368

00:14:06,633 --> 00:14:07,833
WE WERE CONCERNED
ABOUT IT,

369

00:14:07,833 --> 00:14:09,200
BUT BY THE TIME
THAT WE'D GOT THERE,

370

00:14:09,200 --> 00:14:11,500
THE CREWS HAD CLEANED UP
THE ROUTE ENOUGH

371

00:14:11,500 --> 00:14:12,966
THAT WE WERE ABLE
TO CONTINUE ON THROUGH.

372

00:14:12,966 --> 00:14:14,533
BUT I KNOW WE HAD TO CONSIDER

WHETHER WE WANTED

373

00:14:14,533 --> 00:14:16,933
TO HEAD NORTH INTO KANSAS
OR SOUTH INTO TEXAS,

374

00:14:16,933 --> 00:14:19,033
OR A FEW DIFFERENT THINGS
ALONG THOSE WAY.

375

00:14:19,033 --> 00:14:21,033
AND THE TEAM ITSELF
AND OUR PROTECTED SERVICES

376

00:14:21,033 --> 00:14:23,666
HAD TO SET UP A LOT OF DIFFERENT
WAYPOINTS OR WAY STATIONS,

377

00:14:23,666 --> 00:14:26,100
WHERE IF WE RAN
INTO INCLEMENT WEATHER

378

00:14:26,100 --> 00:14:27,333
OR SOMETHING LIKE THAT
ON THE WAY,

379

00:14:27,333 --> 00:14:29,066
WE COULD GET LADEE
INTO A RESTING SPACE

380

00:14:29,066 --> 00:14:30,500
WITHIN TWO OR THREE HOURS.

381

00:14:30,500 --> 00:14:32,900
SO THEY HAD TO DO A LOT OF WORK
IN PLANNING THAT ROUTE OUT.

382

00:14:32,900 --> 00:14:34,866
AND SEE HERE,
THE NEXT DAY

383

00:14:34,866 --> 00:14:36,866

THEY'RE STARTING TO PULL
INTO THE STATE OF VIRGINIA

384

00:14:36,866 --> 00:14:38,633

AS LIGHT CAME BACK UP AGAIN.

385

00:14:38,633 --> 00:14:40,533

I DON'T HAVE A LOT OF PICTURES
FROM THAT POINT.

386

00:14:40,533 --> 00:14:42,566

I THINK OUR VIDEOGRAPHER
BECAME TIRED AT THAT POINT.

387

00:14:42,566 --> 00:14:45,433

HE STOPPED DOCUMENTING QUITE
AS MANY PLACES THEY WENT TO.

388

00:14:45,433 --> 00:14:47,833

AND THEN ON THE FAR SIDE
OF VIRGINIA,

389

00:14:47,833 --> 00:14:49,566

YOU CAN SEE WE ACTUALLY
HAD TO GO THROUGH A TUNNEL.

390

00:14:49,566 --> 00:14:51,033

AND WE HAD TO DO
A LOT OF PLANNING

391

00:14:51,033 --> 00:14:53,200

TO MAKE SURE THAT LADEE ITSELF
AND THE TRUCK IT WAS IN

392

00:14:53,200 --> 00:14:54,400

WOULD FIT THROUGH A TUNNEL

393

00:14:54,400 --> 00:14:56,266
ON THE WAY
TO THE LAUNCH SITE ITSELF.

394
00:14:56,266 --> 00:14:58,566
AND THEN ON THE LAST
PICTURE THERE,

395
00:14:58,566 --> 00:15:01,433
YOU CAN SEE WE FINALLY ARRIVED
AT WALLOPS FLIGHT FACILITY

396
00:15:01,433 --> 00:15:03,900
ON A NICE,
SOMEWHAT CLOUDY DAY,

397
00:15:03,900 --> 00:15:05,033
BUT A VERY BEAUTIFUL DAY.

398
00:15:05,033 --> 00:15:06,500
AND LADEE WAS ABLE
TO MAKE THAT TRIP

399
00:15:06,500 --> 00:15:08,966
IN VERY GOOD TIME
AND WITH VERY GOOD WEATHER.

400
00:15:08,966 --> 00:15:10,500
WE WERE ACTUALLY VERY LUCKY
WITH THE WEATHER

401
00:15:10,500 --> 00:15:12,666
ALONG A LOT OF THE STOPS
ON THE MISSION.

402
00:15:12,666 --> 00:15:15,300
SO WHEN WE GOT TO WALLOPS
FLIGHT FACILITY,

403
00:15:15,300 --> 00:15:16,733

WE HAD A FEW THINGS
THAT WE HAD TO DO.

404

00:15:16,733 --> 00:15:18,766
AND ONE OF THEM IS WE HAD
TO SPIN BALANCE LADEE

405

00:15:18,766 --> 00:15:20,866
AND THIS WAS A--

406

00:15:20,866 --> 00:15:24,966
A TEST OR AN OPERATION THAT
WE WERE PRETTY NERVOUS ABOUT.

407

00:15:24,966 --> 00:15:26,600
AS YOU CAN SEE,
WE HAD TO PUT LADEE

408

00:15:26,600 --> 00:15:28,833
IN THE LARGE FACILITY,
GET EVERYONE OUT OF THERE

409

00:15:28,833 --> 00:15:31,266
AND MAKE CALCULATIONS ON HOW FAR
BACK FROM THE VEHICLE

410

00:15:31,266 --> 00:15:33,966
THEY NEEDED TO BE IN CASE
SOMETHING CAME OFF OF IT.

411

00:15:33,966 --> 00:15:36,866
MAKE SURE THAT EVERYONE WAS SAFE
IN OPERATIONS AND WORKING ON IT.

412

00:15:36,866 --> 00:15:40,233
THE REASON THAT WE HAD TO SPIN
BALANCE LADEE LIKE THIS

413

00:15:40,233 --> 00:15:42,200
IS THAT LADEE

WAS DESIGNED TO SPIN

414

00:15:42,200 --> 00:15:44,966
WHILE ITS--THE FIFTH STAGE
OF THE LAUNCH VEHICLE FIRED

415

00:15:44,966 --> 00:15:46,366
AND THRUSTED IT ON ITS WAY
TO THE MOON.

416

00:15:46,366 --> 00:15:49,133
AND SO WE HAD TO MAKE SURE
THAT IT WAS VERY WELL BALANCED.

417

00:15:49,133 --> 00:15:50,833
FOR OTHER OPERATIONS,
WE HAD TO MAKE SURE

418

00:15:50,833 --> 00:15:53,300
THAT THAT CENTRAL THRUSTER
THAT YOU SEE

419

00:15:53,300 --> 00:15:55,566
DOWN IN THE INTERSTAGE
ADAPTOR THERE

420

00:15:55,566 --> 00:15:58,500
WAS ALSO VERY WELL BALANCED
AND ALIGNED

421

00:15:58,500 --> 00:16:00,566
WITHIN ABOUT TWO HUNDREDTHS
OF AN INCH

422

00:16:00,566 --> 00:16:03,233
IN ORDER TO MAKE SURE THAT
WE COULD MEET THE REQUIREMENTS

423

00:16:03,233 --> 00:16:04,566
THAT WE HAD ON OPERATIONS.

424

00:16:04,566 --> 00:16:07,266
AND SO THIS TEST, THE TEAM
GOT IT UP ON THE VEHICLE,

425

00:16:07,266 --> 00:16:08,533
PUT SOME BALLAST ON IT.

426

00:16:08,533 --> 00:16:10,466
THEN YOU CAN SEE HERE
THEY CUT THE VIDEO IN HALF

427

00:16:10,466 --> 00:16:11,966
SO YOU DIDN'T HAVE
TO WATCH ALL OF IT.

428

00:16:11,966 --> 00:16:13,500
BUT IT GOT UP PRETTY FAST.

429

00:16:13,500 --> 00:16:14,833
THIS WAS ABOUT ON ORDER

430

00:16:14,833 --> 00:16:16,266
OF WHAT THE SPIN RATE
OF THE VEHICLE WAS

431

00:16:16,266 --> 00:16:17,533
WHILE IT WAS DOING
ITS MISSION.

432

00:16:17,533 --> 00:16:19,400
AND THAT CAUSED A LOT
OF CONSTERNATIONS

433

00:16:19,400 --> 00:16:22,300
AND DEEP BREATHS
AND FUN MOMENTS.

434

00:16:22,300 --> 00:16:24,400

AND WHEN WE FOUND THAT IT WAS
ABLE TO PASS THAT ALL,

435

00:16:24,400 --> 00:16:26,200

WE WERE ALL VERY HAPPY.

436

00:16:26,200 --> 00:16:28,233

ONE OF THE KEY TAKEAWAYS
THAT YOU CAN SEE FROM IT THERE

437

00:16:28,233 --> 00:16:30,533

YOU CAN SEE A VERY BLURRY
LADEE ALL AROUND,

438

00:16:30,533 --> 00:16:33,466

AND YOU CAN SEE OUR OCS,
THAT MAIN NOZZLE ON THE BOTTOM.

439

00:16:33,466 --> 00:16:35,800

VERY NICE, VERY STEADY.
YOU CAN SEE A PERFECT SHAPE.

440

00:16:35,800 --> 00:16:38,633

THEY WERE ABLE TO BALANCE
THAT NOZZLE OUT EXTREMELY WELL,

441

00:16:38,633 --> 00:16:40,033

AND THE SYSTEM ITSELF
PERFORMED

442

00:16:40,033 --> 00:16:42,200

OVER THE LIFE OF THE MISSION
EXTREMELY WELL.

443

00:16:42,200 --> 00:16:46,100

ANOTHER FUN ACTIVITY WAS THAT
THE TEAM DECIDED TO PRACTICE

444

00:16:46,100 --> 00:16:47,333

THEIR YMCA MOVES.

445

00:16:47,333 --> 00:16:50,500

WE HAVE A GREAT "Y" AND AN "M",
KIND OF A "C."

446

00:16:50,500 --> 00:16:51,800

IN ORDER TO FUEL
LADEE--

447

00:16:51,800 --> 00:16:53,733

LADEE USED
A BIPROPELLANT SYSTEM.

448

00:16:53,733 --> 00:16:57,033

THE PROPELLANTS ON IT WERE
TOXIC, THEY'RE CARCINOGENIC.

449

00:16:57,033 --> 00:16:58,366

THEY CAN CAUSE
BIRTH DEFECTS.

450

00:16:58,366 --> 00:17:01,133

SO IN ORDER TO USE THEM,
YOU HAVE TO BE TRAINED UP

451

00:17:01,133 --> 00:17:02,500

TO USE A SCAPE SUIT,

452

00:17:02,500 --> 00:17:05,166

BASICALLY A SPACE SUIT
WITHOUT SOME OF THE HARD WALLS

453

00:17:05,166 --> 00:17:06,666

AND RADIATION TOLERANTS
LIKE THAT.

454

00:17:06,666 --> 00:17:09,833

A LOT OF THE PEOPLE
THAT DID THIS WORK, TOO,

455

00:17:09,833 --> 00:17:12,800

WERE ALSO FAIRLY NEW TO THE
PROJECT, FAIRLY NEW TO AMES.

456

00:17:12,800 --> 00:17:14,533

YOU COULD ARGUE THAT WE WERE
SENDING THE INTERNS IN

457

00:17:14,533 --> 00:17:16,000

TO DO THE DANGEROUS WORK.

458

00:17:16,000 --> 00:17:19,200

I PREFER TO SAY THAT THESE
INDIVIDUALS DID EXCELLENT WORK

459

00:17:19,200 --> 00:17:21,433

THROUGHOUT THE MISSION,
AND REALLY WORKED HARD,

460

00:17:21,433 --> 00:17:22,833

AND PUT THEMSELVES
IN A POSITION

461

00:17:22,833 --> 00:17:24,666

WHERE THEY WERE ABLE
TO DIRECTLY CONTRIBUTE

462

00:17:24,666 --> 00:17:27,333

TO WHAT LADEE WAS ABLE
TO DO AS A SUCCESS.

463

00:17:27,333 --> 00:17:28,833

AGAIN, IF YOU COME HERE,

464

00:17:28,833 --> 00:17:32,066

WE'LL GIVE YOU THINGS THAT
YOU CAN DO RIGHT OFF THE START.

465

00:17:32,066 --> 00:17:34,300

AND THEN WE TRANSITION
INTO LAUNCH.

466

00:17:34,300 --> 00:17:36,533

ONCE WE HAD IT FUELED
AND ON THE STACK,

467

00:17:36,533 --> 00:17:38,200

WE WERE ABLE TO LAUNCH IT.

