

Scientific Report on MP1104-290814-046501

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1 Main objectives of the STSM

The main objectives of this STSM were

- To finish and test the polarization calibration software that will be used in the ALMA Phasing Project (APP). The data used for testing are preliminary ALMA-Phasing data, as well as state-of-the-art mixed-polarization observations taken with the Onsala-Effelsberg baseline at 86 GHz.
- To test a new software for the polarization calibration (and analysis) of interferometric observations, using multiple calibrators, spread over large regions of the sky, in a simultaneous fit.

2 Work performed and results obtained

2.1 ALMA Phasing and VLBI polarimetry

The Co-PI of the ALMA Phasing Project, Geoff Crew, provided us with preliminary data obtained from the first phasing attempts at the ALMA site. The data consisted on the cross-correlation among three ALMA antennas and their sum signal (the visibilities were thus computed in a pure linear polarization basis). Our software, PolConvert, could perform the polarimetric conversion to a pure circular basis after adding a number of corrections, to account for some particulars of the data format.

The main problem we encountered was related to an update to the VLBI correlation software, DifX, that should have been performed by some collaborators of the ALMA Phasing Project (as we were expecting), but was not finally added to DifX. The problem was related to the incapability of DifX to assign different data streams (one stream per polarization product) to the same station used in the correlator model. Due to this unexpected problem, we had to implement a solution in PolConvert, to re-arrange all the different polarization products of the VLBI visibilities in a proper way after the correlation.

By the end of my stay, we finally implemented the full ALMA/VLBI data path, from the DifX correlator to AIPS (the standard calibration/imaging software in VLBI). The polarization conversion is working, although we are still investigating the reasons for the non-detection of one fringe among two of the ALMA antennas after running PolConvert (baseline 2–4, see Fig. 1). However, Geoff Crew informed us that these data may have been affected by other problems related to the ALMA control software, which are now under investigation, and advised us to wait until new data are taken.

2.2 Polarimetry tests with the EVN

We also applied PolConvert to some test data at 86 GHz, taken with the stations at Onsala and Effelsberg during one of the GMVA fringe tests, performed on May this year. We removed the quarter-wave plate from the Onsala receiver's

