Uncovering neural activity in the spinal cord

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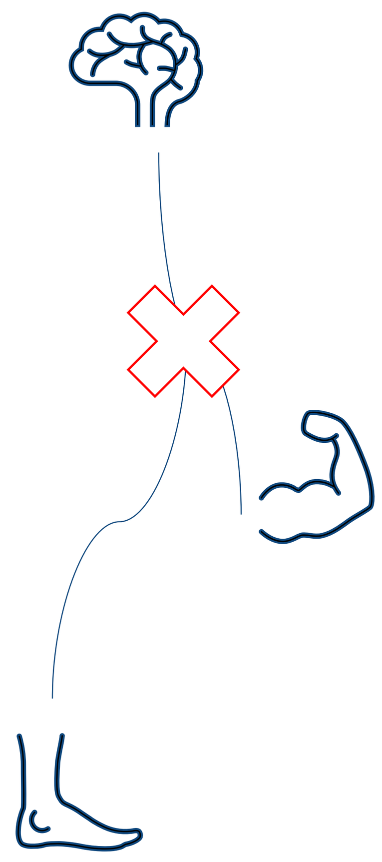
Spinal Cord Injury

- A spinal cord injury causes permanent neurological problems such as loss of motor and sensory function [1]
- Damage to spinal nerves affects the connection between the brain and the rest of the body
- There is a lack of understanding of how electrical activity in the spinal cord changes with injury



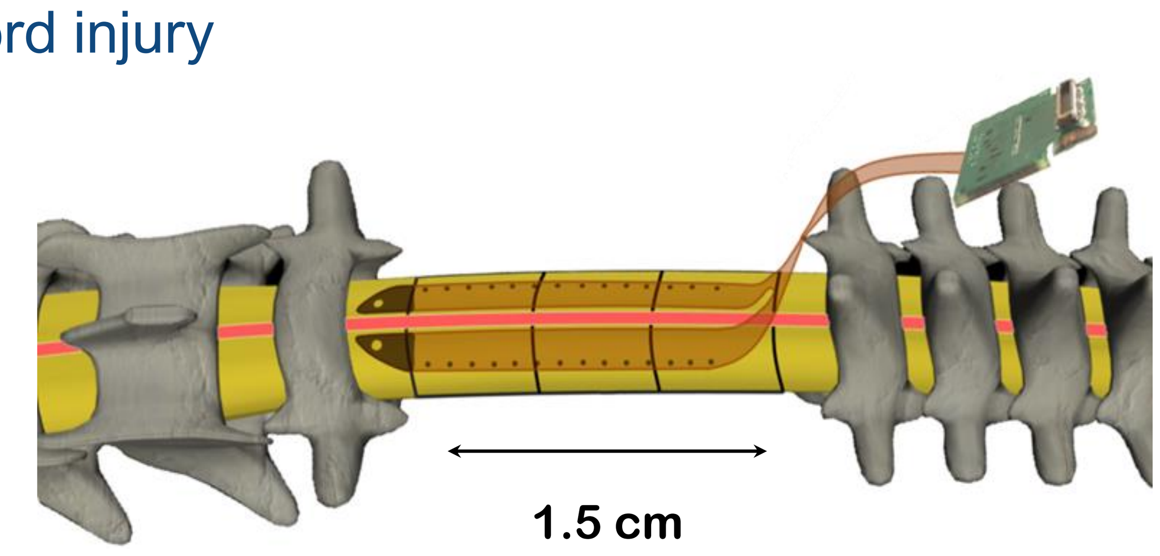
Are signals recorded by this implant from the spinal cord?

A Novel Implant

We have developed an implant made from polyimide plastic that can be implanted underneath the dura of the spinal cord. This contains 22 recording electrodes, each 60 μm in diameter, 800 μm apart, implanted on the thoracic spinal cord [2].

