SMILES ALL ROUND
JET’S ITER-LIKE-WALL DELIVERS

EFDA LEADER APPOINTS NEW SENIOR ADVISOR

DECIPHERING PHOTONS

THE INS AND OUTS OF ENERGY
Moving Forward

EFDA

3  EFDA Leader appoints new Senior Advisor

Associates

5  MAST reaps the benefits of international collaboration

6  Fast ions – one key to plasma instabilities

8  KIT completes design of ITER cryo pump

10 Deciphering photons

JET Insight

11 The Joint European Torus

12 Smiles all round

13 JET guestbook

Community

People

14 Mister H-Mode moves to Russia

16 EFDA welcomes new Heads of Research Unit

In dialogue

17 The ins and outs of Energy

Miscellaneous

18 Newsflash

Title pictures: EFDA, EPFL (Martin Jucker)
EFDA LEADER APPOINTS
NEW SENIOR ADVISOR

In December 2011, Duarte Borba took on the position of the Senior Advisor to the EFDA Leader, succeeding Michael Watkins, who recently retired. After starting his fusion research career at IST in Lisbon, Duarte joined JET in 1991 as a scientist. He later worked in the JET Programme Department and was deeply involved in the formation of EFDA from 1999. During the last four years Duarte Borba headed the ITER Physics Department at EFDA CSU Garching.

Welcome back to JET, Duarte! What will you focus on in your new position?

My main work will be managing and expanding JET's international – meaning beyond Europe – cooperations. JET is part of a global network of large tokamaks and we already have a significant number of scientists, mostly from Japan, Korea and the US, here in Culham. Now we plan to expand these collaborations in order to prepare for ITER. We need multimachine experiments to investigate conditions we cannot create in one single tokamak.

Is the preparation for ITER also the motivation of our international partners to seek a collaboration with JET?

Precisely. Being the largest device and the only one to operate with tritium and now also with a tungsten-beryllium wall, JET's characteristics are closest to what we expect for ITER. Last year an international panel reviewed the JET Programme and strongly recommended JET to play a key role in the network of devices that prepare the operation of ITER.

“JET is the best training ground for future ITER scientists, not only scientifically, but also for working within an international environment”

DUA R T E  B OR B A
So JET will become more international?

This is the view of the EFDA management and that of the review panel. Bringing new partners into JET will also attract funds, as there must be a mutual benefit. Our current stakeholders have a position to protect, as machine resources are limited. We will have to develop agreements that allow us expand the way we do science at JET beyond Europe. This could lead to operating JET beyond the currently planned time span.

Could JET be a training ground for ITER not just scientifically but also for working within an international environment?

Yes. Running multicultural organisations bears challenges and JET is a good example of how these can be overcome efficiently. Having international scientists' teams at JET before they move on to ITER would make them familiar with each other and with the routines of a complex experiment. They could start their work at ITER more efficiently.

You represent EFDA in the Coordination Group of EIROforum, the partnership of Europe's eight large international laboratories. How does EFDA contribute to this network?

Big Science facilities have many common challenges regarding technology, management and analysis methods for data, or publications management. We also share the need to support and manage the careers and mobility of our scientific and technical personnel. EFDA has a lot of experience with mobile teams of scientists and also with data analysis and storage, which some of the EIROforum partners might benefit from.

What are EFDA’s aims with regards to EIROforum?

One of the key issues during EFDA’s Chairmanship of EIROforum in 2010/2011 was to have one strong voice during the shaping of the European research framework programme, Horizon 2020. Speaking with one voice also becomes increasingly important regarding software licensing, for example. We all need software for data analysis or data management. Joint negotiations might get us better deals.

As former Head of the EFDA ITER Physics Department, where do you see the main issues for European fusion research with respect to ITER?

Operating ITER will be more difficult and challenging than working on any device we know. ITER will only perform a few pulses a day. Scientists will have to use the existing tokamaks to narrow down their experiments to the most promising ones. Let me give you just one example: The large heat of ITER plasmas requires us to understand ELM instabilities and develop mitigation methods. We can test various techniques on all tokamaks in Europe and then transfer the successful ones to the larger machines like ASDEX Upgrade and JET. We must select which methods we test at JET and we can take even less of these to ITER. The challenge for the EFDA Physics Department will be to coordinate these efforts in the most efficient way in terms of manpower, facilities and funding.
MAST reaps the benefits of international collaboration

MAST, the spherical tokamak operated by CCFE, is providing new insights into plasma behaviour thanks to a series of diagnostic upgrades developed in partnership with labs around Europe.

