OVERVIEW AND MAIN RESULTS

1. Research Programme in 2009

The year 2009 is an aniversary year for the Romanian EURATOM Association. It is the ten-th year since its foundationin 1999. It is therefore an opportunity for careful evaluation our contribution to the European Fusion Research program, which necessarly must mention our achievements and also our problems or insufficiently expoited opportunities.

The presence of the Romanian Association in the large structure of the EURATOM Fusion Associates can be considered benefical for the entire program since we have provided expertise in areas of great importance for fusion research. Besides physics, we have contributed with results in the areas of technology and we have also contributed to the upgrade of the main European tokamak device, JET.

For the research groups that have been included in the Association as result of a successful Project of EFDA or EFDA-JET, the effect of working in the environment of this unique, integrated structure, with its strict rules and clear procedures has proven very useful and we can note significant progress in both the scientific production and in the managerial work.

The presentation of the results is organized in sections:

- Section I Physics of the Tokamak plasma;
- Section II Plsma Wall Interaction
- Section III Participation at JET Experimental Programme;
- Section IV Participation to the JET Enhancement Project.

Section I presents the theoretical, experimental and technological studies that represent the contribution of our Association in the frame of the EURATOM Fusion Programme. These studies are strongly correlated with the EFDA Work Programme and include collaborations with other Associations. They essentially represent developments of the research on topics to which our association contributes since several years: MHD, turbulence, coherent structures, anomalous transport, plasma-wall interaction, wall properties. The objectives for 2008 and the results obtained by the research groups are presented in the following Subsections:

1. *Interpretation and control of helical perturbations in tokamaks*
2. *Stable organized motion, coherent structures and turbulence in tokamak plasmas*
3. *The anomalous transport in plasma*
4. *Integrated tokamak modeling: Atomic Data and Providing access to the web Portal*
5. *Sheath properties and related phenomena of the plasma-wall interaction in magnetized plasmas*
6. *Physics of the Resistive Wall Modes*

Section II presents the contribution of our Association to the EFDA project Plasma-Wall Interaction. Groups from Romanian Institutes have responded to Call from EFDA and have been integrated in research that combine the efforts of several Association. The areas wer:

1. *Infra Red Thermography;*
2. *Cleaning of Wall surface using a plasma Torch.;*
3. *Application of the technology Thermionic Vacuum Arc to thestudy of the formation of ternary system Be, C and W*
4. *Deposition, errosion and also Removal of materials from the first Wall;*
5. *X-Ray tomographys of plasma and also for the study of the errosion*

The Plasma – Wall Interaction group of subjects has been developed as a particular area with the recognition of its importance by allocation of significant Priority Support by the Commission.

Section III contains a group of subjects related to the experimental work at JET. It is not included here the participation to the specific experiments in the Campaigns C20 – C25 and further in C26 and C27. The Reports regarding this participation has been forwarded to JET. Here we include short review of work intended to serve broader areas of experimental works at JET, like:

1. *Accelerator Mass Spectrometry, a method that allows the measurement of Tritium Depth Profile.*
2. *Profile reconstruction for the plasma parameters in the JET discharges. The methods of tomography have been extended with introduction of statistical measures of recognition of structures in the poloidal plane from the X-ray emmission*
3. *Determination of the field of Neutron emission fromplasma using the Super-Heated Neutron Detectors. This is a continuation of a method proposed and developed at JET by a Romanian group, which hasalready led to cross-check of previous neutron measurements.*

Section IV describes the participation to the JET Enhancement Project (EP2). This actually represents a major part of the work carried out in our Association and one of our major achievements. It contains the following subsections:

1. *Manufacturing and testing of W-coated tiles for installation in JET for ITER-like Wall Project.*
2. *Production of Beryllium coatings for iconel cladding and Beryllium tile markers for the ITER-like Wall Project.*
3. *Upgrade of the Gamma-ray spectrometer cameras KN3-NA at JET.*
4. *Tandem Collimators TCS for plasma diagnostics at JET*

In 2009 it has been examined the possibility that our Association could contribute to the F4E activities related to ITER construction.

