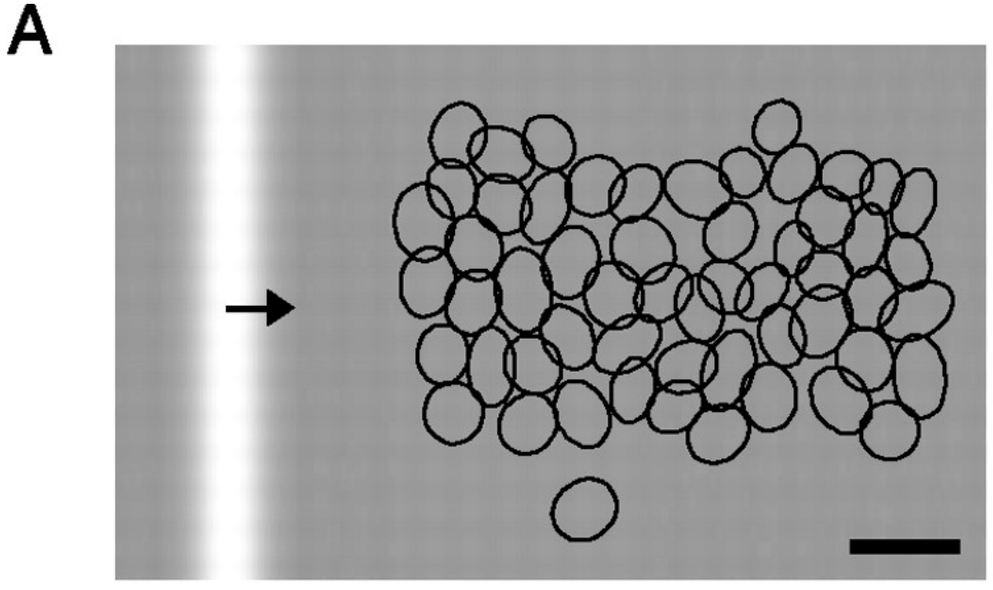
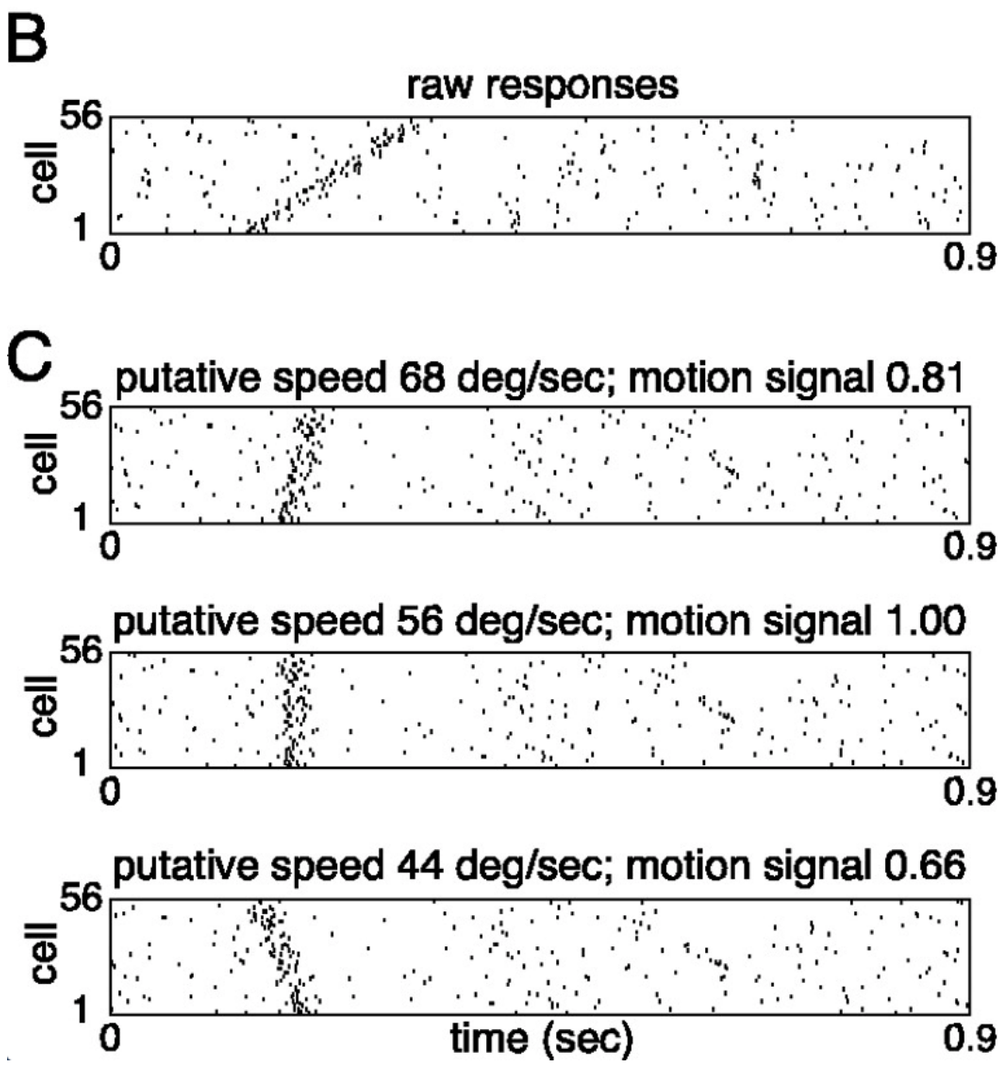
Motion detection in midget and parasol cells

Malcolm Campbell

8-14-14

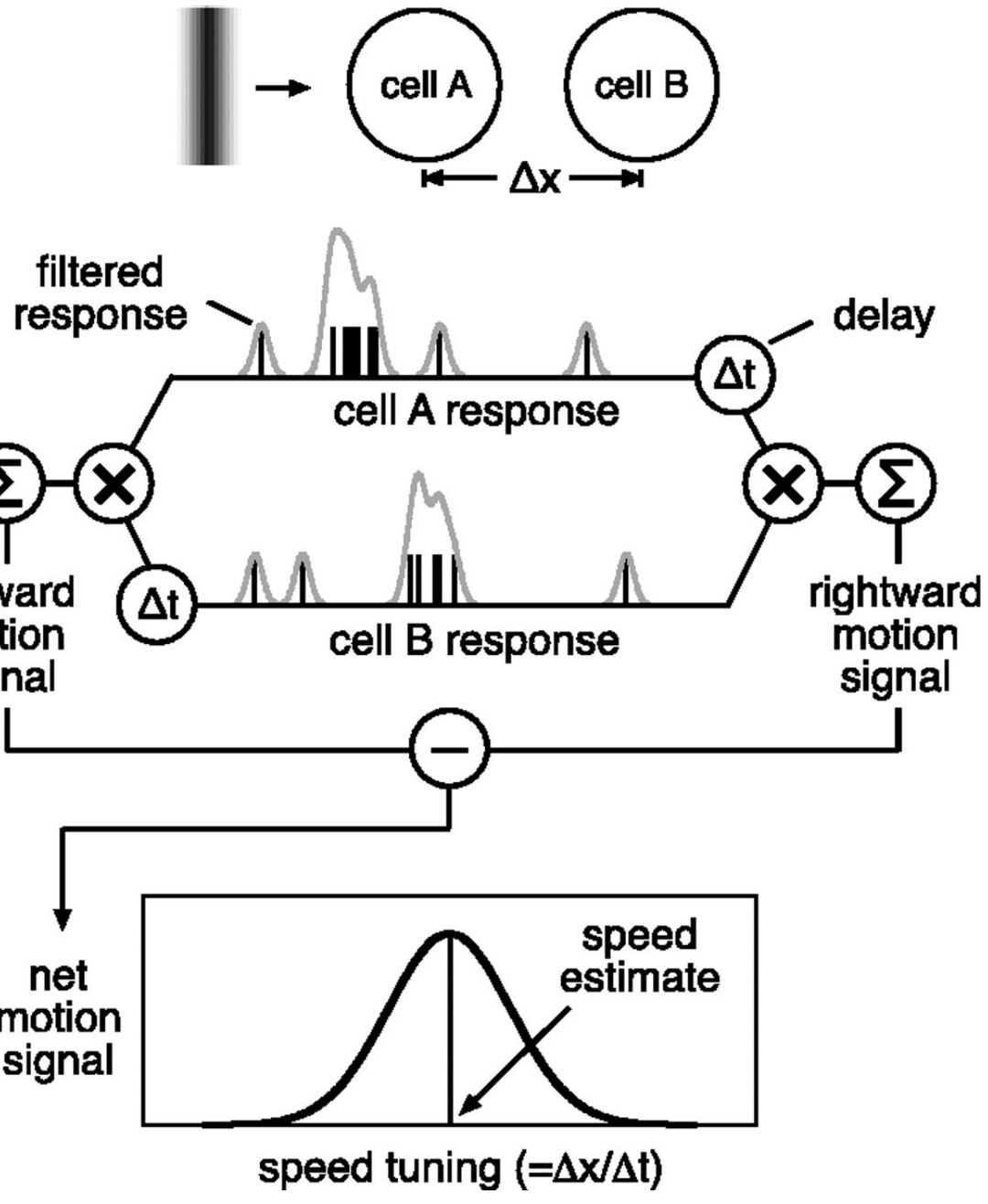
Estimating speed of bar from population response





