

Stanford



Krishna Shenoy

Hong Seh and Vivian W. M. Lim Professor in the School of Engineering and Professor, by courtesy, of Neurobiology and of Bioengineering
Electrical Engineering

CONTACT INFORMATION

- **Faculty Administrator**

Beverly Davis - Faculty Administrator

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Bio

BIO

Our group (Neural Prosthetic Systems Laboratory, NPSL; directed by Prof. Shenoy) conducts neuroscience, neuroengineering, and translational research to better understand how the brain controls movement, and to design medical systems to assist people with movement disabilities. Our neuroscience research investigates the neural basis of movement preparation and generation using a combination of electro-/opto-physiological, behavioral, computational and theoretical techniques. Our neuroengineering research investigates the design of high-performance and robust neural prostheses. Neural prostheses are also known as brain-computer interfaces (BCIs) and brain-machine interfaces (BMIs). These systems translate neural activity from the brain into control signals for prosthetic devices, which can assist people with paralysis by restoring lost motor functions. Our translational research, including an FDA pilot clinical trial termed BrainGate2, are conducted as part of the our Neural Prosthetic Translational Laboratory (NPTL; co-directed by Profs. Shenoy & Henderson).

ACADEMIC APPOINTMENTS

- Professor, Electrical Engineering
- Professor (By courtesy), Neurobiology
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Career Award in the Biomedical Sciences, Burroughs Wellcome Fund (1999)
- Research Fellow, Alfred P. Sloan Foundation (2002)
- Technological Innovations in Neurosciences Award, McKnight Foundation (2007)
- NIH Director's Pioneer Award, National Institutes of Health (2009)
- Postdoc Mentoring Award, Stanford University (2010)
- Distinguished Alumnus Award, The Henry Samueli School of Engineering, University of California at Irvine (2013)

PROGRAM AFFILIATIONS

- Symbolic Systems Program

PROFESSIONAL EDUCATION

- Investigator, Howard Hughes Medical Institute (HHMI) (2015)
- Professor, Stanford University , Hong Seh and Vivian W. M. Professor of Engineering, 2017-present. Professor, 2012-2017. Associate Professor, 2008-2012. Assistant Professor, 2001-2008. Department of Electrical Engineering, Neurobiology (courtesy) and Bioengineering (affiliate) (2001)
- Postdoc, Caltech , Neurobiology, Senior Postdoc, 1998-2001; Neurobiology, Postdoc, 1995-1998 (1998)
- Ph.D., MIT , Electrical Engineering (1995)
- S.M., MIT , Electrical Engineering (1992)
- B.S., University of California, Irvine , Electrical Engineering (1990)

LINKS

- Professor Shenoy's Home Page: <http://www.stanford.edu/~shenoy/>

Research & Scholarship

CLINICAL TRIALS

- BrainGate2: Feasibility Study of an Intracortical Neural Interface System for Persons With Tetraplegia, Recruiting

Teaching

COURSES

2018-19

- Introduction to Neuroelectrical Engineering: EE 124 (Win)

2017-18

- Introduction to Neuroelectrical Engineering: EE 124 (Win)

2016-17

- Introduction to Neuroelectrical Engineering: EE 124 (Win)

2015-16

- Introduction to Neuroelectrical Engineering: EE 124 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Will Allen, Iliana Bray

Postdoctoral Faculty Sponsor

Laura Driscoll, Matthew Golub, Daniel O'Shea

Doctoral Dissertation Advisor (AC)

Saurabh Vyas

Master's Program Advisor

Naryan Murthy

Doctoral (Program)

