

A Scalable System for Social Neural Imaging: Integrating Multi-animal 3D Pose Tracking and Ca₂₊ Imaging in Freely Interacting Animals

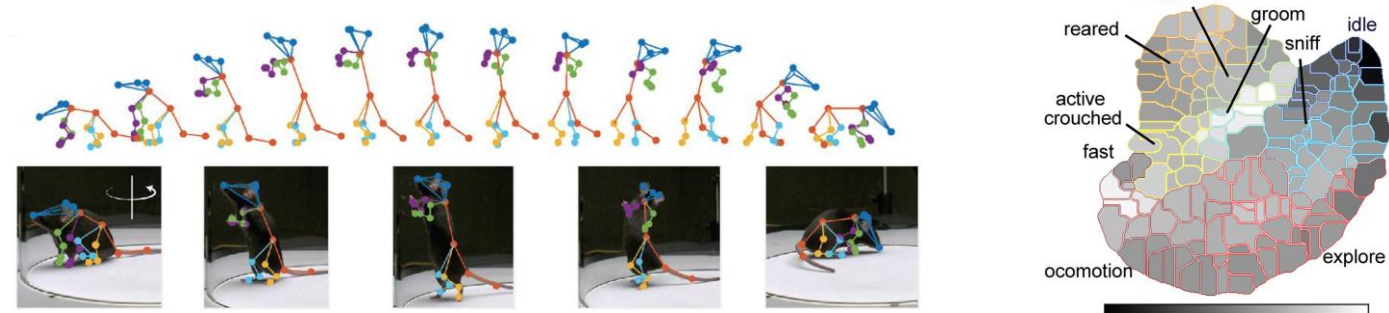
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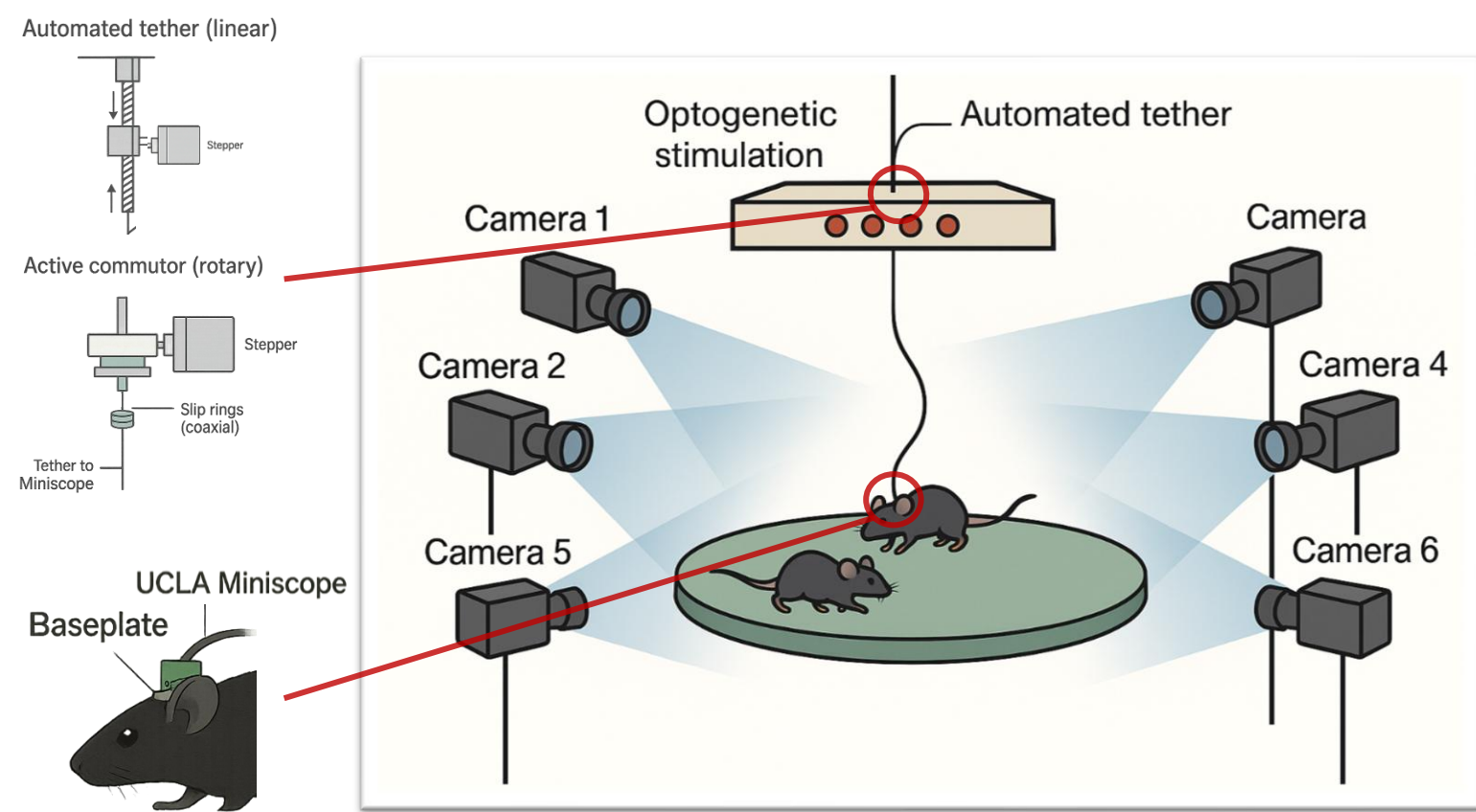
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Background & Purposes

- Prior:** social-DANNCE (sDANNCE) has mapped rich social behavior in rats [1].
- Gap:** Mice add scale/occlusion/identity + head-mount imaging challenges. Cortical-surface level Calcium imaging remains challenging in freely moving animals.
- This work:** Six-camera s-DANNCE-style tracking + Miniscope V4 (1p) using cranial windows.
- Payoff:** Quantitative 3D kinematics + stable $\Delta F/F$ (V1, PMC/M1) → naturalistic social neurobehavior studies.



