

Center for Wireless and Microwave Information Systems

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

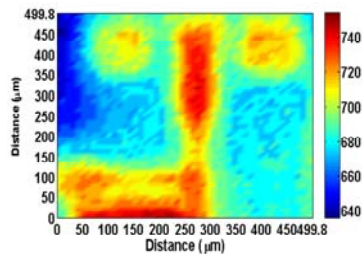
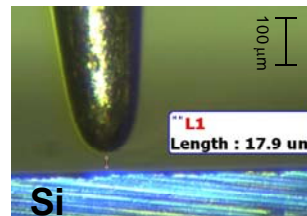
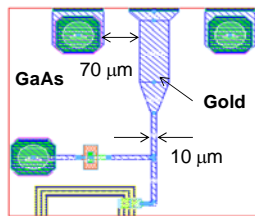
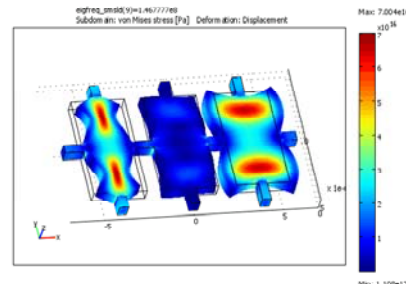
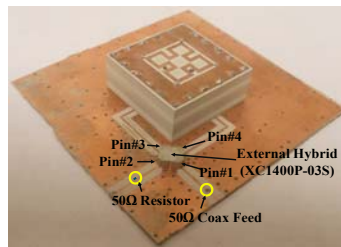
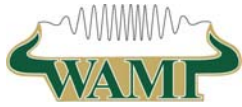
Annual Report 2011

Center Director – Dr. Thomas Weller

**Members: Dr. Huseyin Arslan, Dr. Lawrence Dunleavy, Dr. Richard Gitlin, Dr. Sal Morgera,
Dr. Gokhan Mumcu, Dr. Jing Wang**

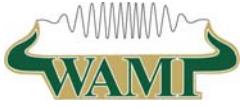
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The Center for Wireless and Microwave Information Systems conducts research across a broad range of technical areas that include device modeling and characterization, RF micro electromechanical systems, advanced materials and nanoscale devices, active antennas, cognitive radio and next generation wireless architectures. 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 2010/11 the Center supported 42 MS and PhD students and 9 undergraduate students. Center faculty submitted over 35 research proposals in the past year; of these 12 proposals were funded including 5 from government agencies. The WAMI faculty had more than 67 publications in journals, conferences and book chapters and gave 5 invited talks.



Newsworthy Notes

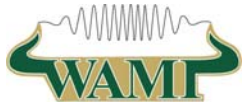
- The **2011 Rudolf E. Henning Distinguished Mentoring Award** was presented to Dr. Linda P.B. Katehi, Chancellor of the University of California - Davis at WAMICON 2011. Dr. Katehi's awards include being a Fellow of IEEE and the American Association for the Advancement of Science, a member of the National Academy of Engineering, the Third Millennium Medal, and a Distinguished Educator Award. She has graduated over 40 Ph.D. students and 11 M.S.-only students during her uniquely productive academic career. Over twenty of her Ph.D. graduates currently hold tenured/tenure-track positions at universities around the world.
- The **12th annual IEEE Wireless and Microwave Technology (WAMI) Conference** was held in Clearwater Beach, FL on April 18-19, 2011. The conference technical program included two paper tracks and one tutorial track over two days consisting of authors presenting state-of-the-art multidisciplinary research on wireless RF and microwave technologies. Two hundred attendees came to the conference made up of academia, industry and government from the US/Canada, Europe, Asia, and Latin America.
- The next **WAMI Advisory Board** meeting is planned for spring 2012 in association with the 2012 WAMICON.
- **Agilent Technologies** was recognized in 2011 for providing the largest-ever in-kind donation to The University of South Florida - \$25.9 million in electronic design automation software. The WAMI Center was the direct recipient of this donation of Advanced Design System tools. Details on the story are available at <http://news.usf.edu/article/templates/?a=3727>.
- 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 and Sonnet for providing our students with no-cost access to their exceptional software tools.



