Drifting^2

or

Analysis of temporal evolution of drifting subpulse phenomenon

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4th ESTRELA workshop

Bologna

Italy

19-22.01.2009

ASTRON

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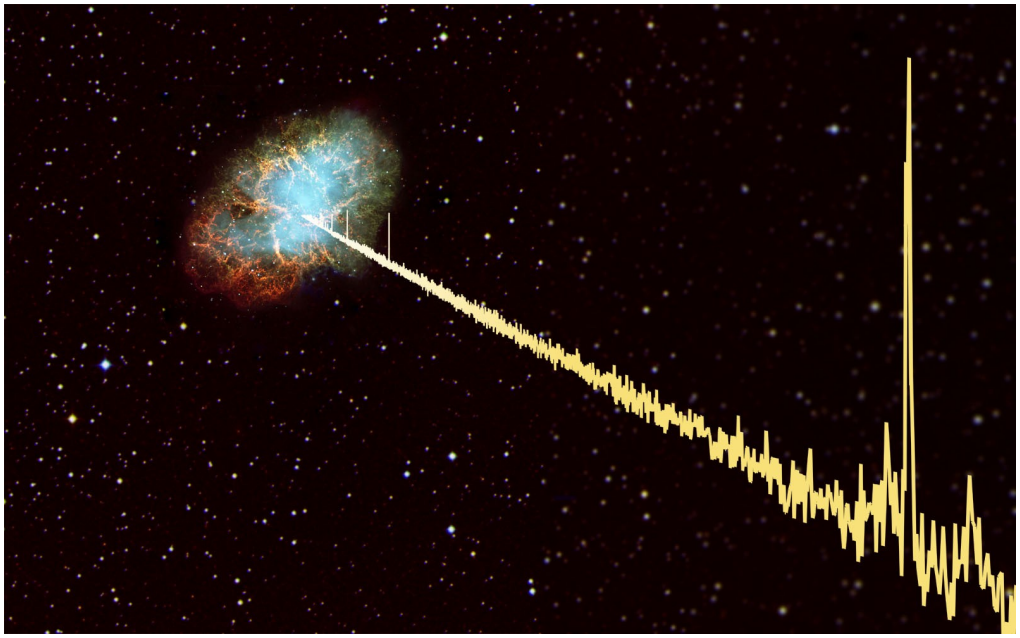
Outline

- Pulsar (very) short overview
- Drifting subpulses
- Methods of analysis
- First results
- Summary & further work

Pulsar (very)short overview

- A pulsar is rapidly spinning highly magnetized neutron star.
- Formed in the supernova explosion of a massive star (11 $M_\odot$ to 20 $M_\odot$).
- Pulsars are „born” with small rotation periods (1 ms < P_0 < 10 ms) and large slow down rates (P-dot ~10^{-12} $s \cdot s^{-1}$).
- They evolve along the lines of constant slow down rate, decreasing their powerful magnetic fields.
- Typical pulsar has a mass of 1.4 $M_\odot$, radius of 10 km, magnetic field strength 10^8 – 10^{13} G and rotation period 0.00139 – 8.5 s.



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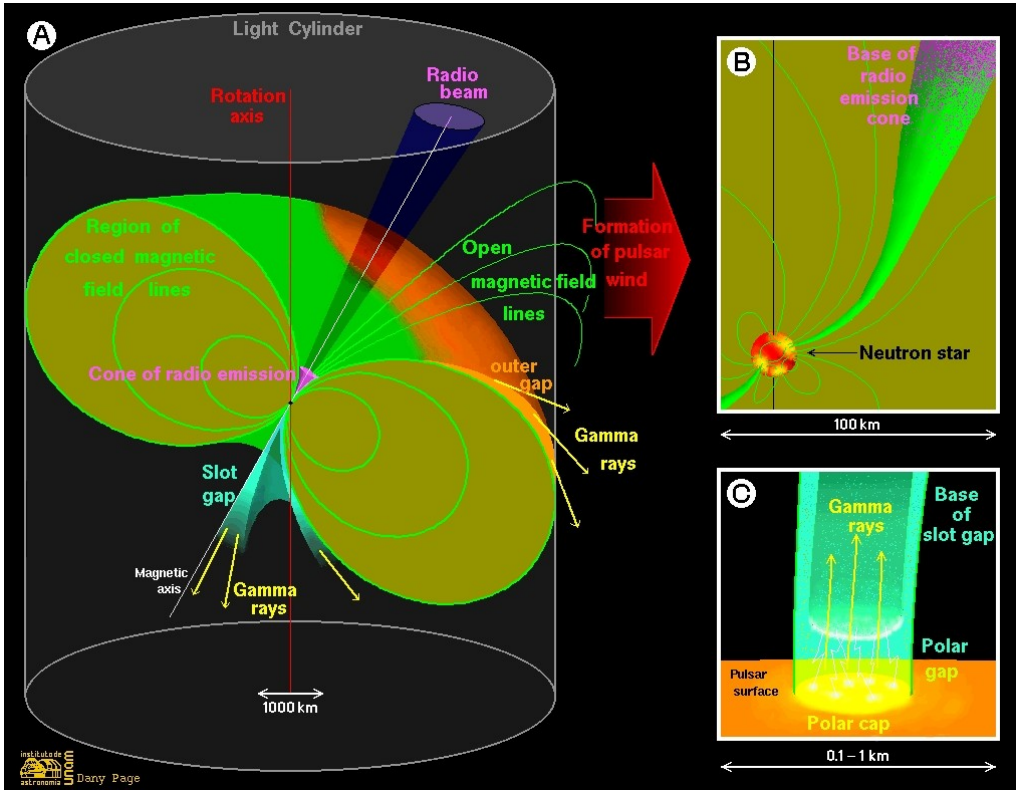
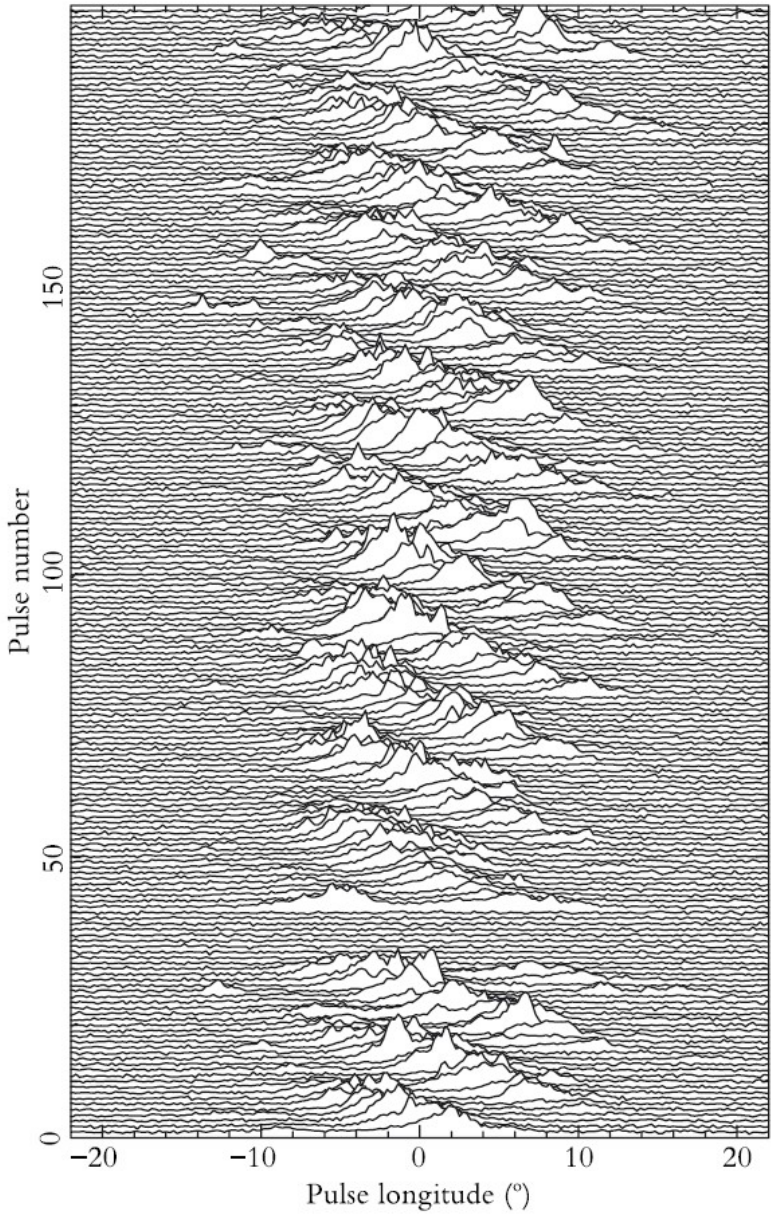