2. Main results

Several important results were obtained in the *physics research*.

The investigation of transport processes, based on the statistical theory of turbulent fluctuations has led us to identify new regimes of diffusion in pure drift wave turbulence or in magnetic stochastic structures. Both analytical methods, inspired by the Decorrelation Trajectory Method, and numerical studies have produced results that extends our knowledge in the field of *density peaking*, generation of *zonal flows* and effect of resonant magnetic perturbation.

A group from the Association is collaborating to the code *GYSELLA* with a collision operator for the gyrokinetic simulations.

The coherent flows in plasma have been related to extrema of functionals defined on the base of field theoretical representation of two-dimensional self-organised vorticity field. The results show compatibility with the experimental observation of the profile of the rotation velocity in the poloidal plane.

In parallel it has been identified a regime of nonlinear tearing modes of the H-mode layer of rotating plasma where the perturbation is purely growing and evolves to a filamentation. This is also compatble with the experimental observations both at MAST and at JET.

The study of Resistive Wall Modes has been extended with the detailed consideration of plasma rotation in toroidal direction and with the inclusion of the neoclassical damping of the rotation. The calculations are mainly analytical but they produce explicit quantitative results on the region of stability of the RWM relative to the space of parameters.

The experiments on the sheath properties have been contined in the framework of the cooperation with FOM Association. The main components as well as the data acquisition system were designed and manufactured in A. I. Cuza University.

The participation to the Integrated Tokamak Modeling effort within EFDA Workplan has been pusued along the two main direction: support for the informatics in relation with the WEB Portal and production of Atomic and Molecular Data accessible to any fusion applications.

Plasma Wall Interaction

In the year 2009 a substantial effort has been directed to works that have been done within Plasm Wall Interaction project of EFDA. This has implied seven Task Agreements (where also are included the Topical Group Special TGS two tasks). One objective has been related to the cleaning of the first wall by using a plasma Torch, where properties of the device working in atmospheric pressure have been revealed for possible broader applications.

The components of triple nature, of elements that are present and can interact under energetic edge plasa, i.e.: Beryllium, Carbon and Tungsten, have been investigated by preparing samples by the Thermionic Vacuum Arc technology which have been further analysed by laboratories in other Association.

Similarly, the group that has developed the technology Combined Magnetron Sputtering and Ion Implantation has produced samples that have been used for LIBS diagnostics. In addition the investigation of errosion of CFC coated by tungsten has continued.

JET Experimental program

The reconstruction (neutron and gamma-ray tomography) method and a code for determining the neutron emission profile in JET were developed and tested. A new technic, relying on Maximum Likelehood principle (also used in astrophysics, etc.) has been developed and applied for the JET plasma profiles of parameters.

A new subject has been started in 2009: the Tritium Depth Profile measurement, using the AMS method.

JET Enhancement Project EP2

The EP2 research and technological support has continued in 2009 with the main projects that have been started before:

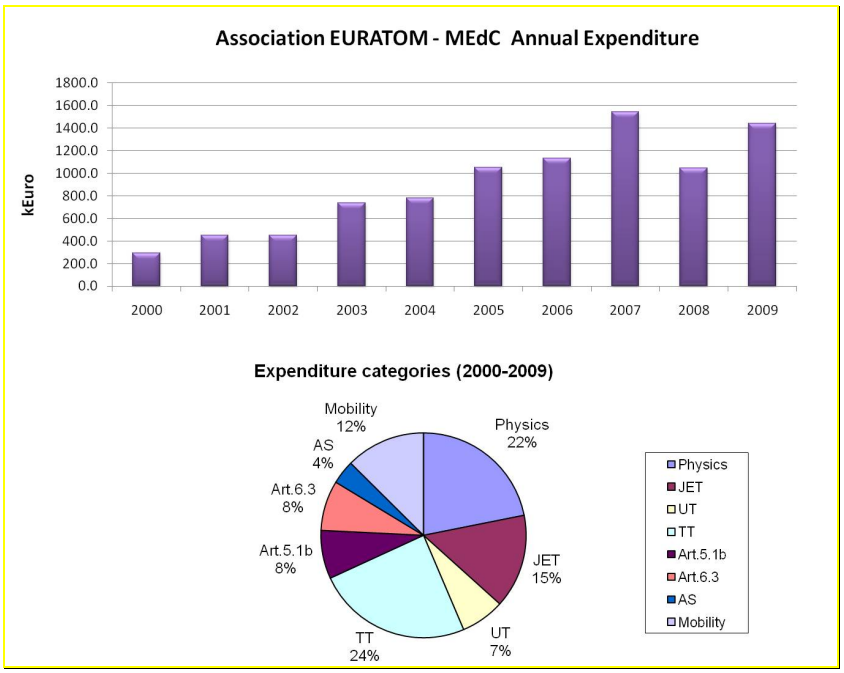
- *W-coating of divertor tiles for installation in JET for ITER-like Wall Project.*
- *Be-coatings for iconel cladding for the ITER-like Wall Project*
- *Gamma-Ray Spectroscopy*
- *Enhancement of the Diagnostics at JET (KN3-NA and TCS)*