Historic Donation for Engineer Training

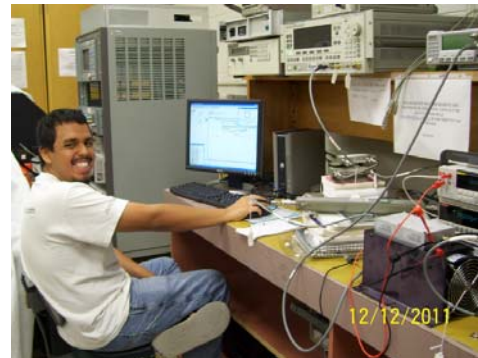
Agilent Technologies Inc. makes a \$25.9 million in-kind donation, the largest ever received by USF.

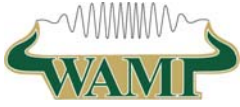




Student Recognition

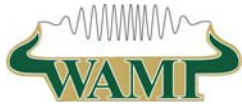
- **David Cure**, a WAMI Ph.D. student, received a NASA GSRP Fellowship in 2010 to support his research on conformal antennas for biomedical applications.
- **Maria Cordoba and Cesar Morales**, WAMI Ph.D. students, each were selected as 2011 College of Engineering Research Week Poster Award recipients.
- **Timothy Palomo**, an undergraduate student researcher in the WAMI Center, was selected as the Electrical Engineering Department Outstanding Graduate in December 2011. Tim also received recognition for having the best senior capstone design project.
- **David Cure**, a WAMI Ph.D. student, received Second Prize in the 2011 HENAAC Conference Student Poster Competition. David also received an Honorable Mention in the student paper competition at the 2011 International Antennas and Propagation Symposium.
- **Evelyn Benabe**, a WAMI Ph.D. student, received a Silver Award Graduate Student Fellowship from the Automatic Radio Frequency Techniques Group in 2011.
- **Kevin Kellogg**, a WAMI M.S./B.S. student, and his co-worker Peter Falvo received the Second Place in the Student-Built Vacuum Systems Design Poster Competition during the American Vacuum Society's (AVS) 57th International Symposium and Exhibition in Albuquerque, October 17-22.
- **Vinicio Carias**, a WAMI Ph.D. student, received USF Graduate Student Success (GSS) Fellowship in Fall 2011 to support his dissertation research. Since Fall 2011, he also enrolled in the Doctoral Student Leadership Institute, which is an new initiative developed by the USF Graduate School.



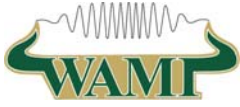


Research Highlights – Current & Recent Projects

- **Functional Magnetic Polymer Nanocomposite Films for Tunable RF Device Applications**, P.I. T. Weller, Co-P.I. H. Srikanth and J. Wang, Granting Agency: National Science Foundation. Development of nanocomposite polymer substrates for microwave applications. A provisional patent application was filed based on research performed in this project: *Magnetically Tunable Nanocomposite Polymer for Microwave Applications*, Provisional Patent Application filed 6/2010, USF Ref: 10A068PR.
- **Non-Linear Device Applications of Nano-Patterned Barium Strontium Titanate Thin Films**, P.I. T. Weller, Co-P.I. A. Kumar and M. Smith (Raytheon), Granting Agency: The National Science Foundation (ECS 0601536). Basic research on the fabrication and characterization of miniaturized (nano-scale) non-linear BST microwave devices. We are currently collaborating with the Center for Ultrafast Science (Dr. John Whitaker) at the University of Michigan to investigate electro-optic sampling of non-linear time domain waveforms resulting for large signal excitation of BST varactors.
- **GOALI – Flexible Ferroelectric-Based Antenna for Conformal Radiometric Imaging**, P.I. T. Weller, Co-P.I. A. Kumar and D. Hoff, Granting Agency: National Science Foundation. In this project the development of tunable conformal antennas and integrated radiometers are being investigated for biomedical sensing and monitoring applications. A provisional patent application was filed based on research performed in this project: *Flexible Low Profile Microwave Antenna*, Provisional Patent Application filed 10/2009, USF Ref. No.: 09B103PR
- **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.
- **Miniature X-band Filters with Coupled Metamaterial Resonators**, P.I.: Gokhan Mumcu, co-P.I.: Thomas M. Weller, Granting Agency: Raytheon. Investigate designs for miniaturized X-band band-stop and band-pass filters.

