NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA ELECTRONICS MEMORANDUM 108

INTERIM REPORT

FREQUENCY SURVEILLANCE AT VLA SITE

James L. Dolan

February 27, 1973

Introduction

The VLA on-site spectrum survey measurements were started on Thursday, December 7, 1972. The equipment consisted of the following:

1) Spectrum analyzer, Hewlett Packard, model 8555.
2) Antenna, Dorne and Margolin, omni-directional, 1 to 12 GHz. Gain approximately isotropic.
3) Preamplifier, 1 to 2 GHz, Avantek, model AM-1000N. Noise figure 2.5–3 dB. Gain 35 dB.
4) Preamplifier, 4 to 8 GHz, Microstate, model ACP-6000-10E2. Noise figure ≈ 7 dB. Gain 35 dB.
5) Chart recorder, Sanborn, model 321, dual channel.

Measurement Procedures

The two bands of immediate interest (1 to 2 GHz and 4 to 5 GHz) were observed on alternate days. The spectrum analyzer was adjusted to scan from 1.15 to 2.15 GHz at 1000 sec per scan (1 MHz per sec). Maximum instantaneous bandwidth of 300 kHz was used providing about 330 milliseconds dwell on a monochromatic signal. There were two instrumental problems in this system.

1) The gain of the 4 to 8 GHz preamplifier was too low, allowing the high noise figure of the spectrum analyzer to contribute enough noise to increase system noise figure to about 12 dB. With the isotropic antenna system, sensitivity was about 1×10^{-18} W/m^2. During the period from December 7, 1972 to January 22, 1973, no signals exceeding this level were observed in the 4.0 to 5.0 GHz band. After January 22, some signals were observed but most appear to be feed through.

2) The vertical rise time of the recorder was insufficient to follow rapid sweeping and pulsing signals such as radar. Although the pulsed signals could be observed on the CRT, the recorder system would not indicate the presence of the signal.

The system was operated under these conditions from December 7, 1972 to January 22, 1973 when some improvements were made. Data for this period is presented on graphs 3-12.

Two new preamplifiers were obtained and put into operation on January 22. Sensitivity for 1 to 2 GHz was essentially unchanged from the 1×10^{-12} W/m^2. However, the sensitivity for the 4 to 5 GHz range was improved to about 1×10^{-10} W/m^2 with the isotropic antenna. In addition to the new amplifiers, a peak detection system was designed and constructed at Green Bank to enable the recorder to follow the radar type signals. This system performed as expected and increased overall system effectiveness. After January 22, both peak and average output were recorded.

Remaining Problems

This system suffers from some inherent problems:

1) No directivity — impossible to locate direction of incoming signals.
2) Feed through from low frequencies to the 4 to 5 GHz band.
3) Statistical analysis required because of scanning techniques. New receivers are being designed to eliminate these problems. Target date for completion is about 4 to 6 months (mid-summer 1973).

Summary

Figures 1 and 2 are plots of data received from the Electromagnetic Compatibility Analysis Center (ECAC) at Annapolis, Maryland. Figure 1 is for the area around Green Bank and Figure 2 is for the site Y15, near Magadelena, New Mexico. The information is from records kept at ECAC and does not include some frequency assignments made by the area coordinator at White Sands, New Mexico. The information was provided as power density versus frequency for certain frequency bands specified by NRAO. The

power density was summed in 5 MHz incremenets. Each transmitter capable of tuning within a given 5 MHz area was included in the power summation for that increment. It can be seen by direct comparison that the spectrum in the Y15 area is more crowded with larger power densities than the Green Bank area.

Starting with Figure 3, the graphs present data from the NRAO monitoring station at Y15. The data was taken manually from the strip charts returned to the NRAO by personnel at the New Mexico Institute of Mining and Technology. The amplitude is estimated to be correct to about an order of magnitude and frequency to about ± 20 MHz as it is somewhat difficult to reset the bandspread to exact frequencies, and the oscillator stability is related to temperature. The resolution on the strip chart is 13 MHz per millimeter. Two graphs per observation period are necessary to present all the data. One graph shows amplitude versus frequency and the other shows percent of observation time a signal was observed. The time was derived as follows:

a) The scan time was 1000 seconds. If the signal appeared during a scan it was assumed present for the entire 1000 seconds.

b) The time was then summed and presented as percent of observation time.

On January 22 the system was slightly modified. The new 1 to 2 GHz preamp does not appear to provide a noise figure as low as the previous amplifier. The 4 to 5 GHz system is better, but it is troubled by what appears to be feed through. A low confidence level is placed on the graphs for 4 to 5 GHz. The peak detector improved the system sensitivity relative to pulse signals and a definite increase in the number of signals is noted after January 22. No signals could be found on the records for the 4 to 5 GHz range before January 22.

One anomally is the lack of activity between January 1 and January 22. The records were double checked and no instrumental changes were made during this period. It appears that the period was relatively free from activity. The signal at 2. 15 GHz is from a microwave relay tower located on the eastern edge of site Y15. It was used as a calibrator and indicator of system reliability.

KEUFFEL & ESSER CO.

