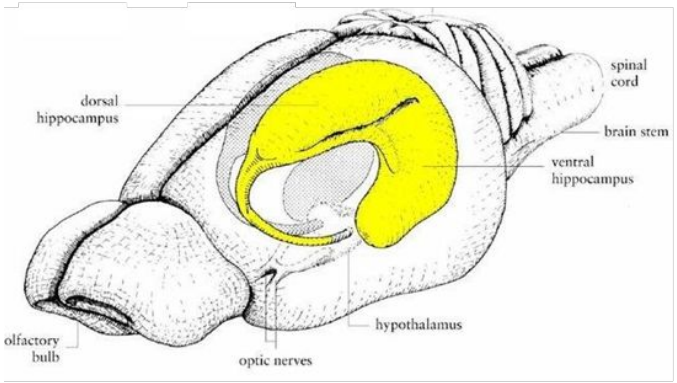
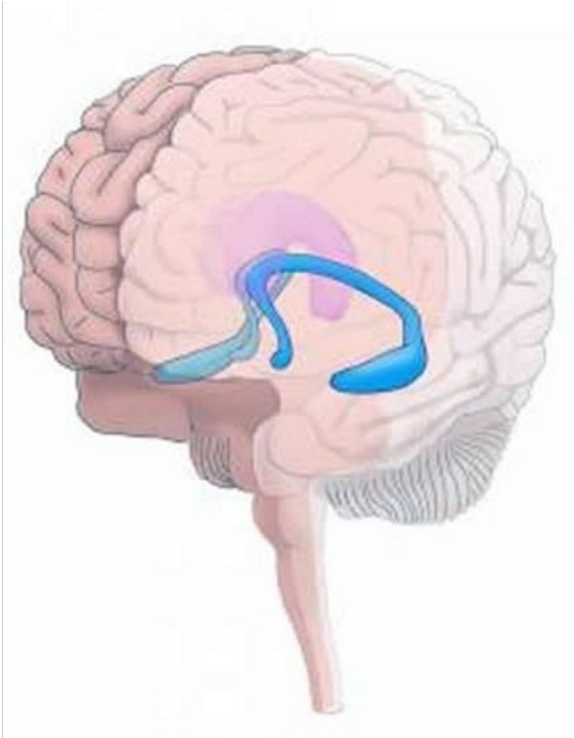
Analysing simulated place cell data through SVD data reduction

By Aaishah, Gundeep, and Eryn

Spatial Memory in Hippocampal Circuit

- Large-scale in vivo electrophysiology
- Recordings targeted to the hippocampus





Spatial Memory in Hippocampal Circuit

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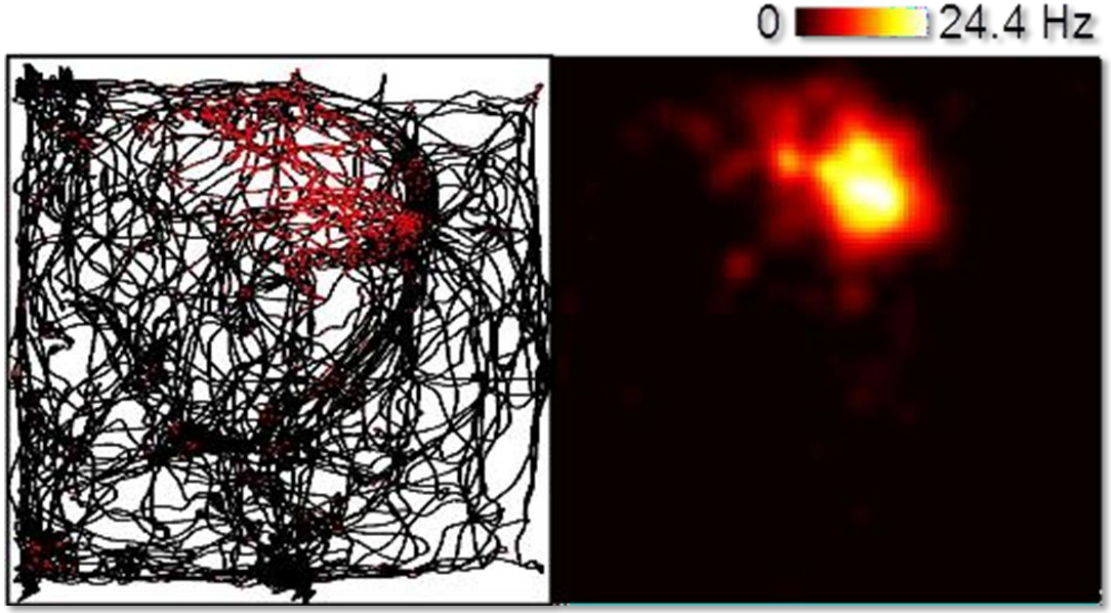
- Recordings targeted to the hippocampus
- Simultaneous recording from hundreds of place cells



