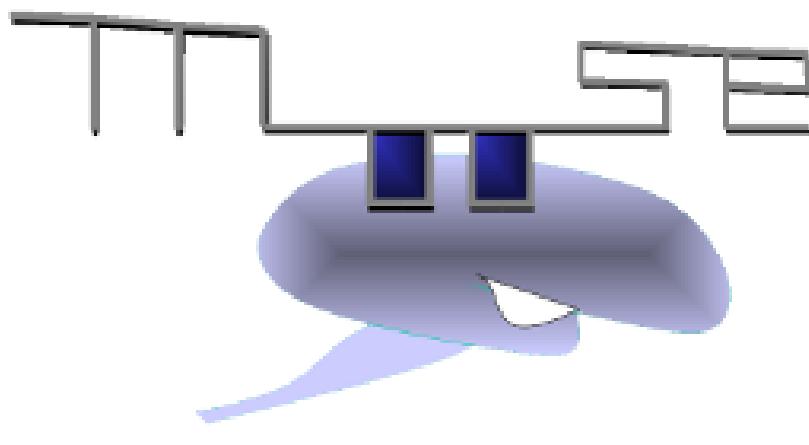


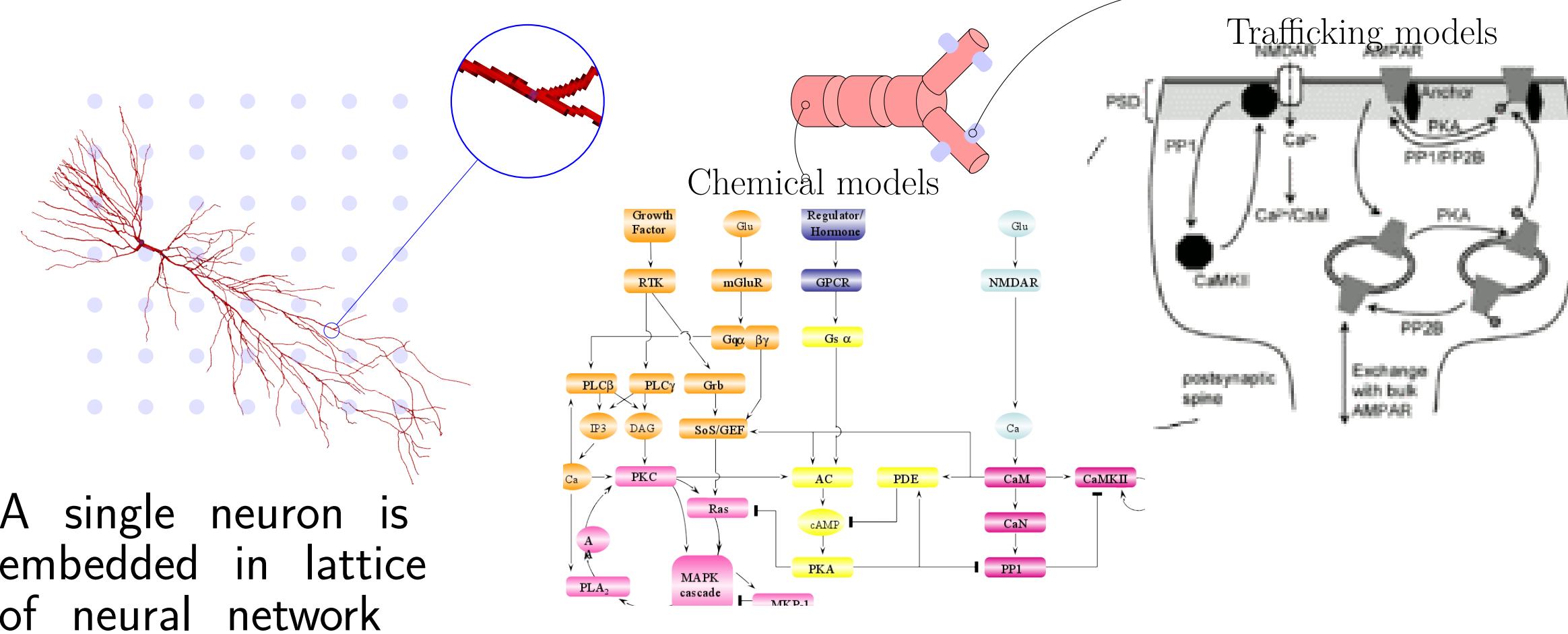
# Modelling Memory Across Scales

Subhasis Ray, Harsha Rani, Sahil Moza, Aditya Gilra, Aviral Goel, Dilawar Singh, Upinder Bhalla



