Interoffice

National Radio Astronomy Observatory

Very Large Array

August 15, 1980

To: K. I. Kellermann

From: A. R. Thompson

VLB ARRAY MEMO No. 17

Subject: VLB Array

I listened in to the meeting on the VLB array proposal yesterday, and would like to offer the following comments.

S-Band Frequency

On the cost summary sheet the S-Band frequency given is 2.2 GHz, rather than the radio astronomy band of 2.69-2.7 GHz. I gather that 2.2 GHz is used because antennas of the deep space network, which are used for VLBI, are equipped for that frequency. From a frequency coordination viewpoint, there are good reasons for using the radio astronomy bands. In bands in which radio astronomy does not have a primary allocation, protection has to depend upon local coordination, and at 2.2 GHz radio astronomers do not even have a footnote to strengthen their case. The band 2.2 - 2.29 GHz contains fixed and mobile communications as well as space research, and one could well run into difficulties with ten sites so widely distributed across the U.S. My suggestion is that you include both 2.2 and 2.7 GHz since the percentage bandwidth for the feed would be no greater than for the 1.4 - 1.7 GHz feed.

I believe there is a general opinion that VLBI systems can stand relatively high levels of interference . The only quantitative data that I know of on this is Bernie Burke's paper in the Battelle Sympossuim Report on the SPS; I am attaching a copy of the paper to this memo. For CW signals Bernie bases his harmful threshold on a signal 40 db below the system noise, and with the low system temperatures that he assumes the resulting harmful power fluxes are not much different from those for single-antenna, total-power systems in CCIR Report 224-4. I suspect that Bernie's criterion tends to be conservative, but a VLBI test-run with simulated interference should be done to find out what the tolerable threshold really is.

Local Oscillator Synchronization by Satellites

It was suggested that it might be possible to synchronize oscillators using a round-trip-phase scheme, transmitting the reference signal by satellite. I think this would be difficult for the following reasons. First, it was suggested that the R.F. carrier of the data link be used for the reference signal. Since the uplink and downlink frequencies must be different, an LO signal in the satellite must be taken account of. This might be possible if the same LO signal is involved for the links going out from the VLBI headquarters as for those this returning to it, but this may not necessarily be the case. Second, if the LO system at an antenna uses submultiples of the transmitted reference frequency, (or frequencies) one cannot ignore multiples of 360° in the round-trip phase variation, and this makes the system more complicated. Round-trip phase variations are likely

to be large for the following reason. A current CCIR report (USSG IM 2/201) states that station-keeping requirement for geostationary satellites is ± 5% of the orbital separation of satellites, i.e. typically ± 0.5°, or ± 370 km at the distance of the orbit. This refers to both north-south and east-west station-keeping motions. I don't know how much of this occurs during a single 24-hour orbit period of a satellite, and the path-length change will be only a small fraction of the satellite's wander. However, it suggests that the round-trip phase variations could be large compared with anything we have experienced with the VLA waveguide.

Electronics Reliability

Since the system will operate with no one present at the antennas for much of the time, high reliability should be an important design goal. I think we should be willing to allow a little extra (say 10%) in the overall electronics cost towards maximizing reliability. In the VLA, some areas are good with regard to reliability and others could be improved. The opportunity to do a thorough design review after the first few antennas became opertional was, I think, crucial to the success of the system, and I hope that the timetable for the VLB array will allow a similar review to be made.

cc: H. Hvatum
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