Virtual National Laboratory for Heavy Ion Fusion
October | November 2002

HIF News

LBNL-PUB-844-02-10/11

Snowmass – Inertial Fusion Energy discussions

During July, the US fusion community sponsored a two-week workshop at Snowmass, Colorado. For magnetic fusion the main topic was future burning plasma experiments such as ITER. The issues facing inertial fusion are different. The burning plasma experiments for inertial fusion, the NIF in the United States and the LMJ in France, are already under construction.

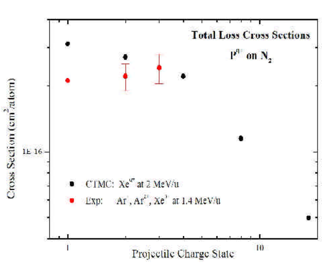
Although the NIF will provide data on burning IFE plasmas, it does not have the capability to operate at high repetition rates. Moreover the NIF has neither the efficiency nor the durability needed for commercial power production. Important issues must be studied and resolved to enable high repetition rates, good efficiency, and adequate lifetime. The IFE community assessed plans to address these issues, particularly plans leading to integrated research experiments for the various approaches. There were three important conclusions:

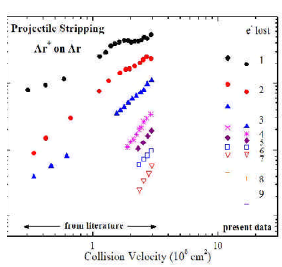
1. **The various driver programs are advancing at different rates because of funding differences and their relative maturity. The most advanced programs are unlikely to be in position to propose an integrated research experiment for several years.**
2. **The inertial fusion community (both proponents and critics of the individual approaches) believes that the near-term research plans are sound and that they address the correct technical issues.**
3. **Funding rates are the programmatic issue. Resolution of this issue will require coordination of the inertial and magnetic programs.**

Regarding the second conclusion, it is noteworthy that there is less agreement about longer-term plans and some of the quantitative aspects of the milestones needed to advance to integrated research facilities. The various disagreements must be resolved by additional workshops and peer review. *– Roger Bangerter*

Stripping of Fast, Heavy, Low-Charge-State Ion Beams

Heavy Ion Fusion requires accelerating, transporting, and focusing intense beams of energetic, low-charge-state, heavy ions onto a DT target. Stripping on background gases increases the charge state of the beam, which causes beam loss, gas desorption, and increases the diameter of the focus. No accurate information existed about electron loss from fast





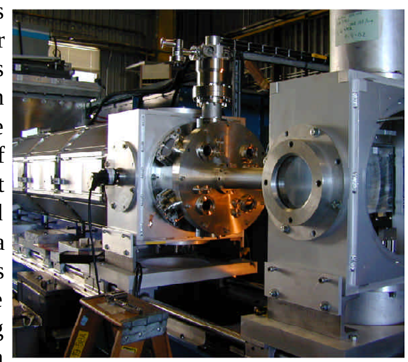
(MeV/u), low-charge-state, heavy ions. Simple one-electron theoretical models are inaccurate.

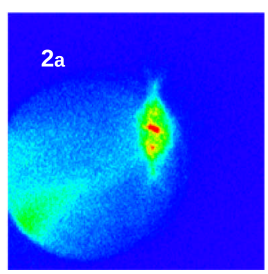
Recently Ron Olson applied the CTMC (Classical Trajectory Monte Carlo) method to calculate projectile stripping cross sections that are in good agreement with experimental data for high charge state ions. To test these calculations for low-charge-state ions and fill a gap in experimental information, we collaborated with the atomic physics and accelerator groups at GSI to measure absolute cross sections for electron loss from Ar^{+}, Ar^{2+}, and Xe^{3+} ions at 0.74 and 1.4 MeV/u, Figs. 1 and 2. The magnitude and energy dependence (v^{-1}) agree with Olson's predictions. The cross sections are nearly independent of incoming projectile charge state, and increase approximately a factor of two between neon and argon targets with N_2 falling in between. We also found that single and multiple electron loss cross sections, Fig. 1, fall within a factor of two of a single curve when scaled by $[\Sigma IP]^{n(v)}$, where ΣIP is the sum of the energies needed to remove the necessary electrons and n(v) is a velocity dependent power ranging from roughly 1 at high velocities to 2-3 at low velocities.

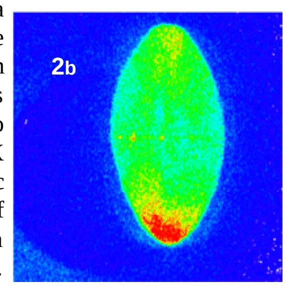
– Bob DuBois

NTX Experiments with Plasmas

The concept of neutralized drift of intense ion beams through the target chamber is essential for the viability of an economically competitive heavy ion fusion power plant. The physics of neutralized drift has been studied extensively with PIC simulations. To provide quantitative comparisons of theoretical predictions with experiment, the NTX (Neutralized Transport Experiment) has been under construction over the past year. Experiments with plasma neutralization began on 9/2, (Fig1). The initial experiment consists of a pulsed metal arc source at the exit of the last pulsed magnet, serving as a 'plasma plug', from which electrons are extracted by the positive potential of the traversing beam. The neutralized ion beam drifts for a meter distance to converge onto a small focal spot, as witnessed by an image on a glass plate. (Fig 2a). The same magnet configuration without plasma yields a large spot at the same location, due to beam blow-up when the space charge is unneutralized (figure 2b). Hardware for the full neutralization experiment with an rf plasma source (from PPPL) is also complete and will be installed at NTX near the focal point to study volumetric plasma effects (to simulate the effects of photoionized plasmas in a fusion chamber) and gas interactions. Quantitative measurements and comparisons with theories are planned for the coming year.*-Simon Yu*




2a


2b

For comments about the content of the HIF News, contact Art Molvik (925)422-9817, or molvik1@llnl.gov.
To get on the mailing list of the HIF News, send a request to PMBronte@lbl.gov

This work was performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48 and by Lawrence Berkeley National Laboratory under contract No. DE-AC03-76SF00098 (LBNL), and by Princeton Plasma Physics Laboratory performed under the auspices of the U.S. Department of Energy under contract No.DE-AC02-76CH-O3073.