The Green Bank North Celestial Cap Pulsar Survey

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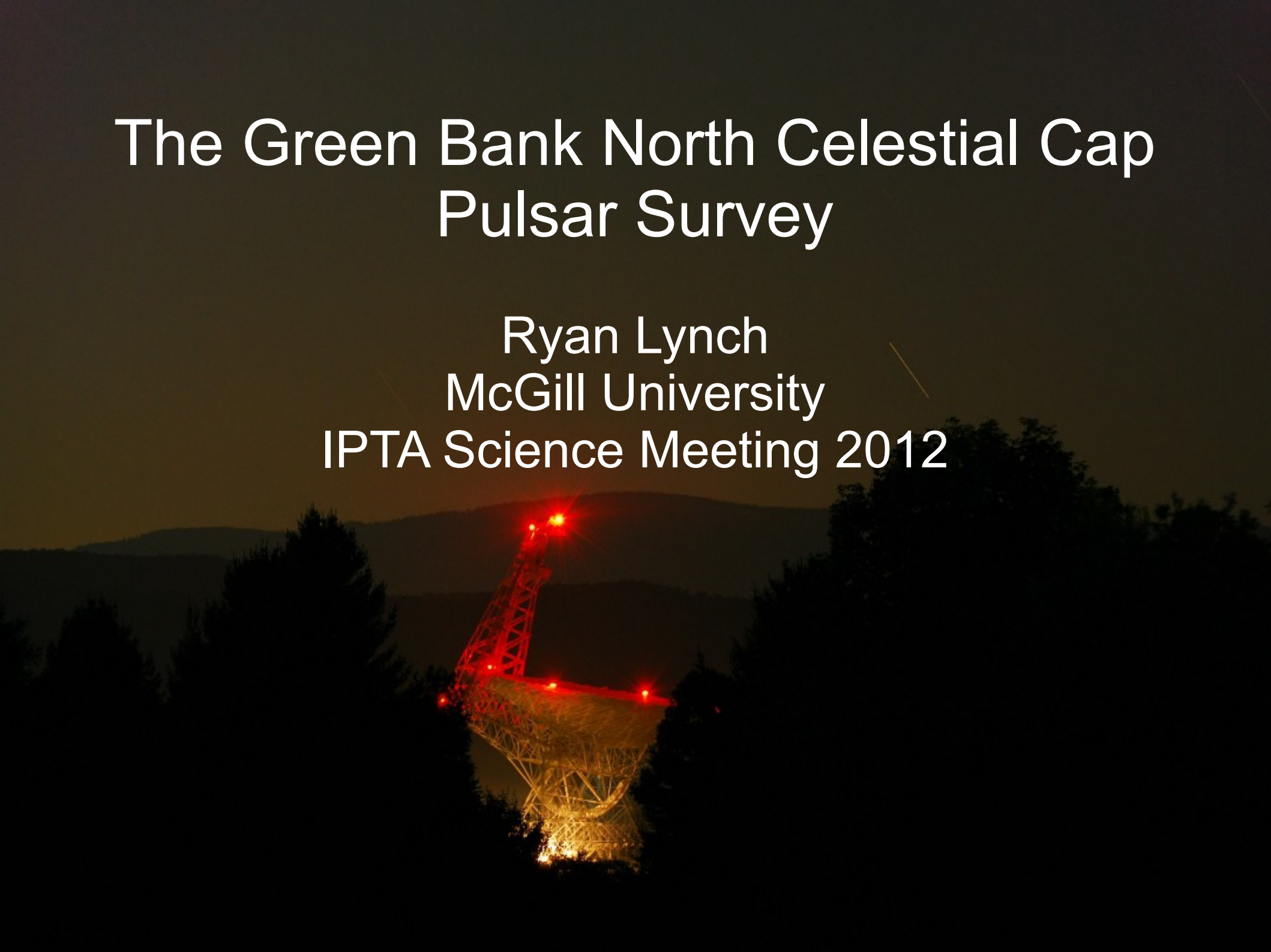
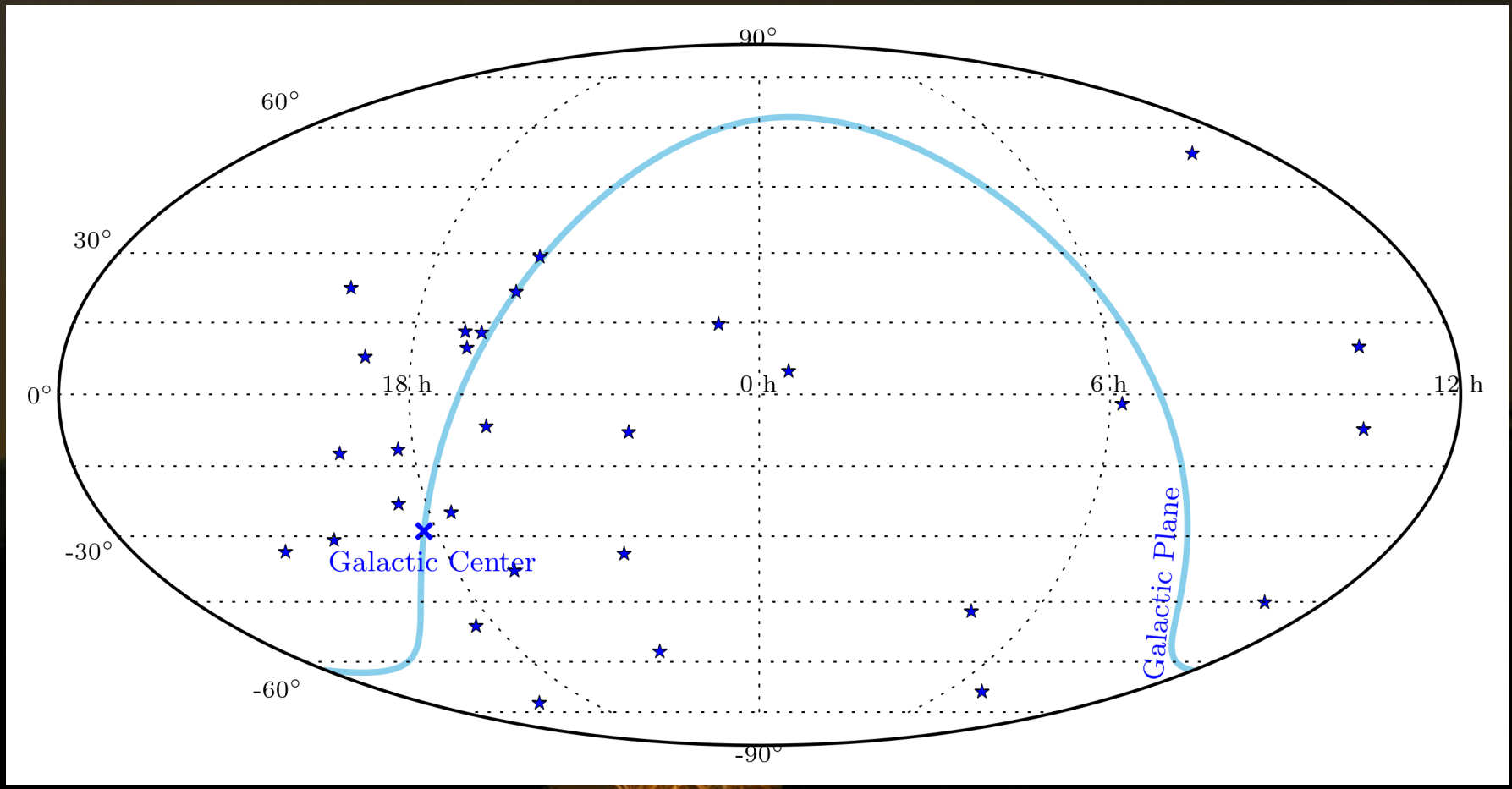
IPTA Science Meeting 2012



