EFDA WORKPROGRAMME 2011

Call for Participation

(Part of the EFDA WP, Transport TG)

Call for Participation Transport

Deadline for Responses: 14. Jan 2011

Topical Group Chair: Clemente Angioni
Topical Group Vice-Chairs: Volker Naulin, Paola Mantica
Topical Group Coordinators:

- Hendrik Mayer (L/H physics)
- Clemente Angioni and Carine Giroud (Impurity transport)
- Basil Duval (Plasma rotation)
- Andrew Kirk (Edge physics)
- Pascale Hennequin (Electron heat transport)
- Peter de Vries (Coordination with JET)

EFDA CSU Responsible Officer: Boris Weyssow

This Call for Participation aims to implement the EFDA Work Programme for 2011 on Transport under Task Agreements as foreseen in the new EFDA Art. 5

Introduction

At its meeting in Dublin on the 23rd June 2010, the EFDA Steering Committee approved elements of the EFDA 2011 Work Programme, among which the Transport Topical Group programme. This includes the preparation and execution of experiments performed in the Associations and the subsequent coordinated analysis of experimental data.

This Call covers the Transport programme implemented under Task Agreements on the basis of the provisions given in Article-5 of the EFDA Agreement.

No JET related activities are meant to be implemented as a result of this call. JET related activities are implemented under EFDA Article-6. However some JET activities are mentioned for information when they closely relate to the activity implemented under Article-5. JET data collected and analysed under the JET part of the EFDA Work Programme can be brought together with other data under EFDA Article-5 Task Agreements when relevant for the progress of the work or used in multi-machine modelling activities.

Scenario development in fusion devices, important for ITER to reach the foreseen Q factor and fundamental for DEMO due to the fuelling self-sufficiency constraint, depends on multi-particle multi-scale transport phenomena which are far from being fully understood. Despite this intrinsic complexity very significant progress has been made in understanding and controlling the plasma transport properties across a variety of plasma conditions. Transport related issues are organised in five long term research projects, physics of L-H Transition, turbulent electron transport, particle and impurity transport at the edge, the role of plasma rotation on confinement and statistical properties of edge turbulent transport.

Resources:

Baseline Support: manpower ceiling of 32 ppy

Priority Support: ceiling of 300 keuro EC manpower and equipment

The priority support proposals should form well defined projects, with quantitative descriptions of the work to be performed outlining the parameter range of the experimental or/and theoretical investigations, novelty compared with previous work and a detailed description of the deliverables.

The activities to be implemented following this call for participation will be organized as follows:

Task Agreement WP11-TRA-01: L-H transition physics

- Triggering of the L-H transition, L-H power threshold and impact of ELM control techniques, role of momentum transport through the plasma edge
- Multi-machine experiments on pedestal width physics

Task Agreement WP11-TRA-02: Turbulent electron heat transport

- Studies of transport and turbulence at small scales (including proposals for diagnostics) and interplay with large scales

Task Agreement WP11-TRA-03: Particle and impurity transport at the edge

- Impurity transport and transient particle transport experiments at the edge, and related theoretical studies

Task Agreement WP11-TRA-04: Physics of plasma rotation and its impact on confinement

- Intrinsic plasma rotation
- Relationship between core rotation and profile stiffness

Task Agreement WP11-TRA-05: Edge turbulent transport, role of 3-D physics
- Studies of 3D fields effects in the edge and SOL

Programmatic Background

The EFDA Transport Topical Group (TTG) will address issues related to the understanding of the physical processes determining transport properties of plasmas in fusion devices. The creation of an EFDA Topical Group for transport is considered suitable to provide a broad framework for exchanging results and tools, and simultaneously to promote interaction and collaboration between the EU experiments while involving theory groups.

The Transport Topical Group will bring added value in stimulating cross-European collaborations, providing an interface with other EFDA structures and interfacing with transport work worldwide, in particular with the ITPA groups and the US TTF.

The work shall be performed in close integration amongst the participants. For each work project, a coordinator will ensure the integration of individual work to facilitate synergy effects and create a live project group.

1. Physics of the L-H transition:

Task Agreement WP11-TRA-01:
Physics of the L-H transition

1.1 Introduction

The pedestal plasma parameters have a strong impact on global confinement in ITER. Access to regimes with high confinement (HH,ITP98(y,2) > or = 1) at high densities with tolerable (mitigated) edge localised modes is pivotal to the ITER mission. Hence, the investigation of the mechanisms leading to and setting the width of the edge transport barrier, with the aim of predicting ITER pedestal parameters, remain an important research area.

