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FUSION FOR ENERGY

HIGHLIGHTS 2021

THE MAIN ACHIEVEMENTS

2021
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FOREWORD

Imagine if we could create a small Sun on Earth as a virtually inexhaustible and clean energy source – and although this may sound like science fiction, it is the ultimate mission of Fusion for Energy ("F4E").

We are the main contributor to ITER – an international project to build and operate the largest research machine to create solar fusion. In parallel, we are collaborating with Japan on three smaller fusion projects to improve our technical know-how.

For F4E, 2021 was a very difficult year as a member of our staff, Mario Gagliardi, tragically took his own life. The pain of this unimaginable loss for his family, friends, and colleagues was deeply felt inside our organisation.

We also continued to face challenges due to the ongoing Covid-19 pandemic. I am very proud of how both our staff and our industrial partners coped and kept on delivering as this report demonstrates. Some highlights include:

- After ten years of intensive work, we transferred the responsibility of the buildings site coordination from F4E to the ITER Organization. We also delivered all 46 heavy nuclear cell doors to the ITER Organization each weighing around 70 tonnes.
- We manufactured four superconducting Toroidal Field magnets (making a total of seven), of which three were delivered to ITER Organization. This is the result of several complex technical operations involving more than 30 EU industrial partners.
- We manufactured and delivered the first three Poloidal Field magnets of up to 17 metres in diameter. The two largest coils were manufactured by F4E in our factory on the ITER site and a third smaller coil in China under contract with F4E.
- We entered the final assembly phase for the first EU Vacuum Vessel sector that stands 11 metres tall and weighs over 5000 tonnes, albeit behind the planned schedule, due mostly to difficulties with the complex welding procedures.
- We successfully tested the First Wall Panels at high heat loads and started series production with two industrial partners for the 215 panels that Europe is providing.
- After installation of the Liquid Nitrogen Plant and Auxiliary systems, F4E completed most of the pre-commissioning tests and successful commissioning of the first sub-system.
- We fabricated and successfully tested prototypes of the MITICA neutral beam source. We also assembled and aligned the first stage of accelerator that is eventually planned to operate at one megavolt and power of up to 16.5 megawatts.
- We delivered the first batch of 150 Inner Vessel Coils that will be used as a Diagnostic System to enable scientists to determine the properties of the plasma inside the ITER machine.
- We started the second phase of the Broader Approach fusion projects with Japan, after having successfully completed most objectives of the first phase.
- Together with our Japanese partners, we commissioned the JT-60SA Satellite Tokamak in Japan and successfully energised the EU-supplied superconducting Toroidal Field magnets.
- We upgraded a prototype accelerator LIPAc for testing fusion materials. We were able to produce a low intensity proton beam, accelerate it, and transport it in line with the requirements.

We signed new contracts with industrial partners and laboratories for a total of €240m in 2021 bringing the total investment made by F4E into European industries and research organisations since 2007 to almost €5.5bn helping to create jobs and support innovation.

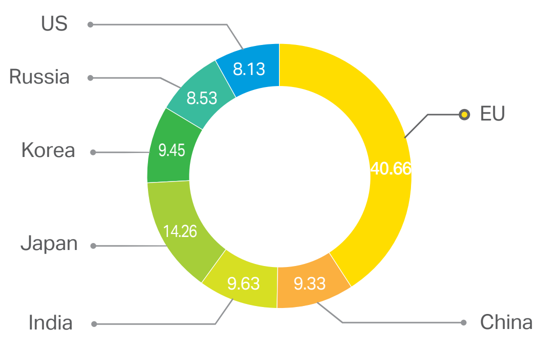
We continue to make internal improvements at F4E, and staff well-being had a renewed focus in 2021 following the tragic event mentioned above. Among a range of actions, we conducted a psychosocial risk assessment survey across the whole organisation and initiated a change agenda involving and engaging our staff.

I would like to conclude by thanking our staff and the teams of our industrial partners for their dedication, resilience, and hard work under those challenging circumstances. I hope you will find out more about our achievements during 2021 through this publication.

Johannes P. Schwemmer
Director

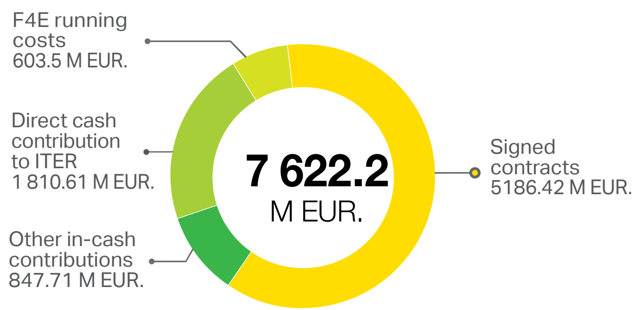
2021 KEY FIGURES

Contributions to ITER



Total contributions in percentages, between the different ITER parties 2007-2021

F4E budget breakdown



Budget breakdown of F4E main activities 2007-2021

Contracts with Industry and Laboratories

€239m
Total value of contracts signed in 2021

€5.1bn
Total value of contracts signed 2007-2021

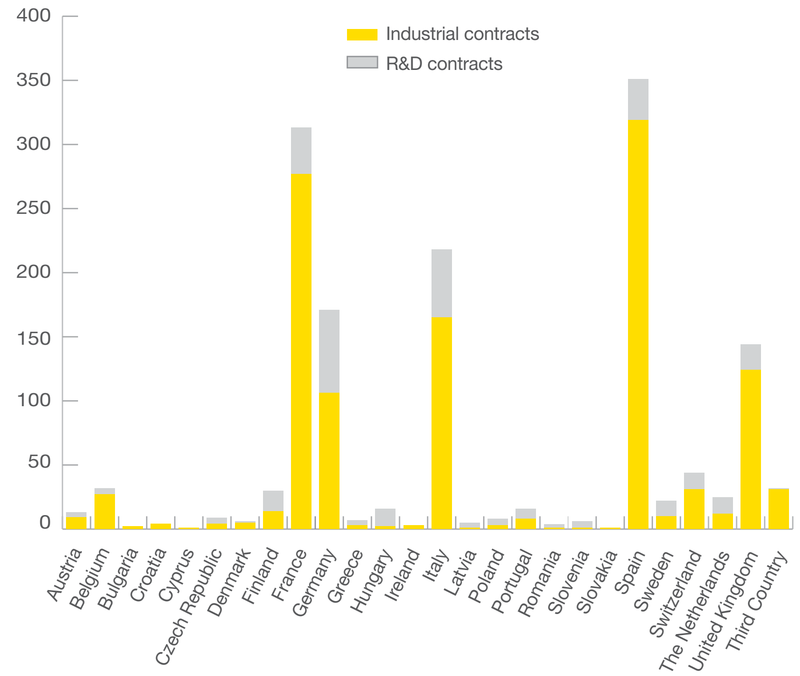
1165
Contracts signed since 2007

565
Companies

1700
Subcontractors

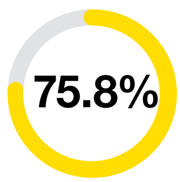
73
Research Organisations

Geographical distribution

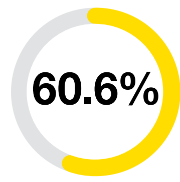


Contracts and grants awarded by F4E 2008-2020

ITER Project Progress



Completion towards ITER First Plasma



Completion beyond ITER First Plasma

SOME OF THE F4E ACHIEVEMENTS DURING 2021

January

F4E launches Technology Transfer Award. Europe and Japan develop tools to follow up LIPAc.

February

Ansaldo Nucleare, Mangiarotti and Walter Tosto prepare for assembly of Europe's first vacuum vessel sector. F4E starts testing two prototypes of bolometer sensors.

March

ITER Cryoplant passes pressure tests. F4E, NIER and UNIBO develop JADE software to improve quality of data in fusion. First-of-a-kind high-resolution encoder developed to view inside the vacuum vessel.

April

Europe concludes Pre-Compression Rings contract. ITER's sixth Poloidal Field coil inserted in the Tokamak pit. F4E chooses VR4Robots software for Europe's remote handling system.

May

HELCZA facility ready to test In-Vessel components. MITICA cryopump cryopanels completed. F4E smartglasses ready to perform remote inspections.

June

Nearly 80% of buildings and infrastructure for ITER's first plasma operations completed. Feedthrough prototypes pass tests successfully. F4E ready to prove fabrication method of Test Blanket Modules.

July

Manufacturing of ITER Torus and Cryostat cryopumps starts. VACT-TRON receives F4E Technology Award. Final assembly of Europe's vacuum vessel sector starts.

August

Equipment in progress to measure plasma facing components. Metrology experts use photogrammetry to check massive ITER components.

September

EU Energy Commissioner visits ITER. Successful operation for LIPAc accelerator. Diamond discs in production. First ITER Cryopump components ready.

October

All ITER Divertor Cassette contracts signed. Commissioning of ITER Cryoplant begins. Design of Collective Thomson Scattering system completed.

November

Painting works completed in ITER Tokamak building. First batch of vacuum vessel magnetic sensors delivered. F4E contributes to COP-26 key publication and Barcelona Energy Days.

December

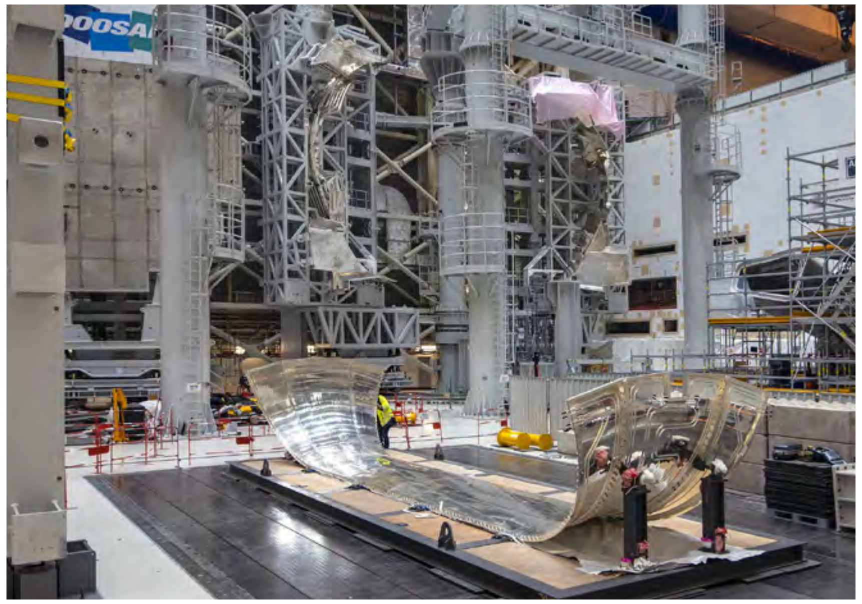
Another European magnet goes through cryotests. Last Toroidal Field coil winding pack heads for final manufacturing. More progress for MITICA beam line components.

SOME OF THE ITER ACHIEVEMENTS DURING 2021

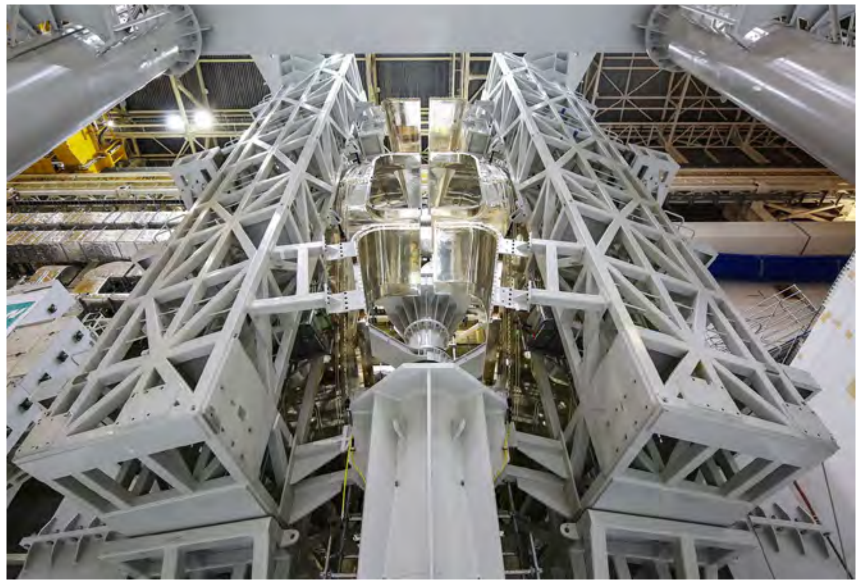
All images provided by ITER Organization

ITER Organization

The ITER Assembly and Construction teams successfully lift the cylindrical lower cryostat thermal shield to get inserted in the Tokamak pit, January 2021 © ITER Organization



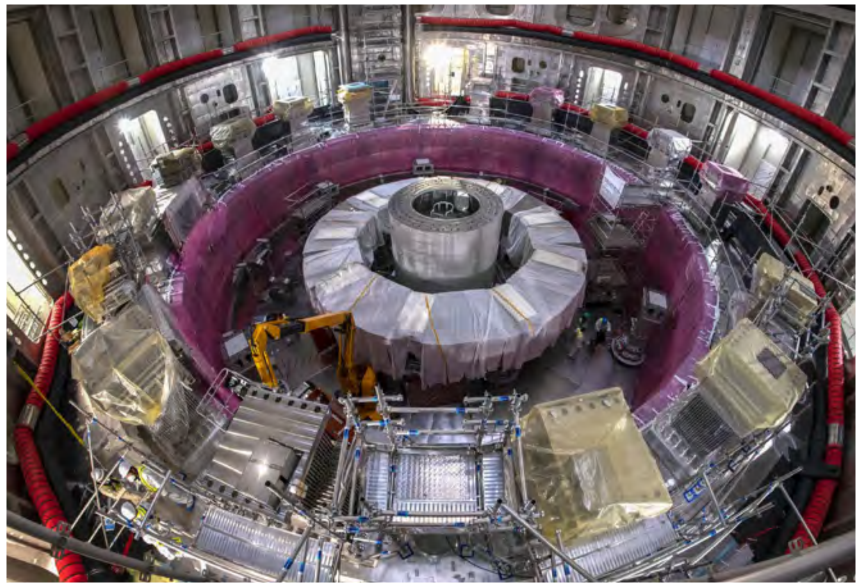
The inboard shielding element for sector 6 of the vacuum vessel sector, prepped in a laydown area in the Assembly Hall, January 2021 © ITER Organization



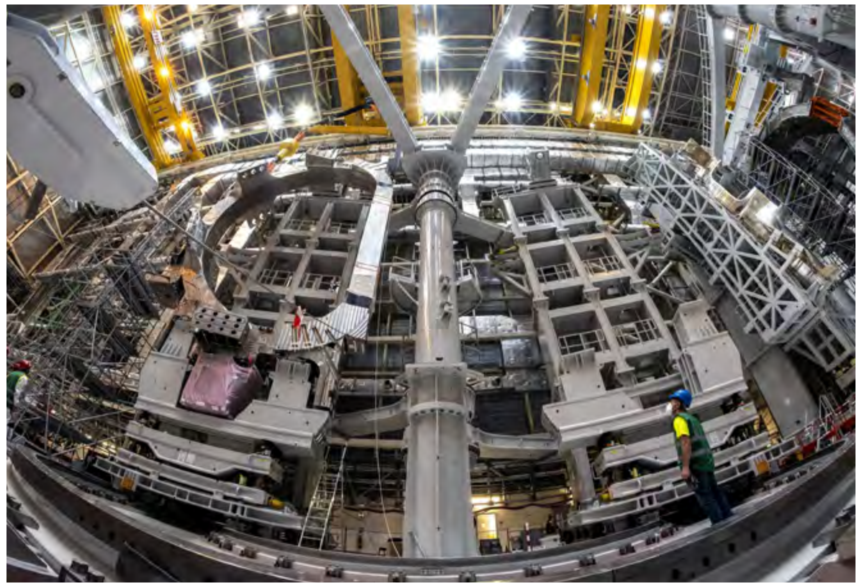
Thermal shield fitting tests carried out on sector sub-assembly tool 2, February 2021 © ITER Organization

A 90° tilt in mid-air for the first vacuum vessel sector upended, March 2021 © ITER Organization

Sector 6 of the ITER Vacuum Vessel, supported by a radial beam above, safely docked in the sector sub-assembly tool, April 2021 © ITER Organization

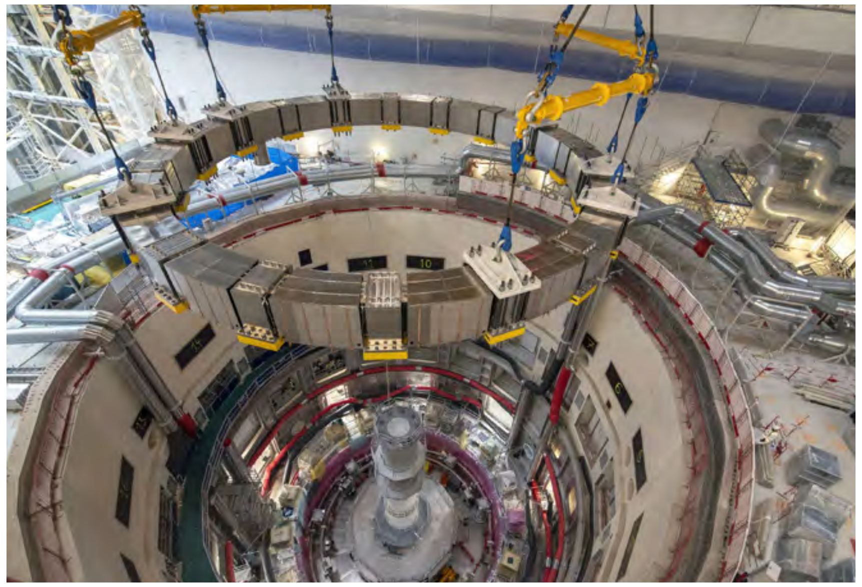


ITER machine assembly advancing. Cryostat lower cylinder, Poloidal Field coil 6 and its temporary supports, central column bottom cylinder, gravity supports positioned. June 2021 © ITER Organization



