DONES – THE MUST-HAVE FOR A FUSION POWER PLANT

DAN BROWN, MARE NOSTRUM AND POSTDOCS IN BARCELONA

From ITER to cancer treatment
Especially for Fusion in Europe, Cosylab has put out the pencils again and drawn our lovely title picture. The software company is a spin-off from the Slovenian Research Unit and has grown with ITER while preparing ITER’s core programme.

Picture: Cosylab

Christopher Watson, former Head of the JET Project Control Office, wrote to us in response to the article on how the Culham site was chosen. Read about what happened when the news broke that Culham would become home to the Joint European Torus.

Picture: private

Meet super achiever Jaime. He is only 18 years old but he already won the European contest for young scientists. And Jaime authored two novels and is featured in a Spanish TED Talk.

Picture: private

Contents

Research Units
4 WEST and its actively cool divertor
6 Dan Brown, Mare Nostrum and Postdocs in Barcelona
8 Need a tricky tungsten piece? Print it!

Marketplace
10 From ITER to cancer treatment

Young Faces
14 EUCYS winner Jaime: Samurai, JET and a fusion novel

Moving forward
16 DONES: The must-have for a future power plant
18 It takes two to fuse

Community
20 JET’s first CD out now

Fuel for Thought
22 JET is far too big for one nation

Community
24 JET is a European success

Imprint
EUROfusion Programme Management Unit – Garching Boltzmannstr. 2 85748 Garching / Munich, Germany phone: +49-89-3299-4128 email: anne.purschwitz@euro-fusion.org editor: Anne Purschwitz

© Petra Nieckchen, Head of Communications Office

This newsletter or parts of it may not be reproduced without permission. Text, pictures and layout, except where noted, courtesy of the EUROfusion members. The EUROfusion members are the Research Units of the European Fusion Programme. Responsibility for the information and views expressed in this newsletter lies entirely with the authors. Neither the Research Units or anyone acting on their behalf is responsible for any damage resulting from the use of information contained in this publication.

For more information see the website: www.euro-fusion.org
The first edition of Fusion in Europe 2018 greets you with many firsts: In Karlsruhe, scientists succeeded for the first time in printing tiny but precise pieces made out of tricky tungsten. The new French member in EUROfusion’s tokamak family, WEST, owns the first actively cooled divertor in Europe, just to name two topics of this issue.

Meanwhile, the Barcelona Supercomputing Center is celebrating a success of a different kind. Well-known novelist Dan Brown, the one who had helped to make CERN famous, has recently paid his first visit to the Catalonian computer experts. The author’s new book “Origin” deals with the ever occurring question of the beginnings of the universe. Since Barcelonan computer Mare Nostrum 4 is also occupied with calculating the processes inside the Sun, it might have something to say about the universe in general. By the way, the team is looking for postdocs. Hurry up and apply!

Jaime, however, has still a bit of time to think about his postdoc. But you can be sure that the EUCYS winner makes the best of it. He did not only win the prize of the European Union contest for young scientists and spent a week at JET. He also authored not his first but already his second novel on a samurai from 15th century Japan and he is starred in a TED talk. And yes, Jaime is only 18 years old.

You can say that Jaime is on a highway into a brilliant future. Talking about fast lanes brings us directly to DONES, the DEMO Oriented Neutron Source.

Does not sound appealing to you? Wait, it’s another first, actually, a frontier experiment to test materials under realistic fusion irradiation conditions. Currently, Spain is applying to become the host for this laboratory.

If you think, this is an awful lot to read, we suggest you take a rest and just listen – to JET’s first CD. The Joint European Torus is not only a pioneer European device, the first and only to operate deuterium-tritium worldwide, it is also a singer. Tune into buzzing sounds, fizzling cables and humming vibrations with the help of the accompanying music group Poupées Électriques.

We hope you enjoy our full-body fusion experience. Stay tuned with us!
Since its first plasma in December 2016, the Tungsten (or Wolfram) Environment in Steady State Tokamak (WEST), has already seen 2,500 shots, short outbursts of plasma lasting only seconds. WEST is built on the foundations of former Tore Supra in French Cadarache. It will be able to produce heat loads comparable to those in ITER. WEST will own a unique feature: an actively cooled divertor.