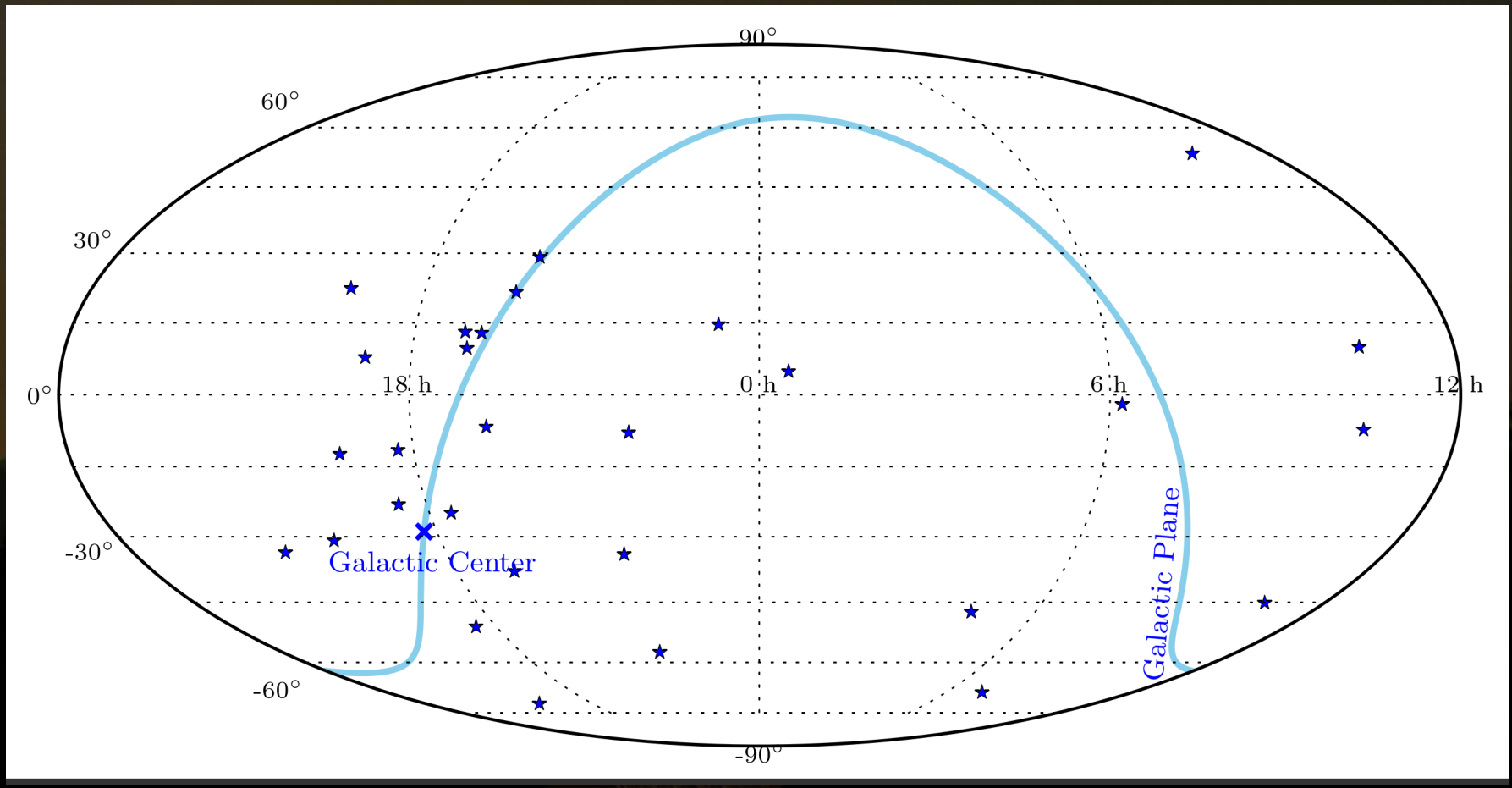
Collaborators

- Scott Ransom (NRAO)
- Dunc Lorimer (WVU)
- Maura McLaughling (WVU)
- Ingrid Stairs (UBC)
- Vicky Kaspi (McGill)
- Rick Jenet (UTB)
- Xavi Siemens (UWM)
- Kevin Stovall (UTB)
- Jason Hessels (ASTRON)
- Vlad Kondratiev (ASTRON
- Jason Boyles (WVU))
- Joeri van Leeuwen (ASTRON)
- Chen Karako (McGill)
- David Kaplan (UWM)
- Mallory Roberts (Eureka)
- David Day (UWM)
- Matt Rohr (UWM)
- Chris Pankow (UWM)
- ARCC (UTB/UWM)

Current IPTA Pulsars



Current IPTA Pulsars



