

# FAST Drift-Scan Pulsar Survey

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# FAST Drift-Scan Pulsar Survey

The Ultra-wideband Drift-Scan Pulsar Survey

At the beginning, we need  
1, tracking; 2, data processing

Single Beam for 270-1000 MHz  
System temperature < 100 K  
Two polarizations  
4096 channels >> 0.25 MHz  
sampling time: 200 us,

For observation:  
"real" observations

PMPS: 0.14 mJy for central beam (Manchester et al. 2001),



# FAST Drift-Scan Pulsar Survey

## Overview



Telescope:  
500 m aperture, using  
300 m



Receiver:  
ultra-wideband  
19-beam



Computers in FAST site:  
Data temporary storage and  
transferring



Data center and super computers:  
Pulsar searching, including database  
for candidate filtering

# FAST Drift-Scan Pulsar Survey

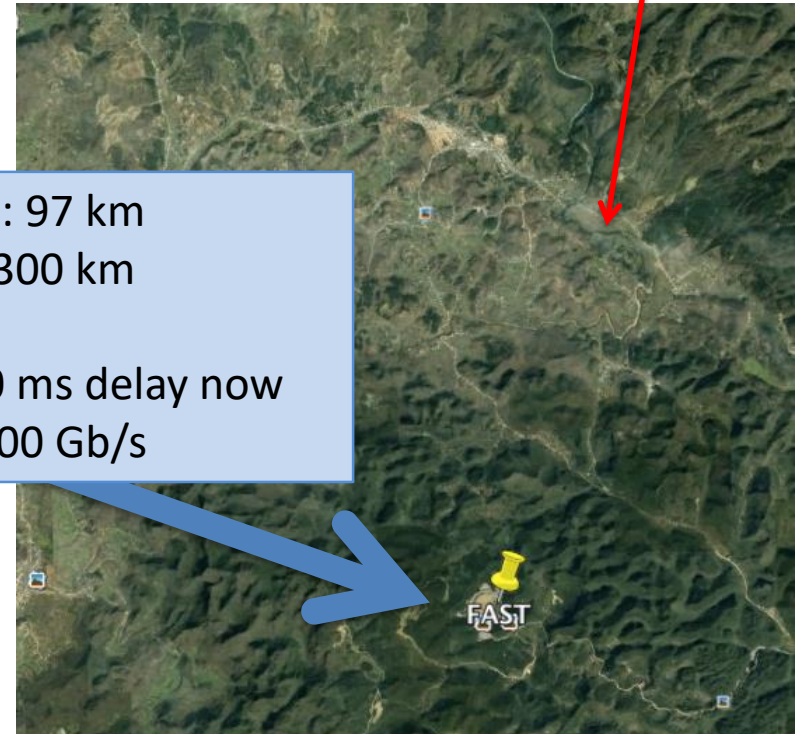
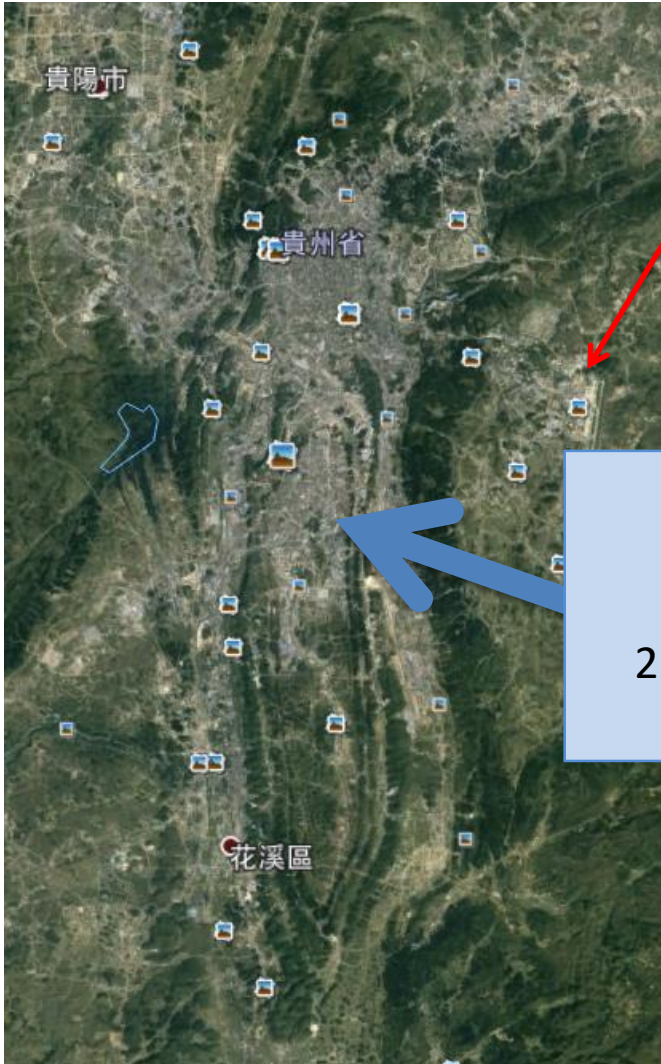
## Data transfer

Guiyang Airport

Astronomical Town

Distance: 97 km  
Fiber: ~300 km

2 Gb/s with ~10 ms delay now  
will be 100 Gb/s



Images from Google Earth

# FAST Drift-Scan Pulsar Survey

## Data rate

One beam: 8-bit, 5 kHz sampling (200 us sampling), 4k channel, 2 polarization

Baseband: 8

Psrfits data: 8

For 19 beam:

Baseband data

Psrfits data: 8

Data rate reduced

One polarization

**81% of 677 T**  
**and**  
**71% of 677 T**

/dev/sda5	394G	117G	258G	32%	/
devtmpfs	32G	0	32G	0%	/dev
tmpfs	32G	1.8M	32G	1%	/dev/shm
tmpfs	32G	3.0G	29G	10%	/run
tmpfs	32G	0	32G	0%	/sys/fs/cgroup
nodev_ps200a_10.10.10.27-1_parastor	677T	517T	125T	81%	/home
/dev/sda1	494M	203M	292M	41%	/boot
nodev_ps200b_10.10.10.29-1_parastor	677T	455T	188T	71%	/data2
tmpfs	6.3G	16K	6.3G	1%	/run/user/42
tmpfs	6.3G	144K	6.3G	1%	/run/user/505
tmpfs	6.3G	124K	6.3G	1%	/run/user/523
tmpfs	6.3G	376K	6.3G	1%	/run/user/515
tmpfs	6.3G	0	6.3G	0%	/run/user/0
tmpfs	6.3G	244K	6.3G	1%	/run/user/506
tmpfs	6.3G	0	6.3G	0%	/run/user/493
tmpfs	6.3G	128K	6.3G	1%	/run/user/1043
tmpfs	6.3G	16K	6.3G	1%	/run/user/1028
10.10.10.103:/stornext/archive/archive	117T	82T	35T	70%	/Quantum_stor
tmpfs	6.3G	84K	6.3G	1%	/run/user/1018
tmpfs	6.3G	180K	6.3G	1%	/run/user/1045
/dev/loop0	3.8G	3.8G	0	100%	/mnt
tmpfs	6.3G	64K	6.3G	1%	/run/user/1022
tmpfs	6.3G	88K	6.3G	1%	/run/user/1021
tmpfs	6.3G	216K	6.3G	1%	/run/user/1041
tmpfs	6.3G	52K	6.3G	1%	/run/user/1042
tmpfs	6.3G	152K	6.3G	1%	/run/user/1051

# FAST Drift-Scan Pulsar Survey

## Band Selections

Band separated by backends: 0-1 GHz, 1-2 GHz

For search:

290-340 MHz (fully processed)

500-750 MHz (10%)

1149-1679 MHz (test)

290-802 MHz (fully processed)

270-526? MHz (?)

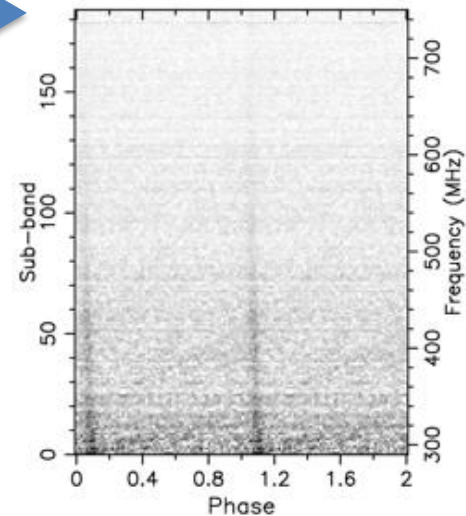
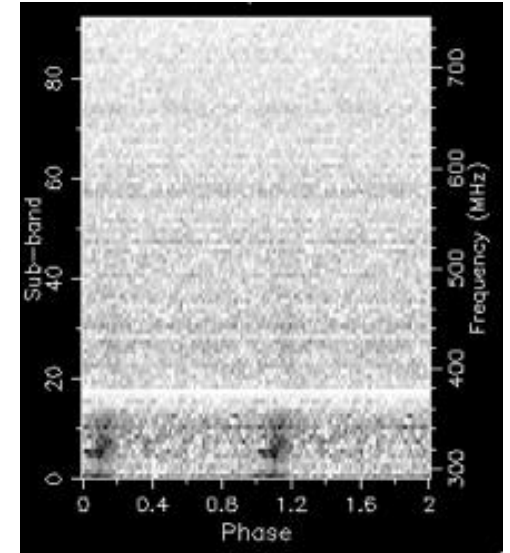
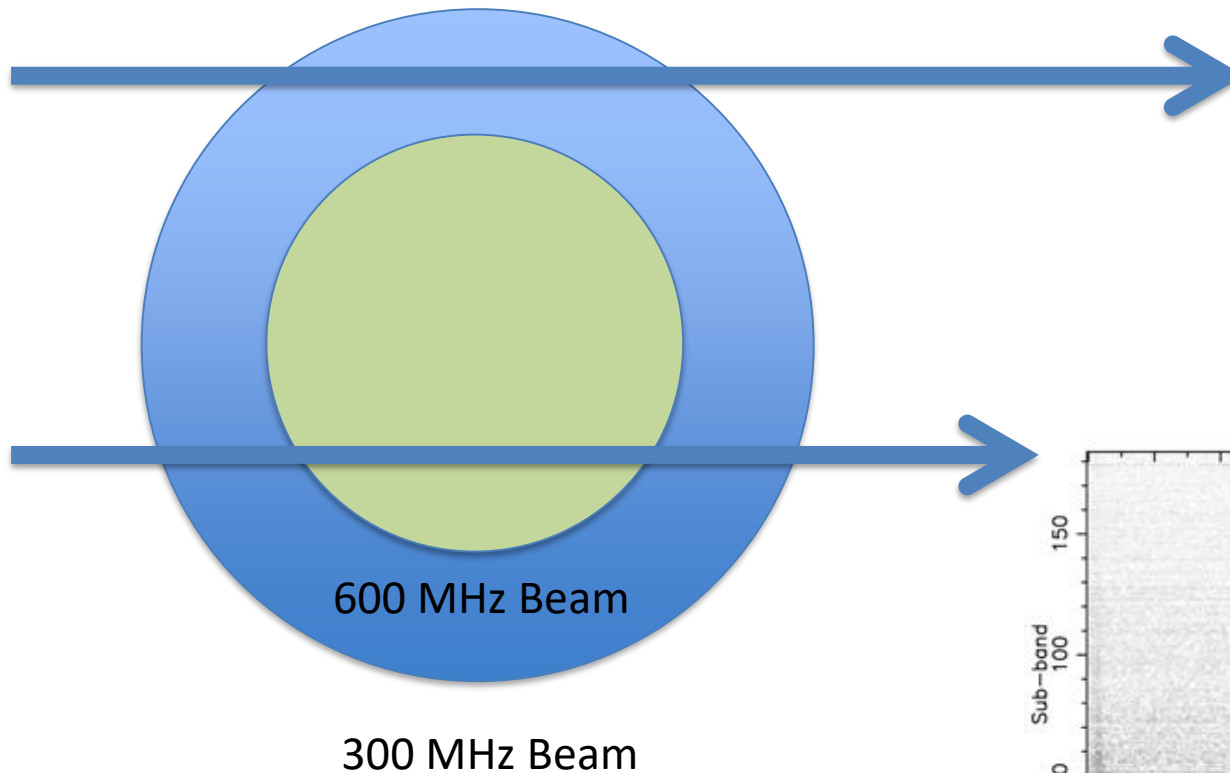
410-538 MHz (fully processed)

Data Length Selection:

