VLA/VLBA Interference Memo #8

The VLA IF Interference Monitor

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Introduction

To address the need for improved interference monitoring at the VLA, a computer-controlled swept-frequency spectrum analyzer monitoring system was installed December 1994, to continuously monitor the intermediate frequenices (IFs) from one antenna. This report summarizes the operation and results to date.

Description

The control computer for the monitor is an Intel 486 66 MHz platform programmed using MS DOS Windows and National Instruments' LabVIEW. Using a TCP-IP Ethernet connection, the data are accessible at the NRAO engineering offices in Socorro. A UNIX shell script presents the data in Tek 4012 format for screen plotting and Postscript format for hard copy. From the spectrum plot of the IF, it is possible to determine the frequency of the interference and the amplitude referenced to the IF noise floor.

480 data points per scan are downloaded from the spectrum analyzer after each sweep via an IEEE 488.2 interface. Each data point represents the relative amplitude of a frequency bin; the span and resolution bandwidth are selected from the front panel of the spectrum analyzer. Though the settings of the HP 8559 are not remotely programmable, the instrument permits an external trigger; a sweep is triggered every 1.5 seconds, approximately.

The peak amplitude of each frequency bin is saved to detect intermittent interference, and the average is calculated to distinguish intermittent emissions from those that are continuous. Instead of saving the individual sweeps, just the results of the peak detection and averaging over a 15 minute interval are kept to save disk space. It is these disk files which can be remotely accessed from the engineering offices.

The software is written in National Instruments LabVIEW. LabVIEW uses a graphical programming language to create programs in block diagram form. Programs called virtual instruments (VIs) have front panels with knobs, push buttons, graphs, and other indicators depicted on the monitor screen; parameters can be entered via mouse or keyboard. The front panel of the top VI for the interference monitor is shown in Figure 1. The three plots on the panel, current sweep (IF), average, and peak, permit verification of operation. In the block diagram, Figure 2, specific objects are wired together to perform the required operations, such as taking the average of the IF, finding the peak, and writing the data to disk file. LabVIEW was selected for this application to save time in using test measurement operations already available, and because by its nature, the software is self-documenting. A possible drawback was the need to wire drivers, for example, for the TCP/IP interface.

Results

The Interference Monitor began collecting data at the VLA December 3, 1994. There is no automatic detection of interference as of this writing so that plots must be accessed and reviewed manually. Since 8 plots are produced per hour, there is time to investigate only a sample of plots. As well, monitoring in the IF is limited to a single narrow band on 1 antenna. As a result, detection of interference is only a sampling, not a survey, and any statistical conclusions are skewed.

A fledgling data base developed from the interference information shows strong intermittent interference in bands allocated to radio astronomy occuring over 50 times from December until this writing in June 1995. The incidents are listed in Figure 3, and example plots are shown in Figures 4 - 8.

Also monitored are adjacent band emissions originating possibly from satellite downlink telemetry mostly in the bands 1427 to 1435 MHz and 1452 to 1490 MHz. With the assumption that the satellite interference is caused when the satellite is close to the antenna main beam, it may be that merging a satellite tracking routine with the files used for directing the observations could predict and thus avoid some of the problem. Such a routine would be helpful as well for better known satellite interference problems such as INMARSAT (1530 - 1534 MHz), GPS (1575.42 MHz), GLONASS (1602 - 1616 MHz), and DBS-1 (12.2 - 12.7 GHz). An example of a recurring intermittent signal at 1427 - 1435 MHz is shown in Fig. 9.

A second problem documented by the monitor is the radiosondes in weather balloons transmitting around 1490 MHz. When the balloon is line-of-site with the VLA, the L-band receiver goes into compression, Figure 10, 11. Results show a reporting and tracking procedure is needed for weather balloons .

Another important problem area seen on the monitor is intermittent military traffic in allocated bands in P-band and at 1365 MHz to 1385 MHz in the L-band. This airborne traffic can ruin observations when line-of-site. The DOD Area Frequency Coordinator may be able to provide early notification.

FAA radar, U. S. Forest Service and other microwave links, and the harmonics of several TV stations can be readily seen above the IF noise floor in adjacent bands, but the emissions are continuous. Frequencies in continuous use in adjacent bands are permanently blocked from observational use and are thus of less interest in the monitoring. Frequencies in continuous use are shown on the L band interference plots developed from SYSLQUIK which are available via the NRAO home page on the World Wide Web.

Conclusion

The current IF monitor proves the efficacy of monitoring, but falls short in three important areas: 1) monitoring in the IF is subject to the vagaries of the observing schedule so that data are incomplete, 2) monitoring with a spectrum analyzer limits the measurements to strong interference -- that appearing above the noise floor in the IF, and 3) detection of interference is not automatic so that reports must be reviewed manually. All three of these drawbacks are to be addressed in follow-on projects.

