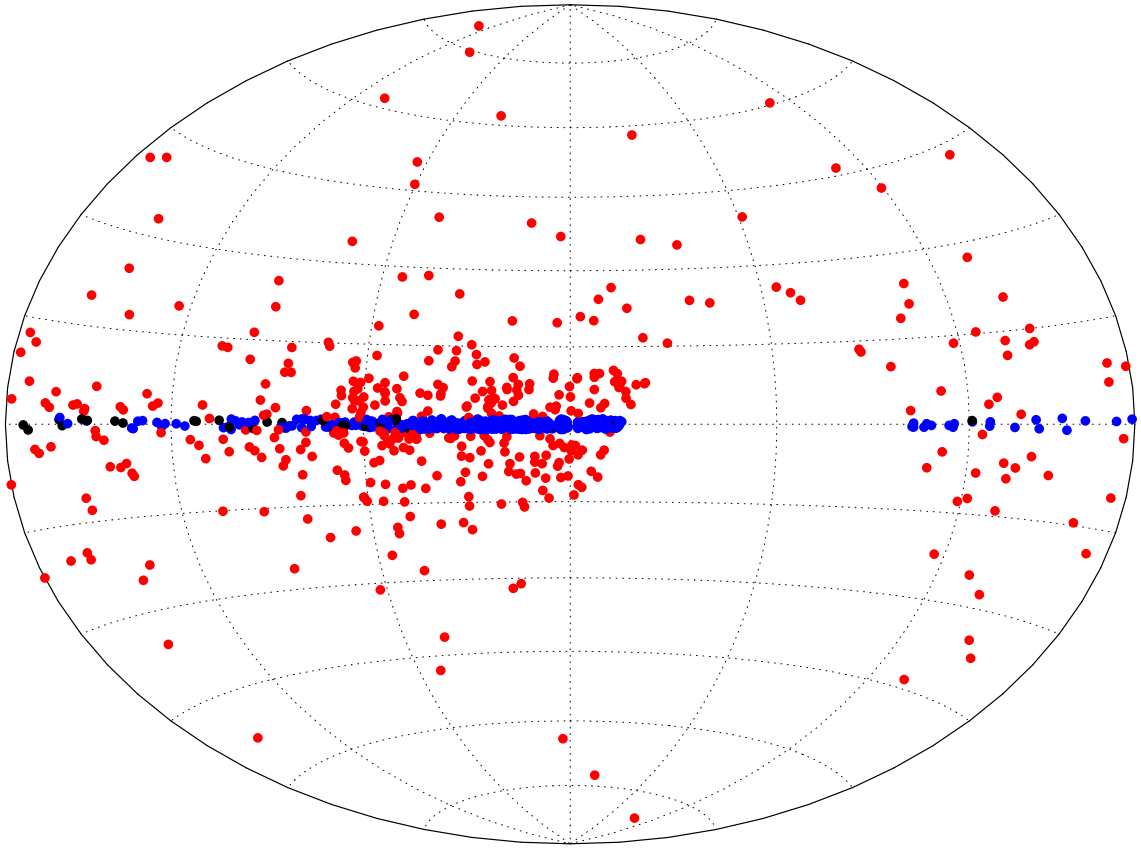
GBT Galactic pulsar survey simulations



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What pulsar surveys have told us so far

Year	Telescope	ν[a] (MHz)	$\Delta\nu$[b] (MHz)	t_{obs}[c] (s)	t_{samp}[d] (ms)	S_{min}[e] (mJy)	Detected[f]
1972	Lovell 76 m	408	4	660	40	10	51/31
1974	Arecibo 305 m	430	8	137	17	1	50/40
1977	Molonglo	408	4	45	20	10	224/155
1977	Green Bank 300 inch	400	16	138	17	10	50/23
1982	Green Bank 300 inch	390	16	138	17	2	83/34
1983	Green Bank 300 inch	390	8	132	2	5	87/20
	Lovell 76 m	1400	40	524	2	1	61/40
1984	Arecibo 305 m	430	1	40	0.3	3	24/5
1985	Molonglo	843	3	132	0.5	8	10/1
1987	Arecibo 305 m	430	10	68	0.5	1	61/24
1988	Parkes 64 m	1520	320	150	0.3	1	100/46
1990	Arecibo 305 m	430	10	40	0.5	2	2/2
1992	Parkes 64 m	430	32	168	0.3	3	298/101
1993	Arecibo 305 m	430	10	40	0.5	1	56/90
1994	Lovell 76 m	411	8	315	0.3	5	5/1
1995	Green Bank 140 inch	370	40	134	0.3	8	84/8
1998	Parkes 64 m	1374	288	265	0.1	0.5	69/170
	Parkes 64 m	1374	288	2100	0.3	0.2	~900/600

