
Centro de Fusão
Nuclear

# INSTITUTO SUPERIOR TÉCNICO

# CONTRACT OF ASSOCIATION EURATOM/IST

**SC18/4.3**

**DOCUMENT FOR THE STEERING COMMITTEE MEETING Nº 18**
**to be held on November 25th 2005**

## 2006 WORK PROGRAMME

**RECOMMENDATION:**

The Steering Committee is invited to approve this document

IST/CFN, October 2005

## 1. INTRODUCTION

This document presents a foresight of the fusion activities to be carried out in 2006 in the frame of:

- The Contract of Association between the European Atomic Energy Community (EURATOM) and Instituto Superior Tecnico (IST);
- The European Fusion Development Agreement (EFDA);
- The Contract of Associate Laboratory signed between IST and "Fundação para a Ciência e a Tecnologia" (FCT).

Section 2 concerns the tokamak ISTTOK while section 3 foresees the activities related with the participation of the Association EURATOM/IST on the use of the JET facilities by the EFDA Associates. Sections 4 to 7 deals with the Portuguese participation on the following foreign projects: ASDEX Upgrade, TJ-II, MAST and TCV. Sections 8 and 9 contain information about the participation of the Association EURATOM/IST on the ITER project and regarding the collaboration with the Association EURATOM/CEA. Sections 10 and 11 present activities on theory and modelling as well as on control, data acquisition and signal processing, which are not related with the previously referred projects. Section 12 describes the keep-in-touch activities on inertial fusion energy. Section 13 contains information about the Portuguese participation on the Fusion Technology Programme, while section 14 presents other fusion-related activities.

## 2. TOKAMAK ISTTOK

### 2.1. Introduction

This project will include activities in the areas of liquid metal limiter, other operation systems and diagnostics, control and data acquisition and plasma physics studies.

### 2.2. Testing of the liquid metal limiter concept[1]

The following tasks are planned for 2006:

- Finalization of the Liquid Metal Limiter (LML) implementation on ISTTOK tokamak;
- Resume of the ISTTOK operation with a liquid Gallium limiter;
- Study of the influence of the LML on the ISTTOK plasma performance;
- Experimental measurements of the Gallium jet power removal capability.

[1] Work in collaboration with the University of Latvia.

### 2.3. Other operation systems and diagnostics

The following activities are foreseen for 2006:

- Implementation of a new gas injection system to achieve precise puffing injections of hydrogen, aiming at long operation periods. A microcontroller will regulate a piezoelectric valve analyzing the information from the pressure gauges and the plasma average density calculated in real time from the interferometer data;
- Use of the currently installed spectroscopy system on ISTTOK to analyse plasma impurities[2]. Profiles of Ga neutral density will be measured during the operation with liquid metal limiter to study its influence on the ISTTOK plasma performance;
- Implementation of a spectroscopic ion beam imaging technique. This tool will allow the inference of the magnetic field from the curvature of a singly charged particle beam moving through the field. This is a measurement of great interest for the plasma devices with highly three-dimensional (3D) magnetic field distribution. The technique utilizes the spectroscopic observation of emission from singly charged ions excited by electron impact as they pass through the plasma. On ISTTOK, this technique will be tested using a $Xe^+$ 22 keV injector of a heavy ion beam diagnostic;
- Test of a Retarding Field Analyzer Probe and measurement of the ion temperature edge profile;
- Test of the combined force-Mach-Langmuir probe;
- Test of a fast CCD camera for 2-D imaging of the edge plasma turbulence[3];
- Upgrade of the time of flight energy analyser of the heavy ion beam diagnostic by installing channeltrons to acquire the "start" and "stop" signals, which will allow an increase of the signal to noise ratio;
- Design and construction of a Bennett RF mass spectrograph for edge plasma investigations.

### 2.4. Control and data acquisition

The following activities are foreseen for 2006:

- Development of a new version of the ISTTOK control software, which will allow the integration of any type of hardware, with drivers programmed in any language, through a plug and play XML based system. Remote hardware configuration and firmware upload is also a primary goal. Data storage will be based on events and timestamps;
- Implementation of a real-time plasma position control system to achieve long-time AC discharges on ISTTOK;

[2] Work in collaboration with the University of Latvia.
[3] Work in collaboration with CIEMAT.

- Finalization of the upgrade of the ISTTOK control and data acquisition system towards a real time philosophy with event driven and time-stamp operation.

