VLB ARRAY MEMO NO. _____

NATIONAL RADIO ASTRONOMY OBSERVATORY

Socorro, NM 87801

RFI INTERFERENCE SURVEY FOR THE VLBA

NORTHEAST SITE
Quabbin Reservoir, Amherst, MA
and
Sargent Camp, Peterborough, NH

September, October 1987

Jim Oty

CONTENTS

ON THE ROAD AGAIN

The RFI survey for the tenth VLBA antenna location, which up to now has been referred to as the 'Northeast' site, was scheduled for the fall of 1987. Two proposed sites were chosen for this survey. One location was at the site of the Five College Radio Observatory at Quabbin Reservoir in West Central Massachusetts and the second site was at Sargent Camp Outdoor Center, operated by Boston University's Human Environment Institute, located near Pererborough, NH. In this report, I have combined the two sites in order to compare the results.

When the go ahead was given for this survey, it was necessary to reassemble all of the RFI measuring equipment, check it out, and decide if it would be better to ship it or drive it to the northeast. The ideal would have been to ship the entire trailer as a unit but the cost was prohibitive so the next alternative was to drive it. A towing vehicle was obtained, the proper trailer towing hitch installed, and the trip got under way on september 19. Five days later data was being gathered at the first location, Quabbin Reservoir.

THE TWO PROPOSED LOCATIONS
(YOU CAN'T SEE THE FORREST FOR THE TREES)

Five College Radio Observatory is located on a reservation owned by the Commonwealth of Massachusetts and under the care and control of the Watershead Management Division of the Metropolitan District Commission. The primary purpose of this reservation is to provide a water supply for the Boston area from Quabbin Reservoir, a man made lake within this reservation. Quabbin Reservoir is split in the middle by Prescott Peninsula, a ten mile long finger of land running north and south, that is not open to the general public. The entire peninsula is covered with trees, most of which are around 60 feet tall, and provides a haven for abundant wildlife, including deer, coyote, turkey, and eagles.

The observatory is located about midway down this peninsula, an a 25 acre tract of land leased by the University of Massachusetts from the Metropolitan District Commission (MDC). The original instrument planned for this site was a multi-element, meter wave telescope. Several of the elements were constructed before the project was ended and one of the structures still remains at the site. The operational instrument is a 14 meter antenna, enclosed in a dome, on a cleared portion of this leased tract.

Access to this location is from route 202, which skirts the northern edge of the reservation. A locked gate controls access so a key is required. A five mile long narrow, paved lane that winds through the trees leads to the observatory. The elevation of the observatory is about 1000 feet but it was impossible to see the surounding horizon because of the trees.

A few general comments about this site:

1. Power. The existing site is powered by a buried line that starts at the access gate and follows the road for five miles. This is a single phase line and it is running at near full capacity.

2. Telephone. Telephone service is provided by a 2 GHz. micro-wave link. All lines, except one emergency number, are connected through the U. Mass. switchboard. The original land line telephone service was abandoned several years ago because of poor quality.

3. Security. Because of the locked gate and the limited access, security seem to be excellent. The only traffic through the area was MDC vehicles and a few woodcutters that had authorization.

4. Snow. Two problems with the winter snows will be evident. Who will plow the road for access to the site and what will the snow loading be on the antenna. The fact that the existing instrument is in a dome should tell us something. These factors should be looked into.

5. Trees. The site is completely surrounded by 60 foot trees. In order to see the horizon, or at least down to five degrees, a large area will have to be cleared. This dense ground cover will no doubt be of some benefit in shielding the antenna from ground based interference generators.

Sargent Camp is located about fifty miles north of Quabbin Reservoir, four miles north of Peterborough in South Central New Hampshire. The camp is operated by the Human Environment Institute of Boston University and consists of a group of rustic buildings around a central clearing on a large wooded tract of land. Many walking trails wind through the woods and an area that is used as a small ski slope is kept clear. Halfmoon Pond, a small lake, is also within the boundries of the camp. The camp is used for many programs by the university. These varied from outreach programs for children to executive seminars and several such programs were in session while I was there.

Access to Sargent Camp is by a narrow, two lane road from Peterborough. The only traffic over this road is from the few local residents. There does not seem to be any commercial activity in the area. The elevation at the proposed location is about 1000 feet and again the area is covered by 50 to 60 foot trees. The surrounding horizon was shielded from view but should be well below five degrees as the highest mountain (hill) in the area is only 3000 feet.

My comments on this site are:

1. Power. The power situation should be a little better than Quabbin. There appears to be adequate three phase power in the immediate area.

2. Telephone. No micro-wave link required here as regular telephone service is availible.

3. Security. While I had no problems with security, this site was open to the public. The camp proper was well lighted and staff members live at the camp.

4. Snow. This problem will be the same as the Quabbin location as the annual snowfall is about the same. The road from Peterborough is plowed by the county but not the highest on the priority list. The locals talk about last

years (or the year before) 40 inch snowfall so as at Quabbin, these factors must be considered.

5. Trees. Again, a large area will have to be cleared of trees. While these trees will give some measure of protection from interference, they will add to the horizon elevation angle.

6. Visibility. The camp manager plans to conduct an experiment to test the antenna visibility. He plans to tether a helium balloon at about 100 feet over the proposed antenna site and check with the neighbors for complaints.

THE RESULTS
(PLOT IT AGAIN, SAM)

The usual survey was conducted at each site. The radio astronomy bands from 75 MHz. through 11 GHz. were sampled for possible interference signals. Acollection of plots are included with this report and are listed in Table I. Comparable plots from each site are shown side by side to show the differences. The usual Table of Harmful Interference Levels is included as Table II.

But first the inevitable comments:

73 MHz. to 75 MHz. Surrounded by TV stations. Very strong and numerous FM stations in the area. Quabbin signal levels slightly stronger.

300 MHz. to 350 MHz. Heavy and sometimes very strong air/ground activity. Probably as a result of air traffic into Boston's Logan airport. Again Quabbin slightly stronger and more frequent.

550 MHz. to 650 MHz. Most UHF TV channels are in use. Some, particularly channels 27, 30, 38 and 40, are very strong. Please note that gain has been reduced on the Quabbin plots due to the stronger signal levels.

500 MHz. to 1 GHz. Quick look at the VLBA IF band shows the heavy usage of the UHF TV band in the New England area. This is a better comparison of the two sites as the gain is the same for both.

1.35 GHZ. to 1.75 GHz. Suspiciously quiet. Long term plots only show the usual Radiosonde activity. One Quabbin plot shows a strong signal at 1.43 GHz. for several hours but did not re-occur. A few low level signals around 1.54 GHz. occurred at both sites.

2.15 GHz. to 2.35 GHz. Quabbin local telephone service uses 2.184 GHz. for transmit frequency (2.134 GHz. receive is out of plot range) and is very strong. Other signals are from a relay facility several miles to the west. Sargent Camp was clear.

4.6 GHz. to 5.2 GHz. No signals at either location.

5.9 GHz. to 6.4 GHz. Low level signals of the ATT long line type at Quabbin. Sargent camp clear.

7.9 GHz. and up No signals at either location.

TABLE I
PROPOSED NORTHEAST LOCATIONS.

Note: Q = Quabbin Reservoir.
S = Sargent Camp

Plot #	Frequency	Filter Fc/BW	Comments
1Q	50 - 100 MHz.	None	East. Typical plot.
1S	50 - 100 MHz.	None	East. Typical plot.
2Q	74 - 76 MHz.	74/5%	East. Single line plot.
2S	74 - 76 MHz.	74/5%	South. Single line plot.
3Q	300 - 350 MHz.	325/50	West. Typical air/ground activity.
3S	300 - 350 MHz.	325/50	North. Typical air/ground activity.
4Q	550 - 650 MHz.	600/100	East. Reduced gain to keep on scale.
4S	550 - 650 MHz.	600/100	North. Normal gain.
5Q	500 - 1000 MHz.	None	East. VLBA IF band. Normal gain.
5S	500 - 1000 MHz.	None	North. Same as 5Q.
6Q	1.3 - 1.8 GHz.	HP1000	Omni Ant. Long term plot. Usual Radiosonde signal.
6S	1.3 - 1.8 GHz.	None	Omni Ant. Same as 6Q.
7Q	1.35 - 1.55 GHz.	1500/1000	South. Signal at 1.43 GHz. was only present for a few hours.
8Q	1.35 - 1.55 GHz.	1500/1000	East. Low level signals around 1.54 GHz.
7S	1.35 - 1.55 GHz.	1500/1000	South. Typical plot.
8S	1.35 - 1.55 GHz.	1500/1000	East. Low level signals around 1.54 GHz.
9Q	1.55 - 1.75 GHs.	1500/1000	West. Typical plot.

9S	1.55 - 1.75 GHz.	1500/1000	South. Typical plot.
10Q	2.15 - 2.35 GHz.	HP2000	West. Strong signal at 2.184 GHz. from local transmitter.
10S	2.15 - 2.35 GHz.	HP2000	West. Typical plot.
11Q	4.6 - 4.8 GHz.	HP4000	Typical plot.
11S	4.6 - 4.8 GHz.	HP4000	Typical plot.
12Q	4.8 - 5.0 GHz.	HP4000	Typical plot.
12S	4.8 - 5.0 GHz.	HP4000	Typical plot.
13Q	5.0 - 5.2 GHZ.	HP4000	Typical plot.
13S	5.0 - 5.2 GHz.	HP4000	Typical plot.
14Q	5.9 - 6.4 GHz.	HP4000	West. Low level ATT type signals.
14S	5.9 - 6.4 GHz.	HP4000	Typical plot.
15Q	7.9 - 8.4 GHz.	HP6000	Typical plot.
15S	7.9 - 8.4 GHz.	HP6000	Typical plot.
16Q	8.4 - 8.9 GHz.	HP6000	Typical plot.
16S	8.4 - 8.9 GHz.	HP6000	Typical plot.
17Q	10.2 - 10.7 GHz.	HP6000	Typical plot.
17S	10.2 - 10.7 GHz.	HP6000	Typical plot.
18Q	10.7 - 11.2 GHz.	HP6000	Typical plot.
18S	10,7 - 11.2 GHz.	HP6000	Typical plot.

TABLE II
HARMFUL INTERFERENCE LEVELS

VLBA TUNNING RANGE	HARMFUL INTERFERENCE LEVELS (Note 1)	RFI MEASURED THRESHOLD (Notes 2 & 3)	FLUX DENSITY FOR 1% COMP. (Note 4)
50 - 100 MHz.	*	-140 dBW/m^2	#
310 - 340 MHz.	-151 dBW/m^2	-148 dBW/m^2	-72 dBW/m^2
580 - 640 MHz.	-146 dBW/m^2	-146 dBW/m^2	-67 dBW/m^2
1.35 - 1.75 GHz.	-135 dBW/m^2	-140 dBW/m^2	-59 dBW/m^2
2.175 - 2.425 GHz.	*	-135 dBW/m^2	-55 dBW/m^2
4.6 - 5.1 GHz.	-120 dBW/m^2	-128 dBW/m^2	-49 dBW/m^2
4.99 - 5.0 GHz. (sub band)	-127 dBW/m^2	-128 dBW/m^2	-49 dBW/m^2
5.9 - 6.4 GHz.	-120 dBW/m^2	-125 dBW/m^2	-47 dBW/m^2
8.0 - 8.8 GHz.	*	-118 dBW/m^2	-44 dBW/m^2
10.2 - 11.2 GHz.	-110 dBW/m^2	-115 dBW/m^2	-42 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 the 0 dBI sidelobes rather than the +10 dBI sidelobes assumed in Memo 81.

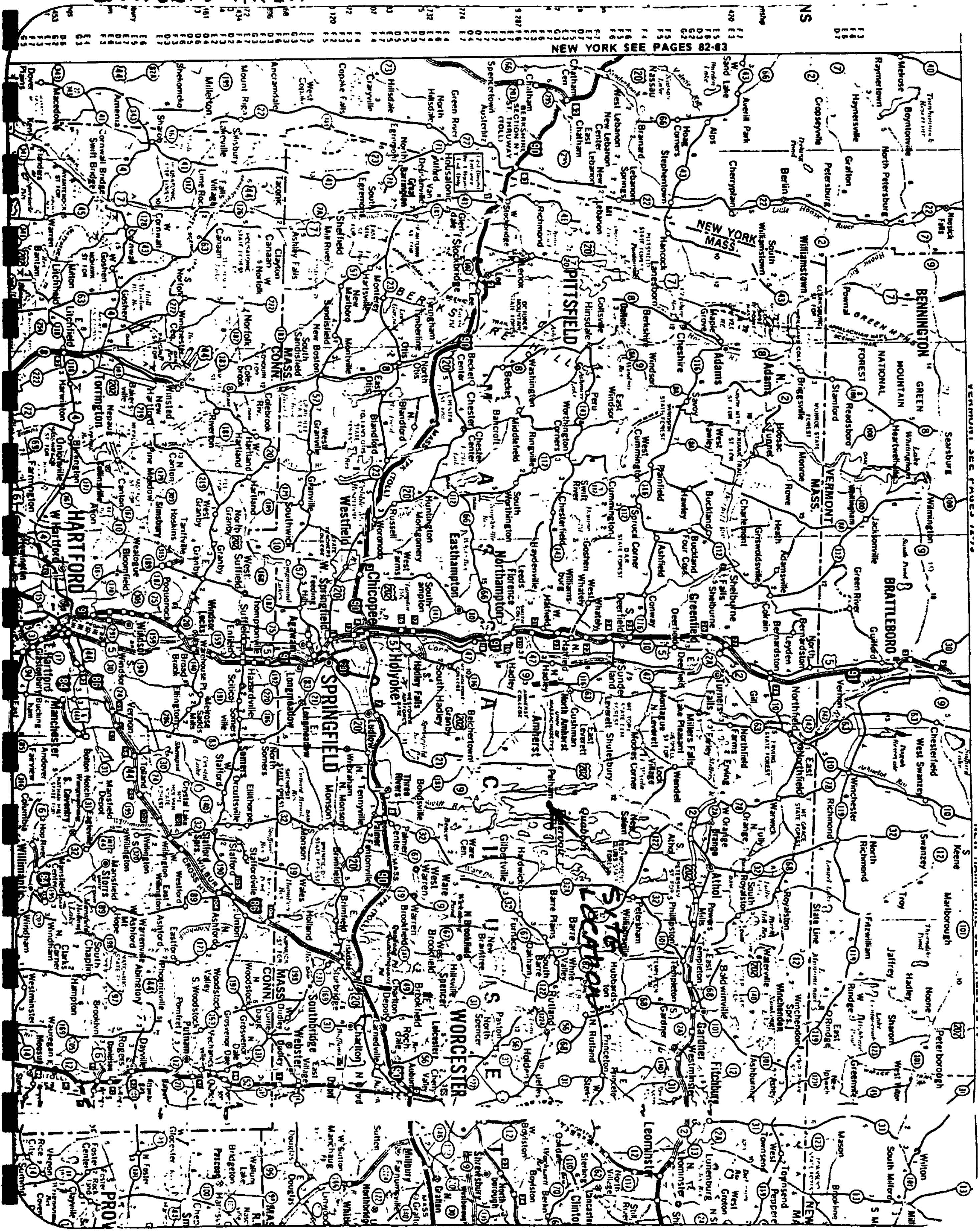
Note 2: These levels are threshold livels from Table I plots.

Note 3: These values may vary slightly from survey to survey because of minor equipment changes.

