



Sandia National Laboratories



Project Accomplishment Summary

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation
Albuquerque, New Mexico

PROJECT ACCOMPLISHMENTS SUMMARY

Cooperative Research and Development Agreement (#1573.95)

between **Sandia National Labs** and Lockheed Martin Corporation

Note: This Project Accomplishments Summary will serve to meet the requirements for a final abstract and final report as specified in Article XI of the CRADA.

Title: Hybrid Band™ Effects Program (Lockheed Martin Shared Vision CRADA)

Final Abstract:

Hybrid Band™ (H-band) is a Lockheed Martin Missiles and Fire Control (LMMFC) designation for a specific RF modulation that causes disruption of select electronic components and circuits. H-Band enables conventional high-power microwave (HPM) effects (with a center frequency of 1 to 2 GHz, for example) using a higher frequency carrier signal. The primary technical objective of this project was to understand the fundamental physics of Hybrid Band™ Radio Frequency effects on electronic systems. The follow-on objective was to develop and validate a Hybrid Band™ effects analysis process.

Background:

H-band investigation was motivated by high frequency RF effects test results at both LMMFC and SNL. While investigating the potential of nonlinear dynamics for enhancing HPM effects on electronic systems, upset effects were produced in electronic systems using a 94 GHz RF source (Salazar, et al., SAND2004-1052). This suggested further investigation into the phenomenology.

Description:

Sandia and LMMFC conducted and analyzed laboratory component and system tests. The following types of devices were tested at SNL at various frequencies in the millimeter wave band:

- Communications and Radiolocation
 - ISM band transceiver board
 - Long Range Cordless Telephone
 - Synthesizer (local oscillator of a transceiver)
 - GPS Receiver (under LMMFC sponsorship)
 - Altimeter
- Digital Systems
 - microcontroller board
 - DSP system
 - Individual functioning digital components

Understanding gained from these tests helped to identify rectification and gain mechanisms to assist the model development and to feed future system trade studies. The project structure included three main tasks: The work under Task 1 (PY1) identified the mechanisms of H-band effects as a function of frequency and waveform. Subtask 1 required Sandia and LMMFC to analyze previous effects testing results, generated from previous Hybrid Band™ studies and to hypothesize the mechanisms for the energy coupling and propagation to subsystems and components. Subtasks 2 and 3 helped evaluate the hypotheses in light of the four technical issues of coupling, propagation, device interaction, and system impact. The fourth Subtask

applied the understanding gained to first predicting, then optimizing the effects at the subsystem and component level. Task 2 (PY2) was to validate the Hybrid Band™ effect analysis process, and Task 3 was interim and final reporting. Unfortunately, funding was not available in the second year for Task 2. When this situation became clear during the first year, the level of effort was reduced and carryover funding was used for the rest of the project period to maximize the H-band effects understanding delivered by this project.

Benefits to the Department of Energy:

Due to its asymmetric nature, understanding the potential for radio frequency directed energy (RFDE) attack on both military and civilian electronic systems is vitally important to our overall national security. A fundamental understanding of RFDE as it may apply to our energy infrastructure is central to the DOE mission. Projects such as this one help provide DOE with the tools to understand the potential of this threat.

Economic Impact:

DARPA has recently expressed interest in further investigation of applications of this concept to the LMMFC customer.

Project Status:

The project has been completed. The results have been compiled into a three-hour (93 slide) technical briefing that has been presented to the customer and to technical advisors in other business areas.

ADDITIONAL INFORMATION

Laboratory/Department of Energy Facility Point of Contact for Information on Project

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Company Size and Points of Contact

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CRADA Intellectual Property

The intellectual property is the technical data and analysis that are documented in the briefing mentioned above.

Technology Commercialization

No commercialization

Project Examples

None

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This summary has been approved for public release by Sandia and Lockheed Martin Corporation

Sandia National Laboratories

By Larry D. Bacon
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Principal Investigator

9/2/2011
Date

Sandia National Laboratories

By [Signature]
Manager
WFO/CRADA Agreements

8/31/2011
Date

Lockheed Martin Corporation

By Mark Browder
Title: Principal Investigator

9/19/2011
Date

In order to expedite the process, if we do not receive your signed reply by 10/05/2011
we will assume your concurrence for the release of this document to the public.