Vol 2002 / 4
December 5, 2002

newsletter

EUROPEAN FUSION DEVELOPEMENT AGREEMENT

Issued by the EFDA Close Support Unit Garching

Contents

http://www.efda.org

New EFDA Leadership in 2003

Departing EFDA Leader will Continue to Support ITER through Active Research

"With December 31, 2002 I am leaving EFDA to return to my research position with the Max-Planck Institut für Plasmaphysik in Garching. Dr. Jérôme Pamela, EFDA Associate Leader for JET, will fill, ad interim, also the EFDA Leader's position, until the nomination of a definitive successor.

When I joined EFDA it was primarily with one mission in mind: to advocate the construction of ITER at all levels, including also that of our own community. Shortly after the start of my tenure, a dramatic thing happened (without my involvement, except perhaps through the magic powers of wishful thinking): a proposal for a European site was brought forward by CEA. This changed things dramatically within our community, and of course the second EU site proposal by Spain further enhanced the feeling of confidence now prevailing. I think enthusiasm for ITER is now a highly infective state of mind, which – as the colleagues who were with me in Snowmass can testify – has by now swept also over the US community and seems to spread rapidly into China, South Korea, India, etc. For the next phase, physics in the work for ITER will step behind technology and project management skills and also legal and diplomatic capabilities.

Physics will come back to central stage, once ITER will start operating. ITER is foremost a facility for experiments on burning plasmas. But even in the technology oriented language of reactor studies, the plasma is the central and most complex subsystem of a fusion reactor, and its functioning will be the contribution of us physicists.

If I can use this occasion to leave one grain (or rock?) of wisdom with our community, I would make the following statement:


Prof. K. Lackner — Prof. A. Bradshaw Director of IPP

It is misleading to think of ITER as one experiment, whose success hinges on the attainment of a precise set of parameters. ITER is rather a facility, which can cover a broad operating space, and the phase space where it will pursue and find success is very large. It is instructive to look at the frequently quoted graph of the triple product $n\tau$ vs. years, not for the quantum jumps, which accompanied each new device, but for the big progress we have made on each given device (take the JET and JT60-U points, as prime examples) by learning (and sometimes luck).

I will now return to active research at IPP. We have, by now, a quite solid knowledge at least of the standard operating regime of tokamaks and how it extrapolates from one device to the other. We know much less about the detailed physics behind it. Searching for the latter promises to give us clues for further performance improvements, and – to be honest – is also big fun. I plan to get a share of this fun.

Merry Christmas and a happy New Year to all EFDA Newsletter readers !"

Prof. Dr. Karl Lackner, EFDA Leader

ITER

In September 2002 the Institute for Plasma Physics (IPP) at Garching (Germany) invited **Prof. Dr. Carlos Alejaldre** from CIEMAT (Spain) and **Dr. Jean Jacquinot** from CEA (France) to present their proposed European ITER sites Vandellós and Cadarache.

You can find their presentations on:

- "Vandellòs ITER site"

http://www-fusion.ciemat.es/fusion/iter/ITER-eng.html

- "Cadarache - a European Site for ITER"

http://www.efda.org

"The main thing is that ITER is built and that this happens in Europe!"

EFDA Newsletter (E.N.): *Imagine you had to direct an advertising film, which presents Vandellòs or Cadarache as the favorite ITER site. What, in your opinion, would be the best title for such a film?*

Carlos Alejaldre: I guess it could be "Fusion is the origin of the sun and Vandellòs is where the sun is", something like that…

Jean Jacquinot: What about "An energy option for next generations at Cadarache"?

E.N.: *To introduce your film you have to present the greatest strength and the weakest point of your ITER site. What would you say?*

Alejaldre: What is quite unique at Vandellòs is the combination of a very good industrial infrastructure and an excellent tourist infrastructure. In the surrounding areas there are already three nuclear power stations and one of the most important petrochemical sites in Southern Europe. Most nuclear industries are not really situated in attractive places. But at Vandellòs there is also a beautiful beach and industry and tourism are aware that they depend on each other, so they take care for the evironment of course…

Jacquinot: A big advantage of the Cadarache site is the fact that there is already a huge support for nuclear and high technology activities. Plasma science exists on-site running a world size lab with Tore Supra operating - this is something that doesn't exist in any of the other sites. I think that all sites satisfy the minimum demands for ITER, but only Cadarache offers industrial and scientific support adequate to the task of running ITER.

E.N.: *…and the weakest point?*

Alejaldre: Maybe the fact that CIEMAT is in Madrid and not right at the site. But we are an institution that is used to run in a decentralized way. We are not such a strong and large institution, but we can deliver important support and the advantage for the ITER project in Spain would be that we would totally depend on the international character of the project.

Jacquinot: (laughs) A weak point at Cadarache….?

E.N.: *One weak point could be that CEA is a very strong partner. Of course this may be seen as an advantage for ITER, but some people may be afraid that in France ITER would not maintain its international character!*

Dr. Jean Jacquinot

Jacquinot: Well, the ILE, which is the ITER Legal Entity, will be regulated by a treaty. As they will have their own rules regulating ITER, they will be free to go for tender for services at CEA, but this will be their own decision. So I think CEA will just be one of the European contributors to ITER. To use our scientific experience in this context is a huge opportunity for all the ITER partners. ITER will be just like JET is in Culham: it will have its own budget for equipment and be totally separated from the other activities in that area.

