1. INTRODUCTION

1.1. FOREWORD

This document describes the main activities carried out in 2002 in the frame of the Contract of Association between the European Atomic Energy Community (EURATOM) and "Instituto Superior Técnico" (IST) and presents a summary of the main scientific and technical results.

The Contract of Association EURATOM/IST frames the Portuguese participation in the EURATOM Specific Research and Training Programme in the Field of Nuclear Fusion Energy, hereinafter referred as Community Fusion Programme. The long-term objective of this Programme is the development of a prototype commercial fusion power plant (Figure 1.1). Research and development (R&D) activities have been, and will be, carried out to achieve this goal by steps:

- The first generation of toroidal fusion devices demonstrated the confinement of a hot and dense plasma by an adequate magnetic field. Three toroidal configurations have been investigated: tokamak, stellarator and reversed field pinch;

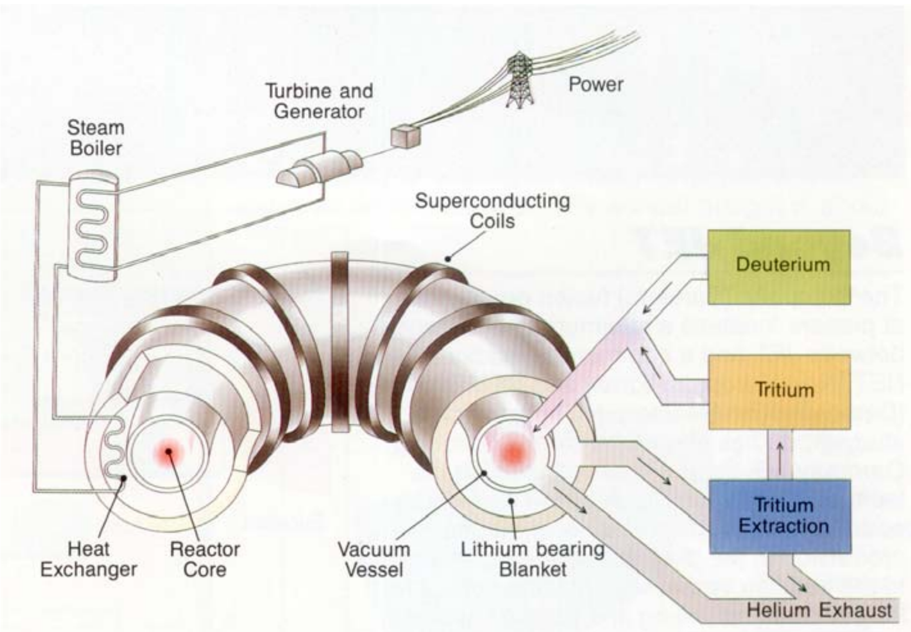

Figure 1.1. Schematic drawing of a fusion power plant

- The machines of the eighties and nineties provided scientific and technical data for the design of the first experimental fusion reactor: the tokamak ITER. JET was the first facility in the world to achieve, in 1991, a significant amount of controlled fusion power (2 MW) with a Deuterium-Tritium experiment. This tokamak has also obtained the world record fusion power (17 MW) and power amplification (ratio of the produced fusion power to the input power, Q=0.65) and proved the safe tritium handling as well as remote handling for installation and maintenance of components inside an activated vacuum chamber (Figure 1.2). Other important contributions regarding performance and high temperature plasma operation came from ASDEX-Upgrade (linked to improved scenarios, divertor physics and technology), TORE SUPRA (related with long pulse operation made possible by superconducting coils), FTU (linked to operation in high magnetic field), TEXTOR (related with improvements in radiative exhaust and plasma-wall interaction) and TCV (linked to highly shaped plasmas and plasma control). Other tokamaks made specialised contributions such as RTP[1] (plasma current filamentation), ISTTOK (diagnostics, digital instrumentation, AC operation and edge physics studies), CASTOR (probe physics and boundary plasma studies). Concept improvements are pursued with MAST (spherical tokamak physics) the stellarators W7-AS (quasi steady-state operation, divertor explorations, improved confinement), TJ-II (exploration of operational range), W7-X (large modular coil advanced stellarator under construction) and the reversed field pinches which study plasmas with a high degree of self-organisation, RFX[2] and EXTRAP.