MAST lends itself to excellent plasma diagnosis as the vacuum vessel has many ports with excellent wide views of the plasma. It has recently completed the first campaign of experiments with its enhanced suite of diagnostics and researchers are delighted with the data that have been gained so far.

**Beam Emission.** A new Beam Emission Spectroscopy (BES) system, the product of a collaboration between CCFE and KFKI-RMKI in Hungary (see Fusion News September 2010), has given physicists the ability to produce previously unseen images of the bubbling turbulence inside the core of the MAST plasma. Irregular fluctuations in the movement of particles from the core to the edge threaten the plasma’s stability and cause unwanted energy losses. Getting a clear picture of this turbulence is therefore essential in understanding and mitigating it. The BES system makes measurements by detecting the light emitted when neutral atoms are injected into the plasma to heat it. The diagnostic’s very high time resolution allows fusion researchers to map the evolution of turbulent structures at small scales. The four images shown here demonstrate this – showing fluctuations in the density of the plasma at five microsecond intervals. “Such images of turbulence in the core of the plasma are only available in a very few fusion experiments worldwide,” explained CCFE’s Dr Anthony Field, who designed the system. “We will now be able to compare our simulations directly with results from MAST for the first time. This will help in modelling the performance – i.e. confinement and stability – of plasmas for next-generation tokamaks, including ITER.”

**Neutron measurements.** Another recent addition to MAST is more evidence of how international collaborations can pay off. Entering the MAST machine area at Culham, one encounters a four-ton white polythene box attached to the tokamak. Although reminiscent of an ancient monolith, the box is in fact a highly advanced ‘camera’ containing a set of detectors to view neutrons escaping from the plasma. Neutrons are mainly produced by fusion reactions involving fast ions generated by the neutral beam system. Measuring the neutrons gives valuable information about the fast ions that formed them. These fast ions can, for instance, drive the formation of instabilities and it is important to determine their speed and other parameters. The neutron camera was a joint effort with Uppsala University in Sweden, who developed the detectors in the camera and the data acquisition system and helped design the camera with CCFE. “The project has given Uppsala a very good opportunity to participate in an international experiment like MAST,” said Dr Marco Cecconello of Uppsala University. “The collaboration with Uppsala is an example of how we can share expertise and expenses around Europe in order to get the best results for the project,” added CCFE’s Dr Mikhail Turnyanskiy.

With a major upgrade to MAST due to begin in 2013, there will be even greater scope for involvement from research colleagues around Europe.

*Nick Holloway, CCFE*

More information:
http://www.ccfe.ac.uk/MAST.aspx
Scientists from EPFL and JET have made significant progress on a method to avoid Neoclassical Tearing Modes, which are instabilities that affect the efficiency of a fusion plasma. Their experiments have demonstrated that by manipulating fast ions in the plasma, one can control a significant root cause of Neoclassical Tearing Modes.
Neoclassical tearing modes, or NTMs, are one of the most detrimental instabilities a fusion plasma can develop. They cause the plasma to lose heat and particles, thus reducing its efficiency, or even causing early plasma termination. A number of sophisticated methods have been developed over recent years to prevent the growth of NTMs, or to limit their severity. One standard technique is to use the plasma heating systems and launch focussed microwaves to increase the temperature or current of the plasma at the NTM location. However, in practice, once NTMs are evident, they are hard to extinguish, although their amplitude can be reduced.

Recently, scientists working at JET have fine tuned an alternative method which seeks to control the major root cause of NTMs. That cause is evident when a population of energetic ions interacts with a certain plasma variation called sawtooth oscillation. Depending on their space and velocity distribution, these fast ions ordinarily lengthen the sawtooth cycle and can subsequently trigger an NTM. A team led by Jonathan Graves from the Swiss Associate EPFL has now demonstrated that energetic ion populations can nevertheless be manipulated in a way that they shorten the sawtooth cycle and thus prevent the formation of NTMs.

Acting on a recently developed theory that predicted this behaviour, the scientists designed and executed novel sawtooth control experiments at JET. With the plasma in high confinement mode, they used radio frequency waves from the Ion Cyclotron Resonance Heating (ICRH) systems to energise helium-3 ions in the plasma core. As long as the ICRH-heating was applied properly, the sawteeth could be controlled and no NTMs developed. When the method was deliberately de-tuned or reversed, dangerous NTMs were triggered.