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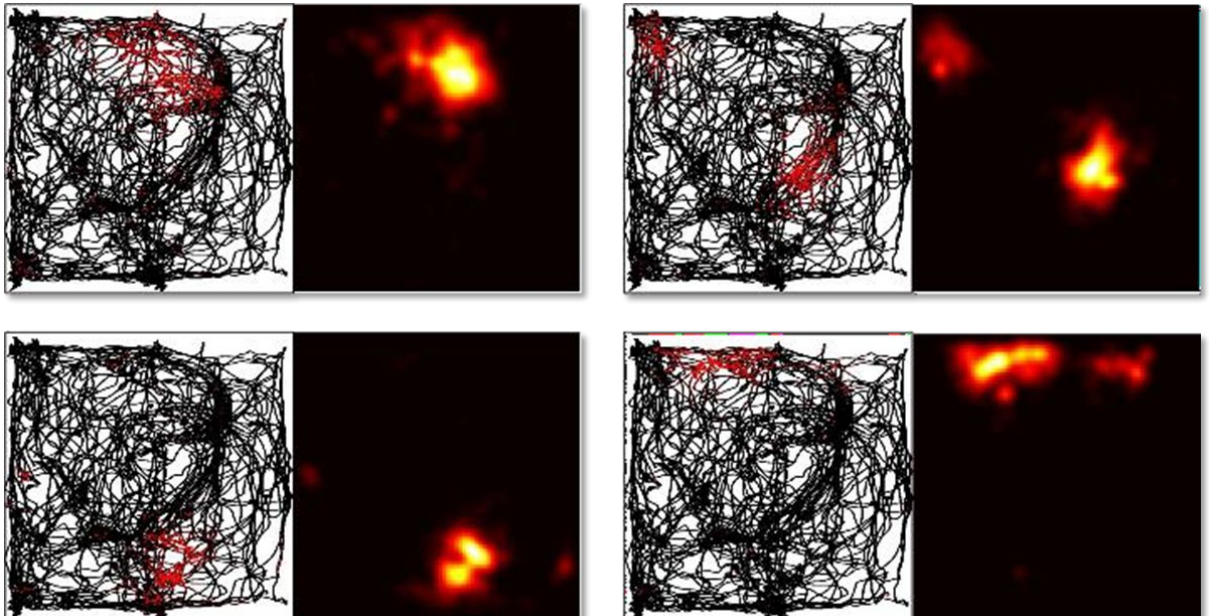
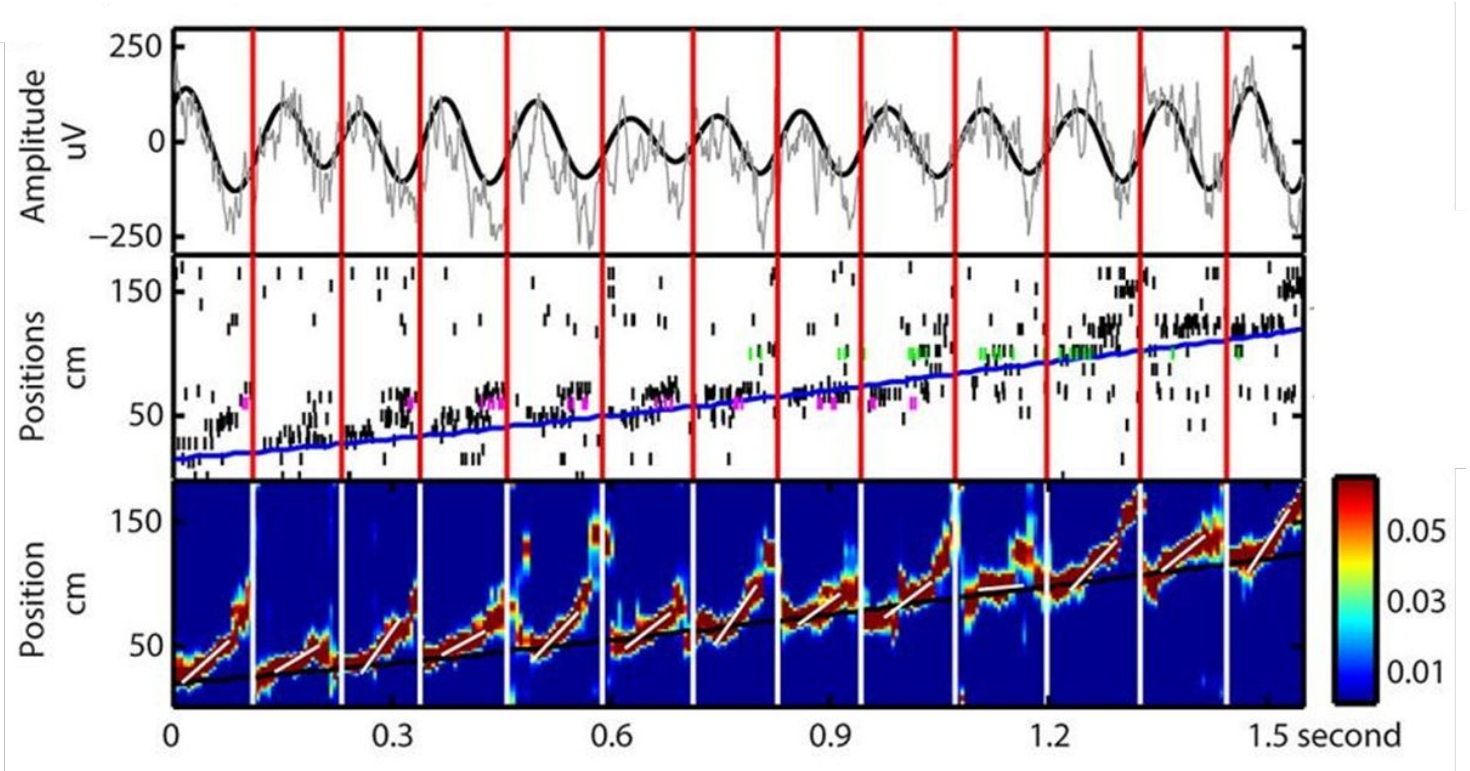
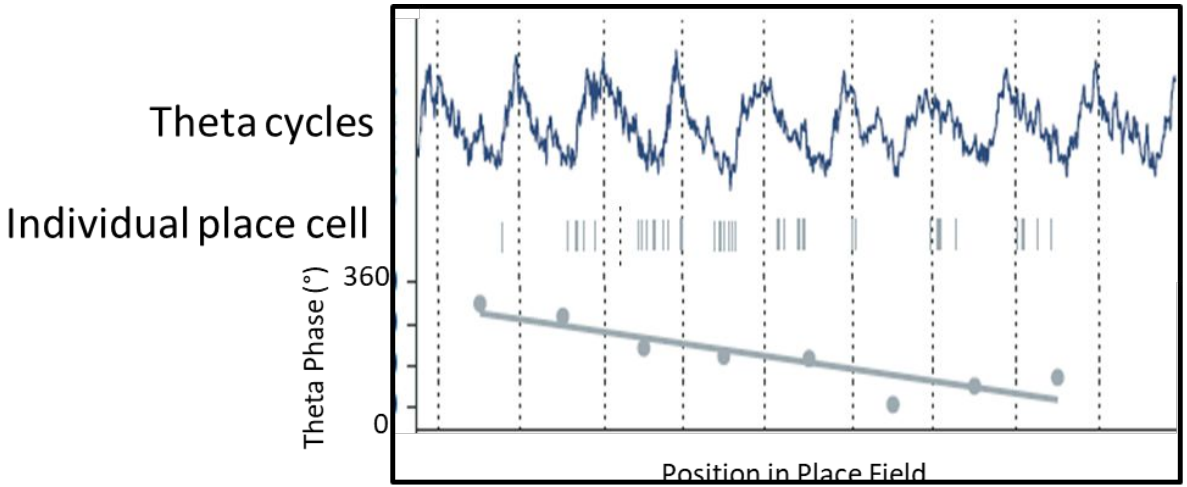


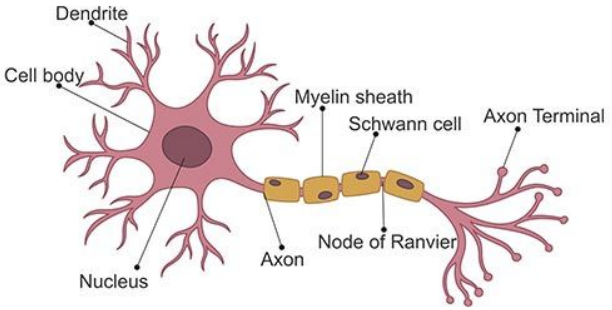
Two types of internally generated sequences: replay and theta sequences