468

00:17:38,200 --> 00:17:40,366

IT LAUNCHED WITHIN ABOUT
THE FIRST TEN SECONDS

469

00:17:40,366 --> 00:17:42,000

OF ITS LAUNCH WINDOW
OPENING.

470

00:17:42,000 --> 00:17:44,266

WE HAD ALMOST PERFECT
WEATHER FOR THAT.

471

00:17:44,266 --> 00:17:45,633

WE WERE WORRIED
ABOUT HURRICANES,

472

00:17:45,633 --> 00:17:46,866

WE WERE WORRIED ABOUT
HIGH WINDS,

473

00:17:46,866 --> 00:17:48,900

WE WERE WORRIED
ABOUT CLOUDS AND THUNDERSTORMS.

474

00:17:48,900 --> 00:17:51,366

AND THE DAY OF, THE WEATHER
WAS ALMOST PERFECT.

475

00:17:51,366 --> 00:17:53,000

YOU CAN SEE A PHOTO

FROM OUR TEAM THERE

476

00:17:53,000 --> 00:17:56,300

FROM THE CHINCOTEAGUE AREA NEAR
THE WALLOPS FLIGHT FACILITY.

477

00:17:56,300 --> 00:17:58,166

IT WENT BEAUTIFULLY.

478

00:17:58,166 --> 00:17:59,800

YOU CAN SEE HERE A VIEW
FROM NEW YORK CITY.

479

00:17:59,800 --> 00:18:03,600

I BELIEVE THIS IS OFF
OF ROCKEFELLER CENTER.

480

00:18:03,600 --> 00:18:06,266

AND YOU CAN SEE THE CITY
THERE IN THE BACKGROUND.

481

00:18:06,266 --> 00:18:09,633

YOU KNOW, DR. WORDEN SAID
THAT HE WAS MILDLY PARANOID

482

00:18:09,633 --> 00:18:13,366

FOR SEVERAL DECADES
ABOUT EVER SEEING AN ICBM

483

00:18:13,366 --> 00:18:15,033

ON A TRAJECTORY
OVER THE EASTERN COAST,

484

00:18:15,033 --> 00:18:17,066

BUT THIS IS ONE THAT WE WERE
ALL HAPPY TO SEE.

485

00:18:17,066 --> 00:18:20,300

AND THEN ONE OF THE MORE
INTERESTING VIEWS YOU CAN SEE

486

00:18:20,300 --> 00:18:21,966
IS HERE FROM A SUBORBITAL
AMPHIBIAN.

487

00:18:21,966 --> 00:18:24,633
THE WALLOPS FLIGHT
FACILITY TEAM,

488

00:18:24,633 --> 00:18:26,233
IN REVIEWING
THE CAMERA FOOTAGE

489

00:18:26,233 --> 00:18:28,400
THAT THEY WERE ABLE TO PICK UP
FROM THE LAUNCH,

490

00:18:28,400 --> 00:18:29,966
WAS ABLE TO FIND OUT,
UNFORTUNATELY,

491

00:18:29,966 --> 00:18:32,933
THERE WAS A SMALL FROG
THAT WAS KIND OF PICKED UP

492

00:18:32,933 --> 00:18:34,500
IN A PLUME FROM
THE VEHICLE ITSELF.

493

00:18:34,500 --> 00:18:37,100
NOW, THE LAUNCH SITE TEAMS
DO A LOT OF WORK

494

00:18:37,100 --> 00:18:39,366
TO TRY TO SCARE ANIMALS AROUND
OUT OF THE WAY.

495

00:18:39,366 --> 00:18:40,633
THEY SET OFF SIRENS.

496

00:18:40,633 --> 00:18:42,366

THEY HAVE HAWKS
AND THINGS LIKE THAT

497

00:18:42,366 --> 00:18:44,166

THAT THEY TRY TO GET ANIMALS
OUT OF THE WAY,

498

00:18:44,166 --> 00:18:45,533

BUT THEY DON'T ALWAYS WORK.

499

00:18:45,533 --> 00:18:47,200

THIS IS JUST ONE OF THOSE
SERENDIPITOUS MOMENTS

500

00:18:47,200 --> 00:18:48,566

WHERE YOU SEE SOMETHING
THAT YOU COULD HAVE

501

00:18:48,566 --> 00:18:50,100

NEVER PLANNED OR INTENDED.

502

00:18:50,100 --> 00:18:53,466

AND WE NOW ALLOW THE FROG
TO JOIN SPACE BAT

503

00:18:53,466 --> 00:18:56,566

IN OUR LIST OF UNINTENTIONAL
ASTRONAUTS.

504

00:18:56,566 --> 00:18:58,266

LADEE'S JOURNEY
TO THE MOON.

505

00:18:58,266 --> 00:18:59,566

YOU CAN SEE HERE
AFTER OUR LAUNCH,

506

00:18:59,566 --> 00:19:03,033

WE HAD A PLAN THAT TOOK US OUT
ON THREE PHASING LOOPS.

507

00:19:03,033 --> 00:19:04,900
AND ON EACH OF THOSE LOOPS,

508

00:19:04,900 --> 00:19:07,566
WE HAD TO PLAN
FOR UP TO TWO BURNS PER LOOP.

509

00:19:07,566 --> 00:19:11,466
WE WERE WORRIED THAT THE SOLID
VEHICLE, THE MINOTAUR V,

510

00:19:11,466 --> 00:19:13,000
SINCE IT WAS
THE FIRST FLIGHT,

511

00:19:13,000 --> 00:19:14,366
WE WEREN'T SURE
EXACTLY HOW WELL

512

00:19:14,366 --> 00:19:15,800
THAT THAT WOULD INJECT US
INTO ORBIT.

513

00:19:15,800 --> 00:19:17,800
TURNED OUT THAT IT WAS
ALMOST PERFECT.

514

00:19:17,800 --> 00:19:20,200
OUR ORBIT DETERMINATION
LAUNCH TEAM SAID

515

00:19:20,200 --> 00:19:22,633
STATISTICALLY PERFECT IS WHAT
THE LAUNCH HAD PROVIDED FOR US.

516

00:19:22,633 --> 00:19:24,600
SO WE WERE ABLE TO CANCEL

MOST OF THE ACTUAL MANEUVERS

517

00:19:24,600 --> 00:19:26,300
THAT WE HAD PLANNED.

518

00:19:26,300 --> 00:19:28,000
THE ONE CHALLENGING THING
ABOUT ALL OF THIS, THOUGH,

519

00:19:28,000 --> 00:19:29,566
IS YOU CAN SEE
THE DATES THERE.

520

00:19:29,566 --> 00:19:31,933
9/13, 9/21.

521

00:19:31,933 --> 00:19:34,433
THOSE WERE ALL DURING THE
GOVERNMENT SHUT-DOWN LAST YEAR.

522

00:19:34,433 --> 00:19:37,033
LADEE'S FLIGHT OPERATIONS TEAM
WAS DETERMINED

523

00:19:37,033 --> 00:19:39,066
TO BE A MISSION-CRITICAL CREW.

524

00:19:39,066 --> 00:19:41,566
SO WE GOT TO COME IN
AND GUIDE THE VEHICLE,

525

00:19:41,566 --> 00:19:43,866
AND WATCH THE VEHICLE
AS IT WAS DOING THESE STEPS.

526

00:19:43,866 --> 00:19:45,800
BUT WE GOT TO COME
INTO A GHOST CENTER.

527

00:19:45,800 --> 00:19:47,133

THERE WAS ALMOST
NO ONE HERE.

528

00:19:47,133 --> 00:19:49,866

IT WAS LIKE COMING INTO A ZOMBIE
MOVIE ON THE WEEKENDS,

529

00:19:49,866 --> 00:19:51,800

AND SEEING NO ONE AROUND.

530

00:19:51,800 --> 00:19:53,200

BUT WHILE WE WERE ABLE
TO DO THAT,

531

00:19:53,200 --> 00:19:56,033

WE WERE ABLE TO EXECUTE
THE FOUR BURNS

532

00:19:56,033 --> 00:19:59,500

THAT PUT US INTO A NICE
TRAJECTORY TO THE MOON.

533

00:19:59,500 --> 00:20:01,400

AND THEN LUNAR ORBIT
INSERTION WAS--

534

00:20:01,400 --> 00:20:04,766

THE FIRST BURN WAS PERFORMED
ON OCTOBER 6th OF LAST YEAR.

535

00:20:04,766 --> 00:20:06,966

YOU CAN SEE A SUMMARY
OF THE BURNS

536

00:20:06,966 --> 00:20:08,400

DOWN THERE
IN THE LOWER RIGHT,

537

00:20:08,400 --> 00:20:10,833

BUT YOU CAN SEE THE PERFORMANCE
ERROR ON NEARLY ALL OF THOSE

538

00:20:10,833 --> 00:20:12,233
WAS LESS THAN A PERCENT.

539

00:20:12,233 --> 00:20:14,133
THE LADEE PROPULSION SYSTEM
WORKED VERY WELL

540

00:20:14,133 --> 00:20:18,300
DUE TO THE SPIN BALANCING AND
THE STRUCTURAL DESIGN EFFORTS

541

00:20:18,300 --> 00:20:19,733
THAT OUR TEAM WENT THROUGH.

542

00:20:19,733 --> 00:20:23,233
THERE WERE A LOT OF QUESTIONS
ABOUT THE LADEE ORBIT,

543

00:20:23,233 --> 00:20:25,000
AND WHY IT TOOK US
AS MUCH EFFORT

544

00:20:25,000 --> 00:20:26,366
AS IT'S TOOK
TO PUT ON IT.

545

00:20:26,366 --> 00:20:28,833
THIS MODEL IS A MODEL
OF THE LUNAR GRAVITY FIELD

546

00:20:28,833 --> 00:20:30,333
THAT CAME OFF
OF THE GRAIL MISSION.

547

00:20:30,333 --> 00:20:32,666
YOU CAN SEE HERE, THEY'RE
SHOWING THE RELATIVE INFLUENCE

548

00:20:32,666 --> 00:20:33,933

FROM ONE SIDE OF THE MOON
TO THE OTHER.

549

00:20:33,933 --> 00:20:36,733

AND YOU CAN SEE
MASS CONCENTRATIONS.

550

00:20:36,733 --> 00:20:38,700

ON THE NEAR SIDE
OF THE MOON,

551

00:20:38,700 --> 00:20:40,533

YOU CAN SEE THAT THERE'S
NOT A WHOLE LOT.

552

00:20:40,533 --> 00:20:41,900

IT LOOKS LIKE
IT'S PRETTY MILD.

553

00:20:41,900 --> 00:20:43,166

AND ON THE FAR SIDE,
YOU CAN SEE

554

00:20:43,166 --> 00:20:45,433

SOME PRETTY BIG
MASS CONCENTRATIONS.

555

00:20:45,433 --> 00:20:46,866

AND YOU CAN SEE THAT
THEY'RE ACTUALLY PRETTY SPOTTY.

556

00:20:46,866 --> 00:20:48,133

NORTH VERSUS SOUTH.

557

00:20:48,133 --> 00:20:50,233

LADEE ITSELF
WAS IN AN EQUATORIAL ORBIT.

558

00:20:50,233 --> 00:20:53,933

A LOT OF THE POLAR ORBITS
ARE ABLE TO GET AWAY

559

00:20:53,933 --> 00:20:56,233

FROM SOME OF THESE
MASS CONCENTRATIONS.

560

00:20:56,233 --> 00:20:58,133

BUT LADEE'S ORBIT
WAS PERTURBED HIGHLY.

561

00:20:58,133 --> 00:21:00,233

YOU CAN SEE A GRAPHIC
OF BASICALLY WHAT IT DOES HERE.

562

00:21:00,233 --> 00:21:01,800

AS LADEE
WAS TRAVELING AROUND,

563

00:21:01,800 --> 00:21:04,266

THOSE MASS CONCENTRATIONS
ON ONE SIDE OF THE MOON

564

00:21:04,266 --> 00:21:06,266

WOULD ESSENTIALLY
PULL OUR PERIGEE,

565

00:21:06,266 --> 00:21:08,233

OR PERIAPSE,
IN CLOSER,

566

00:21:08,233 --> 00:21:10,566

AND PUSH THE APOAPSE A LITTLE
BIT FARTHER FROM THE MOON.

567

00:21:10,566 --> 00:21:12,800

AND SO,
AS THE MISSION EVOLVED,

568

00:21:12,800 --> 00:21:15,200

WE WERE FORCED TO CONSTANTLY
PERFORM MANEUVERS

569

00:21:15,200 --> 00:21:17,900

TO CORRECT OUR ORBIT.

