Ciemat 709
Sp ISSN 614-087-X

EXPERIMENTAL EVIDENCE OF SIGNIFICANT TEMPERATURE FLUCTUATIONS IN THE PLASMA EDGE REGION OF THE TJ-I TOKAMAK

Hidalgo, C.
Balbín, R.
Pedrosa, M.A.
García-Cortés, I.
Ochando, M.A.

CENTRO DE INVESTIGACIONES
ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS

MADRID, 1993

CLASIFICACION DOE Y DESCRIPTORES

700340; 700330
EDGE LOCALIZED MODES
PLASMA INSTABILITY
TAKAMAK TYPE REACTORS
SHEAR
LANGMUIR PROBE

Toda correspondencia en relación con este trabajo debe dirigirse al Servicio de Información y Documentación, Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Ciudad Universitaria, 28040-MADRID, ESPAÑA.

Las solicitudes de ejemplares deben dirigirse a este mismo Servicio.

Los descriptores se han seleccionado del Thesauro del DOE para describir las materias que contiene este informe con vistas a su recuperación. La catalogación se ha hecho utilizando el documento DOE/TIC-4602 (Rev. 1) Descriptive Cataloguing On-Line, y la clasificación de acuerdo con el documento DOE/TIC.4584-R7 Subject Categories and Scope publicados por el Office of Scientific and Technical Information del Departamento de Energía de los Estados Unidos.

Se autoriza la reproducción de los resúmenes analíticos que aparecen en esta publicación.

Este trabajo se ha recibido para su impresión en Septiembre de 1.992

Depósito Legal nº M-482-1993
ISBN 84-7834-179-X
ISSN 614-087-X

IMPRIME CIEMAT

Much effort is being made to determine the underlying mechanisms responsible for the anomalous transport observed in tokamaks and stellarators. Langmuir probes have been extensively used to characterize the structure of edge fluctuations. Measurements of the edge particle transport induced by fluctuations have been made by studying the correlation between density and plasma potential fluctuations, assuming negligible temperature fluctuations [1 and references therein]. Under this approximation edge electrostatic fluctuations can account for most of the edge particle transport. Although no satisfactory theoretical model has been developed to explain all the edge turbulence features, turbulence driven by radiative instabilities has been considered as a possible candidate to partially account for the observed edge fluctuation levels [2-7]. Two simultaneous mechanisms contribute to the radiative instabilities. In the plasma region where dI_z/dT_e is negative, I_z and T_e being the cooling rates and the electron temperature respectively, a decrease in the electron temperature causes an increase in the radiative loss rate, resulting in a further decrease of the electron temperature (thermal instability). Furthermore, providing that there is a coupling mechanism between density and temperature fluctuations (i.e. pressure balance), a decrease in the electron temperature implies an increase in the electron density, with a subsequent increase in the radiative loss rate (condensation instability). The experimental signature of radiative instabilities is the presence of substantial temperature fluctuation. In the case of the condensation drive, a significant coupling between density and temperature fluctuations is expected; in particular, if the pressure balance condition is fulfilled [5], the phase between density and temperature fluctuations should be close to π . Thus, the comparison between the level of temperature and density fluctuations and their relative phase can provide key information to understand the basic mechanisms driving edge turbulence.

In this letter we present experimental evidence of significant edge temperature fluctuations which are in phase close to opposition with the corresponding density fluctuations.

Density and temperature fluctuations have been measured in the plasma edge region of the TJ-I Tokamak (R=30 cm, a=10 cm) using a fast swept Langmuir probe technique [8]. Measurements were done in ohmically heated discharges with B = 1 T, $\bar{n}_e \approx$ (1-2) 10^{13} cm^{-3} and $I_p \approx$ 30 kA. The vacuum chamber acts as a belt limiter. Impurity radiation in the edge is dominated by oxygen and carbon impurities. Typically Z_{eff} is of the order of three [9]. The probe system consists of a square array of four Langmuir probes (2 mm x 2 mm); pins are 2 mm long and 0.4 mm diameter. A broad-band (1 MHz) 75 watts amplifier was used to supply a swept voltage ($\approx$150 V) to a single probe at 300 kHz. Measurements were digitized at 5 MHz, using a 12 bit CAMAC digitizer. Two tips, aligned perpendicular to the local magnetic field, are used to measure the poloidal phase velocity of the fluctuations, deduced from the floating potential fluctuations; this measurement provides the position where the poloidal phase velocity of the fluctuations reverses propagation (shear layer) from the ion to the electron drift direction when moving radially inwards. The position of the shear layer ($a_{shear} \approx a$) has been taken as the point of reference for the measurements. The importance of the shear layer location on edge turbulence has been reported in experiments done in ATF which have shown that the structure of the turbulence appear to be different in the plasma bulk side of the shear layer ($r/a_{shear}<1$) and in the scrape-off layer region ($r/a_{shear}> 1$) [10].