At present, most experimental evidences strongly support the paradigm of sheared electric field suppression of turbulence to explain pedestal transport, although the underlying mechanisms that generate the electric fields is still an open issue, and evidence for the importance of both mean and fluctuation electric fields is growing.

1.2 Objectives

The programme will focus on the triggering mechanism (e.g. sheared flow) for L-H as well as H-L transitions to clarify the respective role of mean/fluctuating electric fields and on the plasma turbulent behaviour at the L-H transition. Particular emphasis will be given to the study of the influence of ELM mitigation techniques such as 3-D magnetic fields and pellet injection on the L-H transition physics and the role of momentum transfer from the core and the scrape off layer into the region where the barrier forms.

1.3 Work Description and Breakdown

Structure

The L-H transition Group Chair is the coordinator of the task

Work Breakdown

WP11-TRA-01-01

Triggering of the L-H transition, L-H power threshold and impact of ELM control techniques

1) What is the dynamics and interplay of fluctuating and DC electric field components during LH and HL transitions?

2) Does the amount of momentum flux through the edge impact on the transition or on the flow behavior?

3) Is there a correlation to SOL flows? In different geometries?

4) Do resonant magnetic perturbations impact on fluctuating and DC electric field components at the transition?

5) Do shallow pellets influence these? Gas fuelling?

6) Can the influence of neutrals on the flow structure be accessed and compared to other momentum sinks?

7) Can Stellarator and Tokamak be compared on these grounds? Is there a way to describe the transition from 2D to 3D confinement?

WP11-TRA-01-02

Multi-machine experiments on pedestal width physics

1) Do turbulence or neoclassical mechanisms set the pedestal structure?

2) Is there a difference in the pedestal structure between large momentum flux (NBI) and low momentum flux (RF) plasmas?

3) Do large and small momentum flux plasmas result in different SOL structures? SOL flows?

4) How do these features change in situations with magnetic breaking in the edge by intrinsic modes or applied fields?

JET related activities

No JET experiments are foreseen to be implemented under this Task. However, should JET carry out experiments in this area, a close coordination with the JET Task Forces will be sought.

Resources

1.4 Scientific and Technical Reports

R&D Progress reports

At the end of each calendar year, during the Topical Group annual meeting, the Task Coordinator shall present a report on activities under the Task Agreement to the EFDA Leader for his approval. These reports shall integrate the progress made by each Association on each activity, and they shall indicate the level of achievement of the objectives, the situation of the activities, the allocation of resources and recommendations for the next year when applicable. The EURATOM financial contribution will be made through the usual procedures for baseline support through the Contract of Association.

R&D Report of achievements under Priority Support

Achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report (and intermediate reports marking substantial progress in the achievement of deliverables, if the EFDA Leader so requests) shall be prepared by the Task Coordinator and submitted to the EFDA Leader. Each participating Association will have to report in one subsection on the degree to which the deliverables of their Task have been achieved, and shall include a breakdown of expenditure. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Milestones and Deliverables

Milestones:

- Mid 2011 Activity Meetings: Collection and discussion of results obtained from the evaluation of theoretical work and experiments performed in 2010 and early 2011.
- End second trimester 2011 Annual meeting of the EU Transport Topical Group: coordinated presentation of the results from the theoretical work and experimental campaigns in 2011.
- December 2011 Final report sent to EFDA-CSU.

Deliverables:

Activity	*Priority Support Deliverables*	*Due Date*
WP11-TRA-01-01	1) Perform experiments and analysis of the respective role of the DC/fluctuating electric field on the L-H and H-L transition and transport barrier formation. 2) An investigation on the role of SOL flows on the LH transition trigger. Perform investigations 3) to elucidate the L-H transition physics with ergodic divertor / resonant magnetic perturbation with different n numbers 4) Investigation on the impact of shallow pellet injection and gas fuelling on DC and fluctuating fields/LH transition. 5) Perform a Tokamak-Stellarator comparative study looking in particular at the role of the magnetic shear.	30. Dec 2011
WP11-TRA-01-02	1) Perform multi-machine experiments to quantify the importance of turbulence / neoclassical mechanisms to set the pedestal structure. 2) Perform studies to assess the importance of momentum transfer from the core to the SOL on the L-H transition, the pedestal development and its performance. 3) Comparison of RF and NBI heated discharges and configurations with different SOL flows with respect LH transition and pedestal performance. 4) Perform studies to determine the role of magnetic breaking in the edge by intrinsic modes or applied fields. 5) Investigations into the role of neutral breaking and comparison with 4)	30. Dec 2011

