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newsletter

EUROPEAN FUSION DEVELOPEMENT AGREEMENT

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Contents

- ITER / FP7 page 1
- Event: Potočnik opens Fusion Expo page 2
- Events: IPP Summer Uni page 3
- Associations: Stochasticity in Fusion Plasmas page 4
- EFDA News page 5
- JET: The ITER-like Wall Project page 6
- Associations: Studies at IPP/CR page 7
- Events: - Italian Scentific Culture Week - EIROforum page 8

http://www.efda.org

News

ITER: the next steps (Competitiveness Council - 18 April 2005)

The Council welcomed the progress achieved together with all the partners, and notably the constructive meeting between Commissioner Potočnik and the Japanese Minister Nakayama on 12 April 2005.

The Council reaffirmed its conclusions of November 2004. It recalled that the European Council on 22/23 March 2005 stressed the need to begin building ITER on the European site by the end of 2005 and called on the Commission to make every effort to achieve that aim, in particular by finalising the international agreement by July 2005. The Competitiveness Council will make every effort to respect, in all certainty, the timetable laid down by the European Council for the finalisation of the international agreement on ITER.

The Council invited the Commission to accelerate the necessary preparatory work for the conclusion of the international agreement so that it can be finalised by the Luxembourg Presidency.

It also invited the Commission to intensify contact with the partners with a view to concluding with a maximum number of partners within the envisaged timeframe, a six partner solution remaining the preferred option of the Council.

Building the Europe of Knowledge: the EU's Proposal for the 7th Research Framework Programme (2007 - 2013)

On 6 April the European Commission adopted a proposal for a new EU programme for Research. The proposal provides new impetus to increase Europe's growth and competitiveness, recognising that knowledge is Europe's greatest resource. The programme places greater emphasis than in the past on research that is relevant to the needs of European industry, to help it compete internationally, and develop its role as a world leader in certain sectors. The programme will also for the first time provide support for the best in European investigator-driven research, with the creation of a European Research Council.

The Commission proposes in particular to double the FP7 budget compared with FP6, rising to EUR 67.8 billion over the period 2007-2013.
Fusion is included in this proposal with 2167 MEuro under the EURATOM part.
The adoption of the final programme is expected by Mid 2006.

Jožef Stefan (1835-1893) was a Slovenian physicist, mathematician and poet. He published nearly 80 scientific articles. He is best known for originating the law stating that the total radiation from a black body is proportional to the fourth power of its temperature. He provided the first measurements of the thermal conductivity of gases, treated evaporation, and, among others, studied diffusion and heat conduction in fluids. Very important are also his electromagnetic equations and works in the kinetic theory of heat.

Every year, the Jožef Stefan Institute (JSI) celebrated Stefan's birthday with a series of events devoted to important scientific achievements in Slovenia over the past year and awards to the best doctoral theses in the fields of natural and engineering sciences. The week of "Stefan's Days" also included an open day at the institute's two sites - in Ljubljana and at the Reactor Centre in Podgorica, and an exhibition, this year the Fusion Expo in the Ljubljana city centre.

Events

Commissioner Potočnik opens Fusion Expo in Ljubljana

In its journey around Europe, presenting the progress of fusion research, the Fusion EXPO stopped for two weeks in Slovenia. The opening ceremony took place on March 21st, close to the birthday of Jožef Stefan, the great Slovenian scientist, whose name was taken by the leading research institute in Slovenia, which hosted the Fusion Expo. The aim of the event was to attract the general public, especially young people and to promote the European fusion research programme by describing the fundamentals of this discipline in a clear and simple way.

The exhibition was opened by the European Commissioner for Science and Research, Dr Janez Potočnik. "Europe has been involved in fusion energy research from its inception, and has developed a leading role", said Potočnik. He stressed Europe's readiness to build and operate ITER with the widest possible international cooperation, and with the aim to start construction this year. The audience was addressed by the Director of the Jožef Stefan Institute (JSI), Prof. Vito Turk, and by the State Secretary from the Ministry of Higher Education, Science and Technology of the Republic of Slovenia, Dr Janez Možina, who expressed the will of the ministry to support fusion research in Slovenia. Members of the newly founded Slovenian fusion Association were also present, as well other representatives of the European Fusion Programme.

