
LEADERS IN LIDAR
CHAPTER 1
THE LASER IS BETTER

1
00:00:00,600 --> 00:00:03,000
The laser: a useful tool

2
00:00:03,000 --> 00:00:05,766
in industry, science and medicine.

3
00:00:06,133 --> 00:00:11,200
When it comes down to it, a
laser is just a light with extreme focus.

4
00:00:11,200 --> 00:00:15,366
It's both elegantly simple
and extremely complicated,

5
00:00:15,366 --> 00:00:19,133
and it changed the way we literally see
the dimensions of our Earth,

6
00:00:19,733 --> 00:00:24,333
our Moon, the planets, asteroids and beyond.

7
00:00:25,200 --> 00:00:27,433
But it was a long road to get there.

8
00:00:27,433 --> 00:00:32,666
[music]

9
00:00:34,133 --> 00:00:37,433
Back in the 1980s at NASA, using lasers to measure

10
00:00:37,433 --> 00:00:42,300
physical features from space
was too experimental, too risky.

11
00:00:42,300 --> 00:00:45,833
Fortunately, it was also a time of change and risk-

12
00:00:45,833 --> 00:00:48,333

taking at Goddard Space Flight Center.

13
00:00:49,100 --> 00:00:50,366
In the 1960s,

14
00:00:50,366 --> 00:00:52,166
there was probably not much question

15
00:00:52,166 --> 00:00:54,200
that when a science or applications mission came up,

16
00:00:54,233 --> 00:00:57,233
for the most part, it went to Goddard

17
00:00:57,233 --> 00:01:01,000
and we've got to do a better job
of selling ourselves

18
00:01:01,000 --> 00:01:05,700
and being sure that we're responsive
to what Headquarters is looking for

19
00:01:05,966 --> 00:01:09,600
in terms of the competition
between ourselves and other NASA centers.

20
00:01:09,600 --> 00:01:12,766
I came here as hired by the center director,

21
00:01:12,766 --> 00:01:16,000
Noel Hinners, in '85, and he said,
So what do you want to do?

22
00:01:16,000 --> 00:01:19,900
I said, I want to map the topography
of Mars, you know, at this scale, not

23
00:01:19,900 --> 00:01:21,400
the scale of buildings.

24
00:01:22,466 --> 00:01:23,433
How do we do that?

25
00:01:23,433 --> 00:01:25,900
He goes, Well, we've got folks.
They do stuff.

26
00:01:25,900 --> 00:01:29,700
And so I met a few of them very quickly,
and that was Jim Abshire, John

27
00:01:29,700 --> 00:01:31,633
Degnan, Jack Bufton.

28
00:01:31,633 --> 00:01:36,166
We started working with laser remote
sensing instrumentation.

29
00:01:36,433 --> 00:01:40,366
It was the same type of instrumentation
that communicated

30
00:01:40,366 --> 00:01:44,033
from ground to satellites
in satellite laser ranging.

31
00:01:45,033 --> 00:01:47,933
We could do a little airborne laser remote

32
00:01:47,933 --> 00:01:52,400
sensing, and Garvin and I sort of
found each other through that.

33
00:01:52,666 --> 00:01:55,966
You know, I said, Come on down to Wallops
and we'll fly this.

34
00:01:55,966 --> 00:02:00,233

And he said, Oh, topography, Earth, yes,
I want to measure it.

35
00:02:01,033 --> 00:02:03,900
We literally took a T-39 training aircraft that was

36
00:02:03,900 --> 00:02:07,266
put together by the Wallops team
really impressively

37
00:02:08,033 --> 00:02:12,100
and bolted in a big telescope with a laser

38
00:02:12,433 --> 00:02:15,700
and went flying out in northern Arizona
where I had done some field work.

39
00:02:15,933 --> 00:02:19,300
So out there we have Meteor Crater,
we have volcanoes

40
00:02:19,600 --> 00:02:22,100
and we have the Grand Canyon
and other the Painted Desert.

41
00:02:22,433 --> 00:02:25,200
So we figured in one place
we could study all this.

42
00:02:25,966 --> 00:02:30,933
And it was on the strength of that,
that Jim Garvin became interested

43
00:02:30,933 --> 00:02:35,666
and put him in a position
to when Dave Smith found

44
00:02:35,666 --> 00:02:41,333
that his radar altimeter was canceled
because it was $30 million instead of ten.

45
00:02:41,900 --> 00:02:43,800
They kept talking to me about, you know,

46
00:02:43,800 --> 00:02:47,100
look, we're really close
to getting a laser altimeter working.

47
00:02:47,100 --> 00:02:50,866
And I've been in lasers
actually for 20 odd years before that,

48
00:02:50,866 --> 00:02:52,066
if you know what I mean.

49
00:02:52,066 --> 00:02:54,100
But laser ranging from the ground to spacecraft.

50
00:02:54,100 --> 00:02:58,433
So I was very familiar with the lasers and
I wasn't averse to it, on the contrary.

