

1000-cell Computational Model of the Rodent M1 Cortex

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The M1 cortex is known to have a layered brain structure with principal cells (PNs) oriented in the same direction. On the other hand, subcortical structures such as the amygdala display a homogenous, nuclear structure where orientation of the PNs is random. We propose the advancement of a more biophysically realistic model of a rodent M1 cortex through the implementation of realistic single cell properties, connectivity, synaptic properties, and afferent inputs as well as the inclusion of the layered topology of the M1 cortex and oriented axon structure for the PNs.

Four cell types of interest – corticospinal (CP), corticostriatal (CS) principal neurons, as well as fast spiking inhibitory (FSI) and low-threshold spiking (LTS) interneurons – are relevant for the beta and gamma rhythms of focus to our modeling study. Important morphological, electrophysiological, and connectivity parameters have been outlined, and a 1000-cell model has been initially implemented that has a nuclear topology. The prime features we wish to update from this initial model is to implement the 3D layered topology as well as aligned axons for PNs. This updated structure is thought to influence internal interactions and the local field potential measurement. A major goal of the creation of this model is to discern the differences between a biophysically realistic model and reduced order models in their predictive capabilities. Additionally, approaches such as population averaging will be analyzed through this model. This will be done while looking at the relations of internal network structure and afferent behavior to beta and gamma bursts that are known to be produced by the M1 cortex in different brain states.