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2022**

# Qualification of Manufacturing Procurement for F4E and ITER

“BASIC MATERIAL TECHNOLOGIES AND ADVANCED  
MANUFACTURING TECHNIQUES”

**Stefan Wikman**

Group Leader of Materials & Manufacturing Technologies  
& Processes

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Bringing  
the power  
of the sun  
to earth

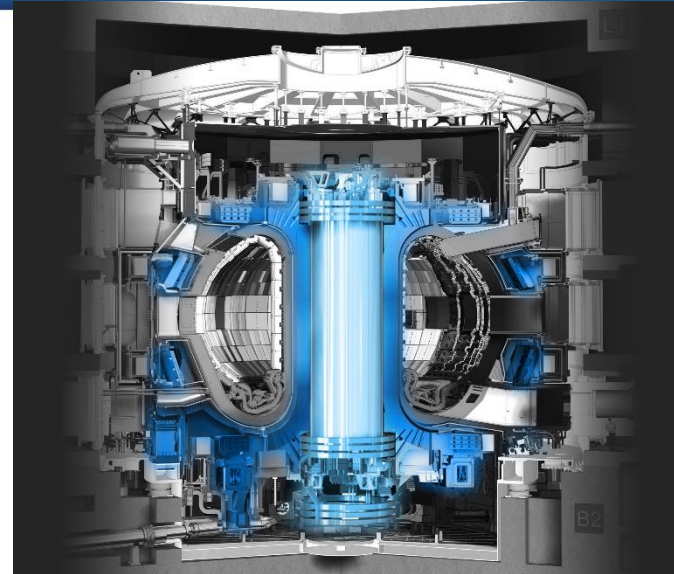
## Qualification of wide range of technologies and requirements

### Support via contracted labs

- Qualification of Materials, Joints and mock-ups etc
- Tests at operational conditions, such as
  - coolant interfaces corrosion tests
  - influence of neutrons on materials properties
- Development/validation of manufacturing processes

### Provides direct expertise support

- Internal insourcing of F4E staff to teams (18 Engineers allocated for full time support)
- Reviews of manufacturing readiness
- Ad Hoc advise
- Manufacturing follow-up

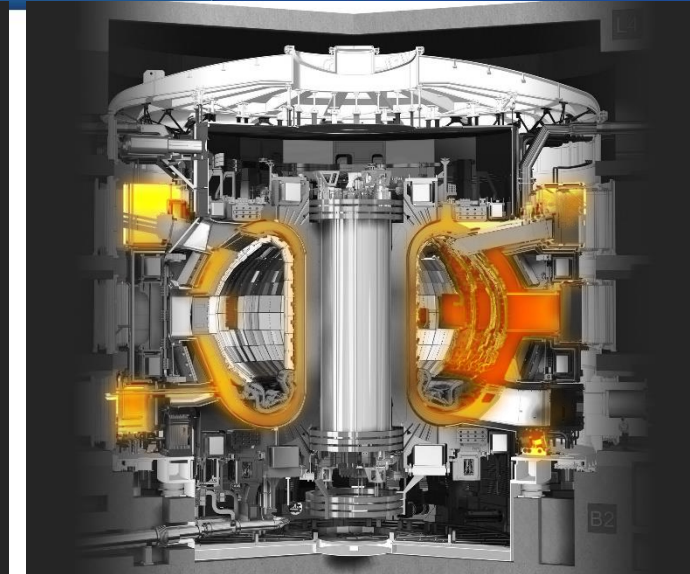


**Magnets: -269 °C**



**Super Conductors:**

- Qualification of mechanical properties materials and welds at cryogenic temperatures

