FUSION FOR ENERGY

BRINGING THE POWER OF THE SUN TO EARTH

ITER Challenges and Participation

Stefan Wikman
Head of Materials & Manufacturing Technologies & Processes
Fusion for Energy

BIG SCIENCE SWEDEN 24 Nov 2020

F4E - The European Domestic Agency for ITER and the development of fusion energy

FUSION FOR ENERGY

F4E is responsible to deliver Europe's contribution to ITER

- Headquarters: Barcelona, Spain
  Offices: Cadarache, France
  Garching, Germany
  Rokkasho, Japan
- Staff: About 500 + thousands contractors
- Budget:

  Presently €6.6 billion 2007-2020

  Next period €5.2 billion 2021-2027

ITER International Organization

Present Estimates

Cost: Estimates up to 26.000.000.000 Euro (From design to end of operation)

First Plasma: 2026

Full plasma operation: 2030

Deuterium Tritium operation start: 2035

Worlds largest science project
Lots of attention and political pressure

FUSION FOR ENERGY

POWER ENGINEERING INTERNATIONAL

The most difficult project on earth

07/23/2013

CNN

Nuclear fusion: the end of our energy problem?

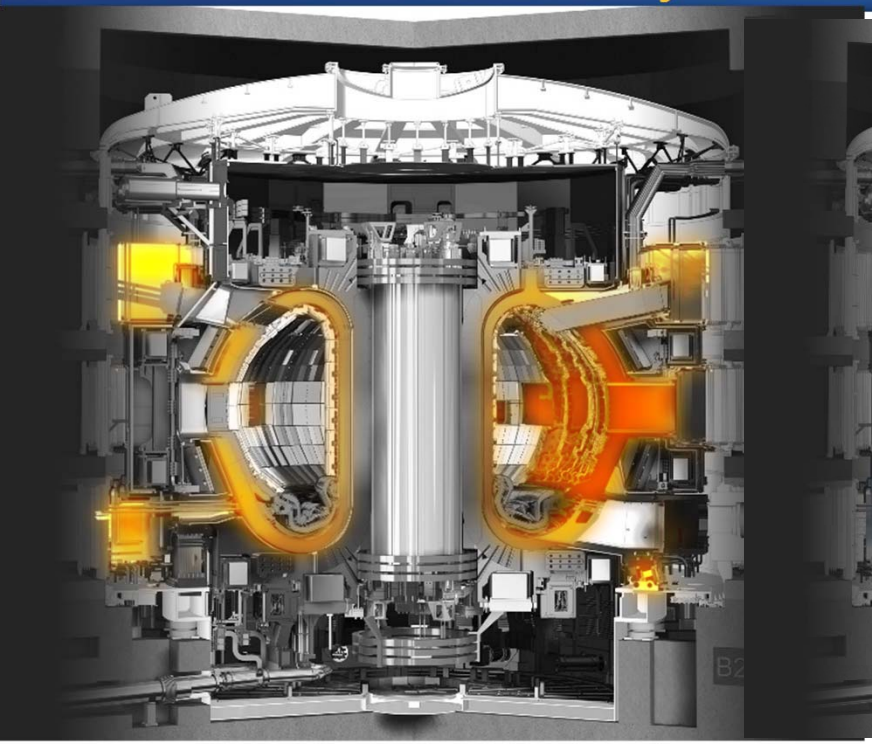
Forbes

ITER, The World's Largest Nuclear Fusion Project: A Big Step Forward

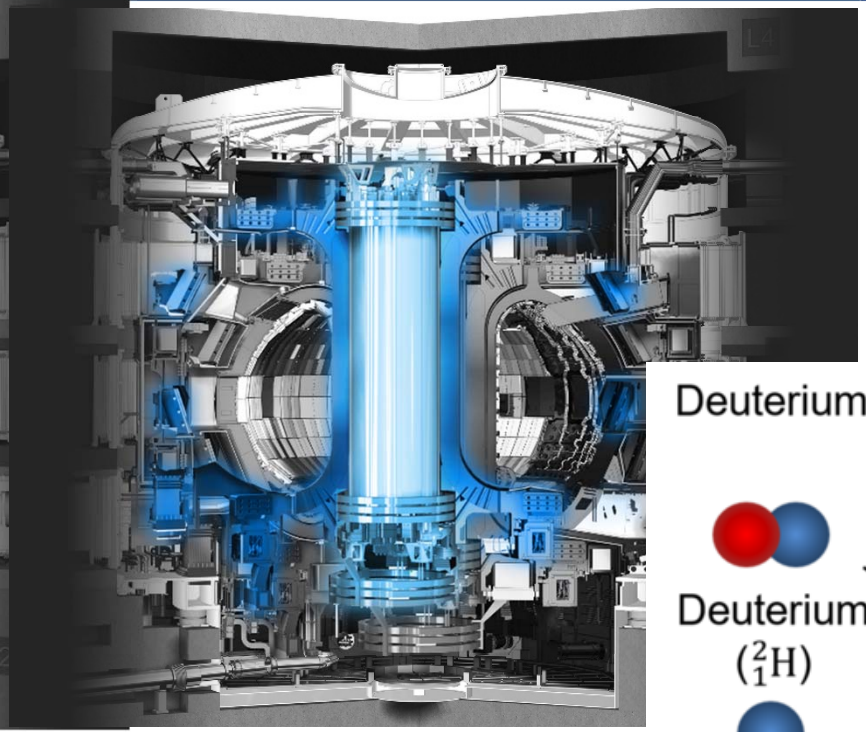
BBC News

Iter: World's largest nuclear fusion project begins assembly

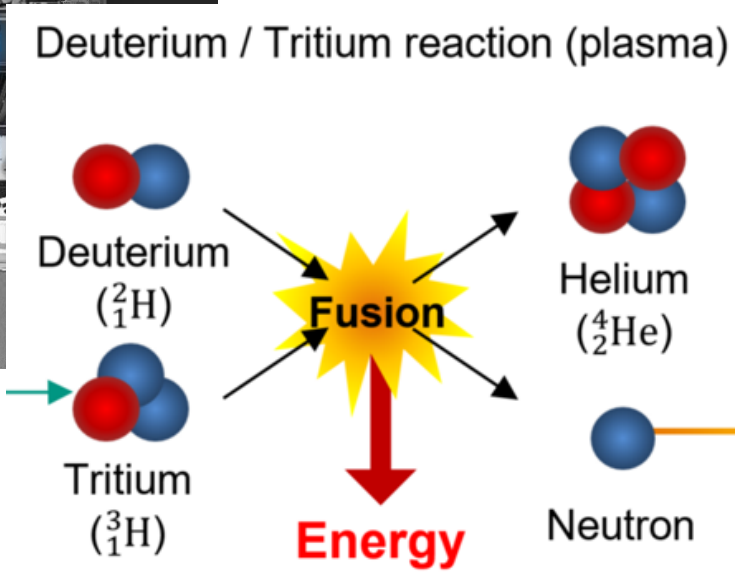
The Challenge:
Two extremes side by side exposed to neutrons