Inside WEST: the tokamak has its origin in the former Tore Supra. Nevertheless, it has been turned into an entire new machine capable to mimic ITER conditions. Pictures: Christophe Roux/CEA
WEST has been constructed the other way round. While designing a tokamak, engineers and scientists usually aim to keep the heat load low in order to preserve the machine from damages. The case was different for WEST because it is meant to be the materials test bed for ITER. Therefore, it has to produce equal heat loads.

**ROCKET SCIENCE**

WEST will soon be able to produce 10 Mega-watts per square meter, similar to powers encountered in a rocket nozzle and to those expected in ITER, once the biggest tokamak on Earth is up and running. Unlike other existing tokamaks, the new French member in the EUROfusion team can cope with those tremendous forces thanks to an actively cooled divertor.

**15 MINUTE PULSES**

A divertor takes the energy that is spit out from the main plasma. It is ‘diverted’ onto the special tiles. In former fusion experiments, the plasma did not last longer than milliseconds. So, the time for exposure was so short that the material could withstand. Since WEST is expected to operate pulses up to 15 minutes under immense heat loads, a special heat exhaust system was mandatory.

**ACTIVELY COOL**

The actively cooled divertor is made out of a support structure which holds the tiles of WEST’s divertor. Attached manifolds feed cool water onto the back of the support structure in order to reduce the temperature of the material when exposed to the large amounts of heat.

“I am really proud that we at CEA host the only superconducting actively cooled divertor experiment in Europe”, says Alain Bécoulet. The Head of the French Research Unit is looking forward to a first experimental campaign which will also carry out material tests within the framework of the European fusion roadmap. “WEST allows us for the first time to test whole components under fusion conditions instead of just samples”, says Michael Reinhart, the Responsible Officer for Plasma Facing Components in EUROfusion.

**WIN-WIN WITH WEST**

This information is not only crucial for the science that makes ITER a success. It is also important for the companies which build ITER’s components. They can test the pieces at WEST before they go into the ITER machine, a win-win with WEST so to speak.

---

**FROM TORE SUPRA TO WEST**

| Name: WEST  
| (Tungsten or Wolfram Environment in Steady-state Tokamak)  
| **Upgrades**  
| • Divertor configuration  
| • All-metal Plasma Facing Components (PFC)  
| • Upgraded cooling system  
| • Novel diagnostics to monitor tungsten PFC  
| **Operation Schedule:**  
| May-July 2018 / Oct-Dec 2018  

**Scope of the campaign**

The upcoming experimental campaign focusses on heat load and power deposition on the new divertor. The experiments are related to heat-exhaust and serve mission 2 of the European fusion roadmap.
The Barcelona Supercomputing Center has sparked attention from different sides. The European Commission proposed to invest one billion euros in high performance computing, and pointed to Barcelona as one of the leading labs. Additional support has come from Dan Brown: His latest novel features this modern chapel. High time to check out the Spanish super skills for fusion.

CALCULATING THE UNIVERSE

It is famous University Professor Robert Langdon who is standing right in front of the Barcelona Supercomputing Center (BSC). Author Dan Brown, who made CERN famous in "Angels&Demons", has chosen to promote another science facility in his latest book. "Origin" discusses nothing less than the fundamental question of the beginnings of the universe. Mankind seems not so far from solving this secret when aiming to create a Sun on Earth. Hence, scientists have to rebuild the processes inside this giant ball of plasma. Thanks to supercomputers, research is now able to model such multiscale operations. In 2016, EUROfusion has even invested in parts of a supercomputer.
in order to simulate fusion: Marconi Fusion in Italy ranks Number 14 amongst the 500 top computers in the world.

“So far, no simulation goes all the way to rebuild the entire complexity of a fusion experiment. And this is our chance.”

**FUSION IS A DRIVING FORCE**

Mervi Mantsinen, her Fusion Group in Barcelona and their supercomputer ‘Mare Nostrum 4’ are complementing the work of Marconi Fusion: The BSC is linked to the EUROfusion programme through the Spanish Research Unit CIEMAT in Madrid.

To Mervi, fusion research is one of the driving forces behind the developments of supercomputers. “We want to calculate the behaviour of every single electron or predict the material behaviour under fusion conditions. This requires a new code development or up-to-date architectures for our systems”, she says. Investing into supercomputing will enable her team to do special calculations within five days instead of approximately 100 years with an ordinary laptop computer.

