EFDA WORKPROGRAMME 2010

Call for Participation

(Part of the EFDA WP, PWI TF)

Deadline for Responses: 5th September 2009

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This Call for Participation aims to implement the Plasma Wall Interaction Work Programme for 2010 under Task Agreements as foreseen in the new EFDA Art. 5.

Index

Introduction 4
1. SEWG Fuel Retention: **6**
Task Agreement WP10-PWI-01: Fuel retention as a function of wall materials foreseen for ITER. **6**
1.1 Introduction 6
1.2 Objectives 6
1.3 Work Description and Breakdown 7
WP10-PWI-01-01 7
WP10-PWI-01-02 7
1.4 Scientific and Technical Reports 8
2. SEWG Fuel removal: **10**
Task Agreement WP10-PWI-02: Exploration of fuel removal methods compatible with retention in mixed materials and metals, including beryllium **10**
2.1 Introduction 10
2.2 Objectives 11
2.3. Work Description and Breakdown 11
WP10-PWI-02-01 11
WP10-PWI-02-02 11
WP10-PWI-02-03 12
WP10-PWI-02-04 12
2.4 Scientific and Technical Reports 13
3. SEWG Dust: **14**
Task Agreement WP10-PWI-03: Dust generation and characterization in different devices, including the impact of fuel removal methods on dust production **14**
3.1 Introduction 14
3.2 Objectives 14
3.3. Work Description and Breakdown 14
WP10-PWI-03-01 14
WP10-PWI-03-02 14
WP10-PWI-03-03 15
3.4 Scientific and Technical Reports 15
4. SEWG Material Migration **17**
Task Agreement WP10-PWI-04: Erosion, transport and deposition of low-Z wall materials **17**
4.1 Introduction 17
4.2 Objectives 17
4.3 Work Description and Breakdown 18
WP10-PWI-04-01 18
WP10-PWI-04-02 18
WP10-PWI-04-03 18
WP10-PWI-04-04 19
4.4 Scientific and Technical Reports 20
5. SEWG High-Z Materials **21**

Task Agreement WP10-PWI-05: Development of the PWI basis in support of integrated high-Z scenarios for ITER. Demonstration of liquid plasma-facing components 21
5.1 Introduction 21
5.2 Objectives 21
WP10-PWI-05-01 21
WP10-PWI-05-02 22
WP10-PWI-05-03 22
WP10-PWI-05-04 22
5.4 Scientific and Technical Reports 23
6. SEWG ITER Material Mix 25
Task Agreement WP10-PWI-06: Determination of expected alloys and compounds in ITER relevant conditions and their influence on PWI processes and fuel retention 25
6.1 Introduction 25
6.2 Objectives 25
6.3 Work Description and Breakdown 25
WP10-PWI-06-01 26
WP10-PWI-06-02 26
WP10-PWI-06-03 26
6.4 Scientific and Technical Reports 27
7. SEWG Transient heat loads and mitigation 29
Task Agreement WP10-PWI-07: Mitigation of disruptions and investigation of ELM and inter-ELM heat loads 29
7.1 Introduction 29
7.2 Objectives 29
7.3 Work Description and Breakdown 30
WP10-PWI-07-01 30
WP10-PWI-07-02 30
WP10-PWI-07-03 30
WP10-PWI-07-04 30
7.4 Scientific and Technical Reports 31

Introduction

At its meeting in Prague on 12 March 2009, the EFDA Steering Committee approved elements of the EFDA 2010 Work Programme, among which the PWI TF programme. This includes the preparation and execution of experiments performed in the Associations and the subsequent coordinated analysis of experimental data. The PWI TF programme requires overall an estimated manpower of **114.75 ppy, including** a ceiling of **23.75 ppy** under Priority support. It is implemented on the basis of calls for participation. The outcome of the calls will be assessed by the PWI Task Force leadership and the EFDA-CSU and implemented under a number of Task Agreements on the basis of the provisions given in Art. 5 of the EFDA Agreement. The work Programme 2010 of the PWI TF consists of 8 Task Agreements which are defined and organised under the 7 Special Expert Working Groups (SEWGs) which constitute the Task Force. They are summarized in table 1.

Table 1: Summary of Task agreements proposed for 2010

	Proposed Task Agreement for 2010
PWI -TF	TFL: TF Coordination and SEWG Coordination
SEWG Fuel retention	TA-1: Fuel retention as a function of wall materials foreseen for ITER
SEWG Fuel Removal	TA-2: Fuel removal compatible with retention in different and mixed first wall materials
SEWG Dust in Fusion Devices	TA-3: Dust generation and characterization in different devices
SEWG Material Migration	TA-4: Erosion, transport and deposition of wall materials
SEWG High-Z Materials	TA-5: Development of the PWI basis in support of integrated high-Z scenarios for ITER. Demonstration of liquid plasma-facing components
SEWG ITER Material Mix	TA-6: Determination of expected alloys and compounds and their influence on PWI processes
SEWG Transient Heat Loads	TA-7: Mitigation of disruption loads for ITER and investigation of Heat loads in ITER relevant ELM scenarios

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 12th March 2008 in Prague (EFDA (08) 36/4.2) and endorsed by the CCE-FU at its meeting of 3rd April 2008 (EUR (08) CCE-FU 41/6.3a). This pertains to well identified actions, including:

- TF and SEWG leadership (0.5 ppy for TF leader and deputies, 0.25 ppy for SEWG leadership)
- joint activities: experimentation, modelling, support to the other Associations, etc.
- selected hardware or manpower costs involving irradiation, work on hot cells, work with tritium and/or beryllium

Exchange of scientists between the involved Associations is planned covering:

- participation in joint experimental campaigns and modelling efforts

- attendance to the SEWG and TF meetings.

