Objective
Predict presurgically the maximum extent to which direct stimulation therapy can propagate through an epileptogenic circuit for influencing its maximal extent.

Strategy
Create a computationally-intensive iterative model to predict activated tracts.

General Workflow
1. Visualization of the Epileptogenic Circuit
2. Virtual Electrode Placement
3. Finite Element Modeling (FEM) to predict the volume of cortical activation (VOCA) due to the action of Electric Fields (E-Fields) using an “activation function”
4. Generation of a Modulated Circuit Tractography (MCT) Map to identify stimulated tracts
5. Post-Implant Validation

Subtracted Post-Ictal DTI (spiDTI)
spiDTI is used to locate transient changes in white matter produced by stereotactic complex partial seizures without generalization. Fractional Anisotropy (FA) is computed in inter-ictal and post-ictal diffusion tensor imaging (DTI) sequences. The results are subtracted. A threshold of 3 std dev from the mean is then used to identify regions with significant changes in FA.

Subtracted Activated SPECT (SAS)
SAS is a post-implant validation technique developed in our laboratory. This technique captures transient blood flow changes during delivery of direct cortical stimulation. It is implemented to corroborate the presurgically modeled VOCA.
1) Stimulation is performed using a bipolar configuration while an intravenous infusion of 5% H-HV or 70% ECD is applied. A SPECT image data set is then acquired (Activated SPECT).
2) The activated SPECT dataset is normalized and subtracted from a baseline SPECT and co-registered with the patient’s SPGR/MPAGE MRI.

Conclusion
Our pre-implant modeling system offers the potential for predicting optimal electrode lead implant sites with a limited set of contacts for modulating the maximal extent of a refractory epileptogenic network. Blood flow-related manifestations of direct cortical stimulation between 2 depth lead contacts implanted in white matter validate this cortical activation model.