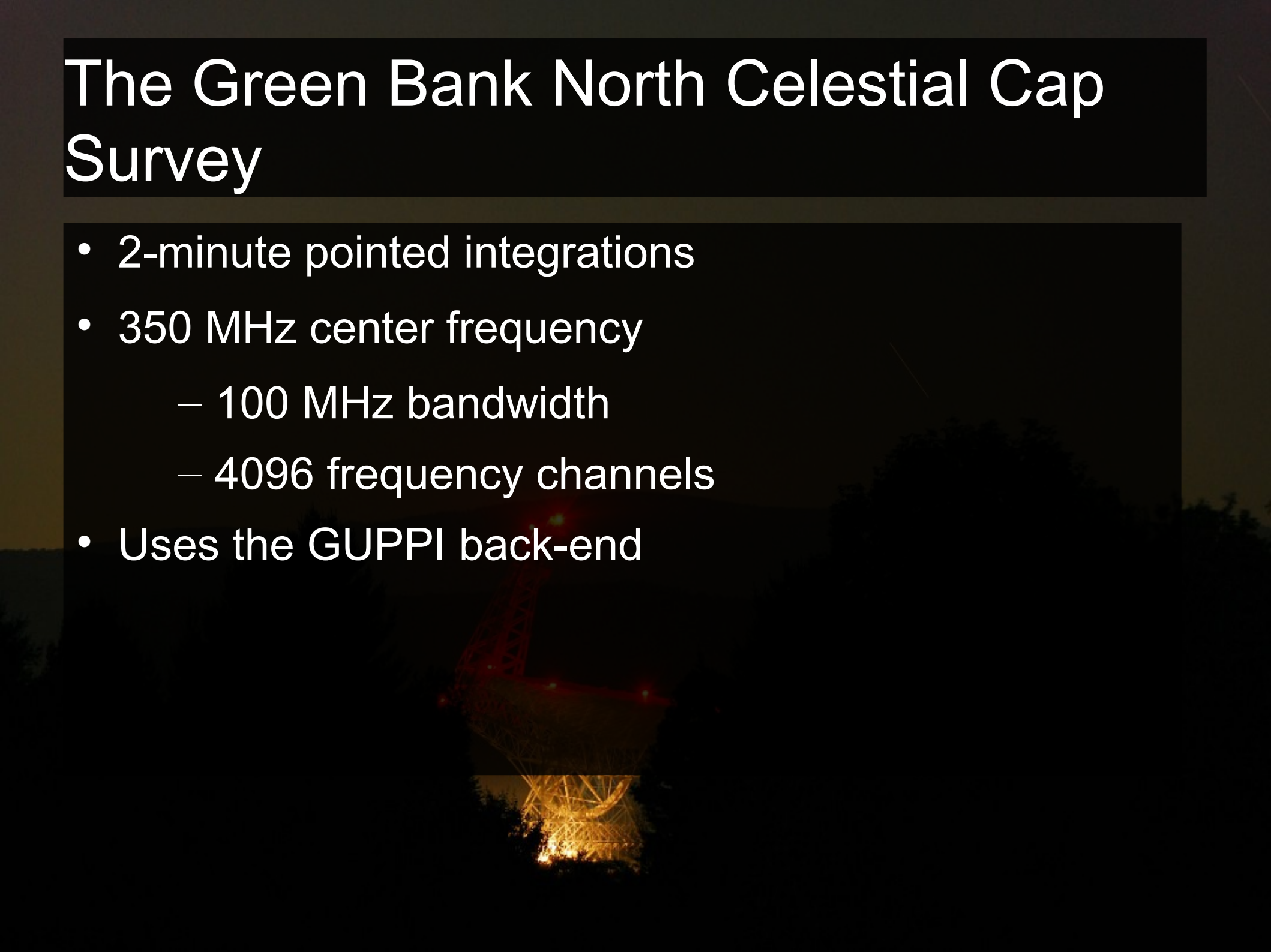
- A straight forward way of improving PTA sensitivity is to find more suitable MSPs, especially in the north

The Green Bank North Celestial Cap Survey

- The most recent in a line of GBT pulsar searches
- Data taking begin in 2009
- Stage I surveyed all $\delta > 38^{o}$
- Stage II will cover the rest of the visible sky
- The primary science goal is to find more MSPs for use in PTAs
  - Simulations suggest that ~200 long-period pulsars and dozens of MSPs could be discovered