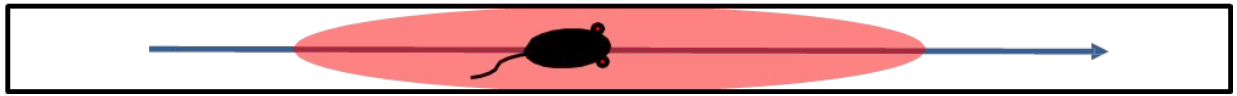


Mechanism of theta sequences: phase precession



Zugaro *et al.*, *Nature Neurosci.* 2005

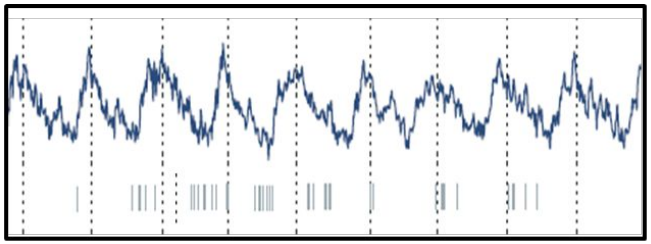




Mechanism of theta sequences: phase precession

Theta cycles

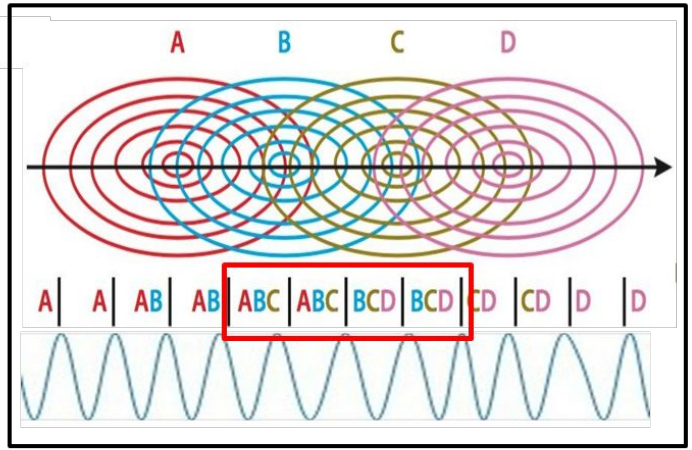
Individual place cell



Zugaro *et al.*, *Nature Neurosci.* 2005

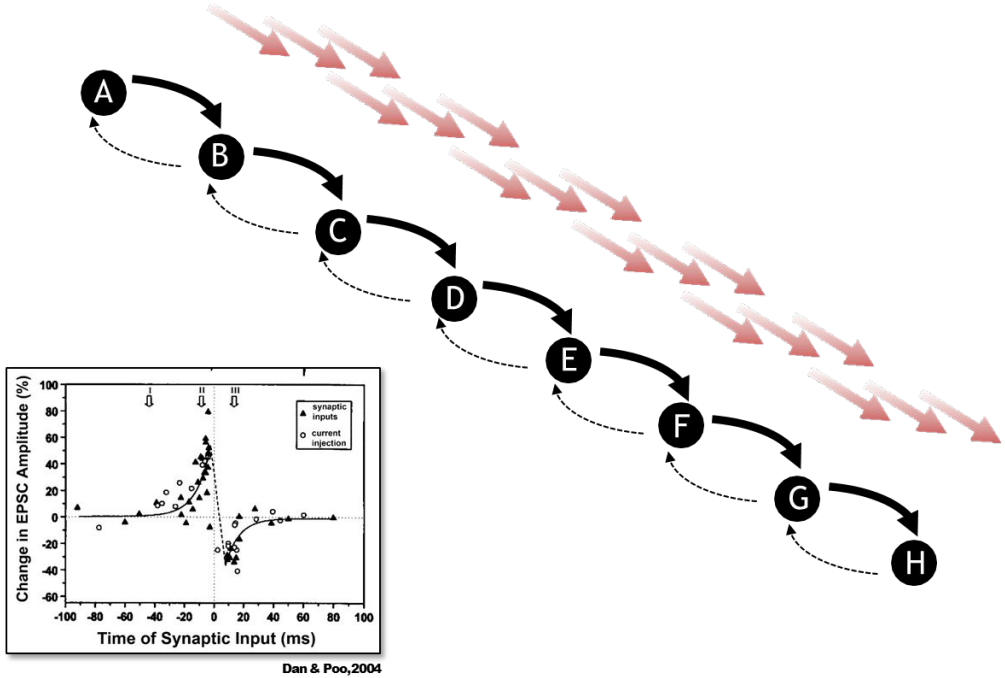
Place cell ensemble

Theta cycles



Skaggs *et al.*, *J. Neurosci.* 1996

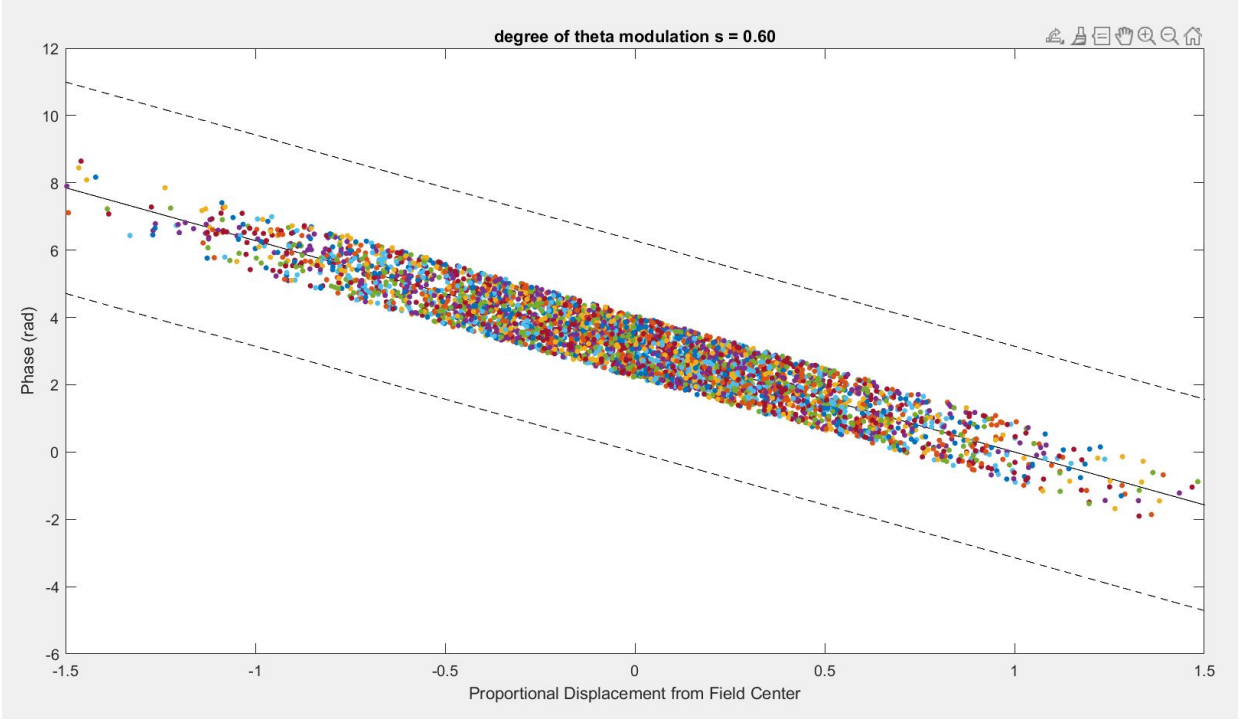
Theta sequences should facilitate plasticity in the 'forward' direction