For all these exchanges, the use of the mobility agreement is foreseen.

For 2010, a total of **23.75 ppy** and **400 kEuro** for hardware under Priority Support, as well as **350 kEuro** under mobility is foreseen (see table 2 below).

Table 2:Estimated budget needed for activity under baseline support, eligible for priority support, hardware and mobility:

	BS (ppy)	PS (ppy)	Hardware (k€)	Mobility (k€)
TF Coordination SEWG Coordination		1 1.75		
TA-1: Fuel retention as a function of wall materials foreseen for ITER	7	3	50	50
TA-2: Fuel removal compatible with retention in different and mixed first wall materials	12	2	40	50
TA-3: Dust generation and characterization in different devices	10	1.5	50	50
TA-4: Erosion, transport and deposition of first wall impurities	17	3	30	50
TA-5: Development of the PWI basis in support of integrated high-Z scenarios for ITER. Liquid plasma-facing components	22	4	80	50
TA-6: Expected alloys and compounds and their influence on PWI processes	9	2	30	50
TA-7: Mitigation of disruption loads for ITER investigation of Heat load in ITER relevant ELM scenarios	14	5.5	120	50
Total	**91 ppy**	**23.75 ppy**	**400 k€**	**350 k€**

1. SEWG Fuel Retention:

Task Agreement WP10-PWI-01: Fuel retention as a function of wall materials foreseen for ITER.

1.1 Introduction

From *gas balance analysis*, common features on the retention behaviour have been observed in different machines. It shows an initial high retention rate in a first phase of the discharge, decreasing towards a steady state value in a second phase. After the shot, the gas recovery corresponds to the gas trapped during the first phase, so that the associated retention mechanism seems to be transient (such as adsorption leading to weakly bound deuterium (D)). The long term recovery, overnight, over weekends and in maintenance periods, is more difficult to assess and makes extrapolation to ITER still difficult. However, from the DT campaign on JET (1997-1998) the amount of particles recovered in the period is not significant/dominant and represents about 10-15% of the total amount retained.

So far, most data on retention were obtained in all-carbon machines, so that comparison with carbon free machines (all-W ASDEX Upgrade, future ITER like Wall in JET) needs to be performed for a better prediction for ITER.

Retention from post-mortem PFC analysis suffers from averaging over many different plasma scenarios, often including wall conditioning such as He-GDC and boronisation, and disruptions. Moreover, the impact of long term outgasing between shots during the campaign (months) and air exposure of the samples when removed from the vessel is difficult to assess.

Scaling of retention rate as a function of plasma/ machine parameters is only poorly characterized (injection rate, incident flux/fluence, PFC materials, PFC temperature). The main retention mechanisms have been identified (co-deposition with C and/or Be, bulk diffusion and trapping in CFC and W) but their relative contributions in ITER conditions are still uncertain, and are a topic of active research, from laboratory experiments, modelling as well as integrated tokamak experiments.

1.2 Objectives

The aim of this Task Agreement is to improve our knowledge on fuel retention in wall materials foreseen for ITER using particle balance to evaluate “how many” particles are retained in the vessel and post mortem analysis to assess where these particles are retained. It is worth noting that these methods are complementary.

The scientific objectives of the task are to:

- perform an extensive post mortem analysis of PFCs for comparison with integrated particle balance results;
- assess sources of possible uncertainties on both methods (such as disruptions, outgassing, cleaning discharges for particle balance, non toroidal/poloidal uniformity, retention in gaps and hidden areas, bulk diffusion for post mortem analysis);
- establish and perform a complementary analysis programme to progress in identifying the retention mechanisms at stake;
- on a longer term : propose ITER relevant fuel retention diagnostics, from particle balance, in situ and/or post mortem analysis.

1.3 Work Description and Breakdown

1.3.1 Work Breakdown

WP10-PWI-01-01

Multi machine scaling of fuel retention for ITER

(AUG, TS, TEXTOR (JET for comparison), other relevant devices, PSI devices)

- Complete studies of retention in C environment for different edge plasma regimes (TS, TEXTOR, and possibly other relevant devices)
- Study the retention in a full W environment for different regimes (L mode, type I ELM, type III ELMs and advanced tokamak regimes). Comparison with results in previous configurations as a function of carbon coverage (AUG)
- Study D retention in Be/W/mixed materials under high fluence (PISCES, IPP dual beam), see also SEWG on ITER material mix
- Assess the contribution of wall conditioning (boron) on the retention, in particular for full metallic devices
- From all the above experiments, establish a multi-machine scaling of retention and refine the fuel retention predictions for ITER

WP10-PWI-01-02

Characterisation of retention mechanisms using particle balance and post mortem analysis

(AUG, TS, other relevant devices (JET for comparison), analysis in several associations)

- Perform an extensive post mortem analysis of PFCs for assessing where the fuel retained in the vessel is located: deposited layers, gaps, bulk material, flakes, remote areas, below limiter/divertor in order to improve mitigation measures (in plasma operation as well as for the design of PFCs) and fuel removal techniques
- comparison with integrated particle balance results.
- Establish and perform complementary analysis program to progress in identifying the retention mechanisms at stake

1.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely related to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF E and TF FT	• Complete the fuel retention database (in D_2, H_2 and He) for comparison between the present carbon configuration and the future ITER like wall (TFE). • Complete the post mortem analysis of JET PFCs, including gaps, Be PFCs etc (TF-FT), assess where the fuel is retained

	• Perform fuel retention studies in the ILW configuration

1.3.3 Resources

It is foreseen that this work requires an estimated manpower of **7 ppy** under baseline support, **3 ppy** under priority support, **50 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:
- Joint post mortem analysis of tokamaks PFCs coordinated within the EU associations for comparison with particle balance, identification of retention mechanisms and location of the trapped fuel.
- Joint experiments to establish a multi machine scaling of fuel retention as a function of the plasma parameters and device characteristics

Part of international effort (ITPA Divertor and SOL), which could lead to missions under mobility.

