

*Center for Wireless and Microwave Information Systems*

# **Center for Wireless and Microwave Information Systems**

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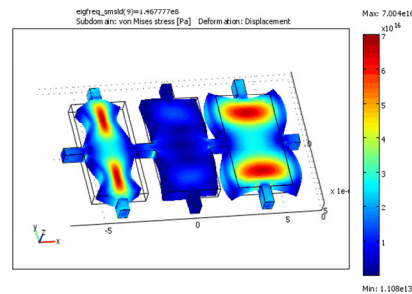
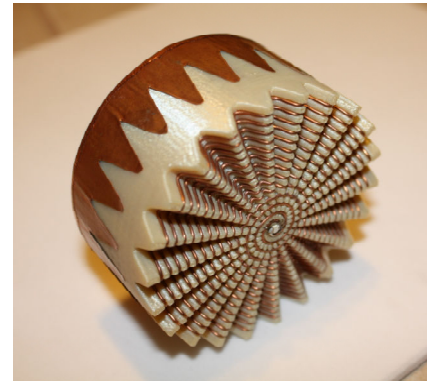
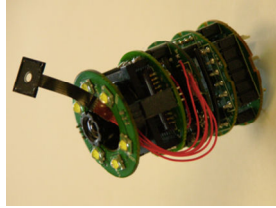
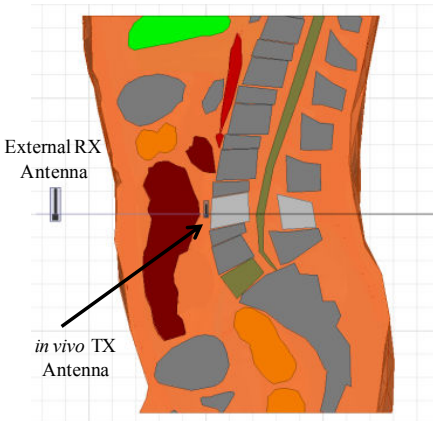
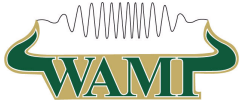
**Department of Electrical Engineering  
University of South Florida**

## ***Annual Report 2013***

**Members: Dr. Huseyin Arslan, Dr. Lawrence Dunleavy, Dr. Richard Gitlin, Dr. Gokhan Mumcu, Dr. Ismail Uysal, Dr. Jing Wang, Dr. Tom Weller (Director)**

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- **Center Updates**
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The Center for Wireless and Microwave Information Systems conducts research across a broad range of technical areas that include device modeling and characterization, RF micro electromechanical systems, advanced materials and nanoscale devices, active antennas, cognitive radio, next generation wireless architectures and RF identification (RFID). Research projects focus on basic scientific development as well as applications such as biomedical sensing, communications, robotics and transportation. Active collaborations are pursued with multiple industry and university partners as well as several centers at the University of South Florida.

In 2012/13 the Center supported 51 MS and PhD students, 3 post-doctoral fellows and 17 undergraduate students. Center faculty submitted over 47 research proposals in the past year; of these 23 proposals were funded. The WAMI faculty had more than 73 publications in journals, conferences and book chapters, 4 patents and gave 12 invited talks. The students and faculty received 9 awards and distinctions including best paper/poster awards and recognition for professional achievement.

## Newsworthy Notes

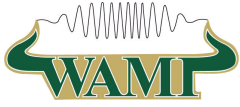
- The **2013 Rudolf E. Henning Distinguished Mentoring Award** was presented to Dr. John Volakis at WAMICON 2013. Prof. Volakis has 30 years of experience in electromagnetics, microwaves, RF circuits, antennas, and RF materials. Throughout his entire career, he has sustained one of the largest educational and research programs with exemplary leadership. He is internationally known for introducing the finite element methods in electromagnetics, novel metamaterial antennas, ultra wideband phased arrays and high performance RF materials. His innovative leadership in such diverse research programs has led to publication of 8 widely used books, 320 journal papers and over 550 conference papers. He has demonstrated an unprecedented dedication to teaching/mentoring of his students and effectively motivated them to pursue success with desire throughout their entire careers. He has mentored nearly a total of 75 PhD