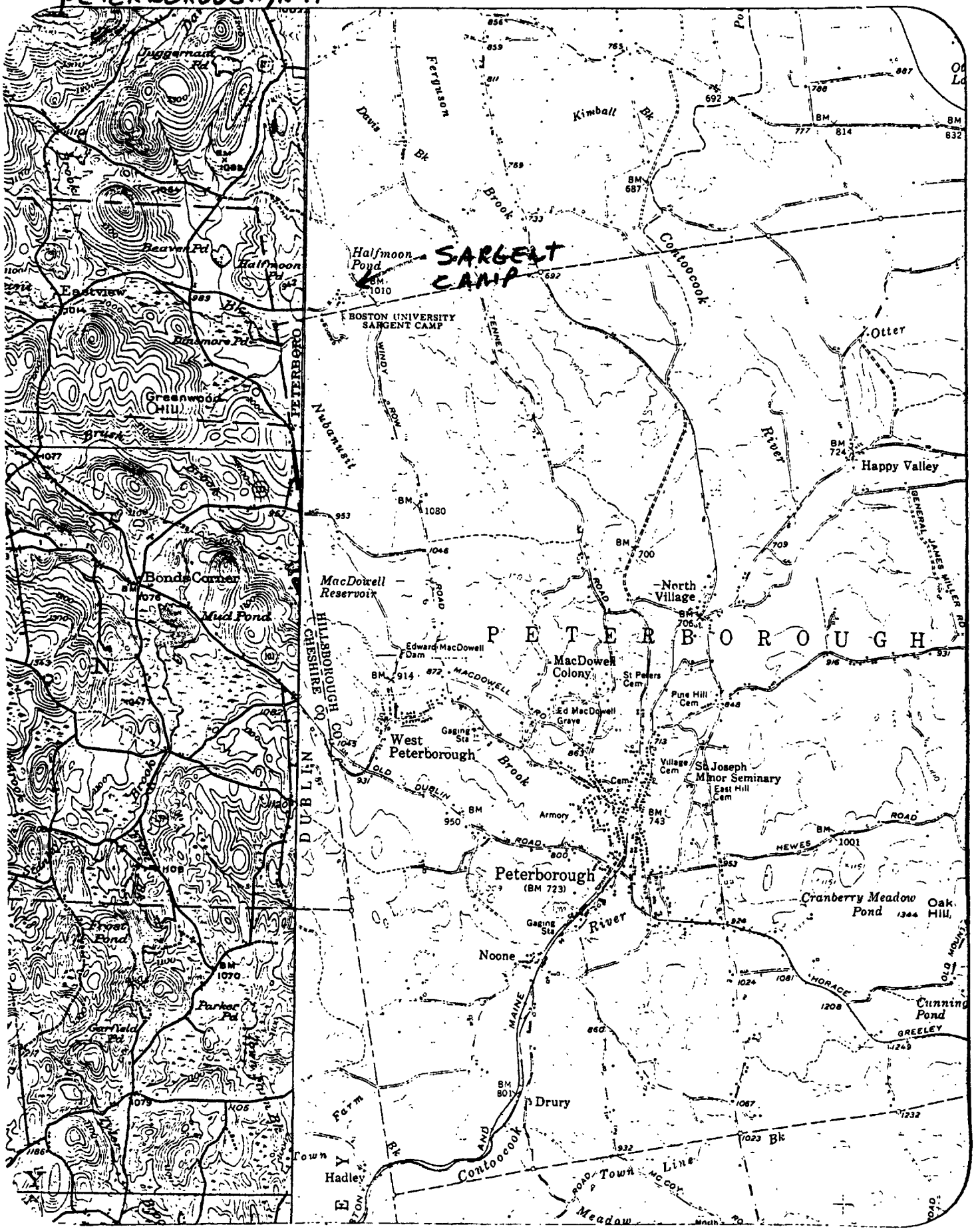
Note 4: These levles are from VLBA Electronics Memo No. 39.

* These frequency bands not included in memo 81.
# These frequency bands not included in memo 39.

