Tokamak ISTTOK

Interaction between mean and fluctuating ExB shear flows on the ISTTOK edge plasma

The interplay between mean and fluctuating ExB shear flows has been investigated in the ISTTOK edge plasma. The GAM shearing rate was found to be lower (by a factor of 2 - 3) than that of the mean flow but comparable to the turbulent decorrelation rate, suggesting that both the time-varying flow and mean flow are important to stabilize turbulence. The externalplasma biasing was found to modify the GAM amplitude particularly for negative bias where the fluctuations are strongly reduced and consequently GAMs are suppressed. For positive bias a small reduction of the GAM amplitude is observed in spite of the increase in the long-range correlation. The increase in the long-range correlationfor positive bias might be interpreted as an enhanced energy transfer from the turbulence into large scale, low frequency structures associated with modest increase in the mean shear flow induced.

Comparison between the edge plasma fluctuations at the low and high field side in the ISTTOK edge plasma

Edge plasma asymmetries have been further investigated on ISTTOK with a probe system that simultaneously samples the plasma on four poloidal angles with emphasys of the edge fluctuations properties. The larger cross-field particle transport observed at the LFS for both B_T and I_p directions was found to be consistent with the fluctuations characteristics. Fluctuations at the outboard are more intermittent as demonstrated by the high fluctuation level and skewness at this location. The frequency resolved turbulent particle flux also shows differences between the inboard and outboard midplane. The contribution of the low frequency range ($f < 50$ kHz) dominates the turbulent flux at the HFS, contrary to the observed at the LFS where a significant transport is observed for frequencies up to 150 kHz. ISTTOK results clearly demonstrate that the turbulence drive is ballooning-like leading to a poloidally asymmetric transport.

Study of the Zonal Flow influence on the local turbulent transport in the ISTTOK edge plasma.

The cross-field turbulent particle transport has been estimated using probe data. To better understand the effect of ZFs on transport, the frequency resolved coherence, cross-phase between I_{sat} and V_f fluctuations and turbulent particle flux measured at two radial location, edge plasma ($r»0.89$) and SOL ($r»1.05$), have been compared. A smaller coherence between I_{sat} and V_f fluctuations was found at the edge plasma for low frequencies (< 30 kHz). Furthermore, in the edge plasma both the phase between I_{sat} and V_f fluctuations and the poloidal wavenumber are close to zero for frequencies below 30 kHz, implying that the cross-field turbulent transport is modest in the frequencies range where ZFs dominate. On the contrary, transport in the SOL is dominated by frequencies below 50 kHz as the coherence between I_{sat} and V_f fluctuations is higher and their phase difference around $p/2$ in this frequency range. Results suggest therefore that ZFs may influence the local turbulent particle transport. Furthermore, the turbulent transport at low frequencies is cancelled as large scale potential fluctuations have symmetric characteristics.

JET facilities

Comparison of scrape-off layer transport in inner and outer wall limited JET plasmas

Dedicated experiments were carried out in JET to characterize the SOL parameters in limiter configuration and to establish a scaling law for the parallel power e-folding length a function of the main plasma parameters. The principal diagnostic used in this work has been a 9-pin probe head mounted onto a fast reciprocating drive system that allows the simultaneous measurement the SOL parameters with high temporal. Broad SOL profiles are observed for inner wall limited plasmas (λ_{Isat} ~5 - 7 cm, λ_{Te} ~12 - 20 cm), with $l_q$substantially larger (by a factor of ~6) than in outer wall limited plasmas. The properties of the fluctuations in the SOL parameters indicate larger turbulent transport for inner wall limited plasmas. Observations are consistent with Tore Supra measurements.In particular, the differences in Mach number between inner and outer limiter pulses supports the existence of a poloidally localized region of enhanced radial transport near the outboard midplane. Similar measurements have also been made in diverted discharges and fit between the outer and inner limiter cases. Preliminary results on the dependence of the SOL power width on the main plasma parameters indicate that $l_q$has a modest negative dependence on both the plasma current and the line-averaged density.

TJ-II

Evolution of the turbulence structure during the generation of edge sheared flows in the TJ-II stellarator

A reduction in the scale length of the fluctuations is observed in regions of strong mean shear, which is effective mainly for low frequency fluctuations in the radial direction and for high frequencies in the poloidal direction. Discharges with density ramp show that radial and poloidal correlations are reduced before the shear layer is formed and that the long-range correlation is high during this process suggesting the importance of fluctuating shear flows in the development of the mean flows with shear. High frequency floating potential fluctuations are reduced when the long-range correlation is high suggesting an energy transfer from small scales to large structures. TJ-II observations are therefore consistent with a picture of amplification of zonal flow-like structures above a certain density, which then in turn reduces the turbulent scale length before the development of a mean flow shear.