The Green Bank North Celestial Cap Survey

- 2-minute pointed integrations
- 350 MHz center frequency
  - 100 MHz bandwidth
  - 4096 frequency channels
- Uses the GUPPI back-end



The GBNCC Survey

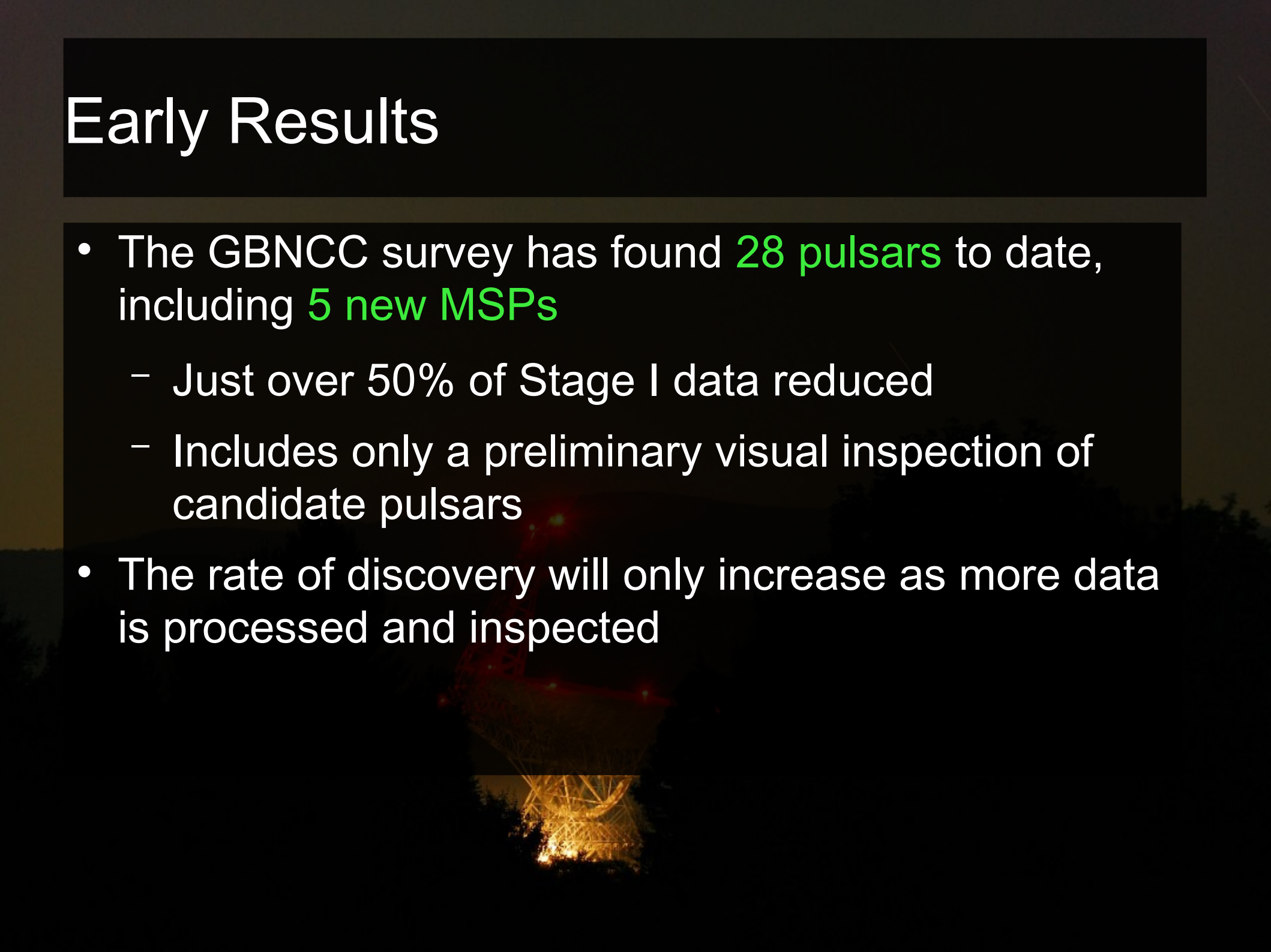
- Total data volume will be ~360 TB when completed (2030 observing hours)
  - Each 120-second integration takes ~90 CPU hours to process (~620 CPU years for whole survey)
- Data reduction pipeline based on PRESTO, written by Kevin Stovall