System Schematic

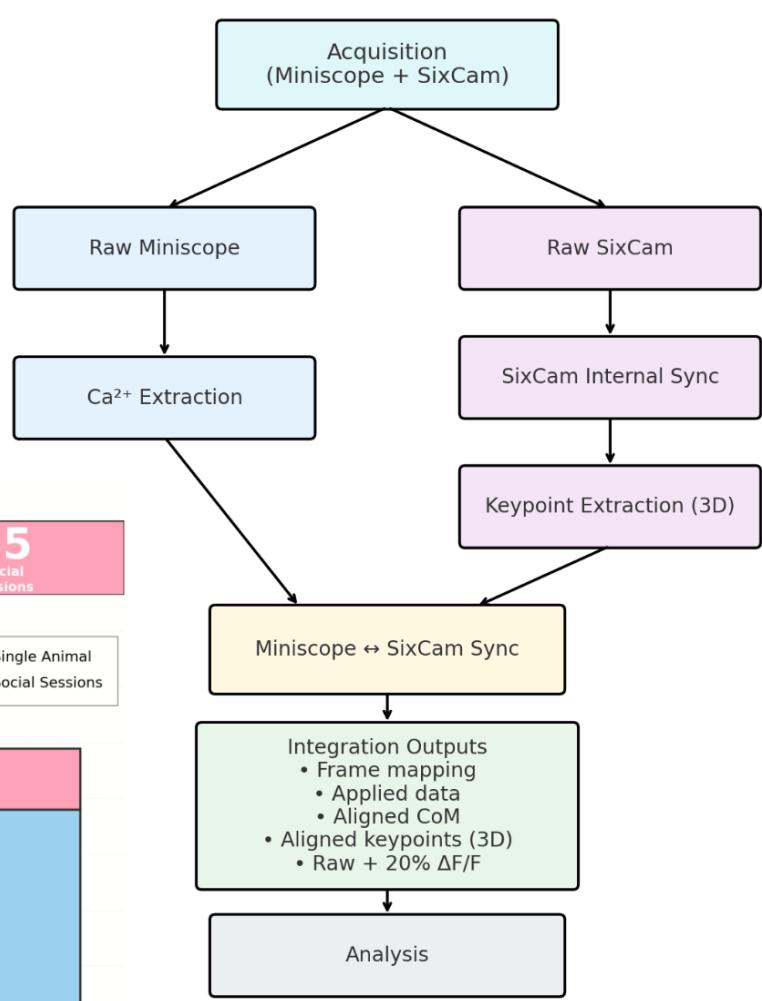
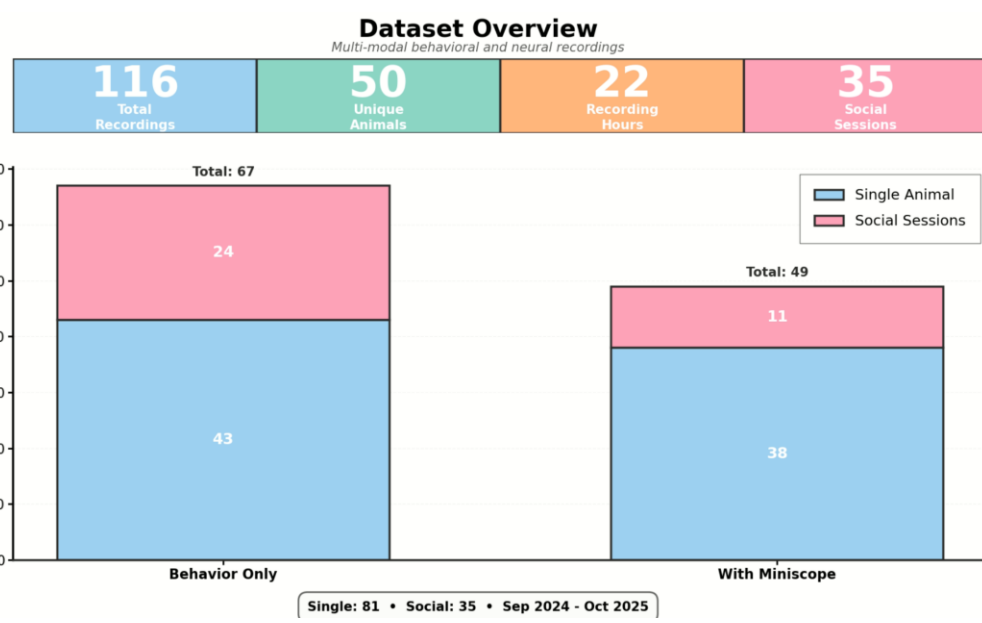


