Combining multi-telescope, multi-frequency data sets for the EPTA…. and IPTA!

Gemma Janssen, JBCA/EPTA

Combining multi-telescope, multi-frequency data





-EPTA timing working group

-EPTA data sets

-examples: combining multi-telescope,

multi-frequency data

Combining multi-telescope, multi-frequency data





The EPTA timing working group:

Nicolas Caballero, David Champion, Gregory Desvignes

Joris Verbiest, Gemma Janssen

(Cees Bassa, Patrick Lazarus)

- Main task: keeping timing up to date, providing TOAs for papers/projects/IPTA/database (see TOAST poster)
- Updating clock files
- Source selection, Source lists per telescope (KJ's talk), New sources

The EPTA: Combining data sets





EPTA timing group 2012:

3 papers on EPTA long-term data sets

(see poster by N. Caballero)

- EPTA status, combining manual, timing solutions
- DM variations, profile evolution
- Noise analysis & timing stability

- Asap: data set provided to the IPTA!

The EPTA: Observations

First generation: long-term timing

Telescope	Instr	T(yr)	Npsrs	Freq(GHz)	BW(MHz)
Effelsberg	EBPP	16	15	1.4, 2.6	80
Lovell	A+DFB	>15, 3	15	0.6, 1.4	64, 384
Nançay	BON128	12	25	1.4, 2.1	128
WSRT	PuMaI	12	15	0.35, 0.8, 1.4, 2.3	80

Next generation: improvements

Telescope	Instr	T(yr)	Npsrs	Freq(GHz)	BW(MHz)
Effelsberg	Asterix	1.25	25+	1.4, 2.6	200, 140
Lovell	Obelix	1.25	25+	1.4	400
Nançay	BON512	1	25+	1.4, 2.1	512
WSRT	PuMaII	5	25+	0.35, 1.4, 2.3	80, 160

The EPTA: Source list





About 20 pulsars selected as “Priority 1”: observed at all telescopes, as many frequencies as possible; longest data sets available
J0613-0200, J1012+5307, J1024-0719, J1600-3053, J1640+2224, J1643-1224, J1713+0747, J1730-2304, J1744-1134, B1855+09, J1909-3744, B1937+21, J2145-0750, J2317+1439

Another ~10 pulsars selected as “Priority2”: observed at most telescopes, multi-frequency if possible. New sources like Fermi MSPs
J0023+0923, J0030+0451, J0218+4232, J0751+1807, J1022+1001, J1738+0333, J1741+1351, J2010-1323, J2017+0603, J2043+1711

- KJ Lee’s talk on Thursday!

The EPTA: solutions





Pulsar	Effelsberg	Jodrell	Nancay	WSRT	Comb
0613-0200	1.9us(13yr)	5.8us(3yr)	1.1 (7yr)	2.3us (11yr)	1.5 (13yr)
1022+1001	2.8us(13yr)	2.0us(3yr)	1.7 (7yr)	1.6us(11yr)	
1024-0719	1.8us (6yr)	3.3us(3yr)	1.1 (7yr)	3.1us(3yr)	1.8 (7yr)
1713+0747	0.5us (13yr)	0.6us(3yr)	0.4us(7yr)	0.7us(11yr)	0.4us(13yr)
1713+0747 New instr	0.17us (0.9yr)	0.20us (1yr)		0.23us (5yr)	

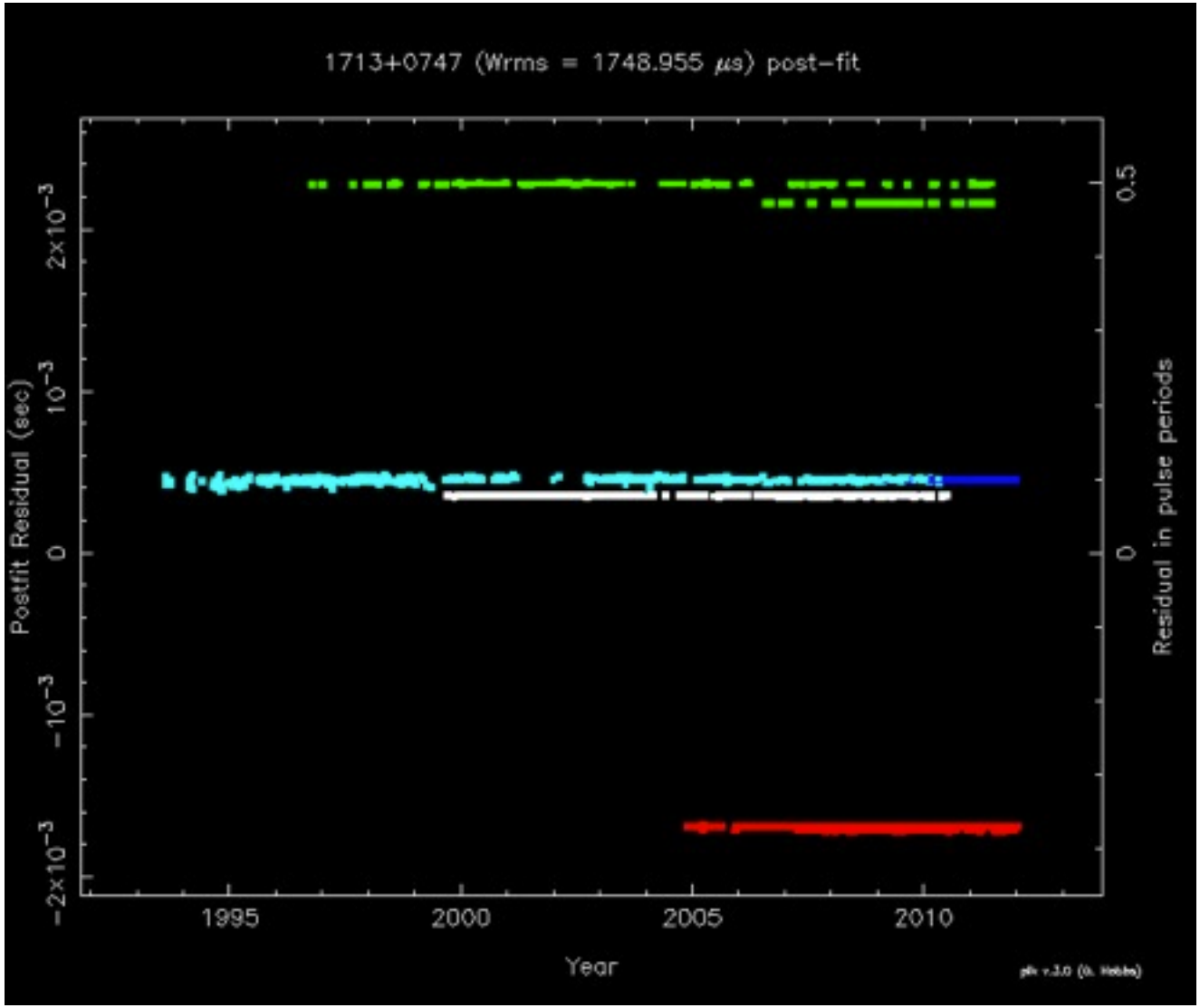




Combining data sets; what can you expect?

