On the astrometric calibration of mm-VLBI using dual frequency observations

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1 Abstract

Context We layout in this document a new method to produce astrometric mm-VLBI images. That is images from mm-VLBI observations, which are registered to an external reference frame. This is currently impossible in general.

Aims In VLBI the major task is to calibrate the observed phases, i.e. to isolate the scientifically interesting contributions from the contaminating phase terms, which are to be removed. To perform astrometrical VLBI we need to reference the observations of the source to a calibrator. We present a new calibration method Source/Frequency Phase Transfer which achieves this, at mm-wavelengths.

Method In mm-VLBI, where the unwanted contributions to the observed phases are dominated by terms of a non-dispersive nature, one could expect to be able to determine them at a lower frequency and transfer the solutions to the target frequency. This is not so, as there are a number of dispersive terms which spoil the method. We add further calibrations steps which allow the removal of the ionospheric (or any other) dispersive terms from the frequency referenced phases.

Results In this note we layout our method, and the results of VLBA experiment BD119 which demonstrates the successful application of this approach.

2 Introduction

The complication in VLBI over connected array interferometers is that the antennae are widely separated, and the atmospheres (which are a major contribution to the residuals of the delay path-length of the signals received) over each antenna are completely unrelated. These antenna-based calibration terms have to be derived from observations made as part of the experiment. The solutions are usually obtained using self-calibration techniques, which involves the direct detection of the source signal within every segment of the coherence time-interval, which is set by the stability of the instrument and, dominantly, the atmospheric turbulence. Self-calibration, which is the standard analysis technique in VLBI, can not distinguish between source position errors and other antenna based calibration errors, and this is why observations which are self-calibrated have lost the absolute position information. Phase referencing, where the position of the source is found with respect to a calibrator, has been used to allow the recovery of relative-astrometry. This calibrator may or may not be directly linked to an absolute reference frame. The observations of the scientifically interesting source, the target, are interleaved (within the coherence time) with observations of another, the reference, from which it is assumed that the antenna calibration terms can be transfered. When the solutions from the reference are applied to the target the offset of the target from its assumed position

is the error in the assumed angular separation between the two sources. This is, in essence, the phase-referencing analysis technique. It is well established in cm-VLBI. In mm-VLBI we also wish do to the same, yet at the highest frequencies one is sensitivity limited. At the cutting edge the instruments are less efficient, the sources are intrinsically weaker, and the phase coherence times are shorter. In particular the coherence time is too short to allow an antenna to switch its pointing between sources in all but the most exceptional cases (Porcas & Rioja, 2002). Therefore it would be hugely beneficial if calibration could be performed at a lower, easier, frequency and applied to the data collected at the higher frequency. That is to transfer the calibration phases from a different frequency, rather than a different source, as in conventional phase-referencing. Frequency switching can be performed much faster than source switching, and one now needs solutions only within every coherence time-interval of the lower frequency.

This Frequency Phase Transfer method has been studied for some time. The earliest reference we found is "Tropospheric Phase Calibration in Millimeter Interferometry" (Carilli & Holdaway, 1999) for application with the VLA, but there must be earlier ones. "VLBI observations of weak sources using fast frequency switching" uses frequency phase transfer for a mm-VLBI experiment (Middelberg etal, 2005), but without achieving astrometry. In "Measurement of core-shifts with astrometric multi-frequency calibration" (Rioja etal 2005), we presented the method discussed here, but applied to a cm-VLBI observation.

3 The Basis of the new astrometric method

The basic method is well established. Non-dispersive phase terms scale with frequency. Therefore, if only non-dispersive terms contributed, one could interleave the observations of a scientifically interesting source, at the target frequency of interest, with observations at another frequency (i.e. a lower one with better coherence times and system temperatures) and use the antenna phase calibration terms derived in the analysis of the lower frequency to calibrate the higher one. The dispersive contributions, which prevent this, arise from: excess ionospheric path length (which scales with wavelength rather than frequency), source structure (which can be found and removed using hybrid mapping) and instrumental terms (which could be found from a suitable calibration scheme).

To express this in terms of the observed phases $\phi^{obs}_{x,obj}$ where obj is either the source (sou) or the calibrator (cal) source, and x is the lower reference (l) or higher target (h) frequency.

$\phi^{obs}_{x,obj} = \phi^{geo}_{x,obj} + \phi^{tro}_{x,obj} + \phi^{ins}_{x,obj} + \phi^{ion}_{x,obj} + \phi^{str}_{x,obj}$

where ϕ^{geo} is the geometric contribution to the phase, ϕ^{tro} is the tropospheric phase, ϕ^{ins} is the instrumental phase, ϕ^{ion} is the ionospheric phase and ϕ^{str} is the source structure phase. (We omit whole numbers of turns of phase, the $2pi$N terms.)

$\phi^{obs}_{l,sou}$ can be found with selfcalibration, with hybrid mapping to remove the source structure contribution $\phi^{str}_{l,sou}$. Let R be the frequency ratio between h

and l. (For this method to work generally R must be an integer (as there are terms of $N\,2\pi$, which become $R * N\,2\pi$, which we have not explicitly included) unless one can be very sure that there are no unmodelled complete turns of phase. See Rioja etal (2005) for discussion and a demonstration.) $R * \phi^{obs}_{l,sou}$ is applied to calibrate the observations at the higher frequency. The relative residuals, ϕ^{corr}, for the frequency referenced visibility phases of the source at the higher frequency are now:

$$\phi^{corr}_{h,sou} =$$
$$\phi^{geo}_{h,sou} - R\phi^{geo}_{l,sou} + \phi^{tro}_{h,sou} - R\phi^{tro}_{l,sou} + \phi^{ins}_{h,sou} - R\phi^{ins}_{l,sou} + \phi^{ion}_{h,sou} - R\phi^{ion}_{l,sou} + \phi^{str}_{h,sou}$$

And as

$$\phi^{tro}_{h,sou} = R\phi^{tro}_{l,sou}$$
$$\phi^{ins}_{h,sou} \neq R\phi^{ins}_{l,sou}$$
$$\phi^{ion}_{h,sou} = \phi^{ion}_{l,sou}/R$$
and
$$\phi^{geo}_{h,sou} = R\phi^{geo}_{l,sou} + 2\pi(\bar{\theta}_{sou}.\bar{D}_{\lambda})$$

Where $\bar{\theta}$ is the relative core shift between both frequencies, $\bar{D}_{\lambda}$ is the baseline vector in wavelengths and $2\pi(\bar{\theta}.\bar{D}_{\lambda})$ is the phase contribution from the frequency dependent change in geometry between h and l (the core shift).

Therefore

$\phi^{corr}_{h,sou} = 2\pi(\bar{\theta}_{sou}.\bar{D}_{\lambda}) + \phi^{str}_{h,sou} + \phi^{ins}_{h,sou} - R\phi^{ins}_{l,sou} + (1/R - R) * \phi^{ion}_{l,sou}$

These visibilities contain the core shift and the structure phases we wish to recover. It also has had the fast, tropospheric contributions removed, but slowly varying additional terms, which have time-scales of many minutes (in Middelberg etal (2005) the improvement in phase coherence was of the order of from 30 seconds to 30 minutes) remain. These ionospheric and instrumental terms prevent the direct imaging of the visibilities, to recover the structure and the core shift $\bar{\theta}$. To image the visibilities required further selfcalibration with long timescales, which allowed the deepest imaging achieved with 86-GHz, but not astrometry.

Rather than self-calibrating on the frequency phase-referenced data, let us introduce a second source, the calibrator. Fast frequency switching on this second source would result in a similar expression for the frequency referenced visibility phase:

$\phi^{corr}_{h,cal} = 2\pi(\bar{\theta}_{cal}.\bar{D}_{\lambda}) + \phi^{str}_{h,cal} + \phi^{ins}_{h,cal} - R\phi^{ins}_{l,cal} + (1/R - R) * \phi^{ion}_{l,cal}$

If the source and the calibrator are sufficiently close the expressions for the ionospheric terms and the instrumental terms are nearly the same. Instrumental terms, on a well-behaved array, should be close to constant across the sky and over hours. The ionospheric terms, coming from a single ionospheric patch, also have wide angular coverage at mm-wavelengths, certainly many degrees.