Timothy Anderson, Evan Wang

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Bioengineering (Phd Program)
- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Simultaneous motor preparation and execution in a last-moment reach correction task.** *Nature communications*
Ames, K. C., Ryu, S. I., Shenoy, K. V.
2019; 10 (1): 2718
- **Macaque dorsal premotor cortex exhibits decision-related activity only when specific stimulus-response associations are known** *NATURE COMMUNICATIONS*
Wang, M., Montanede, C., Chandrasekaran, C., Peixoto, D., Shenoy, K. V., Kalaska, J. F.
2019; 10
- **Macaque dorsal premotor cortex exhibits decision-related activity only when specific stimulus-response associations are known.** *Nature communications*
Wang, M., Montanede, C., Chandrasekaran, C., Peixoto, D., Shenoy, K. V., Kalaska, J. F.
2019; 10 (1): 1793
- **Volitional control of single-electrode high gamma local field potentials by people with paralysis** *JOURNAL OF NEUROPHYSIOLOGY*
Milekovic, T., Bacher, D., Sarma, A. A., Simeral, J. D., Saab, J., Pandarinath, C., Yvert, B., Sorice, B. L., Blabe, C., Oakley, E. M., Tringale, K. R., Eskandar, E., Cash, et al
2019; 121 (4): 1428–50
- **Brain-machine interface cursor position only weakly affects monkey and human motor cortical activity in the absence of arm movements (vol 8, 16357, 2018)** *SCIENTIFIC REPORTS*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Pandarinath, C., Blabe, C., Ryu, S. I., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2019; 9
- **Publisher Correction: Brain-machine interface cursor position only weakly affects monkey and human motor cortical activity in the absence of arm movements.** *Scientific reports*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Pandarinath, C., Blabe, C., Ryu, S. I., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2019; 9 (1): 5528
- **Structure and variability of delay activity in premotor cortex.** *PLoS computational biology*
Even-Chen, N., Sheffer, B., Vyas, S., Ryu, S. I., Shenoy, K. V.
2019; 15 (2): e1006808
- **Volitional control of single-electrode high gamma local field potentials (LFPs) by people with paralysis.** *Journal of neurophysiology*
Milekovic, T., Bacher, D., Sarma, A. A., Simeral, J. D., Saab, J., Pandarinath, C., Yvert, B., Sorice, B. L., Blabe, C., Oakley, E. M., Tringale, K. R., Eskandar, E., Cash, et al
2019
- **Frequency shifts and depth dependence of premotor beta band activity during perceptual decision-making.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Chandrasekaran, C., Bray, I. E., Shenoy, K. V.
2019
- **Accurate Estimation of Neural Population Dynamics without Spike Sorting.** *Neuron*
Trautmann, E. M., Stavisky, S. D., Lahiri, S., Ames, K. C., Kaufman, M. T., O'Shea, D. J., Vyas, S., Sun, X., Ryu, S. I., Ganguli, S., Shenoy, K. V.
2019
- **Principled BCI Decoder Design and Parameter Selection Using a Feedback Control Model.** *Scientific reports*
Willett, F. R., Young, D. R., Murphy, B. A., Memberg, W. D., Blabe, C. H., Pandarinath, C., Stavisky, S. D., Rezaii, P., Saab, J., Walter, B. L., Sweet, J. A., Miller, J. P., Henderson, et al
2019; 9 (1): 8881

