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# The Effelsberg Direct Digitisation System

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To ensure that the Effelsberg Radio telescope remains one of, if not *the*, world-leading cm-wavelength single dish telescope, continual improvement of its receiver and data processing systems are required. The latest major upgrade to Effelsberg is the ongoing development and deployment of the Effelsberg Direct Digitisation (EDD) system: a state-of-the-art end-to-end receiver to science-ready data product observing system. The EDD system consists of two core components, a frontend unit and a backend processing system. The frontend unit is a modular system developed at the MPIfR that can be configured to meet the requirements of the new suite of wide-band receivers being developed for Effelsberg. It provides control, amplification, filtering, mixing and in-receiver digitisation. Digitised voltages from the frontend units are packetised and transmitted as multicast UDP over a 100-GbE Ethernet network to the EDD backend processing system: a high-performance heterogeneous GPU-FPGA computing cluster based on commodity off-the-shelf (COTS) components. The EDD systems' use of direct digitisation at the receiver allows for the removal of older analogue signal and data processing systems at Effelsberg, reducing the maintenance load at the telescope and negating the deleterious effects of analogue cable losses on observation sensitivity.

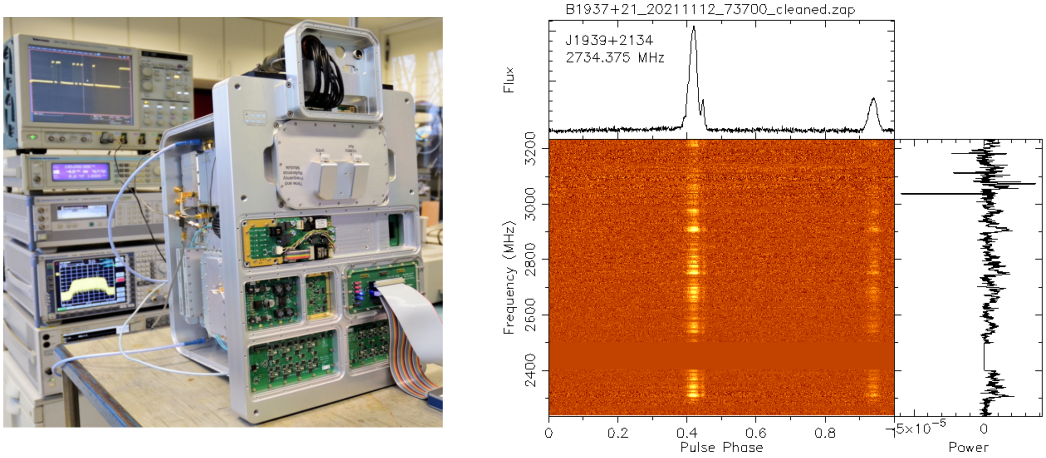


**Figure 1. Left:** An EDD frontend unit during lab commissioning. **Right:** A coherently dedispersed, 11-cm observation of PSR B1937+21 using the EDD backends' pulsar timing pipeline.

In the previous model of operations at Effelsberg, each science case would be handled by one or more single-purpose backends, each with their own digitisation schemes. The EDD backend unifies the capabilities of these systems into a single instrument, providing software pipelines for continuum, spectral polarimetry, pulsar search/timing and VLBI processing. Moreover, the fine-grained noise-diode control offered by the EDD frontend unit allows for novel approaches to commensality, opening the possibility of efficient simultaneous continuum and pulsar/transient search observations to be conducted with the telescope.

In this work, I will present an overview of the EDD system, looking at its design and capabilities. I will show how the system has been deployed not only at Effelsberg, but also at the Thai National Radio Telescope (TNRT) and the SKA-MPI dish on the MeerKAT site in South Africa. Finally I will discuss the future of the EDD system and in particular its scaling-up to handle the first-generation, 256-element, cryogenically cooled phased array feed being developed for Effelsberg.