F4E NEWS

Fusion for Energy Newsletter
No. 19 / July 2016

ITER Worksite
Immense girders of the Assembly Hall cranes arrive

Contracts
140 million EUR for new components and works on-site

Components
Two massive tanks ready for the ITER cryoplant

Innovation
ITER Big Brother cameras developed

Events
IFMIF/EVEDA major components delivered

Representatives of F4E, ITER IO and F4E contractors standing inside the first ITER Toroidal Field coil winding pack - one of the biggest magnets to be manufactured.

ITER magnets celebrate landmark achievement

The inner-core of the first ITER magnet has been manufactured. One of the biggest and most complex magnets in mankind is coming to light. This landmark achievement for the ITER project has been supervised by F4E in close collaboration with ITER IO and other ITER parties.

The workforces that have been working diligently all these years to accomplish this challenging task have gathered at the ASG premises, Italy, to witness history in the making. More than 600 people have contributed to this milestone from at least 26 companies. Work started in 2008 with the production of the conductor that will be used in the Toroidal Field (TF) coils which has reached in total a length of 20 km.

ITER - the biggest fusion device in history will use powerful magnets to confine its super-hot plasma, which is expected to reach 150 million ˚C, so that it refrains from touching the walls of its vessel. This gigantic "D" shaped magnet, known as TF coil, will form part of the 10 out of the 18 TF coils that Europe will manufacture. These will be the biggest Niobium-tin (Nb3Sn) magnets ever produced, which once powered with 68000 A, will generate a magnetic field that will reach 11.8 Tesla - about one million times stronger the magnetic field of the Earth.

To create the inner-core of the TF coil, a pack of seven structures has to be impregnated, stacked, electrically jointed, wrapped, and fully electrically insulated. Pipes through which cold liquid helium will circulate inside the magnet to help it reach a superconducting state and instruments to measure its performance have also been added. Each of these packs, known as a winding pack in the ITER jargon, is 14 m high, 9 m wide and 1 m thick. Its weight is approximately 110 tonnes which compares to that of a Boeing 747!

Iberdrola, ASG and Elytt Energy, have all been working together to manufacture the core of this magnet in close collaboration with CNIM and SIMIC, responsible for the production of the radial plates, which keep the superconductor wrapped inside their grooves and protect it.

For Alessandro Bonito-Oliva, F4E's Manager for Magnets, and his team, the accomplishment of this milestone is of significant importance. "This is a landmark achievement for the whole project. We have been working really hard to meet the tight planning and manage all interfaces so that all pieces come together at the right time. The very good collaboration between the teams of F4E, ITER International Organization and Japan's Domestic Agency for ITER has helped us reach this point and go beyond as production accelerates."

What are the next steps? After some additional operations are concluded in the ASG facility, the inner-core of the magnet will be transferred to SIMIC to conduct a series of tests. Then, it will be inserted in the massive case of the coil and in the end the final casting process will be performed, during which additional epoxy resin will be injected to fill in any remaining gaps. Next in line is the second TF coil, with manufacturing of its components completed and assembly underway.

View on F4E YouTube

Representatives of F4E, ITER IO and F4E contractors standing inside the first ITER Toroidal Field coil winding pack - one of the biggest magnets to be manufactured.

Testing materials and tooling to manufacture one of ITER's magnets

The ITER machine will use powerful superconducting magnets - Poloidal and Toroidal field coils - to confine its burning plasma. In the form of concentric circles, the six PF coils will entrap the hot gas from top to bottom to control its shape and stability. Europe is responsible for five of the PF coils, of which one will be manufactured in China, while the remaining sixth coil will be produced in Russia.

In China's Institute of Plasma Physics (ASIPP) , the qualification activities, which for the time being consist of testing tooling and materials used at the prototyping phase, have kicked off and the results have been overall positive. This phase is of critical importance because it allows engineers to spot potential manufacturing problems and introduce improvements so that the final coils are in line with the specifications. The welding of the second sample of the helium inlet, the entry point of the gas running through each magnet to reach the freezing cold temperatures, has been successfully qualified and passed the leak test. The tooling for the dummy joint boxes, the equipment that will be used to connect the lengths of conductor with power feeders, has been accepted.

Electrical high voltage testing will soon be carried out on a 2 m 3x3 dummy coil and two more 720 m conductors have been accepted raising to 30% the volume of material needed for manufacturing. The testing of the de-spooling unit, which will be used to gently unwind the conductor before it gets wound again in the form of the coil, has also been successfully tested. Last but not least, the metallic structure upon which the "Double Pancakes" - layers of insulated and impregnated conductor stacked together - will rely on, during manufacturing, has been tested to make sure that it can support their weight.

Apart from the technical progress there has also been an administrative milestone. The F4E auditors visited the ASIIP facility and during four days carried out a thorough review of all processes, handling of raw material, documentation and standards. The outcome of their analysis suggested that the facility met all criteria and was in conformity with all requirements.

Placing the lead of the leak test chamber on the metallic structure in order to check that it can support a heavy load

ASIIP teams carrying out the successfully the Helium inlet test on a sample

Developing tiny Big Brother cameras for ITER

Even though ITER will be the biggest fusion device, the efficient use of the remaining space inside its vessel, once all bulky high-tech components will be assembled, is expected to be a hot issue. Perhaps as hot as the fusion reaction of 150 million ˚C that will be confined within its walls by powerful superconducting magnets.

