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Reducing internal RFI at very low frequencies for a polar radio astronomy experiment

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Radio frequency interference (RFI) is created by human activities and directly interferes with our exploration of the Cosmic Universe. The radio astronomy spectrum has been well explored in the frequencies above 20/30 MHz and has given rise to numerous astronomical discoveries on objects of importance like the Sun, Jupiter like planets, Quasars, Pulsars, active galaxies and dark matter and dark energy; but, due to ionospheric opacity to radio waves of extra-terrestrial origin the frequency range from a few hundred KHz to less than 20 MHz remains largely unexplored.Instead, this frequency range is used by manycommunication systems like terrestrial broadcasts, radio broadcasts andmilitary and civilian purposes; in addition, household /industrial devices (ex: welding, home appliances, spark plugs of vehicles, etc.) produce RFIthat fall in the same low frequency band.

Importantly, all the circuit boards that use AC-DC converters, devices like FPGA, interconnecting wires, etc produce RFI that affect signal quality severely. In this presentation, we outline the measurestaken by us to suppress theseinternally generated RFI so that we can measure and calibrate the RFI emanating from all terrestrial broadcasts.Ultimately we would like to produce a global RFI spectrum and calibrate it so that it can be suitably removed in the space based radio astronomy receivers.

The experimental setup consists of two orthogonal antennas followed by a FPGA based baseband receiver. RF front end consists of two 1.8 m monopole Antennas followed by an active broadband matching scheme utilizing low noise amplifiers for impedance transformation. Further the signal is amplified by a pre-amplifier, filtered and passed on to the Data acquisition system. Digital backend design consists of a direct sampling receiver, implemented using a 12-bit high speed ADC and FPGA working with a sampling frequency of 33.33 MHz, for a variably defined acquisition period.The binned spectra obtained with the system showed the noise floor in the range of -70 dBm. A number of experiments were carried out to study the conductive/radiative noise generated by the system.

Due to careful efforts made by us , we have been able to reduce the RFI levels in our circuits substantially. The noise floorover the entire observing range is now below -90 dBm over 16 KHz bandwidth. This corresponds to -132 dB/Hz level.This compact set up of size 15 cm×12 cm× 12 cm will be initially deployed in the Indian Himadri station(78° 55′ 0″ N, 11° 56′ 0″ E) in the Arctic in Norway for understanding the robustness of the circuits and to study the local environmental RFI and also sources like Auroral Kilometric Radiation, solar decametric radio bursts, etc. Based on these results, the setup will be modified to be sent on a PS4 platform of ISRO's PSLVrocket into Low Earth Orbit to study both RFI from the Earth and from radio objects in the sky.