Frechette et al 2005

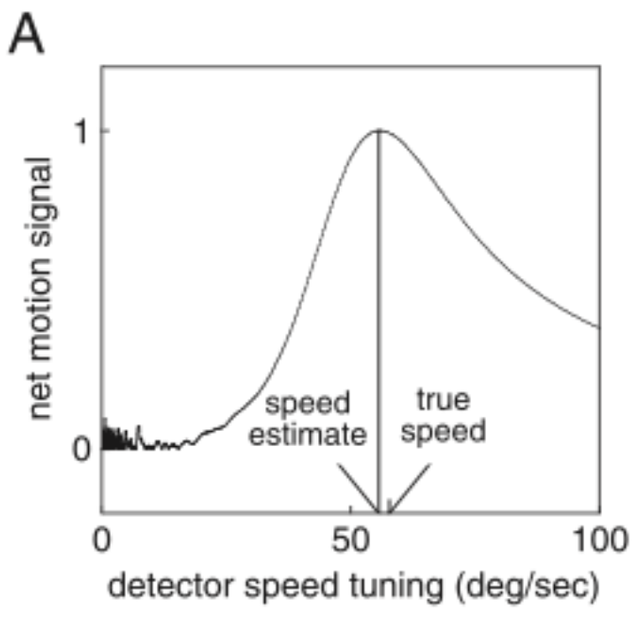
Motion-detection algorithm

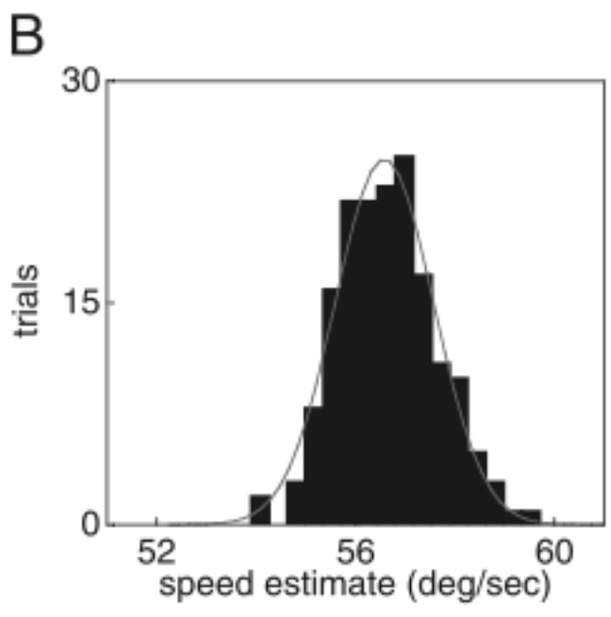


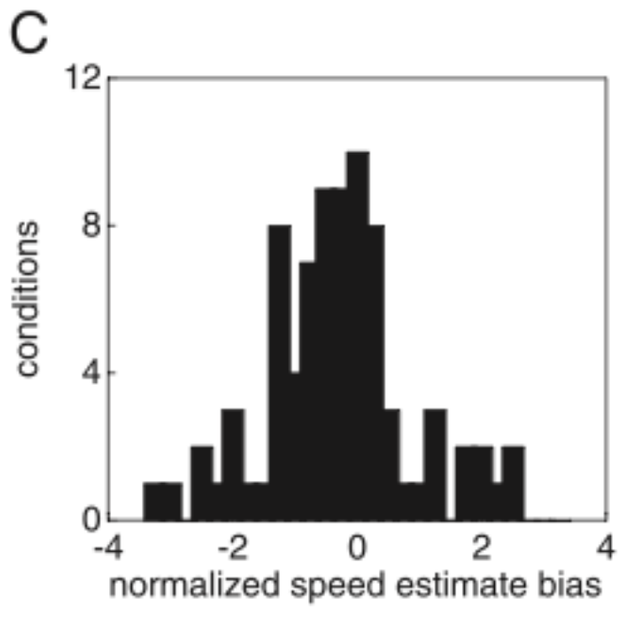
Population:
Add motion signal from all pairs of cells

Frechette et al 2005

This algorithm accurately estimates motion







Frechette et al 2005

Are midgets and parasols equally good at estimating motion?

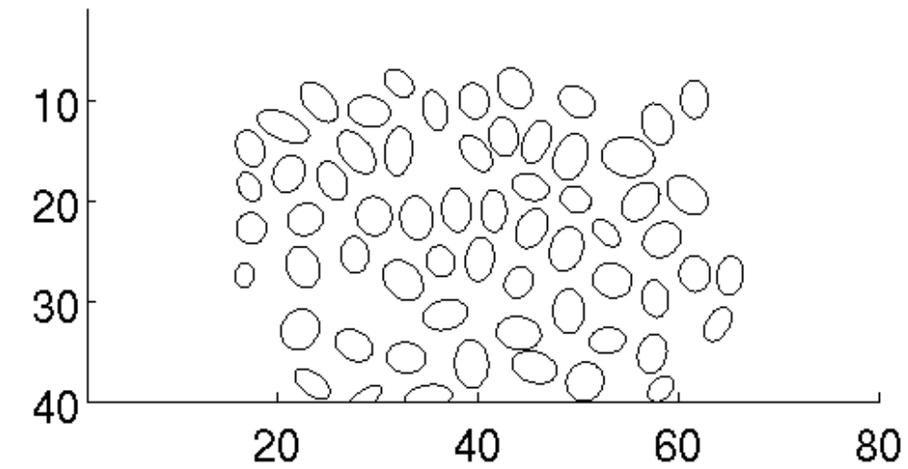
Datasets

- **2007-03-27-1:** 6 runs, 50 trials/run, 3 speeds (1 pix/frame, 8 pix/frame, 16 pix/frame)

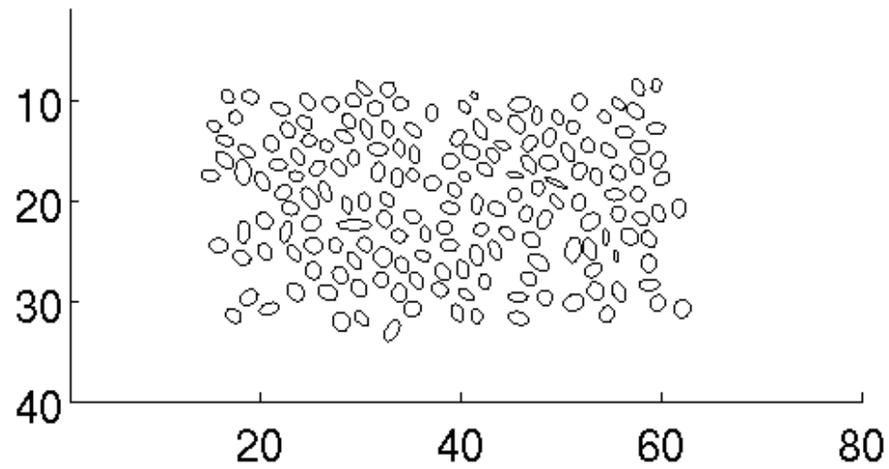
- **2007-08-24-4:** 8 runs, 50 trials/run, 4 speeds (1 pix/frame, 4 pix/frame, 8 pix/frame, 16 pix/frame)

Cell types have similarly complete mosaics

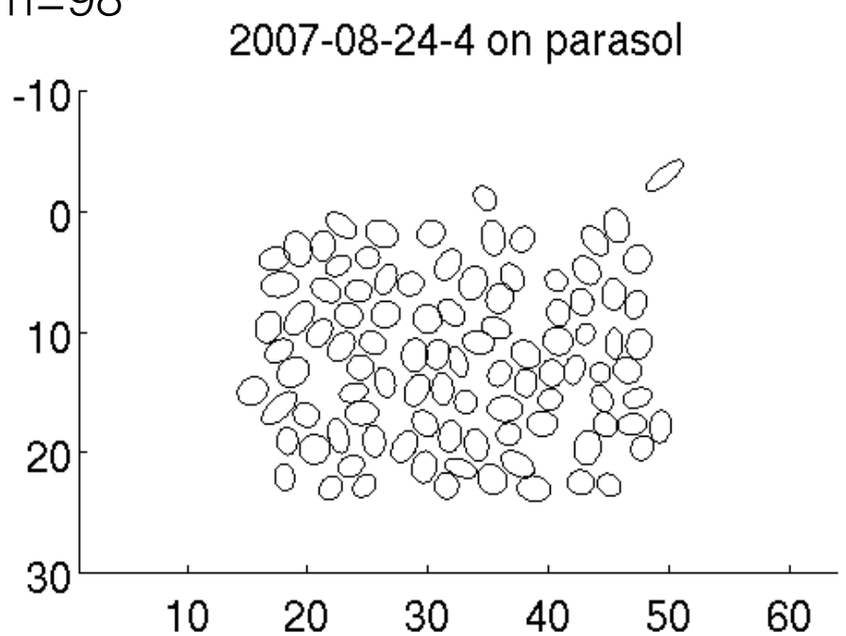
n=63



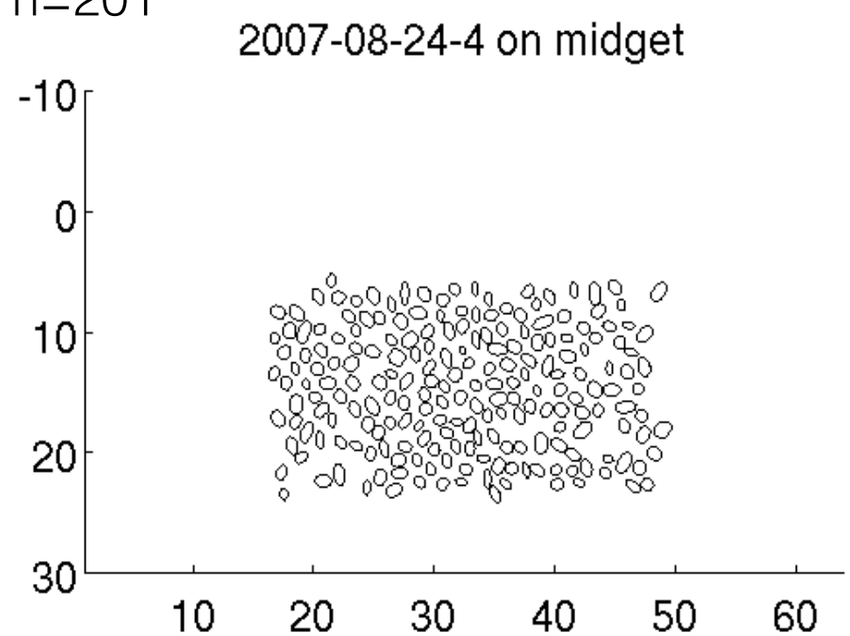
n=175



n=98



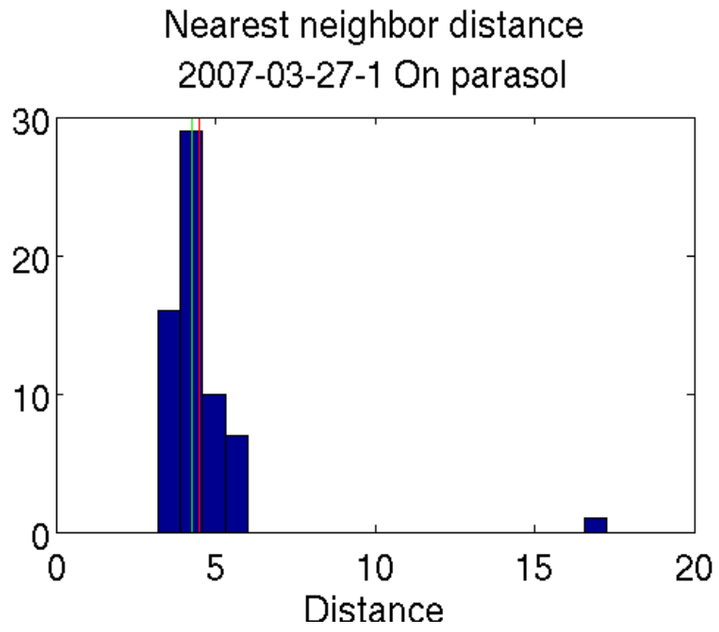
n=201

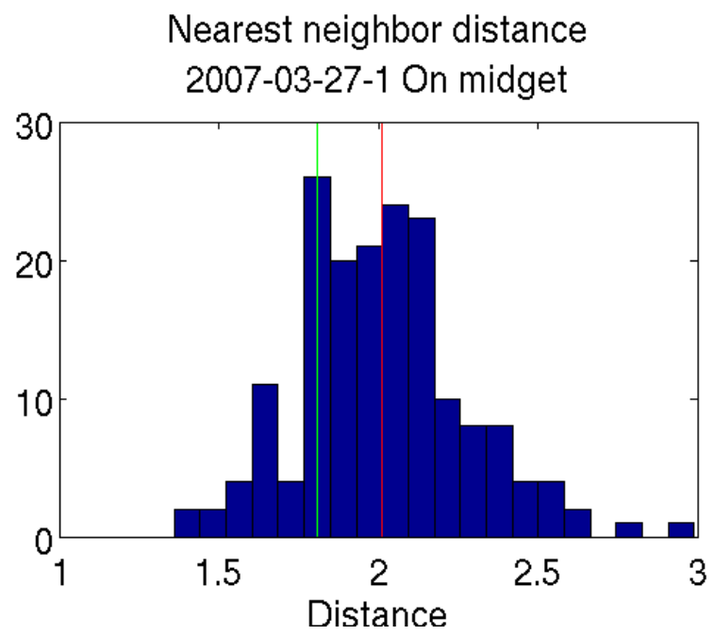


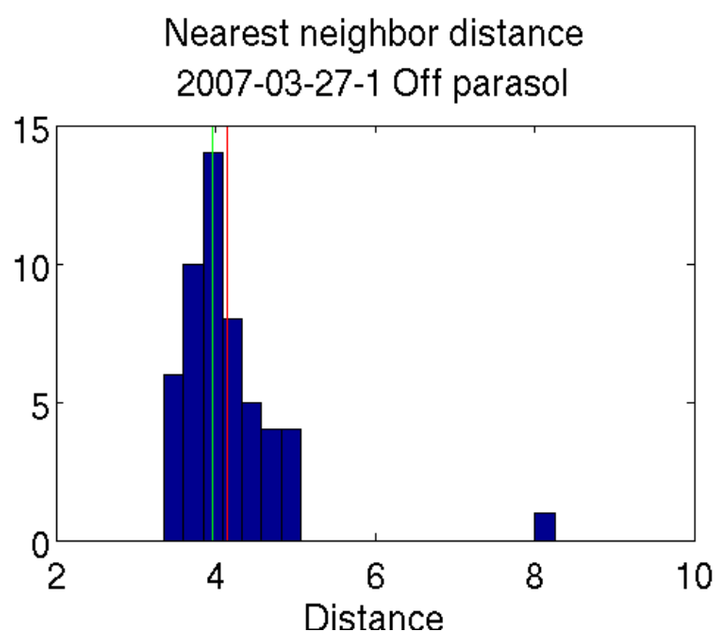
Janky analysis: Identifying missing cells by eye

