VLB ARRAY MEMO No. 401

NATIONAL RADIO ASTRONOMY OBSERVATORY

Socorro, NM

RFI SURVEY FOR THE VLBA

LOS ALAMOS, NM SITE
(TA 33)

August 20 to September 28, 1984

Jim Oty

The RFI survey for the proposed VLBA site at Los Alamos, NM was conducted from August 20, 1984 to September 28, 1984. There were two proposed locations within the boundries of Los Alamos National Laboratories (LANL), Sigma Mesa and TA 33 (see VLBA Memo 330). The TA 33 location was selected for this survey as the Sigma Mesa location is more centraly located at LANL and is more likely to have a worse RFI environment than TA 33.

The TA 33 site is located on the southern edge of LANL property and is accesable from State Road 4. The entire TA 33 area is enclosed by a security fence and access is through a gate that is locked during non duty hours. The area is patroled by LANL security.

There are several locations within TA 33 that could be used for a VLBA antenna. A location, at the extreme end of TA 33, was picked for two reasons. This was the only place that was not line of sight to Sandia Crest, the Albuquerque, NM radio and TV transmitter location, and electric power was readily availible. The exact location is designated as TA33-HP89 on LANL maps. See figure 1.

A complete RFI survey was completed at this site. The survey included all bands from 75 MHz. to 11.2 GHz. The equipment set up remained basicaly the same for all bands. A mast mounted directional antenna connected to wide band amplifiers driving a spectrum analyzer. Data was collected, stored and plotted by a computer. In order to eliminate intermod from high level out of band signals, band pass or high pass filters were required for the bands below C band. A block diagram of the system is included as figure 2. Plots were produced of the individual bands showing frequency, amplitude and time. Since directional antennas were used, at least four directions were monitored, usualy N, S, E and W. The duration of each plot was normaly two or three hours. Many plots were produced but only those of interest are included here. All other plots are on file for future reference. Table I lists the included plots. The threshold level for harmful RFI for each VLBA band is given in VLBA Memo 81 and listed, along with the measurement threshold, in table II.

A brief check was made at a second location about a mile back toward the main TA 33 complex. Sandia Crest was visible from this location and an attempt was made to determine if there was any increase in levels of signals originating there. This would indicate what natural shielding, if any, was present at the first location. The test at this location was limited as power was obtained from a portable generator. For this test, the antenna was connected directly to the spectrum analyzer and no filter was

used. Single record plots of the spectrum from 50 to 650 MHz. were made from this location and compared to similar plots made at location 1. Table III lists the plots used for this comparison.

This RFI survey was the most comprehensive to date. I hope my technique is improving and that the data produced is satisfactory. While I draw no conclusions as to the acceptability of this site, I would like to include some of my observations.

1. The RF environment was the most severe yet encountered. The proximity of a least three high elevation transmitter locations contribute to this - Sandia Crest about 40 miles south, No Name Ridge about 20 miles west, and Tesuque Peak about 25 miles east. It was necessary for me to add band pass or high pass filters to my system to eliminate intermod. These high level, out of band signals must be considered when designing highly sensitive receivers used here or at other locations near 'civilization'.

2. This location seemed to be free of 'local' computer ascociated interference (except that generated within the monitoring trailer). There was no indication that any interference was coming from the high power accelerators at LANL.

3. The commercial power at this loction was very reliable. I detected only one power glitch during the time I was there.

4. As mentioned before, security was evident. The area was fenced and LANL security checked regularly. I was issued a key for the main gate of TA 33 for access after normal duty hours.

5. There may be some concern about the antenna structure being visible from the Rio Grande. The location at TA33-HP89 could be a problem. From the top of a convenient 65 foot structure, located very near the RFI trailer, the river was visible for some distance. Other locations back toward the main complex do not have this problem as they are some distance from the edge of the gorge.

6. Using an inclinometer, I measured the elevation angle of the horizon from three locations, 1, 2, and 3 on figure 1. The surrounding mountains were all below 7 degrees elevation. The highest point on the horizon was a hill at about 135 degrees azimuth, just across the river, that measured 7 degrees. At a location in a depression between 2 and 3, the surrounding horizon was at 8 degrees elevation (location 4, figure 1). The horizon elevation for locations 1, 2 and 3 are plotted in figure 3.

7. A high voltage power line crosses the Rio Grand Gorge about 1 1/2 mile upstream (east) of the TA 33 site. This power line is line of sight from all locations and could pose a problem if plans to upgrade it to 345kv are approved.

TABLE I
TA 33-HP 89

Plot #	Frequency	Filter Fc/BW	Comments
1	50 - 100 MHz	None	North
2	50 - 100 MHz	None	South
3	74 - 76 Mhz	75/2	South, between CH4 and CH5
4	300 - 350 MHz	325/50	Note internaly generated commputer rails. High level signals are air/ground comm.
5	550 - 650 MHz	600/100	Signals are at CH 28 and CH 34 from the east. These are not local TV channels. Other directions clean.
6	1350 - 1550 MHz	1500/1000	
7	1550 - 1750 MHz	1500/1000	Signals at upper end of band are coming from Tesuque Peak.
8	2150 - 2350 MHz	HP2000	No signals from any direction above 2190 MHz.
9	4.6 - 4.8 GHz	None	No signals found from 4.6 to 5.2 GHz. This is a typical plot.
10	4.8 - 5.0 GHz	None	
11	5.0 - 5.2 GHz	None	
12	5.9 - 6.4 GHz	None	One signal at 5.945 GHz. from the east.
13	5.94 - 5.95 GHz	None	Expanded plot of 5.945 GHz.
14	7.9 - 8.4 GHz.	None	Typical of 7.9 to 8.9 GHz. Shows only signals found.
15	8.4 - 8.9 GHz	None	
16	10.2 -10.7 GHz	None	Typical plot of 10.2 to 11.2GHz. No signals.
17	10.7 11.2 GHz	None	

TABLE II
HARMFUL INTERFERENCE LEVELS

VLBA TUNNING RANGE	HARMFUL INTERFERENCE LEVELS (Note 1)	RFI MEASURED THRESHOLD (Note 2)
50 - 100 MHz.	*	-150 dBW/m^2
310 - 340 MHz.	-151 dBW/m^2	-152 dBW/m^2
580 - 640 MHz.	-146 dBW/m^2	-148 dBW/m^2
1.35 - 1.75 GHz.	-135 dBW/m^2	-130 dBW/m^2
2.175 - 2.425 GHz.	*	-128 dBW/m^2
4.6 - 5.1 GHz.	-120 dBW/m^2	-130 dBW/m^2
4.99 - 5.0 GHz. (Sub-band)	-127 dBW/m^2	-130 dBW/m^2
5.9 - 6.4 GHz.	-120 dBW/m^2	-122 dBW/m^2
8.0 - 8.8 GHz.	*	-116 dBW/m^2
10.2 - 11.2 GHz.	-110 dBW/m^2	-113 dBW/m^2

Note 1: These levels, from VLB Array Memo No. 81, are increased by 10 dB since ground based RFI is likely to enter the antenna through 0 dBI sidelobes rather than the +10 dBI sidelobes assumed in Memo 81.

Note 2: These levels are threshold levels from Table I plots.

* These frequency bands not included in memo 81.

TABLE III

Plot #	Frequency	Filter Fc/BW	Comments
18	50 - 150 MHz	None	Baseline plot from site 1.
19	50 - 150 MHz	None	Same as above but from second site. Ch 4 and 5 show <10 dB increase.
20	150 - 650 MHz	None	Baseline plot from site 1.
21	150 - 650 MHz	None	Ch 7 and 13 show about 10 dB increase. CH 14 and 23 about 20 dB. Ch 11 is Santa Fe channel.