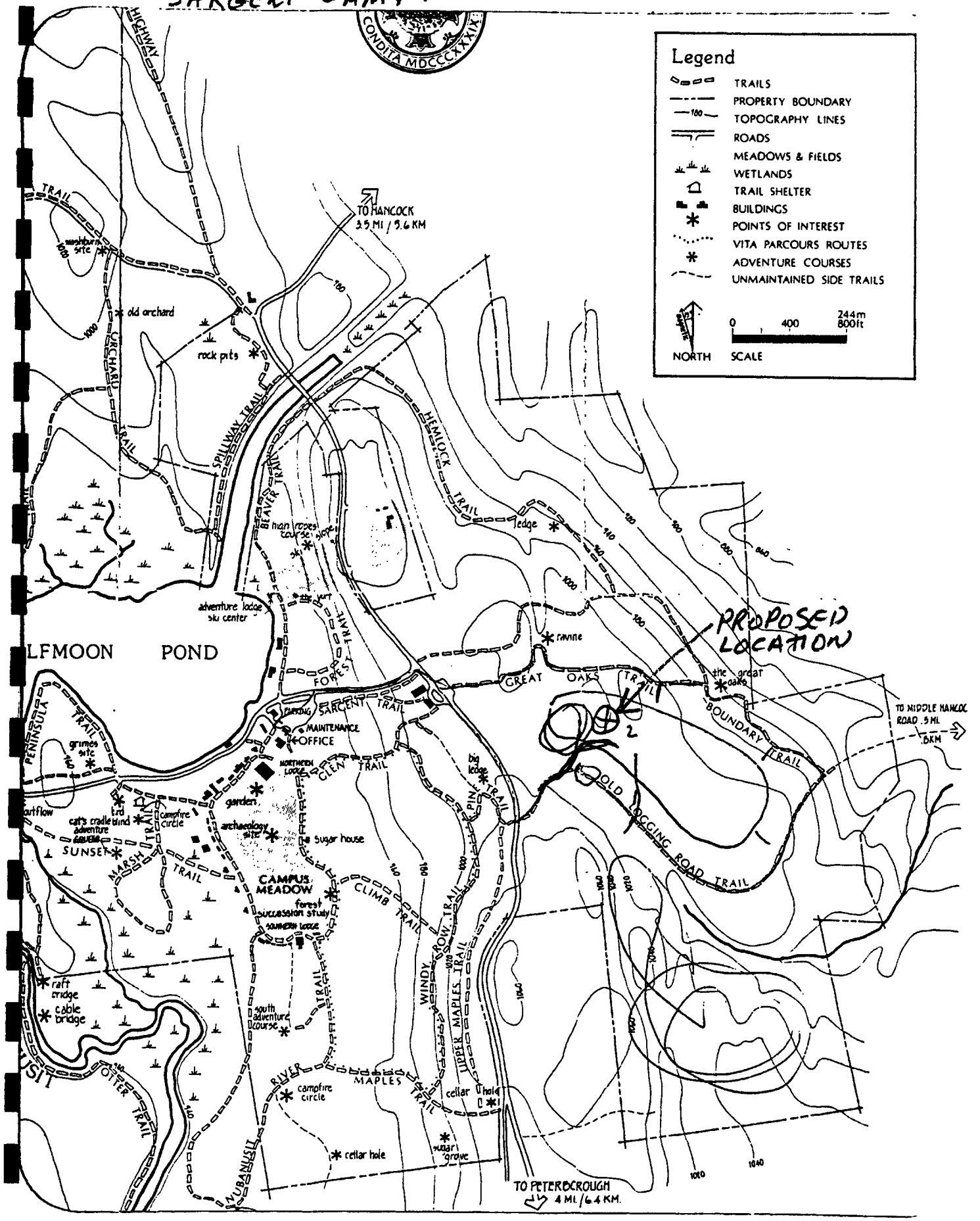
QUABBIN AREA

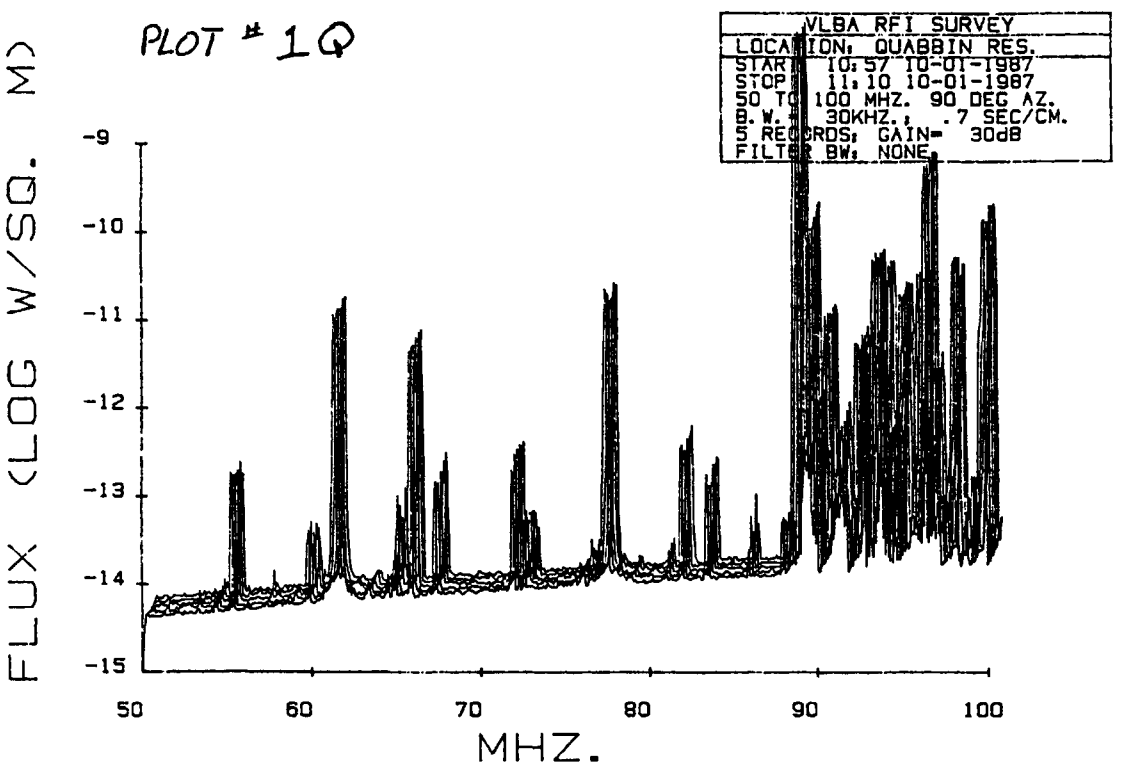


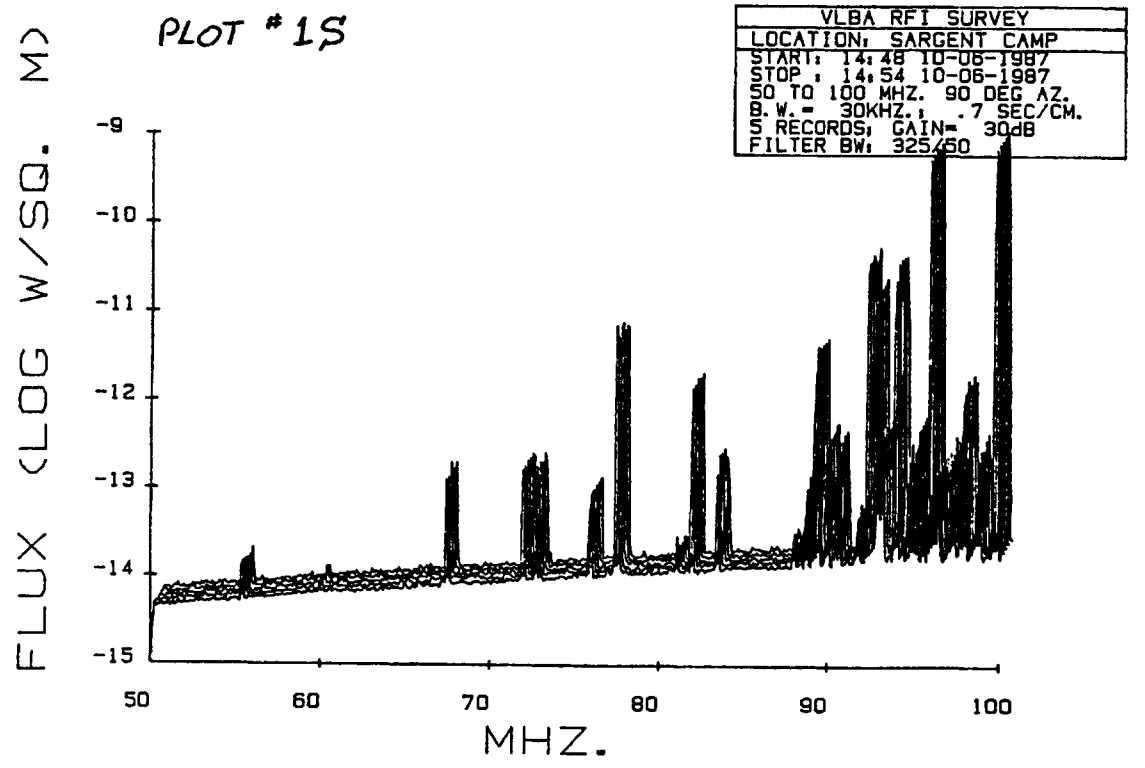
PETERBOROUGH, N H

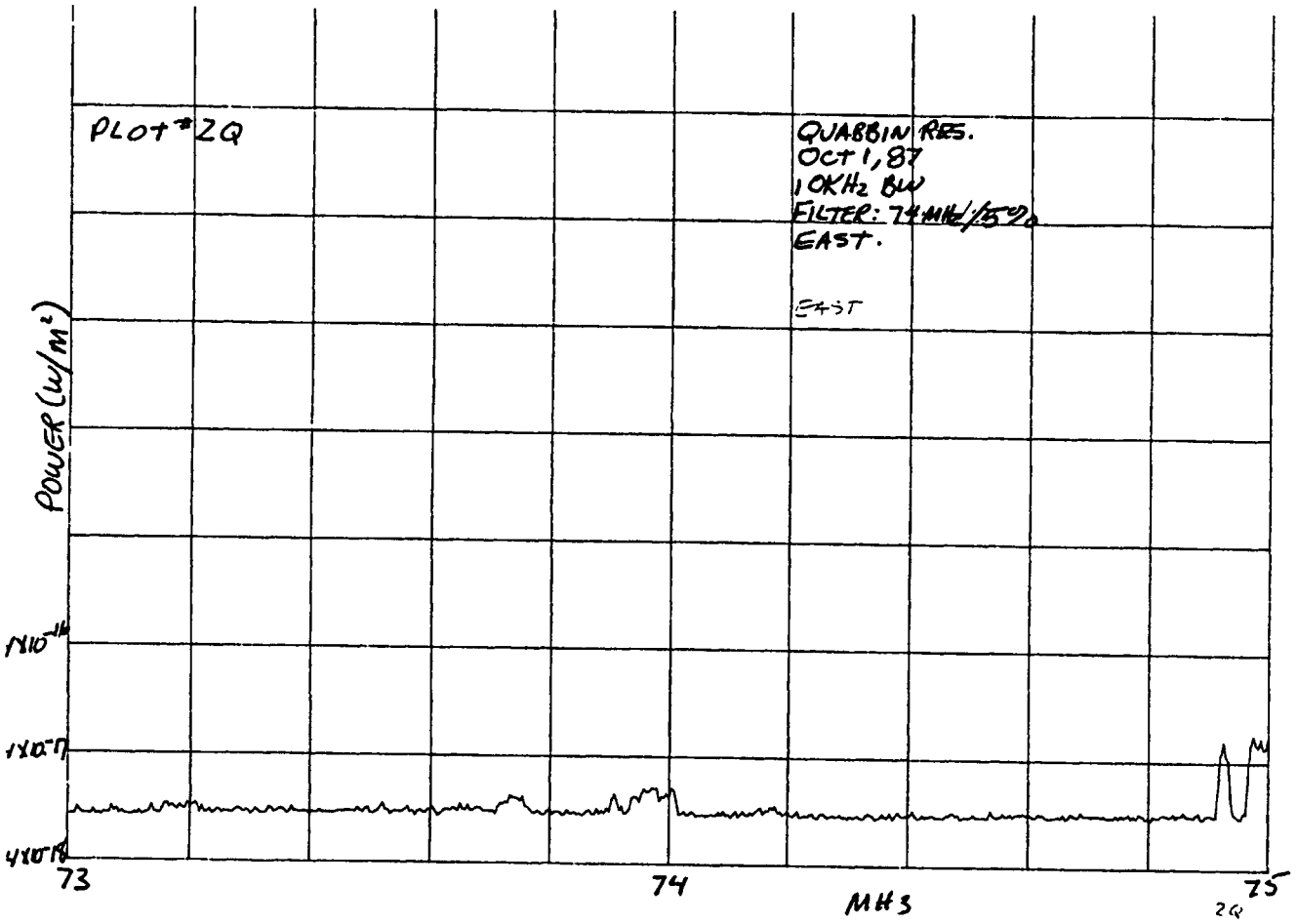


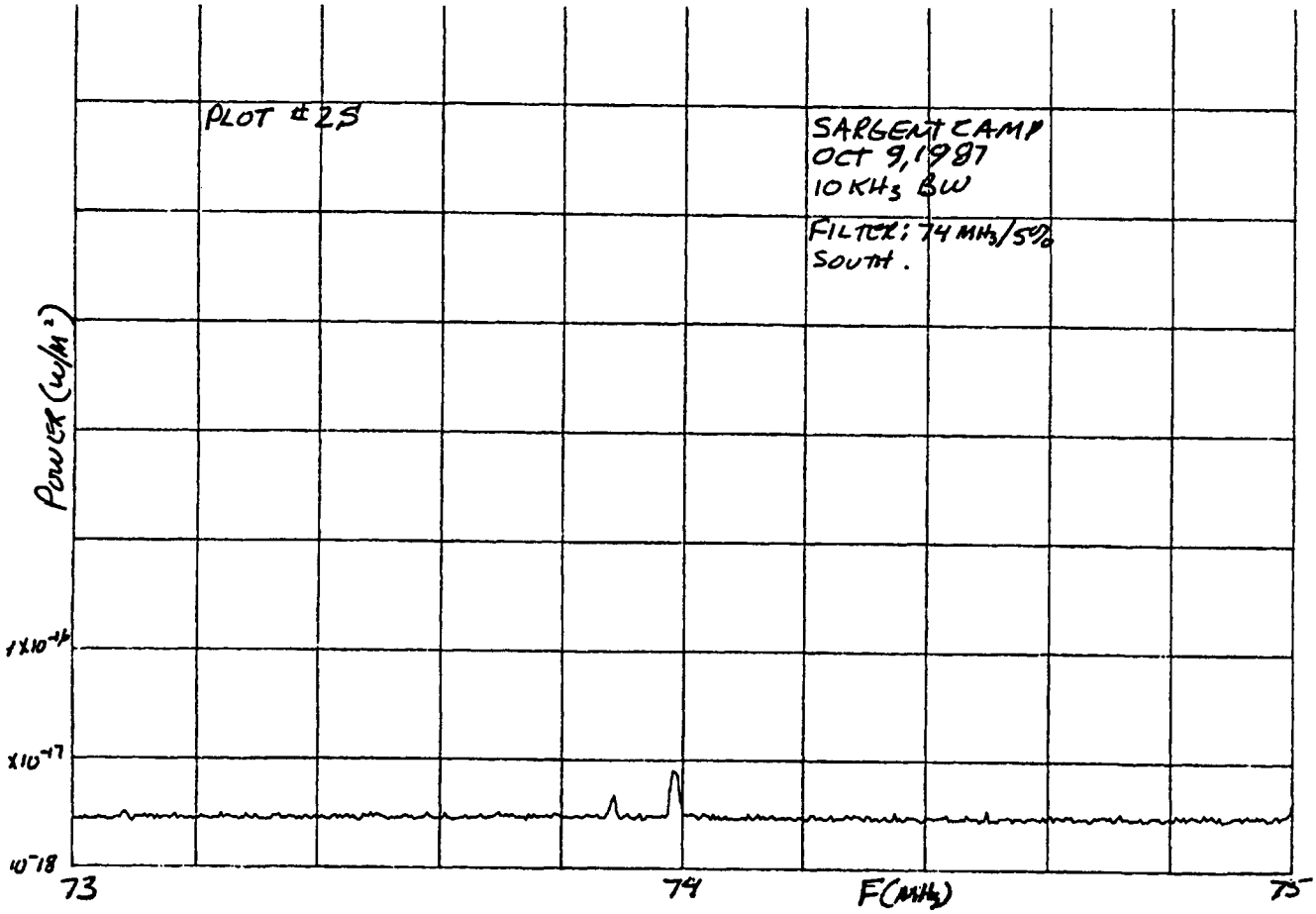
SARGENT CAMP.

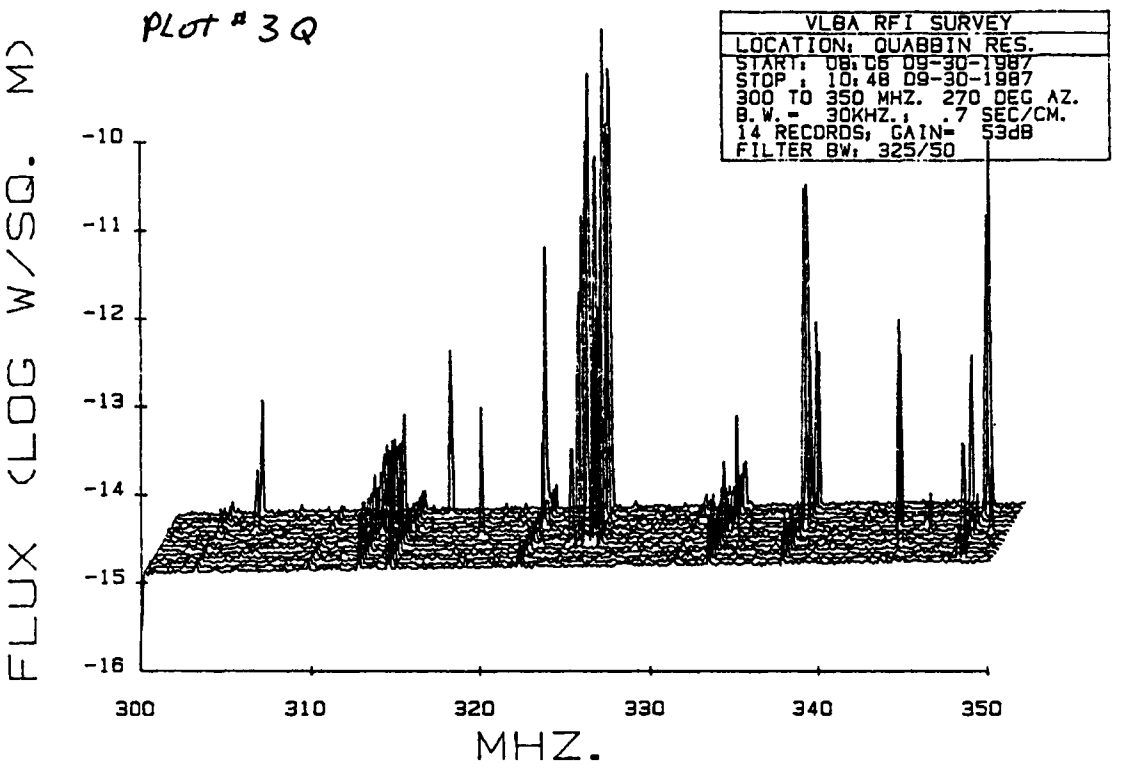



PLOT # 1Q
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
STOP : 11:10 10-01-1987
50 TO 100 MHZ. 90 DEG AZ.
5 RECORDS; GAIN= 30dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
50
60
70
80
90
100
MHZ.

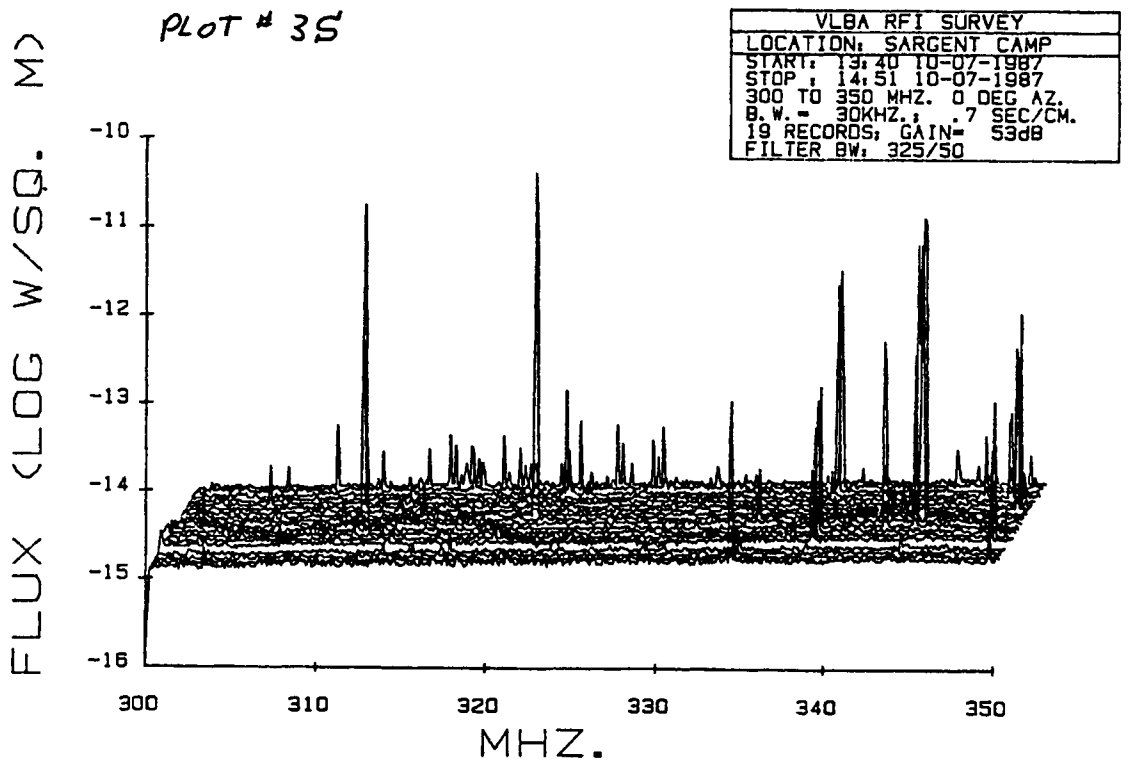

PLOT # 1S
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
STOP : 14:54 10-06-1987
50 TO 100 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
5 RECORDS; GAIN= 30dB
FILTER BW: 325/50
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
50
60
70
80
90
100
MHZ.


PLOT #2Q
QUABBIN RES.
OCT 1, 87
10 KH2 BW
FILTER: 74 MH2/5%
EAST.
EAST
POWER (w/m²)
1X10⁻¹⁶
1X10⁻¹⁷
4X10⁻¹⁸
73
74
75
MH3
2Q


PLOT #2S
SARGENT CAMP
OCT 9, 1987
10 KH3 BW
FILTER: 74 MH3/5%
SOUTH.
POWER (w/M²)
1X10⁻¹⁶
X10⁻¹⁷
10⁻¹⁸
73
74
F(MH3)
75

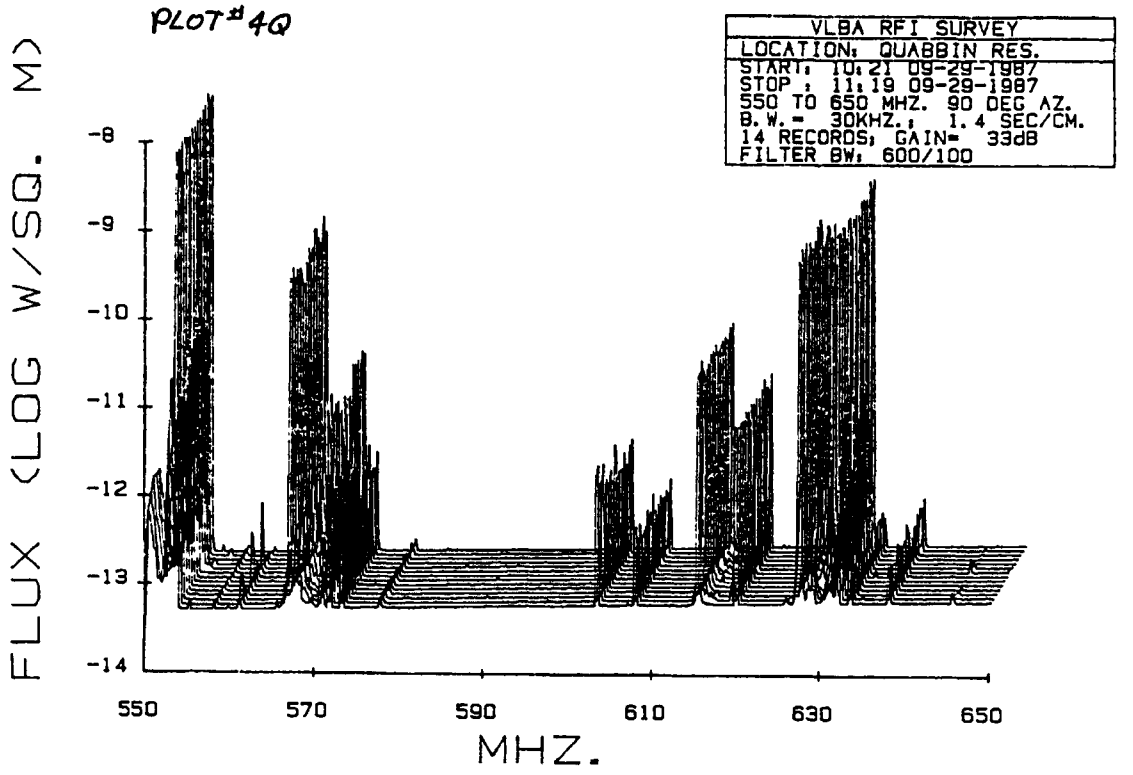

PLOT # 3Q
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 08:06 09-30-1987
STOP : 10:48 09-30-1987
300 TO 350 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
14 RECORDS; GAIN= 53dB
FILTER BW: 325/50
FLUX (LOG W/SQ. M)
-10
-11
-12
-13
-14
-15
-16
300
310
320
330
340
350
MHZ.

3Q


PLOT # 3S
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 13:40 10-07-1987
STOP : 14:51 10-07-1987
300 TO 350 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
19 RECORDS; GAIN= 53dB
FILTER BW: 325/50
FLUX (LOG W/SQ. M)
-10
-11
-12
-13
-14
-15
-16
300
310
320
330
340
350
MHZ.