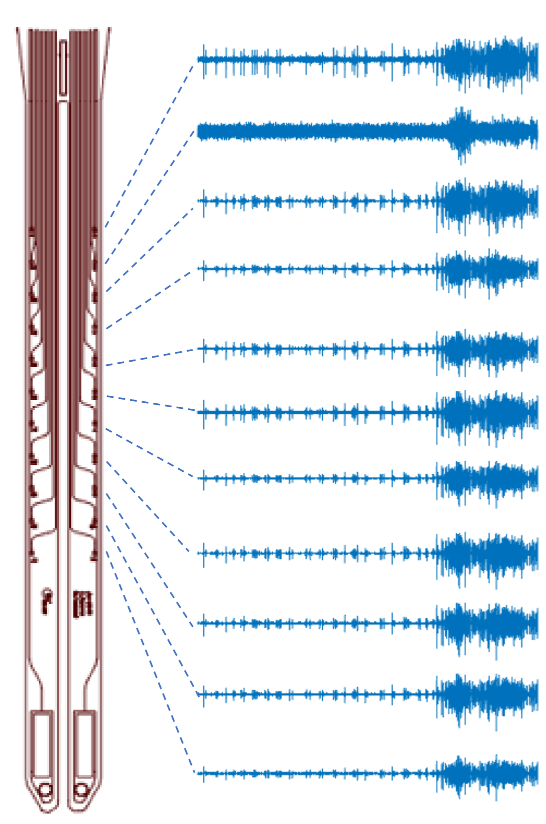
This implant has the ability to record electrical activity on the spinal cord, allowing for the identification of electrical biomarkers of injury. It also contains larger stimulating electrodes, able to provide an electroceutical treatment to treat spinal cord injury

Before using this implant to generate treatments we need to be confident that we are recording spinal cord signals.

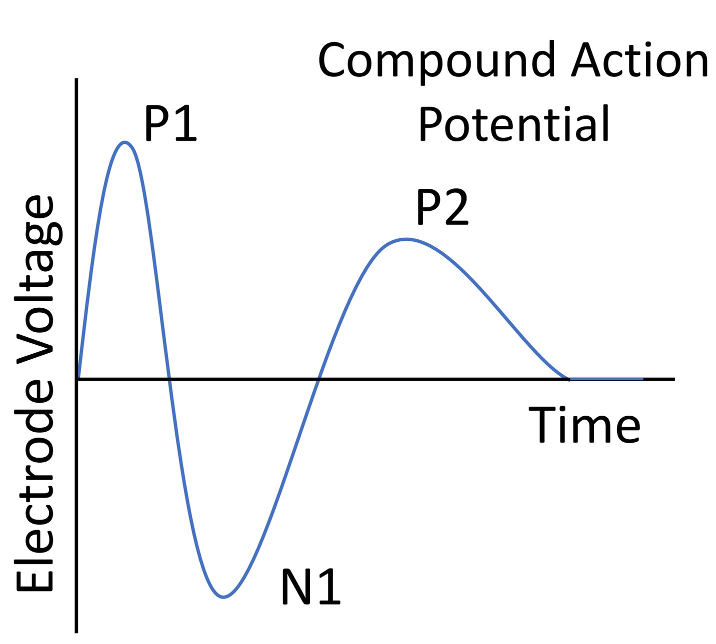


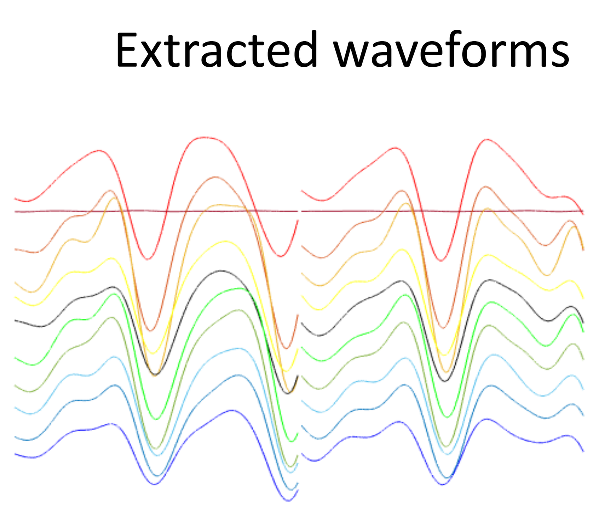
Identifying Spikes

Raw data was filtered to remove low frequency activity, exposing spiking activity. This activity appeared almost synchronous on all channels down one side of the implant.

