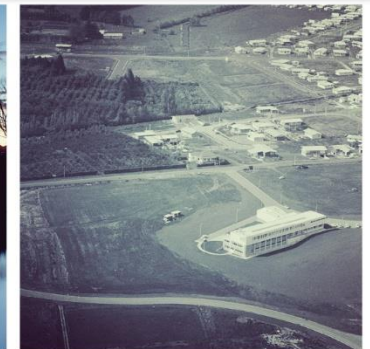


A comparison of modelling approaches to TMS



*Marcus Wilson, Felix Fung, Dan Goodwin,
Peter Robinson, John Reynolds, Jon Shemmell*



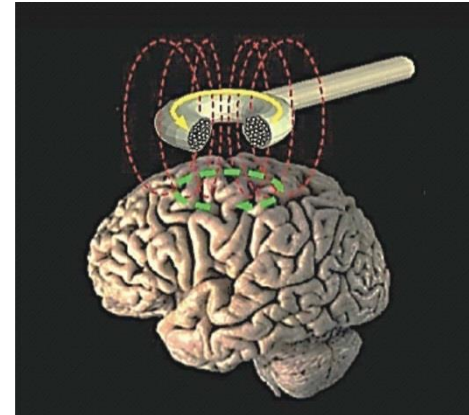
Marcus Wilson, Dan Goodwin (Waikato)

Felix Fung, Peter Robinson (Sydney)

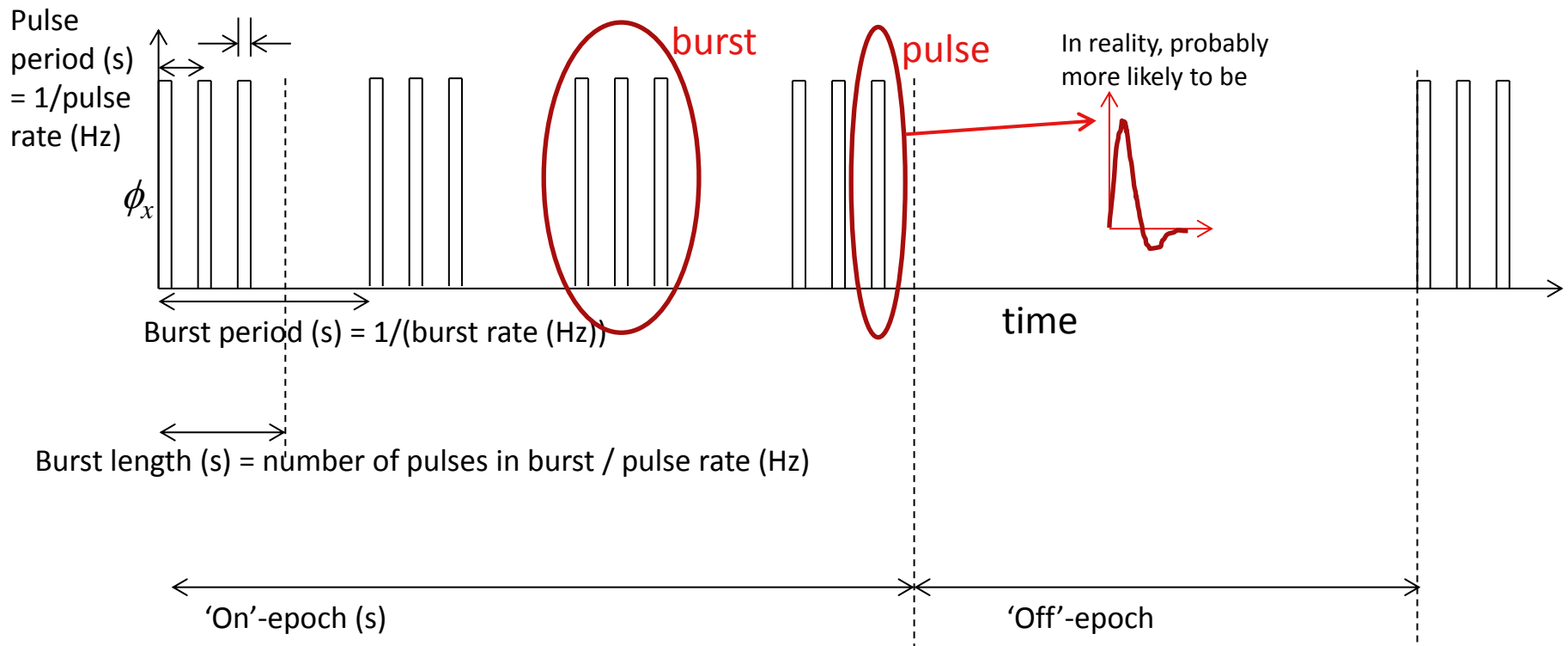
John Reynolds, Jon Shemmell (Otago)

