

1  
00:00:06,259 --> 00:00:10,440  
hello everybody and welcome to today's

2  
00:00:08,609 --> 00:00:12,178  
Hubble hang out my name is Tony Darnell

3  
00:00:10,439 --> 00:00:14,669  
I work at the Space Telescope Science

4  
00:00:12,179 --> 00:00:16,138  
Institute and it is great we have a

5  
00:00:14,669 --> 00:00:17,250  
really interesting hangout planned I

6  
00:00:16,138 --> 00:00:18,929  
think we're going to be talking about

7  
00:00:17,250 --> 00:00:21,570  
the history of the Hubble Space

8  
00:00:18,929 --> 00:00:23,429  
Telescope now before I introduce my

9  
00:00:21,570 --> 00:00:24,899  
guests so I just want to say I better

10  
00:00:23,429 --> 00:00:27,149  
warn you we've been having some

11  
00:00:24,899 --> 00:00:30,448  
technical glitches it started this

12  
00:00:27,149 --> 00:00:32,609  
broadcast so if we start freezing and

13  
00:00:30,449 --> 00:00:35,219  
stuff I think it's an issue with the

14  
00:00:32,609 --> 00:00:37,738  
google hangout system so we hope you'll

15  
00:00:35,219 --> 00:00:40,739  
be paid holidays in advance if it gets

16  
00:00:37,738 --> 00:00:46,890  
really really bad so I just wanted to

17  
00:00:40,738 --> 00:00:49,378  
say that Hubble servicing mission yes

18  
00:00:46,890 --> 00:00:52,890  
that's right that's right so as many of

19  
00:00:49,378 --> 00:00:54,960  
you know Hubble has been in orbit for 24

20  
00:00:52,890 --> 00:00:57,420  
years now taking data and we're

21  
00:00:54,960 --> 00:01:00,509  
approaching its approaching its 25th

22  
00:00:57,420 --> 00:01:02,820  
year and this hangout is going to be the

23  
00:01:00,509 --> 00:01:05,280  
first in a series of heading outs that

24  
00:01:02,820 --> 00:01:07,530  
we do to help celebrate Hubble's 25

25  
00:01:05,280 --> 00:01:09,329  
years in space so this is the first one

26  
00:01:07,530 --> 00:01:12,030  
of those hangouts in that series so we

27  
00:01:09,329 --> 00:01:14,039  
are excited to be able to offer this to

28  
00:01:12,030 --> 00:01:15,478  
you if you want it we hope you're going

29

00:01:14,040 --> 00:01:17,850  
to give us comments and questions you

30  
00:01:15,478 --> 00:01:20,250  
can do it on the YouTube and G+ event

31  
00:01:17,849 --> 00:01:22,048  
pages when we're monitoring those

32  
00:01:20,250 --> 00:01:24,329  
comments you could also use the Q&A app

33  
00:01:22,049 --> 00:01:26,790  
that's on the video screen itself as

34  
00:01:24,329 --> 00:01:29,459  
well as tweeting with the Hubble hang

35  
00:01:26,790 --> 00:01:30,810  
out hashtag so we hope to see we hope to

36  
00:01:29,459 --> 00:01:34,469  
see some comments and questions for you

37  
00:01:30,810 --> 00:01:36,600  
and we will we will look at I'll read

38  
00:01:34,469 --> 00:01:39,750  
them out and as the Hangout progresses

39  
00:01:36,599 --> 00:01:42,569  
so our guest today is we have some guys

40  
00:01:39,750 --> 00:01:45,688  
from the goddard space flight center we

41  
00:01:42,569 --> 00:01:48,809  
have rust weren't it werneth he's the

42  
00:01:45,688 --> 00:01:51,000  
former EV a manager for Hubble and he is

43  
00:01:48,810 --> 00:01:53,399

uh he is now joining us to talk about

44

00:01:51,000 --> 00:01:55,019

some of the some of his experiences with

45

00:01:53,399 --> 00:01:57,750

the Hubble Space Telescope we also have

46

00:01:55,019 --> 00:01:59,849

dr. Kenneth carpenter he is the

47

00:01:57,750 --> 00:02:03,868

operations project scientist for Hubble

48

00:01:59,849 --> 00:02:06,809

at Goddard welcome guys great today ok

49

00:02:03,868 --> 00:02:11,639

also joining me as always dr. carol

50

00:02:06,810 --> 00:02:13,620

christian and scott lewis driving our

51

00:02:11,639 --> 00:02:15,929

internet for us thank you guys all right

52

00:02:13,620 --> 00:02:18,439

the Internet's driving itself apparently

53

00:02:15,930 --> 00:02:23,459

I know I know I really hope that the

54

00:02:18,439 --> 00:02:24,959

doesn't get too bad so um so Hubble's

55

00:02:23,459 --> 00:02:27,569

been around for a while I want to start

56

00:02:24,959 --> 00:02:29,280

at the very beginning and I might

57

00:02:27,568 --> 00:02:30,689

mention that I think Carol Scott and I

58  
00:02:29,280 --> 00:02:33,689  
are going to be doing more of these

59  
00:02:30,689 --> 00:02:35,459  
Hubble hangouts on the history part of

60  
00:02:33,689 --> 00:02:37,049  
it anyway too so we're not I don't think

61  
00:02:35,459 --> 00:02:39,120  
we're going to plan on trying to cover

62  
00:02:37,049 --> 00:02:40,290  
every single bit of the history of

63  
00:02:39,120 --> 00:02:42,628  
Hubble but we are going to get to the

64  
00:02:40,289 --> 00:02:46,709  
focus primarily on the early parts and

65  
00:02:42,628 --> 00:02:49,469  
so I guess some can cannot let me let me

66  
00:02:46,709 --> 00:02:53,060  
start with you I'd like to add where did

67  
00:02:49,469 --> 00:02:55,280  
the idea of putting a telescope in orbit

68  
00:02:53,060 --> 00:02:59,219  
come from where did it originate

69  
00:02:55,280 --> 00:03:01,310  
actually it's a story for this goes back

70  
00:02:59,219 --> 00:03:04,259  
quite away I think the earliest

71  
00:03:01,310 --> 00:03:06,269  
suggestions of doing an orbiting space

72  
00:03:04,259 --> 00:03:10,169  
telescope we're back in the 1920s

73  
00:03:06,269 --> 00:03:12,239  
actually there was a man named and we

74  
00:03:10,169 --> 00:03:14,608  
wrote an article describing the

75  
00:03:12,239 --> 00:03:16,799  
possibility of launching an observer

76  
00:03:14,609 --> 00:03:18,150  
Richard into space on a rocket he was

77  
00:03:16,799 --> 00:03:21,290  
more into Rockets just like Robert

78  
00:03:18,150 --> 00:03:21,289  
Goddard but he was also

79  
00:03:24,800 --> 00:03:28,820  
hang out again I can see that already

80  
00:03:26,599 --> 00:03:30,799  
could you hear that or did it all

81  
00:03:28,819 --> 00:03:33,139  
disappear close up again yeah it all

82  
00:03:30,800 --> 00:03:36,380  
just froze up I'm sorry okay well

83  
00:03:33,139 --> 00:03:38,179  
basically I said that it in 1923 a guy

84  
00:03:36,379 --> 00:03:40,579  
named Herman or Burruss actually wrote

85  
00:03:38,180 --> 00:03:41,960  
about launching an observatory into

86

00:03:40,580 --> 00:03:44,330  
space in Iraq and he was looking for

87  
00:03:41,960 --> 00:03:48,050  
applications of rockets that they were

88  
00:03:44,330 --> 00:03:51,080  
starting to play around with and 1946

89  
00:03:48,050 --> 00:03:54,140  
was probably the seminal article about a

90  
00:03:51,080 --> 00:03:56,960  
Space Telescope a professor named lyman

91  
00:03:54,139 --> 00:03:59,869  
spitzer at princeton wrote for project

92  
00:03:56,960 --> 00:04:02,120  
rand which was a think tank back in the

93  
00:03:59,870 --> 00:04:03,890  
1940s and he wrote an article about the

94  
00:04:02,120 --> 00:04:06,349  
advantages of putting an astronomical

95  
00:04:03,889 --> 00:04:07,729  
telescope into space noting that you

96  
00:04:06,349 --> 00:04:09,439  
wouldn't be looking through the

97  
00:04:07,729 --> 00:04:11,449  
atmosphere which blurs things out from

98  
00:04:09,439 --> 00:04:12,770  
the ground noting you see a broader

99  
00:04:11,449 --> 00:04:14,149  
wavelength of colors if you weren't

100  
00:04:12,770 --> 00:04:16,400

looking through the atmosphere and that

101

00:04:14,150 --> 00:04:18,439

you had a darker background so that's

102

00:04:16,399 --> 00:04:20,629

really sort of the beginning of the idea

103

00:04:18,439 --> 00:04:26,959

of an HST so way back in nineteen forty

104

00:04:20,629 --> 00:04:28,459

six through the set XD there were

105

00:04:26,959 --> 00:04:36,529

various conversations about Hubble in

106

00:04:28,459 --> 00:04:38,299

the 60s would hope you're muted okay

107

00:04:36,529 --> 00:04:40,809

where people talked about what size

108

00:04:38,300 --> 00:04:44,020

telescope they might do and it actually

109

00:04:40,810 --> 00:04:46,519

started out as a four meter telescope

110

00:04:44,019 --> 00:04:48,469

the idea of launching it on a Saturn 5

111

00:04:46,519 --> 00:04:50,149

rocket so as four meters on a Saturn

112

00:04:48,470 --> 00:04:52,820

rocket instead of two and a half meters

113

00:04:50,149 --> 00:04:55,879

in the space shuttle and we actually got

114

00:04:52,819 --> 00:04:57,139

there in pieces basically in 1968 there



115  
00:04:55,879 --> 00:04:59,418  
was something called the large space

116  
00:04:57,139 --> 00:05:03,139  
telescope the LST which was supposed to

117  
00:04:59,418 --> 00:05:05,810  
be a 3-meter telescope and that went

118  
00:05:03,139 --> 00:05:07,339  
along for a couple years in 1974

119  
00:05:05,810 --> 00:05:09,379  
basically all funding got cut by

120  
00:05:07,339 --> 00:05:11,239  
Congress and there was a regrouping

121  
00:05:09,379 --> 00:05:13,279  
people got together and worked with

122  
00:05:11,240 --> 00:05:14,660  
Congress and various politicians and the

123  
00:05:13,279 --> 00:05:17,449  
astronomical community to figure out

124  
00:05:14,660 --> 00:05:19,850  
what is reasonable and out of that game

125  
00:05:17,449 --> 00:05:22,490  
in the way we know today the two and a

126  
00:05:19,850 --> 00:05:25,700  
half meters flown on the shuttle and in

127  
00:05:22,490 --> 00:05:29,150  
a mode of that it could be rest every

128  
00:05:25,699 --> 00:05:31,279  
three to five years so the the idea it

129  
00:05:29,149 --> 00:05:33,799  
float I'm glad you brought up a good

130  
00:05:31,279 --> 00:05:37,638  
point about the the atmosphere and being

131  
00:05:33,800 --> 00:05:41,150  
being you well

132  
00:05:37,639 --> 00:05:44,658  
while the atmosphere does protecta the

133  
00:05:41,149 --> 00:05:46,549  
Sun and radiation at all blocks outs and

134  
00:05:44,658 --> 00:05:49,209  
valuable wavelengths that we'd like to

135  
00:05:46,550 --> 00:05:53,509  
be able to see in astronomy and so

136  
00:05:49,209 --> 00:05:56,418  
strongly sand was the was the was a

137  
00:05:53,509 --> 00:05:59,348  
process back then similar to what it is

138  
00:05:56,418 --> 00:05:59,348  
now now we have

139  
00:05:59,560 --> 00:06:04,290  
these things called decadence at the

140  
00:06:01,600 --> 00:06:04,290  
most and

141  
00:06:04,620 --> 00:06:07,350  
they are all ranked in order of

142  
00:06:05,759 --> 00:06:10,529  
priorities or was getting up on a

143

00:06:07,350 --> 00:06:12,470  
soapbox and saying I wanted almost wait

144  
00:06:10,529 --> 00:06:19,259  
I want to face telescope on his face

145  
00:06:12,470 --> 00:06:20,760  
hello well it wasn't you were breaking

146  
00:06:19,259 --> 00:06:25,800  
up at her there weren't thee they will

147  
00:06:20,759 --> 00:06:29,000  
weren't the regular deck every 10 near

148  
00:06:25,800 --> 00:06:31,770  
studies that you were talking about that

149  
00:06:29,000 --> 00:06:33,990  
but there was a lot of on both of the

150  
00:06:31,769 --> 00:06:36,209  
astronomical community and with Congress

151  
00:06:33,990 --> 00:06:45,949  
and the president to try to get a new

152  
00:06:36,209 --> 00:06:45,948  
project started in those early days

153  
00:06:50,680 --> 00:06:55,329  
cost had to abandon his gonna cost

154  
00:06:53,399 --> 00:07:01,560  
versus the other things NASA was doing

155  
00:06:55,329 --> 00:07:01,560  
it certainly cost was at which it was a

156  
00:07:02,040 --> 00:07:04,950  
a huge issue because people knew that

157  
00:07:03,779 --> 00:07:06,899

wouldn't be cheap and that's one reason

158

00:07:04,949 --> 00:07:08,759

it went from four meters down to three

159

00:07:06,899 --> 00:07:17,759

meters down to two and a half meters was

160

00:07:08,759 --> 00:07:19,789

to try to control the cost but in kind

161

00:07:17,759 --> 00:07:21,899

of science that you would do with an

162

00:07:19,790 --> 00:07:23,730

orbiting telescope that would look at

163

00:07:21,899 --> 00:07:26,579

high energy events in the cosmos wanted

164

00:07:23,730 --> 00:07:29,330

to launch an x-ray satellite the UV

165

00:07:26,579 --> 00:07:31,800

optical community which served by Hubble

166

00:07:29,329 --> 00:07:33,329

wanted Hubble to do their kind of

