

# Luis Gomez

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## Education

- Ph.D. Electrical Engineering**, University of Michigan, Ann Arbor, MI May 2015  
Dissertation: “*Computational Electromagnetics Methods for Transcranial Magnetic Stimulation.*”  
Advisor: Eric Michielssen
- M.S. Electrical Engineering**, University of Michigan, Ann Arbor, MI May 2014  
**M.S. Applied Mathematics**, University of Michigan, Ann Arbor, MI Dec 2013  
**B.S. Electrical Engineering**, University of Florida, Gainesville, FL Aug 2008  
Honors Thesis: “*A MIMO-Inspired High-Resolution, Sparse, Dynamically-Steered Phased Array Receive Antenna.*”  
Advisor: Henry Zmuda
- B.S. Mathematics**, University of Florida, Gainesville, FL Aug 2008

## Awards/Fellowships

- K99/R00 BRAIN Initiative Advanced Postdoctoral Career Transition Award Mar 2019  
EECS Outstanding Graduate Student Instructor Award (*awarded to one GSI each term*) May 2014  
NSF Graduate Research Fellowship (*3 years of funding*) Nov 2009  
Rackham Merit Fellowship (*2 years of funding*) Aug 2008

## Research Experience

- Post-doctoral Fellow**, Duke University Medical School, Durham, NC Aug 2016-Present
- Project 1: Development of optimization methods for design of Transcranial magnetic stimulation (TMS) coils achieving optimal depth, focality and energy tradeoffs
  - Project 2: Development of novel computational electromagnetics solvers for high-fidelity electromagnetic modelling of fields generated during TMS
- Post-doctoral Fellow**, University of Michigan: Radiation Laboratory, Ann Arbor, MI Jan 2015-July 2016
- Project 1: Development of deep learning methodologies for use in inverse scattering algorithms
  - Project 2: Implementation of a general purpose fast-multipole fast-fourier transform accelerated internally combined volume surface integral equation solver for broadband electromagnetic analysis of high-permittivity and negative permittivity objects
  - Project 3: Focal single-source multicoil TMS coil design validation
- Graduate Research Assistant**, University of Michigan: Radiation Laboratory, Ann Arbor, MI Aug 2008-Dec 2014
- Project 1: Development of novel eddy-current finite-difference, integral equation techniques for the analysis of electric fields during transcranial magnetic stimulation (TMS)
  - Project 2: Development of optimization methodologies design of TMS coils
  - Project 3: Development of uncertainty quantification methodologies for TMS
  - Project 4: Development of a fast-finite difference solver for use in real-time analysis of fields generated during TMS

## Publications

### Journal Publications

- C. Zhuotong, **L. J. Gomez**, S. Zheng, A. C. Yucel, Z. Zhang, and V. Okhmatovski, "Sparsity Aware Pre-Corrected Tensor Train Algorithm For Fast Solution of 2D Scattering Problems and Current Flow Modelling on Unstructured Meshes," *Transactions on Microwave Theory and Techniques (In press)*
- L. J. Gomez**, M. Dannhauer, L. M. Koponen and A. Peterchev, "Conditions for Numerically Accurate TMS Electric Field Simulation," *Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation (In press)*
- L. J. Gomez**, S. Goetz, and A. V. Peterchev, "Design of Transcranial Magnetic Stimulation Coils with Optimal Trade-off between Depth, Focality, and Energy," *Journal of neural engineering*, 2018.

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4. B. Wang, Z. Deng, J. Smith, J. Tharayil, C. Gurrey, **L. J. Gomez**, A. Peterchev, "Redesigning Existing Transcranial Magnetic Stimulation Coils to Reduce Energy: Application to Low Field Magnetic Stimulation," *Journal of neural engineering*, 2018.
5. A. C. Yücel, **L. J. Gomez**, and E. Michielssen, "Internally Combined Volume-Surface Integral Equation for EM Analysis of Inhomogeneous Negative Permittivity Plasma Scatterers," *IEEE Transactions on Antennas and Propagation*, vol. 66, no. 4, pp. 1903-1913, 2018.
6. **L. J. Gomez**, A. C. Yücel, and E. Michielssen, "The ICVSIE: A General Purpose Integral Equation Method for Bio-Electromagnetic Analysis," *IEEE Transactions on Biomedical Engineering*, vol. 65, no. 3, pp. 565-574, 2018.
7. A. C. Yücel, **L. J. Gomez**, and E. Michielssen, "Compression of Translation Operator Tensors in FMM-FFT-Accelerated SIE Solvers via Tucker Decomposition," *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 2667-2670, 2017.
8. **L. J. Gomez**, A. C. Yücel, and E. Michielssen, "Internally Combined Volume-Surface Integral Equation for a 3-D Electromagnetic Scattering Analysis of High-Contrast Media," *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 1691-1694, 2017.
9. **L. J. Gomez**, A. C. Yücel, L. Hernandez-Garcia, S. F. Taylor, and E. Michielssen, "Uncertainty Quantification in Transcranial Magnetic Stimulation via High-Dimensional Model Representation," *IEEE Transactions on Biomedical Engineering*, vol. 62, no. 1, pp. 361-372, 2015.
10. **L. J. Gomez**, A. C. Yücel, and E. Michielssen, "Low-frequency Stable Internally Combined Volume-Surface Integral Equation for High-contrast Scatterers," *IEEE Antennas and Wireless Propagation Letters*, vol. 14, pp. 1423-1426, 2015.
11. **L. J. Gomez**, A. C. Yücel, and E. Michielssen, "Volume-Surface Combined Field Integral Equation for Plasma Scatterers," *IEEE Antennas and Wireless Propagation Letters*, vol. 14, pp. 1064-1067, 2015.
12. **L. J. Gomez**, F. Cajko, L. Hernandez-Garcia, A. Grbic, and E. Michielssen, "Numerical Analysis and Design of Single-source Multicoil TMS for Deep and Focused Brain Stimulation," *IEEE transactions on biomedical engineering*, vol. 60, no. 10, pp. 2771-2782, 2013.
13. L. Hernandez-Garcia, T. Hall, **L. J. Gomez**, and E. Michielssen, "A Numerically Optimized Active Shield for Improved Transcranial Magnetic Stimulation Targeting," *Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation*, vol. 3, no. 4, pp. 218-225, 2010.