**CATCHING UP WITH CHINA?**

The Catalanion centre ranks 16 on the list of the Top 500 High Performance Computers worldwide. It lags behind the National Supercomputing Center in Wuxi, China, for instance, which is Number one on the list published in last November.

Will the proposed one billion euros from the European Commission enable the Spanish to climb up the ladder and compete with Asian or American technologies? “At least, the Europeans saw a need to act. Still, I feel like we are late with the European strategy”, says Sergi Girona, the Director of the Operations Department.

**SERVICE IS MORE IMPORTANT**

“It won’t be before 2021 that Europe will host machines with the same computational power like our competitors. Anyhow, capacities are one thing, usability is another: “For me it is more important that we provide flexible services for all scientists in a short time, other than very specific solutions for a few”, adds Sergi.

Get your Postdoc at Mare Nostrum

“We are looking for Postdocs in fusion. The deadline for the first call of applications is 30th of April. It will be highly competitive among all fields of research”, says Mervi. If you are interested, contact her at mervi.mantsinen@bsc.es
Imagine you are a professional car tuner and you need one unique and very precise piece over and over again. A specialised manufacturer could produce it. But it takes weeks plus another week for the parcel to arrive at your garage. 3D printing is the solution, not only for tricky car parts but also for fusion components.

NEED A TRICKY TUNGSTEN PIECE?
PRINT IT!
The Institute for Applied Materials in Karlsruhe succeeded in the 3D printing of fusion components made out of tungsten. 3D printing, also known as Additive Manufacturing (AM), uses successive layers of material to create a three-dimensional object. Tungsten, so far, is the most favoured material for fusion experiments because it can withstand very high temperatures. Plasmas which have been produced inside vessels with tungsten tiles show less impurities. Hence, it does not come as a surprise that it was fusion science which has triggered this new and fast way of prototyping in Germany.

**TURNING STUDIES INTO REALITY**

The final, fully manufactured tungsten piece measures 5.6 cm² and is only 4 mm high – a matter of precision which now can be achieved on the scientists’ desk. The successful outcome enables scientists to tailor fusion relevant materials in less time. It simply won’t take so long anymore before design studies can be turned into 3D or better: reality.

"In just a few hours we produce a first version of the piece, a so called green part. External production would have taken weeks instead."

Steffen Antusch, Head of the Materials Group from the Institute of Applied Materials in the Department of Material Process Technology at the Karlsruhe Institute of Technology (KIT).

---

**TUNGSTEN**

You are looking for one of the toughest things in nature? Take tungsten. The name already says it: in Swedish the words “tung sten” mean ‘heavy stone’. The preferred fusion material is super dense and almost impossible to melt. Unless you increase the temperature above 3410 degree Celsius. Where does that happen at all? In light bulbs, aircrafts or fusion experiments. JET is called ‘little ITER’ for a reason: it owns an ITER-like wall which uses beryllium and tungsten. The same combination will be covering ITER’s inside vessel.

---

KIT has successfully delivered tungsten Langmuir probes to the ‘new’ French tokamak WEST.

www.euro-fusion.org/?p=96546
A spin-off from EUROfusion’s Slovenian Research Unit, the Jožef Stefan Institute, has become a leading partner for software engineering. Today, Cosylab sets up infrastructures for complex machines worldwide. The former students of physics even helped to establish ITER’s central control programme. Going through this demanding project management process had prepared the team perfectly to set up a new branch in the medical sector.
Being in the right place at the right time is one of the secrets of success. Founding member of Cosylab, Rob Šabjan would certainly add a large dose of hard work and specialist skills in paperwork to the magic potion. Without even being aware of it, he and his six colleagues achieved the unpredictable back in 2001, while implementing a very complex control system for ANKA, die ‘Angströmquelle’ Karlsruhe.

ENGINEERING THE CORE
Back then, the Slovenians gained knowledge which could be used to serve various big science projects, including particle accelerators, ion beams and tokamaks. These machines run on a highly distributed network of computers. An ordinary software company would not be able to set up such a complex computing infrastructure. “The system needs to reliably ensure a myriad of very difficult tasks, ranging from real-time process control to operator interfacing and the acquisition and storage of large quantities of data”, says Rok Šabjan, a founding member of Cosylab.

Cosylab’s specialist knowledge when it comes to integrating the right software into demanding devices, like ANKA and similar projects, came in handy for an ambitious project in the south of France. When ITER started to grow from scratch, Cosylab offered its expertise.