One of the conundrums that engineers will have to solve is how to best exploit the limited amount of space they will be left with in order to perform delicate and important tasks such as inspections and maintenance. The multiple inter-connected pieces of equipment and the exposure of some of them to radioactivity do not qualify human intervention as an option. Therefore, the search for ITER's compact but reliable Big Brother system needs to begin.

Marco Van Uffelen, F4E Remote Handling, explains that "we need to draw lessons from space applications and fission technology in order to manufacture cameras that are small in size and strong enough to sustain the ITER in-vessel environment. Basically, we are developing the first of a kind and we are entering an exciting phase of the project because with the help of companies and laboratories we are making headway." It is estimated that the total number of cameras scattered in the machine will be in the range of one hundred and will consist of two types: oversight cameras giving engineers a broad angle inside the vacuum vessel and embedded cameras on tooling or robotics which will help us have vision inside tightly confined spaces of tooling.

The fruitful collaboration between F4E and Oxford Technology Limited (OTL) has generated different subsystem mock-ups that will soon be tested. OTL has successfully involved laboratories, which boast a solid track record in R&D, to develop different parts: ISAE, Toulouse, is responsible for the image sensors; CEA for the illumination system and the Jean Monnet University Saint Etienne for the optic system. Currently, the mock-up measures 15 mm and fits inside a 1 EUR coin. In future, the camera prototype will measure 40 mm x 40 mm x 70 mm.

Experts have been working on the development and validation of these subsystems for almost a year and a half and the next phase will be to test their resistance in a nuclear facility. In Belgium's SCK-CEN the subsystems will be exposed to Gamma radiations and after each irradiation step they will be analysed. The tests on FURHIS (Fusion for Energy Radiation Hard Imaging System) are expected to be concluded on March 2017 and on the basis of their findings the prototyping phase will begin.

Mock-up of the optical subsystem part of the FURHIS project (Fusion for Energy Radiation hard Imaging System) signed between F4E and OTL

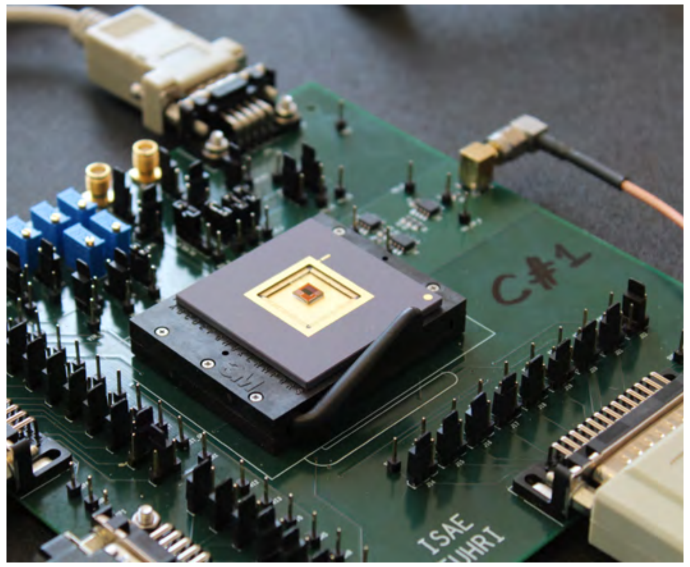
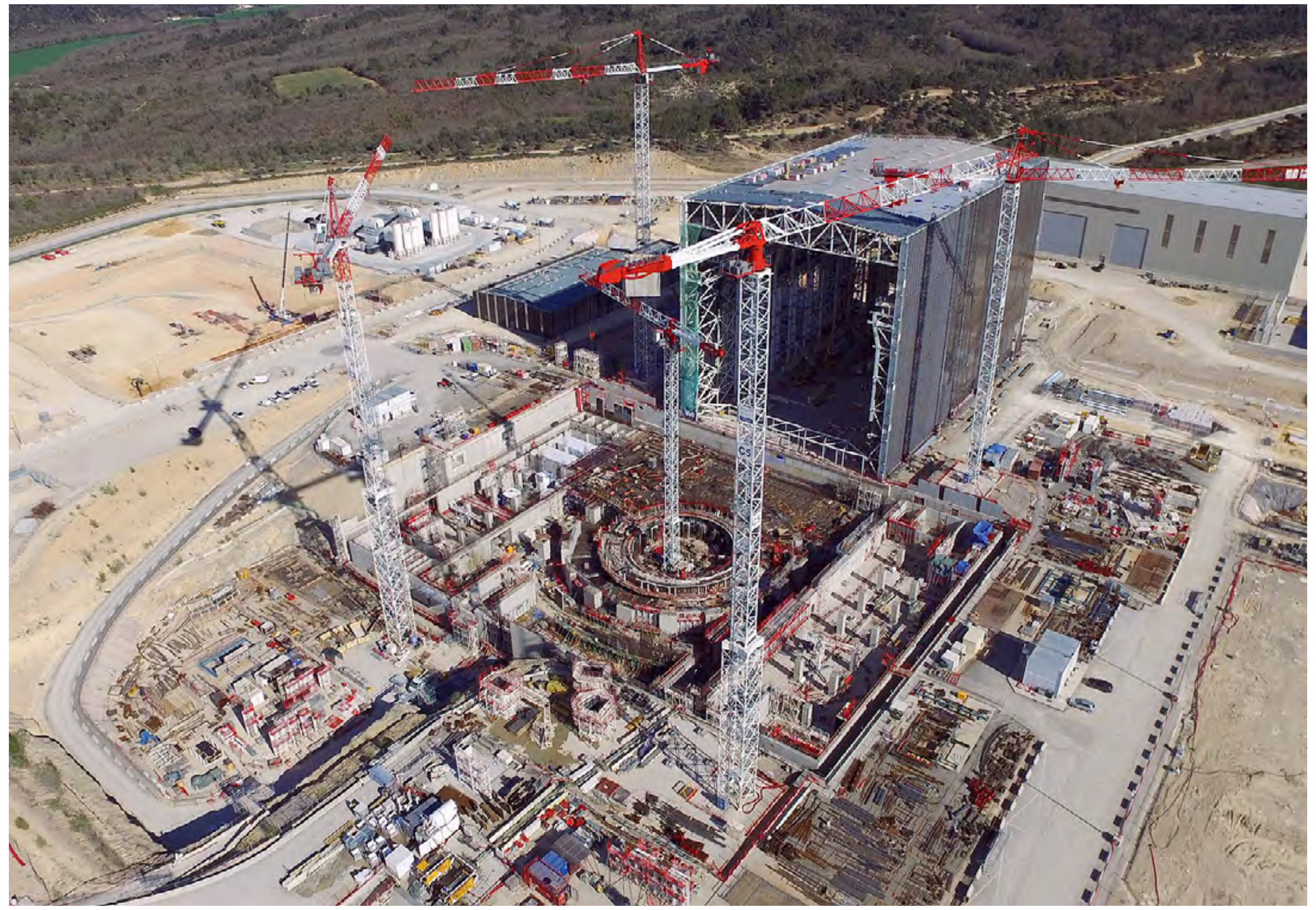


