(851218)

VLB ARRAY MEMO No. 519

NATIONAL RADIO ASTRONOMY OBSERVATORY

Socorro, NM

RFI SURVEY FOR THE VLBA

LOCATIONS ON THE ISLAND OF HAWAII

Hilo, Hawaii

October/November 1985

Jim Oty

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Introduction and general comments.

ALOHA. Welcome to Hawaii. The eighth stop on my trek around the United States (join the VLBA and see the world) was to the the Island of Hawaii, to conduct a Radio Frequency Interference Survey for the VLBA project. This location, because of the distance from homebase, made this survey a little more involved than the previous seven. An attempt was made to have the entire RFI trailer, with equipment, shipped to Hawaii but that proved too complicated and costly. The next best alternative was to pack that equipment necessary to conduct the tests in packing cases, air frieght it to Hilo, HI and rent some type of a van to work out of (did you know that camping trailers are not allowed? There is an ordinance banning them). After a lot of leg work by our business office, particularly Dick Barnes, all was arranged and I departed for Hawaii on October 14.

The timing of this particular RFI survey was also important. There is a large military training area located on the island that is used for training by the Army and Marines. This area, Pohakuloa Training Area (PTA), is located in the saddle between Mauna Loa and Mauna Kea and will probably be line-of-sight from almost any location picked for the VLBA antenna. In order to determine if this training area would create any interference, it was necessary to schedule the RFI survey during a period of peak activity. The military cooperated with us and had 1700 Marines training at PTA from October 1 to November 7. This contingent of Marines put on a very impresive show of artillery fire and low level bombing during the time I was running the survey at the Mauna Loa Solar Observatory location.

The primary survey was completed at the Mauna Loa Observatory location. Shorter tests were conducted at two other locations, Mauna Kea State Park and the C F H Headquarters in Waimea. A fouth location, the 11,800 foot level of Mauna Kea, was on the schedule but time ran out before this site could be checked.

Shipping and Transportaion.

Shipping the equipment to Hawaii went relatively smoothly. We used United Airlines Air Freight because they listed a direct connection to Hilo from the west coast. The equipment was shipped one week before it was needed and arrived in four days. One item, a wooden crate holding the antenna mast and some assorted loose items, was damaged but everything survived. The crate was unusable for the return trip so a repacking job was required (it was necessary to cut about a foot off the mast in order to fit it in the box holding the antenna). The United Air Freight Terminal at Hilo has some strange hours so it was necessary to check with them both coming and going. They are only open for two hours in the evening (4 pm to 6 pm) and only accept large shipments on Tuesday, Wednesday and Thursday. Also bear in mind that shipments leaving the Island have to be checked by the Agricultural Inspector (I was fortunate that he did not make me open the wooden crate with 45 screws in the cover). The return shipment arrived in Albuquerque intact.

I was scheduled to fly into and out of Hilo on United Airlines (as was Napier and Wade). The flight into Hilo was OK but going home was a different story. All three of us, departing on different days, had flights cancelled. In my case it was Mid Pacific Airlines to Honolulu to catch a United flight to L.A. The first United flight I left on, returned to Honululu after about 10 minutes due to equipment failure. The second try made it to L.A. with only a few minutes to catch my next flight. This, of course, meant that my luggage didn't make it until the next day. So much for scheduled airline service. Total one way travel time from Socorro to Hilo, provided all connections are made, is about 12 hours. Also don't forget the time change of three hours (four hours during daylight savings time).

Availibility of facilities on the Island.

The Island of Hawaii seems to have about anything a person could need for rent or for sale. Hotel accomodations were plentiful both in Hilo and in the Waimea/Kona Coast area. This may change when the tourist season starts in December but the occupancy rate for the month of October was only 46%. Automobile rentals were no problem. Most major rental companies were represented at the Hilo airport. Four wheel drive vehicles were also availible (you may want to ask Wade about the Buggy Bronco that he rented, however). The one thing that I wanted to rent and was not availible was a small camping trailer to house my equipment. It seems that there is a county ordinance (the Island of Hawaii is one county) banning trailers. I was able to rent a 15 passenger van without seats that worked fairly well. This meant that I had to rent a car for transportation as the van remained parked at the survey site.

I was also concerned about the availibility of bits and pieces that I might need to set up and operate the RFI survey equipment. I did have to purchase a few things to get set up but fortunately the equipment ran quite well. (I managed to correct the one problem I did encounter with the plotter without needing any parts). There are some "Radio Shack" type stores around but not any high quality, well stocked electronics outlets so there may be a problem with electronic parts. In conversations with others at the different observatories, it seemed that the mail order business was used for most items. Oh yes, bring money. The few things I did buy were more expensive.

Island driving and high altitude working.

The road system on the island is adequate. To reach most places it is only necessary to decide whether to go clockwise or counter-clockwise around the island. To get to the observatories on Mauna Loa or Mauna Kea, however, it is necessary to use highway 200, the Saddle Road. This is a very narrow, winding road that climbs out of Hilo to around 7000 feet and follows the saddle between the two mountains. It is a dangerous road and I saw several accidents while going to and from the Solar Observatory on Mauna Loa. In fact, several of the car rental agencies prohibit using this road. The Dollar car that I rented had no such stipulation on the contract but my rental van did. Only after I threatened not to rent the van was I allowed to drive it on the Saddle Road and then only after I guaranteed my own insurance. The road to the Observatory on Mauna Loa from the Saddle Road is slow and rough but is passable by a standard automobile. It was interesting to note that the vehicle used by the Solar Observatory personel for daily trips to their facilty on Mauna Loa was equiped with a roll bar and safety harnesses.

About half of the time I spent in Hawaii was at the Mauna Loa Observatory at the 11,200 foot level of Mauna Loa. While I did not notice any immediate adverse effects, I found that eight hours at that altitude was very tiring. This made the 90 minute trip back to Hilo seem much longer and more dangerous. I did experience the usual shortness of breath and had a tendancy to make a few more mistakes in operating the equipment, particuarly late in the day. It may be a good idea to limit the amount of time spent at this elevation to a few hours a day until some tolerence is built up.

Pohakuloa Training Area (PTA)

One major concern expressed by many about the Hawaiian VLBA location was the presence of the Pohakuloa Training Area. This training area is located in the saddle between Mauna Kea and Mauna Loa and is used to train large groups of Army and Marine personnel. It was likely, that with the modern weapons used by the military, there could be considerable radio frequency interference generated by these groups. In order to have a valid RFI survey, it was necessary to schedule the survey during an active training period. During the period of October 1 to November 7, a contingent of 1700 marines were scheduled for training at PTA and when I arrived on October 14, the training was in full swing.

The first location selected for the survey was at the Mauna Loa Solar Observatory at the 11,200 foot level of Mauna Loa. The entire Pohakuloa Training Area was in view from this location with the closest boundry only 4 miles away. It was very obvious that training was in progress from the number of artillery bursts and the many low flying aircraft. This activity continued for the entire time I stayed at this location.

My main concern, while at this location, was not only to run a complete RFI survey but to try to determine if any interference was being generated by the training activity. My only guideline, other than knowing the frequency bands for the VLBA, was a memo from W. Brundage (August 27, 1985) listing some typical frequency bands used. I basicly proceeded with the survey as usual but between monitoring sessions, I would scan the spectrum looking for unusual activity, paying particular attention to those bands noted in the memo. After 2 weeks of monitoring, I had found nothing that indicated that any interference was originating from the training area. The only things I could come up with were some UHF channels, used for air/ground and air/air communications, and a few low power radars in the 400 - 450 MHz. range.

I also made a few trips through the training area looking for transmitter locations. There were several "command post" type installations with the usual VHF/UHF antennas but no sign of any radar antennas. The equipment I noticed consisted of large caliber artillery pieces, tanks, personnel carriers, and support vehicles. Nothing looked very ominous as interference generators. If this was in fact a typical training operation, the interference generated should be minimal.

The RFI Surveys.

Site 1. Mauna Loa Observatory.

The main thrust of the RFI survey on the island was conducted at the proposed location at the 11,200 foot level of Mauna Loa. This location is not only one of the prime VLBA antenna locations but also should represent a worse case condition for any interference. From this location, it was line-of-sight to most population centers on the island. Haleakala, a 10,000 foot high mountain on the island of Maui, was visible when the weather was clear. This mountain is only 100 miles away and is a major transmitter site. The other islands, while not visible, also were line-of-sight. And of course, Pohakaloa Training Area was in full view.

There were two commercial stations near this location. One site, that consisted of both micro-wave and VHF/UHV type antennas, was located about 7 miles east but was not line of sight due to the curvature of the mountain. There did not appear to be any problems from this station. The other station, across the saddle road on the lower slopes of Mauna Kea, was a typical telephone relay station and had the usual 6 GHz. signals. The signal strength was low as I was 90 degrees from the signal path. Telephone service to the Observatory was provided by a UHF link directly from Hilo. The up link was at 436.25 MHz. and the down link at 459.40 MHz. These signals were very strong but not bothersome.

All bands from 75 MHz. through 11 GHz. were monitored and the following are my comments:

73 MHz. to 75 MHz. No local (Island of Hawaii), low band TV channels to complicate this band.

300 MHz. to 350 MHz. Many air/ground and air/air communications signals. From this location it was possible to hear both the ground and airborne stations.

550 MHz. to 650 MHz. No TV signals but some activity from westerly direction.

500 MHz. to 1 GHz. Quick look at VLBA IF band. A few TV stations but generaly quiet.

1.35 GHz. to 1.75 GHz. Made several long term plots of this band. Several continuous signals near upper end of band particularly 1711 and 1719. These two signals are strongest from the north west and are probably part of a commercial link across the saddle. Most plots indicated lower end of band mostly clear except one disturbing plot had many signals between 1350 and 1550. These signals were intermittent and occured during late night/early morning time frame. I did manage to get a quick, real time look at these signals but not enough to make any guess as to the origin. They were strongest from the north west and were CW signals.

2.15 GHz. to 2.35 GHz. The usual commercial micro-wave signals at lower end of band.

4.6 GHz. to 5.2 GHz. No signals.

5.9 GHz. to 6.4 GHz. Several commercial micro-wave signals. Most seem to be originating from facility on lower slopes of Mauna Kea.

7.9 GHz. to 8.4 GHz. Two weak signals from the west. Otherwise clear.

8.4 GHz. to 11.2 GHz. No signals.

The major problem with this location seems to be 1350 - 1750 MHz. At times the interference is severe and other times the band is quiet. The two signals near the high end (1711 & 1719 MHz.) are continuous with a maximum power level of about 1X10^-11 W/M^2 (this as compared to the signals in the same frequency range recorded at the Los Alamos, NM location at 1X10^-8 W/M^2). The intermitent signals that appeared in the lower end of the band were also in the 1X10^-11 W/M^2 power range and were strongest from the north west. From the plots that I made, these signals seemed to be more active during the early morning hours. Since these signals were so intermitent, and I only saw them real time briefly, I cannot guess their origin. It is possible that they came from Pohakaloa Training Area but more likely, because of the low signal strength, from farther away (Haleakala or even Honululu).

Table I lists the plots from the Mauna Loa Observatory location included with this report. These are typical plots intended to show items of interest. Many other plots were generated and are on file. A plot of the horizon from this location is included as Figure 3.

Site 2. Mauna Kea State Park (Pohakaloa Training Area).

For the second location, I set up on the grounds of the Mauna Kea State Park and Endangered Bird Sanctuary at the edge of the Pohakaloa Training Area. This location was in the saddle between Mauna Kea and Mauna Loa at about 6500 feet elevation. This survey was a "quick look" survey and was completed in three days. Power was availible from the Park Service.

While this survey was much shorter than the standard survey, all bands from 75 MHz. through 11 GHz. were looked at. As expected, signals were fewer and lower in amplitude at this location. This location was completely shielded to the north by the lower slopes of Mauna Kea but was clear to the east and west so any interference from the Pohakaloa Training Area would be seen.

My comments follow:

73 MHz. to 75 MHz. A poor place for TV and FM reception.

300 MHz. to 350 MHz. Not much activity. No longer line-of-sight to the ground stations and also shielded from many airborne staions.

550 MHz. to 650 MHz. No signals.

500 MHz. to 1 GHz. Quick look at VLBA IF band. Nothing.

1.35 GHz. to 1.75 GHz. Very little activity. Most of the signals seen from MLSO must be effecively shielded.

2.15 GHz. to 2.35 GHz. One fairly strong signal at lower end of band.

4.6 GHz. to 5.2 GHz. No signals.

5.9 GHz. to 6.4 GHz. A few signals. This location is close to the path of the telephone relay stations accross the saddle.

7.9 GHz. to 11.2 GHz. No signals.

Table II lists the plots from the Mauna Kea State Park location included with this report. These are typical plots intended to show items of interest. Other plots were generated and are on file.

No horizon plot of this location was made but the northern half was obscured by Mauna Kea.

Site 3. Waimea (C-F-H Headquaters).

The third location to be surveyed was on the property of the Canada France Hawaii Telescope Headquarters in Waimea. Again this was to be a short survey. After unpacking and setting up my equipment for the third time, I experienced my first failure. The plotter failed to operate properly and most of the first day was spent working on it. After this problem was resolved, the rest of the test proceeded normaly.

This location also proved to be a rather quiet one compared to the Mauna Loa site. Again my comments:

<u>73 MHz. to 75 MHz.</u> Still no TV or FM to speak of.

<u>300 MHz. to 350 MHz.</u> Just a scatering of signals. Very quiet.

<u>550 MHz. to 650 MHz.</u> No signals.

<u>500 MHz. to 1 GHz.</u> Quick look at VLBA IF band. Nothing.

<u>1.35 GHz. to 1.75 GHz.</u> Very little activity. Only one signal noted at 1602 MHz.

<u>2.15 GHz. to 2.35 GHz.</u> Nothing seen.

<u>4.6 GHz. to 5.2 GHz.</u> No signals.

<u>5.9 GHz. to 6.4 GHz.</u> A few signals. Several micro-wave stations seen around town. This location must not be in any of the paths.

<u>7.9 GHz. to 11.2 GHz.</u> No signals.

Table III lists the plots from the C-F-H Headquarters location included with this report. These are typical plots intended to show items of interest. Other plots were generated and are on file.

Again no horizon elevation plot was made. From my location in the parking lot behind C-F-H it was not possible to see a lot of the horizon and it was overcast most of the time.

More general comments.

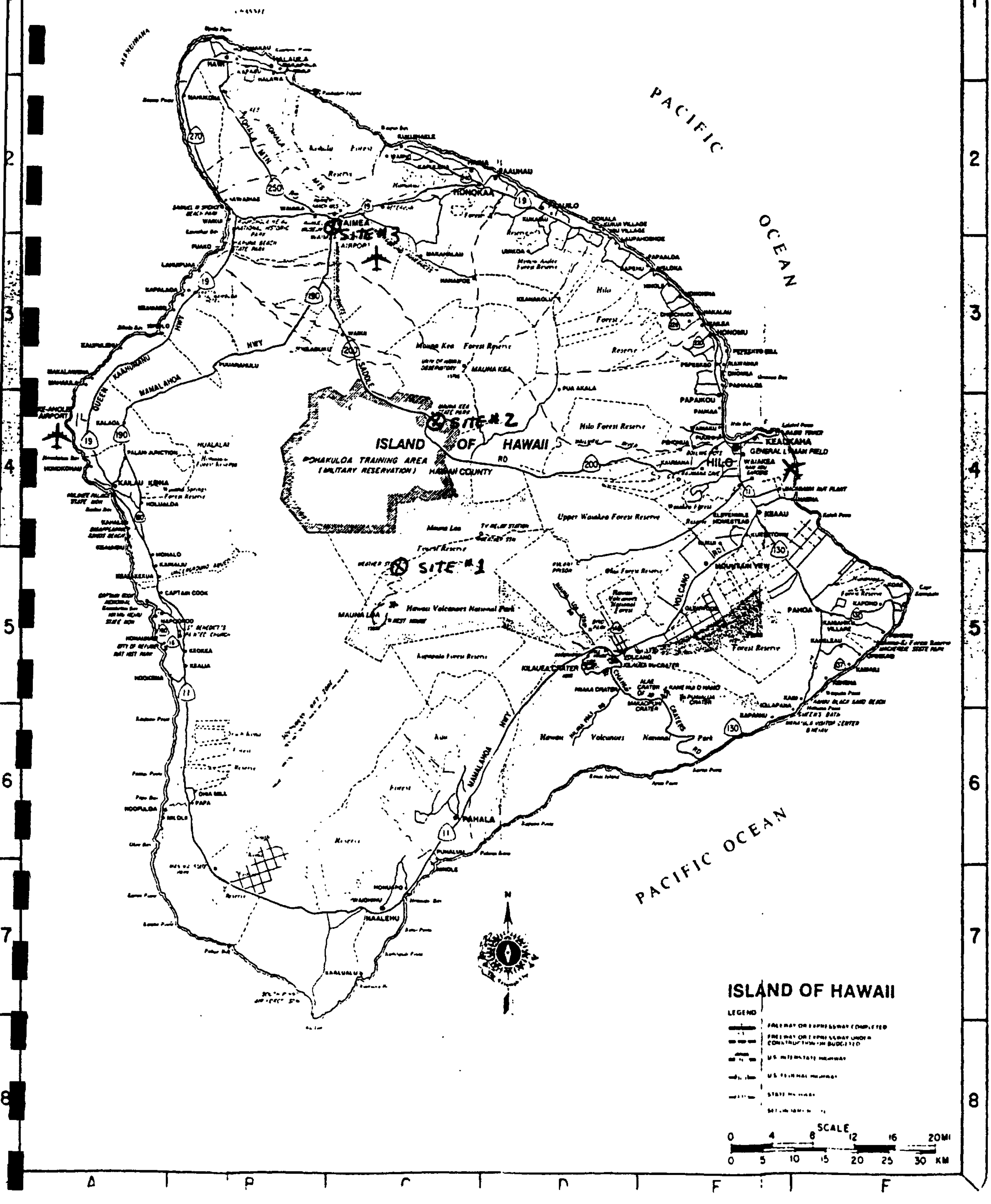
I have included the usual maps, figures and charts with this report. Figure 1, a map of the island of Hawaii, is marked to show the locations of the three surveys. Figure 2 shows the position of the Island of Hawaii in the chain of islands. Note that the other islands, including Oahu with Honolulu, is line-of-sight from the Mauna Loa location. Figure 3 is the horizon elevation plot from the Muana Loa location.

Tables I, II, and III list the plots from the three surveys that are included with this report. Table IV has been expanded to include data from VLBA Electronics Memo 39, Table I. This data gives flux density required by an interfering signal that would result in a 1% comresssion in amplifiers.

One other location, at the 11,800 foot level of Maua Kea, was on the schedule. There was a delay in obtaining permission to conduct the survey and when this permission was granted, time did not permit this one last check. It would be surprising, however, if this locations had a worse RF environment than the the Mauna Loa location. From a brief visual inspection of this location, there appeared to be shielding both from the Pohakaloa Training Area and Haleakela.

(13)

Figure 1



PACIFIC OCEAN
PACIFIC OCEAN
ISLAND OF HAWAII
SITE #3
SITE #2
SITE #1
POHAKULOA TRAINING AREA (MILITARY RESERVATION)
HAWAII COUNTY
HILO
KEAUKAHA
GENERAL LYMAN FIELD
WAIMEA
HONOKAA
KAILUA KONA
CAPTAIN COOK
MOUNTAIN VIEW
VOLCANO
KILAUEA CRATER
PAHALA
NAALEHU
MAUNA KEA
MAUNA LOA
HUALALAI
KEAAU
PAHOA
Hawaii Volcanoes National Park
Hilo Forest Reserve
Upper Waiakea Forest Reserve
SADDLE RD
MAMALAHOA HWY
QUEEN KAAHUMANU HWY
LEGEND
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0 5 10 15 20 25 30 KM
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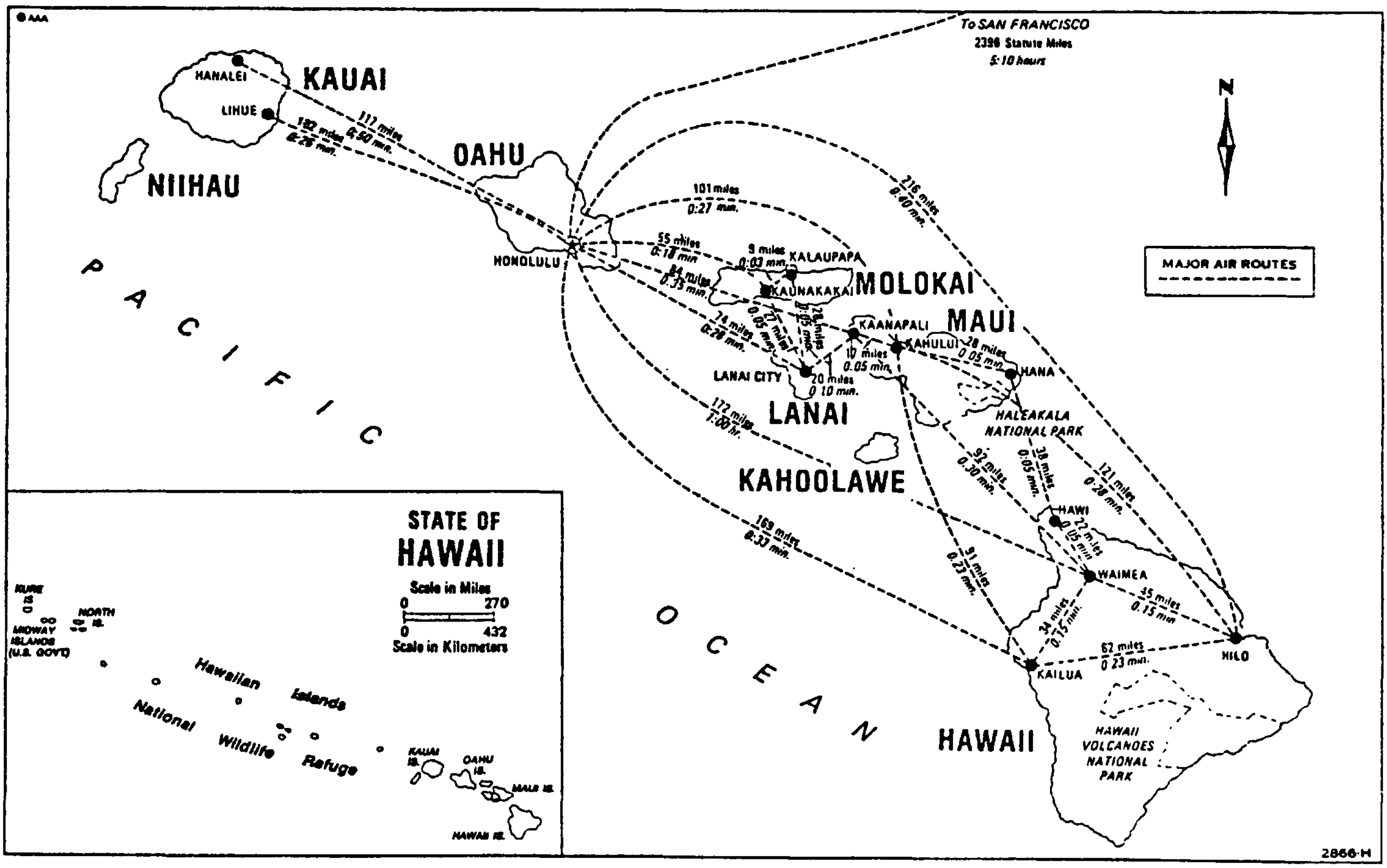
Figure 2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MOLOKAI
KALAUPAPA
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MAUI
KAANAPALI
KAHULUI
HANA
HALEAKALA NATIONAL PARK
LANAI
LANAI CITY
KAHOOLAWE
HAWAII
HAWI
WAIMEA
KAILUA
HILO
HAWAII VOLCANOES NATIONAL PARK
MAJOR AIR ROUTES
PACIFIC
OCEAN
111 miles 0:50 min.
102 miles 0:26 min.
101 miles 0:27 min.
55 miles 0:18 min
9 miles 0:03 min.
84 miles 0:33 min.
74 miles 0:28 min.
216 miles 0:40 min.
172 miles 1:00 hr.
169 miles 0:33 min.
28 miles 0:05 min.
10 miles 0:05 min.
20 miles 0:10 min.
92 miles 0:30 min.
38 miles 0:05 min.
121 miles 0:28 min.
22 miles 0:05 min.
35 miles 0:15 min.
34 miles 0:15 min.
91 miles 0:23 min.
62 miles 0:23 min.
STATE OF HAWAII
Scale in Miles
0 270
0 432
Scale in Kilometers
KURE IS.
MIDWAY ISLANDS (U.S. GOVT)
NORTH IS.
Hawaiian Islands
National Wildlife Refuge
KAUAI IS.
OAHU IS.
MAUI IS.
HAWAII IS.
2866-H

Figure 3

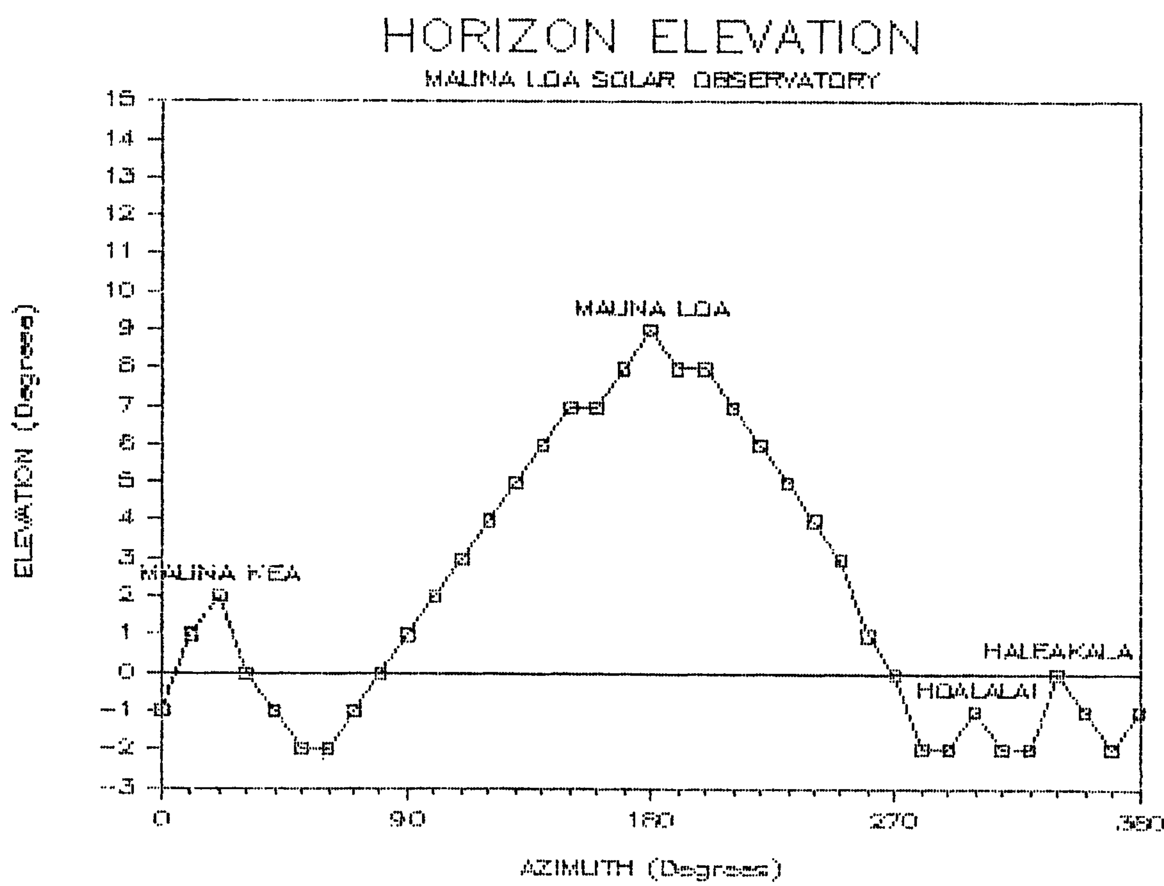

HORIZON ELEVATION
MAUNA LOA SOLAR OBSERVATORY
ELEVATION (Degrees)
AZIMUTH (Degrees)
MAUNA KEA
MAUNA LOA
HALEAKALA
HUALALAI
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
0
90
180
270
360

TABLE I
MAUNA LOA SOLAR OBSERVATORY

Plot #	Frequency	Filter Fc/BW	Comments
1	50 - 100 MHz	None	East. Typical plot.
2	50 - 100 MHz	None	West. Typical plot.
3	74 - 76 MHz	75/5%	East. Single plot showing noise floor.
4	74 - 76 MHz	75/5%	North. Single plot showing noise floor. Higher noise floor than usual from the north.
5	300 - 350 MHz	325/50	North. Shows typical air/ground communications. Ground stations were also quite strong.
6	300 - 350 MHz	325/50	West. Same as plot 5 but this plot is contaminated by local computer noise.
7	550 - 650 MHz	600/100	West. Signal at 580 MHz. is intermittent. Signal at 612.5 MHz. is constant.
8	550 - 650 MHz	600/100	North. Same as above.
9	500 - 1000 MHz	None	East. Quick look for signals in the VLBA IF band.
10	500 - 1000 MHz.	None	West. Same as plot 10.
11	1300 - 1800 MHz.	1500/1000	Omni Antenna. Long term plot.
12	1300 - 1800 MHz.	1500/1000	Northwest. Same as above but using directional antenna.
13	1300 - 1800 MHz.	1500/1000	Northwest. A third plot same as above.
14	1350 - 1550 MHz.	1500/1000	North. This plot looked good, only a few small signals.

Table I (Cont.)

15	1350 - 1550 MHz.	1500/1000	West. Many intermittent signals were present for portion of the time.
15A	1350 - 1550 MHz.	1500/1000	Same plot as above but average rather than peak levels shown.
16	1550 - 1750 MHz	1500/1000	North. Signal at 1711 MHz. from the north. 1719 MHz. more westerly.
17	1550 - 1750 MHz.	1500/1000	West. Same as above.
18	2150 - 2350 MHz	HP2000	North. Usual commercial signals near lower end of band.
19	2150 - 2350 MHz	HP2000	West. Same as above but one strong signal at 2300 MHz.
20	4.1 - 5.1 GHz.	HP4000	North. Long term plot. Only signal is at 4.168 GHz.
21	4.6 - 4.8 GHz	HP4000	Typical plot.
22	4.8 - 5.0 GHz	HP4000	Typical plot.
23	5.0 - 5.2 GHz.	HP4000	Typical plot.
24	5.9 - 6.4 GHz	HP4000	North. Several commercial micro-wave siganls.
25	5.9 - 6.4 GHz.	HP4000	West. Same as above.
26	7.9 - 8.4 GHz.	HP6000	West. Two low level signals found in this band.
27	8.4 - 8.9 GHz	HP6000	Typical plot.
28	10.2 -10.7 GHz	HP6000	Typical plot.
29	10.7 11.2 GHz	HP6000	Typical plot.

TABLE II
MAUNA KEA STATE PARK

Plot #	Frequency	Filter Fc/BW	Comments
30	50 - 100 MHz	None	East. Typical plot.
31	50 - 100 MHz	None	West. Typical plot.
32	74 - 76 MHz	75/5%	East. Single plot showing noise floor. Slightly higher than usual.
33	74 - 76 MHz	75/5%	North. Single plot showing noise floor. Slightly higher than usual.
34	300 - 350 MHz	325/50	East. Very quiet. No ground stations and very few airborne.
35	300 - 350 MHz	325/50	West. Same as plot 34.
36	550 - 650 MHz	600/100	East. No signals.
37	550 - 650 MHz	600/100	West. No signals.
38	500 - 1000 MHz	None	West. Quick look for signals in the VLBA IF band.
39	1300 - 1800 MHz.	1500/1000	Omni Antenna. Long term plot.
40	1350 - 1550 MHz.	1500/1000	East. No signals.
41	1350 - 1550 MHz.	1500/1000	West. One low level signal at 1545 MHz.
42	1550 - 1750 MHz	1500/1000	East. Signal at 1683 MHz. from the East.
43	1550 - 1750 MHz.	1500/1000	West. Same as above.
44	2150 - 2350 MHz	None	South. One signal near low end of band.
45	2150 - 2350 MHz	None.	West. Same as above.
46	4.6 - 4.8 GHz	HP4000	Typical plot.

Table II (Cont.)

47	4.8 – 5.0 GHz	HP4000	Typical plot.
48	5.0 – 5.2 GHz.	HP4000	Typical plot.
49	5.9 – 6.4 GHz	HP4000	West. Several commercial micro-wave siganls.
50	7.9 – 8.4 GHz.	HP6000	Typical plot.
51	8.4 – 8.9 GHz	HP6000	Typical plot.
52	10.2 –10.7 GHz	HP6000	Typical plot.
53	10.7 11.2 GHz	HP6000	Typical plot.

TABLE III
C-F-H HEADQUARTERS

Plot #	Frequency	Filter Fc/BW	Comments
54	50 - 100 MHz	None	East. Typical plot.
55	50 - 100 MHz	None	West. Typical plot.
56	74 - 76 MHz	75/5%	East. Single plot showing noise floor.
57	74 - 76 MHz	75/5%	West. Same as above.
58	300 - 350 MHz	325/50	North. Very quiet.
59	300 - 350 MHz	325/50	West. Same as above.
60	550 - 650 MHz	600/100	South. Typical plot.
61	550 - 650 MHz	600/100	West. Same as above.
62	500 - 1000 MHz	None	South. Quick look for signals in the VLBA IF band.
63	1350 - 1550 MHz.	1500/1000	North. Typical plot.
64	1550 - 1750 MHz	1500/1000	South. Only signal at 1602 MHz.
65	2150 - 2350 MHz	None	Typical plot. No signals.
66	4.6 - 4.8 GHz	HP4000	Typical plot.
67	4.8 - 5.0 GHz	HP4000	Typical plot.
68	5.0 - 5.2 GHz.	HP4000	Typical plot.
69	5.9 - 6.4 GHz	HP4000	North. A few commercial signals.
70	5.9 - 6.4 GHz.	HP4000	South. Same as above.
71	7.9 - 8.4 GHz.	HP6000	Typical plot.
72	8.4 - 8.9 GHz	HP6000	Typical plot.
73	10.2 -10.7 GHz	HP6000	Typical plot.
74	10.7 11.2 GHz	HP6000	Typical plot.

TABLE IV
HARMFUL INTERFERENCE LEVELS

VLBA TUNNING RANGE	HARMFUL INTERFERENCE LEVELS (Note 1)	RFI MEASURED THRESHOLD (Note 2 & 3)	FLUX DENSITY FOR 1% COMP. (Note 4)
50 - 100 MHz.	*	-142 dBW/m^2	#
310 - 340 MHz.	-151 dBW/m^2	-149 dBW/m^2	-72 dBW/m^2
580 - 640 MHz.	-146 dBW/m^2	-143 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.	*	-138 dBW/m^2	-55 dDW/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	-126 dBW/m^2	-47 dBW/m^2
8.0 - 8.8 GHz.	*	-119 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 0 dBI sidelobes rather than the +10 dBI sidelobes assumed in Memo 81.

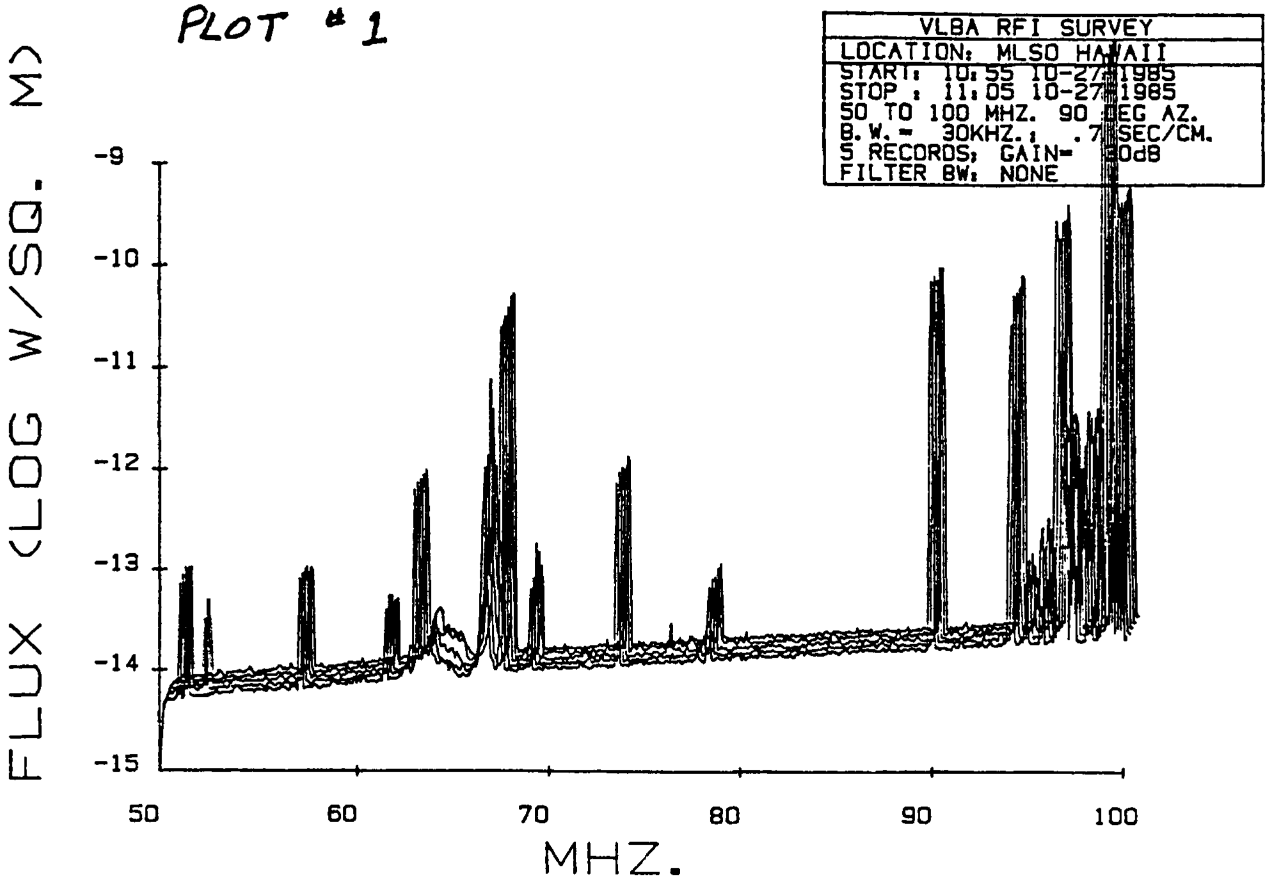
Note 2: These levels are threshold levels from Table I plots.