2. Turbulent electron heat transport:

Task Agreement WP11-TRA-02:
Turbulent electron heat transport: experimental search of turbulence and transport at small scales

2.1 Introduction

Progress in understanding electron heat transport in ITER relevant plasmas with Te~Ti is needed. In such conditions, where ITG is often the dominant mode and the ETG threshold may become lower than the TEM one, electron heat transport may behave differently with respect to TEM dominated (Te>>Ti) plasmas, in which most electron transport studies have been performed so far. The role of small scales and the interplay between large and small scale needs to be studied both with transport experiments and turbulence measurements, and comparison to theory.

2.2 Objectives

Study plasma conditions where turbulent small scales are theoretically predicted to be present in experiments. The role of such scales, diagnosed by appropriate fluctuation measurements, on the overall transport has to be assessed. This project is a challenge for both diagnostics and simulations.

2.3 Work Description and Breakdown

Structure

The Electron Transport Group Chair is the coordinator of the task.

Work Breakdown

WP11-TRA-02-01

Studies of transport and turbulence at small scales (including proposal for diagnostics) and interplay with large scales

1) Are high k fluctuations observed in plasma conditions which are theoretically expected to be above the ETG linear threshold ?

2) Are observed high k fluctuations correlated (in time / in space) with the power balance electron heat flux, in conditions in which they are theoretically expected to produce significant electron heat transport ?

3) How does the presence or absence of large scale turbulence affect the size and the characteristics of small scale turbulence and transport ?

4) How is electron transport different in plasmas with Te~Ti with respect to those with Te>>Ti? Can we observe a transition from TEM to ETG in both the macroscopic properties of the electron heat transport and in the turbulence characteristics ?

5) Can the previous experimentally oriented questions be addressed concurrently also from the theoretical standpoint, with realistic multi-scale simulations with real electron and ion masses?

JET related activities

No JET experiments are foreseen to be implemented under this Task. However, should JET carry out experiments in this area, a close coordination with the JET Task Forces will be sought.

Resources

2.4 Scientific and Technical Reports

R&D Progress reports

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- December 2011 Final Report sent to EFDA-CSU.

Deliverables:

Activity	*Priority Support Deliverables*	*Due Date*
WP11-TRA-02-01	1) Perform high k fluctuation measurements and compare conditions in which ETG modes are theoretically expected and not expected to be linearly unstable. 2) Investigate presence or absence of correlations (in time/space) between high k fluctuation levels and power balance electron heat fluxes in conditions in which a significant electron heat flux is theoretically expected by ETG turbulence. 3) Investigate the interplay between small and large scales exploring conditions in which large scales are theoretically expected to play dominant or subdominant role in the transport. 4) Compare electron transport properties (also by means of perturbative experiments) and turbulence characteristics in plasmas with Te~Ti with those in	30. Dec 2011

	plasmas with Te>>Ti . 5) Study these topics from the theoretical standpoint, with multi-scale simulations, using realistic mass ratio. The task may involve the development of new diagnostic systems for small-scale fluctuations. The task may also involve experimental investigation of scenarios with internal transport barriers, to study conditions in which large scale turbulence and transport are at least partly suppressed.	

3. Particle and impurity transport at the edge:

Task Agreement WP11-TRA-03:
Particle and impurity transport at the edge

3.1 Introduction

The study of particle and impurity transport is of particular importance not only for its impact on the operation of the plasma discharge, but also because it can shed light on aspects of the plasma turbulence.

3.2 Objectives

The transport of bulk particles and impurities at the edge, inside the last closed flux surface, both in L-mode and H-mode, with different ELM types will be considered with emphasis on convective mechanisms. The understanding of the later is important for the plasma fuelling from the edge in particular for ITER as the ionization particle source profile is expected to decay mostly in the SOL.

3.3 Work Description and Breakdown

Structure

The Impurity Transport Group Chair is the coordinator of the task.

Work Breakdown

WP11-TRA-03-01

Impurity transport and transient particle transport at the edge

1) Can local electron particle transport diffusion and convection coefficients be experimentally measured in the edge/pedestal region, e.g. with perturbation techniques?

2) Can different kinds of perturbations be used to find these parameters, ranging from intrinsic perturbations (natural ELMs) to externally imposed perturbations (induced ELMs, pellets, gas puffs)? Do these coefficients depend on the nature of the perturbation?