Image sensor mock-up on the test board part of the FURHIS project (Fusion for Energy Radiation hard Imaging System) signed between F4E and OTL

Fusion for Energy signs 140 million EUR for new components and works on-site

ITER in Latin means “the way” towards a new energy mix. To address this challenge, the biggest fusion project presents industry with a vast range of business opportunities and paves the way to new markets with significant economic benefits. The contracts recently signed for high-tech engineering, frontier R&D and civil construction works, require collaboration between different suppliers and coordination across different levels.



Aerial View of the Tokamak complex and Assembly hall building - April 2016 © EJF Riche

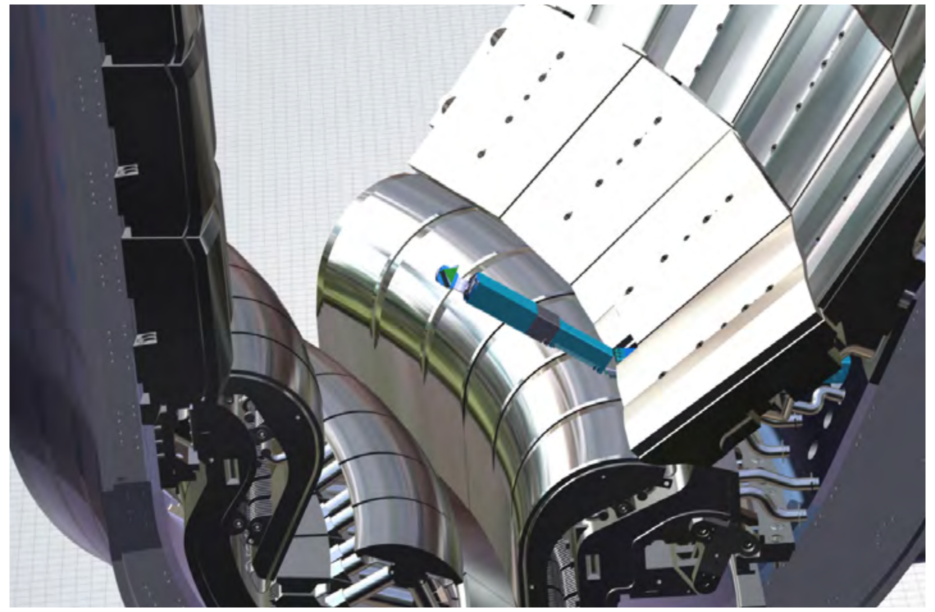


Illustration of a section of the ITER vacuum vessel with one probe forming part of the in-vessel viewing inspection system

View of the Poloidal Fields coils facility with some first equipment installed for the production of the ITER coils

Constructions Industrielles de la Méditerranée (CNIM) has been awarded two contracts, reaching a cumulative value of 80 million EUR. The first contract is in the field of magnets and is expected to run for at least four years. Measuring up to 25 m in diameter and weighing between 200 and 400 tonnes, the Poloidal Field coils will maintain the shape and stability of the ITER plasma creating a cage of concentric magnetic rings from top to bottom. CNIM has been entrusted with the manufacturing of four out of the six PF coils to be manufactured on the ITER site, Cadarache. The operation of equipment, acceptance controls and cold tests at approximately -193 °C/ 80 K will be carried out by the contractor.