167

00:07:31,800 --> 00:07:37,410

science so there was trade-offs about

168

00:07:33,329 --> 00:07:39,479

which kind of telescope would be watched

169

00:07:37,410 --> 00:07:41,130

first one request versus the other so it

170

00:07:39,480 --> 00:07:43,950

was always a constant pressure to do it

171

00:07:41,129 --> 00:07:45,120

as cheaply as you could but make sure it

172  
00:07:43,949 --> 00:07:46,620  
was big enough to do the science that

173  
00:07:45,120 --> 00:07:51,090  
you had proposed otherwise it would be

174  
00:07:46,620 --> 00:07:53,209  
worth anything these guys I need to

175  
00:07:51,089 --> 00:07:55,979  
apologize to everyone about this this

176  
00:07:53,209 --> 00:07:57,149  
this connection it's not anything we can

177  
00:07:55,980 --> 00:07:59,370  
do about it but I do want to apologize

178  
00:07:57,149 --> 00:08:01,019  
for the quality we all keep cutting out

179  
00:07:59,370 --> 00:08:03,329  
so please bear with us and we'll try to

180  
00:08:01,019 --> 00:08:05,159  
do the best we can with it Russ let me

181  
00:08:03,329 --> 00:08:06,899  
ask you something uh let me ask you a

182  
00:08:05,160 --> 00:08:09,180  
quick question here the in the early

183  
00:08:06,899 --> 00:08:11,399  
days of the design did the design of the

184  
00:08:09,180 --> 00:08:12,990  
telescope as you could tell what did it

185  
00:08:11,399 --> 00:08:15,209  
change much from the early days I mean

186  
00:08:12,990 --> 00:08:16,560  
was it or what were some of the factors

187  
00:08:15,209 --> 00:08:19,709  
that went into designing the Hubble

188  
00:08:16,560 --> 00:08:24,449  
Space Telescope the things that chains

189  
00:08:19,709 --> 00:08:27,060  
were first on the software side because

190  
00:08:24,449 --> 00:08:30,300  
of delays we were able to make changes

191  
00:08:27,060 --> 00:08:32,909  
relative to software also battery

192  
00:08:30,300 --> 00:08:36,360  
improvement so I think they were the two

193  
00:08:32,909 --> 00:08:38,668  
big areas during that time and during

194  
00:08:36,360 --> 00:08:42,259  
the delays caused by different reasons

195  
00:08:38,668 --> 00:08:47,039  
that we essentially bought some time

196  
00:08:42,259 --> 00:08:50,460  
although we paid for it because it added

197  
00:08:47,039 --> 00:08:53,159  
total cost and allow some improvements

198  
00:08:50,460 --> 00:08:54,330  
during that development stage isn't it

199  
00:08:53,159 --> 00:08:58,049  
true that when you're building a

200

00:08:54,330 --> 00:09:00,750  
spacecraft you have to kind of design it

201  
00:08:58,049 --> 00:09:03,179  
with technology that's already proven

202  
00:09:00,750 --> 00:09:05,370  
and reliable at the time you're building

203  
00:09:03,179 --> 00:09:07,559  
it and over the course of the the

204  
00:09:05,370 --> 00:09:09,570  
construction of the spacecraft like I'm

205  
00:09:07,559 --> 00:09:11,489  
thinking for example detector design if

206  
00:09:09,570 --> 00:09:12,900  
you're building a camera and you want to

207  
00:09:11,490 --> 00:09:15,870  
have a certain detector any of you in

208  
00:09:12,899 --> 00:09:18,209  
your building it in 1985

209  
00:09:15,870 --> 00:09:19,679  
uh you know and then you're not going to

210  
00:09:18,210 --> 00:09:21,660  
have it finished for another seven or

211  
00:09:19,679 --> 00:09:22,949  
eight years we'll see CDs and detectors

212  
00:09:21,659 --> 00:09:26,278  
have gotten a lot better over that time

213  
00:09:22,950 --> 00:09:27,960  
scale you have to kind of your they're

214  
00:09:26,278 --> 00:09:31,759

almost obsolete from the beginning

215

00:09:27,960 --> 00:09:35,250

weren't they space are that's true and

216

00:09:31,759 --> 00:09:38,549

it also brings out the advantage of

217

00:09:35,250 --> 00:09:41,820

Hubble Space Telescope in that the

218

00:09:38,549 --> 00:09:46,049

initial concept was that as we had new

219

00:09:41,820 --> 00:09:48,390

technology or things needed repair we

220

00:09:46,049 --> 00:09:50,159

could go back to it so during our

221

00:09:48,389 --> 00:09:52,769

servicing missions the five servicing

222

00:09:50,159 --> 00:09:54,750

missions that we had we essentially left

223

00:09:52,769 --> 00:09:57,778

the new telescope because we repair

224

00:09:54,750 --> 00:10:00,690

things and we put in that new technology

225

00:09:57,778 --> 00:10:04,769

that we didn't know back when Hubble was

226

00:10:00,690 --> 00:10:06,630

first designed and or the previous

227

00:10:04,769 --> 00:10:10,309

servicing mission so that points out one

228

00:10:06,629 --> 00:10:14,519

of the great advantages of home oh so



229  
00:10:10,309 --> 00:10:16,500  
the at you when I introduced you your

230  
00:10:14,519 --> 00:10:18,059  
title was Evie a manager for Hubble can

231  
00:10:16,500 --> 00:10:21,809  
you give me something that what is that

232  
00:10:18,059 --> 00:10:24,028  
what does an EV a manager do well of

233  
00:10:21,809 --> 00:10:28,409  
course in NASA we have to talk in

234  
00:10:24,028 --> 00:10:32,309  
acronyms EV a stands for extra vehicular

235  
00:10:28,409 --> 00:10:35,338  
activity and extra vehicular activity is

236  
00:10:32,309 --> 00:10:38,009  
a fancy word for spacewalks getting out

237  
00:10:35,339 --> 00:10:42,000  
of a getting out of outside and outside

238  
00:10:38,009 --> 00:10:44,819  
uh back when Neil Armstrong walked on

239  
00:10:42,000 --> 00:10:48,240  
the moon certainly he got out walked on

240  
00:10:44,820 --> 00:10:50,850  
the moon that was an EVA when the

241  
00:10:48,240 --> 00:10:55,440  
astronauts got out of the shuttle which

242  
00:10:50,850 --> 00:10:57,930  
had met up with Hubble and they went

243  
00:10:55,440 --> 00:11:00,930  
outside to do what we had planned for

244  
00:10:57,929 --> 00:11:02,579  
them to do they were doing ebas because

245  
00:11:00,929 --> 00:11:05,489  
they were in their astronaut suits and

246  
00:11:02,580 --> 00:11:10,320  
they were outside of the environment of

247  
00:11:05,490 --> 00:11:12,600  
the show so the EV a manager from the

248  
00:11:10,320 --> 00:11:16,620  
payload side from Hubble Space Telescope

249  
00:11:12,600 --> 00:11:19,528  
at Goddard Space Flight Center was in

250  
00:11:16,620 --> 00:11:21,778  
charge of developing all the special

251  
00:11:19,528 --> 00:11:24,379  
tools that were needed to meet the

252  
00:11:21,778 --> 00:11:28,559  
requirements for that particular mission

253  
00:11:24,379 --> 00:11:29,789  
to come up with procedures and working

254  
00:11:28,559 --> 00:11:34,079  
with Johnson Space

255  
00:11:29,789 --> 00:11:36,719  
enter and build those tools build the

256  
00:11:34,080 --> 00:11:39,509  
procedures and to do our part in

257

00:11:36,720 --> 00:11:42,000  
training for what the astronauts had to

258  
00:11:39,509 --> 00:11:45,629  
do for all the eda days that won't be

259  
00:11:42,000 --> 00:11:48,210  
that plan for them okay so so that we

260  
00:11:45,629 --> 00:11:49,740  
know from early on that the I mean

261  
00:11:48,210 --> 00:11:52,139  
anybody who knows Hubble knows it was

262  
00:11:49,740 --> 00:11:53,789  
designed to be serviced by shuttles it

263  
00:11:52,139 --> 00:11:57,299  
was put up there by a shuttle was that

264  
00:11:53,789 --> 00:11:58,439  
always the case and I'm not sure who was

265  
00:11:57,299 --> 00:11:59,699  
better able to answer this question so i

266  
00:11:58,440 --> 00:12:02,460  
want to put both can and russ and you

267  
00:11:59,700 --> 00:12:04,950  
guys can decide was it always the case

268  
00:12:02,460 --> 00:12:06,420  
that Hubble was going to be an integral

269  
00:12:04,950 --> 00:12:08,850  
part of the shuttle mission or was there

270  
00:12:06,419 --> 00:12:09,959  
ever a time when you know they were it

271  
00:12:08,850 --> 00:12:11,340

wasn't that we're going to just use a

272

00:12:09,960 --> 00:12:13,920

rocket or something like that to get it

273

00:12:11,340 --> 00:12:15,450

up in space I can start on that if you

274

00:12:13,919 --> 00:12:18,449

want then rest you can comment further

275

00:12:15,450 --> 00:12:21,450

okay go ahead yeah originally the the

276

00:12:18,450 --> 00:12:24,210

concept for HST was for orbiting space

277

00:12:21,450 --> 00:12:26,340

telescope was to launch it on a Saturn 5

278

00:12:24,210 --> 00:12:29,370

so the the moon rocket that wants the

279

00:12:26,340 --> 00:12:31,379

Apollo missions yeah because there were

280

00:12:29,370 --> 00:12:32,970

some left over after the Apollo missions

281

00:12:31,379 --> 00:12:34,350

right after the Apollo program ended

282

00:12:32,970 --> 00:12:38,040

that's right and some of them were in

283

00:12:34,350 --> 00:12:39,690

museums nowadays yeah get some fuel and

284

00:12:38,039 --> 00:12:42,659

those guys maybe they'd still go you

285

00:12:39,690 --> 00:12:44,220

know were you one of the things I

286  
00:12:42,659 --> 00:12:46,709  
discovered in the last couple of months

287  
00:12:44,220 --> 00:12:48,360  
when looking back at the older history

288  
00:12:46,710 --> 00:12:52,550  
of Hubble is one of the early concepts

289  
00:12:48,360 --> 00:12:55,139  
actually had a crew crew person on board

290  
00:12:52,549 --> 00:12:56,969  
helping to run the telescope oh now that

291  
00:12:55,139 --> 00:12:58,919  
would be cool I would sign up for that

292  
00:12:56,970 --> 00:13:00,090  
job I don't know that they ever followed

293  
00:12:58,919 --> 00:13:03,179  
this up out of this scott can you get

294  
00:13:00,090 --> 00:13:04,830  
that graphic up I I love this idea i

295  
00:13:03,179 --> 00:13:07,199  
remember reading about this i was like

296  
00:13:04,830 --> 00:13:09,450  
oh that's amazing and there's all kinds

297  
00:13:07,200 --> 00:13:11,820  
of documentation and arguments about

298  
00:13:09,450 --> 00:13:13,740  
what you know what is it feasible and

299  
00:13:11,820 --> 00:13:16,530  
this is when they're gonna send film

300  
00:13:13,740 --> 00:13:18,240  
canisters down right yeah exactly so if

301  
00:13:16,529 --> 00:13:19,889  
you can see the graphic now you see in

302  
00:13:18,240 --> 00:13:22,080  
that the back end and on the right side

303  
00:13:19,889 --> 00:13:25,049  
of the telescope behind the north as it

304  
00:13:22,080 --> 00:13:28,050  
up now there's actually a person

305  
00:13:25,049 --> 00:13:30,689  
floating sort of horizontally above the

306  
00:13:28,049 --> 00:13:32,309  
instrumentation and because exactly he

307  
00:13:30,690 --> 00:13:35,100  
said Carol they were going to go and

308  
00:13:32,309 --> 00:13:37,199  
actually use film they the person would

309  
00:13:35,100 --> 00:13:38,940  
then take film out of the cameras roll

310  
00:13:37,200 --> 00:13:40,230  
it up and then somehow get it back to

311  
00:13:38,940 --> 00:13:41,520  
the earth I never actually saw an

312  
00:13:40,230 --> 00:13:42,899  
explanation of how in the world they

313  
00:13:41,519 --> 00:13:43,470  
were planning to but they were going to

314

00:13:42,899 --> 00:13:46,699  
have

315  
00:13:43,470 --> 00:13:46,700  
us pick up the film

316  
00:13:50,259 --> 00:13:58,639  
to support that's what I was waiting

317  
00:13:53,239 --> 00:13:59,929  
right here for the Hangout I think one

318  
00:13:58,639 --> 00:14:00,919  
of the reasons they went away from that

319  
00:13:59,928 --> 00:14:03,409  
year in addition to all the

320  
00:14:00,919 --> 00:14:05,419  
complications and trying to support life

321  
00:14:03,409 --> 00:14:06,980  
up there was the contamination issue

322  
00:14:05,419 --> 00:14:09,048  
because there's a lot of contaminants

323  
00:14:06,980 --> 00:14:10,610  
coming out of a even a single person in

324  
00:14:09,048 --> 00:14:12,499  
the background and one of the things

325  
00:14:10,610 --> 00:14:14,269  
we've done very carefully over the years

326  
00:14:12,499 --> 00:14:16,159  
is to try to keep all possible

327  
00:14:14,269 --> 00:14:19,339  
contaminations off the surfaces of the

328  
00:14:16,159 --> 00:14:22,488

the mirrors and the detectors because it

329

00:14:19,339 --> 00:14:24,110

would hinder their people out of the

330

00:14:22,489 --> 00:14:26,360