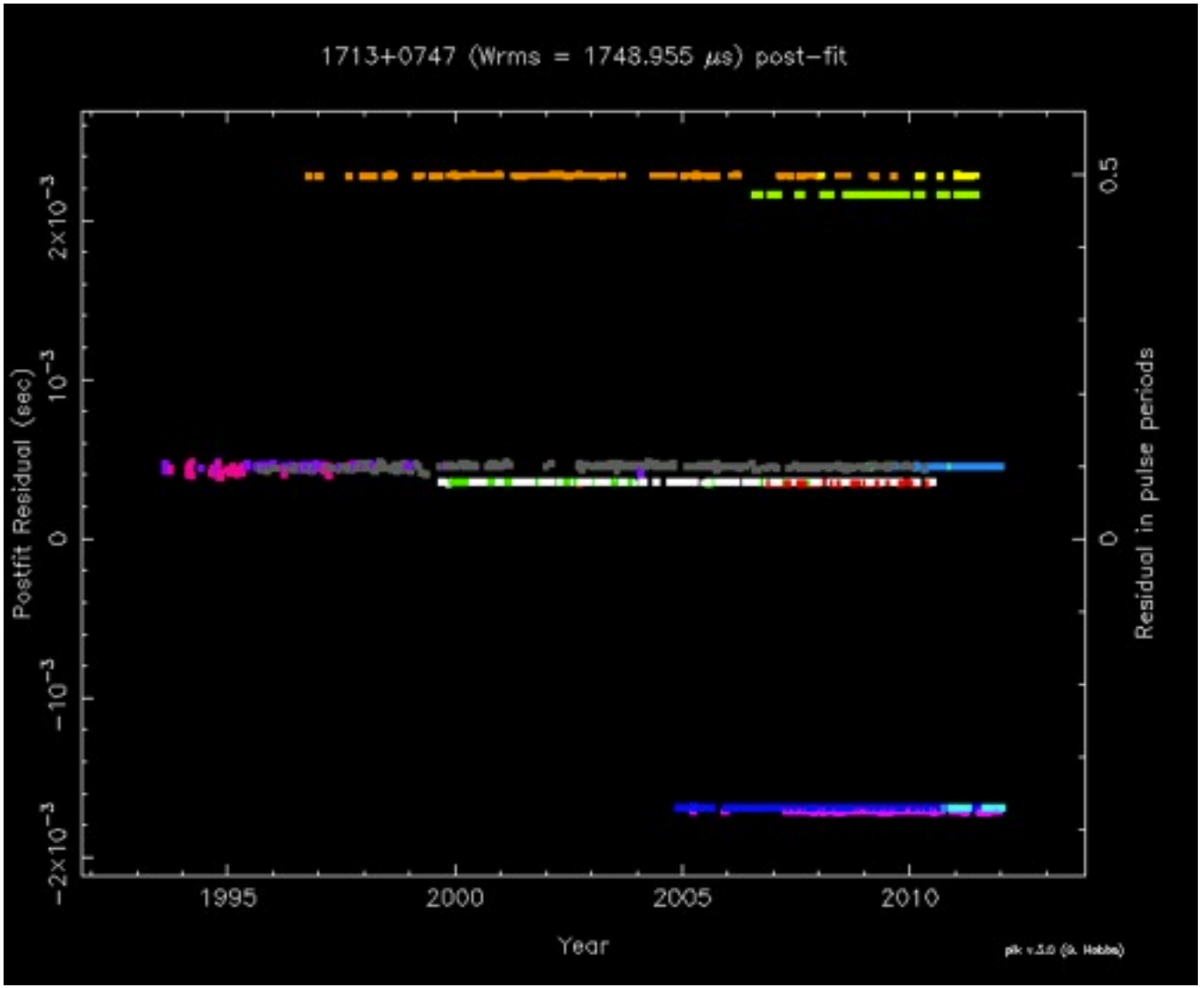
The EPTA: Combining data sets

PSR J1713+0747: Eff(2), JB (afb+dfb), WSRT (3), NCY (2)



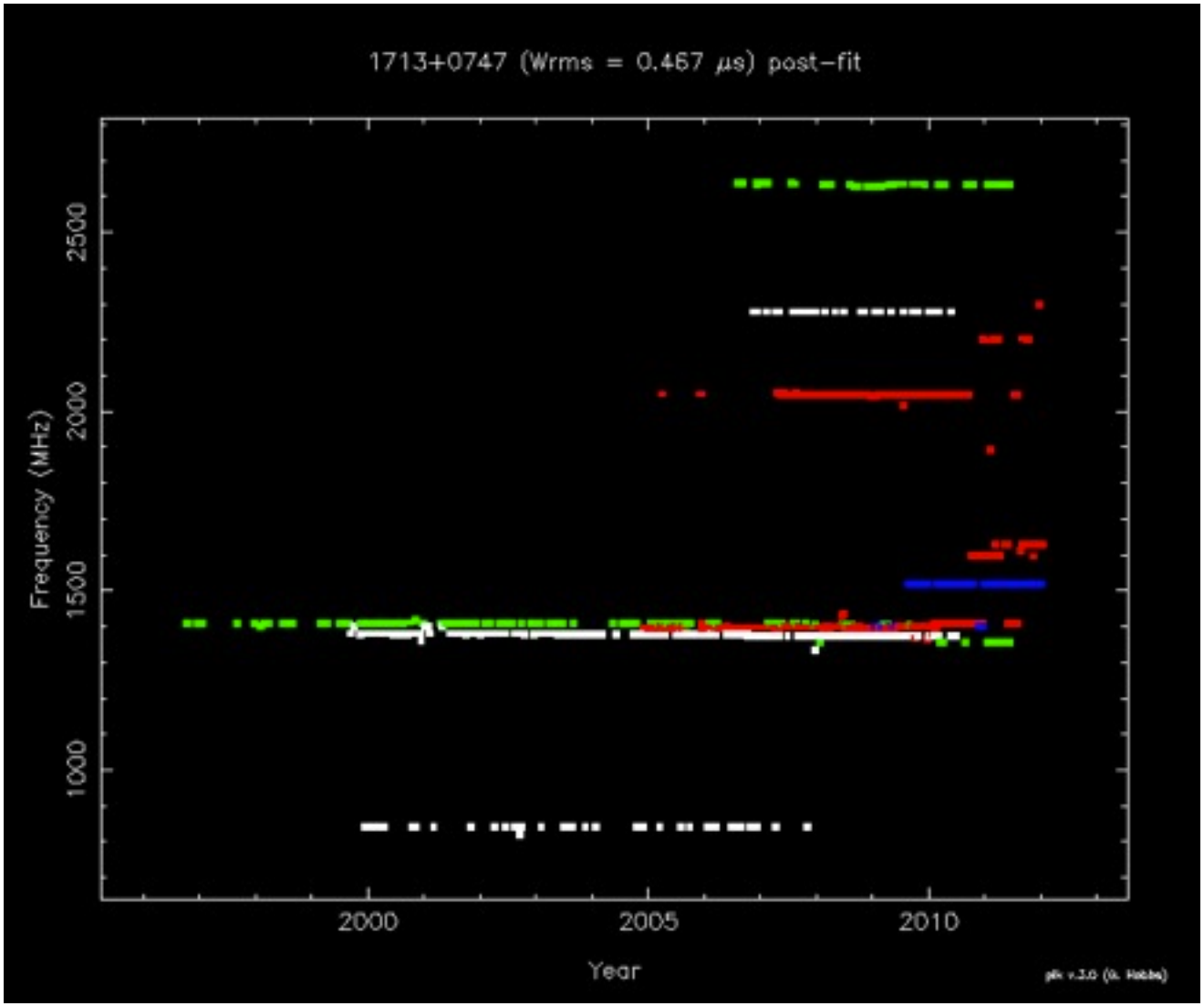
The EPTA: Combining data sets

PSR J1713+0747: Eff(2), JB (afb+dfb), WSRT (3), NCY (2)



