Extracellular potentials of coherently stimulated populations of parallel axons

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January 30, 2015

Introduction

- EFPs have recently been shown to be not only of synaptic origin
- The aim of this study is to understand how the neurophonic EFP is influenced by the anatomical structure of the axons which are the source of the potential.
- This study is mainly concerned with click responses, which have two main components (Fig 1A&B)
- Low frequency click response shows polarity reversal. (Fig 1C)
  - Similar effect seen in chicken and mamals.
  - Previous models focus on dendrites, but there are no dendrites in high-f NL.
- Basic idea outline
  - interplay of bifurcations and terminations leads to dipole-like behaviour (Fig 1D)

Methods

- Experimental Methods
- Multicompartment Model
- Analytical Model

Results

- General results for axonal projections:
  - We can identify two main frequency components which show distinct behaviour
  - The low-frequency component is governed by the local density of bifurcations and terminations
  - The high-frequency is governed by the local fiber density

- The low-frequency component exceeds the high-frequency component in reach

- Results specific to projections with distinct bifurcation and termination zones (like NL):
  - Low-frequency component is dipole-like, cancels out in the middle.
  - The high-frequency component shows a steady increase in latency with depth, while the low-frequency is stationary

Discussion

- Relevance of Findings
  - Interpretation of CSD
  - Dipole has far field, ABR response?
- Compare to other auditory systems (Chicken NL, MSO)
  - Speculate on functional relevance of polarity shift (a la Rinzel & Goldwyn)
- compare to other fiber bundle systems

