XMM-Newton EPIC relative timing analysis

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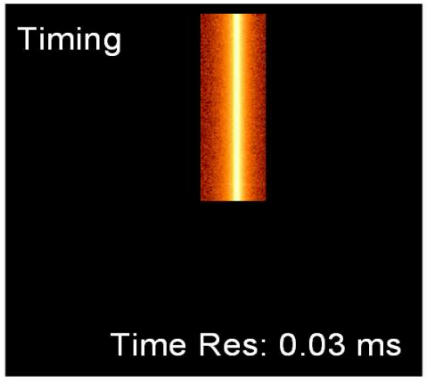
Outline

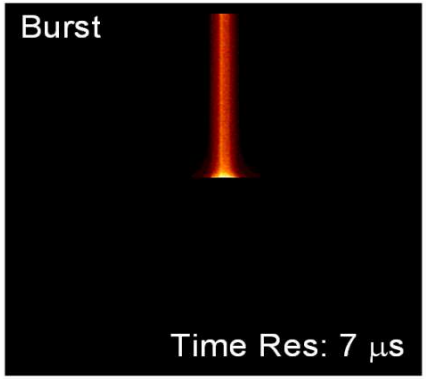
2. Relative timing accuracy
3. Targets
4. Processing of data
5. Radio period of the pulsars
6. X-Ray period of the pulsars
7. Final results

EPIC-pn Relative timing accuracy

ESAC

- Fastest instrument on XMM-Newton
- Highest time resolution reached in timing and burst modes
- Pulsars used in analysis observed in these modes





X-Ray Period = P_X Radio Period = P_R

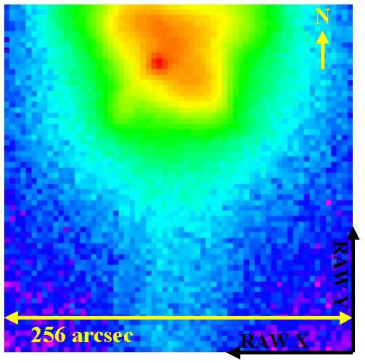
$$\frac{P_R - P_X}{P_R} \equiv \frac{\Delta P}{P_R} \equiv \text{Relative Error}$$

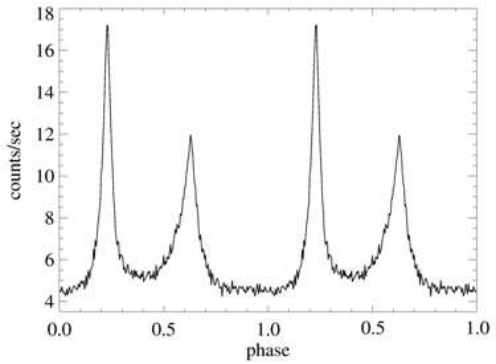
Crab pulsar

XMM-Newton performs two observations a year of the Crab

- Distance: ~2.2kPc
- Period: ~33ms

Rev	ID	Obs. Time (ks)
0056	0122330801	22577
0234	0135730701	9999
0411	0153750201	4634
0411	0153750301	8999
0411	0153750401	8996
0411	0153750501	8999
0698	0160960201	28264
0700	0160960301	10172
0874	0160960401	14718
0874	0160960601	3983
0955	0160960701	8202

