NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

Memo No. 16

Pulsar Signal Processor

Project 2.625

400 MHz INTERFERENCE SURVEY

J. R. Fisher

December 21, 1982

MEMORANDUM

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To: Pulsar Processor File

From: J. R. Fisher

Subj: 400 MHz Interference Survey

An interference monitor was run in parallel with a pulsar search experiment on the 300-ft telescope to get an estimate of the strength and frequency of occurrence of narrow band interference which will have to be dealt with by the pulsar processor. The strength of narrow band interference will set the channel-to-channel isolation specification of the processor.

This interference survey was conducted from December 7 through 17 with the 400 MHz cooled upconverter/FET system which has a system temperature of about 70 K. The monitor receiver consisted of three IF passbands with total power detectors connected to the same front end channel. The passbands of the three IF's are shown schematically in Figure 1. Detector outputs were integrated for 0.3 seconds before further processing. Narrow-band interference was distinguished from wideband interference by comparing the simultaneous outputs of the three detectors. A narrow band signal produced a higher output in only one or two of the three detectors.

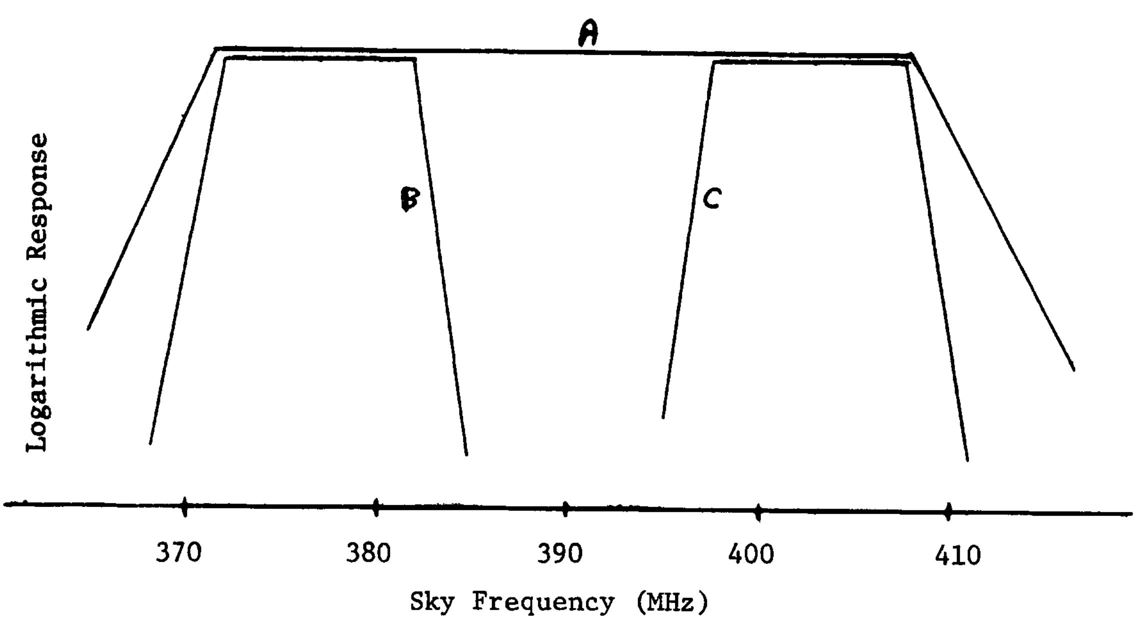


Figure 1. Schematic Filter Response of Three Channels

To help reduce the effects of long-term receiver and antenna temperature changes the detector outputs were differentiated in two ways. The first, which will be called "differential," was a straight point by point subtraction of the current sample from the immediately preceding sample. The second, called "excess," was also an adjacent point difference except when the "differential" exceeded ten times its expected rms fluctuation value in which case all "excess" values were measured with respect to the last data point recorded before a significant output change was measured. The "excess" reference was not updated until ten successive less than ten sigma "differential" values were measured. The "excess" values are more sensitive to interference which stayed on for more than one sample period. Both differentiations will tend to underestimate the strength and particularly the duration of steady interference, but most interference varies in amplitude fairly rapidly so this probably was not a major problem. Very strong interference which overloads a detector would foil both differentiations.

Four sets of statistics were accumulated for each of the two differences and these are displayed in Figures 2-9. The histograms in these figures show the frequency of occurrence of absolute "differential" or "excess" values under four conditions of relative strength in the three passbands. The horizontal scales are logarithmic with the edges of the bins being integral powers of two in Kelvin units. Two values of 1 K and 64 K are marked of which the latter is roughly equal to the system temperature. The detectors saturated at about 700 K, and the random receiver noise produced measured differentials of 0.03 K in channel A and 0.06 K in channels B and C. These noise values correspond to bins 3 and 4, respectively. The vertical scale is the percentage frequency of occurrence of values between or above specified levels.

