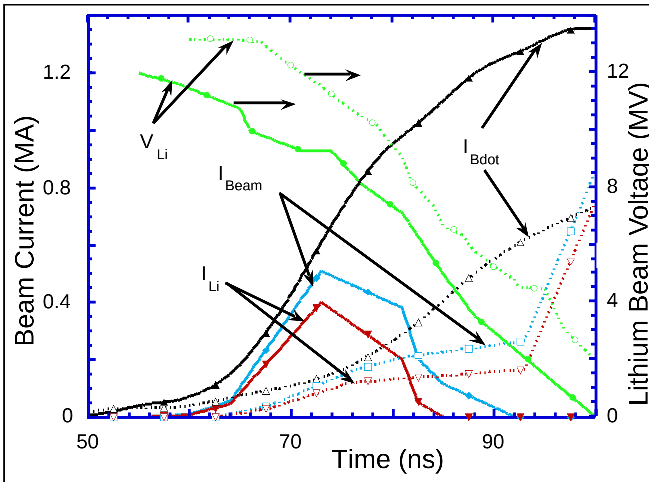
May 1996 Highlights of the Pulsed Power Inertial Confinement Fusion Program



LEVIS shot 656 (bold) has earlier lithium current compared to LiF shot 564 (dotted). Ion current was measured with Bdot monitors (I_{Bdot}), anode Faraday cup (not shown in figure), and magnetic spectrometer (I_{beam}, I_{Li}). For the shots shown, RF cleaning was not used. For LEVIS, most of the difference between I_{beam} and I_{Li} is in C, N, and O ions. For LiF, most of the difference is in F ions at 80 ns and in F and C ions at 90 ns.

The American Physical Society General Meeting and conferences on Physics of High Energy Density Matter, High Temperature Plasma Diagnostics, and Plasma Surface Interactions in Controlled Fusion Devices were in May. We talked about Saturn hohlraum experiments, PBFA-X extraction diode experiments, and NIF diagnostics. We analyzed the PBFA-X experimental series and began modifications to allow z-pinch implosions on PBFA II (PBFA-Z mode).

The extraction ion diode (PBFA X) experiments that began in September and ended in April included eight shots with an advanced laser-evaporation ion source. For this source, LEVIS, two separate lasers evaporate and then ionize the lithium in the anode overcoat, which for these experiments was lithium silver. The LEVIS shots used a new one-beam neodymium laser system that has a subnanosecond jitter. For the first time, radio-frequency (RF) discharge cleaning techniques and heating of the anode surface (to 200 degrees C) were evaluated with an active source on PBFA X. The LEVIS shots had an earlier lithium beam current compared to the shots with the passive LiF source (see figure) and more efficient power coupling from diode to beam, on average, than the LiF shots. If the anode-cathode gap with LiF is reduced from 2.5 cm (shot 564) to 1.8 cm (shot 586), the lithium current begins at the same time as the LEVIS shot shown (shot 656), but the lithium voltage with LiF drops more rapidly (to 4 MV at 80 ns). A lithium beam power of ~ 4 TW was obtained, the most ever in an extraction ion diode.

In extraction geometry, the insulating magnetic field is mainly radial and the ion beam propagates primarily in the axial direction. A uniform beam current distribution is critical to proper operation of an extraction ion diode. Using a new algorithm in the ATHETA electromagnetic design code to account for modifications to the magnetic field because of electron flow, we were able to improve the radial current distribution in a predictable fashion during the PBFA-X series. Previously, about five shots were required to optimize the field design empirically in an extraction ion diode.

The 5-MV, terawatt-class Cornell Beam and Radiation Accelerator (COBRA), based on linear inductive voltage adder technology, was completed COBRA, jointly developed by Cornell and Sandia, will be used, together with the SABRE facility at Sandia, to study extraction ion diode operation for ions heavier than protons.

Modifications to PBFA II to allow magnetically-driven plasma implosions (z pinches) have begun. In this configuration, PBFA Z is designed to optimize the coupling of electrical energy into the kinetic energy of the imploding plasma, which stagnates on axis to produce an intense, energetic x-ray source. Current will be delivered to the z-pinch load through self-magnetically-insulated vacuum transmission lines (MITLs) whose design is based on the successful Saturn MITL configuration. Modifications to the water lines, insulator stack, and MITLs were designed with state-of-the-art two-and three-dimensional mechanical, electrical, and electromagnetic codes. Modeling of the final design predicts a peak current greater than 16 MA delivered to loads of interest for ICF and weapons physics applications. Some of the new hardware, which extends radially outward into the water section, has been delivered. First operation in the PBFA-Z mode is expected to occur in August.

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