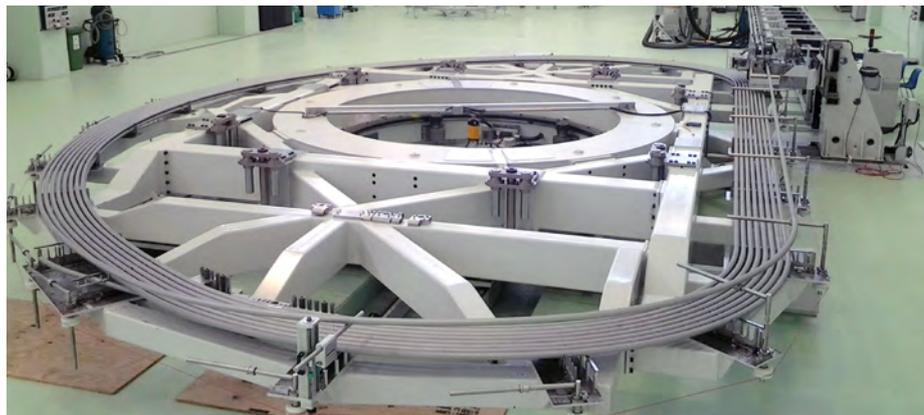




# F4E NEWS

FUSION FOR ENERGY QUARTERLY NEWSLETTER

No. 13 - November 2013



- 2 F4E gets down to business with a new industrial policy
- 3 Are you ready to tap into ITER's business opportunities?
- 4 Europe signs its largest ever contract for ITER with GDF SUEZ Group and M+W Group
- 5 The ITER convoy: 800 tonnes crossing the south of France
- 6 First ever full-size prototype of the double pancake for the TF coil has been wound
- 7 PF coils Engineering Integrator contract signed
- 8 F4E moves forward following the latest Governing Board meeting
- 9 Manufacturing starts for ITER's massive cranes and high tech cargo lift
- 10 ITER Test Blanket Modules: tomorrow's technology gets tested today
- 11 What's so critical about ITER's critical network?
- 12 The seven ITER parties meet in Cadarache to witness the project's progress
- 13 Atkins and F4E showcase ITER at the Royal Academy of Engineering awards ceremony
- 14 Fusion technology breakthroughs and business incentives join forces at ISFNT-11
- 16 F4E hosts ITER Neutronics meeting
- 17 First ever final design review completed
- 18 Kick-off meeting for two major Neutral Beam Test Facility components
- 19 F4E hosts meeting on mineral insulated cabling
- 20 F4E takes ITER to the biggest campus party

## F4E GETS DOWN TO BUSINESS WITH A NEW INDUSTRIAL POLICY

ITER is by far the biggest international partnership in the field of energy and it can only be realised in collaboration with industry, SMEs and research organisations. They are the backbone of this project and without their commitment commercial fusion will remain a distant dream. Therefore, getting the business sector onboard and finding the best possible way to work together is high on the agenda. It's in Europe's interest to broaden its industrial capacity in this domain and improve its competitiveness in a field that promises to yield long term benefits.

One of the first objectives that F4E's Director, Professor Henrik Bindsev, set for the organisation was to foster an open and constructive dialogue with industry, SMEs and the network of ITER Industrial Liaison Officers. "Europe's contribution to ITER is Europe's opportunity for industry. In essence this means jobs, growth and knowledge that will open new markets. We are ready to listen, understand your concerns and respond with a series of actions and incentives in order to help you seize fusion's business potential" he explained.

Taking advantage of industry's presence at the 11th International Symposium on Fusion Nuclear Technology (ISFNT-11), F4E presented its new industrial policy and its roadmap. Four specific actions underpin this new collaborative framework: first, F4E will proactively facilitate and assist with business opportunities; second, financial risks will be shared with contractors and liabilities together with guarantees will be limited; third, the rules in the field of intellectual property have been revised; fourth, the administrative burden will be reduced.

To help you understand what the new measures are about we have prepared a short report:

More actions will be adopted in order to ease business participation in F4E calls: more Info Days and awareness campaigns will

be organised to reach out to stakeholders, financial compensation may be provided for the preparation of bids in the framework of competitive dialogue and last but not least, networking events between SMEs and large industrial suppliers will be planned.

There have also been modifications in the areas of financial risk and liabilities to help future contractors. For example, there will be no pre-financing guarantee for contracts of less than 1 million EUR and no performance guarantee for contracts of less than 10 million EUR.

F4E will align the obligations and liabilities of contractors to standard industrial practices. For example: liabilities will correspond maximum to the total value of the contract price or in some cases even below.

Nuclear liabilities for damages to third parties or for damages occurring on the ITER site will be waived. Risk insurance and decennial insurance on the ITER site is in favour of the contractors and F4E is bearing the cost for the related premium.

Any additional costs incurred by the contractor as a consequence of the change in the applicable legislation or temporary suspension of the contract will be attributed to F4E or other ITER Domestic Agencies (DAs).

There is also good news in the area of Intellectual Property Rights (IPR). First of all, IP ownership in most cases will be in the hands of contractors. Furthermore, contractors will be offered the exclusive rights for the exploitation of IP acquired in the fields outside fusion and



Professor Henrik Bindsev, F4E Director, explains the new industrial policy

non-exclusive rights in the field of fusion.

Cutting down the administrative burden is another commitment undertaken by F4E. Standardised tender documentation and model contracts will be created. Contractual provisions will be aligned to industry standards and harmonised selection criteria will be established.

E-procurement and further improvements on the Industry and Associations portal will be introduced.

## ARE YOU READY TO TAP INTO ITER'S BUSINESS OPPORTUNITIES?

ITER is often described as the biggest international research collaboration in the field of energy bringing together half of the world's population and 80% of the global GDP. A complex and ambitious project pushing our imagination to its limits and inviting us to explore if fusion energy can be a viable energy source in tomorrow's energy mix.

To reach the holy grail of energy, as some have called fusion, scientists and engineers need to work hand in hand with industry and SMEs to manufacture the ITER components and develop the necessary appetite and expertise to invest in fusion technology. In 2012 the value of the energy sector was in the range of \$6 trillion. Currently, in the EU the energy sector exceeds a turnover of about 885 billion EUR and keeps more than 22,000 enterprises afloat, which employ over 1.2 million people. The business potential of the energy market is vast and the opportunity for growth is clear.

So how is ITER unlocking Europe's business potential?

To answer this question we traveled to five countries and interviewed 14 representatives from industry and SMEs, laboratories and senior policy figures from the fusion community. We asked them to describe the potential they see in ITER and the direct benefits stemming from Europe's participation to the project.

Professor Henrik Bindslev, F4E's Director, set the tone by describing the unique character of the project and the spillover effects spreading into the areas of knowledge, jobs and growth. Similarly, Professor Osamu Motojima, Director General of ITER International Organization, elaborated on the new technologies that industry would acquire through its participation and the expertise that future generations of scientists will develop through their involvement.

In our first clip we interviewed the Industry Liaison Officers, the business satellites of the ITER project in each European country, and asked them to give their opinion on the business potential of the project. Their message was strong and clear: ITER means business opportunities and Europe's industry should grab the opportunity to be involved.