Yes, it was a lot of work and difficult at times, but it helped us to grow and learn.
GROWING WITH ITER
Cosylab’s initial big ITER project was nothing less than participating in the set-up of the first version of CODAC (Control, Data Access and Communication), ITER’s basic control programme. It formed the groundwork for developing ITER’s system further. Today, Cosylab is still supporting regular updates of CODAC and carries out training and support for ITER developers. After all, the former student’s company is currently working on a total of five contracts for the largest tokamak to come.

Winning the ITER contract was no walk in the park. Although ITER’s control system experts were delighted by the Slovenian expertise and attitude from the very start, there was still a tender that the young company had to win. Because ITER is a publicly funded nuclear research experiment implemented by 35 nations, transparency is of the utmost significance. For this reason, every company must go through a complex process in order to be permitted to supply services or goods to the largest fusion experiment to come.

IT’S ALL ABOUT QUALITY
Cosylab has expanded into a second industrial sector: control systems and support for medical devices. Particle accelerators, Cosylab’s original field of interest, are also used in medicine, for example, for treating cancer. Proton and carbon ion therapy machines accelerate a beam of particles and deliver it very accurately into the tumour. This kind of treatment is called proton, ion or simply particle therapy.

The difference between working for a tokamak and working for a hospital is not so great given ITER’s thorough documentation requirements. (especially when you consider the fact that ITER is a nuclear machine.)
We are dealing with larger scope projects and greater challenges on the customer’s side. I expect this trend to continue.

Rok Šabjan

In the medical sector, the supplier needs to prove that his machine works safely and effectively, as required by standards and regulations. “They are different than the ones that apply to ITER of course, but in the end they are quite similar, since we are talking about high integrity systems in both cases”, adds Rok.

SKILLS AND PROPER MENTORING

But knowing how to operate such demanding systems is not just a matter of being in the right place at the right time: “It wasn’t all about luck, though luck did matter. Dr Mark Pleško, who is today the CEO of the company, trained us very efficiently in various competences, such as technical and project management, as well as working with people and developing a business while encouraging an entrepreneurial mind set”, says Rok.

COMPLEX PROJECTS ARE TRENDING

Cosylab no longer has much in common anymore with a student’s start-up. It now runs offices in Japan, the United States, China and Sweden with a total of 170 people working under its roof.
It was really encouraging to meet scientists who have shared their enthusiasm for shaping tomorrow’s energy”, says Jaime Redondo Yuste. The EUCYS winner has paid a visit to the Joint European Torus (JET) and is still amazed. “It’s absolutely fantastic to go to Culham and see so many people from different nationalities”, the 18 year old Spaniard says. Meet Jaime, the achiever, who is obviously crazy about science and experiments and who has authored two Samurai novels.
SERVING FUSION AND SPACE
Jaime admits that he did not know much about fusion research. It was only when he decided to apply for the European Union Contest for Young Scientists (EUCYS) that he came across this field and decided to do a project called “A study of interaction between magnetic field and electronic ions” in which he carried out simulations about what is happening in fusion plasma. This knowledge is important in order to maintain the proper fusion conditions. Moreover, it delivers information about the impact on the device material.
Jaime performed the experiments in his high school lab and discovered that his approach is important for other applications. “It might be useful for the space industry too. They are also looking for material solutions that can stand harsh environments”, the student of mathematics and physics adds.

FIND YOUR VOCATION
It seems like studying sciences is the way to go for Jaime who had already successfully participated in the Spanish National Olympiads for Physics, Mathematics and Chemistry. He even qualified for the international tournament where he won a bronze medal in the Iberoamerican competition. Jaime then finished school with the best possible grades in Spain. He did so well that the renowned Spanish newspaper ‘El Mundo’ featured him. Still, Jaime flaunts many talents. He has authored two fantasy novels on Samurai Akari Kento. Akari Kento. "By the age of 13, I was really enthusiastic about 15th century Japan", Jaime says. Considering his many different interests, he was struggling to find out what to study at university. “I am also very interested in philosophy and history”, Jaime says.

A futuristic novel which also features fusion energy?.... I have not thought about it, but it sounds good!