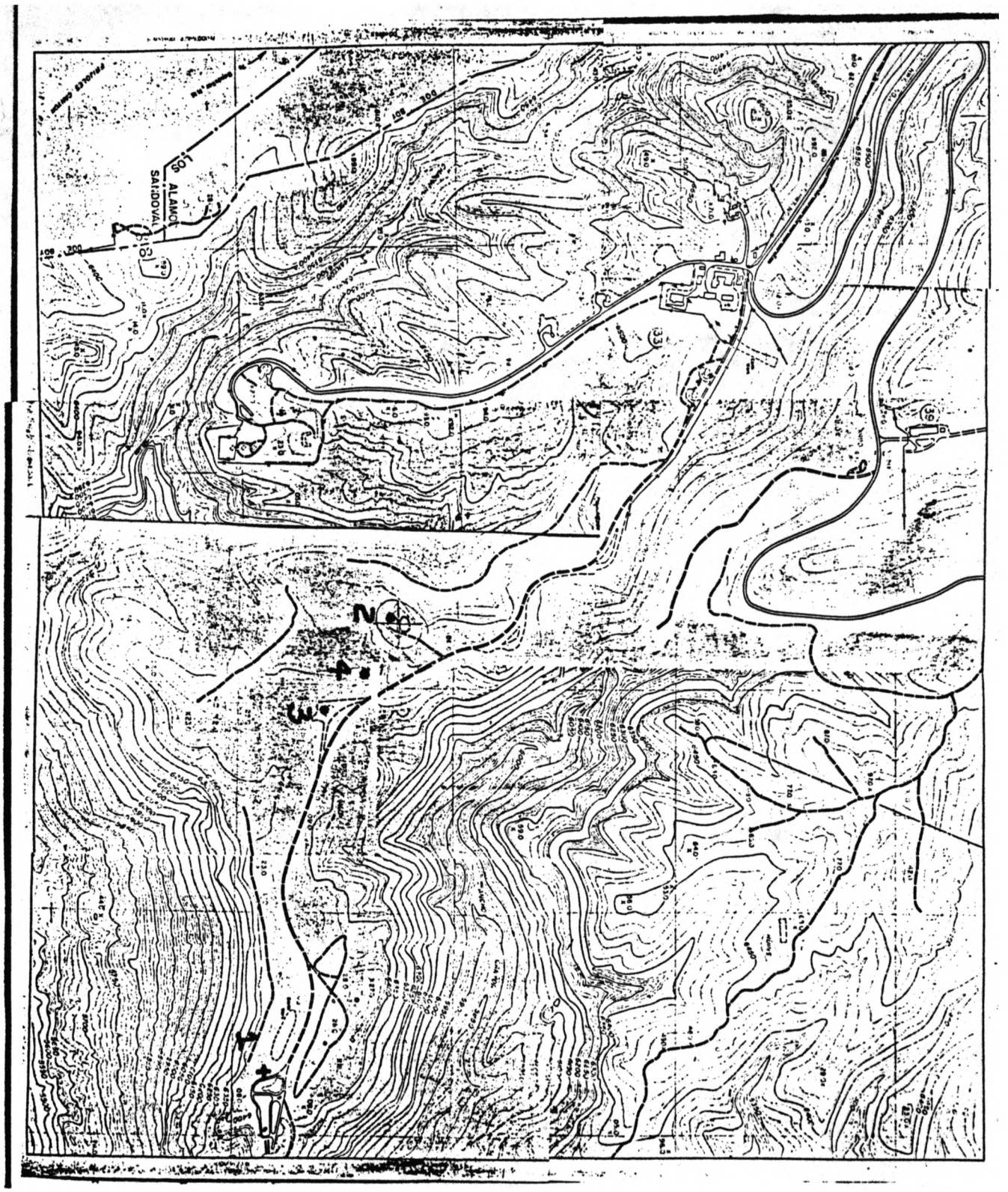


FIGURE
1

FIGURE 2

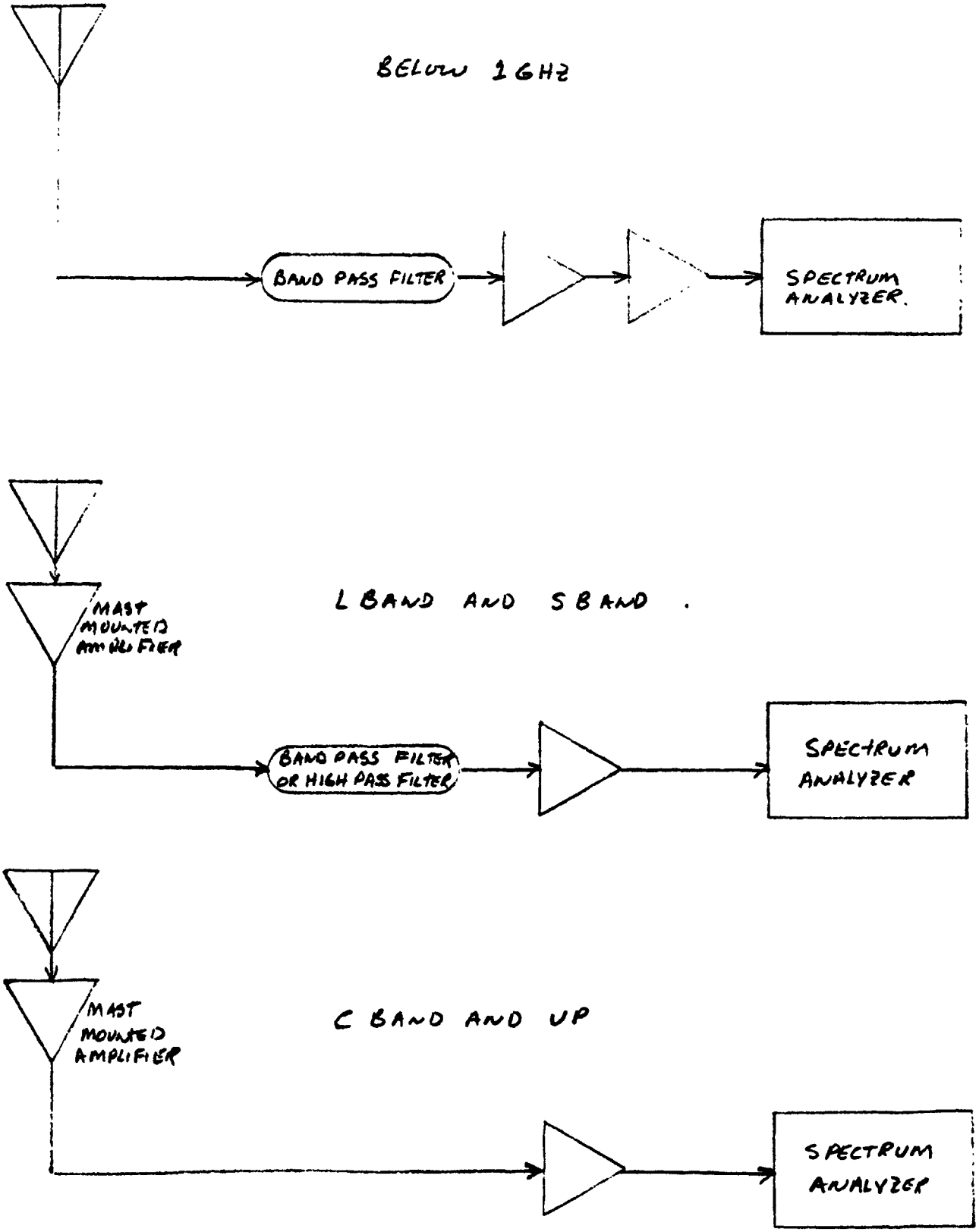
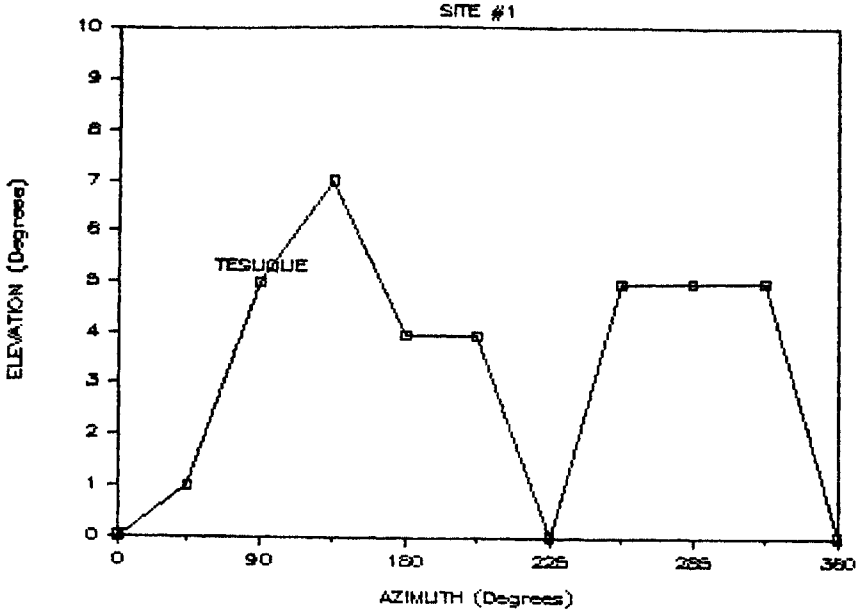

BELOW 1 GHz
BAND PASS FILTER
SPECTRUM ANALYZER.
L BAND AND S BAND .
MAST MOUNTED AMPLIFIER
BAND PASS FILTER OR HIGH PASS FILTER
SPECTRUM ANALYZER
C BAND AND UP
MAST MOUNTED AMPLIFIER
SPECTRUM ANALYZER

