

- Dominic designs a custom MEMS device which allows to investigate neuroplasticity, the spatial and network reorganization of neurons in response of other neurons feedback. Primary rat cortical neurons are grown in a microfluidic chamber, each side extending their axons through micro-channels with the other side. The device has three compartments, cells in one chamber is connected to the two others, the two other chambers are only connected to the central one. Electrical stimuli are applied to the neurons of one of the extreme chambers and not to neurons in the other one, thus applying feedback in only one direction: one of the peripheral chambers to the central chamber. Neuronal activity and physiological changes in the connections between each well are then studied and compared.
- Organotypic cells compared to cell cultures maintain cytoskeleton and are less limited in term of axon growth or synapse formation. Rat cortical slices will be cut using a tissue chopper and placed onto petri dishes with three polydimethylsiloxane (PDMS) wells separated by microchannels. Cultures will be covered with a medium and placed into a tissue incubator. Each slice will be perfused with artificial cerebrospinal fluid (aCSF) and drugs. Electrical activity will be stimulated by electrodes in the peripheral dish with pulses calibrated to generate action potential, the neuronal response will be recorded with microelectrodes placed on the central well. Implicit feedback from the third extremal well is not to be discarded and to increase the reliability of the model, an electrode will also be attached to the neurons of the dish with no explicit stimuli.
- The previous model is simple but may not fully represent the complexity of interactions between neurons. 2D cultures may affect the spatial growth of the neural network. In addition, a 3D cultures like organoids have better cell-cell interactions and simulate cellular functions and neural signaling which resemble better in-vivo tissues. However, at brain organoids derived from human PSCs begin to apoptosis due to lack of vascularization and exogenous factors, and cannot be used to study the development of human fetal brain after the first trimester. If the aim of the study is to study neuroplasticity in presence of neurological diseases which can appear in adult or in advanced ages, organoids cannot be used.

No details on how to grow the neurons in each compartment will grow and connect
 No details on how a single AP will be triggered on the neurons.