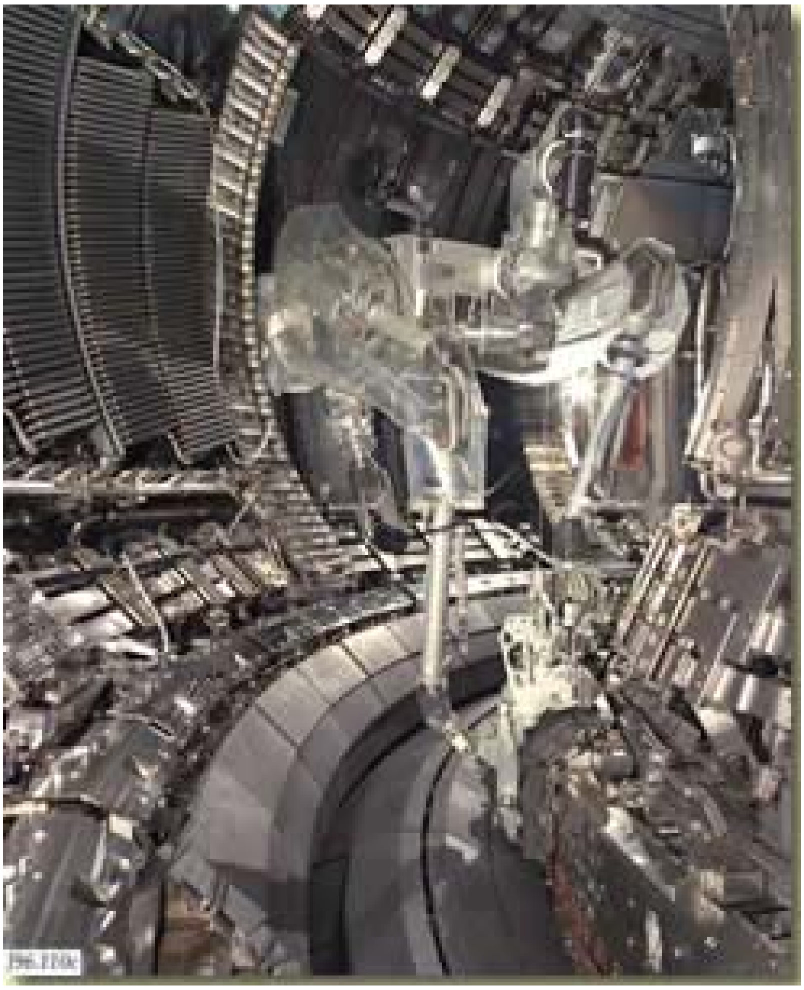

Figure 1.2 – Manipulator installing the tiles of the JET Mark II divertor

- The next step will be ITER (Figure 1.3). The main objective of this tokamak is to demonstrate prolonged (300 - 500 s) fusion power production (500 MW) in D-T plasmas, with power amplification higher than 5 in steady state and 10 in shorter pulsed operation. The design of this tokamak is finalized and Negotiations for its joint implementation are in progress between EURATOM, Japan, Russian Federation, Canada, United