FIGURE 3

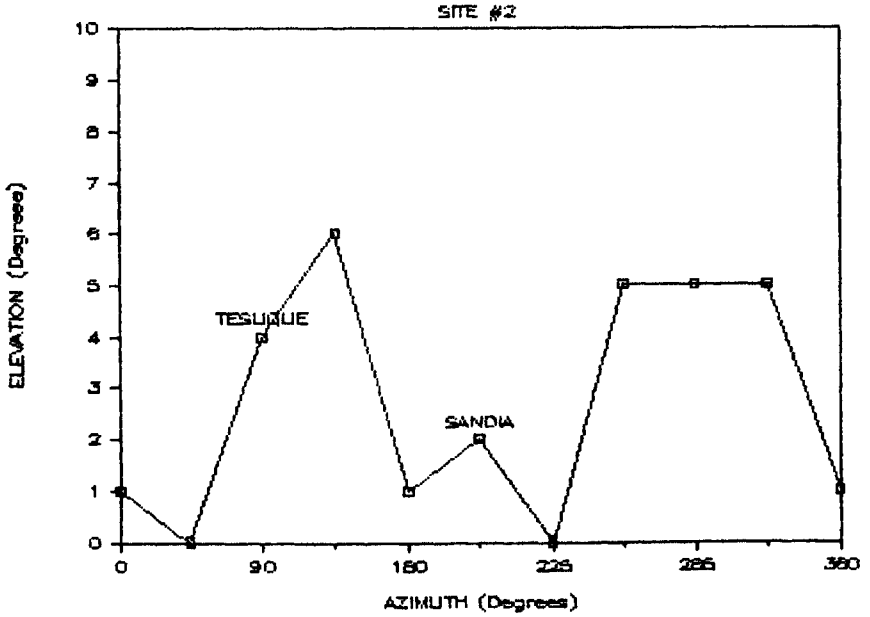
LANL TA33 HORIZON

SITE #1



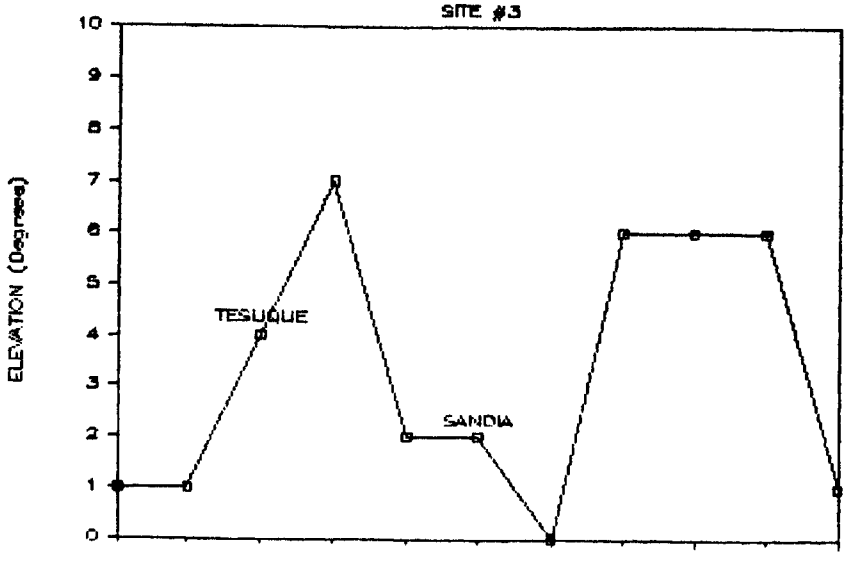
LANL TA33 HORIZON

SITE #2

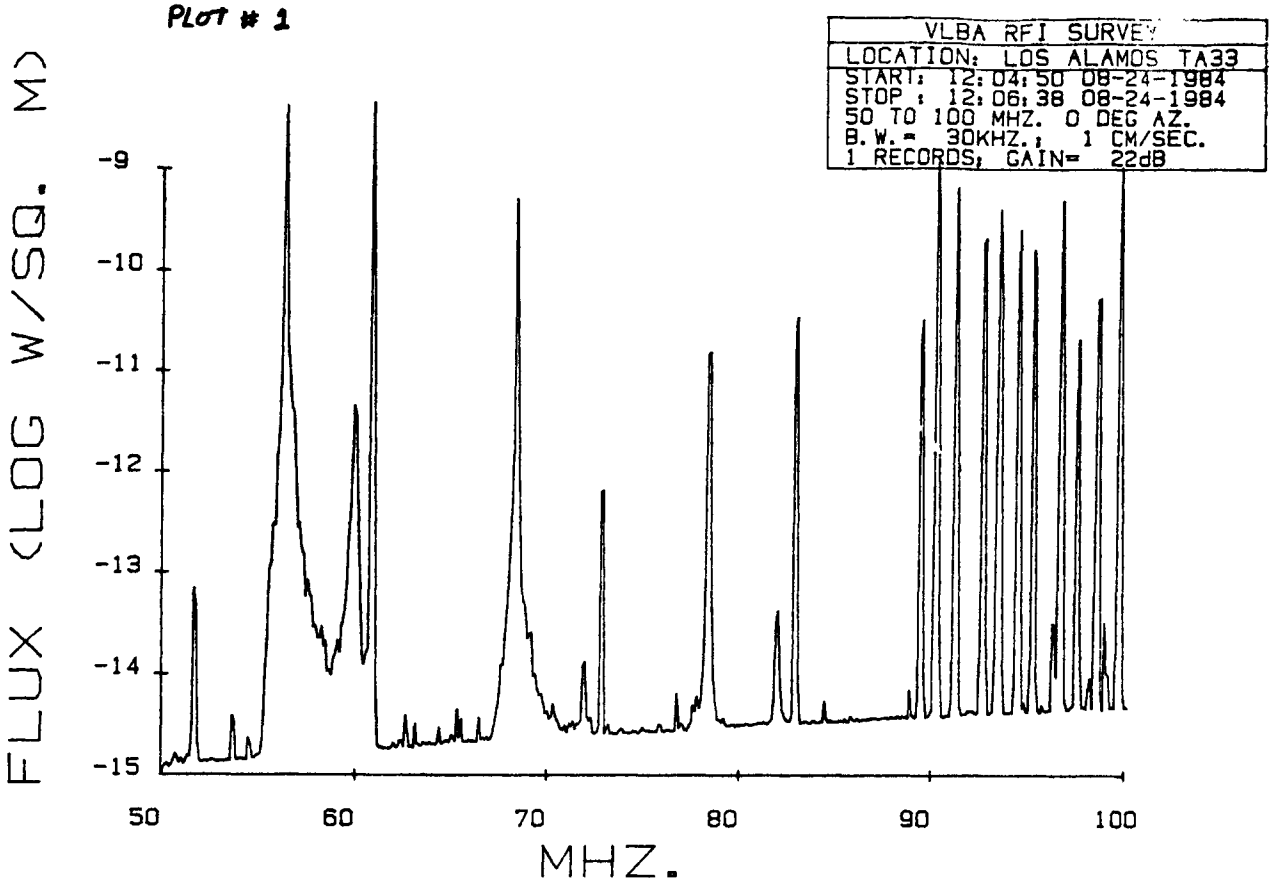


LANL TA33 HORIZON

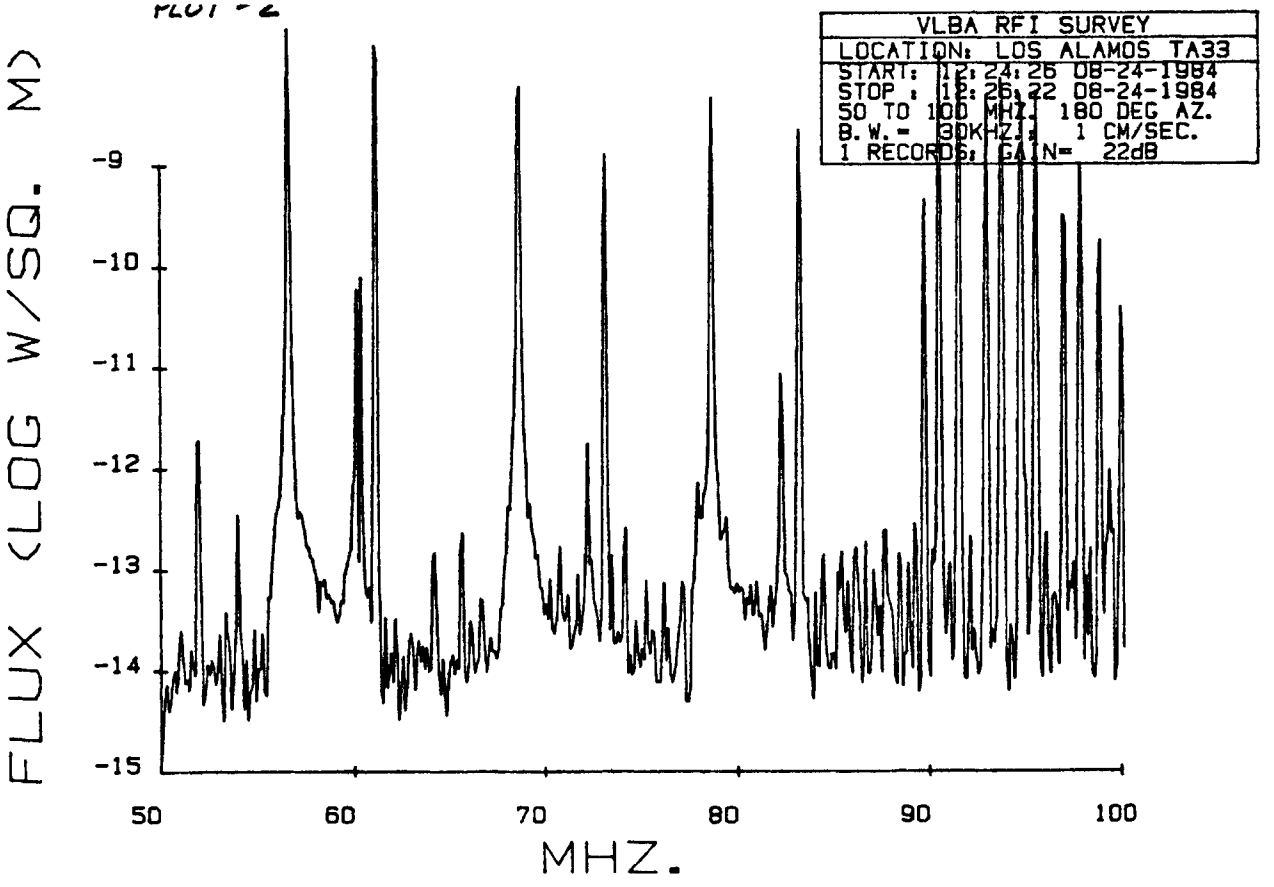
SITE #3



PLOT # 1

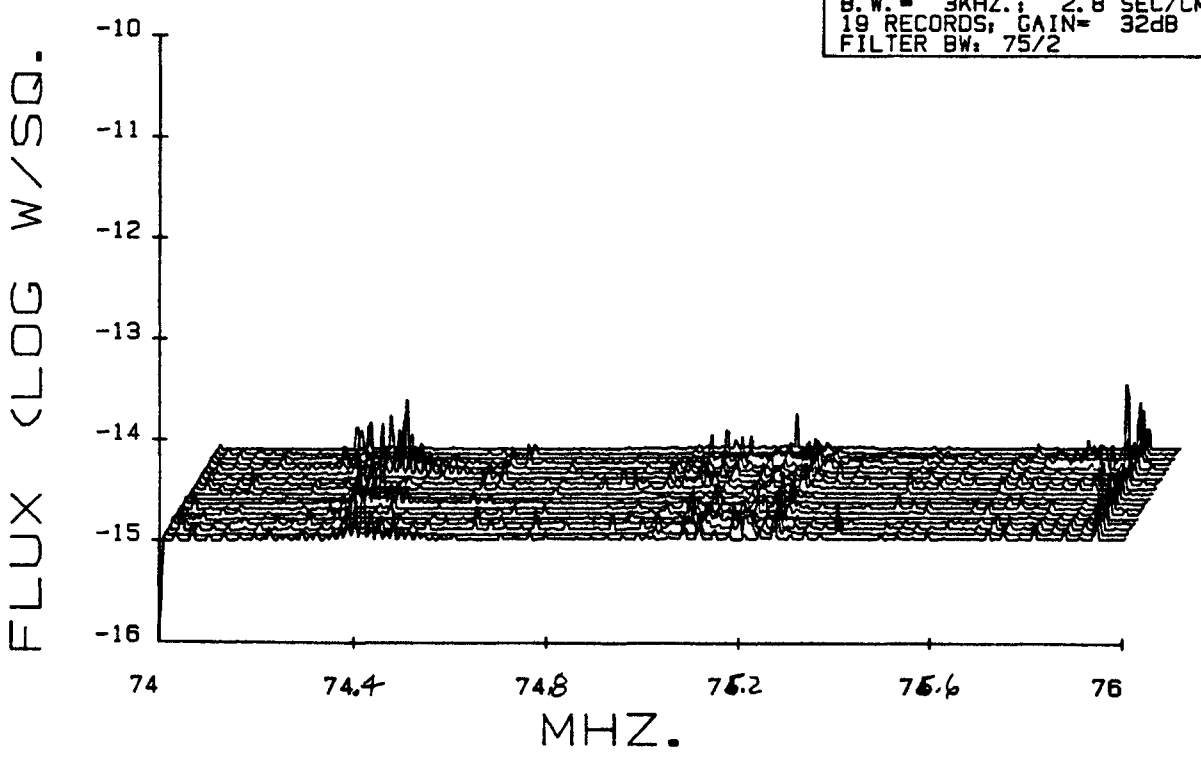

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 12:04:50 08-24-1984
STOP : 12:06:38 08-24-1984
50 TO 100 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 1 CM/SEC.
1 RECORDS; GAIN= 22dB
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
50
60
70
80
90
100
MHZ.

PLOT # 2


VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 12:24:26 08-24-1984
STOP : 12:26:22 08-24-1984
50 TO 100 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 1 CM/SEC.
1 RECORDS; GAIN= 22dB
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
50
60
70
80
90
100
MHZ.

PLOT #3

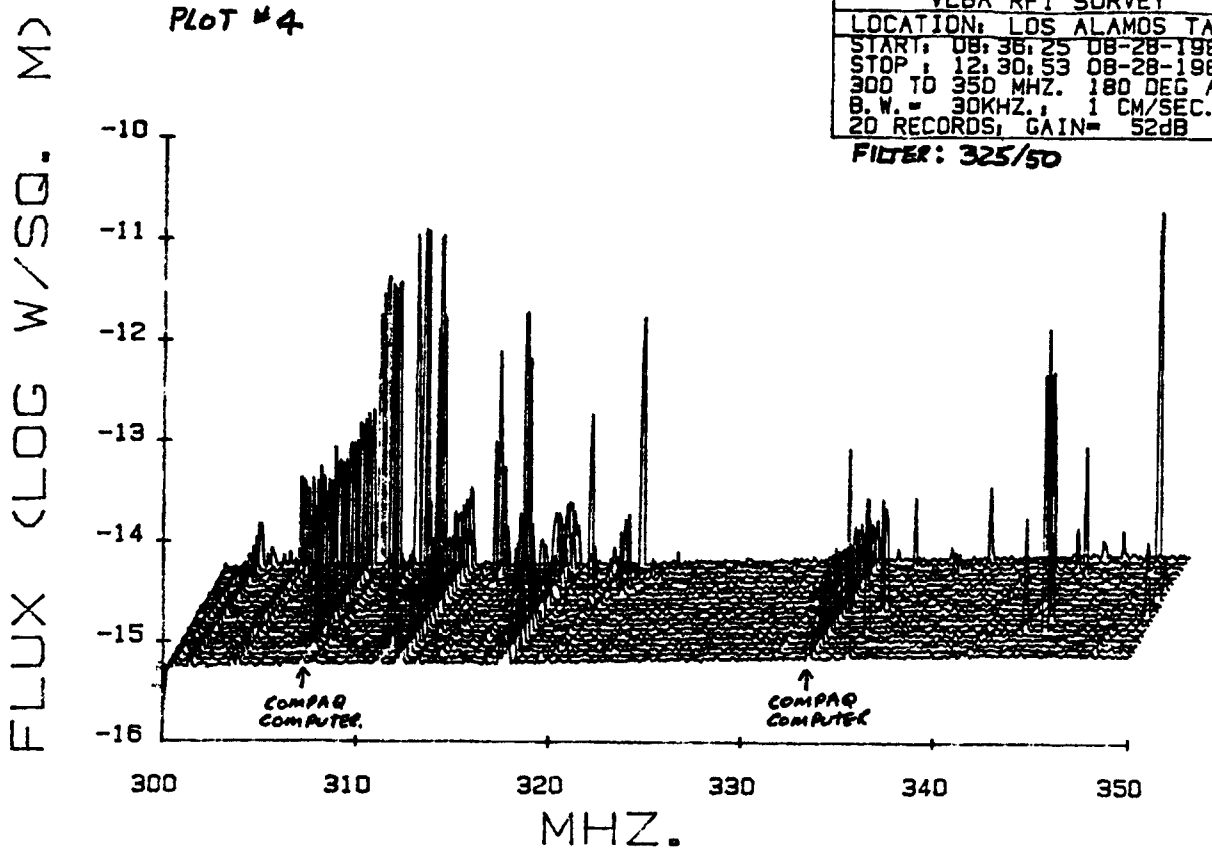
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 15:59:29 09-25-1984
STOP : 16:43:01 09-25-1984
74 TO 76 MHZ. 180 DEG AZ.
B.W. = 3KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 32dB
FILTER BW: 75/2



