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FUSION FOR ENERGY

# HIGHLIGHTS 2025

THE MAIN ACHIEVEMENTS

# 2025

# Foreword

Dear stakeholders, colleagues, readers,

Fusion energy is entering a decisive phase. Scientific progress, growing industrial capabilities and increasing levels of public and private investment are reshaping the global landscape. Meanwhile, the strategic importance of fusion for Europe—supporting energy security, sustainability and competitiveness—has never been clearer.

In this context, Fusion for Energy (F4E) is playing a central role in delivering Europe's contribution to ITER, the Broader Approach, and IFMIF-DONES while strengthening the foundations of a future fusion ecosystem. The achievements presented in this report reflect both the scale of this endeavour and the collective effort of our staff, supply chain and stakeholders across Europe and beyond.

**2025 has been a year of strong delivery.** F4E maintained a high level of performance achieving 91% of the milestones set to meet, reaching its strongest result to date. This results from the professionalism of our staff, the knowledge and expertise mastered by our supply chain, the systematic application of lessons learnt, and an increasingly close integration with ITER Organization.

**Progress on all fronts and deliveries of major components.** On the ITER site, the civil engineering teams successfully handed over the Control Building together with the Neutral Beam and Fast Discharge buildings. The insertion of the first European Vacuum Vessel sector in the Tokamak Pit marked a major step forward in the assembly of the device, illustrating the tangible progress after years of complex design and manufacturing. We also celebrated important advancements in the areas of power supply systems, in-vessel components, diagnostics. Europe continued to make progress in the production and delivery of critical components for the future phases of the project.

Beyond ITER, Europe has strengthened its collaboration with Japan through **Broader Approach Agreement**, in particular through JT-60SA, which remains essential to reducing technical risks and preserving European know-how. At the same time, F4E has expanded its portfolio with the advancement of the IFMIF-DONES programme, a strategic facility for the qualification of materials for future fusion power plants. F4E's Technology Development programme has advanced by including a number of Technology Mapping Workshops in 2025.

**F4E's contribution goes beyond project delivery.** Our activities continue to shape a unique European industrial ecosystem, bringing together large companies, SMEs and research organisations. Through sustained engagement with industry and new partnerships—including with emerging fusion start-ups—we are reinforcing Europe's position in a rapidly evolving landscape. Knowledge exchange, talent development and stakeholder dialogue, including initiatives such as the F4E Roundtable in July 2025, further contribute to strengthening the fusion community.

**Europe holds a strong position in the global fusion race.** The capabilities developed through ITER and associated programmes have created a robust industrial and scientific base. Building on these assets, Europe must continue to act with ambition and coherence to maintain its leadership. In this context, F4E stands ready to support the implementation of the European fusion strategy, capitalising on its experience, technical expertise and close links with industry and research organisations.

Fusion remains a long-term endeavour, requiring sustained commitment and disciplined industrial execution. Step by step, tangible progress is being made towards making fusion a viable and sustainable energy source with ITER as the cornerstone of the EU programme. The work carried out today is essential to enabling Europe's future access to safe, reliable and carbon-free energy.

I would like to conclude by expressing my sincere gratitude to the Member States and the European Commission in F4E's Governing Board, the ITER Organization and all our partners for their continued trust and support. Above all, I would like to thank the F4E staff, the companies and organisations working with us for their professionalism, expertise and commitment.

**Marc Lachaise**
Director, Fusion for Energy

## Fusion - an energy for the future

Fusion is the process that powers the Sun and other stars. Harnessing it on Earth, as an energy source, is a major scientific and technological challenge with far-reaching potential rewards:

- The fuels required are widely available reducing the risk of any geopolitical tensions. There are enough supplies to last millions of years.
- Small amounts of fuel can generate plenty of energy: 60 kg of fusion fuel can provide the same amount of energy as 250 000 tonnes of oil.
- No greenhouse gas emissions or long-lasting radioactive waste are produced. Fusion power plants would be inherently safe posing no risk to populations in the vicinity.
- Fusion plants would be able to complement the power generation with renewables by providing a steady "baseload" electricity supply, when needed.

With these advantages, fusion has the potential to broaden Europe's energy mix and provide our citizens with safe, sufficient and sustainable power.


## Fusion for Energy

Fusion for Energy (F4E) is the European Union organisation responsible for providing Europe's contribution to ITER, the biggest scientific experiment on the path to fusion energy, amounting to nearly half of the project.

In parallel, F4E is involved in major fusion R&D projects as part of the Broader Approach agreement between Europe and Japan, including the JT-60SA fusion device. Finally, F4E contributes to the construction of IFMIF-DONES, a large-scale facility to test fusion materials.

Ultimately, F4E will use the knowledge and expertise built through these projects to support the construction of demonstration fusion power plants.

## Delivering fusion projects

The top priority is the timely execution of Europe's contribution to international fusion projects. F4E collaborates with a vast supply chain to provide complex components and infrastructure for ITER and other experiments. Since 2007, we have signed more than 1400 contracts with at least 3000 European companies and laboratories, injecting over 7 billion EUR in the economy. Through these activities, we are developing and testing key technologies to pave the way for commercial fusion.

## Investing in innovation and talent

Building new knowledge and creating expertise are vital to Europe's fusion ecosystem. F4E's human capital, its contribution to Big Science, and it potential to attract, train and shape new talent via its supply chain, are shaping tomorrow's workforce. To bridge the technology gaps for commercial power plants, F4E's Technology Development Programme supports R&D in key areas so that Europe masters new know-how.

## Positioning Europe in the fusion race

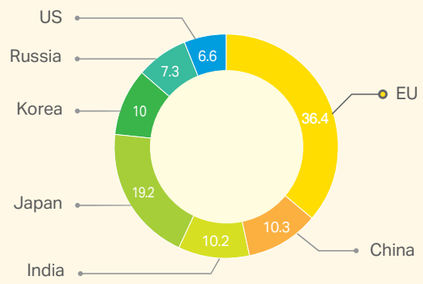
Europe's involvement in fusion generates significant business opportunities for companies, SMEs and laboratories as part of F4E's supply chain. In turn, they create new jobs, acquire skills and hands on experience in a new market which can generate breakthroughs and spin-offs to other sectors. F4E is helping them to stay competitive and to reap the numerous benefits of fusion technologies.

*According to the latest independent study, the investment of F4E for the period 2008-2024, amounted to nearly 5.6 billion EUR and generated an extra 5.95 billion EUR in Gross Value Added. These activities sustained an average of 5,600 additional full-time jobs per year (a total of 39,000 job-years).*

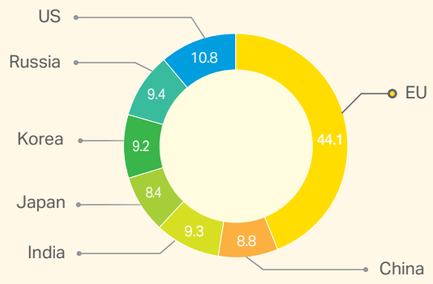
*Source: Fusion for Energy Impact on Europe's Economy and Industrial Competitiveness (2018-2024)*

# 2025 Key figures

## Contributions to ITER

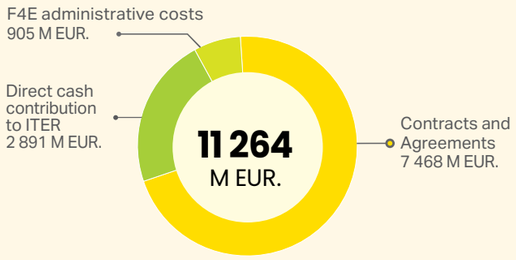



Total In Kind contributions in percentages
ITER Parties 2007-2025

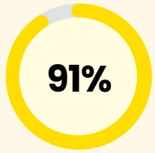



Total In Cash contributions in percentages
ITER parties 2007-2025

## F4E budget breakdown of main activities 2007-2025



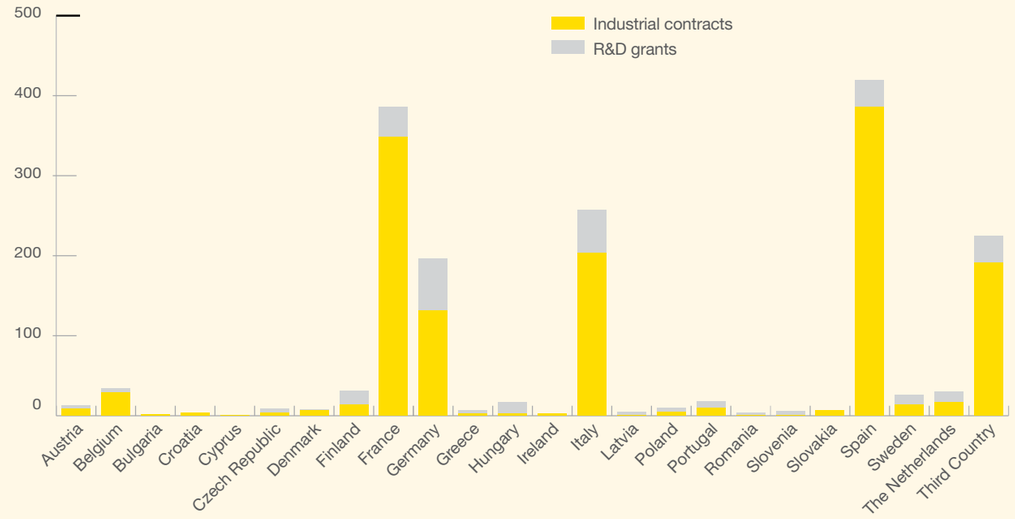

## ITER Project Progress 2025




Completion of planned activities reported by F4E


Cumulative completion of planned activities on critical path reported by ITER Organization