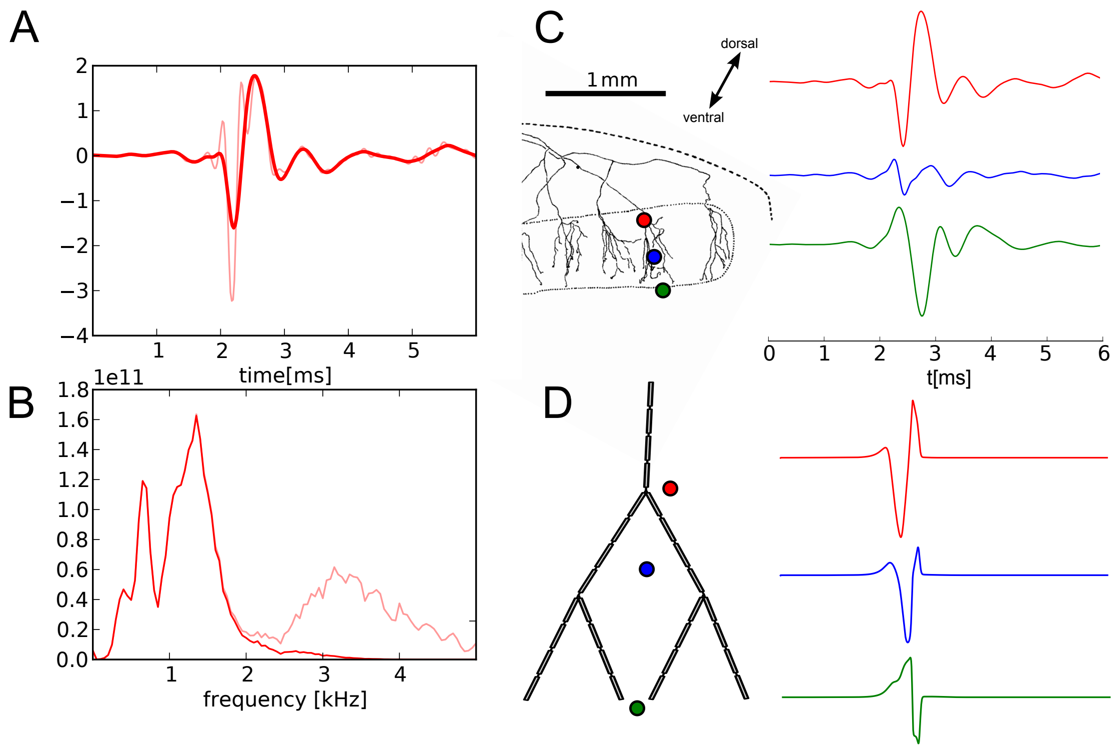


Figure 1: Introduction Figure