Plasma: 150.000.000 °C



Magnets: -269 °C



Many material combinations never used before

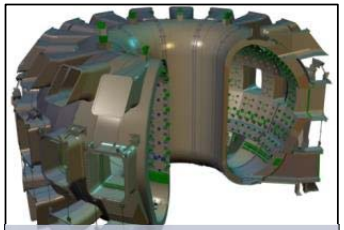
European contributions to ITER

Wide range of technical scope

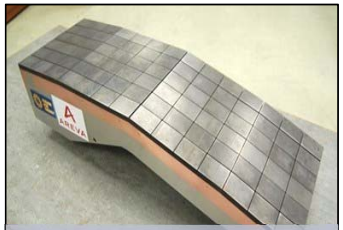
FUSION FOR ENERGY

Site & Buildings

Superconducting Magnets



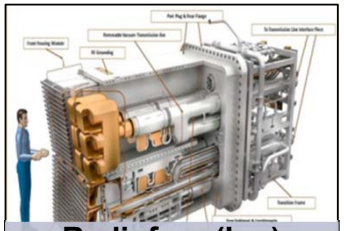
Vacuum Vessel



Wall Protection

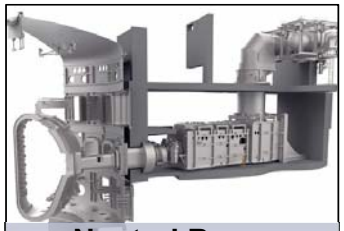
Robotic Remote Handling

Cryoplant & Fuel Systems

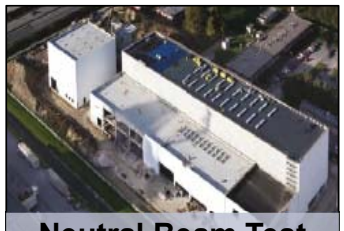


Radiofreq (Ion) Cyclotron Heating

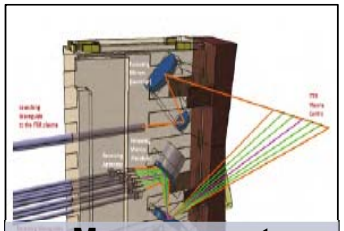
Radiofreq (Electron) Cyclotron Heating



Neutral Beam Injectors



Neutral Beam Test Facility in Padua (IT)

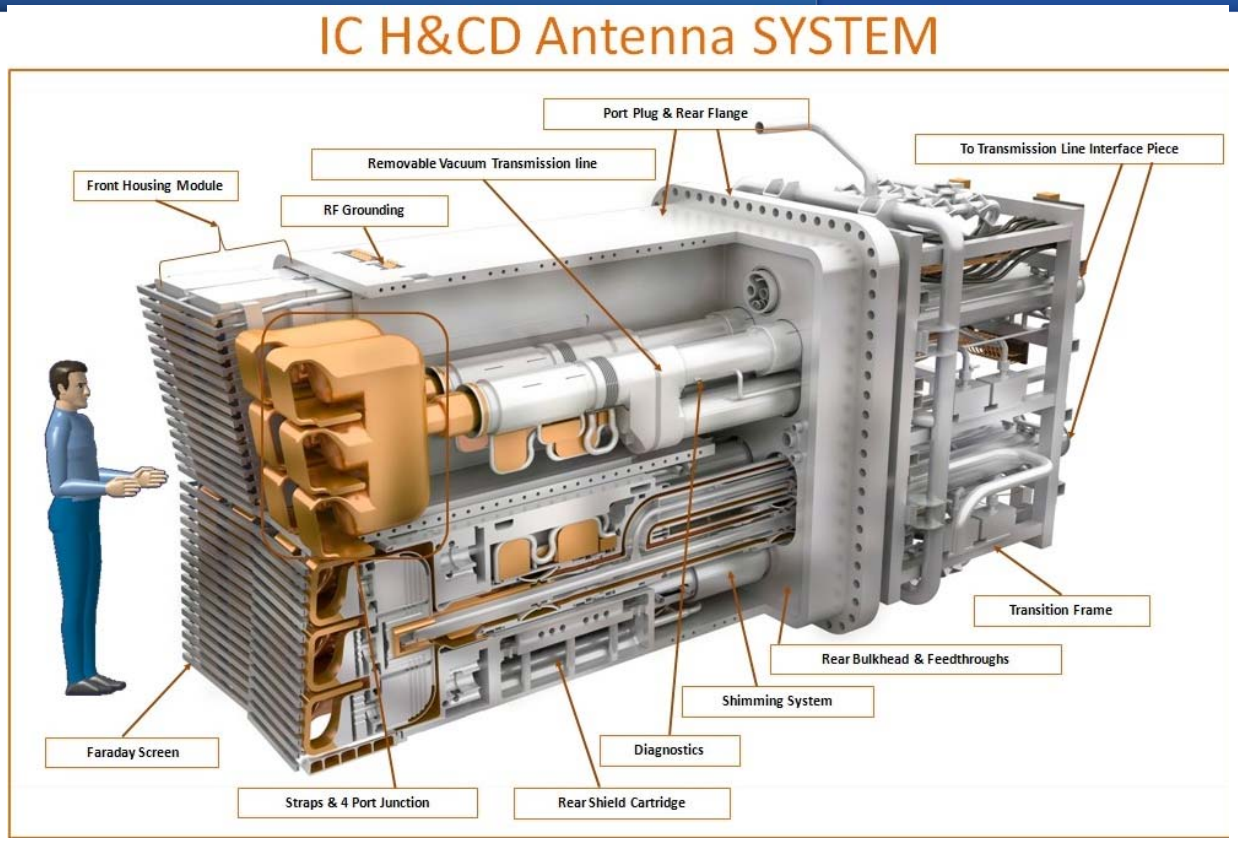


Measurement Systems

Fuel Breeding Modules (TBM)