Sue O'Neill, Ireland's ILO, highlighted the growing potential of fusion industry and Dan Mistry, UK ILO, brought fusion a step closer to the market by reminding companies of the opportunities in the field of conventional engineering. The scale of the project requires the contribution and collaboration of many sectors. Sabine Portier, French ILO, explained that "ITER offers the possibility to build business partnerships" which will pave the way to new markets. Industry and SMEs from different countries have to learn to form consortia and compete in order to deliver high-end components at a competitive rate. Kurt Ebbinghaus argued that "a project like ITER will improve the capability of industry in terms of engineering and fabrication [...] and create spin-offs for other business." Søren Bang Korsholm, Denmark's ILO, encouraged industry and SMEs to see



Company representatives exchanging contacts during the ITER business Forum meetings

themselves as legitimate partners in this project, a thought which was shared by Christian Dierick, Belgium's ILO, who stated that "ITER is not a project only for big players."

In the second clip, business representatives had the opportunity to express their views on the direct economic benefits stemming from their participation to ITER. Dr. Michael Peiniger, Research Instruments, explained how cutting edge requirements pushed companies a step further. Similarly, Paolo Bonifazi, Walter Tosto, called ITER "the booster" which accelerated the pace of progress in his company. From SENER, Maria Rosa Sacristian, stressed the multi-disciplinary character of the project and the way it has helped companies to identify new markets. Jean-Claude Cercassi, CNIM, elaborated on the "new processes, jobs and growth" that have been created together with the development of new tooling which will prove useful in other operations. Aldo Pizzuto, ENEA, highlighted the role of fusion laboratories in the project and their capacity to generate new technologies that are not yet available to industry. Linda Hedegaard, Site Facility, saw plenty of opportunities for SMEs too through their participation as subcontractors in large contracts. The successful partnership between small and large players was also addressed by Maria Teresa Domiguez, Empresarios Agrupados, who acknowledged that thanks to ITER this new international way of doing business emerged in this field of energy.

## EUROPE SIGNS ITS LARGEST EVER CONTRACT FOR ITER WITH GDF SUEZ GROUP AND M+W GROUP

Fusion for Energy (F4E) has signed its largest contract to date with Cofely Axima, Cofely Ineo, Cofely Endel (GDF Suez Group) and M+W Group. The strong expertise of the Franco-German group of companies will be used to provide the building services for the Tokamak complex, where the ITER Tokamak machine will be located, and the surrounding buildings. The contract is expected to run for six years and its budget is approximately 530 million EUR.



Representatives of F4E, GDF Suez Group and M+W Group at the signing ceremony

Professor Henrik Bindslev, F4E's Director, stated that "this is an important achievement for Europe not only because of the volume of the contract but also because European companies will be given an unprecedented opportunity to share and acquire new know-how that will generate future business opportunities." Guy Lacroix, Managing Director of GDF SUEZ Energy Services in charge of Cofely Axima, Cofely Ineo and Cofely Endel confirmed that "being part of the largest international collaboration in the field of fusion energy makes us extremely proud. All the members of the consortium bring together a diversity of skills and expertise which allow us to demonstrate that we can be at the forefront of large scale industrial projects like ITER."

The ITER site in figures:  
The size of the ITER platform is 42 hectares

and Europe is the party responsible for the delivery of the 39 buildings that the ITER platform will host. Currently, the personnel directly involved in construction counts 250 people and by the end of 2014 it is expected to reach 2,000 people. One of the key challenges will be to accommodate the needs of the rapidly growing workforce and to guarantee the optimal use of space for the different companies operating on the ground, in order to carry out the construction of all infrastructure in parallel and on time.

The scope and key figures of the contract: The contract covers the design, supply, installation and commissioning of the mechanical and electrical equipment for the Tokamak complex, which consists of the Tokamak, Diagnostic and Tritium buildings, plus the surrounding buildings which reach a total of 97,200 m<sup>3</sup>. Thanks

to this contract all the necessary works for the ITER Assembly phase will start in order to host ITER's high tech equipment in compliance with the strict safety requirements and in line with the rigorous qualification tests.

Through this contract a Heating Ventilation Air Conditioning (HVAC) system will be delivered that is powerful enough to treat the air flow of 1,000,000 m<sup>3</sup>/hour which corresponds to the volume of air inhaled and exhaled by 3,5 million people every hour. Furthermore, Instrumentation and Control (IC) systems, power supplies, interior and exterior lighting, gas and liquid networks will be installed. State of the art fire detection and extinguishing systems, consisting of 2,000 fire detectors, will be supplied, pipe fittings and handling equipment with various interfaces connecting buildings and systems.

## THE ITER CONVOY: 800 TONNES CROSSING THE SOUTH OF FRANCE

Transporting the exceptionally heavy ITER components that will be manufactured in different parts of the world is no easy task. It requires impeccable logistics, excellent coordination and last but not least the vehicle and the right infrastructure that can sustain the load. The plan is to ship the components to the south of France and then transport them all the way to Cadarache where they will finally be assembled.

Try and imagine crossing 41 different picturesque villages of France's Provence driving a vehicle that is 33 m long, 10 m high, 9 m wide, that together with its load weighs 800 tonnes and has 352 tyres. Could you be at the driving seat? The spirit behind the well-orchestrated campaign for the ITER convoy, undertaken by the French authorities between 16-20 September, was to test all of these parameters without disturbing the daily life of the local population.

The preparatory works for the test drive, the total cost of which reached 112 million EUR, started a long time ago in order to enlarge 35 km of route, build and reinforce 26 bridges, improve the size of 19 roundabouts and develop new parts of the highway. Crowds joined the 140 members of France's gendarmerie, who escorted the vehicle vigilantly at 5 km/h throughout the four nights, in order to witness history in the making and take pictures of this impressive operation.

F4E's Federico Casci, Head of Project Office and Eric Pangole, Technical Officer for transport activities, were also there to follow step by step the convoy's trip to ITER. We managed to speak to them right after the convoy crossed the gates of the ITER site to find out more about the significance of this event. "This is an important achievement for Europe. It is the conclusion of many years of work involving actors from different bodies like EFDA and CEA at an earlier stage. Once the Cadarache site was selected and new organisations were set up like F4E, ITER International Organization (IO) and Agence ITER France, then most of the involved people carried on with their duties ensuring continuity" explains Federico



Casci. Transportation studies were carried out more than ten years ago to prepare the candidature of the Cadarache site to host ITER.

Eric Pangole explains that "It is also a symbolic milestone for Europe and France since it finally demonstrates that the Cadarache site fully meets the ITER requirements in terms of logistics and transportation infrastructure. Moreover, it is an important achievement for F4E given the fact that it has contracted and financed the test of the itinerary. We have participated in working groups related to this subject and have been involved together with AIF and IO in the selection process of the contractor, Daher, responsible for the transportation of the ITER components."

The transport operation is considered impressive due to the exceptional dimensions

and weight of the ITER components together with the number of actors involved, which range from public authorities to private companies. The most extraordinary part of the test convoy exercise, however, was seeing all these years of hard work and preparations unfolding in front of our eyes even at the slow pace 5 km/h. It was a tour de force in slow motion.



