Heavy Ion Fusion Engineering and Enabling Accelerator Technology Development

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The Heavy Ion Fusion Virtual National Laboratory is a collaboration among LBNL, LLNL, and PPPL. There are also external partners at various other laboratories and universities. The engineering and technology development activities can be organized into the following three categories: ion sources and injectors, induction modules and pulsers, and superconducting and pulsed quadrupole magnets. Target and chamber technology development is occurring under the Virtual Lab for Technology and will not be discussed here. High current density ion sources to make a multiple beam injector more compact is a major focus of the current activities. A 500kV test stand is currently being commissioned to investigate high gradient insulators and improved vacuum gap gradients, as well as testing both surface ionization and plasma sources. Because high acceleration gradients decrease the length of the induction accelerator and the number of focusing elements, there is a potential for significantly reducing the cost of the machine. There are several collaborations with insulator manufacturers to achieve higher gradients while lowering the manufacturing cost and maintaining high vacuum compatibility. High gradient insulators and improved vacuum gap voltage holding are important both for the induction cells and the injector structure. Unconventional induction cell geometries are also being considered to increase the acceleration gradient. Solid-state pulser technology is being pursued through SBIR contracts to provide reliable pulsers with agile waveform control, a required capability to compress the beam and correct for space charge effects. Ferromagnetic material development is continuing to look at low-loss, high flux swing material that is affordable. Producing thinner ribbon and developing insulation that can withstand the annealing process are among the most recent efforts. The testing of prototype pulsed and superconducting magnets over the last year has provided the basis for developing both of these magnet systems for the present single beam experiments. One of these options will be chosen to pursue a compact, multiple beam magnet array. A heavy ion fusion driver will require technology development in these areas to meet the required performance goals and remain economically feasible.