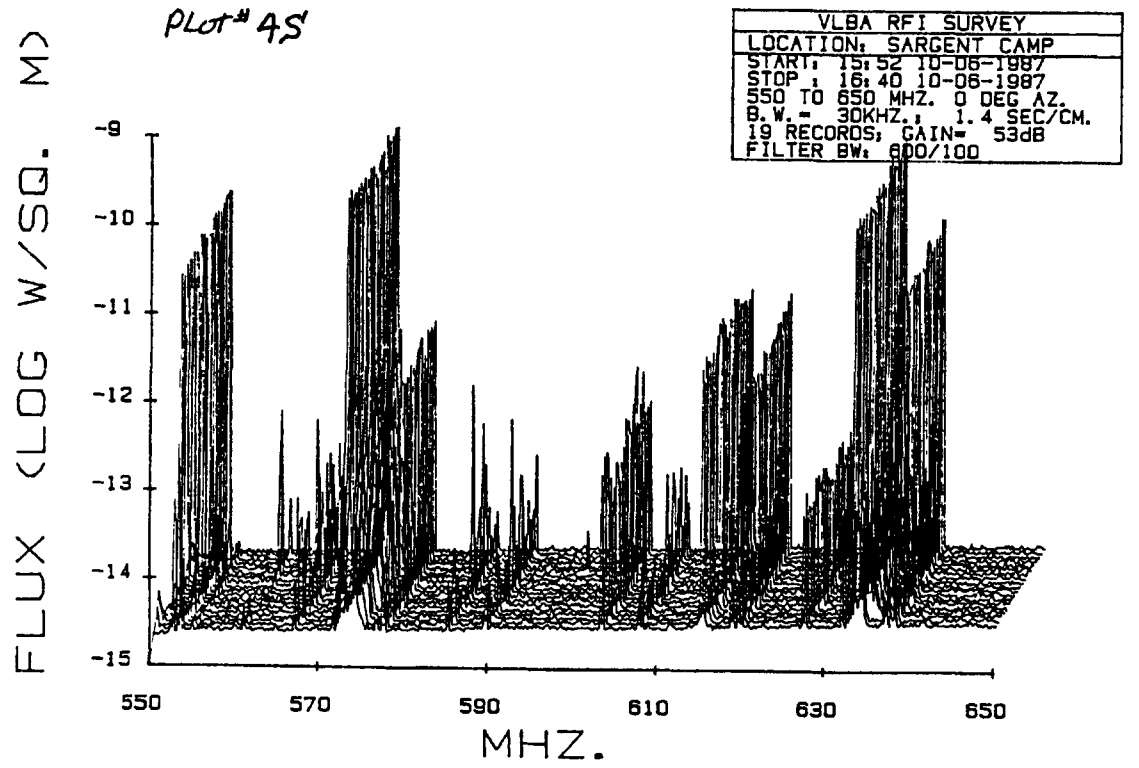
3S

PLOT #40



40

PLOT #45



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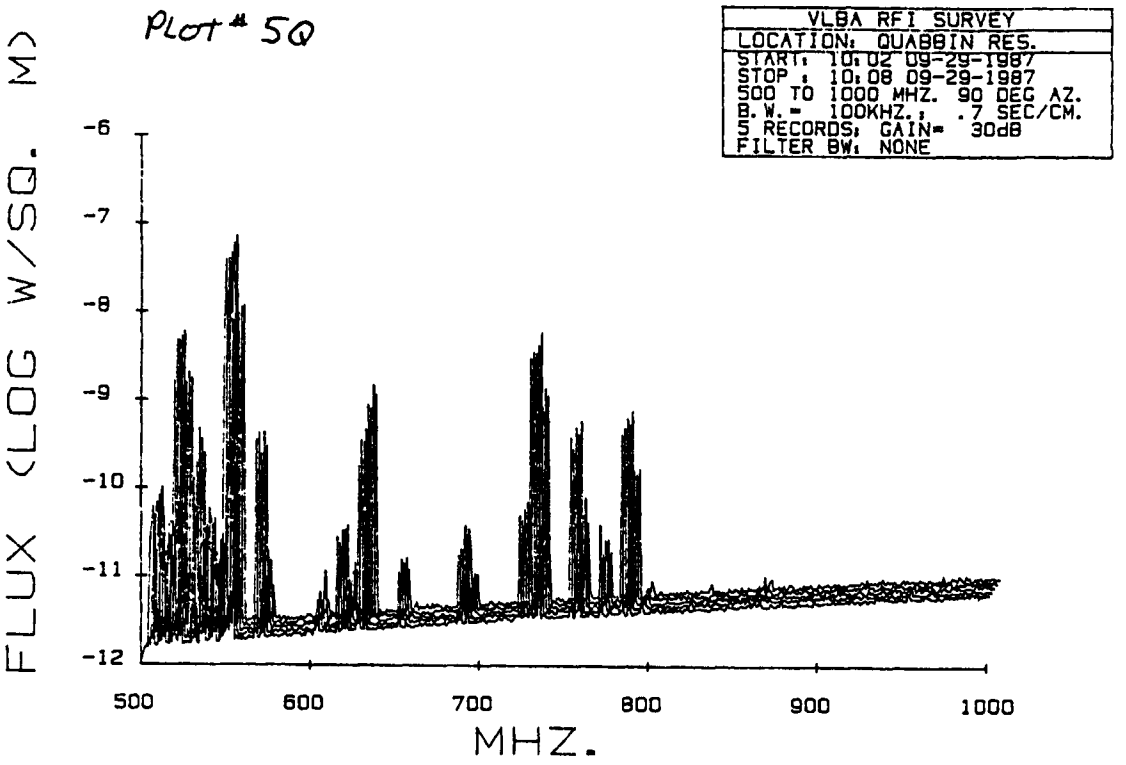
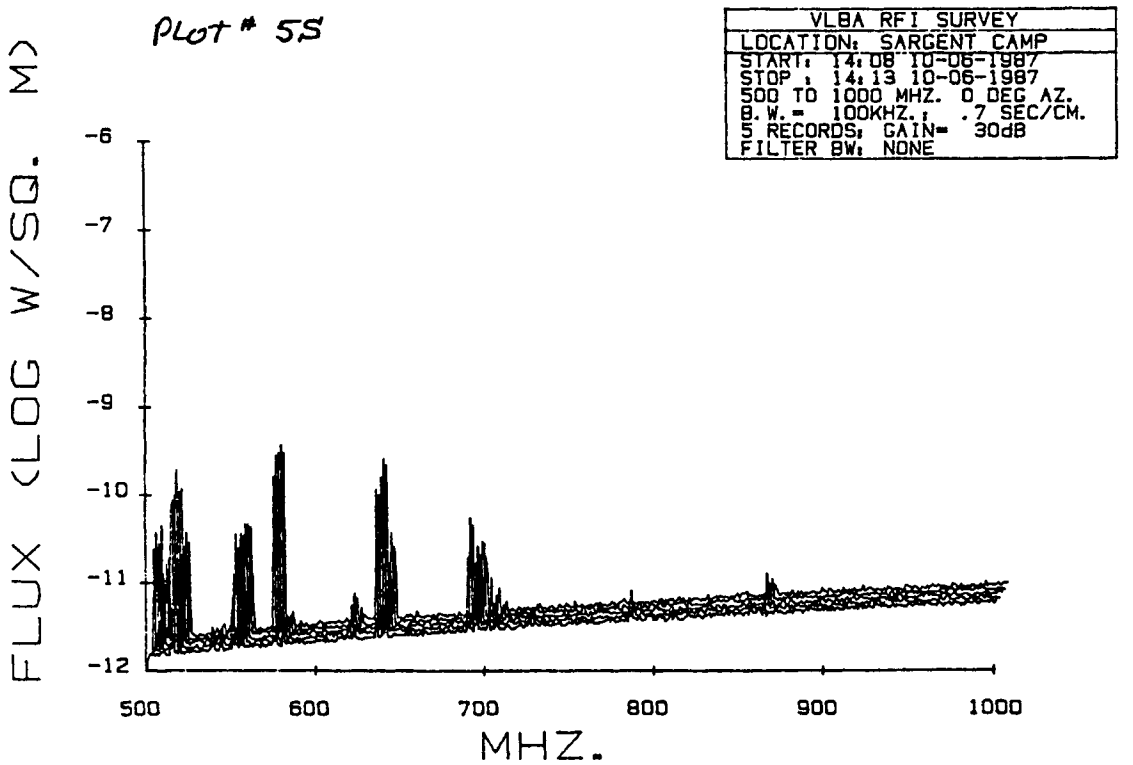
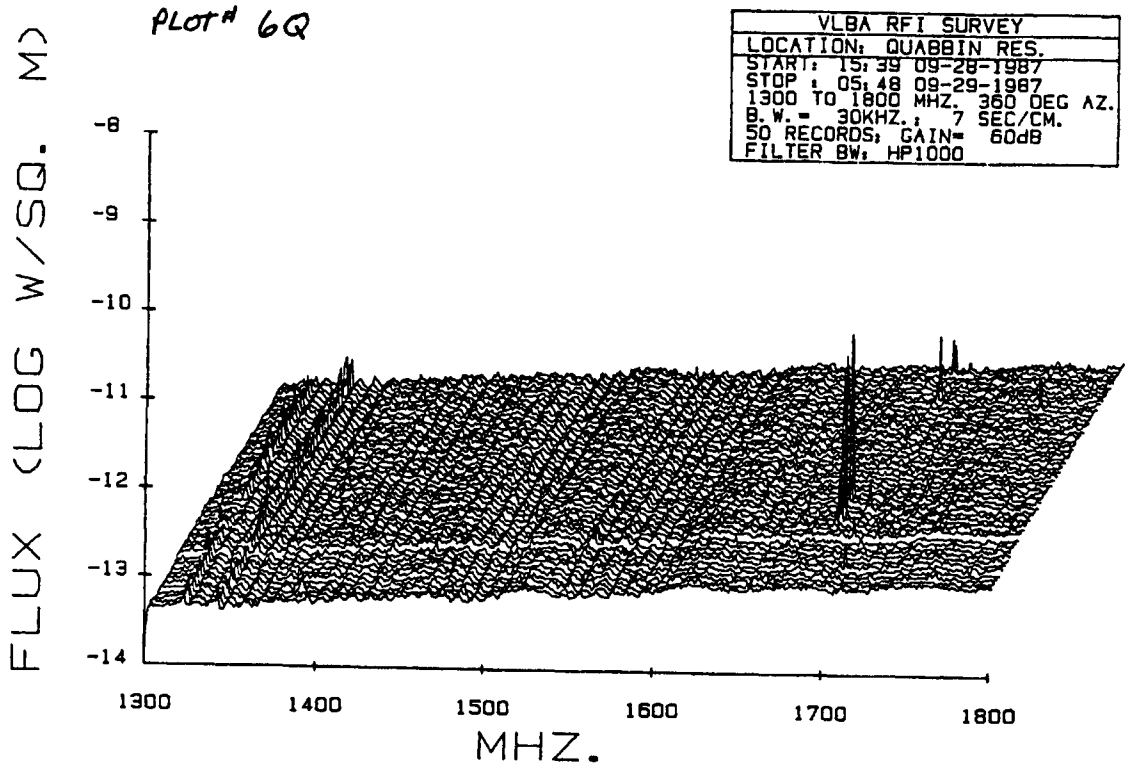

Plot # 50
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 10:02 09-29-1987
STOP : 10:08 09-29-1987
500 TO 1000 MHZ. 90 DEG AZ.
B.W.= 100KHZ.; .7 SEC/CM.
5 RECORDS; GAIN= 30dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
500
600
700
800
900
1000
MHZ.

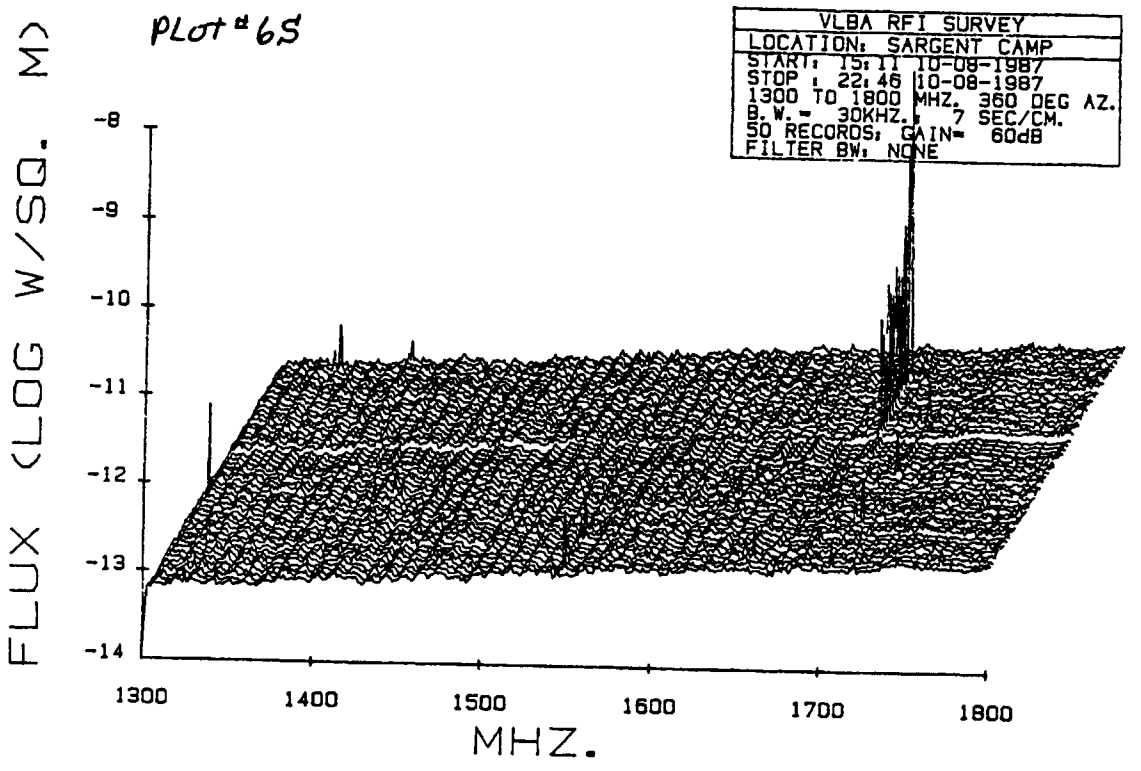
50


Plot # 55
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 14:08 10-06-1987
STOP : 14:13 10-06-1987
500 TO 1000 MHZ. 0 DEG AZ.
B.W.= 100KHZ.; .7 SEC/CM.
5 RECORDS; GAIN= 30dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
500
600
700
800
900
1000
MHZ.

55

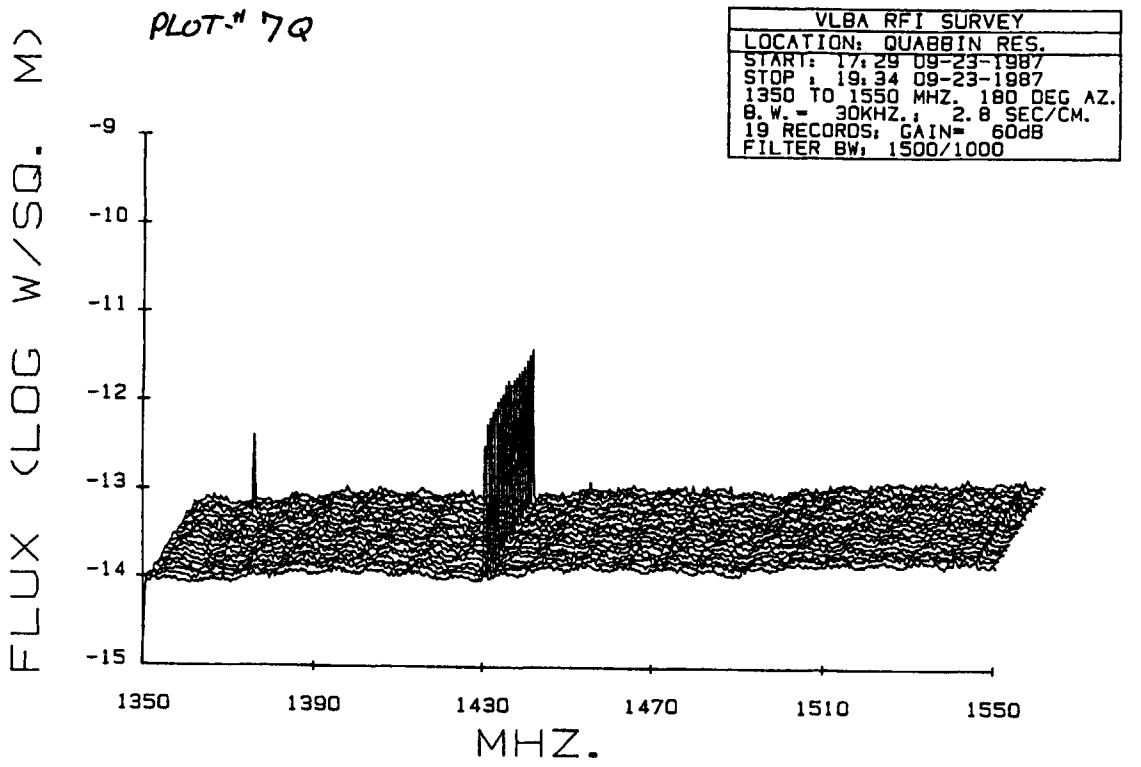

PLOT # 6Q
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 15:39 09-28-1987
STOP : 05:48 09-29-1987
1300 TO 1800 MHZ. 360 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
50 RECORDS; GAIN= 60dB
FILTER BW: HP1000
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
1300
1400
1500
1600
1700
1800
MHZ.