Current probe ($\tilde{I}_s/I_s$), temperature ($\tilde{T}_e/T_e$) and density ($\tilde{n}/n$) fluctuations have been determined by sweeping the applied voltage (V) to a single Langmuir probe at a frequency of 300 kHz (figure 1). The current-voltage characteristic has been fitted by the expression [11]

$$I= I_s\,(1-\exp[e(V-V_f)/kT_e])$$

where I_s is the ion saturation current and V_f is the floating potential. The ion saturation current is linearly proportional to the local plasma density (n) and to the velocity (v) of the ions entering the probe sheath [11]. The velocity is taken as $v \propto (T_e/m_i)^{1/2}$, although the ratio T_e/T_i is not known in the present experiment. Using a nonlinear least-square fitting routine, we have determined the electron temperature (T_e), the ion saturation current (I_s) and deduced the local plasma density ($n \propto I_s T_e^{-1/2}$) in a time scale ($\approx 2\mu s$)

smaller than the relevant times of the turbulence (≈10 μs). Capacitance to ground has been minimized to reduce parasitic capacitive currents to less than 3 mA (rms). Edge density and electron temperature are in the range $n_e \approx (1 - 3)\ 10^{13}\ cm^{-3}$ and $T_e \approx (10\text{-}30)$ eV.

An important point is to determine which part of the characteristic I-V should be used to get the electron temperature [12-14]. The effect of varying the cut-off voltage, V_c, (i.e. fitting of the I-V characteristic for V<Vc) in determining the electron temperature and its fluctuations has been studied in the range $(V_c\text{-}V_f)/kT_e \approx 0 - 1$. In this range the determined parameters T_e and $\tilde{T}_e/T_e$ are not very sensitive to V_c [8]. In the present experiments we have used the cut-off voltage given by $(V_c\text{-}V_f)/kT_e \approx 0.5$. It has to be noted that this result is not in contradiction to previous experiments in JET [13], which show that a true departure from the exponential behaviour occurs for $V_c>V_f$. It is expected that the higher the probe size (as is the case of the JET probes) the clearer the departure expected from the exponential behaviour for $V_c>V_f$ [14]. As a consequence, small probes as those used in the present experiment allow to sample a significant fraction of the electron distribution. The drawback of using small probes is that the effective probe area is not well defined [15] and thus only relative variation in the local electron density can be monitored.

The measured ion saturation currents by the fast swept probe method were in good agreement with those computed when the probe was at a fixed bias in the ion saturation regime (figure 2). This agreement show the reliability of the fast swept probe technique.

Figure 3 shows the probe current, density and temperature (rms) fluctuation levels in the plasma bulk side of the velocity shear location ($r/a_{shear}<1$). Measurements are plotted versus the local electron density deduced from the ion saturation current and the electron temperature ($n \propto I_s T_e^{-1/2}$). The local density can be considered as a monitor of the probe radial position: the higher the local density the further inside the plasma the measurements are taken. Measurements were done in the radial range $r/a_{shear} \approx 0.9 - 1$.

The estimated temperature fluctuation levels are in the order of 40 %, and are comparable to the corresponding density fluctuations. The measured temperature fluctuation levels are higher than those previously reported in Caltech tokamak [16]. However, it has to be noted that whereas in the present experiments the I-V characteristic has been fitted from the ion saturation regime up to about the floating potential, in the Caltech experiment the I-V characteristic was fitted from the floating potential up to the plasma potential. Fitting the I-V characteristics up to the plasma potential can possibly overestimate the electron temperature [13] and as a consequence could lead to underestimate of the temperature fluctuations in the Caltech experiment [16].

Fluctuations in the ion saturation current decrease when the probe moves radially inwards. This result is common for all studied devices independently of their magnetic configuration (tokamaks-stellarators) and size [1,10]. However, whereas $\tilde{I}_s/I_s$, $\tilde{T}_e/T_e$ and $\tilde{n}/n$ are comparable near the shear location, $\tilde{I}_s/I_s$ is smaller than both $\tilde{n}/n$ and $\tilde{T}_e/T_e$ in the plasma edge region ($r/a_{shear}<1$). Taking into account that the ion saturation current is proportional to the local electron density and to the square root of the electron temperature, the present results imply that density and temperature are fluctuating in phase close to opposition (figure 4.a).

The current probe fluctuation levels ($\tilde{I}_s/I_s$) are given by

$$(\tilde{I}_s/I_s)^2 = (\tilde{n}/n)^2 + (1/4)(\tilde{T}_e/T_e)^2 + \langle\tilde{n}\,\tilde{T}_e\rangle/nT_e$$

where $\langle\tilde{n}\,\tilde{T}_e\rangle$ is the correlation term between density and temperature fluctuations.