The top two histograms in Figures 2-9 are statistics for channel A under the condition that the A "differential" or "excess" absolute value is greater than that for either B or C. This condition is satisfied when a narrowband signal occurs anywhere is passband A. The second and third pairs of histograms in each figure show the occurrences of narrow band signals in the two narrower passbands. The fourth pair of histograms was intended to show the statistics of wideband interference which should occur with equal strength in all three channels but these diagrams tend to be heavily contaminated by narrow band signals in two of the three passbands simultaneous with low level wide band interference.

The data were divided into nighttime and daytime periods to see if the interference had a diurinal dependence. The nighttime extends roughly from 1800 to 0600 EST and includes about 90 hours of recording, and the daytime runs from 0600 to 1800 EST and includes about 69 hours. Four figures are plotted for each half of the day. The first two show the percentage of occurrences in each intensity interval with two different vertical scales. The second two are cumulative plots showing the percentage above each intensity level.

The cumulative plots of "excess" signal levels are probably the best estimators of the interference encountered during this experiment. Figures 4 and 5 and 8 and 9 show no significant difference between day and night. Narrow band interference occurred in the 40 MHz wideband channel about 7% of the time with a strength above 1 K and about 2% of the time above 64 K. Channel B interference occurred 3.6% above 1 K and 1.5% above 64 K, and channel C interference occurred about 11% of the time above 1 K and 0.3% above 64 K.

The interfering signals tended to be the same ones during the 10 days of measurement so we cannot say that our measurements are representative of those which would be made at nearby frequencies. Also, there was a tendency to underestimate the interference strength and duration because of the differential nature of the data which relies on a short term variation of the detector output and because some receiver time was preempted to determine the source of interference. However, within these limitations the statistics should provide a reasonable basis for determining the pulsar processor dynamic range. The results agree well with the intuitive estimate of several pulsar observers that interfering signal strengths roughly equal to the receiver noise power are what the processor should be capable of handling.

For reference, a 1 K signal in a 20 MHz bandpass is equal to -128.6 dBm at the receiver front end.