Green Bank

ECAC DB-1200B

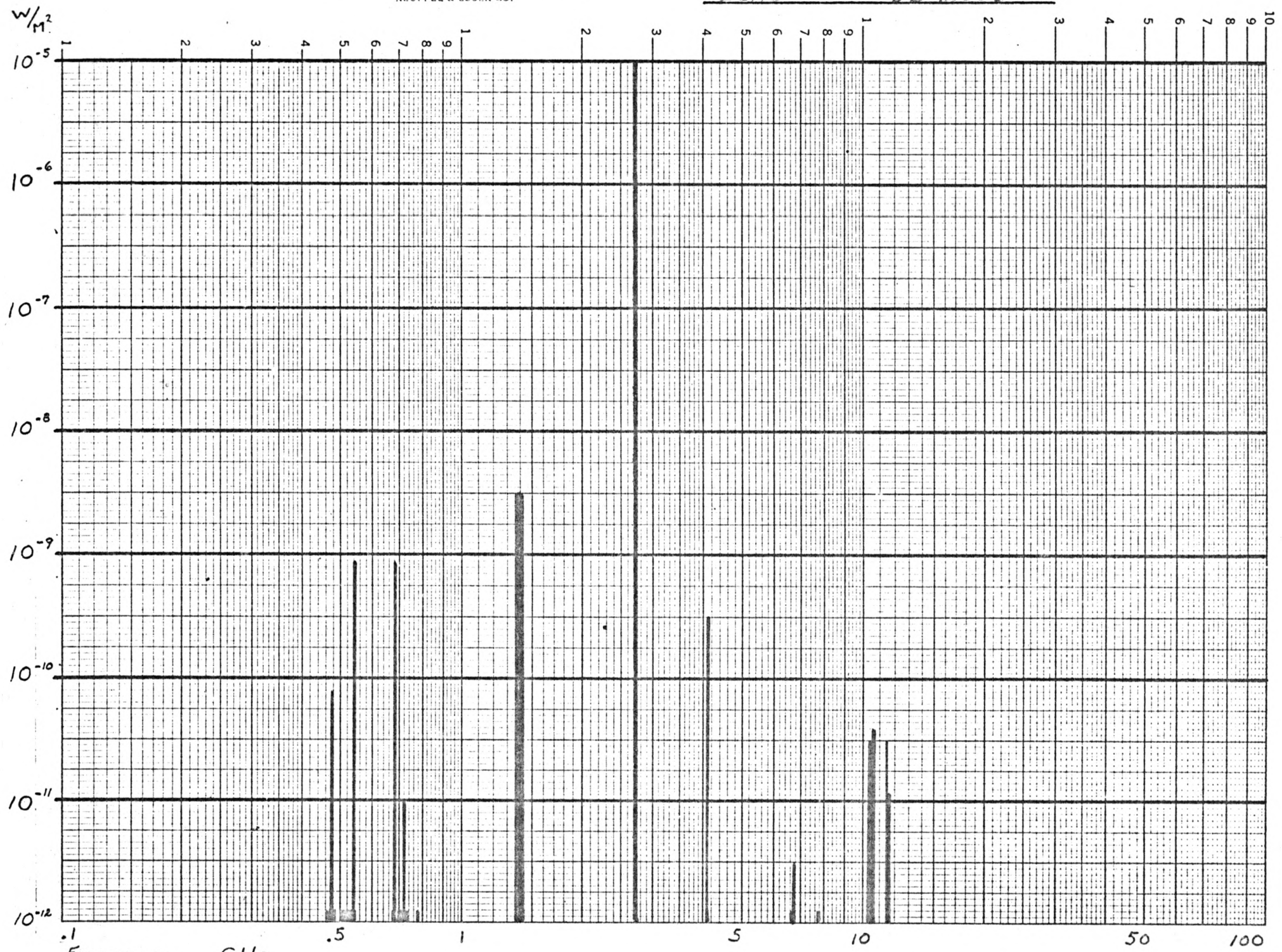


FIGURE 1

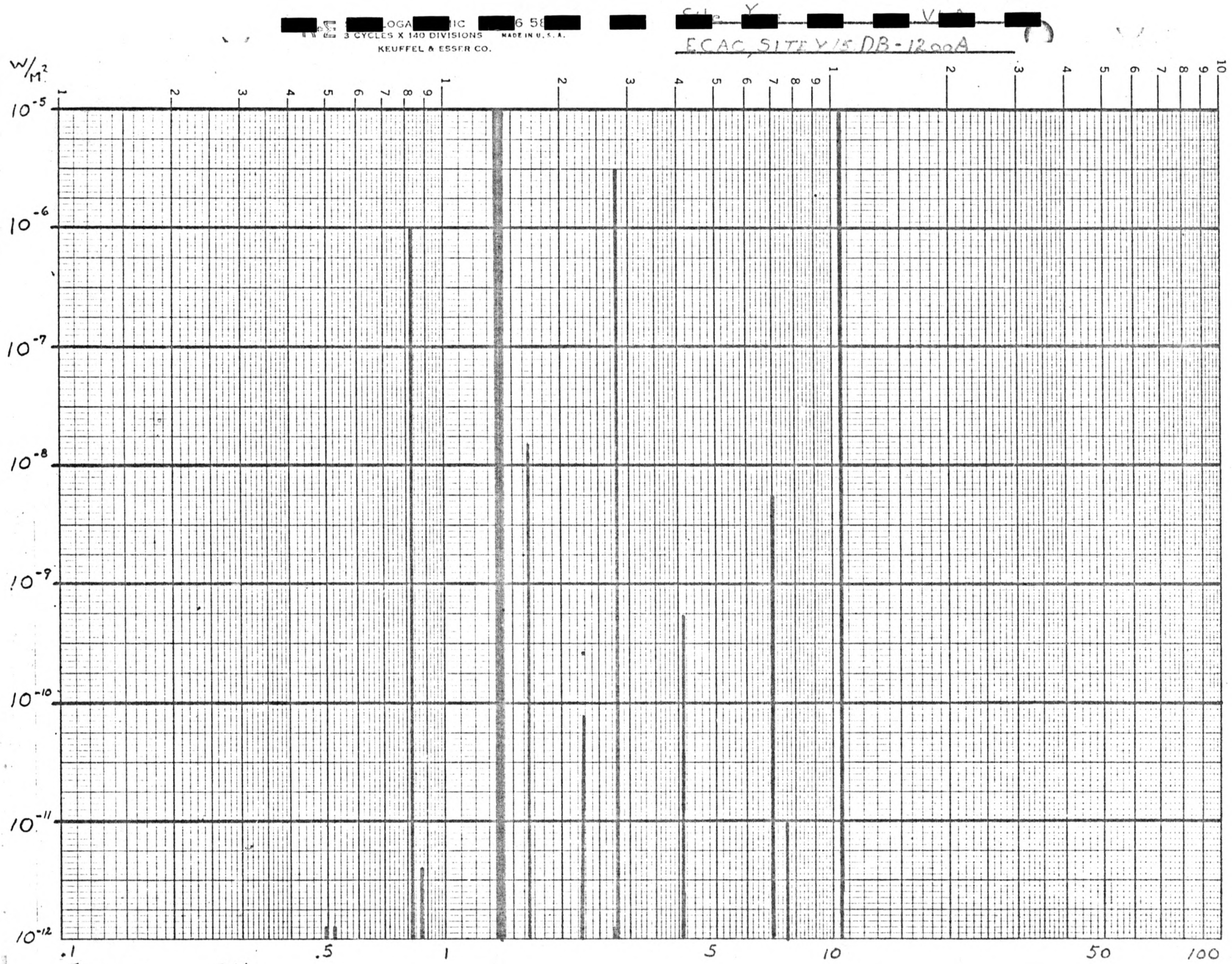
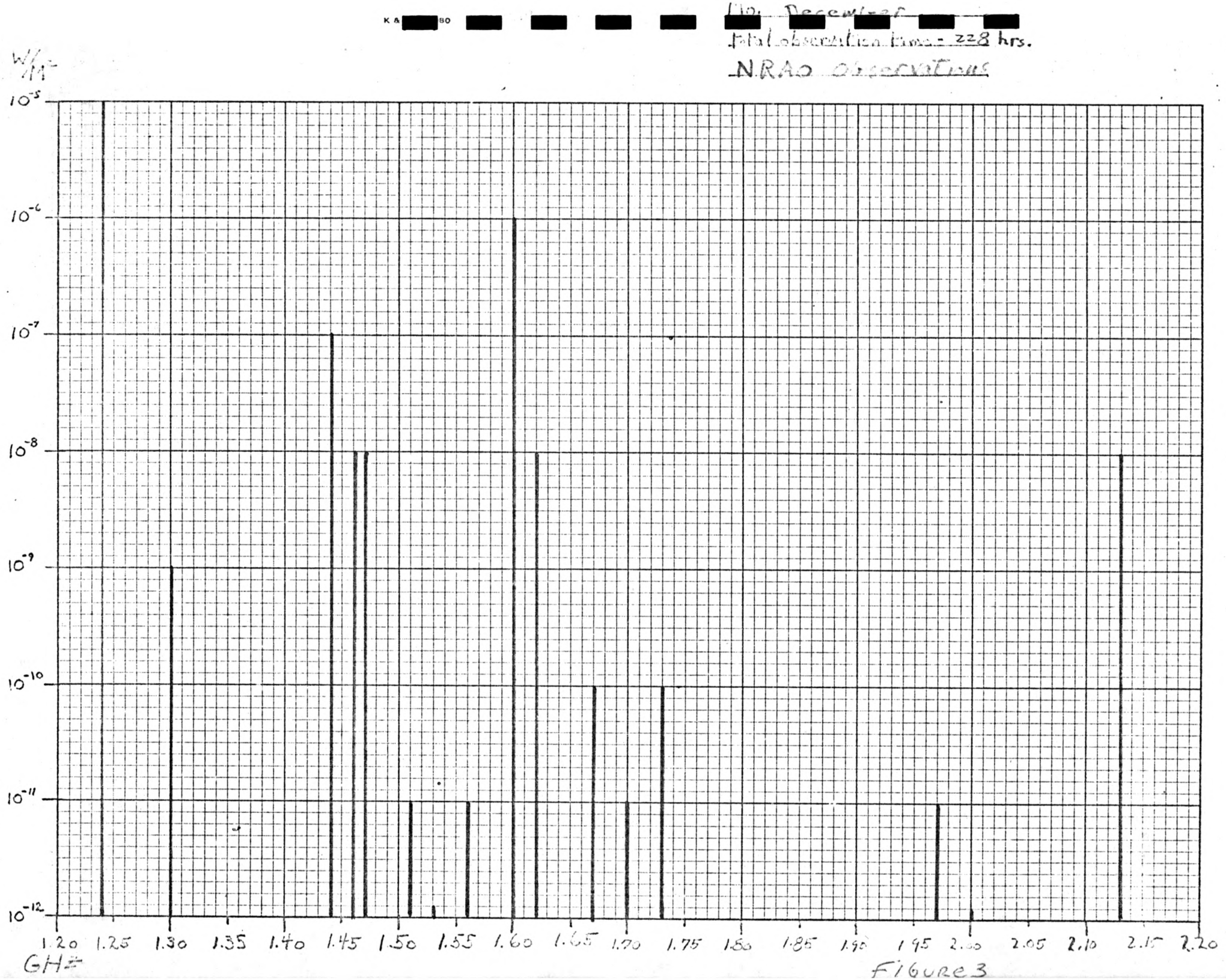

3 CYCLES X 140 DIVISIONS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
ECAC, SITE V15 DB-1200A
W/M²
10⁻⁵
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
10⁻¹⁰
10⁻¹¹
10⁻¹²
.1
.5
1
5
10
50
100
Frequency GHz

FIGURE 2



Dec.

total observation time = 228 hrs.