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

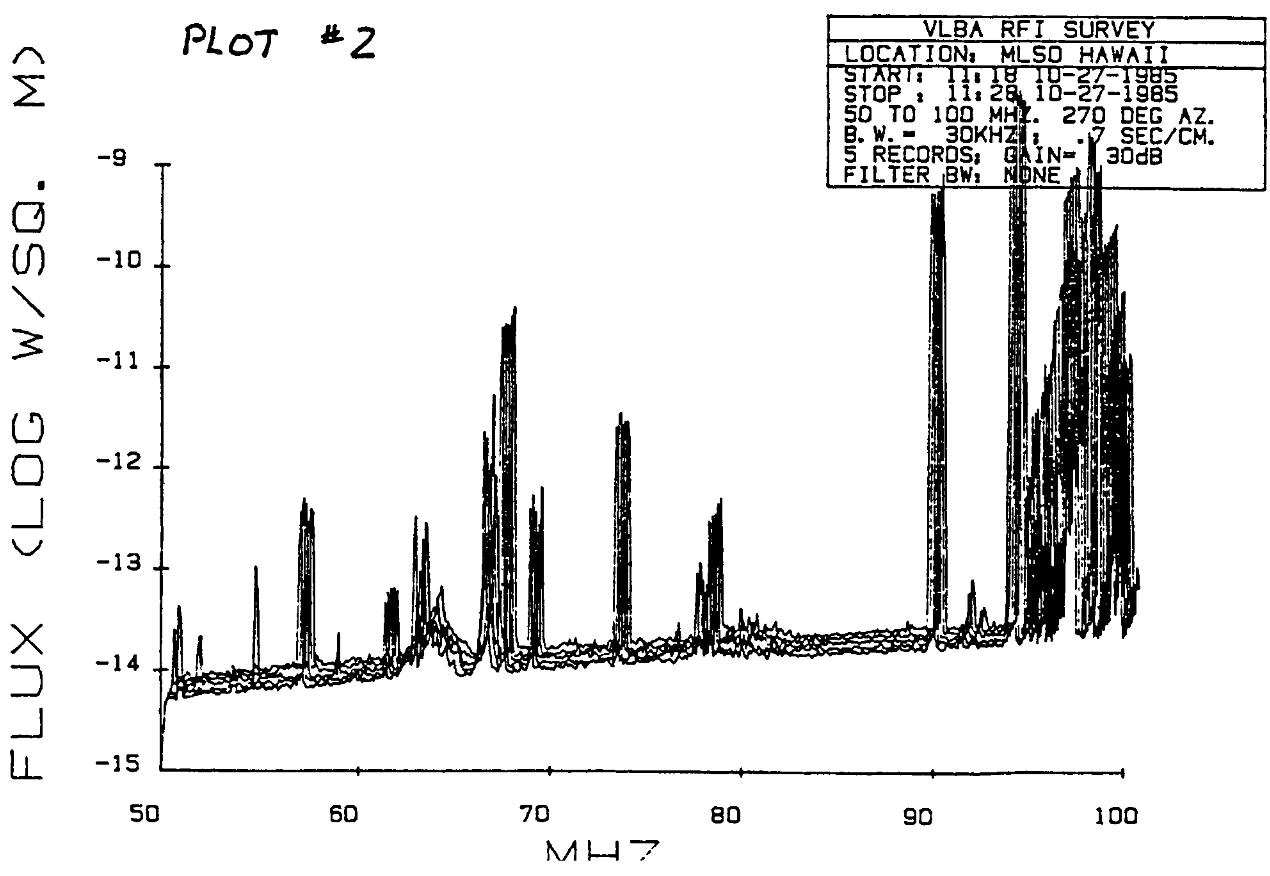
Note 4: These levels are from VLBA Electronics Memo No. 39.

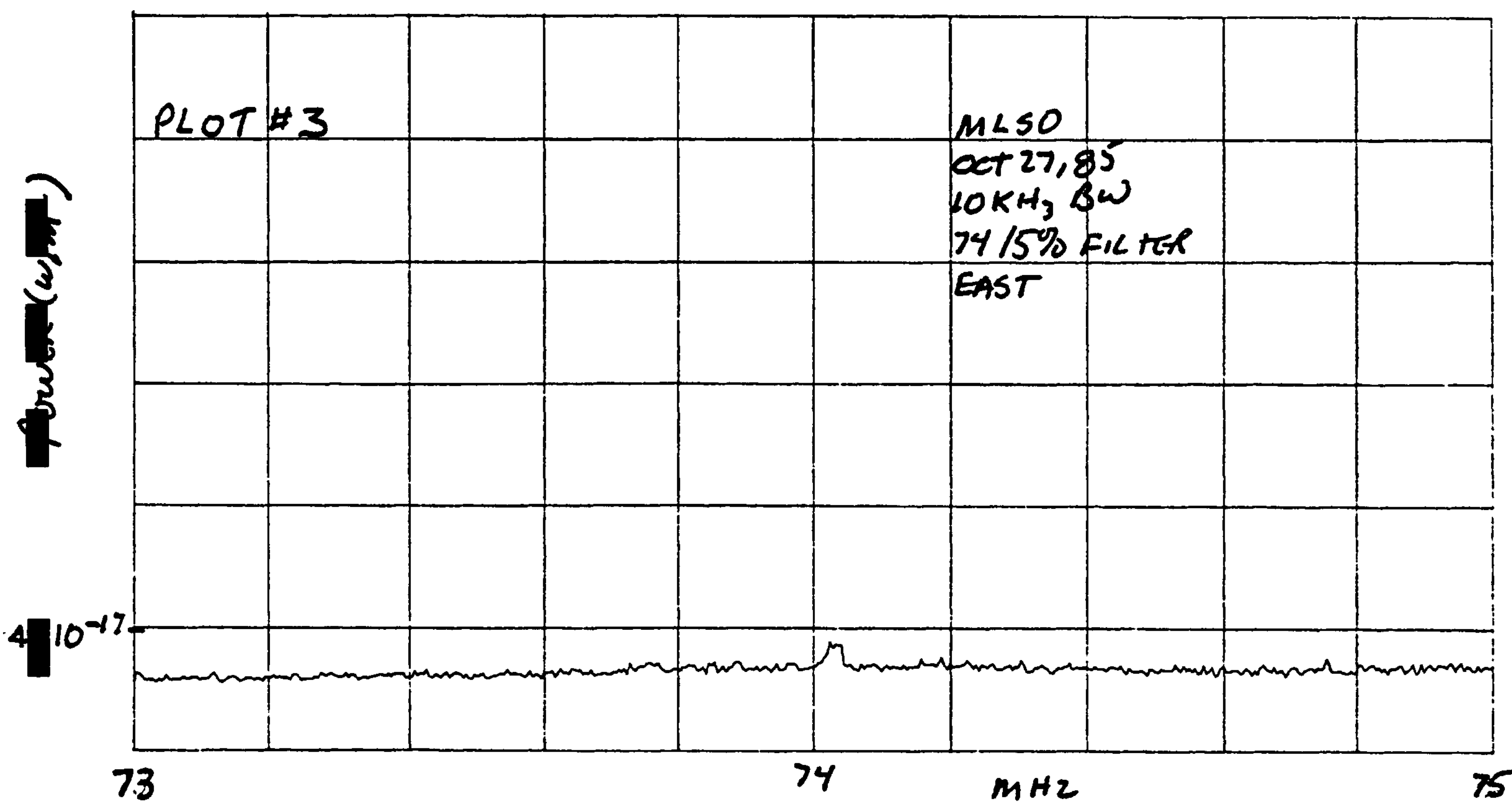
* These frequency bands not included in memo 81.
# These frequency bands not included in memo 39.

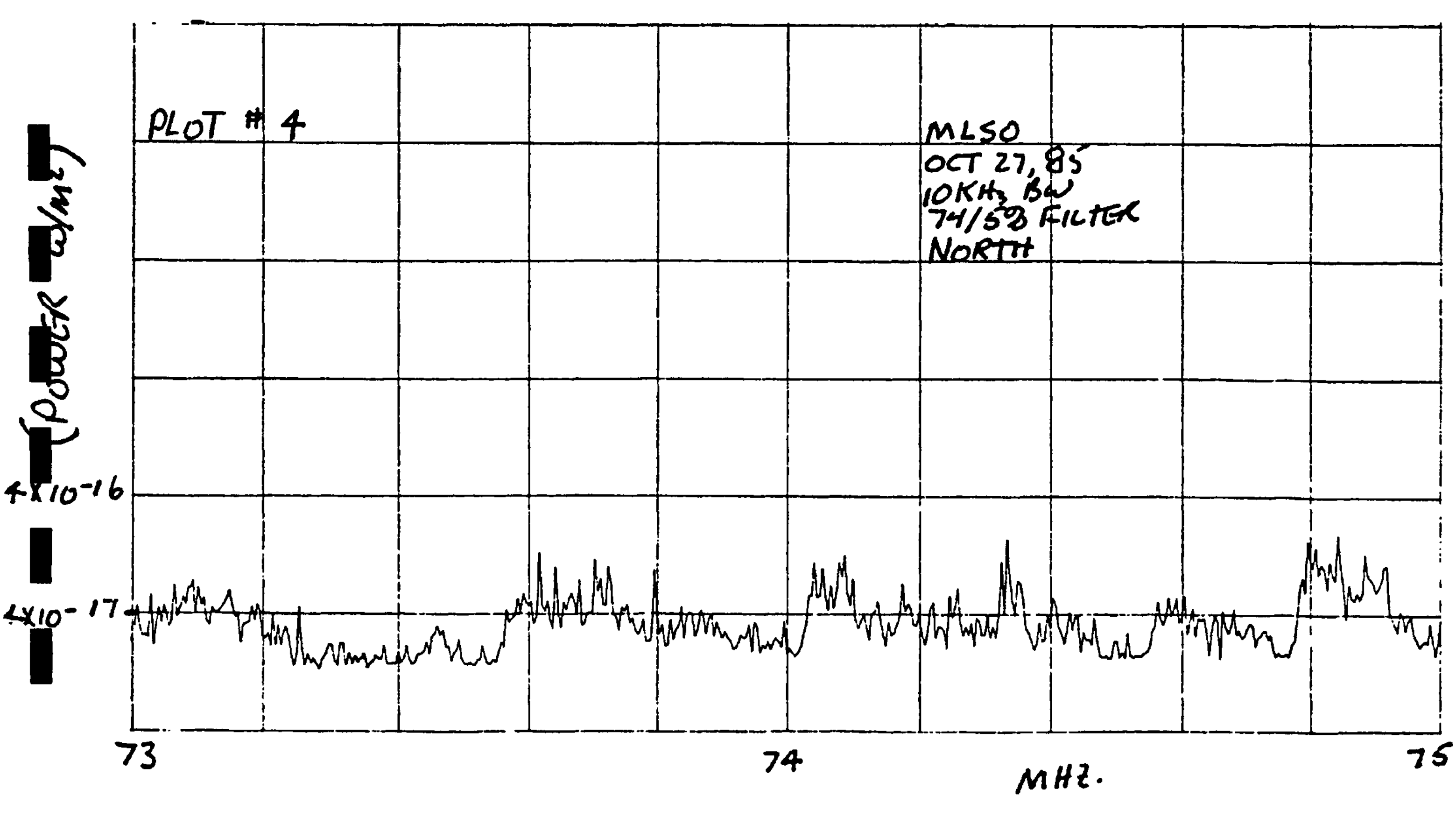
PLOT #1


VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 10:55 10-27-1985
STOP : 11:05 10-27-1985
50 TO 100 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
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.

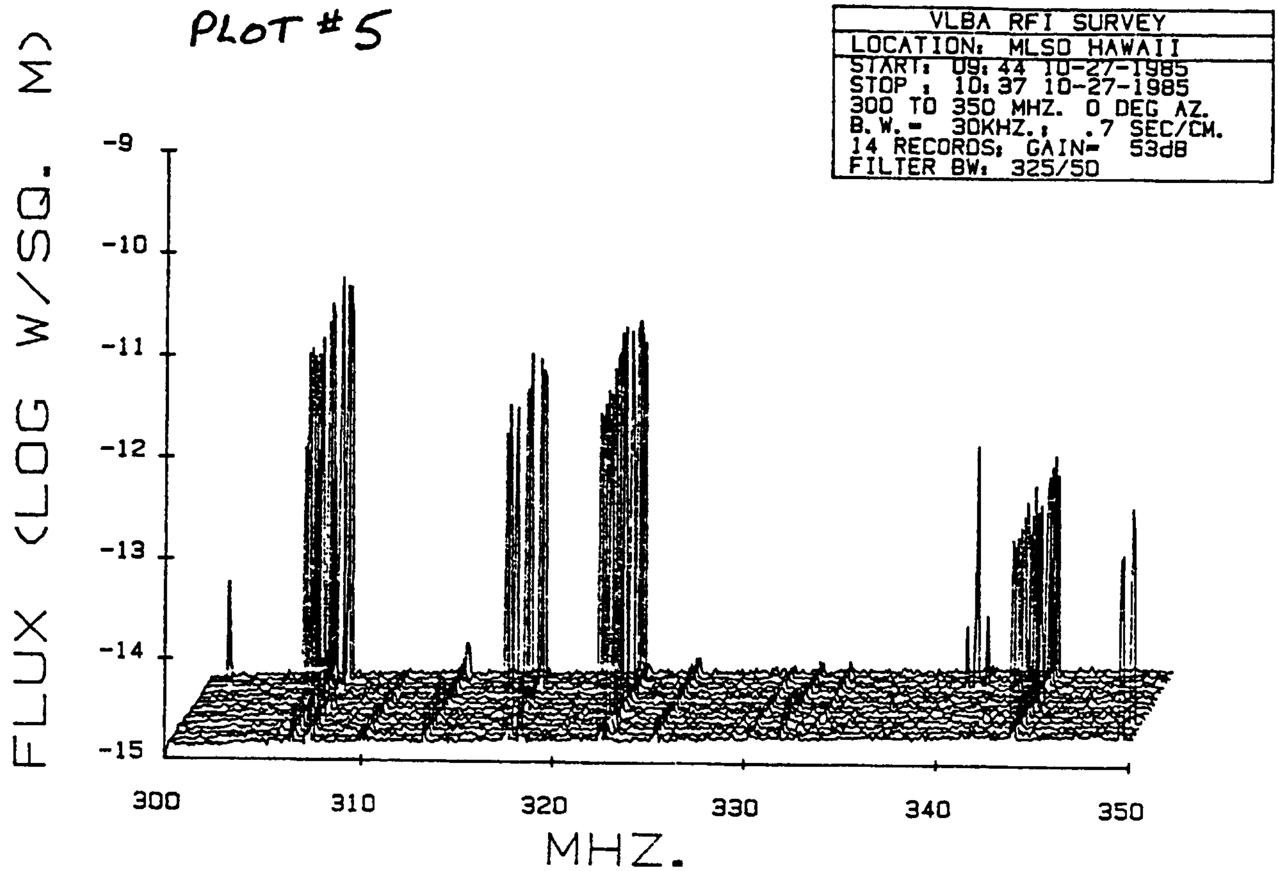
PLOT #2


VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 11:18 10-27-1985
STOP : 11:28 10-27-1985
50 TO 100 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
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


PLOT #3
MLSO
OCT 27, 85
10KHz BW
74/5% FILTER
EAST
[redacted] (w/m²)
4[redacted]10⁻¹⁷
73
74
MHz
75

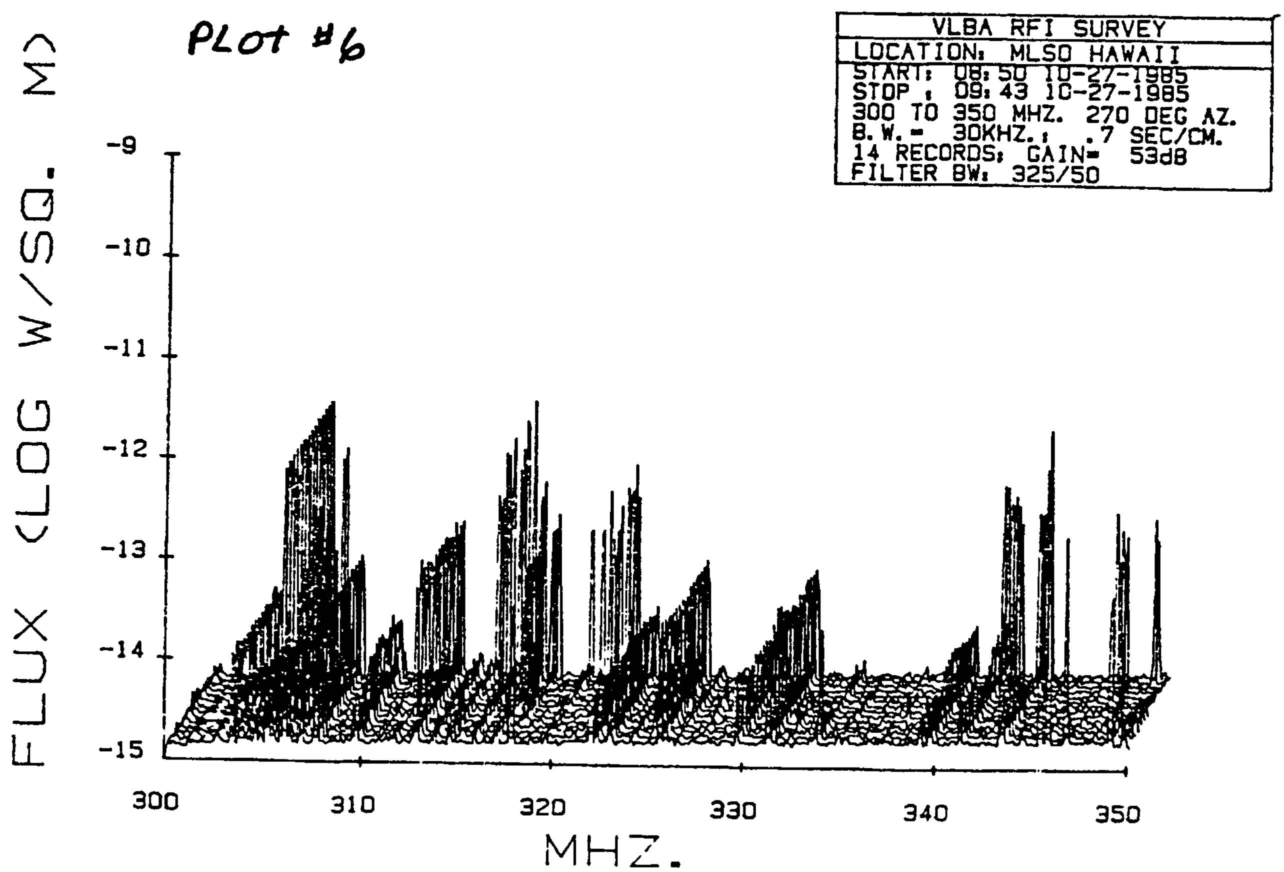

PLOT # 4
MLSO
OCT 27, 85
10KHz BW
74/5% FILTER
NORTH
(POWER [redacted] w/m²)
4x10⁻¹⁶
4x10⁻¹⁷
73
74
MHz.
75

PLOT #5

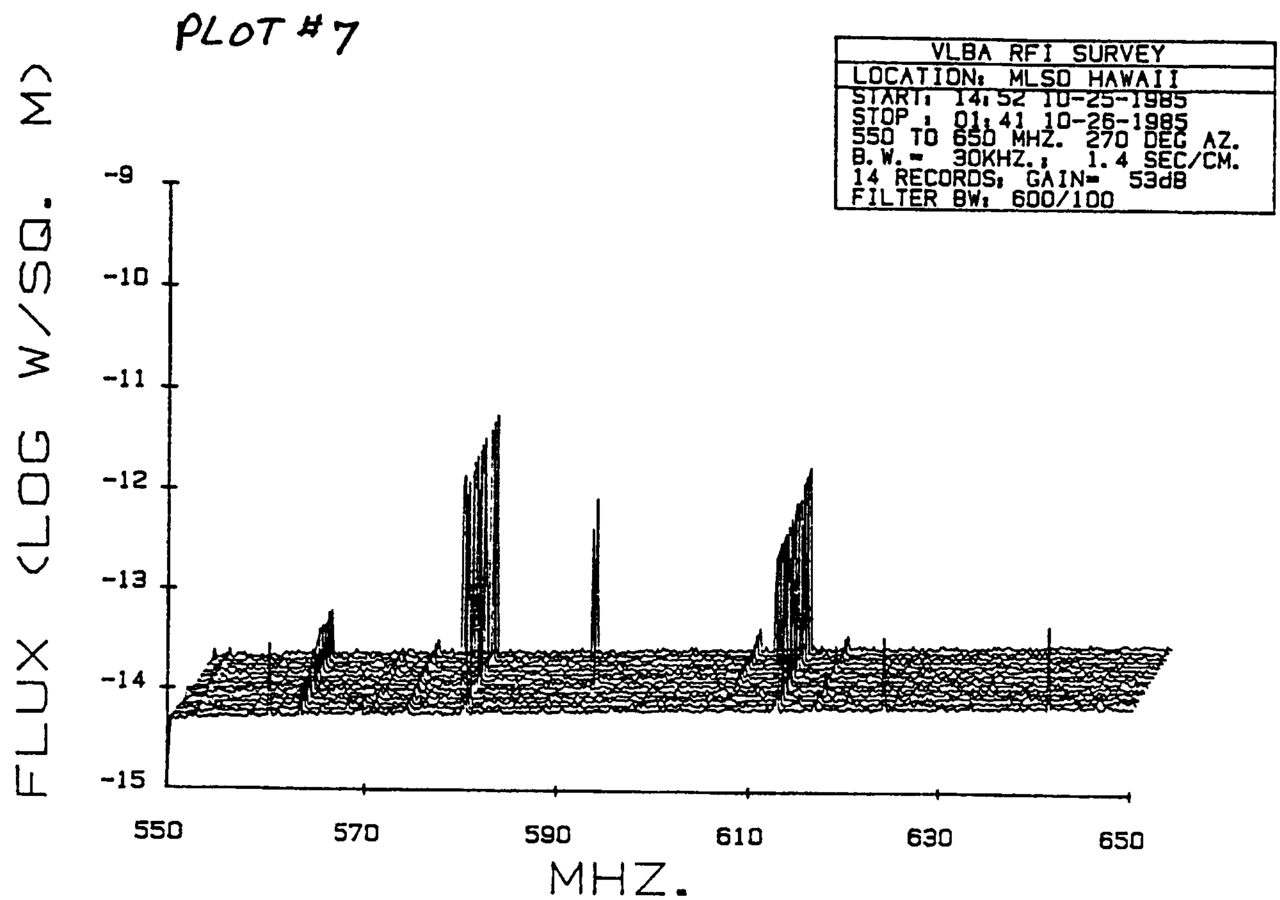


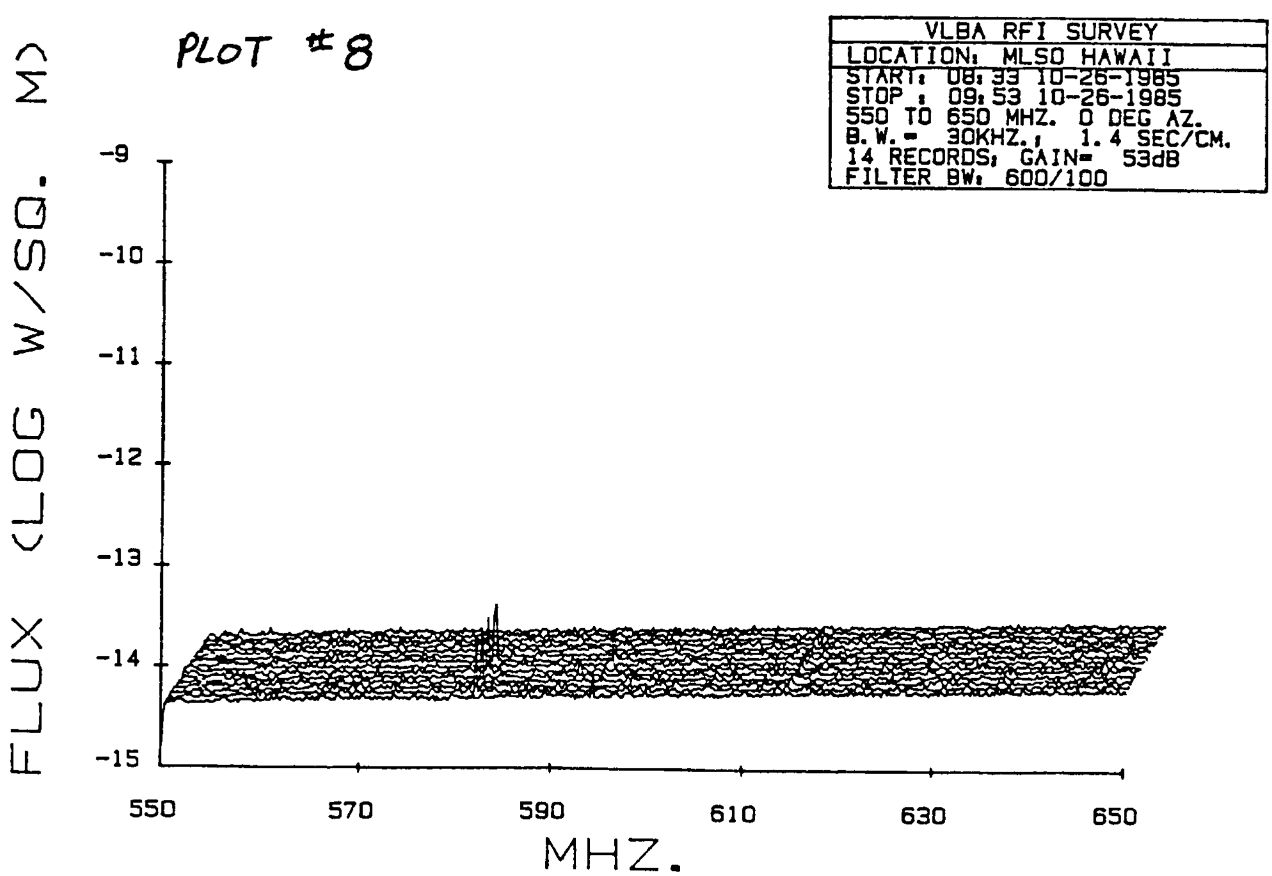
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 09:44 10-27-1985
STOP : 10:37 10-27-1985
300 TO 350 MHZ. 0 DEG AZ.
B. W. = 30KHZ. ; .7 SEC/CM.
14 RECORDS; GAIN= 53dB
FILTER BW: 325/50
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
300
310
320
330
340
350
MHZ.

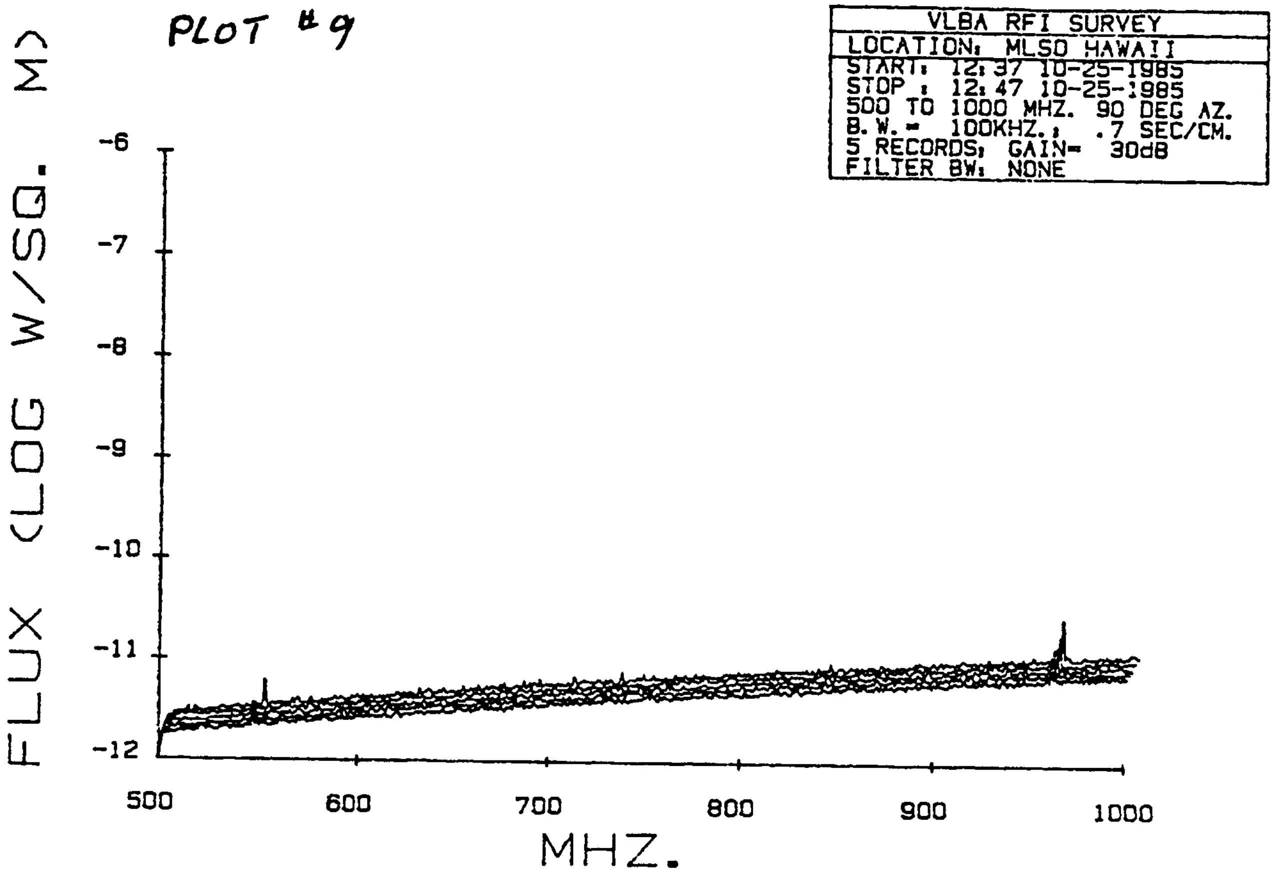
PLOT #6

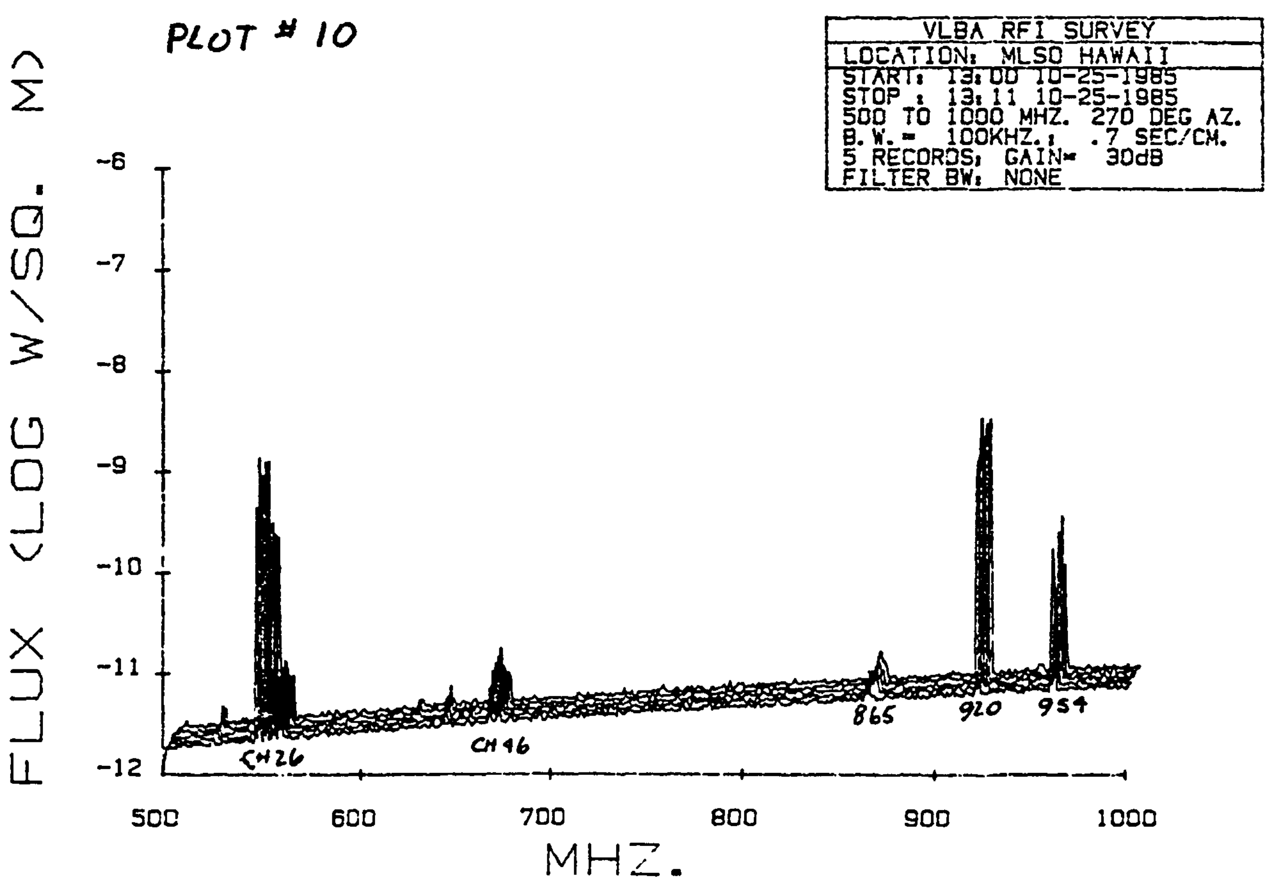


VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 08:50 10-27-1985
STOP : 09:43 10-27-1985
300 TO 350 MHZ. 270 DEG AZ.
B. W. = 30KHZ. ; .7 SEC/CM.
14 RECORDS; GAIN= 53dB
FILTER BW: 325/50
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
300
310
320
330
340
350
MHZ.

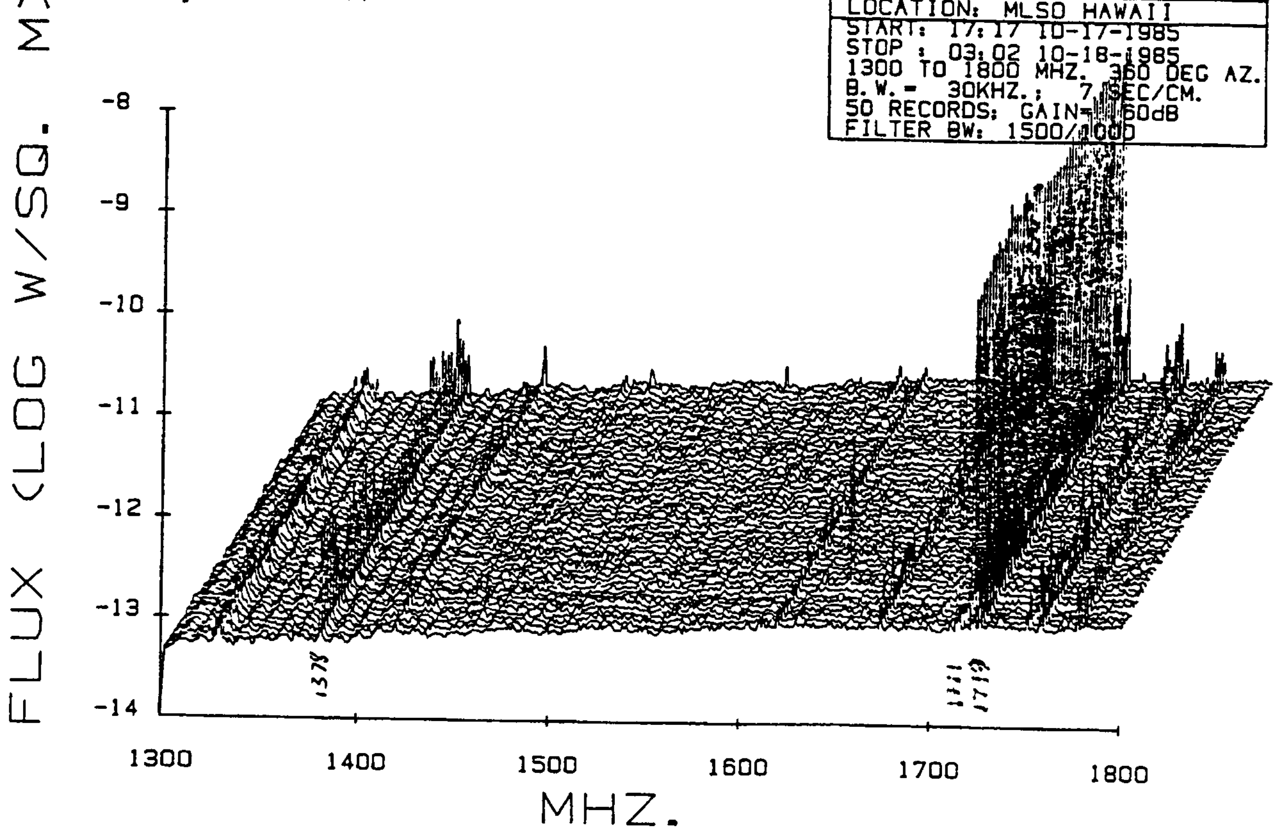

PLOT #7
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 14:52 10-25-1985
STOP : 01:41 10-26-1985
550 TO 650 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 1.4 SEC/CM.
14 RECORDS; GAIN= 53dB
FILTER BW: 600/100
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
550
570
590
610
630
650
MHZ.


PLOT #8
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 08:33 10-26-1985
STOP : 09:53 10-26-1985
550 TO 650 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 1.4 SEC/CM.
14 RECORDS; GAIN= 53dB
FILTER BW: 600/100
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
550
570
590
610
630
650
MHZ.