It has to be noted that only when temperature fluctuations are negligible then the current-probe fluctuations are dominated by density fluctuations. However, when density and temperature fluctuations are strongly correlated with $(\tilde{n}/n)\approx(\tilde{T}_e/T_e)$ and $\alpha_{nT_e} \approx \pi$, it follows that $(\tilde{I}_s/I_s) \approx 0.5\ (\tilde{T}_e/T_e)$, in consistency with the results presented in fig. 3.

Fourier analysis of the current probe, temperature and density fluctuations deduced from the fast swept probe technique shows fluctuations that are dominated by frequencies below 100 kHz (figure 4.b).

It has to be noted that whereas the thermal drive requires the restrictive condition $dI_Z/dT_e<0$, the relevant parameter for the impurity condensation drive is n_ZI_Z, being n_Z the impurity concentration. Thus, the existence of radiation (present in all devices) and some kind of coupling mechanism between density and temperature fluctuations are the only required conditions for the condensation drive. The fulfilment of these general requirements in the present experiment make the condensation drive an attractive candidate to partially explain edge turbulence features. However, although the presence of significant temperature fluctuations can be an indicator of radiative drives, other models would also predict significant temperature fluctuations under realistic assumptions. A systematic study of the correlation between radiation levels and turbulence levels is needed to fully understand the role of radiative instabilities on edge turbulence.

Two different factors contribute to the total uncertainty associated with the electron temperature and current fluctuations deduced from the fast swept method. First, variations in the local plasma parameters (density, potential and temperature) during the sweeping time of the probe are estimated to produce apparent temperature fluctuations of approximately 10% on the measured temperature fluctuations, using the analysis presented in reference 16. However, the observed uncoupling between current-probe and temperature fluctuations (that is to say, the fact while current-probe fluctuation levels decrease when moving radially inward, temperature fluctuation levels remain basically constant, see fig. 3) strongly suggests that the inferred temperature fluctuations are not dominated by the contribution of plasma fluctuations occurring simultaneously. Second, additional errors on the measured level of temperature fluctuations are due to deviations from the electron-maxwellian distribution. The fitting errors of the I-V characteristics are in the range of (5-10)% for the ion saturation current and about (10-15)% for the electron temperature.

The accumulated errors imply that only fluctuation levels approximately above 10% and 20% for $\tilde{I}_S/I_S$ and $\tilde{T}_e/T_e$ respectively can be resolved with the present experimental set-up. However, as shown in figure 3 the measured fluctuation levels for current and temperature fluctuations are significantly above the maximum uncertainties.

In conclusion, the present experiments show that the fast swept Langmuir probe technique is a powerful method to determine the mechanisms underlying edge turbulence. Evidence of substantial temperature fluctuations has been found in the plasma edge region ($r/a_{shear}<1$) with $\tilde{n}/n \approx \tilde{T}_e/T_e$. Furthermore, $\tilde{T}_e/T_e$ and $\tilde{n}/n$ are fluctuating in phase close to opposition. These results suggest that radiative instabilities, and in particular the condensation effects, could play a key role in driving plasma edge fluctuations. On the other hand, the presence of temperature fluctuations can significantly affect the interpretation of the Langmuir probe data (the approximation $\tilde{I}_s/I_s \approx \tilde{n}/n$ is called into question) and makes it necessary to reconsider the validity of the particle fluxes computed with the approximation $\tilde{T}_e/T_e \approx 0$. A systematic study of the correlation between edge radiation levels and the level of density and temperature fluctuations is needed.

ACKNOWLEDGEMENTS

The support of the whole TJ-I team is greatly appreciated. The authors have benefited from conversation with B.A. Carreras, A. Carlson, P.H. Diamond, L. Giannone, J.H. Harris, H. Niedermeyer, C.P. Ritz and A.J. Wootton. This work has been partially supported by the DGICYT (Dirección General de Investigaciones Científicas y Técnicas) of Spain under project number PB90-0639-C02-02.

FIGURE CAPTIONS

Figure1

(a) Langmuir probe (I-V) characteristics measured in the proximity of the velocity shear layer in the TJ-I tokamak and (b) I-V characteristic with the deduced values for the electron temperature and ion saturation current.

Figure 2

Ion saturation current deduced from the fast swept Langmuir probe (300 kHz) and with the probe bias in the ion saturation regime.

Figure 3

Fluctuations in the ion saturation current ($\tilde{I}_s/I_s$), electron temperature ($\tilde{T}_e/T_e$) and density ($\tilde{n}/n$) versus the local plasma density ($n \propto I_s T_e^{-1/2}$). Measurements were done in the radial range $r/a_{shear} \approx 0.9$ - 1. The shaded area shows the location of the velocity shear layer with respect to the density profile.

