



**FUSION  
FOR  
ENERGY**

Bringing  
the power  
of the sun  
to earth

# Fusion for Energy & ITER Powering the Future of Energy in Europe

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Head of Market Analysis IP & TT

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**6th Forum FUSION Germany**

**Greifswald 15 January 2025**



- **F4E in the Fusion landscape**
- Building a fusion Supply Chain
- Germany in the picture
- Upcoming opportunities

# The future of European competitiveness

Part B | In-depth analysis and recommendations

SEPTEMBER 2024

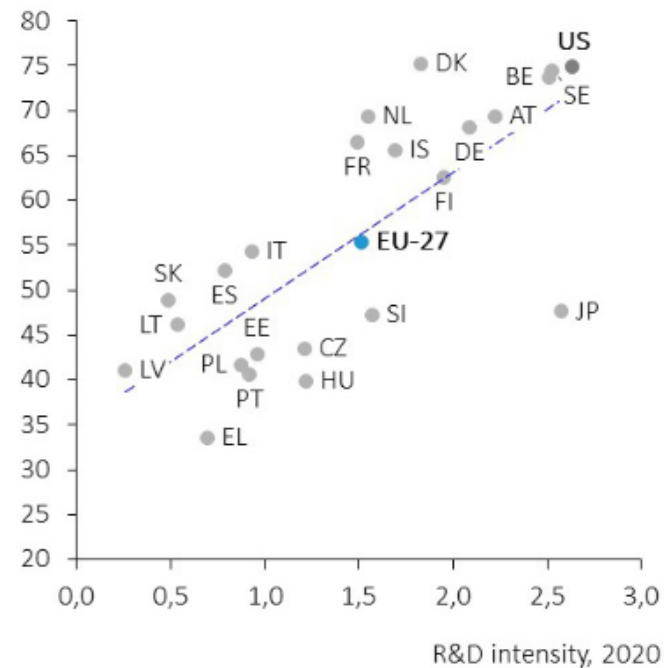


**“Nuclear fusion is a disruptive technology that holds the potential to revolutionize the energy landscape in the second half of this century.”**

## The impact of research and innovation

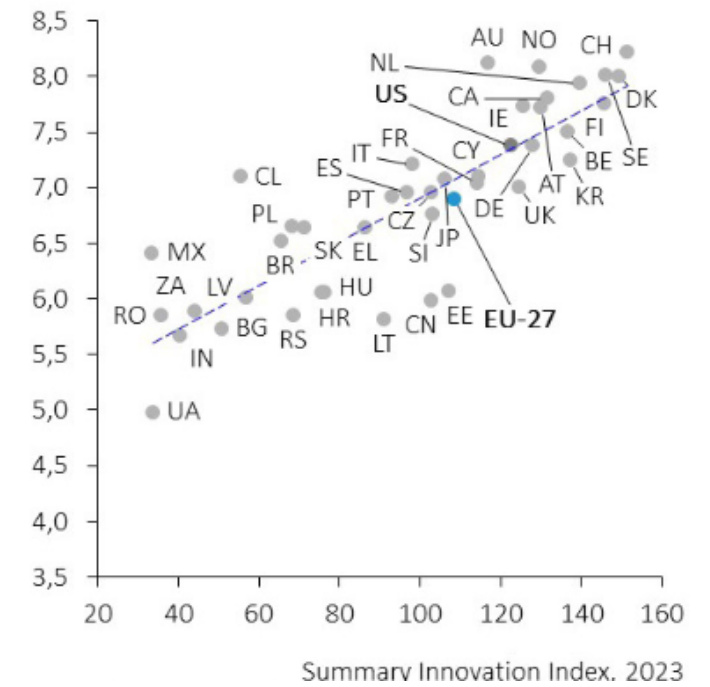
### R&I investment and productivity

Labour productivity, 2021



### Innovation capacity and well-being

Where-to-Born Index, 2023





# Fusion for Energy (F4E) key contributor to ITER and the development of EU fusion



- ▶ F4E is EU Joint Undertaking based in Barcelona  
Offices also in Cadarache & Garching (Munich)
- ▶ **Staff: ~465 highly competent team of engineers, project managers, supply chain, IP and legal officers**
- ▶ **Budget: €5.6 billion 2021-2027**
- ▶ F4E Director: Marc Lachaise (since 16 May 2023)
- ▶ Main role is to provide the European contribution to ITER as its European “Domestic Agency”, but also involved in other projects to develop fusion
- ▶ F4E is a multinational and multicultural organization, keen on the implementation of Diversity & Inclusion and wellbeing policies

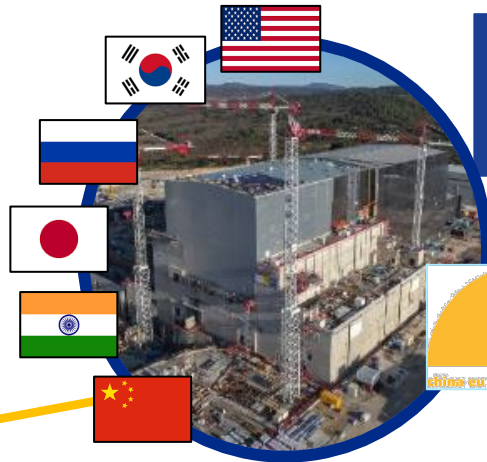


# Four projects on the EU public Fusion Roadmap



**Broader Approach**  
Three projects with Japan  
*IFERC | IFMIF-EVEDA | JT60SA*

JT60SA, largest tokamak until ITER – starting operations in December 2023



**ITER**  
F4E is responsible of Europe's contribution to ITER as the EU "Domestic Agency"



**Ciemat**

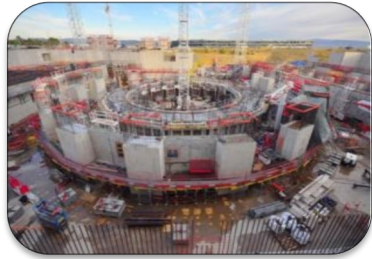
**IFMIF-DONES**  
Early phase of design & construction of Demo Orientated NEutron Source



**DEMO**  
Early design studies by EuroFusion DEMOnstration Fusion Reactor F4E to lead future construction



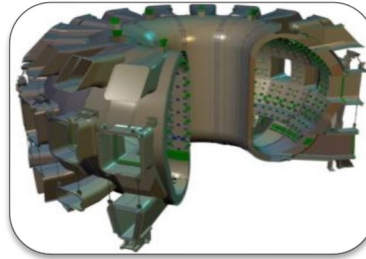
# F4E contributes to ITER with a wide range of cutting-edge technologies



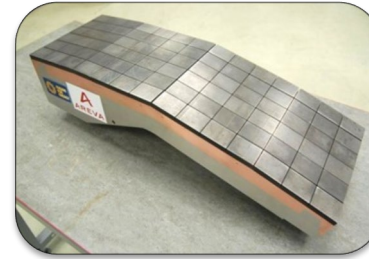
**Site & Buildings**



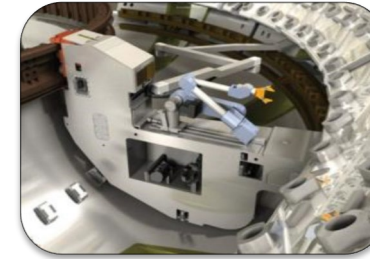
**Superconducting  
Magnets**



**Vacuum  
Vessel**



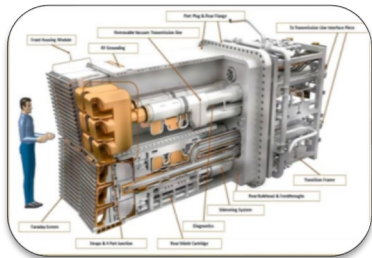
**Wall Protection**



**Robotic Remote Handling**



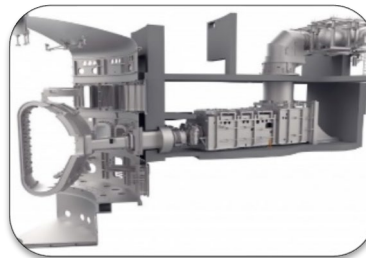
**Cryoplat  
& Fuel Systems**



**Radio (Ion) Cyclotron  
Heating**



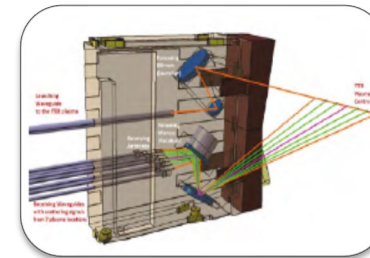
**Radio (Electron)  
Cyclotron Heating**



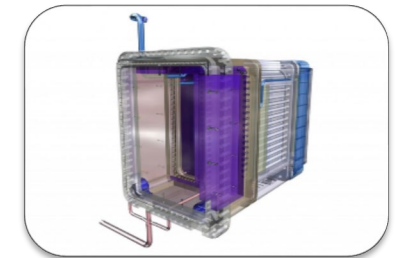
**Neutral Beam Injectors**



**Neutral Beam Heating**



**Measurement Systems**



**Fuel Breeding Modules  
(TBM)**





# ITER Project – State of Play

## PROJECT PROGRESS

Tritium building completed  
(December 2023)