What pulsar surveys have told us so far

The pulsar population

After correcting for observational selection effects, we find:

- few $\times 10^4$ beamed to Earth
  - roughly a 50/50 split between MSPs/normal pulsars
  - similar number (or more) RRATs? (won't mention these here)

- large Z-scale height
  - 300 pc for normal pulsars
  - 500 pc for MSPs

Biggest database so far is Parkes multibeam (PM) survey

What pulsar surveys have told us so far

Recent application to PM survey (astro-ph/0607640)

- Start with PDFs in R, z, L and P
- Populate model axisymmetric galaxy with 10^6 pulsars
- Calculate expected w, S, DM, $T_{\rm sky}$ & $\tau_{\rm scatt}$
- "Observe" this population with model PM surveys
- Compare "detections" with sample of ~ 1000 PM pulsars
- Modify PDFs appropriately and repeat until convergence

Result of this process are model Galactic populations for normal (published) and MSPs (in preparation)

What the GBT could do for pulsars

Consider two approaches

- A 350-MHz all sky survey (N.B. observations underway)
  - $T_{\rm sys} = 35$ K (no sky); $G = 2$ K/Jy; FWHM$= 17.7$'; BW=64 MHz
  - 10.4 sr (34,000 deg^2); 1 beam; i.e. $\sim 5 \times 10^5$ pointings

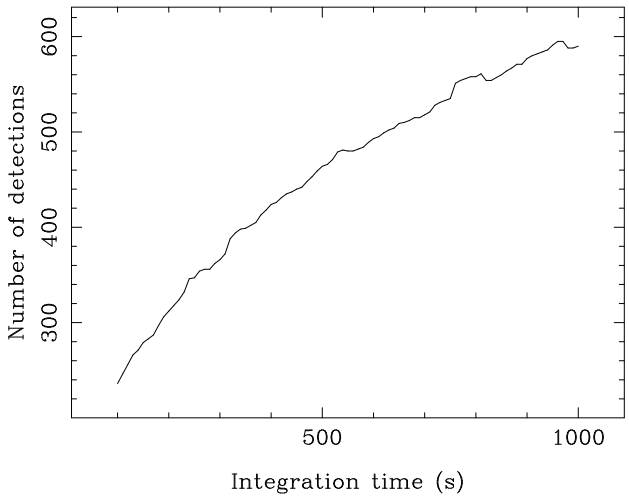
- A "dream" S-band multibeam survey of $|b| < 5^\circ$
  - $T_{\rm sys} = 25$ K; $G = 2$ K/Jy; FWHM$= 3.2$'; BW=600 MHz
  - 0.86 sr (2,800 deg^2); 19 beams; i.e. $\sim \times 10^6$ pointings

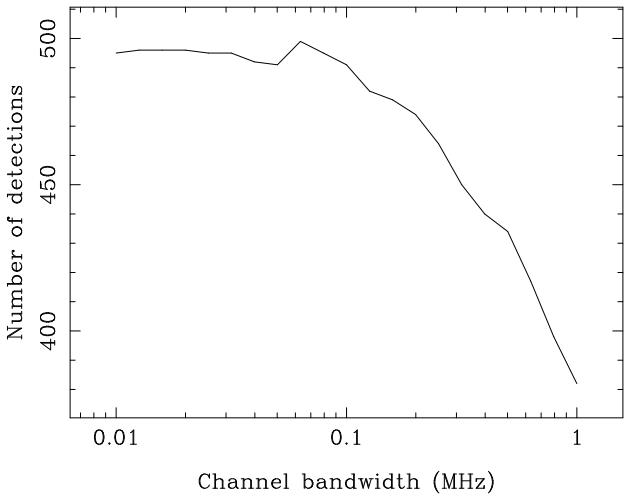
Investigate survey yields as functions of:

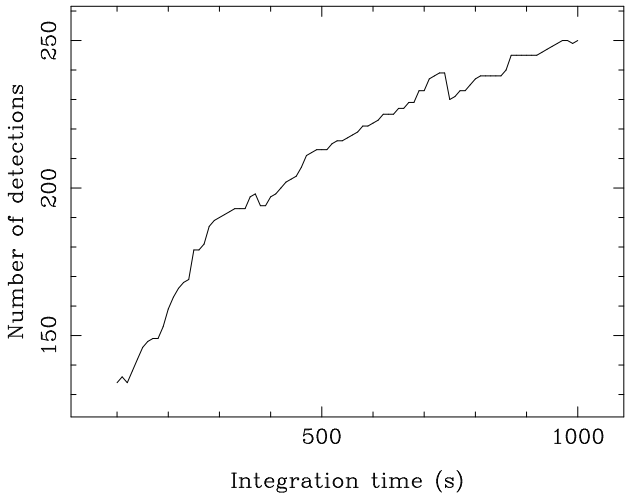
- Integration time (100–3600 s)
- Channel bandwidth (0.01–1 MHz)

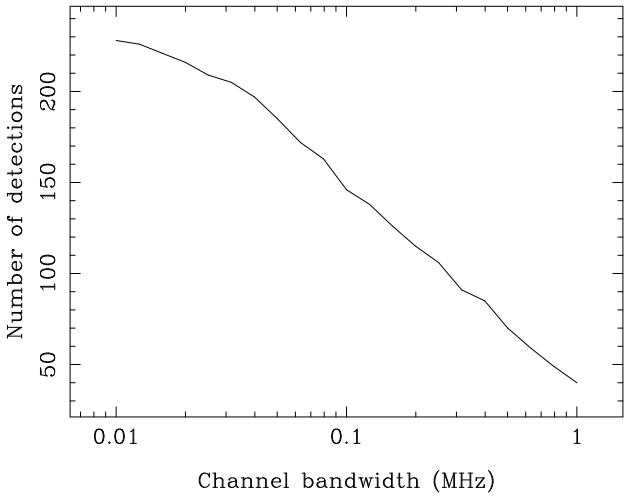
What the GBT could do for pulsars

350 MHz all-sky survey



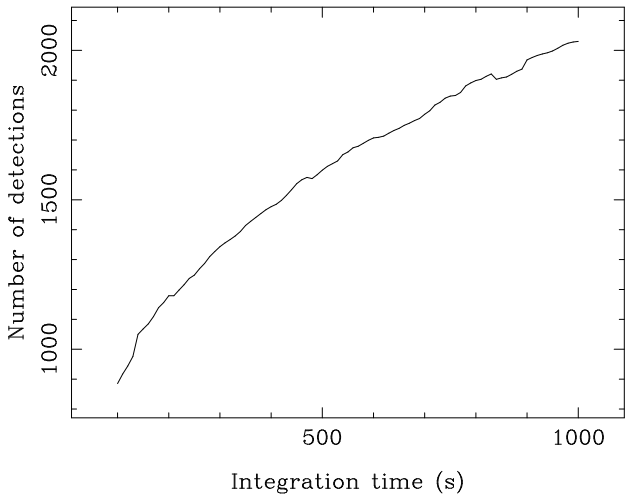


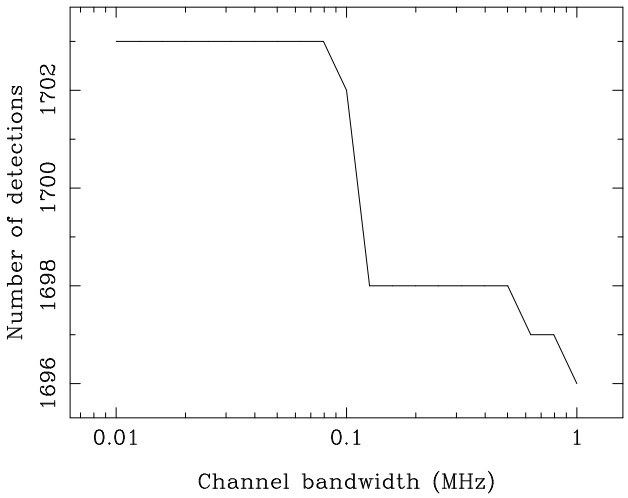


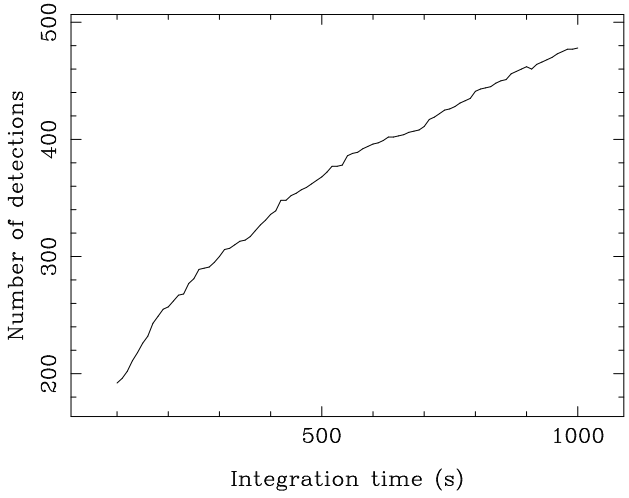


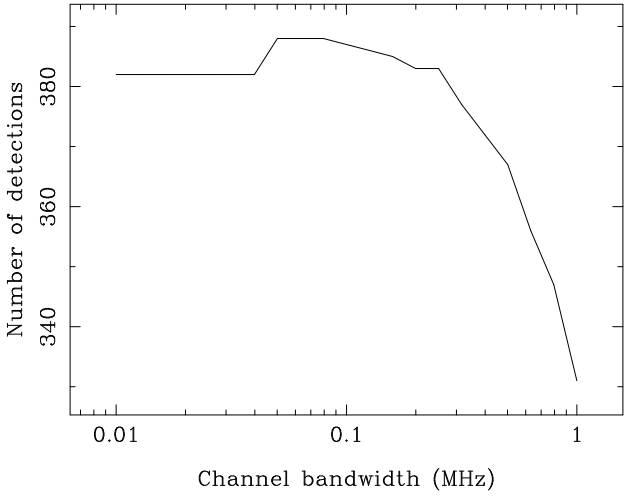
What the GBT could do for pulsars

S-band Galactic plane survey









What the GBT could do for pulsars

How long to survey and what is the payoff?

$$t_{\rm obs350} \sim 600 \text{ days } \left(\frac{t_{\rm int}}{100{\rm s}}\right); t_{\rm obsSBAND} \sim 450 \text{ days } \left(\frac{t_{\rm int}}{600{\rm s}}\right)$$

Predicted NORMAL PULSAR DETECTIONS:

$$N_{350} \sim 240 \left(\frac{t_{\rm int}}{100{\rm s}}\right)^{1/2} \quad \text{and} \quad N_{\rm SBAND} \sim 1700 \left(\frac{t_{\rm int}}{600{\rm s}}\right)^{1/2}$$

Predicted MILLISECOND PULSAR DETECTIONS:

$$N_{350} \sim 120 \left(\frac{t_{\rm int}}{100{\rm s}}\right)^{1/2} \quad \text{and} \quad N_{\rm SBAND} \sim 400 \left(\frac{t_{\rm int}}{600{\rm s}}\right)^{1/2}$$

Conclusion

GBT is a potential Galactic-MSP bagger!

A 350-MHz survey could CURRENTLY

- find of order 100 MSPs with current capabilities

A 1950-MHz MULTIBEAM survey with $|b| < 5^\circ$ could

- find of order 400 MSPs
- find over 1000 normal pulsars

N.B. For $|b| < 1^\circ$, the yields would be of order 80 MSPs and 400 normal pulsars

Conclusion

GBT could give a quantum leap for MSPs