Installation of a Gundestrup probe for plasma rotation measurements in the TJ-II edge plasma

A Gundestrup probe has been installed on the TJ-II to measure the edge parallel and perpendicular plasma rotation. The probe has been used in floating potential mode due to tungsten electrodes emission in the region inside the LCFS, strongly limiting the use of the probe. The Gunsdestrup probe has been used in discharges with dynamic electrode bias (bias with a triangular waveform with frequencies around 400 Hz) to study the parallel and perpendicular viscosity by exploring the different evolution of the two components of the edge flow.

Summary and highlights of research achievements

Part II – Scientific Output

A. Publications

Books and book chapters

Papers in international refereed scientific journals

Author(s)	C. Silva, H. Figueiredo, P. Duarte and H. Fernandes
Paper title	Characterization of the poloidal asymmetries in the ISTTOK edge plasma
Journal name	Plasma Phys. Control. Fusion
Volume, page	53, 085021
Year	2011

Author(s)	C. Silva, C. Hidalgo, M.A. Pedrosa, D. Carralero, N. Tamura, K. Ida
Paper title	Coupling between long-range toroidal correlations and radial transport in the TJ-II boundary plasma
Journal name	Nucl. Fusion
Volume, page	51, 063025
Year	2011

Author(s)	M.A. Pedrosa, C. Silva, C. Hidalgo, D. Carralero, B. van Milligen and J. Morera

Paper title	Inward and outward propagation of the floating potential fluctuations in the plasma edge of the TJ-II stellarator
Journal name	Nucl. Fusion
Volume, page	51, 073027
Year	2011

Author(s)	Y. Xu, D. Carralero, C. Hidalgo, S. Jachmich, P. Manz, E. Martines, B. van Milligen, M.A. Pedrosa, M. Ramisch, I. Shesterikov, C. Silva, M. Spolaore, U. Stroth and N. Vianello, ,
Paper title	Long-range correlations and edge transport bifurcation in fusion plasmas
Journal name	Nucl. Fusion
Volume, page	51, 063020
Year	2011

Author(s)	B.A. Carreras, B.Ph. van Milligen, R.B. Perez, M.A. Pedrosa, C. Hidalgo and C. Silva
Paper title	Extraction of intermittent waveforms associated with the zonal flow at the transition leading to the edge shear flow layer
Journal name	Nucl. Fusion
Volume, page	51, 053022
Year	2011

Author(s)	R.B. Gomes, R. Mateus, E. Alves, H. Fernandes, C. Silva, P. Duarte
Paper title	Hydrogen retention in gallium samples exposed to ISTTOK plasmas
Journal name	Fusion Engineering and Design
Volume, page	86, 2458
Year	2011

Author(s)	D. Nunes, J.B. Correia, P.A. Carvalho, N. Shohoji, H. Fernandes, C. Silva, L.C. Alves, K. Hanada, E. Ōsawa
Paper title	Production of Cu/diamond composites for first-wall heat sinks
Journal name	Fusion Engineering and Design
Volume, page	86, 2589
Year	2011

Author(s)	C. Silva, H. Figueiredo, P. Duarte, H. Fernandes
Paper title	Poloidal Asymmetries in the ISTTOK Edge Plasma
Journal name	Journal of Nuclear Materials
Volume, page	415, 455
Year	2011

Author(s)	H. Fernandes, F. Gömöry, A. della Corte, G. Celentano, J. Souc, C. Silva, I. Carvalho, R. Gomes, A. Di Zenobio, G. Messina
Paper title	Toroidal high temperature superconducting coils for ISTTOK
Journal name	Fusion Engineering and Design
Volume, page	86, 1458
Year	2011

Author(s)	H. Figueiredo, C. Silva, B. Gonçalves, P. Duarte, H. Fernandes
Paper title	Plasma flow and transport on the tokamak ISTTOK boundary plasma
Journal name	Journal of Nuclear Materials
Volume, page	415, 433
Year	2011