### 2.5. Plasma physics studies

The following studies will be carried out in 2006:

- *Study of the momentum fluxes using the combined force-Mach-Langmuir probe*[4]

The combined force-Mach-Langmuir probe will be tested and used to determine simultaneously the parallel Mach number, ion temperature and the plasma force in the parallel direction. The ion temperature will be compared with that derived from the retarding field analyzer probe data.

- *Study of the edge plasma turbulence using the fast CCD camera*[4]

Plasma turbulence is known to have complex two and three-dimensional structures which evolve in rapidly time. There are therefore clear advantages in measuring the 2 and 3D nature of these structures using fast cameras. A fast CCD camera (100 kHz) will be tested for turbulence studies in collaboration with Ciemat. Results will be compared with those obtained with other edge diagnostics as multi-pin Langmuir probe arrays.

- *Study of AC discharges*

Independent real-time control systems will be implemented on the primary current, vertical field and horizontal field. ISTTOK AC operation will be carried out aiming at optimizing the tokamak discharges.

- *Studies on Reynolds stress and fluctuations*[5]

Simultaneous measurements made with emissive probes of the Reynolds stress and the fluctuation-induced radial particle flux with and without biasing will proceed. Results will be compared with those of cold probes.

## 3. PARTICIPATION ON THE USE OF THE JET FACILITIES BY THE EFDA ASSOCIATES

### 3.1. Introduction

The participation of the Association EURATOM/IST on the use of the JET facilities by the EFDA Associates will include activities in the areas of operation, scientific exploitation, performance enhancements and management.

[4] Work in collaboration with CIEMAT.
[5] Work in collaboration with the University of Innsbruck and CIEMAT.

### 3.2. Operation

In the frame of JOC positions:

- Dr. Sébastien Hacquin will work in the LIDAR and Microwave Diagnostics Group. His activity will be mainly focussed on: (i) operation and maintenance of the KG3, KG8b reflectometry diagnostics; (ii) collaboration in the upgrade of the X-mode swept frequency KG8a reflectometer; and (iii) data validation and analysis of the KK3 (ECE) and reflectometry diagnostics;
- Dr. Isabel Nunes will work in the Plasma Operation Team, in the planning of the experiments and as Session Leader during the campaigns.

### 3.3. Scientific exploitation

The participation on the JET 2006 work programme is foreseen to include contributions from seventeen scientists (four of them as session leaders), related to their participation in experimental campaigns (C15-C17) at the JET site. The work will be mainly focussed on developments and physics studies related with task forces M, S1, S2, T, D and E.

The following main activities are foreseen:

- *Task Force M (plus support to S1, S2 and T)*

- Maintenance and validation of the database related to fast MHD phenomena, namely of sawtooth data from new regimes (as the high Beta plasmas) and with ICRH;
- Scientific co-ordination of experiments in the area of "Redistribution of NBI fast ions in the presence of TAE modes" and "Resonance condition for Alfven cascades (AC) excitation";
- Processing of pulses with the MHD codes IDBALL and MISHKA and the interpretative code JETTO, on the request of the task forces;
- Use of observed TAE and fishbone activity as a diagnostic for central q-profile evolution, requiring EFIT q-profile analysis with MSE and polarimetry constrains and modelling of q betwween sawtooth using the codes JETTO and CRONUS;
- Continuation of the improvement of the JETTO code , by implementing the Porcelli's ITER sawtooth mode and partial reconnection model, namely to study sawtooth crash effects;
- Improvement of the edge stability physics in JETTO by using alternative models for peeling and ballooning marginal stability, benchmarked against parametric stability scans with MISHKA;
- Study of the changes in the fast particles distribution caused by fishbone bursts and TAEs, using new JET diagnostics recently installed;
- Use of numerical codes to study the sawteeth instability and analysis of the interplay between different instabilities:sawteeth, fushbones and TAEs interacting with the same population of fast ions;