Figure 1: LabVIEW Front Panel

Connector Pane

Monitor.vi

Front Panel

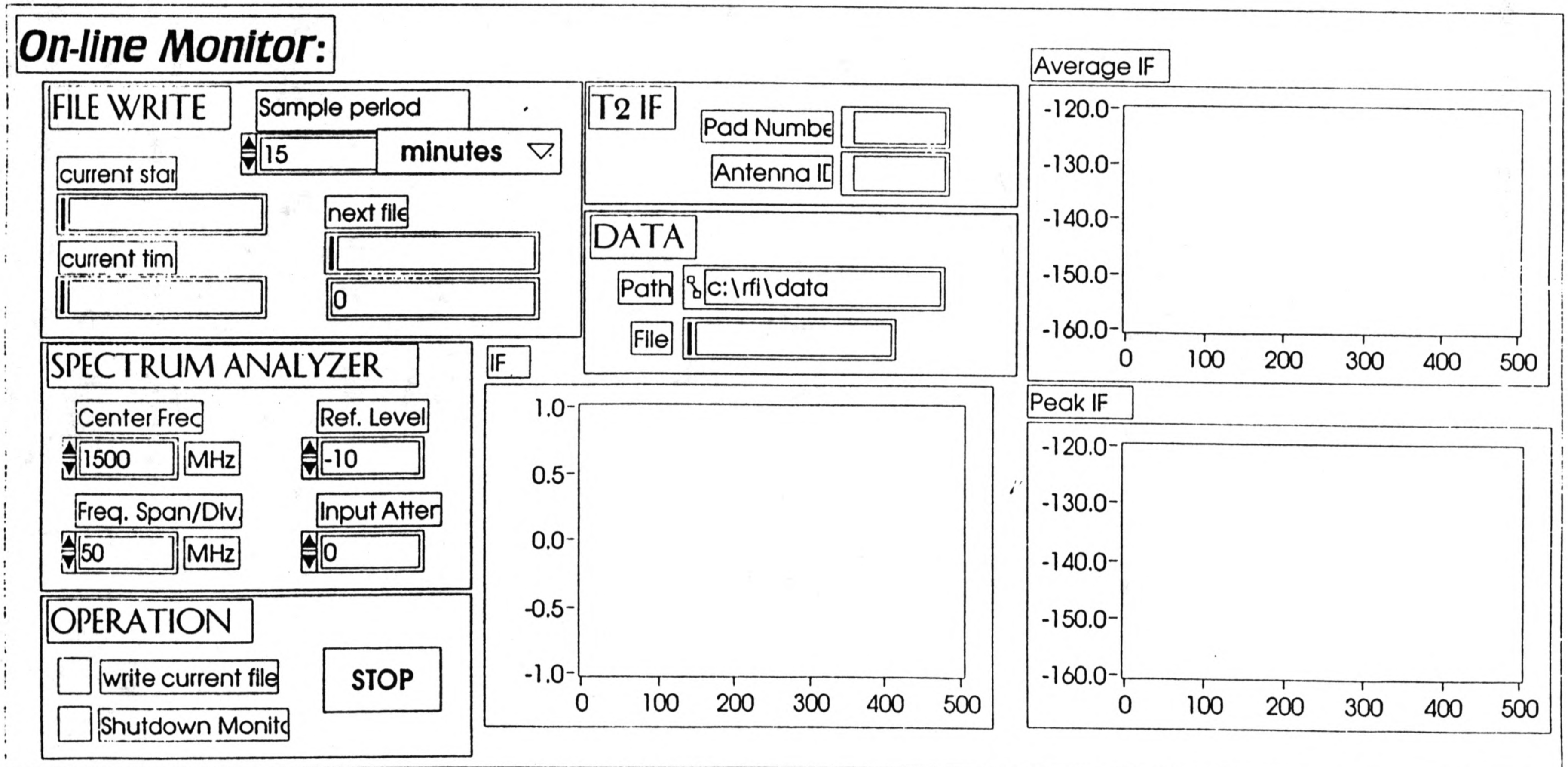


FIG 2

Block Diagram

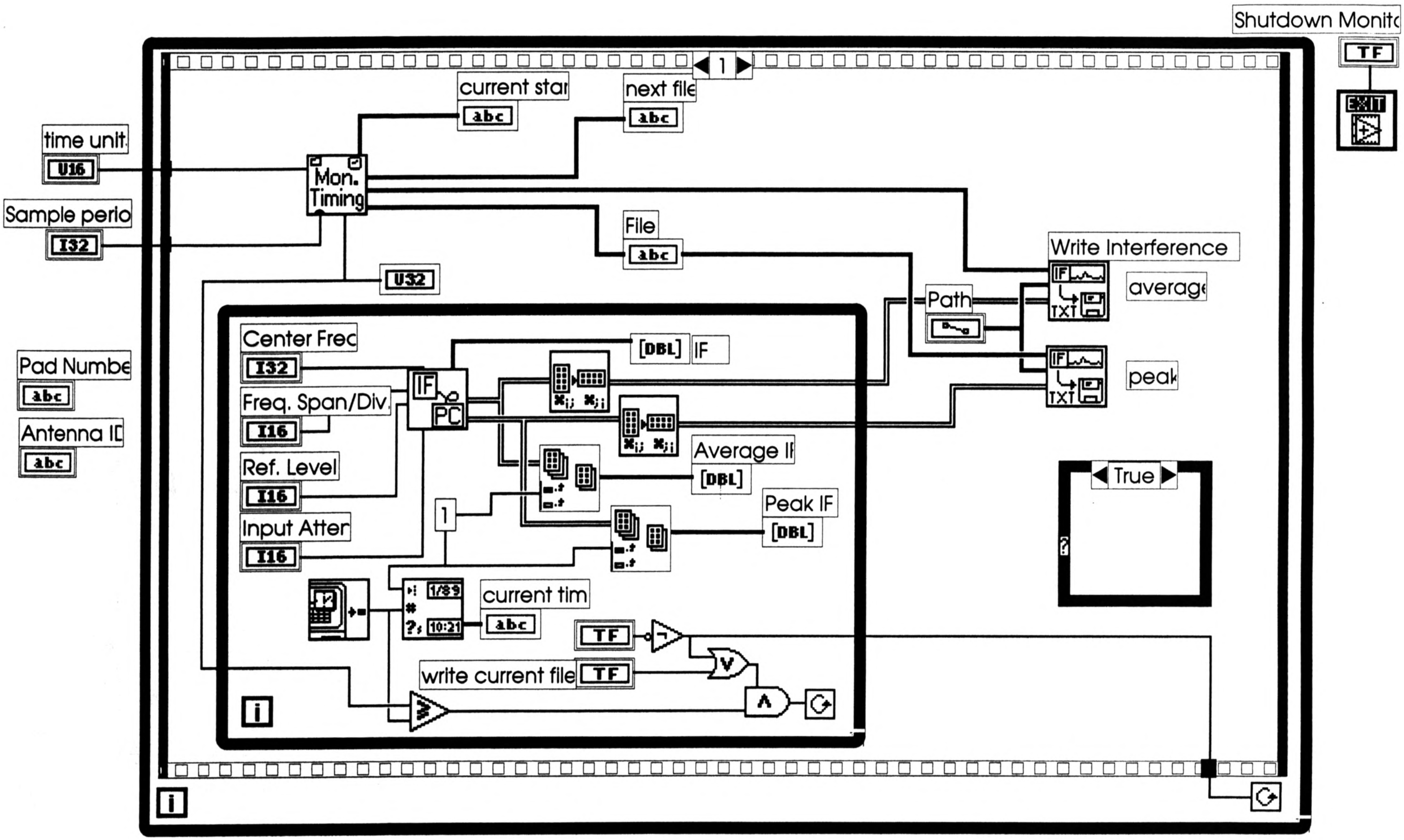


Figure 3.