Drifting subpulses

- Pulse shapes of some pulsars are modulated.
- This modulation can be periodic resulting in repeating tyre-like pattern.
- The repeating pattern is made of so-called „drift bands”.
- One model explaining this behaviour is the carousel model.
- The carousel is made of rotating entities called „sparks”.
- As the carousel (and the pulsar) rotates, different parts of the emission beam are cutting line-of-sight making the subpulses drift.



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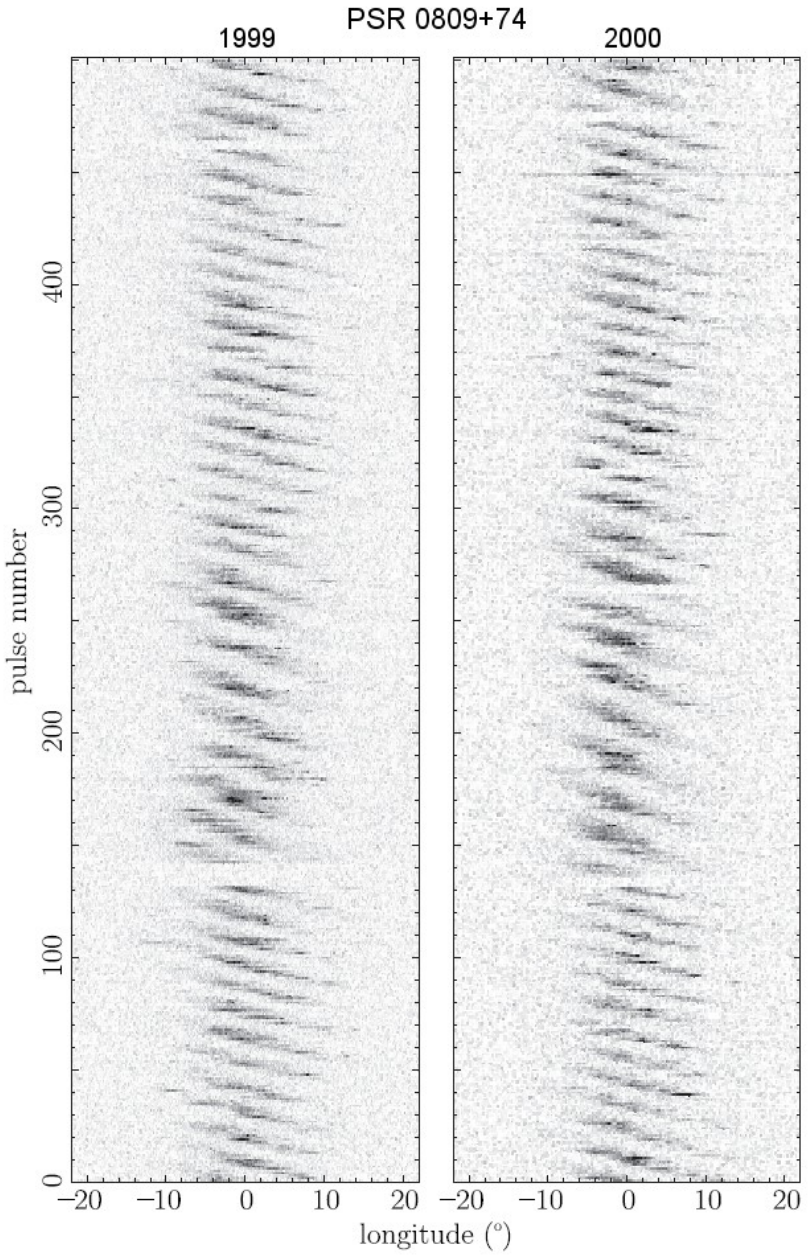

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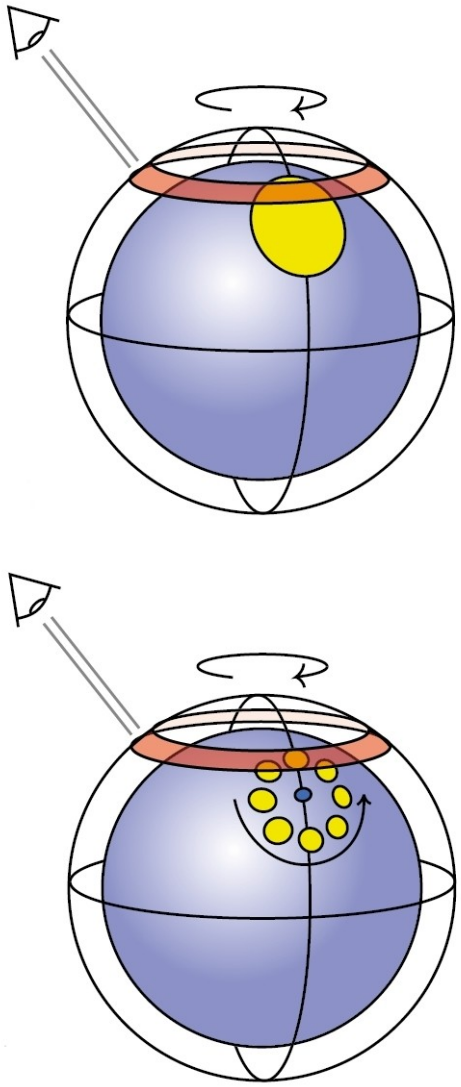