SCIENCE = SURPRISE+FASCINATION
Jaime while still being only 18 years old has surely been through this process. Since he was a little kid, he felt this surprise with regard to science. “My father, a chemist, performed experiments at home with liquids changing their colours. It fascinated me. It was just natural for me to start doing my own tests with magnets and coil, he explains. There is plenty of beauty in all those experiments: from the simplest one which predicts the time of a falling rock up to the most complex fusion trials”, he explains. Jaime wants now to enrol in a PhD programme in physics. I cannot decide yet where I will work. Fusion is definitely a topic that would interest me, so... why not?” he admits. And what about sharing his passion for physics with his love for writing books? “A futuristic novel which also features fusion energy?.... I have not thought about it, but it sounds good!”

EUCYS prize: The European Union Contest supports young scientists in various fields. It offers students the opportunity to compete at European level. As one of the eight EIROforum members, EUROfusion is part of EUCYS. Each EIROforum member awards a special prize. EUROfusion member awards a special prize. EUROfusion offers one lucky contestant a one week visit to the fusion experiment JET in Culham, England.

TED Talk
(in Spanish)
youtu.be/mYTQd9Q8nqY
DONES: THE MUST-HAVE FOR A FUTURE POWER PLANT

The DEMO Oriented Neutron Source (DONES) should soon become reality. What sounds rather specific and hard to grasp is actually a matter of high interest in fusion research. DONES will be a frontier science facility and the indispensable step towards the first fusion power plant.

DONES creates an environment in which materials can be tested under realistic fusion irradiation conditions, a neutron source which has no equivalence on Earth.

HIGH-ENERGY NEUTRONS

The ‘real’ fusion fuel, a deuterium-tritium mixture, produces a large amount of energetic neutrons. Those neutrons can damage components by knocking atoms in their material out of their position. A future fusion reactor will have long pulses. The amount of generated neutrons is much higher compared to those already seen in the short nuclear pulses of the Joint European Torus. Therefore, it is valid to test materials under the influence of neutrons which carry the same amount of energy and intensity as expected in future fusion plants. DONES will mimic the full operational lifetime of a fusion reactor. Its results serve the proper preparation of the first demonstrational fusion power plant, in short DEMO.

The highway to DEMO

“It is like testing a new motorway to get the official licence to open it. What we achieved so far is testing our road with one compact car driving on it every half an hour. But in the long pulse fusion operation in DEMO, we see a constant flow of heavy trucks on the highway’s surface. So, we need to figure out what the material will be like after two years of intense traffic.” Eberhard Diegele (EUROfusion’s Power Plant Physics and Technology Department).
PREPARING DEMO
Consequently, EUROfusion’s roadmap has turned DONES into one of the three main pillars of its programme. The testing facility is the step that comes in parallel to ITER. The large tokamak is supposed to prove that fusion energy is feasible. ITER’s outcome as well as the materials qualified in DONES will feed into the design of DEMO. It is no wonder that Europe, which operates a fully-fledged research programme aiming to realise fusion electricity in the 21st century, wants to become the host to this several hundred million Euro project.

SERVING MANY SCIENCES
Not only will the outcome serve fusion in terms of qualified materials, tritium breeding modules or liquid metals. Other scientific and technological areas such as nuclear physics in general, medicine, electronics or astrophysics will also benefit from the unique test site.

GRANADA READY TO GO
Last year, Spain and Croatia flagged their interest to host DONES. Subsequently, a technical group of experts was put together to visit the proposed sites in both countries. After an agreement between Spain and Croatia, Granada was proposed to become the future site. The experts found the area in the south of Spain ‘fully operational’ and ready to start with construction works. Currently, the Spanish government negotiates about available funds from the European Commission.

A ‘PRE-DONES’ IN JAPAN
Europe, by the way, is not the only one interested to host DONES. Through the Broader Approach Agreement signed in 2007 between Japan and Euratom, the Asians reinforced the strong cooperation with European fusion research. The agreement compiles activities which ensure the preparations beyond ITER. One of them being a joint Engineering and Validation and Engineering Design Activity (EVEDA) for the International Fusion Materials Irradiation Facility (IFMIF). It remains to be seen whether Japan wishes to develop its own facility, to establish a partnership with the European facility or to pursue both options.

“As far as the European IFMIF Home Team is concerned, building on the good collaboration we have with the Japanese Home Team under the Broader Approach Agreement and IFMIF/EVEDA (DONES’ predecessor), we think that the strong partnership with Japan should be maintained also for this project”, states Roland Heidinger from Fusion for Energy who is the European Project Manager for IFMIF/EVEDA.