6Q


PLOT # 6S
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 15:11 10-08-1987
STOP : 22:46 10-08-1987
1300 TO 1800 MHZ. 360 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
50 RECORDS; GAIN= 60dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
1300
1400
1500
1600
1700
1800
MHZ.

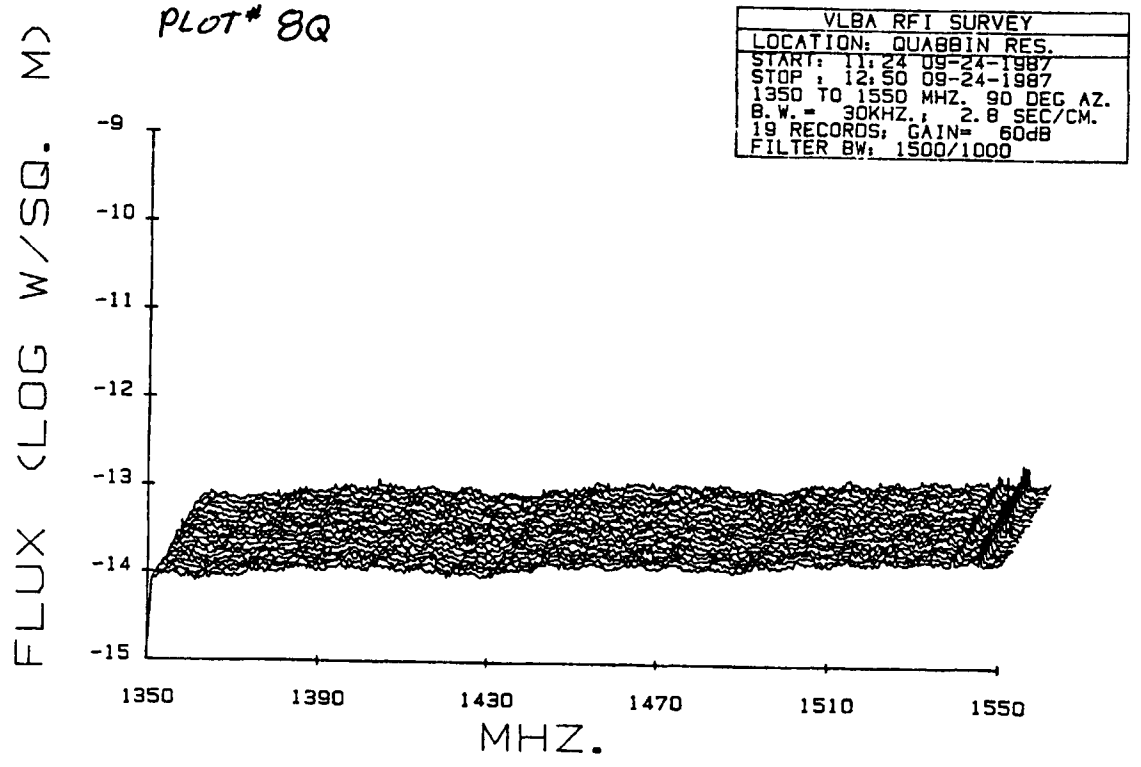
6S

PLOT # 7Q



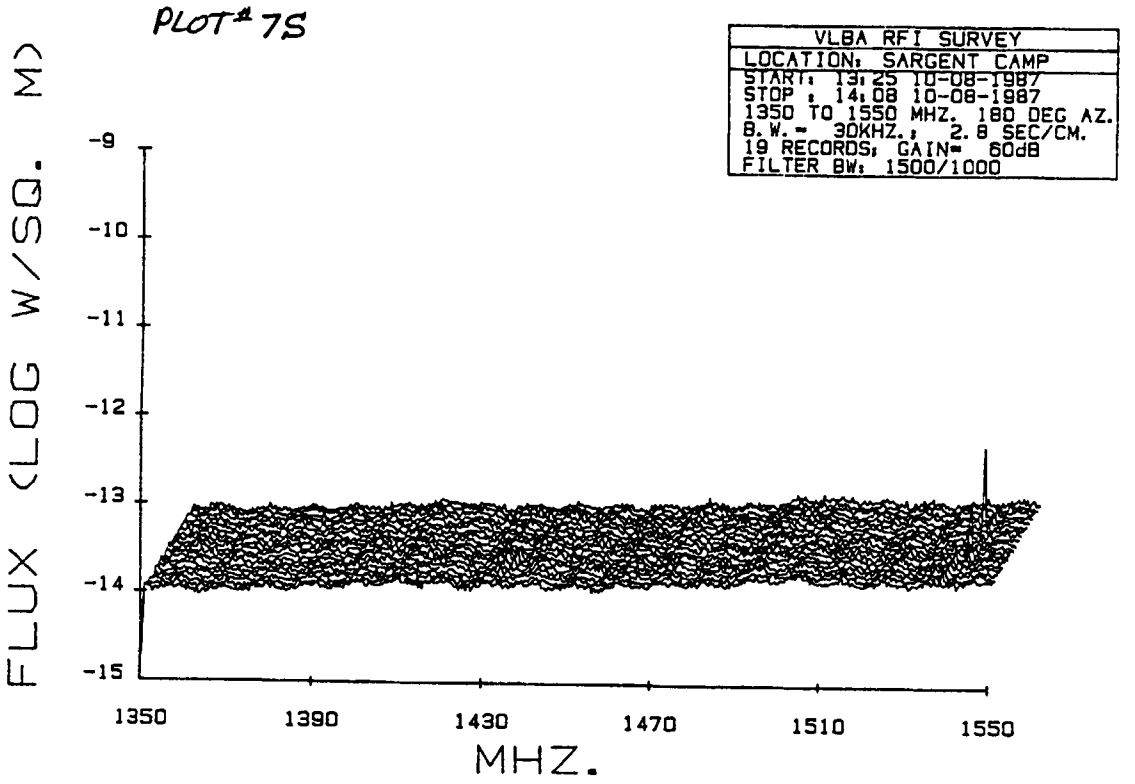
7Q

PLOT # 8Q



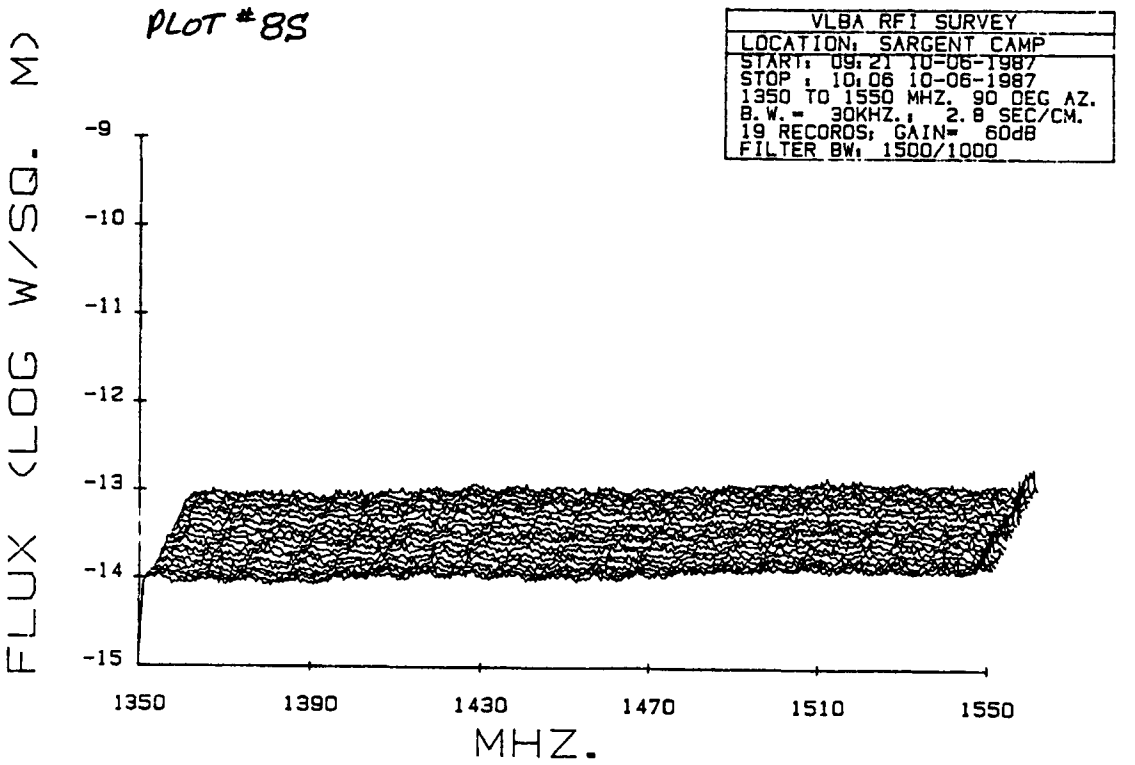
8Q

PLOT # 7S



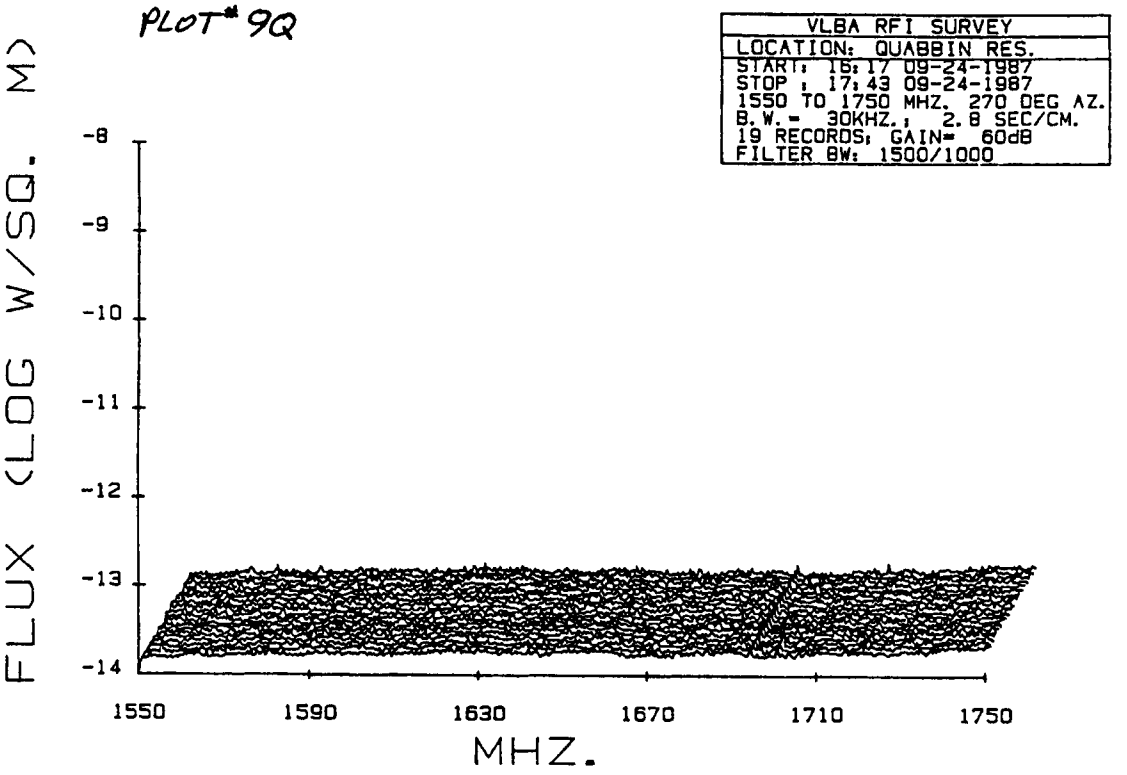
7S

PLOT # 8S

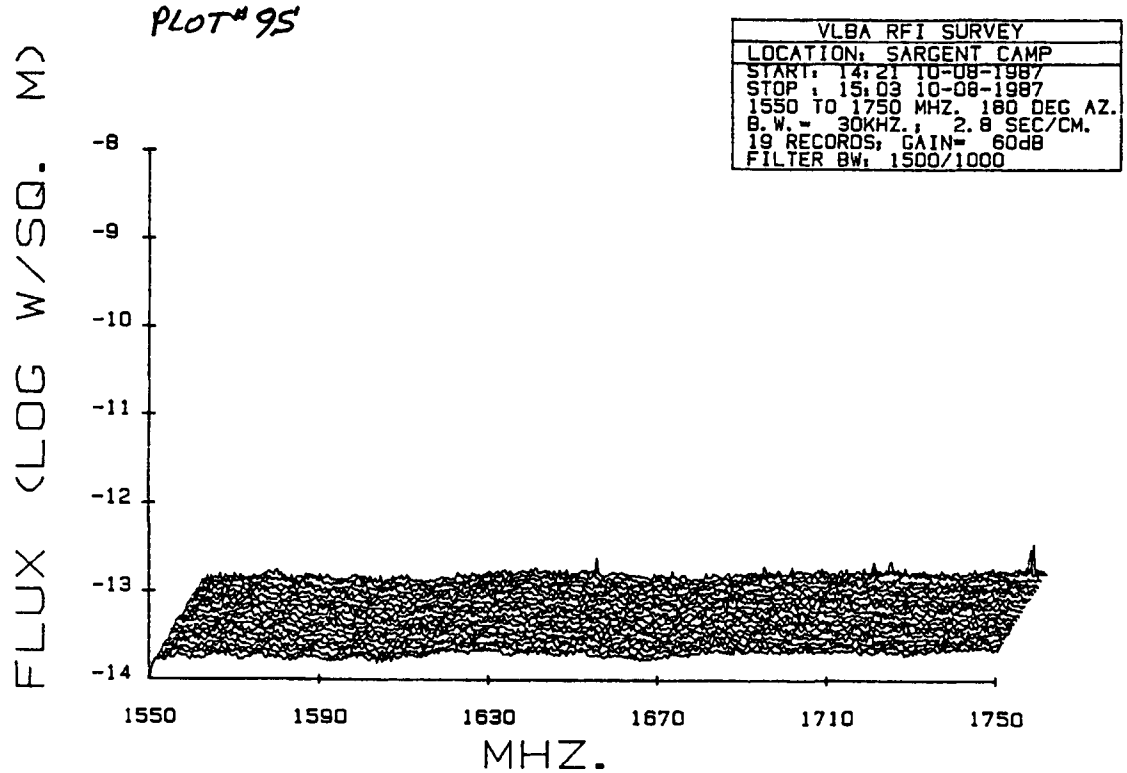


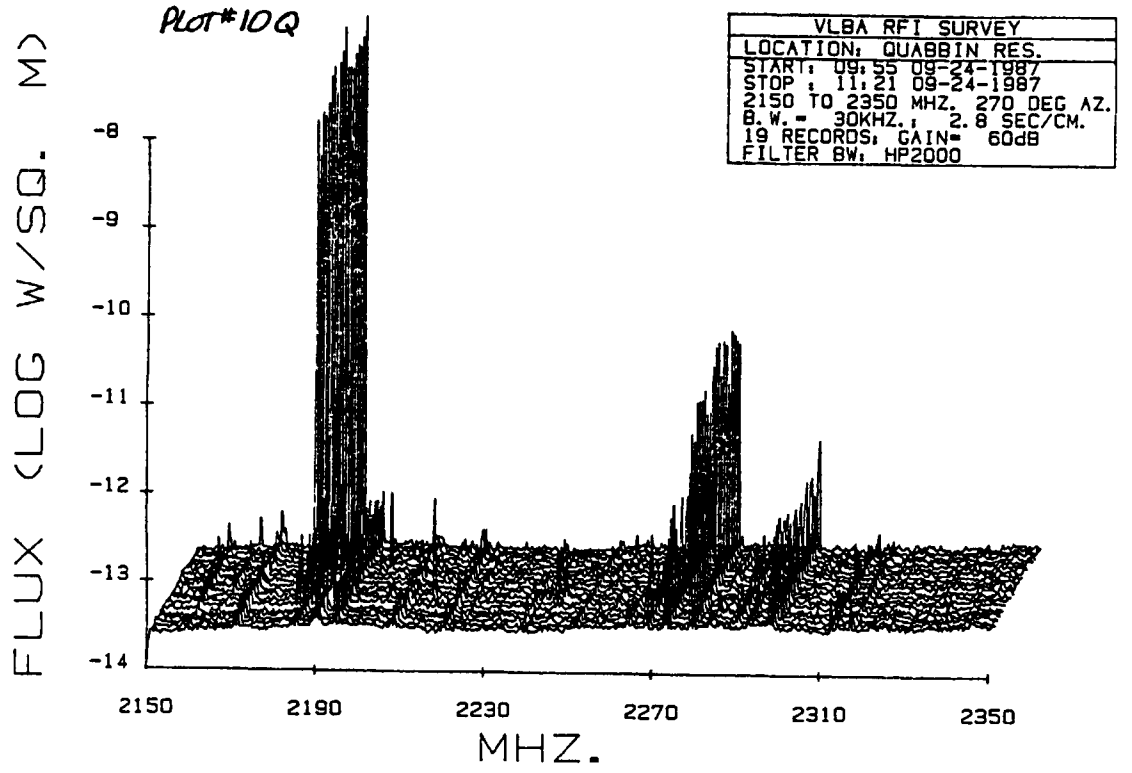
8S

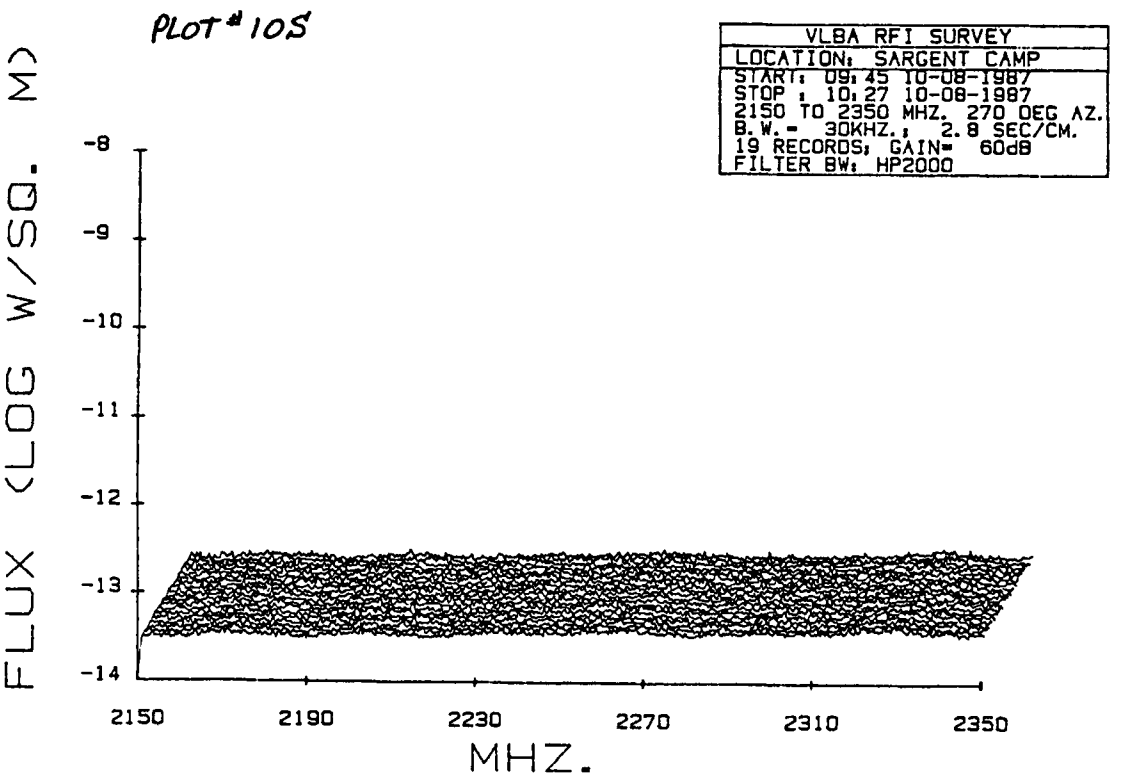
PLOT # 9Q



PLOT # 9S

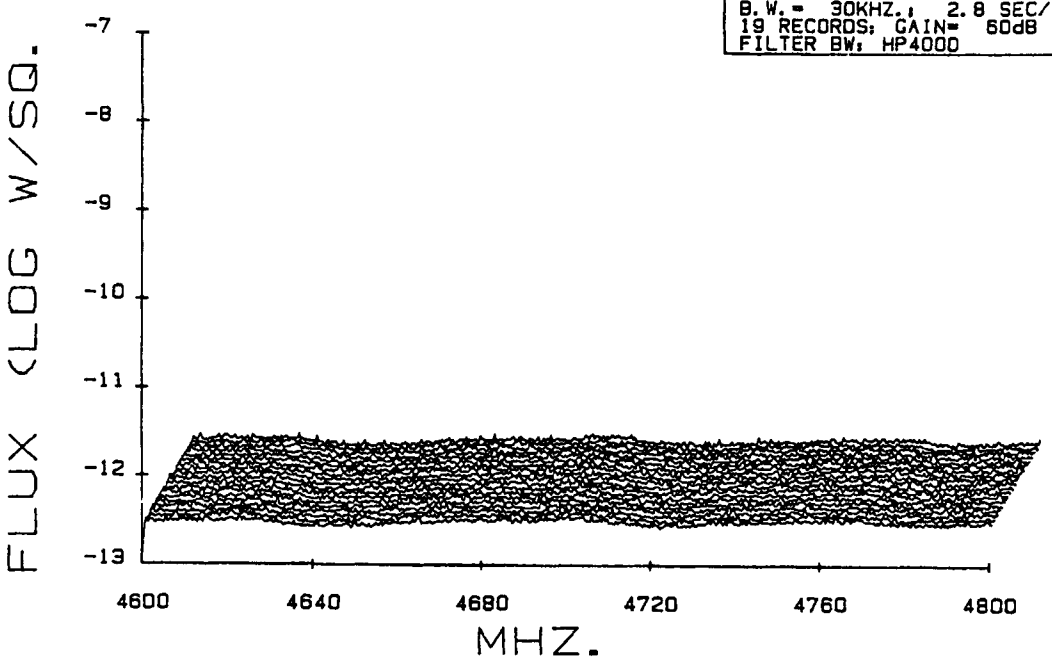



PLOT*10Q
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 09:55 09-24-1987
STOP : 11:21 09-24-1987
2150 TO 2350 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP2000
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
