EFDA WORKPROGRAMME 2008/2009

MHD Activities

Version 1.0

TASK AGREEMENTS

WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05

Between:

The EFDA Leader

and the following Associates

- CEA
- CRPP
- ENEA
- ENEA-CNR
- ENEA-RFX
- FOM
- FZJ
- HAS
- IPP
- IPP.CR
- IST
- MEdC
- ÖAW
- RISØ
- UKAEA
- ULB
- VR

Start date: ***25th Oct 2008***	*EFDA Responsible Officer:* ***Duarte Borba***	*Tel.* ***+49 89 3299-4210***	*E-mail:* ***duarte.borba@efda.org***
Association: *Signature:* *Date:*			

Summary of the association involvement for the WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05 Task Agreements

Association	Sum of Manpower Baseline Support (ppy)	Sum of Manpower Priority Support (ppy)	Sum of Hardware Priority Support (kEuros)	Sum of Consumable expenditure	Sum of Commission Contribution (kEuros)
CEA	6.65	2.00	0.00	0.00	47.20
CRPP	1.07	0.40	0.00	0.00	12.00
ENEA	0.6	1.20	0.00	10.00	29.85
ENEA-CNR	0.40	0.00	0.00	0.00	0.00
ENEA-RFX	2.17	1.55	0.00	0.00	23.10
FOM	3.57	0.20	0.00	0.00	5.88
FZJ	0.10	0.00	0.00	0.00	0.00
HAS	0.30	0.80	0.00	0.00	5.76
IPP	4.70	1.19	0.00	20.00	38.18
IPP.CR	0.60	0.00	0.00	0.00	0.00
IST	0.80	0.00	0.00	0.00	0.00
MEdC	1.40	0.00	0.00	0.00	0.00
ÖAW	0.50	0.36	0.00	0.00	12.24
RISØ	1.04	0.62	30.00	0.00	30.81
UKAEA	4.65	1.23	0.00	0.00	19.57
ULB	0.66	0.00	0.00	0.00	0.00
VR	1.06	0.55	0.00	0.00	17.60

EFDA WORKPROGRAMME 2008/2009

Fast Particles

Version 1.0

TASK AGREEMENT WP09-MHD-01

Index

1. Introduction

At its meeting in Barcelona on 7 May 2008, the EFDA Steering Committee approved elements of the EFDA 2008 Work Programme **(EFDA SC (08) 38/3.2)**, among which the Topical Groups (TGs) programme. At its meeting in Culham on 6 October 2008, the EFDA Steering Committee approved the revision of the elements of the EFDA 2008 Work Programme **(EFDA SC (08) 39/3.2)**. Revised resources required to fulfil the objectives of the Topical Group Work Programme including **56.7 ppy** of Manpower and **2020 kEuros** Hardware expenditure under Priority Support were approved, corresponding to EC funding of up to **2168.8 kEuros**, out of which **20.3 ppy** of Manpower and **570 kEuros** Hardware expenditure under Priority Support were approved for the implementation of the work under the second topical group call.

A second call for participation in the TGs programme under EFDA was launched on 17th of September 2008. **68** proposals under priority support, coming from **20** Associations, were received, covering **32** out of the **32** launched tasks.

This programme is implemented on the basis of the EFDA Art. 5 provisions. The implementation results from calls for proposals. The outcome of the calls is assessed by the EFDA-CSU and the Topical Group leadership and implemented under 13 Task Agreements: WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05, WP09-HCD-02, WP09-HCD-03, WP09-HCD-04, WP09-DIA-02, WP09-TGS-02a, WP09-TGS-02b, WP09-TGS-02c and WP09-DEM-01

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 24th March 2009 in Prague (EFDA (09) 40/4.1.2) and endorsed by the CCE-FU at its meeting of 31st March 2009 (EUR (09) CCE-FU 45/7.5).

2. Objectives

2.1 General background

Plasma stability represents a key area to address in the preparation for next step devices. Here a range of processes must be controlled if they are not to lead to serious performance limitations in ITER and DEMO. This must build on the promising improvements in understanding and control obtained so far, developing them in order to predict and design the control approaches required in future devices.
In this call, which represents the bulk of proposals from the newly formed plasma stability and control topical group, issues have been arranged under five task agreements, corresponding to the five fields of plasma stability being explored by the group. In each area the most important high priority projects, with major elements of priority support resources, have been identified as separate tasks.

The involvement of Associations in the following task belonging to this Task Agreement results from a Calls for Proposals launched on 17/9/2008.

- WP09-MHD-01-01 (WP III-1-a): Improve confidence in predictions of fast particle stability boundaries in ITER and model confined/escaping fast ions seen in present experiments.

2.2 Scientific rationale and main objectives of the task

The objectives of the Task Agreement are reported in the following.

WP09-MHD-01-01 (WP III-1-a): Improve confidence in predictions of fast particle stability boundaries in ITER and model confined/escaping fast ions seen in present experiments.

Fast particles interact with MHD waves for on one hand they may drive or stabilize MHD instabilities (destabilization of Toroidal Alfvén Eigenmodes or Energetic Particles Modes and stabilization of sawtooth are just two examples), and on the other hand MHD instabilities affect confinement of fast particles. In ITER, for instance, the alpha-particle partial pressure may be significant enough to induce collective instabilities leading to energy confinement degradation and first wall damage due high alpha particle fluxes. Therefore, understanding the physics of these fast particles (in particular in presence of a significant population of them) and in general of fast ions is one of the key issues for controlling burning plasmas.
On present-day machines there is an urgent need to understand the mechanisms of fast ion transport (this has clear consequences for example on NBI heating and current drive

efficiency) and the nonlinear behaviour of multiple Alfvén modes since they may be also destabilised in ITER.

Objectives
Improve confidence in predicting the fast particle stability boundaries in ITER (intermediate n).
Improve theoretical understanding and develop/extend nonlinear models for the evolution of multiple instabilities and related fast particle transport and losses. On this topic there is a natural link with ITM task force and the Transport Topical Group).

3. Work Description and Breakdown

3.1 Structure

The work in this Task Agreement involves experiments in dedicated facilities, laboratory tests and simulation or code improvements as well.
The activities, for those tasks implying more than one Association, are coordinated by one the Participating Association (Task Coordinator), as underlined in table 3.1, whose additional commitment is the organization of the work, planning of the experiments, its realisation and the writing of a final report.

The Responsible for the whole Task Agreement is indicated in the first row of the table 3.1 with the identification label WP09-MHD-01/01 (Task Agreement Coordinator). The Task Coordinator is kept updated of the progress of all the tasks and interacts with the EFDA-CSU Responsible Officer.

Part of the work performed for the above Task Agreement is be funded through priority support

3.2 Work Breakdown and involvement of Associations

The work breakdown of the task by Association is as follows:

WP09-MHD-01-01 Improve confidence in predictions of fast particle stability boundaries in ITER and model confined/escaping fast ions seen in present experiments

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-01/01 / IPP	IPP	Task agreement coordination. Data analysis of fast particles and escaping fast ions, comparisons with modelling in collaboration with TEKES.
WP09-MHD-01/01 / ENEA	ENEA	Simulation with MonteCarlo techniques (ORBIT code) of Fast Ion Losses measured by the Fast Ions Loss Detector in ASDEX-Upgrade
WP09-MHD-01/01 / CRPP	CRPP	Collaborative EU efforts on investigation of Alfven eigenmodes stability and effects on fast ions
WP09-MHD-01/01 / RISØ	RISØ	Analyze the confinement of fast ions using CTS during Alfvenic activities.
WP09-MHD-01/01 / UKAEA	UKAEA	Provision of well diagnosed cases for modelling fast particle instabilities

The work breakdown and involvement per work programme of the Associates which results from the call for participation and the assessment conducted by the EFDA-CSU and the MHD TG is given in the Table 3.1 here below

Table 3.1 Work Breakdown 2009

Year	Tasks	Associates	Manpower Baseline Support (ppy)	Manpower Priority Support (ppy)	Hardware Priority Support kEuros	Consumable expenditure
2009	**WP09-MHD-01/00** Task Agreement Coordinator	**IPP**	**0.25**			
	WP09-MHD-01-01 /ENEA	**ENEA**	**0.17**	**0**	**0**	**0**
	WP09-MHD-01-01 /CRPP	**CRPP**	**0.1**	**0**	**0**	**0**
	WP09-MHD-01-01 /RISØ	**RISØ**	**0.21**	**0.2**	**0**	**0**
	WP09-MHD-01-01 /IPP	**IPP**	**0**	**0.2**	**0**	**0**
	WP09-MHD-01-01 /UKAEA	**UKAEA**	**2.45**	**0.2**	**0**	**0**
		Total	**3.18**	**0.6**		

3.3 JET related activities

No JET related activities are meant to be implemented under the present Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in the present 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.