The observations of the calibrator are then analysed with an extra step of self-calibration (again removing the $\phi^{str}_{h,cal}$ contribution). Then the phase corrections derived are subtracted from the residuals of the frequency referenced target source to get the source/frequency referenced visibility phase:

$\phi^{corr}_{h,sou} - \phi^{corr}_{h,cal} = 2\pi(\bar{\theta}_{sou}. - \bar{\theta}_{cal}).\bar{D}_\lambda + \phi^{str}_{h,sou}$

So the visibilities contain only the information on the source structure and the combined relative core shifts between the two frequencies for the two sources. (As, in fact, does conventional phase-referencing at two frequencies.) Direct imaging of these visibilities will recover this information.

We have summarised the contributions and how they are handled in our new strategy for astrometric frequency phase transfer. Because of the large calibration overhead this method is only applicable to mm-VLBI, where no other method would succeed. Previous efforts to exploit frequency phase transfer failed (even for mm-VLBI), because of what is believed to be the ionospheric contribution. Whilst improved phase stabilisation was achieved, and the deepest ever detection of VLBI cores at 86-GHz were produced, astrometric results could not. Our improved method removes the ionospheric and instrumental residual contributions and preserves the astrometry in the calibrated visibilities.

4 Scheduling of Observations

The application of this calibration method requires some extra considerations at the time of scheduling the observations. In all discussions here it is assumed that the two frequencies are 43 and 86-GHz, as in cm-VLBI standard phase-referencing is easy enough that one does not need to follow this method (but of course it works, see Rioja etal (2005)).

One needs to select a source that can be detected in, at least, the lower frequency, with a suitable calibrator source nearby, which can be detected at both frequencies. Experience shows, however, that the coherence time for the higher frequency will increase upto several minutes after the application of the calibration terms from the lower frequency. Do not be shy to request more bandwidth (for the calibrator) than you will need for the source (if, for example, it is a line observation). A minimum should be 4 IFs of 16 MHz, which is not a particularly excessive data-rate.

Here we represent the layout of the observations at two frequencies (43 (freq 1) and 86-GHz (freq 2)):

Target: Source A (total time: 5 min)

- Freq 1 (30 sec)
- Freq 2 (30 sec)
- Freq 1 (30 sec)
- Freq 2 (30 sec)
- .....

Calibrator: Source B (total time: 5 min)

- Freq 1 (30 sec)
- Freq 2 (30 sec)

Freq 1 (30 sec)

Freq 2 (30 sec)

.....

And repeat

But of course all these time-scales are only indications. One needs to guarantee a detection. One also needs to include observations on a good strong calibrator to provide manual phase-cal to align the polarisations and the different IFs, and the bandpasses.

Examples of a schedule for the observations of a continuum-SiO maser experiment and a schedule for the observations of a continuum-continuum experiment are appended. Both are for the VLBA and between 43- and 86-GHz.

5 Data Analysis with AIPS

In the first stages of the analysis the standard data-reduction strategies are followed. For the VLBA these are:

VLBALOAD (noting that data recorded at 512 Mb/s or higher probably was correlated in two passes and will require loading in the same fashion). We generate CL table entries every 15 seconds, as this aids getting good solutions.

VLBAFIX. Sort out the mislabelled polarisations. (Note that at the time of writing this applies the flagging tables – which can be far too aggressive – and it would be better if one did not, but kept the flexibility for later. This can be achieved by applying the steps manually with FLAGVAL=-1, or deleting the FG table.) The output is different files for the different frequencies.

VLBATECR. Apply the Total Electron Content (ionospheric) corrections. These are needed to keep the ionospheric errors to a minimum. (JPL is the default model, but Middelberg suggests that CODE might be better.)

VLBAEOP. Earth Orientation Corrections. These are needed if the correlator model (of EOP) has to be updated. These corrections are non-dispersive, so are solved for in the Frequency Phase Transfer. However it is best to minimise all errors.

VLBACALA. Standard amplitude corrections. If one wishes to include opacity corrections INV needs to be set to 1 in APCAL. This point does not appear in the help file.

VLBAPANG. Correct the phase rotation between the polarisations with CLCOR and OPCODE 'pang'.

Prime Calibrator We perform fringe fitting on the calibrator to find the constant delays and phases between the IFs. There are a number of approaches here, from which we usually pick the easiest for each individual situation. The important thing is to ensure that a **single constant value** is found for the delays and phases. The rates should be kept to zero. One approach is: Zero the rates and phases and fit a zeroth order polynomial to the delays (CLCAL, INTERP 'poly', CUTOFF 1), then find the relative (but constant) phases from a short section of data. Alternatively we find solutions for a portion of the data, then replace all the other calibration terms with those from a good IF (SNCOR, OPCODE 'cpsn' and 'pcop'). If the later is used a subsequent solution for the entire period will contain the required, constant, phases and delays, which must be applied to the penultimate solution table with smoothing. The final step using the prime calibrator is to generate the band-pass solutions with BPASS. In mm-VLBI the best solutions seem to come from the autocorrelations (BPASSPRM 1 0).

Calibrator Source These solutions can be applied to the data, and the data SPLIT or UVCOP into files for each different source and frequency. In fact one must split here, otherwise the indexing table insists on single solutions per scan – and these are only 20 seconds long. This is also a good place to generate a new flagging table. We normally wish to flag the first 8 seconds of every scan (as that seems to be a good value for the frequency switching time). To do this we need to run INDXR with a very small gap between scans (CPARM(1) set to about 1/6 minutes) to identify the frequency switching scans. Then we run QUACK and flag eight seconds from the beginning of the scans, without any padding (which would add another five seconds). I.e. APARM 0,8/60,-1. Then rerun INDXR to merge the short scans into one (CPARM 0), and one can now have solutions upto an hour in length, with a flagging table which clips eight seconds from the start of every new frequency scan.

Now the solution on the calibrator can be found. The IFs and polarisations should be aligned (but check!) so one can sum the polarisations and IFs for all following steps. We start with the lower frequency, solving for phase, rate and delay.

Frequency scaling is only needed for the phase term, as the delays and the phase rates are stored in a frequency independent fashion. Phase scaling can be done either outside AIPS with a simple script (an example is appended), or with Parsel-Tongue, [or in CLINV which will, at some point, have a scaling option added].

Once the scaled phases are applied the data has an increased coherence time. Typical time scales appear to be the order of ten minutes. The phase variations are believed to be due to the small ionospheric contributions (dominantly from the lower frequency, and scaled up). If an increase in coherence time is all that is required, it is sufficient to apply the normal fringe searching – or pure phase calibration – techniques, with longer coherence times, after which the image can be formed. To apply the ionospheric and instrumental corrections to the source

the solutions found must be transferred to the source data after that data has been processed as far as the previous, frequency scaling, step.

Target Source On the lower frequency observations of the source, we repeat the same process as with the calibrator. Using FRING we generate delays, rates and phases. We export the SN table, double the phases, and apply the re-read table to the higher frequency. Then we apply the transferred final solutions from the calibrator to this data to produce a fully phase-referenced dataset.

A complication can come for the maser targets, when there is not a sufficiently strong single compact feature for calibration. This was the case for recent observations of TX-Cam (BD108B). AIPS, unfortunately, can not cope with complicated models to calibrate against. One can not have different models for different channels, therefore we exported the data to **miriad**, where one can do this, and self-calibrate much weaker sources. In this experiment each channel was carefully cleaned (to avoid artificial structure) and this model fed back to self-calibrate the (u,v) data. A script to convert the miriad solutions to an AIPS SN table is appended.

6 Demonstrations of the new method and Results

On 18 February 2007 we carried out VLBI observations, with the VLBA, of two pairs of continuum sources (1308+326 & 1380+328, and 3C273 & 3C274), for seven hours, switching rapidly between two frequencies (43 and 86 GHz). The data rate was 512 MBps (i.e. 2-bit sampling of 8 IFs of 16 MHz). Each pair of sources, one $14'$ apart and the other 10^o apart, were observed during several $\sim$1.5-hourlong sessions within the experiment. Firstly manual phase-cal and primary calibration was done on the primary calibrator (3C273). These solutions were assumed to be fixed for the experiment (as normally found). We derived self-calibration solutions from the analysis of the observations at the lower frequency, and scaled the resulting phase terms by a factor of 2 (using the external perl script), which we applied to the higher frequency. The final step was to self-calibrate on the strongest of the pair at the higher frequency and apply these final corrections to the other, which is then imaged. An additional complication that we have not dealt with is the source structure at each frequency. This was only needed for the 3C pair, which are much more complex (and interesting) sources. For this case the lower frequency FRING solutions and the CALIB solutions (based on the best image) were both doubled and applied to the higher frequency.

