Three questions

Motivated by puzzling B0329 results: bonsai vs presto, coherent vs incoherent beams.

1. Is our detrending scheme removing S/N?

2. Is our clipping scheme masking bright pulses?

3. Is bonsai's variance estimation scheme underestimating S/N of bright pulsars? (Current scheme assumes rare isolated peaks. OK for FRB's but untested for pulsars.)

Plan: separate these issues and study them independently in simulations, then revisit the real data.

Work in progress: only results for #1 so far.

Is our detrending scheme removing S/N?

Current scheme:

```
d1 = rf_pipelines.polynomial_detrender(nt_chunk=1024, axis='time', polydeg=4)
d2 = rf_pipelines.spline_detrender(nt_chunk=1024, axis='freq', nbins=6)
```

Second detrender is more likely to be a problem.
Expect fractional SNR removed by second detrender to depend on:

$$\Delta = \frac{\mathrm{DM}}{\mathrm{pulse\ width}}$$

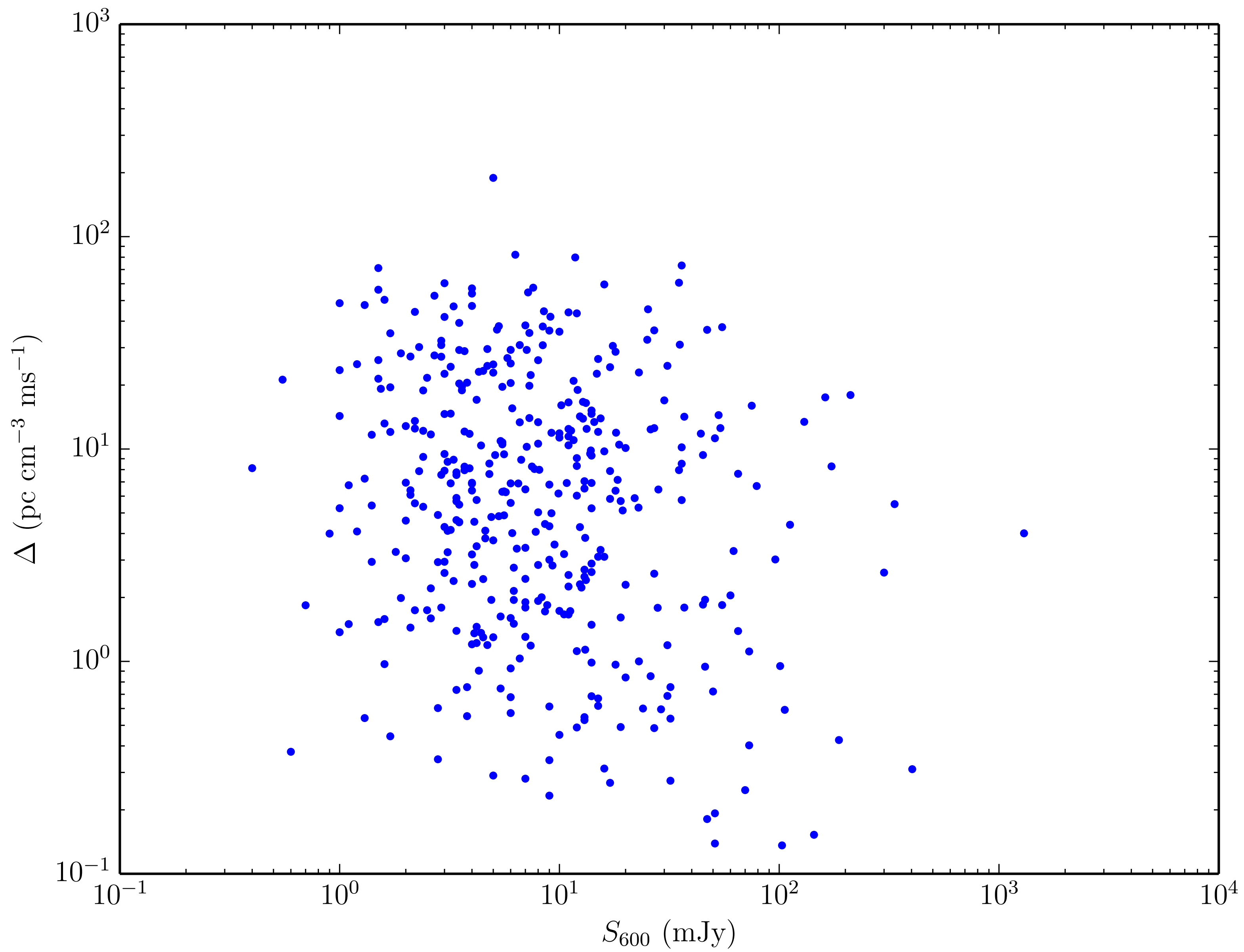
(units pc cm^{-3} ms^{-1})

Before showing Monte Carlo results, let's get a sense for what values of Delta can we expect for pulsars and FRB's.

Delta for pulsars. The following scatterplot shows all psrcat entries for which S600 is available (~400 pulsars).