- What is transcranial magnetic stimulation?
- Theta-burst stimulation
- Neural field modelling
- STDP and CaDP plasticity models
- Numerical results
- Conclusions

- Transcranial Magnetic Stimulation
 - Apply short magnetic pulses to cortex
 - Induces plasticity (somehow)
 - Used for stroke rehabilitation, Parkinson's, depression, *etc.*
 - Literature is murky; contradictory results; little repeatability

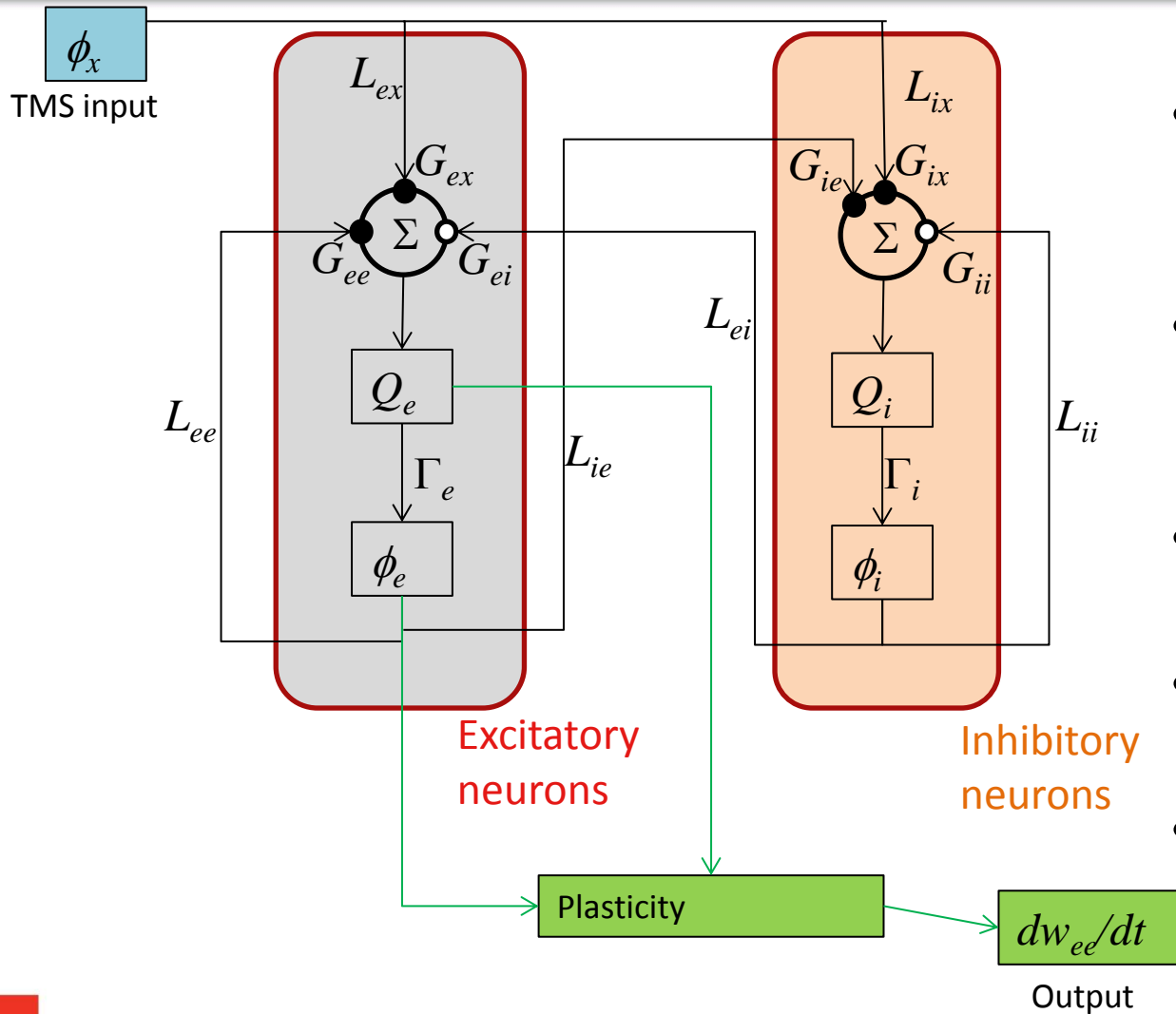


Theta-Burst Stimulation (TBS)



Rothwell Paradigm (see Huang et al. (2005). Neuron 45, 201-206.)