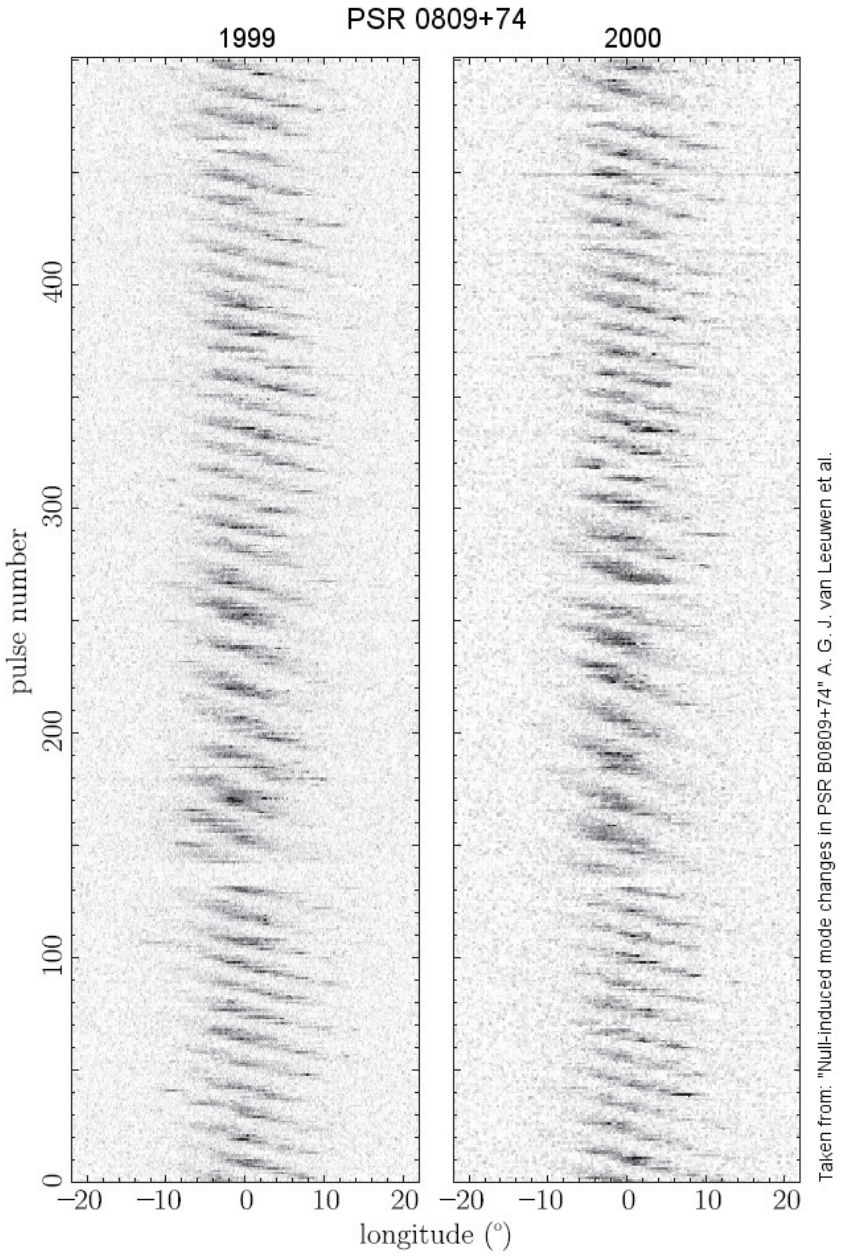
Taken from "Radio Pulsars" A. G. J. van Leeuven

Drifting subpulses

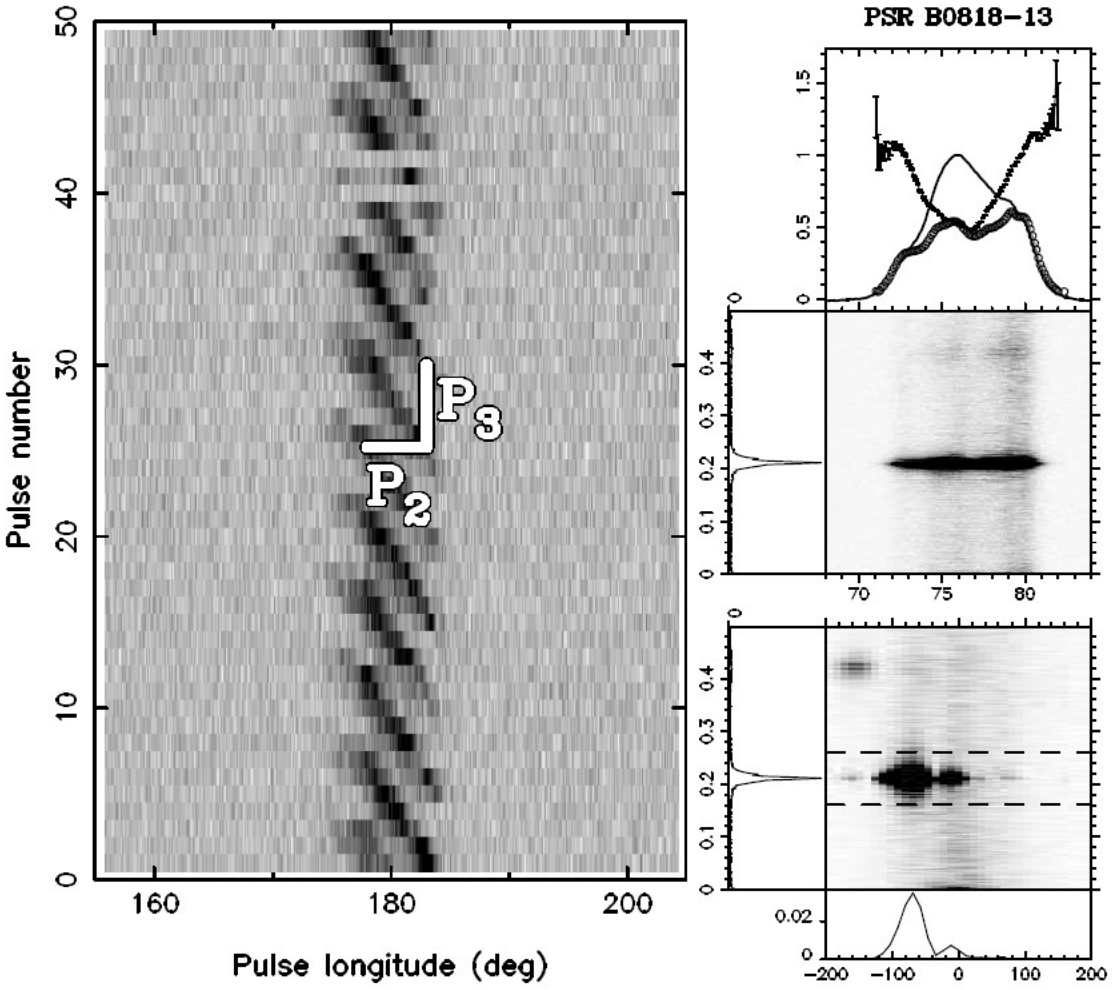
- There are detailed studies of drifting subpulses for some pulsars.
- Weltevrede et al. presented results from a large survey for drifting subpulses in pulsars.
- The survey done with WSRT at 21 and 92 cm included a sample of ~200 pulsars (130 at both frequencies).
- The survey was very successful: 1/3rd of the surveyed pulsars showed drifting subpulses.
- Some pulsars affected by mode changing or nulling.
- However, the greater S/N the bigger chance of detecting drifting subpulses.

Methods of analysis

- In such a large sample of pulsars we noticed spectra with more than one spectral features.
- There are some pulsars known to have more than one drift values, this behaviour is called mode changing.
- Some pulsars are also affected by various intrinsic/extrinsic effects which make detection of drifting subpulses difficult or impossible.
- We developed an extension to the 2DFS technique for discovering and characterising the temporal changes of drifting subpulses: Sliding Two-Dimensional Fluctuation Spectra (S2DFS).

