ITER

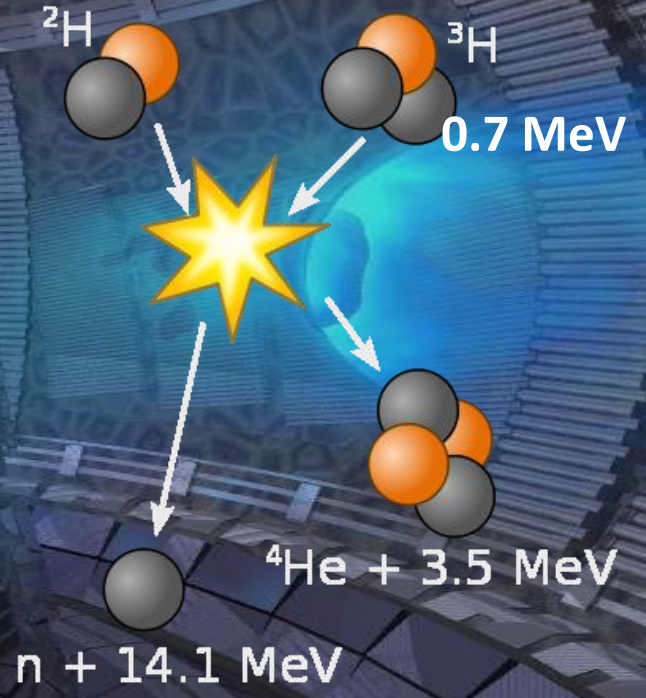
The way to new, clean, safe and nearly unlimited energy

Bernard BIGOT, Director-General, ITER Organization

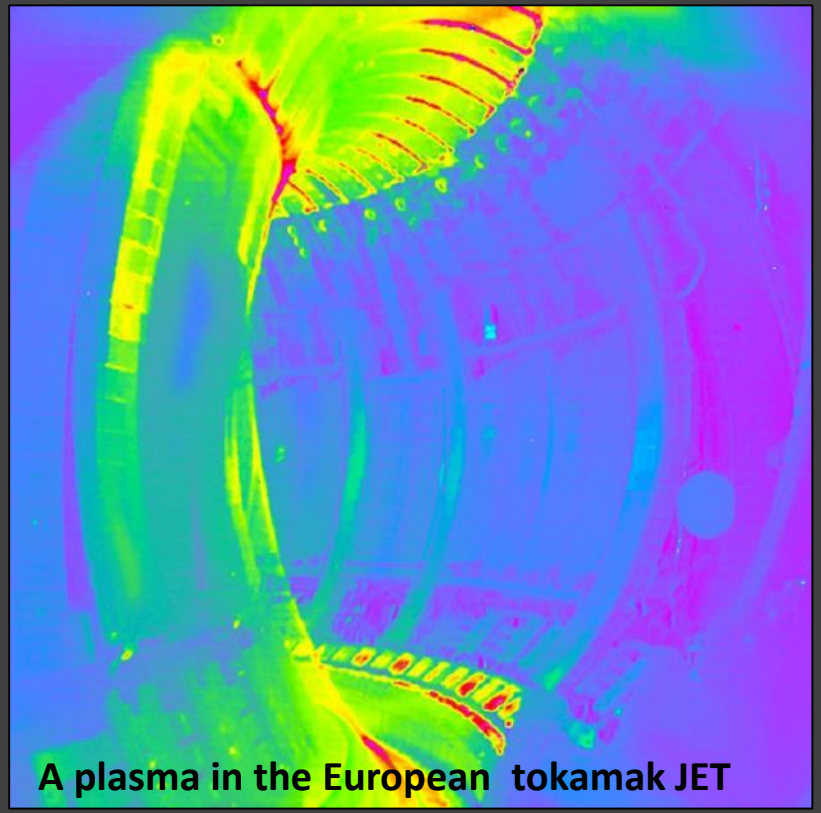
Fusion on Earth

1 gram of fusion fuels = 8 tons of oil

- A plasma of Deuterium + Tritium (hydrogen isotopes) is heated to more than 150 million °C.
- The hot plasma is shaped and confined by strong magnetic fields.
- Helium nuclei sustain burning plasma.
- Neutrons transfer their energy to the Blanket .
- In a fusion power plant, conventional steam generator, turbine and alternator will transform the heat into electricity.