The information gained from DONES is crucial for a future fusion energy source. Europe should have easy access to it.

Angel Ibarra, Head of the Fusion Technology Division in EUROfusion’s Spanish Research Unit CIEMAT.
What happens if two very ambitious fusion programmes join? Progress in realising fusion energy for sure. Nine EUROfusion coordinators are currently involved in a well-defined collaboration with Chinese fusion labs. Know how, resources and determined scientists on both sides will push research further.
“The Chinese machines simply increase our possibilities”, says Annika Ekedahl. One of them is the tokamak HL-2A, at the Southwestern Institute of Physics (SWIP) in Chengdu. It uses, for instance, different plasma heating methods, which can’t or won’t be pursued by the European Programme due to different priorities. The other important experiment is called EAST, the Experimental Advanced Superconducting Tokamak at the Chinese Academy of Science Institute of Plasma Physics (ASIPP) in Hefei.

**FUSION ENERGY IS THE GOAL**
Nevertheless, the fusion programmes in Europe and China have one common goal: realising fusion energy. A Technology Management Plan, signed by Dr Andras Siegler (former Director for Energy Research from the European Commission) and Dr Luo Delong (Head of the Chinese Domestic Agency, which is under auspices of the Ministry of Science and Technology of the People’s Republic of China) in 2016, fostered a deeper cooperation between both parties within the Peaceful Uses of Nuclear Energy agreement. The mutual motivation has now resulted in five well defined objectives. Annika’s project is one of them: investigating relevant heating methods for long plasma operations either in the western or the eastern part of the world. Each proposal is coordinated by one European scientist and his or her Chinese counterpart.

**POST-ITER PROJECTS**
Annika’s experiments belong to a series of topics which address the successful start of ITER and training of future staff. But, what comes after ITER? Europe’s answer to this is DEMO, the first demonstrational fusion power plant. China has come up with a comparable project: The China Fusion Engineering Test Reactor.

“DEMO won’t be built before 2040. So there is room to embark on joint design, research and development issues together”, says Gianfranco Federici. He and his Power Plant Physics and Technology team have just returned from a fruitful meeting in Beijing. “We set up additional projects regarding breeding blankets, magnets, remote maintenance and diagnostics”, he reports.

**INVESTING IN THE FUTURE**
Meanwhile, Annika cannot wait to continue her experiments in China, which build on four years of intense exchange between both countries. Along with her Chinese partner Xianzu Gong she is about to install commonly used diagnostics either on the before mentioned HL-2A or the Experimental Advanced Superconducting Tokamak (EAST) at the Chinese Academy of Science Institute of Plasma Physics (ASIPP) in Hefei. Innovative plasma modelling ads up to the top priorities. EUROfusion also funds two entire PhD programmes which enrol in Annika’s project. This includes a six-month stay for the Europeans at ASIPP. In addition, China finances students of their own who will get trained at European universities and labs in order to get to know European experimental facilities, modelling systems or different diagnostics.

Darren McDonald and Xavier Litaudon from EUROfusion’s ITER Physics Department, who oversaw the preparations are delighted by the good spirit of the collaboration. “This is vital for our research. Only sustained efforts will lead us further on our way to fusion electricity”, concludes Xavier Litaudon.
It’s about time to discover fusion with your eyes AND your ears. Yes, with your ears. JET offers buzzing sounds, fizzling electric cables and humming fusion plasmas. The music group “Poupées Électriques” recorded the resonances of the European fusion experiment and has finally released the CD “JET – Nuclear Fusion Device”.
“It’s amazing to celebrate our plasma anniversary with actual plasma music”, says Paco Castejón. He was an eye- and ear witness of a pre-presentation from Poupées Électriques’ “JET – Nuclear Fusion Device”. During the celebrations of the 20th anniversary of the first plasma from Spanish stellarator TJ-II, the musicians synthesized JET’s vibrant tunes with percussions, piano and a theremin. Vibrant visuals create an almost full-body experience of fusion as art.

The extraordinary performance makes nuclear fusion scientist Paco recall what happened back then when the Spanish experiment premiered: “I still remember when we could see the TJ-II plasma emitting light at 7 pm on December 20th in 1997. 20 years later, after a successful scientific exploitation, we celebrate such moment with wine and very special music”, adds Paco.

