

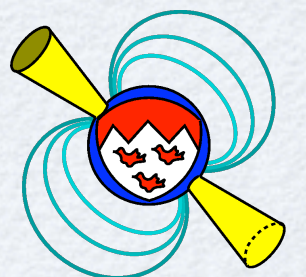
DISCOVERIES OF ROTATING RADIO TRANSIENTS IN THE 350 MHz GREEN BANK TELESCOPE DRIFT-SCAN SURVEY

Chen Karako

McGill University

IAU Symposium 291, Beijing

Aug. 21, 2012



DRIFT-SCAN COLLABORATION

- **Anne Archibald (McGill)**
- Aaron Berndsen (UBC)
- Jason Boyles (WVU)
- Fernando Cardoso (WVU)
- Angus Cherry (UBC)
- Jason Hessels (ASTRON)
- **Vicky Kaspi (McGill)**
- Vlad Kondratiev (ASTRON)
- Joeri van Leeuwen (ASTRON)
- Duncan Lorimer (WVU)
- **Ryan Lynch (McGill)**
- Maura McLaughlin (WVU)
- Christie McPhee (UBC)
- Tim Pennucci (UVA)
- Scott Ransom (NRAO)
- Mallory Roberts (Eureka)
- Ingrid Stairs (UBC)

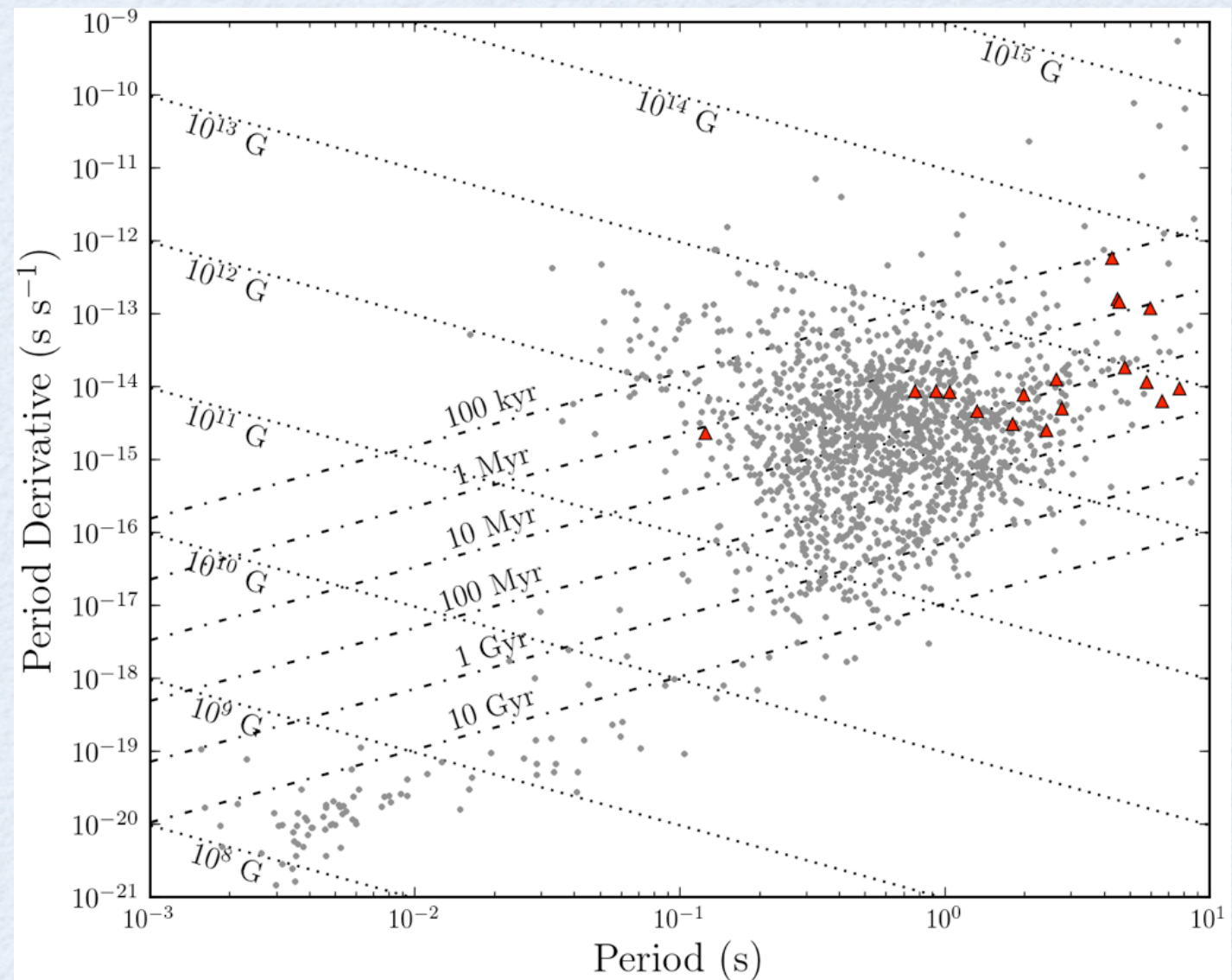
WHAT'S A RRAT?



- Definitions vary...
 - A pulsar only detectable by its single pulses
 - Pulses not detectable every period; up to ~1000 periods of separation between pulses
- Won't be seen in periodicity searches

MOTIVATION

- Why search for RRATs?
- Known RRAT population very small
- Don't yet know where fit in with pulsar population
 - Evolutionary link?
- RRATs may outnumber regular pulsars!



RRAT parameters taken from The RRATalog (McLaughlin).

