# MICHAEL BEYELER

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## EDUCATION

**Ph.D. in Computer Science**  Sep 2012 – Jun 2016
*University of California, Irvine*  *GPA: 3.96 / 4.0*

**M.Sc. in Biomedical Engineering**  Sep 2009 – Nov 2011
*ETH Zurich, Switzerland*  *GPA: 5.36 / 6.0*

**B.Sc. in Electrical Engineering**  Oct 2005 – Feb 2009
*ETH Zurich, Switzerland*  *GPA: 4.51 / 6.0*

## PROFESSIONAL APPOINTMENTS

**Postdoctoral Fellow in Neuroengineering and Data Science**  Aug 2016 – present
*Vision+Cognition Group (Profs. I. Fine, G. Boynton)*  *University of Washington*
*eScience Institute (Dr. A. Rokem)*  *Seattle, WA*

· Developing neurophysiologically inspired models of prosthetic vision, with the goal of improving the perceptual experience of blind patients implanted with a retinal prosthesis ("bionic eye").
· Experimentally validating these algorithms in Argus II retinal prosthesis patients (in collaboration with the University of Minnesota and Second Sight Medical Products, Inc.).

**SSNR Junior Specialist**  Jun 2016 – Jul 2016
*Cognitive Robotics Lab (Profs. J. Krichmar, N. Dutt), UC Irvine*  *Irvine, CA*

· Devised an efficient neuromorphic system for high-dimensional data compression and factor analysis, inspired by visual motion processing in the mammalian brain (patent pending).

**Research Assistant**  Jun 2015 – Aug 2015
*Brain-Inspired Computing Group (Dr. D. Modha), IBM Research – Almaden*  *San Jose, CA*

· Ported recurrent neural network models to IBM's TrueNorth Neurosynaptic chip (patent pending).

**Research Assistant**  Jun 2013 – Sep 2013
*Fraunhofer Institute IPA (Dr. F. Mirus, Prof. A. Verl)*  *Stuttgart, Germany*

· Developed fast and robust computer vision algorithms for autonomous driving.

**Junior Specialist**  Nov 2011 – Jul 2012
*Cognitive Robotics Lab (Profs. J. Krichmar, N. Dutt), UC Irvine*  *Irvine, CA*

· Co-developed and maintained CARLsim, an open-source software platform for the efficient simulation of large-scale spiking neural networks on x86 and CUDA architectures.
· Interacted with Hughes Research Laboratories (HRL), as part of DARPA SyNAPSE, to design spiking neural network based controllers of autonomous robots amenable for VLSI neuromorphic chips.

**Research Assistant**  Oct 2010 – Dec 2010
*Lab for Biosensors and Bioelectronics (Prof. J. Vörös), ETH Zurich*  *Zurich, Switzerland*

· Produced prototypes and aided in the design of a flexible multi-electrode array for *in vivo* rat's spinal cord stimulation.

## HONORS AND AWARDS

· National Institutes of Health (NIH) K99/R00 Pathway to Independence Award     2018 – present
· Amazon Web Services (AWS) Cloud Credits for Research Award     2017
· COSYNE Presenters Travel Award     2017
· Moore/Sloan/Wash. Research Found. (WRF) Innovation Postdoctoral Fellowship     2016 – 2018
· Swiss-American Society Stipend     2013
· UC Irvine Chair's Fellowship for outstanding Ph.D. applicants     2012 – 2016

## PROFESSIONAL SERVICE

### Editing
· Review Editor, Frontiers in Neurorobotics     2017 – present

### Committees
· Postdoctoral Representative, UW Research Advisory Board     2017 – present
· Member, Reproducibility Working Group, UW eScience Institute     2016 – 2018
· Neuronline Community Leader, Society for Neuroscience     2016 – 2017

### Workshops
· Co-organizer, Recent Computational Advances in Neuroengineering, COSYNE workshop     2018

### Ad-Hoc Reviewing · Journals     *publons.com/author/1188259/michael-beyeler*
ACM Journal on Emerging Technologies in Computing Systems (JETC) · Frontiers in Neurorobotics · Frontiers in Neuroscience · IEEE Transactions on Cybernetics · IEEE Transactions on Neural Networks and Learning Systems (TNNLS) · Journal of Neural Engineering · Journal of Vision · Neural Networks · Neurocomputing · PLoS Computational Biology · PLoS ONE · Sensors · Vision Research