students and post-doctoral researchers with 20 of them having co-authored papers that won awards at international conferences. Among these graduate students, 16 have become faculty members at major universities throughout the world. A large number of his students took leadership roles in major corporations or started new companies. His service to Professional Societies include: 2004 President of the IEEE Antennas and Propagation Society, twice the general Chair of the IEEE Antennas and Propagation Symposium, IEEE APS Distinguished Lecturer, IEEE APS Fellows Committee Chair, IEEE-wide Fellows committee member & Associate Editor of several journals. He is a Fellow of IEEE and ACES. Among his awards are: The Univ. of Michigan College of Engineering Research Excellence award (1993), Scott award from The Ohio State Univ. College of Engineering for Outstanding Academic Achievement (2011) and the IEEE Tai Teaching Excellence award (2011).

- The **14<sup>th</sup> annual IEEE Wireless and Microwave Technology (WAMI) Conference** was held in Orlando, FL on April 7-9, 2013. The conference technical program included one workshop, two paper tracks and two tutorial tracks over three days consisting of authors presenting state-of-the-art multidisciplinary research on wireless RF and microwave technologies. Approximately two hundred attendees came

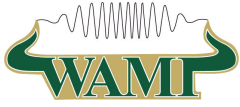




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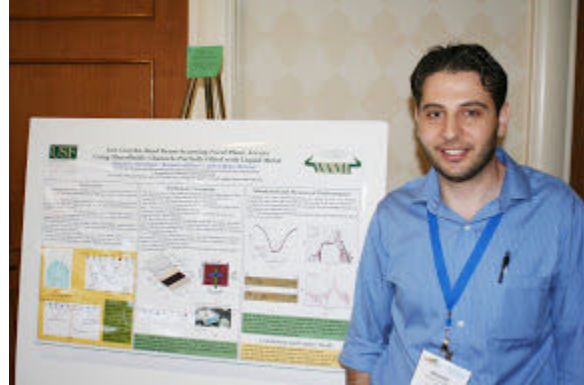
to the conference made up of academia, industry and government from the US/Canada, Europe, Asia, and Latin America.

- The first set of GaAs circuits from Dr. Wang's MMIC course was submitted for fabrication to TriQuint in Fall 2013 as part of the university partnership program. The TriQuint process design kit (PDK) has been integrated across multiple courses – RF/Microwave Circuits I and II, MMIC Design, and RF/MW Power Amplifier Design – to allow students the opportunity to design, layout and eventually test their own GaAs MMIC designs. Details can be found at <http://wami.eng.usf.edu/education/courses.htm>.
- Special thanks to Raytheon for their continued financial support, which is used to provide supplemental funds for our students, support conference travel, and allow the WAMI Center to maintain its facilities. Mini Circuits continues to be a strong supporter of the WAMI teaching laboratory by contributing microwave components. The Center also acknowledges the continuing strong support of Agilent Technologies, Applied Wave Research, Modelithics and Sonnet for providing our students with no-cost access to their exceptional software tools.
- The schedule for the 2014 **WAMI Advisory Board** meeting is TBD pending final arrangements for the combined IMS 2014 / WAMICON / ARFTG conference in Tampa in June.