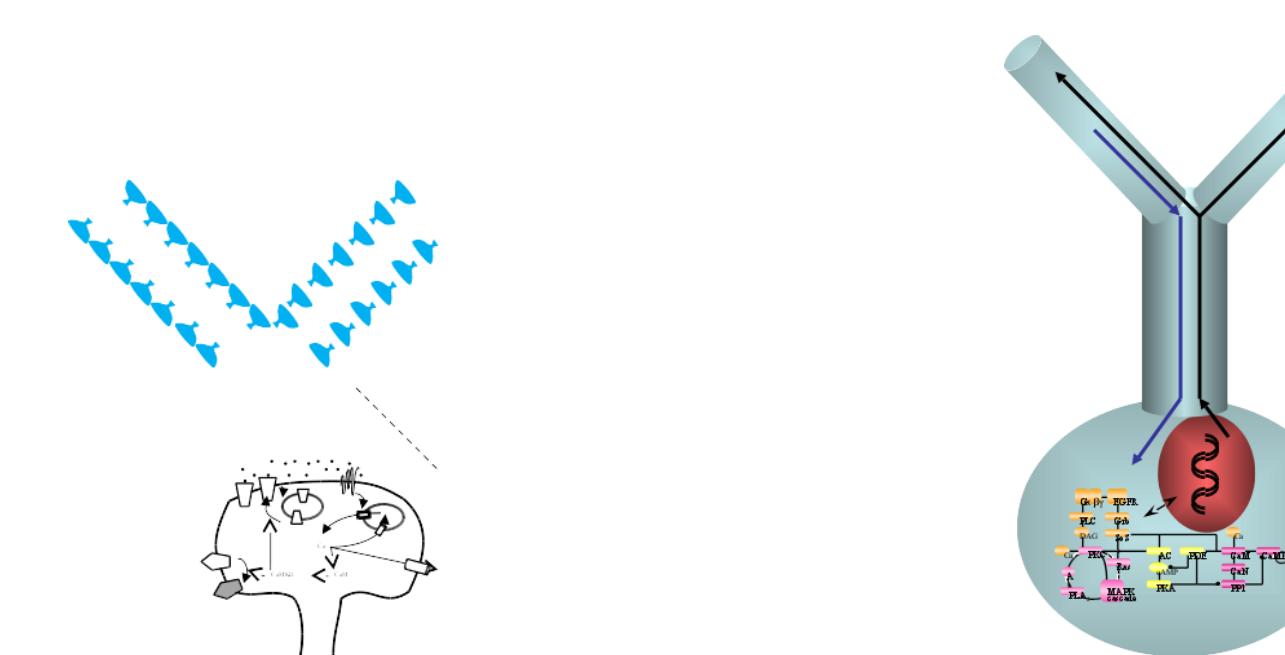