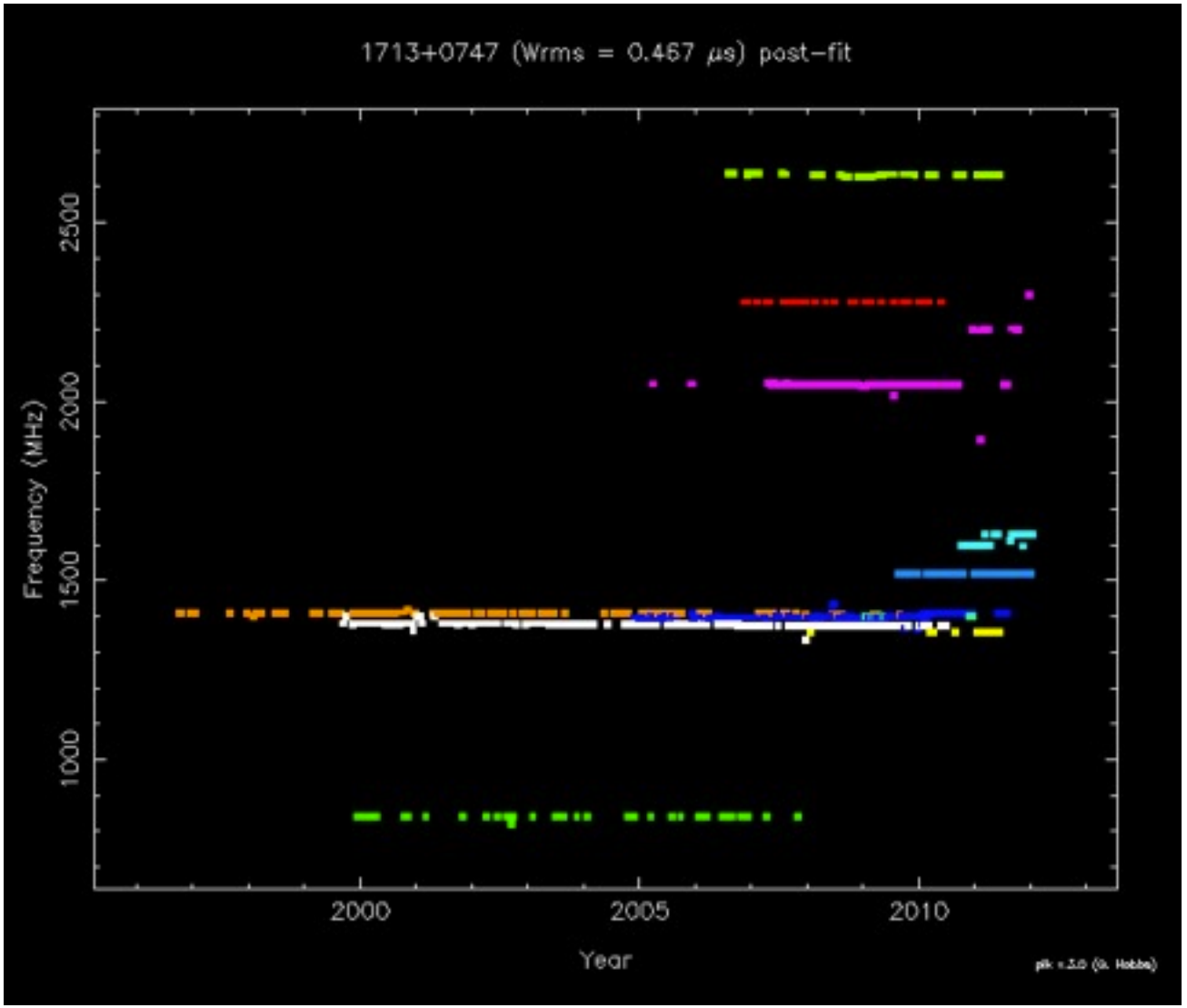
The EPTA: Combining data sets

PSR J1713+0747: Eff(2), JB (dfb), WSRT (3), NCY (2)



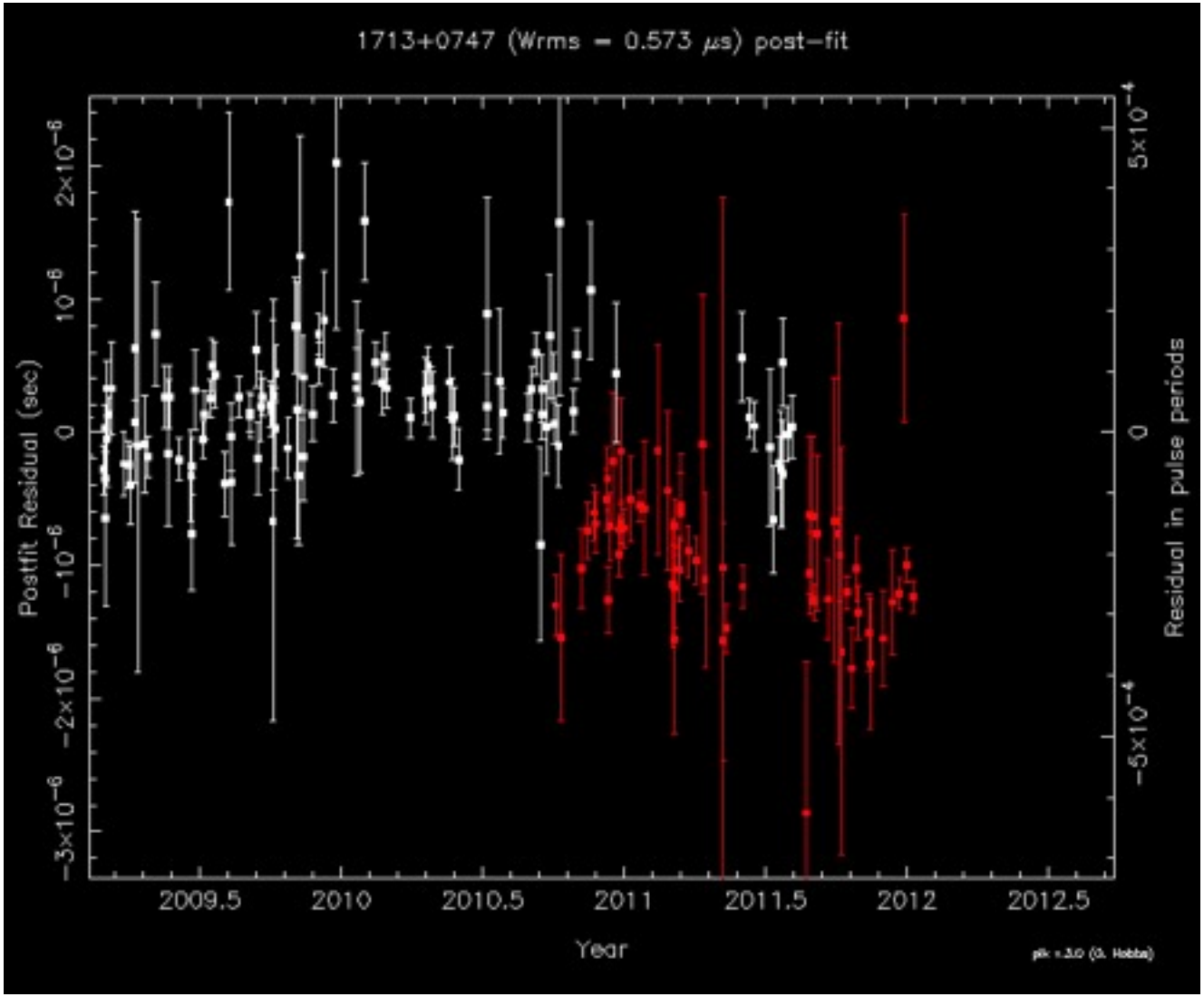
The EPTA: Combining datasets

PSR J1713+0747: Eff(2), JB (dfb), WSRT (3), NCY (2)



