Electromagnetics at Sandia National Laboratories

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The purpose of this paper is to provide a broad overview of the types of electromagnetic (EM) research, development, and applications that occur in a national laboratory environment. In a general sense, EM capabilities at Sandia National Laboratories include three focus areas: *applied electromagnetic theory*, *high power electromagnetics* (*HPEM*), and *RF systems and applications*. Although these focus areas overlap in expertise and capabilities, the primary mission objectives for each are quite different. These areas are comprised of a collection of electrical and mechanical engineers, plasma physicists, and computer scientists that support internal Sandia customers, NNSA and DoD defense, DOE, and work-for-other projects.

The *applied electromagnetic theory* group provides advanced theoretical analysis, as well as model and high-performance code development for many programs within and external to the lab. While this group is engaged in a wide breadth of activities including nanophotonic design, physics and engineering model development, and next-generation code development, currently a primary focus is to provide analytic and modeling/simulation evidence for weapon qualification in normal, abnormal, and hostile electromagnetic environments. Here the objective is to quantify coupling through the system to ultimately assess effects of these various external environments on the functional (component-level) weapon performance. Although this theoretical group is partnered with several sister experimental departments, analysis and simulations are critical for addressing gaps in testing capabilities, hardware limitations, and uncertainty quantification.

In the *HPEM* program areas the focus is the development of specialized high power pulse and continuous wave electrical systems and components for a variety of applications, including RF and high power microwave weapons, communications systems, and RF enabled cyber/security. In addition, there are programs directed toward the quantification and prediction of the effects on electrical systems caused by high power electromagnetic fields. The *RF systems and applications* programs provide system analysis and design, algorithm development, and hardware development for a wide variety of RF communications, radar, and geolocation missions. This involves the integration of electromagnetic, digital communications, and signal processing and sensing expertise in terrestrial, airborne and spaceborne systems.

In this presentation, a short summary of select projects occurring within each of these focus areas will be provided. The goal will be to communicate examples of the opportunities and technical challenges for applied electromagnetics research in a national laboratory setting.