

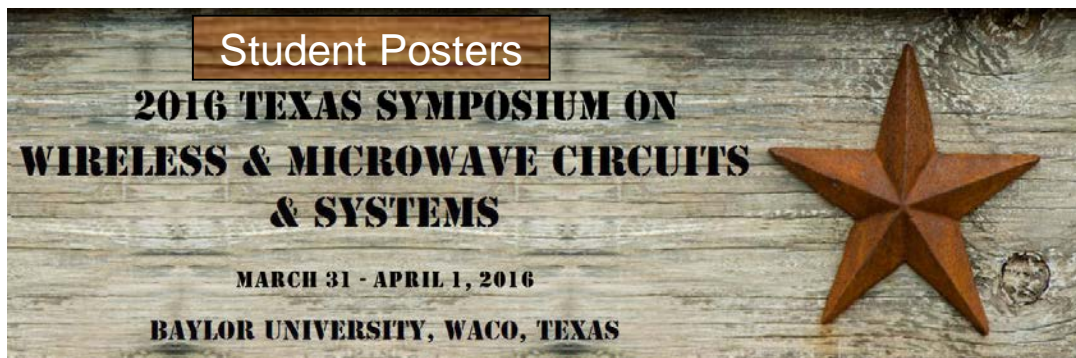
# Student Poster Session

Thursday, March 31, 2016

5:20p.m. – 6:30p.m.

2016 Texas Symposium on  
Wireless and Microwave Circuits and Systems  
Baylor University

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# ***Student Poster Presentations***

## **Baylor University**

- ❖ Investigation of Surface Wave Propagation along a Multi-Coil Wireless Power Transfer System (1)  
*Student Author:* Bin Xu  
*Faculty Advisor:* Prof. Yang Li, Baylor University
  
- ❖ Dynamic Spectral Mask Construction for Radar Transmission Based on Communication Receiver Locations (2)  
*Student Authors:* Casey Latham, Jacob Boline, and Christopher Kappelmann  
*Faculty Advisor:* Prof. Charles Baylis, Baylor University  
*Sponsor:* National Science Foundation (NSF)
  
- ❖ Electrically-Small Folded Cylindrical Helix Antenna for Wireless Body Area Networks (3)  
*Student Author:* Dong Xue  
*Faculty Advisors:* Profs. Brian Garner and Yang Li, Baylor University  
*Sponsor:* Collaborative Faculty Research Investment Program of Baylor University, Baylor Scott & White Health, Baylor College of Medicine
  
- ❖ Simulating Electromagnetic Wave Propagation on Moving Humans: Comparison with Experimental Results (4)  
*Student Author:* George Lee  
*Faculty Advisor:* Profs. Brian Garner and Yang Li, Baylor University  
*Sponsor:* Baylor University, Baylor Scott & White
  
- ❖ Comparison of Multidimensional Circuit Optimization Techniques (5)  
*Student Authors:* Joseph Barkate, Alexander Tsatsoulas, and Zachary Hays  
*Faculty Advisor:* Prof. Charles Baylis, Baylor University  
*Sponsor:* Baylor Wireless and Microwave Systems (WMCS)

- ❖ Bias Smith Tube Optimization for Adaptive Radar (6)  
*Student Author:* Matthew Fellows  
*Faculty Advisor:* Prof. Charles Baylis, Baylor University  
*Sponsor:* National Science Foundation (NSF)
  
- ❖ Investigation of Human Micro-Doppler Features in Foliaged Environments (7)  
*Student Author:* Willis Troy  
*Faculty Advisors:* Profs. Michael Thompson and Yang Li, Baylor University
  
- ❖ Characterization of Narrowband On-Body Wireless Channels Using Motion Capture Experimentation (8)  
*Student Author:* Erik Forrister  
*Faculty Advisors:* Profs. Brian Garner and Yang Li, Baylor University  
*Sponsors:* Baylor University and Baylor Scott and White