immediate equation actually it was a

331

00:14:24,110 --> 00:14:28,999

very positive thing let's say that would

332

00:14:26,360 --> 00:14:31,879

be I mean beyond being an astronaut

333

00:14:28,999 --> 00:14:34,220

which would be an awesome job being the

334

00:14:31,879 --> 00:14:37,069

person inside the Hubble Space Telescope

335

00:14:34,220 --> 00:14:40,459

I think would be the perfect job like

336

00:14:37,068 --> 00:14:42,769

sign me up I would be amazing I couldn't

337

00:14:40,458 --> 00:14:46,638

agree more obvious i do i work a

338

00:14:42,769 --> 00:14:48,318

telescope in space and that was supposed

339

00:14:46,639 --> 00:14:49,909

to be a shirtsleeve environment it

340

00:14:48,318 --> 00:14:52,068

wasn't big astronaut clunky suit or

341

00:14:49,909 --> 00:14:53,719

anything amazed to be pressurized cabin

342

00:14:52,068 --> 00:14:57,259

so you could go there and your YouTube



343

00:14:53,720 --> 00:14:59,869

t-shirt and work mark I could do a

344

00:14:57,259 --> 00:15:03,829

Hubble hangout from space from Hubble oh

345

00:14:59,869 --> 00:15:06,319

yeah that would be I'd watch that that'd

346

00:15:03,828 --> 00:15:07,458

be great okay so i would really look

347

00:15:06,318 --> 00:15:08,988

through Hubble which no one's ever

348

00:15:07,458 --> 00:15:11,808

really done you know we do it all with

349

00:15:08,989 --> 00:15:13,668

remote detectors now oh man that would

350

00:15:11,808 --> 00:15:16,308

my other show the virtual star party

351

00:15:13,668 --> 00:15:18,678

would add more depth and oh wow never

352

00:15:16,308 --> 00:15:20,238

mind exploding my brain with

353

00:15:18,678 --> 00:15:23,058

possibilities of this thing that never

354

00:15:20,239 --> 00:15:24,649

happened maybe we should be me anyways

355

00:15:23,058 --> 00:15:27,350

we should do it in the future anyway to

356

00:15:24,649 --> 00:15:28,668

have it in Earth orbit playbook what

357  
00:15:27,350 --> 00:15:30,499  
about well that's a different topic I

358  
00:15:28,668 --> 00:15:32,539  
won't go there I was going to ask about

359  
00:15:30,499 --> 00:15:37,819  
the space station but that's that's off

360  
00:15:32,539 --> 00:15:39,798  
topic so the so the the decision was

361  
00:15:37,818 --> 00:15:42,110  
made at some point that it was going to

362  
00:15:39,798 --> 00:15:43,578  
go in the shuttle what were the what

363  
00:15:42,110 --> 00:15:45,409  
were the circumstances of that what was

364  
00:15:43,578 --> 00:15:47,688  
the final driver for saying hey no we're

365  
00:15:45,409 --> 00:15:49,278  
not doing this no no sir shirtsleeve

366  
00:15:47,688 --> 00:15:51,259  
environment no launching on a Saturn 5

367  
00:15:49,278 --> 00:15:52,789  
we're using the shuttle what was it what

368  
00:15:51,259 --> 00:15:55,278  
was a driver for that Russ is that

369  
00:15:52,789 --> 00:16:01,339  
something you can comment on I believe I

370  
00:15:55,278 --> 00:16:03,860  
can the pants for the space shuttle and

371

00:16:01,340 --> 00:16:07,910  
Hubble Space Telescope merged about that

372  
00:16:03,860 --> 00:16:10,519  
time about one time up within a time

373  
00:16:07,909 --> 00:16:13,059  
frame I'd say within the 70s okay so

374  
00:16:10,519 --> 00:16:17,000  
this is we're talking 70 still yes ah

375  
00:16:13,059 --> 00:16:18,769  
actually the funding for Hubble or the

376  
00:16:17,000 --> 00:16:21,679  
authorization from Congress came out in

377  
00:16:18,769 --> 00:16:24,789  
about nineteen seventy-seven and of

378  
00:16:21,679 --> 00:16:29,120  
course the first shuttle launch was in

379  
00:16:24,789 --> 00:16:32,269  
81 so around the time when proponents to

380  
00:16:29,120 --> 00:16:33,950  
reach of these programs were trying to

381  
00:16:32,269 --> 00:16:37,789  
get approval for Hubble and for the

382  
00:16:33,950 --> 00:16:45,350  
shuttle with the shuttle doing Earth

383  
00:16:37,789 --> 00:16:47,509  
orbit to get up and back to Hubble which

384  
00:16:45,350 --> 00:16:49,940  
would be in low-earth orbit it made

385  
00:16:47,509 --> 00:16:55,039

sense to make certain that Hubble was

386

00:16:49,940 --> 00:16:57,560

designed to fit in like gin and be a

387

00:16:55,039 --> 00:17:03,230

wanna be seller

388

00:16:57,559 --> 00:17:06,588

those two press how Hubble came about so

389

00:17:03,230 --> 00:17:11,318

English out so that would turn out to be

390

00:17:06,588 --> 00:17:13,879

a very pivotal decision to to to make a

391

00:17:11,318 --> 00:17:16,549

the shuttle be able to go up and get

392

00:17:13,880 --> 00:17:21,130

this thing later in its in its history

393

00:17:16,549 --> 00:17:23,779

but uh but it sounds like you know that

394

00:17:21,130 --> 00:17:25,760

I'm sorry folks it looks like I think

395

00:17:23,779 --> 00:17:27,740

we've identified that it's an

396

00:17:25,759 --> 00:17:31,160

infrastructure issue with the Google

397

00:17:27,740 --> 00:17:33,079

stuff and it's it's still happening here

398

00:17:31,160 --> 00:17:38,570

and there intermittently my again my

399

00:17:33,079 --> 00:17:40,759

apologies on that so the the so the

400  
00:17:38,569 --> 00:17:42,679  
decision to actually service it would be

401  
00:17:40,759 --> 00:17:44,650  
turn out to be an important one if we

402  
00:17:42,680 --> 00:17:48,289  
had launched it with the Saturn five

403  
00:17:44,650 --> 00:17:49,850  
probably well maybe I don't know could

404  
00:17:48,289 --> 00:17:50,960  
we have gone up and shut and serviced it

405  
00:17:49,849 --> 00:17:54,949  
with the shuttle anyway if we had

406  
00:17:50,960 --> 00:17:57,500  
launched it with Centrifly we could have

407  
00:17:54,950 --> 00:18:00,769  
if we had planned ahead as we would have

408  
00:17:57,500 --> 00:18:06,950  
if we if that were to be the plan Google

409  
00:18:00,769 --> 00:18:10,309  
to have fixtures on it as we but the

410  
00:18:06,950 --> 00:18:12,819  
interfaces were yes we we could do that

411  
00:18:10,309 --> 00:18:14,928  
if it were launched by another vehicle

412  
00:18:12,819 --> 00:18:16,220  
okay so we've made decisions we're going

413  
00:18:14,929 --> 00:18:19,580  
to have a Space Telescope it's going to

414  
00:18:16,220 --> 00:18:21,650  
go in wait wait I have a question so

415  
00:18:19,579 --> 00:18:23,509  
from the timeline understanding from

416  
00:18:21,650 --> 00:18:26,660  
Canon rods it sounds like there was a

417  
00:18:23,509 --> 00:18:28,700  
long period of time deciding to do a

418  
00:18:26,660 --> 00:18:30,980  
Space Telescope but then it was pretty

419  
00:18:28,700 --> 00:18:34,069  
quick to switch from for the launch

420  
00:18:30,980 --> 00:18:35,809  
vehicle I mean it was like over five to

421  
00:18:34,069 --> 00:18:39,889  
ten years is that right I mean that's

422  
00:18:35,809 --> 00:18:43,089  
quick in the space arena is that right I

423  
00:18:39,890 --> 00:18:45,980  
think so there was a huge push in the

424  
00:18:43,089 --> 00:18:49,879  
mid-70s I think by the astronomical

425  
00:18:45,980 --> 00:18:52,039  
community was led by involved in the

426  
00:18:49,880 --> 00:18:54,110  
early portion of the telescope and John

427  
00:18:52,039 --> 00:18:55,909  
Bacall who also happened to be at for

428

00:18:54,109 --> 00:18:58,879  
instant they managed to get the

429  
00:18:55,910 --> 00:19:01,190  
community together a group of

430  
00:18:58,880 --> 00:19:03,200  
politicians and public together to

431  
00:19:01,190 --> 00:19:05,450  
actually supports idea and then they

432  
00:19:03,200 --> 00:19:06,860  
worked with manned spaceflight on the

433  
00:19:05,450 --> 00:19:08,509  
shuttle and sort of got everybody

434  
00:19:06,859 --> 00:19:11,419  
converges very fascinating with all the

435  
00:19:08,509 --> 00:19:12,920  
different pieces coming together

436  
00:19:11,420 --> 00:19:15,350  
and the fact that they brought the price

437  
00:19:12,920 --> 00:19:17,240  
down at the same time I think is what it

438  
00:19:15,349 --> 00:19:19,359  
allowed it to finally move forward and

439  
00:19:17,240 --> 00:19:23,269  
gain the traction that it hadn't had

440  
00:19:19,359 --> 00:19:24,679  
okay cool thanks yeah thank you uh okay

441  
00:19:23,269 --> 00:19:26,869  
so we got it in the shuttlebay it's

442  
00:19:24,680 --> 00:19:29,690

going it's going to be that's because

443

00:19:26,869 --> 00:19:33,469

it's constrained obviously by the site

444

00:19:29,690 --> 00:19:36,320

of the the what the shuttle can do so

445

00:19:33,470 --> 00:19:39,110

the design B was was primarily

446

00:19:36,319 --> 00:19:40,730

constrained tie the size of the shuttle

447

00:19:39,109 --> 00:19:48,679

bay but I'm if i remember right Russ

448

00:19:40,730 --> 00:19:50,000

that didn't it take up Eric in there can

449

00:19:48,680 --> 00:19:56,870

you ask that again you broke out though

450

00:19:50,000 --> 00:20:01,519

oh I did constrained about the size of

451

00:19:56,869 --> 00:20:04,639

the shuttle bay in my still bear picking

452

00:20:01,519 --> 00:20:08,420

up then I think I remember it taking up

453

00:20:04,640 --> 00:20:11,630

every square empty space in the shuttle

454

00:20:08,420 --> 00:20:15,759

bay itself is that true that's that's

455

00:20:11,630 --> 00:20:21,680

pretty much true we had of course Tareq

456

00:20:15,759 --> 00:20:24,740

hope to it that was in the bay and at



457  
00:20:21,680 --> 00:20:27,230  
that time we had her rolled up and then

458  
00:20:24,740 --> 00:20:30,380  
each mast of the solar array was folded

459  
00:20:27,230 --> 00:20:32,589  
up against the side and that's about all

460  
00:20:30,380 --> 00:20:38,420  
that would fit in that shuttle bay and

461  
00:20:32,589 --> 00:20:40,099  
to get employed that's all so I guess

462  
00:20:38,420 --> 00:20:42,380  
the way NASA does things is it always

463  
00:20:40,099 --> 00:20:44,059  
uses contractors I did that with Apollo

464  
00:20:42,380 --> 00:20:46,700  
and it does it with doing it now at the

465  
00:20:44,059 --> 00:20:48,409  
James Webb Space Telescope whoo-hoo

466  
00:20:46,700 --> 00:20:49,970  
built who built this thing whoo what was

467  
00:20:48,410 --> 00:20:53,210  
the primary contractor for the Hubble

468  
00:20:49,970 --> 00:20:56,299  
Space Telescope primary contractor for

469  
00:20:53,210 --> 00:21:00,920  
the structure was Lockheed Martin out in

470  
00:20:56,299 --> 00:21:02,809  
sunnyvale california the there were many

471  
00:21:00,920 --> 00:21:06,080  
other contractors that were building

472  
00:21:02,809 --> 00:21:11,000  
scientific instruments various parts

473  
00:21:06,079 --> 00:21:14,329  
solar arrays and the mirror so there are

474  
00:21:11,000 --> 00:21:17,329  
many many contractors but for the main

475  
00:21:14,329 --> 00:21:19,909  
part of Hubble it was Lockheed Martin

476  
00:21:17,329 --> 00:21:22,309  
and Scott has an image up of some of the

477  
00:21:19,910 --> 00:21:23,600  
various integration or building phases

478  
00:21:22,309 --> 00:21:25,169  
of the telescope which is kind of cool

479  
00:21:23,599 --> 00:21:27,179  
since need to see that

480  
00:21:25,170 --> 00:21:30,920  
bill so it was built it looks like in

481  
00:21:27,180 --> 00:21:30,920  
the 80s how long did it take to build

482  
00:21:32,390 --> 00:21:41,730  
you back Kenneth well it was pretty much

483  
00:21:38,099 --> 00:21:43,919  
what was ready to go in January of 86

484  
00:21:41,730 --> 00:21:45,529  
and would have gone if it hadn't

485

00:21:43,920 --> 00:21:48,930  
happened for the the Challenger accident

486  
00:21:45,529 --> 00:21:53,069  
which to lead us another four years into

487  
00:21:48,930 --> 00:21:55,440  
the actual lunch in 1990 so you know if

488  
00:21:53,069 --> 00:21:59,159  
you figure it started basically in the

489  
00:21:55,440 --> 00:22:02,910  
late 70s you're you're talking well yeah

490  
00:21:59,160 --> 00:22:04,740  
nice or so so and you know we did make

491  
00:22:02,910 --> 00:22:06,900  
further improvements in whatever between

492  
00:22:04,740 --> 00:22:09,740  
86 and 91 look like well are some of the

493  
00:22:06,900 --> 00:22:12,720  