## FIRST EVER FULL-SIZE PROTOTYPE OF THE DOUBLE PANCAKE FOR THE TF COIL HAS BEEN WOUND

For the first time ever, a Toroidal Field (TF) coil full-size super-conducting prototype of the double pancake (DP) is being manufactured, and the first step of the manufacturing process, winding, was completed at the beginning of August. This milestone, which was carried out at the ASG premises in La Spezia, Italy, follows the production of the winding line.



The ITER device will operate with a system of superconducting magnets which relies on the TF coils, the central solenoid, the Poloidal Field coils and the correction coils. F4E is responsible for procuring 10 TF coils (Japan will contribute an additional nine TF coils) — ‘D’ shaped coils which will be operated with an electrical current of 68 000 amps in order to produce the magnetic field which confines and holds the plasma in place in the ITER tokamak. Each TF coil weighs about 300 t and is about 16.5 m tall and 9.5 m wide.

Each TF coil contains in total seven DPs which produce the magnetic field (two DPs which contain cable-in-conduit conductors measuring 450 m and five DPs where the conductors measure 750 m in length). Each DP is composed of a conductor length, which carries the

electrical current, and of a stainless steel D-shaped plate called a radial plate, which holds and mechanically supports the conductor through groves machined on both sides along a spiral trajectory. The conductor is composed of about 1000 superconducting and copper wires cabled inside a 2 mm-thick round stainless steel jacket 43.7 mm in diameter.

The winding of the DP, the most challenging component in the TF coil from the manufacturing point of view, consists of bending the conductor length along a D-shaped double spiral trajectory. As it is necessary that the DP conductor fit precisely inside the radial plate groove, it is vital to control the trajectory of the conductor in the DP and the trajectory of the groove in the radial plate with an extremely high level

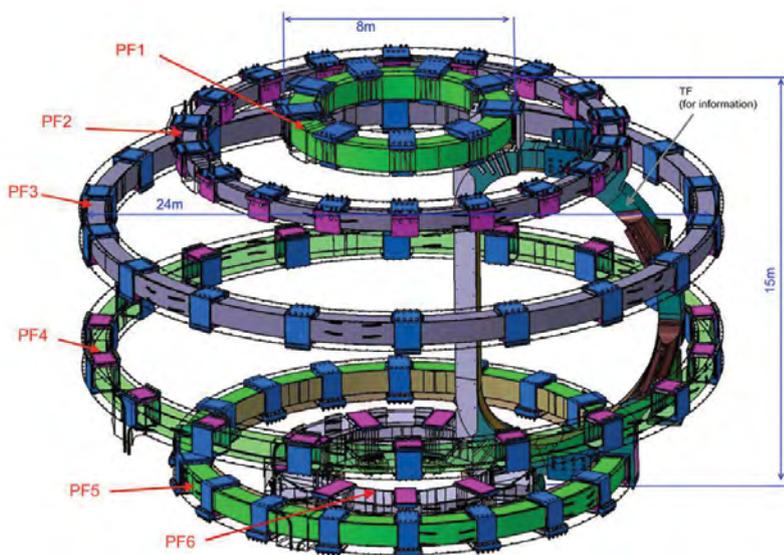
of accuracy. In particular, the trajectory of the conductor must be controlled with an accuracy as high as 0.01 %, and this is why the winding line utilises a numerically controlled bending unit as well as laser-based technology to measure the position and the dimensions of the conductor. The winding takes place in an environment with a controlled temperature of  $20\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ , and at an average speed of 5 m of conductor length per hour.

A consortium composed of the Italian company ASG and the Spanish companies Iberdrola and Elytt is responsible for the manufacturing of the prototype as well as the future actual DPs. With the winding of the prototype now completed, other manufacturing steps are needed: the DP will be heat-treated at  $650\text{ }^{\circ}\text{C}$  in a specially constructed inert atmosphere oven, then electrically insulated and finally transferred into the grooves of the stainless-steel radial plates. After assembly and the application of electrical insulation on the outside of the radial plate, the module is finally impregnated with special radiation-resistant epoxy resin, thus forming the prototype DP module. This work is scheduled to be completed by the beginning of next year and will then allow for the prototype to be tested by being cooled to  $-77\text{ }^{\circ}\text{K}$  in order to assess the effect of the low temperature. It will then be cut into sections in order to analyse the quality of the impregnation of the insulation of the superconducting conductor.

The double pancake prototype being wound at the ASG premises in La Spezia, Italy

## PF COILS ENGINEERING INTEGRATOR CONTRACT SIGNED

F4E has signed the contract for the Poloidal Field (PF) coils engineering integrator (EI). Awarded to ASG and worth approximately 27.5 million EUR, this contract is the first of a number of work packages which will cover tooling (equipment necessary in order to manufacture and handle the components), site and infrastructure, manufacturing and cold testing.



These work packages are currently being prepared in order to provide F4E's contribution of PF coils 2–6 (PF coils 2–5 will all be manufactured in Europe, while PF coil 6 will be manufactured in China, but cold tested in Europe; the Russian domestic agency will procure PF coil 1). The PF coils contribute to generating the magnetic field to control the plasma position, maintaining the plasma's shape and stability inside the tokamak in order to provide the conditions for the fusion reaction. The PF coil system consists of six horizontal, circular coils placed outside the toroidal magnet structure. As their very large size makes it impossible to transport them, manufacture of four of the six PF coils will take place in the PF coil winding building, directly on the ITER site in Cadarache, France.

The ASG EI team is composed of approximately 20 engineers working to issue the manufacturing plan (developing plans in support of rigorous quality assurance, control of manufacturing activities and establishing a production time schedule) to define the manufacturing layout and workflow, as well as to issue the manufacturing drawings and procedures for the production of all four PF coils. ASG will also support F4E in the procurement of the tooling and equipment for component manufacture; in addition, they will supervise the manufacturing and cold-test activities (the final acceptance test which involves cooling the coil to a low temperature of 80 °K in order to reproduce thermal stresses similar to the ones experienced in the operating conditions in the ITER machine).

The focus will now be on implementing the EI contract and negotiating the next procurement, which is for winding tooling (expected to be signed during the first quarter of 2014). It is envisaged that the calls for tender for the other remaining contracts (except the contract for the cold-testing facility) will be launched during 2014.

The EI contract is the first of several in order to produce Europe's contribution of PF coils, circular coils placed outside the toroidal magnet structure.

## F4E MOVES FORWARD FOLLOWING THE LATEST GOVERNING BOARD MEETING

New initiatives by Fusion for Energy (F4E) to enhance its engagement with European industry and fusion laboratories were welcomed by its Governing Board (GB) during its 27<sup>th</sup> meeting on 26 and 27 June in Barcelona.



'We intend to renew our partnerships with European industry and fusion laboratories and make progress on all fronts to honour our commitment to the ITER project', said Stuart Ward, the GB's Chair. 'During the past 6 months, the construction of the Tokamak building on the ITER site has started and the fabrication of a number of key components for the ITER project by European industry is underway, including the superconducting magnets and the vacuum vessel', he added.

F4E's Director, Professor Henrik Bindslev, described the renewed dialogue with the industrial liaison officers of Member States to seek opportunities for greater engagement by industry in F4E's business opportunities and seeking an optimal sharing of risk between F4E and contractors, which will help to control costs. 'We want to understand how to incentivise industry to participate in contracts with F4E and to have an equitable sharing of the

risks', said Professor Bindslev. The GB has adopted an industrial policy and policy on intellectual property rights and endorsed proposals from F4E on how to implement them.