570

00:21:17,900 --> 00:21:19,633

PREVENT OURSELVES FROM RUNNING
INTO THE MOON,

571

00:21:19,633 --> 00:21:22,133

AND PREVENT OURSELVES
FROM DRIFTING TOO FAR AWAY

572

00:21:22,133 --> 00:21:24,366

TO COLLECT USEFUL SCIENCE
FROM OUR INSTRUMENTS.

573

00:21:24,366 --> 00:21:26,800

AND THEN YOU CAN SEE,
DOWN THERE AT THE END,

574

00:21:26,800 --> 00:21:28,233

THAT RELOCATED MARGIN,

575

00:21:28,233 --> 00:21:31,266

THAT WAS TIME THAT WE WERE ABLE
TO PUT INTO SCIENCE OPERATIONS

576

00:21:31,266 --> 00:21:32,666

THAT WE WEREN'T
ORIGINALLY BOOKING.

577

00:21:32,666 --> 00:21:35,366

AND THAT WAS DUE TO
THE NEAR-PERFECT PERFORMANCE

578

00:21:35,366 --> 00:21:37,000

THAT WE HAD FROM
OUR LAUNCH VEHICLE

579

00:21:37,000 --> 00:21:39,133
AND FROM OUR PROPULSION SYSTEM
DURING THOSE BURNS.

580

00:21:39,133 --> 00:21:40,733
WE WERE ABLE TO USE
THE EXTRA MARGIN WE HAD

581

00:21:40,733 --> 00:21:43,333
TO RETURN MORE SCIENCE.

582

00:21:43,333 --> 00:21:45,966
SOME OF THE SCIENCE MEASUREMENTS
WE DID--I'LL GET INTO THESE.

583

00:21:45,966 --> 00:21:47,233
LADEE ARGON MEASUREMENTS.

584

00:21:47,233 --> 00:21:49,933
THESE WERE RETURNED
BY THE NMS INSTRUMENT.

585

00:21:49,933 --> 00:21:53,200
APOLLO 17 DETERMINED
A LOT OF ARGON AROUND THE MOON.

586

00:21:53,200 --> 00:21:55,733
AND IT WAS NOT DETECTED BY THE
LUNAR RECONNAISSANCE ORBITER.

587

00:21:55,733 --> 00:21:57,400
THE LUNAR RECON ORBITER
WAS A LOT HIGHER UP

588

00:21:57,400 --> 00:21:59,333
THAN THE APOLLO 17 WERE.

589

00:21:59,333 --> 00:22:01,333

BUT ONE OF THE QUESTIONS
WAS WHETHER THAT ARGON

590

00:22:01,333 --> 00:22:02,633

WAS REALLY THERE,

591

00:22:02,633 --> 00:22:04,100

WHETHER IT WAS BEING BROUGHT IN
FROM SOMEWHERE ELSE,

592

00:22:04,100 --> 00:22:05,533

OR WHAT WAS GOING ON.

593

00:22:05,533 --> 00:22:07,633

YOU CAN SEE KIND OF A SCHEMATIC
DOWN IN THE BOTTOM LEFT-HAND

594

00:22:07,633 --> 00:22:10,300

ABOUT WHAT THE BEHAVIOR OF
THE ARGON WAS AROUND THE MOON.

595

00:22:10,300 --> 00:22:14,100

WHEN IT WAS HOT, YOU COULD SEE
THOSE ARGON MOLECULES

596

00:22:14,100 --> 00:22:16,700

PICKING UP A LOT OF ENERGY
FROM THE SUN.

597

00:22:16,700 --> 00:22:18,700

THE SOLAR ENERGY INCIDENT ON IT.

598

00:22:18,700 --> 00:22:21,733

AND BEING ABLE TO LOFT
THEMSELVES UP FAIRLY HIGH,

599

00:22:21,733 --> 00:22:23,733

TENS OF KILOMETERS

OFF THE LUNAR SURFACE.

600

00:22:23,733 --> 00:22:26,600

AND THEN WHEN THEY CAME DOWN
OVER THE DARK SIDE OF THE MOON,

601

00:22:26,600 --> 00:22:29,300

THEY COOLED OFF FAIRLY RAPIDLY
AND BOUNCED MUCH LOWER,

602

00:22:29,300 --> 00:22:31,066

AND BASICALLY STUCK
TO THE SURFACE.

603

00:22:31,066 --> 00:22:34,566

AND THEN WHEN THEY GOT BACK HOT,
THEY WOULD POP BACK UP AGAIN.

604

00:22:34,566 --> 00:22:36,766

AND SO YOU CAN SEE THAT
POINTED OUT

605

00:22:36,766 --> 00:22:39,433

IN THE GRAPHICS
ON THE RIGHT

606

00:22:39,433 --> 00:22:42,000

FROM THE NMS TEAM,
SHOWING WHERE THEY MEASURED

607

00:22:42,000 --> 00:22:43,900

THE HIGHEST CONCENTRATIONS
OF ARGON.

608

00:22:43,900 --> 00:22:45,966

THERE WAS A FAIRLY LARGE
QUESTION

609

00:22:45,966 --> 00:22:47,500

AT THE START OF THE MISSION

610

00:22:47,500 --> 00:22:50,666

ABOUT WHETHER THIS ARGON
WOULD BE FOUND IN ONE PLACE,

611

00:22:50,666 --> 00:22:52,433

OR WHETHER IT WOULD DIFFUSE
ALL AROUND THE MOON OR NOT.

612

00:22:52,433 --> 00:22:55,033

IF THIS DIFFUSION ACTION
WAS FAIRLY FAST,

613

00:22:55,033 --> 00:22:56,633

THEN WE WOULD EXPECT
TO SEE ARGON

614

00:22:56,633 --> 00:22:58,100

PRETTY MUCH CONSTANTLY
AROUND THE MOON,

615

00:22:58,100 --> 00:23:00,333

AND JUST WHETHER IT WAS HOT
OR WHETHER IT WAS COLD

616

00:23:00,333 --> 00:23:01,833

YOU'D SEE MORE OR LESS.

617

00:23:01,833 --> 00:23:04,433

HOWEVER, WE KNOW THAT THERE
IS SOME ARGON 40 BEING GENERATED

618

00:23:04,433 --> 00:23:06,800

AS A RESULT OF THE RADIOACTIVE
DECAY OF POTASSIUM 40

619

00:23:06,800 --> 00:23:08,166

THAT'S IN THE LUNAR CRUST.

620

00:23:08,166 --> 00:23:10,200
AND IF THAT GENERATION
MECHANISM

621
00:23:10,200 --> 00:23:12,200
IS FASTER THAN
THE DIFFUSION MECHANISM,

622
00:23:12,200 --> 00:23:13,633
WE MIGHT BE ABLE
TO FIND SOMETHING

623
00:23:13,633 --> 00:23:16,366
THAT THERE WAS CONCENTRATED
ARGON AROUND THE LUNAR SURFACE.

624
00:23:16,366 --> 00:23:18,200
AND WHAT THEY ACTUALLY
DID FIND WAS

625
00:23:18,200 --> 00:23:19,733
THERE IS A FAIRLY HIGH
CONCENTRATION

626
00:23:19,733 --> 00:23:21,166
ON THE LUNAR SURFACE.

627
00:23:21,166 --> 00:23:22,566
IT'S AROUND MINUS-50 DEGREES
LATITUDE.

628
00:23:22,566 --> 00:23:24,866
IT'S AROUND AN AREA
CALLED ARISTARCHUS.

629
00:23:24,866 --> 00:23:27,666
AND THERE ARE SOME PEOPLE
WORKING VERY HARD

630
00:23:27,666 --> 00:23:29,333

TO TRY TO FIGURE OUT
WHY THIS IS.

631

00:23:29,333 --> 00:23:31,533
ABOUT ALL THAT OUR MISSION
SCIENTISTS WILL TELL US

632

00:23:31,533 --> 00:23:34,766
ABOUT THIS AT THE MOMENT IS THAT
THIS LOCATION IS SPECIAL.

633

00:23:34,766 --> 00:23:36,300
WE'RE NOT EXACTLY SURE WHY.

634

00:23:36,300 --> 00:23:38,033
WE THINK THAT IT HAS
SOMETHING TO DO

635

00:23:38,033 --> 00:23:39,333
WITH HOW THE MOON ITSELF
WAS FORMED,

636

00:23:39,333 --> 00:23:41,133
HOW PLANETOLOGY,
HOW THE PLANETS ARE EVOLVING,

637

00:23:41,133 --> 00:23:43,800
BUT THEY HAVEN'T BEEN ABLE
TO FULLY EXPLAIN THAT YET.

638

00:23:43,800 --> 00:23:46,000
THAT'S SOMETHING
THAT'S STILL ONGOING.

639

00:23:46,000 --> 00:23:47,300
MOVING ON TO SOME OF OUR
OTHER INSTRUMENTS.

640

00:23:47,300 --> 00:23:48,833
THIS IS--I'LL TALK

A LITTLE BIT MORE

641

00:23:48,833 --> 00:23:50,033

ABOUT SOME
OF THE OPERATIONS.

642

00:23:50,033 --> 00:23:52,000

THIS INSTRUMENT, UVS,
WAS A LITTLE BIT MORE

643

00:23:52,000 --> 00:23:53,633

OPERATIONALLY INTENSIVE.

644

00:23:53,633 --> 00:23:56,266

THEY HAD TO PUT TOGETHER
A LOT OF DIFFERENT PROFILES

645

00:23:56,266 --> 00:23:57,700

ABOUT HOW WE USE
THEIR INSTRUMENTS

646

00:23:57,700 --> 00:23:59,700

SO THAT THEY COULD GET
GOOD DATA OFF OF IT.

647

00:23:59,700 --> 00:24:02,633

THERE'S A COUPLE OF IMAGES HERE
THAT TALK ABOUT

648

00:24:02,633 --> 00:24:04,166

HOW DATA WAS RETURNED.

649

00:24:04,166 --> 00:24:06,933

IN THIS CASE, AS WE WERE COMING
BACK FROM BEHIND THE MOON,

650

00:24:06,933 --> 00:24:08,133

IN THE DARK-LIT PORTION,

651

00:24:08,133 --> 00:24:09,500

THEY WOULD TURN ON
THEIR INSTRUMENT

652

00:24:09,500 --> 00:24:12,166

AND TAKE READINGS FROM THE DARK
PORTION OF THE MOON.

653

00:24:12,166 --> 00:24:13,866

AND THEN, AS THEY WERE
APPROACHING THE TERMINATOR,

654

00:24:13,866 --> 00:24:17,033

YOU CAN SEE THE FAINT GLOW
FROM THE SUN APPROACHING.

655

00:24:17,033 --> 00:24:20,100

YOU COULD START SEEING
THE ACTUAL DUST PARTICLES

656

00:24:20,100 --> 00:24:22,333

IN THE ATMOSPHERE GETTING HOT
AND EMITTING DATA.

657

00:24:22,333 --> 00:24:24,733

AND SO THEY WERE ABLE
TO THEN USE THAT

658

00:24:24,733 --> 00:24:27,033

TO TURN IT INTO THE DATA
PRODUCTS ON THE RIGHT.

659

00:24:27,033 --> 00:24:29,366

YOU CAN SEE SOME OF THE ROUGH
DATA PRODUCTS ON THE TOP RIGHT.

660

00:24:29,366 --> 00:24:32,033

AND IN THE BOTTOM RIGHT, YOU CAN
SEE THE PROCESS DATA PRODUCTS.

661

00:24:32,033 --> 00:24:33,366
AND SO THEY'LL TAKE
DIFFERENCES

662
00:24:33,366 --> 00:24:34,866
BETWEEN THE DIFFERENT
MEASUREMENTS

663
00:24:34,866 --> 00:24:36,066
AND THE DIFFERENT
POINTS IN TIME,

664
00:24:36,066 --> 00:24:37,866
AND THEY'LL BE ABLE TO,
IN THIS CASE,

665
00:24:37,866 --> 00:24:41,100
POINT OUT THAT THEY'RE SEEING
A LARGE AMOUNT OF SODIUM

666
00:24:41,100 --> 00:24:42,300
AT THIS MEASUREMENT.

667
00:24:42,300 --> 00:24:43,600
AND THEY'LL BE ABLE
TO USE THOSE

668
00:24:43,600 --> 00:24:45,233
TO DETERMINE WHAT
THE CONSTITUENTS

669
00:24:45,233 --> 00:24:47,400
AND THE RELATIVE ABUNDANCE
OF THOSE CONSTITUENTS

670
00:24:47,400 --> 00:24:48,933
IN THE ATMOSPHERE ARE.