### **Texas Tech University**

- ❖ Efficient Near-Field Inductive Wireless Power Transfer for Miniature Implanted Devices Using Strongly Coupled Magnetic Resonance at 5.8 GHz (9)  
*Student Author:* Bhargava Teja Nukala  
*Faculty Advisor:* Prof. Prof. Donald Y. C. Lie, Texas Tech University
  
- ❖ A Study on Linearity vs. LTE Signal Bandwidth and Supply Voltage for High Efficiency SiGe Power Amplifier Design with CW Load-Pull (10)  
*Student Author:* Jerry Tsay  
*Faculty Advisor:* Prof. Prof. Donald Y. C. Lie, Texas Tech University

### **University of Houston**

- ❖ A Time Difference of Arrival (TDOA) Localization Method Based on De-embedding the Propagation Background (11)  
*Student Author:* Mengna (Mona) Yang  
*Faculty Advisors:* Profs. David R. Jackson and Ji Chen, University of Houston  
*Sponsor:* Sandia National Laboratories

## University of Texas at Dallas

- ❖ Millimeter-Wave Performance of Broadband Aperture Antenna on Laminates (12)  
*Student Author:* Christopher Miller  
*Faculty Advisor:* Prof. Prof. Rashaunda Henderson,  
University of Texas at Dallas  
*Sponsors:* Semiconductor Research Corporation (SRC) and UT Dallas  
Electrical Engineering Department
  
- ❖ Demonstrating Laguerre-Gaussian Modes using Spiral Phaseplates with E band Radios (13)  
*Student Authors:* Haohan Yao, Harini Kumar, Thethnin Ei, and Shilpi Sharma  
*Faculty Advisor:* Prof. Prof. Rashaunda Henderson,  
University of Texas at Dallas  
*Sponsor:* NxGen Partners, LLC
  
- ❖ Patch Antenna Array for the Generation of Millimeter-wave Hermite-Gaussian Beams (14)  
*Student Authors:* Haohan Yao, Harini Kumar, and Thethnin Ei  
*Faculty Advisor:* Prof. Prof. Rashaunda Henderson,  
University of Texas at Dallas  
*Sponsor:* NxGen Partners, LLC
  
- ❖ Physical Phaseplate for the Generation of Millimeter-Wave Hermite-Gaussian Beams (15)  
*Student Authors:* Haohan Yao, Harini Kumar, and Thethnin Ei  
*Faculty Advisor:* Prof. Prof. Rashaunda Henderson,  
University of Texas at Dallas  
*Sponsor:* NxGen Partners, LLC
  
- ❖ 67 GHz Modified Dipole Antenna on FR408 Substrate (16)  
*Student Author:* Lei Fang  
*Faculty Advisor:* Prof. Rashaunda Henderson,  
University of Texas at Dallas  
*Sponsor:* The National Science Foundation (NSF)

- ❖ Printed Circuit Board Rectangular Waveguide with Full Band Microstrip to Waveguide Transition (17)

*Student Author:* Michael Gomez

*Faculty Advisor:* Prof. Rashaunda Henderson,  
University of Texas at Dallas

*Sponsor:* Semiconductor Research Corporation (SRC)

# **Investigation of Surface Wave Propagation along a Multi-Coil Wireless Power Transfer System**

Bin Xu

Department of Electrical and Computer Engineering  
Baylor University

*Faculty Advisor:* Dr. Yang Li, Baylor University

## **Abstract**

The surface wave propagation along a multi-coil wireless power transfer system is investigated with the motivation of extending the power transfer range. First, the power transfer efficiencies of coil arrays with different numbers of repeaters are simulated and measured. Then the wave propagation along the array is investigated and its associated wave characteristics are extracted using a super resolution algorithm. A backward traveling surface wave is found to be the dominant propagation mechanism, and its decay constant decreases as the number of repeaters increases. An empirical formula correlating the power transfer efficiency with the surface wave decay constant is proposed.