$\lambda/D * \cos \theta * 1, 1.22, 1.5, \text{ or even } 2?$

# FAST Drift-Scan Pulsar Survey

## Band Selections



# FAST Drift-Scan Pulsar Survey

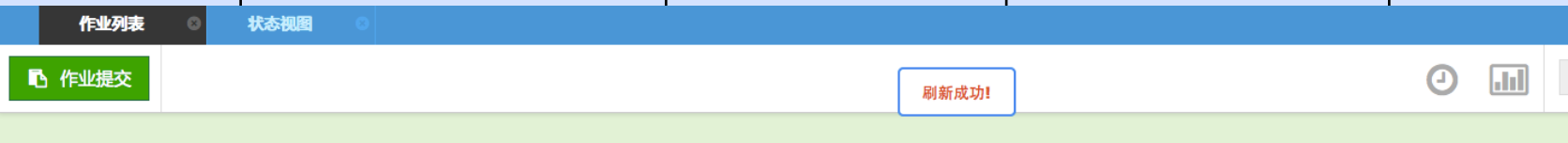
## Algorithms and Softwares

<b>Search Method</b>	<b>Target in drift scan</b>	<b>Code</b>	<b>Platform</b>	<b>Tested</b>
<b>FFT</b>	<b><math>p_0 &lt; 0.5 \text{ s} ?</math></b>	<b>PRESTO, SigProc</b>	<b>CPU, GPU, etc</b>	<b>Yes</b>
<b>FFA</b>	<b><math>0.5 \text{ s} \leq p_0 \leq 3 \text{ s} ?</math></b>	<b>ffa in SigProc, ffancy</b>	<b>CPU, GPU?</b>	<b>No</b>
<b>Single Pulse</b>	<b><math>p_0 &gt; 3 \text{ s}</math></b>	<b>python code in PRESTO, Heimdall, ZWW's</b>	<b>GPU</b>	<b>Partially</b>



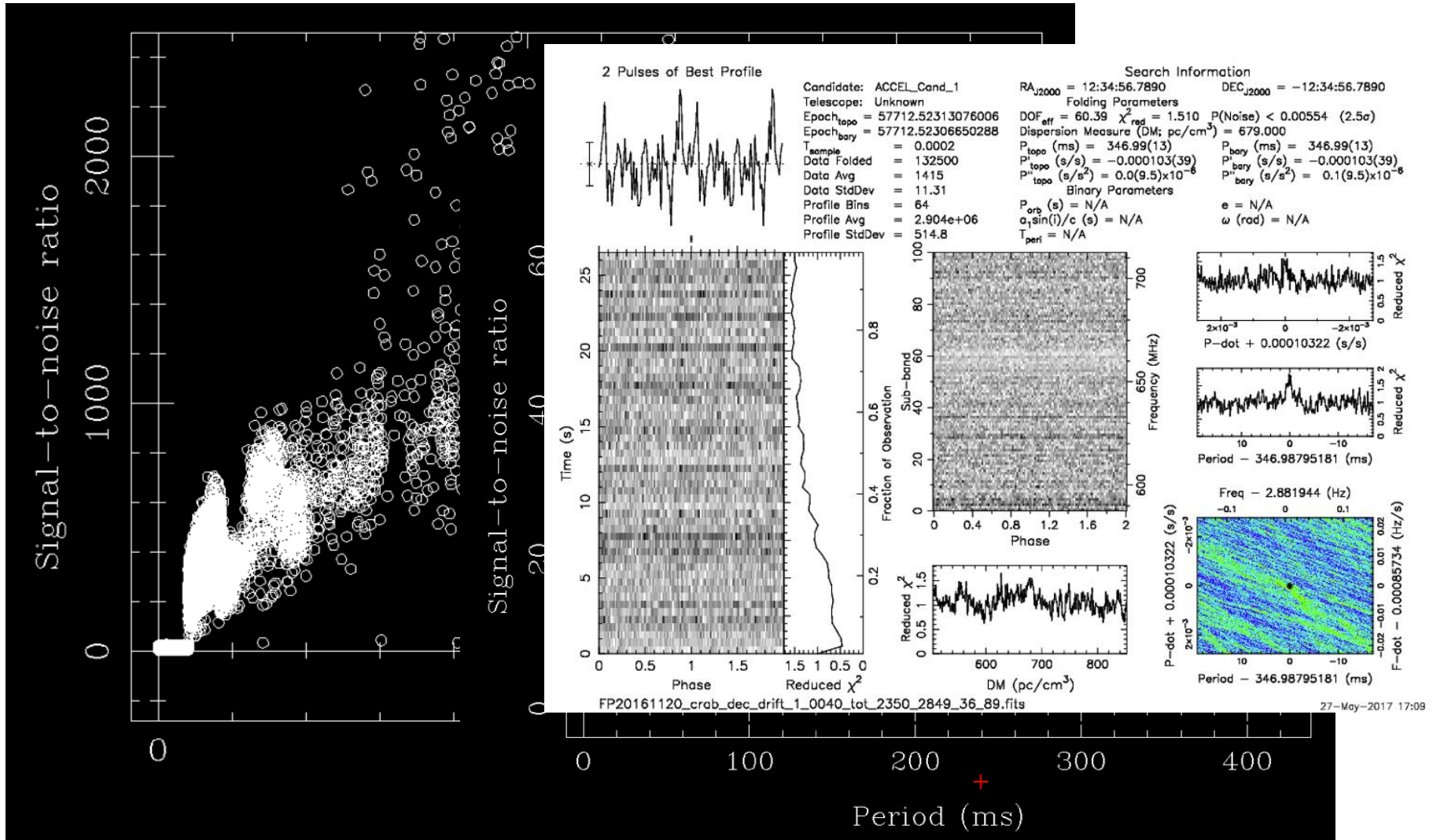
# FAST Drift-Scan Pulsar Survey

## Hardware

Hardware	CPU Cores	GPU	Toolkit	Search for				
Co N FA								
	作业ID	作业名	所有者	队列	状态	开始时间	运行时间	
	<input type="checkbox"/>	2598.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:16:21	00:00:58
	<input type="checkbox"/>	2599.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:16:59	00:01:03
	<input type="checkbox"/>	2600.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:17:14	00:01:08
	<input type="checkbox"/>	2601.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:17:54	00:00:59
	<input type="checkbox"/>	2602.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:18:08	00:01:12
	<input type="checkbox"/>	2603.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:18:46	00:01:47
	<input type="checkbox"/>	2604.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:19:03	00:01:41
	<input type="checkbox"/>	2605.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:19:45	00:01:05
	<input type="checkbox"/>	2606.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:19:57	00:01:01
	<input type="checkbox"/>	2607.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:20:33	00:01:08
	<input type="checkbox"/>	2608.admin	FP20170601_0-1G_unkn...	pzc	low	完成	2017-06-22 09:20:47	00:01:00
	<input type="checkbox"/>	2609.admin	FP20170601_0-1G_unkn...	pzc	low	运行	2017-06-22 09:21:26	
	<input type="checkbox"/>	2610.admin	FP20170601_0-1G_unkn...	pzc	low	运行	2017-06-22 09:21:46	

