

## **Experimental ECCD efficiency in the TJ-II stellarator**

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Electron Cyclotron Current Drive (ECCD) experiments carried out in the TJ-II stellarator are analysed.

Contrary to tokamaks, where any non-inductive current is masked by the main current induced by the transformer, experiments with induced currents in stellarators are easier and less sensitive to errors. The main problem is that stellarators are not really current-free devices, since they present the bootstrap current that depends on pressure profile and can be of the same magnitude as the EC driven current. This obstacle should be overcome to have a precise measurement of ECCD efficiency. The appropriate tool to do this is the ECCD and a knowledge of its behaviour, in particular in respect to its dependence on power (efficiency) is specially important to reach real net current-free operation.

With an proper calibration, the TJ-II ECRH system allows us to change the parallel refraction index without inducing any current, since both transmission lines are located at stellarator symmetric positions. Thus, an approximate knowledge of the bootstrap current is achievable for different stellarator symmetric launching configurations, either with  $N_{\parallel} \neq 0$  along the magnetic axis or with off-axis injection also with  $N_{\parallel} \neq 0$ . In the optimum case, in which bootstrap current is characterized for different plasmas, EC current can be induced at different power levels and measured by extracting bootstrap current from the total measured current

Another approach to investigate current drive efficiency, and not so critically depending on system calibration, is to perform low frequency perturbative power modulation experiments in phase or antiphase (at approximately constant total power), assuming that plasma profiles do not change significantly (and bootstrap current neither). It is possible in such a way to get, keeping the same  $|N_{\parallel}|$  in both lines, different power levels in each line and, alternatively, more current in one direction than in the other.

The background current measured in this situation should be the bootstrap current. Once this is done, phase or antiphase power modulation of both gyrotron is carried out. If, as previously assumed, the current modulation is due only to ECCD, we can obtain an ECCD efficiency estimation. The same experiment is done for different total power levels.