# **Dynamic Spectral Mask Construction for Radar Transmission Based on Communication Receiver Locations**

Casey Latham, Jacob Boline, and Christopher Kappelmann  
Department of Electrical and Computer Engineering  
Baylor University

*Faculty Advisor:* Dr. Charles Baylis, Baylor University  
*Sponsor:* National Science Foundation

## **Abstract**

Currently, the spectrum is allocated using outdated methods, where the spectral bands are all purchased by individual users. Part of the outdated system is the idea that a spectral mask is static and is based upon a specific set of guidelines. As the spectrum becomes more fully utilized in the lower bands, other methods are being sought to solve the spectrum crunch.

One such method is the idea of cognitive radio, where a secondary user can use a specific band if the licensed user is not present. Once the licensed user returns to the spectrum, the secondary user must choose a different band. This poster describes a dynamic spectral mask, which changes based upon the location, frequency, and acceptable interference power levels of nearby communication receivers. The algorithm operates in such a manner where the radar transmitter is located around the origin, with communication receivers with randomly-generated properties surrounding the radar. The algorithm seeks to determine the largest gap in spectrum and creates a dynamic spectral mask to prevent the radar from operating above the maximum acceptable interference power level of the communication receivers. In the future, this work will be applied by allowing wireless networks to report this information to radar systems, which would allow the radar transmitting spectra to be dynamically constrained.

# **Electrically-Small Folded Cylindrical Helix Antenna for Wireless Body Area Networks**

Dong Xue

Department of Electrical & Computer Engineering  
Baylor University

*Faculty Advisor:* Prof. Brian Garner, Prof. Yang Li, Baylor University

*Sponsor:* Collaborative Faculty Research Investment Program of Baylor University,  
Baylor Scott & White Health, Baylor College of Medicine

## **Abstract**

The emerging technology of Wireless Body Area Networks (WBAN) is promising for many applications such as continuous and remote healthcare monitoring. Practical WBAN implementation requires compact low-power devices. Therefore, an electrically-small antenna is needed. This poster presents wearable folded cylindrical helix (FCH) antennas designed at multiple medical frequency bands. Their performances are simulated in FEKO software and compared with conventional monopoles. The antenna transmission loss is simulated on a simplified human phantom model and tested on a real human body. It is found that the FCH has similar transmission performance as the monopole while the height is significantly reduced.



# **Simulating Electromagnetic Wave Propagation on Moving Humans: Comparison with Experimental Results**

George Lee  
Department of Mechanical Engineering  
Baylor University

*Faculty Advisor:* Prof. Brian Garner, Baylor University and Prof. Yang Li, Baylor University

*Sponsor:* Baylor University, Baylor Scott & White

## **Abstract**

Wireless body area network (WBAN) technology has great potential to improve human quality of life in many practical applications, especially in the field of remote, long-term health monitoring. Implementing a practical and usable WBAN system that is small and power efficient requires an understanding of on-body electromagnetic (EM) wave propagation in order to design optimal on-body antennas for WBAN sensors. Previous studies (Zedong et al., *Sensors*, 12, 17569-17587, 2012; Munoz et al., *IEEE Transactions on Antennas and Propag.*, 62, 5268-5281, 2014) have studied on-body EM wave propagation during common motions, such as walking, through experimental measurement. Experimental methods provide valuable on-body transmission data; however, they can only provide point-to-point propagation loss data and can be very time consuming.

This study focuses on developing a full-wave simulation platform in order to study on-body EM wave propagation between transmitters and receivers on moving human bodies. The simulation platform has the capability to provide greater insight into dynamic on-body wave propagation than experimental measurement methods alone. Motion data of human volunteers performing various motion activities is collected frame by frame using motion capture techniques while on-body transmission data is being simultaneously recorded. The motion capture data is used to direct the motion of a human body phantom model in order to replicate the experimentally performed motion activities. The human body model consists of simple geometric cylinders that represent key parts of the human body, such as the torso, arms, and legs, and has its material properties set to be homogeneous muscle tissue. Simulation of the electric field distributions along and around the human body model is performed using CST Microwave Studio.

This simulation study consists of multiple human subjects, both male and female, multiple antenna placements (chest to back, chest to wrist, etc.), and multiple motion activities (arm swings, boxing, etc.). Simulation results are verified by comparison with experimental transmission data collected using a vector network analyzer.