Pipeline & Alignments: BBOP

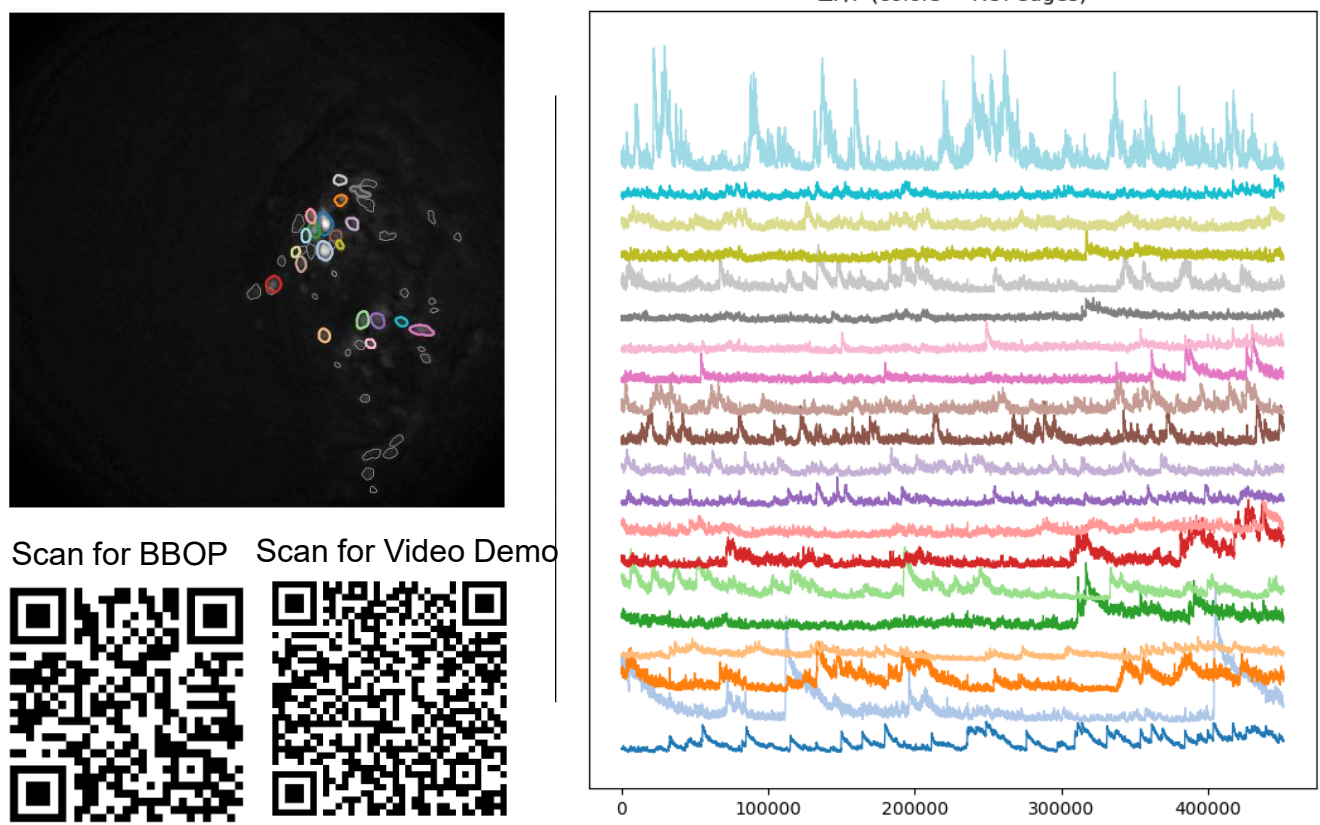
