

VLBI Pipeline (VPIPE)

A CASA-based solution to your VLBI data-reduction needs

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Some context

- VPIPE was originally developed because I could not be bothered to reduce wide-field VLBI data manually anymore and I didn't want to revert back to AIPS.
- Wide-field VLBI data is a rare big data problem in VLBI, hence a pipeline was needed to be scalable.
- However, to reduce wide-field VLBI, you have to reduce the standard continuum data first — hence the VLBI Pipeline was born.

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Before reducing VLBI data manually



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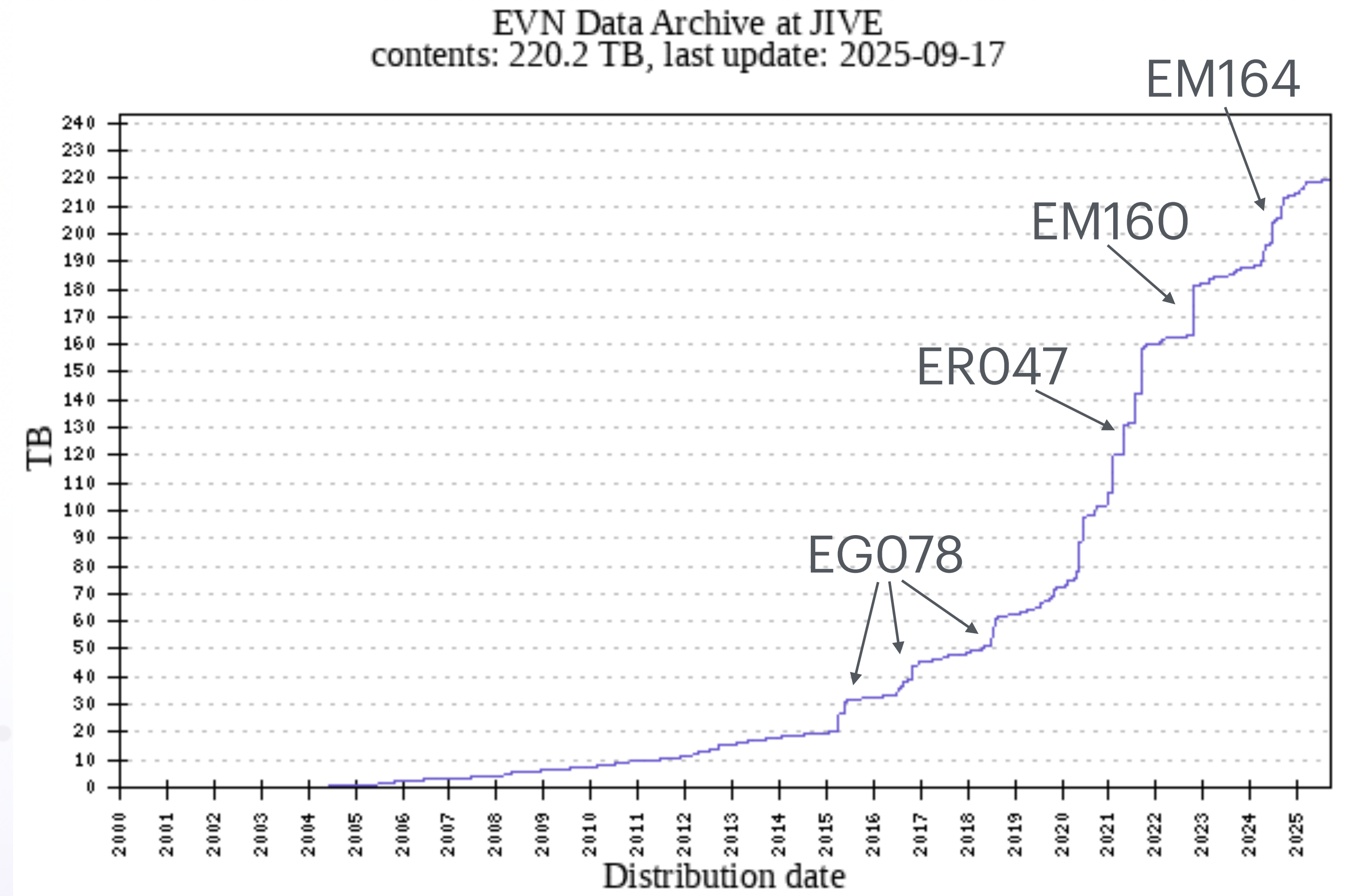
After reducing VLBI data manually



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What is VPIPE?

- It is a generic, modular CASA-based pipeline for continuum VLBI data reduction.

Strengths:

- Full continuum VLBI calibration including flagging — tested on EVN and VLBA data.
- Full wide-field VLBI support including primary beam corrections.
- Optimised for clusters (Slurm, PBS) but can be run locally.
- Modular scripts for calibration.
- Few dependencies — just needs CASA + wsclean.
- Supports CASA 6.5+ (tested up to 6.7.0).
- Has a wiki with some documentation!

