ITER – HERE COMES THE SUN

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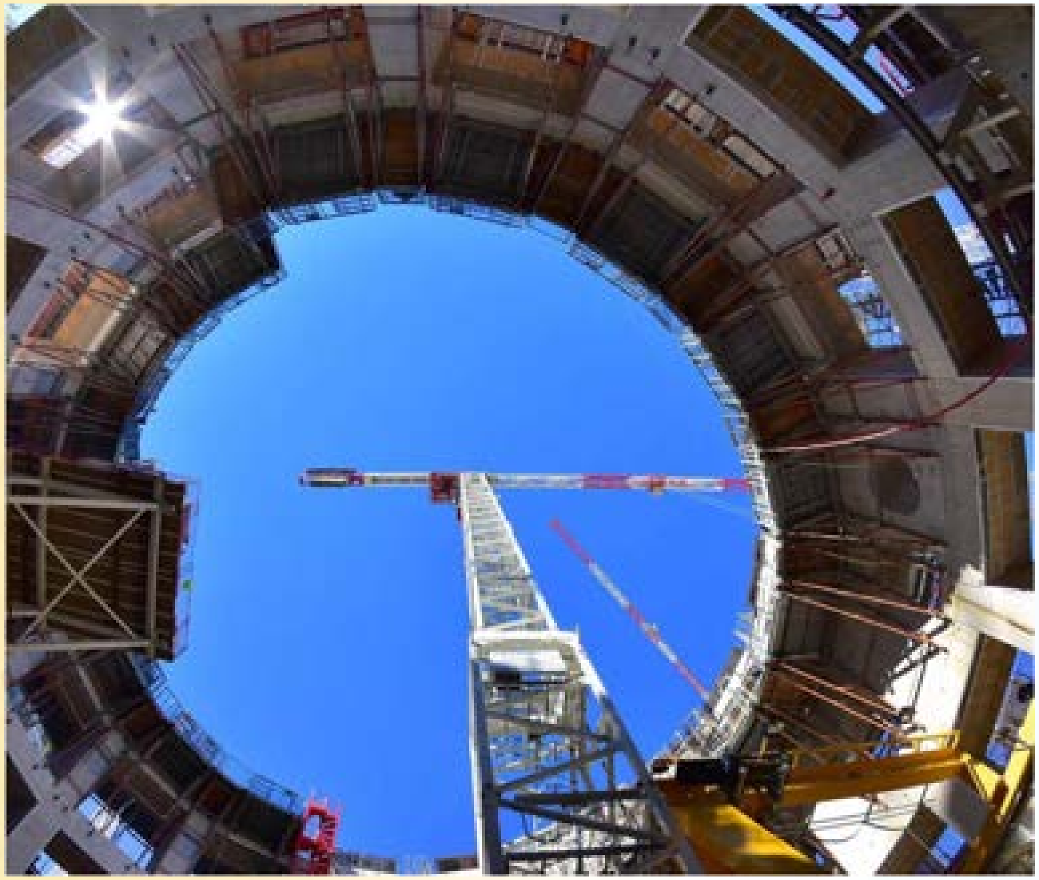


A FEW WORDS ABOUT FUSION

WHAT DOES ITER DO?