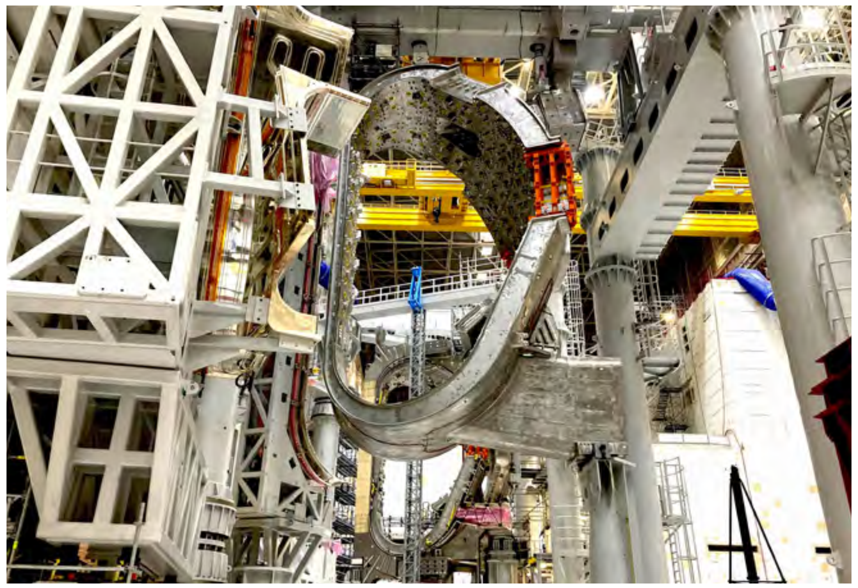
First Toroidal Filed coil positioned on tool, June 2021 © ITER Organization

ITER assembly advancing. Tool capable of supporting a vertical vacuum vessel sector (440 tonnes, centre) and two toroidal field coils (2 x 350 tonnes, left and right). September 2021 © ITER Organization



Another magnet to be installed in the Tokamak pit. Poloidal Field coil 5, procured by Europe, lifted 35 m above its final position. September 2021 © ITER Organization

Lowering of correction coil 4 in the Tokamak pit. The space between Poloidal Field coil 5, Poloidal Field coil 6, lower magnet feeders, and staging platforms does not exceed 25 mm. October 2021 © ITER Organization



Second vacuum vessel sector positioned on assembly tool, December 2021 © ITER Organization

The 30-metre-deep Tokamak pit ready to receive its first 40-degree vacuum vessel section. The central column, equipped with ladders and access ports, will be used to reach different levels of the emerging torus. December 2021 © ITER Organization

Japan

Factory acceptance testing concluded successfully for the four gyrotron units required for ITER's First Plasma. May 2021 © QST

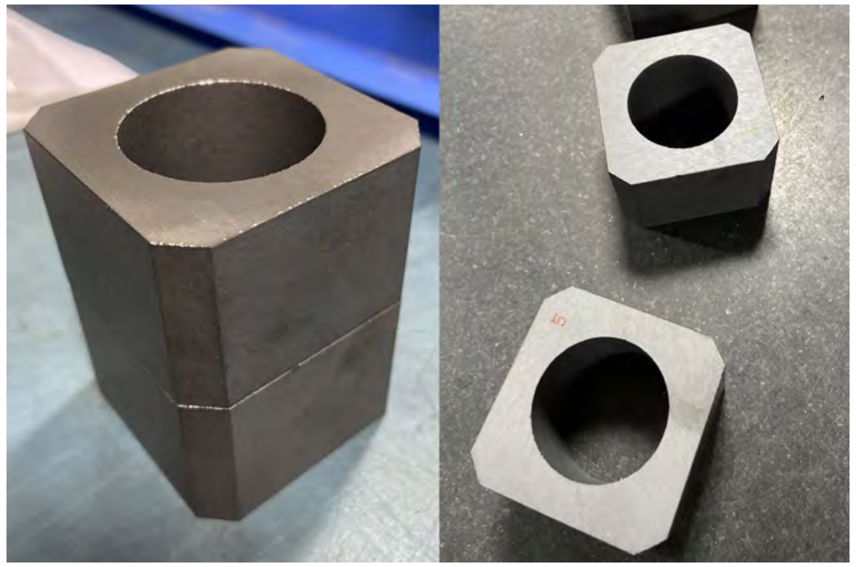
ITER Toroidal Field coil, manufactured in Japan, unwrapped in the Cleaning Facility. May 2021 © ITER Organization

ITER Toroidal Field coil, manufactured in Japan, unwrapped in the Cleaning Facility. May 2021 © ITER Organization

India

Major elements of the cryostat top lid produced by India, aligned on the floor of the workshop. February 2021 © ITER Organization

Seven of the 12 segments of the cryostat's top lid have been assembled on the work platform. March 2021 © ITER Organization



Shielding material qualified in India. Boron carbide (B4C) blocks to be used for India's plasma-facing diagnostic systems. September 2021 © ITER India

Equipment procured by India has been installed in the 6 000 m² Cooling Plant on the northern corner of the ITER site, including heat exchangers as shown in the image. October 2021 © ITER Organization

Russia

Impregnation completed for ITER Poloidal Field coil 1, Sredne-Nevsky Shipyard in St. Petersburg, Russia. 2021 © Rosatom

Russia completed full-scale prototype of ITER Divertor dome, Efremov Institute, Saint Petersburg. November 2021 © Rosatom

Auxiliary systems for gyrotrons sent from Nizhny Novgorod, Russia, to ITER site, Cadarache, France. December 2021 © Rosatom

United States

First central solenoid module, a 1 200-tonne magnet coil, arrived in September at the ITER site, France. The second module arrived towards the end of October. © ITER Organization

First module of central solenoid undergoing tests and verifications—metrology, sensors, electrical insulation inspection. October 2021 © ITER Organization

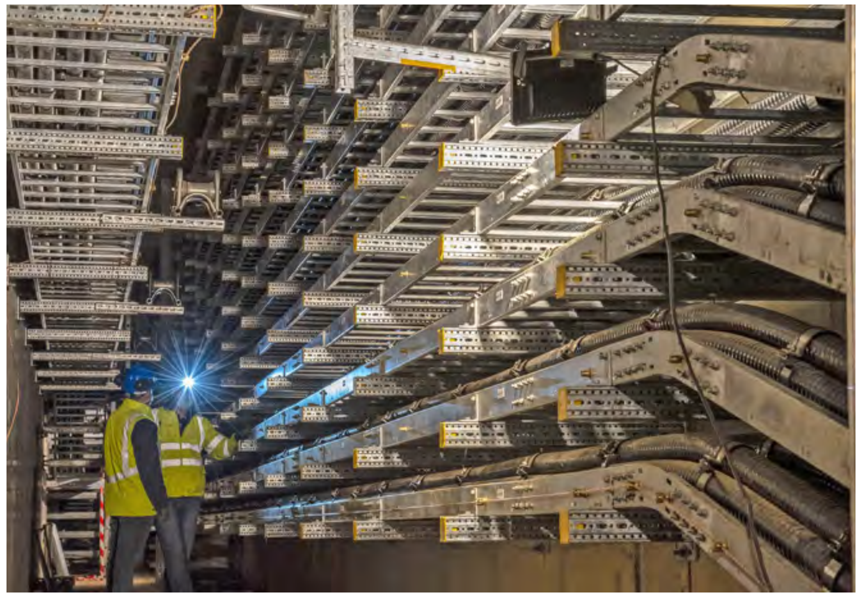
Korea

Second ITER Vacuum Vessel sector procured by Korea, delivered on-site. August 2021 © ITER Organization

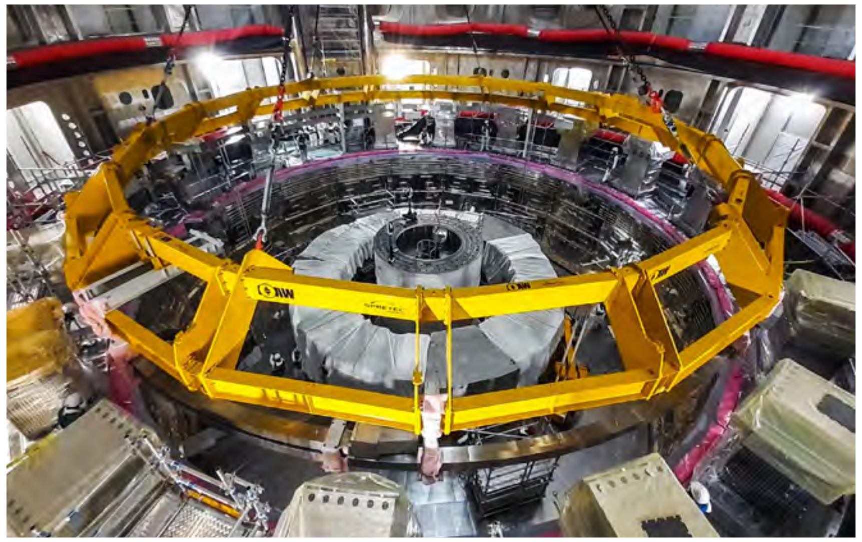
Contractors completed factory testing on the first of the nine vacuum vessel gravity supports, Korea, December 2021 © ITER Korea

China

Magnet terminal box, procured by China and manufactured at the Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP), lifted and moved inside the basement of the Tokamak Building. January 2021 © ITER Organization



Cables located below the west entrance of the magnet power conversion buildings head in all directions, eventually reaching the four corners of the platform. Procured by China, the cables are delivered in drums and unspooled. February 2021 © ITER Organization



This 10-tonne circular feeder, procured by China, was inserted in the ITER assembly pit. The feeder will connect to a cryostat feedthrough to deliver electrical power to the six side correction coils located at the mid-section of the machine. May 2021 © ITER Organization

Acceptance tests of correction coils, procured by China, completed successfully. October 2021 © ITER Organization

01

Building ITER

The ITER platform measures 42 hectares and is located in Cadarache, France. It is one of the largest levelled surfaces in the world.
Europe is responsible for the construction of 39 buildings, the infrastructure and power supplies on-site which will be needed to operate the world's biggest fusion device.
More than 2 000 people, working for European companies, are involved in ITER's civil engineering works. Architects, engineers, technicians, planners, inspectors are some of the professionals contributing to the project. They are building the facilities where the components arriving from all over the world will be stored, assembled and installed.
Our teams on the ground are building the "home" of one of the most impressive technology projects.

THE ITER SITE

Most of the buildings and infrastructure required for ITER's first plasma operations are nearly ready. The workforces on the ground and the companies involved in civil engineering works, remained focused on meeting their targets. The new health and safety protocol, rolled out to comply with COVID-19 guidelines, ensured continuity of services and well-being of staff. Looking back on the past twelve months it's clear that our collective efforts paid off.

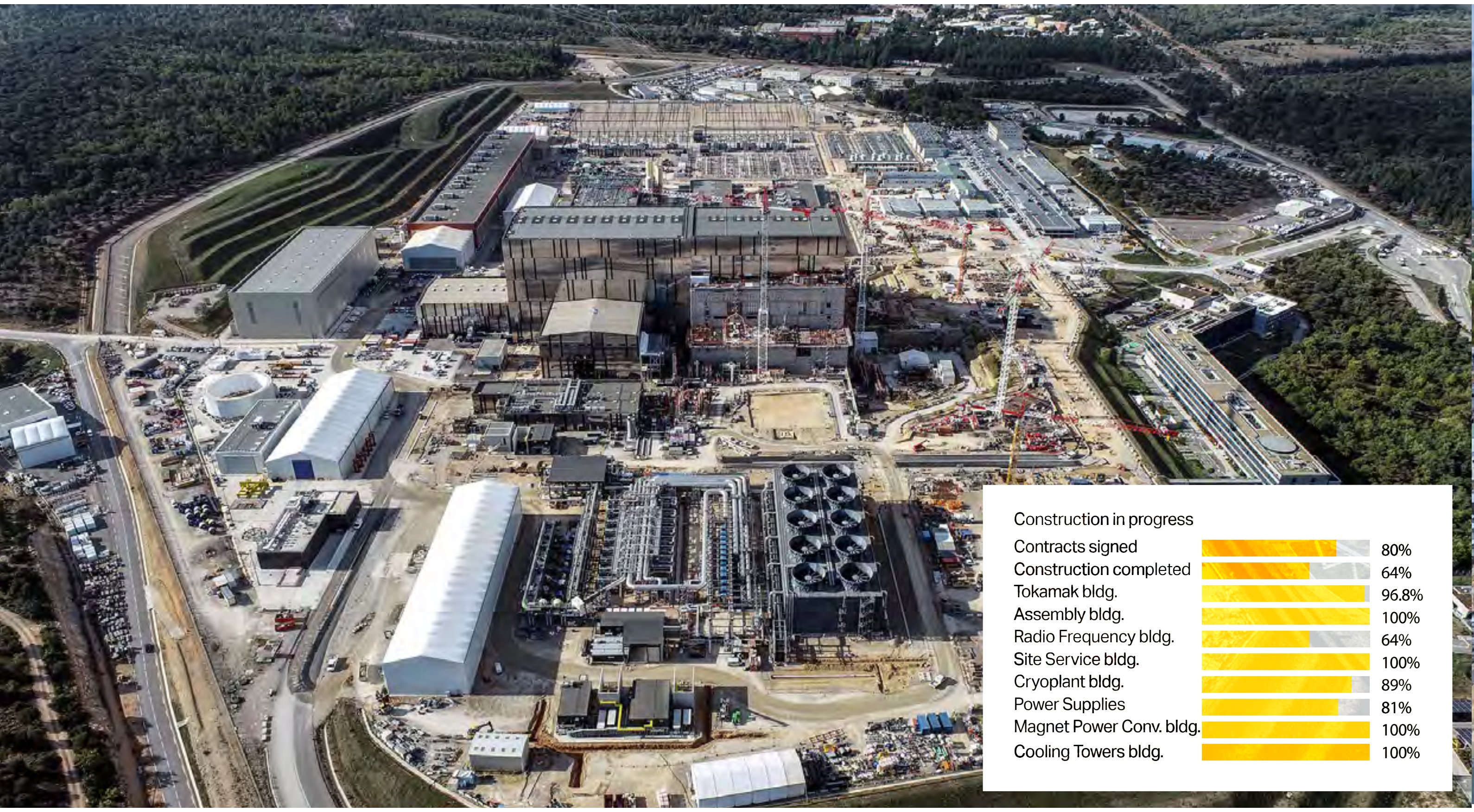
F4E handed over more buildings to ITER Organization, in order to move forward with the assembly and installation of equipment in the Tokamak building—the "heart" of the experiment. The civil engineering, painting and finishing works were completed, paving the way for the first major components to be installed in the pit. Inside this massive fortress, the teams of F4E contractors made progress with the shielding and confinement doors, which will protect the rest of the building from radiation. All 300 doors were installed. Special tooling and carefully planned logistics were essential in achieving this task because most of these doors weigh several tonnes. Meanwhile, F4E went ahead with the procurement of more lifts, metallic platforms, cable trays, etc.

The contract for the emergency power supplies buildings was signed, and more progress was made with services in the Cyroplant. The Vinci Ferrovial Razel-Bec (VFR) consortium re-started works at the Tritium building, after the signature of a second contract, by pouring more concrete and positioning rebars. The excavation of the Neutral Beam Power Supplies building was completed by Demathieu Bard, marking the start of civil engineering works. Other buildings, however, came full circle like the Site Services, and the Cleaning Facility, which F4E handed over to ITER Organization. More progress also unfolded inside the buildings. For instance, heating, ventilation, air-conditioning (HVAC) and piping works advanced in the Cryoplant and the Radio Frequency buildings. The last underground galleries were completed paving the way for a definite road network with signs, making access and transport of equipment easier.

We grappled with the new reality of the pandemic, and managed to boost the morale of our workforces, marking 2021 a new beginning for the construction site. Better prepared, more resilient, and as one team.