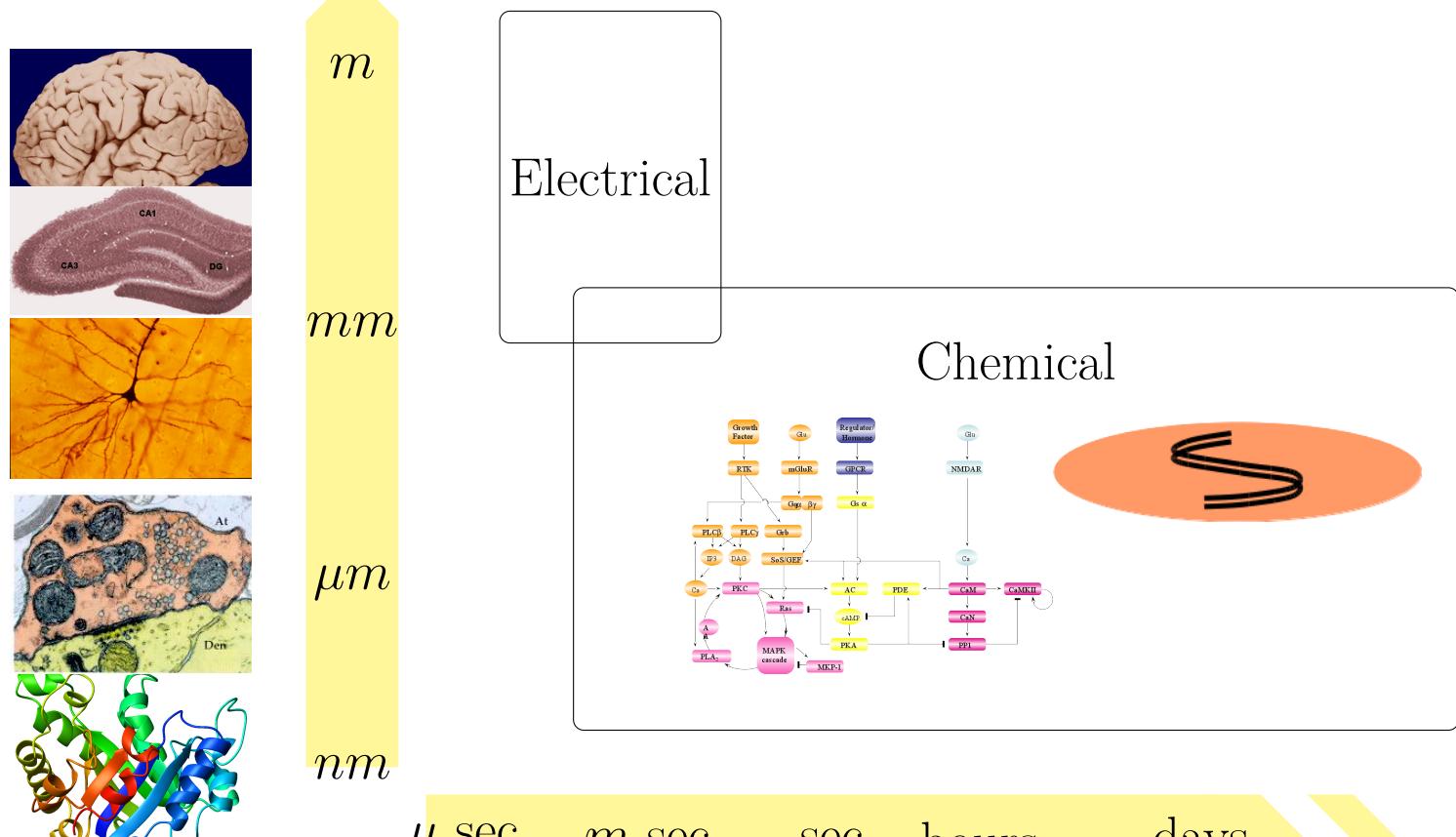
## 1. Why Multiscale?