# FAST Drift-Scan Pulsar Survey

## Candidate Selection - Diagrams





# FAST Drift-Scan Pulsar Survey Database

ATNF Pulsar Catalogue Version 1.6

Pulsar Catalogue Menu

- Pulsar Data
- Telescope Data
- Survey Project
- Pages About Pulsar
- FITS Files

### Pulsar Data

#### Overview

Here we've provided two interactive tables. The first contains specifications for all major pulsar surveys conducted since 1967. The second below the first contains data/search pipeline information for the same surveys. Some surveys used multiple search pipelines (or parameters), and these are listed as separate entries. Status indicators for each survey can be obtained by simply clicking the reference(s) next to the survey name. We hope you find this resource useful. We've tried to make it as complete and accurate as possible. Note that the omission of a survey here should be treated as a mistake, as opposed to a judgement on its significance. If you notice any errors or would like to add a new entry, please get in touch via [pulsar@pulsar.net.au](mailto:pulsar@pulsar.net.au)

Home/About Us | User defined tables | Sort on field | Credits | Pulsar names | Filter on table(s) | Print Table | Download

Search:

#	Name	PSR	R.A.	Decl.	PSRA	PSRDec	PI	Proj/epoch	Elong	Lat	PSRLong	P
		(h:m:s)	(d:m:s)	(m:s)	(m:yy)	(m:yy)	(m)	(R,G)	(deg)	(deg)	(m:yy)	
1	search	search	search	search	search	search	search	search	search	search	search	search

ATNF Pulsar Catalogue Version 1.6

Press Esc to exit full screen

Pulsar Catalogue Menu

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### Pulsar Data Chart

#### PSRCAT plot(Catalogue v1.6)

Source: <http://www.atnf.csiro.au/research/pulsar/psrcat>

Legend: ● Binary ● High Energy

Y-axis:  $\log(P)$  (ranging from 30 to 130)

X-axis:  $\log(P)$  (ranging from 140 to 200)

The plot shows a dense distribution of pulsars, with red dots representing binary pulsars and blue dots representing high-energy pulsars. The data points are scattered across the parameter space, with a notable concentration of binary pulsars at lower  $\log(P)$  values.

From Hui Zhang's PPT

# FAST Drift-Scan Pulsar Survey

## Numbers

Total:

60 (3 to be known pulsars, 2 also shown in LOFAR page) from drifting and 4 (2 Fermi, 1 by luck, 1 GC) from tracking

Confirmed by other telescopes and published in CRAFTS website:

42 + 1(2?)

Confirmed by FAST (may also confirmed by other telescopes):

25 (should be more now) + 1

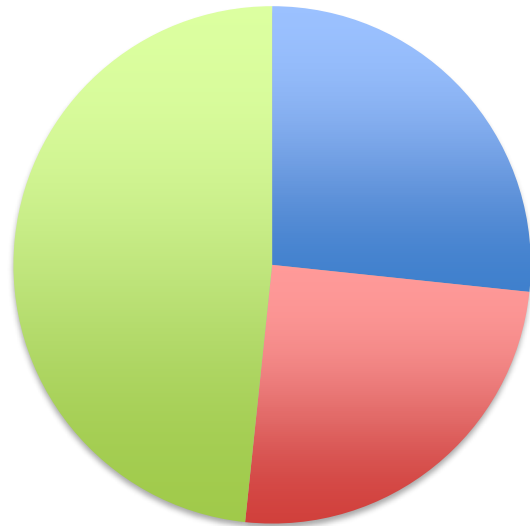
In addition:

Pulsar J0848+16 in AO 327 drifting scan page (<http://www.naic.edu/~deneva/drift-search/>) has a DM value of 38.2 and a period of 452.26 ms. From FAST drifting scan data, its period should be  $2 \times 452.26$  ms. This pulsar was detected in 20171217 data.

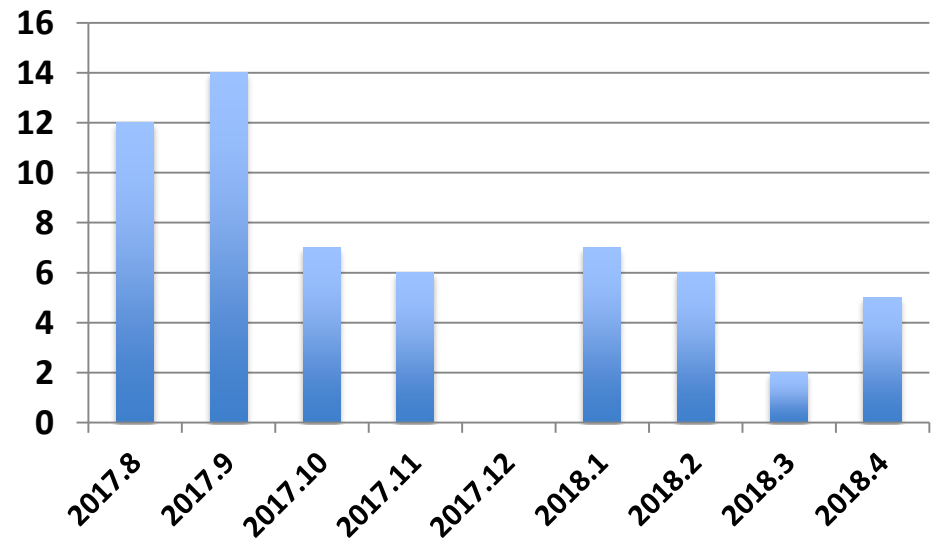
**Already told AO 327 people and confirmed.**

