

JEFFREY SHAINLINE

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PHYSICIST, QUANTUM NANOPHOTONICS / FAINT PHOTONICS GROUPS
APPLIED PHYSICS DIVISION, PHYSICAL MEASUREMENT LABORATORY
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

address 325 Broadway, Boulder, CO, 80305

email jeffrey.shainline@nist.gov

phone (303) 497-6292

PROFESSIONAL RESEARCH EXPERIENCE

1/2017—present NIST Staff Scientist, Project Leader

2/2015—1/2017 NIST Term Employee

Applied Physics Division, Quantum Nanophotonics / Faint Photonics Groups

- Leading the Physics and Hardware for Intelligence project.
- Developing the theoretical foundation for the emerging field of science and technology known as superconducting optoelectronic networks.
- Developing fabrication process to combine waveguide-integrated nano-LEDs, waveguide-integrated single-photon detectors, superconducting amplifiers, Josephson junctions, and passive photonic routing networks.
- Co-PI for IARPA SuperCables Test and Evaluation Team.
- Member of NIST Artificial Intelligence Coordination Team.
- Managing a team of seven scientists.

2/2013—2/2015 National Research Council Postdoctoral Fellow

Applied Physics Division, Quantum Nanophotonics / Faint Photonics Groups

- Led successful silicon photonics effort to integrate single photon detectors with nanophotonic waveguide devices.
- All fabrication for the project consisting of eight photolithography masks and three electron beam lithography layers. Process includes wet and dry etch, metal deposition via evaporation and sputtering, PECVD of dielectrics, and thermal oxidation.
- Developed fiber-to-chip packaging and test solutions for cryogenic device characterization.
- Initiated a research effort into the utilization of superconducting electronics with integrated nanophotonics for neuromorphic computing.
- Contributed to successful DARPA proposal regarding frequency combs in the mid-IR for spectroscopy.

9/2010—2/2013 Research Associate

Group of Prof. Miloš Popović

- Led photonic device design for the DARPA POEM program to integrate silicon photonics with CMOS electronics for processor-to-memory links. This included design, layout, and testing of devices such as modulators, filter banks, and grating couplers integrated with CMOS electronics in a 45nm CMOS process as part of a three-university collaboration with an industry partner. This program led to the first demonstration of optical links between processor and memory on a monolithic optoelectronic chip.
- Succeeded in implementing critical devices such as optical modulators in both a bulk CMOS DRAM process and an SOI CMOS logic process.
- Led a project to utilize multimode interference in guided wave optical structures to enable low-loss placement of electrical/mechanical contacts and waveguide crossings.

*National Institute
of Standards and
Technology*

*University of
Colorado, Boulder*

EDUCATION

- PhD in Physics* 2005-2010 Brown University
- Adviser: Jimmy Xu
 Thesis topic: Silicon microdisks for subwavelength and dynamic photonic circuit elements
 Honors:
- 2011 Beyer Award for Excellence in Scholarship and Service from the Brown University Physics Department
 - 2009 Forrest Award for Excellent Work Related to Experimental Apparatus from the Brown University Physics Department
 - Finalist in the 2009 Emil Wolf outstanding student paper competition at Frontiers in Optics
 - Graduate Fellowship, Brown University Physics Department, 2005-2006
- Bachelor of Science in Physics* 2002-2005 University of Colorado, Boulder
- Adviser: Chris Greene
 Thesis topic: S-wave scattering in one- and two-channel central potentials
 Honors: Magna Cum Laude

SELECTED PRESS

- 2018 “Optical neural network demo” *Science Daily*. [link](#)
 “New chip enlightens optical neural network demo” *Tech Explorist*. [link](#)
- 2017 “Mimicking the brain with superconductors and LEDs.” *Physics*. [link](#)
 “Synthetic brains made of superconductors and light.” *Physics Central, Physics Buzz Blog*. [link](#)
- 2015 “Linking chips with light.” *IEEE Spectrum*. [link](#)
- 2014 “A Step Closer to a Photonic Future.” *OFC Conference*. [link](#)
 “Waveguide optical modulator and tunable filter fabricated using standard CMOS techniques.” *Laser Focus World*. [link](#)
 “2014 VLSI Symposia to delve into CMOS silicon-photonics technology.” *Laser Focus World*. [link](#)
- 2013 “CU, MIT breakthrough in photonics could allow for faster and faster electronics.” *University of Colorado*. [link](#)
 “Better Optical Modulators Boost Silicon Photonics.” *Photonics.com*. [link](#)
 “Major silicon photonics breakthrough could allow for continued exponential growth in microprocessors.” *Kurzweil Accelerating Intelligence*. [link](#)
 “Breakthrough in photonics could allow for faster and faster electronics.” *Phys.org*. [link](#)