The offset from the centre of the map represents the combined relative core shift between the two frequencies, at both sources. I.e. any offset between frequency 1 and 2 will be a combination of the shift in source 1 and source 2. This can easily be disentangled by including additional calibrating sources, which will have different core shifts and core shift directions.

Figure 1 shows the image of 1308+328, made following this method. These sources have been shown to have no intrinsic core shifts, so we expect the image to fall at the origin, as it does. The flux recovery is 60%. Compare this to the flux recovery in the only traditional phase-referencing done at 86-GHz (Porcas & Rioja, 2002) on this same source, where the recovery was only 20%.

Figure 2 shows the image of 3C274 (M87). The sources for the 3C pair are 10^o apart, compared to the $14'$ for the 1308+32 pair, so it is a challenging test. The source does not appear at the centre, being $70\,\mu$sec to the South. However the predicted core shift for 3C273 is 65 μsec (and that for 3C724, zero) (Lobanov, 1998), so it is possible that we again have a perfect solution. As the theoretical predictions are not, at best, an exact science, it would be wise instead to take the core shift we find in this case as an order of magnitude estimate of the reliability of the method. That is we apply an upper bound of 0.1 mas to the astrometric accuracy produced by this strategy.

7 Summary

We have demonstrated a new method of astrometric VLBI calibration, suitable for mm-VLBI. The additional step required to remove the ionospheric, and all other slowly varying dispersive terms, is done by including another source to cross calibrate with. Because the ionospheric patch size is very large at mm frequencies one can use calibrators at considerable distance from the source. In the demonstration here the pair was 3C273 and 3C274, which are 10^o apart. A single pair is sufficient to demonstrate the method, however the astrometric solution (the offset from expected position) contains the contribution from both sources (as happens in standard phase-referencing as well). This problem, however, fulfils the closure condition, so three or more sources can be used to form a closure triangle and separate the contributions from each individual source.

This method has also been shown to work well, in terms of astrometric recovery, in observations made without weather constraints. Of course the images made with the worst weather have significant flux loss, recovering only 23% as opposed to the best case which was 88%. We are still working to understand what the weather conditions actually were (i.e. whether 'good', 'normal' or 'poor'), to guide future proposal requests. The work in understanding these details (from experiment BD123) is on-going and will be discussed fully in future work.

References

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[5] Rioja, M. J., Dodson, R., Porcas, R. W., Suda, H., Colomer, F. 2005. Measurement of core-shifts with astrometric multi-frequency calibration. ArXiv Astrophysics e-prints arXiv:astro-ph/0505475.

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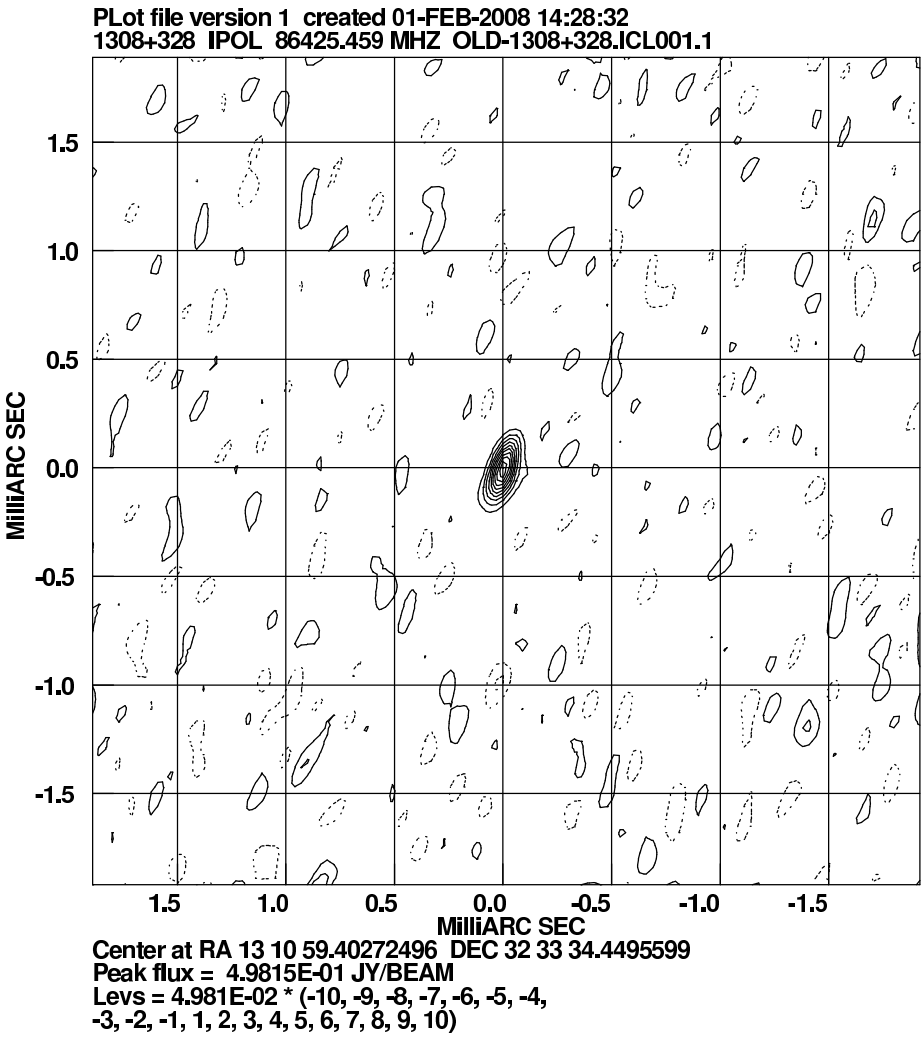

Figure 1: 1308+328 image, at 86 GHz, calibrated with the 43 GHz phases and further corrections from 1308+326 – 14″ away. The offset from the phase centre is zero to within the errors, as expected from other phase-referencing experiments .

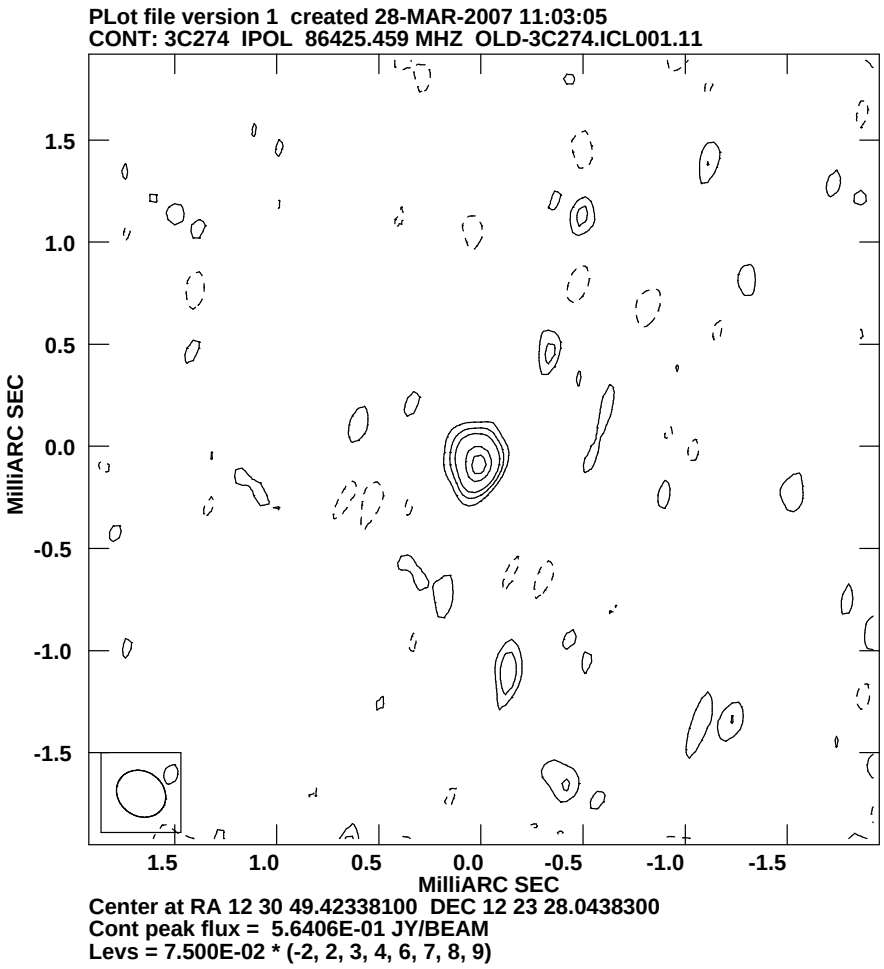

Figure 2: 3C274 image, at 86 GHz, calibrated with the 43 GHz phases and further corrections from 3C273 – 10^o away. The offset from the phase centre (70 μsec) is close to that predicted on theoretical grounds.

