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Pulsed Power as a Science: Predictive simulations for beams, z-pinches, and other applications

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This presentation will overview my 40 years of research and the people with whom I have had the pleasure of working, both domestically and internationally. In 1978 Sandia's electron beam fusion program emerged from a weapons simulator community that was machine-oriented and relied on design principles and "JCM" criteria. Simulation tools were primarily used retrospectively. Fusions'extraordinary requirements stimulated tremendous innovation in pulsed power, beams, pinches, and simulation tools. I started by developing ion beam deposition and transport models that were integrated into radiation-hydrodynamics codes; validated by experiments on Gamble II and Proto I; and helped initiate Sandia's light ion beam fusion program. SDI program research led to the development of the ITS suite of electron-photon Monte Carlo codes (1985). Research on PBFA-I and PBFA-II on generating, transporting, and focusing ion beams required developing transport, diagnostic simulation, and analysis tools, which were used in focusing protons to 5 TW/cm^2 (1991) and lithium beams to 2 TW/cm^2, heating hohlraums to 65 eV (1996). They also helped identify anode plasma formation by electron heating as the source of diode impedance collapse leading to efforts to include electron-electrode interaction models into PIC codes and initiating hybrid fluid-PIC development (IPROP, LSP). Electrode physics remains a powerflow grand challenge for high yield fusion. In 1999 I led rad-MHD development (ALEGRA-HEDP) and oversaw EOS and conductivity model development using QMD/DFT, resulting in predictive capabilities for dynamic material experiments. Improved z-pinch dynamic hohlraum modeling and experiments resulted in thermonuclear neutrons (2004). 3-D wire array dynamics were modeled and understood. We developed advanced radiographic sources and built an LTD test bed. At NRL I have overseen advances in modeling and experiments in beams, pinches, pulsed power, and their applications (2009-). My goal throughout has been to develop and validate predictive simulation tools; making Pulsed Power a Science.

Author: MEHLHORN, Tom (Naval Research Laboratory)

Presenter: MEHLHORN, Tom (Naval Research Laboratory)

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