Joaquín Sánchez, Chair of an ad hoc working group which was set up by the GB in December 2012 to explore how to enhance the partnership between F4E and European fusion laboratories, presented its report to the GB. 'I am very pleased that the Governing Board has endorsed all of the working group's recommendations and I am confident that this can bring about a real improvement in the cooperation between F4E and the European fusion laboratories that possess much of the knowledge required for ITER construction and operation', said Dr Sánchez. Implementation of the working group's recommendations, in particular the introduction of lump-sum grants, will be completed by the end of this year.

With the entry of Croatia into the European Union, it is necessary to change the F4E statutes so that the country is assigned voting rights. Consequently, the GB approved a proposal which will be decided upon by the Council of the European Union.

The mandate of several GB members was renewed for an additional 2 years from 1 July: Stuart Ward continues as Chair of the GB; Cor Katerberg remains Vice Chair of the GB and Chair of the Administration and Finance Committee; Joaquín Sánchez stays on as Vice Chair of the GB and Chair of the Technical Advisory Panel; and Beatrix Vierkorn-Rudolph continues as Chair of the Audit Committee. In addition, the mandate of Lisbeth Grønberg as Chair of the Executive Committee has been renewed for a period of 2 years from 1 September.

### Background:

The Governing Board is responsible for the supervision of F4E in the implementation of its activities. It makes recommendations and takes decisions on a wide range of matters, such as adopting the financial regulation and its implementing rules, adopting the annual work programmes and budgets, approving the annual accounts and annual activity reports and adopting rules on industrial policy, intellectual property rights and the dissemination of information in agreement with the European Commission. Each member of F4E is represented on the Governing Board by two representatives, one of which has scientific and/or technical expertise in the areas related to its activities. Most decisions are taken by a two-thirds majority or a simple majority.

—  
Governing Board Chair, Stuart Ward (centre).

## MANUFACTURING STARTS FOR ITER'S MASSIVE CRANES AND HIGH TECH CARGO LIFT

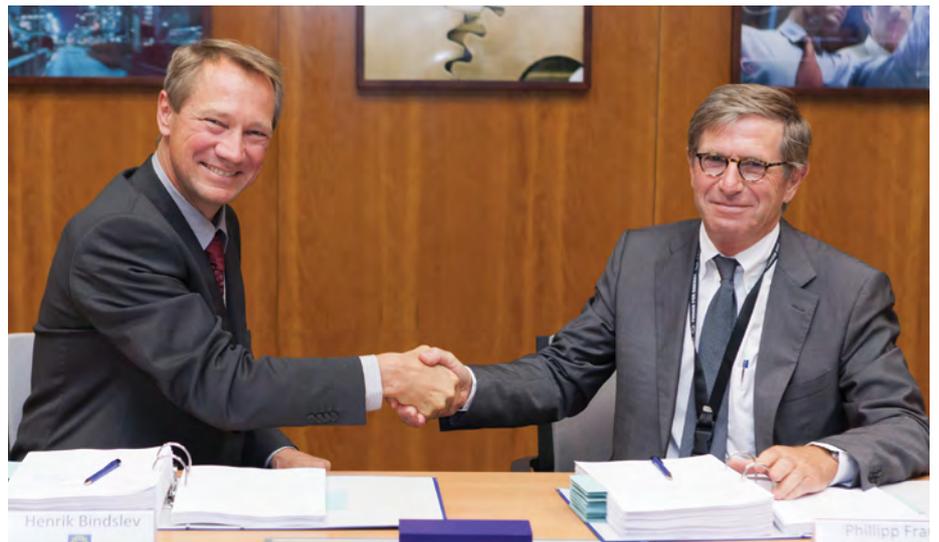
Fusion for Energy, has signed a contract with the NKMNOELL-REEL consortium formed by NKMNoell Special Cranes GmbH (Germany) and REEL S.A.S. (France) part of Groupe REEL, for the the design, certification, manufacturing, testing, installation and commissioning of the four cranes that will be used to assemble the Tokamak machine and the Tokamak cargo lift which will move the casks containing components of the machine. The budget of the contract is in the range of 31 million EUR and it is expected to run for five years.

The cranes will be located within the Tokamak building and the Assembly Hall building and will operate like a pair of safe hands moving the heavy components between the two areas and positioning them during assembly with extreme precision. The consortium will deliver two 750 tonne cranes that in tandem will lift up to 1,500 tonnes of the ITER components during its assembly stage, two 50 tonne auxiliary cranes and the Tokamak cargo lift. Sophisticated engineering combined with advanced safety lifting and remote handling technologies are some of the elements that describe the nature of the work undertaken by the two companies.

### How will the cranes work?

The four electric overhead travelling cranes will be moving between the key buildings of the ITER project: the Assembly Hall and the Tokamak building, which is divided in two areas housing the Tokamak machine and a crane hall above the machine.

The major heavy lifting requirements shall be met by the two 750 tonne cranes. Each of them will be equipped with two trolleys, each carrying a single 375 tonne hoist. In total, the four 375 tonne hoists will provide a maximum lifting capacity of 1500 tonnes, which is the weight of 187 London double-decker buses in total. The cranes shall be capable of working in tandem to provide a fully synchronised lift and precise positioning. Two auxiliary cranes of 50 tonnes capacity each, will be used for other lifting activities working independently of each other.



From left to right: Professor Henrik Bindselev, Director of Fusion for Energy, congratulating Mr. Philipp Frantz, Managing Director of REEL S.A.S

### What components will the cranes carry?

The principal purpose of the Tokamak crane system is to lift and receive heavy components, support the assembly operations, move the cryostat components and transport the assembled vacuum vessel sectors and other major components. When the Tokamak machine becomes operational there will be no further planned use for the cranes. The 750 tonne cranes will remain parked and electrically isolated while the 50 tonne cranes will continue to be used in the Assembly Hall.

### How will the Tokamak cargo lift work?

The Tokamak cargo lift shaft will be located in the Tokamak building with connecting