Dr Milan Čerček, the promoter of the Slovenian fusion Association, guided the distinguished guests through the exposition. The Commissioner praised the instructiveness of the presentation and the way of promoting this potential source of energy for the future. He acknowledged the contribution of the Slovenian scientists and congratulated both the JSI and the University of Ljubljana for having established the Slovenian/EURATOM Association. In the visitors' book Dr Potočnik expressed his belief, that "all those that strive for the future should be supported and listened to".

EU Commissioner Dr Janez Potočnik (right), and the Director of the Jožef Stefan Institute, Prof. Vito Turk, cut the ribbon in front of the ITER model

On the same day, with the first Steering Committee meeting of the newly established Slovenian Fusion Association (SFA), Slovenia officially joined the European fusion community.

In the following days, ten guides, mostly researchers from the JSI with an expertise in fusion, guided about 2500 visitors through the exhibition. Both the questions posed during the visits and the number of visitors were an excellent indicator of the success of the Expo. The plasma ball, the small plasma magnetic-confinement experiment, the ITER model and the 3D film, Starmakers, were the main attractions of the exhibition.

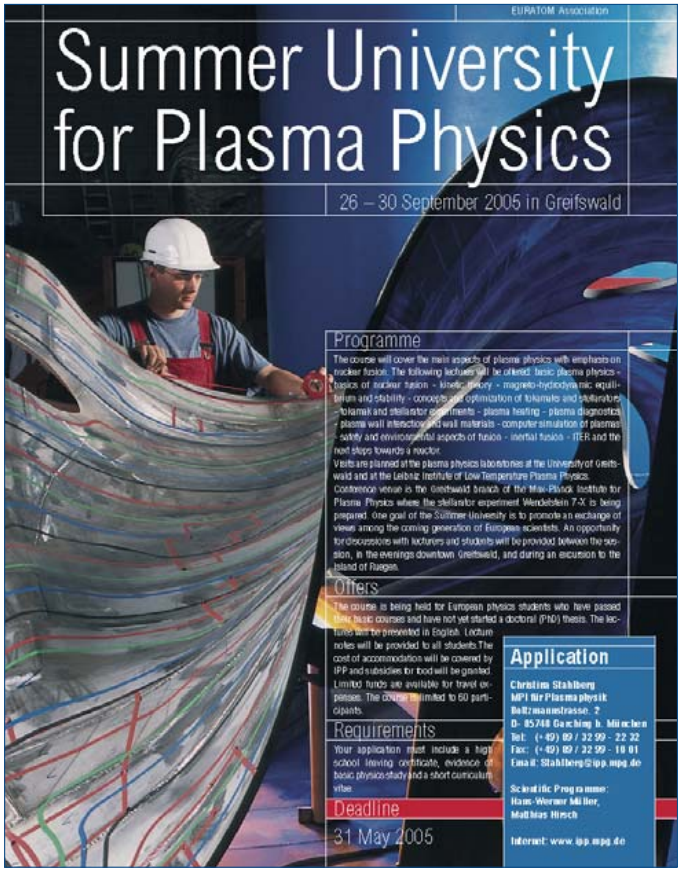
The Expo was visited by the majority of Ljubljana's secondary schools and many technical faculties triggering a favourable public opinion on fusion and a larger interest in science and engineering studies. The presence of the Expo in Slovenia will hopefully trigger a larger public awareness of the energy problem and of the opportunities provided in fusion research.

IPP Summer University for PlasmaPhysics 2005

From September 26 to 30 the Greifswald Branch of the Max Planck Institute for Plasma Physics (IPP) will host the “IPP Summer University for Plasma Physics”.

The course will cover the main aspects of plasma physics with emphasis on nuclear fusion. Lectures will also be offered on industrial plasma applications, complex and dusty plasmas, computer simulation of plasmas, safety and environmental aspects of fusion, as well as ITER and the next steps towards a reactor.

Opportunities for discussions with lecturers and students will be provided between the sessions, in the evening in downtown Greifswald, and during an excursion to the Island of Rügen.



Visits are planned to the plasma physics laboratories at the University of Greifswald and to the Leibniz Institute of Low Temperature Plasma Physics.

The course is intended for European physics students with a basic qualification in physics, but who have not yet started a doctoral (PhD) thesis.

Greifswald is the site where IPP is preparing for Wendelstein 7-X, the new stellarator experiment.

