Re-Design of Converging Ion Guns for Nuclear Fusion of Advanced Fuels

Marcos Navarro, Brian Egle, Matt Michalak, Gerald Kulcinski, John Santarius, Richard Bonomo
Fusion Technology Institute, University of Wisconsin-Madison

Goal
Increase the reaction rate of the D-D and D-^3^He nuclear fusion reactions in Inertial Electrostatic Confinement (IEC) devices to the levels required for several non-electric applications of nuclear fusion such as detecting clandestine materials.

Previous Findings
- The Farnsworth-Hirsch fusor reported neutron production rate of 5x10^7 n/s at a cathode voltage of 168 kV and current of 10mA.
- Number of fusion reactions too low for commercial use.
- Mainly used as neutron generators.

Experimental Approach
- Cathode voltages range from -50 kV to -150 kV, currents from 2-30 mA and chamber pressures from 10^-2^-10^-3 μTorr.
- Data gathered required the use of neutron detectors, Fusion Ion Doppler Shift (FIDO) diagnostic, two separate proton detectors and optical cameras.

Results
- In a defocused mode, SIGFE matched experimental results of the Hirsch device.
- Most of the reactions took place at the walls of the device.
- Less than 0.2% of fusion reactions occurred in a 9.5 mm spherical cavity at the center.

Fuels for testing:
- D-D
- D-^3^He
- ^3^He-^3^He
- D-T

Planned Research:
- Design ion guns with higher current outputs.
- Balance ion currents.
- Vary fuel configuration to find highest neutron production rates.
- Operate the SIGFE in a pulsed mode.