### Ad-Hoc Reviewing · Conferences
Computational and Systems Neuroscience (COSYNE) · Design, Automation and Test in Europe (DATE) · IEEE International Conference on Intelligent Robots and Systems (IROS) · IEEE International Symposium on Circuits and Systems (ISCAS) · Scientific Computing with Python (SciPy)

## PUBLICATIONS

*scholar.google.com/citations?user=1CDDZSIAAAAJ*

### Manuscripts Under Review
M4 **Beyeler, M.**, Nanduri, D., Weiland, J., Rokem, A., Boynton, G. M., and Fine, I. (under review). A model of ganglion axon pathways accounts for the shape of percepts elicited by retinal implants. Code: *github.com/VisCog/ArgusShapes*.

M3 Boynton, G. M., Rokem, A., **Beyeler, M.**, Dorn, J., Sinclair, N. C., Shivdasani, M. N., Petoe, M. A., Hornig, R., and Fine, I. (under review). Efficient and scalable measurements of sensitivity for high resolution electrode arrays.

M2 **Beyeler, M.** (under review). Biophysical model of axonal stimulation in epiretinal visual prostheses. *bioRxiv* 424622, doi: 10.1101/424622.

M1 **Beyeler\*, M.**, Rounds\*, E. L., Carlson, K. D., Dutt, N., and Krichmar, J. L (in revision, *PLOS Computational Biology*). Sparse coding and dimensionality reduction in cortex. *bioRxiv* 149880, doi: 10.1101/149880. (\*equal contribution)

### Peer-Reviewed Journal Publications
J5 **Beyeler, M.**, Rokem, A., Boynton, G. M., and Fine, I. (2017). Learning to see again: Biological constraints on cortical plasticity and the implications for sight restoration technologies. *Journal of Neural Engineering* 14(5). **Featured cover article.**

J4 **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2016). 3D visual response properties of MSTd emerge from an efficient, sparse population code. *Journal of Neuroscience* 36(32): 8399–8415.

J3 **Beyeler, M.**, Oros, N., Dutt, N., and Krichmar, J. L. (2015). A GPU-accelerated cortical neural network model for visually guided robot navigation. *Neural Networks* 72: 75–87.

J2 **Beyeler, M.**, Richert, M., Dutt, N. D., and Krichmar, J. L. (2014). Efficient spiking neural network model of pattern motion selectivity in visual cortex. *Neuroinformatics*, 1–20.

J1 **Beyeler, M.**, Dutt, N. D., and Krichmar, J. L. (2013). Categorization and decision-making in a neurobiologically plausible spiking network using a STDP-like learning rule. *Neural Networks* 48C: 109–124.

### Peer-Reviewed Conference Publications

C6 Chou*, T.-S., Kashyap*, H. J., Xing, J., Listopad, S., Rounds, E. L., **Beyeler, M.**, Dutt, N., and Krichmar, J. L (2018). CARLsim 4: An open source library for large scale, biologically detailed spiking neural network simulations using heterogeneous clusters. *Proceedings of the IEEE International Joint Conference on Neural Networks (IJCNN)*, Rio de Janeiro, Brazil. (*equal contribution) Code: *github.com/UCI-CARL/CARLsim4*. **Best Student Paper Nominee.**

C5 **Beyeler, M.**, Boynton, G. M., Fine, I., and Rokem, A. (2017). pulse2percept: A Python-based simulation framework for bionic vision. *Proceedings of the 16th Python in Science Conference*, p.81–88. Code: *github.com/uwescience/pulse2percept*.

C4 **Beyeler*, M.**, Carlson*, K. D. , Chou*, T-S., Dutt, N., Krichmar, J. L. (2015). CARLsim 3: A user-friendly and highly optimized library for the creation of neurobiologically detailed spiking neural networks. *Proceedings of the IEEE International Joint Conference on Neural Networks (IJCNN)*, Killarney, Ireland. Code: *github.com/UCI-CARL/CARLsim3*. (*equal contribution)

C3 Carlson, K. D., **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2014). GPGPU accelerated simulation and parameter tuning for neuromorphic applications. Proceedings of *19th Asia and South Pacific Design Automation Conference (ASP-DAC)*, Suntec, Singapore.

C2 **Beyeler, M.**, Mirus, F., and Verl, A. (2014). Vision-based robust road lane detection in urban environments. *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China.