50 MINUTES FUSION SOUNDS
Paco surely knows about current fusion research but many people still don’t. Reason enough for futuristic musicians like Carlos Arillo and his group to welcome the Joint European Torus into his ensemble. With his friend Ana Manzanares who works in Culham, Carlos set off to England in order to record the signature sounds of the world’s most developed fusion experiment. He got hooked: “I make music of the future. It’s vital to connect it to the energy of the future”, he says. Finally, the CD is out now. Besides providing nine tracks and a total of 50 minutes fusion sounds, it offers a flashy booklet which explains JET and introduces its scientists.

“I make music of the future. It’s vital to connect it to the energy of the future.”
Carlos Arillo

Touring European stages with JET
“Our show comes with synchronized visuals and the sound played live. I assure you, it’s quite an intense experience”, says band leader Carlos Arillo. Poupées Électriques will perform at the XIII International Conference on Art and Technology on 17th and 18th of April. Watch a sneak peak of the visuals:

youtu.be/Uyhn231XGbc

Nine tracks carry the sound of JET which comes in a limited edition box. It also includes a spectacular tokamak poster and a 16-page booklet on nuclear fusion from the perspective of the scientists involved. Order your copy here:
www.poupeeselectriques.com/es/shop/jet-nuclear-fusion-device
I have recently hosted a reception for Members of the European Parliament entitled ‘Fusion after Brexit’ to discuss the implications of the UK’s departure from Euratom on European Nuclear Fusion Research. To this event, I had invited primary European fusion experts such as Ian Chapman (CEO of the UK Atomic Energy Authority and Director of the Culham Centre for Fusion Energy) as well as the EUROfusion Programme Manager Tony Donné and Jan Panek (Head of Unit ITER in the European Directorate-General ‘Energy’).

They all spoke passionately about JET’s leading role in paving the way for ITER and the long-awaited delivery phase of nuclear fusion. This cross-party event was also an opportunity to discuss the UK’s departure from the nuclear community – Euratom – which is putting the UK’s leading role in jeopardy.

THE BREXIT THREAD
JET and the Culham Centre for Fusion Energy are based in Oxfordshire, in my South East England constituency. I have been visiting JET in November 2017 and I witnessed this incredibly impressive feat of science.

I’ve long been aware that fusion offers the prospect of plentiful clean energy when developed on commercial scale with the Culham centre showing the first successful proof of concept.
experiments. JET is an EU venture through and through. It is far too big a project for any one nation state and it hinges on cross-border collaboration and involves scientists from every EU member state and beyond. The hundreds of researchers, engineers and technicians visit the centre to conduct experiments. The parts used to assemble the world’s biggest nuclear fusion experiment so far, come from all around the Union. Crucially, so does the €283 million that underpins the JET programme for the five years through 2018.

Brexit threatens all of this! The UK government’s decision to leave Euratom puts the future of fusion research, in which Britain has led the way, at stake. If and when this happens, any progress and ground-breaking scientific research and collaboration could be endangered. The UK will lose access to EU funding, inhibit easy movement and stifling rapid and responsive cross-border work. The current funding for JET also ends in December 2018, so experiments in 2019 and beyond – vital for ITER preparation – are threatened if ongoing close collaboration between the UK and Euratom cannot be negotiated.

UK MUST REMAIN PART OF EURATOM
If the UK Government gets Brexit wrong, it will seriously damage Britain’s world-leading scientific reputation and with it the wider international fusion programme. It is essential to both the UK and the rest of the EU that we somehow keep the UK as part of the Euratom community after Brexit – assuming it does, in fact, go ahead.

Fusion research will always be an international effort. By holding this event we helped to build support in Brussels for finding a way to sustain the partnership that will benefit Britain, Europe and the wider international fusion community.

Watch the speech John Howarth gave at the European Parliament in November 2017

[Link: https://youtu.be/LQIMhAbtoa4]
Christopher Watson was right on the scene when the news broke that Culham would become the home of the unique Joint European Torus. The later Head of the JET Project Control Office has written to us in response to the article “Hijacking a jet – how Culham was chosen”. He draws a line joining the 25 October 1977 to the referendum two years ago, in which the United Kingdom voted to withdraw from the European Union.