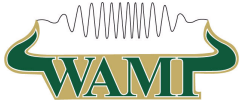


## Student Recognition

- **Eduardo Rojas, Ramiro Ramirez, Sean Murphy and William Mitchell**, WAMI Ph.D. and undergraduate students, are semi-finalists in the 2014 IEEE AP-S RFID Design Contest.
- **Ahmad Gheethan**, a WAMI Ph.D. student, won 1<sup>st</sup> Prize in the nation-wide TI Design Challenge.
- **Ibrahim Nassar**, a WAMI Ph.D. student, took 1<sup>st</sup> Prize in the WAMICON 2013 Student Paper Competition. Ibrahim also received a selective IEEE MTT-S Graduate Fellowship in 2013. He currently works at Ansys.
- **Maria Cordoba**, a WAMI Ph.D. student, took 1<sup>st</sup> Prize in the WAMICON 2013 Student Research Presentation competition.
- **Timothy Palomo**, a WAMI Ph.D. student, received a Best Poster Award at the USF Capstone and Research Poster Competition and received a \$500 travel award.
- **Abhishek Dey**, a WAMI Ph.D. student, was a IEEE Antennas and Propagation Society Symposium Student Paper Competition finalist – rated in top 15 out of 141 papers, 2013. Awarded \$1250 for travel grant. Abhi also received a Best Poster Award at the USF Capstone and Research Poster Competition and received a \$500 travel award.
- **Bryce Hotalen**, a WAMI undergraduate student, received an IEEE MTT-S Undergraduate Scholarship. Bryce currently works at TriQuint.
- **I-Tsang Wu**, a WAMI Ph.D. student, took 1<sup>st</sup> Prize in the 42nd Annual Symposium of the Ultrasonic Industry Association (UIA 2013) Student Paper Competition.
- **Vinicio Carias**, a WAMI Ph.D. student, was awarded a prestigious one-year Fulbright Research Grant to continue his dissertation research at the Institute for Microsystems Technology (IMTEK) of the University of Freiburg, Germany, which is one of the largest institution in the field of microsystems technology in Europe.
- A Capstone Design team consisting of 4 students (**Drew Burgett, Randy Montero, Christopher Stefanovic, Derek Seroky**) took second place in Spring 2013 USF EE capstone competition. The title of their project: RF Charging Robot.



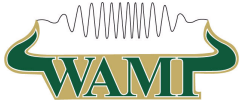




## Research Highlights – Current & Recent Projects

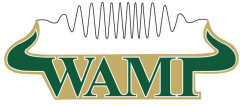
- **Collaborative Research: A Systems-Centric Foundation for Electrical and Computer Engineering Education**, P.I. S. Thomas, Co-P.I. T. Weller, Granting Agency: National Science Foundation. Development of systems-centric, hands-on learning modules for the introductory circuits course. This is a joint project with U. Hawaii, U. Minnesota, U. Vermont and Northern Arizona U.
- **GOALI Collaborative Research: 3D RF Microsystems using Direct Digital Manufacturing Technology**, P.I. T. Weller, Co-P.I. C. Lusk (Mechanical Engineering) and K. Church (Sciperio), Granting Agency: The National Science Foundation. Investigate new 3D microwave systems using digital manufacturing techniques. This is a collaborative project with Georgia Tech (J. Papapolymerou).
- **GOALI: Integrated Microwave Microneedle-Electrode System for Fine Scale Material and Device Characterization**, P.I. S. Bhansali, Co-P.I. T. Weller, Granting Agency: National Science Foundation. MEMS-based uni-axial and co-axial microneedles are being integrated with microwave electronics to develop miniature systems for microwave microscopy.
- **GOALI: COLLABORATIVE RESEARCH: Passive, Diamagnetic Inertial Sensing Integrated with High-Sensitivity Telemetry**, P.I. J. Wang, Co-P.I. T. Weller, Granting Agency: National Science Foundation. This is a collaborative project being conducted with the University of Vermont to develop passive sensor networks using high-sensitivity, MEMS-based diamagnetic accelerometers.
- **Design and Demonstration of Antennas for Selected RFID Applications**, P.I. T. Weller, Granting Agency: Silent Partners. The specific goal for the new tag antenna designs is to improve the achievable performance when tags are mounted on either metallic objects or objects with high water content.
- **3D Formable RF Materials**, P.I. T. Weller, Granting Agency: Army Research Office. Microwave characterization of materials used in 3D printed RF electronics.
- **Three-Dimensional (3D) Structural Radio Frequency (RF) Electronics**, P.I. T. Weller, Granting Agency: Sciperio (Air Force Phase 2 SBIR sub-contract). The





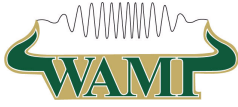
purpose of this project is to investigate a 2.45 GHz phased array module using direct print additive manufacturing techniques.