Through the second contract signed with CNIM, a cutting-edge inspection system will be produced. A combination of high-tech vision system and robotics will be deployed to carry out the delicate checks inside the ITER machine. It will take up to seven years for the company to deliver the viewing system, which will perform the 3D mapping of the components inside the vessel and provide technical information about their state. The system will collect measurements and images with a resolution better than 1 mm at distances of 0.5 m – 4 m and better than 3 mm from up to 10 m away. “These contracts highlight the expertise of CNIM in the field of Large Scientific Instruments and the quality of our industrial facilities, which are perfectly suited to large-scale projects” explained Philippe Demigné, member of CNIM’s Management Board and President of Bertin Technologies.

ITER offers an impressive array of business opportunities when it comes to sophisticated civil engineering. With a platform measuring more than 42 hectares, and Europe being the party responsible for the delivery of the 39 buildings and facilities, F4E has the responsibility to award contracts in this domain.

A consortium consisting of three subsidiaries of the Spie batignolles Group (Spie batignolles TPCI / Spie batignolles sud-est and Valérian) and ADF has signed a contract in the range of 60 million EUR to deliver the networks for the electricity and hydraulic services so that facilities are operational. The roadworks connecting all buildings will also be delivered through this contract. The works will unfold to almost half of the entire ITER platform covering a surface of more than 200 000 m^2. “After having designed and built the PF Coils building, the first infrastructure on the ITER site, we are happy to be back on the project. This contract demonstrates our expertise and our ability to design and build infrastructure for the biggest fusion facility. Spie batignolles Group together with Spie batignolles TPCI Valerian and ADF would like to thank F4E for its trust and look forward to collaborating”, explained Guillaume Galant, Sales Director of Spie batignolles TPCI.

WHAT IS ITER?

ITER is the biggest international partnership in the field of energy and will demonstrate the viability of fusion. The project brings together half of the world's population (China, Europe, Japan, India, the Republic of Korea, the Russian Federation and the United States) and represents 80% of the global GDP. It will be the world's largest experimental fusion facility and the first in history to produce net energy of 500 MW. The site of the ITER project is in Cadarache, in the south of France.

WHAT IS FUSION?

Fusion is the process which powers the sun and the stars. When light atomic nuclei fuse together and form heavier ones, a large amount of energy is released. Fusion research is aimed at developing a safe, limitless and environmentally responsible energy source. The fuels needed for fusion are abundant on Earth. With fusion there are neither greenhouse gas emissions nor long-lasting radioactive waste. Fusion reactors are intrinsically safe with no risk of a chain reaction.

HOW IS EUROPE CONTRIBUTING TO ITER?

Europe, as host of the project, is responsible for nearly half of the ITER components and the construction of 39 buildings on site. Fusion for Energy (F4E) is the EU organisation managing Europe's contribution to ITER in collaboration with industry, SMEs and research organisations.

WHY INVESTING IN FUSION IS IMPORTANT?

The EU is the largest energy importer in the world. To meet our daily needs and fight climate change we need to develop a diversified and sustainable energy mix, and fusion can be part of it. Investing in fusion will give European companies the opportunity to improve their expertise and acquire new skills, increase their competitiveness, help them tap into new markets, create jobs and generate spin-offs with significant economic benefits.

ITER IN FIGURES

Size of the site: 42 hectares
Weight of the machine: 23 000 tonnes
Number of components: 1 000 000
Plasma volume: 840 m^3
Temperature at plasma core: 150 000 000°C
Fusion power: 500 MW