E.N.: *For your film you have to cast a person who plays a credible ITER director. Who in your opinion would be best suited to this role: an individual who comes from fusion or from industry?*

Alejaldre: In principle for the top position I would choose a member of the fusion community. In this position you must fight strongly for fusion, so you have to believe strongly in this project. But around this person there should be a good collection of high level managers,

Interview

and of course there industrial experience would be relevant. But for the director – some people say it would be difficult to find somebody intelligent enough to run ITER and stupid enough to accept the job (laughs).

Jacquinot: I would say, the main selection criterium is that he or she fits the job description. We need a highly motivated person, who is intellectually very able. He or she could in the end fit much better than any of the specialists.

E.N.: *You will also have to explain to the audience of your film, what happens to the other projects, TJ-II and Tore Supra, when ITER is built. ITER is a tokamak and TJ-II a stellarator – has CIEMAT been converted to the tokamak principle?*

Alejaldre: What people don't know is that we will put a helical coil into ITER, when it comes to Spain! (laughs) No, we believe in fusion and clearly the next step is a tokamak like ITER. But there is no conflict between ITER and TJ-II – tokamaks and stellarators are like first cousins, much of the physics is common, and the stellarator can deliver a lot of important results for the tokamak. When ITER comes, the European research on fusion is strengthened, but this has nothing to do with the local research. They could exist next to each other, maybe not TJ-II but TJ-III – or an upgrade of TJ-II.

E.N.: *What about the CEA tokamak Tore Supra?*

Jacquinot: I think this is a question of money. If ITER comes to Cadarache, ITER becomes the absolute priority of the French Association. So if the money for the ITER project is what it is now, clearly Tore Supra will be progressively phased down. If Europe takes fusion more seriously and increases the budget during the 7th Framework Programme, it is possible that Tore Supra might be able to continue operation. France has already increased its budget, because Tore Supra has worked in a very satisfactory manner with new world records of energy coupled to plasmas to contribute to the ITER studies. We will have to see and review the situation. But if we should have to make sacrifices, it should not be on ITER.

E.N.: *If ITER comes to your country would this be the same for you as for a film producer winning the Oscar for his lifework?*

Alejaldre: It's not really the same, but Spain has experienced a tremendous economic growth in the last decade and the country needs to be given a qualitative push. As a large technological institution ITER could be the driver that pushes Spain to a higher technological level. This is why it has become so important for me to convince people to support Spain. In Spain ITER will be the project! But in the end the important thing is that ITER comes to Europe.

Jacquinot: In some ways yes: ITER will be much bigger than our other projects, both in terms of scope and also in international prestige. But I would also say the main thing is that ITER will be built and that this happens in Europe. Of course it would be a great satisfaction for my Association if it is built in France. In any case I think that there will be a satisfying role for each of the ITER parties in this new step of fusion towards the future.

Prof. Dr. Carlos Alejaldre

E.N.: *So good luck for both of your sites and thank-you for this interview!*

Interview: Doris Lutz-Lanzinger

Prof. Dr. Carlos Alejaldre is the director of the Euratom-Association CIEMAT (Centro de Investigationes Energéticas, Medioambientales y Technológicas) in Madrid (Spain).

For **more information** on CIEMAT see:

http://www.ciemat.es/eng/

Dr. Jean Jacquinot is the Head of the Euratom-CEA Association at Cadarache (France).

For **more information** on CEA Cadarache see:

http://www-cad.cea.fr/

ITER

Canada's formal bid to host the ITER project is based on the **Clarington site**. It is located in the province of Ontario near the city of Toronto.

If you would like to learn more about Clarington and ITER Canada see:

http://www.itercanada.com

5th Negotiations Meeting, Canada: Successful Launch of Site Assessment Process

Momentum towards construction of the ITER fusion project increased as delegations from Canada, the European Union, Japan and the Russian Federation met from September 17 - 18 in Toronto to negotiate the implementation of the project.

A notable accomplishment in the framework of the Negotiations was the start of the process for candidate site assessment as a group of international experts began the assessment of Canada's proposed site at Clarington.

Agreement on arrangements for the transitional phase towards the possible joint im-plementation of ITER in 2003 was also significant. These arrangements would continue under the auspices of the International Atomic Energy Agency (IAEA), represented at the Negotiations meeting by Dr. R.E.H.Clark.

Significant progress was made on an extensive range of issues, including matters such as the implementing treaty (the Joint Implementation Agreement) and organizational structure. The delegations agreed that the current CTA International Team Leader, Dr. R. Aymar, would be nominated as Interim Project Leader on commencement of the ITER Transitional Arrangements.

Over the next few months, the negotiators and technical experts have a full schedule of meetings with a view to finalizing the Joint Assessment of Specific Sites by early next year and completing the drafting of the Joint Implementation Agreement by mid-2003.

