

**Overview of University of Wisconsin  
Inertial-Electrostatic Confinement Fusion Research\***

J.F. Santarius<sup>1</sup>, G.L. Kulcinski<sup>1</sup>, R.P. Ashley<sup>1</sup>, D.R. Boris<sup>1</sup>, B.B. Cipiti<sup>1</sup>,  
S. Krupakar Murali<sup>1</sup>, G.R. Piefer<sup>1</sup>, R.F. Radel<sup>1</sup>, T.E. Uchytel<sup>1</sup>, and A.L. Wehmeyer<sup>1</sup>

<sup>1</sup>*Fusion Technology Institute, University of Wisconsin,  
1500 Engineering Drive, Madison, WI 53706  
santarius@enr.wisc.edu*

In Inertial Electrostatic Confinement (IEC) devices, a large voltage difference between concentric, nearly transparent grids in spherical or cylindrical geometry accelerates ions to fusion relevant velocities. Geometric convergence, in theory, leads to a high-density core and increased fusion reaction rates. The University of Wisconsin operates two IEC devices, a cylindrical aluminum chamber and a spherical, water-cooled, stainless-steel chamber, with a power supply capable of 75 mA and 200 kV. The objective of the research program is to generate fusion reaction products efficiently for various applications, including protons for creating radioisotopes for nuclear medicine and neutrons for detecting clandestine materials. One UW IEC device has already produced measurable quantities of proton-produced <sup>13</sup>N and <sup>94m</sup>Tc, and it has also generated  $1.8 \times 10^8$  neutrons per second. The UW IEC devices also serve as materials test beds for ions impacting surfaces at 10-200 kV.

Most IEC devices worldwide, including the UW devices, presently operate primarily in a pressure range (1-10 mtorr) that allows ions to make only a few passes through the core before they charge exchange and lose substantial energy or they collide with cathode grid wires. It is believed that fusion rates can be raised by increasing the number of passes and operating at a pressure where ion flow is not impeded by neutral gas. To that end, a helicon ion source has been developed to explore operation at pressures of  $\sim 0.05$  mtorr, with ion currents up to 30 mA.

The UW IEC research group uses standard proton detectors, neutron detectors, residual gas analyzers, and spectroscopic diagnostics. New diagnostic techniques have also been developed, including eclipse disks to localize proton production and chordwires to estimate ion flux using power balance. Theoretical and computational efforts are underway to provide a better understanding of IEC core physics and fusion reaction rates. These model ion flow dynamics, space-charge buildup, charge exchange, ionization, neutral collisions, and attenuation by the cathode grid.

\* Research supported by the Grainger Foundation, the Greatbatch Foundation, and the University of Wisconsin.