Preventing NTMs at ITER

ITER plasmas will be not only populated with fast ions generated by the heating systems. Also the deuterium-tritium fusion reaction will produce energetic alpha particles which will have the potential to act on sawteeth and trigger dangerous NTMs. ITER plasmas will also contain a minority quantity of helium-3 ions, whose purpose is to efficiently heat the plasma core when energised via ICRH radio frequency waves. The above mentioned calculations show that a properly manipulated helium-3 ion population can counteract the damaging effects alpha particles and other fast ions have on sawteeth and in turn avoid NTMs. The success in the JET experiment, which utilised helium-3 ions in proportions similar to those planned for ITER, inspires confidence that NTMs in ITER can be nipped in the bud.

Contact:
Jonathan Graves, EPFL: jonathan.graves@epfl.ch
KIT completes design of ITER cryo pump

Twenty years’ experience went into the design of the prototype torus cryo vacuum pump for ITER. The design will now be given to a manufacturer to build a 1:1 size prototype, which will be tested at KIT’s test facility for ITER pump models, TIMO-2.

The stakes are high for the ITER torus cryo vacuum pumps: Six pumps will create pressures down to one billionth that of air inside the 1,400 cubic metres of the vacuum vessel. “Just realising the immense pumping speed of 75 cubic metres per second within a pump diameter limited to about two metres is a challenge” says Christian Day.

He is head of KIT’s vacuum technology group, which is in charge of designing all the ITER cryo pumps. The heart of a cryo pump is an extremely cold surface, the cryo panel, which traps the atoms and molecules contained in the gas. At ITER, the cryo pumps will be also used to clean the vessel of helium produced by the fusion reaction. Helium is a headache for cryo pumps, as it hardly sticks to surfaces even as cold as four or five kelvin. KIT’s vacuum experts spent years looking for the most efficient carbon structure to trap helium and finally settled for coconut charcoal from a certain patch of land in Indonesia. Now KIT possesses an entire year’s harvest – enough to supply ITER and several future fusion plants.

ITER holds yet another challenge for the pump engineers: The deuterium and tritium absorbed in the cryo panels must be released regularly and fed back into the fuel cycle. Every ten minutes, the cryo panel of one of the eight pumps is heated to 100 kelvin to set free the trapped gas, and then cooled down again to four kelvin. “The ITER design allows us only 150 seconds for either the heating or the cooling process. That is very hard to realise, as 210 kilograms of steel in the panel have to be brought to temperature” explains Day. On top of that the mechanical stress which the heating and cooling cycles exert on the pumps has to be taken into account in the design.
As if these were not enough challenges for the pump designers, ITER also wants to use the pre-production prototype as a spare pump during operation if needed. For the KIT team that meant having to come up with a pump design that not only meets the pumping requirements, but also complies with all other ITER regulations – which go as far as demanding resistance against unlikely earthquakes at Cadarache. “We had to run lots of extra simulations and specify the materials to be used in much detail. We also had to integrate all changes made to the ITER requirements during our on-going design process.” says Christian Day.

The pump design has now been approved by F4E and ITER will be passed to a manufacturer, which F4E will identify through a call-for-tender procedure. The finished pump will be fully tested under ITER-like conditions in KIT’s TIMO-2 test facility. In the meantime the KIT vacuum technology group will continue designing the cryo pumps for ITER’s Neutral Beam Heating system. The group has also started to explore pump designs for a future fusion power plant within the EFDA Power Plant Physics and Technology activities.

Contact:
Christian Day, KIT: christian.day@kit.edu
DECIPHERING PHOTONS

For nearly 30 years atomic physicists have supported fusion scientists to interpret the spectral emissions of a plasma. The recent move to tungsten walls makes this collaboration even more important.

When JET started up in 1983, theoretical atomic physicist Hugh Summers, Professor at the University of Strathclyde, Scotland, was asked to join the project for a period of two years. The JET diagnostic team needed atomic models that helped them to interpret the spectral emissions of the plasma. Nearly 30 years later, and, in his own words, “overdue for retirement”, Hugh still shares his time between Strathclyde and JET, working on the ADAS project which originates from those early days.

ADAS stands for Atomic Data and Analysis Structure. The project provides atomic data and computer codes to model the radiation properties of plasma ions. ADAS grew from being a JET project to a global service financed by its participants. These include many European Associates, all ITER partners, the ITER project itself, as well as several astrophysics groups which use ADAS for their spectroscopic measurements. Two years ago, the EU recognised the importance of ADAS for ITER and provided four years of extra funding. ADAS took the opportunity to install experts at some participant’s sites and now finances three post-doctoral fellowships at IPP Garching, CEA Cadarache and JET.