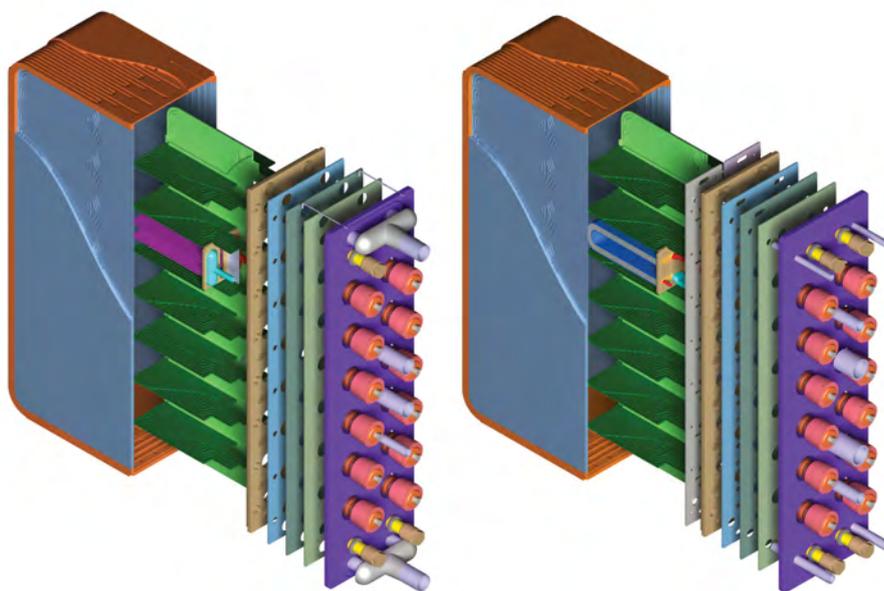
doors into the Hot Cell building. The lift will carry the casks that contain components of the machine. The cask is 3,7 metres high by 2,7 metres wide and 8,5 metres long. When empty, its total mass is roughly 60 tonnes. The size of a cask is the size of a London double-decker bus. Automated transfer systems and high tech remote handling systems will be deployed to transfer the casks. The transfer process involves the transfer and return of empty and full casks between various levels of the Tokamak building and the Hot Cell building by remote control. Therefore, all components involved in the transfer need to be integrated in a seamless manner.

## ITER TEST BLANKET MODULES: TOMORROW'S TECHNOLOGY GETS TESTED TODAY

One of the most fascinating aspects of the ITER project is the technology that is being deployed in order to test the viability of fusion energy at such a scale. For an outsider, the project is a leap to the future. For scientists and technical experts who have spent most of their life in the fusion community, ITER is validating and upgrading existing know-how that has been accumulated throughout the years in fusion laboratories around the world. There will be some, however, who will be given a once in a lifetime opportunity to push the envelope further and use ITER as a laboratory. They will witness technological breakthroughs and pave the way for DEMO, the fusion demonstration reactor planned to come after ITER. Amongst the fortunate vanguard fusion specialists are those involved in the Test Blanket Modules (TBMs).

During the last International Symposium on Fusion Nuclear Technology there was a lot of buzz about the progress made in the area of TBMs. What is this blanket made of that is exposed to plasma reaching 150 million°C and what purpose does it serve? We met with Yves Poitevin, F4E's Project Team Leader for TBMs and Materials Development, to understand the background, the state of play and the potential of this domain.

Apart from deuterium, ITER will require the administration of tritium in order to make the fusion reaction happen. In DEMO, it will need to be bred continuously within the reactor in order to keep the fusion reaction going. How can this be achieved? Tritium can be produced within the reactor once the neutrons of the fusion reaction bounce on lithium, which is contained in the reactor's blanket. "One of our aims is to test the prototypes of future breeding blankets in real fusion conditions offered by ITER and then export that knowledge to DEMO. In essence, we are generating a new component and qualifying it in unprecedented



(left to right) HCLL – Global view of the “Helium-Cooled Lithium Lead”, HCPB- Global view of the “Helium-Cooled Pebble Bed” - IDOM copyright

conditions. Furthermore, through this process, we are licensing a nuclear system based on advanced materials and top fabrication technology” Yves Poitevin explains. “We are writing a new chapter in this field by collecting

new data, developing new codes and extrapolating them to DEMO. This is a real opportunity for Europe's research and industrial communities to collaborate and develop together a vital technology for fusion reactors.”

Work started in the late 90s when the European Fusion Development Agreement (EFDA) conducted research to address the need for the development of new materials and technologies for tritium production. The transition from research to licensing and fabrication is challenging. F4E has been collaborating with specialised engineering companies like IDOM, Atmosstat, Iberdrola, AMEC, Empresarios Agrupados to take stock of their expertise. Similarly, for the design and qualification phases the input received by laboratories like KIT, CEA, ENEA, CIEMAT, UJV, KFKI, NRG, etc. has proved extremely valuable. Approximately 30 contracts have already been signed in this domain and the work is gradually increasing in volume.

Europe is standing at the crossroads of two blanket concepts: the Helium-Cooled Pebble-Bed (HCPB) and the Helium-Cooled Lead Lithium (HCLL). The key difference lies in the type of material used for the tritium breeder. In order to choose which way to go for DEMO, it has been decided to test both concepts simultaneously in ITER by placing the TBMs in an equatorial port of the machine.

In terms of the TBMs structural materials, Europe has set its hopes on EUROFER, a newly developed reduced activation ferritic/martensitic (RAFMs) steel developed in Europe, which provides adequate resistance to neutron irradiation, corrosion and with acceptable resistance at high temperatures. "EUROFER is Europe's choice for ITER's TBMs because of its properties, its mechanical resistance and its tolerance to neutrons irradiation" explains Yves Poitevin. Part of EUROFER design limits have been recently added to the RCC-MRx nuclear construction code and progress is being made to complete them. Japan, Korea, India and China are also developing their own TBMs for ITER. The potential is there for developing in parallel different degrees of expertise. What is here, however, is the opportunity to invest in and test today a technology that will be necessary tomorrow.



Yves Poitevin, F4E's Project Team Leader for "Test Blanket Modules and Materials Development"

## WHAT'S SO CRITICAL ABOUT ITER'S CRITICAL NETWORK?



Overflow network - pipes' backfilling

You may have seen ITER's impressive 42-hectare platform in one of the aerial view images that we have released in the past. Usually, we fly high and above in order to capture the activity carried out on this piece of land that is 1 km long, 400 m wide and compares in size to 60 soccer fields.

This time, however, we decided to touch ground and go deep in order to give you another view of the work in progress. If you want to build you have to dig and that's what we decided to capture in this month's clip: ITER's critical network.

We met with Ben Slee, the Deputy Manager of the "Sites, Buildings and Power supplies" Division to find out more about the nature of the works. First, we asked him why these networks are called critical. It's all linked to time, schedule and the need to get them right before any infrastructure is in place. The network consists of the rainwater collection system, which has a length of 1.2 km and a diameter between 1 and 2.2 metres. We also spoke to Fabien Sappa, construction supervisor of the Engage consortium, responsible for the Architect Engineer contract, who explained that the pipes go 15 metres deep and the heaviest element is 12 tonnes. He outlined the three stages of the work and highlighted the challenge of doing all the work manually.

To watch the clip visit the F4E Youtube channel

## THE SEVEN ITER PARTIES MEET IN CADARACHE TO WITNESS THE PROJECT'S PROGRESS

The initiative of Günther H. Oettinger, EU Energy Commissioner, to call a ministerial level meeting in Cadarache paid off. It was the second time in the history of the project that ministerial representatives of the seven ITER parties met and were able to witness the progress of the biggest international scientific collaboration in the field of energy.



What started as an idea decades ago has unfolded into a multi-faceted fully fledged project connecting frontier science, engineering, industry and research in order to make fusion energy a possibility for tomorrow's energy mix.

With a rapidly evolving construction site in the background and with increasing manufacturing activity linked to ITER components, the seven parties acknowledged the progress of the project and used their political clout to echo once again the importance they attach to this collaboration. The French Minister of Higher Education and Research, representing the host state, explained that the project "addresses important societal concerns and nurtures major scientific ambition."

