

CAPTURE-CASA6 : a CASA 6 compatible version of uGMRT-pipeline

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What is CAPTURE ?

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.

The current release is available here:

<https://github.com/ruta-k/CAPTURE-CASA6>

The basics of the CAPTURE pipeline are described in the paper [Kale and Ishwara-Chandra, 2021, ExA, 51, 95](#) and there are further updates on it that are released in this version. The main updates are:

- I) sub-banding of measurement set before imaging and self-calibration.
- II) Further control on tclean parameters through the config file.
- III) Compatibility with CASA 6 and later versions.

The current version is a CASA-6 compatible version of uGMRT-pipeline called CAPTURE.

CAPTURE is designed to work for bands 3, 4 and 5 of the uGMRT. It can also be used for all the bands of legacy GMRT data.

Warning: There are no automated checks on the calibration or other validations of the results obtained from CAPTURE 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.

How to use CAPTURE ?

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.

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.py
```

OR at the CASA ipython prompt using,

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

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

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What are the steps followed in CAPTURE for analysis ?

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

CAVEATS for CAPTURE:

1. Use CASA version 6 and above. The pipeline has been tested in CASA 6.2 and 6.2.
2. 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`
3. For the FITS file provide the name in capital letters such as, `MYSOURCE_20JULY2019.FITS` or `TEST.FITS` etc.
4. 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.
5. 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 CASA 6 compatible task "ugmrtpb" should be used. The instructions to use this task are provided in the documentation for the same.
6. 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.
7. 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.

Future releases:

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

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

Following are longer term plans:

1. Correction for ionospheric effects and direction dependent calibration.
2. Option to carry out imaging using WSCLEAN.

Contributions to CAPTURE:

If you would like to contribute to CAPTURE, please write to ruta@ncra.tifr.res.in.

Table 1. The parameters in config_capture.ini are described in this table.

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.
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.
ltafile	=	file.lta	Name of the lta file.
gvbpath	=	./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.
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: CAPTURE-CASA6 schematic diagram showing the analysis steps.

