Science IPT Activities at the ATF, December 2007

The main thrust of Science IPT work at the ATF in December was (1) general exercising of the system, checking for reliability and system bugs, and (2) continuing the work of understanding interferometric phase instabilities. During this period primarily Tony Remijan, Antonio Hales, Remy Indebetouw and Darrel Emerson worked closely together either with the observing itself or with data analysis and interpretation.

Overall, the most important aspect of the ATF work continues to be the roll-out and testing of software. During November, full operation under version 4 of the software had been achieved. This provided software control of the LO phase and delay tracking (in addition to the antennas, etc). With this in place a preliminary baseline determination was obtained such that, by the beginning of December, the system was producing sufficiently stable fringes to enable investigation of hardware effects, such as those described below.

During December a first attempt was made to install a new software version (5.0.1) which was intended to consolidate numerous recent developments. This was not completed successfully, but it is hoped that extensive work over the Christmas period will have resolved the remaining problems. Unfortunately the upgrade led to instabilities with version 4 (even though the expectation was that a clean roll-back would be possible). The problem is believed to be relative timing of the various components of real-time delay correction. This restricted the number of uninterrupted runs of uncorrupted data that could be taken, but it was possible to work on the local-oscillator Line Length Corrector (LLC) and this produced the most significant progress on hardware during the month.

The photonic LLC introduces phase jumps every time it resets itself, which it has to do from time to time because of the limited range of path correction that it can provide. The interval between resets can be as short as a few minutes or as long as a few hours depending on how rapidly the effective length of the optical fibre is changing. The most reliable indicator of timing and magnitude of these phase jumps proved to be the LLC optical fringe counts which are recorded by the corrector hardware. Antonio Hales implemented an algorithm to use these optical fringe counts to correct the interferometric phase; the success of this algorithm is illustrated in Figure 1. The residual slow, large-scale drift (see especially Figure 2) is believed to be the result of a few mm in the current assumed baseline parameters; however, we do not yet have enough data (2 or 3 several-hour runs without system problems would be desirable) to confirm that the derived baseline offset is stable at the sub-mm level.

In Figure 2, there is a jump in corrected phase at about HA=63 which is not yet understood; investigations, together in particular with the ALMA photonics group, continue. This jump seems to be associated with a LLC reset, but in this case the optical fringe counts were not an adequate representation of the magnitude of the phase jump.