4. Scientific and Technical Reports

4.1: Progress reports

At the end of each calendar year, during MHD annual Topical Group 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.

4.2: 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 in Table 4.2 of their Task have been achieved, and shall include a breakdown of expenditure, under the headings of Annex 1. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones described in Section 4.3. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Table 4.2: Deliverables under Priority Support

Activity 2009	Priority Support Deliverables	Due Date
WP09-MHD-01/01 / RISØ / PS	Analyze the confinement of fast ions using CTS during Alfvénic activities measuring changes in the fast ion distribution function before and after Alfven events in ASDEX-Upgrade , in collaboration with IPP.	March 2010
WP09-MHD-01/01 / IPP / PS	Coordination of experiments at AUG related to fast particles / fast escaping ions and data analysis of fast particles and escaping fast ions, comparisons with modelling in collaboration with TEKES.	March 2010
WP09-MHD-01/01 / UKAEA / PS	Co-ordination of modelling activities in the area of Fast Particle physics. Provision of well diagnosed cases for modelling fast particle instabilities.	March 2010

4.3: Milestones.

March 2010
Final report for the activities of 2008 and 2009

5. Priority Support Expenditure Forecast

The forecast of the total expenditures eligible for priority support in this Task Agreement is **77.31 kEuro**. A full breakdown of forecast of expenditures is given respectively in Annex 1, Table A1. The Community financial contribution will be up to a maximum of **15.46 kEuro** under Art. 8.2a and 8.2b of the Contract of Association[1].

For exchange of scientists between the involved Associations details of the forecast of expenditure under the Mobility Agreement is shown in Annex 2. This data shall be included in the annual Mobility Plan of the Associations.

6. Intellectual Property

The Associates shall identify, in the task agreement reports, all information relevant from the Intellectual Property Rights point of view. Guidelines regarding the content of this IPR

[1] Art 8.2a and 8.2b of the Contract of Association -"a) an additional rate supplementing baseline support and not exceeding a final rate of 40% for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4. b) a rate not exceeding 40 %, for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4."

chapter are given in the EFDA Explanatory Note to the Associates of 28 November 2007 (IPR report (art.5) final).

7. Quality Assurance

EFDA QA rules applicable where appropriate (EFDA-Annex QA- EFDA QA requirements for Suppliers (EFDA_D_2AN6G6).

8. Background Documentation

- EFDA 2008 – 2009 Work Programme

Summary financial table for Priority Support for Task Agreement WP09-MHD-01 (total expenditure)

Year	Association	Activity	Manpower Priority support Expenditure		Hardware expenditure	Consumables expenditure	Total	Comments
			ppy	k€	k€	k€	k€	
2009	RISØ	MHD-01-01	0.2	34.75	0	0	34.75	Analyze the confinement of fast ions using CTS during Alfvenic activities in ASDEX Upgrade, in collaboration with IPP.
2009	IPP	MHD-01-01	0.2	20.56	0	0	20.56	Co-ordination of data analysis of fast particles and escaping fast ions, comparisons with modelling in collaboration with TEKES.
2009	UKAEA	MHD-01-01	0.2	22	0	0	22	Co-ordination of modeling activities in the area of Fast Particle physics. Provision of well diagnosed cases for modelling fast particle instabilities in collaborative experiments.
		Total	0.6	77.31	0	0	77.31	

Annex 2: Indicative mobility support[1]

Year	Association	Estimated number of trips	Estimated number of staff involved	Estimated total cost (k€)	Comments.
	CRPP	**2**	**2**	**2.4**	**For the TPG annual meeting and one subgroup meeting**
	RISØ	**6**	**3**	**5.0**	**Experiments to be performed at ASDEX Upgrade**
	Total	**8**	**5**	**7.4**	

[1] To be included in the Associations' annual mobility plan.

EFDA WORKPROGRAMME 2008/2009

Disruptions

Version 1.0

TASK AGREEMENT WP09-MHD-02

Index

1. Introduction

At its meeting in Barcelona on 7 May 2008, the EFDA Steering Committee approved elements of the EFDA 2008 Work Programme **(EFDA SC (08) 38/3.2)**, among which the Topical Groups (TGs) programme. At its meeting in Culham on 6 October 2008, the EFDA Steering Committee approved the revision of the elements of the EFDA 2008 Work Programme **(EFDA SC (08) 39/3.2)**. Revised resources required to fulfil the objectives of the Topical Group Work Programme including **56.7 ppy** of Manpower and **2020 kEuros** Hardware expenditure under Priority Support were approved, corresponding to EC funding of up to **2168.8 kEuros**, out of which **20.3 ppy** of Manpower and **570 kEuros** Hardware expenditure under Priority Support were approved for the implementation of the work under the second topical group call.

A second call for participation in the TGs programme under EFDA was launched on 17th of September 2008. **68** proposals under priority support, coming from **20** Associations, were received, covering **32** out of the **32** launched tasks.

This programme is implemented on the basis of the EFDA Art. 5 provisions. The implementation results from calls for proposals. The outcome of the calls is assessed by the EFDA-CSU and the Topical Group leadership and implemented under 13 Task Agreements: WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05, WP09-HCD-02, WP09-HCD-03, WP09-HCD-04, WP09-DIA-02, WP09-TGS-02a, WP09-TGS-02b, WP09-TGS-02c and WP09-DEM-01

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 24th March 2009 in Prague (EFDA (09) 40/4.1.2) and endorsed by the CCE-FU at its meeting of 31st March 2009 (EUR (09) CCE-FU 45/7.5).

2. Objectives

2.1 General background

Plasma stability represents a key area to address in the preparation for next step devices. Here a range of processes must be controlled if they are not to lead to serious performance limitations in ITER and DEMO. This must build on the promising improvements in understanding and control obtained so far, developing them in order to predict and design the control approaches required in future devices.
In this call, which represents the bulk of proposals from the newly formed plasma stability and control topical group, issues have been arranged under five task agreements, corresponding to the five fields of plasma stability being explored by the group. In each area the most important high priority projects, with major elements of priority support resources, have been identified as separate tasks.

The involvement of Associations in the following task belonging to this Task Agreement results from a Calls for Proposals launched on 17/9/2008.

- WP09-MHD-02-01 (WP III-2-a): Prediction of disruptions based on a physical model and development of diagnostics for disruption studies.

- WP09-MHD-02-02 (WP III-2-a) Phase I: Fast measurements of impurity radiation during disruptions - Includes a Call for Interest.

- WP09-MHD-02-03 (WP III-2-a-2): Simulation of VDEs using DINA to validate the halo current models.

2.2 Scientific rationale and main objectives of the task

The objectives of the Task Agreement are reported in the following.

Unmitigated disruptions represent an intolerable risk for ITER and should be avoided by a reliable control of the plasma discharge. However the understanding of how to predict and avoid such events is at a rudimentary level since extensive development of avoidance and control techniques has not been envisaged on existing devices. In addition, an extrapolation of the effects of a disruption from existing devices to ITER is affected by uncertainties which must be reduced to guarantee the integrity of the machine. The joint exercise carried out by JET and AUG for developing a technique capable of predicting each other disruptions was encouraging but not accurate enough to be promising for ITER despite the fact that their present disruption recognition system, based on a locked mode detector which does not need any training, is rather reliable.

<u>WP09-MHD-02-01 (WP III-2-a): Prediction of disruptions based on a physical model and development of diagnostics for disruption studies</u>

Develop a disruption prediction model based on simple and robust real-time measurements of physical quantities and on recognition algorithms related to physics laws and to well-

established empirical behaviour. Compare the effectiveness of the model with the neutral network approach.

WP09-MHD-02-02 (WP III-2-a) Phase I: Fast measurements of impurity radiation during disruptions - Includes a Call for Interest.

Develop diagnostics techniques aiming at quantifying the influx of impurities from the plasma facing components during the disruption and understand the penetration of injected impurities in mitigated events.

WP09-MHD-02-03 (WP III-2-a-2): Simulation of VDEs using DINA to validate the halo current models.