GBT DRIFT-SCAN SURVEY

- How do we search for RRATs?
- GBT 350 MHz Drift-Scan Survey
 - 30,000 140-s pointings, 10347 sq deg
- Produce diagnostic single pulse plots as part of survey processing (PRESTO)
- Manually examine plots



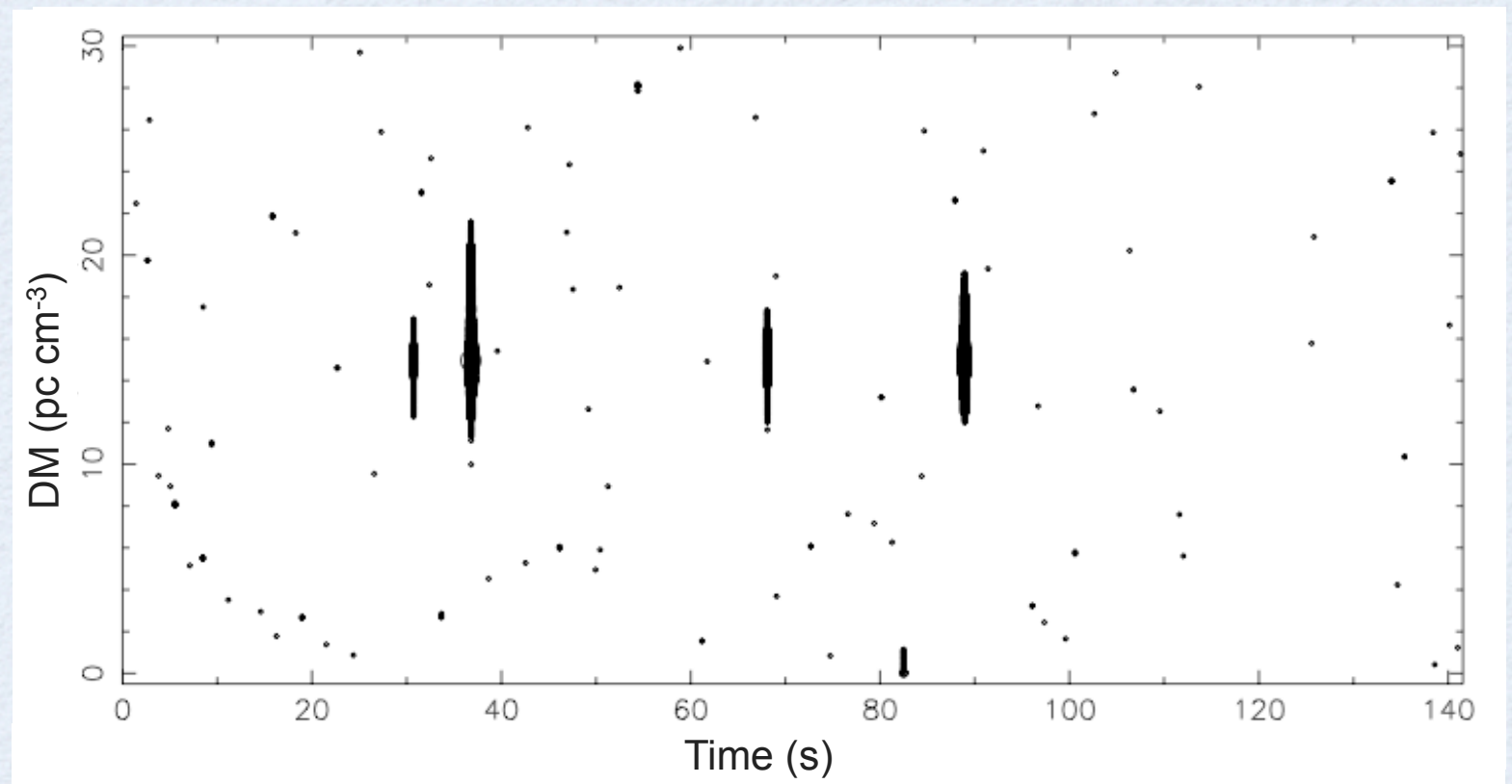
Image credit: NRAO

SEARCH ALGORITHM

- Why automate the search for RRATs?
- 30,000+ pointings in GBT drift-scan survey = 30,000+ single pulse plots to manually examine = *tedious!*
- Developed a post-processing identification algorithm for single pulse candidates: **distinguish astrophysical pulses from RFI**
- Universal: can be applied to future surveys

SEARCH ALGORITHM

- Initially: single pulse candidate events for every beam
 - dot size $\sim S/N$
- Idea: **group** together events which may belong to the same pulse, based on proximity in t , DM



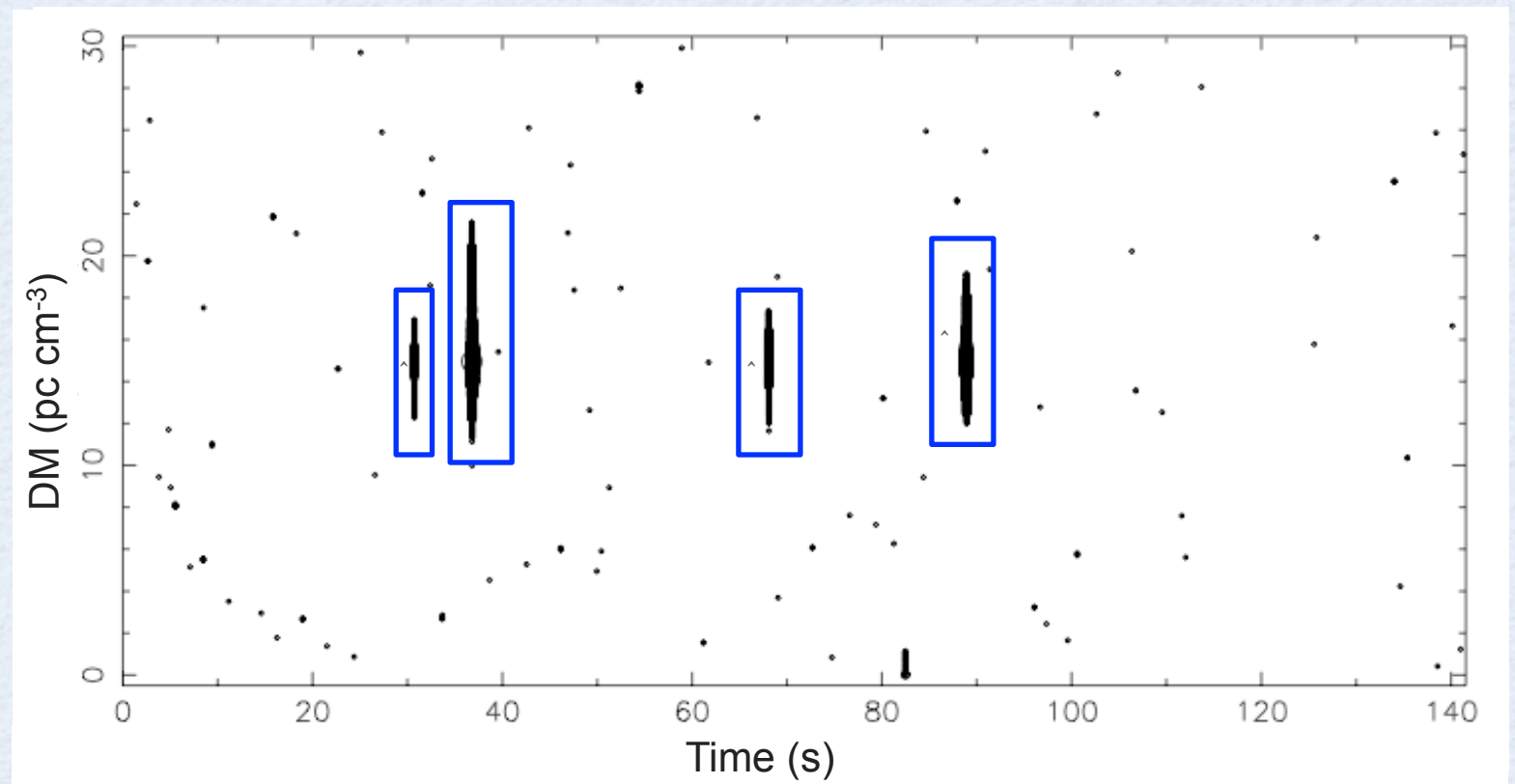
Single pulse plot for RRAT J2324-0507.

