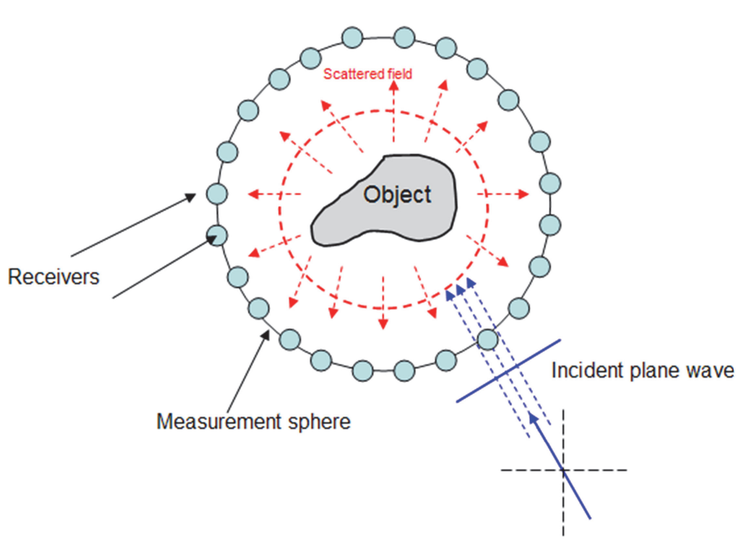
Systematic Method for Producing Scattered Field Data

R. S. Ritter[1], M. Fiddy[2]
1. Olivet Nazarene University, Bourbonnais, IL, USA
2. University of North Carolina - Charlotte, Charlotte, NC, USA

Introduction: One of the greatest challenges in developing algorithms for imaging is the lack of suitable scattered field data from known structures. Such a method is proposed and demonstrated utilizing COMSOL to create a virtual testing environment.



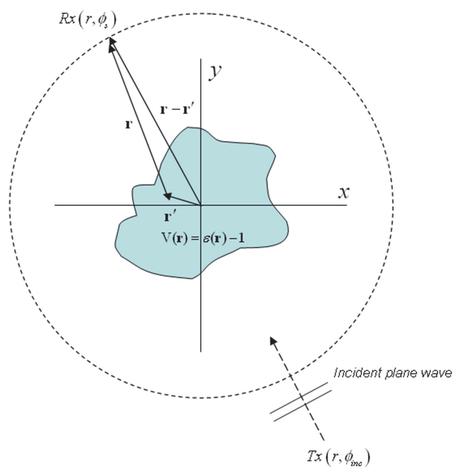
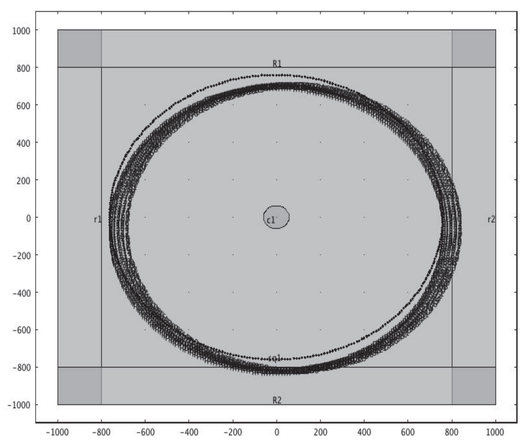


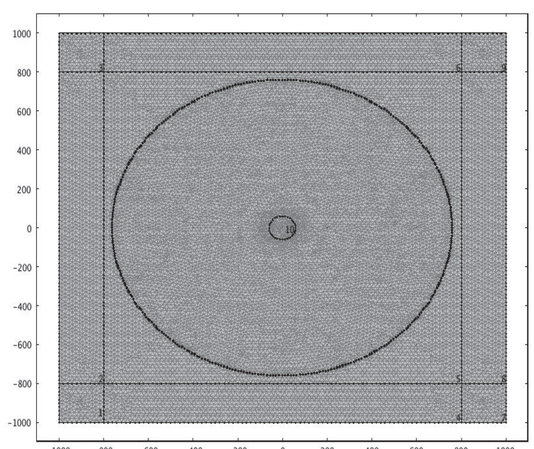
Figure 1. Experimental Setup **Figure 2**. Mathematical Model

Computational Methods: The finite element method in COMSOL is utilized to solve for the scattered field in this model using the following relationship [1]

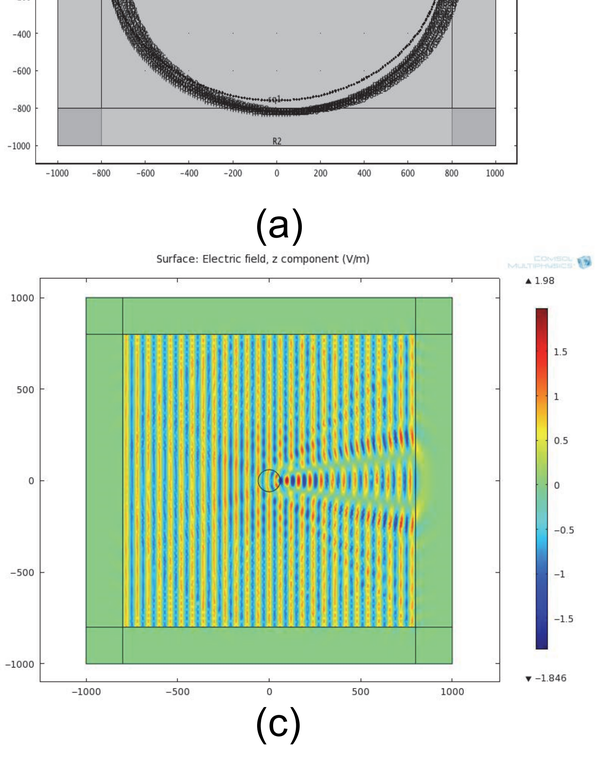
$$\frac{\partial}{\partial x}\left(\frac{1}{\mu_r}\frac{\partial E_z}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{1}{\mu_r}\frac{\partial E_z}{\partial y}\right)+k_0^2\varepsilon_r E_z = jk_0 Z_0 J_z$$