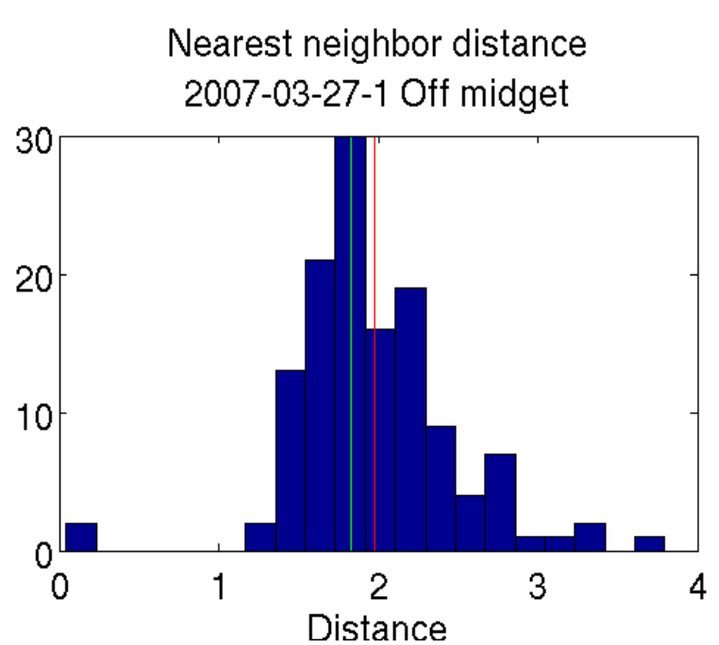
	On P	On M	
2007-03-27-1	9/63 (14%)	30/175 (17%)	Fisher's test p = 0.84
2007-08-24-4	12/98 (12%)	21/201 (10%)	Fisher's test p = 0.70
Total	21/161 (13%)	51/376 (14%)	Fisher's test p = 1

Better analysis:
Use nearest neighbor distances to create "optimal tiling"