## Comparison of Multidimensional Circuit Optimization Techniques

Joseph Barkate, Alexander Tsatsoulas, Zachary Hays  
Department of Electrical Engineering  
Baylor University

*Faculty Advisor:* Prof. Charles Baylis, Baylor University  
*Sponsor:* Baylor Wireless and Microwave Systems (WMCS)

### Abstract

For reconfigurable power amplifiers, the ability to simultaneously optimize multiple circuit characteristics in real-time is essential. The performance of a power amplifier has been shown to be directly correlated to its corresponding load impedance, input power and biasing voltages. This poster illustrates multiple optimization techniques and compares their effectiveness in quickly achieving a solution based on predefined spectral requirements. Each optimization method's utility is quantitated by the final efficiency and linearity achieved at the operating configuration.

Previously, the power amplifier design process required the iterative approach of performing load-pulls, power sweeps and bias sweeps in order to achieve an acceptable design solution. The proposed multi-dimensional search algorithms aim to optimize multiple power amplifier circuit characteristics inside the Smith Tube simultaneously. In previous work a gradient-based search algorithm has demonstrated effectiveness in optimizing both two and three-dimensional search spaces. In total, a comparison of three separate searches is performed in 2, 3, 4 and 5 dimensions. Namely the searches being compared are the Gradient, Pattern and Simplex searches. As the dimensionality of the search space increases the strengths and weakness of each search is revealed as the curse of dimensionality impacts some search methods more than others. The Simplex search based of the Nelder-Mead method utilizes a special polytope of  $n+1$  vertices in  $n$  dimensions and is commonly applied to nonlinear optimization problems where the derivatives of the search space are known. This search method excels in lower dimensions but fails to converge quickly when in higher dimensions due to the geometric simplex shape created in higher dimensions.

The Pattern Search is another method of optimization that does not require the gradient of the search space, and as a result, is theoretically superior for optimizing in higher-dimensional search spaces. In this optimization method one input parameter is varied at a time by steps of the same magnitude and when no decrease or increase in these steps is recorded the corresponding step size of the search is decreased until the step reaches a predefined threshold of convergence. To compare the performance of each search, multiple searches are demonstrated from different starting locations across multiple different  $N$ -dimensional search spaces. A statistical T-test is used to relate the search results and determine which search exhibits superior performance based upon a normal distribution.

## **Bias Smith Tube Optimization for Adaptive Radar**

Matthew Fellows  
Department of Electrical and Computer Engineering  
Baylor University

*Faculty Advisor:* Dr. Charles Baylis, Baylor University  
*Sponsor:* National Science Foundation

### **Abstract**

Today's radar systems need to become smarter in order to deal with the stricter requirements on them due to the increasing number of wireless devices inhabiting the frequency spectrum. Adaptive Radar is a method for adapting a radar system to whatever new requirements are placed on it. The goal of the research presented in this poster is to empower adaptive radar systems to adapt their power amplifiers to those new requirements while maintaining the best level of performance possible. The adaptation of the radar power amplifier is achieved through optimization algorithms in a search space called the Smith Tube, which is a three-dimensional extension of the Smith Chart. The Smith Tube allows for additional power amplifier input characteristics such as input power or bias voltage to be optimized at the same time as the power amplifier's load impedance. This poster will be focused on using a Smith Tube where a power amplifier's drain-to-source voltage is used for the vertical dimension in the Smith Tube.

# Investigation of Human Micro-Doppler Features in Foliaged Environments

Willis Troy  
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Baylor University

*Faculty Advisor:* Dr. Michael Thompson, Baylor University  
Dr. Yang Li, Baylor University

## Abstract

Foliage is an obstacle for remote monitoring, often acting as a barrier for detection in border security and concealing victims in search and rescue missions. Doppler radar circumvents many issues of remote sensors while providing a capability in measuring and monitoring human motion. The radar's usage of the Doppler Effect allows the measurement of a human's torso velocity and auxiliary velocities resulting from the limbs. The auxiliary velocities are often referred to as micro-Dopplers and provide unique signatures for motion classification. Unfortunately, foliaged environments can still obfuscate human Doppler features through path attenuation, multipath, and motion of surrounding vegetation. However, Kilic, et. al, has shown that simulations of human micro-Doppler returns at 5 GHz can still result in distinguishable spectrograms despite clutter. [Kilic, et.al (2015), *Detection of moving human micro-Doppler signature in forest environments with swaying tree components by wind. Radio Sci., 50, 238–248.*] Unfortunately, experimentation in the literature is scarce and often limited to light foliage.