6th Negotiations Meeting, Japan: Assessment Completed for Two of Four Potential ITER Sites

At their Sixth Negotiations meeting on October 29 - 30 in Rokkasho-mura the delegations continued to progress towards implementation of the project. M. Kimura, the Governor of Aomori Prefecture, emphasized that Aomori would like to host ITER and contribute to the international community through the promotion of the project.

Further progress was made in many areas, including the implementing treaty (the Joint Implementation Agreement), procurement allocation and the intellectual property rights that would accrue to participants in the project. The Negotiators agreed that the international organization responsible for implementing the project would be known as the ITER International Fusion Energy Organization. Furthermore the Negotiators were reported on the ongoing process of the Joint Assessment of Specific Sites (JASS). The JASS ad-hoc group has so far completed assessments of the Clarington and Rokkasho-mura sites. The final two site assessments – at Cadarache (France) and at Vandellòs (Spain) – will be held in December. The JASS report will be finalized by early 2003 and drafting of the Agreement should be completed by mid-2003.

The next Negotiations meetings will be held in Barcelona (Spain) on December 9-10, 2002 and in St.Petersburg (RF) on February 18-19, 2003.

The Japanese Government decided to propose **Rokkasho-mura** in the Aomori Prefecture, situated in the northern part of the main island, as an ITER site.

You can find more information on Rokkasho-mura on:

http://www.pref.aomori.jp/iter/index.html

ITER & the Associations

ITER Awareness Workshop for Industry

An international workshop was hosted on 22 October in the Baylis Conference Centre, Slough by UKAEA Culham Division's Fusion and Industry team. With the decision on whether and where to build ITER expected within a year, the Euratom-UKAEA Association brought together the ITER Director and senior ITER project managers from across Europe to brief over 70 UK companies on the technology associated with ITER and business opportunities arising from its construction and operation. The workshop was attended by over 120 delegates and some 25 companies also exhibited.

In the lead up to the workshop UKAEA had researched the UK market for companies with the skills and technology experience needed to bid for ITER contracts. The seminar was the first opportunity for many companies to learn about the scale of ITER, the project technologies and timescale as well as meeting ITER design engineers.

The day started with an overview of ITER by Dr. R. Aymar and a presentation by Dr. J.-P. Rager (European Commission) on European involvement in ITER. Two technical presentations were made before lunch: Dr. N. Mitchell (ITER Joint Work Site Naka) on magnets, cryogenic systems and magnet power supplies and Dr. D. Campbell (EFDA-CSU Garching) on heating and current drive, diagnostics and control. After lunch further technical talks were given by Dr. D. Murdoch (EFDA-CSU Garching) on tritium systems and civil engineering, Dr. R. Tivey (ITER Joint Work Site Garching) on in vessel components and materials assessment and Dr. D. Maisonnier (EFDA-CSU Garching) on remote handling, hot cells and decommissioning. The day ended with presentations on opportunities for industry, the first by Dr. A. Chevalier from NNC (UK) on industrial involvement in fusion and the EFET industry grouping and the last by Dr. R. Freeman of the Diamond Synchotron Light Source, an example of a major new facility which is just starting its construction phase.

Delegates were also given plenty of time to chat informally to the speakers and to network in the exhibition area. They were invited to submit their companies' details into an UK expertise directory being set up by the UKAEA Fusion and Industry Team.

R. Aymar and J.-P. Rager welcomed the initiative taken by the UKAEA Fusion and Industry. "ITER construction will be characterised by the awarding of very large complex contracts, worth over 100 million Euros, but also smaller conventional contracts will also be awarded particularly involving SMEs. We believe industry has a far greater role to play in ITER construction than earlier projects and are delighted to see there is such interest from UK companies."

From left to right: C. Forty (UKAEA), R. Aymar (ITER), J.P. Rager (EU Commission)

Technology transfer from fusion research is bringing tangible benefits to many UK and European companies. You would like to find out how your company can tap into the skills and technologies of fusion research to make a real difference to your product development, quality systems and ultimately competitive edge?

Please see:

http://www.fusion.org.uk/industry/index.html

Fusion in Europe

The Institute for Plasma Physics in Jülich has been successfully working in the field of plasma wall interaction since the mid-seventies. In 1982 the fusion experiment TEXTOR started operation. It was especially constructed for extensive interdisciplinary investigations in the field of plasma and nuclear physics, material and surface research, as well as plasma chemistry.

For **more information** on Forschungszentrum Jülich please see

http://www.fz-juelich.de/ipp

Dr. Volker Philipps (54) has been working at the Forschungszentrum Jülich for 25 years in the field of plasma-wall interaction. He studied physics at the University of Marburg (Germany) and did his doctorate degree at the Technical University of Aachen (RWTH, Germany) in the field of solid-state physics.

Commissioner Busquin visits TEXTOR

On September 10, 2002 Philippe Busquin (fourth from left), EU Commissioner for Research, visited TEXTOR, together with (from left to right) Prof. U. Samm (Division Manager IPP Jülich), MdB D. Nietan (German Member of Parliament) and Prof. R. Weynants (Division Manager Ecole Royale Militaire/KMS Belgium). Mr Busquin was especially interested in hydrogen technology and promised further EU support for FZJ on this subject.

