

Nathan R. McDonald

**High Performance Systems Branch, Information Directorate
Air Force Research Laboratory**

Professional Preparation:

M.S. in Nanoscale Engineering, College of Nanoscale Science and Engineering, University at Albany, SUNY, Albany, NY, 2012

B.S. in Physics, University at Albany, SUNY, Albany, NY, 2008

Research Interests:

Neuromorphic computing hardware for size, weight, and power, constrained systems, with emphasis on optical reservoir computing.

Professional Appointments and Experience:

3/09 – present: Mathematician, Air Force Research Laboratory, Rome, NY

5/08 – 9/08: Associate Mathematician (intern), Air Force Research Laboratory, Rome, NY

Technical Publications:

1. L. Loomis, **N. McDonald**, C. Merkel, "An FPGA Implementation of a Time Delay Reservoir Using Stochastic Logic," *arXiv preprint arXiv:1809.05407*
2. **N. McDonald**, "Reservoir Computing & Extreme Learning Machines using Pairs of Cellular Automata Rules," *2017 International Joint Conference on Neural Networks (IJCNN)*, 2017, pp. 2429-2436.
3. N. Soures, C. Merkel, D. Kudithipudi, C. Thiem and **N. McDonald**, "Reservoir Computing in Embedded Systems: Three variants of the reservoir algorithm," in *IEEE Consumer Electronics Magazine*, vol. 6, no. 3, pp. 67-73, July 2017.
4. C. Zhao, B. T. Wysocki, C. D. Thiem, **N. R. McDonald**, and Y. Yi, "Energy Efficient Spiking Temporal Encoder Design for Neuromorphic Computing Systems," in *IEEE Transactions on Multi-Scale Computing Systems*, vol. 2, no. 4, pp. 265-276, Oct.-Dec. 1 2016.
5. C. Zhao, B. Wysocki, Y. Liu, C. Thiem, **N. McDonald**, Y. Yi, "Spike-Time-Dependent Encoding for Neuromorphic Processors," *J. Emerg. Technol. Comput. Syst.* 12, 3, Article 23 (September 2015)
6. M. T. Arafin, C. Dunbar, G. Qu, **N. McDonald** and L. Yan, "A survey on memristor modeling and security applications," *Sixteenth International Symposium on Quality Electronic Design*, Santa Clara, CA, 2015, pp. 440-447.
7. Rajendran, J.; Karri, R.; Wendt, J.B.; Potkonjak, M.; **McDonald, N.**; Rose, G.S.; Wysocki, B., "Nano Meets Security: Exploring Nanoelectronic Devices for Security Applications," in *Proceedings of the IEEE*, vol.103, no.5, pp.829-849, May 2015
8. B. T. Wysocki, **N. R. McDonald**, C. D. Thiem, "Hardware-based Artificial Neural Networks for Size, Weight, and Power Constrained Platforms," accepted at SPIE 2014, Baltimore, MD, 5-9 May 2014

9. Wysocki, Bryant ; **McDonald, Nathan** ; Thiem, Clare ; Renz, Thomas ; Bohl, James, “Neuromorphic Computing for Very Large Test and Evaluation Data Analysis,” Air Force Research Lab Rome NY Information Directorate, Final technical rept. Oct 2010-Sep 2013
10. Feng Ji; Li, H.H.; Wysocki, B.; Thiem, C.; **McDonald, N.**, "Memristor-based synapse design and a case study in reconfigurable systems," in Neural Networks (IJCNN), The 2013 International Joint Conference on , vol., no., pp.1-6, 4-9 Aug. 2013
11. L. Zhang, Z. Chen, J. J. Yang, B. Wysocki, **N. McDonald**, and Y. Chen, “A Compact Modeling of TiO₂-TiO_{2-x} Memristor,” *Appl. Phys. Lett.*, **102**, 153503 (2013)
12. Rose, G.S.; **McDonald, N.**; Lok-Kwong Yan; Wysocki, B., "A write-time based memristive PUF for hardware security applications," *Computer-Aided Design (ICCAD), 2013 IEEE/ACM International Conference on* , vol., no., pp.830,833, 18-21 Nov. 2013
13. Rose, G.S.; **McDonald, N.**; Lok-Kwong Yan; Wysocki, B.; Xu, K., "Foundations of memristor based PUF architectures," in *Nanoscale Architectures (NANOARCH), 2013 IEEE/ACM International Symposium on* , vol., no., pp.52-57, 15-17 July 2013
14. B. Wysocki, **N. McDonald**, M. Fanto and T. McEwen, "Designing STEM activities to complement neural development in children," *2013 IEEE Integrated STEM Education Conference (ISEC)*, Princeton, NJ, 2013, pp. 1-5.
15. Rose, G.S.; Rajendran, J.; **McDonald, N.**; Karri, R.; Potkonjak, M.; Wysocki, B., "Hardware security strategies exploiting nanoelectronic circuits," *Design Automation Conference (ASP-DAC), 2013 18th Asia and South Pacific*, pp.368,372, 22-25 Jan. 2013
16. Thiem, Clare ; Wysocki, Bryant ; Bishop, Morgan ; **McDonald, Nathan** ; Bohl, James, “Foundations of Neuromorphic Computing,” Air Force Research Lab Rome NY Information Directorate, Final technical rept. Sep 2009 - Sep 2012
17. J. Rajendran, R. Karri, J.B. Wendt, M. Potkonjak, **N. McDonald**, G.S. Rose, and B. Wysocki, “Nanoelectronic Solutions for Hardware Security,” IARC CryptologyePrint Archive <http://eprint.iacr.org/2012/575> (2012)
18. **N. R. McDonald**, S. M. Bishop, N. C. Cady, “Experimentally Demonstrated Filament-based Switching Mechanism for Al/Cu_xO/Cu Memristive Devices,” *Integrated Reliability Workshop Final Report (IRW), 2012 IEEE International*, pp. 195-198, Oct 2012
19. **N.R. McDonald**, S.M. Bishop, B.D. Briggs, J.E. Van Nostrand, N.C. Cady, “Influence of the plasma oxidation power on the switching properties of Al/Cu_xO/Cu memristive devices,” *Solid-State Electronics*, Vol. 78, pp. 46-50 (2012)
20. **N.R. McDonald**, “Al/Cu_xO/Cu Memristive Devices: Fabrication, Characterization, and Modeling,” M.S., College of Nanoscale Science and Engineering, University at Albany, SUNY, Albany, NY, 2012, 1517153
21. S.M. Bishop, B.D. Briggs, Z.P. Rice, S. Addepalli, **N.R. McDonald**, and N.C. Cady, “Fabrication and Characterization of Copper Oxide Resistive Memory Devices,” *Mater. Res. Soc. Symp.* Vol. 1337, p. 55 (2011)
22. P.M. Alsing and **N. McDonald**, “Grover’s search algorithm with an entangled database state,” *Quantum Information and Computation IX, SPIE Defense Security and Sensing Symposium*, p. 8057-11, 25-29 April 2011
23. **N. McDonald**, R. Pino, P. Rozwood, B. Wysocki, “Analysis of dynamic linear and non-linear memristor device models for emerging neuromorphic computing hardware design," *Neural Networks (IJCNN), The 2010 International Joint Conference on*, pp.1-5 18-23 July 2010