This work focuses on classifying human motion activities in foliaged environments through micro-Doppler signatures. As a preliminary step, we measure human motion activities in an open-space environment. Next, we record data at two foliaged locations in a local park. Activities are recorded with a vector network analyzer (VNA) for 20 seconds and are constrained to: different frequencies (2.45, 5, and 10 GHz), different activities (walking, running, and crawling), and different number of participants (1 or 2). Data is subsequently subdivided into 5 second intervals for feature extraction, training, and classification. Feature extraction techniques are performed through the use of joint time-frequency transforms. Classification techniques are used to find a robust classifier for all environments and frequencies. Results indicate that we can successfully monitor and track activities.

# Characterization of Narrowband On-Body Wireless Channels Using Motion Capture Experimentation

Erik Forrister  
Department of Mechanical Engineering  
Baylor University

*Faculty Advisor:* Dr. Brian Garner, Baylor University and Dr. Yang Li, Baylor University  
*Sponsor:* Baylor University and Baylor Scott and White

## Abstract

Wireless Body Area Networks (WBANs) are a networks of sensors and actuators placed in, on, and around the human body. Once realized, WBANs would potentially have many life-improving applications, including long-term remote health monitoring. WBANs would collect and transmit relevant health information to caregivers, who would then be able to intervene to avert immanent life-threatening health problems. In order for this technology to be realized, the WBAN must be composed of reliable, long-term, and unobtrusive sensors that provide good data transmission on and around the active human body. To design optimized sensor antenna that achieve these characteristics, the fading of the signal transmission due to body position and motion for normal daily activities must be well understood. The purpose of this experimental study was to investigate the fading of on-body antenna for various human subjects, activities, transmission frequencies, and antenna positions (transmission channels).

Antenna transmission strength and three-dimensional body motion data were collected simultaneously using a Vector Network Analyzer (VNA) and a multi-camera Motion Capture System respectively. The synchronized VNA and Motion capture data were recorded and analyzed at 120 Hz. Seven adult subjects, four males and three females, performed activities that consisted of left arm swing, both arms swing, rowing, boxing, hopping, and sitting motions. During each activity, a pair of quarter-wavelength monopole antennas were configured in each of three ways to record transmission from: (1) the chest to the back, (2) the chest to the left wrist, (3) and the right wrist to the left wrist. The data was analyzed by plotting the signal attenuation against key motion variables for each activity. The data was also averaged across multiple subjects which revealed the general trend for each trial and allowed clear comparisons between trials.

Signal strength was observed to vary with the frequency of the antenna, the position of the antenna, and the activity performed. Signal strength was observed to fluctuate with body position despite sustained transmission frequency, transmission channel, and activity type. Signal attenuation occurs when the body is blocking the line of sight of the antennas, and the signal must creep around the body. Larger signal attenuation occurs when additional body segments block the most optimal path of the creeping wave. These results may guide future studies in analyzing the transmission signal strength of wireless on-body nodes on a dynamic body, and ultimately lead to the design of an unobtrusive, optimized antenna for power conservation and reliability.

# **Efficient Near-Field Inductive Wireless Power Transfer for Miniature Implanted Devices Using Strongly Coupled Magnetic Resonance at 5.8 GHz**

Bhargava Teja Nukala  
Department of Electrical Engineering  
Texas Tech University

*Faculty Advisor:* Prof. Donald Yu Chun Lie, Texas Tech University

## **Abstract**

An efficient wireless power transfer (WPT) design using near-field inductive 4-coil strongly-coupled magnetic-resonance (SCMR) for powering up miniature biosensors at the ISM band of 5.8 GHz is proposed and analyzed. The miniature device has a tiny square planar inductor of size  $110 \times 110 \mu\text{m}$  as a receiver (RX) coil integrated on a standard silicon substrate. Another planar coil of 3 mm in diameter is designed on a FR4 substrate as the transmitting (TX) coil, which is fixed at 1 mm away from the RX coil in this study. The corresponding 4-coil SCMR system has the same TX and RX coils but with two relay coils between them, where the closest distance from the relay coil to the RX coil is also fixed at 1 mm. Analytic equations are used to describe the design for both scenarios.