Fusion's advantages

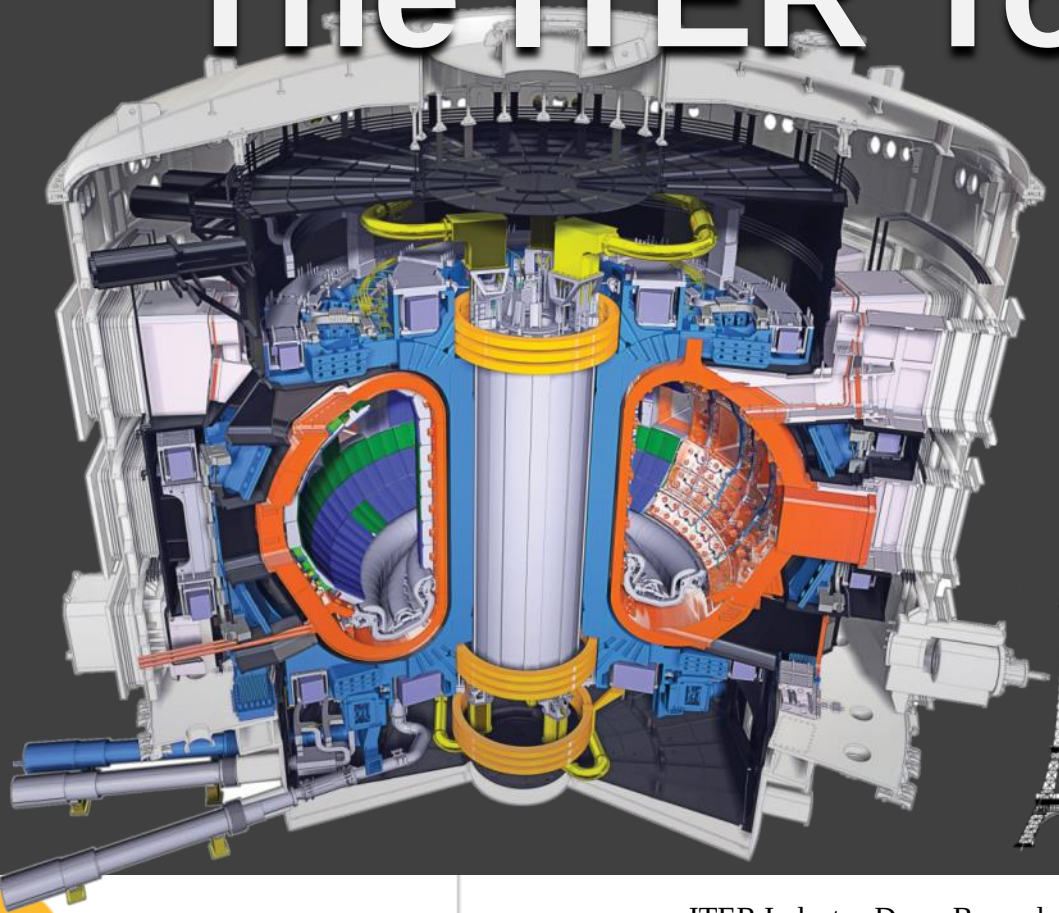


A plasma in the European tokamak JET

- A new energy source of massive, predictable and potentially continuous or variable power complementary of the renewable energies
- Safe, environmentally responsible
- Almost limitless supply of fuel for hundreds of millions of years, widely distributed around the globe
- No CO_2 or other greenhouse gases
- No long-lasting high-activity radioactive waste

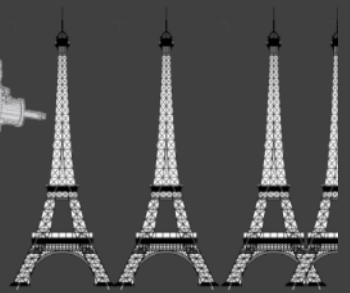

ITER
A multinational scientific collaboration without equivalent in history
A large-scale experiment to demonstrate the feasibility of fusion energy
BRINGING THE POWER OF THE SUN TO EARTH
iter
FUSION FOR ENERGY

The ITER Tokamak



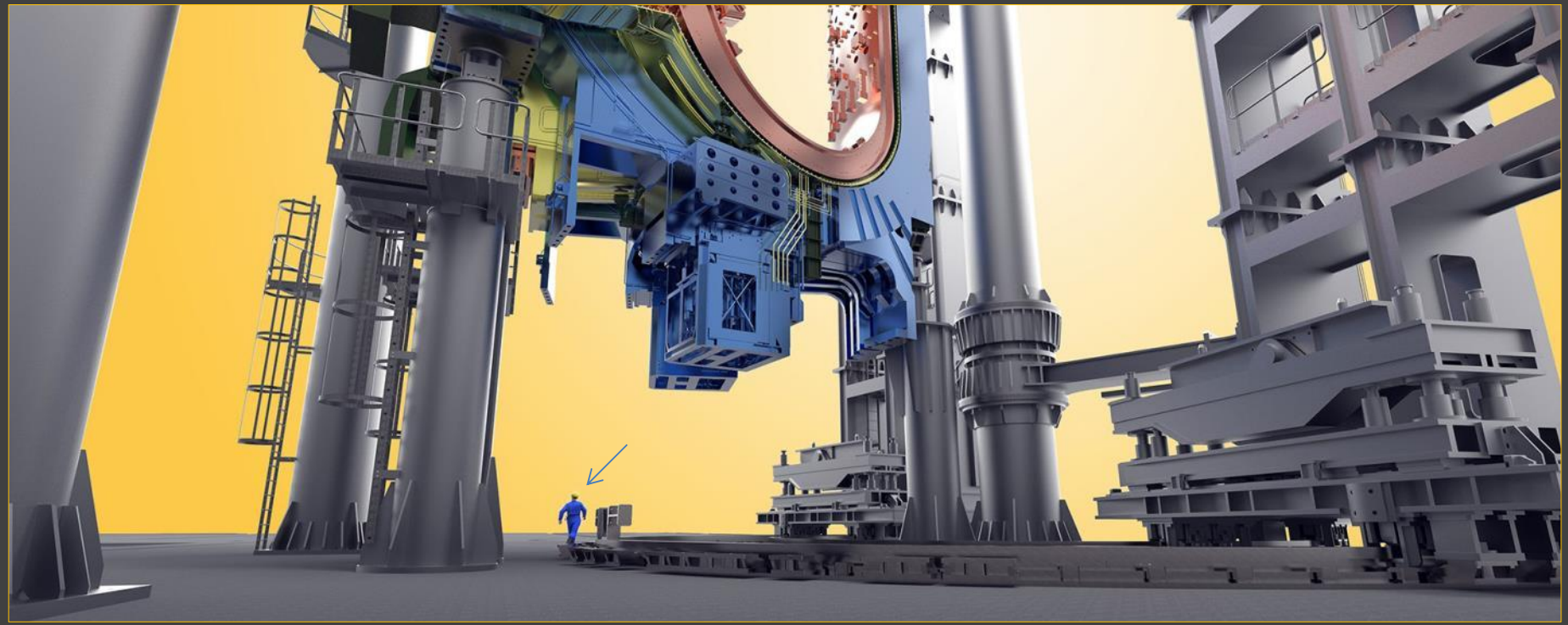
Vacuum Vessel: ~ 8 000 t.
TF Coils: ~ 18 x 360 t.
Central solenoid: ~ 1 000 t.
Etc.
Total ~ 23 000 t.

R=6.2 m, a=2.0 m,
I_p=15 MA, B_T=5.3 T,
23,000 tonnes



3,5 times the weight of the Eiffel Tower!