- **Additive Manufacturing Technologies – Phase 1**, PI T. Weller, Sponsor: Jabil. The purpose of this project is to investigate the application of direct digital manufacturing for high frequency consumer electronics fabrication.
- **Remote Environmental Monitoring and Diagnostics in the Perishable Supply Chain** P.I. C. Nunes, Co-P.I. I. Uysal, Granting Agency: US Army Natick Soldier RD&E Center. Using RFID sensor technology to monitor freshness of army rations and develop smart distribution systems. This is a joint project with University of Florida.
- **Research and Improvement of the RFID System’s Performance Metrics for Packaging Line 4** P. I. I. Uysal, Granting Agency: Cephalon/Teva Pharmaceuticals. Academic approach to improve performance of a real RFID implementation for high-speed serialization.
- **Assessment and Documentation of Current State-of-the-Art in RFID Tags** P.I. I. Uysal, Granting Agency: Abbott Pharmaceuticals. Extensive review and documentation of the available RFID technology spectrum in the market.
- **Testing and Calibration of RF Temperature Sensors** P.I. I. Uysal, Granting Agency: RFID Innovative Solutions LLC. Testing and calibration of ISO18000-7 Temperature Sensors developed by RFID IS LLC.
- **Reducing Strawberry Waste and Losses in the Postharvest Supply Chain via Intelligent Distribution Management** P.I. I. Uysal, Co-P.I. C. Nunes, Granting Agency: Walmart Foundation. Temperature mapping of the cold chain with wireless sensors to enable smart distribution practices
- **Increasing Consumption of Specialty Crops by Enhancing their Quality and Safety** P.I. C. Nunes, Co-P.I. I. Uysal, Granting Agency: US Department of Agriculture. Algorithmic modeling of the effects of environmental variables like temperature and humidity on specialty crops.
- **Improving the Communications Performance and Reliability of *In Vivo* Wireless Medical Devices** –Gitlin. Funded by the NSF. This STTR project has the goal of advancing novel wireless communications technologies that enable high performance, reliable communications, and the ability to overcome link and/or power failures among networked *in vivo* medical devices.



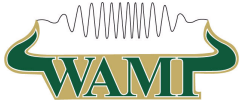
- **Channel Modeling and Optimized Radio Access Design for *In Vivo* Wireless Communication**---Arslan and Gitlin. Funded by QNRF. This project is directed towards developing reliable signal processing and wireless communications technologies and methodologies to address the major challenges of the *in vivo* communication channel that will be faced by emerging wireless body area networks.
- **Holistically Application-Aware Multi-dimensional Cognitive Radio (HAMCR)** ---Arslan and Gitlin [and Haas (Cornell)]. Funded by NSF. HAMCR is an application-aware cognitive radio with new technology that enables substantial growth in the capacity of wireless networks, with support for diverse applications, without additional spectrum. HAMCR maximizes spectrum utilization by trading off the spectral resource allocations of connections for the application-level QoS, while still maintaining acceptable levels of QoS for the users of the underlying applications, thus satisfying an increased number of users in times of shortage of spectral resources.
- **Innovative Cardiac Rhythm Management (*iCRM*)** system. Funded by Jabil Circuit. The goal of the project is to leverage existing electrocardiogram [ECG] technologies to improve outcomes in CRM. Signals from an external and an Intracardiac ECG are combined, or fused, in a wireless *Communicator* that contains a *Learning System* that processes the multi-dimensional networked ECG information.
- **GOALI: COLLABORATIVE RESEARCH: Antenna-Coupled ALD-Enabled Metal-Insulator-Insulator-Metal Diodes for High Responsivity and High Resolution THz/Infrared Focal Plane Arrays**, P.I. J. Wang, Co-P.I. G. Mumcu, N. Kislov, Granting Agency: National Science Foundation. The objective of this research is to develop a new class of room temperature metal-insulator-insulator-metal tunnel diode detectors and monolithically integrate them within novel miniature antenna focal plane array configurations for high resolution and high responsivity THz/infrared imaging as well as energy harvesting.
- **GOALI: Efficiency Enhancement of Solar Cells Through Electronic Structure Design**, P.I. R. Schlaf, Co-P.I. J. Wang, A. LaVoie (Novellus), Granting Agency: National Science Foundation. The proposed work aims at the characterization and subsequent tailoring of the electronic structure of nanolaminates and interfaces manufactured with atomic layer deposition (ALD).
- **Acoustic Emission Technology on a Chip**, PI J. Wang, Co-PI R. Guldiken, WavesinSolids, LLC through National Science Foundation (NSF) SBIR Phase I and Phase IB Program. The goal of this work is to thoroughly investigate the folded-beam MEMS resonator with interdigitated capacitive transducers to address the current limitations of MEMS acoustic emission sensors such as low sensitivity.
- **Development and evaluation at the laboratory level of biosensors for the diagnosis of all dengue virus serotypes based on the Non-Structural**