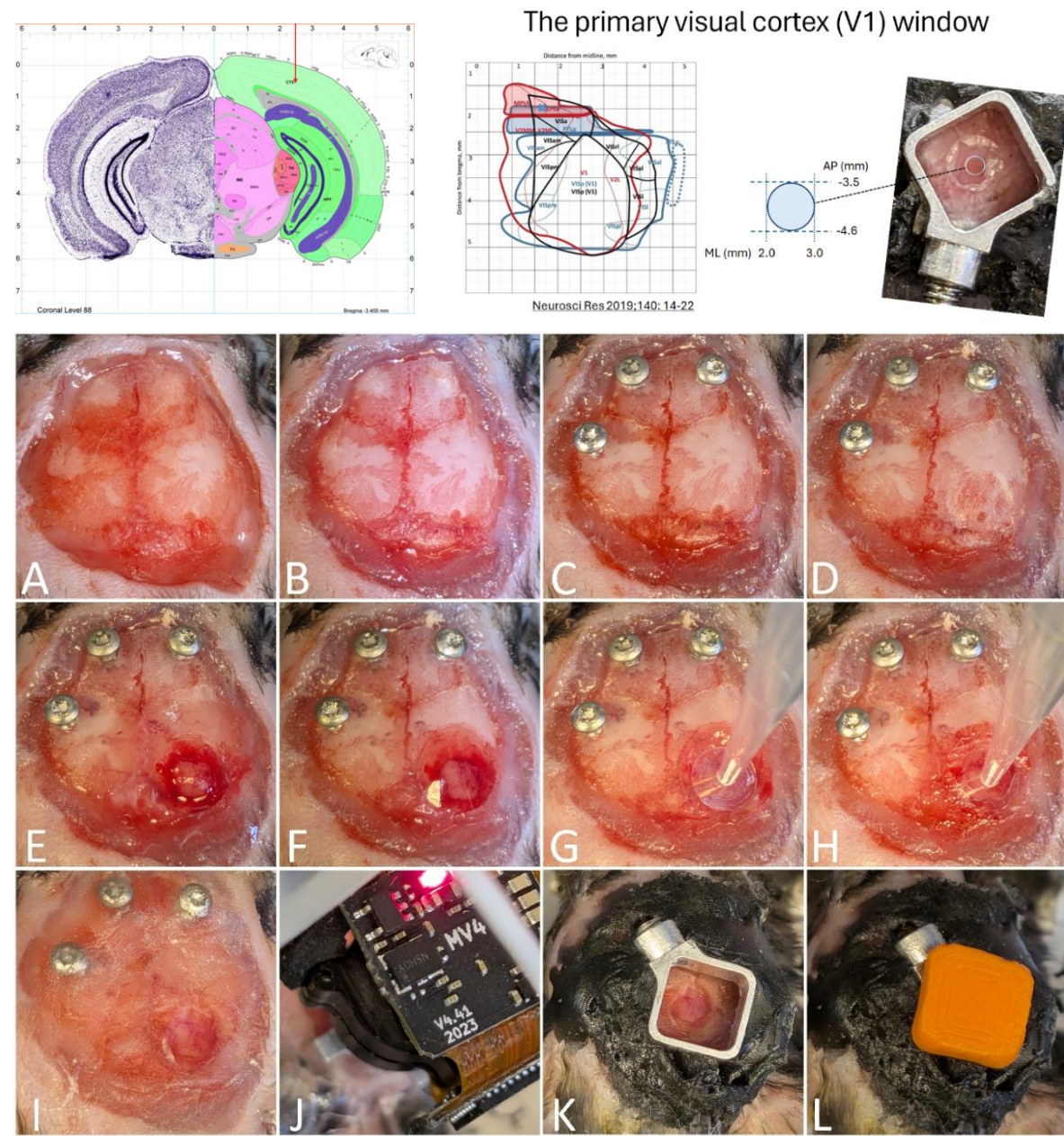
BBOP Pipeline Highlights