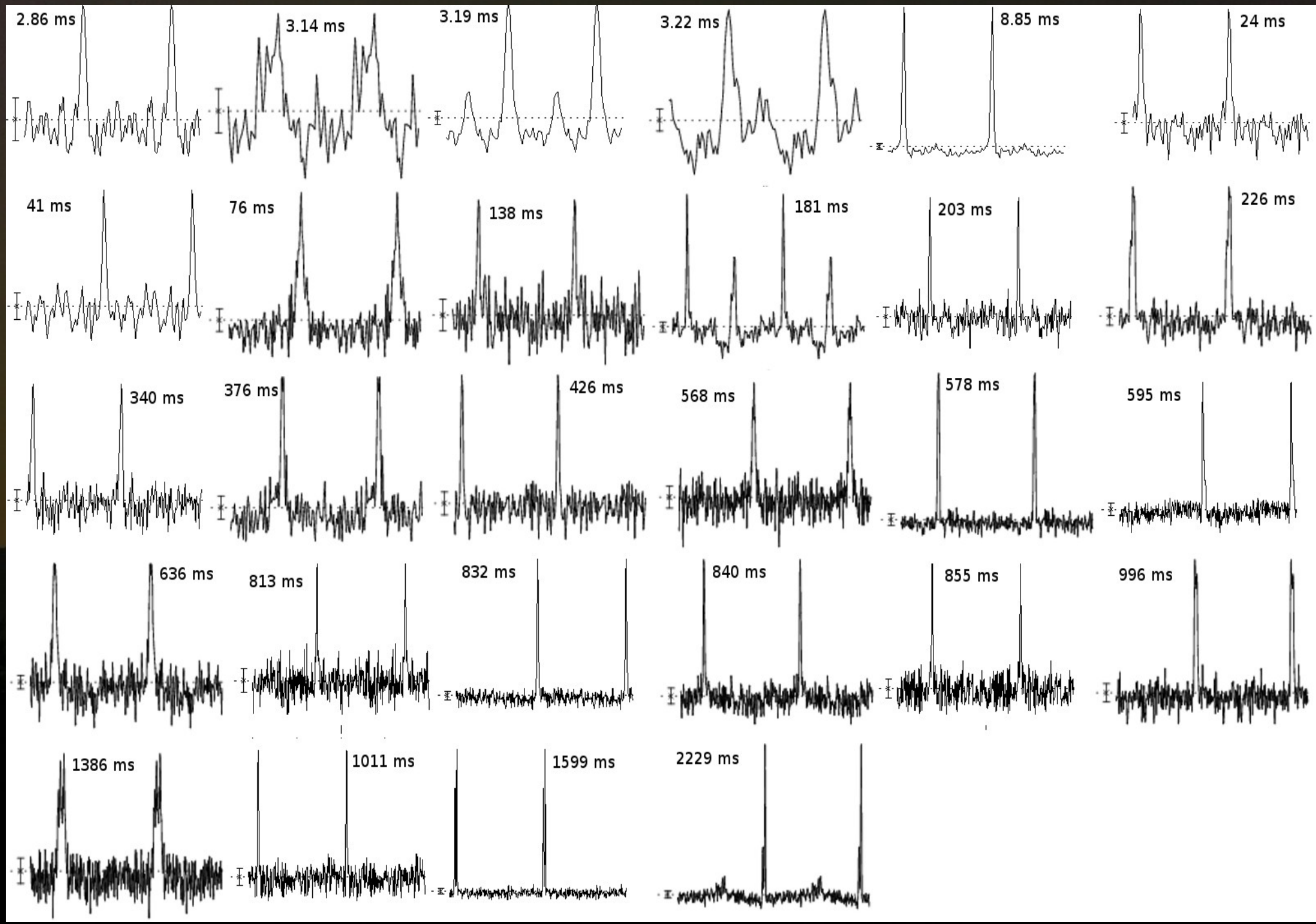
The GBNCC Survey

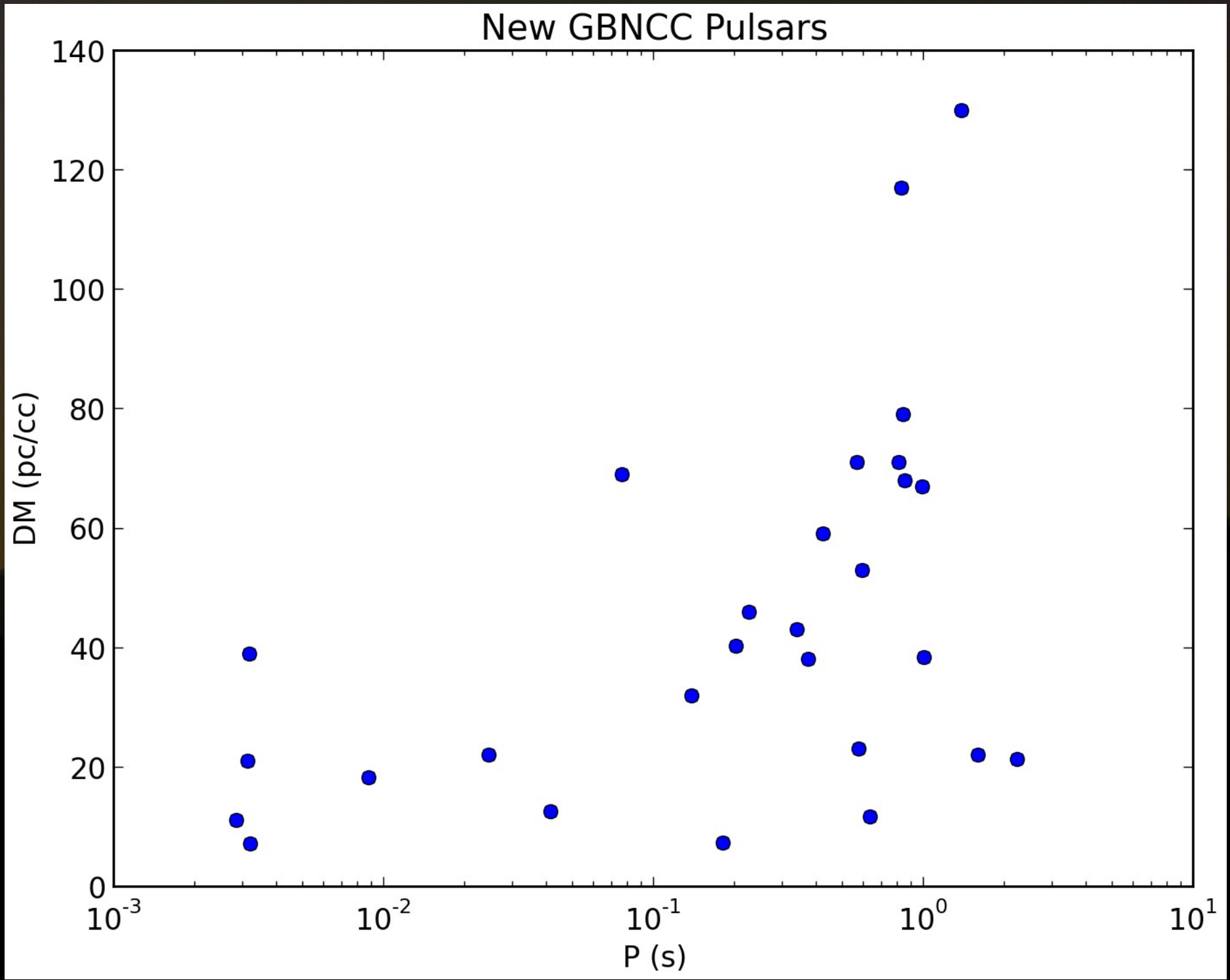
- Early data processing focused on beams containing bright NVSS or Fermi sources
- All data now being reduced at McGill, UTB, and UWM
  - Bulk of data processing carried out on CLUMEQ's Guillimin super computer
  - 2048 cores dedicated to pulsar processing