3) Can the dependence of convection and diffusion on plasma parameters (e.g. collisionality) and confinement mode be determined?

4) Is impurity transport neoclassical or turbulent at the edge in the different confinement modes of operation (L-mode, H-mode, with different ELM types)

5) From the theoretical standpoint, is there a significant particle convection in edge turbulence simulations? Which is its size and which are its main parametric dependences?

6) Is it possible to develop a compound model including increase impurity influx after ELMs?

JET related activities

No JET experiments are foreseen to be implemented under this Task. However, should JET carry out experiments in this area, a close coordination with the JET Task Forces will be sought.

Resources

3.4 Scientific and Technical Reports

R&D Progress reports

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R&D Report of achievements under Priority Support

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Milestones and Deliverables

Milestones:

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Deliverables:

Activity	*Priority Support Deliverables*	*Due Date*
WP11-TRA-03-01	1) Transient transport experiments at the edge separating particle diffusion and convection in conditions where perturbations are produced by the plasma, e.g. natural ELMs or by imposing external perturbations, e.g. induced ELMs, gas puffs and small pellets. 2) Assess the existence and size of electron particle convection at the edge, in different confinement regimes, and as a function of plasma parameters, in particular by comparisons between plasmas at high densities (relevant to reproduce conditions of limited penetration of the ionization source) with those at expected ITER collisionalities in the edge region (more relevant for the turbulence regime). 3) Experimental studies to determine the magnitude of impurity transport in different confinement modes of operation, L-mode and H-mode with different ELM types, in the edge region, inside the last closed flux surface. 4) Comparison between the measured diffusion and convection coefficients of	30. Dec 2011

	impurities, possibly with different charge numbers, with accurate calculations of the neoclassical transport at the edge, in order to obtain critical information on the size of turbulent transport in the different regimes. 5) Simulations of edge turbulence investigating existence of convective particle transport mechanisms, their physical origin, and their main parametric dependences. 6) Development of a combined modeling capability dealing with the impurity influx after large transport events in a quantitative manner . The task may involve development of diagnostics of the plasma kinetic profiles at the edge, density and temperatures, with high resolution in time and in space and, if required by the experimental set up, diagnostics of the edge ionization source profile, e.g. through D alpha spectroscopy. The task may also involve the development and application of specific diagnostics for edge impurity transport, e.g. fast (ms) multi-chord VUV systems and edge CXRS systems.	

4. Physics of plasma rotation and role of plasma rotation on confinement:

Task Agreement WP11-TRA-04:
Physics of plasma rotation and role of plasma rotation on confinement

4.1 Introduction

Although good progress has been achieved in the understanding of momentum transport, still extrapolating the toroidal rotation, in magnitude and profile shape, to future tokamaks, such as ITER, is much less reliable than for temperature or density, mainly due to uncertainties in sources, intrinsic or induced by RF waves or non-axi-symmetric magnetic perturbations. On the other hand, the detailed physics behind the stabilizing effect of rotational shear on turbulence deserves further investigation, following recent JET observations on the reduction of core ion stiffness in rotating plasmas.

4.2 Objectives

Perform work to improve the understanding of edge driven intrinsic rotation and momentum sources different from neutral beams. Perform ion stiffness studies at different rotation levels. A few key questions are highlighted below.

4.3 Work Description and Breakdown

Structure

The Plasma Rotation Group Chair is the coordinator of the task.

Work Breakdown

WP11-TRA-04-01

Studies on intrinsic plasma rotation

1) Is residual stress observed experimentally? Where is preferentially located, under which conditions is it particularly significant?

2) Can the interaction between SOL flows and plasma rotation be quantified?

3) Is a peaked profile of edge driven intrinsic rotation experimentally observed?

4) Is RF driving a counter-torque? In which conditions? Is breaking of “Rice” scaling in JET due to specific large effect of RF?

5) Is consistent modeling of momentum transport and effects of non-axi-symmetric fields available?

WP11-TRA-04-02

Effect of core rotation and profile stiffness

1) Is rotational shear decreasing ion heat transport stiffness in machines different from JET? Is low magnetic shear enhancing such stiffness mitigation?

2) Are hybrids’s core and ion ITBs regions of reduced stiffness or increased threshold?

3) Is this effect observed in simulations?

JET related activities

No JET experiments are foreseen to be implemented under this Task. However, should JET carry out experiments in this area, a close coordination with the JET Task Forces will be sought.