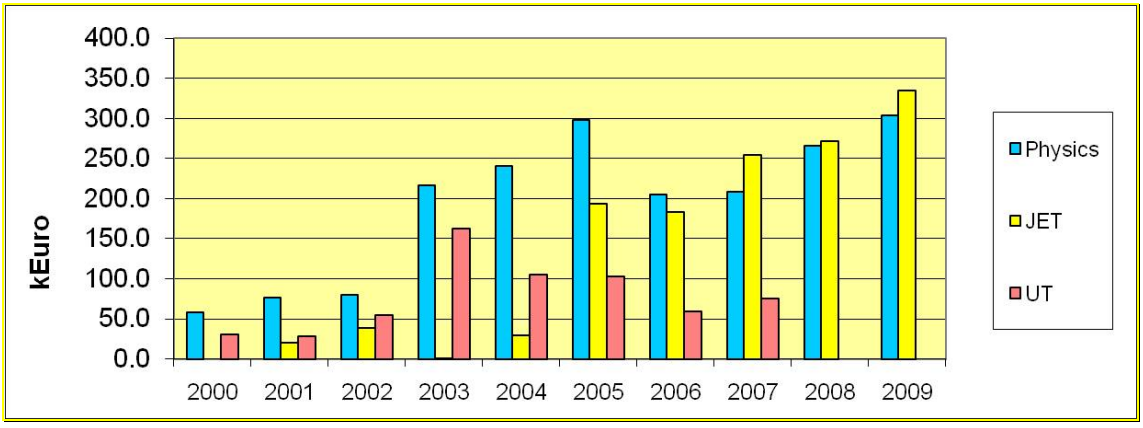
The *manufacturing* phase has been continued. At the beginning of 2009 it has been proposed by JET to extend the application of the coating with Tungsten to the tiles belonging to the *divertor* of the tokamak. This is a major challenge since it is question of coating with a double layer of a final width of 25 microns of Tungsten on CFC. The CMSII has proven to be able to produce samples of a quality that has fullfilled the constrained imposed by the regime of plasma in the divertor zone.

This remarkable success of the group of Ruset et al. has been mentioned several times in the documents of the Commission, of EFDA anf of JET. All these documents are placed on the web page of the Association.

