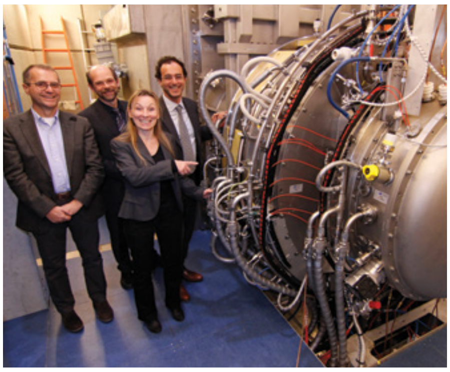
F4E NEWS

FUSION FOR ENERGY QUARTERLY NEWSLETTER

No. 11 - January 2013



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FUSION FOR ENERGY APPOINTS HENRIK BINDSLEV AS NEW DIRECTOR

Henrik Bindslev was appointed as the new Director of the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy). He was previously the Vice Dean for Research at Aarhus University, Faculty of Science and Technology.

Stuart Ward, Chair of the Fusion for Energy Governing Board, took the opportunity to congratulate Henrik Bindslev on his new position and thanked all members of the Board for their collaboration when taking this important decision.

"I am honoured to have been appointed Director of Fusion for Energy at a time that Europe's contribution to ITER enters a decisive stage and rapid progress will be made on all fronts. It is the moment to engage actively with Europe's industry and fusion community to honour our commitment to this prestigious international project" said Bindslev.

Henrik Bindslev has been engaged in energy research for more than 20 years and has considerable experience in research management, both in Denmark and internationally. He was Vice Dean for research at Aarhus University, Faculty of Science and Technology and previously also Chair of the European Energy Research Alliance (EERA).

He was a delegate to the European Strategy Forum on Research Infrastructures (ESFRI) and Chairman of ESFRI's Energy Strategy Working Group. Previously, he was the Director of Risø DTU, the Danish National Laboratory for Sustainable Energy, managing 700 members of staff.

He was educated at Denmark's Technical University and completed a DPhil in Plasma Physics at the University of Oxford. He worked as a fusion researcher at different facilities including ten years at the Joint European Torus (JET), Europe's biggest fusion research device, and has published more than 150 papers.

The Director is appointed by Fusion for Energy's Governing Board for a period of five years, once renewable up to five years. The appointment is made on the basis of a list of candidates proposed by the European Commission after an open competition, following a publication in the Official Journal of the European Communities.

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01 Dr Henrik Bindslev
02 Mr Stuart Ward, Chair of Fusion for Energy's Governing Board, congratulating Dr Henrik Bindslev on his appointment

LANDMARK CONTRACT FOR THE CONSTRUCTION OF THE TOKAMAK COMPLEX AND SURROUNDING BUILDINGS IS SIGNED

F4E celebrates a landmark achievement with the signature of one of its largest contracts in the area of the civil engineering works for the construction of the Tokamak complex, the building that will host the ITER Tokamak machine. Other buildings and amenities surrounding the Tokamak complex will also be delivered through this contract.

Representatives of F4E and the VFR consortium at the contract signing ceremony

This is a key development for the ITER project and a milestone of significant importance for Europe, because it demonstrates F4E's commitment to this international collaboration in the field of energy and delivers on an instrumental chapter of its construction. The contract is expected to run for five and a half years and its budget is in the range of 300 million EUR. The VFR consortium, which consists of French companies VINCI Construction Grands Projets, Razel-Bec, Dodin Campenon Bernard, Campenon Bernard Sud-Est, GTM Sud and Chantiers Modernes Sud as well as Spanish company Ferrovial Agroman, boasts a proven track record in the field of construction and will deliver on a contract that is underpinned by impressive complexity, multiple interfaces and strict safety standards.

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 200 people and by mid-2014 it is expected to reach 3,000 people. One of the key challenges will be to accommodate the needs of the rapidly growing workforce and to guarantee an optimal use of space to the different companies operating on the ground, in order to carry out the construction of all infrastructures in parallel and on time.

The scope and key figures of the Tokamak complex and surrounding buildings contract:
Through this contract the following infrastructure and amenities will be constructed: the Tokamak complex, consisting of the Tokamak, Diagnostics and Tritium buildings, the ITER Assembly Hall, the radio frequency heating building, the areas for heating, ventilation and air conditioning, the cleaning facility and site services buildings, the cryoplant compressor and coldbox building, the control buildings, the fast discharge and switching network resistor building, and three bridges.

A total of 150,000 m^3 of concrete will be used for all buildings out of which 110,000 m^3 will be used for the construction of the Tokamak complex. This is the equivalent of the concrete used for 3,000 houses of 120 m^2. The building will be 80 metres high, 120 metres long and 80 metres wide. Its footprint will be bigger than that of a football stadium. The Tokamak building will rely on 493 plinths equipped with anti-seismic bearings, already in place, in order to sustain the overall weight of the machine, which will be in the range of 23,000 tonnes, and which is almost three times the weight of the Eiffel Tower.

The Tokamak complex will host 100 heavy nuclear and confinement doors in total. The major doors will measure 4 metres high by 4 metres long and 35 cm thick. Their unit weight will be in the range of 40 tonnes and they will be remotely operated.

The works within the framework of the contract will require 7,500 tonnes of steel for the different structures and 16,000 tonnes of steel for reinforcement bars. The total number of embedded parts upon which the ITER equipment will be located, is expected to reach the impressive number of 60,000 units. Overall, it is estimated that 600 people will be involved in the works conducted in this contract.

F4E SIGNS CONTRACT FOR THE SUPPLY OF 70 RADIAL PLATES FOR ITER

The contract for the supply of 70 radial plates to the ITER magnets system has been signed between Fusion for Energy (F4E) and the Consortium of SIMIC S.p.A and Constructions Industrielles de la Méditerranée (CNIM). In the range of 160 million EUR, this is one of the largest industrial contracts signed by F4E and it is expected to run for a period of approximately four years.

