Continuous Calibration for LBA with CABB

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1 Introduction

Here we present analysis of the ATCA data for the recent LBA experiments V452 A and B. When the differential phases drift between the antennas there is a change in the effective gain, which can be corrected with a gain table, and change in the D-term solution for which there is currently no means for correction. The belief to be tested was whether the phase drifts are sufficiently small so that there is no overwhelming need for continuous or regular phasing up. We find that this is not the case and suggest remedies.

The CABB correlator is run in parallel to the VLBI observing, so we were able to download the archived data and, with **atlod**, extract the relevant IFs with **ifsel**. At this point with 2GHz continuum band, channelised to 64MHz, IF1 corresponds to Freq1, IF2 corresponds to Freq2. IF3 is the high spectral resolution zoomed version of IF1 and IF4 is the same for IF2. The ATCA configuration was compact: EW352.

1.1 V452A

Central frequencies were 5.0, 5.6, 6.0 and 6.64 GHz. IF1 and IF2 have 33 channels spanning 2GHz. IF3 and 4 have 2048 channels spanning 64MHz. IF1 and IF2 were not usable. Antenna 6 was not recording data.

Figure 1 shows the uncalibrated phases for the whole experimental run after the initial setup. Both XX, YY, 6.0 and 6.7 GHz show near identical phase solutions. Figure 3a) shows the predicted gain for the tied array (for both all antennas except CA06 and the first 4 antennas).

1.2 V452B

Central frequency were 2.75, 3.21, 1.70 and 1.76 GHz. IF1 and IF2 have 33 channels spanning 2GHz. IF3 and 4 have 2048 channels spanning 64MHz. IF1 and IF2 were not usable.

Figure 2 shows the uncalibrated phases for the whole experimental run after the initial setup. Both XX, YY, 1.7 and 1.8 GHz show near identical phase solutions. The most notable effect is the rapid drift of the phases for antenna 5 at 20hr UT. CA05 is only 245m from the reference antenna, where as CA04 and CA02 are 120 and 150m respectively. The phase drift will have significantly impacted the effective gain of tied ATCA, as shown in Figure 3b).

2 Suggested procedure

We can not depend on the phases tracking each other, even at the lowest frequencies. Therefore we believe continuous phase calibration (pcal) on a suitable source should be included in VLBI data collection at ATCA. The schedule could call the procedure for every suitably flagged calibrator which has a scan length greater than 1 minute. The calibrator should have phase noise better than 5^o over 32 MHz per cycle, which implies a flux of 0.4 Jy at cm wavelengths and double that at 43-GHz. In most circumstances an hourly scan of a suitable source , such as the primary calibrator or fringe finder, would provide the ideal target.

This will realign the array internally, but should not alter the phases between VLBI sites as long as the reference ATCA antenna is common for the VLBI correlator and CABB. This implies that the CABB reference antenna should be in the tied array.

The Cmd field in the schedule should be set to '*wait N; corr pcal*' where N is 3 + the number of cycles taken to slew to the source from the previous location. This precaution needs to be taken because the 'wait' instruction does not guarantee on-source cycles will be waited, and the phase calibration instruction 'pcal' looks at the previous 3 on-source cycles to determine the appropriate correction. The SUM file lists the slew times for each source change, and should be a good estimate of the required delay.

3 Conclusion

Even at L band and with compact configurations we can not assume that the phases will track each other. However the CABB software is capable of handling the required corrections with little additional effort. Additionally it is believed that if the ATCA D-term are set to zero in the setup that phase drifts would not effect these. This is an assumption which may be testable in the V452B data, and will be investigated.

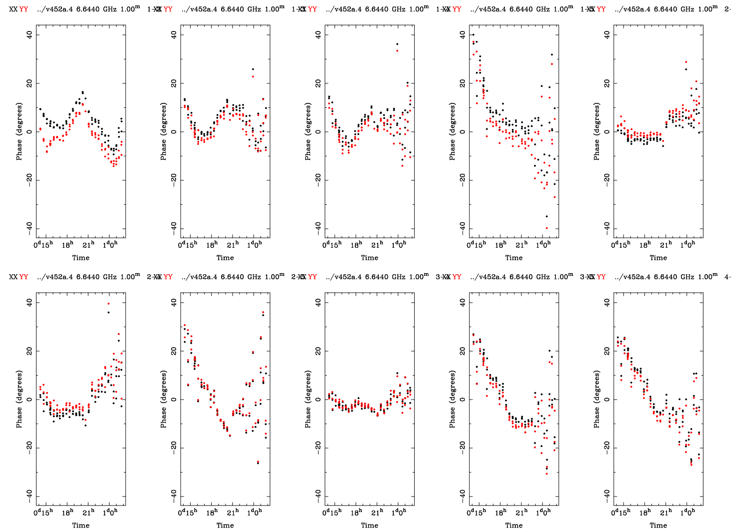

Figure 1: Uncorrected XX and YY phases for V452A across 64MHz at 6.7 GHz, for the calibrator 1729-373.

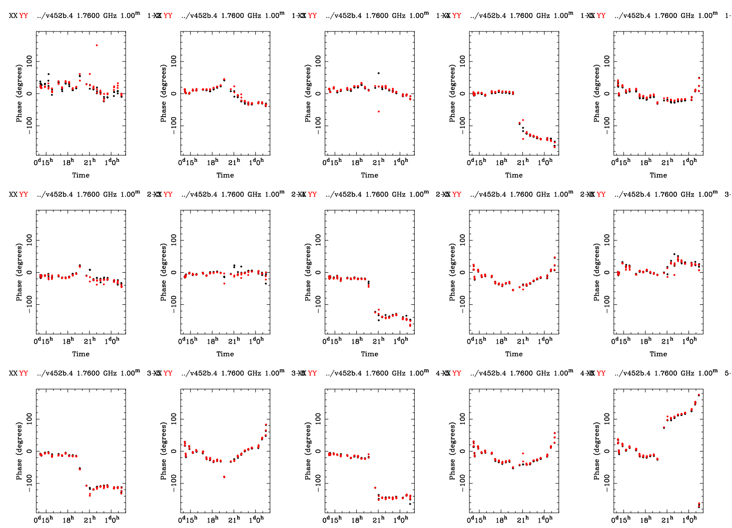

Figure 2: Uncorrected XX and YY phases for V452B across 64MHz at 1.8 GHz, for the calibrator 1729-373.

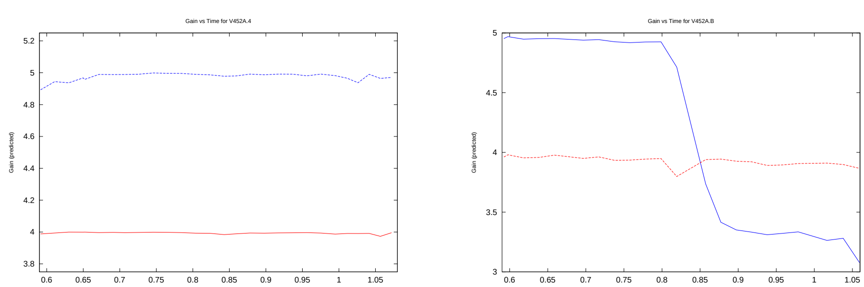

Figure 3: Effective array gains for V452A (left) and V452B (right) based on the absolute sum of complex gains for the array with antennas 1:5 (blue) and antennas 1:4 (red) summed.