2150
2190
2230
2270
2310
2350
MHZ.


PLOT#10S
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 09:45 10-08-1987
STOP : 10:27 10-08-1987
2150 TO 2350 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP2000
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
2150
2190
2230
2270
2310
2350
MHZ.

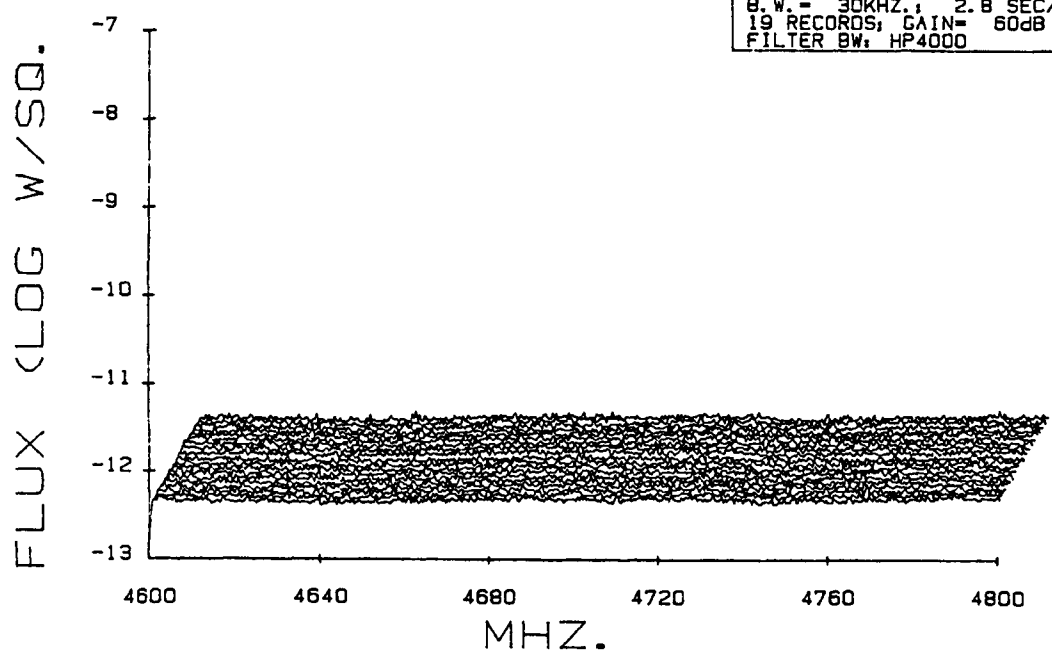
PLOT # 11Q

VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 19:18 09-25-1987
STOP : 22:50 09-25-1987
4600 TO 4800 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP4000

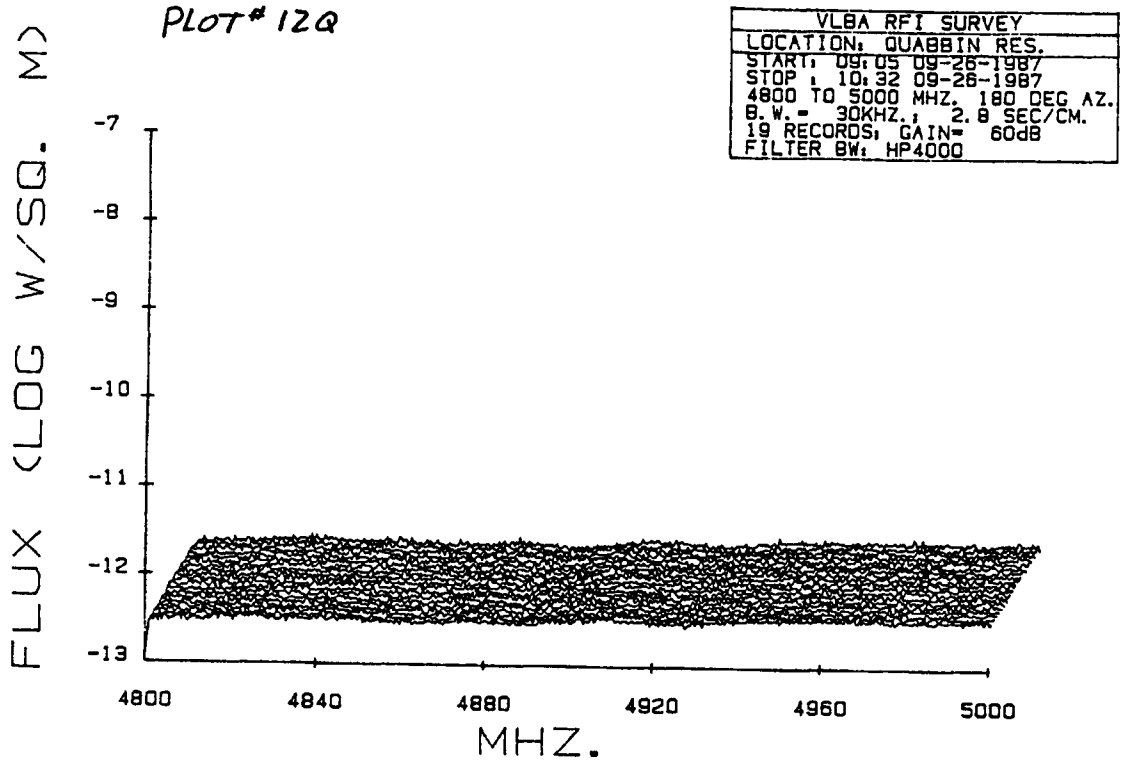


PLOT # 11S

VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 13:29 10-04-1987
STOP : 14:14 10-04-1987
4600 TO 4800 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP4000



PLOT # 12Q



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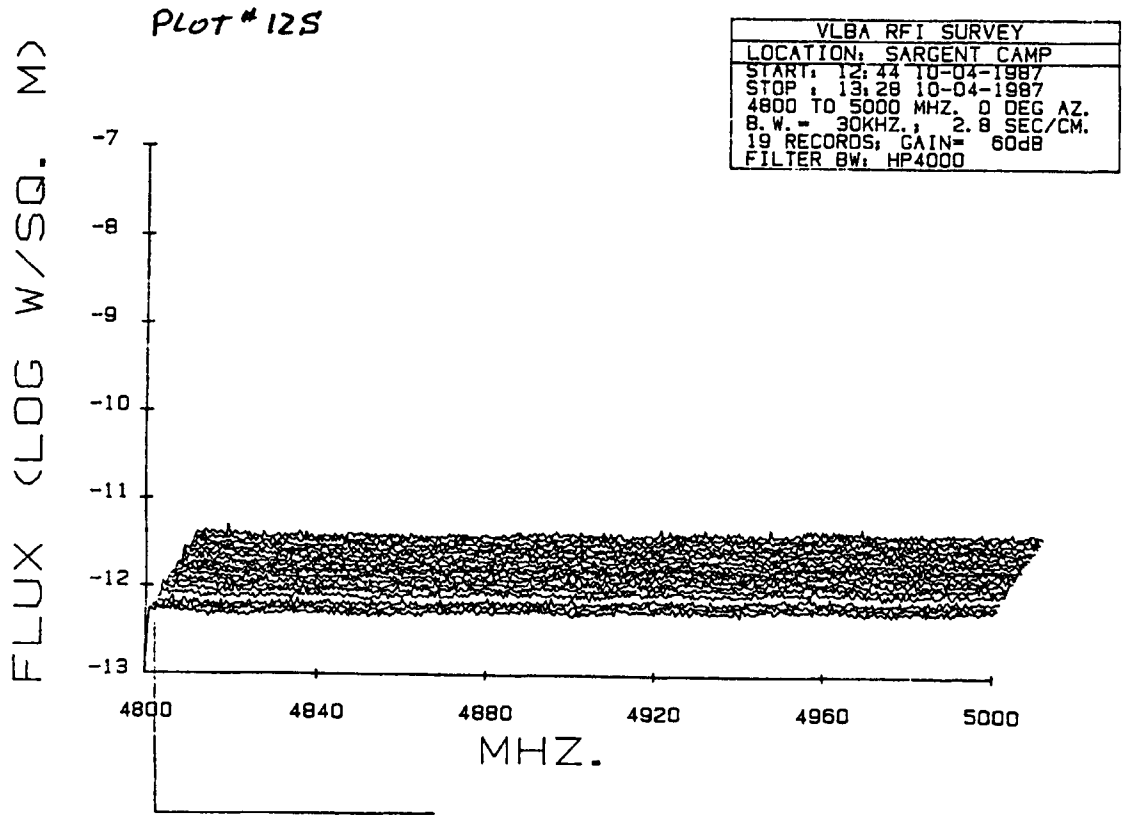
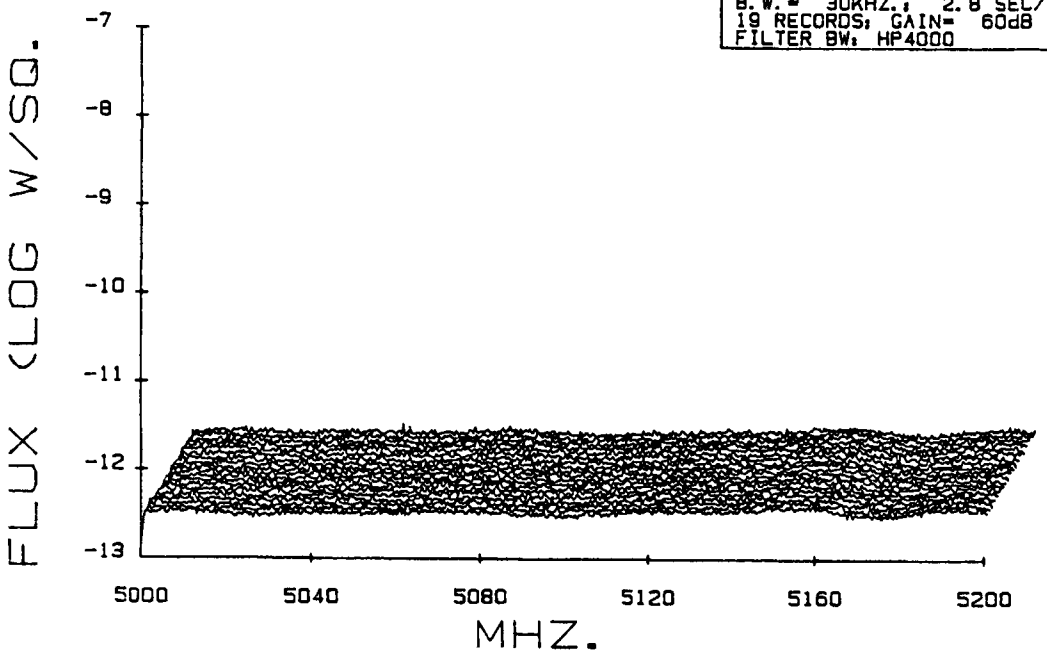
PLOT # 12S



