

Introduction
Experiment
Results
The Future!

Software for Mind Control

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(Rev. -2)

Outline

Introduction

Goals

Tools — hardware

Experiment

Results

Chronic recording

Current Steering

The Future!

Ideas

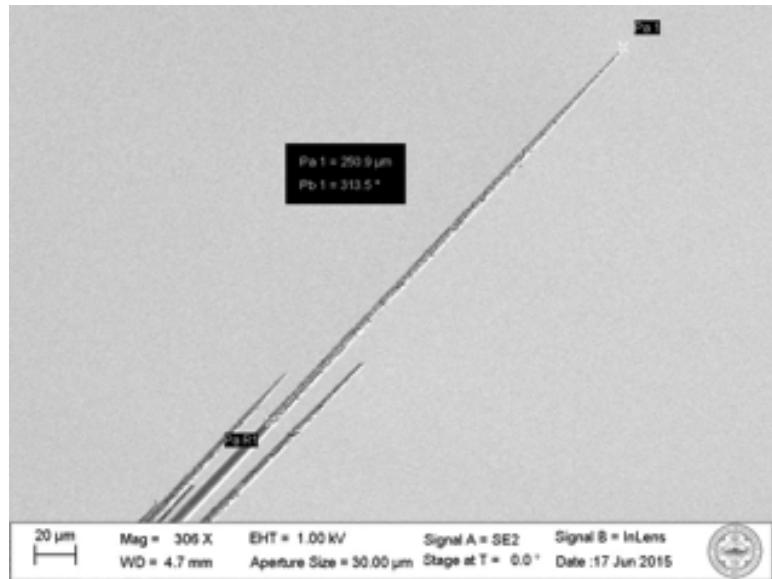
Goals

- ▶ Goal-directed modification of behaviour
 - ▶ Optimise stimulation parameters
 - ▶ Learn to produce desired output
 - ▶ Minimise voltage
- ▶ Demonstrate chronically implanted electrodes
- ▶ Safely stimulate despite small surface area

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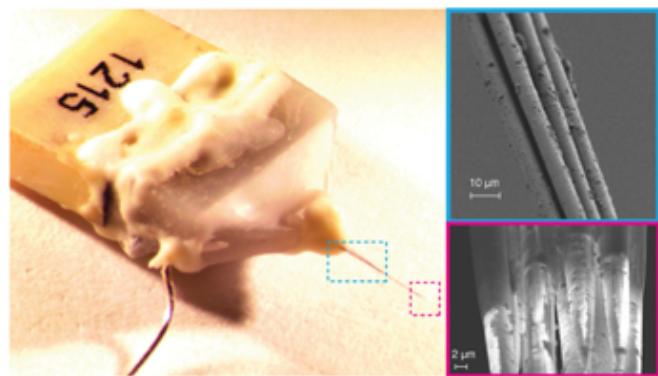
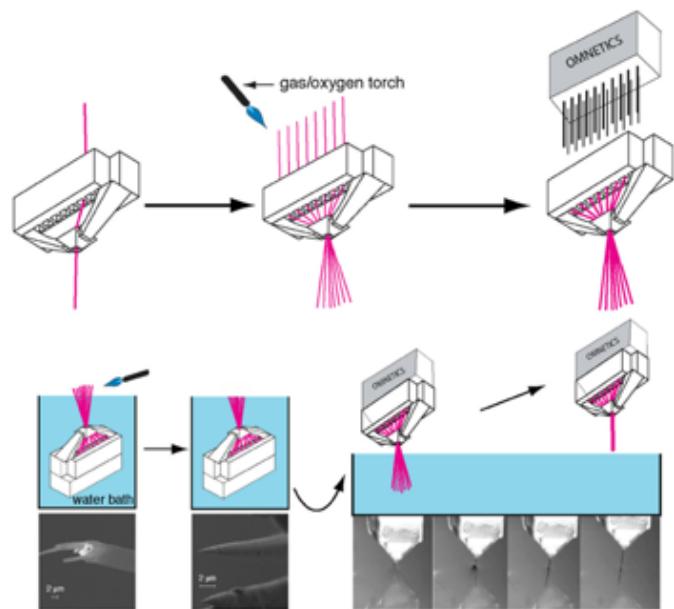
Goals
Tools — hardware