# FAST Drift-Scan Pulsar Survey

## Search Results

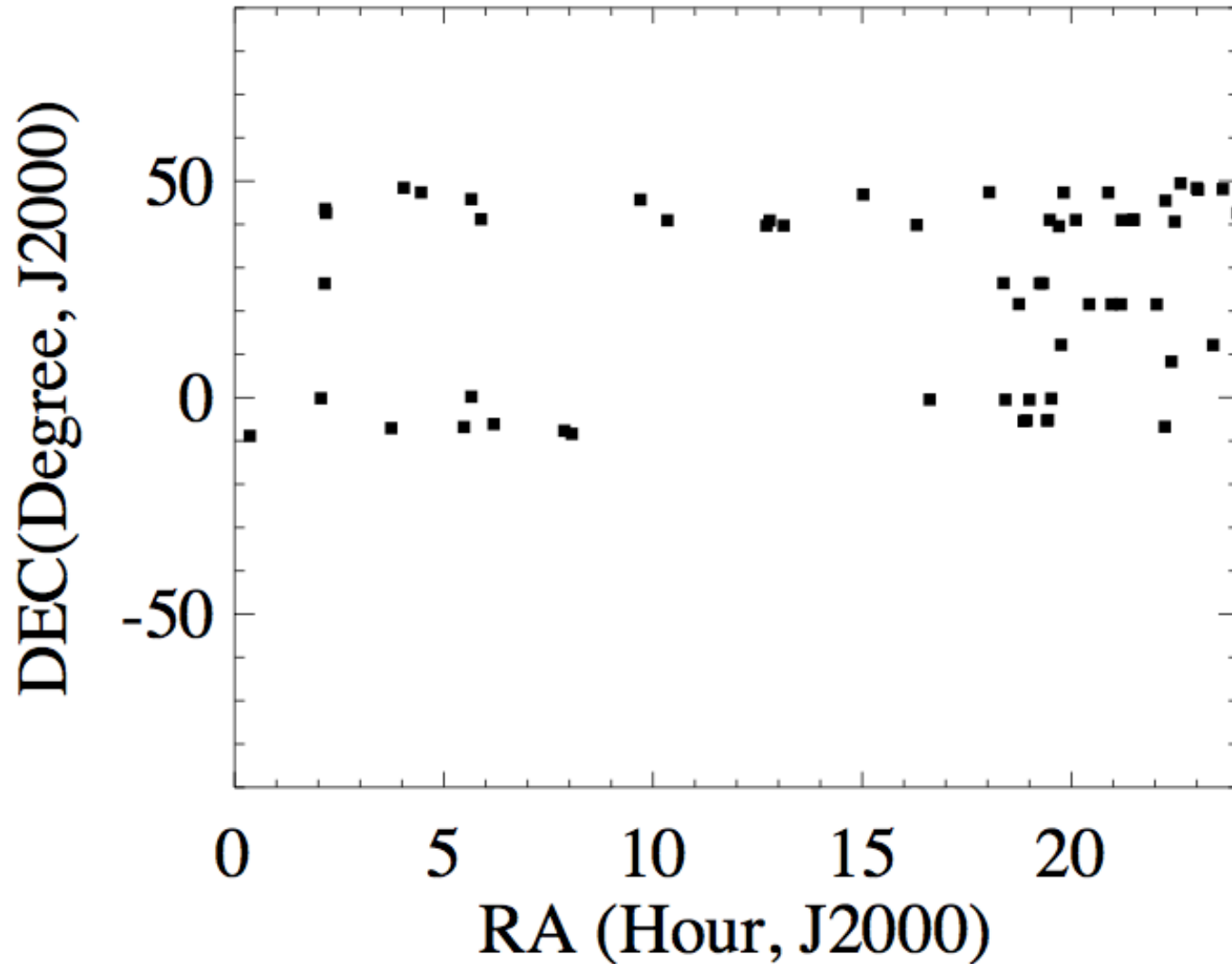


- SP+FFT
- SP only
- FFT only



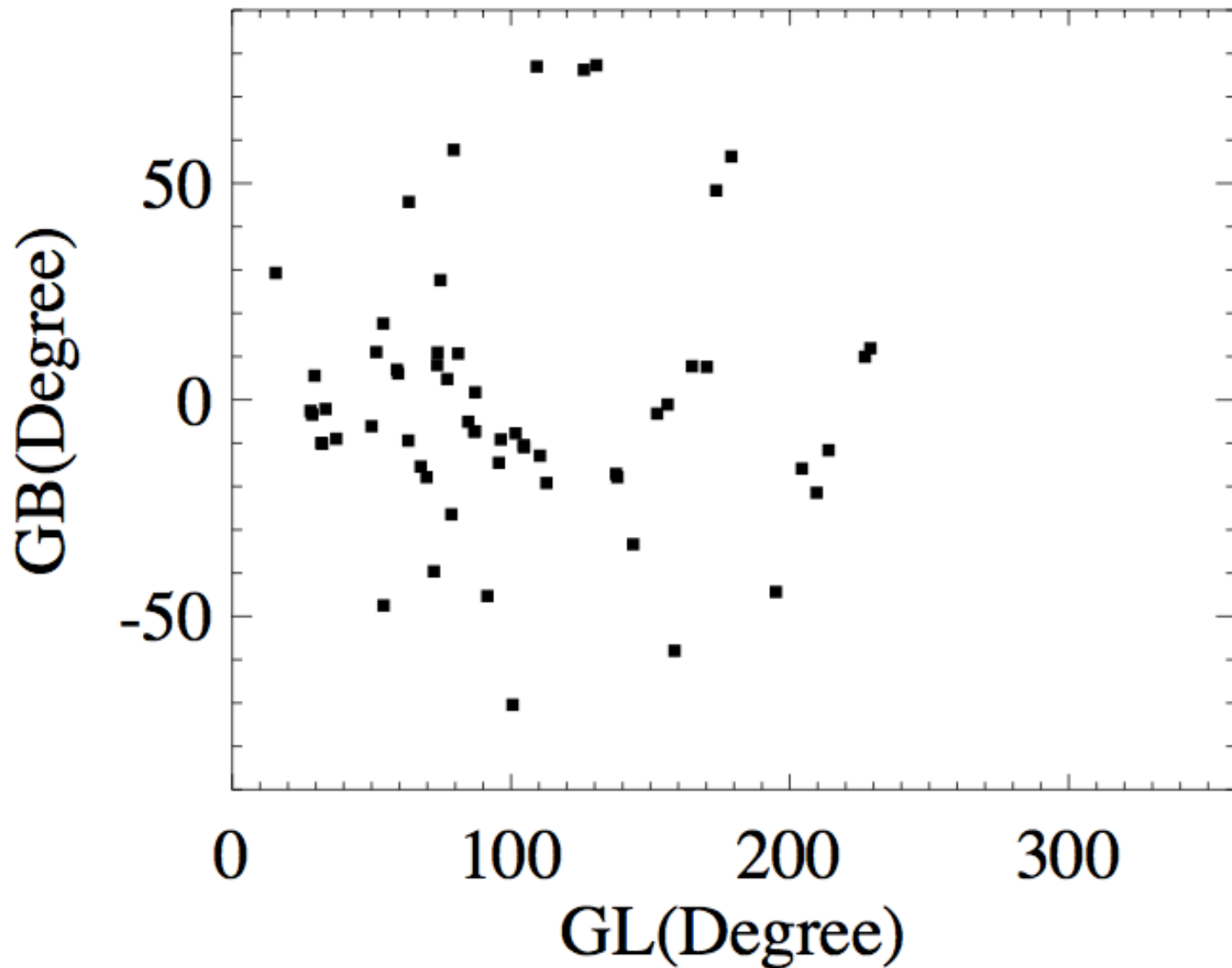
# FAST Drift-Scan Pulsar Survey

## Search Results



# FAST Drift-Scan Pulsar Survey

Search Results