*Some like it hot: torus of **TEXTOR**, inspected by Commissioner Busquin and during an experiment. Since March 2001 TEXTOR has been modified by adding a "Dynamic Ergodic Divertor" (DED). You can follow the steps of this modification on*

http://www.fz-juelich.de/ipp/aktuelles/

*On December 6, 2002 **TEXTOR** will officially re-open. The new DED coil has already been successfully tested at the beginning of October.*

FZ Jülich Provides a New European Team Research Leader

Dr. V. Philipps from the Institute for Plasma Physics at the Forschungszentrum Jülich (FZJ) has recently been appointed by EFDA to be the leader of the new task force for "Plasma-Wall Interaction" until the end of 2004. The setting up of this joint European team demonstrates the importance for ITER of the research on the interactions between the plasma and the vacuum vessel wall in fusion devices. Research on plasma-wall interactions has always been one of TEXTOR's major activities, and one in which FZ Jülich has gained international recognition.

(Please see also page 7)

Fusion in Europe

New European Task Force on Plasma-Wall Interaction (PWI) Created by EFDA

The European Task Force is motivated by the large extension of the plasma duty cycle, i.e. pulse length, expected in ITER compared with present devices. This requires essential knowledge to be acquired for the operation of ITER with respect to the expectations of the plasma-facing components lifetime (divertor and main chamber) and the tritium inventory build-up rates. In more detail, the Task Force's topics of research are: erosion behaviour and impurity source location in tokamaks, transport and re-deposition of eroded material, fuel recycling, retention and removal, transient heat loads, erosion and re-deposition modelling, plasma edge physics processes related to material erosion and re-deposition (such as radial and parallel plasma flows) and their modelling, and development and test of diagnostics relevant to the previous topics.

Present experiments indicate that the use of carbon fibre composites as armour material for the divertor target area in ITER may result in unacceptable long-term tritium retention. The goal of the Task Force is to concentrate and co-ordinate European research in the PWI area on these topics and to offer scientific and technological concepts for a solution to the expected problems in this area for ITER operation. These concepts should be based on an improved understanding of the physical processes involved, which will provide the basis for better predictions of the relative importance of these processes in ITER discharges. An important task is to extrapolate the current knowledge, mainly from devices with a full carbon wall, to the ITER-like choice of wall materials in the foreseen starting configuration (beryllium in the main chamber, tungsten at the divertor baffles, and carbon in the lower divertor region). A parallel strategy which will be followed is to evaluate the concept of a fully metallic first wall in ITER and to provide the scientific basis for this alternative choice.

The Task Force will take advantage of the positive experience obtained at JET operated under EFDA, with the creation of Task Forces that have European-wide membership. The Task Force will also try to improve the efficiency of work by synergies, which are expected from the expansion of the work from individual efforts towards the co-ordinated operation of all European devices. Naturally, an essential ingredient for its success is the commitment and close co-operation of all European Associations and all Association scientists are invited to contribute to it.

Task Force Leaders Team,
from right to left: V. Philipps (Task Force Leader, FZ-Jülich),
A. Loarte (Deputy, EFDA-CSU) and
J. Roth (Deputy, IPP Garching)

As a first step, the Task Force work programme has been formulated in a meeting with contact persons from the European Associations held in Augsburg (Germany) on the 14th and 15th November. This meeting has served to define the individual contributions of the different Associations to the various research topics of the Task Force. The Task Force will work in close co-operation with the JET Task Forces E and FT, which co-ordinate the European research at JET in this field.

The **Task Force** has European-wide membership and contact persons at the following institutions:

CEA-Cadarache (T. Loarer), CIEMAT (F. Tabares), CNR-Milano (F. Ghezzi), CRPP-Lausanne (R. A. Pitts), EFDA-CSU Garching (A. Peacock), ENEA-Frascati (G. Maddaluno), FOM (N. Lopes-Cardozo), FZ-Jülich (P. Mertens), FZ-Karlsruhe (I. Landman), IPP-Garching (A. Kallenbach), IST-Lisbon (J. Carvalho-Soares), ITER-IT (G. Federici), Jozef Stefan Insititute-Ljubljana (I. Cadez), NRG-Petten (J.G. van der Laan), Royal Institute of Technology Stockholm-VR (M. Rubel), TEKES (J. Likonen), UKAEA (G. Counsell)

More information on the EU-PWI Task Force:

http://www.efda-taskforce-pwi.org/

Safety factor "q":
Number of turns the helical magnetic field lines in a tokamak make around the major circumference per single turn round the minor circumference. This has no connection with the ordinary sense of "safety" but relates to plasma stability.

Non-inductive current:
Toroidal plasma current not driven by the transformer. It can be generated by the injection of waves in the toroidal direction in the plasma of a tokamak. It can also be selfgenerated by the pressure gradients in the plasma: this is the so-called "bootstrap" effect.