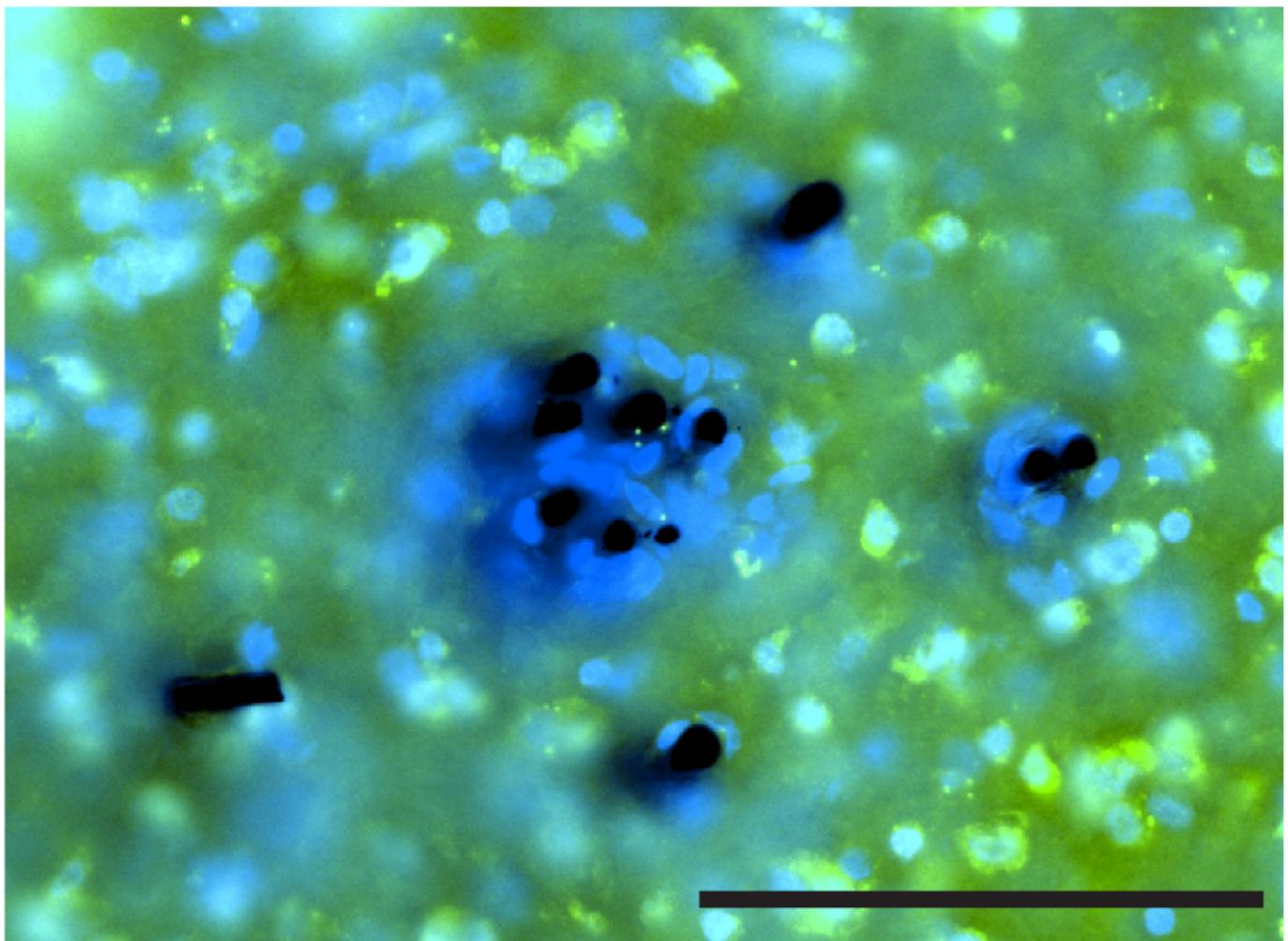
Electrodes

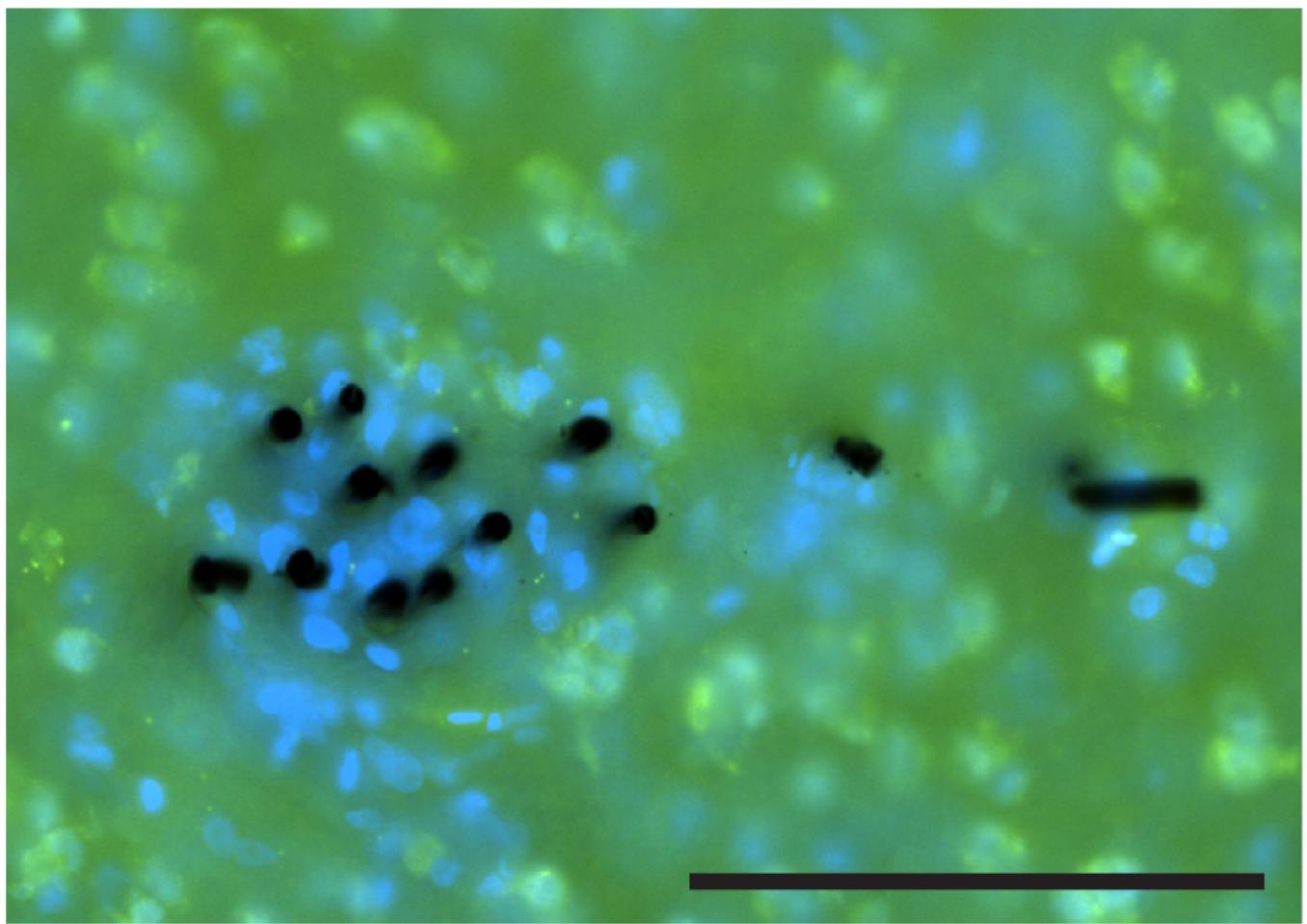


Chronic high-count
high-impedance...

- ▶ Carbon fibres
- ▶ Silicon carbide
- ▶ Optical...?



