The Parkes Pulsar Backends

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Abstract. Pulsars are a major area of research at the CSIRO Astronomy and Space Science Parkes Observatory, ATNF. The quality and extent of the backend instrumentation available at Parkes has been a major factor in the success of this pulsar research. In collaboration with other observatories and universities, the development of these backend systems continues to provide the radio pulsar community with high performance and flexible instrumentation at Parkes Observatory. Each of the available backends is described.

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THE ANALOGUE FILTER BANK (AFB)

The pulsar filter bank data acquisition system was designed for pulsar observations using the 13-beam 20cm (Multibeam) receiver at Parkes. However, it can also be used with any other receiver. It was built as a collaboration between ATNF and Jodrell Bank Observatory and was commissioned in 1997. Several of the filter bank units were built by the Pulsar Group of the Astronomical Observatory of Bologna (now at the Cagliari Observatory, Sardinia - INAF). The Parkes 20cm Multibeam receiver has 13 beams, each with two polarizations. The AFB produces 2 x 96 x 3 MHz channels for each beam using 1 bit digitization. Several other standard configurations are currently available.

THE DIGITAL FILTER BANKS DFB3/4

The ATNF pulsar digital filter banks (DFB)[1] were designed mainly for the Parkes pulsar timing array project and they aim to achieve better than sub-microsecond timing precision for many millisecond pulsars. The DFBs give 8 bit Nyquist-sampled data over bandwidths of up to 1 GHz, synchronous folding at the pulsar period, and the ability to provide real-time interference-mitigation (DFB3 only). They also provide a flexible system for searching for pulsars and studies of individual pulse emission: the number of stored bits, bandwidth, polarisation products and sampling time can all be set by the user. Data in folding and search modes are output as FITS files. The DFB3 also has a mode that provides digitized baseband output suitable for the next generation of realtime coherent dedispersion systems such as APSR (see below).

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[1] http://www.atnf.csiro.au/research/pulsar/ppta/index.php?n=Hardware.DFB

APSR

The ATNF Parkes Swinburne Recorder (APSR) is a next-generation baseband data recording and processing system developed in collaboration between Swinburne University of Technology and the ATNF. APSR has 8 times the bandwidth (from 128 MHz to 1 GHz) and greater dynamic range (from 2 to 8 bit sampling) than previous instrumentation (CPSR2) developed by Swinburne University.

BPSR

The Berkeley Parkes Swinburne Recorder (BPSR) is a high resolution digital filterbank data acquisition and processing system for the Parkes Multibeam receiver, developed in collaboration between Swinburne University of Technology and the University of California at Berkeley. BPSR is an integral part of the High Time Resolution Universe Survey currently underway at Parkes. Compared to the AFB, the major technical innovations of BPSR include much higher time resolution (64 vs 125 microseconds), frequency resolution (1024 vs 96 channels) and dynamic range (2 bit vs 1 bit).

BPSR consists of 13 Interconnect Break-out Boards (iBOB) developed by the CASPER group at the University of California, Berkeley. Each iBOB divides dual-polarization 400 MHz bands into 1024 channels using a polyphase filterbank to give a spectral resolution of 390 kHz. BPSR also has remote administration capability in preparation for future remote operation of ATNF observatories.

CASPSR

In collaboration with the Center for Astronomy Signal Processing and Electronics Research (CASPER) at Berkeley, the Swinburne Pulsar Group has designed and installed a new pulsar instrument at Parkes, the CASPER Parkes Swinburne Recorder (CASPSR). It is an integral part of the development path toward pulsar instrumentation for next-generation facilities like the Australian Square Kilometre Array Pathfinder (ASKAP) and the Karoo Array Telescope (Meer-KAT). All of the instruments developed at Swinburne University of Technology[2] make use of DSPSR,[3] a high-performance, open-source digital signal processing software library and application suite for use in radio pulsar astronomy.

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[2] http://astronomy.swin.edu.au/pulsar/?topic=instrumentation

[3] http://dspsr.sourceforge.net