C1 **Beyeler*, M.**, Stefanini*, F., Proske, H., Galizia, C. G., and Chicca, E. (2010). Exploring olfactory sensory networks: simulations and hardware emulation. *Proceedings of the IEEE Biomedical Circuits and Systems Conference (BioCAS)*, Paphos, Cyprus. (*equal contribution) **Best Paper Nominee.**

### Books

B3 **Beyeler, M.** (2017). Machine Learning for OpenCV. *Packt Publishing Ltd.*, Birmingham, UK, 382 pages, ISBN 978-178398028-4. **Also available in Korean, Japanese, and as a video course.** Code: *github.com/mbeyeler/opencv-machine-learning*.

B2 Howse, J., Joshi, P., and **Beyeler, M.** (2016). OpenCV: Computer Vision Projects with Python. *Packt Publishing Ltd.*, Birmingham, UK, 558 pages, ISBN 978-178712549-0.

B1 **Beyeler, M.** (2015). OpenCV with Python Blueprints. *Packt Publishing Ltd.*, Birmingham, UK, 230 pages, ISBN 978-178528269-0. Code: *github.com/mbeyeler/opencv-python-blueprints*.

### US Patent Applications

P2 Appuswamy, R., **Beyeler, M.**, Datta, P., Flickner, M. D., and Modha, D. S. (2018). Long short-term memory (LSTM) on spiking neuromorphic hardware. US Patent App 15/434,672.

P1 **Beyeler, M.**, Dutt, N. D., and Krichmar, J. L. (2017). Sparse and efficient neuromorphic population coding. US Patent App 15/417,626.

## CONTRIBUTED PRESENTATIONS AND <u>A</u>BSTRACTS

A28 **Beyeler, M.**, Nanduri, D., Weiland, J. D., Rokem, A., Boynton, G. M., And Fine, I. (2018). Optimizing stimulation protocols for prosthetic vision based on retinal anatomy. *Annual Meeting of the Organization of Computational Neuroscience (CNS)*, Seattle, WA. (poster)

A27 **Beyeler, M.**, Rounds, E. L., Carlson, K. D., Dutt, N., and Krichmar, J. L. (2018). Sparse coding and dimensionality reduction in the brain. *Annual Meeting of the Organization of Computational Neuroscience (CNS)*, Seattle, WA. (poster)

A26 Chou, T.-S., Kashyap, H. K., Xing, J., Listopad, S., Rounds, E. L., **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2018). CARLsim 4: An open source library for large scale, biologically detailed spiking neural network simulation using heterogeneous clusters. *Annual Meeting of the Organization of Computational Neuroscience (CNS)*, Seattle, WA. (oral)

A25 **Beyeler, M.**, Nanduri, D., Weiland, J. D., Rokem, A., Boynton, G. M., and Fine, I. (2018). Optimizing stimulation protocols for prosthetic vision based on retinal anatomy. *Annual Meeting of the Vision Sciences Society (VSS)*, St. Pete's Beach, FL. (poster)

A24 **Beyeler, M.**, Yucel, E. I., Rokem, A., Boynton, G. M., and Fine, I. (2018). Optimizing stimulation protocols for prosthetic vision based on retinal anatomy. *Computational and Systems Neuroscience (COSYNE) workshops*, Breckenridge, CO. (oral)

A23 **Beyeler, M.**, Rokem, A., Boynton, G. M., and Fine, I. (2018). Modeling the perceptual experience of retinal prosthesis patients. *UWIN Neural Computation and Engineering Connection (NCEC)*, Seattle, WA. (oral)

A22 Rounds, E. L., **Beyeler, M.**, Carlson, K. D., Dutt, N., and Krichmar, J. L. (2017). Sparse coding and dimensionality reduction in cortex. *47th Annual Meeting of the Society for Neuroscience (SfN)*, Washington, DC. (poster)

A21 Kashyap, H. J., Chou, T.-S., Rounds, E. L., Listopad, S., **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2017). CARLsim4: A C++ library for the design, simulation, and parameter tuning of biologically detailed spiking neural networks on high performance clusters. *47th Annual Meeting of the Society for Neuroscience (SfN)*, Washington, DC. (poster)

A20 **Beyeler, M.**, Rokem, A., Boynton, G. M., and Fine, I. (2017). Reverse-engineering optimized stimulation protocols in epiretinal prosthesis patients. *The Eye & the Chip*, Detroit, MI. (oral, **Platform Presentation**)