SEARCH ALGORITHM

- Initially: single pulse candidate events for every beam

- dot size $\sim S/N$

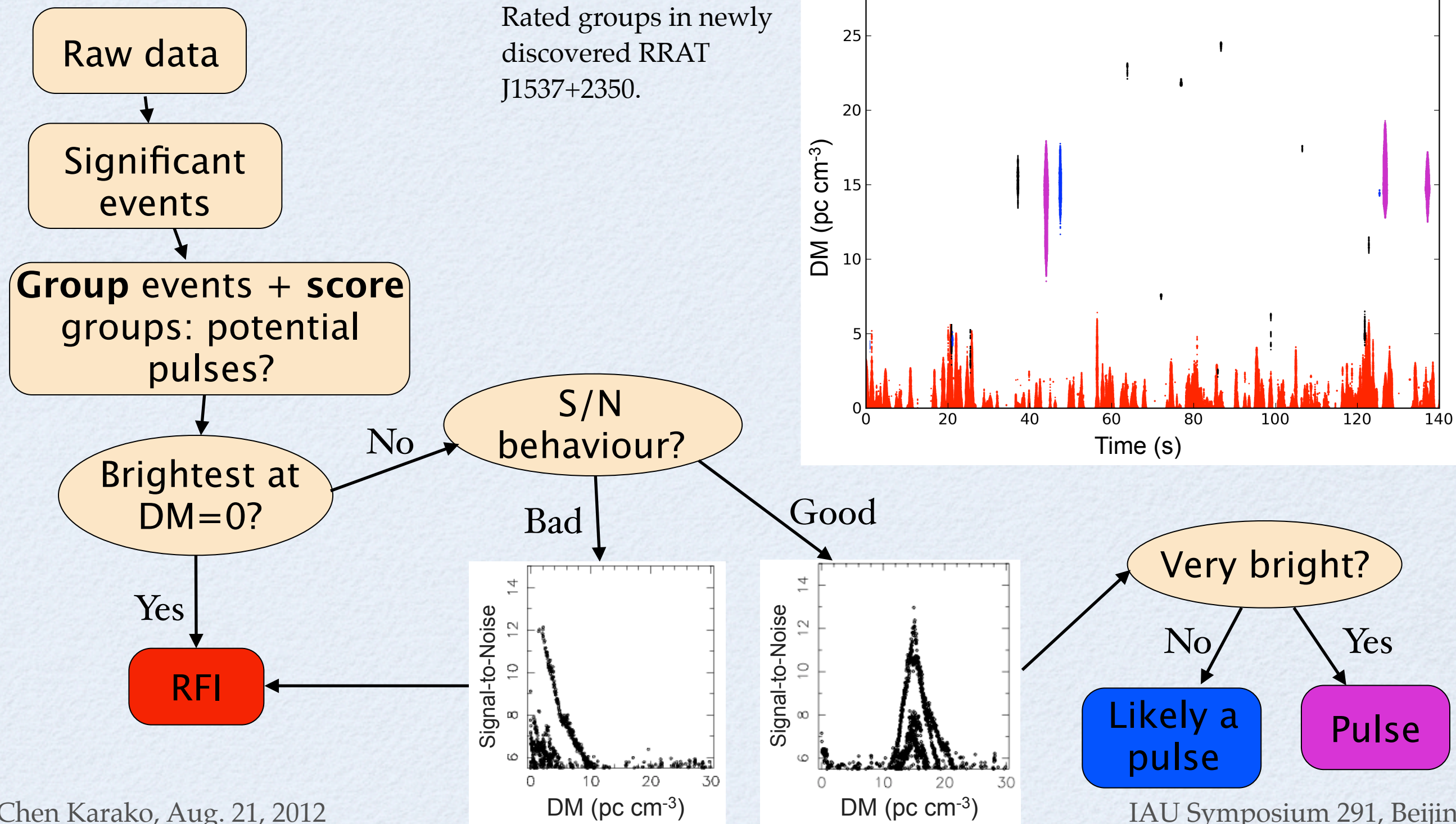
- Idea: **group** together events which may belong to the same pulse, based on proximity in t , DM



Single pulse plot for RRAT J2324-0507.