Validate the halo current models using simulations of VDEs with the DINA code.
Benchmark the DINA code using data from an ITER relevant device.
Validate or refute the assumptions presently made when DINA is applied to ITER by means of the widest possible use of DINA on existing devices, where experimental measurements are available.

3. Work Description and Breakdown

3.1 Structure

The work in this Task Agreement involves experiments in dedicated facilities, laboratory tests and simulation or code improvements as well.
The activities, for those tasks implying more than one Association, are coordinated by one the Participating Association (Task Coordinator), as underlined in table 3.1, whose additional commitment is the organization of the work, planning of the experiments, its realisation and the writing of a final report.

The Responsible for the whole Task Agreement is indicated in the first row of the table 3.1 with the identification label WP09-MHD-02/00 (Task Agreement Coordinator). The Task Coordinator is kept updated of the progress of all the tasks and interacts with the EFDA-CSU Responsible Officer.

Part of the work performed for the above Task Agreement is be funded through priority support

3.2 Work Breakdown and involvement of Associations

The work breakdown of the task by Association is as follows:

WP09-MHD-02/00
Task Agreement Coordinator

Tasks	Associates	Activities
WP09-MHD-02/00 / IPP	IPP	**Task coordinator** follow-up the progress of all the tasks, organise reporting and interact with the EFDA-CSU Responsible Officer (reporting; remedy to short-comings etc.)

WP09-MHD-02-01 (WP III-2-a): Prediction of disruptions based on a physical model and development of diagnostics for disruption studies

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-02/01 / IPP	IPP	Prediction of disruptions based on a physical model and development of diagnostics for disruption studies.
WP09-MHD-02/01 / UKAEA	UKAEA	Analysis of disruption precursors, in collaboration with the JET Work Programme.

WP09-MHD-02-02 (WP III-2-a) Phase I: Fast measurements of impurity radiation during disruptions - Includes a Call for Interest.

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-02/02 / CRPP	CRPP	Use installed DMV fast valve to stimulate disruptions. Fast X-ray and bolometric tomography and spectroscopic measurements. Fast visible camera and multi-filtered digital video cameras to follow disruption events
WP09-MHD-02/02 / FZJ	FZJ	Measurements of different spectral lines of He, C, Ne, Ar, Kr, Xe during MGI disruptions and density limit disruptions in TEXTOR using a fast visible camera (frame rate 500 kHz).
WP09-MHD-02/02 / UKAEA	UKAEA	Collaborative data analysis of impurity dynamics in MAST disruptions.

WP09-MHD-02-03 (WP III-2-a-2): Simulation of VDEs using DINA to validate the halo current models.

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-02/03 / IPP	IPP	Simulation of vertical displacement events (VDEs) using DINA to validate the halo current models in collaboration with Kurchatov Institute (Victor Lukash).
WP09-MHD-02/03 / UKAEA	UKAEA	UKAEA will make available data from the MAST halo diagnostic arrays to EU collaborative colleagues for analysis and modelling.

The work breakdown and involvement per work programme of the Associates which results from the call for participation and the assessment conducted by the EFDA-CSU and the MHD TG is given in the Table 3.1 here below

Table 3.1 Work Breakdown 2009

Year	Tasks	Associates	Manpower Baseline Support (ppy)	Manpower Priority Support (ppy)	Hardware Priority Support kEuros	Consumable expenditure
2009	**WP09-MHD-02/00** Task Agreement Coordinator	**IPP**	**0.25**			
	WP09-MHD-02-01/IPP	**IPP**	**0.2**	**0.25**	**0**	**0**
	WP09-MHD-02-02/CRPP	**CRPP**	**0.2**	**0**	**0**	**0**
	WP09-MHD-02-02/FZJ	**FZJ**	**0.1**	**0**	**0**	**0**
	WP09-MHD-02-02/UKAEA	**UKAEA**	**0.05**	**0**	**0**	**0**
	WP09-MHD-02-03/IPP	**IPP**	**0**	**0.45**	**0**	**20**
	WP09-MHD-02-03/UKAEA	**UKAEA**	**0.05**	**0**	**0**	**0**
		Total	**0.85**	**0.7**	**0**	**20**

3.3 JET related activities

No JET related activities are meant to be implemented under the present Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in the present 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 modeling activities under Art.5.

4. Scientific and Technical Reports

4.1: Progress reports

At the end of each calendar year, during MHD 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.

4.2: 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 in Table 4.2 of their Task have been achieved, and shall include a breakdown of expenditure, under the headings of Annex 1. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones described in Section 4.3. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Table 4.2: Deliverables under Priority Support

Activity 2009	Priority Support Deliverables	Due Date
WP09-MHD-02/01 / IPP / PS	Prediction of disruptions based on a physical model and development of diagnostics for disruption studies.	March 2010
WP09-MHD-02/03 / IPP / PS	Simulation of vertical displacement events (VDEs) using the DINA code to validate the halo current models in collaboration with Kurchatov Institute (Victor Lukash).	March 2010

4.3: Milestones.

March 2010
Final report for the activities of 2008 and 2009

5. Priority Support Expenditure Forecast

The forecast of the total expenditures eligible for priority support in this Task Agreement is **115.35 kEuro**. A full breakdown of forecast of expenditures is given respectively in Annex 1, Table A1. The Community financial contribution will be up to a maximum of **27.07 kEuro** under Art. 8.2a and 8.2b of the Contract of Association[3].

For exchange of scientists between the involved Associations details of the forecast of expenditure under the Mobility Agreement is shown in Annex 2. This data shall be included in the annual Mobility Plan of the Associations.

6. Intellectual Property

The Associates shall identify, in the task agreement reports, all information relevant from the Intellectual Property Rights point of view. Guidelines regarding the content of this IPR chapter are given in the EFDA Explanatory Note to the Associates of 28 November 2007 (IPR report (art.5) final).

[3] Art 8.2a and 8.2b of the Contract of Association -"a) an additional rate supplementing baseline support and not exceeding a final rate of 40% for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4. b) a rate not exceeding 40 %, for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4."

7. Quality Assurance

EFDA QA rules applicable where appropriate (EFDA-Annex QA- EFDA QA requirements for Suppliers (EFDA_D_2AN6G6).

8. Background Documentation

- EFDA 2008 – 2009 Work Programme

Summary financial table for Priority Support for Task Agreement WP09-MHD-02 (total expenditure)

Year	Association	Activity	Manpower Priority support Expenditure		Hardware expenditure	Consumables expenditure	Total	Comments
			ppy	k€	k€	k€	k€	
2009	IPP	MHD-02-01	0.25	34.05	0	0	34.05	Prediction of disruptions based on a physical model and development of diagnostics for disruption studies.
2009	IPP	MHD-02-03	0.45	61.3	0	20	81.3	Simulation of vertical displacement events (VDEs) using DINA to validate the halo current models. Expenditures related to the Software License of the DINA code.
		Total	0.7	95.35	0	20	115.35	

Annex 2: Indicative mobility support[1]

Year	Association	Estimated number of trips	Estimated number of staff involved	Estimated total cost (k€)	Comments.
2009	**CRPP**	**2**	**2**	**2.4**	**For the TPG annual meeting and one subgroup meeting.**
	FZJ	**1**	**1**	**1.0**	**For the TPG annual meeting.**
	Total	**3**	**3**	**3.4**	

[1] To be included in the Associations' annual mobility plan.

EFDA WORKPROGRAMME 2008/2009

Sawtooth and Neo-Classical Tearing Modes (NTMs) Physics and Control

Version 1.0

TASK AGREEMENT WP09-MHD-03

Index

1. Introduction

At its meeting in Barcelona on 7 May 2008, the EFDA Steering Committee approved elements of the EFDA 2008 Work Programme **(EFDA SC (08) 38/3.2)**, among which the Topical Groups (TGs) programme. At its meeting in Culham on 6 October 2008, the EFDA Steering Committee approved the revision of the elements of the EFDA 2008 Work Programme **(EFDA SC (08) 39/3.2)**. Revised resources required to fulfil the objectives of the Topical Group Work Programme including **56.7 ppy** of Manpower and **2020 kEuros** Hardware expenditure under Priority Support were approved, corresponding to EC funding of up to **2168.8 kEuros**, out of which **20.3 ppy** of Manpower and **570 kEuros** Hardware expenditure under Priority Support were approved for the implementation of the work under the second topical group call.

A second call for participation in the TGs programme under EFDA was launched on 17th of September 2008. **68** proposals under priority support, coming from **20** Associations, were received, covering **32** out of the **32** launched tasks.