PLOT #4

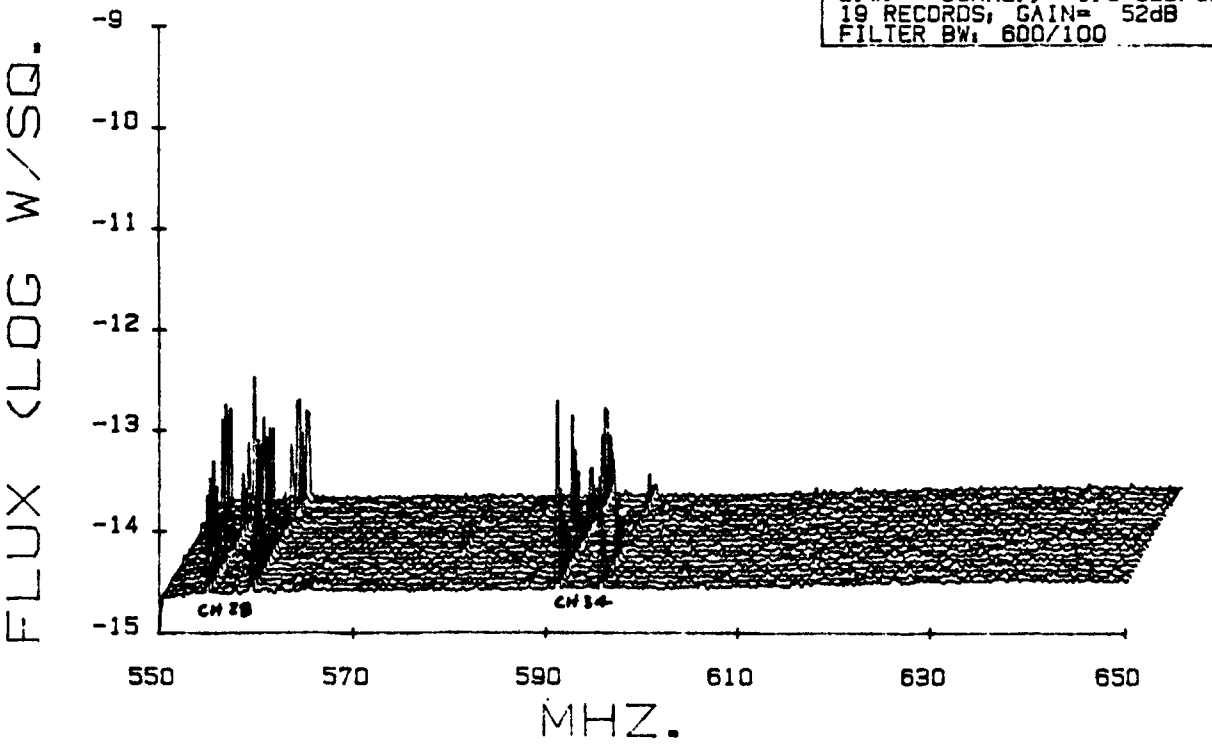
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 08:36:25 08-28-1984
STOP : 12:30:53 08-28-1984
300 TO 350 MHZ. 180 DEG AZ.
B.W. = 30KHZ.; 1 CM/SEC.
20 RECORDS; GAIN= 52dB

FILTER: 325/50



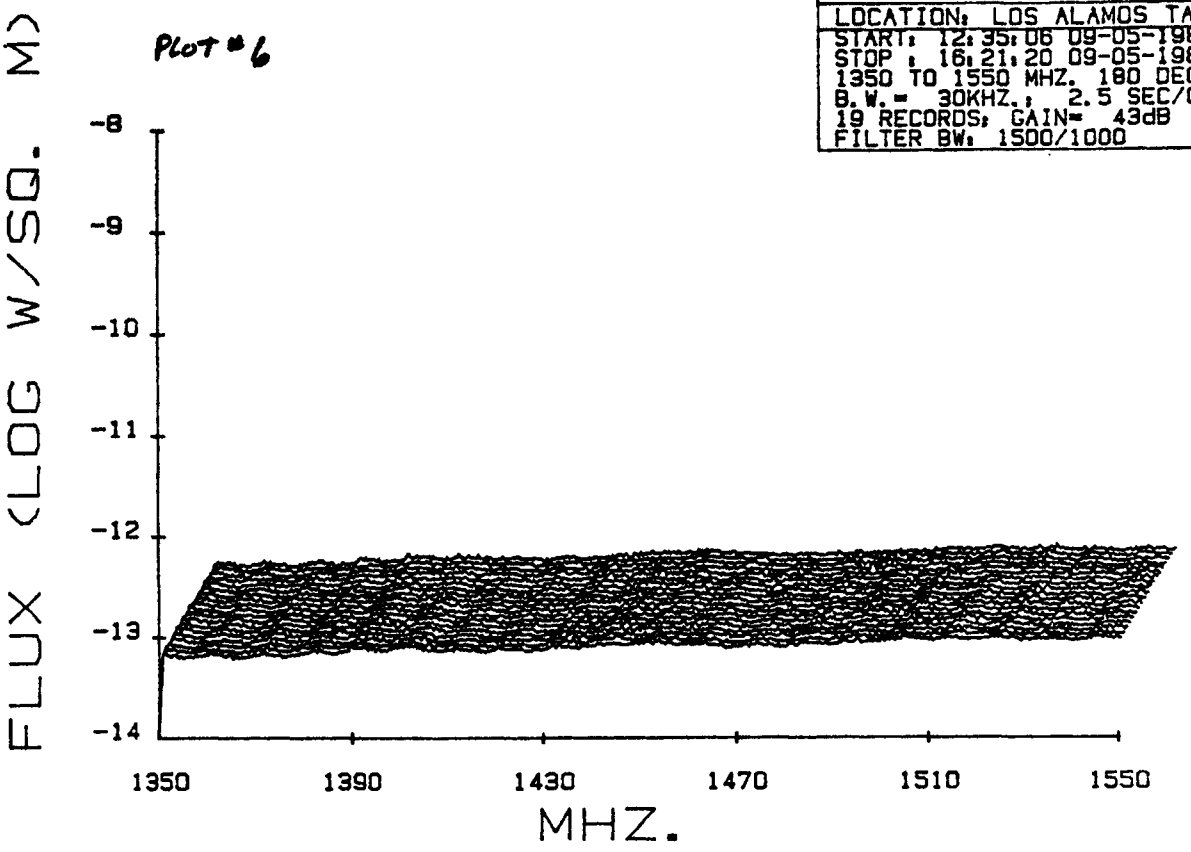
PLOT #5

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 11:14:07 09-11-1984
STOP : 13:25:33 09-11-1984
550 TO 650 MHZ. 90 DEG AZ.
B.W. = 30KHZ.; 1.5 SEC/CM.
19 RECORDS; GAIN= 52dB
FILTER BW: 600/100



