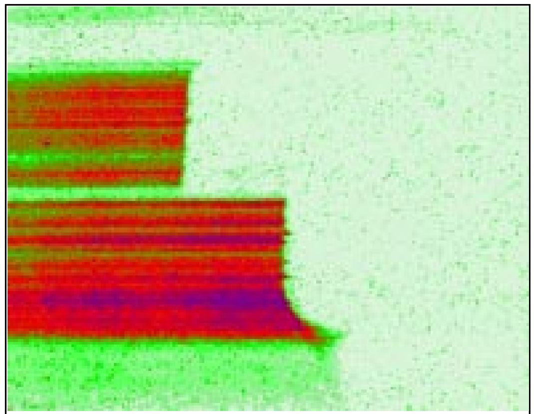
December 1995 Highlights of the Pulsed Power Inertial Confinement Fusion Program



Streak image from z-pinch-driven experiment, using active shock breakout diagnostic.

We have tested the hohlraum environment and diagnostics that will be needed to study the physics that will occur during the foot of the drive pulse for the National Ignition Facility. In these new z-pinch-driven experiments on Saturn, clean streak camera data have been obtained with an active shock breakout (ASB) diagnostic (see figure) at the 68-eV radiation temperature measured. In contrast, on Nova with a passive shock breakout diagnostic, streaked images cannot be resolved below 100 eV. We are designing a similar ASB diagnostic for Nova.

Target design calculations suggest that it may be of interest to drive non-cryogenic DT capsules within a dynamic (i.e., imploding) hohlraum created by a magnetically-driven implosion (a z pinch). At the power levels expected for operation of PBFA II in the imploding plasma (PBFA-Z) mode, calculations suggest 10^{13} thermonuclear neutrons should be produced with DD fuel.

We are making progress in coupling power from PBFA II to an extracted ion beam in the PBFA-X (extraction) mode. Experiments will be implemented over the next three months to evaluate the effects of electrode surface cleaning, anode heating, improved vacuum, electron limiters, and active ion sources upon the power coupling and lithium beam purity. The combination of RF glow discharge cleaning, anode heating, and improved vacuum should reduce the current in non-lithium ions. For example, operation with one of the four cryopumps indicates we may reach 10^{-7} Torr, two orders of magnitude better than we obtained in the radially-focusing ion diode. Reduced pressure is important to prevent recontamination of surfaces by contaminant ions accelerated along with the desired lithium ions.

At the Karlsruhe Research Center (FZK), research relevant to our ICF program has been done for more than a decade. The German program has similar problems with controlling ion divergence and beam purity, and German research on extraction diodes and ion sources has been particularly beneficial to our program. FZK scientists have developed an active source that can provide a high purity proton beam; we are applying similar techniques to develop an active lithium ion source on PBFA X. Extraction experiments on the KALIF facility have confirmed our theory that lower ion current enhancement (the ratio of ion current density in the diode to the Child-Langmuir value) can reduce ion divergence. In early December we visited Karlsruhe to strengthen and broaden this informal collaboration, which will include the temporary exchange of staff. We discussed recent KALIF experiments in which extracted, 1 TW/cm^2 protons beams are focused onto planar targets. Similar experiments at higher power intensity are planned on PBFA X with lithium ions.

We hosted a two-day workshop on the physics of high-currrent-density ion sources. Attendees were from Sandia, Weizmann Institute, Cornell University, Naval Research Laboratory, Krall Associates, Mission Research Corporation, FZK, Lawrence Berkeley Laboratory, General Atomics, University of Michigan, and University of Wisconsin. The experimental, diagnostic, and modeling status of existing sources was reviewed. We plan increased emphasis on source modeling and on source experiments and diagnostics in facilities ranging from light laboratories and “university-scale” accelerators to high power on PBFA X.

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