This programme is implemented on the basis of the EFDA Art. 5 provisions. The implementation results from calls for proposals. The outcome of the calls is assessed by the EFDA-CSU and the Topical Group leadership and implemented under 13 Task Agreements: WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05, WP09-HCD-02, WP09-HCD-03, WP09-HCD-04, WP09-DIA-02, WP09-TGS-02a, WP09-TGS-02b, WP09-TGS-02c and WP09-DEM-01

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 24th March 2009 in Prague (EFDA (09) 40/4.1.2) and endorsed by the CCE-FU at its meeting of 31st March 2009 (EUR (09) CCE-FU 45/7.5).

2. Objectives

2.1 General background

Plasma stability represents a key area to address in the preparation for next step devices. Here a range of processes must be controlled if they are not to lead to serious performance limitations in ITER and DEMO. This must build on the promising improvements in understanding and control obtained so far, developing them in order to predict and design the control approaches required in future devices.
In this call, which represents the bulk of proposals from the newly formed plasma stability and control topical group, issues have been arranged under five task agreements, corresponding to the five fields of plasma stability being explored by the group. In each area the most important high priority projects, with major elements of priority support resources, have been identified as separate tasks.

The involvement of Associations in the following task belonging to this Task Agreement results from a Calls for Proposals launched on 17/9/2008.

- WP09-MHD-03-01 (WP III-2-b): Sawtooth and NTM Physics and Control

2.2 Scientific rationale and main objectives of the task

The objectives of the Task Agreement are reported in the following.

WP09-MHD-03-01 (WP III-2-b): Sawtooth and NTM Physics and Control

The emphasis of the sawtooth physics studies is on diagnosis and interpretation of the sawtooth crash, its consequent impact on plasma profiles, fast particles, the overall cycle; and understanding inter-relation with other events such as NTMs and ELMs. Recent studies using existing diagnostics include the use of 2D Electron Cyclotron Emission imaging, Soft and Hard X-ray tomography, and Collective Thompson Scattering. 2D ECE imaging is implemented on TEXTOR and planned for AUG.
Control in ITER will be required to avoid long sawtooth periods in the standard ELMy H-mode scenario caused by the strong stabilisation effect of alpha particles and fast ions generated by the auxiliary heating systems. Sawtooth control has been demonstrated in several devices using a range of techniques (ECCD, ICCD, off axis NBI, profile modification, etc).
Extrapolation of the NTM island seeding mechanism and evolution to ITER is required in order to optimise control strategies. At present, the ITER scaling foresees the destabilisation of NTMs at modest values of beta normalised, but uncertainties exist regarding the role of rotation, of ion polarization current and other small island physics effects.
ECCD control is a key priority for ITER, particularly for the 2/1 NTM. Although the physics of the NTM control seems to be well covered by existing programmes, increased emphasis needs to be placed on the real time location and targeting aspects.

Objectives

Perform similarity experiments to understand the underlying sawtooth physics mechanisms.
Perform comparison of NTM behaviour with non-linear MHD modelling, in particularly, at critical and saturated island sizes.
Develop real time sawteeth control capability with tracking of the q=1 surface, including the development of techniques to locate and deliver the heating and current drive at the optimal location. Extend the control techniques to the right regimes with actuators applicable in ITER (ECCD and/or off axis NBI).
Develop real time control capability for the NTM, including tracking technology to locate and target the mode; and extend these techniques to the right regimes with actuators applicable on ITER (ECCD and/or off axis NBI). This might lead to identifying needs and developing proposals for new diagnostics with improved tracking capability.
Perform modelling of the sensors and actuators for a more physics based and better extrapolation of action and requirement for control in ITER, testing against present devices.

3. Work Description and Breakdown

3.1 Structure

The work in this Task Agreement involves experiments in dedicated facilities, laboratory tests and simulation or code improvements as well.
The activities, for those tasks implying more than one Association, are coordinated by one the Participating Association (Task Coordinator), as underlined in table 3.1, whose additional commitment is the organization of the work, planning of the experiments, its realisation and the writing of a final report.

The Responsible for the whole Task Agreement is indicated in the first row of the table 3.1 with the identification label WP09-MHD-03/00 (Task Agreement Coordinator). The Task Coordinator is kept updated of the progress of all the tasks and interacts with the EFDA-CSU Responsible Officer.

Part of the work performed for the above Task Agreement is be funded through priority support

3.2 Work Breakdown and involvement of Associations

The work breakdown of the task by Association is as follows:

WP09-MHD-03/00
Task Agreement Coordinator

Tasks	Associates	Activities
WP09-MHD-03/00 /???	CEA/IPP (tbd)	**Task coordinator** follow-up the progress of all the tasks, organise reporting and interact with the EFDA-CSU Responsible Officer (reporting; remedy to short-comings etc.)

WP09-MHD-03-01 (WP III-2-b): Sawtooth and NTM Physics and Control

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-03/01 / ENEA-CNR	ENEA-CNR	Focus on ion polarization current to explore NTM intrinsic mechanism trigger varying the difference between mode rotation frequency and the toroidal plasma rotation.
WP09-MHD-03/01 / CRPP	CRPP	Real-time control of Sawteeth, NTMs, Studies of NTM stability depending on localized ECCD effects in TCV. MHD control and link to ITBs
WP09-MHD-03/01 / FOM	FOM	Operate and analyse the data of NTM experiments and sawtooth studies using an in-transmission-line ECE diagnostic for tearing mode and sawtooth detection and localization on TEXTOR. Installation and operation of the 2D-ECE imaging system on AUG in collaboration with IPP.
WP09-MHD-03/01 / IPP	IPP	Installation of 2D ECE imaging diagnostic in ASDEX Upgrade in collaboration with FOM. Development of online control mechanisms for NTM feed-back stabilisation. Integration in AUG CODAC system, incl. real-time equilibria and ECRH deposition calculations (TORBEAM).

WP09-MHD-03/01 / IST	IST	Critical island width determination with XTOR code and real-time mode identification algorithm testing.
WP09-MHD-03/01 / MedC	MedC	Modelling of the sawtooth oscillations observed in experiments such as in AUG in a model based on the hysteresis mechanism.
WP09-MHD-03/01 / RISØ	RISØ	Tracking NTM's with a new front end CTS receiver at ASDEX-Upgrade. Analysis of sawtooth will be also performed.
WP09-MHD-03/01 / UKAEA	UKAEA	Linear stability analysis of Sawteeth in joint experiments on AUG and MAST and comparison of the results with theory. Draw out implications for control in larger devices.
WP09-MHD-03/01 / ULB	ULB	Adapt SFELES code (a robust code that solves classical fluid type equations for a geometry with at least one direction of periodicity) to MHD problems in Tokamak plasmas.
WP09-MHD-03/01 / CEA	CEA	Modelling and Simulation of the Nonlinear Dynamics of NTMs.

The work breakdown and involvement per work programme of the Associates which results from the call for participation and the assessment conducted by the EFDA-CSU and the MHD TG is given in the Table 3.1 here below

Table 3.1 Work Breakdown 2009

Year	**Tasks**	**Associates**	**Manpower Baseline Support (ppy)**	**Manpower Priority Support (ppy)**	**Hardware Priority Support kEuros**	**Consumable expenditure**
2009	**WP09-MHD-03/00** Task Agreement Coordinator	**???**	**0.25**			
	WP09-MHD-03-01/ENEA-CNR	**ENEA-CNR**	**0.4**	**0**	**0**	**0**
	WP09-MHD-03-01/CRPP	**CRPP**	**0.483**	**0.2**	**0**	**0**
	WP09-MHD-03-	**FOM**	**0.5**	**0**	**0**	**0**

	01/FOM					
	WP09-MHD-03-01/FOM	**FOM**	**3.07**	**0.2**	**0**	**0**
	WP09-MHD-03-01/IPP	**IPP**	**4**	**0.29**	**0**	**0**
	WP09-MHD-03-01/IST	**IST**	**0.8**	**0**	**0**	**0**
	WP09-MHD-03-01/MEdC	**MEdC**	**0.5**	**0**	**0**	**0**
	WP09-MHD-03-01/RISØ	**RISØ**	**0.5**	**0.17**	**30**	**0**
	WP09-MHD-03-01/UKAEA	**UKAEA**	**0.6**	**0**	**0**	**0**
	WP09-MHD-03-01/ULB	**ULB**	**0.66**	**0**	**0**	**0**
	WP09-MHD-03-01/CEA	**CEA**	**1**	**0**	**0**	**0**
		Total	**12.763**	**0.86**	**30**	**0**

3.3 JET related activities

No JET related activities are meant to be implemented under the present Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in the present 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 modeling activities under Art.5.