## PROJECT PROGRESS

Last TF coil delivered  
(December 2023)

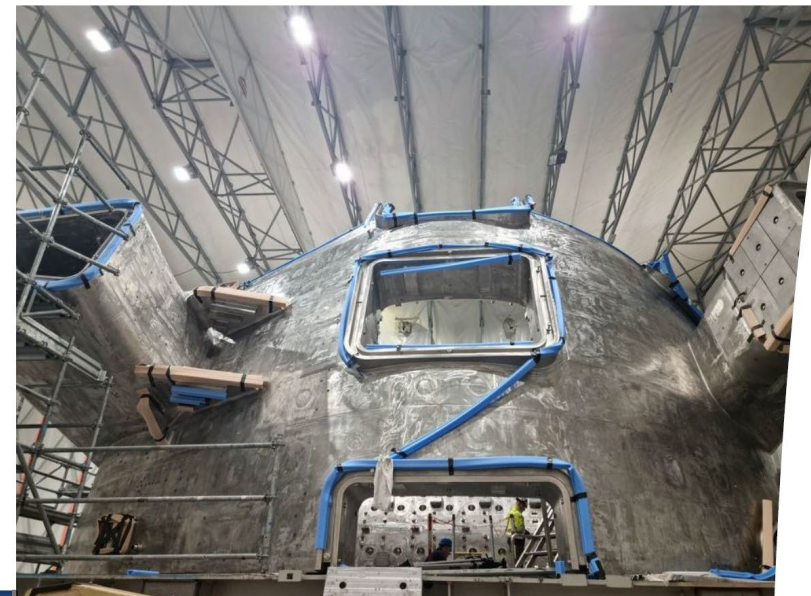
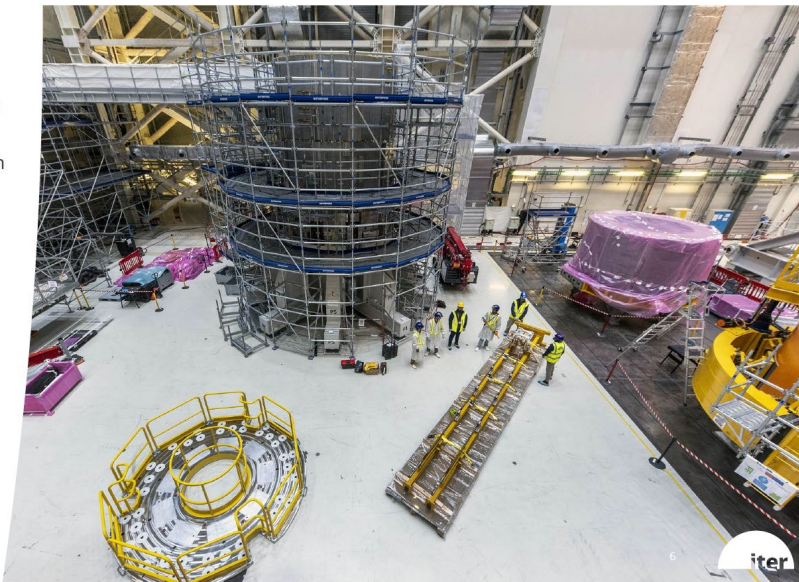
IO-DA celebration to take  
place on 15 April.



## PROJECT PROGRESS

In process of stacking 3 CS  
modules (29 Feb 2024)

Fourth CS module arrived in  
December



## EU VV MANUFACTURING

First European vacuum  
vessel sector passed  
its leak test (February  
2024)





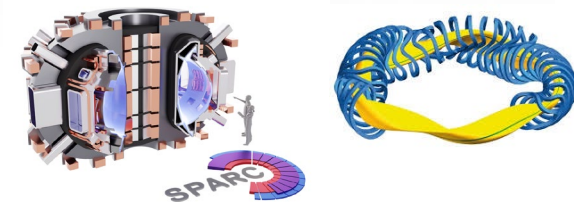
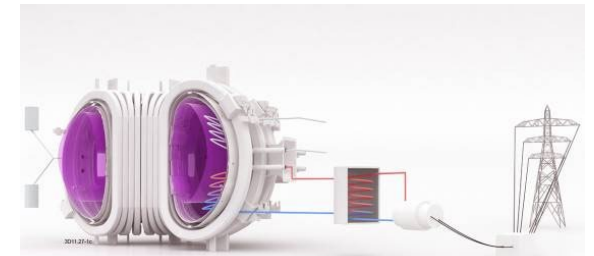
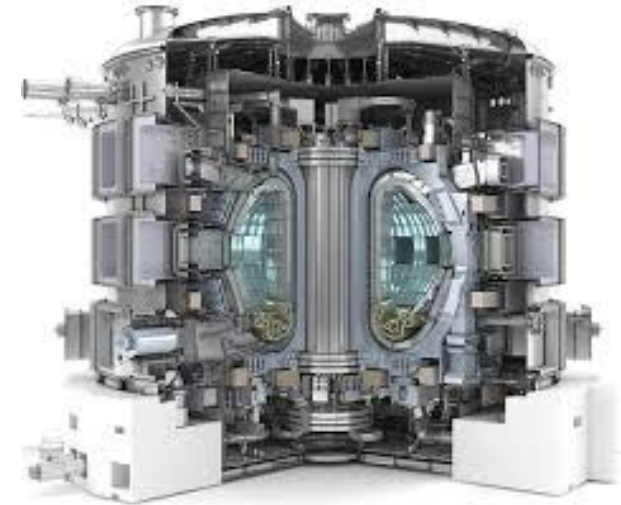
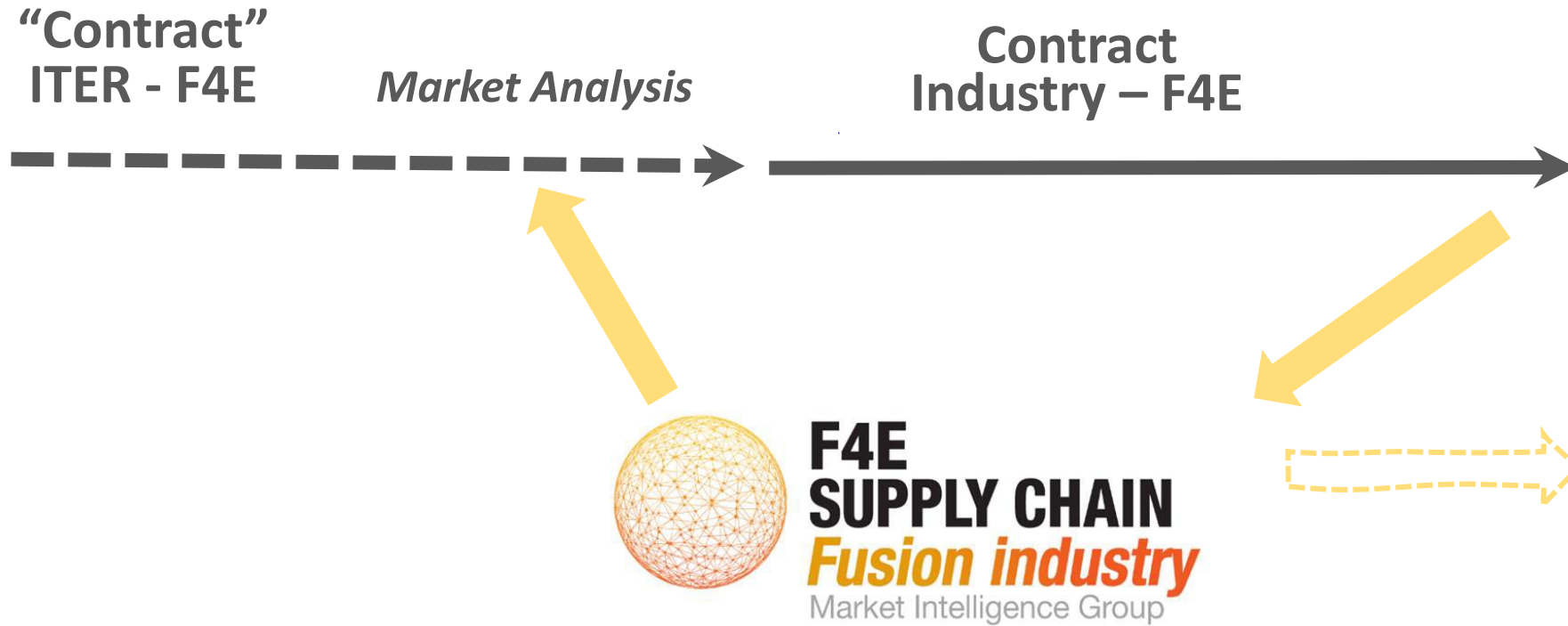
Last PF Coil (PF3) manufactured by Europe has been completed and moved into storage.

