VLB ARRAY MEMO No. 253

NORTHEAST RADIO OBSERVATORY CORPORATION
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TO: VLBA Recorder/Acquisition Group

FROM: Alan E. E. Rogers

SUBJECT: Sources of closure errors. The MK III experience and the VLBA specifications.

A. POLARIZATION

The major source of phase closure errors in experiments using the MK III have recently been found to be due to polarization impurity in the feeds.

Any imperfect feed can be characterized by the sum of responses to both senses of circular polarization. If the source is unpolarized the RCP interferometer response between 2 imperfect feeds is

$$RR^* e^{i\Delta\psi} + \alpha\beta^* LL^* e^{-i\Delta\psi}$$

where $\Delta\psi$ is the difference of feed position angles ($\psi_\beta - \psi_\alpha$) and α and β are frequency dependent complex factors which represent the imperfections of each feed. The phase closure error which results is given by:

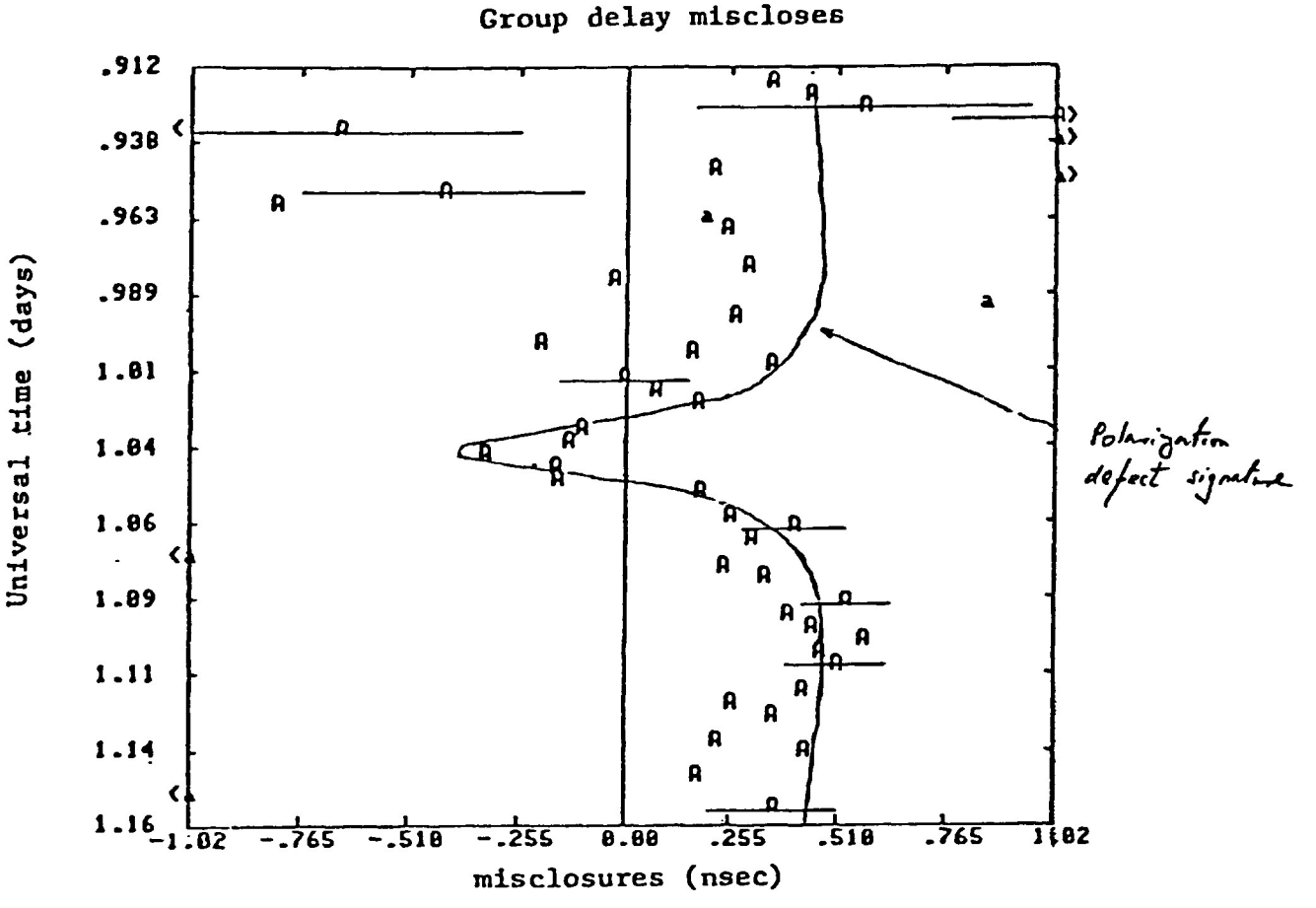
$$\phi_{\alpha\beta\gamma} = Im\left[\alpha\beta^* e^{-2i(\psi_\beta - \psi_\alpha)} - \alpha\gamma^* e^{-2i(\psi_\gamma - \psi_\alpha)} + \beta\gamma^* e^{-2i(\psi_\gamma - \psi_\beta)}\right]$$

If the feeds have 20 dB isolation between circular ports then $|\alpha| \approx 0.1$ and the magnitude of the closure errors are $\pm$ 1.7 degrees. Figure 1 shows the closure delay errors (the derivative of closure phase) observed with feeds whose polarization isolation is only about 15 dB and is frequency dependent. If we want to keep closure phase errors under 1 degree peak we should specify a minimum of 23 dB isolation between RCP and LCP or an axial ratio of better than 1.14 : 1

B. BANDPASS VARIATIONS

Bandpass variations in the MK III video converters are very small (< 0.5 dB and < 5° over 80% of the band) and no closure phase errors have been identified with the variations in the video converter responses. However a specification which controls only 80% of the bandpass is not not sufficient since large variations in the remaining 20% could cause significant closure phase errors. If variations in the remaining 20% are specified as less than 1 dB and 20° then the maximum closure phase error would be 0.5°.

Haystack - Effelsberg - Onsala



Notes: 1. Pol. defect Hays - Onsala $\tau_0 = 0.5$ n.s, $\phi = 0$

2. No attempt has been made to find τ_0 and ϕ which fit best.

(Data from T. A. Herring - MIT Ph.D. Thesis 1983)

FIGURE 1.