1.4 Scientific and Technical Reports

1.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

1.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

1.4.3 Milestones and Deliverables

Milestones:

Mid 2010
SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:
Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:

a) One technical report per facility involved according to the objectives described above by October 2010.

b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

2. SEWG Fuel removal:

Please note that technology oriented tasks on the development of fuel removal techniques for ITER will be implemented under EFDA Emerging Technology in a later call for participation.

Task Agreement WP10-PWI-02: Exploration of fuel removal methods compatible with retention in mixed materials and metals, including beryllium

2.1 Introduction

The retention rate of tritium in the ITER vessel is likely to require *in-situ* tritium recovery during operations or during the maintenance period (depending on the choice of first wall and divertor materials), or methods to actively control the inventory by limiting the tritium uptake during each pulse. In addition to scenario improvements allowing a reduction of tritium retention, detritiation techniques shall be made available to insure a safe operation of ITER. Two main types of actions are foreseen:

- heating the PFCs in order to release the tritium;
- removing the material in which the tritium is trapped (mainly in the co-deposition).

Among methods used for heating one should make the difference between techniques based on PFC bulk heating and those relying on surface heating.
Bulk heating in vacuum (to around 350°C) is a practical technique for dealing with tritium trapped in beryllium co-deposits, and heating of the divertor alone might address much of this retention. For tritiated hydrocarbon deposits, however, the required temperature for efficient detritiation is impractically high. In order to enhance the efficiency to a sufficient level it is needed to operate under oxidising atmosphere (O2 or steam). Unfortunately, oxidation can induce de-conditioning of the PFCs, requiring extensive re-conditioning, and could therefore be a very time consuming method. It is also foreseen that the choice of this technique would require significant changes in terms of design for the PFCs and for the tritium plant in order to handle the exhaust gases produced. This technique has been extensively studied, however, and has proven its efficiency as far as detritiation is concerned and should not be therefore ruled out.

The removal of material (co-deposits) can also be performed by photonic methods. The main advantage is that, as well as detritiating, these techniques also contribute to reducing the dust inventory (co-deposition being one of the sources for dust production). Furthermore they are capable of removing co-deposits without harming the PFC surface, and could also be used for window and mirror cleaning (which may be necessary for several of the optical diagnostics). With these removal methods, it would be necessary to collect aerosols and dusts produced by the co-deposit ablation. Therefore, it is requested to proceed with a feasibility study on a potential remote handled application of a photonic ablation technique on ITER, emphasising the need to guarantee an efficient collection of the wastes.

Besides this ITER will certainly have issues with tritium retention in mixed materials involving Be and W in conjunction with carbon and oxygen impurities. For all technologies, Tasks are expected to include quantification of the removal rates, and applicability to ITER in their objectives.

2.2 Objectives

The aim of this Task Agreement is to:

- Develop an integrated scenario for fuel removal in ITER:
  - Explore possible methods to limit tritium uptake during the discharge
  - Derive a credible tritium inventory control scheme relying on developed cleaning techniques to meet ITER operational requirements.
  - Assess combined efficiency, removal rates and schedule needed.
- Assess efficiency of developed fuel removal methods (heating, chemical and photonic) for reducing hydrogenic retention in co-deposits as well as in metals and mixed materials
- Explore new fuel removal methods, targeted at hydrogenic retention in metals (for ITER with future all-metal divertor)
- Investigate wall conditioning scenarios (in particular RF conditioning, in collaboration with the EFDA TG on heating and current drive).

2.3. Work Description and Breakdown

2.3.1 Work Breakdown

For all of the cleaning methods below, the impact on dust production should be assessed, in coordination with the SEWG “Dust in Fusion Devices”.

WP10-PWI-02-01

Wall conditioning

- Investigate wall conditioning techniques (particularly RF conditioning) in tokamaks, with emphasis on fuel removal efficiency, operation under ITER conditions, and side effects such as dust production and plasma restart.

WP10-PWI-02-02

Plasma assisted chemical cleaning methods

- Explore the impact of repetitive oxidising plasmas (GDC/RF) on beryllium bulk properties and other in-vessel components.
- Study the effect of sample temperature for oxidative or advanced chemical cleaning (with or without glow discharge) on oxide film formation, and demonstrate beryllium oxide removal rates
- Resolve the impact of nitrogen-containing molecules on cleaning processes and understand the discrepancy between laboratory and tokamak experience

WP10-PWI-02-03

Photonic cleaning methods

- Improve the understanding of the break-up processes for metallic films in photonic "cleaning", such as measuring the hydrogenic content of the particulates relative to the film composition, optimising gaseous release, and preventing spread of dust. Assess practical methods of exploiting laser techniques in ITER.

WP10-PWI-02-04

Fuel removal in gaps

- Develop methods for the removal of deposited films in tile gaps and castellations, measuring the efficiency as function of aspect ratio, etc. Possible techniques are glow discharge cleaning in oxygen or O-based gas mixtures (for which the relative importance of the ion species should be quantified), and use of a plasma torch

2.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF FT	• Test fuel removal techniques on JET PFCs, in particular containing Be (TF FT) • Assess the efficiency of ICRF wall conditioning in the carbon configuration of JET, to be compared with the ILW configuration.