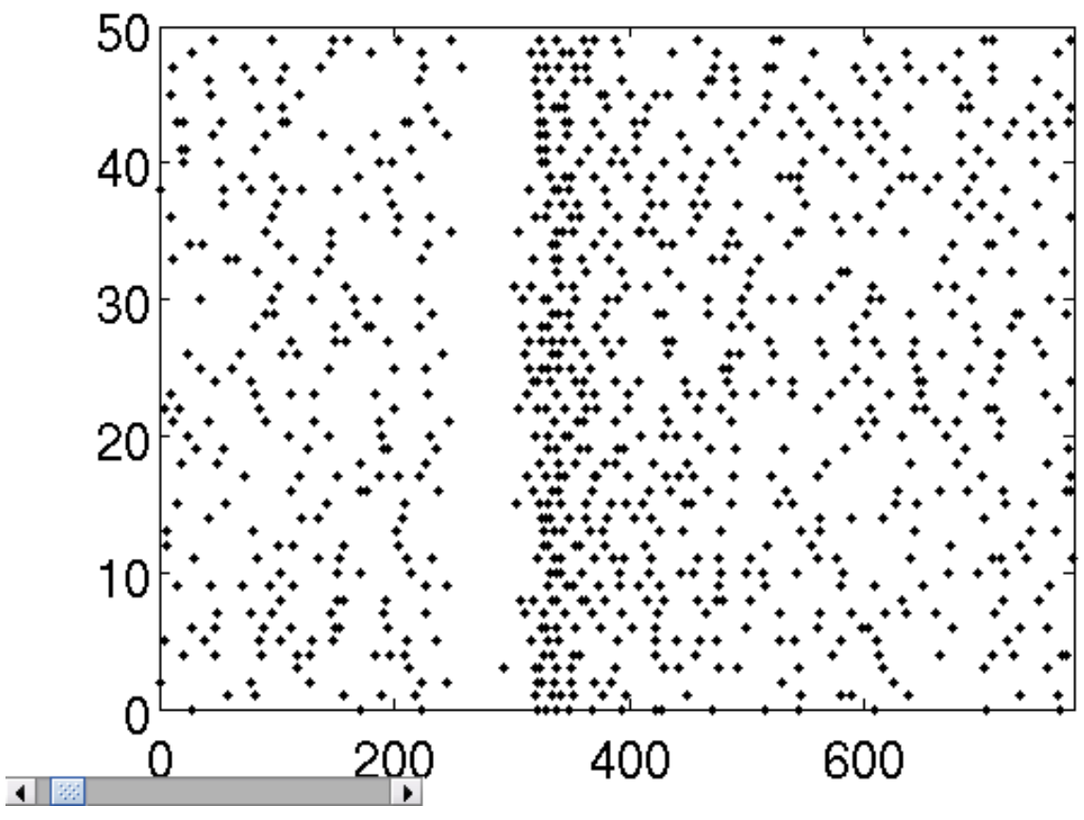




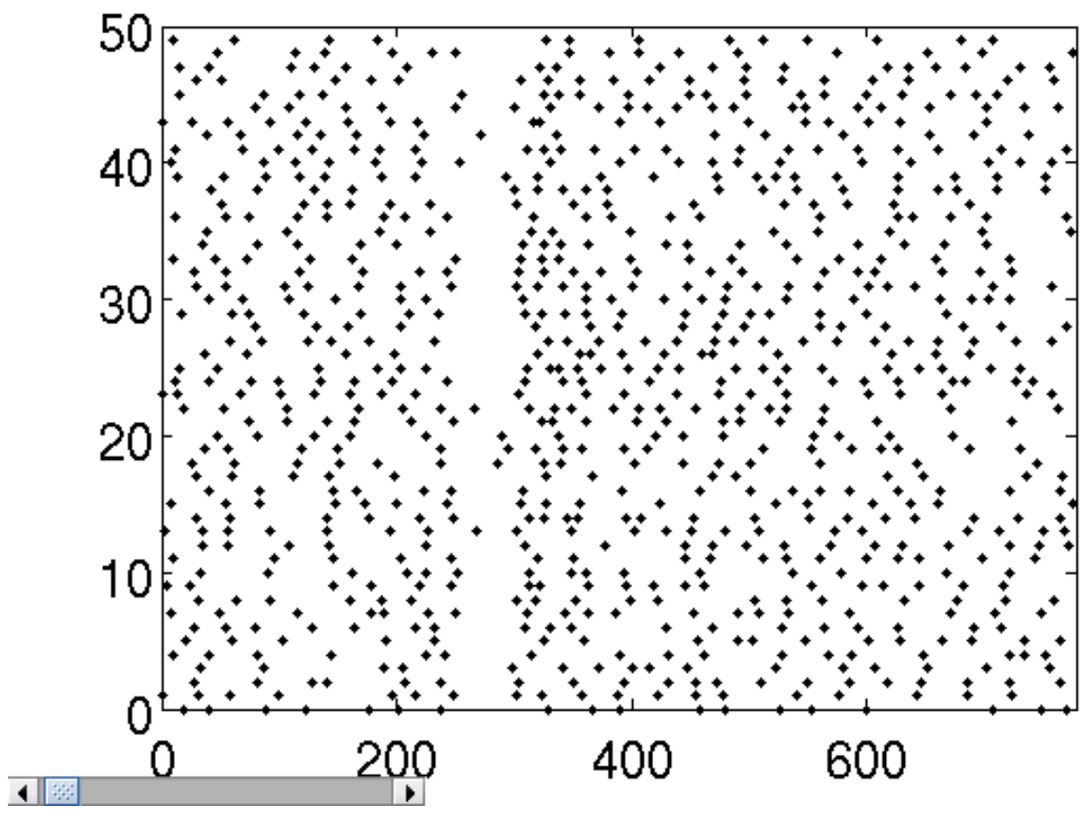
Rasters:
Used to select “good” runs

“Good” response: 2007-08-24-4, Run 7

ON parasol



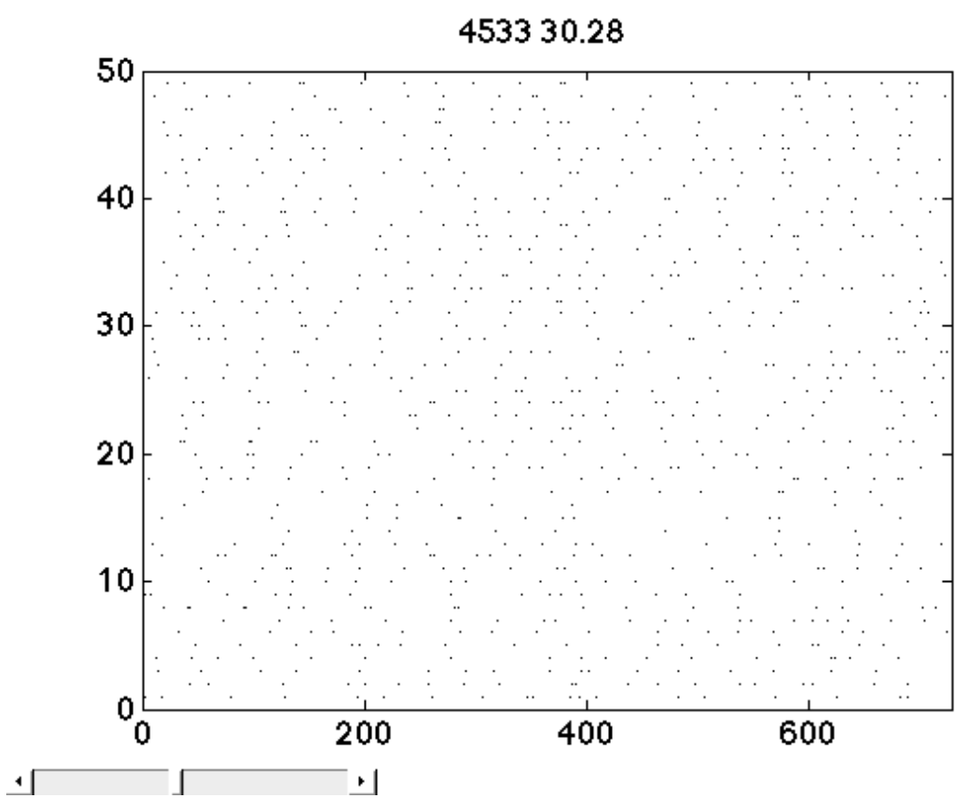
ON midget



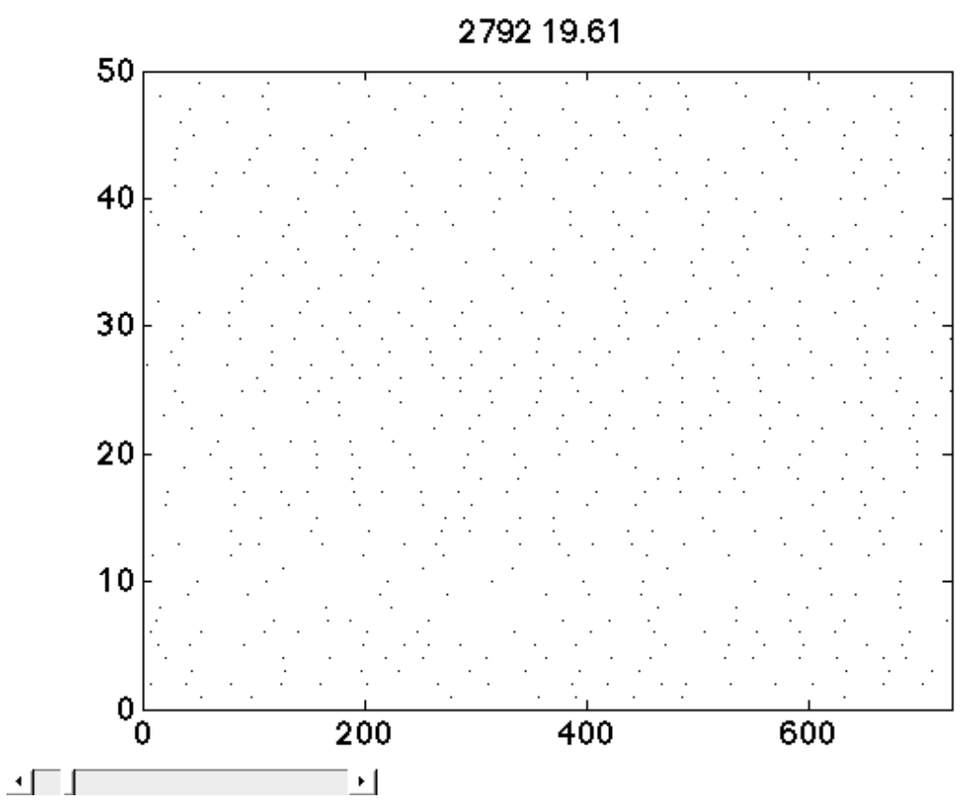
Rasters:
Used to select “good” runs

“Bad” response: 2007-08-24-4, Run 2

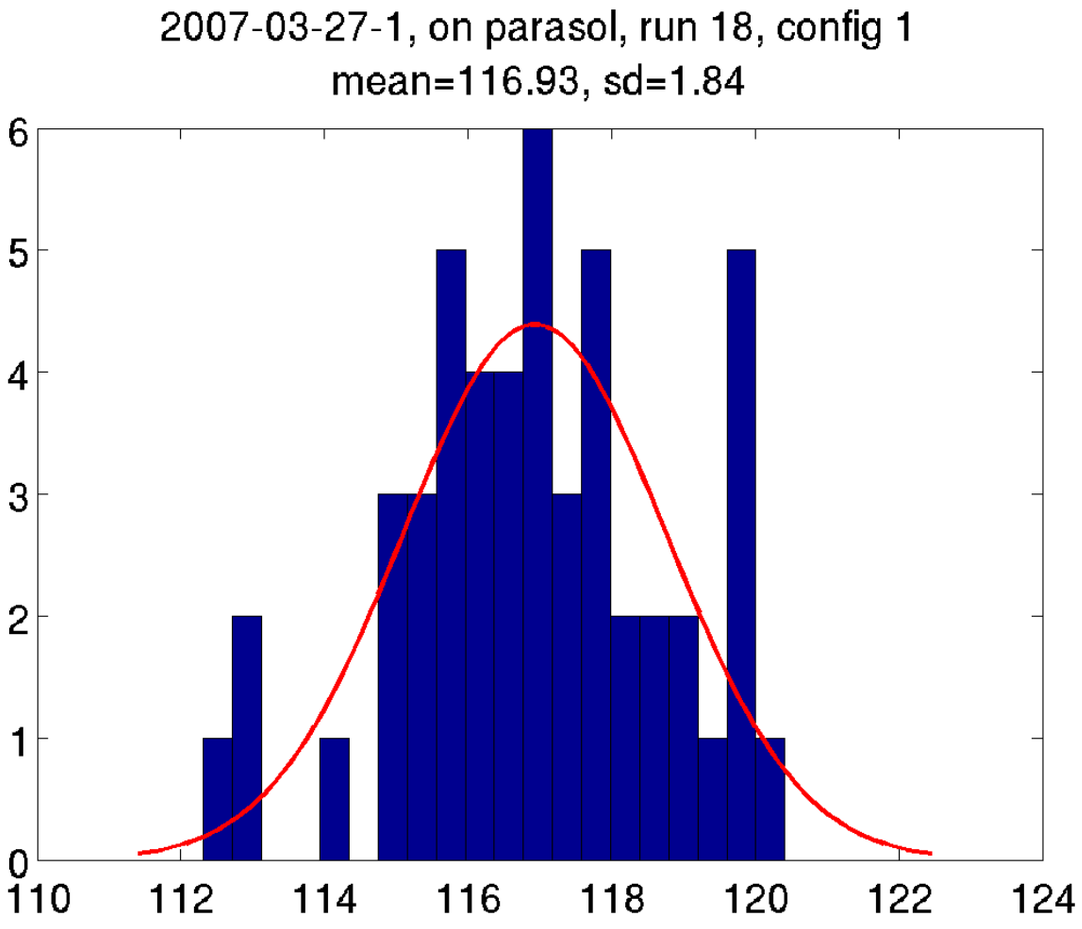
ON parasol