For **more information** on the Summer University and on Wendelstein 7-X:

http://www.ipp.mpg.de

Associations

Second Workshop on Stochasticity in Fusion Plasmas

More than 50 scientists from 10 countries came to Jülich (Germany) between March the 14th and 17th 2005 to discuss recent progress in the understanding of stochastic phenomena in nuclear fusion. The series of international workshops on "Stochasticity in Fusion Plasmas" (SFP) has been initiated by the Research Centre Jülich Association in October 2003 because of growing interest in the effects of magnetic field ergodisation within the magnetic confinement fusion community. TEXTOR's Dynamic Ergodic Divertor (DED) is a pioneering experiment in this context.

In particular the role of ergodic magnetic fields for transport and stability is increasingly recognised. This is not only triggered by the hope to develop new methods for particle and heat exhaust in fusion reactors. In addition, a better understanding of transport around the stochastic tips (in jargon “tangles”) of magnetic islands due to tearing mode instabilities is strongly desired. One of the most prominent results from stochasticity research so far is that edge ergodisation can reduce or even suppress large type I ELMs - which is a very beneficial development for next generation devices. Respective experiments have been carried out at the DIII-D tokamak, and it is currently being investigated if and how far the physical findings can be transferred to JET and ITER.

Many contributions proved the importance of ergodisation not only for specific tokamaks but also for stellarators. Specially designed experiments have shown the chaotic transport of particle fluxes in the boundary layer of several fusion machines and the importance of ergodisation for disruptions. A major fraction of the presentations was devoted to the new results obtained from TEXTOR's Dynamic Ergodic Divertor - covering divertor properties, transport in ergodic magnetic fields and the excitation of modes by externally imposed field perturbations.

As the ergodised structures are of a three dimensional nature, advanced 3-D transport codes had to be developed which are based on Monte Carlo solution techniques for MHD equations. These codes have been applied successfully both to tokamaks and island divertors of stellarators. For the study of the nonlinear dynamics in ergodic systems new mapping techniques have been introduced. The mappings concern both the tracking of the magnetic field lines and that of the particle orbits. Another subject of interest was the penetration of external magnetic perturbation fields into the plasma - there leading to the excitation of tearing modes and to a force transfer from the external system to the plasma.

The workshop has addressed these three topics:

- mitigation of ELMs by ergodisation of the edge magnetic field lines,
- experimental results from ergodised plasmas, and
- theory development for ergodic systems.

The next SFP workshop will be held in Jülich in 2007.

More information can be found at http://www.fz-juelich.de/sfp/, including all talks and contributions from the participants.

EFDA News

EFDA Releases its Conceptual Study on Commercial Fusion Power Plants

In April, EFDA released the final report of the European Fusion Power Plant Conceptual Study (PPCS).

The study examined four plant models, all based on the tokamak concept.

The results for two models suggest that a first commercial fusion power plant, one that would be accessible by a “fast track” route of fusion development, with ITER and the successful qualification of the materials, will be economically acceptable. These models rely on plasma performances marginally better than the design basis of ITER. The results for the other two models illustrate the potential for more advanced power plants. The study also confirms the safety and environmental advantages mentioned in previous studies.

The report is available on the EFDA website with the following path:

>> Downloads
>> EFDA Reports

Launch of Enhancements for a possible use of JET beyond 2006

At its 27th meeting, held in Cascais, Portugal, on 4 April 2005, the EFDA Steering Committee approved the launch of 3 projects for upgrading JET, as part of a proposed "JET programme in support of ITER". This programme had received a very positive support from the EFDA Scientific and Technical Advisory Committee (STAC) on 14 December 2004. The 3 projects are the "ITER-like wall", the "Neutral Beam Enhancement" and the "High frequency Pellet injector". The engineering design has started and the first call for tenders are being prepared. In addition, proposals for diagnostics and plasma control are in preparation and will be presented at STAC in June.

The operation of JET beyond 2006, as part of the ITER Accompanying Programme, remains subject to the approval of an appropriate funding for the next Framework Programme (FP7). Commission's proposals for FP7 published on 6 April contain promising news in this respect, including a substantial increase of the fusion funding under EURATOM. Dr Pablo Fernandez Ruiz, Director in charge of energy research in the Commission, commented that "the proposed budget for fusion, if adopted by the Council, would enable realising ITER and permit at the same time a vigorous Accompanying Programme."

The implementation of the “ITER-like” wall and “Neutral Beam Enhancement” is foreseen to be conducted during a shutdown in 2008 for exploitation in 2009 and 2010.

