

# CAPTURE-POL

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## What is CAPTURE-POL ?

CAPTURE stands for CASA Pipeline-cum-Toolkit for Upgraded GMRT data REDuction. It is a calibration and imaging pipeline for interferometric data obtained using the Upgraded GMRT. It uses Common Astronomy Software Applications (CASA, NRAO, [McMullin et al 2007](#)) and python.

**CAPTURE-POL** is the modification of CAPTURE that can carry out polarization calibration and imaging for uGMRT band-4 data.

The current release is (v1.0.0) available here:

<https://github.com/ruta-k/CAPTURE-POL>

The basics of the CAPTURE pipeline are described in the paper [Kale and Ishwara-Chandra, 2021, ExA, 51, 95](#) and the polarization calibration is described in [Silpa et al 2020, MNRAS, 499, 5826](#).

**Warning:** There are no automated checks on the calibration or other validations of the results obtained from CAPTURE-POL for science. Therefore it is the user's responsibility to check the validity of the results of this pipeline before using these for science.

**Feedback:** Feedback is welcome on github (raise issues) or over email on [ruta@ncra.tifr.res.in](mailto:ruta@ncra.tifr.res.in).

## How to use CAPTURE-POL ?

The pipeline files need to be located in the same directory as the data. All the new files will be created in the same directory.

This version of CAPTURE-POL was tested in 5.7.2 and is expected to work in CASA 5.X versions where  $X \geq 5$ . It is assumed here that you have a suitable CASA version installed.

Open `config_capture.ini` in a text editor. Change and save the settings as per your requirements.

Run the pipeline using (it is assumed that you have a CASA 6 version installed):

```
casa -c capture-pol.py
```

OR at the CASA ipython prompt using,

```
execfile("capture-pol.py")
```

The inputs in `config_capture.ini` are shown in Table 1.

## What are the steps followed in CAPTURE for analysis ?

A schematic diagram showing the main steps in CAPTURE is shown in Fig. 1.

## *CAPTURE-POL*

### **CAVEATS for CAPTURE-POL:**

1. LTA to FITS conversion: If you are starting from a "lta" file - you need to make sure that the listscan and gvfits are executable before starting to run the pipeline. You can convert these to executable files using the commands e.g.: `$chmod +x listscan $chmod +x gvfits`
2. For the FITS file provide the name in capital letters such as, `MYSOURCE_20JULY2019.FITS` or `TEST.FITS` etc.
3. In case of legacy GMRT dual frequency data please convert the lta to FITS outside the pipeline by choosing one polarization at a time in the .log file. The pipeline will only work for the FITS file directly provided.
4. Primary beam correction: The images produced by the pipeline are not corrected for the effect of the primary beam. You need to run the primary beam correction separately. The task 'wbpbgmrt' can be used to do the correction. Follow the instructions given along with the task.
5. The data files where the primary and secondary calibrators are not named in the standard IAU format, CAPTURE will fail. It can be used after renaming the calibrators.
6. CAPTURE can run when the primary calibrator is used as a secondary calibrator and no phase calibrator scan exists in the file. In such a case the primary calibrator with maximum number of scans will be considered the phase calibrator. If there is a combination of a secondary calibrator and a flux calibrator used for phase calibration of the target source, then CAPTURE will recognise only the phase calibrator scans as secondary calibrator and run.
7. CAPTURE-POL can be used only for band-4 at the moment.
8. 3C286 or 3C138 are the polarized calibrators and 3C84 is the unpolarized calibrator. These are necessary to achieve polarization calibration.
9. The polarization calibration is implemented on an experimental basis and needs inspection before the results can be used for science.

### **Future releases:**

Some developments that are already being tested will be included in future releases.

1. CAPTURE-POL for band-3.
2. Diagnostic plots and statistics at calibration and imaging steps.
3. More tclean controls for polarization imaging from the `config_capture.ini` file.
4. Primary beam correction integrated with the main pipeline.

### **Contributions to CAPTURE-POL:**

If you would like to contribute to CAPTURE-POL, please write to [ruta@ncra.tifr.res.in](mailto:ruta@ncra.tifr.res.in).