The tuning caps are used for the TX and RX coils which helps the entire 2-coil system to resonate at 5.8 GHz. The simulated maximum power coupling of the 2-coil system is -26.29 dB. However, the simulated maximum power coupling of the 4-coil SCMR system is -20.19 dB, which is about 6 dB better than that of the optimized 2-coil system. 3-Dimensional (3-D) S-parameter and B-Field electromagnetic (EM) simulations show that the optimized 4-coil system outperforms the optimized 2-coil WPT system with ~6-7 dB higher B-field flux, which is consistent with the S-parameter simulation results. The impressive SCMR inductive power coupling of ~ -20.2 dB (i.e., ~ 1% power transfer efficiency) unto the tiny RX coil demonstrated its potential for wirelessly powering up novel miniaturized implantable devices and sensors without bulky batteries.

# A Study on Linearity vs. LTE Signal Bandwidth and Supply Voltage for High-Efficiency SiGe Power Amplifier Design with CW Load-Pull

Jerry Tsay  
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Texas Tech University

*Faculty Advisor:* Prof. Donald Yu-Chun Lie, Texas Tech University

## Abstract

A highly-efficient SiGe power amplifier (PA) design and its linearity, power-added efficiency (PAE) and RF power output ( $P_{OUT}$ ) are studied with several LTE 16QAM signal modulation bandwidth and supply voltages. The monolithic PA is designed in the IBM/GlobalFoundries' 0.35- $\mu\text{m}$  SiGe BiCMOS technology with through-silicon vias (TSV) to minimize the RF ground parasitic effects, and a continuous wave (CW) load-pull measurement at the fundamental frequency is used to help reach a high efficiency and adequate linearity with proper source/load matching. The PA is tested with LTE 16QAM modulated signals and passes the stringent LTE spectrum emission mask (SEM) at an average linear  $P_{OUT} = 23.5/23.1/23.1$  dBm with 48.0/45.2/45.0% PAE for LTE 5/10/20 MHz inputs, respectively.

The adjacent channel leakage ratios ACLR1 and ACLR2 exhibit opposite trends vs. increasing 16QAM LTE signal bandwidth at low  $P_{OUT} = 17.1$  dBm before the PA hits compression (i.e.,  $P_{1dB} = 22.3$  dBm). At a compressed output of  $P_{OUT} = 23.1$  dBm the PA linearity as measured in the Adjacent Channel Leakage Ratio (ACLR1/ACLR2) is not sensitive to the increasing LTE 16QAM bandwidth from 5 to 20 MHz, while some PA output spectral asymmetry is observed for ACLR2 at 10MHz and 20 MHz but not at 5 MHz input. Not surprisingly, lowering the PA supply voltages from 5V to 4V or to 3V has a larger effect on degrading the ACLR performance than increasing the modulation bandwidth from 5 MHz to 20 MHz. No predistortion is applied in this work. The data indicates that, as reported similarly in the literature, a static CW load-pull measurement is quite valuable for RF PA design, but it cannot accurately predict a SiGe PA's linearity performance with a modulated input signal of MHz bandwidth. In addition, a non-constant-envelope modulated LTE signal of high peak-to-average-power-ratio (PAPR) such as the 16QAM waveform demands excellent PA linearity, which poses as a major challenge for monolithic PA design.