JET - Advanced Scenarios

Real-time Feedback Control of the Pressure and Current Density Profiles

The development of steady state operational regimes with improved confinement and stability is known as "advanced tokamak" research. In JET advanced tokamak research mainly focuses on plasmas with internal transport barriers (ITBs), generated by modifications of the current density profile in the plasma core. New real-time measurements and feedback control algorithms have been developed and implemented to successfully control the ITB dynamics and the current density profile in highly non-inductive regimes. Global confinement parameters, ion or electron temperatures, density and safety factor profiles (q-profiles) can now be calculated in real-time. The real time control of stationary ITBs in full current drive operation represents a ***major milestone*** towards the definition and viability of steady state tokamak. The JET real time control experiments pave the way to long steady-state ITB operation in preparation of the ITER 'advanced' tokamak scenario.

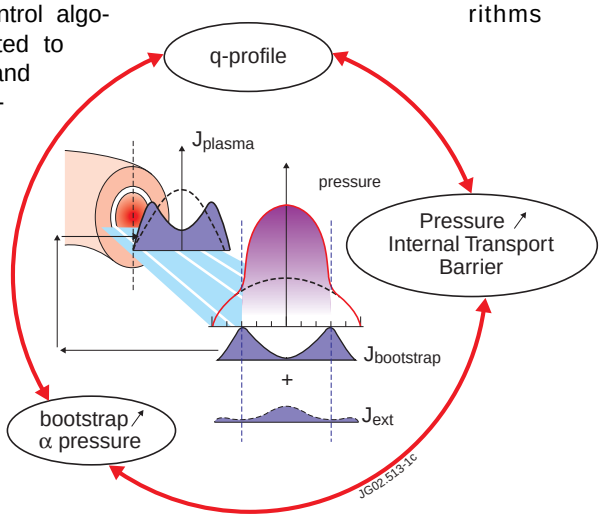


Fig. 1 Current density, pressure and self-generated bootstrap current are strongly coupled on steady state operation with full non-inductive current drive.

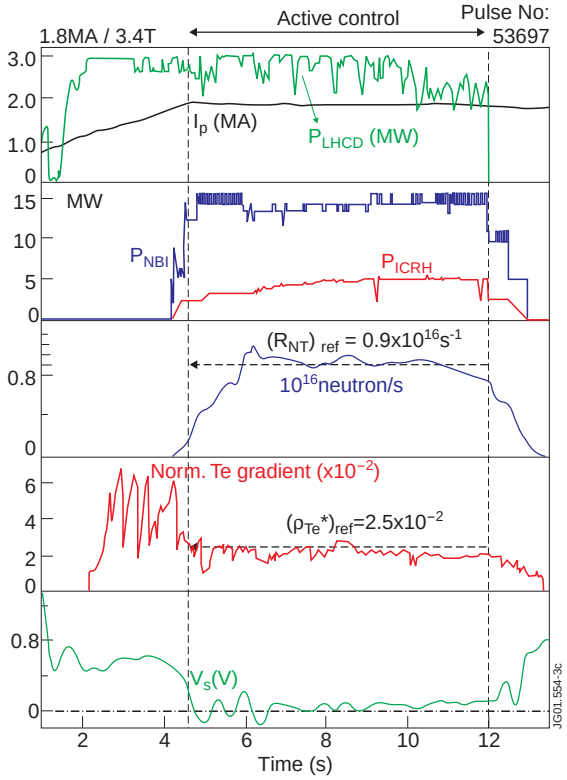


Fig. 2 Time evolution of the main plasma parameters of a discharge with combined feedback control of the normalised electron temperature gradient (ρTe) and neutron yield (R_{NT}) using ICRH and NBI powers.*

Improvement of the tokamak concept, i.e. confinement and stability, is a crucial challenge that could lead to operating the device in a high-performance continuous mode. In a ***steady state tokamak reactor***, like in a foreseen 'advanced scenario' for ITER, the plasma current will be entirely sustained by non-inductive means and the self-generated bootstrap current must provide a significant fraction of the plasma current. The non-inductive currents, pressure profiles, confinement and safety factor profiles (q) are strongly coupled in steady state operation with high fusion performance, as illustrated in Fig. 1. Modification of the safety factor profile will affect the confinement and core pressure (e.g. the formation of core transport barriers), and variation of the core pressure will modify the self-generated bootstrap current that in turns influences the safety factor profile. Maintaining the required high confinement level in steady state will therefore require active control of the plasma profiles.

In JET ***non-inductive quasi-stationary operation*** has been achieved in high fusion performance discharges with a large bootstrap current fraction, with a well developed ITB affecting both ions and electrons thermal confinement. In those experiments, simultaneous feedback control of the electron temperature gradient and of the neutron yield has allowed an ITB to be maintained with a pre-requested strength in quasi-steady state for 7.5 seconds (Fig. 2).

An **Interfero-polarimeter diagnostics** is used to determine the plasma density and the current density profile. This is achieved by measuring the phase and polarisation shifts of two infrared Laser beams: one probing beam crossing the plasma and one reference beam.

Grad-Shafranov equation: A differential equation which describes the equilibrium of an axi-symmetric system such as a tokamak plasma.