671
00:24:48,933 --> 00:24:51,433
UVS ITSELF ACTUALLY

HAD SEVERAL OPERATING MODES.

672

00:24:51,433 --> 00:24:53,166

I DON'T HAVE TIME TO GO
INTO ALL OF THEM HERE,

673

00:24:53,166 --> 00:24:55,266

BUT A LOT OF THEM LOOKED AT
HOW THE DUST

674

00:24:55,266 --> 00:24:57,833

ATTENUATED THE ATMOSPHERE
AS THE SUN WAS DROPPING DOWN

675

00:24:57,833 --> 00:24:59,266

TOWARD OUR HORIZON,

676

00:24:59,266 --> 00:25:03,033

OR HOW IT MIGHT BE SCATTERED
BY THE DUST IN THE ATMOSPHERE.

677

00:25:03,033 --> 00:25:04,233

BUT WHAT THEY WERE
ABLE TO DO

678

00:25:04,233 --> 00:25:06,100

IS MAP OUT A LOT OF SODIUM
IN THE ATMOSPHERE.

679

00:25:06,100 --> 00:25:07,900

THEY WERE ABLE
TO DETERMINE,

680

00:25:07,900 --> 00:25:09,433

AS YOU CAN SEE
FROM THE BOTTOM RIGHT,

681

00:25:09,433 --> 00:25:11,266

THAT SODIUM VARIES A LOT
WITH LUNAR PHASE.

682

00:25:11,266 --> 00:25:13,000

IT INCREASES
TOWARD FULL MOON,

683

00:25:13,000 --> 00:25:17,166

BUT THEN AS THE MOON ENTERS
THE EARTH'S MAGNETOTAIL,

684

00:25:17,166 --> 00:25:19,966

SODIUM PRODUCTION
DROPS OFF DRASTICALLY.

685

00:25:19,966 --> 00:25:21,233

AND THEY HAVEN'T BEEN ABLE
TO EXPLAIN THAT YET.

686

00:25:21,233 --> 00:25:22,700

THE TEAM IS STILL
WORKING ON THAT.

687

00:25:22,700 --> 00:25:25,066

THEY'RE STILL DOING ANALYSIS.
AND THERE ARE IDEAS OF IT.

688

00:25:25,066 --> 00:25:29,733

THERE ARE SOME VARIATIONS
THAT SUGGEST THAT OTHER THINGS,

689

00:25:29,733 --> 00:25:31,333

SUCH AS MICROMETEORITES,

690

00:25:31,333 --> 00:25:33,633

OR THINGS LIKE THAT
MIGHT BE INFLUENCING THOSE.

691

00:25:33,633 --> 00:25:35,466

BUT THE EXPLANATIONS

692

00:25:35,466 --> 00:25:38,300
FOR WHY THEY'RE SEEING THAT
CHANGE IN SODIUM ABUNDANCE

693
00:25:38,300 --> 00:25:39,700
WILL HELP CONSTRAIN
WHAT WE'RE SEEING

694
00:25:39,700 --> 00:25:41,700
IN OTHER ATMOSPHERIC--
OR OTHER PLANETARY BODIES

695
00:25:41,700 --> 00:25:44,800
AROUND THE SOLAR SYSTEM.

696
00:25:44,800 --> 00:25:47,366
OTHER ITEMS CHARACTERIZING
LUNAR DUST.

697
00:25:47,366 --> 00:25:49,400
YOU CAN SEE HERE SOME OF
THE MEASUREMENTS FROM LDEX.

698
00:25:49,400 --> 00:25:51,900
THEY RECORDED OVER 11,000
IMPACTS OVER THE MISSION.

699
00:25:51,900 --> 00:25:53,266
THEY WERE ABLE TO DETERMINE

700
00:25:53,266 --> 00:25:54,633
THAT THERE IS A FAIRLY LARGE
DUST CLOUD,

701
00:25:54,633 --> 00:25:57,533
OR FAIRLY SUBSTANTIAL DUST CLOUD
THAT'S SUSTAINED

702
00:25:57,533 --> 00:26:00,333
BY A BOMBARDMENT

FROM INTERPLANETARY PARTICLES.

703

00:26:00,333 --> 00:26:01,800

AND, INTERESTINGLY,
YOU CAN SEE

704

00:26:01,800 --> 00:26:05,733

THAT THAT'S NOT ACTUALLY
TOWARD THE DAYLIGHT TERMINATOR.

705

00:26:05,733 --> 00:26:09,933

THE TEAM ITSELF IS WORKING ON
FINDING OUT WHY THEY DETERMINE--

706

00:26:09,933 --> 00:26:12,100

OR DETECT IT MORE
AT THAT ANGLE.

707

00:26:12,100 --> 00:26:13,833

IT'S PROBABLY ABOUT 10 TO 15
DEGREES OFF

708

00:26:13,833 --> 00:26:15,833

FROM THE TERMINATOR ITSELF.

709

00:26:15,833 --> 00:26:17,400

THEY DON'T HAVE AN EXPLANATION
FOR IT YET.

710

00:26:17,400 --> 00:26:20,233

THAT'S STILL COMING UP.

711

00:26:20,233 --> 00:26:21,833

MOVING ON TO A FEW
OTHER THINGS.

712

00:26:21,833 --> 00:26:26,200

THE ORBIT DETERMINATION TEAM
WAS ABLE TO WORK EXTREMELY WELL

713

00:26:26,200 --> 00:26:27,766

WITH THE DATA THEY WERE
RECEIVING OFF THE MISSION.

714

00:26:27,766 --> 00:26:31,066

AT SOME POINT WE WERE ABLE
TO COORDINATE OURSELVES

715

00:26:31,066 --> 00:26:33,000

WITH THE LUNAR RECONNAISSANCE
ORBITER.

716

00:26:33,000 --> 00:26:36,366

WE WERE MOVING AT NEARLY
2.2 KILOMETERS A SECOND,

717

00:26:36,366 --> 00:26:37,933

RELATIVE DELTA VELOCITY.

718

00:26:37,933 --> 00:26:40,500

IT'S REALLY FAST, REALLY HARD
TO TAKE PICTURES OF THAT.

719

00:26:40,500 --> 00:26:42,600

BUT WE WERE ABLE
TO GIVE THEM AN EPHEMERIS,

720

00:26:42,600 --> 00:26:45,433

OR AN ESTIMATE OF WHAT OUR
POSITION WOULD BE AT SOME POINT.

721

00:26:45,433 --> 00:26:48,400

THEY POINTED THEIR L.R.--
THEIR MAIN LROC CAMERA AT IT

722

00:26:48,400 --> 00:26:50,233

AND TOOK A PICTURE,
AND WHAT YOU CAN SEE THERE--

723

00:26:50,233 --> 00:26:52,866

THERE'S THE SOMEWHAT
PROCESSED IMAGE.

724

00:26:52,866 --> 00:26:56,000

AND YOU CAN SEE WHAT THE VEHICLE
ITSELF LINED UP AFTERWARDS.

725

00:26:56,000 --> 00:26:59,000

OUR TEAM WAS ABLE TO DETERMINE
OUR POSITION FAIRLY ACCURATELY

726

00:26:59,000 --> 00:27:01,200

OVER THE ENTIRE DURATION
OF THE MISSION.

727

00:27:01,200 --> 00:27:02,833

STAR TRACKER IMAGES.

728

00:27:02,833 --> 00:27:05,000

WE WERE ABLE TO USE
OUR STAR TRACKERS AS CAMERAS

729

00:27:05,000 --> 00:27:07,366

LATER IN THE MISSION, ONCE WE
DID SOME SOFTWARE CHANGES.

730

00:27:07,366 --> 00:27:08,966

WE WERE ABLE TO PULL THINGS
OFF OF THEM.

731

00:27:08,966 --> 00:27:11,966

YOU CAN SEE, THIS IS A SEQUENCE
WHERE WE TURNED ON THE CAMERA

732

00:27:11,966 --> 00:27:13,666

AND STARTED TAKING IMAGES
AS WE WERE TRAVELING

733

00:27:13,666 --> 00:27:15,366

OVER THE LUNAR SURFACE ITSELF.

734

00:27:15,366 --> 00:27:18,100
AND THE CAMERA IMAGES,
WHILE NOT WONDERFUL,

735

00:27:18,100 --> 00:27:21,700
WERE STILL GOOD ENOUGH
FOR US TO BE ABLE TO DETERMINE

736

00:27:21,700 --> 00:27:23,300
A LOT OF THE DIFFERENT FEATURES

737

00:27:23,300 --> 00:27:24,800
THAT WE WERE SEEING
ON THE SURFACE.

738

00:27:24,800 --> 00:27:27,033
DIFFERENT CRATERS,
DIFFERENT MOUNTAINS,

739

00:27:27,033 --> 00:27:29,666
DIFFERENT RANGES
ON THE MOON THEMSELVES.

740

00:27:29,666 --> 00:27:31,600
AND YOU CAN SEE HERE,
HERE'S AN ANIMATION.

741

00:27:31,600 --> 00:27:35,366
YOU CAN SEE THE PLEIADES
RUNNING PAST ON ONE SIDE.

742

00:27:35,366 --> 00:27:37,366
AND ON THE OTHER SIDE,

743

00:27:37,366 --> 00:27:40,333
A COLLECTION FROM A DIFFERENT
POINT IN TIME.

744
00:27:40,333 --> 00:27:42,233
YOU CAN SEE
RIGHT AS WE WERE COMING

745
00:27:42,233 --> 00:27:43,933
TOWARD THE DAYLIGHT
TERMINATOR,

746
00:27:43,933 --> 00:27:46,900
THE CAMERAS THEMSELVES
START TRYING TO ADJUST

747
00:27:46,900 --> 00:27:49,333
THEIR AUTOMATIC GAIN SETTINGS
TO DEAL WITH THE INCREASED LIGHT

748
00:27:49,333 --> 00:27:50,700
COMING FROM THE SUN.

749
00:27:50,700 --> 00:27:52,200
AND THERE YOU CAN SEE
THAT THE FRAME RATE

750
00:27:52,200 --> 00:27:54,800
SLOWS DOWN SIGNIFICANTLY
AS THEY WERE DOING THAT.

751
00:27:54,800 --> 00:27:57,133
BUT WE WERE ABLE TO GET
PRETTY GOOD DATA OFF OF THOSE

752
00:27:57,133 --> 00:27:58,466
OVER THE COURSE
OF THE MISSION.

753
00:27:58,466 --> 00:28:00,600
THAT WAS ONE ENGINEERING PRODUCT
THAT WE PUT TOGETHER

754

00:28:00,600 --> 00:28:02,133
THAT WE DIDN'T EXPECT TO
AT FIRST.

755
00:28:02,133 --> 00:28:04,833
MOVING INTO SOME OF LADEE'S LAST
DAYS,

756
00:28:04,833 --> 00:28:07,466
YOU CAN SEE HERE WAS OUR
PREDICTION FOR ALTITUDE

757
00:28:07,466 --> 00:28:08,933
OVER THE END
OF THE MISSION.

758
00:28:08,933 --> 00:28:11,866
USING SOME OF THAT EXTRA
PROPELLANT THAT WE HAD,

759
00:28:11,866 --> 00:28:14,300
WE DECIDED TO GO FOR SOME
REALLY HIGH-PRIORITY,

760
00:28:14,300 --> 00:28:15,766
LOW-ALTITUDE SCIENCE.

761
00:28:15,766 --> 00:28:18,500
FOR MOST OF THE MISSION,
LADEE'S PERIAPSE

762
00:28:18,500 --> 00:28:21,400
WAS DOWN AT THE 35
TO 40 KILOMETER TYPE OF RANGE.

763
00:28:21,400 --> 00:28:23,133
AND FOR THIS LAST PORTION
OF THE MISSION,

764
00:28:23,133 --> 00:28:25,466

WE DECIDED TO TRY TO PUSH
THAT DOWN INTO THE TEN, FIVE,

765

00:28:25,466 --> 00:28:27,500
AND DOWN INTO TWO KILOMETER
TYPE RANGES,

766

00:28:27,500 --> 00:28:30,800
JUST TO TRY TO REALLY DETERMINE
WHETHER THE DUST ATMOSPHERE

767

00:28:30,800 --> 00:28:32,933
AND THE ARGON CONCENTRATIONS
CHANGED

768

00:28:32,933 --> 00:28:35,433
AT THOSE LOWER ALTITUDES.