2.3.3. Resources

It is foreseen that this work requires an estimated manpower of **12 ppy** under baseline support, **2 ppy** under priority support, **40 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:

- Beryllium related work: impact of repetitive exposure to GDC and/or RF oxidising plasmas of surface and bulk beryllium. Treatment of oxidised beryllium samples with glow or RF assisted plasmas (e.g. in He and Ar) to establish cleaning rates and assess removed material.
- Coordinated surface analysis of treated samples (tokamak and laboratory) to characterise surface deposits remaining after cleaning and damage to bulk material, including tritium and beryllium analyses where appropriate.
- Joint experiments on RF conditioning, to assess cleaning efficiencies and optimize the cleaning process (RF parameters, magnetic field …).

Part of international effort (ITPA Divertor and SOL), which could lead to missions under mobility.

2.4 Scientific and Technical Reports

2.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

2.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

2.4.3 Milestones and Deliverables

Milestones:
Mid 2010
SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:
Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:

a) One technical report per facility involved according to the objectives described above by October 2010.
b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

3. SEWG Dust:

Please note that technology oriented tasks on the development of dust diagnostics and dust removal techniques for ITER will be implemented under EFDA Emerging Technology in a later call for participation.

Task Agreement WP10-PWI-03: Dust generation and characterization in different devices, including the impact of fuel removal methods on dust production

3.1 Introduction

The formation and accumulation of carbon and metal dust in a fusion reactor may create, like T retention, serious safety and operational problems. A strategy to deal with the dust accumulation has been accepted into the ITER baseline.
Dust sampling and analysis have been performed in different facilities, showing discrepancies between devices. The most important issues to be addressed are the following:

- Mechanisms for dust generation during plasma/maintenance phase including conditioning and fuel removal techniques
- Quantification of dust production in tokamaks from all the processes above
- Physics basis for techniques for dust removal and dust diagnostics

3.2 Objectives

The aim of this Task Agreement is to improve our knowledge on dust generation and its characterization in different tokamaks. It also includes the development of dust generation and transport models in order to provide better predictions for ITER.

3.3. Work Description and Breakdown

3.3.1 Work Breakdown

WP10-PWI-03-01

Dust generation in present devices

- Metal dust formation (W and Be): Identification of dust generation mechanisms. Validate modelling for dust creation and suspension. Implications for ITER standard scenario.
- Characterize dust generation in present devices (TS, TEXTOR, AUG and possibly other relevant devices; comparison to JET)): location in vacuum vessel, generation rates, physical and chemical properties (size, reactivity, surface specific area, fuel content, etc).

WP10-PWI-03-02

Conversion of co-deposits to dust

- Assess the dust conversion factor (gross erosion to dust production) for different EU devices.
- Assessment of dust generation by various techniques for fuel and co-deposit removal (see also SEWG on fuel removal).

WP10-PWI-03-03

Dust and plasma operation

- Improve detection of dust in the plasma and relate the dust generation to discharge conditions**.**
- Improve understanding of the impact of dust formation on the plasma performance and operation.

3.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF E and TF FT	• Observation of dust by visible and IR cameras • Dust sampling during shutdowns (TF FT)

3.3.3 Resources

It is foreseen that this work requires an estimated manpower of **10 ppy** under baseline support, **1.5 ppy** under priority support, **50 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:

- Coordinated analysis (including fuel retention) of dust samples from different devices;
- Coordinated assessment of erosion and dust production to determine the dust conversion factor, using a standardized methodology for all the devices involved;
- Diagnostic exchange between devices for joint characterization of consequences of dust on plasma operation and performances (e.g. fast cameras)

Part of international effort (ITPA Divertor and SOL, bilateral collaboration with RF), which could lead to missions under mobility.

3.4 Scientific and Technical Reports

3.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

3.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

3.4.3 Milestones and Deliverables

Milestones:
Mid 2010
SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:
Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:
a) One technical report per facility involved according to the objectives described above by October 2010.
b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

4. SEWG Material Migration

Task Agreement WP10-PWI-04: Erosion, transport and deposition of low-Z wall materials

4.1 Introduction

Present status:

- Chemical erosion of carbon-based materials is adequately described as function of temperature, energy and incident flux. The role of synergistic effects with seeding gases is not fully understood. Work is ongoing concerning gases like Ne, Ar and N_2.
- At plasma temperatures below 10 eV and fluxes above $10^{23}/m^2s$, new experimental data from PILOT-PSI and tokamaks are available. ERO modelling is ongoing (need for plasma background as input). Experiments in H-mode are foreseen in the near future (2009). First measurements indicate a non linear increase of deposition measured by QMBs as a function of ELM energy. Chemical re-erosion yield of deposited layers due to ELMs is sill an open issue.
- Major trends of the global migration pattern are being identified. Experiments in AUG have confirmed that the outer midplane is the main impurity source with carbon walls. The outer divertor is a minor erosion source in comparison to the main chamber. However, it can switch from erosion-dominated to deposition-dominated by changing e.g. the geometry or the surface conditions. The transport from the outboard midplane to the inner divertor ($^{13}CH_4$ gas puffs experiments in AUG and JET) is reproduced in simulations, but absolute values are overestimated in the modelling. Re-erosion appears to be more pronounced in experiments.
- The long term material deposition is associated with the tritium retention issues, which become most prominent in PFCs with gap structure. No final conclusion on an optimum geometrical arrangement has been found yet. In particular the deposition in the bottom of gaps, far away from the top surface, is unclear and shall be investigated in the future by both modelling and experiments.
- Diagnostics for erosion/lifetime surveillance with resolution relevant for device safety are needed.