One use of ADAS is, to monitor plasma impurities such as atoms dislodged from the wall. When these impurities enter the hot plasma, they are excited and emit light. ADAS connects the observed spectral lines to the number of incoming atoms. The recently installed tungsten wall tiles are a challenge for ADAS and the spectroscopists: Tungsten has 74 electrons and takes on many different states. The electrons transit between energetically close states and emit a large variety of very weak signals. The extra EU funding boosted the tungsten modelling capabilities of ADAS – at the end of January, the team accomplished an important milestone, the first theoretical estimate for the relation between the observed plasma lines and the number of tungsten atoms coming in from the wall.

Contact and Information:
http://www.adas.ac.uk/index.php
http://www.adas-fusion.eu/
EFDA provides the work platform to exploit JET in an efficient and focused way. More than 40 European fusion laboratories collectively contribute to the JET scientific programme and develop the hardware of the machine further. The tokamak is located at the Culham Science Centre near Oxford in the UK. It is funded by EURATOM, by the European Associates, and by UK’s fusion Associate, the Culham Centre for Fusion Energy (CCFE) as host. CCFE operates the JET facilities including carrying out the maintenance and refurbishment work required to realise the given scientific goals.
JET’s new ITER-Like-Wall has delivered a factor of ten reduction in fuel retention, much to the delight of the team that designed and installed it. “Although the calculations and lab tests suggested it might perform this well, often in the real machine things are different,” said Task Force Leader Dr Guy Matthews, who led the project to replace JET’s carbon tiles with beryllium and tungsten components. “But it has behaved exactly as predicted – we are very happy!”

Very low fuel loss
The amount of fuel retained in the vessel after a plasma pulse is a key parameter for JET’s performance. Although carbon withstands extreme heat well, it has been replaced as wall material because it binds all too readily with the hydrogen isotopes used as fusion fuel. This loss of fuel is a particular problem in the case of the tritium, because its short lifetime makes it scarce and therefore expensive. Also, handling of the vessel is greatly complicated if it still contains a significant amount radioactive tritium.

As both these issues would be even more significant in the scaled up context of ITER, scientists throughout the seven ITER nations have been following these experiments closely. Fortunately, following the move to metal tiles, the fuel retention has dropped by an order of magnitude.

In fact, the levels of fuel lost in each pulse are so low now that the measurement system had to be improved significantly to detect them. The fuel retention is determined by comparing careful measurements of the volume of gas injected into the chamber with the amount of exhaust. These results were initially not conclusive, because the retention quantities were now as small as the uncertainty in the gas temperature measurements.

However, an overhaul of the temperature sensors increased the precision and gave the team confidence that the fuel retention really was as good as they’d hoped.

Cleaner plasma
As well as reducing fuel retention the metal wall has led to a cleaner plasma overall. “Since the first plasma, we have had to do no conditioning at all,” says Dr Matthews.

With the carbon wall, weekly cleaning procedures were required, such as overnight glow discharges or beryllium evaporation. Also, after a disruption a recovery pulse was often required to remove contamination before the machine would operate at high power again. However with the new wall, says Guy Matthews, “the need for cleaning has currently all but disappeared, and we have had no false starts at all. I don’t think anyone would have expected that!”

Phil Dooley, EFDA
Some of the nearly 600 persons who paid a visit to JET from December through February:

- 280 school students, along with 29 teachers, visited the facilities.
- About 110 university students and scientists from various disciplines visited JET/CCFE.
- 20 industry representatives came for tours and discussions.

**Vicky Ford** (Member of the European Parliament for the East of England) and **Richard Ashworth** (MEP for the South East of England) visited the JET and CCFE on 20 February and had discussions with EFDA Leader Francesco Romanelli and CCFE director Steve Cowley. Long-time MEP Richard Ashworth has keen interest in fusion and has been to Culham before. He is member of the parliament’s Budget Committee, which was instrumental in agreeing extra funds for ITER back in December. Vicky Ford serves her first period as MEP and also came to Culham for the first time. She is keen to learn more about fusion, as she is member of the parliament’s committee on Industry, Research and Energy (ITRE), which assesses long term R&D priorities in Europe.