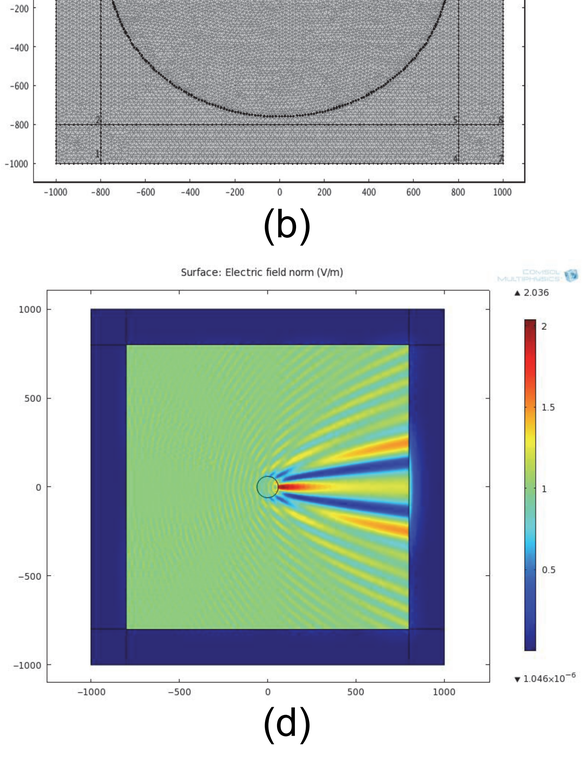
(a)



(b)



(c)



(d)

Figure 2. (a) Basic Model (b) Mesh Construction (c) Graphical Representation of E_z (d) Normalized Representation of E_z

Results: Data generated from this method were processed using imaging algorithms in [2] and the results then compared with measured data from real test [3] for comparison

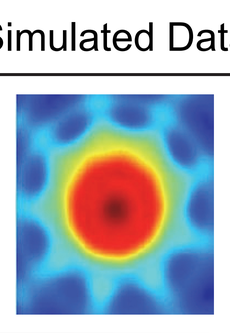
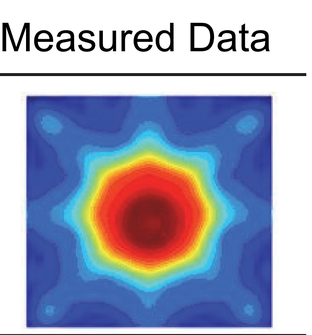
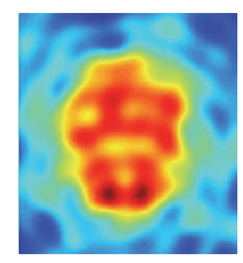
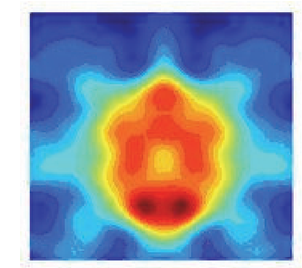
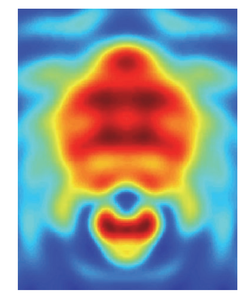
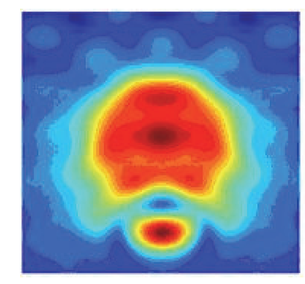
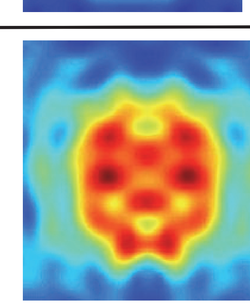
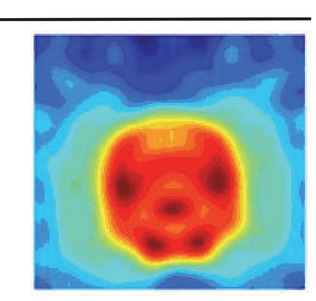
Target Setup	Simulated Data	Measured Data
FoamDielInt		
FoamDielExt		
FoamMetExt		
FoamTwinDiel		

Table 1. Simulated vs Measured Data Images for Various Targets

Conclusions: While imaging result evaluations can at times be somewhat subjective, it is evident from Table 1 that the data from this newly developed virtual testing method is consistent with the data obtained from similar real life experiments.

References:

1. Jin, J, The Finite Element Method in Electromagnetics, IEEE Press, New York, 2002.
2. Fiddy, M, and Ritter, R, Introduction to Imaging from Scattered Fields, CRC Press/Taylor and Francis, 2014
3. Eyraud C., et al. “Laboratory controlled data for validating inversion algorithms”, Institut Fresnel, UMR-CNR 6133, France.

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