things that you were changed you know oh

494  
00:22:09,740 --> 00:22:14,370  
you're able to update detectors for

495  
00:22:12,720 --> 00:22:16,200  
instance and some of the instruments

496  
00:22:14,369 --> 00:22:17,939  
either the can't even respect to grass

497  
00:22:16,200 --> 00:22:21,660  
where you could get higher sensitivity

498  
00:22:17,940 --> 00:22:23,580  
see fainter objects on the sky we're

499  
00:22:21,660 --> 00:22:25,680

able to improve the ground system

500

00:22:23,579 --> 00:22:28,859

software a lot to improve the scheduling

501

00:22:25,680 --> 00:22:31,440

and the data reduction and archiving of

502

00:22:28,859 --> 00:22:32,789

material so basically you know because

503

00:22:31,440 --> 00:22:34,830

we had the extra time people just kept

504

00:22:32,789 --> 00:22:36,450

working and improving things and what

505

00:22:34,829 --> 00:22:37,819

went to orbit and what was in the ground

506

00:22:36,450 --> 00:22:39,840

system at launch was actually

507

00:22:37,819 --> 00:22:41,819

substantially better just because we had

508

00:22:39,839 --> 00:22:43,349

the luxury of time the that well you

509

00:22:41,819 --> 00:22:46,169

don't have in a rushed lunch schedule

510

00:22:43,349 --> 00:22:48,539

yeah sounds kind of a silver lining out

511

00:22:46,170 --> 00:22:52,980

of a bad situation so that would ya yes

512

00:22:48,539 --> 00:22:55,039

to it okay well so let's just go ahead

513

00:22:52,980 --> 00:22:59,069

and talk briefly about so it gets it

514  
00:22:55,039 --> 00:23:01,139  
launched in 1990 it goes up we turn it

515  
00:22:59,069 --> 00:23:03,839  
on and we start looking through it and

516  
00:23:01,140 --> 00:23:05,940  
the images are a little bit fuzzy one of

517  
00:23:03,839 --> 00:23:11,669  
the contractors the guy the people that

518  
00:23:05,940 --> 00:23:13,890  
built the the mirror a perkin-elmer had

519  
00:23:11,670 --> 00:23:16,560  
introduced an aberration into the prime

520  
00:23:13,890 --> 00:23:20,670  
the primary mirror did that affect the

521  
00:23:16,559 --> 00:23:24,720  
science very much okay well it certainly

522  
00:23:20,670 --> 00:23:27,420  
did because the telescope wasn't as well

523  
00:23:24,720 --> 00:23:29,309  
focused due to the aberration you

524  
00:23:27,420 --> 00:23:30,900  
couldn't get the resolution between

525  
00:23:29,309 --> 00:23:33,269  
objects on the sky that you were hoping

526  
00:23:30,900 --> 00:23:36,120  
to get otherwise and the sensitivity of

527  
00:23:33,269 --> 00:23:37,859  
the various instruments went down

528  
00:23:36,119 --> 00:23:38,409  
because it was less light falling on a

529  
00:23:37,859 --> 00:23:41,859  
good

530  
00:23:38,410 --> 00:23:43,779  
in pixel on the detectors one bright

531  
00:23:41,859 --> 00:23:46,329  
spot there and that was pretty much the

532  
00:23:43,779 --> 00:23:48,309  
case for the the imaging instruments

533  
00:23:46,329 --> 00:23:50,559  
some of the performance there was

534  
00:23:48,309 --> 00:23:52,359  
recovered in the end by some after the

535  
00:23:50,559 --> 00:23:55,389  
fact software reduction which packed the

536  
00:23:52,359 --> 00:23:58,899  
light back in to a smaller space on the

537  
00:23:55,390 --> 00:24:00,610  
image but one thing that sometimes gets

538  
00:23:58,900 --> 00:24:02,800  
forgotten is that the spectrographs

539  
00:24:00,609 --> 00:24:05,889  
which usually have a little opening a

540  
00:24:02,799 --> 00:24:07,809  
slit at the front to narrow the beam of

541  
00:24:05,890 --> 00:24:11,259  
light coming in they could still perform

542

00:24:07,809 --> 00:24:13,089  
at their original specification level in

543  
00:24:11,259 --> 00:24:15,700  
terms of resolution and how well they

544  
00:24:13,089 --> 00:24:18,189  
could separate colors or places on the

545  
00:24:15,700 --> 00:24:20,650  
sky because of that narrow slit now you

546  
00:24:18,190 --> 00:24:22,090  
did lose light because the image wasn't

547  
00:24:20,650 --> 00:24:23,560  
as well focused some of the light didn't

548  
00:24:22,089 --> 00:24:25,809  
make it through the slit so you had to

549  
00:24:23,559 --> 00:24:27,909  
expose longer so in the case of the

550  
00:24:25,809 --> 00:24:30,429  
spectrographs the quality of the data

551  
00:24:27,910 --> 00:24:32,620  
you could get the same quality of the

552  
00:24:30,430 --> 00:24:34,450  
day as long as you were we will get in

553  
00:24:32,619 --> 00:24:36,159  
it so you could do fewer objects you

554  
00:24:34,450 --> 00:24:37,569  
could still do the same quality science

555  
00:24:36,160 --> 00:24:40,269  
and that's something that was a little

556  
00:24:37,569 --> 00:24:41,769

harder to do with the the imagers until

557

00:24:40,269 --> 00:24:43,690

we put the corrective optics in place

558

00:24:41,769 --> 00:24:45,279

right and i think that's amazing you're

559

00:24:43,690 --> 00:24:47,529

in but the cleverness that was in those

560

00:24:45,279 --> 00:24:49,720

years and then so that brings us uh to

561

00:24:47,529 --> 00:24:51,430

some servicing missions then we we had

562

00:24:49,720 --> 00:24:54,250

we had found our need for the first one

563

00:24:51,430 --> 00:24:58,600

you want to come at us back up a minute

564

00:24:54,250 --> 00:25:02,680

oh yeah yeah I like to add what what to

565

00:24:58,599 --> 00:25:06,369

what Ken said by all means I like to say

566

00:25:02,680 --> 00:25:10,000

that the mirror was ground with a very

567

00:25:06,369 --> 00:25:17,379

high technology process absolutely

568

00:25:10,000 --> 00:25:19,269

perfectly to the wrong spec they did it

569

00:25:17,380 --> 00:25:20,830

they did it the way it was supposed to

570

00:25:19,269 --> 00:25:24,309

be done just with the wrong instructions



571  
00:25:20,829 --> 00:25:26,349  
wrong recipe right and the amount that

572  
00:25:24,309 --> 00:25:28,389  
it was off it was too flat around the

573  
00:25:26,349 --> 00:25:32,919  
outside edge of this two point four

574  
00:25:28,390 --> 00:25:35,950  
meter mirror by 150th the diameter of a

575  
00:25:32,920 --> 00:25:39,310  
piece of human hair but it in space

576  
00:25:35,950 --> 00:25:42,430  
optics it it doesn't take much and Ray

577  
00:25:39,309 --> 00:25:46,629  
was a tremendous problem but i Ken said

578  
00:25:42,430 --> 00:25:50,680  
anything that was uh using the center

579  
00:25:46,630 --> 00:25:51,730  
part of the mirror for three years or so

580  
00:25:50,680 --> 00:25:54,640  
we did get pretty good

581  
00:25:51,730 --> 00:25:57,099  
it opted expac but again that leads into

582  
00:25:54,640 --> 00:25:59,410  
your question about servicing missions

583  
00:25:57,099 --> 00:26:00,819  
right so how many were there Russ how

584  
00:25:59,410 --> 00:26:02,620  
many altogether how many servicing

585  
00:26:00,819 --> 00:26:06,399  
missions were there for how we went from

586  
00:26:02,619 --> 00:26:10,179  
sm one servicing mission 1 up to sm for

587  
00:26:06,400 --> 00:26:12,519  
Scott how the graphic up oh good that so

588  
00:26:10,180 --> 00:26:18,090  
that sounds like we had for servicing

589  
00:26:12,519 --> 00:26:22,450  
missions however we really had 50 room

590  
00:26:18,089 --> 00:26:25,839  
for sm-3 because we were coming up on a

591  
00:26:22,450 --> 00:26:29,410  
potential y2k problem at the end of 1999

592  
00:26:25,839 --> 00:26:32,980  
we had a requirement to get up there get

593  
00:26:29,410 --> 00:26:35,380  
back be safe on the ground by December

594  
00:26:32,980 --> 00:26:37,870  
thirty first nineteen ninety nine I did

595  
00:26:35,380 --> 00:26:39,970  
not know that that yeah we were

596  
00:26:37,869 --> 00:26:43,509  
everybody was sweating bullets are you

597  
00:26:39,970 --> 00:26:45,610  
friggin busy oh my gosh yeah I had no

598  
00:26:43,509 --> 00:26:50,289  
idea sir war they were free the fallout

599

00:26:45,609 --> 00:26:56,079  
expired well yeah we have just gravity

600  
00:26:50,289 --> 00:26:58,389  
and momentum stops with wife that's what

601  
00:26:56,079 --> 00:27:00,789  
we heard so NASA had a requirement

602  
00:26:58,390 --> 00:27:02,530  
everybody's on the ground yeah during

603  
00:27:00,789 --> 00:27:06,849  
that that when the clocks turn over

604  
00:27:02,529 --> 00:27:08,740  
that's why I know that now yeah from the

605  
00:27:06,849 --> 00:27:11,259  
servicing viewpoint from the EDA

606  
00:27:08,740 --> 00:27:15,339  
viewpoint we had a lot on our plate in

607  
00:27:11,259 --> 00:27:17,710  
what originally was called sm-3 so in

608  
00:27:15,339 --> 00:27:20,109  
order that nobody forgot that we

609  
00:27:17,710 --> 00:27:21,670  
couldn't do all that since we had a new

610  
00:27:20,109 --> 00:27:26,349  
requirement to be back on the ground

611  
00:27:21,670 --> 00:27:28,900  
before New Year's Eve 2000 we broke it

612  
00:27:26,349 --> 00:27:32,019  
up into two servicing missions so we

613  
00:27:28,900 --> 00:27:33,940

have a 3 a and a 3 B so in answer to

614

00:27:32,019 --> 00:27:36,519

your question the total number of

615

00:27:33,940 --> 00:27:41,529

servicing missions was five but the last

616

00:27:36,519 --> 00:27:43,329

one was sm4 in 2009 oh that's there was

617

00:27:41,529 --> 00:27:45,490

actually a second reason why the

618

00:27:43,329 --> 00:27:49,240

servicing mission 3 was split into two

619

00:27:45,490 --> 00:27:52,329

and that's because we had a increasing

620

00:27:49,240 --> 00:27:55,019

number of gyro failures yes in to that

621

00:27:52,329 --> 00:27:57,399

mission and eventually ran out of

622

00:27:55,019 --> 00:27:59,049

sufficient gyros to operate the mission

623

00:27:57,400 --> 00:28:00,580

so we did what's called a call-up

624

00:27:59,049 --> 00:28:02,589

mission which was has always been an

625

00:28:00,579 --> 00:28:04,599

option we had the option to tell manned

626

00:28:02,589 --> 00:28:05,379

spaceflight we need an emergency mission

627

00:28:04,599 --> 00:28:06,549

now

628  
00:28:05,380 --> 00:28:08,470  
that's a service Hubble because

629  
00:28:06,549 --> 00:28:10,930  
something's gone wrong so we said we're

630  
00:28:08,470 --> 00:28:12,490  
going to exercise that option now we're

631  
00:28:10,930 --> 00:28:14,410  
just going to do the gyros which are

632  
00:28:12,490 --> 00:28:16,359  
absolutely critical and a few other

633  
00:28:14,410 --> 00:28:18,310  
things that are ready to go like the

634  
00:28:16,359 --> 00:28:22,299  
advanced computer and the fine guidance

635  
00:28:18,309 --> 00:28:33,339  
sensor and we're getting before 2000 and

636  
00:28:22,299 --> 00:28:34,839  
get HST back into operation graphic

637  
00:28:33,339 --> 00:28:36,639  
after you can see the things that are

638  
00:28:34,839 --> 00:28:38,439  
installed and of course the astronomers

639  
00:28:36,640 --> 00:28:39,970  
had to wait for 3 B to get their

640  
00:28:38,440 --> 00:28:43,779  
instrument but it was more important to

641  
00:28:39,970 --> 00:28:47,710  
put these technical instrumentation in

642  
00:28:43,779 --> 00:28:52,509  
there to maintain the kitchen gyros so

643  
00:28:47,710 --> 00:28:54,490  
you could told ya pretty far yeah right

644  
00:28:52,509 --> 00:28:56,109  
so cut out right there explain what the

645  
00:28:54,490 --> 00:29:01,539  
gyros do because there are an important

646  
00:28:56,109 --> 00:29:03,819  
part the dry road so control the the

647  
00:29:01,539 --> 00:29:05,440  
pointing of the spacecraft across the

648  
00:29:03,819 --> 00:29:07,059  
sky so if there if you don't have a

649  
00:29:05,440 --> 00:29:09,100  
sufficient number to operate the

650  
00:29:07,059 --> 00:29:11,169  
telescope you basically can't do any

651  
00:29:09,099 --> 00:29:13,779  
science at all so they're sort of the

652  
00:29:11,170 --> 00:29:15,340  
base basic level of support that the

653  
00:29:13,779 --> 00:29:16,869  
telescope needs to move around in the

654  
00:29:15,339 --> 00:29:20,259  
state pointed at a particular direction

655  
00:29:16,869 --> 00:29:21,939  
on the sky so that's why that got top

656

00:29:20,259 --> 00:29:25,240  
priority over everything else at that

657  
00:29:21,940 --> 00:29:27,220  
