

1. INTRODUCTION

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1.1. FOREWORD

This document describes the activities carried out in 2009 mainly in the frame of:

- The Contract of Association (CoA) signed in 1990 between the “European Atomic Energy Community” (Euratom) and IST, hereinafter referred to as Association Euratom/IST;
- The Contract of Associated Laboratory signed in 2001 by “Fundação para a Ciência e a Tecnologia” (FCT), hereinafter mentioned as Associated Laboratory (AL);
- Task Agreements with the European Fusion Development Agreement (EFDA);
- Contracts with the ITER International Organization (ITER IO);
- Projects of the general 7th Framework Programme of the European Unit;
- Projects of the European Space Agency (ESA);
- Projects funded by “Fundação para a Ciência e a Tecnologia”.

“Instituto de Plasmas e Fusão Nuclear” (IPFN) developed in 2009 a very large variety of research, development, technology transfer, education, training and outreach activities in the main domains of our expertise: Plasma Physics and Engineering, Controlled Nuclear Fusion, Lasers and Photonics, Space and Advanced Computing. Some events should be underlined by their relevance: (i) maintenance of a very significant participation in the JET scientific exploitation (Figure 1.1); (ii) discussion and/or signature of the important contracts with F4E, ITER IO and ESA; (iii) increase of our collaboration with industry; and (iv) hiring of five Assistant Researchers in “Ciência-2009”.

The quality of our research and development activities is well expressed by the scientific output presented in chapter 24 as well as by the international participation of several members of our staff in management bodies and in the organization of scientific conferences.

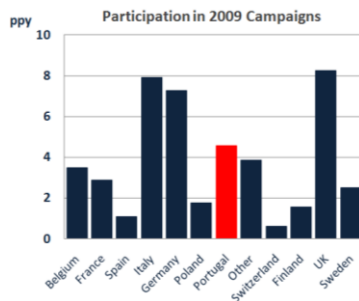


Figure 1.1 – Participation in the 2009 JET campaigns

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³Vice-President of IPFN.

1.2. ORGANIZATION

Figure 1.2 presents a block diagram of the IPFN organization. The scientific activity is organized in two Thematic Areas:

- Controlled Nuclear Fusion;
 - Technologies of Plasmas and Intense Lasers.
- and eight Scientific Groups:
- Experimental Physics on Magnetic Confinement Fusion Devices;
 - Microwave Diagnostics for Fusion Plasmas;
 - Theory and Modelling of Magnetic Confinement Fusion Plasmas;
 - Control and Data Acquisition;
 - Lasers and Plasmas;
 - Gas Discharges and Gaseous Electronics;
 - Quantum Plasmas;
 - Fundamental Physics in Space.

1.3. ACTIVITIES ON CONTROLLED NUCLEAR FUSION

1.3.1. Introduction

These activities, carried out according to the Contract of Association Euratom/IST are described in chapters 2 to 12.

The CoA frames the Portuguese participation in the Euratom Specific Research and Training Programme in the Field of Nuclear Fusion Energy, hereinafter referred as Euratom Fusion Programme. This Programme has as its long-term objective the development of a prototype commercial fusion power plant. It 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 (EU) and Switzerland (Associates); (ii) the European Fusion Development Agreement (EFDA) and the Mobility Agreement, both signed by Euratom and its Associates; and (iii) the European Joint Undertaking for ITER and the Development of Fusion Energy (F4E), signed by Euratom, the EU Member States and Switzerland.

1.3.2. Main projects of the Association Euratom/IST

The work programme of the Association Euratom/IST included activities carried out in Portugal (mainly related with the tokamak ISTTOK) and abroad related with the operation and scientific exploitation of large and medium-sized tokamaks and stellarator (JET, ASDEX-Upgrade, TCV, and TJ-II) as well as with the design and construction of the next generation fusion devices (ITER

