LA-UR- 11-01101

Approved for public release; distribution is unlimited.

Title: The PHELIX Portable Pulsed Power Machine: Hydrodynamics Experiments and Beyond

Author(s): R. E. Reinovsky, W. A. Reass, D. M. Oro
P. J. Turchi, D. B. Holtkamp, B. J. Hollander,
J. R. Griego, C. L. Rousculp

Intended for: 18th IEEE Pulsed Power Conference
Chicago, IL, USA
19-23 June 2011

Los Alamos
NATIONAL LABORATORY
EST. 1943

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Form 836 (7/06)

The PHELIX Portable Pulsed Power Machine: Hydrodynamics Experiments and Beyond

The PHELIX pulsed power machine is designed to drive cm-scale condensed matter, shock physics and hydrodynamics experiments in an architecture compatible with the high resolution, multi-frame proton radiography diagnostic at the Los Alamos Neutron Science Center (LANSE). To meet the tightly constrained footprint available for experiment on LANSCE, PHELIX employs a compact, modularized 120KV capacitor bank coupled to a current step-up transformer packaged into a self-contained, removable and portable unit. Each of two capacitor modules is comprised 4 "ATLAS," 60 kV, 60 kJ, fiberglass encased capacitors switched with a two 120 kV rail switches .The output of each module goes through a low-inductance, reticulated vitreous carbon resistor (R ~ 10 mΩ) to prevent excessive voltage reversal and is cable coupled to the four-turn primary windings of a toroidal, multi-filar, air-insulated, transformer. The single-turn secondary winding consists of a machined multi-segment, aluminum toroid that surrounds the primary windings. The secondary winding feeds a short (~10 cm) radial, disk transmission line with a thin (~1mm) solid insulated gap, and the compact liner implosion experimental load. PHELIX provides a very fast (<5 us) rise-time and 4-5 MA peak current drive with low reversal

PHELIX is also a prototype magnetic drive option for the LANL Materials and Radiation in Extremes (MARIE) initiative. In addition to liner implosion applications, other types loads connected to the transformer such as a linear (rail gun) accelerator for planar impact experiments, and a dense-plasma-focus have been assessed. Addition of power conditioning switches in the PHELIX circuit offer promise of increased efficiency for some load configurations, and faster risetime for others. In place of the current multiplying transformer, a pulsed, high-field magnet has been proposed as a part of a high-energy particle experiment. Conceptual applications of PHELIX to a variety of experiments that employ the proton-radiography diagnostic will be discussed.