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Thesis title: Experimental characterization of the edge plasma near a lower hybrid antenna during non-inductive current drive experiments.

Topic: A controlled fusion reactor requires non-inductive current source for a continuous operation. In order to prepare this ultimate phase, the ITER tokamak will address scenarios where 50% of the plasma current is generated by non-inductive external sources provided by the particles and waves injection systems. Among the high frequency waves, the lower hybrid (LH) waves allow a peripheral power deposition required to shape the current profile beneficial for the energy confinement.
Before reaching the hot dense confined plasma, the wave has to channel through relatively cold plasma where non-linear interaction between the wave and the plasma may lead to a modification of the wave spectrum launched by the antenna. It results a decrease of the current drive efficiency expressed in ampere of current per injected watt.
Wave scattering on density fluctuations but also parametric decay of the launched wave are possible mechanisms which are to be studied experimentally from Langmuir probes embedded in the LH antenna.
In particular, waves with large wave number along the magnetic field k// (drift/interchange instability) could play a major role when LH wave is launched. Modelling of the LH wave propagation in a turbulent scrape-off layer showed that this type of instability can broaden the LH wave spectrum and reduces the current drive efficiency.
After a study of various published papers on the wave-edge plasma interaction, the student should train to use the data of the DCEDRE2 diagnostic collecting the antenna probes. During the experiment on the WEST tokamak, he will be in charge of the diagnostic operation (which will include a specific set of probes to measure k//) and his exploitation for the related physics.
Parametric instabilities lead to either a broadening of the RF spectrum around the 'pump' frequency (3.7GHz on WEST and HL-2A) or to side lobes in the spectrum shifted by the ion cyclotron frequency (~10-30MHz). This will be documented and analyzed with a dedicated measurement of the RF spectra.
Level of turbulence and turbulence spectrum near the LHCD antenna will have to be documented for different antenna and plasma configurations.
Self-similar experiments could be conducted on HL-2A and WEST tokamaks in order to compare edge plasma turbulence and LHCD performance. For this purpose, the student will have to stay 6 months in Chengdu (China).
Finally the link between the probes measurements, the RF spectra and the LHCD data (LHCD coupling, LHCD efficiency, HXR emission…) will have to be established

Competencies: electromagnetism, waves in plasma physics,

Degrees : master fusion, master in physics