Interference in RA bands at the VLA Dec. 94 - June 95, a list of examples

Date	Time RFI Noted	Derived Sky Frequency
23 Dec 9	1500 - 2100 MST	1610 MHz
5 Jan 95	0830 MST	1385 MHz
28 Jan 95	0700 MST	1385 MHz
29 Jan 95	0700 MST	1385 MHz
30 Jan 95	0500 MST	1420 MHz
13 Feb 95	0815 - 0845 MST	1380 MHz
13 Feb 95	0830 MST	1390 MHz
15 Feb 95	1530 - 1630 MST	1425 MHz
17 Feb 95	0945 MST	1399 MHz
28 Feb 95	1915 - 1930 MST	1385 MHz
2 Mar 95	1930 MST	1385 MHz
3 Mar 95	0600 MST	1385 MHz
9 Mar 95	0300 MST	1662 MHz
10 Mar 95	0400 MST	1390 MHz
10 Mar 95	0500 MST	1362 MHz
10 Mar 95	1900 MST	1386 MHz and 1422 MHz
11 Mar 95	1400 - 1700 MST	1422 MHz
11 Mar 95	1900 MST	1386 MHz and 1422 MHz
12 Mar 95	1700 - 1900 MST	1422 MHz
14 Mar 95	1800 MST	1356 MHz and 1395 MHz
18 Mar 95	1500 MST	1418 MHz
24 Mar 95	1800 MST	1387 MHz
24 Mar 95	1800 - 1930 MST	1422 MHz
24 Mar 95	1900 MST	1384 MHz
24 Mar 95	1900 MST	1381 MHz
25 Mar 95	1800 - 1930 MST	1385 MHz
25 Mar 95	1800 - 2000 MST	1422 MHz
29 Mar 95	1845 - 2215 MST	322.18 MHz
29 Mar 95	1930 - 2230 MST	324.30 MHz
3 Apr 95	0600 - 1400 MDT	Various from 1398 - 1415 MHz
24 Apr 95	0600 - 0630 MDT	Various from 1360 - 1410 MHz
28 Apr 95	0600 & 2300 MDT	1377 MHz
29 Apr 95	0600 MDT	1380 MHz
30 Apr 95	0345 - 0600 MDT	1380 MHz

Note: Roving Sands 28 April - 9 May

28 Apr 95	0600 MDT	1419 & 1422 MHz
28 Apr 95	0600 MDT	1375 MHz
28 Apr 95	2300 MDT	1375 MHz

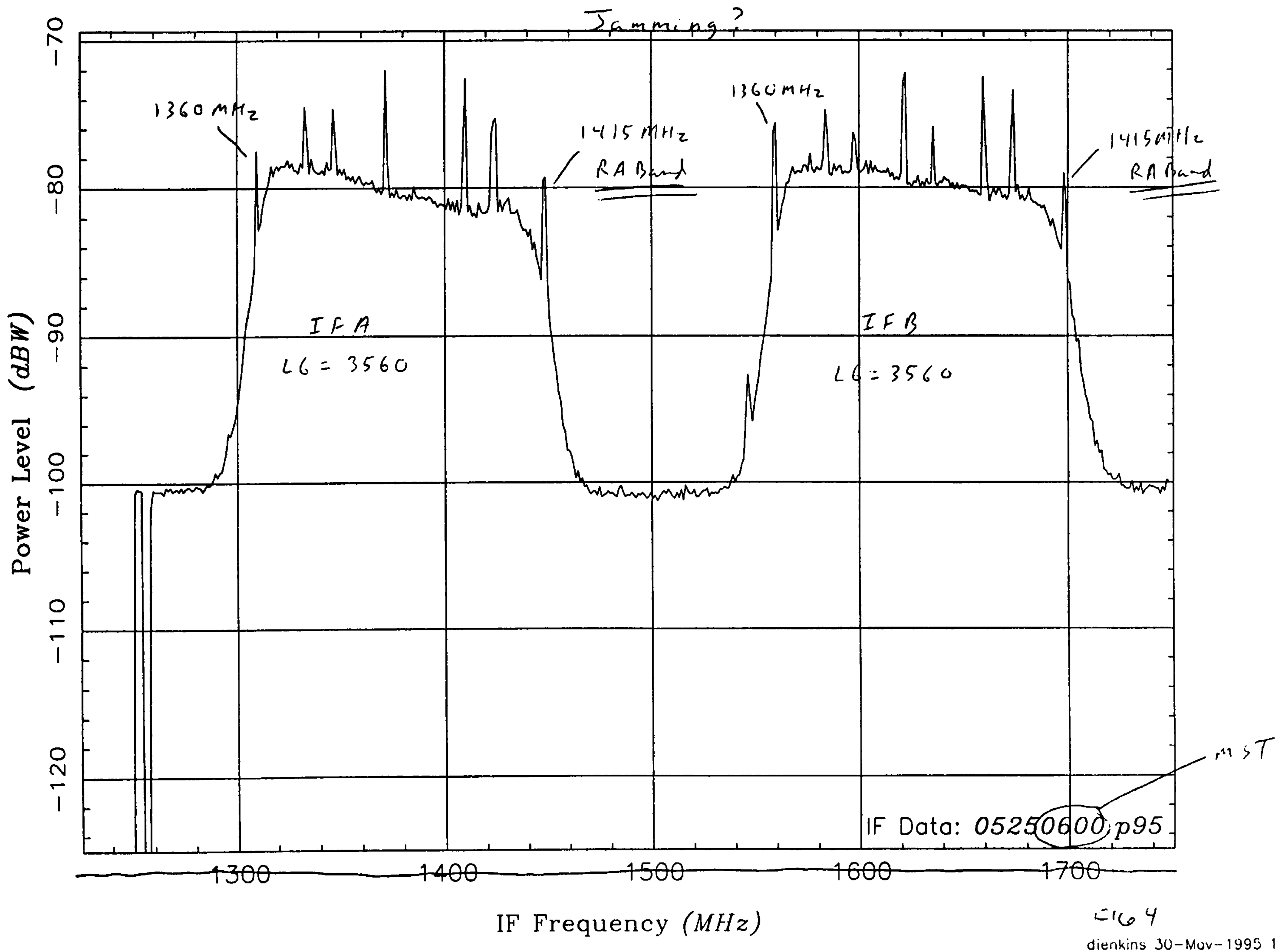
29 Apr 95	0600 MDT	1380 MHz
30 Apr 95	0345 MDT	1380 MHz
1 May 95	0430 - 1100 MDT	Various from 1330 - 1360 MHz
1 May 95	2045 - 2100 MDT	1415 MHz
6 May 95	1915 - 2130 MDT	1390 MHz
7 May 95	1900 - 2145 MDT	1390 MHz
9 May 95	0400 MDT	1420.5 MHz
13 May 95	1100 MDT	1423.4 MHz
16 May 95	1800 MDT	1418.8 & 1414.25 MHz
17 May 95	0100 MDT	1418.8 & 1411.3 MHz
18 May 95	0600 MDT	1418.8 & 1409.8 MHz
	0700 MDT	1415.3, 1417.8, 1412.8, 1418.8 MHz
	1000 MDT	1415.3 & 1416.3 MHz
21 May 95	0700 MDT	1422.8 MHz
22 May 95	0700 MDT	1422.8 MHz
25 May 95	0700 MDT	Numerous from 1360 to 1415 MHz
25 May 95	1300 MDT	1420.5 MHz
8 Jun 95	1830 MDT	22,403 MHz