The actuators were the ***ion cyclotron resonance heating (ICRH)*** and ***neutral beam injection (NBI)*** power, respectively. One of the main conclusions of this first set of experiments is the role played by the pre-programmed ***Lower Hybrid Current Drive (LHCD)***, during the prelude and high power heating phases, in pre-forming and sustaining the safety factor profile evolution, respectively. The transport reduction, observed also in other tokamak devices, is associated with localised turbulence suppression, which is related to the precise shape of the q-profile. Moreover, a strong correlation has also been shown between the creation of ITB and the appearance of integer-q magnetic surfaces at parti-cular locations. Active feedback control of the current density profile in addition to the pressure profile, is thus a key to reproducibly trigger an ITB and to maintain its quality and strength in a steady state condition.

Previously real-time control of the q-profile had been performed through the ***internal inductance parameter***. Its control is not sufficient to maintain an optimised q-profile in ITB discharges. Recent efforts have been made to provide a real-time identification of the q-profile and develop an algorithm, which allows its control. The ***algorithm*** uses as input the signals of magnetic and interfero-polarimeter diagnostics. The approach described in the previous paragraph to control the pressure profile is based on decoupled control loops for the core pressure and maximum temperature gradient with devoted actuators (NBI and ICRH, respectively). For the q-profile, a ***'model-based' control scheme*** was followed, in which more information on the spatial structure of the system is taken into account. To validate this 'model based' technique direct control of the safety factor profile has been attempted using LHCD as the only actuator. The experiment was performed during an extended LHCD prelude phase. In a tokamak like ITER, this phase would precede the application of the main additional heating power to create an ITB once the desired optimised q-profile is obtained. The ***plasma parameters*** were chosen in order to be close to those needed for a purely non-inductive regime with the available LH power, and thus have a larger flexibility for obtaining the required q-profiles. The feedback control was performed on five points of the q-profile located at fixed normalised radii. The reference q-profile is reached within 12s (Fig. 3).

To reach the pre-set reference q-profile the controller minimises in the least square sense the difference between the five target q-values and the real-time measurements. The successful and very recent experiment reported here should be considered as a ***'proof of principle'***. In the near future, this general 'model-based' approach will be implemented to control high-pressure, high-bootstrap fraction, ITB discharges where pressure and current density profiles are strongly (non-linearly) coupled. In addition, a substantial effort is being devoted to a better identification of the magnetic equilibrium by solving the Grad-Shafranov equation in real time.

The sustainment and real time control of ITBs in full current drive operation with a significant fraction of bootstrap current represents a ***major milestone*** towards the definition and viability of steady state tokamak operation. Real time measurements of the kinetic and magnetic profiles together with 'model-based' feedback control algorithms will be extensively used in future experimental campaigns on JET to further increase the plasma fusion performance.

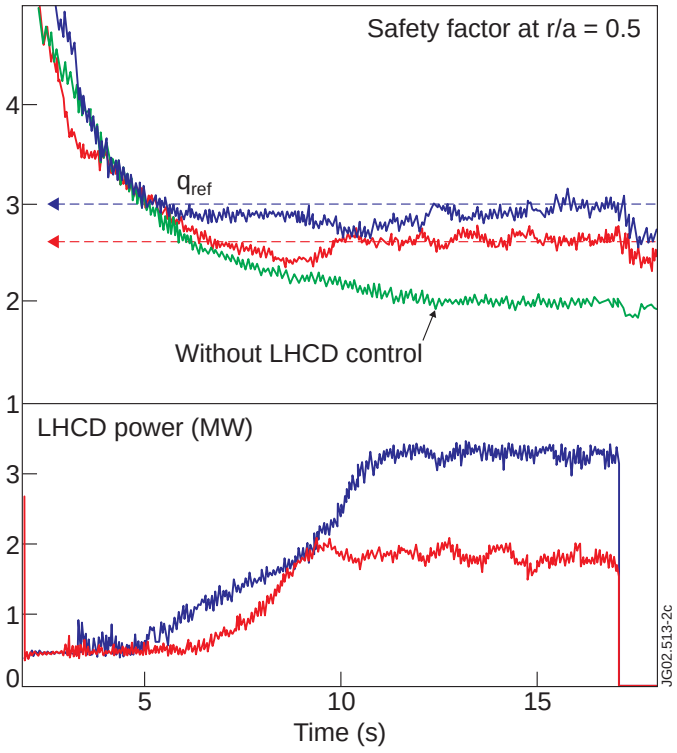


Fig. 3: Real time control of the q-profile. Time evolution of the LHCD power, measured and reference q-values at mid-radius of two discharges with different pre-set reference q-values, q_{ref} (blue and red time traces). A discharge without LHCD feedback control is presented for comparison (green time trace).

