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VLBI phase-reference investigations at 86 GHz

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Abstract. We present preliminary results from a successful attempt at 3mm phase-referencing using the VLBA.

1. Introduction

VLBI phase-reference mapping using source switching was first realised by Alef (1988) and has become a standard tool for imaging weak radio sources (Beasley & Conway, 1995). However, at mm-wavelengths the short temporal and spatial coherence of the troposphere (Rogers et al, 1984) mitigates against its widespread application. We embarked upon a foolhardy investigation to determine whether, in special circumstances, it might be feasible.

2. The Observations

Observations were made on 19th January, 2002, using 7 antennas of the VLBA at 86 GHz, in "dynamic scheduling" mode to take advantage of good tropospheric conditions. Our goal was to make a phase-referenced map of the compact source 1308+328, using as phase reference the stronger, flat-spectrum BL Lac object 1308+326, 14′.3 away. We used 14 22-min tape passes, recording both RHC and LHC polarisations, using 2-bit sampling and a total bit-rate of 256 Mb/s. Each pass was preceded by telescope pointing at 7mm on 3C273, and included 2-minute scans on 3C273, 3C279, 1308+326, 1308+328 as well as periods of rapid switching (scan lengths of 10, 15 or 20s) between the target and reference sources. Correlation was done at the VLBA correlator and analysis was performed in AIPS.

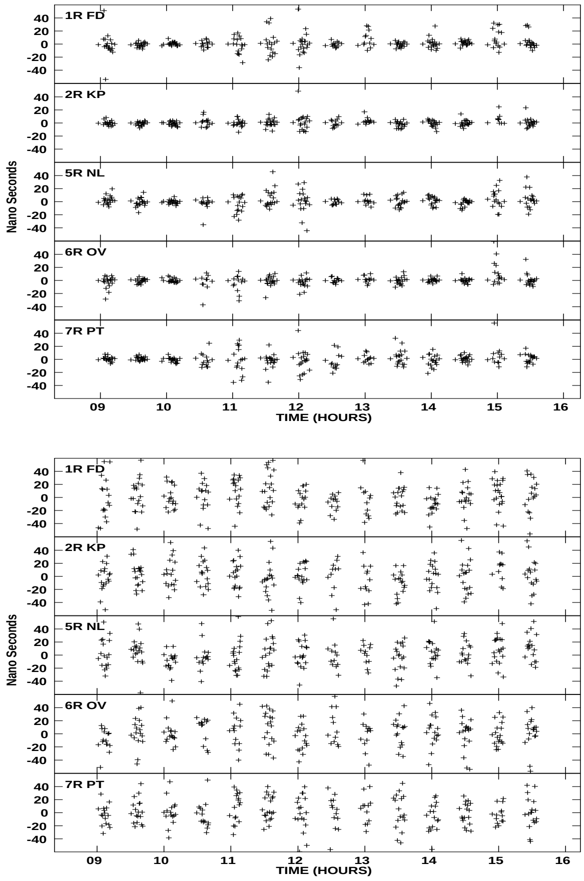

Fig. 1. RCP delay solutions from fringe-fitting with narrow search windows: **(top)** 1308+326; **(bottom)** 1308+328

3. Analysis and Results

In this preliminary analysis we made a rough calibration of the visibility amplitudes by simply applying the radiometry and antenna gains provided. We discarded the data from VLBA-MK due to poor performance. We used the high S/N detections of 3C279 on all baselines to calibrate the instrumental relative phases between IF channels; VLBA-LA was used throughout as the reference station. Initial fringe-fitting with relatively wide search windows established residual delays and rates for all antennas and sources on all scans of 2-min duration, and most of the calibrator scans during rapid switching. This permitted us to re-fringe with narrow search windows (delay 30 ns, rate 50 mHz) and detect essentially all short reference-source scans, and many of the target (with low S/N - see Fig 1).

Fig 2 shows the antenna phase solutions from the reference source during a period of rapid switching and demonstrates that the phases can be easily tracked and connected between successive 15s scans; the bottom plot shows the result of simple linear phase connection. For much of the time this was possible for many antennas.

We used only the short scans in further analysis. Hybrid maps of both sources (using SELF solutions from FRING and no further phase corrections) are shown in Fig 3 (top panels). Gaussian fitting to 1308+326 shows it to be resolved (0.2 mas in P.A. −39°). 1308+328 appears unresolved; its peak is probably overestimated due to noise