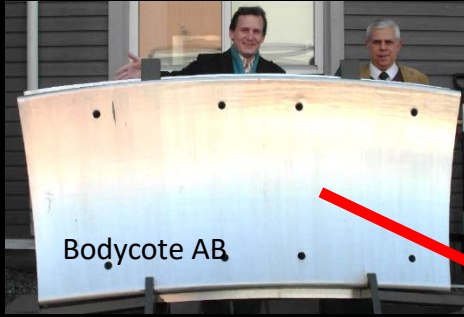


**Plasma: 150.000.000 °C  
+ neutron irradiation**

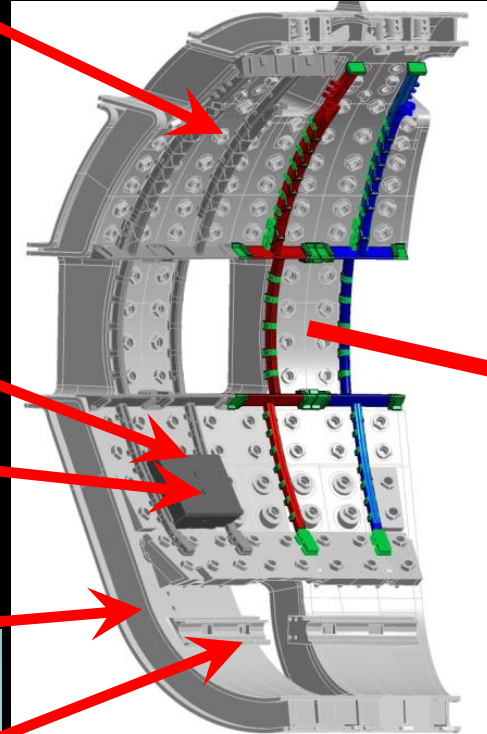
**Toroidal field coils**

Magnetic energy 41 gigajoules  
Magnetic field of 11.8 tesla

# Material challenges procuring components facing the “little sun”

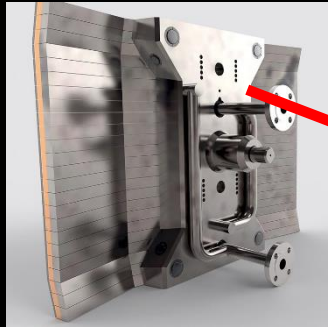


First Wall/blankets

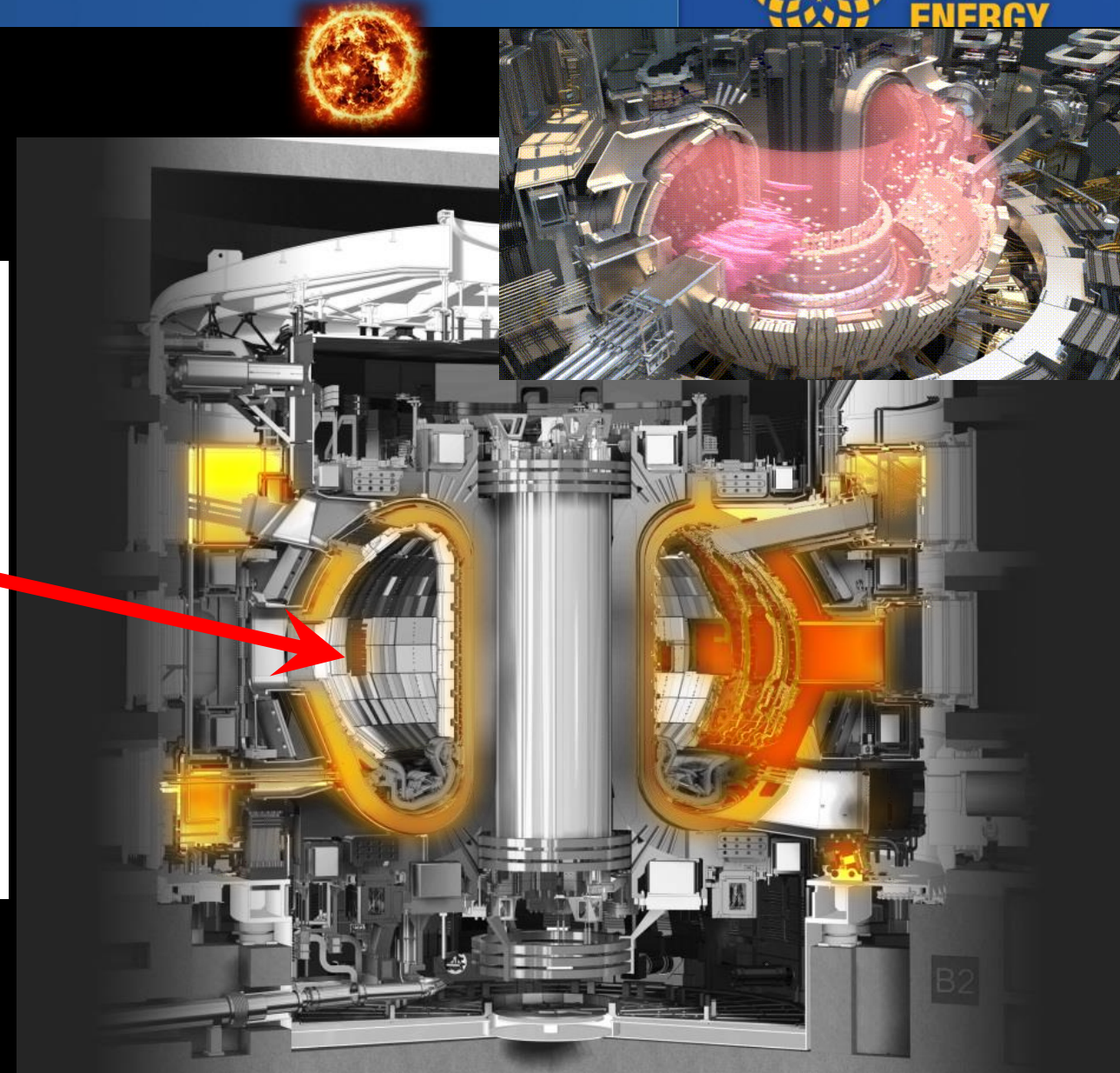
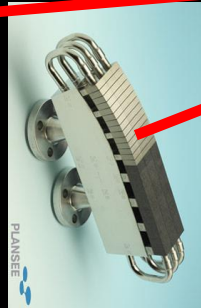