The milestone marks the end of a ten-year adventure—from building and equipping the facility, to qualifying the first double pancakes, and finally to the successful fabrication of coils PF2, PF3, PF4 and PF5

- F4E in the Fusion landscape
- **Building a fusion Supply Chain**
- Germany in the picture
- Upcoming opportunities



# EU Fusion Industry is an input and an output



# Supply Chain Knowledge is Technology-centered



FUSION  
FOR  
ENERGY

Technology Network





Value of contracts signed since 2007 is more than € 6 billion,  
involving more than 700 companies and research centres



## ▶ High-Tech Jobs

Approx. 34,000 job years  
created 2008-2017  
(83,000 more by 2030)



## ▶ Industrial expertise

Over 700 companies,  
over 2100 subcontractors  
in 24 countries



## ▶ Economic growth

Investment in fusion  
brings a net economic  
benefit of 5-6%



## ▶ Innovation

400+ new technologies,  
tools and processes  
20+ spin-offs, start-ups,  
joint-ventures



## ▶ Competitiveness

Companies are expanding  
into new markets from  
ITER work



**400+ new technologies**, tools and processes, and around 40 spin-offs, start-ups, and JV

**Flexible IP policy fostering the use of technologies by industry.**

**Specific F4E Technology Transfer Programme** to identify the business potential of technologies developed and facilitate their commercial use. F4E offer free technology brokerage services to industry to help them find a partner and innovate.

**Fusion Technology Transfer Marketplace** showcasing 40+ technologies ready to be marketed benefitting the companies that have developed them (now joint with EUROfusion).

We provide an annual “**Technology Transfer award**” (10k€) to projects that have succeeded or plan to use their fusion technologies in a non-fusion environment.

Annual **Demonstrator call** (50k€) to offer financial support to integrate fusion solutions in non-fusion applications.

## ▶ **Competitiveness**

Companies are expanding into new markets from ITER work





European  
Fusion Technology  
Marketplace

WHO WE ARE

OUR TECHNOLOGY PORTFOLIO

SUCCESS STORIES

NEWS

Unleash your business potential with fusion technologies

# European Fusion Technology Marketplace

Our aim is to promote the technologies developed by Fusion for Energy (F4E) and the European Fusion Laboratories (EUROfusion) by making them widely available and commercially viable to industry.

OUR TECHNOLOGY PORTFOLIO



EUROfusion



FUSION  
FOR  
ENERGY

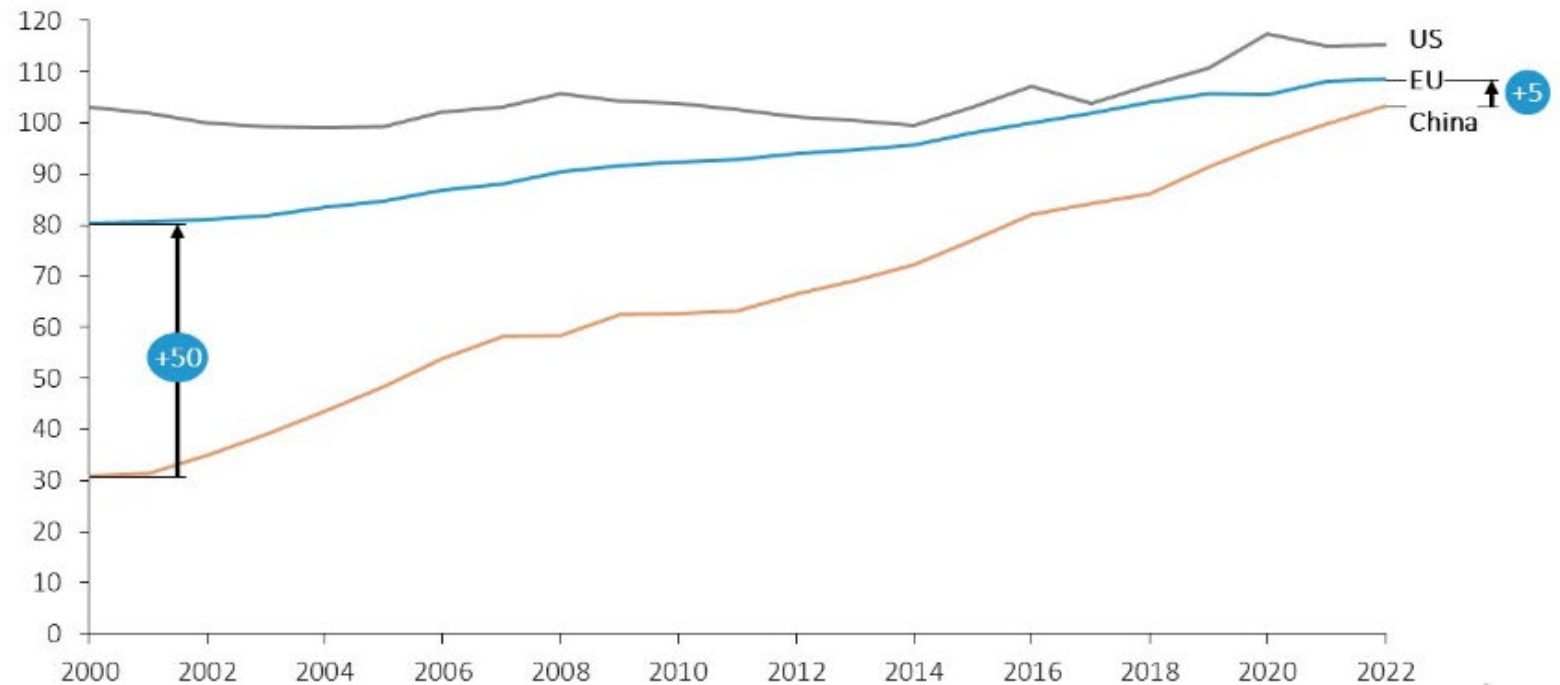
# The future of European competitiveness

Part B | In-depth analysis and recommendations

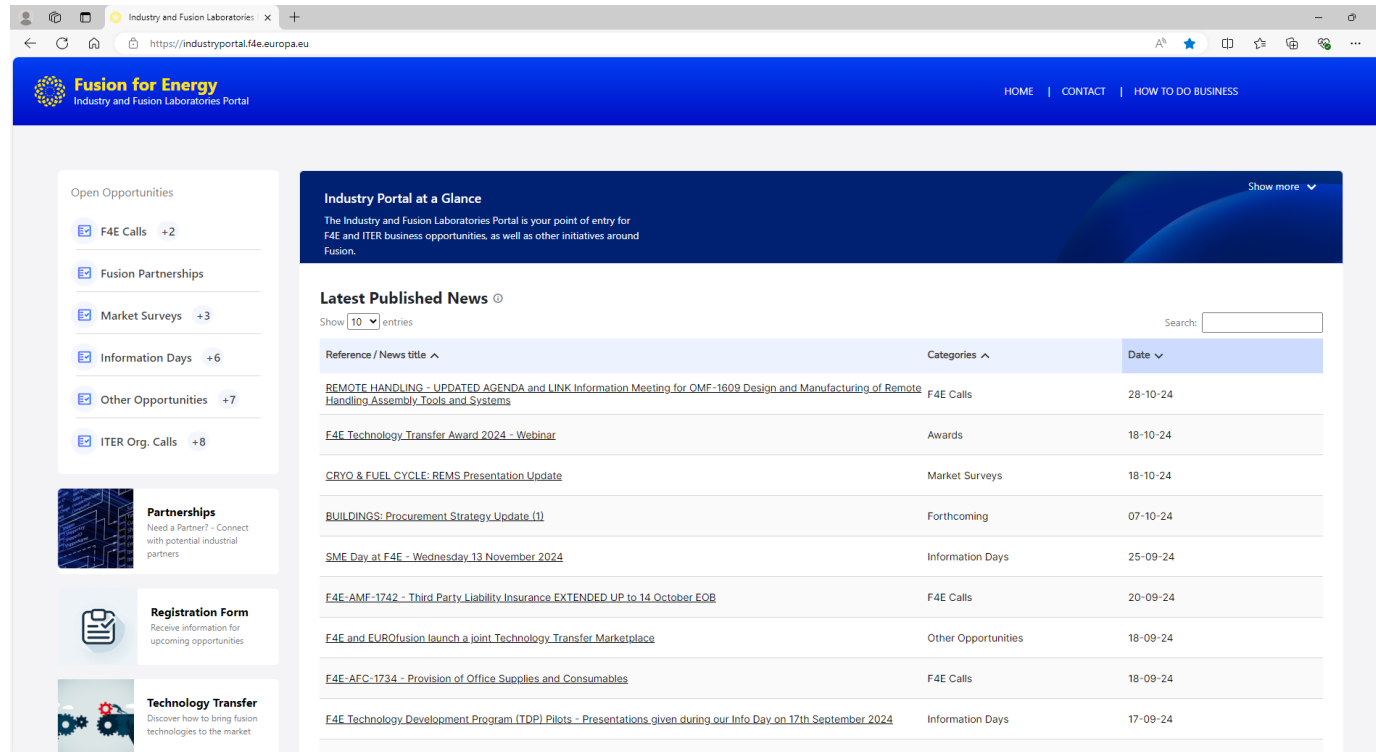
SEPTEMBER 2024

## Evolution of the innovation performance of the EU and its main competitors

European Innovation Scoreboard



<https://industryportal.f4e.europa.eu/>



The screenshot shows the 'Industry and Fusion Laboratories Portal' website. The header includes the Fusion for Energy logo and navigation links for HOME, CONTACT, and HOW TO DO BUSINESS. The main content area features a 'Latest Published News' section with a table of recent updates. On the left, there are sections for 'Open Opportunities' (listing F4E Calls, Fusion Partnerships, Market Surveys, Information Days, Other Opportunities, and ITER Org. Calls) and 'Partnerships', 'Registration Form', and 'Technology Transfer'.