Events

Participants to the EFDA Round Tables:

"Benefits from ITER in the European Union"

- Prof. K. Lackner (EFDA)
- Dr. R. Andreani (EFDA)
- Dr. P. Barabaschi (ITER)
- Mr. A. Vallée (Framatome-ANP)
- Dr. J. Jacquinot (CEA)
- Dr. C. Alejaldre (CIEMAT)
- Prof. W. d'Haeseleer (University of Leuven, Belgium)

"JET – a bridge to ITER"

- Dr. J. Pamela (JET)
- Prof. C. Varandas (IST)
- Dr. P. Mantica (CNR)
- Dr. T. Hender (UKAEA)
- Prof. H. Zohm (IPP)
- Mr. G. Caudron (MEP)
- Mr. G. Adam (MEP)

FP6 Launch: EFDA Round Tables at the European Research Conference

A major conference was held by the European Commission in Bruxelles from 11 to 13 November 2002 to mark the start of the EU's Sixth Framework Programme for research, which will cover the period from 2002 to 2006.

Approx. 9,000 visitors took part in this event, which was located in the Palais du Heysel.The aim was to present the objectives and priorities of the Framework Programme and to explain rules for participation. At the same time the conference was meant to create opportunities for a scientific debate among the involved institutions.

The major features of this three-day event were as follows:

- Conference sessions addressing all the main thematic priorities of the FP6;
- Sessions providing guidance on how to participate in the Framework Programme;
- A participants' forum to present the most important topics to the visitors and to stimulate discussions on the debated topics;
- An exhibition, where interesting EU-sponsored research projects were on display to complement the verbal project presentations.

EFDA took part to the event with a stand integrated into the EIROforum island where also the other EIROforum partners (i.e. CERN, EMBL, ESA, ESO, ESRF, ILL) were also represented.

The 45 m^2 stand featured a series of posters addressing the main topic of fusion research in the EU and its machines, an ITER corner on the current European site proposals for the "next step", a small plasma experiment and a number of high-heat flux components of Plansee to describe the current achievements in this field. On a plasma screen the activities of the European fusion associations were also presented.

Dr. F. Casci (EFDA Garching, right) presenting the EFDA stand to a visitor

The stand was complemented by another contact point of the EU Commission in the Sustainable Development area, where additional lectures were also held, and by the Dutch Fusion Road Show, which attracted a large audience at each of its performances.

Two round tables, one on ITER and one on JET were held in the Participants' forum to explain the European interest in both these projects.

One of the highlights of the event was the signature of the EIROforum Charter by the DGs of the seven organisations, together with the EU Commissioner P. Busquin.

Interest in our fusion activities was large and the visitors included MEPs, the press and research operators. Among the visitors of the stand, were the EU Commissioner Busquin and the Minister of the Catalunia region, Mr. Mas-Colell, who reiterated the interest of his region in hosting ITER.

Events

Top Experts in the World of Fusion Technology gathered in Helsinki

SOFT 2002 was officially opened by Dr. Sinikka Mönkäre, the Finnish Minister of Trade and Industry, who repeated the support of her Government to this kind of research. Dr. J.P. Rager (European Commission) presented the latest developments of the European Fusion Programme, while Prof. W.D'Haeseleer of the University of Leuven provided an overview of the energy problems and the ability and timing of fusion penetration into this arena.

The presentations indicated that the Technology Programme for the "next step" activities clearly show that the fusion community is now ready for ITER. Only the construction of this device would allow further progress in this field of knowledge. At the same time, the long term fusion programme had made progress in the field of materials. In this case the International Fusion Materials Irradiation Facility (IFMIF) would be the additional useful step to prepare for demonstration and commercial fusion power reactors. The participation of industry to the conference and to the exhibition showed its interest in fusion research, and how the work carried out in this area has exerted a beneficial influence on the development of technologies used in daily life. The presentation of the four candidate sites for ITER – Cadarache (France), Vandellòs (Spain), Clarington (Canada) and Rokkasho-mura (Japan) - was followed by the audience with great interest and showed the commitment of the four candidate countries to provide an excellent site.

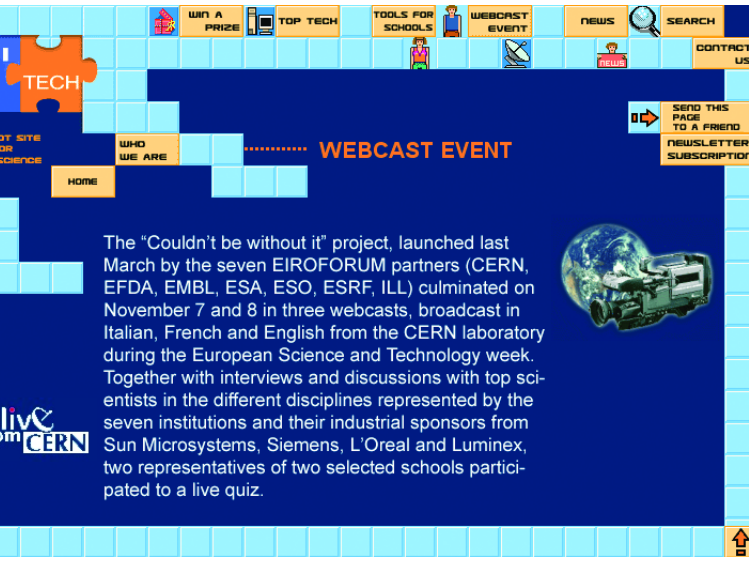
On the last day the SOFT flag was passed on to the "Consorzio RFX" which will organize the 2004 conference in Venice. The hope of everybody is that SOFT 2004 will be the first one of the ITER era.