51
00:02:59,100 --> 00:03:02,200
But NASA offered me a situation that said, look,

52
00:03:02,200 --> 00:03:04,300
we've got a certain amount of money for you.

53
00:03:04,433 --> 00:03:06,600
We're willing to spend $10 million
on this instrument.

54
00:03:07,366 --> 00:03:09,933
But, you know,
there has to be some sort of competition.

55
00:03:09,933 --> 00:03:12,133
You need to choose which instrument

56
00:03:12,133 --> 00:03:14,366
you would like to fly
to measure the altimetry.

57
00:03:14,700 --> 00:03:16,333
And there were four candidates.

58
00:03:17,466 --> 00:03:21,200
Three of them are radar and one the laser that we call MOLA

59
00:03:21,800 --> 00:03:24,866
There was no one in their right mind
that would bid

60
00:03:24,866 --> 00:03:26,133
a laser altimeter.

61
00:03:26,133 --> 00:03:27,433
Seriously.

62
00:03:28,000 --> 00:03:28,966
And I was all gung ho.

63
00:03:28,966 --> 00:03:31,900
I was a young guy, you know, no gray hair.

64
00:03:31,900 --> 00:03:33,466
There was a lot of reticence.

65
00:03:33,466 --> 00:03:37,766
There was so little trust
that this could be done.

66
00:03:38,100 --> 00:03:41,433
NASA's made a monumental achievement

67
00:03:41,433 --> 00:03:45,900
in both radar and visible near infrared

68
00:03:45,900 --> 00:03:49,100
imaging of the surfaces of Earth
and other planets.

69
00:03:49,466 --> 00:03:51,700
But those are flat field views.

70
00:03:51,700 --> 00:03:52,733
And the missing dimension,

71
00:03:52,733 --> 00:03:56,400
the hidden dimension, which drives
where energy goes, where the water flows,

72
00:03:57,033 --> 00:03:58,133
you know,

73
00:03:58,133 --> 00:04:00,533
stability of landscapes is the third
dimension.

74
00:04:00,533 --> 00:04:01,933
We take for granted the map.

75
00:04:02,300 --> 00:04:04,966
Sometimes you need the map to do with beyond the map.

76
00:04:04,966 --> 00:04:08,000
Making those maps with that crucial third dimension is

77
00:04:08,000 --> 00:04:11,633
what laser altimetry or LiDAR is best at.

78
00:04:11,633 --> 00:04:13,200
And over the decades

79
00:04:13,200 --> 00:04:17,600

Goddard's gotten pretty good at explaining
just how laser altimetry works.

80
00:04:17,600 --> 00:04:19,100
This is a laser altimeter.

81
00:04:19,100 --> 00:04:21,466
What it does
is it sends a short pulse of light.

82
00:04:21,466 --> 00:04:25,600
From a moving platform that's observing
a surface, an airplane, a satellite.

83
00:04:25,600 --> 00:04:27,433
Gets a reflection
straight back off the surface.

84
00:04:27,433 --> 00:04:31,466
We record that reflection
and the time very precisely.

85
00:04:31,466 --> 00:04:34,600
Of the pulse from the spacecraft
down to the surface and back again.

86
00:04:34,600 --> 00:04:37,133
Which allows us to measure
the range to the surface.

87
00:04:37,133 --> 00:04:39,600
When that's done repeatedly in orbit,
you can build up a map.

88
00:04:39,600 --> 00:04:41,766
[music hit]

89
00:04:41,766 --> 00:04:42,766
The fast rate of

90
00:04:42,766 --> 00:04:45,800
light pulses and the small footprint
allow lidar

91
00:04:45,800 --> 00:04:49,433
to measure with a much finer scale
than traditional radars.

92
00:04:50,000 --> 00:04:53,700
They had a big review,
and the leading radar guy

93
00:04:53,700 --> 00:04:58,200
that had flown radars to Venus, Gordon
Pettengill, at the end said, well,

94
00:04:58,200 --> 00:05:00,100
I don't know about you folks,

95
00:05:00,100 --> 00:05:01,700
the laser is better.

96
00:05:01,700 --> 00:05:05,333
In time, Goddard would become a leader in lidar

97
00:05:05,333 --> 00:05:09,766
in mapping our Earth and planets
with unprecedented precision.

98
00:05:09,766 --> 00:05:13,666
But for now,
they had to actually build the first one.

99
00:05:13,666 --> 00:05:16,266
The requirements were, of course,
we were at a much higher orbit,

100
00:05:16,300 --> 00:05:20,500
and orbit was faster than going around

the Moon so we needed a larger telescope,

101
00:05:20,500 --> 00:05:25,066
needed a more sensitive detector,
we needed more laser energy.