JRF/cjd

Attachments
  Figures 2-9

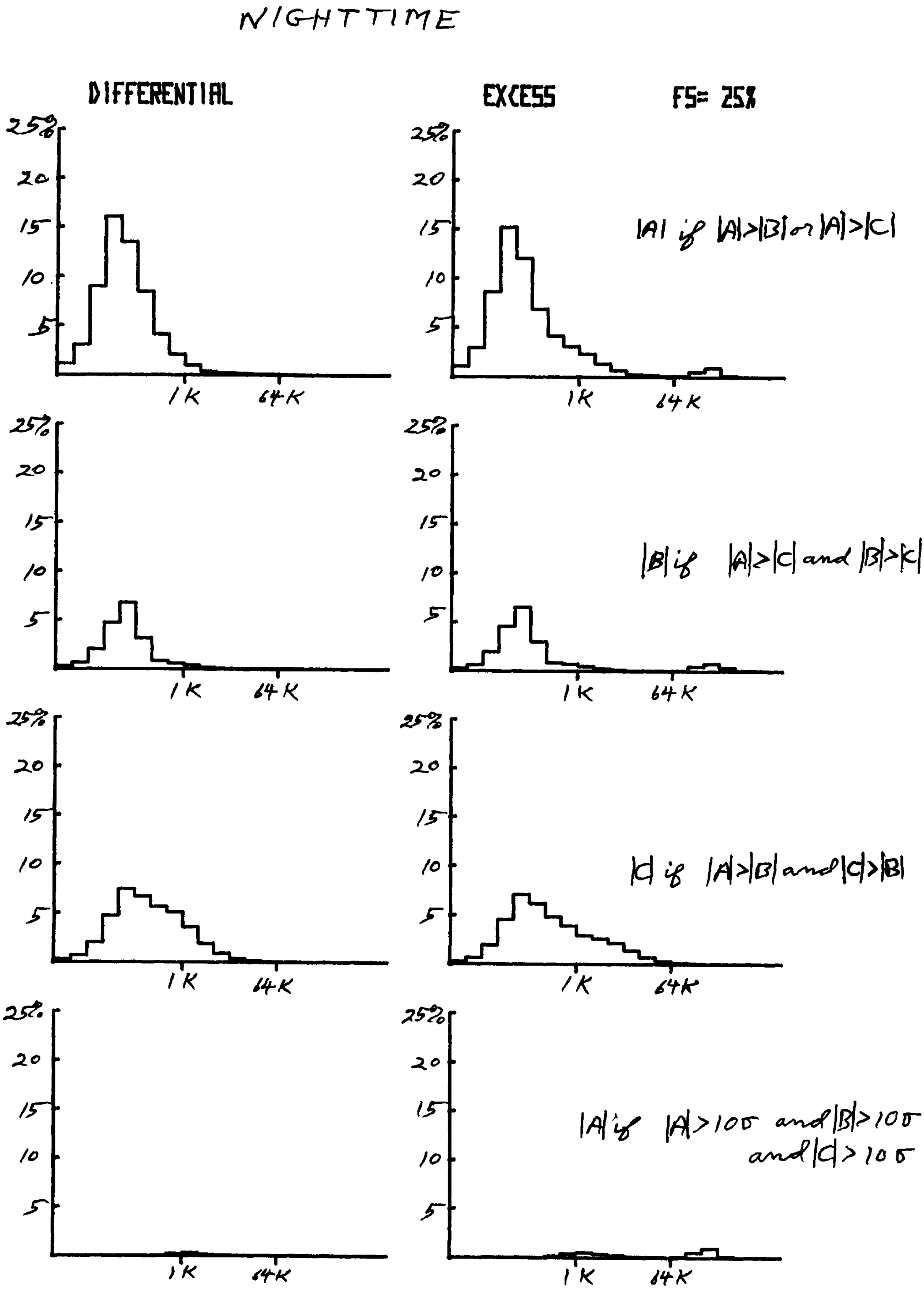
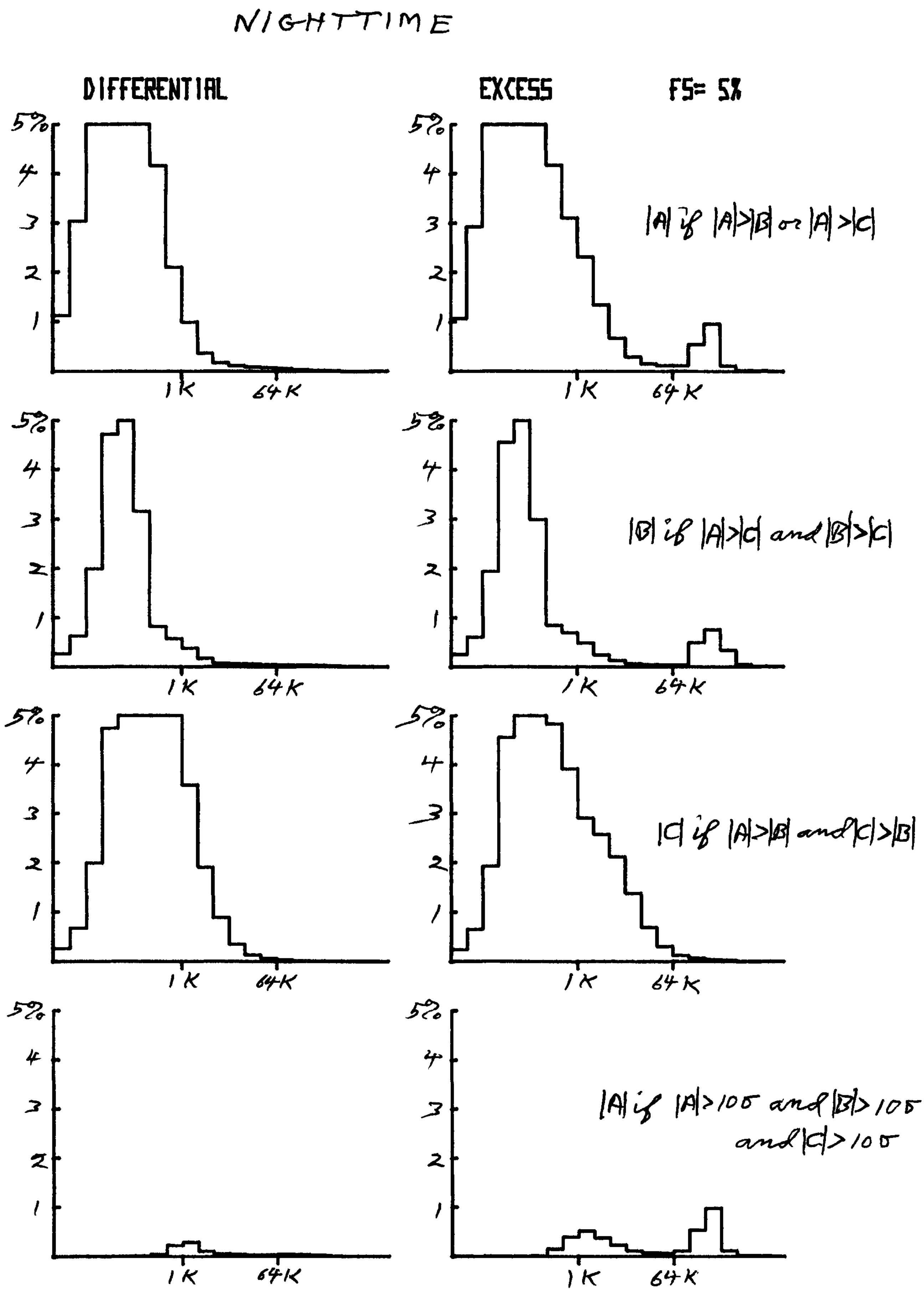

NIGHTTIME
DIFFERENTIAL
EXCESS
FS= 25%
|A| if |A|>|B| or |A|>|C|
|B| if |A|>|C| and |B|>|C|
|C| if |A|>|B| and |C|>|B|
|A| if |A|>100 and |B|>100 and |C|>100
25%
20
15
10
5
1K
64K