4. Scientific and Technical Reports

4.1: Progress reports

At the end of each calendar year, during MHD 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.

4.2: 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 in Table 4.2 of their Task have been achieved, and shall include a breakdown of expenditure, under the headings of Annex 1. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones described in Section 4.3. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Table 4.2: Deliverables under Priority Support

Activity 2009	Priority Support Deliverables	Due Date
WP09-MHD-03/01 / CRPP / PS	Co-ordinated experiments on real-time control of Sawteeth and NTMs. Real-time control of Sawteeth and NTMs. Studies of NTM stability depending on localized ECCD effects in TCV. MHD control and link to ITBs.	March 2010
WP09-MHD-03/01 / FOM / PS	Installation and operation of a 2D ECE-Imaging system on AUG, for NTM studies such as the determination of the (minimal seed) island size of NTM.	March 2010
WP09-MHD-03/01 / IPP / PS	Coordination of experiments for NTM physics and control in collaboration with UKAEA and FZJ. Installation and operation of a 2D ECE-Imaging system on AUG in collaboration with FOM	March 2010
WP09-MHD-03/01 / RISØ / PS	Installation of a new front end to the present CTS receiver at ASDEX-Upgrade for tracking NTM's. Build and test a new NTM control system. Using CTS on TEXTOR detailed measurements of Sawtooth behaviour.	March 2010

4.3: Milestones.

March 2010
Final report for the activities of 2008 and 2009

5. Priority Support Expenditure Forecast

The forecast of the total expenditures eligible for priority support in this Task Agreement is **140.23 kEuro**. A full breakdown of forecast of expenditures is given respectively in Annex 1, Table A1. The Community financial contribution will be up to a maximum of **34.05 kEuro** under Art. 8.2a and 8.2b of the Contract of Association[5].

For exchange of scientists between the involved Associations details of the forecast of expenditure under the Mobility Agreement is shown in Annex 2. This data shall be included in the annual Mobility Plan of the Associations.

[5] Art 8.2a and 8.2b of the Contract of Association -"a) an additional rate supplementing baseline support and not exceeding a final rate of 40% for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4. b) a rate not exceeding 40 %, for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4."

6. Intellectual Property

The Associates shall identify, in the task agreement reports, all information relevant from the Intellectual Property Rights point of view. Guidelines regarding the content of this IPR chapter are given in the EFDA Explanatory Note to the Associates of 28 November 2007 (IPR report (art.5) final).

7. Quality Assurance

EFDA QA rules applicable where appropriate (EFDA-Annex QA- EFDA QA requirements for Suppliers (EFDA_D_2AN6G6).

8. Background Documentation

- EFDA 2008 – 2009 Work Programme

Summary financial table for Priority Support for Task Agreement WP09-MHD-03 (total expenditure)

Year	Association	Activity	Manpower Priority support Expenditure		Hardware expenditure	Consumables expenditure	Total	Comments
			ppy	k€	k€	k€	k€	
2009	CRPP	MHD-03-01	0.2	30	0	0	30	Co-ordinated experiments on real-time control of Sawteeth and NTMs. Studies of NTM stability depending on localized ECCD effects in TCV. MHD control and link to ITBs.
2009	FOM	MHD-03-01	0.2	29.41	0	0	29.41	Installation and operation of a 2D-ECE imaging system on ASDEX-Upgrade in collaboration with IPP.
2009	IPP	MHD-03-01	0.29	34.98	0	0	34.98	Installation of 2D ECE imaging diagnostic in ASDEX Upgrade in collaboration with FOM. Development of online control mechanisms for NTM feed-back stabilisation. Integration in AUG CODAC system, incl. real-time equilibria and ECRH deposition calculatio (…)
2009	RISØ	MHD-03-01	0.17	15.84	30	0	45.84	Installation of a new front end to the present CTS receiver (~30kEuro) at ASDEX-Upgrade for tracking NTM's in collaboration with IPP. Build and test a new NTM control system.
		Total	0.86	110.23	30	0	140.23	

Annex 2: Indicative mobility support[1]

Year	Association	Estimated number of trips	Estimated number of staff involved	Estimated total cost (k€)	Comments.
2009	**CRPP**	**4**	**2**	**7.6**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	FOM	**14**	**5**	**14.0**	**Joint the sawtooth and NTM experiments on AUG in which 2D-ECEI. Joint TEXTOR and AUG experiments on closed-loop control of tearing modes and sawteeth and NTM and sawtooth inversion radius tracking.**
	IST	**2**	**1**	**4.0**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	RISØ	**8**	**4**	**8.0**	**Joint experiments to be performed at ASDEX Upgrade and at TEXTOR.**
	ULB	**2**	**2**	**1.8**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	CEA	**2**	**2**	**2.0**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	UKAEA	**7**	**3**	**5.3**	**Joint experiments on AUG, D-IIID and NSTX to explore sawtooth stability and implement modelling, and lead NTM beta limits studies.**
	ENEA-CNR	**2**	**2**	**3.0**	**For the TPG annual meeting and one subgroup meeting.**
	Total	**41**	**21**	**45.7**	

[1] To be included in the Associations' annual mobility plan.

EFDA WORKPROGRAMME 2008/2009

Edge Localised Modes (ELMs)

Version 1.0

TASK AGREEMENT WP09-MHD-04

Index

1. Introduction

At its meeting in Barcelona on 7 May 2008, the EFDA Steering Committee approved elements of the EFDA 2008 Work Programme **(EFDA SC (08) 38/3.2)**, among which the Topical Groups (TGs) programme. At its meeting in Culham on 6 October 2008, the EFDA Steering Committee approved the revision of the elements of the EFDA 2008 Work Programme **(EFDA SC (08) 39/3.2)**. Revised resources required to fulfil the objectives of the Topical Group Work Programme including **56.7 ppy** of Manpower and **2020 kEuros** Hardware expenditure under Priority Support were approved, corresponding to EC funding of up to **2168.8 kEuros**, out of which **20.3 ppy** of Manpower and **570 kEuros** Hardware expenditure under Priority Support were approved for the implementation of the work under the second topical group call.

A second call for participation in the TGs programme under EFDA was launched on 17th of September 2008. **68** proposals under priority support, coming from **20** Associations, were received, covering **32** out of the **32** launched tasks.

This programme is implemented on the basis of the EFDA Art. 5 provisions. The implementation results from calls for proposals. The outcome of the calls is assessed by the EFDA-CSU and the Topical Group leadership and implemented under 13 Task Agreements: WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05, WP09-HCD-02, WP09-HCD-03, WP09-HCD-04, WP09-DIA-02, WP09-TGS-02a, WP09-TGS-02b, WP09-TGS-02c and WP09-DEM-01

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 24th March 2009 in Prague (EFDA (09) 40/4.1.2) and endorsed by the CCE-FU at its meeting of 31st March 2009 (EUR (09) CCE-FU 45/7.5).

2. Objectives

2.1 General background

Plasma stability represents a key area to address in the preparation for next step devices. Here a range of processes must be controlled if they are not to lead to serious performance limitations in ITER and DEMO. This must build on the promising improvements in understanding and control obtained so far, developing them in order to predict and design the control approaches required in future devices.
In this call, which represents the bulk of proposals from the newly formed plasma stability and control topical group, issues have been arranged under five task agreements, corresponding to the five fields of plasma stability being explored by the group. In each area the most important high priority projects, with major elements of priority support resources, have been identified as separate tasks.

The involvement of Associations in the following task belonging to this Task Agreement results from a Calls for Proposals launched on 17/9/2008.

- WP09-MHD-04-01 (WP III-3-a-1, a-5, a-4, a-3): ELMs: Physics Understanding, Non_linear MHD and Pellet induced ELMs, Resonant magnetic field perturbation (RMP) stabilisation of ELMs.

2.2 Scientific rationale and main objectives of the task

The objectives of the Task Agreement are reported in the following.

WP09-MHD-04-01 (WP III-3-a-1, a-5, a-4, a-3): ELMs: Physics Understanding, Non_linear MHD and Pellet induced ELMs, Resonant magnetic field perturbation (RMP) stabilisation of ELMs.