4.2 Objectives

The expected ITER-like domain will be characterised by a fully detached and recombining plasma in the inner divertor leg and semi-detached recombining plasma in the outer divertor leg. The present knowledge suggests that only the outer divertor will undergo net chemical erosion whereas the inner divertor will be deposition dominated and will probably show significant material mixing. The approach to ITER-like conditions for material erosion must go through two different routes:

- on the experimental side new experiments must be performed with ITER reference materials in linear plasma devices able to reach the high fluences expected in ITER, but modified to reach ion flux and surface and electron temperature conditions relevant to ITER. The influence of ELMs needs to be studied in linear devices, but also dedicated experiments must be done in tokamaks. The addition of impurities (Be,

B, O etc.) as well as seeding gases (Ne, N_2, Ar etc.) needs to simulate the plasma composition expected in ITER.
- In parallel, this needs to be accompanied by dedicated, well controlled ion beam experiments, as well as modelling for basic understanding and more reliable extrapolations.

The scientific objectives of the task are.
- Cross machine comparisons of main wall erosion and local re- and co-deposition
- Characterisation of outer and inner divertor erosion as well as the migration of impurities from main chamber to divertor and inside the divertor
- Further development of material migration codes
- Measurement and modelling of chemical erosion of low-Z materials in tokamaks for plasmas at low temperatures including the impact of seeding gases

4.3 Work Description and Breakdown

4.3.1 Work Breakdown

WP10-PWI-04-01

Cross machine comparisons of main wall erosion and local re- and co-deposition
Measurements of local gross and net erosion in the main chamber along with local re-deposition., using midplane probes or long term samples left in place for a run campaign (e.g. ASDEX-Upgrade, MAST, TEXTOR, Tore Supra in comparison with JET and US devices). Such measurements should be performed in a coordinated spectroscopic approach (for gross erosion) to guarantee consistent measurements. Potential use of markers to track where the eroded material migrates.

WP10-PWI-04-02

Characterisation of outer and inner divertor erosion as well as the migration of impurities from main chamber to divertor and inside the divertor
Use of ^{13}C and other marker studies for migration studies in post-campaign erosion and deposition measurements and associated modelling. Additionally use of 'single marker tiles' (for example Mo on tungsten tiles in ASDEX-Upgrade, and Mo, ^{13}C or W on C for carbon PFC machines) for toroidal and poloidal migration measurements. It should be clarified if the transport to remote areas can be attributed to chemical erosion only, or if it is a combination of physical and chemical erosion.

WP10-PWI-04-03

Further development of material migration codes
Development/improvement/combination of local and global erosion/transport codes (such as ERO …), to take into account PFC surface shaping to predict deposition patterns for both steady state diverted operation and during limiter start-up/ramp down phases. Benchmark with existing experimental data on the effect of surface roughness, shadowing effects and gap deposition. Try to use codes to find optimized shape of PFCs for ITER.

WP10-PWI-04-04

Measurement and modelling of chemical erosion of low-Z materials in tokamaks for plasmas at low temperatures including the impact of seeding gases

Low electron temperature plasma operation at high electron density is foreseen for the ITER divertor target plates. The intrinsic radiation by carbon seems currently to be insufficient to achieve the needed radiated fraction. Therefore seeding gases for radiation are foreseen. The interaction of seeding gases such as N_2 is complicated and can cause additional chemical erosion of carbon. However, the increase of erosion might be compensated by the reduction of sputtering due to plasma cooling. Experiments in tokamaks such as AUG and TEXTOR and linear machines (MAGNUM) will be used to investigate the erosion at high deuterium ion fluxes with and without additional impurity seeding.

4.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF E and TF FT	• Measurements (spectroscopy/QMB) and modelling (EDGE2D/EIRENE, DIVIMP and ERO) of first wall material erosion under ITER relevant conditions (TF E) • Material transport studies with tracers ($^{13}CD_4$ injection to study the C transport, possibly SiH_4 injection as a mimic for Be transport) and associated post mortem analysis (TF E and FT) • Detachment in L-mode discharges at high magnetic field in hydrogen plasmas (H-mode threshold higher) for benchmark of atomic and molecular data

4.3.3 Resources

It is foreseen that this work requires an estimated manpower of 17 **ppy** under baseline support, **3 ppy** under priority support, **30 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:

- Coordinated experiments on gross and net erosion, with a standardized methodology for spectroscopic data, including hardware for marker tiles and upgrade of spectroscopic tools
- Coordinated experiments on carbon erosion associated with seeding impurities
- Development of modelling tools for local erosion/deposition (in particular taking into account gaps and realistic geometries) and benchmarking against present day tokamak or lab data

Part of international effort (ITPA Divertor and SOL), which could lead to missions under mobility.

4.4 Scientific and Technical Reports

4.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

4.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

4.4.3 Milestones and Deliverables

Milestones:

Mid 2010

SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:

Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:

a) One technical report per facility involved according to the objectives described above by October 2010.

b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

5. SEWG High-Z Materials

Task Agreement WP10-PWI-05: Development of the PWI basis in support of integrated high-Z scenarios for ITER. Demonstration of liquid plasma-facing components

5.1 Introduction

- Un-boronised full W tokamak (AUG) operation could be demonstrated (start-up feasible, W erosion tolerable, good confinement, low D retention in W coatings, in agreement with lab. experiments). A concern is the W erosion by ELMs and by ions accelerated by ICRH.
- Good performance is obtained in impurity seeded (nitrogen) boronised discharges: significant divertor heat loads were obtained after boronisation (suppression of low Z impurities), leading to W coating damage. They were successfully reduced by radiation cooling.
- Successful initiation of irradiated W sample characterization.
- Progress of diagnostics (W spectroscopy, erosion measurements by QMBs).
- Liquid lithium limiter based on capillary porous system tested up to $5MW/m^2$. First experiments with liquid Ga jet were performed on ISTTOK. Hydrogenic retention and stability is to be investigated.