ITER Tokamak building

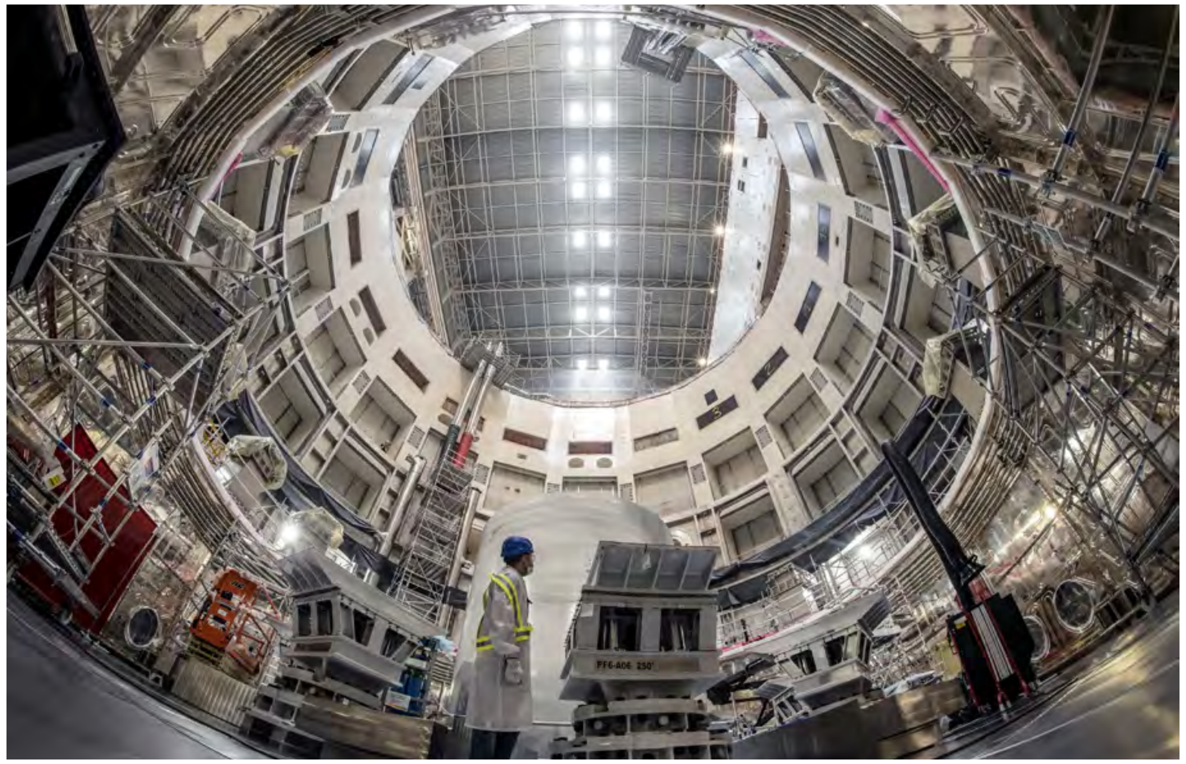
North view of the ITER construction site, Cadarache, France, May 2021. © ITER Organization/EJF Riche



West view of the ITER construction site, Cadarache, France, October 2021. © ITER Organization/EJF Riche

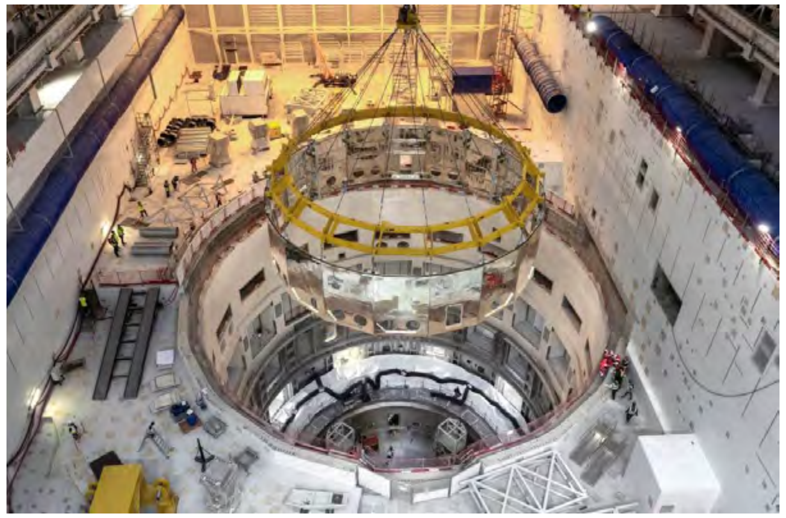
East view of the ITER construction site, Cadarache, France, May 2021. © ITER Organization/EJF Riche

Inside the Tokamak building



Inside the painted Tokamak pit, where a technician finishes welding the lower cylinder of the cryostat to the base, Cadarache, France, March 2021. © ITER Organization

Last layer of paint applied inside the Tokamak building, Cadarache, France, October 2021. © F4E



The 50-tonne lower cryostat thermal shield ready to be inserted in the Tokamak pit, Cadarache, France, January 2021. © ITER Organization

Bottom cylinder of the in-pit assembly tool installed. With a central column and radiating beams braced against the pit walls, the in-pit column tool will support the nine sectors of the vacuum vessel as they are welded together. Cadarache, France, March 2021. © ITER Organization

Aerial view of ITER Tokamak pit capturing components, tools, staging platforms and equipment. Cadarache, France, October 2021. © ITER Organization

The central column of the in-pit column tool is in place. The nine radial beams will arrive next to support a vacuum vessel sub-assembly. Cadarache, France, December 2021. © ITER Organization

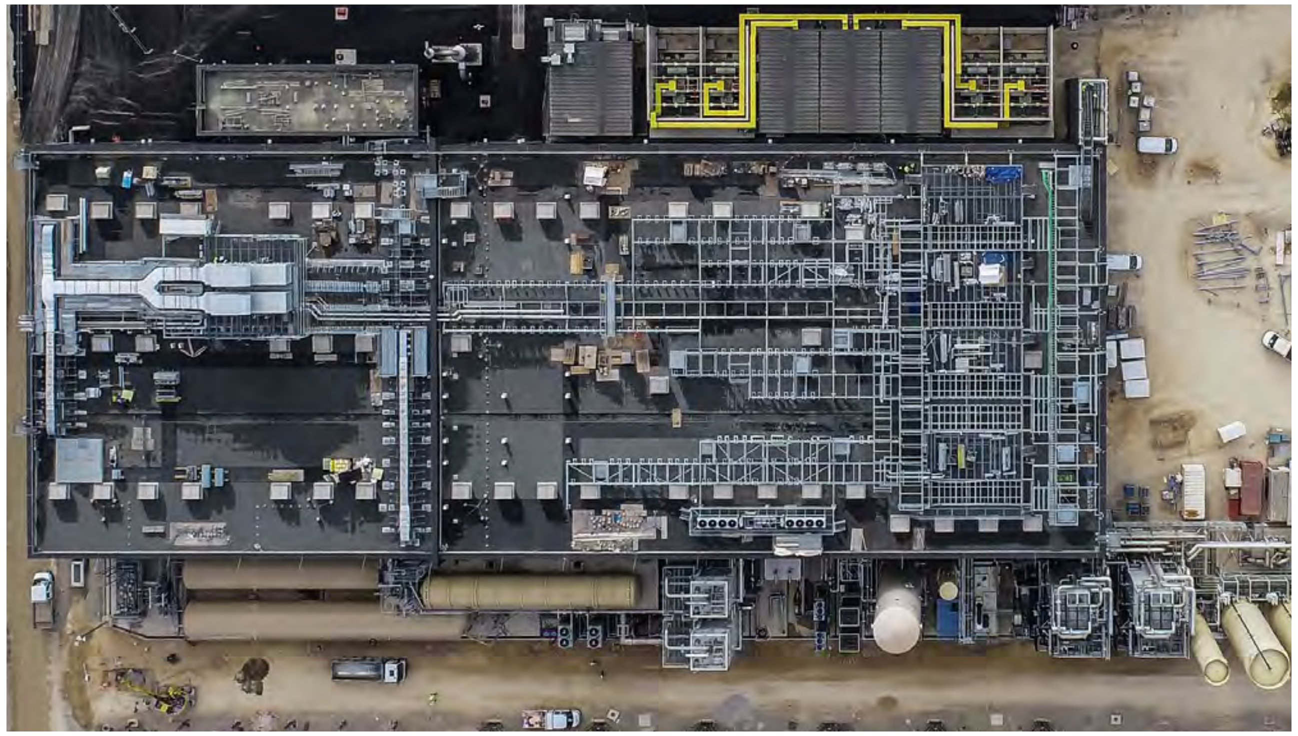
TOKAMAK COMPLEX

Diagnostics, Tokamak and Tritium buildings

Dimensions:
120 x 80 m,
60 m high, 17 m deep

Weight:
360 000 t (the equivalent of the Empire State building)

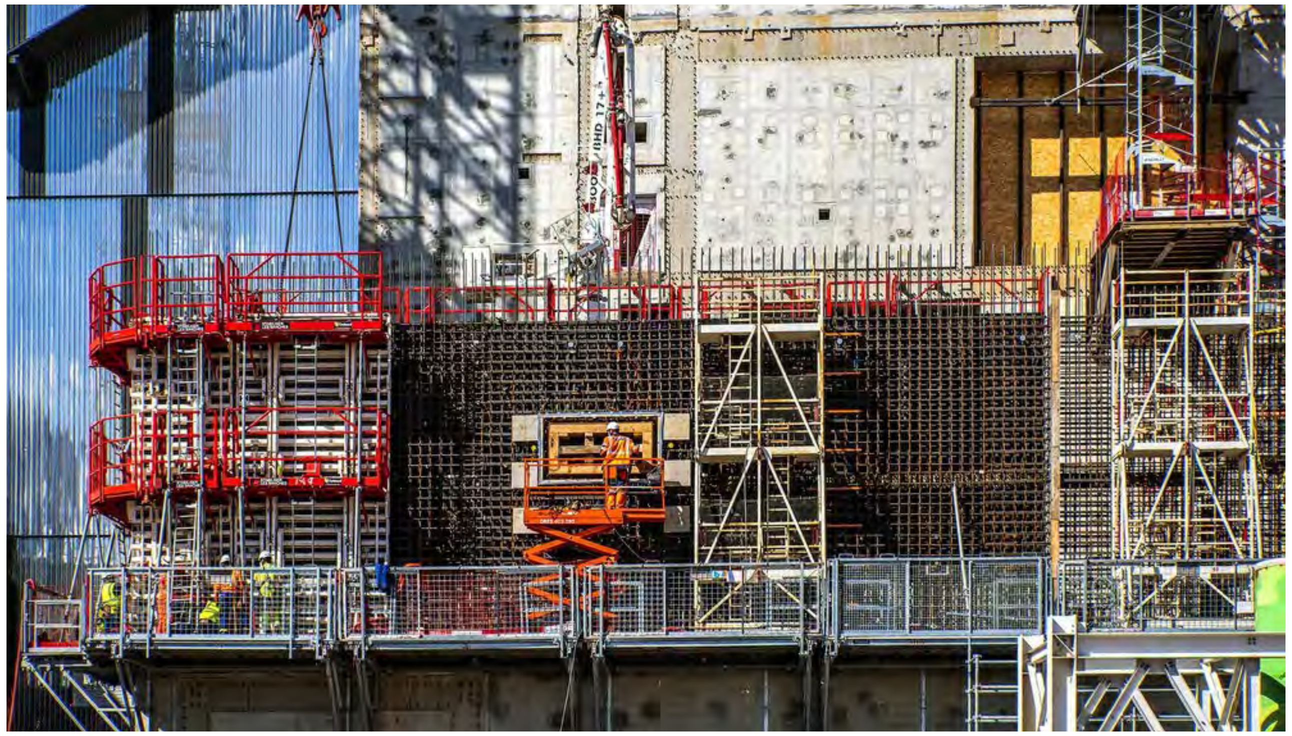
ITER Cryoplant



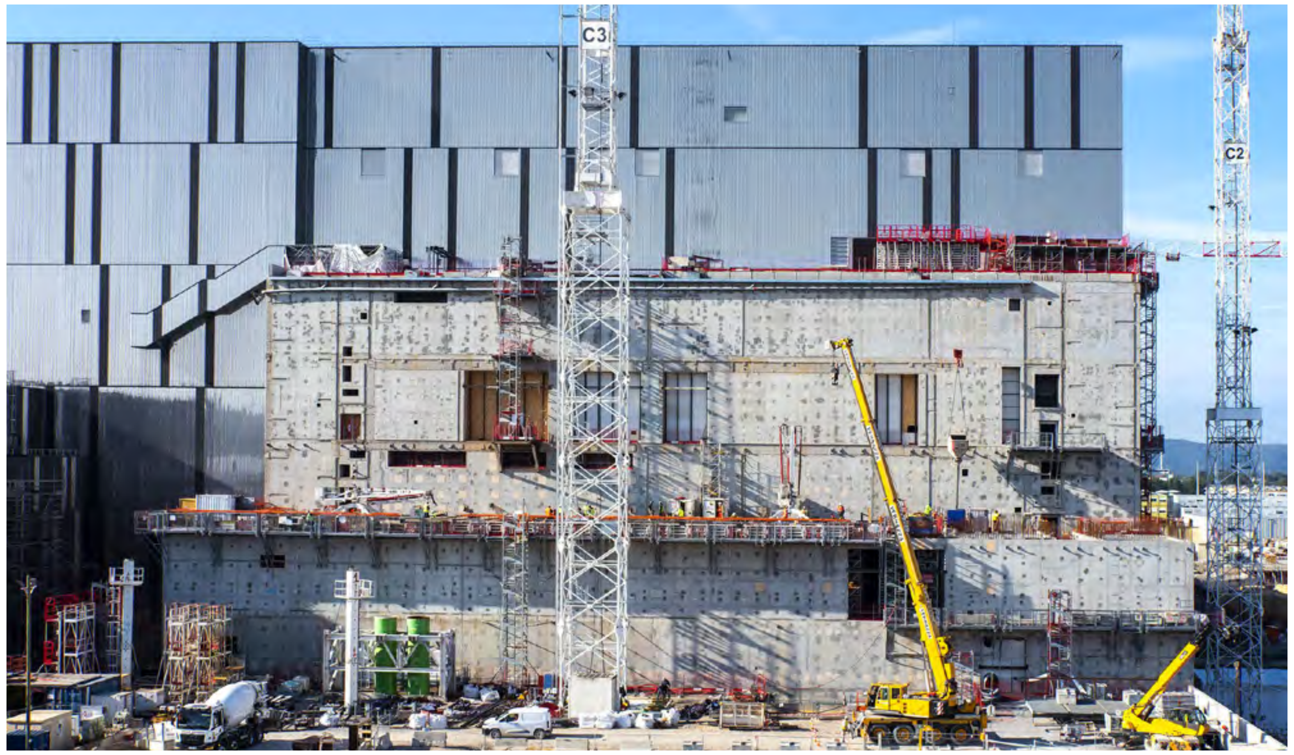
Large power machines inside the cryoplant will dissipate considerable amounts of heat (on the order of 20 MW). HVAC ducts on the building's roof are tasked with extracting it. The yellow elements at the top are busbars feeding electrical power to the installation. November 2021. © ITER Organization/EJF Riche

Installation work in the cryoplant nearing completion, ITER construction site, Cadarache, France, June 2021. © Christian Lünig

ITER Tritium building



Concrete pouring and rebars installed in the Tritium building, ITER construction site, Cadarache, France, May 2021. © ITER Organization/EJF Riche

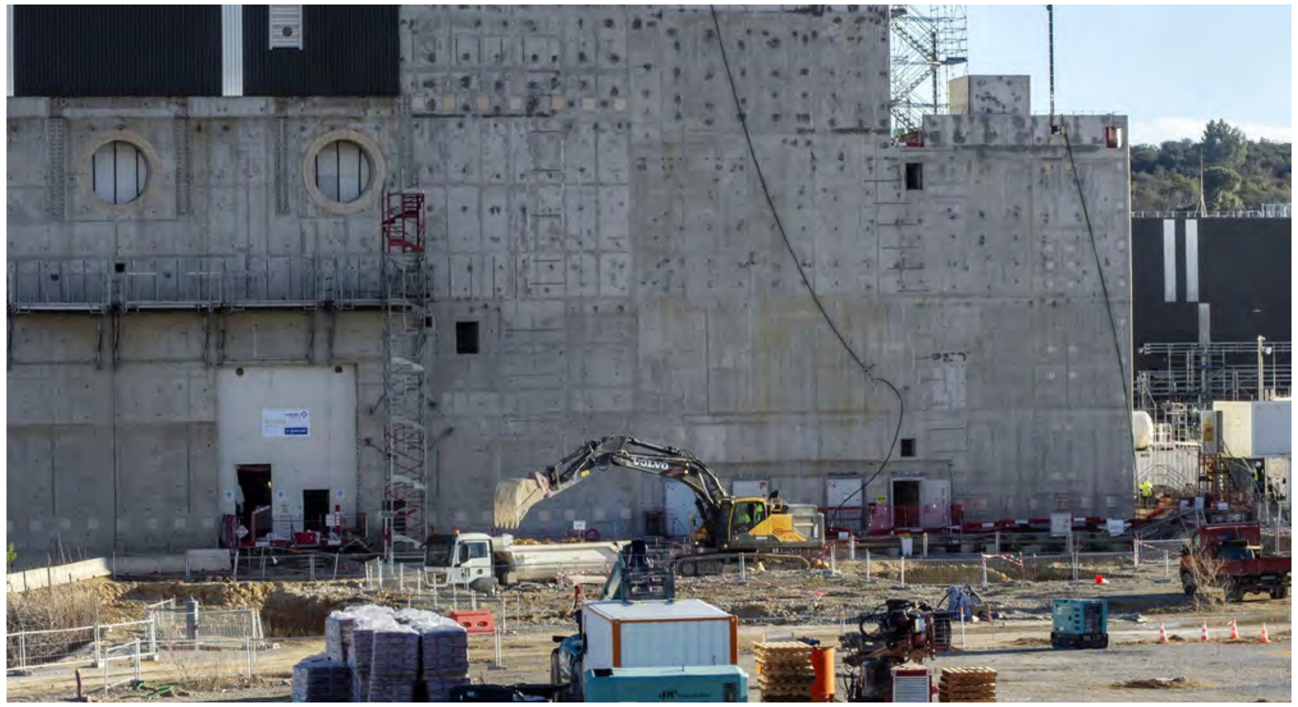


Two levels of the Tritium Building have been erected. Teams working on the basemat for L3. When completed, it will rise to the height of the concrete segment of the Tokamak Building in the background. ITER construction site, Cadarache, France, October 2021. © ITER Organization/EJF Riche

