Self-Consistent Simulation of Local Electron Plasma Resonance in Non-Magnetized Low-Temperature Microwave Surface-Wave Plasma

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Surface-wave (SW) plasmas are RF or microwave-driven discharges sustained by a surface electromagnetic wave propagating along a dielectric-plasma interface. Although they can benefit from external DC magnetic field, the simpler non-magnetized design has been widely applied for various industrial applications. Local non-collisional electron heating along the $\omega = \omega_{pe}$-surface near the wall (electron plasma resonance) has been suggested as a major mechanism in the energy balance of such plasmas. This is essentially transient-time heating (maximal heating at $\omega\tau \sim 1$, where $\tau = \Delta / v_{th}$ is the transit time), and works only if the resonances is very narrow. The resonance zone width Δ is proportional to the effective electron-neutral collision frequency ν, and therefore this effect is thought to be pronounced only at low pressures. At such conditions the electron kinetic is essentially non-local: the fast electron diffusion mixes the electron gas so that all memory of where a particular electron was heated is lost long before it suffers an inelastic collision. In a previous work [1] we reported self-consistent numerical modeling of such SW plasma in purely non-local approximation and were indeed able to observe the non-collisional transit-time heating discussed above.

In this contribution we explore the opposite scenario: gas pressure high enough to produce almost purely local electron kinetics. The same geometry is in [1] (one-dimensional plasma slab), as well as two-dimensional models (e.g. the one form Fig. 1) were studied. Our initial expectation was that the high collisional frequency would broaden the local resonance and make it irrelevant, but the results suggested otherwise. The resonance still remained clearly pronounced, and its influence was much stronger than at lower pressures. This is due to the fact that at high pressure the ionization rate is linked very strongly to the local RF electric field intensity, and even small field variations get reflected in the electron density profile.

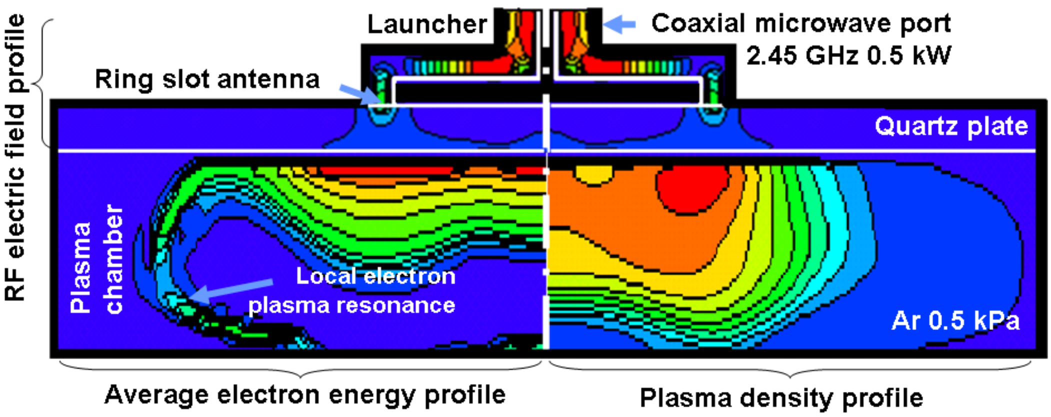

Fig. 1. Self-consistent modeling of an axially-symmetric SW plasma

Reference: [1] I. Ganachev, L. D. Tsendin, and H. Sugai: *Proc. ESCAMPIG-16/ICRP-5 2002*, vol. 1, p. 217.