- Studies on the prevention of runaway electron generation at disruptions in JET as part of the development of disruptions mitigation techniques in reactor-scale;
- Further investigation of the role of super-thermal and runaway electrons in internal reconnection events and at ITB regimes in JET;
- Study of the triggering of NTMs by mode coupling using saddle coils to create an error field;
- Studies on the double tearing mode activity with special emphasis on both the linear and nonlinear stability and on the MSE data analysis;
- Study of Quiescent H-mode (QHM) discharges , using MISHKA for the stability and JETTO for transport modelling, to understand the differences between the edge stability in JET and the QHMs in ASDEX Upgrade and DIII-D (in collaboration with General Atomics,U.S.A.);
- Further studies of Chirping modes, using the improved time-frequency visualization of the Choi-Williams distribution;
- Localization of Alfven cascades from combined O-mode and X-mode reflectometry measurements;
- Study of the turbulence behaviour during ITB formation and of the link between the level of turbulence and the poloidal rotation velocity;

o *Task Force T*

- Continuation of the predictive modelling of impurity seeding experiments with JETTO / SANCO (for the core), including the coupling with the code EDGE2D (for the edge plasma);
- Continuation of the study of the influence of the growth of NTM islands on energy and particle transport, by implementing in JETTO a code to simulate the additional transport due to islands;
- Continuation of the TRANSP analysis to model the NBI fast ions affected by NTMs.

o *Task Force D (plus support to E and M)*

- Participation in turbulence and MHD studies using KG8b and KG3 reflectometry systems. Benefits for the physics studies are foreseen from the new microwave access upgrade for reflectometry and ECE;
- Reinstallation of the KG8a, X-mode broadband swept reflectometer (in the range 50-75 Ghz) aiming at providing density profiles with high spatial and temporal resolution at the edge; the study of the impact of ELMs on the profiles is foreseen (to be compared with results from ASDEX Upgrade);
- Exploitation of the MSE system plus MHD analysis with the equilibrium reconstruction EQUINOX for combined polarimetry/MSE measurements at JET(in collaboration with CEA, Cadarache);
- Assessment of the possibility of using the MSE diagnostic for sawtooth real-time control;
- Test of a new probe head designed to study turbulence driven momentum transport;

- *Task Force E*

- Detailed study of the SOL parameters dependence on the pedestal quantities for plasmas optimised for reciprocating probe measurements (high clearence discharges);
- Continuation of the comparison of turbulence properties in forward and reverse field configurations;
- Study of the radial transport as a function of time and space across the SOL during ELMs;
- Determination of the cross-field heat and particle fluxes to the main chamber plasma facing components.

### 3.4. Enhancements

Concerning the JET-EP project, the Association EURATOM/IST will be in charge of the following contracts:

- Participation on the commissioning of the MPRu diagnostic (JW5-OEP-IST-18).
- Refurbishment of the old-mode reflectometer (kG8a) (JW5-OEP-IST-19).

Presently, IST is discussing new contracts in the areas of data acquisition for the neutron diagnostics, real-time plasma control and fast wave reflectometer.

### 3.5. Management

The Association EURATOM/IST foresees a similar participation on the JET management to that of the year 2005.

## 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.

o *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.

o *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.

o *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 $12 \times 10^{19}$ $m^{-3}$) 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.

## 5. PARTICIPATION ON THE TJ-II PROGRAMME

This project will have four main research lines, where the following main activities are foreseen:

- *Microwave reflectometry*
  - Continuation of the scientific exploitation of the frequency hopping correlation reflectometer, namely to study the formation of shear layers at specific plasma locations.
  - Development of another channel on the same frequency band (Q 33-50GHz) to allow simultaneous correlation measurements using the existing and the new hopping systems.

- *Heavy ion beam diagnostic*
  - Improvement of the signal-to-noise ratio;
  - Participation on the scientific exploitation of the diagnostic.

- *Electrode biasing experiments*
  - Participation on the electrode biasing experiments with negative voltages aiming at achieving steady-state discharges with enhanced confinement
  - Implementation on TJ-II of a Gundestrup probe of TJ-II with the aim of measuring the parallel and perpendicular flows in the edge plasma.
  - Design and construction of a Retarding Field Energy Analyser Probe to measure the edge ion temperature.

- *Control and data acquisition*
  - Participation on the development of a JAVA Web Start platform for control, data acquisition and remote participation.

## 6. PARTICIPATION ON THE MAST PROGRAMME

This project will include the following activities in the area of microwave reflectometry:

- Possible implementation of a hopping system with agile and pre-selected frequency steps for fluctuation studies at several probing layers during each discharge;
- Implementation of a set low-pass filters with selectable cut-off frequencies for different plasma regimes;
- Analysis of the reflectometry data aiming at physics studies to be defined in collaboration with the MAST team.