Radio Frequency building

The Radio Frequency Heating Building (on the right) is the radio powerhouse on site, housing all wave-generating equipment for the electron and ion cyclotron heating systems. ITER construction site, Cadarache, France, October 2021. © ITER Organization

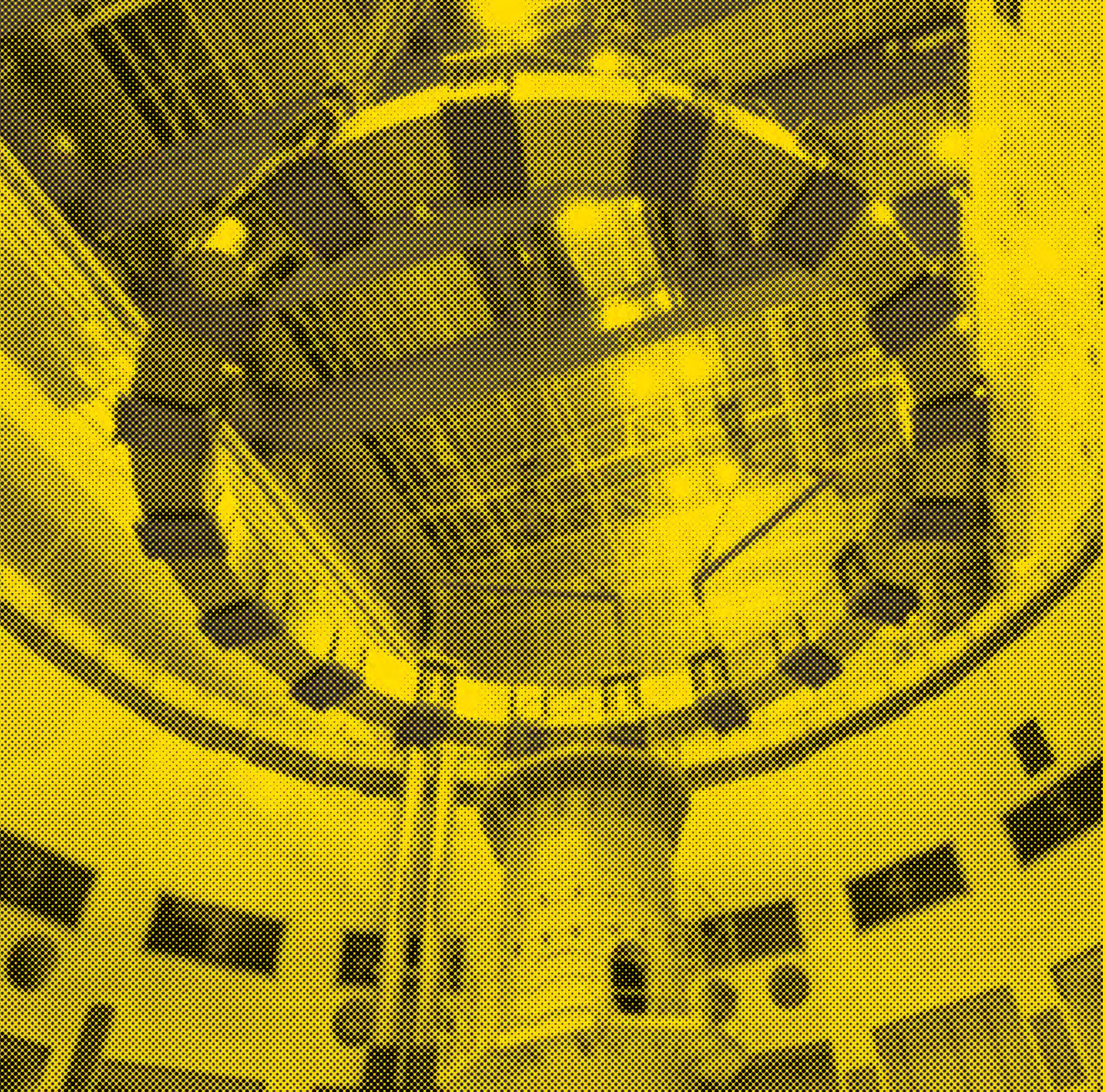
Control building



On a level area in front of the Tokamak Complex, excavation works started for a series of buildings that will be dedicated to the power supply of the ITER Neutral Beam heating system, ITER construction site, Cadarache, France, January 2022. © ITER Organization

West view of the ITER construction site, Cadarache, France, October 2021. © ITER Organization/EJF Riche

All HVAC equipment installed on the roof of the Tokamak Assembly Preparatory Building, ITER site, Cadarache, France, January 2021. © ITER Organization



02

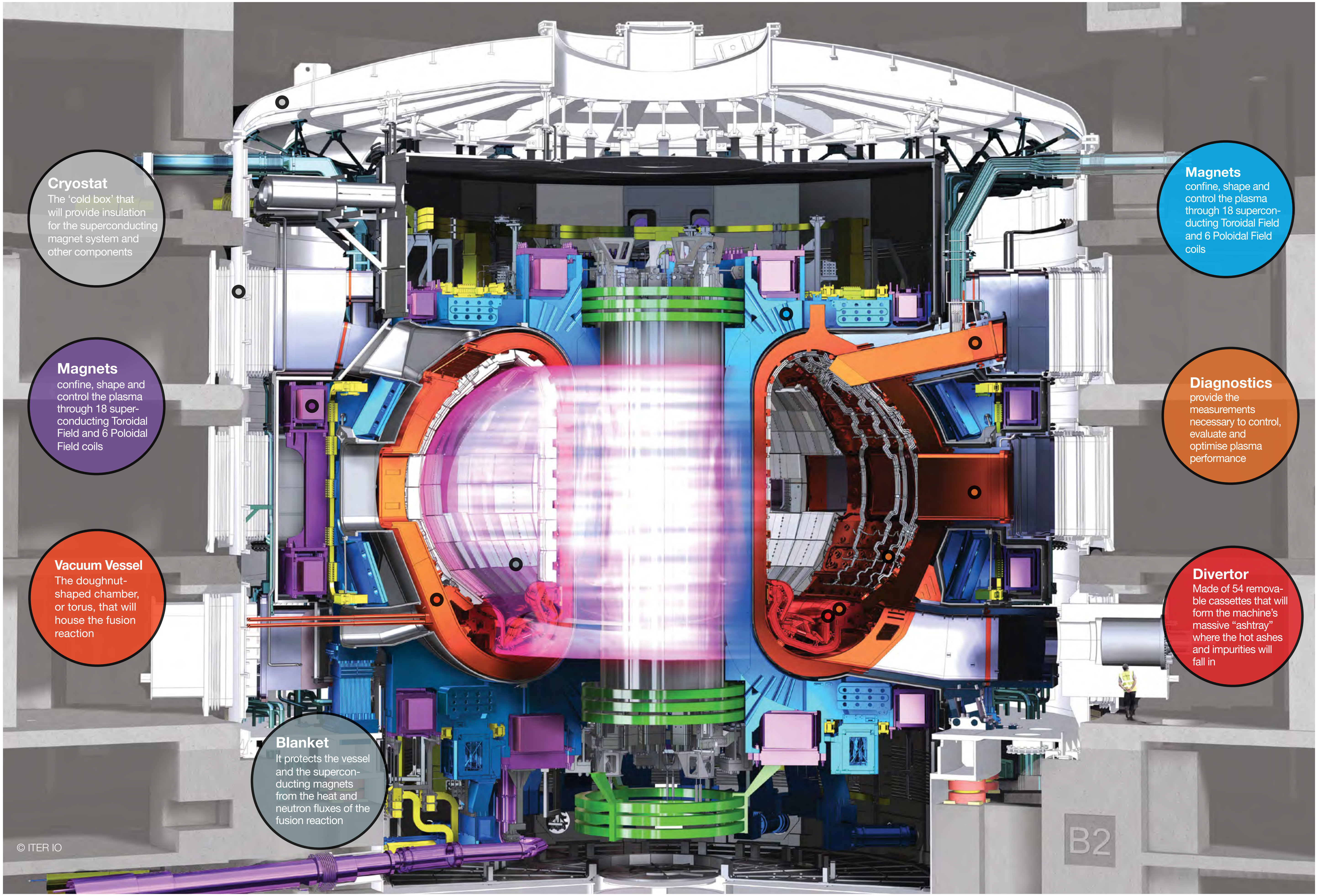
Manufacturing the ITER components

ITER is the biggest international scientific partnership to test the potential of fusion energy. An impressive technology puzzle that will generate new knowledge and stimulate industrial expertise.

Europe's contribution to ITER, financed by the EU budget, amounts to roughly 50%. It offers a unique opportunity to industry, SMEs and fusion laboratories to get involved in an emerging energy market. Manufacturing spreads all over Europe counting at least 560 main contractors and approximately 1700 subcontractors.

This year's main priority was performing design and manufacturing safely given the pandemic. Some of our main achievements include the insertion of Poloidal Field coil six in the Tokamak pit; the delivery of more Toroidal Field coils on-site; the start of commissioning of the cryoplant. There was progress with MITICA's beam line components, and more Electron Cyclotron power supplies reached the site. The start of assembly of the first vacuum vessel sector, progress in Diagnostics, and the advancement of In-Vessel components were also among our main achievements.

This section is dedicated to our staff and the teams of our suppliers who worked relentlessly for the European contribution to ITER in spite of the exceptional circumstances.


Cryostat
The 'cold box' that will provide insulation for the superconducting magnet system and other components
Magnets
confine, shape and control the plasma through 18 super-conducting Toroidal Field and 6 Poloidal Field coils
Vacuum Vessel
The doughnut-shaped chamber, or torus, that will house the fusion reaction
Blanket
It protects the vessel and the supercon-ducting magnets from the heat and neutron fluxes of the fusion reaction
Magnets
confine, shape and control the plasma through 18 supercon-ducting Toroidal Field and 6 Poloidal Field coils
Diagnostics
provide the measurements necessary to control, evaluate and optimise plasma performance
Divertor
Made of 54 remova-ble cassettes that will form the machine's massive "ashtray" where the hot ashes and impurities will fall in
B2
© ITER IO

MAGNETS

ITER will operate with the largest and most integrated superconducting magnet system ever built. It will help scientists to confine, shape and control the burning plasma.

The central solenoid will act as the magnets' backbone and the correction coils will reduce any errors resulting from the position and geometry of other coils.

The Toroidal Field (TF) coils will create a massive magnetic cage to confine the plasma, expected to reach 150 million ˚C, by keeping it away from the walls of the vacuum vessel. Europe will manufacture 10 out of the 18 TF coils involving more than 700 people from 40 companies. Japan will manufacture the remaining eight plus one spare.

To cope with the fatigue exercised on the TF coils, and with any deformation resulting from the powerful magnetic fields, three Pre-Compression Rings (PCRs) will be placed on top of them and three below them. An extra set of three will be provided if there is a need to replace the lower set. Europe is responsible for the production of all PCRs.

Finally, six Poloidal Field (PF) coils will embrace the TF coils from top to bottom in order to maintain the plasma's shape and stability. Europe is responsible for five of them, of which one manufactured in China, with the agreement to perform cold and final tests in the F4E PF coils factory on-site. The remaining coil is produced in Russia.

Work in progress Poloidal Field coils

Contracts signed	100%
Tooling	100%
Qualification	100%
Manufacturing	78%

Work in progress Toroidal Field coils

Contracts signed	100%
Tooling	100%
Qualification	100%
Manufacturing	98%*

Pre-Compression Rings- Completed

**All 70 Radial Plates and 10 Winding Packs are completed. The remaining 2% represents the work calculated over the entire production.*

Toroidal Field coils

Three additional Toroidal Field coils delivered by Europe

The sixth of the ten Toroidal Field coils procured by Europe, delivered to the ITER site, Cadarache, France, December 2021. © DAHER

TOROIDAL FIELD COILS

The gigantic "D" shaped coils will be the biggest Niobium-tin (Nb_3Sn) magnets ever produced, which once powered with 68 000 A will generate a magnetic field of 11.8 Tesla—about 250 000 times the magnetic field of the Earth! Each coil is approximately 14 m high, 9 m wide and weighs 110 t. When inserted into its metallic case its total load will exceed 300 t, which compares to that of an Airbus 350.

Moving one of Europe's Toroidal Field coils from the transport frame to the storage frame, ITER Assembly Hall, Cadarache, France, July 2021. © ITER Organization

Last Winding Pack ready to go through final manufacturing

Winding packs are the inner core of the Toroidal Field coils. Pictured the last one departing from ASG Superconductors to travel by sea to SIMIC, where it will undergo final manufacturing. ASG Superconductors, La Spezia, November 2021. © F4E

Poloidal Field coils

Fabrication full speed for two remaining Poloidal Field coils

ITER Poloidal Field coil 4 in fabrication. Technician checking the stacking of the Double Pancakes of the magnet, which measures 24 m in diameter. Manufacturing performed in PF coils factory, Cadarache, France, December 2021. © F4E

PF COILS FACTORY

The construction of the PF coils factory was undertaken by F4E together with a number of industrial partners. The factory is about the size of two football pitches: approximately 250 m long, 45 m wide and 17 m high. It includes regular services (heating, ventilation and air conditioning, electrical, piping), two overhead cranes (one standard crane with a capacity of 25 t and another crane especially adapted with a capacity of 40 t), one gantry crane to lift 400 t, offices, technical rooms and workshop space.

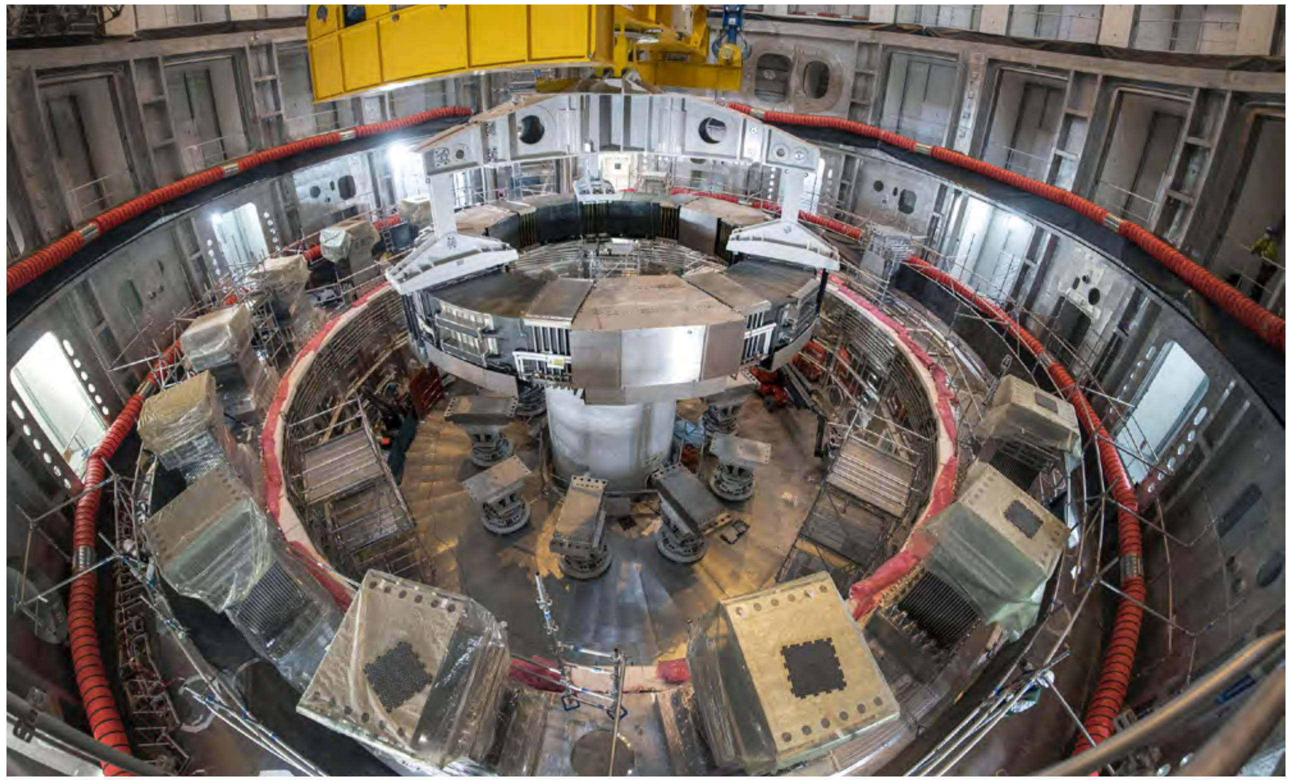
Technicians from CNIM working on the first Double Pancake of ITER Poloidal Field coil 3. Manufacturing performed in PF coils factory, Cadarache, France. © F4E

Another Poloidal Field coil delivered

Poloidal Field coil 2, measuring roughly 17 m, handed over to ITER Organization, Cadarache, France, December 2021. © ITER Organization

Poloidal field coil 2 (PF2) moved into storage, ITER site, Cadarache, France, December 2021. © ITER Organization

Two Poloidal Field coils installed in the Tokamak



ITER's sixth Poloidal Field coil slowly arrives at its destination. It will remain on temporary supports until the vacuum vessel has been assembled and welded. Cadarache, France, April 2021. © ITER Organization

Europe's fifth Poloidal Field coil successfully descends in the Tokamak pit. Cadarache, France, September 2021. © ITER Organization

Pre-Compression Rings

First set of Pre-Compression Rings installed

Installation of a set of three spare Pre-Compression Rings in the Tokamak pit, July 2021. Two other sets of three rings will hold tightly the Toroidal Field coils at top and bottom against any expansion forces during operation. © ITER Organization

PRE-COMPRESSION RINGS

The fiberglass composite rings, consisting of more than a billion miniscule glass fibers, are glued together by a high-performance epoxy resin. The rings have a diameter of approximately 5 m, a cross-section of nearly 300 mm x 300 mm and will weigh roughly 3 t. Pre-Compression Rings (PCRs) are "comfort cushions" that will take the pressure off the Toroidal Field coils from potential stress and fatigue resulting from the confinement of the burning plasma. Europe has produced all PCRs for the ITER device.