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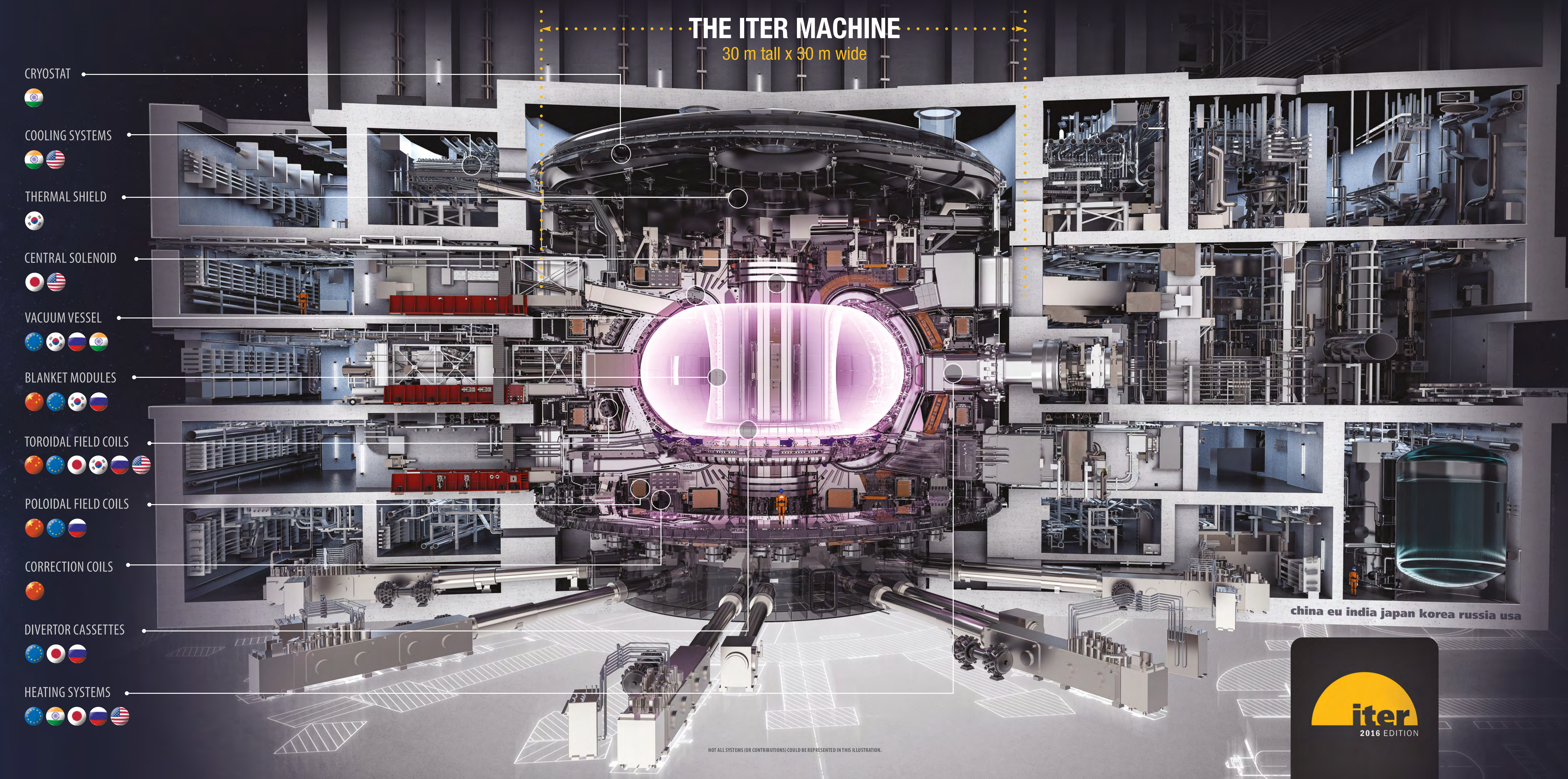
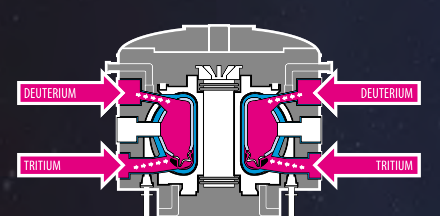
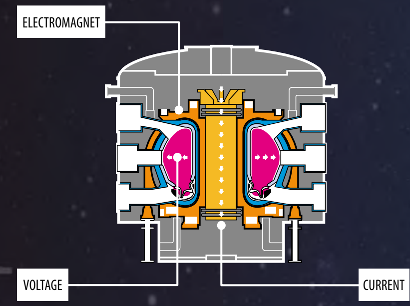


HOW ITER WORKS

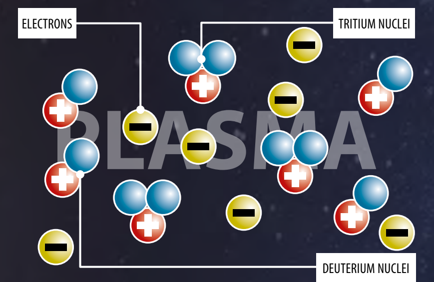
1. Puffs of deuterium and tritium hydrogen gas are injected into the doughnut-shaped vacuum vessel. The gas weighs less than a postage stamp and fills a volume one-third that of an Olympic swimming pool.



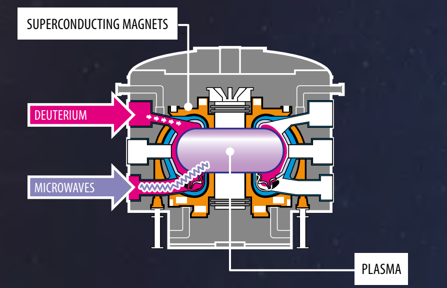
2. Electricity flowing through the central solenoid magnet produces a voltage across the gas.



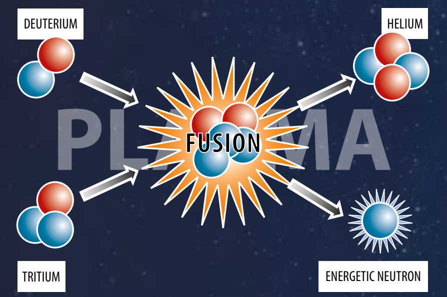
3. Voltage rips electrons from the deuterium and tritium atoms. They turn into charged atoms (ions) within a few microseconds, forming a particle soup called a plasma.