Figure 4

(a) Phase between density and temperature fluctuation in the plasma edge region $r/a_{shear} \approx 0.9$ (n_e (a.u.) ≈ 1.6) and (b) frequency spectra for the ion saturation current, the electron temperature and the density fluctuations deduced from the fast swept Langmuir probe technique.

REFERENCES

[1] A.J. Wootton, B.C.Carreras, H. Matsumoto, et al, Phys. Fluids **12**, 2879 (1990).

[2] C. Hidalgo, C.P. Ritz, T.L. Rhodes, W.L. Rowan, P.H. Diamond, H. Lin, D.R. Thayer, A.J. Wootton, Nuclear Fusion **31**, 1661 (1991)

[3] J.F. Drake, Phys. Fluids **30**, 2429 (1987).

[4] J.F.Drake, L. Sparks, G. Van Hoven, Phys. Fluids **31**, 813 (1988).

[5] D.R. Thayer, P.H. Diamond, Phys. Fluids **30**, 3724 (1987).

[6] Y.Z. Zhang, S.M. Mahajan, Phys. Fluids B **4**, 207 (1992).

[7] A.S. Ware, P.H. Diamond, B.A. Carreras, J.N. Leboeuf and D.K. Lee, Phys. Fluids B **4** , 102, (1992).

[8] C.Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés and J. Vega, Rev. Sci. Instrum., in press (1992).

[9] C. Pardo and B. Zurro, *Análisis Experimental del Plasma TJ-I con Técnicas de Esparcimiento y Emisión de Radiación*, Ciemat-610, (1987).

[10] C. Hidalgo, J.H. Harris, T. Uckan, et al., Nuclear Fusion **31**, 1471 (1991).

[11] J.D. Swift, M.J.R. Schwar, *Electrical Probes for Plasma Diagnostics,* (Iliffe, London, 1970).

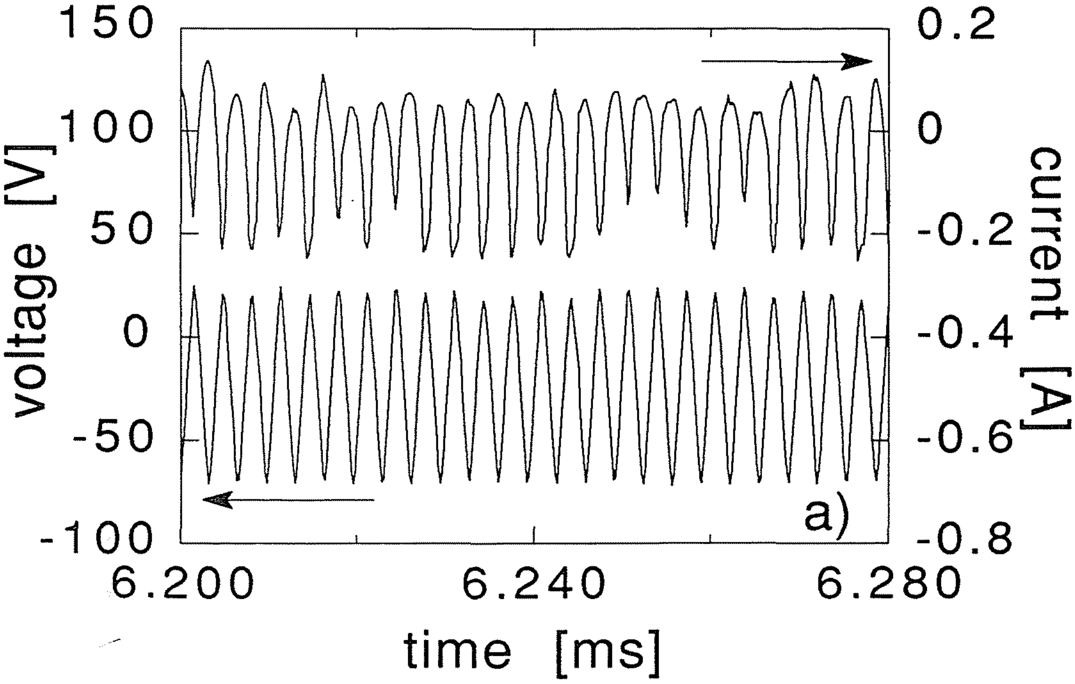
[12] R.A. Pitts and P.C. Stangeby, Plasma Physics and Controlled Fusion **32**, 1237 (1990).

[13] J.A. Tagle, P.C. Stangeby and S.K. Erents, Plasma Physics and Controlled Fusion **29**, 297 (1987).

[14] P.C. Stangeby, J. Phys. D **15**, 1007 (1982).

[15] P.C. Stangeby, G.M. McCraken, S.K. Erents and G. Matthews, J. Vac. Sci. Technol. A **2**, 702 (1984).