VACUUM VESSEL

The vacuum vessel is a special double-walled container that will house the fusion reactions of the ITER plasma. Within this doughnut-shaped vessel, plasma particles will collide and release energy without touching any of its walls thanks to magnetic confinement.

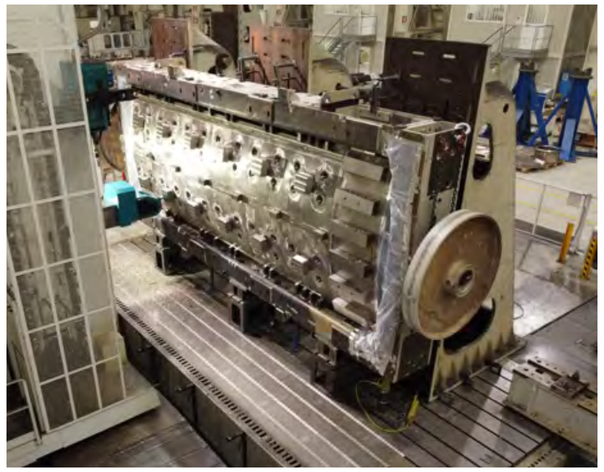
Europe is providing five of the nine vacuum vessel sectors of thick special grade stainless steel. Manufacturing these first of a kind components is very challenging due to the strict technical requirements compliant with nuclear standards, the application of new techniques, and last but not least, the sheer size of the components as each sector is 12 m high, 6.5 m wide and 6.3 m deep. The sectors weigh approximately 500 t each. More than ten European companies are involved in their fabrication.

Work in progress

Sector 5	
Design	100%
Manufacturing	99%
Assembly	71%
Overall	96.3%
Sector 4	
Design	100%
Manufacturing	98%
Assembly	25%
Overall	92.3%
Sector 9	
Design	100%
Manufacturing	92%
Assembly	4%
Overall	84.9%
Sector 3	
Design	100%
Manufacturing	85%
Overall	78.3%
Sector 2	
Design	100%
Manufacturing	84%
Overall	77.2%

Start of final assembly for Europe's vacuum vessel sector 5

The four segments of Europe's first sector entered the stage of final assembly. More than seven companies, involving at least 200 people, worked over the last years to roll out the production of the five sectors that F4E needs to deliver to ITER. Poloidal Sector 5 will be the first, produced by the AMW consortium with an extensive network of sub-contractors.



First segment of sector 5 of the ITER Vacuum Vessel, manufactured in Europe, placed on the jig in the factory of Mangiarotti, Italy, June 2021. Poloidal segment 1 manufactured by Mangiarotti © F4E

Another segment of sector 5 of the ITER Vacuum Vessel, poloidal segment 4, manufactured in Europe, lifted to be moved to the jig in the factory of Mangiarotti, Italy, June 2021. © F4E

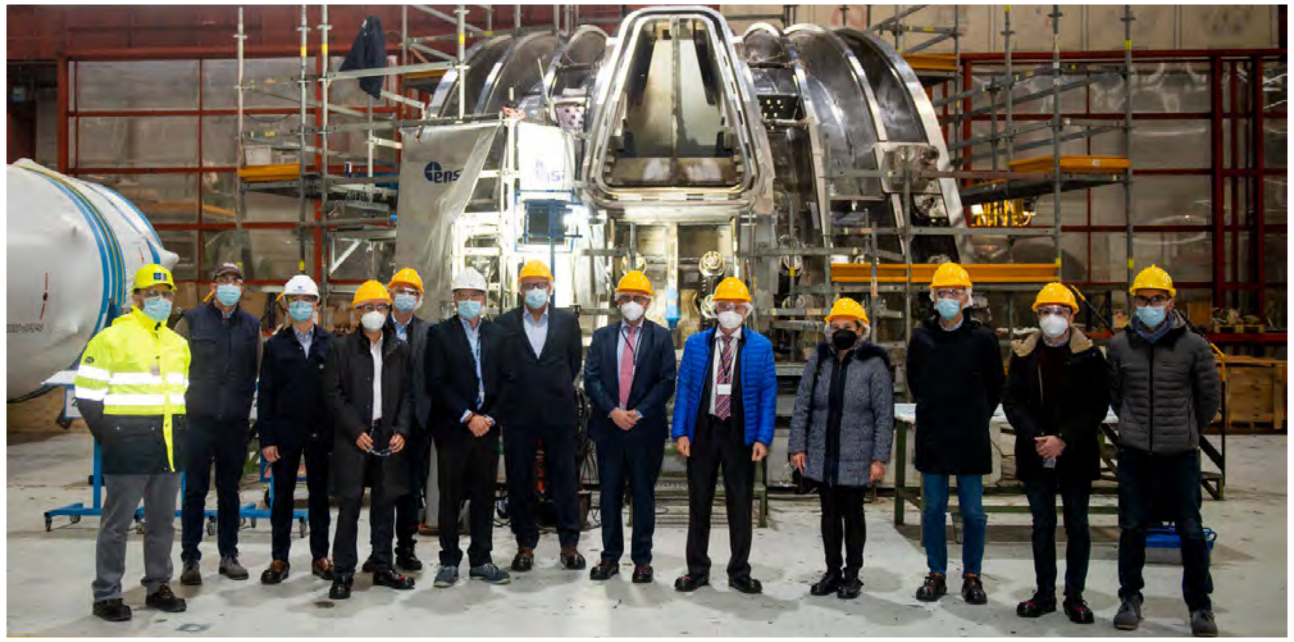
Placing on the jig in the factory of Mangiarotti, poloidal segment 4, manufactured by Mangiarotti, Italy, June 2021. The component is part of sector 5 of the ITER Vacuum Vessel manufactured in Europe. © F4E

Final tests for Europe's ITER Vacuum Vessel sector 5

Europe's vacuum vessel sector 5 leaving the radiographic bunker of Mangiarotti to go through final tests, Mangiarotti, Italy, November 2021. © Mangiarotti

ENSA completes first segment

F4E, AMW, ENSA and CDTI witnessed the completion of the first segment at ENSA- an important milestone after years of effort. F4E and Ministry representatives acknowledged the good progress of the works streamlining the manufacturing of the segments for Sectors 9, 3 and 2.



F4E visit at ENSA to witness the progress of welding operations to Europe's vacuum vessel sectors, November 2021. © ENSA

Works advancing for Europe's ITER Vacuum Vessel sector 4

Technicians performing dimensional checks on Europe's vacuum vessel sector 4, poloidal segment 3, Walter Tosto, Italy, December 2021. © Walter Tosto

New tool for vacuum vessel inspections

The interior of the ITER Vacuum Vessel will be covered by 440 blanket modules attached to a total of 1760 housings, around 200 per vacuum vessel sector. F4E has procured an inspection tool to examine these parts accurately and quickly. Experts need roughly one hour to perform all the necessary measurements manually in each housing. With the help of this novel tool, only five minutes are required!

A part of ITER Vacuum Vessel sector 5, holed like a Gruyère cheese, with dozens of housings. Mangiarotti, Italy, November 2021. © F4E

Virtual fitting to join the pieces of ITER components

The ITER Vacuum Vessel is composed of nine sectors, which, in turn, are made of four segments. As there are small gaps between components, there is not a unique way in which these segments can be put together. So, which is the best? Virtual fitting is a simulation technique developed by F4E experts to mimic the assembly of the real components in a virtual environment. By simulating different alignment scenarios, experts can anticipate future problems and take informed decisions on which option is better to join the different pieces. The technique was applied successfully on two mock-up segments of the vacuum vessel and toroidal field coils.

Inspector checking vacuum vessel sector 3, poloidal segment 2 at Walter Tosto, Italy, April 2021 © F4E

REMOTE HANDLING

Remote handling helps us to carry out tasks without being physically present. It is widely used in space exploration missions, underwater repairs or challenging maintenance works. The limited space inside ITER together with the weight and exposure of some of the components to radiation will require the use of remote handling systems during maintenance. Europe is responsible for four of the six major remote handling systems of ITER. For each of them it carries out design activities, R&D and manufacturing in order to deliver the appropriate tooling.

Work in progress

Divertor RH	
Contracts signed	40%
Design	75%
Cask & Plug RH	
Contracts signed	20%
Design	65%
Neutral Beam RH	
Contracts signed	22%
Design	64%
In Vessel Viewing System	
Contracts signed	20%
Design	76%

Virtual reality will guide engineers to perform ITER maintenance works

F4E chose the VR4Robots software for Europe's Remote Handling systems. The tool will help engineers to visualise maintenance processes, simulate or perform in real time remote handling operations. Europe will also build a bridge between the Genrobot software and VR4Robots.

Retiina remote handling simulator; a VR4Robots physics-based digital twin of Veolia Nuclear Solutions' Dexter Remote Manipulator System. © Veolia Nuclear Solutions (UK) & Tree C Technology

DIAGNOSTICS

The Diagnostics systems will help scientists to study and control the plasma behaviour, measure its properties and improve our understanding in physics. This system will act as "the eyes and ears" of engineers giving them insight thanks to a wide range of cutting edge technologies.

ITER will offer an unparalleled view of the entire plasma, whose pulse duration will be 100 times longer than any fusion device currently in operation. The diagnostic systems will also help them to ensure the safe operation of the machine, given the extreme environment in the vessel and the large amounts of energy inside the plasma. Europe is responsible for roughly 25% of all Diagnostics in ITER, involving more than 60 companies and research laboratories.

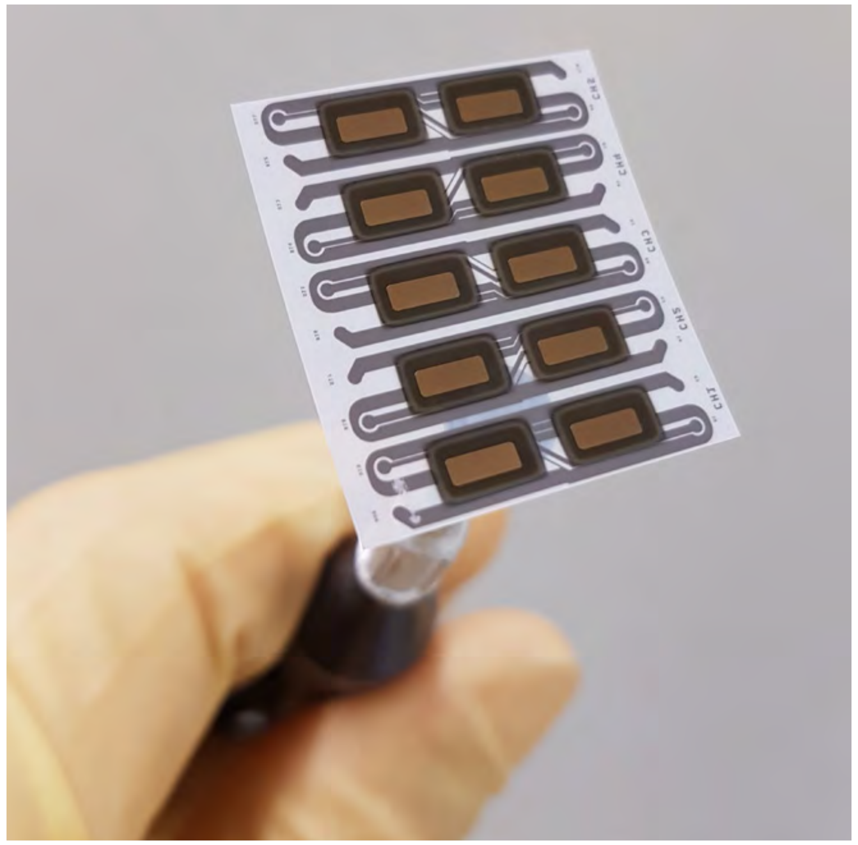
Work in progress

Contracts signed	63%
Design	89%
Manufacturing	17%

Measuring the radiation emitted by the ITER plasma

Bolometers are sensors used to measure the amount of radiated power in fusion devices. In ITER, they will have to meet more demanding requirements than in any other fusion facility to date.

In 2017 F4E started a programme for prototyping and testing of two types of bolometers with several manufacturers. F4E experts have received 18 prototypes of each type and now it is their turn to test them.



Prototype sensor produced by CSEM. © CSEM

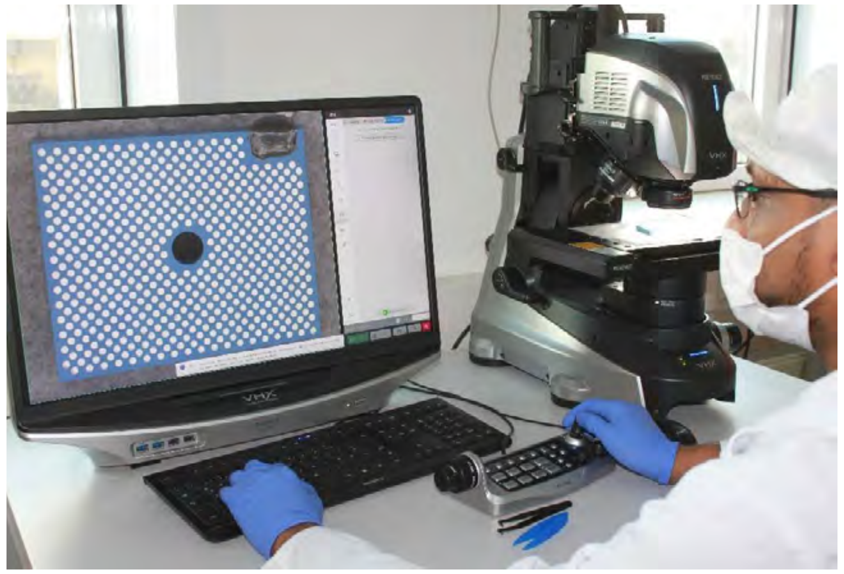
Carrying the diagnostic signals outside the ITER Vacuum Vessel

Cables carrying signals produced by ITER sensors must be very resistant to withstand the extreme conditions of the machine. The F4E Diagnostics Team, together with IDOM, have been working on different feedthrough prototypes that have successfully passed all tests.

Electrical feedthrough bulkheads going through different tests. Left: thermal cycling tests; top right: impact test; bottom right: helium leak test. © Tecnalia

Europe delivers equipment for ITER Vacuum Vessel diagnostics

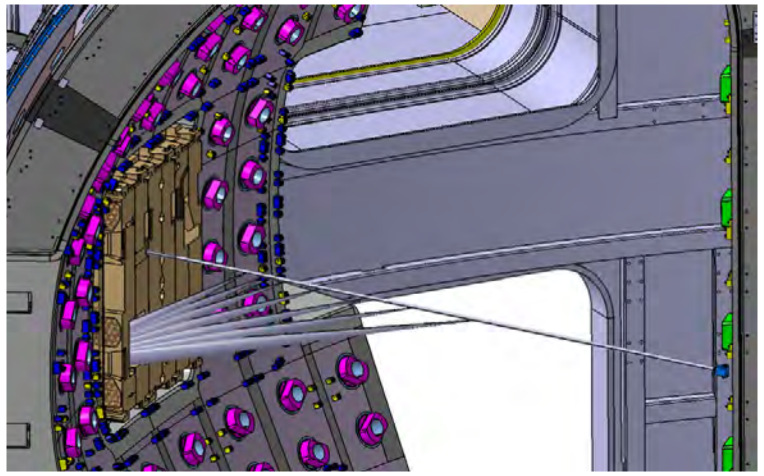
To measure the plasma behaviour of the ITER device, its energy, and instabilities, approximately 450 sensors will be installed in the vacuum vessel to help scientists receive this information. F4E delivered to ITER Organization a first batch of them.