N.R.A.O. observations

Figure 3

[redacted] Mo. December [redacted]

total observation time - 228 hrs

NRAO observations

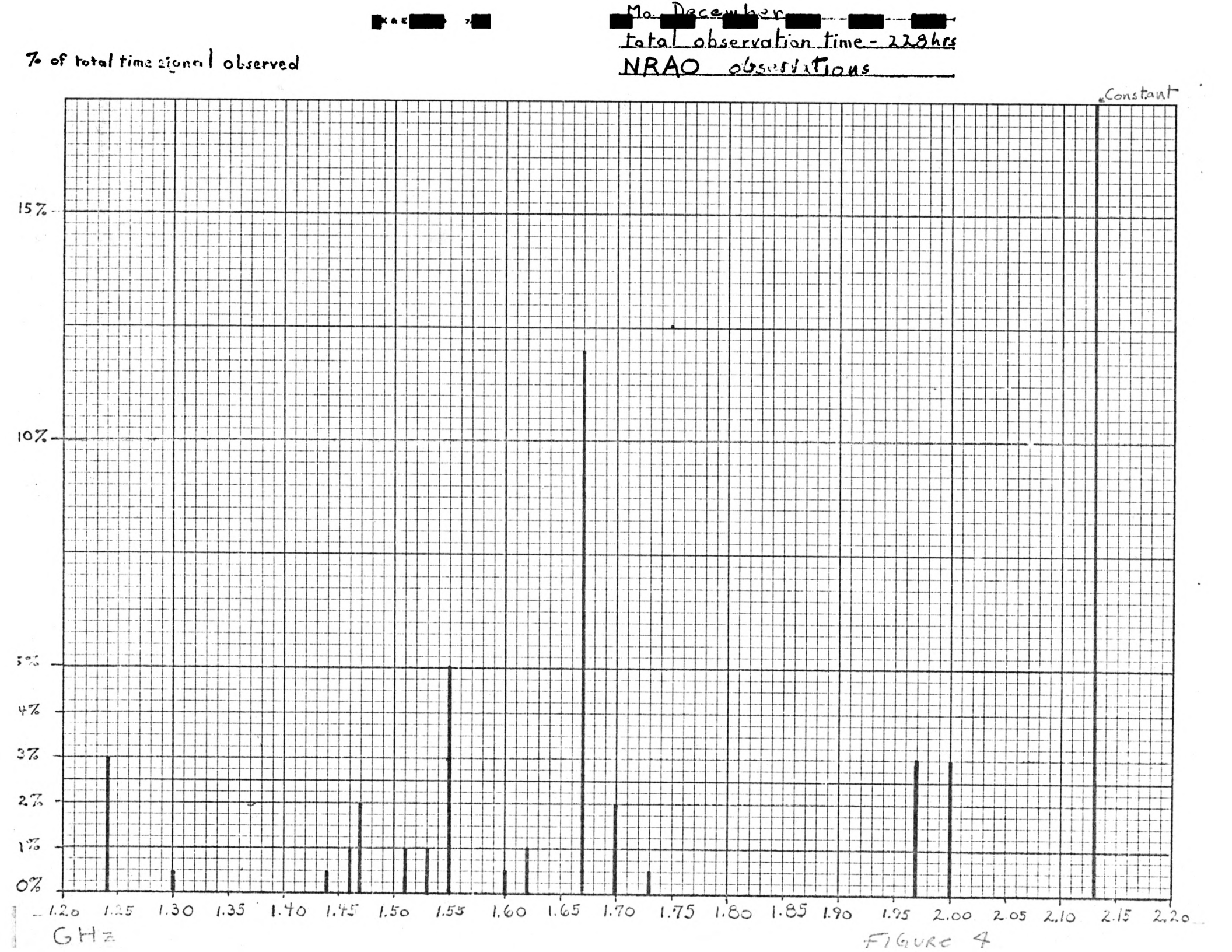


FIGURE 4

Mon Jan 1 - 22

Total observation time - 256 hrs.

NRAO observations

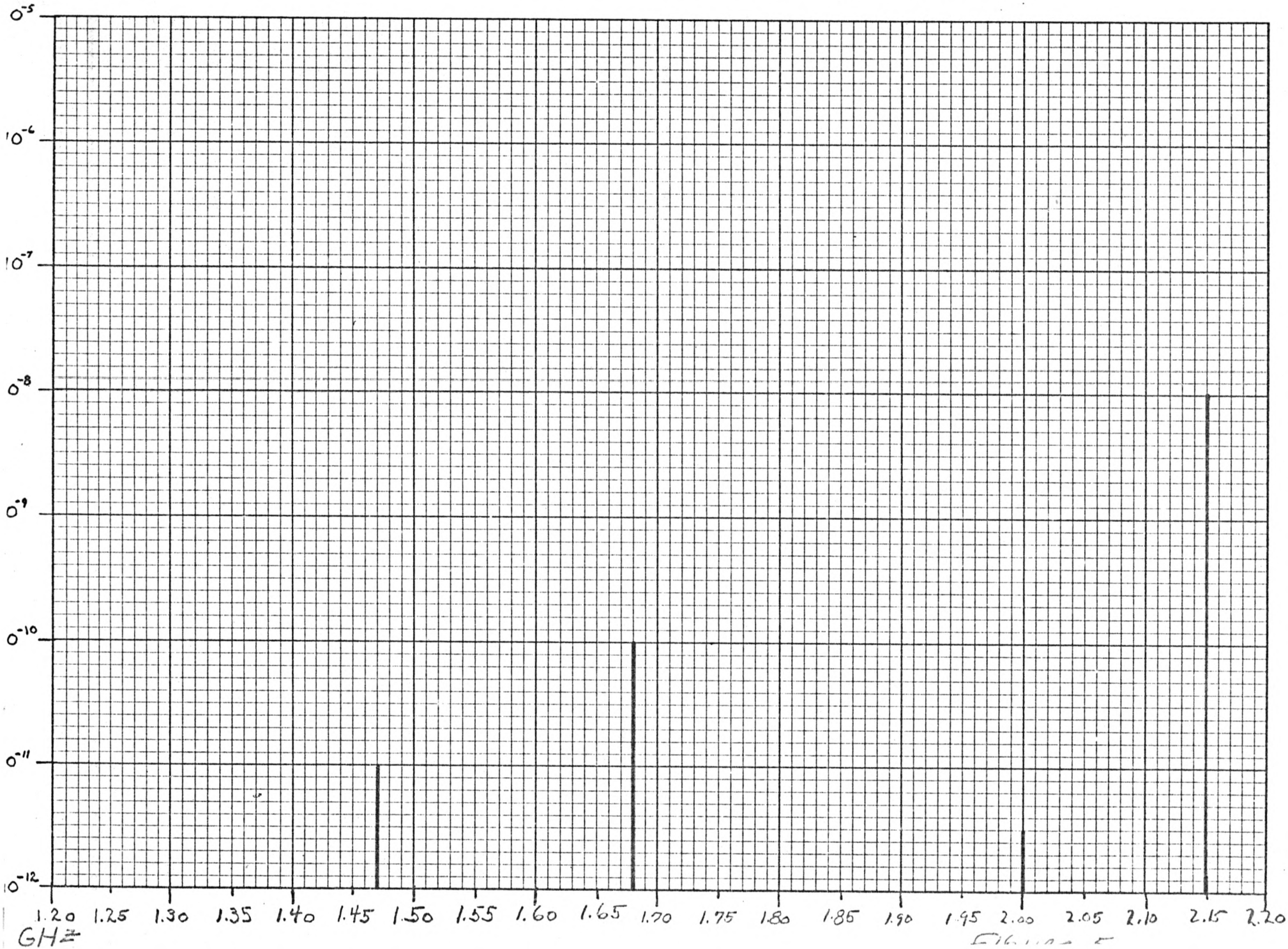


FIGURE 5

Ka [redacted] Mo Jan 1-22

Total observation time - 256 hrs.