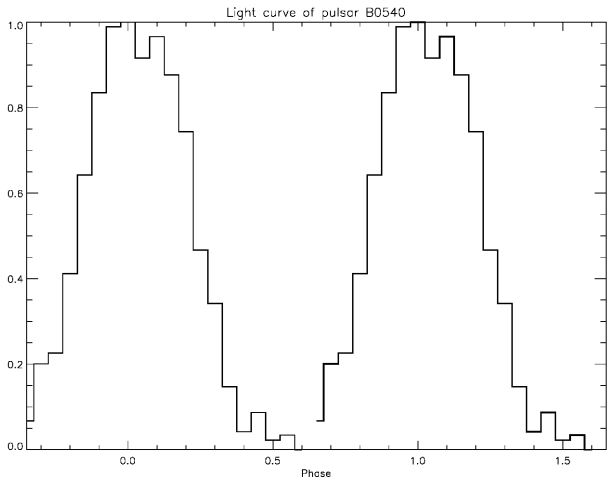




PSR 0540

- Pulsar in the Large Magellanic Cloud
- Distance: ~50kPc
- Period: ~50ms

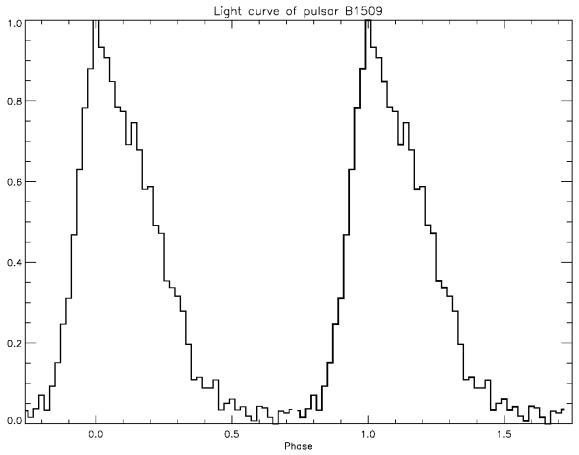
Rev	ID	Obs.Time (ks)
0085	[illegible]	17

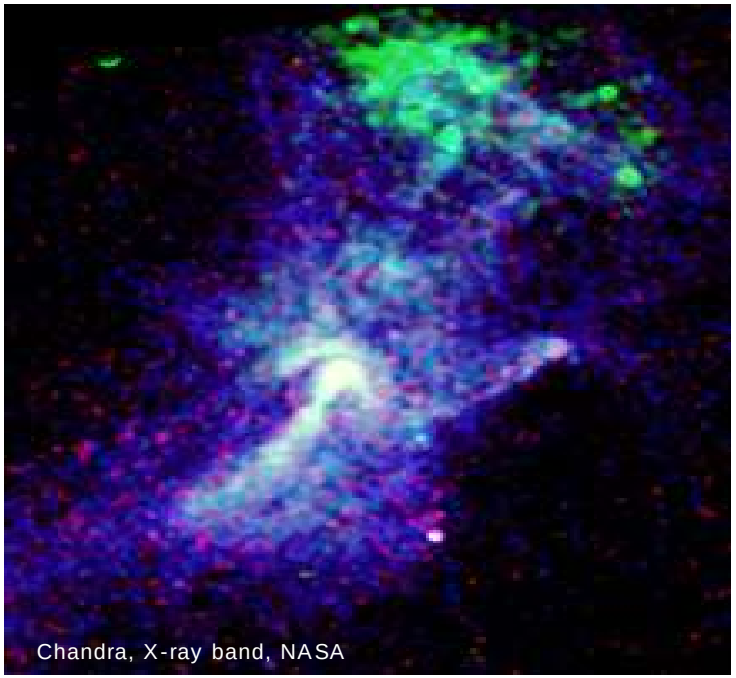


PSR 1509-58

- Pulsar in the SNR MSH 15-2
- Distance: ~6kPc
- Period: ~150ms

Rev	ID	Obs.Time (ks)
0137	0128120401	10





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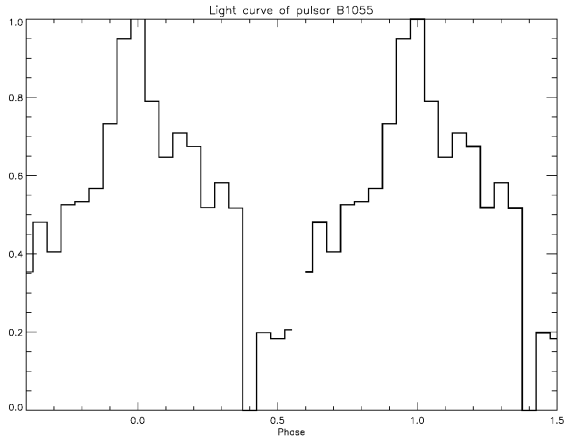
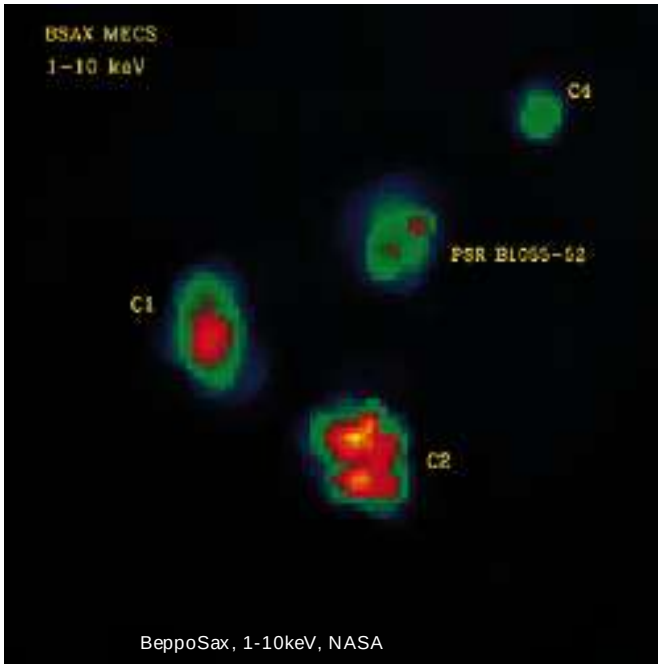
PSR B1055-52

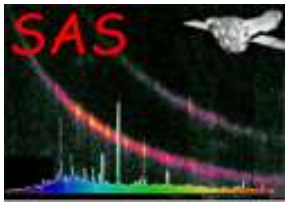
- One of the ‘three musketeers’ (PSR B1055, B0656,Geminga)
- Distance: 0.5 – 1.5 kPc
- Period: 197ms

Rev	ID	Obs.Time (ks)
0187	[illegible]	20





data processing



AIO (XMM-Science Archive)

ODF

epproc

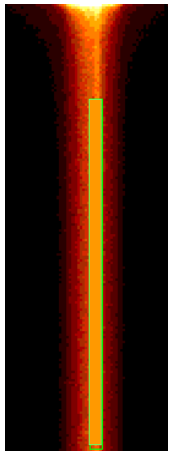
Event File

barycen

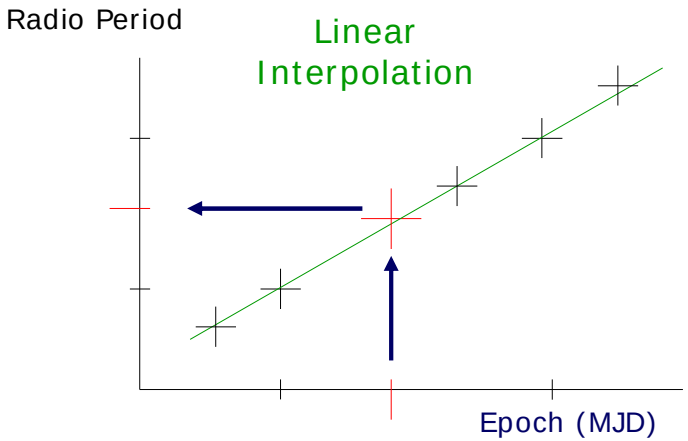
Event File Barycentric Corrected

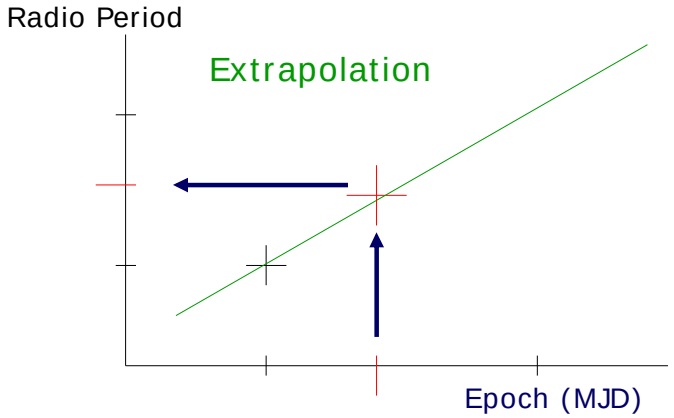
evselect

Source Region



Radio periods of the pulsars





Crab

B0540, B1509, B1055

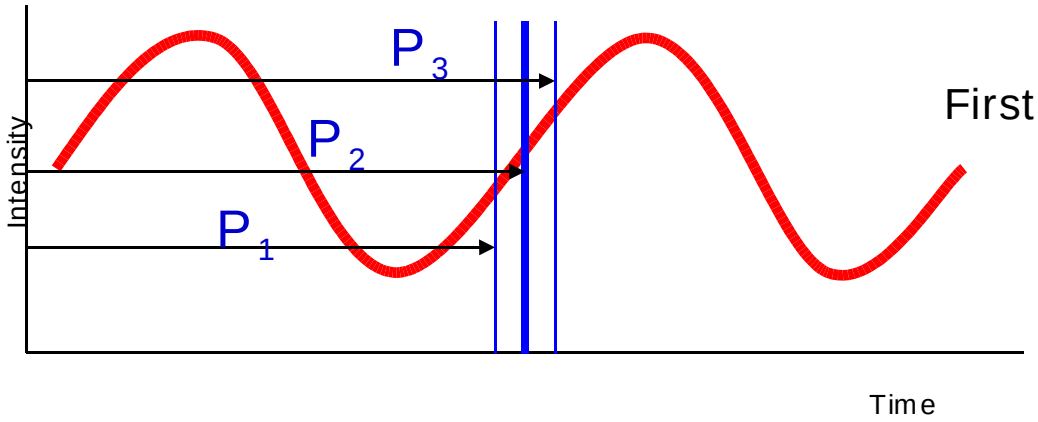
Automatic tool for Crab!

The University of Manchester
Jodrell Bank Observatory

X-ray period of the pulsars

ESAC

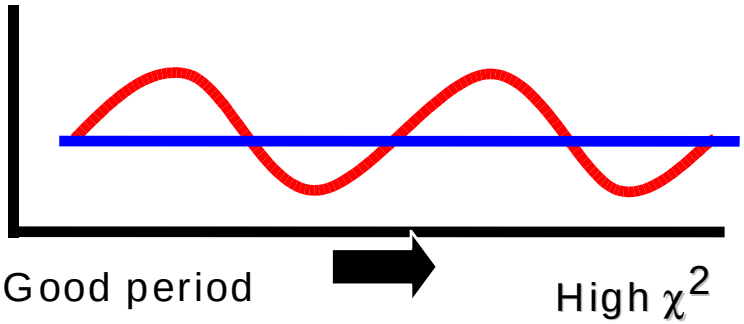
Fold the data over a range of test periods Pi:

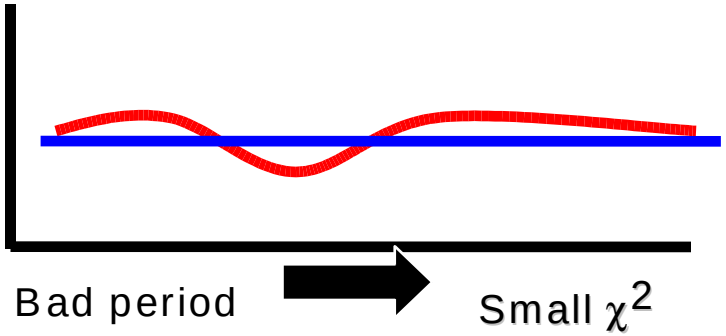


First trial: radio period

efsearch Xronos

For each test period determine $\chi 2$ of the fit of the folded light curve vs. a uniform distribution:

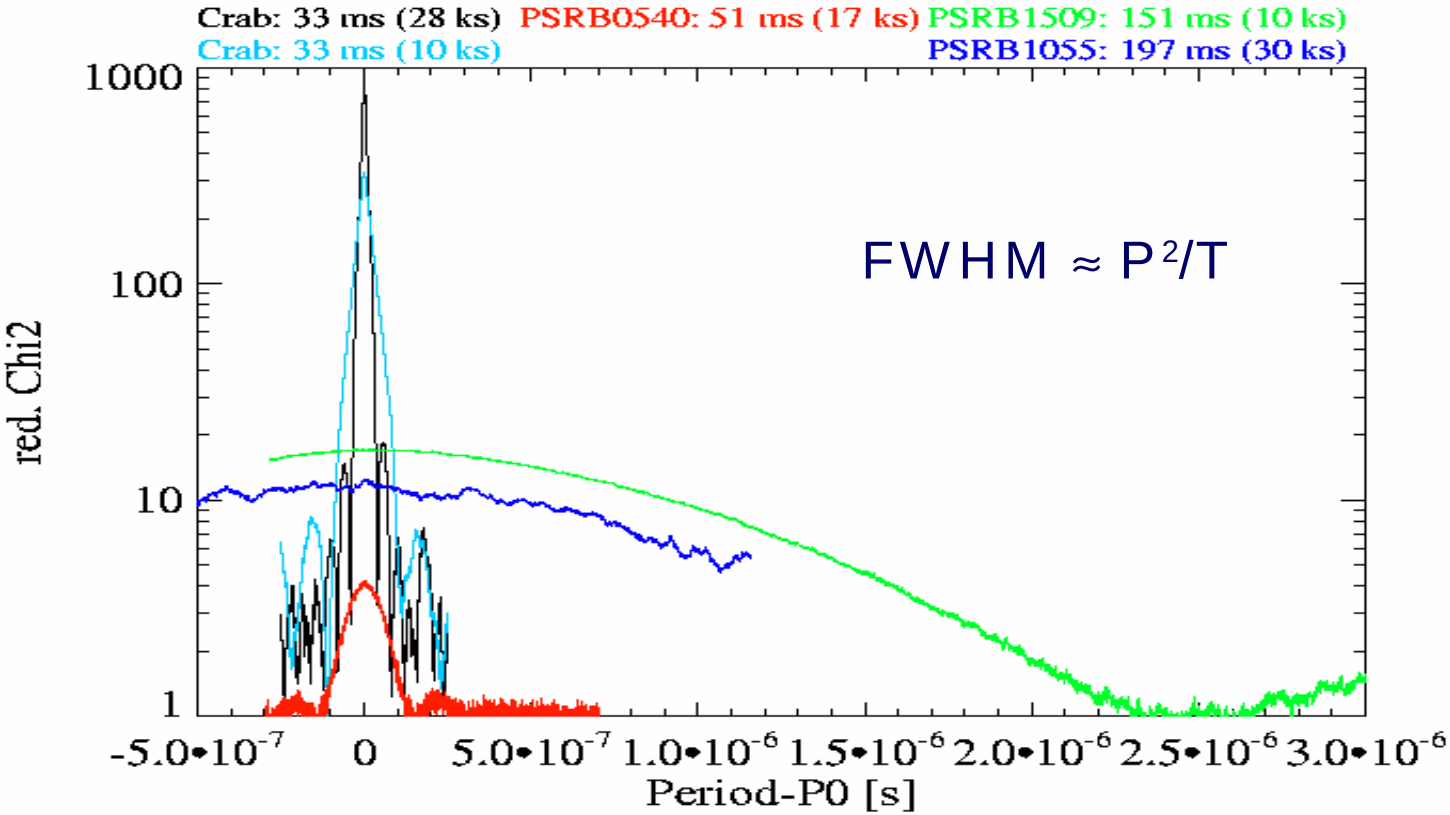




χ2 distribution

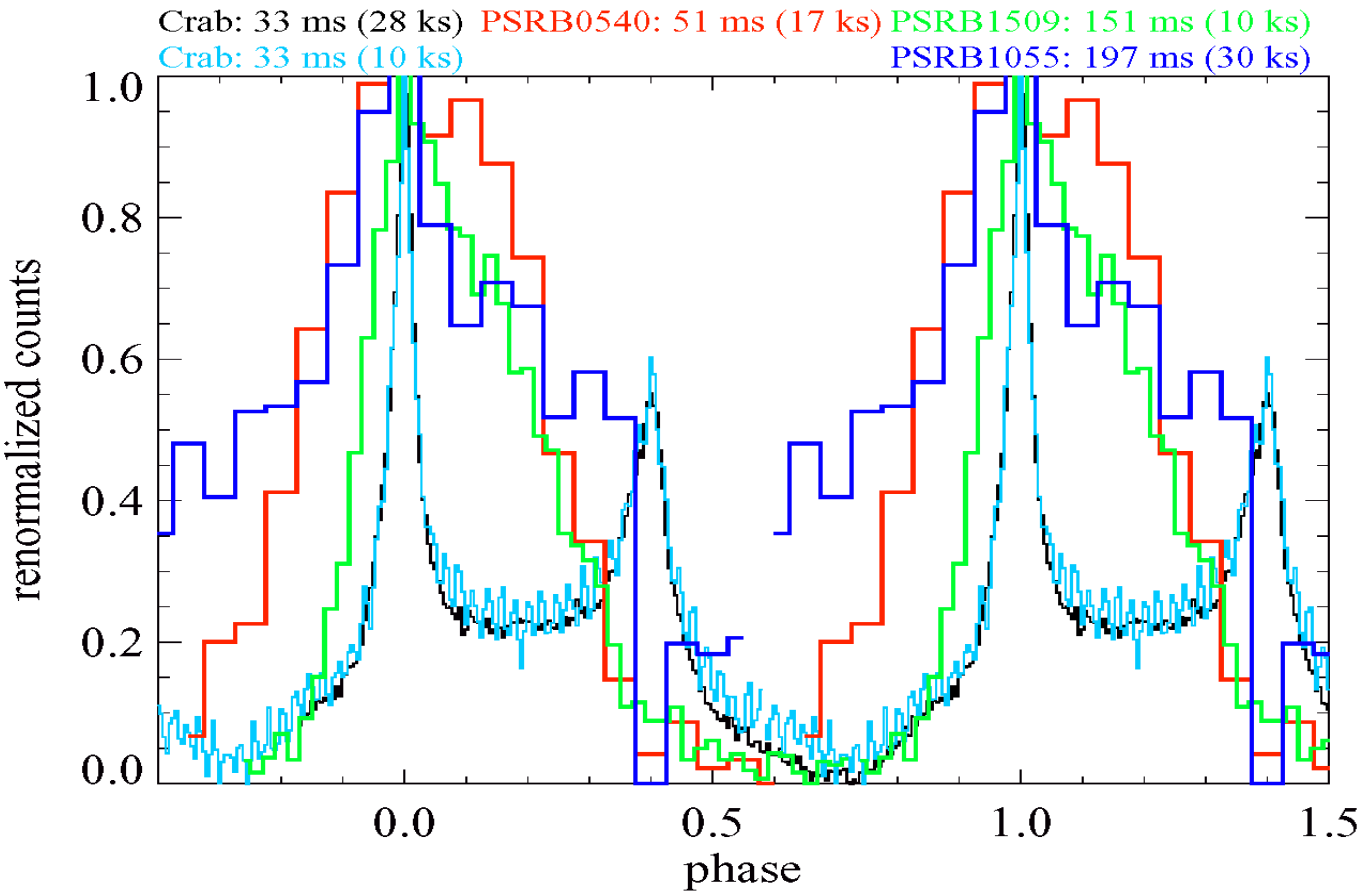
ESAC

The weighted mean of the periods with χ^2 gives the best X-ray period

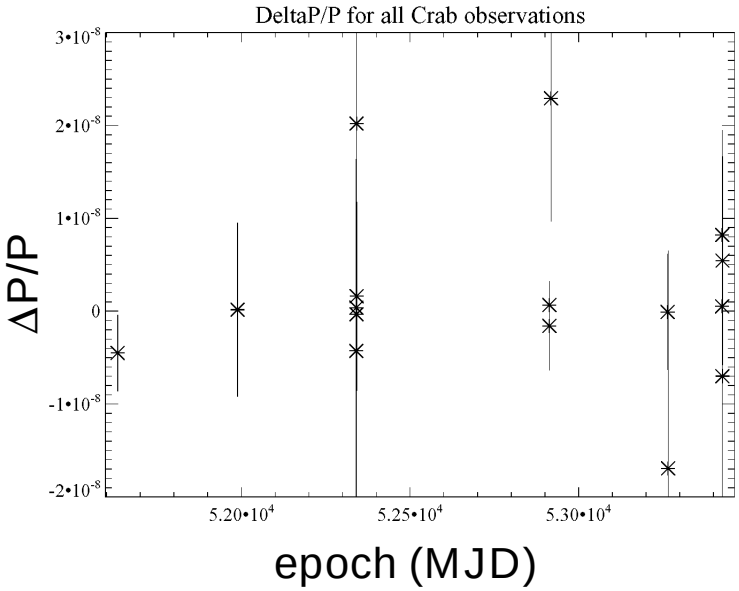


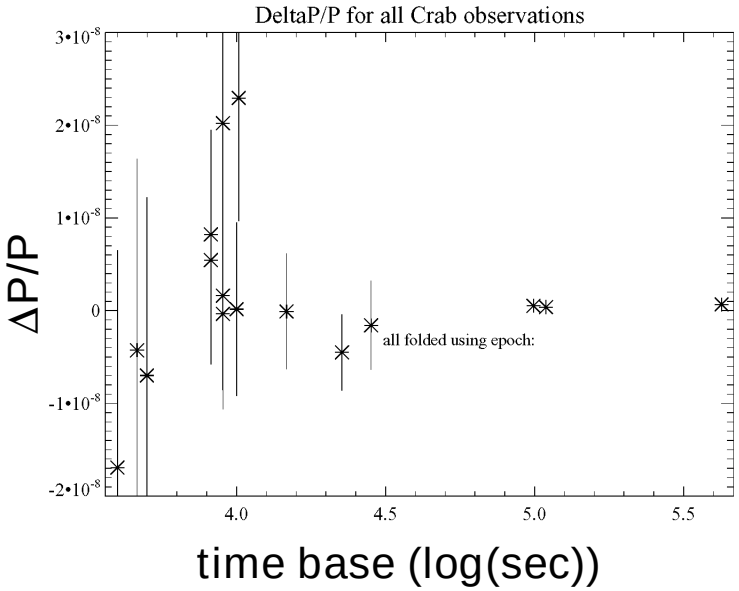
Reduced chi2 vs period for all pulsars

Folded light curves



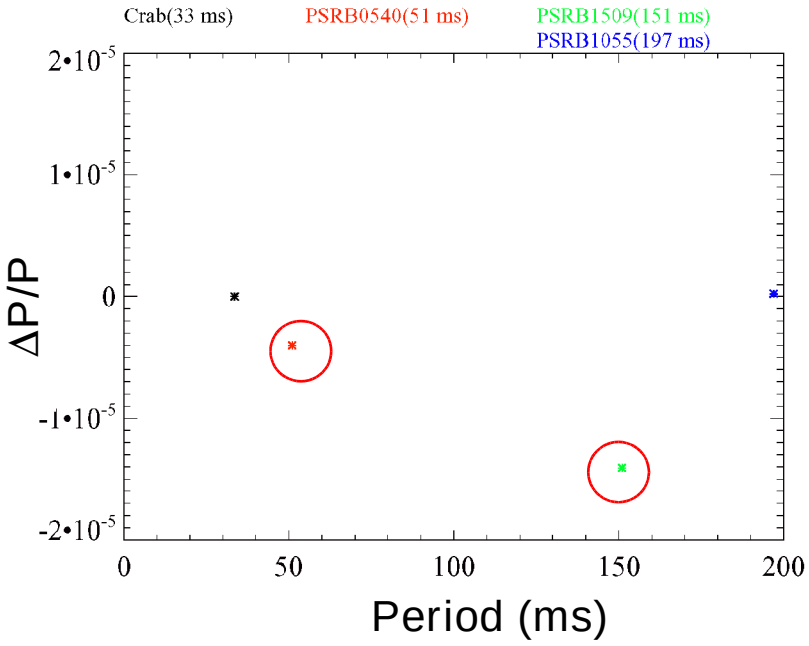
Relative timing accuracy for the Crab