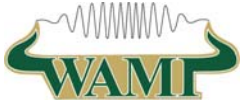


- **GOALI: COLLABORATIVE RESEARCH: Antenna-Coupled ALD-Enabled Metal-Insulator-Insulator-Metal Diodes for High Responsivity and High Resolution THz/Infrared Focal Plane Arrays**, P.I. J. Wang, Co-P.I. G. Mumcu, N. Kislov, Granting Agency: National Science Foundation. The objective of this research is 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).
- **Injection-Moldable Low-k and Low-CTE Polymer Nanocomposites with Minimal Cure Shrinkage for Integrated Ultra High Density Interconnects**, P.I. J. Wang Co-P.I. R. Toomey, T. Weller, Granting Agency: Draper Laboratory and Florida High Tech Corridor. The proposed research involve synthesis of nanoparticles, polymer processing with uniform dispersion of nanoparticles with tight particle size distribution, producing injection-moldable polymer nanocomposites with tailored coefficient of thermal expansion (CTE) and minimum cure shrinkage. The proposed work will address some of the critical needs by the advanced multi-chip-module (MCM) project at Draper Lab.
- **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**, P.I. J. Wang, Granting Agency: Modelithics. The objective is to characterize (measure) example microwave devices and construct and verify improved models for high frequency transistors, such as Heterojunction Bipolar

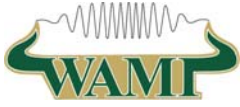


Transistors (HBTs) as well as field effect transistors of multiple types such as GaN HEMT, SiC MESFET, GaAs pHEMT, and Silicon MOSFET (LDMOS and VMOS).

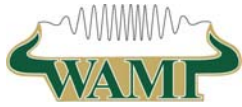
- **Metamaterial based Antennas & Coupling reduction for Miniature Anti-Jam GPS Arrays**, PI: G. Mumcu, Raytheon IDEA Program and Florida High Tech Corridor. The proposed dual band miniature ($\leq \lambda/10 \times \lambda/10$) GPS antenna elements and their coupling reduction within a tightly packed 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, PaneraTech, Inc. through National Science Foundation (NSF) SBIR Phase I Program. Design a structural imaging array consisting of compact ultra-wideband antenna elements to work in contact with the high temperature glass furnace walls.
- **Development of a High-Density Cylindrical Ion Trap Array Mass Spectrometer using Micro-Fabrication Techniques**, P.I. F. Amerom, Co-P.I. J. Wang, S. Bhansali, T. Short, T. Greely, Granting Agency: National Science Foundation. The objective is to develop high-density cylindrical ion-trap array mass spectrometers using micro-fabrication techniques. The devices will have lower system power and vacuum requirements, compared to more traditional mass spectrometer designs. The mass spectrometers will be used to analyze environmental water samples.
- **Virtually Transparent Epidermal Imagery**, P.I. Y. Sun, Co-P.I.s. A. Anderson and R.D. Gitlin. This work has recently been funded by the NSF as a Cyber-Physical System (CPS) award. The objective of this research is to develop a cyber-physical system capable of displaying the in vivo surgical area directly onto patients' skin in real-time high definition. This system will give surgeons an "x-ray" vision experience, since they see directly through the skin, and remove a spatial bottleneck and additional scarring caused by laparoscopes in minimally invasive surgery. The approach is to develop wireless micro-cameras that: occupy no space required for surgical tools, produce no additional scarring to the patient, and transfer wireless high-definition video images. A virtual view generating system will project the panoramic videos from all cameras to the correct location on the patient's body with geometry and color distortion compensation. The results will be a potential paradigm shift in minimally invasive surgery.
- **Research and Training Internship for Enhanced Microwave Characterization and Circuit Design**, 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 for high frequency transistors.