## Book Chapters

14. A. C. Yücel, **L. J. Gomez**, W. Sheng, H. Bagci, and E. Michielssen, "Recent Trends in Uncertainty Quantification for Large-scale Electromagnetic Analysis: From Tensor Product Cubature Rules to Spectral Quantic Tensor Train Approximation," in *New Trends in Computational Electromagnetics* (ed. O. Ergul), pp. 1-31, 2019 (*In Press*)

## Invited Talks

15. "Computational Electromagnetics Enables Personalized Medicine: A Case Study in Transcranial Magnetic Stimulation," UCLA, Los Angeles, CA (April 2016)
16. "Computational Electromagnetics Enables Personalized Medicine: A Case Study in Transcranial Magnetic Stimulation" Michigan State University, East Lansing, MI (February 2016)

## Selected Conference Publications

1. **L. J. Gomez**, A. Yücel, W. Sheng, and E. Michielssen, "Fast Surrogate Model-Assisted Uncertainty Quantification via Quantized Tensor Train Decompositions," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2019
2. **L. J. Gomez**, L. M. Koponen, R. Hamdan, S. Goetz, and A. V. Peterchev, "Computationally Designed Focal Deep Transcranial Magnetic Stimulation (fdTMS) Coils," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2019
3. M. Wang, C. Qian, Z. Chen, E. di Lorenzo, **L. J. Gomez**, S. Zheng, V. Okhmatovski, and A. C. Yücel, "Tucker-Enhanced VoxHenry Simulator for Inductance Extraction of Voxelized Conducting/Superconducting Structures," *IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization*, May 2019

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4. **L. J. Gomez**, S. Goetz, and A. V. Peterchev, " Synthesis of Focal Deep Transcranial Magnetic Stimulation (fdTMS) Coils," *NYC Neuromodulation and NANS Summer Series Conference*, August 2018
5. **L. J. Gomez**, W. Sheng, A. Yücel, E. Michielssen, "Fast Statistical Characterization of Rough Surface Scattering via Tensor Train Decompositions," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2016
6. **L. J. Gomez**, N. Dalal, A. Yücel, R. Villegas, L. Honglak, E. Michielssen, "Deep Learning Augmented Inverse Scattering Algorithm," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2016
7. A. Yücel, **L. J. Gomez**, E. Michielssen, "An Internally Combined Volume-Surface Integral Equation for 3D Plasma Scatterers," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2015
8. A. Yücel, **L. J. Gomez**, E. Michielssen, "Tucker Decomposition for Compressing Translation Operator Tensors in FMM-FFT Accelerated SIE Solvers," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2015
9. **L. J. Gomez**, A. Yücel, E. Michielssen, " Low-Frequency Stable Internally Combined Volume-Surface Integral Equation for 3D High-Contrast Scatterers," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2015
10. A. Yücel, **L. J. Gomez**, E. Michielssen, "An Internally Combined Volume-Surface Integral Equation for 3D Plasma Scatterers," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2015
11. A. Yücel, **L. J. Gomez**, E. Michielssen, "Tucker Decomposition for Compressing Translation Operator Tensors in FMM-FFT Accelerated SIE Solvers," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2015
12. A. Yücel, **L. J. Gomez**, Y. Liu, H. Bagci, E. Michielssen, " A FMM-FFT Accelerated Hybrid Volume Surface Integral Equation Solver for Electromagnetic Analysis of Re-Entry Space Vehicles," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2014
13. **L. J. Gomez**, A. Yücel, E. Michielssen, " Sensitivity of TMS-Induced Electric Fields to the Uncertainty in Coil Placement and Brain Anatomy," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2014
14. **L. J. Gomez**, A. Yücel, E. Michielssen, " A Well-Conditioned Volume-Surface Combined Field Integral Equation (VSCFIE) for Inhomogeneous Scatterers with Negative Permittivities," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2014
15. **L. J. Gomez**, A. Yücel, L. Hernandez, E. Michielssen, " Uncertainty Quantification in Transcranial Magnetic Stimulation," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2013
16. **L. J. Gomez**, E. Michielssen, " A Well-Conditioned Volume-Surface Field Integral Equation (VSCFIE) for Inhomogeneous Cylindrical Scatterers with High-Electrical Contrasts," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2013
17. **L. J. Gomez**, L. Hernandez, A. Grbic, E. Michielssen, " Single-Source Multi-Coil Transcranial Magnetic Stimulators for Deep and Focused Stimulation of the Human Brain," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2013
18. F. Cajko, E. Michielssen, **L. J. Gomez**, P. G. Martinsson, L. Hernandez, "A Fast Direct Solver for TMS Analysis and Design in 3D," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2011
19. **L. J. Gomez**, L. Hernandez, A. Grbic, E. Michielssen, "Focused Multi-coil Transcranial Magnetic Stimulation," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2011
20. F. Cajko, E. Michielssen, **L. J. Gomez**, P. G. Martinsson, L. Hernandez, " A Fast Direct Solver for Transcranial Magnetic Stimulation Analysis," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2010
21. **L. J. Gomez**, L. Hernandez, A. Grbic, E. Michielssen, "A Simulation of Focal Brain Stimulation using Metamaterial Lenses," *Antennas and Propagation Society International Symposium (APSURSI)*, July 2010