769

00:28:35,433 --> 00:28:38,266
WE ALSO DID HAVE ONE
HIGH-PRIORITY ENGINEERING TEST

770

00:28:38,266 --> 00:28:40,100
THAT OCCURRED
AT SOME POINT HERE,

771

00:28:40,100 --> 00:28:43,033
AND THAT ENGINEERING TEST
WAS A FOUR-HOUR LUNAR ECLIPSE.

772

00:28:43,033 --> 00:28:45,600
LADEE WAS NEVER DESIGNED
TO OPERATE

773

00:28:45,600 --> 00:28:47,466
THROUGH AN ECLIPSE
OF THAT MAGNITUDE.

774

00:28:47,466 --> 00:28:49,733
AND AT FIRST, IT WAS THOUGHT

THAT THE SYSTEM ITSELF

775

00:28:49,733 --> 00:28:52,066
WOULD FREEZE AND DIE
BECAUSE OF THE ECLIPSE.

776

00:28:52,066 --> 00:28:54,433
WE WERE PLANNING ON IMPACTING
WITH THE LUNAR SURFACE

777

00:28:54,433 --> 00:28:55,966
PRIOR TO THAT DATE.

778

00:28:55,966 --> 00:28:59,533
WITH THE ON-ORBIT DATA
THAT WE WERE ABLE TO GATHER

779

00:28:59,533 --> 00:29:01,766
ABOUT HOW THE THERMAL SYSTEM
AND OUR BATTERIES

780

00:29:01,766 --> 00:29:03,833
AND OUR SOLAR ARRAY SYSTEM
WAS PERFORMING,

781

00:29:03,833 --> 00:29:05,366
WE WERE ABLE TO PROJECT

782

00:29:05,366 --> 00:29:06,833
THAT WE WOULD BE ABLE
TO FLY THROUGH THAT.

783

00:29:06,833 --> 00:29:08,400
HEADQUARTERS GAVE US THE CHANCE
TO DO SO

784

00:29:08,400 --> 00:29:10,900
IN ORDER TO TRY TO COLLECT SOME
OF THIS LOW-ALTITUDE SCIENCE.

785

00:29:10,900 --> 00:29:13,066

AND LADEE DID SUCCESSFULLY
FLY THROUGH THAT ECLIPSE.

786

00:29:13,066 --> 00:29:15,333

WE HAD TO RECONFIGURE
A LOT OF OUR FAULT MANAGEMENT

787

00:29:15,333 --> 00:29:18,000

SO THAT THE FAULT MANAGEMENT
SYSTEM DIDN'T SHUT OFF THINGS

788

00:29:18,000 --> 00:29:19,266

WHEN WE DIDN'T WANT THEM TO.

789

00:29:19,266 --> 00:29:21,033

AND WE HAD TO POWER OFF
A FEW THINGS

790

00:29:21,033 --> 00:29:23,200

JUST TO SUST--CONSERVE
BATTERY ENERGY.

791

00:29:23,200 --> 00:29:25,733

BUT WE WERE ABLE TO DO THAT.

792

00:29:25,733 --> 00:29:27,866

AFTER WE DID THAT TEST

793

00:29:27,866 --> 00:29:30,000

AND WE GOT OURSELVES BACK
INTO OUR SCIENCE ORBIT,

794

00:29:30,000 --> 00:29:32,466

OUR ORBIT DETERMINATION FOLKS
CAME BACK,

795

00:29:32,466 --> 00:29:33,866

AND THEY DID

SOME MEASUREMENTS.

796

00:29:33,866 --> 00:29:35,933
AND THEY FOUND THAT THE ORBIT

797

00:29:35,933 --> 00:29:38,033
THAT WE PLACED OURSELVES
INTO THE LAST TIME

798

00:29:38,033 --> 00:29:41,333
HAD SOME PRETTY LOW PREDICTED
HEIGHTS ABOVE THE LUNAR TERRAIN.

799

00:29:41,333 --> 00:29:42,700
YOU CAN SEE HERE
THERE ARE TWO LINES:

800

00:29:42,700 --> 00:29:45,100
ONE AT TWO KILOMETERS,
AND ONE AT ZERO KILOMETERS.

801

00:29:45,100 --> 00:29:49,500
LADEE HAD A PREDICTED
UNCERTAINTY IN ITS ALTITUDE

802

00:29:49,500 --> 00:29:51,066
OF AROUND TWO KILOMETERS.

803

00:29:51,066 --> 00:29:53,266
SO WHEN THE TEAM NOTICED THAT,
AT SOME POINT,

804

00:29:53,266 --> 00:29:56,866
WE STARTED DIPPING BELOW
THAT TWO-KILOMETER UNCERTAINTY

805

00:29:56,866 --> 00:29:58,966
AND WHAT OUR ALTITUDE
PREDICTS WERE.

806

00:29:58,966 --> 00:30:01,433

AND AT THAT POINT, THEY SAID
"WE ARE IN UNCERTAINTY RANGE.

807

00:30:01,433 --> 00:30:04,166

SOME OF THOSE PASSES
MIGHT BE IMPACTS."

808

00:30:04,166 --> 00:30:06,766

AND YOU CAN SEE HERE, SOME OF
THEM WERE ACTUALLY PREDICTED

809

00:30:06,766 --> 00:30:09,066

TO BE BELOW
ZERO KILOMETERS.

810

00:30:09,066 --> 00:30:10,900

NOW, THAT TWO-KILOMETER
UNCERTAINTY

811

00:30:10,900 --> 00:30:12,733

WAS A PLUS OR MINUS
TWO KILOMETERS.

812

00:30:12,733 --> 00:30:14,666

SO, AGAIN,
WE WERE FAIRLY HOPEFUL

813

00:30:14,666 --> 00:30:16,900

THAT WE MIGHT BE ABLE
TO LIVE THROUGH THIS.

814

00:30:16,900 --> 00:30:20,133

BUT WHEN WE NOTICED THIS, WE
STARTED MAKING PLANS TO TAKE--

815

00:30:20,133 --> 00:30:23,033

MONITOR THIS VEHICLE AND TRY
TO ACHIEVE AS MUCH SCIENCE DATA

816

00:30:23,033 --> 00:30:24,433

AS WE COULD
DURING THIS TIME.

817

00:30:24,433 --> 00:30:26,600

AND THE TEAM, IN SOMEWHAT
BLACK HUMOR FASHION,

818

00:30:26,600 --> 00:30:28,766

DECIDED TO NAME THESE
POTENTIAL IMPACT SITES

819

00:30:28,766 --> 00:30:30,266

LIKE YOU WOULD HURRICANES.

820

00:30:30,266 --> 00:30:32,466

AND YOU CAN SEE ANDREA, BRUCE,
CHARLENE, DEREK, ERIN, FRANCIS,

821

00:30:32,466 --> 00:30:34,100

AND A FEW OTHERS.

822

00:30:34,100 --> 00:30:36,000

THE NAMING CONVENTION
THAT WE CHOSE

823

00:30:36,000 --> 00:30:37,700

WAS THAT NONE OF THESE NAMES
COULD BE OF PEOPLE

824

00:30:37,700 --> 00:30:39,166

ON THE ACTUAL
OPS TEAM ITSELF.

825

00:30:39,166 --> 00:30:41,100

SO THEY COULDN'T BE BLAMED
FOR ANYTHING.

826

00:30:41,100 --> 00:30:42,866

BUT THEN WE CAME
INTO THE OP CENTER ITSELF

827
00:30:42,866 --> 00:30:44,833
AND STARTED WATCHING
AS THIS HAPPENED.

828
00:30:44,833 --> 00:30:48,400
AND WE SAW ANDREA
AT 1.44 KILOMETERS

829
00:30:48,400 --> 00:30:49,666
ACTUAL OVER THE SURFACE,

830
00:30:49,666 --> 00:30:52,366
AND THAT LOOKS PRETTY CLOSE
TO THAT PREDICT.

831
00:30:52,366 --> 00:30:55,233
AND WE SAW BRUCE
AT 1.2 KILOMETERS.

832
00:30:55,233 --> 00:30:57,766
THAT LOOKS LIKE PRETTY CLOSE
TO THAT PREDICT.

833
00:30:57,766 --> 00:31:02,066
AND WE SAW CHARLENE
AND DEREK AND ERIN

834
00:31:02,066 --> 00:31:05,200
AT A QUARTER OF A KILOMETER
OVER THE LUNAR SURFACE.

835
00:31:05,200 --> 00:31:08,200
AND THEN...

836
00:31:08,200 --> 00:31:10,600
WE SAW WHAT WE SEE HERE.

837

00:31:10,600 --> 00:31:13,800

AND HERE, WE CAN SEE
LADEE COMING UP,

838

00:31:13,800 --> 00:31:16,533

FLYING OVER THE LUNAR SURFACE
IN ITS TRAJECTORY.

839

00:31:16,533 --> 00:31:18,300

AND YOU CAN SEE THE EARTH
IN THE BACKGROUND.

840

00:31:18,300 --> 00:31:20,466

AND WHAT WE WERE LOOKING AT
IN ALL THESE GEOMETRIES

841

00:31:20,466 --> 00:31:23,500

WAS THE EARTH WAS FAIRLY LOW
OVER THE HORIZON.

842

00:31:23,500 --> 00:31:27,166

AND ALL OF THESE IMPACT TIMES,
OR POSSIBLE IMPACT TIMES,

843

00:31:27,166 --> 00:31:29,000

WAS RIGHT AROUND THE TIME

844

00:31:29,000 --> 00:31:30,400

THAT WE WOULD HAVE LOST
COMMUNICATIONS

845

00:31:30,400 --> 00:31:31,600

WITH THE VEHICLE ITSELF.

846

00:31:31,600 --> 00:31:33,100

AND SO THERE WAS A LOT
OF UNCERTAINTY

847

00:31:33,100 --> 00:31:35,033

ABOUT WHETHER
WE LOST THE SIGNAL,

848

00:31:35,033 --> 00:31:37,500
WHETHER IT WAS FROM AN IMPACT
OR WHETHER IT WAS JUST BECAUSE

849

00:31:37,500 --> 00:31:40,266
WE WENT BEHIND THE MOON
AND JUST LOST SIGNAL.

850

00:31:40,266 --> 00:31:42,500
SO YOU CAN SEE HERE
LADEE'S FLYING ALONG,

851

00:31:42,500 --> 00:31:44,766
AND ANOTHER ITEM IS IS THAT
WE GENERALLY TENDED TO FLY

852

00:31:44,766 --> 00:31:46,666
IN THIS SIDEWAYS
ORIENTATION.

853

00:31:46,666 --> 00:31:49,300
AND YOU CAN SEE HERE
THAT WE WERE WATCHING IT

854

00:31:49,300 --> 00:31:51,566
COMING INTO THE FRANCIS
CONFIGURATION.

855

00:31:51,566 --> 00:31:56,033
A RELATIVE VELOCITY OF ABOUT
1.7 KILOMETERS A SECOND.

856

00:31:56,033 --> 00:32:00,733
AND RIGHT AS WE CAME UP,
WE LOST SIGNAL WITH THE VEHICLE.

857

00:32:00,733 --> 00:32:02,566

AND WE CAN SEE IT HERE.

858

00:32:02,566 --> 00:32:05,400

ONE OF OUR MAIN
ORBIT DYNAMISISTS WATCHING

859

00:32:05,400 --> 00:32:07,133

AS THAT SIGNAL CUT OFF.

860

00:32:07,133 --> 00:32:10,166

AND YOU WATCH AS FOUR AND A HALF
YEARS OF WORK

861

00:32:10,166 --> 00:32:13,300

STOPPED TALKING TO YOU
IN ONE SECOND.

862

00:32:13,300 --> 00:32:15,033

AND YOU WONDER,
WAS THAT IT?

863

00:32:15,033 --> 00:32:17,900

OR DID WE LUCKILY MAKE IT
OVER THE SURFACE?

864

00:32:17,900 --> 00:32:20,466

AND TO DATE, WE'VE NEVER HEARD
ANYTHING MORE FROM LADEE

865

00:32:20,466 --> 00:32:22,200

AND THE ORBIT
THAT TERMINATION PREDICTS

866

00:32:22,200 --> 00:32:24,866

SHOW THAT WE DID, IN FACT,
IMPACT THE MOON

867

00:32:24,866 --> 00:32:27,966

AT A SITE ON THE OUTER EASTERN
RIM OF THE SUNDMAN V CRATER.

868

00:32:27,966 --> 00:32:29,433
AND THE COORDINATES
ARE THERE AT ABOUT

869

00:32:29,433 --> 00:32:32,900
11.84 X -93 LUNAR LATITUDE
AND LONGITUDES.

