

AWIMAGER

BASIC INFORMATION

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GOAL

We tested two different aspect of the imaging step in the frame of LOFAR. First we tested the capability of AWImager to make correct images and second we tested its ability to be part of a selfcal loop.

DETAILS

Data

Data were simulated with BBS inside an LBA observation of VirgoA (so pretty low dec and ugly UV-cov). The simulated data consists in a single point source (10 Jy) in the center of the field, plus 10 more 1 Jy point sources placed on a spiral around the central one, up to a distance of 5 deg (see Fig.1). Fluxes in the QUV stokes are set to 0.

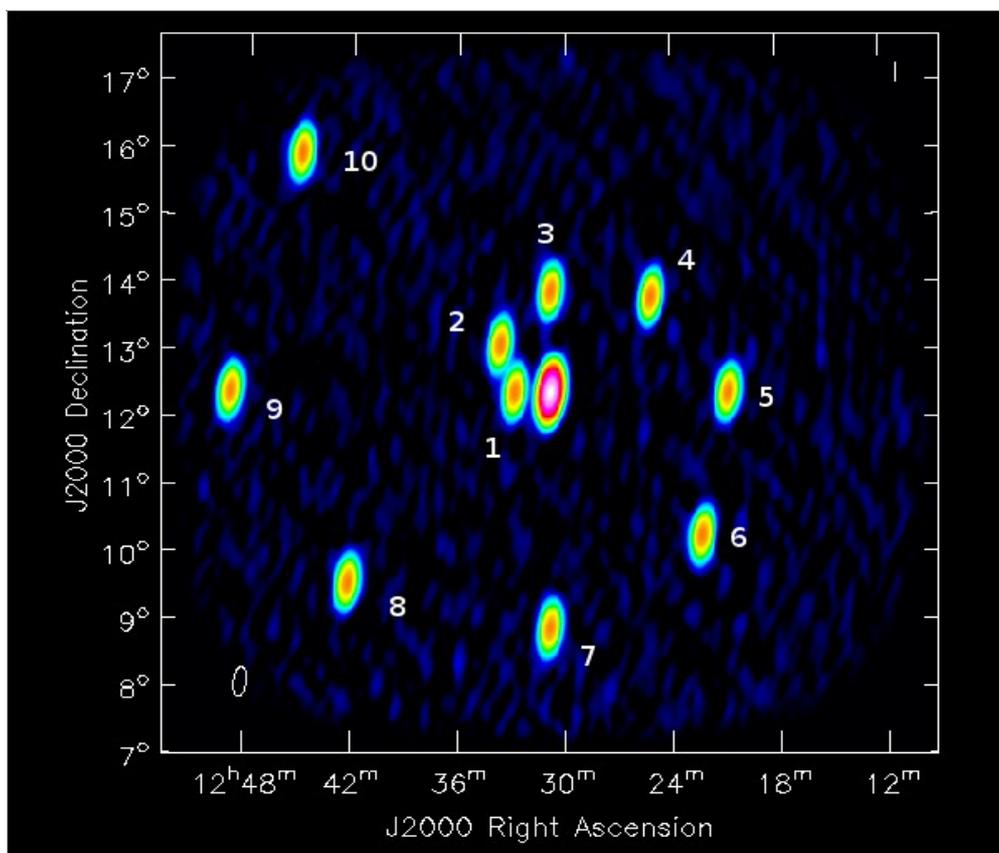


Fig. 1: Imaging of the simulated data. Source in the center is 10 Jy while all the others are 1 Jy.