[1] Now shut down
[2] Under rebuilt

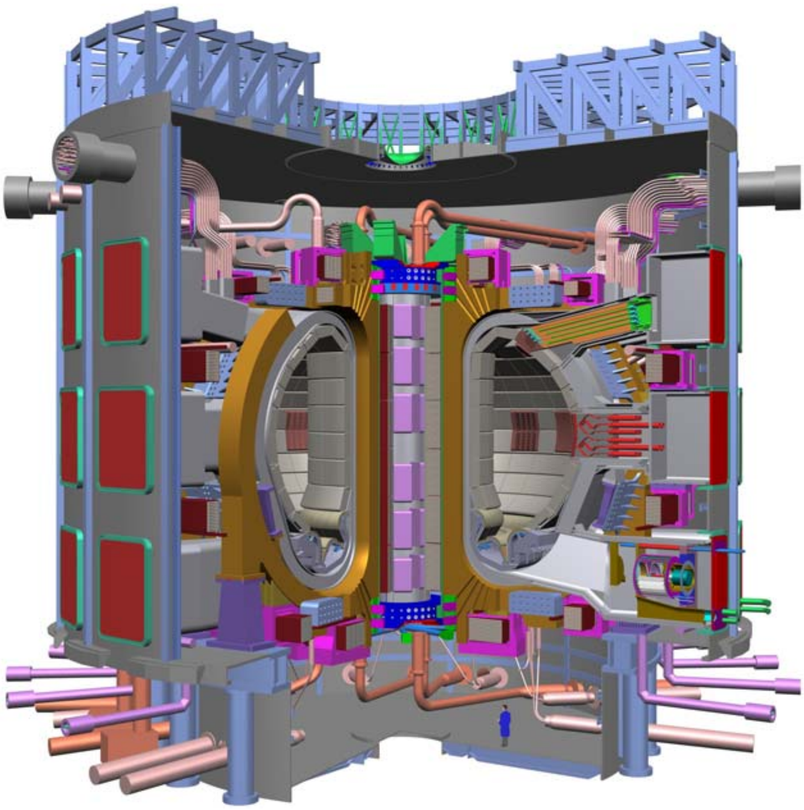

Figure 1.3 – Schematic drawing of ITER

States of America, People's Republic of China and the Republic of South Korea. Four candidate sites have been presented: Vandellos (Spain), Cadarache (France), Clarington (Canada) and Rokkasho-mura (Japan) (Figure 1.4).

Figure 1.4 – Location of the four ITER candidate sites

- The route towards a commercial fusion power plant will imply research and development activities in parallel and beyond the ITER Project. Two intermediate steps (DEMO and PROTO) have been foreseen in a timescale of about 50 years towards the commercial scale. Recently a fast track approach was proposed aiming at demonstrating that electricity generation from fusion reactions would be feasible within a shorter time scale, based on the parallel and overlapping development of technologies and combining experimental work into only one device between ITER and a commercial fusion power plant.

The Community Fusion Programme is presently implemented through several Agreements, in particular: (i) Contracts of Association signed between EURATOM and Institutions of the Member States of the European Union, Switzerland and candidate countries to the EU (Associates); (ii) The European Fusion Development Agreement (EFDA) signed by EURATOM and the Associates.

1.2. MAIN PROJECTS OF THE ASSOCIATION EURATOM/IST IN 2002

The Association EURATOM/IST had in 2002 the following main Projects:

- Tokamak ISTTOK;
- Participation in the collective use of the JET facilities by the EFDA Associates;
- Participation in the ASDEX-UPGRADE Programme;
- Participation in the TJ-II Programme;
- Participation in the MAST Programme;
- Participation in the TCV Programme;
- Participation in the ITER Project;
- Other activities on theory and modelling;
- Other activities on control, data acquisition and signal processing;
- Activities in the Fusion Technology Programme;
- Keep-in-touch activities on inertial fusion energy.

The research and development activities carried out in the frame of these projects are summarized in section 1.3 and described in detail in chapters 2 to 12, which also present the main scientific and technical results. Chapter 13 describes other fusion related activities and chapter 14 contains the list of publications.

Table 1.1 presents information about the responsible person(s) and the Institutions involved in each Project.

1.3. SUMMARY OF THE ACTIVITIES

1.3.1. Tokamak ISTTOK

This Project had in 2002 six main areas of work:

- *Tokamak operation*

ISTTOK was in operation during 32 weeks. The remaining time was used for the maintenance of the discharge systems, the implementation of some diagnostic improvements and for the annual holidays.

- *Testing of the liquid metal limiter concept*[3]

IST/CFN has started a collaboration with the Association EURATOM/University of Latvia on the exploratory testing of a liquid metal limiting boundary to the plasma. Following positive recommendation of the project

[3] Work in collaboration with the Association EURATOM/University of Latvia

Project	Responsible Person(s)	Collaborating Institutions	
		Portuguese	**Other**
Tokamak ISTTOK	José Cabral Carlos Varandas	CFN[4], UBI[5], GEI[6], CFA[7]	CIEMAT[8], IPP-Kharkov[9], UI[10], IFUR[11], IFUSP[12]
Participation in the collective use of the JET Facilities by the EFDA Associates	Fernando Serra	CFN, GEI, UBI	EFDA[13] CSU[14] Culham UKAEA[15]
Participation in the ASDEX Upgrade programme	Maria Emília Manso Fernando Serra	CFN	IPP-Garching[16]
Participation in the TJ-II programme	Carlos Varandas Maria Emília Manso	CFN, GEI	CIEMAT
Participation in the MAST programme	Carlos Varandas Maria Emília Manso	CFN	UKAEA
Participation in the TCV programme	Carlos Varandas	CFN	CRPP[17]
Collaboration with the ITER Project	Carlos Varandas Maria Emília Manso	CFN	EFDA CSU Garching
Other studies on theory and modelling	Fernando Serra J. Pedro Bizarro	CFN	IFP[18], PT[19], DFRC[20]
Other activities on control and data acquisition	Carlos Varandas	CFN, GEI	IFUSP
Keep-in-touch activities on inertial fusion energy	J.T. Mendonça	CFP[21]	
Activities in the Fusion Technology Programme	Carlos Varandas J.C. Soares	ITN[22], CFN, GEI	ENEA[23]