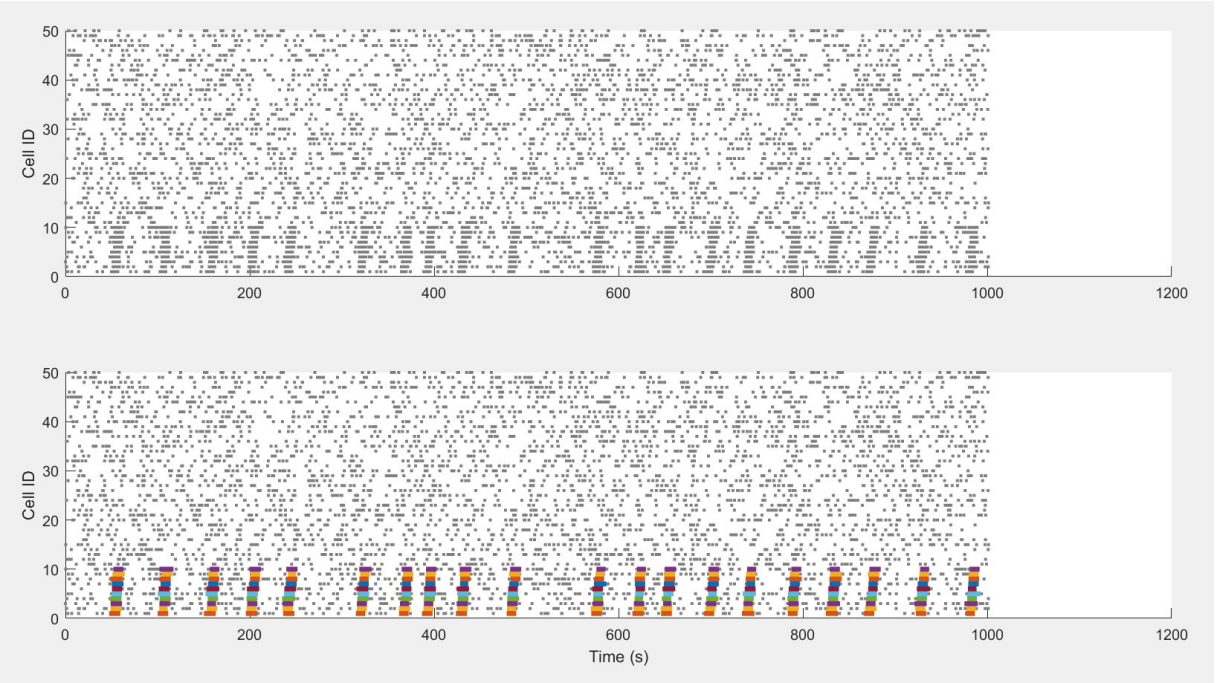
Summary of Data Reduction

1. Generate assembly cell data
2. Build coordinates
3. Time Series
4. Dimension Reduction
5. Analysis

Displacement Phase Graph

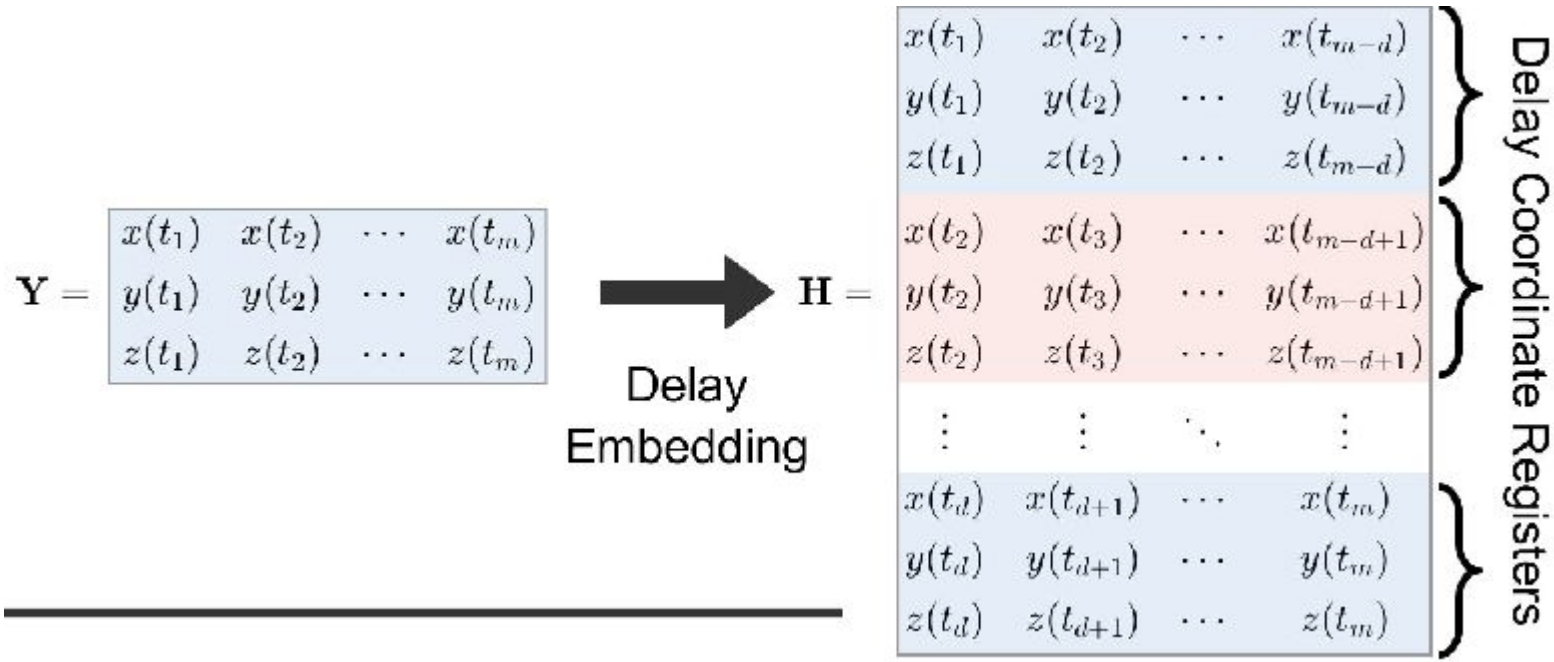


Assembly cells and noise cells

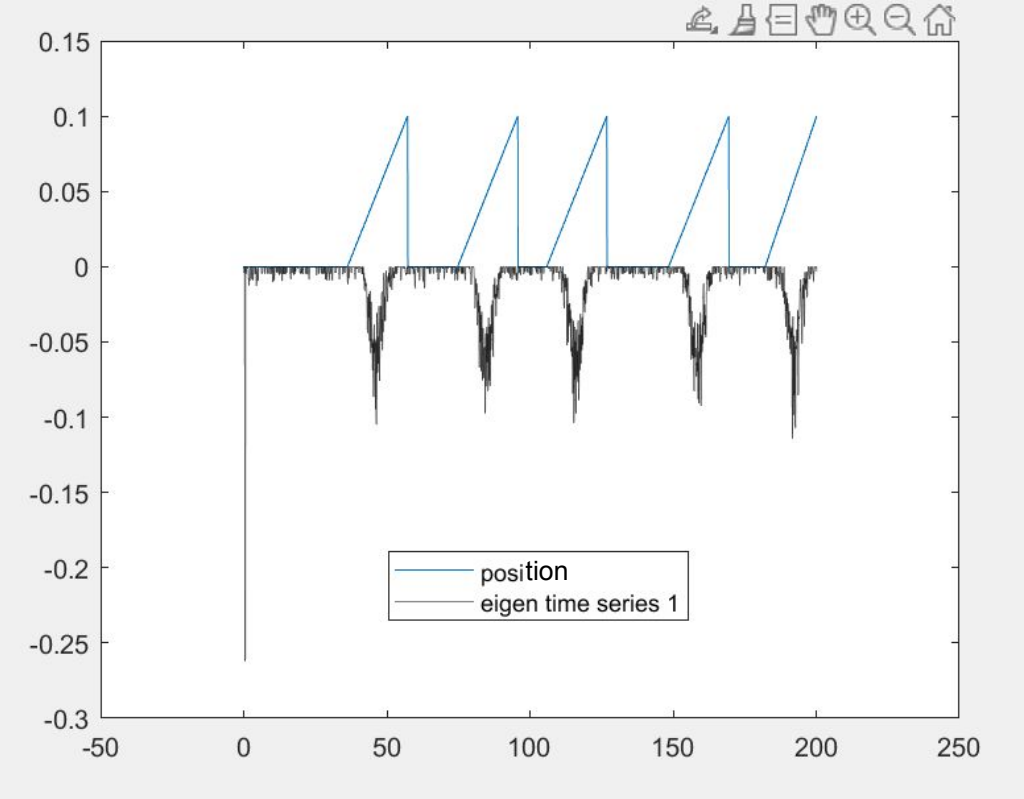


- 10 assembly cells