SELECTED JOURNAL PUBLICATIONS

- 2020 1. [J.M. Shainline](#), “Does Cosmological Evolution select for technology?”, *New. J. Phys.*, 22, 073064 (2020).
2. S. Khan, S.M. Buckley, J. Chiles, R.P. Mirin, S.W. Nam, and J.M. Shainline, “Low-loss, high-bandwidth fiber-to-chip coupling using capped adiabatic tapered fibers”, *APL Photonics*, 5, 056101 (2020).
3. S.M. Buckley, A.N. Tait, G. Moody, B. Primavera, S. Olson, J. Herman, K.L. Silverman, S. Papa Rao, S.W. Nam, R.P. Mirin, and J.M. Shainline, “Optimization of photoluminescence from W centers in silicon-on-insulator”, *Opt. Express*, 28, 16057 (2020).

- 2019
4. A.N. McCaughan, V.B. Verma, S.M. Buckley, J.P. Allmaras, A.G. Kozorezov, A.N. Tait, S.W. Nam and J.M. Shainline, "A superconducting thermal switch with ultrahigh impedance for interfacing superconductors to semiconductors", *Nature Electronics*, 2, 451 (2019).
 5. C. McDonald, G. Moody, S.W. Nam, R.P. Mirin, J.M. Shainline, A. McCaughan, S. Buckley, and K.L. Silverman, "III-V integrated circuit with waveguide-coupled light-emitting diodes and WSi superconducting single-photon detectors", *Appl. Phys. Lett.*, 115, 081105 (2019).
 6. J.M. Shainline, "Fluxonic Processing of Photonic Synapse Events", *IEEE J. Selected Topics Quant. Electron.*, 26, 7700315 (2019). (Invited)
 7. J.M. Shainline, S.M. Buckley, A.N. McCaughan, J.T. Chiles, A. Jafari-Salim, M. Castellanos-Beltran, C.A. Donnelly, M.L. Schneider, R.P. Mirin, and S.W. Nam, "Superconducting Optoelectronic Loop Neurons", *J. Appl. Phys.*, 126, 044902 (2019). (Featured article)
- 2018
8. J.M. Shainline, S.M. Buckley, A.N. McCaughan, J.T. Chiles, A. Jafari-Salim, R.P. Mirin, and S.W. Nam, "Circuit designs for superconducting optoelectronic loop neurons," *J. Appl. Phys.*, 124, 152130 (2018).
 9. J. Chiles, S. Buckley, S.W. Nam, R.P. Mirin, and J.M. Shainline, "Design, fabrication, and metrology of 10×100 multi-planar integrated photonic routing manifolds for neural networks," *APL Photonics*, 3, 106101 (2018).
 10. N. Nader, D.L. Maser, F.C. Cruz, A. Kowligy, H. Timmers, J. Chiles, C. Fredrick, D.A. Westly, S.W. Nam, R.P. Mirin, J.M. Shainline, and Scott Diddams, "Versatile silicon-waveguide supercontinuum for coherent mid-infrared spectroscopy," *APL Photonics*, 3, 036102 (2018).
- 2017
11. J. Chiles, S. Buckley, N. Nader, S.W. Nam, R.P. Mirin, and J.M. Shainline, "Multi-planar amorphous silicon photonics with compact interplanar couplers, cross talk mitigation, and low crossing loss," *APL Photonics*, 2, 116101 (2017). (Editor's Pick)
 12. S. Buckley, J. Chiles, A.N. McCaughan, G. Moody, K.L. Silverman, M.J. Stevens, R.P. Mirin, S.W. Nam, and J.M. Shainline, "All-silicon light-emitting diodes waveguide-integrated with superconducting single-photon detectors," *APL*, 111, 141101 (2017).
 13. J.M. Shainline, S.M. Buckley, N. Nader, C.M. Gentry, K.C. Cossel, J.W. Cleary, M. Popović, N.R. Newbury, S.W. Nam, and R.P. Mirin, "Room-temperature-deposited dielectrics and superconductors for integrated photonics," *Opt. Express*, 25, 10322 (2017).
 14. J.M. Shainline, S.M. Buckley, R.P. Mirin, and S.W. Nam, "Superconducting optoelectronic circuits for neuromorphic computing," *Phys. Rev. Applied*, 7, 034013 (2017). (Editors' Suggestion)
- 2016
15. H.Q. Nguyen, S.M. Hollen, J.M. Shainline, J.M. Xu, and J.M. Valles Jr., "Driving a superconductor to insulator transition with random gauge fields," *Scientific Reports*, 6, 38166 (2016).
- 2015
16. C. Sun, M.T. Wade, Y. Lee, J.S. Orcutt, L. Alloatti, M.S. Georgas, A.S. Waterman, J.M. Shainline, R.R. Avizienis, S. Lin, B.R. Moss, R. Kumar, F. Pavanello, A.H. Atabaki, H.M. Cook, A.J. Ou, J.C. Leu, Y.-H. Chen, K. Asanović, R.J. Ram, M.A. Popović, and V.M. Stojanović, "Single-chip microprocessor that communicates directly using light," *Nature*, 528, 534 (2015).
 17. C.M. Gentry, J.M. Shainline, M.T. Wade, M.J. Stevens, S.D. Dyer, X. Zeng, F. Pavanello, T. Gerrits, S.W. Nam, R.P. Mirin, and M.A. Popović, "Quantum-correlated photon pairs generated in a commercial 45 nm complementary metal-oxide-semiconductor microelectronic chip," *Optica*, 2, 1065 (2015).
- 2014
18. K.K. Mehta, J.S. Orcutt, J.M. Shainline, O. Tehar-Zahav, Z. Sternberg, R. Meade, M.A. Popović, and R.J. Ram, "Polycrystalline silicon ring resonator photodiodes in a bulk complementary metal-oxide-semiconductor process," *Optics Letters*, 39, 1061 (2014).
 19. Y. Liu, J.M. Shainline, X. Zeng, and M.A. Popović, "Ultra-low-loss CMOS-compatible waveguide crossing arrays based on multimode Bloch waves and imaginary coupling," *Optics Letters*, 39, 335 (2014).

