Position determination and imaging of bright radio stars by EVN observations using phase-referencing

Yertay Yeskali, Ming Hui Xu
Helmholtz Center Potsdam and Technical University Berlin

Motivation

Enhancing the accuracy of the Celestial Reference Frame (CRF) is primary motivation for this research. Precise determination of the radio star positions by Very Long Baseline Interferometry (VLBI) will strongly contribute to the improvement of the CRF. By comparing the positions of radio stars in radio and optical CRFs and evaluating the consistency between two frames, the alignment and accuracy of the CRF can be further refined.

Data Calibration

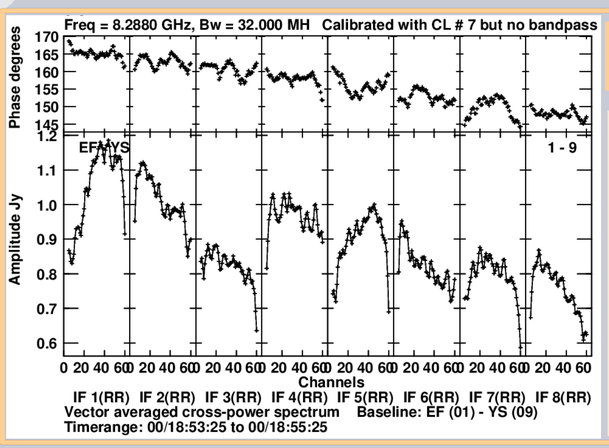
The data is calibrated using the NRAO software package Astronomical Image Processing System (**AIPS**, Greisen et al 2003). Imaging and model-fitting will be made using **DIFMAP**. Additionally, to raw visibility data, JIVE provided CL table with parallactic angle and gain correction, which was applied. Next, after INDXR we reduced ionosphere delay by TECOR. In APCAL, we applied TY, GC for the amplitude.

The VLBI Observations

The 12 EVN telescopes observed 5 epochs at 8 GHz, utilizing 8sub-bands of 64 MHz, in right and left circular polarizations.
Observations were scheduled in phase-referencing manner to obtain phase solutions from a calibrator source and apply to nearby located target source by switching between two sources in the separation limit of 3˚.

	source \ time	18 min										18 min										...
scan 1	Calibrator 1	80		80		80		80		80		80										
	Target 1		130				130		130		130											
	Calibrator 2				80																	
scan 2	Calibrator 3												80		80		80		80		80	
	Target 2													130				130		130		130
	Calibrator 4															80						
...	...																					

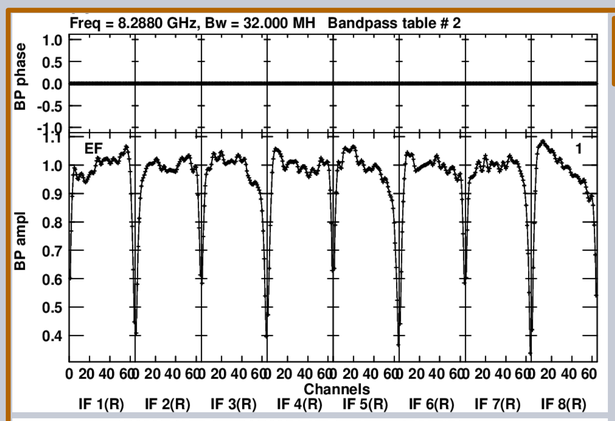
Table 1: Phase-referencing schedule of our EVN observations. On-source interval is 18 minutes, where calibrators are measured 80 seconds and targets 130 seconds.