Table 1.1 – Responsible person(s) and Institutions involved in each project

by the CCE-FU (Consultative Committee for the Euratom Research and Training Programme (Fusion)) for the award of preferential support, work started with the definition of the technical characteristics of the vacuum system. Two new diagnostics were designed (a spectrometer to measure the liquid metal (Gallium) erosion rate and a combined mass-energy analyzer based on a Bennet-type mass spectrometer for the study of the SOL plasma).

- *Diagnostic developments*

The ISTTOK Team performed improvements on the visible spectrometer for the monitoring of spectroscopic lines due to plasma impurities and on the heavy ion beam diagnostic (a new ion injector and a 4 channel time-of-

[4] CFN means "Centro de Fusão Nuclear"
[5] UBI means "Universidade da Beira Interior"
[6] GEI means "Grupo de Electrónica e Instrumentação da Faculdade de Ciências e Tecnologia da Universidade de Coimbra"
[7] CFA means "Centro de Física Atómica da Universidade de Lisboa"
[8] CIEMAT means "Centro de Investigaciones Energeticas Medioambientales y Tecnologicas"
[9] IPP- Kharkov means "Institute of Plasma Physics of the National Science Center" "Kharkov Institute of Physics & Technology".
[10] UI means "University of Innsbruck".
[11] IFUR means "Institute of Physics of the University of Riga"
[12] IFUSP means "Instituto de Física da Universidade de São Paulo"
[13] EFDA means "European Fusion Development Agreement"
[14] CSU means "Close Support Unit"
[15] UKAEA means "United Kingdon Atomic Energy Authority"
[16] IPP-Garching means "Max-Planck-Institut für PlasmaPhysik"
[17] CRPP means "Centre de Recherches en Physique des Plasmas de École Polytechnique Fédérale de Lausanne"
[18] IFP means "Istituto di Física del Plasma"
[19] PT means "Politécnico di Turino"
[20] DFRC means "Department de Recherches sur la Fusion Controlée".
[21] CFP means "Centro de Física dos Plasmas"
[22] ITN means "Instituto Tecnológico e Nuclear"
[23] ENEA means " Ente per le Nuove Tecnologie, l'Energie e l'Ambiente"

flight energy analyzer). Three new diagnostics were also developed and installed on ISTTOK: a H_α-diagnostic for the analysis of the light emitted at that spectral line by the limiter-plasma interaction, a new set of emissive probes[24] and a bolometer, based on AXUV[25] and UVG[26] photodiodes. IST/CFN remotely collaborated on the development of new Thomson scattering diagnostics for the tokamaks GLOBUS-M and ETE.

- *Slow control system*

A new slow control system for ISTTOK is being developed, in a hierarchical structure based on CANbus aiming at to overcome some constrains of the present system. The assembly and testing of the hardware modules and of the software developed in a distributed, decentralized, object-oriented, modular and user-friendly philosophy were finalized. Tests of the new system were performed.

- *Real-time plasma control system*

The development of this system based on 12 MHD coils proceeded in 2002. The feedback control systems of the primary current and vertical magnetic field, a SQL database for the experimental results, numerical codes for signal analysis, algorithms for the control of the plasma position and tools for the remote access to the experimental results were developed. External calibrations of the magnetic probes and of the acquisition system were performed. Tests of the performance and accuracy of the system were made.

- *Plasma physics studies*

Studies on the runaway electron characteristics in discharges with minor and major disruption events, simultaneous limiter and electrode biasing experiments and plasma potential measurements by emissive probes were carried out in 2002.