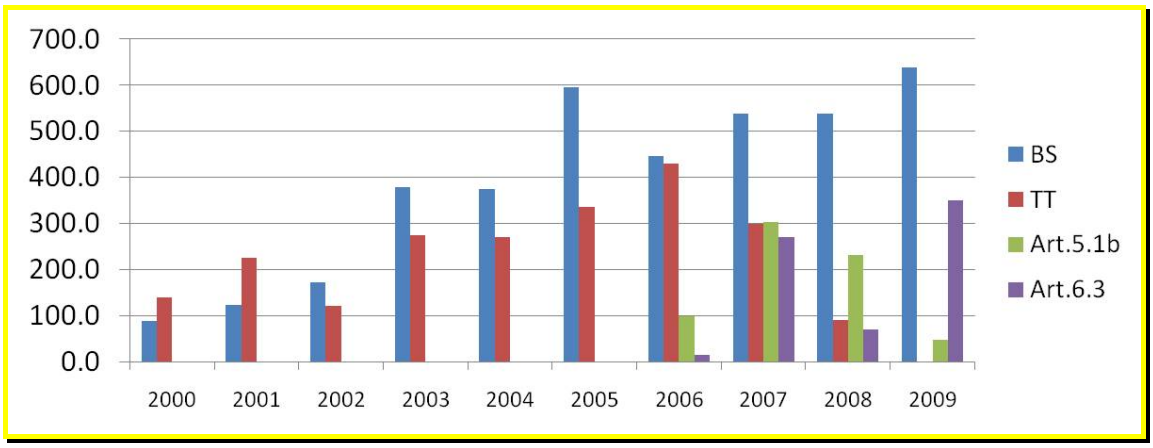
In end 2009 one of the colleagues from our Association (L. Zoita) has been selected to become a member of the CSU Culham of EFDA at JET, as responsible officer for Enhancement Project 2, with particular tasks related to Tungsten and Beryllium Orders.

Resumative graphs showing the evolution of the Association in the years 2000 – 2009