Pulse rate = 50 Hz (20 ms between pulses)
Burst rate = 5 Hz, 3 pulses per burst
On-epoch = 2 s, Off epoch = 8 s (intermittent TBS), or
On-epoch = 10 s, Off epoch = 0 s (continuous TBS)

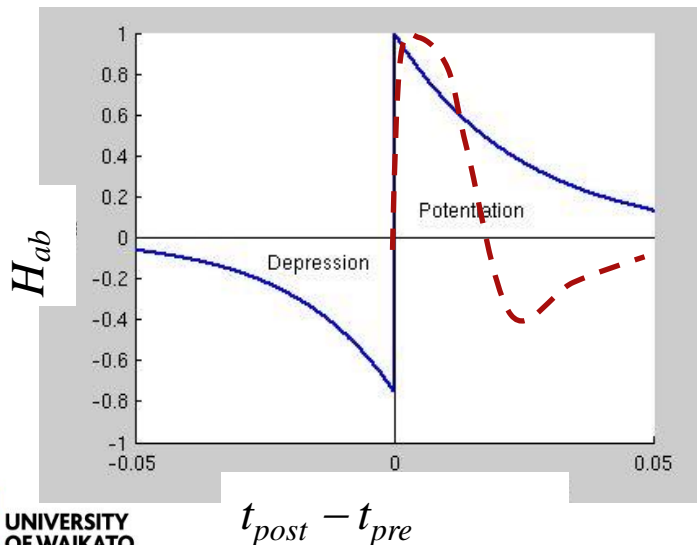
Neural model



- Population-based neural field model
- Excitatory and inhibitory populations
- Model population firing rates
- From Robinson *et al.* (Sydney)
- Parameters well established

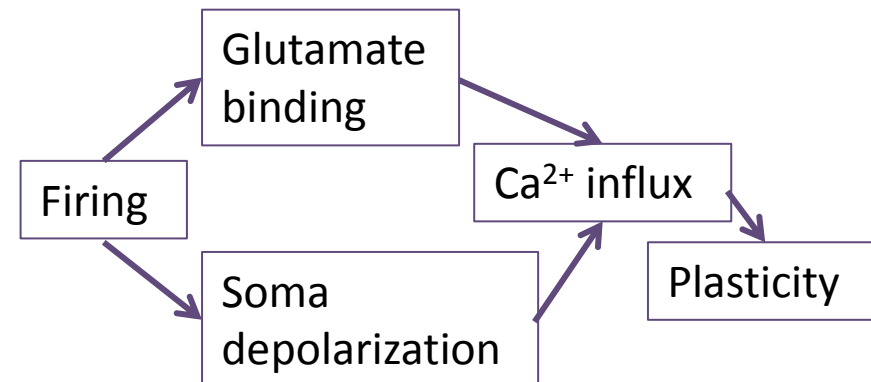
- Spike-Timing Dependent Plasticity (STDP)

