Dedicated to 80-th anniversary of L.I. Krupnik

HIBP as a tool to study the Alfvén Eigenmodes in toroidal plasmas

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Energetic ion driven Alfvén Eigenmodes (AE) are believed to be an important element disturbing the transport in a future reactor. The study of the properties of the AE in modern toroidal devices is the crucial contribution into the reactor relevant physics. AE are conventionally studied by Mirnov coils, which provides the poloidal **m** and toroidal **n** mode numbers and their spectral characteristics. Heavy Ion Beam Probing (HIBP) becomes a new tool to study AE with the high spatial and frequency resolution. HIBP in the TJ-II heliac observed the locally (~1 cm) resolved AE at radii $-0.8 < \rho < 0.9$. The set of low **m** (**m**<8) branches, detected with the high frequency resolution (< 5 kHz) is supposed to be Toroidicity Induced Alfvén Eigenmodes (TAE) [1]. TAE are pronounced in the local density, electric potential and poloidal magnetic field oscillations, detected simultaneously by HIBP in the frequency range 50 kHz<ω_{AE}<300 kHz [2]. AE are visible in the NBI-heated plasma; the high coherency between Mirnov and HIBP data was found for specific branches of AE. The mode location is close to the plasma center for co-NBI (<450 kW), and to the mid radius for counter- (<450 kW) and balanced NBI (<900 kW), indicating the deformation of the rotational transform profile by NBI current drive. When the density rises, AE frequency is decreasing, $\omega_{AE} \sim n_e^{-1/2}$, the cross-phase between the plasma density and potential remains permanent. Poloidally resolved density and potential measurements provides the AE poloidal wavelength and AE contribution to the turbulent particle flux $\mathbf{\Gamma_{ExB}}$. Typically, $\mathbf{\Gamma_{ExB}^{AE}}$ was found to be comparable with the broadband turbulence flux $\mathbf{\Gamma_{ExB}^{BB}}$ from the same frequency domain.

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[2] A. Melnikov, et al., 36-th EPS Conference on Plasma Physics, Sofia (2009) P4.186.