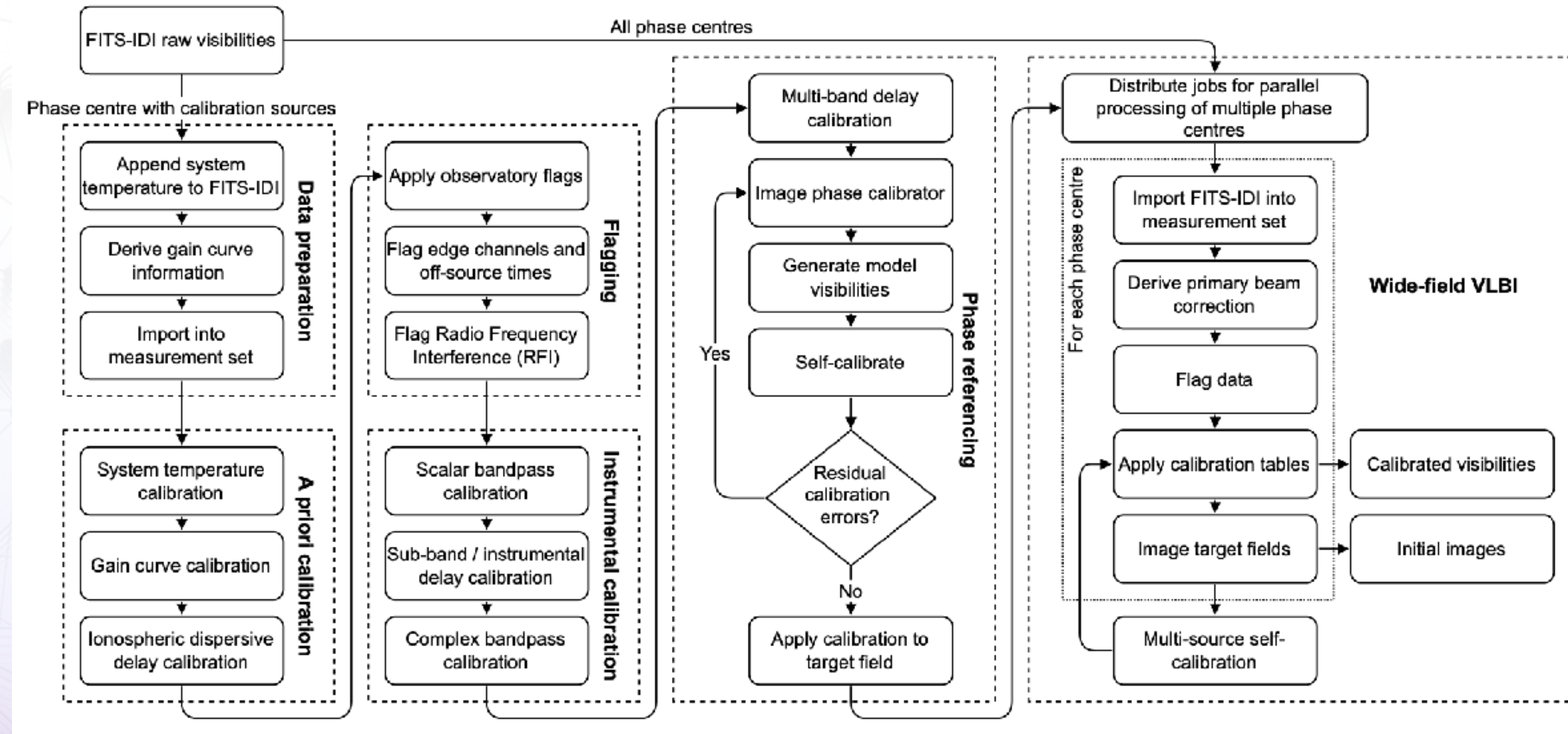
Cons:

- No spectral line support yet
- No automated parameter estimation yet
- Advanced flux scaling for wide-band VLBI in beta
- Single, overworked primary developer

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Example workflow for EVN data

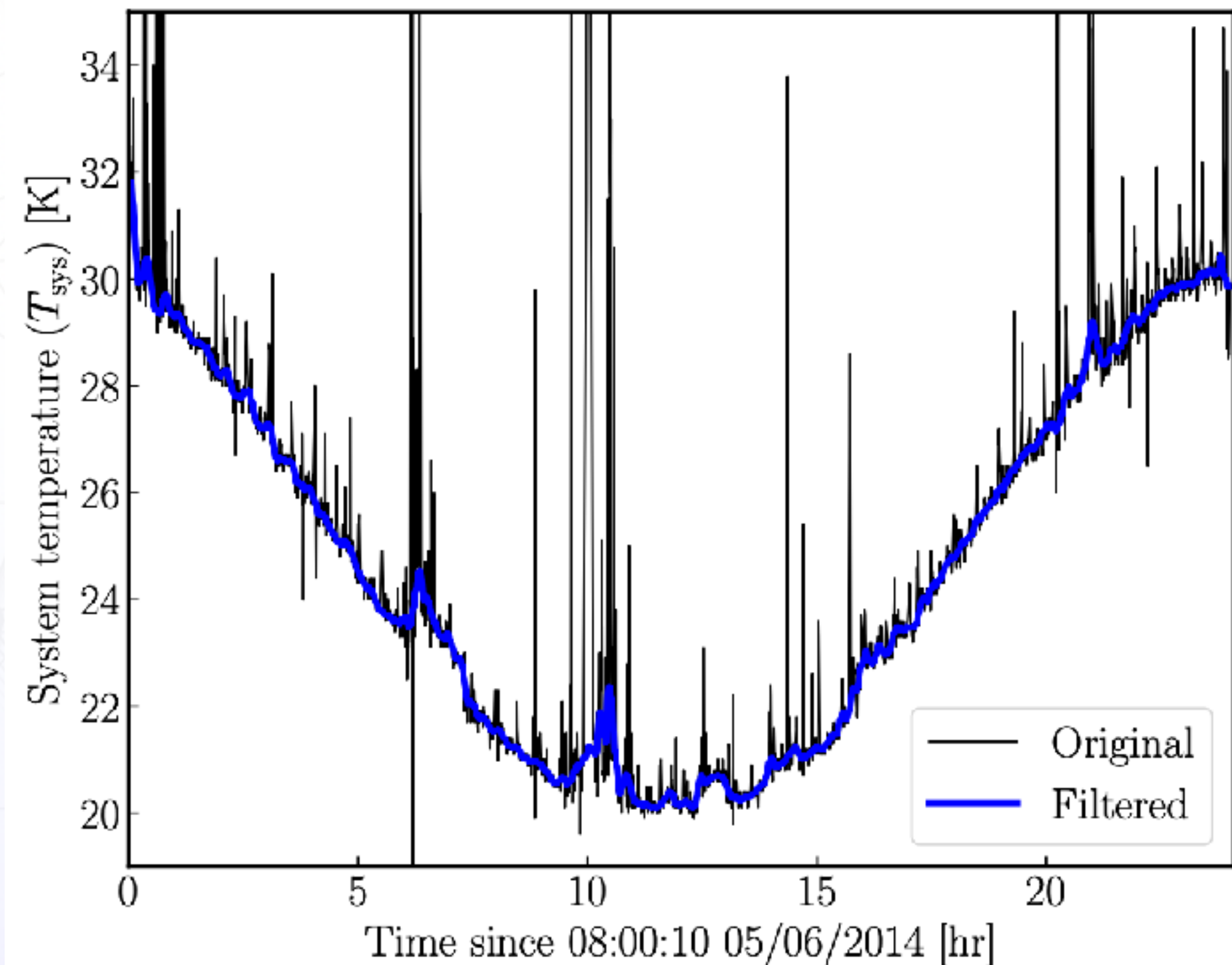
- Combination of parallelism across casamp, job manager (e.g., job arrays) & code optimisations makes VPIPE run in around
- Parallelised and calibrates data (w/ 100 phase centres) in about 50% of observing time.