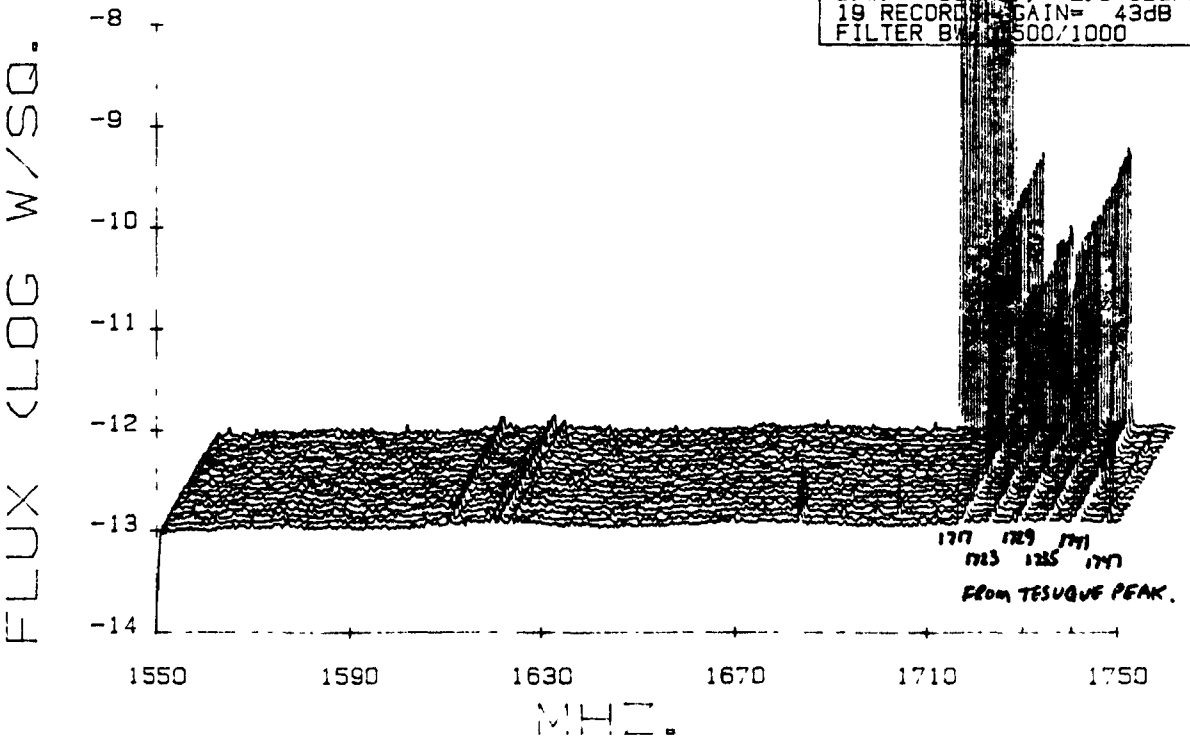
PLOT # 6

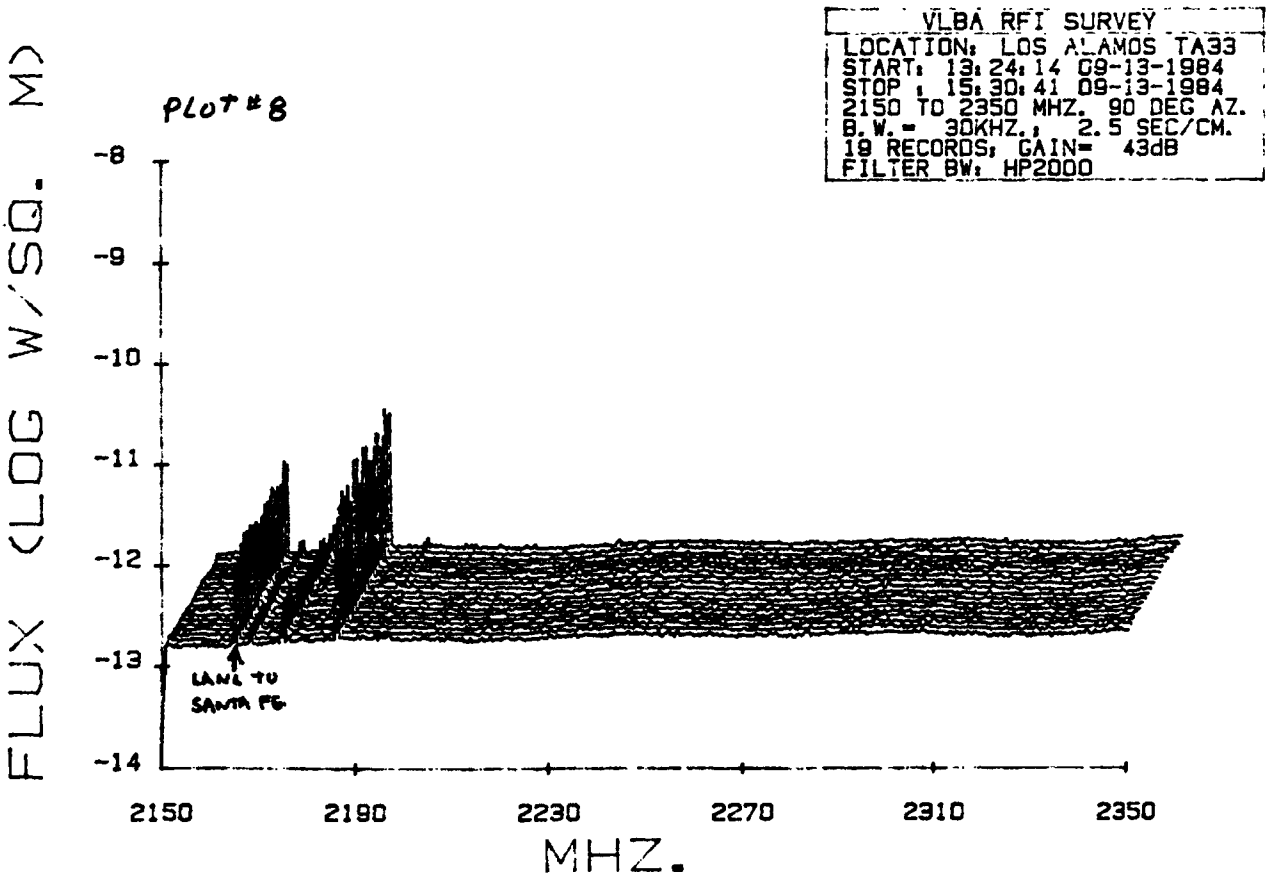
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 12:35:06 09-05-1984
STOP : 16:21:20 09-05-1984
1350 TO 1550 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 2.5 SEC/CM.
19 RECORDS; GAIN= 43dB
FILTER BW: 1500/1000



PLOT # 7

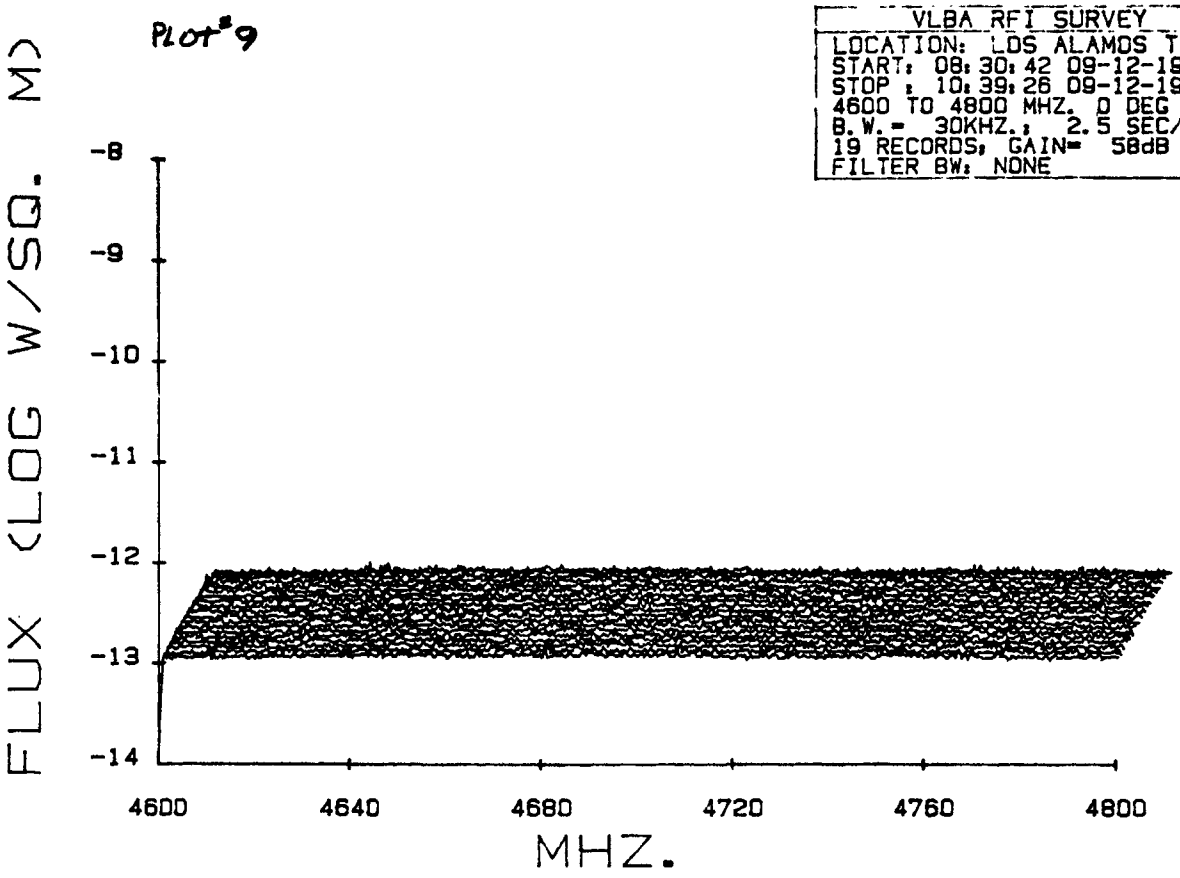
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 17:2[illegible]:51 09-06-1984
STOP : 02:[illegible]:07 09-06-1984
1550 TO 17[illegible] MHZ. 90 DEG AZ.
B.W.= 30[illegible]; 2.5 SEC/CM.
19 RECORDS; GAIN= 43dB
FILTER BW: 1500/1000




VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 13:24:14 09-13-1984
STOP : 15:30:41 09-13-1984
2150 TO 2350 MHZ. 90 DEG AZ.
B.W.= 30KHZ., 2.5 SEC/CM.
19 RECORDS; GAIN= 43dB
FILTER BW: HP2000
PLOT #8
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
LANL TO SANTA FE
2150
2190
2230
2270
2310
2350
MHZ.

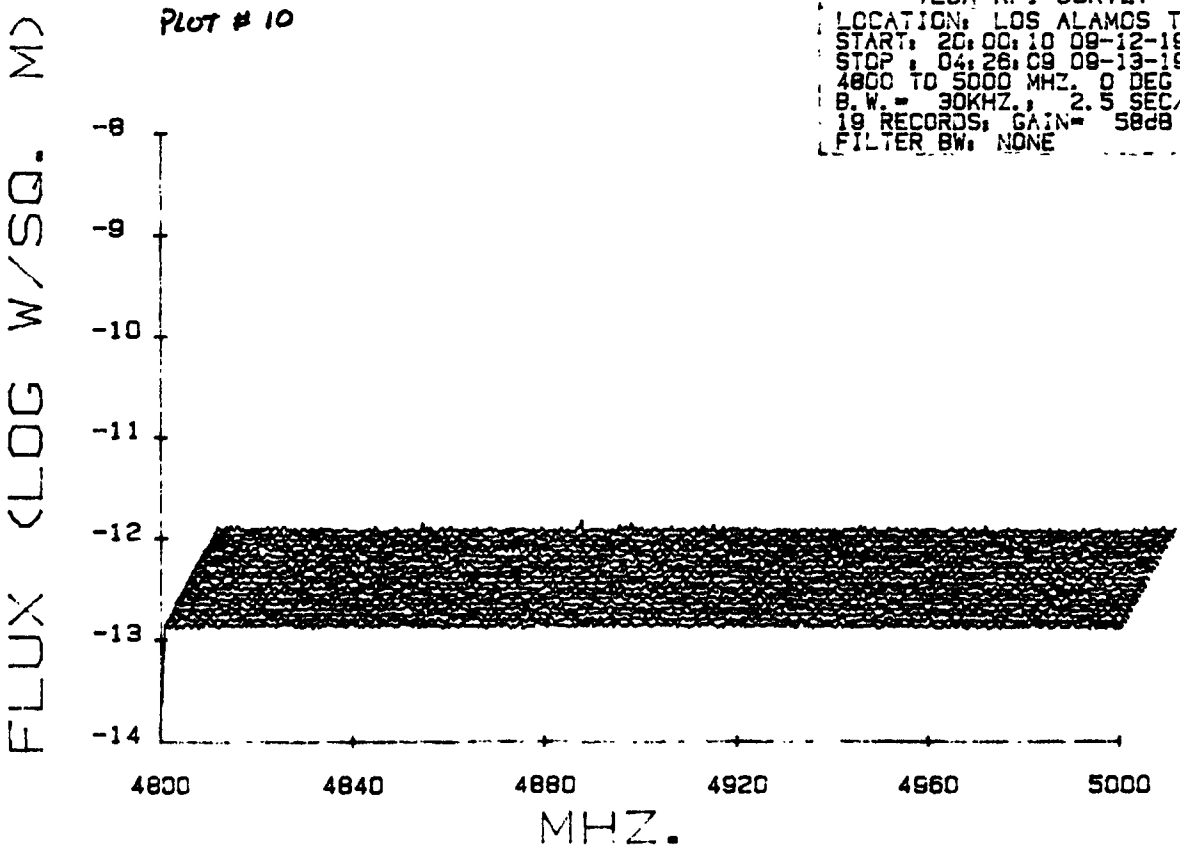
Plot #9

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 08:30:42 09-12-1984
STOP : 10:39:26 09-12-1984
4600 TO 4800 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 2.5 SEC/CM.
19 RECORDS; GAIN= 58dB
FILTER BW: NONE