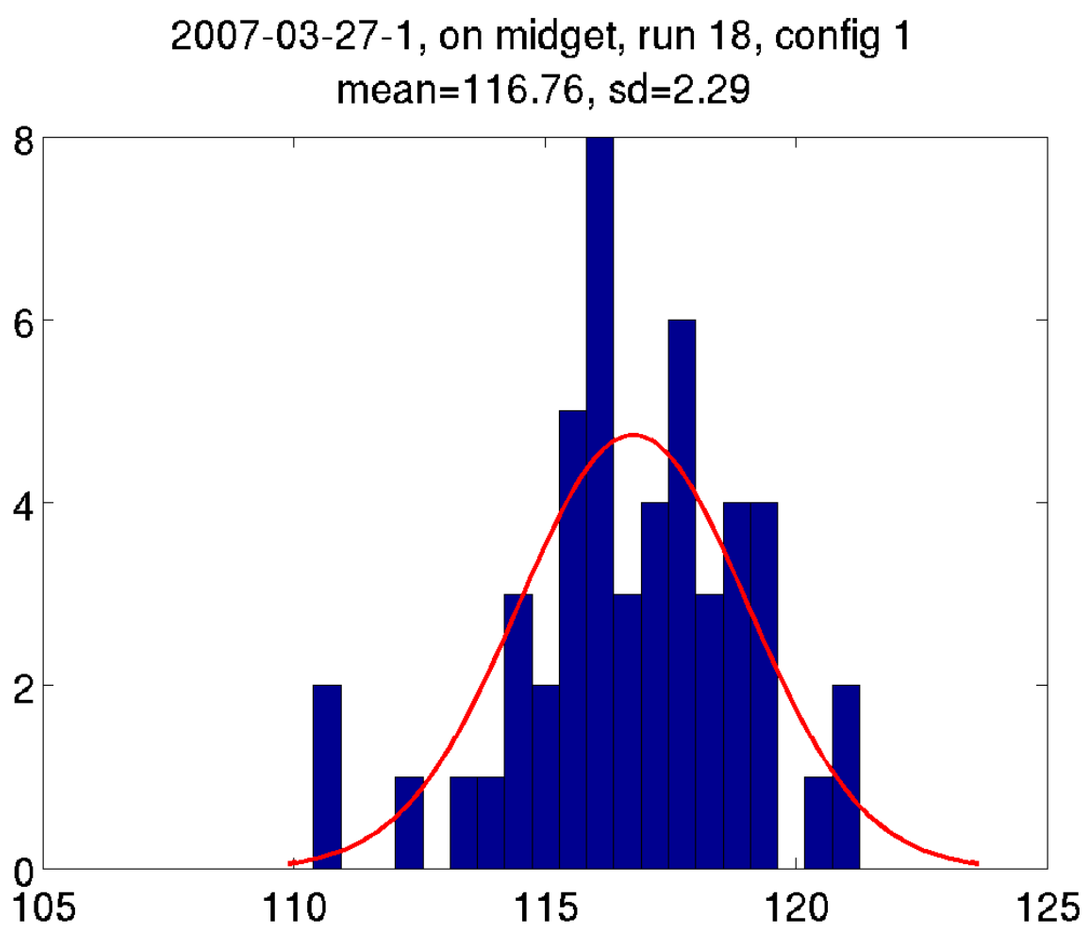


ON midget



Example speed estimate

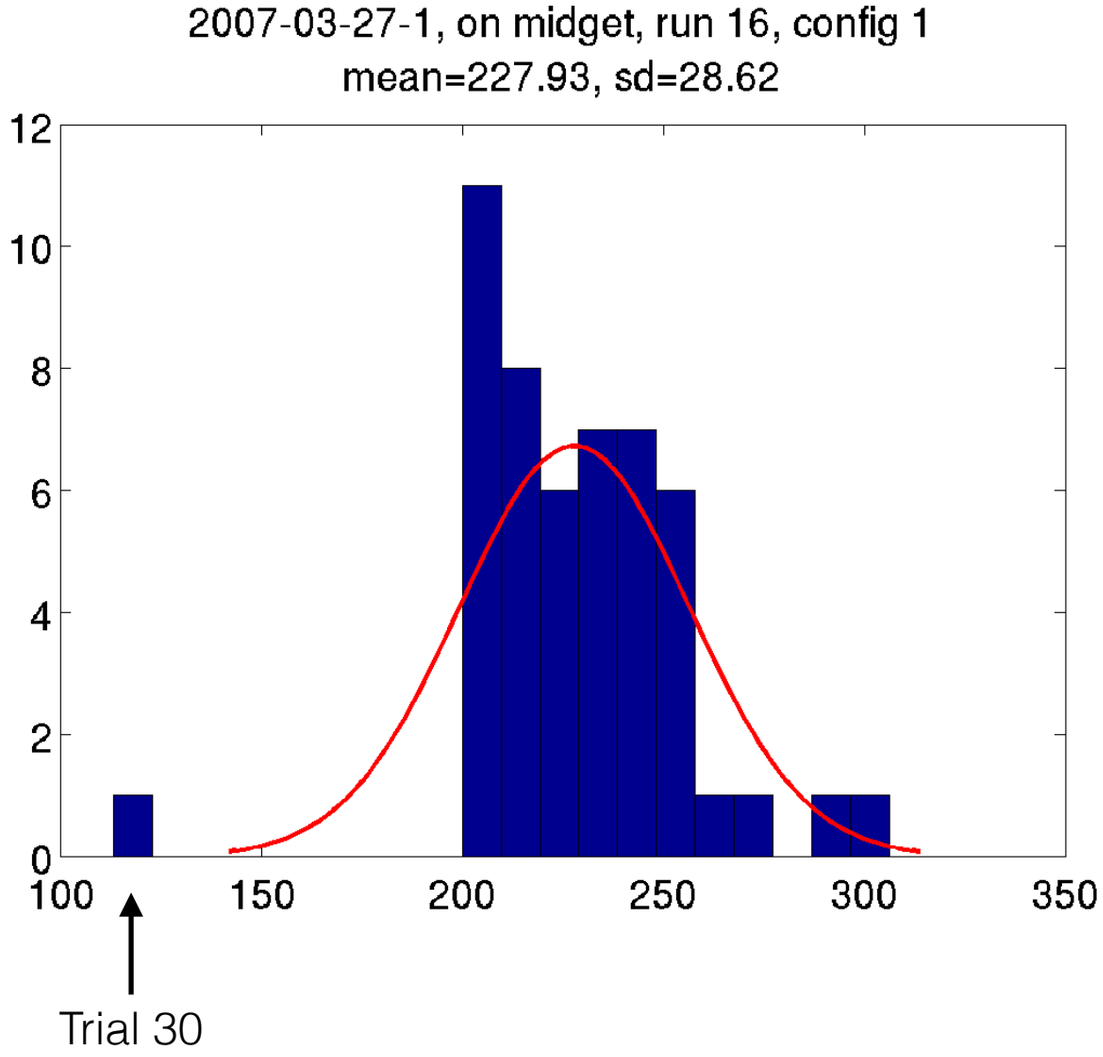


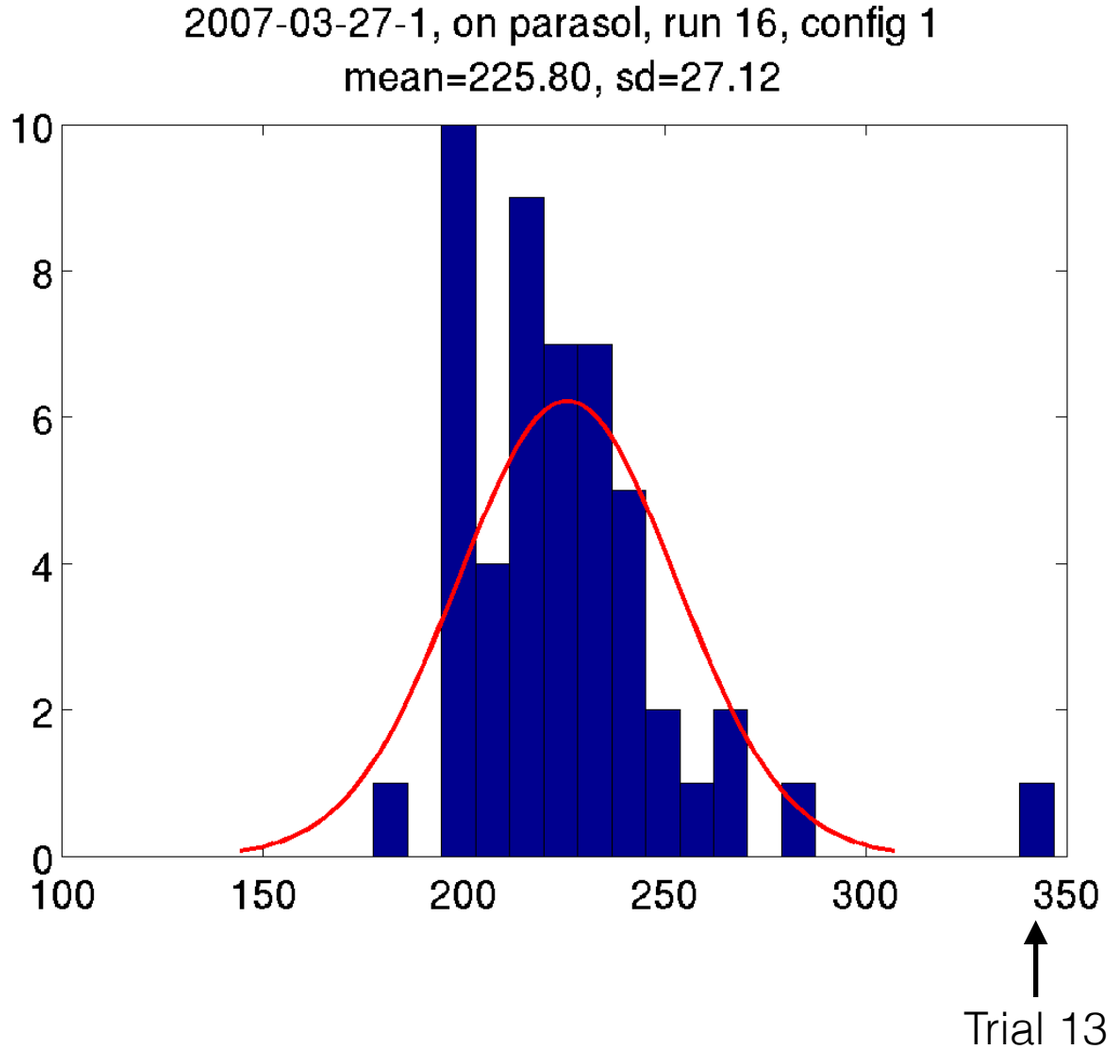


Measure of accuracy = robust SD of speed estimate (MAD)

Caveat: Outlier trials

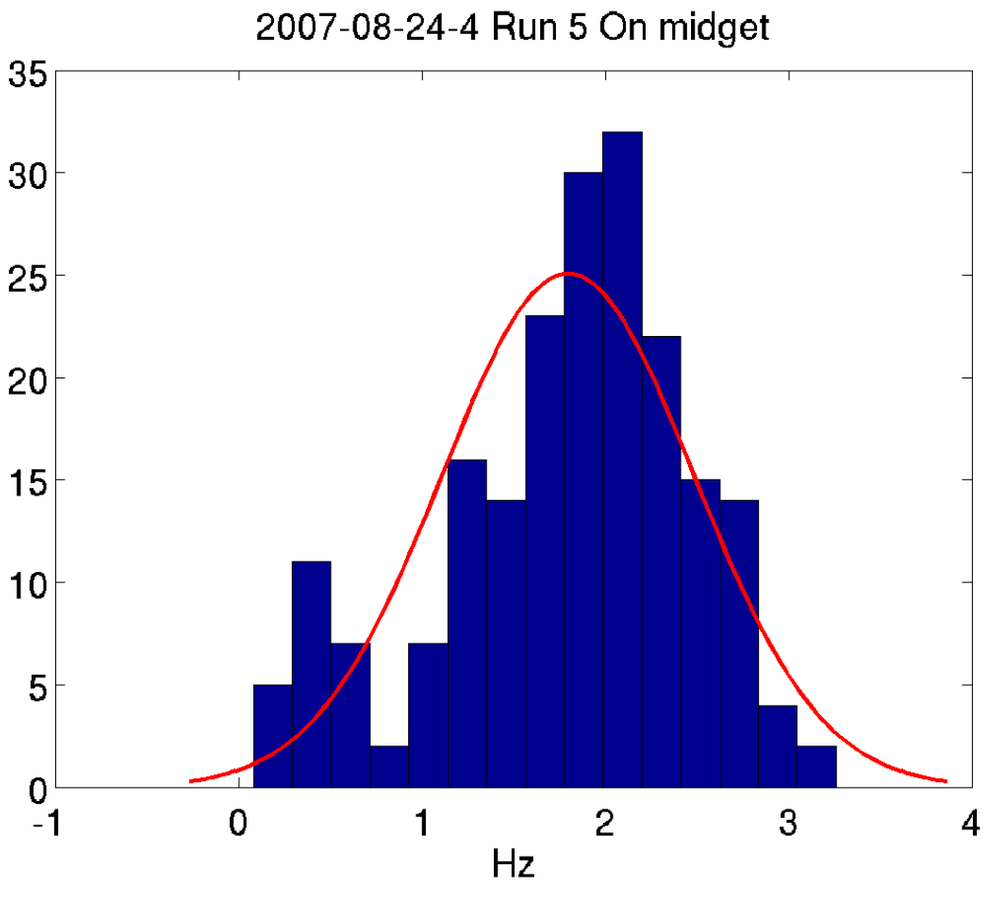
- While some trials were outliers for some cell types, there were no trials that were consistently outliers across cell types

