4. PARTICIPATION ON THE ASDEX UPGRADE PROGRAMME

4.1. Introduction

This project will include activities in the areas of microwave reflectometry MHD, turbulence and transport studies and management.

4.2. Microwave reflectometry

The following activities will be carried out:

- *Microwave circuits and systems*

- Final stages of the development and testing of a prototype of a coherent heterodyne advance multimode FM/FH reflectometer with ultra fast switching times (< 10 μs) and fast full band sweeping (typical 10 μs) ;
- Implementation of new fast switches in the "frequency hopping" diagnostics at both fluctuation monitors channels (Q and V bands);
- Possible replacement of the main linear power sources by switched ones for higher efficiency;
- Implementation of amplitude compressing detector amplifiers to allow more data acquisition resolution on small amplitude signals.

- *Control and data acquisition*

- Finalization of a new client to perform hardware debugging and testing;
- Implementation of the control system for the recently installed fixed frequency hopping reflectometry system;
- Continuation of the development of a new PCI data acquisition system aiming mainly to increase the local memory per channel.

- *Data processing*

- Test and automatic use of new data software tools for automatic evaluation of the very edge density profile with X-mode probing waves using the upgrade Q and V band X-mode channels;
- Build-up of a density profile data base for the application of neural networks for very fast profile evaluation;
- Development of novel methods to characterize the error bars on the inverted density profiles.

- *Diagnostic developments*

- Experiments with combined O and X mode operation to improve the very edge profile evaluation and comparison with the results obtained from the numerical simulation;

- To assess numerically the effect of turbulence plus the non measured outer edge profile on the accuracy of broadband results and comparison with experimental data.

o *Modelling*

- Study of the Dopper effects on the reflected signals aiming at the estimation of plasma poloidal velocity.

o *Plasma physics studies*

- *Study of the impact of ELMs on density profiles*

  Calculation of time delays between the onset of the ELMs at HFS and LFS. Analysis of particle losses as well as radial velocity of the particle flux caused by ELMs in similarity experiments with type II ELMs (ASDEX Upgrade/JET) and type I (ASDEX Upgrade/JET/CMod);

- *L - H transition studies*

  Further density profile measurements with high temporal and spatial resolution (up to $12x10^{19}$ m^{-3}) to resolve the pedestal formation in the L-H transition, and its dependence with plasma shape;

- *Analysis of the turbulence behaviour at HFS/LFS, during plasma configuration changes from Lower Single Null to Double Null H-mode discharges*, and comparison with predictions from turbulence modelling , in open field lines vs. closed field lines;

- *Estimation of the radial distribution of both turbulence and MHD events (namely ELMs, their precursors/postcursors and TAEs) in H-mode scenarios*, using the "frequency hopping" capability of the fluctuation monitoring channels;

- *Measurement of turbulence linked with electron heat transport*

  Following the assessment of the reduction of the turbulence in the region inside the deposition layer when ECRH is on (during ECRH modulation experiments), a detailed analysis of the density profile behaviour (namely the density gradients both inside and outside the deposition layer) is required to predict the change in the fluctuation levels;

- *ELM frequency control by pellet injection and magnetic triggering*

  Extension of the documentation for the comparison between natural and triggered ELMs is foreseen using W-band for pedestal analysis. New analysis tools based on time traces of turbulence shall be used.

- *X-mode reflectometry*

  Development of an appropriate algorithm to recalculate the total magnetic field, in front of the X-mode antennae.

4.3. MHD, turbulence and transport studies

This project will have four main research lines, where the following activities are planned for 2006:

- *Fast particle physics*

The participation is foreseen in MHD experiments in the area of fast particle physics, namely to study the particle confinement in the presence of Alfven instabilities (TAEs), using the newly installed fast particle loss detectors and microwave scattering diagnostic.

- *Study of runaway generation in tokamak disruptive events*

Continuation of studies of energetic electrons generated in different scenarios in ASDEX- Upgrade, namely due to the device geometry and related to strong MHD activity enhanced runaway losses.

- *Mode conversion current drive studies for MHD control purposes*

Investigation of the possibility of achieving current drive during ICRF heating in the mode conversion regime under asymmetrical antenna position in relation to the midplane; if successful this approach can be used for suppression of 3/2 NTM by moving ion-ion resonance to the NTM location (in collaboration with IPP-Kharkov, Ukraine).

- *Analysis of turbulence and transport in the SOL of ASDEX Upgrade*

The extension of the code (GEM3) will be made to cope with the edge and SOL regions simultaneously (using a divertor-free geometry) and to include thermal effects. Comparison with experimental measures of turbulence at the edge for double and single null configurations (namely with reflectometry, simultaneously at HFS and LFS).

4.4. Management

The Association EURATOM/IST foresees to proceed with the participation on the ASDEX-Upgrade programme management, with Prof. Maria Emilia Manso as member of the Programme Committee.