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P4.1093 Some Issues in Realizing the RF Current Condensation Effect

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Since the suggestion that magnetic islands produced by tokamak tearing modes might be stabilized by non-inductive currents [1], a great number of experimental, theoretical, and computational efforts have been exerted. The stabilization effect relies upon rf waves driving current preferentially at the island center. The most studied rf current drive methods for producing these currents for stabilizing the tearing mode, particularly the neoclassical tearing mode, are lower hybrid current drive (LHCD) [2] and electron cyclotron current drive (ECCD) [3]. Both can be localized to stabilize the neoclassical tearing mode, although the localization of the current produced through ECCD might be more easily localized. Both exploit the fact that a high current drive efficiency is obtained when the rf waves are damped in plasma by superthermal electrons. In both cases it is thought that the neoclassical tearing modes must be stabilized before they grow too large, because the current required to stabilize large islands would be correspondingly greater and therefore more expensive. The requirement to stabilize islands while they are small makes more severe the requirement for precise localization.

However, power dissipated within the islands tends to lead to a temperature peaking at the island center, which induces more dissipation at the center. This positive feedback leads to a current condensation effect, where the current tends to condense on the island center, exactly where it is most effective at stabilizing the neoclassical tearing mode [4]. This effect makes it possible both to stabilize larger islands and to do so with less precise localization. Since this condensation effect relies on the sensitivity of the power deposition to the electron temperature, the condensation will tend to be most pronounced when the current is carried by the fastest electrons, which is also where the current drive efficiency is highest. Here we explore what are the issues in reaching this regime of both high rf current drive efficiency and effective rf current condensation, both for lower hybrid current drive and for electron cyclotron current drive.

References

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