1.3.2. Participation in the collective use of the JET facilities by the EFDA Associates

CFN has proceeded with its participation in the collective exploitation of the JET Facilities by the EFDA Associates, which are operated by UKAEA. CFN activities have been concentrated on the following areas:

- *Operation*

Three members of the CFN staff belonged in 2002 to the JET Operation Team working in the Reflectometry and LIDAR Diagnostic Group and in the Motional Stark Effect Diagnostic Group.

- *Scientific exploitation*

The CFN involvement in the JET scientific exploitation included the participation of 12 scientists in the experimental campaigns C5-C7 (with Dr. Filomena Nave acting as Session Leader in several experiments) and the development of numerical codes, leading to the following plasma physics studies: (i) Comparison of the effects of enhanced radiation on ELM behaviour in JET plasmas; (ii) Study of the onset of neo-classical tearing modes in JET discharges; (iii) Study of non-linear coupling using bi-coherence analysis; (iv)Time-frequency analysis of non-stationary signals in fusion plasmas using the Choi Williams distribution; (v) Use of TRANSP

[24] Work performed in collaboration with the University of Innsbruck, on behalf of the Association EURATOM/OÄW.
[25] AXUV means sensitive from soft X-rays to ultra-violet radiation.
[26] UVG means sensitive from ultra-violet to visible radiation.

for transport analysis of the radiative improved confinement H-mode; (vi) Study of the effect of plasma shape on the TAE stability; (vii) Analysis of the Alfvén cascades instabilities; (viii) Numerical analysis of the loss of sawtooth stabilisation by ICRH driven fast particles in low density discharges; (ix) Study of the physical mechanism of the fast destruction of energy confinement that triggers major density limit disruptions; (x) Study of runaway electrons in JET disruptions; (xi) Direct measurements of the radial electric field using the upgraded MSE diagnostic; (xii) Turbulence studies with the upgraded correlation reflectometer; (xiii) Analysis of the interplay between parallel transport and poloidal flows using a new reciprocating probe; (xiv) Edge Localized Modes propagation and fluctuations in the JET SOL region using probes.

- *JET Enhanced Performance Project*

CFN was in charge of five tasks within this Project:

- Study of turbulence by microwave reflectometry (Project Leader and implementation)

The microwave and data acquisition components of this diagnostic were shipped to Culham. The diagnostic was commissioned at JET. Software was developed for the integration of the dedicated data acquisition system in CODAS, including the adaptation of a new communication protocol. Intensive tests of the microwave components and data acquisition system were made.

- Microwave access (Project Leader and implementation)

Task 1.0 report on the reflectometry frequency access range and waveguide specifications as well as Task 2.0 report on the antenna design specifications and performance were elaborated.

- Real-time diagnostic

Software for real-time analysis of the experimental data provided by the Motional Stark Effect diagnostic was developed.

- Reflectometer for the ICRH Project

A preliminary study of the waveguides was carried out taking into account the space constraints inside the tokamak. Ray tracing calculations were performed using adequate antenna patterns and typical JET plasma geometries, in order to estimate the reflectometer's performance for the foreseen antenna positioning.

- Fast Data Acquisition (FDA) Project (design and procurement activities)

Eight Fast ADC modules were developed and tested in CFN. Assembling and testing of these boards in a CODAS VME crate and installation in a CODAS cubicle near the KK3 diagnostic were made. The system software was integrated in the CODAS offline network. A system Remote Boot feature was implemented and tested to ease maintenance tasks in the case of hardware failure by allowing rapid changing of the system hard disk and backup/restore of the system software. The system was tested in the online CODAS network by acquiring real data from the JET tokamak. Collected data was analysed and compared with the data obtained from the old system using data reduction techniques on the new data in order to allow a correct comparison. The data sets were found to match almost perfectly showing the correct operation of the system.

- Management.

The Association EURATOM/IST has collaborated on the management of the collective use of the JET Facilities by the EFDA Associates in the following manner: (i) Dr. Duarte Borba as a member of the staff of the Close Support Unit to the EFDA Associate Leader for JET; (ii) Prof. Fernando Serra as a member of the EFDA Sub-Committee for JET (until 6 March 2002) and as a member of the Scientific and Technology Advisory Committee STAC (from March 2002); and (iii) Prof. Horácio Fernandes and Dr. Paulo Varela as members of the Remote Participation Users Group.

