

# Ultra-wide Bandwidth Observation of 19 pulsars with Parkes Telescope



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# OUTLINES



**Background**

**Emission Properties**

**Discussion**

**Summary**

# Background

## ATNF Pulsar Catalogue, Version: 1.67

- 3300+ Pulsars
- Basic observation parameters : flux densities, pulse profiles...
- Radiation region structure, emission mechanism

❑ Lack: 78%  $S_{400}$ , 31%  $S_{1400}$ , 97%  $S_{2000}$  ;

23%  $W_{50}$ , 46%  $W_{10}$  ;

Spectrum information, Polarization

parameters

❑ Only a tiny proportion of pulsars have been studied in a relatively wide frequency range (e.g., Dai et al. 2015).

#	PSRJ		S400 (mJy)		S1400 (mJy)		S2000 (mJy)	
1	J0006+1834	<a href="#">cnt96</a>	0.2	0	<a href="#">cn95</a>	*	0	*
2	J0007+7303	<a href="#">aaa+09c</a>	*	0	*	*	0	*
3	J0011+08	<a href="#">dsm+16</a>	*	0	*	*	0	*
4	J0025-19	<a href="#">mss+20</a>	*	0	*	*	0	*
5	J0033+57	<a href="#">hrk+08</a>	*	0	*	*	0	*
6	J0033+61	<a href="#">hrk+08</a>	*	0	*	*	0	*
7	J0034+69	<a href="#">slr+14</a>	4.5	0	<a href="#">slr+14</a>	*	0	*
8	J0038-2501	<a href="#">acd+19</a>	*	0	*	*	0	*
9	J0039+35	<a href="#">scb+19</a>	*	0	*	*	0	*
10	J0048+3412	<a href="#">dtws85</a>	2.3	3	<a href="#">lylg95</a>	*	0	*
11	J0050+03	<a href="#">dsm+16</a>	*	0	*	*	0	*
12	J0054+66	<a href="#">hrk+08</a>	*	0	*	*	0	*
13	J0054+6946	<a href="#">slr+14</a>	*	0	*	*	0	*
14	J0056+4756	<a href="#">dtws85</a>	3.0	5	<a href="#">lylg95</a>	*	0	*
15	J0057-7201	<a href="#">ckm+01</a>	*	0	*	*	0	*

#	PSRJ		W50 (ms)		W10 (ms)	
1	J0002+6216	<a href="#">cwp+17</a>	*	0	*	*
2	J0007+7303	<a href="#">aaa+09c</a>	*	0	*	*
3	J0043-73	<a href="#">tsm+19</a>	*	0	*	*
4	J0052-72	<a href="#">tsm+19</a>	*	0	*	*
5	J0054+66	<a href="#">hrk+08</a>	*	0	*	*
6	J0057-7201	<a href="#">ckm+01</a>	*	0	*	*
7	J0100-7211	<a href="#">lfmp02</a>	*	0	*	*
8	J0106+4855	<a href="#">pga+12</a>	*	0	*	*
9	J0146+6145	<a href="#">ims94</a>	*	0	*	*
10	J0158+21	<a href="#">dsm+13</a>	*	0	*	*
11	J0229+20	<a href="#">dsm+13</a>	*	0	*	*
12	J0241+16	<a href="#">dsm+13</a>	*	0	*	*
13	J0244+14	<a href="#">dsm+13</a>	*	0	*	*
14	J0337+79	<a href="#">kk1+15</a>	*	0	*	*
15	J0357+3205	<a href="#">aaa+09c</a>	*	0	*	*