Fig. 2



NIGHTTIME
DIFFERENTIAL
EXCESS
FS= 5%
5%
4
3
2
1
1K
64K
|A| if |A|>|B| or |A|>|C|
|B| if |A|>|C| and |B|>|C|
|C| if |A|>|B| and |C|>|B|
|A| if |A|>100 and |B|>100
and |C|>100

Fig. 3

NIGHTTIME CUMULATIVE

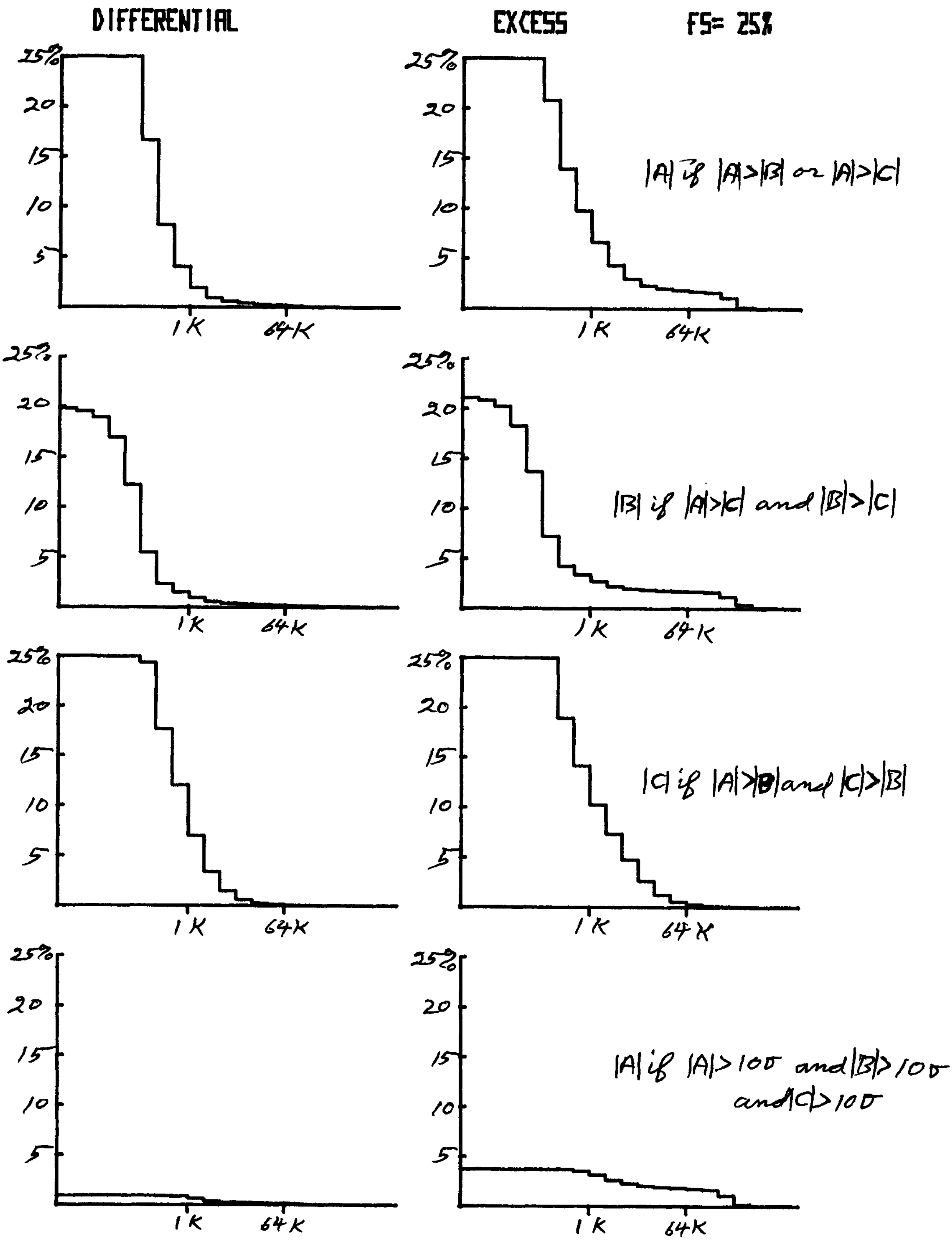


Fig. 4

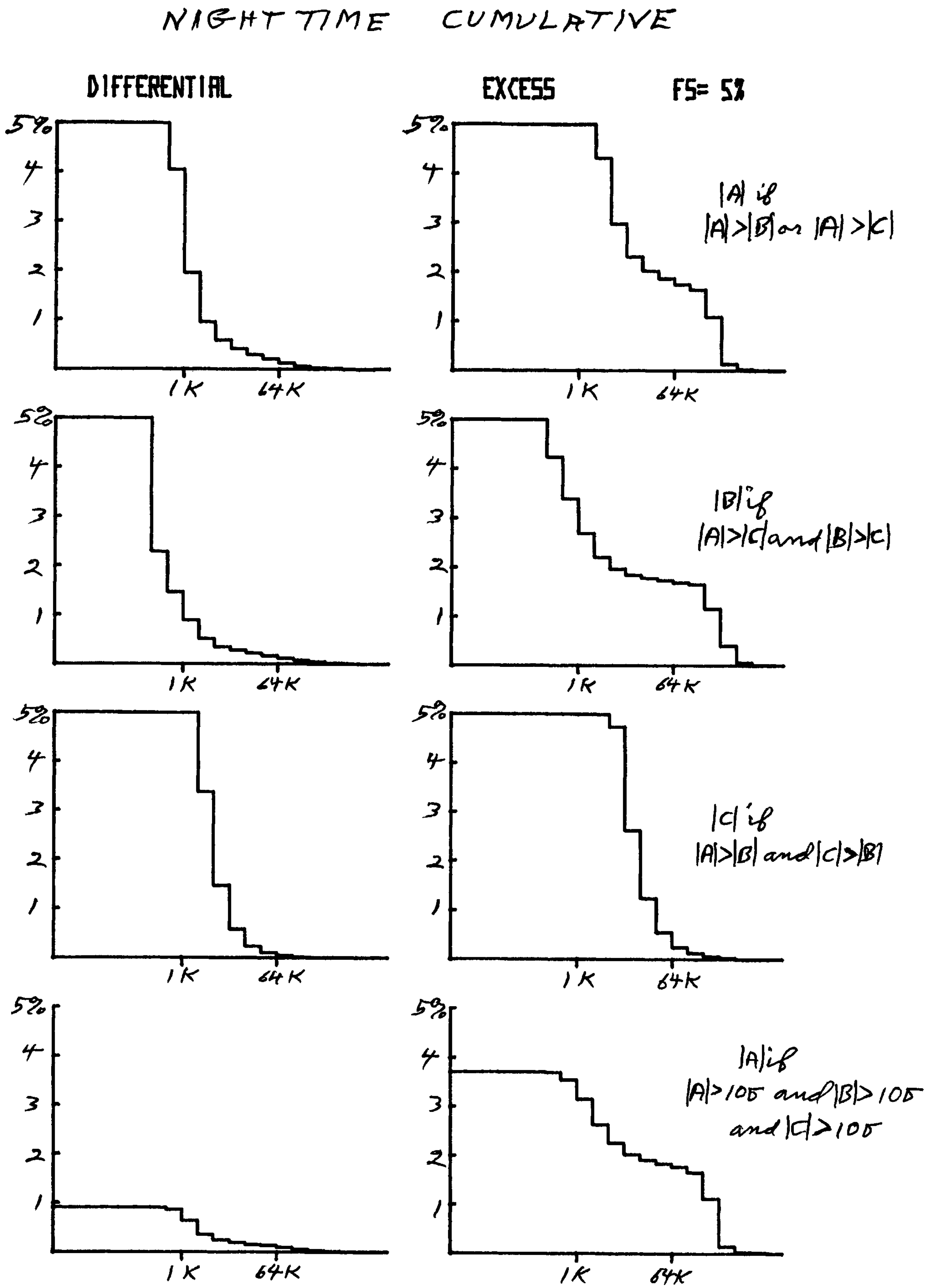
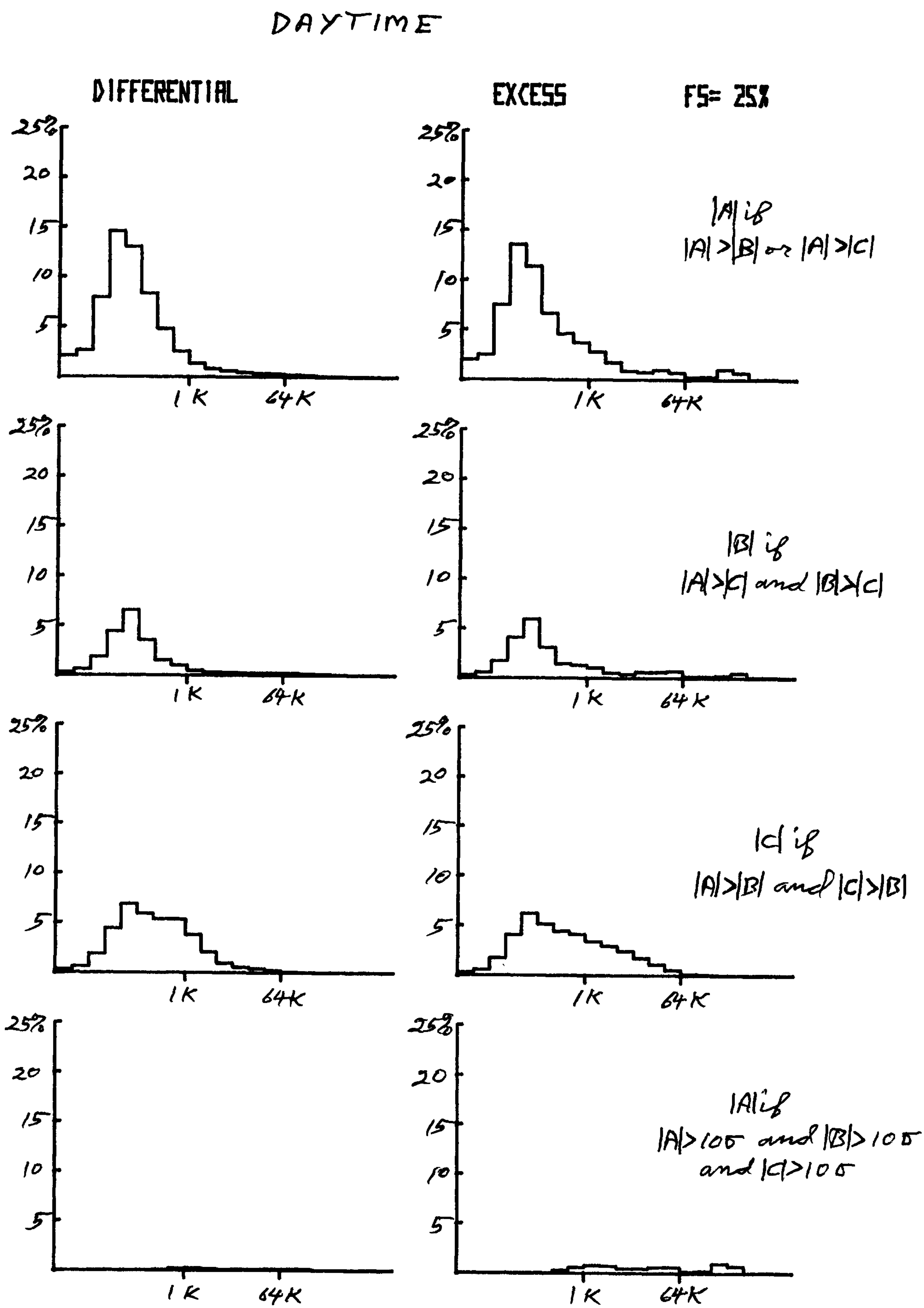