- Scan:** Flag Processing Status
- Filter:** For executions of any stages
- Execute:** Sync → Predict → Align

rec_file	sync	COM	social	post-oxy
mice1	✓	✓	✓	✓
mice2	✓	✓	✓	✓

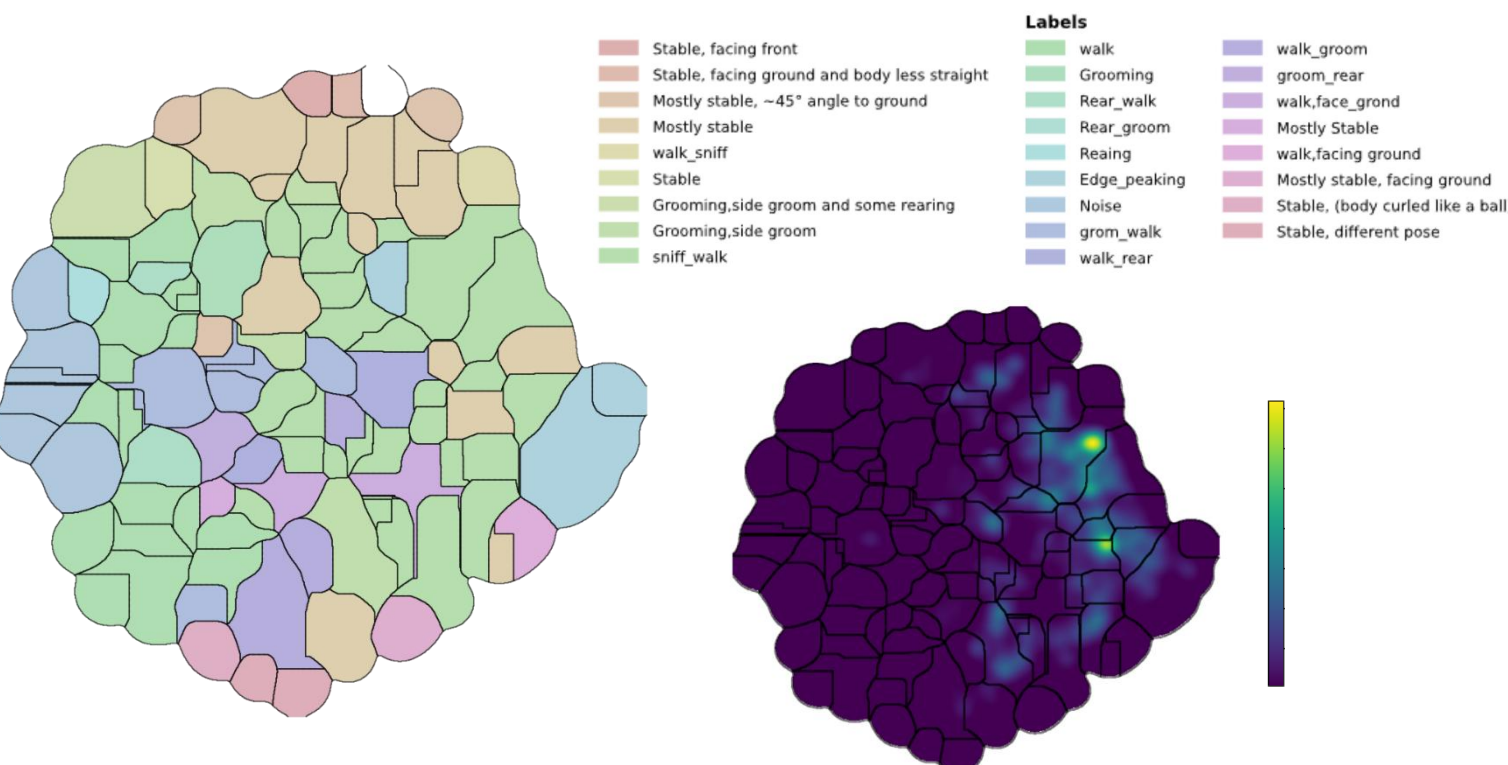


Neural Data Pipeline

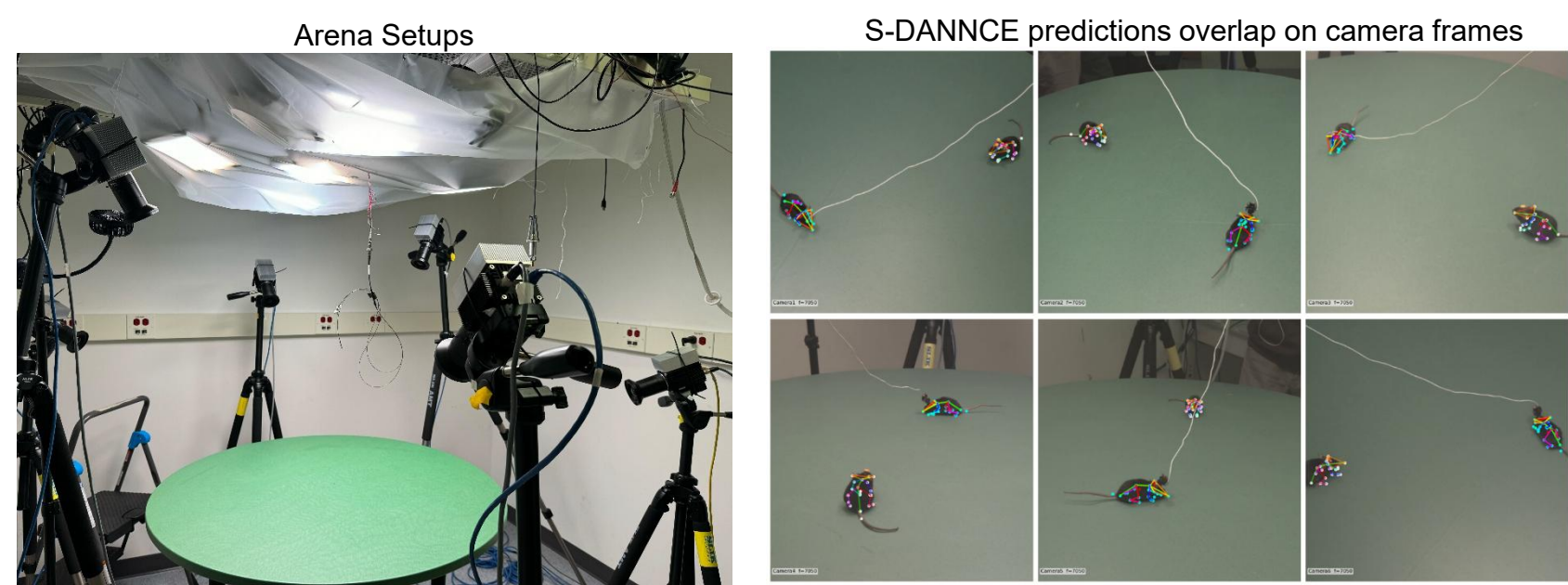


1. AAV1-hSyn-Soma-jGCaMP8s was injected into the primary visual cortex (V1) with a depth of 0.25 mm from the pia 4-5 weeks prior to window chamber construction.
2. The cortical window (approximately 1 mm in diameter) was made over the primary visual cortex centered at the cross AP -3.5 mm and ML 2.5 mm.
3. Recordings of raw videos of the window. The Ca₂₊ extraction is by a customized script based on MiniAn [3], with optimized parameter adjustments to capture most neurons