Author(s)	R.B. Gomes, C. Silva, H. Fernandes, P. Duarte, I. Nedzelskiy, O. Lielausis, A. Klyukin, E. Platacis
Paper title	ISTTOK tokamak plasmas influence on a liquid gallium jet dynamic behavior
Journal name	Journal of Nuclear Materials
Volume, page	415, 989
Year	2011

Author(s)	V. Livramento, D. Nunes, J.B. Correia, P.A. Carvalho, U. Mardolcar, R. Mateus, K. Hanada, N. Shohoji, H. Fernandes, C. Silva, E. Alves
Paper title	Tungsten–microdiamond composites for plasma facing components
Journal name	J. Nucl. Materials
Volume, page	416, 45
Year	2011

Author(s)	J. Sánchez et. al.,
Paper title	Overview of TJ-II experiments
Journal name	Nucl. Fusion
Volume, page	51, 094022
Year	2011

Author(s)	C. Ionita, J. Grunwald, Ch. Maszl, R. Starz, M. Cercek, B. Fonda, T. Gyergyek, G. Filipic, J. Kovacic, C. Silva, H. Figueiredo, T. Windisch, O. Grulke, T. Klinger, and R. Schrittwieser
Paper title	The Use of Emissive Probes in Laboratory and Tokamak Plasmas
Journal name	Contrib. Plasma Phys
Volume, page	51, 264

Year	2011

Author(s)	L. Jakubowski, V. Plyusnin, K. Malinowski, M. Sadowski, J. Zebrowski, M. Rabinski, H. Fernandes, C. Silva, P. Duarte, M. Jakubowski
Paper title	Studies of run-away electron beams and hard X-ray emission in ISTTOK tokamak
Journal name	Problems of Atomic Science and Technology
Volume, page	1, 170
Year	2011

Author(s)	I. S. Nedzelskiy, C. Silva, P. Duarte, and H. Fernandes
Paper title	Ion temperature fluctuation measurements using a retarding field analyzer
Journal name	Rev. Sci. Instrum.
Volume, page	82, 043505
Year	2011

B. Publications and contributions in conferences and workshops

Papers in conference proceedings

Author(s)	C. Silva

Paper title	Interaction between mean and fluctuating ExB shear flows on the ISTTOK edge plasma, Workshop on Electric Fields
Conference	Proc. 38th EPS Conference on Plasma Physics, (Strasbourg) 27 June-1st July 2011
Volume, page	ECA Vol. 35, P-5.119
Year	2011

Invited talks

Conference	18th European Fusion Physics Workshop
Start-end date	6-8 December
Location	Tyrol, Austria
Author(s)	C. Silva
Talk title	Turbulent transport in the presence of long-range correlations (zonal flows)

Oral contributions

Conference	Workshop on Electric Fields, Turbulence and Self-Organisation in Magnetised Plasmas
Start-end date	3-5 July 2011
Location	Strasbourg, France
Author(s)	C. Silva

Talk title	Interaction between mean and fluctuating ExB shear flows on the ISTTOK edge plasma

Posters

Conference	38th EPS Conference on Plasma Physics
Start-end date	27 June-1st July 2011
Location	Strasbourg
Author(s)	C. Silva
Poster title	Interaction between mean and fluctuating ExB shear flows on the ISTTOK edge plasma

C. Other publications and outputs

Patents

Laboratorial prototypes

D. Education and training

Doctorate theses completed

Master's theses completed

Short training courses

E. Distinctions and awards

Scientific committees of conferences and workshops

- *International Programme Committee of the annual Workshop on the Role of Electric Field on Plasma Confinement and Exhaust*
- *International Programme Committee of the International Workshop on Electrical Probes in Magnetizes Plasmas, Iasi, Romania, September 2011*
- *International Programme Committee of the International Conference on Research and Applications of Plasmas, Warsaw, Poland, September 2011*

Management activities

- *Responsible for the Project TJ-II and for several EFDA projects*
- *Secretary of the Association Euratom/IST steering committee*
- *Member of the IPFN Directive Board*
- *Deputy Leader of the Tokamak ISTTOK project*
- *Member of the Fusion for Energy (F4E) Administration and Finance Committee (AFC)*

Refereeing of scientific publications

Nuclear Fusion, J. Nuclear Materials

Projects/funding awarded

E. Public Information activities

Media accounts of research

Science communication to the public

- Organizer of a "Ciência Viva" summer course for high school students
- Regular talks on Nuclear Fusion and visits to the ISTTOK laboratory for high school and graduate students