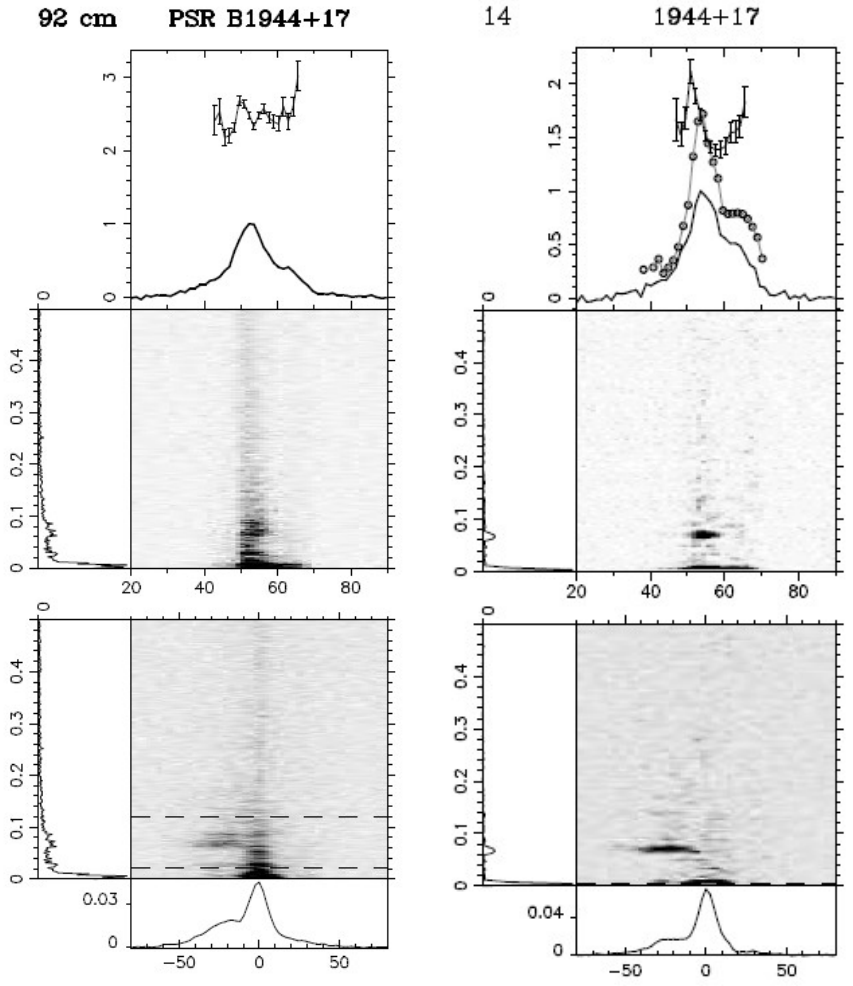


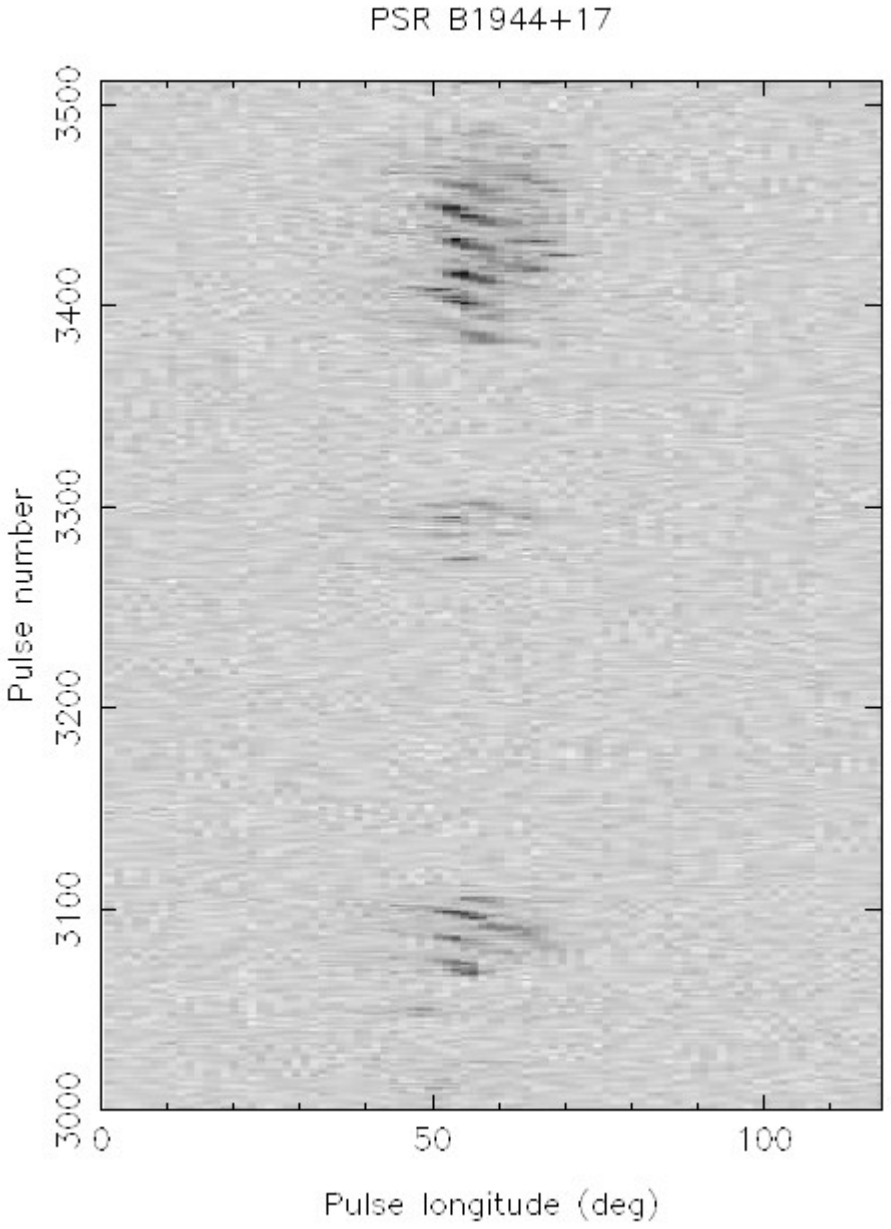
Methods of analysis



Taken from "The modulation and propagation of the radio emission of pulsars" by Weltevrede