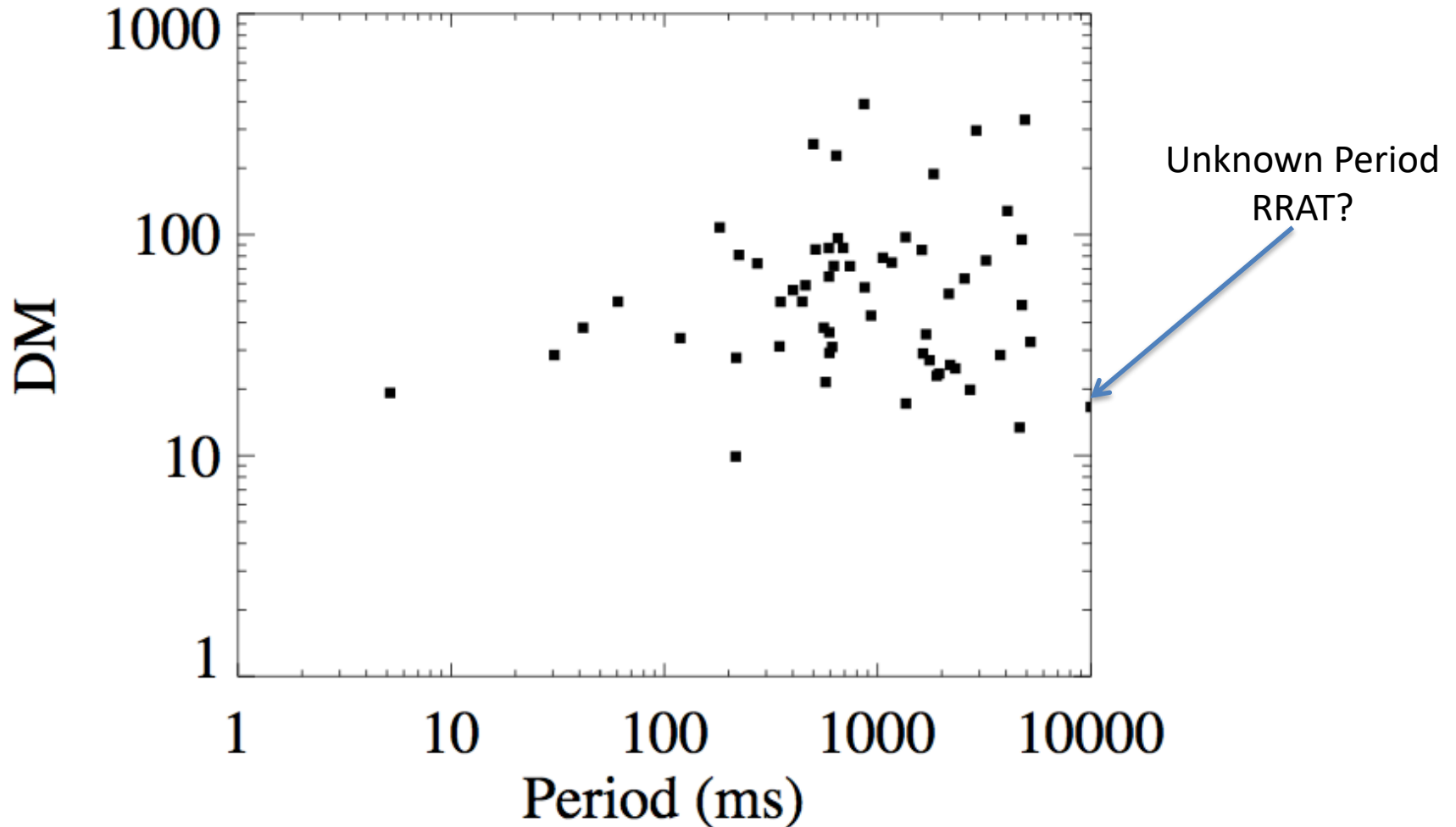




# FAST Drift-Scan Pulsar Survey

## Search Results

### FAST Candidate Distribution, P0-D



# FAST Drift-Scan Pulsar Survey

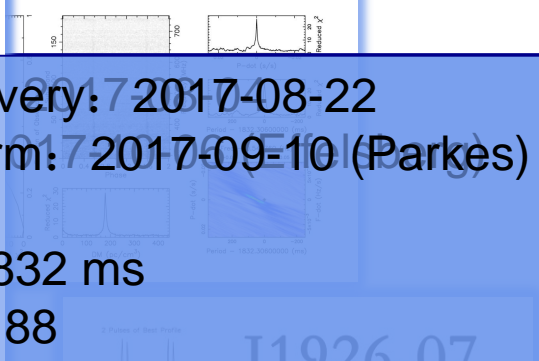
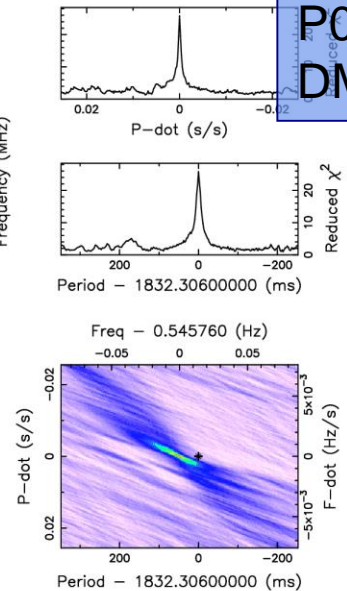
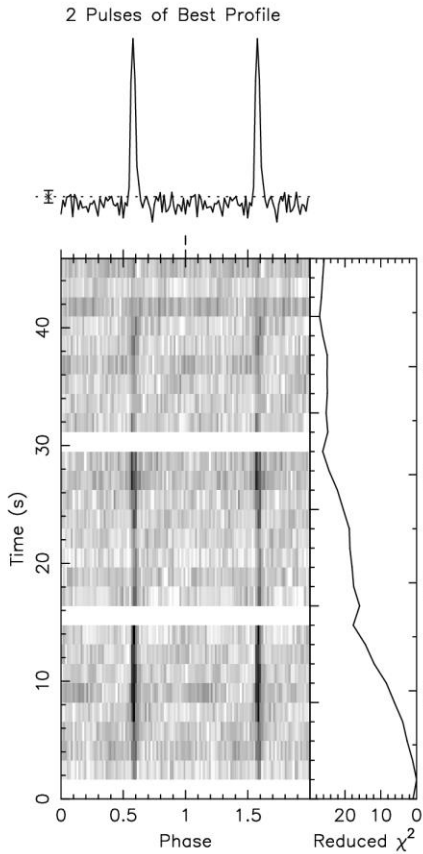
Some New Pulsars

