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newsletter

EUROPEAN FUSION DEVELOPEMENT AGREEMENT

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http://www.efda.org

News

Competitiveness Council of Ministers selects European ITER site

The Council decided unanimously to amend the Commission's negotiation directives on the establishment of an international framework concerning ITER authorizing the Commission to put forward Cadarache (France) as the European candidate site. The Council also decided unanimously that the ITER European Legal Entity (ELE) will be located in Spain.

The next meeting of the Parties to the ITER agreement was held on 4 December. Three candidates for hosting ITER this site, Cadarache (France), Clarington (Canada) and Rokkasho (Japan) have been put forward.

For more information please see:
http://www.efda.org/portal/pr_iter_site.htm and http://www.recherche.gouv.fr/discours/2003/itercompetition.htm

P-2.5 Meeting in Vienna (4-5 December 2003)

On 4-5th December 2003, a preparatory meeting for the ministerial meeting for ITER was held at the headquaters of the IAEA in Vienna (Austria).
Please find more details on page 2.

JET successfully completes the Trace Tritium Experiments

The JET 'Trace Tritium Experiments' (TTE) Campaign was completed successfully. It was the first use of tritium in JET experiments under the EFDA organisation.
Please find more details on page 3.

Minister Haigneré calls on mobilization around Cadarache candidacy

On November 27, Claudie Haigneré, French Minister for Research and New Technologies, in her visit to Cadarache (France) called on mobilization around Europe's candidacy for the ITER project in Cadarache.

At the Competitiveness Council meeting in Brussels, on November 26, C. Haigneré had announced: "I am delighted that Europe has come together behind Cadarache's candidacy. This is good news for France, for Europe and for research in general".

The French Prime Minister Jean-Pierre Raffarin was glad that "Europe joins forces on a single project in order to win the global competition".

On November 17 Jean-Pierre Raffarin and Claudie Haigneré had visited together the Cadarache site proposed to host ITER.

ITER

Common Message from Preparatory Meeting for Ministerial Meeting for ITER

Skyline of Vienna

Delegations from Canada, China, European Union, Japan, the Republic of Korea, the Russian Federation, and the United States met in Vienna on 4-5th December, 2003 to advance the ITER negotiations. The meeting was held at the headquarters of the IAEA; the meeting was moderated by IAEA Deputy Director General Werner Burkart.

The delegations have achieved a major milestone in the ITER negotiations, namely, full coverage of cost-sharing for the two candidate sites in the European Union and Japan.

The delegations are confident that this achievement provides the basis for reaching consensus on the preferred site at the Ministerial Meeting for ITER.

The Ministerial Meeting for ITER will take place on 20th December, 2003 in Washington, DC.

Ninth ITER Negotiations Meeting in China

The Palace of Heavenly Purity - Bejing, China

Delegations from Canada, the People's Republic of China, the European Union, Japan, the Republic of Korea, the Russian Federation and the United States of America met in Bejing (China) on November 9 – 10, 2003 to continue their efforts to reach agreement on the implementation of the international fusion energy research project ITER. This was the first such Negotiations Meeting to be held in the People's Republic of China, and the first full Negotiations Meeting attended by the Republic of Korea, which formally joined the ITER partnership in June 2003.

In his welcoming speech to the delegations, Mr. Xu Guanhua, the Minister of Science and Technology of the People's Republic of China, emphasized the importance of the ITER Project in the search for new sources of energy, not only for China, but for the whole world. Mr. Xu said "ITER is the most significant stage in realizing the dream of creating secure, effective and clean fusion energy."

At the Negotiations Meeting, delegates discussed a full range of legal, technical, administrative and managerial topics, including the form and the structure of the international organization, staffing, resources, and risk management, which will form the basis for the Agreement on implementing ITER and the operation of the International ITER Organization.

The Negotiators agreed that substantial progress was made on all topics, and delegations are optimistic that final decisions on the site of ITER and the cost-sharing arrangements will be in place before the end of 2003.

For **more information** see:

http://energy.gov/engine/content.do?BT_CODE=PRESS-ROOM

> press releases
> November 10, 2003

First place for ITER in the US

The US Department of Energy has put ITER in first place in its list of research facilities to be funded in the near term.