- 40 noisy cells
- 80% noise

Time-delay coordinates and SVD

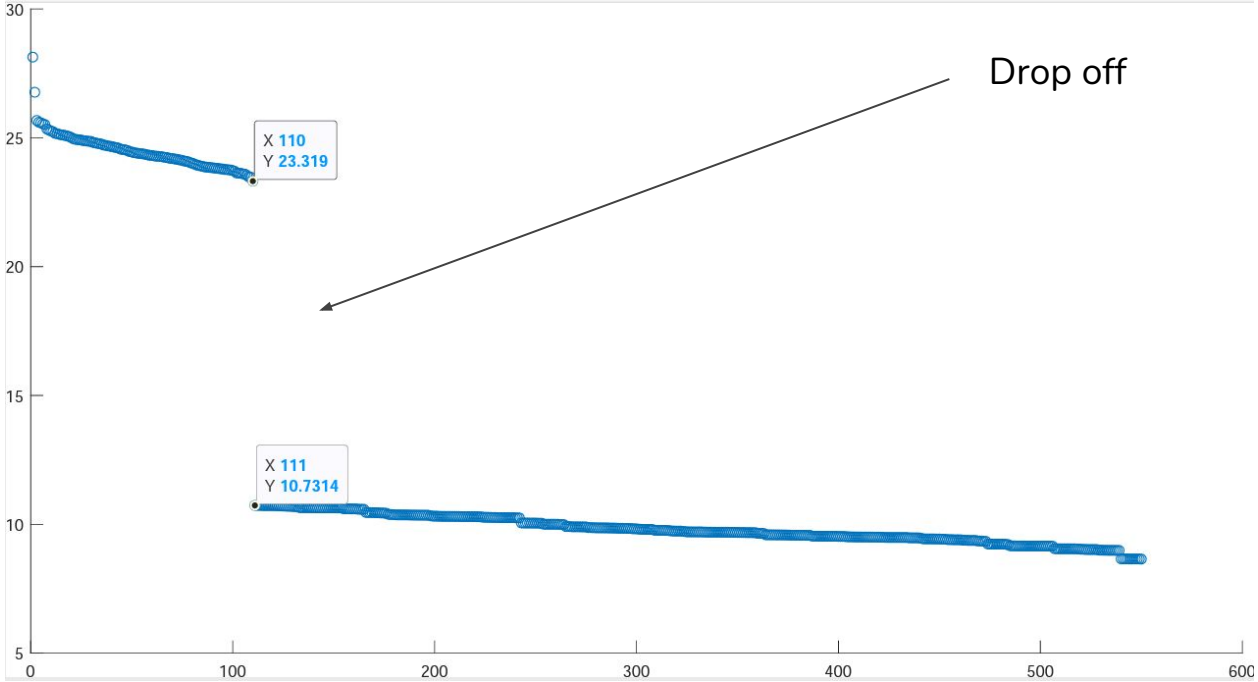


Position vs first eigen timeseries

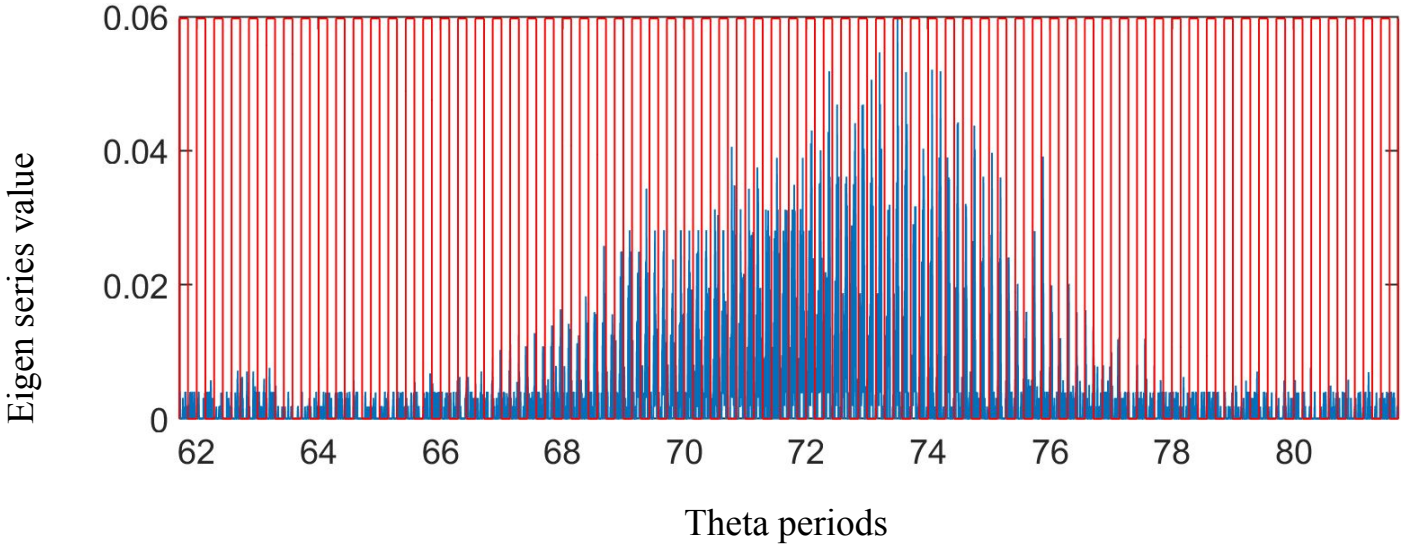


We can see a strong correlation with the position and the 1st eigen time series

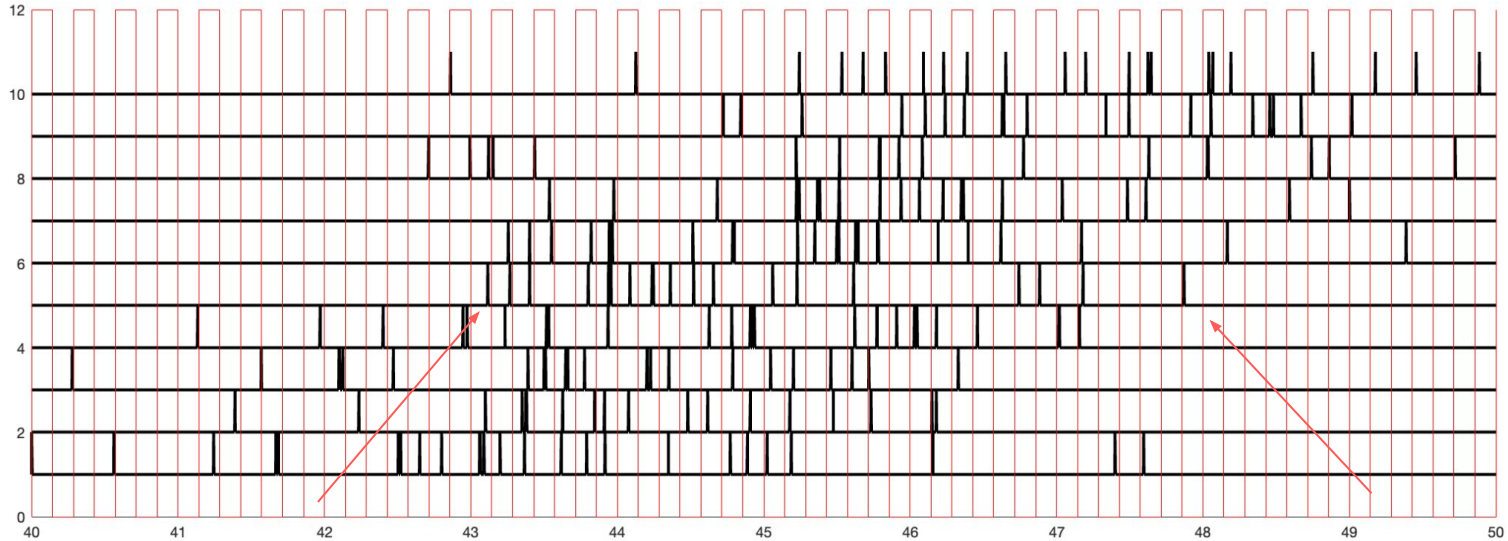