5.2 Objectives

- Provide data and basic understanding of PWI phenomena to support the development of integrated scenarios (start up, steady state operation, auxiliary heating) for a full W divertor and in an all-metal machine. Develop W related diagnostics in collaboration with TG Diagnostics.
- Investigate the effects of transient heat loads on materials and the impact of material damage on plasma operation.
- Benchmark edge codes on W transport against tokamak experimental data
- Demonstrate the usability of the liquid metals as plasma facing components.

5.3 Work Description and Breakdown

5.3.1 Work Breakdown

WP10-PWI-05-01

PWI in a full-W device

- Participate in the control of W core accumulation under high power regimes (central ECRH, ELM pace-making). In particular, assessment of the most reliable method for reducing W erosion by ICRH (comparison with C-Mod)
- Investigate the effect of different seed impurities (Ne,Ar,N_2) on W erosion and PFCs heat loads (comparison with Mo erosion in FTU)

- W related diagnostic: development of W influx diagnostics. IR measurements in an all-metal machine (collaboration with TG diagnostics)
- W morphology under plasma bombardement: growth of nanostructures and blister generation on W under He and hydrogenic fluxes (collaboration with TG materials)
- Fuel retention (in collaboration with the SEWG fuel retention) : assess current understanding of hydrogenic retention in high-Z materials: modelling of deep retention, permeability at high temperature, dependence on fluence, role of ELMs and disruptions, influence of neutron irradiation, discrepancy between lab. and tokamak retention

WP10-PWI-05-02

Damage of metal PFCs under high heat fluxes
Effect of divertor target pre-damage on device operation, effects of unmitigated and mitigated ELMs on W, molten material dynamics (MEMOS modelling), upgrading of used and/or development of new techniques for thick W coating deposition. Test of shaped FW mock-ups, development of models taking into account surface shaping.

WP10-PWI-05-03

Interpretative PWI modelling
Benchmarking the codes used for ITER predictions (ERO, DIVIMP, SOLPS…) against AUG full-W results in terms of W erosion, core contamination, fuel retention. This will be carried out in close connection with the ITM TF.

WP10-PWI-05-04

Potential of liquid metal PFCs
Assessment of hydrogenic retention in liquid metals and stability against transients of liquid metals.
Design, tests, installation and commissioning of liquid limiters in EU devices (FTU, IST, TJII …)

5.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF E, TF FT, TF D, **TF-S1 and S2**	• Development of scenarios compatible with the JET ILW configuration from the PWI point of view (radiative scenarios, ELM mitigation, control of W accumulation) (TF E + TF-S1 and S2). • Start-up in an all-metal device without surface conditioning by deposition of coatings. • Identification of central W spectroscopic lines relevant for JET and ITER. (TF E + TF D)

	• Characterisation of W divertor erosion (TF E and FT) • Hydrogenic retention in W and Be (TF E) • Benchmarking the codes used for ITER predictions (ERO, DIVIMP, SOLPS…) against first ILW results.

8.3.3 Resources

It is foreseen that this work requires an estimated manpower of **22 ppy** under baseline support, **4 ppy** under priority support, **80 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:

- Collaborative effort on assessing and reducing the impurity production during ICRH heating, on fuel retention (high-Z, liquid metals), on W related diagnostic development, on neutron irradiation tests, and on W associated modelling.
- Hardware:
  - development of in vessel structures using liquid metals as plasma facing material, construction of FW mock-up.
  - development of alternative coatings techniques for high-Z materials under specifications developed by the TF and characterisation of coating techniques for tungsten component
- Collaborative effort on W influx diagnostic development on investigations on H retention in high-Z materials under fusion relevant conditions (W, liquid metals)

Part of international effort (bilateral collaboration with US (PISCES) and RF (plasma guns), ITPA Divertor and SOL), which could lead to missions under mobility.

5.4 Scientific and Technical Reports

5.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

5.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

5.4.3 Milestones and Deliverables

Milestones:
Mid 2010
SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:
Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:
a) One technical report per facility involved according to the objectives described above by October 2010.
b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

6. SEWG ITER Material Mix

Task Agreement WP10-PWI-06: Determination of expected alloys and compounds in ITER relevant conditions and their influence on PWI processes and fuel retention

6.1 Introduction

- Both Be-W alloy formation and carbide formation of Be and W have been investigated in well controlled laboratory experiments and principal mechanisms are understood. However more knowledge is needed on the dynamics of these processes under high impinging flux conditions and transient surface temperature changes. In addition, studies of ternary systems including Be, W and C and/or oxygen, have just started and need more dedicated experiments.
- Intermixing dynamics under simultaneous impact of Be, C, W and D on surfaces are subjects of ongoing research in plasma simulators and dual ion beam experiments. Be-W and Be-C intermixing is being investigated in the plasma simulator PISCES-B. Simultaneous impact of C and D on W is investigated in a dual ion beam ion facility at IPP Garching. Further experiments are needed in these fields to supply and extend the data base for benchmarking BCA (binary collision approximation) codes such as TRIDYN and molecular dynamics simulations, which are required to extrapolate to ITER conditions.
- D retention in mixed layers deposited on surfaces of the three ITER PFMs has been investigated for all relevant binary material combinations. However, only few data exist on the influence of layer structure and layer thickness for D-retention in both the layers and the deep bulk regions below. More experiments of this kind are required.
- For all previously listed issues, the effect of transient temperature excursion, both on the scale of few seconds (loss of plasma control) and on ms scale (ELMs and disruptions) must be investigated. This requires additional experimental and modelling efforts.
- Plasma material transport codes and surface codes such as TRIDYN and specific kinetic material intermixing codes are available. Benchmarking and further development are under way but require continuous work well beyond the present 2010-2011 work plan.