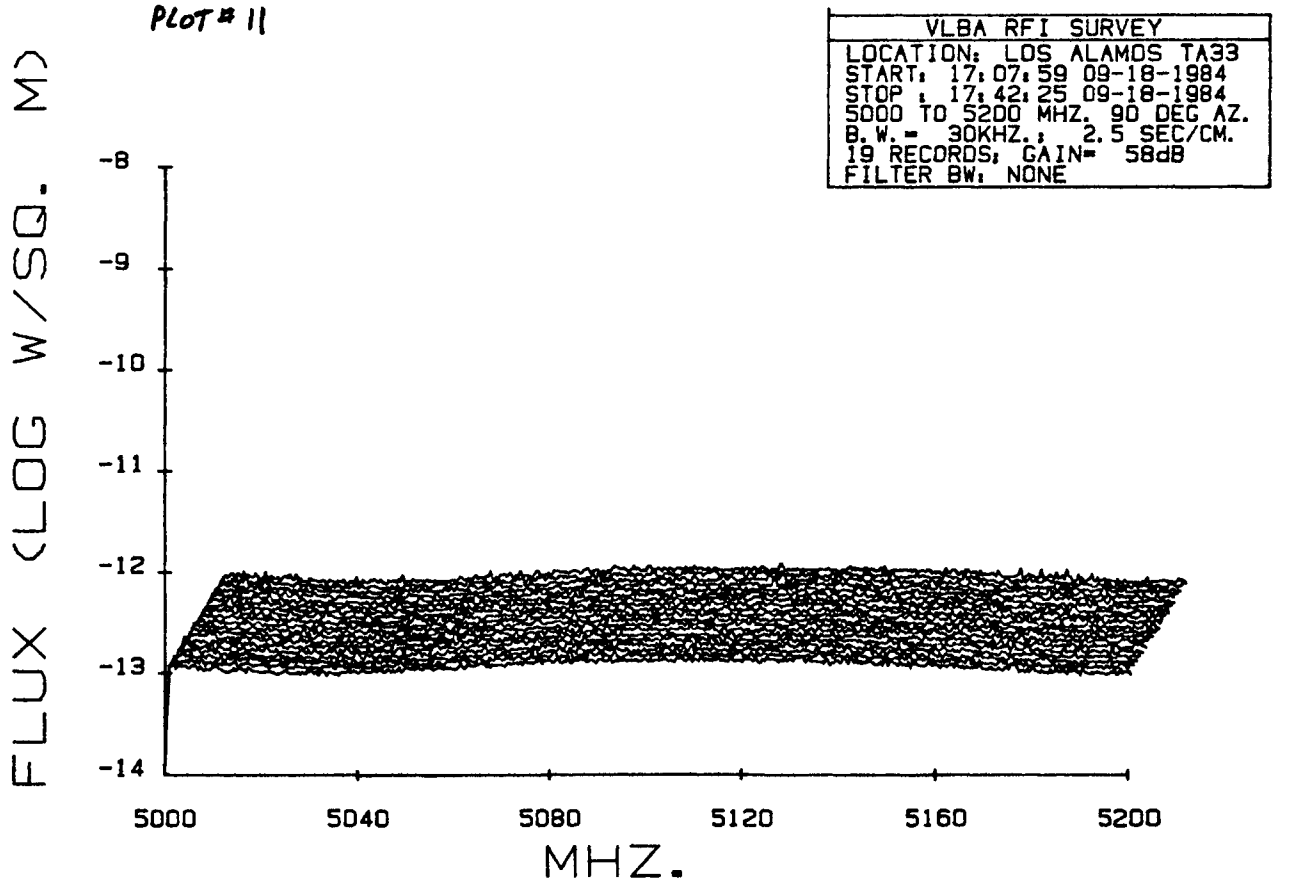


Plot # 10

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 20:00:10 09-12-1984
STOP : 04:26:09 09-13-1984
4800 TO 5000 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 2.5 SEC/CM.
19 RECORDS; GAIN= 58dB
FILTER BW: NONE

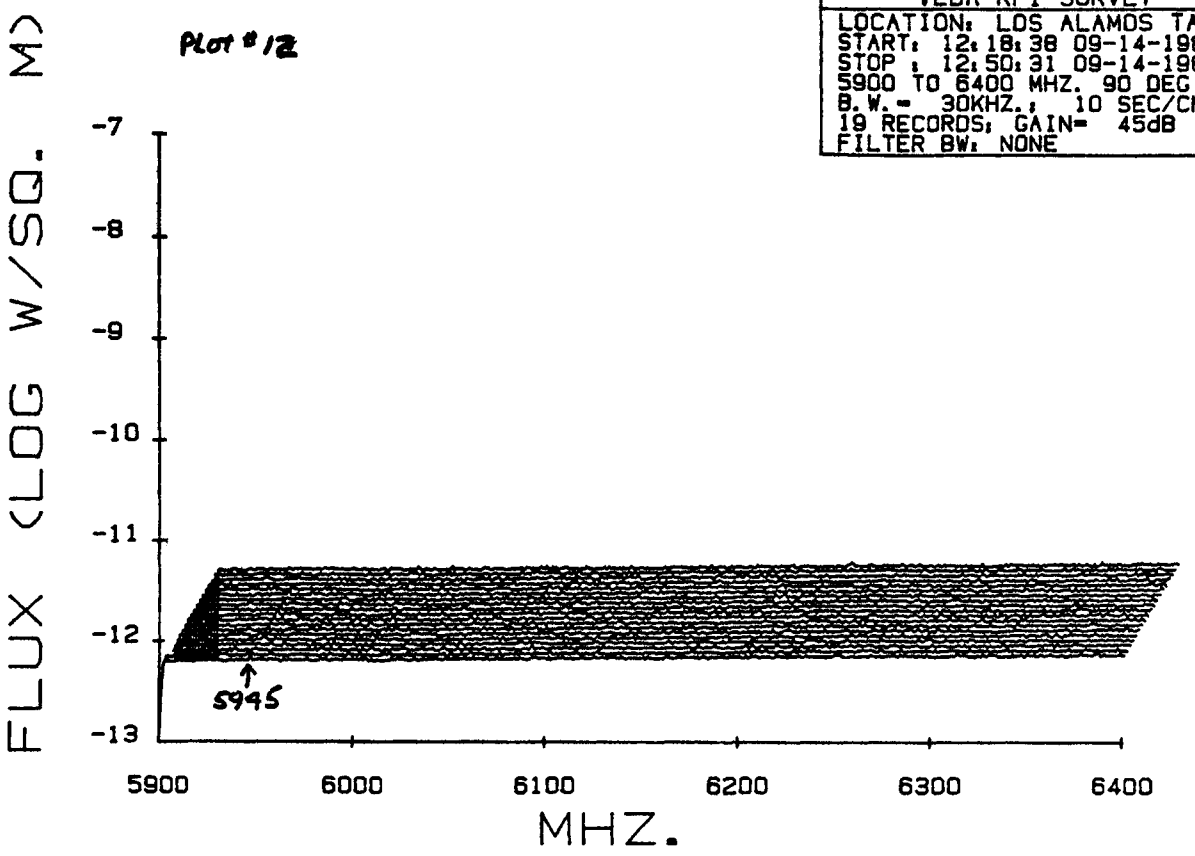


PLOT # 11


VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 17:07:59 09-18-1984
STOP : 17:42:25 09-18-1984
5000 TO 5200 MHZ. 90 DEG AZ.
B.W. = 30KHZ.; 2.5 SEC/CM.
19 RECORDS; GAIN= 58dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
5000
5040
5080
5120
5160
5200
MHZ.

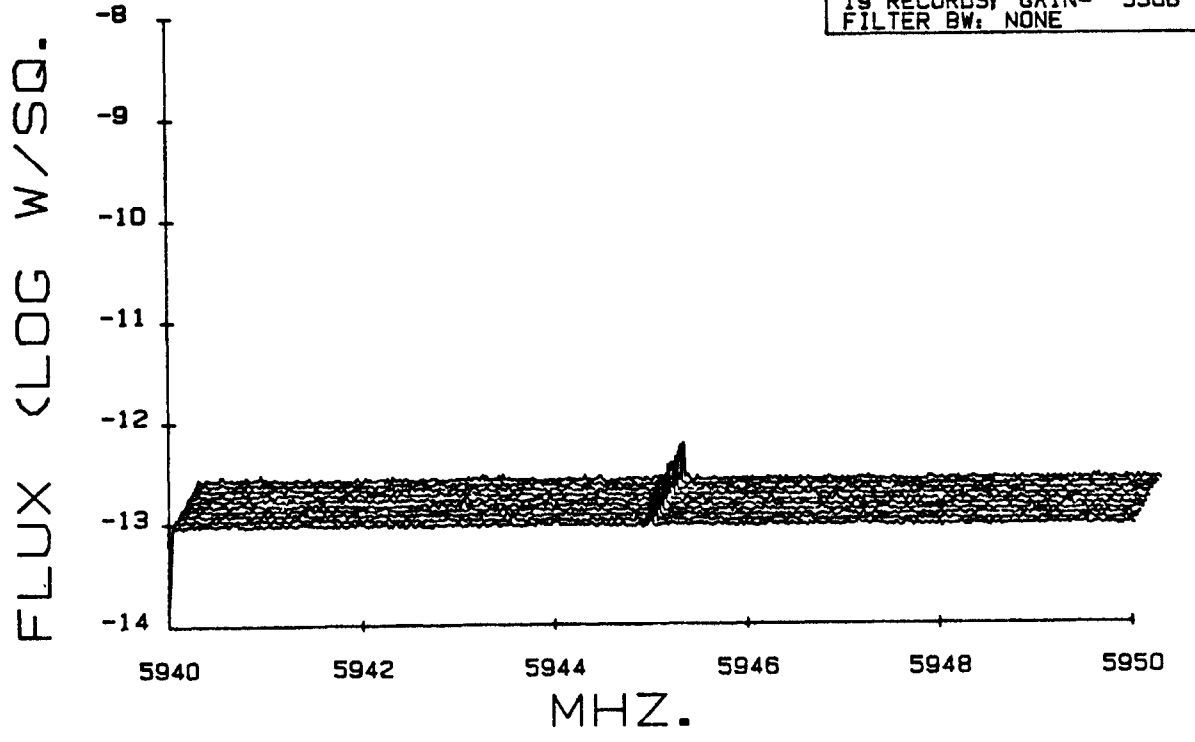
Plot # 12

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 12:18:38 09-14-1984
STOP : 12:50:31 09-14-1984
5900 TO 6400 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; 10 SEC/CM.
19 RECORDS; GAIN= 45dB
FILTER BW: NONE



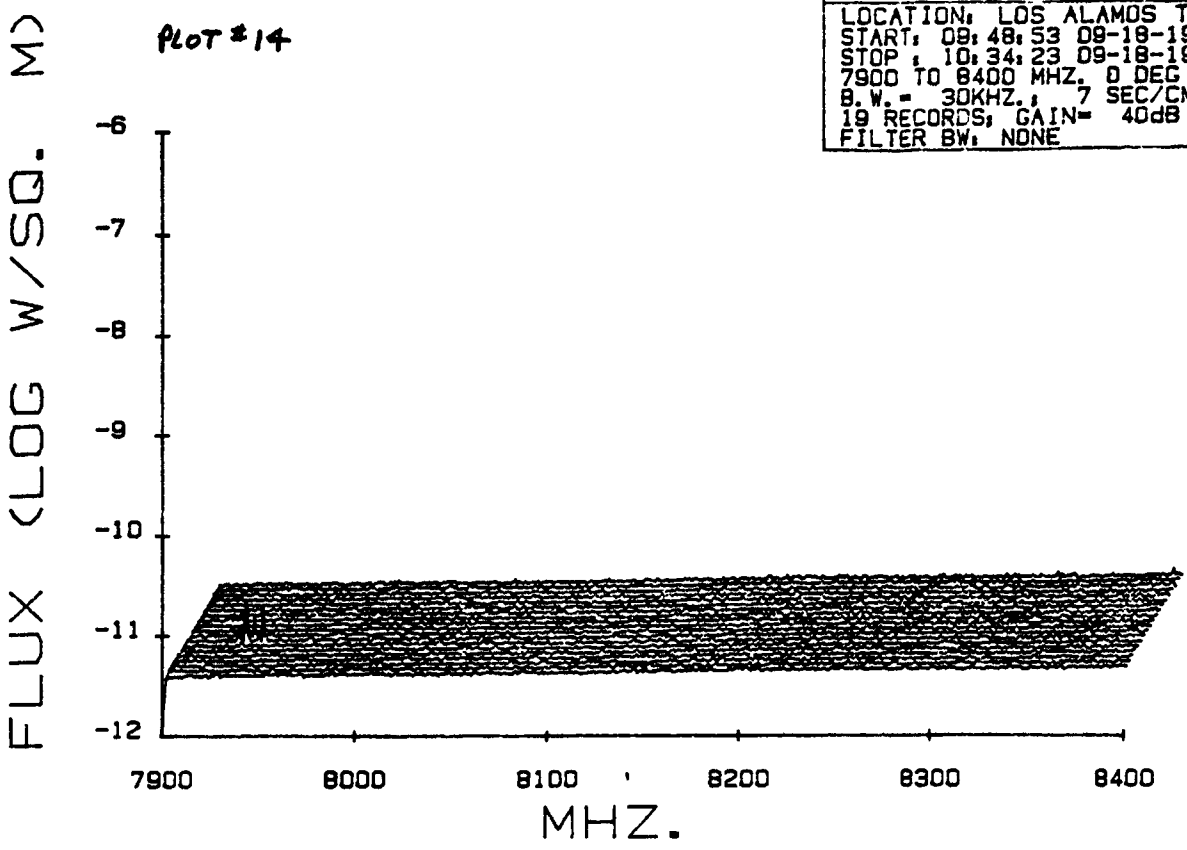
Plot # 13

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 15:39:44 09-14-1984
STOP : 15:38:06 09-14-1984
5940 TO 5950 MHZ. 90 DEG AZ.
B.W.= 10KHZ.; 1.5 SEC/CM.
19 RECORDS; GAIN= 55dB
FILTER BW: NONE