- 2013 20. J.M. Shainline, J. Orcutt, M.T. Wade, K. Nammari, O. Tehar-Zahav, Z. Sternberg, R. Meade, R.J. Ram, V. Stojanović and M.A. Popović, "Depletion-mode polysilicon optical modulators in a bulk CMOS process," *Optics Letters*, 38, 2729 (2013).
21. J.M. Shainline, J.S. Orcutt, M.T. Wade, K. Nammari, B. Moss, M. Georgas, C. Sun, R.J. Ram, V. Stojanović, and M. Popović, "Depletion-mode carrier-plasma optical modulator in zero-change advanced CMOS", *Optics Letters*, 38, 2657 (2013).
- 2012 22. J. S. Orcutt, B. Moss, C. Sun, J. Leu, M. Georgas, J. Shainline, E. Zraggen, H. Li, J. Sun, M. Weaver, S. Urosevic, M. Popović, R. J. Ram, and V. Stojanović, "Open Foundry Platform for High-Performance Electronic-Photonic Integration" *Optics Express*, 20, 12222-12232, (2012).
- 2011 23. S.M. Hollen, H.Q. Nguyen, E. Rudisaile, M.D. Stewart, Jr., J. Shainline, J.M Xu, and J.M Valles, Jr., "Cooper-pair insulator phase in superconducting amorphous Bi films induced by nanometer-scale thickness variations", *Physical Review B*, 84, 064528 (2011).
- 2010 24. J.M. Shainline, G. Fernandes, Z. Liu, and J. Xu, "Broad tuning of whispering-gallery modes in silicon microdisks," *Optics Express* 18, 14345-14352 (2010).
- 2009 25. J. Shainline, S. Elston, G. Fernandes, Z. Liu, R. Zia and J. Xu, "Subwavelength silicon microcavities," *Optics Express* 17, 23323-23331 (2009).
26. H.Q. Nguyen, S.M. Hollen, M.D. Stewart, Jr., J. Shainline, A. Yin, J. Xu, and J.M. Valles, "Observation of giant positive magnetoresistance in a Cooper pair insulator", *Physical Review Letters*, 103, 157001 (2009).
27. J.M. Shainline and J. Xu, "Slow light and band gaps in metallodielectric cylinder arrays," *Optics Express*, 17, 8879-8891 (2009).
- 2008 28. J.M. Shainline and J. Xu, "Directly-pumped silicon lasers," *Optics and Photonics News*, 19, 34-39 (2008).
- 2007 29. J.M. Shainline and J. Xu, "Silicon as an emissive optical medium," *Laser & Photonics Reviews*, 1, 334-348 (2007).
- 2005 30. R. Santra, J.M. Shainline and C.H. Greene, "Siegert Pseudostates: Completeness and Time Evolution," *Physical Review A*, 71, 032703 (2005).