Notes: The interference incidents listed were taken by manual inspection of interference reports generated from a monitor system installed December 1994, on the IF of one of the VLA antennas. Monitoring the IF limits data to the band, front end filter, and L6 settings of the observe file in progress. For instance, the front end filter limits the observing band to a maximum of 55 MHz. Furthermore, there is no automatic detection system for interference, so that interference incidents are recorded through visual inspection of only a sampling of the 192 plots generated daily by the monitor. As such, the reports listed should be considered as examples, not as an exhaustive list. Times shown are not necessarily when interference began or when it ended, but only when it was noted. As well, though we have tried to get the information right, each analysis must be done by hand. A mistake in noting the L6 or a wrong button on a calculator will cause big errors, and may have occurred in rare instances.

~~CCJ 3 May 95~~

A5555
Schiminovich, Columbia

VLA On-Line IF Monitor Data - Peak



E164
dienkins 30-Mov-1995 16:54

MS555

Schiminovich, Columbia

VLA On-Line IF Monitor Data – Peak

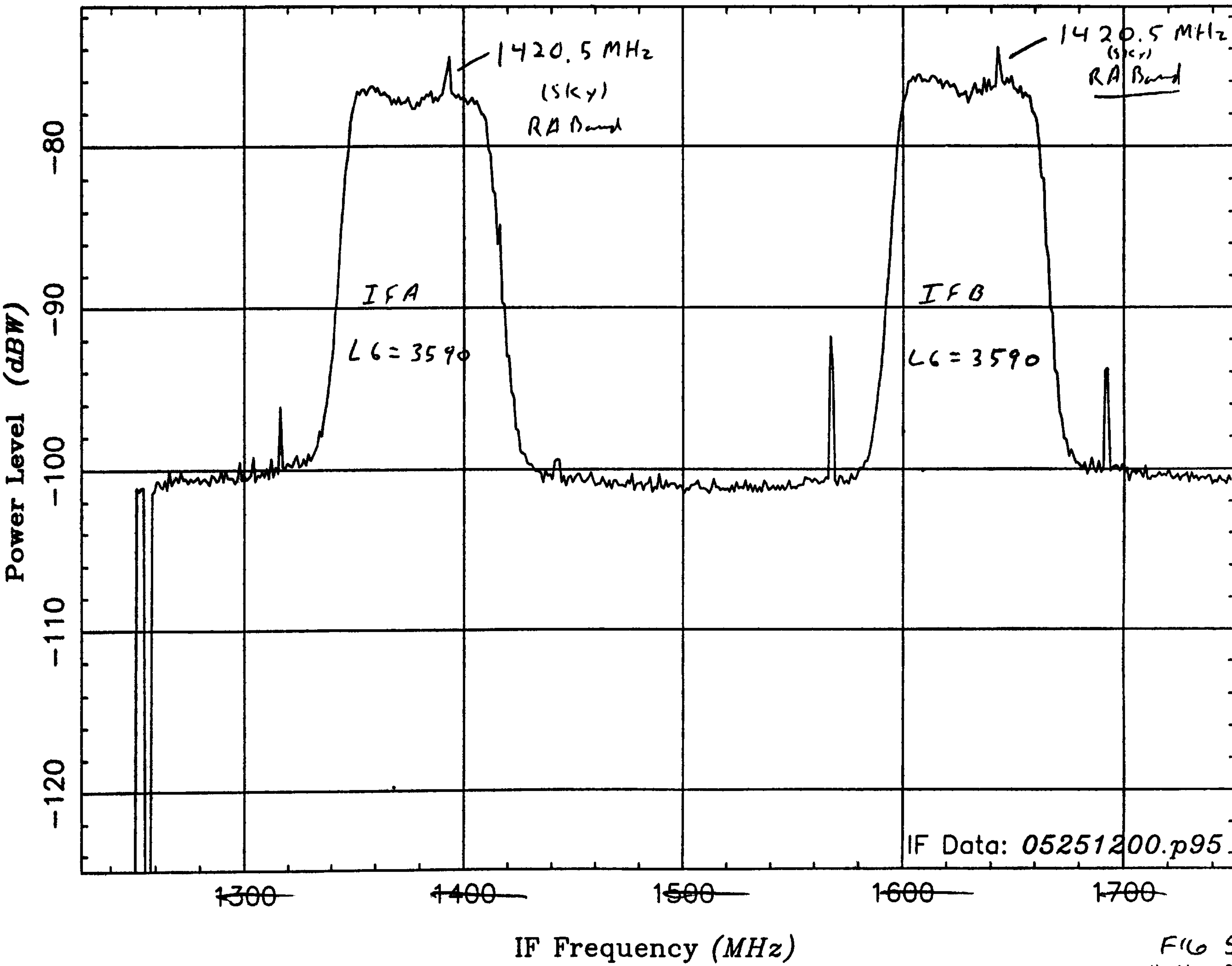


FIG 5

djenkins 2-Jun-1995 15:41

AS553

Schiminovich, Columbia

VLA On-Line IF Monitor Data - Average

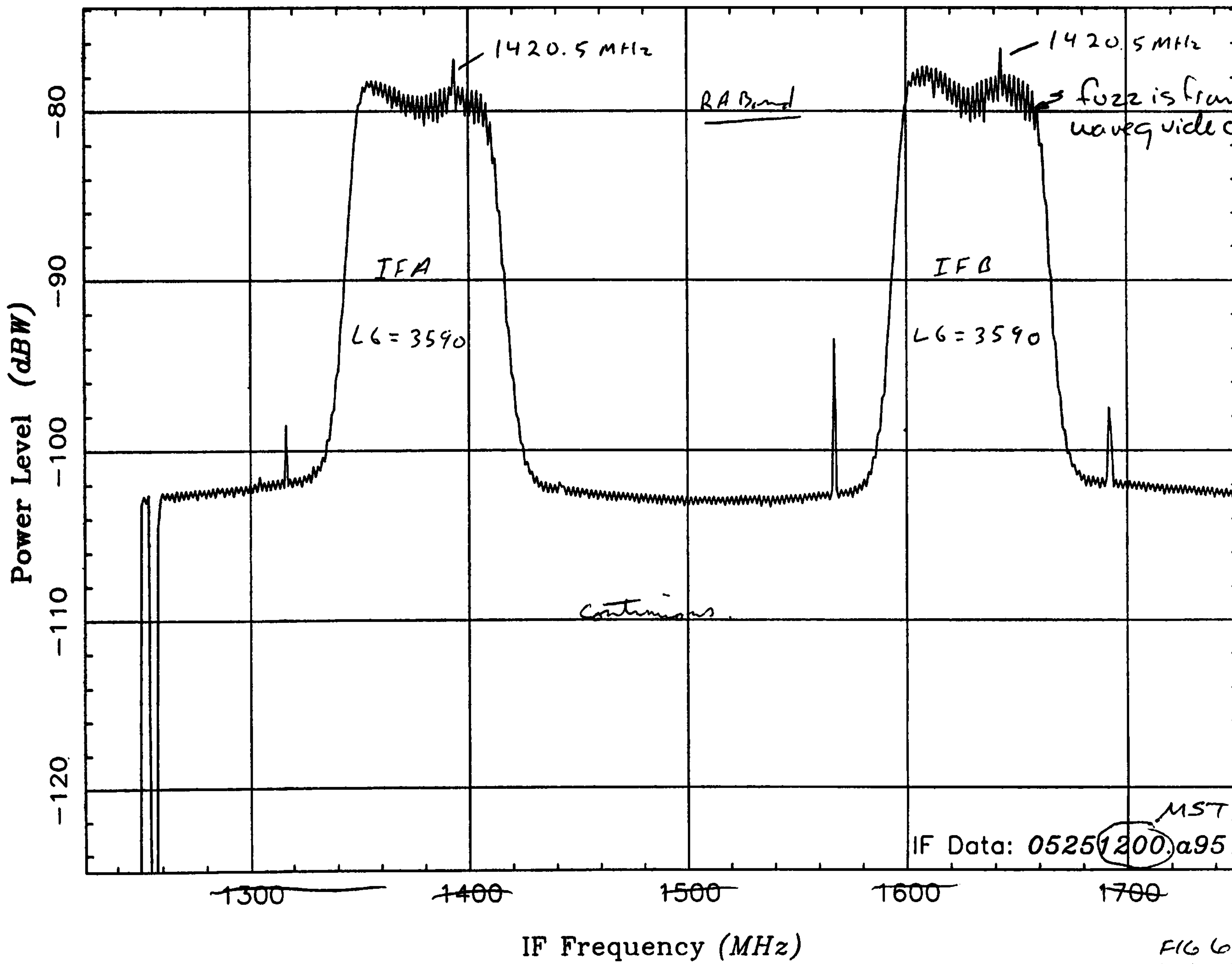
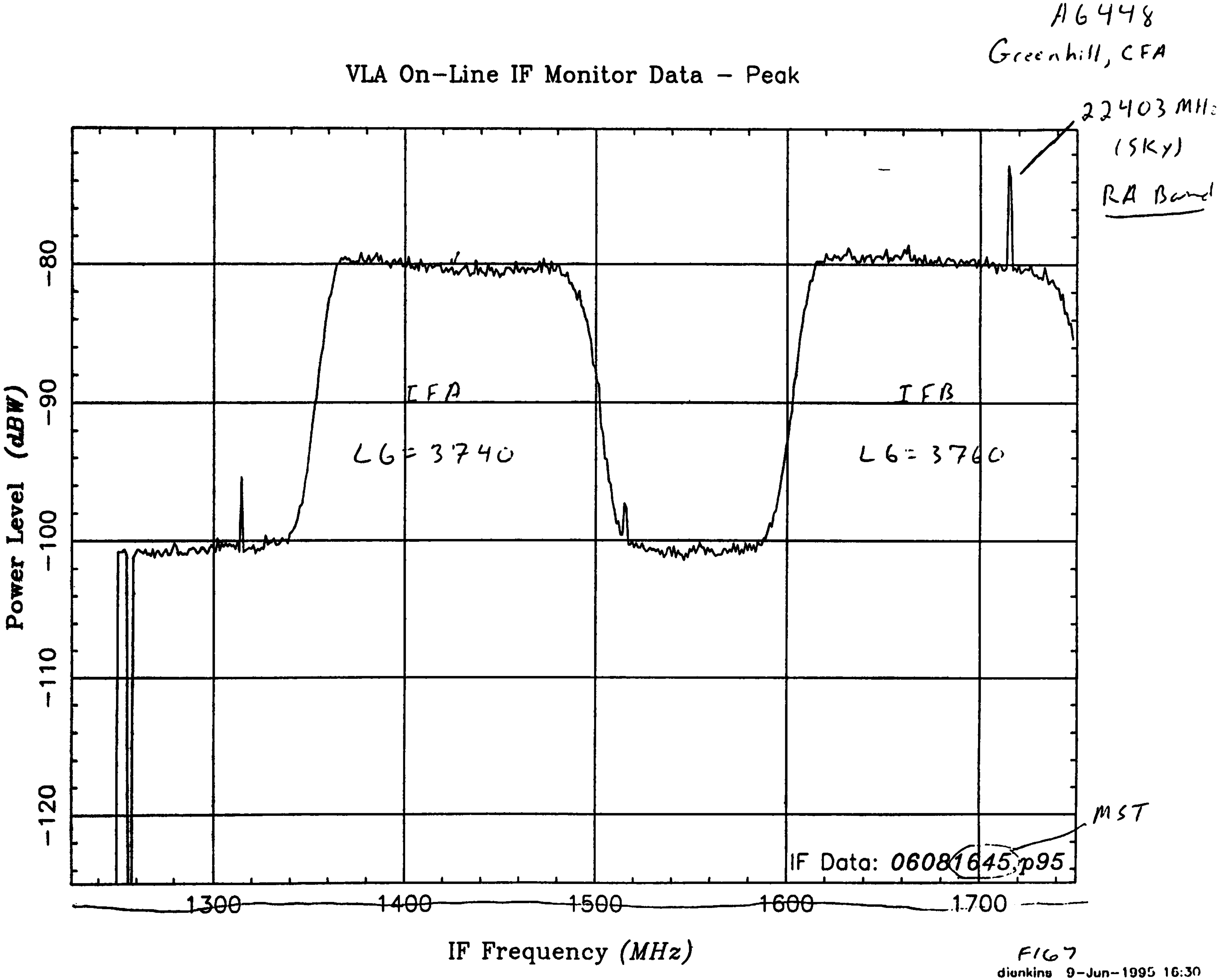