Vacuum Vessel

Divertor



Vacuum Vessel wall

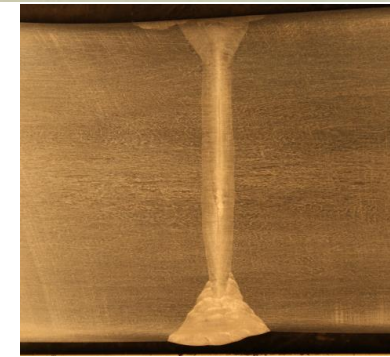


## OFC-1082 Running contract for “Materials and manufacturing testing/qualification services” (ceiling 2.700.000 Euro)

Re-occurring call for tender to maintain active service contract  
Been awarded to TWI UK, Tecnalia Spain and today with ISQ Portugal

### New call 2024 for 4 years contract

- And continuous support to establish other service contracts for other F4E units



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Some services reaches end of the line with ITER

## OFC-413 Lot 3 and Lot 4 Closed December 2021 for irradiation and post irradiation testing (ceiling 4.000.000 Euro)

Studsvik AB Sweden with NRG Netherlands

New irradiation service contracts via EUROFUSION as F4E closes such validation testing (takes 5 - 8 years and out of F4E scope)



# Approaching machine systems

## See opportunities? – What to think about to qualify manufacturing



Building works  
~700 MEUR in 10+  
contracts

Diagnostics  
~90 MEUR in 80+ contracts

Neutral Beam and Heating  
~120 MEUR in 20+ contracts

In-Vessel  
~600 MEUR in 20+  
contracts

Procurement examples from 2020

2022

2023

2024

2025

...

Antennas  
~60 MEUR in 30+ contracts

Cryogenics and Fuel Cycle  
~180 MEUR in 20+ contracts

### Example: Quality Classes and Nuclear Safety Protocol

Check what is applied and don't be worried if it looks "heavy"

Higher quality requirements typically contains same EN, ASTM etc standards, but extra manufacturing control:

- supervisor witness, inspector witness, and ok to proceed with next step authorization

Have subcontractors aware early with work instructions and manufacturing control plans – to be followed!

F4E can help mentor new suppliers on site to get going 😊

**Nuclear Safety – if not certain then don't proceed and communicate**

### Procurement

- materials (316LN)
- components (pipes, bolts, cabling, sensors, etc.)
- Free-issue items

### For materials, look at requested grades

- Market supply changes rapidly, be vigilant on details
- F4E got some flexibility, especially on small items

### Joining & Inspection

- EB / TIG welding, diffusion bonding by HIP, etc.
- NDT (visual, x-ray, UT, etc.)