The EU Commissioner, managing the biggest share of budget between the seven parties, stated that "the ITER project is a historical undertaking. Intensive effort and innovative methods will be required to meet all challenges that still lay ahead, especially the challenge of staying within a tight but realistic schedule while containing costs." The commitment to remain focused on budget and delivery was shared by all delegations. This point was addressed by Professor Osamu Motojima, Director General of ITER International Organization, who acknowledged the fact that "good progress has been made possible through the enormous collaborative effort within what we call the 'Unique ITER Team'; that is a strong partnership formed by the ITER International Organization and the seven Domestic Agencies."

Apart from discussing the progress of the project and witnessing the evolution of the construction site, the meeting offered all delegations the opportunity to connect and reminded them that only through international collaboration we can effectively tackle societal and economic challenges, like energy and climate change, that crosscut all continents.

Ministerial representatives from the ITER parties with Günther H. Oettinger, EU Commissioner for Energy and Geneviève Fioraso, French Minister of Higher Education and Research. ©ITER

## ATKINS AND F4E SHOWCASE ITER AT THE ROYAL ACADEMY OF ENGINEERING AWARDS CEREMONY

The Royal Academy of Engineering (RAE) annual awards ceremony is one of the most prestigious events celebrating the very best of British engineering. It is the perfect occasion to highlight the achievements of a sector that employs thousands of people, generates growth and has a direct impact on our quality of life. It is also the venue where senior policy makers, business and industry representatives learn from one another and exchange views.

Excellence, vision and innovation underpin the nominations in all categories with the Mac Robert Award, the premier prize for UK innovation in engineering, being the highlight of the evening. The ceremony took place in July at the Battersea Power Station, located in South London, known for its iconic four chimney plant which will be soon be part of an urban re-generation project.

This year's RAE annual awards were sponsored by Atkins, a partner to the ITER project through the Architect Engineer contract, awarded by F4E, which ranks as one of the biggest contracts of the kind awarded in Europe. Atkins was celebrating one million person hours in ITER demonstrating its commitment to the biggest international research collaboration in the field of energy. The ITER mock-up travelled all the way to London and was unveiled in front of Princess Anne, the daughter of Queen Elizabeth II, George Osborne, the UK Chancellor of the Exchequer, Sir John Parker, Chair of the RAE, senior policy makers, CEOs and the media.

Prof Dr Uwe Krueger, Atkins' CEO, welcomed guests at the Atkins stand and in his opening words explained that "ITER is one of these projects that really excite the imagination of scientists and engineers. Atkins is passionate about it, whether we are fortunate to be working in Cadarache or just following the innovation of colleagues and peers from a distance". F4E's Chair of the Governing Board, Mr. Stuart Ward,



represented Europe's contribution to ITER and offered insightful information on the progress of the ITER project and the merits of fusion energy. He described the event as "a unique opportunity to communicate on a project that combines frontier science and engineering from around the world. The attraction of delivering fusion energy is what keeps all ITER parties, industry and fusion research associations committed". ITER attracted a lot of interest in terms of technology breakthroughs and business opportunities.

As the event was coming to an end, the purple plasma lights of the ITER

mock-up stood out at the marquee signalling the dawn of a new energy at the premises of the old coal-fired power plant. For those who could not see the ITER mock-up Atkins offered them the possibility to become familiar with the new source of energy by hosting the ITER mock-up at the Royal Academy of Engineers exhibition during the last two weeks of July.

Mr Stuart Ward, Chair of F4E's Governing Board with Jeremy Webb, Editor of New Scientist magazine

## FUSION TECHNOLOGY BREAKTHROUGHS AND BUSINESS INCENTIVES JOIN FORCES AT ISFNT-11

The International Symposium on Fusion Nuclear Technology (ISFNT-11) is one of the three major events that the fusion community proudly organises in order to exchange know-how, debate technology breakthroughs and report on new achievements carried out by fusion Associations and industry. During the scientific sessions, technology is being reviewed rigorously and lively discussions unfold about the next steps the fusion community needs to take.



01

Dr. Joaquin Sánchez, Director of Spain's National Fusion Laboratory and General Chair of this year's ISFNT, opened the event by confirming that the symposium gathered more than 800 participants with particular focus on plasma technology, breeding blanket technology, the Broader Approach and DEMO. "The fusion community is growing. I'm not only talking in terms of numbers but also in terms of ambition. We are here to discuss the progress we have made so that we position this technology as a viable alternative" he explained in his opening speech.

Dr. Hideyuki Takatsu, Chair of the ISFNT International Standing Committee,

stressed that "one of the novelties of this event is the possibility to discuss near and long term challenges that fusion technology faces. We will go beyond the state of the art and aim to inspire the future generations by discussing for instance the fusion roadmap and DEMO" he stated.

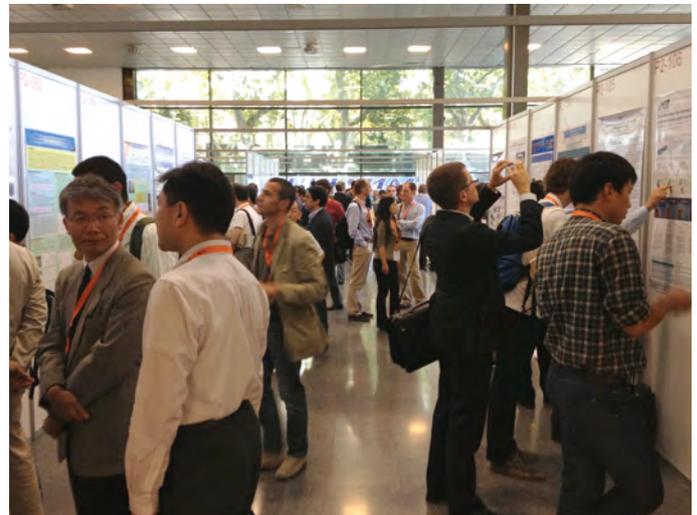
Given the fact that this year's ISFNT was taking place in Barcelona, the responsibility fell on the shoulders of IREC and CIEMAT to organise the event in collaboration with the Catalan authorities, CDTI, b-TEC and F4E, ensuring a wide presence through a series of presentations and posters as part of

the scientific programme. Furthermore, sessions targeting industry and SMEs were also planned in order to stimulate business interest and raise awareness about the direct benefits through their involvement.

Professor Henrik Bindslev, took the opportunity to welcome all participants to Barcelona, the seat of F4E, and highlighted the need for closer collaboration between Associations, industry and policy-makers. "We need to work in this knowledge triangle and deliver fast. We need to build communication channels between these communities so that technology breakthroughs turn into commercial realities" he explained. On the same train of thought, Perre Torres, Secretary for Labour and Competitiveness of the Catalan authorities, emphasised the tangible benefits stemming from a project like ITER in terms of jobs, knowledge and its contribution to a new diversified and sustainable energy model. It was the perfect moment for Professor Osamu Motojima to take the floor and deliver a status report on ITER. "Fusion is not a dream. It has become a target" he explained and then reported on a series of key events like the ministerial meeting that took place earlier in September, the inauguration of the ITER IO headquarters, the French prime ministerial decree on ITER and elaborated on the progress of several components in the fields of magnets, cryogenics, vacuum vessel, buildings and construction.