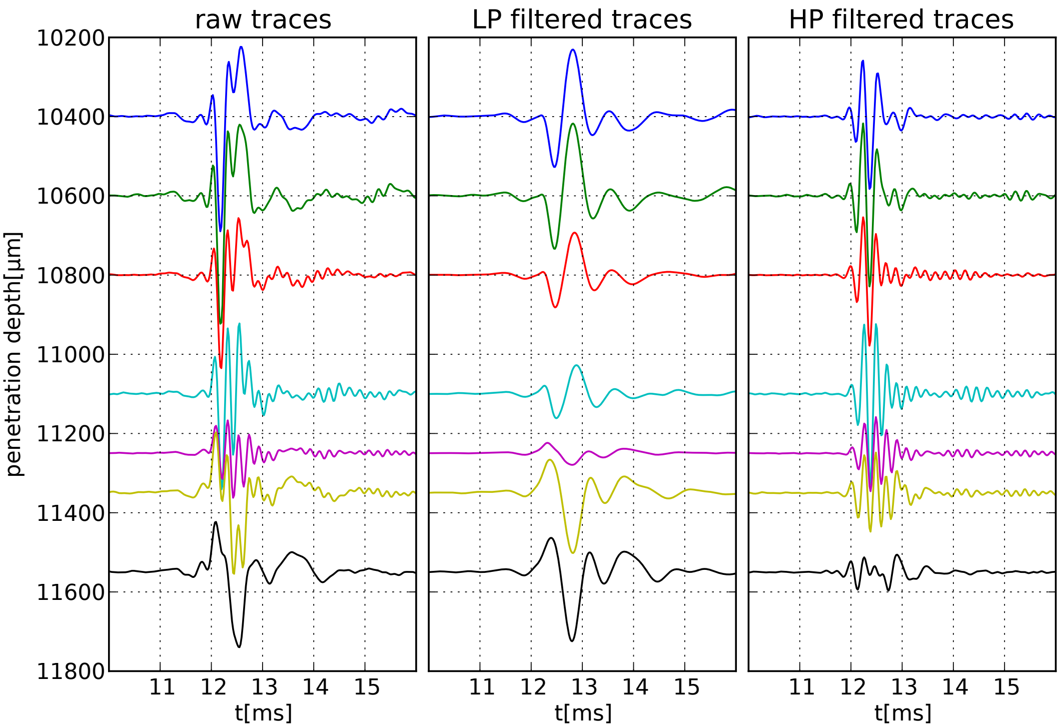
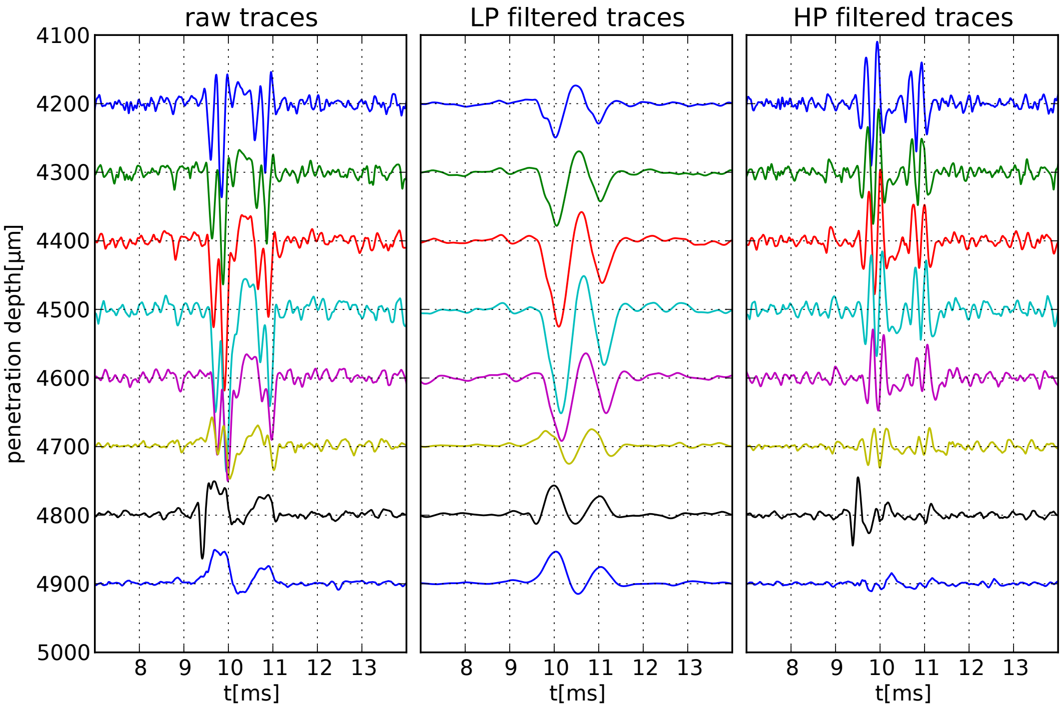