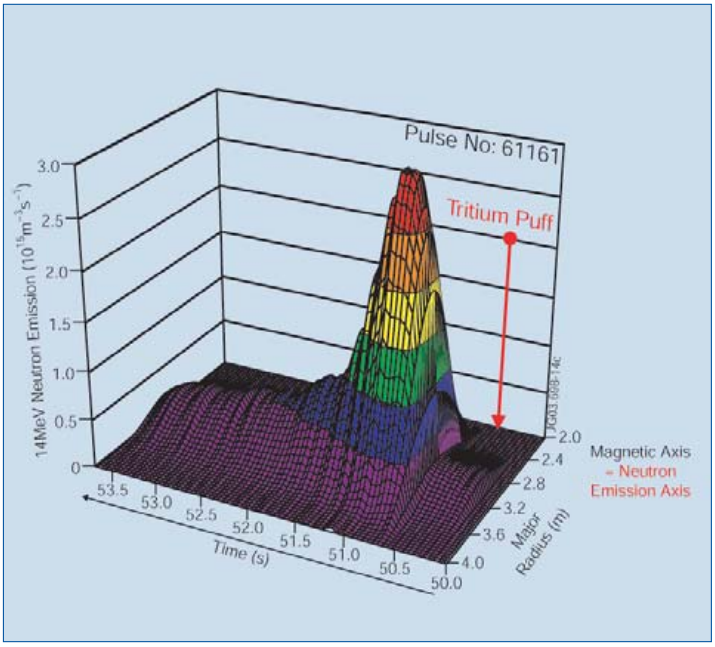
JET

JET successfully completes the Trace Tritium Experiments

On 1 November, the JET 'Trace Tritium Experiments' (TTE) Campaign was brought to a successful conclusion. This Campaign marked the first use of tritium in JET experiments under the EFDA organisation with the Association Euratom - UKAEA as Operator.

The experiments in TTE used tritium injected into the plasma either via gas introduction system or in the form of high velocity neutrals from the Neutral Beam Injection (NBI) system. The fraction of tritium in the plasma was always kept at 'trace' levels, i.e. <1-2% of the deuterium majority fuel. Some 25 experimental proposals gathered data during the TTE.

In total, over 160 JET pulses were supplied with tritium and there were no significant faults on the tritium systems. The rate of DT fusion reactions is about two orders of magnitude larger than that of DD reactions, and the energy of the emitted neutrons is distinctive – 14 MeV. When the tritium ions fuse with the majority deuterium ions, the neutrons 'tag' the motions of the tritium particles. By observing them it is thus possible to follow particle transport of a fuel ion in the plasma, something that is otherwise remarkably difficult to do. Tritium transport has been studied in all the foreseen ITER operating scenarios, including plasmas with internal transport barriers, and with scans of key physics parameters such as the normalised Larmor radius or plasma collisionality.



Time development of spatial profile of 14 MeV neutrons (from D-T fusion) produced following a 5 mg tritium puff into a 2.4T/2.0 MA low triangularity 'Hybrid scenario' JET pulse.

The re-establishment of a 'full quota' of 14 MeV neutron diagnostics on JET was one of the most important side benefits of this Campaign.

The amounts of tritium injected into any one plasma during this month-long experimental campaign were minute – only up to 5 mg per shot. "Although the tritium is injected in such small quantities into the plasma, it is supplied to the machine in gram quantities then recovered and recycled within the system", explained UKAEA's Tim Jones, who led the team undertaking the technical preparations. "Establishing this tritium supply and reprocessing capability is nearly as demanding on the JET Operator as providing the fuelling for a 50:50 Deuterium-Tritium (D-T) plasma."

The Scientific Co-ordination for the experiments came from staff in nine of the EFDA Associations. The Campaign was led by teams from ENEA (Italy), VR (Sweden) and UKAEA. There were also experimental neutron detector devices installed by Russian visitors to detect the 14 MeV neutrons emitted by the plasma DT reactions. This was the first active participation by Russian physicists in JET campaigns, and more visits are planned.

Derek Stork, Leader of EFDA-JET Task Force DT, said:
"The use of tritium in this precise, diagnostic, manner will yield invaluable information on the way in which fuel will be confined and transported in a future reactor, and also the way in which high energy tritium can provide plasma heating."

Associations

Overall performances

Magnification < 2000
Spatial Resolution ≅ 10µm
Density Resolution > 0.5%
3-D Reconstruction Time ≅ 5min.
(512 x 512x 256 voxels)

Probe Dimensions
Diameter < 40 mm
Height < 500 mm

For **more information** see:

Institute of Atomic Physics
http://alpha1.infim.ro/ifa

Any questions on micro-tomography?