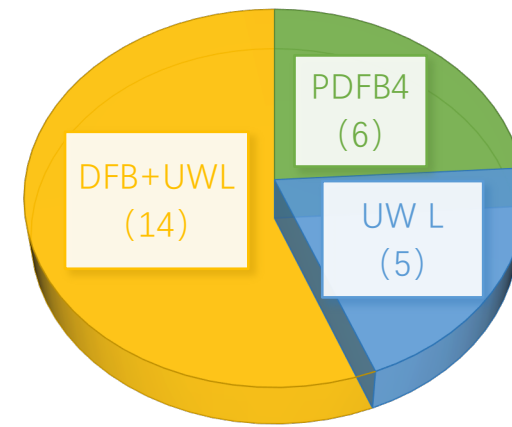


# Objectives and Results

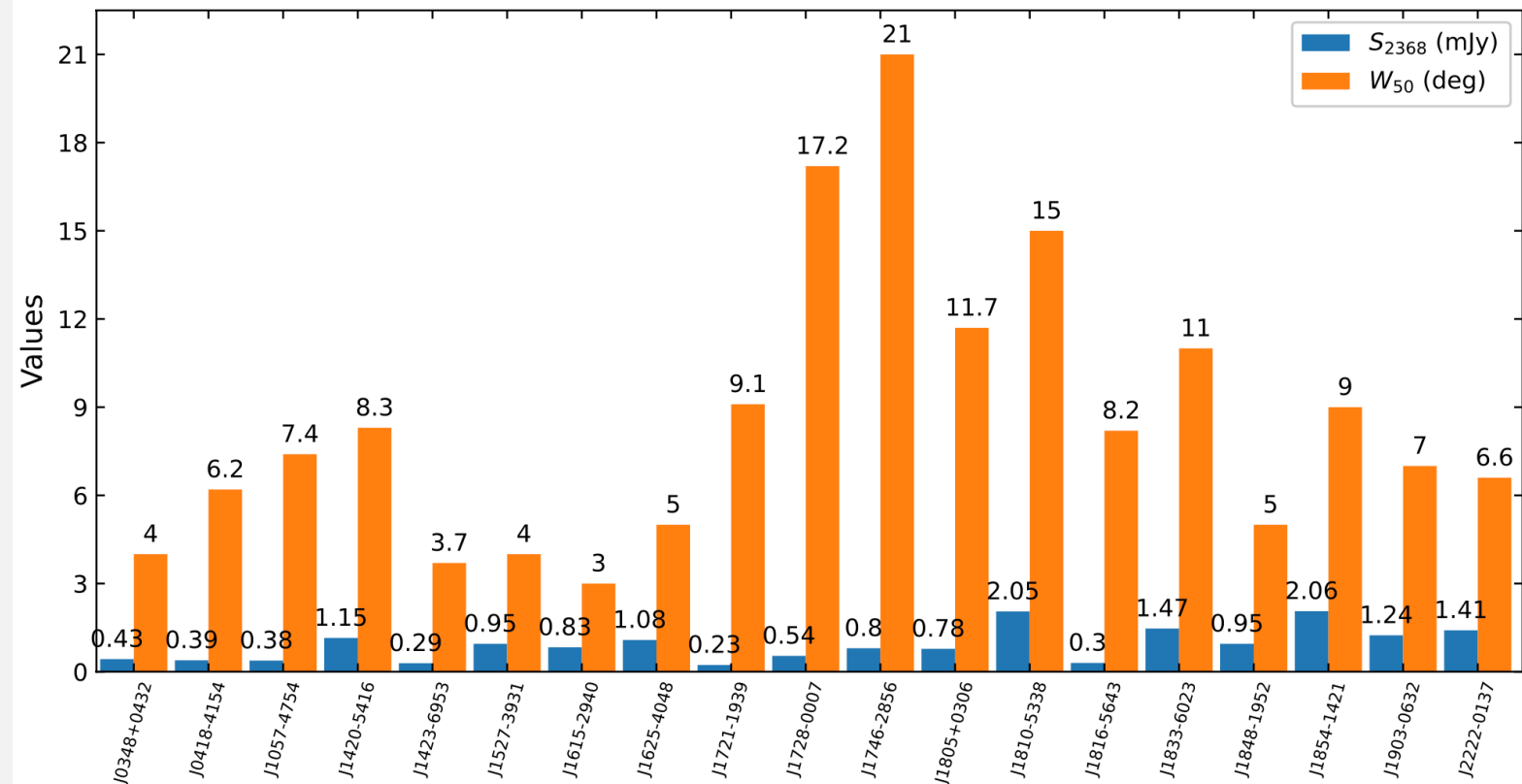
**Targets: 54 pulsars (P1004)**

- Time length: 24 hours in total
- Each pulsar: 10—30minutes
- Time : Sep. 2019
- Mode: Fold
- Backend: Medusa ,PDFB4  
UWL:704~4032MHz([Hobbs et al. 2020](#))
- Location: majority of the pulsars lie close to the Galactic plane
- Discovered in the Molonglo surveys or with the Parkes 70 cm receiver ([Manchester et al.1978](#))