The onset of large ELMs is broadly accepted to be usually associated with the triggering of peeling-ballooning modes, and codes can predict the threshold and the structure of these instabilities, including many of the key parameter dependencies, with considerable precision. However, there are important physics aspects that need further investigation, including the effect of toroidal rotation and details physics of ELMs in the different regimes.
Crucial questions surrounding ELM mitigation using the pellet technique is the ability to achieve the ELM frequency increase required on ITER: of the order of 10 times when compared to unmitigated ELM frequencies
Remaining key questions to be addressed include the understanding of the action of edge resonant magnetic field perturbation on ELMs, as a function of general parameter variations such as plasma shape and density. These studies could require some further code developments, and improved measurements such as edge currents and plasma rotation. This task would benefit from co-ordination of joint projects to make the comparisons between model and experiments.

Objectives

Compare the non-linear phase of ELMs with MHD models. Utilise and possible further develop new codes to compare phenomenology and parameter dependence.
Study toroidal rotation issues on ELM frequency and size.
Study the action of edge resonant magnetic field perturbations on the stability of the ELM in rotating plasmas, with the possible extension of non-linear MHD analysis.
Identify stabilisation criteria for ELMs with RMPs in terms of mode numbers applied and resonant locations.
Perform cross-machine studies of pellet ELM pacing at JET, AUG and others devices if possible.

3. Work Description and Breakdown

3.1 Structure

The work in this Task Agreement involves experiments in dedicated facilities, laboratory tests and simulation or code improvements as well.
The activities, for those tasks implying more than one Association, are coordinated by one the Participating Association (Task Coordinator), as underlined in table 3.1, whose additional commitment is the organization of the work, planning of the experiments, its realisation and the writing of a final report.

The Responsible for the whole Task Agreement is indicated in the first row of the table 3.1 with the identification label WP09-MHD-04/00 (Task Agreement Coordinator). The Task Coordinator is kept updated of the progress of all the tasks and interacts with the EFDA-CSU Responsible Officer.

Part of the work performed for the above Task Agreement can is funded through priority support

3.2 Work Breakdown and involvement of Associations

The work breakdown of the task by Association is as follows:

WP09-MHD-04/00
Task Agreement Coordinator

Tasks	Associates	Activities
WP09-MHD-04/00 /CEA	CEA	**Task coordinator** follow-up the progress of all the tasks, organise reporting and interact with the EFDA-CSU Responsible Officer (reporting; remedy to short-comings etc.)

WP09-MHD-04-01 (WP III-3-a-1, a-5, a-4, a-3): ELMs: Physics Understanding, Non_linear MHD and Pellet induced ELMs, Resonant magnetic field perturbation (RMP) stabilisation of ELMs.

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-04/01 / ENEA-RFX	ENEA-RFX	Investigations of the magnetic structure of ELM filaments and comparisons of triggered and natural ELMs with the probe at AUG developed by ÖAW and RISØ.
WP09-MHD-04/01 / CRPP	CRPP	Analyses and modelling of the effects of magnetic field perturbation on magnetic topology.
WP09-MHD-04/01 / HAS	HAS	Nonlinear ELM precursor measurements on MAST using BES including comparison between single and double null plasmas. Explore of pellet ELM mitigation technique to improve understanding of ELM triggering on ASDEX Upgrade. Edge turbulence measurements in TEXTOR using Li-BES.
WP09-MHD-04/01 / IPP.CR	IPP.CR	Modelling of transport caused by ExB convection cells and rotation braking by neoclassical toroidal viscosity and benchmark with the code developed at CEA.
WP09-MHD-04/01 / MedC	MedC	Analysis of pedestal data on local current density for improved equilibrium reconstruction and studies of the MHD prediction for the coincidence of the current and vorticity sheets.
WP09-MHD-04/01 / ÖAW	ÖAW	Specific investigations of the magnetic structure of ELM filaments and pedestal during ELMs, comparison of triggered and natural ELMs.
WP09-MHD-04/01 / RISØ	RISØ	Investigations of the properties of ELM dynamics by probe measurements at AUG.
WP09-MHD-04/01 / UKAEA	UKAEA	Prepare data for non-linear modelling with BOUT and execute additional complementary modelling of ELMs and RMP effects.

WP09-MHD-04/01 / CEA	CEA	Perform detailed modelling of non linear phase of ELM with flows.

The work breakdown and involvement per work programme of the Associates which results from the call for participation and the assessment conducted by the EFDA-CSU and the MHD TG is given in the Table 3.1 here below

Table 3.1 Work Breakdown 2009

Year	Tasks	Associates	Manpower Baseline Support (ppy)	Manpower Priority Support (ppy)	Hardware Priority Support kEuros	Consumable expenditure
2009	**WP09-MHD-04/00** Task Agreement Coordinator	**CEA**	**0.25**			
	WP09-MHD-04-01/ENEA-RFX	**ENEA-RFX**	**0.30**	**0**	**0**	**0**
	WP09-MHD-04-01/CRPP	**CRPP**	**0.283**	**0.2**	**0**	**0**
	WP09-MHD-04-01/HAS	**HAS**	**0.10**	**0.3**	**0**	**0**
	WP09-MHD-04-01/HAS	**HAS**	**0.20**	**0.5**	**0**	**0**
	WP09-MHD-04-01/IPP.CR	**IPP.CR**	**0.60**	**0**	**0**	**0**
	WP09-MHD-04-01/MEdC	**MEdC**	**0.40**	**0**	**0**	**0**
	WP09-MHD-04-01/ÖAW	**ÖAW**	**0.50**	**0.36**	**0**	**0**
	WP09-MHD-04-01/RISØ	**RISØ**	**0.33**	**0.25**	**0**	**0**
	WP09-MHD-04-01/UKAEA	**UKAEA**	**1.40**	**0.83**	**0**	**0**
	WP09-	**CEA**	**4.90**	**1.50**	**0**	**0**

	MHD-04-01/CEA					
		Total	**9.263**	**3.94**		

3.3 JET related activities

No JET related activities are meant to be implemented under the present Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in the present 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 modeling activities under Art.5.

4. Scientific and Technical Reports

4.1: Progress reports

At the end of each calendar year, during MHD 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.

4.2: 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 in Table 4.2 of their Task have been achieved, and shall include a breakdown of expenditure, under the headings of Annex 1. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones described in Section 4.3. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Table 4.2: Deliverables under Priority Support

Activity 2009	Priority Support Deliverables	Due Date
WP09-MHD-04/01 / CRPP / PS	Modelling and analyses of effects of magnetic field perturbation on magnetic topology.	March 2010
WP09-MHD-04/01 / HAS / PS	Explore of pellet ELM mitigation technique to improve understanding of ELM triggering on ASDEX Upgrade. Nonlinear ELM precursor measurements on MAST using BES.	March 2010
WP09-MHD-04/01 / ÖAW / PS	Measurements in all three directions of space in SOL during L-H transitions and ELMs on ASDEX-Upgrade and COMPASS-D.	March 2010
WP09-MHD-04/01 / RISØ / PS	Investigations of the properties of ELM dynamics by probe measurements at AUG, in collaboration with IPP, ÖAW and ENEA-RFX associations. Evaluation of data mainly from magnetic fluctuations and comparison with modelling of ELM filament propagation. Evaluation of data comparing magnetic fluctuations with electrostatic fluctuations for ELM filament propagation.	March 2010
WP09-MHD-04/01 / UKAEA / PS	Prepare data for non-linear modelling with BOUT and execute additional complementary modelling of ELMs and RMP effects, including the effects of plasma response to magnetic perturbation. Development of BOUT++ non-linear MHD code for ELM simulations including incorporating models for RMP control of ELMs.	March 2010
WP09-MHD-04/01 / CEA / PS	Further development of non-linear code JOREK in toroidal geometry with parallel flows. Perform detailed modelling of the non-linear phase of ELMs with flows. Development of full non-linear resistive MHD code in toroidal geometry.	March 2010

4.3: Milestones.

March 2010
Final report for the activities of 2008 and 2009

5. Priority Support Expenditure Forecast

The forecast of the total expenditures eligible for priority support in this Task Agreement is **387.31 kEuro**. A full breakdown of forecast of expenditures is given respectively in Annex 1, Table A1. The Community financial contribution will be up to a maximum of **77.46 kEuro** under Art. 8.2a and 8.2b of the Contract of Association[7].

[7] Art 8.2a and 8.2b of the Contract of Association -"a) an additional rate supplementing baseline support and not exceeding a final rate of 40% for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4. b) a rate not exceeding 40 %, for

For exchange of scientists between the involved Associations details of the forecast of expenditure under the Mobility Agreement is shown in Annex 2. This data shall be included in the annual Mobility Plan of the Associations.