point right it's very it's very critical

658  
00:29:25,240 --> 00:29:28,779  
so the first to the first servicing

659  
00:29:27,220 --> 00:29:31,000  
mission we put in a new camera wide

660  
00:29:28,779 --> 00:29:36,069  
field planetary camera up taking some

661  
00:29:31,000 --> 00:29:37,630  
amazingly uh I humanity altering images

662  
00:29:36,069 --> 00:29:40,539  
and I'm not overstating it when I say it

663  
00:29:37,630 --> 00:29:44,590  
that way uh there was also co-star which

664  
00:29:40,539 --> 00:29:46,359  
was the fix for the the error in the

665  
00:29:44,589 --> 00:29:49,389  
mirror Russ can you tell us a little bit

666  
00:29:46,359 --> 00:29:53,729  
about what co-star did what it was well

667  
00:29:49,390 --> 00:29:56,680  
casar became a new requirement for our

668  
00:29:53,730 --> 00:30:00,039  
1993 servicing mission we had already

669  
00:29:56,680 --> 00:30:02,350  
been planning for it at lunchtime but it

670  
00:30:00,039 --> 00:30:04,869

turned out that we had to add something

671

00:30:02,349 --> 00:30:09,069  
new and that was a new scientific

672

00:30:04,869 --> 00:30:11,739  
instrument that would by itself correct

673

00:30:09,069 --> 00:30:17,649  
the optics going to the other axial

674

00:30:11,740 --> 00:30:19,180  
instruments and to our credit at NASA we

675

00:30:17,650 --> 00:30:23,140  
came up with a

676

00:30:19,180 --> 00:30:25,750  
a innovative relatively simple way to

677

00:30:23,140 --> 00:30:29,230  
solve the problem as best we could and

678

00:30:25,750 --> 00:30:31,990  
that was in the lake path of this big

679

00:30:29,230 --> 00:30:35,049  
scientific instrument to put in small

680

00:30:31,990 --> 00:30:37,960  
mirrors that were trainable and and

681

00:30:35,049 --> 00:30:40,480  
allow corrective optics to the lake path

682

00:30:37,960 --> 00:30:44,019  
coming in to be passed along to the

683

00:30:40,480 --> 00:30:46,539  
other estimates and not and we were

684

00:30:44,019 --> 00:30:50,289  
successful in 1993 with that first



685  
00:30:46,539 --> 00:30:53,889  
servicing mission yet but we back at the

686  
00:30:50,289 --> 00:30:55,629  
time we launched in 1990 we didn't know

687  
00:30:53,890 --> 00:30:57,790  
how important that mission was going to

688  
00:30:55,630 --> 00:31:00,400  
be so you have a model there right next

689  
00:30:57,789 --> 00:31:02,740  
to you of the Hubble where was co-star

690  
00:31:00,400 --> 00:31:08,110  
placed you say in the light path where

691  
00:31:02,740 --> 00:31:10,809  
was it where does it put co-star what

692  
00:31:08,109 --> 00:31:13,719  
well first off there are Bay these big

693  
00:31:10,809 --> 00:31:18,329  
doors that open up so the astronauts can

694  
00:31:13,720 --> 00:31:21,009  
access for axial mission actual axial

695  
00:31:18,329 --> 00:31:24,490  
scientific instruments so this

696  
00:31:21,009 --> 00:31:27,549  
particular bay door here is where

697  
00:31:24,490 --> 00:31:29,710  
co-star was we had sacrificed the

698  
00:31:27,549 --> 00:31:31,690  
original instrument so I was gonna ask

699  
00:31:29,710 --> 00:31:33,069  
you how'd you find space for it okay so

700  
00:31:31,690 --> 00:31:35,230  
you took something out to put the

701  
00:31:33,069 --> 00:31:37,569  
hammock yeah any extra there's a

702  
00:31:35,230 --> 00:31:39,690  
question on the on Twitter right now

703  
00:31:37,569 --> 00:31:42,490  
from Daniel Fisher about this is that

704  
00:31:39,690 --> 00:31:44,620  
Hubble's high-speed photometer never got

705  
00:31:42,490 --> 00:31:50,950  
a chance and had to go for co-star why

706  
00:31:44,619 --> 00:31:54,089  
do we never fly one again but this all

707  
00:31:50,950 --> 00:31:57,610  
has to do with scientific importance and

708  
00:31:54,089 --> 00:32:00,519  
decisions as time went on as we were

709  
00:31:57,609 --> 00:32:03,579  
leading up to nineteen ninety three the

710  
00:32:00,519 --> 00:32:06,369  
scientists had to make a decision as to

711  
00:32:03,579 --> 00:32:08,439  
which instrument could be sacrificed so

712  
00:32:06,369 --> 00:32:11,259  
that we could correct every other xeo

713

00:32:08,440 --> 00:32:13,860  
instrument yeah I think what it amounts

714  
00:32:11,259 --> 00:32:16,690  
to is that the high-speed photometer

715  
00:32:13,859 --> 00:32:19,209  
although very doing important science

716  
00:32:16,690 --> 00:32:21,910  
was the least use of the scientific

717  
00:32:19,210 --> 00:32:24,160  
instruments and you know if you were

718  
00:32:21,910 --> 00:32:26,019  
forced to get rid of something you know

719  
00:32:24,160 --> 00:32:28,540  
the best thing to do is to go with the

720  
00:32:26,019 --> 00:32:29,950  
one that was being least productive out

721  
00:32:28,539 --> 00:32:32,710  
of the crew it was a painful decision

722  
00:32:29,950 --> 00:32:34,330  
for everybody to make yeah but

723  
00:32:32,710 --> 00:32:36,308  
seemed to be the right thing to do and

724  
00:32:34,329 --> 00:32:37,778  
to answer your question about why it

725  
00:32:36,308 --> 00:32:40,450  
wasn't flown again or a similar

726  
00:32:37,778 --> 00:32:42,119  
instrument every time we put a new set

727  
00:32:40,450 --> 00:32:45,490

of instruments up we had a competition

728

00:32:42,119 --> 00:32:48,519

where various groups in the astronomical

729

00:32:45,490 --> 00:32:52,120

new era would get together and propose

730

00:32:48,519 --> 00:32:54,250

new instruments and it's just a Fatah

731

00:32:52,119 --> 00:32:57,609

meter never rose to the top again in

732

00:32:54,250 --> 00:32:58,990

that very very strict competition very

733

00:32:57,609 --> 00:33:04,209

heavy competition there were always

734

00:32:58,990 --> 00:33:08,500

newer and better ideas will wanted to

735

00:33:04,210 --> 00:33:10,480

invest okay well I don't want to go over

736

00:33:08,500 --> 00:33:12,538

all the details of every servicing

737

00:33:10,480 --> 00:33:17,528

mission but I would like to ask you uh

738

00:33:12,538 --> 00:33:19,359

either us or can I sister r us actually

739

00:33:17,528 --> 00:33:22,690

lunging servicing mission ever done on

740

00:33:19,359 --> 00:33:28,439

the Hubble Space Telescope are was it

741

00:33:22,690 --> 00:33:34,419

the latest one what was the hardest did

742  
00:33:28,440 --> 00:33:37,298  
overall mr. instrument hello I'm sorry

743  
00:33:34,419 --> 00:33:40,240  
are you good we were frozen hello we are

744  
00:33:37,298 --> 00:33:44,319  
preferred so good to answer both

745  
00:33:40,240 --> 00:33:46,659  
questions my question was oh okay yeah

746  
00:33:44,319 --> 00:33:48,490  
most complicated instrument and most

747  
00:33:46,659 --> 00:33:53,500  
complicated mission both of those who

748  
00:33:48,490 --> 00:34:01,319  
have interests right okay complicated

749  
00:33:53,500 --> 00:34:04,210  
instructions were probably stiff and

750  
00:34:01,319 --> 00:34:06,099  
power control unit and for different

751  
00:34:04,210 --> 00:34:10,418  
reasons what's the app the power control

752  
00:34:06,099 --> 00:34:14,398  
yet without an acronym this disk space

753  
00:34:10,418 --> 00:34:17,138  
telescope tell us what this is I'm sorry

754  
00:34:14,398 --> 00:34:21,519  
tell you break it up space telescope

755  
00:34:17,139 --> 00:34:28,869  
imaging system yeah so are you we all

756  
00:34:21,519 --> 00:34:32,980  
are i think and pc you is power the pad

757  
00:34:28,869 --> 00:34:35,608  
our control that was very critical

758  
00:34:32,980 --> 00:34:38,829  
because for the first time in his life

759  
00:34:35,608 --> 00:34:42,699  
we have had to completely found the

760  
00:34:38,829 --> 00:34:46,929  
power or to the telescope so i think a

761  
00:34:42,699 --> 00:34:50,769  
lot of us we're not breathing for a long

762  
00:34:46,929 --> 00:34:50,769  
that was in

763  
00:34:53,239 --> 00:35:00,179  
the power control unit was in the sub 3

764  
00:34:57,148 --> 00:35:05,460  
b's i was two thousand two ish i'll try

765  
00:35:00,179 --> 00:35:08,309  
be yes and then first time the power had

766  
00:35:05,460 --> 00:35:11,300  
been shut down it was a tricky task as

767  
00:35:08,309 --> 00:35:14,250  
far as the astronauts were concerned

768  
00:35:11,300 --> 00:35:17,970  
because we had 30 some connectors to

769  
00:35:14,250 --> 00:35:20,190  
take off temporarily store and then get

770

00:35:17,969 --> 00:35:22,250  
back on and get back on so that the

771  
00:35:20,190 --> 00:35:26,429  
electrical connections were made and

772  
00:35:22,250 --> 00:35:28,800  
then I had to turn the power back on

773  
00:35:26,429 --> 00:35:31,889  
since power had never been turned off it

774  
00:35:28,800 --> 00:35:34,230  
had never been turned back on so those

775  
00:35:31,889 --> 00:35:38,519  
of us on the ground and the astronauts

776  
00:35:34,230 --> 00:35:42,150  
up there had a sigh of relief and proud

777  
00:35:38,519 --> 00:35:45,900  
accomplishment that it worked fine I can

778  
00:35:42,150 --> 00:35:48,660  
back around the sm to time i should i

779  
00:35:45,900 --> 00:35:51,539  
tell me you will never be able to change

780  
00:35:48,659 --> 00:35:54,719  
out that power control unit it was one

781  
00:35:51,539 --> 00:35:56,880  
of the units on hubble that wasn't ever

782  
00:35:54,719 --> 00:36:00,269  
thought we'd be back in there to want

783  
00:35:56,880 --> 00:36:04,140  
anything with that and there were other

784  
00:36:00,269 --> 00:36:07,559

things on how old it for us for reasons

785

00:36:04,139 --> 00:36:09,779

that make sense you just couldn't change

786

00:36:07,559 --> 00:36:11,489

out power control unit was one of them

787

00:36:09,780 --> 00:36:15,030

the astronaut told me he'd never be able

788

00:36:11,489 --> 00:36:18,359

to do it uh it essentially set up set up

789

00:36:15,030 --> 00:36:22,140

a challenge to us and guess what from sm

790

00:36:18,360 --> 00:36:26,280

2 up the sm-3 be we figured out a way to

791

00:36:22,139 --> 00:36:29,329

do it and the astronauts did it power

792

00:36:26,280 --> 00:36:32,310

came back on how was still working yeah

793

00:36:29,329 --> 00:36:34,170

wow so i did none that so the power

794

00:36:32,309 --> 00:36:39,420

control unit just was never thought to a

795

00:36:34,170 --> 00:36:43,380

new he deserves why was that well the

796

00:36:39,420 --> 00:36:45,059

people time first off it wouldn't be a

797

00:36:43,380 --> 00:36:51,869

requirement that everything had to be

798

00:36:45,059 --> 00:36:54,719

replaceable um and looked at fault tree



799  
00:36:51,869 --> 00:36:57,359  
analysis determined that there's

800  
00:36:54,719 --> 00:37:01,079  
probably chance that that whole unit

801  
00:36:57,360 --> 00:37:04,320  
would ever have to be replaced so it was

802  
00:37:01,079 --> 00:37:06,569  
on the list of things that did

803  
00:37:04,320 --> 00:37:09,600  
necessarily was not

804  
00:37:06,570 --> 00:37:14,039  
expected to be replaced it certainly

805  
00:37:09,599 --> 00:37:18,059  
could be but and we did hope sent and

806  
00:37:14,039 --> 00:37:21,119  
the mounting structure and all those

807  
00:37:18,059 --> 00:37:24,299  
electrical connections sure we could do

808  
00:37:21,119 --> 00:37:26,460  
it but it was a very tight space it was

809  
00:37:24,300 --> 00:37:28,470  
not an easy task either designing it on

810  
00:37:26,460 --> 00:37:30,900  
the ground designing the replacement all

811  
00:37:28,469 --> 00:37:33,929  
of them and training the astronauts and

812  
00:37:30,900 --> 00:37:36,930  
having them do it on spec in space so

813  
00:37:33,929 --> 00:37:39,119  
Russ I mean in your story you talk about

814  
00:37:36,929 --> 00:37:41,519  
how you figure out how I mean this is

815  
00:37:39,119 --> 00:37:44,609  
required tools astronauts can't just

816  
00:37:41,519 --> 00:37:47,400  
take it after swim fins replace the

817  
00:37:44,610 --> 00:37:51,210  
power unit requires very specialized

818  
00:37:47,400 --> 00:37:53,039  
tools talk about that a little well

819  
00:37:51,210 --> 00:37:56,220  
everything we did had it had a

820  
00:37:53,039 --> 00:37:59,849  
requirement for either replacement kind

