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Trajectory Based RFI Subtraction and Calibration for Radio Interferometry

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Radio interferometry calibration and Radio Frequency Interference (RFI) removal are usually done separately. We show that jointly modelling the antenna gains, the RFI parameters and the uncontaminated, calibrated visibilities has significant benefits when the RFI follows precise trajectories, such as for satellites and most terrestrial sources. By leveraging the RFI signal itself we obtain improved calibration solutions with potentially orders of magnitude improvement. We present `tabascal` (**TrA**jectory **BA**sed RFI **S**ubtraction and **CAL**ibration), a new algorithm that recovers uncontaminated, calibrated visibilities with reliable uncertainty estimates.

We test `tabascal` on simulated MeerKAT calibration and target observations contaminated by satellite-based RFI. We obtain visibility estimates that are both unbiased and lead to reduced image noise compared to uncontaminated data. Although we test `tabascal` on satellite-based RFI, it is a general method that relies only on a parameterizable trajectory for the RFI and can handle multiple RFI sources. Figure 1 below shows the source extraction for a simulated 15 minute target observation of 100 point sources following a 5 minute calibration observation. The mean RFI amplitude here is 390 Jy but `tabascal` can handle much stronger RFI at the expense of more computation.

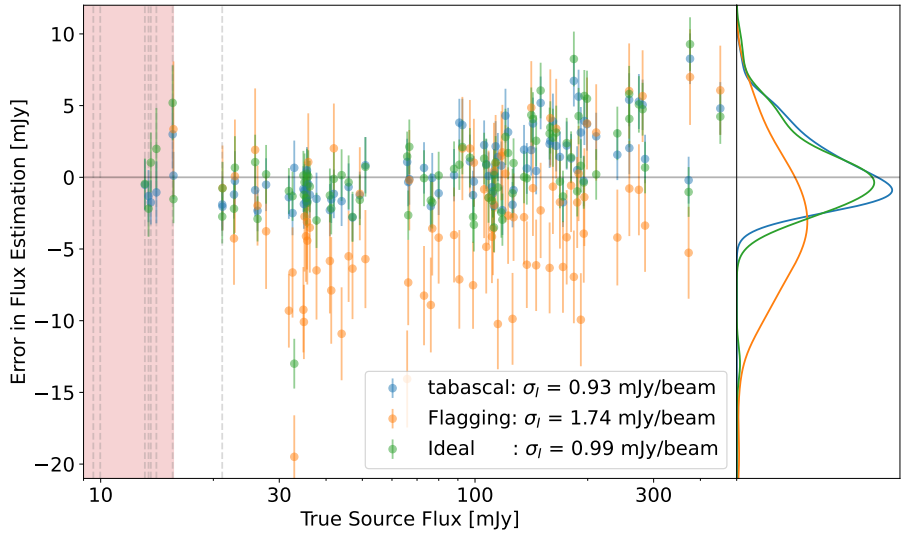

Figure 1. Comparison of flux estimation errors on extracted sources. `tabascal`-processed data leads to equivalent source extraction to that obtained by uncontaminated data whereas traditionally flagged data leads to larger bias and flux errors. The mean RFI intensity in this data portion is 390 Jy. The images used were created from simulated visibilities for a 15 minute, single channel (1.227 GHz) MeerKAT target observation with 100 point sources.