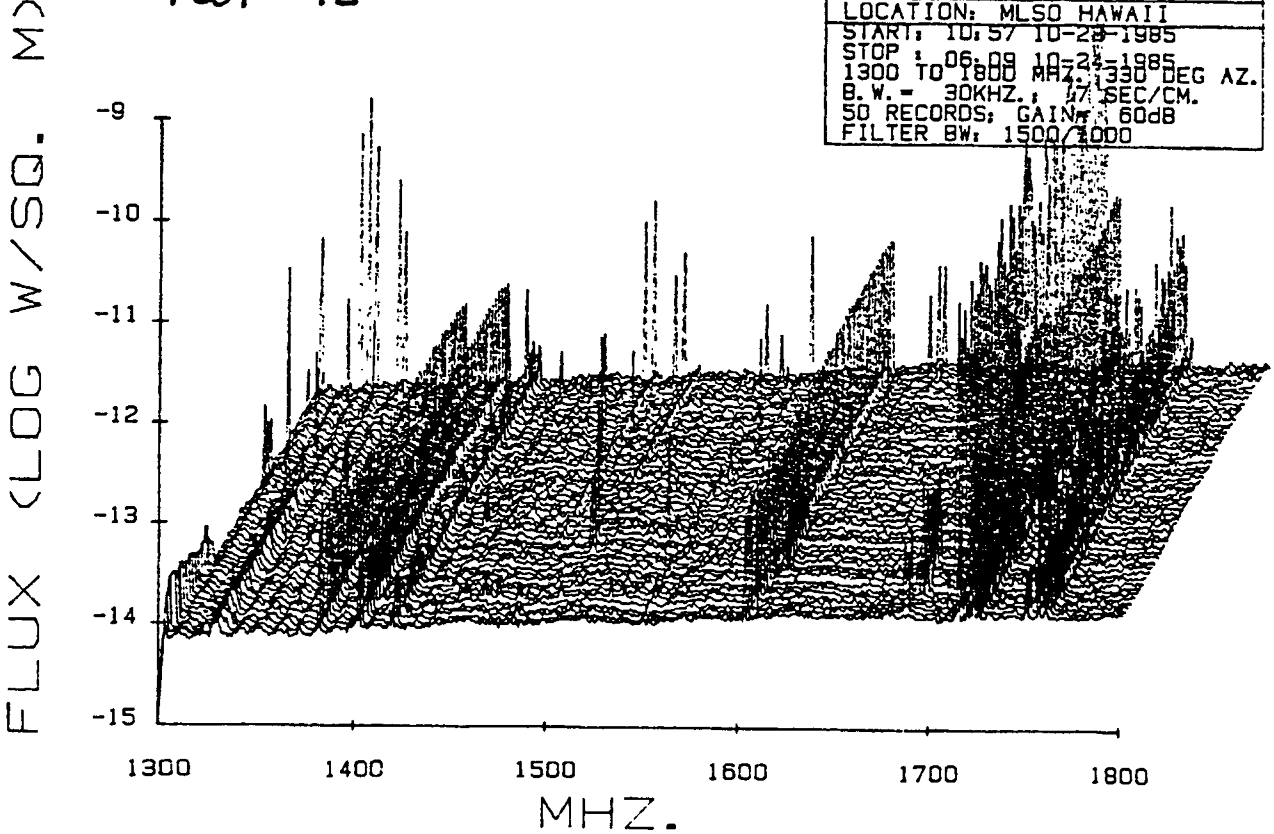

PLOT #9
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 12:37 10-25-1985
STOP : 12:47 10-25-1985
500 TO 1000 MHZ. 90 DEG AZ.
B.W.= 100KHZ.; .7 SEC/CM.
5 RECORDS; GAIN= 30dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
500
600
700
800
900
1000
MHZ.


PLOT # 10
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 13:00 10-25-1985
STOP : 13:11 10-25-1985
500 TO 1000 MHZ. 270 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
CH26
CH46
865
920
954
500
600
700
800
900
1000
MHZ.