**JET IS A EUROPEAN SUCCESS!**

*Do you remember the day on 25 October 1977?*  
Vividly! I actually sat in Bas Pease’s office, waiting for the telephone call from Brussels. [Sebastian "Bas" Pease was the director of fusion research at the UK Atomic Energy Authority from 1968 to 1987].

*How was it when the call from Brussels finally came?*  
I immediately headed for the JET Management Committee, and I broke into its meeting to report to Bas. It turned out that they already knew the result, since someone else who had a mobile phone, had received a call from Brussels a few minutes earlier!

*We had all been waiting for a decision on the project ever since the EU Council of Ministers gave its first decision on the subject in May 1975. All that had remained was to give a final site decision, and to agree the contribution of the EU to its total cost.*

*You had been waiting two years for the final decision?*  
Yes, this time was a period of total frustration for the entire Design Team, and all the national officials like myself who were engaged in the negotiations. Whatever decision was taken on the site would mean that the majority of the JET Design Team at Culham would either...
have to leave, or to reconcile themselves to many years living and working at Culham. So there was a great deal at stake for them and their families, quite apart from their loyalties to their country.

What was at stake for you?
Although I was not yet a member of the team, I hoped to join it. So, I and my family had the same conflicting feelings. Issues to do with friends and relations left behind in our mother country, home-building in a new country, schooling, language and membership of an international team all played a part.

How did your colleagues react when they learned that Culham had made it?
The overall feeling was relief. The German members of the team were admirably magnanimous over the decision that their government had made, and joined in the congratulations to Culham. I was personally delighted at the outcome, though apprehensive at the sheer volume of work that would immediately fall on the Culham administration.

Would you say that Culham was always the ‘more reasonable’ choice?
I have no idea how opinions were divided among the ‘fusion community’ as a whole. So far as I know, they were never formally consulted as a collective. Though doubtless the Commission staff that was involved had taken soundings.

How did the team feel about it?
The JET Design Team had been living and working in Culham for the preceding two years. They had a strong team sense and had found solutions to many problems that new arrivals would face.

But Culham did have some pluses?
Technically, Culham had some advantages and Garching had others. These had not proved decisive in the negotiations. All the minuses of each could be solved, in most cases by a certain expenditure of money. The language issue was important to those who did not have reasonable English, but these were a minority, at least among the scientists.

The British negotiating team had gone to great lengths to help incoming families to feel welcome. Particularly their children, who went to the European School, including my youngest daughter who was entitled to go to the European school, became essentially bilingual or even trilingual very quickly.
You talk about a strong European team spirit right from the start? Did nationality ever matter?
The only respect in which national origins remained dominant were what one might call 'sociological' – the Germans were systematic, the Italians were mafiosi, the Irish were laid-back, the English believed in compromise etc. So the procedures of the Joint Undertaking had to cope with this diversity. But in retrospect, I would not wish to exaggerate such aspects. JET is a European success!

The British Government was eager to host this pioneering European project. Now, the UK voted to leave the Union. JET hardly featured in the national political debate and referendum on withdrawal.

The UK has always been a very proud host to JET. It has made major contributions to its funding, along with all the other member countries. Happily, the EU decision to wind up the JET Project, and to transfer responsibilities for operation and upgrades of the machine to the UK, was only taken after the success of demonstrating controlled fusion on an industrial scale. That decision was taken long before the referendum in 2016.

What do you think of these developments?
My personal view on all this is mixed. I had a wonderful five years from 1977-82, first as a member of the British civil service and then as one of JET team. I had an inside view of the governance of the EU and the roles of the Commission and the European Parliament.

During that period, I felt equally a British citizen and a good European. I think, with some exceptions, the system worked well. The decision processes were sometimes unduly slow. The concept of subsidiarity was not always taken seriously.

But all these blemishes were to be set against the outstanding advantages of a system which maintained the peace in Europe, and set high standards of safety and environmental concern. So in the referendum I voted for Britain to remain part of the EU, and if given a chance at the end of the Brexit negotiation, I will again vote for Britain to Remain in the EU.
EUROPEAN CONSORTIUM FOR THE DEVELOPMENT OF FUSION ENERGY
REALISING FUSION ELECTRICITY

Our partners:

ITER
FUSION FOR ENERGY

Eurofusion
Many more facilities are involved in the European fusion research. The map shows only those for which EUROfusion contributes to the operation costs.

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014–2018 under grant agreement No 633053.