- **Closed-loop cortical control of virtual reach and posture using cartesian and joint velocity commands.** *Journal of neural engineering*
Young, D., Willett, F., Memberg, W. D., Murphy, B. A., Rezaii, P., Walter, B., Sweet, J. A., Miller, J., Shenoy, K. V., Hochberg, L., Kirsch, R. F., Ajiboye, A. B.
2018
- **Brain-machine interface cursor position only weakly affects monkey and human motor cortical activity in the absence of arm movements.** *Scientific reports*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Pandarinath, C., Blabe, C., Ryu, S. I., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2018; 8 (1): 16357
- **Inferring single-trial neural population dynamics using sequential auto-encoders** *NATURE METHODS*
Pandarinath, C., O'Shea, D. J., Collins, J., Jozefowicz, R., Stavisky, S. D., Kao, J. C., Trautmann, E. M., Kaufman, M. T., Ryu, S. I., Hochberg, L. R., Henderson, J. M., Shenoy, K. V., Abbott, et al
2018; 15 (10): 805+
- **A Comparison of Intention Estimation Methods for Decoder Calibration in Intracortical Brain-Computer Interfaces** *IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING*
Willett, F. R., Murphy, B. A., Young, D., Memberg, W. D., Blabe, C. H., Pandarinath, C., Franco, B., Saab, J., Walter, B. L., Sweet, J. A., Miller, J. P., Henderson, J. M., Shenoy, et al
2018; 65 (9): 2066–78
- **Single Neuron Firing Rate Statistics in Motor Cortex During Execution and Observation of Movement.** *Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual Conference*
Jiang, X., Ryu, S. I., Shenoy, K. V., Kao, J. C.
2018; 2018: 981–86
- **Development of an optogenetic toolkit for neural circuit dissection in squirrel monkeys** *SCIENTIFIC REPORTS*
O'Shea, D. J., Kalanithi, P., Ferenczi, E. A., Hsueh, B., Chandrasekaran, C., Goo, W., Diester, I., Ramakrishnan, C., Kaufman, M. T., Ryu, S. I., Yeom, K. W., Deisseroth, K., Shenoy, et al
2018; 8: 6775
- **ERAASR: an algorithm for removing electrical stimulation artifacts from multielectrode array recordings** *JOURNAL OF NEURAL ENGINEERING*
O'Shea, D. J., Shenoy, K. V.
2018; 15 (2): 026020
- **Neural Population Dynamics Underlying Motor Learning Transfer** *NEURON*
Vyas, S., Even-Chen, N., Stavisky, S. D., Ryu, S. I., Nuyujukian, P., Shenoy, K. V.
2018; 97 (5): 1177+
- **Feasibility of Automatic Error Detect-and-Undo System in Human Intracortical Brain-Computer Interfaces.** *IEEE transactions on bio-medical engineering*
Even-Chen, N., Stavisky, S. D., Pandarinath, C., Nuyujukian, P., Blabe, C. H., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2018; 65 (8): 1771–84
- **Cortical control of a tablet computer by people with paralysis.** *PloS one*
Nuyujukian, P., Albites Sanabria, J., Saab, J., Pandarinath, C., Jarosiewicz, B., Blabe, C. H., Franco, B., Mernoff, S. T., Eskandar, E. N., Simeral, J. D., Hochberg, L. R., Shenoy, K. V., Henderson, et al
2018; 13 (11): e0204566
- **Stable long-term BCI-enabled communication in ALS and locked-in syndrome using LFP signals.** *Journal of neurophysiology*
Milekovic, T., Sarma, A. A., Bacher, D., Simeral, J. D., Saab, J., Pandarinath, C., Soric, B. L., Blabe, C., Oakley, E. M., Tringale, K. R., Eskandar, E., Cash, S. S., Henderson, et al
2018
- **Rapid calibration of an intracortical brain-computer interface for people with tetraplegia.** *Journal of neural engineering*
Brandman, D. M., Hosman, T., Saab, J., Burkhart, M. C., Shanahan, B. E., Ciancibello, J. G., Sarma, A. A., Milstein, D. J., Vargas-Irwin, C. E., Franco, B., Kelemen, J., Blabe, C., Murphy, et al
2018; 15 (2): 026007
- **Unsupervised Discovery of Demixed, Low-Dimensional Neural Dynamics across Multiple Timescales through Tensor Component Analysis.** *Neuron*
Williams, A. H., Kim, T. H., Wang, F., Vyas, S., Ryu, S. I., Shenoy, K. V., Schnitzer, M., Kolda, T. G., Ganguli, S.
2018
- **Laminar differences in decision-related neural activity in dorsal premotor cortex** *NATURE COMMUNICATIONS*