821  
00:37:56,219 --> 00:38:01,919  
of repair and as you mentioned you just

822  
00:37:59,849 --> 00:38:05,279  
can't take up normal will totally

823  
00:38:01,920 --> 00:38:09,030  
everything we took up heading for Hubble

824  
00:38:05,280 --> 00:38:12,240  
missions had to be specially designed to

825  
00:38:09,030 --> 00:38:16,800  
consider safety being able to complete

826  
00:38:12,239 --> 00:38:19,799  
the mission successfully and and the

827

00:38:16,800 --> 00:38:21,780  
materials in the environment so there

828  
00:38:19,800 --> 00:38:24,180  
wasn't any grease that would be out

829  
00:38:21,780 --> 00:38:27,810  
guessing at the time there weren't sharp

830  
00:38:24,179 --> 00:38:30,779  
edges it had to withstand the changes in

831  
00:38:27,809 --> 00:38:32,789  
temperature and in the case pro unit

832  
00:38:30,780 --> 00:38:35,820  
with all those electrical connectors on

833  
00:38:32,789 --> 00:38:37,679  
it big circular connectors we had to

834  
00:38:35,820 --> 00:38:41,160  
make sure we did neither put too much

835  
00:38:37,679 --> 00:38:44,159  
torque or too little torque either in

836  
00:38:41,159 --> 00:38:46,699  
removing or replacing so we had all

837  
00:38:44,159 --> 00:38:49,349  
those challenges to make certain that

838  
00:38:46,699 --> 00:38:51,359  
mechanically and electrically it could

839  
00:38:49,349 --> 00:38:54,539  
be the old one could be taken out the

840  
00:38:51,360 --> 00:38:57,150  
new one could be put in and it worked

841  
00:38:54,539 --> 00:38:59,279

afterwards my favorite about that on

842

00:38:57,150 --> 00:39:01,920

this topic is was with SM for when they

843

00:38:59,280 --> 00:39:03,120

had a design that's been I guess it John

844

00:39:01,920 --> 00:39:06,119

Grunsfeld had to used they were

845

00:39:03,119 --> 00:39:08,009

unscrewing all these screws and so to in

846

00:39:06,119 --> 00:39:09,389

so to get all of those screws off

847

00:39:08,010 --> 00:39:10,860

without them floating around and

848

00:39:09,389 --> 00:39:13,109

becoming their own little satellites

849

00:39:10,860 --> 00:39:15,599

they designed this thing that look like

850

00:39:13,110 --> 00:39:17,519

a tackle box and you you screw through

851

00:39:15,599 --> 00:39:20,130

you you operated the screwdriver and

852

00:39:17,519 --> 00:39:21,329

screws and nuts or whatever they were

853

00:39:20,130 --> 00:39:22,920

I'll into their so they could they

854

00:39:21,329 --> 00:39:25,789

wouldn't be lost I thought that was my

855

00:39:22,920 --> 00:39:27,840

that was clever I thought this was good

856  
00:39:25,789 --> 00:39:31,500  
that was going to be the second answer

857  
00:39:27,840 --> 00:39:34,140  
to my question they said this did to

858  
00:39:31,500 --> 00:39:40,920  
your question this disrepair that we did

859  
00:39:34,139 --> 00:39:42,929  
in sm 4 in 2009 and that we always plan

860  
00:39:40,920 --> 00:39:45,119  
for a nominal operation and nominal

861  
00:39:42,929 --> 00:39:46,909  
operation for that was to have this big

862  
00:39:45,119 --> 00:39:49,920  
blue plate that you're talking about

863  
00:39:46,909 --> 00:39:55,920  
donec and a special tool that we built

864  
00:39:49,920 --> 00:39:58,349  
to be able to have have that with it say

865  
00:39:55,920 --> 00:40:01,320  
a screwdriver bit go in for all the

866  
00:39:58,349 --> 00:40:05,389  
different fasteners and there were over

867  
00:40:01,320 --> 00:40:10,850  
100 teen fasteners or so washers

868  
00:40:05,389 --> 00:40:10,849  
fasteners and have that

869  
00:40:13,079 --> 00:40:24,099  
sleep oh look you mentioned it hey there

870  
00:40:19,269 --> 00:40:28,889  
it is to reach through each one of these

871  
00:40:24,099 --> 00:40:33,099  
opening count the fastener watch

872  
00:40:28,889 --> 00:40:35,949  
whatever was with it and essentially we

873  
00:40:33,099 --> 00:40:37,989  
made a sandwich we designed this so it

874  
00:40:35,949 --> 00:40:39,730  
would be bolted to the plate that we're

875  
00:40:37,989 --> 00:40:43,719  
trying to take off to get to a circuit

876  
00:40:39,730 --> 00:40:46,420  
board on hub so in that sandwich we had

877  
00:40:43,719 --> 00:40:49,329  
this outer plate there are cavities in

878  
00:40:46,420 --> 00:40:52,659  
between here so as each faster came out

879  
00:40:49,329 --> 00:40:54,670  
it floated with in that cavity and they

880  
00:40:52,659 --> 00:40:58,750  
went through with proper tools that were

881  
00:40:54,670 --> 00:41:00,940  
needed got all of those off and then

882  
00:40:58,750 --> 00:41:04,300  
this whole sandwich of this special

883  
00:41:00,940 --> 00:41:06,340  
plate that we designed and they the

884

00:41:04,300 --> 00:41:09,940  
plate on hole that we're trying to get

885  
00:41:06,340 --> 00:41:12,700  
to behind it or bolted together and that

886  
00:41:09,940 --> 00:41:20,369  
the actual one is the one you were used

887  
00:41:12,699 --> 00:41:23,079  
uh truth in it ever tell you this is an

888  
00:41:20,369 --> 00:41:25,559  
engineering unit that we used in neutral

889  
00:41:23,079 --> 00:41:28,929  
buoyancy testing and training the extra

890  
00:41:25,559 --> 00:41:30,279  
but with our video connection you

891  
00:41:28,929 --> 00:41:32,500  
probably wouldn't tell the difference

892  
00:41:30,280 --> 00:41:35,380  
but they are the actual flight hardware

893  
00:41:32,500 --> 00:41:38,079  
in this total thank you for your honesty

894  
00:41:35,380 --> 00:41:41,740  
you know what so that we had when we got

895  
00:41:38,079 --> 00:41:45,429  
it back on go ahead and finish sorry the

896  
00:41:41,739 --> 00:41:47,439  
first thing we did I'm sorry I'm sorry

897  
00:41:45,429 --> 00:41:49,509  
tiny go ahead no I was telling you to go

898  
00:41:47,440 --> 00:41:53,050

ahead I we're all cutting out now oh

899

00:41:49,510 --> 00:41:54,850

okay the first thing we did was to count

900

00:41:53,050 --> 00:41:57,190

all those fasteners said that none would

901

00:41:54,849 --> 00:42:00,009

be floating loose floating back down the

902

00:41:57,190 --> 00:42:03,220

barrel the telescope and they were all

903

00:42:00,010 --> 00:42:06,580

there so this was the type of design we

904

00:42:03,219 --> 00:42:09,579

had to go through to have a specialized

905

00:42:06,579 --> 00:42:12,670

design and design this on the ground it

906

00:42:09,579 --> 00:42:14,380

has to fit up there and and we went back

907

00:42:12,670 --> 00:42:17,650

through the drawings & and the

908

00:42:14,380 --> 00:42:19,599

photographs to be able to tell all these

909

00:42:17,650 --> 00:42:22,660

dimensions that we have on this to make

910

00:42:19,599 --> 00:42:24,429

it work properly so this believes me to

911

00:42:22,659 --> 00:42:25,539

my next question which is

912

00:42:24,429 --> 00:42:26,859

when you guys are when you're working



913  
00:42:25,539 --> 00:42:29,469  
through these procedures for how to

914  
00:42:26,860 --> 00:42:33,970  
repair things on Hubble you have a full

915  
00:42:29,469 --> 00:42:35,919  
mock-up of Hubble around and you said in

916  
00:42:33,969 --> 00:42:39,639  
the neutral buoyancy tank right is it

917  
00:42:35,920 --> 00:42:42,059  
and then you practice your rehearsals

918  
00:42:39,639 --> 00:42:45,309  
there correct in assuming that's what

919  
00:42:42,059 --> 00:42:49,239  
one thing we do we have low scale

920  
00:42:45,309 --> 00:42:51,670  
mock-ups that we put in the water 6.2

921  
00:42:49,239 --> 00:42:54,129  
million gallon swimming pool essentially

922  
00:42:51,670 --> 00:42:58,420  
down at Johnson Space Center in Houston

923  
00:42:54,130 --> 00:43:01,450  
Texas the astronauts go in on old suits

924  
00:42:58,420 --> 00:43:07,389  
uh we take advantage of neutral buoyancy

925  
00:43:01,449 --> 00:43:11,289  
we give them the Tauri underwater and we

926  
00:43:07,389 --> 00:43:13,119  
go in on scuba and make sure that we

927  
00:43:11,289 --> 00:43:15,940  
know what they're doing and that they're

928  
00:43:13,119 --> 00:43:18,519  
doing the things that will link to a

929  
00:43:15,940 --> 00:43:20,349  
successful change out right okay so

930  
00:43:18,519 --> 00:43:21,610  
we're getting close to the end of the

931  
00:43:20,349 --> 00:43:24,009  
hanging out here I want to get to some

932  
00:43:21,610 --> 00:43:26,620  
questions on the Q&A app Cecil Morgan is

933  
00:43:24,010 --> 00:43:29,620  
asking wasn't HST originally designed to

934  
00:43:26,619 --> 00:43:31,480  
be brought back to ground by shuttle for

935  
00:43:29,619 --> 00:43:35,319  
servicing I can do you have any comment

936  
00:43:31,480 --> 00:43:38,940  
on that yeah that was the the concept of

937  
00:43:35,320 --> 00:43:42,070  
thought it would might be Rock every

938  
00:43:38,940 --> 00:43:47,050  
read if I guess fixed up on the ground

939  
00:43:42,070 --> 00:43:50,019  
and sent back into orbit happen ended up

940  
00:43:47,050 --> 00:43:55,900  
not doing that for a couple reasons

941

00:43:50,019 --> 00:43:59,880  
women that's not doing that uh-uh it is

942  
00:43:55,900 --> 00:43:59,880  
you're breaking up Tony can you hear me

943  
00:43:59,909 --> 00:44:05,949  
yeah I know we all are no I can't hear

944  
00:44:02,889 --> 00:44:08,139  
you I ribes I was asking you I was

945  
00:44:05,949 --> 00:44:10,480  
asking you why why that it didn't end up

946  
00:44:08,139 --> 00:44:11,949  
happening I was just I was just asking

947  
00:44:10,480 --> 00:44:14,860  
why that didn't end up happening that

948  
00:44:11,949 --> 00:44:16,839  
way well right and the end of people

949  
00:44:14,860 --> 00:44:18,550  
thought it would be actually too

950  
00:44:16,840 --> 00:44:20,890  
complicated and too expensive to bring

951  
00:44:18,550 --> 00:44:23,380  
the telescope down refurbish it and

952  
00:44:20,889 --> 00:44:25,659  
sending send it up there was a lot of

953  
00:44:23,380 --> 00:44:27,700  
concern about possible contamination as

954  
00:44:25,659 --> 00:44:29,799  
the telescope was back down to the

955  
00:44:27,699 --> 00:44:31,869

ground there'd be in addition to the

956

00:44:29,800 --> 00:44:34,120

chemical contamination you have a lot of

957

00:44:31,869 --> 00:44:36,489

forces exerted on the telescope during

958

00:44:34,119 --> 00:44:37,929

reentry and relaunched and the ability

959

00:44:36,489 --> 00:44:38,288

the possibility that you'd shake things

960

00:44:37,929 --> 00:44:41,379

apart

961

00:44:38,289 --> 00:44:43,559

mine in the end do more damage than he

962

00:44:41,380 --> 00:44:45,999

would gain advantage so that ear of

963

00:44:43,559 --> 00:44:47,679

servicing and orbit sidesteps the

964

00:44:45,998 --> 00:44:50,288

contamination issue to a large degree

965

00:44:47,679 --> 00:44:54,039

and the additional stresses from launch

966

00:44:50,289 --> 00:44:55,239

so there were also concerns that landing

967

00:44:54,039 --> 00:44:56,859

with the telescope in the back of the

968

00:44:55,239 --> 00:45:01,208

shuttle could be very dangerous or you

969

00:44:56,858 --> 00:45:04,659

had a unusually sharp deceleration of

970  
00:45:01,208 --> 00:45:06,159  
the shuttle landing at the airport that

971  
00:45:04,659 --> 00:45:09,728  
the whole telescope might just come

972  
00:45:06,159 --> 00:45:12,639  
through the crew bay and desirable event

973  
00:45:09,728 --> 00:45:14,498  
as well the whole pile of reasons while

974  
00:45:12,639 --> 00:45:16,328  
we thought well you know it sounded good

975  
00:45:14,498 --> 00:45:18,389  
on paper but it would be much better if

976  
00:45:16,329 --> 00:45:20,709  
we just serviced in orbit and the

977  
00:45:18,389 --> 00:45:22,538  
techniques for doing that in orbit came

978  
00:45:20,708 --> 00:45:24,639  
along quickly enough that they were

979  
00:45:22,539 --> 00:45:26,410  
rapidly adopted and we switched to the

980  
00:45:24,639 --> 00:45:30,219  
bus service in orbit every three to five

981  
00:45:26,409 --> 00:45:34,268  
years ok so there's another reason from

982  
00:45:30,219 --> 00:45:37,838  
from an EV a viewpoint we we added solar

983  
00:45:34,268 --> 00:45:39,998  
rays that no longer would allow the