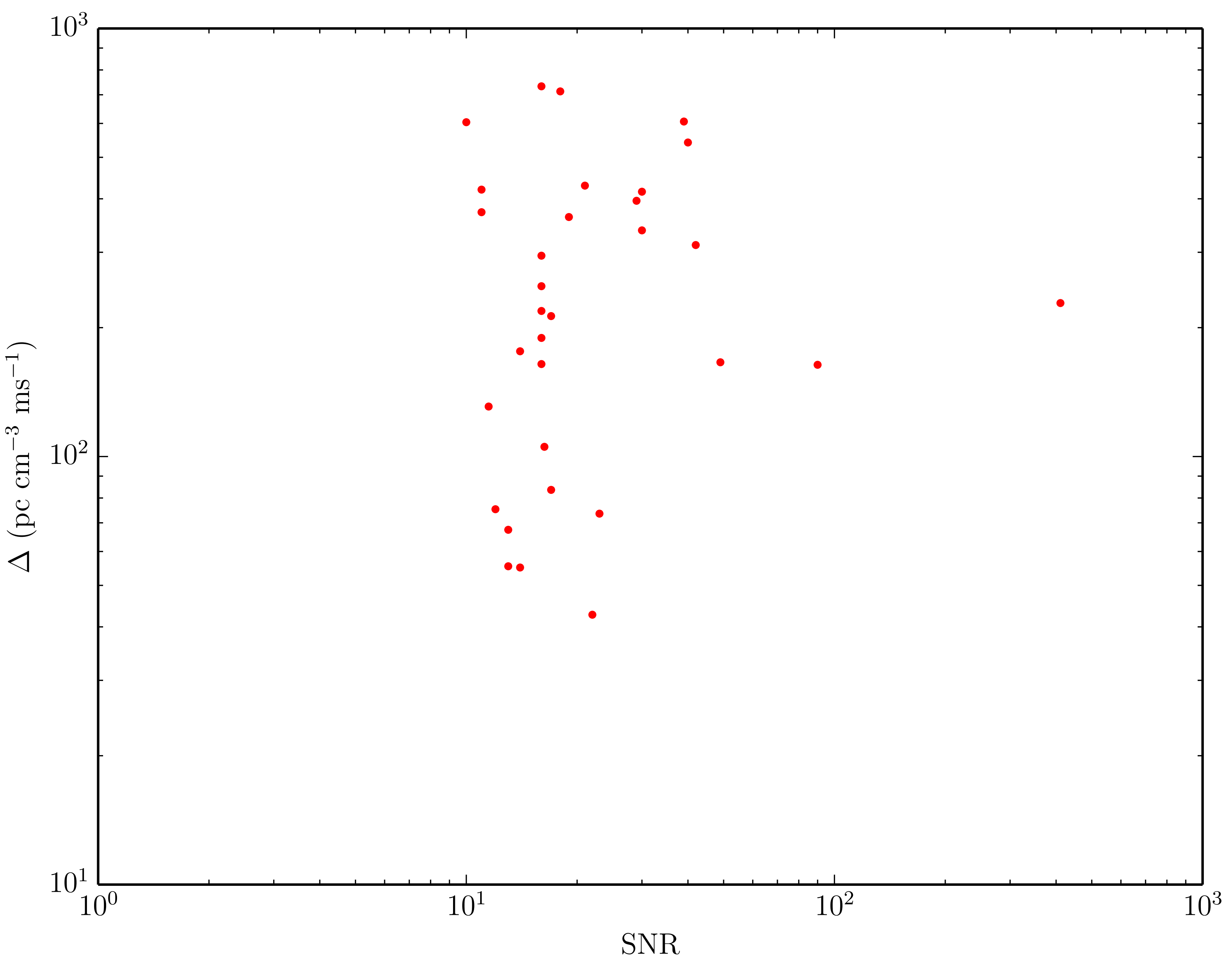
Pulsars typically have $1 \lesssim \Delta \lesssim 10$, but a wider range is possible.