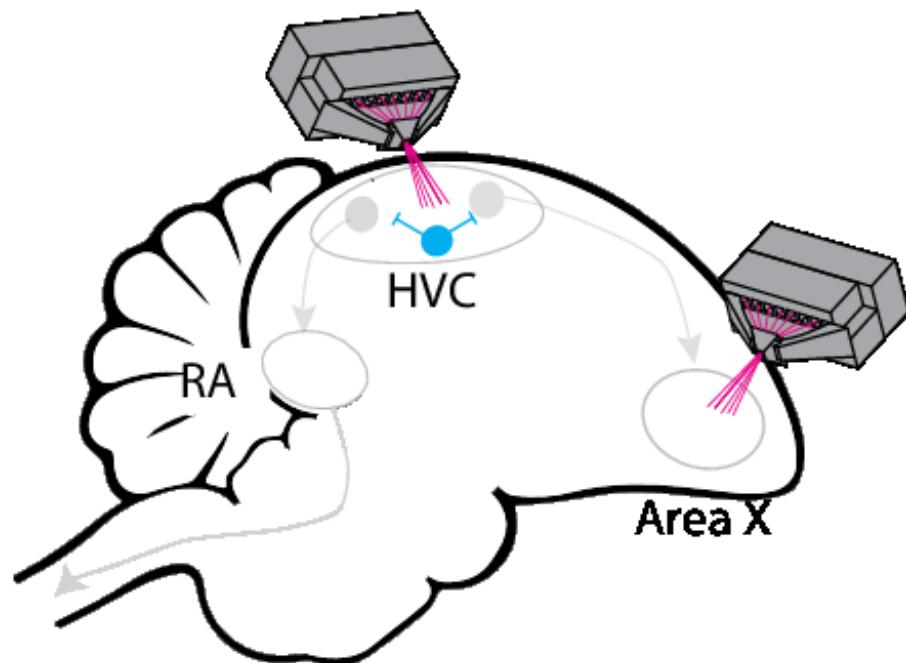




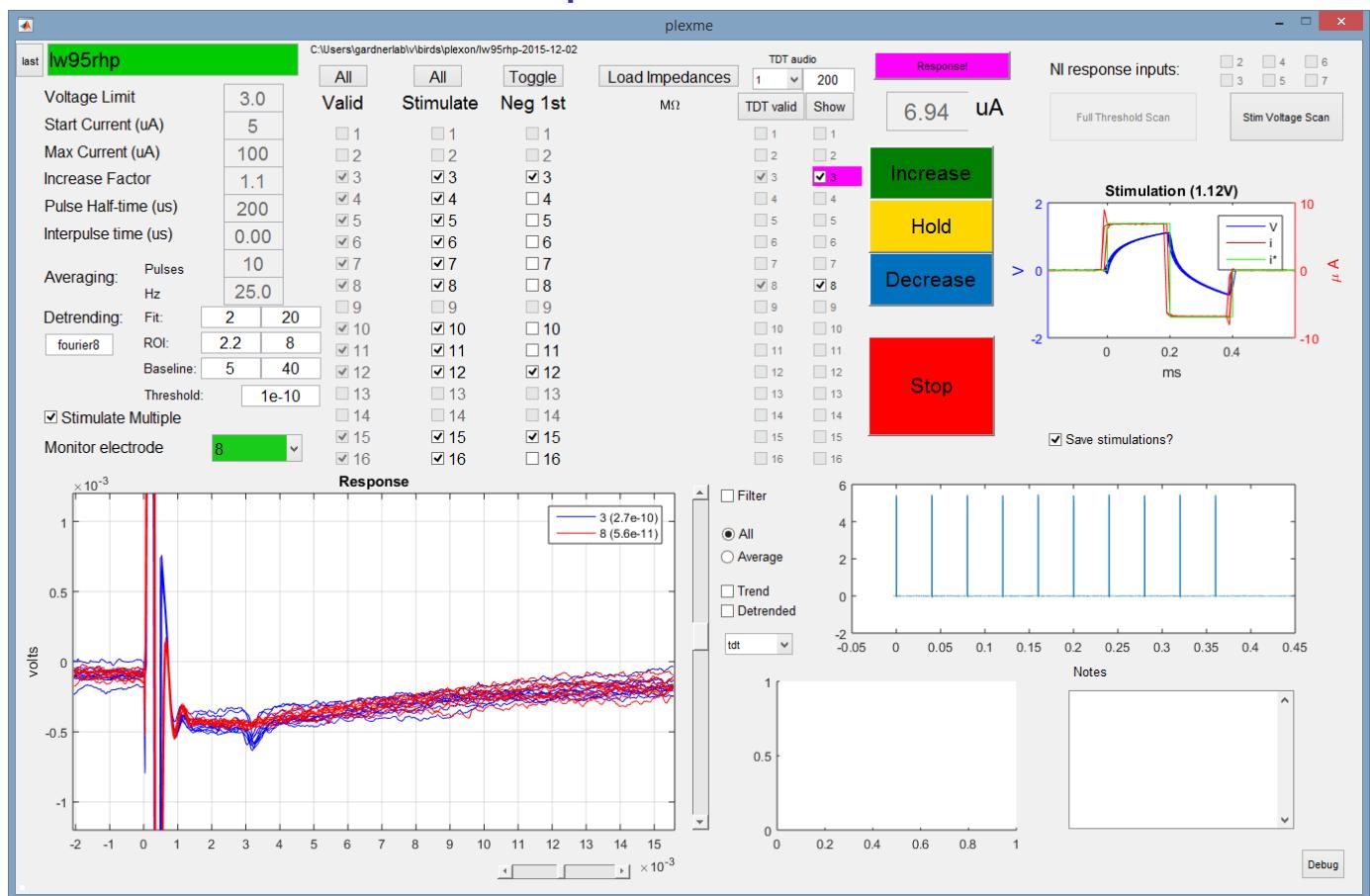
Plexon stimulator

- ▶ 16 channels
- ▶ Current-controlled
- ▶ Externally triggered
- ▶ Arbitrary pulse waveforms
- ▶ Resolution: $30 \text{ nA} \times 1\mu\text{s}$
- ▶ Matlab API
- ▶ Reprogramming time $\approx 0.1\text{s}/\text{channel}$ (?)
- ▶ Voltage monitoring is expensive!