984  
00:45:37,838 --> 00:45:43,358  
telescope to fit in the shuttle that's

985  
00:45:39,998 --> 00:45:46,509  
right we also put panels on the outside

986  
00:45:43,358 --> 00:45:50,380  
for thermal control we put things inside

987  
00:45:46,509 --> 00:45:52,688  
and it would probably take in two or

988  
00:45:50,380 --> 00:45:55,539  
three trips of a shuttle to go up to

989  
00:45:52,688 --> 00:45:58,418  
bring back all the pieces that yeah

990  
00:45:55,539 --> 00:46:01,509  
that's it's not very efficient I guess

991  
00:45:58,418 --> 00:46:04,268  
so I did we would have loved to have it

992  
00:46:01,509 --> 00:46:06,309  
brought back and we could go down to DC

993  
00:46:04,268 --> 00:46:09,968  
and see it in the Smithsonian but that

994  
00:46:06,309 --> 00:46:12,219  
that was not a practical way to do it

995  
00:46:09,969 --> 00:46:14,499  
that's too bad it really is now this

996  
00:46:12,219 --> 00:46:16,088  
isn't directly related to Hubble but did

997  
00:46:14,498 --> 00:46:18,368  
I think your shuttle was pretty much

998

00:46:16,088 --> 00:46:19,659  
designed to land without anything in the

999  
00:46:18,369 --> 00:46:22,568  
cargo bay wasn't it let me do but it

1000  
00:46:19,659 --> 00:46:23,858  
didn't ever land full of stuff the unit

1001  
00:46:22,568 --> 00:46:25,659  
does anybody know I mean it's not a

1002  
00:46:23,858 --> 00:46:29,139  
Hubble question for exactly but I'm just

1003  
00:46:25,659 --> 00:46:30,640  
curious well ldf didn't it long duration

1004  
00:46:29,139 --> 00:46:32,588  
facility I think came back in the

1005  
00:46:30,639 --> 00:46:34,509  
initial did it okay okay i wasn't i

1006  
00:46:32,588 --> 00:46:36,369  
don't i don't recall that that's

1007  
00:46:34,509 --> 00:46:37,958  
probably not nearly as heavy or as dense

1008  
00:46:36,369 --> 00:46:40,599  
as some would have been because it was

1009  
00:46:37,958 --> 00:46:42,639  
basically a an outer shell with samples

1010  
00:46:40,599 --> 00:46:44,919  
of material all around the periphery but

1011  
00:46:42,639 --> 00:46:46,778  
but remember for servicing missions they

1012  
00:46:44,918 --> 00:46:50,048

take instruments up and they take stuff

1013

00:46:46,778 --> 00:46:52,329

out look so it's never coming back empty

1014

00:46:50,048 --> 00:46:53,739

from a certain equipment

1015

00:46:52,329 --> 00:46:55,029

right yeah as a matter of fact a number

1016

00:46:53,739 --> 00:46:58,359

of those instruments are down in the

1017

00:46:55,030 --> 00:47:01,960

Smithsonian for jobs to do and say hi as

1018

00:46:58,360 --> 00:47:06,039

well as well as co-star which you to see

1019

00:47:01,960 --> 00:47:10,090

the correction that we may in 1993 with

1020

00:47:06,039 --> 00:47:11,949

the corrective optics so Eamonn Fenton

1021

00:47:10,090 --> 00:47:13,960

on the Q&A app as asking an interesting

1022

00:47:11,949 --> 00:47:15,879

question would it not be a future option

1023

00:47:13,960 --> 00:47:18,429

to have multiple smaller aperture

1024

00:47:15,880 --> 00:47:19,930

telescopes like Hubble acting like an

1025

00:47:18,429 --> 00:47:21,730

interferometer rather than a single

1026

00:47:19,929 --> 00:47:24,009

larger telescope like James wow that's



1027  
00:47:21,730 --> 00:47:26,650  
an interesting idea sort of a series or

1028  
00:47:24,010 --> 00:47:28,300  
a network of telescopes pointing up in

1029  
00:47:26,650 --> 00:47:31,630  
orbit what do you think of that Kenneth

1030  
00:47:28,300 --> 00:47:33,160  
what 61 read my webpage I've actually

1031  
00:47:31,630 --> 00:47:36,180  
worked tonight dear called stellar

1032  
00:47:33,159 --> 00:47:39,309  
imager which was exactly that basically

1033  
00:47:36,179 --> 00:47:41,199  
31 meter mirrors working together in

1034  
00:47:39,309 --> 00:47:43,539  
space all pointing at the same target at

1035  
00:47:41,199 --> 00:47:46,239  
the same time and focusing light onto a

1036  
00:47:43,539 --> 00:47:48,009  
central hub and you could indeed it

1037  
00:47:46,239 --> 00:47:50,049  
would be kind of like a James Webb which

1038  
00:47:48,010 --> 00:47:52,660  
already has segments but separating them

1039  
00:47:50,050 --> 00:47:54,310  
out over much longer baseline so instead

1040  
00:47:52,659 --> 00:47:56,500  
of having a six and a half meter

1041  
00:47:54,309 --> 00:47:59,049  
diameter you might have a virtual mirror

1042  
00:47:56,500 --> 00:48:01,119  
that could be 500 meters or a kilometer

1043  
00:47:59,050 --> 00:48:03,010  
in diameter with a lot of open spaces

1044  
00:48:01,119 --> 00:48:04,539  
between it but you would observe an

1045  
00:48:03,010 --> 00:48:08,260  
object and then move the mirrors around

1046  
00:48:04,539 --> 00:48:10,420  
and kind of fill in that virtual mirror

1047  
00:48:08,260 --> 00:48:12,340  
and get the resolving power on the sky

1048  
00:48:10,420 --> 00:48:15,309  
of something a kilometer in diameter

1049  
00:48:12,340 --> 00:48:16,720  
instead of six or 10 meters and that

1050  
00:48:15,309 --> 00:48:19,059  
something like that would actually allow

1051  
00:48:16,719 --> 00:48:21,069  
you to resolve features on the surfaces

1052  
00:48:19,059 --> 00:48:23,320  
of other stars you can see spots and

1053  
00:48:21,070 --> 00:48:25,269  
flares just like you see on the Sun on

1054  
00:48:23,320 --> 00:48:29,380  
very distant stars if you had so I

1055

00:48:25,269 --> 00:48:33,820  
diameter that's day going I don't winds

1056  
00:48:29,380 --> 00:48:35,769  
that lunch thing I guess I broke so you

1057  
00:48:33,820 --> 00:48:38,230  
know it's it's uh it's it's probably

1058  
00:48:35,769 --> 00:48:40,719  
decades off now we know how to do it but

1059  
00:48:38,230 --> 00:48:42,550  
it would be a tremendous technologies

1060  
00:48:40,719 --> 00:48:44,889  
development but it is possible there's

1061  
00:48:42,550 --> 00:48:46,600  
not a lot like something like that I

1062  
00:48:44,889 --> 00:48:47,440  
would totally love it okay Scott I might

1063  
00:48:46,599 --> 00:48:51,039  
could you have anything i'm missing

1064  
00:48:47,440 --> 00:48:53,530  
somewhere not that I'm seeing the ones

1065  
00:48:51,039 --> 00:48:57,400  
from Twitter are mainly just awesome

1066  
00:48:53,530 --> 00:49:02,740  
responses to demand to the demand option

1067  
00:48:57,400 --> 00:49:04,389  
for it so let's see here sand archons is

1068  
00:49:02,739 --> 00:49:05,879  
well my daughter is going to freak when

1069  
00:49:04,389 --> 00:49:08,009

I relay this

1070

00:49:05,880 --> 00:49:10,380

yeah that would be an awesome job to

1071

00:49:08,010 --> 00:49:12,600

grow up to want to be I mean what

1072

00:49:10,380 --> 00:49:14,099

inspiring the use of the future like

1073

00:49:12,599 --> 00:49:16,589

what you wanna do I want to go man a

1074

00:49:14,099 --> 00:49:18,509

telescope in space that would yes I know

1075

00:49:16,590 --> 00:49:21,390

it would be a great job no question

1076

00:49:18,510 --> 00:49:24,510

about it well I I'm really sorry about

1077

00:49:21,389 --> 00:49:26,309

all the technical problems guys but this

1078

00:49:24,510 --> 00:49:27,480

will not be the only history hang out

1079

00:49:26,309 --> 00:49:29,400

that we do for Hubble cuz we just

1080

00:49:27,480 --> 00:49:31,349

touched the surface on this one so

1081

00:49:29,400 --> 00:49:32,849

hopefully the the technical issues won't

1082

00:49:31,349 --> 00:49:34,199

be around the next time and where I'm

1083

00:49:32,849 --> 00:49:38,130

going to invite both of these guys back

1084  
00:49:34,199 --> 00:49:39,629  
again and I also want to have a Caroline

1085  
00:49:38,130 --> 00:49:41,789  
I talked about this we also want to have

1086  
00:49:39,630 --> 00:49:43,260  
a hangout that's dedicated to the nuts

1087  
00:49:41,789 --> 00:49:46,230  
and bolts of Hubble you know how do we

1088  
00:49:43,260 --> 00:49:47,490  
actually operate it and so that's in the

1089  
00:49:46,230 --> 00:49:50,070  
pipeline to and hopefully these guys

1090  
00:49:47,489 --> 00:49:51,959  
will join us again for that I want to

1091  
00:49:50,070 --> 00:49:53,550  
ask this last question to all of you and

1092  
00:49:51,960 --> 00:49:56,849  
Scott that I'd like to get your feedback

1093  
00:49:53,550 --> 00:49:59,370  
your reaction to this too can you can

1094  
00:49:56,849 --> 00:50:01,349  
you give me can each of you give me some

1095  
00:49:59,369 --> 00:50:03,750  
comments on what Hubble the Hubble Space

1096  
00:50:01,349 --> 00:50:13,519  
Telescope has meant to you personally

1097  
00:50:03,750 --> 00:50:16,489  
and I'll start with you Carol really ok

1098  
00:50:13,519 --> 00:50:21,150  
well I came from the ground-based

1099  
00:50:16,489 --> 00:50:23,279  
astronomical community and we had some

1100  
00:50:21,150 --> 00:50:26,250  
pretty good instrumentation there and

1101  
00:50:23,280 --> 00:50:33,060  
did some interesting science I think the

1102  
00:50:26,250 --> 00:50:37,289  
Hubble then opens a lot of new areas of

1103  
00:50:33,059 --> 00:50:39,809  
study so technologically I think the

1104  
00:50:37,289 --> 00:50:42,659  
telescope is magnificent and astronomers

1105  
00:50:39,809 --> 00:50:44,940  
just just love it for the technology and

1106  
00:50:42,659 --> 00:50:47,909  
the amazing instrumentation on it and

1107  
00:50:44,940 --> 00:50:50,099  
the fact that you know every few years

1108  
00:50:47,909 --> 00:50:53,369  
it turned into a brand new telescope

1109  
00:50:50,099 --> 00:50:56,309  
somebody said these comment about oh you

1110  
00:50:53,369 --> 00:50:59,190  
know it's a you know 25 years old yeah

1111  
00:50:56,309 --> 00:51:01,349  
but the last servicing mission was 2009

1112

00:50:59,190 --> 00:51:04,139  
so it's it's really a five year old

1113  
00:51:01,349 --> 00:51:07,259  
telescope so it's like fantastic and the

1114  
00:51:04,139 --> 00:51:10,469  
mirror is beautiful even though it's not

1115  
00:51:07,260 --> 00:51:12,840  
the perfect curvature the as rust talked

1116  
00:51:10,469 --> 00:51:15,299  
about the ingenuity of the instrument

1117  
00:51:12,840 --> 00:51:18,000  
building got around that and now we can

1118  
00:51:15,300 --> 00:51:19,890  
take full advantage of it I also think

1119  
00:51:18,000 --> 00:51:22,139  
that for Hubble the

1120  
00:51:19,889 --> 00:51:24,118  
changed a little bit the way people do

1121  
00:51:22,139 --> 00:51:26,159  
science the fact that we have large

1122  
00:51:24,119 --> 00:51:29,910  
groups they collaborate frontier fields

1123  
00:51:26,159 --> 00:51:32,009  
as an example of the field now all these

1124  
00:51:29,909 --> 00:51:35,149  
other telescopes are working together

1125  
00:51:32,010 --> 00:51:38,099  
people who are using kinds of facilities

1126  
00:51:35,150 --> 00:51:41,039

to look at specific problems in

1127

00:51:38,099 --> 00:51:43,650

astronomy which we never did before so I

1128

00:51:41,039 --> 00:51:45,990

think it changed the culture of science

1129

00:51:43,650 --> 00:51:48,539

and it's just it's a magnificent that's

1130

00:51:45,989 --> 00:51:49,889

helped it's just fantastic thank you

1131

00:51:48,539 --> 00:51:51,690

Scott can you give us some personal

1132

00:51:49,889 --> 00:51:53,338

comments about what you know about what

1133

00:51:51,690 --> 00:51:54,900

it's meant for you yeah I mean it's

1134

00:51:53,338 --> 00:51:57,900

something that you and I have talked

1135

00:51:54,900 --> 00:51:59,880

about privately but you know I remember

1136

00:51:57,900 --> 00:52:03,119

when Hubble launched and it you know I

1137

00:51:59,880 --> 00:52:07,588

was fairly young at the time we're for

1138

00:52:03,119 --> 00:52:11,490

sniper right young whippersnapper but so

1139

00:52:07,588 --> 00:52:13,588

seeing and being excited about it uh and

1140

00:52:11,489 --> 00:52:15,868

seeing you know the the beautiful images



1141  
00:52:13,588 --> 00:52:18,690  
have come down over time as I've grown

1142  
00:52:15,869 --> 00:52:22,410  
up to really appreciate science and

1143  
00:52:18,690 --> 00:52:24,240  
astronomy MIT and as it's become a more

1144  
00:52:22,409 --> 00:52:26,940  