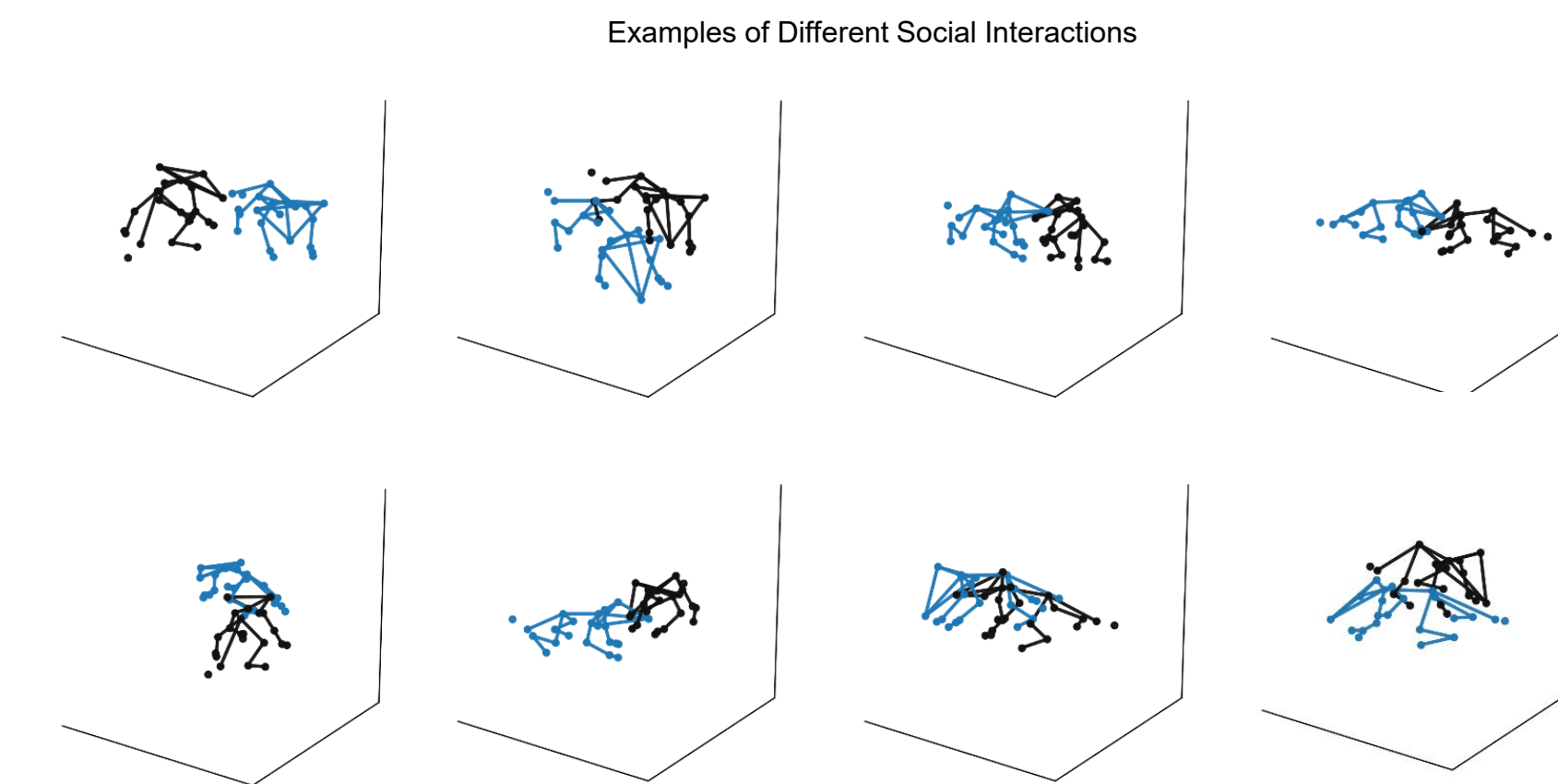
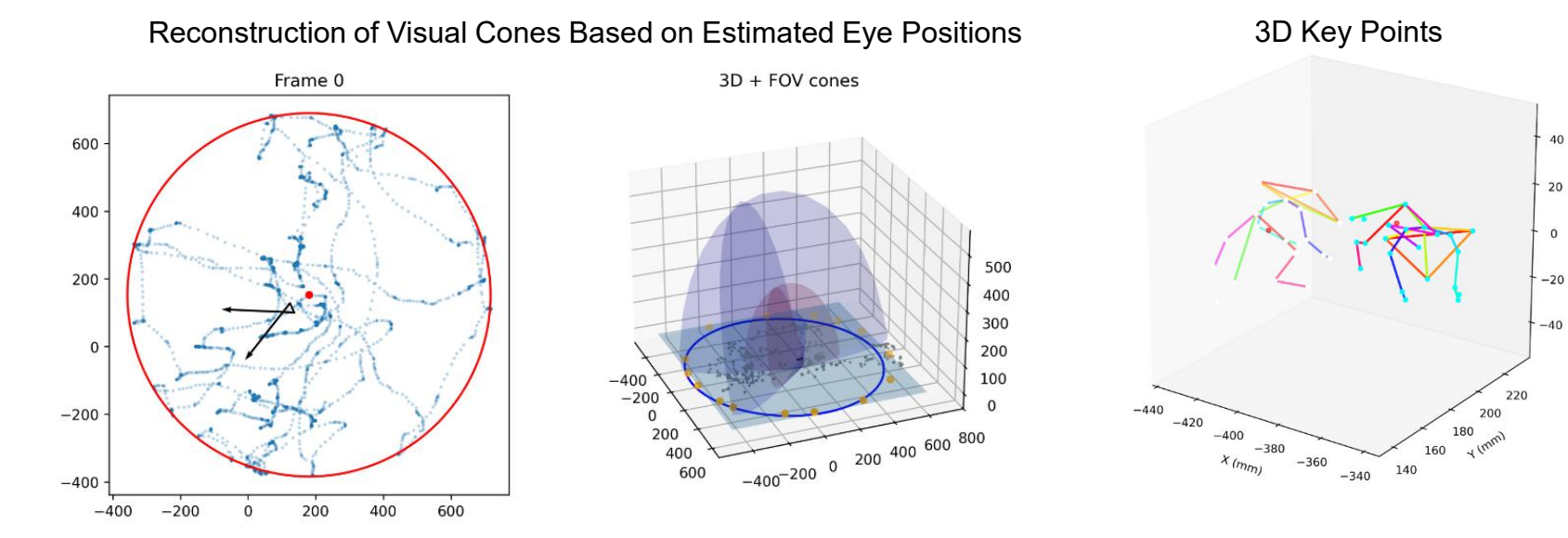