A19 Boynton, G. M., Rokem, A., **Beyeler, M.**, Dorn, J., Sinclair, N. C., Shivdasani, M. N., Petoe, M. A., Hornig, R., and Fine, I. (2017). Efficient and scalable measurements of sensitivity for high resolution electrode arrays. *The Eye & the Chip*, Detroit, MI. (poster, **Best Poster Award**)

A18 **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2017). A sparse coding model of MST can account for human heading perception in the presence of eye movements. *European Conference on Visual Perception (ECVP)*, Berlin, Germany. (poster)

A17 **Beyeler, M.**, Boynton, G. M., Fine, I., and Rokem, A. (2017). pulse2percept: A Python-based simulation framework for bionic vision. *Python in Science Conference (SciPy)*, Austin, TX. (oral, **youtube.com/watch?v=KxsNAa-P2X4**)

A16 **Beyeler, M.**, Rokem, A., Boynton, G. M., and Fine, I. (2017). Modeling the perceptual experience of retinal prosthesis patients. *Annual Meeting of the Vision Sciences Society (VSS)*, St. Pete's Beach, FL. (oral)

A15 **Beyeler, M.**, Rokem, A., Boynton, G. M., and Fine, I. (2017). Modeling the perceptual experience of retinal prosthesis patients. *Computational and Systems Neuroscience (COSYNE)*, Salt Lake City, UT. (poster)

A14 **Beyeler, M.**, Richert, M., Oros, N., Dutt, N., and Krichmar, J. L. (2016). GPU-accelerated real-time simulation of information processing in early visual cortex. *UWIN Neural Computation and Engineering Connection (NCEC)*, University of Washington, Seattle, WA. (poster)

A13 **Beyeler, M.**, Dutt, N., and Krichmar, J. L. (2016). Efficient coding of optic flow can account for MSTd visual response properties. *46th Annual Meeting of the Society for Neuroscience (SfN)*, San Diego, CA. (poster)

A12 **Beyeler, M.**, Richert, M., Oros, N., Dutt, N., and Krichmar, J. L. (2016). GPU-accelerated real-time simulation of information processing in early visual cortex. *The Eye & the Chip*, Dearborn, MI. (poster)

A11 **Beyeler, M.**, Richert, M., Oros, N., Dutt, N., and Krichmar, J. L. (2016). A cortical neural network model of visual motion perception for decision-making and navigation. *23rd Joint Symposium on Neural Computation (JSNC)*, University of California, Los Angeles (UCLA), Los Angeles, CA. (poster)

A10 **Beyeler, M.**, Richert, M., Oros, N., Dutt, N., and Krichmar, J. L. (2016). A cortical neural network model of visual motion perception for decision-making and navigation. *Computational and Systems Neuroscience (COSYNE)*, Salt Lake City, UT. (poster)

A9 **Beyeler, M.**, Carlson, K. D., Chou, T.-S., Dutt, N., and Krichmar, J. L. (2015). An optimized library for the design, simulation, and parameter tuning of biologically detailed spiking neural networks. *45th Annual Meeting of the Society for Neuroscience (SfN)*, Chicago, IL. (poster)

A8 **Beyeler, M.**, Carlson, K. D., Chou, T.-S., Dutt, N., and Krichmar, J. L. (2015). CARLsim 3: A user-friendly and highly optimized library for the creation of neurobiologically detailed spiking neural networks. *IEEE International Joint Conference on Neural Networks (IJCNN)*, Killarney, Ireland. (oral)

A7 **Beyeler, M.**, Carlson, K. D., Chou, T.-S., Dutt, N., and Krichmar, J. L. (2015). CARLsim 3: A user-friendly and highly optimized library for the creation of neurobiologically detailed spiking neural networks. *22nd Joint Symposium on Neural Computation (JSNC)*, University of Southern California (USC), Los Angeles, CA. (poster)

A6 **Beyeler, M.**, Richert, M., Oros, N., Dutt, N., and Krichmar, J. L. (2014). A cortical spiking neural network model for visually guided robot navigation. Neurobiologically Inspired Robotics workshop, *IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China. (oral, **Best Student Talk Award**).