**protein- 1 (NS-1)**, PI J. Wang, Granting Agency: the Administrative Department of Science, Technology and Innovation–COLCIENCIAS, Colombia. The aim of the proposed work is to develop lab-on-a-chip devices that can be used as immunoassays for all dengue virus serotypes based on the Non-Structural protein-1 (NS-1) for accurate and early diagnosis of dengue infection.

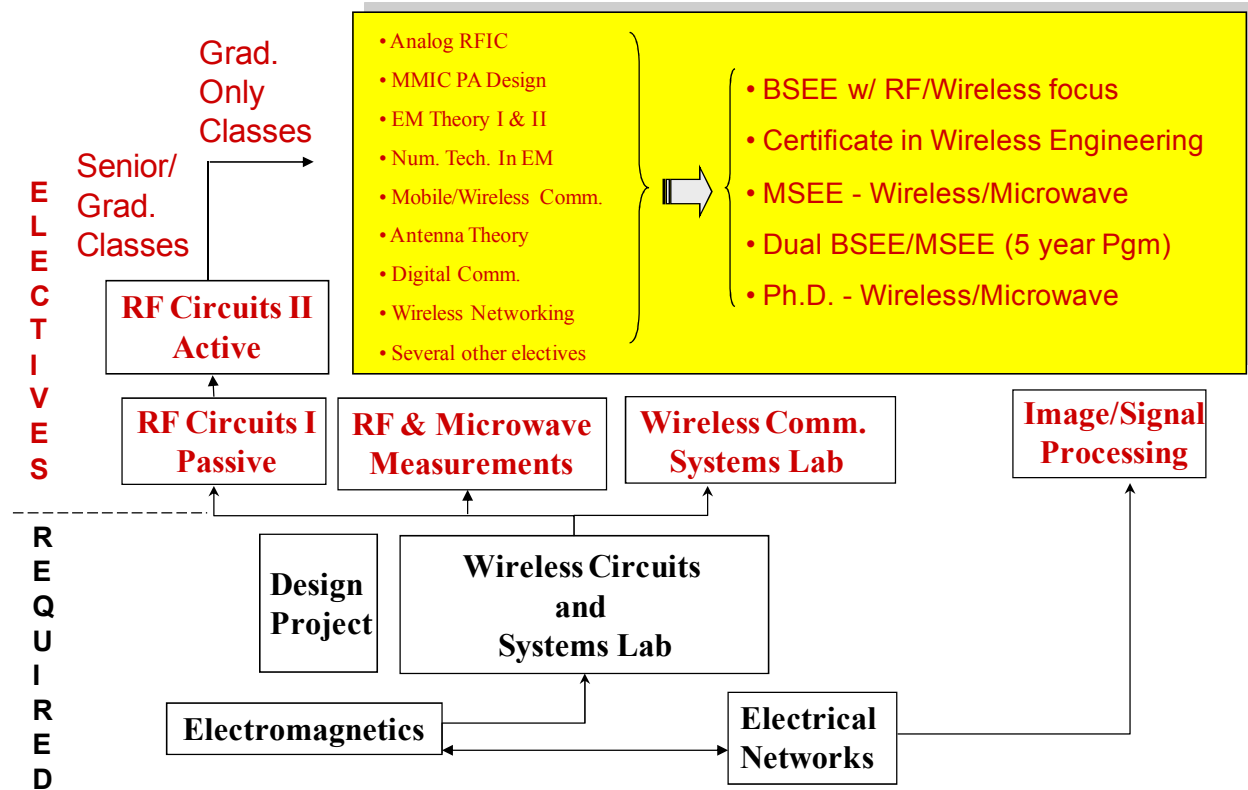
- **Simulation and Modeling of Ion Mobility Separative Capability**, P.I. J. Wang, Granting Agency: Draper Laboratory and Florida High Tech Corridor. The goal of the proposed work will be the optimization of resolution of the Differential Mobility Spectroscopy (DMS) which is currently limited to ~50. Furthermore, the experience gained from this task will be utilized later on in the understanding of ion transfer efficiencies from atmospheric pressure to vacuum.
- **Improved Device Fabrication Technology for High Frequency/High Q Resonator Filters**, P.I. J. Wang, Grant Agency: Plasma Therm LLC and Florida High Tech Corridor. The objective is to demonstrate and improve performance of USF developed high frequency MEMS filter device using advanced deep silicon etching technology. In particular, MEMS device structures with capacitive transducers with sub 250nm of narrow trench will be investigated to enhance of the performance.
- **Research and Training Internship for Enhanced Microwave and Millimeter-Wave Circuit Design, Characterization and Modeling**, PI: J. Wang, Granting Agency: Modelithics, Inc. and Florida High Tech Corridor. Research and training grant for development and verification of improved models as well as modeling and characterization techniques for high frequency transistors.
- **Metamaterial based Antennas & Coupling reduction for Miniature Anti-Jam GPS Arrays**, PI: G. Mumcu, Raytheon IDEA Program and Florida High Tech Corridor. The proposed dual band miniature ( $\leq \lambda/10 \times \lambda/10$ ) GPS antenna elements and their coupling reduction within a tightly packed array environment through the use of metamaterial structures will pave the way for realization of miniature anti-jam GPS arrays, potentially realizing performance of a 14" diameter Complex Radiation Pattern Antenna (CRPA) within <5" diameter Fixed Radiation Pattern Antenna (FRPA) size.
- **Structural Imaging of High Temperature Furnace Walls**, PI: G. Mumcu, Granting Agency: PaneraTech, Inc. through National Science Foundation (NSF) SBIR Phase II Program. Design an imaging array consisting of compact ultra-wideband antenna elements to work in contact with the high temperature glass furnace walls.