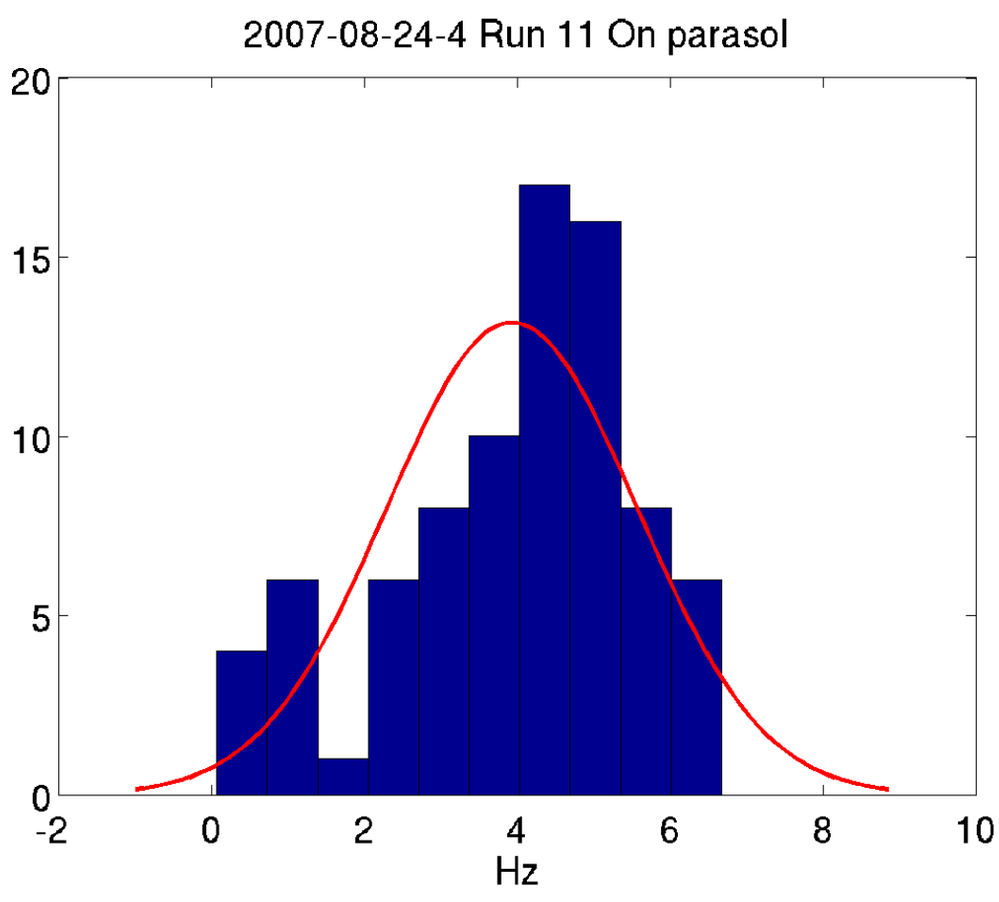




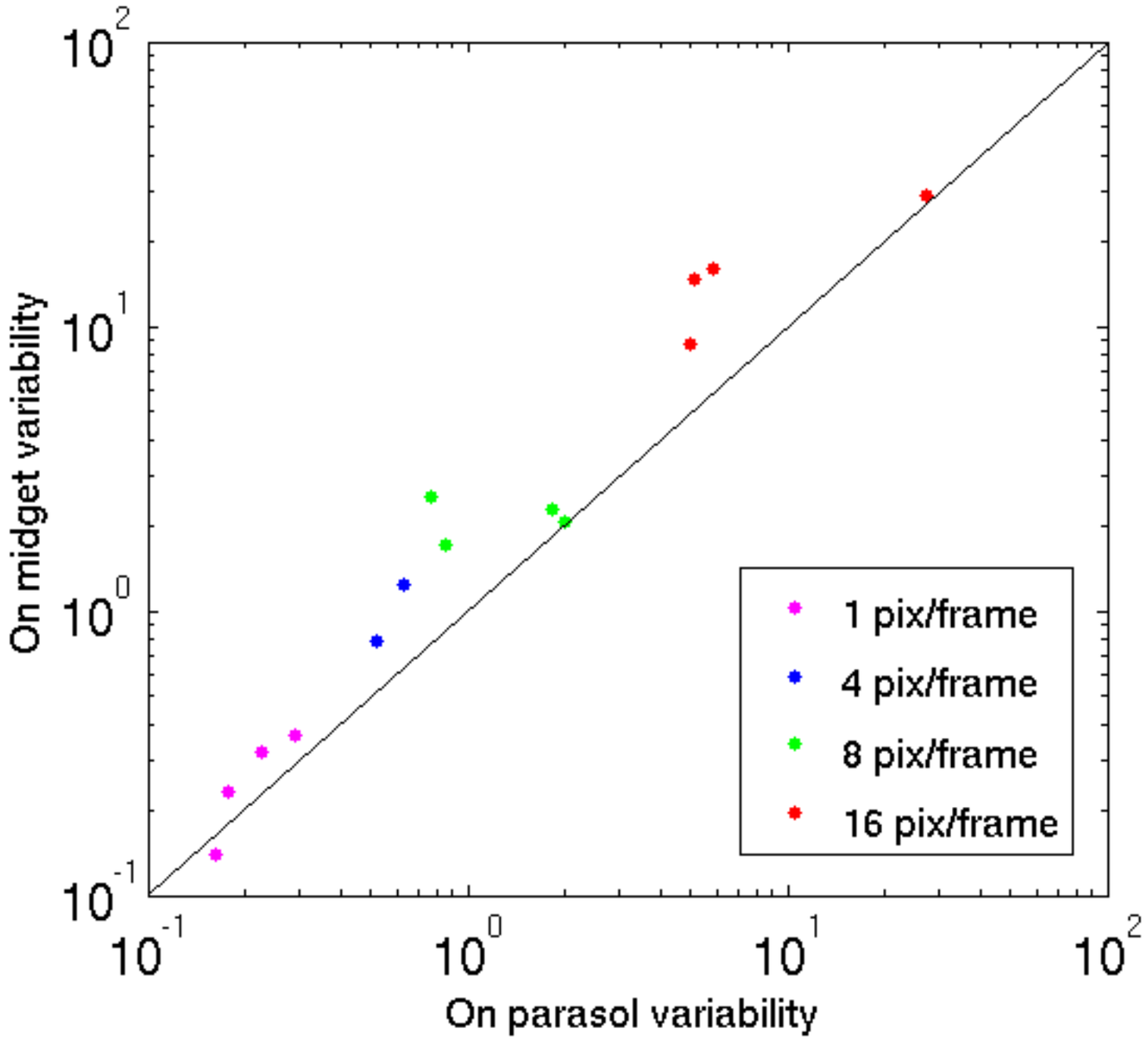
Firing rate histograms were sometimes bimodal

- These cells were generally consistent across runs
- In CellFinder, they did not appear to be poorly spike-sorted



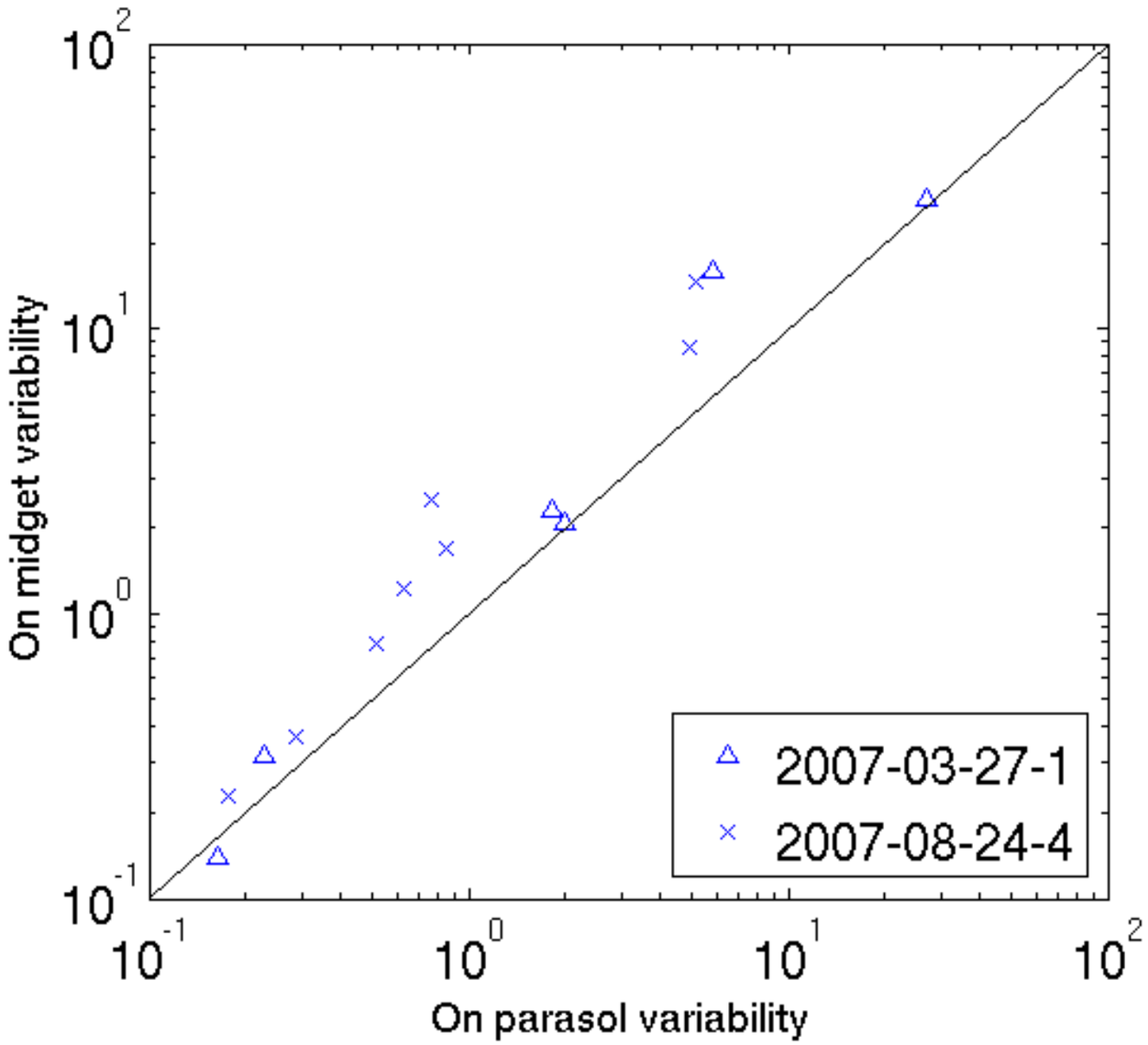


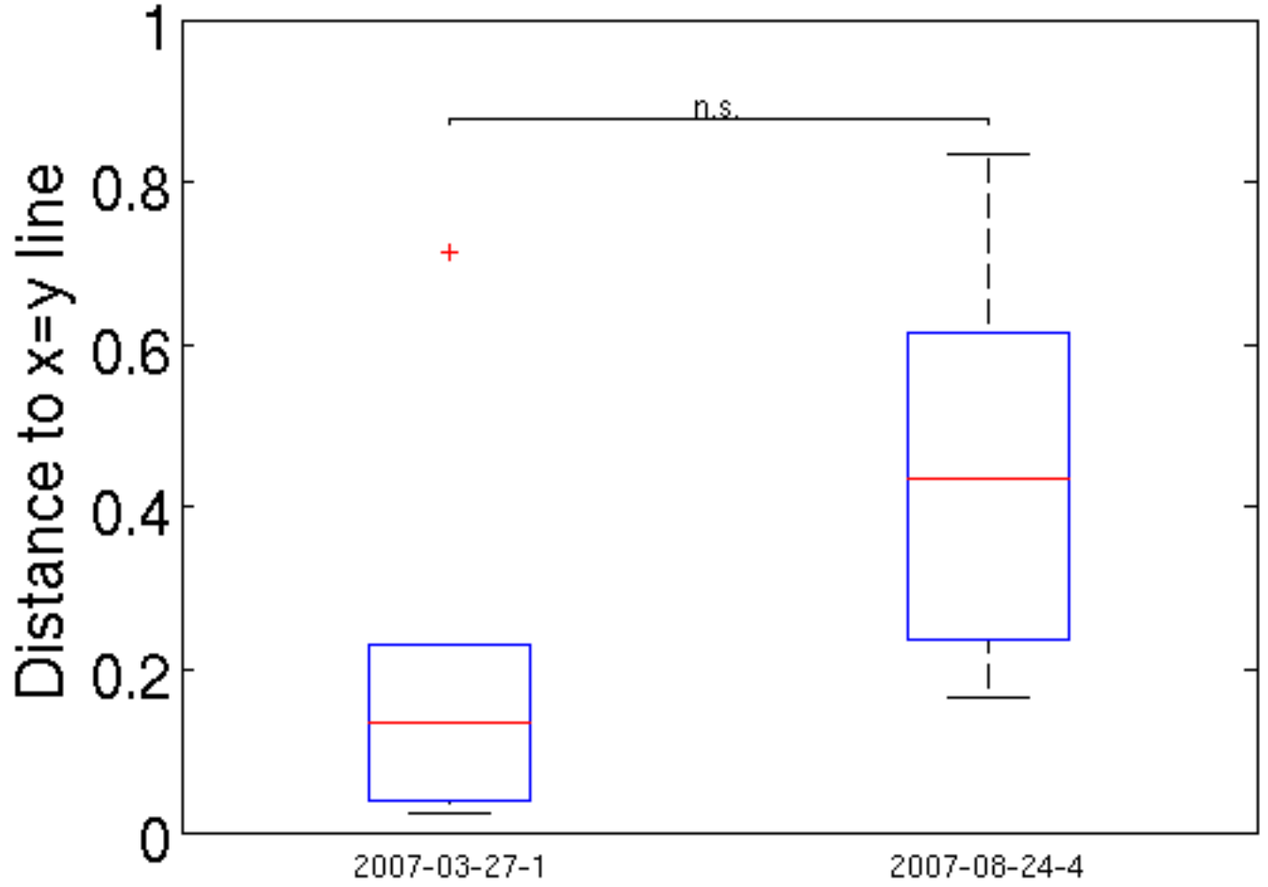
ON midgets are less accurate than ON parasols