1. Imager test

Data have been simulated with BBS (no noise added) with the BEAM turned ON in a LBA dataset with the same UV-coverage of an 8 h VirgoA observation. All the remote station were flagged to speed up the procedure. As a preliminary test for AWImager an image of this simulated data has been done (Fig.1). The fluxes of the ten 1 Jy sources are (between brackets the beam-uncorrected value):

1. 1.031835e+00 (1.031839e+00)
2. 9.992662e-01 (1.012118e+00)
3. 1.012191e+00 (1.045775e+00)
4. 1.014027e+00 (9.992201e-01)
5. 9.974497e-01 (9.501189e-01)
6. 1.003099e+00 (8.812889e-01)
7. 9.966373e-01 (8.453111e-01)
8. 9.966382e-01 (8.283383e-01)
9. 1.003011e+00 (8.758132e-01)
10. 1.031732e+00 (9.991207e-01)

As expected, the farther we go from the phase center, the lower the uncorrected values are. This is not true for source 10, a possible explanation is the asymmetry of the primary beam shape. Anyway, AWImager has been reliable (~ 1-3 % of error probably due to deconvolution effects) in reconstructing the simulated flux even at 5 deg from the phase center. A value compatible with 0 has been found in stokes UVQ.

2. Self-Calibration

The selfcal test has been performed with BBS+AWimager+casapy2BBS.py starting from a model of ONLY the core 10 Jy source and then letting the loop run for 10 cycles. BBS parset for the calibration step was:

```
Strategy.Stations = []
Strategy.InputColumn = DATA
Strategy.ChunkSize = 200
Strategy.UseSolver = F
Strategy.Steps = [solve, correct]

Step.solve.Operation = SOLVE
Step.solve.Model.Sources = []
Step.solve.Model.Gain.Enable = T
Step.solve.Model.Cache.Enable = T
Step.solve.Model.Beam.Enable = T
Step.solve.Solve.Parms = ["Gain:*"]
Step.solve.Solve.CellSize.Freq = 0
Step.solve.Solve.CellSize.Time = 1
Step.solve.Solve.CellChunkSize = 200
Step.solve.Solve.Options.MaxIter = 150
Step.solve.Solve.Options.EpsValue = 1e-9
Step.solve.Solve.Options.EpsDerivative = 1e-9
Step.solve.Solve.Options.ColFactor = 1e-9
Step.solve.Solve.Options.LMFactor = 1.0
Step.solve.Solve.Options.BalancedEqs = F
Step.solve.Solve.Options.UseSVD = T
Step.solve.Solve.PropagateSolutions = T

# for the new imager data must be corrected in the "center" direction
Step.correct.Operation = CORRECT
Step.correct.Model.Sources = [center]
Step.correct.Model.Gain.Enable = T
```

Step.correct.Model.Beam.Enable = T
Step.correct.Output.Column = CORRECTED_DATA

The skymodel produced by casapy2BBS includes QUV stokes as well. In order to limit the number of clean components a mask of ~100 pixel around every source has been given to casapy2BBS.

The Imaging step has been performed with AWImager with this parameters:
awimager ms=\${ms} image=\${img} weight=uniform wprojplanes=64 npix=512 gain=0.2
cellsize=75arcsec data=CORRECTED_DATA padding=1. niter=700 timewindow=500
stokes=IQUV threshold=0. operation=csclean

2.1 Results on Selfcal

After the first cycles we already recovered the other 10 sources, although their flux was lower than the "correct" one. A small fraction of the flux has curiously moved to the QUV stokes. Here is a list of the beam corrected flux value per source at the first and the last step (10th) of the selfcal (between brackets the beam-uncorrected value):

1. 9.224589e-01 (8.652467e-01) → 9.818316e-01 (9.326376e-01)
2. 6.734132e-01 (6.688278e-01) → 9.749066e-01 (9.497994e-01)
3. 9.072010e-01 (9.589082e-01) → 1.005655e+00 (1.037963e+00)
4. 9.178095e-01 (9.576299e-01) → 1.006304e+00 (1.022243e+00)
5. 9.586295e-01 (9.332604e-01) → 9.948337e-01 (9.489714e-01)
6. 8.759621e-01 (7.572943e-01) → 9.973624e-01 (8.745618e-01)
7. 9.210906e-01 (7.379901e-01) → 9.981148e-01 (8.442309e-01)
8. 9.354236e-01 (7.877423e-01) → 9.913414e-01 (8.230673e-01)
9. 8.774783e-01 (7.813033e-01) → 1.006316e+00 (8.754464e-01)
10. 9.208879e-01 (9.369740e-01) → 1.027000e+00 (9.929435e-01)

All the source fluxes converged to 1. Strangely, some of the flux is moved to other stokes (see Fig. 2), although initial model and simulated data had Q=U=V=0. The amount of flux in the UVQ stokes is about 2-5% of the total source flux. In some selfcal cycles it appears to be preferentially in some sources while on other cycles on different sources.