A technician is inspecting a sensor coil in VIA electronic, Germany. © VIA electronic

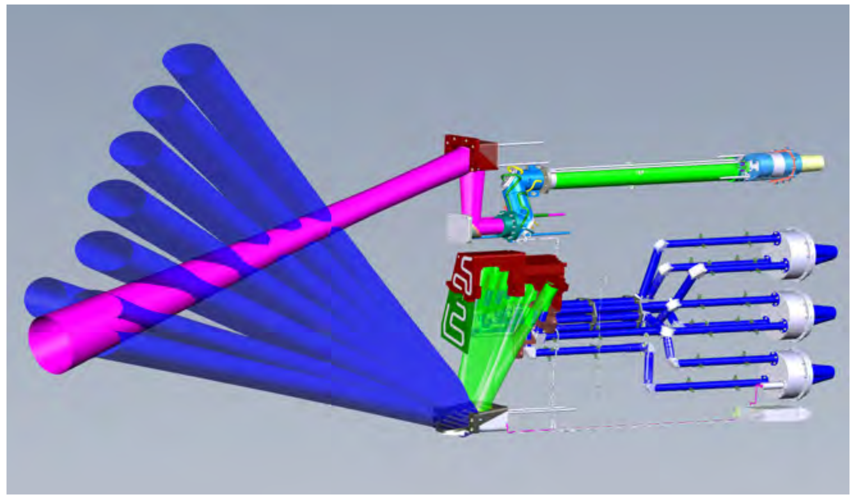
Contract signed to monitor the temperature of ITER plasma

F4E has signed a contract with IDOM to develop the Core Plasma Thomson Scattering system, a bit like the “thermometer” of the ITER plasma.



Laser to be injected by the Core Plasma Thomson Scattering system into the vacuum vessel, reaching the beam dump (small blue box). The scattered light is collected by the system for further analysis. © F4E

Design of Collective Thomson Scattering system completed

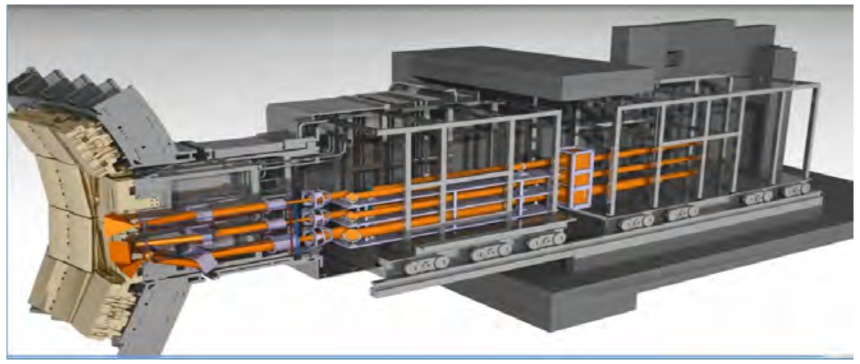


The Collective Thomson Scattering system will measure alpha particles by launching a high power beam – illustrated in purple – into the plasma. The information gathered by the receivers is shown in dark blue. © DTU

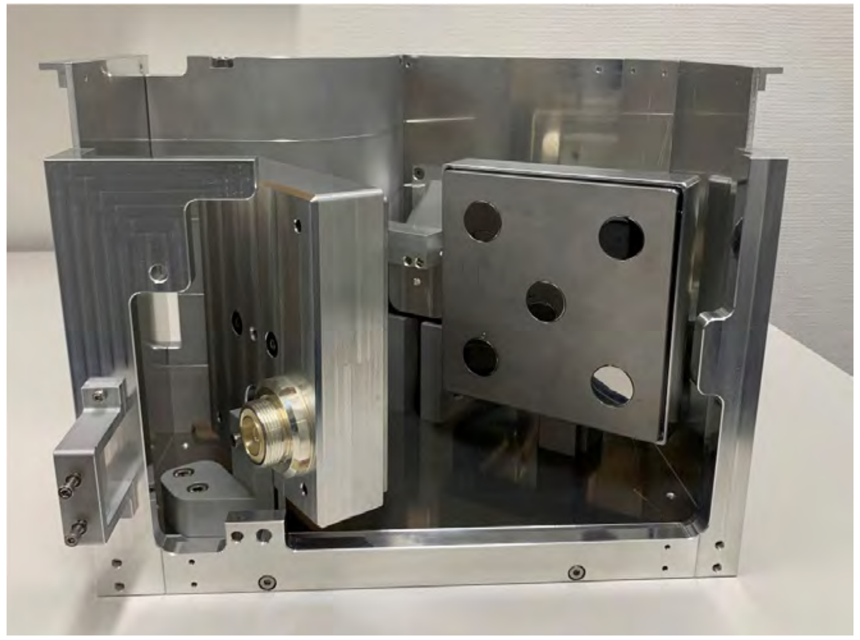
Alpha particles are the natural result of fusion reactions, as they are obtained from deuterium and tritium nuclei, the “fuel” gases of the plasma. They must be well confined to keep the experiment at high temperature and avoid disturbances. The Collective Thomson Scattering system (CTS) will measure the amount of alpha particles and other fast ions in the plasma.

Measuring the temperature of the plasma-facing components

The ITER Equatorial Port Wide Angle Viewing System (WAVS) is an optical diagnostic that will provide real-time measurements of the visible and infrared light coming from the divertor and the main chamber wall. These measurements will contribute to the safe operation of the machine by providing information about the temperature of the plasma-facing components. F4E is currently performing the final design of this system.



Integration of the Wide Angle Viewing System in the Equatorial Port 12. © F4E



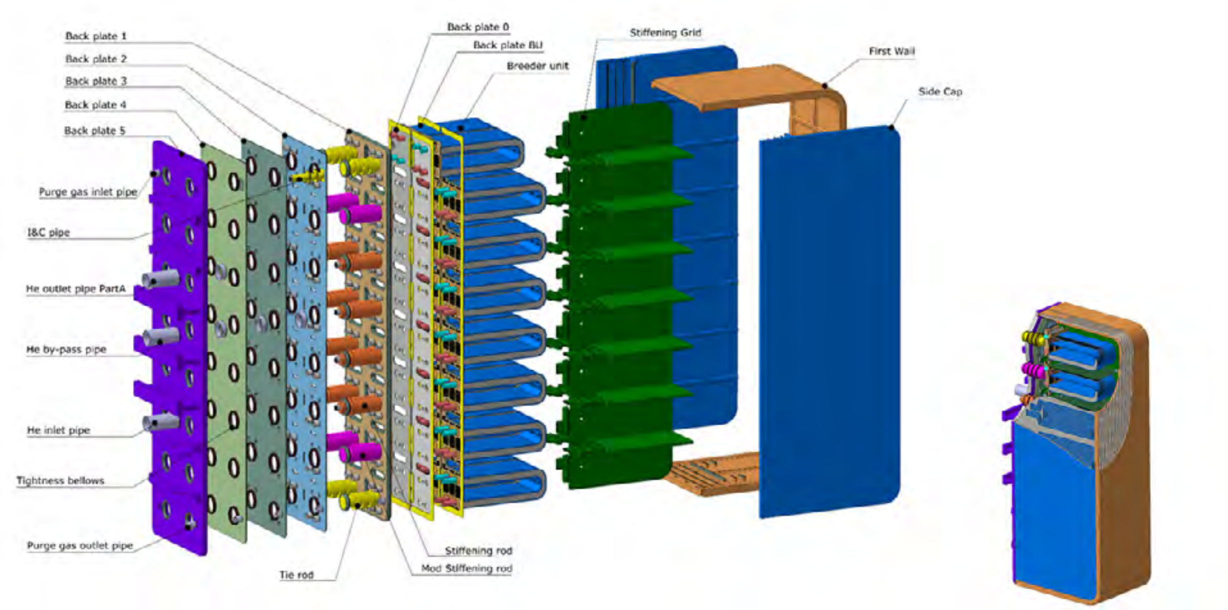
First mirror unit mock-up prototype with realistic geometry. © University of Basel

TEST BLANKET MODULES

Experts working in the area of Test Blanket Modules Systems (TBMS) are among those who will use ITER to understand how tritium can be continuously bred in order to keep the fusion reaction going. Without a doubt, the lessons drawn will have significant implications towards the design of future fusion reactors like DEMO. In essence, they will generate a new nuclear system and licensing using advanced materials and top fabrication techniques.

Contracts awarded to prove the fabrication of Test Blanket Modules

F4E and CEA/Framatome joined forces to test the feasibility of the Test Blanket Module sets fabrication and their assembly processes. Amongst other things, they will examine the welding processes and related technologies for the manufacturing of structures using EUROFER97—the newly developed steel that provides adequate resistance to neutron irradiation.



Helium Cooled Pebble Bed (HCPB) European Test Blanket Module concept. © F4E

IN-VESSEL

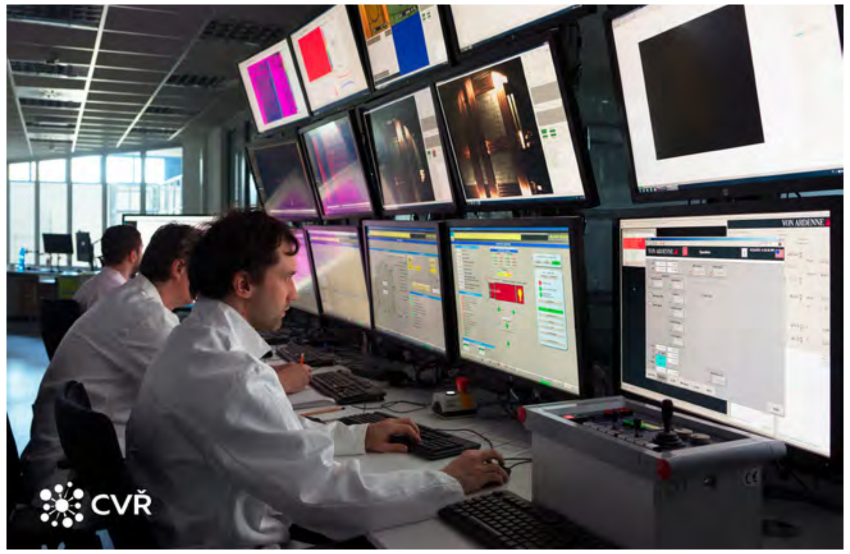
The extremely hot temperature of the fusion plasma will be mostly felt by the In-Vessel components, otherwise known as plasma-facing components, due to their direct exposure to high heat and neutron fluxes. The divertor, likened to a massive "ashtray" where the plasma ashes and impurities are diverted to, consists of 54 cassettes, all to be manufactured by Europe, and is located at the lower part of the machine. The blanket is made of 440 modules, the first wall panels, covering the walls of the vacuum vessel. Europe is responsible for the production of 215 of them.

Work in progress

Blanket Cooling Manifold	
Design & Qualification	97%
Blanket & First Wall Panels	
Qualification	100%
Series production	50%
Series process qualification	25%
Divertor Vertical Target	
Qualification	45%
Divertor Cassette Body	
Qualification stage I	100%
Qualification stage II	80%
Design & Engineering	75%
Manufacturing	5%

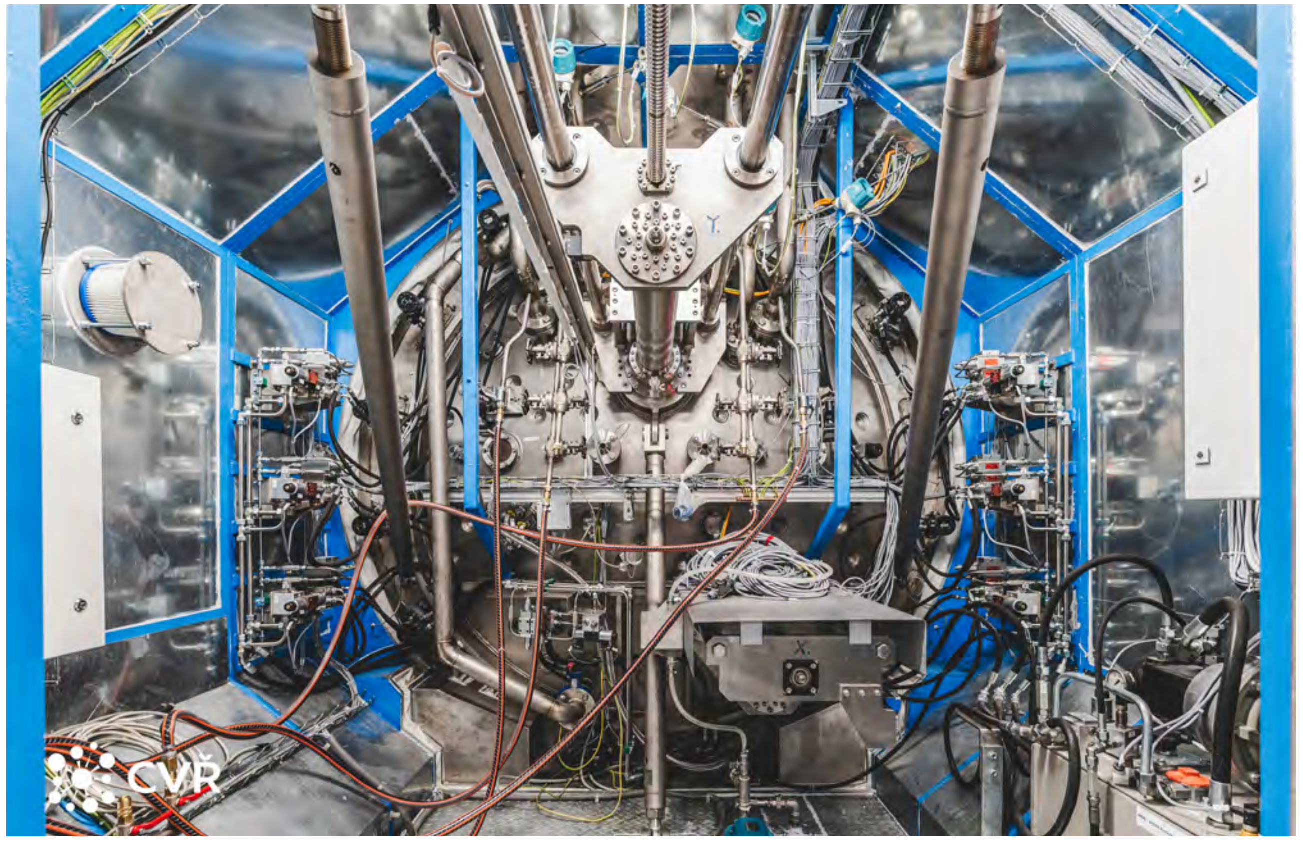
HELCZA—the new facility where Europe will test In-Vessel components

Almost nine years ago, F4E launched a call to co-finance a high-heat flux test facility, able to handle components containing beryllium. With the support of EU funds, and the Ministry of Education, Youth and Sports of the Czech Republic, HELCZA became a reality. The facility is equipped with a set of advanced diagnostics to monitor the ITER first wall panels' behaviour during testing. The beryllium management system will ensure the safety of the operators before, during and after the testing. What kind of tests can be performed? Thermal resistance tests, material research, conduct studies of phenomena under high heat flux conditions. HELCZA can also be of service to the aerospace industry, applications in the areas of safety, health, and environment.



Control centre of HELCZA Facility. © CVŘ

Positioning shielding frames on test sample, HELCZA Facility. © CVŘ



Outer view of sample lid, HELCZA Facility. © CVŘ

All contracts awarded for ITER Divertor Cassette bodies

One of the ITER components to feel the blistering heat of the super-hot plasma is the divertor. Located in the lower part of the machine, it consists of 54 units known as cassettes, which will form a massive tray of roughly 142 m^2, where all impurities resulting from the fusion reaction will end up falling. Each cassette is made of a body, which will host a layer of components to protect its surface from the high plasma temperatures. Europe will deliver 58 cassette bodies (54 + 4 spares). The first should be ready in 2025 and the last towards the end of 2027. Each cassette body measures 0.8 x 2.3 x 3.5 m and weighs roughly 4.8 tonnes. Until recently, F4E had signed contracts for the production of 19 units. A new contract was signed for the remaining 38 units, plus one optional, with Walter Tosto, marking the final procurement for this equipment.

Metrology preliminary check performed on parts of ITER Divertor Cassettes bodies, Walter Tosto, Italy, September 2021. F4E has signed two contracts with Walter Tosto for the delivery of cassette bodies. © Walter Tosto

Metrology preliminary check performed on parts of ITER Divertor Cassettes bodies, Walter Tosto, Italy, September 2021. F4E has signed two contracts with Walter Tosto for the delivery of cassette bodies. © Walter Tosto

CRYOPLANT AND FUEL CYCLE

The ITER machine will have to cope with extreme temperature fluctuations. Cold helium will circulate inside the magnets to bring their temperature down to -269 ˚C in order to confine the hot plasma. The magnets, thermal shields and cryopumps will have to be cooled down and maintained with the help of one of the most advanced cryogenic systems to date. The cryoplant can be described as a massive refrigerator that will generate the freezing cold temperatures required for the fusion machine. Europe is responsible for the Liquid Nitrogen (LN2) Plant and its auxiliary systems.