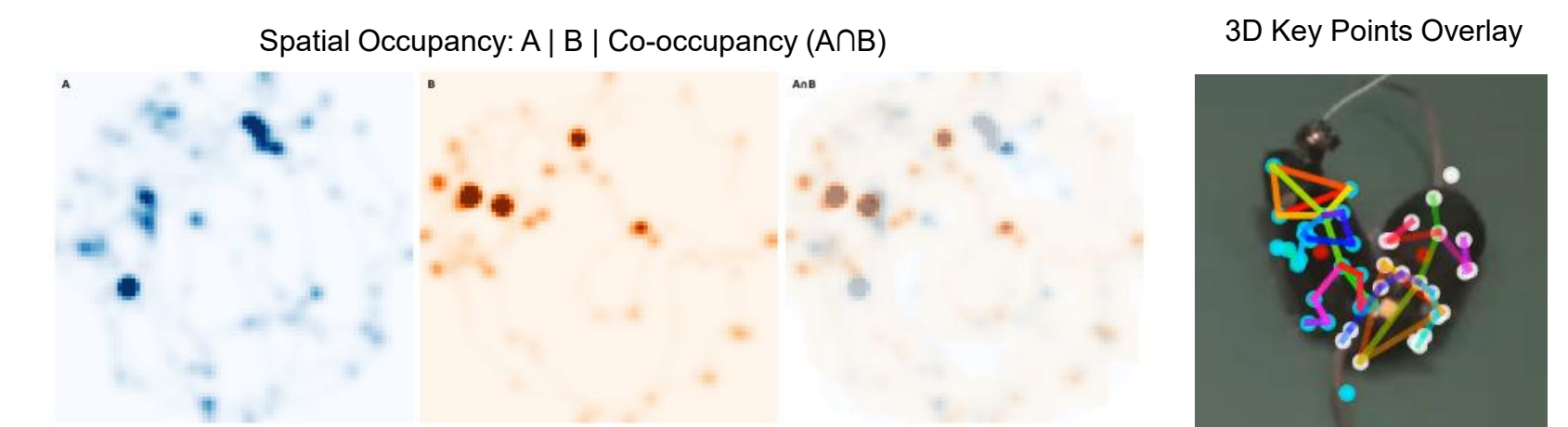
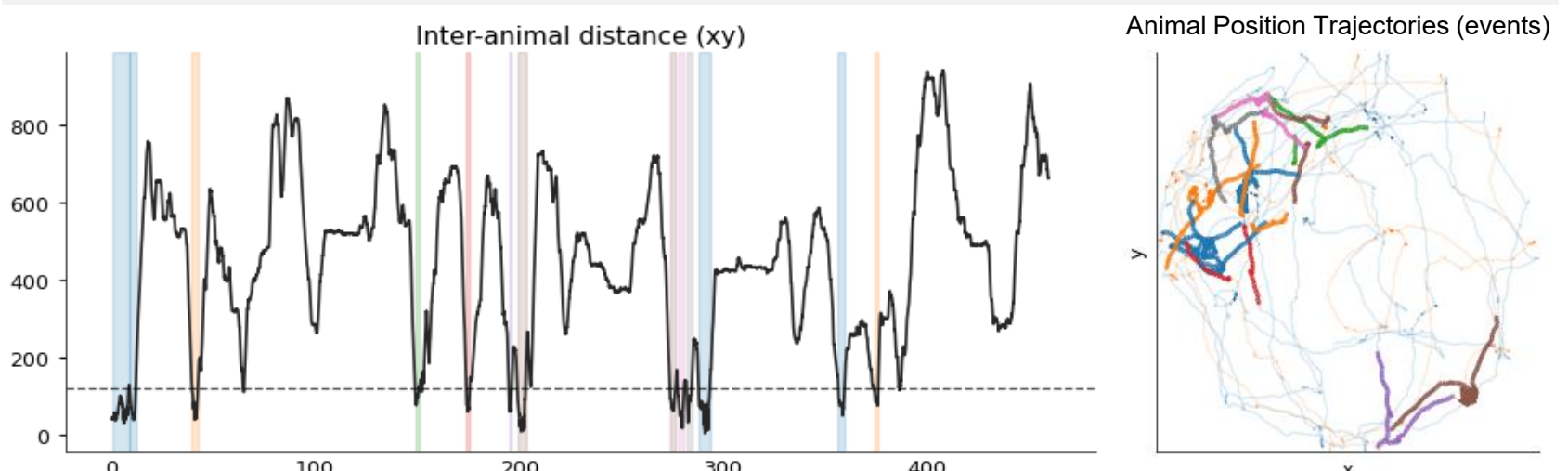
Unsupervised Behaviors Clusters



