Influence of perpendicular RF and DC currents on I-V probe characteristics connected to ICRF antennas

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Powered ICRF antennas draw net electron current when they are magnetically connected to another part of the grounded tokamak wall. Langmuir probe characteristics downstream of an ICRF antenna register net ion current when biased to the same potential as the wall. There is experimental evidence that the current path is not purely parallel to the magnetic field, but that radial DC currents can flow [1]. It is important to understand the mechanisms of radial current flow in order to arrive at a self-consistent balance between DC transverse currents and the plasma potential increase in biased flux tubes (driven by RF rectification). Recent modelling has shown that the radial RF currents can result from RF rectification [2] but do not produce net DC radial currents. We investigate possible mechanisms for radial DC and RF current flow by running a set of PIC (XOOPIC) simulations. Long flux tubes (1m) driven with a RF electrode magnetically connected to a biased probe have been simulated to test first the influence of the flute hypothesis on the I-V characteristic. They clearly demonstrate the existence of DC transverse currents in perpendicular potential gradient regions.
We finally propose a new modelling coupling parallel currents driven by sheaths, both RF and DC transverse currents, and plasma density in flux tubes to reconstruct IV probe characteristics.

[1] D.A. D'Ippolito et al., Nuclear Fusion 42 (2002), 1357-1365
[2] A. Ngadjeu et al. , Journal of Nuclear Materials, In Press, Available online (2010).