

# Near Field Measurements of a Dipole Antenna and Specific Absorption Rates in a Flat Phantom

Eric Merideth, David Xia, Nasim Vakili, and Christopher C. Davis

Department of Electrical and Computer Engineering

Part of an International Laboratory Comparison for the Cell Phone Industry. Measurement of the Near-Field Antennas Patterns of a Dipole in Close Proximity to an Absorbing Flat Phantom and Mapping of the Spatial SAR Values

## Theoretical Data

### Specific Absorption Rate(SAR)

The rate of energy absorption per mass (Watts/kg). Usually averaged over a specified volume (1cm<sup>3</sup> or 10cm<sup>3</sup>)

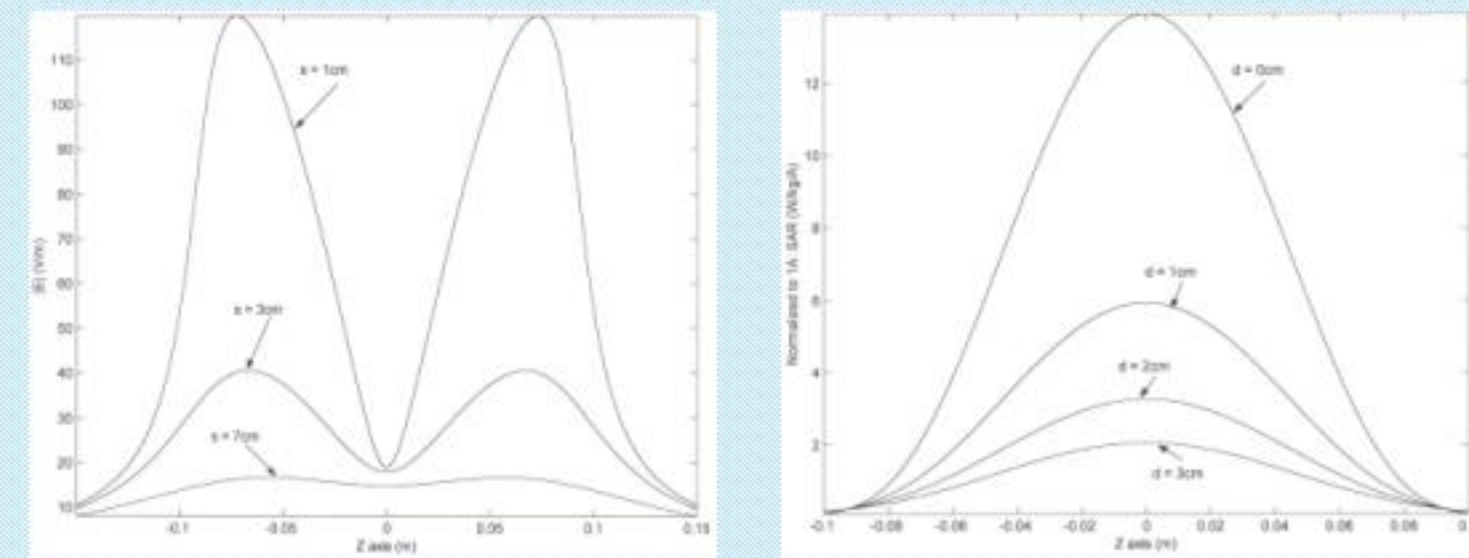
$$SAR = \frac{\sigma |E|^2}{\rho}$$

$\sigma$  = conductivity of the dielectric medium

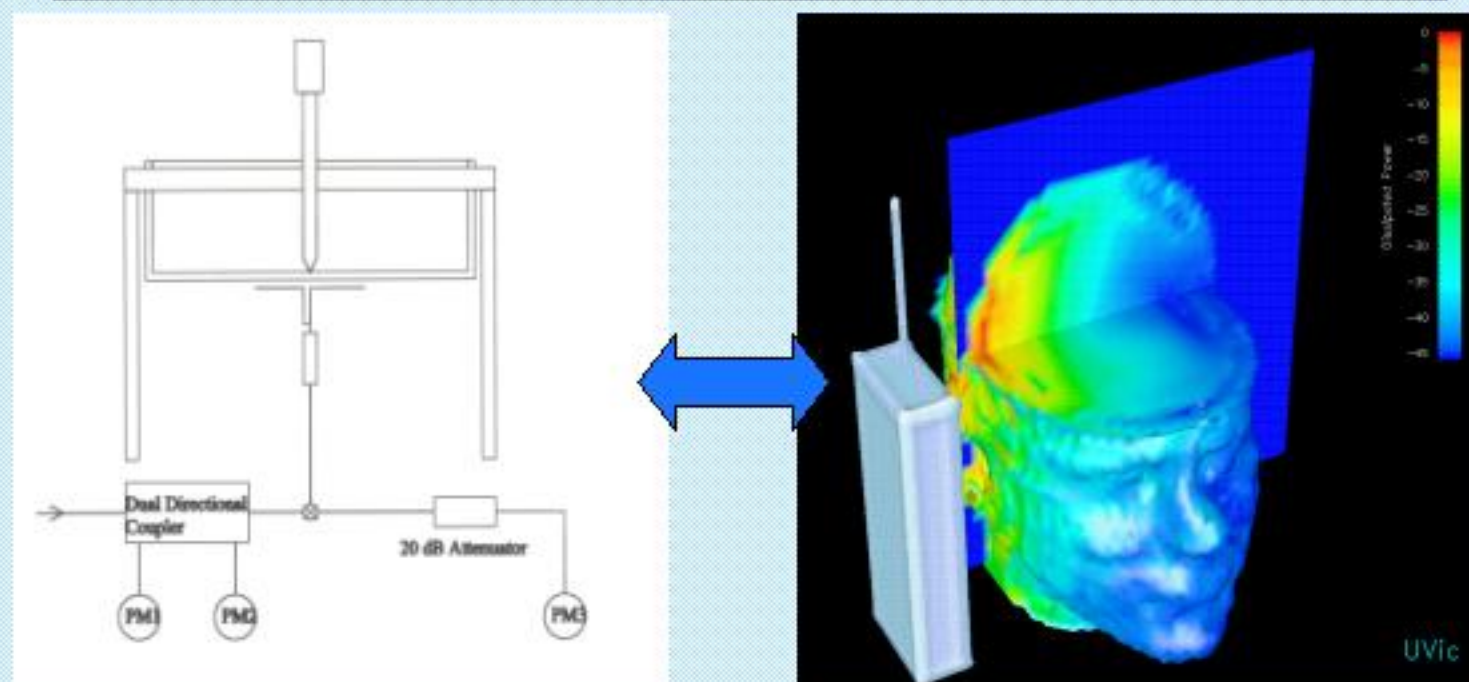
$\rho$  = density of the dielectric medium

