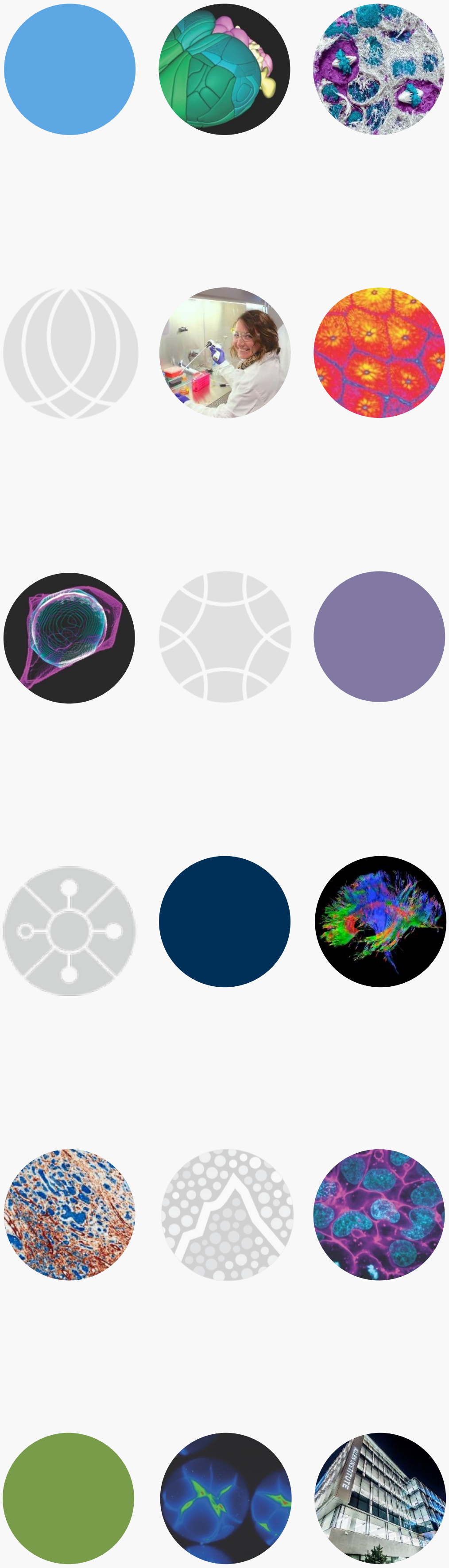
OpenScope 2023-2024 Annual Report

Principal Investigators
Jerome Lecoq
Christof Koch

ALLEN INSTITUTE for NEURAL DYNAMICS

NIH
U24 NS113646



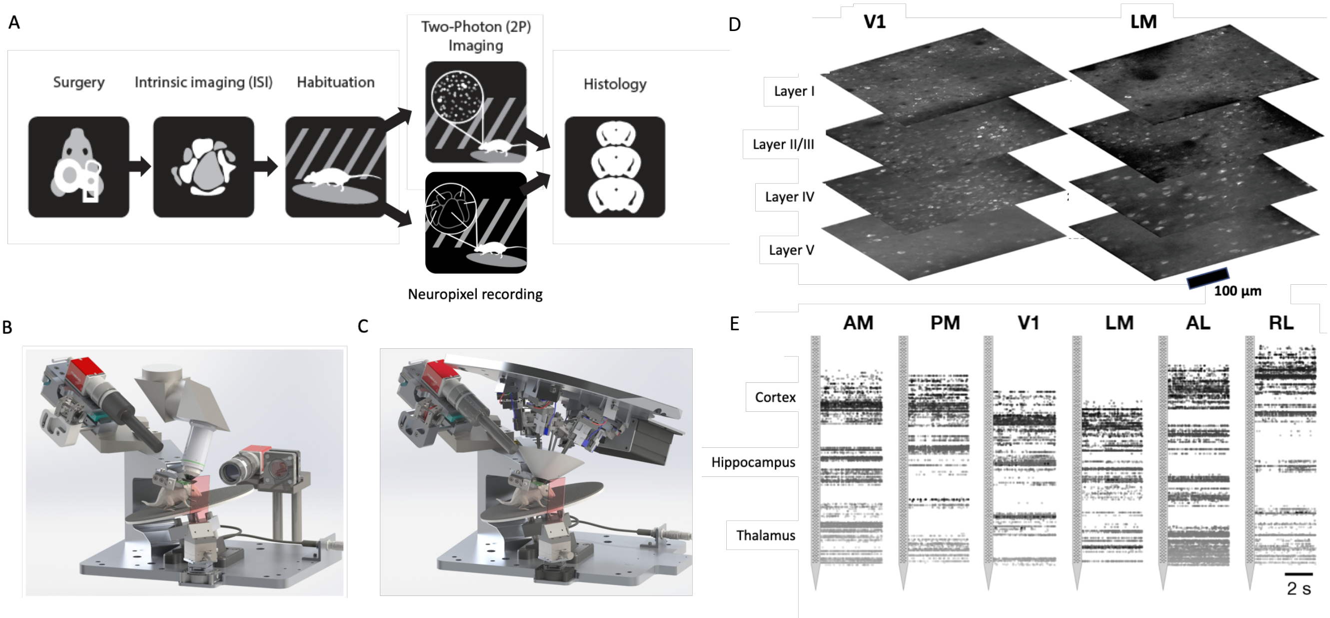
About OpenScope

OpenScope

OpenScope opens the Allen Brain Observatory pipeline to the community—enabling theoretical, computational, and experimental scientists to test sophisticated hypotheses on brain function in a program analogous to astronomical observatories that survey the night sky.

Once a year, OpenScope invites external scientists to propose experiments to be run on the Allen Institute pipeline. These proposals are competitively reviewed for scientific merit and feasibility by a panel of leading experts from the international community. If selected, the proposed experiments are performed with the Allen Institute's verified, reproducible, and open protocols for *in vivo* Neuropixels electrophysiology or two-photon calcium imaging. Any resulting data is made freely available to the selected applicants and to the broader community. The goal is to lower barriers to testing new hypotheses about brain function, bring new computational and theoretical talents to the field, and enhance the reproducibility of results in brain research—thereby accelerating progress toward an integrated understanding of neural activity in health and disease.

The OpenScope Program is supported by the National Institute Of Neurological Disorders And Stroke of the National Institutes of Health under Award Number U24NS113646. (This content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health)



Two End-to-End data pipelines

