

## MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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To: Millimeter-wave VLBI Group  
 From: Alan E.E. Rogers *A.E.E.R.*  
 Subject: Global Fringe Fitting Software

I have implemented an "unofficial" global fringe fitting program on the UNIX systems which might be useful for looking at some of those marginal detections we have in mm VLBI and some other experiments.

### Algorithm

The algorithm implemented is one of the global search in which each scan (or segment of a scan) is incoherently averaged with each baseline. The search is made over N-1 clocks and N-1 clock rates. The SNR of this algorithm for antennas of equal SEFD is given by

$$SNR = 2^{-1} S^2 M^{1/2} (N(N-1)/2)^{1/2}$$

where        S        =        SNR of each segment  
               M        =        number of sequential segments  
               N        =        number of stations

As with any search process the value of SNR needed for a significant detection depends on the number of points searched and

$$PE \approx \frac{n}{SNR} e^{-SNR^2/2} (2\pi)^{1/2}$$

where        n        =        number of points searched

Typically an  $SNR > 7$  is needed for detection. This detection scheme can be shown to be optimum under the assumption that the source has structure and the closure phases are unknown.

### Implementation

- 1] Use "*aedit*" to filter out an alist of scans to be searched (all scans must have the correct value of single band delay).
- 2] Use "*linkdata*" to link scans to your directory area.
- 3] Copy script called *doglobal* and edit to set-up your desired search ranges.
- 4] Run *script* to run "*global*".

Reference: Rogers, A., Doeleman, S., and Moran, J., "Fringe detection methods for Very long baseline arrays" - to be submitted to Astron. J.

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*****
Sample aedit control file to select data:
sources NRAO530
timerange 93317-231000 93317-233000
baselines KO KP PO
nfreq > 2
type 2
length 200
edit inputs
edit duplicates procdat
sort scantime
sort baseline
write scans.out
exit
y
*****
Sample script to form linkdata:
#!/bin/csh
rm scans.out
rm -r ./linkdata/2484
aedit -r aedit.ctl -f tempalist.out
linkdata -d ./linkdata scans.out
*****
Sample script to do global fringe search:
#!/bin/csh
echo global search
echo use aedit and dofind script to put data to be searched in linkdata
@ amb = 125
@ d1 = 0
@ d2 = $amb
@ d3 = 5
@ r1 = -1
@ r2 = 1
@ r3 = 1
@ c = 20
echo $amb is the multiband ambiguity spacing in ns
echo delay search goes from $d1 to $d2 in steps of $d3 ns
echo rate search goes from $r1 to $r2 in steps of $r3 ps/s
echo $c sec is the coherent integration time
rm temp1.out
@ r = $r1
while ($r <= $r2)
    @ d = $d1
    while ($d <= $d2)
        rm temp.out
# fringex in filer mode - all data in linkdata area
        fringex -f ./linkdata/* $c 0 -2 $r $d > temp.out
        sort -o temp.out -k 10.1b,10.2b -k 8.1b,8.8b -k 11.1b,11.4b temp.out
# average all the data incoherently for each baseline
/home/sneezy/aeer/fringav/fringav -a temp.out >> temp1.out
        echo $r $d
        @ d = $d + $d3
    end
    @ r = $r + $r3
end
echo global searches for fringes on up to 10 stations
/home/sneezy/aeer/fringav/global temp1.out $amb $d3 $r1 $r2 $r3
*****
Sample output:
global search
use aedit and dofind script to put data to be searched in linkdata
125 is the multiband ambiguity spacing in ns
delay search goes from 0 to 125 in steps of 5 ns
rate search goes from -1 to 1 in steps of 1 ps/s
20 sec is the coherent integration time
global searches for fringes on up to 10 stations
max snr= 9.52 in 16875 points found at
    KO= -10.0ns 1.0ps/s snr= 4.1
    KP= -75.0ns 1.0ps/s snr= 1.8
    OP= -65.0ns 0.0ps/s snr=10.6
station clocks
    K= 0.0ns 0.0ps/s
    O= 10.0ns -1.0ps/s
    P= 75.0ns -1.0ps/s
*****
in the search above the source was detected snr=9.52
but only a definite detection on the OP baseline snr=10.6
other baselines KO snr=4.1 and KP snr=1.8 may not be detections
*****

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