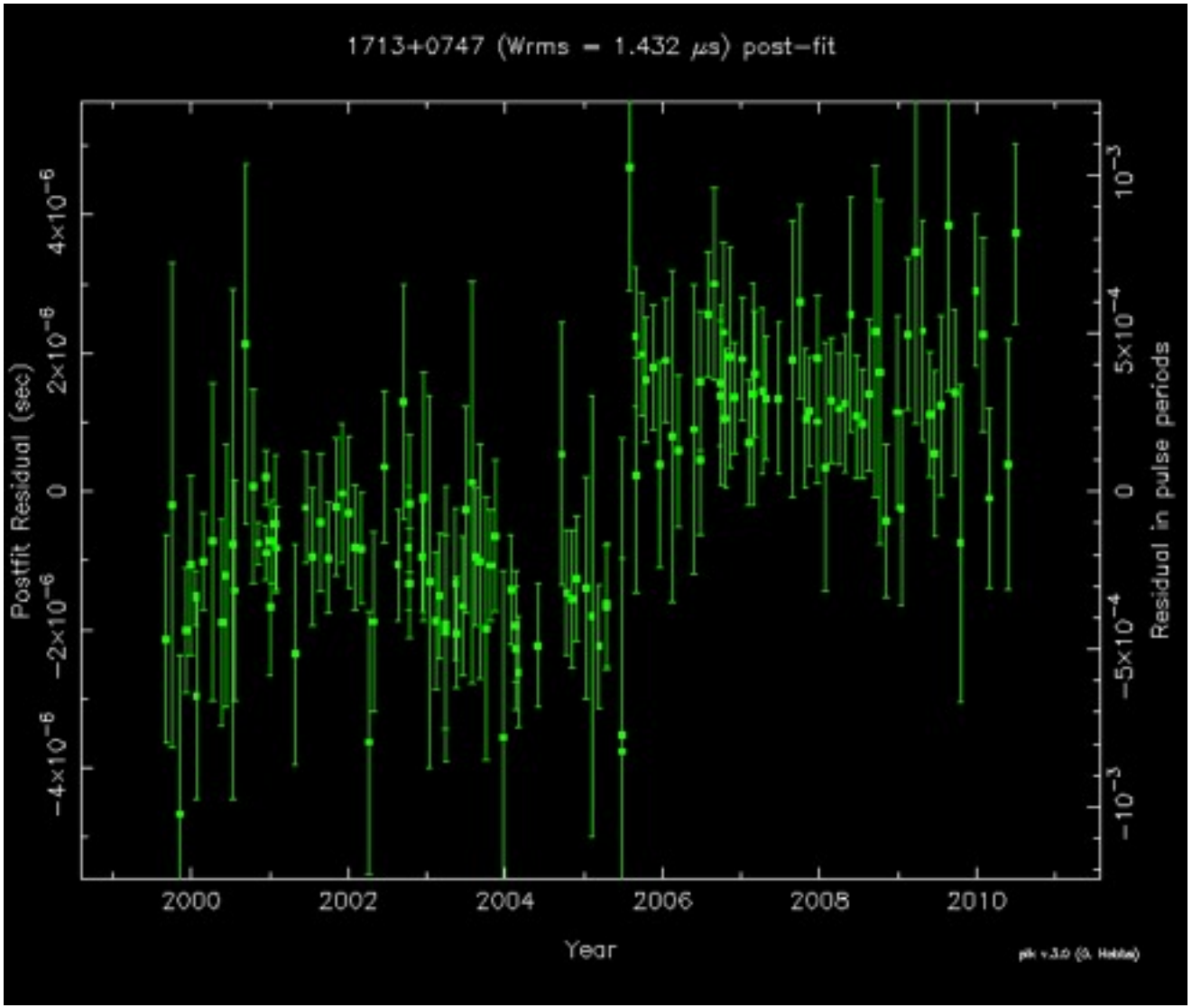
The EPTA: Combining datasets

Nancay configuration change: needs extra jump!