The OpenScope platform tests novel hypotheses on brain function using an established data collection pipeline. The platform utilizes cutting-edge behavioral training, Neuropixels recordings, and two-photon calcium imaging. The resulting data is curated, standardized, and disseminated with open standards and is eventually released to the public after a one-year embargo.

The OpenScope program provides the community access to:

- End-to-end standardized experimental platform including brain surgery, animal training, neuronal recordings (*in vivo* Neuropixels electrophysiology or two-photon calcium imaging), and brain reconstruction.
- Animal behavior training to test novel hypotheses of brain function.
- Data standardization and sharing via NWB files in the cloud.
- Datasets that are cross-referenced through shared standards and data access, allowing further meta-analysis by the community.
- Dissemination of results as selected teams analyze and submit their outcomes to bioRxiv and peer-reviewed journals.

Selection process

A double-blinded selection process

We established a two-stage selection process under the guidance of the OpenScope Scientific Steering Group. Applicants first submit a 2-page Letter Of Intent (LOI) that is screened for feasibility by internal Allen Institute reviewers. The top-scored (up to 18) feasible LOIs are then invited to submit 6-page full proposals, which are again scored by blinded internal and external scientific reviewers.

The top projects are discussed by the Scientific Steering Group, where the committee considers overarching programmatic goals and portfolio balance to make the final selection. The external reviewers include neuroscientists from across the community, and the entire process is blinded.