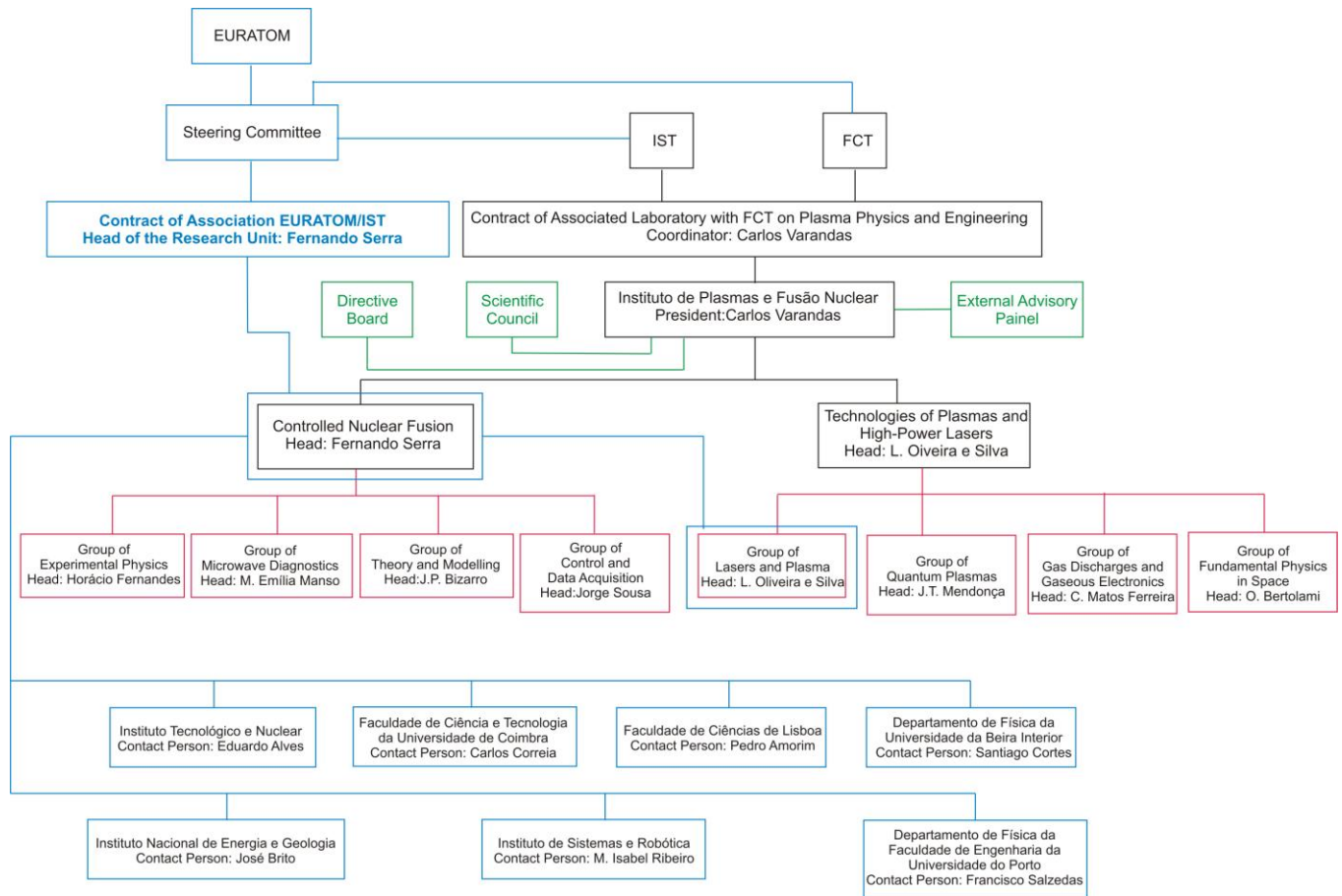


Figure 1.2 – Organization of IPFN

and W7-X). Its main projects in 2009 were:

- Tokamak ISTTOK;
- Participation in the ITER Project;
- Participation in the EFDA Programme;
- 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 COMPASS Project;
- Collaboration with the Association Euratom/CEA
- General activities on theory and modelling;
- Keep-in-touch activities on inertial fusion energy;
- Other fusion-related activities.

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

1.4. ACTIVITIES ON TECHNOLOGIES OF PLASMAS AND INTENSE PLASMAS

The activities carried out in the frame of this thematic area are described in chapters 13 to 23. The main projects in 2009 were:

- Plasma theory and simulations;

- New radiation sources from plasmas and optical physics;
- Laser-plasma accelerators and applications;
- High intensity laser science and technology;
- Coherent XUV sources and applications;
- Fast ignition and HiPER;
- Plasma Engineering Laboratory;
- Non-equilibrium kinetics and simulations of plasmas and afterglow plasmas;
- Modelling of plasma sources;
- Quantum plasmas;
- Fundamental physics in space.