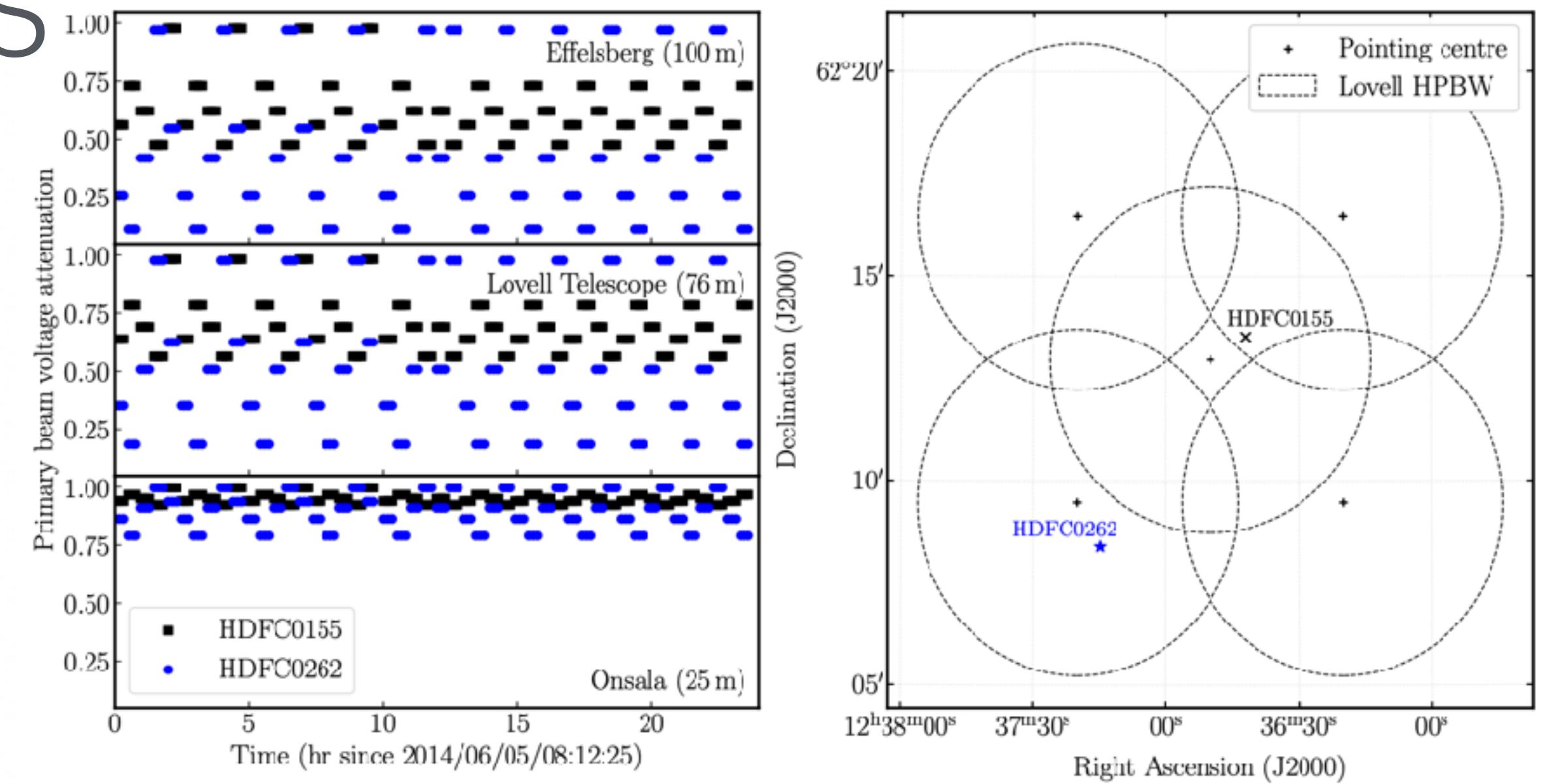
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Some VPIPE features