1.3.3. Participation in the ASDEX-UPGRADE Programme

The Portuguese participation in the ASDEX-Upgrade[27] (AUG) Programme has had two research lines: microwave reflectometry, and MHD and turbulence studies. Research and development activities have been carried out in the following areas:

- *Microwave systems and electronics*

Solid state switches were installed for toggling between fixed frequency and broadband operation. A 1.3 MHz high-pass 5th order Butterworth filter was developed and installed to remove the parasitic low frequency of the W band microwave signal. The intermediate frequency amplifiers of the heterodyne detection systems were replaced by more robust ones. The bandwidth in the W band channel was reduced from 75-110 GHz to 75-100 GHz in order to avoid problems in ultra fast swept operation (25 μs). The reference pin from the Q band fluctuation monitor channel was removed to accommodate the new heterodyne detection to be implemented in 2003. An heterodyne Q-band fixed frequency channel was developed using synthesizer sources, to study radial correlation parameters of plasma turbulence. A new localization for the W band antenna was assessed in view of the necessity to displace it due to the forthcoming installation of the new ECRH antennas.

- *Control and data acquisition*

The control software was re-written from scratch due to the complexity of the changes in the diagnostic resulting from the upgrades in the hardware made in 2001. The new control server was implemented together with a new client that can be used/compiled in several platforms (UNIX, Windows). The communication and logging protocols were implemented and fully tested. The graphical user interface (GUI) of the client, a Web based acquisition database, to store the information of reflectometry experiments on AUG as well as relevant physics issues related to those experiments, and a Web based logbook database for the daily maintenance and logistics related information were developed. A forum was implemented allowing discussions and conferences on the Web.

- *Data processing*

Algorithms to reject density profiles corrupted by plasma turbulence were tested. Data processing algorithms to automatically compute edge pedestal data (position, density, and width) from broadband reflectometry data were developed and implemented. 2D smoothing data analysis techniques was implemented to extract density profiles in the presence of strong plasma turbulence as well as of level 2 public shot files with the smoothed density profiles.

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[27] ASDEX-Upgrade is a tokamak of the Association EURATOM/IPP, in operation in Garching.

- *Modelling*

The plasma response in broadband reflectometry due to the presence of rotating and locked MHD modes using 1D and 2D codes was simulated. The link between the k-spectrum of non-coherent density fluctuations and the phase variations of the reflectometry signals was investigated.

- *Plasma physics studies*

The following tasks were made: (i) Study of edge density pedestral characteristics in standard and advanced plasma scenarios; (ii) Contribution to the study of the impact on confinement of inboard launched pellets; (iii) Study of the effects of type I and type III ELMs on density profiles and estimation of ELM-induced particle losses; (iv) Studies on locating rational surfaces from reflectometer fluctuations; (v) Study of the role of magnetic islands in the energy quench preceding disruptions; (vi) Study of runaway generation in tokamak disruptive events; (vii) Code developments for the analysis of turbulence and transport in the SOL of ASDEX-Upgrade.

1.3.4. Participation in the TJ-II Programme

The CFN participation in the TJ-II[28] Programme has been mainly focussed on the following areas:

- *Microwave reflectometry*

IST/CFN began the development of an heterodyne Q-band fixed frequency channel using synthesizer sources, to study radial correlation parameters of plasma turbulence.

- *Heavy ion beam diagnostic*

Test of the transimpedance amplifiers were made and new pre-amplifiers for the detected signals were developed. The multiple cell array detector (MCAD), the manipulator system and the transimpedance amplifiers were implemented on TJ-II. New deep Faraday cup type cells were developed aiming at decreasing the plasma loading effect on the measurements. An upgrade version of the dedicated control and data acquisition software was developed and installed in the TJ-II system.

- *Edge plasma physics*

The statistical properties of the radial correlation of turbulence in the TJ-II boundary region were studied.

1.3.5. Participation in the MAST[29] Programme

This Project aims at the development and scientific exploitation of a microwave reflectometer. The assembly, implementation and testing of the diagnostic were finalized. Improvements in the detection amplifiers in order to reduce the noise were carried out. Assessment of the reflectometry diagnostic performance and the first plasma measurements were performed.

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[28] TJ-II is a stellarator of the Association EURATOM/CIEMAT, in operation in Madrid.

[29] MAST is the “Mega Ampère Spherical Tokamak” of the Association EURATOM/UKAEA, in operation in Culham.

