VLB ARRAY MEMO No. 492

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To: VLBA

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Subject: Low Fringe Rates - are they a problem?

Low fringe rates, that is a fringe rate less than a few times the accumulation frequency, have often been a problem. In my opinion, one of the major reasons for the corruption of low fringe rate data by the "DC" fringe is the incorrect normalization of the correlator output when there are a small number of fringe rotations in the accumulation period. This deficiency is present in some VLBI correlators. Another cause of data corruption is the D.C. offsets in the samplers of older generation equipment. Tests of low fringe rate data (180 milliHz) taken on the Haystack-Westford baseline using Mark III show no evidence for "DC" correlation at the level of 3×10^{-5} - see Data Acquisition Memo #34. If the samplers use modern ultra-fast comparators (like the AD9685) one would expect the D.C. offset at each station to the less than 1% and the resulting correlation less than 10^{-4}. A software bandpass filter applied to the cross-spectral function (like that in the MkIII processor) should reduce any residual correlation due to D.C. offsets to a negligible level.

While D.C. offsets should not pose any problems, the presence of correlated interference could produce an artificial fringe at zero fringe rate. For example, the MkIII phase calibration system generates a significant "DC" fringe - see Acquisition Memo #34. About the only source of correlated interference which might be present at VLBA sites is that generated by the station electronics, computers, etc. If this interference somehow looks directly into baseband the technique of offsetting the baseband converter L.O.'s should help. Consider observing at the wavelength for which the fringe rates will be lowest i.e., 300 MHz. If we use the criteria that data with fringe rates under ± 2 Hz will be corrupted this will in-turn make regions of the uv plane where $|u|/\cos(\mathrm{DEC}) < 30$km unusable, which in-turn produces a significant reduction (~30%) in the uv coverage on the Los Alamos-Pietown-VLA baselines. If the Los Alamos and Pietown sites are offset $\pm$10KHz from the VLA uv coverage loss will be reduced to a low level (<6% on the next longest baseline without L.O. offset Kitt Peak-VLA). If the VLBA electronics performs as expected the only anticipated path for correlated interference is through the feed into the front end in which case techniques like fringe rotation at the stations (or L.O. offsets) and phase switching will not eliminate the spurious correlation.

My conclusion is that low fringe rate data should not have problems that can be fixed by L.O. offsets or phase switching. We should, however, carefully evaluate the "DC" correlation in the VLBA hardware as soon as it is set up for tests.