V-NeuroStack

3-D time stacks for finding patterns in spontaneous activity of neurons in mouse brain slice

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Introduction

We present **V-NeuroStac*k*,** a web application which uses 3-D time stacks to identify patterns in the neuronal activity & to understand functional relationships between neurons.

This approach can help us identify patterns in the neuronal activity which may not be visible using a 2-dimensional view of the slice.

Methods & Materials

Following data files were used:
1. Spreadsheet containing intensities for 139 neurons over 600 sec (10fps)
2. Spreadsheet containing x and y value of each of the neuron on the image
3. Communities information generated by CommDy algorithm [1]

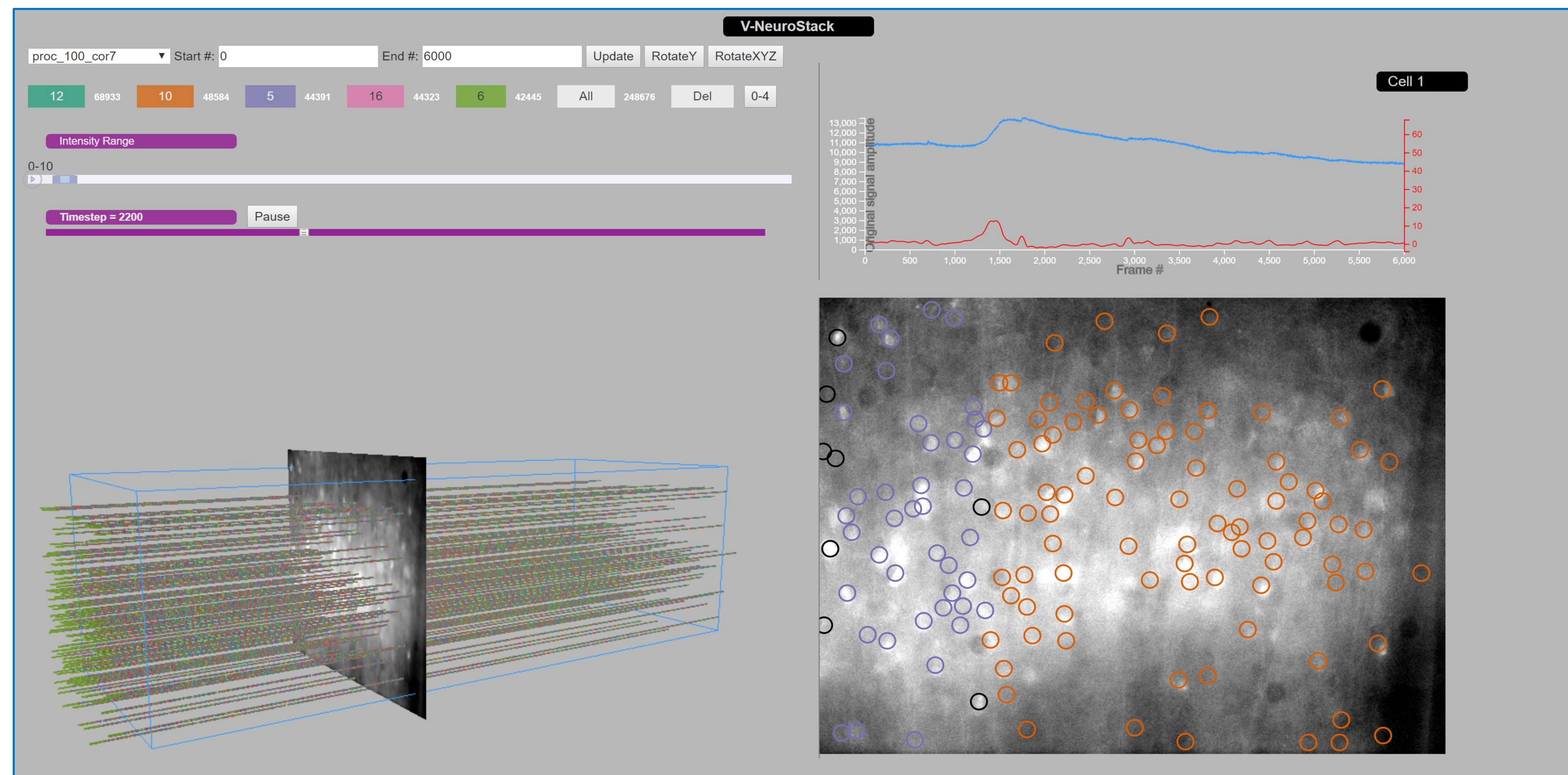Tools: JavaScript, D3.js, Three.js, Python

