EFDA WORKPROGRAMME 2010

Call for Participation

(Part of the EFDA WP, H&CD and Fuelling TG)

H&CD and Fuelling Technologies

Deadline for Responses: 20th November 2009

TG Chairmanship: Alain Becoulet, Marie-Line Mayoral (JET) Coordination Committees: Tim Jones (NBI), Laurie Porte (ECRH), Raymond Koch (ICRH), A. Becoulet (CCLH), Christian Day (Fuelling)

EFDA CSU contact person: Boris Weyssow

This Call for Participation aims to implement the EFDA Work Programme for 2010 on H&CD and Fuelling under Task Agreements as foreseen in the new EFDA Art. 5

Introduction

At its meeting in Prague on 12 March 2009, the EFDA Steering Committee approved elements of the EFDA 2010 Work Programme, including a set of tasks relating to the EFDA Topical Groups on Heating, Current Drive, Fuelling, MHD, Transport and Diagnostics. This Call covers the Heating, Current Drive and Fuelling (HCD) technology related work implemented under Task Agreements on the basis of the provisions given in Article-5 of the EFDA Agreement.

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

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

Task Agreement HCD-02-01: Support to European Facilities and ITER (LHCD)
Task Agreement HCD-02-02: Reliability Neutral Beam Advanced Technologies
Task Agreement HCD-02-03: Fuelling Technologies

Programmatic Background

The EFDA Heating and Current Drive Topical Group Work-programme will cover the physics and technology issues related to the development of the Heating, Current Drive and Fuelling systems available for fusion plasmas and the integration of these technologies aiming at steady-state plasma operation. These include Neutral Beam Injection (NBI), both based on the acceleration of positive and negative ion beams; Ion Cyclotron Resonant Heating (ICRH); Lower Hybrid Current Drive; and Electron Cyclotron Resonant Heating (ECRH) and current drive (ECCD).The H&CD will address areas of direct ITER relevance, urgent needs, with a clear link with F4E and ITER; as well as longer term developments relevant for DEMO; and urgent needs in connection with fusion device upgrades already agreed or under consideration in the EU. Under areas related to the physics aspects, modelling development, support needs and requests towards the EU experimental program in the various devices will be carried out under the coordination of the H&CD TG, while technology activities will include conceptual design studies, research and development needs among the EU fusion devices.

1. Support to European Facilities and ITER (LHCD):

Task Agreement WP10-HCD-02-01:

Support to European Facilities and ITER (LHCD)

1.1 Introduction

LHCD is the most promising method for achieving and controlling long pulse operation on ITER. LHCD systems in general still need significant research and development before being installed on ITER.

The on-going task HCD-08-03-01 “LH4IT: EU contribution to the ITER LHCD development plan” will provide the necessary elements for an international discussion around the future of the ITER LHCD system. In case of a positive decision, including a possible declaration of interest from Europe and other ITER Parties, a dedicated research and development work programme is to be launched.

A task for the preparation of an LHCD system for ASDEX Upgrade (LH4AUG) could also be launched in the future, pending request from IPP.

1.2 Objectives

Further develop the design of an ITER LH system ready for procurement by F4E

1.3 Work Description and Breakdown

Work Breakdown

WP10-HCD-02-01-01

Design of an LH system for ITER

Co-ordinate and report on the design of an LH system for ITER.

JET related activities

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

Resources

Baseline Support: 2.33 ppy.

Priority Support: 0.66 ppy.

LHCD development plan: coordination and conceptual design activities.

1.4 Scientific and Technical Reports

Progress reports

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

Report of achievements under Priority Support

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

Milestones and Deliverables

Milestones:

- Mid 2010 Activity Meetings: Collection and discussion of results obtained early 2010.
- End third trimester 2010 Annual meeting of the Topical Group: coordinated presentation of the results.

- December 2010 Final report sent to EFDA-CSU.

Deliverables:

- Co-ordinate and report on the design of an LH system for ITER

2. Neutral Beam Advanced Technologies:

Task Agreement WP10-HCD-02-02:

Neutral Beam Advanced Technologies

2.1 Introduction

Further developing negative neutral beams technologies could significantly improve reliability and efficiency for possible application on DEMO (or earlier if successful). This includes Cs-free operation, electrostatic residual ion dump studies, space charge neutralisation, physics of extraction of negative ions, alternative neutraliser technology and assessment of their potentiality as off-axis current drive source.

It is also important to improve to present level of understanding of the basic processes ruling the neutral beam sources to help consolidating and improving the present source development activities, aiming at a more integrated modelling of the NB injector to be used for interpretative and predictive simulations of neutral beam systems, including the one developed for ITER

2.2 Objectives

- Produce a coherent picture of the exploitation and enhancement of the neutral beam test facilities in preparation and support of ITER developments. High voltage holding for long pulse, including protocols for High Voltage conditioning.
- Better determination of DEMO requirements for Neutral Beam Heating systems, including overall system optimization, materials and thermomechanical issues, critical heat flux analysis, health monitoring techniques and in-vessel components.
    - Systematic validation and general improvement of neutral beam source models.
    - Feasibility-sensitivity analysis of Neutral Beam modularity and overall reduction in gas requirements including source.
    - Improved Caesium management and understanding of the processes.
    - Development of DEMO relevant Beamline diagnostics and study possible alternative DEMO relevant accelerator techniques.

