National Radio Astronomy Observatory

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VLBA Electronics Memo No. 143

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To: Recipients of VLBA Memos

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Subject: VLBA Site Spectrum Analyzer Requirements

INTRODUCTION

This memo addresses the immediate requirements for spectrum analyzers at each of the VLBA sites. Do to the difficulty and time delay in achieving results from the VLBA site observations it has become painfully obvious of the necessity in procuring spectrum analyzers for each site. I am attempting to compile the requirements of each group in the electronics division so that we may identify a spectrum analyzer that will meet most of our requirements.

NECESSITY OF A SPECTRUM ANALYZER

The basic problem boils down to the time between observations and correlation. Monitor points within the system do aid in identifying the existence of problems but they do little to reveal what the actual problems are in the system. Further, monitor points are few and far between (literally). The delay in correctly identifying problems until after correlation assures us that even more data will be corrupted. Each of the following groups in the electronics division has necessity requirements for a spectrum analyzer.

LO/IF/FO Group

1. Identification of ambiguous false "out of lock problems". Currently, there is no way to determine if the BBCs are really out of lock or if the monitor data is corrupted.

2. Tracing a problem to either the BBC or IF distributor or distribution of the IFs. We can't always tell if we are dealing with a BBC problem, a IF distributor problem, or other rack hardware. We have sent out modules that are our "best guess". We could certainly save on time and shipping costs here.

3. Checking of phase noise on the BBC LO or maser. Phase noise problems will not show up in any monitor points. This could potentially save a tremendous amount observing time if the maser is bad due to the difficulty in remotely diagnosing this type of problem.

4. Checking BBC filter response. The BBCs are experiencing an aging problem. The active filters are much too sensitive to component drift causing the filters to become droopy.

Each of the necessity requirements above can easily be checked with a spectrum analyzer even during observing. This will certainly reduce corrupt data.

FE Group

1. Chasing RFI whether internal or external. There is no good way to determine if RFI is internally or externally generated. This will save lots of time.

2. Checking the overall condition of the IF (pre-if distributor). If the IFs coming from the front end have some irregularities then this can be checked without the need of erroneously replacing LO modules to track the problem.

3. Checking the purity and power level of the LO reference signals, and for the lower 3 bands, the actual LO input signal at the front ends.

4. Stage by stage RF trouble shooting of the front ends for the lowest 3 bands.

IPG

1. RFI is an increasing problem at each of the 10 VLBA sites. A spectrum analyzer will provide means for RFI monitoring.

2. Can monitor outputs of IF Distributor, BBC, or separate RFI antenna. The high flexibility and ease of use will enable site technicians to associate elevated system temperatures with externally generated RFI.

3. The independence of the spectrum analyzer will allow RFI monitoring without occupying time on the VLBA receiver system.

4. During periods when the spectrum analyzer is not being used for other tasks, it can be programmed to sweep across VLBA bands and log RFI data. Information such as frequency, power, time, and direction is required for determination of placement of filters, will aid the VLBA user community in setup of observation files, and will help NRAO to maintain clear airways.

DAQ Group

1. Checking head stack quality, wear, head assembly electronics, the capstan servo board for lock, and the formatter. The signal to noise ratio is indicative of the write/read electronics on the head assembly mechanical alignment quality analysis. Head stack contour can indicate wear by the shape of the profile. Head assembly electronics with noise/signal problems have distinctive appearances enabling spectrum analyzer troubleshooting. Parity problems it the signal can indicate lock problems on the capstan servo board.

SPECTRUM ANALYZER REQUIREMENTS

The spectrum analyzer requirements vary between each group. The IPG and FE groups would prefer one that sweeps to 60 GHz so that the receivers can be looked at directly. The cost of this approach would be prohibited. The receivers can be monitored at the IF distributor in the 500 to 1000MHz range. Narrow resolution bandwidths are required for LO in order to measure phase noise a 300 Hz RWB is sufficient. The IPG/FE groups need variable RWB starting at 1 KHz, to be able to identify modulation types for RFI and have higher sensitivity. Each group would like to have an interface to be able to down load data for help in trouble shooting and RFI identification. LO needs the requirement of changing the scale from 10dB/ to 1dB/ since we are experiencing a lot of bandpass flatness problem. DAQ requirements are minimal. They need only a frequency scan of 100KHz to10 MHz with a 1KHz RWB and an interface.

IPG GOALS

The IPG group has long range goals to be able to access a spectrum analyzer through a PC over the Internet at each VLBA site. This will allow them to control the analyzer and look at any RFI at any given time. They eventually would also like to put a small L-Band antenna at each site which would be connected to the analyzer for monitoring independent of the telescope. In the short-term future, such a spectrum analyzer could be left connected to the T121 IF monitor port, allowing real-time RFI searches within ±250MHz of the observing frequency. We are all very aware of the increasing interference in the world and this will be a necessary tool to aid in RFI mitigation.

LIST OF AVAILABLE SPECTRUM ANALYZERS

Here is a list of spectrum analyzers that will meet the needs above.

TEK 2712	$15K	9 KHz to 1.8 GHz
HP8591E	$11K	9 KHz to 1.8 GHz
IFR2398	$6.5K	9 KHz to 2.7 GHz

CONCLUSION

There has never been any question of the need for a spectrum analyzer at the VLBA sites. The question has always been funding. We would certainly save some on shipping costs if we had the analyzers but the real saving cannot be measured in dollars. Those saving are related to lost observing and corrupted data. Of the spectrum analyzers listed above, the TEK 2712 is the one we currently use here in the AOC. I believe it is very important to have the same analyzer at each site so choosing the 2712 may be the first choice. (Note: with EVLA the TEK 2712s we are currently using will no longer be acceptable because of the EVLAs wider band width.) Used 2712s can be purchased for about half price. The biggest draw back to the 2712 is that it has been on the market for a long time and may be subject to being discontinued. The IFR2398 is new to the market so no used ones are available. I have never dealt with IFR equipment before, so I am not familiar with there quality. The HP8591E has been on the market for a while and used ones are available for about half price.