Features

1. V-Neurostack displays in 3D
2. Switch between datasets using dropdown menu
3. Every cross-sectional slice of the stack can be viewed in greater detail with 2D view on the right.
4. Auto play and slider options move 2D slice to a specific point.
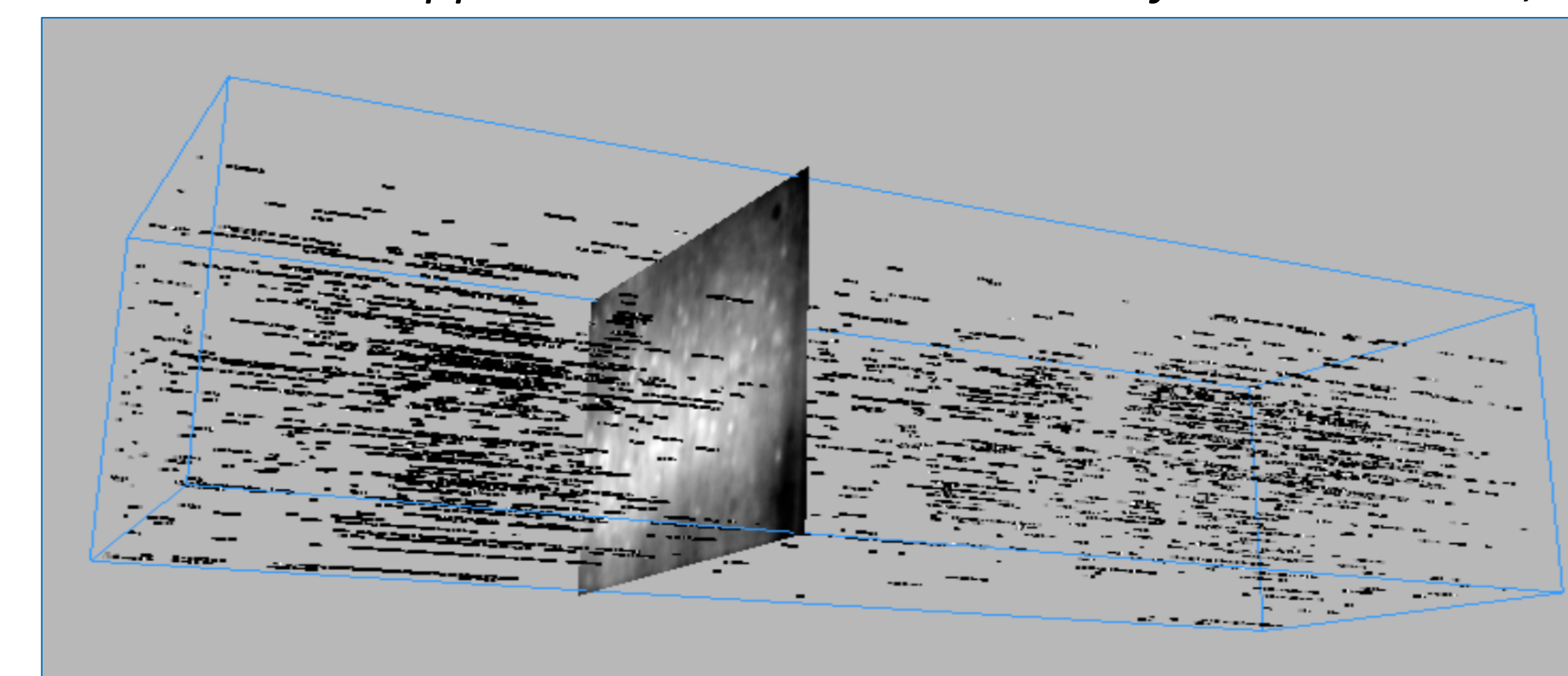5. Line graph shows both raw intensities and it first derivative displaying 600 seconds of data.