6. Intellectual Property

The Associates shall identify, in the task agreement reports, all information relevant from the Intellectual Property Rights point of view. Guidelines regarding the content of this IPR chapter are given in the EFDA Explanatory Note to the Associates of 28 November 2007 (IPR report (art.5) final).

7. Quality Assurance

EFDA QA rules applicable where appropriate (EFDA-Annex QA- EFDA QA requirements for Suppliers (EFDA_D_2AN6G6).

8. Background Documentation

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expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4."

Summary financial table for Priority Support for Task Agreement WP09-MHD-04 (total expenditure)

Year	Association	Activity	Manpower Priority support Expenditure		Hardware expenditure	Consumables expenditure	Total	Comments
			ppy	k€	k€	k€	k€	
2009	CRPP	MHD-04-01	0.2	30	0	0	30	Collaborative experiments on the effects of magnetic field perturbation on magnetic topology, including modelisation and data analyses.
2009	HAS	MHD-04-01	0.3	10.8	0	0	10.8	Collaborative experiments on nonlinear ELM precursor measurements on MAST using BES: SND-DND comparison, in collaboration with UKAEA.
2009	HAS	MHD-04-01	0.5	18	0	0	18	Collaborative experiments on exploring pellet ELM mitigation techniques and improved understanding of ELM triggering on ASDEX Upgrade, in collaboration with IPP.
2009	ÖAW	MHD-04-01	0.36	61.2	0	0	61.2	Specific investigations of the magnetic structure of ELM filaments and pedestal during ELMs, comparison of triggered and natural ELMs in ASDEX Upgrade in collaboration with IPP.
2009	RISØ	MHD-04-01	0.25	43.46	0	0	43.46	Collaborative experiments on ELM dynamics by probe measurements at ASDEX-Upgrade, in collaboration with IPP, ÖAW and ENEA-RFX associations. Evaluation of data mainly from magnetic fluctuations and comparison with modelling of ELM filament propagatio (…)
2009	UKAEA	MHD-04-01	0.83	55.85	0	0	55.85	Specific software developments related to non-linear MHD studies. Prepare data for non-linear modelling with BOUT and execute additional complementary modelling of ELMs and RMP effects.
2009	CEA	MHD-04-01	1.5	168	0	0	168	Specific software developments related to non-linear MHD studies. Perform detailed modelling of non-linear phase of ELM with flows.
		Total	3.94	387.31	0	0	387.31	

Annex 2: Indicative mobility support[1]

Year	Association	Estimated number of trips	Estimated number of staff involved	Estimated total cost (k€)	Comments.
2009	**ENEA-RFX**	**2**	**2**	**2.0**	**Visits to IPP-Garching, RISØ and ÖAW.**
	CRPP	**4**	**2**	**7.6**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	HAS	**12**	**6**	**21.1**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	IPP.CR	**2**	**1**	**9.0**	**Visits to UKAEA Culham and CEA Cadarache.**
	MEdC	**1**	**1**	**4.5**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	ÖAW	**5**	**4**	**10.0**	**Modelling and Simulation of ELM's.**
	RISØ	**1**	**1**	**3.0**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	UKAEA	**1**	**2**	**1.5**	**Visits to CEA for joint discussions and modelling work on ELMs.**
	CEA	**2**	**2**	**2.0**	**For the TPG annual meeting and one subgroup meeting and trips related to collaborative experiments.**
	Total	**30**	**21**	**60.7**	

[1] To be included in the Associations' annual mobility plan.

EFDA WORKPROGRAMME 2008/2009

Toroidal Viscosity Braking and RWM Feedback Control

Version 1.0

TASK AGREEMENT WP09-MHD-05

Index

1. Introduction

At its meeting in Barcelona on 7 May 2008, the EFDA Steering Committee approved elements of the EFDA 2008 Work Programme **(EFDA SC (08) 38/3.2)**, among which the Topical Groups (TGs) programme. At its meeting in Culham on 6 October 2008, the EFDA Steering Committee approved the revision of the elements of the EFDA 2008 Work Programme **(EFDA SC (08) 39/3.2)**. Revised resources required to fulfil the objectives of the Topical Group Work Programme including **56.7 ppy** of Manpower and **2020 kEuros** Hardware expenditure under Priority Support were approved, corresponding to EC funding of up to **2168.8 kEuros**, out of which **20.3 ppy** of Manpower and **570 kEuros** Hardware expenditure under Priority Support were approved for the implementation of the work under the second topical group call.

A second call for participation in the TGs programme under EFDA was launched on 17th of September 2008. **68** proposals under priority support, coming from **20** Associations, were received, covering **32** out of the **32** launched tasks.

This programme is implemented on the basis of the EFDA Art. 5 provisions. The implementation results from calls for proposals. The outcome of the calls is assessed by the EFDA-CSU and the Topical Group leadership and implemented under 13 Task Agreements: WP09-MHD-01, WP09-MHD-02, WP09-MHD-03, WP09-MHD-04, WP09-MHD-05, WP09-HCD-02, WP09-HCD-03, WP09-HCD-04, WP09-DIA-02, WP09-TGS-02a, WP09-TGS-02b, WP09-TGS-02c and WP09-DEM-01.

The activities under Priority Support in these Task Agreements were recommended by the EFDA Steering Committee at its meeting of 24th March 2009 in Prague (EFDA (09) 40/4.1.2) and endorsed by the CCE-FU at its meeting of 31st March 2009 (EUR (09) CCE-FU 45/7.5).

2. Objectives

2.1 General background

Plasma stability represents a key area to address in the preparation for next step devices. Here a range of processes must be controlled if they are not to lead to serious performance limitations in ITER and DEMO. This must build on the promising improvements in understanding and control obtained so far, developing them in order to predict and design the control approaches required in future devices.
In this call, which represents the bulk of proposals from the newly formed plasma stability and control topical group, issues have been arranged under five task agreements, corresponding to the five fields of plasma stability being explored by the group. In each area the most important high priority projects, with major elements of priority support resources, have been identified as separate tasks.

The involvement of Associations in the following task belonging to this Task Agreement results from a Calls for Proposals launched on 17/9/2008.

- WP09-MHD-05-01: Neoclassical Toroidal Viscosity Braking; RWM feedback control.

2.2 Scientific rationale and main objectives of the task

The objectives of the Task Agreement are reported in the following.

WP09-MHD-05-01: Neoclassical Toroidal Viscosity Braking; RWM feedback control.

The role of resonant magnetic error field components on RWM destabilization has been investigated in several tokamaks. Much less is known about non-resonant magnetic error field components. They have a strong effect on the plasma flow, and therefore on the RWM stabilization mechanism, through their role in damping the toroidal flow by a neoclassical viscous torque mechanism. Predictions on Neoclassical Toroidal Viscosity (NTV) for ITER have high priority and high urgency, because of their implications on ELM RMP coil designs. Stellarator and reversed field pinch community could contribute, in particular regarding 3D effects. Recent experiments in DIII-D with balance torque show that there are several unexpected issues regarding feedback control of RWM.

Objectives

Provide data to validate NTV models and build a common database. Develop theory models including plasma response to non resonant error field components and magnetic shielding and provide a survey of existing tools, providing a reliable extrapolation to ITER.

3. Work Description and Breakdown

3.1 Structure

The work in this Task Agreement involves experiments in dedicated facilities, laboratory tests and simulation or code improvements as well.

The activities, for those tasks implying more than one Association, are coordinated by one the Participating Association (Task Coordinator), as underlined in table 3.1, whose additional commitment is the organization of the work, planning of the experiments, its realisation and the writing of a final report.

The Responsible for the whole Task Agreement is indicated in the first row of the table 3.1 with the identification label WP09-MHD-05/00 (Task Agreement Coordinator). The Task Coordinator is kept updated of the progress of all the tasks and interacts with the EFDA-CSU Responsible Officer.

Part of the work performed for the above Task Agreement is be funded through priority support

3.2 Work Breakdown and involvement of Associations

The work breakdown of the task by Association is as follows:

WP09-MHD-05-01: Neoclassical Toroidal Viscosity Braking; RWM feedback control.