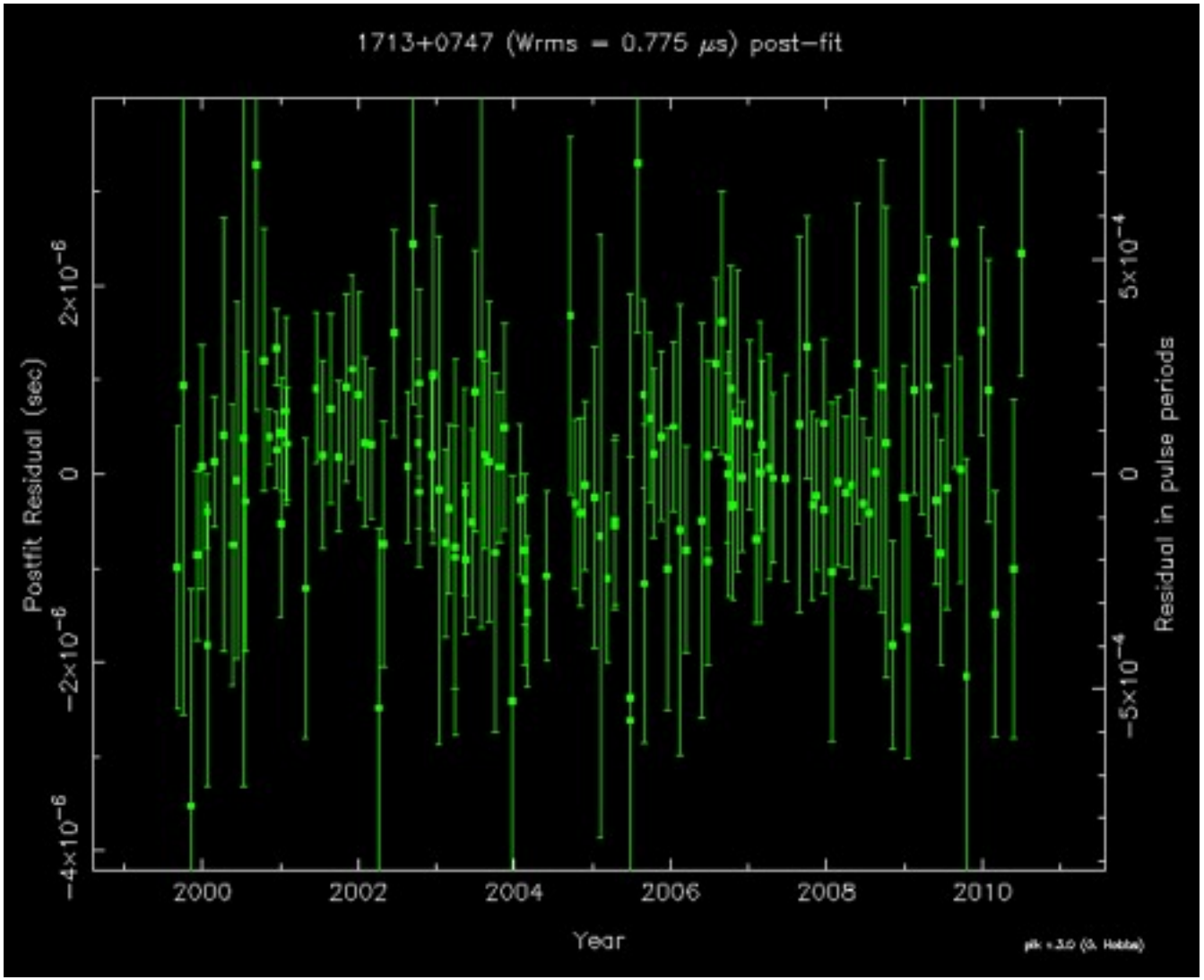
The EPTA: Combining datasets

WSRT clock offset June 2005



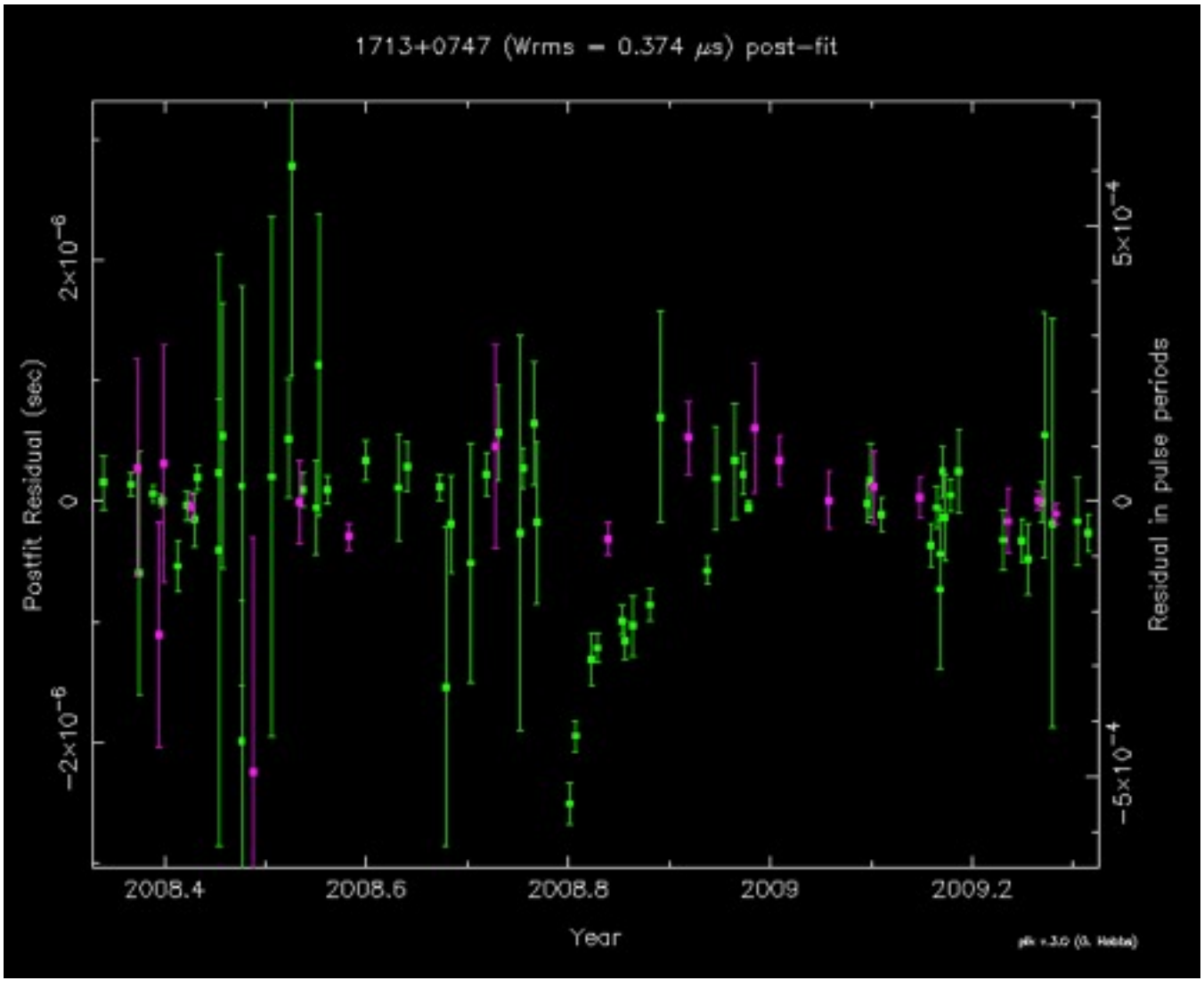
The EPTA: Combining datasets

WSRT clock offset June 2005



The EPTA: Combining data sets