1.3.6. Participation in the TCV[30] Programme

The main objectives of this Project are the development and scientific exploitation of the following systems:

- *Horizontal Pulse Height Amplitude (PHA) spectrometer*

Routine operation of this diagnostic was performed for the measurement of the electron temperature and analysis of the line radiation in the soft X-ray range from 1 to 10 keV. Users Reference Guides were elaborated.

- *Vertical PHA spectrometer*

This diagnostic is being developed aiming at operating in almost all the TCV plasma configurations and providing real-time control capabilities, overcoming the constrains of the horizontal PHA. The spectrometer design, including the issues related with its implementation on TCV, was finalized. A CAMAC DSP based algorithm was improved aiming at meeting the experimental aims and performance. The tests of the basic components of the diagnostic were initiated. Software was developed for the utilization of a CFN DSP-based VME system on these diagnostics, aiming at achieving real-time operation for the feedback control of some TCV and diagnostic parameters. A Linux based server and control program as well as a remote graphical user interface for the implementation of the CFN DSP-based VME system in the TCV control and data acquisition system were developed.

- *Rotating crystal spectrometer*

This diagnostic is based on equipment lent by the Princeton Plasma Physics Laboratory. Cleaning up of the vacuum chamber, replacement of the gold O-rings by viton ones and test of its performance at high vacuum were carried out. Tests of the step motor support structure, CRPP manufactured amplifiers, crystals reflectivity and multichannel plates (MCPs) performance were made. Call for tenders for a new set of crystals and MCPs were initiated.

- *Advanced plasma control system*

The development by IST/CFN of a new digital plasma control system for TCV was discussed after summer 2002. This system will be based on a CFN DSP-based VME module, which was specially designed for real-time feedback control. Meetings between CRPP and IST staff to understand how the CFN DSP-based VME module could be used on TCV were held. A proposal for the upgrading of the central analogue controller of the TCV plasma control system was elaborated.

1.3.7. Participation in the ITER Project

The Portuguese participation in the ITER Project included in 2002 activities related to:

- *Diagnostics design and integration*

A member of the IST/CFN staff belonged during this year to the ITER International Team, working at Garching on the Motional Stark Effect (MSE) Diagnostic, Charge Exchange Recombination Spectroscopy and X-ray System.

[30] TCV is a "Tokamak de Configuration Variable" of the Association EURATOM/Swiss Confederation, in operation in Lausanne.

- *Microwave reflectometry*

A software tool was developed to simulate O/X mode reflectometry experiments aiming at demonstrating the possibility of measuring Bt (r) with combined O and X mode probing. First dedicated O/X mode measurements have been performed at the LFS of ASDEX Upgrade. The assessment of the reliability and accuracy of plasma position measurements from reflectometry was performed.

- *ITER Negotiations*.

Prof. Carlos Varandas, in his function as EFDA Steering Committee Chairman, participated in five international ITER negotiation meetings and chaired one meeting of the "Negotiator's Standing Sub-Group".

1.3.8. Other activities on theory and modelling

Besides the work on theory and modelling previously presented, this section reports on two topics:

- *Role of magnetic reconnection (ideal and resistive) processes in the dynamics and confinement of thermonuclear plasmas*

Studies on feedback stabilization of vertical displacement instabilities, forced magnetic reconnection in fusion burning plasma experiments and shear flow effects on tearing mode stability were carried out.

- *Non-inductive current drive*

Studies on the effects of magnetic ripple for lower-hybrid wave propagation, beam-tracing and diffraction effect studies on lower-hybrid wave propagation and development of kinetic codes for RF heating and current drive were made.

1.3.9. Other activities on control, data acquisition and signal processing

This Project aims at the development of:

- *A fast, galvanic isolated, PCI data acquisition module*

The conceptual design of the module was made. A proposal regarding the use of this module on the JET fast magnetics KC1F diagnostic was elaborated and discussed with the EFDA Culham Close Support Unit (CSU). The development of the circuit schematic has started.

- *PCI time digitisers and transient recorders*

The conceptual designs of a PCI time digitizer module and a PCI transient recorder module were made taking into account the requirement of the neutron diagnostic of the JET Enhancement Programme. A proposal aiming at the use of these modules on JET was elaborated and discussed with the Project Leader and the EFDA Culham CSU.