$$E = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

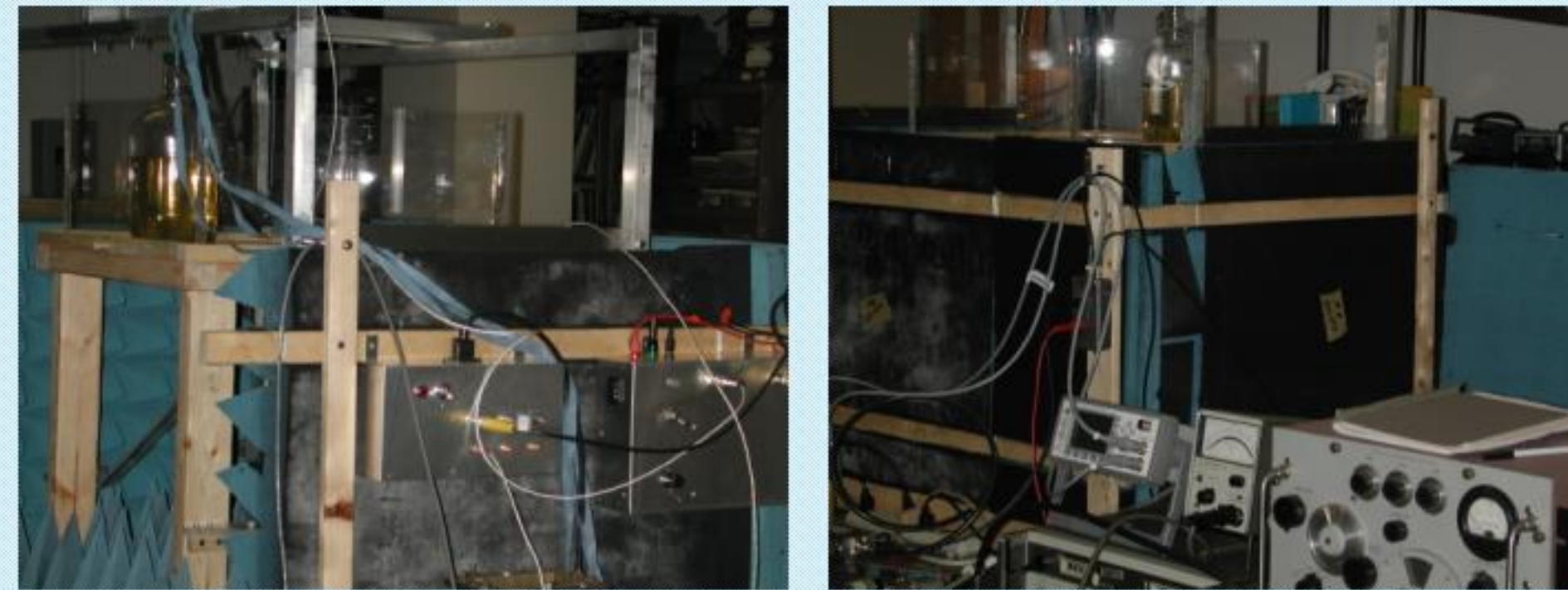
Free space scan over dipole axis: SAR profile along antenna axis at 835MHz (normalized to 1A feed current)



