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Novel Plasma & Electron Beam Source Studies at AFRL

One class of interesting frequency tunable high power microwave (HPM) sources is comprised of nonlinear transmission lines (NLTLs). NLTLs use solid-state nonlinear materials, such as ferrites, nonlinear dielectrics, or semiconductor junctions to convert a portion of Gaussian or video pulse-like inputs into RF energy. At the output of the NLTL, this RF energy is superposed on a slower quasi-DC pulse which is the remains of the input signal. The quasi-DC output signal can be a substantial part of the output and so represents a considerable loss in efficiency. Combining a NLTL with vacuum electron device technology may enable reclaiming some of this lost energy while preserving frequency tunability. The possibility of generating GW-class NLTL-modulated electron beams which are coupled to a slow wave structure to increase the extractable RF energy will be discussed.

Novel quasi-free-space plasma experiments being performed at the Air Force Research Laboratory (AFRL) will then be discussed. Studies of free space and quasi-free-space microwave-driven plasmas are of interest for transmitting HPMs through the atmosphere. An apparatus for generating and studying these plasmas has recently been built and tested at AFRL. While many large-chamber plasma research devices compatible with RF heating schemes have been reported, the present apparatus is novel in that the HPM beam is passed through the chamber with the beam coming to a focus at the chamber center. An overview of the apparatus will be provided, followed by a description of the microwave focal array, and results from initial plasma formation and diagnostics.

About the Speaker: Dr. Brad W. Hoff received the B.S. degree in physics from the U.S. Naval Academy, Annapolis, MD, USA, in 1999. Upon graduation from the U.S. Naval Academy, he served five years in the U.S. Navy, where he successfully completed the Navy's Nuclear Power Program and served as a Nuclear Trained Officer aboard the aircraft carrier USS Enterprise (CVN 65). After leaving active duty, he attended graduate school at the University of Michigan, earning M.S.E. degrees in nuclear engineering and electrical engineering, and the Ph.D. degree in nuclear engineering, in 2006, 2007, and 2009, respectively. He is currently a Senior Research Physicist with the Directed Energy Directorate, Air Force Research Laboratory, Kirtland Air Force Base, Albuquerque, NM, USA.