TASKS	ASSOCIATES	ACTIVITIES
WP09-MHD-05/01 / ENEA	ENEA	Development of the CarMa code to analyse RWMs with 3D conducting structures, with particular reference to the possibility of inclusion of the effects of plasma rotation.
WP09-MHD-05/01 / ENEA-RFX	**ENEA-RFX**	Task Co-ordination. Setup, execution and analysis of experimental runs on RFX-mod with different coil configurations and/or different control strategies for RWM control.
WP09-MHD-05/01 / MedC	MedC	Calculation of the wall response and investigation with a semi-analytical RWM model and code of dissipation mechanisms.
WP09-MHD-05/01 / UKAEA	UKAEA	Experimental studies of NTV on MAST and also via collaborative work with TEXTOR. Develop models and benchmark codes, along with experimental testing to provide a robust tools for RWM feedback prediction for future devices.
WP09-MHD-05/01 / VR	**VR**	Task Co-ordination. Measurements on EXTRAP T2R of plasma rotation braking due to non-resonant external magnetic fields
WP09-MHD-05/01 / CEA	CEA	Theory and modelling of neoclassical toroidal viscosity and benchmarking with experiments.

WP09-MHD-05/01 / FZJ	FZJ	Collaborative experimental studies of NTV in TEXTOR

The work breakdown and involvement per work programme of the Associates which results from the call for participation and the assessment conducted by the EFDA-CSU and the MHD TG is given in the Table 3.1 here below

Table 3.1 Work Breakdown 2009

Year	Tasks	Associates	Manpower Baseline Support (ppy)	Manpower Priority Support (ppy)	Hardware expenditure (k€)	Consumable expenditure (k€)
2009	**WP09-MHD-05/00** Task Agreement Coordinator	**ENEA**	**0.125**	**0**	**0**	**0**
		VR	**0.125**	**0**	**0**	**0**
	WP09-MHD-05-01/ENEA	**ENEA**	**0.3**	**1.2**	**0**	**10**
	WP09-MHD-05-01/ENEA-RFX	**ENEA-RFX**	**1.87**	**1.55**	**0**	**0**
	WP09-MHD-05-01/MEdC	**MEdC**	**0.5**	**0**	**0**	**0**
	WP09-MHD-05-01/UKAEA	**UKAEA**	**0.1**	**0.2**	**0**	**0**
	WP09-MHD-05-01/VR	**VR**	**0.93**	**0.55**	**0**	**0**
	WP09-MHD-05-01/CEA	**CEA**	**0.5**	**0.5**	**0**	**0**
		Total	**4.45**	**4**	**0**	**10**

3.3 JET related activities

No JET related activities are meant to be implemented under the present Task Agreement. JET related activities are implemented under EFDA Art.6. However some JET activities can be mentioned for information in the present 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.

4. Scientific and Technical Reports

4.1: Progress reports

At the end of each calendar year, during MHD 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.

4.2: 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 in Table 4.2 of their Task have been achieved, and shall include a breakdown of expenditure, under the headings of Annex 1. The Task Coordinator will collect the individual subsections into the final report for Priority Support activities addressing the milestones described in Section 4.3. The EURATOM financial contribution will be made after approval by the EFDA Leader of these reports.

Table 4.2: Deliverables under Priority Support

Activity 2009	**Priority Support Deliverables**	**Due Date**
WP09-MHD-05/01 / ENEA-CREATE / PS	Perform simulations of RWM feedback capabilities/requirements in terms of current/voltage for the BVI coils and mid-plane error correction coils; study the effect of magnetic noise for RWM feedback; benchmark feedback models against experimental data. Develop the CarMa code for RWM modelling with 3D conducting structures.	**March 2010**
WP09-MHD-05/01 /	Perform comparison between experiment and simulation in order to assess the models (Cariddi and Mars-F). Design of a modal non	**March 2010**

ENEA-RFX / PS	diagonal controller on the basis of the integrated development of a model of modal direct transfer functions. Development of controller models (MIMO and SISO) including plasma response and evaluation of the required sensors for optimal control.	
WP09-MHD-05/01 / UKAEA / PS	Experimental studies of NTV on MAST in collaboration with TEXTOR. Develop models and benchmark codes, along with experimental testing to provide a robust tool for RWM feedback prediction for future devices.	**March 2010**
WP09-MHD-05/01 / VR / PS	Measurements on EXTRAP T2R of plasma rotation braking due to non-resonant external magnetic fields. Experimental comparison of MIMO and SISO systems for RWM feedback on EXTRAP T2R.	**March 2010**
WP09-MHD-05/01 / CEA / PS	Theory and modelling of Neoclassical Toroidal Viscosity. Benchmarking with experiments and predictions for ITER RMP ELM coils, including low collisionality regimes. Integration of NTV model in nonlinear MHD codes for RMPs.	**March 2010**

4.3: Milestones.

March 2010
Final report for the activities of 2008 and 2009

5. Priority Support Expenditure Forecast

The forecast of the total expenditures eligible for priority support in this Task Agreement is **430.75 kEuro**. A full breakdown of forecast of expenditures is given respectively in Annex 1, Table A1. The Community financial contribution will be up to a maximum of **88.15 kEuro** under Art. 8.2a and 8.2b of the Contract of Association[9].

For exchange of scientists between the involved Associations details of the forecast of expenditure under the Mobility Agreement is shown in Annex 2. This data shall be included in the annual Mobility Plan of the Associations.

[9] Art 8.2a and 8.2b of the Contract of Association -"a) an additional rate supplementing baseline support and not exceeding a final rate of 40% for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4. b) a rate not exceeding 40 %, for expenditure on specific co-operative projects, which have been recommended for or have been awarded priority status by the CCE-FU according to the conditions and the procedures set out in Annex II, part A, Articles II.3 and II.4."

6. Intellectual Property

The Associates shall identify, in the task agreement reports, all information relevant from the Intellectual Property Rights point of view. Guidelines regarding the content of this IPR chapter are given in the EFDA Explanatory Note to the Associates of 28 November 2007 (IPR report (art.5) final).

7. Quality Assurance

EFDA QA rules applicable where appropriate (EFDA-Annex QA- EFDA QA requirements for Suppliers (EFDA_D_2AN6G6).

8. Background Documentation

- EFDA 2008 – 2009 Work Programme

Summary financial table for Priority Support for Task Agreement WP09-MHD-05 (total expenditure)

Year	Association	Activity	Manpower Priority support Expenditure		Hardware expenditure	Consumables expenditure	Total	Comments
			ppy	k€	k€	k€	k€	
2009	ENEA	MHD-05-01	1.2	129.25	0	10	139.25	Specific software developments related to non-linear MHD studies. Development of the CarMa code to analyse RWMs with 3D conducting structures, with particular reference to the possibility of inclusion of the effects of plasma rotation, including ~5kE (…)
2009	ENEA-RFX	MHD-05-01	1.55	115.5	0	0	115.5	Setup, execution and analysis of experimental runs on RFX-mod with different coil configurations and/or different control strategies for RWM control.
2009	UKAEA	MHD-05-01	0.2	20	0	0	20	Experimental studies of NTV in MAST and in collaboration with TEXTOR and VR. Develop models and benchmark codes, along with experimental testing to provide a robust tool for RWM feedback prediction for future devices.
2009	VR	MHD-05-01	0.55	88	0	0	88	Collaborative experimental studies of NTV in collaboration with TEXTOR and UKAEA. Measurements on EXTRAP T2R of plasma rotation braking due to non-resonant external magnetic fields.
2009	CEA	MHD-05-01	0.5	68	0	0	68	Specific software developments related to non-linear MHD studies. Theory and modelling of neoclassical toroidal viscosity and benchmarking with experiments.
		Total	4	420.75	0	10	430.75	

Annex 2: Indicative mobility support[1]

Year	Association	Estimated number of trips	Estimated number of staff involved	Estimated total cost (k€)	Comments.
2009	**ENEA-CREATE**	**4**	**3**	**17.0**	**Visit to fusion laboratories and institutions involved in RWM research are foreseen. In particular, UKAEA will be made to set up the cooperative effort in developing the CarMa code.**
	MEdC	**3**	**2**	**15.2**	**For the TPG annual meeting and one subgroup meeting and trip related to collaborative experiments.**
	UKAEA	**2**	**1**	**1.5**	**Visits related to studies on NTV on TEXTOR, CMOD and NSTX.**
	VR	**2**	**3**	**2.5**	**Meetings at RFX for discussion of experiments; visit to IPP Greifswald**
	CEA	**2**	**2**	**2.0**	**For the TPG annual meeting and one subgroup meeting**
	Total	**13**	**11**	**38.2**	

[1] To be included in the Associations' annual mobility plan.