The 2002 edition of the Symposium of Fusion Technology (SOFT) from 9 to 13 September has been organized by the Euratom-Tekes Association, in co-operation with VTT (Technical Research Center of Finland), Fortum and PrizzTech at the Marina Congress Center in Helsinki (Finland).
A warm and sunny weather welcomed the over 400 participants who gathered here to review the status of fusion technology and prepare the strategy for the forthcoming years which should lead us toward ITER.

For **more information** see:

http://www.vtt.fi/val/soft2002/

"Couldn't be without it": Science for Next Generation "Internauts"



The two winners of the Italian webcast from a secondary school in Modena, were offered by EFDA a trip to Oxford (UK) for a visit to the JET tokamak located on the Culham site. During the English Webcast a live connection to JET gave the possibility to Dr. J. Pamela, the Associate EFDA leader, to explain the role of EFDA. Dr. J. Silver, a guest from Culham, explained how his invention in the field of health, water glasses, could help people in the developing countries to solve the problem of manufacturing spectacles for correcting eyesight.

"Internauts" from all over the world were also invited to find out what modern Europeans can't live without and how vital fundamental science research has been in the creation of modern technology. For entertainment, for example, the personal computer is a clear winner as the device was considered most essential by all Europeans. This hit parade of technological marvels is the result of this year's phone and online survey conducted by the Sci-Tech…couldn't be without it! Team. The live event showed the fascinating opportunities that lie ahead in the world of research.

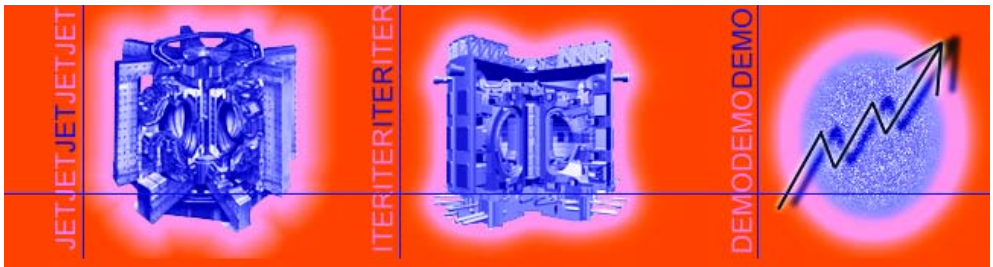
To see the results and the recorded webcasts, just click at the address:

http://www.cern.ch/sci-tech

For more information on EIROFORUM see:

http://www.eiroforum.org

Questions & Answers



What is the difference between a machine like JET and ITER?

The JET tokamak, in operation since 1983, has provided important results which give a high degree of confidence in the feasibility of magnetic fusion reactor physics. JET, for instance, has proven the principle of plasma self-heating by fusion reactions. However, in steady state only about 18% of the total power needed to maintain the plasma at the required temperatures was provided by these reactions, the rest was supplied externally. In ITER, as in future fusion power plants, self-heating of the plasma will be the dominating effect.

ITER's aim is to confirm and optimise the physics of the future reactor and to demonstrate the technological feasibility of magnetic fusion power. Key technologies, such as the tritium fuel cycle and remote handling, will be extensively used in ITER, and it will be of paramount importance to demonstrate the viability of such techniques with an adequate degree of reliability.

Will all ITER parties have t he same rights to use the machine for their research purposes?

Negotiations among the current participants (i.e. Canada, the EU, Japan and the Russian Federation) started in 2001 towards an agreement for the joint implementation of ITER. Other countries (i.e. USA and China) are considering joining. All the countries, which provide the financial support for the construction and operation of the machine, will have a role in the use of ITER. All the knowledge derived by the exploitation of the experiments will be shared among them. Bilateral agreements with other countries could be used for their participation in ITER experiments.

Industry has helped the laboratories to build the current fusion devices and to develop the technology for fusion research. Did industry itself benefit from this relationship?

The benefit achieved by industry in its co-operation with the fusion laboratories is twofold. The direct advantage is due to the know-how accumulated on the topic while working together with fusion experts, both physicists and engineers. This has allowed industry to increase its knowledge in all critical aspects linked to the design of fusion device components. The second, indirect, benefit originates from the spin-offs, which inevitably derive from working in a high-technology environment. New materials, techniques and procedures, developed while working on fusion, have been used also for solving problems in other areas and have had a positive influence in the development of other kinds of components and products. Examples include advances in superconducting technology, fabrication processes, and measurement techniques.

The recommended main steps in the European strategy for the development of fusion are:

ITER – the "next step"

DEMO - the demonstration reactor

PROTO - the prototype power station

TIMETABLE

JET
- 16 MW/2s Fusion Power in 1997
- Q (Fusion power / Power in): 0.65

ITER
- 500 MW/400s Fusion Power in 2015
- Q: >10

DEMO / PROTO
- 2 GW/steady
- Fusion Power in 2030 – 2040
- Q: 20 - 50

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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