LATEST ACHIEVEMENTS IN PICTURES

FLIGHT ACROSS ITER

IMMERSIVE VIEWS

Our energy dilemma

Increasing consumption

Fossil fuels

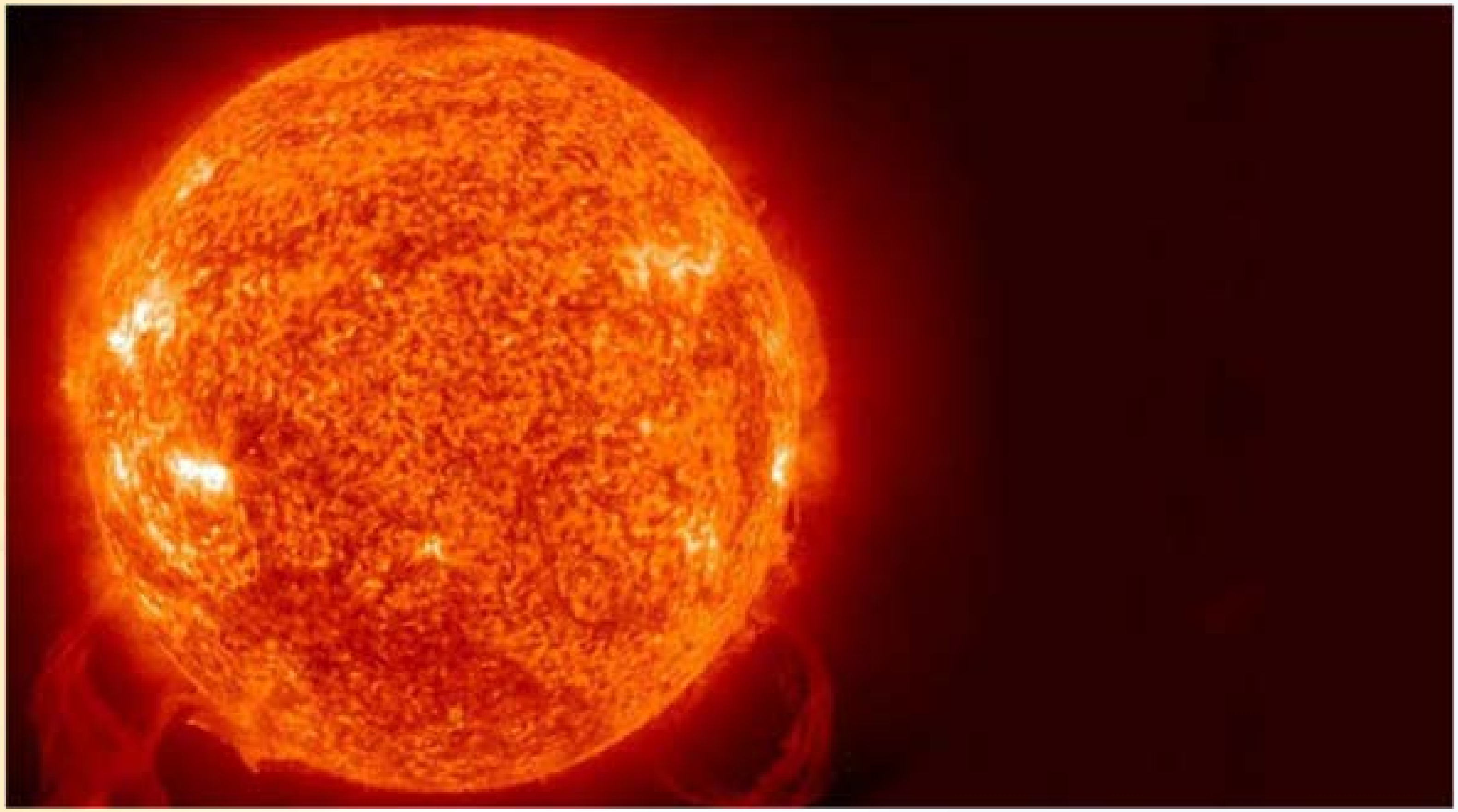
De-carbonization

Renewables

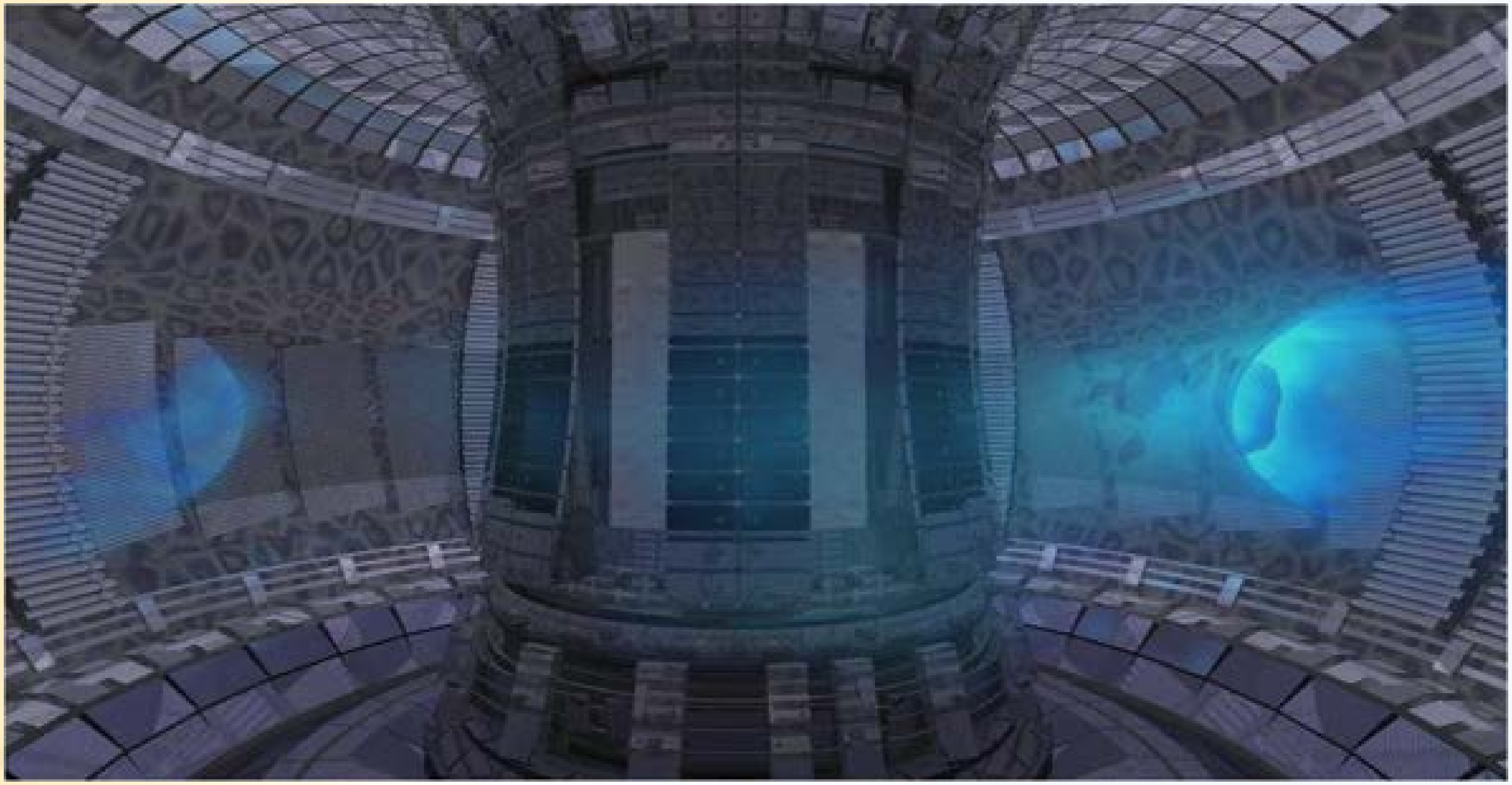
Nuclear: image problem

CO_2 capture

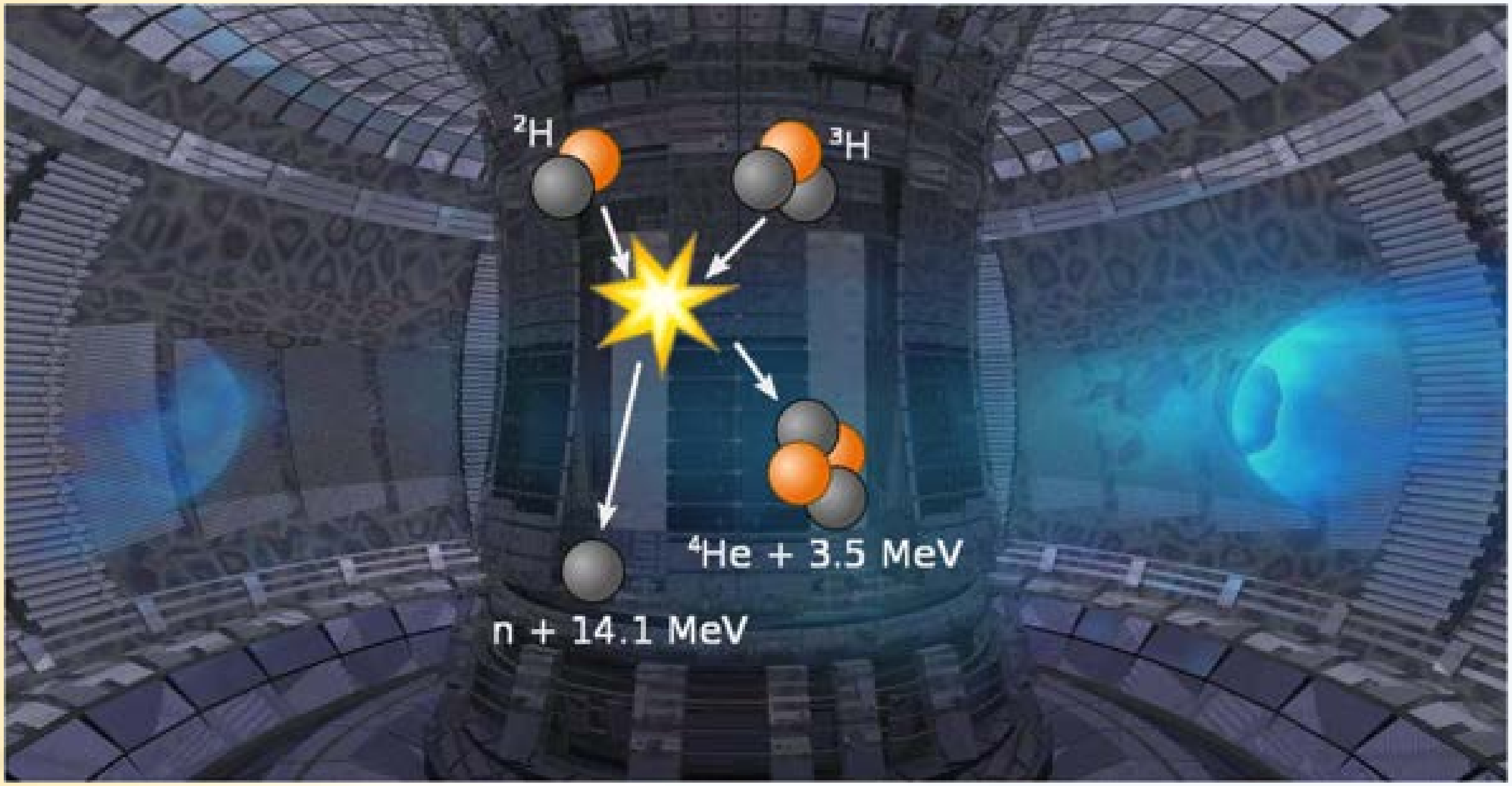
Fusion in the universe

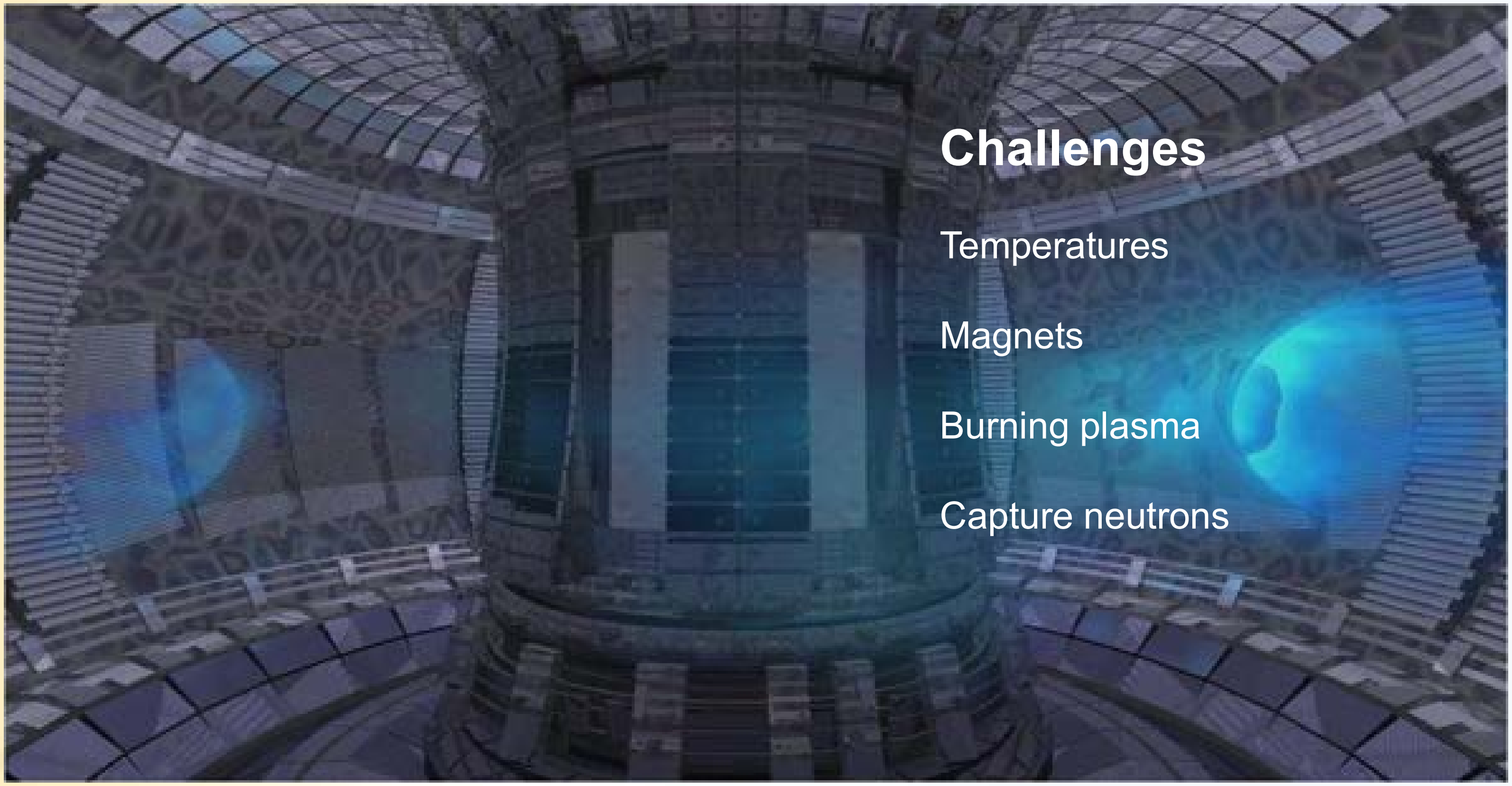


Fusion on Earth

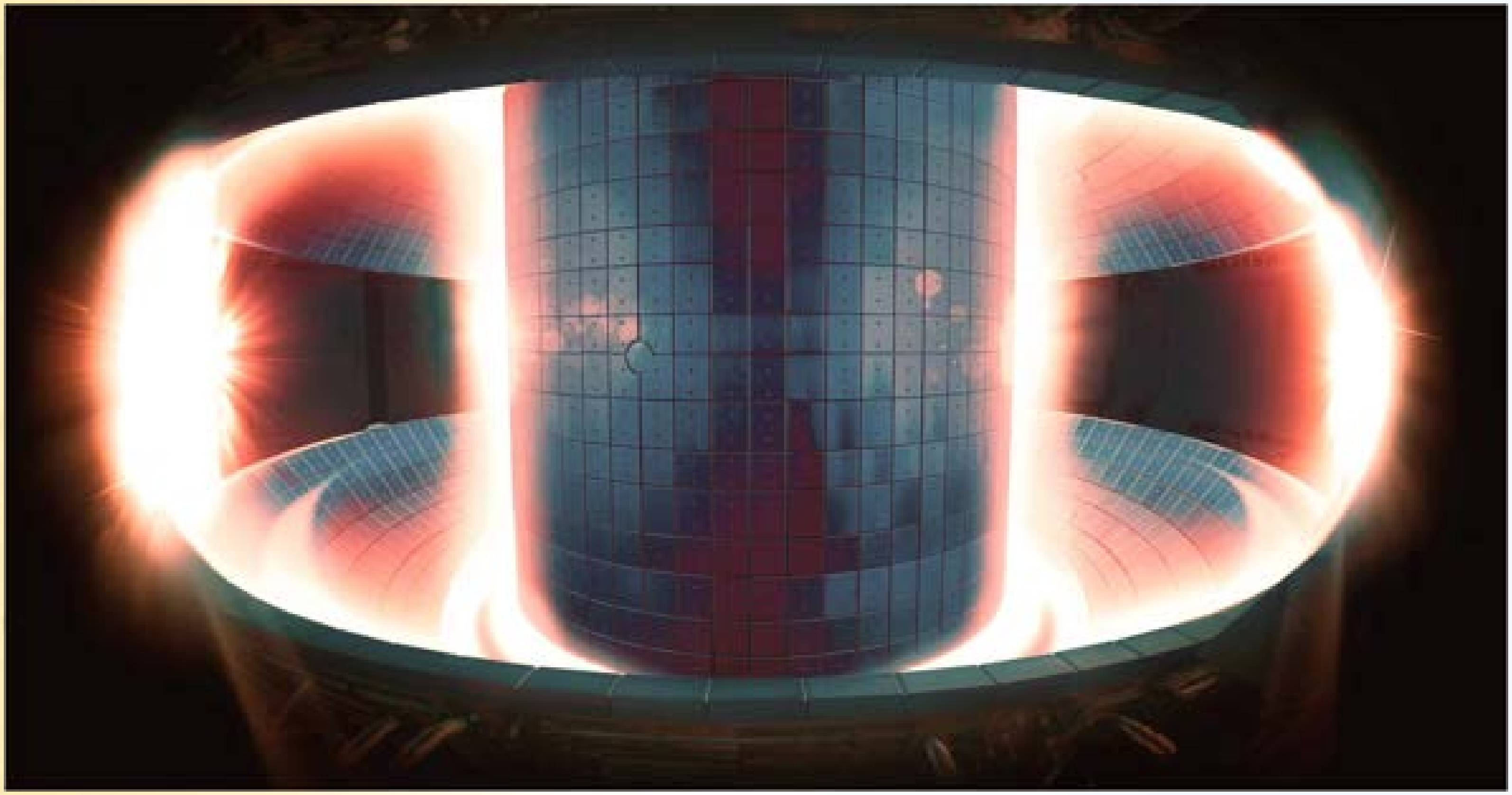


Fusion on Earth




Challenges
Temperatures
Magnets
Burning plasma
Capture neutrons

Making the C.A.S.E. for fusion



Clean

Abundant

Safe

Efficient

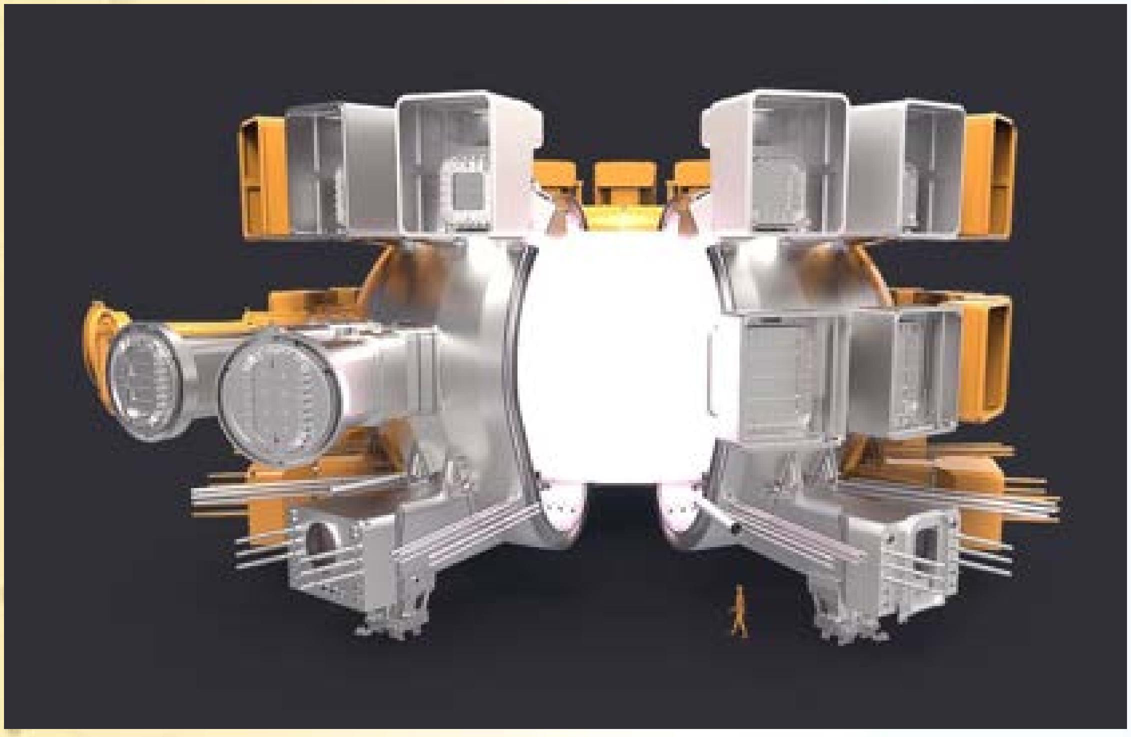
Making the C.A.S.E for fusion

24 grams

How much tritium would you need to fuel your entire life – for everything: electricity, heating, tr wo

How does it work?



The vacuum vessel

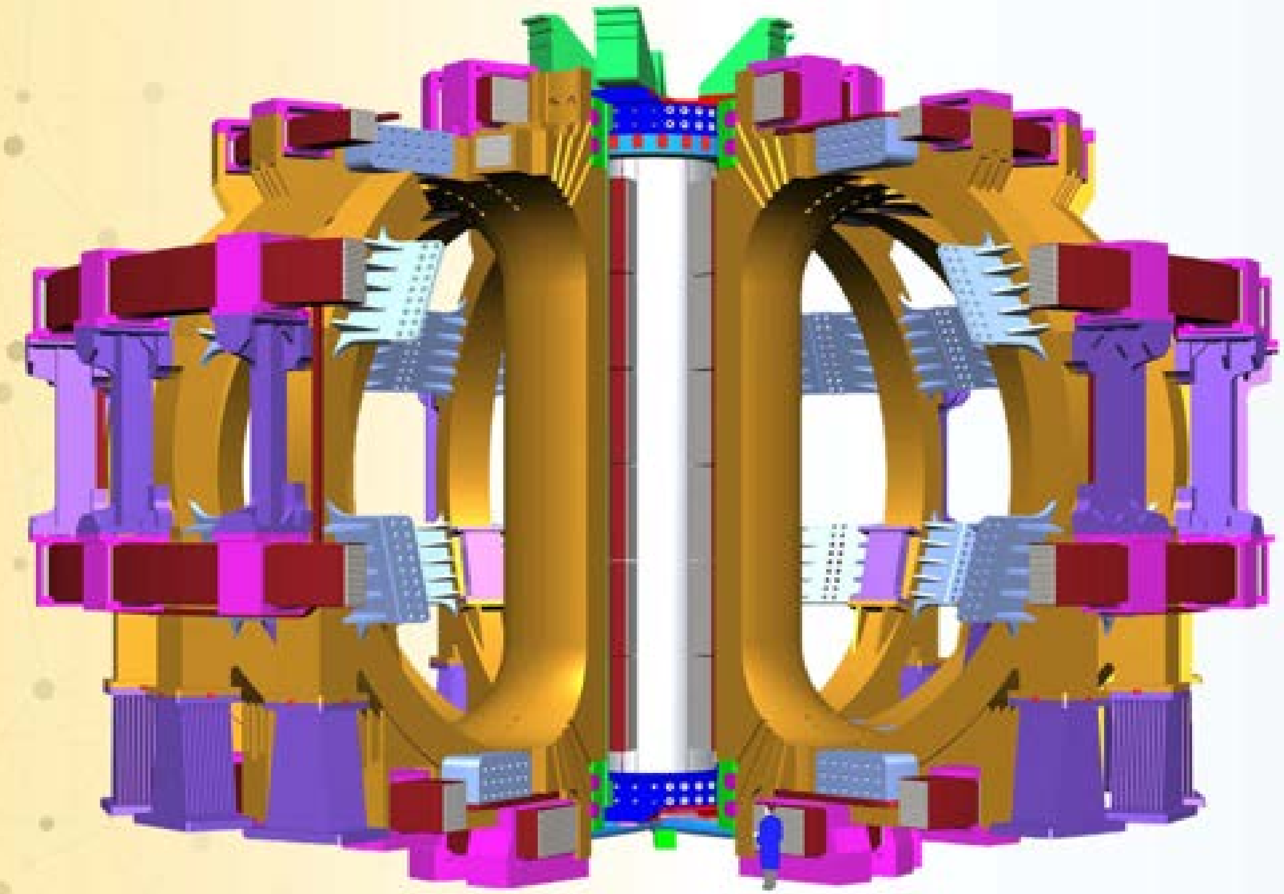
Double wall steel container
- blanket modules
- cooling water

High-vacuum environment

Primary containment barrier

Volume:	1,400 m^3
Plasma volume:	840 m^3
Weight:	8,500 t

How does it work?



A large magnetic cage

Central solenoid
- 13 m high
- 1,000 tons

18 toroidal field coils
- 17 m high
- 360 tons each

6 poloidal field coils
- 8-24 m in diameter
- 200-400 tons

How does it work?

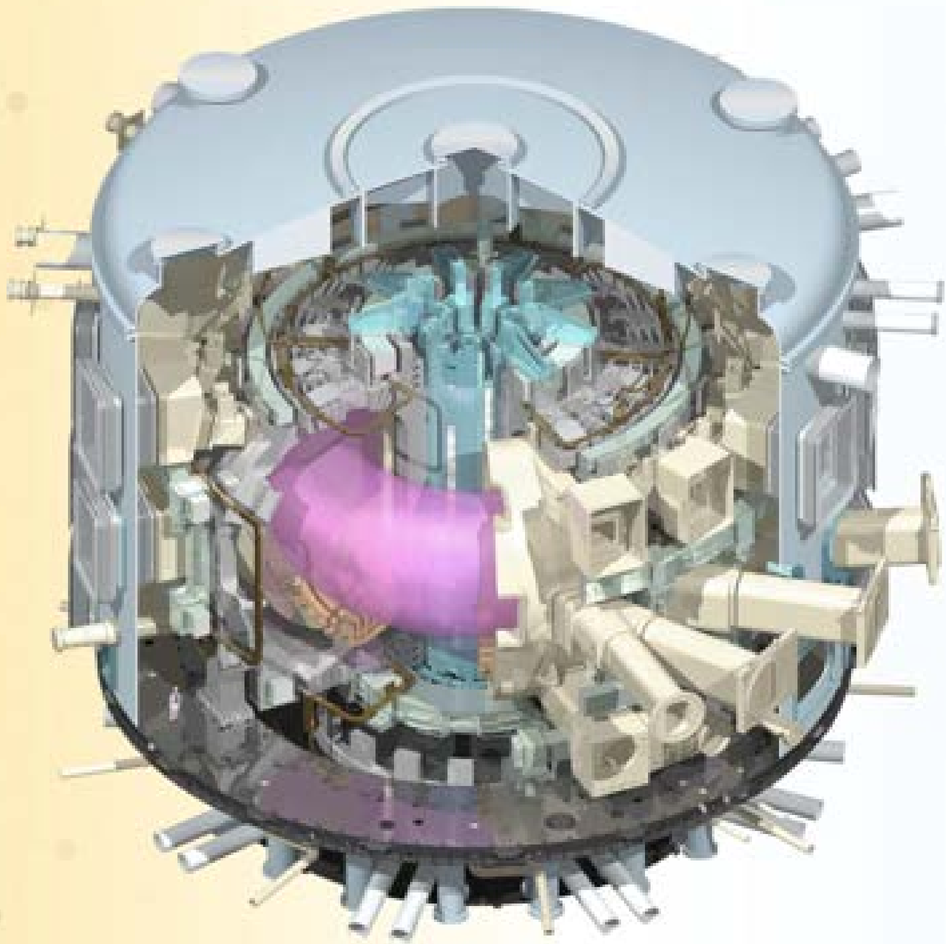
The Cryostat

Largest stainless steel high-vacuum pressure container ever built

Provides high-vacuum and ultra-cool environment

Height:	30 m
Diameter:	30 m
Weight:	3,850 t

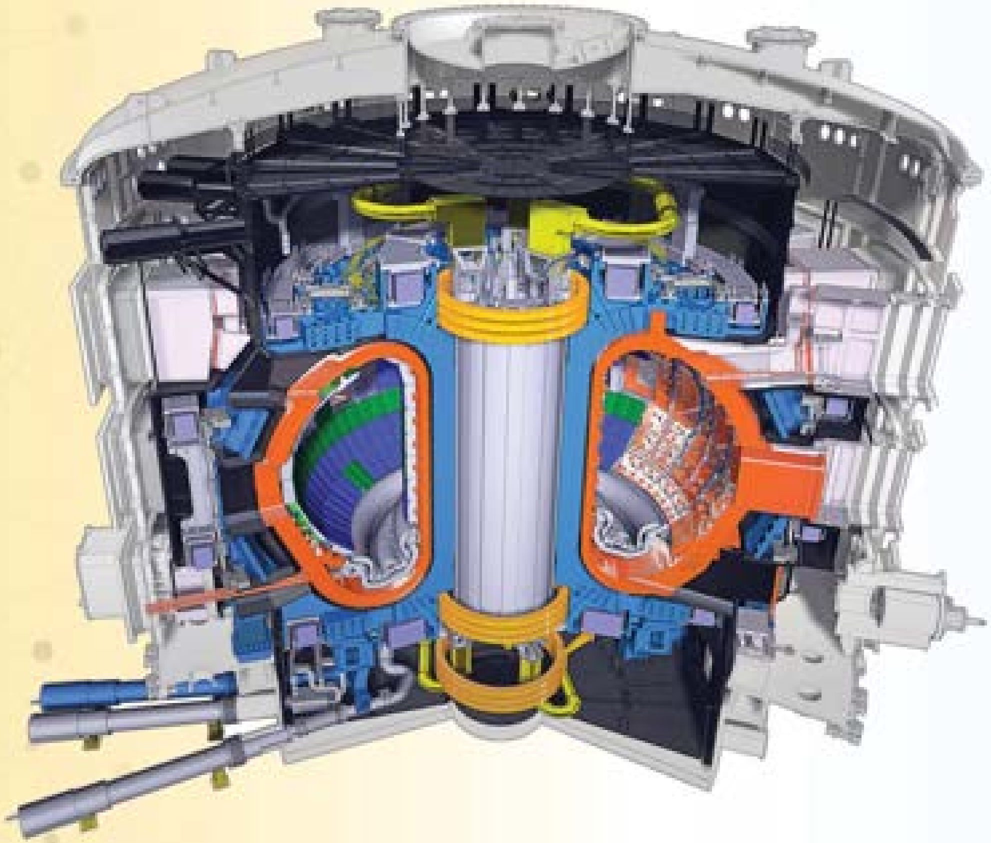
How does it work?



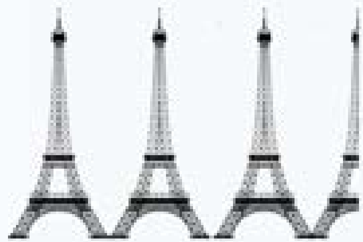
Run a strong electrical current in the DT gas to create a plasma.

Continued heating by:
- electromagnetic waves
- high-energy neutral particles

ITER - a heavy weight



23,000 tonnes



3.5 times the weight of the Eiffel tower

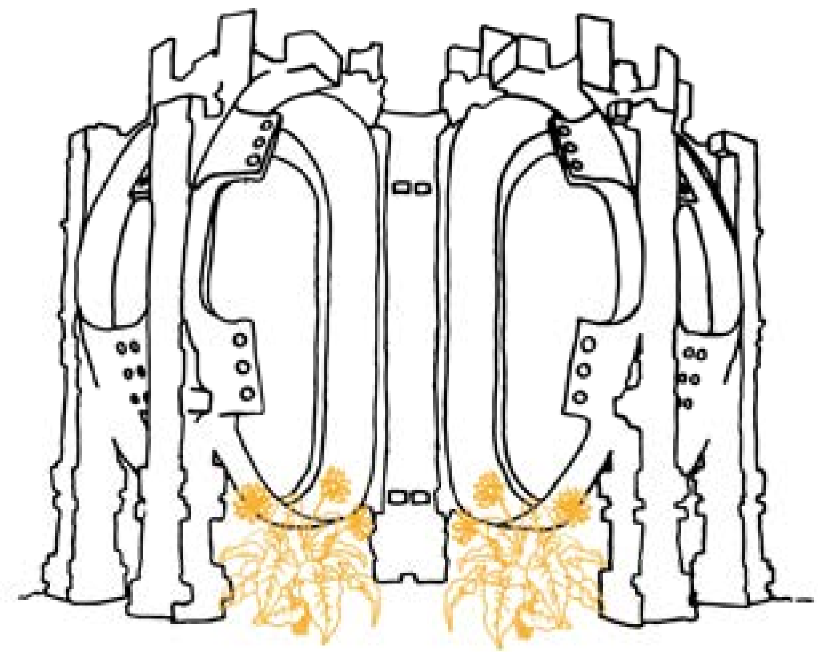
ITER's mission

Scientific and technological feasibility of fusion

Burning plasma

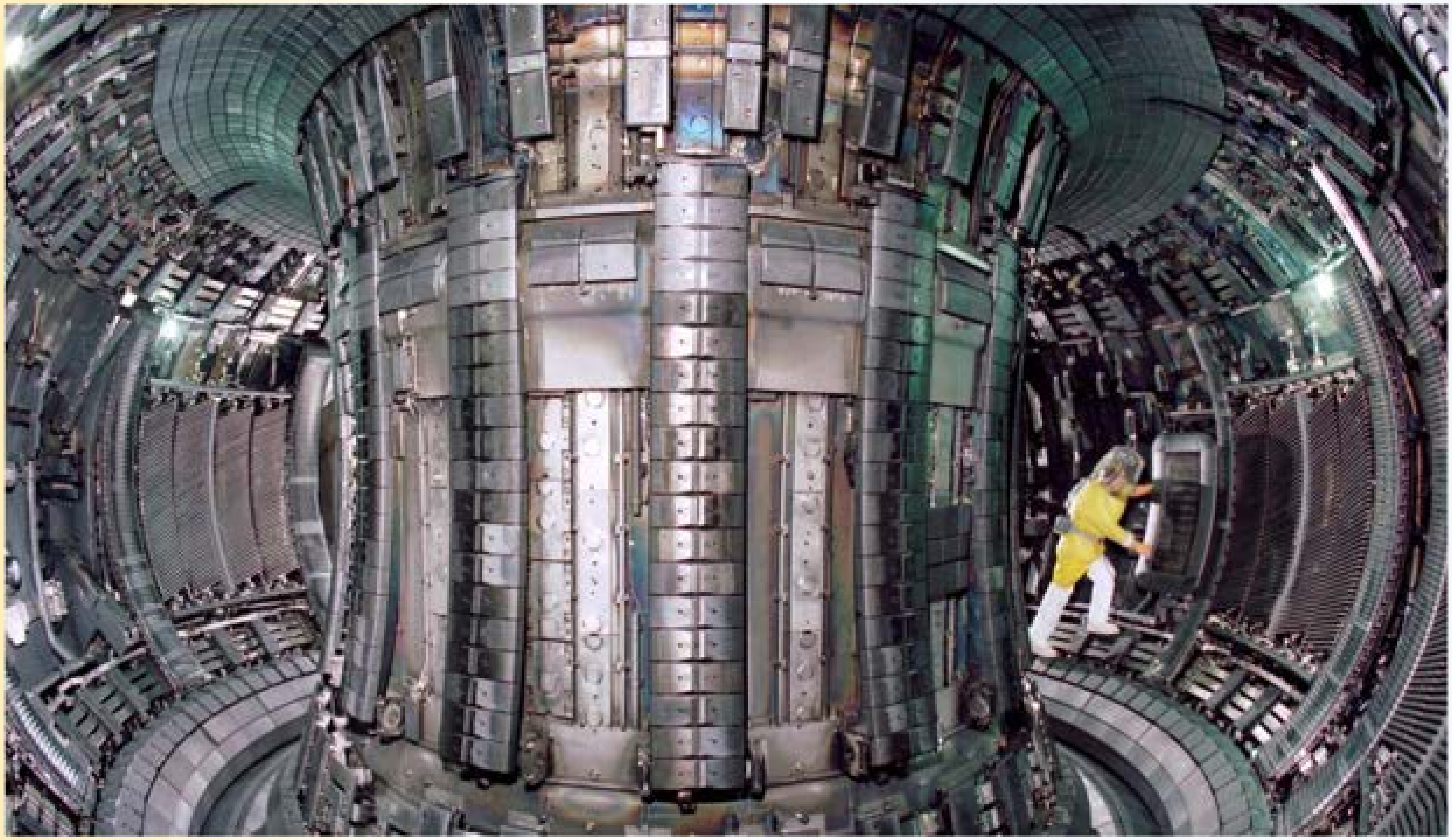
Tritium breeding

Q≥10



60 years of constant progress

60 years of constant progress



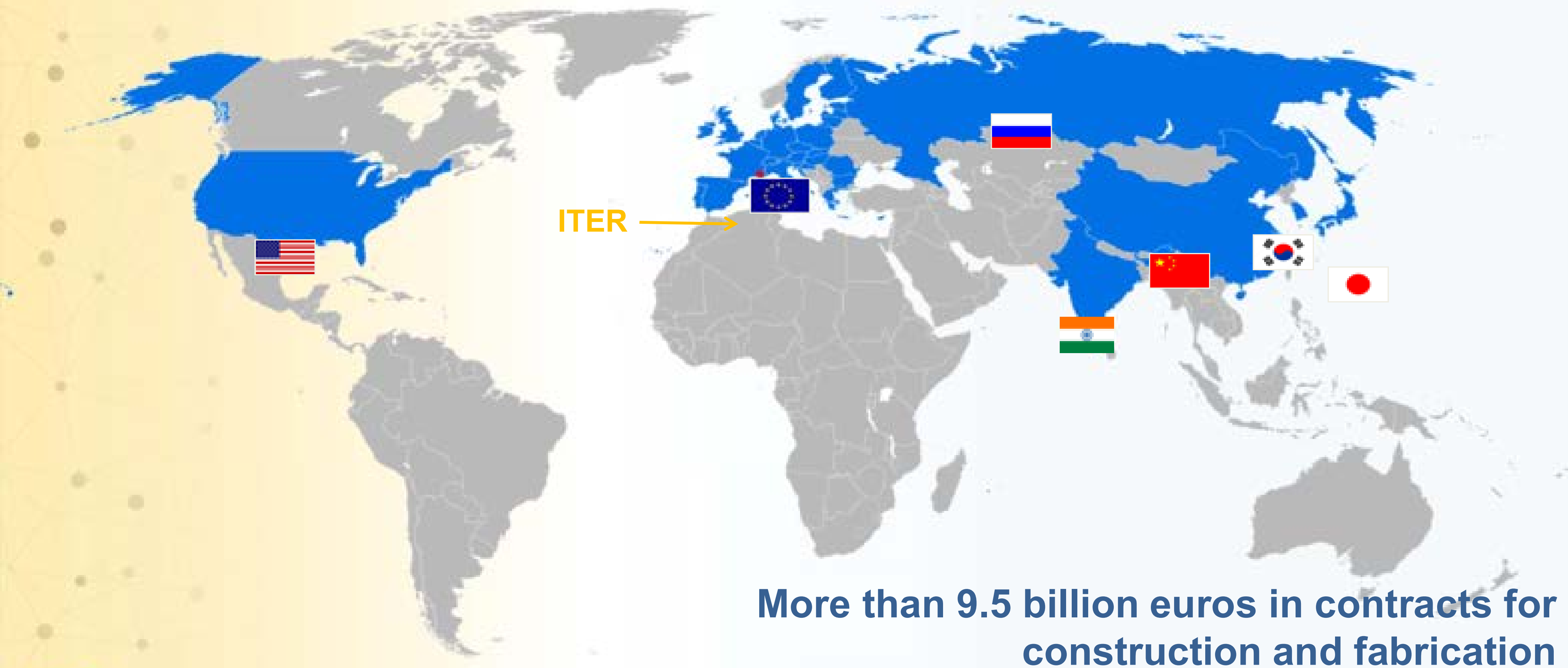
«For the benefit of all mankind…»

ITER – an integrated project

Global challenge – global response

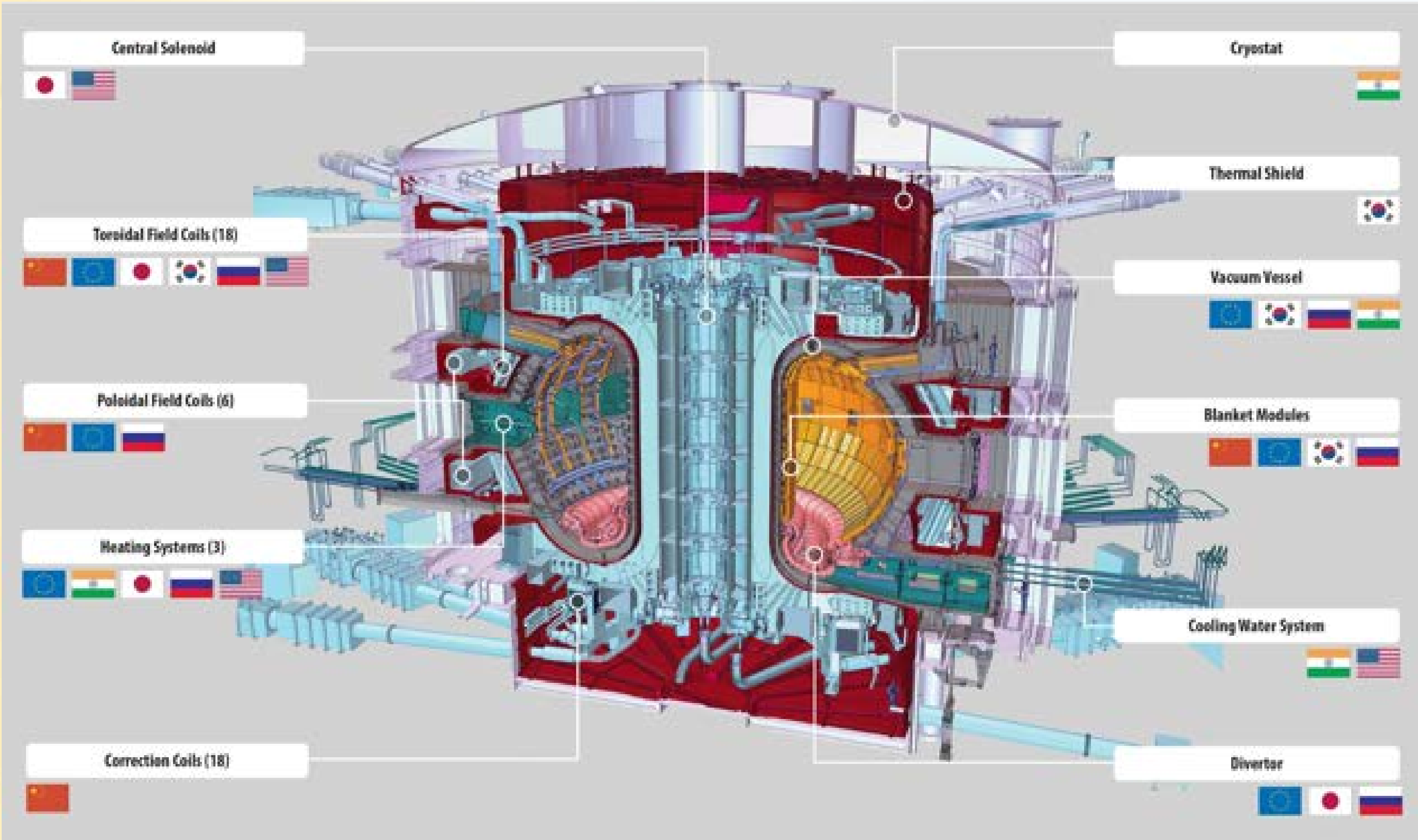
A unique formula

Economic benefits

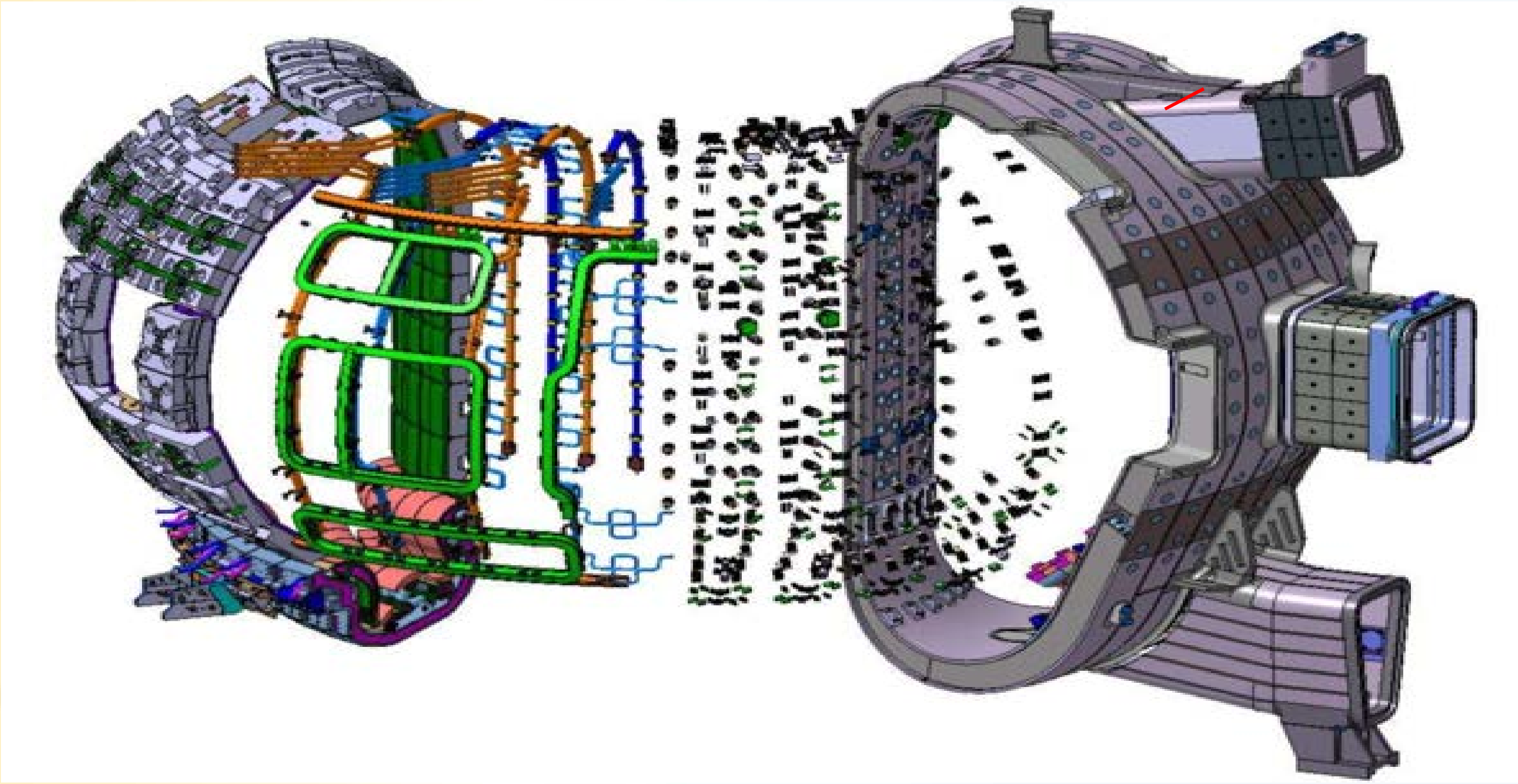


More than 9.5 billion euros in contracts for construction and fabrication

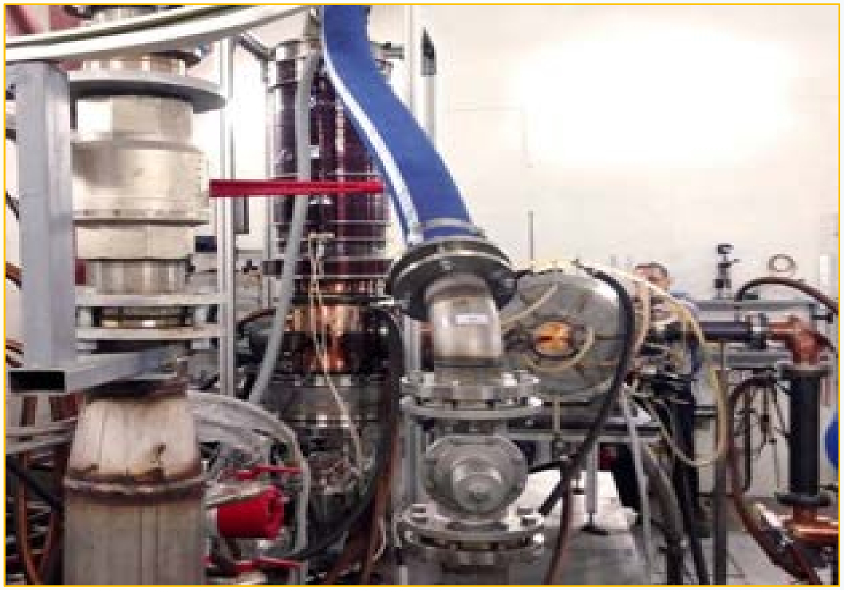
Who manufactures what?



The integration challenge



Engineering innovations: gyrotrons



Gyrotron prototype developed by Russia

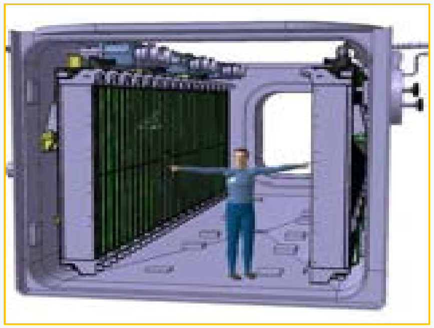
Gyrotron prototype developed by F4E EU

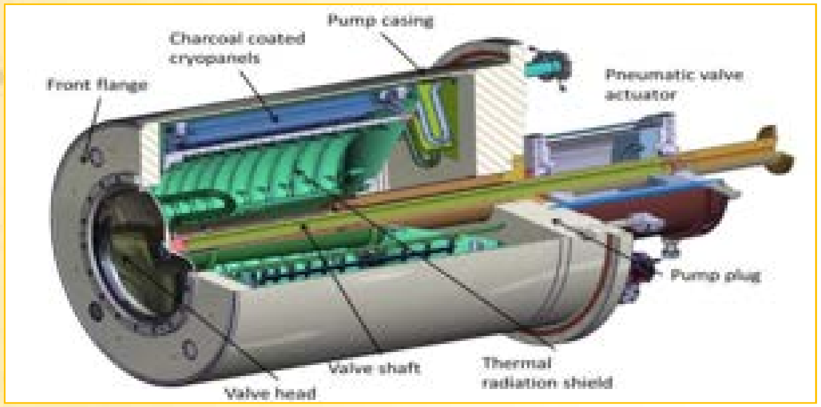
Gyrotron prototype developed by Japan

Engineering innovation: vacuum systems

8-tonne machined flange of the first Torus Cryo-pump.

Neutral Beam Injection Cryo-pump: 8 meters long, 2.8 meters high.



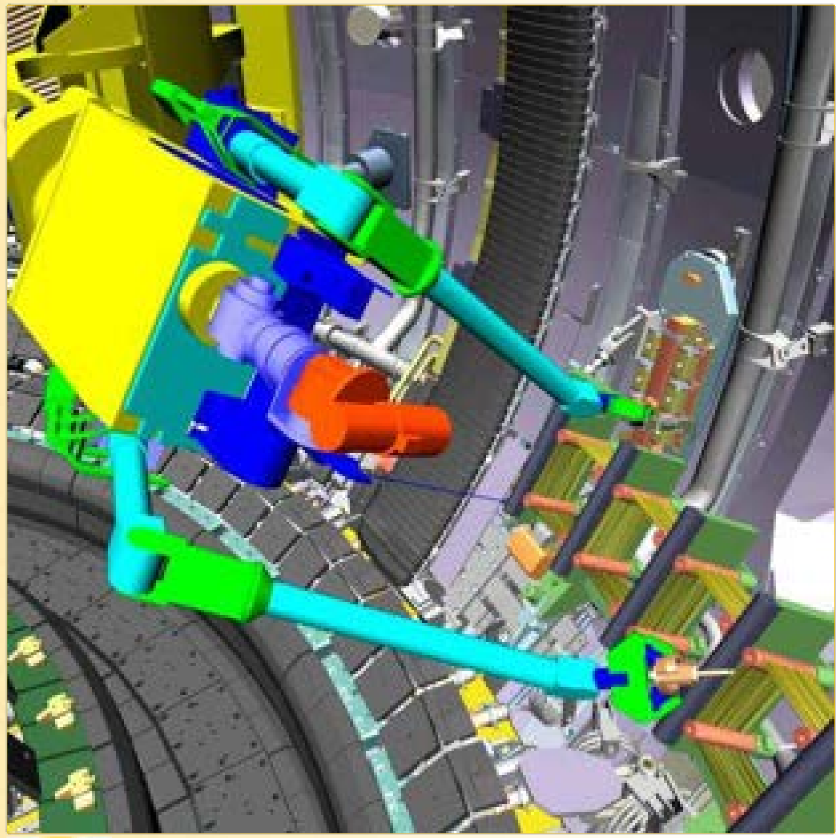


Torus and Cryostat Cryo-pump (1.8 m. diameter)

The ITER vacuum system:

- the cryostat, at ~ 8500m3;
- the vacuum chamber at ~1330 m3;
- the neutral beam injectors at ~180m3 each;
- plus lower volume systems.
- more than 400 vacuum pumps will employ 10 different technologies.

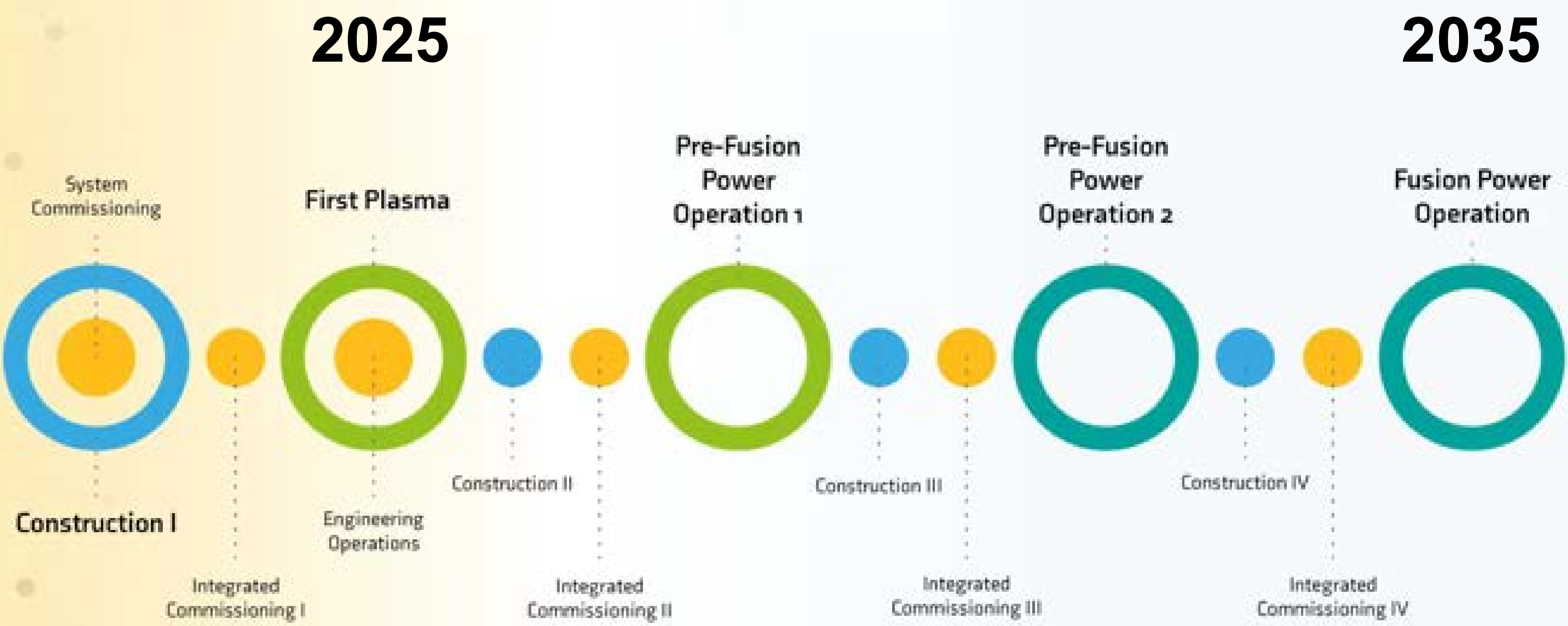
Engineering innovation: robotics and remote handling



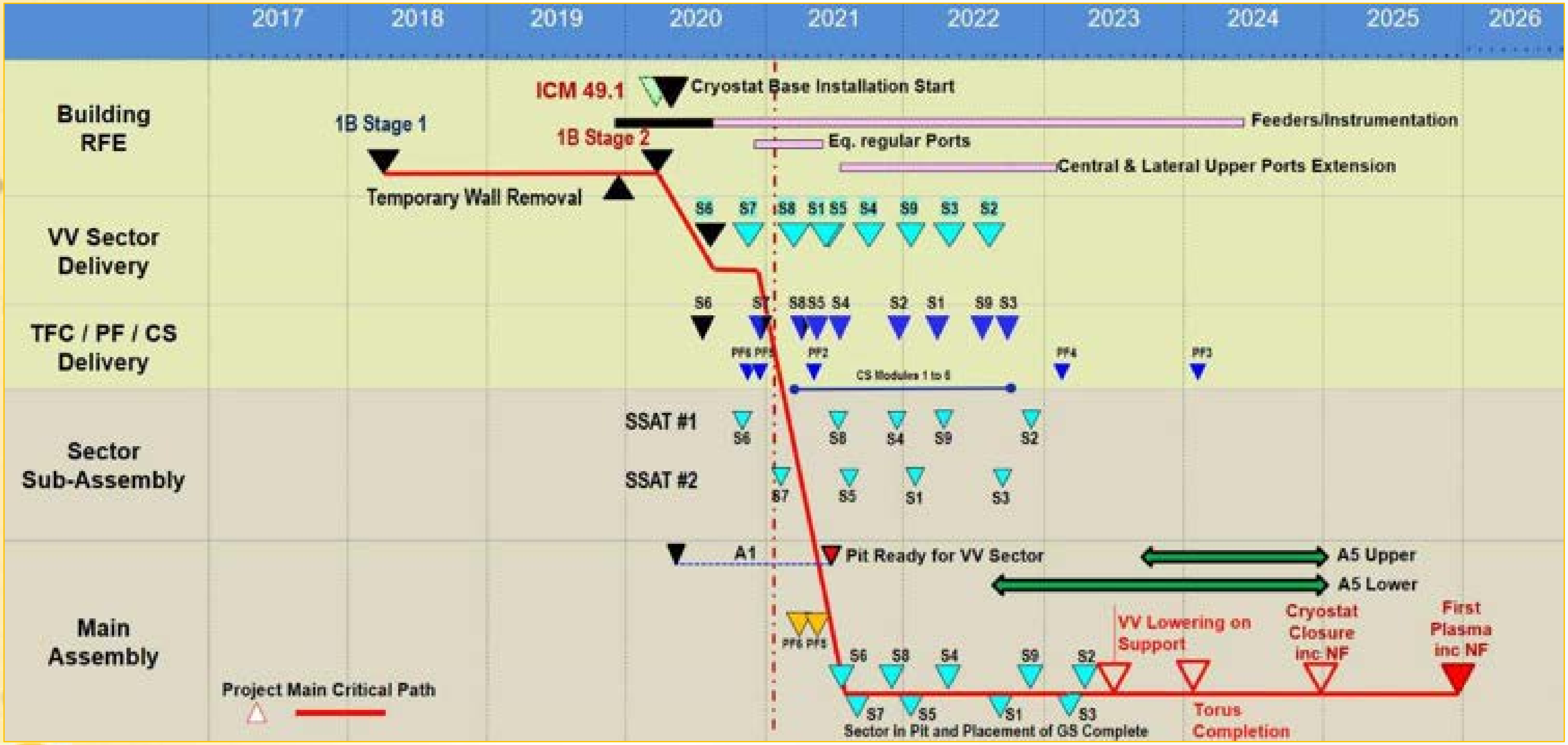
Cutting-edge robotics and remote handling tools will be used in both the assembly and operational phases.

72% of the work towards First Plasma is done

Staged approach



Revised Construction Strategy



A word on COVID-19

Over six years of progress

April 2014

November 2020

Worksite progress

Worksite overview

iter
china eu india japan korea russia usa

Electrical network

Electrical conversion

Giant horizontal magnets

Poloidal field coil number five is completed, cold test is done - centre.
On the outside – a double pancake of PF4.

March 2021

Cooling water tower

All ten funnels for the giant fans are installed.

February 2020

Cooling water tower

Each funnel is about ten meters wide.

February 2020

Cooling water tower

All ten fans are installed. They will create the updraft for the cooling. Here, a worker checks the gear box at the fan.

November 2020

Transport of TF13

Toroidal field coil #13, manufactured in Japan, is the third TF coil to arrive at ITER.

Here transport crosses the A51 near Meyrargues.

July 2020

PF6 transport to ITER

Poloidal field coil #6, manufactured in China, passes the Canel de Provence on its way to ITER.

June 2020

Cryostat base section

Transfer of Cryostat base into Assembly Hall.

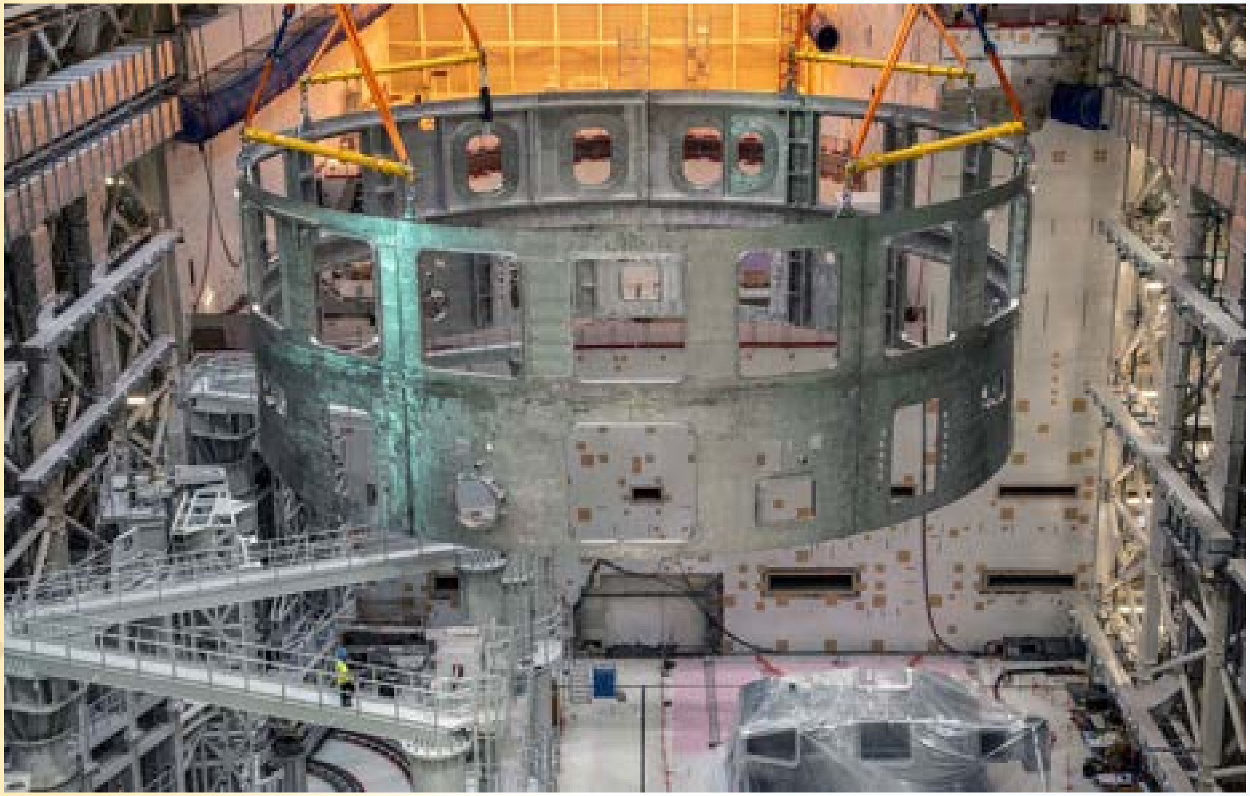
April 2020

Cryostat base insertion

The docking of a spaceship – the Cryostat base is being lowered into the Tokamak pit.

May 2020

Cryostat lower cylinder insertion



The Cryostat lower cylinder has been taken into the Assembly Hall and then lowered into the Tokamak.

August 2020

What is one of the most precisely made machines?

A Swiss watch?

Characteristic size:
≈ 1 mm
Tolerance:
≈ 1 µm
Precision ratio:
≈ 1/1000

ITER TF Coil

Characteristic size:
≈ 17 m
Tolerance:
≈ 2 mm
Precision ratio:
≈ 1/8500

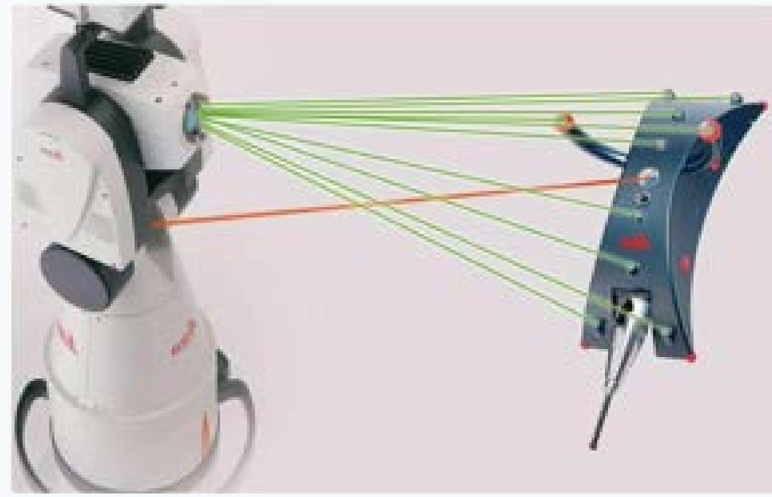
8½ x harder than a Swiss watch!!!

Precision is essential to harness the force of ITER.

Large Volume Metrology

Modern large volume metrology methods are used non-stop:

- Laser Trackers
- Photogrammetry
- Laser Templating

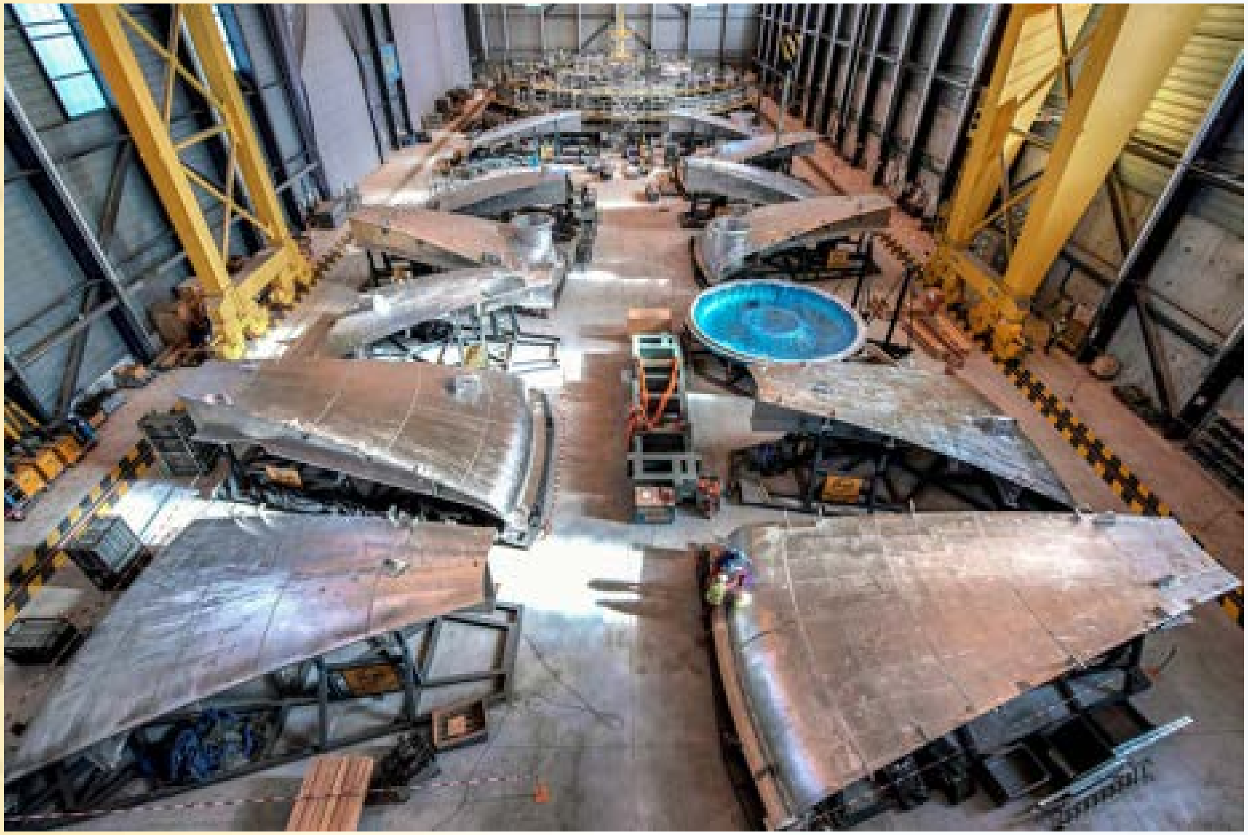


Don't forget data management!

Laser Templating

- Freeform component placement.

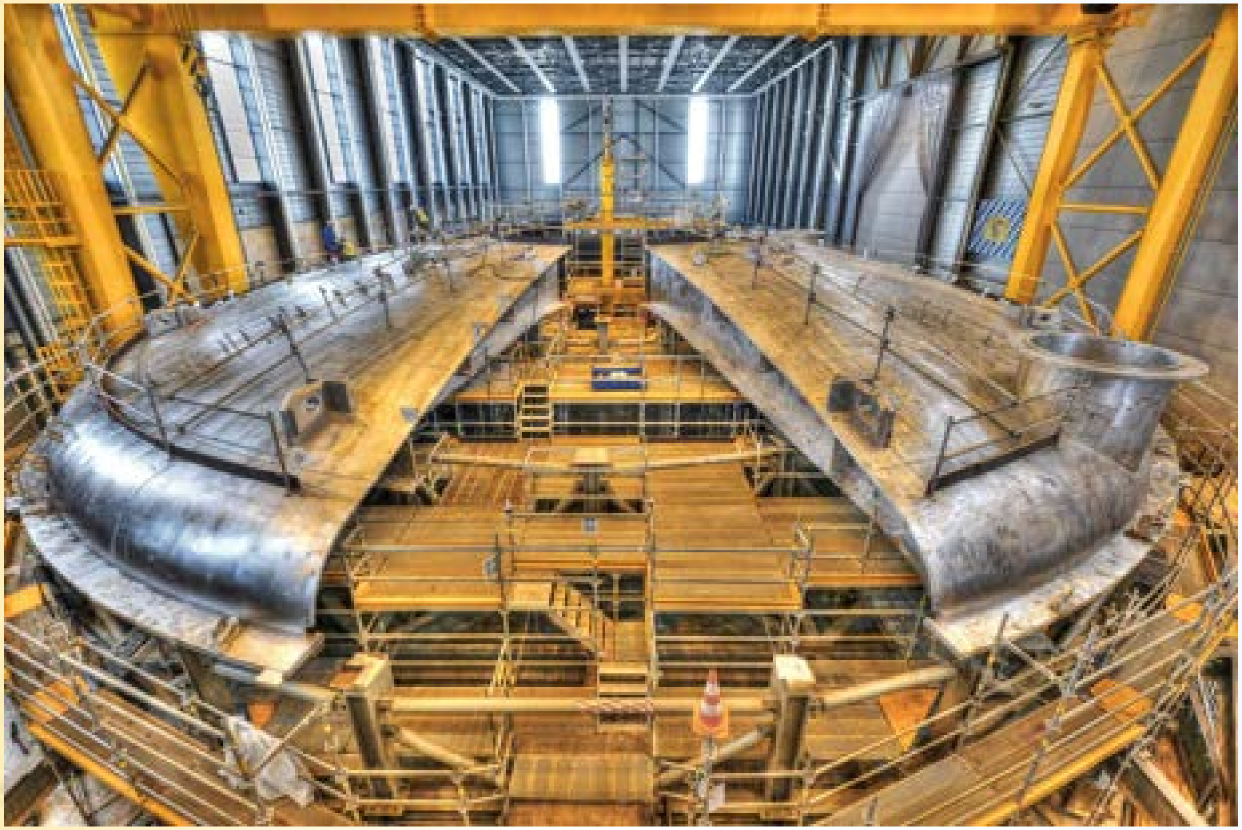
All parts of Cryostat lid now in workshop



All parts of the last section to assembly, the top lid, have now arrived at ITER and been taken to the Cryostat workshop. Welding to start in spring and completed by end 2021.

February 2021

Welding of Cryostat lid



Welding to be completed by end 2021.

Photo: Christian Lünig, March 2021

Start of Machine Assembly

ITER ceremonially marks the start of machine assembly.

Next major milestone will be First Plasma in 2025.

28 July 2020

1^{st} vacuum vessel sector on site

The first vacuum vessel sector arrived at the ITER site.

It’s one of nine and was manufactured in Korea by Hyundai Heavy Industries.

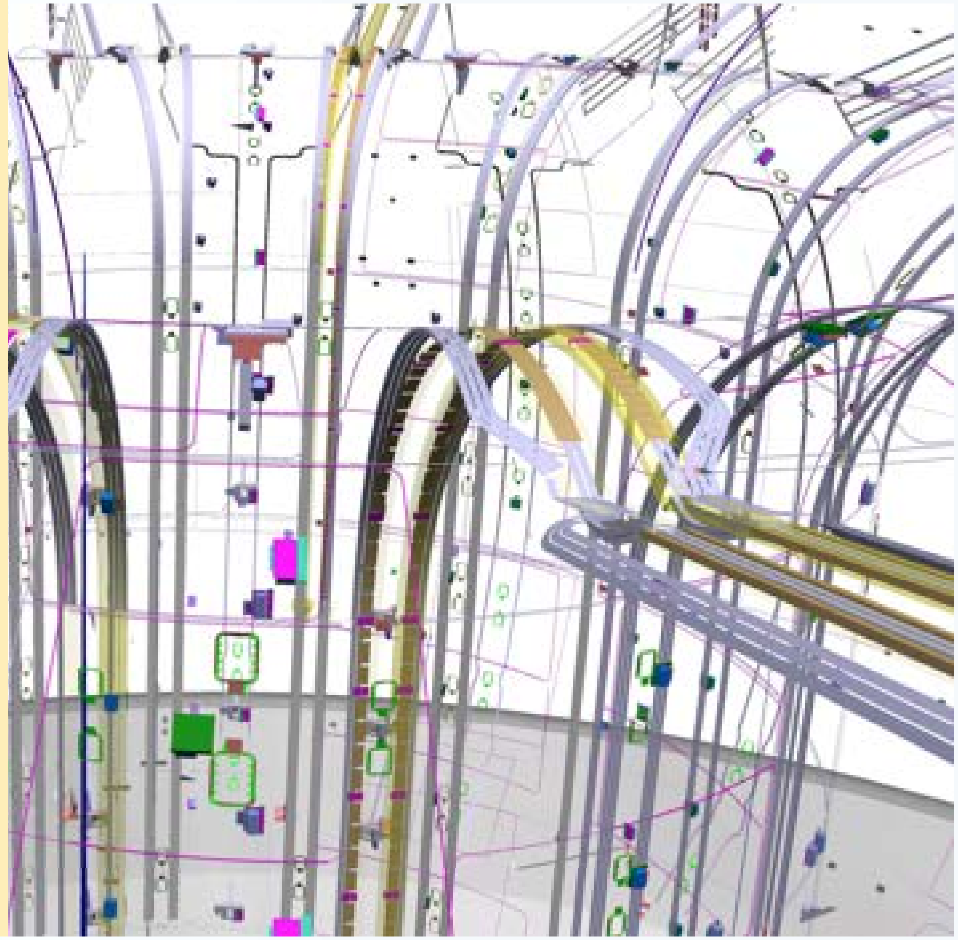
August 2020

In-Vessel Diagnostics

30 000 Welded Attachments
120 000 Cable Clips
Tolerances - mm

Configuration Control is Critical!

3D Model
+ Metadata
+ Schedule
+ Tolerance Analysis

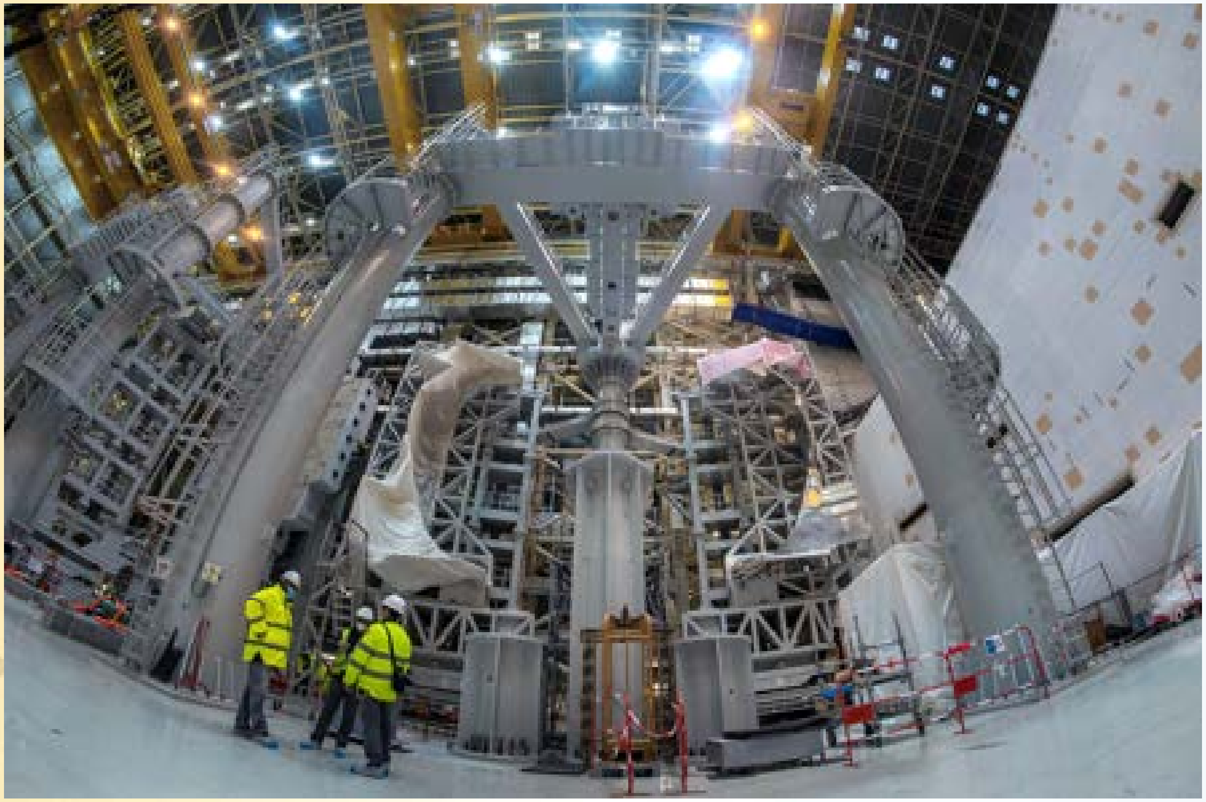


Vacuum vessel thermal shield

The first thermal shield for a vacuum vessel sector has arrived and is being prepared for assembly.

October 2020

Vacuum vessel thermal shield



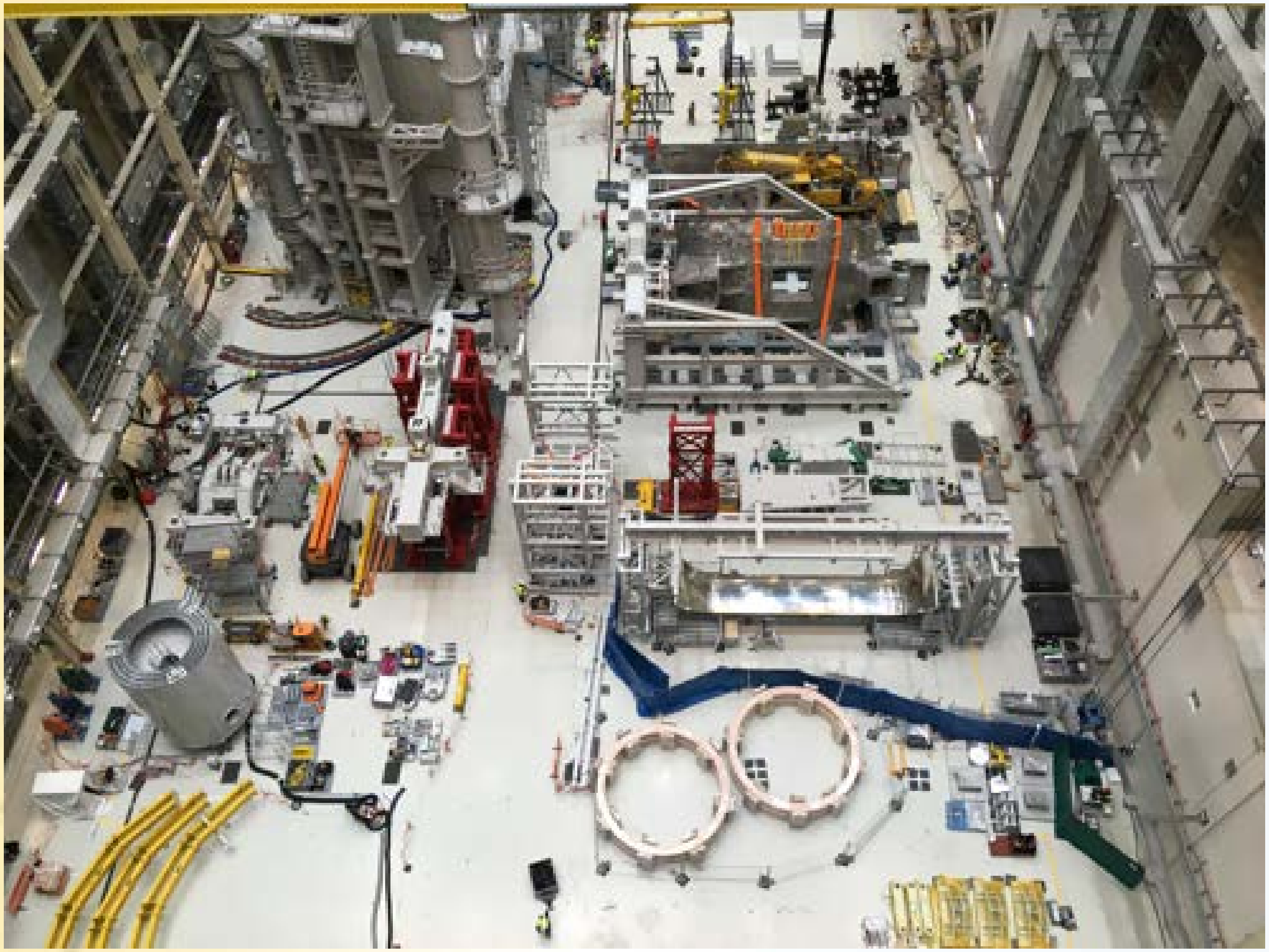
As part of this preparation it has been installed in the SSAT for trial assembly. At 10 tonnes it's a light weight for ITER standards.

January 2021

Ready for take-off: vacuum vessel sector #6

Photo: Christian Lünig
March 2021

Assembly Hall



View into Assembly Hall

March 2021

Tokamak pit

Lid removal from bioshield – view into tokamak pit.

April 2020

Activities in the Tokamak

A view into the Tokamak pit with all temporary supports for poloidal field coil #6 in place.

March 2021

Flying across ITER

Thank you!