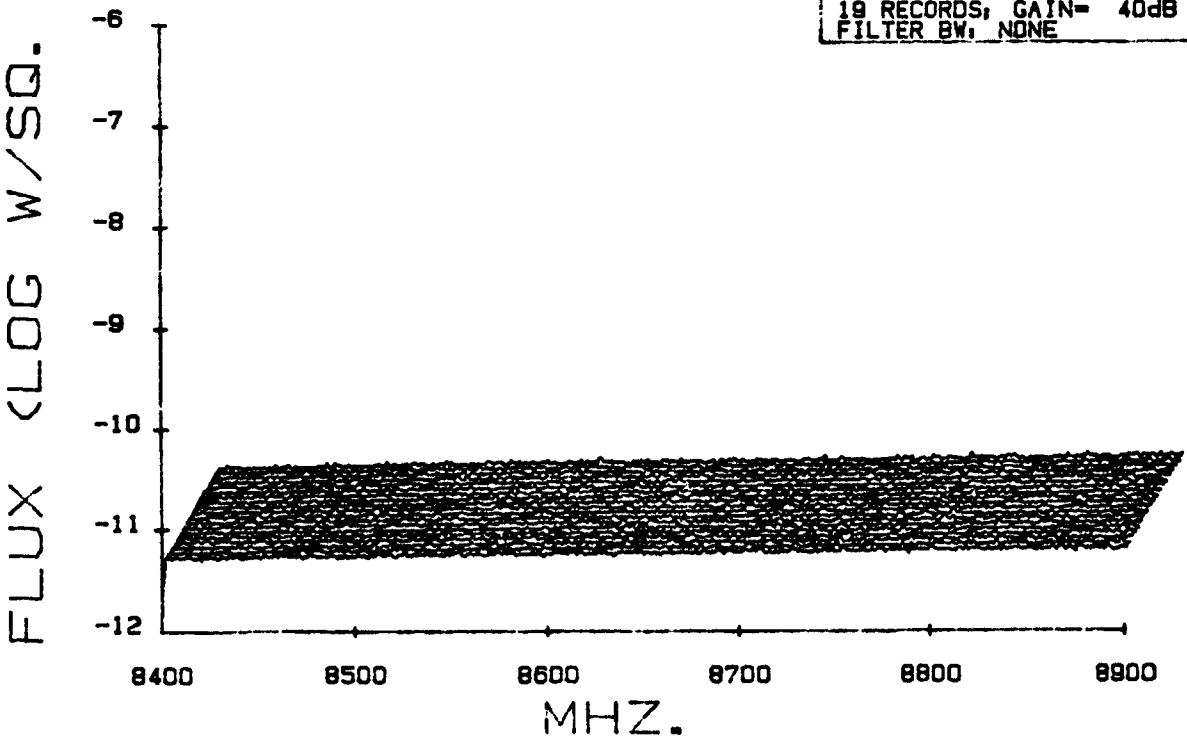
PLOT #14

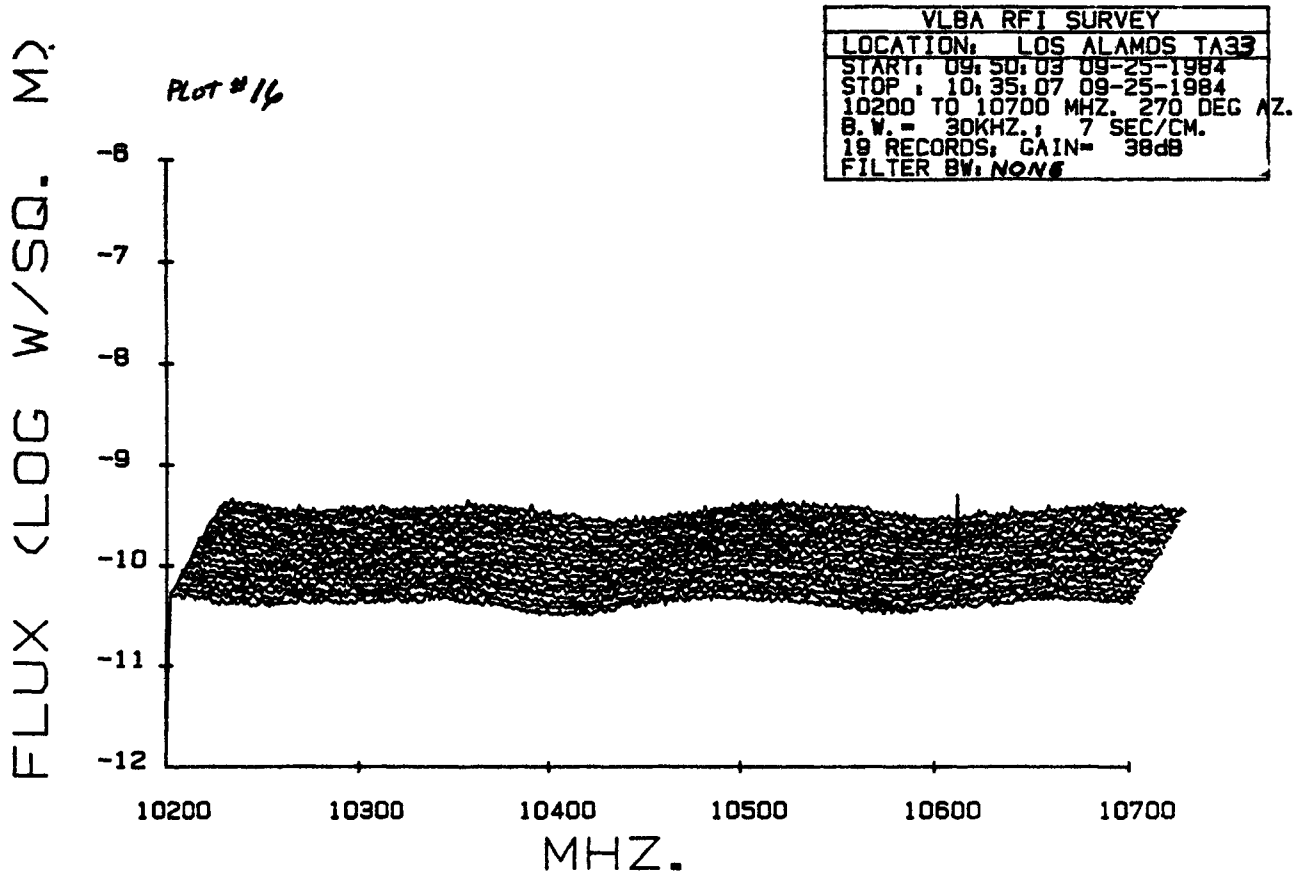
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 09:48:53 09-18-1984
STOP : 10:34:23 09-18-1984
7900 TO 8400 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 40dB
FILTER BW: NONE

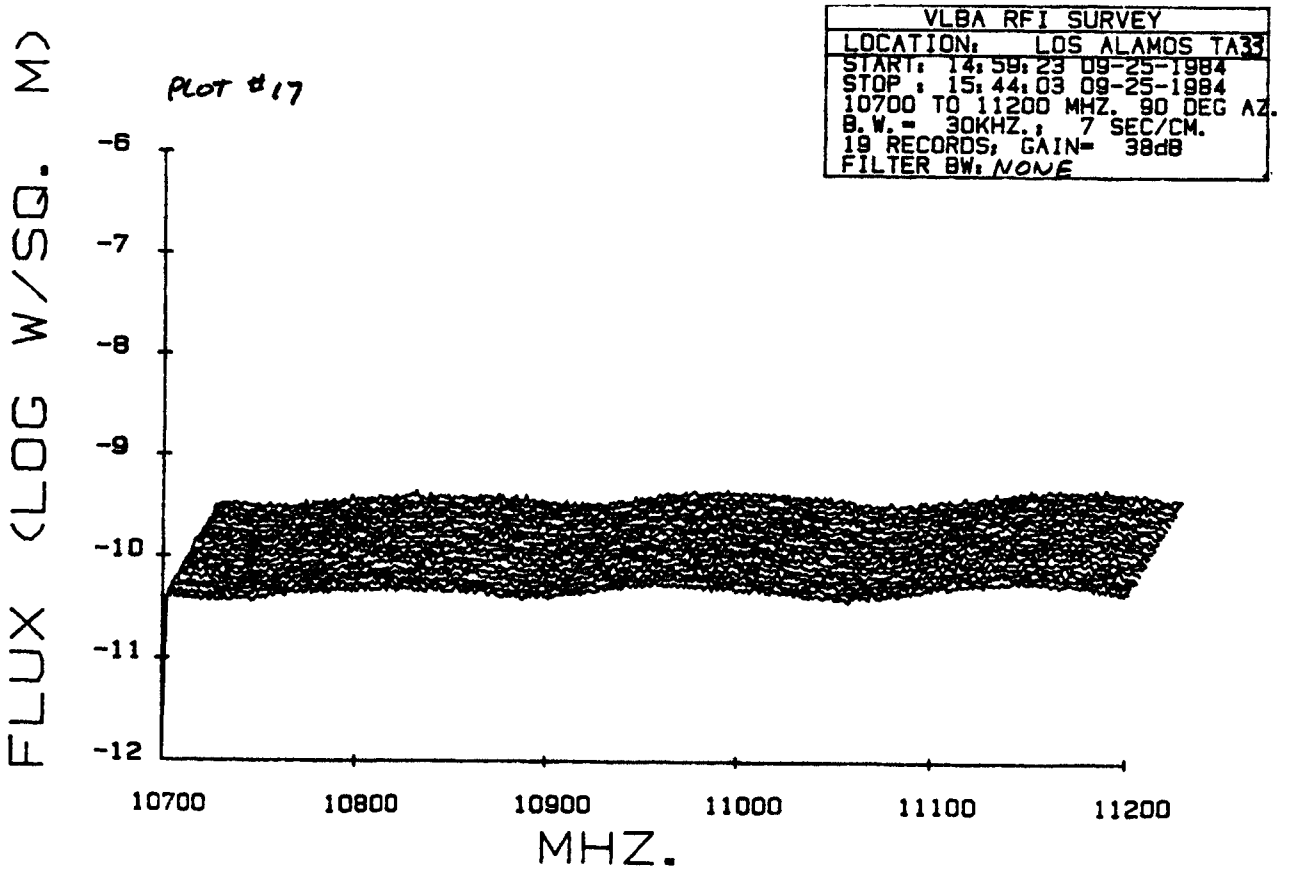


PLOT #15

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 13:59:23 09-18-1984
STOP : 14:44:21 09-18-1984
8400 TO 8900 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 40dB
FILTER BW: NONE



