Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Interictal to Ictal Phase Transition in a Small-World Network
LOUIS NEMZER, Nova Southeastern University, GARY CRAVENS, Nova Southeastern University College of Osteopathic Medicine, ROBERT WORTH, Indiana University School of Medicine — Real-time detection and prediction of seizures in patients with epilepsy is essential for rapid intervention. Here, we perform a full Hodgkin-Huxley calculation using n $\approx$ 50 *in silico* neurons configured in a small-world network topology to generate simulated EEG signals. The connectivity matrix, constructed using a Watts–Strogatz algorithm, admits randomized or deterministic entries. We find that situations corresponding to interictal (non-seizure) and ictal (seizure) states are separated by a phase transition that can be influenced by congenital channelopathies, anticonvulsant drugs, and connectome plasticity. The interictal phase exhibits scale-free phenomena, as characterized by a power law form of the spectral power density, while the ictal state suffers from pathological synchronization. We compare the results with intracranial EEG data and show how these findings may be used to detect or even predict seizure onset. Along with the balance of excitatory and inhibitory factors, the network topology plays a large role in determining the overall characteristics of brain activity. We have developed a new platform for testing the conditions that contribute to the phase transition between non-seizure and seizure states.

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Date submitted: 10 Nov 2016 Electronic form version 1.4