Singular value matrix confirms decay for 10 cells for 10 delays



Averaging over several trials resembles Gaussian spike distribution.



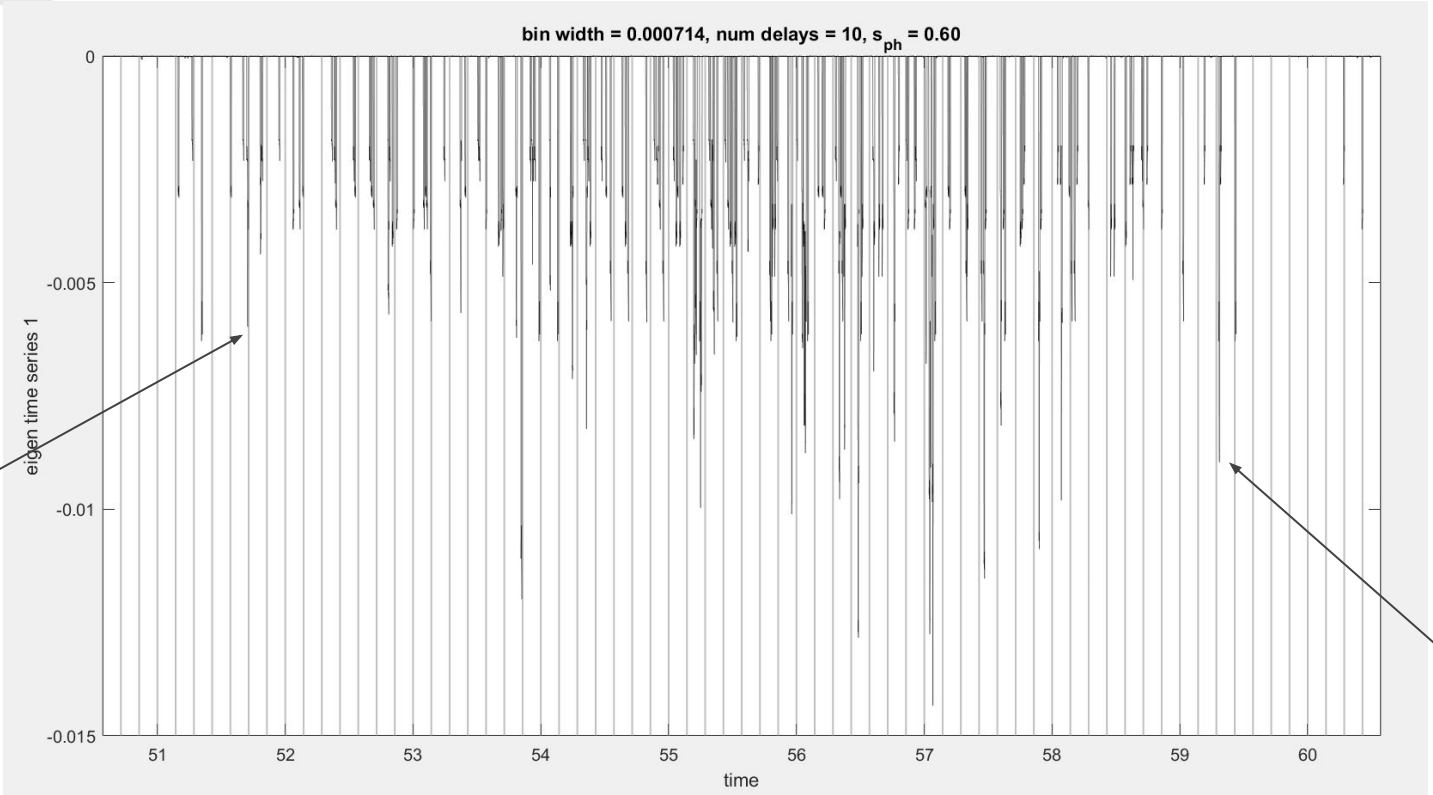
Original spike data theta precession



Each vertical bar resembles 1/7th of a second (1 theta period)

After a few periods, it moves from the right to the left.