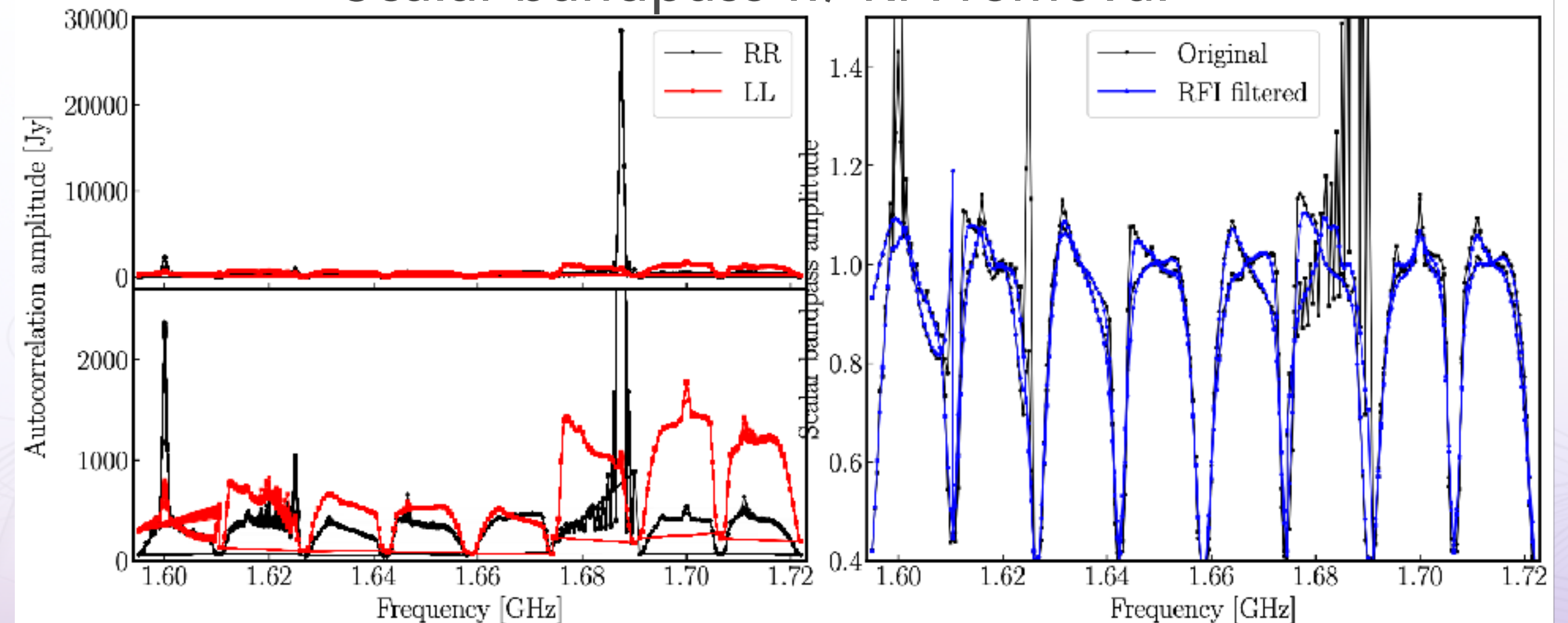
T_{sys} outlier removal



Primary beam correction (from vex)



Scalar bandpass w/ RFI removal



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How to run VPIPE

Before starting to use the pipeline, it is highly advised that you check the wiki which will give you all the information regarding the parameters that need to be set or can be changed. The pipeline is designed to be highly customisable so the inputs lists are fairly long.