In July 2023, we posted our Request for Proposals (RFP) detailing the types of projects allowed, the application format, and upcoming due dates. For this application cycle, we received 23 LOIs in early September 2023. The entire selection process (submission, reviews, and private communications) was managed online via a secured platform (https://www.submittable.com).

18 teams were invited to submit full proposals. On Nov 21st, we received 14 full proposals that were distributed across 6 external reviewers who kindly volunteered to help this community effort. All reviewers signed Confidentiality Agreements and were blinded to the applicants' identity. The top-scored 8 proposals were sent forward to the OpenScope Scientific Steering Group along with the reviewer ranking and notes. The selected 4 projects for 2024 were approved and selected on January 31st by the Scientific Steering Committee.

Projects Recommended for Award in 2023-2024

Neuropixels project 1:

"Psychedelic Coding"

The Charité and University of Berlin

Roberto De Filippo, Dietmar Schmitz, Torben Ott

Neuropixels project 2:

" Elucidating the role of prior experience in shaping the representations of natural stimuli"

Weizmann Institute of Science

Yaniv Ziv, Alon Rubin, Itay Talpir, Daniel Deitch

Two-photon project 1:

"From Pixels to Percepts: Understanding Texture Discrimination in the Mouse Visual Cortex"

University of Calgary, University of British Columbia

Javier Orlandi, Federico Bolanos, Tim Murphy

Two-photon project 2:

"Probing center-surround interactions through local and global visual motion"

University of Freiburg, Berlin

Julia Veit, Henning Sprekeler

Non-selected teams' identities and projects remain blinded and confidential. Applications included individuals from North America (20), Europe (20), Middle East (3), Asia (2), and Australia (2) and included applicants from both the theoretical and experimental neuroscience community.

Scientific outcomes

Scientific highlights from 2022 project

“Global Local Oddballs (GLO)”

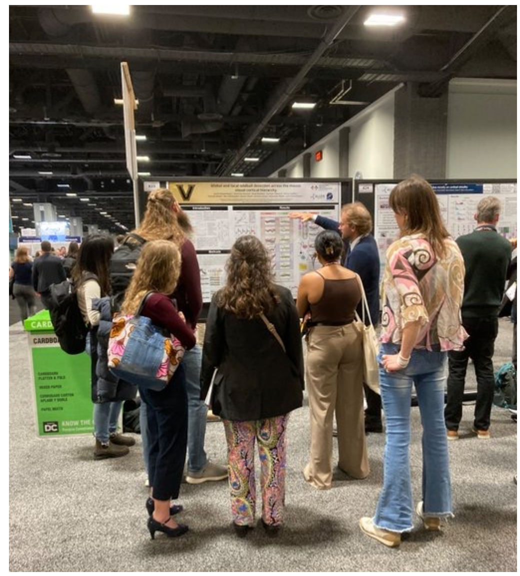
Neural Circuitry Underlying Detection of Local and Global Prediction Errors

Vanderbilt University: Alex Maier, Andre Bastos, Jacob Westerberg

Poster at SFN

PSTR025 - Visual Cortex: The Function of Neuronal Ensembles and Circuits

PSTR025.15 / X25 - Global and local oddball detection across the mouse visual cortical hierarchy



“Illusion”

Utilizing Illusory Contours to Elucidate the Neural Mechanism of Binding

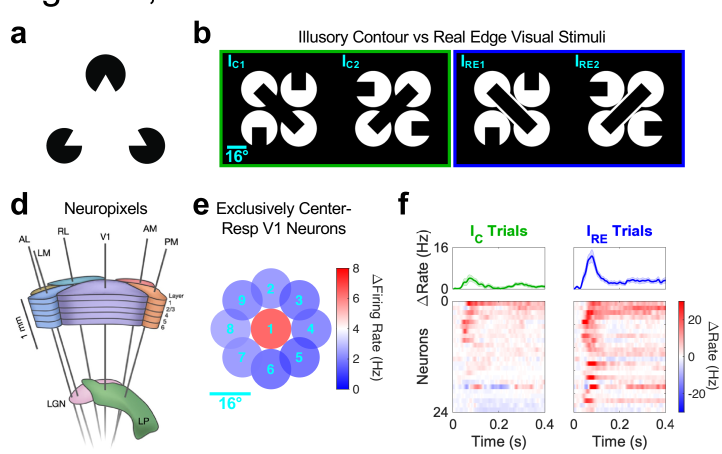
UC Berkeley: Hyeyoung Shin, Hillel Adesnik