CONCLUSION

AWImager is working correctly and it manage to reconstruct the flux within few % in the inner 5 deg of an LBA image. Selfcal cycle works, more baselines will likely help the convergence. Some attention should be payed to the polarization to understand the behavior described above.

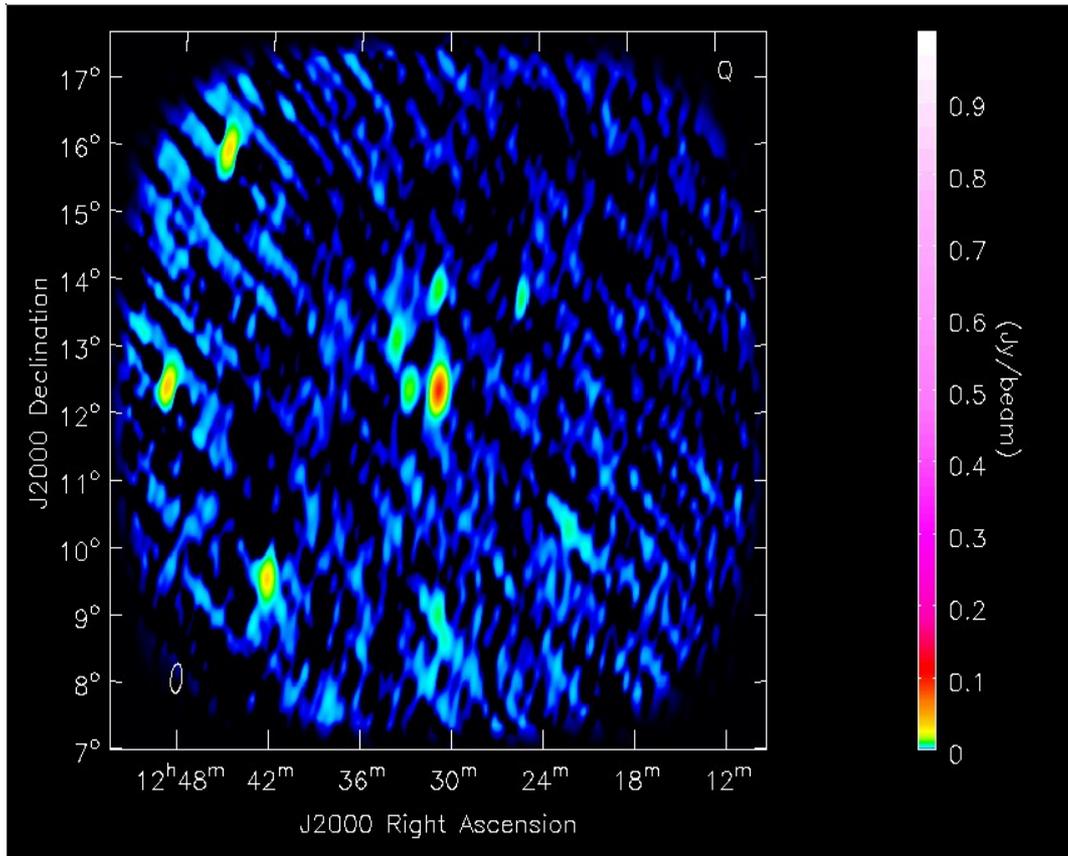


Fig. 2: Above: Q-stokes. Bottom-left: U-stokes. Bottom-right: V-stokes. All images are after 10 cycles of selfcal. Some of the flux is erroneously transported into other stokes.