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3-D X-Ray Microtomography at MEC Romania

At the National Institute of Laser, Plasma and Radiation Physics (NILPRP) Association Euratom-MEC in Bucharest (Romania) a laboratory for microtomography was established during 2001-2002 with European Community support (EFDA Newsletter, Vol. 2003/2, April 5, 2003). Its research is focused on the project "Non-destructive analysis of fusion materials samples by X-ray microtomography" and aims at the improvement of developing and testing of fusion materials by employing state of the art non-destructive techniques (NDT).

X-ray-tomography as an NDT tool for fusion material samples can provide information on:

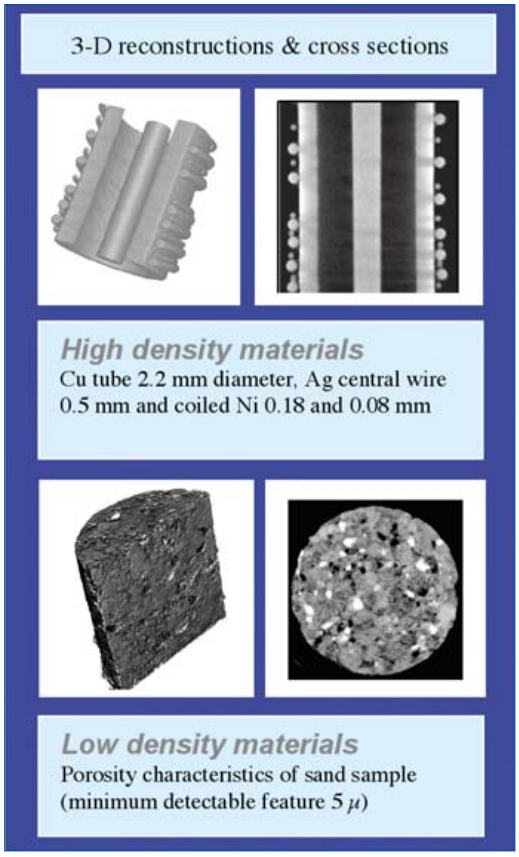
- density variations
- visualization of micro-cracks developed by mechanical/thermal cycling
- permeability and pore network connectivity in porous materials
- microstructure integrity of various components
- accurate geometrical measurements in 3-D

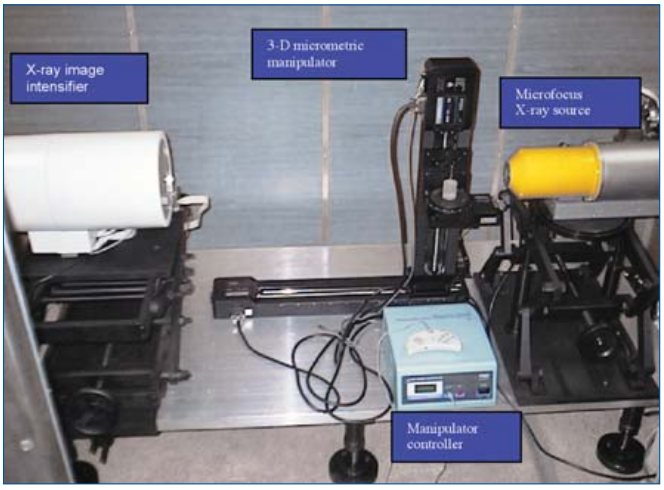
Computer-aided tomography systems (figure below) are configured to take many views of the object in order to build a 3-D model of its internal structure. 2-D slices through this volume can be viewed as images, or the 3-D volume may be rendered, sliced, and measured directly.

For the NDT inspection of individual miniaturised samples the microtomography analysis is guaranteed for feature recognition down to a few microns. In order to examine flat components, a computed laminography function was recently added. In this case objects are imaged from an oblique direction with respect to the rotational axis to overcome some of the disadvantages of the conventional CT systems and ensures large magnification of the region of interest.

3-D tomographic reconstructions are obtained by a proprietary highly optimized computer code based on a modified Feldkamp algorithm. Beam hardening artefacts, the most challenging problem in high density materials inspection, are reduced by a correction method based on X-ray spectrum filtering and the linearization of the transmission curve.

The microtomographic facility is available for the EFDA Technology Workprogramme. The activities will be focussed on implementation of suitable NDT inspection methods for the structural integrity assessment of instrumented capsules and rigs by microtomography and experimental validation of real time micro-radiography of miniaturized samples under mechanical stress.