Publication

Recurrent pattern completion drives the neocortical representation of sensory inference

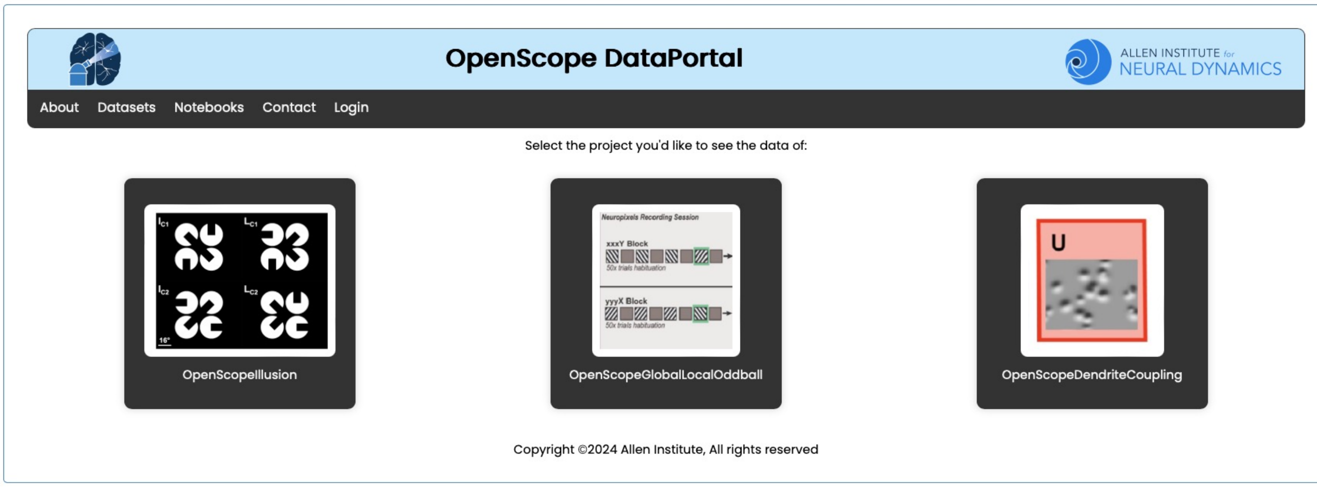
bioRxiv, currently in review

https://doi.org/10.1101/2023.06.05.543698



Publications and peer-reviewed posters linked to OpenScope projects

- **Next-generation brain observatories**. Koch, Christof; Svoboda, Karel; Bernard, Amy; Basso, Michele A; Churchland, Anne K; Fairhall, Adrienne L; Groblewski, Peter A; Lecoq, Jérôme A; Mainen, Zachary F; Mathis, Mackenzie W, Neuron, 110, 22, 3661-3666, 2022
- **L2/3 and L5 pyramidal neuron somata and apical dendrites exhibit distinct responses to unexpected violations of visual flow**. Gillon et al., COSYNE 2020
- **Learning from unexpected events in the neocortical microcircuit**, Pina, Gillon et al., COSYNE 2021
- **Differential encoding of temporal context and expectation across the visual hierarchy**, Wyrick et al., COSYNE 2022
- **Parallel inference of hierarchical latent dynamics in two-photon calcium imaging of neuronal populations**, Prince et al., bioRxiv 2021
- **Measuring Stimulus-Evoked Neurophysiological Differentiation in Distinct Populations of Neurons in Mouse Visual Cortex**, Mayner et al., eNeuro. 2021
- **Differential encoding of temporal context and expectation under representational drift across hierarchically connected areas**, Wyrick et al., bioRxiv. 2023
- **Responses to pattern-violating visual stimuli evolve differently over days in somata and distal apical dendrites,** CJ Gillon, JE Pina et al, Journal of Neuroscience 2024
- **Recurrent pattern completion drives the neocortical representation of sensory inference**, H Shin, et al, bioRxiv. 2023