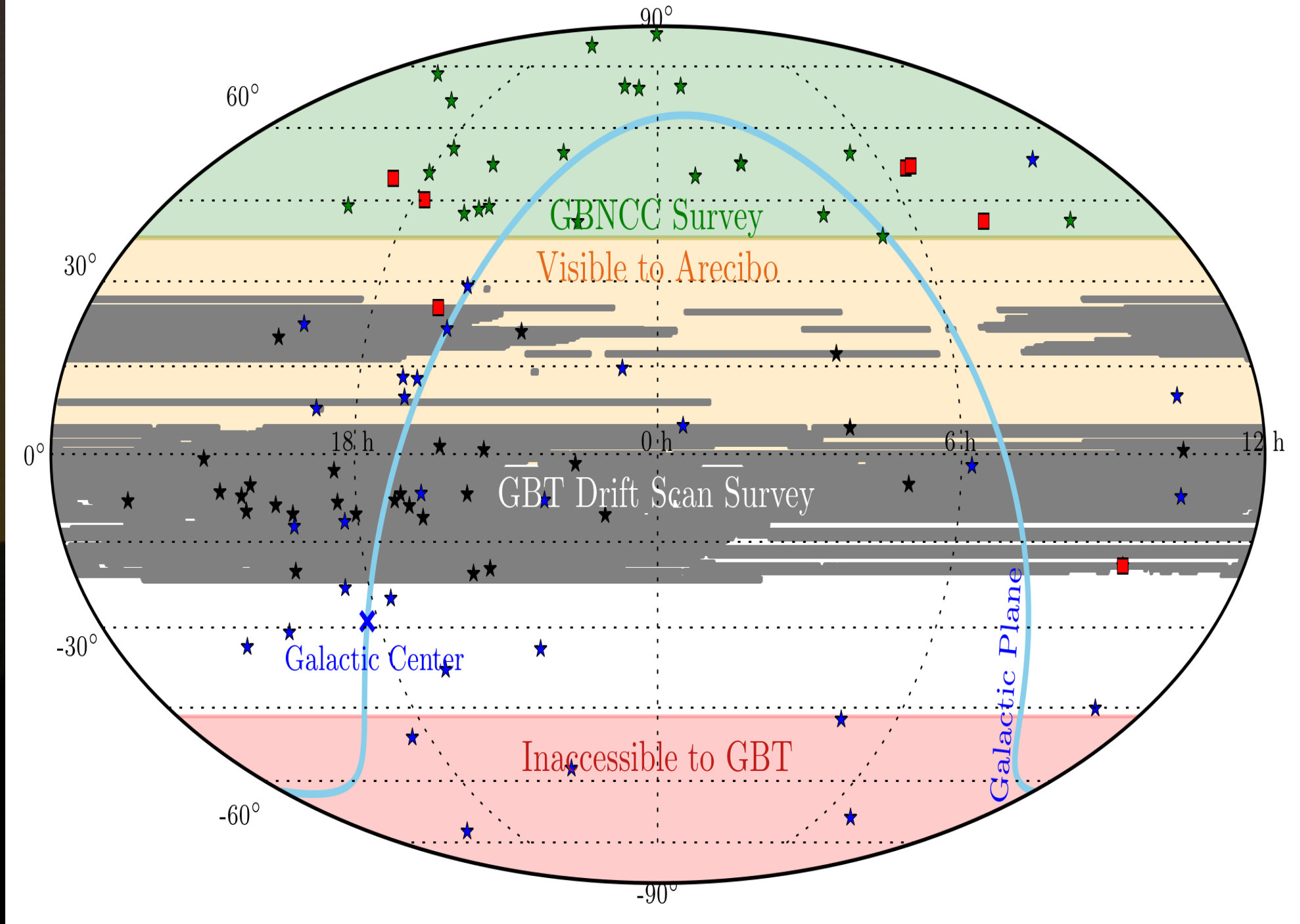
Early Results

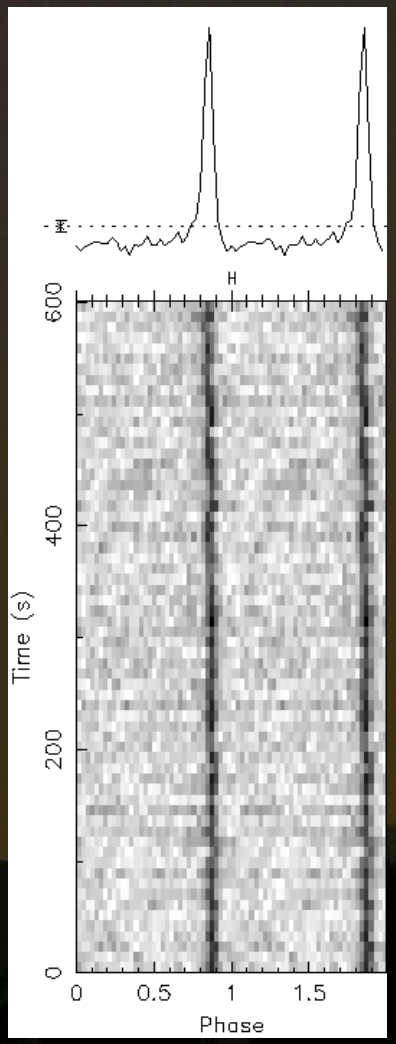
- The GBNCC survey has found 28 pulsars to date, including 5 new MSPs
  - Just over 50% of Stage I data reduced
  - Includes only a preliminary visual inspection of candidate pulsars
- The rate of discovery will only increase as more data is processed and inspected



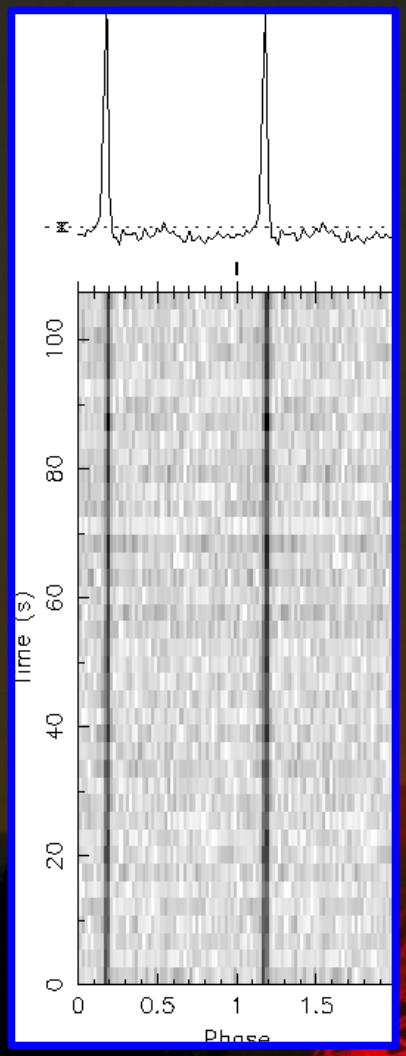

2.86 ms
3.14 ms
3.19 ms
3.22 ms
8.85 ms
24 ms
41 ms
76 ms
138 ms
181 ms
203 ms
226 ms
340 ms
376 ms
