

# A Machine Learning Approach to Whole Brain Neural Network Analysis of *C. Elegans*

Wu Stephen モデリング研究系 助教

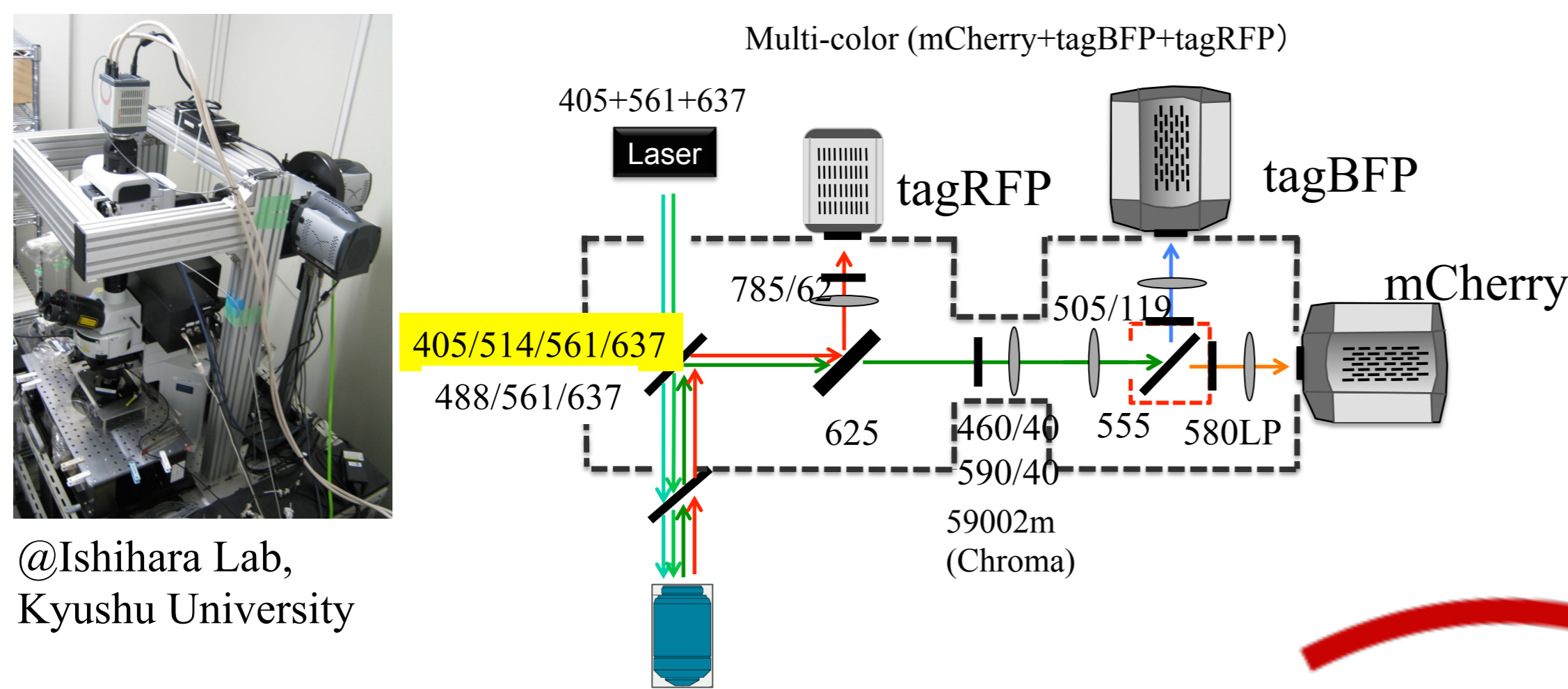
Yoshida, R.<sup>1,2</sup>, Tokunaga, T.<sup>2,3</sup>, Hirose, O.<sup>1,2,4</sup>, Toyoshima, Y.<sup>2,5</sup>, Jang, M.<sup>2,5</sup>, Kanamori, M.<sup>2,5</sup>, Oe, S.<sup>2,6</sup>, Teramoto, T.<sup>2,6</sup>, Iwasaki, Y.<sup>2,7</sup>, Ishihara, T.<sup>2,6</sup>, Iino, Y.<sup>2,5</sup>  
<sup>1</sup>The Institute of Statistical Mathematics, <sup>2</sup>JST-CREST, <sup>3</sup>Kyusyu Tech. Univ., <sup>4</sup>Kanazawa Univ., <sup>5</sup>Univ. of Tokyo, <sup>6</sup>Kyusyu Univ., <sup>7</sup>Ibaraki Univ.

