DYNAMICS DAYS SOUTH AMERICA 2010
International Conference on Chaos and Nonlinear Dynamics

INPE – National Institute for Space Research
São José dos Campos – SP – Brazil – July 26-30, 2010

On the Plasma Turbulence Control on Texas Helimak

Toufen D. L.[1], *Guimarães-Filho Z. O.*[2], *Caldas I. L.*[1], *Gentle K. W.*[3]

[1]Universidade de São Paulo, São Paulo, Brazil, dennis@if.usp.br
[2]Equipe DSC/PIIM, Université de Provence, Marseille, France
[3]Fusion Reserch Center, University of Texas at Austin, Texas, USA

keywords: Fluid Dynamics, Plasma and Turbulence; Time series analysis.

1 Introduction

The presence of electrostatic turbulence at the plasma edge is one of the important causes for excessive particle transport [1] and consequent weakening of plasma confinement in toroidal magnetic field.

This problem has been investigated on the Texas Helimak experiment [2]. In Helimak, the characteristics of whole plasma are similar to those of the plasma edge of the Tokamak. This machine confines a basic plasma with some phenomena of fusion plasmas in a simple geometry [3]. In addition, the radial profile of the electric field can be modified using external bias imposed by plates on top and bottom of the vacuum vessel. The height of the vacuum vessel is 2m, the inner radius is 0.6m and the outer radius is 1.6m.

This work uses data of the Texas Helimak experiment [4] to explore the variations of some plasma characteristics, as a function of the radial electric field profile, and their consequences on turbulence and confinement. The shots showed in this paper are for low pressure ($1x10^5$ Torr) of Argon.

2 Results

In order to investigate the turbulence dependence which external bias, the floating potential power spectrum is calculated for each Langmuir probe measurement in different radial positions. The results for three shots with different external bias values are shown in Figure 1. The analysis for different radial positions is especially interesting because the magnetic field depends directly of that position.

In this figure is possible to see that the power spectra of the shots with negative bias and ground have narrow bands while the positive bias presents a broadband spectrum. This result indicates that positive bias increase the turbulence and consequently weaks the confinement.

Another interesting thing to notice in Figure 1 is the dependence of the spectrum with the radial position. In general, the spectrum has more power on the machine center, R=1.1m, and decreases at the inner and outer borders.

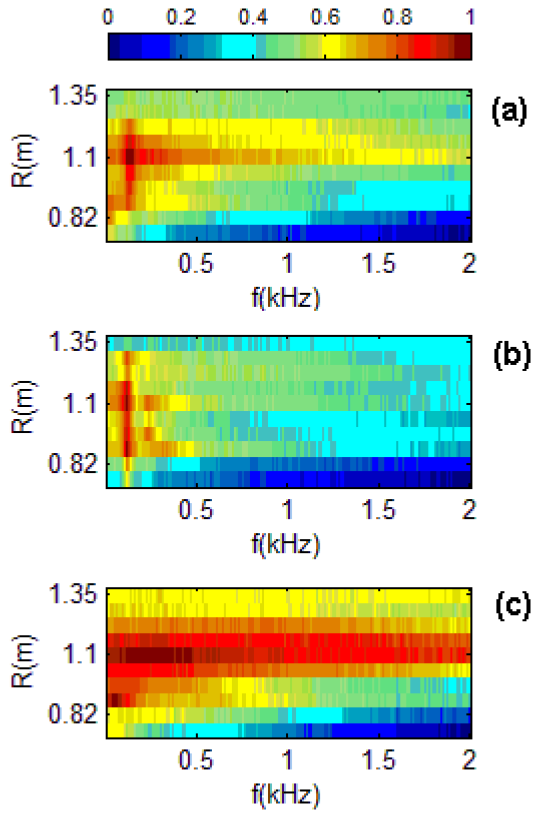

Figure 1 – Power spectrum of the floating potential as function of the Helimak radius for three different external bias values : Ground (a), -10V (b) and +10V (c). The colors indicate the relative power according to the shown scale.

Figure 2 shows electron temperature radial profiles for five shots with different external bias values. The yellow bar shows the radial position of the plates where the external bias are applied.

By the observation of the figure 2 is possible to see the temperature dependence on the bias value, especially on the bias plate radial region. Notice that for negative (positive) bias the temperature increases (decreases). As higher temperatures indicate better confinement, negative bias improves the plasma confinement. The same conclusion was obtained from turbulence spectra of Fig. 1.

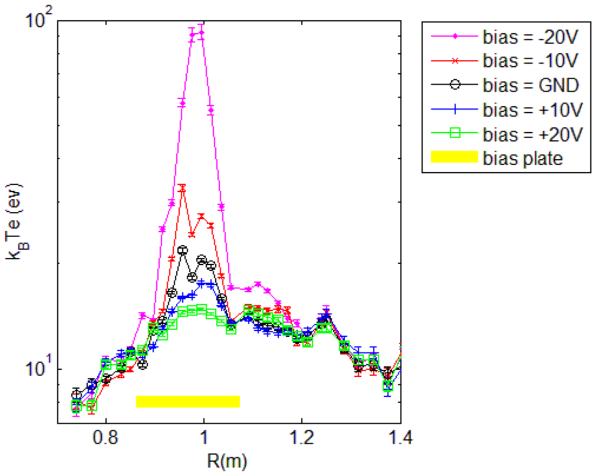

Figure 2 – Electron temperature radial profiles on Texas Helimak as a function of external bias.

3 Conclusion

Texas Helimak experiment permits the analysis of some plasma parameters as a function of de external bias and consequently their dependence on the radial electric field profile. The analyses of the power spectra indicate that the plasma becomes less turbulent for negative bias values. The same conclusion is obtained from temperature profile analyses; shots with negative bias present higher temperatures. These two results indicate that the confinement is improved by negative external bias. This work will continue with the analysis of the coupled waves and chaotic particle transport driven by electric drift waves.

References

[1] C. Hidalgo. “Edge Turbulence and Anomalous Transport in Fusion Plasmas”. Plasma Phys. Control. Fusion. Vol. 37, pp. A53-A67, 1995.

[2] K. W. Gentle and Huang He. “Texas Helimak” Plasma Science and Tecnoligy. Vol. 10, No. 3, pp. 284-289, June 2008.

[3] J. C. Perez, at al. “Drift Wave instability in the Helimak experiment” Physics of Plasma. Vol. 13, pp. 032101(1-9), March 2006.

[4] The experiments were obtained by Prof. K. W. Gentle and his research group.