Virtual National Laboratory for Heavy Ion Fusion
May 2002
HIF News
LBNL-PUB-844-02-05

Hohlraum wall material selection

Indirect-drive laboratory targets have used a 50% mixture of Au and Gd for hohlraum-wall materials, for high reflectivity to soft x-rays. Materials for power-plant targets will have additional requirements including the feasibility and cost of fabrication, of recycling, and issues associated with radioactivity, chemical safety, and corrosion. The table rates some candidates by the driver energy absorbed in the wall (Debbie Callahan). Some choices perform as well as Au and Gd, but other factors also need consideration.

Both mercury and lead will attack steel, and are chemically toxic. Mercury volatility results in 10,000 times lower inventory than with lead, and therefore lower corrosion. They have different problems: mercury has a higher saturation concentration in air (Susana Reyes), lead precipitates and freezes out on surfaces making recovery and maintenance difficult.

Hafnium can be separated by contact with beryllium in an on-line slipstream, as planned to reduce the molten salt and remove corrosion products. The beryllium electrodes would be processed off-line to remove the hafnium. At 6 Hz, ~0.25 g of these materials on the inside of each hohlraum, gives 50 tons/y to recycle. Xenon, with krypton, would be frozen on the surface along with mercury and hafnium.

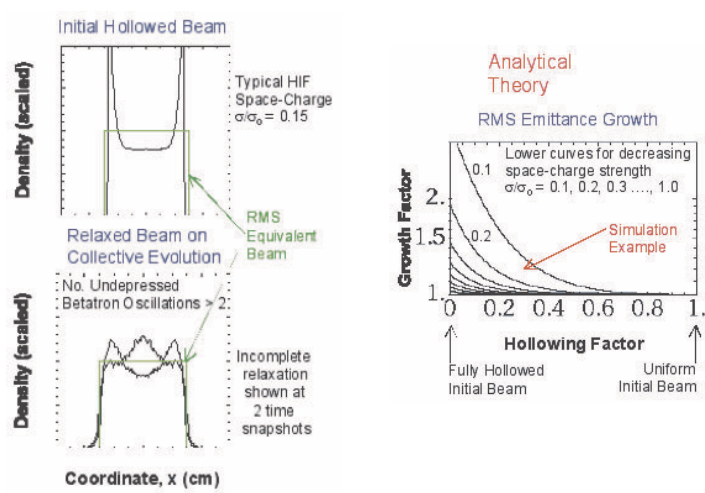
Material	$E_{wall}/E_{wall\ AuGd}$
Au/Gd (50:50)	1.00
Au	1.25
Pb	1.28
Hg	1.26
Hg/Xe (50:50)	1.18
Hg/Ta/Cs (45:20:35)	1.03
Pb/Hf (70:30)	1.04
Pb/Hf/Xe (45:20:35)	1.00
Hg/Hf/Xe/Kr(45:20:20:15)	~1.00

A systems study is needed to determine the optimum materials because the costs of safety, corrosion protection, fabrication and reprocessing could counterbalance higher accelerator costs needed to compensate for lower target gain resulting from the extra wall losses. *– Ralph Moir*

US/Japan Workshop: On March 4-5, 2002 over twenty Japanese and US researchers participated in the 6th Japan-US Workshop on the Physics and Engineering of Ion Beam Inertial Fusion. The first day we met at Lawrence Berkeley National Laboratory, to hear talks from both sides of the Pacific, with tours of the US Virtual National Laboratory's High Current Experiment, HCX, and components of the Neutralized Transport Experiment, NTX. The second day, at Lawrence Livermore National Laboratory, we heard additional talks, and toured the 500 kV Source Test Stand (STS 500) and the National Ignition Facility. Most segments of the HIF community were represented, including beam physics from source to target, chamber dynamics, and target physics. Talks on ion sources, laser plasmas for ion sources, ion beam simulations, electron experiments, beam loading effects, and core material research were presented, as well as reviews of the major Heavy Ion Facilities and experiments in both Japan and the US. We explored areas where increased collaboration would be of mutual benefit, identifying a number of topics. These included bunch compression physics (required for both MUSES and the IRE), technology for high-repetition rate induction cells, "double-focused" final focus systems (which would use quadrupoles for the first part of the final focus section and a plasma lens for the final part), and simulations and modeling. The workshop also marked the beginning of the second year of US/Japan exchanges in which researchers from each nation make one or two week visits to the other's institutions to get a more extensive understanding of the mutual progress being made in Heavy Ion Fusion. *– John Barnard, Ron Davidson, and Kazuhiko Horioka*

A Theory of Beam-Emittance Growth due to Nonuniform Space Charge

Space-charge dominated beams emerging from injectors can have significant initial errors such as space-charge nonuniformities and envelope mismatch which contain free energy relative to an ideal, uniform density beam with a matched envelope. These errors typically launch a broad spectrum of collective waves internal to the beam. The waves can phase-mix and nonlinearly interact as the beam is transported through an accelerator channel to rapidly drive the beam to a relaxed state with more uniform density and increased phase-space area (i.e., emittance). Simulations and upper-bound theoretical analyses based on approximate system conservation constraints have been employed to parametrically understand how much free energy is available to drive undesirable emittance growth. We find that the available energy and growth is surprisingly limited for all but those with most extreme parameters, implying that significant beam nonuniformities can be tolerable. The figure illustrates a PIC simulation of a strongly hollowed initial density profile that undergoes rapid collective oscillation to a smoothed density state with residual fluctuations. Theoretical curves to the right provide good bounds of the modest emittance growth observed in the simulations for varying space-charge strength. Aspects of this ongoing work have been submitted to PRST-AB, with authors from all three VNL laboratories. *– S.M. Lund*



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.