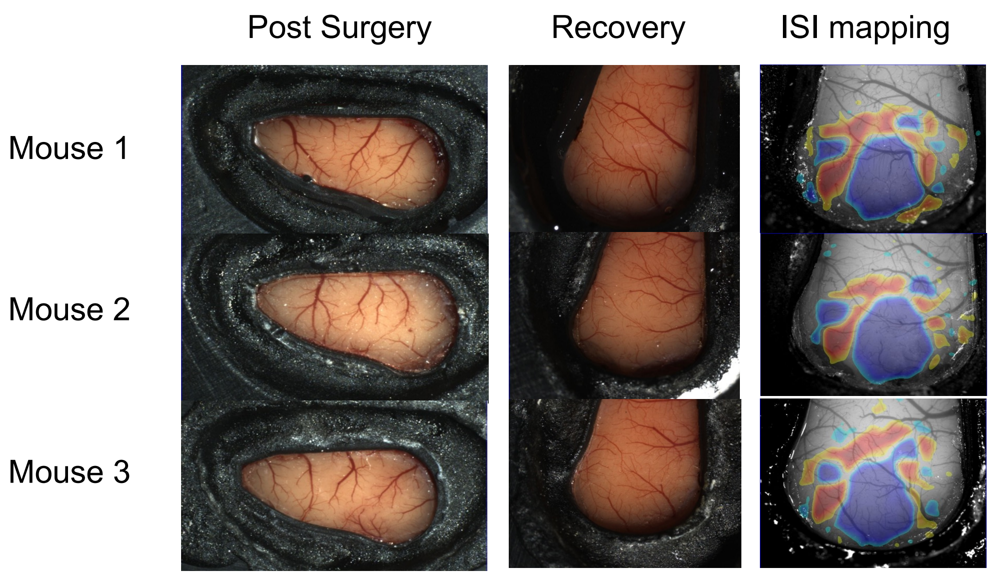
Data releases

In January and February 2024, following our one-year embargoed policy we released 3 datasets on Dandi Archive.

- **Dataset 248**: Allen Institute OpenScope - Illusion project
- **Dataset 253:** Allen Institute OpenScope - Global/Local Oddball project
- **Dataset 871:** Allen Institute OpenScope - Predictive Learning and Somato-dendritic Coupling

In addition to the detailed description on Dandi Archive, we created the OpenScope DataPortal (https://openscopedatafront.web.app/) to share detailed meta-data for all recorded sessions, along with additional project descriptions and comprehensive Jupyter notebooks. Those resources were created in collaboration with the 2022 OpenScope teams and extensively described during our Data Release Webinar (see **Outreach** section).