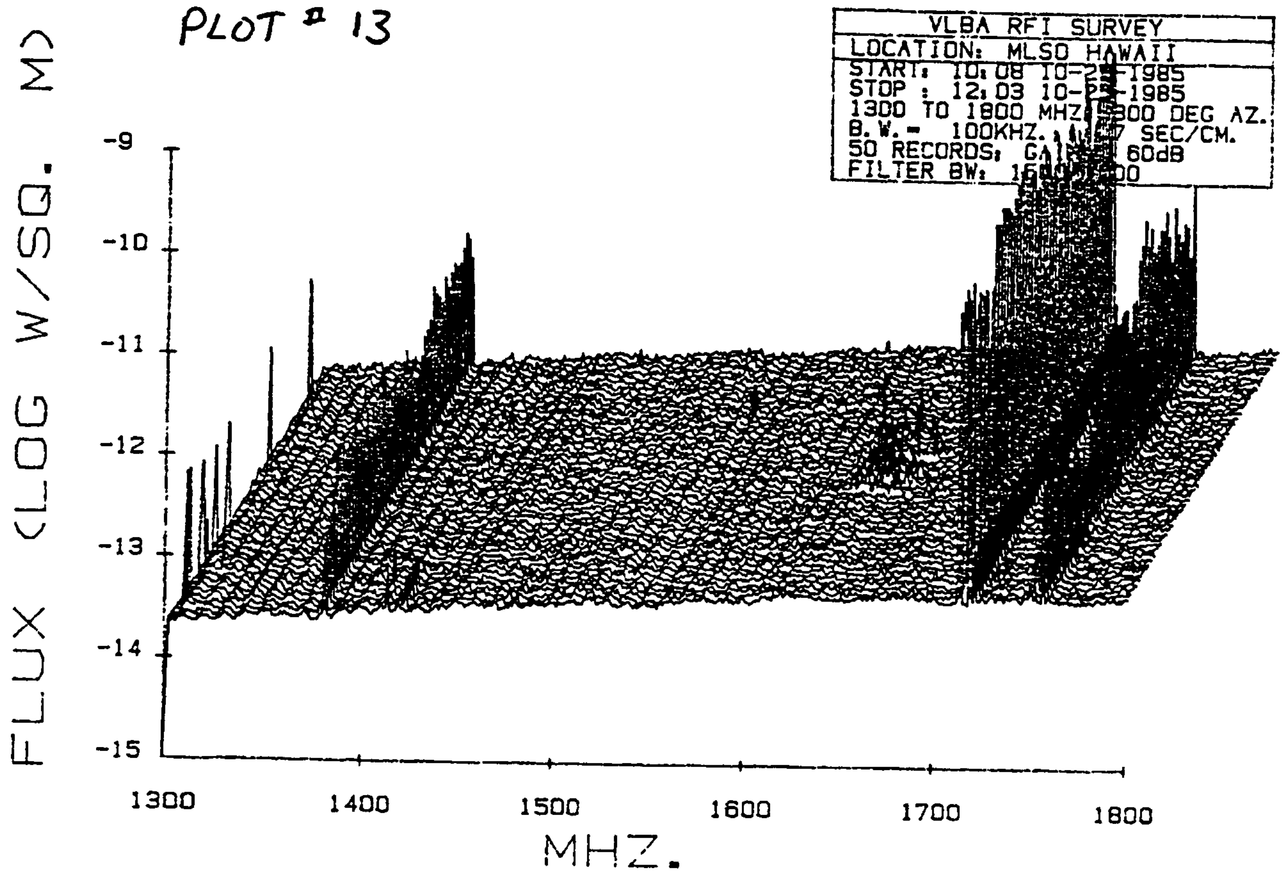
PLOT # 11



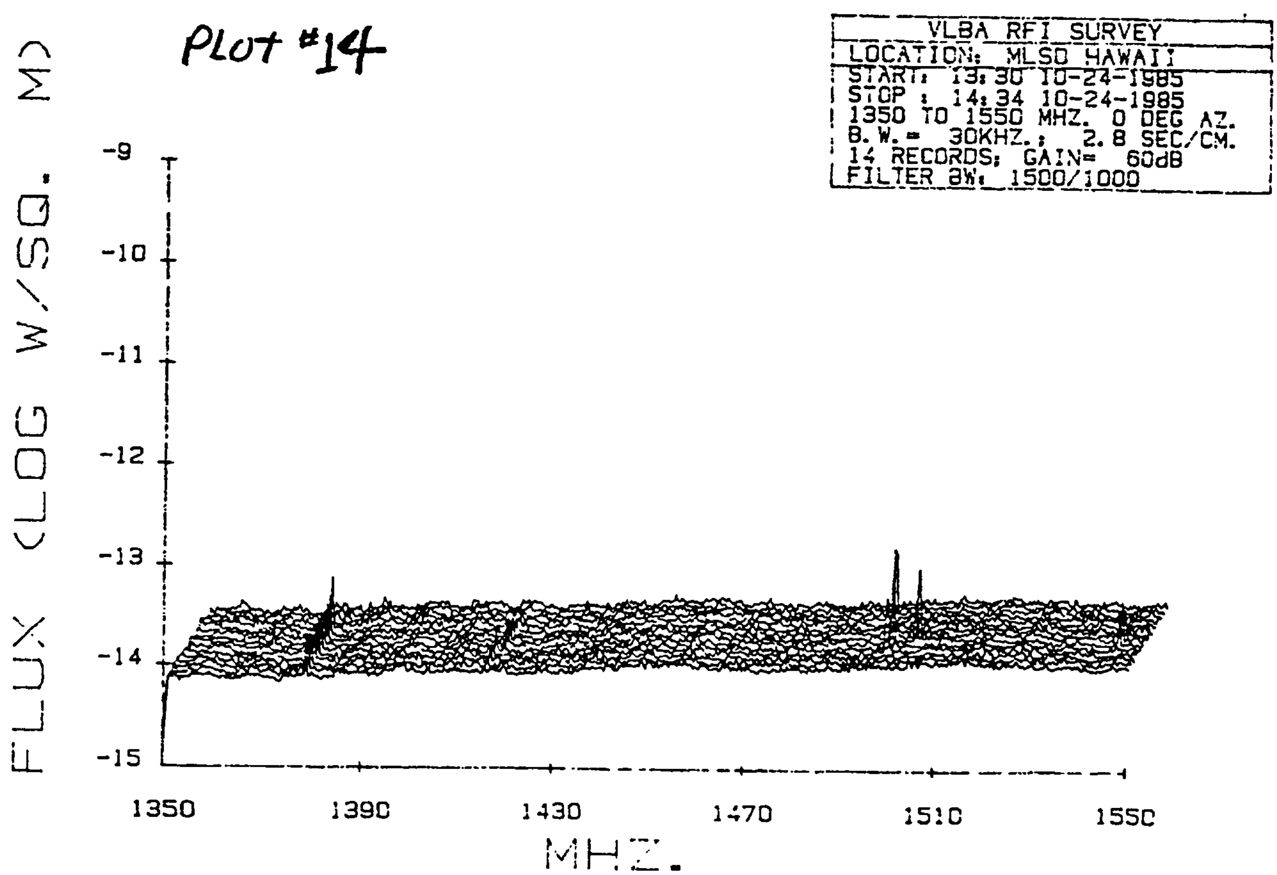
PLOT # 12



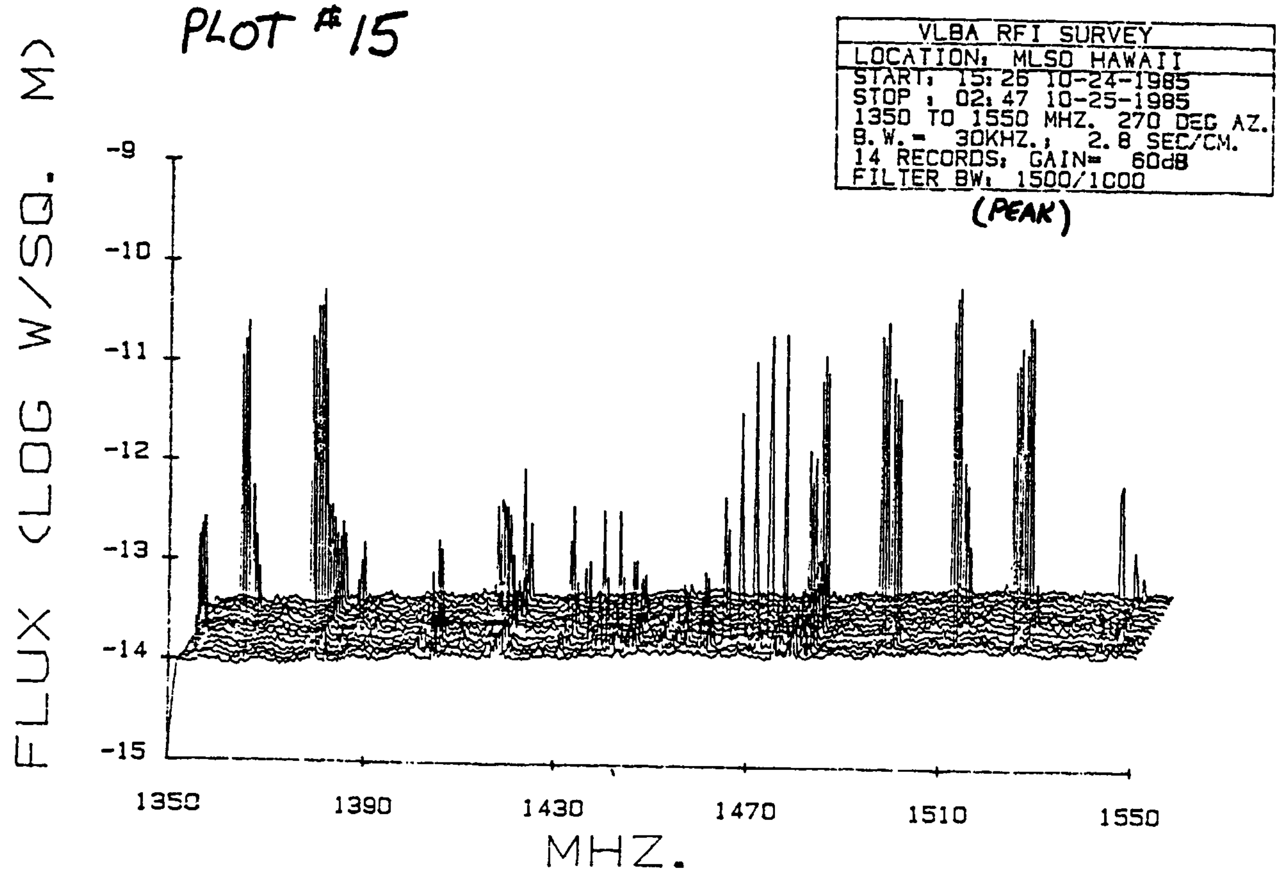
PLOT # 13



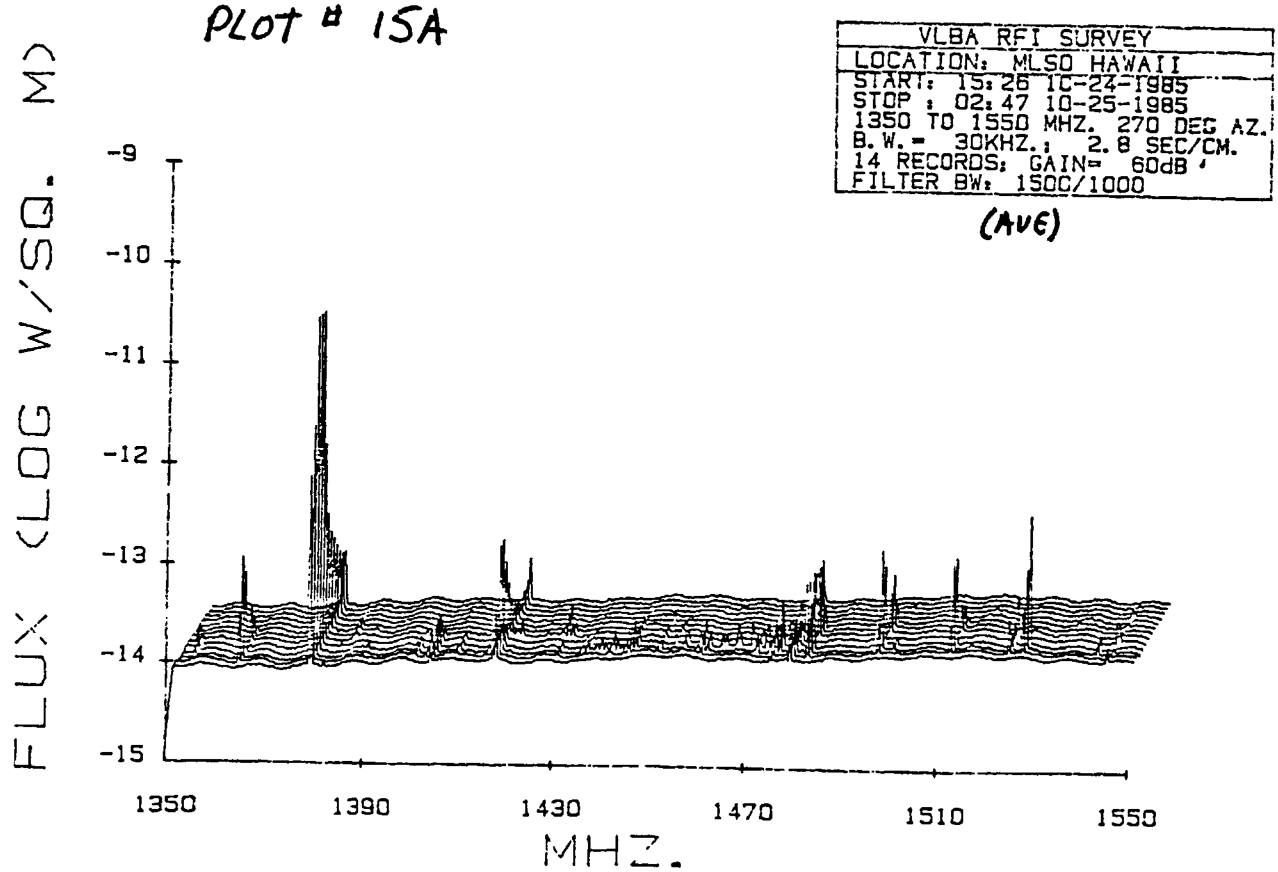
PLOT #14



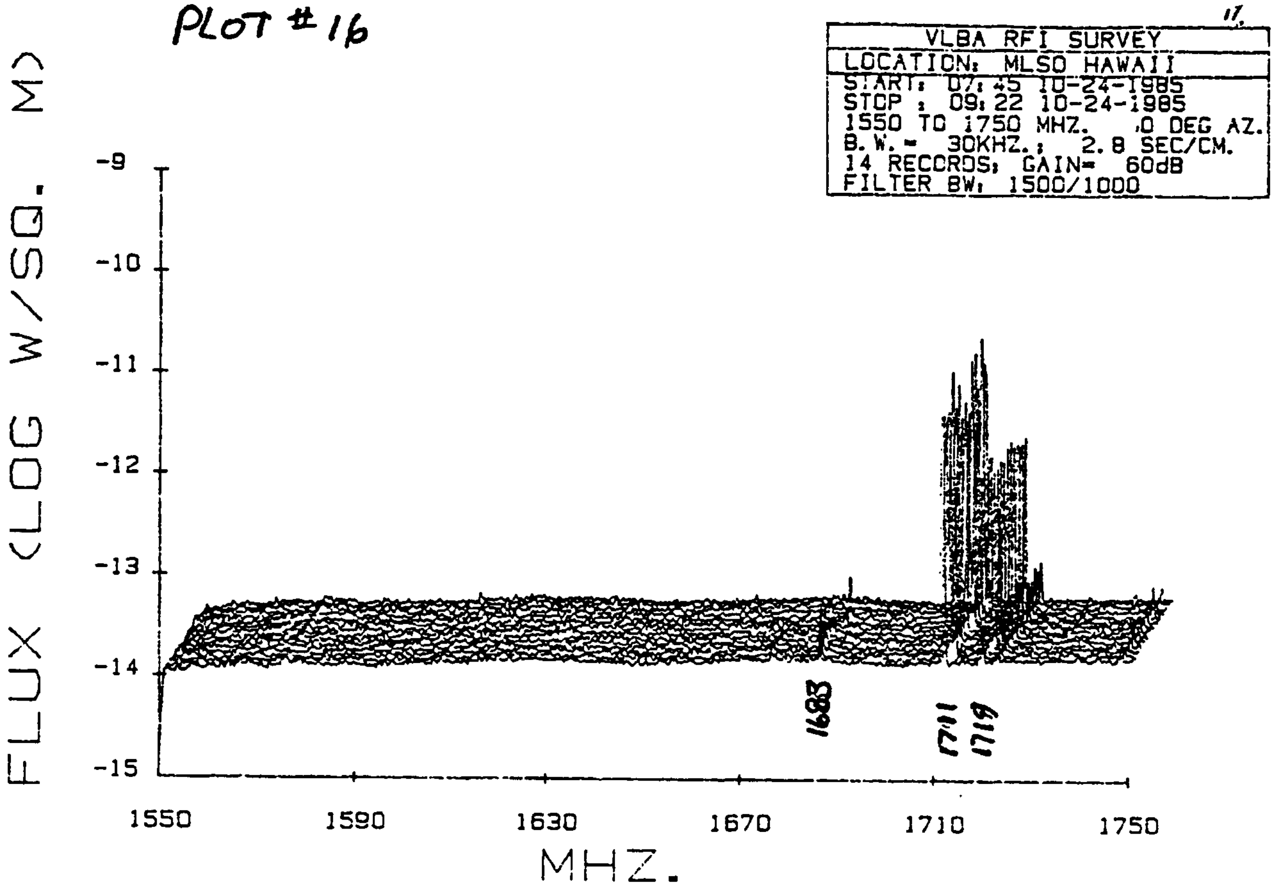
PLOT #15



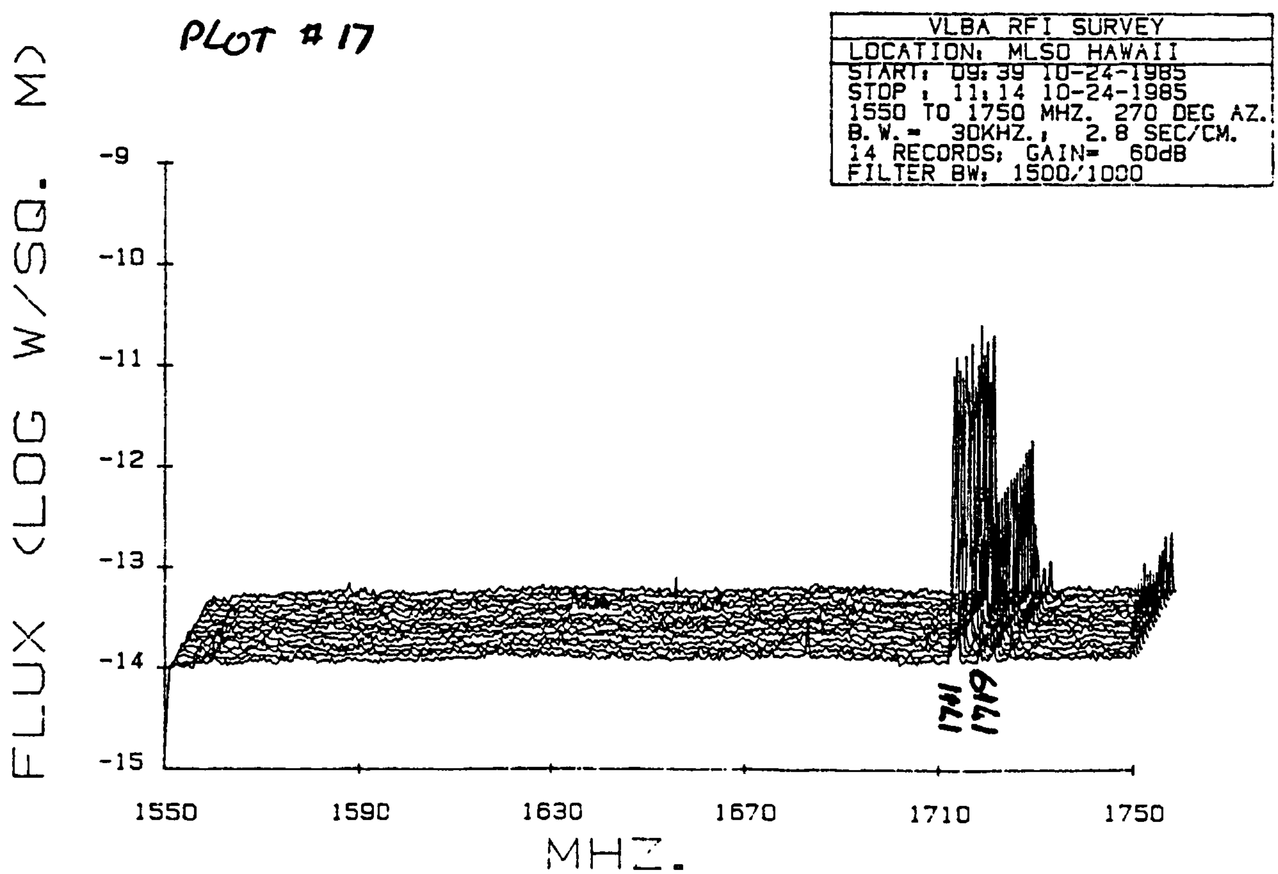
PLOT # 15A



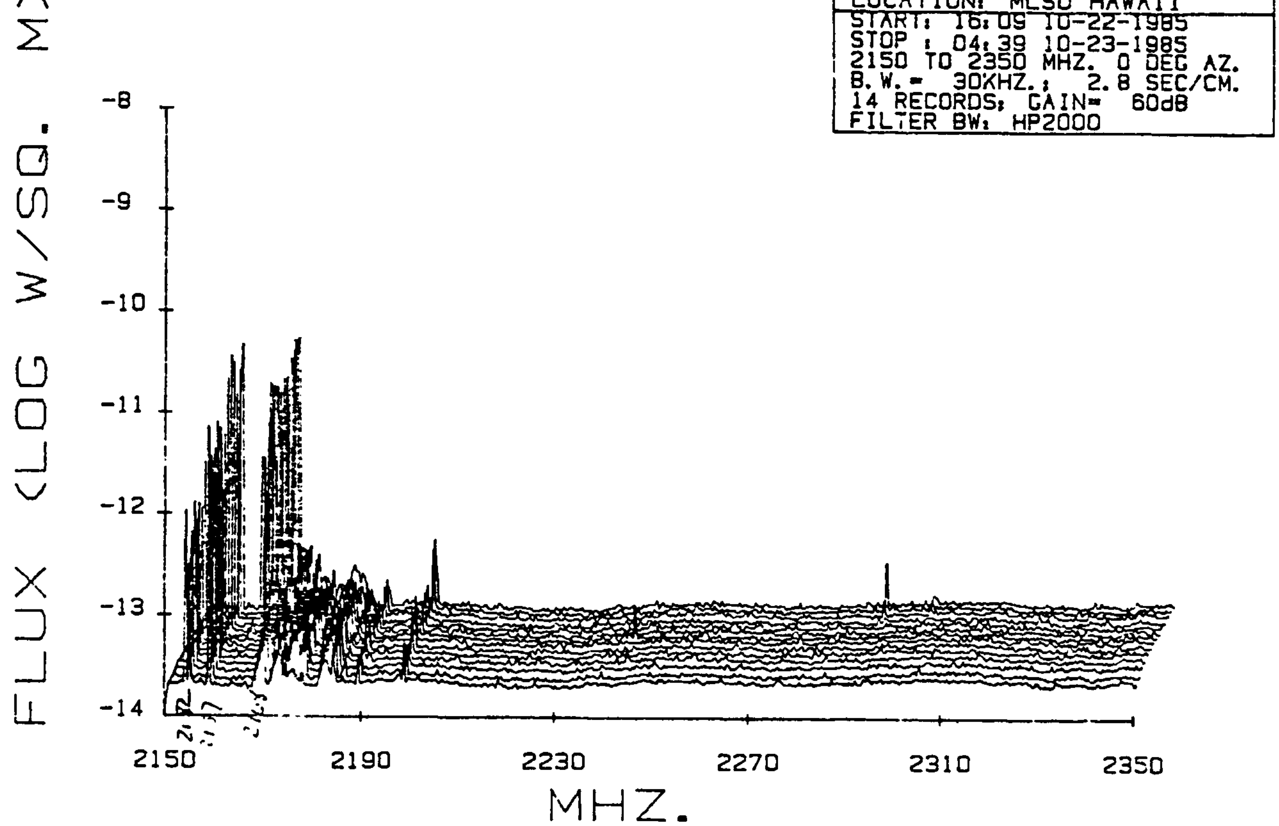
PLOT #16



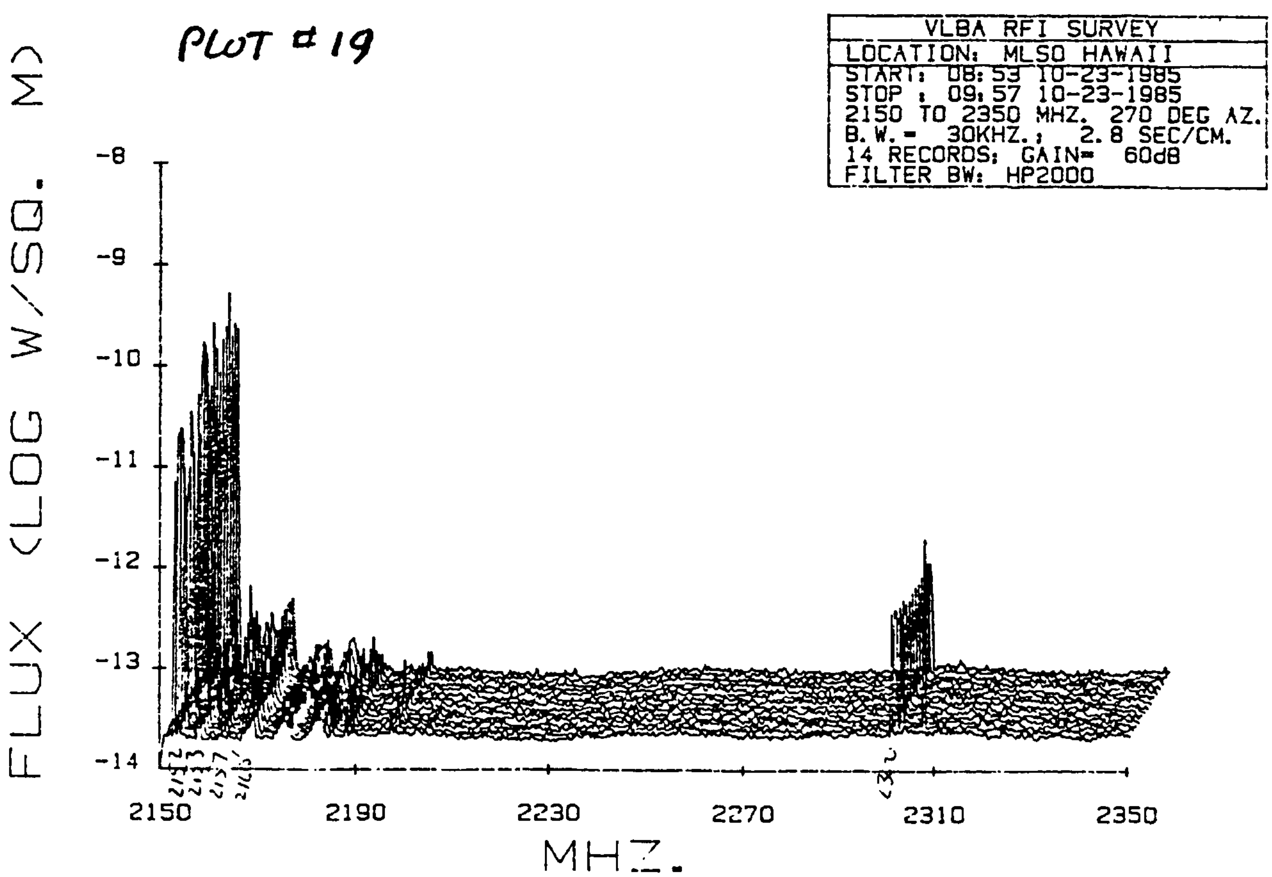
PLOT # 17



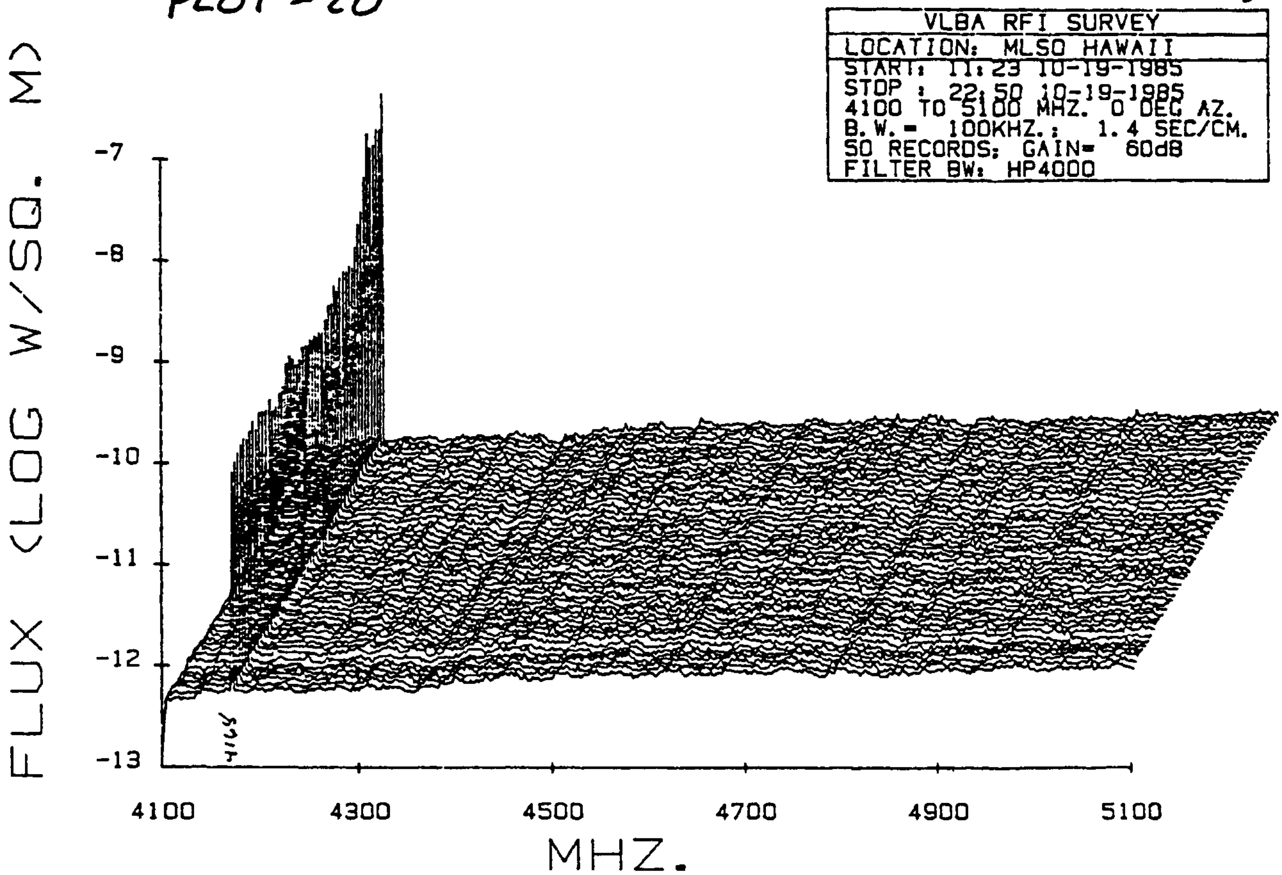
PLOT #18



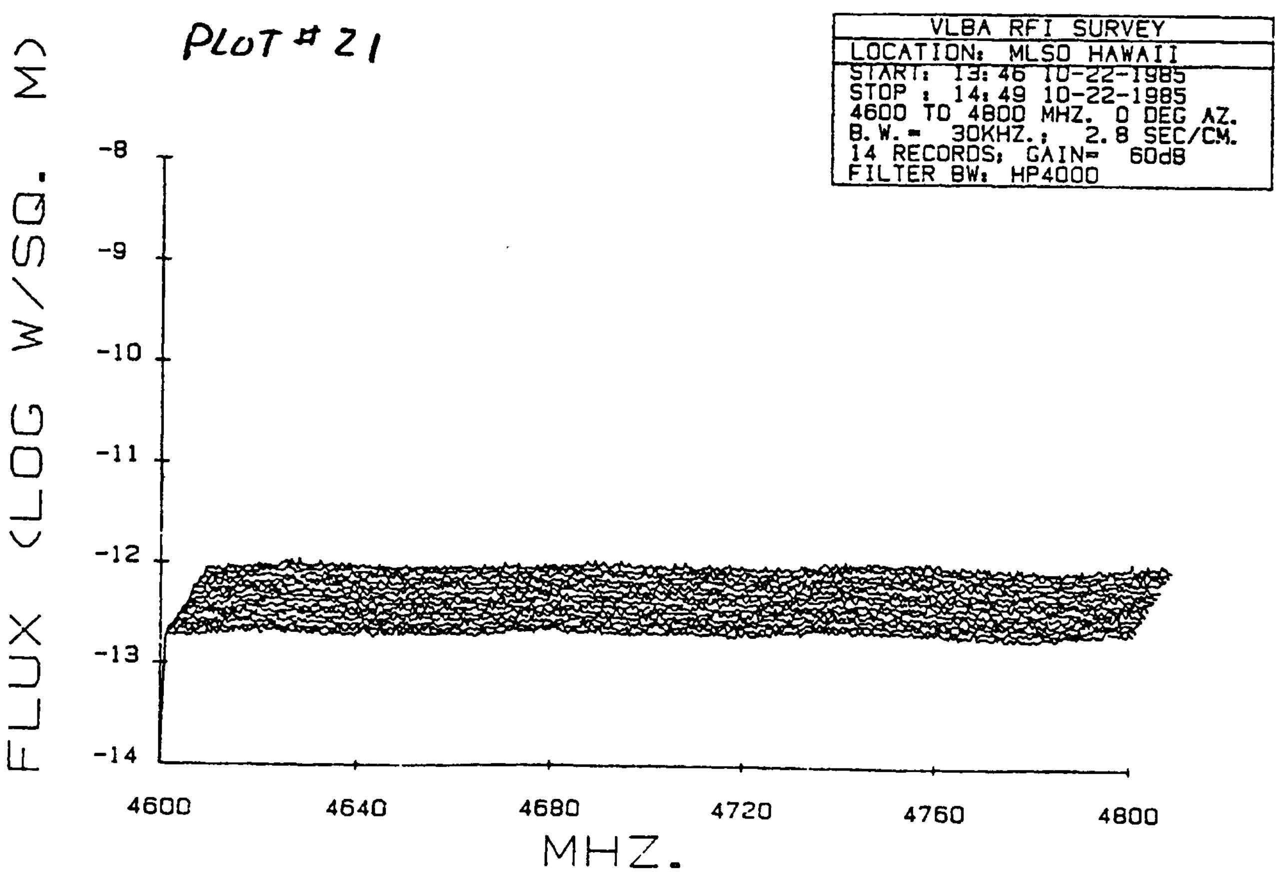
PLOT #19

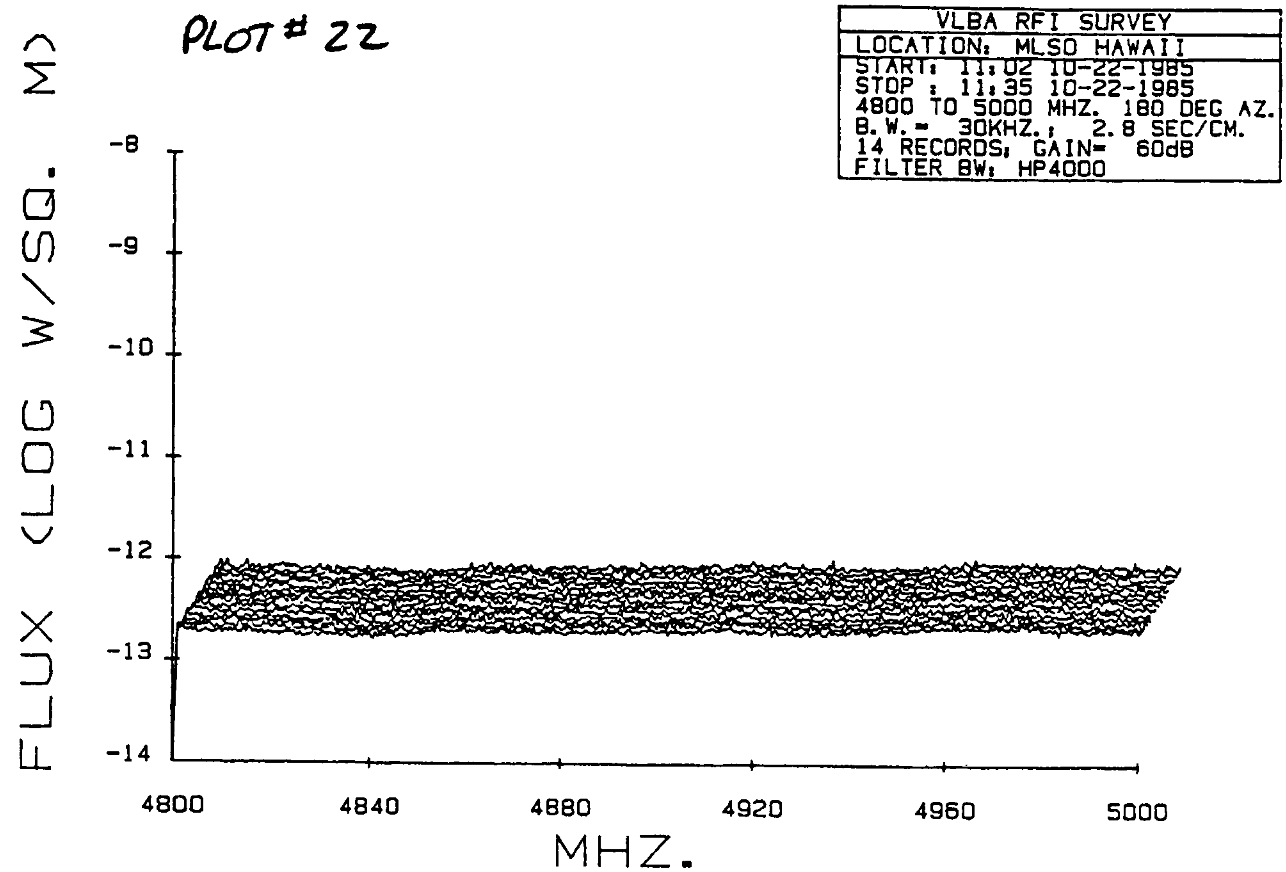


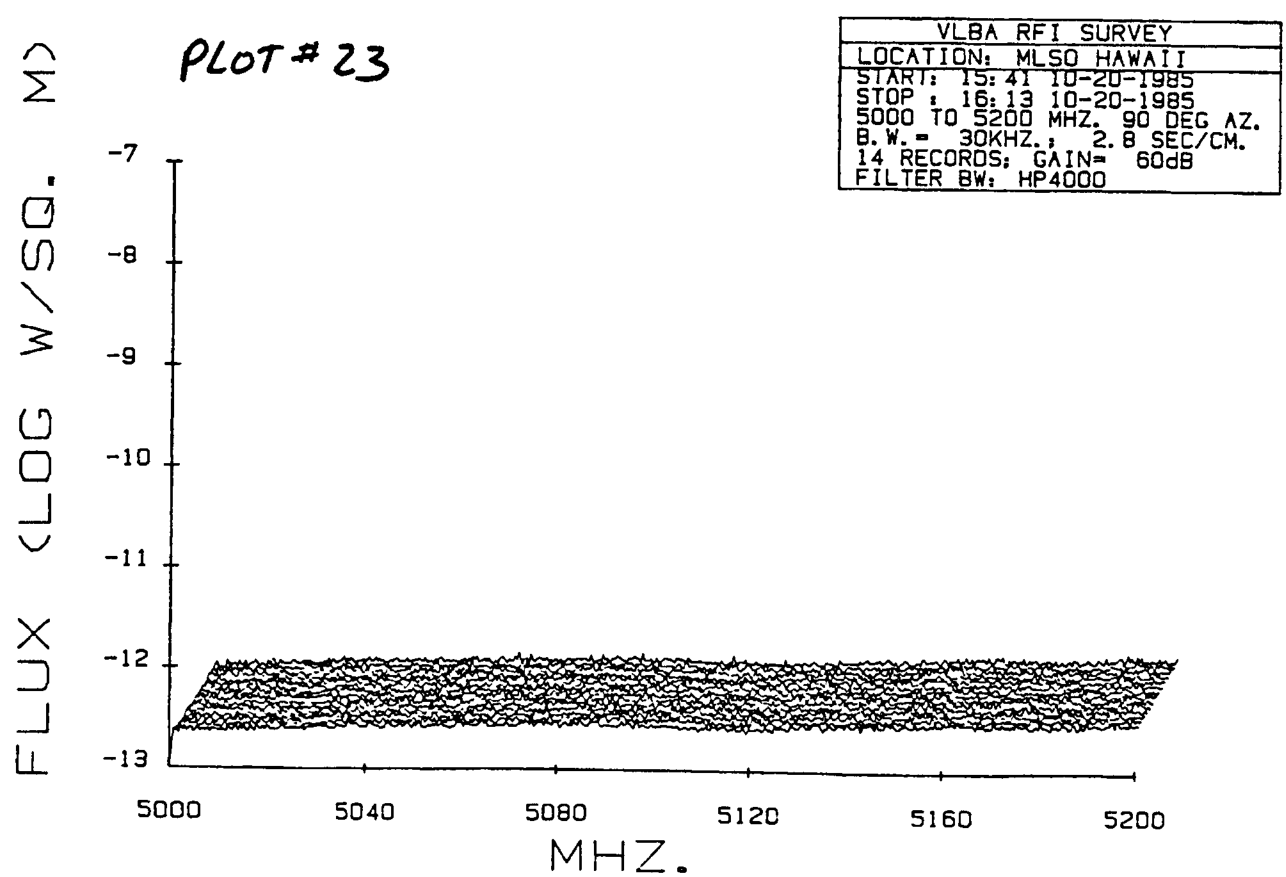
PLOT #20



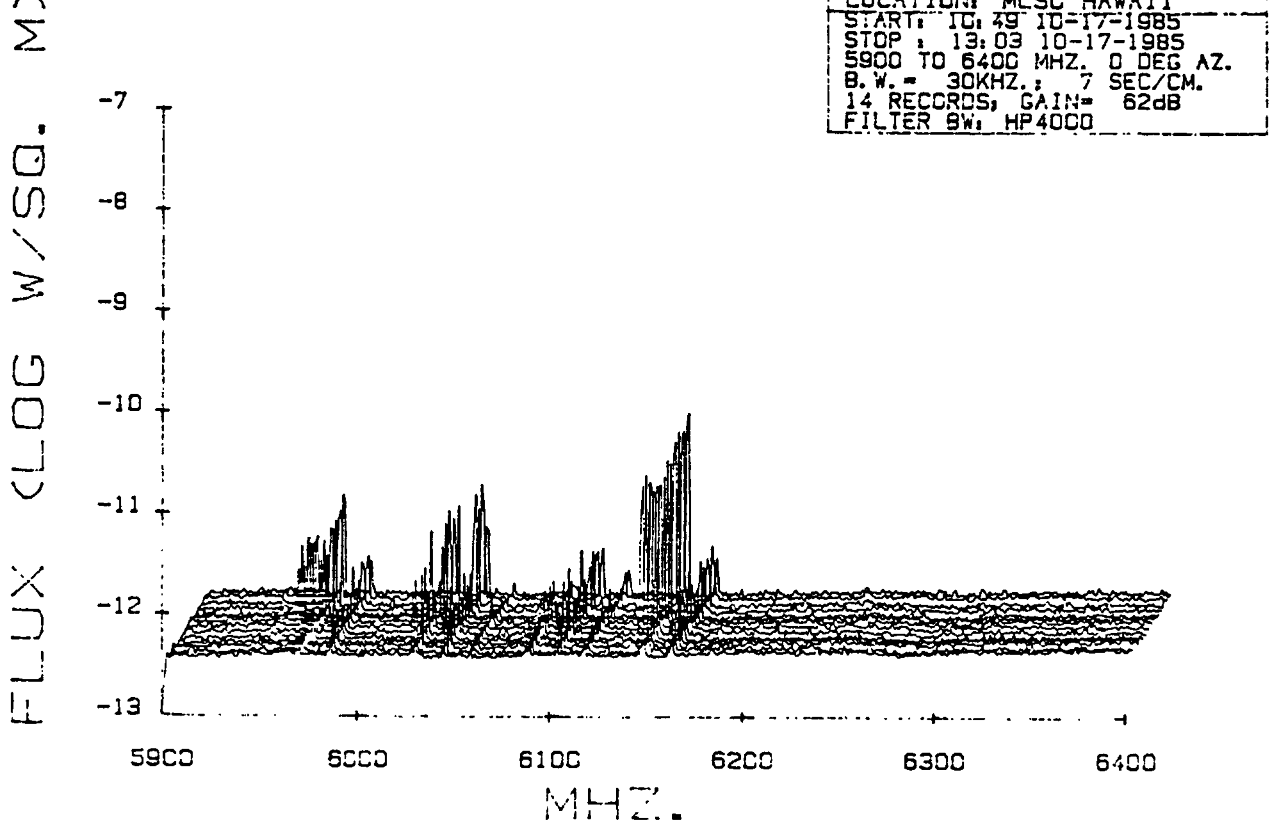
PLOT #21



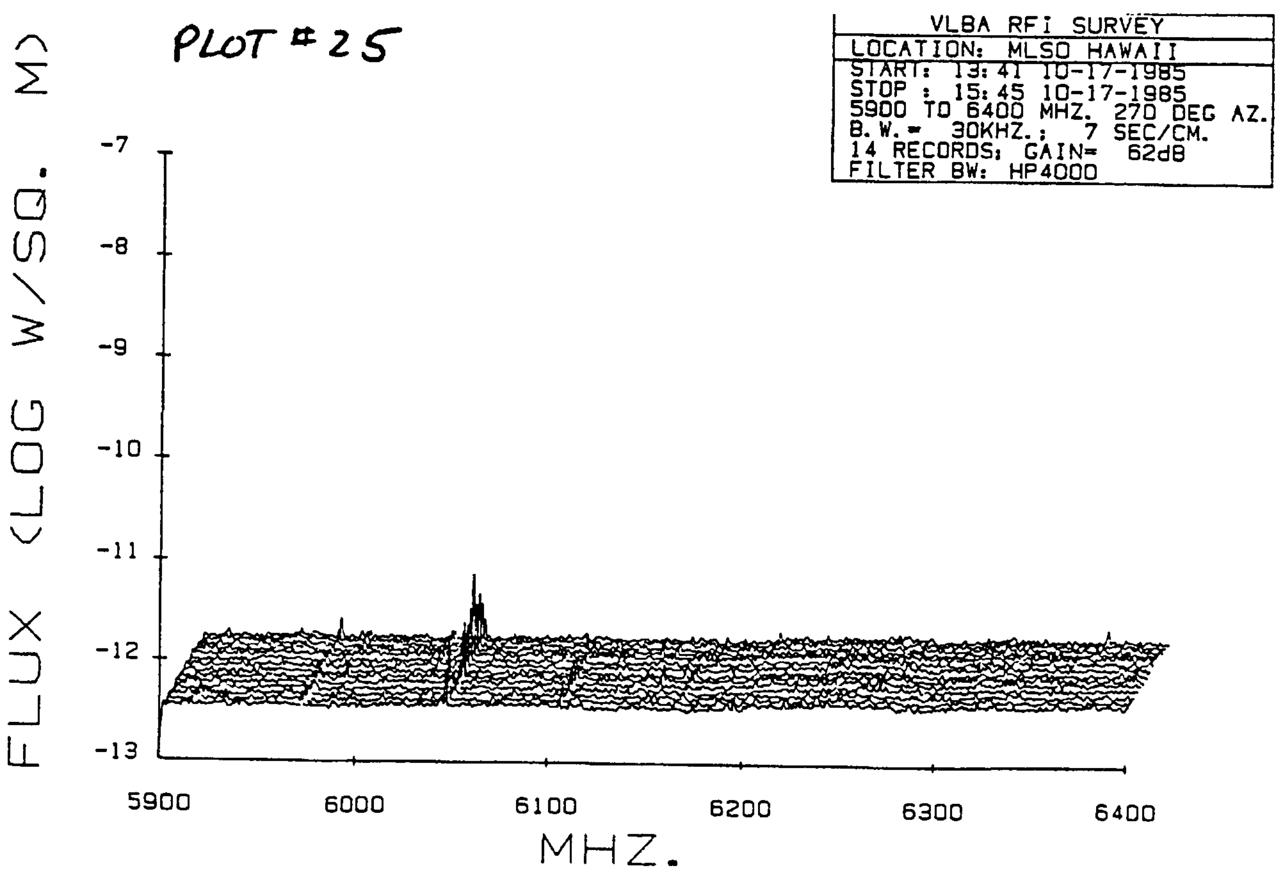

PLOT # 22
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 11:02 10-22-1985
STOP : 11:35 10-22-1985
4800 TO 5000 MHZ. 180 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
14 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-8
-9
-10
-11
-12
-13
-14
4800
4840
4880
4920
4960
5000
MHZ.

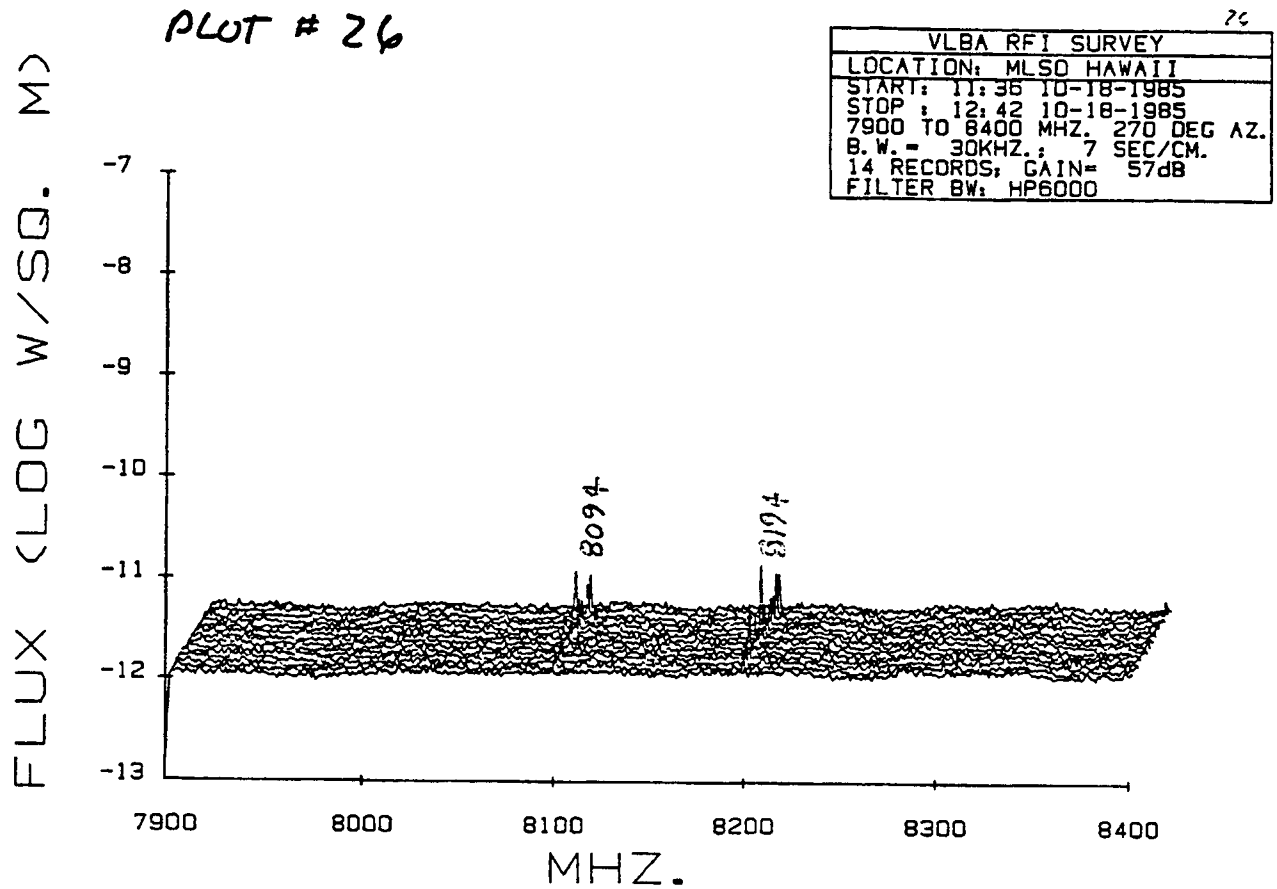

PLOT # 23
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 15:41 10-20-1985
STOP : 16:13 10-20-1985
5000 TO 5200 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
14 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
5000
5040
5080
5120
5160
5200
MHZ.

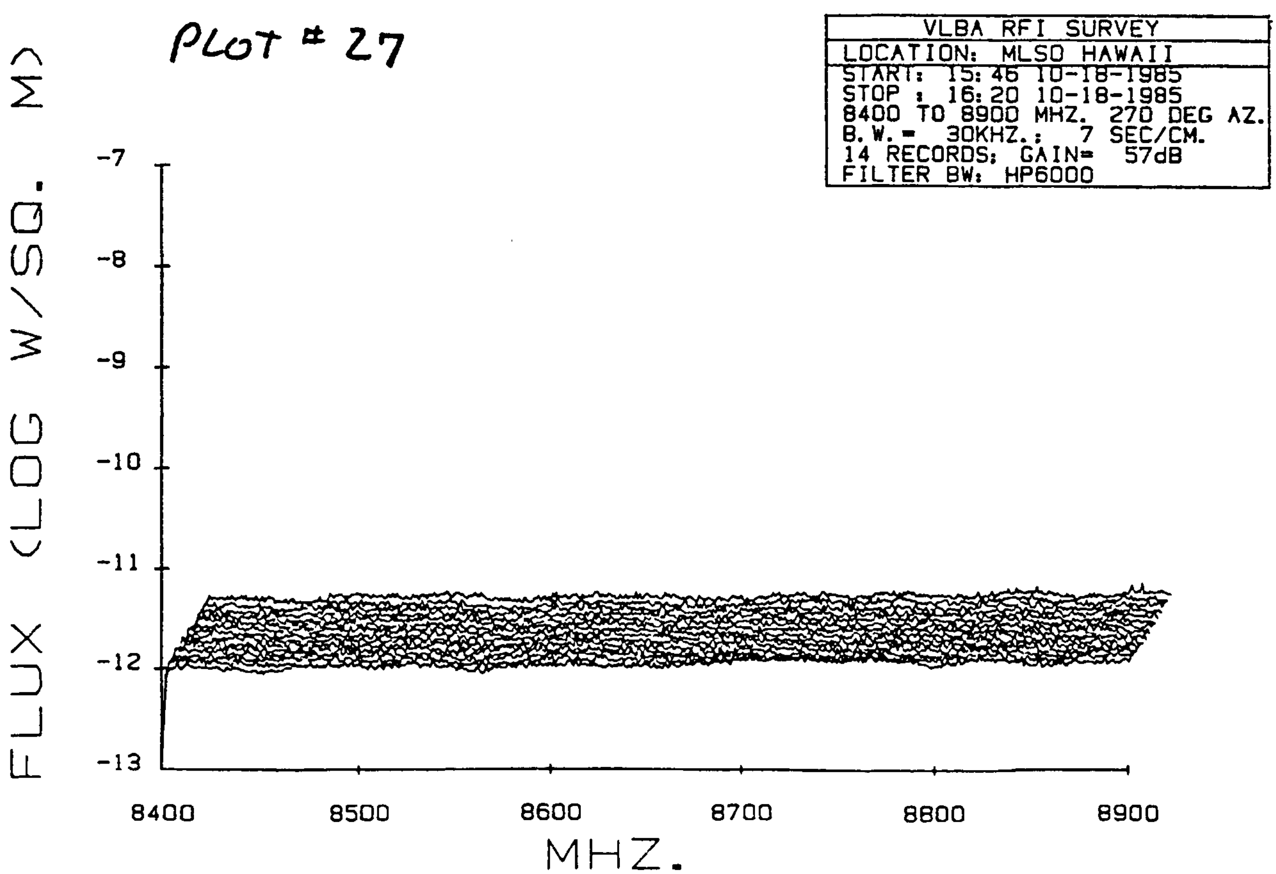
PLOT #24



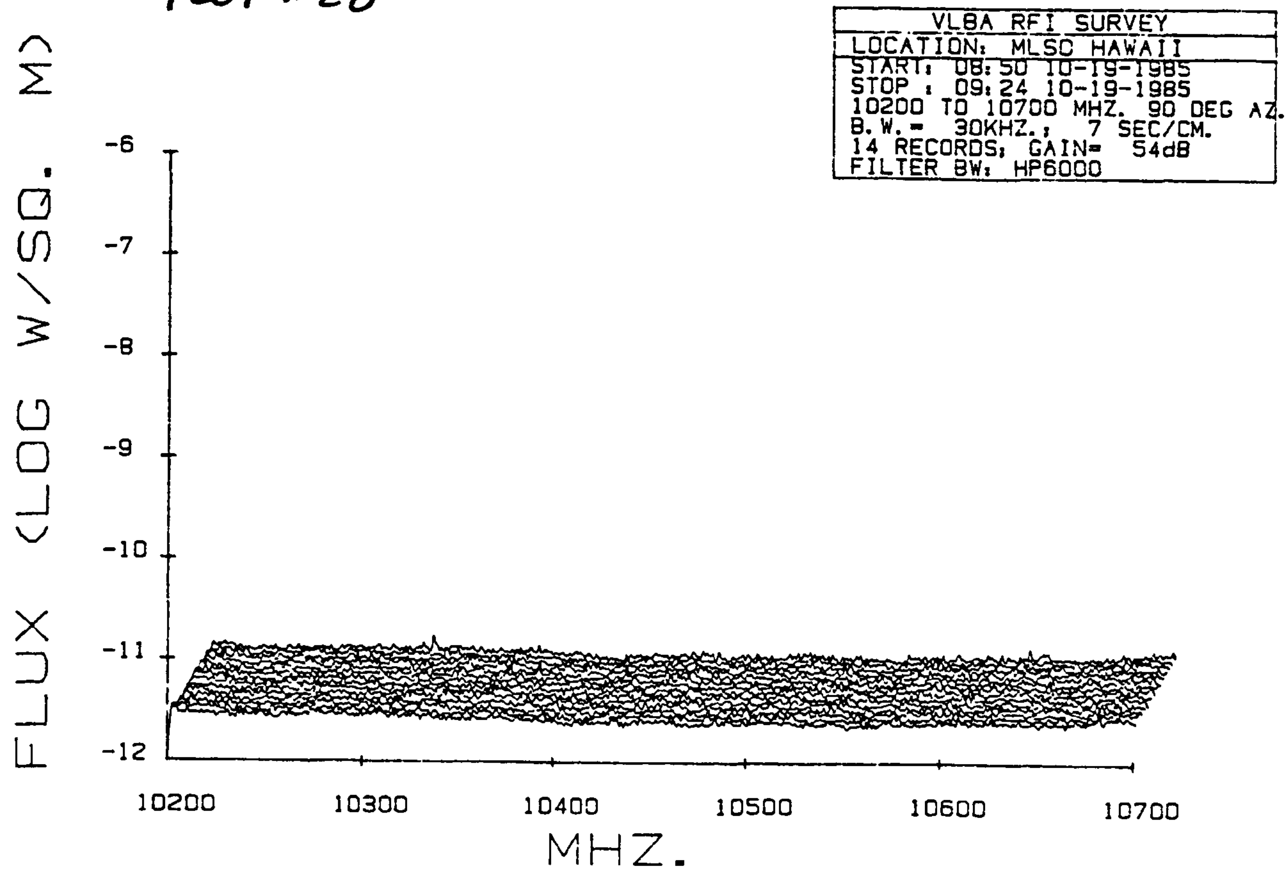
PLOT #25



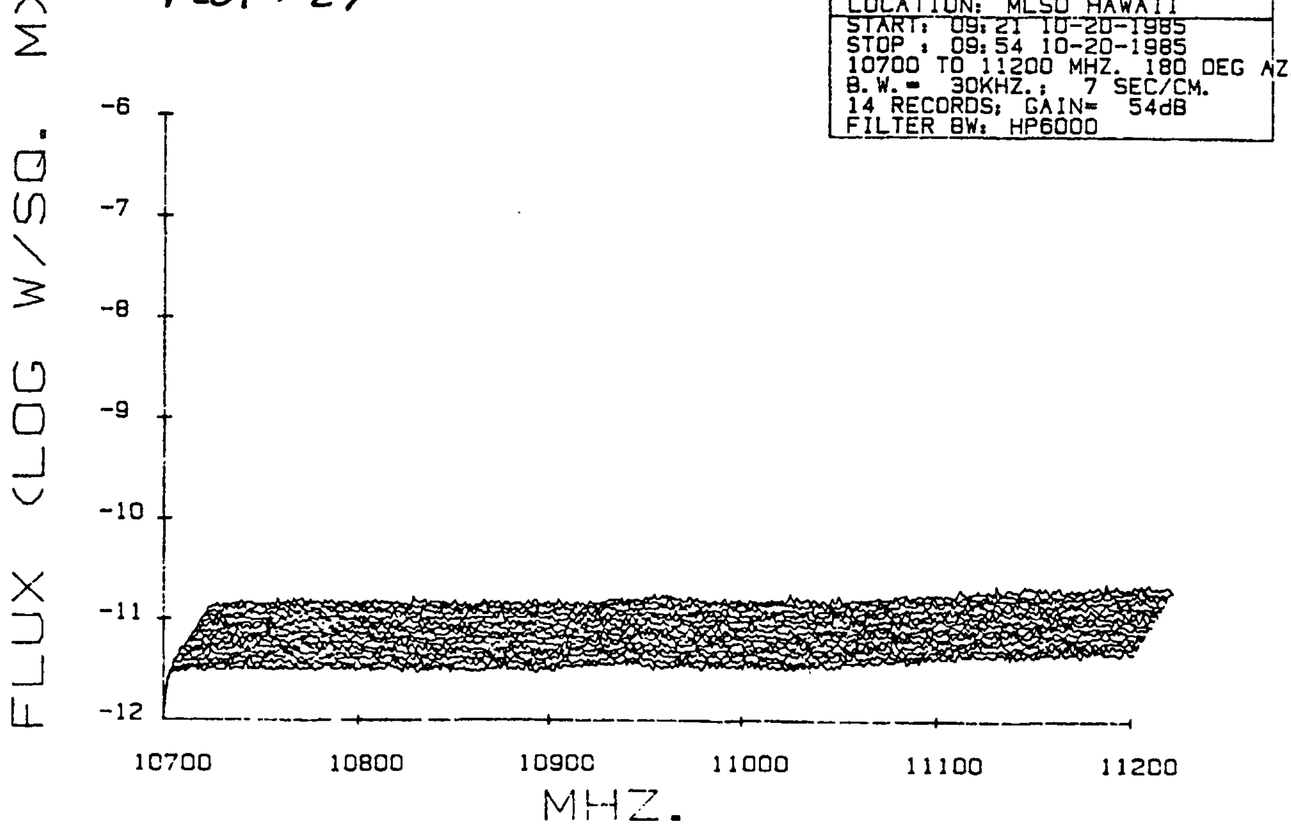

PLOT # 26
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 11:36 10-18-1985
STOP : 12:42 10-18-1985
7900 TO 8400 MHZ. 270 DEG AZ.
B.W. = 30KHZ.: 7 SEC/CM.
14 RECORDS; GAIN= 57dB
FILTER BW: HP6000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
8094
8194
7900
8000
8100
8200
8300
8400
MHZ.

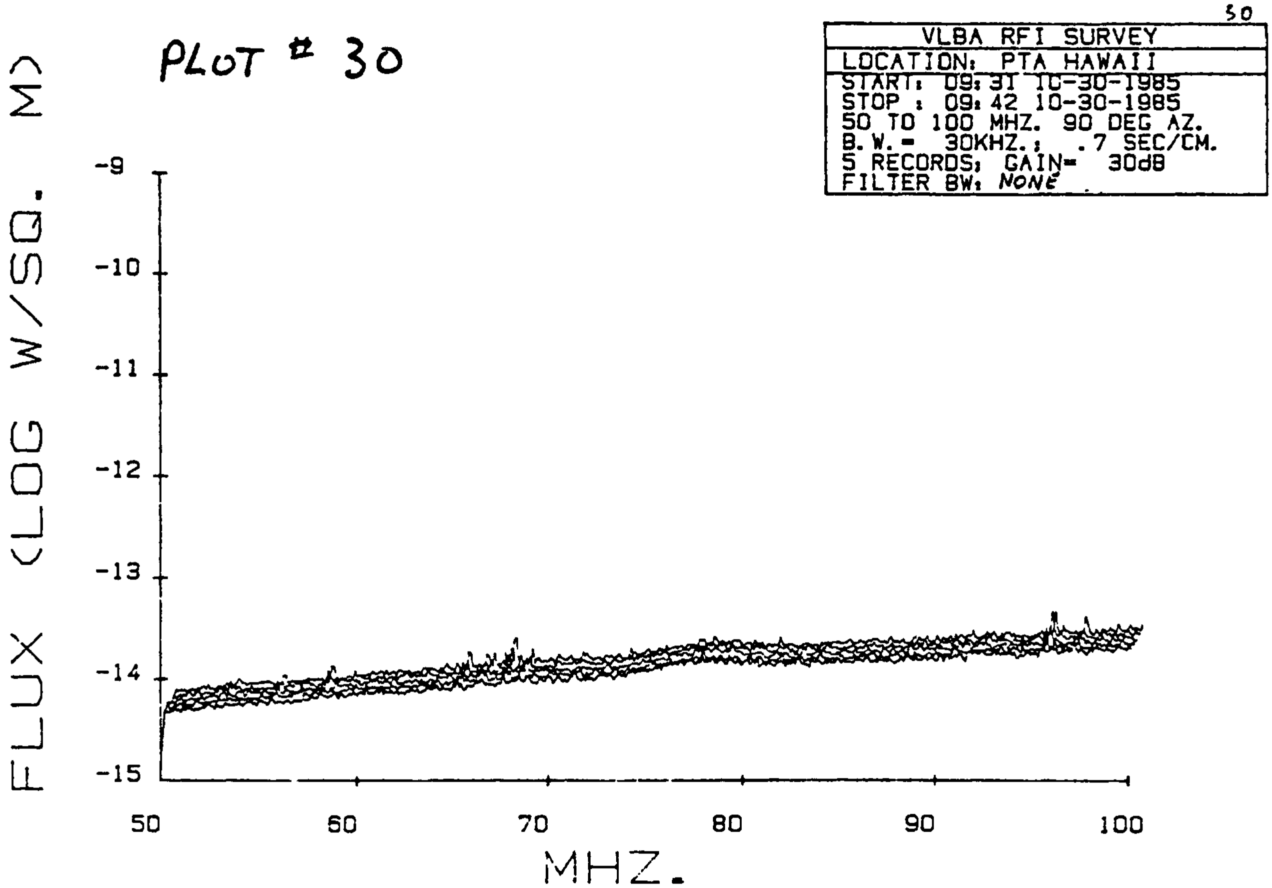

PLOT # 27
VLBA RFI SURVEY
LOCATION: MLSO HAWAII
START: 15:46 10-18-1985
STOP : 16:20 10-18-1985
8400 TO 8900 MHZ. 270 DEG AZ.
B.W. = 30KHZ.: 7 SEC/CM.
14 RECORDS; GAIN= 57dB
FILTER BW: HP6000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
8400
8500
8600
8700
8800
8900
MHZ.

