VLBA Acquisition Memo # 23

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TO: VLBA Acquisition Group

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SUBJECT: Is Phase Switching Needed?

D.C. offsets in the clipper/sampler will produce spurious fringes at zero fringe rate. Phase switching can be used to eliminate the spurious D.C. fringes. Orthogonal switching functions such as Walsh functions have to be used to eliminate the correlation on all baselines. Recording errors can also introduce D.C. offsets because the probability of error is asymmetrical. Ones are more likely to become zeroes than zeroes become ones. To eliminate recording bias the phase switching must be undone after playback in the DPS or processor.

D.C. offsets could also be eliminated in the processor without phase switching by digital measurement of the D.C. biases on each data stream and subsequent software correction. No additional hardware is needed in the correlator for D.C. bias correction. The phase calibration extraction hardware can be used at zero phase cal rate to measure the bias for each channel at each station. (Phase calibration will have to be turned off for low fringe rate experiments because the calibration pulses produce a zero fringe rate correlation that is not eliminated by phase switching or local oscillator offsets.) At low fringe rates rates it is relatively simple to compute the rotated bias terms and correction can be applied either before or after the fourier transform to fringe rate. The rotated cross correlation

$$R_{xy}(\tau) = \langle (x(t)+a)(y(t-\tau)+b)(c(t)+is(t)) \rangle$$

$$= \langle x(t)y(t-\tau)(c(t)+is(t)) \rangle + ab\langle c(t)+is(t) \rangle$$

where a, b are D.C. biases

and $c(t), s(t)$ are 3-level sine and cosine functions

Another method of software correction is to high pass filter the cross spectral function since the bias terms produce false fringes at D.C. in the cross spectral bandpass.

Local oscillator offsets could also be used to eliminate the D.C. fringe by placing fringes at a large apparent fringe rate. Phase switching could be implemented with very little added hardware, but since it adds to the complexity of the system as well as introducing a potential for other spurious signals at the switching rates, I favor the software method.