Given the fact that Europe is responsible for the supply of 10 out the 18 Toroidal Field (TF) coils in the ITER device, 70 radial plates will need to be manufactured in order to host the circular superconducting conductors of the TF coils in their grooves. The signature of this contract is an important milestone for Europe's in-kind contribution to ITER following the successful manufacturing of two European prototypes, known for their unprecedented size and high tolerance. The production of the components will take place in Italy (SIMIC S.p.A) and France (CNIM) in state of the art facilities.

The function and characteristics of the radial plates in the ITER device:
The ITER device will operate with a system of superconducting magnets which relies on the Toroidal Field (TF) coils, the central solenoid, the Poloidal Field coils and the correction coils. TF coils are "D" shaped coils whose core task in the ITER device is the confinement of plasma.

The radial plate is one of the components of the TF coils. This D-shaped stainless steel plate measures 13.4 m x 8.7 m x 0.12 m. The radial plate has on each side spiral round-shaped grooves which are closed by cover plates.

The superconducting conductor of the TF coils, once heat-treated and electrically insulated, is inserted into the grooves of the radial plates. In order to successfully fit the superconductor into the radial plate grooves, its trajectory must match that of the radial plate. It is for this reason that all grooves of the radial plates are machined according to the as-built trajectory of the double pancake conductor. Afterwards, the radial plate is electrically insulated and impregnated with epoxy resin, forming a so-called double pancake module. Then, seven double pancake modules are stacked, electrically connected and impregnated together to form a winding pack, the core structure of the TF coil. Finally, the winding pack is inserted in a welded stainless steel shell, known as the coil case, to form the TF coil.

Each TF coil is composed of five regular and two side double pancakes. A total of 70 radial plates will be supplied by F4E (50 regular and 20 side radial plates) for the 10 TF coils to be supplied by Europe.

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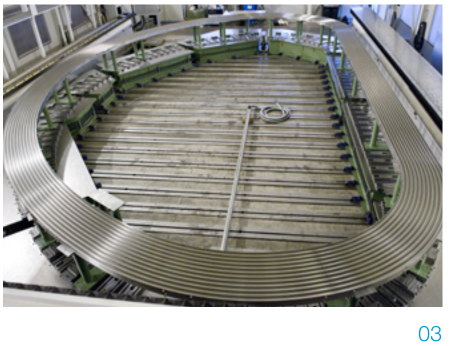

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01 Representatives of F4E, SIMIC and CNIM involved in the signature and follow-up of the radial plates contract
02 Radial plate prototype, © CNIM
03 Radial plate prototype, © SIMIC

ITER SITE INFRASTRUCTURE WORKS SET TO START

The ITER site is set to go through one of its biggest transformations with the signature of the site infrastructure works contract thanks to which a variety of civil engineering works such as lighting, drainage, special foundations, roads and trenches will be carried out. The value of contract, awarded to COMSA EMTE, is in the range of 35 million EUR and is expected to run for five years.

80 people will be deployed to the ITER site in order to ensure the co-ordination of the activities and reconfigure the 500,000 square metres that will be directly affected by the works.

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 200 people and by mid-2014 it is expected to reach a capacity of 3,000 people. One of the key challenges is to accommodate the needs of the rapidly growing workforce and guarantee an optimal use of space among the different companies operating on the ground, in order to carry out the construction of all infrastructures in parallel and on time.

Following the successful completion of the site adaptation activities, the site infrastructure works aim to interconnect all buildings and enable them to perform their functions.

The scope of the site infrastructure works contract:
The civil engineering works carried out through this contract will deliver to the ITER site a fully integrated drainage system comprising of an industrial water drainage system to collect process discharges, a precipitation drainage system to collect run-off water from all impermeable surfaces on the site and sanitary drainage to collect non-nuclear laundries, waters and wastes from the buildings.

Outdoor lighting will be installed in order to ensure occupational safety on the ITER platform and in parallel, indoor lighting will equip all buildings by means of power outlet boxes, sub-distribution panels, wiring, circuits and pull boxes. Furthermore, service trenches will be developed to host the different types of networks between buildings and installations following each particular routing.

Roads, parking and laydown areas will be built to allow cars, trucks, machines and cranes to access all buildings and installations on the ITER platform. Special foundations, mainly slabs, to support equipment and installations across the site will be constructed.

A water management system comprising of potable water for consumption, hot water for the heating of buildings and a fire protection water system will be delivered. A component cooling water network will be built to transfer heat from the systems for heat removal and it will operate side by side with the heat rejection system that will buffer heat loads during operation through an open loop system consisting of cooling towers, cold and hot basins, water pumps, valves, sensors and interconnected piping.

Site adaptation and infrastructure works in progress on the ITER site, November 2012

THE NEUTRAL BEAM TEST FACILITY IS PROGRESSING

A great deal of progress has been made for the establishment of the Neutral Beam Test Facility (NBTF) hosted by Consorzio-RFX in Padova, Italy. During the autumn, F4E awarded several procurement contracts allowing for manufacturing of necessary components to move full-speed ahead.

The Neutral Beam Injection System is one of the main F4E contributions to ITER. It is composed of two Neutral Beam (NB) injectors, essential to reach the high temperature necessary for fusion reactions to occur in the plasma. The Neutral Beam Test Facility will host the prototypes of the ITER Neutral Beam Injector, which will be tested and developed there. The NBTF will host 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 & 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 a full power (16.5 MW).