Resources

4.4 Scientific and Technical Reports

R&D Progress reports

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R&D Report of achievements under Priority Support

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Milestones and Deliverables

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Deliverables:

Activity	*Priority Support Deliverables*	*Due Date*
WP11-TRA-04-01	1) Perform systematic comparisons (also at the edge or ITB locations) between experimental measurements of poloidal and toroidal rotation with theoretical predictions of neoclassical and turbulent momentum transport. 2) Investigate rotation in different confinement geometries (e.g. single or double null configuration) to identify role of SOL flow on core rotation. 3) Compare profiles of toroidal rotation in absence of NBI and with/without RF sources to determine in which conditions it is peaked or flat	30. Dec 2011

	4) Perform experiments (e.g. stepped NBI torque) to determine residual torque due to other sources. Apply RF in various conditions to achieve hollow rotation profiles. Compare with Rice scaling in presence of strong RF power in various schemes. 5) Implement and test simulation tools capable of handling consistent treatment of core momentum transport (first principle or empirical using D+V) in presence of non-axi-symmetric fields. Perform theoretical and simulation studies on points above.	
WP11-TRA-04-02	1) Perform ion stiffness studies at different rotation levels and varying magnetic shear in machines with sufficient CX diagnostics and capability to vary rotation and ion power deposition 2) Compare hybrid core profiles between JET and other machines, including gyro-kinetic simulations at least linear to derive threshold 3) Perform systematic scans using non-linear gyro-kinetic simulations with background rotation flow	30. Dec 2011

5. Statistical properties of edge turbulent transport:

Task Agreement WP11-TRA-05:
Statistical properties of edge turbulent transport: role of 3-D physics

5.1 Introduction

Edge turbulence is often assumed to be toroidally axi-symmetric. However, toroidal field ripple and the application of resonant magnetic perturbations (RMP) breaks this axi-symmetry thereby modifying the edge plasma properties. These have to be determined in order to be able to access the power loadings on material surfaces in future fusion devices such as ITER and DEMO. Several machines are now equipped with RMP coils and or can adjust the field ripple. In addition, comparisons between the edge turbulence on tokamaks, stellerators and reversed field pinches (RFPs) could shed light on the changes in turbulence processes.

5.2 Objectives

Research should be done combining the possibilities offered by the coils recently installed on some machines and the improved diagnostics to better understand the processes determining the edge transport in different confinement regimes and how they are linked to core transport and to impurity production through plasma wall interactions.

5.3 Work Description and Breakdown

Structure

The Edge Transport Group Chair is coordinator of the task.

Work Breakdown

WP11-TRA-05-01

Studies of 3D fields effects in the edge and SOL

1) Do non-axisymmetric fields impact on filamentary structures (L and H-mode regimes, Blobs and ELM filaments)?

2) How is the edge transport affected by the application of 3D fields?

3) What is the poloidal and toroidal dependence of the fluxes in this situation?

4) What can we learn from Stellarators, RFPs for this situation?

WP11-TRA-05-02

Improvements of diagnostics for edge transport and sources

Improve edge plasma diagnostics to characterize edge transport/particle sources to have access to the relevant physics and upgrades of edge diagnostics to allow ion temperature and/or plasma potential measurements.

JET related activities

No JET experiments are foreseen to be implemented under this Task. However, should JET carry out experiments in this area, a close coordination with the JET Task Forces will be sought.

Resources

5.4 Scientific and Technical Reports

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Deliverables:

Activity	*Priority Support Deliverables*	*Due Date*
WP11-TRA-05-01	1) Investigation on the effect of non-axisymmetric fields on the filamentary structures (L and H-mode regimes) 2) Investigation into changes in edge transport due to the application of 3D fields 3) Characterization of the edge turbulence in these 3D situations (including effect of ion temperature and 3D fast particle losses) 4) Edge turbulence and transport modeling by incorporating 3D field effects into the codes. 5) Comparison studies between tokamaks, stellarators and RFPs on the above topics.	30. Dec 2011

	This task is expected to involve the development or upgrade of edge plasma diagnostics to characterize edge transport/particle sources, diagnostics to allow ion temperature and/or plasma potential measurements, and the measurement of currents	
WP11-TRA-05-02	Development of electric field (ExB flow) measurements through the movement of turbulence eddies, Doppler and correlation reflectometers, Beam emission Spectroscopy (BES) and Electron Cyclotron Emission imaging. Further developments of data evaluation techniques.	30. Dec 2011