important part of my life now to the

1145  
00:52:24,239 --> 00:52:29,429  
point where I'm working help telling the

1146  
00:52:26,940 --> 00:52:31,048  
story of a bubble through Hubble

1147  
00:52:29,429 --> 00:52:32,699  
hangouts it really means a lot to me

1148  
00:52:31,048 --> 00:52:34,679  
personally that I'm able to get back in

1149  
00:52:32,699 --> 00:52:38,730  
this way because it has really inspired

1150  
00:52:34,679 --> 00:52:41,518  
me to learn more about our universe and

1151  
00:52:38,730 --> 00:52:44,099  
being able to share that with with

1152  
00:52:41,518 --> 00:52:45,959  
people that's really how it affected me

1153  
00:52:44,099 --> 00:52:47,430  
if watching the servicing missions and

1154  
00:52:45,960 --> 00:52:50,099  
learning more and seeing a lot of the

1155  
00:52:47,429 --> 00:52:52,048  
the the ultra deep field limits and

1156  
00:52:50,099 --> 00:52:54,000  
learning more and being able to share

1157  
00:52:52,048 --> 00:52:57,809  
that with with more and more people and

1158  
00:52:54,000 --> 00:52:59,278  
now even in a larger scope now doing

1159  
00:52:57,809 --> 00:53:01,740  
with double hangouts so it's something

1160  
00:52:59,278 --> 00:53:04,199  
that's really really inspired me and

1161  
00:53:01,739 --> 00:53:05,399  
many different ways love it good and

1162  
00:53:04,199 --> 00:53:06,838  
you're doing great with the Hubble

1163  
00:53:05,400 --> 00:53:08,818  
hangouts to it we could imagine doing

1164  
00:53:06,838 --> 00:53:11,038  
these without you so I rest you got any

1165  
00:53:08,818 --> 00:53:15,509  
comments on I'm from a personal nature

1166  
00:53:11,039 --> 00:53:18,230  
on the Hubble well Hubble weren't

1167  
00:53:15,509 --> 00:53:21,829  
working on Hubble from the eda viewpoint

1168  
00:53:18,230 --> 00:53:26,789  
I personally have tremendous pride in

1169

00:53:21,829 --> 00:53:28,859  
how it has resulted that you can talk to

1170  
00:53:26,789 --> 00:53:32,250  
almost anybody they know a little bit

1171  
00:53:28,858 --> 00:53:33,239  
about Hubble ah the tremendous

1172  
00:53:32,250 --> 00:53:37,619  
accomplished

1173  
00:53:33,239 --> 00:53:41,000  
that it has made and the images that it

1174  
00:53:37,619 --> 00:53:43,769  
brings back when I talk to school kids

1175  
00:53:41,000 --> 00:53:45,510  
their teachers don't like it but I tell

1176  
00:53:43,769 --> 00:53:49,170  
them to throw away their science books

1177  
00:53:45,510 --> 00:53:51,840  
they're astronomy get all of that and

1178  
00:53:49,170 --> 00:53:54,960  
then I so that I get invited back I have

1179  
00:53:51,840 --> 00:53:59,070  
to explain I just got your attention by

1180  
00:53:54,960 --> 00:54:02,519  
saying that don't you dare spines books

1181  
00:53:59,070 --> 00:54:06,809  
away the fact that it's made on science

1182  
00:54:02,519 --> 00:54:09,949  
and to be a small part of the team of

1183  
00:54:06,809 --> 00:54:13,409

astronauts scientists engineers

1184

00:54:09,949 --> 00:54:15,868

technicians that nASA has put together

1185

00:54:13,409 --> 00:54:19,230

to do this I couldn't have asked for a

1186

00:54:15,869 --> 00:54:21,960

better job wonderful right now Ken I'll

1187

00:54:19,230 --> 00:54:24,570

leave that last word it's been a fun

1188

00:54:21,960 --> 00:54:27,240

ride you know who thought when I signed

1189

00:54:24,570 --> 00:54:29,369

on to this for a couple of years back in

1190

00:54:27,239 --> 00:54:32,699

the mid-80s that it would have gone on

1191

00:54:29,369 --> 00:54:35,730

so long it's a it's been a privilege to

1192

00:54:32,699 --> 00:54:37,079

be able to stay with this observatory

1193

00:54:35,730 --> 00:54:39,780

that's up the leading edge of science

1194

00:54:37,079 --> 00:54:41,340

and has been there continuously now for

1195

00:54:39,780 --> 00:54:43,260

25 years and that's only possible

1196

00:54:41,340 --> 00:54:44,850

because we were able to do the servicing

1197

00:54:43,260 --> 00:54:46,670

otherwise we wouldn't have been able to

1198  
00:54:44,849 --> 00:54:49,858  
stay ahead of advancements on the ground

1199  
00:54:46,670 --> 00:54:51,630  
but it's it's been a privilege to be

1200  
00:54:49,858 --> 00:54:53,849  
here and be involved and watch all of

1201  
00:54:51,630 --> 00:54:55,680  
the unexpected discoveries that were

1202  
00:54:53,849 --> 00:54:58,829  
made along with all the things that we

1203  
00:54:55,679 --> 00:55:01,289  
thought Hubble would be capable of doing

1204  
00:54:58,829 --> 00:55:03,299  
of helping to verify the accelerating

1205  
00:55:01,289 --> 00:55:05,429  
expansion of the universe which no one

1206  
00:55:03,300 --> 00:55:07,930  
in their right mind remotely she seemed

1207  
00:55:05,429 --> 00:55:10,329  
of back when we

1208  
00:55:07,929 --> 00:55:12,250  
we were watching comets collide in the

1209  
00:55:10,329 --> 00:55:14,170  
Jupiter's a whole string of things that

1210  
00:55:12,250 --> 00:55:15,369  
we didn't really anticipate and it's

1211  
00:55:14,170 --> 00:55:17,230  
been a whole lot of fun seeing them and

1212  
00:55:15,369 --> 00:55:19,779  
being able to observe them and actually

1213  
00:55:17,230 --> 00:55:21,190  
get real information out of them so

1214  
00:55:19,780 --> 00:55:23,440  
there's that and then there's just the

1215  
00:55:21,190 --> 00:55:26,920  
whole story of the lesson to be learned

1216  
00:55:23,440 --> 00:55:28,900  
from never giving up and you know being

1217  
00:55:26,920 --> 00:55:30,490  
up to overcome adversity first you had

1218  
00:55:28,900 --> 00:55:31,750  
the spherical aberration which looked

1219  
00:55:30,489 --> 00:55:34,000  
like it was going to kill the mission

1220  
00:55:31,750 --> 00:55:36,639  
that we bounced back from very rapidly

1221  
00:55:34,000 --> 00:55:39,699  
with a lot of talented people finding

1222  
00:55:36,639 --> 00:55:41,079  
the solution and then later on when the

1223  
00:55:39,699 --> 00:55:42,939  
last servicing mission looked like it

1224  
00:55:41,079 --> 00:55:45,099  
was cancelled and Hubble was going to

1225  
00:55:42,940 --> 00:55:48,579  
stop operating you know 2010 or

1226

00:55:45,099 --> 00:55:50,650  
something we stuck with it found a way

1227  
00:55:48,579 --> 00:55:52,630  
to keep people employed and productive

1228  
00:55:50,650 --> 00:55:55,300  
until the decision got reversed and we

1229  
00:55:52,630 --> 00:55:56,710  
got the last mission in 2009 which now

1230  
00:55:55,300 --> 00:55:58,360  
looks critical for getting Hubble to

1231  
00:55:56,710 --> 00:56:00,429  
opera

1232  
00:55:58,360 --> 00:56:04,720  
rate prolapse with operations with the

1233  
00:56:00,429 --> 00:56:05,889  
James Webb Space Telescope I think it's

1234  
00:56:04,719 --> 00:56:11,439  
critical to have both of them up there

1235  
00:56:05,889 --> 00:56:13,509  
at the same time send the sky from the

1236  
00:56:11,440 --> 00:56:16,150  
far UV ultraviolet bluer than the eye

1237  
00:56:13,510 --> 00:56:18,340  
sees out to the far read that James Webb

1238  
00:56:16,150 --> 00:56:20,230  
will be able to detect well I couldn't

1239  
00:56:18,340 --> 00:56:23,289  
agree more in the public outcry from the

1240  
00:56:20,230 --> 00:56:25,510

last supper Hubble mission servicing

1241  
00:56:23,289 --> 00:56:28,269  
mission was I was very humbling and I

1242  
00:56:25,510 --> 00:56:29,410  
was very amazing to watch the amount of

1243  
00:56:28,269 --> 00:56:33,400  
support that the Hubble Space Telescope

1244  
00:56:29,409 --> 00:56:35,079  
has for mine go ahead Tony I was just

1245  
00:56:33,400 --> 00:56:37,300  
going to say like this even we're

1246  
00:56:35,079 --> 00:56:40,779  
talking about this service mission back

1247  
00:56:37,300 --> 00:56:43,300  
in 2009 we're still putting out new

1248  
00:56:40,780 --> 00:56:45,370  
information we just released so that's

1249  
00:56:43,300 --> 00:56:49,180  
from today's press today's press release

1250  
00:56:45,369 --> 00:56:51,219  
I mean just is seeing the ghost to these

1251  
00:56:49,179 --> 00:56:52,960  
ghetto if you guys might go to a hubble

1252  
00:56:51,219 --> 00:56:55,059  
site that Oregon check out today's press

1253  
00:56:52,960 --> 00:56:56,170  
release with this brand new image that's

1254  
00:56:55,059 --> 00:56:58,750  
come out there and it's absolutely



1255  
00:56:56,170 --> 00:57:02,200  
fantastic it can it's because we've been

1256  
00:56:58,750 --> 00:57:05,110  
able to continue along and upgrade the

1257  
00:57:02,199 --> 00:57:08,259  
telescope and and and stay wanting to do

1258  
00:57:05,110 --> 00:57:10,269  
more science that were allowed to do

1259  
00:57:08,260 --> 00:57:12,970  
even more discoveries like these and

1260  
00:57:10,269 --> 00:57:14,559  
continue it going nice and I often

1261  
00:57:12,969 --> 00:57:17,139  
argued that the Hubble Space Telescope

1262  
00:57:14,559 --> 00:57:19,480  
is probably the most important

1263  
00:57:17,139 --> 00:57:21,069  
scientific instrument ever built since

1264  
00:57:19,480 --> 00:57:23,710  
the telescope from Galileo because I

1265  
00:57:21,070 --> 00:57:26,170  
don't think there's a single instrument

1266  
00:57:23,710 --> 00:57:28,210  
that has ever changed the course and the

1267  
00:57:26,170 --> 00:57:30,639  
way we look at the universe more than

1268  
00:57:28,210 --> 00:57:32,920  
that telescope has and so and it has

1269  
00:57:30,639 --> 00:57:34,449  
literally changed my life I can I can

1270  
00:57:32,920 --> 00:57:35,889  
trace a path from the first time I ever

1271  
00:57:34,449 --> 00:57:39,009  
watched the Hubble Deep Field in my

1272  
00:57:35,889 --> 00:57:40,449  
career to here and it has been so Hubble

1273  
00:57:39,010 --> 00:57:42,520  
has been an intimate part of my life

1274  
00:57:40,449 --> 00:57:44,949  
ever since I first saw that first deep

1275  
00:57:42,519 --> 00:57:46,449  
field in the mid 90s well folks I want

1276  
00:57:44,949 --> 00:57:48,039  
to thank everybody I'm sorry about the

1277  
00:57:46,449 --> 00:57:50,230  
technical difficulties that's it for

1278  
00:57:48,039 --> 00:57:53,469  
this week though next week we are going

1279  
00:57:50,230 --> 00:57:55,960  
to have a hangout on the a on Hubble

1280  
00:57:53,469 --> 00:57:58,449  
observations which have been put

1281  
00:57:55,960 --> 00:58:02,380  
together that allowed astronomers to

1282  
00:57:58,449 --> 00:58:04,569  
make a thermal map of an exoplanet this

1283

00:58:02,380 --> 00:58:05,829  
is the temperature variations across the

1284  
00:58:04,570 --> 00:58:08,050  
planet itself and we're going to have

1285  
00:58:05,829 --> 00:58:10,269  
the principal investigators involved in

1286  
00:58:08,050 --> 00:58:12,010  
that science next week so that's next

1287  
00:58:10,269 --> 00:58:13,929  
Thursday 3 p.m.

1288  
00:58:12,010 --> 00:58:16,210  
look forward to seeing you there Russ

1289  
00:58:13,929 --> 00:58:17,679  
can thank you very much this has been a

1290  
00:58:16,210 --> 00:58:18,940  
great hangout I hope you'll come back

1291  
00:58:17,679 --> 00:58:20,769  
and do another one with us because this

1292  
00:58:18,940 --> 00:58:23,019  
is we're not done we're not done with up

1293  
00:58:20,769 --> 00:58:25,389  
with the history of Hubble yet so I hope

1294  
00:58:23,019 --> 00:58:27,639  
you're awesome thank you both thank you

1295  
00:58:25,389 --> 00:58:29,589  
I don't understand it I want to have a

1296  
00:58:27,639 --> 00:58:32,980  
hangout from Russia's office I think

1297  
00:58:29,590 --> 00:58:35,829

he's got a lot of cool all right what is

1298

00:58:32,980 --> 00:58:44,050

time oh look at this look at that what's

1299

00:58:35,829 --> 00:58:52,239

wrong yes all right so I'm having a

1300

00:58:44,050 --> 00:58:54,850

field trip from LA you're waking so glad

1301

00:58:52,239 --> 00:58:57,309

have this great room yeah thank you very

1302

00:58:54,849 --> 00:58:59,949

much everybody all right close yeah

1303

00:58:57,309 --> 00:59:01,960

that's it that's it for this week thank

1304

00:58:59,949 --> 00:59:06,869

you all for watching and as always keep

1305

00:59:01,960 --> 00:59:06,869

clean around everyone