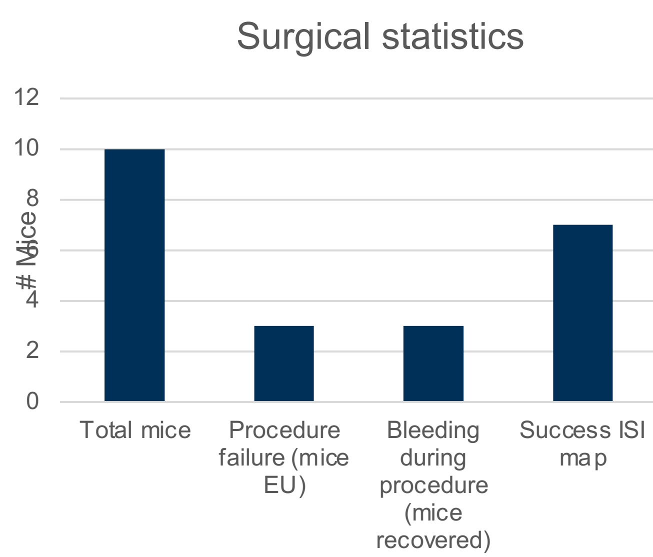
Ongoing developments



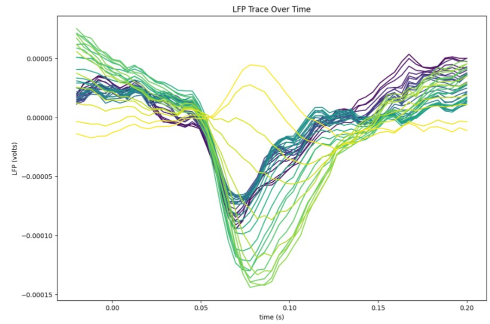
Ophys Surgical developments

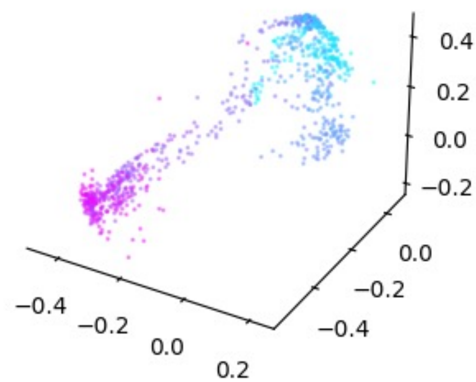
In 2022, we had performed surgical and hardware developments on the two-photon platform to deploy a custom-shape glass implant that would allow to record broadly across the dorsal cortex in the same mouse. This work has proved that we could implant and record with two photon imaging with our chosen implant strategy.

In 2023, we standardized our implant. To that end, we designed a custom 3d printed plastic lip to go all around the border of the implant. This lip allowed to securely hold the glass on top of the mouse skull. This allowed us to scale this procedure up and train our surgeon using standardized operating procedures.



We quantified the success of this procedure (see figure with surgical statistics). Notably we found that the added lip allowed for a reproducible procedure (see top figure). As a result, we offered this new capability for proposals in 2023 RFP.





OpenScope DataBook

In 2022, we built the capability to convert and push NWB files to the Dandi archive, as stored on this public repository (https://github.com/AllenInstitute/OpenScopeNWB). This development proved to be instrumental in 2023 as we used this capability to push datasets to DANDI archive almost immediately following data collection.

In 2023, having developed the ability to upload datasets to the cloud, we focused our attention on enabling reproducible analysis from DANDI cloud-storage. In collaboration with the DANDI team, we developed a Jupyter DataBook called "OpenScope DataBook" (https://github.com/AllenInstitute/openscope_databook) connected both to DandiHub cloud deployment (https://hub.dandiarchive.org/hub/) and linked to https://mybinder.org. This DataBook contains Jupyter notebooks describing how to access datasets on DANDI, both locally and in streaming mode. Throughout 2023, we greatly increased the coding resources available through the openscope databook. We added notebooks to explain how to access electrophysiology files, Optical physiology files, behavior data as well as perform a range of essential analysis. For example, the databook now contains example code to select responsive neurons, code to leverage CEBRA (https://cebra.ai) or TCA (https://github.com/neurostatslab/tensortools) to create embedding based on the neuronal activity. Importantly, we developed those notebooks in collaboration with each package developer.