VLBAMPCL

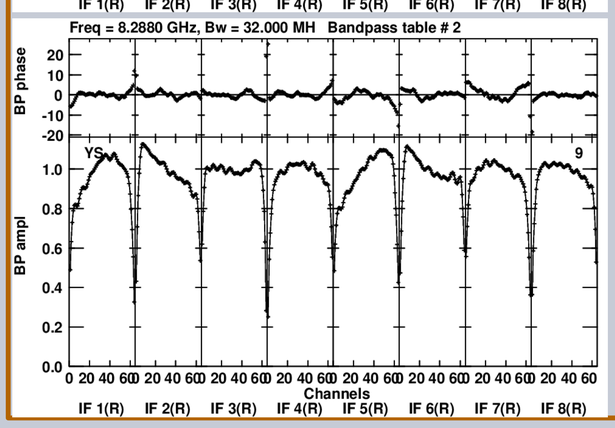
Phase and amplitude **after** performing manual phase calibration **VLBAMPCL** using a strong Fringe .Finder source J050+1331

Polarization: RCP
Baseline: EF-YS



BPASS

Phase and amplitude of Effelsberg antenna in Bandpass table (BP2) generated by BPASS task.



Phase and amplitude of Yebes antenna in Bandpass table (BP2) generated by BPASS task.

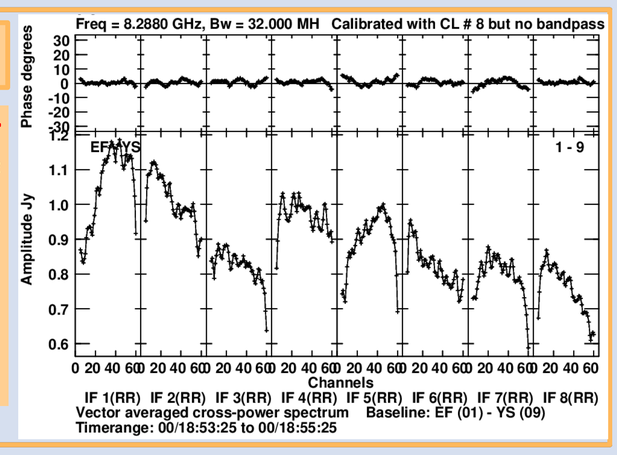
AIPS Data calibration pipeline

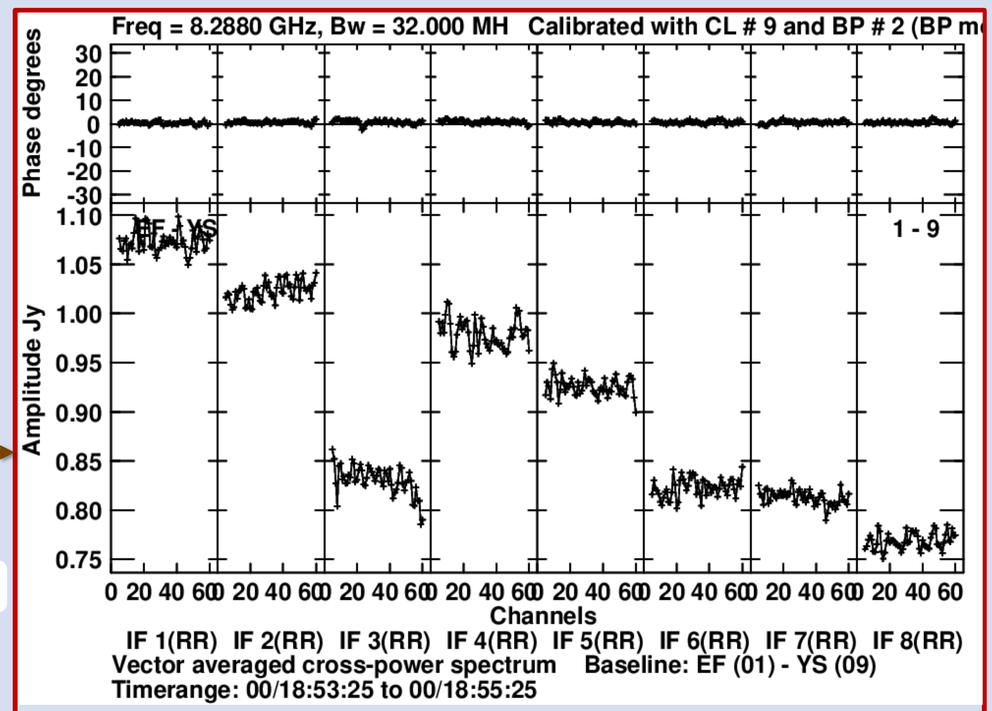
- FITLD
- TACOP
- INDXR
- TECOR
- APCAL
- VLBAMPCL
- FRING
- BPASS
- SPLIT
- CALIB
- FITTP