Work in progress

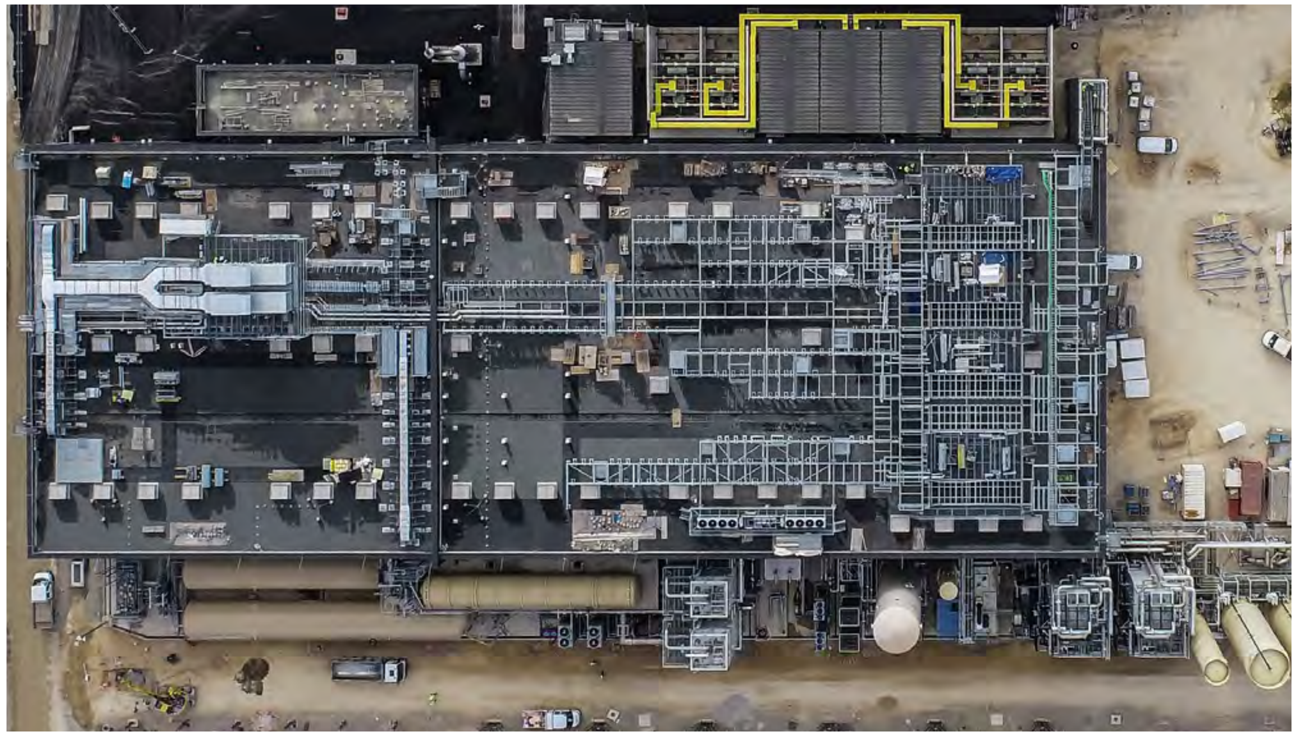
LN2 Plant	
Contracts signed	95%
Design	100%
Manufacturing	100%
Installation & Commissioning	70%
Vacuum Pumping	
Contracts signed	58%
Design	60%
Manufacturing	23%
Tritium Plant	
Contracts signed	32%
Design	35%
Manufacturing	18%
REMS and Rad Waste	
Contracts signed	7%
Design	9%
Manufacturing	0%

Preparing the ITER Cryoplant commissioning

After the installation of the piping and its welding, the completion of pressure tests was the last big milestone before the end of the mechanical works in the facility. Electrical and instrumentation works were also completed. The commissioning of the six gas helium storages started. Each of them is 24 m tall, 5 m in diameter and will contain 400 m^3 of gas pressurised to 20 bar (approximately the pressure of 20 atmospheres).

As big as two football pitches, the cryoplant provides cooling fluids for the superconducting magnets, the cryopumps, and thousands of square metres of thermal shielding, Cadarache, March 2021. © Christian Lünig

Gaseous helium storages that would be enough to fill 4 million party balloons. Cadarache, September 2021. © F4E



Large power machines inside the cryoplant will dissipate considerable amounts of heat (on the order of 20 MW). HVAC ducts on the building's roof are tasked with extracting it. The yellow elements at the top are busbars feeding electrical power to the installation. November 2021. © ITER Organization/EJF Riche

Manufacturing of torus and cryostat cryopumps started

Production started for eight cryopumps. They will ensure the proper vacuum conditions in ITER. Six of them will pump out the residual gas from the vacuum vessel housing the fusion reaction, while another two will deal with the cryostat. The first components have already been manufactured.

Welding the cryopanels at Research Instruments (RI), Germany, August 2021. These rectangular-shaped components measuring 1 m long and 0.2 m wide will perform the pumping by trapping the gas particles in their supercold surface. © RI

Two pump plugs in the workshop, not yet fully machined. These are the biggest components of the cryopumps. France, July 2021. © ALSYOM

Europe delivered warm regeneration box

ITER will have several cryopumps to ensure the proper vacuum conditions in the experiment. After some time, however, the equipment will get saturated of gas particles and will need to release them to continue pumping correctly. Europe has delivered to ITER Organization the warm regeneration box, a piece of equipment to help with this task.

The warm regeneration box in the Cryoworld premises, some weeks before delivery to ITER Organization. Netherlands, November 2021. © F4E

Operators unloading the warm regeneration box in the ITER premises, France, December 2021. © F4E

NEUTRAL BEAM AND ELECTRON CYCLOTRON POWER SUPPLIES AND SOURCES

To heat up the ITER plasma at 150 million ˚C, roughly ten times the temperature at the core of the Sun, we will need powerful heating systems using high-energy beams. This requires the fabrication and testing of new equipment before manufacturing the ITER components.

For this reason the ITER Neutral Beam Test Facility (NBTF), located in Padua, Italy, has been set up consisting of two test beds:

SPIDER (Source for Production of Ion of Deuterium Extracted from Radio Frequency plasma), will help scientists to develop the ion source, one of the critical elements needed for the operation of the ITER Neutral Beam Injectors.

MITICA (Megavolt ITER Injector and Concept Advancement) will develop and test a full-size prototype of a Neutral Beam Injector.

The NBTF receives contributions from F4E, ITER Organization, the ITER Domestic Agencies of India and Japan, as well as Italy's Consorzio RFX, the host of the infrastructure.

Work in progress
Electron Cyclotron Power Supplies
1st to 8th unit
- Manufacturing 80%
- Delivery 40%

Neutral Beam Test Facility
SPIDER - Completed

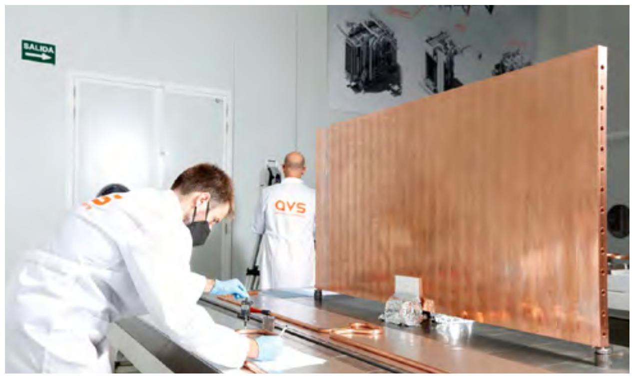
MITICA
- Contracts signed 100%
- Design 95%
- Manufacturing 80%
- Delivery 70%

ITER
Heating Neutral Beam Power Supplies
- Contracts signed 85%
- Design 70%
- Manufacturing 10%

Neutral Beam Line Components
- Contracts signed 85%
- Design 20%

MITICA beam line components shaping up

F4E in collaboration with AVS–Tecnalia is producing the beam line components of the MITICA experiment. They consist of the neutraliser, the electrostatic residual ion dump, the calorimeter and auxiliary equipment. In 2021, the manufacturing readiness review for the critical parts of the equipment was completed. More prototypes advanced and the qualification of critical processes was concluded for the production of some components.

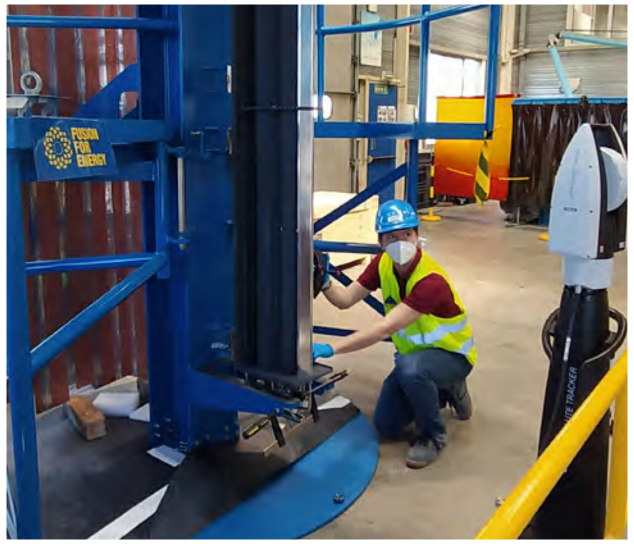


Performing dimensional measurements on one of the 200 calorimeter tubes to be produced, AVS, Spain, November 2021. ©F4E

Inspection of the support pieces used for the beam stop elements, AVS, Spain, November 2021. © F4E

MITICA Cryopump section passes qualification tests

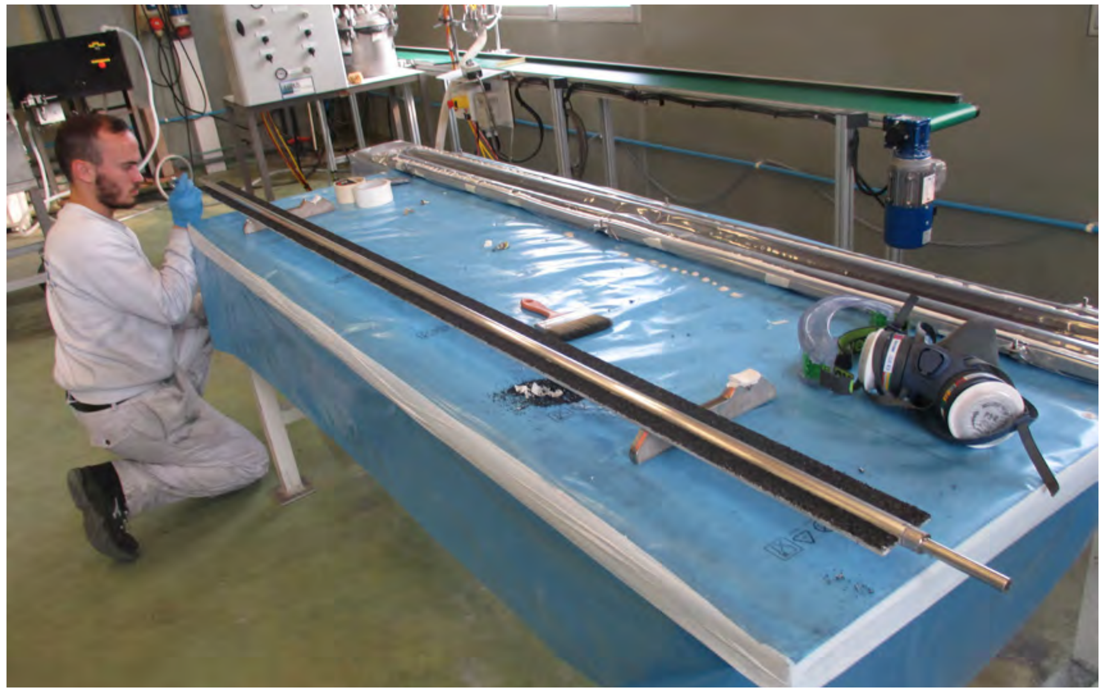
The cryopump will ensure the vacuum conditions of the experiment. It consists of 64 pumping sections assembled in two frames. F4E and its contractor, SDMS, have already manufactured, assembled and tested a mock-up pumping section successfully. The qualification of this component signalled the start of the serial production.



Giacomo Calchi, F4E Metrologist, inspecting the mock-up pumping section. SDMS, Saint-Romans, France, April 2021. © F4E

All MITICA Cryopanels manufactured

Each pumping section is made of three cryopanels, which perform the vacuum pumping function, and four thermal radiation shields, which keep cryopanels at the right temperature. A total of 231 cryopanels were successfully coated with charcoal to be assembled in the MITICA cryopump.



SDMS operator inspecting a panel after the charcoal granules application. SDMS, Saint-Romans, France. © F4E

Electron Cyclotron High Voltage Units delivered

Several heating systems will be deployed to raise the temperature of the ITER plasma to 150 million °C. The Electron Cyclotron is one of them. F4E in collaboration with Ampegon, delivered two Electron Cyclotron High Voltage Power Supply units.

Another power supplies unit for the ITER Electron Cyclotron, procured and financed by F4E, leaving from Ampegon, Switzerland, to be delivered to Cadarache, France. © Ampegon

Another power supplies unit for the ITER Electron Cyclotron, procured and financed by F4E, leaving from Ampegon, Switzerland, to be delivered to Cadarache, France. © Ampegon

ANTENNAS AND PLASMA ENGINEERING

Large antennas will channel the electromagnetic waves generated by two heating systems – the Electron Cyclotron (EC) and the Ion Cyclotron (IC) – to heat ITER's plasma to the temperatures required for fusion to happen. EC Launchers will help scientists to target specific parts of the plasma by guiding the waves with the help of mirrors. F4E is working on these projects with support on engineering from companies and European fusion laboratories.

Work in progress

EC Launcher	
In-vessel Design	95%
Ex-vessel Design	70%
Manufacturing	9%
IC Antenna	
Design	48%
EC Control System	
Design	80%
Manufacturing	20%

First prototype of the ITER Blanket Shield Module (BSM) successfully produced

F4E together with the French company ATMOSTAT successfully completed this task. The BSM will be produced using special materials due to its exposure to high plasma temperatures. In terms of manufacturing, to avoid any deformations resulting from welding, the technical teams discovered a new way to perform the linear welds.

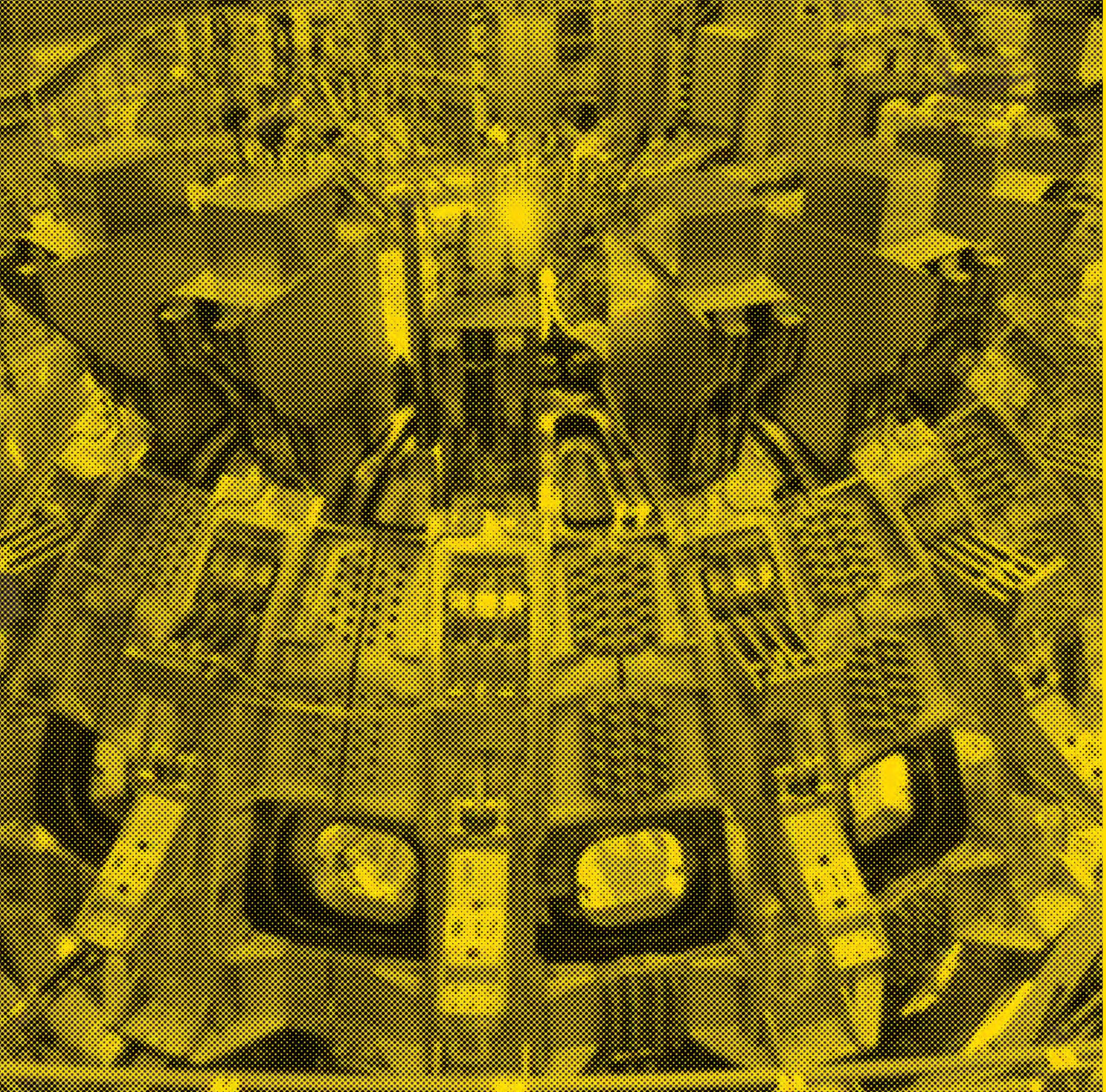
First prototype of ITER Blanket Shield Module (BSM) successfully fabricated by ATMOSTAT. © ATMOSTAT

Discs in production that will allow more microwave power to heat ITER plasma

Diamonds can act as resistant windows through which the power produced by the Electron Cyclotron and the Upper and Equatorial Launchers will travel in the hermetically sealed vacuum vessel. F4E and Diamond Materials are responsible for the production of 60 diamond discs to help up us flare up the super-hot plasma. Following the successful completion of the Manufacturing Readiness Review, their production officially started.