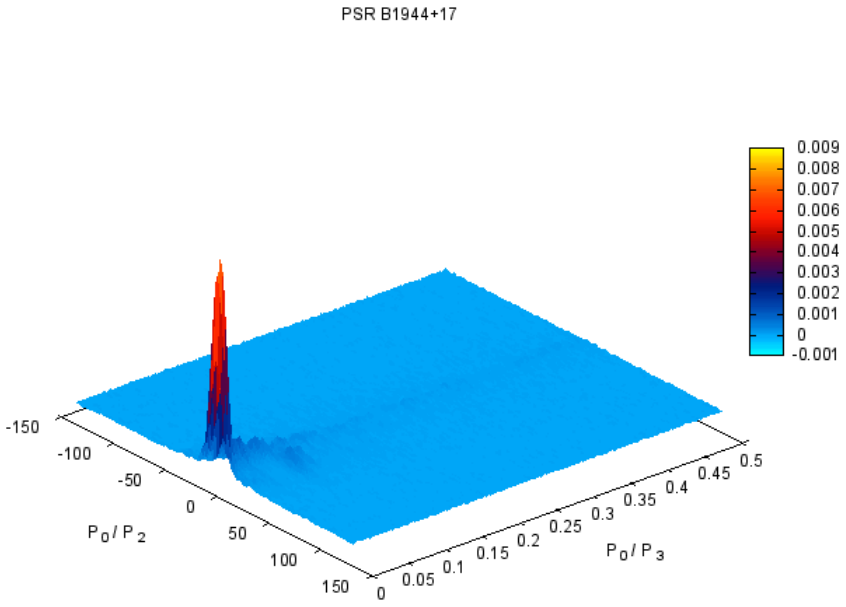
Methods of analysis

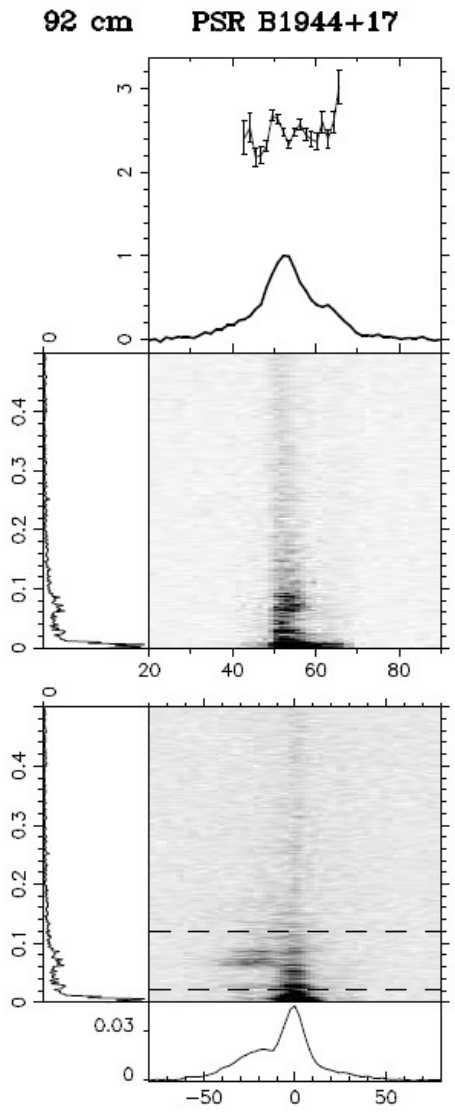




Methods of analysis

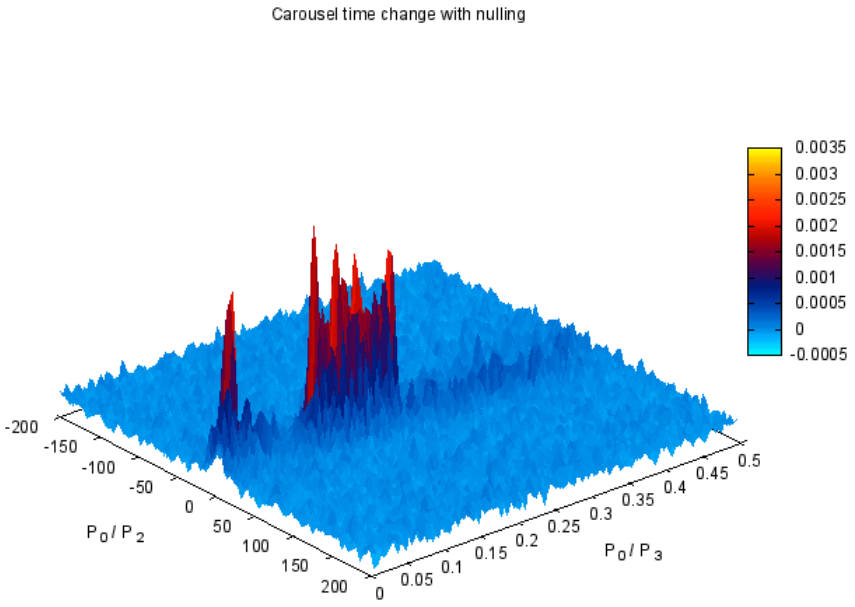
- The S2DFS uses 2DFS but it „slides” the DFT window along the pulse stack which helps to resolve any changes of drift rate.

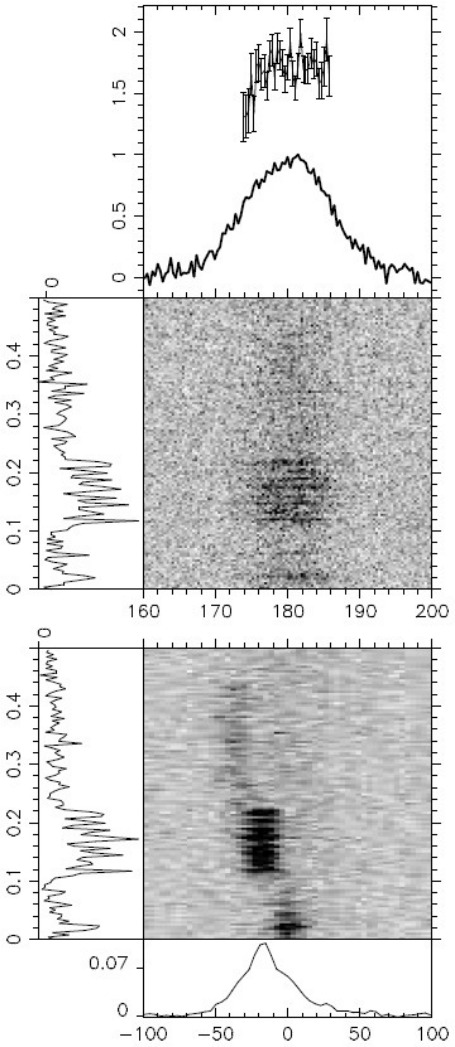




First results

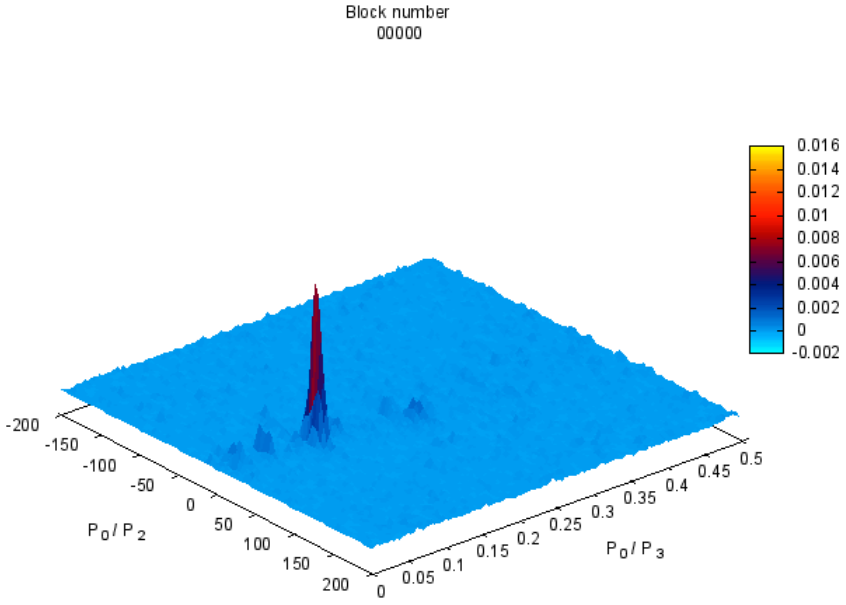
- We have simulated signals from few pulsars to check the new method.
- First emission scenario: the constant change of carousel circulation time.
- This means that the drift rate changes.

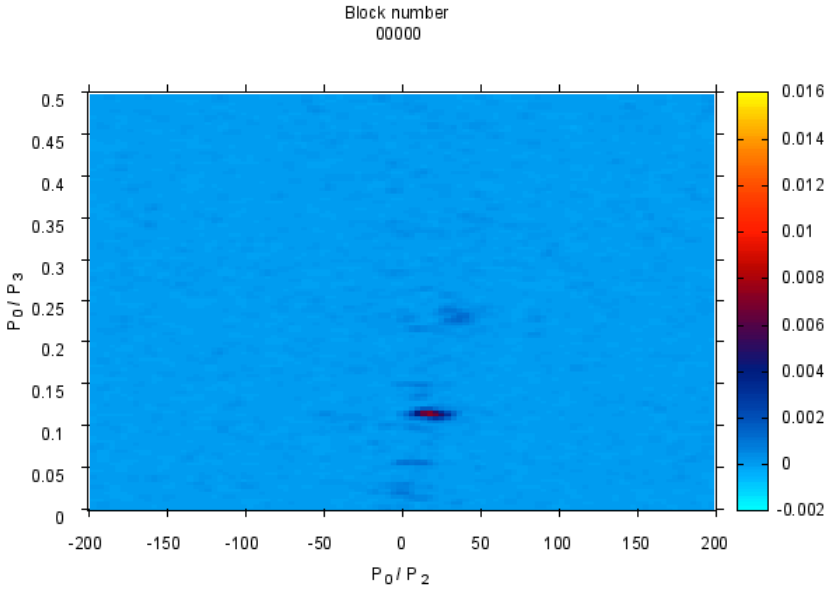




First results

- First emission scenario: constant change of drift rate.





