Enhancement of an Inertial Electrostatic Confinement Device with a Helicon Ion Source for Helium-3 Fusion

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HELIOS is an inertial electrostatic confinement (IEC) fusion device specifically designed for ^{3}He-^{3}He fusion studies as part of the advanced fuels program at the University of Wisconsin [1]. HELIOS uses a helicon discharge as a source of ions, which are subsequently accelerated radially to fusion energies by the electrostatic field between the spherical chamber wall and a concentric cathode grid. The experimental setup, in which ^{3}He-^{3}He fusion in an IEC system has previously been demonstrated [2], has been upgraded in order to raise fusion rates to allow for diagnostic studies of IEC physics with helium-3 fuel, in order to benchmark the single-atomic-species formalism of a Volterra-integral-equation numerical code on spherically convergent ion flow [3]. The helicon ion source has been characterized through double probe measurements of plasma density and electron temperature for various rf antenna and magnetic field. Furthermore, the high-voltage feed-through has been redesigned to sustain higher cathode voltages for an increase in achievable ion energies.

[1] G.R. Piefer et al., Fusion Sci. Technol. 47, 1255 (2005).
[2] G.R. Piefer, "Performance of a Low-Pressure, Helicon Driven IEC ^{3}He Fusion Device," Ph.D. thesis, University of Wisconsin–Madison (2006).
[3] G.A. Emmert and J.F. Santarius, Phys. Plasmas 17, 013502 (2010).