6.2 Objectives

The aim of this Task Agreement is to improve our knowledge on material mixing in ITER relevant environment, in particular :

- Formation and properties of mixed materials
- Fuel retention in mixed materials
- Associated modelling

6.3 Work Description and Breakdown

6.3.1 Work Breakdown

WP10-PWI-06-01

Formation and properties of mixed materials

- Lab studies on ternary systems: Study of the ternary system Be-C-W in dedicated lab experiments, influence of oxygen on physical and chemical properties of the mixed material (IPP Garching / BESSY Berlin and possibly other laboratories).
- Analysis of tokamaks deposits: Analysis of W-C (with possible inclusion of oxygen) and Be-C (JET TF FT for comparison) deposits collected in tokamaks (AUG, TEXTOR and possibly other devices) for comparison to lab. experiments: composition, fuel retention properties.
- Influence of thermal excursions: Exposure of mixed material layers on pure substrates to repeated thermal shocks either in tokamak divertors equipped with manipulators (AUG, MAST and possibly other devices) or suitable heat flux test facilities. In-situ and ex-situ analysis of erosion behaviour, fuel retention properties and structural layer damage (flake/dust creation).
- Influence of He and seeded impurities: Exposure of mixed material layers and pure substrates to plasmas with admixtures of He and/or impurities envisaged for seeding either in linear plasma devices (PISCES, Pilot/Magnum, PSI-2 and possibly other devices) or tokamak divertors equipped with manipulators (AUG, MAST and possibly other devices). Analysis of erosion behaviour, evolution of surface morphology and fuel retention properties.
- Continuation of present work in dedicated lab. experiments: effect of the substrate temperature, including the effect of transient temperature excursions; effect of the incoming flux composition.
- Study of reaction kinetics for Be-W and Be-C (for instance Be / W inter-diffusion, Be sublimation from Be / W alloys …)

WP10-PWI-06-02

Fuel retention in mixed materials

Investigation of D retention in mixed materials and of surface vs. bulk retention in systems with mixed layers on pure substrate materials as function of temperature, composition and structure of the mixed material and of incident flux composition. Influence of simultaneous impact of D and He on hydrogen retention in such systems (PISCES under bilateral contract; dual beam facility at IPP Garching, Nat. Inst. f. Laser, Plasma and Radiation Physics, Bucharest and possibly other laboratories).

WP10-PWI-06-03

Modelling of material mixing for extrapolation to ITER conditions

- Extension of transport codes (B2/EIRENE, DIVIMP, ERO) to simulate wall erosion, material migration and deposition/mixing for devices with several different wall materials. Extension of computational area to wall (in collaboration with the ITM TF). Experimental benchmarking data from PISCES-B, possibly Pilot-PSI and other relevant devices, as well as JET Be/C migration experiments for comparison.

- Extension of kinetic MC simulation of material mixing to include effects of diffusion (elevated temperature, transients), chemical effects, surface topology (SDTRIM-SP 2D and 3D) and material structure (trapping sites).
- MD modelling of mixed layer erosion processes and D-retention properties.

7.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF FT	Post mortem analysis on composition, fuel retention and chemical characterisation of Be-C deposits (TF FT)

6.3.3 Resources

It is foreseen that this work requires an estimated manpower of **9 ppy** under baseline support, **2 ppy** under priority support, **30 kEuro** of hardware investment and **50 kEuro** under mobility.

Activities eligible for priority support

- Production of mixed material samples for both laboratory and fusion device PWI studies.
- Joint analysis of mixed material PWI properties particularly for samples exposed in fusion experiments, for comparison of laboratory and tokamak mixed deposits and to assess the influence of thermal excursions
- Development and benchmarking of integrated impurity edge transport - material surface modelling codes.

Part of international effort (bilateral collaboration with US (PISCES), ITPA Divertor and SOL) which could lead to missions under mobility.

6.4 Scientific and Technical Reports

6.4.1: Progress reports

At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

6.4.2: Report of achievements under Priority Support

In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

The EURATOM financial contribution will be made after approval of these reports by the EFDA Leader.

6.4.3 Milestones and Deliverables

Milestones:
Mid 2010
SEWG Meeting: Collection and discussion of results obtained from the evaluation of experiments in 2009 and early 2010

October 2010:
Annual meeting of the EU TF on PWI: coordinated presentation of the results from the experimental campaigns in 2010

December 2010: Final report sent to EFDA-CSU.

Deliverables:

a) One technical report per facility involved according to the objectives described above by October 2010.
b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.

7. SEWG Transient heat loads and mitigation

Task Agreement WP10-PWI-07: Mitigation of disruptions and investigation of ELM and inter-ELM heat loads

7.1 Introduction

Several methods are studied presently to mitigate transient loads during disruptions: massive gas injection, pellet injection, RMP (runaway suppression) and disruption avoidance by ECRH. Scaling to ITER requires, however, more insight into the relevant physics mechanisms. The main focus here should be on

- Temporal and spatial distribution of heat loads on the main chamber PFCs and in the divertor during mitigated disruptions in comparison to non-mitigated disruptions.
- Heat load by runaway electrons. A quantification of these loads is mandatory for further load estimates for ITER. This comprises the incident angle, runaway energy and affected area.
- Heat load by radiation. Radiation is very inhomogeneous during a disruption and can lead to strong local heating of PFCs. This is especially an issue for massive gas injection.