- **Uncooled Nanoscale Infrared High-Speed Sensors for Missile Seeker Applications**, PI: J. Wang, subcontract to NanoCVD, Co. through US-Army SBIR Phase II grant and Florida High Tech Corridor. Development of an uncooled infrared detectors consisting of a microscale antenna in conjunction with a nanoscale metal-insulator-metal tunnel diode (MIMTD). Successful development of uncooled nanoscale infrared high-speed sensors, in accordance with the proposed effort, will open up a variety of applications such as driver's night vision enhancement.
- **Implementation of miniaturized on-chip passives and antennas based on injection-moldable nanocomposites for multi-chip-module (MCM) technology**, PI: J. Wang, Co-PI: R. Toomey, H. Srikanth, Granting Agency: Draper Laboratory and Florida High Tech Corridor. The objective of this work is to advance the current state-of-the-art technology in the area of injection-moldable polymer nanocomposites with monodispersed dielectric/magnetic particles and minimal cure shrinkage for multi-chip module (MCM) assembly.
- **Development of Miniature On-Chip Low-Loss High-Q Filter Arrays**, PI: J. Wang, Granting Agency: Raytheon Company and Florida High Tech Corridor. The objective is to design, develop and demonstrate a new class of miniature on-chip low insertion-loss high-Q tunable filters with key emphasis on the manufacturability.
- **Miniature Metamaterial Antennas for High Resolution THz Imaging Arrays**, PI: G. Mumcu, New Researcher Grant, University of South Florida. Miniaturization of slot dipoles using metamaterial based miniaturization and antenna loading techniques. Conventional CPW fed slot antennas will be miniaturized by >50% to enable a significantly improved resolution for mm-wave and THz imaging applications.
- **Interference Cancellation and Avoidance for OFDM based Future Generation Wireless Cellular Communications Systems**, PI: H. Arslan. This project is supported by NTT DoCoMo USA Labs, San Jose, CA. The goal of the project is the investigate interference scenarios for future fourth generation wireless communication systems. Especially, interference cancellation and avoidance for future OFDM based wireless communication system has been studied.
- **Signal Intelligence for Next Generation Wireless Communications Systems**, co-PI: H. Arslan. This is a collaborative project with Texas A&M University and its campus in Qatar –TAMUQ. The project is supported by QNRF (NSF of Qatar), subcontracted to USF through TAMUQ. PI (Dr. Qaraqi) is from TAMUQ. The goal for the project is to analyze wireless signals so that critical information about the received signals (or interference) can be extracted. The extracted information include location of interference, source of interference, modulation and signaling type of interference, bandwidth and carrier frequency of interference etc.



- **(Pending) Project Summary: Innovative Non-linear RF System Modeling Solutions Validated within a Re-configurable SDR Test Environment** PI: H. Arslan, NSF STTR Proposal with Modelithics Inc. This Small Business Technology Transfer Program (STTR) Phase I project will investigate emerging and new nonlinear RF system modeling solutions verified in a re-configurable physical hardware and simulation-based SDR test environment. By verifying the model performance in such an environment, we can evaluate how accurate the generated models are in system-level simulations. Of interest are metrics such as error-vector-magnitude (EVM), bit error rate (BER) and adjacent channel power ratio (ACPR). A key focus will be on the system impact of power amplifier behavior under variations in bias voltages, compression level and carrier frequencies.