Naval construction-size components…

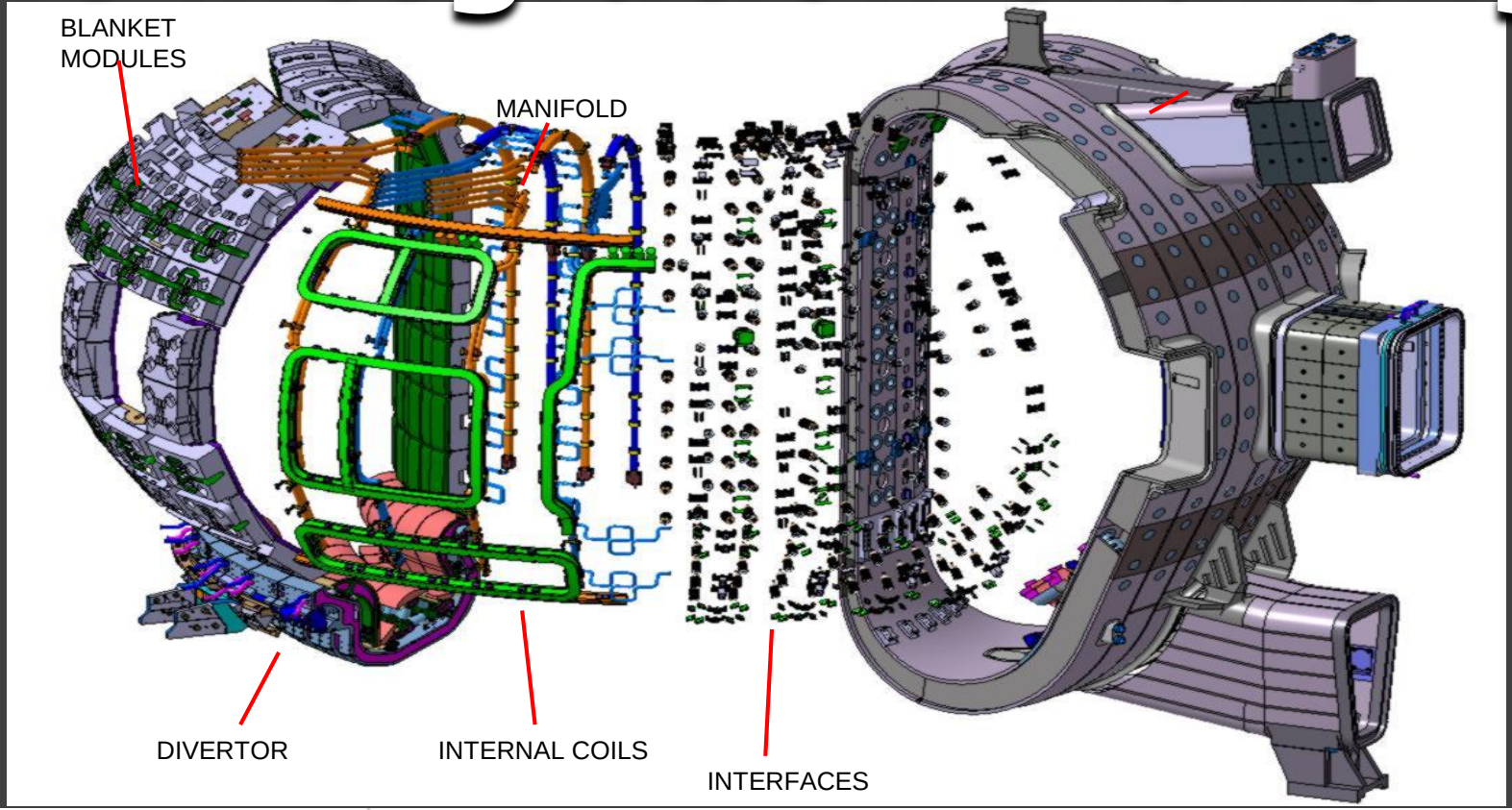


Inside the Assembly Hall, giant tools will handle loads up to 1,500 tons

…watch-like precision

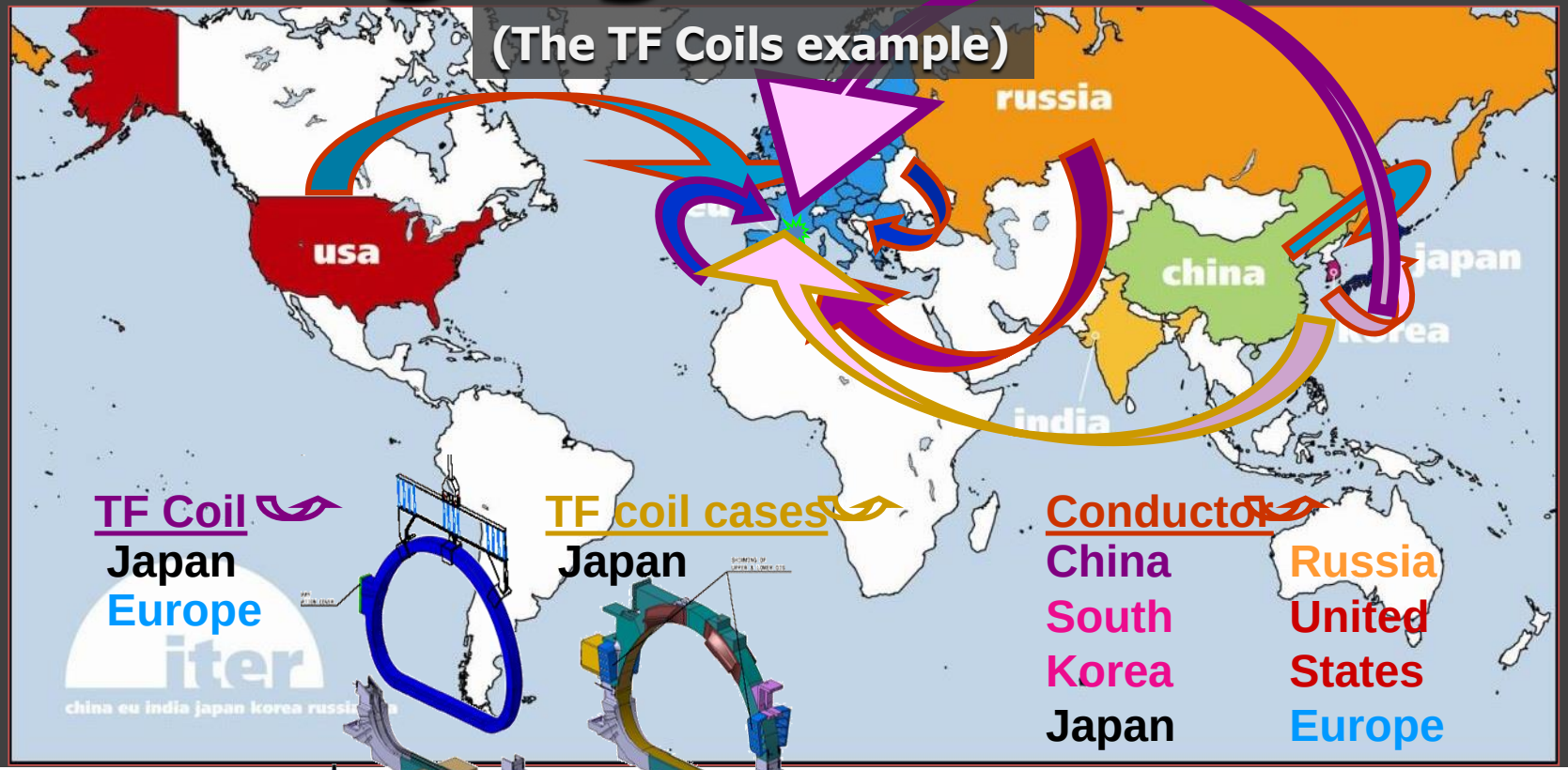
Laser measurements of grooves in TF Coil radial plates. Tolerances are in the 1/10th millimetre range.