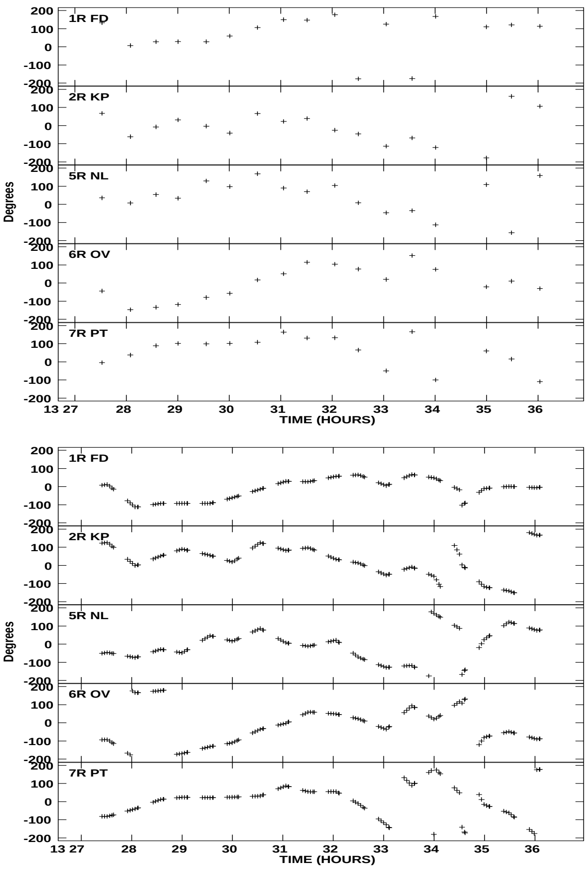

Fig. 2. Antenna phase solutions with respect to VLBA-LA for 1308+326 during a rapid switching period: **(top)** 15s fringe-fit solutions; **(bottom)** interpolation using simple linear (nearest) phase connection

bias. The bottom pane shows a phase-referenced map of 1308+328, made by calibrating the data with the interpolated 1308+326 phase. Note the much lower peak w.r.t. the hybrid map (representing a coherence loss ca. 20%). The offset of the peak from the map centre (0.34 mas in P.A. −41°) is of some interest. It represents a correction to the target-reference source separation determined at 8.4 GHz (Rioja et al, 1996), presumably due to resolution and opacity effects in the 1308+326 jet; a similar shift was measured at 5 GHz in VSOP phase-reference observations (Porcas & Rioja, 2000).

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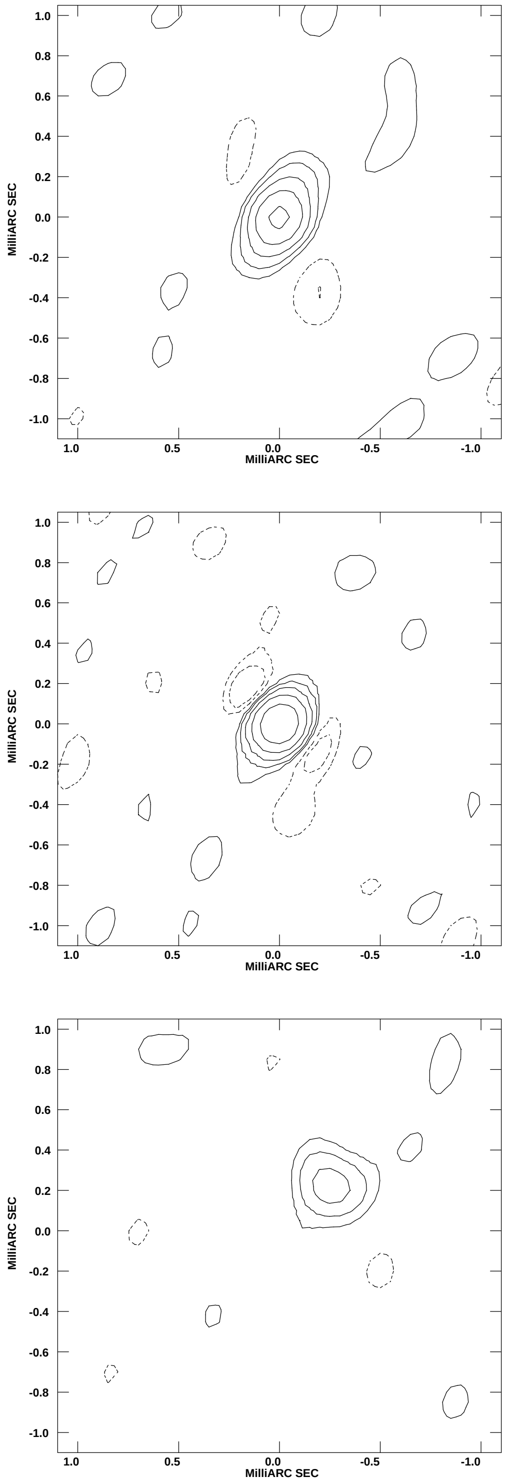

Fig. 3. 86 GHz maps; uniform weighting, restoring beam 0.2x0.2 mas, contour levels at -2, -1,1,2,4.. x CLEV:
(top) Hybrid map of 1308+326, peak 709, CLEV 30 mJy;
(middle) Hybrid map of 1308+328, peak 469, CLEV 15 mJy;
(bottom) Ph-ref. map of 1308+328, peak 85, CLEV 15 mJy

References

Alef, W., 1988, in IAU Symposium 129, ed. M. J. Reid & J. M. Moran (Dordrecht: Kluwer) 523

Beasley, A. J. & Conway, J. E., 1995 in ASP Conf. Ser. 82, Very Long Baseline Interferometry and the VLBA, eds. J. A. Zensus et al., (San Francisco: ASP), 327

Porcas, R.W. & Rioja, M.J., 2000, in Proc. of the 14th Working Meeting of European VLBI for Geodesy and Astrometry, ed. P. Tomasi et al. (IRA, Bologna) 139

Rioja, M. J., Porcas, R. W. & Machalski, J., 1996, in Proc IAU Symposium 175, ed. R. Ekers et al., (Dordrecht: Kluwer) 122

Rogers, A. E. E., Moffet, A. T., Backer, D. C. & Moran, J. M., 1984, Radio Science, 19, 1552