Conclusion

1. View patterns in the neuronal activity over a period of 5700+ frames.
2. Patterns may imply
   a. Higher presence of datapoints in one community than another
   b. There exits a strong correlation between these neurons
3. This flexibility in exploring patterns in firing of neurons has the potential to open further research questions on understanding spontaneous as well as other forms of neuronal activity in any brain region.
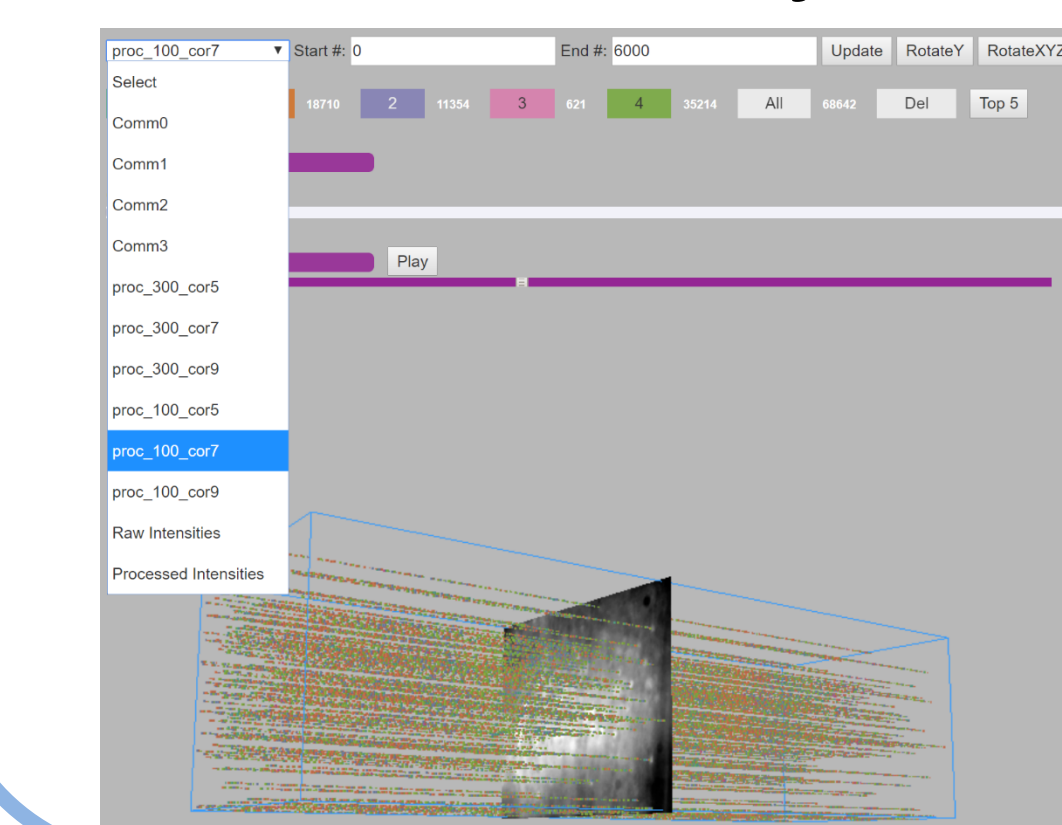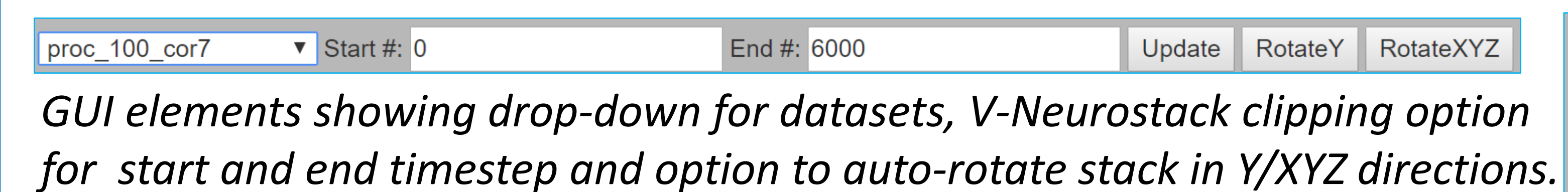
Results