125

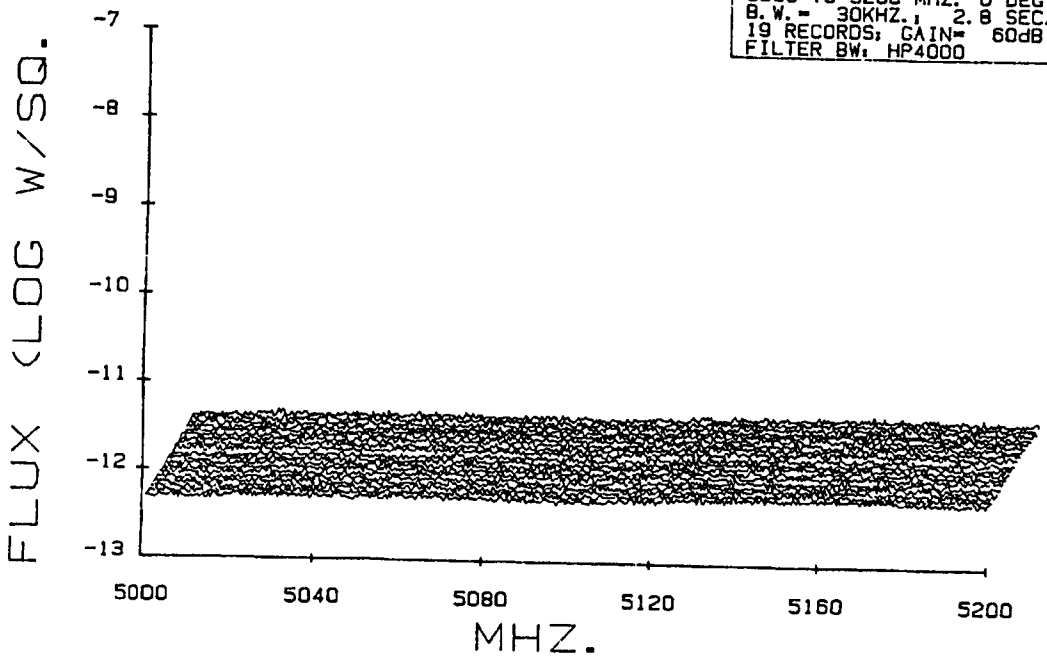
PLOT #13Q

VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 10:50 09-26-1987
STOP : 12:16 09-26-1987
5000 TO 5200 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP4000

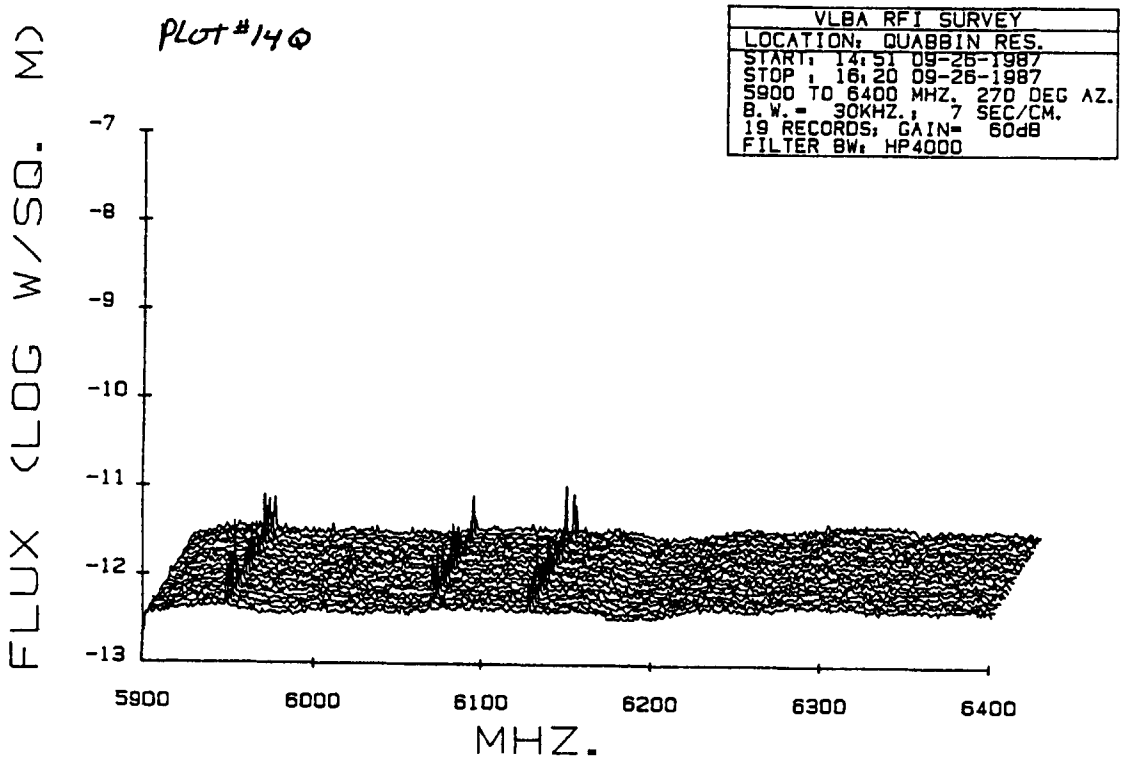


PLOT # 13S

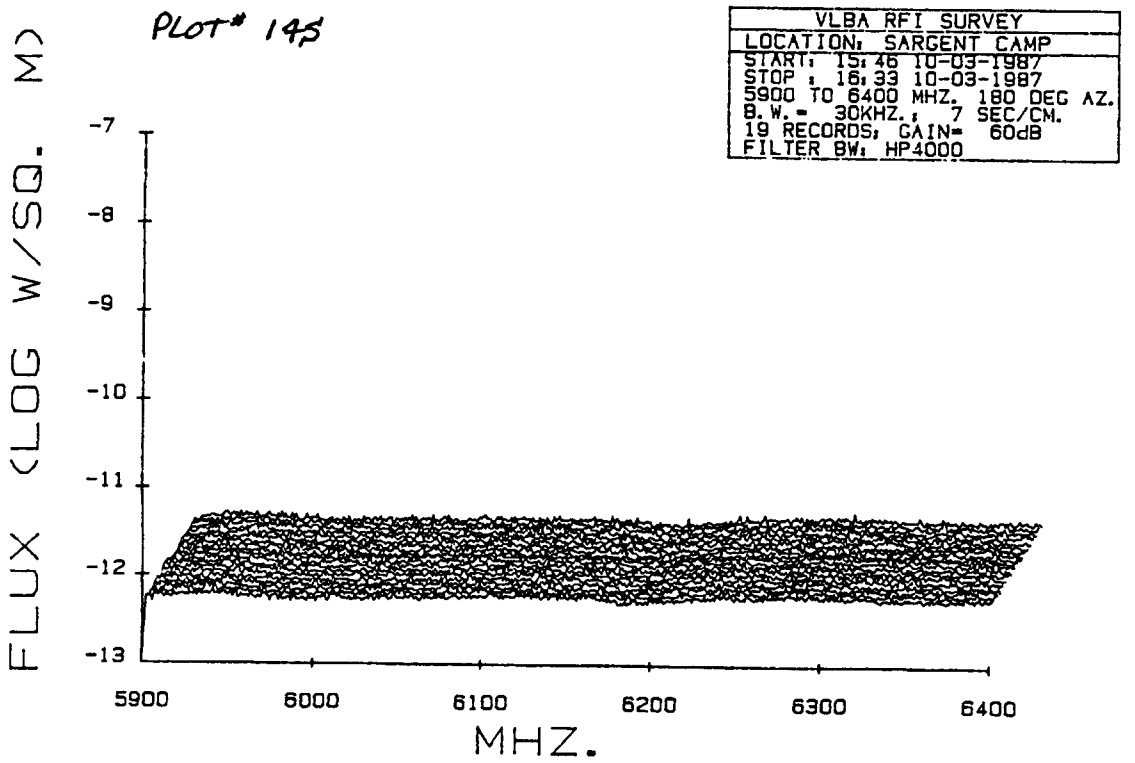
VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 11:52 10-04-1987
STOP : 12:52 10-04-1987
5000 TO 5200 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
19 RECORDS; GAIN= 60dB
FILTER BW: HP4000



PLOT #140

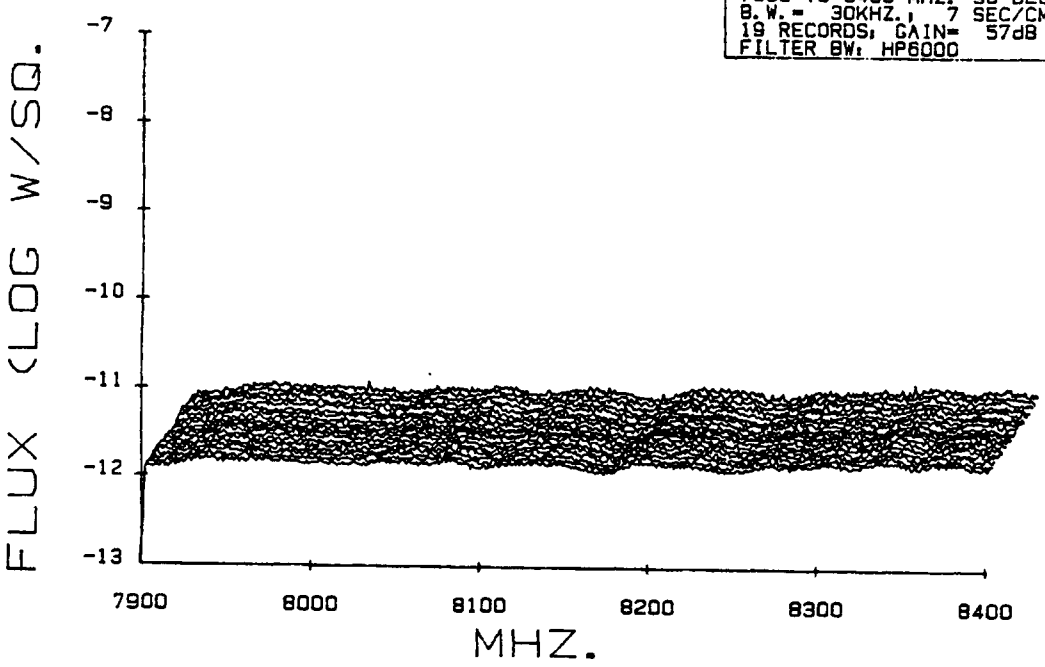


PLOT # 145



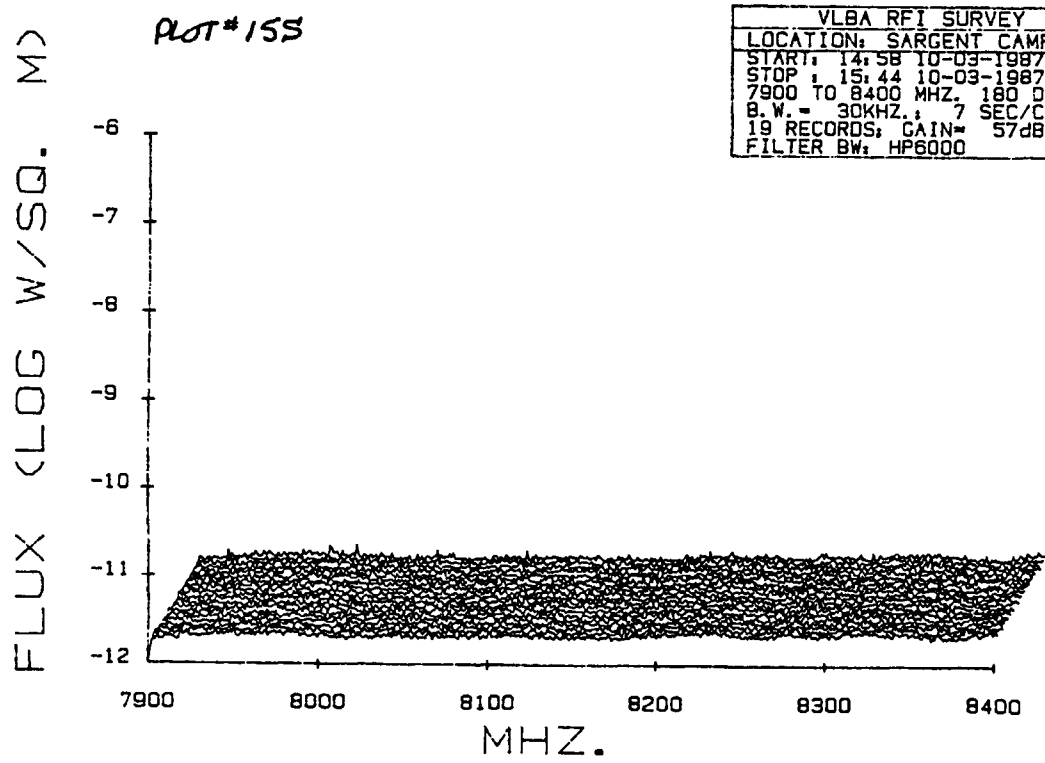
PLOT# 15Q

VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 13:18 09-27-1987
STOP : 16:14 09-27-1987
7900 TO 8400 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 57dB
FILTER BW: HP6000