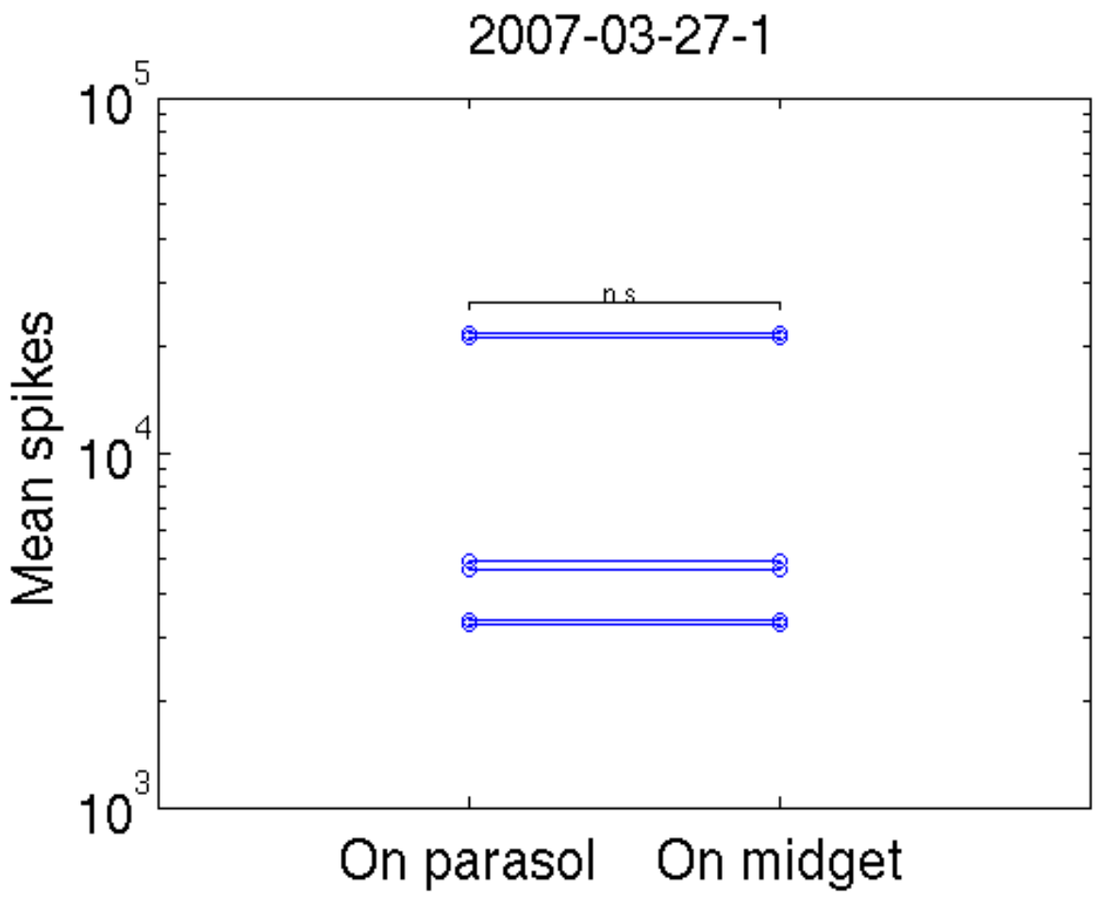
Paired, two-sided
Wilcoxon signed rank test
p = 0.00024

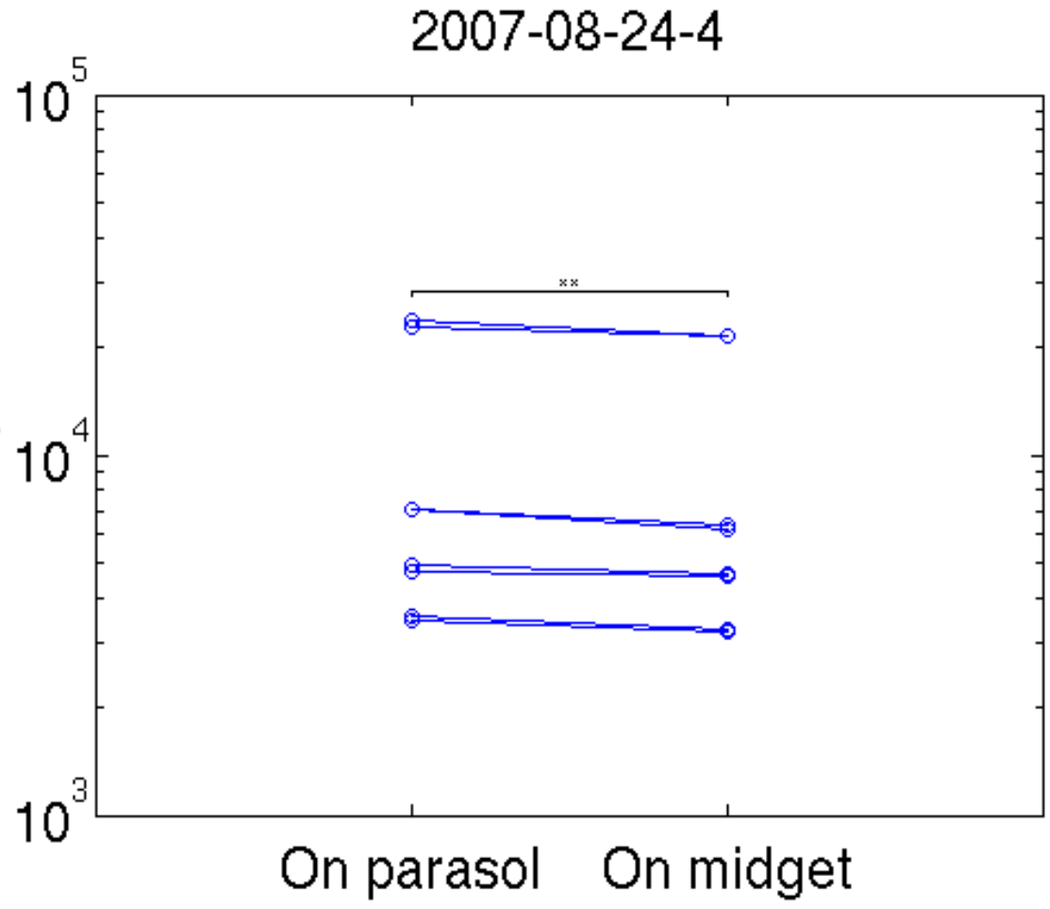
This difference is slightly, but not significantly, bigger in one dataset





Higher firing rate?