President of the National Commission for Nuclear Energy of Brazil visits JET

On the 18th of April, Dr Odair Dias Gonçalves, President of the National Commission for Nuclear Energy of Brazil, Dr Paulo Wrobel, Adviser of Science and Technology, Embassy of Brazil and Minister Ana Maria Sampaio Fernandes, Head of Economic and Commercial Sector of the Embassy visited the JET facility. Dr Odair Dias Gonçalves was welcomed by Dr Michael Watkins representing the EFDA Associate Leader for JET (Jerome Paméla), Sir Chris Llewellyn Smith, Chairman of the EURATOM Consultative Committee for Fusion and Head of the EURATOM-UKAEA research unit, Dr Pascal Lallia European Commission, representing Energy Research Director Pablo Fernandez Ruiz, Dr Chris Carpenter and Dr Duarte Borba.

After some introductory discussions, Sir C. Llewellyn Smith presented fusion and the Fast Track approach while M. Watkins explained the role of JET, emphasising its unique capabilities for the preparation of ITER.

Dr Odair Dias Gonçalves showed a great interest in fusion research and on the possibilities for Brazil to co-operate on fusion with EURATOM, in particular on possible participation in the EFDA JET Workprogramme and in ITER.

The following tour of the JET facility allowed the delegation to visit the control room, the remote handling and tritium storage facilities.

JET

The ITER-like Wall Project at JET

One of the main challenges for ITER, and for fusion reactors, is the compatibility between a reactor-grade plasma and the first wall. The first wall requirements are that it must not contaminate the plasma and degrade performance, while the plasma must neither damage the wall nor shorten its lifetime. Limited use can be made of CFC (carbon fibre reinforced carbon), which is a robust material under high heat loading, as it could lead to high tritium retention, and the ITER tritium inventory needs to be strictly controlled.

The combination of materials proposed for the ITER first wall (see details in the box) has never been tested in a tokamak, let alone in one with ITER-relevant geometry and plasma parameters. Recently, approval has been given to conduct such a test on JET, with the installation of an ITER-like first wall in 2008.

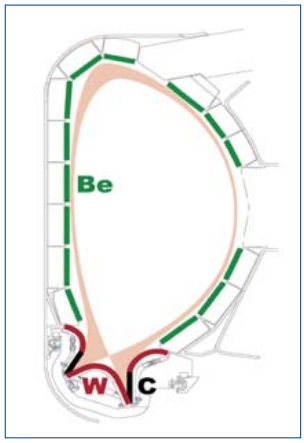
For tungsten plasma facing components, tungsten-coated CFC tiles could be appropriate. A 3.5 μm coating technology has already been tested in situ, but this may not be sufficient for the full range of experiments envisaged. A research programme is currently underway to test the suitability of coatings of various thicknesses, exposed to power loading in a neutral beam test bed. The outcome will determine whether tungsten-coated CFC is suitable, and what thickness will be required. Should coated CFC not be deemed suitable, the alternative would be to use solid tungsten tiles. Tungsten will also be used for neutral beam shine-through protection tiles. These tiles may also be modified for improved inertial or interpulse cooling, to extend Advanced Tokamak operation to 20 s pulses. During the one year installation period, extensive use of remote handling technology will be made to implement the new first wall and divertor.

Following installation in 2008, the JET experimental programme will focus on optimising operating scenarios compatible with the ITER-like wall. The level of retained tritium and its dependence on plasma scenarios will be determined, and detritiation techniques will be tested. Plasma performance will be tested to show that the level of tungsten reaching the core is acceptably low. The lifetime of the wall will be studied with ITER-relevant power loading provided by increased neutral beam heating power. This level of heating power is expected to produce ELMs and disruptions which could cause melt damage to the first wall. The performance and life of the wall will be studied in the presence of such events, and mitigation techniques for ITER will be demonstrated and optimised.

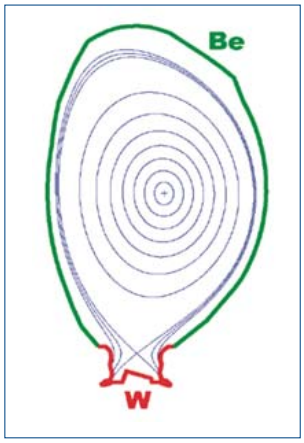
The ITER design comprises a beryllium-clad first wall in the main chamber (to suppress carbon migration which co-deposits tritium in the divertor region), CFC at the divertor strike points (to handle the highest heat loads), and tungsten for the rest of the divertor (to handle higher heat loads than beryllium can, while minimising carbon sources).