The integration challenge

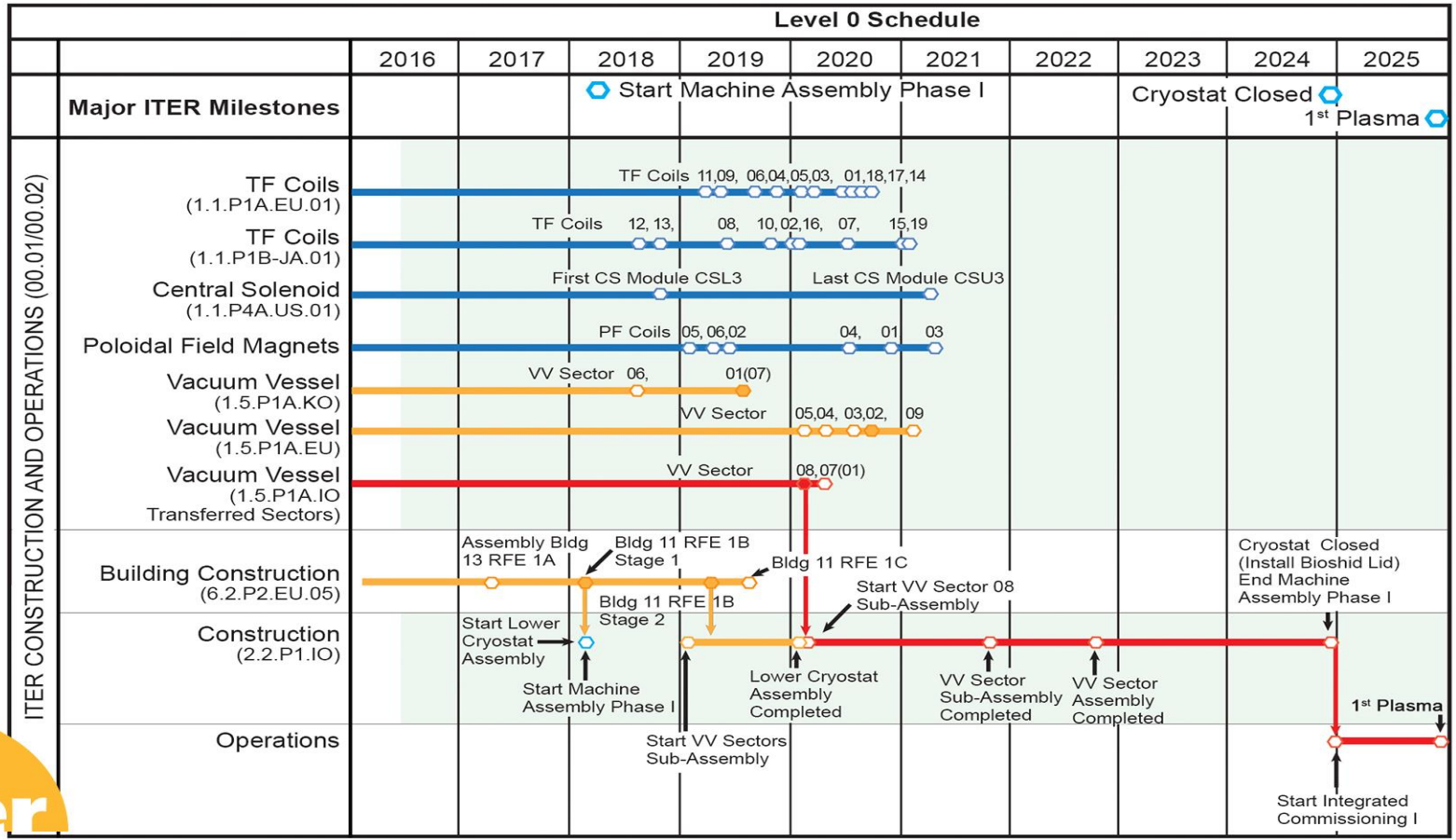


Managing collaboration

(The TF Coils example)