[16] P.C. Liewer, J.M. McChesney, S.J. Zweben and W. Gould, Phys. Fluids **29**, 309 (1986).


150
100
50
0
-50
-100
voltage [V]
0.2
0
-0.2
-0.4
-0.6
-0.8
current [A]
a)
6.200
6.240
6.280
time [ms]

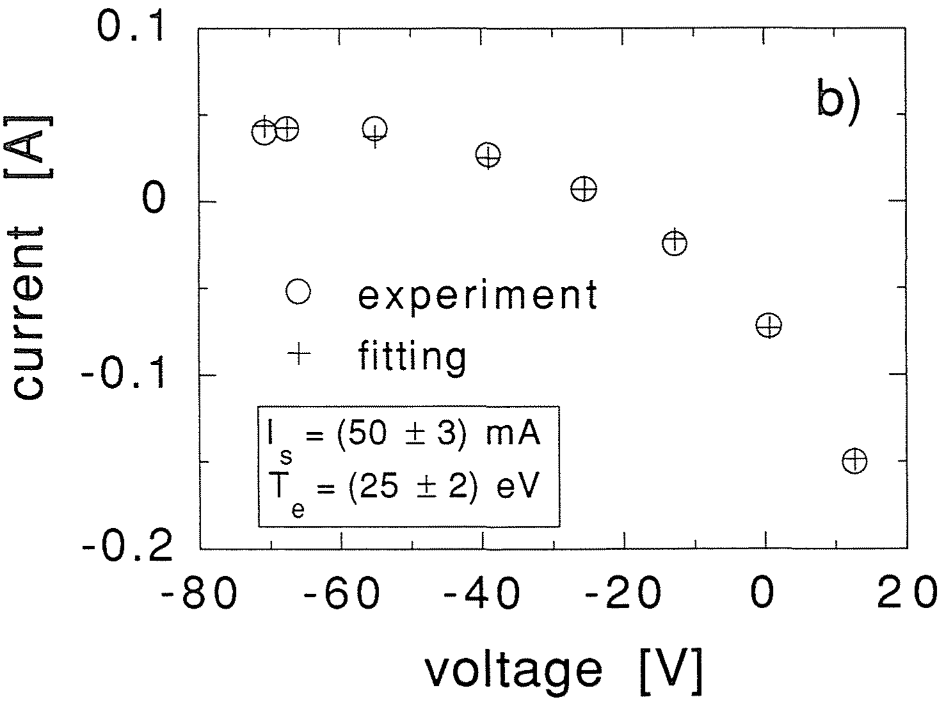

0.1
0
-0.1
-0.2
current [A]
b)
experiment
fitting
I_s = (50 ± 3) mA
T_e = (25 ± 2) eV
-80
-60
-40
-20
0
20
voltage [V]