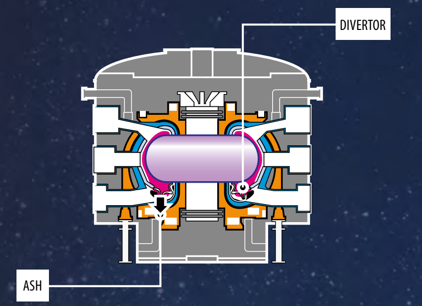
4. The plasma is trapped in the centre of the vacuum vessel by strong magnetic fields created by an array of superconducting coils. Collisions within the plasma bring temperatures to approximately 10 million °C, but that is not enough for fusion to take place.



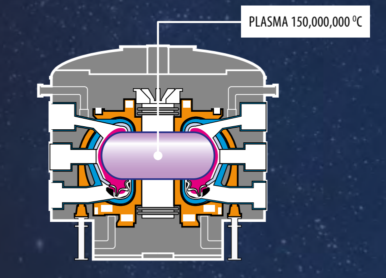
5. To raise the temperature further, scientists fire radio and microwaves into the plasma and high-energy beams of deuterium atoms. The plasma then reaches 100 - 200 million °C, hot enough for the deuterium and tritium nuclei to fuse.



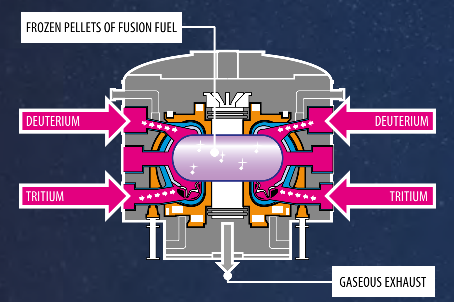
6. Fusion produces high-energy neutrons and helium particles that deposit their energy into the plasma and keep it hot, before becoming "ash". The ash is eventually forced out through the divertor.



7. Neutrons and other particles bombard the tiles on the plasmafacing components and heat them. In a future power station this heat will be harnessed to make electricity.



8. The plasma must be continuously refuelled with deuterium and tritium for the process to continue. Unspent fuel is also recovered from the gaseous exhaust and the reaction is fine-tuned by firing frozen pellets of fusion fuel deep into the plasma.



ITER Worksite April 2016 © EJF Riche

ITER construction A site full of action!

If you want to grasp the scale and complexity of the ITER project you have to visit the construction site. It is only then that one realises the titanic effort made by more than 1 400 people working on the progress of buildings and infrastructure.

Panoramic view of the Tokamak complex consisting of the Tritium, Tokamak and Diagnostics buildings. Cladding progresses at the Assembly Hall. June 2016, F4E ©

It is on this 42 hectare platform, hosting 39 buildings and facilities, that the components manufactured by thousands of companies around the world will reach their final destination. "By bringing together the F4E and ITER IO staff working in the area of Buildings, Infrastructure and Power Supplies (BIPS), we have managed to structure the work in a more efficient manner, cut down duplication of tasks and accelerated the pace of construction. The clock is ticking and we are doing our best with the teams of our contractors to go at full speed" explains Laurent Schmieder, heading the BIPS team.

The Assembly Hall, where the impressive ITER components will be assembled, has attracted a lot of interest during the last couple of months due to the arrival of the

girders that will be part of the massive cranes operating in this facility. Because of their size, the convoy delivering them on-site has been classified as the biggest-ever. Currently, the Assembly Hall is the tallest building and its sleek façade makes it stand out. With the east and west sides completed, the workforces are now focusing on the cladding of its north and south wings. Meanwhile, the rails upon which the girders and trolleys of the cranes that will move between the Tokamak building and the Assembly Hall are being fixed 45 metres above the ground. The girders have already been stationed inside the building to start preparing for their spectacular lifting operation scheduled to start in mid-June. The Assembly Hall will communicate with the Cleaning Facility (45 m x 40 m x 18 m) where the ITER components will be meticulously cleaned from any dust and impurities before they enter inside the massive hall to be assembled. Following the completion of its foundations, the first 11 columns have been erected together with some sections of its steel structure.

In front of the Assembly Hall lies the most emblematic building of the project - the Tokamak complex, which consists of the Tokamak, Tritium and Diagnostics buildings. Works have already started on the first floor of the Tokamak building with the pouring of the first plot of concrete (540 m³). In parallel, the construction of the bioshield walls, the cryostat's safety ring made of concrete has also been progressing. After the completion of the bioshield walls on the ground floor of the Tokamak building, works on its first floor have started together with the installation of the heavy embedded plates – known as shear lugs. Romaric Darbour, BIPS Deputy, explains that "these exceptionally heavy embedded plates weigh approximately 3 tonnes each and had to be placed with an accuracy of 20 mm. This delicate task has been successfully carried out with the help of our civil works contractors who developed specific tools." At the Tritium building, after the successful installation of the six water detritiation tanks which will be part of ITER's fuel cycle, the formwork of the slab above them has started to take shape with more concrete to be poured in the next couple of weeks. The first floor of the Diagnostics building is almost completed and the construction activities on the second floor slab have started.

Work progressing at the Transformers area, ITER construction site, June 2016 © F4E

Close to the Tokamak complex and alongside the Assembly Hall is the Site Services building. The main structural works have been completed and the finishing works are ongoing. The 80 metre-long building will provide other facilities with chilled water and amongst other utilities it will host a demineralised water plant and air compressors. A network of incoming and outgoing pipes will operate inside and under the building.

