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Pulsar Observations at Urumqi Observatory — Recent Status and Coherent De-dispersion Experiment



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Urumqi Observatory, NAOs, CAS

Summary

- Introduction
- Pulsar Observations at Urumqi Observatory — recent status
- Pulsar Coherent De-dispersion Experiment
- Plan for pulsar digital backend development

1. Introduction

- De-dispersion technique: key of pulsar observations

Dispersion process broadens the pulse signal.

Frequency resolution is vital to high precision observations

- **Incoherent & coherent de-dispersion, their advantages and disadvantages.**

- Analogue filterbank system
- Compromise between Frequency resolution and bandwidth.
- Digital filterbank system
- Requirements for higher dedispersion capability.
PuMa, CPSR2, GASP, COBRA etc.

2. Pulsar Observations at Urmuqi Observatory - recent status

Observation System (incoherent)

Sensitivity: 0.5 mJy

$f_c = 1540\text{MHz}$ $T_{\text{sys}} \sim 22\text{K}$

$\text{BW} = 2 \times 320\text{MHz}$

$2 \times 128 \times 2.5\text{MHz}$



Urumqi 25m Radio Telescope at Nanshan

Observation Bands

92 cm

49 cm

18 cm cryogenic

13 cm cryogenic

6 cm cryogenic

3.6 cm cryogenic

1.3 cm

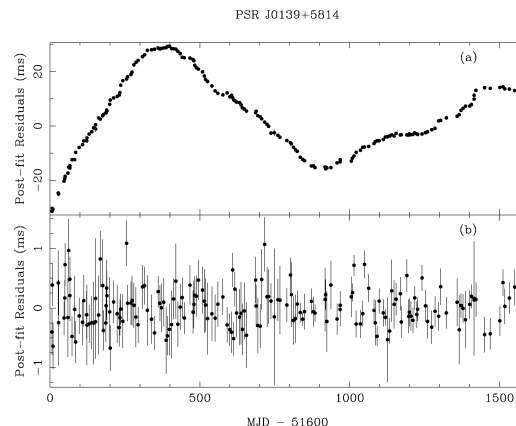


Urumqi Filterbank System

2. Pulsar Observations at Urmuqi Observatory

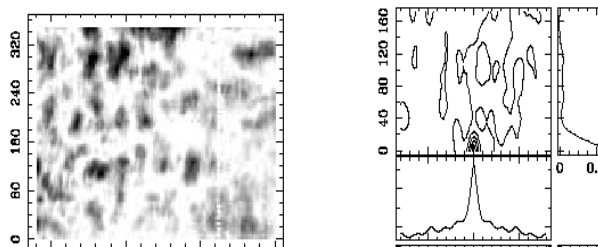
- recent status

- Timing observations of 74 pulsars have been carried out from 2000Jan to 2002 Jun. (room temperature)
- 275 pulsars have been monitored since 2002 July. (cryogenic system)
- Long term interstellar scintillation of several strong pulsars have been monitored since 2000.
- Search Mode for recent observation system are developing. Target search may be carried out soon.



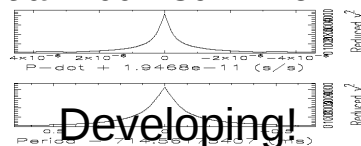
Timing

Zou et al. 2005 MNRAS 362 1189

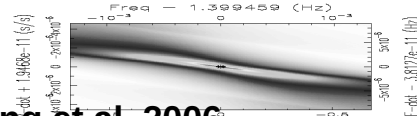


Scintillation

Wang et al. 2001 CJAA Vol. 1 No. 1 421



Target Search



Dong et al. 2006

3.Coherent De-dispersion Experiment at Urumqi

Motivation of this work:

- To observe pulsars at lower frequencies at UO
327MHz & 610MHz (2 polarizations, bw~30MHz)
- High precision timing (millisecond pulsars)
- Four stokes parameters of strong pulsars.
- RFI mitigation (key of the test)
-
- Preparation for UO's pulsar digital backend in future

3.Coherent De-dispersion Experiment at Urumqi

Hardware & software

- Data acquisition and record.

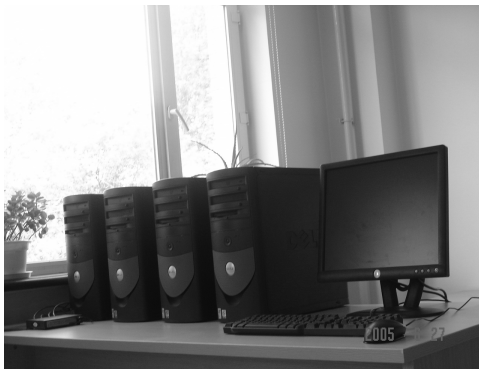
Complex-sampled baseband data.