24. R.E. Pino, J.W. Bohl, **N. McDonald**, B. Wysocki, P. Rozwood, K.A. Campbell, A. Oblea, and A. Timilsina, "Compact method for modeling and simulation of memristor devices: Ion conductor chalcogenide-based memristor devices," *Nanoscale Architectures (NANOARCH)*, 2010 IEEE/ACM International Symposium on , pp.1-4 17-18 June 2010
25. **N. McDonald**, "A Review of Select Quantum Computing Simulators and an Introduction to Entangled Photon Detection", AFRL-RI-RS-TR-2009-188 (in-house technical report) (2009)

Conference Presentations:

1. **N. McDonald**, "Reservoir Computing & Extreme Learning Machines using Pairs of Cellular Automata Rules," *2017 International Joint Conference on Neural Networks (IJCNN)*, 2017, pp. 2429-2436.
2. B. Wysocki and **N. McDonald**, "Tutorial: Reservoir Computing", *2015 IEEE Symposium on Computational Intelligence for Security and Defense Applications, CISDA 2015*, May 26-28, 2015.
3. B. Wysocki and **N. McDonald**, "Designing STEM Activities to Compliment Neural Development in Children." *NYSUT Regional Education Conference 2016*
4. **N. R. McDonald**, "Memristive Devices for Hardware Security Primitives," *CHASE Conference on Secure/Trustworthy Systems and Supply Chain Assurance*, 8-9 April 2015
5. B. Wysocki and **N. McDonald**, "Designing STEM Activities to Compliment Neural Development in Children." *NYSUT Regional Education Conference 2015*
6. **N. R. McDonald**, S. M. Bishop, and N. C. Cady, "Experimentally Demonstrated Filament-based Switching Mechanism for Al/Cu_xO/Cu Memristive Devices," *Integrated Reliability Workshop (IIRW)*, 2012 International, 14-18 Oct 2012
7. **N. R. McDonald**, "Al/Cu_xO/Cu Memristive Devices: Fabrication, Characterization, and Modeling," *Network Science and Reconfigurable Systems for Cybersecurity Conference*, 28-29 August 2012
8. **N. R. McDonald**, S. M. Bishop, B. D. Briggs, J. E. Van Nostrand, and N. C. Cady, "Analysis of Nonpolar Resistive Switching Exhibited by Al/Cu_xO/Cu Memristive Devices Created Via Plasma Oxidation," *Semiconductor Device Research Symposium (ISDRS)*, 2011 International, (2011)
9. **N. McDonald**, R. Pino, P. Rozwood, B. Wysocki, "Analysis of dynamic linear and non-linear memristor device models for emerging neuromorphic computing hardware design," *Neural Networks (IJCNN)*, *The 2010 International Joint Conference on*, pp.1-5 18-23 July 2010

Book Chapters:

1. B Wysocki, **N. McDonald**, C. Thiem, G. Rose, M. Gomez II, Hardware-based Computational Intelligence for Size, Weight, and Power Con-strained Environments. In: *Network Science and Cybersecurity (Advances in Information Security)*, Springer Berlin/Heidelberg, 2013, pp. 137-154.
2. G. Rose, D. Kudithipudi, G. Khedkar, **N. McDonald**, B. Wysocki, and L.-K. Yan, Nanoelectronics and Hardware Security. In: *Network Science and Cybersecurity (Advances in Information Security)*, Springer Berlin/Heidelberg, 2013, pp. 105-125.

Patents:

- 1) Hardware Based Random Number Generator, Patent №: US 8,680,906 B1, 25 Mar 2014

Awards:

2018 AFRL/RI General Robert C. Mathis Award

2016 MVEEC Young Technologist of the Year Award

2015 AFOSR Star Team Award

2014 AFRL/RI Research and Development Technology Team Award

2013 AFRL/RI Fred I. Diamond Award

Professional Affiliations and Societies:

Phi Beta Kappa

Phi Theta Kappa