Reference / News title	Categories	Date
<a href="#">REMOTE HANDLING - UPDATED AGENDA and LINK Information Meeting for OMF-1609 Design and Manufacturing of Remote Handling Assembly Tools and Systems</a>	F4E Calls	28-10-24
<a href="#">F4E Technology Transfer Award 2024 - Webinar</a>	Awards	18-10-24
<a href="#">CRYO &amp; FUEL CYCLE: REMS Presentation Update</a>	Market Surveys	18-10-24
<a href="#">BUILDINGS: Procurement Strategy Update (1)</a>	Forthcoming	07-10-24
<a href="#">SME Day at F4E - Wednesday 13 November 2024</a>	Information Days	25-09-24
<a href="#">F4E-AMF-1742 - Third Party Liability Insurance EXTENDED UP to 14 October EOB</a>	F4E Calls	20-09-24
<a href="#">F4E and EUROfusion launch a joint Technology Transfer Marketplace</a>	Other Opportunities	18-09-24
<a href="#">F4E-AFC-1734 - Provision of Office Supplies and Consumables</a>	F4E Calls	18-09-24
<a href="#">F4E Technology Development Program (TDP) Pilots - Presentations given during our Info Day on 17th September 2024</a>	Information Days	17-09-24

Ted Tender electronic daily to receive automatic notifications when a call is published:

<https://ted.europa.eu/en/>.

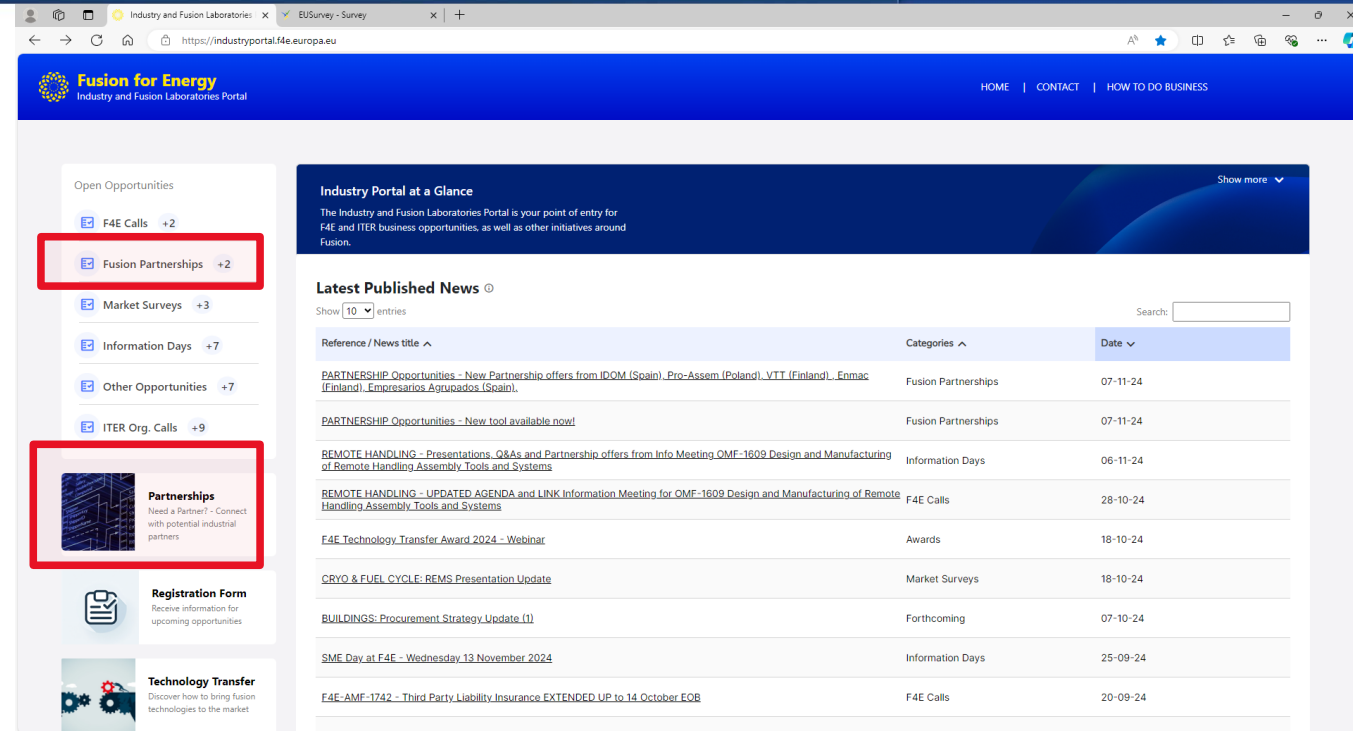
Some good tutorials on Ted here: [Discover our video tutorials - ted.europa.eu - TED](#)



# Further set-up for Supply Chain



**New feature available for companies/SMEs to increase their visibility and offer/request partnership on the F4E Industry Portal**  
**F4E Partnership marketplace**



## F4E-EUROFusion Techno Transfer Marketplace



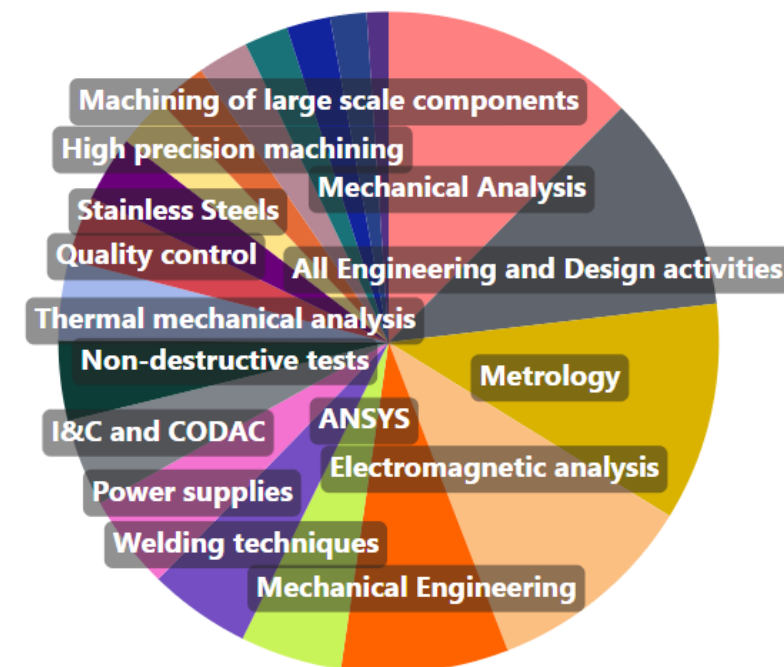
**Registration for companies/SMEs, requires selection of relevant Technologies => Info on Pre-procurement !**  
**Register in the internal F4E Supply Chain database**



- F4E in the Fusion landscape
- Building a fusion Supply Chain
- **Germany in the picture**
- Upcoming opportunities

- ▶ 588 M€ estimated return via F4E contracts
- ▶ Success rate of German entities at 46% (vs. average EU entities 33%)
- ▶ Positive collaboration so far
- ▶ Capabilities identified in key technologies
- ▶ More opportunities to come ! (cf. next session)
- ▶ A greater involvement in pre-procurement is key => connect with ILO