raw traces
LP filtered traces
HP filtered traces
penetration depth[μm]
10200
10400
10600
10800
11000
11200
11400
11600
11800
11
12
13
14
15
t[ms]

Figure 2:



raw traces
LP filtered traces
HP filtered traces
penetration depth[µm]
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
8
9
10
11
12
13
t[ms]

Figure 3:

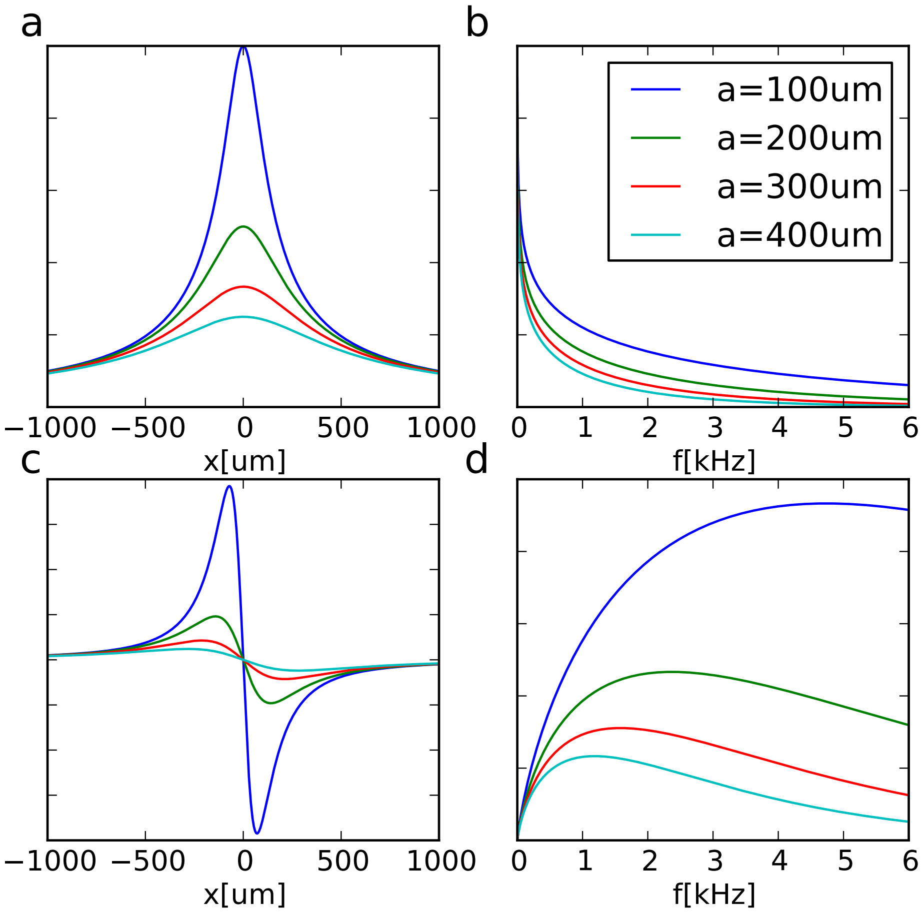


Figure 4: Impulse responses (left column) and frequency responses (right column) of the regular weighting functions w (a-b) and the derivative w' (c-d).

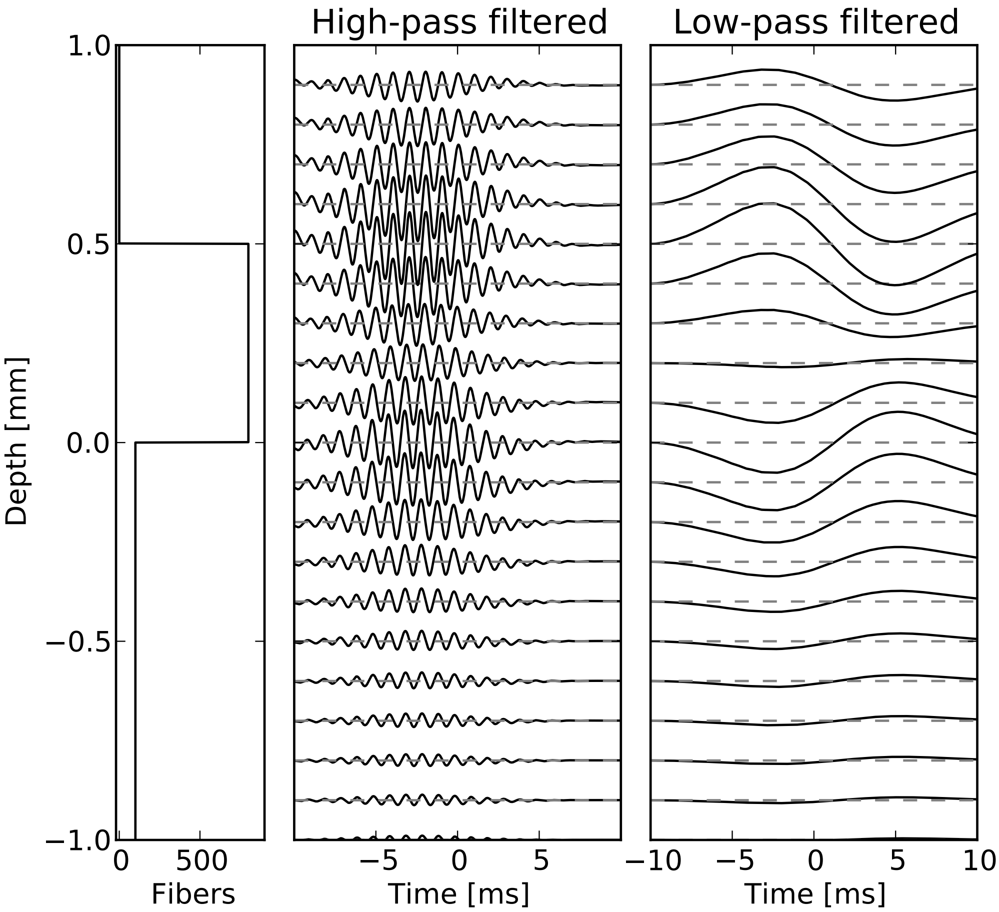


Figure 5: Minimal model of a bifurcating axon bundle. The number of fibers is a piecewise constant function of recording depth, shown on the left hand side. The center and right column show the field potential responses at various depths. The low-frequency component of the response, shown in the right column, shows a characteristic dipole-like behavior. The distance from the bundle was $\rho = 200\mu$m, and the velocity $v = 5$m/s.