In total, three contracts have been signed during the past few months and the signing of the contract for the SPIDER Beam Source and Vacuum Vessel, worth around seven and a half million EUR, marks an especially important step as it is these components that make up the heart of the SPIDER experiment. Involving highly demanding technologies which necessitate complex assembly and tight tolerances, i.e. very exact measurements with only a small margin of error, the SPIDER Beam Source will be the first ITER full-scale ion source built in the world. The contract has been awarded to a European consortium consisting of French company Thales, German company Galvano-T and Italian companies CECOM and Zanon.

A further milestone is the signature of contract for the NBTF Cooling Plant system for which manufacturing is starting on the components that will evacuate the 70 MW of heat from the SPIDER and MITICA test beds. The contract, worth eight million EUR, has been awarded to Italian company, Delta-ti Impianti S.p.A.

The contract concerning the PRIMA Vacuum and Gas Injection Plant, worth about two and a half million EUR, has been awarded to Italian company Angelantoni Test Technologies. The contract covers the design and construction of the gas injection and vacuum plant systems which are vital for operation: the gas injector will provide the deuterium and hydrogen gas needed for the operation of the plasma, while the vacuum system will pump and therefore deter the gas from spreading and hindering the functioning of other parts of the plant where very good vacuum conditions are required.

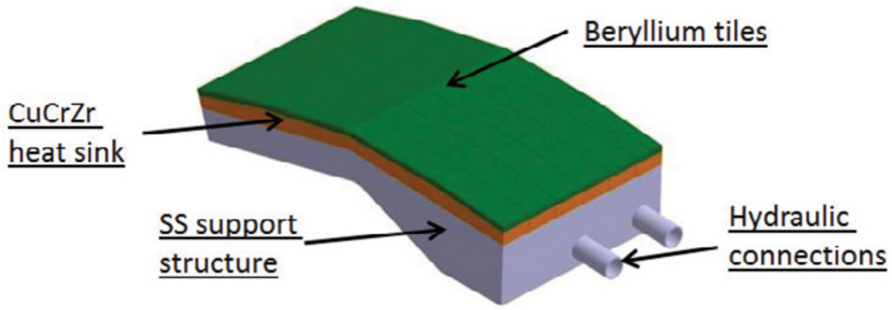
With the contract for the SPIDER High Voltage Deck and Transmission Line now in an advanced stage of its tendering and awarding procedure, the set of the main European industrial contracts for the construction of SPIDER is being completed. From 2013 onwards, the remaining European contracts for MITICA will be awarded.

In addition, the NBTF is also moving forward in a very concrete way, namely through construction: the NBTF building is currently being built. The works, which are funded by Italy in its capacity of Host State for the NBTF, include the construction of the halls which will host the MITICA and SPIDER experiments. The works are scheduled to be concluded by 2014, although the installation of some of the sub-systems will be possible starting from September 2013.

Progress on the NBTF site: The construction of buildings is moving ahead

F4E SIGNS CONTRACT FOR FIRST WALL PANEL SEMI-PROTOTYPES

F4E has signed a contract for the manufacturing of a semi-prototype for first wall panels. The contract encompasses the manufacturing of one Blanket first wall panel semi-prototype component containing beryllium parts for which some of the critical technologies are only developed by a few European companies.



The use of beryllium in the first wall panel semi-prototype necessitates a rare specialised technology

The signing of the contract with a consortium consisting of Iberdrola Ingeniería y Construcción S.A.U. (Spain), AMEC Nuclear UK Ltd (United Kingdom) and Mecánica Industrial Buelna, S.L. (Spain), marks a positive milestone in F4E's efforts to encourage European industry to develop their know-how in this specialised field of technology and widen the pool of available competence.

So what are first wall panels? They are 1m x 1.5 m detachable elements which together with the shield block (a block of stainless steel on which the first wall panels are fixed) form the Blanket. The Blanket is the part of the ITER machine that acts as a first barrier and protects the vacuum vessel which is the heart of the ITER machine, from the neutrons and other energetic particles that are produced by the hot plasma. The First Wall consists of 440 panels, of which F4E will provide about half. Depending on the location of the modules in the Blanket, different design parameters are necessary. F4E is providing the Normal Heat Flux panels (the Enhanced Heat Flux panels will be provided by the Chinese and Russian Domestic Agencies). Normal Heat Flux panels are designed to withstand heat fluxes of up to 2 MW per m^2, whereas Enhanced Heat Flux panels can withstand heat fluxes up to 4.6 MW per m^2. The panels are made up of beryllium tiles which are bonded with a copper alloy and stainless steel using Hot Isostatic Pressing (HIP), a method that involves pressure generated by gas in order to compress the metals together homogenously from every direction. The use of beryllium in the manufacturing necessitates a specialised technology which is only carried out by a handful of European companies.

In order to minimise fabrication risks, it was decided to proceed step by step towards the fabrication of the series of panels, i.e. introducing the fabrication of semi-prototypes first and then manufacturing full-scale prototypes before focusing on the manufacturing of the actual panels to be used in the ITER machine. The semi-prototypes manufactured under the scope of this contract, will be one-sixth of the size of the actual panels. Fabrication is scheduled to start in February 2013 and work will be concluded in the first quarter of 2014. Following the completion of the semi-prototypes, the next step will be to produce a full-scale prototype, for which a tender will be launched during the first half of 2013. The contract for the series of panels to be used in the ITER machine will be placed in 2015.

F4E SIGNS CONTRACT FOR THE SUPPLY OF ITER PRE-COMPRESSION RINGS

F4E and EADS CASA Espacio have signed the contract for the supply of nine Pre-Compression Rings (PCRs), including three spares, that will support the ITER machine's magnet system. The total budget of the contract is in the range of 12 million EUR and it is expected to run for approximately four years.

The key function of PCRs is to reduce the fatigue of the ITER machine's magnet structures from the powerful electro-magnetic forces and consequently prolong their operation from ten to over twenty years. The signature of the PCRs contract marks another European milestone that will deliver the largest composite structures ever built for operation in a cryogenic environment. The work will be carried out in a centre of excellence located in Spain, which has a proven track record in the field of composites for space applications.

