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VLBI capabilities in CASA and pipeline developments

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The calibration of Very Long Baseline Interferometry (VLBI) requires specific steps which are not used in connected element interferometers such as the VLA or ALMA. For many years this functionality was only available in AIPS and a few small, dedicated packages. We present how CASA was extended with VLBI capabilities, how it is being exploited for calibration of the EVN and EHT, and for user training.

New functionality in CASA

For years, fringe fitting was the major lacking feature in CASA, and our analysis revealed several other tasks required adjustments to handle VLBI observations. The initial implementation of the new *fringefit* task in CASA was kept as close as possible to the original AIPS FRING task, which exploits the Schwab-Cotton global fringe fitting algorithm [1]. New features have been added more recently, such as a dispersive delay term.

Scripts were developed to translate meta-data used for flagging and amplitude calibration from the formats used by AIPS. Several tasks in CASA were adjusted to handle these meta-data and the calibration tables specific to VLBI. In collaboration with the team at NRAO there is now an extensive document tracking the requirements for future VLBI upgrades to CASA.

Jupyter-CASA infrastructure and pipeline

An interface to run CASA inside a Jupyter notebook has been developed [2]. This enables processing of VLBI observations in a Jupyter notebook with fully integrated CASA capabilities. It has proven invaluable for training new users, and is a promising tool for quick and reproducible verification tests. An EVN calibration notebook has been developed and is being verified and tested internally in JIVE. It has been demonstrated at the latest CASA-VLBI workshop, and is expected to be used intensively in future education.

To simplify data access for EVN users, a science platform is under development where users can process and analyze their EVN observations using JIVE computing resources. This platform will use the Jupyter-CASA notebooks, allowing users to verify archived results, and easily adjust calibration and analysis parameters to produce science ready data products.

Automated VLBI processing

One of the first power users of the CASA-VLBI infrastructure was the Event Horizon Telescope collaboration. A dedicated calibration pipeline (rPicard) was developed and used as verification for the publication of the first black hole shadow image [3]. With only a few years of CASA-VLBI development, rPicard matched the performance of AIPS and HOPS based pipelines, demonstrating the performance and flexibility of CASA. The pipeline has since then expanded to process other VLBI observations, such as the VLBA and EVN.

References

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