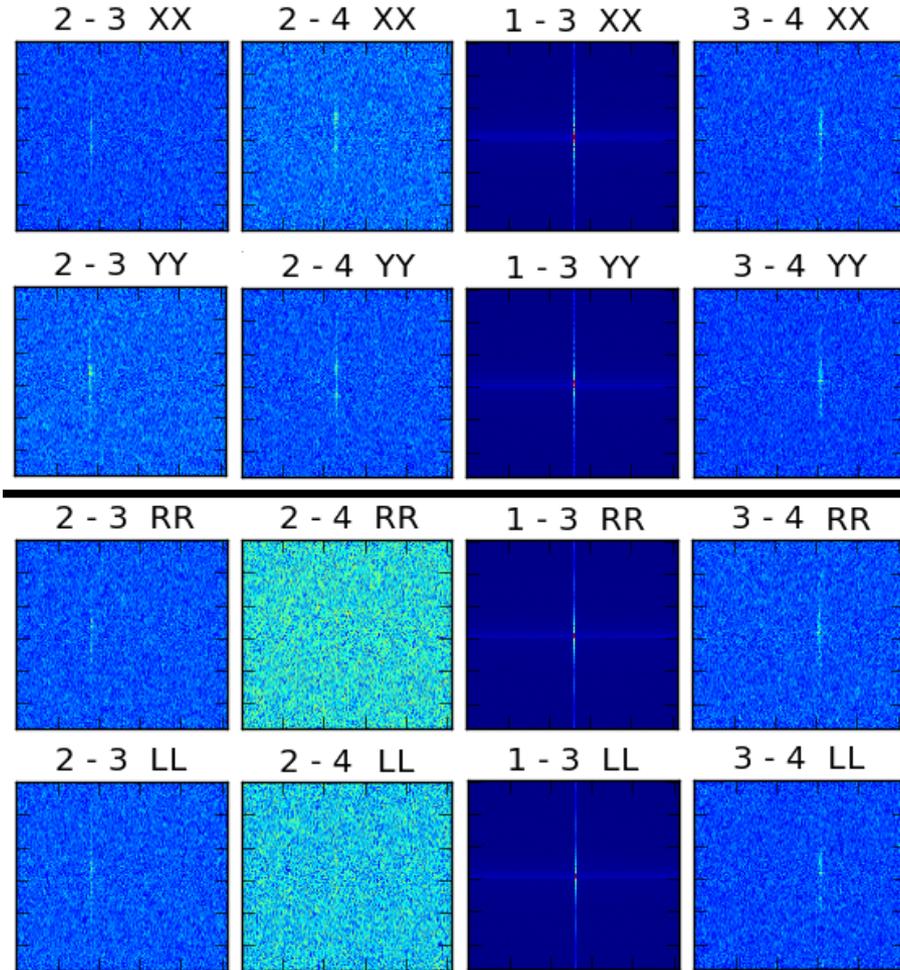


Figure 1: Up, VLBI-mode fringes among three ALMA antennas (antenna codes 2, 3, and 4) and their phased signal (antenna code 1), in pure linear basis. Bottom, same as above, but in pure circular basis after running PolConvert. Fringe rate is in horizontal axis and delay is in vertical axis. Notice the spread in delay space, due to some issues with the bandpass response, possibly related to problems with the ALMA control software used in these observations.

frontend, to make the station record in a linear polarization basis (hence emulating the Phased-ALMA signal), whereas Effelsberg was recording in the ordinary circular basis. We got successful fringe detections (although weak) in the “mixed” (i.e., linear-to-circular) basis, and could successfully use PolConvert (together with some estimates of the right X/Y gains at Onsala) to perform the conversion of the data into a pure circular basis. As expected, the cross-hands correlations (RL and LR) went to zero, indicating a high purity in the signal polarimetry, whereas the fringe detections at the parallel hands (LL and RR) were very clear (see Fig. 2). Although I got preliminary results on this fringe test in August, I could refine the correlation and polarization conversion during my stay at the MPIfR.

These results will be shown in the next EVN meeting (to be celebrated on 7-11 October in Cagliari, this year) and in the future EHT meeting (to be celebrated in Waterloo, Canada, on 9-15 November), and I will of course acknowledge the COST action in these presentations and in the eventual proceedings.