NRAO observation

% of total time signal observed

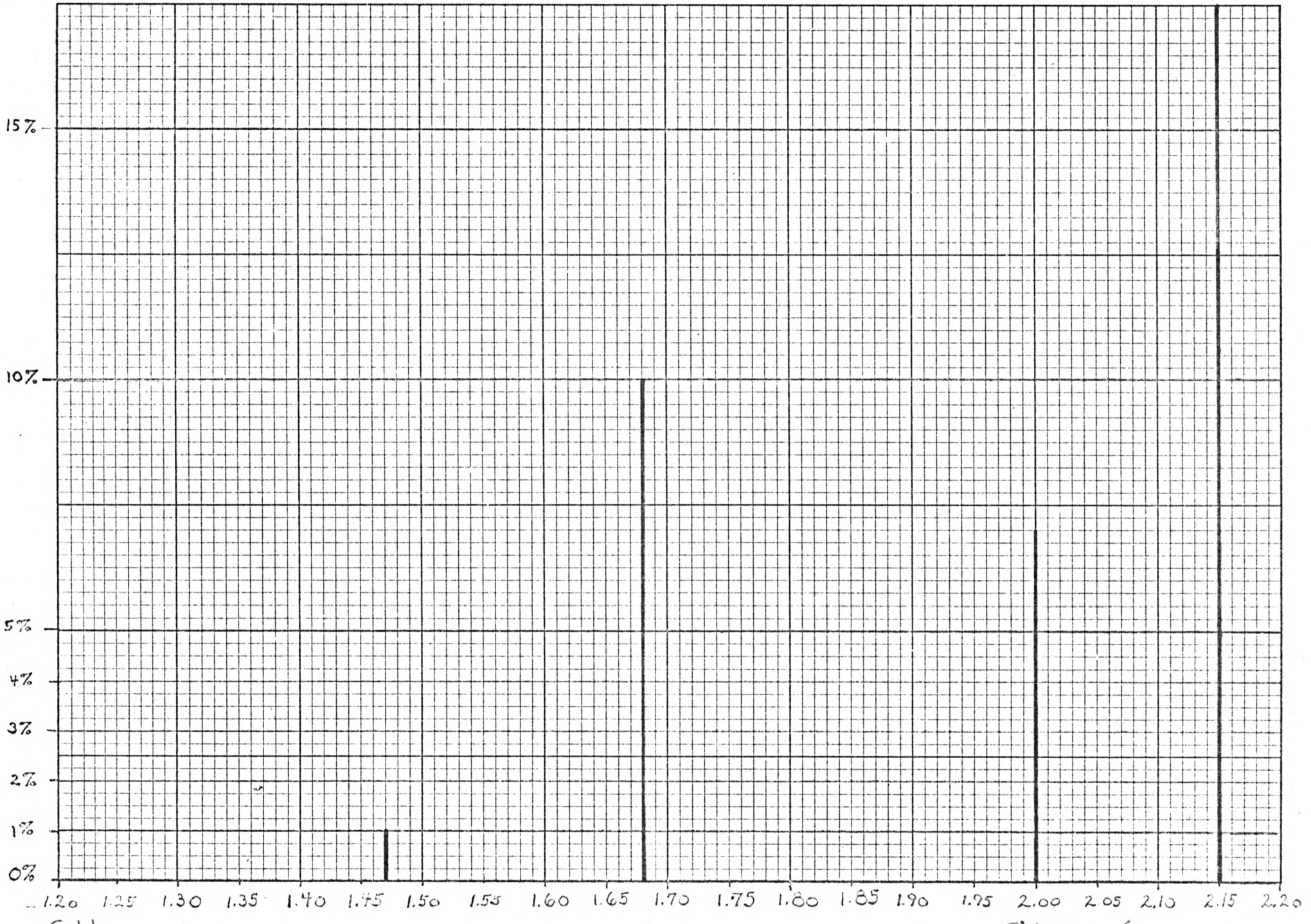
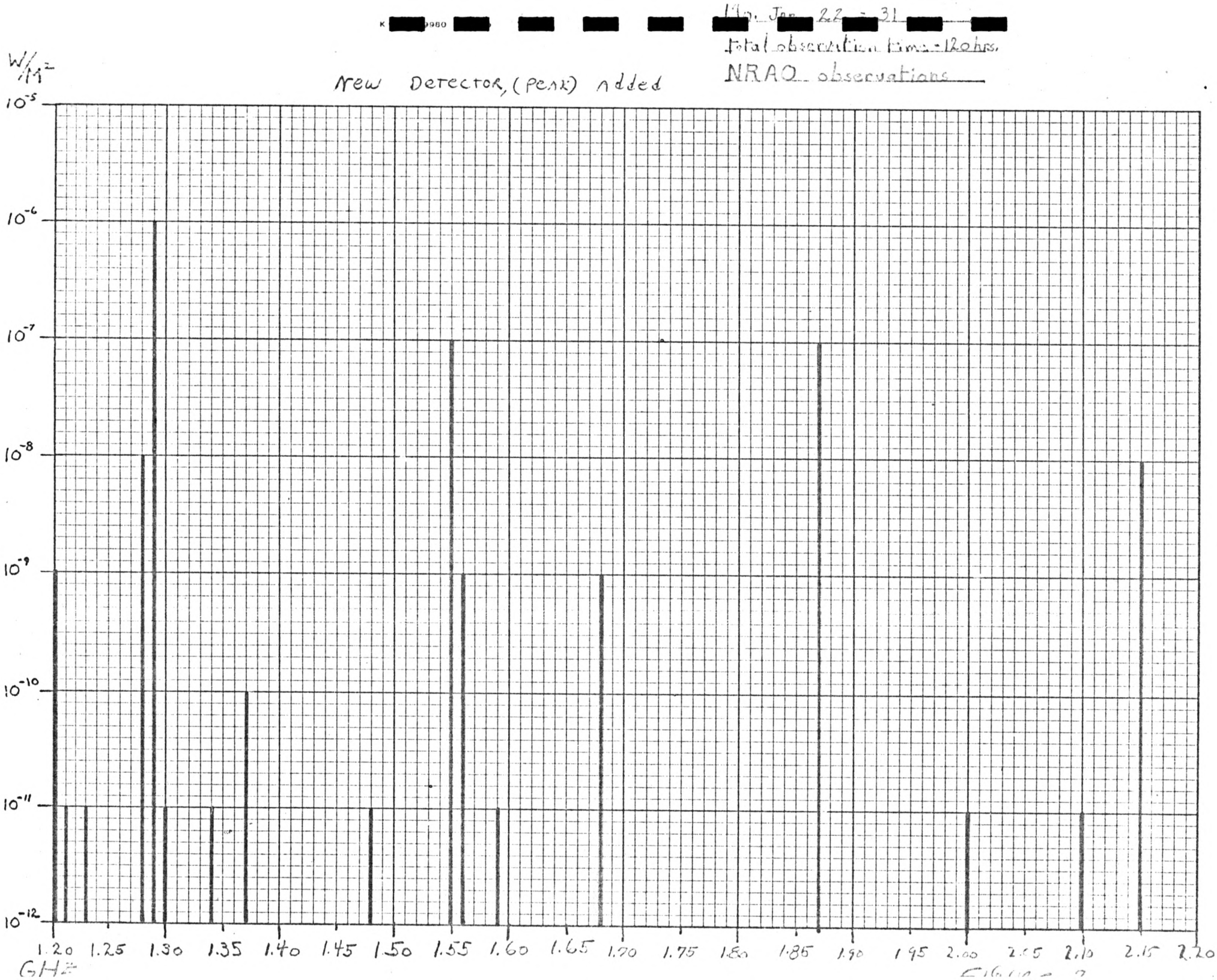


Figure 6


W/M²
New Detector, (peak) added
Jan 22 - 31
Total observation time - 12 hrs.
NRAO observations
10⁻⁵
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
10⁻¹⁰
10⁻¹¹
10⁻¹²
1.20 1.25 1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70 1.75 1.80 1.85 1.90 1.95 2.00 2.05 2.10 2.15 2.20
GHz

Mo. Jan. 22 - 31

Total observation time - 120 hrs.