Examples of Planned work

Antennas
~60 MEUR in 30+ contracts



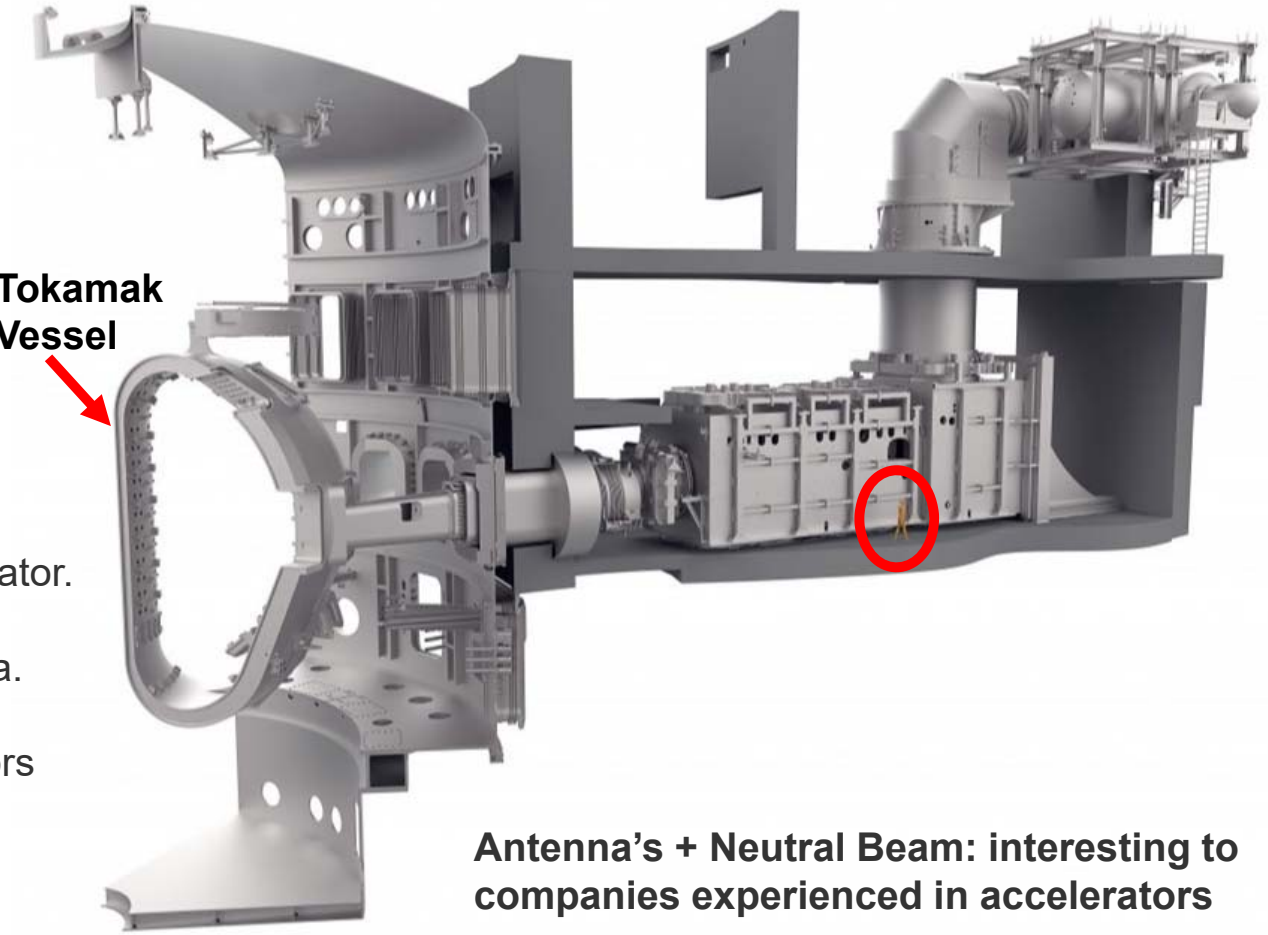
Units delivering 20 MW of radio frequency power to the plasma

Examples of Planned work

FUSION FOR ENERGY

Antennas
~60 MEUR in 30+ contracts

Neutral Beam and Heating
~120 MEUR in 20+ contracts



A neutral beam injector is a particle accelerator.