8 Appendix A: Schedules

We attach complete schedules, for a maser experiment and a continuum experiment, to provide a over-detailed example of the method.

8.1 Maser Schedule: BD125A

```
! ================================================================
!   Preferred Dynamic Constraints.  Alter [defaults] as desired.
! ================================================================
! Equipment constraints:
!    Stations.  Below each station code, the "o" indicates an
!       [optional] station that is to be used if it is available.
!       Change "o" to "r" if the station is required or change
!       "o" to "n" if the station is not to be used.
!           SC  HN  NL  FD  LA  PT  KP  OV  BR  MK
!           n   n   o   o   o   o   o   o   o   o
!       Minimum number of stations [9 (6 for 3mm)]: 9 with good weather
!       May we swap PT for a single VLA antenna? [yes] no
!          Consult http://www.aoc.nrao.edu/~lsjouwer/y1gotcha.html
!          to decide.  If you adopt the default, then both PT and
!          VLA1 must be in the stations list in the keyin file.
!    Bands and polarizations.  Below each band code, insert "R"
!       if the righthand polarization is to be used, "L" if the
!       lefthand polarization is to be used, "d" if dual
!       polarizations are to be used, or "o" if the band is in
!       your setups but scheduling should not be constrained by
!       its availability.
!           90cm  50cm  20cm  13cm  6cm  4cm  2cm  1cm  7mm  3mm
!                                                      d    d
! Weather constraints:
!    [appropriate for bands marked "L", "R", or "d" above
!     and for at least the minimum number of stations]
!      'Good'
! Date constraints:
!    Preferred date(s), usually a series start [none]:
!             Dec/Jan/Feb
!    Excluded dates plus reason [none]:
!             March onwards, as we will select the next strong target.
!    Preferred interval between segments in days [none]:
!    Special conditions (e.g., a series with different
!       spacings in time) [none]:
!     This experiment needs to be close (a few days would be perfect)
!     to the other part, bd108a.
!
!     The spectral line frequency is set for the 1st Jan. 'Doppler' is
!     not being used because of the number of frequency changes
!     (~150). It would be good to be able to update the
!     observed frequency for a smaller (i.e. not +- 1 month) date
!     range. Please, if possible, give us a few weeks warning of observing.
!
!     This schedule will test a new method of calibration. We will
!     need the best possible conditions for this.
!
! ================================================================
! ============================================================
```

```
! ================  Cover Information  ====================
! ========================================================

EXPT = 'BD125 freq phase cal 3/7 mm'
EXPCODE  = 'BD125A'
VERSION  = 2
PINAME   = 'Richard Dodson'
ADDRESS1 = 'OAN'
ADDRESS2 = 'Apartado 112, E-28803'
ADDRESS3 = 'Alcala de Henares, Madrid Spain'
PHONE    = '(+34) 91-8855060'
OBSPHONE = '(+34) 91-8855061'
FAX      = '(+34) 91-8855062'
email    = 'r.dodson@oan.es'
obsmode ='VLBA Dual 3.5mm and 7mm observations'
obstype  = 'VLBI'
NOTE1 = 'Doppler is not possible with the freq phase ref technique'
NOTE2 = 'phase-refereNCE experiment, DO NOT INTERRUPT the SCANS'
NOTE3 = 'SPECTRAL LINE observations, make sure PHASE CAL is OFF'
NOTE4 = 'using target for pointing'
! ============================================================
!       Program Control Information
! ============================================================
overwrit
overwrit
sumitem =  early, dwell
autotape = 2
! ============================================================
! ==========================================================
! ==============  Correlator Information  ==================
! ==========================================================

correl   = 'Socorro'
coravg   = 1
! 2sec for 22/43 & 1sec for 43/86
corchan  = 512
! 1024 for 22/43 & 512 for 43/86
cornant  = 8
corpol   = 'off'
corwtfn  = 'uniform'
corsrcs  = 'standard'
cortape  = DAT
corship1 = 'OAN, Apdo 112'
corship2 = 'Alcala de Henares, 28803'
corship3 = 'Spain'

! ==========================================================
! ====================  Source Catalog  ====================
! ==========================================================

SRCCAT /
! Program sources:
EQUINOX='J2000'
source='oCet'    ra=02:19:20.7927  dec=-02:58:39.513  vel = 45 /!H20
! ICRS  coord. (ep=2000 eq=2000) :
! 02 19 20.7927 -02 58 39.513 [ 10.53 5.52 55 ] A
! 1997A&A...323L..49P (Hippacos)
```

```
source='P-ocet' ra=02:19:20.7927  dec=-02:58:39.513  vel = 45 /

endcat /

lineinit /
! 7mm 28SiO for pointing:
 lineset='PSiO431'  restfreq=43122.080, 43122.080, 43222.080, 43222.080 /
! 7mm 28SiO v=1, j=1-0, 28SiO v=2, j=1-0
!
!lineset = 'SiO43'
!   restfreq= 42820.587, 42879.916, 43122.080, 43122.080 /
!
! 3mm 28SiO v=2, j=2-1, 29SiO v=0,j=1-0
!
!lineset = 'SiO86-a'
!   restfreq= 85640.456 , 85759.132 /
!
! 3mm 28SiO v=1, j=2-1
!
!lineset = 'SiO86-b'
!   restfreq= 86243.442 , 86243.442 /
!
!
!
!lineset='H2O'     restfreq=22235.08   /
!lineset='SiO425'  restfreq=42519.3    /
!lineset='SiO428'  restfreq=42820.54   /
lineset='SiO431'  restfreq=43122.03   /
lineset='SiO862'  restfreq=86243.35   /
!lineset='SiO868'  restfreq=86846.89   /
endline /

! ============================================================
! ====================  Station Catalog  ====================
! ============================================================

stafile  = '$SCHED/catalogs/stations.dat'

!! ================================================================
!!       Peakfile etc.
!! ================================================================
!!!!!!Not needed for 13mm/7mm
!autopeak
pkwatch
peakfile = none
!!
peakinit /
  srcfile  = none
  minfreq  = 60000.0
  dwell    = 1:00
  minel    = 10.0
  setup    = '$SCHED/setups/pt7mm.set'
  linename = 'PSiO431'
  sources  = 'P-ocet'
  STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
             VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK /
```

```
endpeak /

! ============================================================
! ==============  Spectral line rest frequecies  ===========
! ============================================================

! ============================================================
! ====================  Observing setup  =====================
! ============================================================
! The setups for BD108. The frequencies need setting by hand.

setinit = 'bd108sio2.set'  /
nchan    = 4  bits = 2  bbfilter = 16.0
pol      = dual
!freqref    = 43109.84
freqref    = 43109.99
freqoff = 0.,0.,16.,16.
pcal     = 'off'
band     = '7mm'
/
endset /

setinit = 'bd108sio3mm.set'  /
nchan    = 4  bits = 2  bbfilter = 16.0
pol      = dual
!freqref    = !  LO sum=   86226.98
freqref    = 86226.99
freqoff = 0.,0.,16.,16.
pcal     = 'off'
band     = '3mm'
/
endset /

!setinit = 'bd108sio3mm.set'  /
!nchan    = 2  bits = 2  bbfilter = 16.0
!pol      = dual
!pcal     = 'off'
!band     = '3mm'
!/
!endset /


! ============================================================
! =================  Initial Scan Information  =============
! ============================================================
!
STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
           VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK

lst      = VLBA_PT
year     = 2007  month = 7  day = 1
start    = 00:00:00

!
!dopsrc 'ocet'
!  1 Jan
!LINENAME = 'sio428'  DOPPLER
```

```
!SETUP  = 'bd108sio3mm.set'
!LINENAME = 'sio431'  DOPPLER
!SETUP  = 'bd108sio2.set'
!   LO sum=   43108.64  43108.64  43108.64  43108.64 ! Jun 1
!   LO sum=   43109.84  43109.84  43109.84  43109.84 ! Jul 1
!   LO sum=   43110.12  43110.12  43110.12  43110.12 ! Aug 1
!LINENAME = 'sio862'  DOPPLER
!SETUP  = 'bd108sio3mm.set'
!   LO sum=   86224.56  86224.56  86224.56  86224.56 ! Jun 1
!   LO sum=   86226.98  86226.98  86226.98  86226.98 ! Jul 1
!   LO sum=   86227.52  86227.52  86227.52  86227.52 ! Aug 1
!LINENAME = 'h2o'  DOPPLER
! sure I have this wrong
! it might be best to be done by hands.
! ============================================================
! ========================  The Scans  =======================
! ============================================================

minpause=55

!! Band pass calibrators 384/3C454/4C39

!!! If all on one day would want to alternate the lines to
!!! ensure best uv matching.

!!! Finalise: SiO 1 & 2, Cycle time(s) for iono,
!!! freq switching time for 22/43

!!! Whether PCAL is possible.

!!! Time on BPASS? 10 min too long

!!! 0215 is .. say 0.9 Jy at 3mm? more at 7mm

   setup     = 'bd108sio2.set'
      source = '3c454.3'  dur =  0:10  gap = 3:00  point /
      source = '3c454.3'  dur =  5:00 gap=0 /
   setup     = 'bd108sio3mm.set'
      source = '3c454.3'  dur =  5:00  gap = 0:00   /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 01:10   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set' ! hi
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'  ! lo
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'  ! hi
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'   ! lo
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
```

```
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set' ! hi
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'  ! lo
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set' ! hi
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'  ! lo
      source = '0215+015'  dur =  00:25  /
!
!STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
!           VLBA_KP, VLBA_OV, VLBA_BR
!STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
!           VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set' ! hi
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'  ! lo
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
```

```
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
!
!STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
!           VLBA_KP, VLBA_OV, VLBA_BR
!STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
!           VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15  / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
```

```
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

!
!! Band pass calibrators

   setup     = 'bd108sio2.set'
      source = '3c84'  dur =  0:10  gap = 3:00  point  /
      source = '3c84'  dur =  3:00 gap = 0/
   setup     = 'bd108sio3mm.set'
      source = '3c84'  dur =  3:00 /

!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 1:10   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
!

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
!      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
```

```
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
```

```
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
!
!      source = '3c84'  dur =  00:10 gap=03:00 point /
```

```
!

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15  / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
```

```
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

!! Band pass calibrators

   setup     = 'bd108sio2.set'
      source = '3c84'  dur =  0:10 gap = 3:00 point /
      source = '3c84'  dur =  3:00 gap = 0/
   setup     = 'bd108sio3mm.set'
      source = '3c84'  dur =  3:00  /

!!!!! Change to other SiO line

!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 1:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
```

```
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
!
!      source = '3c84'  dur =  00:10 gap=03:00 point /
!

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
```

```
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

!
!! Band pass calibrators

   setup     = 'bd108sio2.set'
      source = '3c84'  dur =  0:10 gap = 3:00 point  /
      source = '3c84'  dur =  3:00 gap = 0/
   setup     = 'bd108sio3mm.set'
      source = '3c84'  dur =  3:00 /

!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 1:10   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /


   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
```

```
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
   setup     = 'bd108sio2.set'

      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /
!
!      source = '3c84'  dur =  00:10 gap=03:00 point /
!

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /
!
      source = 'p-ocet'  dur =  00:10 gap=1:30 point /
!
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:13   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
```

```
      source = 'OCET'  dur =  00:35  gap = 0:13   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:13   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:13  / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:15   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:13   / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:13   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:15   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:13  / ! slew and lo
```

```
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:13   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:13  / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  gap = 0:13   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd108sio3mm.set'
      source = '0215+015'  dur =  00:25  gap = 0   /
   setup     = 'bd108sio2.set'
      source = '0215+015'  dur =  00:25  /

   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  gap = 0:13  / ! slew and lo
group = 2 repeat = 5
   setup     = 'bd108sio3mm.set'
      source = 'OCET'  dur =  00:35  gap = 0   /
   setup     = 'bd108sio2.set'
      source = 'OCET'  dur =  00:35  /

! ---------------------------------------------------------------------
```