870

00:32:32,900 --> 00:32:34,200
IF YOU WANT
TO GO LOOK AT IT,

871

00:32:34,200 --> 00:32:35,466
YOU CAN ACTUALLY SEE
WHERE THOSE ARE

872

00:32:35,466 --> 00:32:37,166
ON A COUPLE OF DIFFERENT
MAPPING SITES.

873

00:32:37,166 --> 00:32:40,166
THAT IMPACT SITE ACTUALLY
IS ON AN AREA OF THE MOON

874

00:32:40,166 --> 00:32:42,133
THAT ACTUALLY LIBRATES
BACK AND FORTH.

875

00:32:42,133 --> 00:32:44,166
AND SO YOU CAN SEE
THAT IMPACT SITE

876

00:32:44,166 --> 00:32:45,833
AT CERTAIN TIMES
OF THE YEAR,

877

00:32:45,833 --> 00:32:47,666
AND AT CERTAIN TIMES
IT'S ACTUALLY ON THE FAR SIDE.

878

00:32:47,666 --> 00:32:50,266

SO THERE IS A SCHEDULE
THAT'S OUT AND PUBLISHED

879

00:32:50,266 --> 00:32:52,933

ABOUT DIFFERENT TIMES THAT YOU
CAN FIND THOSE IMPACT SITES,

880

00:32:52,933 --> 00:32:54,600

SO YOU CAN ACTUALLY LOOK AT THAT
WITH GROUND-BASED TELESCOPES

881

00:32:54,600 --> 00:32:56,333

AND SEE IF YOU
CAN FIND ANYTHING FUN,

882

00:32:56,333 --> 00:32:59,400

AND SEE LADEE'S FINAL
RESTING PLACE.

883

00:32:59,400 --> 00:33:03,333

SO THAT WAS MY EXPERIENCE
OF FLYING LADEE

884

00:33:03,333 --> 00:33:05,100

NOW, A FEW OF THE OTHER THINGS

885

00:33:05,100 --> 00:33:07,133

THAT I WAS ASKED
TO TALK ABOUT TODAY,

886

00:33:07,133 --> 00:33:08,500

WELL, WHAT'S NEXT?

887

00:33:08,500 --> 00:33:10,900

AS JACOB SHOWED ABOUT
AND TALKED A LITTLE BIT ABOUT,

888

00:33:10,900 --> 00:33:13,566
ONE OF THE NEXT THINGS THAT WE
HAVE IS CALLED BIOSENTINEL.

889
00:33:13,566 --> 00:33:17,400
A BIOSENTINEL IS
A 6U AUTONOMOUS NANOSATELLITE.

890
00:33:17,400 --> 00:33:18,833
IT'S A LITTLE BIT BIGGER

891
00:33:18,833 --> 00:33:20,533
THAN MOST OF THE CUBE SETS
THAT WE'VE FLOWN.

892
00:33:20,533 --> 00:33:23,800
THERE'S ABOUT A 4U MICROFLUIDIC
BIOLOGY PAYLOAD IN THERE.

893
00:33:23,800 --> 00:33:26,800
WE TAKE MICROWELLS,
WE FILL THEM WITH YEAST,

894
00:33:26,800 --> 00:33:29,366
AND WE SPECIALLY TAILOR
THE STRAIN OF YEAST THAT WE HAVE

895
00:33:29,366 --> 00:33:31,700
TO LOOK FOR RADIATION DAMAGE
IN THE YEAST CELLS.

896
00:33:31,700 --> 00:33:34,700
AND WE CAN CORRELATE
RADIATION IMPACTS

897
00:33:34,700 --> 00:33:37,466
TO GROWTH IN THE ACTUAL
YEAST CELLS.

898
00:33:37,466 --> 00:33:39,266

AND WHAT WE CAN DO
IS EXTRAPOLATE THAT

899

00:33:39,266 --> 00:33:43,700
TO THE RATES THAT RADIATION
IMPACTS MIGHT HAVE

900

00:33:43,700 --> 00:33:45,833
ON ASTRONAUTS THAT ARE OUT
IN THE LUNAR ENVIRONMENT,

901

00:33:45,833 --> 00:33:47,733
OR DEEP-SPACE ENVIRONMENTS
AS WELL.

902

00:33:47,733 --> 00:33:50,633
BUT ONE OF THE CHALLENGES HERE
IS THAT WE HAVE TO RESERVE,

903

00:33:50,633 --> 00:33:52,733
WITH THAT 4U BIO PAYLOAD,

904

00:33:52,733 --> 00:33:54,733
WE HAVE TO RESERVE
ABOUT 2U FOR THE BUS,

905

00:33:54,733 --> 00:33:58,333
ATTITUDE CONTROL, RADIOS,
GN&C HERE.

906

00:33:58,333 --> 00:34:00,200
EVERYTHING ELSE.

907

00:34:00,200 --> 00:34:02,500
ALL OF THE COMPLEXITY
THAT WE HAD IN LADEE,

908

00:34:02,500 --> 00:34:04,866
IN A 300-,
350-KILOGRAM BUS,

909

00:34:04,866 --> 00:34:07,500

WE'RE NOW TRYING TO CRAM
INTO A 14-KILOGRAM BUS.

910

00:34:07,500 --> 00:34:09,200

IT DOESN'T DO QUITE AS MUCH,

911

00:34:09,200 --> 00:34:10,866

BUT ALL OF THE FUNCTIONS
NEED TO BE THERE.

912

00:34:10,866 --> 00:34:12,500

AND SO THIS IS A REAL
ENGINEERING CHALLENGE

913

00:34:12,500 --> 00:34:16,400

TO PROVIDE SOME OF THE DATA
THAT OUR TEAM NEEDS.

914

00:34:16,400 --> 00:34:18,900

FOR THAT,
SOMETIMES I LIKE

915

00:34:18,900 --> 00:34:20,466

TO JOKINGLY CALL THIS
THE B.S. MISSION.

916

00:34:20,466 --> 00:34:22,466

I LIKE THE ACRONYMS
OR INITIALS THERE.

917

00:34:22,466 --> 00:34:24,300

BUT SINCE WE'RE ALSO
TAKING YEAST

918

00:34:24,300 --> 00:34:25,800

AND GROWING YEAST IN SPACE,

919

00:34:25,800 --> 00:34:28,000
I ALSO LIKE TO CALL THIS THE
BEER SAT MISSION. I DON'T KNOW.

920
00:34:28,000 --> 00:34:30,266
I THINK THAT ONE'S A LITTLE MORE
POETIC NAME, PERSONALLY.

921
00:34:30,266 --> 00:34:33,700
BIOSENTINEL ITSELF
IS GOING TO BE LAUNCHED

922
00:34:33,700 --> 00:34:35,366
OFF OF THE SPACE LAUNCH SYSTEM.

923
00:34:35,366 --> 00:34:37,866
IT'S THE NEXT ITERATION
OF A LARGE, UNCREWED VEHICLE,

924
00:34:37,866 --> 00:34:39,833
OR THE LARGE CREWED VEHICLES
WILL BE TAKING OUR ASTRONAUTS

925
00:34:39,833 --> 00:34:42,433
TO THE MOON,
TO DEEP-SPACE TARGETS,

926
00:34:42,433 --> 00:34:45,233
ASTEROIDS, TO THE MARS,
EVENTUALLY.

927
00:34:45,233 --> 00:34:46,966
THIS WILL BE
A SECONDARY PAYLOAD.

928
00:34:46,966 --> 00:34:51,300
THE ORBIT ITSELF IS STILL
TO BE DETERMINED.

929
00:34:51,300 --> 00:34:54,366

BUT RIGHT NOW,
PRELIMINARY INDICATIONS SHOW US

930
00:34:54,366 --> 00:34:57,633
GOING INTO A SLIGHTLY EARTH
INTERIOR ORBIT.

931
00:34:57,633 --> 00:35:01,433
0-POINT-98 BY 0-POINT-92
ASTRONOMIC IN AN ORBIT.

932
00:35:01,433 --> 00:35:03,300
ONE OF THE BIG CHALLENGES
THAT WE HAVE THERE

933
00:35:03,300 --> 00:35:04,800
IS THAT WE HAVE TO RELY

934
00:35:04,800 --> 00:35:06,300
ON THINGS LIKE STAR TRACKERS
FOR CONTROL.

935
00:35:06,300 --> 00:35:08,166
THERE'S NO MAGNETIC FIELDS.
WE HAVE TO HAVE PROPULSION,

936
00:35:08,166 --> 00:35:11,133
AS THERE'S NO MAGNETIC FIELDS
TO HELP US OUT.

937
00:35:11,133 --> 00:35:13,766
AND OUR RANGES FROM EARTH
ARE EXTREMELY LONG.

938
00:35:13,766 --> 00:35:15,333
AT THE END OF OUR
NOMINAL MISSION,

939
00:35:15,333 --> 00:35:17,466
WE'LL BE ABOUT 40 MILLION

KILOMETERS FROM EARTH.

940

00:35:17,466 --> 00:35:19,233

AT THE END OF OUR
EXTENDED MISSION,

941

00:35:19,233 --> 00:35:21,933

WE'LL BE ABOUT 110 MILLION
KILOMETERS FROM EARTH.

942

00:35:21,933 --> 00:35:24,533

THIS IS ORDERS OF MAGNITUDE
FARTHER THAN LADEE WAS,

943

00:35:24,533 --> 00:35:26,033

AND IT'S A MAJOR
ENGINEERING CHALLENGE.

944

00:35:26,033 --> 00:35:27,833

THIS IS SOMETHING
THAT WE'RE WORKING ON RIGHT NOW

945

00:35:27,833 --> 00:35:29,266

AS A PROJECT HERE AT AMES.

946

00:35:29,266 --> 00:35:32,400

GETTING A LITTLE BIT
INTO SOMETHING ELSE,

947

00:35:32,400 --> 00:35:35,933

JACOB AND JAMIE ASKED ME
TO TALK A LITTLE BIT

948

00:35:35,933 --> 00:35:37,333

ABOUT, WELL, WHO AM I

949

00:35:37,333 --> 00:35:39,533

IN ADDITION TO JUST
WHAT I'M DOING HERE.

950

00:35:39,533 --> 00:35:41,533

A LOT OF THE THINGS
THAT I LIKE TO DO

951

00:35:41,533 --> 00:35:44,500

AROUND AFTER WORK AND MY AFTER
HOURS IS PLAY A LOT OF SPORTS.

952

00:35:44,500 --> 00:35:47,766

I'M ON ABOUT TWO SOFTBALL TEAMS,
COACH ONE OF THEM.

953

00:35:47,766 --> 00:35:49,500

YOU CAN SEE
HERE'S ONE GROUP THERE.

954

00:35:49,500 --> 00:35:51,300

THAT TEAM IS A MOUNTAIN VIEW
CITY LEAGUE TEAM.

955

00:35:51,300 --> 00:35:53,866

ABOUT HALF THE TEAM IS NASA,
ABOUT HALF THE TEAM IS NOT.

956

00:35:53,866 --> 00:35:56,266

AND THERE'S A HANDFUL OF PEOPLE
FROM THE TEAM HERE IN THE ROOM.

957

00:35:56,266 --> 00:35:58,933

I USED TO PLAY ON A COUPLE
OF INDOOR SOCCER TEAMS.

958

00:35:58,933 --> 00:36:02,800

I USED TO RUN DISTANCE.
THERE'S ME IN A HALF MARATHON.

959

00:36:02,800 --> 00:36:04,766

ABOUT A YEAR AND A HALF AGO
I WAS PLAYING

960
00:36:04,766 --> 00:36:06,066
ON ONE OF THOSE
INDOOR SOCCER TEAMS

961
00:36:06,066 --> 00:36:07,533
AND WAS KICKED IN THE SIDE
OF THE KNEE,

962
00:36:07,533 --> 00:36:09,566
AND IT DESTROYED MY ANTERIOR
CRUCIATE LIGAMENT,

963
00:36:09,566 --> 00:36:11,833
MY MEDIAL COLLATERAL LIGAMENT
AND MY MENISCUS.

964
00:36:11,833 --> 00:36:13,300
SO I'M CURRENTLY
WORKING MY WAY

965
00:36:13,300 --> 00:36:15,000
BACK INTO BEING ABLE
TO DO SOME OF THOSE THINGS.

966
00:36:15,000 --> 00:36:18,033
BUT I'M STILL BACK INTO PLAYING
SOFTBALL AT THIS POINT.

