Virtual National Laboratory for Heavy Ion Fusion

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HIF News

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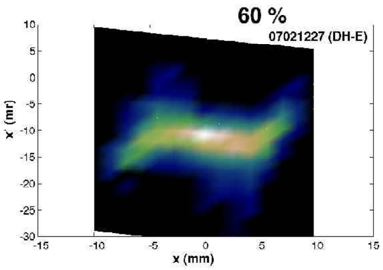
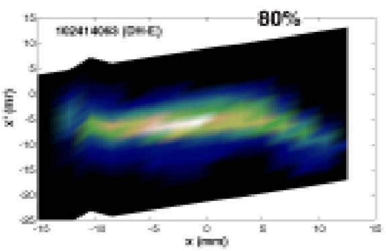
High fill-factor experiments on HCX

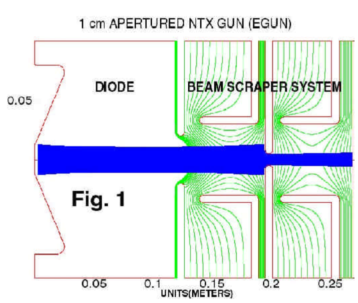
Recent High-Current Experiment (HCX) measurements with a K^+ (0.2 A, 1 MeV) beam and the first 10 electrostatic transport quadrupoles show no emittance growth through the lattice, within the diagnostic sensitivity (~ ±10%). Currents collected on quadrupole electrodes indicate particle losses of <0.5%, while Faraday cup current monitors indicate ~1% losses in the entire distances. Sensitive halo measurements show that halos as small as 10^{-3} of the beam core can be probed with present diagnostics. PIC simulations presented at the Moscow HIF Symposium predict that matched beam excursions filling 80% of the quadrupole bore would result in negligible emittance growth, if perfect alignment and envelope control were maintained. The figures show a snapshot of the horizontal beam phase space in the converging plane (so the beam is smaller at the diagnostic station) after the last quadrupole for two fill-factors: where the beam filled 60% and a more aggressive 80% of the 46mm-diameter aperture. Since the transportable current scales as the square of the fill factor, determining its maximum will have a large impact on the cost of multi-beam induction accelerators for HIF. This year, further fill factor, matching, halo and diagnostic development experiments will be carried out in the 10 electric quadrupole lattice, and measurements will begin with 4 magnetic quadrupoles. Next year, planned electric lattice extensions promise better resolution and first systematic looks at the collective evolution of beam inhomogeneity. *– P. Seidl and L. Prost*

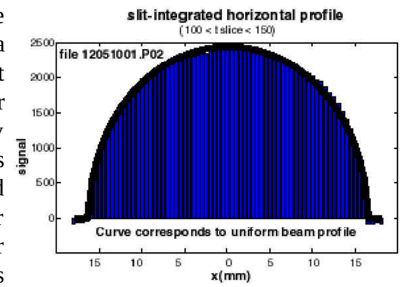




Beam Aperture Experiments at NTX

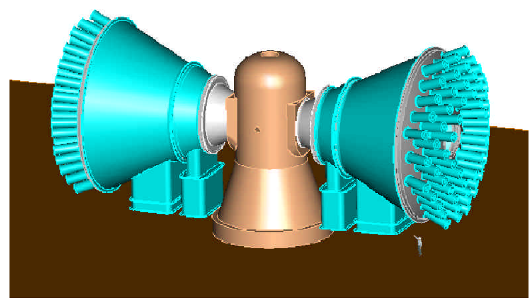
A high brightness ion source is an essential component of the Neutralized Transport Experiment (NTX). An ion beam extracted from a Pierce-type diode suffers from spherical aberrations as evidenced from the phase space distortion (emittance growth) and from the non-uniform density profile. Since the source of these aberrations are the high order field components, the particles at the edge of the beam are the most affected. One way to generate high brightness beams is to remove the edge of the beam after it is generated in the diode; but scraping the beam also generates secondary electrons that must be controlled to prevent them from perturbing the beam. We have designed a beam scraper system that includes an electron trap for the control of secondary electrons. Figure 1 shows the beam as it is generated in the diode and after passing through the scraper system and Figure 2 shows the slit-integrated density profile for the apertured beam. The measured emittance is approximately the expected emittance coming from the emitter temperature and the slit-integrated density profile shows the expected shape for a uniform density beam; thus showing that scraping a beam from a typical diode and controlling the secondary electrons provides a mechanism to generate high brightness beams.
- Enrique Henestroza





Robust Point Design for a HIF Power Plant

An updated, self-consistent point design for a heavy ion fusion (HIF) power plant has been completed. The design, which is based on an induction linac driver, indirect-drive targets, and a thick liquid wall chamber, meets all known physics and technology constraints. Conservative parameters were selected to allow each design area to meet its functional requirements in a robust manner, and thus this design is referred to as the Robust Point Design (RPD-2002). The driver energy is 7 MJ, with 5.25 MJ from 72 Bi^+ main pulse beams at 4 GeV, and 1.76 MJ from 48 Bi^+ foot beams at 3.3 GeV. This study includes a target that, through detailed simulations, provides a gain of 57. The accelerator has a calculated efficiency of 38%. Operating at 6 Hz, the plant has a net electric power of 1 GWe. The final focusing magnets are shielded by a combination of flowing molten salt jets and vortices, magnetic dipoles and solid shielding material, resulting in lifetimes of 30 years or longer based on 3D particle transport simulations. The superconducting quadrupoles that constitute the final focusing magnets have very large apertures, stored energy and forces, but the fields required have been obtained in other particle accelerators. The final spot size based on our analytic and numerical understanding of neutralized beam transport, meets the target requirement of ~2 mm. Figure 1 illustrates the layout of the final focus magnet arrays (60 beams from each side) and the chamber. ***– Wayne Meier***



For comments about the content of the HIF News, contact Art Molvik (925)422-9817, or molvik1@llnl.gov.
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