NIGHT TIME CUMULATIVE
DIFFERENTIAL
EXCESS
FS= 5%
5%
4
3
2
1
1K
64K
|A| if
|A|>|B| or |A|>|C|
|B| if
|A|>|C| and |B|>|C|
|C| if
|A|>|B| and |C|>|B|
|A| if
|A|>105 and |B|>105
and |C|>105

Fig. 5



DAYTIME
DIFFERENTIAL
EXCESS
FS= 25%
25%
20
15
10
5
1 K
64 K
|A| if
|A| > |B| or |A| > |C|
|B| if
|A| > |C| and |B| > |C|
|C| if
|A| > |B| and |C| > |B|
|A| if
|A| > 100 and |B| > 100
and |C| > 100

Fig. 6

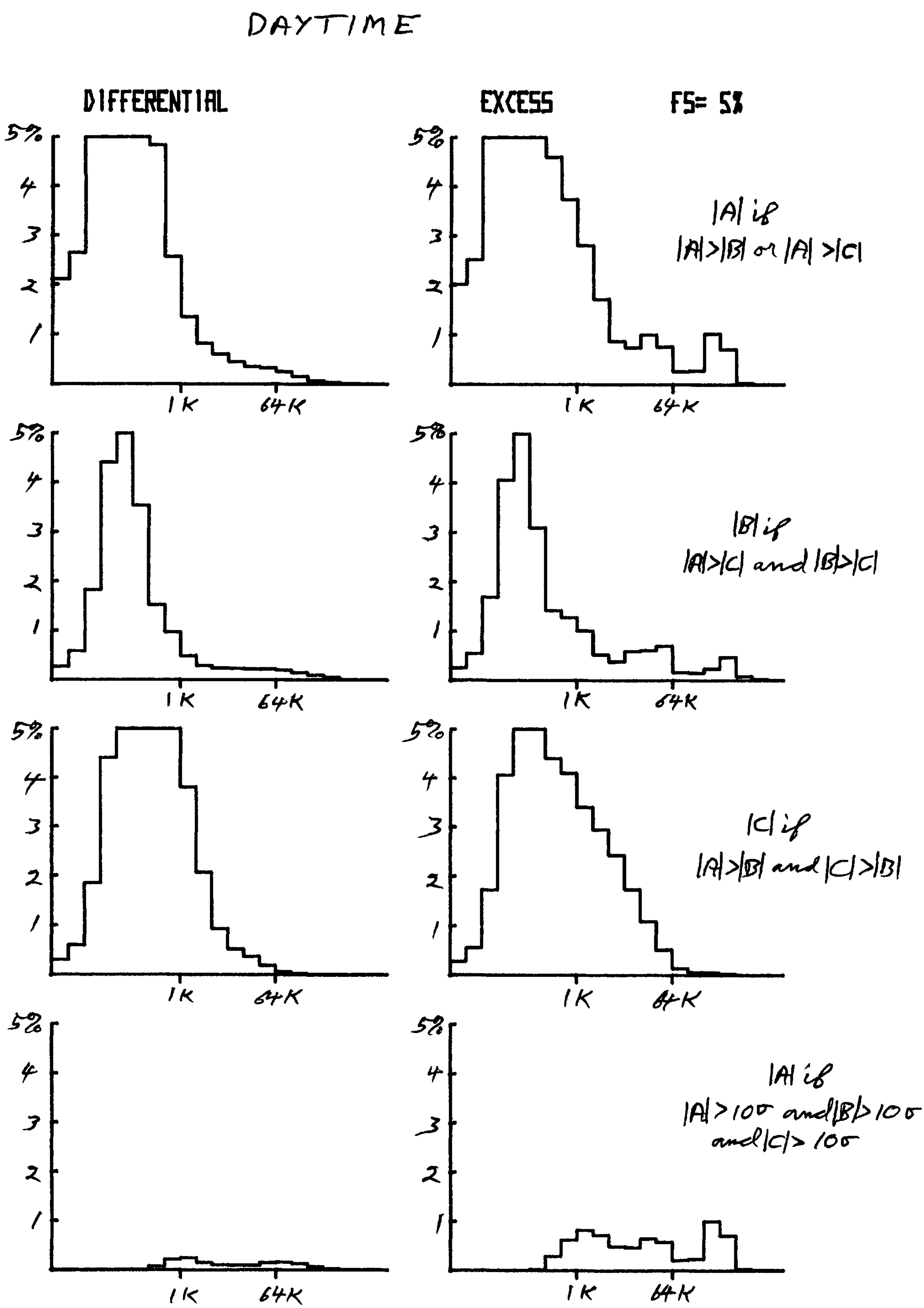

DAYTIME
DIFFERENTIAL
EXCESS
FS= 5%
5%
4
3
2
1
1K
64K
|A| if
|A|>|B| or |A| >|C|
|B| if
|A|>|C| and |B|>|C|
|C| if
|A|>|B| and |C|>|B|
|A| if
|A|>100 and |B|>100
and |C|> 100