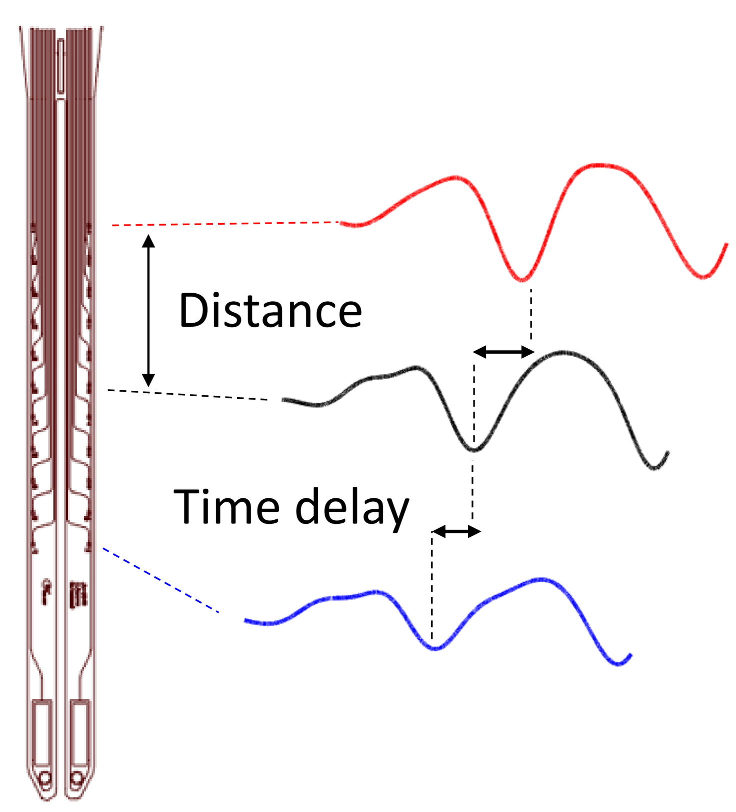


Spikes seen in the traces looked similar to compound action potentials seen in spinal cord literature [3], exhibiting a triphasic shape.

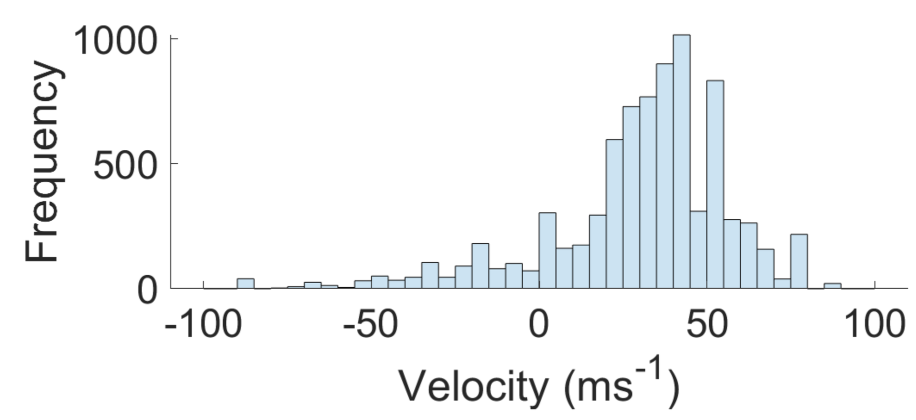




Spikes were identified when they matched a template waveform. Time delays were determined using cross-correlation, by determining the shift in time where the waveforms are the most similar. A linear model was used to calculate velocity (v = d/t).