**Reminder**

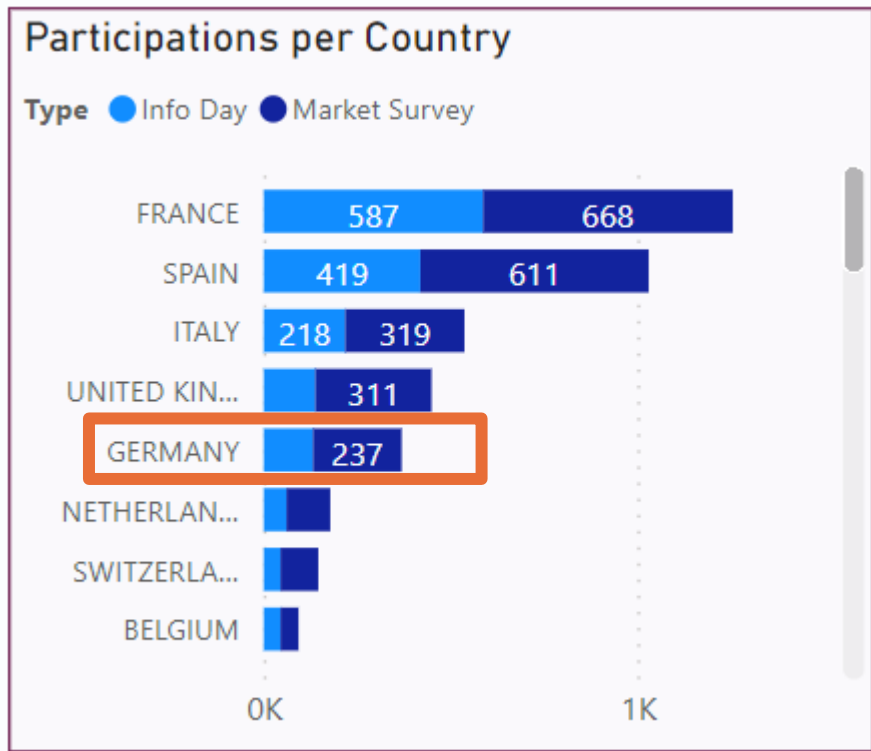




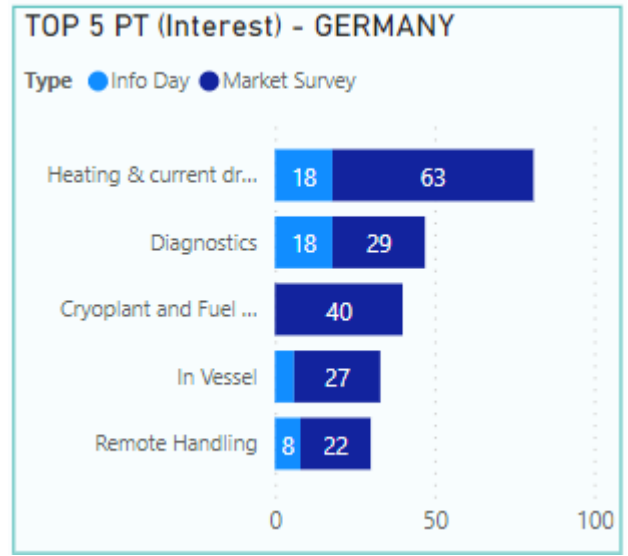
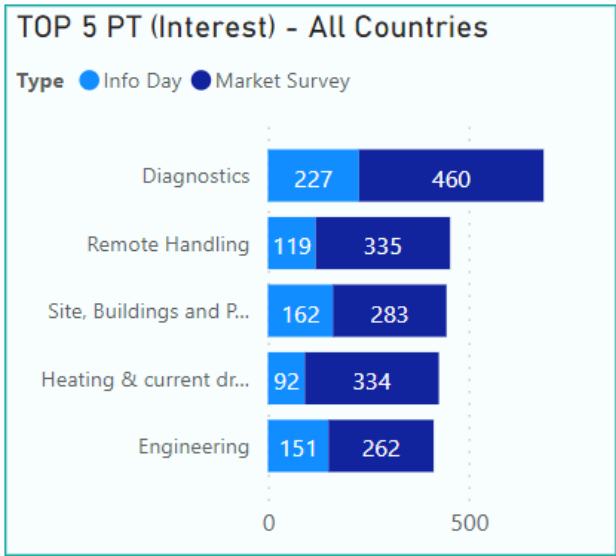
# How many pre-procurement activities does Germany participate in? Which programs is Germany interested in?



## Participations



## Programs



- Fusion, Fusion For Energy (F4E) and ITER
- Building a fusion Supply Chain
- Germany in the picture
- **Upcoming opportunities**

## OPE-1775 Tungsten-CuCrZr bonding.

3 contracts in parallel of about 300 k€

Gradient Joint of W to CuCrZr in 3 stages:

### Stage 1:

- Development of **manuf. process** to produce 12x22x22 mm **tungsten tiles**.
- **Characterization of the W-tiles.**
- **Microstructural characterization** of the W-tiles (

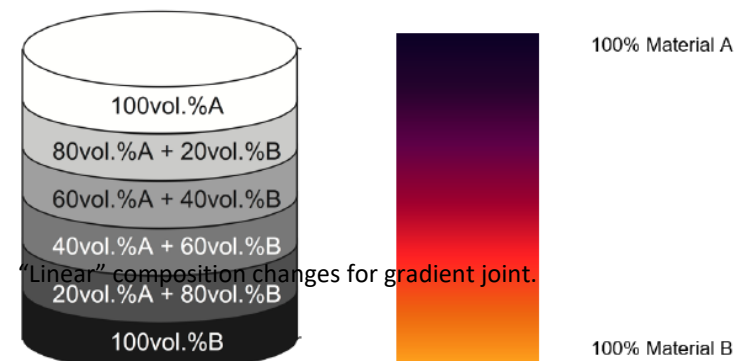
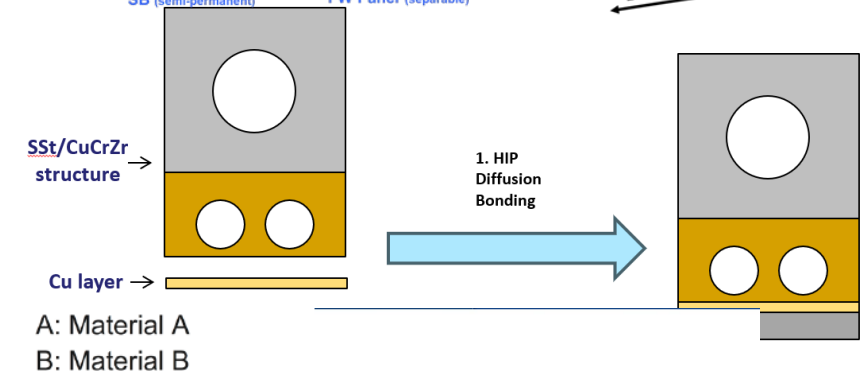
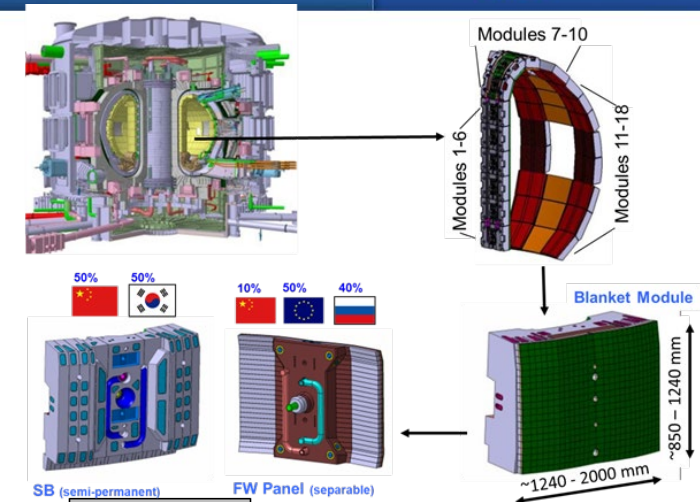
### Stage 2:

- Development of **manuf. process** to produce **W/CuCrZr** gradient tiles.
- **Mechanical characterization** of the W-to-CuCrZr **bonding**.
- **Microstructural characterization** of the gradient W-tiles.

### Stage 3:

- Manufacturing of W to CuCrZr gradient joints.
- Supply 40 specimens of W/CuCrZr gradient tiles manufactured

**... preliminary activities before manufacturing phase of 1-1.5 million tiles.**





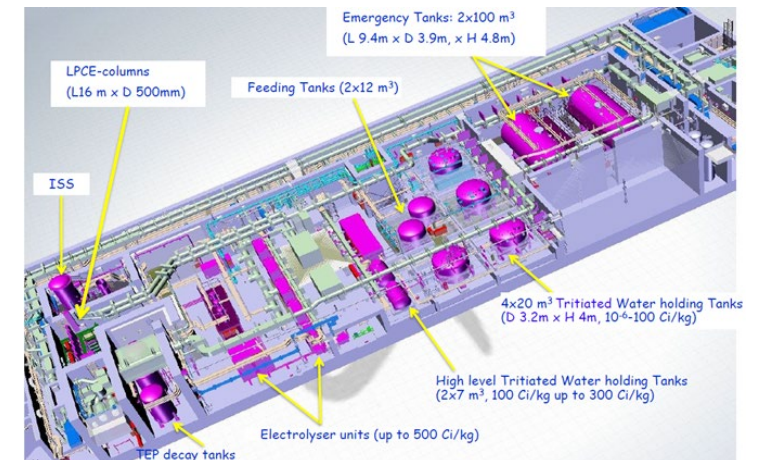
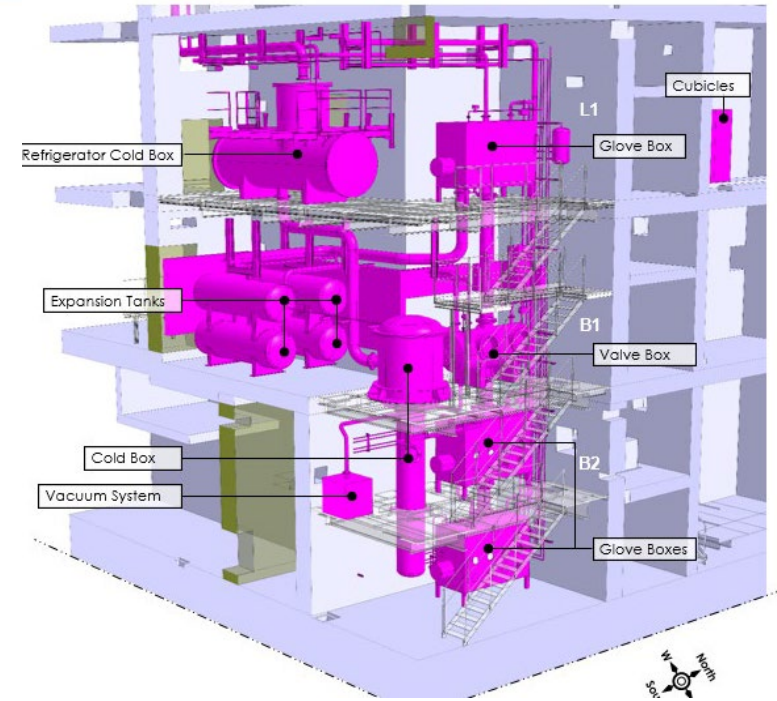
## Tritium => Stainless Steel components