NRRO observations

% of total time signal observed

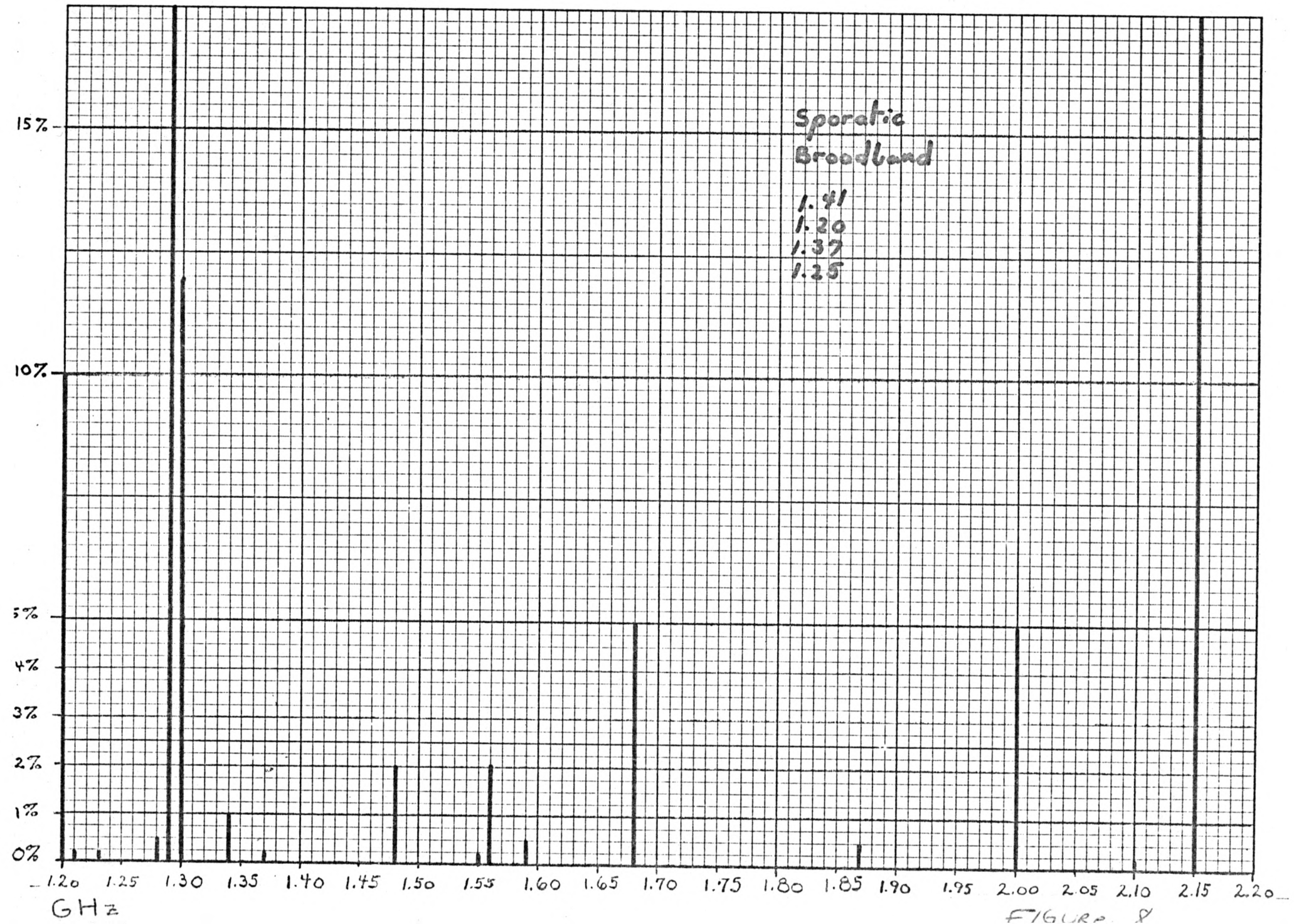


FIGURE 8

Total observation time - 168 hrs.
NRAO observations

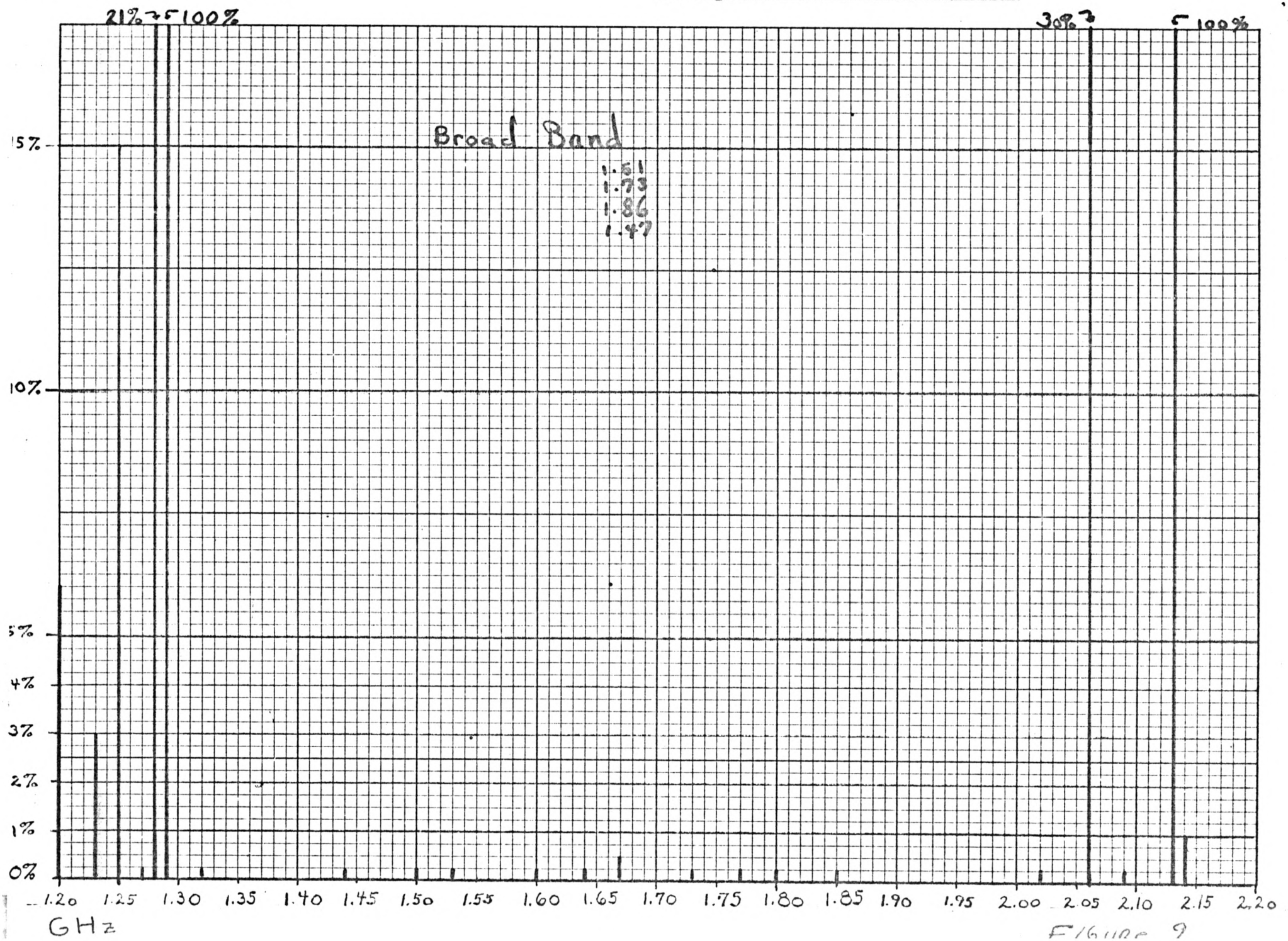


Figure 9

Mo. Feb. 1 - 15

Total observation time - 168 hrs.