- Memory and plasticity involve brain mechanisms from molecular scale to enormous networks.
- We have developed MOOSE the Multiscale Object Oriented Simulation Environment, to model plasticity across scales.

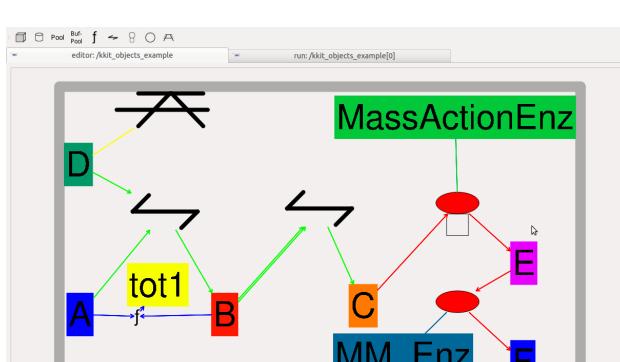


## 2. Multiscale Modeling in MOOSE

- $10^{11}$  cells,  $10^{15}$  synapses, 10000? reactions per synapse
- Electrical events: < 1 ms, Chemical events: 1 sec → 1000 sec
- Structural events: 100 sec → months



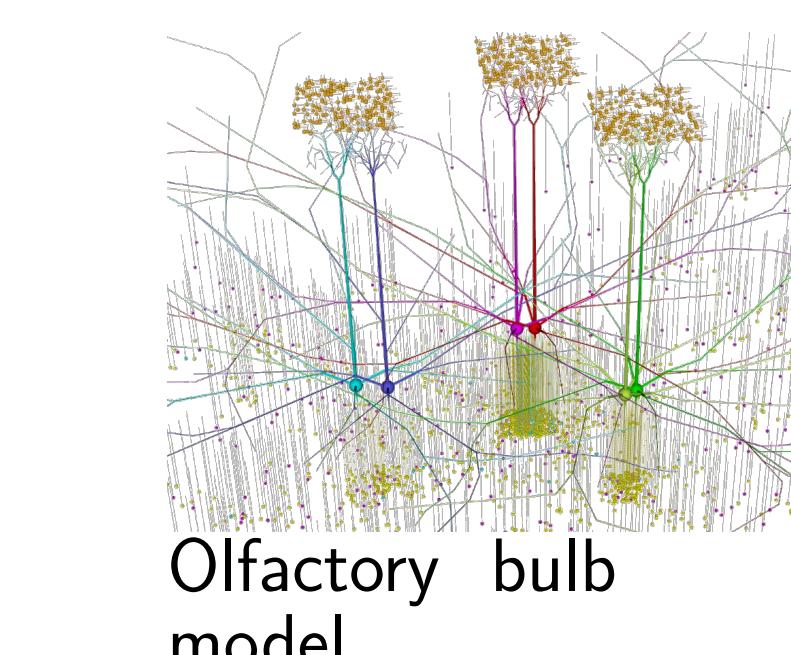
