RF Ion Source-Driven IEC Design and Operation

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The IEC (Inertial Electrostatic Confinement) concept has the long range potential for a low-Q fusion reactor. However, in the near term, the has been demonstrated to offer a very attractive compact MeV neutron source in the 10^{8-9} neutron/sec range for various uses such as neutron activation analysis (NAA). Simple changes in operation of the same unit can also provide MeV protons or intense keV X-rays. Such an IEC neutron source has already been used for industrial of various metallic ores during unloading on a conveyer belt. In this case, the IEC replaced a Cf-252 source to provide on-off capability. If the IEC yield is increased by several orders of magnitude, a number of exciting new applications become practical, including use in hospital production of radioisotopes for medical applications. This would also be an important step towards scale-up to reactor level operation.

This paper presents the recent studies aimed at achieving higher yield IECs using a unique external ion source ILLIBS (Illinois Ion Beam Source). ILLIBS employs a RF-driven plasma in an graded magnetic field configuration. Use of this gun allows initiation of the plasma discharge below the normal (Paschen curve) break down region where losses due to charge exchange are greatly reduced. These results suggest that with D-T gas mixture in this unit, a neutron rate of 7.3×10^{12} n/sec at 1.2 mTorr, 75 kV and 1.5 A ion current, should be obtainable with production efficiency 5.9×10^{7} n/J. This represents a significant improvement in neutron production efficiency. Experimental studies of the ILLIBS ion source will be provided along with data for it's operation on the IEC. Implications for future scale-up to higher fusion power levels will be presented.