## Abstract

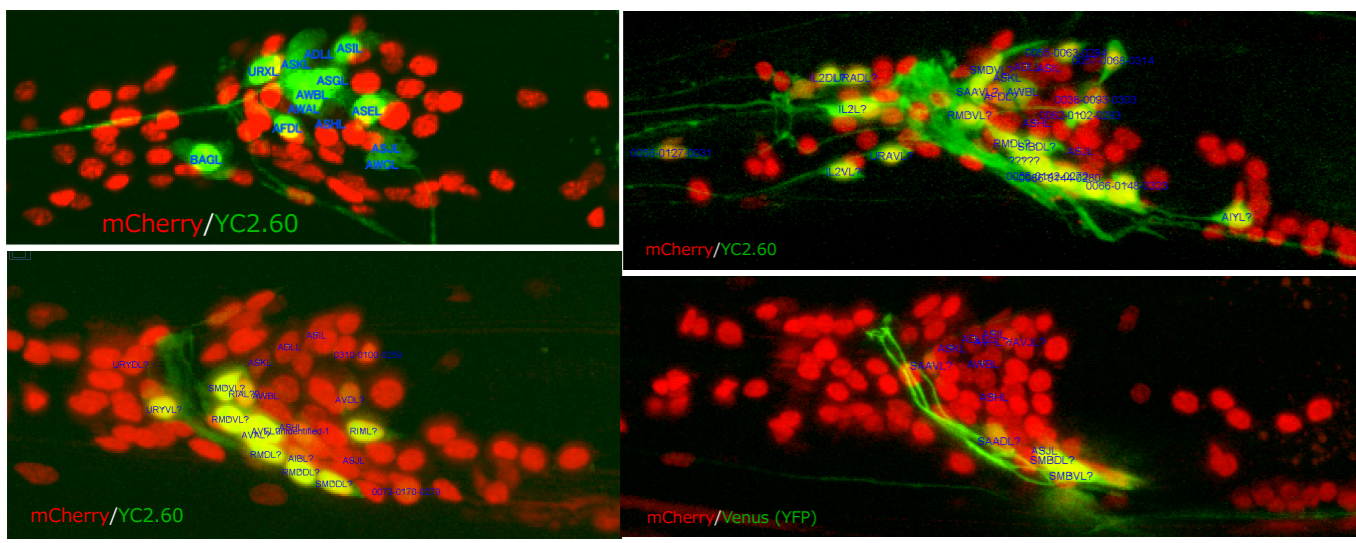
A five-year-long cross-disciplinary project on studying whole brain neuronal activity of *Caenorhabditis elegans* (*C. elegans*) has taken part since 2013. The objective is to understand the underlying mechanisms of the complicated neural dynamics through recent advancements of 4D calcium imaging techniques. We tackle this great challenge with state-of-the-art machine learning techniques, which facilitates improved throughput of image processing. The machine learning pipeline begins with the detection and

segmentation of imaged cells, followed by tracking of the crowded objects that exhibit great mobility in a time-lapse image sequence. For a given tracked cell, fluorescence intensities of the segmented voxels define temporal dynamics of its neural activities. Then, such information of all the brain cells is collectively analyzed to produce a network-based visualization, improving our understanding of the information processing mechanism of the neural system. This poster demonstrates the outline of the complete workflow.