102
00:05:25,433 --> 00:05:29,666
So in order to put our concept together,
we had to gather a team

103
00:05:31,233 --> 00:05:31,733
and then we

104
00:05:31,733 --> 00:05:35,533
had to convince the management
that this was not a crazy idea

105
00:05:35,533 --> 00:05:39,166
and that we actually had
a realistic chance of making this happen.

106
00:05:39,533 --> 00:05:41,000
We worked a lot of hours.

107
00:05:41,000 --> 00:05:42,966
I can remember

108
00:05:43,400 --> 00:05:47,433
Jim talking about, you know, working ten-hour days,
and I was doing about the same.

109
00:05:47,433 --> 00:05:50,500
But, you know, it really
it really didn't matter

110
00:05:50,500 --> 00:05:53,600
because it was so exciting

111
00:05:53,600 --> 00:05:58,000

to be working on something that was going to actually map Mars.

112
00:05:58,233 --> 00:06:02,233
I was fresh out of getting my master's
degree in computer engineering.

113
00:06:03,000 --> 00:06:03,600
I was young.

114
00:06:03,600 --> 00:06:06,800
I mean, I was it was
I had to really dive in deep.

115
00:06:06,800 --> 00:06:12,000
I had to spend about two years
working with the team on algorithms.

116
00:06:12,266 --> 00:06:15,866
How were we going to find the surface
of the of Mars, how we were going

117
00:06:15,900 --> 00:06:19,533
to track it, how we're going to compute
all the precise ranges.

118
00:06:19,800 --> 00:06:22,200
And we were just, we were sort of making our way.

119
00:06:22,200 --> 00:06:25,033
We were, we were defining the rules as we went.

120
00:06:25,400 --> 00:06:28,500
We finished the instrument pretty much on time.

121
00:06:28,500 --> 00:06:31,466
And certainly,
as they said in the letter to me, look,

122
00:06:31,466 --> 00:06:35,633

if you don't make it on time and
in budget, we will fly a brick instead.

123
00:06:35,866 --> 00:06:38,500
Okay?
We're not going to hold this mission up.

124
00:06:39,266 --> 00:06:40,933
I mean, I knew about planetary missions.

125
00:06:40,933 --> 00:06:42,966
They have to go within certain windows.

126
00:06:42,966 --> 00:06:44,933
But anyway, we made it alright.

127
00:06:44,933 --> 00:06:47,100
[music]

128
00:06:47,100 --> 00:06:51,966
Five, four, three, two, one.

129
00:06:52,700 --> 00:06:53,866
And liftoff.

130
00:06:53,866 --> 00:06:55,433
Liftoff of the Titan III

131
00:06:55,433 --> 00:06:59,933
rocket with the Mars Observer and America's return to the Red Planet.

132
00:07:00,533 --> 00:07:03,300
And the vehicle has cleared the tower.

133
00:07:03,300 --> 00:07:06,533
We've got X-band launch at Canberra.

134
00:07:06,533 --> 00:07:08,433

All right!

135
00:07:08,433 --> 00:07:14,666
[applause]

136
00:07:14,666 --> 00:07:16,166
A very happy crew.

137
00:07:17,466 --> 00:07:20,633
The Mars Observer is on its way to Mars.

138
00:07:21,700 --> 00:07:24,333
Trajectory is right on the money.

139
00:07:24,333 --> 00:07:29,700
[music]

140
00:07:29,700 --> 00:07:30,966
We've assumed

141
00:07:30,966 --> 00:07:35,333
that the spacecraft properly
executed its orbit insertion sequence,

142
00:07:35,333 --> 00:07:38,466
and we presume the spacecraft is in orbit
about Mars.

143
00:07:38,466 --> 00:07:43,433
But we have no positive confirmation of
that because as for the last three days,

144
00:07:43,433 --> 00:07:45,933
we have no communication
with the spacecraft.

145
00:07:45,933 --> 00:07:47,700
--That is to say you simply don't know
what happened to that.

146
00:07:47,700 --> 00:07:50,100
It could be in orbit.
It could have flown past the planet.

147
00:07:50,100 --> 00:07:52,233
What are the scientists
doing to relieve the tension in there?

148
00:07:52,233 --> 00:07:55,666
Screaming loudly, probably. [laughter]

149
00:07:55,833 --> 00:07:58,900
We still don't have communication
with the spacecraft.

150
00:07:58,900 --> 00:08:03,833
However, we are very hopeful
and we're cautiously optimistic

151
00:08:03,833 --> 00:08:07,100
that communication will be restored--
--Every day without communications

152
00:08:07,100 --> 00:08:10,200
clearly lessens our probability of success.

153
00:08:10,200 --> 00:08:12,466
--Though, you know, we give up?

154
00:08:12,466 --> 00:08:14,566
We have not given up.

155
00:08:14,566 --> 00:08:21,133
[music]

156
00:08:21,133 --> 00:08:24,066
But I was not concerned about the spacecraft.

157
00:08:24,066 --> 00:08:27,000
It never crossed my mind the spacecraft would let us down.