1713-event October 2008: found in Nancay data

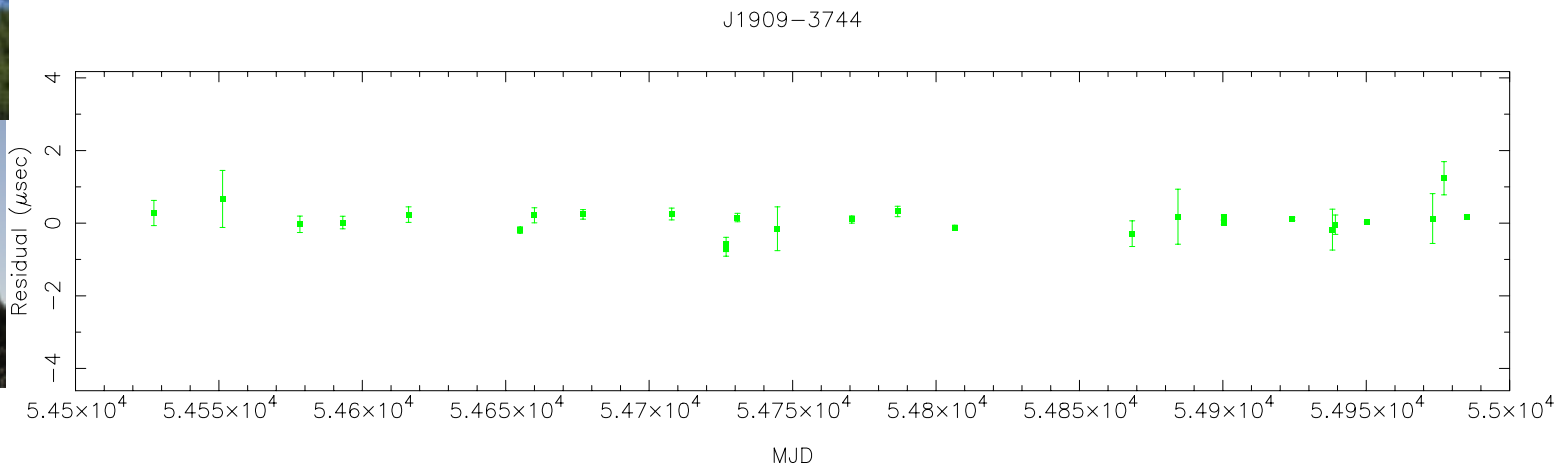


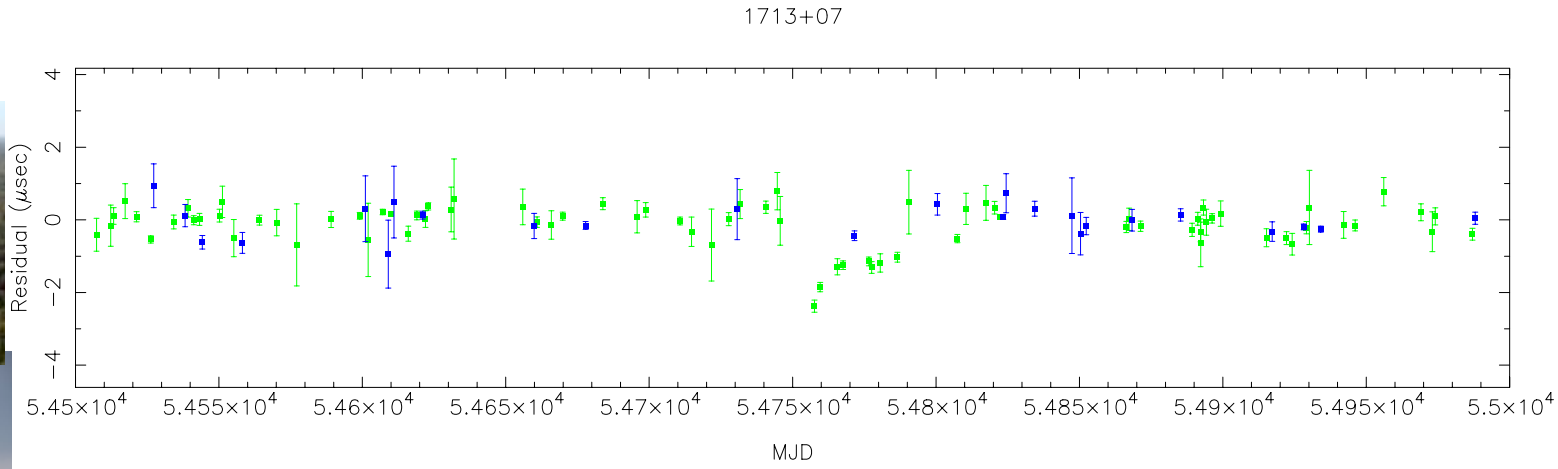
The EPTA: Combining data sets





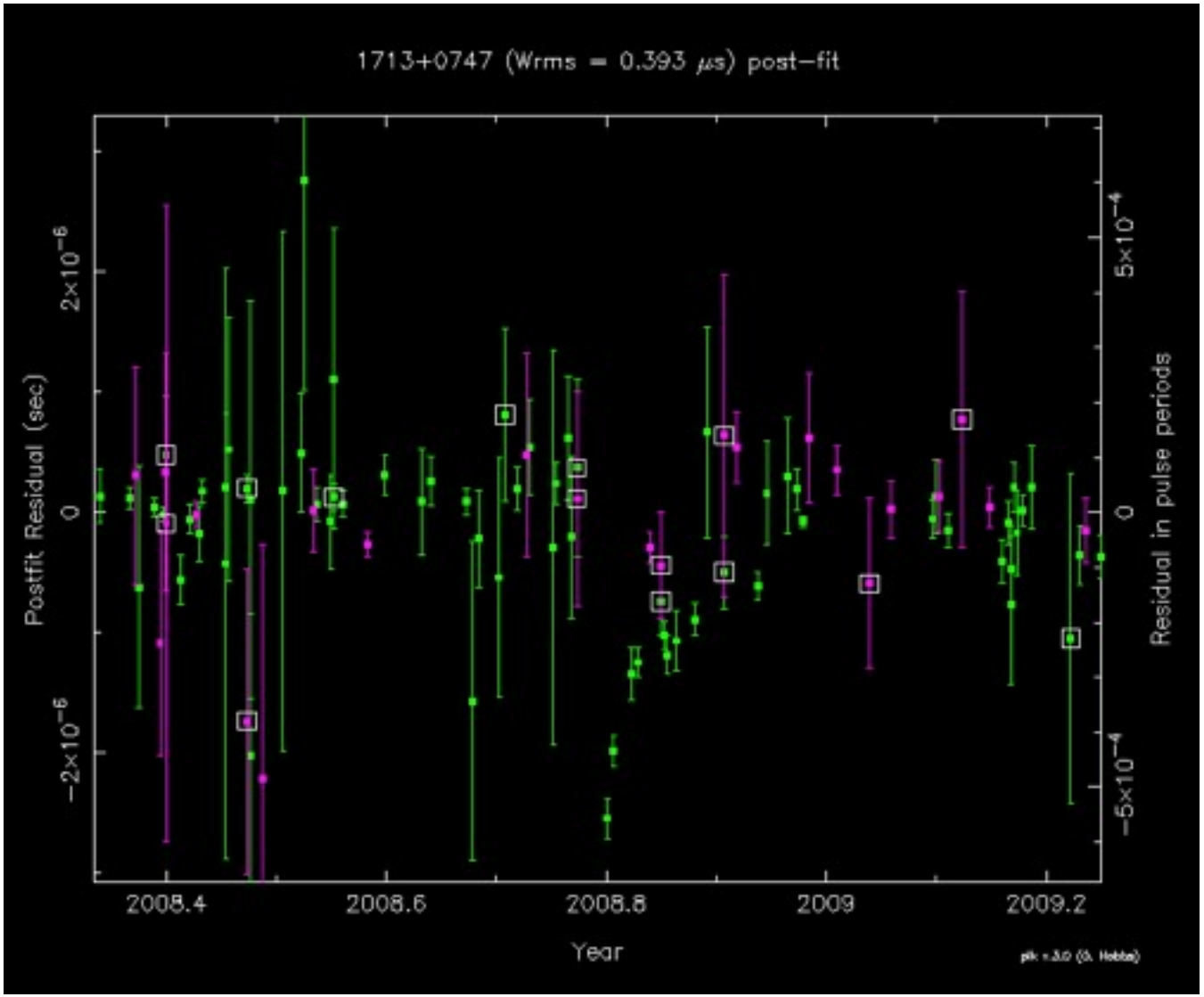
1713-event: pulsar-dependent. Not seen in J1909-3744