Presently, three methods are proposed to mitigate ELM loads in ITER: perturbation fields, pellet pace-making, radiative scenarios (type-III ELMs). Quantification of the heat loads in these scenarios has started, but the database is less advanced than the one for the reference type-I ELMy H-mode scenario. Moreover, the analysis of the heat load pattern can contribute to the understanding of the mitigation process by RMP (resonant magnetic perturbation). The ELM dynamics (filaments) determines the energy distribution on main chamber wall and divertor PFCs. Extrapolation to ITER would need a more quantitative analysis of this correlation.

In addition to transient pulses due to ELMs, steady heat loads will impinge on the main chamber wall surfaces as a consequence of far scrape-off layer (SOL) tails in density and temperature driven by turbulent convective transport. This has consequences for the design of the main chamber PFCs in ITER.

The ITER divertor must operate in a partially detached state in order to stay within the steady state power handling capability of the target plates. The possibility of transient reattachment presents a potentially extremely serious threat to target plate integrity.

7.2 Objectives

- Assessment of heat and particle fluxes during disruptions. Characterisation of heat load distribution for ITER relevant disruption types.
- Optimisation of disruption mitigation techniques
- Assessment of heat fluxes during ELMs
- Assessment of inter ELMs heat fluxes
- Investigations on transient reattachment.

The characterisation of disruptions and their mitigation should be performed in collaboration with TG MHD and TG Diagnostic.

7.3 Work Description and Breakdown

7.3.1 Work Breakdown

WP10-PWI-07-01

Assessment of heat and particle fluxes during disruptions

Measurements of power and particle fluxes on divertor, limiter and other main chamber PFCs (including runaway fluxes) for disruption types expected in ITER and for mitigated disruptions (AUG, TS, MAST, TCV, TEXTOR, FTU, ISTTOK and C-mod/DIII-D through suitable international collaborations, comparison to JET). Particularly, this should include data about heat flux asymmetries caused by convective flux and radiation, heat deposition by runaway electrons and heat loads in mitigated disruptions.

WP10-PWI-07-02

Optimisation of disruption mitigation techniques

Optimisation of massive gas injection (MGI) and other techniques for disruption mitigation and runaway suppression. For MGI, the main focus will be on gas injection rates, valve position and number of valves, and gas composition. Evaluation of size scaling and requirements for ITER

Development of the associated modelling (gas jet penetration, radiation etc …).

WP10-PWI-07-03

Assessment of heat fluxes during ELMs

Characterisation/quantification of plasma parameters and heat loads on divertor and main chamber PFCs in mitigated/suppressed ELM scenarios (RMP, radiative scenarios with type III ELMs, pellet pacemaking), including ELM dynamics in comparison to non-mitigated ELMs. (AUG, MAST, TCV, TEXTOR, and DIII-D through suitable international collaborations, comparison to JET).

WP10-PWI-07-04

Assessment of inter ELMs heat fluxes

Characterisation/quantification of plasma parameters and inter-ELM heat loads on PFCs, with emphasis on the main chamber wall, including state of the art knowledge on far-SOL transport to PFCs and fast particles impact.

Studies of heat loads on divertor and other PFCs during loss of detachment/re-attachment events

7.3.2 JET related activities

No JET related activities are meant to be implemented under this Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in this TA when they closely relate to the activity implemented under Art.5. JET data collected under the JET part of the EFDA WP can be brought together with other data under this TA when relevant for the progress of the work or used in multi-machine modelling activities under Art.5.

JET TF E and TF M	• Quantification of heat loads during mitigated and non-mitigated disruptions (including runaway loads) (TF E and TF M) • Optimisation of massive gas injection and other techniques for disruption mitigation • Characterisation of ELM loads using fast diagnostics, in particular for mitigated ELMs (TFE) • Characterisation/quantification of inter-ELM heat loads on main chamber wall and in the divertor, including detachment/re-attachment studies

7.3.4 Resources
It is foreseen that this work requires an estimated manpower of **14 ppy** under baseline support, **5.5 ppy** under priority support, **120 kEuro** of hardware investment and **50 kEuro** under mobility.

Activity eligible for priority support:
- Coordinated experiments on ELM and inter-ELM heat loads, including studies of the impact of the loss of divertor detachment.
- Coordinated experiments on disruption mitigation, in particular for the assessment of associated heat loads on PFCs, and joint modelling of massive gas injection.
- Support for transfer of disruption mitigation equipment or diagnostics for coordinated experiments.
- Support for diagnostic development for fast transients

Part of international effort (ITPA Divertor and SOL, bilateral collaboration with RF), which could lead to missions under mobility (DIII-D, Alcator C-mod …).

7.4 Scientific and Technical Reports

7.4.1: Progress reports
At the end of each calendar year, during the PWI TF annual meeting, the SEWG leader in charge of the task coordination shall present a report on all activities (under baseline and priority support) 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.

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7.4.2: Report of achievements under Priority Support
In addition, achievement of Priority Support deliverables will be reported separately to the EFDA Leader. A final report shall be prepared by the SEWG leader in charge of the task coordination 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 Tasks 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 associated milestones defined.

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Milestones:
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Deliverables:

a) One technical report per facility involved according to the objectives described above by October 2010.
b) Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER by end 2010.