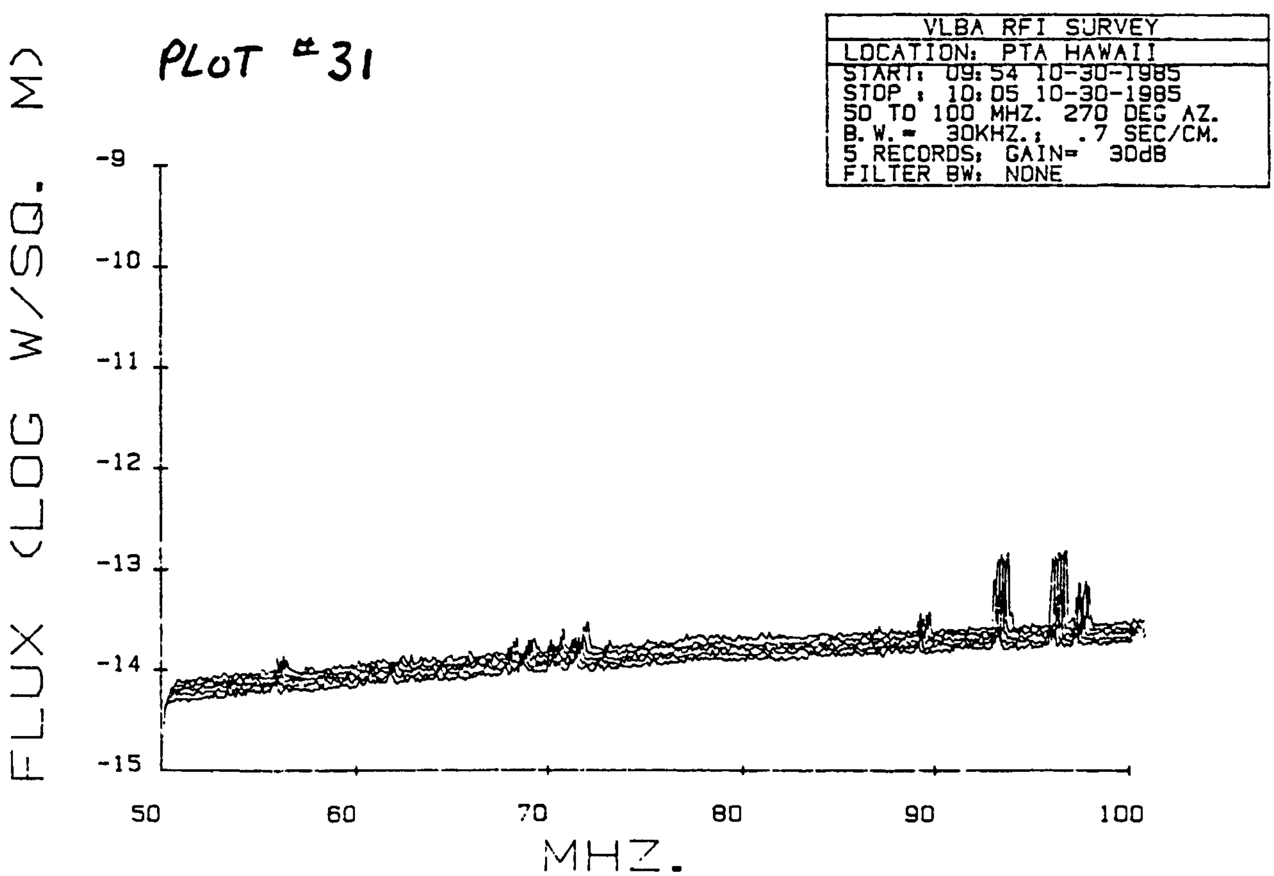
PLOT #28



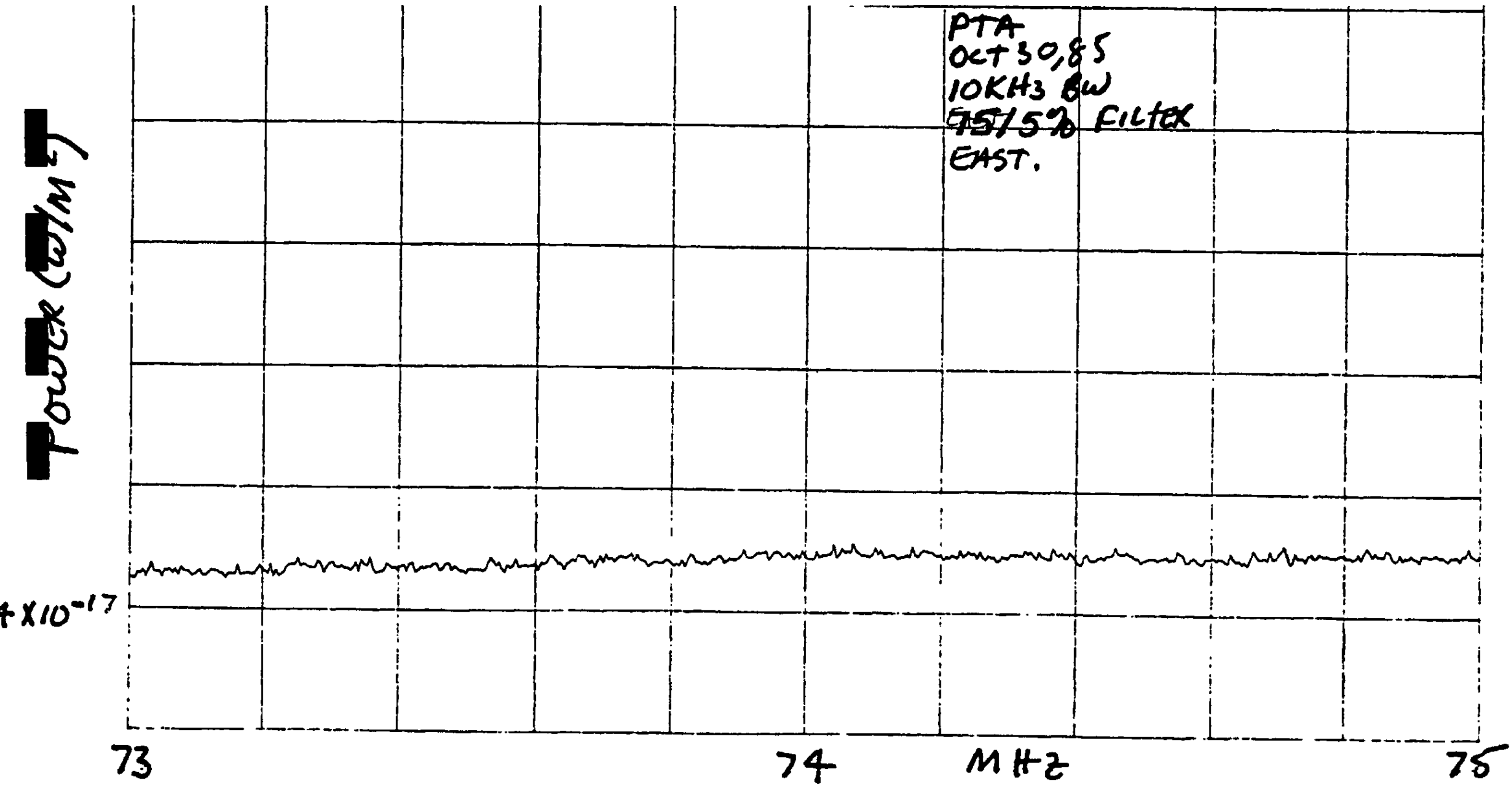
PLOT #29



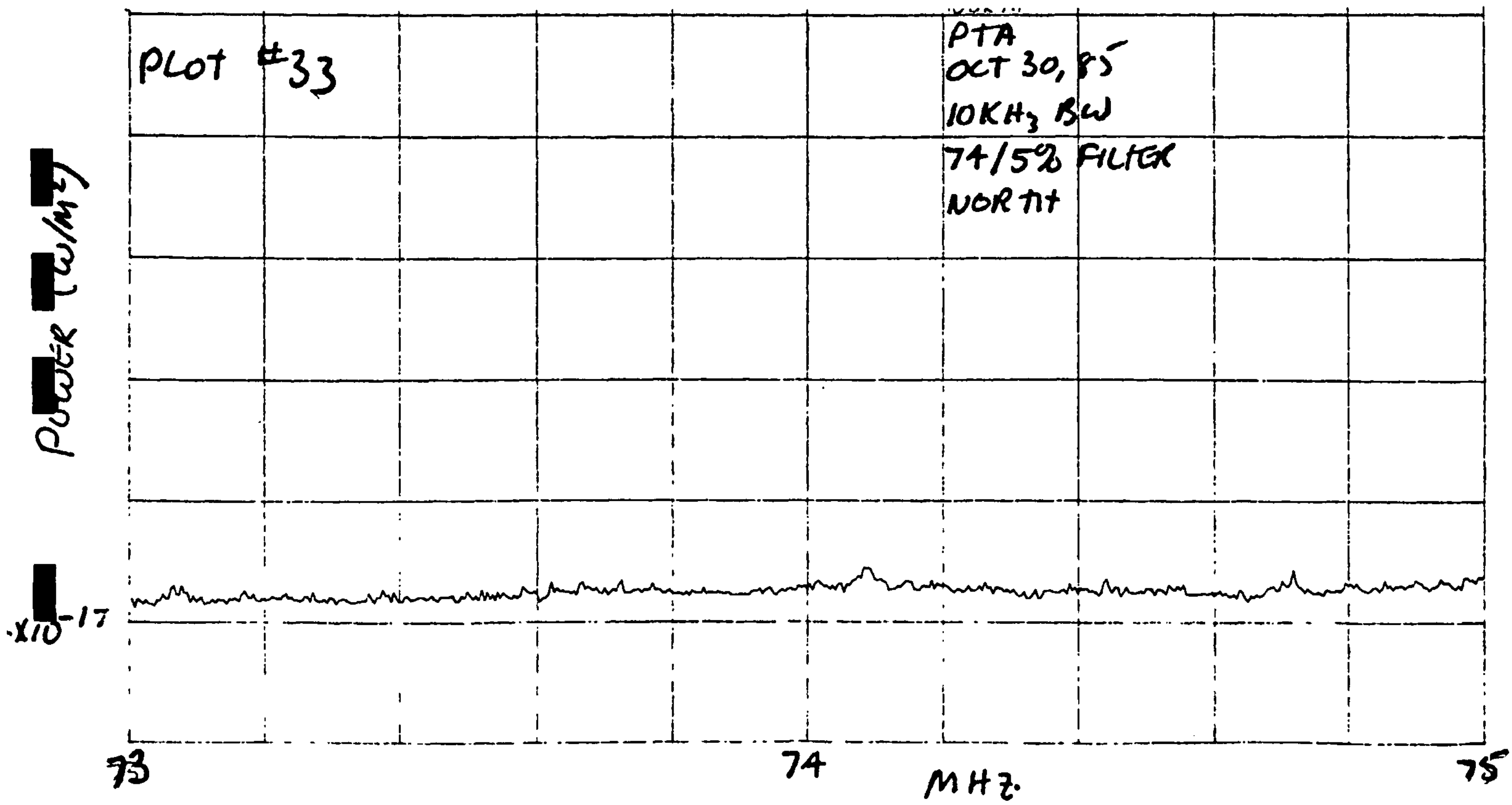

PLOT # 30
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 09:31 10-30-1985
STOP : 09:42 10-30-1985
50 TO 100 MHZ. 90 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
5 RECORDS; GAIN= 30dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-9
-10
-11
-12
-13
-14
-15
50
60
70
80
90
100
MHZ.


PLOT # 31
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 09:54 10-30-1985
STOP : 10:05 10-30-1985
50 TO 100 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; .7 SEC/CM.
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 #32



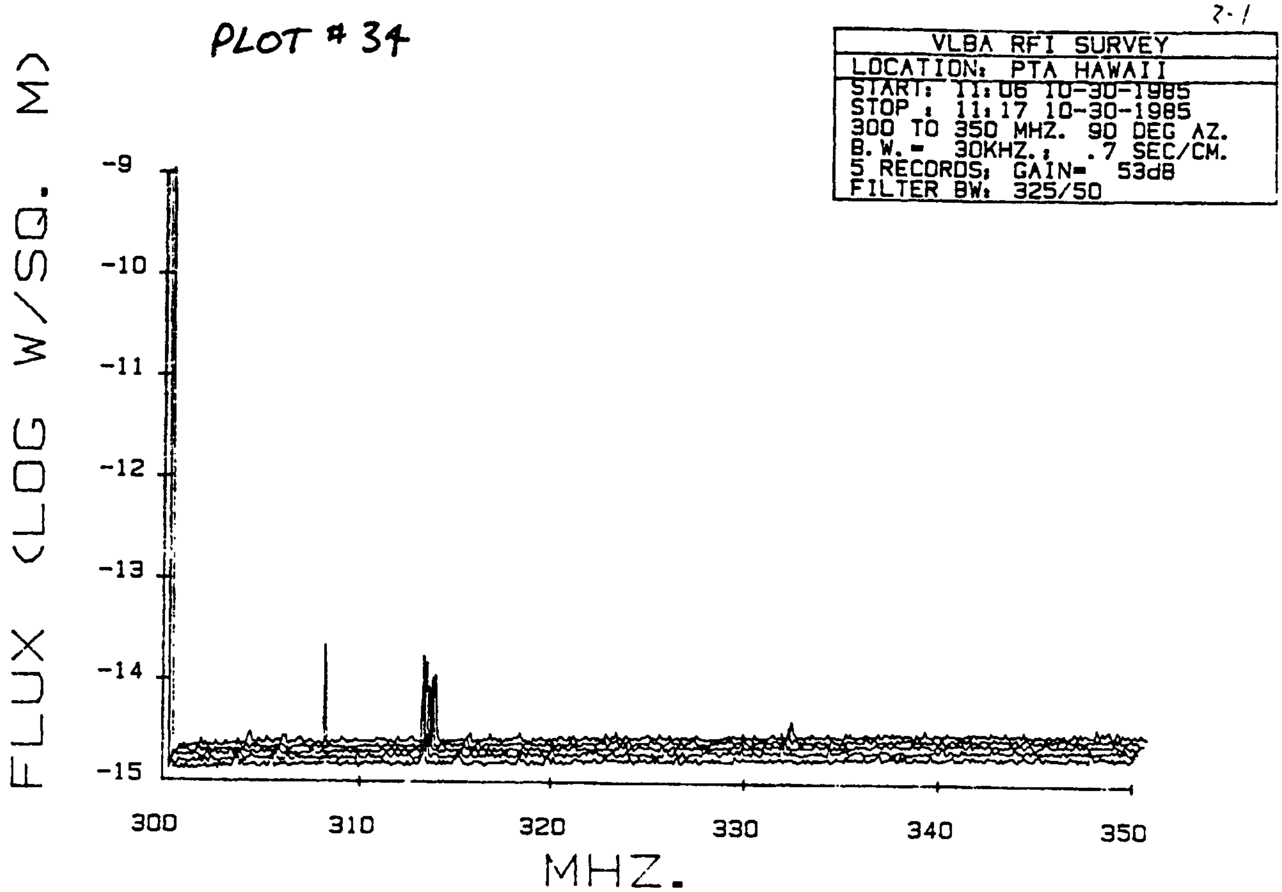
PTA
OCT 30, 85
10KHz BW
75/5% FILTER
EAST.
[redacted] POWER [redacted] (W/M²)
X10-17
73
74
MHz
75



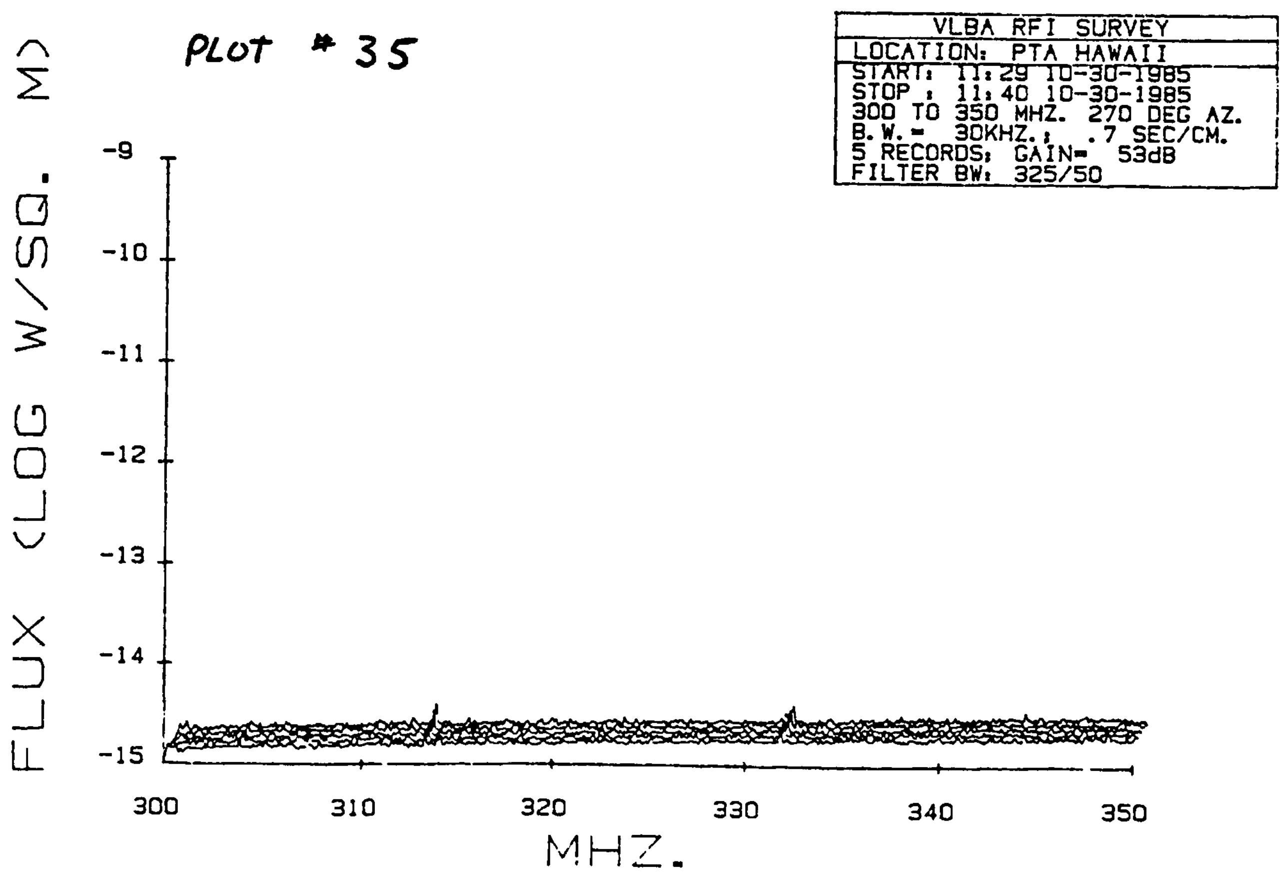
PLOT #33
PTA
OCT 30, 85
10KHz BW
74/5% FILTER
NORTH
POWER [redacted] (W/M²)
[redacted]
X10-17
73
74
MHz.
75