Fig. 7

DAYTIME CUMULATIVE

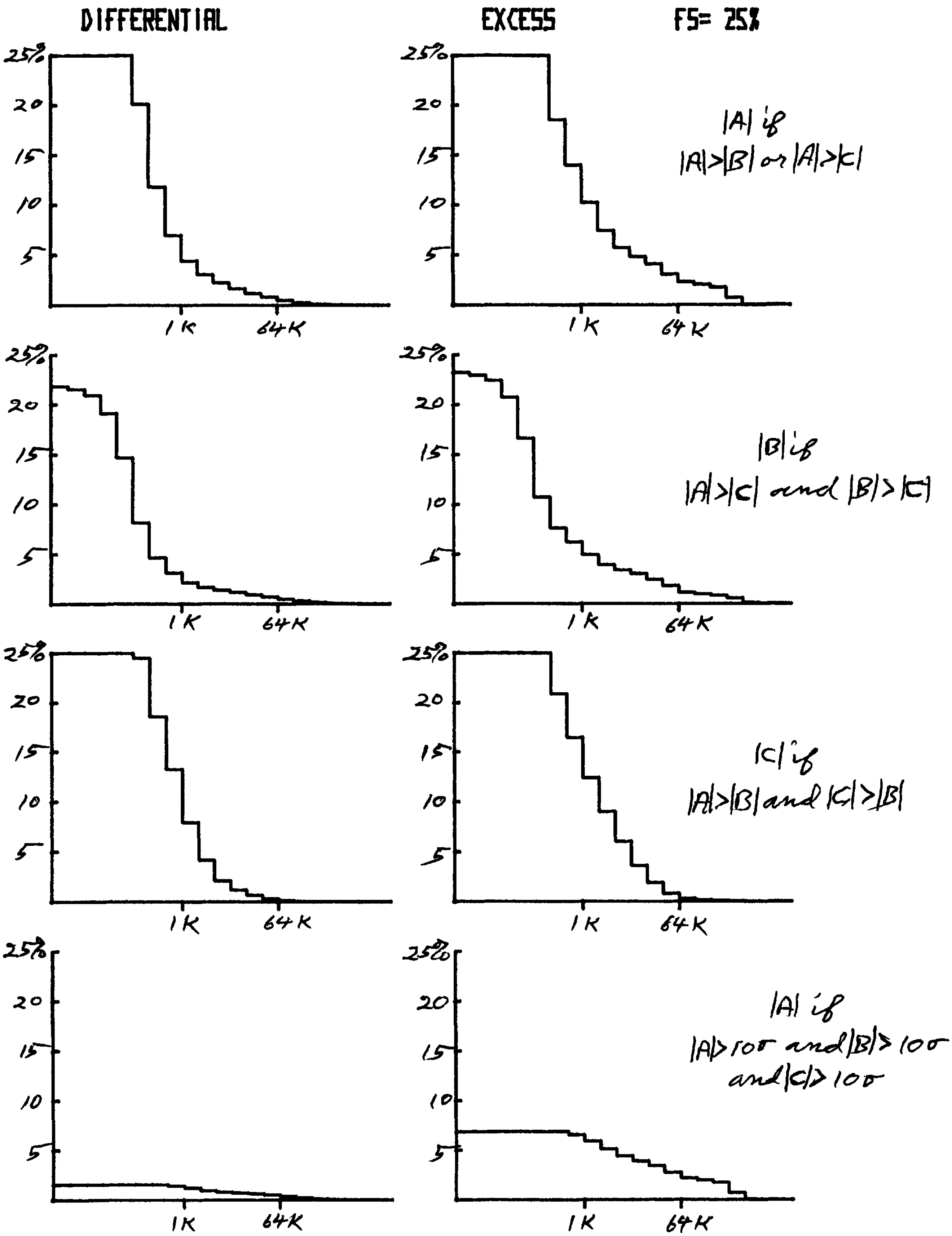


Fig. 8

DAYTIME CUMULATIVE

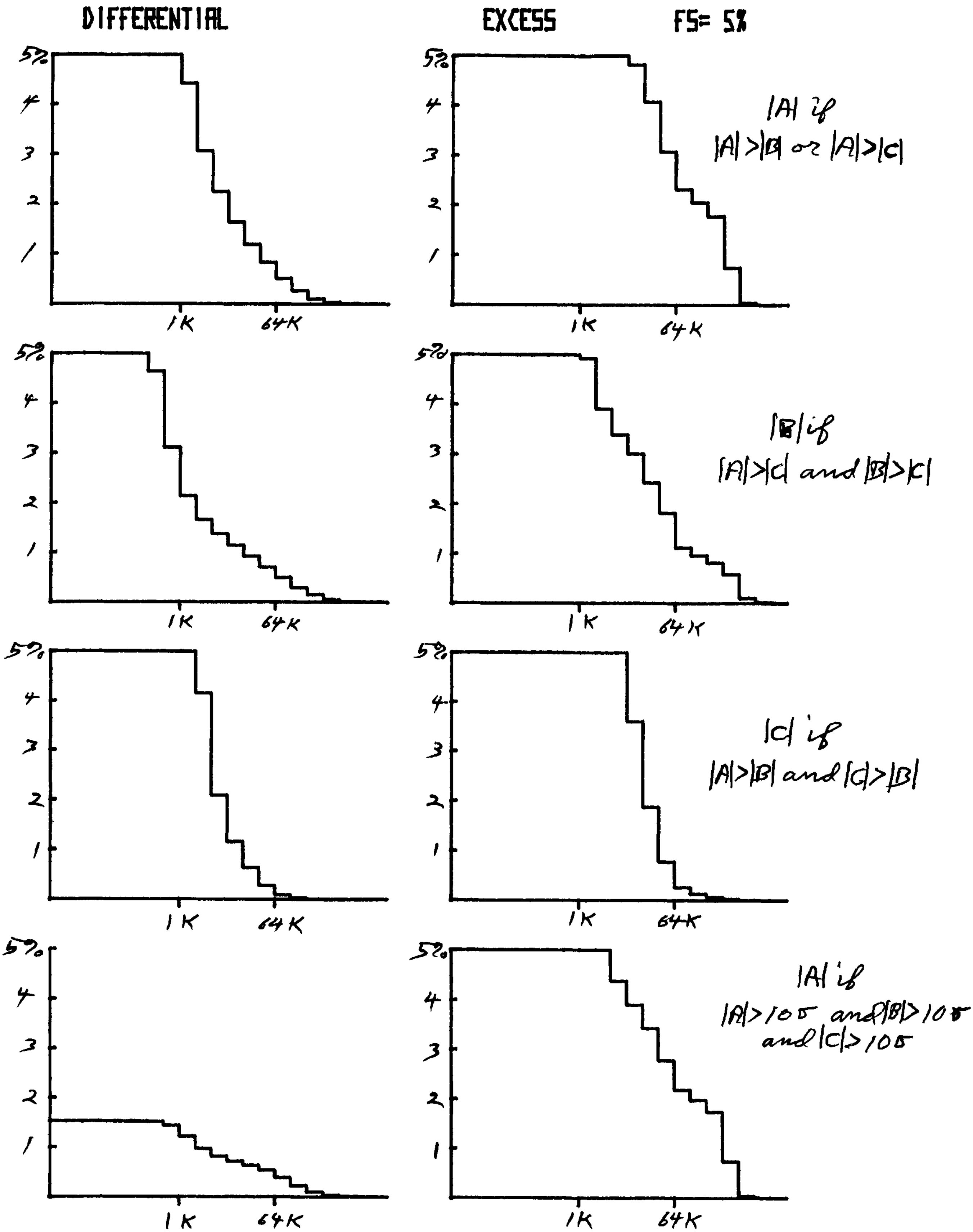


Fig. 9