NRAO observations

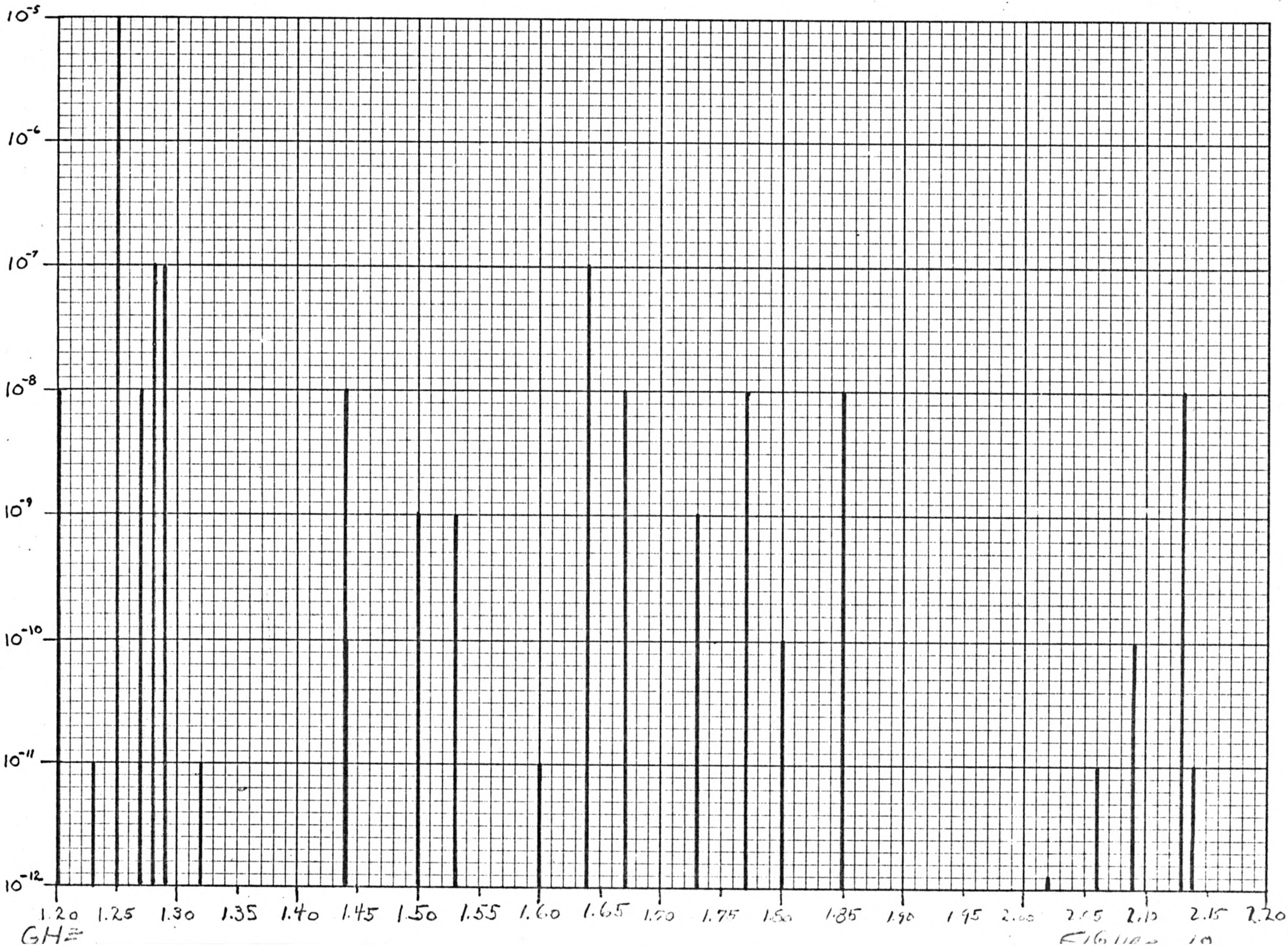


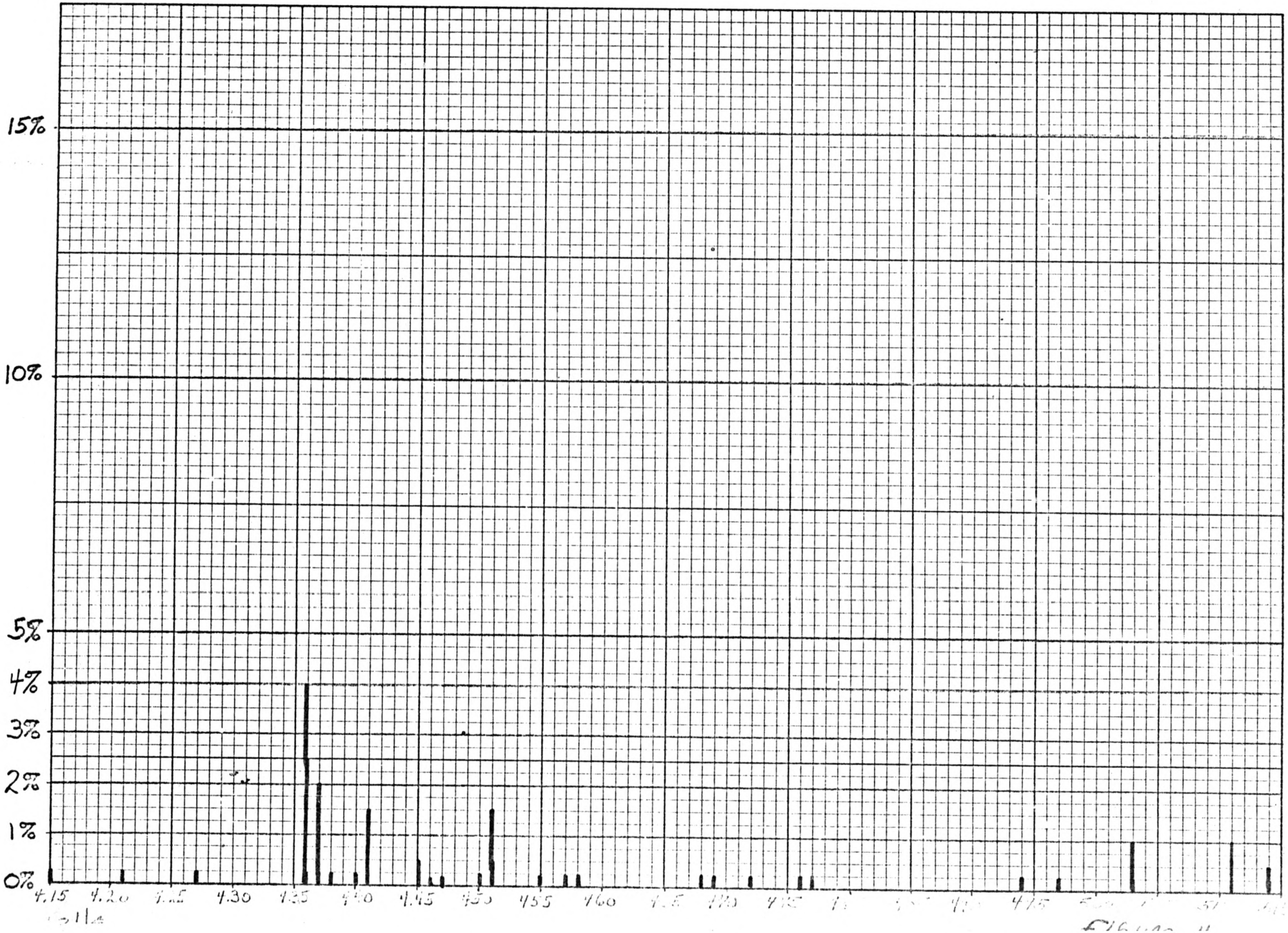
FIGURE 10

[redacted] F[redacted] [redacted]

total observations - 166 hrs.