Associations

WENDELSTEIN 7-X: first stellarator coils now being tested

The WENDELSTEIN 7-X stellarator will test an optimised magnetic field configuration: the quality of plasma equilibrium and confinement will be comparable to that of a tokamak. With discharges lasting up to 30 minutes, WENDELSTEIN 7-X is to demonstrate the essential property of stellarators, viz. continuous operation. Thus, WENDELSTEIN 7-X will be the first step in demonstrating that fusion devices of the stellarator type are suitable for power plants.

The technical core of the device is the coil system comprising 50 specially shaped single coils for producing the magnetic field cage confining the plasma. A further 20 planar coils will serve to vary the magnetic field. The long pulse times involved call for the use of superconductors (niobium-titanium) for the magnets. Manufacture of the stellarator coils is being handled by the German-Italian consortium, Babcock Noell Nuclear GmbH/Ansaldo Superconduttori SpA. Up to date three coils have been completed and more than half of the coils are in production. The acceptance tests for all coils are being conducted at the Low Temperature Institute of CEA Research Centre at Saclay in France. There, each coil is cooled in a cryostat to cryogenic temperature (4 K) and energized up to the rated current. The design margin with respect to quenching, i.e. disappearance of the superconducting properties, is then checked. The first non-planar coil was delivered to Saclay in June. It has successfully passed the functional tests and demonstrated the required operational margin. The first of the 20 planar magnet coils, which are being manufactured by the Tesla company in the United Kingdom, was delivered at the end of October.

The production of the cryostat by the Deggendorfer Werft company in Germany is making good progress. The cryostat is the thermally insulating vessel necessary for the coils operating at cryogenic temperatures. The ring-shaped cryostat with an inner diameter of about 8 m and an outer diameter of about 16 m, encloses the vacuum vessel equipped with about 300 ports affording access to the plasma vessel for heating, cooling and diagnostics to measure relevant parameters. The first segment of the plasma vessel and the ports will be delivered in November for installation of the first half-module. The appropriate two half-shells of the outer vessel will be supplied in spring 2004, but will not be needed for installation till 2006.

Strong support for the project is being given by the Associations of the European Fusion Programme. The Karlsruhe Research Centre (FZK) in Germany has successfully developed and is constructing the high-power (1 MW-CW) gyrotrons. A microwave power of 10 megawatts at a frequency of 140 GHz in continuous operation mode will be installed for plasma generation and heating. The “Microwave Heating Project” established for this purpose is coordinating the various contributions from other Associations (CRPP, CEA), laboratories and industry (Thalès). The design and planning of the appropriate transmission lines are being performed by the Institute for Plasma Research (IPF) at the University of Stuttgart (Germany).

The superconducting bus system linking the coils with one another and with the current leads is being designed, manufactured, and installed by Jülich Research Centre (FZJ) in Germany. Tests of prototypes of the electrical connecting elements at cryogenic temperature were successfully completed at CRPP, at PSI in Switzerland and Russia’s Efremov Institute. An engineer from ENEA (Italy) is taking care of system engineering, while CIEMAT (Spain), the University of Vienna (Austria) and UKAEA (UK) are helping to supervise production. Experts from EFDA are also supporting the project in the mechanical structure area.

WENDELSTEIN 7-X is being built at the Greifswald Branch Institute of the Max-Planck-Institut für Plasmaphysik (Germany). When completed, it will be the largest and most advanced stellarator in the world. The assembly will start in spring of 2004. The start of operation is planned for the year 2010.

For **more information** see:

http://www.ipp.mpg.de/eng/for/projekte/w7x/for_proj_w7x.htm

A sector of the plasma vessel at Deggendorfer Werft (Germany)

Web pages on industry involvement in ITER have been opened at the EFDA address (http://www.efda.org). This area is designed to be an information point for all the European industries interested in future collaborations within the ITER project.

