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Influence of ECR Heating on NBI-Driven Alfvén Eigenmodes in the TJ-II Stellarator

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Controlling the amplitude of Alfvén Eigenmodes (AE) in fusion plasmas is an open issue with paramount relevance for ITER and beyond, because the fast-ion losses associated to these modes might be deleterious for plasma performance as well as destructive for the plasma facing components. Experiments in TJ-II have demonstrated a clear effect of the ECRH application on the NBI driven AE activity. Moderate values of ECH power produce the onset of a chirping mode whose amplitude is strongly dependent on plasma density and on the power and the launching direction of the injected ECRH waves. When the power of a second gyrotron is added the chirping mode amplitude is reduced and, depending on the density conditions, it may even be suppressed. CNPA measurements show that ECRH power enhances the detected steady neutral flux.
Dependence on plasma density: experiments are restricted to a range of low plasma densities, in which the ECRH impact on the AEs is observable in TJ-II. The amplitude of the bursting AE rises with increasing density for moderate ECRH values but appears to be independent of plasma density in the mitigated AE state resulting from switching-on a second gyrotron.
Dependence on power deposition location and magnetic configuration: rotational transform as well as ECRH launching direction scans have been carried out. The main finding is a clear relation between the ECRH effect and the power deposition location. For a given magnetic configuration, strong chirping occurs for specific deposition locations that depend on the magnetic configuration.
Dependence on ECRH power: for a given magnetic configuration and low plasma density, a clear reduction of the chirping mode amplitude occurs when ECRH power is decreased. Moreover, the quasi-periodic character of the chirping repetition frequency is progressively lost. For slightly higher plasma densities the mode amplitude becomes weakly dependent on power and no regular repetition frequency is observed.
Dependence of the AE amplitude on NBI parameters: in the absence of external ECH perturbation, the NBI parameters can be varied to explore the mode properties. Using the TJ-II Doppler reflectometer, the density fluctuations amplitude at the AE frequency has been measured. The result shows that the mode amplitude depends weakly on neutral beam energy while it increases notably with the beam current.

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Author: Dr CAPPA, Álvaro (Laboratorio Nacional de Fusión. CIEMAT)

Co-authors: Dr ASCASÍBAR, Enrique (Laboratorio Nacional de Fusión. CIEMAT); Dr CASTEJÓN, Francisco (Laboratorio Nacional de Fusión. CIEMAT); Dr FONTDECABA, Josep María (Laboratorio Nacional de Fusión.

CIEMAT); Dr LINIERS, Macarena (Laboratorio Nacional de Fusión. CIEMAT); Dr ESTRADA, Teresa (Laboratorio Nacional de Fusión. CIEMAT)

Presenter: Dr CAPPA, Álvaro (Laboratorio Nacional de Fusión. CIEMAT)

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