## The Ultimate Goal: Characterization of SAR in the Human Head from a Cell Phone

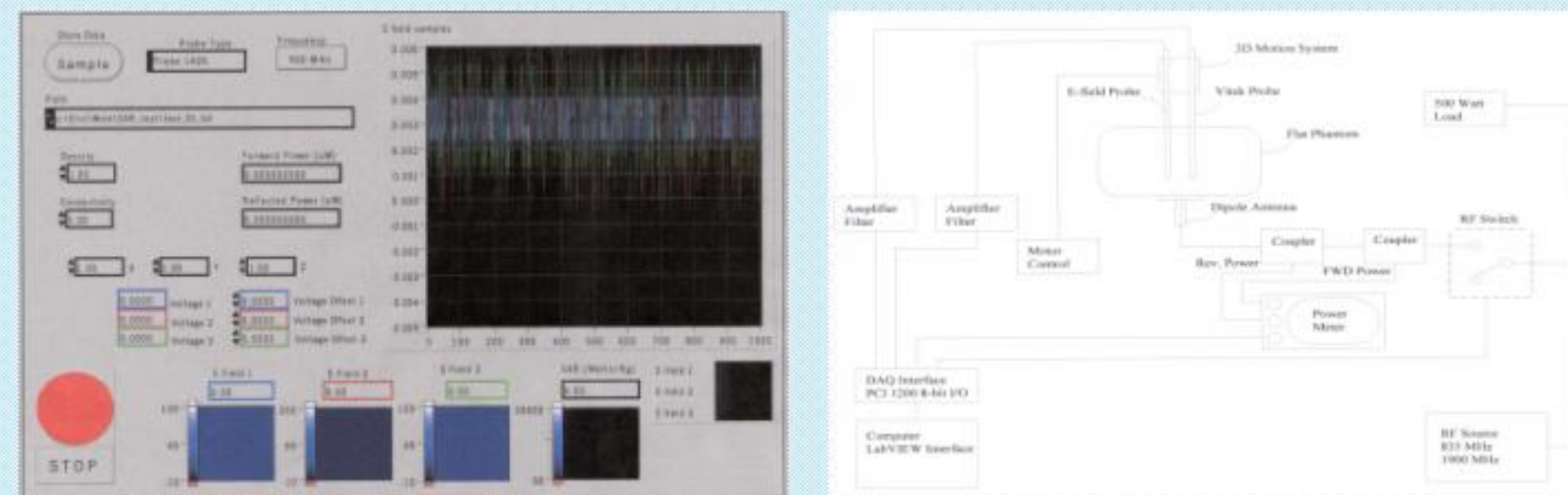


## Apparatus



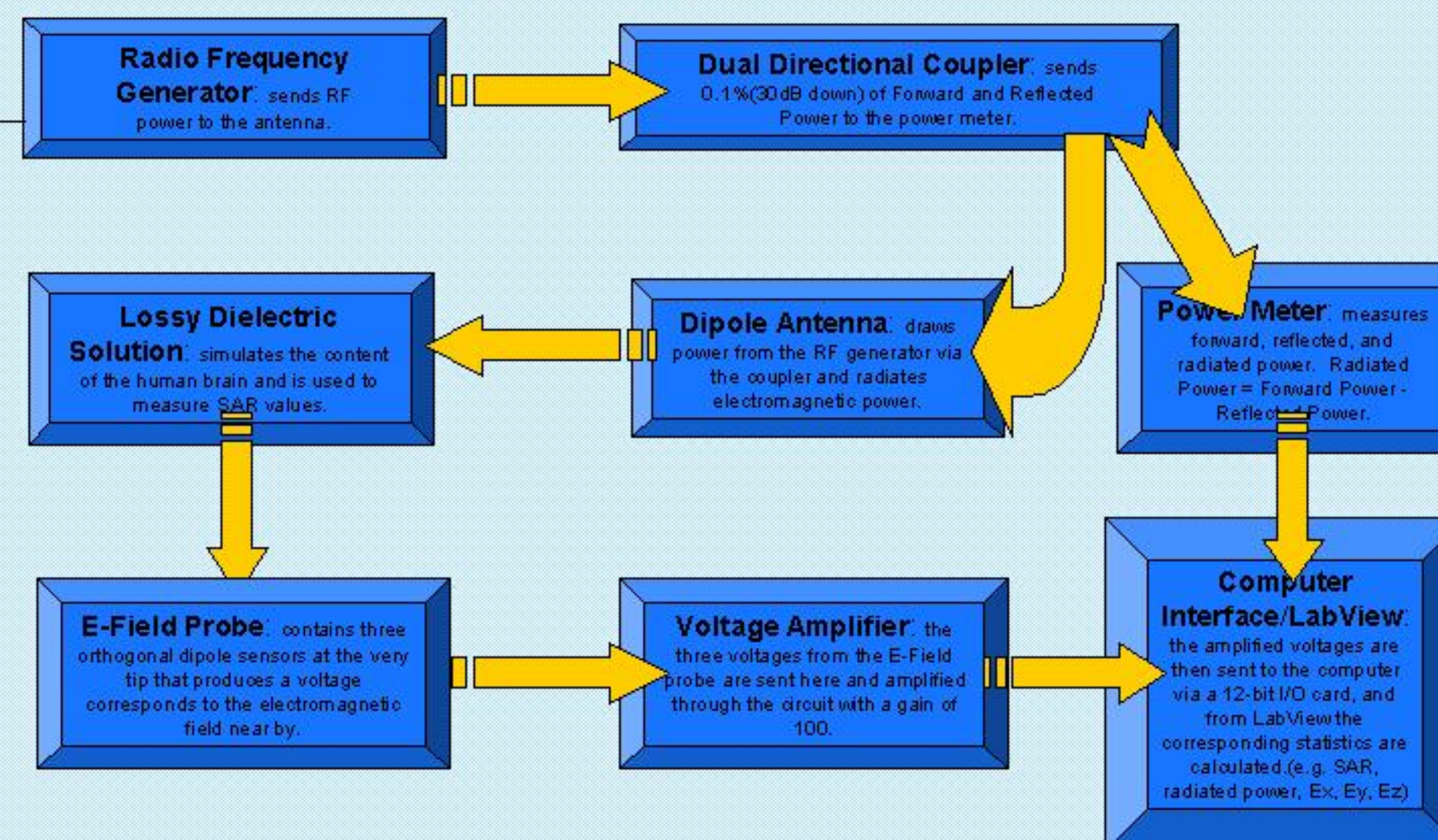
LabView Interface

Apparatus Diagram



Note: The above diagram is for the entire system, which also contains a temperature probe. Only an E-field probe was used in this experiment.