### Joining methods

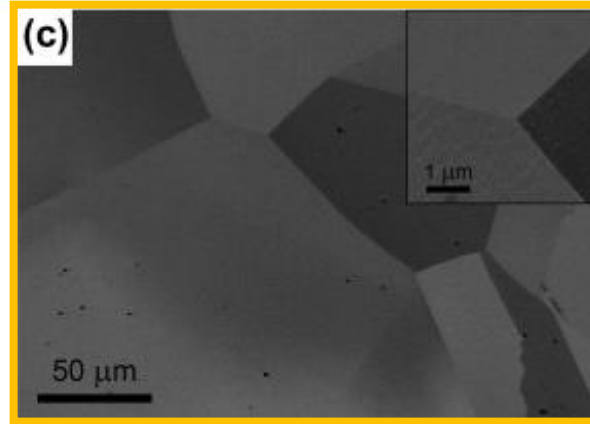
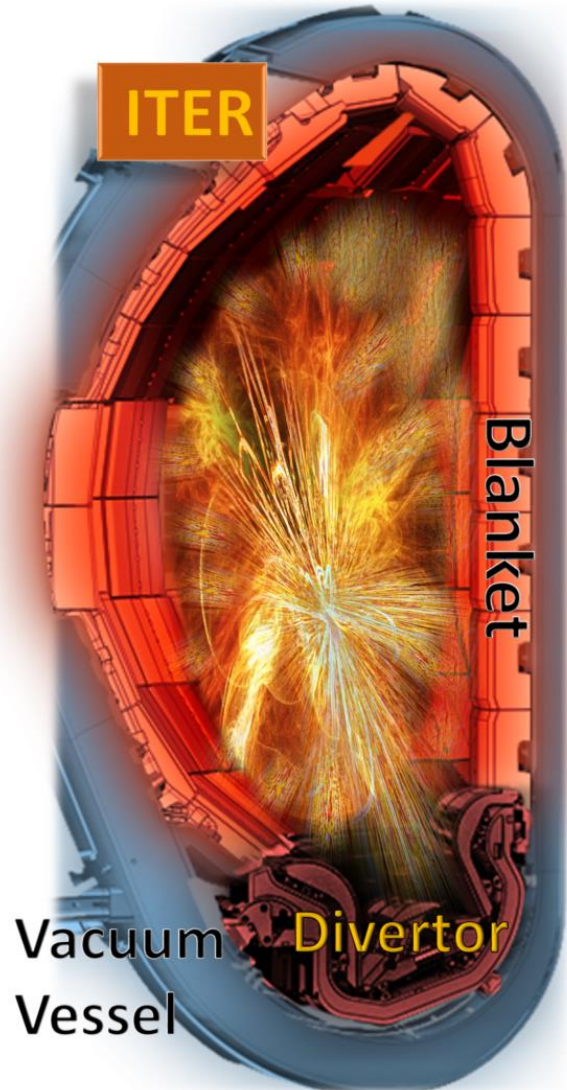
- Spec's often written to allow suppliers to reply with their expert choice of joining method (even if examples are given)
- Pay attention to Non Destructive Testing requirements (especially if RT (x-ray) on larger components)



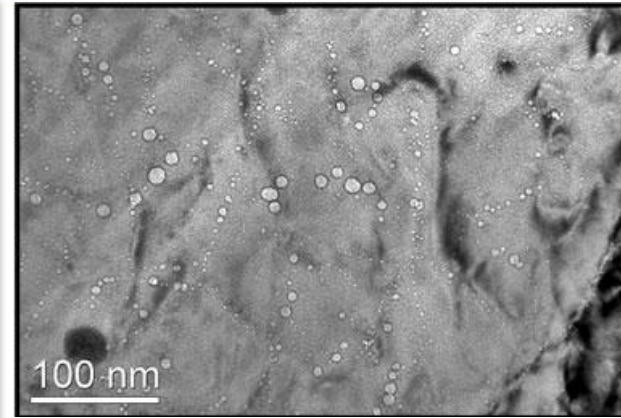
Weld inspection, Probeam

# Advanced concept

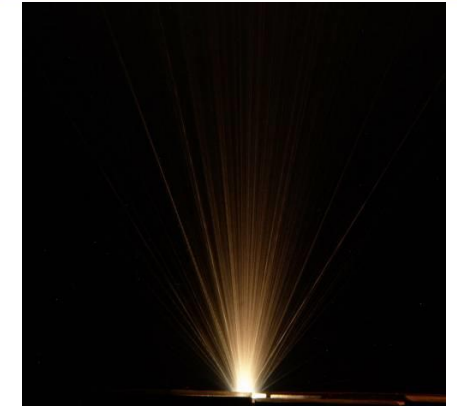
Qualified step by step for each material – but we are “back to basics”



Base material before exposure



Irradiation causes distortion and eventually forming “He-bubbles” + activation



Heat flux particle exposure  
Up to 1+ GW/m<sup>2</sup>

This background work is done for ITER → Selection of materials

Some qualification often necessary (included in contracts)

With exposure effects known the qualification is mainly to demonstrate that base materials and joints meet criteria

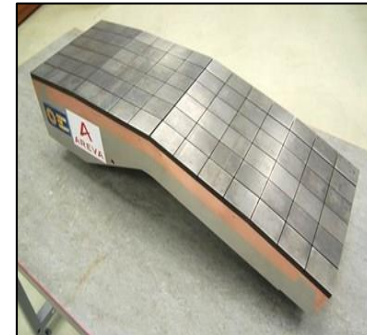
Sometimes with mock-up



### Today

It's a **competitive participation** in high value-added activities with balanced participation by large/medium/small companies and research organizations.

Successful companies often offer what they do best and involve subcontractors early and adapts to find alternatives



## Feedback from suppliers

*Spin-off exposure to new markets*

*Unique possibilities*

*Developed new know-how*

*QA and nuclear codes increased critical thinking competence of the teams*

*Collaborations never thought possible*





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