- Based on timing between pre- and post-events
- Quick numerically but phenomenological



- Ca^{2+} dependent plasticity (CaDP)

- Depends on post- and pre- activity through glutamate and Ca^{2+} levels
- Low-level model but slower numerically
- Neurofield code of University of Sydney

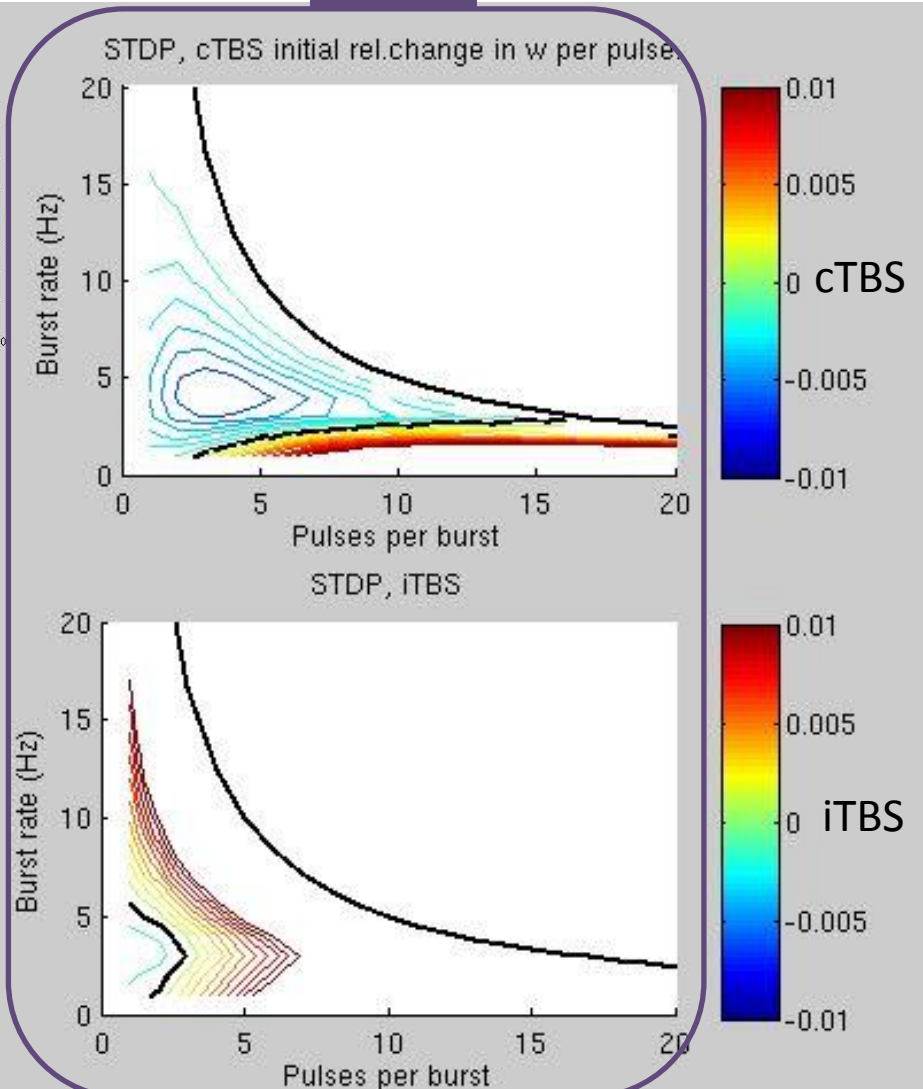
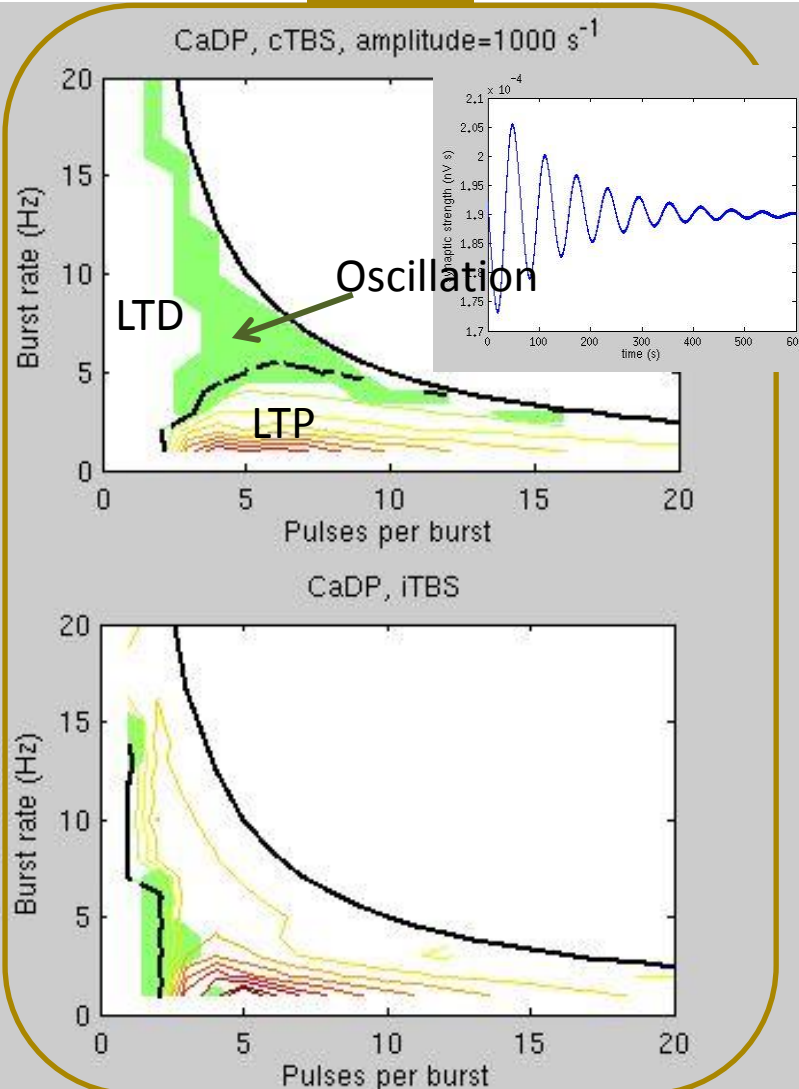


