Imaging Results from the uGMRT Real-time Broadband RFI Excision System

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Radio halos and relics in clusters of galaxies are low brightness ($\sim$ μJy arcsec^{-2} at 1.4 GHz) extended sources and are direct probes of relativistic electrons and magnetic fields on mega-parsec scales. Low- frequency (< GHz) radio observations with the Upgraded Giant Metrewave Radio Telescope (uGMRT) are most appropriate for studying these sources [e. g. 1]. One of the most important challenges with the uGMRT is the corruption of astronomical data due to man made broadband radio frequency interference (RFI). The effect of RFI is more pronounced on the shorter baselines which are critical for studying the extended radio emission. A real-time RFI excision system for filtering broadband RFI [2] is developed as part of the GMRT Wideband Backend (GWB). This system uses robust threshold-based detection to identify broadband RFI in the time-domain data for each antenna and polarization. The RFI samples are replaced by digital noise samples. Diverse engineering and astronomical tests have been carried out using this real-time excision technique [3] which show improvements of ~10 dB in the signal-to-noise ratio.

We describe observations on calibrator radio sources (resolved) and extended sources in galaxy clusters carried out during June to October 2018. Typically 1 – 5% of the samples (at 2.5ns time resolution) were affected by the RFI excision. A fair comparison of the filtered and unfiltered data was carried out by ensuring a similar treatment in the online processing (using digital copy of the input) and offline processing pipeline. This generic methodology of simultaneous analysis has been specifically developed for testing the real-time RFI excision. The offline processing pipeline utilises the tasks and tools available in the Common Astronomy Software Applications (CASA) software customized for use with the uGMRT data. The spatial cross-correlation spectrum (visibilities) at short baselines show significant improvement and the impact can be seen in the images in the form of reduced standard deviation of noise and improved image fidelity. Early science results using this system for different uGMRT frequency bands will be shown along with analysis and interpretation. The broadband RFI excision system is planned to be released for the uGMRT user community to provide a better observing in presence of broadband interference.

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