For B0329, $\Delta = 4$



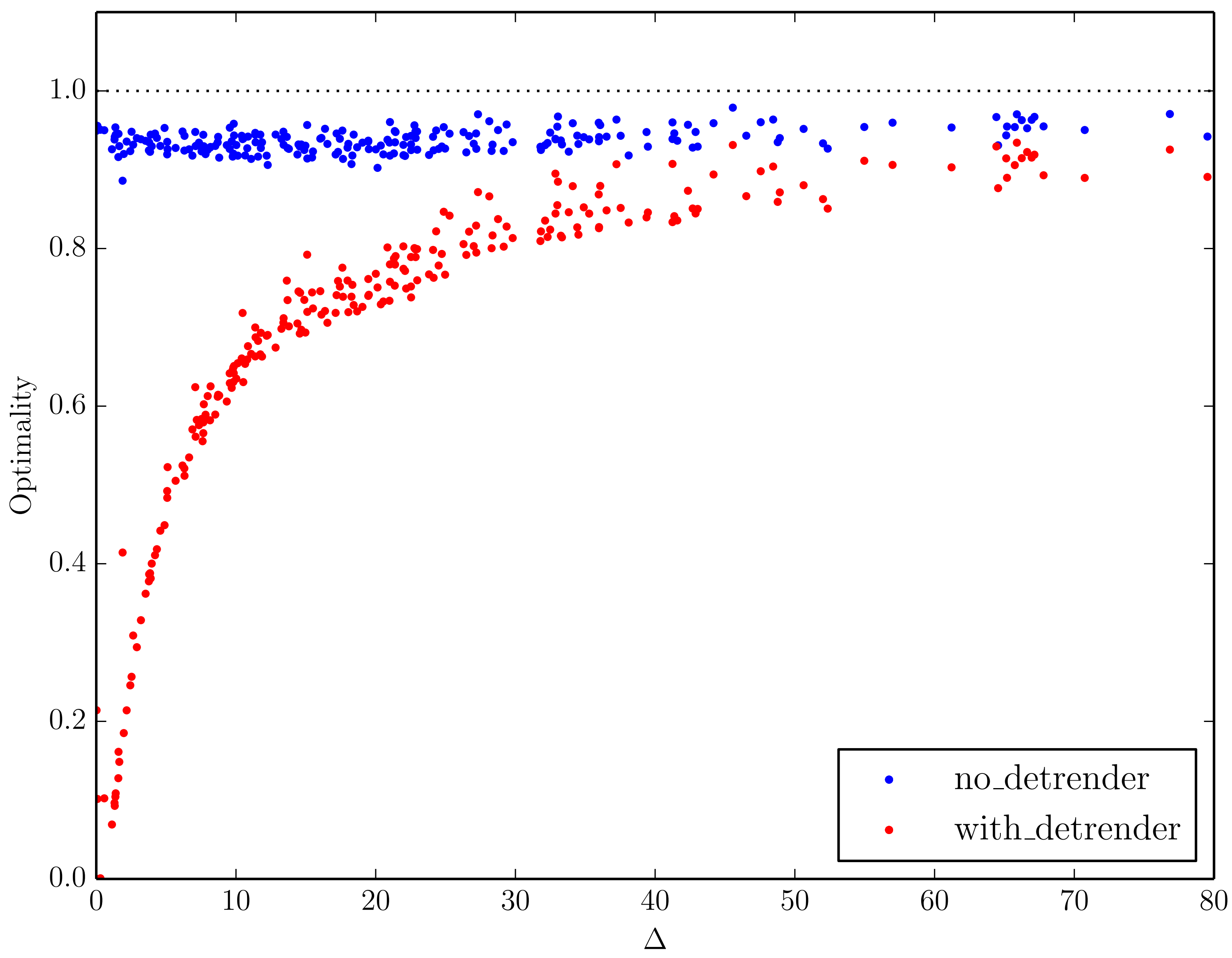
Delta for FRB's. The following scatterplot shows all entries in frbcat.

Not a huge sample size, current range is $40 \leq \Delta \leq 800$



Monte Carlo results from frb_olympics. Each point in the scatterplot is one MC sim, with randomized $0 \leq \mathrm{DM} \leq 200$ and $0 \leq \mathrm{width} \leq 10\ \mathrm{ms}$.

Sims suggest detrenders are unlikely to be a problem for FRB's ($\Delta \geq 40$) but remove most of the SNR for B0329 ($\Delta = 4$).



Random thoughts

- Work in progress, and puzzling B0329 results aren't fully explained yet. (The detrender study can't explain why bonsai gets similar SNR for coherent and incoherent beams.)
- We can use different pipeline configs for the real-time trigger and offline postprocessing! Our default pipeline config (with lots of detrending) is optimized for detecting FRB's in an RFI-rich environment. Not surprising that it's poorly optimized for characterizing bright pulsars.
- Related: I doubt we will want to change our real-time trigger much (by using less detrending or removing clippers), but I suspect we will want multiple pipeline configs for offline postprocessing (for bright pulsars, faint FRB's, etc.)
- Comparison with presto is valuable and we should have this in our offline postprocessing too!

Random thoughts

- For bright pulsars, our real-time trigger is suboptimal. That's OK: it would be better to capture bright pulsars by "scheduling" than "triggering". Chitrang is working on this!
- Building up a library of reference acquisitions of bright pulsars would be very useful right now.
- It's hard to say how optimal our pipeline is! One idea: can we capture a bright pulsar with a CHIME feed on the 26-m, and simultaneously with CHIME? Compare SNR for CHIME and the 26-m on a per-pulse basis.
- Another idea: capture pulsars with CHIME, fold with presto, compare total detection SNR with GBNCC?

Random thoughts

- One reason why our pipeline might still be suboptimal: bonsai uses suboptimal frequency channel weighting (=1), should use optimal channel weighting (g/σ^2)
- For the fully optimal weighting to be implemented, bonsai needs to know the gain g for every frequency channel.
- Another reason why our pipeline might still be suboptimal: beamformer should weight each feed by (g/σ^2) before combining feeds. (I think Kiyo showed that we are taking an order-one sensitivity hit here.)
- There is a lot of optimization and characterization work to do right now, but our top priority should be installing more computers! :)