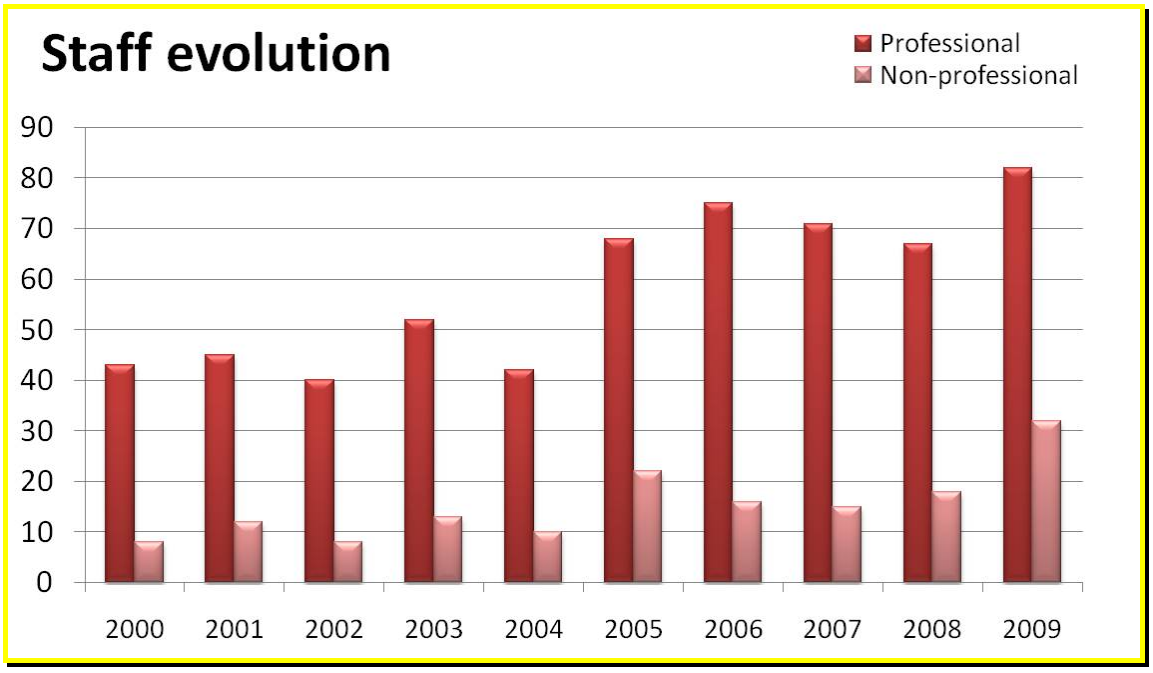


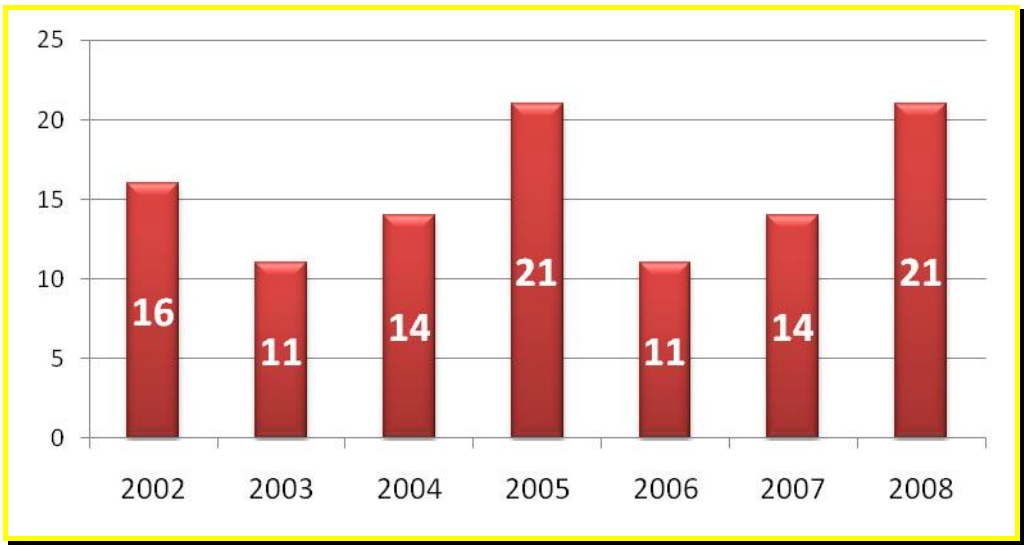


Baseline expenditure structure (Physics, JET Notifications,Technology)

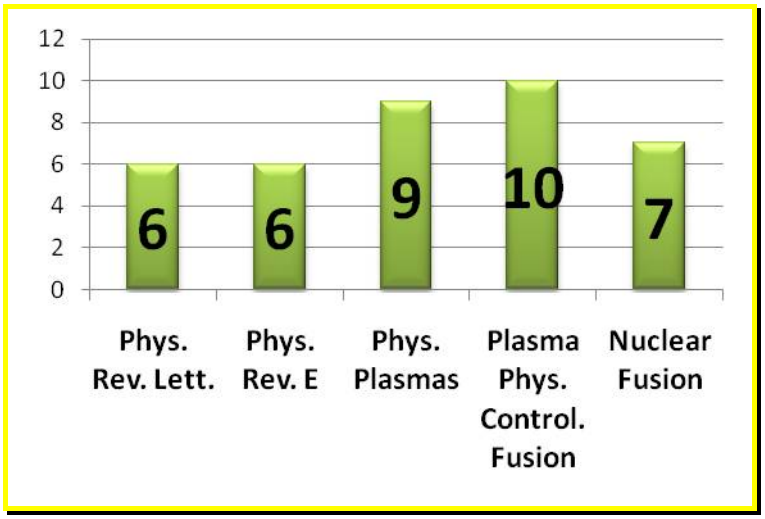


Expenditure structure evolution (Baseline, Technology Tasks, Art. 5.1b, Art. 6.3)

