3D PIC simulations of rotating spoke in a wall-less Hall thruster

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In this work, the self-consistent 3D-3V Particle-in-Cell simulation code STOIC (electroSTatic Optimized particle In Cell) [1,2] has been applied to simulate the low-frequency rotating plasma instabilities in the ISCT200 thruster [3,4] operating in the wall-less configuration [5,6].

The model utilizes an equidistant Cartesian grid which explicitly assures momentum conservation and absence of self forces in the PIC algorithm. The simulation includes electrons, Xe^+ ions and neutral Xenon atoms. All relevant collisional processes are included in the model: Coulomb collisions between charged particles; electron-neutral elastic, ionization and excitation collisions; ion-neutral momentum transfer and charge exchange collisions and neutral-neutral elastic collisions. The dynamics of the background neutral gas is self-consistently resolved with direct simulation Monte Carlo (DSMC).

The simulation domain represents a rectangular slab with dimensions 70x70x50mm. The total number of computational particles in the simulation was about $20*10^6$. The simulations were carried on a 16-processor Intel Xeon workstations. The duration of a typical computation run was about 20 days. About 12 millions time steps were performed which corresponds to a simulated time of 960 microseconds.

In the simulations spokes rotating with the velocity of about 3-5 km/s were observed. For the most of the simulated regimes the m = 1 mode was present with a few occurrences of m = 2 mode. The spokes rotating both in the *ExB* and counter-*ExB* directions were detected. In the cource of the simulations it was found that the spoke rotation direction can be changed by the variation of the anode voltage and the neutral gas injection parameters.

The detailed discussion of the simulation outcomes with regard to the spoke dynamics and the origin as well as comparisons between the simulation and the experimental results will be presented at the workshop.

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