V-NeuroStack Application – Shows time stacks for 139 neurons, with controls, cross-section of one timestep and intensities for Cell 1.
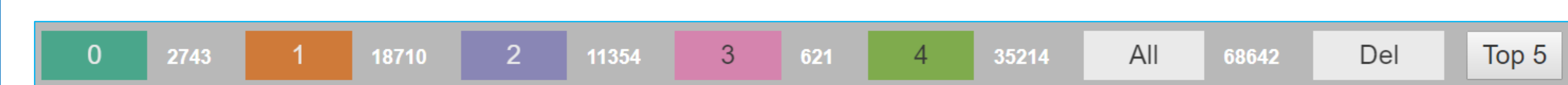

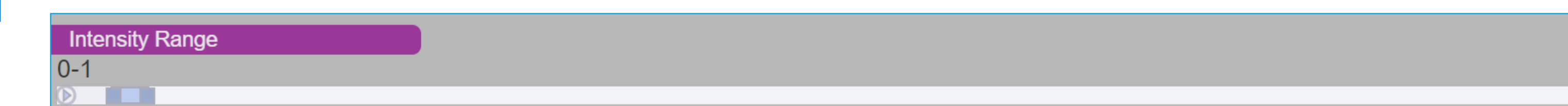*V-Neurostack with first derivative of intensities.*

Drop-down showing various datasets with V-Neurostack for CommDy[1] values generated for processed intensities with window size 100 and correlation co-efficient 0.7.