Antedromic HVC←X response

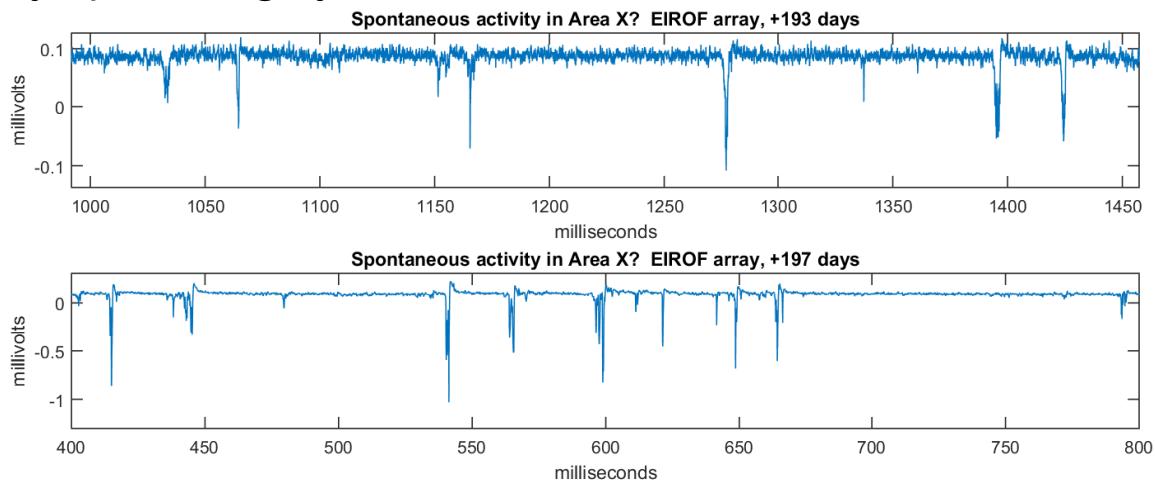


Antedromic HVC \leftarrow X response



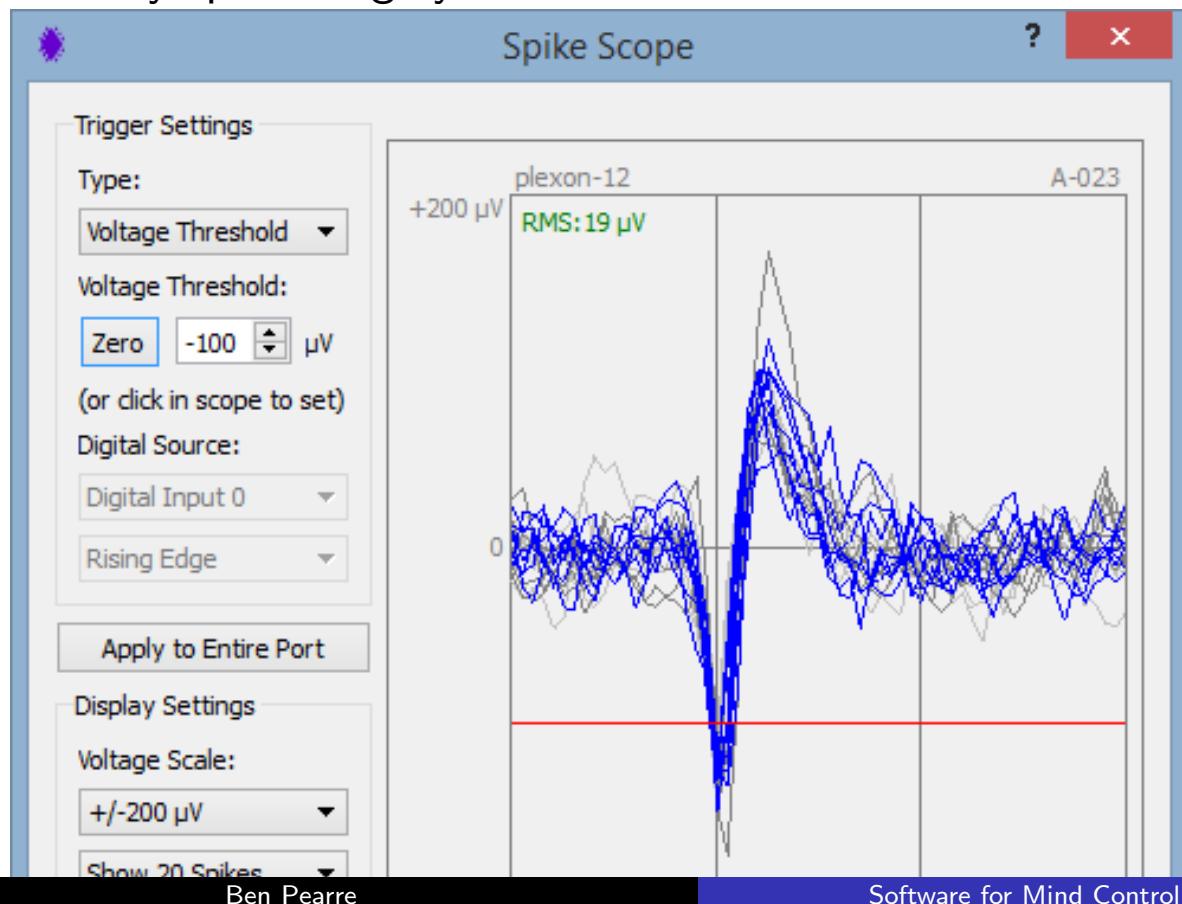