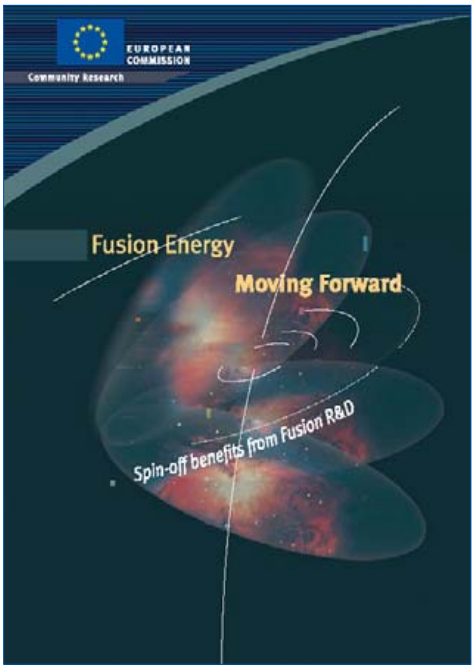
German ITER Industry Workshop at FZ Karlsruhe

Almost one hundred participants, of which 66 represented industrial companies, gathered in Karlsruhe (Germany) on October 27-28 at the "German ITER Industry Workshop". On behalf of the Bundesministerium für Bildung und Forschung (BMBF) the meeting was organized by the Euratom Association Forschungszentrum Karlsruhe (FZK). The aim was to inform German industry on the present status of the ITER planning and to encourage them to participate in the future ITER construction.

Prof. Reinhard Maschuw, member of the FZK Board of Directors, welcomed the participants and stressed the importance of early involvement of industry in the ITER project and the willingness of FZK to maintain the link to German industry for that purpose.

Mr. Axel Fischer and Mr. Jörg Tauss, members of the German Federal Parliament both called for ITER to be located in Europe, and it was underlined that this project constitutes a substantial multiplier effect in terms of both economic benefits and progress in science and research.

Dr. Beatrix Vierkorn-Rudolph, representing the Federal Minister of Education and Research, supported the view, advocating a European site for ITER, and explained that German companies have an excellent record in providing very large, complex components and meeting performance challenges, and therefore they are in a good position to participate in the realization of the project. Furthermore, research institutes that are involved in fusion research should also participate significantly in the construction of ITER.



Dr. Günter Janeschitz explained the objectives of the workshop in more detail and gave an introduction to the physical and technical basis of fusion as an energy source.

Representatives of EFDA and of the European Commission explained the current procedures for industries to participate in tendering actions and informed about possible future ways to undertake work for the project. A technical overview of the ITER design, of the technology R&D in progress and of the achieved results was presented by representatives of ITER and EFDA.

The second day was devoted to the presentation of the experience gained by industry in support of the ITER Engineering Design Activities and to the possible joint involvement of fusion laboratories and industrial companies in the procurement of components for ITER such as the fuel cycle system, heating systems, superconducting magnets and diagnostics.

The useful and successful collaboration between the fusion research community and industry was underlined as a good starting point for the future. The participants from industry not only listened to the speakers but also, at the side of the meeting, asked specific questions about their future possible involvement. Most of the comments and questions concentrated on the time schedule to the final decision of ITER and on the mechanisms through which contracts will be awarded by the European Legal Entity (ELE) which will manage the European contribution to the ITER procurements.

A small exhibition was hosted next to the conference room with information on fusion and on industrial fusion activities.

The workshop was closed with the intention of strengthening the contacts which were started during the workshop and with the wish for a strong involvement of companies in the ITER procurement process in future.

A visit to FZK was organized with tours to the large facilities: TOSKA (for superconducting coil testing), the Tritium Laboratory and the Gyrotron laboratory for W7-X and ITER.

Events

Rimini - Gdansk - Budapest: Fusion Expo on Tour

In the month of August the Fusion Expo, the traveling exhibition of EFDA, changed its logistics centre. After more than three years in Cadarache (France) it is now sited in Padova (Italy) under the coordination of Euratom Association ENEA - Consorzio RFX. Immediately following the change of site, the Expo continued to tour Europe with three shows that attracted several thousand visitors. At the end of August the fusion exhibition was hosted at the "Quartiere Fieristico" in Rimini (Italy) at the "Meeting per l'Amicizia tra i Popoli". The presence at this important event was made possible through the collaboration with the Euratom Association ENEA CNR in Milano (Italy). The Expo was displayed in the scientific part of the meeting and was visited by approx. 9000 persons, many of them students and young families who were interested in knowing more about this possible new source of energy. It was also the first time that the Expo used its new visualization system which allowed the showing of the film "The Starmakers" in its full 3D beauty.

Web sites:

Rimini:
http://www.meetingrimini.org/eng/index.php

Gdansk:
http://www.hewelianum.pl/

Budapest:
http://www.millenaris.hu/index.php?lang=en

Science is fun.
Visitor at the Fusion Expo in Gdansk

At the beginning of September, the Expo went to Gdansk (Poland) on the invitation of the "Hewelianum" science centre. The Fusion Expo was the first event hosted in this former fortress on the hill. In the two and a half weeks of its presence, the exhibition was visited by, among others, 126 school groups with a total of about 3200 persons. The attractive science centre made it possible to exhibit the EXPO in very appealing atmosphere. The 3D visualization system was again a strong attraction for the public.