NRAO observations

% of total time signal observed

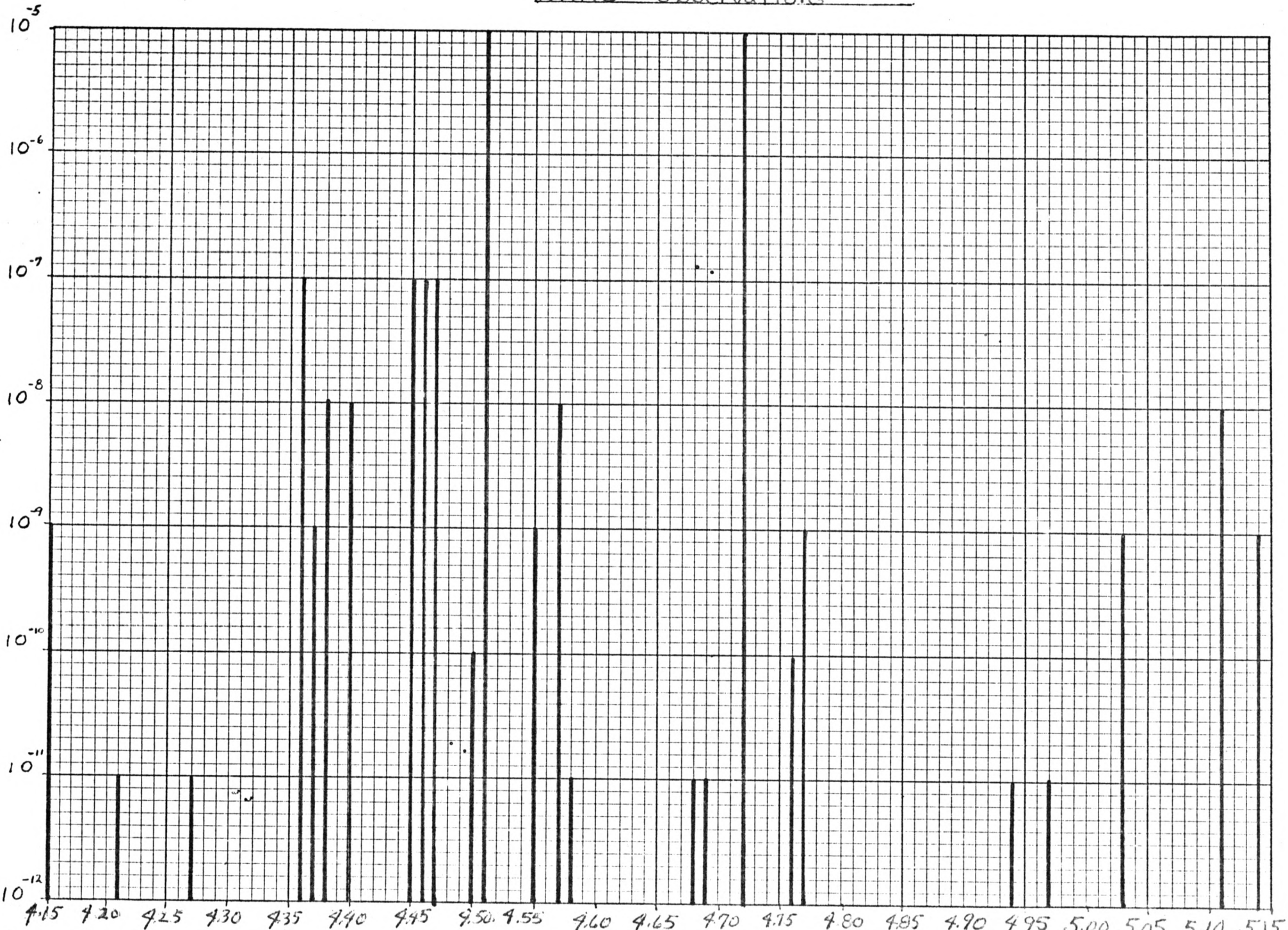


K & E 99 9980 74579

[redacted] [redacted] [redacted] 15[redacted]

total observation time · 166 hrs.

NRAO observations



NATIONAL RADIO ASTRONOMY OBSERVATORY

ADDENDUM TO VLA MEMORANDUM 108

Frequency Surveillance at VLA Site

James L. Dolan

April 4, 1973

Since the previous report was written (27 February 1973), the spectrum surveillance at the VLA site has continued, with the following changes in equipment.

On March 20, the 4.0 to 5.0 GHz system was equipped with a tracking YIG preselector that appears to solve the spurious problem. It is somewhat premature to comment on C band, but at least up to the present no signals above our detection level have been definitely identified. The antenna is of small capture area ($\simeq 2 \times 10^{-4}$ m^2), keeping sensitivity down to about 10^{-9} to 10^{-10} w/m^2. A new antenna that will improve sensitivity by an order of magnitude will be installed.

The accompanying graphs for 1.2 to 2.2 GHz are a continuation of those presented in Memo 108, with the exception of the time being noted on the frequency-amplitude graph.

The four bands of particular interest in the L band regions,

1.35 to 1.40 GHz
1.40 to 1.45 GHz
1.605 to 1.620 GHz
1.660 to 1.675 GHz

were checked on all records to this date for information on total power in the band with respect to time. We intended to plot this data, but a table