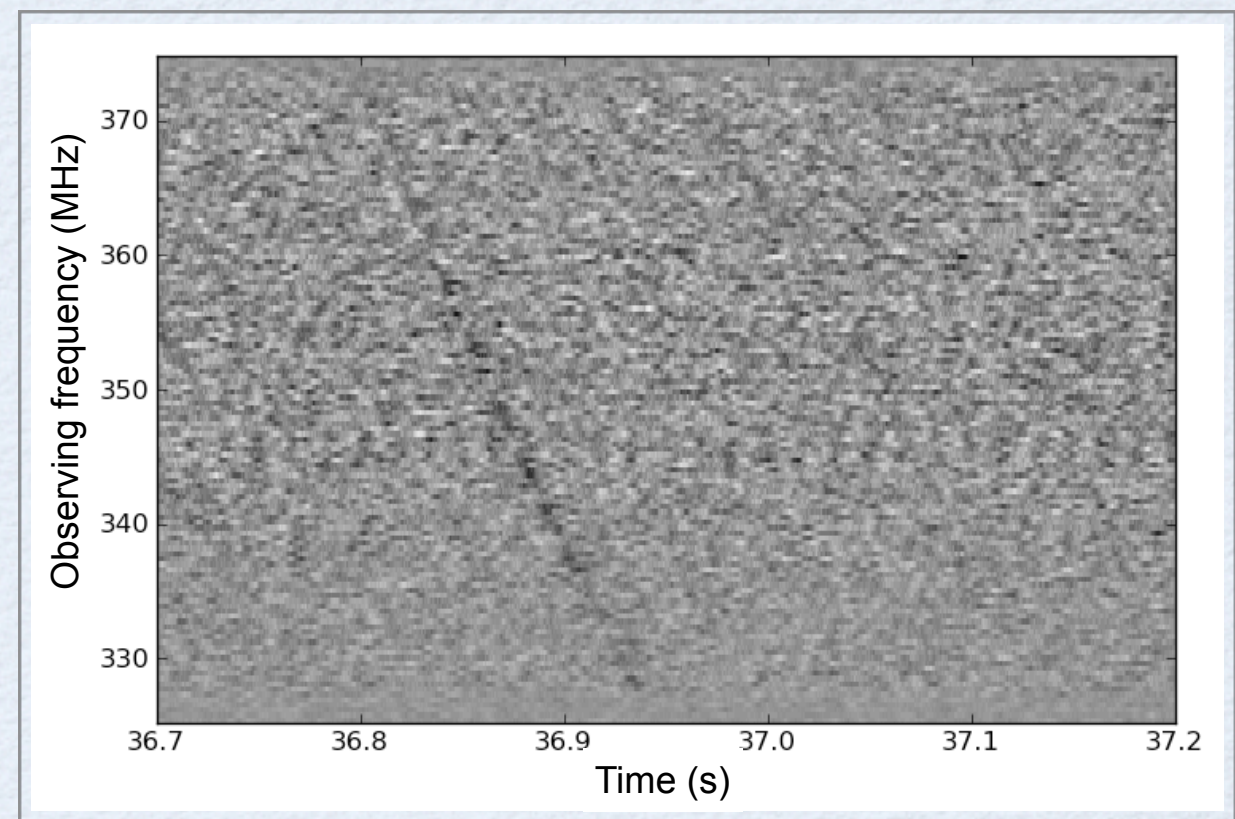
- then: **score** groups to distinguish astrophysical pulses from RFI

SEARCH ALGORITHM



SEARCH ALGORITHM

- Finally, examine flagged beams
- Go back to raw data to check for dispersion relation (“waterfall plots”)



RRAT J2324-0507

RESULTS

- **34 RRAT candidates** found overall in drift-scan survey
 - vs. 31 regular pulsars (!)
- Of the 8 followed up, 7 have been confirmed
- Hope to begin timing these sources soon
- Remaining candidates await confirmation observations

Table 1. Properties of New Drift-Scan RRATs

Name	Discovery Position		DM (pc cm ⁻³)	# Pulses detected (discovery)	Burst rate* (/hr)	P* (s)
	R.A. (J2000) (h m s)	Dec. (J2000) (° ' ")				
RRAT 1704−0440	17:04:54.43	−04:40:37.9	43±1	1		0.238
RRAT 1537+2350	15:37:47.36	+23:50:51.1	15±1	5	77 ± 14	3.45
RRAT 1944−1017	19:44:08.58	−10:17:07.2	31±1	9	77 ± 14	0.409
RRAT 2324−0507	23:24:22.17	−05:07:36.0	15±1	4	46 ± 9	0.869
RRAT 2006+2021	20:06:54.79	+20:21:05.8	66±1	3		4.63
RRAT 0206−0443	02:06:11.00	−04:43:33.4	15±1	1		
RRAT 0447−0442	04:47:03.79	−04:42:15.2	30±1	4		4.38
RRAT 0513−0417	05:13:20.72	−04:17:53.4	19±1	1		
RRAT 0526−1908	05:26:04.86	−19:08:48.8	26±2	1		
RRAT 0544−0309	05:44:46.42	−03:09:44.9	68±2	3		
RRAT 0606−0129	06:06:37.50	−01:29:23.9	17±3	1		
RRAT 0614−0328	06:14:37.82	−03:28:44.9	18±1	5		0.136
RRAT 0645−0128	06:45:39.55	−01:28:58.1	15±2	2		
RRAT 0706−1058	07:06:43.16	−10:58:20.3	19±1	1		
RRAT 0719−1907	07:19:38.34	−19:07:30.2	27±1	3		
RRAT 0807−1057	08:07:02.66	−10:57:41.4	18±1	2		
RRAT 0808−0746	08:08:43.30	−07:46:58.9	36±1	1		
RRAT 0858−0746	08:58:23.86	−07:46:31.4	40±3	4		0.884
RRAT 0957−0617	09:57:09.05	−06:17:20.5	27±1	7		1.72
RRAT 1059−0102	10:59:31.93	−01:02:01.6	18±1	1		
RRAT 1132+2455	11:32:09.18	+24:55:58.7	24±1	3		1.00
RRAT 1222−1806	12:22:25.02	−18:06:27.5	17±1	1		
RRAT 1236−1806	12:36:36.40	−18:06:28.1	18±1	1		
RRAT 1253−0101	12:53:04.55	−01:01:56.4	170±5	1		
RRAT 1332−0326	13:32:14.78	−03:26:26.3	27±1	2		
RRAT 1336−2034	13:36:28.21	−20:34:21.8	19±1	3		0.184
RRAT 1610−0128	16:10:58.44	−01:28:04.0	27±1	1		
RRAT 1914−1129	19:14:46.31	−11:29:33.5	90±1	1		
RRAT 2335−0443	23:35:51.41	−04:43:50.3	15±1	1		

*Note the period may be an integer fraction of the tabulated value.