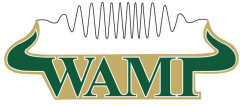


## Selected Curriculum Activities

The WAMI faculty was engaged in several on-going and new activities in 2012/2013 aimed at improving the RF/microwave/wireless curriculum. These activities include:

- A new, multi-university collaboration that will develop hands-on laboratories for the introductory circuits course, emphasizing systems-centric learning and the broad applications of electrical engineering. This project, called ENFUSE (Engaging Fundamentals & Systems Engineering) is sponsored by the National Science Foundation and involves the University of Hawaii, University of Vermont, University of Minnesota and Northern Arizona University.
- EGN6025 RFID and NFC Technologies for IT – A completely online and elective course designed and taught by Dr. Uysal as part of the Master of Science in Information Technology program was approved as a graduate course by USF Tampa Graduate Council in December 2013.
- Through a new partnership with TriQuint, the WAMI faculty has integrated the use of their GaAs process design kit into several of the RF/microwave courses. Students now have the opportunity to design, layout and test circuits fabricated by TriQuint.
- WAMI faculty members are developing new courses on RF/microwave circuits and antenna theory as part of the USF EE Department's on-line master's program.





## Professional Activities

- **WAMI Advisory Board Meeting**  
– The 15<sup>th</sup> meeting of the WAMI Center’s External Advisory Board was held in Orlando, FL in April 2013 prior to WAMICON 2013.
- **2013 IEEE International Conference on RFID** – Dr. Uysal was a member of the Technical Program Committee and the Local Arrangements Chair for this conference, which was held in Orlando in Spring of 2013.
- **Dr. Gitlin** was named a Distinguished University Professor and also received an Outstanding Faculty award.
- **2014 International Microwave Symposium** – Drs. Dunleavy and Weller are chair and vice-chair, respectively, for the IEEE MTT Society’s flagship conference that will be held in Tampa in 2014. (Yes, it is finally here!)