### Isotope Separation System Cryosystem (cat D) Final Design and Supply

- Nuclear system, 6 cryogenic distillation columns (H/D/T)
- Column height of 7.5 m, cooling power of 1kW @ 16K.
- Tight tolerances.
- Target CFT: Q1 2026. Market Survey ongoing
- 2 main contracts: Cryogenic refrigeration & Process plant.

### Water Detritiation System (cat D) Final Design and Supply

- Reception and Purification System: Target CFT Q2-3 2025.
- Distillation columns (2 x 28 m)
- Protection Important Component.
- Target CFT Q1 2026. Market survey Ongoing



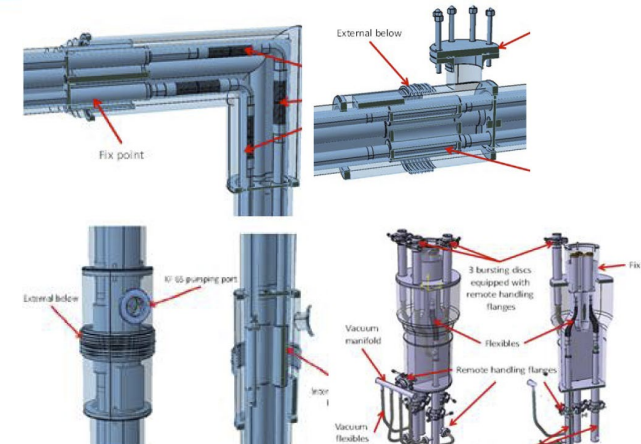
## OPE-1592 CRYOLINES DN25 (cat A).

Target CFT Q1 2025 (contract signature August 2025).  
About 200 meters.

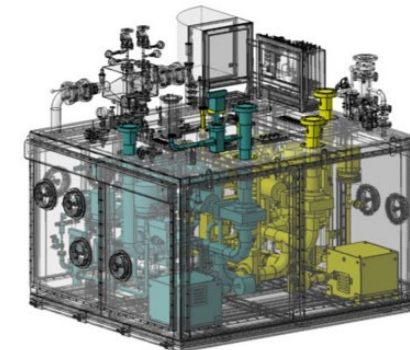
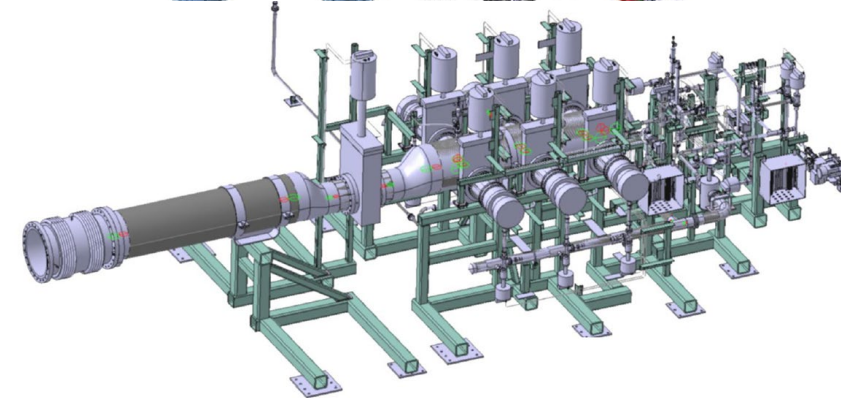
## OPE-17XY Leak Detection (ex-OPE-0982): Cat. B

Market Survey Q1 2025; CFT Q3-4 2025.

- 7 skids with leak detection equipment
- Manufacturing and preparation of vacuum pipes spools;
- Vacuum welding (1.000 welds);
- Machining process for 300 vacuum flanges (ITER flange);
- Vacuum assembly and clean area availability;
- FAT Factory Acceptance integrated with I&C;
- High leak tightness



Examples of some of the rigid cryolines subcomponents



## NB Cryopumps (3 units, cat **D**) Target CFT Q2-3 2025

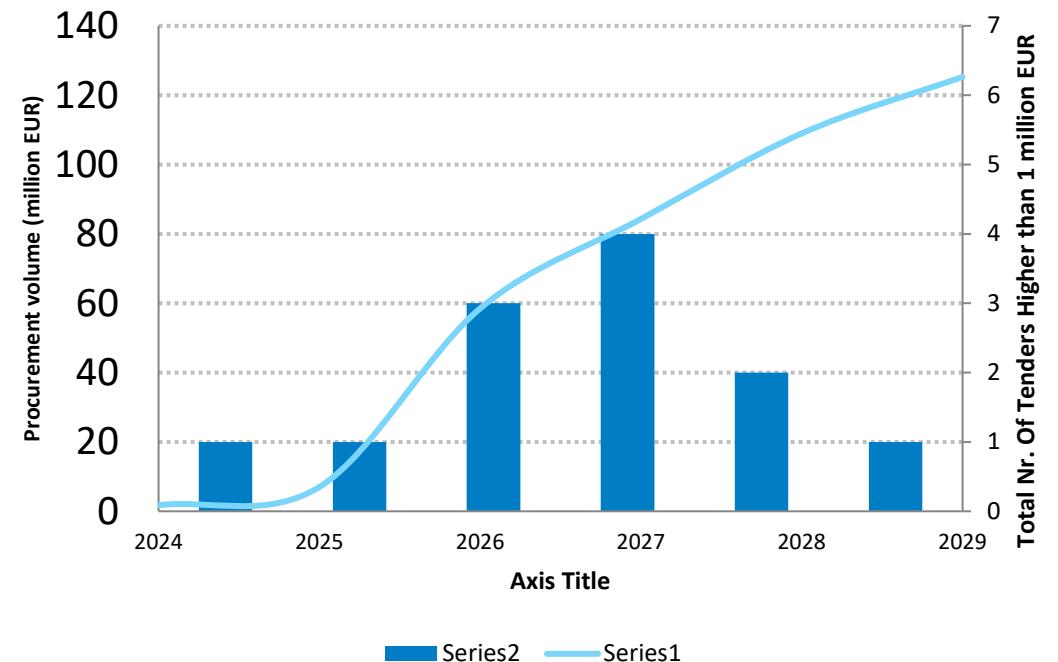
- 1000 cryopanel ; >1000 m<sup>2</sup> pumping surface.
- Build-to-Print.
- Tight tolerances.
- 1000s of radiographies.
- >500 leak tests.
- (Protection Important Component)

## All Vacuum, Cryogenics and Leak detection technologies

About 120 M€ of Procurement 2025 to 2029.



Mitica cryopump prototype







**FUSION  
FOR  
ENERGY**

Big Science  
BuSINESS  
Forum  
2024

## Technology Development Program

D-T Fuel Cycle technologies development roadmap (v0)