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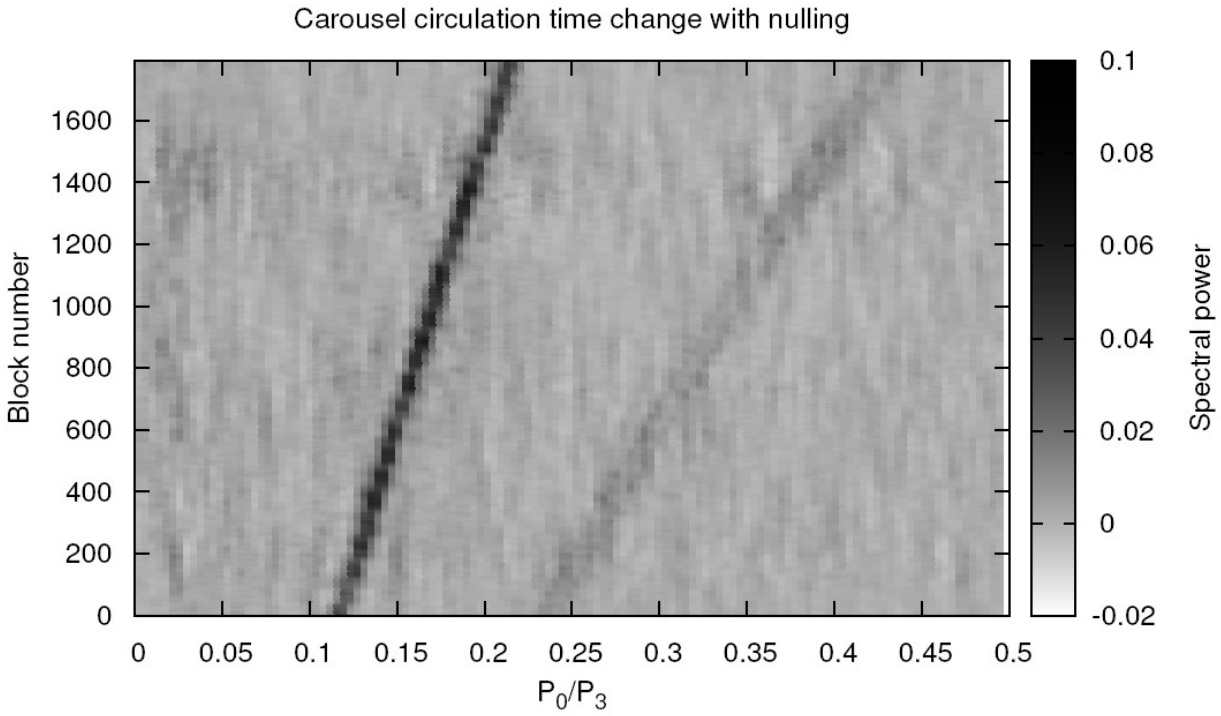
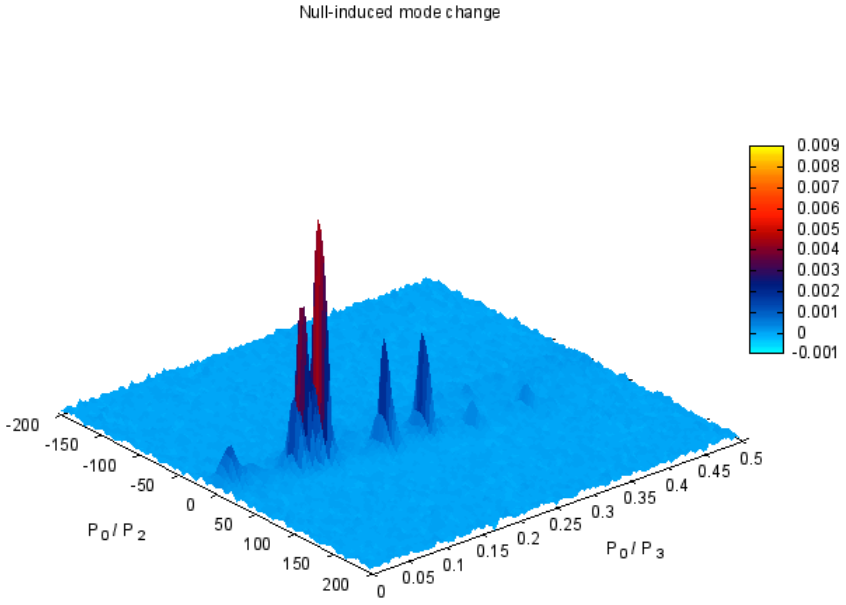
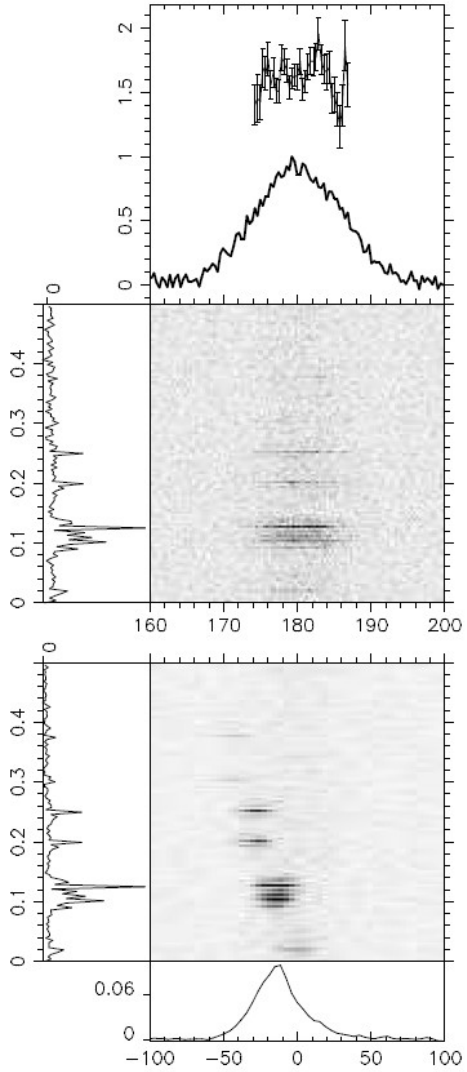


First results

- We have simulated signals from few pulsars to check the new method.
- Second emission scenario: null-induced mode change.
- This means that there are two drift modes. The switch between modes is induced by a nulling phenomenon.





First results

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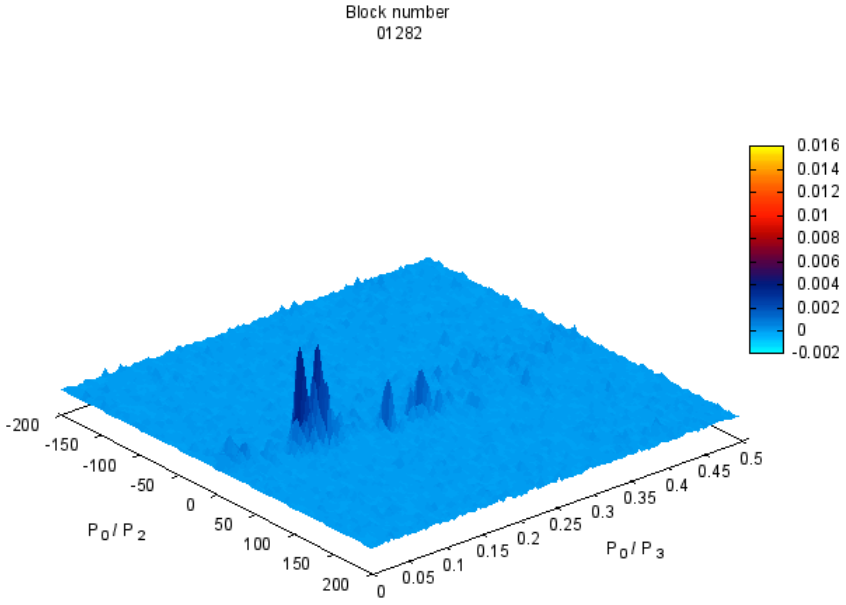

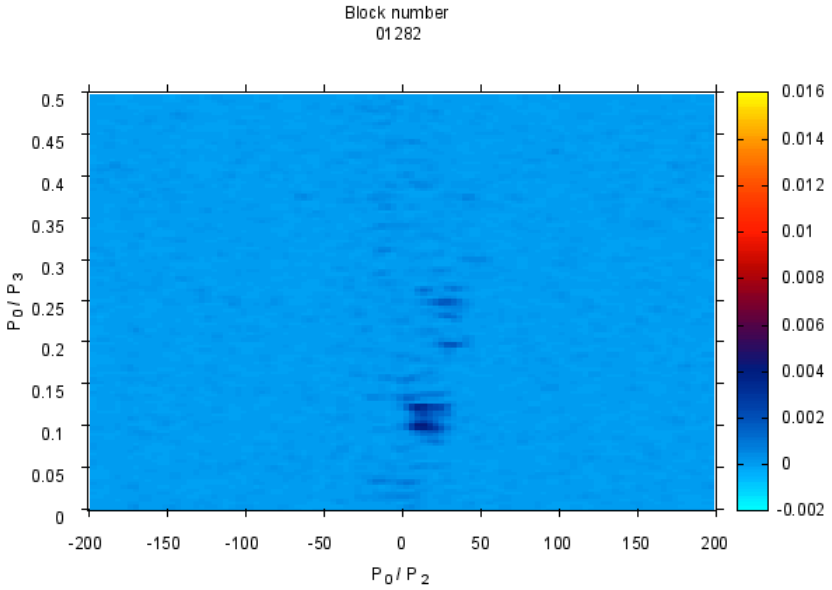

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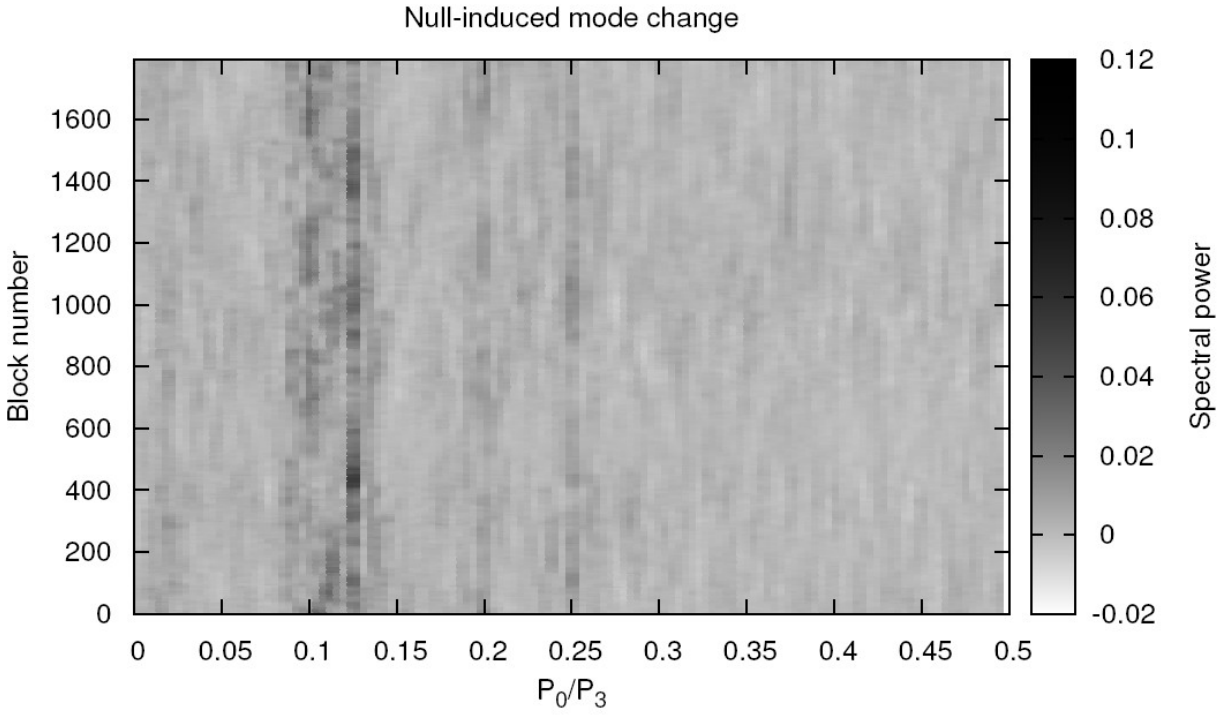