GUI elements showing drop-down for datasets, V-Neurostack clipping option for start and end timestep and option to auto-rotate stack in Y/XYZ directions.
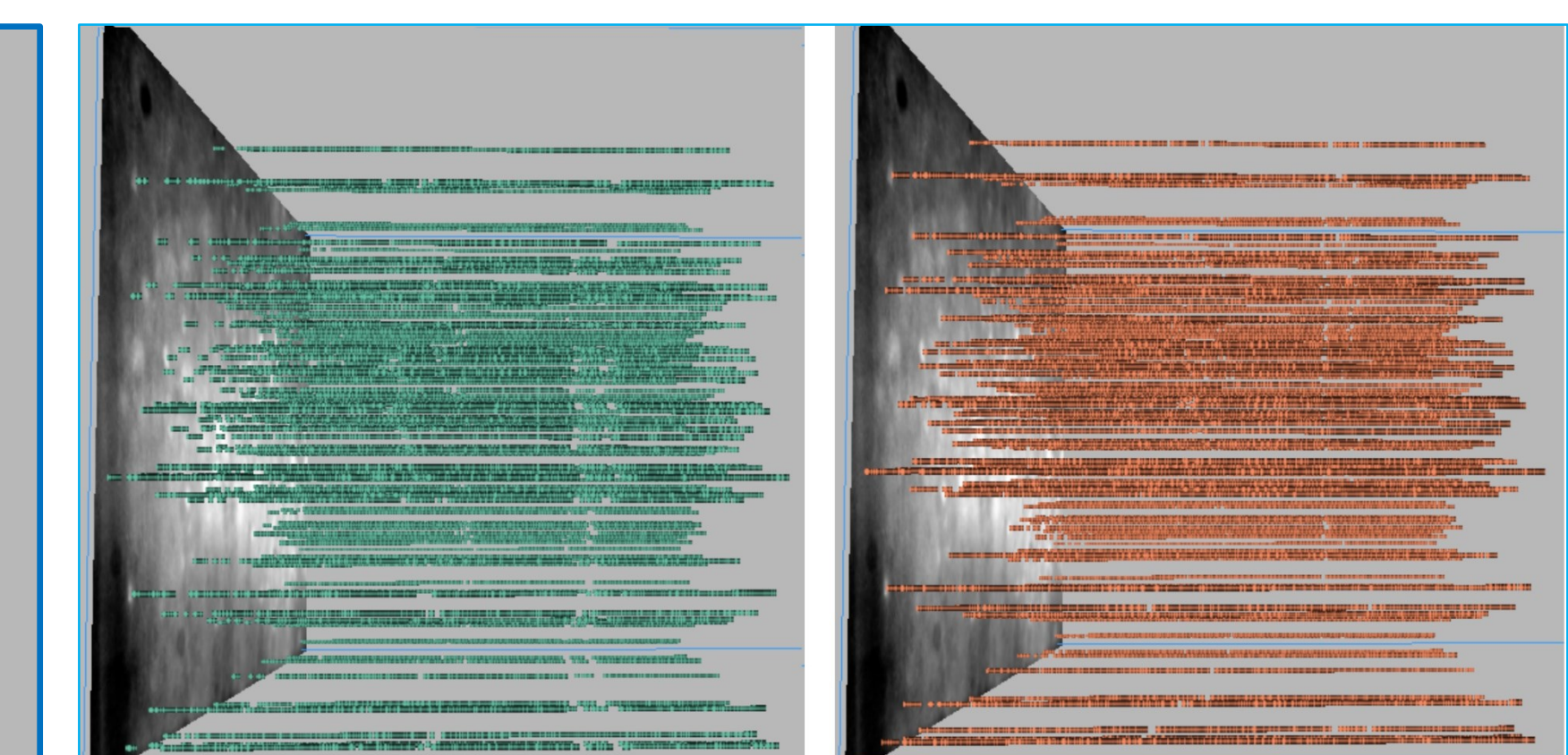