The ITER site galleries under construction that will enable the connection of necessary services between buildings, June 2016 © F4E

The foundations of the Cryoplant facility, which will generate the cold temperatures required for the ITER magnets, are being concluded, including the galleries underneath the facility. In terms of the area that will house the compressors, 17 out of the 18 concrete pads have been poured. Regarding the cooling water system, the excavation has been completed and the gallery works have been advancing. The large basin measuring 27 000 m³ will be used to store the water of ITER's cooling system.

With regards to the Radio Frequency buildings, the foundation works have been progressing. Meanwhile, the excavation and concrete works at the transformers area have advanced in order to prepare the pit for the installation of the first transformer from China, which arrived on the site in mid-June.

ITER water detritiation tanks installed

The installation of the six large-sized tanks, part of ITER's water detritiation system, has been successfully completed. This is considered a landmark achievement for two reasons: first, these have been the first European components to arrive on-site and second, they are the first components of the ITER machine to be installed in the Tokamak complex, where the main systems of the biggest fusion device will be housed.

Transferring one of the bigger water detritiation tanks weighing approximately 20 tonnes in ITER's Tritium building

Installing one of the smaller water detritiation tanks weighing approximately 5 tonnes in ITER's Tritium building

Giovanni Piazza and Josep Benet, F4E's Technical Officers following the manufacturing of these tanks, were present to witness this historical moment and supervise this delicate operation. "The size of the tanks and the limited space where we had to fit them required good planning and a high level of precision. The installation required excellent co-ordination with ITER International Organization (IO) and F4E's Buildings team to perform the installation without any impact on the pace of construction" they explained.

When ITER starts operating, these tanks will collect the water containing tritium in order to recover it and subsequently use it in future fusion reactions. Four tanks, weighing approximately 5 tonnes and measuring 20 m^3 each, will be part of this system. Two bigger tanks, weighing approximately 20 tonnes and measuring 100 m^3 each, will be used for the tritium recovery phase in exceptional circumstances.

The contract awarded to Ensa, Spain, builds on the expertise of Empresarios Agrupados and GEA as subcontractors. The companies had to comply with a series of safety and quality requirements that apply to ITER components. It has taken roughly 20 months for the six tanks to be designed and manufactured for a value of approximately 2 million EUR.

View on F4E YouTube

The immense girders of the Assembly Hall cranes have arrived at the ITER site

The girders of the Assembly Hall cranes have made it to the ITER site. It has been a long trip for the metallic structures since they left the workshop of the NKMNOELL-REEL consortium towards the end of February, travelled by sea to reach the port of Marseille and were then loaded on the longest convoy to reach Cadarache.

The second girder of the cranes operating in the Assembly Hall has arrived at the ITER site (left) and in the Marseille industrial harbour of Fos-sur-Mer, March 2016.

Due to the convoy's impressive size, and weight of roughly 200 tonnes, special arrangements had to be made. In fact, it is considered as the longest convoy to date and it happens to be Europe's first-ever heavy exceptional equipment delivered to ITER. DAHER, responsible for the logistics and transportation of ITER components, undertook this mission impossible and made it possible.

The best way to visualise the size of the convoy is to imagine 15 medium-size cars driving slowly at 2-5 km/h at night, so as not to disturb the local community, following a specific route of 104 km meticulously adapted by the French authorities. The delivery of the two girders has unfolded during two weeks because they had to be transported one at a time. With both girders now on site another milestone in the area of buildings and infrastructure, managed by F4E and ITER International Organization, has been accomplished.

Each of the two girders is more than 46 m in length with overall cross dimensions of about 4 x 3.5 m. Think of the girders as the shoulders of the electric cranes that will travel between the Assembly Hall and the Tokamak building. The heaviest components will be lifted by two 750 tonne cranes. When working in tandem they will be able to lift 1 500 tonnes, which is approximately the weight of four Boeing 747 aircrafts.

Their trolleys, have also been delivered on site towards the end of April. Meanwhile, the spectacular lifting of the equipment and cabling making up the cranes started in June. The tooling will be lifted 45 m above the ground.

Key European components of the Prototype Accelerator installed

The arrival of major accelerator components in Japan has opened a new chapter for the IFMIF/EVEDA project of the Broader Approach Agreement. The start of the new commissioning phase of the Linear IFMIF Prototype Accelerator (LIPAc) is seen as a step forward regarding its design validation, and is expected to boost the expectations of the fusion community vis à vis this facility.

Policy-makers and scientists attending the installation ceremony of LIPAc, IFMIF/EVEDA, Rokkasho, Japan.

Installing the Radio Frequency Quadrupole and Injector already in position in Rokkasho, IFMIF/EVEDA, Rokkasho, Japan.

LIPAc is designed to run a deuteron beam of 125 mA at 9 MeV in a continuous wave. This powerful accelerator will reach 1.1 MW beam power. Therefore, do not be fooled by its small size! CEA, CIEMAT, INFN and SCK-CEN are among its main contributors investing their extensive expertise in the design and manufacturing of its systems. The prototype accelerator will deploy cutting-edge technologies and operate in unprecedented beam conditions. Its injector, developed by CEA, has demonstrated that the deuterium beam can reach unprecedented characteristics between (100 keV, >100 mA). With the help of the Radio Frequency Quadrupole (RFQ) developed by INFN, the beam energy will increase by a factor of 50.

