

# Year 2 Pulsar Timing

Here is the [link to the page](#) we used to organize timing during Year 1.

## Preamble

- Before the first year on orbit, we wrote a Pulsar Timing Consortium [Memo of Understanding](#) for sustained timing of known pulsars with Edot > 1E34 erg/s. This acquired two appendices:
  1. to add the [radio observatory at Urumqi](#) in China
  2. to add [Ben Stappers](#) to the list, after he moved to the U. of Manchester and took on Jodrell Bank duties from Lyne & Kramer.
- During the first year, Paul Ray put together a Pulsar Search Consortium (=PSC), described in [this document](#).

These documents expired at the end of Year 1. **The purpose of this page is to update them.**

Our intent is to merge the "Consortium" and the "PSC" into one single body, if practical.

Two broad issues need to be addressed --

1. Observation strategies
2. Publication policy

Jump to the October 14 teleconference minutes [Oct14TeleConf](#)

## Observation strategies

We'll consider two aspects separately --

1. Monitoring of known radio (and X-ray) pulsars.
2. Follow-ups of LAT sources (blind search pulsars, and unidentified DC sources)

( Only 5 X-ray pulsars are covered by the original MoU and involve a small number of people (2 at McGill, 1 at GSFC, 1 at Columbia). We'll deal with these individually once we've covered the thornier issues. )

## Monitoring of known radio pulsars

The situation is shaping up nicely. Here is a message I sent to Simon Johnston:

*Date: Wed, 16 Sep 2009 15:27:40 +0200 (CEST)  
From: D.A. Smith <[smith@cenbg.in2p3.fr](mailto:smith@cenbg.in2p3.fr)>  
To: [simon.johnston@atnf.csiro.au](mailto:simon.johnston@atnf.csiro.au)  
Subject: radio timing after Lucas, Damien, Patrick...*

*Life after Lucas, Damien, Patrick doesn't seem **too** grim to me.*

*Damien is not a .par producer, only a user. He'll be a postdoc in the group with Paul Ray at NRL and will continue doing alot of what he's been doing. (He wants to learn how to build LAT .par's with Paul!).*

*Lucas will continue building Nancay .par's from Bonn. What's better is that he'll be sitting near Aris, who has been doing them for Jodrell! Lucas' dream is that he and Aris combine TOA's and share the work load.*

*Patrick is now part of the Jodrell effort. Could Patrick continue to build .pars for Parkes? Maybe not. Could Patrick dump Parkes TOAs on Aris and Lucas, for them to include in the .par fabrication machine? Maybe.*

*So that leaves two big Parkes tasks in the lurch:  
i) actually driving out to telescope and staying up all night ;  
ii) reducing Parkes raw data to TOAs that could be fed to Lucas and Aris*

*Certainly Lucas is very enthusiastic about the idea we discussed on the phone last time, that he come to Sydney for a month, to observe and to learn more of the radio trade. Michael K certainly wants Lucas to become a "real" radio astronomer. So... Lucas can chip into (ii) once he returns from Australia, in <6 months maybe.*

*For i, you said that you would offload your northern Fermi targets (to the friends mentioned above!) and then spread the remainder amongst other Parkes observing campaigns, such that you'd end up with one night every three months instead of two nights every month.*

And here is what Simon answered:

Date: Wed, 23 Sep 2009 11:51:20 +1000 (EST)  
From: Simon Johnston <Simon.Johnston@atnf.csiro.au>  
To: D.A. Smith <smith@cenbg.in2p3.fr>  
Subject: Re: radio timing after Lucas, Damien, Patrick...

Sounds good to combine timing and searching together. Agree.