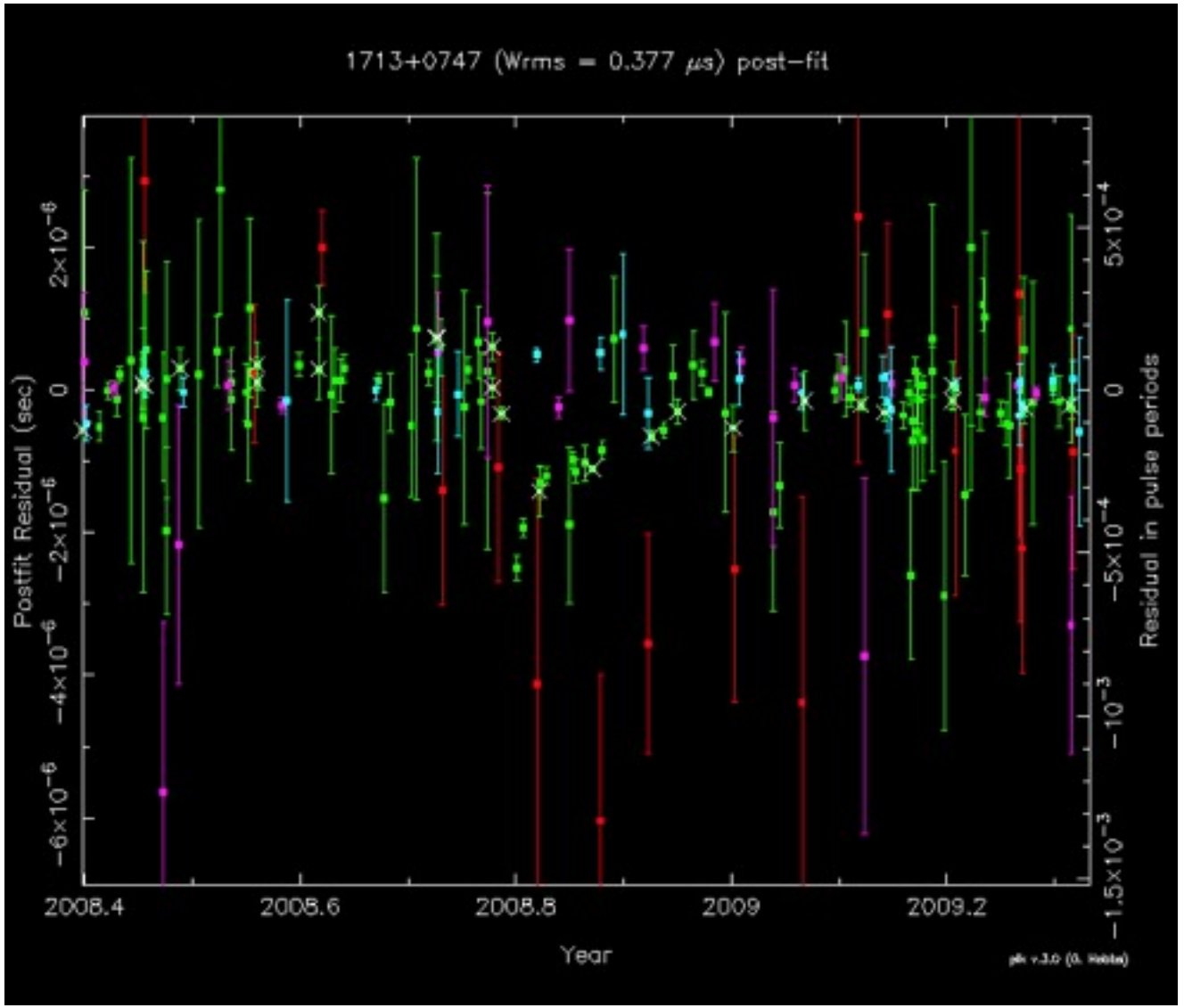
The EPTA: Combining data sets

1713-event: difficult to confirm with EPTA data alone



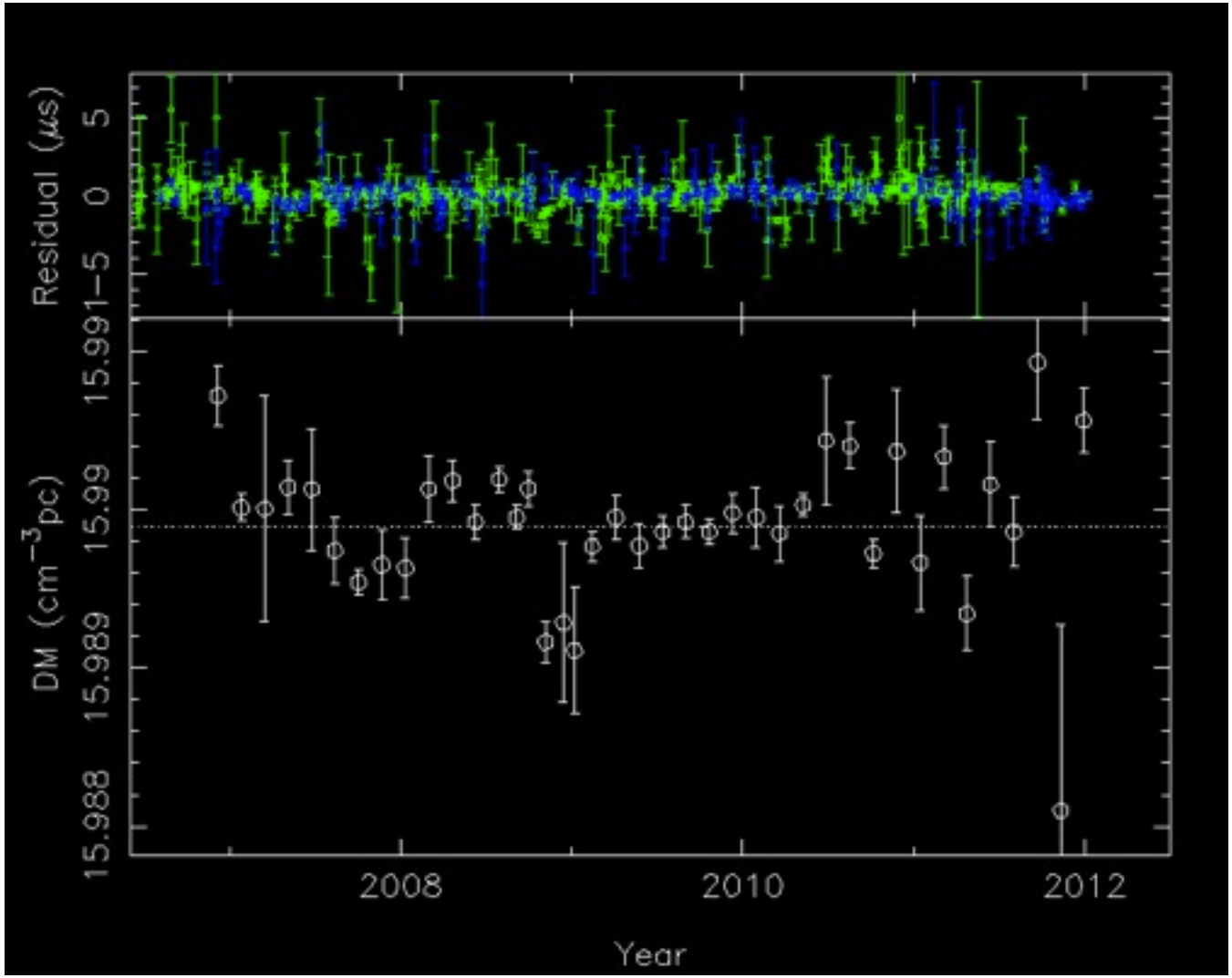
The EPTA: Combining data sets

1713-event: also in PPTA data



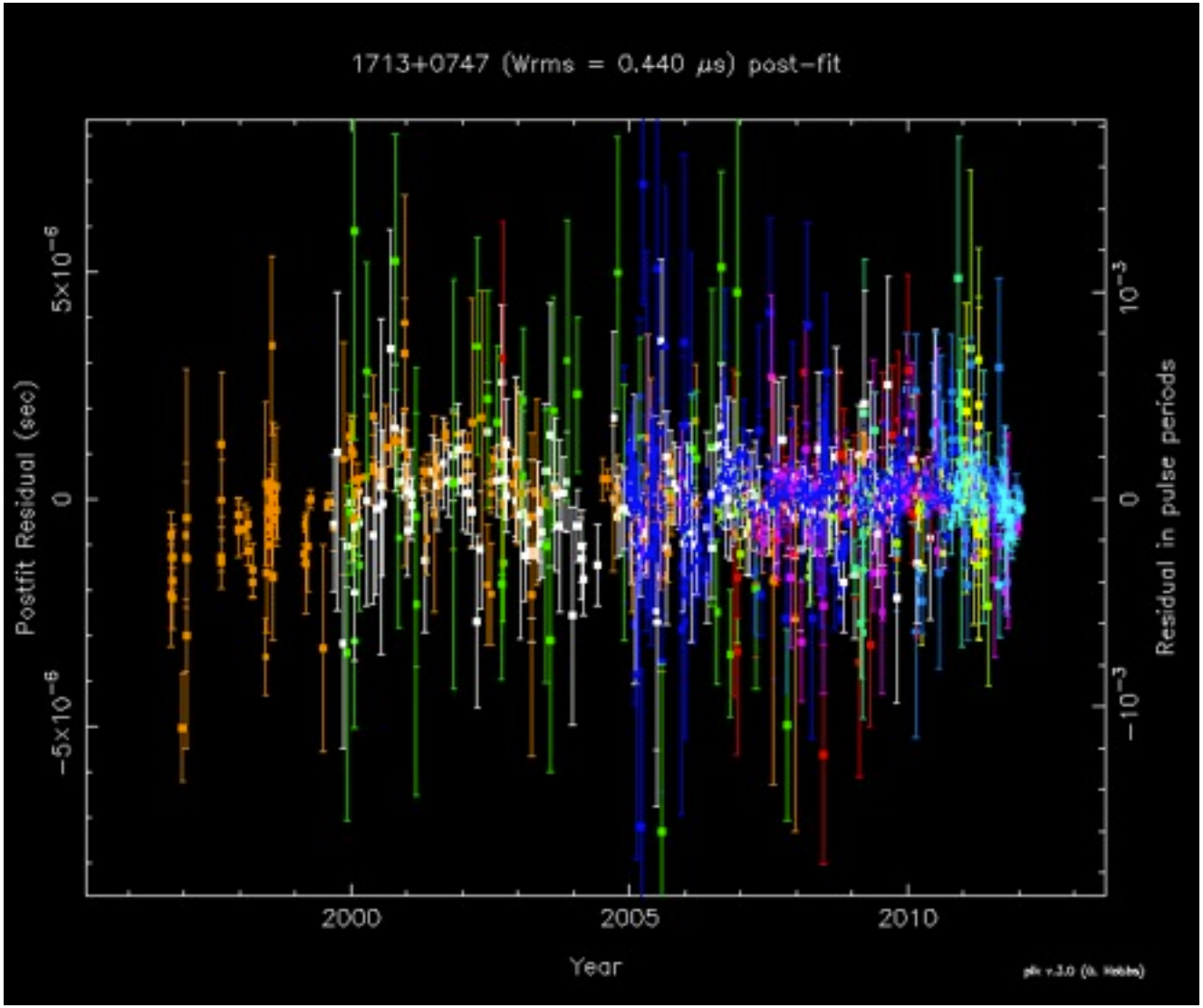
The EPTA: Combining data sets

Work in progress by G. Desvignes with EPTA timing group, M. Bailes



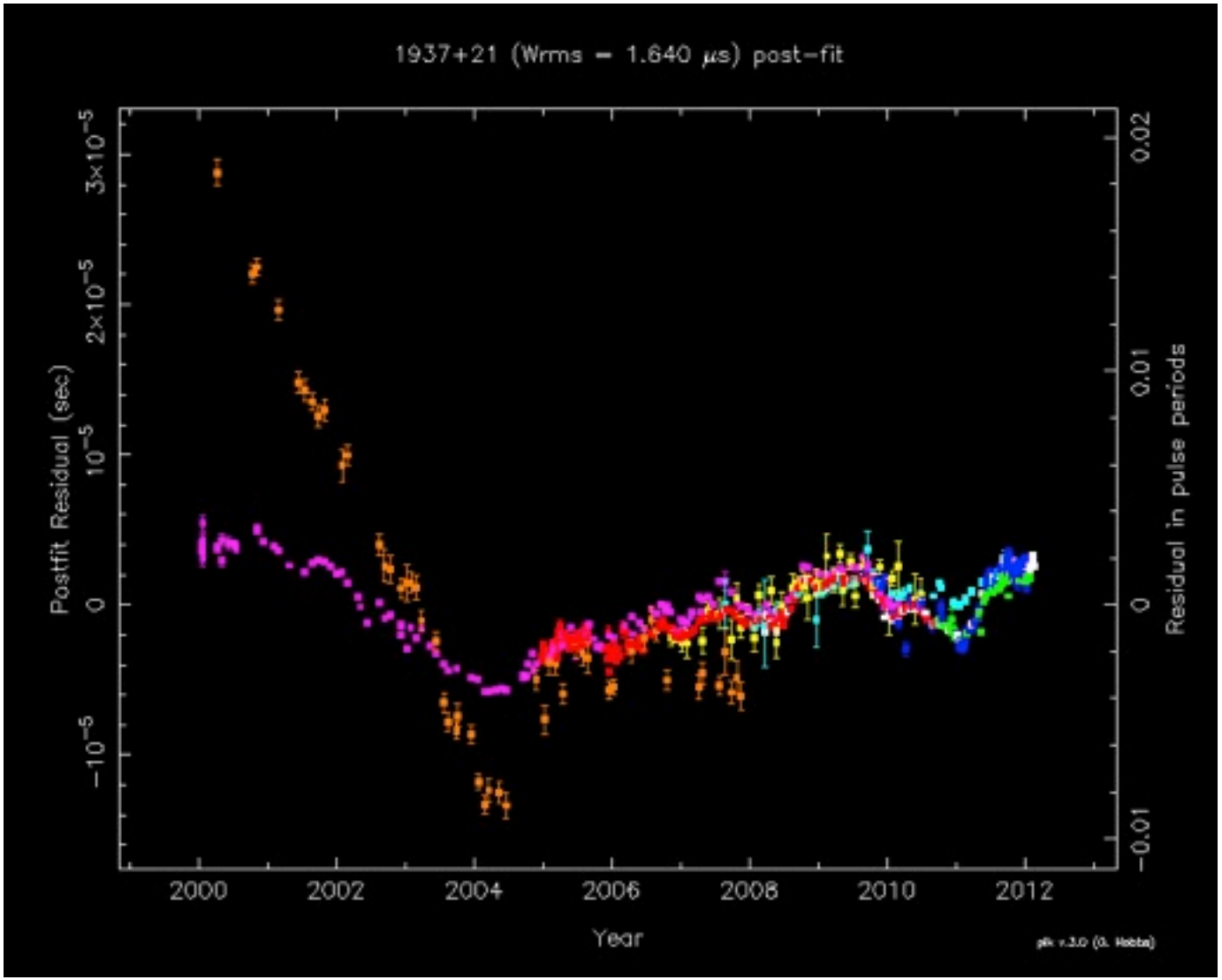
The EPTA: Combining data sets

Full EPTA combination



The EPTA: Combining data sets

B1937+21

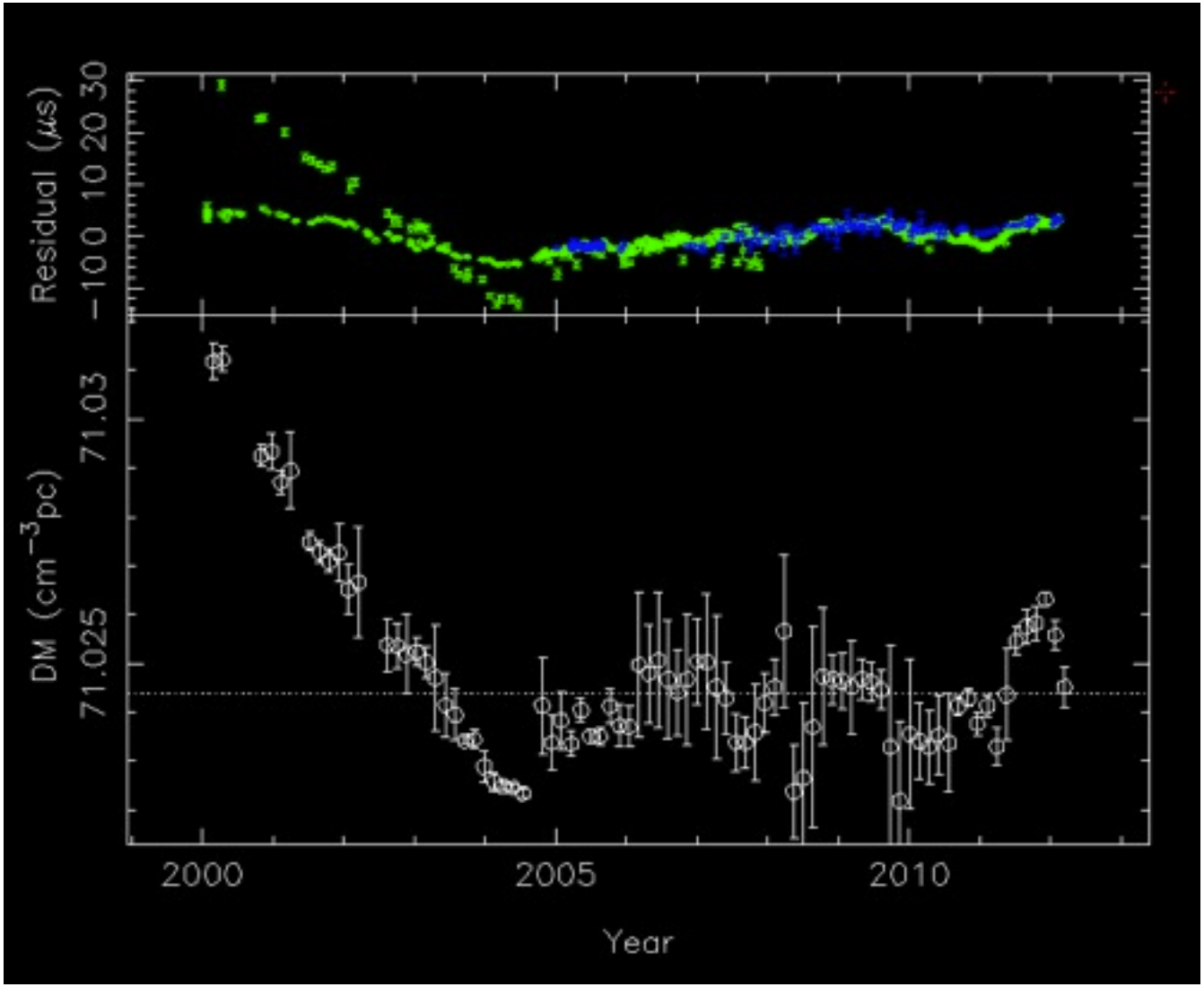


The EPTA: Combining datasets





B1937+21: DM variations



The EPTA: Combining data sets





When combining multiple multi-frequency data sets:

-pre-whiten data per frequency band

-determine jumps per frequency band