FIG 6

dienkins 2-Jun-1995 15:49


A6448
Greenhill, CFA
VLA On-Line IF Monitor Data - Peak
22403 MHz
(Sky)
RA Band
-80
-90
-100
-110
-120
Power Level (dBW)
IFA
L6=3740
IFB
L6=3760
MST
IF Data: 06081645.p95
1300
1400
1500
1600
1700
IF Frequency (MHz)
F167
djenkins 9-Jun-1995 16:30

AG 448
Greenhill, CFA

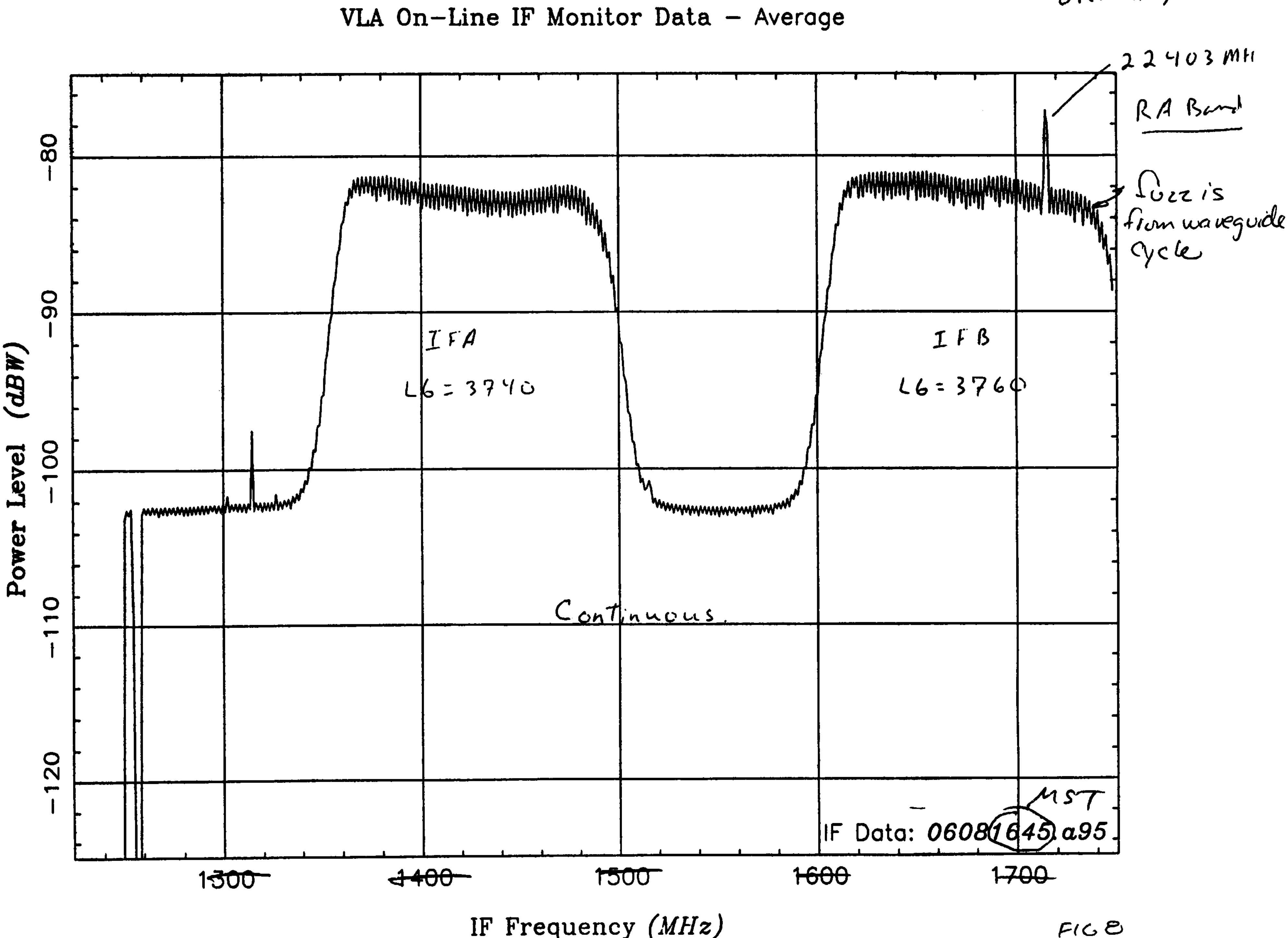


FIG 8
dienkins 9-Jun-1995 16:32

AH343
M. HOLDAWAY

VLA On-Line IF Monitor Data - Peak

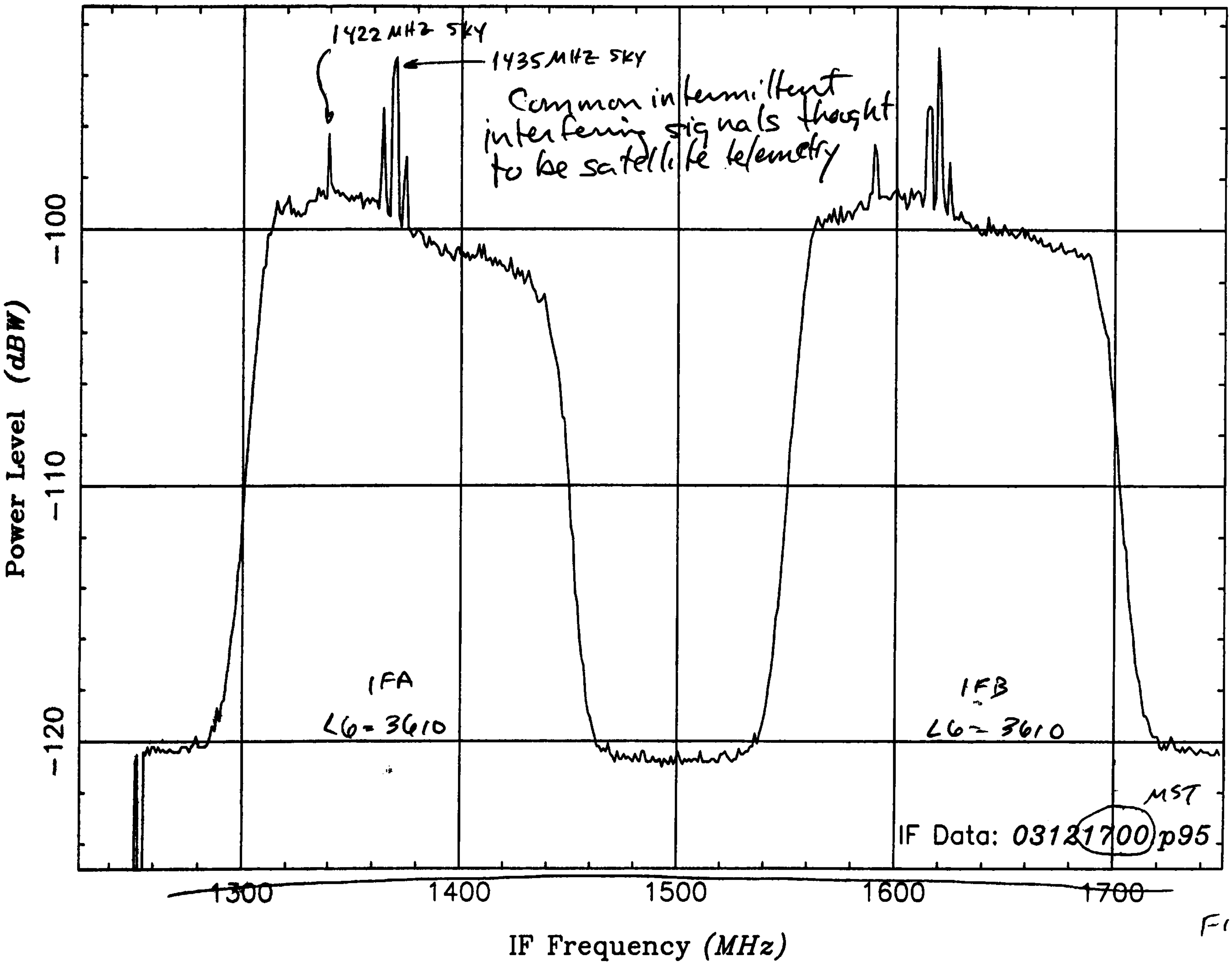


FIG 9