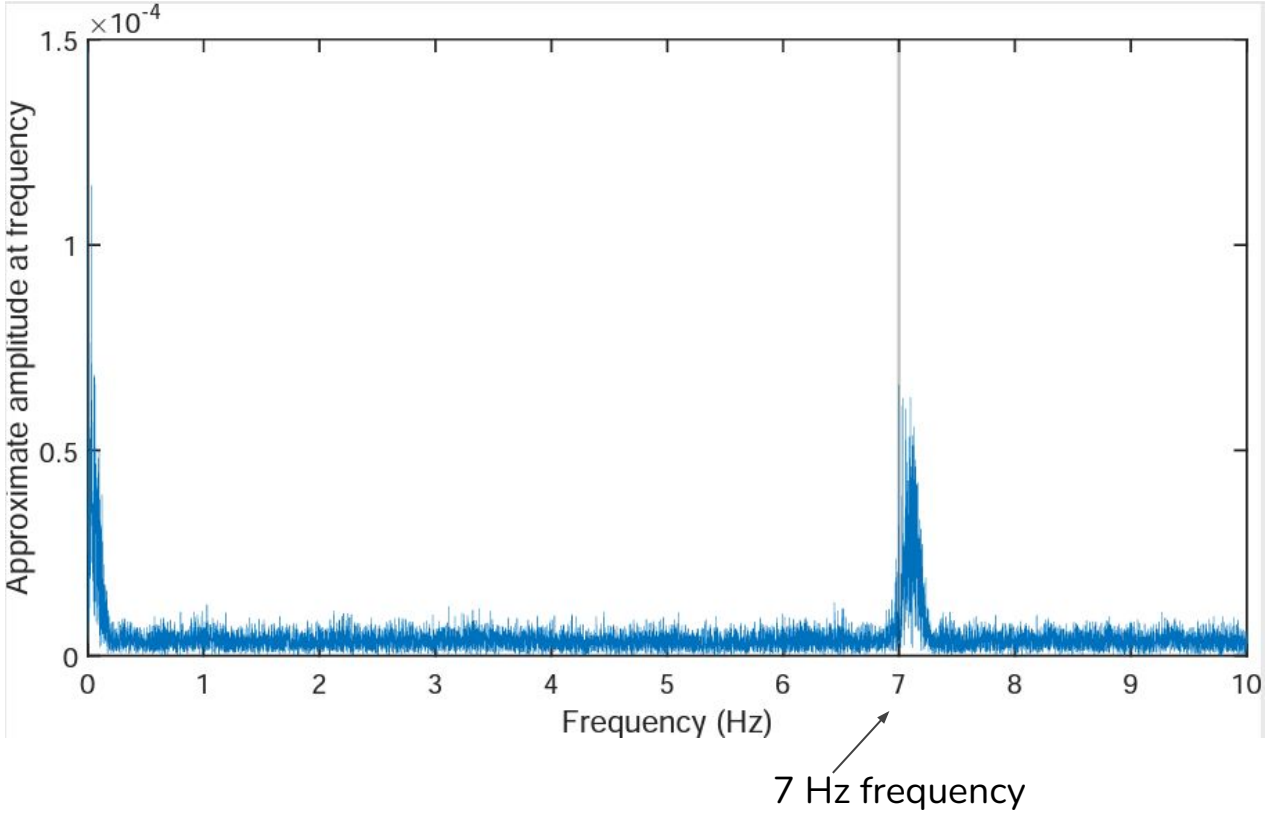
Eigen series theta precession is present.



Towards the right

Towards the left

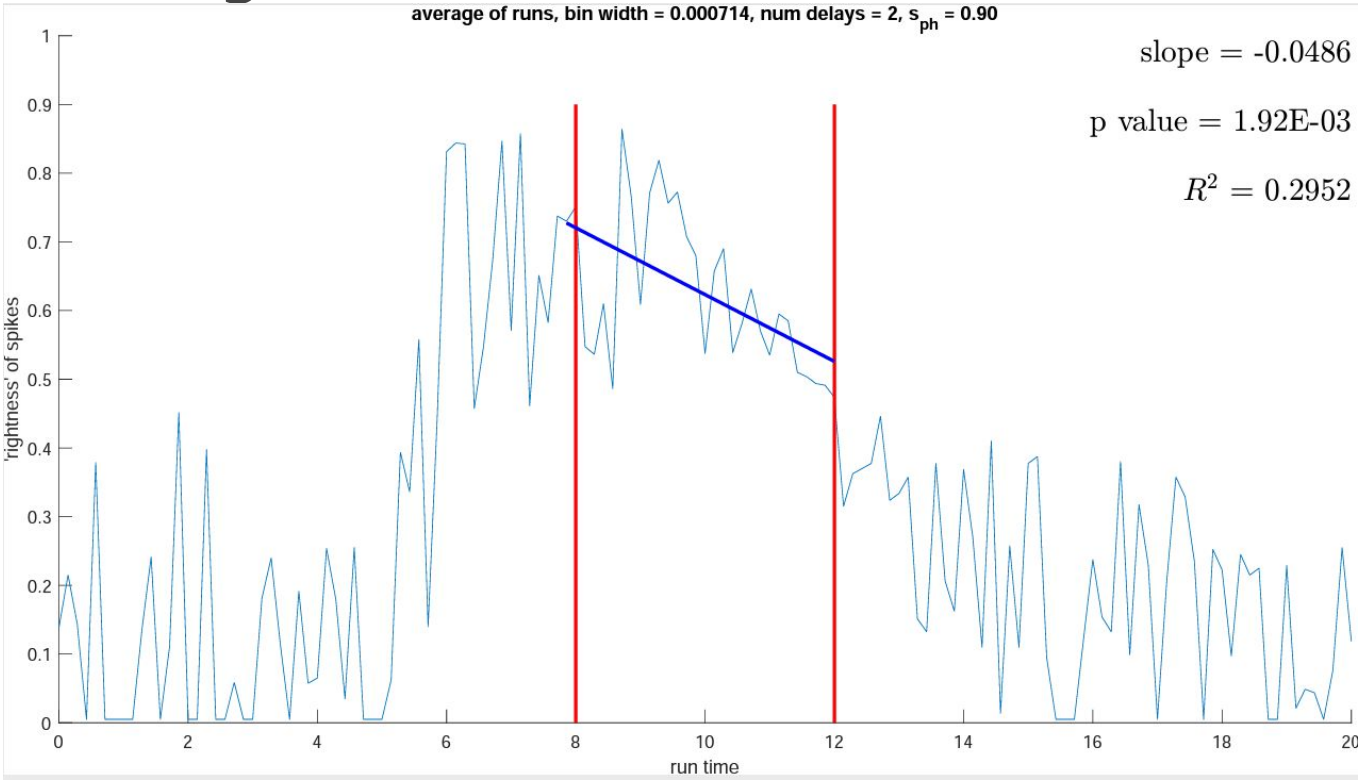
Fourier transform is used to find theta oscillations



