

DIRECT PLASMA POTENTIAL AND TURBULENCE MEASUREMENTS BY HIBP IN TOROIDAL DEVICES

(Survey of T-10 and TJ-II experiments)

Melnikov, A.V.¹ and HIBP team^{1,2,3}.

¹ Institute of Tokamak Physics, RRC “Kurchatov Institute”, 123182, Moscow, Russia

² Asociación EURATOM-CIEMAT, 28040, Madrid, Spain

³ Institute of Plasma Physics, NSC KIPT, 310108, Kharkov, Ukraine

e-mail: melnik@nfi.kiae.ru

The direct study of the electric potential and its fluctuations has been done for comparable plasma conditions in the T-10 tokamak ($B=1.5-2.5$ T, $R=1.5$ m, $a=0.3$ m, $P_{\text{ECRH}}<2.0$ MW,) and TJ-II stellarator ($B=1$ T, $\langle R \rangle=1.5$ m, $\langle a \rangle=0.22$ m, $P_{\text{ECRH}}<0.6$ MW, $P_{\text{NBI}}<0.9$ MW) by Heavy Ion Beam Probe. Despite the large differences in the topology of the confining magnetic field between two machines, the electric potential shows the following striking similarities:

- (i) Similar magnitudes for the potential ϕ and electric field E_r ;
- (ii) For $n_e > 1 \times 10^{19} \text{ m}^{-3}$, the electric potential is negative with comparable absolute values despite the use of different heating methods: OH and ECRH in T-10, ECRH and/or NBI in TJ-II;
- (iii) An increase in n_e and τ_E is accompanied by similar changes in ϕ and E_r : both become more negative. Application of ECRH, causing a rise in T_e and a reduction in τ_E , results in more positive values for ϕ and E_r ;
- (iv) Spontaneous and biased transitions to improved confinement regimes are associated with more negative values for E_r and turbulence suppression.

These results indicate the importance of ϕ and E_r in determining turbulence, and thus energy confinement: negative ϕ and E_r characterize the regimes with better confinement in TJ-II and T-10.

In addition, Geodesic Acoustic Modes (GAM) in T-10 and Alfvén Eigenmodes (AE) in TJ-II exhibit dozens Volts potential oscillations and potential-density coherence. While GAMs modulate the high-frequency turbulence, AE contribution to the bulk plasma turbulent particle flux was found to be widely variable from negligibly low level up to being comparable with the flux induced by broadband turbulence.