Fig. 1

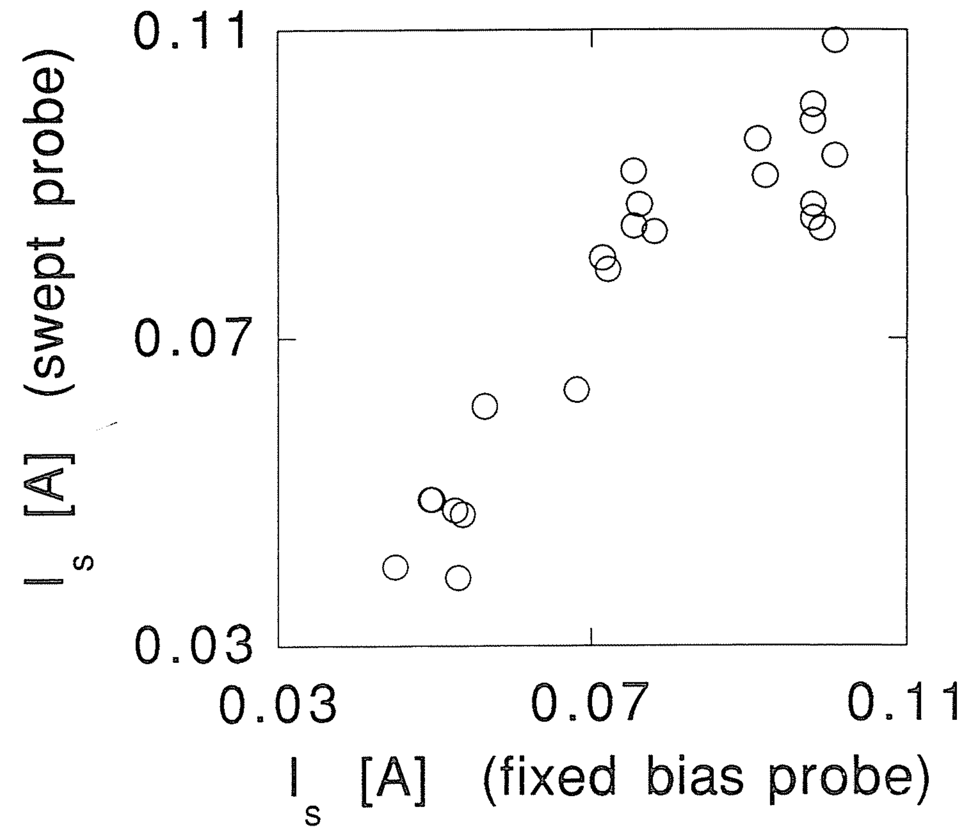


Fig. 2

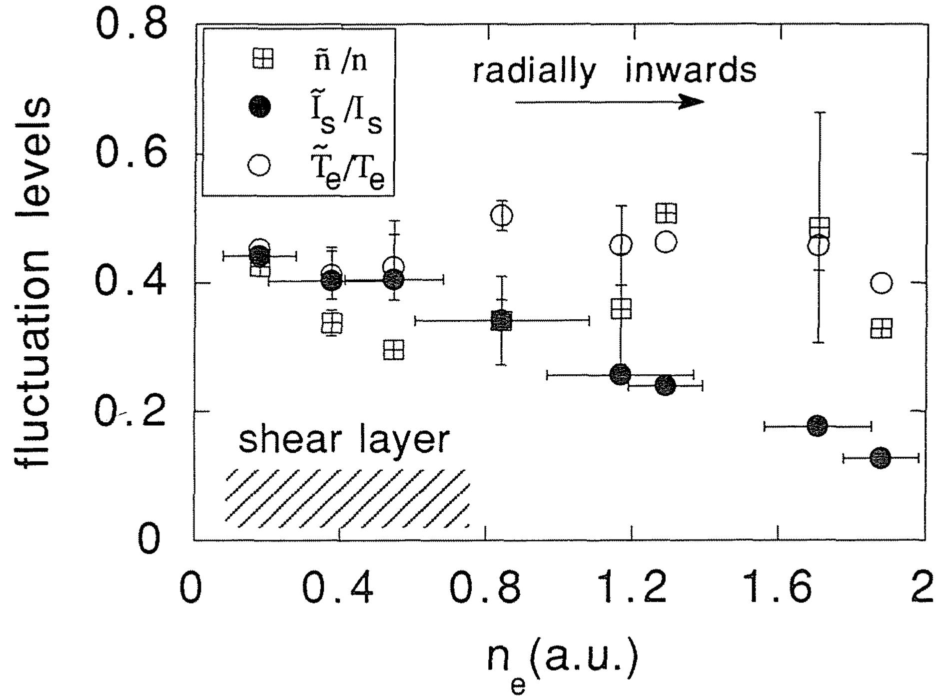

0.8
0.6
0.4
0.2
0
fluctuation levels
ñ /n
$\tilde{I}_s/I_s$
$\tilde{T}_e/T_e$
radially inwards
shear layer
0
0.4
0.8
1.2
1.6
2
n_e(a.u.)