8.2 Continuum Schedule: BD119

```
! ============================================================
!   Preferred Dynamic Constraints.  Alter [defaults] as desired.
! ============================================================
! Equipment constraints:
!    Stations.  Below each station code, the "o" indicates an
!       [optional] station that is to be used if it is available.
!       Change "o" to "r" if the station is required or change
!       "o" to "n" if the station is not to be used.
!           SC  HN  NL  FD  LA  PT  KP  OV  BR  MK
!           n   n   o   o   o   o   o   o   o   o
!       Minimum number of stations [9 (6 for 3mm)]: 6 with good weather
!       May we swap PT for a single VLA antenna? [yes] no
!          Consult http://www.aoc.nrao.edu/~lsjouwer/y1gotcha.html
!          to decide.  If you adopt the default, then both PT and
!          VLA1 must be in the stations list in the keyin file.
!    Bands and polarizations.  Below each band code, insert "R"
!       if the righthand polarization is to be used, "L" if the
!       lefthand polarization is to be used, "d" if dual
!       polarizations are to be used, or "o" if the band is in
!       your setups but scheduling should not be constrained by
!       its availability.
!           90cm  50cm  20cm  13cm  6cm  4cm  2cm  1cm  7mm  3mm
!                                                      d    d
! NB>  I have changed the 16 IFs of LL for 8 IFs of LL & RR, I hope that this
!           is not a problem or issue.
!
! Weather constraints:
!    [appropriate for bands marked "L", "R", or "d" above
!     and for at least the minimum number of stations]
!      'Good'
! Date constraints:
!    Preferred date(s), usually a series start [none]:
!             Dec/Jan/Feb
!    Excluded dates plus reason [none]:
!             March onwards
!    Preferred interval between segments in days [none]:
!    Special conditions (e.g., a series with different
!       spacings in time) [none]:
!
!
!
!     This schedule will test a new method of calibration. We will
!     need the best possible conditions for this.
!
! ============================================================
! ==========================================================
! ================  Cover Information  =====================
! ==========================================================

EXPT = 'BD119 freq phase cal 3/7 mm'
EXPCODE  = 'BD119'
VERSION  = 4
PINAME   = 'Richard Dodson'
ADDRESS1 = 'OAN'
ADDRESS2 = 'Apartado 112, E-28803'
ADDRESS3 = 'Alcala de Henares, Madrid Spain'
```

```
PHONE    = '(+34) 91-8855060'
OBSPHONE = '(+34) 91-8855061'
FAX      = '(+34) 91-8855062'
email    = 'r.dodson@oan.es'
obsmode ='VLBA Dual 3.5mm and 7mm observations'
obstype  = 'VLBI'
NOTE1 = 'phase-refereNCE experiment, DO NOT INTERRUPT the SCANS'
NOTE2 = 'New version with improved position and pointing'
! ================================================================
!       Program Control Information
! ================================================================
overwrit
overwrit
sumitem =  early, dwell
autotape = 2
! ================================================================
! ============================================================
! ==============  Correlator Information  ==================
! ============================================================

correl   = 'Socorro'
coravg   = 1
! 2sec for 22/43 & 1sec for 43/86
corchan  = 64
! 1024 for 22/43 & 512 for 43/86
cornant  = 8
corpol   = 'off'
corwtfn  = 'uniform'
corsrcs  = 'standard'
cortape  = DAT
corship1 = 'OAN, Apdo 112'
corship2 = 'Alcala de Henares, 28803'
corship3 = 'Spain'

! ============================================================
! ====================  Source Catalog  ======================
! ============================================================

SRCCAT /
! Program sources:
EQUINOX='J2000'
! 1308+326, 1308+328, 3C273, 3C274
SOURCE='1308+328'  RA=13:10:59.402725  DEC= 32:33:34.44956
 RAERR= 0.255 DECERR=  0.26  EQUINOX='J2000' /
! From ICRF- ext . 1
! (Unit of errors are s/arcsec .. what is needed? )
! now in mas

source='P-RLMi' ra=09:42:34.773 dec=34:44:33.78 equinox=b1950
                vel=-2., -2. /

source='P-SCrB' ra=15:19:21.5 dec=31:32:47. equinox=b1950
                vel=1.8, 1.8 /
source='P-RXBoo' ra=14:24:11.62 dec=25:42:13.3  equinox=j2000
                vel= 3., 3. /

!! http://www.ls.eso.org/lasilla/Telescopes/SEST/html/telescope-calibration/point-sources/sio-sources.html
```

```
endcat /

lineinit /
! 7mm 28SiO for pointing:
 lineset='PSiO431'  restfreq=43122.080, 43122.080, 43222.080, 43222.080 /
! 7mm 28SiO v=1, j=1-0, 28SiO v=2, j=1-0
!
!lineset = 'SiO43'
!   restfreq= 42820.587, 42879.916, 43122.080, 43122.080 /
!
!lineset = 'SiO86-a'
!   restfreq= 85640.456 , 85759.132 /
!
! 3mm 28SiO v=1, j=2-1
!
!lineset = 'SiO86-b'
!   restfreq= 86243.442 , 86243.442 /
!
!
!
!lineset='H2O'     restfreq=22235.08   /
!lineset='SiO425'  restfreq=42519.3    /
!lineset='SiO428'  restfreq=42820.54   /! This was stronger in June
! lineset='SiO431'  restfreq=43122.03   /
! lineset='SiO862'  restfreq=86243.35   /
!lineset='SiO868'  restfreq=86846.89   /
endline /

! ============================================================
! ====================  Station Catalog  ====================
! ============================================================

stafile  = '$SCHED/catalogs/stations.dat'

!! ================================================================
!!       Peakfile etc.
!! ================================================================
!!!!!!Not needed for 13mm/7mm
autopeak
pkwatch
peakfile = none
!
peakinit /
  srcfile  = none
  minfreq  = 60000.0
  dwell    = 1:00
  minel    = 10.0
  setup    = '$SCHED/setups/pt7mm.set'
  linename = 'PSiO431'
  sources  = 'P-SCrB', 'P-RLMi', '3c273' !, 'P-RXBoo'
  STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
             VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK /
endpeak /

! ============================================================
! ==============  Spectral line rest frequecies  ============
```

```
! ========================================================

! ========================================================
! ====================  Observing setup  ==================
! ========================================================
! The setups for BD108. The frequencies need setting by hand.

! use v7mm-512-8-2.set
setinit = 'bd119_7mm.set'  /
  nchan    = 8
  bits     = 2
  bbfilter = 16.0
  freqref  =  43212.99
  freqoff  =  -32.50, -32.50, -16.50, -16.50,  -0.50,  -0.50,  15.50,  15.50
  netside  =  U, U, U, U, U, U, U, U
  pol      = dual
!nchan    = 8  bits = 2  bbfilter = 16.0
!pol      = dual
!!freqref    = 43104.49
!freqref    = 43104.49
pcal     = 'off'
!band     = '7mm'
/
endset /

! use v3mm-512-8-2.set
setinit = 'bd119_3mm.set'  /
  nchan    = 8
  bits     = 2
  bbfilter = 16.0
  freqref  =  86425.99
  freqoff  =  -32.50, -32.50, -16.50, -16.50,  -0.50,  -0.50,  15.50,  15.50
  netside  =  U, U, U, U, U, U, U, U
  pol      = dual
  pcal     = 'off'
!nchan    = 8  bits = 2  bbfilter = 16.0
!pol      = dual
!!freqref    = !   LO sum=   86216.26  1 Jan
!freqref    = 86215.49
!pcal     = 'off'
!band     = '3mm'
/
endset /

! ========================================================
! =================  Initial Scan Information  ============
! ========================================================
!
STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
           VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK

lst      = VLBA_PT
! year     = 2007  month = 1  day = 1
day=60821
start    = 10:00:00

!
```

```
! 1308+328 0.4 Jy. Estimated 23 secs
!
!At the observations, the antennas will switch rapidly between the
!frequencies, and alternate scans on each of the
!AGN's.  Using a 23-secs per frequency, and 7 seconds to switch, the
!switching cycle is 1 minute. This, with a 5 minute source cycle, will
!be the basic observing strategy for the 1308+32 pair. For the other
!pair, where signal to noise is much greater, we will test other
!cycle times to determine the most efficient observational strategy.
!
! ============================================================
! ========================  The Scans  =======================
! ============================================================

minpause=55

!STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
!           VLBA_KP, VLBA_OV, VLBA_BR
!!!! Time on BPASS? 10 min too long
!   setup     = 'bd119_7mm.set'
!      source = '3c273'  dur =  0:10:00 gap=0:04:00 /
!!! point /



STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
           VLBA_KP, VLBA_OV, VLBA_BR
   setup     = 'bd119_7mm.set'
      source = '3c273' dur =  05 gap=3:00 point /
! dont point on MK
STATIONS = VLBA_NL, VLBA_FD, VLBA_LA, VLBA_PT,
           VLBA_KP, VLBA_OV, VLBA_BR, VLBA_MK
      source = '3c273'  dur =  3:00 gap= 0 /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  3:00 gap=0 /
!! Band pass calibrators


   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
! point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

!! Band pass calibrators
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  3:00 gap=0 /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  3:00 gap=0 /
!! Band pass calibrators


!point
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 3:00   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:40  gap = 0   / ! slew and lo
```

```
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:40  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 4
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 4
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+326'  dur =  00:25  gap = 4:00   / ! slew and lo
group = 2 repeat = 4
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 4
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+326'  dur =  00:25  gap = 4:00   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
```

```
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+328'  dur =  00:35  gap = 4:00   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+328'  dur =  00:35  gap = 5:00   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
```

```
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /


   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  04:00  gap = 5:00 /
!! point  / ! slew and lo
      source = '3c273'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
!point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
!point
      source = '3c274'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '3c273'  dur =  00:25  gap = 3:20   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '3c273'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c273'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  gap = 0:20   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '3c274'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '3c274'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 60  / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+328'  dur =  00:35  gap = 4:00   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+328'  dur =  00:35  gap = 4:00   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 3
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+326'  dur =  00:25  gap = 4:00   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
!point
      source = '1308+328'  dur =  00:35  gap = 4:00   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 4:00   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /
```

```
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+328'  dur =  00:30  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+328'  dur =  00:35  /

   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   / ! slew and lo
group = 2 repeat = 2
   setup     = 'bd119_7mm.set'
      source = '1308+326'  dur =  00:25  gap = 0   /
   setup     = 'bd119_3mm.set'
      source = '1308+326'  dur =  00:25  /

! ---------------------------------------------------------------------
```

