Virtual National Laboratory for Heavy Ion Fusion

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HIF News

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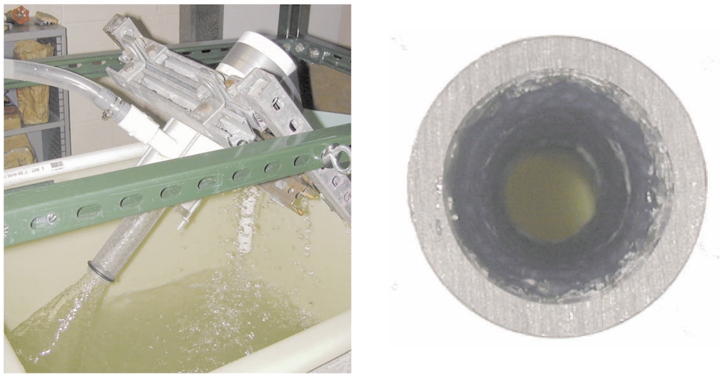
New molten salt composition for reduced beam-line gas pressure

A new ternary salt mixture was identified at U.C. Berkeley for use in HIF chambers. This salt adds NaF to LiF and BeF_2, which have been studied previously, for thick-liquid protection. The new salt, called "flinabe," has a substantially lower melting temperature (~320° C) compared to flibe (460°C). Used at lower temperatures, flinabe has a very low vapor pressure that can enhance performance in HIF beam lines and in MFE liquid-protection. While it is still desirable to use higher temperatures (600 to 650° C) in the main chamber of HIF power plants to maintain a high power-cycle efficiency, low-temperature flinabe can be used in vortex-flow in the beam tubes, to achieve much lower gas pressure in the final-focus magnet region. Like flibe, the dominant gas species for flinabe is BeF_2. Compared to 600° C flibe, which has a gas density of 10^{13} cm^{-3} (10^{-1} Pa), equilibrium flinabe vapor at 400° C is estimated to have a density that is 4 orders of magnitude lower – 10^{9} cm^{-3} (10^{-5} Pa). This has the potential to eliminate beam stripping in the focusing magnets as an issue. – *Per Peterson and Grant Fukuda*

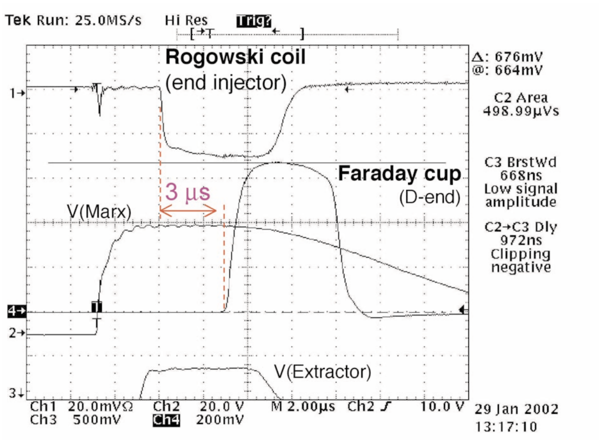


Flinabe would be used in beam-tube vortex flows, currently being studied in water-hydraulics experiments at U.C.Berkeley, shown in side and end views.

First beam in the High-Current Experiment HCX

On Friday January 11, 2002 ~180 mA of K+ from the electrostatic quadrupole (ESQ) injector was injected into the matching section and the HCX system for the first time. The figure shows the ion beam, detected at the end of the HCX via a Faraday cup, and the injected current, measured with a Rogowski loop. The time of flight between them was 3 µs, near that expected for the K+ ions at 1.0 MeV. Our goals for HCX are to understand space-charge-dominated beam transport at high aperture filling and the phenomena that limit it. For this we will:

- Optimize and characterize the beam in the matching section, the 10 ESQs, and as it expands into the diagnostic tank beyond. We will begin studies of varying the fill factor - the degree to which the beam fills the available aperture.
- In FY02-03 we will transport the beam through at least four magnetic quadrupoles. We are developing new diagnostics to study the accumulation of electrons in the ion beam, their interactions, and amelioration during transport through the magnetic quadrupoles.
- We will add 20-30 more electrostatic quads in FY03, corresponding to ≈6 plasma oscillations, enough to make meaningful comparisons to particle-in-cell simulations of the experiment. With the new diagnostics under development, this will also enable better measurements of the phase space evolution of the beam at high aperture filling.
- In FY04 a prototype induction module will be used to test control of longitudinal beam expansion and active beam waveform feedback and correction. – *Frank Bieniosek and Peter Seidl*



Selection of superconducting magnet design

In a heavy-ion fusion driver, arrays of superconducting quadrupoles will transport parallel beams through a sequence of induction acceleration cells. The heavy-ion fusion program has supported superconducting magnet development for the High Current Experiment (HCX) and future machines for the past several years, through a collaboration of the HIF-VNL (LBNL, LLNL) and external partners (MIT, Advanced Magnet Lab-AML).

As a first step in magnet development, single-bore prototypes for HCX were designed, fabricated and tested. Two design approaches were proposed by AML and LLNL in 2000. In the AML approach, grooved plates support a round 7-strand cable. The LLNL approach uses double pancake coils wound around iron cores. Two prototypes of each design were tested in 2001 by MIT and LBNL. All four surpassed the minimum gradient specification for HCX. Information collected during prototype design, fabrication and test formed the basis for a design selection aimed at focusing the available resources on a single development path. A 7-member board was formed in December 2001. The rating system was designed to take into account all aspects of magnet design, fabrication and test. Independent evaluations showed a preference for the LLNL approach, which was confirmed during subsequent discussions among board members. The main points in favor of the LLNL design are the potential for reaching higher gradient in the same physical envelope, and better training performance during test.

Present effort centers on the development of a cryostat housing two superconducting quadrupoles. One additional quadrupole with optimized parameters will also be fabricated and tested in FY02. – *GianLuca Sabbi and Peter Seidl*

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