426 ms
568 ms
578 ms
595 ms
636 ms
813 ms
832 ms
840 ms
855 ms
996 ms
1386 ms
1011 ms
1599 ms
2229 ms


New GBNCC Pulsars
DM (pc/cc)
P (s)
0
20
40
60
80
100
120
140
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}

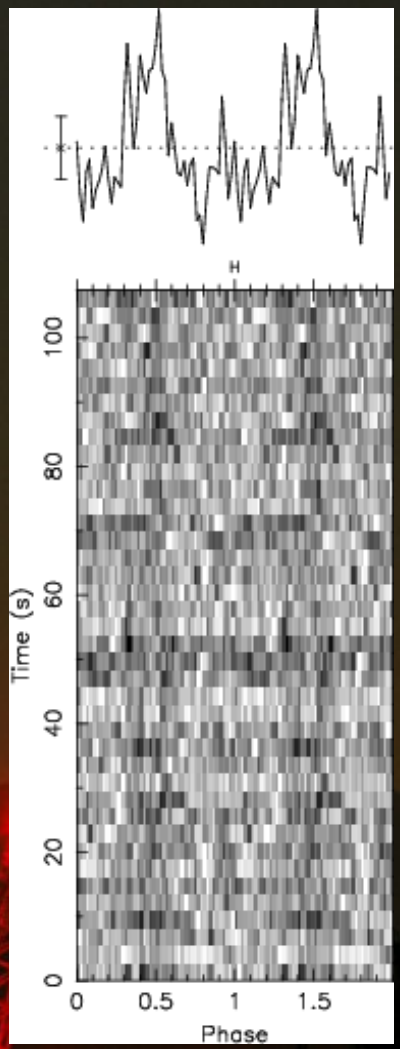

90°
60°
30°
0°
-30°
-60°
-90°
18 h
0 h
6 h
12 h
GBNCC Survey
Visible to Arecibo
GBT Drift Scan Survey
Galactic Center
Galactic Plane
Inaccessible to GBT



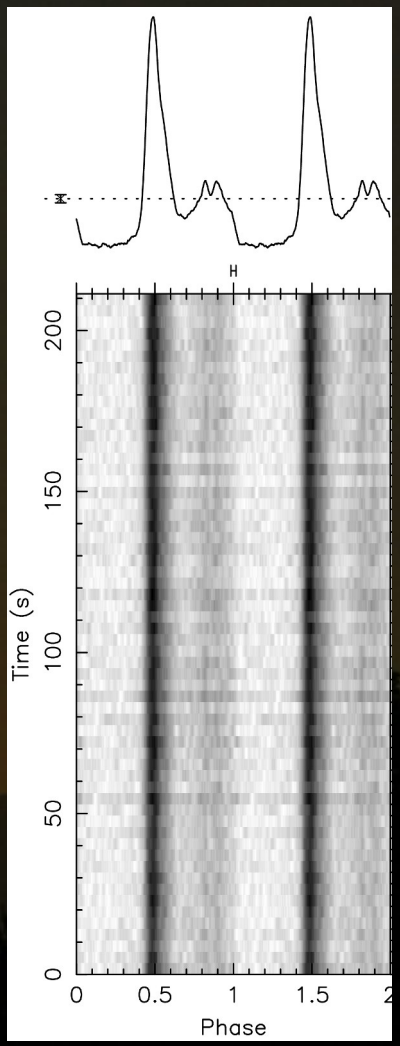
J0636+51
P = 2.86 ms
D = 480 pc
σ_{TOA} ~ 1 μs