GUI elements showing community numbers, number of data points in each community, total number of datapoints in the selected dataset. We can also switch between Top5 communities and 0-4 community values.
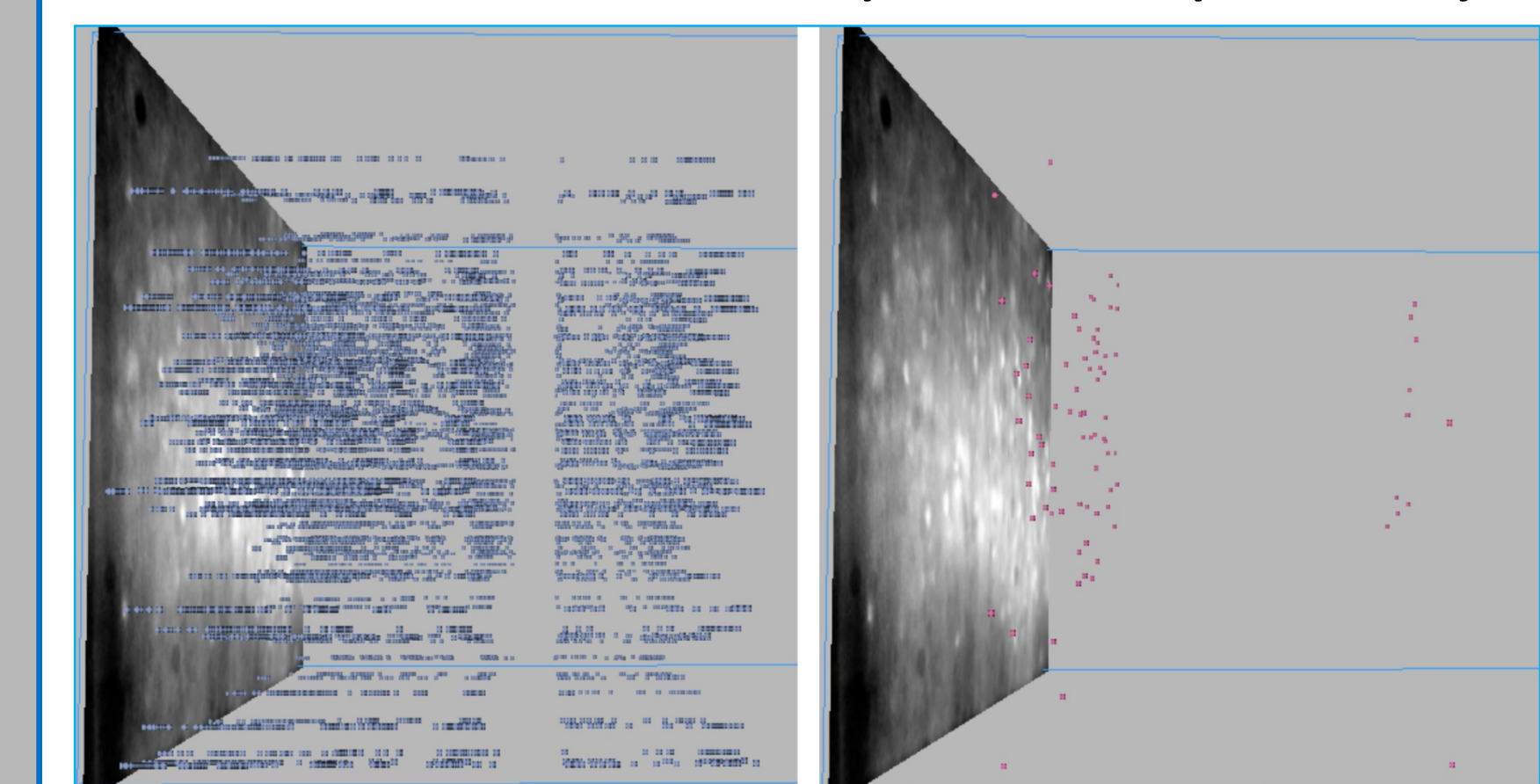