Results (1)

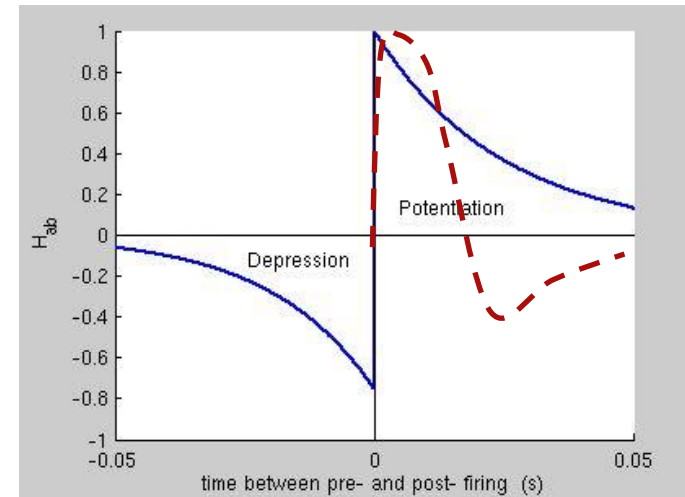
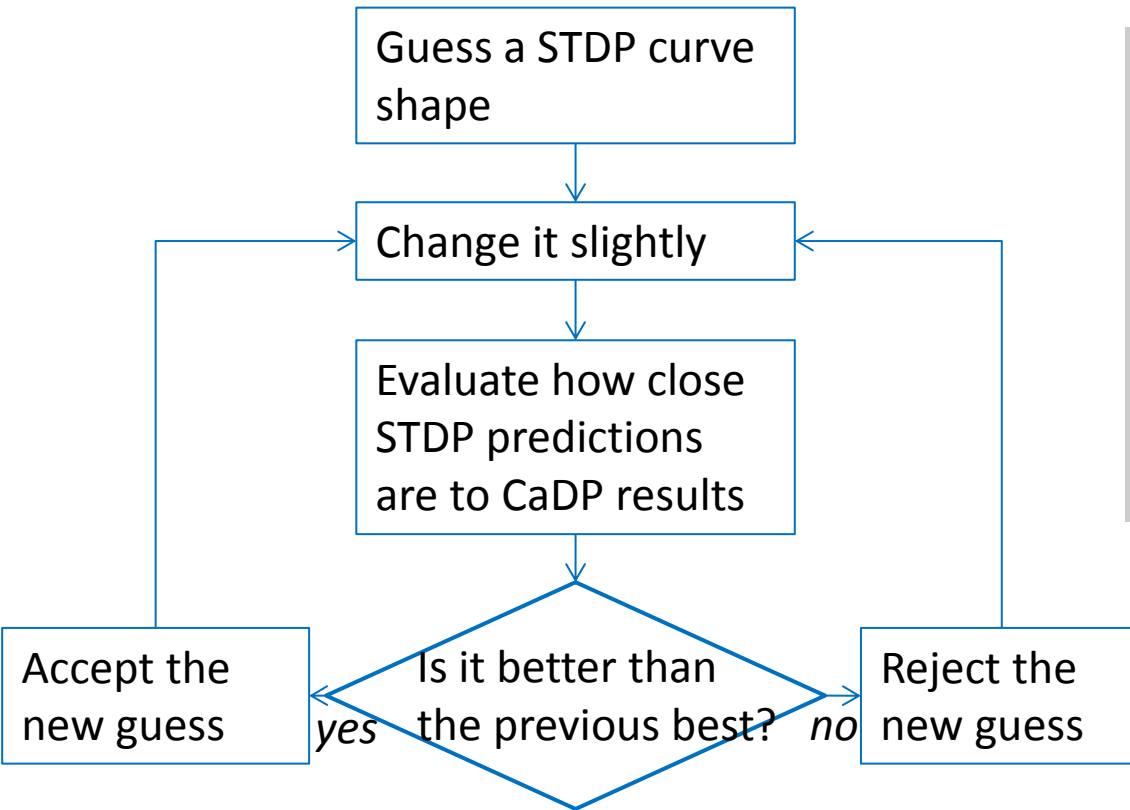