J1859-01

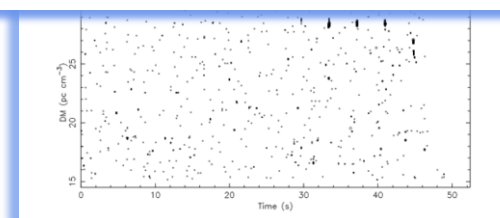
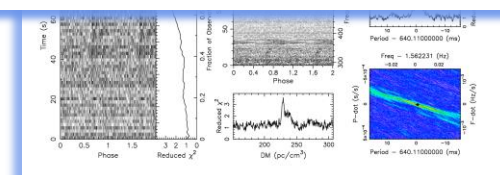
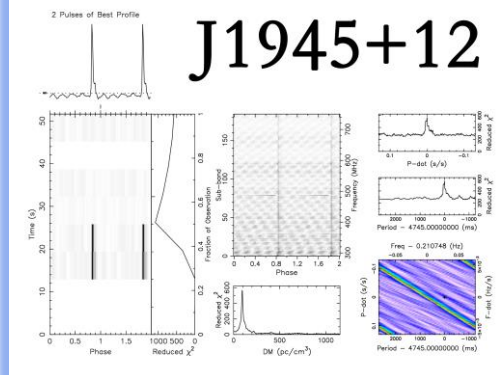
# J1859-01

Discovery: 2017-08-22  
Confirm: 2017-09-10 (Parkes)