Recording — IrO₂ in X

197 days post-surgery



Recording — bare carbon in X

234 days post-surgery



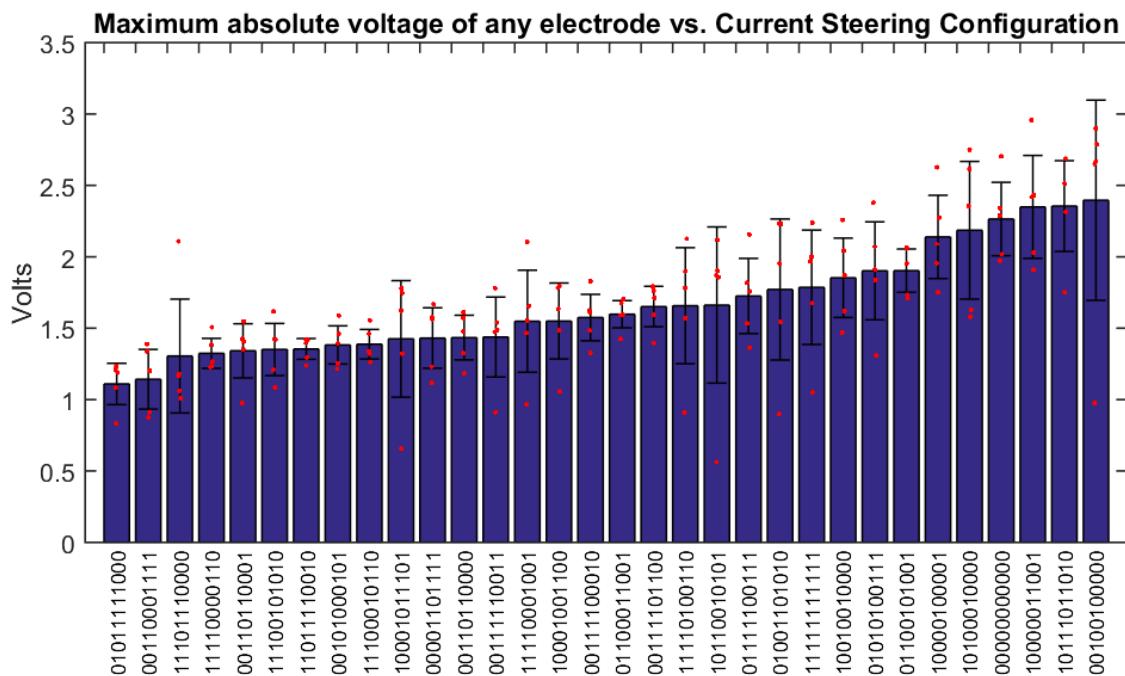
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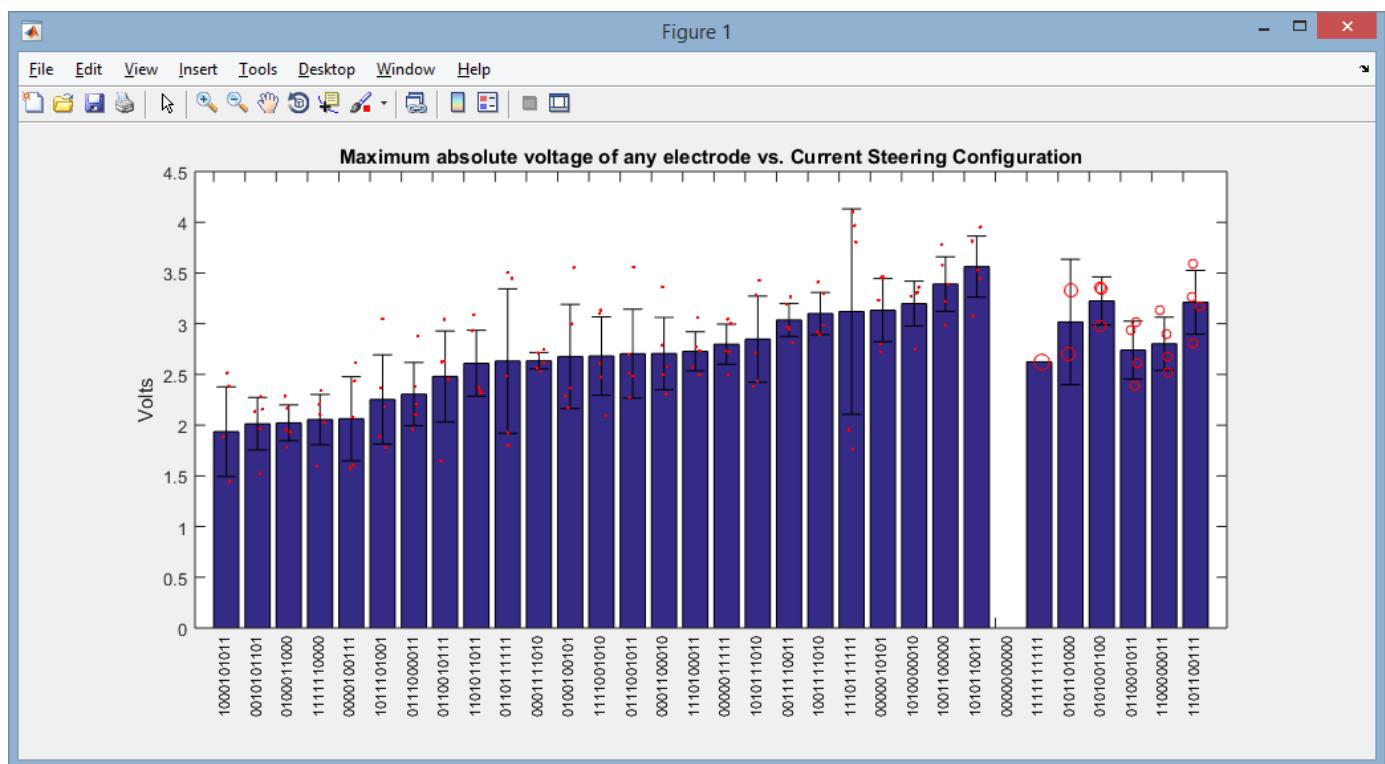
Previous work