There was just enough time for dismantling, transportation and reassembly and, on October 8, the Expo was officially opened in Budapest (Hungary). The local host, the Euratom Association Hungarian Academy of Science, had managed to get an attractive location in the Millenaris Park, right in the centre of the town. The Expo was integrated with additional information on the activities of the Hungarian Association. Also this exhibition was very successful and was visited by around 80 schools with a total of 2100 students and a total number of visitors of around 3500. A very good media coverage (i.e. press, radio, TV) was given to all events, particularly those in Poland and Hungary.

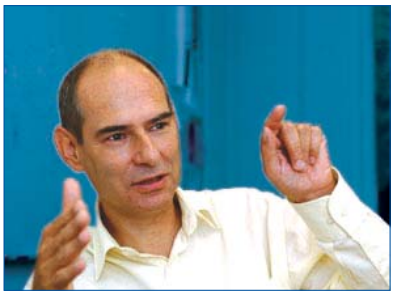
EFDA Associate Leader for JET Dr.J.Paméla in Gdansk giving his opening speech

Personalities

Royal / Shell Prize 2003 for Niek Lopes Cardozo

On November the 12th, the 44th Royal / Shell Prize for 2003 has been awarded to Prof. Niek Lopes Cardozo, head of fusion research at the Association Euratom-FOM Institute for Plasma Physics Rijnhuizen in Nieuwegein, the Netherlands. The Royal / Shell Prize is given each year to scientists who have rendered outstanding services to the development of sustainable energy. An independent jury, consisting of members of the Royal Dutch Society of Sciences and the Royal Dutch Academy of Sciences, selected Prof. Lopes Cardozo.

The jury honoured him as a creative plasma physicist of high international reputation. Prof. Lopes Cardozo and his team look into the relation between turbulence and certain geometric resonances in a confined magnetic field. Through a novel experiment he proved that turbulent layers in the plasma are connected with a complete series of such resonances. The jury also acknowledged his enthusiastic commitment for the dissemination of fusion science through the "Fusion Road Show", an interactive presentation which was developed in 1999 to present fusion energy to college students.



Picture: Ernst Bode

Prof. Niek Lopes Cardozo

There was a lot of attention given to the event by the press, and many guests attended the ceremony. In a debate with four former prize-winners, a clear consensus emerged about the urgency of the energy problem. Jeroen van der Veer, Managing Director of Royal Dutch / Shell Group, said: "In all respects, nuclear fusion fits in the image of innovation. … If nuclear fusion will become the energy-option that the scientists now envision, it will have a large impact on the energy sector. This is why we follow closely the work of Lopes Cardozo and all other researchers."

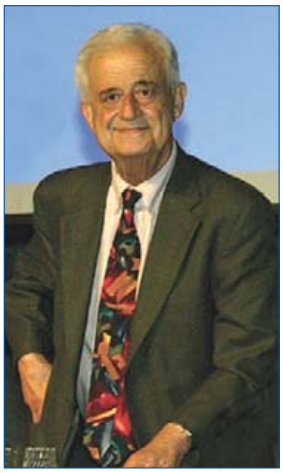
For more information see our EFDA website:

http://www.efda.org
and additionally
http://www.jet.efda.org
http://www.iter.org

Obituary

In Memoriam: Marshall Rosenbluth

On September 28, 2003, Prof. Marshall Rosenbluth, a towering figure in the field of nuclear fusion and plasma physics, passed away aged 76. His life in fusion spanned more than 50 years. Born in Albany, New York (US), he graduated from Harvard in 1946 and worked for his physics PhD at the University of Chicago. After having published the Metropolis algorithm together with a small group of Los Alamos physicists, he joined General Atomics in San Diego in 1956 to pioneer fusion energy. Rosenbluth also held a professorship at the University of California at San Diego, joined the Institute for Advanced Study at Princeton and directed the Institute for Fusion Studies at the University of Texas. As a member of the ITER Joint Central Team he contributed to the physics definition of the project. His many publications in plasma theory have influenced nearly every aspect of plasma physics and he was awarded several prizes, such as the US National Medal of Science and the Hannes Alfvén Prize of the European Physical Society (see Newsletter September 2002).



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