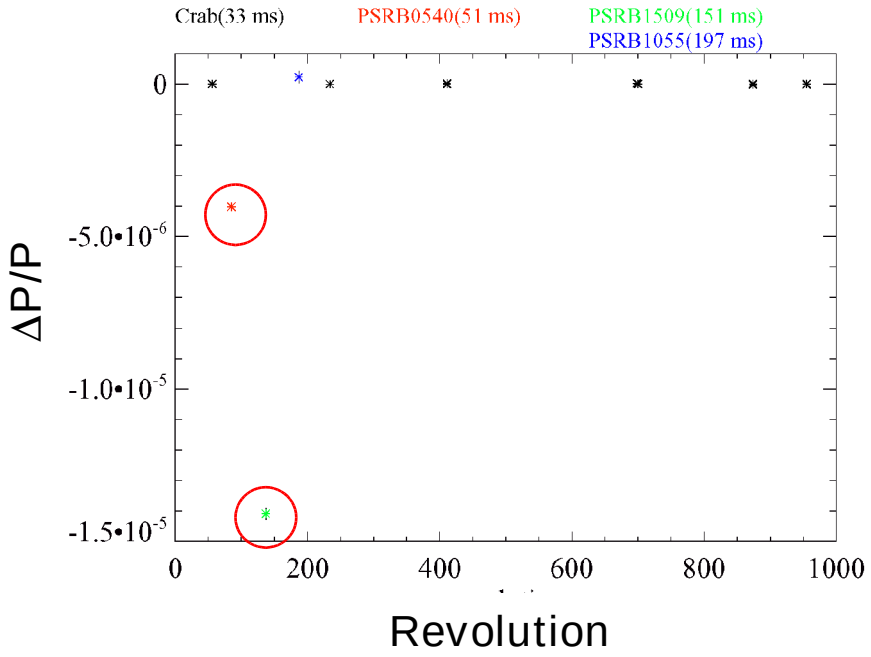




$\Delta P/P < 3.10^{-8}$

Relative timing accuracy for all pulsars





Things to do now…

- Automatic tool available to check the relative timing accuracy for future Crab observations

- Future XMM-Newton observation of pulsars B0540 and B1509 in order to verify relative timing??

- Absolute timing analysis: create a tool to check the absolute timing accuracy geo-centre XMM data or barycentre radio data