967
00:36:18,033 --> 00:36:22,100
OTHER THINGS THAT I ENJOY
ARE CONCERTS.

968
00:36:22,100 --> 00:36:23,400
AND AS PART
OF THOSE CONCERTS,

969
00:36:23,400 --> 00:36:25,100
I HAVE GREAT FUN
WITH COSTUME DAY.

970

00:36:25,100 --> 00:36:27,833

I DON'T KNOW HOW MANY OF YOU
HAVE BEEN ABLE TO SEE DR. WORDEN

971

00:36:27,833 --> 00:36:30,900

WITH SOME OF HIS
MAGNIFICENT COSTUMES,

972

00:36:30,900 --> 00:36:34,366

BUT I RATHER LIKE THE IDEA
AND TRY TO DO SO MYSELF.

973

00:36:34,366 --> 00:36:36,833

PATH TO AMES.
HOW DID I GET HERE?

974

00:36:36,833 --> 00:36:38,833

I KNOW JACOB TALKED A LITTLE BIT
ABOUT IT.

975

00:36:38,833 --> 00:36:40,200

AND IT'S KIND OF INTERESTING

976

00:36:40,200 --> 00:36:41,933

THAT WE HAVE A GROUP
OF IDAHO STUDENTS HERE.

977

00:36:41,933 --> 00:36:44,633

I AM FROM THE SMALL LITTLE TOWN
OF BLACKFOOT, IDAHO,

978

00:36:44,633 --> 00:36:46,333

OFF ON THE EASTERN SIDE
OF THE STATE.

979

00:36:46,333 --> 00:36:48,433

TOWN OF ABOUT 10,000 PEOPLE.

980

00:36:48,433 --> 00:36:51,033

AS YOU CAN SEE,

981

00:36:51,033 --> 00:36:52,966

IT'S A TOWN OF SOME
VERY RUGGED BEAUTY,

982

00:36:52,966 --> 00:36:54,200

BUT NOT A LOT OF PEOPLE.

983

00:36:54,200 --> 00:36:56,800

AND WE HAVE A JOYOUS
POTATO MUSEUM.

984

00:36:56,800 --> 00:36:58,000

IT'S WORLD-FAMOUS.

985

00:36:58,000 --> 00:36:59,366

IF YOU GO THERE,
YOU GET A FREE POTATO.

986

00:36:59,366 --> 00:37:01,833

IF YOU'RE ON YOUR WAY
TO YELLOWSTONE NATIONAL PARK

987

00:37:01,833 --> 00:37:03,433

YOU CAN GET FREE DINNER.

988

00:37:03,433 --> 00:37:05,866

I WAS THERE FOR THE FIRST
18 YEARS OF LIFE,

989

00:37:05,866 --> 00:37:08,066

AND THEN I DECIDED THAT I WAS
GOING TO GO TO SCHOOL.

990

00:37:08,066 --> 00:37:11,433

AND THE SCHOOL THAT I HIT ON
IS IN NORTHERN UTAH,

991

00:37:11,433 --> 00:37:14,500
IN A SMALL TOWN CALLED LOGAN,
A TOWN OF ABOUT 25,000 PEOPLE.

992
00:37:14,500 --> 00:37:16,833
SO I WAS STEPPING UP,
BUT STEPPING UP VERY SLOWLY.

993
00:37:16,833 --> 00:37:18,400
AND AS YOU CAN SEE,

994
00:37:18,400 --> 00:37:20,066
THERE'S STILL SOME RUGGED BEAUTY
IN THAT AREA.

995
00:37:20,066 --> 00:37:21,966
THIS IS THE UTAH STATE CAMPUS,
AND AS YOU CAN SEE,

996
00:37:21,966 --> 00:37:23,233
IT'S RIGHT ON THE EDGE
OF THE MOUNTAINS.

997
00:37:23,233 --> 00:37:25,500
AND OFF IN THE MOUNTAINS
YOU CAN SEE SKI RESORTS.

998
00:37:25,500 --> 00:37:26,866
RIVERS, HIKING, BIKING:

999
00:37:26,866 --> 00:37:29,200
ALL THINGS THAT I AVAIL
MYSELF OF.

1000
00:37:29,200 --> 00:37:31,400
BUT THE REAL REASON
I WENT THERE

1001
00:37:31,400 --> 00:37:34,066
WAS THAT THAT SCHOOL HAD FLOWN

MORE STUDENT PAYLOADS

1002

00:37:34,066 --> 00:37:35,333

AS G.A.S. CANISTERS,

1003

00:37:35,333 --> 00:37:38,133

GETAWAY SPECIAL CANISTERS

ON THE SPACE STATION,

1004

00:37:38,133 --> 00:37:39,400

OR ON THE SPACE SHUTTLE,

1005

00:37:39,400 --> 00:37:41,100

THAN ANY OTHER UNIVERSITY HAD

AT THAT POINT.

1006

00:37:41,100 --> 00:37:42,800

AT THAT POINT, I ALREADY KNEW

THAT I WANTED TO BE INVOLVED

1007

00:37:42,800 --> 00:37:44,166

WITH THE SPACE PROGRAM.

1008

00:37:44,166 --> 00:37:48,333

AND SO I WENT THERE.

I DID SEVEN YEARS AT UTAH STATE

1009

00:37:48,333 --> 00:37:50,366

WORKING ON A LOT OF THERMAL

CONTROL SYSTEMS,

1010

00:37:50,366 --> 00:37:52,800

A LITTLE BIT OF ATTITUDE CONTROL

AND THINGS LIKE THAT.

1011

00:37:52,800 --> 00:37:56,800

AFTER THAT, I PROMPTLY FOLLOWED

UP ON ALL OF THAT SPACE TRAINING

1012

00:37:56,800 --> 00:38:00,166
BY GOING TO GERMANY
AND WORKING ON ROBOTICS.

1013
00:38:00,166 --> 00:38:01,833
DIDN'T DO ANYTHING
WITH SPACE AT ALL.

1014
00:38:01,833 --> 00:38:03,100
BUT I WENT TO THE TOWN
OF SIEGEN.

1015
00:38:03,100 --> 00:38:05,800
SIEGEN IS A SMALL CITY
OF ABOUT 150,000 PEOPLE.

1016
00:38:05,800 --> 00:38:07,900
AGAIN, YOU CAN SEE THE GENERAL
PATTERN OF STEPPING UP

1017
00:38:07,900 --> 00:38:09,333
AND STEPPING UP SLOWLY.

1018
00:38:09,333 --> 00:38:11,266
AND SIEGEN IS BETWEEN
FRANKFURT AND COLOGNE.

1019
00:38:11,266 --> 00:38:13,233
ABOUT HALFWAY. AND I WAS THERE
FOR ABOUT NINE MONTHS

1020
00:38:13,233 --> 00:38:15,366
WORKING ON HAPTIC ROBOTS.

1021
00:38:15,366 --> 00:38:17,200
THAT ROBOT HAD A HANDFUL
OF SENSORS ON THERE

1022
00:38:17,200 --> 00:38:19,166
THAT WOULD DETECT IF YOU WERE

GETTING CLOSE TO OBJECTS,

1023

00:38:19,166 --> 00:38:20,866
IF YOU NUDGED THEM,
IF YOU BUMPED THEM.

1024

00:38:20,866 --> 00:38:22,766
AND IT PUT A LOT OF FEEDBACK
INTO A JOYSTICK

1025

00:38:22,766 --> 00:38:25,000
OR INTO A HEADSET.

1026

00:38:25,000 --> 00:38:26,800
THINGS TO ALLOW YOU,
AS A REMOTE OPERATOR,

1027

00:38:26,800 --> 00:38:28,733
TO FIGURE OUT
HOW YOU'RE INTERACTING

1028

00:38:28,733 --> 00:38:30,333
WITH THE ENVIRONMENT
AROUND YOU.

1029

00:38:30,333 --> 00:38:32,233
I GOT DONE WITH THAT.
I TRIED TO STAY THERE,

1030

00:38:32,233 --> 00:38:34,200
BUT THEY DIDN'T HAVE
TOO MANY JOBS AT THAT POINT.

1031

00:38:34,200 --> 00:38:36,166
SO I ENDED UP COMING BACK
TO THE STATES

1032

00:38:36,166 --> 00:38:38,700
AND GOING TO A GROUP CALLED
THE AEROSPACE CORPORATION.

1033

00:38:38,700 --> 00:38:40,900

THEY'RE DOWN IN LOS ANGELES,
CALIFORNIA.

1034

00:38:40,900 --> 00:38:44,366

AND I GOT SENT OUT TO HELP
A LOT OF OTHER PEOPLE AROUND.

1035

00:38:44,366 --> 00:38:46,866

I WORKED WITH THE AIR FORCE
ON THE GPS III PROGRAM.

1036

00:38:46,866 --> 00:38:48,666

IT'S ONE OF THE WORLD'S BEST
CLOCK RADIOS.

1037

00:38:48,666 --> 00:38:50,566

IT IS A CLOCK RADIO.
IT'S VERY COOL,

1038

00:38:50,566 --> 00:38:52,966

BUT IT'S NOT THE MOST
COOL THING.

1039

00:38:52,966 --> 00:38:54,400

I ALSO DID A LOT OF WORK
AT JPL

1040

00:38:54,400 --> 00:38:57,166

WORKING ON THINGS LIKE JIMO:
THE JUPITER ICY MOONS ORBITER.

1041

00:38:57,166 --> 00:39:00,766

I WAS TRYING TO TAKE
A NUCLEAR-POWERED SPACECRAFT

1042

00:39:00,766 --> 00:39:02,000

OUT TO THE MOONS OF JUPITER

1043

00:39:02,000 --> 00:39:03,666

AND USE A LOT
OF ELECTRIC PROPULSION

1044

00:39:03,666 --> 00:39:05,166

TO MOVE AROUND
BETWEEN THE DIFFERENT MOONS.

1045

00:39:05,166 --> 00:39:09,400

I ACTUALLY WORKED AS WELL
ON THE MARS SCIENCE LABORATORY.

1046

00:39:09,400 --> 00:39:12,166

A LITTLE BIT ON THE INITIAL
CONCEPT STUDIES.

1047

00:39:12,166 --> 00:39:13,833

WHAT DID IT LOOK LIKE?
WHAT WAS IT GOING TO DO?

1048

00:39:13,833 --> 00:39:15,866

WAS IT GOING TO HAVE
IN SITU RESOURCE UTILIZATION?

1049

00:39:15,866 --> 00:39:19,533

WAS IT GOING TO HAVE
OTHER CHEMISTRY,

1050

00:39:19,533 --> 00:39:22,100

BIOCHEMISTRY PAYLOADS?
HOW WERE THEY GOING TO LAND IT?

1051

00:39:22,100 --> 00:39:23,466

WERE THEY GONNA USE
THE SKYCRANE

1052

00:39:23,466 --> 00:39:25,300

OR A LARGER AEROSHELL?

1053

00:39:25,300 --> 00:39:28,100
I WAS INVOLVED WITH THE PROJECT
WAY BACK THEN.

1054
00:39:28,100 --> 00:39:31,433
AND THEN WE DECIDED
THAT IT WAS GONNA BE ON.

1055
00:39:31,433 --> 00:39:33,566
L.A. VERSUS SAN FRANCISCO.

1056
00:39:33,566 --> 00:39:36,933
I WAS--MET PETE KLUPAR,
A HANDFUL OF YOU KNOW HIM,

1057
00:39:36,933 --> 00:39:40,566
THAT WAS WORKING AT THE CENTER
AT THE TIME WITH DR. WORDEN,

1058
00:39:40,566 --> 00:39:42,333
AND SAID, "WE NEED SOME PEOPLE
WHO CAN HELP US

1059
00:39:42,333 --> 00:39:44,066
WRITE PROPOSALS
ABOUT SMALL SATELLITES."

1060
00:39:44,066 --> 00:39:46,833
AND SO I CAME UP
AND WORKED ON LCROSS

1061
00:39:46,833 --> 00:39:48,966
AND WORKED ON LADEE
AND WORKED ON TESS.

1062
00:39:48,966 --> 00:39:50,500
THIS WAS--
TESS WAS A FOLLOW-ON

1063
00:39:50,500 --> 00:39:52,700

THAT IS STILL BEING WORKED ON.
IT'S A FOLLOW-ON TO KEPLER.

1064
00:39:52,700 --> 00:39:55,066
IT DOESN'T LOOK QUITE AS FAR
AWAY AS KEPLER DOES,

1065
00:39:55,066 --> 00:39:56,533
NOR DOES IT LOOK
FOR QUITE AS LONG,

1066
00:39:56,533 --> 00:39:59,266
BUT IT LOOKS AT A LOT MORE STARS
IN THE NIGHT SKY AROUND US.