1.3.10. Keep-in-touch activities on inertial fusion energy

In the frame of the support to the co-ordination of European civil inertial fusion energy work, Portuguese activities were carried out in 2002 in three main research lines:

- Upgrade of the laser system

The laser system underwent two major upgrades which will allow us to obtain 200 fs pulses upon amplification to the Joule level and compression. The upgraded laser system is currently being characterised. At the high-power end, a vacuum spatial filter was assembled and installed, and a new vacuum compression stage is currently being designed, which will ensure that the amplified and compressed pulses are delivered to the target free of air-induced distortion effects. Work on Optical Parametric Chirped Pulse Amplification (OPCPA) has also started, with the purpose of benefiting from this promising amplification technique.

- Demonstration experiments on laser-triggered plasma waveguides

A series of demonstration experiments on laser-triggered plasma waveguides was performed. Plasma channels up to 25 mm long were created and characterised by shadowgraphy and shearing interferometry.

- Theory and simulation.

Some questions raised by the recent experimental and theoretical developments in fast ignition, such as the role of collisionless instabilities for the transport of ultra high current electron beams, ion acceleration in laser-thin solid interactions, and spherical targets versus cone shaped targets for fast ignition, were addressed with a combination of relativistic kinetic theory, relativistic fluid theory and massively parallel fully explicit particle-in-cell simulations.

1.3.11. Activities in the Fusion Technology Programme

The Portuguese participation in the Fusion Technology Programme included in 2002, besides the Underlying Technology work on fusion materials characterization by nuclear techniques, activities performed in the frame of four Tasks:

- TW1:TTMS–002; Deliverable D21: Impurity measurements on Eurofer 97

Several different shaped Eurofer heats (E83694, E83698 and E83699) were analysed with ion beam techniques (PIXE and RBS), Neutron Activation and ICR (Ion Cyclotron Ressonance). The distribution of the impurities was measured with the microprobe.

- TW1:TTBB–005; Deliverable D9: Surface composition investigations of Li4SiO4 and Li2TiO3 exposed to long term annealing

Both titanate and orthosilicate Li pebbles were analysed with nuclear microprobe techniques to access their chemical compatibility with Eurofer samples. The analysed pebbles were annealed for several periods of time ranging from 50h to 2000h.

- TW2:TTBB–07; Deliverable D13: Report on study of the impact of irradiation on electrical conductivity of Be pebble beds

Several 1mm Be pebble beds were filled with different atmospheres (He+ 0.1%H_2 and Ar) or under vacuum ($P<10^{-6}$ mbar) and irradiated at the ITN Nuclear Reactor. The resistivity as function of the irradiation γ field was measured for all the pebble beds.

- TW2:TTMS–002a; Deliverable D4: Eurofer microstructure characterisation: Correlation with macroscopic properties

Due to some experimental problems in the X-ray diffractometer, measurements on the heat E83699 were not finalized. The kinetics of the phase transformation and the microstructure evolution started to be studied using high resolution X-ray diffraction and both TEM and SEM analysis.

1.4. HUMAN AND FINANCIAL RESOURCES

Table 1.2 and 1.3 contain information about the human and financial resources of the Association EURATOM/IST.

Area		Type of Activity	Professionals			Non Professionals	Total
			Ph.D	Master	Graduation		
Physics	Magnetic Confinement	Research	19.45	18.0	15.40	0	52.85
		Administration	0	0	1.00	1.0	2.00
		Technicians	0	0	0	3.0	3.00
		Secretariat	0	0	0	4.0	4.00
	Inertial Confinement	Research	5.00	0	7.10	0	12.10
		Secretariat	0	0	0	0.3	0.30
Technology		Research	1.25	0	0.55	0	1.80
Total			25.70	18.0	24.05	8.3	76.05

Table 1.2 – Personnel of the Association EURATOM/IST in person year

Category	Expenditure in €
General Support	
Physics	
Magnetic Confinement	3,937,654
Inertial Fusion Energy	600,000
Underlying Technology	31,920
European Fusion Development Agreement	
Technology Tasks	160,000
Article 5 Contracts	223,851
Article 6 Contracts	123,143
Article 9 secondments	59,559
Mobility	362,990
Total	5,499,117

Table 1.3 – Expenditure (in Euros) in 2002 of the Association EURATOM/IST