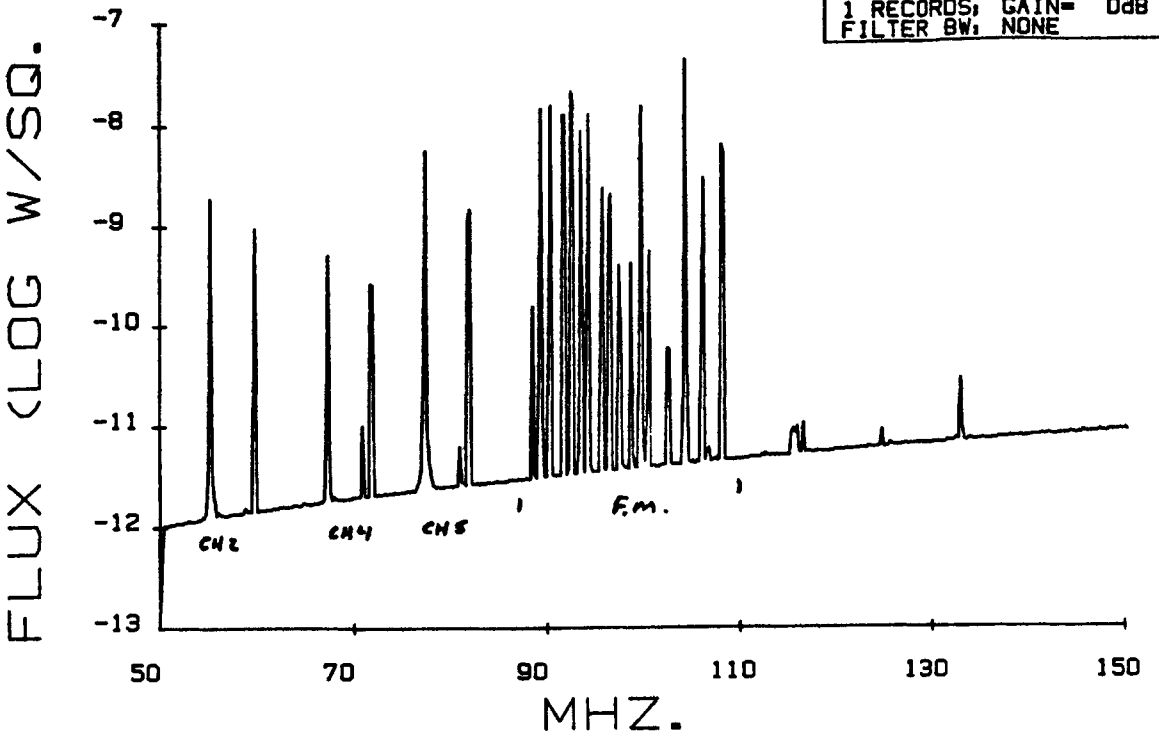

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 09:50:03 09-25-1984
STOP : 10:35:07 09-25-1984
10200 TO 10700 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 38dB
FILTER BW: NONE
PLOT #16
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
10200
10300
10400
10500
10600
10700
MHZ.


VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 14:59:23 09-25-1984
STOP : 15:44:03 09-25-1984
10700 TO 11200 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 38dB
FILTER BW: NONE
PLOT #17
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
10700
10800
10900
11000
11100
11200
MHZ.

PLOT # 18

FROM LOCATION #1

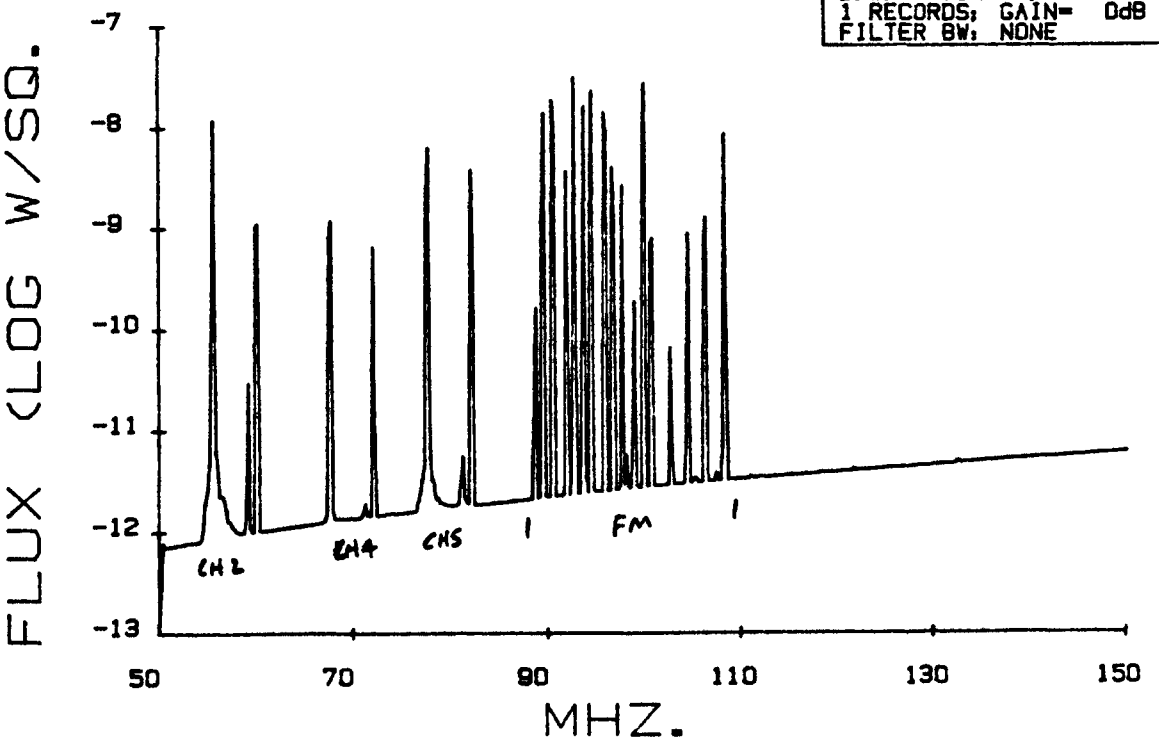
VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 08:50:14 09-27-1984
STOP : 08:53:37 09-27-1984
50 TO 150 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 1.5 SEC/CM.
1 RECORDS; GAIN= 0dB
FILTER BW: NONE



PLOT # 19

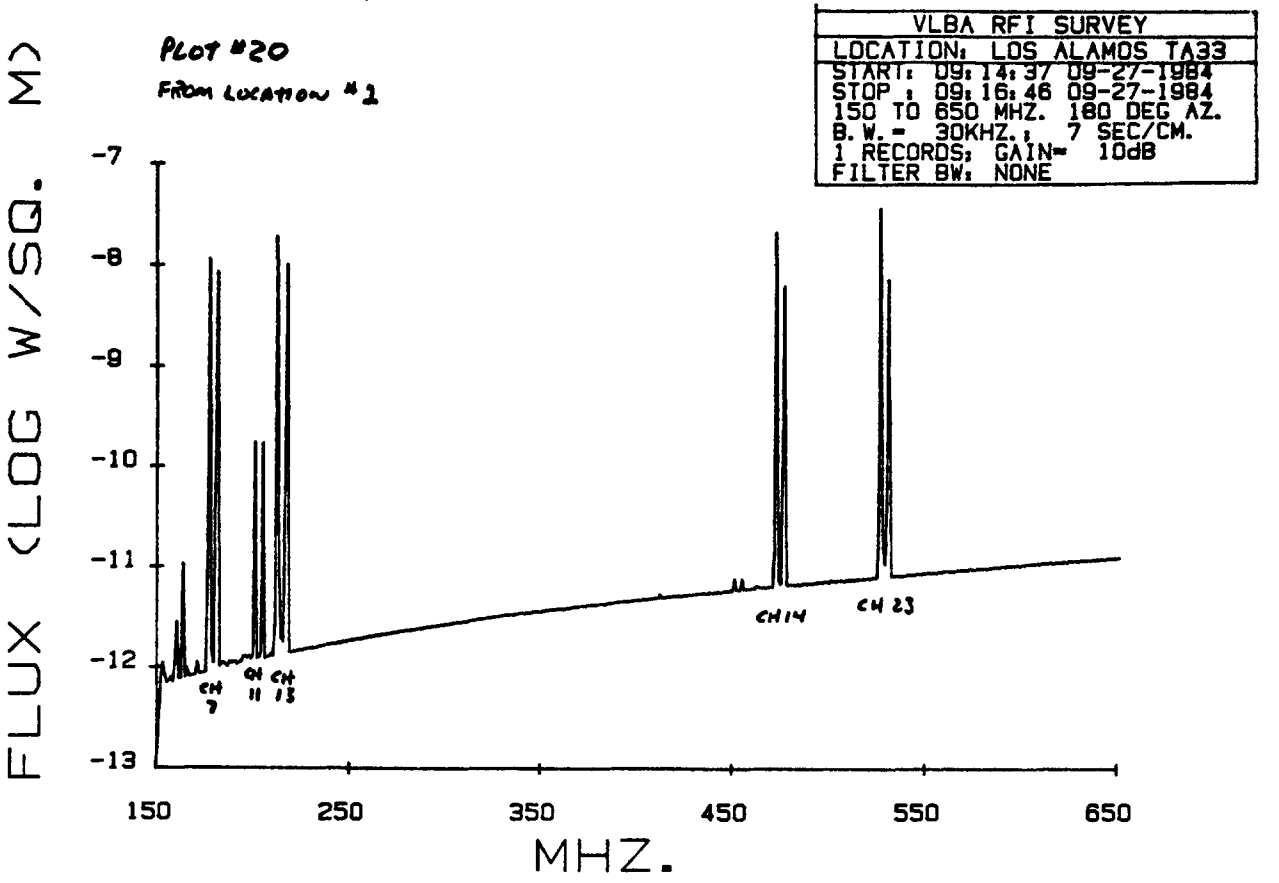
FROM LOCATION #2

VLBA RFI SURVEY
LOCATION: LANLTA33-1 GEN
START: 15:43:44 09-27-1984
STOP : 15:45:43 09-27-1984
50 TO 150 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 1.5 SEC/CM.
1 RECORDS; GAIN= 0dB
FILTER BW: NONE



PLOT #20
FROM LOCATION #1

VLBA RFI SURVEY
LOCATION: LOS ALAMOS TA33
START: 09:14:37 09-27-1984
STOP : 09:16:46 09-27-1984
150 TO 650 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
1 RECORDS; GAIN= 10dB
FILTER BW: NONE



PLOT #21
FROM LOCATION #2

VLBA RFI SURVEY
LOCATION: LANLTA33-1 GEN
START: 16:20:19 09-27-1984
STOP : 16:22:28 09-27-1984
150 TO 650 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
1 RECORDS; GAIN= 0dB
FILTER BW: NONE