02



03

Investing in fusion is important not only for the success of ITER but also for stimulating further progress on the technological front. Industry and SMEs play a key role in fulfilling this task. Therefore, an industrial exhibition was planned to offer visibility to all companies attending the event and an industrial workshop to raise awareness of the upcoming business opportunities. Belén del Cerro, Spain's Industry Liaison officer for ITER, chaired the workshop and in her opening remarks reminded the audience that "strengthening the participation of industry in the ITER project is a top priority."

Professor Henrik Bindslev took the opportunity to present the F4E industrial policy together with a list of actions that will facilitate and assist the participation of industry and SMEs. "In spring, we established four working groups in collaboration with ILOs to address the concerns expressed by European economic operators. We have listened and revised our rules to make them compatible with the business ethos of our times. We will make participation simpler across all levels with ILOs, reduce administrative burden, limit liabilities as well as guarantees and afford contractors exclusive intellectual property rights and ownership in almost all cases." The new guidelines were perceived as a positive signal to industry and SMEs with ILOs stressing the need for more interaction with F4E and ITER IO.

So where do we stand in terms of Europe's procurement packages and are there any business opportunities in the horizon?

Jean- Marc Filhol, Head of F4E's ITER Department, gave answers to these questions offering a wealth of data. Since 2009, 25 Information Days have been organised bringing together more than 1340 representatives from industry, SMEs and Associations. 50 market surveys have been conducted to identify expertise across business operators in Europe. As of July 2013, F4E has signed more than 200 operational procurement contracts and approximately 100 grants with a total value of 2.4 billion EUR, a substantial share of Europe's in-kind contribution. The presentation gave an overview of the progress made on different ITER components and provided a preview of the big tenders carried out this year mainly from the areas of magnets and buildings. The presentation was complemented by two F4E interventions reporting on the cryoplant and fuel cycle by Alain Teissier and another on the Neutral Beam Test Facility and gyrotorn power supplies by Tulio Bonicelli.

The uniqueness of the ITER project has raised the need for new ways of collaboration between industry and research centres. Maite Dominguez representing the Fusion Industry Innovation Forum (FIIF) explained why

industry is of fundamental importance so that fusion technology takes off. F4E's Victor Saez reported on a cluster of activities that will consolidate the partnership between research centres and industry and highlighted the added value of both parties.

The 11th ISFNT offered participants the possibility to present the current progress of fusion technology by means of presentations and posters, debate the energy roadmap and the evolution of future fusion devices in plenary sessions and bring research closer to business, industry and SMEs through networking events and seminars. The symposium broke the news about F4E's industry policy and gave the impression that fusion technology is moving in the right direction. The next ISFNT will take place in South Korea between 14-18 September 2015. See you all there!

- 01 Right to left: H.Bindslev, F4E Director, welcomes J.Sánchez, CIEMAT Director and P.Torres, Secretary of Enterprise and Competitiveness of Catalonia at the F4E exhibition stand
- 02 Professor Osamu Motojima, ITER IO Director General with Jean-Marc Filhol, F4E Head of ITER Department
- 02 Technical experts discuss new findings during the ISFNT-11 poster sessions

## F4E HOSTS ITER NEUTRONICS MEETING

The eighth annual ITER Neutronics meeting was hosted by F4E in Barcelona in July. The three-day event, which serves as a popular platform for discussion and dissemination of ITER nuclear-analysis issues, results and expertise, had the largest attendance of the series so far, with over 50 international delegates from Europe, China, India, Japan and the United States. The participants were mainly nuclear analysts and developers from the ITER International Organization, ITER Domestic Agencies, academia and industry.



Neutronics is one of the key fields in the design of fusion technology. Thanks to their neutral nature, the 14 MeV neutrons generated in deuterium–tritium plasmas (as will be produced in ITER) deeply penetrate into surrounding components and release energy in the machine. Neutrons also generate tritium through reactions with lithium in a breeding blanket — the component that surrounds the plasma. In addition, neutron measurements provide important information about plasma parameters, such as shape, temperature and density, that are necessary to generate fusion conditions. On the other hand, neutrons also cause damage which has repercussions for the performance and lifetime of the tokamak components.

The ITER Neutronics meeting kicked off with a welcome address by Jean-Marc Filhol, F4E's Head of ITER Department, during which he highlighted the importance of

neutronics analyses and the value of this meeting series to foster communication and collaboration among experts. He noted that ITER neutronics issues, such as radiation effects in coils, and in components ensuring machine safety, have become a permanently monitored item in high-level ITER committee meetings.

The programme, prepared by F4E's Technical Officer Raul Pampin, consisted of technical presentations and discussion sessions organised in several areas of expertise. Speakers highlighted challenges and progress within the field, particularly in the area of estimating parameters relevant to safety, i.e. radiation dose rates. Discussions focused on the development of crucial software and algorithms to simulate the unique and intricate conditions of the ITER machine, thereby enabling the production of reliable calculations of safety parameters in an efficient way. Furthermore, progress

was made on the definition of much-needed general standards for neutronics computations. In conclusion, future needs and opportunities were identified for experiments to further validate the complex methods being developed.

The meeting was closed by Michael Loughlin, ITER's Nuclear Coordination Officer, in a speech that summarised the most notable findings and conclusions, praised the efficient meeting organisation and highlighted very many positive outcomes of the event. His views were shared by the vast majority of attendees. He also announced that next year's ITER Neutronics meeting will be hosted by ENEA and held in Frascati, Italy, during the month of May.

---

The delegates of the Neutronics meeting hosted by F4E

## FIRST EVER FINAL DESIGN REVIEW COMPLETED

F4E held its first ever final design review (FDR) during the summer. The meeting, which paves the way for the start of manufacturing, was held to assess the final design of the ITER continuous external Rogowski coils. These coils are to be located outside the vacuum vessel, within the cases of three Toroidal Field (TF) coils. Their purpose is to measure the toroidal current flowing within the contour of the TF coils, which approximates to the plasma current under steady conditions, a key measurement with relevance for safety and plasma control.

While most of the components to be delivered by F4E are based on final designs provided by the ITER International Organisation, in some cases, such as with the continuous external Rogowski coils, F4E is responsible for finalising the design and so for conducting the FDR.

The meeting was led by an official review panel, appointed by F4E and chaired by Dr Edward Strait from General Atomics (United States). It comprised international technical experts as well as F4E and ITER International Organisation representatives in areas such as quality control, safety and interfacing components. Representatives from the F4E supplier, led by CEA (France), and relevant F4E and ITER staff also attended. Presentations and discussions focused on checking that the selected design-solution definition met the system requirements in terms of performance, integration in ITER and documentation. Factory and site acceptance test procedures were also presented, as well as those for assembly, installation and commissioning.

In their report, the panel noted their appreciation for the large amount of work that had gone into the design, the supporting analysis and testing of prototypes and confirmed their satisfaction with the maturity of the design. The call for tender for the system is planned for early 2014, following the resolution of a few outstanding issues noted by the panel, with manufacturing commencing later in the year.



The participants of the first-ever F4E final design review.

## KICK-OFF MEETING FOR TWO MAJOR NEUTRAL BEAM TEST FACILITY COMPONENTS

A kick-off meeting between F4E and the Italian company Coelme was held during the summer to discuss the design, manufacturing and installation of the SPIDER High-Voltage deck (HVD) and Transmission Line (TL) at the Neutral Beam Test Facility (NBTF) at the Consorzio RFX site in Padova, Italy. This kick-off meeting follows a flurry of contracts for the NBTF that were signed late last year and clearly shows how the set of the main European industrial contracts for the construction of SPIDER is rapidly being completed.



