Microwave Applied 
Metrology Research 
Group

...on our way to the BRIC!

Nine Great Years at Baylor 
and Only Four Different Lab Locations

BRIC Gallery Public Meeting Area

BRIC Space Allocation Plan – Electrical Engineering

Lab Faculty Member | Research Lab Focus | Floor #
--- | --- | ---
1 | Jean, Randall Microwave Metrology | 219.11
2 | Duran, Russell Avionics Lab | 219.10
3 | Baylis, Charles Microwave Active Circuits Lab | 219.13
4 | Li, Yang Antennas and Wireless Propagation Lab | 219.15
5 | Marks, Robert Computational Intelligence Applications Lab | 219.17
6 | Thompson, Mike Applied Telecommunications and DSP Lab | 219.19
7 | Hu, Jonathan Photonics Research Lab | 219.21

Lab Faculty Member | Research Lab Focus | Floor #
--- | --- | ---
8 | Grady, Mack Renewable Energy and Grid Security Lab | 225.03
9 | Gravagne, Ian Distributed Power Systems Lab | 225.05
10 | Lee, Kwang Power & Energy Lab | 225.09
11 | Song, Ben Power Electronics Lab | 300.L
12 | Dong, L./Eisenbarth, S. Cyber-Physical Systems Lab | 300.M

Microwave Sensing Fundamentals

Complex permittivity describes energy storage and energy due to impressed electric fields.

\[
\varepsilon' \varepsilon_j \frac{\partial B}{\partial t} = 4\pi \mu
\]

\[
\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}
\]

\[
\nabla \times \mathbf{B} = \frac{4\pi \mathbf{J}}{c^2} + \frac{1}{c^2} \frac{\partial \mathbf{E}}{\partial t}
\]
What you always wanted to know about Microwave Applied Metrology

For me it started on the moon . . . . . . . but my early academic career focused on the earth

What you always wanted to know about Microwave Applied Metrology

. . . but I somehow wound up in a hamburger plant . . . and other interesting places with my collection of tools.

What you always wanted to know about Microwave Applied Metrology

Today I inflict microwaves on poor graduate students.

The changing faces of WMCS through the years

2003-2004

The changing faces of WMCS through the years

2011-2012

The faculty of WMCS today

2011-2012
Key Factors for Success in Microwave Applied Metrology

- Understanding of Material Properties
- Creative Exploitation of Measurement Geometry
- Robust Algorithms for Extracting Information from the Measurement Data
- Low Cost Implementation of the Measurement System

Current Projects

- Time Domain VNA Development

Guided Microwave Spectrometer measurement comparison

Current Projects

- Time Domain VNA Development

Current Projects

- Automatic Calorie Counter

Transit Time Tomography
Current Projects

- **W/CM Ratio in Fresh Concrete**

Varying Moisture Data Set for Paste, Mortar and Concrete

Typical Artificial Neural Network Structure

<table>
<thead>
<tr>
<th>Input Nodes</th>
<th>Hidden Layer 1</th>
<th>Hidden Layer 2</th>
<th>Output Layer</th>
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<td>PC 1</td>
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W/CM Value

Properly Trained ANN Performance

Recent Interests in Ground Sensors

- Wireless sensor networks for scientific and military applications (e.g., forest fire detection).
- Measurement campaigns: Joshi et al., 2005; Buhl and Rogers, 2008; Meng et al., 2009.
- For near-ground, short-distance communication in the forest, the propagation mechanisms are more complex.
Mode Strength

Low passband: Surface wave
High passband: Leaky wave

Transmission Loss-Magnitude

(\text{Li et al., 2008})

- Passband/stopband behaviors are clearly observed.
- Boundaries of passband/stopband correspond to quarter-wave wire resonance at 800 MHz and plasmonic cut-off frequency at 1600 MHz.

Mid-IR Supercontinuum Generation (Dr. Jonathan Hu)

Supercontinuum generation
- Nonlinearity
- Dispersion

Generate light with wide spectrum for gas sensing

Nanophotonic Biosensor (Dr. Hu)

Use nanotechnology to build biosensor