Technician in the back editing the macro that runs the machine, technician in the front inspecting the initial growth phase of diamond discs. © Diamond Materials

Technician getting ready to inspect an 80mm free-standing unpolished diamond disc. © Diamond Materials



03

The Broader Approach

Taking a step closer to fusion energy through Research & Development

Bringing together two parties that share the same vision on how to address fusion research, summarises the spirit of collaboration in the "Broader Approach". In February 2007, an Agreement was signed between Europe and Japan, complementing the ITER project, to promote R&D in the field of fusion technologies.

The Broader Approach consists of three projects:

- The Satellite Tokamak, known as JT-60SA, a fusion device about half the size of ITER to study plasma operations;
- The International Fusion Materials Irradiation Facility - Engineering Validation and Engineering Design Activities (IFMIF-EVEDA), an installation built to design, test and qualify the materials for future fusion power plants;
- The International Fusion Energy Research Centre (IFERC) comprising three sub-projects for plasma remote experimentation and simulation.

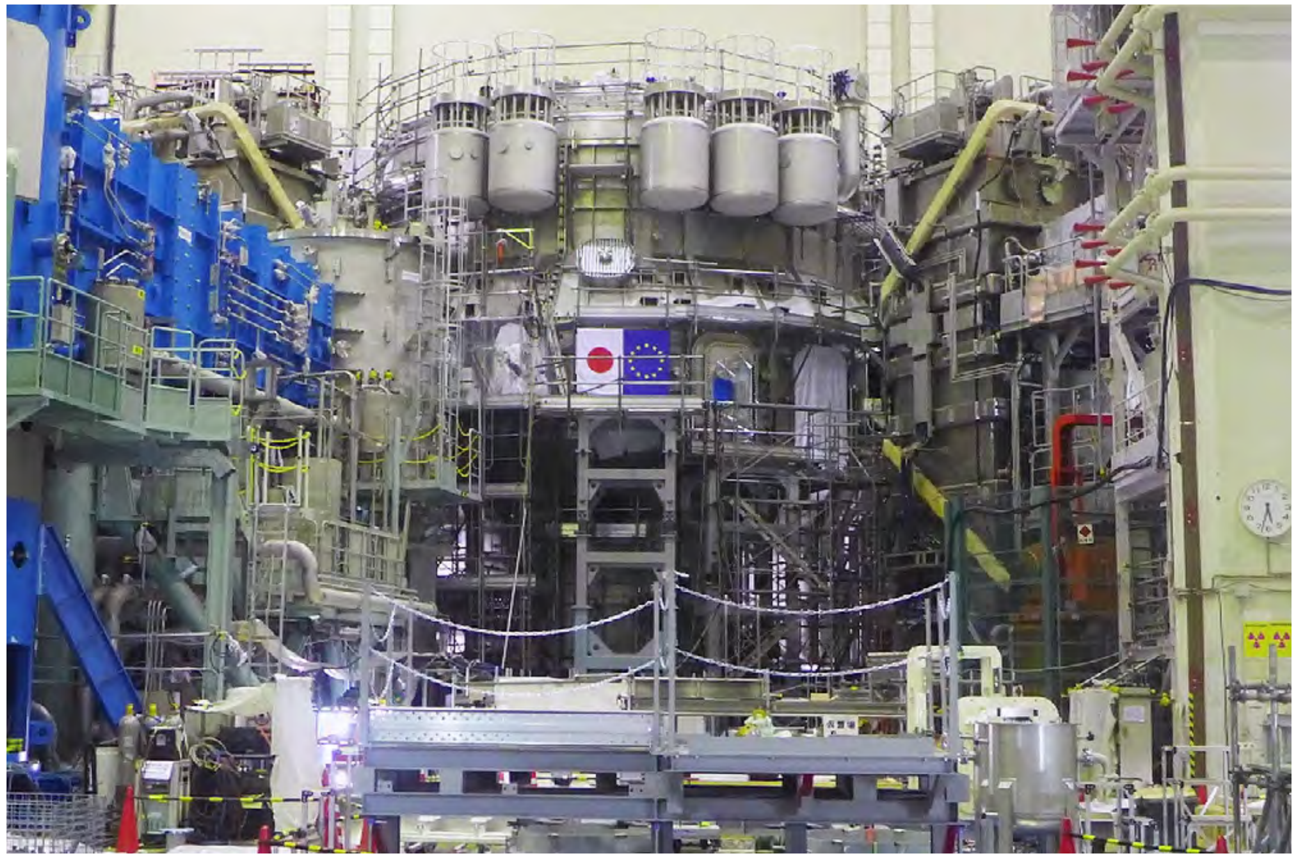
The first phase of the three projects was completed. In 2020, the second phase of the Broader Approach Agreement was signed, offering continuity to this valuable partnership between the European Union and Japan.

JT-60SA

The JT-60SA is the largest tokamak in the world until ITER starts operations. Located in Naka, Japan, this device is the upgrade of an existing tokamak to be capable of long pulse operation. The upgrade involved the complete dismantling of the old device, the refurbishing of the buildings, the upgrade of power supply and heating systems. This experimental device will support ITER through complementary experiments in order to improve the design of the Demonstration (DEMO) fusion reactor, which will be connected to the grid.

Full current for Europe's Toroidal Field coils

The year started by energising all JT-60SA magnetic coils systems. In March, the team marked a major millstone: Europe's 18 Toroidal Field coils, among the largest superconducting magnets in operation to date, were the first to reach full current (25.7 kA), producing the design toroidal field of 2.25 Tesla on tokamak major radius. A first glow discharge plasma was documented by optical diagnostics. Subsequently, a short circuit caused some limited direct damages to the device, requiring extensive tests and repair to restart operations for the first plasma.



View from above of JT-60SA prior to starting operations, January 2021 © F4E/QS

IFMIF/EVEDA

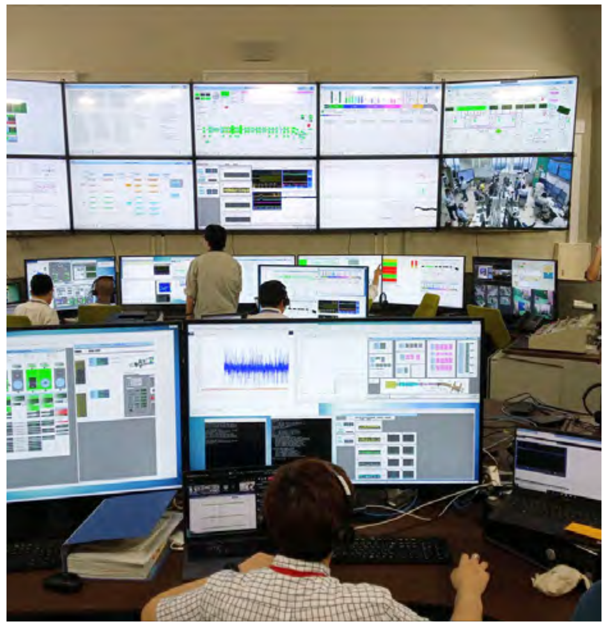
Reproducing the conditions of the future fusion reactors is the objective of the International Fusion Materials Irradiation Facility (IFMIF). This accelerator-based facility will test materials similar to the conditions of the DEMO reactor, which will follow ITER. The know-how acquired will help engineers to improve the durability of materials and minimise their activation. The Engineering Validation and Design Activities (EVEDA) for IFMIF are conducted in Rokkasho, Japan.

Successful beam operation for LIPAc accelerator

The teams working in LIPAc made further progress towards the development of the device: the accelerator was able to produce a low intensity proton beam, accelerate it, and transport it. This was achieved in line with the new configuration of the machine, which consists of the complete accelerator except for the cryomodule, which will be assembled next year. Next came the use of a deuteron beam, which also proved successful.

Operation rehearsal in the Central Control Room, Japan, June 2021. © IFMIF/EVEDA

Preparation of sensor installation in the intermediate transport line in place of the cryomodule, Japan, March 2021.
© FMIF/EVEDA



First shot from Central Control Room. Japan, July 2021.
© IFMIF/EVEDA

Realignment of a magnet in the Low Energy Beam Transport (LEBT) line. Japan, March 2021. © IFMIF/EVEDA

IFERC

The International Fusion Energy Research Centre (IFERC) Project, hosted in Rokkasho, Japan, comprises three sub-projects:

- **The Computational Simulation Centre (CSC) hosted “Helios”, a supercomputer which offered the fusion community the possibility to run simulations. In 2019 the CSC prepared the framework for an exchange of computer time between Europe and Japan to allow joint projects in their respective supercomputers.**
- **The Demonstration Reactor (DEMO) activities aim at reinforcing collaboration with EUROfusion in the area of materials, design and planning. This year, the DEMO Activity Integrated Project Team continued working on pre-conceptual DEMO designs.**
- **ITER Remote Experimentation Centre (REC) started working on offering Europeans remote access to JT-60SA and the LIPAc accelerator, after having successfully demonstrated remote participation in experiments.**

IFERC - ITER Collaboration

A collaborative work programme brought formally together the two projects towards the end of the year to address two areas. First, teams worked in remote experimentation by giving ITER parties access to data from tests carried out on ITER applications. Second, teams collaborated in computer simulations using supercomputer resources. IFERC supported ITER in studying unplanned plasma disruptions, and divertor physics codes. Finally, IFERC supported IFMIF/EVEDA to allow the commissioning of components and operation through remote participation activities.

04

Working together with stakeholders

F4E engaged with European and national policy-makers using mainly electronic periodic updates respecting the restrictions imposed by the pandemic.

A constant flow of information between F4E, its committees, and the network of ITER Industrial Liaison Officers (ILOs), provided updates on various initiatives putting safety first; new measures aligning manufacturing procedures with new health and safety standards; tools put in place to ensure business continuity.

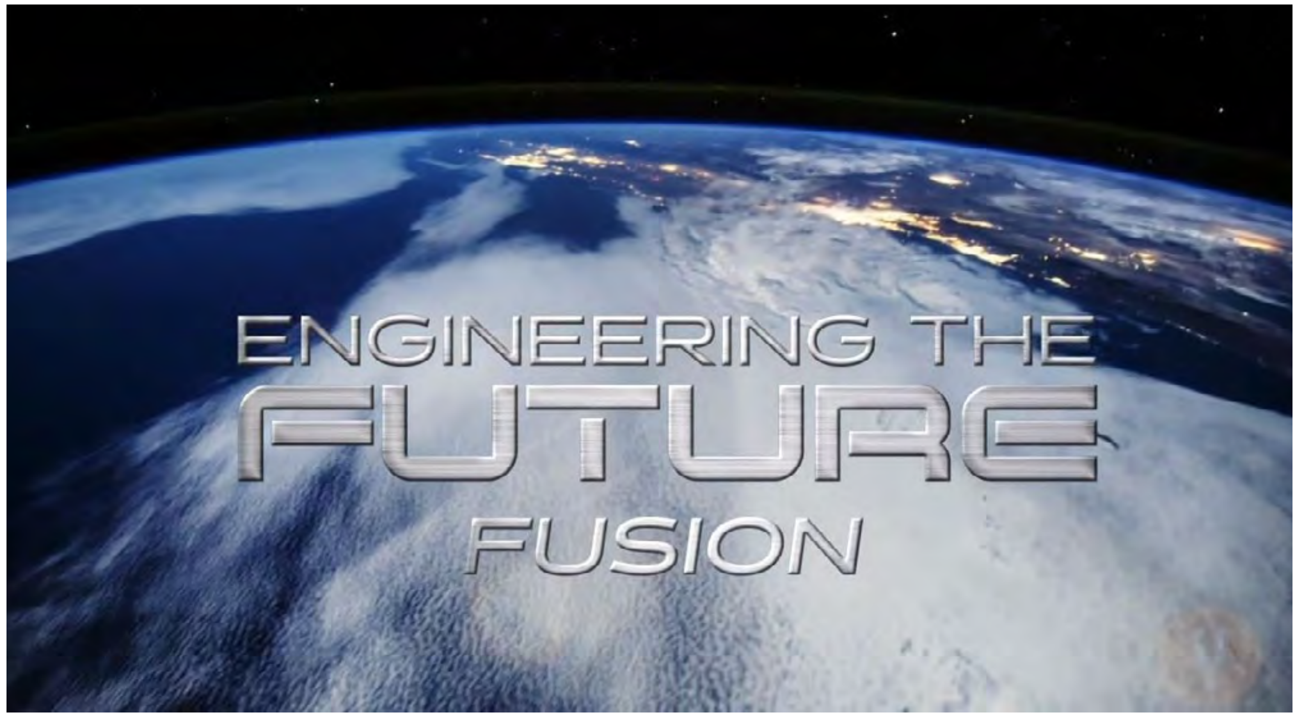
To strengthen the spirit of partnership between ITER Parties, Europe maintained its firm commitment to building stronger ties by reaching out to its international partners in order to share good practice.

F4E in Big Science Business Forum (BSBF) webinar

"How industry and research infrastructure can innovate the big science market" was the topic of the third BSBF webinar. A virtual audience of over 450 people joined F4E, CERN, ESA, EMBL, CDTI, PERIIA and some academic bodies, such as UPM.

Engineering the future-Fusion

A new series on Curiosity Stream and HBO Max explored the potential of fusion. F4E collaborated with Bigger Bang Communications, the production team behind the Netflix hit "Revolutions: The Ideas that changed the world", to meet the people behind the extraordinary machines that will shape our future. F4E members of staff and our industrial partners -SIMIC and ASG Superconductors- were amongst those featured.



Big Research Infrastructures discuss logistics of the future

F4E in collaboration with DAHER took part to the online Research Infrastructure (RI) Logistica conference to present how they overcame challenges in managing the logistics of ITER components.

VAC-TRON receives F4E Technology Transfer Award

F4E's first Technology Transfer Award, launched early in the year, offered a reward of 10 000 EUR to the most promising breakthrough. The experts overseeing this exercise were impressed with the overall quality of the applications, the range of technologies addressed and their long-term impact in markets beyond fusion. One of them stood out for its novelty and its commercial prospect—VAC-TRON, a Spanish SME, specialised in the field of hermetic interconnectors.

Franc Moreno, VAC-TRON Industrial Director. The company was the recipient of the F4E's first Technology Transfer Award. © VAC-TRON

EU Commissionner Kadri Simson in ITER

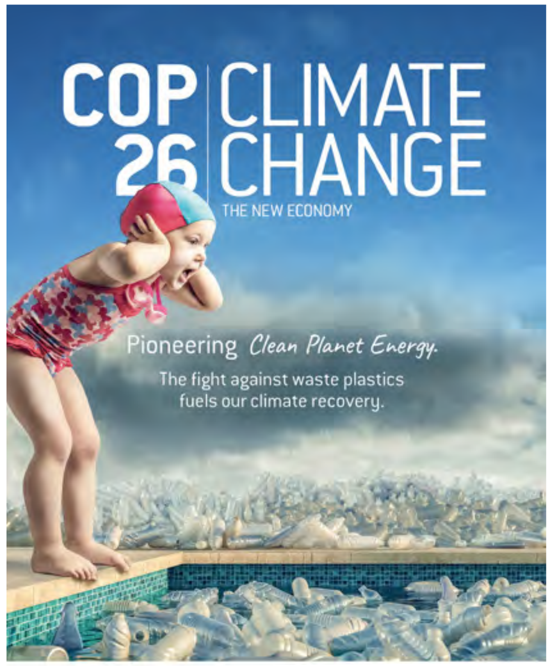
A visit to the ITER site offered the European Commissioner for Energy, Kadri Simson, the opportunity to witness the progress in construction and manufacturing. Specific working meetings were held with Bernard Bigot, ITER Organization Director General, and Johannes Schwemmer, F4E Director.

EU Commissioner Kadri Simson with ITER Director General Bernard Bigot. © ITER Organization

Fusion in COP-26 as abundant, safe, sustainable energy for the future

The COP26 summit brought together world leaders to take action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change.

In one of the key publications of the summit, Johannes Schwemmer, Director of Fusion for Energy, made the case for fusion.



F4E in Barcelona 2021 Energy Days

This year's edition focused on the "Impulse of research to the sustainable future of tomorrow". The event, co-organised by the UPC BarcelonaTech University, the Government of Catalonia, the City Halls of Barcelona and Sant Adria de Besòs, and Fusion for Energy (F4E), highlighted the role of research and innovation and the importance of the collaboration with industry.

Stavros Chatzipanagiotou, F4E Head of Communications, addressing the conference © F4E

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