cianes 14-Mar-1995 09:08

AH 535
M. Holdaway

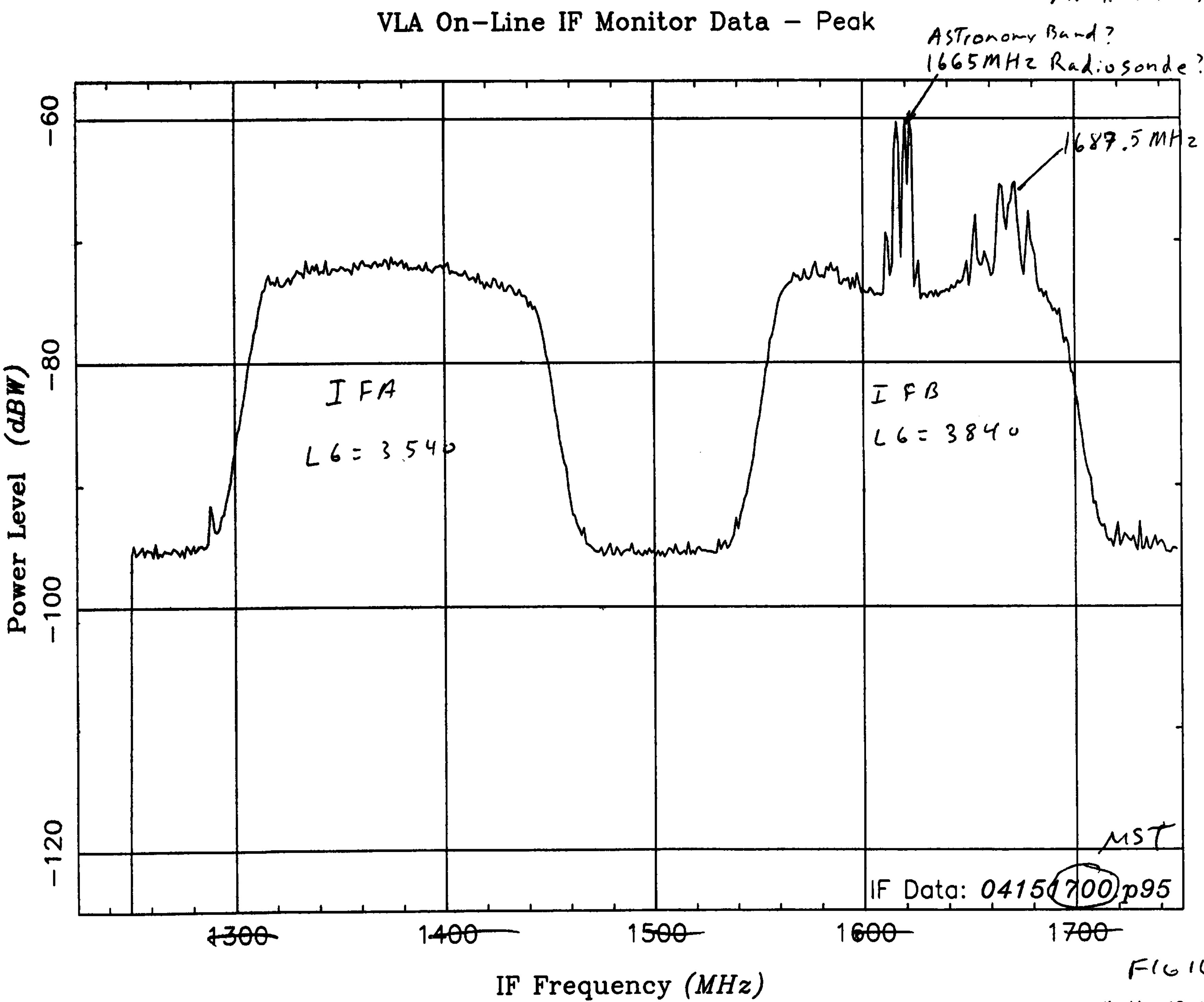


FIG 10

dienkins 18-Apr-1995 15:35

AH 536

M. Holdaway

VLA On-Line IF Monitor Data – Average

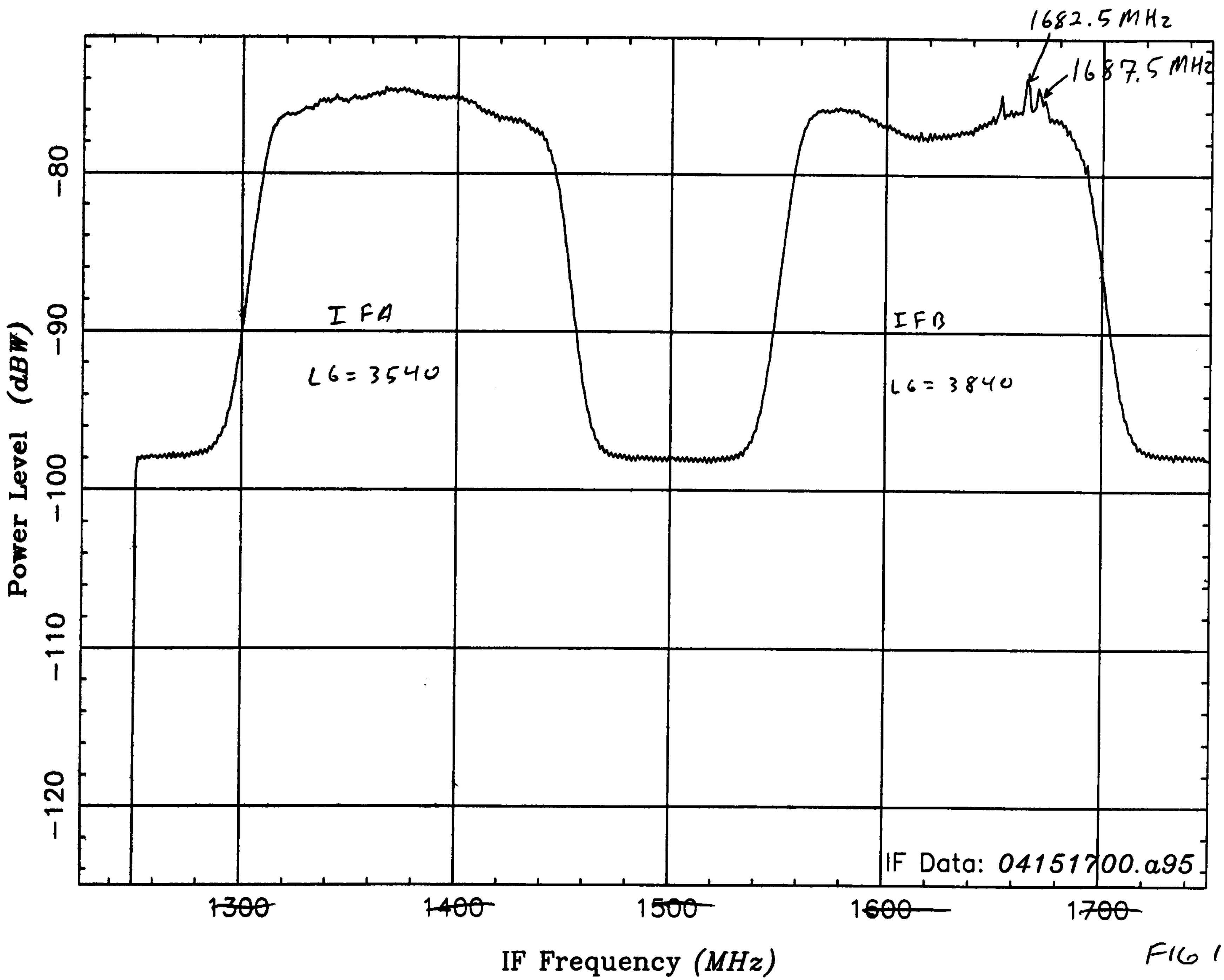


FIG 11

dienkins 18-Apr-1995 15:35