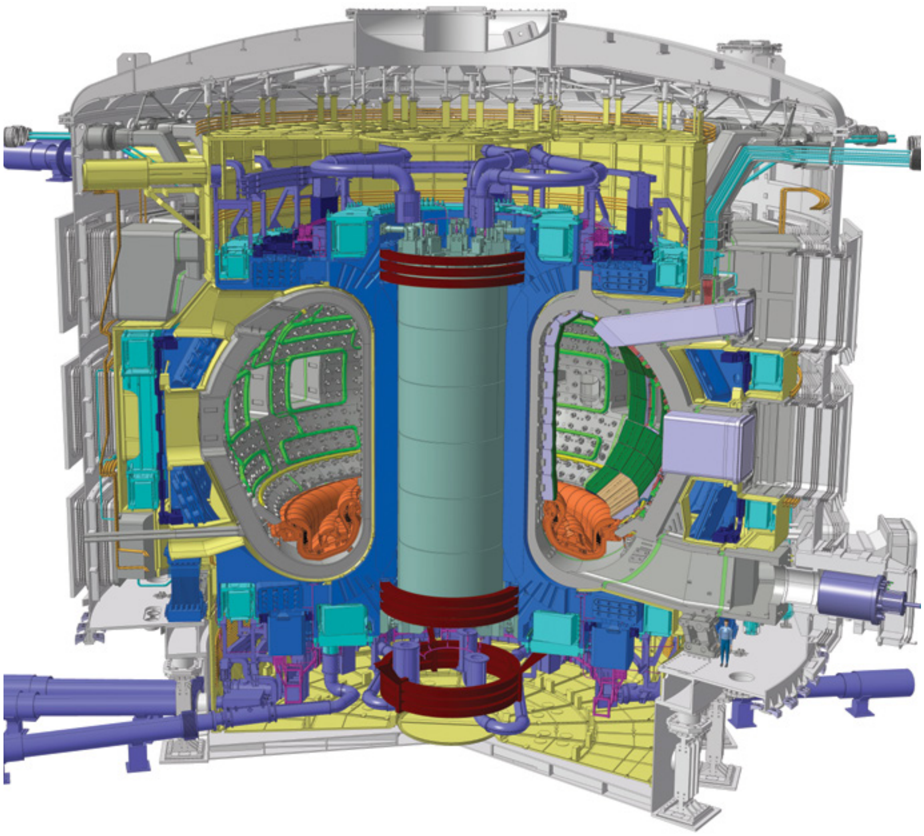
The function of PRCs in the ITER machine:

The ITER machine will operate with a system of superconducting magnets which relies on the Toroidal Field (TF) coils, the central solenoid, the Poloidal Field coils and the correction coils (see ITER image).

TF coils are "D" shaped coils whose core task in the ITER device is the confinement of plasma. PRCs are the keystones of the TF coils system and will be assembled to the top and bottom of TF coils in order to prevent them from deforming when the powerful magnetic field is created.

The size of the PCRs, their assembly and maintenance:

The basic design relies on 5 m diameter fibreglass composite rings with a cross section of about 300 mm x 300 mm. Three PCRs will be installed and loaded at the top and three at the bottom of the TF coil system and will apply a centripetal force equivalent to that of 3,000 tonnes on the top and bottom of each TF coil reducing their overall constraints.



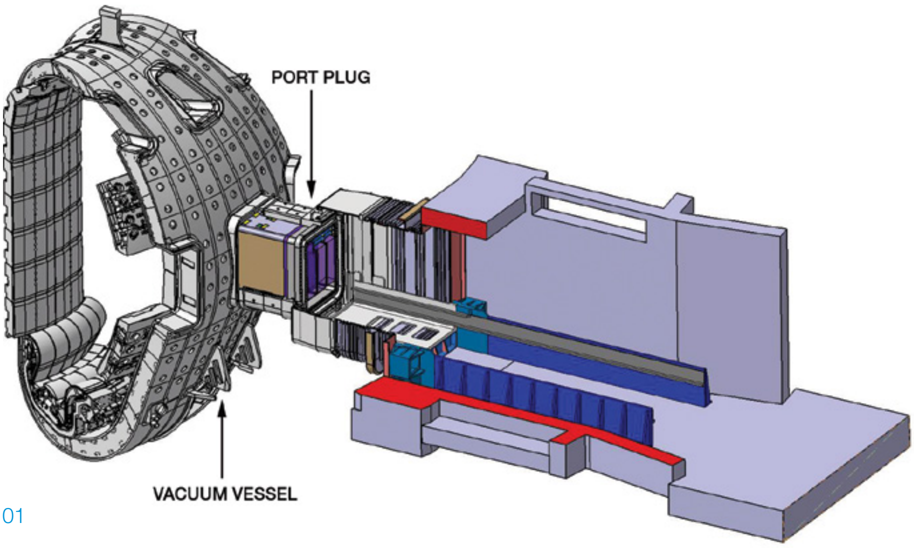
In order to avoid the circulation of electrical currents and withstand high loads, the PCRs will be manufactured of fibreglass composite, where in every cross section nearly a billion of miniscule glass fibres will be glued together.

Their load will need to be maintained for the entire 20 years of ITER operation, while accommodating thermal shrinkages during cool-down/warm-up, cyclic forces, settlements and unexpected motions. Due to the limited access to carry out in-service inspection of the PCRs, in case there is a need for the replacement of the lower PCRs, it will be carried out by using one or more of three spare rings made available below the Tokamak in the cryostat.