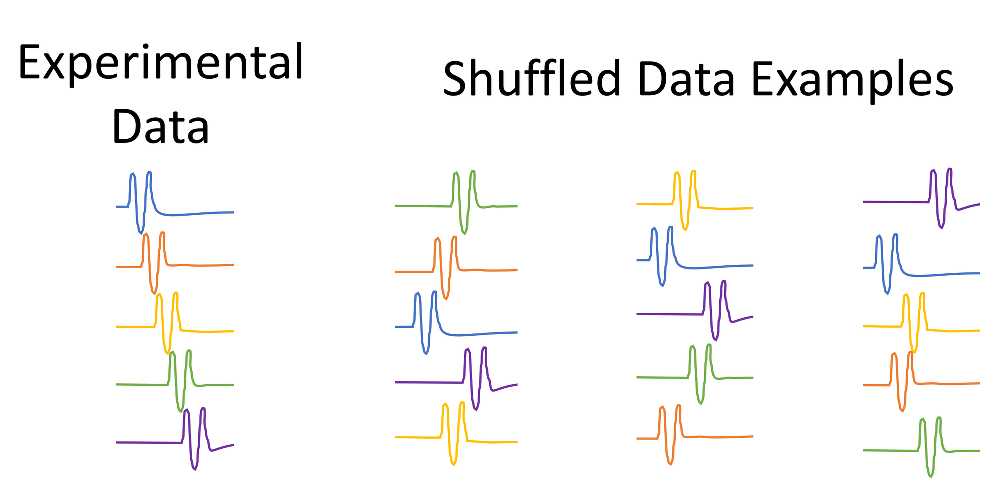


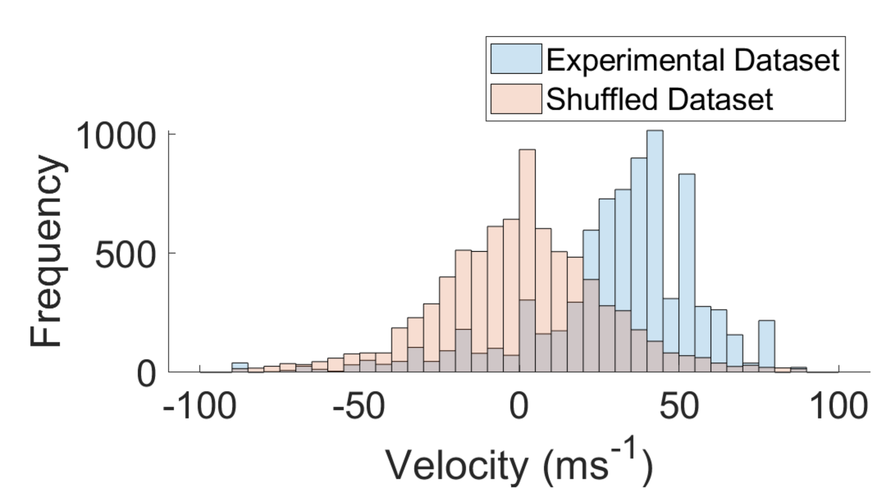
Results and Validation



Developed a histogram of velocities from all spikes. This shows a cluster of peaks at $30-40ms^{-1}$, suggesting the implant is recording afferent activity (sensory signals propagating up the spinal cord).

The channel order was shuffled randomly for every spike, creating a negative control that represents no propagating activity. This tests the hypothesis of spikes appearing synchronously across all channels. This highlighted the significance of the results and confirms that these spikes are propagating.





Conclusions and Future Work

Our implant is recording activity of neural origin.

- Spikes extracted are of similar shape and duration to that seen in spinal cord recording literature [3]
- Propagation speeds are indicative of sensory fibres (12-130 ms^{-1}) [4]

Next steps are to use this analysis to develop electrical biomarkers of spinal cord injury.

References

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CATWALK – Funding research to cure spinal cord injury