*Onto the data reduction. Patrick has this mostly automated (apart from flagging of bad data) and I think I understand how to drive it all. So I can certainly produce TOAs in a finite time after the observing. However this still leaves the actual timing itself and this is complicated, time consuming and fairly manual given glitches, timing noise, multi-freqs etc etc. I'm not sure I'll have time to do this so your suggestion of a central clearing house in Bonn sounds like a very good one. Plus it has the advantage of being able to combine TOAs from the different telescopes. I could send Aris/Lucas the TOAs and they could do the actual timing. As long as they (and Michael) are keen on this that would be great.*

*This brings us back to rationalising the timing list at Parkes. In some ways given you have to trek out to Parkes anyway, observing for 24 hours rather than 12 makes little difference. However shorter observing does make it possible to tack the timing onto other programs and then persuading the observers to spend an extra day there. Also (a) we could cut northern sources, (b) for some sources with low timing noise 1 month is overkill and (c) are all these sources worth doing anyway??? We have until Dec 15 to decide (next obs deadline) and by then we'll know about whether we'll be getting a good postdoc or not. Affaire a suivre as they say in France.*

I propose next to a) make sure that DJT, RWR, and PSR are on-board with what I'm doing and then b) talk to Michael Kramer. We have touched on these topics in the past and my impression is that he'll be good with it. But it's time to clarify. I further propose that once some key people agree on some key issues, that I will start to update the document.

Note that the Americans are not timing large numbers of pulsars. Only the six at GBT from the MoU, to a good first approximation. We certainly want Fernando to keep pounding away at PSR J1930+1852 (the only one of the six that we haven't yet seen in gamma-rays) as well as any others he wants to do with us (e.g. PSR J1935+2025 that is a good candidate but not covered by the MoU).

But my inclination is: let the australo-europeans agree on how to track the hundreds and hundreds of pulsars. I expect the Americans to be glad to hear it, and they will then see how to further coordinate with that. (Example: we have seen that large numbers of lower-resolution TOA's sometimes compliment small numbers of GBT-quality TOAs for an overall better timing solution.)

## How many radio pulsars do we want to monitor?

I feel strongly that it is too early to start abandoning large numbers of pulsars, and that we easily have the resources to monitor them anyway.

- Jodrell Bank seems committed to following all of the northern ones independently of us anyway
- With the Bonn central clearing house, it looks like the overlap between the australo-european telescopes is going to get rationalized ==> less telescope time for the same number of pulsars
- The doubling time for LAT datasets is still << than the mission lifetime, and we are no where near having unlocked the secrets that we ambition to address in the 2nd Pulsar Catalog.
- Let's keep going!

This said... LAT pulsar timing allows us to stop or slow the radio monitoring of the "important but ridiculously difficult" ones. Certainly PSR J1124-5916. Paul, can you time PSR J0205+6449? So again, we can economize precious GBT time if we want.

We'll also try to leverage the NRL/Bonn connection (my two students!) to see which Parkes sources Simon can back off on.

## Follow-ups of LAT sources (blind search pulsars, and unidentified DC sources)

Paul's PSC MoU is about follow-ups using ephemerides from the LAT blind pulsar discoveries, specifically referring to Year 1 LAT proprietary data.

We no longer have exclusive access to the photon lists. But we're the best when it comes to

- blind search pulsar ephemerides
- detailed positions ; spectral shapes ; variability indices ; extension or not ; blazar-ness or not of the unidentified catalog DC sources.

We can pretty much keep the spirit of Paul's document, broadening the scope to include candidate positions for blind radio period searches, with the various figures-of-merit just mentioned.

And if/when they discover a new radio pulsar, we'll look for the gamma pulsations straight away!

At present, I am aware of these significant efforts:

- Steve Healy with Roger Romani
- Matthew Kerr cooperating with Mallory Roberts
- Elizabeth Ferrara has been classifying the spectra of non-Ids
- I don't know if Paul is active in this, but certainly Damien would like to get into the business when he hits Washington, I guess after Thanksgiving.

So... Nancay is chomping at the bit to get some coordinates. They've done a lot of back-end upgrades lately to enhance search capability and are pretty cocky that they can find things *fast* when they know where to point (they have been practicing by re-discovering difficult objects). Their beam is 20' in declination and 4' in R.A. It'd be nice if we could settle some of all this so that we can start farming out pulsar candidate coordinates!