- Development of Alternative neutraliser technologies aiming at increased efficiency of NNBI systems.

2.3 Work Description and Breakdown

Work Breakdown

WP10-HCD-02-02-02

Sources

Systematic validation of neutral beam source models aiming at improving Caesium management.

WP10-HCD-02-02-01

DEMO requirements for Neutral Beam Heating systems

Overall system optimization for DEMO, including, materials and thermomechanical issues, critical heatflux analysis, health monitoring techniques and in-vessel components

WP10-HCD-02-02-03

Accelerator techniques and Beamline diagnostics

Development of DEMO relevant Beamline diagnostics and study of possible alternative DEMO relevant accelerator techniques.

WP10-HCD-02-02-04

Alternative neutraliser technologies

Development of Alternative neutraliser technologies aiming at increased efficiency of NNBI systems.

JET related activities

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

Resources

Baseline Support:10 ppy.

Priority Support:2 ppy

2.4 Scientific and Technical Reports

Progress reports

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

Report of achievements under Priority Support

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

Milestones and Deliverables

Milestones:

- Mid 2010 Activity Meetings: Collection and discussion of results obtained from the evaluation of theoretical work and experiments performed in 2009 and early 2010.
- End third trimester 2010 Annual meeting of the Topical Group: coordinated presentation of the results from the theoretical work and experimental campaigns in 2010.
- December 2010 Final report sent to EFDA-CSU.

Deliverables:

- Coordination of specific developments in the area Neutral Beam Advanced Technologies.
- Conceptual designs and modelling of:
    - Sources
    - Accelerator techniques
    - Alternative neutraliser technology
- Synthetic analysis by the group of experts involved, recommendation for future work and implications for ITER and DEMO.

3. Fuelling Technologies:

Task Agreement WP10-HCD-02-03:

Fuelling Technologies

3.1 Introduction

ITER and DEMO require high performance fuelling/pumping systems, satisfying constraints unknown to present fusion devices. The fuelling systems have to allow for long pulse operation, beyond 1000 seconds for ITER, with very high reliability, and be ready for protection of the plasma facing component from mechanical shocks (e.g. disruptions) or heat load (e.g. ELMs).

Cryopumps have no mobile components and can handle large flows, but need cryogenic supply at 5K. On the other hand, turbo-molecular pumps offer a permanent pumping solution (with no oil or gas involved) but have a limited pumping flow and have mobile components.

3.2 Objectives

- Achieve developments on pellet injectors for pace-making purpose with reduced influence on the plasma core.
- Find solutions for a reliable high speed pellet injectors and/or reliable multiple pellet launchers for plasma core fuelling.
- Get status report on pump development and first report on feasibility of rough pumps of interest for ITER and/or DEMO.
- Get understanding on extrapolation of ITER pumping/fuelling systems to DEMO
- Get a comprehensive overview of existing and of potentially feasible systems such as NBI, SMBI, Compact toroid for plasma fuelling of the next generation of burning plasma devices.

3.3 Work Description and Breakdown

Work Breakdown

WP10-HCD-02-03-01

Pellet injectors for pace-making purposes

Feasibility studies aiming at further development of pellet injectors for ELM pace-making purposes.

WP10-HCD-02-03-02

Pellet injectors for fuelling purposes

Feasibility studies for development of new high speed pellet injectors and multiple pellet launchers. Further develop high speed pellet injectors and multiple pellet launchers.

WP10-HCD-02-03-03

Pumps Systems

- Assess the ITER solutions for pumping & fuelling and derive requirements for these systems under various DEMO configuration options (outline R&D needs, identify immediate and longer term actions)
- Review status of pump development of interest for DEMO.
- Initiate work in the area of steady-state, tritium-compatible rough pumping.

WP10-HCD-02-03-04

Fuelling systems for DEMO

Further assess the capabilities of existing and of potentially feasible fuelling systems for DEMO.

JET related activities

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

Resources

- Baseline Support:4 ppy

3.4 Scientific and Technical Reports

Progress reports

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

Report of achievements under Priority Support

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

Milestones and Deliverables

Milestones:

- Mid 2010 Activity Meetings: Collection and discussion of results obtained from the reviews and feasibility studies performed in 2009 and early 2010.
- End third trimester 2010 Annual meeting of the Topical Group: coordinated presentation of the results in 2010.
- December 2010 Final report sent to EFDA-CSU.

Deliverables:

- Feasibility study of pellet injectors for pace-making purpose (i.e. not perturbing the core plasma).
- Feasibility study of a high speed pellet injectors and multiple pellet launchers.
- Review status of pump development of interest for DEMO.
- Perform studies to assess the capabilities of existing and of potentially feasible fuelling systems for DEMO (NBI, SMBI, Compact toroid,…).