- ▶ Fast
- ▶ Wrong

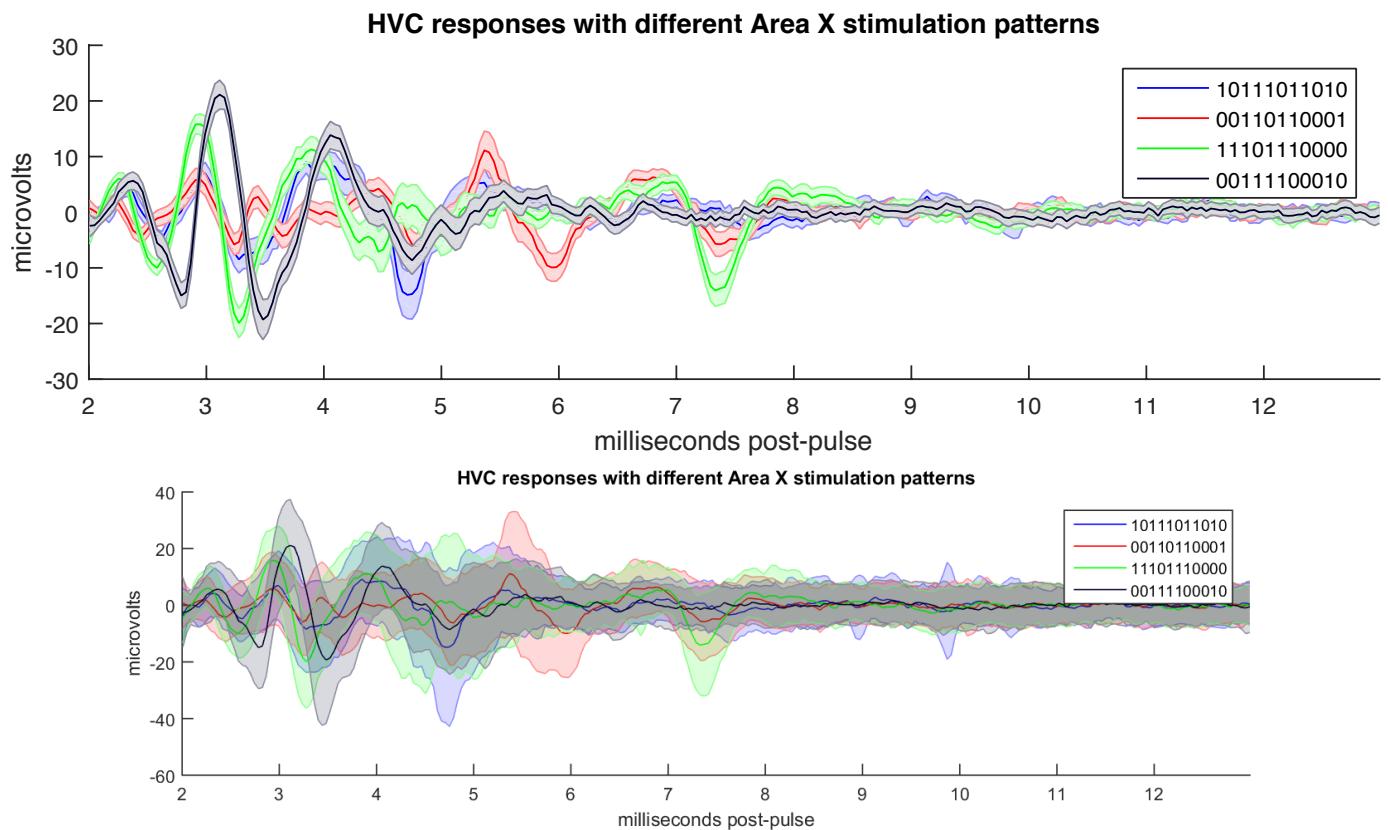
Voltage minimisation



Voltage minimisation



Response shaping in HVC



Stimulation optimisation

Criteria?

- ▶ Minimise voltage
- ▶ See response (binary?)
- ▶ Correlation maximisation
- ▶ Response separation
- ▶ Directed change to song
 - ▶ Acute
 - ▶ Chronic

Policy outputs?

- ▶ Pulse train timing
- ▶ Channel timing
- ▶ Arbitrary pulse shape

Policy inputs?

- ▶ Vocalisation
- ▶ Other motor output?
- ▶ Neural activity

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Ideas