ITER Cryostat cutaway image highlighting in red the nine Pre-Compression Rings

F4E'S DIAGNOSTICS FRAMEWORK PARTNERSHIP AGREEMENT SIGNED FOR THE ITER PLASMA POSITION REFLECTOMETRY

F4E's Framework Partnership Agreement (FPA) for the design of Diagnostic components for the ITER Plasma Position Reflectometry is signed. Amounting to 3.5 million EUR for a period of up to four years, the FPA has been awarded to a consortium consisting of three EURATOM associations: Instituto Superior Técnico (IST), from Portugal; Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), from Spain; and Consiglio Nazionale delle Ricerche, Istituto di Fisica del Plasma "Piero Caldirola" (IFP-CNR), from Italy.



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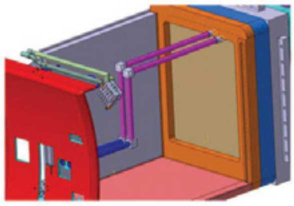

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01 The Plasma Position Reflectometry antennas and waveguides which launch and receive the radio frequency signal to measure the plasma density profile. © ITER International Organization

02 The Plasma Position Reflectometry antennas and waveguides which launch and receive the radio frequency signal to measure the plasma density profile. © ITER International Organization

The FPA concerns the design of the Plasma Position Reflectometry components (antennas, waveguides, microwave electronics and real-time analysis software) for the Diagnostics systems. The antennas and waveguides launch and receive a radio frequency signal in the range 15-75 GHz which is assessed by microwave electronics and real-time analysis software to determine the density profile at the plasma edge and the distance between the plasma and tokamak wall. Control of the plasma density profile is important in order to keep the plasma stable and prevent it from touching the wall, leading to a plasma disruption which would stop the fusion process.

So what exactly is a Framework Partnership Agreement (FPA)? It establishes a long-term collaboration (for up to 4 years) with a beneficiary or consortium (i.e. group of beneficiaries). The Agreement defines a set of rules (i.e. a framework) for conduct of the work; with the work itself performed under separate specific grants agreements. The FPA is well-fitted to projects requiring mostly R&D and design and where the design is at its first stages. It is ideal for Diagnostics, where designs are usually 'first-of-a-kind' and require a large, specialised design base and need long continuity of the design team. A further advantage of the FPA is that it enables F4E to have stronger project management roll, to steer the work and to develop a better collaboration with the recipient of the Agreement.

The FPA for the design of Diagnostic components for the ITER Plasma Position Reflectometry covers R&D, engineering, quality support and managerial activities, and testing from functional specifications, up to the supply of an F4E-approved final design. It will bring together the work of some 30 physicists and engineers per year.

THE LATEST PROGRESS FROM THE ITER SITE

On the ITER platform, work is progressing well on the Assembly Hall of the Tokamak complex area.
This 57 metre high building, located next to the Tokamak pit, will host the two 750 tonnes cranes that will assemble the components of the ITER machine.

On 20 September 2012, the first structural concrete was poured in one of the three galleries by GTM (VINCI Group contractor). It was considered a big step forward linked to the foundation works.

It all started back in April 2012, where 500 boreholes (soil investigations to detect any void in the rock) preceded the impressive phase of excavation. Scrapers and shovels dug to 2.5 metres deep to extract close to 12,000 m^3 of soil. During summer, the blinding concrete pouring activities kicked off in order to flat level the surface and make way for the reinforcement activities that will end up using 1,400 tonnes of steel! The foundations works are expected to end by March 2013.

The basemat design, measuring 2.2 metres thick in the perimeter and 1.2 metres thick in the centre, integrates openings for electrical galleries, drainage, piping and tunnels that will be connected to the Tokamak complex building. According to Miguel Curtido, F4E's Technical Project Officer, "It will be the first time that we will have to coordinate the work of two contractors working in parallel and very close proximity in order to be comply with our planning". In fact, other tunnels and precipitation drainage activities will be performed in parallel with works on the Assembly Hall foundations. "Good coordination will be one of the daily challenges for the next years due to the complexity of the project and our commitment to deliver on time", he added.

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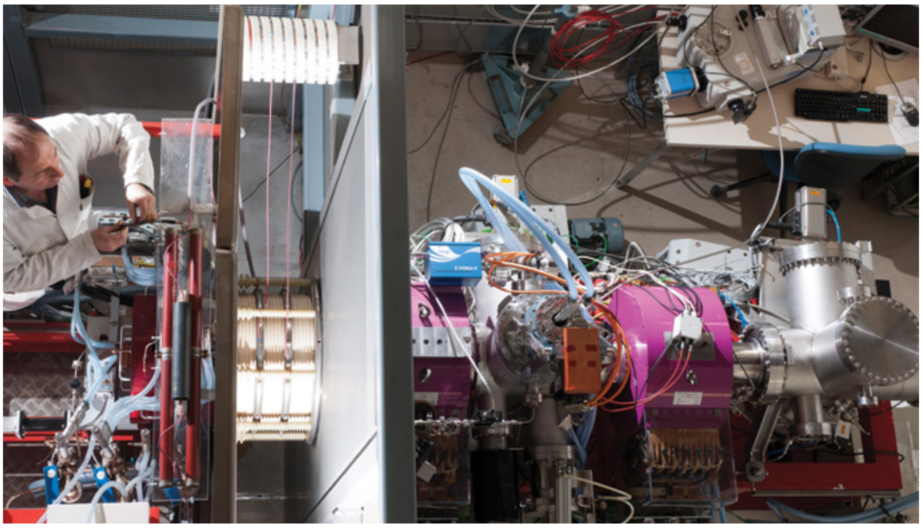
01 Progress of the work at the contractors' area on the ITER site, November 2012

02 Panoramic view of Assembly Hall area of the Tokamak complex, October 2012

IFMIF/EVEDA ACCELERATOR (LIPAC) INJECTOR PASSES ACCEPTANCE TESTS

For three days, from 19 to 21 November 2012, all eyes of the CEA team and representatives of JAEA and F4E were riveted to the measurement devices in the small control room of the IFMIF Injector at CEA/Saclay during the acceptance tests of the injector. This is the first component of the Linear IFMIF Prototype Accelerator (LIPAc) presently under construction, under the framework of the Broader Approach Agreement, aiming to demonstrate the feasibility and to develop the technology for IFMIF.