In January JET welcomed **Mr Hiroshi Kataoka**, a senior official of the **Japanese Ministry of Education, Culture Sports, Science and Technology** (MEXT) (Mr Kataoka is Director of the International Nuclear and Fusion Energy Affairs Division, Research and Development Bureau of MEXT). With him came **Dr Hideyuki Takatsu**, newly appointed **Chair of the ITER Council** and Deputy Director General of the Japanese Domestic Agency for ITER. The delegation toured the JET facilities and spent a morning with EFDA Leader Francesco Romanelli, Lorne Horton and Duarte Borba of EFDA as well as Tim Jones from CCFE. Francesco Romanelli congratulated Dr Takatsu on his election as Chair of the ITER Council and Dr Takatsu acknowledged the strong focus of the JET Programme on the key scientific issues for the operation of ITER. With its ITER-Like Wall and its capability to operate with tritium, JET plays a central role for all ITER partners to gain knowledge for the operation of ITER.
Friedrich Wagner, retired Director of IPP, has won a Russian research grant worth about 3.5 million Euros, together with Russian colleagues from St. Petersburg State Polytechnic University and in cooperation with the Ioffe Institute of the Russian Academy of Sciences.
Congratulations, Fritz!
You will lead the research laboratory of advanced tokamak physics, a collaboration between St. Petersburg Polytechnic University and the Ioffe Institute. What will you do there?

The laboratory has about 80 members and three experiments, and I will try to fulfill the role of the so-called Leading Scientist for the next two years. That is new territory for me but also for my Russian colleagues. Now, they know themselves, how to do science or how to operate a tokamak. I will contribute as a lecturer and I will bring in my knowledge and experience as well as my network. In the end, the main issue will be the future of this institute and the main Ioffe experiment, the spherical tokamak GLOBUS-M. I hope I can contribute with ideas on the Institute’s future strategy. Maybe the Leading Scientist has some visibility, maybe it might be easier for me as an external partner to open doors.

How did your participation in the competition for this Russian government grant come about?

I have been working with the Ioffe Institute and the Polytechnic University in St. Petersburg for decades. When I joined IPP in 1975, I wanted to measure ion temperatures via charge exchange. At that time the best instruments came from Ioffe Institute, so IPP started a collaboration. Now, last spring, the Russian colleagues approached me with the idea to participate in a grant competition, which aims at bringing foreign scientists to Russian universities. As I am officially retired and available and not yet ready for the role as couch potato, I accepted the offer.

What are your personal aims for the next two years?

I will spend four months per year – split into several stays – in St. Petersburg. My most important objective is that the laboratory continues after termination of my engagement. Russia has vast financial resources from oil, gas and coal exports. Should a fraction be spent on research, then it would be a good and appropriate idea to spend some of it on fusion. When I joined fusion, Russian sciences with the three major labs in Kurchatov, Budger, and Ioffe institute had a leading position in fusion research. Russia is part of ITER and needs the necessary scientific basis at home. I hope that I can reach Russian students with seminars and lectures and interest them in a career in high-temperature plasma physics.

What is the situation of young researchers in Russia?

I will learn more as soon as I am there. In the seminars and laboratories I see many „old friends“. Obviously, during the last years, young people did not see much future prospects in going into research. But like elsewhere, Russia seems to recognise the need to engage and support young scientists, and in fusion especially with respect to ITER. It would be a great fulfilment if I could support this process a little.

What are you looking forward to in particular for the next two years?

I am generally looking forward to this new mission and to work with my Russian colleagues. I will also enjoy the cultural life in St. Petersburg – the Eremitage, the Russian Museum, the Mariinksy theater, the many palaces and memorial sites. My wife knows the city well from earlier stays and she will accompany me at times.

Thank you very much, Fritz!
We wish you a successful time in St. Petersburg.

More information:
http://tinyurl.com/IPP-Wagner
EFDA WELCOMES NEW HEADS OF RESEARCH UNIT

Finnish Association EURATOM-Tekes – Tuomas Tala
Dr Tuomas Tala works at VTT Technical Research Centre and has served as Deputy Leader and Leader of the JET Task Force Transport.

“I hope to continue the research teamwork between the plasma physics and fusion technology groups in Finland originated by my predecessor Seppo Karttunen. I also hope to be prepared for the new challenges expected with the start of Horizon 2020 framework.”

Polish Association EURATOM-IFPiLM – Roman Zagórski
Prof. Roman Zagórski is a Professor in the Institute of Plasma Physics and Laser Microfusion in Warsaw and leads the Institute’s theory and modelling group. From 2008 until 2011, he was as the Plasma Wall Interactions Responsible Officer at the EFDA CSU Garching.