## Publication Policy

## Cat I versus Cat II, and Lead Authors

I'll begin with a few words from Simon (from same e-mail as above):

*I also think minimising the changes to the MoU would be best. Are you thinking about splitting "discovery/upper limit" papers from "follow-up science" type papers? For the former case I suggest that as before all consortium members be allowed to sign. For the follow-up this is less clear - presumably these are Cat II papers and on specific objects (eg Vela) so perhaps only the people supplying the radio data should be on those papers. Just a thought. Again the same for searching - any discovery/upper limit should include all on the consortium.*

The LAT-internal discussion about numbers of Cat I vs Cat II papers is independent of the above: we can decide to write a Cat II paper where all Consortium members are eligible.

We probably need to make a sort-of-clear statement to the Consortium about the criteria for papers to be 200 authors following Aous' lead, versus a smaller number with different lead authors.

I could use input from DJT RWR PSR ETC on this one.

### List of names for the new MoU

There are roughly four names that I wonder about removing from the new document. We should talk. It's not worth a whole lot of our attention.

Actually, there is an issue... there are more "timers" on the Consortium document than there are "searchers" on the PSC memo. If we "or" the two lists, then folks who have been building .par files will also get credit for searches. Also, Urumqi, from whom we never received anything we ever used, is a putative "timer" but certainly not a "searcher".

## October 14 Teleconference

Teleconference to coordinate "Pulsar Timing for Fermi beyond Year 1" for the hundreds of pulsars monitored by the Australian and European radio telescopes.

Wednesday 14 October 2009: 11am Manchester / Noon Bonn-Bordeaux / 9pm Sydney.

Attending: Ben Stappers, Michael Kramer, Simon Johnston, David Smith. (Dave Thompson invited but couldn't make it).

Agenda:

- 1) Coordinating the observations and .par preparations for the hundreds of high Edot pulsars.
- 2) Continuation of the Pulsar Search Consortium activities.
- 3) Publication policy
- 4) Action items.

=====  
CONCLUSIONS -- currently under revision by attendees.  
=====

### 1) Coordination of observations and the making of timing solutions.

Lucas Guillemot will be asked to lead this activity. He will work with the specialists at the individual observatories: Patrick for Jodrell Bank, Ismael for Nancy, Simon for Parkes.

TOAs used to build Fermi .par files will be kept in a private data base, accessible only to the active contributors of these TOAs, to be used exclusively for gamma-related studies.

Patrick & Lucas are asked to "rationalize" the observing strategies. For example, Nancy could focus on fainter pulsars requiring longer observations ; Parkes could eliminate some of the northern targets, or targets near the over-subscribed Galactic center. Since Jodrell Bank will presumably continue to time all northern pulsars anyway, Patrick can help Lucas determine which pulsars will best benefit from additional TOAs.

Michael insists on the complementarity of the Nancy<=>Jodrell Bank observations in order to obtain good coverage and accuracy. He believes that both institutions have strong arguments to justify these campaigns to their agencies.

Deadline for an improved Parkes observation list: December 1st, so as to be useful for the Dec 15th telescope time.

### 2) Continuation of the Pulsar Search Consortium.

David apologizes for having forgotten to invite Paul Ray to the meeting. (Paul later said he didn't mind.)

General satisfaction with the current status quo.

Ben comments that even if eligible, he expects people to sign papers only if they were active. Michael views that having observed a target justifies signature, even if discovery did not ensue.

### 3) Publication Policy

Of the papers we've written so far, there have been good things (e.g. CAT I and II papers with radio lead authors) and there have been painful things (e.g. the preparation of some of these papers).