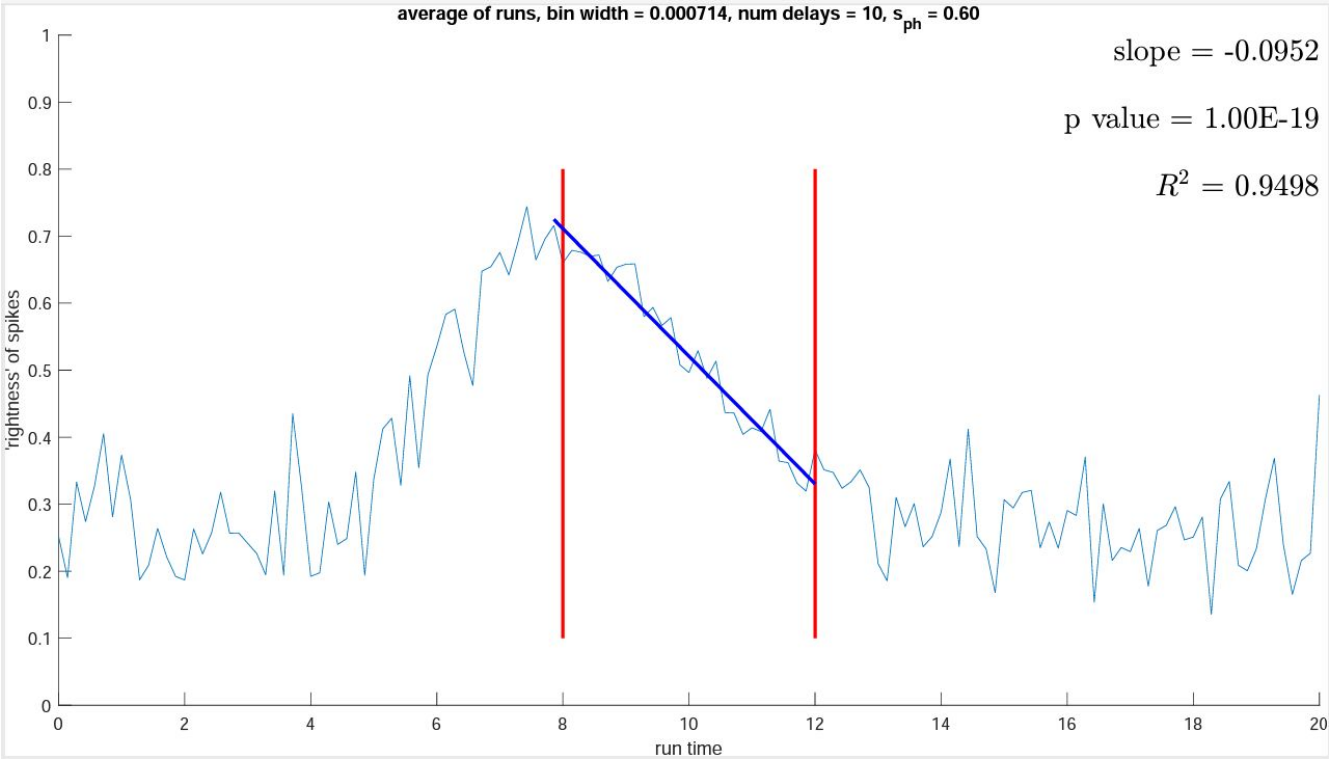
Parameters we decided on after experimentation

```
% precession parameters

s_ph   = 0.6;      % phase precession controller 1 --> perfect  -1 --> none
sig    = 8;        % width for place cell Gaussian
% *network* set up
nAsC = 10;       % number of representative place cells
nBaC = 40;       % number of background noisy cells % 80%
% timing set up
T = 1000;            % Final time in seconds T=1000 gives ~ 24 or 25 runs

% hyper-parameters

bin_width = 0.01/14;  % in seconds // 0.001 sec = 1 ms // made it correlate with 1/7 sec
period

num_delays = 10; % increasing is better
tau = 1; % Don’t increase tau (size of delay)
```

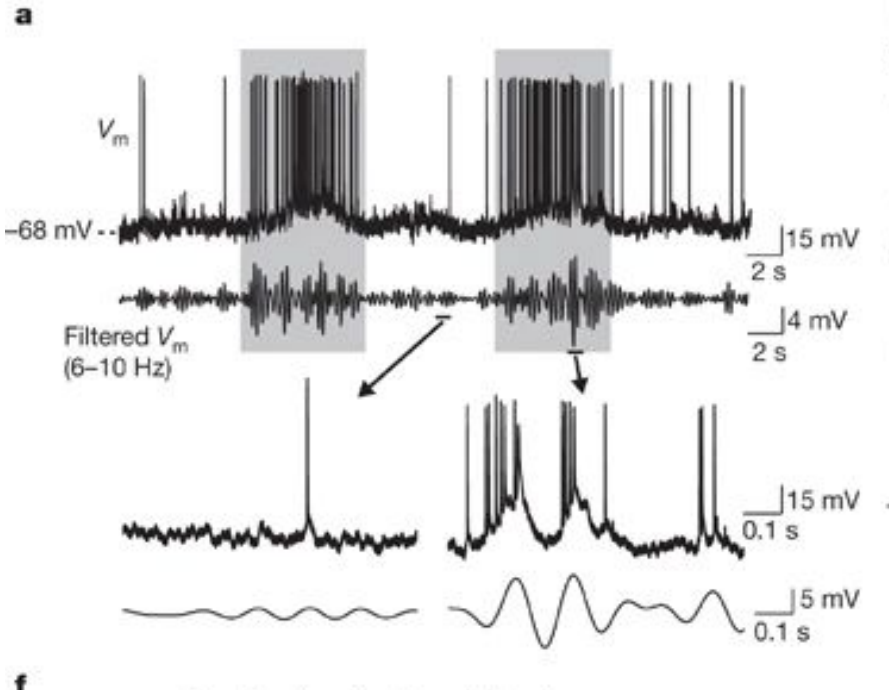
50% noise (10 assembly and 10 noisy background cells), 5 runs



80% noise (10 assembly and 40 noisy background cells), 25 runs



SVD can be a useful mechanism for analyzing place cell data



Next steps:

1. Use real data
2. Smooth curves
3. Try different techniques

Thank You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