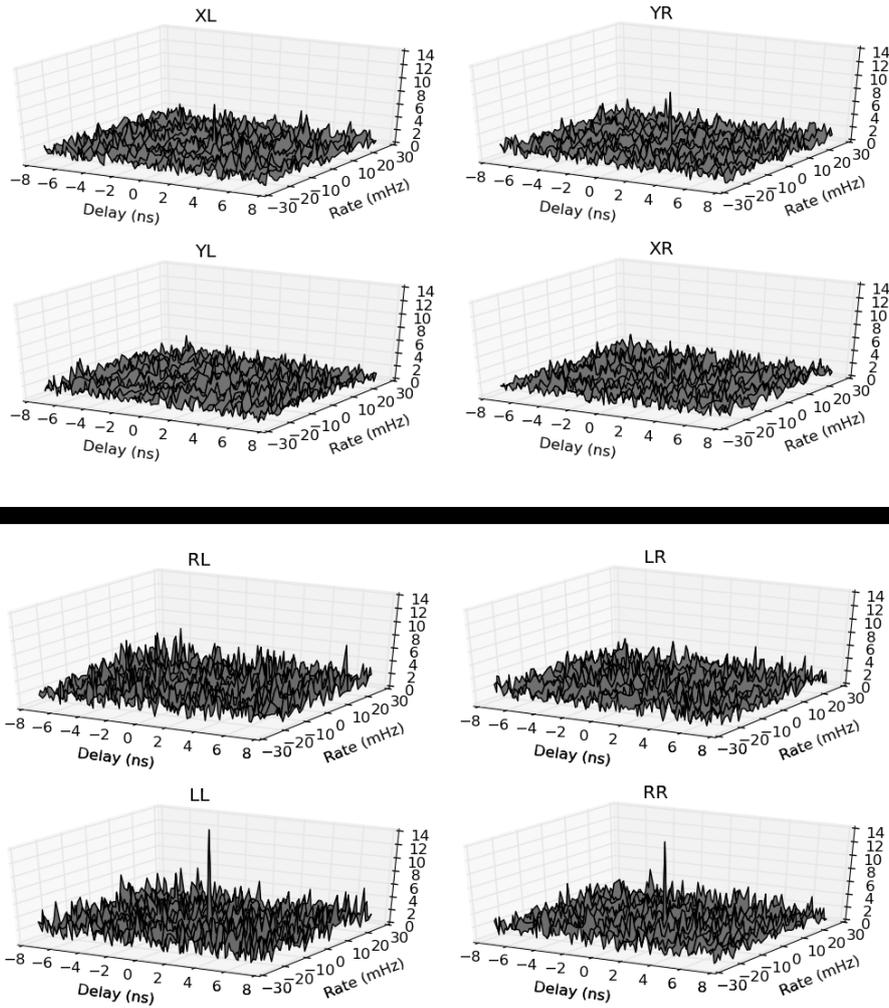


Figure 2: Up, fringes in “mixed” polarization basis (linear to circular), between Onsala and Effelsberg at 86 GHz, observing an unpolarized source. Bottom, fringes with the same data, but after running PolConvert. Notice the clear detections in the parallel hands (RR and LL) and the lack of signal in the cross-hands (RL and LR)

2.3 Multi-source leakage calibrator

Another main objective of my visit to Bonn was the test of my new calibration software, capable of simultaneously using several (and potentially resolved) calibrators to estimate the polarization leakage in the antenna receivers. Although I have performed some preliminary fitting, and the results seem to be promising, I did not have enough time to get more definitive results. In any case, the acknowledgement to the COST action will be added to the future expected publication related to this software.

3 Present and future collaborations with host

3.1 Current collaborations

Besides the joint efforts that the MPIfR and OSO are dedicating to the ALMA Phasing polarimetry, I have many other collaborations with MPIfR staff, which have been revived after my short visit: from VLBI observations of radio supernovae (with Dr. Andreas Brunthaler) to optimization of the Global-mm-VLBI-

Array calibration (with Dr. Thomas Krichbaum), as well as multi-frequency VLBI observations of AGN (with Dr. Eduardo Ros).

3.2 New collaboration on EHT polarimetry

Part of my stay at the MPIfR was also dedicated to the development of a software that translates HOPS fringe data into ordinary UV-FITS files (properly accounting for full-polarization data, for which subtleties in the different antenna orderings in HOPS have to be taken into account), in order to be able to perform a proper interferometric imaging (deconvolution) on new 1.3 mm VLBI observations (being performed by the current members of the EHT project). Very interesting results are being found in these state-of-the-art observations, like fractional polarizations of the order of 50% (!) in the longest baselines (i.e., smallest features) of observations of the Galactic center, SgrA*.

VLBI polarimetry will surely bring extraordinary scientific results in the forthcoming years.

4 Foreseen publications

- Proceedings of the EVN Symposium 2014 (Cagliari, Italy).
- Proceedings of the EHT-2014 meeting (Waterloo, Canada).
- J. Hodgson et al. (A&A, in prep.)

5 Summary of trip and stay at MPIfR

The trip to MPIfR was performed on 29 August, as expected. My interaction with Alan Roy and Thomas Krichbaum was intense and fruitful and almost all objectives were fulfilled. All my previous collaborations with the MPIfR staff were reinforced, and a new collaboration project with Krichbaum was also established, related to polarimetry imaging with the Event Horizon Telescope.

The trip back to Onsala began on 10 September (evening), and ended on 11 September (afternoon). The trip back to Onsala was anticipated in 1 day, due to personal reasons.