VLB ARRAY MEMO No. 126

A Post-processing Software System
for VLBA Continuum Observations

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I. Introduction

Attached is a block diagram showing the main elements of a post-processing software system for mapping VLBI continuum sources. It is drawn from current experience with the VLA and VLBI software systems.

The logistical organization of the VLBA will allow the creation and maintenance of an on-line bookkeeping data file (like the VLA MONITOR data base), and a file containing the fringe amplitude, phase, delay and rate of regularly scheduled calibrator observations. The bookkeeping data set should contain system temperatures, a data quality flag, weather information (temperature, relative humidity, winds, pressure), pointing deviations, etc. System temperature corrections and data editing could be done automatically either in the processor or immediately after the processor. The calibrator data set could be used to 1) track station clock drifts, 2) aid in maintaining station gain curves, and 3) serve as polarization calibrators.

II. The individual steps in the post-processing are:

1). The processor. Use the calibrator data set to center the fringes in residual delay and rate. One could probably extrapolate ahead a couple of hours, thus the calibrator scans wouldn't have to be processed separately and in advance of the program sources. Steps 2 and 3, editing and fringe fitting, could be accomplished in the processor hardware.

2). The on-line editor. The editing would use data quality information in the bookkeeping data set. It's important that editing preceed the fringe fitting step.

3). Fringe fitting. The fringe fitting stage should be a global fitting algorithm that fits all baselines simultaneously (like the current VBFIT for VLBI data in AIPS by Cotton and Schwab). Accurate values for cross-handed polarizations would be based on delays and rates derived from the parallel-handed fits. The calibrator data set rates and delays could be used to center the fringe fitting windows. For most sources (reasonably compact), the fringe fitting could be done in the processor and the fringe fit values would be the observer's archive data set. For those very complex and extended sources, the global fringe fitting could be part of the iterative self-cal process. The raw processor output would have to be kept as input to the fringe fit program each time around. Our current VBFIT program uses an input model of the source brightness distribution, and could be used in an iterative manner.

4). The calibration programs.

a). Ampcal, applies system temperatures from bookkeeping data set, applies a set of standard gain curves or gain curves derived from recent cal scans in the calibrator data base.

b). Polcal, applies polarization calibration derived from the user's own calibrators or from the cal scans in the calibrator data base.

5). General purpose programs that would be optional in most cases.

a). Fixup, calculate and apply corrections to fringe phases, rates and delays for source or station coordinate errors, or for a better model atmosphere than in the processor.

b). Editing, user specifies data to be deleted. This is a time consuming step in current VLBI data reduction. The on-line editing in step 2 must be made to work.

c). Average, user further averages his data.

d). Various display programs, list, plot, print, etc.

6). Self-cal, Invert and Clean steps could take place in AIPS. VLBI data has already been successfully self-cal'd and mapped in AIPS.

III. Wide Fields of View

The VLBA record system will accomodate four 12.5 MHz bands. Thus the processor delay lag separation will be 40 nanoseconds. On the longest baseline (8000 km), a 40 nanosec delay shift subtends an angle of 320 mas on the sky. In the 'double bandwidth' mode, the delay lags will be 20 nanoseconds apart and 160 mas on the sky. Sources having structure across several hundred milli-arcseconds will be washed out at the field-of-view edges. If the processor output (32 delay channels) is transformed into frequency channels, each (narrow) frequency channel has a wider field-of-view. The fringe fitting would then fit the data in the frequency domain, and return amplitudes, phases, rates and frequency phase slopes at several frequencies. Thus the output of fringe fitting program would be as if the observations were done through a parallel set of narrow bandwidths (with large delay beams). The frequency channel data would be calibrated and mapped individually, and merged into a final map in the image plane.

CONTINUUM POST-PROCESSING FOR VLBA