9 Appendix B: Scripts

We provide the simple script used to double (or any other ratio) the phases in an exported AIPS SN table, and write out a new one, and another which will convert the solution tables for miriad to solution tables for AIPS.

9.1 change.sn.phase.pl

Scales the phases in the SN table by a factor, which is by default 2. Used for scaling the phases from the lower frequency solutions for use with the high frequency.

```
#!/usr/bin/perl -w

use Getopt::Long;

GetOptions(#'debug!'=>\$debug,
   'factor=f'=>\$factor,
   'help!'=>\$help);


if ($help) {
    print <<HELP;
    Identify the REAL/IMAG channels and increase them by a factor.
--factor F Defaults to 2
HELP
    exit(0);
}

#if ($factor) { print $factor."\n"; exit; }
```

```
$factor=2 if (!$factor);
$i=-1;$pass=0;
while (<>)
{
  $pass=-1 if (substr($_,0,7) eq "***END*");
  if (substr($_,0,3) eq "END") {
      print "HISTORY TBOUT  / Table phases scaled by $factor\n";
      }
  if ($pass<=0) {print;}
  else {
$re=substr($_,($i-2),14);
        $im=substr($_,($i+13),14);
if ((substr($re,0,6) eq "'INDE'") || (substr($im,0,6) eq "'INDE'"))
{print;}else {
    $a=sqrt($re*$re+$im*$im);
    $p=atan2($im,$re);
    $p2=$factor*$p;
    $re2=$a*cos($p2);
    $im2=$a*sin($p2);
# print;
    printf("%s%15.6e%15.6e%s",
   substr($_,0,$i-3),$re2,$im2,substr($_,$i+27,999));
# $pass=-1;
}
    }
  if (substr($_,0,8) eq "COL. NO.")
  {#print;
   #$c=$_;
   $_=<>;
   print;
   #print substr($_,0,60)."\n";
   $i=index($_,"REAL");
#   print "i is $i \n";
   if ($i >= 0)
   {#print "Column no ".substr($c,$i,6)." has real part\n";
    while ($pass != 1) {
$_=<>;
#print substr($_,0,60)."\n";
print;
$pass=1 if (substr($_,0,7) eq "***BEGI");
        } #while
   } # $i > 0
  }# Col No
} # while
```

