**2018 IMAG Futures Meeting – Moving Forward with the MSM Consortium (March 21-22, 2018)**

*Pre-Meeting Abstract Submission Form*

*\*Please submit to the NIBIB IMAG mailbox (*NIBIBimag@mail.nih.gov*) by* ***January 8th, 2018***

*\*Save your abstract as “MSM PI Last Name \_ 2018 IMAG Futures Pre-Meeting Abstract”*

**PI(s) of MSM U01: Terence D Sanger, Simon F Giszter**

**Institution(s): University of Southern California, Los Angeles; Drexel University, Philadelphia**

**MSM U01 Grant Number:** U01 EB021921 02

**Title of Grant:** MULTISCALE MODELS OF NEURAL POPULATION CONTROL IN SPINAL CORD

**Abstract**

Which MSM challenges are you addressing from the IMAG 2009 Report and how?

<https://www.imagwiki.nibib.nih.gov/content/2009-imag-futures-report-challenges>

(indicate which challenge (#) you’re addressing)

*You may insert images by copying and pasting below*

#1 Next-generation multiscale models that integrate between different scientific fields and predict integrated functions-

 Our project long term seeks to integrate neurophysiological single unit recordings and circuit knowledge with high level behavior and biomechanics states to produce system behavior predictions in terms of stochastic dynamics probabilities, using stochastic dynamic operators (SDOs) identified at the single unit scale.

#3 Novel methods to fuse data-rich and data-poor scales to enable predictive modeling-

 Our methods permit high resolution models at the single neuron recording scale to be integrated with higher scale and coarser brain region, and behavior level state variations to create enhanced predictions of outcomes from the neural ensemble data.

#4 Novel methods to fuse biological and/or behavioral processes and mechanisms to model outcomes as a result of various interventions-

 Our methods can incorporate many scales of information and predictions of dynamics changes after intervention.

#10 Predictive multiscale models that strongly incorporate uncertainty quantification-

 Our method based on Stochastic Dynamic Operators inherently incorporates uncertainty quantification in dynamics predictions, potentially using information on several scales.

Are you using machine learning and or causal inference methods and how?

*You may insert images by copying and pasting below*

 We employ SDOs to capture system information and make predictions based on neural firing. These predictions can scale from high level (e.g., likelihood of a complex behavior or avoidance of a high risk state) to neural to neural local statepredictions that begin to relate directly to neural circuit causality. We have explicitly begun to explore the use of SDO methods as a 'circuit breaking' technique to identify neural connectivity locally within neural recording of circuits.

Please briefly describe significant MSM achievements made (or expected).

*You may insert images by copying and pasting below*

 We have used the SDO methods to predict electromyographic recordings. We have used the analysis to predict from model neural data, the downstream outcomes in spinal motor behavior. We have used the SDO framework to show we can identify circuit causality within model spinal circuits conforming to the state of the art knowledge of organization.

Please suggest any new MSM challenges that should be addressed by the MSM Consortium moving forward.

*You may insert images by copying and pasting below*

 We believe it will be important to expand SDO application to optical recording data where individual spikes are not recorded but rather a convolution of spiking processes and calcium dynamics produces the recorded signal events. This will support larger scale applications of the methods.

What expertise are on your team (e.g. engineering, math, statistics, computer science, clinical, industry) and who?

*Please list as “Expertise – Name, email”*

 *Clinician, Mathematician, Bioengineer- Terence Sanger, MD PhD, tsanger@usc.edu; Neuroscientist, Bioengineer - Simon Giszter, PhD, sgiszter@drexelmed.edu; Engineering, Statistics - Maryam Abolfath-Beygi, PhD, mabolfat@usc.edu*

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