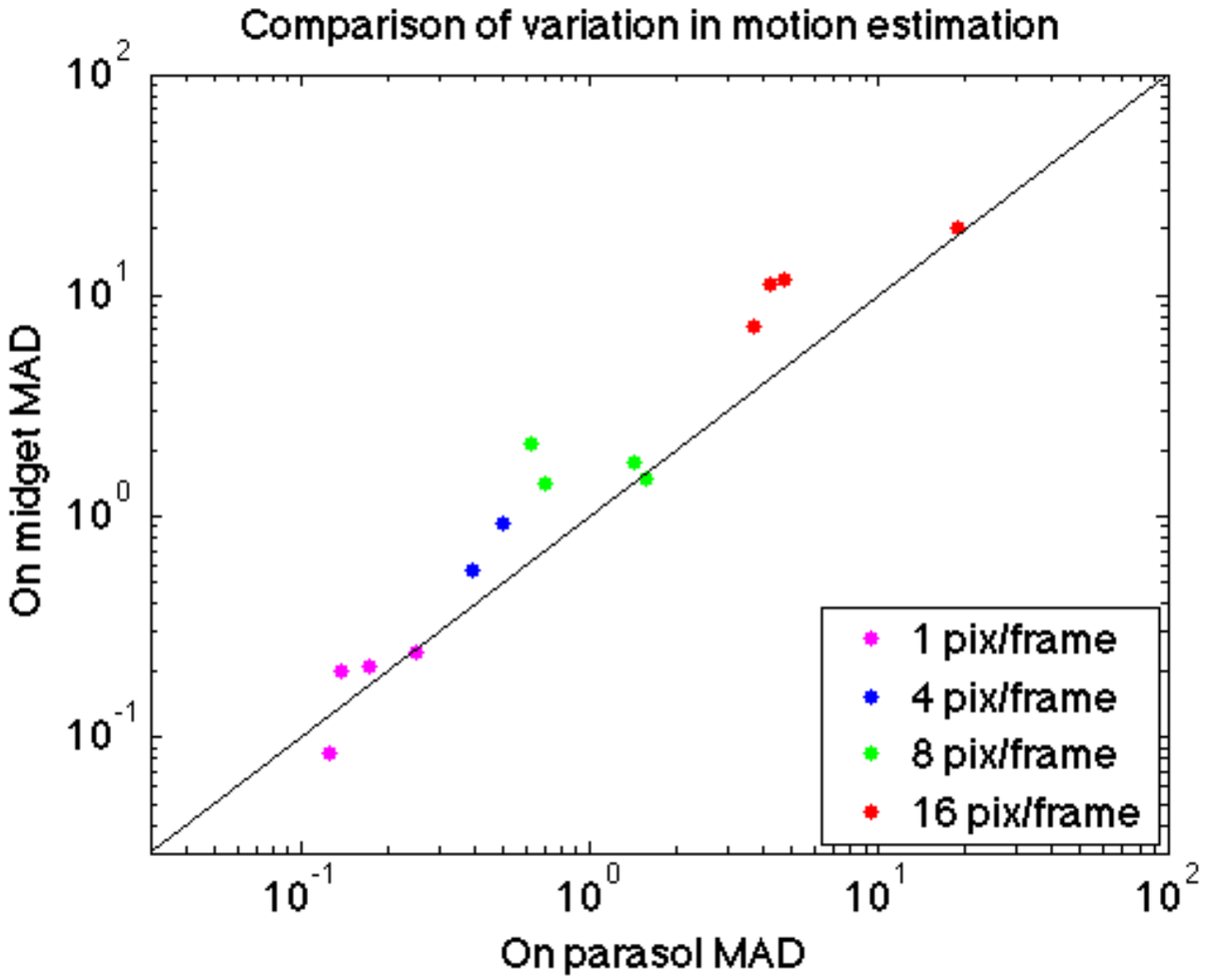


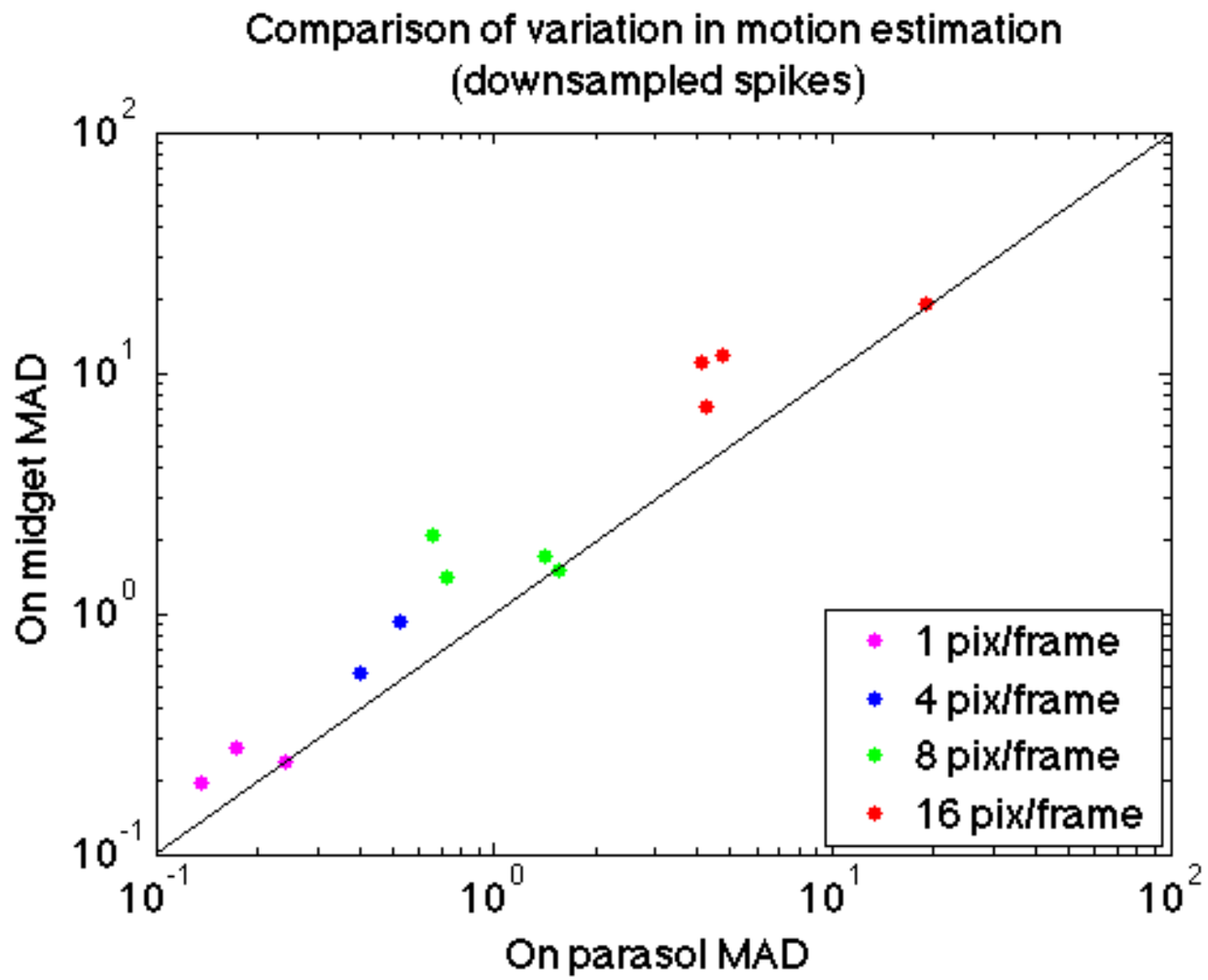


Downsampling spikes

- Controls for firing rate differences between ON parasols and ON midgets
- Method: fractional downsampling of spikes from cell-type with greater mean spike count
- Downsampling performed on each run separately

Downsampling spikes





The missing data point had MAD = 0. I will rerun with a different seed velocity.

Summary

- In two datasets, ON parasols consistently estimate motion more accurately than ON midgets

- These two datasets have very similar cell mosaics

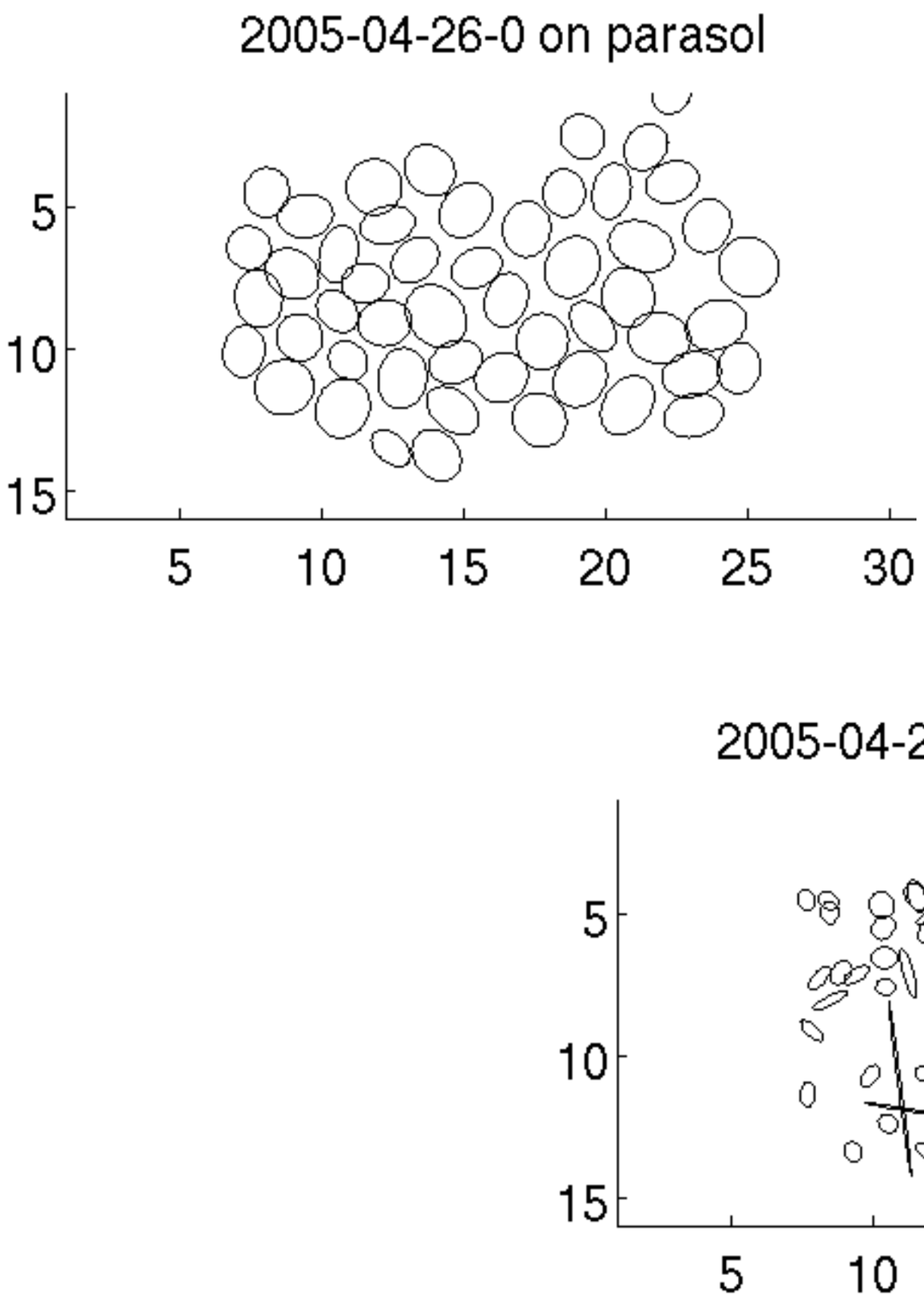
- There do not appear to be bad trials, or a subpopulation of cells that are poorly spike-sorted

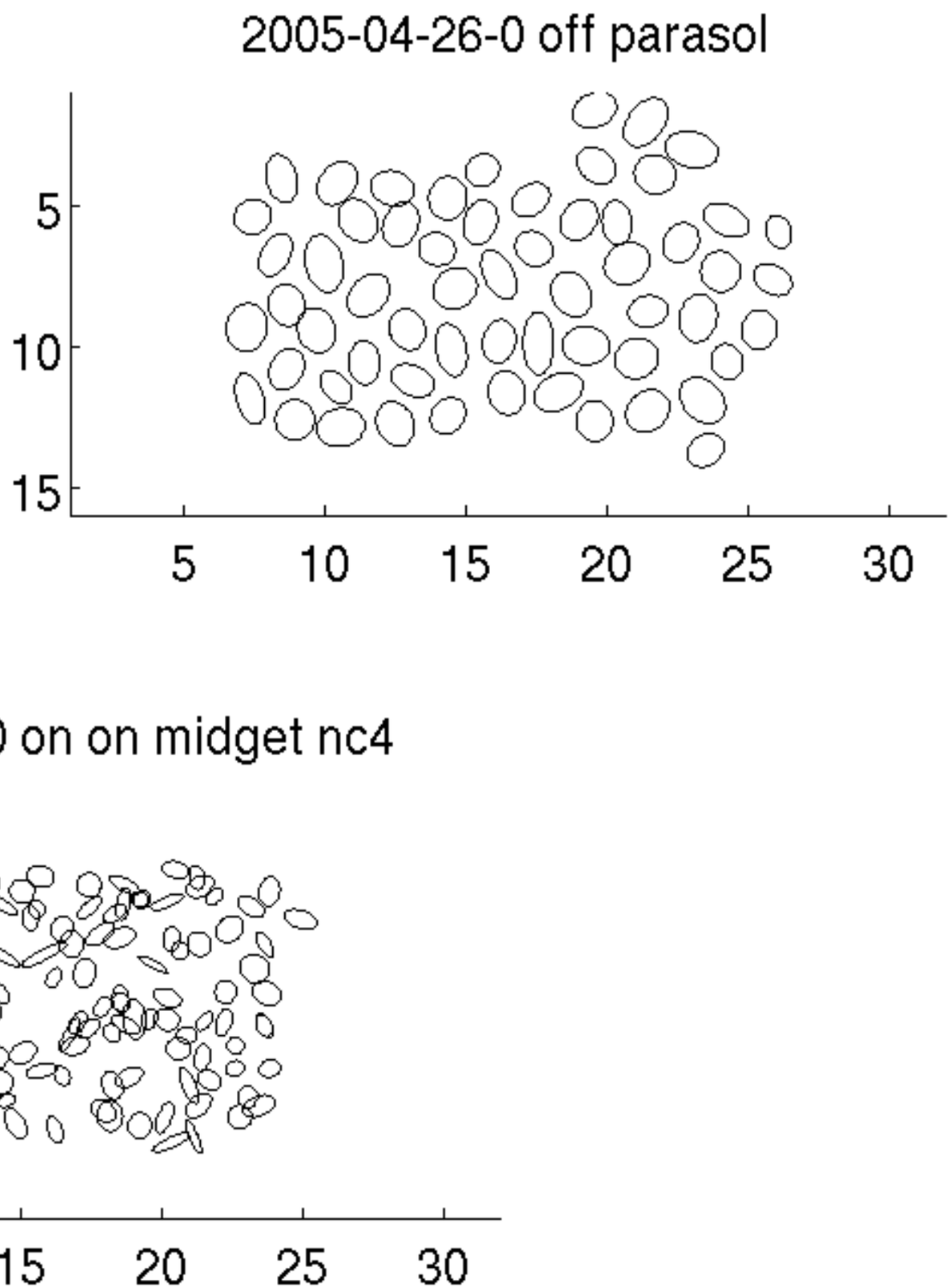
- The result survives downsampling to account for firing rate differences

- More datasets are needed for this to be convincing

Other datasets?

- Search datasets on Bertha!
- See READ_ME.txt in “malcolm” folder for a list of search results
- One promising dataset: 2005-04-26-0


2005-04-26-0 on parasol
5
10
15
5
10
15
20
25
30


2005-04-26-0 off parasol
5
10
15
5
10
15
20
25
30

2005-04-26-0 on on midget nc4
5
10
15
5
10
15
20
25
30