# **A Time Difference of Arrival (TDOA) Localization Method Based on De-embedding the Propagation Background**

Mengna Yang  
Department of Electrical and Computer Engineering  
University of Houston

*Faculty Advisors:* Prof. David R. Jackson, Prof. Ji Chen, University of Houston  
*Sponsor:* Sandia National Laboratories

## **Abstract**

The Time Difference of Arrival (TDOA) localization method is one of the most classic methods used to determine the unknown location of a transmitting wireless device, based on acquiring the differences in arrival time at sensors (receivers) that are in visible to the transmitting source (target). By maximizing the cross-correlation between the signals arriving at any two receivers, the corresponding TDOA for these two receivers can be efficiently estimated. In principle, only three receivers are enough for 2-D localization in the absence of noise. However, the accuracy can be significantly influenced by Non-Line-of-Sight (NLOS) effects when scattering objects such as walls appear within the propagation route. A method is proposed here to accommodate NLOS effects, which incorporates a transfer function that relates the field at a given receiver to the source field as a function of frequency. The transfer function is obtained by electromagnetic analysis of the propagation system, using techniques such as reciprocity, the transverse equivalent network (TEN) and the finite difference time domain (FDTD) method. The NLOS effects are removed in the frequency domain by dividing the spectrum of the received signal at a given receiver by the transfer function and then multiplying by the simple free-space propagation transfer function. The propagation system is thus calibrated back to free space. Since the transfer function is different at each possible source position, and the source position is unknown, an iterative method is proposed to do the localization.

In this investigation, two 2-D models are proposed to illustrate the method: (1) a single-wall model, representing a typical obstacle case, and (2) a parallel-wall model, representing a canonical multi-path case. In both cases, the transfer function can be obtained analytically, although the commercial software XFDTD is also used. A simple dipole source radiating a sinusoidal carrier wave modulated by a lower frequency baseband Gaussian signal is assumed. After applying the TDOA method combined with the proposed iterative method, the simulation results show significant improvement over the usual TDOA method. The localization accuracy is then studied with respect to varying various parameters of interest, including the sampling frequency in the analog-to-digital converter, the wall parameters, and the sensor locations. The effects of added Gaussian noise are also studied. Experimental results were obtained at Sandia National Laboratories, and they demonstrate an improvement in localization when using the proposed method.



## **Millimeter-Wave Performance of Broadband Aperture Antenna on Laminates**

Christopher Miller  
Department of Electrical Engineering  
University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, University of Texas at Dallas

*Sponsor:* Semiconductor Research Corporation (SRC)

*Sponsor:* UT Dallas Electrical Engineering Department

### **Abstract**

This poster summarizes the design, fabrication and characterization of a coplanar waveguide (CPW) fed modified aperture bowtie antenna operating from 60 to 90 GHz. Modifications to the bowtie edges extend the bandwidth up to 50% without increasing radiator area. Until recently, radiation pattern measurements at UT Dallas have been limited to 18 GHz. With the acquisition of a Nearfield Systems Inc. spherical scanner, near-field measurements can now be taken from 67 GHz to 325 GHz. The poster will include measurements for the modified bowtie antenna taken from 67-85 GHz. The NSI 700S-360 spherical near-field measurement system used in conjunction with an Agilent network analyzer, GGB Picoprobes and Cascade micromanipulator allow for on-wafer measurements of the antenna under test. Measured input return loss and radiation patterns agree well with simulation.

## **Demonstrating Laguerre-Gaussian Modes using Spiral Phaseplates with E-band Radios**

Haohan Yao, Harini Kumar, Thethnin Ei, Shilpi Sharma  
Department of Electrical Engineering  
University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, University of Texas at Dallas  
*Sponsor:* NxGen Partners, LLC

### **Abstract**

This poster presents the performance of spiral phaseplates (SPPs) to generate millimeter-wave (mm-wave) Laguerre-Gaussian (LG) beams at E-band frequencies. Based on the dielectric thickness of the SPPs, two modes of the LG beam,  $\ell = 1$  and  $\ell = 3$ , have been designed. The SPPs are manufactured by a controlled milling process of a solid block of high density polyethylene (HDPE) which has a refractive index of  $n = 1.52$  at 28 GHz. Radiation pattern measurements of the LG beam were taken using an Agilent vector network analyzer and NSI 700S-360 spherical near-field scanner system from 71 – 78 GHz. The loss of the 300 mm diameter SPPs is characterized using Fujitsu's E-band impulse radios.