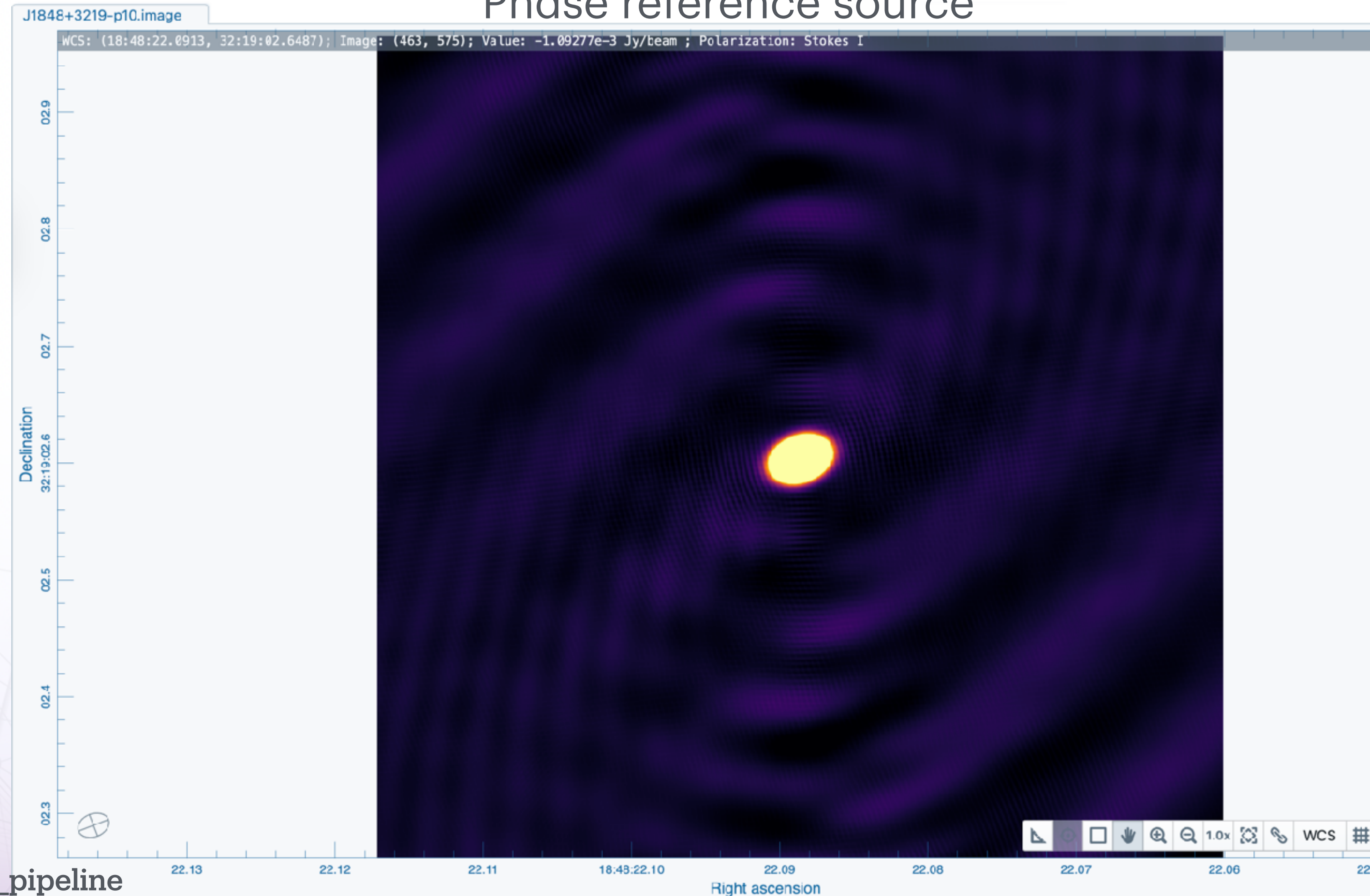
1. Copy the vlbi_pipe_inputs.txt and vlbi_pipe_params.json files to the directory where you want to reduce the data (you can pick any directory but this allows for easy bookkeeping)
2. Edit vlbi_pipe_inputs.txt to include the location of the vlbi_pipe_params.json and edit the steps of what you'd like to be run (1=run, 0=don't run)
3. Edit vlbi_pipe_params.json to tailor the calibration steps. Most importantly, set the global params (see the wiki for details)