Simon says that a lesson learned from 6P4 is that it needs to be more clear at the outset which co-authors intend to make contributions of substance. He and Patrick thought that 6P4 was nearly finished, only to discover that a vocal subset of the 200 co-authors wanted substantial changes. Solution is to have co-authors state their active interest earlier, and for the lead authors to outline the core ideas to them earlier.

After a short discussion of some of the sociological and ideological elements involved, we agreed to try to continue to just make the best of it all. The LAT people recognize the need for quality radio pulsar work ; the radio people recognize the subtlety of LAT spectral and spatial analyses.

#### 4) Action items:

- i) David will write this summary. **Done.**
- ii) David will begin the re-write of the new MoU+PSC document to touch some of the above points. (Observation strategy details are beyond the scope of the document).
- iii) David will inform the rest of the consortium (namely, our GBT & Arecibo friends) of the austral-european intent. **Mostly done -- there was a face-to-face with Fernando and Scott and LAT folks at the Fermi Symposium on November 4th, Dave JT and/or J Eric G will write up some minutes.**

## Discussion of Future Pulsar Timing and Searching Efforts Involving Fermi LAT

November 5, 2009

Attendees: Parent, Guillemot, Ransom, Camilo, Grove, Thompson, Ray, Saz Parkinson

We note that this group is a small fraction of those interested in this topic. Agreements within this group are obviously not binding, but rather represent a starting point for discussion. In particular, any plans for publications that involve the LAT team must be approved by the LAT Principal Investigator.

Two key themes seemed to run through the meeting:

1. Need for more internal communication
2. Need for better-defined publication policy

On the question of combining the two consortia, there was no consensus, although there was agreement that the mailing lists could be combined, since there is strong overlap. In reality, the two groups are doing quite different things, so it was not clear that we gain much by combining.

There is a perception that some members of the consortia are contributing little but are still being offered the chance to sign papers. One thing we agreed on was that we should strongly encourage all participants in either timing or searching to sign papers only when they have made a significant contribution to the overall effort. This does not mean restricting to direct contribution to a given paper, but rather to the whole timing or searching effort.

We agreed also that membership in the email list does not guarantee authorship.

There was general agreement (perhaps not unanimous agreement) that the publication policy should be clarified right up front.

Before we circulate one or more draft MOU's, we agreed it would probably be worthwhile to contact all the participants in both groups to ask them what specifically they are planning in the coming year. That does not necessarily mean a list of pulsars or search regions, but some concrete proposal for how that group or individual will contribute to the overall effort. Once we know what is proposed, we can better draft the MOU(s). There may be individuals or even groups who choose to work on their own. At the same time, we should look for others who might want to join.

We agreed that the publication policy should emphasize that more papers in the coming year (although not necessarily all) will be LAT Category II papers. It should also be made clear that authorship on such papers is not automatically offered, but is determined by the lead authors. A recommendation was made for the Galactic group leads to start pushing for more pulsar papers to be Category II.

Two things that we didn't completely discuss at the meeting:

1. Galactic group leads will coordinate with the lead authors so the Cat II authorship lists are inclusive, to try to ensure LAT Team and Consortium members who have made a significant contribution to the overall effort are indeed offered the chance to sign.
2. We should emphasize that Cat II authorship order need not be alphabetical.

We discussed that continued radio timing of the brightest LAT pulsars is probably not essential, although some regular checks on the radio would be useful. One challenge from the radio group is for the LAT team to see how many of these pulsars can be timed successfully by the LAT. An example is the 0205 pulsar in 3C58, for which Fernando has lost lock in the radio. Can it be found in the gamma-ray data, knowing the position and approximate timing information? We had three explicit examples here. The other two are J1747 and J1833.

We agreed that timing a large number of pulsars for one more year would be useful, but probably not for five years.

We agreed that the driver for any of this work should be well-defined science, not just hand-waving. Example: finding a larger sample of PWNe associated with pulsars would be useful, since the sample we have is so limited. Much of the energy loss of the neutron star is going into these. In order to find those, we need the timing to be able to look at the off-pulse emission.