## F4E contracts and grants by country




Number of contracts and grants awarded by F4E 2008-2025
*Since 2021 Switzerland and United Kingdom are listed as 'Third Country'*

## Contracts with Industry and Laboratories

**€337M**
Total value of contracts signed in 2025

**€7.16Bn**
Total value of contracts signed 2007-2025

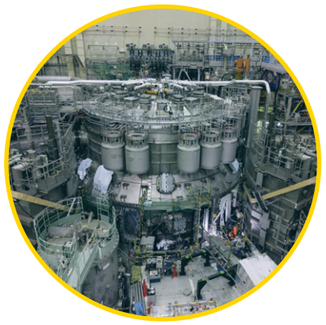
**1430**
Contracts signed since 2007

**694**
Companies

**2400**
Subcontractors

**75**
Research Organisations

# F4E achievements



## January

New components to upgrade JT-60SA. F4E meets industry at Forum Fusion Germany. Collaboration with EUROfusion labs in Electron Cyclotron Heating technologies.

## March

Europe delivers sector 4 of ITER Vacuum Vessel. F4E hosts first technology mapping workshop. New LIPAc section transferred into accelerator vault. All ITER cryopumps manufactured.

## May

Commissioning underway for Europe's ITER Cryoplant. New grant signed to advance divertor remote handling solutions. More ITER diagnostics move into manufacturing.

## February

France's President Macron and India's PM Modi visit ITER. ICAS consortium wins Fusion Technology Transfer Award. European systems power up Japanese gyrotrons in JT-60SA.

## April

ITER Divertor Cassettes pass important tests. Contracts signed for Technology Development Programme. F4E promotes new opportunities at ITER Business Forum.


## June

F4E Roundtable brings together 200 stakeholders to discuss Europe's future in fusion. ITER Fast Discharge Building completed. F4E and Proxima Fusion sign collaboration agreement.

## July

Massive cryopump installed in MITICA. International experts review Test Blanket Modules design. Kilometres of pipes manufactured to cool down ITER.

## September

F4E and CERN join forces in Big Science. Europe's construction teams complete ITER Control Building. New diagnostics systems installed in JT-60SA.


## November

Multilateral International DONES Agreement signed. Neutral Beam buildings handed over to ITER Organization. All European Cold Valve Boxes delivered.

## August

European high voltage supplies energised. HELCZA facility ready to test more in-vessel components. Fast progress in ITER emergency power supply buildings.

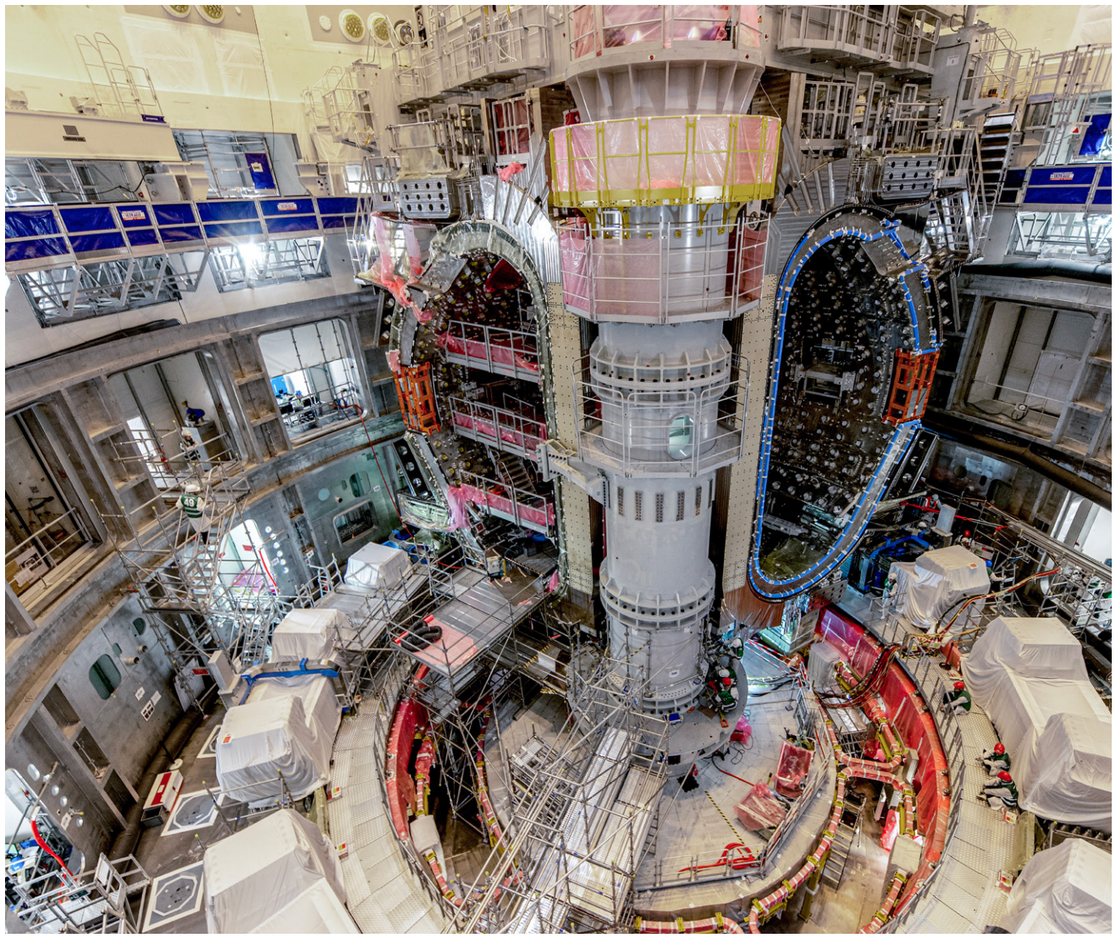
## October

F4E Supply Chain Days bring together European industry. Axon' Cable wins F4E Technology Transfer Demonstrator call. EU Agencies hand over award to F4E's Women's Leadership Development Programme.

## December

F4E signs agreement with Novatron Fusion. Production of ITER First Wall Panels advances. New framework contract for ITER assembly tools signed. Gyrotron design ready for manufacturing.

# ITER in progress



©ITER Organization

## One third of the ITER Vacuum Vessel in place.

The first three, out of the nine Vacuum Vessel sector modules, were transferred into the Tokamak Pit during the year. Europe's sector #5 arrived in November.

©ITER Organization

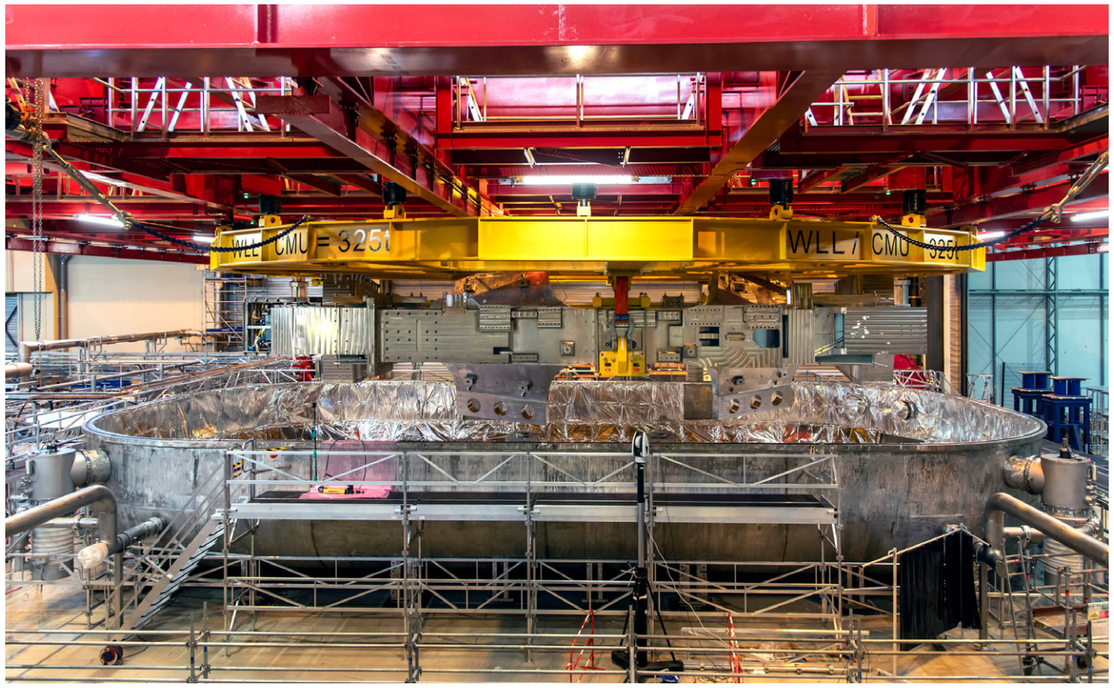
## Heavy-lifting at the Assembly Hall.

Activities were in full swing at the Assembly Hall, adjacent to the Tokamak Building. Besides the powerful tooling, the teams' clockwork coordination is key to assembling the 1,100-tonne sector modules, made of one Vacuum Vessel sector, two Toroidal Field coil and a thermal shield.

## One module left for the stack

The ITER central solenoid, a massive magnet provided by the US, comprises six 110-tonne cylindrical modules. The fifth one was installed onto the tower in November.

©ITER Organization



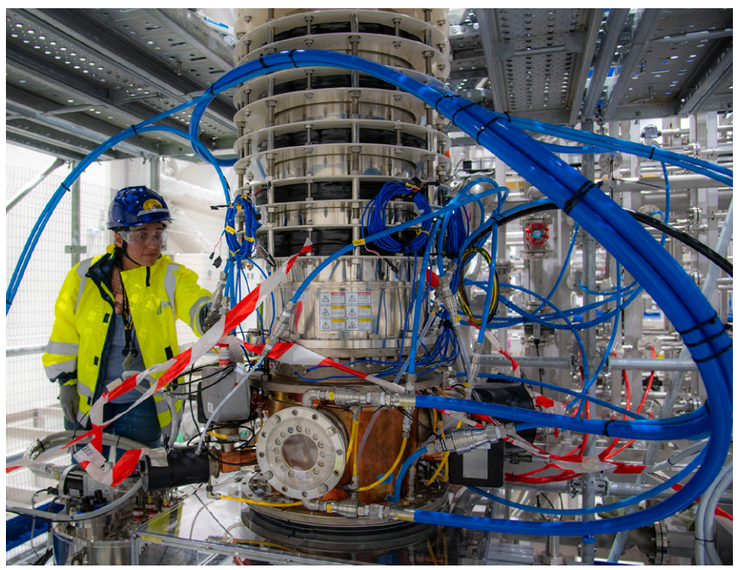

©ITER Organization

## Infrastructure for cold tests

The former on-site factory of the Poloidal Field coils is now a testbed for the large ITER magnets. In December, the first Toroidal Field coil was deposited inside the massive cryostat, manufactured by China, where it will be cooled down to 4 K (-269 °C).

## First gyrotrons ready

At the Radiofrequency Building, the teams completed the installation of the first of ITER's gyrotrons, the plasma-heating microwave generators. The component, supplied by Japan, entered commissioning phase.



©ITER Organization

©ITER Organization

## Deep-space cold for the cryopump.

At the dedicated test facility, the first of Europe's cryopumps was successfully cooled to 5 K (-268 °C). This ultra-low temperature will allow the component to trap residual particles inside ITER and achieve ultra-low pressures.


# 01

## Delivering on Europe's fusion projects

F4E commits as top priority to the successful construction and operation of the ITER, Broader Approach, DONES and other fusion projects.

F4E in partnership with ITER Organization, works to deliver Europe's contributions to ITER on quality, budget and schedule; improve efficiency through integration of teams; engage in all phases of the project, including assembly, commissioning, and operations.

In addition, F4E supports the involvement of EUROfusion and European fusion laboratories in the exploitation of JT-60SA and LIPAc which will generate valuable knowledge for ITER. Finally, F4E contributes to the construction and future phases of DONES which is will benefit from all the expertise acquired from LIPAc.

# ITER

## Building the largest fusion project

ITER's timely delivery is at the core of F4E's mission. In 2025, F4E honoured its commitments and stayed on track across all programmes. The yearly indicators show a record overall performance, with 91% of milestones reached on schedule – a very strong result for a first-of-a-kind environment.

This remarkable pace, resulting from F4E's teams and its supply chain, is documented through tangible achievements in many areas. New infrastructure was completed on-site, major components were delivered and the commissioning of plants systems advanced. The momentum was also felt across Europe's factories with more designs entering their final stage and new contracts being signed.

The ITER site captured from a drone in May 2025. ©ITER Organization / EJF Riche

### A landmark scientific partnership

ITER is the flagship international project paving the way for fusion energy. It's an impressive technology puzzle that is pushing the frontiers of science by creating new industrial know-how. Europe's contribution to ITER is mainly financed by the EU budget and channeled via F4E , which amounts to nearly half of the project. F4E collaborates with European industry and laboratories offering them the opportunity to gain expertise in a strategic technology.

## A mega-site in construction

The world's biggest fusion project, located in Cadarache (France), is taking shape in a 42-hectare platform. The ITER site will host around 40 buildings, together with infrastructure and power supplies. Europe is responsible for the construction, which has advanced. This year, the civil engineering teams completed several new buildings. One of them is the Control Building, where experts will monitor and operate the reactor. F4E also handed over the Neutral Beam Heating and Fast Discharge buildings, as well as two busbar bridges.

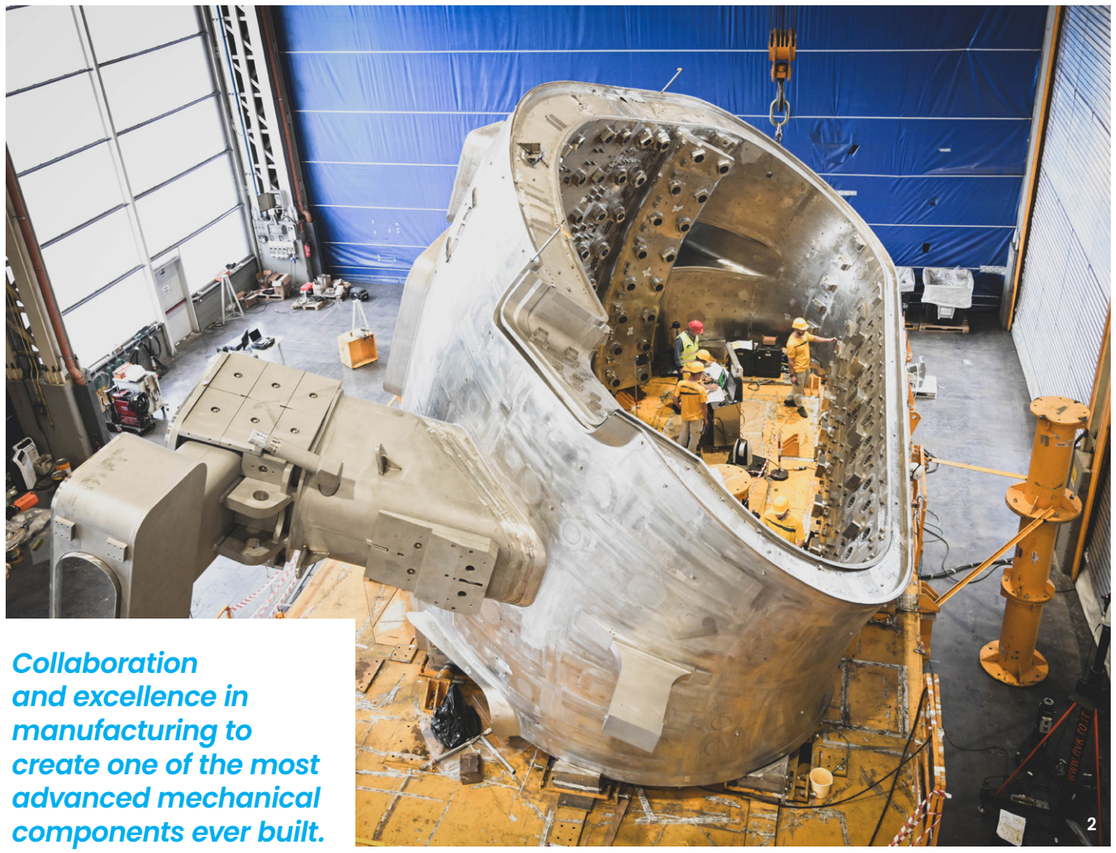

*Four new buildings ready to house technologies and personnel responsible for powering and monitoring ITER.*

1. The teams of F4E, ITER Organization and construction partners in the Main Control Room. September 2025. ©ITER Organization.
2. A frontal view of the ITER Tokamak Complex and surrounding buildings at sunset. September 2025. ©ITER Organization

Overhead shot of the ITER site in May 2025. ©ITER Organization / EJF Riche

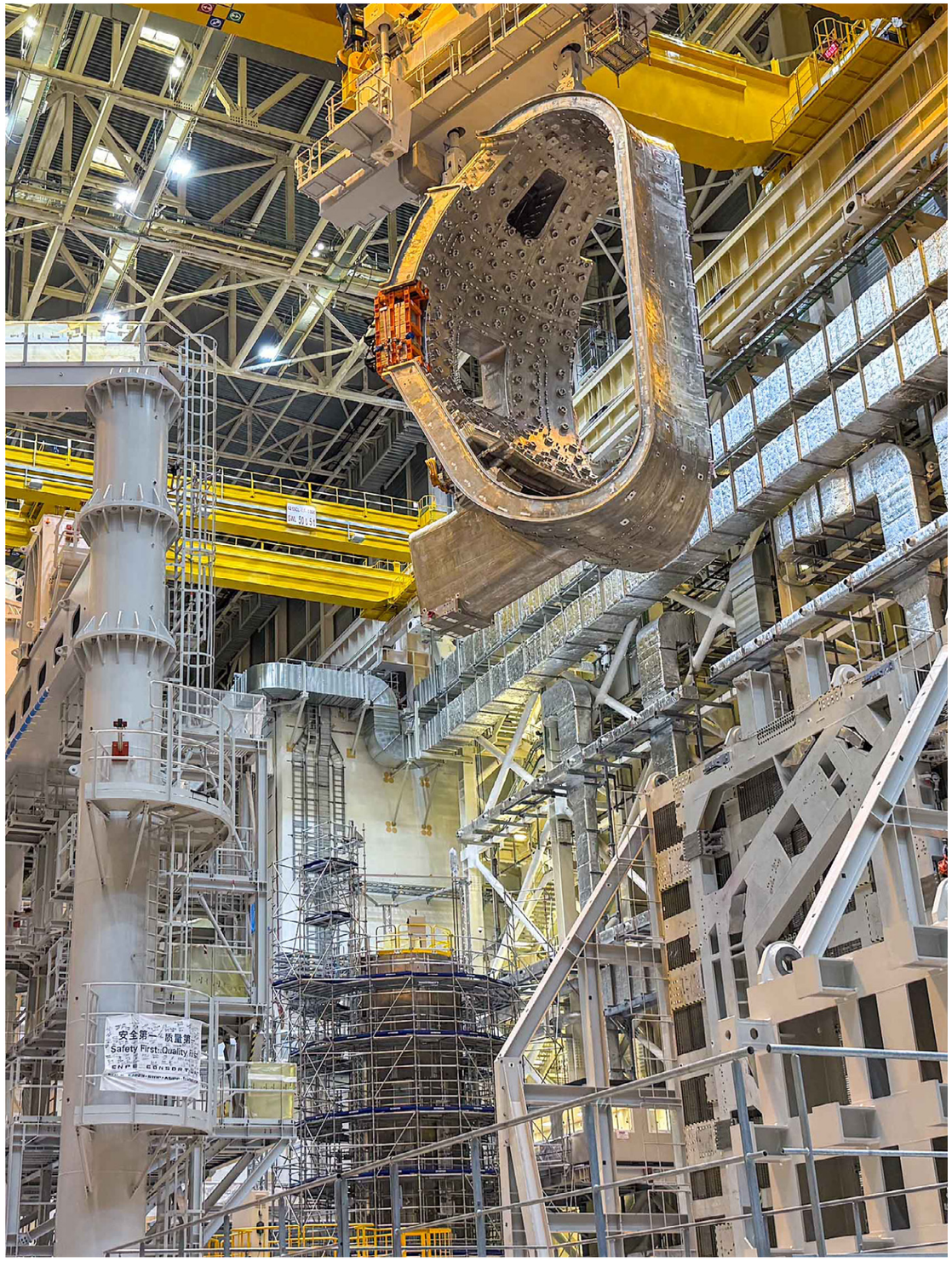
# Another European Vacuum Vessel sector manufactured

The Vacuum Vessel is a double-walled stainless-steel container that will house the fusion reactions of the ITER plasma. F4E and its partners completed the second out of Europe's five sectors. Manufacturing this massive component (11.4 m high, 500 tonnes) involved more than 150 professionals from 15 companies. The remaining three sectors made steady progress in the workshops of different factories.

***Collaboration and excellence in manufacturing to create one of the most advanced mechanical components ever built.***

1. The completed Sector 4 lifted for shipment in February 2025. ©Walter Tosto.
2. Walter Tosto technicians working inside Sector 4. ©Walter Tosto.




Europe's Vacuum Vessel Sector 4 moving into the ITER sub-assembly tool in December 2025. ©ITER Organization.

## Deliveries for cold vacuum systems

F4E delivered the last of the eight cryopumps, designed to create a high vacuum inside ITER thanks to ultra-cool panels, and the final cold valve boxes that dispatch helium from -269 °C up to 210 °C. In addition, at the Neutral Beam Test Facility in Padua (Italy), the 8-meter-long cryopump was installed inside MITICA's vessel and cooled down to cryogenic temperatures.


1

*The ITER cryopumps raised the benchmark of this high-vacuum technology.*


2

1. A set of the torus and cryostat cryopumps, under storage at ITER. ©F4E
2. Celebration of the completion of Europe's last cryopumps at Research Instruments. March 2025. ©RI

## Production in motion for components at the heart of ITER

In-vessel components are made to endure intense heat and radiation from ITER's plasma. Their fabrication advanced in different European facilities. The first cassette bodies, part of the ITER Divertor which forms the "ashtray" where all plasma impurities fall, passed demanding final tests while the inner-vertical targets went through the first high-heat flux tests. In parallel, series production started for Europe's 215 first wall panels, while their prototypes completed a long series of tests. Europe also finished 18 kilometres of pipes, as part of the manifolds, where cooling water will run beneath the blanket to extract heat.

1


2

*The Divertor Cassettes will resist the extreme conditions inside ITER.*

1. The teams of DMV, Dockweiler and F4E next to a sample of ITER blanket manifold pipes. June 2025. ©F4E
2. Group picture in the workshop of the ITER Divertor Cassette, at SIMIC (Italy). April 2025. ©SIMIC

*Europe's team tested the machines to generate ultra-cold fluids at – 269 °C, a temperature only found in deep space.*

## A massive refrigerator in action

The ITER cryoplant, one of the biggest in the world, will generate ultra-cold helium to cool down ITER's magnets, thermal shields and cryopumps. The European teams entered the commissioning phase, starting with the two liquid nitrogen refrigerators. Technicians operated compressors, cold boxes and other parts of the circuits, preparing them to produce powerful doses of cold.

1. The Liquid Nitrogen Plant includes large tanks, compressors and cold boxes. ©F4E
2. Exterior view of the ITER cryoplant, with the liquid nitrogen tank towering over the large facility. April 2025. ©F4E



## Europe gets ready to power up ITER

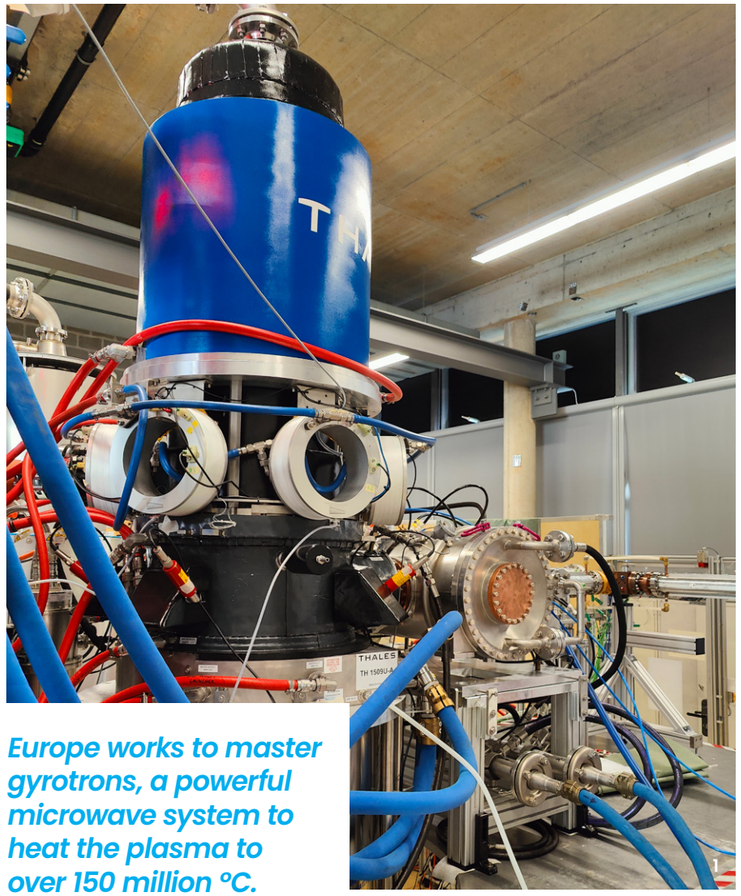
The electrical infrastructure provided by F4E and its partners will be key to heating up the ITER plasma. At the Radiofrequency Building, the European team energised the Electron Cyclotron High Voltage Power Supplies for the first time. This paved the way for full commissioning, a sequence of tests to ensure the system can deliver the precise voltage for gyrotrons to create powerful microwaves. In parallel, Europe made more progress with the delivery of hardware for the Neutral Beam Power Supplies and the installation of parts of the system, such as the large transformers.

*Europe's eight high voltage units can deliver up to 6MW, an extraordinary power for the gyrotrons.*

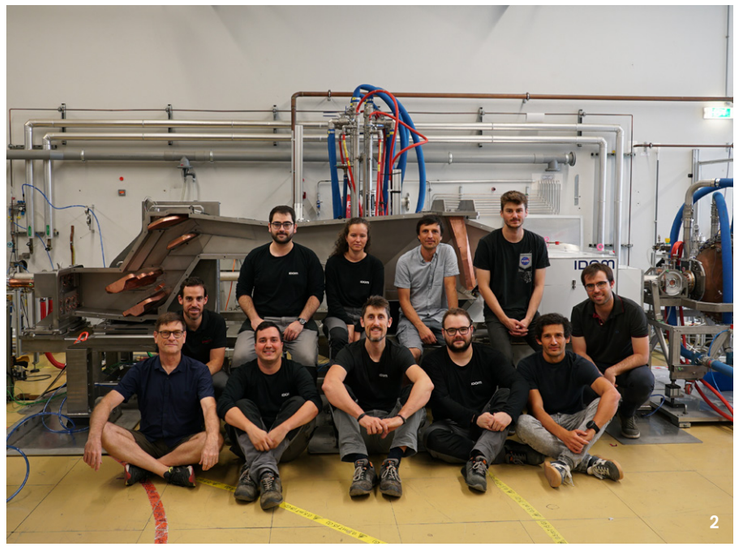
1. Transformers delivered by Europe to the ITER site. ©F4E
2. F4E, Ampegon, ITER Organization and DTT teams next to the EC power supplies in November 2025, after completing local commissioning. ©F4E

## Advancing cutting-edge plasma heating technologies

To heat the plasma to over 150 million °C and control it, ITER will rely on an array of high-tech systems. Europe is contributing to the neutral beam heating, that will inject high-energy particles, and the electron cyclotron heating, using powerful radiofrequency waves. Prototyping and testing advanced for the electron cyclotron waveguides and upper launchers, which will channel microwaves into the reactor. F4E and partners also completed the final design for the gyrotrons, stepping into the manufacturing phase. In addition, a new contract was signed to manufacture the Drift Ducts, a component linking ITER's Neutral Beam Injectors with the Vacuum Vessel.

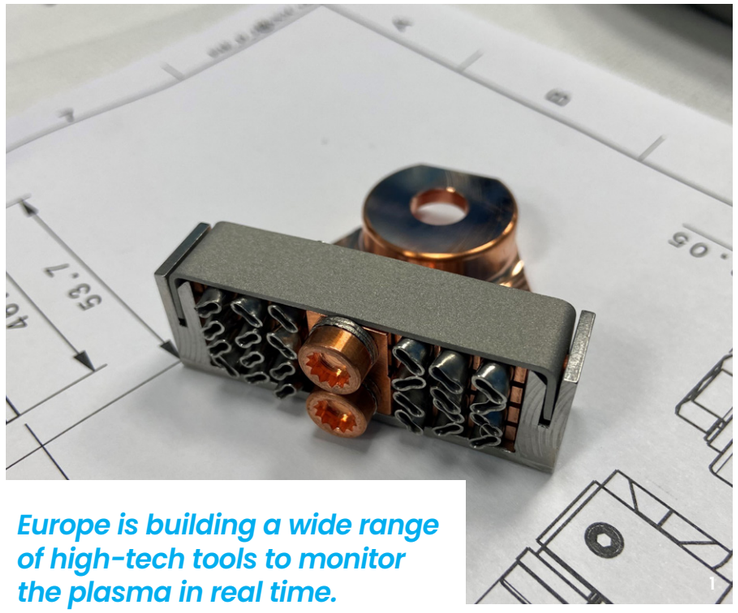



*Europe works to master gyrotrons, a powerful microwave system to heat the plasma to over 150 million °C.*

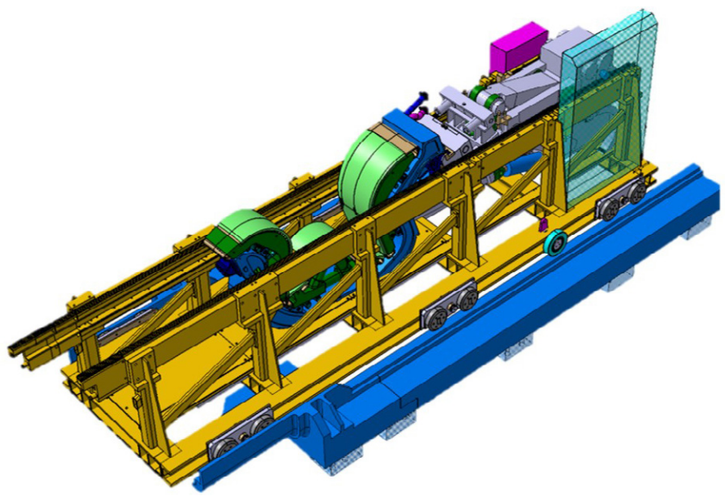


## More diagnostics move into manufacturing

ITER will use a wide range of advanced diagnostics to monitor and control the plasma in real time. Europe is responsible for roughly 25% of these systems. In 2025, F4E signed contracts to manufacture several systems such as the Collective Thomson Scattering system, designed to track fast ions in the plasma; the Wide-Angle Viewing system, to measure the temperature of the inner surfaces; and the Radial Neutron Camera, to detect neutrons from the fusion reaction. Furthermore, F4E delivered thousands of in-vessel supports to attach over 18 kilometres of cables carrying diagnostic signals outside the device.



*Europe is building a wide range of high-tech tools to monitor the plasma in real time.*



## Partnerships and innovation for remote handling tools

Assembling and maintaining ITER will rely on advanced robotics to manipulate heavy components inside the device. Europe, responsible for four of the six major ITER remote handling systems, worked to improve its know-how and deliver new equipment for ITER's revised assembly plan. F4E signed a framework contract with five suppliers to develop and fabricate a broad range of tools for the divertor, the cask and plug, and the ex-vessel neutral beam systems.

1. Pre-series gyrotron installed at the Falcon testbed at the Swiss Plasma Center. ©F4E
2. The Upper Launcher full-scale mock-up by IDOM and F4E was tested at the Swiss Plasma Center. ©F4E

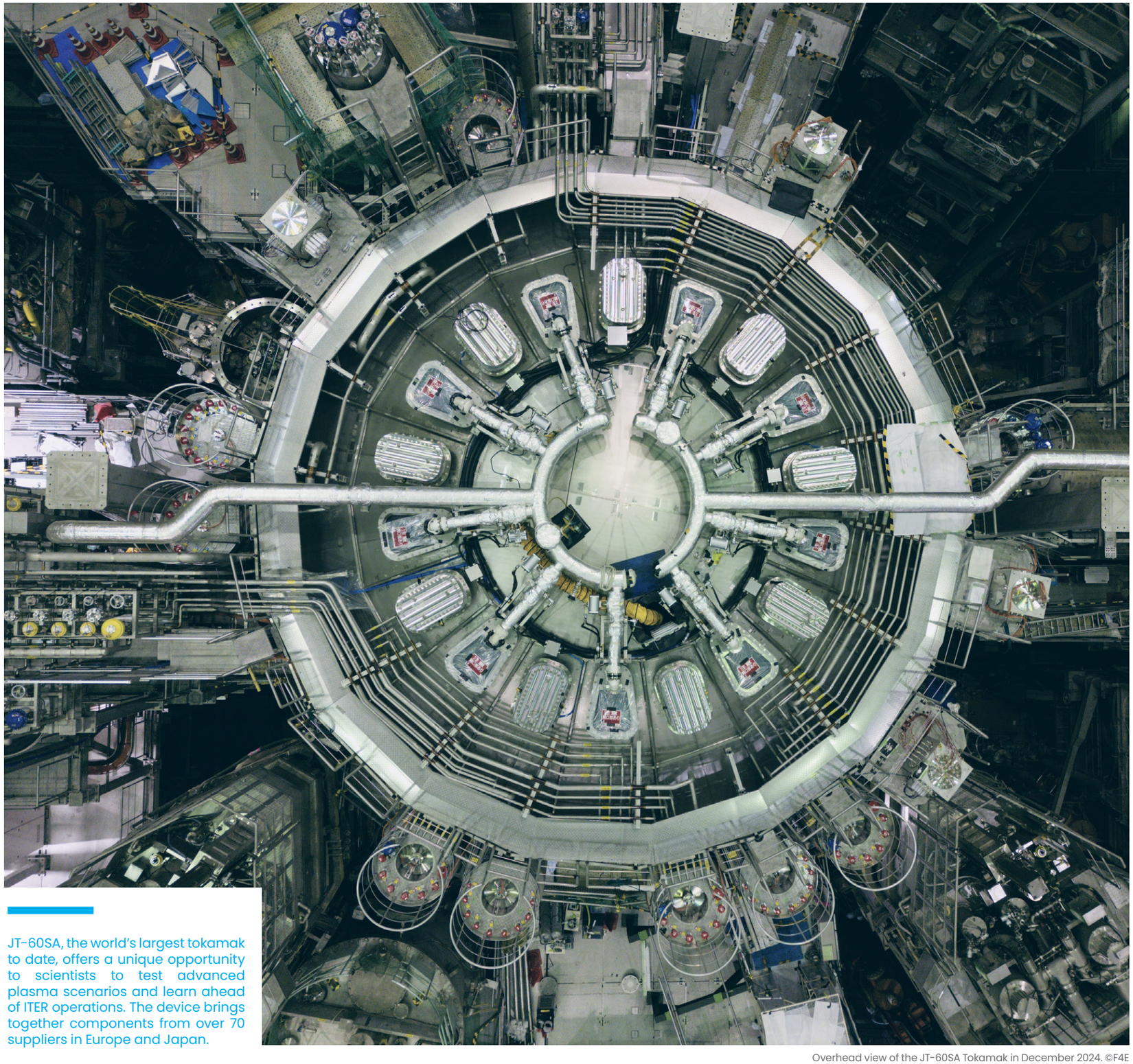
1. F4E delivered 11,700 clamps and 57,000 clips to wire up ITER. ©F4E
2. 3D model of the Divertor Transport System, one of the tools included in the new contract.. ©ITER Organization / F4E

# Broader Approach

## Europe and Japan advancing fusion research

The Broader Approach Agreement is a partnership between Europe and Japan that deepens their fusion expertise via three distinct projects: the JT-60SA Tokamak, the International Fusion Materials Irradiation Facility - Engineering Validation and Engineering Design Activities (IFMIF/EVEDA) and the International Fusion Energy Research Centre (IFERC).

In these facilities, located in Japan, experts from both parties are testing cutting-edge fusion technologies to gain new knowledge that will feed into ITER and other projects. During 2025, both JT-60SA and LIPAC went through upgrades paving the way for the restart of operations.



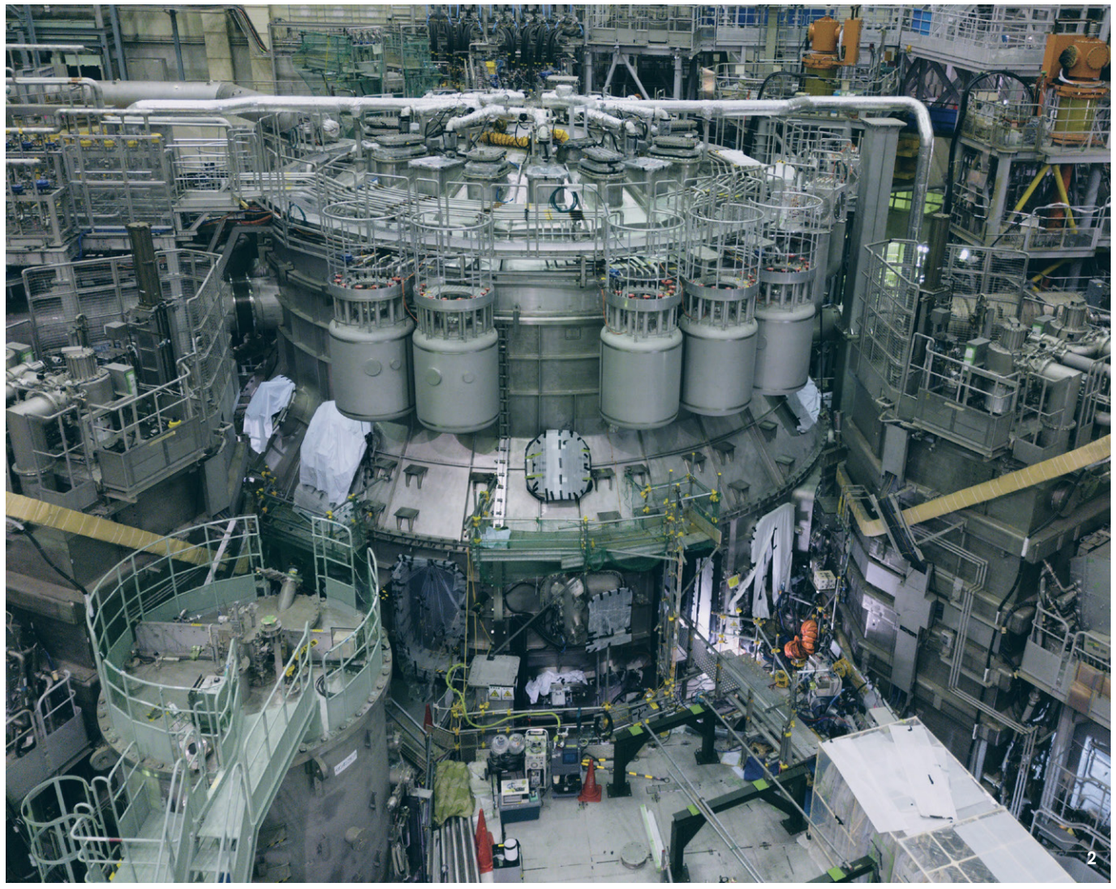
JT-60SA, the world's largest tokamak to date, offers a unique opportunity to scientists to test advanced plasma scenarios and learn ahead of ITER operations. The device brings together components from over 70 suppliers in Europe and Japan.

Overhead view of the JT-60SA Tokamak in December 2024. ©F4E

## Upgrades in full swing at JT-60SA

The teams at JT-60SA, the world's largest tokamak to date, installed more systems to prepare the device for high-performance plasma operations from the end of 2026. F4E provided key components, including cryopumps, diamond windows or diagnostics like the Edge Thomson Scattering. In addition, Japanese gyrotrons and European power supplies were integrated and tested, proving they are ready to enhance the plasma's performance.


*The teams installed new systems to push towards hotter, more powerful plasmas.*



1. Lifting of a Neutral Beam tank at the JT-60SA Tokamak Hall. ©F4E
2. View of the JT-60SA Tokamak in December 2024. ©F4E





*The new superconducting section will allow LIPAc to speed particles to record energy levels.*

## Installation activities in LIPAc

In Rokkasho (Japan), the LIPAc accelerator grew in length and power. The technology is a key prototype for future fusion material testing facilities like IFMIF-DONES. During the year, the teams focused on the installation in the beam line of the 6-meter Superconducting Radio Frequency linear accelerator, which will enable LIPAc to reach its full configuration and unprecedented performance levels.

1. Technicians position the SRF linac in the beam line of LIPAc. ©IFMIF/EVEDA
2. Transport of the cryomodule containing the SRF Linac into the accelerator vault in February 2025. ©IFMIF/EVEDA

# IFMIF-DONES

## Laying the foundations for a new international collaboration

The International Fusion Materials Irradiation Facility – Demo Oriented Neutron Source (IFMIF-DONES) is a future research infrastructure under construction in Spain. As part of the DONES programme, the accelerator-based facility will be used for the testing, validation and qualification of the materials to be used in future fusion power plants like DEMO.

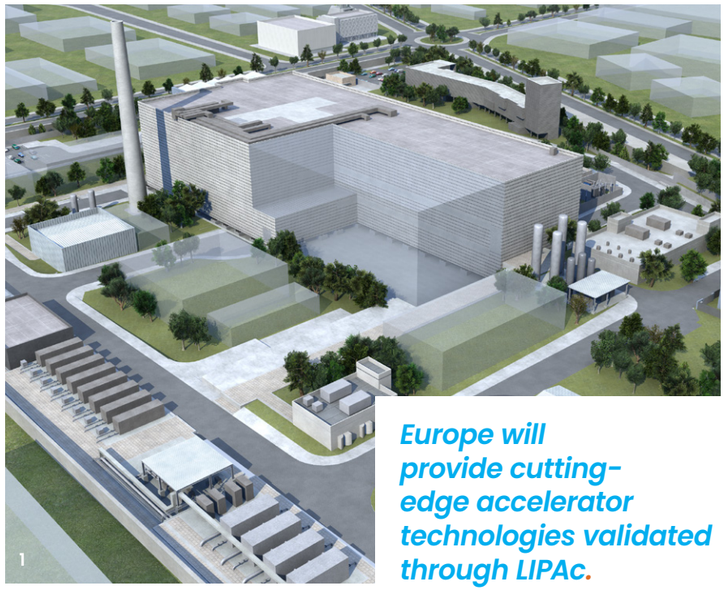
The DONES Programme grew stronger in 2025, with five parties committing to building the facility. Europe confirmed its contribution and supported the ramp-up of the programme with tangible progress on various fronts.

The IFMIF-DONES administration building is ready

Aerial view of the DONES construction site in 2025. ©IFMIF-DONES

## International agreement signed to build IFMIF-DONES

Spain, Japan, Croatia, Italy and the EU signed the Multilateral International DONES Agreement (MIDA). This gives a legal framework to the collaboration to build and commission the world-class facility in Granada (Spain). Through F4E, the EU will provide 25% of the construction costs, an investment of 202 million EUR, covering key technologies like the particle accelerator. Spain will be the main contributor with 55% of the costs counting also on the contributions of Italy (8%), Japan (5.1%) and Croatia (5%).



*Europe will provide cutting-edge accelerator technologies validated through LIPAc.*


1. 3D render of the IFMIF/DONES facility. ©IFMIF-DONES
2. Signatories of the MIDA hold the agreement, alongside members of the DONES Steering Committee and Programme team. ©MICIU

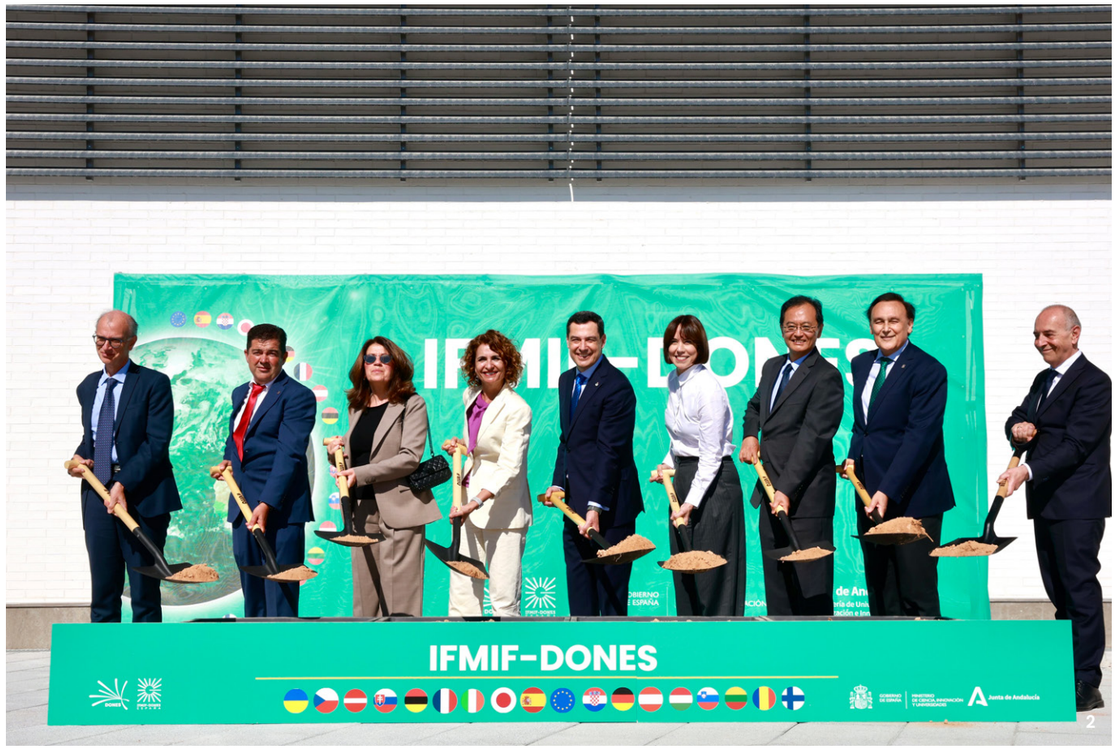




## Civil engineering works underway

Political representatives from the parties laid the first stone for the main building, while the DONES teams moved to the new administration building. In parallel, the programme continued to advance in the fields of safety, design and procurement.

*The next-generation materials for fusion will be irradiated and studied at IFMIF-DONES.*




1. View of the construction of the DONES Administration Building nearing finalisation. ©IFMIF-DONES
2. Representatives from the EU, Croatia, Spain, Andalusia, Japan and Italy laid a symbolic first stone for Main Building of the IFMIF-DONES Facility. ©IFMIF-DONES

# 02

## Building knowledge and attracting talent for the future

We develop the fusion talent and knowledge base for the future development of commercially viable fusion power plants in Europe though:

- Learning lessons and retaining knowledge from ITER and the Broader Approach projects.
- Developing strategic fusion technologies with EUROfusion and European Fusion Laboratories.
- Attracting and growing the next generations of fusion talent.
- Driving the engineering design and validation activities for DEMO in collaboration with EUROfusion, laboratories and industry.

# Knowledge and talent

## Capitalising on European expertise for the next phase

Europe is a scientific leader in fusion. It counts with the largest supply chain which thrives on the talent, skills and expertise of the companies and laboratories involved in various international projects. ITER has given them the opportunity to acquire new knowledge which is essential to the design and operation of future fusion power plants.

In 2025, F4E rolled out, in coordination with other parties, various initiatives to boost Europe's readiness, know-how and competitiveness.


Technicians of Walter Tosto inspect an ITER Vacuum Vessel sector during manufacturing. ©F4E

## Boosting innovation and technology readiness

The F4E Technology Development Programme (TDP) took its first steps. Its goal is to anticipate needs for ITER by supporting R&D in early-stage technologies. Parallel to this, F4E gathered insights from hundreds of experts working in European industry, laboratories, academia and Big Science through a series of workshops. The sessions aimed at mapping critical technologies by covering five areas: fuel cycle, metrology, additive manufacturing, artificial intelligence and magnets.

Furthermore, F4E signed five contracts for the TDP pilots. The suppliers were tasked to demonstrate two technologies not available yet in the market: a wearable monitor for tritium in air and gradient joints for plasma-facing materials. At the end of the year, the TDP launched a new round of calls in five topics. With these actions, F4E can help de-risk and master technologies whilst retaining know-how in Europe.

***Five technology mapping workshops addressed : fuel cycle, metrology, additive manufacturing, AI and magnets.***

©Istockphoto





Photos taken during the five technology mapping workshops organised by F4E in 2025. ©F4E

## Connecting expertise in fusion and Big Science

F4E continued to work closely with ITER Organization, European fusion laboratories, and other bodies, to make progress in technologies like Test Blanket Modules (TBM). Scientists will use these first-of-a-kind prototypes in the ITER environment to examine various concepts for a tritium breeding blanket, key to the fuel self-sufficiency of future reactors. The two European TBM designs, and the one co-developed with Korea, gained new ground, as the teams met to assess a vast range of aspects, from safety to manufacturing and operation.

F4E also stepped up its efforts in knowledge management by better connecting European expertise across fusion projects. The synergies with EUROfusion continued, with initiatives like the network of experts on electron cyclotron heating. F4E actively engaged with communities of practice, ranging from engineering topics like nuclear qualification and safety to procurement and contracts in Big Science.

A cooperation agreement between F4E and CERN was also signed. The partnership aims to address shared challenges in fusion reactors and particle accelerators. Through this framework, the organisations will pool their world-class capabilities, via exchanges of personnel, knowledge and data. As a result, both parties will accelerate their delivery in technologies like superconducting magnets, cryogenics, or advanced materials.

Representatives of F4E and CERN after the signature of the agreement in September 2025. ©CERN

## Innovation and growth resulting from fusion and going beyond

Working for complex projects like ITER stimulates the capabilities of European companies. In 2025, a survey to a sample of F4E suppliers showed that 77% had enhanced their know-how and 66% acquired new skills. In terms of reputation, 80% of respondents enjoyed higher visibility and 62% accessed new partnerships.

In fact, the breakthroughs in fusion often find their way to new markets. The F4E Technology Transfer Programme continued to harvest success stories and surpassed 130 technology offers in the joint portfolio with EUROfusion. Additionally, F4E's 2025 Technology Transfer Award recognised Metromecánica for taking a robotic metrology tool from ITER to the automotive sector. In parallel, Axon' Cable won the 2025 Demonstrator Call with a project to adapt fusion remote handling wires to environments like space or particle accelerators.

**5,600** full-time jobs per year supported by F4E in 2018-2024

**66%** of F4E suppliers gained new skills

**77%** enhanced technical know-how

**62%** formed new partnerships facilitating knowledge transfer

**54%** improved talent attraction

*Data from a survey to a sample of 61 suppliers, part of F4E's 13th Annual Assessment


IDOM technicians working on ITER's diagnostic feedthroughs. The Spanish firm built on its experience with F4E to grow as a first-class fusion supplier. ©IDOM

## Empowering and attracting talent

Delivering fusion relies, above all, on people. F4E strives to develop a skilled and diverse European workforce by attracting and training the next generation of experts. To this end, representatives from F4E took part in various career events, including a pan-EU virtual fair or the largest fair in Scandinavia for engineering students.

These efforts also put a special focus on empowering female talent. A new cohort of staff members graduated from F4E's Women's Leadership Development Programme, awarded by the EU Agencies Network as an exemplary initiative of diversity and inclusion.

In addition, F4E financed one scholarship for a female graduate to attend the Xcitech School on Science and Technology and recruited a new trainee in collaboration with the International Atomic Energy Agency (IAEA) under the Marie Sklodowska-Curie Fellowship Programme (MSCFP), aimed at increasing female presence in nuclear studies and fusion.

***Fusion is a multigenerational endeavour requiring variety of skills and long-term career paths.***

F4E Talent Acquisition expert discussing with German students. ©IPP





## Developing a competitive European workforce

F4E has contributed to growing a skilled fusion workforce in Europe. According to F4E's 13th annual socio-economic impact assessment, F4E activities sustained an average of 5,600 additional full-time jobs per year for the period 2008-2024. A survey to F4E suppliers, part of the same report, revealed that 54% of firms improved talent attraction and 43% noted better retention rates. Furthermore, 41% of respondents increased higher-skilled positions, and 32% and 28% of firms reported growth in temporary and permanent staff, respectively.

Companies emphasised that F4E activities were instrumental to creating dedicated fusion teams. They improved their project management, organisational capabilities, and developed specialised technical skills, particularly in engineering processes, materials, mechanical and nuclear engineering, welding, and advanced manufacturing. Counterfactual and mediation analyses confirmed that working with F4E had a statistically significant positive effect on employment.

***54% of F4E suppliers improved talent attraction and 43% noted better retention.***


Two F4E experts inside the ITER Assembly Hall. ©F4E

# 03

## Supporting Europe to lead in the fusion race

We pave the way for a transition from research to industry, and the creation of a competitive European industrial fusion sector through:

- Lowering entry barriers for industry, especially SMEs, to work with F4E.
- Developing geographically broad and sustainable supply chains.
- Supporting growth of European private sector fusion start-ups.

# From research to industry

## The moment to unlock Europe's fusion potential

The global race for fusion is accelerating, and Europe is moving fast to secure a lead position. F4E's contribution to ITER and other projects has put together one of the largest fusion supply chains in the world. A stronger and more cohesive industrial ecosystem is taking shape to help the EU harness the benefits of this disruptive technology.

Technician during the fabrication of Europe's ITER Toroidal Field Coils. ©F4E

## F4E Roundtable, a forum for EU fusion stakeholders

Europe's fusion policy conversation gained momentum in Barcelona. The F4E Roundtable brought together more than 200 representatives from EU institutions, industry, SMEs, start-ups, and laboratories. Speakers addressed key topics such as public-private partnerships, long-term investment, workforce development and technology readiness, all integral to the EU fusion strategy developed by the European Commission.



*Voices from public and private actors called for Europe to act decisively and collaborate to stay ahead in the fusion race.*

1. Christophe Grudler, Member of the European Parliament, addressed the F4E Roundtable. ©F4E
2. One of the panel discussions at the F4E Roundtable in Barcelona in June 2025. ©F4E

## Policy-makers witness ITER's scale and progress

F4E engaged with high-level political authorities, showcasing the progress and impact of Europe's contribution to ITER and other projects while discussing Europe's position in the fusion race. F4E Director, Marc Lachaise, took part in two hearings at the European Parliament to provide an update on the progress.

Members of the European Parliament visited ITER together with representatives from industry and fusion laboratories to see the facilities and learn more about the commercial benefits. Later in the year members of the Slovenian government travelled to ITER.

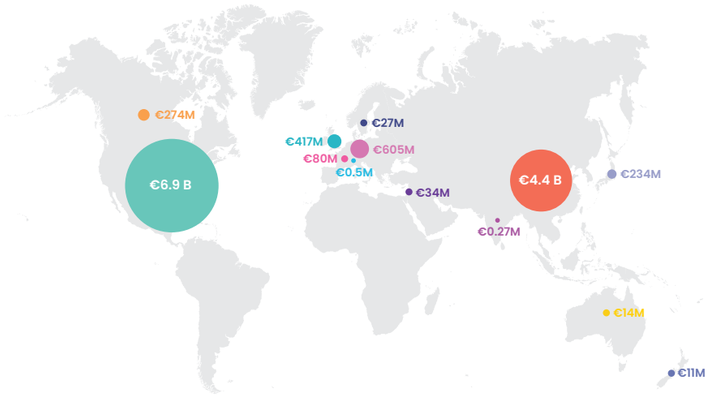
France's President, Emmanuel Macron, and India's Prime Minister, Naredra Modi, visited the site and highlighted the international collaboration of the project.

*France's President Macron and Indian's PM Modi praised the impressive scale of the ITER project.*

F4E Director Marc Lachaise next to the President Macron and Prime Minister Modi at ITER. ©ITER Organization

## Valuable data-based insights on the booming fusion market

The F4E Fusion Observatory, an initiative aiming to provide market intelligence published its two first reports. Both analyses focused on the global investment in the fusion private sector initiatives, breaking down geographical and technology trends. The second edition, with cut-off date in September, reported that the cumulative funding reached 13 B EUR, an eight-fold increase since 2020. A bipolar landscape is emerging, led by the US and China. Meanwhile, the EU is trailing behind, counting 5% of global investment and eight companies in the market.




Geographical distribution of the investment in the private fusion sector. ©F4E






## Joining forces with fusion companies

Private fusion initiatives are increasing in Europe. F4E seeks to support their growth and competitiveness by leveraging on the experience from major projects like ITER. In this spirit, F4E signed two collaboration agreements with the companies Proxima Fusion (Germany), and Novatron Fusion (Sweden). This framework provides for the exchange of information and best practice in areas of common interest, from safety and quality standards to civil engineering or advanced fusion technologies.


1

***First collaboration agreements signed to exchange know-how in fusion technologies.***

2

1. Pierre-Yves Chaffard, F4E Projects Department Adviser, and Peter Roos, Novatron Fusion Group CEO in Helsinki in October 2025 ©NFG
2. Lucio Milanese, Chief Operating Officer of Proxima Fusion and Marc Lachaise, Director of F4E, signing the collaboration agreement in June 2025. ©F4E

## Engaging with Europe's supply chain

A resilient and inclusive supply chain is key to Europe's fusion ambitions. F4E works to keep its industrial partners engaged for ITER and the next phase. The first-ever F4E Supply Chain Days were a success, gathering more than 150 company delegates in Barcelona and online. The event offered them the opportunity to network and express their ideas on how to improve F4E's collaboration tools.

F4E met stakeholders in many other national and international events. For example, the ITER Business Forum, the World Nuclear Exhibition or Big Science forums in Spain, Germany and Denmark which brought together the innovation community and raised awareness on the business opportunities in fusion.

## Offering opportunities to SME

The flexibility, innovation and unique skillsets of small and medium enterprises (SME) are essential for Europe to succeed in fusion projects. F4E is determined to increase their involvement in the supply chain. The dialogue with these firms resulted in an SME action plan, a set of measures to lower entry barriers, simplify procedures and assist in finding business partners. In addition, F4E has reinforced its outreach to smaller companies through market surveys, information days and a network of Industry Liaison Officers.

Beyond growth and expertise, these firms have been able to develop new products and services, enter high-tech markets and strengthen their reputation.

A snapshot from the F4E clip with European SME. ©F4E

*SMEs, innovative contracts and sustainability were the main topics of the F4E Supply Chain Days.*

Group photo after one of the F4E Supply Chain Days sessions. ©F4E

## Getting in touch with the EU

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