### Flow Chart of Major Components

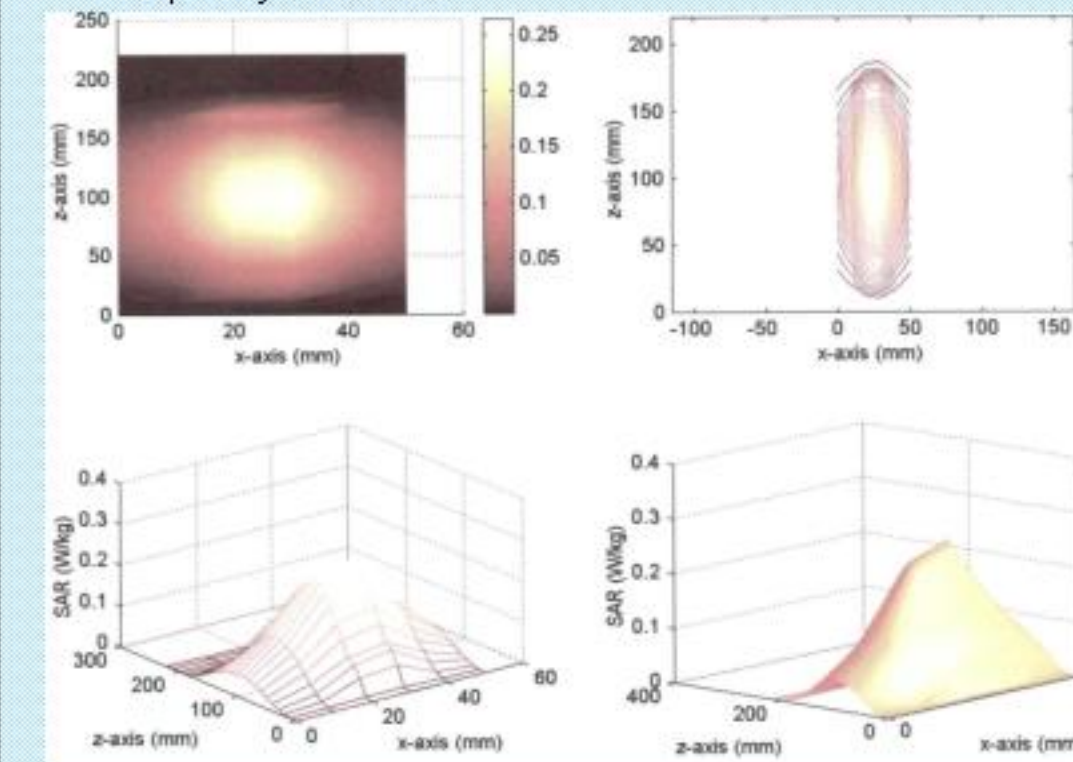


## Experimental Data

### Area Scans

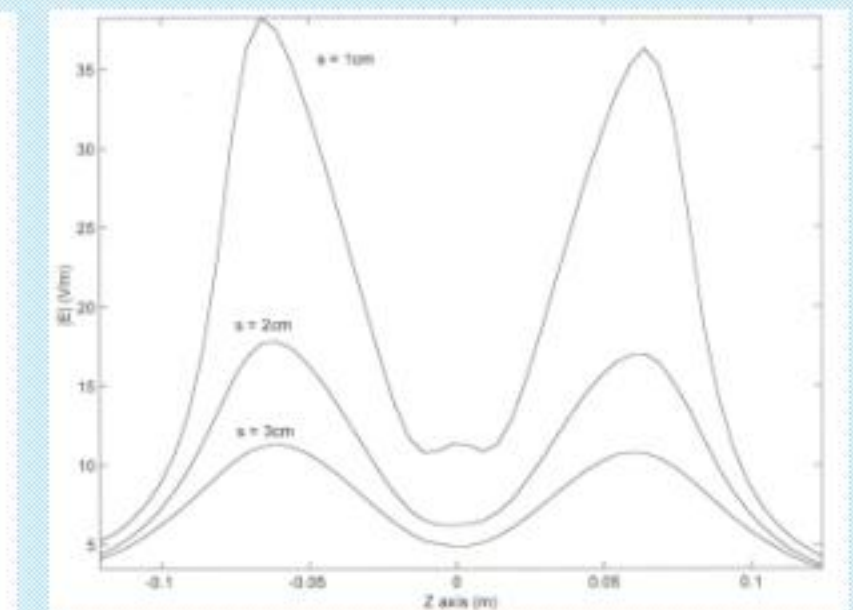
Experimental area scan in lossy solution (scale in W/kg):  
Forward Power = 30.1mW  
Frequency = 835MHz