2-1

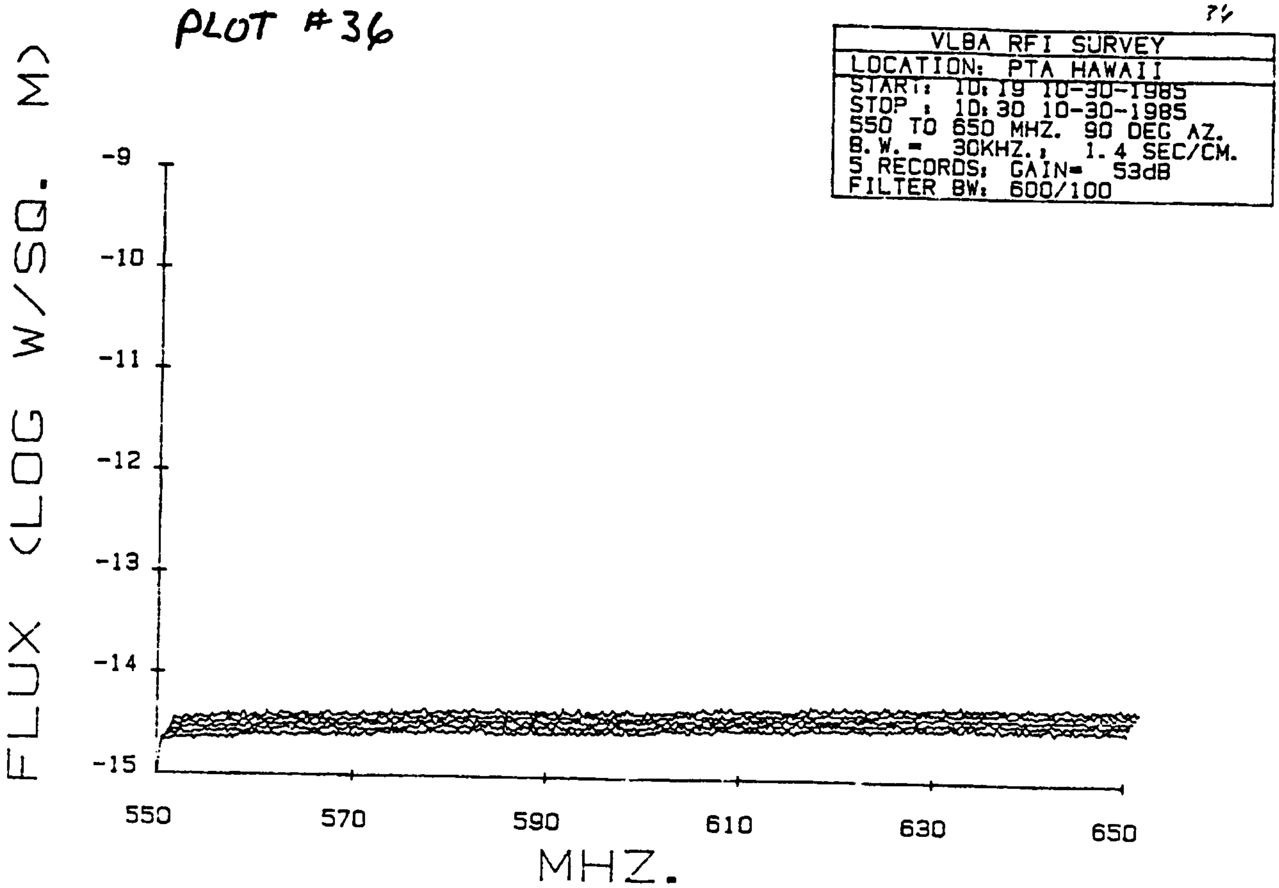
PLOT # 34



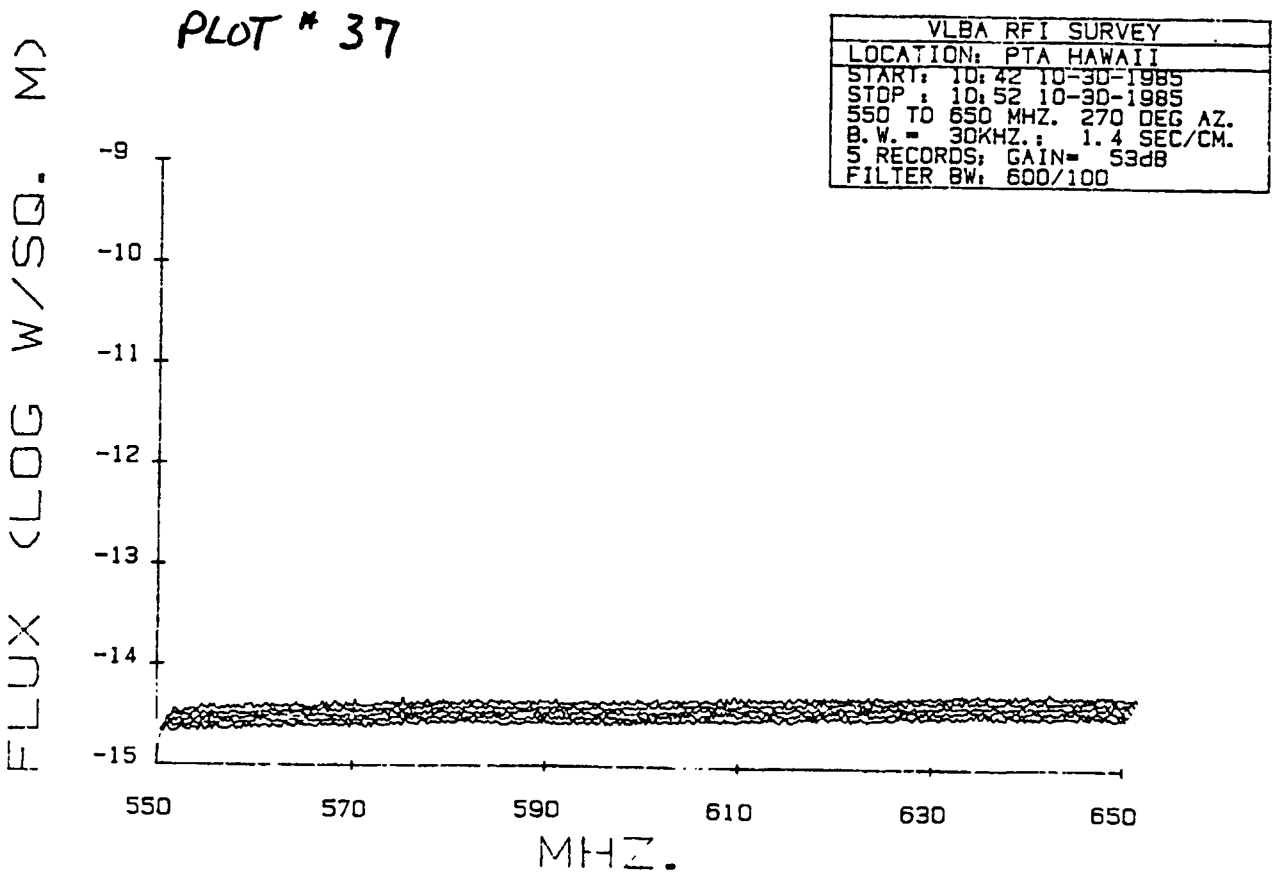
PLOT # 35



PLOT #36

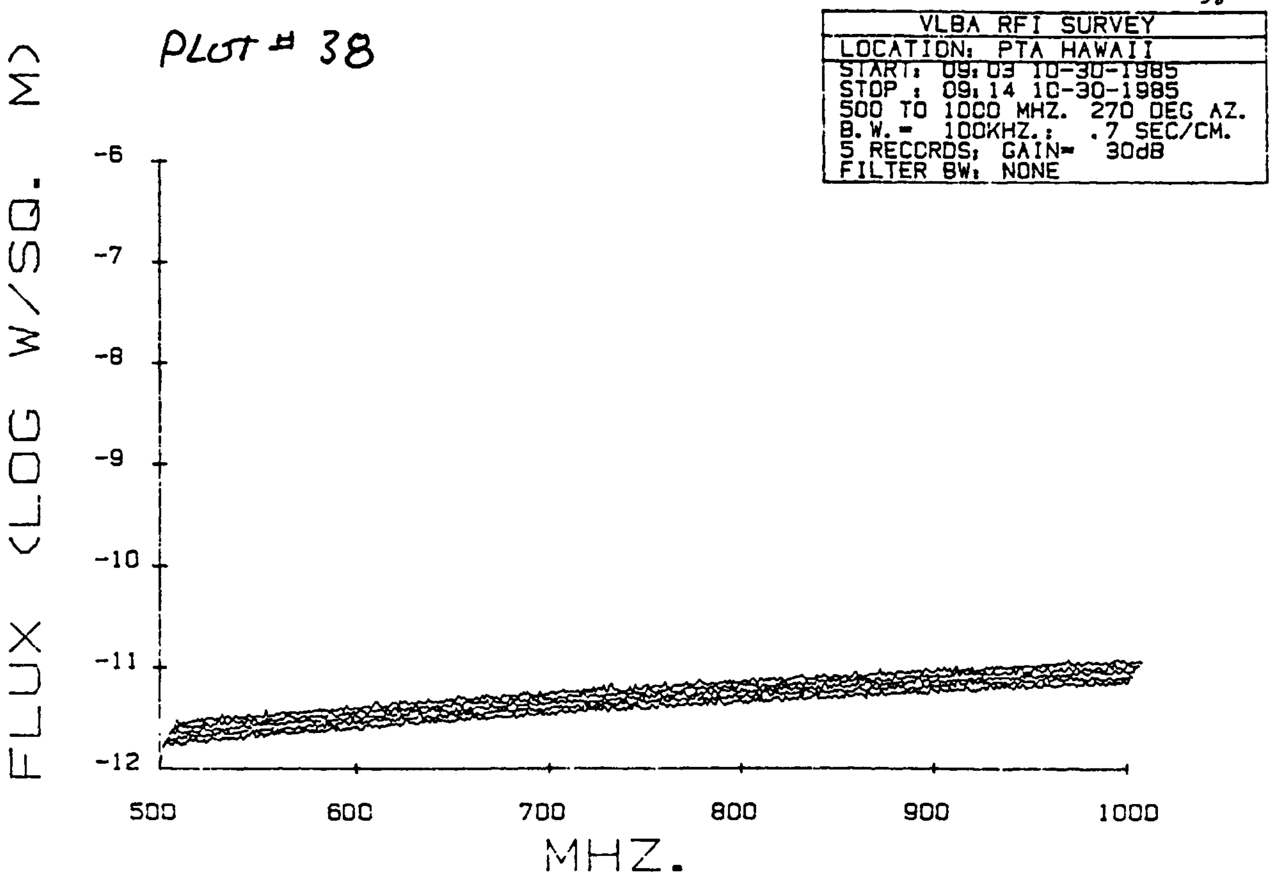


PLOT # 37

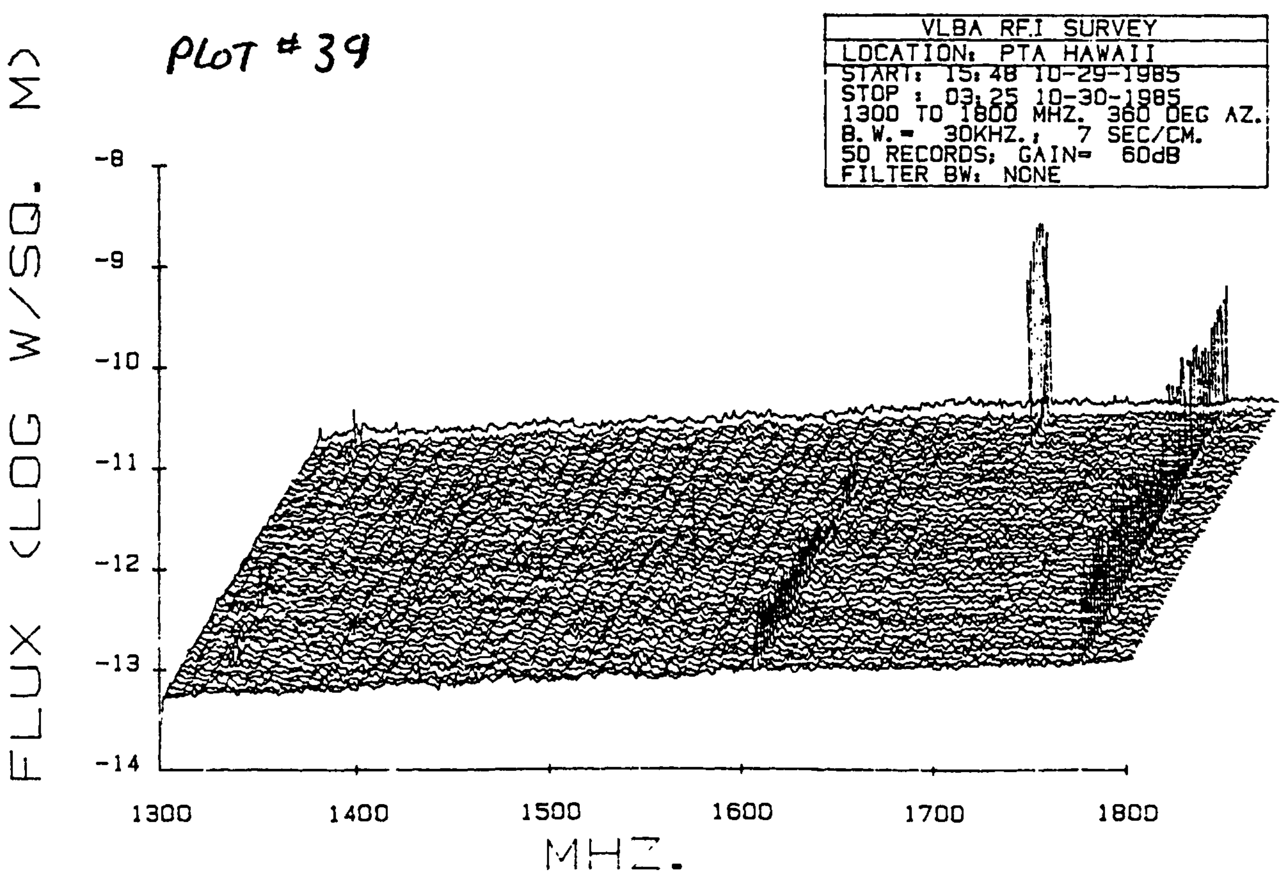


38

PLOT # 38

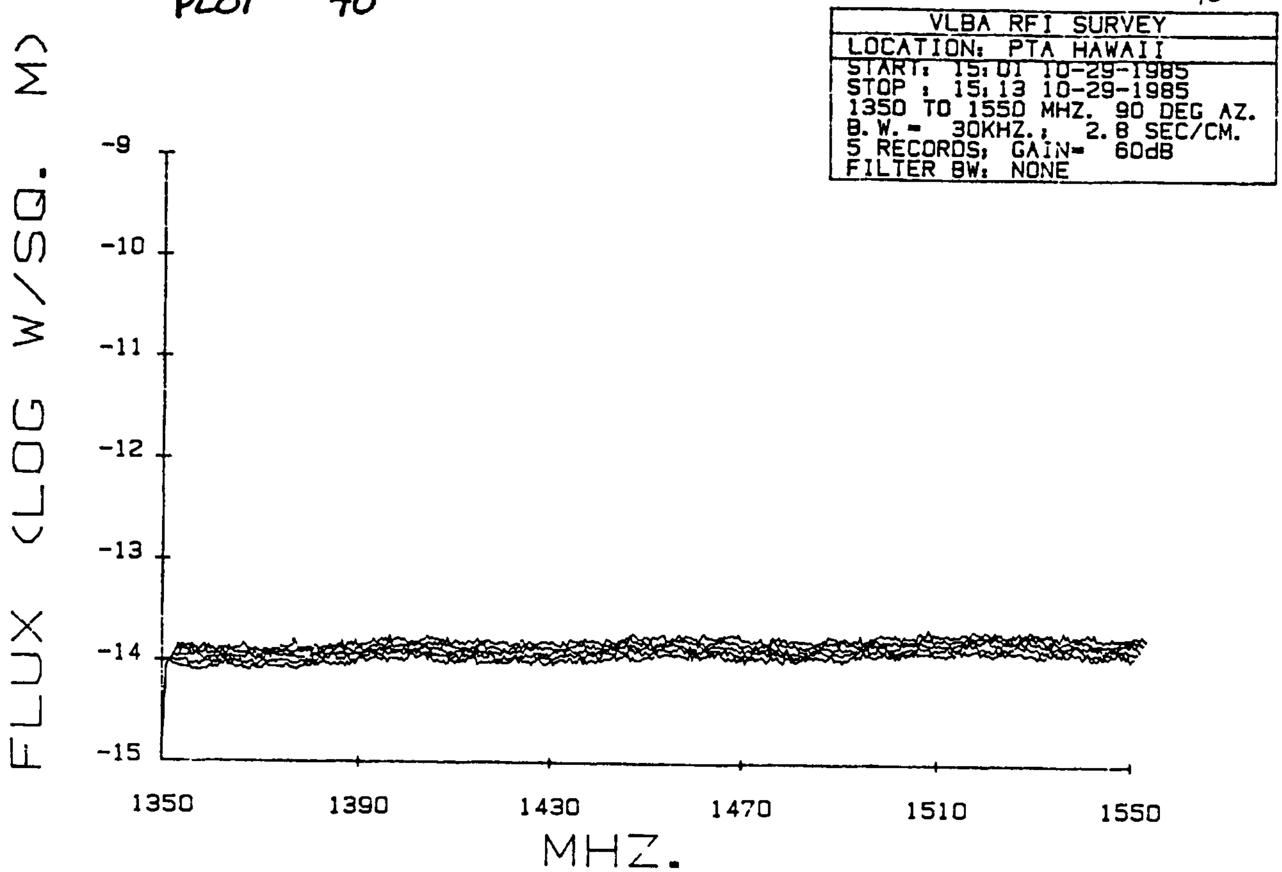


PLOT # 39

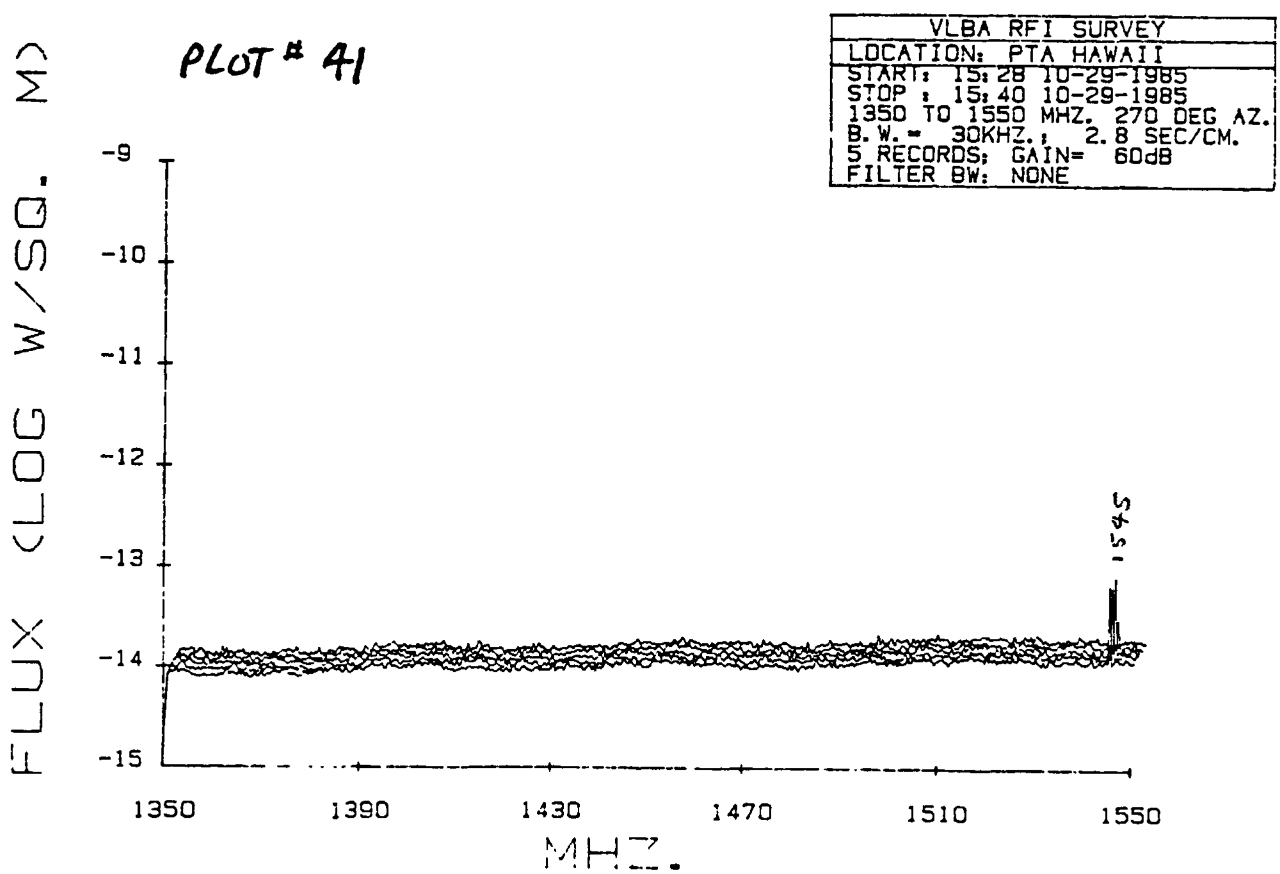


PLOT #40

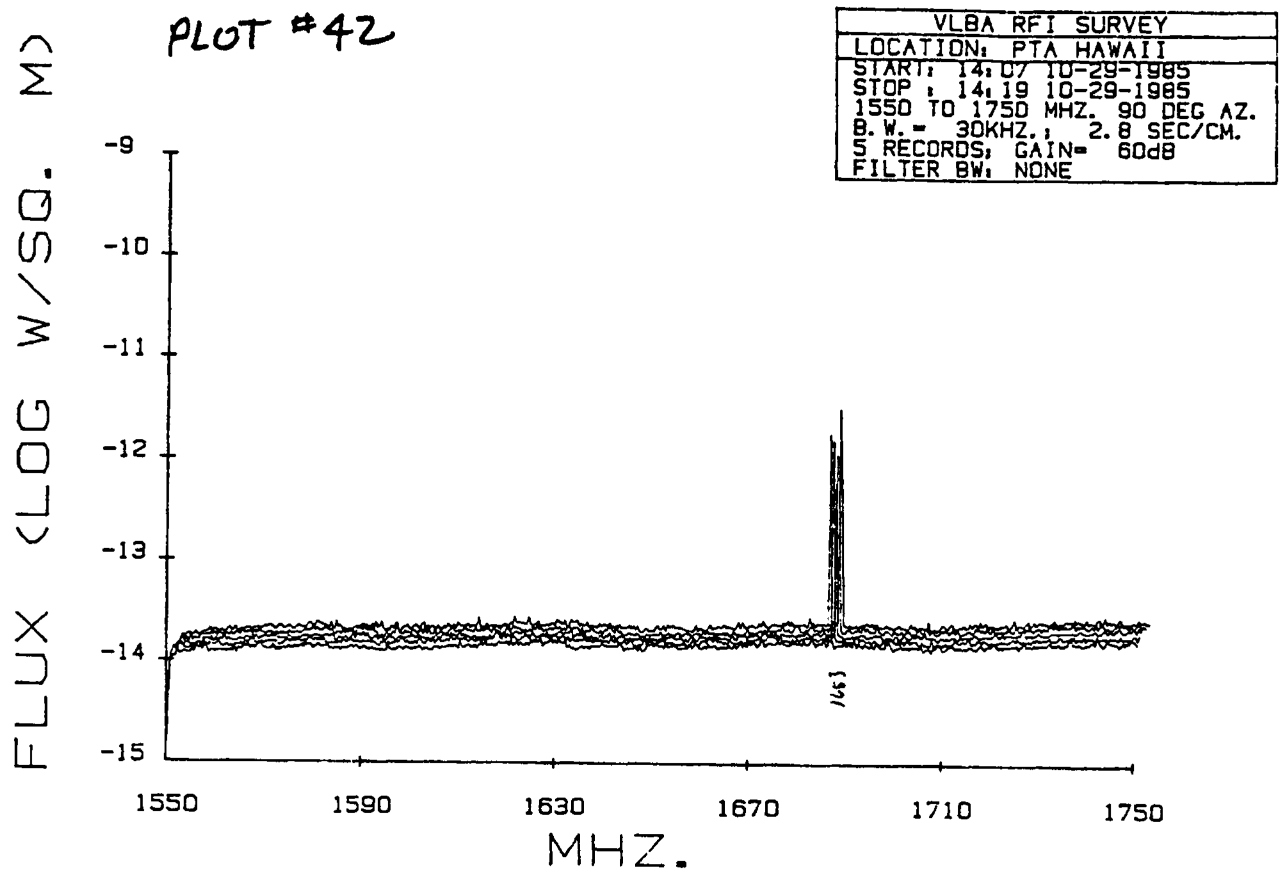
40



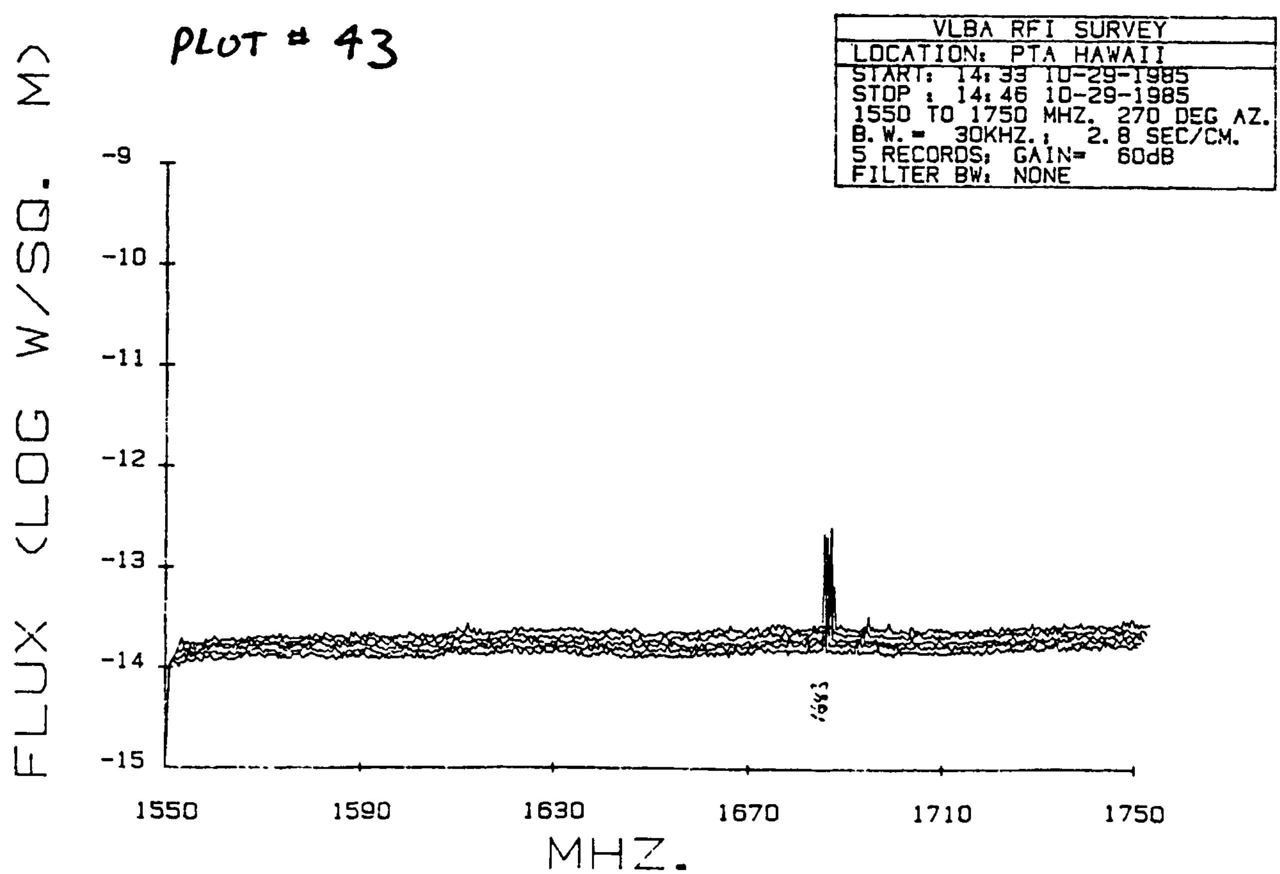
PLOT # 41



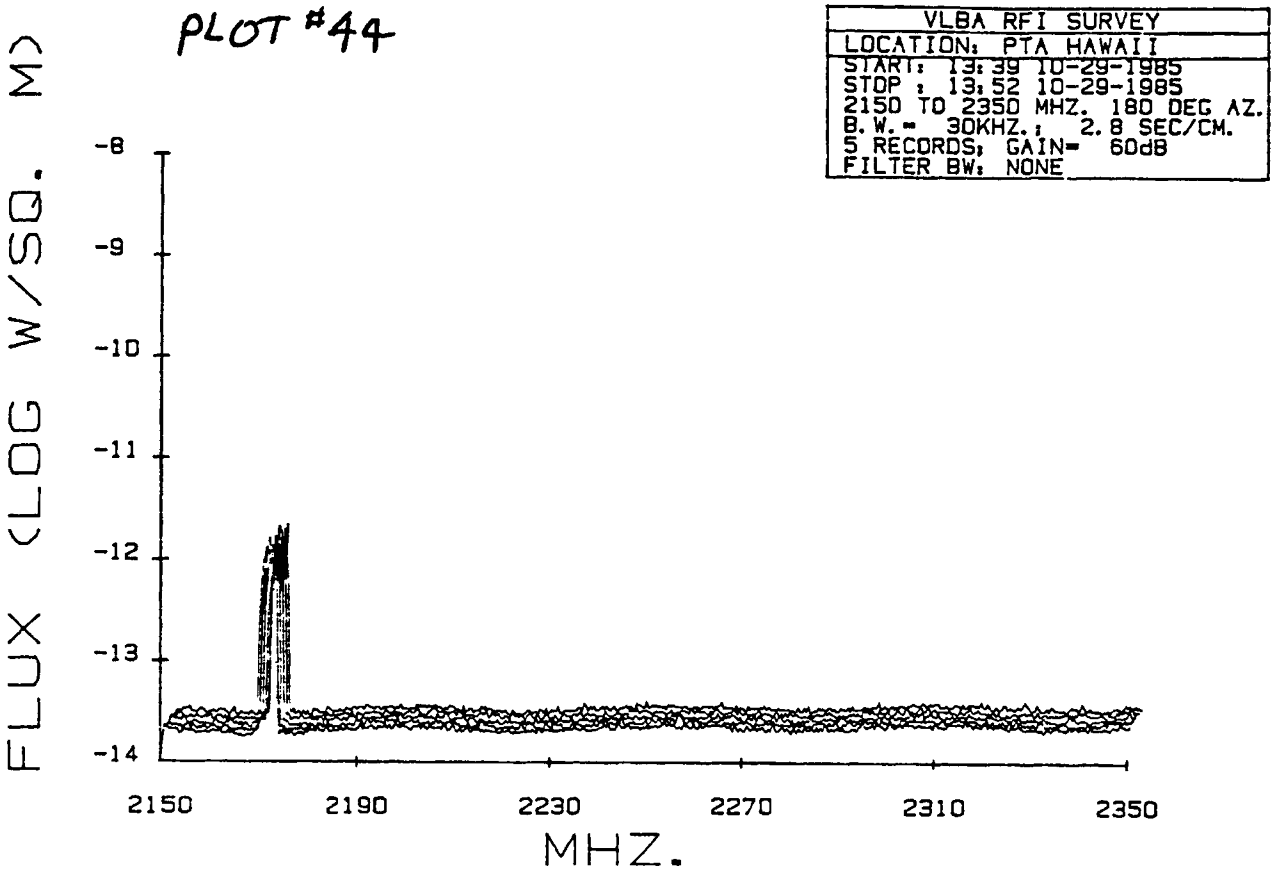
PLOT #42



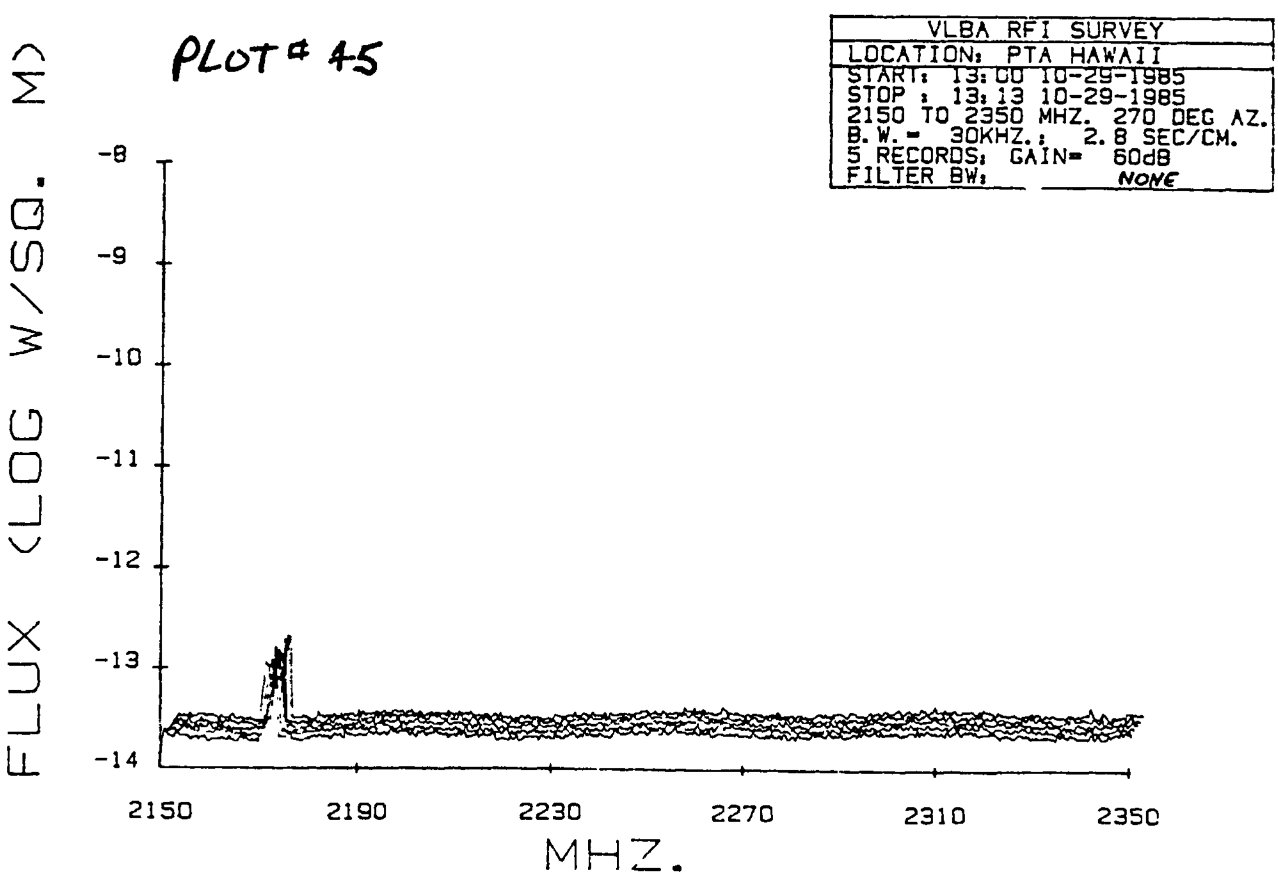
PLOT # 43

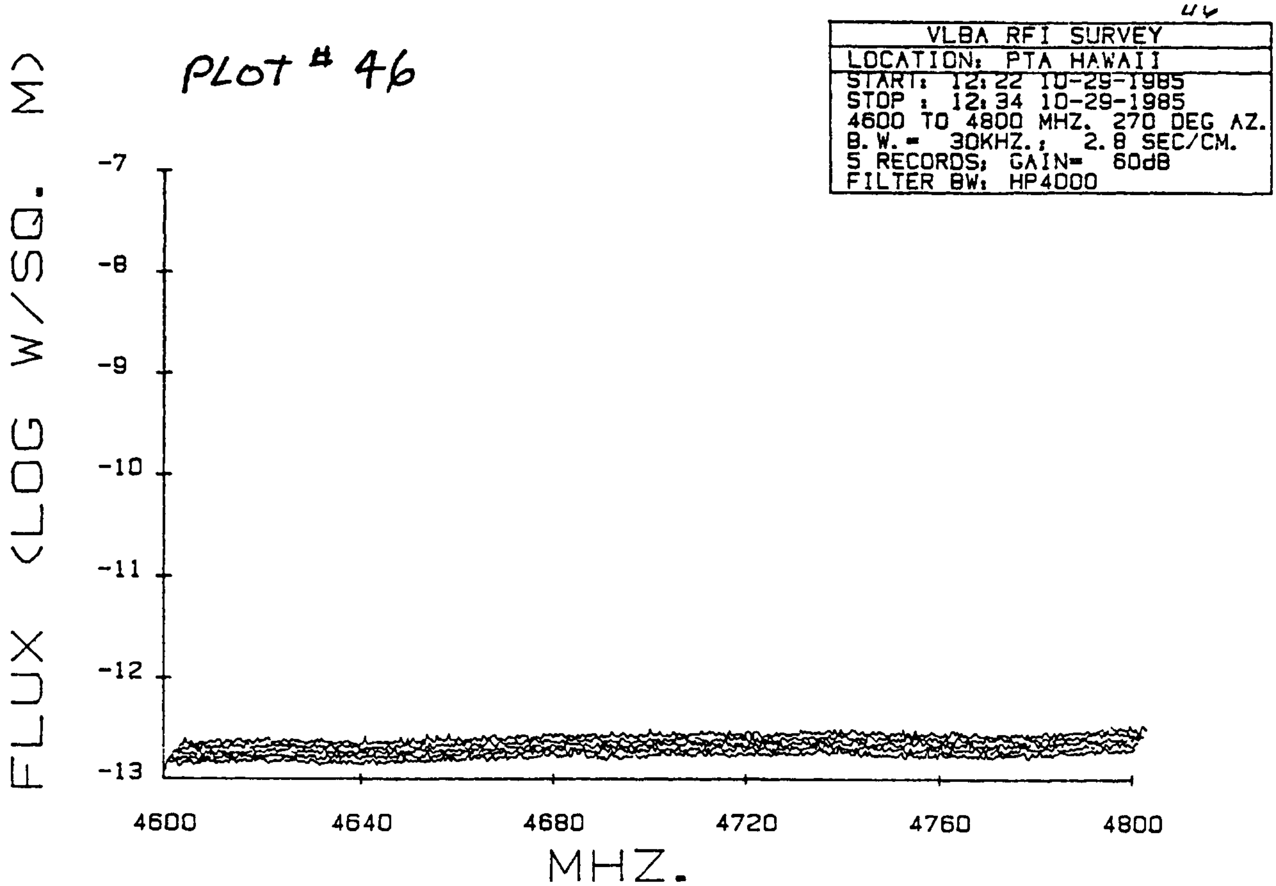


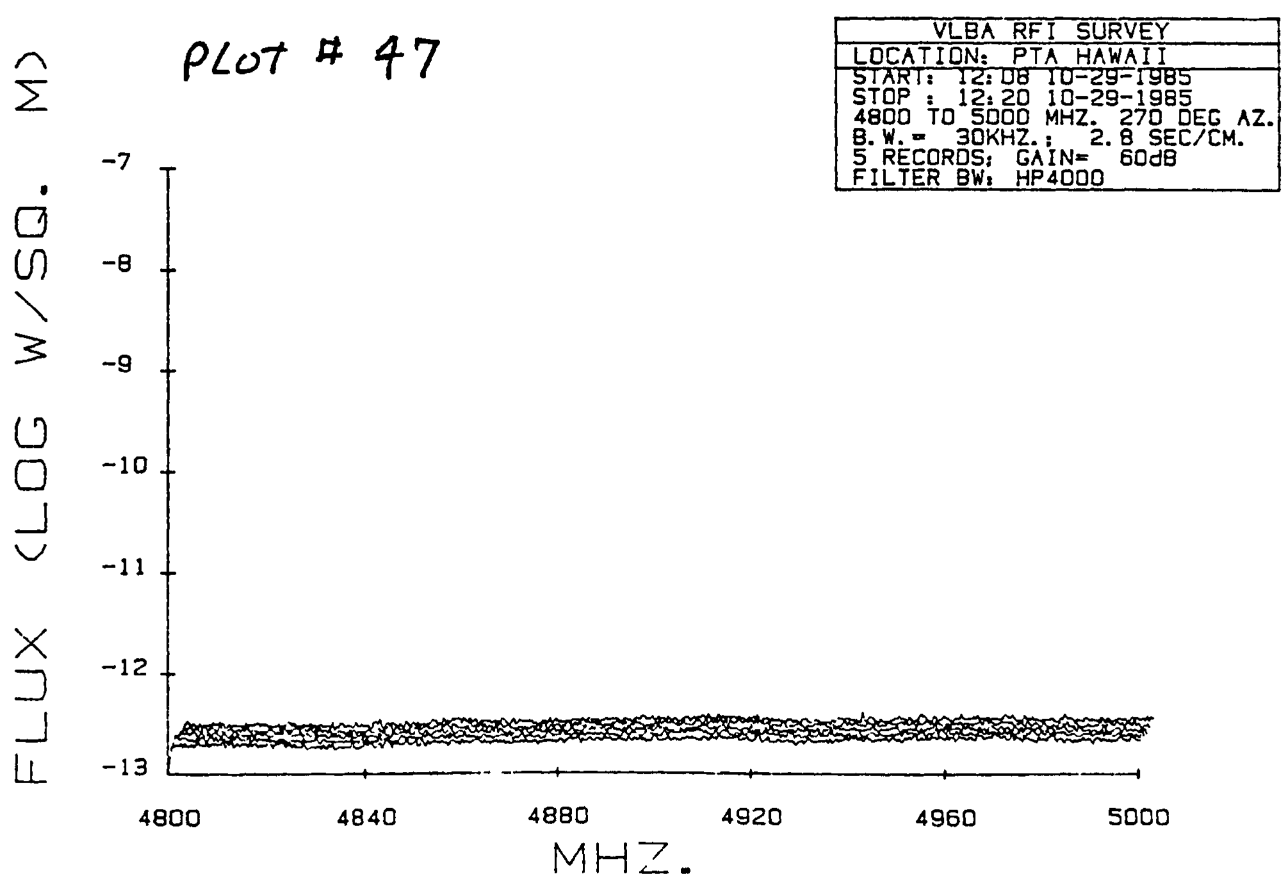
PLOT #44

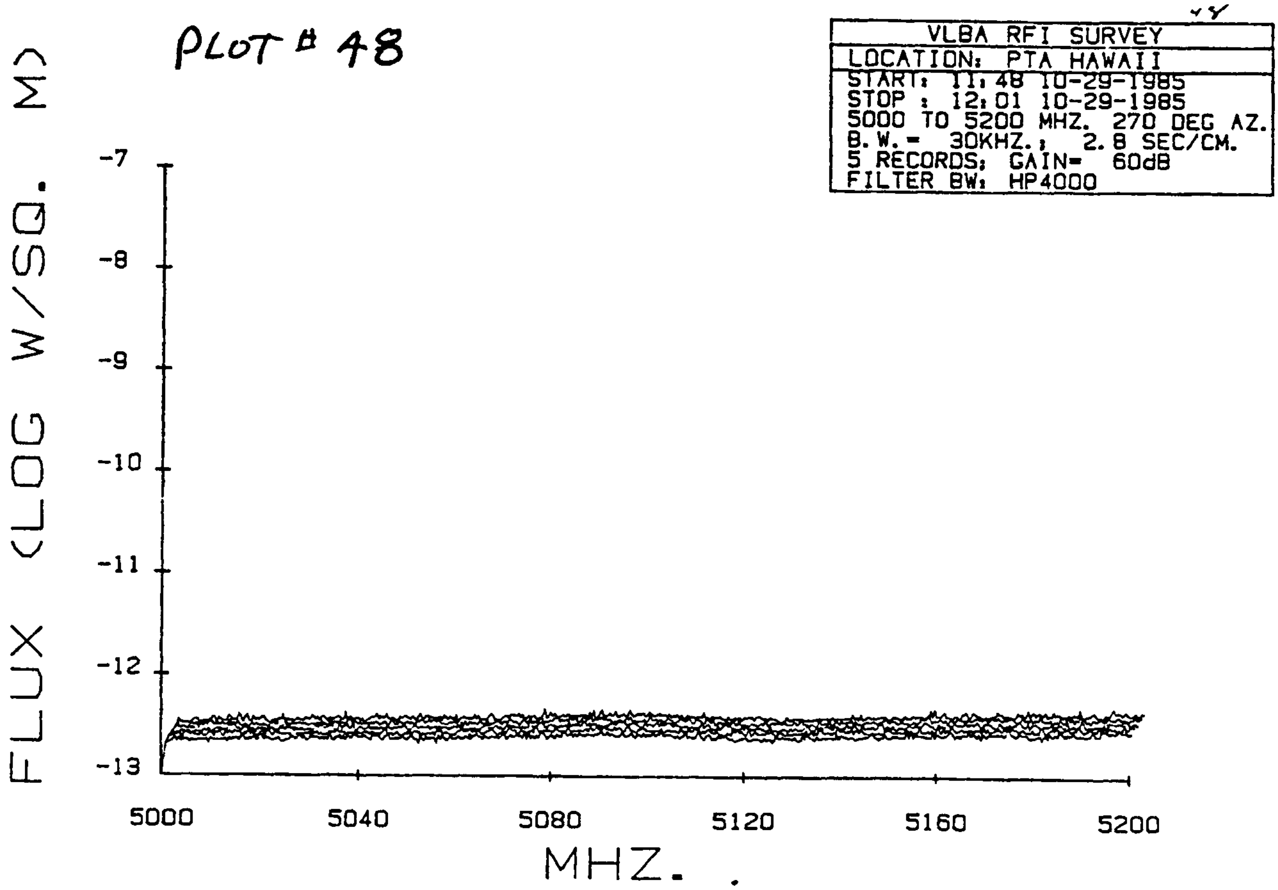


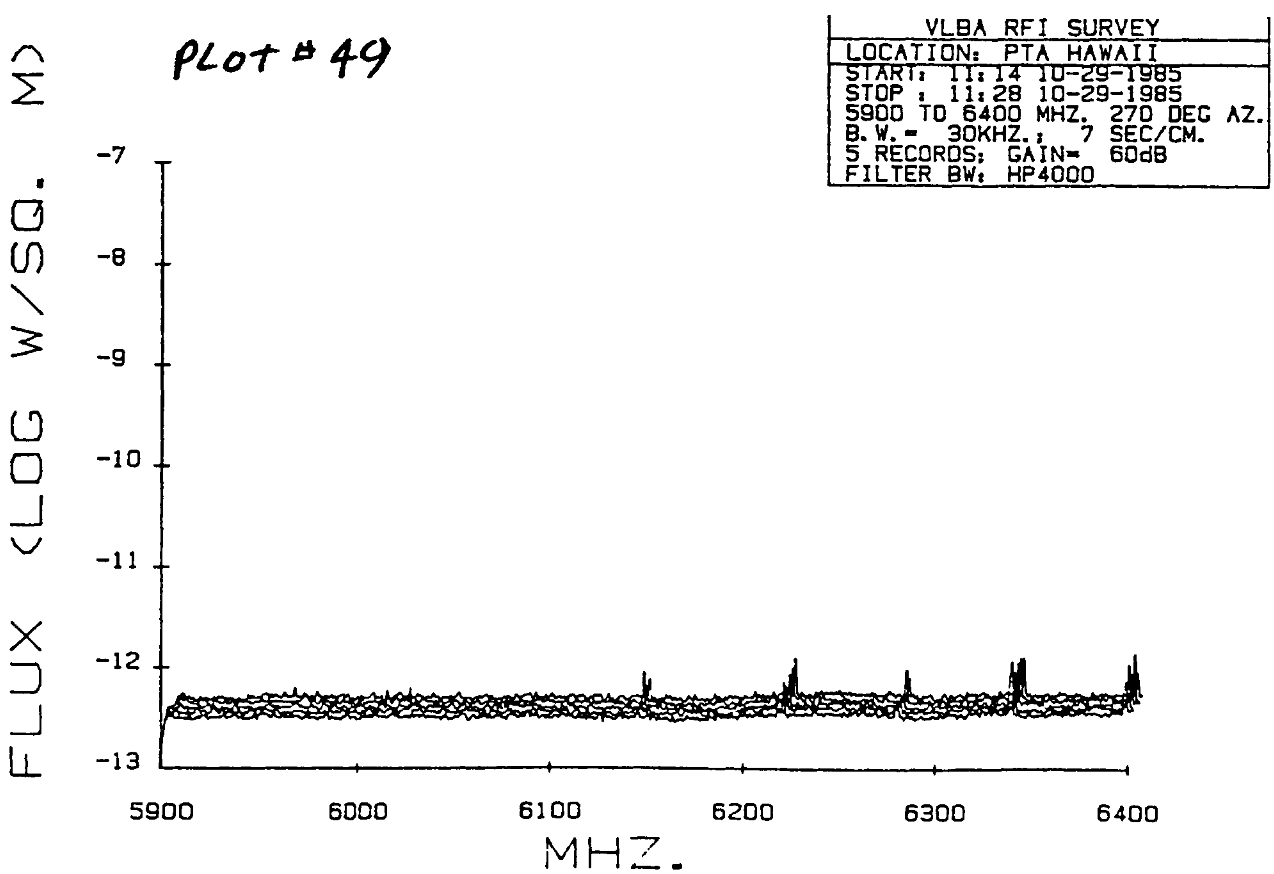
PLOT # 45



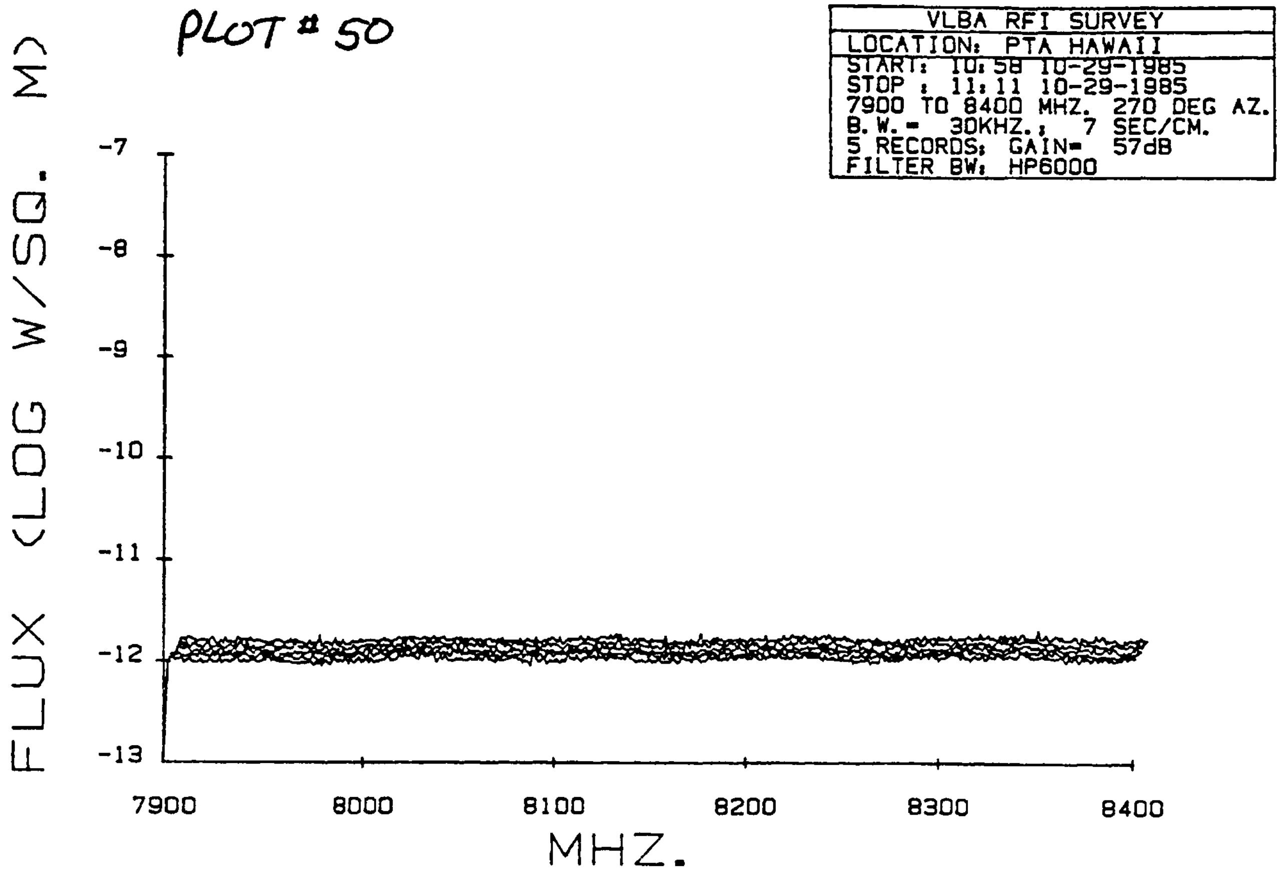

PLOT # 46
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 12:22 10-29-1985
STOP : 12:34 10-29-1985
4600 TO 4800 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
4600
4640
4680
4720
4760
4800
MHZ.


PLOT # 47
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 12:08 10-29-1985
STOP : 12:20 10-29-1985
4800 TO 5000 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
4800
4840
4880
4920
4960
5000
MHZ.

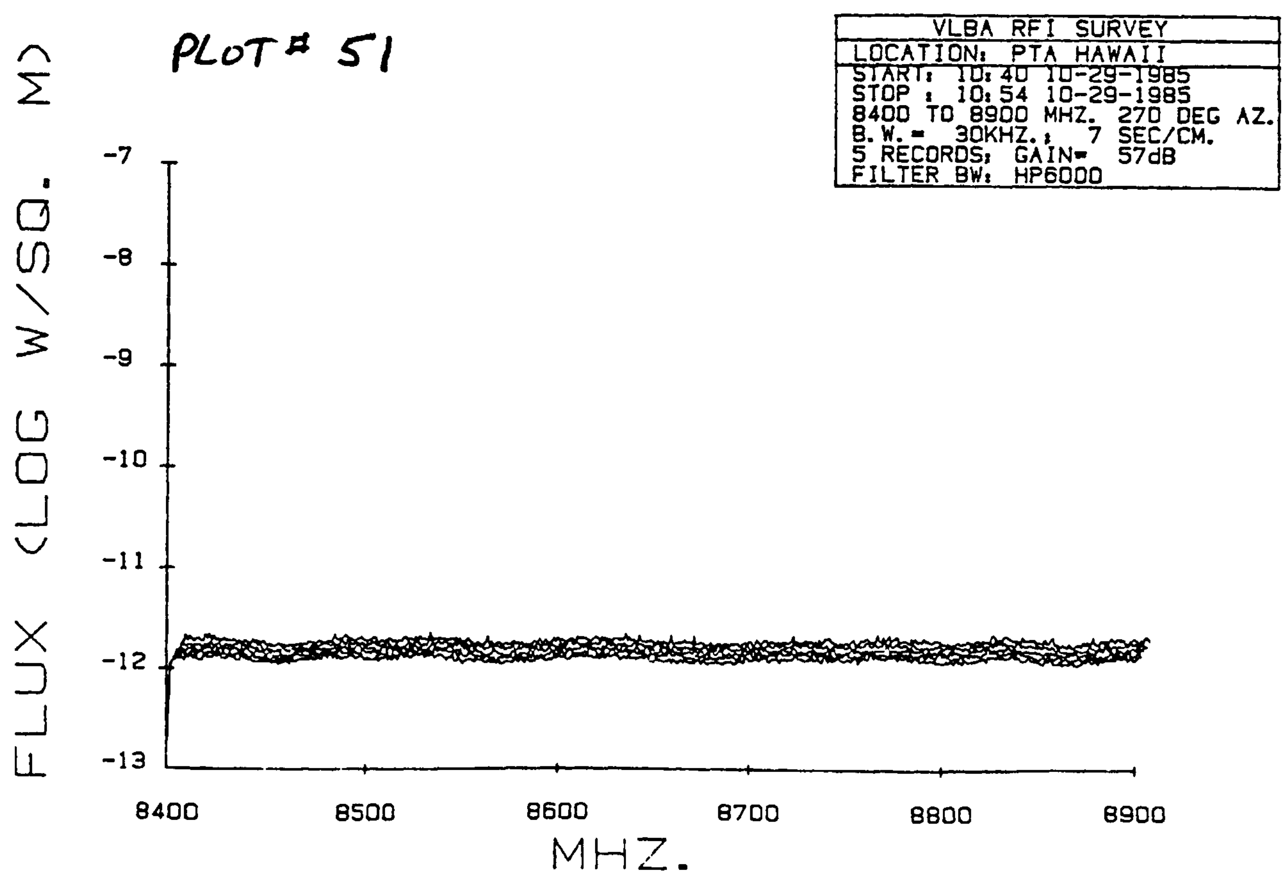

PLOT # 48
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 11:48 10-29-1985
STOP : 12:01 10-29-1985
5000 TO 5200 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 2.8 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
5000
5040
5080
5120
5160
5200
MHZ.


PLOT # 49
VLBA RFI SURVEY
LOCATION: PTA HAWAII
START: 11:14 10-29-1985
STOP : 11:28 10-29-1985
5900 TO 6400 MHZ. 270 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
5900
6000
6100
6200
6300
6400
MHZ.