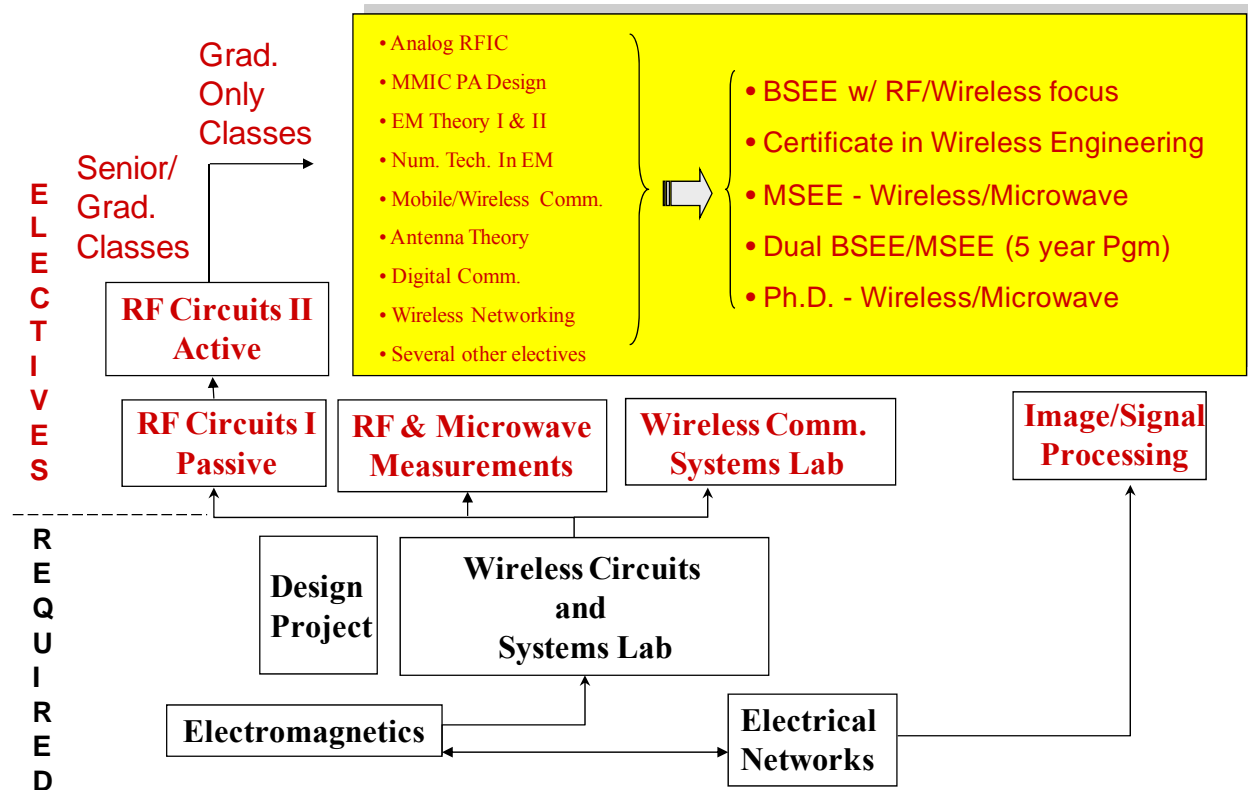


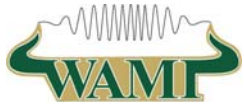
Selected Curriculum Activities

The WAMI faculty continues to advance the educational opportunities provided to undergraduate and graduate students in USF's Electrical Engineering Department. In *Educating the Engineer of 2020*, Charles Vested noted "We need to establish a proper intellectual framework within which to study, understand, and develop large, complex engineered systems." In addressing this call to action, the WAMI Center has participated in a multi-year project sponsored by the National Science Foundation to develop system-centric undergraduate curriculum. The project involves USF, the University of Vermont, Northern Arizona University and the University of Hawaii; the USF PI is Tom Weller. One product of this project is a collection of on-line modules constituting a course on wireless sensor networks, several of which were incorporated into USF's RF/Microwave Circuits I and II courses.

Other curriculum enhancement activities include:

- Conversion of the Wireless Circuits and Systems course lecture material to a fully on-line version (Larry Dunleavy)
- Development of a new course on advanced antenna theory (Gokhan Mumcu)
- Pilot study of a remote-delivery approach for the Wireless Circuits and Systems laboratory course (Tom Weller)
- Development of a Professional Master's in Electrical Engineering degree program (in progress).