CaDP

STDP

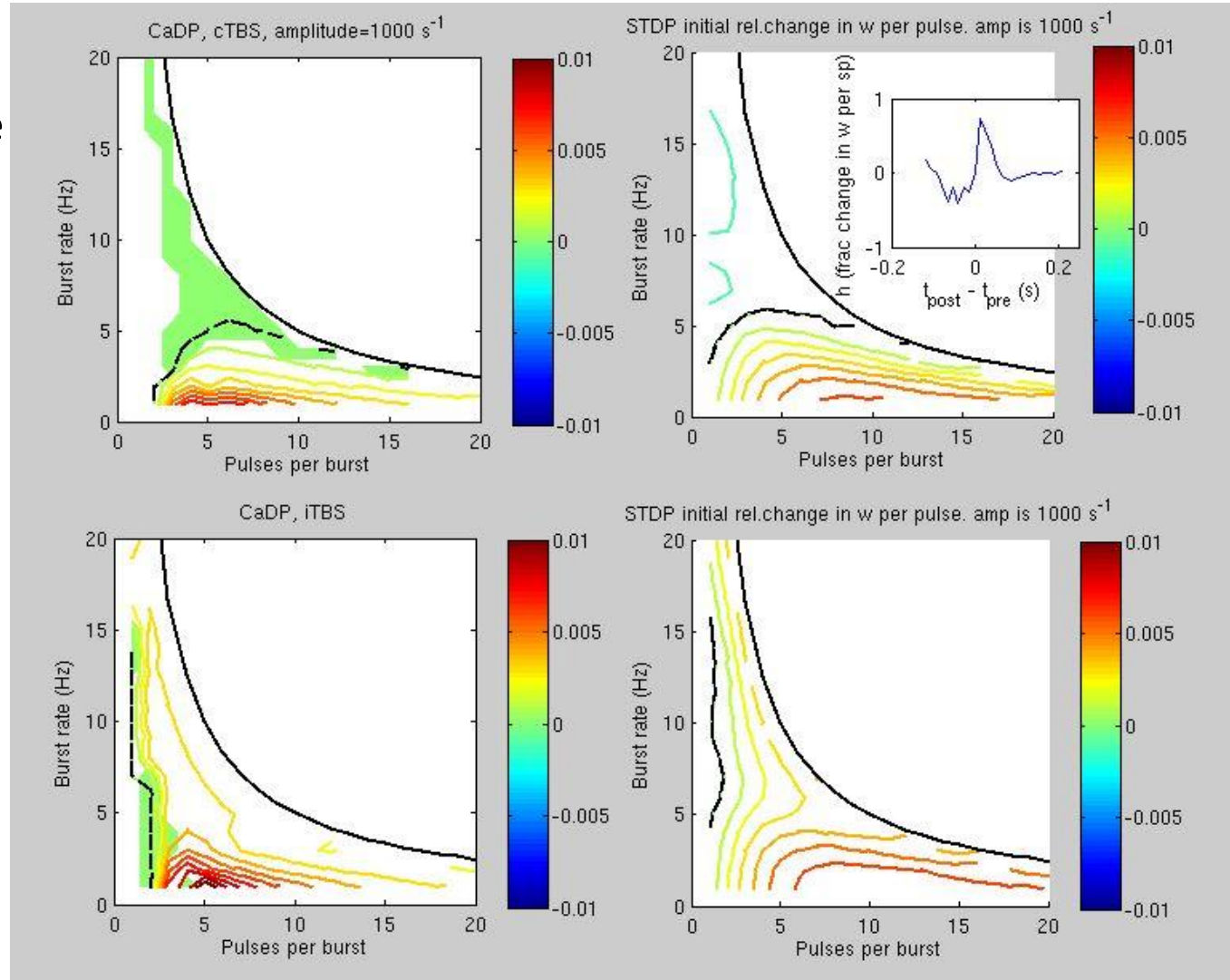
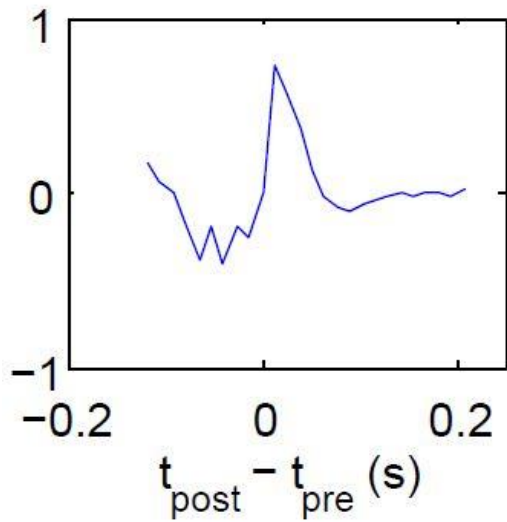


Tuning the STDP curve



Results of STDP tuning

A plausible STDP curve



- STDP gives (surprisingly?) similar quantitative results to CaDP at moderate stimulation amplitudes
- Regions of strong LTP and LTD predicted (agrees with experiment)
- Tuning the STDP curve gives plausible results
- CaDP can predict plasticity is oscillatory – may explain some ambiguity in experimental results
- STDP fails at high TMS rates (e.g. 200 Hz, 5 ms between pulses).
- **Need some repeatable experimental data**