1067
00:39:59,266 --> 00:40:01,566
LOOKING FOR EXOPLANETS
AROUND A LOT OF THINGS

1068
00:40:01,566 --> 00:40:03,633
IN OUR NEAR
SOLAR NEIGHBORHOOD.

1069
00:40:03,633 --> 00:40:05,566
SO THESE ARE THE KIND OF THINGS
THAT I'VE WORKED ON

1070
00:40:05,566 --> 00:40:09,000
IN THAT WONDERFUL, LONG PATH
AND WINDING PATH AROUND THERE.

1071
00:40:09,000 --> 00:40:12,633
AND SO THAT IS ALL
THAT I'VE GOT FOR YOU TO DO,

1072
00:40:12,633 --> 00:40:14,766
AND I HOPE THAT THAT'S BEEN
AN ENTERTAINING TALK.

1073
00:40:14,766 --> 00:40:16,166

AND I HOPE YOU LEARNED
A LITTLE BIT MORE

1074
00:40:16,166 --> 00:40:17,966
ABOUT THE LADEE MISSION.

1075
00:40:17,966 --> 00:40:20,800
[applause]

1076
00:40:28,633 --> 00:40:30,633
- SO, WE HAVE TIME
FOR A FEW QUESTIONS.

1077
00:40:30,633 --> 00:40:33,033
PLEASE RAISE YOUR HAND,
WAIT FOR THE MICROPHONE.

1078
00:40:33,033 --> 00:40:36,033
AND WHEN YOU GET IT, PLEASE
STAND UP AND ASK THE QUESTION.

1079
00:40:39,433 --> 00:40:42,033
- A COUPLE BACK HERE?

1080
00:40:44,400 --> 00:40:46,800
OH.
- IF I REMEMBER CORRECTLY,

1081
00:40:46,800 --> 00:40:48,333
AND CORRECT ME IF I'M WRONG,

1082
00:40:48,333 --> 00:40:49,733
THE CHINESE HAD PUT
A LANDER DOWN

1083
00:40:49,733 --> 00:40:51,066
WHILE LADEE
WAS UP THERE.

1084

00:40:51,066 --> 00:40:52,800

DID YOU SEE ANYTHING?

- YES, THAT'S RIGHT.

1085

00:40:52,800 --> 00:40:54,400

CHANG'E LANDED RIGHT ABOUT

1086

00:40:54,400 --> 00:40:56,066

MIDDLE OF THE WAY

THROUGH THE MISSION.

1087

00:40:56,066 --> 00:40:58,933

THERE IS STILL A LOT OF WORK

GOING ON WITH THE SCIENCE TEAM.

1088

00:40:58,933 --> 00:41:02,433

THEY WERE ABLE TO SEE SOMETHING

HAPPEN ABOUT THAT TIME.

1089

00:41:02,433 --> 00:41:04,866

THE PROBLEM WAS IS THAT

THERE WAS ALSO A METEOR SHOWER

1090

00:41:04,866 --> 00:41:06,300

RIGHT AT ABOUT THAT TIME.

1091

00:41:06,300 --> 00:41:09,300

SO IT'S VERY DIFFICULT FOR THEM

TO TRY TO DISAMBIGUATE

1092

00:41:09,300 --> 00:41:11,533

WHETHER THE INCREASED DUST

AND THE INCREASED MATERIAL

1093

00:41:11,533 --> 00:41:13,766

THAT THEY SAW WAS DUE

TO THE CHANG'E LANDER

1094

00:41:13,766 --> 00:41:16,200

OR DUE TO THE METEORITE SHOWER

AT THAT POINT.

1095

00:41:16,200 --> 00:41:17,633

AS FAR AS I KNOW,

1096

00:41:17,633 --> 00:41:20,800

THEY DO NOT HAVE ANY CONCLUSIVE
FINDINGS ONE WAY OR ANOTHER.

1097

00:41:20,800 --> 00:41:23,333

BUT I KNOW THE TEAM
IS HARD AT WORK ON IT.

1098

00:41:25,300 --> 00:41:27,066

- I WAS JUST WONDERING,
WHEN YOU DID THE SPIN TESTING,

1099

00:41:27,066 --> 00:41:28,600

DID YOU HAVE TO ACTUALLY
MAKE ADJUSTMENTS,

1100

00:41:28,600 --> 00:41:30,433

OR WAS IT ALREADY
IN BALANCE?

1101

00:41:30,433 --> 00:41:32,066

- WE DID HAVE TO MAKE
ADJUSTMENTS.

1102

00:41:32,066 --> 00:41:33,933

WE DID HAVE A HANDFUL
OF BALLAST SITES

1103

00:41:33,933 --> 00:41:35,933

THAT WERE DOWN ON THE BOTTOM
OF THE VEHICLE

1104

00:41:35,933 --> 00:41:37,366

THAT WERE INTERNAL TO IT.

1105

00:41:37,366 --> 00:41:38,933

BUT WE ALSO HAD
SOME BALLAST SITES

1106

00:41:38,933 --> 00:41:41,666

THAT WERE UP AT THE TOP
OF THE VEHICLE ON THE OUTSIDE.

1107

00:41:41,666 --> 00:41:44,066

AND WE CAME IN WITH AN INITIAL
SET OF PREDICTIONS

1108

00:41:44,066 --> 00:41:46,033

OF WHAT THE VEHICLE WOULD NEED
TO BALANCE IT OFF

1109

00:41:46,033 --> 00:41:48,366

ON ITS FINAL SPIN.

1110

00:41:48,366 --> 00:41:50,400

THE VIDEO YOU SAW THERE WAS
ACTUALLY FROM THE SECOND TEST.

1111

00:41:50,400 --> 00:41:53,233

WE SPUN IT ONCE,
MADE A SET OF UPDATES,

1112

00:41:53,233 --> 00:41:55,533

PUT THE FINAL BALLAST MASSES
ON THERE,

1113

00:41:55,533 --> 00:41:56,800

SPUN IT A SECOND TIME.

1114

00:41:56,800 --> 00:41:58,800

AND I BELIEVE THE SECOND TIME
WAS CLOSE ENOUGH

1115

00:41:58,800 --> 00:42:02,133

THAT WE WERE ABLE TO GO
WITH THOSE BALLAST SITES

1116
00:42:02,133 --> 00:42:05,033
FOR THE FINAL FLIGHT.

1117
00:42:08,333 --> 00:42:10,900
- THANKS, BRIAN.
TWO QUESTIONS:

1118
00:42:10,900 --> 00:42:12,400
ENGINEERING QUESTION,
SCIENCE QUESTION.

1119
00:42:12,400 --> 00:42:14,500
ENGINEERING QUESTION:
DID YOU HAVE TO ACCOUNT

1120
00:42:14,500 --> 00:42:18,033
FOR THE TRUCK TRIP IN YOUR
SHOCK AND VIBE TESTING,

1121
00:42:18,033 --> 00:42:19,733
OR WAS IT--

1122
00:42:19,733 --> 00:42:21,633
AND THEN THE SCIENCE
QUESTION IS,

1123
00:42:21,633 --> 00:42:26,200
ONE OF THE THINGS THAT WAS USED
TO JUSTIFY LADEE LONG AGO

1124
00:42:26,200 --> 00:42:27,600
WHEN IT WAS JUST A CONCEPT

1125
00:42:27,600 --> 00:42:33,533
WAS THE FACT THAT THE--SOME OF
THE COMMAND MODULE PILOTS

1126

00:42:33,533 --> 00:42:36,166
IN ORBIT AROUND THE MOON
DURING APOLLO

1127

00:42:36,166 --> 00:42:40,766
SAW THESE STREAMERS
BEFORE SUNRISE.

1128

00:42:40,766 --> 00:42:42,300
DID--AND I KNOW LADEE
DIDN'T HAVE

1129

00:42:42,300 --> 00:42:44,066
HIGH DYNAMIC RANGE,
HIGH-RES CAMERAS,

1130

00:42:44,066 --> 00:42:48,766
BUT DID LADEE OR ANYTHING EVER
VERIFY THOSE STREAMERS?

1131

00:42:48,766 --> 00:42:51,033
- OKAY, SO BOTH OF THOSE
ARE VERY GOOD QUESTIONS.

1132

00:42:51,033 --> 00:42:53,766
THE FIRST ONE, YES,

1133

00:42:53,766 --> 00:42:58,366
WE ACTUALLY DID HAVE TO ENVELOPE
ALL OF OUR TRANSPORT CONDITIONS

1134

00:42:58,366 --> 00:43:03,433
IN THE ANALYSIS AND THE TESTING
THAT OUR MECHANICAL TEAM DID.

1135

00:43:03,433 --> 00:43:06,600
WE HAD ORIGINALLY
SCHEDULED A TEST.

1136

00:43:06,600 --> 00:43:08,833
IT'S KIND OF AN AGGRESSIVE TEST,
CALLED A SINE-BURST TEST

1137
00:43:08,833 --> 00:43:11,966
WHERE WE TOOK--WE WERE GOING
TO TAKE THE LADEE STRUCTURE

1138
00:43:11,966 --> 00:43:13,700
WITH A LOT OF MASS SIMULATORS
ON IT

1139
00:43:13,700 --> 00:43:16,400
AND SHAKE IT PRETTY VIOLENTLY
ON A MASS SIMULATOR TABLE.

1140
00:43:16,400 --> 00:43:18,800
WE ACTUALLY HAD A FAILURE
BECAUSE OF THAT.

1141
00:43:18,800 --> 00:43:21,366
WE THEN SWITCHED TO AN
ALTERNATIVE QUALIFICATION METHOD

1142
00:43:21,366 --> 00:43:23,066
WHERE WE USED
A LOT OF STATIC LOADS

1143
00:43:23,066 --> 00:43:24,500
THAT YOU COULD APPLY
ON THE GROUND,

1144
00:43:24,500 --> 00:43:27,333
AND DID A LOT OF ANALYSIS
BASED ON THE RESULTS THAT WE GOT

1145
00:43:27,333 --> 00:43:29,833
FROM THOSE STATIC LOADS TO SHOW
WHAT IT WOULD RESPOND TO.

1146

00:43:29,833 --> 00:43:31,566

BUT, YES,
THE TRANSPORT LOADS

1147

00:43:31,566 --> 00:43:33,133

WERE PART OF WHAT
WE HAD TO PROVE

1148

00:43:33,133 --> 00:43:34,866

THAT THE VEHICLE ITSELF
WOULD WITHSTAND.

1149

00:43:34,866 --> 00:43:36,866

WE DIDN'T HAVE TO SPECIFIC
TESTING FOR IT,

1150

00:43:36,866 --> 00:43:39,600

BUT THE LOADS AND THE ANALYSIS
HAD TO ENCOMPASS IT.

1151

00:43:39,600 --> 00:43:41,733

FOR THE SECOND PART,
ABOUT WHETHER WE ACTUALLY SAW

1152

00:43:41,733 --> 00:43:43,566

THOSE DUST STREAMERS
OR DUST GLOW,

1153

00:43:43,566 --> 00:43:46,133

THE SCIENCE TEAM IS STILL
WORKING ON THAT.

1154

00:43:46,133 --> 00:43:48,400

I DON'T BELIEVE THEY'VE
PUBLISHED ANYTHING CONCLUSIVE

1155

00:43:48,400 --> 00:43:50,066

ONE WAY OR ANOTHER.

1156

00:43:50,066 --> 00:43:51,600

I DON'T WANT TO SPEAK
ON THAT ONE,

1157

00:43:51,600 --> 00:43:54,566
BECAUSE I DON'T WANT TO SAY THAT
YES, THEY DID WHEN THEY DIDN'T,

1158

00:43:54,566 --> 00:43:55,866
OR VICE VERSA.

1159

00:43:55,866 --> 00:43:57,866
AS FAR AS I KNOW,
THERE'S STILL ANALYSIS GOING ON,

1160

00:43:57,866 --> 00:44:00,566
AND THAT'S--
IT IS STILL UNKNOWN.

1161

00:44:00,566 --> 00:44:03,933
SO, SORRY I CAN'T ANSWER THAT
ANY BETTER FOR YOU.

1162

00:44:06,866 --> 00:44:08,866
ANY OTHER QUESTIONS?

1163

00:44:12,300 --> 00:44:14,566
WELL, THAT LOOKS LIKE ABOUT IT.
THANK YOU VERY MUCH.

1164

00:44:14,566 --> 00:44:17,433
[applause]