## Teaching Experience

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- Graduate Student Instructor**, University of Michigan, Ann Arbor, MI Jan-May 2014
- Class Title: Electrical Circuits, Systems, and Applications (EECS 314)
  - Collaborated on class specifics and exam development, met with students for one on one tutoring, was responsible for grading and organization of four weekly lab sections each with ~20 students
- Tutor**, University of Florida: Broward Tutoring Center, Gainesville, FL Sept-Dec 2007
- Held private, as well as, 'walk in' tutoring sessions on various subjects including: Circuits 2, Signals and Systems, Linear Algebra, Calculus 3, Advanced Calculus, Numbers and Polynomials, Digital Logic, Physics 1 and 2

## Internship Experience

- Product Cost Take Out Intern**, GE Consumer and Industrial, Louisville, KY Jan-May 2008
- Worked in finding creative ways to remove cost from range electronics
  - Analyzed several temperature sensors and found a more cost efficient solution for temperature measurements in convection ovens.
- Undergraduate Research Intern**, Northwestern University: Center for Photonic Communication and Computing, Evanston, IL June-Aug 2008
- Developed a framework for automatically sending and collecting data from an AOM pulse shaping setup. Then, used the framework to collect data showing linear and quadratic phase modulation of a 2.6 picoseconds pulse.
- Undergraduate Research Intern**, Massachusetts Institute of Technology: Computer Science and Artificial Intelligence Lab (CSAIL), Cambridge, MA June-Aug 2006
- Developed automated digital filters to remove noise from an audio signal using Fourier and Short-time Fourier techniques; developed test methods to compare various filter efficiencies. Studied Speech Recognition systems and different pattern recognition algorithms

## Service

- Antennas and Propagation Society International Symposium (APSURSI), July 2019**
- Technical Program Committee, Super Reviewer
  - Co-organizer and chair of a special session on “Application of Machine/Deep Learning and Uncertainty Quantification Techniques in Computational Electromagnetics”

## Reviewer

- Brain Stimulation Journal
- NeuroImage Journal
- Journal of Neural Engineering
- IEEE Journal on Electromagnetics, RF, and Microwaves in Medicine and Biology
- IEEE Transactions on Biomedical Engineering
- IEEE Transactions on Antennas and Propagation
- IEEE Magnetics Letters

## Society of Hispanic Professional Engineers (SHPE) University of Michigan

- SHPE-Grad Professional Chair 2013-2014
- SHPE-Grad Professional Chair 2012-2013
- SHPE Alumni Chair 2012-2013
- SHPE-Grad Graduate Programs Liaison 2012-2013
- SHPE Recruitment and Retention Chair 2011-2012
- SHPE-Grad Social Chair 2011-2012

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## References

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Louise Ganiard Johnson Professor of Engineering, Electrical Engineering and Computer Science, University of Michigan

Angel Peterchev

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Associate Professor, Department Psychiatry & Behavioral Sciences, Duke University

Luis Hernandez-Garcia

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Research Professor, Biomedical Engineering and MRI Research Facility, University of Michigan

Risto Ilmoniemi

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Head of Department, Dept. of Neuroscience and Biomedical Engineering, Aalto University

Vladimir Rokhlin

[rokhlin@cs.yale.edu](mailto:rokhlin@cs.yale.edu)

Arthur K. Watson Professor of Computer Science and Mathematics, Yale University