Fig. 3

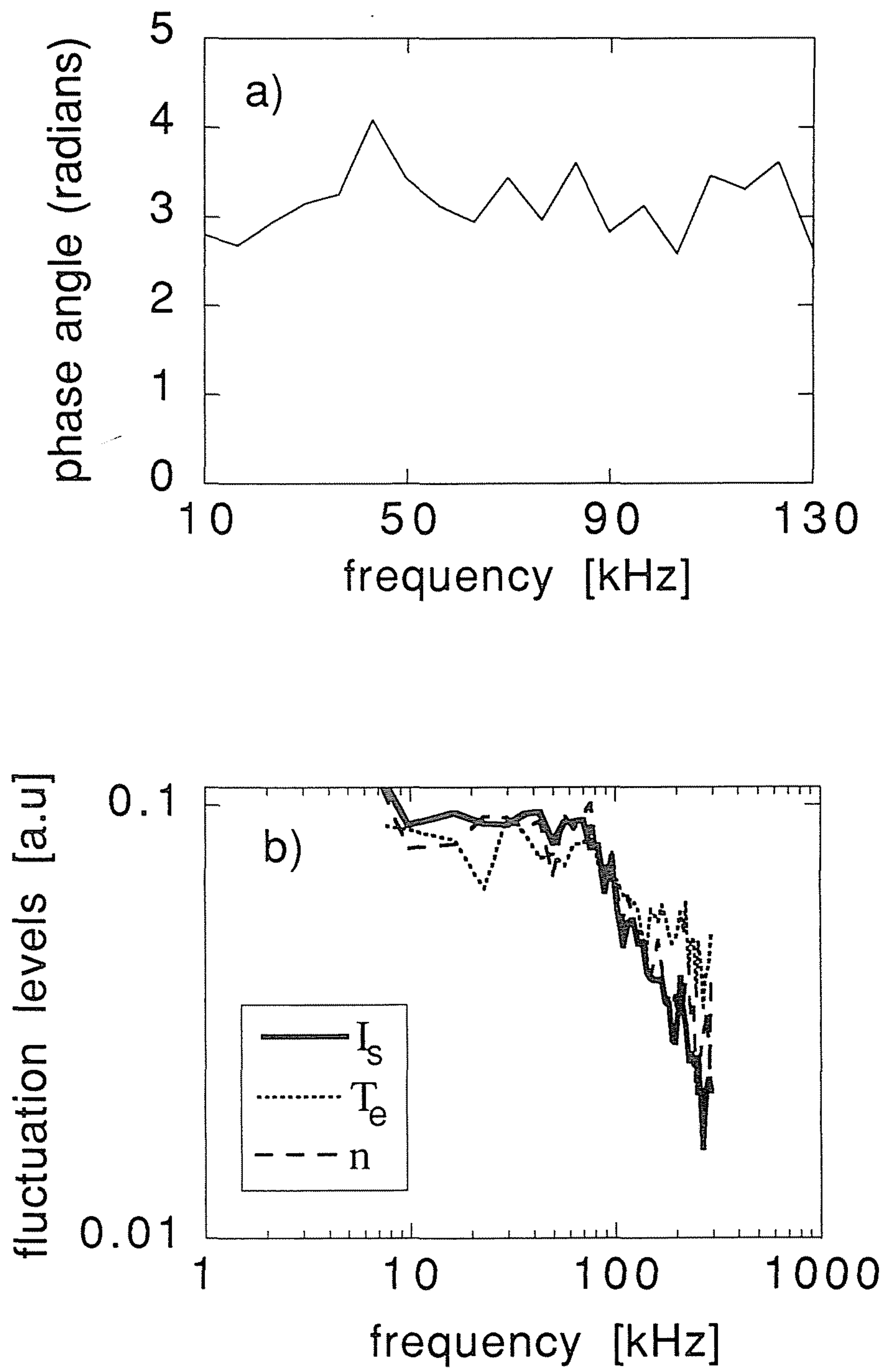

a)
phase angle (radians)
0
1
2
3
4
5
10
50
90
130
frequency [kHz]
b)
fluctuation levels [a.u]
0.01
0.1
1
10
100
1000
frequency [kHz]
I_s
T_e
n

Fig. 4

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EXPERIMENTAL EVIDENCE OF SIGNIFICANT TEMPERATURE FLUCTUATIONS IN THE PLASMA EDGE REGION OF THE TJ-I TOKAMAK
C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Density and temperature fluctuations have been measured in the plasma bulk side of the velocity shear location of the TJ-I tokamak using a foast swept Langmuir probe technique. Evidence of sustantial temperature fluctuations which are in phase close to opposition with the corresponding density fluctuations has been found. This result suggests the possible role of radiation in determining edge fluctuation levels and call into question the determination of the density and potential fluctuations from the Langmuir current-probe and floating potencial fluctuations.

DOE CLASIFICATION AND DESCRIPTORS: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EXPERIMENTAL EVIDENCE OF SIGNIFICANT TEMPERATURE FLUCTUATIONS IN THE PLASMA EDGE REGION OF THE TJ-I TOKAMAK
C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Density and temperature fluctuations have been measured in the plasma bulk side of the velocity shear location of the TJ-I tokamak using a foast swept Langmuir probe technique. Evidence of sustantial temperature fluctuations which are in phase close to opposition with the corresponding density fluctuations has been found. This result suggests the possible role of radiation in determining edge fluctuation levels and call into question the determination of the density and potential fluctuations from the Langmuir current-probe and floating potencial fluctuations.

DOE CLASIFICATION AND DESCRIPTORS: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EXPERIMENTAL EVIDENCE OF SIGNIFICANT TEMPERATURE FLUCTUATIONS IN THE PLASMA EDGE REGION OF THE TJ-I TOKAMAK
C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Density and temperature fluctuations have been measured in the plasma bulk side of the velocity shear location of the TJ-I tokamak using a foast swept Langmuir probe technique. Evidence of sustantial temperature fluctuations which are in phase close to opposition with the corresponding density fluctuations has been found. This result suggests the possible role of radiation in determining edge fluctuation levels and call into question the determination of the density and potential fluctuations from the Langmuir current-probe and floating potencial fluctuations.

DOE CLASIFICATION AND DESCRIPTORS: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EXPERIMENTAL EVIDENCE OF SIGNIFICANT TEMPERATURE FLUCTUATIONS IN THE PLASMA EDGE REGION OF THE TJ-I TOKAMAK
C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Density and temperature fluctuations have been measured in the plasma bulk side of the velocity shear location of the TJ-I tokamak using a foast swept Langmuir probe technique. Evidence of sustantial temperature fluctuations which are in phase close to opposition with the corresponding density fluctuations has been found. This result suggests the possible role of radiation in determining edge fluctuation levels and call into question the determination of the density and potential fluctuations from the Langmuir current-probe and floating potencial fluctuations.