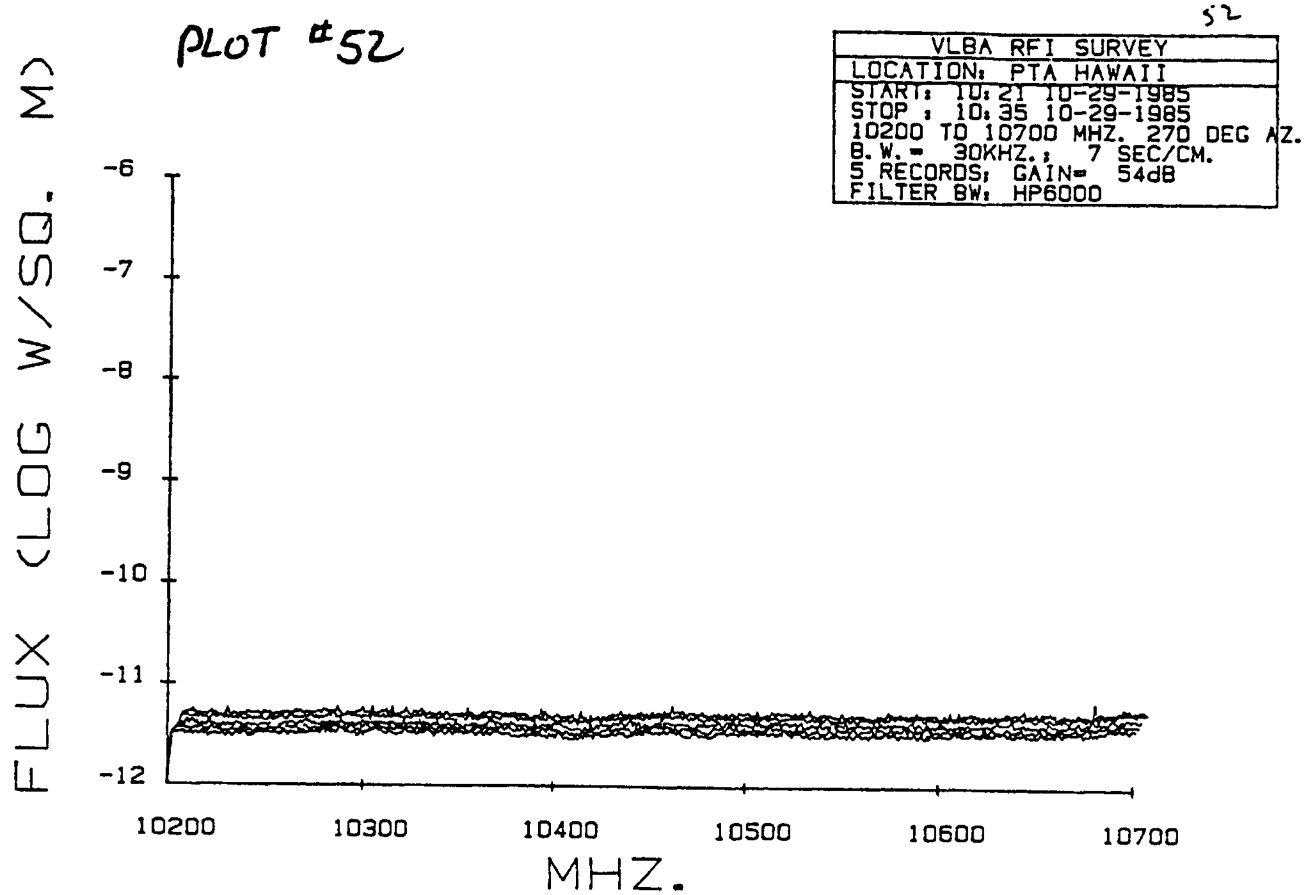
PLOT # 50



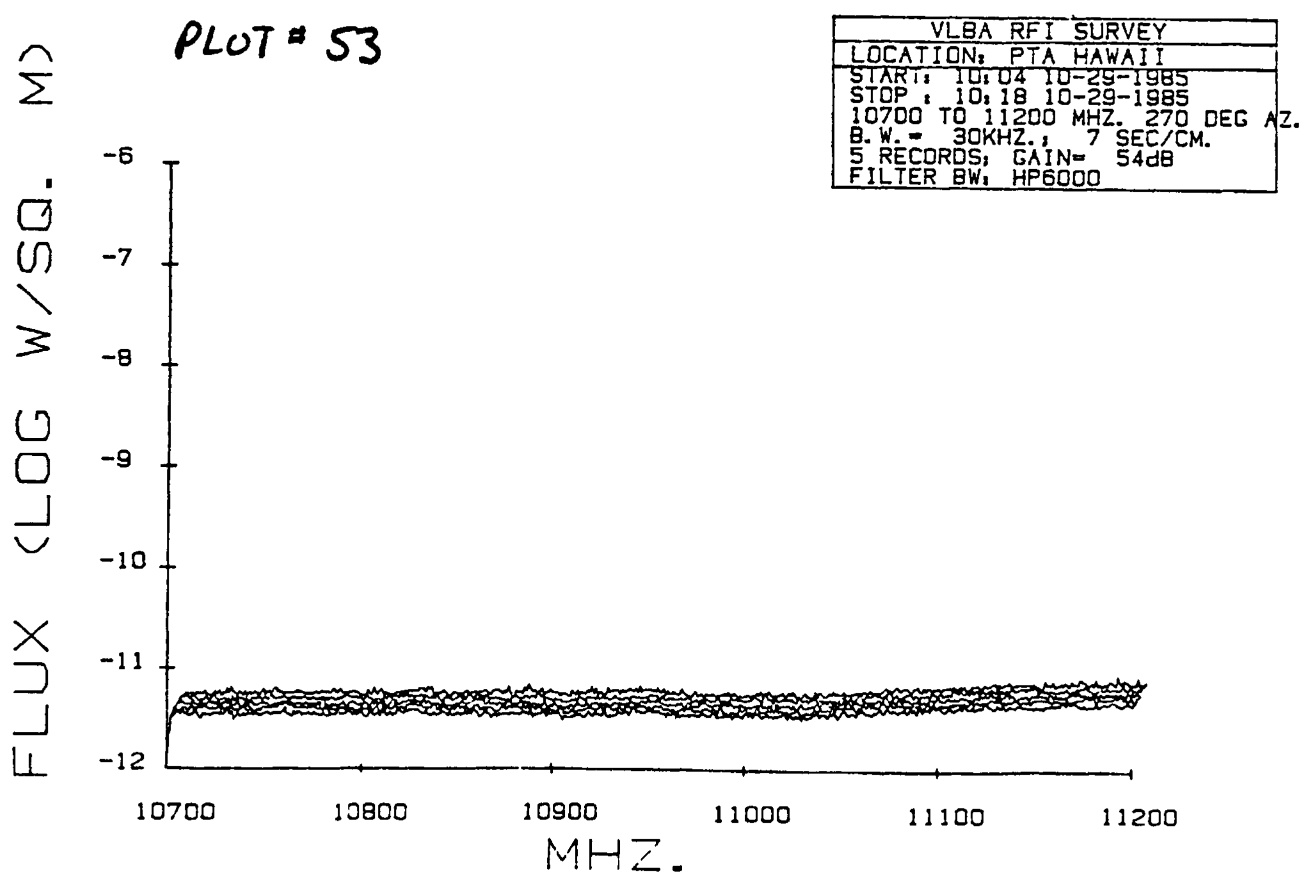
PLOT # 51



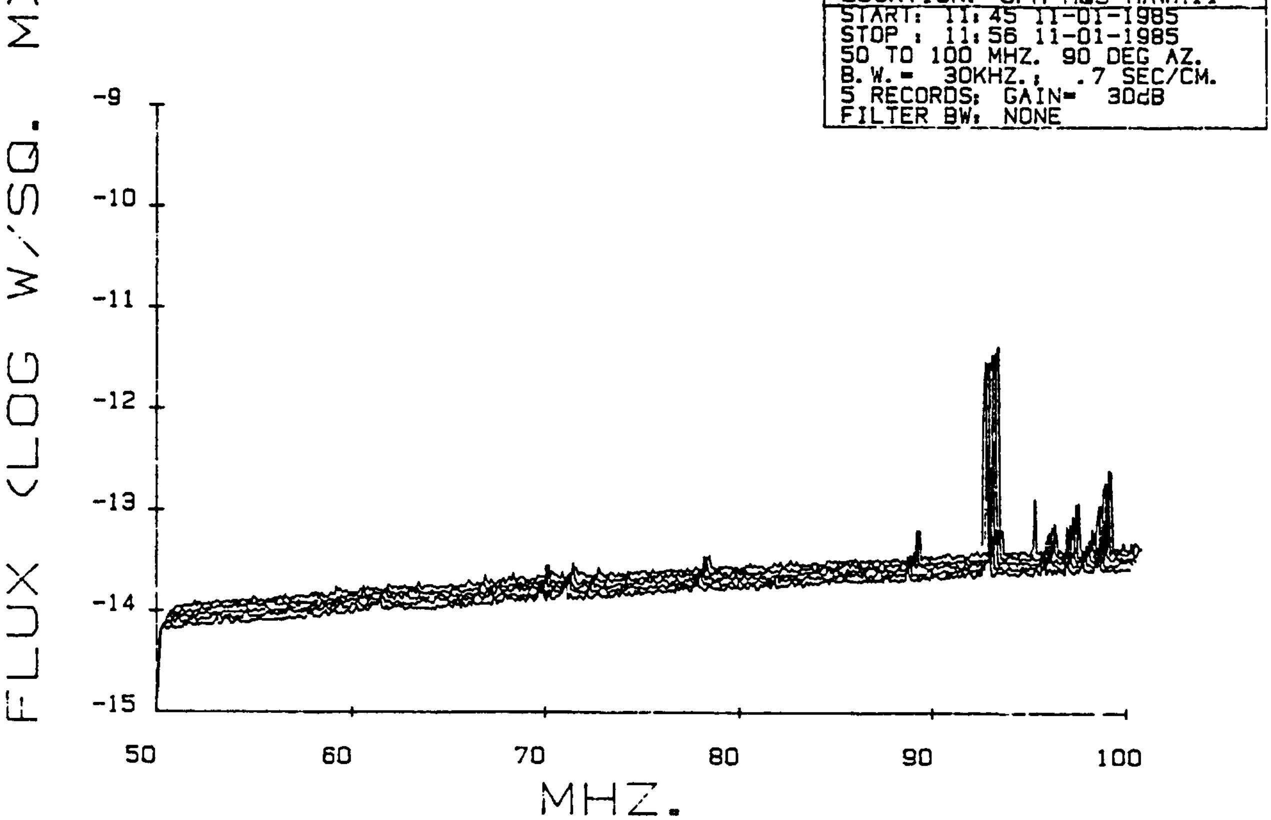
PLOT #52



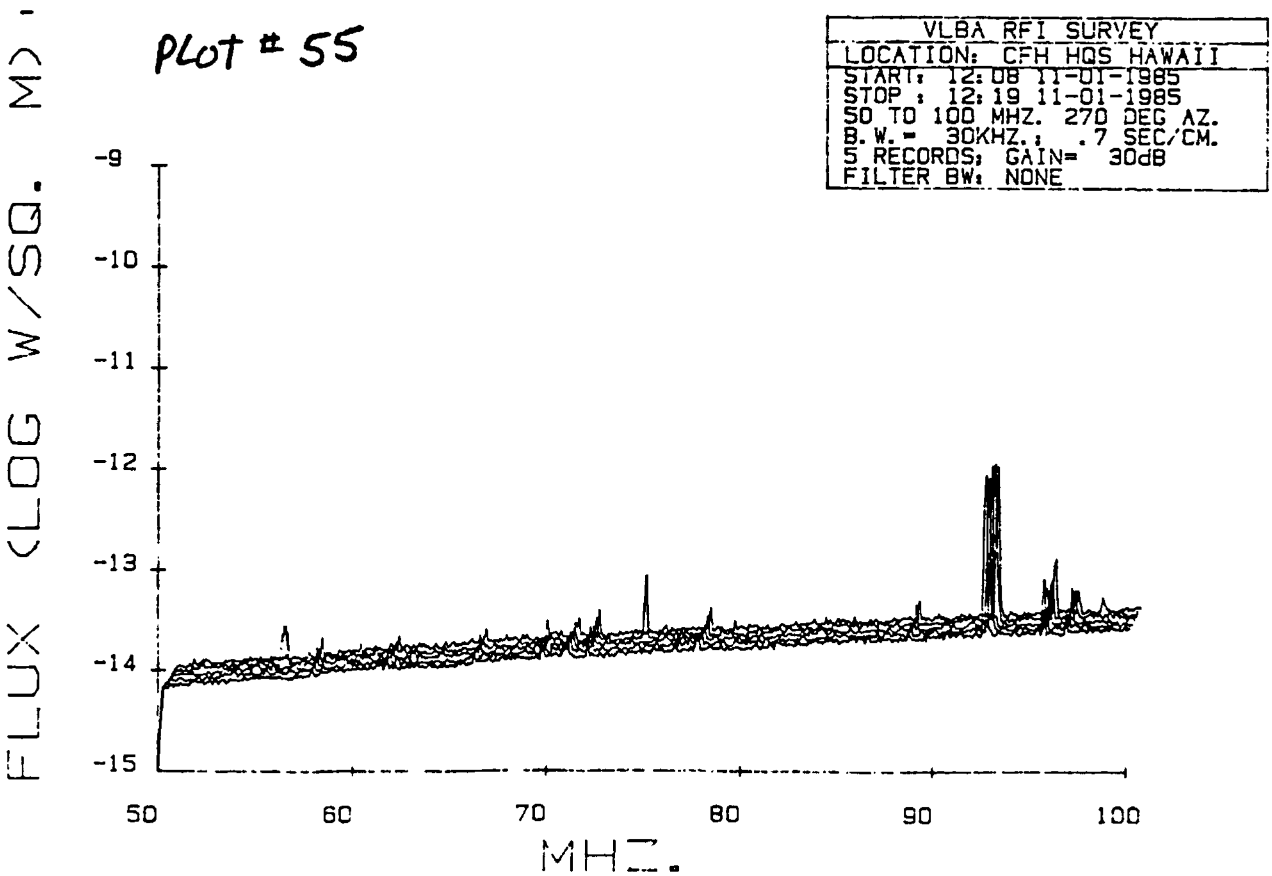
PLOT # 53

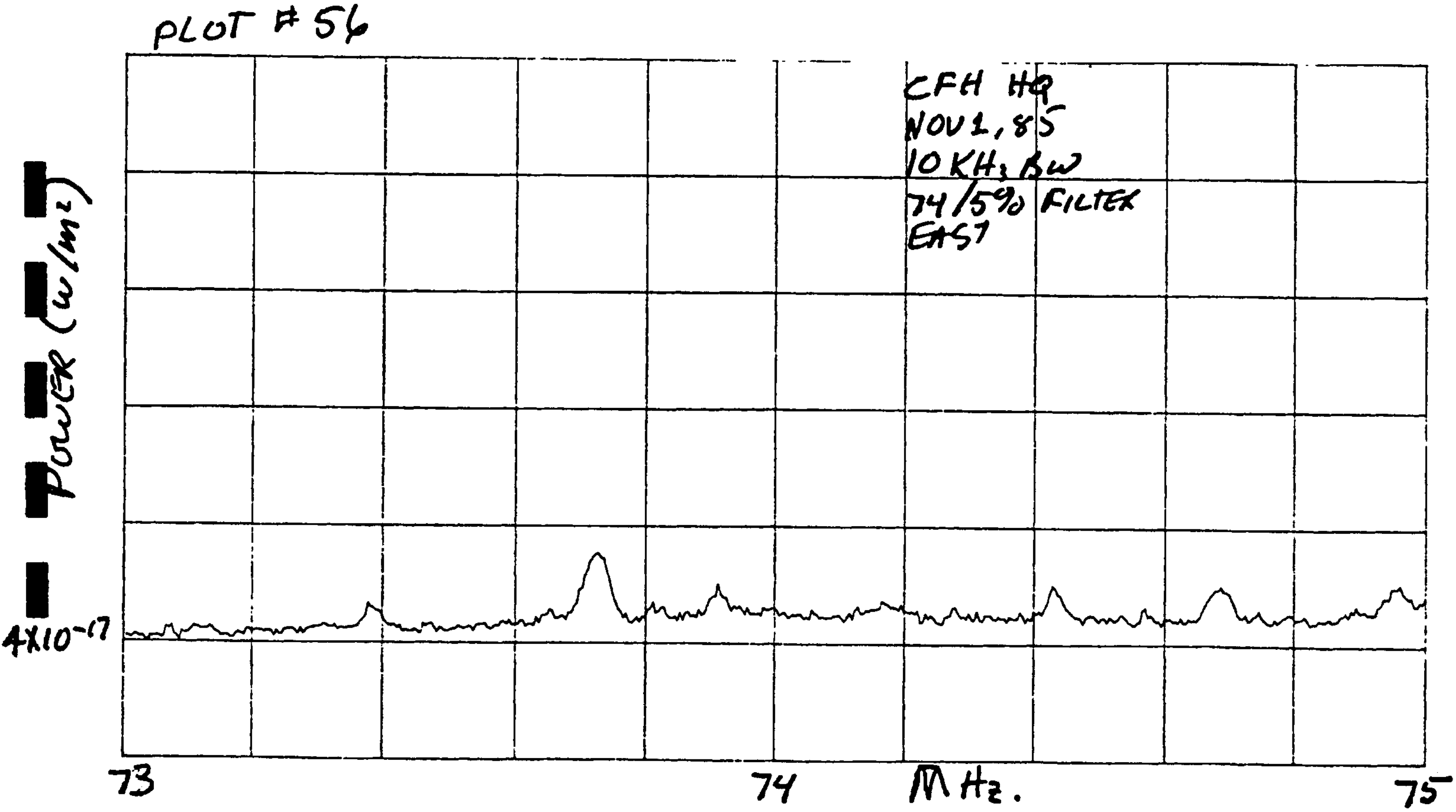


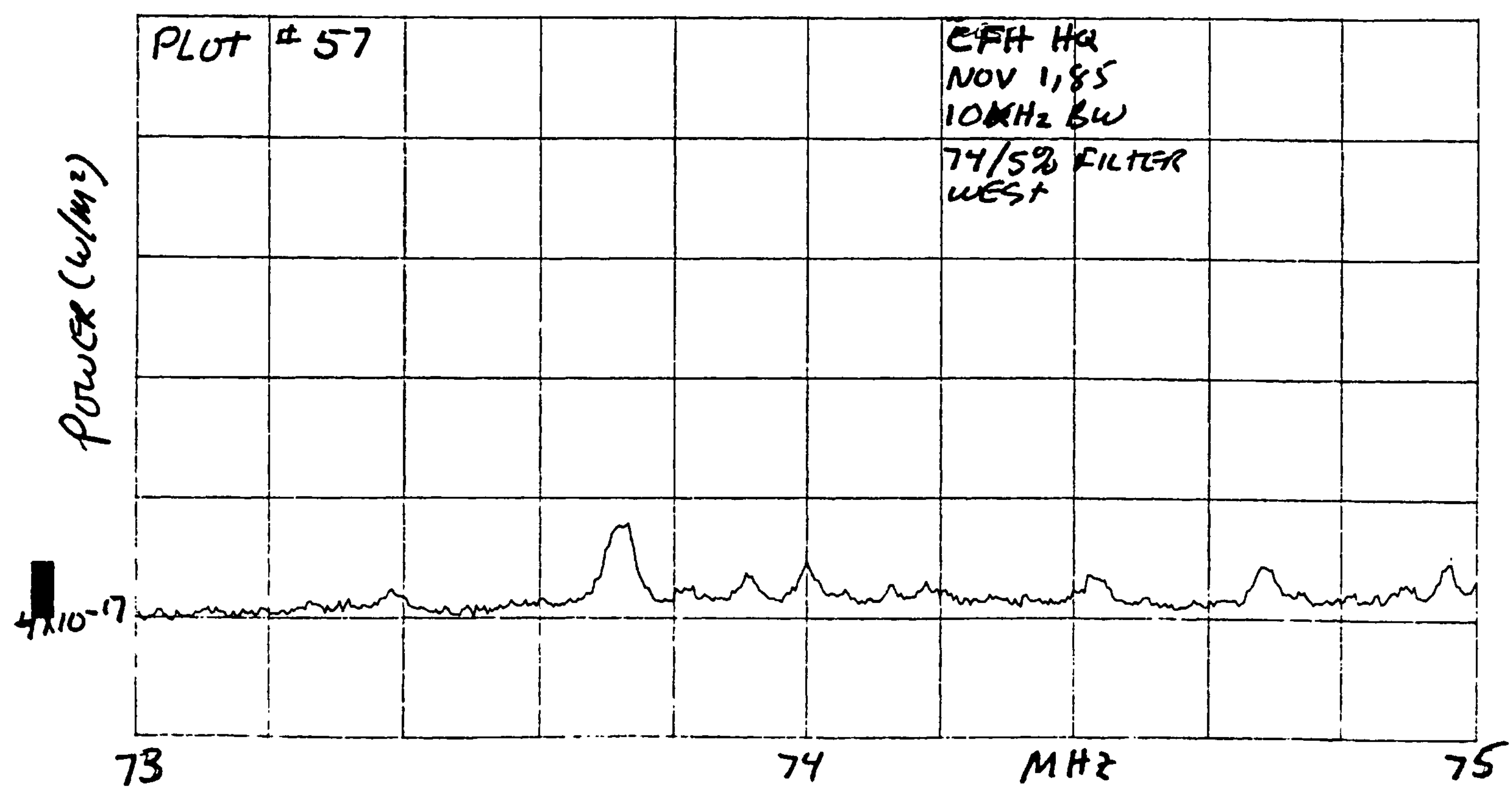
PLOT # 54



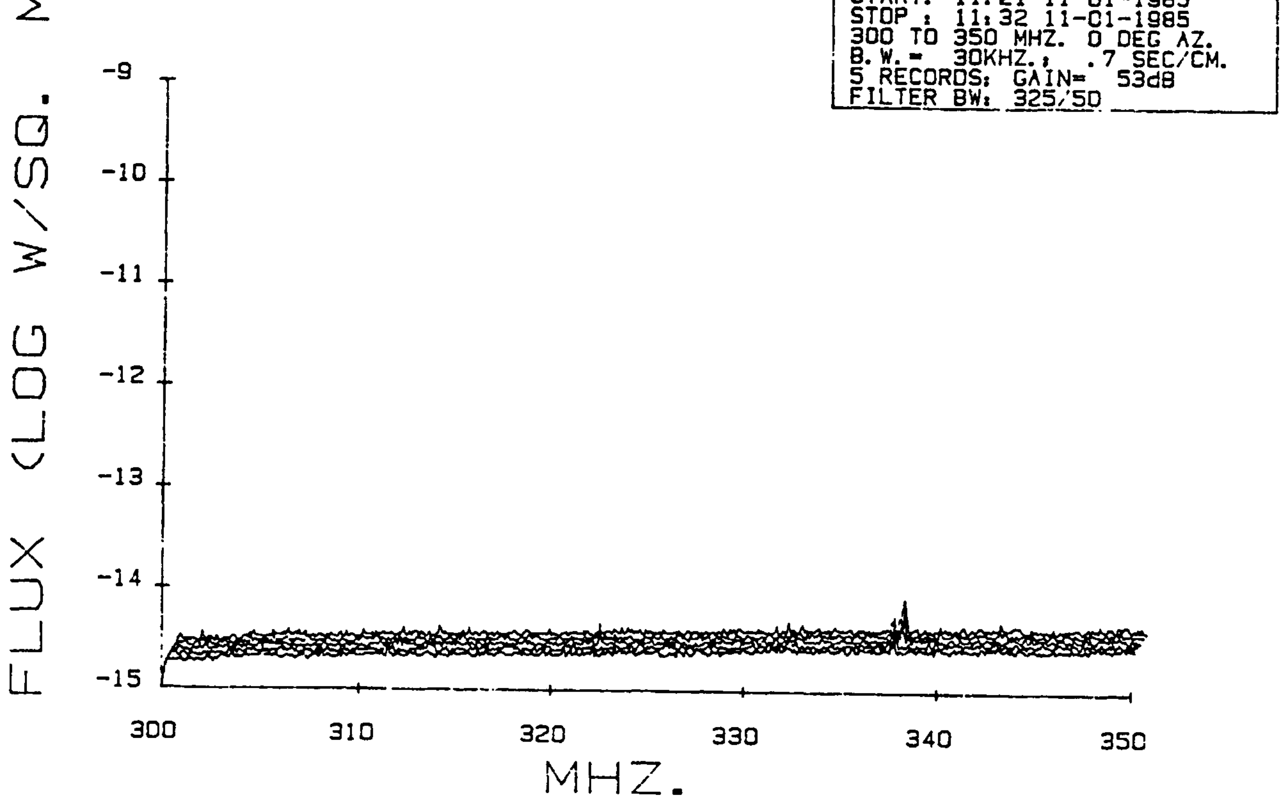
PLOT # 55



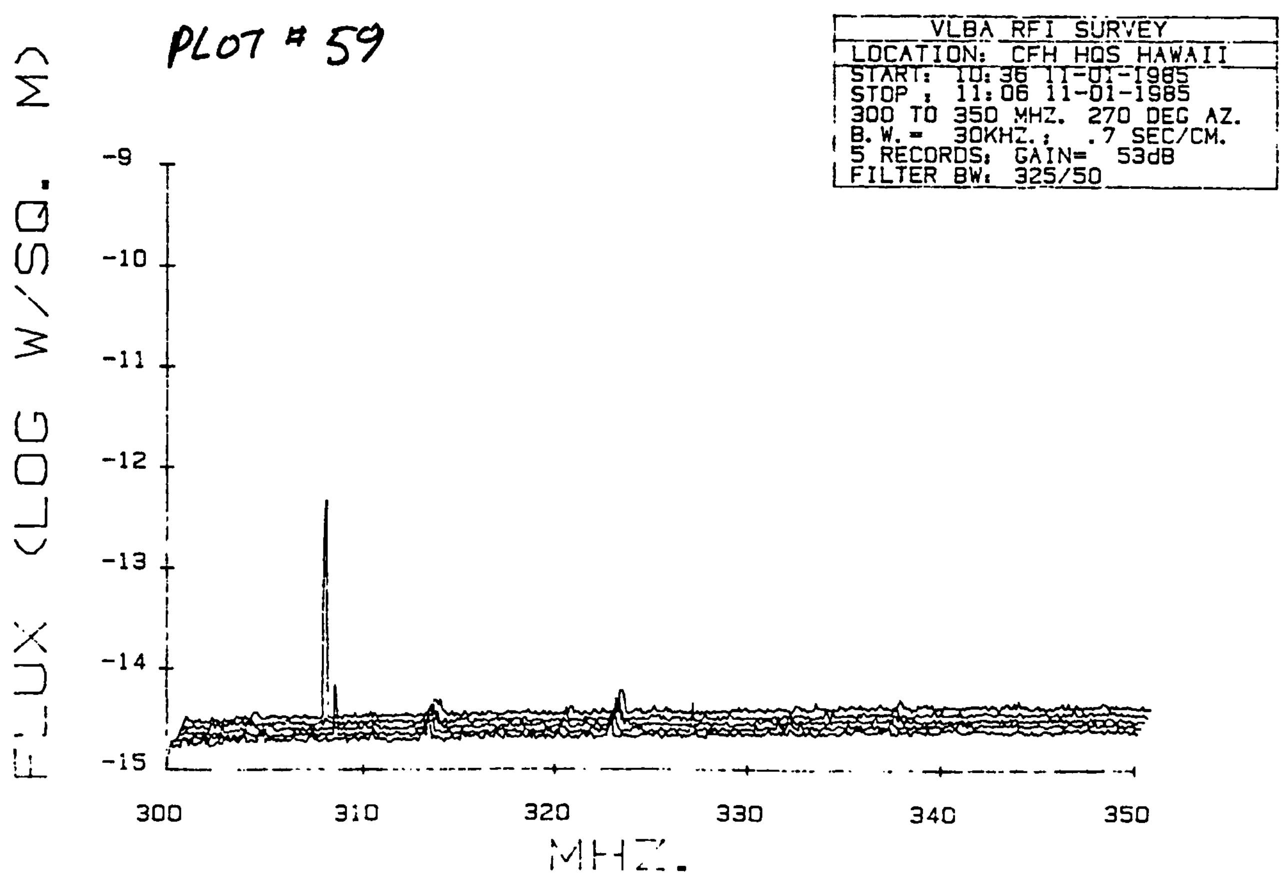

PLOT # 56
CFH HQ
NOV 1, 85
10 KHz BW
74/5% FILTER
EAST
POWER (W/M²)
4X10-17
73
74
MHz.
75


PLOT # 57
CFH HQ
NOV 1, 85
10 KHz BW
74/5% FILTER
WEST
POWER (W/M²)
4X10-17
73
74
MHZ
75

PLOT #58

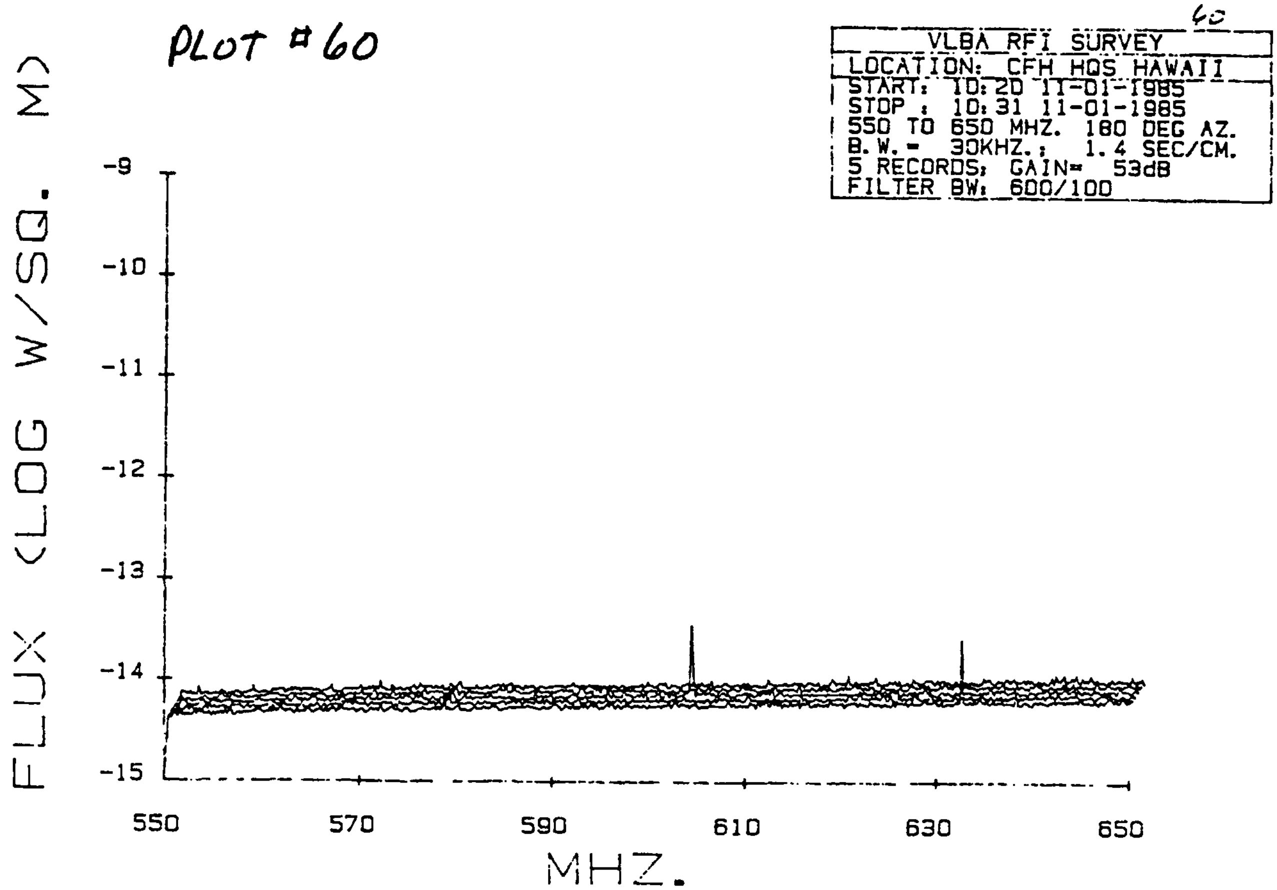


PLOT #59

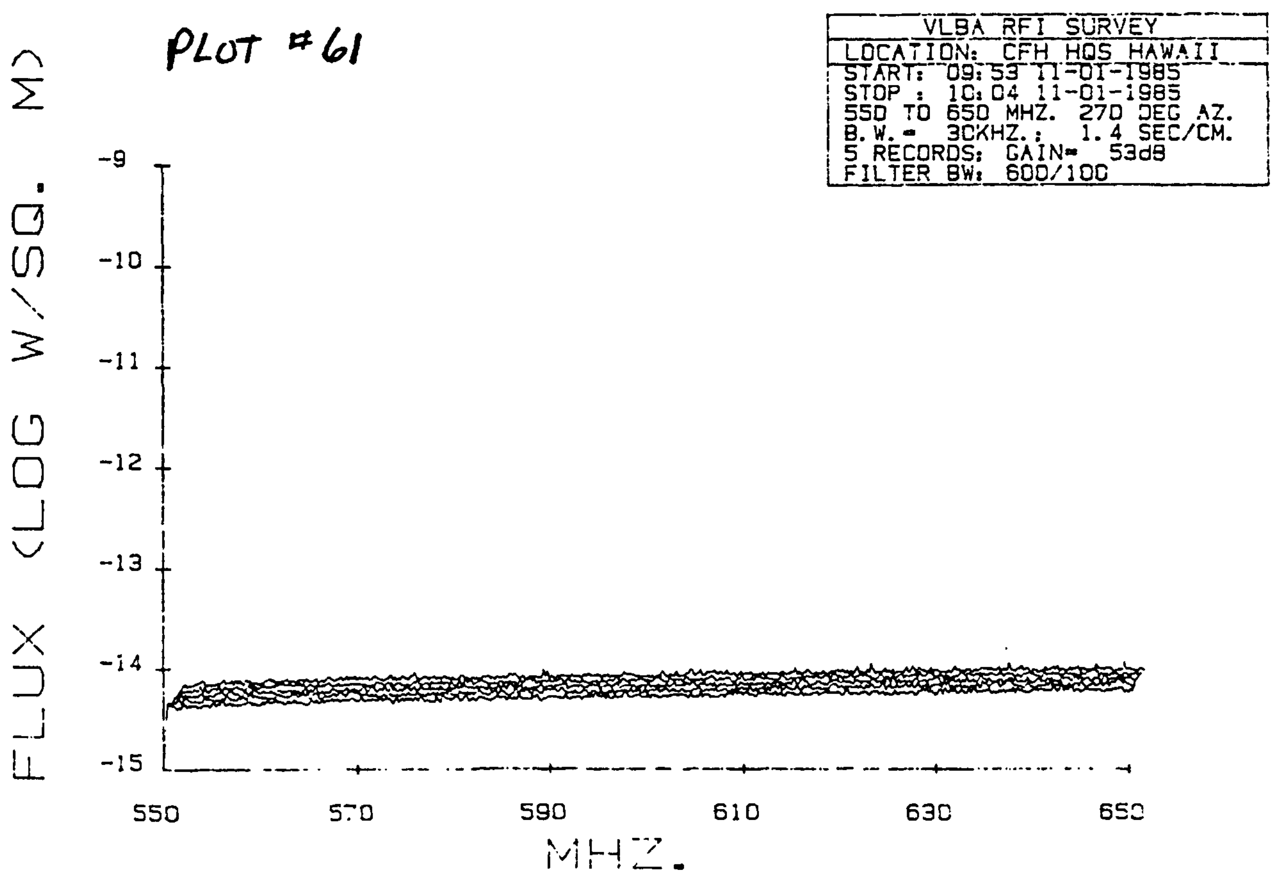


60

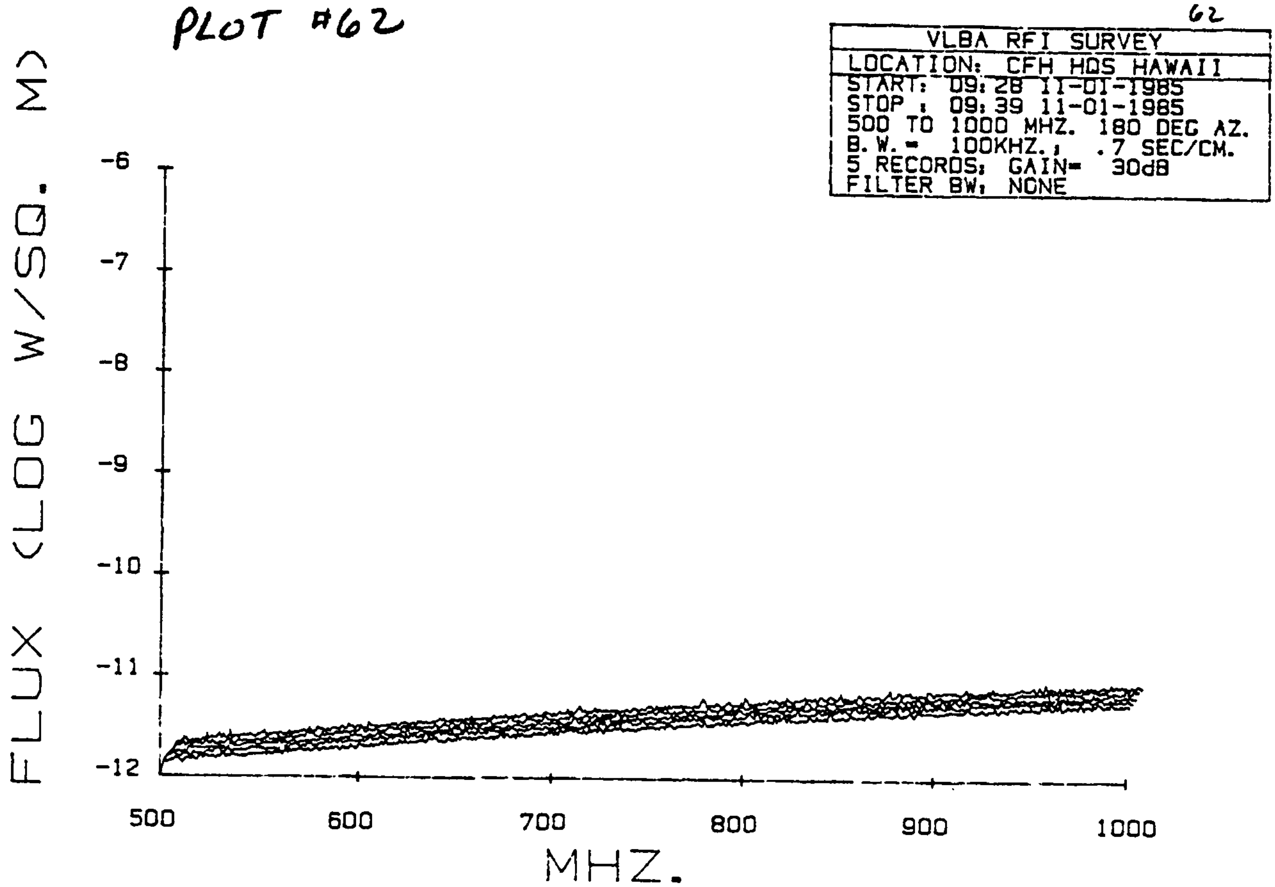
PLOT #60



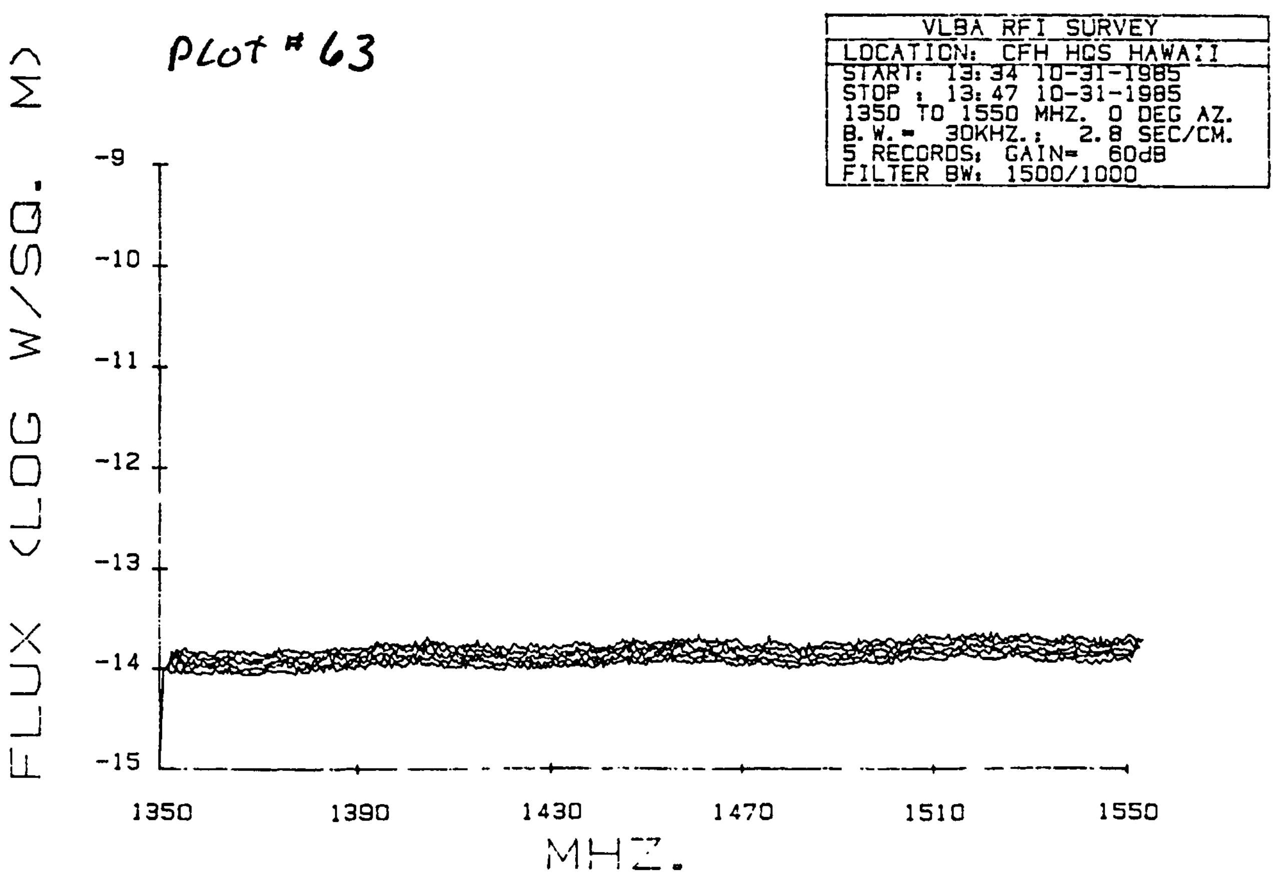
PLOT #61



PLOT #62

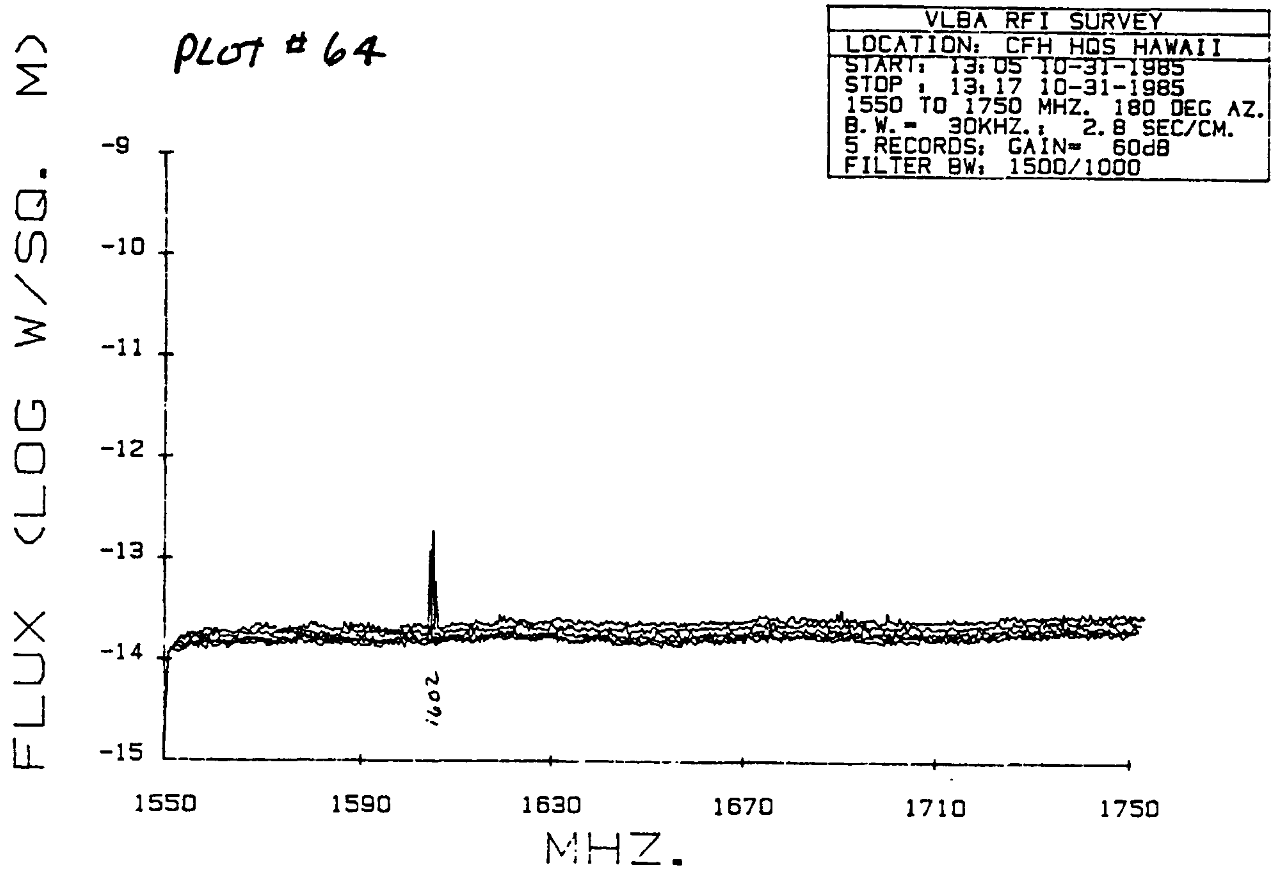


PLOT #63

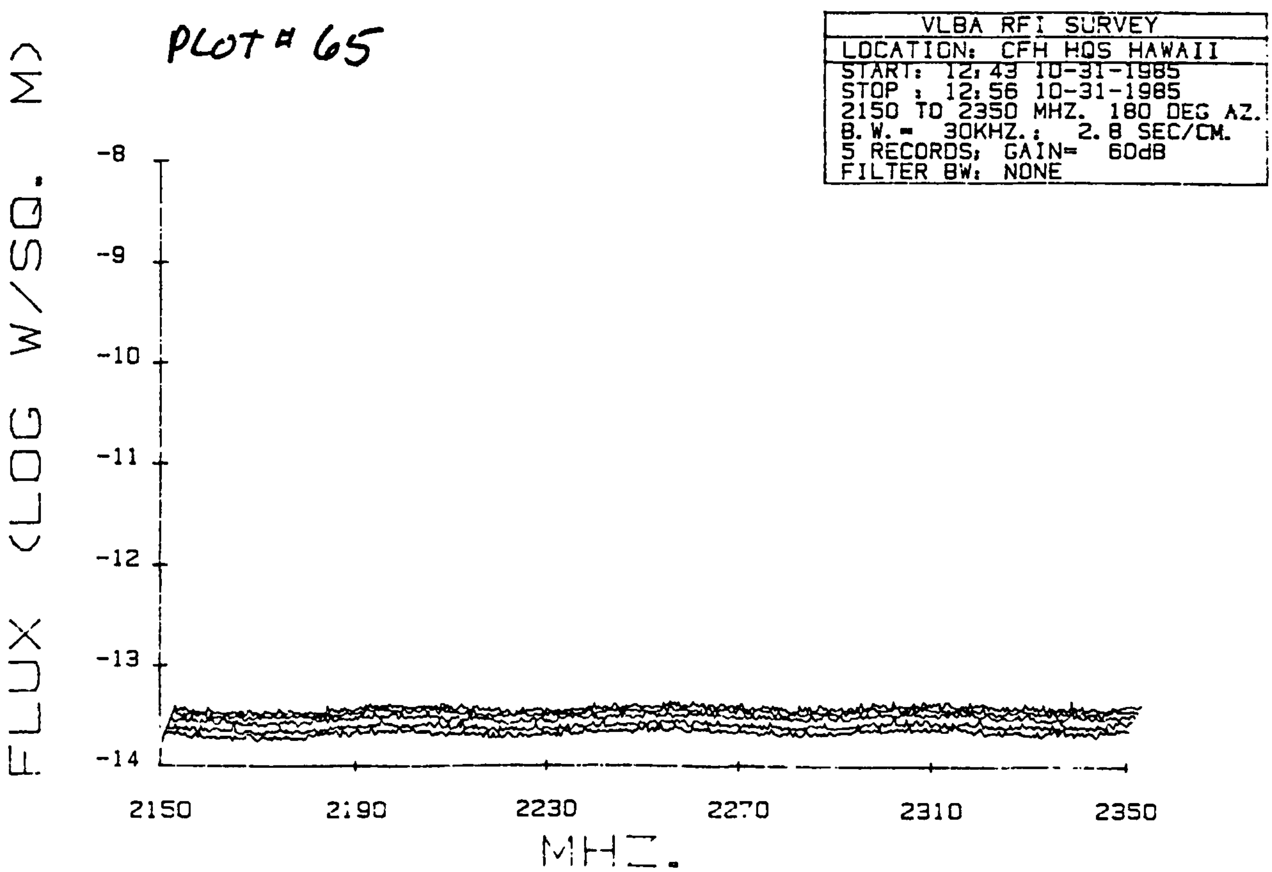


6c

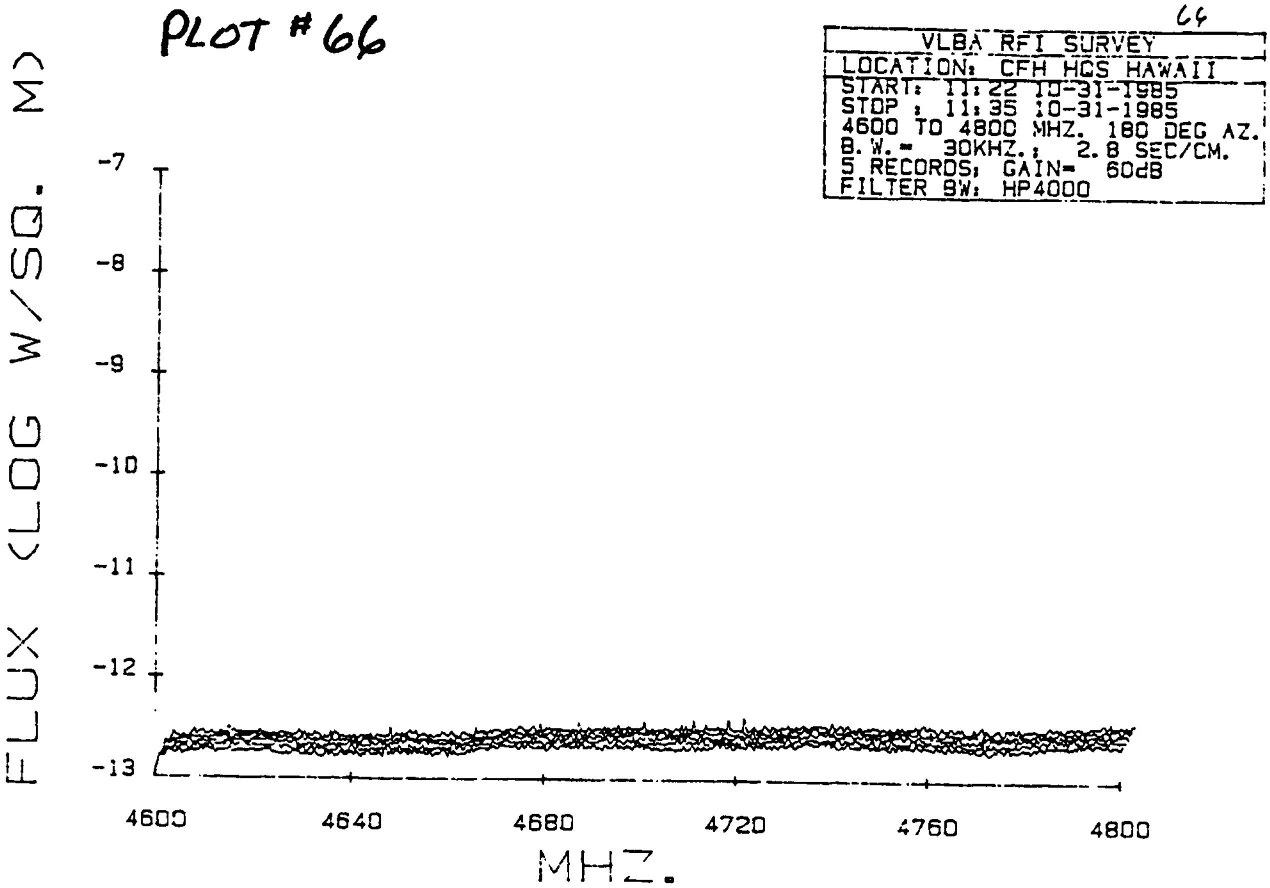
PLOT # 64



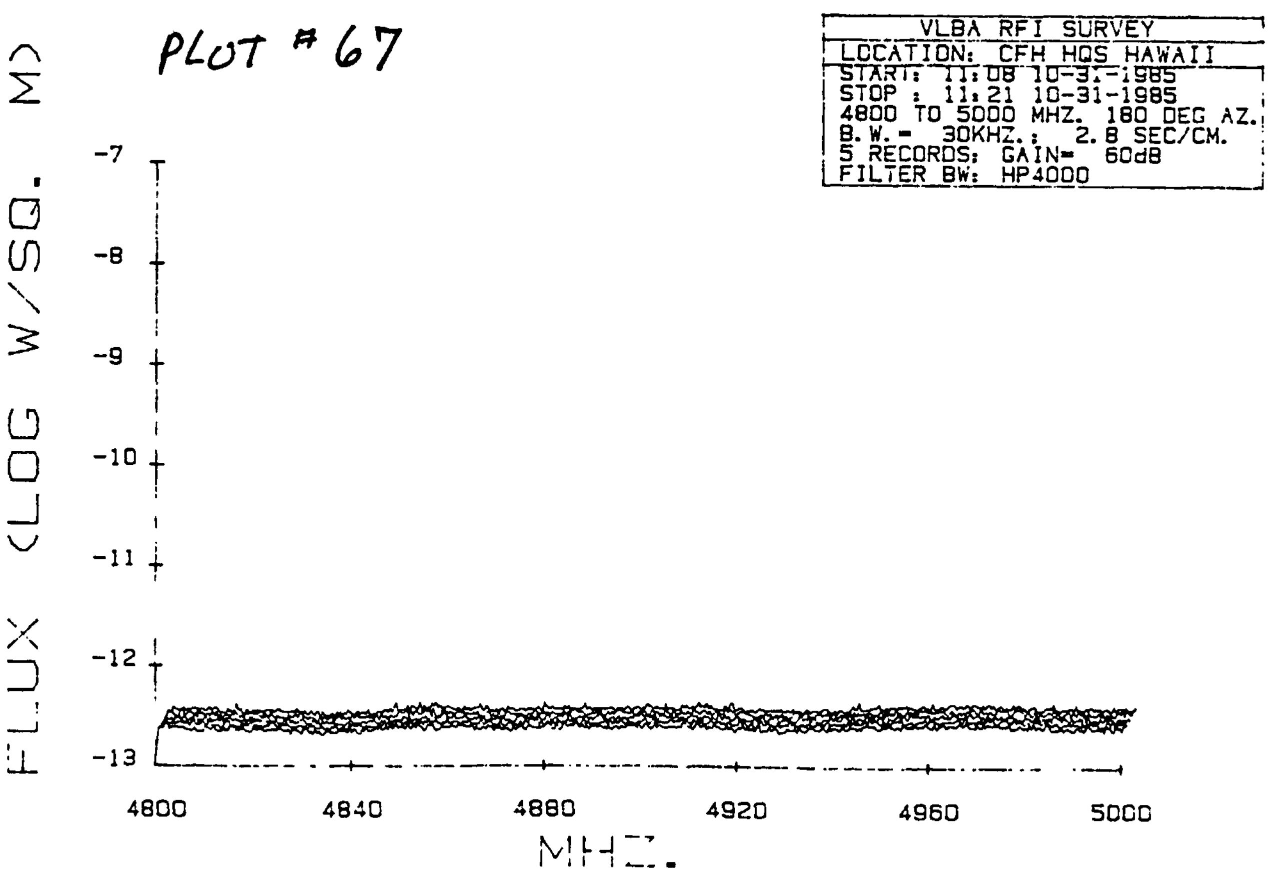
PLOT # 65



PLOT # 66

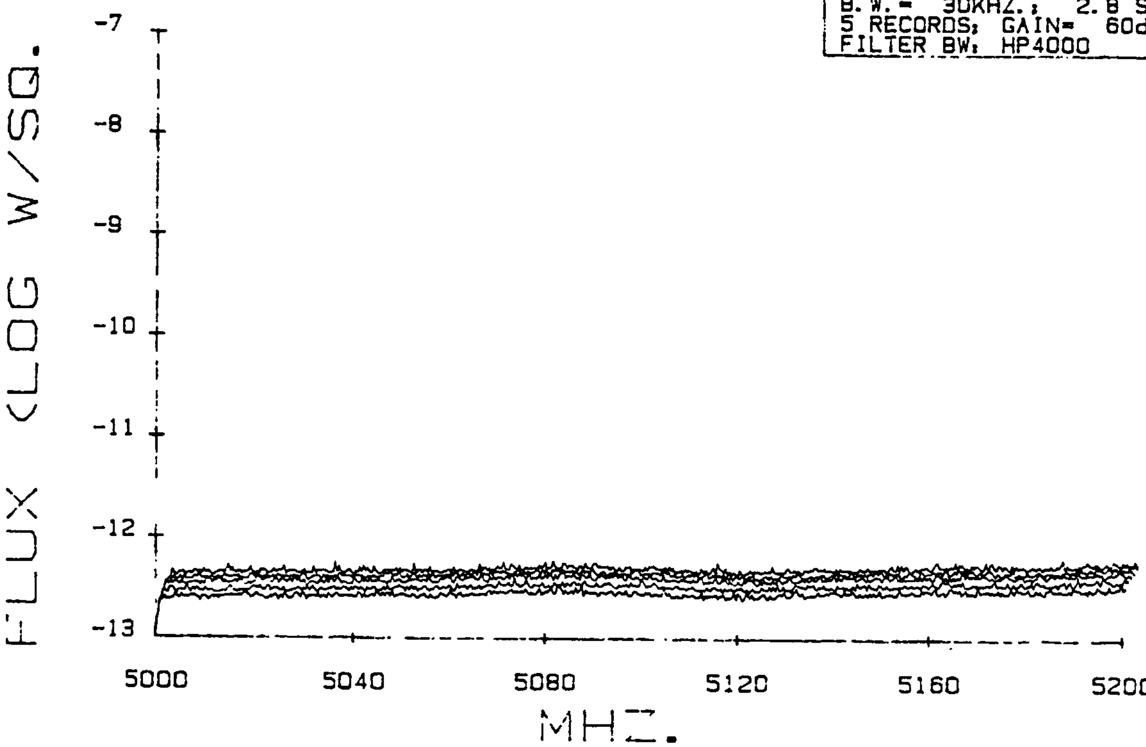


PLOT # 67



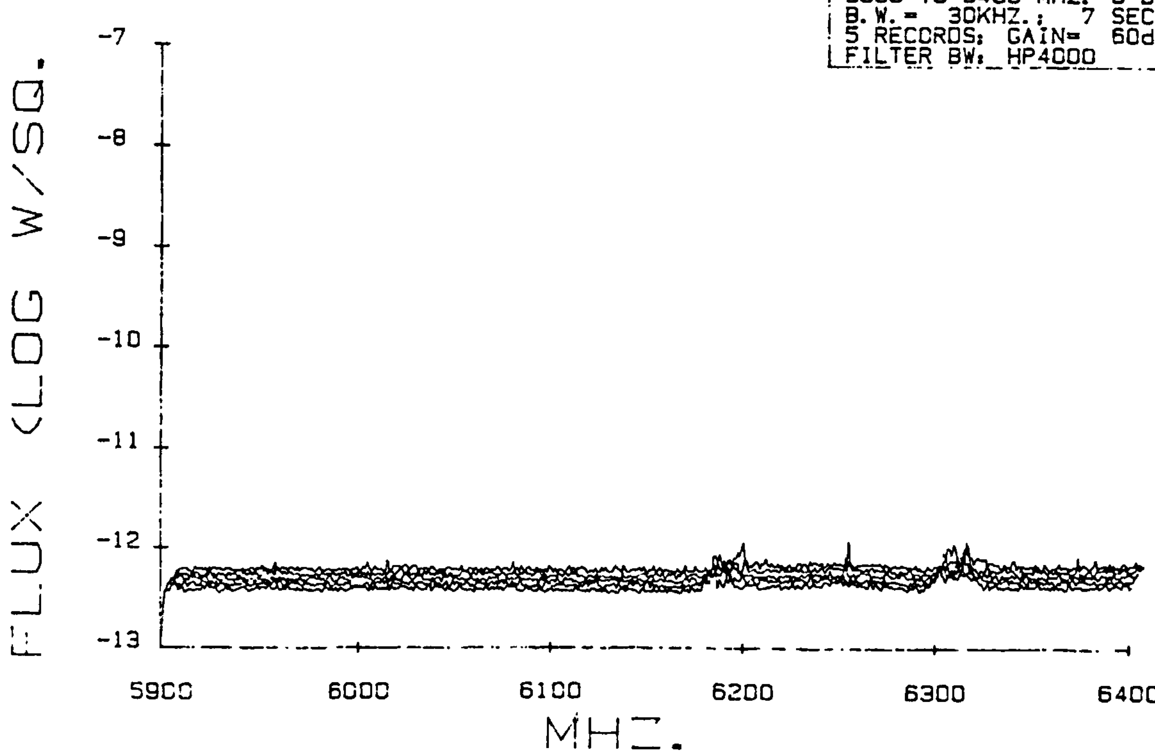
PLOT #68

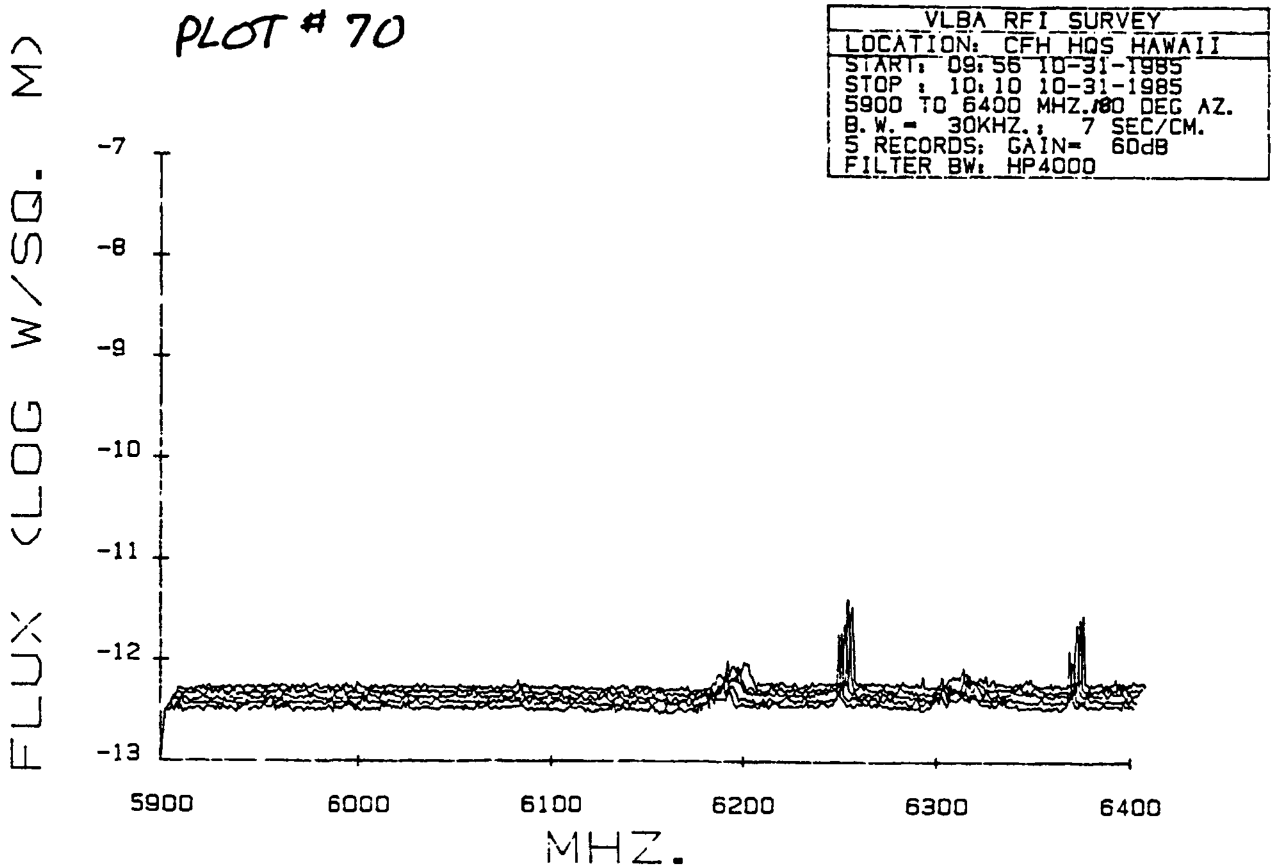
VLBA RFI SURVEY
LOCATION: CFH HQS HAWAII
START: 10:54 10-31-1985
STOP : 11:07 10-31-1985
5000 TO 5200 MHZ. 180 DEG AZ.