Table 1. Properties of New Drift-Scan RRATs

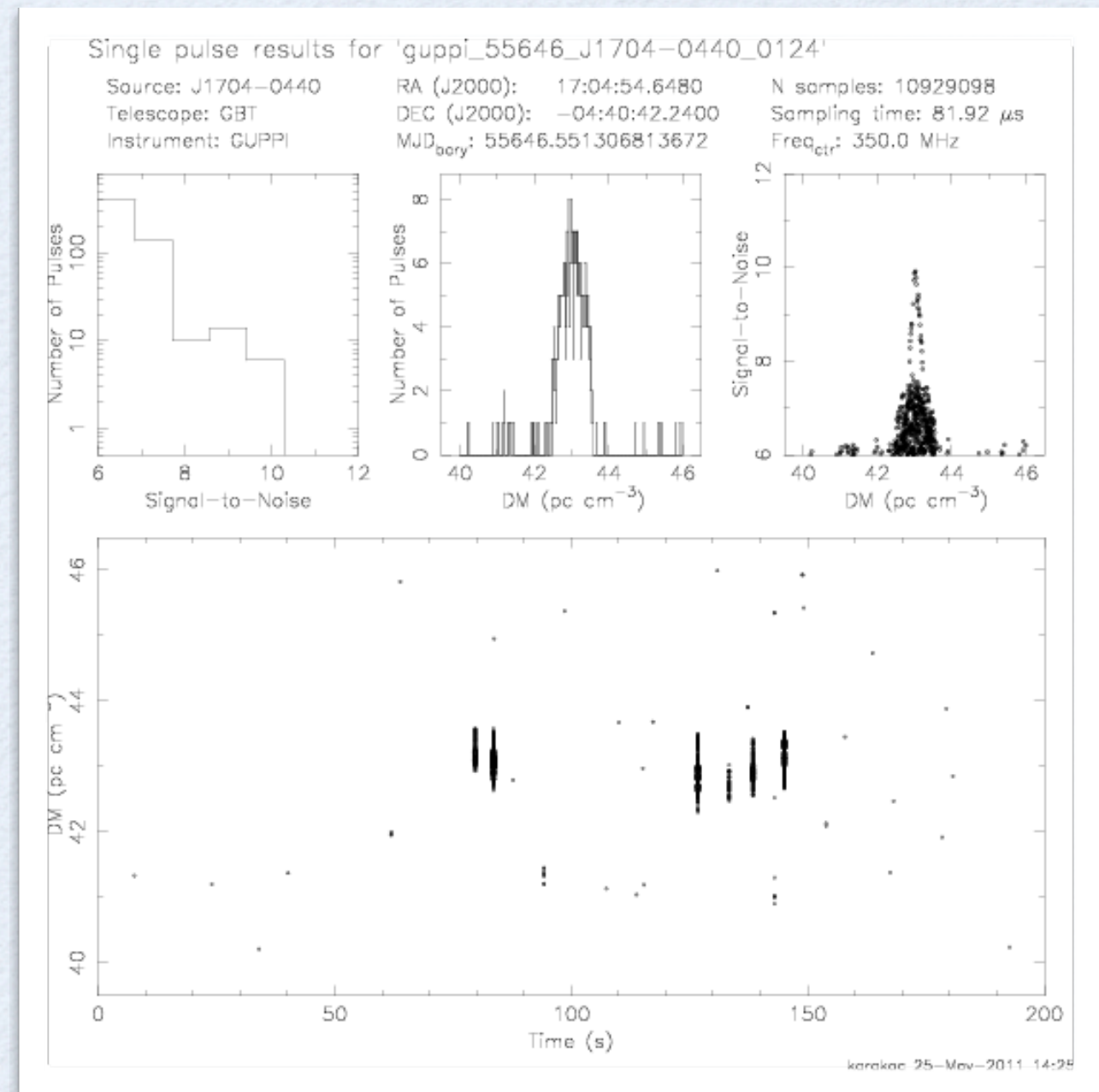
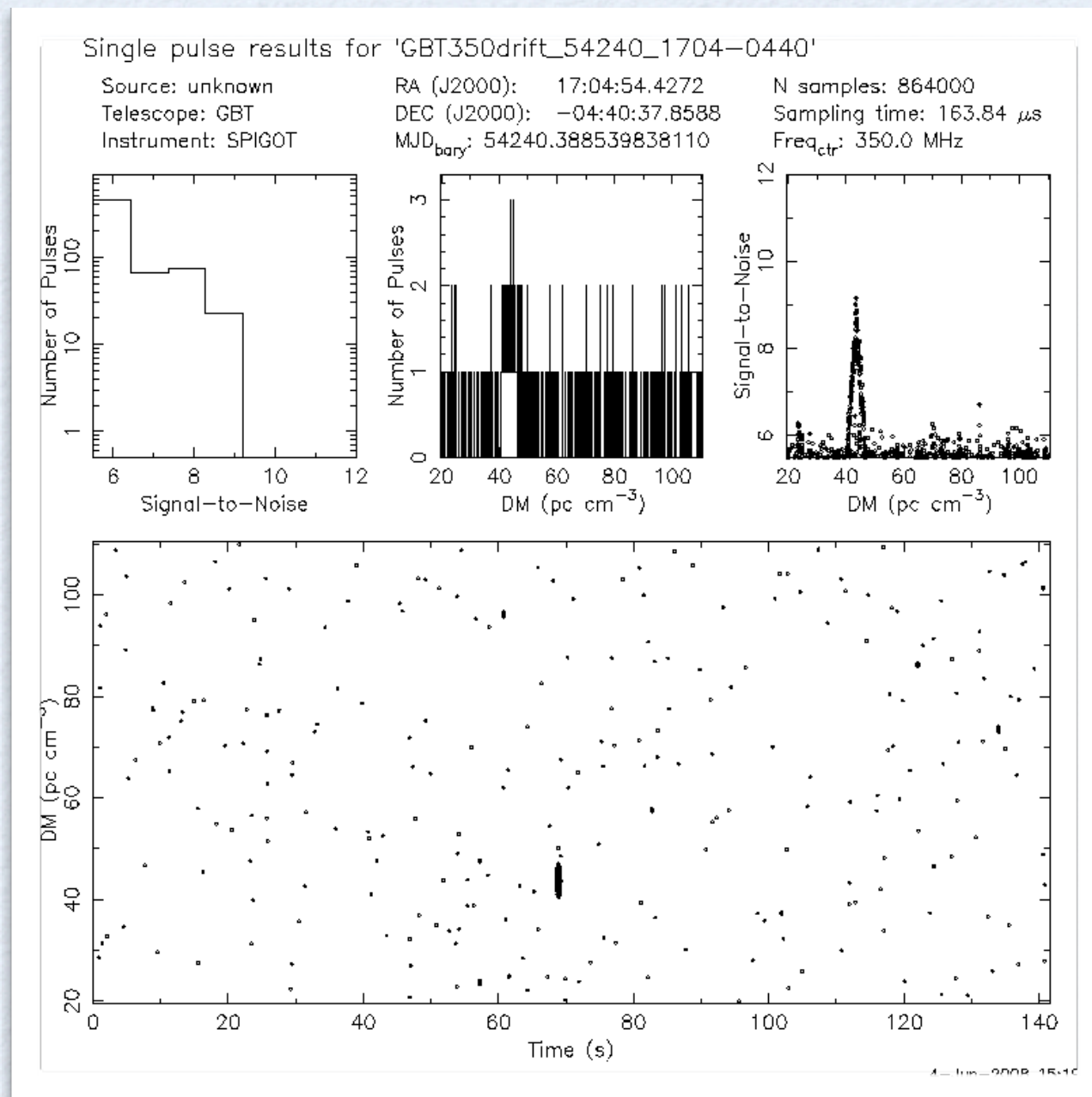
Name	Discovery Position		DM (pc cm ⁻³)	# Pulses detected (discovery)	Burst rate* (/hr)	P* (s)
	R.A. (J2000) (h m s)	Dec. (J2000) (° ' ")				
RRAT 1704−0440	17:04:54.43	−04:40:37.9	43±1	1		0.238
RRAT 1537+2350	15:37:47.36	+23:50:51.1	15±1	5	77 ± 14	3.45
RRAT 1944−1017	19:44:08.58	−10:17:07.2	31±1	9	77 ± 14	0.409
RRAT 2324−0507	23:24:22.17	−05:07:36.0	15±1	4	46 ± 9	0.869
RRAT 2006+2021	20:06:54.79	+20:21:05.8	66±1	3		4.63
RRAT 0206−0443	02:06:11.00	−04:43:33.4	15±1	1		
RRAT 0447−0442	04:47:03.79	−04:42:15.2	30±1	4		4.38
RRAT 0513−0417	05:13:20.72	−04:17:53.4	19±1	1		
RRAT 0526−1908	05:26:04.86	−19:08:48.8	26±2	1		
RRAT 0544−0309	05:44:46.42	−03:09:44.9	68±2	3		
RRAT 0606−0129	06:06:37.50	−01:29:23.9	17±3	1		