use only overlapping parts if possible

-search for and include clock jumps

-unwhiten data with jumps fixed

-measure DM variations

-apply DM corrections to TOAs

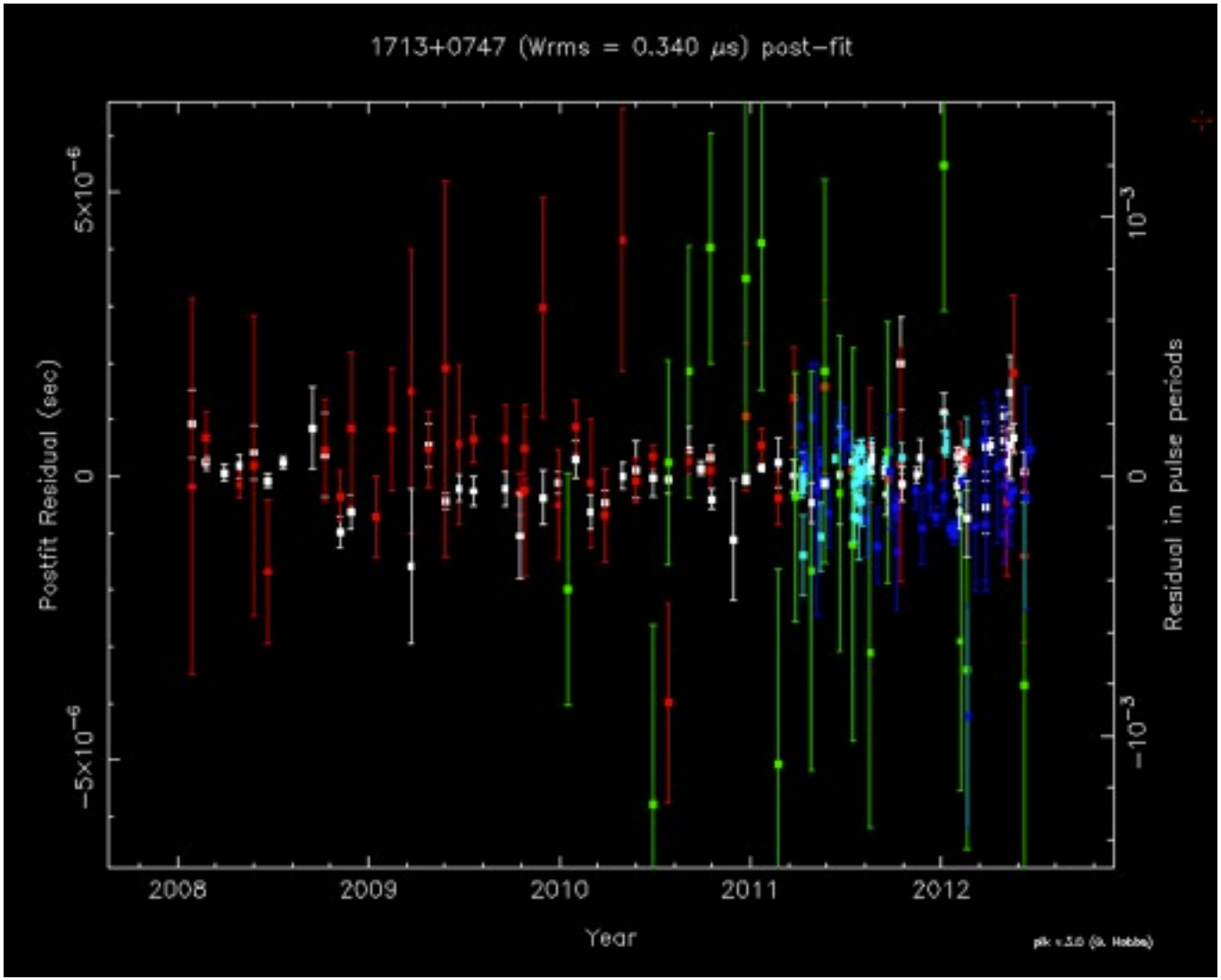
-include errors on the jumps and DM measurements

on the TOA error

Work in progress! (EPTA timing group; poster: KJ Lee)

The EPTA: Future data sets

J1713+0747, next-generation



The EPTA: IPTA data sets status





-Re-analysed all long-term data sets from scratch

-combinations to determine jumps and clock offsets

-inserting flags necessary to handle data

-last bits of finetuning now in progress

-we will start having data sets available for IPTA from mid-July

EPTA is mini-IPTA; combining data sets in an optimal way is essential for the IPTA

We are ready to start working on the IPTA limit paper!