9.2 gplist_to_sntab.pl

Reads the miriad gain table and generates a SN table from that. Useful for using the better miriad channel based models and selfcalibration and passing that back to the AIPS enviroment.

```
#!/usr/bin/perl -w

use Getopt::Long;

my $first=1;
my $no_lines=0;
my @dt;
my $last_t=-1;
my $d2r=3.1415926535898/180;
my @r;
my @i;

GetOptions('debug!'=>\$debug,
   'nohist!'=>\$nohist,
   'help!'=>\$help,
   'refant=i'=>\$refant);

$refant=1 if (!$refant); # Could extract from the history?

if ($help || scalar @ARGV !=1) {
    print <<HELP;

 gplist_to_sntab.pl [--refant=N] [--nohist] [--help] miriad_dataset > sn.table

Given the dataset it generates a gplisting internally and then the SN
table.

You can set the refant and switch of the history inclusion
(and get this help message).

HELP

    exit;

}

stat $ARGV[0] || die "cannot open $ARGV[0]: exiting\n";
die "Dont know path to miriad\n" if (!`echo $MIRBIN`);

$no_pol=`gethd in=$ARGV[0]/npol`;chomp $no_pol;
```

```
die "number of polarisations reported as $no_pol\n"
    if (!($no_pol==1 ||$no_pol==2 ||$no_pol==4));
$no_pol=2 if ($no_pol==4); # no sure about this case -- but it seems likely.

open FH, "gplist vis=$ARGV[0] options=complex |";

while (<FH>) {
    if ($first) {
if (!/GpList/) {
    print "Is this a listing from gplist?\n$_\n";
    exit;
} else { $_=<FH>;}
if (/(\d)\s+antennas/i) { $no_ant = $1; $_=<FH>; }
$complex=1 if (/The complex gains listed in the table are/);
$phase=1 if (/The phase gains listed in the table are/);
$amp=1 if (/The amplitude gains listed in the table are/);
$_=<FH>; $_=<FH>;
    }

    if (/(\d+):(\d+):(\d+)/) {  # There will be 10
push @t,$1+($2+$3/60)/60;
split;
if ($phase) {
    for ($n=0;$n<$no_ant;$n++)
    { $r[$n][$no_lines]=cos(@_[$n+1]*$d2r);
      $i[$n][$no_lines]=sin(@_[$n+1]*$d2r); }
        } elsif ($amp) {
    for ($n=0;$n<$no_ant;$n++)
    { $r[$n][$no_lines]=@_[$n+1];$i[$n][$no_lines]=0; }
        } elsif ($complex) {
    for ($n=0;$n<$no_ant;$n++)
    { if ($n<5) {$r[$n][$no_lines]=@_[2*$n+1];
 $i[$n][$no_lines]=@_[2*$n+2];}
      else {$r[$n][$no_lines]=@_[2*$n-10];
    $i[$n][$no_lines]=@_[2*$n-9];}
      if ($n==4) {$_=<FH>; split;}
      print "r: $r[$n][$no_lines] i: $i[$n][$no_lines]\n" if ($debug);
    }
} else { print "No idea what the format is\nexiting\n"; exit; }

push @dt,$t[-1]-$last_t  if (!$first);
if ($first) { $first = undef; }

#printf "\n",$t,$dt,$na,$r,$i if (!$first);
$last_t=$t[-1];
$no_lines++;
```

```
    }
}
close FH;

push @dt,$dt[-1];
$no_lines=scalar @t;$no_lines *= $no_ant;
if ($no_pol==2) { $no_pass=3;
  $no_fields=22;
      } else { $no_pass=2;
       $no_fields=15; }
print <<ENDHEAD;
XTENSION= 'TABLE   '           / extension type
BITPIX  =                    8 / printable ASCII codes
NAXIS   =                    2 / Table is a matrix
NAXIS1  =                  132 / Max. no. of characters/pass
NAXIS2  =                  $no_lines / Number of entries in table
PCOUNT  =                    0 / Random parameter count
GCOUNT  =                    1 / Group count
NOPASS  =                    $no_pass / Number of passes thru table
TFIELDS =                   $no_fields / Number of fields in each row
EXTNAME = 'AIPS SN '           / AIPS table file
EXTVER  =                    1 / Version Number of table
TBCOL1  =                    9 / Starting char. pos. of field
TFORM1  = 'D24.15  '           / Fortran format of field  1
TFDIM1  =                    1 / Dimension of field  1
TTYPE1  = 'TIME                  '           / type (heading) of field  1
TUNIT1  = 'DAYS    '           / physical units of field  1
TBCOL2  =                   33 / Starting char. pos. of field
TFORM2  = 'E15.6   '           / Fortran format of field  2
TFDIM2  =                    1 / Dimension of field  2
TTYPE2  = 'TIME INTERVAL           '           / type (heading) of field  2
TUNIT2  = 'DAYS    '           / physical units of field  2
TBCOL3  =                   48 / Starting char. pos. of field
TFORM3  = 'I11     '           / Fortran format of field  3
TFDIM3  =                    1 / Dimension of field  3
TTYPE3  = 'SOURCE ID               '           / type (heading) of field  3
TUNIT3  = '        '           / physical units of field  3
TBCOL4  =                   59 / Starting char. pos. of field
TFORM4  = 'I11     '           / Fortran format of field  4
TFDIM4  =                    1 / Dimension of field  4
TTYPE4  = 'ANTENNA NO.             '           / type (heading) of field  4
TUNIT4  = '        '           / physical units of field  4
TBCOL5  =                   70 / Starting char. pos. of field
TFORM5  = 'I11     '           / Fortran format of field  5
TFDIM5  =                    1 / Dimension of field  5
```

```
TTYPE5  = 'SUBARRAY               '           / type (heading) of field  5
TUNIT5  = '        '             / physical units of field  5
TBCOL6  =                   81 / Starting char. pos. of field
TFORM6  = 'I11     '             / Fortran format of field  6
TFDIM6  =                    1 / Dimension of field  6
TTYPE6  = 'FREQ ID                '           / type (heading) of field  6
TUNIT6  = '        '             / physical units of field  6
TBCOL7  =                   92 / Starting char. pos. of field
TFORM7  = 'E15.6   '             / Fortran format of field  7
TFDIM7  =                    1 / Dimension of field  7
TTYPE7  = 'I.FAR.ROT              '           / type (heading) of field  7
TUNIT7  = 'RAD/M**2'             / physical units of field  7
TBCOL8  =                  107 / Starting char. pos. of field
TFORM8  = 'I11     '             / Fortran format of field  8
TFDIM8  =                    1 / Dimension of field  8
TTYPE8  = 'NODE NO.               '           / type (heading) of field  8
TUNIT8  = '        '             / physical units of field  8
TBCOL9  =                 1009 / Starting char. pos. of field
TFORM9  = 'E15.6   '             / Fortran format of field  9
TFDIM9  =                    1 / Dimension of field  9
TTYPE9  = 'MBDELAY1               '           / type (heading) of field  9
TUNIT9  = 'SECONDS '             / physical units of field  9
TBCOL10 =                 1024 / Starting char. pos. of field
TFORM10 = 'E15.6   '             / Fortran format of field 10
TFDIM10 =                    1 / Dimension of field 10
TTYPE10 = 'REAL1                  '           / type (heading) of field 10
TUNIT10 = '        '             / physical units of field 10
TBCOL11 =                 1039 / Starting char. pos. of field
TFORM11 = 'E15.6   '             / Fortran format of field 11