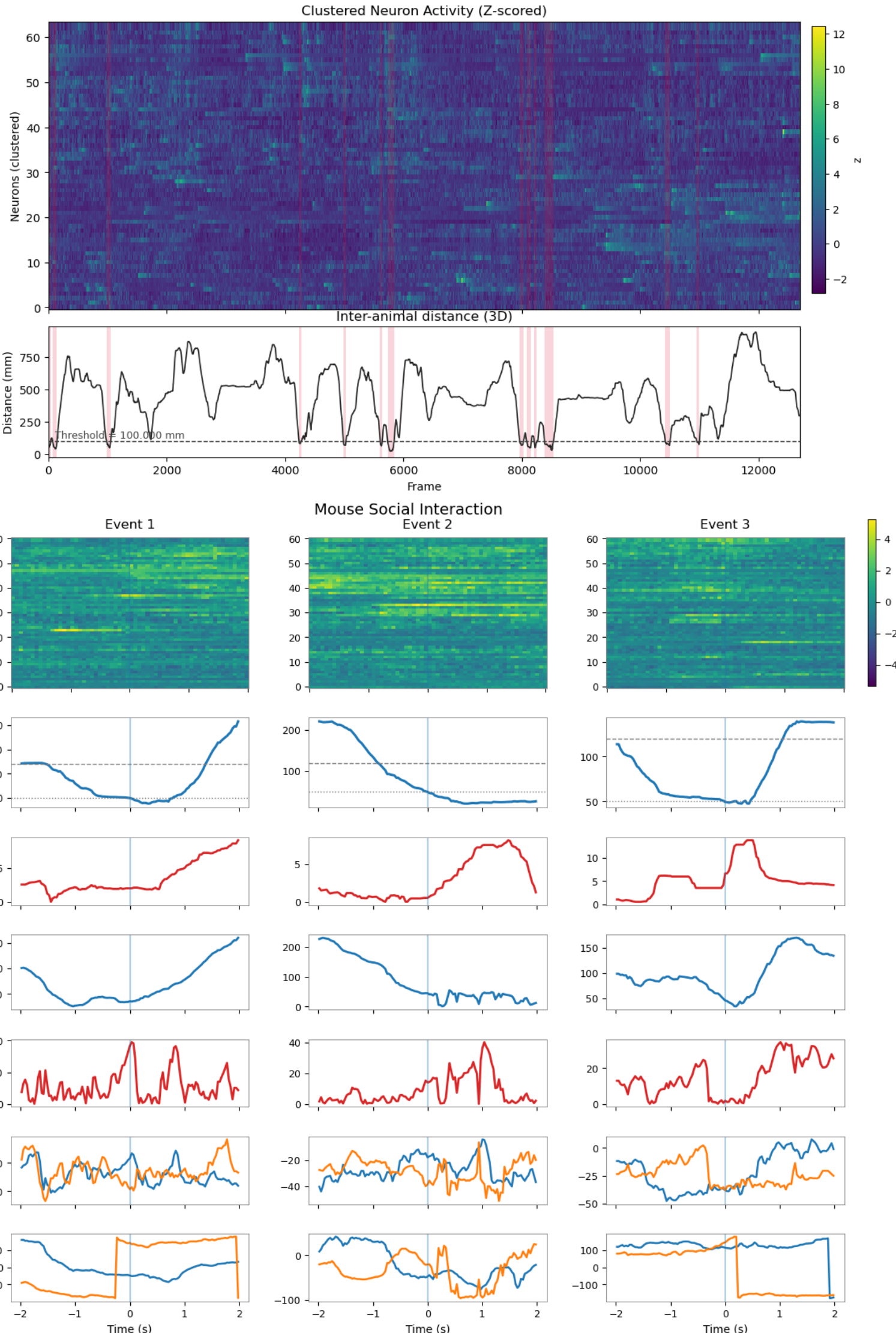
Behavior Data Pipeline



A large enriched arena provides space for naturalistic locomotion and social interaction, enabling reliable 3D tracking and capturing a wider range of behavior for neural analyses.



Aligned Data For Social Interactions



Summary

We have built a system that can be used for decoding neural activity in mice during both solitary and social natural behaviors. This setup makes it possible to ask how visual and motor circuits encode key spatial variables—edge distance, partner proximity, and approach/escape structure—and how neural activity predicts future movement and social trajectories.

References

1. Klibaite, U., Li, T., Aldarondo, D., Akoad, J. F., Ölveczky, B. P., & Dunn, T. W. (2025). Mapping the landscape of social behavior. *Cell*, 188(8), 2249–2266.e23. <https://doi.org/10.1016/j.cell.2025.01.044> PubMedDunn,
2. T. W., Marshall, J. D., Severson, K. S., Aldarondo, D. E., Hildebrand, D. G. C., Chettih, S. N., Wang, W. L., Gellis, A. J., Carlson, D. E., Aronov, D., Freiwald, W. A., Wang, F., & Ölveczky, B. P. (2021). Geometric deep learning enables 3D kinematic profiling across species and environments. *Nature Methods*, 18(5), 564–573. <https://doi.org/10.1038/s41592-021-01106-6>
3. Dong, Z., Mau, W., Feng, Y., Pennington, Z. T., Chen, L., Zaki, Y., Rajan, K., Shuman, T., Aharoni, D., & Cai, D. J. (2022). Minian, an open-source miniscope analysis pipeline. *eLife*, 11, e70661. <https://doi.org/10.7554/eLife.70661> (eLife)