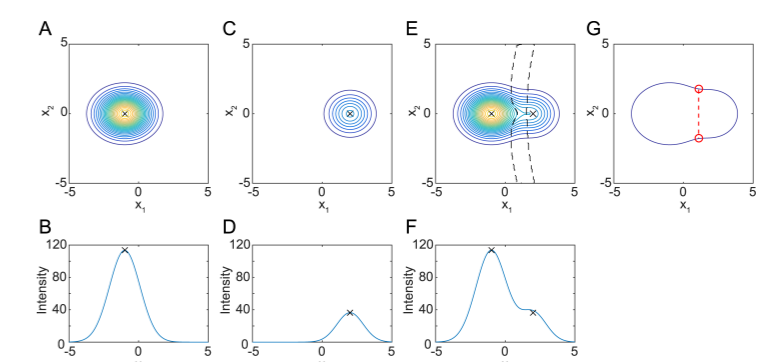
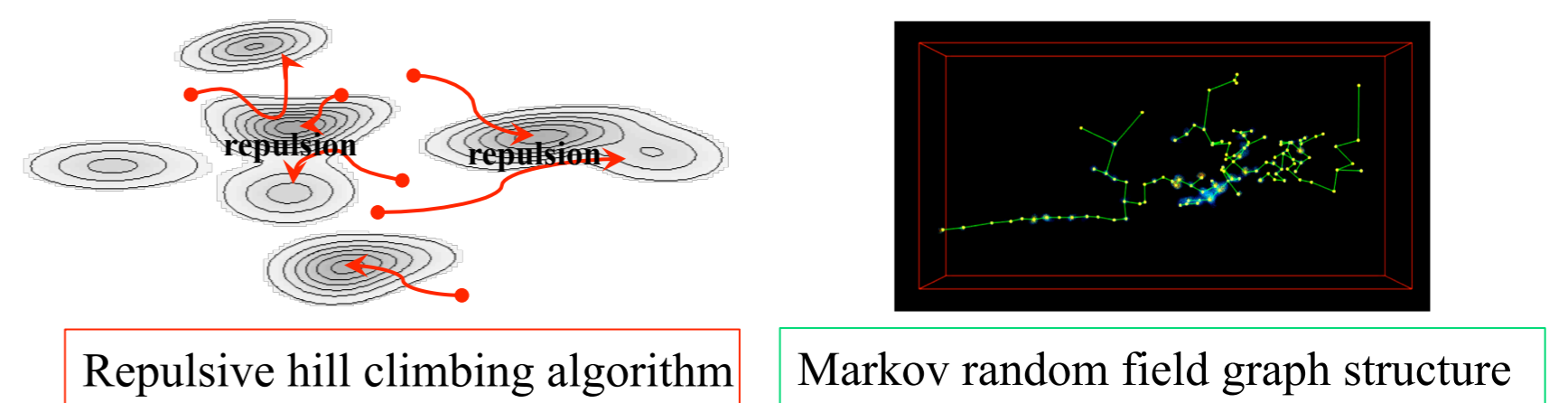
### 1. State-of-the-art 4D pan-neural imaging