P0=1832 ms  
DM=188

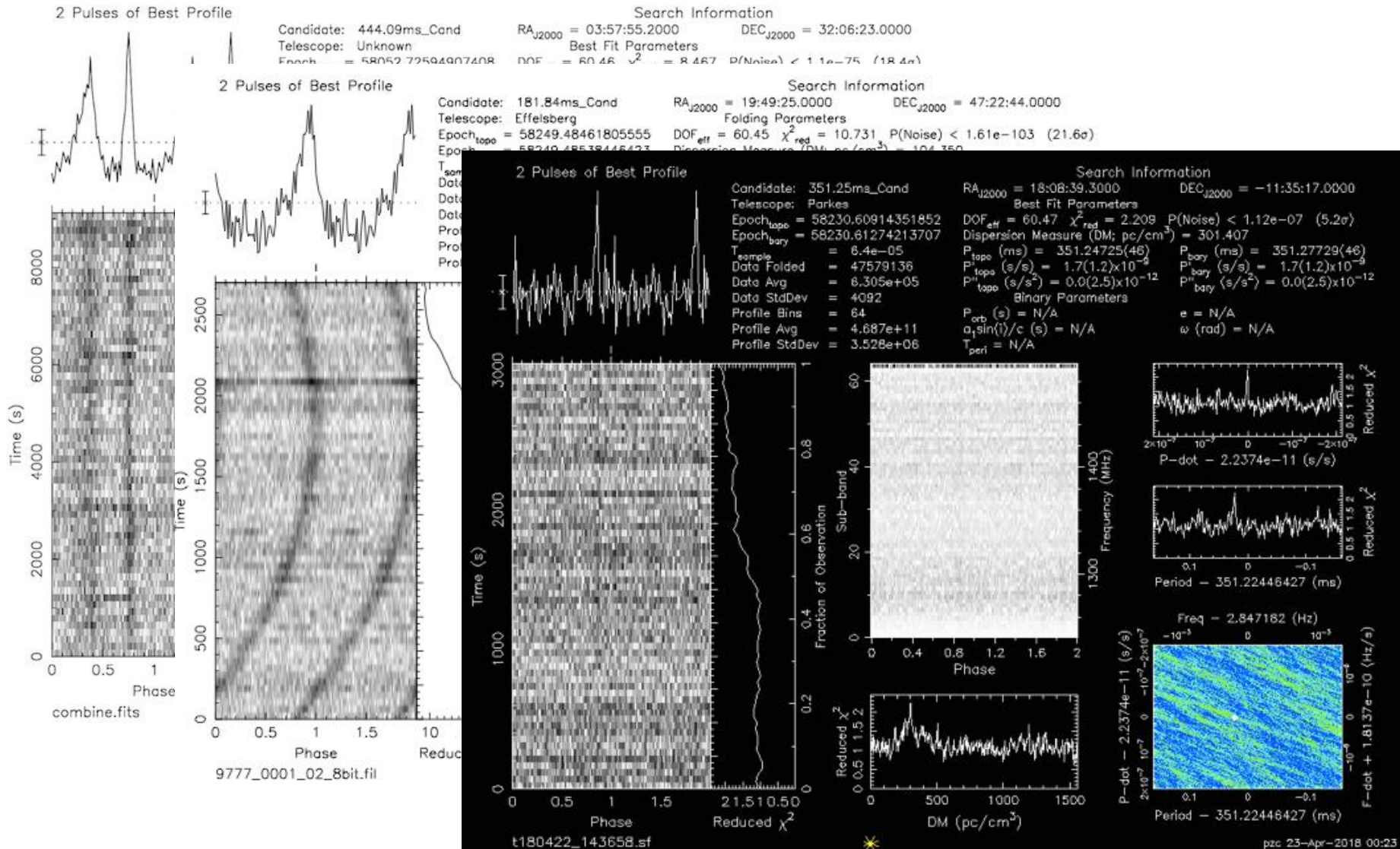


# J1945+12



# FAST Drift-Scan Pulsar Survey

## Some New Pulsars



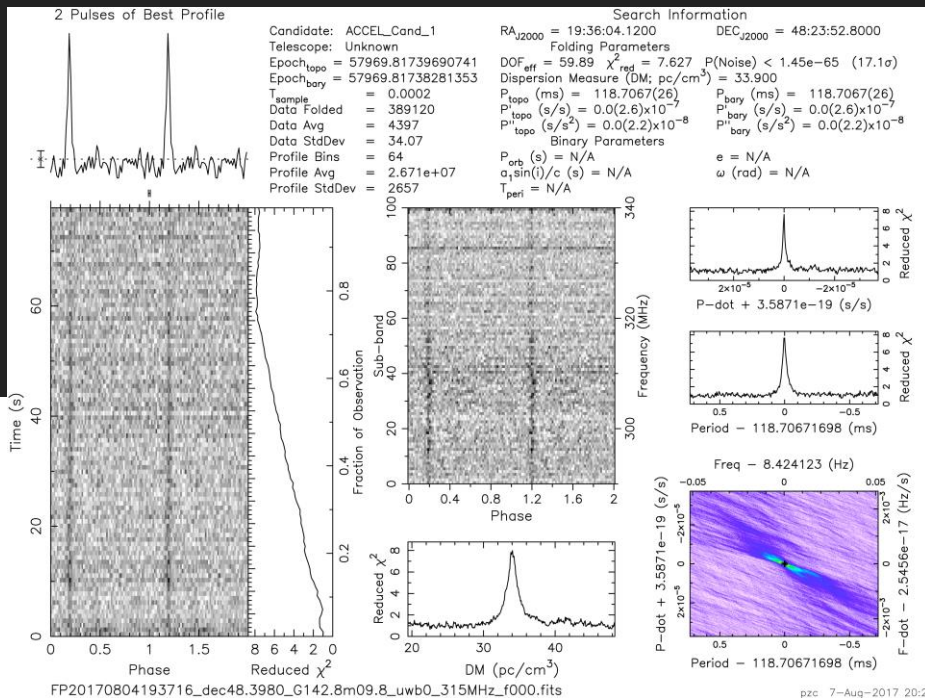
# FAST Drift-Scan Pulsar Survey

## Future – CRAFTS



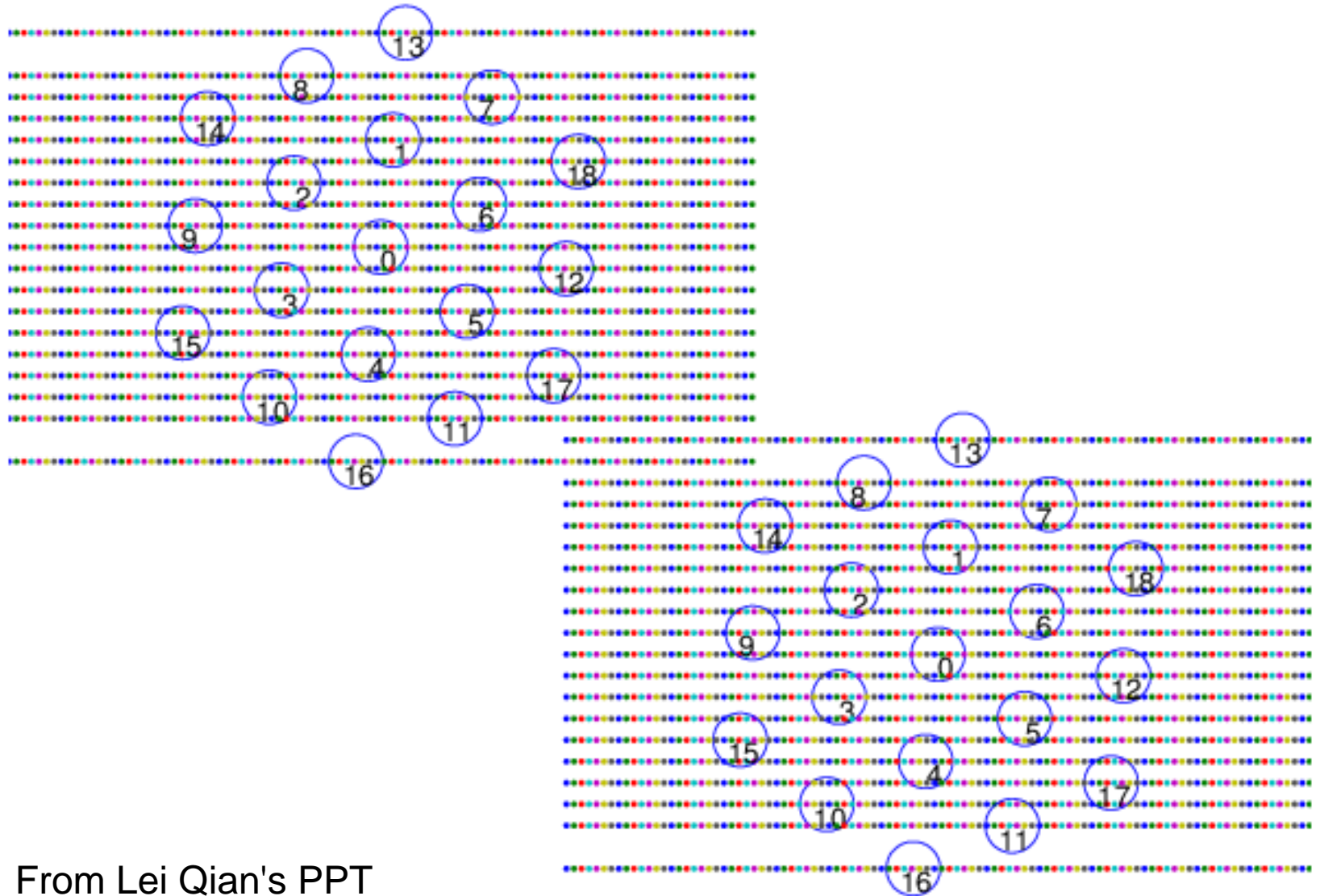
### CRAFTS

The Commensal Radio Astronomy FAST Survey  
FAST 多科学目标同时扫描巡天



# FAST Drift-Scan Pulsar Survey

Future – CRAFTS and 19-beam



From Lei Qian's PPT

# FAST Drift-Scan Pulsar Survey

## Thank you!

Zhichen Pan

Weiwei Zhu, Di Li, Youling Yue, Lei Qian, Pei Wang, .....

IPTA 2018, Albuquerque, NM  
2018-06-21

Photo Credit: Zachary and Shana