Reaction at single molecule level



Reaction Diffusion Solver



Single Neuron Model

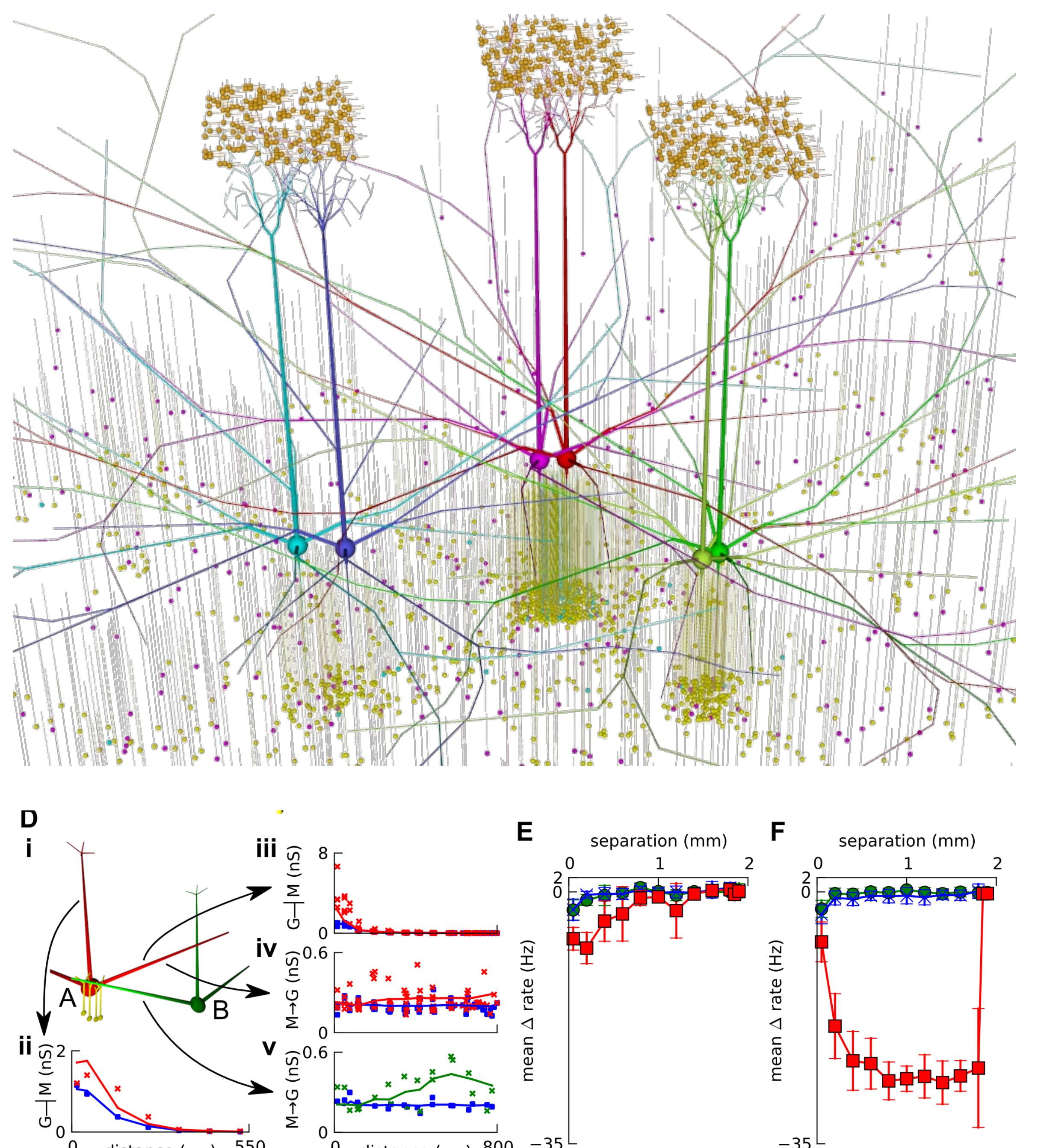


Olfactory bulb model

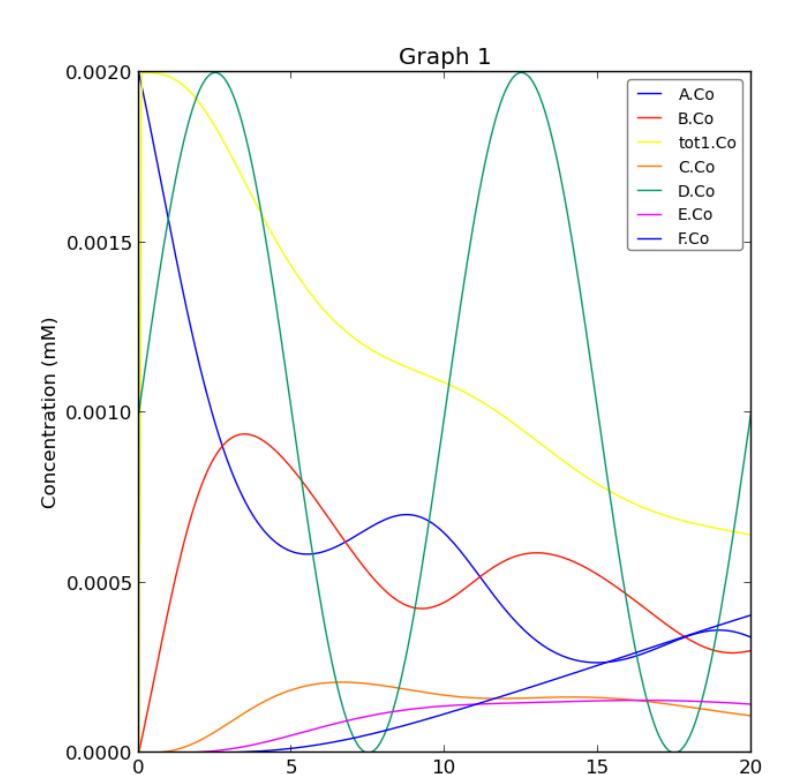
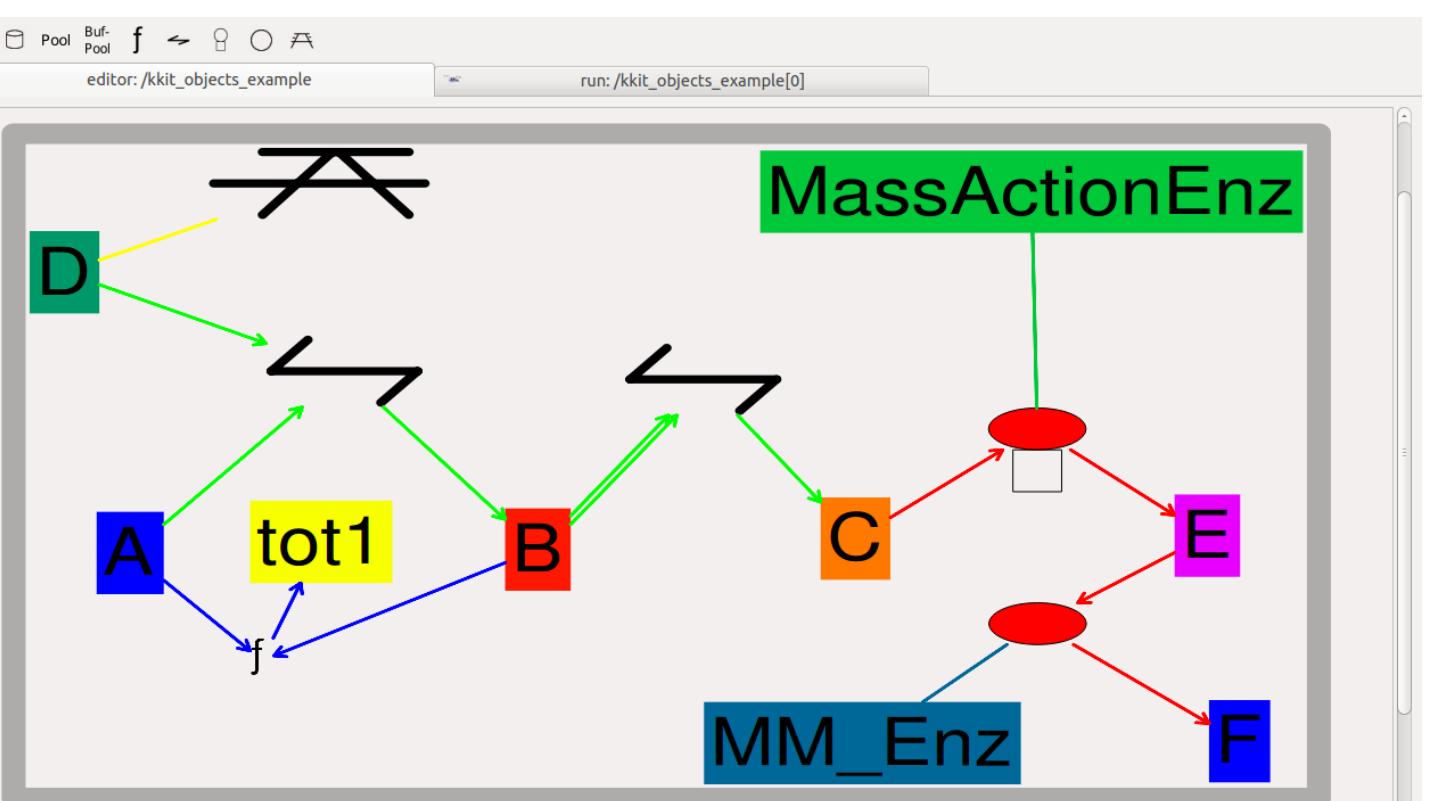
## 3. Some projects using MOOSE