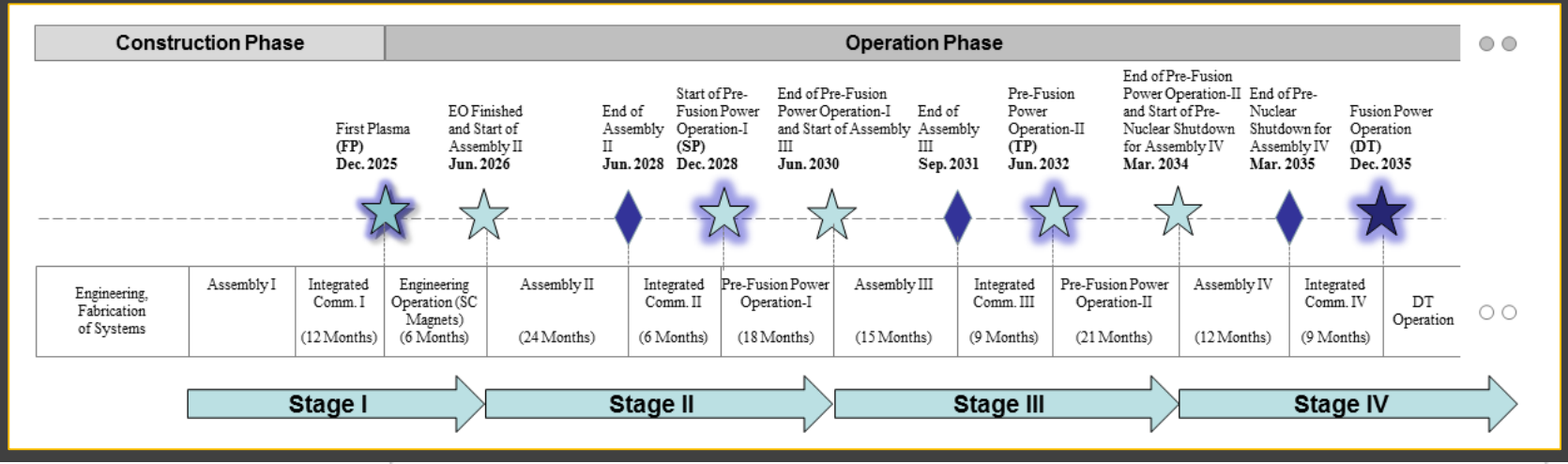
Best technically achievable schedule: First Plasma 2025



A staged approach to full fussion power: 2035

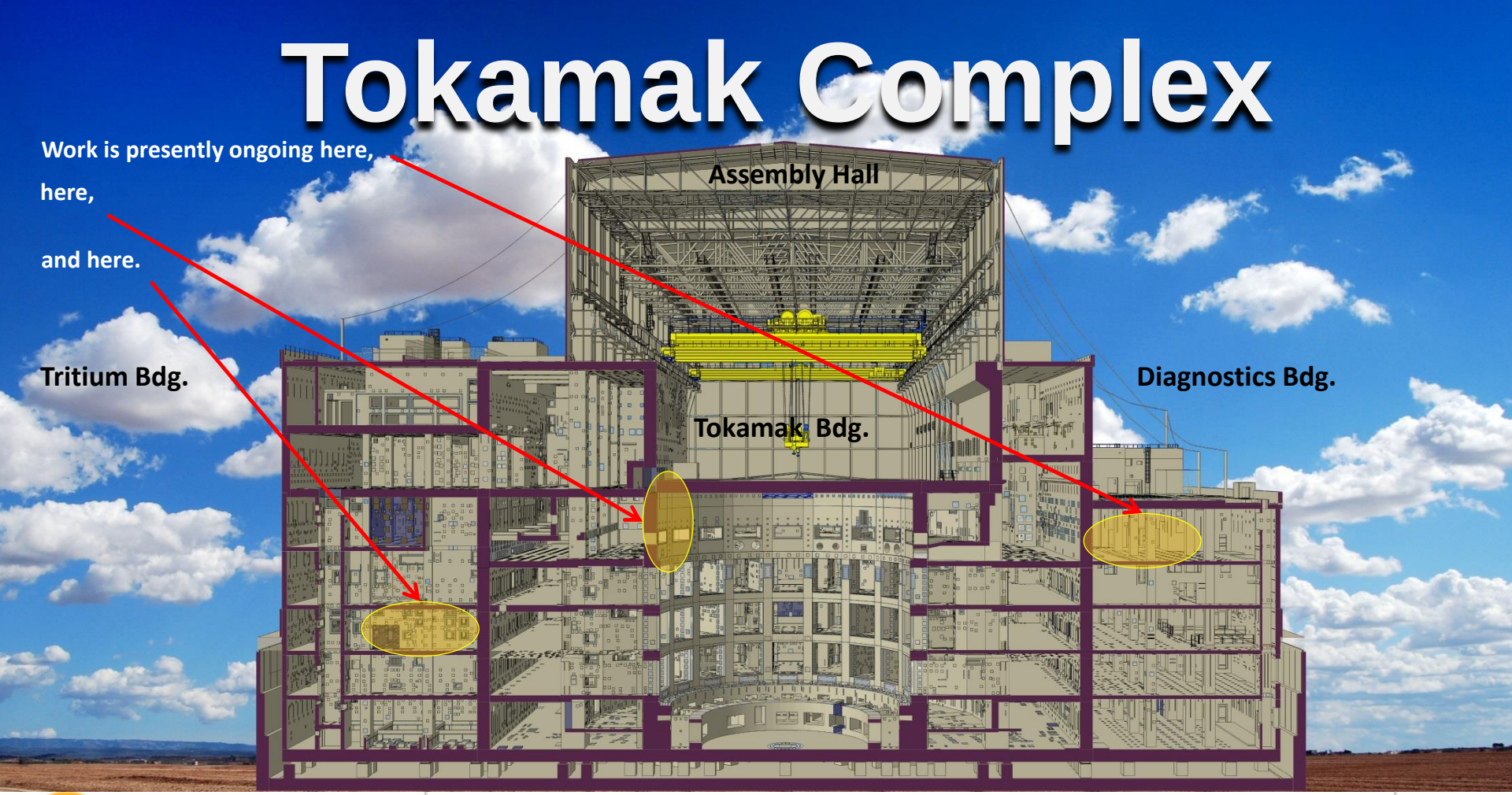
Extensive interactions among IO and DAs to finalize revised baseline schedule proposal

- ✓ Schedule and resource estimates through First Plasma (2025) consistent with Members' budget constraints
- ✓ Proposed use of 4-stage approach through Deuterium-Tritium (2035) consistent with Members' financial and technical constraints