-
- Chandrasekaran, C., Peixoto, D., Newsome, W. T., Shenoy, K. V.
2017; 8: 614
- **A High-Performance Neural Prosthesis Incorporating Discrete State Selection With Hidden Markov Models** *IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING*
Kao, J. C., Nuyujukian, P., Ryu, S. I., Shenoy, K. V.
2017; 64 (4): 935-945
 - **High performance communication by people with paralysis using an intracortical brain-computer interface.** *eLife*
Pandarinath, C., Nuyujukian, P., Blabe, C. H., Sorice, B. L., Saab, J., Willett, F. R., Hochberg, L. R., Shenoy, K. V., Henderson, J. M.
2017; 6
 - **Trial-by-Trial Motor Cortical Correlates of a Rapidly Adapting Visuomotor Internal Model.** *journal of neuroscience*
Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 37 (7): 1721-1732
 - **Feedback control policies employed by people using intracortical brain-computer interfaces** *JOURNAL OF NEURAL ENGINEERING*
Willett, F. R., Pandarinath, C., Jarosiewicz, B., Murphy, B. A., Memberg, W. D., Blabe, C. H., Saab, J., Walter, B. L., Sweet, J. A., Miller, J. P., Henderson, J. M., Shenoy, K. V., Simeral, et al
2017; 14 (1)
 - **Corrigendum: Making brain-machine interfaces robust to future neural variability.** *Nature communications*
Sussillo, D., Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 8: 14490-?
 - **A Nonhuman Primate Brain-Computer Typing Interface** *PROCEEDINGS OF THE IEEE*
Nuyujukian, P., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 105 (1): 66-72
 - **Leveraging neural dynamics to extend functional lifetime of brain-machine interfaces.** *Scientific reports*
Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 7 (1): 7395
 - **Motor Cortical Visuomotor Feedback Activity Is Initially Isolated from Downstream Targets in Output-Null Neural State Space Dimensions.** *Neuron*
Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 95 (1): 195–208.e9
 - **Feasibility Analysis of Genetically-Encoded Calcium Indicators as a Neural Signal Source for All-Optical Brain-Machine Interfaces**
Sun, X., Kao, J. C., Marshel, J. H., Ryu, S. I., Shenoy, K. V., IEEE
IEEE.2017: 174–80
 - **Augmenting intracortical brain-machine interface with neurally driven error detectors.** *Journal of neural engineering*
Even-Chen, N., Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2017; 14 (6): 066007
 - **Signal-independent noise in intracortical brain-computer interfaces causes movement time properties inconsistent with Fitts' law.** *Journal of neural engineering*
Willett, F. R., Murphy, B. A., Memberg, W. D., Blabe, C. H., Pandarinath, C., Walter, B. L., Sweet, J. A., Miller, J. P., Henderson, J. M., Shenoy, K. V., Hochberg, L. R., Kirsch, R. F., Ajiboye, et al
2017; 14 (2): 026010
 - **The need for calcium imaging in nonhuman primates: New motor neuroscience and brain-machine interfaces** *EXPERIMENTAL NEUROLOGY*
O'Shea, D. J., Tiautmann, E., Chandrasekaran, C., Stavisky, S., Kao, J. C., Sahani, M., Ryu, S., Deisseroth, K., Shenoy, K. V.
2017; 287: 437-451
 - **Making brain-machine interfaces robust to future neural variability** *NATURE COMMUNICATIONS*
Sussillo, D., Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2016; 7
 - **Tensor Analysis Reveals Distinct Population Structure that Parallels the Different Computational Roles of Areas M1 and V1.** *PLoS computational biology*
Seely, J. S., Kaufman, M. T., Ryu, S. I., Shenoy, K. V., Cunningham, J. P., Churchland, M. M.
-

2016; 12 (11)

- **The need for calcium imaging in nonhuman primates: New motor neuroscience and brain-machine interfaces.** *Experimental neurology*
O'Shea, D. J., Trautmann, E., Chandrasekaran, C., Stavisky, S., Kao, J. C., Sahani, M., Ryu, S., Deisseroth, K., Shenoy, K. V.
2016
- **The Largest Response Component in the Motor Cortex Reflects Movement Timing but Not Movement Type.** *eNeuro*
Kaufman, M. T., Seely, J. S., Sussillo, D., Ryu, S. I., Shenoy, K. V., Churchland, M. M.
2016; 3 (4)
- **A high-performance neural prosthesis incorporating discrete state selection with hidden Markov models.** *IEEE transactions on bio-medical engineering*
Kao, J. C., Nuyujukian, P., Ryu, S. I., Shenoy, K. V.
2016: -?
- **The Importance of Planning in Motor Learning.** *Neuron*
O'Shea, D. J., Shenoy, K. V.
2016; 92 (4): 669–71
- **Virtual typing by people with tetraplegia using a self-calibrating intracortical brain-computer interface.** *Science translational medicine*
Jarosiewicz, B., Sarma, A. A., Bacher, D., Masse, N. Y., Simeral, J. D., Sorice, B., Oakley, E. M., Blabe, C., Pandarinath, C., Gilja, V., Cash, S. S., Eskandar, E. N., Friehs, et al
2015; 7 (313): 313ra179-?
- **Virtual typing by people with tetraplegia using a self-calibrating intracortical brain-computer interface.** *Science translational medicine*
Jarosiewicz, B., Sarma, A. A., Bacher, D., Masse, N. Y., Simeral, J. D., Sorice, B., Oakley, E. M., Blabe, C., Pandarinath, C., Gilja, V., Cash, S. S., Eskandar, E. N., Friehs, et al
2015; 7 (313): 313ra179-?
- **Clinical translation of a high-performance neural prosthesis.** *Nature medicine*
Gilja, V., Pandarinath, C., Blabe, C. H., Nuyujukian, P., Simeral, J. D., Sarma, A. A., Sorice, B. L., Perge, J. A., Jarosiewicz, B., Hochberg, L. R., Shenoy, K. V., Henderson, J. M.
2015; 21 (10): 1142-1145
- **Clinical translation of a high-performance neural prosthesis** *NATURE MEDICINE*
Gilja, V., Pandarinath, C., Blabe, C. H., Nuyujukian, P., Simeral, J. D., Sarma, A. A., Sorice, B. L., Perge, J. A., Jarosiewicz, B., Hochberg, L. R., Shenoy, K. V., Henderson, J. M.
2015; 21 (10): 1142-?
- **Optogenetics: 10 years after ChR2 in neurons-views from the community** *NATURE NEUROSCIENCE*
Adamantidis, A., Arber, S., Bains, J. S., Bamberg, E., Bonci, A., Buzsaki, G., Cardin, J. A., Costa, R. M., Dan, Y., Goda, Y., Graybiel, A. M., Haeusser, M., Hegemann, et al
2015; 18 (9): 1202–12
- **Assessment of brain-machine interfaces from the perspective of people with paralysis.** *Journal of neural engineering*
Blabe, C. H., Gilja, V., Chestek, C. A., Shenoy, K. V., Anderson, K. D., Henderson, J. M.
2015; 12 (4): 043002-?
- **Auto-deleting brain machine interface: Error detection using spiking neural activity in the motor cortex.** *Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual Conference*
Even-Chen, N., Stavisky, S. D., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2015; 2015: 71-75
- **Assessment of brain-machine interfaces from the perspective of people with paralysis** *JOURNAL OF NEURAL ENGINEERING*
Blabe, C. H., Gilja, V., Chestek, C. A., Shenoy, K. V., Anderson, K. D., Henderson, J. M.
2015; 12 (4)
- **A neural network that finds a naturalistic solution for the production of muscle activity** *NATURE NEUROSCIENCE*
Sussillo, D., Churchland, M. M., Kaufman, M. T., Shenoy, K. V.
2015; 18 (7): 1025-?
- **Single-trial dynamics of motor cortex and their applications to brain-machine interfaces** *NATURE COMMUNICATIONS*