## **Patch Antenna Array for the Generation of Millimeter-wave Hermite-Gaussian Beams**

Haohan Yao, Harini Kumar, Thethnin Ei  
Department of Electrical Engineering  
University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, University of Texas at Dallas

*Sponsor:* NxGen Partners, LLC

### **Abstract**

This poster presents the use of patch antennas to form millimeter-wave Hermite-Gaussian (HG) beams at E-band frequencies. The patch antenna array is designed with four inset-fed microstrip patch elements with a microstrip feeding network to produce an  $HG_{11}$  beam. The array was designed and simulated in ANSYS HFSS, a full-wave electromagnetic simulator. The designed patch antennas were fabricated on Isola Global's FR408 laminate, which has a relative permittivity of 3.75, and loss tangent of 0.018. Radiation patterns and S-parameter measurements were taken with an Agilent vector network analyzer and NSI 700S-360 spherical near-field scanner. Radiation patterns at 73 GHz agree well with simulation. The overall size of the array is 8 mm x 8 mm x 0.125 mm.

## **Physical Phaseplate for the Generation of Millimeter-Wave Hermite-Gaussian Beams**

Haohan Yao, Harini Kumar, Thethnin Ei  
Department of Electrical Engineering  
University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, University of Texas at Dallas

*Sponsor:* NxGen Partners, LLC

### **Abstract**

This poster demonstrates the design, fabrication and characterization of a physical phaseplate, which transforms plane waves into Hermite-Gaussian (HG) mode beams. The phaseplate is designed for a  $HG_{11}$  mode operating from 71 to 76 GHz. Simulations were conducted in ANSYS HFSS to predict the performance of the phaseplate. Two 100 mm x 100 mm plates were assembled with layers of low cost laminate and high performance polymers to generate the  $HG_{11}$  mode. The phaseplates were placed in the far-field a 10 dB horn antenna and the radiation pattern was characterized using an Agilent vector network analyzer and NSI 700S-360 spherical near-field scanner. The simulations and measurements are in good agreement and demonstrate the desired Hermite-Gaussian beam.

## 67 GHz Modified Dipole Antenna on FR408 Substrate

Lei Fang  
Department of Electrical Engineering  
University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, University of Texas at Dallas

*Sponsor:* The National Science Foundation (NSF)

### Abstract

In this poster, a planar modified dipole antenna structure is proposed, where two radiation arms are printed on the top and bottom layers of a 0.127 mm FR408 substrate. To decrease the ground plane effect, a microstrip line and broadside coupled parallel strips form the feed structure to the dipole arms. The overall structure size is 3 mm × 2 mm × 0.127 mm. ANSYS HFSS simulation results show that the resonance frequency is 67 GHz and that the  $|S_{11}| < -10$  dB bandwidth is larger than 30%. The simulated radiation pattern is a donut shape with a gain of 2.17 dB. This antenna is fabricated in the UT Dallas cleanroom using a standard lithography process, and the actual performance will be measured on a Nearfield Systems spherical scanner.

# **Printed Circuit Board Rectangular Waveguide with Full Band Microstrip to Waveguide Transition**

Michael Gomez  
Department of Electrical Engineering  
The University of Texas at Dallas

*Faculty Advisor:* Prof. Rashaunda Henderson, The University of Texas at Dallas  
*Sponsor:* Semiconductor Research Corporation (SRC)

## **Abstract**

This poster presents the design, fabrication, assembly and performance of a layered printed circuit board (PCB) dielectric rectangular waveguide that operates from 4 to 6 GHz in the H band. Metallized via fences form the waveguide walls by stacking 1.57 mm thick FR408 ( $\epsilon_r = 3.66$ ,  $\tan \delta = 0.0127$ ) substrates. A microstrip probe transition is used to feed the waveguide. The designed probe is able to support the full bandwidth of the PCB waveguide and is demonstrated thru measurement. The feasibility of using a low cost technology to realize a dielectric filled rectangular waveguide is demonstrated.