TOTAL : 25

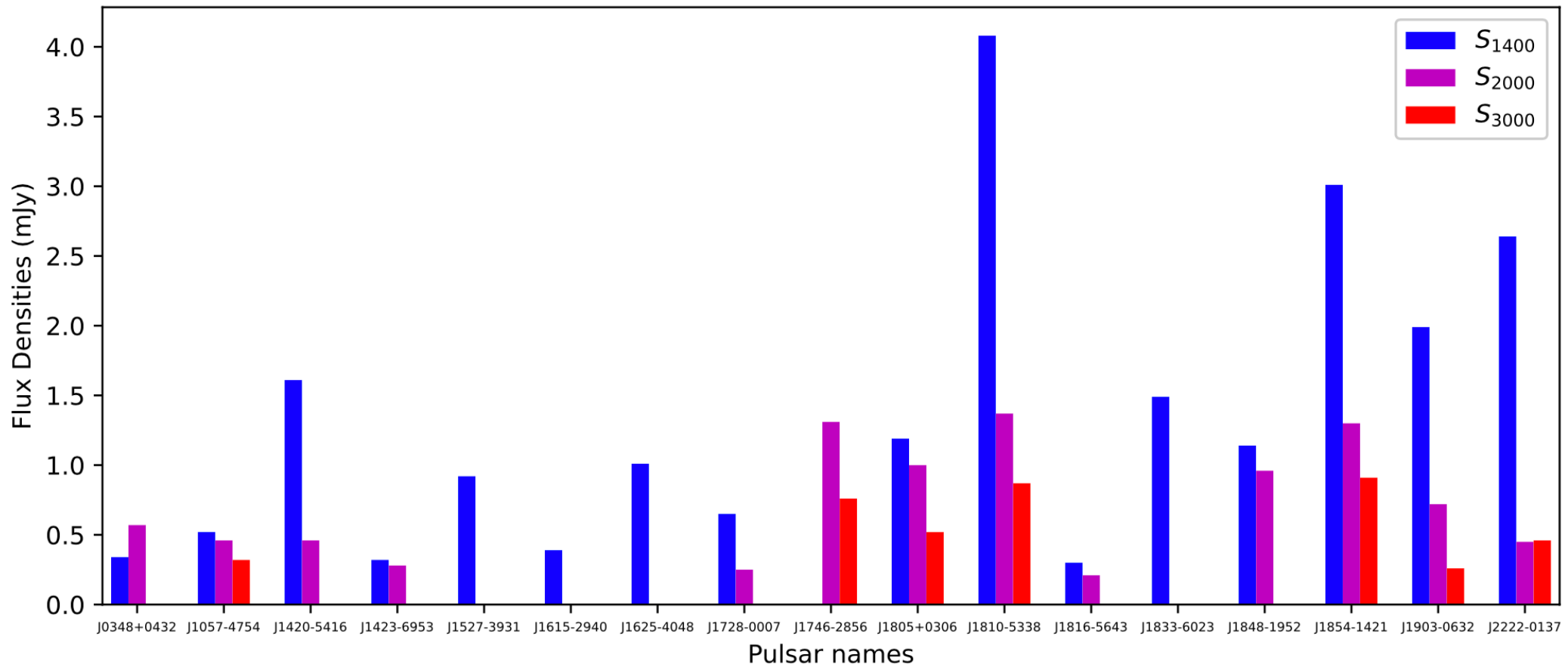


19 Pulsars Observational Parameters



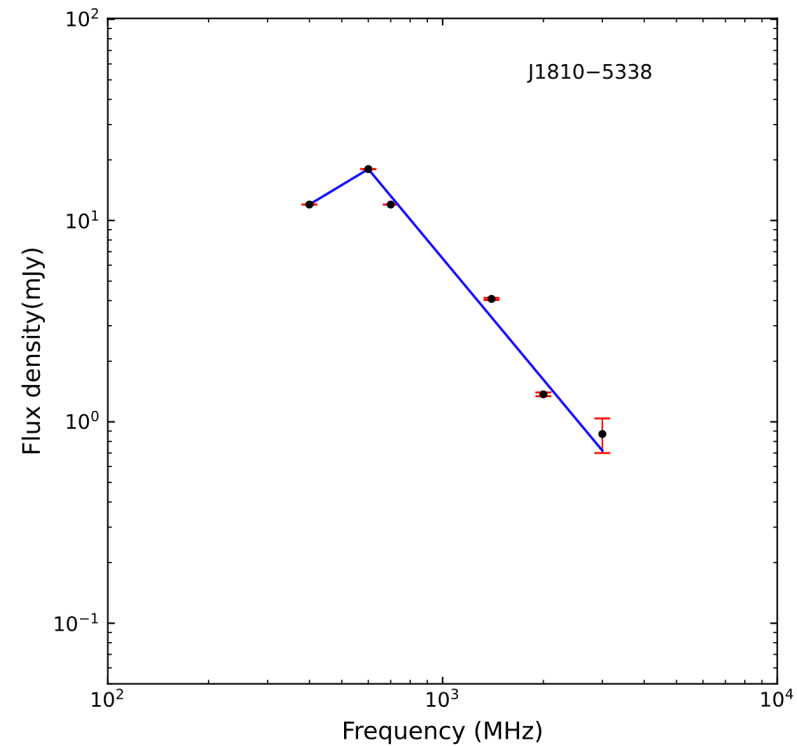
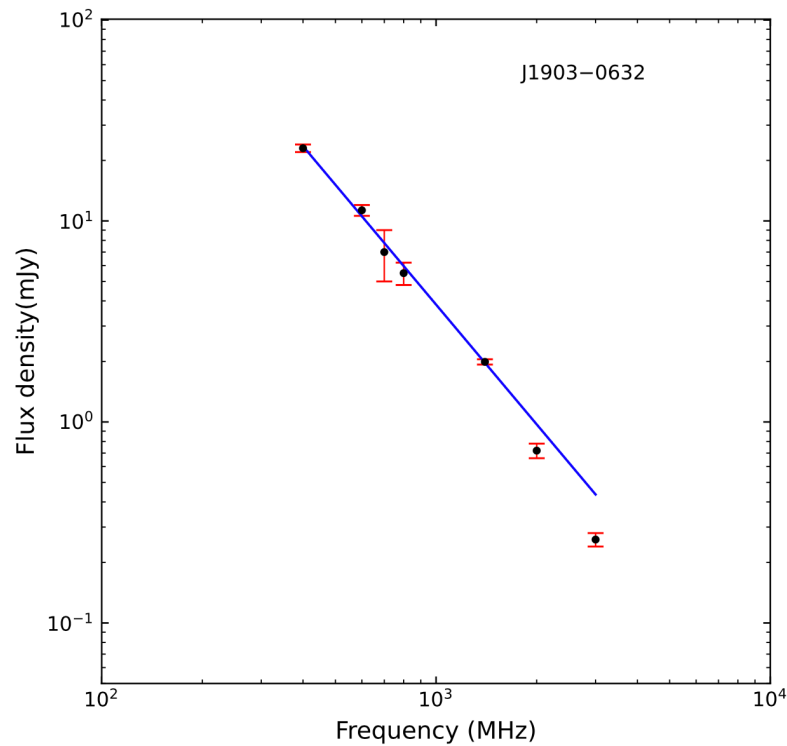
# Flux density measurements

- Many pulsars have been observed at one or other frequencies of 150, 200, 300, 400, 600, 700, 800, 1400, 2000, 3000 and 6000 MHz (e.g., [Dai et al. 2015](#); [Jankowski et al. 2018](#)).
- Three sub-bands: 400, 400, and 600 MHz
- Can't be measured since too many frequency channels are removed
- The pulse profiles of only one or two sub-bands can be seen for some pulsars



# Spectral indices

- Five spectral modes: *Simple power law (17)* , *Broken power law (1)* , Log-parabolic spectrum, Power law with high-frequency cut-off, Power law with low-frequency turn-over ([Jankowski et al.2018](#))
- 17 spectral indices: range (-0.6, -3.10), flatter than the mean values(-1.6)