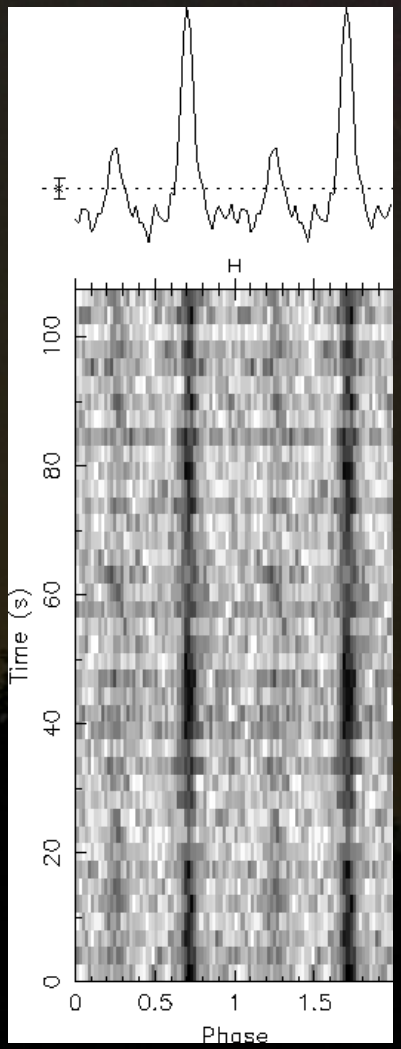
J0645+51
P = 8.85 ms
D = 680 pc
σ_{TOA} < 1 μs



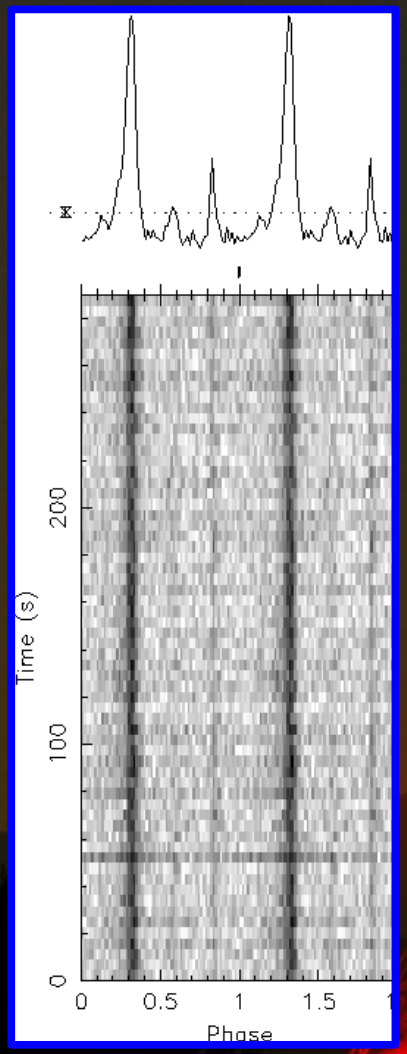
J0740+41
P = 3.14 ms
D = 700 pc
σ_{TOA} >10s μs

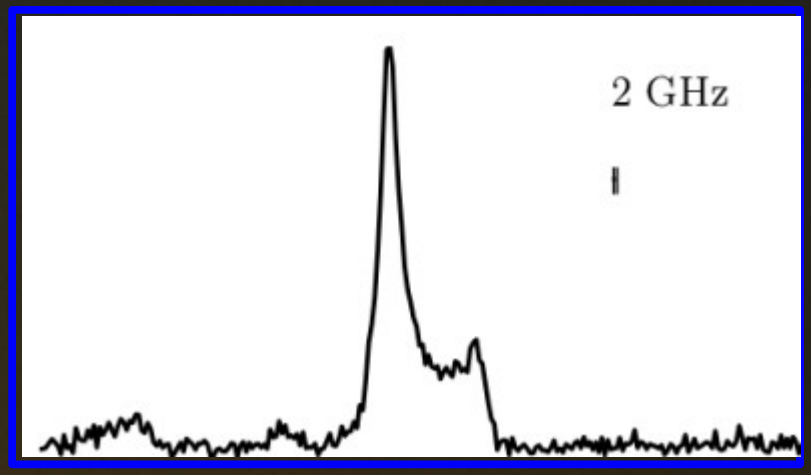


J1710+49
P = 3.22 ms
D = 660 pc
σ_{TOA} ~ 5 μs



J1816+45
P = 3.19 ms
D = 2.4 kpc
Black widow





J1923+25
P = 8.85 ms
D = 1.6 kpc
σ_{TOA} ~ 6 μs @ 820 MHz
σ_{TOA} ~ 1 μs @ 2 GHz

J0931-19
P = 4.64
D = 1.8 kpc
σ_{TOA} ~ 3 μs

Looking ahead...

- Stage II data taking is ongoing
  - Will soon be able to process in near real time
- Will be using Cyber SKA infrastructure to judge candidate pulsars
- Several complimentary investigations of AI to automatically identify good candidates

Summary

- The primary goal of the GBNCC survey is to find more PTA MSPs...success!
  - 5 MSPs discovered so far, with 1 already included in PTA timing
  - 2 potential PTA MSPs from the Drift Scan survey
- These results are preliminary
  - Data processing is proceeding rapidly
  - Stage II data taking is underway
- Look for even more pulsars, and hopefully more MSPs in the coming months