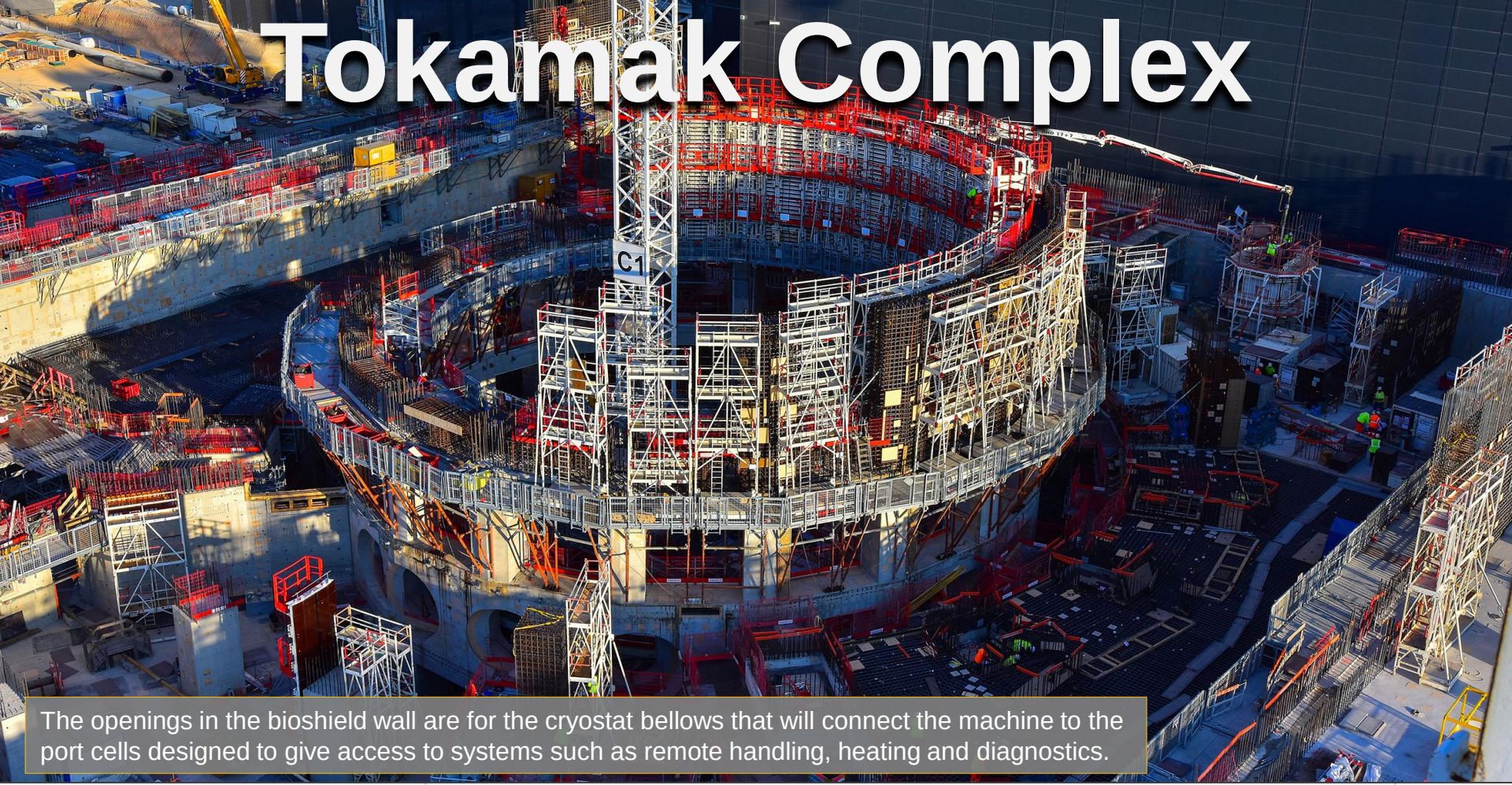



Worksite progress
Assembly Hall
Radiofrequency Heating
Service Bdg.
Cooling System
Cryostat Workshop
PF Coil Winding Facility
400 kV Switchyard
~ Machine axis
Bioshield
Tritium Bdg.
Tokamak Bdg.
Diagnostics Bdg.
Magnet Power Conversions Bdgs.
11 October 2017

Tokamak Complex



Tokamak Complex



The openings in the bioshield wall are for the cryostat bellows that will connect the machine to the port cells designed to give access to systems such as remote handling, heating and diagnostics.

Assembly Hall

Before being integrated in the machine, the components will be prepared and pre-assembled in this 6,000 m2, 60-metre high building. The Assembly Hall is equipped with a double overhead travelling crane with a total lifting capacity of 1,500 tons.