The injector has to deliver a high intensity and low emittance deuteron beam (140 mA, 100 keV) with high reliability. The ion source is based on an electron cyclotron resonance (ECR) cavity, excited by a 2.45 GHz magnetron. The extracted beam must be properly matched to the entrance of the downstream component (Radio Frequency Quadrupole) by means of a dual solenoid focussing scheme in the Low Energy Beam Transport (LEBT) line. In order to meet the beam emittance and matching requirements, the strong space charge must be very well compensated by a dense electron cloud produced by interaction of the deuteron beam with the residual gas all along the HEBT line.



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An experimental programme had been carefully established to increase gradually the performance of the high intensity LIPAc Injector. On the first day, a proton beam was produced at low duty cycle by injection of hydrogen gas in the plasma chamber of the ECR source. On the two following days, by switching from hydrogen to deuterium, the deuteron beam was produced and the duty cycle was smoothly ramped up from 10% to 100% (continuous beam). Meanwhile, all parameters were adjusted (magnetic configuration in the plasma chamber, gas flow rate, voltage of the extraction electrodes, HEBT solenoid field, etc) in order to optimise the current and the beam emittance at the exit of the beam line. A current of 140 mA with an energy of 100 keV was achieved (resulting in a total current of more than 170 mA due to the additional molecular species D2 and D3). The emittance was within the range of the specification (0.2 to 0.3 pi mm.mrad) but could not be measured at full duty cycle as the present emittance scanner could not sustain such a high beam power (14 kW).

After this successful test campaign, the injector has proven its ability to produce a high intensity continuous deuteron beam (world record) with high quality, and is ready to be dis-assembled, packed and shipped to Rokkasho in Japan with an expected arrival at the end of March 2013. It will be the first accelerator component of the Linear IFMIF Prototype Accelerator to be installed and commissioned in the accelerator building of the Rokkasho Broader Approach site.

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01 The Injector at the CEA/Saclay facilities (left: ECR ion source; right: Low Energy Beam Transport line). © P. Stroppa/CEA

02 CEA Injector team and representatives of JAEA and F4E in the control room at CEA/ Saclay during the acceptance tests

WORLD'S LARGEST TEST FACILITY FOR NEGATIVE ION SOURCES OPENS TO DEVELOP HEATING FOR ITER

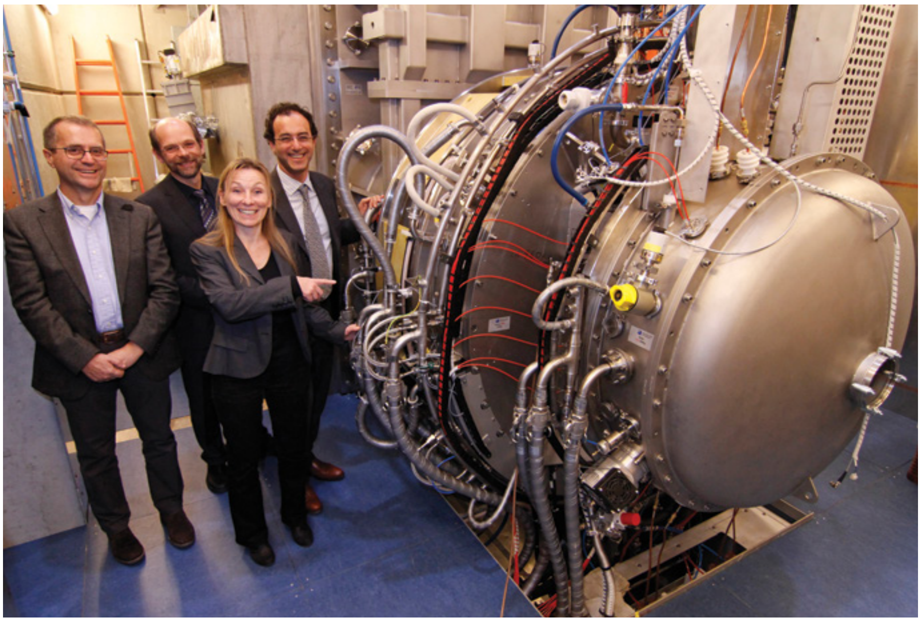
The half-size test facility of the ITER Neutral Beam ion source, ELISE (Extraction from a Large Ion Source Experiment), has been inaugurated at the Max Planck Institute for Plasma Physics (IPP) in Garching, Germany.

ELISE is a key experiment in conducting research to develop one of the main heating systems of ITER – the neutral beam injector – which will contribute heating the plasma to million degrees necessary for a fusion reaction to occur. ELISE is funded by F4E by means of a contract worth about 4 million EUR and coordinated at a technical level by Dr Antonio Masiello of F4E's Neutral Beam and EC Power Supplies and Sources project team.

Today's existing neutral beam devices can contribute to reaching temperatures which are a fraction of that of the sun. However, new and more demanding requirements on the hydrogen atoms being injected into the plasma and transferring their energy to the plasma through collisions, will need to be used when operating ITER. Indeed, the ITER machine will necessitate that the particles are about one order of magnitude faster so that they can penetrate deep enough into the voluminous plasma in order to heat it. Instead of the electrically positively charged ions used to accelerate the particle beam (the beam used to inject the hydrogen atoms), ITER will use extremely fragile negatively charged ions. A prototype for a new type of source in which the ions are generated by a Radio Frequency (RF) electromagnetic field was firstly developed at IPP for this purpose. The successful experiments carried out on the prototype led to a change in 2007 of the ITER baseline design: the so-called "arc driven" ion source (in which the ions were generated by means of an electric discharge) was replaced by the more promising RF source. The ELISE test facility was then conceived as an intermediate step in order to adapt the prototype to match ITER's requirements.