Phantom Material conductivity = 0.85(S/m)  
Real relative permittivity = 41  
s = 15mm d = 5mm

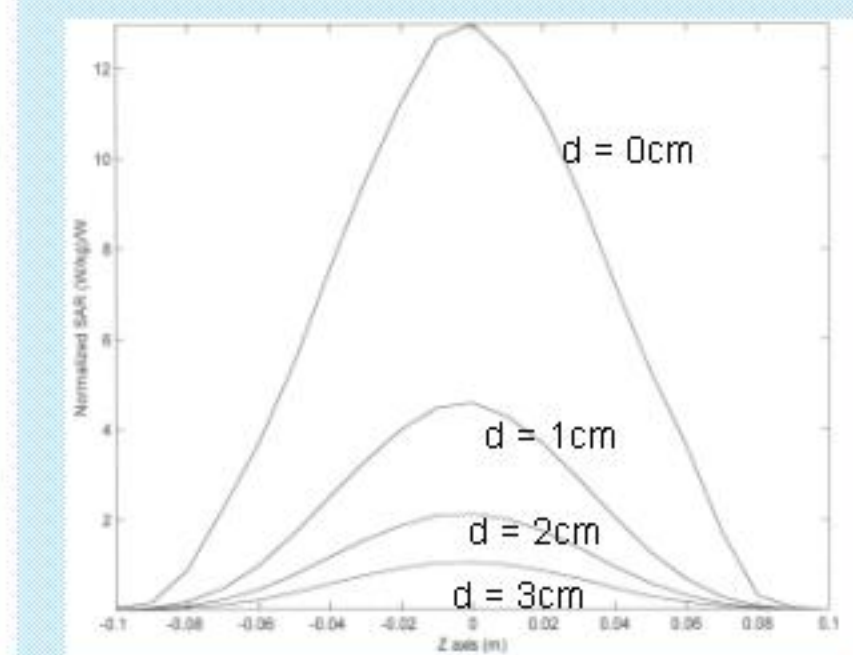


### Profile Scans

Experimental free space scan over dipole axis:  
Forward Power = 30.1mW  
Frequency = 835MHz



Experimental SAR profile along the axis (normalized to 1W radiated power):  
Frequency = 835MHz



### Composition of Phantom Dielectric Medium

835MHz				TOTAL			
Ingredients	Formula	Required (kg)	Required (grams)	Required (lb)	Volume (liters)	Mass (kg)	Density (kg/l)
Water		41.45%	0.829		1.632	2.000	1.225
Sugar		56.00%	1.120				
Salt (NaCl)		1.45%	0.029	29.0			
HEC		1.00%	0.020	20.0			
di-ethylene glycol		0.00%	0.000	0.0			
Dowlicl-75		0.10%	0.002	2.0			
Total final mass (weight) = 2.0 liters							
900MHz				TOTAL			
Ingredients	Formula	Required (kg)	Required (grams)	Required (lb)	Volume (liters)	Mass (kg)	Density (kg/l)
Water		40.71%	0.814		1.627	1.998	1.229
Sugar		56.63%	1.133				
Salt (NaCl)		1.48%	0.030	29.6			
HEC		0.99%	0.020	19.8			
di-ethylene glycol		0.00%	0.000	0.0			
Dowlicl-75		0.10%	0.002	2.0			

## Conclusions

- A near-field antenna measurement system has been constructed and EM radiation and SAR measurements made
- The experimental data agree closely with theory

## Future Work

- Uncertainty analysis
- Calibration of the entire system
- Anthropometric phantom with actual cell phones