Development of a coherent pulsar dedispersor for the Nançay radiotelescope

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ABSTRACT

In the frame of a scientific collaboration between the University of California, Berkeley, the LPCE/CNRS in Orléans and the Observatoire de Paris-Nançay (both in France), we are building a coherent pulsar dedispersor. This instrumentation is characterized by a real-time dispersion removal made in software. A ∼150MHz bandwidth is Nyquist sampled, divided in a number of smaller bandwidth units (∼1MHz) and processed in the Fourier complex domain to remove the effect of the dispersion, crucial for pulsar observations. In addition to proper A/D converters and channels division, a large computer power is needed to do the processing. First light of this instrumentation is expected during summer 2002.

INTRODUCTION

A collaboration between University of California, Berkeley, the Naval Research Lab, Washington, DC and the Observatoire de Paris-Nançay was settled to conduct a pulsar survey in Nançay. The NBPP (Navy Berkeley Pulsar Processor) instrumentation was installed in Nançay for this purpose and is now used to do timing observations of millisecond pulsars (see communication 1668 in this Conference). With the increasing need for better instrumentations, the Observatoire de Paris-Nançay and the University of California, Berkeley started a new scientific collaboration which will lead to

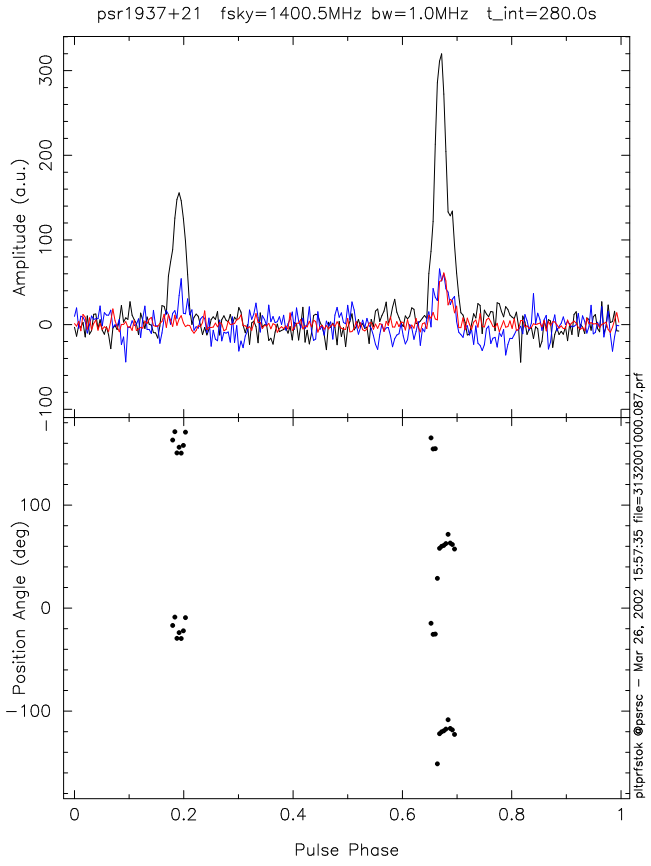

Figure 1: Result of the simulation of processing a 1MHz channel of PSR B1937+21 data previously recorded in Green Bank on November 9, 2001. Note that in the same time, 128 such 4MBytes/s data stream were processed in real-time by the cluster in Nançay.

the design and construction of a coherent pulsar dedispersor. This instrumentation will keep advantage of the fact that, in radio astronomy, the phase of the wavefronts is preserved during the frequency conversion to the IF to coherently dedisperse the pulsar signals.

A COHERENT DEDISPERSOR

In order to achieve the ultimate time resolution together with a perfect dispersion removal, pulsar signals needs to be Nyquist sampled in two orthogonal polarizations after conversion to baseband. Data are then processed in the Fourier domain to remove the effect of the dispersion introduced by the ionized component of the interstellar medium.

Several previous pulsar observations in this particular mode were already done [1]. But for the very first time, we proposed to do the dedispersion processing in real-time. No huge storage capability is needed and data results are immediately avaialble.

The strength of the signal around IF 300MHz is controlled by adjustable attenuators. Digitalized signal is frequency-splitted in a number of ∼1MHz bandwidth channels in the same time they are down-converted to baseband. The different time series will then be formatted before being send through a very fast network to a super-calculator in order to be dedispersed.

A SUPER-CALCULATOR

In the frame of the construction of the coherent pulsar dedispersor, but also for other reasons such as the (re-)processing of the Nançay pulsar survey, a super-calculator was installed at Nançay. This is a cluster of PC, composed of 77 bi-processors Athlon 1.2GHz with 1GB of memory each linked through a 1 Gbits network to a master node (also a bi-processor Ahtlon 1.2GHz with 2GB of memory) and to a RAID disk of several hundreds of GB.

A FIRST SIMULATION

In order to test as much as possible the processing capability of the calculator, we used 8 nodes of the cluster as transmiters of data stream and 64 others as receivers and processors. During almost 5 minutes, a little bit more than 512MBytes/s were exchanged through the switch between the nodes and processed in pseudo real-time. The result obtained for one of the 1MHz channel is shown in Fig.1 for data coming from an observation made in Green Bank several months ago and stored on disk. The mean load of the switch was only 30% while the mean load of the Athlon processors was of the order of 80%.

CONCLUSION

At the time of this writing, the different pieces of the coherent pulsar processor are under tests (the processing part was detailed here). In the very next future, those parts will be bring together and hopefully the first light will occur during the summer 2002.

REFERENCES

[1] Stairs I.H., Splaver E.M., Thorsett S.E., Nice D.J., Taylor J.H., 2000, *MNRAS*, **314**, 459