B.W. = 30KHZ.; 2.8 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000

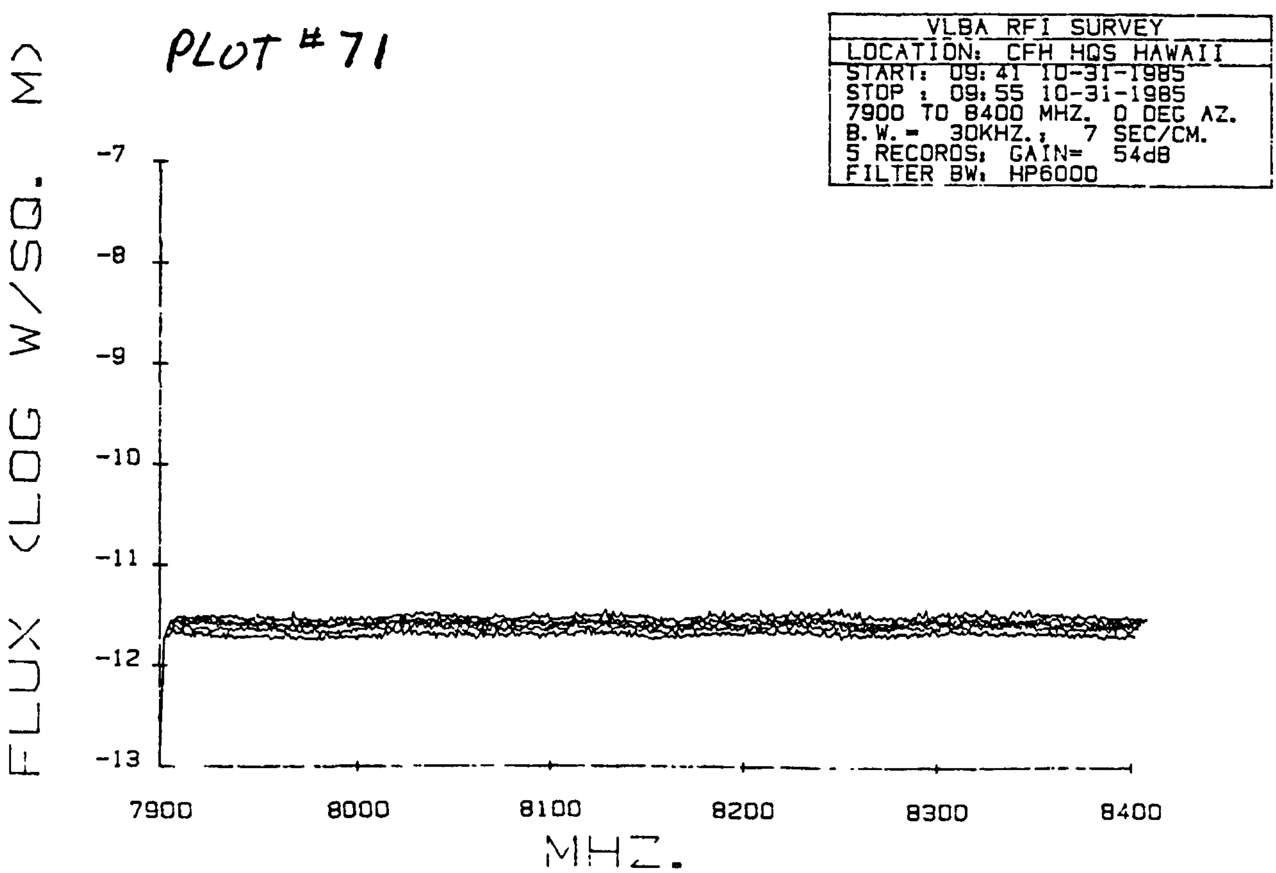


PLOT #69

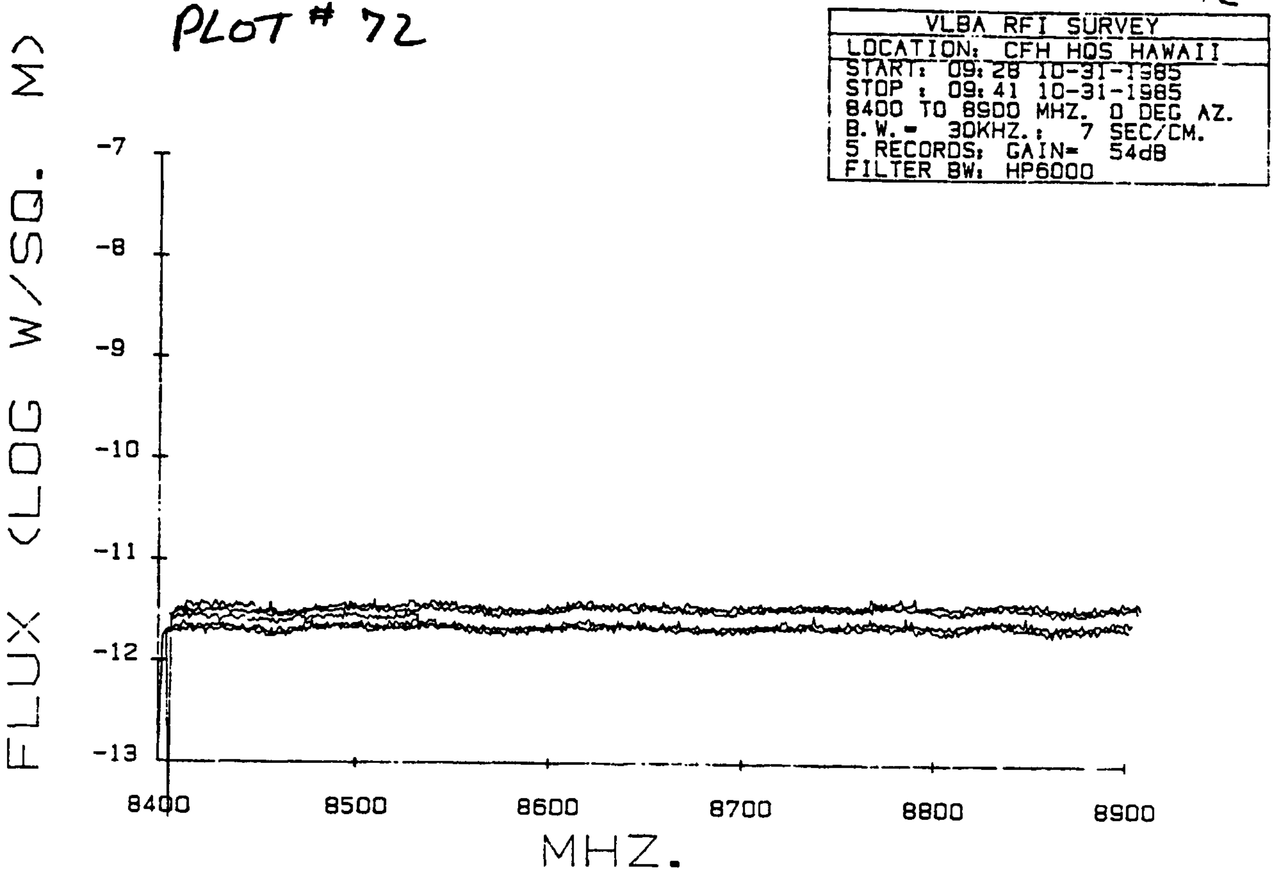
VLBA RFI SURVEY
LOCATION: CFH HQS HAWAII
START: 10:25 10-31-1985
STOP : 10:38 10-31-1985
5900 TO 6400 MHZ. 0 DEG AZ.
B.W. = 30KHZ.; 7 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000



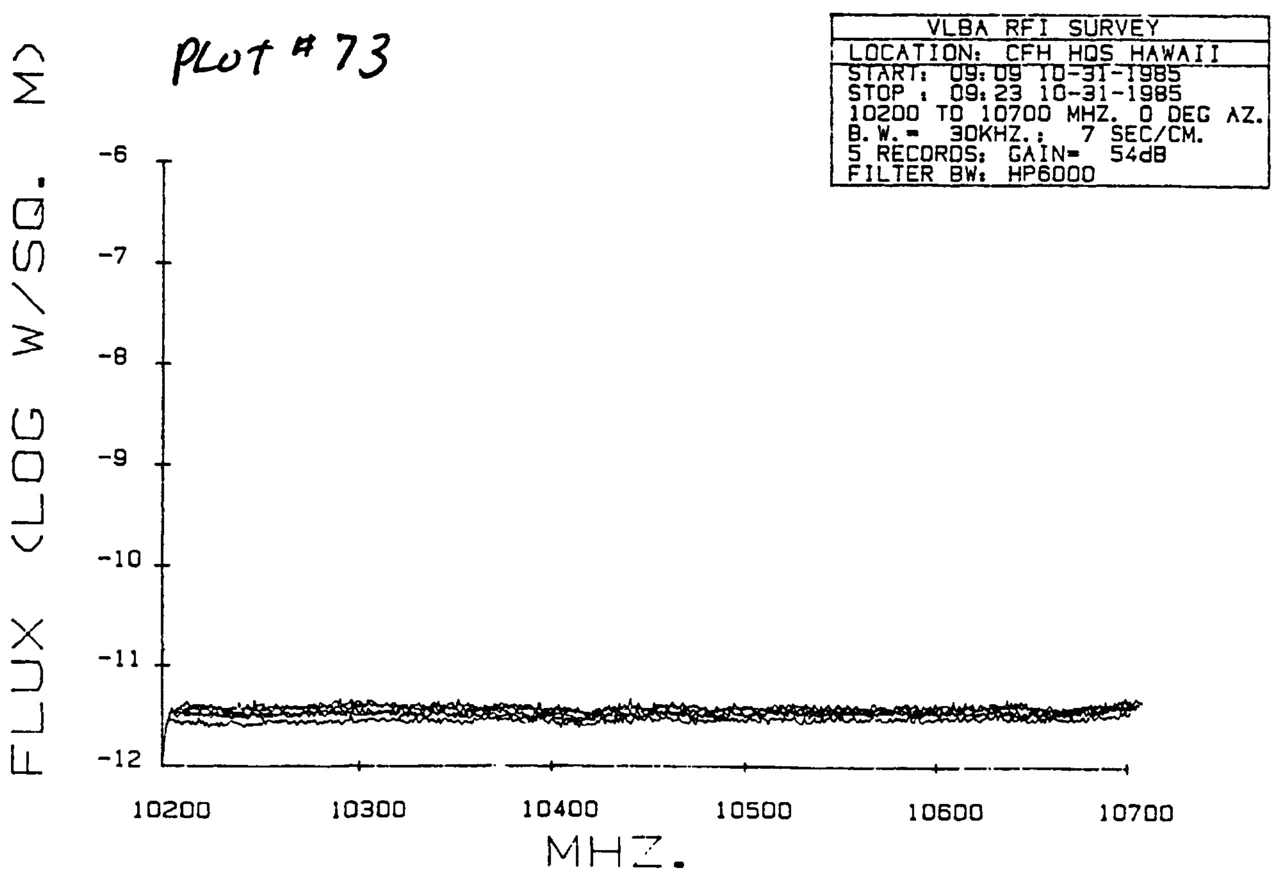

PLOT # 70
VLBA RFI SURVEY
LOCATION: CFH HQS HAWAII
START: 09:56 10-31-1985
STOP : 10:10 10-31-1985
5900 TO 6400 MHZ. 180 DEG AZ.
B. W. = 30KHZ. ; 7 SEC/CM.
5 RECORDS; GAIN= 60dB
FILTER BW: HP4000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
5900
6000
6100
6200
6300
6400
MHZ.


PLOT # 71
VLBA RFI SURVEY
LOCATION: CFH HQS HAWAII
START: 09:41 10-31-1985
STOP : 09:55 10-31-1985
7900 TO 8400 MHZ. 0 DEG AZ.
B. W. = 30KHZ. ; 7 SEC/CM.
5 RECORDS; GAIN= 54dB
FILTER BW: HP6000
FLUX (LOG W/SQ. M)
-7
-8
-9
-10
-11
-12
-13
7900
8000
8100
8200
8300
8400
MHZ.

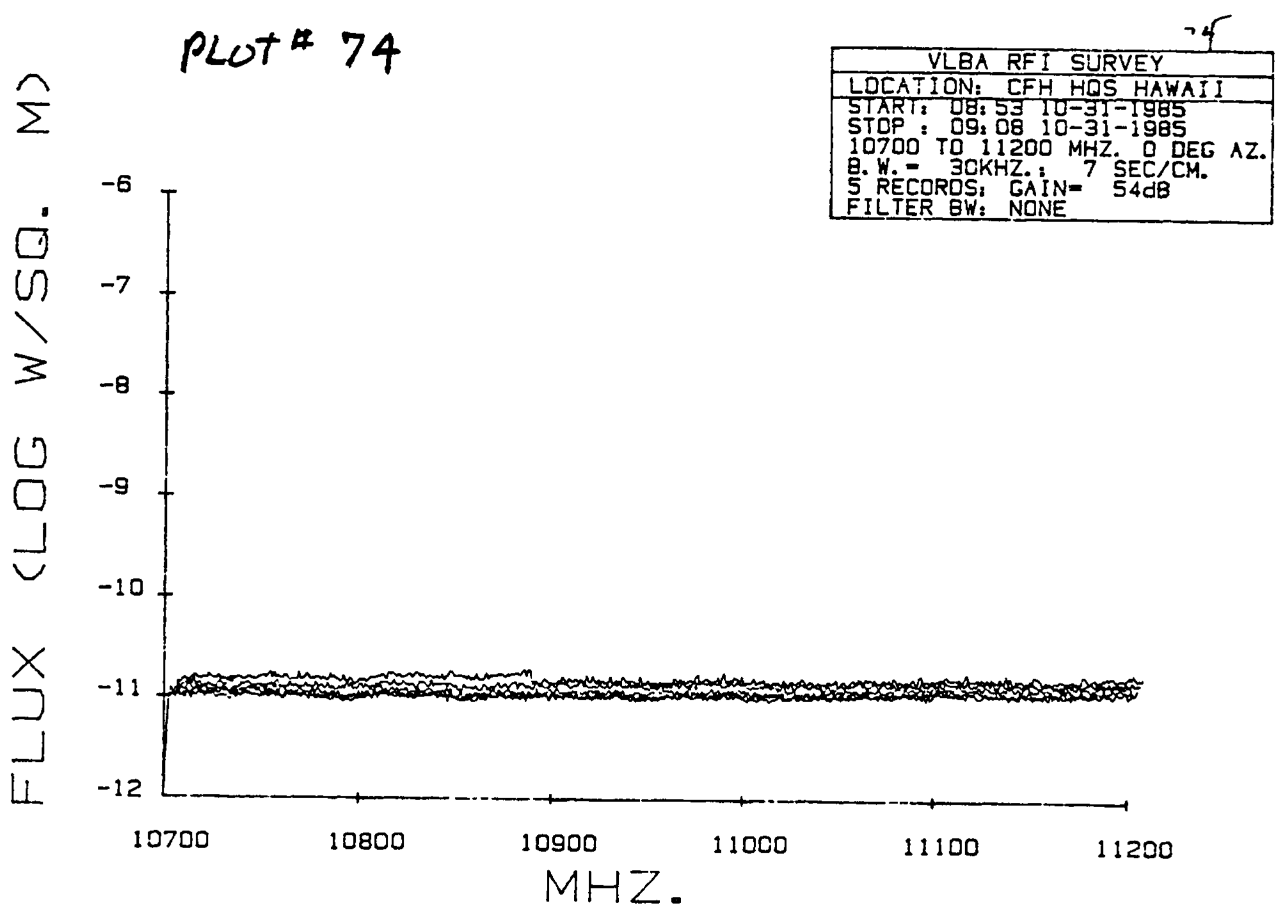
PLOT # 72



PLOT # 73



PLOT # 74



VLBA RFI SURVEY
LOCATION: CFH HQS HAWAII
START: 08:53 10-31-1985
STOP : 09:08 10-31-1985
10700 TO 11200 MHZ. 0 DEG AZ.
B.W.= 30KHZ.; 7 SEC/CM.
5 RECORDS; GAIN= 54dB
FILTER BW: NONE
FLUX (LOG W/SQ. M)
-6
-7
-8
-9
-10
-11
-12
10700
10800
10900
11000
11100
11200
MHZ.