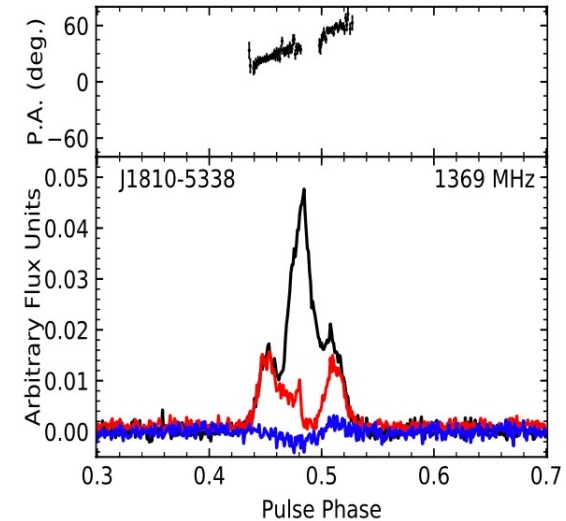
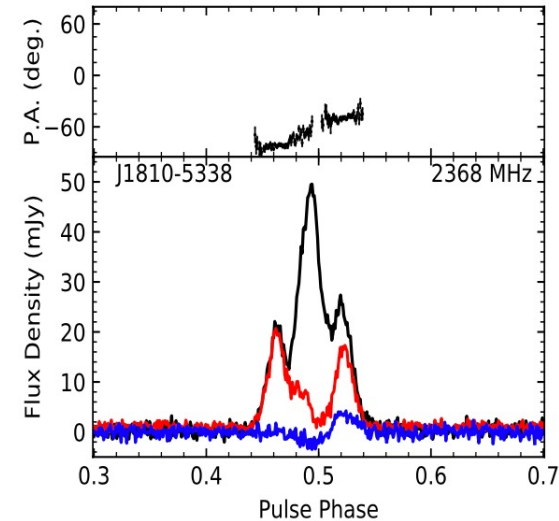
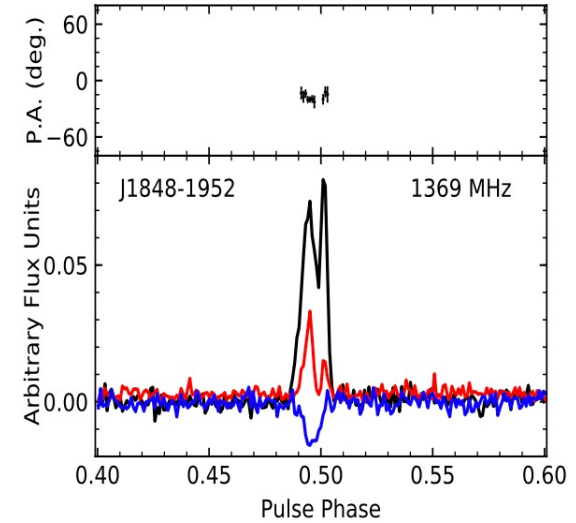
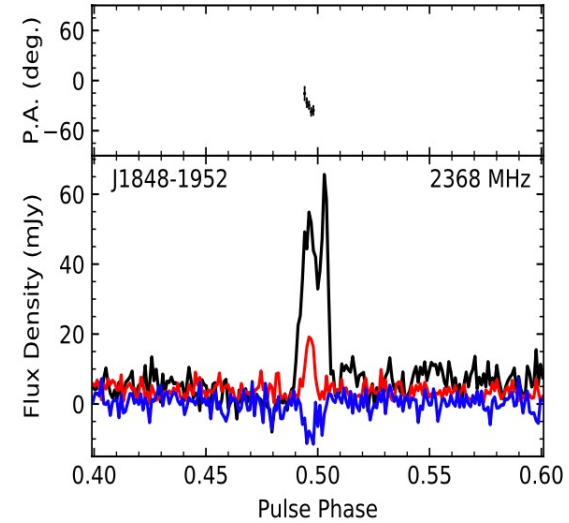
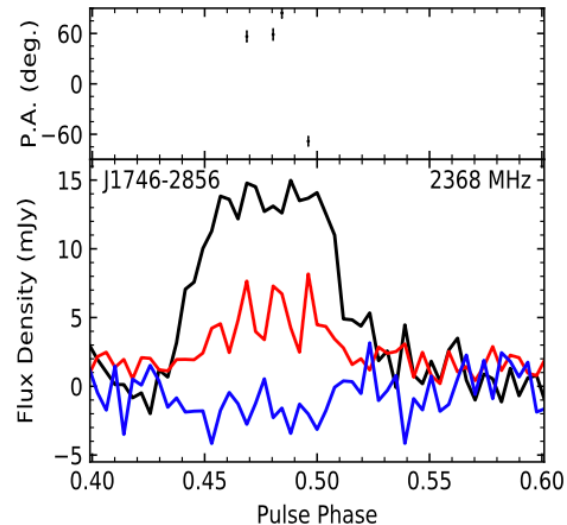
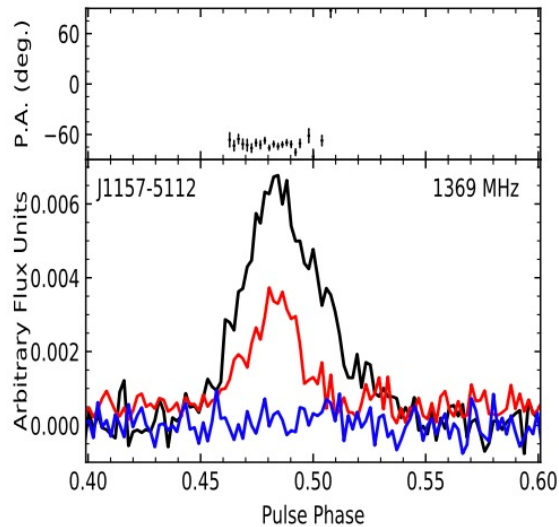