4. Run CASA to generate the bash scripts that will run the pipeline using python <path to VLBI pipeline repo>/run_vlbi_pipe.py <path to input file>/vlbi_pipe_inputs.txt
5. This will generate a bash script in the cwd called vp_runfile.bash. Execute and start the pipeline with bash vp_runfile.bash

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VPIPE on the JVS 2025 dataset

Phase reference source

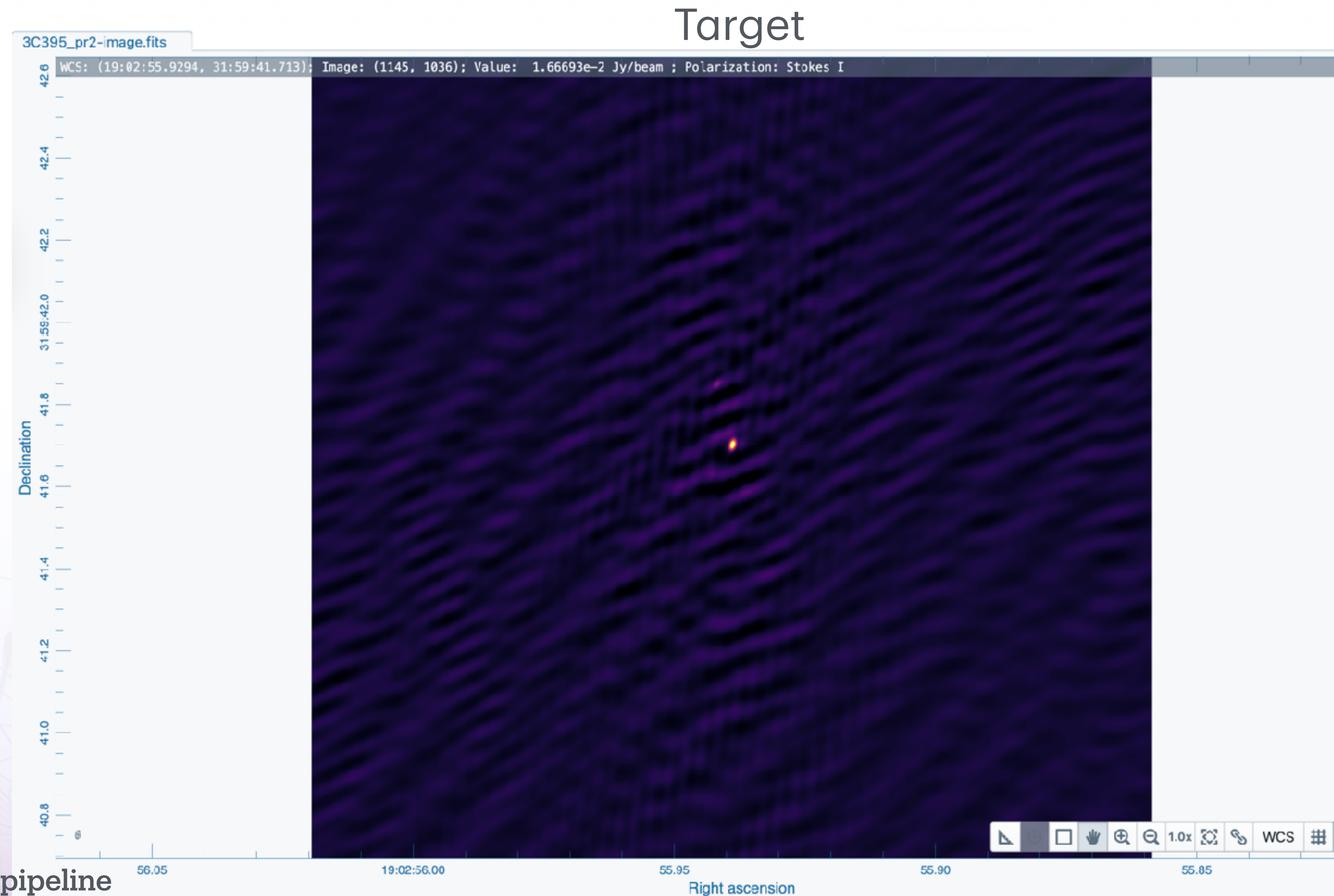
- Ran in around 70 mins
- 10 rounds of phase calibrator self-calibration (no target self-calibration).
- Structure slightly different due to reweighting of antennas