Table 1.

| Parameter          | Value  | Description   |
|--------------------|--|---|
| fromlta            | = True   | Convert lta file to FITS.   |
| fromfits           | = True   | Convert FITS to MS.   |
| frommultisrcms     | = True   | When working with a multi-source MS file.   |
| findbadants        | = True   | Find bad antennas.  |
| flagbadants        | = True   | Find and flag bad antennas.   |
| findbadchans       | = True   | Find bad channels within known RFI affected frequency ranges.                               |
| flagbadfreq        | = True   | Find and flag bad channels.   |
| flaginit           | = True   | Do initial flagging.  |
| doinital           | = True   | Calibrate the data.   |
| doflag             | = True   | Flag on the calibrated data.  |
| redocal            | = True   | Re-do the calibration.  |
| dopocal            | = True   | Polarization calibration.   |
| dosplit            | = True   | Split the target source data.   |
| flagsplitfile      | = True   | Flag the target source data.  |
| dosplitavg         | = True   | Average target source data in frequency.  |
| doflagavg          | = True   | Flag on the frequency averaged data.  |
| makedirty          | = True   | Make a dirty image.   |
| dosefcal           | = True   | Run imaging and self-calibration.   |
| dosubbandselfcal   | = True   | To run sub-banded self-calibration.   |
| domidselfcal       | = False  | For continuing halted self-calibration.   |
| dopolimages_target | = True   | Image target in polarization.   |
| dosplit_calibrator | = True   | Split calibrator files.   |
| ltafile            | = file.lta   | Name of the lta file.   |
| gybinpath          | = ./listscan,./gvfits  | Path to the listscan and gvfits executables.  |
| fits_file          | = TEST.FITS  | Name of the FITS file.  |
| msfilename         | = test.ms  | Name of the multi-source MS file.   |
| splitfilename      | =  | Name of the split file if available.  |
| splitavgfilename   | =  | Name of the frequency averaged file if available.   |
| selfcalvis         | = selfcalvis.ms  | Last selfcalibrated visibility file.  |
| scalsrno           | = 0  | Selfcal iteration to continue.  |
| finalvis           | = selfcal-final.ms   | Self-calibrated target vis file for polarization imaging.                                   |
| setquackinterval   | = 10   | Time in seconds to flag at the beginning and at the end of each scan.                       |
| ref_ant            | = C00  | Provide reference antenna name. Note that the antenna number will not work.                 |
| clipfluxcal        | = 0.0,80.0   | Clipminmax levels in Jy for flux calibrator.  |
| clipphasecal       | = 0.0,60.0   | Clipminmax levels in Jy for the secondary calibrator/s.                                     |
| cliptarget         | = 0.0,30.0   | Clipminmax in Jy for target source.   |
| clipresid          | = 0.0,10.0   | Clipminmax in Jy for residual column used only during self-calibration.                     |
| chanavg            | = 20   | Number of channels to average. Choose in order to avoid bandwidth smearing.                 |
| subbandchan        | = 50   | Number of channels in one sub-band.   |
| imcellsize         | = 1.0arcsec  | Cell size for imaging.  |
| imsize_pix         | = 7000   | Image size in pixel units.  |
| clean_robust       | = 0  | Robust parameter in tclean.   |
| scaloops           | = 8  | Total number of self-calibration loops (including both phase-only and amplitude and phase). |
| mJythreshold       | = 0.01   | A setting equal to the expected rms in mJy is found to work fine.                           |
| pcaloops           | = 4  | Number of phase-only self-calibration loops; should be <= scaloops.                         |
| scalsolints        | = 8.0min, 4.0min, 2.0min, 1.0min, 4.0min, 2.0min, 1.0min, 1.0min | List of "solint"s for the task gaincal in self-calibration.                                 |
| niter_start        | = 1000   | Number of iterations for the first imaging in the self-calibration loop.                    |
| use_nterms         | = 2  | The nterms parameter used in tclean.  |
| nwprojpl           | = -1   | Number of w-projection planes; -1 implies that it is determined internally in tclean.       |

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Fig. 1: A schematic diagram showing the steps followed in CAPTURE-POL.

