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VLB ARRAY MEMO No. 411

To: VLBA Acquisition Group  
From: Hans F. Hinteregger  
Subject: Diminishing Returns

VLBA Array Memo No. 405 shows a misunderstanding of the evident consensus regarding what was called "wasteful" use of tape in certain special modes of operation.

No one advocates a system design which forces fifty pounds of tape per day per station to be used regardless of need; indeed we are planning to reduce the shipping weight of tape well below this level at the specified average data rate of 100 Mbps. There is little doubt that the VLBA tape/transport configuration will need only about twenty-five pounds per day in 1988 - though it is too early to promise or guarantee this or anything more than meeting specs. Exceeding the spec by as much as a factor of four is plausible within that time frame, without even invoking the availability of much improved tape. If we can do it reliably, and if the tape industry cooperates, we will. There should be no doubt that we continue to be committed to minimizing the shipping and capital cost of tape (consistent with the reliability demanded by the VLBA).

Haystack has proposed, for the sake of simplicity, reliability and optimization of playback SNR, that only a single playback speed be implemented. The correlator group has noted that very large speedups - 62.5KHz to 4MHz, a factor of 64 in the worst case - would be difficult for the processor to support. There is no spec to date as to how large a speed-up factor the processor must support, and the correlator group has not stated what speed-up factor it considers easy or reasonable. Haystack suggested that the maximum speed-up factor should be  $\geq 4$ . There is no impact on recording system complexity if the factor is larger: Record speed flexibility is free but playback speed flexibility is complex and costly. If it is easy for the processor to support a speed-up factor of 8 or 16, it should, of course, do so. If not, we agreed, the overall tape usage efficiency would not be significantly compromised if high oversampling factors were used in recording the narrowest bandwidth spectral line observations so as to force the record speed to be no less than one quarter the standard playback speed. Such observations are expected to use only a subset of the heads in a stack (a group of 8 out of 32 for example) at a time so that a tape in this "wasteful" mode would last 8 times as long as in a mode recording with 32 heads at the average rate. In this case (assuming for example four 62.5KHz channels, two-bit sampled, with no oversample processing) it should be clear that the return for insisting on either a processor speed-up factor of 64 (rather than only 4) or on a 1/16 speed playback capability (very difficult at best, requiring

additional special head assemblies) is small indeed. Tape usage would be reduced from 12.5% of average to about 0.8% of average for such special observations. This example shows that there is indeed no excuse for adding any more complexity to recorder or processor to eliminate the purported "wastefulness". To add such complexity would truly be wasteful because scarce design time and talent would be diverted.

The argument against special (slightly more tape efficient) coding of 3-level quantized samples is similar. Special coding adds complexity that is not needed. The only widely acknowledged justification for the added complexity of supporting three or four-level quantization (and oversample processing) as well as two-level quantization is to maximize signal-to-noise ratio in a given integration time in the spectral line case where the signal (line) bandwidth is less than the channel bandwidth.

Spectral line observations will generally use only a subset of heads (a group of eight at a time will, I suspect, be popular); thus spectral line tape usage will undoubtedly be less than 25% of the total. If five three-level samples are coded into eight bits (efficient code, requiring special clock and ROM) instead of ten bits (suitable for three or four-level samples, clocked like two-level) saving in overall tape useage is at most 5%. The benefit is again too small and too specialized to warrant the added complexity. (Since there is no good reason to change, continuum VLBI is likely to continue to be done with two-level sampling.)

We should focus our efforts on reliably meeting basic system specs in the least complicated manner, with just enough of an eye on the future so that significant improvements - factors of two (if not four) not 5% in density, maximum aggregate bandwidth, number of channels, and total processing power - can be made easily when the time is ripe, without having to throw every existing component of the system overboard.