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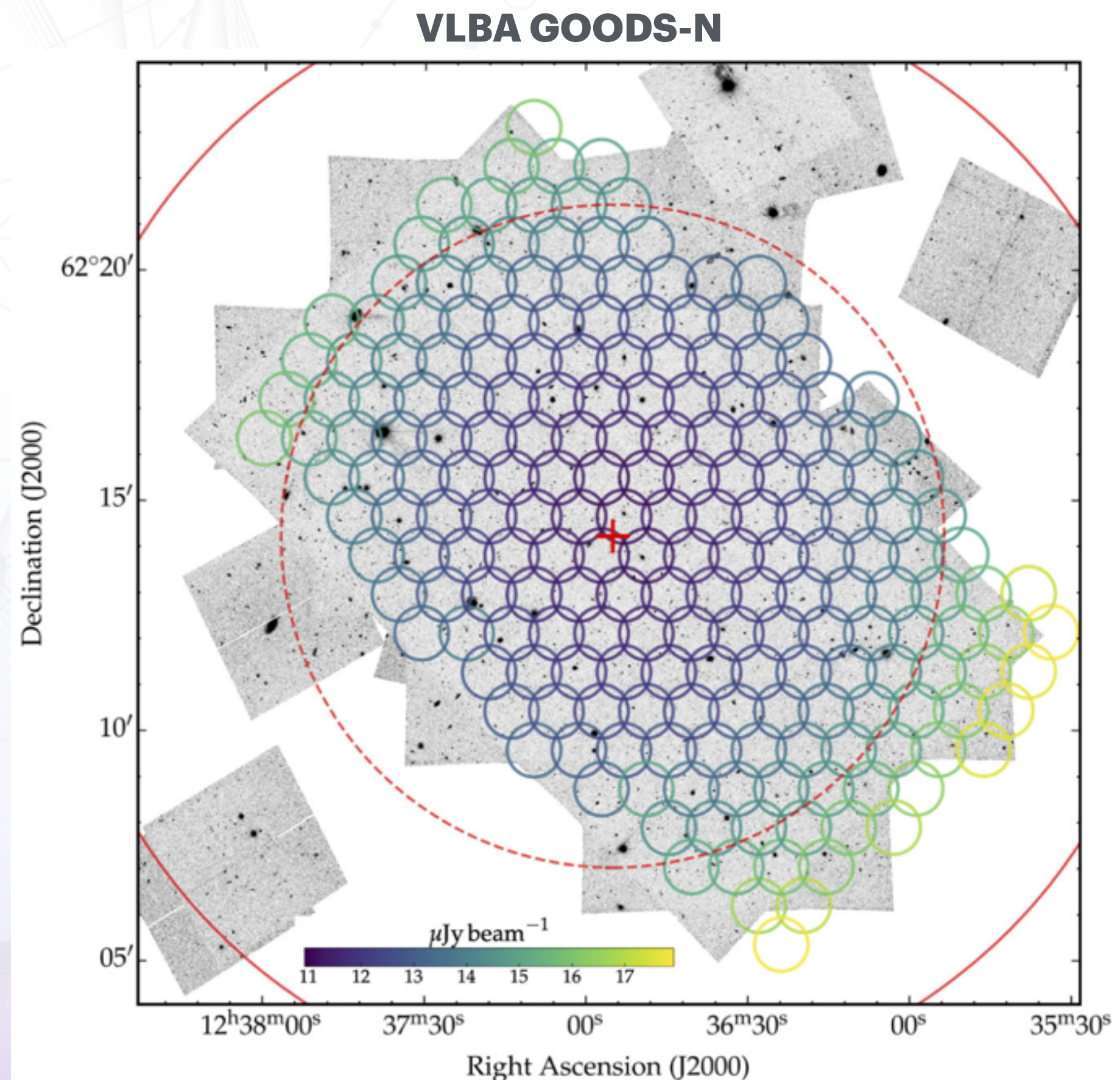
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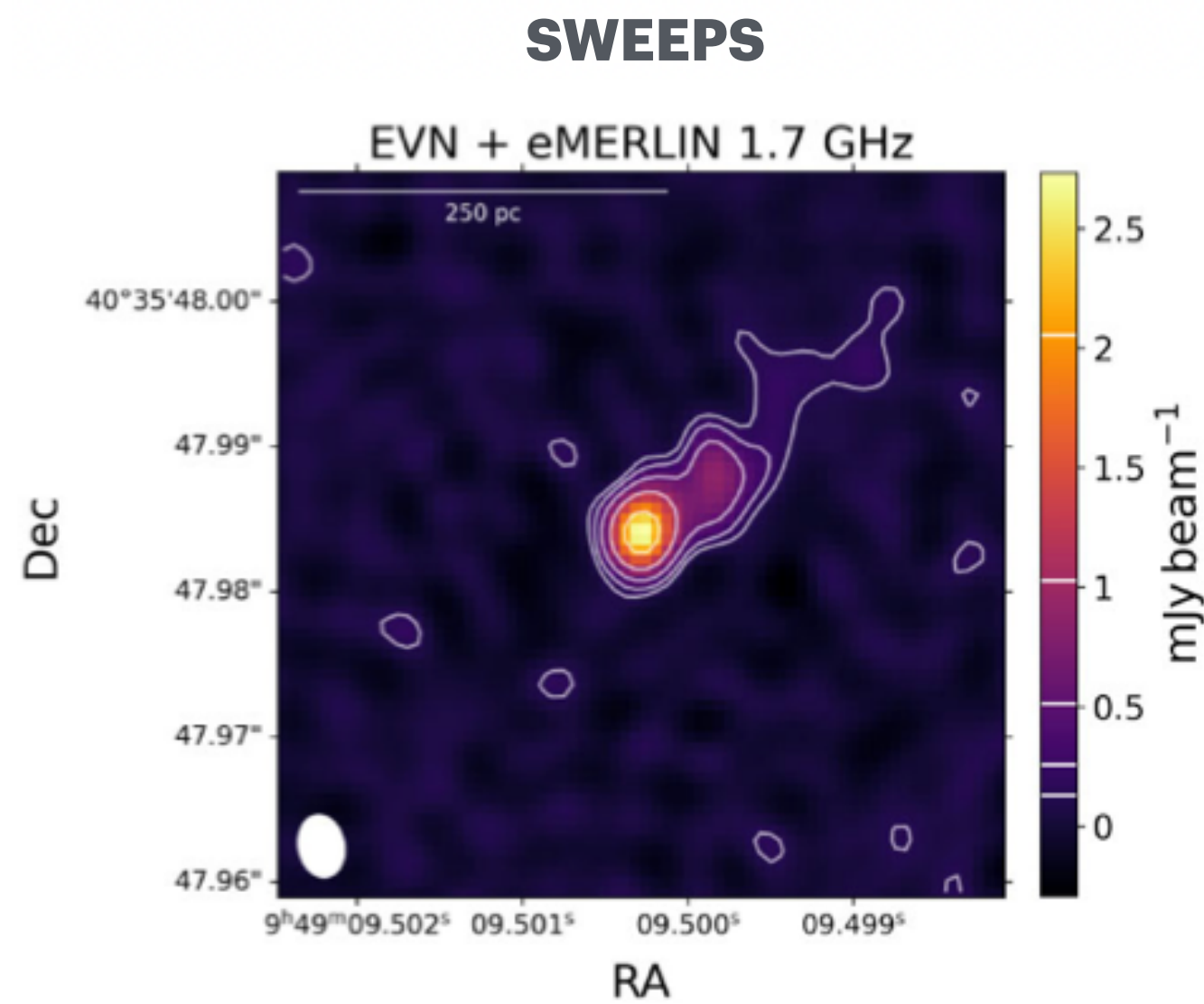
VPIPE proof-of-concept