4 VC used: 2 for each polarization.

2 bits digitized.

BW of Observations:

$$\begin{array}{l} n_{vc} \quad n_p \\ 4 \times 2\text{MHz} = 2 \times 4\text{MHz} \\ 4 \times 4\text{MHz} = 2 \times 8\text{MHz} \\ 4 \times 8\text{MHz} = 2 \times 16\text{MHz} \\ 4 \times 16\text{MHz} = 2 \times 32\text{MHz} \end{array}$$



4-node Beowulf cluster

Rocks software

VLBI backend Mark5A



- Off-line processing

C program on Linux

+ MPICH

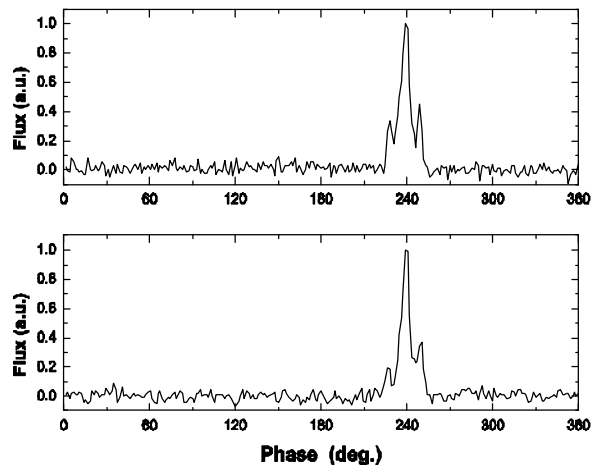
+ FFTW

4 - product outputs

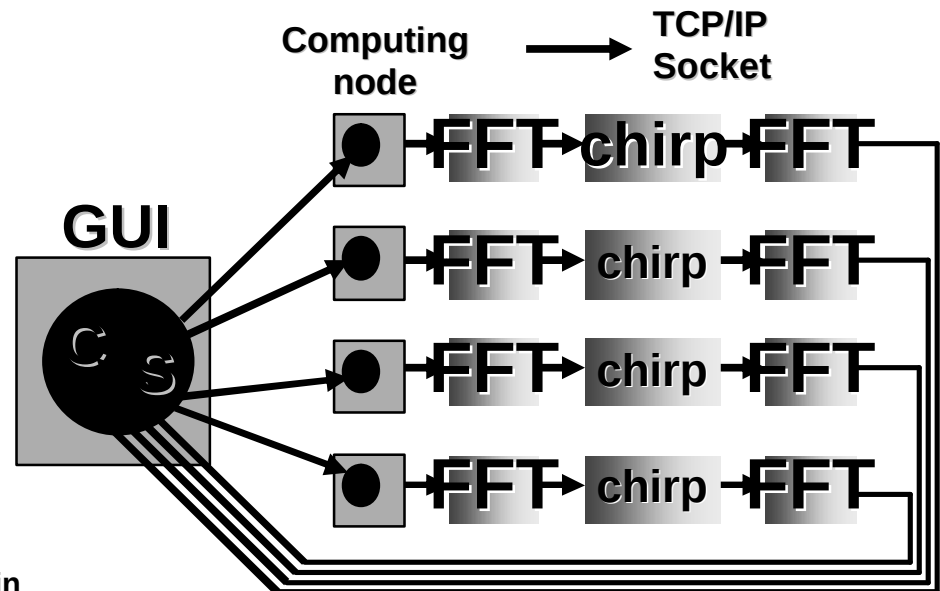
3.Coherent De-dispersion Experiment at Urumqi

Observations of several pulsars have been conducted by using 25m telescope at 1540MHz so far. Folded profiles were obtained.

RFI mitigation function of the testing system to come soon!



Average profiles of PSR0329+54 acquired in coherent de-dispersion observations



4. Plan for pulsar digital backend development

- A digital filter bank system (DFB) with a baseband data interface for coherent dedispersion system is planned to be built for UO. (ATNF-UO cooperation). Funding to come.

8-bit sampling, 1GHz of bw, 2048 frequency channels, 2048 phasebins, 4-product correlator

○ Flexibility, multi-frequencies, higher sensitivity, higher precision, polarization

- UO plan to develop a coherent dedispersion system based on the data acquisition unit of the DFB system.
- A 24-node cluster will be necessary to process the data.