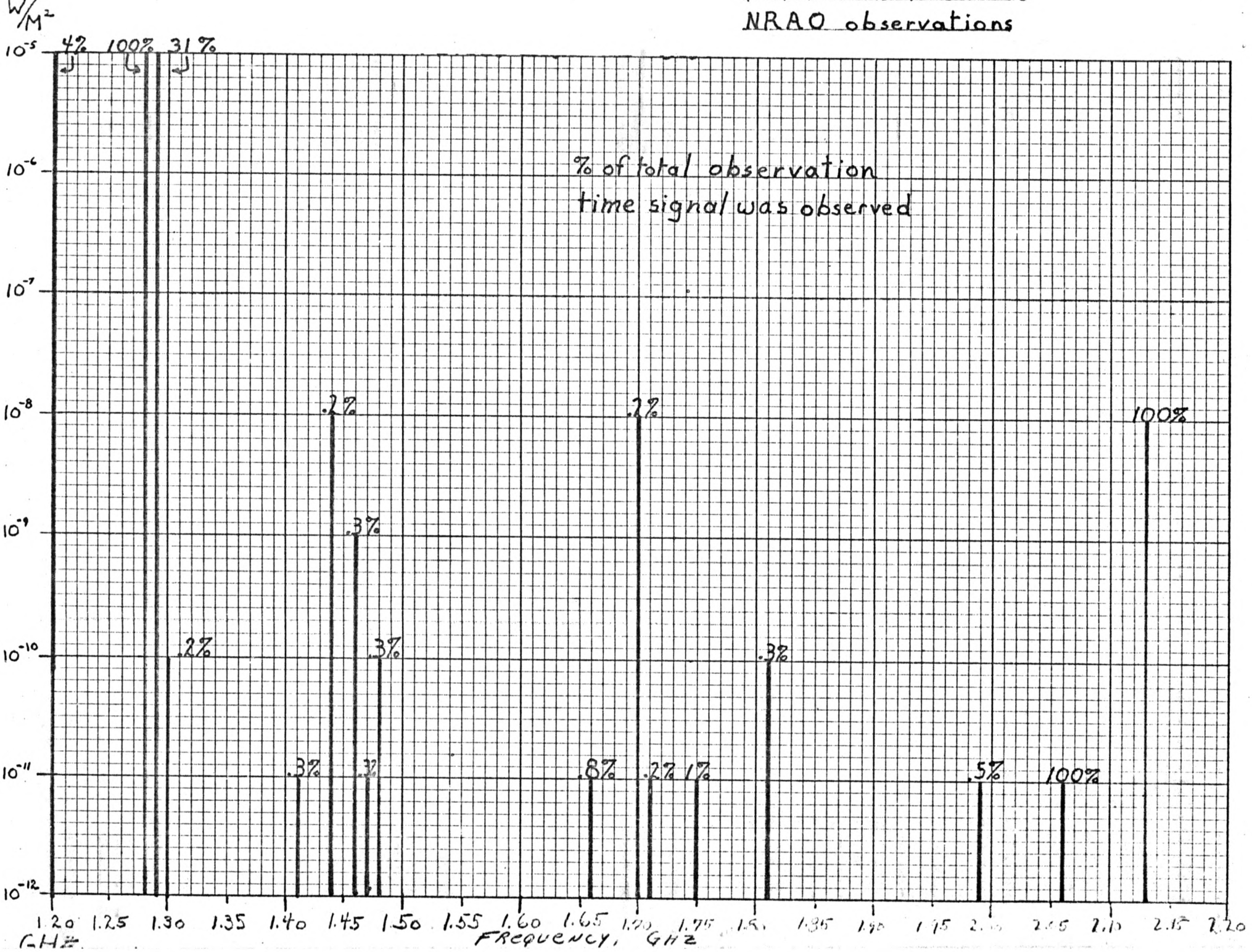
seemed to be the best way to show the small percent of time the bands contained power densities large enough to detect. (Our detection level is about an order of magnitude less than the level that will interfere with the VLA operation. Therefore, any signal we see is a potential problem.) The table shows worst case conditions, because some of the signals are peak and no effort was made to determine average power from the pulsed signals. Also on the narrow bands, frequency resolution was somewhat poor, so all signals adjacent to the bands were included. The times shown on the table are not cumulative. For example, the longest time any band contained interference was 0.2%. The 1.602 - 1.622 GHz band contained power density of 1×10^{-8} w/m^2 for 2 hours. (This shows up on the curve as 2 hours at all levels below 1×10^{-8} w/m^2.)

Recent conversations with the area frequency coordinator, Mr. Hungate, indicated that the strong continuous radar observed near 1.3 GHz probably belongs to the F.A.A., and, as suspected, it is located near Albuquerque at a place called West Mesa. Mr. Hungate feels that the signals observed in the OH region 1.660 to 1.700 GHz are mostly radiosonde equipment. The entire segment is assigned to meteorological aids, some satellite borne. Many radiosondes are used in the area. The radio astronomy service is assigned the band 1.660 - 1.670 GHz, but must accept interference from meteorological satellites. Radiosonde users in this band are supposed to notify U.S. radio astronomers, but I doubt that they do.

Mo. Feb. 15-28

Total observation time - 158 hrs.

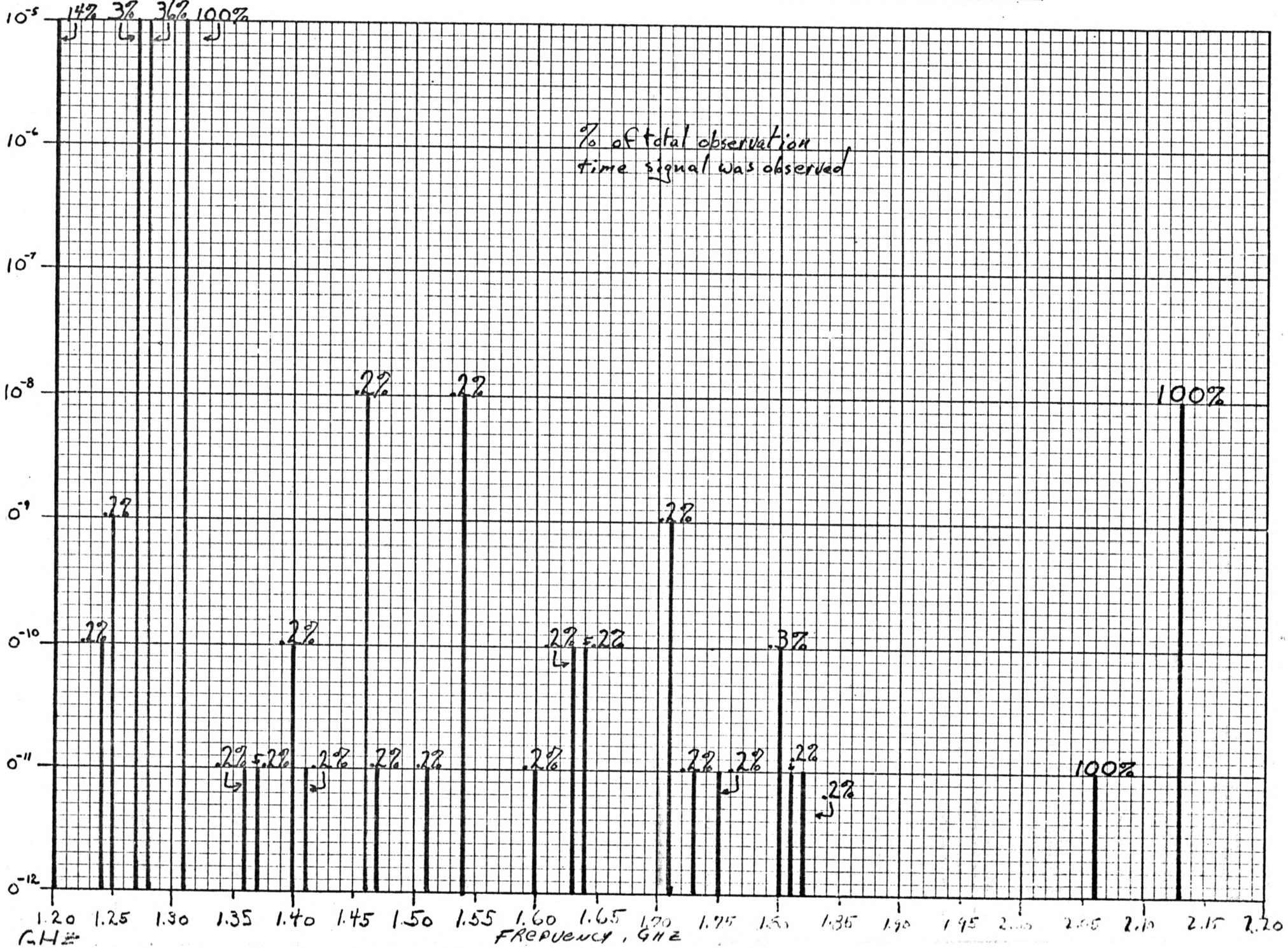
NRAO observations



Mo-MAR 1-11

total observation time - 166 hrs.

NRAO observations



BAND	TIME SIGNAL IS PRESENT	POWER DENSITY	% total time	NOTES
1.35 - 1.40 GHz	¾ hour	10^{-12}	0.07%	12/1/72 - 3/14/73
	¾ hour	10^{-11}	0.07%	total time - 1100 hrs.
	½ hour	10^{-10}	0.05%	
1.40 - 1.45 GHz	2¼ hours	10^{-12}	0.2%	
	2¼ hours	10^{-11}	0.2%	
	1¼ hours	10^{-10}	0.1%	
	1 hour	10^{-9}	0.09%	
	1 hour	10^{-8}	0.09%	
	½ hour	10^{-7}	0.05%	
1.602 - 1.622 GHz	2 hours	10^{-12}	0.2%	
	2 hours	10^{-11}	0.2%	
	2 hours	10^{-10}	0.2%	
	2 hours	10^{-9}	0.2%	
	2 hours	10^{-8}	0.2%	
1.657 - 1.677 GHz	1¼ hours	10^{-12}	0.1%	
	1¼ hours	10^{-11}	0.1%	