COMPACT RADIO ASTRONOMY RECEIVERS - DIGITISING THE SIGNAL AT THE ANTENNA

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In traditional radio astronomy receiver systems, the conversion from analogue to digital signals is done far away from the actual antenna. Even in modern radio systems, like LOFAR, this is the case. An important reason for this is the generated interference at the observation frequency. The A-to-D convertors and the digital signal processing hardware therefor placed in a shielded environment to overcome this problem. Although the generated RFI is shielded, this leads to very bulky systems. Another reason for the fairly complex systems is the origin of the astronomical signals: wideband signals and extremely weak. To be able to detect and analyse these signals, complex downconversion systems with multiple local oscillators and filtering were needed in the analogue domain. Simpler, single-downconversion, sideband-separating solutions have usually been ruled out by the difficulty in realizing ultrawideband hybrid couplers for the intermediate frequency and the relatively limited sideband isolation.

Our goal is to develop the next generation of high-performance, compact, integrated radio astronomy receivers using the latest advances in modern digital computing to digitize the signal as close to the antenna feed as possible. We call this compact receiver systems. This will reduce the total analogue path length as well as the amplifier gain required along with their associated temperature-dependant amplitude and phase fluctuations. Of course, the requirements for the A-to-D are the same, but now we sample real close to the antenna instead of far away in a shielded environment.

The task is now to design a receiver that directly samples the output of the feedline. Challenges that pop up in this approach are the generated RFI, the demands on the distributed clock to maintain good phase stability, the wideband request for radio astronomy, and the limited available power. In this paper the challenges will be worked out and evaluated to come up with the design for a compact receiver system for radio astronomy.