Contribution ID: **650** Type: **Poster**

EX/P6-29: Spectral Broadening and Lower Hybrid Current Drive in High Density Tokamak Plasmas

Thursday, 11 October 2012 14:00 (4h 45m)

To control the plasma current profile represents one of the most important problems of the research of nuclear fusion energy based on the tokamak concept, as its solution would allow satisfying the necessary conditions of stability and confinement of plasma column. This problem can be solved by using the lower hybrid current drive (LHCD) effect, which was demonstrated to occur also at reactor grade high plasma densities, provided that a proper method, assessed on FTU (Frascati Tokamak Upgrade), should be utilised.
It was predicted by theory that operations with relatively high temperature in the plasma periphery are useful for diminishing the parametric instability (PI)–produced spectral broadening and, consequently, enabling the coupled lower hybrid (LH) to penetrate into the bulk at rector grade high plasma density and producing current drive effects. Experiments of Frascati Tokamak Upgrade (FTU) confirmed these predictions indeed.
We show here results obtained by a fully kinetic plasma model that describes the non-linear evolution of the spectral broadening phenomenology. The previous perturbative limit has been removed by completely solving the non linear coupled equations of the modes involved in the instability, utilising a fully kinetic plasma model. The LH sideband waves can be now properly considered also when their amplitude is well above the noise level, as occurs indeed in the data provided by radiofrequency probes available from experiments. A comparison of the LH spectral broadening obtained by modeling and experiment is presented, and the impact on the LH wave propagation and damping is discussed.
Considering the FTU method and assuming reasonably high electron temperature at the edge, the PI-produced spectral broadening is expected to be mitigated in ITER, thus enabling the penetration of the coupled LH power in the main plasma.
By successful LHCD effect, the control of the plasma current profile at normalised minor radius of about 0.8) would be possible, with much higher efficiency than that obtainable by other tools. A useful reinforce of bootstrap current effects would be thus possible by LHCD in ITER.

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Session Classification: Poster: P6

Track Classification: EXW - Magnetic Confinement Experiments: Wave–plasma interactions; cur-

rent drive; heating; energetic particles