## 7. PARTICIPATION ON THE TCV PROJECT

This project has two research lines, where the following activities will be carried out:

o *X-ray diagnostics*

- Installation of a new acquisition system on the horizontal pulse height analysis (PHA) diagnostic aiming at increasing its throughput;
- Scientific exploitation of the horizontal PHA diagnostic;
- Improvement of the real-time capabilities of the vertical PHA diagnostic by measuring the electron temperature and remotely controlling the aperture as a function of the count rate leading to a stable throughput of the system;
- Study of the evolution of the soft X-ray spectra for plasmas whose characteristics vary deeply from discharge to discharge;
- Optimization of the operation of the rotating crystal spectrometer;
- Beginning of high resolution studies of the X-rays spectra on impurities transport.

o *Advanced plasma control system (APCS)*

- Testing of the new version of the CPLD to control the DMBUS and of the data mover algorithms with this new component;
- Implementation and testing of some of the control algorithms requested by the TCV control team;
- Integration of the VME system crate and its nine DSPs boards as well as the host CPU of the APCS in the TCV control System;
- Integration of the APCS in the TCV timing system;
- Integration and testing of the software already developed in the host CPU which configures the DSPS modules;
- Calibration of the overall analog signals of the system;
- Testing of the system in the TCV plasma control substituting the old analogue system.

## 8. PARTICIPATION ON THE ITER PROJECT

The participation of the Association EURATOM/IST on the ITER project will have two research lines, where the following activities are foreseen:

o *Microwave reflectometry*

- Demonstration of new applications of reflectometry as required for ITER, namely fast evaluation of density profiles using a neural network approach;
- Finalization of the participation as the leading Association of EFDA TaskTW3-TPDSUP, on the design analysis of the position reflectometer system for ITER, including:
  - Co-ordination of the activities, within the EU Fusion Associations participating in this task;
  - Provide input to the drawing-up of a plan for full development of the plasma-position reflectometer system for ITER, including detailed specifications for future design tasks on the system and R&D tasks on critical components;
  - Assess existing documentation and assist the ITER IT in the updating of ITER documentation in this area.
- Participation as leading Association (a proposal has been presented) in the EFDA EU/RF collaborative Task TW5-TPDS-DIARFA, Experimental Assessment of ITER HFS Waveguides, including:
  - Experimental characterization of the full mock-up HFS in the counterpart RF laboratory;
  - Characterize experimentally the critical components. Provide the infrastructure for the experimental testing;
  - Contribute to the analysis of the experimental results, the subsequent optimization of the waveguide design, and definition of future design and R&D activities on HFS waveguide technology, manufacture, ITER-installation and testing. Support the interpretation of the experimental work with numerical waveguide and full-wave plasma simulations;
  - Exchange expertise on using reflectometry for density-profile measurements, collaborating on such measurements on an EU plasma device and on the T-10 tokamak;
  - Provide technical advice on the progress and execution of the RF contribution for the purpose of contract monitoring;
  - Participate in the experimental characterization of the full mock-up in the counterpart RF laboratory.

o *Control and data acquisition*

- Participation on the Group nominated for the assessement of the ITER control and data acquisition system;

## 9. COLLABORATION WITH THE ASSOCIATION EURATOM/CEA

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

- *Microwave reflectometry*

- Studies of Doppler effects on standard as well as on dedicated Doppler reflectometry taking into account time variation of plasma turbulence;
- Further modelling of density fluctuations footprints aiming at quantifying the level of turbulence from the reflectometry response.

- *ITER-like PAM LHCD antenna for TORE SUPRA*

- Testing of the multijunctions and antenna will be conducted in Cadarache, and electromagnetic coupling codes will be improved with more realistic geometry.

- *Turbulence studies*

- Studies of infinite-dimensional Hamiltonian systems (with or without small dissipative perturbations) with particular emphasis in the long-term prediction of such systems and strategies for the control of their turbulent;
- Analysis by infinite-dimensional Hamiltonian techniques of the gyrokinetic equation resulting from the kinetic equation that explains the average over the particles motion along the magnetic field lines. Of particular importance are the long-term prediction of the solutions and the establishment of barriers to the microturbulent drifting;
- Application of the above mentioned techniques to the Vlasov-Maxwell equation. Here some potentially promising techniques include not only its treatment as an infinite-dimensional Hamiltonian system but also the evolution of the densities (Perron-Frobenius equation) as well as the exploration of its infinite-dimensional Lie group symmetries;
- Exploration of the possibility of adapting the (non-commutative) tomographic techniques to plasma diagnostics.