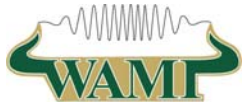




Professional Activities

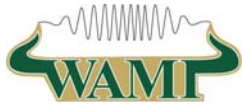
- **WAMI Advisory Board Meeting**
– The 13th meeting of the WAMI Center’s External Advisory Board was held in Clearwater, FL in April 2011 prior to 2011 WAMICON.
- **2014 International Microwave Symposium** – Drs. Dunleavy and Weller are chair and co-chair, respectively, for the IEEE MTT Society’s flagship conference that will be held in Tampa in 2014. While the event is still several years away, planning is already in progress!



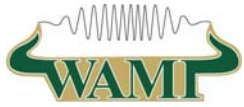


Recent Publications and Presentations – 2010-11

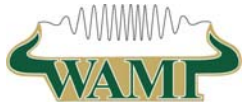
1. K. Stojak, S. Pal, H. Srikanth, C. Morales, J. Dewdney, T. Weller and J. Wang, "Polymer nanocomposites exhibiting magnetically tunable microwave properties," *Nanotechnology*, vol. 23, no. 13, 135602 (6 pp), February 2011.
2. I. Nassar and T. Weller, "Development of Novel 3-D cube Antennas for Compact Wireless Sensor Nodes," accepted for publication in *IEEE Trans. AP*, August 2011.
3. Bonds, Q.; Weller, T.; Herzig, P.; , "Towards Core Body Temperature Measurement via Close Proximity Radiometric Sensing," *Sensors Journal, IEEE* , vol. PP, no.99, February 2011.
4. Morales, C.; Dewdney, J.; Pal, S.; Skidmore, S.; Stojak, K.; Srikanth, H.; Weller, T.; Jing Wang; , "Tunable Magneto-Dielectric Polymer Nanocomposites for Microwave Applications," *Microwave Theory and Techniques, IEEE Transactions on* , vol.59, no.2, pp.302-310, Feb. 2011.
5. Maria Cordoba and Thomas Weller, "Low-Cost Non-Contact Microwave Probe Design for Insulating Materials Characterization," 2011 ARFTG Conference, September 2011.
6. David Cure, Thomas Weller and Felix Miranda, "Low Profile Tunable Antenna for Biomedical Radiometry Applications," 2011 HENAAC Conference, August 2011.
7. Supriya Ketkar, Manoj Ram, Ashok Kumar, Thomas Weller and Andrew Hoff, "Stabilization of Graphene-Polyaniline based nanocomposite Electrodes using Barium Strontium Titanate for Supercapacitor Application," submitted to 2012 TMS Annual Meeting & Exhibition, July 2011.
8. Supriya Ketkar, Manoj Kumar, Ashok Kumar, Thomas Weller and Andrew Hoff, "Electrical and Structural Diagnostics of Barium Strontium Titanate (BST) Thin Films," 2010 MRS Fall Meeting proceedings.
9. D. Cure and T. Weller, "A comparison between Jerusalem Cross and Square Patch- based Frequency Selective Surfaces for Low Profile Antenna Applications," ICEAA-IEEE APWC, September 12-17, 2011 in Torino, Italy.
10. T. Price, T. Weller, Y. Shen and X. Gong, "Comparison of Barium Strontium Titanate Varactors on Magnesium Oxide and Alumina Substrates," *IEEE WAMICON 2011*, April 2011.
11. T. Weller, et al., "A Wireless Interrogator - Passive Sensor Approach for Deeply Embedded Sensing Applications," 2011 International Antennas and Propagation Symposium, Spokane, Washington, July 2011.
12. D. Cure, T. Weller, F. Miranda and P. Herzig, "One dimensional capacitive loading in a frequency selective surface for low profile antenna applications," 2011 International Antennas and Propagation Symposium, Spokane, Washington, July 2011.
13. L. Ledezma and T. Weller, "Miniaturization of Microstrip Square Open Loop Resonators Using Surface Mounted Capacitors," *IEEE WAMICON 2011*, April 2011.
14. I. Nassar and T. Weller, "The Ground Plane Effect of a Small Meandered Line Antenna," *IEEE WAMICON 2011*, Clearwater, FL, April 2011.
15. G. Arrobo and R. D. Gitlin, "New Approaches to Reliable Wireless Body Area Networks," in *IEEE International Conference on Microwaves, Communications, Antennas and Electronics Systems*, (COMCAS 2011), November 2011.
16. G. Arrobo and R. D. Gitlin, "Improving the Reliability of Wireless Body Area Networks," in *Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2011)*, August 2011.
17. G. Arrobo and R. D. Gitlin, "Effect of the number of clusters on the performance of Cooperative Network Coding," *Wireless Telecommunications Symposium 2011 (WTSI 2011)*, April 2011.
18. G. Arrobo and, R. D. Gitlin, "Effect of the Connectivity on the Performance of Cooperative Network Coding," in *12th Annual IEEE Wireless and Microwave Technology Conference (WAMICON 2011)*, April 2011.