-
- Kao, J. C., Nuyujukian, P., Ryu, S. I., Churchland, M. M., Cunningham, J. P., Shenoy, K. V.
2015; 6
- **Neural population dynamics in human motor cortex during movements in people with ALS** *ELIFE*
Pandarinath, C., Gilja, V., Blabe, C. H., Nuyujukian, P., Sarma, A. A., Soricice, B. L., Eskandar, E. N., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2015; 4
 - **A high performing brain-machine interface driven by low-frequency local field potentials alone and together with spikes.** *Journal of neural engineering*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Ryu, S. I., Shenoy, K. V.
2015; 12 (3): 036009-?
 - **A high performing brain-machine interface driven by low-frequency local field potentials alone and together with spikes** *JOURNAL OF NEURAL ENGINEERING*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Ryu, S. I., Shenoy, K. V.
2015; 12 (3)
 - **Comparison of spike sorting and thresholding of voltage waveforms for intracortical brain-machine interface performance.** *Journal of neural engineering*
Christie, B. P., Tat, D. M., Irwin, Z. T., Gilja, V., Nuyujukian, P., Foster, J. D., Ryu, S. I., Shenoy, K. V., Thompson, D. E., Chestek, C. A.
2015; 12 (1): 016009-?
 - **Comparison of spike sorting and thresholding of voltage waveforms for intracortical brain-machine interface performance.** *Journal of neural engineering*
Christie, B. P., Tat, D. M., Irwin, Z. T., Gilja, V., Nuyujukian, P., Foster, J. D., Ryu, S. I., Shenoy, K. V., Thompson, D. E., Chestek, C. A.
2015; 12 (1): 016009-?
 - **A High-Performance Keyboard Neural Prosthesis Enabled by Task Optimization** *IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING*
Nuyujukian, P., Fan, J. M., Kao, J. C., Ryu, S. I., Shenoy, K. V.
2015; 62 (1): 21-29
 - **Vacillation, indecision and hesitation in moment-by-moment decoding of monkey motor cortex.** *eLife*
Kaufman, M. T., Churchland, M. M., Ryu, S. I., Shenoy, K. V.
2015; 4
 - **Neural population dynamics in human motor cortex during movements in people with ALS.** *eLife*
Pandarinath, C., Gilja, V., Blabe, C. H., Nuyujukian, P., Sarma, A. A., Soricice, B. L., Eskandar, E. N., Hochberg, L. R., Henderson, J. M., Shenoy, K. V.
2015; 4
 - **Single-trial dynamics of motor cortex and their applications to brain-machine interfaces.** *Nature communications*
Kao, J. C., Nuyujukian, P., Ryu, S. I., Churchland, M. M., Cunningham, J. P., Shenoy, K. V.
2015; 6: 7759-?
 - **Performance sustaining intracortical neural prostheses.** *Journal of neural engineering*
Nuyujukian, P., Kao, J. C., Fan, J. M., Stavisky, S. D., Ryu, S. I., Shenoy, K. V.
2014; 11 (6): 066003-?
 - **Performance sustaining intracortical neural prostheses** *JOURNAL OF NEURAL ENGINEERING*
Nuyujukian, P., Kao, J. C., Fan, J. M., Stavisky, S. D., Ryu, S. I., Shenoy, K. V.
2014; 11 (6)
 - **Combining Decoder Design and Neural Adaptation in Brain-Machine Interfaces** *NEURON*
Shenoy, K. V., Carmena, J. M.
2014; 84 (4): 665-680
 - **A freely-moving monkey treadmill model** *JOURNAL OF NEURAL ENGINEERING*
Foster, J. D., Nuyujukian, P., Freifeld, O., Gao, H., Walker, R., Ryu, S. I., Meng, T. H., Murmann, B., Black, M. J., Shenoy, K. V.
2014; 11 (4)
 - **A freely-moving monkey treadmill model.** *Journal of neural engineering*
D Foster, J., Nuyujukian, P., Freifeld, O., Gao, H., Walker, R., I Ryu, S., H Meng, T., Murmann, B., J Black, M., V Shenoy, K.
2014; 11 (4): 046020-?