- *Real-time MSE diagnostic*

- Improvement of the software of the real-time MSE diagnostics of JET and TORE SUPRA;
- Improvement of MHD and equilibrium codes based on the real-time MSE results.

## 10. OTHER THEORY AND MODELLING STUDIES

This project will have five research lines, where the following main activities are foreseen:

- *Plasma momentum braking studies*
  - Investigation of the toroidal plasma angular momentum braking with the Error Field Correction Coils at JET using a numerical code developed for toroidal plasmas;

- *Studies on the physics of neo-classical tearing mode(NTM) triggering*
  - Investigation of the nonlinear growth of the tearing mode near marginal stability conditions; a scan in plasma parameters (namely the magnetic Reynolds and Prandtl numbers) will be made to assess the conditions leading to nonlinear growth and saturation of the mode;

- *Magnetic reconnection studies*
  - A forced reconnection numerical code will be pursued to test different boundary conditions on the plasma edge and assess their role on the dynamics of reconnection events; it will be applied to TEXTOR experiments to investigate the variation of the external Dynamic Ergodic Divertor current threshold for Alfven mode penetration with plasma rotation an heating;

- *Studies on lower-hybrid wave propagation*
  - A working version of a fully consistent 3D toroidal equilibrium code is expected to be available soon. Comparative tests against other codes, benchmarks and preliminary results will follow.

- *Tokamak equilibria with current density reversal*
  - Effort will be put into extending this framework to nonstatic equilibria, hoping to clarify if plasma flows may lead to a toroidal current reversal.

## 11. OTHER ACTIVITIES ON CONTROL, DATA ACQUISITION AND REMOTE PARTICIPATION

This project will include the following activities:

- Design, manufacturing and installation of a 72 channel PCI-based data acquisition system for the tokamak CASTOR[6].
- Development and test of a high performance control and data acquisition platform based on the ATCA and ASI/SRIO/Infiniband standards.

[6] Work in collaboration with IPP-Prague.

- Participation, presently under discussion, on the design and implementation of the control and data acquisition system of the new COMPASS-D tokamak[6].

## 12. KEEP-IN-TOUCH ACTIVITIES ON INERTIAL FUSION ENERGY

The main results expected in 2006 will arise from three different areas:

- *Laser system*

- The full, upgraded laser chain should be capable of producing pulses in the multi-tens of terawatt level. A detailed characterisation of this performance will be undertaken. This power level opens up new possibilities for experiments, and places the Laboratory for Intense Lasers at a highly competitive international level.
- *OPCPA* – The broadband technique introduced by ourselves theoretically will be experimentally tested. Ultra-broadband pulses will be generated at the output of the oscillator by means of a photonic crystal fibre, stretched, amplified in the OPCPA amplifier, and compressed. A successful demonstration will represent a considerable improvement in the OPCPA concept, with a potential impact in all the laboratories currently using this technique.

- *Diode-pumped Yb-doped laser materials*

- The collaboration with Jena – one of the leading facilities in the world using this technique – will allow us to develop and explore this new branch of laser physics at our Laboratory. The amplifier performance of several new materials will be evaluated, while simultaneously leading to the development of a new amplifier.

- *Target area*

- Several experiments are planned, pending the characterisation of the upgraded laser system. These include the guiding of laser pulses inside preformed plasma channels and the measurement of the accelerated electron spectra, X-ray generation by laser-solid interaction, and the propagation of laser pulses inside metallic capillaries. These experiments may produce significant results with relevance for the fast ignitor concept, as well as for the laser-plasma community.

## 13. PARTICIPATION ON THE FUSION TECHNOLOGY PROGRAMME

The following activities are foreseen for 2006:

- Continuation of the work on task TW5-TTMS-006 deliverable Characterization of reference EU ODS-EUROFER batch;

- Submission of a new proposal for the exploration of new routes to produce ODS EUROFER and for the study of the stability of beryllides.

## 14. OTHER FUSION-RELATED ACTIVITIES

The following other activities are also foreseen in 2006:

- Participation in training actions of engineers in the areas of microwave circuits and systems and digital instrumentation for data acquisition and real-time control;
- Collaboration with the Portuguese universities on graduation and post-graduation actions on Plasma Physics and Engineering;
- Collaboration with Brazillian Institutions ("Laboratório de Plasmas da Universidade de S. Paulo" and "Laboratório Associado de Plasmas do Instituto Nacional de Pesquisas Espaciais") in the areas of microwave reflectometer, data acquisition and studies on edge physics.