Table 1.2 contains information about the responsible person(s) and the Institutions involved in each project.

| Project | Responsible Person(s) | Collaborating Institutions | |
|--|---------------------------------------|---|--|
| | | Portuguese | Other |
| Tokamak ISTTOK | Horácio Fernandes Carlos Silva | IPFN ³ , UBI ⁴ , CEI ⁵ , CFA ⁶ | CIEMAT ⁷ , IPP-Kharkov ⁸ , UI ⁹ , IFUR ¹⁰ , IFUSP ¹¹ |
| Participation in the ITER Project | Carlos Varandas Bruno Gonçalves | IPFN | EFDA CSU Garching |
| Participation in the EFDA Programme | Bruno Gonçalves Carlos Silva | IPFN | |
| Participation in the collective use of the JET Facilities by the EFDA Associates | Fernando Serra Bruno Gonçalves | IPFN, CEI, UBI | EFDA ¹² CSU ¹³ Culham UKAEA ¹⁴ |
| Participation in the ASDEX Upgrade programme | Maria Emília Manso Fernando Serra | IPFN | IPP-Garching ¹⁵ |
| Participation in the TJ-II programme | Carlos Varandas Maria Emília Manso | IPFN | CIEMAT |
| Participation in the COMPASS Project | Carlos Varandas | IPFN | IPP.CR ¹⁶ |
| Collaboration with the Association Euratom/CEA | J. Pedro Bizarro | IPFN | |
| General activities on theory and modelling | J. Pedro Bizarro | IPFN | IPP ¹⁷ , PT ¹⁸ , DFRC ¹⁹ |
| Keep-in-touch activities on inertial fusion energy | J.T. Mendonça | IPFN | |
| Other fusion related activities | Carlos Varandas | IPFN | |

Table 1.1 – Responsible person(s) and collaborating Institutions in the 2009 projects of the Association Euratom/IST

| Project | Responsible Person(s) | Collaborating Institutions | |
|---|------------------------------|---|---|
| | | Portuguese | Other |
| Plasma theory and simulations | L.O. Silva | IPFN, ISCTE ²⁰ , INESC-ID ²¹ | UCLA ²² , UR ²³ , IC ²⁴ , RAL ²⁵ , MPIQO ²⁶ , PT ²⁷ |
| New radiation sources from plasmas and optical physics | L.O. Silva J.M. Dias | | |
| Laser-plasma accelerators and applications | L.O. Silva N. Lopes | IPFN, FCUL ²⁸ | US ²⁹ , RAL, USA ³⁰ , OU ³¹ |
| High intensity laser science and technology | L.O. Silva G. Figueira | IPFN | |
| Coherent XUV sources and applications | L.O. Silva M. Fajardo | IPFN | LOA ³² , PALS ³³ |
| Fast ignition and HiPER | L.O. Silva J. Davies | IPFN | RLA, UPM ³⁴ , OsU ³⁵ , URLS ³⁶ , LULI ³⁷ |
| Plasma Engineering Laboratory | C.M. Ferreira F.M. Dias | IPFN | US, RAL, OU |
| Non-equilibrium kinetics and simulations of plasmas and afterglow plasmas | C.M. Ferreira J. Loureiro | IPFN | UV-SA ³⁸ , LSGS ³⁹ , UP ⁴⁰ , LPTP ⁴¹ , DFUM ⁴² , RISSPO ⁴³ , IPT ⁴⁴ , FG ⁴⁵ , MU ⁴⁶ , BrU ⁴⁷ |
| Modelling of plasma sources | C.M. Ferreira | IPFN, CFUM ⁴⁸ | DFUC, CSI ⁴⁹ , LPGP ⁵⁰ , LPCE ⁵¹ , LLAN ⁵² , UV ⁵³ |
| Quantum plasmas | J. Tito Mendonça | IPFN, UM ⁵⁴ | RAL, UFF ⁵⁵ , UN ⁵⁶ , UAb ⁵⁷ , RUB ⁵⁸ |
| Fundamental physics in space | Orfeu Bertolami | IPFN, CCTAE ⁵⁹ , UL ⁶⁰ | ESA ⁶¹ , JPL ⁶² , ZARM BU ⁶³ |

Table 1.2 – Responsible person(s) and collaborating Institutions in the 2009 projects of the Associated Laboratory

³ IPFN means “Instituto de Plasmas e Fusão Nuclear”

⁴ UBI means “Universidade da Beira Interior”

⁵ CEI means “Centro de Electrónica e Instrumentação da Faculdade de Ciências e Tecnologia da Universidade de Coimbra”

⁶ CFA means “Centro de Física Atómica da Universidade de Lisboa”

⁷ CIEMAT means “Centro de Investigaciones Energeticas Medioambientales y Tecnológicas”

⁸ IPP- Kharkov means “Institute of Plasma Physics of the National Science Center” “Kharkov Institute of Physics & Technology”.

