Calibration Artefacts: Phase Only Calibration

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Calibration is the process by which we estimate and correct instrumental and environmental errors in interferometric data. We usually perform calibration by finding the antenna gains that minimize the difference between our observed and predicted visibilities. We require a sky model to create predicted visibilities. It turns out that if our sky model is incomplete then we produce calibration artefacts.

Calibration artefacts have been studied to some extent in (Grobler, T. L., et al., *Monthly Notices of the Royal Astronomical Society,* **439,** 2014, pp. 4030-4047). It should however be noted that the aforementioned study only considered full complex calibration (phase and amplitude are solved simultaneously). The study revealed that when performing phase and amplitude calibration, with an incomplete sky model, leads to faint negative ghosts (calibration artefacts) and if they form on top of real emission they cause source suppression.

Recently A.J. Stewart et al. managed to produce a bright anti-symmetrical ghost (http://www.astron.nl/lofarscience2014/Documents/Tuesday/SessionII/Stewart.pdf). This ghost was created by employing LOFAR and phase-only calibration. Firstly, it should be noted that phase only calibration is used de facto in calibration pipelines and is usually performed after applying the amplitude calibration solutions obtained from an external calibrator. The fact that we can produce bright positive ghosts with phase only calibration implies that we should treat the results we obtain with it with caution, especially in pipelines in which we expect our sky models to be missing large amounts of flux as is the case in transient detection pipelines.

Below we present another simulated test case (with WSRT) that confirms the results obtained by A.J. Stewart. We added two sources to a sky model, a 100Jy off-axis source and a 80Jy source at the center. We then made a measurement set containing both sources in it (left image), we then calibrate (**phase-only**) with only the 80Jy source. The result a positive anti-symmetrical ghost is created (right image). The off-axis source is now about 62Jy and the newly created source is about 28Jy. The central source is about 92Jy. These fluxes were measured directly on the dirty map and can therefore only be considered as rough estimates. Find the images below that illustrates this.