FRING

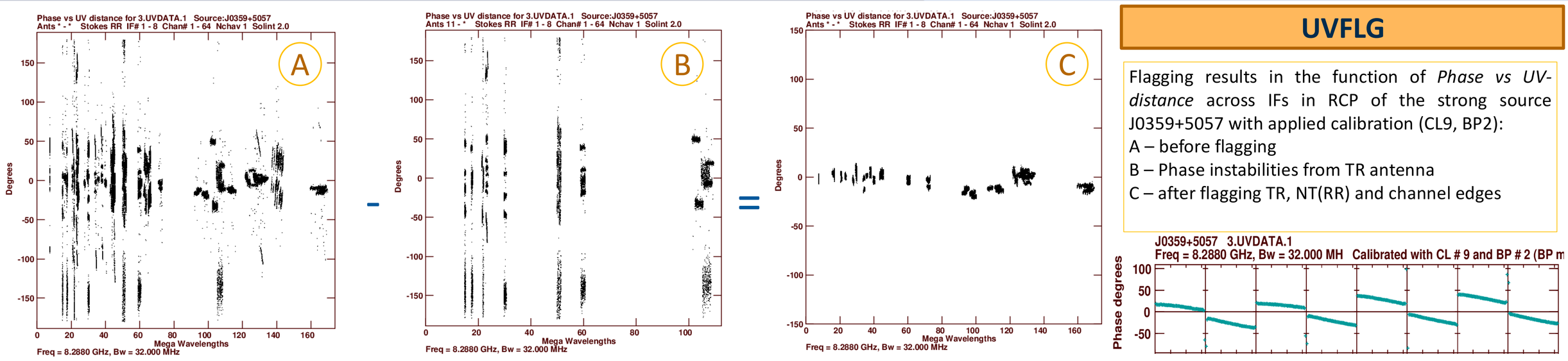
Phase and amplitude **after** performing global fringe fitting in task FRING.

Polarization: RCP
Baseline: EF-YS





Calibrated phase and amplitude after applying tables after FRING and BPASS of RCP on baseline EF-YS.



UVFLG

Flagging results in the function of *Phase vs UV-distance* across IFs in RCP of the strong source J0359+5057 with applied calibration (CL9, BP2):
A – before flagging
B – Phase instabilities from TR antenna
C – after flagging TR, NT(RR) and channel edges

Outlook

- Calibration of the radio stars via phase-referencing
- Performing the data calibration of other 4 epochs of EVN observations
- Obtaining the positions of radio stars via high-resolution imaging via DIFMAP
- Comparison analysis of positions between epochs and archival data

References

1. Lunz, S., Anderson, J. M., Xu, M. H., et al, 2023, A&A 676, A11
2. Lindegren L, et al, 2020, A&A 633, A1
3. Xu M.H., Savolainen T., Lunz S., Anderson J.M., Zubko N., Schuh H., EVGA, 138-141
4. Reid M. J., Honma M, Micro-Arcsecond Radio Astrometry, 2014, A&A, 54
5. Boboltz et al., 2003, AJ 126, 484
6. Beasley A. J., Conway J. E., 1995, ASP Conference Series, p. 327-343
7. Chen W., Zhang B., et al, 2023, MNRAS 524, 5357-5367

www.gfz-potsdam.de
yertay@gfz-potsdam.de minghui.xu@gfz-potsdam.de