RRAT 0614−0328	06:14:37.82	−03:28:44.9	18±1	5		0.136
RRAT 0645−0128	06:45:39.55	−01:28:58.1	15±2	2		
RRAT 0706−1058	07:06:43.16	−10:58:20.3	19±1	1		
RRAT 0719−1907	07:19:38.34	−19:07:30.2	27±1	3		
RRAT 0807−1057	08:07:02.66	−10:57:41.4	18±1	2		
RRAT 0808−0746	08:08:43.30	−07:46:58.9	36±1	1		
RRAT 0858−0746	08:58:23.86	−07:46:31.4	40±3	4		0.884
RRAT 0957−0617	09:57:09.05	−06:17:20.5	27±1	7		1.72
RRAT 1059−0102	10:59:31.93	−01:02:01.6	18±1	1		
RRAT 1132+2455	11:32:09.18	+24:55:58.7	24±1	3		1.00
RRAT 1222−1806	12:22:25.02	−18:06:27.5	17±1	1		
RRAT 1236−1806	12:36:36.40	−18:06:28.1	18±1	1		
RRAT 1253−0101	12:53:04.55	−01:01:56.4	170±5	1		
RRAT 1332−0326	13:32:14.78	−03:26:26.3	27±1	2		
RRAT 1336−2034	13:36:28.21	−20:34:21.8	19±1	3		0.184
RRAT 1610−0128	16:10:58.44	−01:28:04.0	27±1	1		
RRAT 1914−1129	19:14:46.31	−11:29:33.5	90±1	1		
RRAT 2335−0443	23:35:51.41	−04:43:50.3	15±1	1		