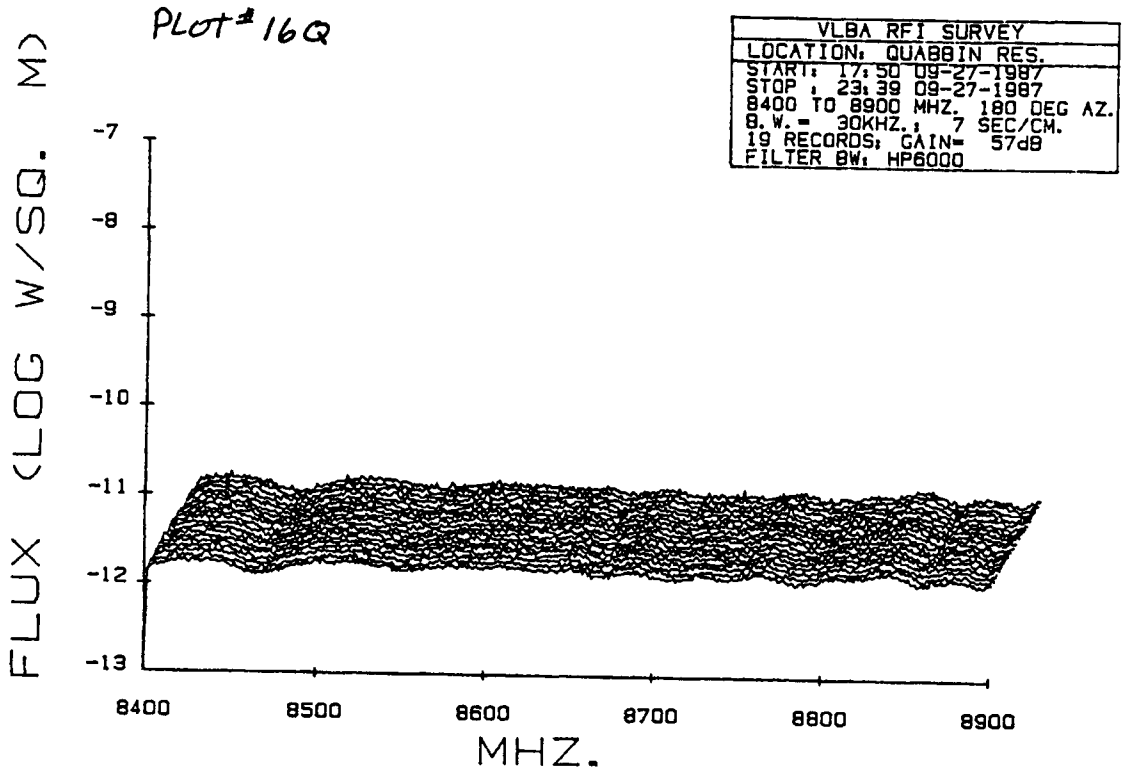


PLOT# 15S

VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 14:58 10-03-1987
STOP : 15:44 10-03-1987
7900 TO 8400 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 57dB
FILTER BW: HP6000

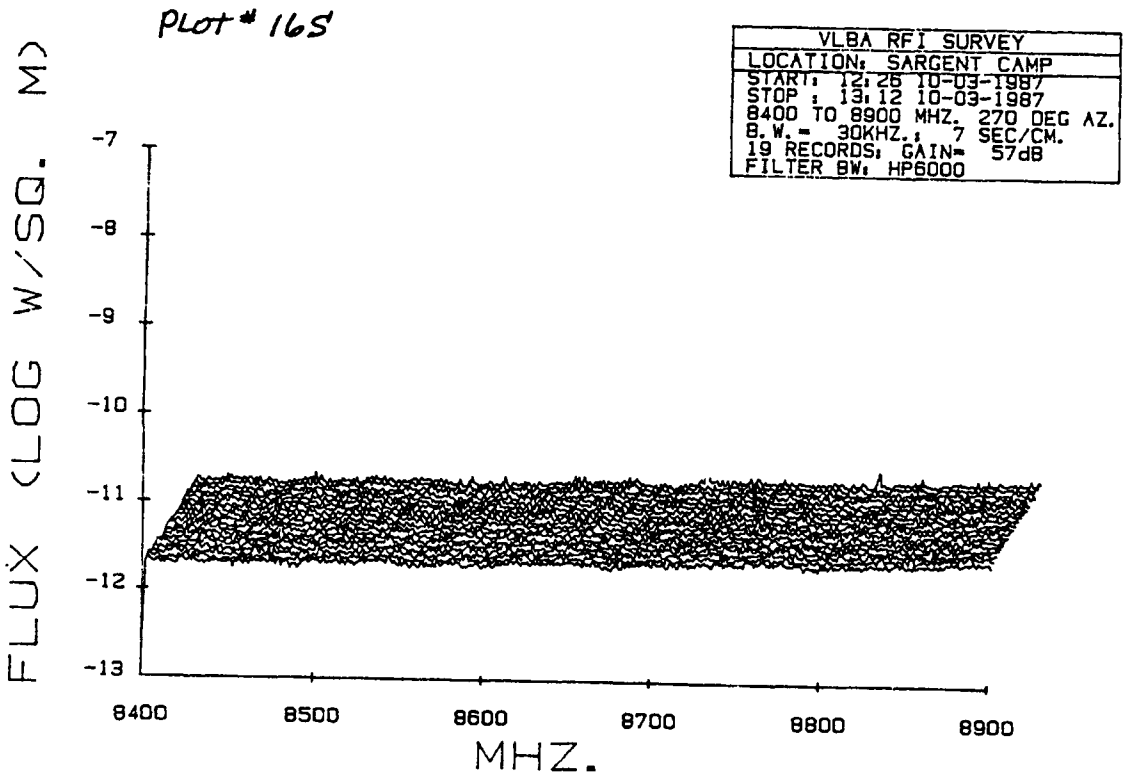


Plot # 16Q



16Q

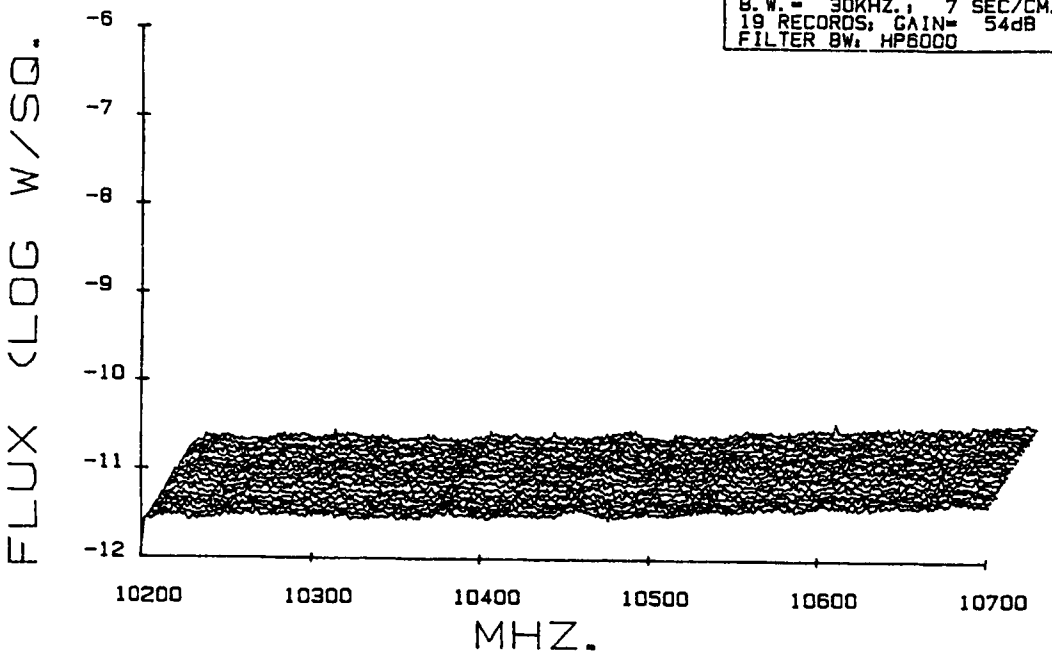
Plot # 16S



16S

PLOT #17Q

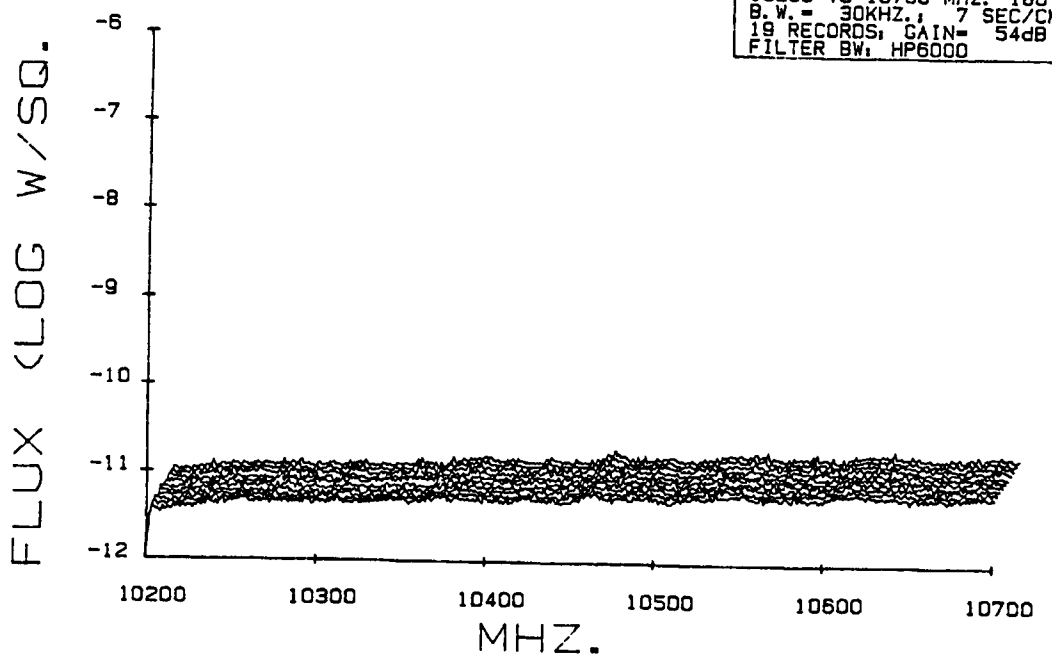
VLBA RFI SURVEY
LOCATION: QUABBIN RES.
START: 09:01 09-28-1987
STOP : 10:31 09-28-1987
10200 TO 10700 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 54dB
FILTER BW: HP6000



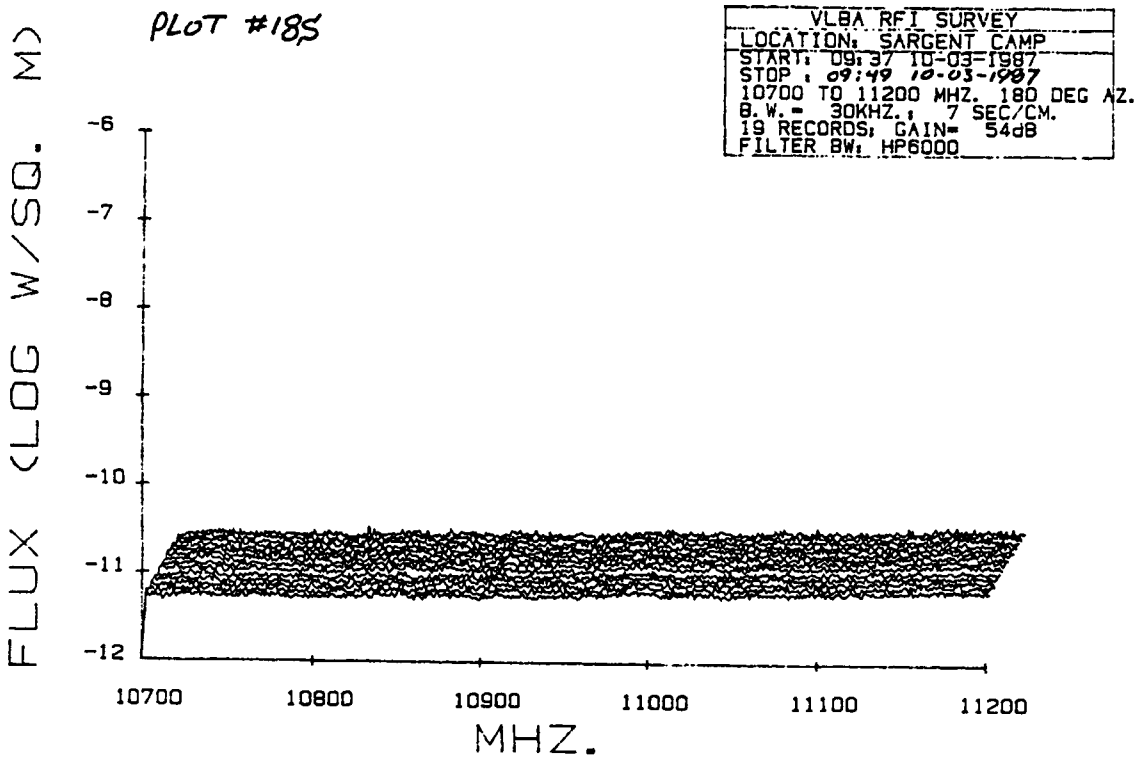
17Q

PLOT # 17S

VLBA RFI SURVEY
LOCATION: SARGENT CAMP
START: 11:25 10-03-1987
STOP : 11:40 10-03-1987
10200 TO 10700 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
19 RECORDS; GAIN= 54dB
FILTER BW: HP6000



PLOT #185



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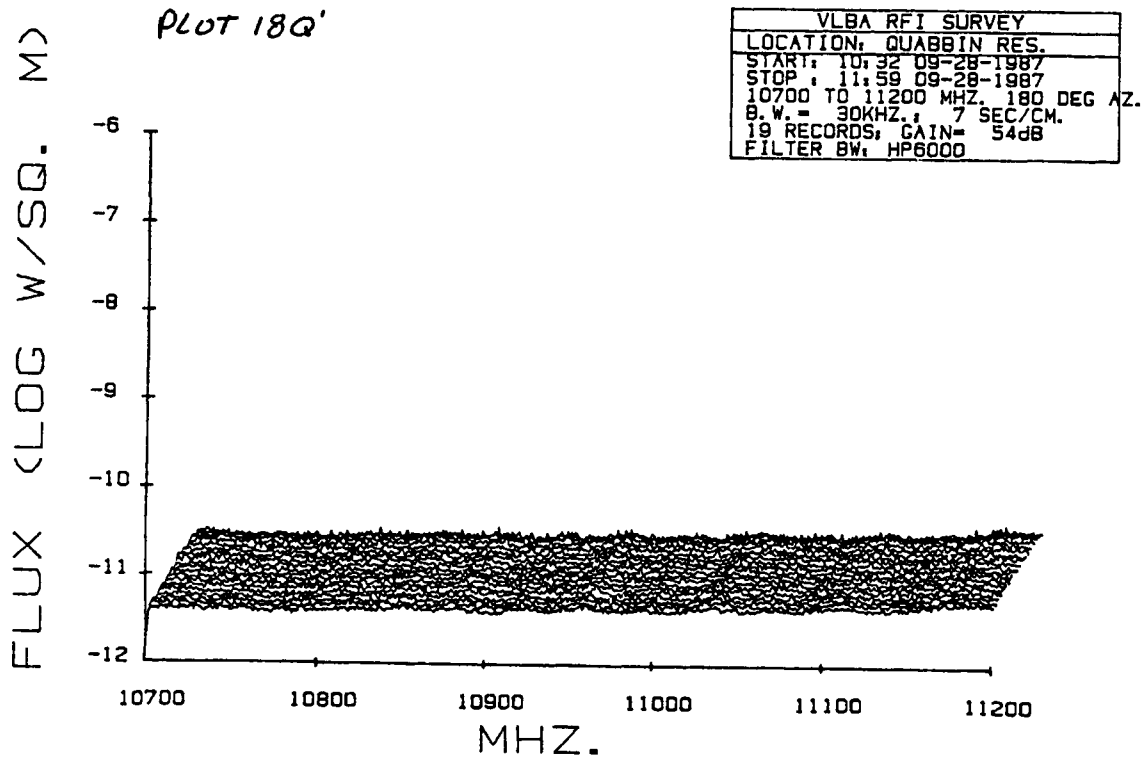
PLOT 180'



180