Range slider to view processed intensities for different range values between 0-68 with an option to autoplay through the entire range.
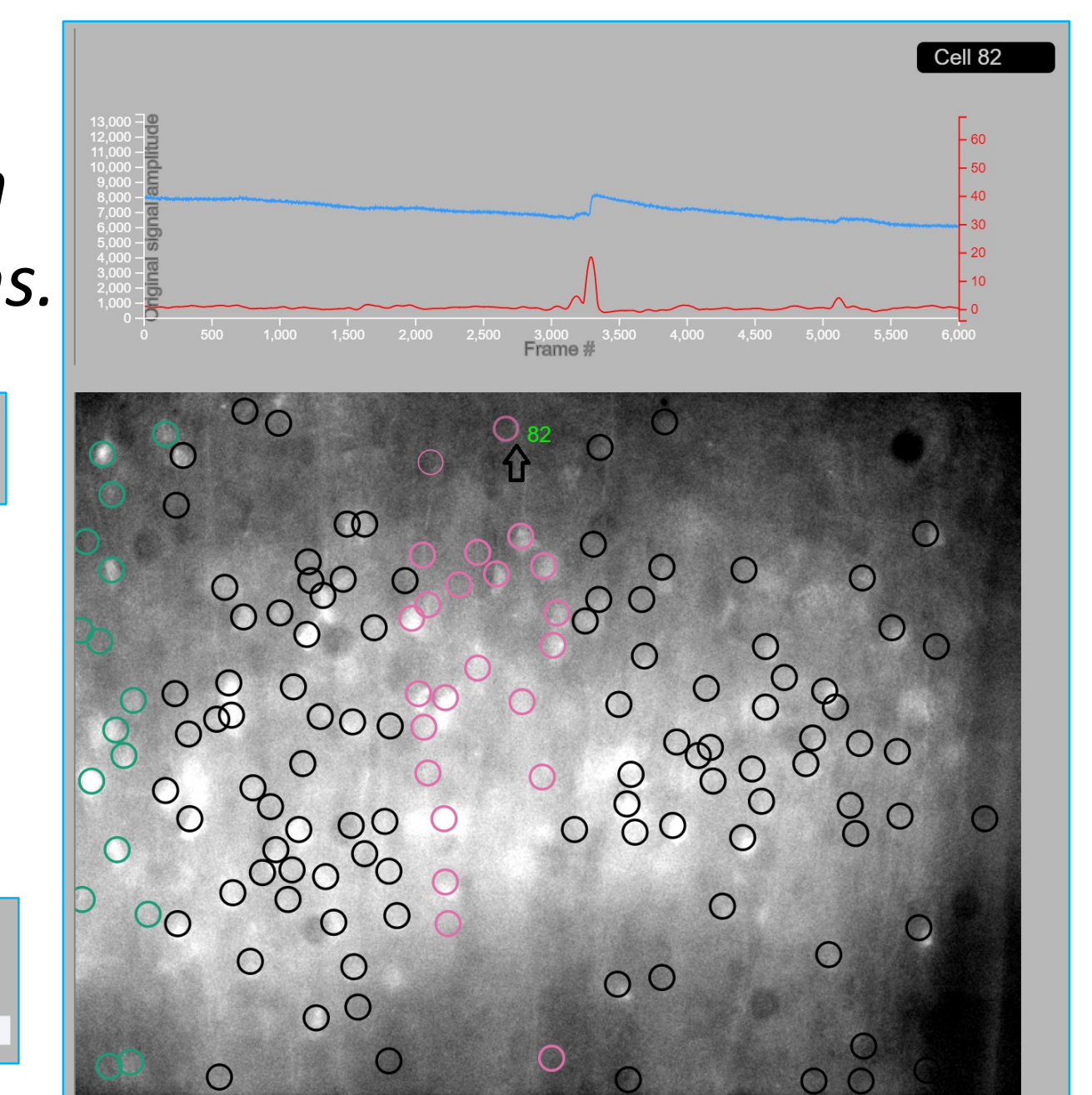

Controls to view cross-sectional slice of the V-Neurostack showing the chosen timestep. It has a slider & autoplay button to control the movement.

Neuron pattern for first 1500 timeframes (comm0 dataset) for 1st and 2nd color comms. Green & Orange comm. have 98611 and 96600 datapoints respectively.

Neuron pattern for first 1500 timeframes (comm0) for 3rd and 4th color comms. Blue & pink comm. have 19006 and 83 datapoints respectively.

Cross-sectional view of V-Neurostack. Line graph showing raw intensities ranging between 0 and 13500 and first derivative of intensities ranging between 0 and 68.

References

[1]Tantipathananandh, Chayant, Tanya Berger-Wolf, and David Kempe. "A framework for community identification in dynamic social networks." *Proceedings of the 13th ACM SIGKDD international conference on Knowledge discovery and data mining*. ACM, 2007.

Acknowledgements

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