- VPIPE is not published (yet!) — but has been used for some publications to date.

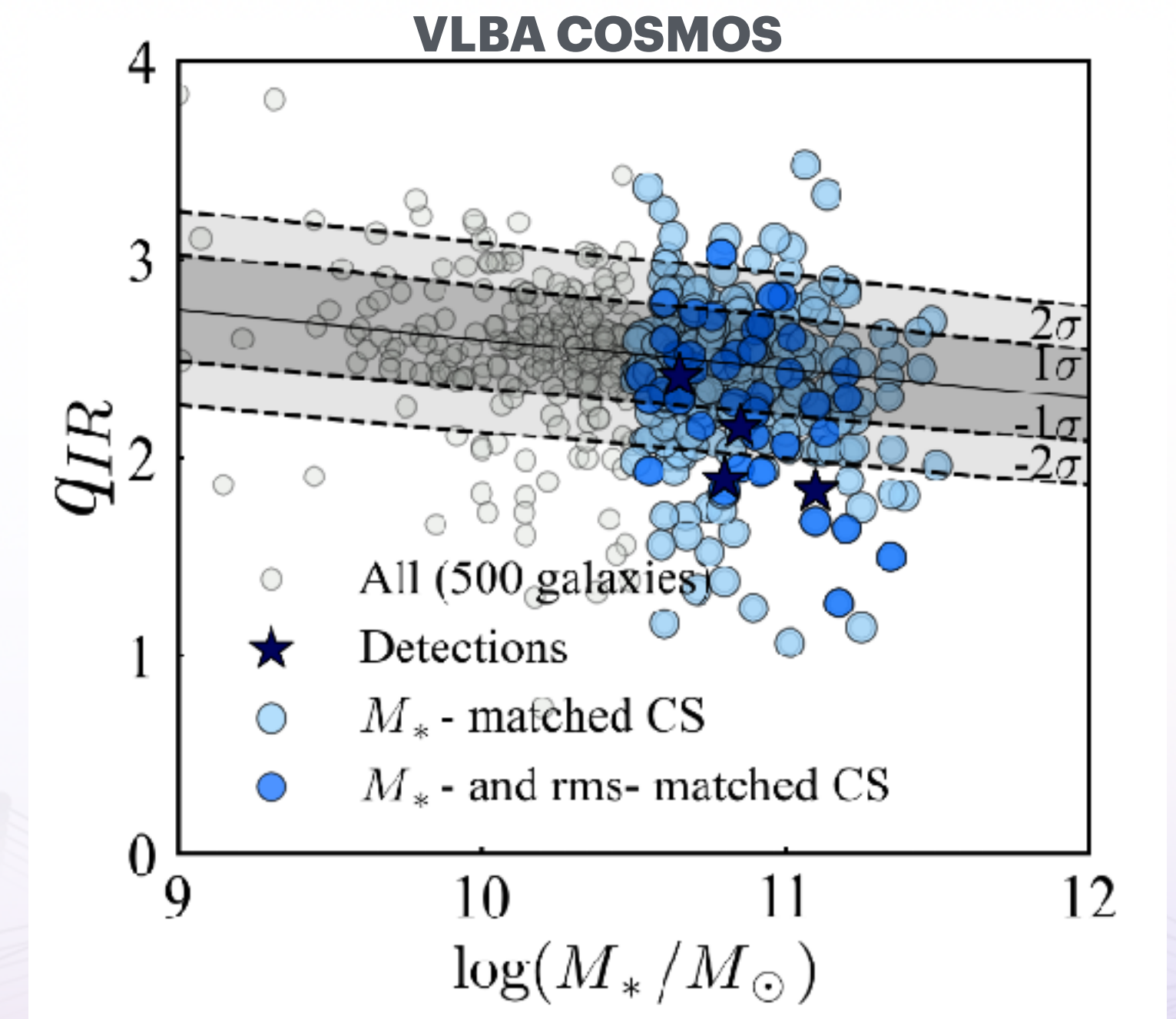


Deane et al, Njeri et al., (2024)

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Herbé-George et al., (2025)



Peluso et al., (accepted)

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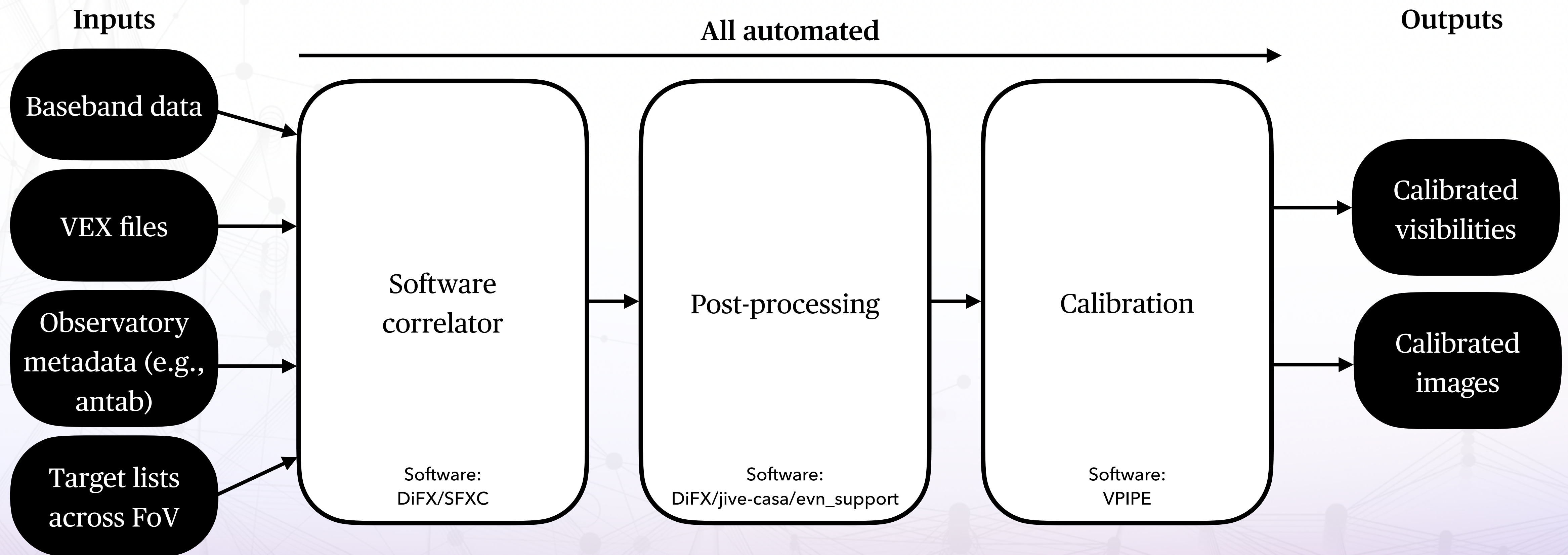
What's in development?

- Support for spectral-line data
- Improved QC/diagnostics
- Automated parameter estimation
- Direction dependent calibration — multi-source self-calibration (in beta), direction-dependent smearing deconvolution

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The ultimate goal - a commensal wide-field workflow

- Leveraging modularity/containerisation, developing an **automated** end-to-end (re)-correlator + calibration workflow producing science ready images across the whole field-of-view!



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Conclusions

- VPIPE is an 'easy' way to calibrate your cm VLBI data and includes all of the CASA optimisations so you don't need to deal with it.
- It can calibrate any continuum or wide-field VLBI data set with flexible and modular options to include your own bespoke code.
- It's still under development so bear that in mind — I am happy to help get you started if you wish to try it out.