Assembly Hall

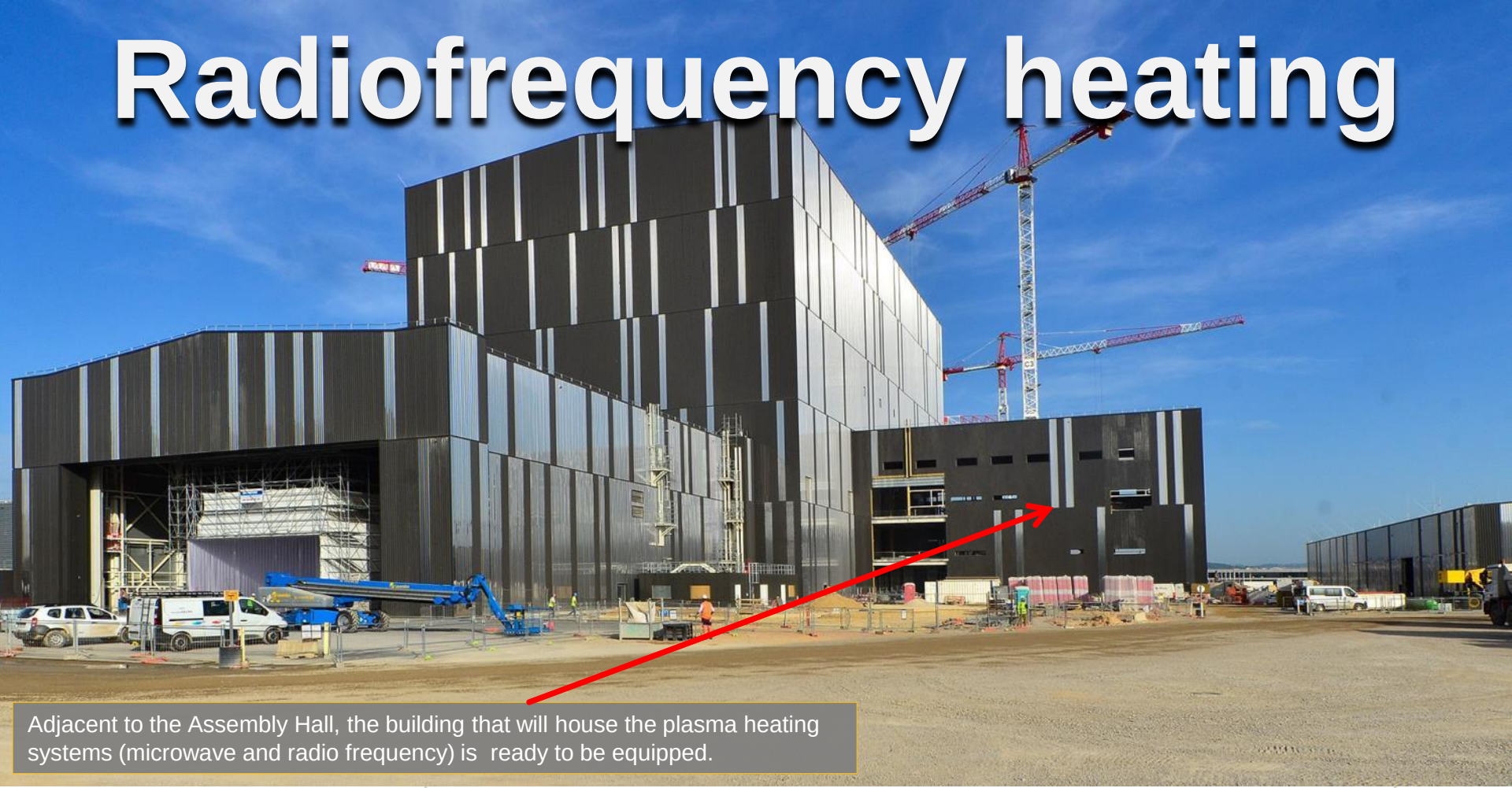
Sector sub-assembly tools

Installation of the pre-assembly (SSAT-1 & -2) tools is ongoing.

Cryoplant

The ITER Cryoplant will be the largest single platform cryofacility in the world. It will distribute liquid helium to various machine components (superconducting magnets, thermal shield, cryopumps, etc.).

Radiofrequency heating

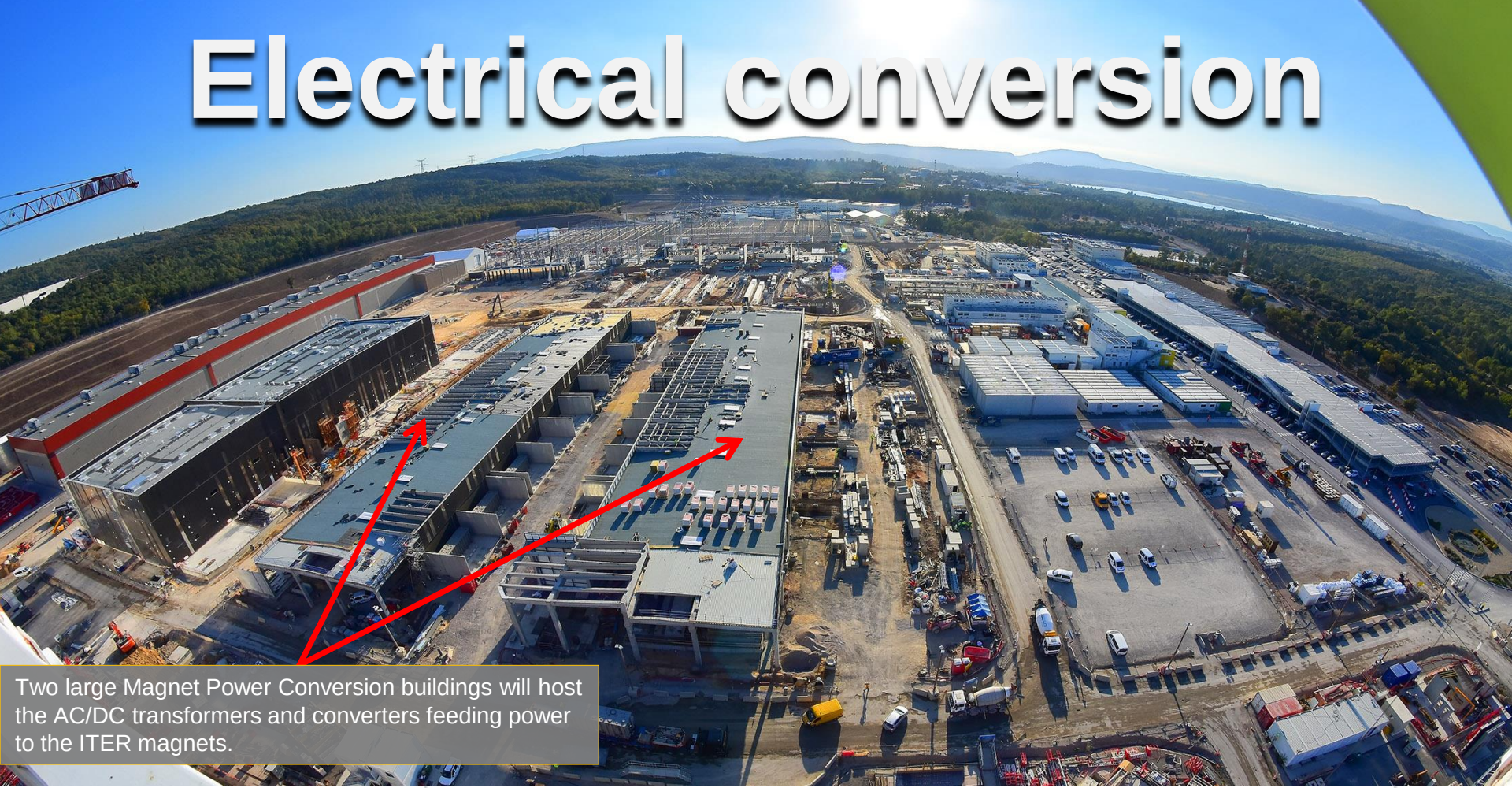


Adjacent to the Assembly Hall, the building that will house the plasma heating systems (microwave and radio frequency) is ready to be equipped.

Electrical network

The connexion of the 400 kV switchyard to the French grid was successfully demonstrated on 30 March.

