# Thomas J. Richner, PhD

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## Summary

Engineer and research scientist with 10+ years of research and development experience integrating machine learning, dynamical systems, gradient-free optimization, neural networks, neural interfaces, photonics, and applied mathematics. Currently, I research the brain as a system of stochastic fractional differential equations both theoretically and using system identification methods. My greatest strength is iterating between math, physics, numerical methods, and software engineering. I am looking to join a startup that is advancing science, engineering, and intelligence.

## Education

### PhD Neuroengineering — 2010 - 2014
University of Wisconsin-Madison
- NIH Fellowship, Neuroengineering Training Program
- Developed multiple bidirectional optoelectronic neural interface systems [1-5]
- Developed the first fully-transparent thin-film neural interfaces with graphene [2-4]
- My R&D led to the founding of NeuroOne (Nasdaq: NMTC) [1, 3, 4]
- First author: 2 x J Neural Engineering, J Cerebral Blood Flow
- Co-author: 12 papers

### MS Biomedical Engineering — 2008 - 2010
University of Wisconsin-Madison
- Led neural interface systems integration, experimental design, and analysis [1-4]
- Raised microfabricated connection yield from 50% to 95% [1, 2]
- First author: J Neural Engineering, Co-author: 3 papers

### BS Biomedical Engineering — 2006 - 2008
Washington University in St. Louis
- Scholarship, McKelvey dual degree engineering
- Finite element modeling of protein electrostatics

### BS Mathematics — 2003 - 2006
Northland College
- Summa cum laude, graduated in 3 years with 128 credits
- Researched wave propagation in spiking neural networks

## Experience

### Mayo Clinic — Sep 2019 – present
Research Scientist — Jan 2024 - present
- AI and dynamical systems research applied to epilepsy
- Researched the Lyapunov spectra of continuous-time recurrent neural networks modeled as a system of stochastic fractional differential equations. [7]
- From scratch, then on a stack: PyTorch, Hydra, Git, Docker, SLURM, GCP
- Developed a phase response indicator of epilepsy based on brain stim [in prep]
- First author: Frontiers in Computational Neuroscience, Co-author: 2 papers

Postdoctoral Fellow, Engineer Apr 2021 - Dec 2023

- Designed, performed, and analyzed electrical brain stimulation experiments with machine learning (ML): Data-driven system identification of latent parameters
- Co-author: 4 papers, 1 conference paper

Postdoctoral Fellow, Engineer Sep 2019 - Mar 2021

- Built a platform for research in the operating room with awake patients
- Captured 50 surgeries with five simultaneous time series data streams
- One patent, one first-author conference paper

### University of Minnesota Oct 2017 - Sep 2019

Senior Fellow

- Built a closed-loop system that optimizes the stimulation waveform in real time using Bayesian optimization with a Gaussian-process regression surrogate [8]
- Proposed that a thermal mechanism explains inhibitory effect of focused ultrasound based on the observed time constant and designed an independent laser-heating experiment that reproduced the effect, supporting the mechanism. [9]
- Co-first author: Brain, Co-author: 3 papers

### University of Washington, Seattle Jul 2014 - Sep 2017

Senior Fellow

- Fellowship, Washington Research Foundation
- Designed, instrumented, and conducted all experiments, using frequency sweeps and complex stimuli to enable system identification of neural and blood-flow responses. [6]
- Built a biophysical recurrent neural network (RNN) of seizure propagation.
- Redesigned and carried out experiments validating silver-nanowire-coated spinal neural interfaces with optical stimulation and electrophysiological recording, in collaboration with Polina Anikeeva, MIT Professor of Materials Science. [10]
- Co-author: J Neurophysiology, Dev Neurobiology, J Neural Engineering, Science Advances

## Contributions

34 peer-reviewed papers, 30 first-author conference abstracts, 4 conference papers, 2 patents

Google Scholar: https://scholar.google.com/citations?user=a5hmYP8AAAAJ&hl=en&oi=ao
citations: 2396, h-index: 18

## Selected peer-reviewed papers


[1] Richner, T. J., Brodnick, S. K., Thongpang, S., Sandberg, A. A., Krugner-Higby, L. A., & Williams, J. C. (2019). Phase relationship between micro-electrocorticography and cortical neurons. *Journal of Neural Engineering* https://doi.org/10.1088/1741-2552/ab335b

[2] Richner, T. J., Baumgartner, R., Brodnick, S. K., Azimipour, M., Krugner-Higby, L. A., Eliceiri, K. W., Williams, J. C., & Pashaie, R. (2014). Patterned optogenetic modulation of neurovascular and metabolic signals. *Journal of Cerebral Blood Flow & Metabolism.* Co-first author.

[3] Richner, T. J., Thongpang, S., Brodnick, S. K., Schendel, A. A., Falk, R. W., Krugner-Higby, L. A., Pashaie, R., & Williams, J. C. (2014). Optogenetic micro-electrocorticography for modulating and localizing cerebral cortex activity. *Journal of Neural Engineering* https://doi.org/10.1088/1741-2560/11/1/016 010

[4] Park, D. W., Schendel, A. A., Mikael, S., Brodnick, S. K., Richner, T. J., Ness, J. P., Hayat, M. R., Atry, F., Frye, S. T., Pashaie, R., Thongpang, S., Ma, Z., & Williams, J. C. (2014). Graphene-based carbon-layered electrode array technology for neural imaging and optogenetic applications. *Nature Communications*, 5.

[5] Pashaie, R., Anikeeva, P., Lee, J. H., Prakash, R., Yizhar, O., Prigge, M., Chander, D., Richner, T. J., & Williams, J. (2014). Optogenetic Brain Interfaces. *Biomedical Engineering, IEEE Reviews In*, *7*, 3–30. https://doi.org/10.1109/RBME.2013.2294796

[6] Chen, R. C. H., Atry, F., Richner, T., Brodnick, S. K., Pisaniello, J., Ness, J., Suminski, A., Williams, J. C., & Pashaie, R. (2020). A system identification analysis of optogenetically evoked electrocorticography and cerebral blood flow responses. *Journal of Neural Engineering*.

[7] Richner, T. J., Dervinis, M., & Lundstrom, B. N. (2026). Adaptation modulates effective connectivity and network stability. *Frontiers in Computational Neuroscience*, 20.

[8] Stieve, B. J., Richner, T. J., Krook-Magnuson, C., Netoff, T. I., & Krook-Magnuson, E. (2023). Optimization of closed-loop electrical stimulation enables robust cerebellar-directed seizure control. *Brain*, 146(1), 91–108. Co-first author.

[9] Darrow, D. P., O'Brien, P., Richner, T. J., Netoff, T. I., & Ebbini, E. S. (2019). Reversible neuroinhibition by focused ultrasound is mediated by a thermal mechanism. *Brain Stimulation*, 12(6), 1439–1447.

[10] Lu, C., Park, S., Richner, T. J., Derry, A., Brown, I., Hou, C., Rao, S., Kang, J., Mortiz, C. T., Fink, Y., & Anikeeva, P. (2017). Flexible and stretchable nanowire-coated fibers for optoelectronic probing of spinal cord circuits. *Science Advances*, 3(3), e1 600 955.