# Polarization profiles

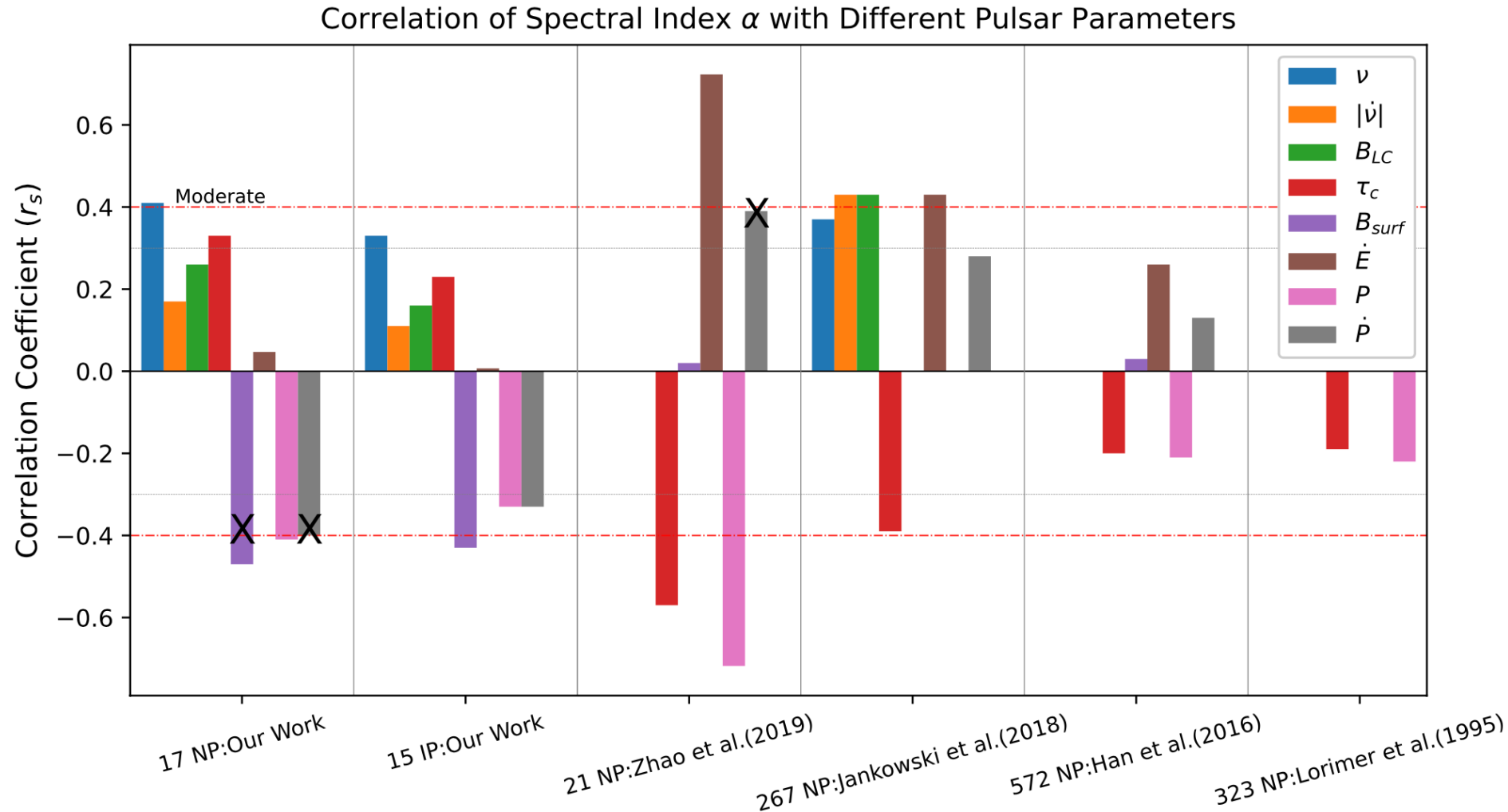
- 13 pulsars: 6 in both freqs, 7 in 1369 or 2368 MHz
- No “S” or “OPM” (Yan et al. 2011)
- Diversity of polarization?
- Evolution ?
- 12 pulsar, no polarization? (Zhou et al. 2022)

