Abstract
We demonstrate an open-source, cross-platform solution for online sharp-wave ripple (SWR) detection and disruption.

Specifically, we show that our system can achieve high accuracy (>97%) and low latency (~40-60 ms) in online detections of SWR activity in a synthetic "gold-standard" dataset (matching state-of-the-art latencies). Additionally, we show that optimizing the platform, results in online detections ~10-15 ms behind offline SWR detections.

Background & Motivation
What are sharp-wave ripples (SWRs)?
Coordinated bursts of neural activity in the hippocampus that stem from the CA3 region causing oscillations in the CA1 region. These events are ~150-250 Hz and last ~100 ms. These events can be causally linked through online detection and disruption of SWR activity.

Why do we care about them?
The CA1 neurons active during a SWR can be the same ones active while an animal is going through a spatial navigation task. This implies that SWRs are associated with a subject replaying a past experience. This association has been shown to support behavioral traces and multiunit activity.

Objectives
To facilitate the dissemination closed-loop SWR manipulation studies, we aim to:
1. build an open-source, cross-platform online SWR detection and disruption system
2. achieve "acceptable" detection latencies using simple algorithm SWR detection (as it has been shown that a variety of detection algorithms result in similar latencies).

System Architecture & Detection Algorithm
Hippocampal neural data (LFP) is collected and sent to a computer (1-3).

Trodes software is used to detect SWR events and initiate a stimulation pulse (4-6).

A microcontroller triggers a biphasic stimulator to disrupt the SWR (7-8).

Our implementation utilizes a synthetic SWR dataset to replace the rodent in (1) of the system architecture figure above.

Results and Discussion
Variations in the threshold show an intuitive optimization plot. Additionally, optimizing the hardware and software communication leads to lower latencies.

As the general length of a SWR is ~100 ms, these detection latencies show that we can interrupt the SWR prior to a majority of the event transpiring.

Conclusions & Future Works
We have been able to build an open-source, cross-platform system for online SWR detection and disruption. This system has comparable latencies to those reported by previous works in the field. This modular system is being extended to support behavioral traces and multiunit activity.

Currently, we are preparing for in vivo testing to answer further neuroscience inquiries. We believe this system will enable researchers to better understand the mechanisms of memory.

References