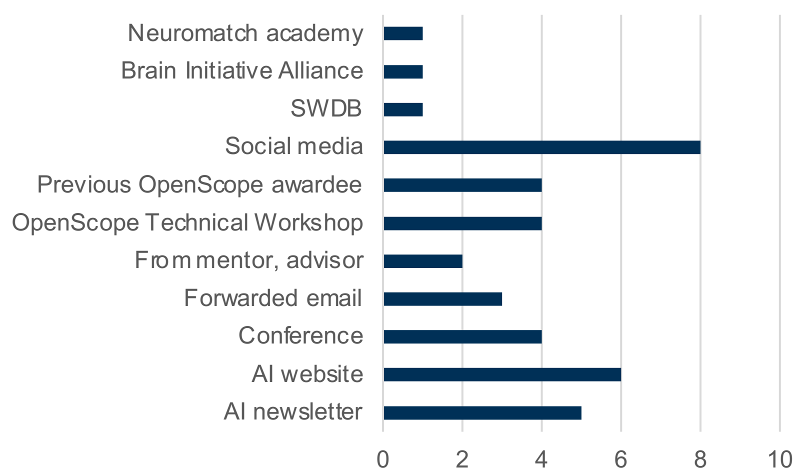
In 2024, we released the first 1.0 release of the OpenScope Databook at the Data Release webinar (see Scientific Workshop) with a comprehensive walkthrough to the Databook.

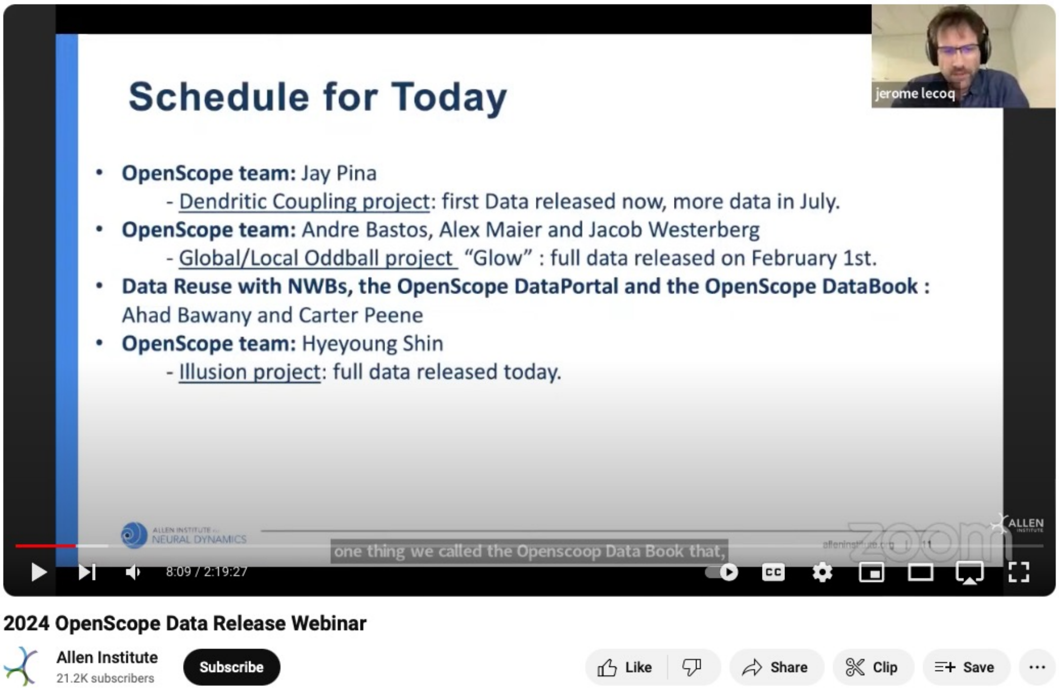
Outreach

OpenScope brand

In 2023, to improve awareness of the OpenScope program and its unique identity in the neuroscience ecosystem, we **created an entirely new custom Logo.** This logo was leveraged at SFN 2023, on all social media posts and presentations. We purchased the domain http://openscope.ai and redirected it to our web portal. We also performed surveys to better understand how to spread our initiative (see Figure for applicants).

Where applicants heard of OpenScope





Scientific workshop

We organized an online webinar on January 24th 2024 to showcase the datasets created by the OpenScope program, At this 2 hours long webinar, attendees could listen to three previous OpenScope awardees about their experimental design and the collected data sets that were released to the community. Attendees also learned about the OpenScope Databook, which supports data re-use within and between DANDI projects.

