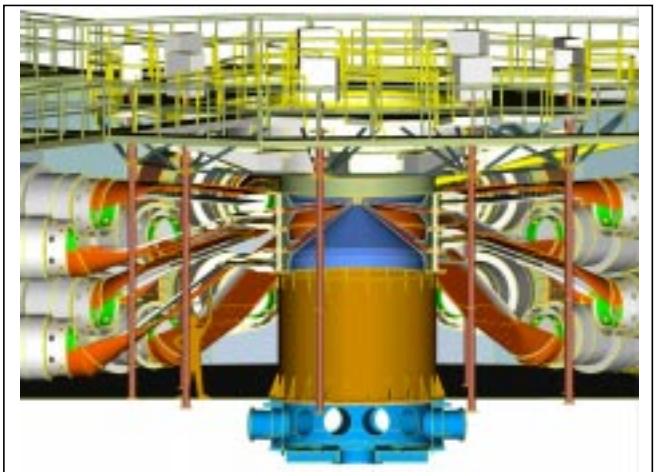
August 1996 Highlights of the Pulsed Power Inertial Confinement Fusion Program

We have developed new program plans for light ion ICF through the end of FY99. New hardware was installed on SABRE for ion source and ion diode tests. Diagnostics and wire load hardware are being prepared for operation of PBFA II in the z-pinch mode (PBFA Z). Malcolm Haines of Imperial College, London gave a series of five lectures at Sandia on the physics of z pinches.



Center section view of PBFA Z. Components inside coaxial pulse forming lines are new. The constant impedance horizontal water lines feed four inner vacuum MITLs.

The figure shows a center section view of PBFA Z. We will use this new pulsed power facility as a source of intense x rays for capsule ablator physics, radiation flow studies, radiation drive symmetrization, and hydrodynamic instabilities relevant to stockpile stewardship and indirect drive ICF, including ignition on the National Ignition Facility (NIF). Sixteen sets of short circuit hardware are being prepared for PBFA Z operation and the x ray diodes (XRDs) are being calibrated. On-line spectral unfolds will be utilized to speed up data analysis of the XRDs. Plans are being developed for wire loads on PBFA Z that include vacuum baking and minimal handling.

New program plans are being developed with respect to light ion ICF research that are consistent with a near-term change in the Pulsed Power Program emphasis from ion beams to z pinches. These include (1) the design and construction during FY97 of a single, shallow-focusing diode for both ion source and ion beam transport experiments on the SABRE accelerator and (2) theory and experiments to test the two-stage diode concept. The two-stage diode has the potential to improve critical diode parameters such as ion beam divergence and the power coupling between the magnetically insulated transmission lines (MITLs) and the second stage.

Support laboratory and university research will be coupled with experiments on moderate power accelerators (SABRE, COBRA, and Gamble II) in the downsized ion beam program. Facility modifications for studies of lithium beam focusing and lithium plasma formation are being completed. SABRE has been reassembled after installation of the RF cleaning hardware from PBFA X (at 1 - 1.5 kW power levels) and new high magnetic field banks. These modifications occurred following a series of SABRE experiments to assess a high-current, low-cost radiography technology. SABRE is now ready for calibration shots. An enlarged support laboratory with an expanded set of diagnostics and surface and subsurface cleaning hardware is being prepared to characterize the laser evaporation ion source LEVIS. Issues to be addressed in this facility include the cleaning necessary to produce a thin-film lithium surface with less than one monolayer of desorbed impurities and methods necessary to ionize the lithium rapidly and completely.

Simulations with the 3-D, electromagnetic IPROP code will guide self-pinched transport experiments in the new large-area, shallow-focusing extraction ion diode on Gamble II at NRL. With self-pinched transport, the azimuthal magnetic field produced by the net current following breakdown and ionization of the background gas pinches the ion beam and allows it to propagate within a small channel. In the simulations, a 50-kA, 1.5-MV proton beam with a 65-mrad divergence (which includes the effects of both the microdivergence and the focusing angle) is injected into a 50-cm-long cylinder filled with argon at different pressures. The simulations suggest that the effect of the risetime of the voltage pulse is not significant and that net currents of 25 - 30 % are possible.

The test stand to evaluate commercial switches for the NIF power conditioning system was down for two to three weeks for modifications to allow easier and faster changeover between different operating points. No commercial switch has been identified yet that satisfies both the electrical critieria (conduction at 24 kV and 500 kA for 360 μs) and lifetime requirement (10,000 shots). More than 250 switches will be required for the NIF power conditioning system. During August we began testing a full-voltage pulsed power module in the NIF prototype configuration.

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