Two designs of the ITER-like wall are under consideration for JET. The reference design consists of a beryllium wall in the main chamber and an all-tungsten divertor. Another option is to use CFC tiles at the divertor strike points, which would make the material choices identical to those in the ITER design. A final choice between these two options will be made in 2006.
Preparations for installation of the new wall have been progressing rapidly, following final approval of the project in April 2005.

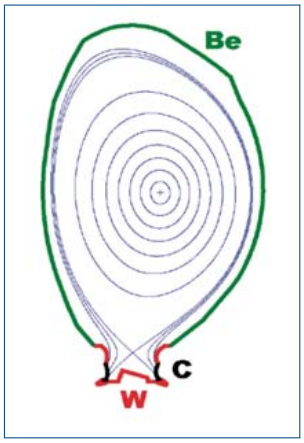
The ITER-like wall programme on JET will benefit from expertise gained at ASDEX Upgrade on tungsten coating of carbon tiles. There is also a synergy between the objectives of the two programmes: ASDEX Upgrade is exploring the viability of a tungsten first wall (tungsten is considered the long-term front runner as a material for fusion reactors), while JET will be looking at more immediate ITER needs. Both experiments will confront the challenge of operation with an all-metal wall but tackled from two different directions, low Z (beryllium) and high Z (tungsten), providing highly complementary data.



Reference design for ITER first wall; backup/second stage design has an all-tungsten divertor



Reference design for wall change on JET - matches ITER backup/second stage design.



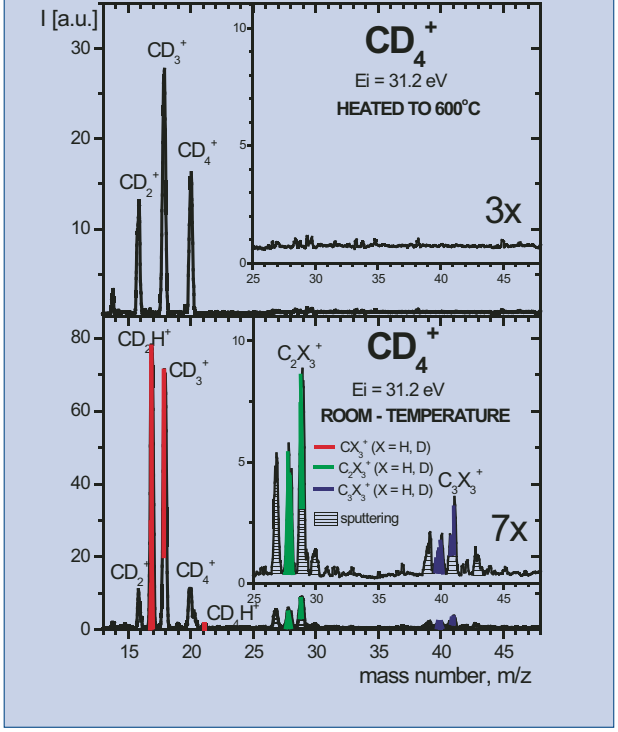
Alternative design for wall change on JET - matches ITER reference design

N.B. The cross sections of JET and ITER are not in the same scale.

Associations

Studies of hydrocarbon ion collisions with carbon surfaces in the Association EURATOM-IPP.CR

Plasma-wall interactions represent an important aspect in operation of fusion devices. Hyperthermal plasma particles may collide with solid surfaces such as limiters or divertors eroding the material by chemical and physical processes. Earlier data on chemical erosion of graphic material under the effect of hydrogen discharge (simulating conditions of the ITER divertor) showed production of considerable amounts of methane. Importance of collisions of slow (1-50 eV) molecular, namely hydrocarbon ions with parts of divertor surfaces (carbon, tungsten) and at the same time lack of such data has been repeatedly emphasised. With this motivation, interaction of low energy ions with carbon surfaces was investigated in the J. Heyrovsky Institute of Physical Chemistry, Academy of Sciences, Prague as a part of studies aimed at extending the manifold of atomic and molecular data for edge plasmas.