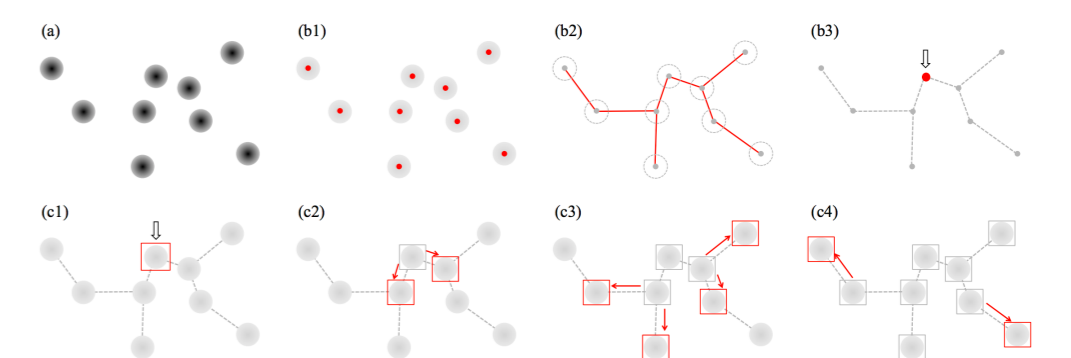
@Ishihara Lab, Kyushu University



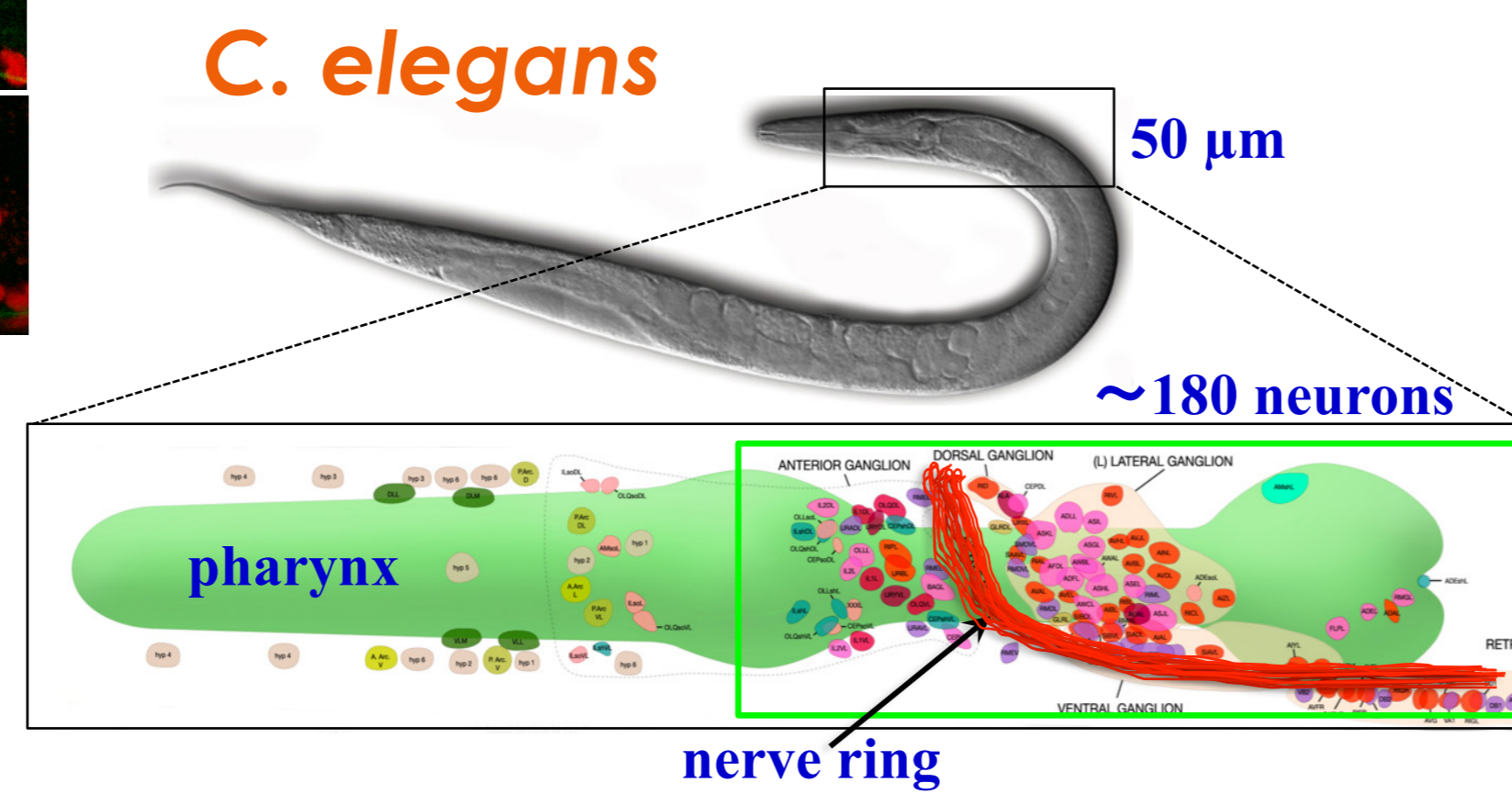
### 2. Automatic neuron detection, segmentation, tracking