Program:

- 1:00pm PT: Intro to OpenScope program: Jerome Lecoq
- 1:15pm PT: Past OpenScope Awardee: Jay Pina
- 1:45pm PT: Past OpenScope Awardee: Andre Bastos & Jacob Westerberg
- 2:15pm PT: Past Overview of the OpenScope Databook (Carter Peene and Ahad Bawany)
- 3:00pm PT: OpenScope Awardee: Hyeyoung Shin

The webinar had 66 registered attendees from diverse institutions and career levels, and 357 views on YouTube.

It can still be watched at this address: https://www.youtube.com/watch?v=tXj-fPi4Sgs




Technical workshop

We held our third 3-day technical workshop on June 21-23, 2023. As previously, this workshop was co-organized with the Allen Institute for Neural Dynamics, the Allen Institute Neural Dynamic Program, and the University of Washington.

In this workshop, participants from around the world had the opportunity to tour our *in vivo* electrophysiology and imaging facilities and learn the details of these methods from Allen Institute and UW scientists and staff. Lectures and demonstrations covered all aspects of generating high-quality physiology datasets, from surgery to behavior training to neural recordings. Participants also learned how to access data from the Allen Brain Observatory and about the OpenScope program. The workshop was advertised on social medias and a dedicated web portal.

The workshop was geared towards graduate students, postdocs, staff scientists, and PIs with some experience with *in vivo* recordings. We received 104 applications and selected 40 final participants. The selection process prioritized wide distribution of attendees, aiming to avoid selecting applicants from the same institutions. In the end, attendees came from 40 different institutions. The workshop ended with a group discussion where attendees could give their feedback on the workshop and on the OpenScope program.

Submit a project to OpenScope

HOW TO APPLY? ⟶

Request for Proposals in 2023-2024

We plan to release our yearly RFP in the early summer of 2024. It will be communicated on our web portal http://openscope.ai as well as through the Allen Institute social media accounts.

In 2023, we considerably extended the description of the call on our web portal and added a detailed FAQ

This call will be the last supported call under current U24 support.

OpenScope
Scientific Steering Committee

External
Steering Committee Members

Natalie Trzcinski
Program Director at
National Institute of
Neurological Disorders
and Stroke (NINDS)

Satrajit S Ghosh
Principal Research Scientist
MIT

Assistant Professor
Harvard Medical School

Mackenzie Mathis
Assistant Professor
EPFL
Bertarelli Foundation
Chair of Integrative
Neuroscience
European Laboratory for
Learning and Intelligent
Systems (ELLIS) Scholar

Konrad Paul Kording
Nathan Francis Mossell
University Professor
University of Pennsylvania

Nicholas A. Steinmetz
Assistant Professor
Department of Biological
Structure
University of Washington

Joel Zylberberg
Assistant Professor and
Canada Research Chair
York University

Adrienne Fairhall
Professor
Department of Physiology and Biophysics

Adjunct Professor
Department of Physics

Adjunct Professor
Department of Applied Mathematics

Co-Director
UW Computational Neuroscience Center
University of Washington

Allen Institute
OpenScope Leadership

Christof Koch
Meritorious Investigator
Brain & Consciousness
The Allen Institute

Co-PI on OpenScope Award

Jerome Lecoq
Associate Investigator
Neural Dynamics Program
The Allen Institute

Co-PI on OpenScope award

John Phillips
Executive Director
Strategy & Partnership
The Allen Institute

THANK YOU

We wish to thank the Allen Institute founder, Paul G. Allen, for his vision, encouragement, and support.

brain-map.org
alleninstitute.org

ALLEN INSTITUTE *for* NEURAL DYNAMICS

Research reported in this publication was supported by the National Institute Of Neurological Disorders And Stroke of the National Institutes of Health under Award Number U24NS113646. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health