The interaction of hydrocarbon ions (see box) striking a carbon surface (Highly Ordered Pyrolytic Graphite, samples of Tokamak tiles) under a preselected angle was investigated in beam scattering experiments using mass spectrometric techniques. These experiments showed clearly that, at room temperature, the carbon surface was covered by a hydrocarbon layer (presumably backstreaming of cracked hydrocarbons from the vacuum system). Indeed, it is well known that the hydrocarbons form a stable surface coverage under most conditions, and are very difficult to avoid even in non-fusion high vacuum systems. If the studied surface was heated to above 600°C, the product ions were only undissociated projectile ions and their fragmentation products resulting from inelastic collisions with the carbon surface. A mass spectrum of product ions for collisions of the CD_4^+ projectile (energy 31.2 eV) on a heated surface is shown in the figure, upper part. If the surface was at room temperature, both fragmentation and chemical reactions of the projectile ion with the surface material were observed (see figure, lower part), which proves the presence of the hydrocarbon layer. The chemical reactions were (a) transfer of H-atom from the surface material, formation of a protonated projectile (CD_4H^+) and its fragmentation products (red peaks in the figure) (b) carbon-chain build up reaction (green and blue peaks) in an interaction of the projectile ion with the terminal CH_3- groups of the surface material.

These results not only allow for more detailed understanding of the plasma-wall interaction, but also can motivate for diagnostics applications. For example, removal of the hydrocarbon layer by heating above 600°C could be sensitively checked by the above mentioned facile H-atom transfer reaction.

The following ions were under studies: CH_n^+(n=3-5), $C2H_m^+$(m=2-5), $C_3H_p^+$ (p=3-8) and their D and ^{13}C isotopic variants, incident energies 10-50 eV.
The survival probability of these ions on the surface ranged from 0.3% (CH_4^+) to about 10% (CH_5^+) for incident angle 30° with respect to the surface and decreased steeply with increasing incident angle (about 5-10 smaller for 50°).

Article provided by:

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For more information:
http://www.jh-inst.cas.cz/

Events

The Italian Scientific Culture Week

The 15th edition of the "Scientific Culture Week" promoted by the Education, University and Research Ministry took place in Italy between the 14th and 20th of March.

These events are considered important as they promote and test the ambitious project of the Government in its promise to guarantee a certified and updated scientific and technical information that will enhance Italy's scientific value.

In the framework of the World Year of Physics, one of the themes was: "Energy as a basis of the modern society".

At the ENEA Frascati Research Centre on March 14th an "Open Day" took place with talks on fusion and optical technologies, guided visits to the laboratories and to the FTU facility. A show was organised with interesting experiments in different fields such as superconductivity, optics with laser sources, biology and air pollution measurements.

The other days of the week were devoted to visits from schools.

More than 1500 people (students, teachers, single people and families of employees), 600 only for the "Open Day", visited the centre. Many questions on safety, environmental impact and time scale of a future fusion power plant were addressed to the researchers, showing the great interest of the public in fusion as energy source.

The Scientific Culture Week's aim was to diffuse a solid and critical technical scientific culture and to open communication and exchange channels between the human society (*in primis* the school) and the research world (Universities, Institutes, Industry, etc).

More information on the ENEA Frascati Research Centre and on FTU is available at:

http://www.fusione.enea.it/

EIROforum presents its Paper "Towards a Europe of Knowledge and Innovation"

On April 20, EIROforum, a collaboration between seven European intergovernmental scientific research organisations (CERN, EFDA, EMBL, ESA, ESO, ESRF, ILL), presented to EU Science and Research Commissioner Dr. Janez Potočnik their joint paper "Towards a Europe of Knowledge and Innovation".

This forward-looking document sets out comprehensive proposals for the future of European scientific research. Its objective is to further reinforce the close ties between EIROforum members and the European Commission. This increased collaboration, combined with the individual expertise of each of the EIROforum partners, should provide a strong boost to European research, and to the Lisbon Goals of Knowledge for Growth.

At the event to launch the paper, the EU Commissioner defined EIROforum "as a pillar in the ongoing construction of the European Research Area".

He also added that "EIROforum partners are a crucial driving force in European research. They are evidence of the usefulness of a pan-European approach to meet some of the biggest challenges in research today, demonstrating that working together can achieve more than any individual effort."

For **more information** see:

http://www.eiroforum.org

For more information see our EFDA website:

http://www.efda.org

and additionally

http://www.jet.efda.org

http://www.iter.org

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