The NBTF will house two independent test beds, namely SPIDER (Source for Production of Ion of Deuterium Extracted from Radio Frequency plasma), where the first full-scale ITER ion source will be tested and developed with an acceleration voltage up to 100 kV; and MITICA (Megavolt ITER Injector and Concept Advancement) which will be the first 1:1 full ITER injector aiming at operating up to the full acceleration voltage of 1 MV and at full power (16.5 MW). F4E will supply the ITER machine with two neutral beam (NB) injectors (i.e. two similar injectors such as in MITICA). These injectors are essential for heating and reaching the high temperature necessary for fusion reactions to occur in the plasma.

The HVD and the TL are two vital components for the SPIDER experiment. The HVD consists of a mechanical

structure which will hold the set of power supply equipment weighing around 40 t. Measuring approximately 13 x 11 m, the HVD will be installed in a pit around 1 m below ground-floor level, and will be mounted on supporting insulators so that it can withstand the high 100 kV voltage of the power supplies. The HVD will be covered by a metallic screen in order to reduce electromagnetic interference, which could have negative effects on the power supply.

The high-voltage Transmission Line will connect the power supplies installed inside the HVD to the SPIDER ion source and beam acceleration. Measuring around 30 m in length, the Transmission Line uses unique double-screening sandwich panels which give extra protection against electromagnetic interference.

The kick-off meeting provided the opportunity to explain how this contract fits within the overall context of the ITER project, the key actors and their respective roles, and to set up the information and communication flows. The meeting also marks the start of the work on the detailed design of both the HVD and the TL. Following the completion of the design, which is expected by the end of 2013, manufacturing of the two components will start. It is envisaged that the HVD will be ready for installation in mid-2014, and the TL will follow 6 months later. Final acceptance will take place after site testing, which is scheduled for the end of 2014 and mid-2015.

Discussions about the design, manufacturing and installation of the High Voltage Deck and Transmission Line was on the agenda during the kick-off meeting

## F4E HOSTS MEETING ON MINERAL INSULATED CABLING

F4E has hosted a meeting concerning mineral-insulated cables (MIC) — the cables for diagnostic systems inside the ITER vacuum vessel, which F4E is responsible for procuring. The objective of the meeting was to inform participants of an upcoming call for tender for the procurement of cabling for prototyping and to interview participant companies that produce cabling for nuclear environments to survey the solutions they already have available on the market and to learn more about their previous experience.

In total, representatives of eight companies from France, Germany and the United Kingdom attended the meeting and showed a strong interest and eagerness in learning about ITER business opportunities.

ITER will be equipped with an extensive set of diagnostics inside the tokamak to measure plasma parameters. The plasma diagnostics will protect the machine from damage during operation, control the functioning of the machine and provide information for detailed studies of the physics of fusion energy production. A diagnostic system is typically made up of sensors and cabling inside the tokamak, transmission lines outside the tokamak and electronics. The sensors will measure various plasma characteristics such as the magnetic fields and current. The cabling inside the tokamak and the transmission lines will deliver these measurements to electronics located in a separate building, for digitisation and subsequent processing by the diagnostic software, to determine plasma parameters.

Approximately 9 000 cables of various types and lengths must be manufactured for the ITER machine. The cumulative length of the cables is estimated to be around 20 km. MICs have performed well in other fusion experiments because of their compatibility with the vacuum environment inside the tokamak and their robust construction. Although the ITER design specification has yet to be finalised, it is more than likely that MICs will be used inside the tokamak. The fusion plasma releases a large amount of heat and the diagnostic cables in the tokamak need to be able to withstand temperatures up to 500 °C. The cables are 'lifetime' components intended for ITER's entire operating lifespan of 20 years. This is because there is no possibility of maintenance or replacement once the cables have been installed in the machine.

Following the information meeting, F4E's immediate next steps include carrying out extensive testing using samples of cables from various manufacturers in order to determine if they are suitable for ITER.



F4E and industry representatives during the meeting about mineral-insulated cables.

## F4E TAKES ITER TO THE BIGGEST CAMPUS PARTY

It's an event like no other. Thousands from all over Europe reach the same destination to celebrate the triumphs of ICT during five days. The event brings together graduates, journalists, intellectuals, business executives and policy-makers who share the same enthusiasm about technology breakthroughs. They go on stage to present, discuss and debate new findings.

For some it's a source of inspiration for a new career path and for others a way to find out what is coming in the next couple of years. It's Campus Party Europe!

This year's event was hosted in London for the first time between 2-7 September at the O2 Arena and aimed to attract the interest of 10,000 participants otherwise known as "Campuseros". The informal nature of the event allowed people to move freely from one session to another and to participate in 500 hours of content distributed between conferences, workshops, competitions and activities across 20 themes.

F4E agreed to participate for the second year in a row and through a short talk and a series of clips it generated a fair amount of interest. F4E's Dr Mario Cavinato went on stage and invited the crowd to go back in time in order to understand how fusion energy has evolved and what potential it has, what are the challenges that our energy mix faces, how ITER has made progress and what Europe's contribution is. The crowd responded well to the presentation and raised questions regarding the plasma temperatures, the relation between magnetic and inertial confinement concepts, the performance of JET and the ITER machine. "Overall, I found this event rewarding because it allows us to interact with people in a very

spontaneous way. We bring science and technology closer to so many different groups who are eager to learn and become more aware of the technologies in ITER and their potential. It was a great opportunity to connect both with professionals and young passionate students" he explained.



Inside the O2 Arena hosting this year's event

### Fusion for Energy

The European Joint Undertaking for ITER and Development of Fusion Energy

C/ Josep Pla, 2  
Torres Diagonal Litoral, Edificio B3  
08019 Barcelona  
Spain

Tel: +34 93 320 18 00  
E-mail: [info@f4e.europa.eu](mailto:info@f4e.europa.eu)

[www.fusionforenergy.europa.eu](http://www.fusionforenergy.europa.eu)  
[www.youtube.com/fusionforenergy](http://www.youtube.com/fusionforenergy)  
[www.twitter.com/fusionforenergy](http://www.twitter.com/fusionforenergy)  
<http://www.flickr.com/photos/fusionforenergy>

F4E News is a newsletter published by Fusion for Energy (F4E)

**Editorial team:** S. Shamsie, A. Apollonatos

**Contributors:** S. Arshad, A. Bonito-Oliva, M. Cavinato, S. Chatzipanagiotou, G. Counsell, S. Egyedy, J. Fanthome, C. Forestier, D. Gutierrez Garcia, R. Monk, F. Munoz, E. Noukou, R. Pampin Garcia, E. Pangole, M. Perez Lasala, Y. Poitevin, M. Simon, P. Valente, B. Wadge, S. Ward, A. Winstanley

**Design:** M. Boulguy

For free subscriptions, please specify your requirements via e-mail:  
[press@f4e.europa.eu](mailto:press@f4e.europa.eu)

Printed in Belgium on chlorine-free paper

ISSN 1831-5887

© Fusion for Energy