Pulse widths: 17  $W_{50}$ , 10 decrease, 6 increase





# Correlations



- Spearman rank correlation coefficient:  $p < 5\%$ ,  $r_s \geq 0.4$
- No consistent correlation is found across the different samples, and results from disparate samples are distinct





# Possible explanations

The minimum detectable flux density of the UWL system: 
$$S_{min} = \frac{\alpha \beta T_{sys}}{G(N_p \Delta \nu T)^{1/2}} \left( \frac{W}{P-W} \right)^{1/2}$$

- For 19 pulsars with different duty cycles: 0.02 — 0.76mJy
- Estimated  $S_{2368}$  for 22 pulsars: 0.06 — 1.34mJy ([Zhou et al. 2022](#))

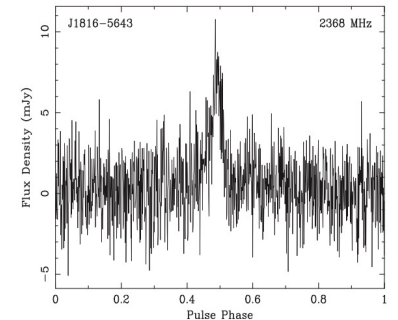
## 29 pulsars undetected

- ✓ Equation is not suitable for estimating the sensitivity of the UWL system
- ✓ The flux density of a pulsar decreases rapidly with increasing observing frequency
- ✓ The bandwidth of the UWL system cannot be fully utilized
- ✓ The radio emission of pulsars is strongly affected by propagation through the interstellar medium ([Kumamoto et al. 2021](#))



## The non-detection of polarization in rest 12 pulsars:

- The S/N of some pulse profiles (PSRs J0057-7201, J1816-5548, etc.) is low
- For a medium S/N, the degree of linear polarization for other pulsars may be low





# Summary



The **first time** to report the **emission properties** of 19 pulsars observed with the UWL system.

Discussed the reason why some pulsars or relevant information are **not detected under the UWL system**: RFI ? Bandwidth ? IMS ?

Many pulsars still lack basic information, and we **need to continue this work** in the future **by observing each pulsar for a longer time** or **using telescopes with larger observation apertures** (such as FAST) at a specific frequency.

Thanks !