- **Information Systems Opportunities in Brain-Machine Interface Decoders** *PROCEEDINGS OF THE IEEE*
Kao, J. C., Stavisky, S. D., Sussillo, D., Nuyujukian, P., Shenoy, K. V.
2014; 102 (5): 666-682
- **Self-recalibrating classifiers for intracortical brain-computer interfaces.** *Journal of neural engineering*
Bishop, W., Chestek, C. C., Gilja, V., Nuyujukian, P., Foster, J. D., Ryu, S. I., Shenoy, K. V., Yu, B. M.
2014; 11 (2): 026001-?
- **Self-recalibrating classifiers for intracortical brain-computer interfaces.** *Journal of neural engineering*
Bishop, W., Chestek, C. C., Gilja, V., Nuyujukian, P., Foster, J. D., Ryu, S. I., Shenoy, K. V., Yu, B. M.
2014; 11 (2): 026001-?
- **Cortical activity in the null space: permitting preparation without movement.** *Nature neuroscience*
Kaufman, M. T., Churchland, M. M., Ryu, S. I., Shenoy, K. V.
2014; 17 (3): 440-448
- **Cortical activity in the null space: permitting preparation without movement.** *Nature neuroscience*
Kaufman, M. T., Churchland, M. M., Ryu, S. I., Shenoy, K. V.
2014; 17 (3): 440-448
- **Intention estimation in brain-machine interfaces.** *Journal of neural engineering*
Fan, J. M., Nuyujukian, P., Kao, J. C., Chestek, C. A., Ryu, S. I., Shenoy, K. V.
2014; 11 (1): 016004-?
- **Intention estimation in brain-machine interfaces.** *Journal of neural engineering*
Fan, J. M., Nuyujukian, P., Kao, J. C., Chestek, C. A., Ryu, S. I., Shenoy, K. V.
2014; 11 (1): 016004-?
- **Neural Dynamics of Reaching following Incorrect or Absent Motor Preparation** *NEURON*
Ames, K. C., Ryu, S. I., Shenoy, K. V.
2014; 81 (2): 438-451
- **Cortical activity in the null space: permitting preparation without movement** *Nature Neuroscience*
Kaufman, M., T.
2014
- **Hybrid decoding of both spikes and low-frequency local field potentials for brain-machine interfaces.** *Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual Conference*
Stavisky, S. D., Kao, J. C., Nuyujukian, P., Ryu, S. I., Shenoy, K. V.
2014; 2014: 3041-3044
- **Intention estimation in brain-machine interfaces** *Journal of Neural Engineering*
Fan, J., M., Nuyujukian, P., Kao, J., Chestek, C. A., Ryu, S. I., Shenoy, K. V.
2014; 11:016004
- **DataHigh: graphical user interface for visualizing and interacting with high-dimensional neural activity.** *Journal of neural engineering*
Cowley, B. R., Kaufman, M. T., Butler, Z. S., Churchland, M. M., Ryu, S. I., Shenoy, K. V., Yu, B. M.
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