Delivers high-energy particles to the plasma.

Two 1MV, 40A heating neutral beam injectors

Antenna's + Neutral Beam: interesting to companies experienced in accelerators

Examples of Planned work

Antennas
~60 MEUR in 30+ contracts

Neutral Beam and Heating
~120 MEUR in 20+ contracts

In-Vessel
~600 MEUR in 20+ contracts

Diagnostics
~90 MEUR in 80+ contracts

Building works
~700 MEUR in 10+ contracts

Cryogenics and Fuel Cycle
~180 MEUR in 20+ contracts

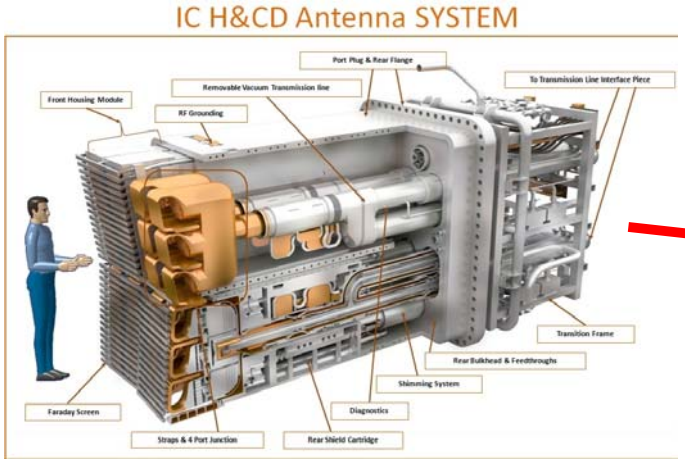
Service contracts

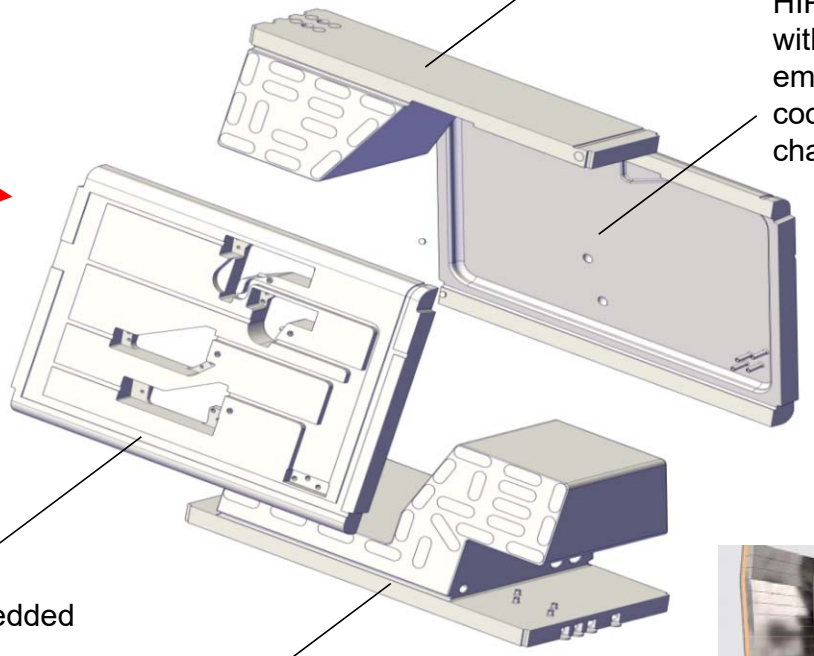
Qualifications

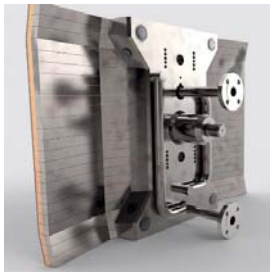
Analysis

Typical example component manufacturing needs

Advanced topics – but don't only look at the most advanced functions







Large procurements of:

- structural materials and base materials
- tubes, bolts
- cabling and insulators
- coatings
- …

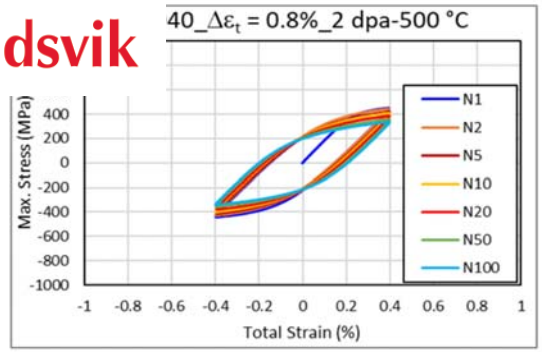
followed by machining and joining operations
(stainless steels, copper alloys etc)

Materials assessment and qualification

Demanding to meet all requirements

- Definition of Design Criteria
- Definition of Acceptance Criteria
- Qualification According to Codes & Standards
- Irradiation Campaigns at ITER Relevant doses
- Assessment of the Effect of Corrosion in the Heat Transfer Systems

Scale model and prototype manufacture/qualification



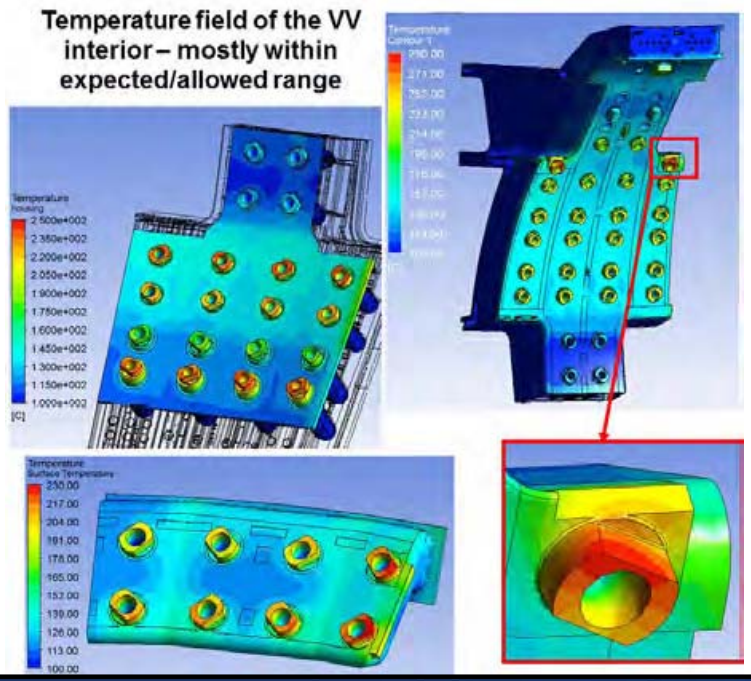
After qualification it is clear **subcontractors are needed** by consortia's to meet all criteria and manufacturing needs.

Look for matching engineering service possibilities

FUSION FOR ENERGY

Example: Preparation for welding

- Simulation of assembly and welding distortions
- Complex Engineering calculations
- Verification of production conditions



Acceptance testing

- leak testing, pressure testing, flow testing, hardness, etc.

Metrology

- positioning, dimensional, alignment, etc.
- Tolerances: e.g. few

Joining & Inspection

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

Participation

Types of direct contracts:

- Commercial procurement 100% financed (most common)
- Research grants min 40% financed (less every year)
- Expertise (direct consultancy, normally in-person)

Indirect contracts:

- Offer services as subcontractor to larger supplier/consortia

EU General Financial Regulation (based on Public Procurement Directive 2014/24/EU): wide competition, fair treatment, transparency, proportionality, non-discrimination

Very strict regulations for public procurement

Concluding remarks

Towards F4E: Reinforce communication and understanding of procedures/regulations

Find a balanced participation via large system consortia's and suppliers, medium/small companies and research organizations.

Make an assessment of already established suppliers/labs at larger calls

FUSION FOR ENERGY

Follow us on:

 www.f4e.europa.eu

 www.twitter.com/fusionforenergy

 www.youtube.com/fusionforenergy

 www.linkedin.com/company/fusion-for-energy

 www.flickr.com/photos/fusionforenergy