- ⁹ UI means “University of Innsbruck”.
- ¹⁰ IFUR means “Institute of Physics of the University of Riga”
- ¹¹ IFUSP means “Instituto de Física da Universidade de São Paulo”
- ¹² EFDA means “European Fusion Development Agreement”
- ¹³ CSU means “Close Support Unit”
- ¹⁴ UKAEA means “United Kingdom Atomic Energy Authority”
- ¹⁵ IPP-Garching means “Max-Planck-Institut für PlasmaPhysik”
- ¹⁶ IPP.CR means “Institute for Plasma Physics – Czech Republic”
- ¹⁷ IFP means “Istituto di Física del Plasma”
- ¹⁸ PT means “Politécnico di Torino”
- ¹⁹ DFRC means “Department de Recherches sur la Fusion Controlée”.
- ²⁰ ISCTE means “Instituto Superior de Ciências do Trabalho e Empresas”
- ²¹ INESC-ID means “Instituto Nacional de Engenharia de Sistemas e Computadores – Investigação e Desenvolvimento”
- ²² UCLA means “University of California Los Angeles”
- ²³ UR means “University of Rochester”
- ²⁴ IC means “Imperial College”
- ²⁵ RAL means “Rutherford Appleton Laboratory”
- ²⁶ MPIQO means “Max Planck Institute for Quantum Optics”
- ²⁷ PT means “Politécnico di Torino”
- ²⁸ FCUL means “Faculdade de Ciências da Universidade de Lisboa”
- ²⁹ US means “University of Strathclyde”
- ³⁰ USa means “University of Salamanca”
- ³¹ OU means “Oxford University”
- ³² LOA means “LOA/École Polytechnique”
- ³³ PALS means “Prague Asterix Laser System”
- ³⁴ UPM means “Universidad Politécnica de Madrid”
- ³⁵ OsU means “Osaka University”
- ³⁶ URLS means “University of Rome La Sapienza”
- ³⁷ LULI means “LULI/École Polytechnique”
- ³⁸ UV-SA means “Université de Versailles-Service d’Aéronomie”
- ³⁹ LSGS means “Laboratoire de Science et Génie des Surfaces”
- ⁴⁰ UP means “Université de Provence”
- ⁴¹ LPTP means “Laboratoire de Physique et Technologie des Plasmas”
- ⁴² DFUM means “Department de Physique, Université de Montréal”
- ⁴³ RISSPO means “Research Institute for Solid State Physics and Optics”
- ⁴⁴ IPT means “Moscow Institute of Physics and Technology”
- ⁴⁵ FG means “Fluid Gravity”
- ⁴⁶ MU means “Masaryk University”
- ⁴⁷ BrU means “Brno University of Technology”
- ⁴⁸ CFUM means “Centro de Física da Universidade do Minho”
- ⁴⁹ CSI means “Consejo Superior de Investigaciones Científicas”
- ⁵⁰ LPGP means “Laboratoire de Physique des Gaz et des Plasmas”
- ⁵¹ LPCE means “Laboratoire Plasmas et Conversion d’Énergie”
- ⁵² LLAN means “Laboratoire des Lésions des Acides Nucléiques”
- ⁵³ UV means “Université de Versailles”
- ⁵⁴ UM means “Universidade do Minho”
- ⁵⁵ UFF means “Universidade Federal Fluminense do Rio de Janeiro”
- ⁵⁶ UN means “Université de Nice”
- ⁵⁷ UAb means “University of Aberdeen”
- ⁵⁸ RUB means “Ruhr Universität Bochum”
- ⁵⁹ CCTAE means “Centro de Ciências e Tecnologias Aeronáuticas e Espaciais”
- ⁶⁰ UL means “Universidade Lusófona”
- ⁶¹ ESA means “European Space Agency”
- ⁶² JPL means “Jet Propulsion Laboratory”
- ⁶³ ZARM BU means “Bremen University”