As the world's largest system of its kind, ELISE has taken three years to be assembled. The system's core is uniquely comprised of 640 ion beamlets, making up one beam which has an intensity of up to 20A and with energy up to 60keV. The overall beam has an area of approximately 1 m^2 and can reach 1.2 MW of power. Each of the two foreseen Neutral Beam systems for ITER will deliver 16.5 MW heating power to the plasma. ELISE represents therefore a significant improvement from the previously operating devices whose beam size is approximately one order of magnitude smaller.

Now that ELISE is inaugurated, IPP researchers will spend the next two years studying whether the new ion source can generate a particle beam approaching ITER's requirements. The experiments on ELISE are extremely important to give new insights for the construction, assembly and operation of the next step devices, such as the full-size prototype of the ITER source, SPIDER, which will start operation in 2015 at the Consorzio RFX research institute in Padova, Italy.



From left to right: Tullio Bonicelli, F4E Team Leader – Neutral Beam, Bernd Heinemann, IPP Team Leader – Neutral Beam, Ursel Fantz, ELISE Division Head of ITER Technology, and Antonio Masiello, F4E Technical Responsible for the ELISE contract, inaugurate the ELISE test facility.

KEY COMPONENTS DELIVERED TO THE JT-60SA COIL TEST FACILITY IN SACLAY

A convoy of trucks carrying Belgium's voluntary contribution to the Broader Approach, left on 17 September from the headquarters of ALM in Liège and crossed the French frontiers in order to deliver several key components to the Toroidal Field (TF) coil test facility of the Commissariat à l' Energie Atomique et aux Energies Alternatives (CEA) in Saclay. Getting the cryostat to the facility was challenging and required the removal of many traffic signs along the way.

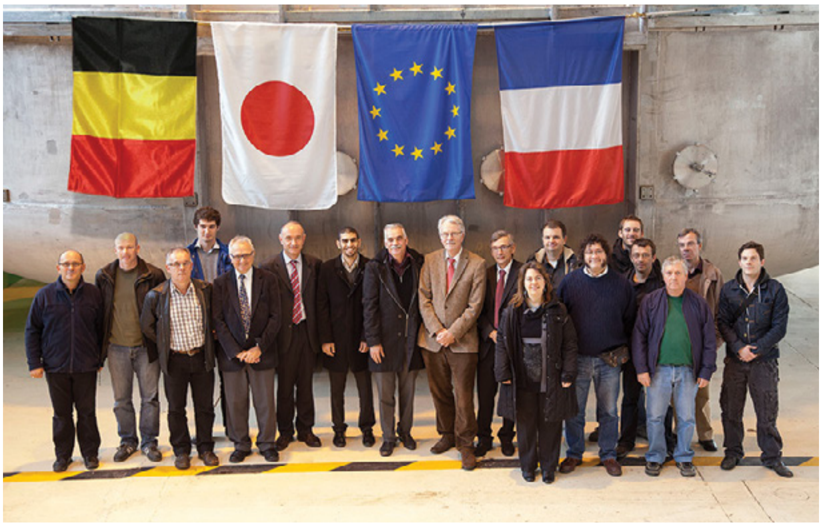
The delivery was comprised of a large vacuum vessel (cryostat) measuring 11 metres long, 7 metres wide and 5 metres high with an integrated liquid nitrogen shield, three cryogenic supports for handling and operating the TF coils in the cryostat, several handling tools, a vacuum system to provide the insulation vacuum, and a valve box vessel as the interface between the helium refrigerator and the cryostat.

The role of the cryostat is to provide thermal insulation for the TF coils when they are cooled close to absolute zero and powered with a current of 25.7 kA.

On 21 September the JT-60SA Project leader Shinchi Ishida visited CEA to witness the arrival of the components. The delivery of the test cryostat, together with the test frames and the valve box vessel mark an important milestone for the set-up of the TF coil test facility.

CEA Saclay with support by CEA Cadarache has taken the responsibility of setting-up the complete test facility to perform the cryogenic tests with the TF coils. The 18 TF coils plus a spare coil are part of the joint contribution between CEA and L'Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile (ENEA) and are currently being manufactured.

The CEA Saclay test team, drawing on its experience from similar tests of superconducting coils for the W7-X project, will use part of the equipment from the previous tests.


01


02

01 Representatives of the Broader Approach project with CEA management
02 The valve box vessel

INSPIRING YOUNG STUDENTS TO CHOOSE FUSION AS A CAREER

As part of the activities organised during the Catalan week of Science, F4E's technical expert Jesus Izquierdo, promoted the work of F4E and gave a real insight into what it could be like to work as a scientist or engineer. The audience, several classes of young Catalonian students currently deciding what university studies to choose, proved to be an inquisitive and appreciative audience who were eager to learn more.

A nuclear engineer by training and with a strong background in fusion, Izquierdo's presentation featured clips from films where fusion is part of the story line, such as Matrix and the Batman film, the Dark Knight. "It was especially fun to explain what a scientist or an engineer working at F4E does and the challenges we face", he says. "The kids were both impressed and enthusiastic about working at F4E when I told them about all the different nationalities we have working here and the internationality of the ITER collaboration with seven global parties involved. It is true that they were particularly attentive because their teachers had prepared them in advance by presenting the topic to them before my presentation, but as curious young people they were already very knowledgeable about energy shortage issues, the necessity to create efficient energy and environmental issues linked to energy consumption."