### 3.1 OLFACTORY BULB PROJECT

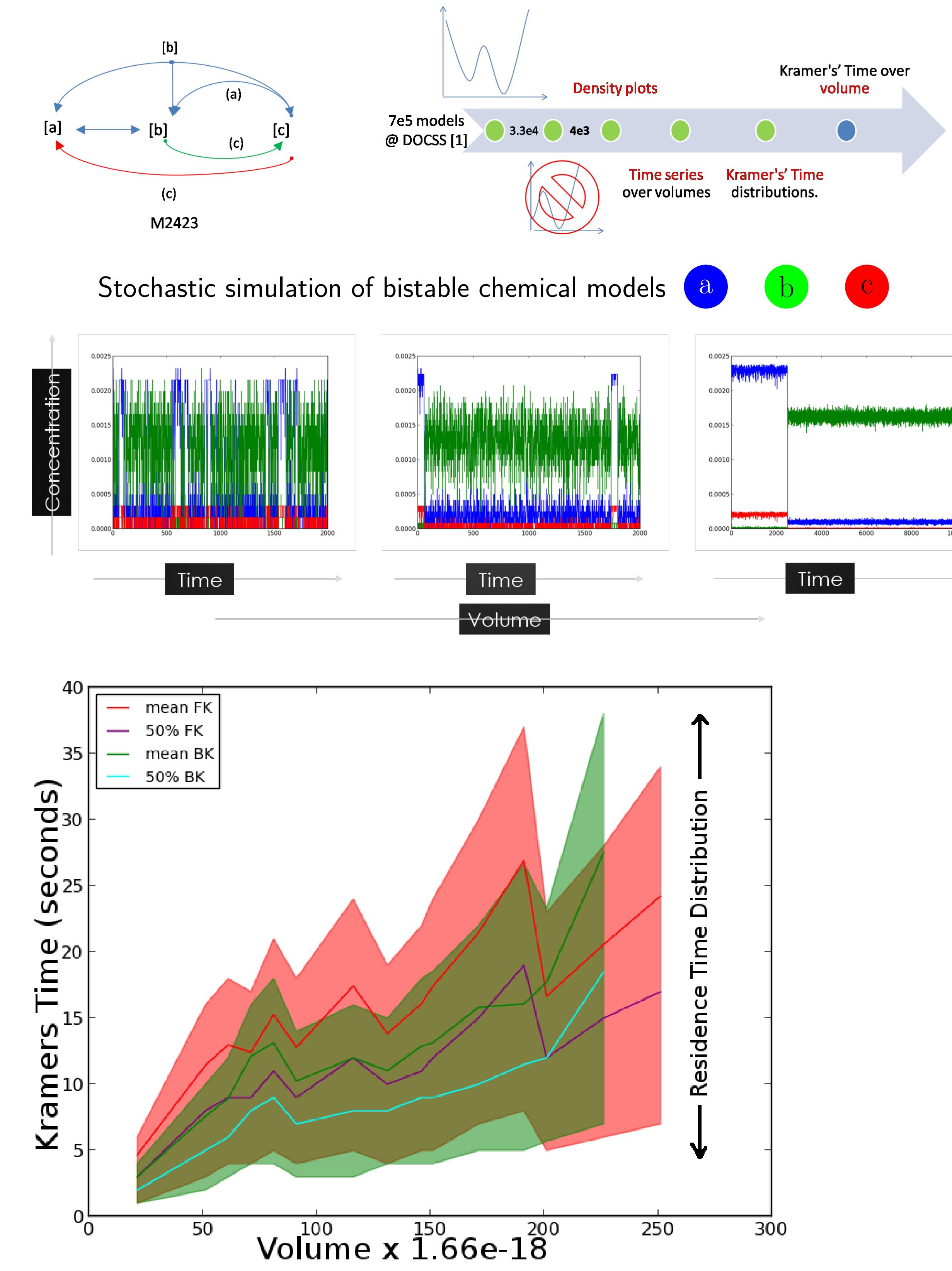
Network coding and computation in olfaction and somatosensory cortex. It explains linear coding and phase-decorrelation and predicts connectivity, lateral dendrite output structure.



### 3.2 SIGNALLING PATHWAYS



### 3.3 ROBUSTNESS OF CHEMICAL SWITCHES



## 4. Summary

We use models to,

- Integrate many scales of neuronal data with basic physical/chemical principles.
- Explain phenomena of plasticity, activity and neuronal coding.
- Predict circuit mechanisms, plasticity rules, and emergent phenomena such as *decorrelation*, *robustness*, and *memory decay*.