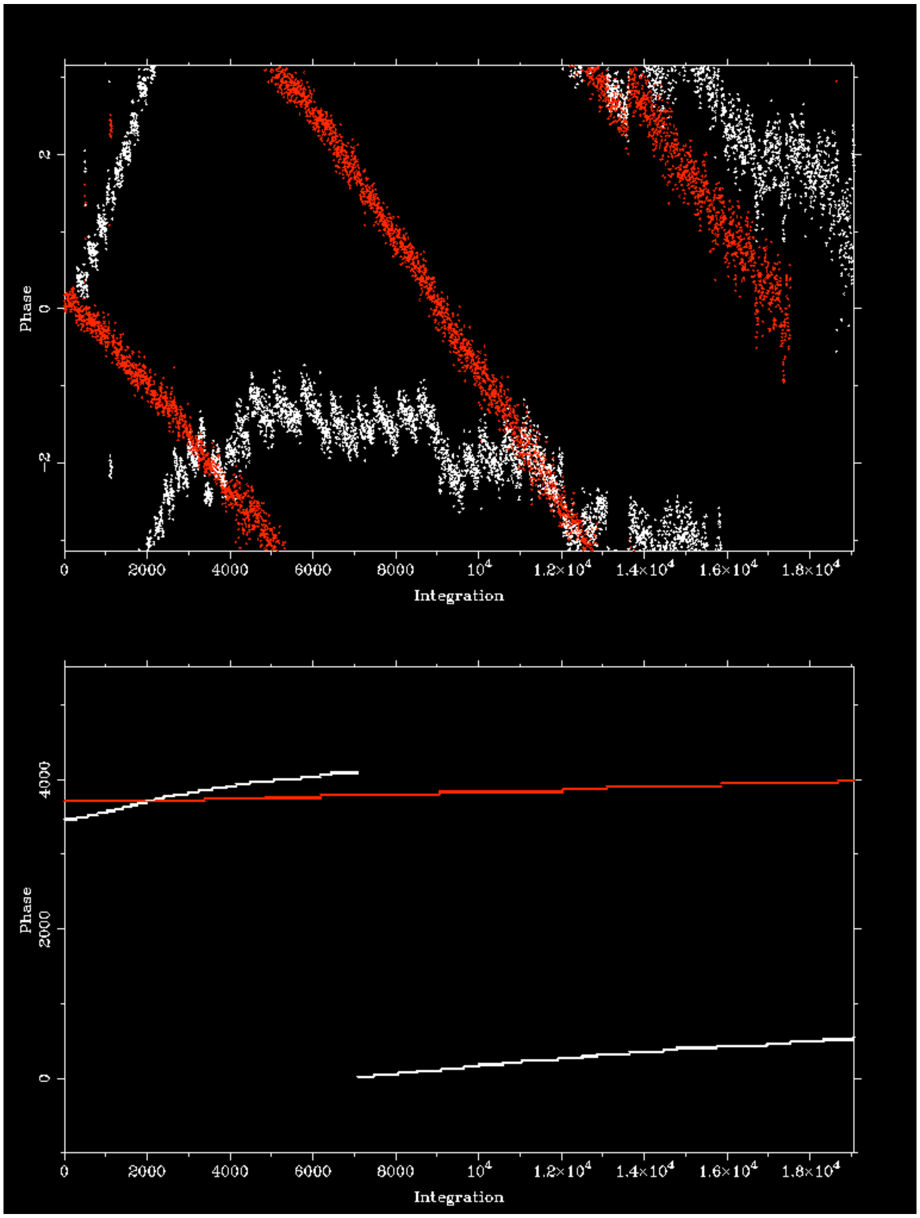

Figure1: The top panel shows (white dots) the raw interferometer phase measured over about 6 hours on 2007-12-14. Note the many phase jumps and the saw-tooth pattern; these jumps are caused by the Line Length Corrector resets. In the lower panel, the cumulative optical fringe counts for the LLC in each antenna are plotted; white for AEC and red for Vertex. The steps in fringe counts are evident by the steps in the traces, and are much more frequent for AEC. The red dots in the upper panel show the corrected interferometric phase, using the optical fringe counts as a measure of LLC resets.

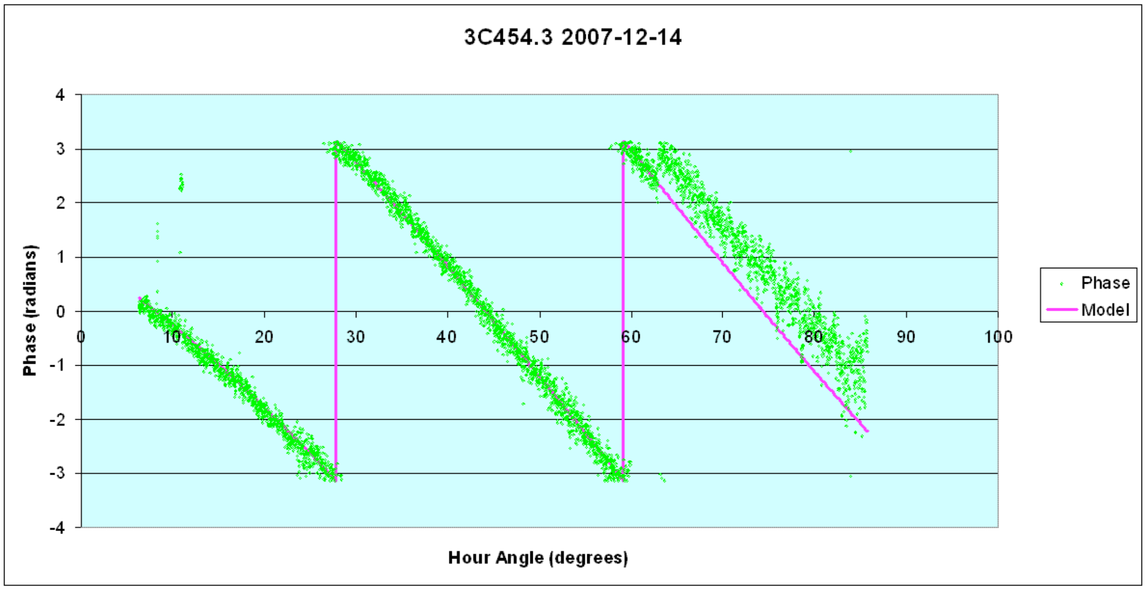

Figure 2: The same corrected phase (green dots) as in Figure 1, but plotted against hour angle (degrees). The best fit phase from a model fitting X- and Y- baseline offsets of one antenna is shown by the solid purple line; the magnitude of the baseline error is a few mm. Note the jump in phase at about HA=63 degrees, which seems to be associated with a LLC reset where the optical fringe counts have not corrected represented the magnitude of phase jump. The cause of this phase jump is not yet understood.

Future work: (1) it is important to continue the system reliability checks, and (2) work will continue to understand and resolve phase instabilities. It is not yet certain that all of the large scale drift seen in Figure 2 can be ascribed to errors in the assumed baseline parameters, although that may be the case. Software reliability continues to be the limiting factor in the acquisition of sufficient test data of adequate quality, but it should be born in mind that improving the software remains the highest priority in carrying out the work at ATF.