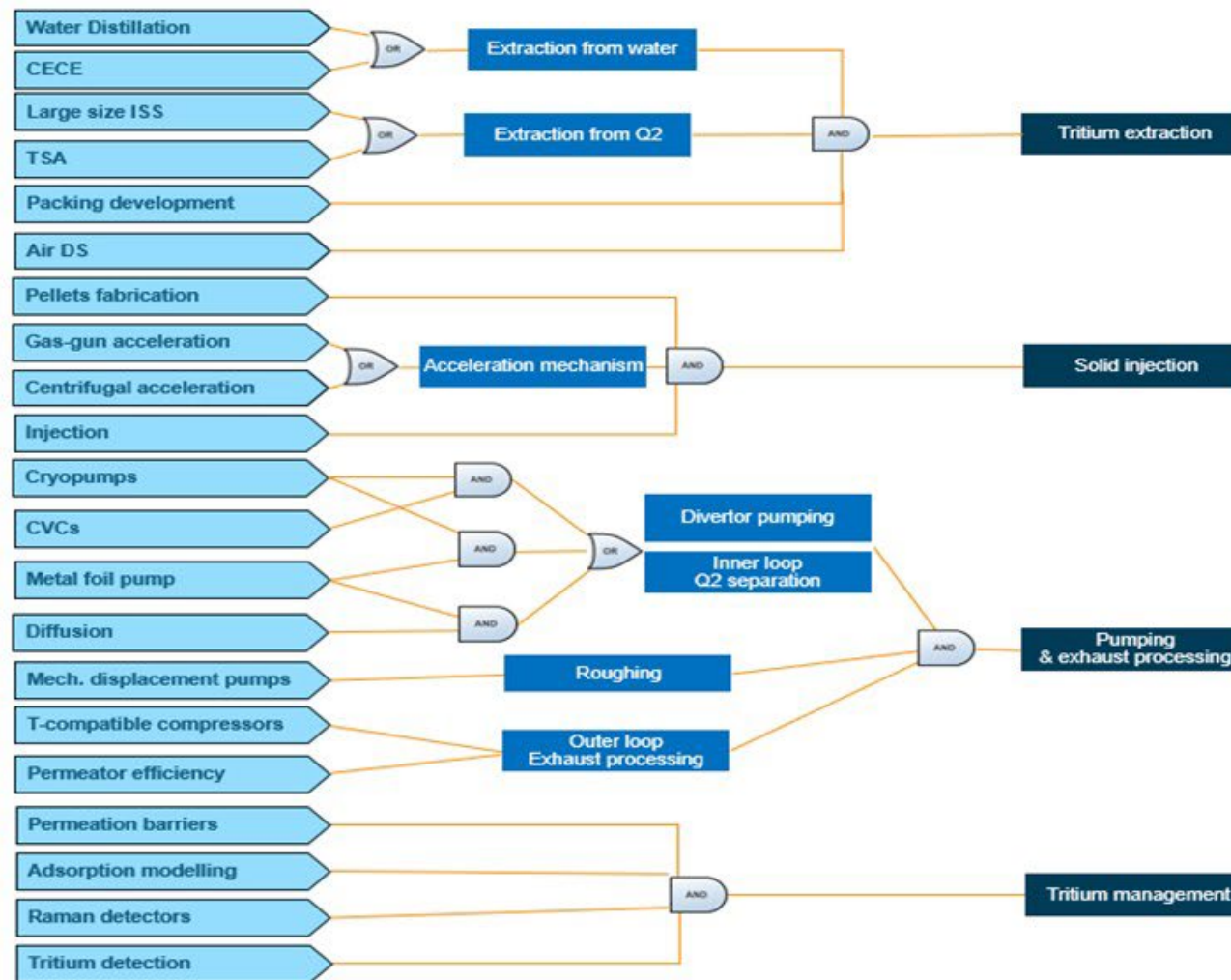


Workshop with European industry, start-ups, researchers and policy makers

- Feb. 2025 (remote, 0.5 day)
- Mar. 2025 (in-person, 1.5 day, Barcelona)

### 1<sup>st</sup> opportunity:

- Prototype for personal Tritium detector
- 2 x ~350 kEUR funding
- Launch by end 2024



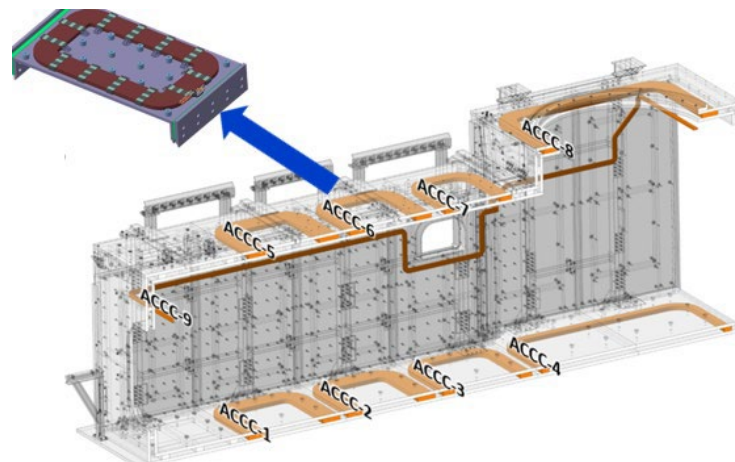
Mature  
for Fusion Power Plant fuel cycle

[https://ec.europa.eu/eusurvey/runner/F4E\\_Fuel\\_Cycle\\_Workshop](https://ec.europa.eu/eusurvey/runner/F4E_Fuel_Cycle_Workshop)

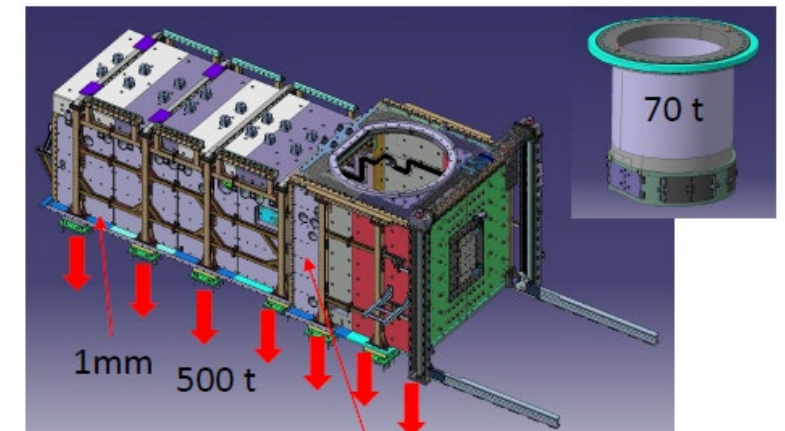
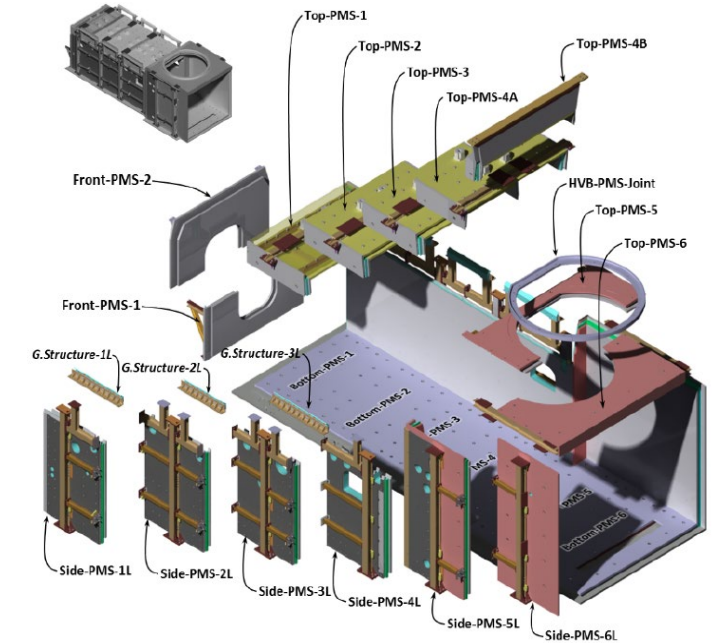
## Neutral Beam Magnetic Shielding Cat. D. (2 units)

- Active Compensation Correction Coils (ACCC): 2 x 8 units.
- Passive Shielding with plates (see next slide)
- Skills: Machining and precise Assembly (1mm gaps/0.1 mm tolerances) of heavy components (500t) nuclear classified (RCC-MR) + coil design and manufacturing).

Target CFT: Q3 2025.

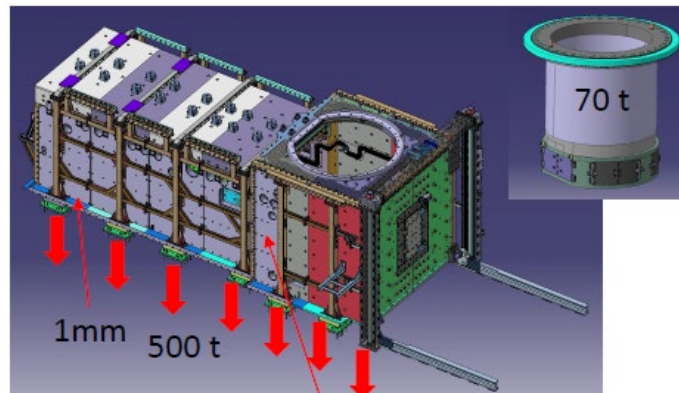
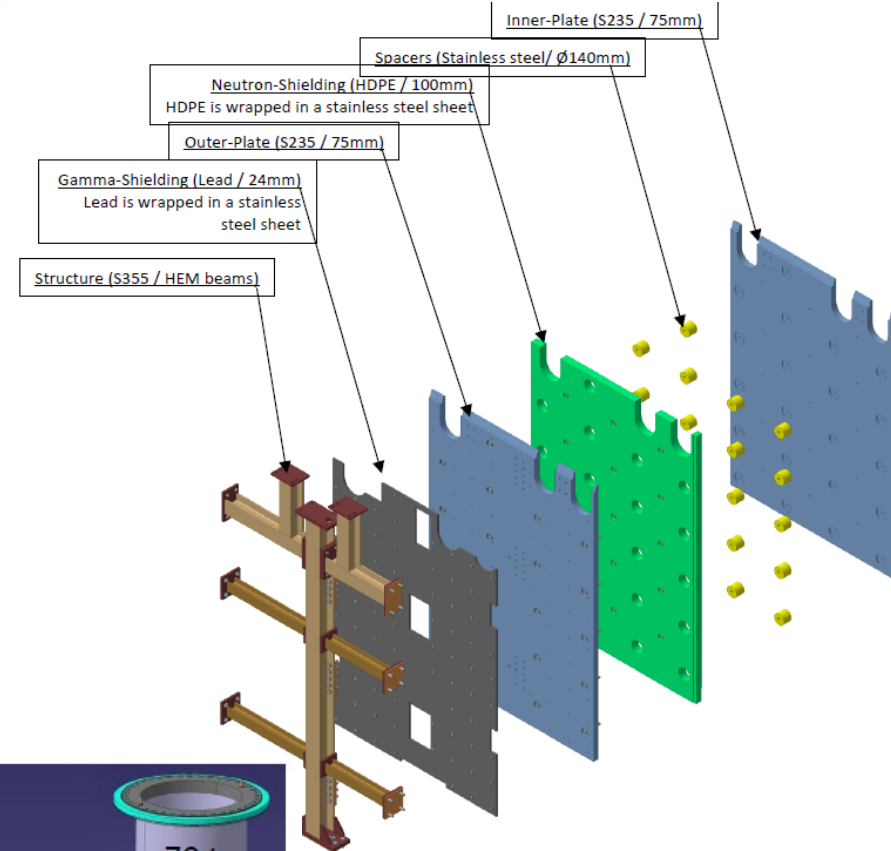


Active Compensation Correction Coils (ACCC)



## Neutral Beam Magnetic Shielding Focus on Materials

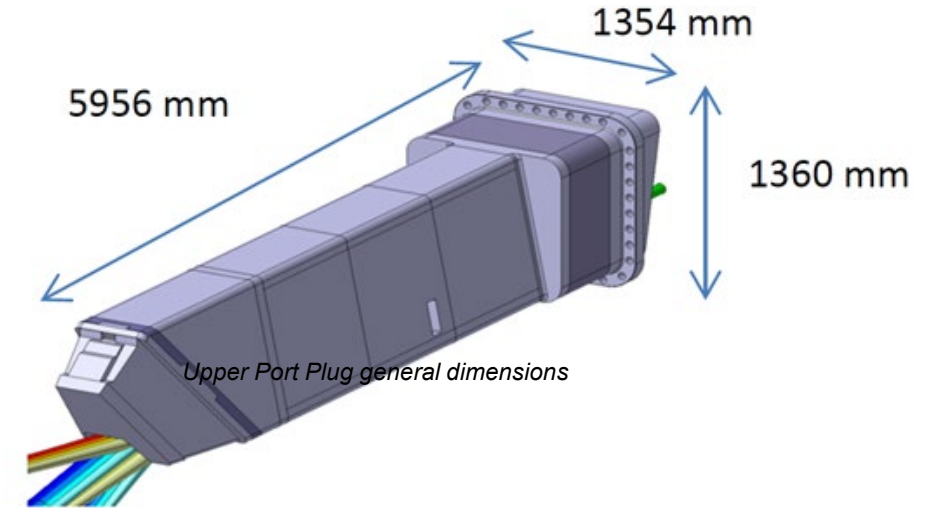
- **Steel S235** plates (EN 10025-2) (2 x 400 tons). 80 mm thick about 5 meters. Annealing needed.
- **Pure iron** plates
- **LEAD** plates
- **HDPE** polymer plates
- **Bumax BOLTS**





## 6 Diag PORTS Manufacturing and Assembly. Cat. D.

- Target => CFT: Q3 2025.
- **316L(N)-IG) Austenitic stainless steel** “X2CrNiMo17-12-2 controlled nitrogen” with a concentration of Cobalt, Niobium and Tantalum not exceeding 0.05%, 0.01% and 0.01% weight respectively
- **Polybore HE 430**, as neutron shielding blankets for ISS (TBC).
- **B<sub>4</sub>C (Boron Carbide) pellets**: sintered B<sub>4</sub>C pellets used to fill the DSMs B<sub>4</sub>C Shielding Chambers, as neutron shielding (about 15 tons).
- **Commercial Off-The-Shelf (COTS) items**: bogie wheels, fasteners, flexible metal seals, piping fittings, connectors, etc.
- **Glass To Metal Process** with 99% purity N<sub>2</sub> atmosphere.



- **B<sub>4</sub>C plates for WAVS**: about 3 tons (1.250 plates of 250 x 250 x 20 mm) (Then 3 other batches in future) => CFT in 2026.
- **Feedthroughs** (Tritium barrier)

## Final Design and Supply of Ancillary Systems

- **1<sup>st</sup> System** - Final Design and Manufacturing of Tritium Extraction & Accountancy Systems + Gloveboxes in Tritium Room.

Market Survey closed – **CFT Q3 2025** Cat **C**

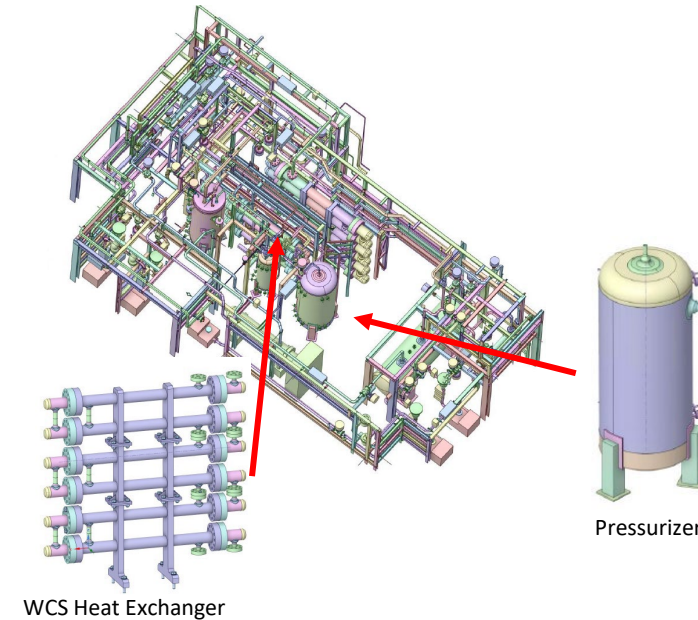
- **2<sup>nd</sup> System** – Water Cooling System, Coolant Purification System

Market Survey Closed – **CFT Q3 2025** Cat **D**

- **3<sup>rd</sup> System** – Water Cooled Lead Lithium loop - Cat

**B**

=> **Market Survey imminent.**



**OPE-1405: Integration and testing of Actively Cooled Divertors of JT-60SA,** estimated contract value: **CD**, Market Survey closed, planned launch **Q1 2025**  
(Competitive with Negotiation)

**OPE-1725: JT60SA Pellet Injectors (re-issue):** Market Survey to be decided, dissemination to target companies and ILO network will be performed. Value **A**, planned **Q1 2025** (Competitive with Negotiation)



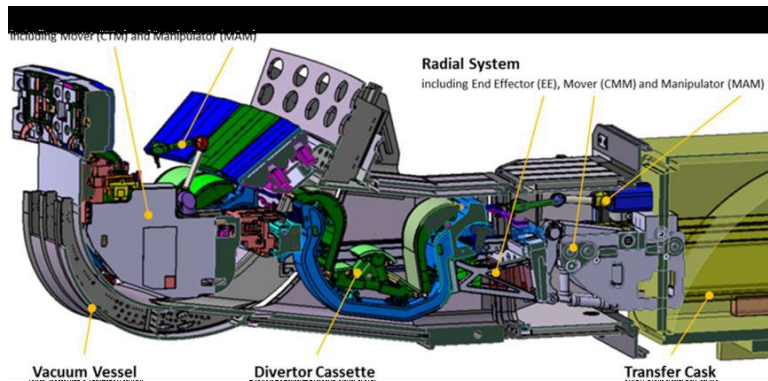
- On-going **Market Survey**
- Upcoming joint ITER/F4E **Technical information Day Online** 17<sup>th</sup> January (10h-13h)

Registration at [industryportal-info@f4e.europa.eu](mailto:industryportal-info@f4e.europa.eu) , and [hcc@iter.org](mailto:hcc@iter.org) ref. HCF INFODAY 17/01



Figure#2: Site Layout with location of the Hot Cell Facility Worksite area<sup>5</sup>.

On-going **OMF-1609** Design & Manufacturing of Remote Handling System for Machine Assembly. See on F4E Industry Portal offers of partnership.



**Destructive and ND Testing of Material and Mock-ups: (ex-OMF-1082).**

Cat. **B**. Target CFT: Q1 2025.

## Contacts

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[heinz-ullrich.kraft@web.de](mailto:heinz-ullrich.kraft@web.de) [christine.jobert@cafap.fr](mailto:christine.jobert@cafap.fr)

## Useful links

[F4E Industry Portal](#)

[Partnership opportunities \(consult\)](#)

[Offer or Request a Partnership](#)

[F4E Supply Chain Registration](#)

[Technology Transfer Platform](#)

**Thank you**