*Note the period may be an integer fraction of the tabulated value.

DISCOVERY & CONFIRMATION

- J1704-0440, $P=0.238$ s

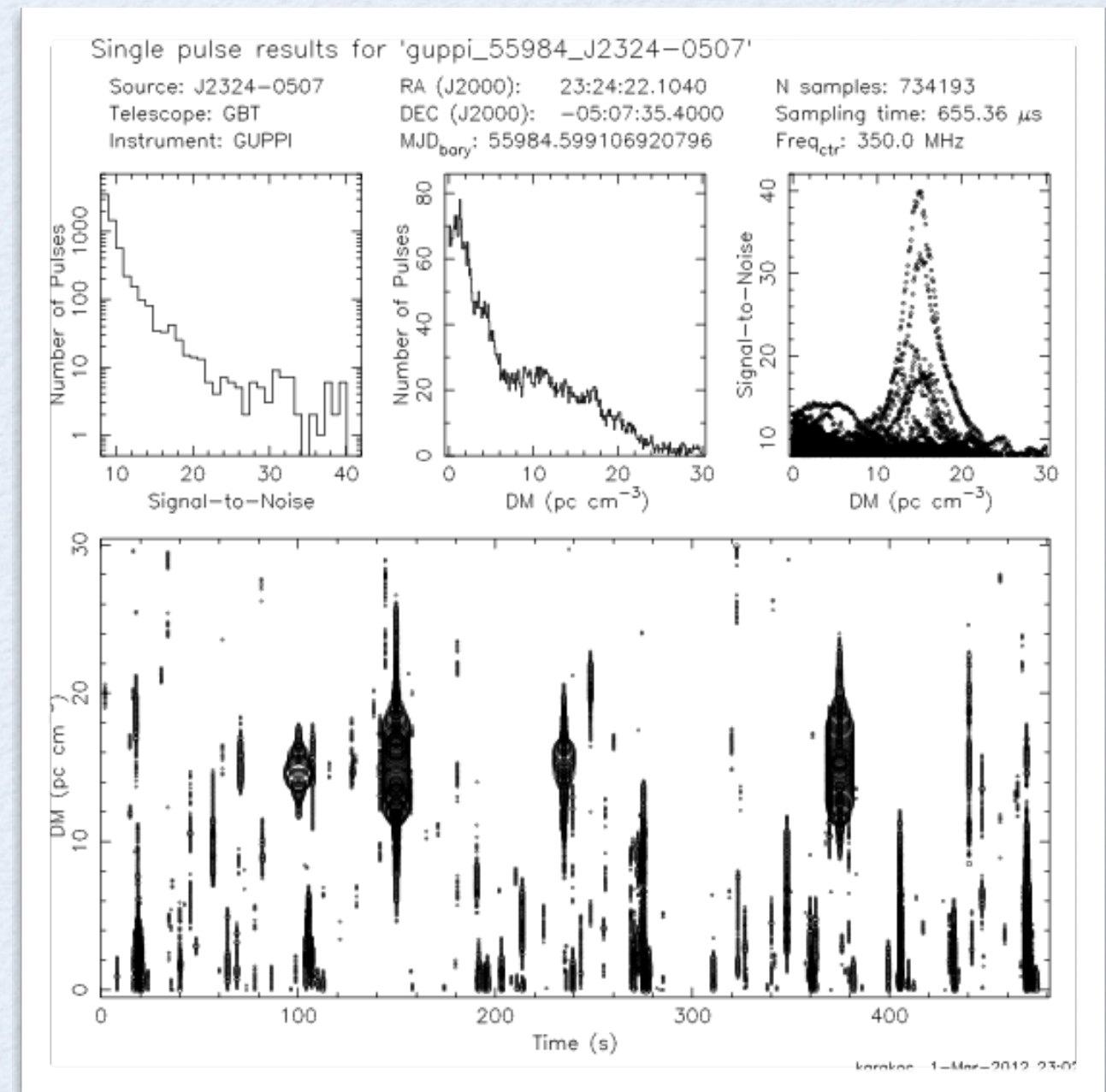
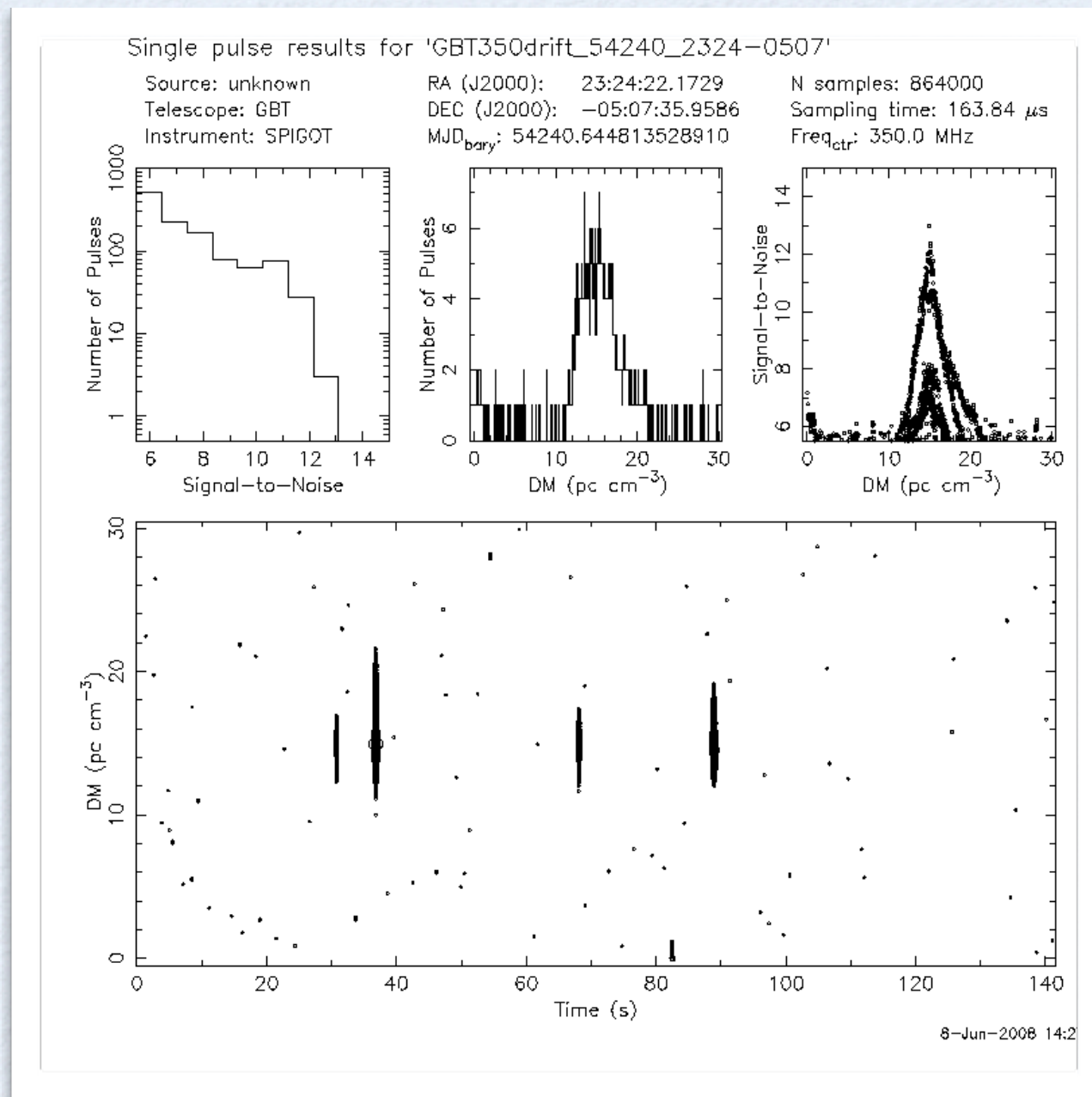
✓ CONFIRMED