Gaussian mixture model with 3D Clump Splitting

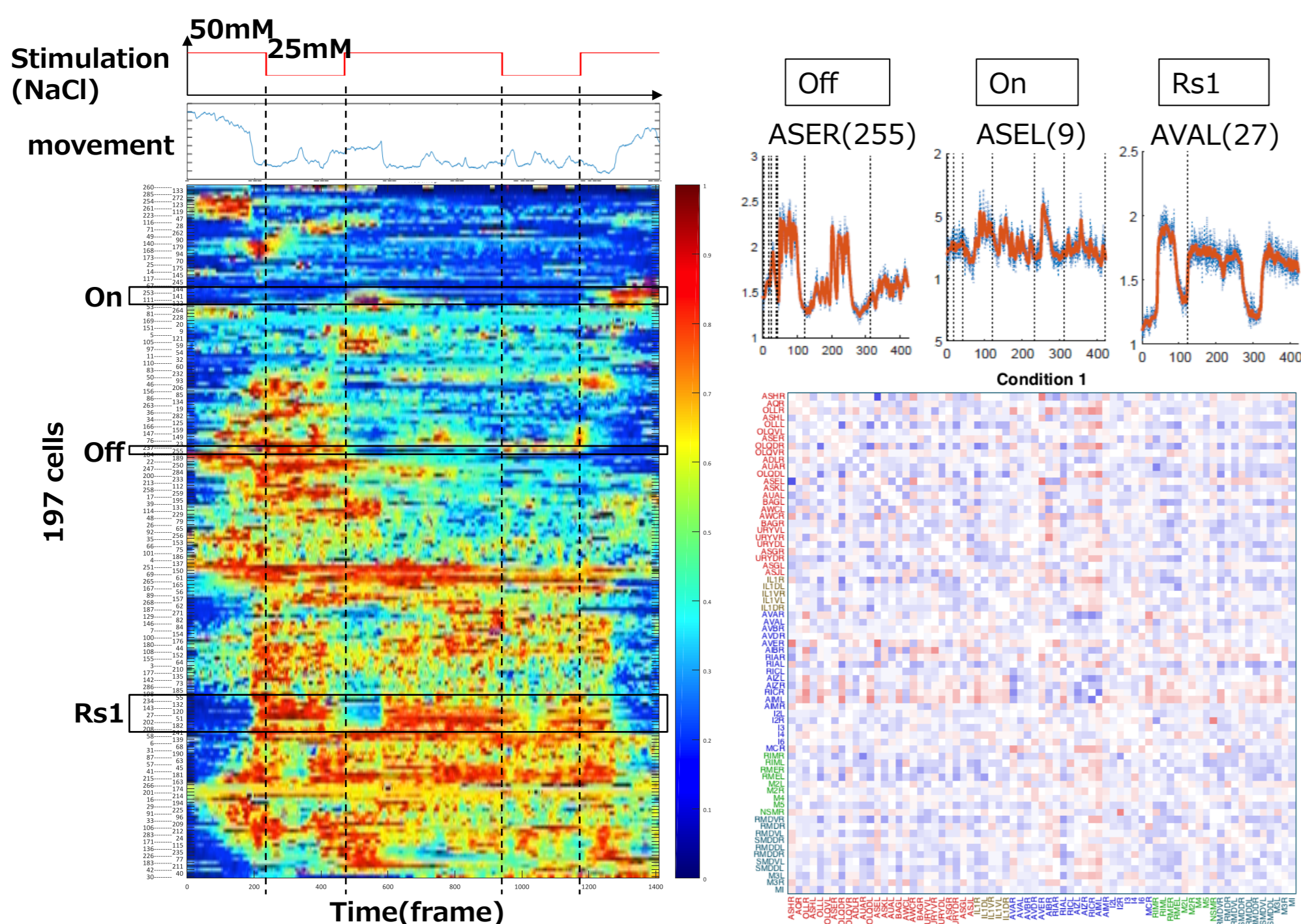


Spatial correlation: Spatial particle filter



### 4. Scientific discovery using large data set

Neuron signal correlation => Neural Network dynamics



### 3. Automatic annotation algorithm