The Catalan week of Science is a yearly event which involves pupils at high schools participating in science and engineering activities. Spearheaded by the Catalan government some ten years ago, the idea is get young people interested in science and engineering and to promote these subjects as possible areas of interest when students have to choose focus for further studies. Around 350 different activities – conferences, courses and workshops – were organised in 60 different locations in Catalonia during one week in late November. This year's edition featured three different themes: sustainable energy, neuroscience and active ageing.

F4E's technical expert Jesus Izquierdo got Catalonian youth excited about choosing a career in science or engineering

UK COMPANIES LEARN MORE ABOUT F4E BUSINESS OPPORTUNTIES

A total of approxiamately 90 UK companies came together at the "Business Opportunities for UK plc from Fusion & ITER" one-day event organised by the UK Atomic Energy Authority and the Central England Branch of the Nuclear Institute at Culham Science Centre.

Representatives from F4E were on hand to explain the procurement process and procurement opportunities that are arising from the construction of ITER in terms of engineering expertise. Additional F4E presentations focused on technical requirements for the ITER machine, in particular remote handling, projects related to buildings and infrastructure on the ITER site, as well as the Neutral Beam and electron cyclotron power sources. In order to establish a more personal, interactive contact, UK companies were also given the opportunity to have 1:1 meetings with F4E's Business Intelligence staff in order to clarify questions and gain further understanding.

Feedback from event participants and co-hosts was positive and the event was deemed successful.

The programme and presentations of the event can be accessed on F4E's Industry and Associations Portal.

Anthony Courtial, F4E Business Intelligence, was on hand to inform UK participants of potential procurement opportunities

F4E HOSTS THE BLANKET INTEGRATED PROJECT TEAM MEETING

The Blanket Integrated Project Team (IPT) quarterly meeting was hosted by F4E on 24-25 October. This 39th meeting gathered the Integrated Project Team for the ITER blanket which consists of ITER IO representatives and the other relevant Domestic Agencies from China, Japan, Korea, Russia, United States as well as F4E in order to work together and share information on the design and activities of the Blanket project. The Blanket is the part of the ITER machine that acts as a first barrier and protects the vacuum vessel, the heart of the ITER machine, from the neutrons and other energetic particles that are produced by the hot plasma.

F4E is responsible for the supply of about 50% of the ITER first wall panels of the Blanket (Russia contributes 38% and China the remaining 12%), which encompasses 218 panels. Each panel consists of a stainless steel support structure bonded to a heat sink material and beryllium tiles. The heat sink material is made up of a copper alloy which transfers the heat generated from the plasma to the water coolant, while the beryllium tiles act as an interface for the plasma. The use of metallic beryllium is especially suitable because, thanks to its low atomic number, even though the temperature will be high, it will limit the contamination of the plasma. F4E also contributes with the manifolds, the stainless steel piping system used to bring cooling water to the inner in–vessel components. The series fabrication for the first wall panel will start in 2015, and the procurement for the manifolds in 2014.

Among 30 participants, in addition to F4E staff, attended the meeting which was deemed a success as it enabled work to advance and communication to be enhanced. Side meetings were also organised in order to further progress on the specific areas of the design.

Participants from ITER IO, the Domestic Agencies in China, Japan, Korea, Russia, United States, and F4E attended the BIPT quarterly meeting

CZECH INDUSTRY ENTHUSIASTIC OVER F4E BUSINESS OPPORTUNITIES

The previous work invested in encouraging Czech companies to be potential bidders for F4E's Calls for Tender is starting to show results: the annual industry event for 2012, organised by F4E's Czech Industrial Liaison Officer (ILO) Karel Cervenka, brought together a significant number of relevant Czech industry representatives.

Gathered in Prague's Technology Innovation Centre, the some 40 delegates showed a high interest for the presentations about the ongoing and future F4E Call for Tenders and the work of F4E. The meeting participants have particular know-how in certain ITER relevant materials such as stainless steel grades so F4E's technical expert, Stefan Wikman, held a special presentation about the materials used in the ITER machine, including detailed examples of their necessary design qualification and the stringent ITER requirements.

F4E strives to encourage European industry to answer F4E Calls for Tender for ITER components and interaction with the Czech companies during the meeting suggest that this will indeed be the case. Representatives from several Czech associations and research centres which specialise in areas such as mechanics, nuclear engineering and software, also attended the meeting and enthusiastically took in information on how to apply for F4E grants.

The Czech delegates showed a high interest for the presentations about the ongoing and future F4E Call for Tenders and the work of F4E.

FRENCH GOVERNMENT GIVES ITER CONSTRUCTION THE OFFICIAL GO-AHEAD

On Saturday 10 November, France's Prime Minster Jean-Marc Ayrault signed the official decree authorising ITER International Organization (ITER IO) to proceed with ITER's nuclear installation.

The go-ahead marks an important milestone in the roadmap of the biggest international research project in the field of energy because it validates the enormous amount of work undertaken by ITER IO during the last years to guarantee compliance with strict safety, quality and security standards. In the course of this process, F4E and EFDA contributed by means of different studies addressing various aspects of safety.

This is the result of a long and complex chain of interactions with local populations, policy makers, independent experts and the French Nuclear Safety Authority. ITER is the first fusion facility that qualifies as a nuclear installation.

And while policymakers are evaluating different energy alternatives and try to tame the size of the carbon footprint emitted by their countries, this positive development can also be seen as the expectation that one day fusion energy can play a role in Europe's sustainable energy mix.

Works in progress at the ITER Tokamak Assembly Hall, October 2012

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

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For free subscriptions, please specify your requirements via e-mail: press@f4e.europa.eu

Printed in Belgium on chlorine-free paper
ISSN 1831-5887

FU-AB-12-003-EN-C