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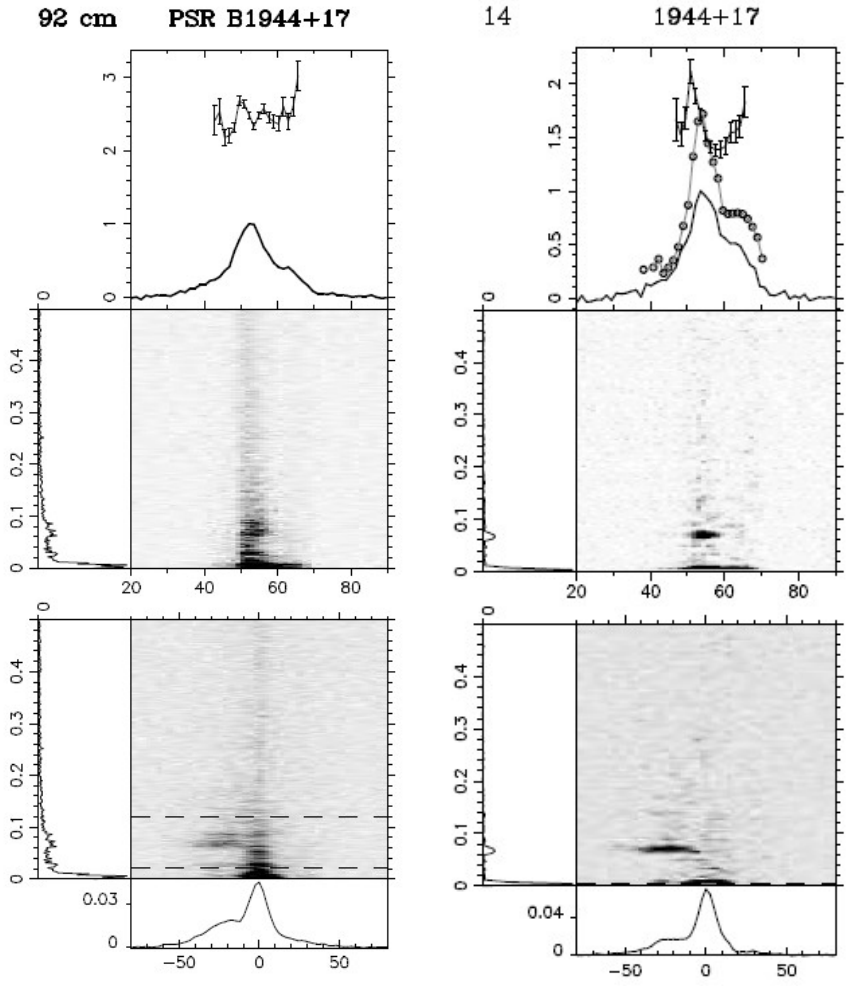
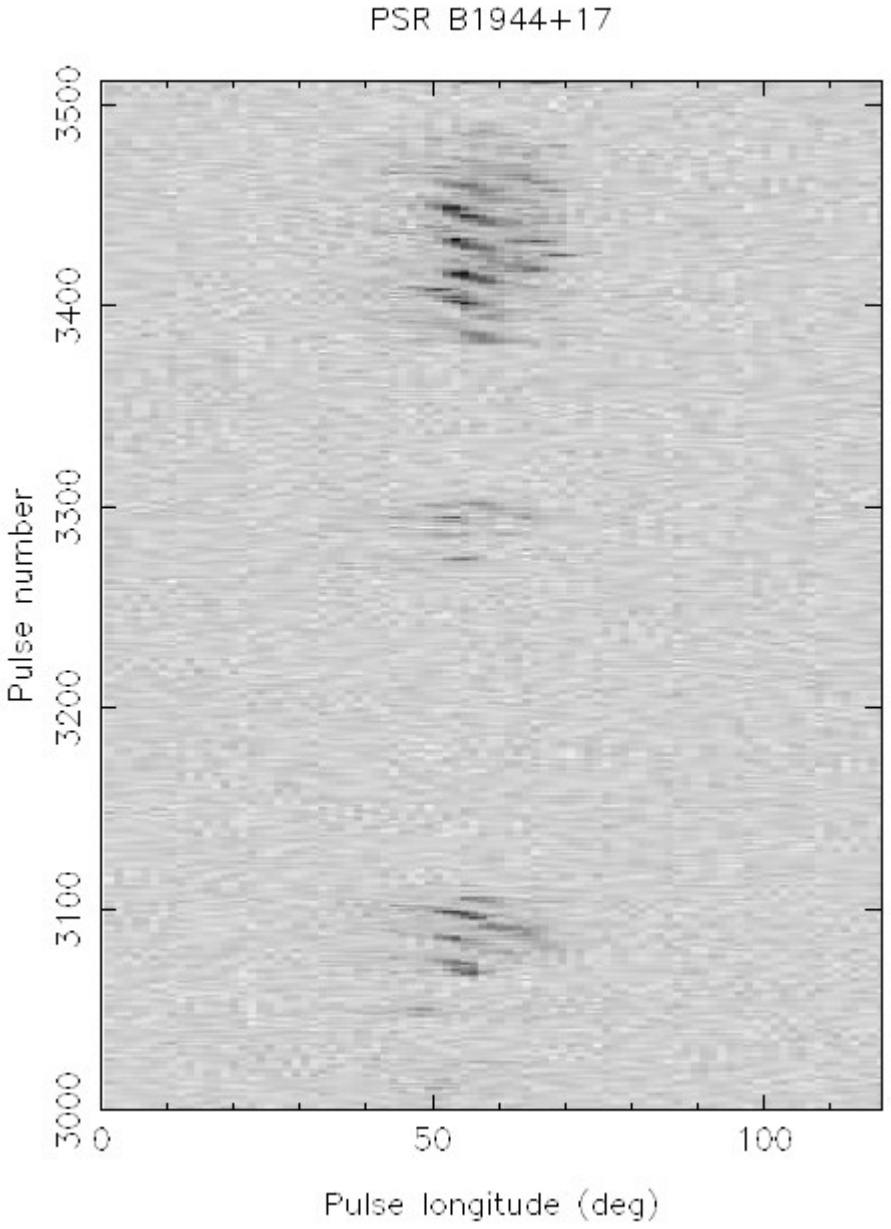
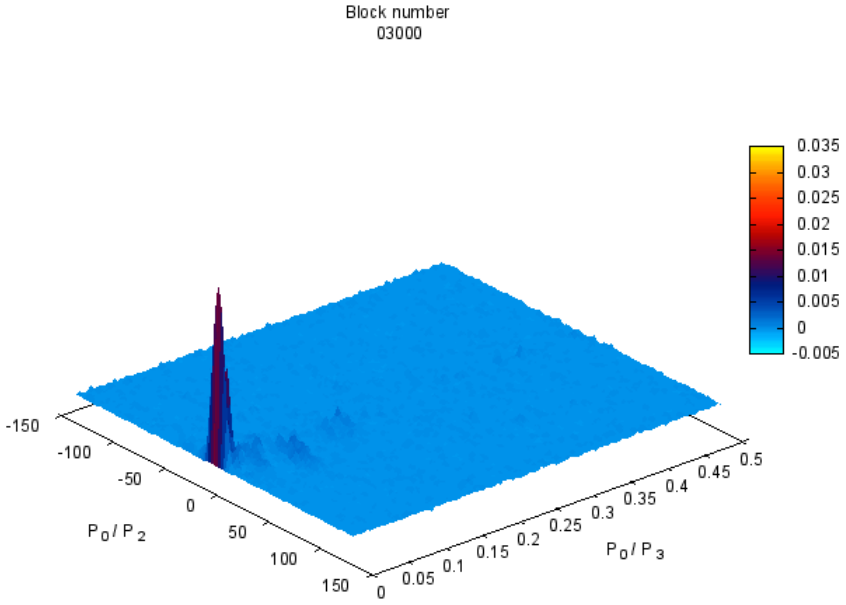
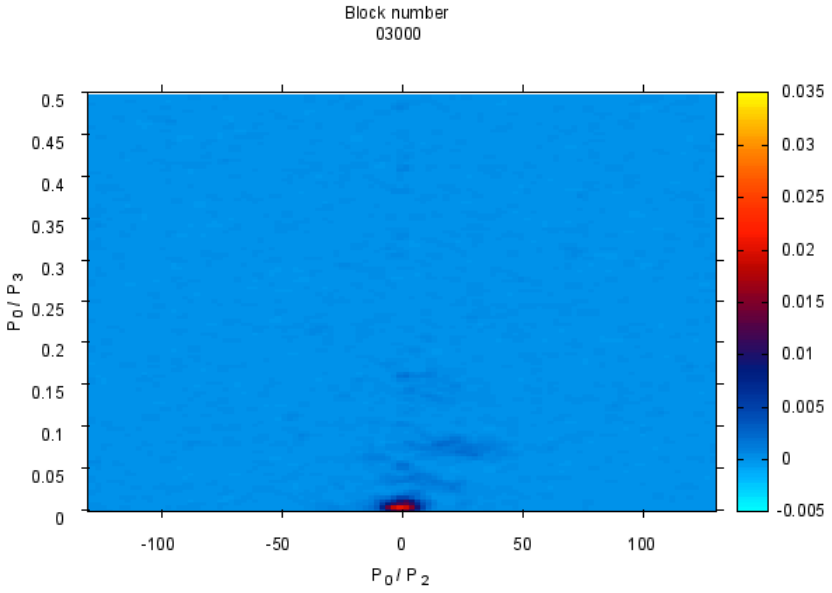




First results

- Results from PSR B1944+17





Summary & further work

- The 2DFS is a good tool for detection of drifitng subpulses.
- However, results may be affected by extrinsic/intrinsic effects.
- The S2DFS proved to be good support to the 2DFS.
- The next step is to re-analyse the sample using S2DFS technique.