To celebrate the commissioning of the accelerator's injector together with the first phase of installation of the RFQ and the Radio Frequency power generator, representatives from the policy and scientific communities from Europe and Japan visited the facility and witnessed the process on-site. The presence of delegates from all European countries that have been involved in the IFMIF/EVEDA project can be read as an expression of their commitment to the project and as a token of appreciation for this technical milestone.

So what is next? In the course of the year, the injector will undergo further upgrades in order to operate in a continuous wave mode. In parallel, the preparation activities for the beam commissioning with the RFQ, the Medium Energy Beam Transport (MBET), a beam shaping device, and the Diagnostic Plate (DP), an assembly of instruments to conduct measurements, will move forward.

The RFQ, currently under installation at Rokkasho, is the longest one ever constructed. Six out of the eight RF power chains produced by CIEMAT have been installed and are able to deliver 200 kW each to operate the RFQ. The remaining two chains will arrive before summer. The installation of the Medium Energy Beam Transport with the Radio Frequency amplifier and the Diagnostic Plate is ongoing and is expected to be completed by September.

F4E presents upcoming ITER business opportunities to Czech industry

The ITER project offers a wide range of business opportunities to companies and research centres ready to be directly involved as main contractors or indirectly as subcontractors.

Anthony Courtial, F4E Market Intelligence, explaining the upcoming business opportunities to participants.

European companies and research centres, through their participation to ITER, have a lot to gain. First, they get to sharpen their technical skills; they establish new business partnerships and tap into new markets that will generate more income for them. Second, they become familiar with the dynamics of an international project and develop a sense of the rigorous technical specifications and manufacturing challenges. But above all, they grow and learn. For all of the above reasons Karel Cervenka, on behalf of the Institute of Plasma Physics of the Czech Academy of Sciences, organised an information day on ITER business opportunities.

More than 30 representatives from different companies attended the event which offered a status report on the progress of the ITER project, a business forecast regarding contracts in the pipeline and a mapping of expertise and competences required. On behalf of F4E, Anthony Courtial and Michaela Trbolova, addressed all these topics in detail and elaborated on the rules of procurement and F4E's industry and European fusion laboratories portal. As a result, more than 50% of the participants registered on the portal and are actively seeking ways to contribute to the ITER project. The companies and laboratories have a proven track record in the fields of cryogenics, instrumentation, assembly services, as well as welding, engineering and R&D.

For an overview of F4E business opportunities, visit the Industry and Fusion Laboratories Portal at: www. industryportal.f4e.europa.eu

Two massive tanks ready for the ITER cryoplant

The different pieces of the biggest cryoplant in the world are coming together at galloping pace.

Two of the biggest tanks that will form part of ITER's cryoplant have been manufactured. The massive pieces of equipment, produced by Air Liquide and their subcontractor Chart Ferox, measure 35 m x 4.5 m each and will require an exceptional convoy to be transported from the port of Marseille, Fos-sur-Mer, to the ITER construction site, Cadarache.

F4E and ITER International Organization (IO) have been closely supervising the manufacturing process of the two tanks, which started in August last year and has been finalised this spring. The ITER machine will use powerful superconducting magnets to entrap the hot plasma which is expected to reach 150 million ˚C. For this to happen cold helium will have to circulate inside the magnets to bring their temperature down to -269 ˚C. However, from time to time the magnets might experience a so-called quench. Basically, they will stop being superconducting, start becoming resistant and their temperature will momentarily rise by 50 ˚C. Consequently, it will no longer be possible to confine the plasma. As the temperature rises, the helium circulating through the cryogenic system will start to expand and will need to be extracted from the machine. This is where the two massive tanks, known as quench tanks, come to play. When this phenomenon occurs the gas will be directed to these tanks, where it will be captured and stored at -196 ˚C.

The two pieces of equipment are key to the operation of the cryogenic system of the biggest fusion device and this achievement results from the smooth collaboration between F4E, its suppliers and ITER IO.

Erratum

In the article "First JT-60SA TF coil completed and delivered", page 28 in F4E News, no. 18 / April 2016, the first sentence in the last paragraph in the article reads "Following delivery at the Cold Test Facility at CEA Saclay, the first TF coil will now be tested to ensure that it will be able to work well in the ITER machine." It should read "Following delivery at the Cold Test Facility at CEA Saclay, the first TF coil will now be tested to ensure that it will be able to work well in the JT-60SA machine."

Fusion for Energy
The European Joint Undertaking for ITER and the 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

www.fusionforenergy.europa.eu
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Editorial team: S. Shamsie, A. Apollonatos
Contributors: J. Benet Ciurana, A. Bonito-Oliva, M. Cornelis , A. Courtial, C. Damiani, R. Darbour, F. Dubertret, P. Gavouyere-Lasserre, R. Harrison, R. Heidinger, J. Knaster, R. Lanza, G. Kouzmenko, E. Noukou, A. Puiu, P. Readman , B. Slee, K. Smith, A. Teissier, M. Van Uffelen
Design: M. Boulguy

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