SELECTED CONFERENCE PRESENTATIONS

- 2020 1. J.M. Shainline, "Superconducting Optoelectronic Systems for Neuromorphic Supercomputing," 2020 International Symposium on Superconductor Electronics, Yokohama, Japan, (2020). (Invited)
- 2019 2. J.M. Shainline, "Fluxonic Processing of Photonic Synapse Events," Neuro-Inspired Computational Elements Workshop, Albany, New York, (2019). (Invited)
- 2018 3. J.M. Shainline, J.T. Chiles, S.M. Buckley, R.P. Mirin, and S.W. Nam, "Multiplanar dielectric waveguides for neural communication," IEEE International Conference on Group IV Photonics, Cancun, Mexico, (2018). (Invited)
4. J.M. Shainline, "The Largest Cognitive Systems will be Optoelectronic," IEEE International Conference on Rebooting Computing, Tysons, Virginia, (2018).
- 2017 5. J.M. Shainline, S.M. Buckley, J.T. Chiles, A.N. McCaughan, R.P. Mirin, and S.W. Nam, "Photonic interconnects with superconducting electronics for large-scale neuromorphic computing," IEEE Photonics Society Summer Topicals, San Juan, Puerto Rico, (2017). (Invited)
- 2016 6. J.M. Shainline, S.M. Buckley, R.P. Mirin, and S.W. Nam, "Neuromorphic computing with integrated photonics and superconductors," IEEE International Conference on Rebooting Computing, San Diego, CA, (2016).

2013

7. J.M. Shainline, J.S. Orcutt, K. Nammari, M.T. Wade, O. Tehar-Zahav, Z. Sternberg, R. Meade, R.J. Ram, V. Stojanović, and M. Popović, "Depletion-mode polysilicon optical modulators in a bulk CMOS process," presented at the postdeadline session of the Conference on Lasers and Electro-Optics, June 2013, paper CTh5D.3.

PATENTS

- J.M. Shainline, S.W. Nam, S.M. Buckley, R.P. Mirin, "Neuromimetic circuit, U.S. Patent Application 15/841701."
- J.M. Shainline, M. Popović, J.S. Orcutt, and V. Stojanović "Depletion-mode carrier-plasma optical modulator in zero-change advanced CMOS, US Patent Application 61/834362."
- J.S. Orcutt, J.M. Shainline, M. Popović, V. Stojanović, Z. Sternberg, O. Tehar-Zahav, and R. Meade, "Method and structure providing a front-end-of-line and back-end-of-line coupled waveguides, US Patent No. 9778416."
- O. Tehar-Zahav, Z. Sternberg, R. Meade, E. Megged, J.S. Orcutt, J.M. Shainline, M. Popović and V. Stojanović, "Selective polycrystalline silicon defect-state detector formation."
- R. Meade, K. Mehta, E. Megged, J. Orxcutt, M. Popović, R. Ram, J. Shainline, Z. Sternberg, V. Stojanović, and O. Tehar-Zahav, "Method and optoelectronic structure providing polysilicon photonic devices with different optical properties in different regions, US Patent No. 9768330."

PROFESSIONAL AFFILIATIONS

- Americal Physical Society
- Optical Society of America
- IEEE

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