VLBA Correlator Memo No. 59

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# National Radio Astronomy Observatory
# Charlottesville, Virginia

1986 May 5

**To:** VLBA Correlator Memo Series

**From:** J. D. Romney

**Subject:** Update on Correlator Group Activities

Most readers of this series are aware that work on the VLBA correlator was suspended late in 1985 as a result of the reduced funding available for 1986. As the Array subsystem most likely to benefit from rapid technological developments in microelectronics, the correlator was a natural candidate for this sort of postponement. Additionally, unexpected increases in the estimated cost had made it doubtful in any case that we could proceed with correlator construction and still keep intact the favorable antenna contract. Neither the NRAO nor Caltech found it attractive to maintain a long-term commitment to later resumption of the existing subcontract, which accordingly was terminated by mutual agreement.

To continue some "correlator consciousness" during these early years of Array construction, a standby correlator group was formed in Charlottesville, charged with the following tasks: exploring alternative approaches to correlator design which might allow significant cost reductions and perhaps enhanced performance; incorporating advances in microelectronic technology into the existing design (described in Correlator Memo 41 and subsequent addenda); and representing the correlator's interests in negotions with other subsystems on interfaces *etc.* The principal members of this group are J. D. Romney, J. M. Benson, R. P. Escoffier, and J. H. Greenberg; all four are currently involved on a part-time basis, in addition to other VLBA and NRAO activities. We also benefit from occasional participation by B. G. Clark, E. B. Fomalont, J. Granlund, F. R. Schwab, and many other NRAO personnel.

This memorandum summarizes the correlator group's recent activities and current focus of interest, by way of introduction to forthcoming, more detailed documents. Reorganization of the periodic telephone meetings, and the availability of a computer conference for informal discussion of VLBA correlator issues, are also described.

ALTERNATIVE CORRELATOR ARCHITECTURES. The group began by undertaking a survey of possible alternatives to the serial lag correlator architecture which has been conventional for VLBI. One principal variant considered was a high-speed system, similar to the VLA correlator, which would allow both recirculating and/or time-shared correlation at the relatively slow sample rates of the VLBA. However, since the specifications require the full 512-point spectral resolution even at the widest band, it is clear that recirculation could offer even more resolution at narrower bandwidths, but no reduction in the overall required multiplier complement. Time-sharing might allow a hardware reduction by a factor between two and four.

Another alternative surveyed was correlation in the spectral domain, in which all the individual station data streams are Fourier transformed before "correlation". Baseline cross-power spectra are then formed by pairwise multiplication of these station spectra, obviating the need to form large numbers of cross-correlation lags. Such a scheme has been implemented at Nobeyama

Observatory, and was contemplated briefly during the correlator design study at Caltech — but under the then-current construction schedule it could not be developed sufficiently for serious consideration. This approach appears to offer such substantial cost advantages for the VLBA correlator, and to allow numerous technically superior features as well, that we decided a more intensive study was warranted.

SPECTRAL-DOMAIN CORRELATOR STUDY. Correlation in the spectral domain represents a radical departure from conventional techniques for determining the cross-power spectrum from which scientific results are eventually obtained. Only one implementation of this scheme has been reported, and it is far less extensively studied than lag correlation in the technical literature; we can expect both adverse as well as favorable implications for the sensitivity and accuracy achievable. For all these reasons, we consider a thorough investigation to be essential before we can conclude that this approach to a VLBA correlator is viable.

Our study began early in 1986, and is expected to continue until early 1987. At that time we expect to have both a definitive report on the acceptability of the spectral correlator, and a preliminary design and cost estimate. An initial benchmark system has been developed, and is presented in detail in the immediately following Correlator Memos 60 – 64 and later documents in preparation or planned. We can already assert with some confidence that such a system could be built at significantly lower cost than a conventional lag correlator. Further study of this scheme will follow three different avenues: analytic studies and numerical simulations are both already in progress, and we plan to begin building demonstration and prototype hardware within the next few months.

VLBA CORRELATOR CONFERENCE. At this stage of the investigation it is important that we remain aware of the many different observations the VLBA will be called upon to support, and of their diverse requirements for the correlator. And, of course, we would like to benefit from the experience of those currently building and operating wideband lag correlators for VLBI. For these reasons, we have retained and reorganized the periodic telephone meetings of the correlator group. This "VLBA Correlator Conference" now meets bimonthly; in addition to the NRAO personnel mentioned previously (and others not mentioned), recent participants have included D. C. Backer, D. N. Fort, J. M. Moran, T. J. Pearson, M. J. Reid, A. E. E. Rogers, and A. R. Whitney. Now that a benchmark design has been completed, and the environment for technical trade-offs is clearer, we expect this group to provide an increasingly valuable resource.

VLBACORR COMPUTER "TELECONFERENCE". An additional forum for discussion of VLBA correlator issues is available to users registered either on CVAX in Charlottesville or PHOBOS at Caltech. This so-called teleconference has been in existence for some time but has been relatively dormant. With the following memoranda in this series to serve as grist, we encourage anyone interested to participate, either by contributing actively to the discussion, or perhaps just by eavesdropping. VLBACORR actually consists of two linked TC's; messages sent to that name on either of the VAX nodes mentioned will be forwarded to the other. The "teleconference" mechanism is an element of the Software Tools system, and messages must be sent using the STMail facility and read via the TC program. My memorandum of 1986 March 21 on this subject should help novices get started both reading and submitting contributions to VLBACORR.