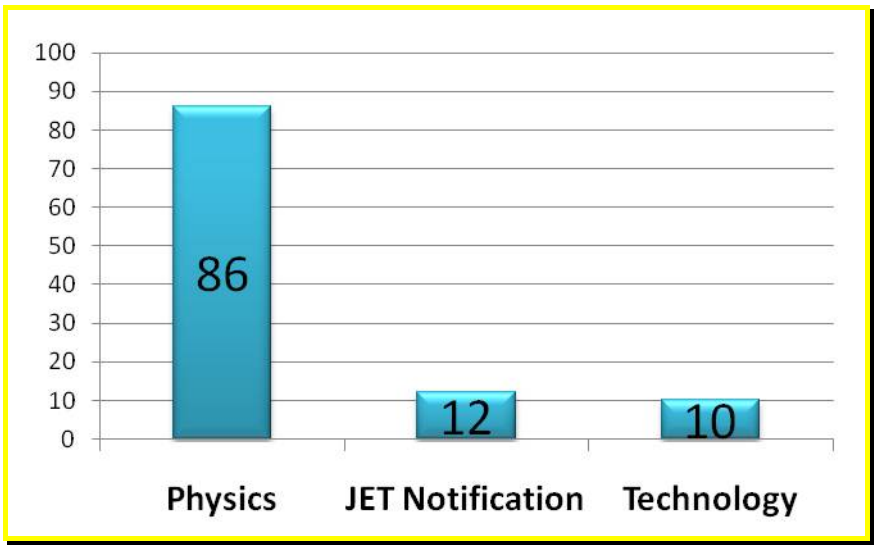




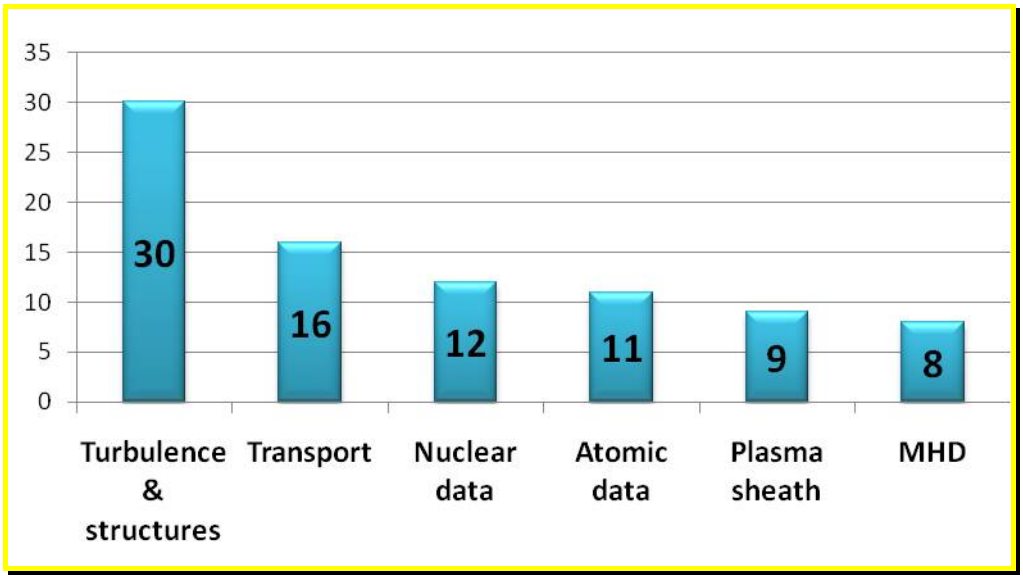
ISI papers/ year



Papers/ main Journals



ISI papers/ activity type



ISI papers/ domain of research

3. Organization

The Fusion Research Unit is coordinated by the Institute of Atomic Physics. It contains research groups from several institutes located in several towns in Romania:

- National Institute for Laser, Plasma and Radiation Physics (NILPRP), Magurele-Bucharest;
- "Horia Hulubei" National Institute of R&D for Physics and Nuclear Engineering (IFIN-HH), Magurele-Bucharest;
- National Institute of R&D for Cryogenics and Isotope Technologies (ICIT), Ramnicu Valcea;
- University of Craiova (UCv), Craiova;
- "Al. I. Cuza" University (UAIC), Iassy.

4. Collaborations

A strong collaboration with JET was developed in the last three years. As in last year, more than half of the 2009 budget for the Baseline Research was reserved for this collaboration.

We have continued the collaborations in the Euratom system. The most active collaborations in 2009 were with:

- Association EURATOM-Etat Belge, Universite Libre de Bruxelles
- IPP Garching, Tokamakphysik
- Association EURATOM - CEA sur la Fusion, IRFM, Cadarache and Universite de Provence, Marseille, France.
- Association EURATOM – Sweden, Chalmers
- Association EURATOM/ÖAW, Innsbruck University, Austria
- Association EURATOM/FOM, FOM Institute for Plasma Physics "Rijnhuizen", The Netherlands

5. Meetings

The Association Day 2009 has been organised in Bucharest, on 26-27 November.