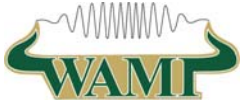
19. G. Arrobo, R. D. Gitlin, and Z. Haas, "Effect of Link-Level Feedback and Retransmissions on the Performance of Cooperative Networking", in *IEEE Wireless Communications and Networking Conference 2011 (WCNC 2011)*, March 2011.
20. Jamal Haque, M. Cenk Erturk, and Huseyin Arslan, "Cognitive Aeronautical Communication System", accepted *International Journal of Interdisciplinary Telecommunications and Networking (IJITN)*.
21. Hazar Aki, M. Cenk Erturk, and Huseyin Arslan, "Fractional Reuse Partitioning Schemes for Overlay Cellular Architectures" accepted *International Journal of Interdisciplinary Telecommunications and Networking (IJITN)*.
22. Jamal Haque, M. Cenk Erturk, and Huseyin Arslan "Aeronautical ICI Analysis and Doppler Estimation" accepted for *IEEE Communication Letters*.
23. A. Sahin and H. Arslan, "Edge Windowing for OFDM Based Systems", accepted for *IEEE Communication Letters*, August 2011.
24. Sabih Güzelgöz, Hüseyin Arslan, Arif Islam, Alexander Domijan, "A Review of Wireless and PLC Propagation Channel Characteristics for Smart Grid Environments", *Hindawi Journal of Computer Systems, Networks, and Communications*, 2011.
25. Serhan Yarkan, Sabih Guzelgoz, Huseyin Arslan, "Statistical wireless channel propagation characteristics in underground mines at 900 MHz: A comparative analysis with indoor channels", *Elsevier Journal of Ad Hoc Networks*, February, 2011.
26. Sabih Guzelgoz, Hasan Basri Celebi, Huseyin Arslan, "Statistical Characterization of the Paths in Multipath PLC Channels", *IEEE Transactions on Power Delivery*, vol.26, no.1, pp.181-187, Jan. 2011.
27. Mehmet B. Celebi, Hasari Celebi, Huseyin Arslan, Khalid A. Qaraqe, "A Bispectrum Detector for FM Modulated Wireless Microphone Signals", accepted Paper in 4th International Conference on Cognitive Radio and Advanced Spectrum Management, Barcelona, Spain, Oct. 2011 (invited).
28. O. Ileri, I. Hokelek, H. Arslan, E. Ustunel, "Improving data capacity in cellular networks through utilizing partially overlapping channels," 2011 IEEE 19th Conference on Signal Processing and Communications Applications (SIU), pp.1121-1124, 20-22 April 2011.
29. A.Gorcin, H.Celebi, K.A. Qaraqe, H. Arslan, "An Autoregressive Approach on Spectrum Occupancy Modeling and Prediction Based on Synchronous Measurements", *IEEE 22nd IEEE Personal Indoor Mobile Radio Communications Conference (PIMRC'11)*, Toronto, Canada, 11-14 September 2011.
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