TFDIM11 =                    1 / Dimension of field 11
TTYPE11 = 'IMAG1                  '           / type (heading) of field 11
TUNIT11 = '        '             / physical units of field 11
TBCOL12 =                 1054 / Starting char. pos. of field
TFORM12 = 'E15.6   '             / Fortran format of field 12
TFDIM12 =                    1 / Dimension of field 12
TTYPE12 = 'DELAY 1                '           / type (heading) of field 12
TUNIT12 = 'SECONDS '             / physical units of field 12
TBCOL13 =                 1069 / Starting char. pos. of field
TFORM13 = 'E15.6   '             / Fortran format of field 13
TFDIM13 =                    1 / Dimension of field 13
TTYPE13 = 'RATE 1                 '           / type (heading) of field 13
TUNIT13 = 'SEC/SEC '             / physical units of field 13
TBCOL14 =                 1084 / Starting char. pos. of field
TFORM14 = 'E15.6   '             / Fortran format of field 14
TFDIM14 =                    1 / Dimension of field 14
TTYPE14 = 'WEIGHT 1               '           / type (heading) of field 14
```

```
TUNIT14 = '        '           / physical units of field 14
TBCOL15 =                 1099 / Starting char. pos. of field
TFORM15 = 'I11     '           / Fortran format of field 15
TFDIM15 =                    1 / Dimension of field 15
TTYPE15 = 'REFANT 1                '           / type (heading) of field 15
TUNIT15 = '        '           / physical units of field 15
ENDHEAD

    if ($no_pol==2) {
print <<ENDHEAD;
TBCOL16 =                 1110 / Starting char. pos. of field
TFORM16 = 'E15.6   '           / Fortran format of field 16
TFDIM16 =                    1 / Dimension of field 16
TTYPE16 = 'MBDELAY2                '           / type (heading) of field 16
TUNIT16 = 'SECONDS '           / physical units of field 16
TBCOL17 =                 2009 / Starting char. pos. of field
TFORM17 = 'E15.6   '           / Fortran format of field 17
TFDIM17 =                    1 / Dimension of field 17
TTYPE17 = 'REAL2                   '           / type (heading) of field 17
TUNIT17 = '        '           / physical units of field 17
TBCOL18 =                 2024 / Starting char. pos. of field
TFORM18 = 'E15.6   '           / Fortran format of field 18
TFDIM18 =                    1 / Dimension of field 18
TTYPE18 = 'IMAG2                   '           / type (heading) of field 18
TUNIT18 = '        '           / physical units of field 18
TBCOL19 =                 2039 / Starting char. pos. of field
TFORM19 = 'E15.6   '           / Fortran format of field 19
TFDIM19 =                    1 / Dimension of field 19
TTYPE19 = 'DELAY 2                 '           / type (heading) of field 19
TUNIT19 = 'SECONDS '           / physical units of field 19
TBCOL20 =                 2054 / Starting char. pos. of field
TFORM20 = 'E15.6   '           / Fortran format of field 20
TFDIM20 =                    1 / Dimension of field 20
TTYPE20 = 'RATE 2                  '           / type (heading) of field 20
TUNIT20 = 'SEC/SEC '           / physical units of field 20
TBCOL21 =                 2069 / Starting char. pos. of field
TFORM21 = 'E15.6   '           / Fortran format of field 21
TFDIM21 =                    1 / Dimension of field 21
TTYPE21 = 'WEIGHT 2                '           / type (heading) of field 21
TUNIT21 = '        '           / physical units of field 21
TBCOL22 =                 2084 / Starting char. pos. of field
TFORM22 = 'I11     '           / Fortran format of field 22
TFDIM22 =                    1 / Dimension of field 22
TTYPE22 = 'REFANT 2                '           / type (heading) of field 22
TUNIT22 = '        '           / physical units of field 22
ENDHEAD
```

```
}

print <<ENDHEAD;
NO_ANT  =            $no_ant
NO_POL  =            $no_pol
NO_IF   =            1
NO_NODES=            0
MGMOD   =   1.00000000000000000E+00
APPLIED =                    F
REVISION=           10
ORIGIN  =            0
ISORTORD =                   1
HISTORY Generated from Miriad GP table with $0
ENDHEAD

if (!$nohist) {
open FH, "<$ARGV[0]/history" ||
    die "ARGV[0] is not a miriad directory with history\n";
while (<FH>) {
   $first =1 if (/miriad/i); # Skip till the miriad history
   print "HISTORY $_"  if ($first);
}
close FH;
}

print <<ENDHEAD;
END
COL. NO.      1                       2             3          4          5          6
     ROW   TIME                    TIME INT       SOURCE I   ANTENNA    SUBARRAY   FREQ
  NUMBER   DAYS                    DAYS
***BEGIN*PASS***
ENDHEAD

# Pass 1
    for ($no_lines=0;$no_lines<scalar @t;$no_lines++) {
    for ($n=0;$n<$no_ant;$n++) {
printf("%7D %24.15E%15.6E%11D%11D%11D%11D%15.6E%11D\n",
       $n+$no_lines*$no_ant+1,$t[$no_lines]/24.0,$dt[$no_lines]/24,
       1,$n+1,1,1,0,0);}}

print "***END*PASS***\n";

if ($no_pol==2) {
print "COL. NO.      9             10             11             12             13
print "     ROW   MBDELAY1       REAL1          IMAG1          DELAY 1        RATE 1
print "  NUMBER   SECONDS                                     SECONDS        SEC/SEC
```

```
print "***BEGIN*PASS***\n";

# Pass 2
    for ($no_lines=0;$no_lines<scalar @t;$no_lines++) {
    for ($n=0;$n<$no_ant;$n++) {
printf("%7D %15.6E%15.6E%15.6E%15.6E%15.6E%15.6E%11D%15.6E\n",
       $n+$no_lines*$no_ant+1,0,
       $r[$n][$no_lines],$i[$n][$no_lines],
       0,0,5,$refant,0);
    }}

print "***END*PASS***\n";
print "COL. NO.     17             18             19             20             21
print "     ROW   REAL2          IMAG2          DELAY 2        RATE 2         WEIGHT 2
print "  NUMBER                                 SECONDS        SEC/SEC\n";
print "***BEGIN*PASS***\n";

# Pass 3
    for ($no_lines=0;$no_lines<scalar @t;$no_lines++) {
    for ($n=0;$n<$no_ant;$n++) {
printf("%7D %15.6E%15.6E%15.6E%15.6E%15.6E%11D\n",
       $n+$no_lines*$no_ant+1,
       $r[$n][$no_lines],$i[$n][$no_lines],
              0,0,5,$refant);}}
} else {
print "***END*PASS***\n";
print "COL. NO.      9             10             11             12             13
print "     ROW   MBDELAY1       REAL1          IMAG1          DELAY 1        RATE 1
print "  NUMBER   SECONDS                                     SECONDS        SEC/SEC
print "***BEGIN*PASS***\n";

# Pass 2
    for ($no_lines=0;$no_lines<scalar @t;$no_lines++) {
    for ($n=0;$n<$no_ant;$n++) {
printf("%7D %15.6E%15.6E%15.6E%15.6E%15.6E%15.6E%11D\n",
       $n+$no_lines*$no_ant+1,0,
       $r[$n][$no_lines],$i[$n][$no_lines],
       0,0,5,$refant);
    }}
}
print "***END*PASS***\n";
```