A5 **Beyeler, M.**, Mirus, F., and Verl, A (2014). Vision-based robust road lane detection in urban environments. *IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China. (oral)

A4 **Beyeler, M.**, Richert, M., Nageswaran, J. M., Dutt, N. D., and Krichmar, J. L. (2014). Large-scale spiking neural network model of visual motion processing. *21st Joint Symposium on Neural Computation (JSNC)*, University of California, Irvine (UCI), Irvine, CA. (poster)

A3 **Beyeler, M.**, Richert, M., Nageswaran, J. M., Dutt, N. D., and Krichmar, J. L. (2014). Large-scale spiking neural network model of visual motion processing. *Dynamics of Multifunction Brain Networks MURI Winter School*, University of California, San Diego (UCSD), San Diego, CA. (oral)

A2 **Beyeler, M.**, Richert, M., Nageswaran, J. M., Dutt, N. D., and Krichmar, J. L. (2013). Large-scale spiking neural network model of visual motion processing. *44th Annual Meeting of the Society for Neuroscience (SfN)*, San Diego, CA. (poster)

A1 **Beyeler, M.**, Dutt, N. D., and Krichmar, J. L. (2013). Spiking neural network model of visual pattern recognition and decision-making using a stochastic STDP learning rule. *20th Joint Symposium on Neural Computation (JSNC)*, California Institute of Technology (Caltech), Pasadena, CA. (poster)

## INVITED TALKS

T8 Modeling the perceptual experience of retinal prosthesis patients. *Center for Applied and Translational Sensory Science (CATSS), University of Minnesota*, Minneapolis, MN, Feb 2018.

T7 A GPU-accelerated cortical neural network model for visually guided robot navigation. *Cluster of Excellence Cognitive Interaction Technology (CITEC), Bielefeld University*, Bielefeld, Germany, Aug 2017.

T6 3D visual response properties of MSTd emerge from an efficient, sparse population code. *Center for Perceptual Systems, University of Texas, Austin*, Austin, TX, Jul 2017.

T5 Restoring vision to the blind: The challenge of sight recovery technologies. *UW Medicine, University of Washington*, Seattle, WA, Feb 2017.

T4 Pulse trains to percepts: The challenge of sight recovery technologies. *Second Sight Medical Products Inc.*, Sylmar, CA, November 2016.

T3 A cortical neural network model for perceptual decision-making and visually guided robot navigation. *Department of Psychology, University of Washington*, Seattle, WA, Dec 2015.

T2 TrueNorth implementation of long short-term memory. *IBM Research*, San Jose, CA, Aug 2015.

T1 A cortical spiking neural network model for visually guided robot navigation. *Qualcomm Technologies Incorporated*, San Diego, CA, Nov 2014.

## TEACHING ACTIVITIES

**Invited Lectures**                                                                                         2018 – present
*University of Washington (UW) / University of Puget Sound (UPS)*                         *Seattle / Tacoma, WA*

· UW Neurohackademy: Image processing & computer vision with scikit-image (all levels)
· UW Auditory Neuroscience Training Grant (ANTG): Introduction to machine learning (graduate)
· UPS NRSC 490 Advanced Topics in Neuroscience: Visual neuroprostheses (undergraduate)

**Certified Software Carpentry Instructor**                                                             2017 – present
*eScience Institute, University of Washington*                                                             *Seattle, WA*

· Teaching Python, shell, Git, and software engineering skills to scientists and engineers (all levels) at bootcamps and in online sessions. Developing new instructional content.

**Teaching Assistant**                                                                                               2015 – 2016
*Department of Computer Science, UC Irvine*                                                               *Irvine, CA*

· CS-143A: Principles of Operating Systems (undergraduate)
· CS-171: Introduction to Artificial Intelligence (undergraduate)

## COMMUNITY INVOLVEMENT AND OUTREACH

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|---|---|
| · Volunteer, Lighthouse Foundation for the Blind, Inc. | 2018 – present |
| · Volunteer, IEEE Robotics and Automation Society | 2014 – 2016 |
| · Volunteer, Mathobotix "Bytes and Bots" K-12 Summer Camp | 2013 – 2014 |

## PROFESSIONAL ASSOCIATIONS

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|---|---|
| · American Association for the Advancement of Science (AAAS) | 2018 – present |
| · Organization for Computational Neurosciences (OCNS) | 2018 – present |
| · Vision Sciences Society (VSS) | 2017 – present |
| · Society for Neuroscience (SfN) | 2013 – present |
| · IEEE Robotics and Automation Society (RAS) | 2014 – 2016 |