DOE CLASIFICATION AND DESCRIPTORS: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EVIDENCIA EXPERIMENTAL DE FLUCTUACIONES SIGNIFICATIVAS DE TEMPERATURA ELECTRONICA EN EL BORDE DEL PLASMA DEL TOKAMAK TJ-I

C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Mediante la técnica de sondas de Langmuir con barrido rápido se han determinado los niveles de fluctuaciones de densidad y temperatura en borde del plasma del tokamak TJ-I. Las fluctuaciones de temperatura ($\tilde{T}_e/\bar{T}_e$) se encuentran aproximadamente en oposición de fase con las correspondientes de densidad ($\tilde{n}/n$), con $\tilde{T}_e/\bar{T}_e \approx \tilde{n}/n$. Este resultado sugiere la importancia de las inestabilidades radiactivas como mecanismo generador de la turbulencia del borde y cuestiona la interpretación de los parámetros fluctuantes (corriente de saturación iónica y potencial flotante) de los sondas de Langmuir.

CLASIFICACION DOE Y DESCRIPTORES: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EVIDENCIA EXPERIMENTAL DE FLUCTUACIONES SIGNIFICATIVAS DE TEMPERATURA ELECTRONICA EN EL BORDE DEL PLASMA DEL TOKAMAK TJ-I

C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Mediante la técnica de sondas de Langmuir con barrido rápido se han determinado los niveles de fluctuaciones de densidad y temperatura en borde del plasma del tokamak TJ-I. Las fluctuaciones de temperatura ($\tilde{T}_e/\bar{T}_e$) se encuentran aproximadamente en oposición de fase con las correspondientes de densidad ($\tilde{n}/n$), con $\tilde{T}_e/\bar{T}_e \approx \tilde{n}/n$. Este resultado sugiere la importancia de las inestabilidades radiactivas como mecanismo generador de la turbulencia del borde y cuestiona la interpretación de los parámetros fluctuantes (corriente de saturación iónica y potencial flotante) de los sondas de Langmuir.

CLASIFICACION DOE Y DESCRIPTORES: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EVIDENCIA EXPERIMENTAL DE FLUCTUACIONES SIGNIFICATIVAS DE TEMPERATURA ELECTRONICA EN EL BORDE DEL PLASMA DEL TOKAMAK TJ-I

C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Mediante la técnica de sondas de Langmuir con barrido rápido se han determinado los niveles de fluctuaciones de densidad y temperatura en borde del plasma del tokamak TJ-I. Las fluctuaciones de temperatura ($\tilde{T}_e/\bar{T}_e$) se encuentran aproximadamente en oposición de fase con las correspondientes de densidad ($\tilde{n}/n$), con $\tilde{T}_e/\bar{T}_e \approx \tilde{n}/n$. Este resultado sugiere la importancia de las inestabilidades radiactivas como mecanismo generador de la turbulencia del borde y cuestiona la interpretación de los parámetros fluctuantes (corriente de saturación iónica y potencial flotante) de los sondas de Langmuir.

CLASIFICACION DOE Y DESCRIPTORES: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE

CIEMAT - 709
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Instituto de Investigación Básica.- Madrid

EVIDENCIA EXPERIMENTAL DE FLUCTUACIONES SIGNIFICATIVAS DE TEMPERATURA ELECTRONICA EN EL BORDE DEL PLASMA DEL TOKAMAK TJ-I

C. Hidalgo, R. Balbín, M.A. Pedrosa, I. García-Cortés, M.A. Ochando
20 pp., 4 fig., 16 ref.

Mediante la técnica de sondas de Langmuir con barrido rápido se han determinado los niveles de fluctuaciones de densidad y temperatura en borde del plasma del tokamak TJ-I. Las fluctuaciones de temperatura ($\tilde{T}_e/\bar{T}_e$) se encuentran aproximadamente en oposición de fase con las correspondientes de densidad ($\tilde{n}/n$), con $\tilde{T}_e/\bar{T}_e \approx \tilde{n}/n$. Este resultado sugiere la importancia de las inestabilidades radiactivas como mecanismo generador de la turbulencia del borde y cuestiona la interpretación de los parámetros fluctuantes (corriente de saturación iónica y potencial flotante) de los sondas de Langmuir.

CLASIFICACION DOE Y DESCRIPTORES: 700340, 700330, EDGE LOCATIZED MODES, PLASMA INSTABILITY, TOKAMAK TYPE REACTORS, SHEAR, LANGMUIR PROBE