“I plan to focus my efforts on further integrating the research teams of the Polish Association with activities closely related to priorities of EFDA programme, in particular JET and DEMO. Special attention will be devoted to fostering the involvement of Poland in ITER construction through participation in F4E grants.”

Slovenian Fusion Association (SFA) Euratom MHEST – Andrej Trkov
Professor Andrej Trkov works at the Jožef Stefan Institute. His involvement in fusion has been in the analysis of fusion neutronics experiments. He has also worked at IAEA as Deputy Section Head of the Nuclear Data Section.

“I want to promote studies of materials and material behaviour under extreme conditions, including interactions with plasma, radiation damage and heat deposition. These are likely to be the limiting factors for successful utilisation of nuclear fusion for power production after the problems of plasma stability management are resolved.”

French Association EURATOM-CEA – Alain Bécoulet
Dr Alain Bécoulet is Head of the Institute for Magnetic Fusion Research (IRFM) at CEA. He was Chairman of the EFDA Topical Group on Heating and Current Drive and has been a member of the EFDA Science and Technology Advisory Committee (STAC) from 2001 until 2011.

“I intend to help the European Fusion Community adapt to the scientific and technical challenges of ITER’s construction and future operation, taking the full benefit of the present investments. This calls for an ambitious accompanying programme, supported by collective views and commitments.”

More about the new HRUs online: http://www.efda.org/newsletters/2012-march
Energy is a much discussed topic in Germany since the government decided to pull out of nuclear power and expand renewable sources. As a contribution to this public debate, scientists at IPP Greifswald designed a certified teachers training on the subject. One of their aims was to raise awareness of the large variety of information about energy issues and to provide tools and knowledge to help interpret it. They soon found that background information on energy is in great demand. Three times more teachers wanted to sign up than the 28 participants the one-day course could accommodate. The high level of interest triggered plans to repeat the course not only in the Greifswald area, but also in other regions of Germany.

Energy basics. The day started with basics: How much energy does an average person consume per day – including the energy needed to produce and transport the goods that the person uses? How much energy can renewable sources like wind or solar power provide in comparison? The book “Sustainable Energy – Without The Hot Air” by David MacKay, which analyses these questions for Great Britain, provided the basis for the session. The organisers of the training adapted his calculations to German conditions.

Energy scenarios. Next, Tobias Eder of IPP Garching introduced energy scenarios as a tool to assist political decision making. He provided insight into the various assumptions and boundary conditions that add up to variations in these scenarios and demonstrated how sensitive the models are to changes in public opinion. The scenarios show, for instance, that a society that decides not to care about global warming, will rely on cheap coal, while a society that does take measures against greenhouse gas emissions is expected to expand renewable energies, nuclear fission and – if available – fusion.

Fusion energy. The last session of the day looked into fusion – how it works and what potential it offers securing our future energy supply. The day finished with a visit to the assembly hall of Wendelstein 7-X, the advanced stellarator which is under construction in Greifswald.

Contact:
Michael Drevlak, Andrea Kleiber, Ralf Kleiber, Axel Könies, Jörg Riemann, IPP Greifswald
**ANNOUNCEMENTS**

**IPP Summer University on Plasma Physics and Fusion Research**

Garching, Germany, 17–21 September 2012

**Deadline for application: 31 May 2012**

The course addresses European physics or engineering students who have passed their undergraduate or bachelor courses and have not yet decided on the subject of their PhD thesis.

**More information:**
http://tinyurl.com/IPP-SummerUniversity

---

**What’s up with Fusion Expo?**

Fusion Expo has just returned from Nancy, France. The exhibition will now undergo some updates.

Stay tuned at [http://www.efda.org/fusion-expo](http://www.efda.org/fusion-expo)

**Contact:** Tomaž Skobe, tomaz.skobe@ijs.si

---

**www.efda.org**

**Fusion veterans live**
A video of Donato Palumbo’s commemoration at JET

**Fishbones**
You see dinner. A physicist sees bursts of magnetic instability.

**Photos and videos**
Browse our multimedia gallery

**Newsletter archive**
Read past issues or search for specific articles in Fusion in Europe and our former publications JET Insight and Fusion News
28 European countries signed an agreement to work on an energy source for the future: EFDA provides the framework, JET, the Joint European Torus, is the shared experiment, fusion energy is the goal.

Our partners: