FINALLY, A DIVERTOR! – WENDELSTEIN POWERS UP

ITER HITS ON ALL SIX ... POLOIDAL MAGNETS

“FUSION IS THE SAFETY BELT FOR OUR ENERGY NEEDS!”
Saša Novak holds the Sun in her hands.
What sounds easy is hard to achieve and it’s even harder to talk about it.

András Siegler is one of the founding fathers of EUROfusion. Now that he is retiring as Director of Energy in the Directorate-General Research & Innovation of the European Commission he has talked to Fusion in Europe about his achievements and the prospects of fusion energy: „We simply have to find out if it is possible“.

© Tony Donné (EUROfusion Programme Manager) 2017.
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.

Contents

Moving Forward
4 Finally, a Divertor! – Wendelstein powers up
6 Six make the cut

Research Units
8 Infinite material testing for ITER

EUROfusion scoops
10 I am a scientist and I talk about it

Community
14 Impressions
16 Polytechnicheskaya – Soviet tales of fusion

The ITERsection
20 ITER hits on all six ... poloidal magnets
22 JET is ready to go full throttle

Interview
23 Fusion is the safety belt for our demanding energy needs!

Summing Up
26 Let there be light – a must see!
Can you believe they are trying to build a Sun on Earth? – Director Mila Aung-Thwin was amazed when he first heard about ITER. He immediately felt the need to tell the story of the fusion quest and began to work on a documentary. Four years and four visits to the ITER site later, the movie “Let there be light” is currently screening at some of the most famous film festivals worldwide.

It highlights ITER as one of the few good things that came out of the Cold War when, in 1985, Gorbachev and Reagan agreed to build a joint nuclear fusion experiment. Fusion research has always been collaborative. Although the tokamak was born in Russia, Eastern and Western scientists decided to declassify their work in the late 1950s.

“Bringing the Sun down to Earth had seemed like just another utopian Soviet concept, but it has survived as a possible solution to solve mankind’s energy needs”, says American artist Emily Newman who has recently realised a project about fusion pioneer Viktor Golant from Saint Petersburg.

While artists tell stories about all the lives that have been dedicated to fusion, the world’s largest tokamak grows in the fields of Provence in France. Did you know that some of its magnets are produced directly on site because they are too heavy to be shipped? Fusion in Europe monitors the progress and takes a look at the manufacturing of the Poloidal Field Coils inside the Winding Facility on ITER’s soil.

It is not only a tokamak that is capable of mimicking the Sun, a stellarator can do this as well. As flexible as EUROfusion is, its experts now have the opportunity to dive deeper into the plasma produced by Wendelstein 7-X. The most developed stellarator is about to be switched back on in summer, after the installation of a divertor and graphite tiles. These changes will allow the energy input to be increased considerably.

Have you ever considered a material that is able to withstand the temperature and the particle fluxes of the Sun? Such ideas play a major role in the thrilling task of bringing the Sun down to Earth. A superconducting magnet, as heavy as three elephants, is now the superhero in EUROfusion’s Dutch Research Unit DIFFER. It enables the material testing device Magnum-PSI to create conditions similar to those in the ITER divertor. Big science, quite literally.

But why do only a few people know about this? Our Slovenian colleague, Saša Novak, thought about this for a long time. When she started working, she did not want to bore other people in their spare time with her lab reports. After being trained in communications, she decided to speak out in favour of research and what it does for everyone’s daily life.

In fact, many spin-offs have resulted along the journey to ITER and beyond. The retiring Director of Energy in the European Commission, András Siegler, names Magnetic Resonance Imaging (MRI) in medicine as one of the most famous results.

“There must be more. Fusion has paid off far sooner than most people believe”, he says in his farewell interview.
The stellarator Wendelstein 7-X has received its first divertor. Just one step closer towards realising plasma pulse lengths of half an hour without breaking the machine.

Fusion is different. Even when it comes to ashtrays. For the scientists working at Wendelstein 7-X, there is no such thing as a newly installed divertor, a component generally referred to as “the ashtray for fusion devices”.

“LIMITED” PERFORMANCE
“The higher heat handling capabilities of the divertor allows us to make longer pulses with higher energy input”, says Arturo Alonso, W7-X’s task force leader. A divertor takes the energy that is split out from the main plasma. It diverts waste particles directly into the trash with the help of magnetic field lines. For the first operational period of Wendelstein 7-X (from 10th December 2015 to 10th March 2016) a limiter had to do the job of the actual divertor, but its performance was quite “limited”.
MACHINE WORKS EXCELLENTLY
Last year, the fusion experiment only had to prove that its magnetic field functions excellently. And so it did. As a result, during its premier operation the longest discharge lasted for six seconds only, with the heating limited to 660 kW due to a permitted injected energy of 4MJ. The plasma was just for practice.

GRAPHITE TILES MAKE THE CHANGE
Now that the divertor is in place and the wall elements made of copper-chromium-zirconium have been covered by graphite tiles, researchers expect extended pulse lengths of about one minute, as the permitted energy input per discharge moves from 4 Megajoule up to 80 Megajoule, a 20 fold increase in terms of energy input!

IMPROVED GRIP ON PARTICLE CONTROL
You can imagine the excitement amongst fusion researchers when the stellarator is switched on again at the end of August. Now, they can finally start to characterise the plasma.

“With the installation of a divertor, we expect to have a better grip on the control of particles and impurities and thus be able to substantially increase the plasma performance.”

Arturo Alonso

ANOTHER MODIFICATION TO COME IN 2020
In the end, the overall goal is to reach pulse lengths of about 30 minutes with a heating power of 18,000 Megajoules. W 7-X will be prepared for this only after 2020. The passively-cooled divertor will then be changed for an actively-cooled one, which should again enormously increase the energy allowance of the most developed stellarator in the world.
One crucial theme of the EUROfusion Roadmap is improving divertor designs in preparation for the demonstration fusion reactor. Divertors, often referred to as the ashtrays of a fusion device, are the components that deal with fusion exhaust products. To meet the need for improved divertors, the EUROfusion Roadmap has prioritised research into heat-exhaust systems.
EUROfusion selected six of those ten projects to receive support. These included: ASDEX Upgrade at the Max Planck Institute of Plasma Physics, Garching (Germany), JULE-PSI at Forschungszentrum Jülich (Germany), MAST-Upgrade at CCFE (United Kingdom), TCV at the Swiss Plasma Centre (Switzerland) and WEST at CEA (France) as well as a small project at the Josef Stefan Institute (Slovenia).

In late 2015, EUROfusion called for proposals on the subject of plasma exhaust projects, which were then evaluated by an independent panel of experts. The call, termed Plasma Exhaust (PEX) Assessment, received ten proposals covering both conventional and alternative divertors, along with traditional materials and plasma facing units as well as advanced materials.

FOCUS ON PEX

“There is never a dull moment for EUROfusion, and every year has its special feature,” says EUROfusion Programme Manager Tony Donné. “In 2016, it was the PEX assessment that required a lot of our attention,” he adds.

PAVING THE WAY FOR FUTURE EXPERIMENTS

“This is one of the most important decisions EUROfusion has taken since it forms the foundation for future experiments,” says Xavier Litaudon, Head of EUROfusion’s ITER Physics Department.

Support for three projects is currently on hold namely COMPASS-U (Czech Republic), the Divertor Test Tokamak, DTT, (Italy), and OLMAT-TJII (Spain).

DTT APPROVAL

The approval for the DTT, in particular, requires further assessment because unlike the other proposals, the Divertor Test Tokamak will be a completely new facility which is built from scratch. Moreover, the assessment team needs more information regarding whether and how the DTT will fit into the EUROfusion roadmap. A workshop in summer will partly help to answer these questions.

This is one of the most important decisions EUROfusion has taken since it forms the foundation for future experiments.

Xavier Litaudon
A magnet as heavy as three African bush elephants with the size of a small van is boosting research for EUROfusion. After the successful delivery of a superconducting magnet, which weighs more than 17 tons, Magnum-PSI at EUROfusion’s Dutch Research Unit DIFFER is now the first facility to investigate material under ITER conditions.

Magnum-PSI is designed to expose candidate wall materials for ITER and its successors to the harsh conditions that can be expected inside future fusion reactors. As a superconducting machine, Magnum-PSI is capable of operating continuously. Hence, it will enable the first lifetime studies of fusion materials in a laboratory environment.

**A TIGHT AND ENERGETIC BEAM**

The 2.5 tesla superconducting magnet is the key to the Magnum-PSI facility”, explains Hans van Eck, Head of Fusion Facilities and Instrumentation at DIFFER.

The magnetic field it produces is used to guide the hot, charged particles in the plasma from Magnum-PSI’s cascaded arc source towards the target material in a tight, energetic beam. This replicates the conditions at the wall of a fusion reactor, where materials will face intense bombardments of heat and fast particles with power densities similar to those found at the surface of the sun.

**SIMULATING THE ITER DIVERTOR**

Van Eck: “With the previous pulsed conventional magnet system, Magnum-PSI was only able to main-
Magnum-PSI has already launched some experiments in its new superconducting configuration. The results from the first few months are really promising, as the machine operates according to specification. “We will be investigating a long-term exposure of tungsten this summer. For this reason, we are realising an extremely large plasma fluence corresponding to roughly one-tenth of that expected in the ITER divertor”, explains Hans van.

**LIFETIME STUDIES**

Magnum-PSI has already launched some experiments in its new superconducting configuration. The results from the first few months are really promising, as the machine operates according to specification. “We will be investigating a long-term exposure of tungsten this summer. For this reason, we are realising an extremely large plasma fluence corresponding to roughly one-tenth of that expected in the ITER divertor”, explains Hans van.
I AM A SCIENTIST – AND I TALK ABOUT IT!
It occurred to me only during one of the cosy evenings with good home-made food when a chat drifted to science and to the issue of its merits. An old friend, an economist, looked up from his plate full of goodies, and asked me provocatively:

“Well, can you tell me what, in fact, you scientists have achieved? What, for example, are you personally doing?”

At first, I took a deep breath, my thoughts balancing between indignation and verbal confrontation, but then I realised:

“I never talk about my work and achievements outside the scientific community. So how could he possibly know what I do?”

ABOUT MY RESEARCH

In fact, what I do isn’t going to take us to space nor am I developing anti-cancer drugs. Although the title “Dr.” sometimes appears in front of my name, I cannot properly explain how and why dangerous plugs occur in blood
vessels, and I do not understand autophagy. But I do know a little about advanced inorganic materials which, unfortunately, does not sound very interesting.

So, when someone asks me what kind of science I am doing, I usually briefly respond that I am working on the development of new and improved materials (sometimes I add “for use in extreme conditions” or “for future fusion power plants”). And, not very surprisingly, there is no second question to follow.

**DON’T YOU FIND IT INTERESTING?**

Well, I can understand this reaction! Who actually cares that we recently managed, with great effort and a few little tricks, to “convince” silicon carbide particles in colloidal suspension to penetrate a 3-dimensionally woven ceramic fabric to reach the oppositely charged electrode behind it? As a result, we are now able to prepare a fibre-reinforced ceramic composite with very low porosity and respectable thermal conductivity!

And who cares about the zeta-potential of sub-micron particles? As far as I am concerned, it is extremely interesting, because the zeta-potential, which describes surface charge at the particles, determines the behaviour of many suspensions and materials when in contact with fluids (including blood cells and plug formation on blood vessels). I observe its effects on everyday life with immense curiosity, and I can proudly say that we have also solved several technological problems this way.

**BEING A PART OF EUROFUSION**

Who else would understand my excitement when we finally managed to produce a composite of tungsten with small carbide inclusions, and my joy when we were able to identify all the phases in its microstructure? Frankly, this is only a very tiny step in the development of future fusion power plants and for most people, a good reason to stop reading. If they haven’t stopped already …

If by chance talk turns to fusion energy, the conversation among friends often becomes entangled in the eternal question of the safety (read: danger) of nuclear (read: nuclear fission) power plants or the continuous budget increases for the ITER reactor, the delays in its constructions and so on. People like talking about problems.

But to me, the future of fusion power plants is associated with several very challenging questions, of course, mostly associated with structural materials for the reactor chamber. We, as scientists, are attempting to find the best answers within one of the largest European projects, EUROfusion, and I am very proud to be a part of it.

➔ To be honest, I have never mentioned this to my friends.

**WE ARE NOT SIMPLY PLAYING IN EXPENSIVE SANDPITS**

I suppose that many of my colleagues do not bother their friends with conversation about their achievements, probably even those working on cancer treatment and space research. The result is that scientists are mostly perceived as people who are paid by the government to play in expensive “sandpits”, and investigate something in the silence of their labs that does not benefit anyone. Meanwhile, mischievous science fiction is becoming a (scientific) reality. Just by itself?

**IMAGINE HOLDING THE SUN IN YOUR HANDS!**

Now, a few years later, I have learned a lot about science communication. As a member of FuseCOM, EUROfusion’s communication network, I have participated in many training sessions and received efficient tools which enable me to talk more frequently and more understandably about my work.
Now, if I recognise hesitation when it comes to science I immediately ask:

Well, so you don’t support investments in science, science that makes your computer faster, diagnostics in medicine more efficient and the electricity available to your kids?

If my listener does not sparkle out of curiosity for fusion, I ask:

Imagine holding the Sun in your hands. Or, putting an artificial Sun into a box! Can you even imagine what kind of material is able to survive this? Actually, if the plasma were not magnetically confined, no material would survive this! And it’s not only due to the high temperatures.

SHORT VITA

Prof Saša Novak works at the Department for Nanostructured Materials at the Jožef Stefan Institute, part of EUROfusion’s Slovenian Research Unit. She made science famous in her home country when she literally created “Science on the street” in 2013. This is a series of short scientific lectures given by invited scientists. The events take place at public places in Slovenia and are designed to raise public awareness of science and its impact on the economy and well-being.
Impressions

FUSION IN EUROPE
1. Inside the JET mock-up, Source: EUROfusion & CCFE; Photographer: Christophe Roux (CEA-IRFM).
2. Mechanical engineer Miklós Palánkai working on the new Hungarian contribution to ITER: a device to test the cables from different suppliers. Picture: Wigner
3. Diagnostic ports at the Mega Ampere Spherical Tokamak Upgrade (MAST-U), Source: EUROfusion & CCFE; Photographer: Christophe Roux (CEA-IRFM).
4. Parts of the Spanish stellarator TJ-II, Picture: EUROfusion
5. A Czech cake in the shape of a tokamak plasma to celebrate shot number 10,000 at their device COMPASS, Picture: IPP Prague
6. Inside the JET mock-up, Source: EUROfusion & CCFE; Photographer: Christophe Roux (CEA-IRFM).
7. JET from above, Source: EUROfusion & CCFE; Source: EUROfusion & CCFE; Photographer: Christophe Roux (CEA-IRFM).
8. The letters NBI stand for Neutral Beam Injection. They were written on a table next to the Spanish stellarator TJ-II. Picture: EUROfusion
9. Colourful model of TJ-II in the entry hall of a CIEMAT building. Picture: EUROfusion
10. Consorzio RFX Padova served delicious chocolate balls with pink rainbow plasma on top during the „Pedrocchi Fusion Night“. Picture: Consorzio RFX Padova
11. A worker inside Wendelstein 7-X lit up blue from a special tool. Picture: EUROfusion
13. This is, or rather was, EATER: the Eindhoven Advanced Tokamak Reactor, Picture: Fusion Group/TU Eindhoven
14. Diagnostic ports at the Mega Ampere Spherical Tokamak Upgrade (MAST-U), Source: EUROfusion & CCFE; Photographer: Christophe Roux (CEA-IRFM).
The poetics of the tokamak were fascinating for me. It has become a symbol for the Soviet mentality”, says American artist Emily Newman. Sharing her time between Pittsburgh and St Petersburg, Singapore born Emily has always been interested in stories from the Cold War. “I think, the idea of bringing the Sun down to Earth, of conquering nature, was in a sense presumptuous but no joke at all.”
PIONEERING PLASMA PHYSICS

Her movie “Polyteknicheskaya, Don’t Love Here” is a 15 minute film which depicts the St Petersburg suburb of the same name. In the Soviet Union of the 1960s, this neighbourhood sprang up around the Polytechnical and Ioffe Physics Institutes, at that time one of the first institutes which had started investigating plasma physics. Referred to locally as “Polyteknicheskaya” after the new underground station, this was one of the first Soviet-planned suburbs, embodying the optimistic spirit of the post-Stalinist “thaw.” Those who received private apartments in the new modern blocks were considered a fortunate elite.

THE TOKAMAK IN THE KITCHEN

One of them was fusion pioneer Viktor Golant who received a large sunny flat on the top floor of one of the highest blocks. In fact, it was his daughter, painter Evgenia Golant, who introduced Emily to fusion. “She has told me the story of her family which was deeply involved in Polyteknicheskaya’s scientific
community”, Emily says. Although the Soviet Union collapsed and many fusion scientists left the country, Viktor stayed with the tokamak Tuman-3M until he died in 2008. Viktor’s family still lives in Polytechnicheskaya, in the same flat, and from time to time a little tokamak model appears on the kitchen table. It carries a cognac bottle instead of a central solenoid.

FROM IOFFE TO ITER
The history of fusion research in Saint Petersburg has left its traces. In fact, the investigations at the Ioffe Physics Institutes formed the key foundations for the development of fusion energy. Mikhail Turnyanskiy, now EUROfusion Group Leader, started his career at the Russian institute in the 1990s, while it was still under the leadership of Viktor Golant. Mikhail was part of a group that had been developing neutral particle analysers. “Some of the people I worked with are now realising the particle analyser diagnostics for ITER”, he says.

A RARE TRIUMPH OF SOVIET UTOPIANISM
It is important for artist Emily to show the influence of the great Soviet dreams on today’s society, even though they appeared to be far-fetched: “The tokamak might seem like another utopian soviet fantasy, which would have been thrown out along with the whole project of communism, but it still remains a very viable solution to our energy needs. That this work has not ceased is, in a sense, a rare triumph of Soviet utopianism”, says Emily.

TRADING SECRETS LIKE A SPY
Emily’s main focus is not the wonders of past societies but to teach children about the rivalry between East and West. One of her recent works involves children across geographical, political and historical borders. The project called “Ice Station Zebra” tells of a search for a crashed satellite capsule full of secrets, spies and stories. The kids are asked to develop tales that pursue the idea that spies are fun, and that the shared secrets are friendly and playful.
ITER – A COLD WAR STORY

“This is to show that the concept of ‘I don’t like you because you don’t like me’, which I think the Cold War was mainly about, can be overcome.”

Emily Newman

This definitely applies to the history of fusion science. The ITER project stands as a reminder of that when former Soviet General Secretary Gorbachev proposed the idea of a collaborative international project to develop fusion energy to US President Reagan in 1985. And this story is yet far from being over.
From now on Fusion in Europe will check in on the progress of ITER more regularly. Our series “The ITERsection” explains what makes this tokamak the most complex machine in the world. By reporting about the fusion puzzle, made of pieces coming from Europe, China, Russia, South Korea, Japan, India and the US, the articles won’t only introduce scientific challenges, but they will also look at the demanding engineering tasks and the involved scientists.

NO ITER, NO EUROFUSION
Let’s take a look at Europe which acts as one of the seven ITER members. EUROfusion has centred its research almost entirely around ITER. Dedicated experts in 28 European countries want the world’s largest tokamak to deliver what it is built for: the proof that fusion works. Until ITER finally starts operating, the Joint European Torus (JET) is the only experiment in the world able to use the real fusion fuel, Deuterium-Tritium (D-T), and the only candidate capable of executing preliminary studies for ITER with D-T. It is EUROfusion’s task to coordinate the scientific exploitation of JET. Its ITER-like wall, for instance, gives crucial information about the experiments expected within the largest tokamak on Earth.

CHECKING ON ITER’S HEART
This time we will look at some of the components that make up ITER’s heart. The article highlights one particular set of magnetic coils which create, amongst other magnets, the box to hold the super-hot plasma in place. These six poloidal field coils (PF), also called horizontal coils, are situated outside the toroidal field (TF) coil magnets, also called the vertical coils. The task of the horizontal coils is to control the shape of the plasma and to secure its stability by keeping it away from the walls. They embrace the other D-shaped coils (toroidal), from the top to bottom. The process of manufacturing PF coils is demanding. Not only are these magnets gigantic, they are made up of elements from various parts of the world that come together in order to form one section of the tokamak’s heart.
ONE MAGNET OR FOUR BLUE WHALES

Due to their impressive size, four of these magnets will be manufactured on the ITER site because they are simply too heavy to be shipped. The largest coil has a diameter of about 25 metres and the heaviest weighs more than 400 tons. This is about four times the weight of a Blue Whale! The different metals and their sheer size make them so unwieldy. Inside, the coils rest "cable-in-conduit" superconductors which are made of niobium-titanium, a technically challenging combination to produce. The metal is mixed with copper to form superconductor/copper strands. These are, in turn, enclosed in a stainless steel jacket.

THE WORLD’S LARGEST MAGNETIC FIELD

Why does ITER need such powerful magnets at all? The world’s largest tokamak to come is thus able to create the world’s largest magnetic field. The larger size and higher field enable ITER to operate with 15 megaampere of plasma current, five times more than in today’s largest tokamaks. This naturally requires powerful electrical current which is supplied by the previously mentioned superconducting cables. Their unique feature is to transport electricity without losing precious energy to electrical resistance.

PROCESSING THE COILS

In May this year, a major milestone was reached for the technician. After gaining sufficient experience they were able to switch from using dummies to using the actual niobium-titanium superconductor which is now being used to make the first real coil (PF5). Measuring 17 metres in diameter, PF5 will be the second ring to take its place in the Tokamak assembly sequence.

Pierluigi Valente, Responsible Technical Officer for the supply of the European share of PF coils, is more than confident: “What you see today is the result of the work that commenced almost three years ago. Seeing all of these manufacturing stages in practice is extremely gratifying.” Nevertheless, his job is far from being completed. Three more European PF coils are set to follow between this year and 2021.

TWO MORE TO COME

Thus, the four European poloidal field coils currently being built on the ITER site are a challenge on their own. But, as the article mentioned earlier, ITER’s heart needs a total of six rings. The two remaining coils are being manufactured elsewhere. Europe also contributes to the bottom coil (PF6) which is being made in China, following an agreement made between the ITER’s European Domestic Agency Fusion For Energy and the Chinese Institute of Plasma Physics. Meanwhile, the top poloidal field coil is being produced in Russia.

PUZZLING FOR SUCCESS

And this is just the story of the six horizontal magnets around ITER’s heart. There are toroidal field coils and correctional coils all waiting to be manufactured by six different nations. The challenge will be to fit all of the pieces together at the end of the day. From this time onwards, Fusion in Europe will report more frequently on ITER developments. The ITER spirit lives, not only from the demanding engineering tasks, but also from the people involved in the construction. As a result, in the next edition, we will be introducing ITER’s Electron Cyclotron Section Leader Mark A. Henderson who considered ITER as nothing less but a ‘fusion cathedral’.
JET IS READY TO GO
FULL THROTTLE

JET, also referred to as ‘little ITER’, provides international researchers with the unique data required in order to prepare for the experiments at the world’s largest tokamak to come. ITER’s predecessor is the only fusion device in the world that is able to operate with deuterium-tritium (D-T). This is the fuel which is intended for use in future fusion power plants. In 1997, Europe’s flagship facility carried out the last D-T campaign and produced a total of 16 megawatts of fusion power. “We usually use hydrogen isotopes as fuel but if we inject tritium into the plasma we increase the performance by a factor of 100”, adds Eva.

BENCHMARKING ITER
EUROfusion makes sure that JET’s results will be efficiently exploited and shared. Xavier Litaudon, Head of the ITER Physics Department of EUROfusion, confirms that the planned D-T experimental campaign in 2019 – 2020 will benchmark the ITER relevant 14-MeV neutron detection calibration, the calculation of the neutron flux, and the machine activation. It will also enable the investigation of the radiation damage of functional materials for ITER.

A BRILLIANT CAMPAIGN
All of this needs to be well arranged and practiced in advance. Since JET went into shutdown on 15th November last year, researchers and engineers have declared the recent campaign as one of the most successful in the long history of the European fusion device.

“\nWe have to try again and see what is really the best performance for ITER we can deliver”, says plasma operations expert Eva Belonohy. She works at the Culham Centre for Fusion Energy (CCFE) and can’t wait for the next experiments to take place inside EUROfusion’s flagship – the Joint European Torus (JET).

Plasma operations expert Eva Belonohy shares her excitement about the upcoming experiments on EUROfusion’s flagship device. Pictures: © Copyright protected by United Kingdom Atomic Energy Authority

The campaign was brilliant, the results were just great”, says Eva. The tokamak was able to meet almost all of the goals and, just as if to show that 34 years of operation is nothing but a number, JET delivered the most successful performance in years.

EVA ON YOUTUBE
For this reason it is hardly surprising that Eva’s eyes glisten when she talks about the current D-T rehearsals at JET. Do you want to see the enthusiasm? Take a look at her explanations in this short YouTube video:

www.youtube.com/watch?v=HcqpnQv8RL4&t=1s
FUSION IS THE SAFETY BELT FOR OUR DEMANDING ENERGY NEEDS!

András Siegler is one of the founding fathers of EUROfusion. Now that he is retiring as Director of Energy in the Directorate-General Research & Innovation of the European Commission he takes a look back on his achievements. The strong advocate for science compares fusion to going to the Moon: “We simply have to find out if it is possible.”
One of your first tasks in 2013 was to make the rather loose conformation of the European Fusion Development Agreement (EFDA) into an official consortium called EUROfusion ...

This was not easy at all. EFDA had dealt with many individual contracts with the fusion labs. The labs needed to be moulded into a coherent and efficient consortium. Hence, the entire paradigm of the old programme changed. This major transformation task was waiting on my desk when I arrived. Although the scientific goal, the European fusion roadmap, had already been finalised in 2012, we still needed to set up the largest and most comprehensive single scientific programme in Europe. It was one of the most exciting things my team and I had to accomplish.

What was the hardest part?

First and foremost it was the act of convincing the Member States. Some were quicker than others to realise the benefits. As you can imagine, in order to establish the consortium many nuts and bolts needed to be put in place. The devil is in the detail. The Research Units also had to agree on the new co-funding scheme whereby the Commission contributes 55% and the research institutes the rest. What was, and still is, very important is that small and large laboratories alike have found their place. This has given them increased scope for research with the added responsibility of managing the implementation of the roadmap. During the transition, it was our job to ensure that nobody was left behind and that all were able to contribute.

Almost three years after its start what do you think of EUROfusion now?

I am really proud. There is no other comparable large and coherent single scientific programme in Europe. EUROfusion is the archetype of co-funded schemes. It is a true all-European endeavour, the European Research Area at work.

---

**András Siegler** served as the Director of the European Commission in charge of research and innovation in energy (non-nuclear and nuclear) up until the end of June this year. He graduated in control engineering and holds a doctoral degree in mechanical engineering and a postgraduate degree in economics.

He started his career as a research engineer in mechatronics and computer aided design and has held various senior positions. Between 1996 and 2004, he was in charge of the Hungarian policy, legislation and fund management for research including the use of EU funds for boosting R&I.

Before joining the Commission in 2005, he represented Hungary in the research policy bodies of the EU, NATO, OECD and CERN.
Do you think that fusion research has already made an impact?
I think the organisation of European fusion research has been a huge success and is a model envied by other global actors. Our scientists have been increasingly filing for patents and have found well referenced solutions. It was a great pleasure to work in this field with such fantastic scientists who are not afraid to go looking for answers. If they needed to change, they changed. For example, in terms of the plasma facing materials, initially carbon was used inside the fusion experiments, now it is beryllium and tungsten. Of course, it’s easy to present the result but it’s another thing to make such decisions. I dearly cherish this commitment.

Still, the UK vote to leave the European Union has now put the Joint European Torus (JET) at risk.
I would like to put the minds of people at JET at ease. The UK government is committed to continue with the work and to honour their obligations independently of the outcome of the Brexit negotiations. Although nobody can anticipate the results of the talks between the UK and the European Commission, we will propose that JET remains part of the programme until 2020, at least.

What do you personally think of fusion energy and its future prospects?
I compare it to big scientific projects like flying to the Moon, the Apollo Programme or CERN, in the sense that we strive for new knowledge which sometimes means we have to take risks. We want to know whether we will be able to use fusion energy tactically. Nobody on Earth can possibly know what the economic situation in 2040 or 2050 will be, and we also cannot know whether we will have enough affordable energy without fusion. It is a safety belt to handle the demand for energy. And this is why we need to know whether it works.

Do you think that fusion research is sufficiently well communicated?
Good communication is fundamental and more of it should be done. Maybe Euratom, which deals with both fission and fusion, is not at the forefront here. The word nuclear is still a cause of concern for laymen. People do not distinguish between fission and fusion, and the risks attributed to fission are not inherent to fusion. We have to acknowledge that half of the countries of the EU support fission and half do not. So, the European Commission, when supporting fission research, should consider this and concentrate on nuclear safety. On the other hand, more explanation and presentation of fusion and its clear distinction from fission is required. In this respect, I have to say that the ITER Organization in Cadarache and Fusion for Energy [ITER’s European Domestic Agency] in Barcelona are doing a lot for this.

There is another topic to talk about: Spin-offs, results of fusion research which have already served other fields.
It has been very close to my heart to convince the involved companies around the world to share their fusion outcome with other fields, such as the medical industry with MRI, and other research communities with NMR spectroscopy, to give two good examples of superconductor technology transfer. There must surely be more. If I am not fully satisfied with something during my period, it is that we did not identify more spin-offs. I am convinced that fusion experiments do pay-off sooner than expected and the programme should catalogue the evidence to support this conviction.

“It was a great pleasure to work in this field with such fantastic scientists who are not afraid to go looking for answers.”
András Siegler
A brilliant documentary now tells the history of fusion, from the initial idea in Russia up until the construction of ITER. Independent director Mila Aung-Thwin, who worked on “Let there be light” for more than four years, explains the idea and shares the initial feedback.

Why did you choose fusion energy as the topic?
I don’t usually make films about science, I really prefer human stories. But I had been thinking of the overall energy problem for a few years. We have to switch off fossil fuels, but I couldn’t see any viable alternative. When I heard about ITER, I knew what fusion was, but like many people, I had written it off as basically a pie-in-the-sky idea. ITER made me realise how much closer we had come than I assumed. How is it possible that we have not heard of a project of this magnitude and importance? That’s crazy and I thought this would make a good film!

How was the feedback after the first shows in Cannes, Barcelona, South by Southwest ...?
The reaction has been amazing. The audience starts out knowing very little about fusion, and at the end, especially in the US, they ask: “Which congressman should I call and complain about the lack of fusion support?” I have been very happy to find that people like the characters in the film, the scientists who are dedicating their careers to tackling a puzzle that probably won’t be solved within their lifetimes. That was my goal – I think these guys are heroes and should be recognised for their efforts.
EUROPEAN CONSORTIUM FOR THE DEVELOPMENT OF FUSION ENERGY

REALISING FUSION ELECTRICITY BY 2050

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