DISCOVERY & CONFIRMATION

- J2324-0507, $P=0.869$ s

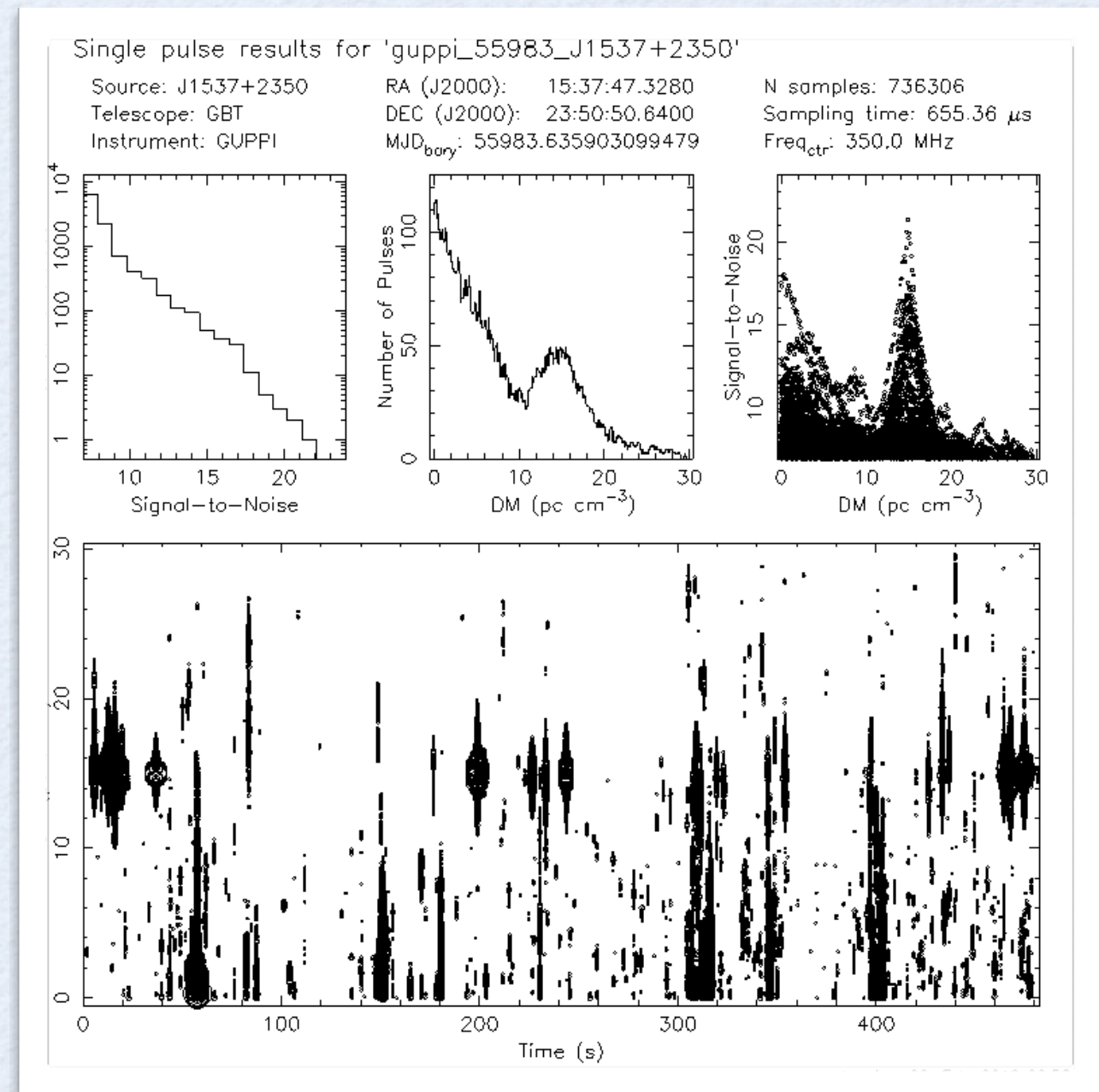
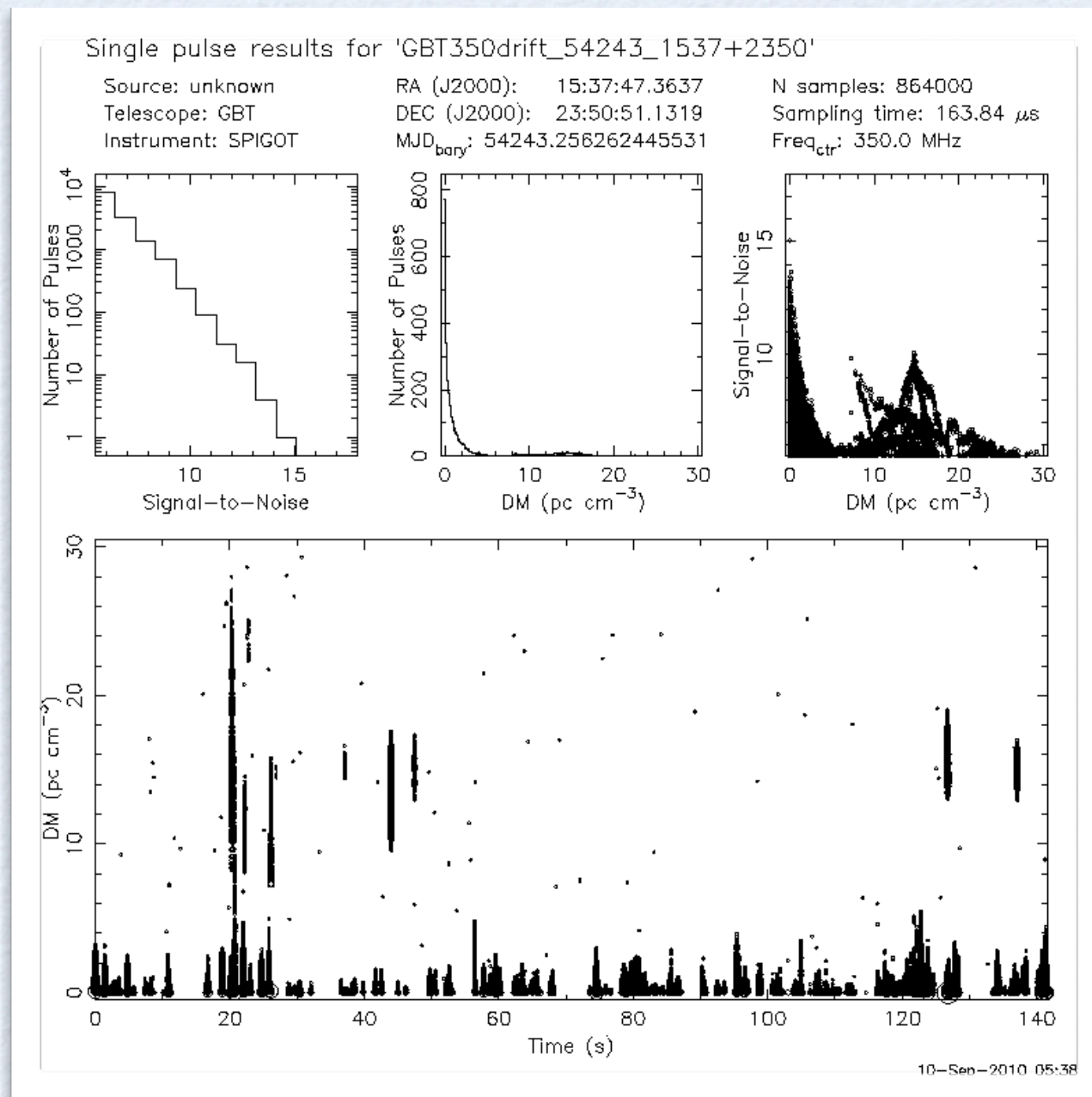
✓ CONFIRMED



DISCOVERY & CONFIRMATION

- J1537+2350, $P=3.45$ s

✓ CONFIRMED



LOOKING AHEAD...

- Timing of confirmed sources
- Follow up of remaining 26 candidates
- Improvements to algorithm will allow to identify weaker pulses (there may still be more RRATs in the data!)
- Making code more robust to RFI will further reduce time spent manually examining flagged plots
- **Implement code on other surveys, eg. GBNCC**