Electrical conversion



Two large Magnet Power Conversion buildings will host the AC/DC transformers and converters feeding power to the ITER magnets.

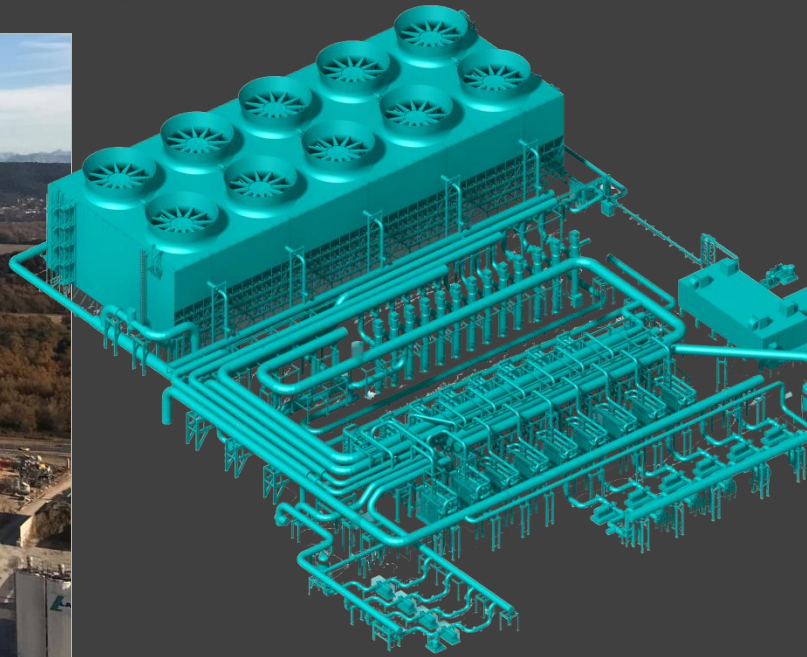
PF Coil winding facility

Too large to be transported by road, four of ITER's six ring-shaped magnets (the poloidal field coils, 8 to 24 m in diametre) will be assembled by Europe in this 12,000 m² facility.

Cryostat workshop

Manufactured in India, the 30 m x 30 m cryostat (the insulating vacuum vessel that encloses the machine) is being assembled and welded on site. The base is in the last stage of completion.

Cooling water systems



ITER power will be partly evacuated by cooling towers (procured by India).

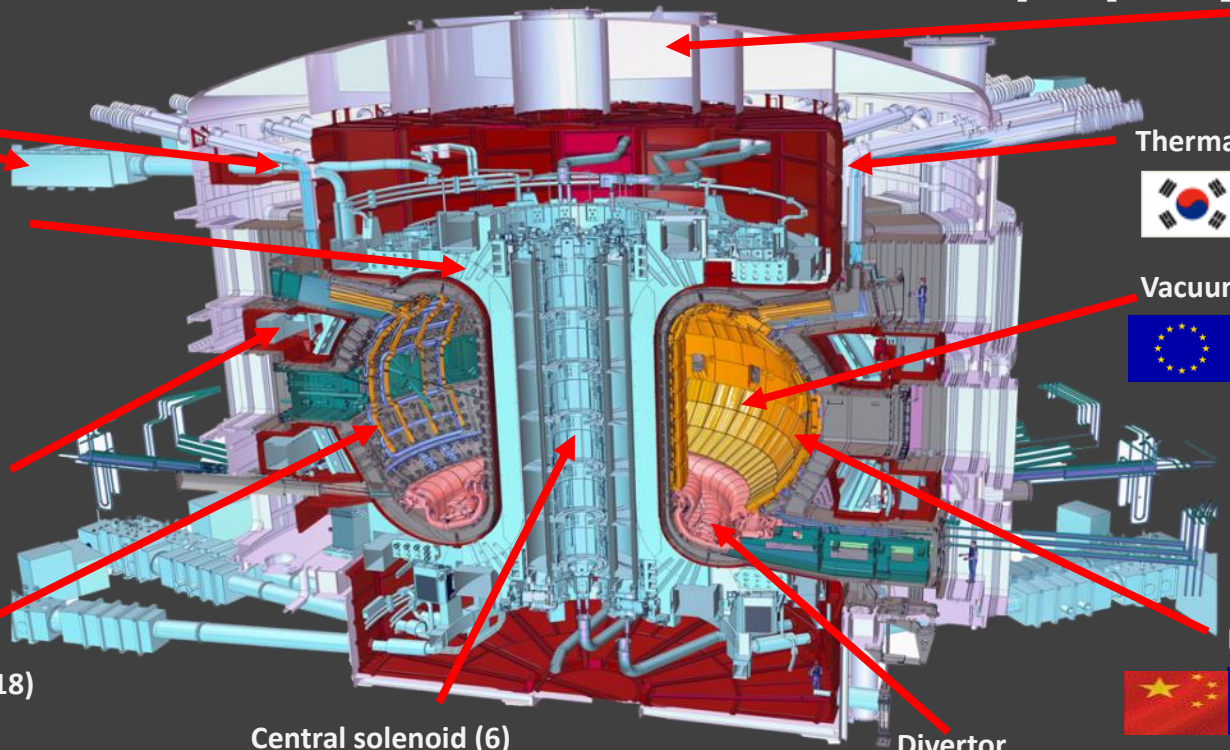
Into the industrial phase with highly challenging specifications

Manufacturing of ITER components is taking place at the cutting edge of technology:

- **Geometrical tolerances measured in millimetres for steel pieces up to 17 m tall weighing several hundred tons**
- **Superconducting power lines cooled to *minus* 270 degrees Celsius**
- **Plasma facing components to withstand heat flux as large as 20 MW per m^2**
- **Cryoplant cooling capacity up to 110 kW at 4.5 K; maximum cumulated liquefaction rate of 12,300 litres/hr**
- **Etc.**

Who manufactures what?

The ITER Members share all intellectual property



Feeders (31)

Cryostat

Thermal shield

Toroidal Field coils (18)

Vacuum vessel

Poloidal field coils (6)

Blanket modules

Correction coils (18)

Central solenoid (6)

Divertor

Manufacturing progress

Members committed and delivering

• Converter–transformers delivered

• PF Coil # fabrication on-going

• Assembly and welding of Cryostat

• Assembly tests for NBE 1 MV bushing

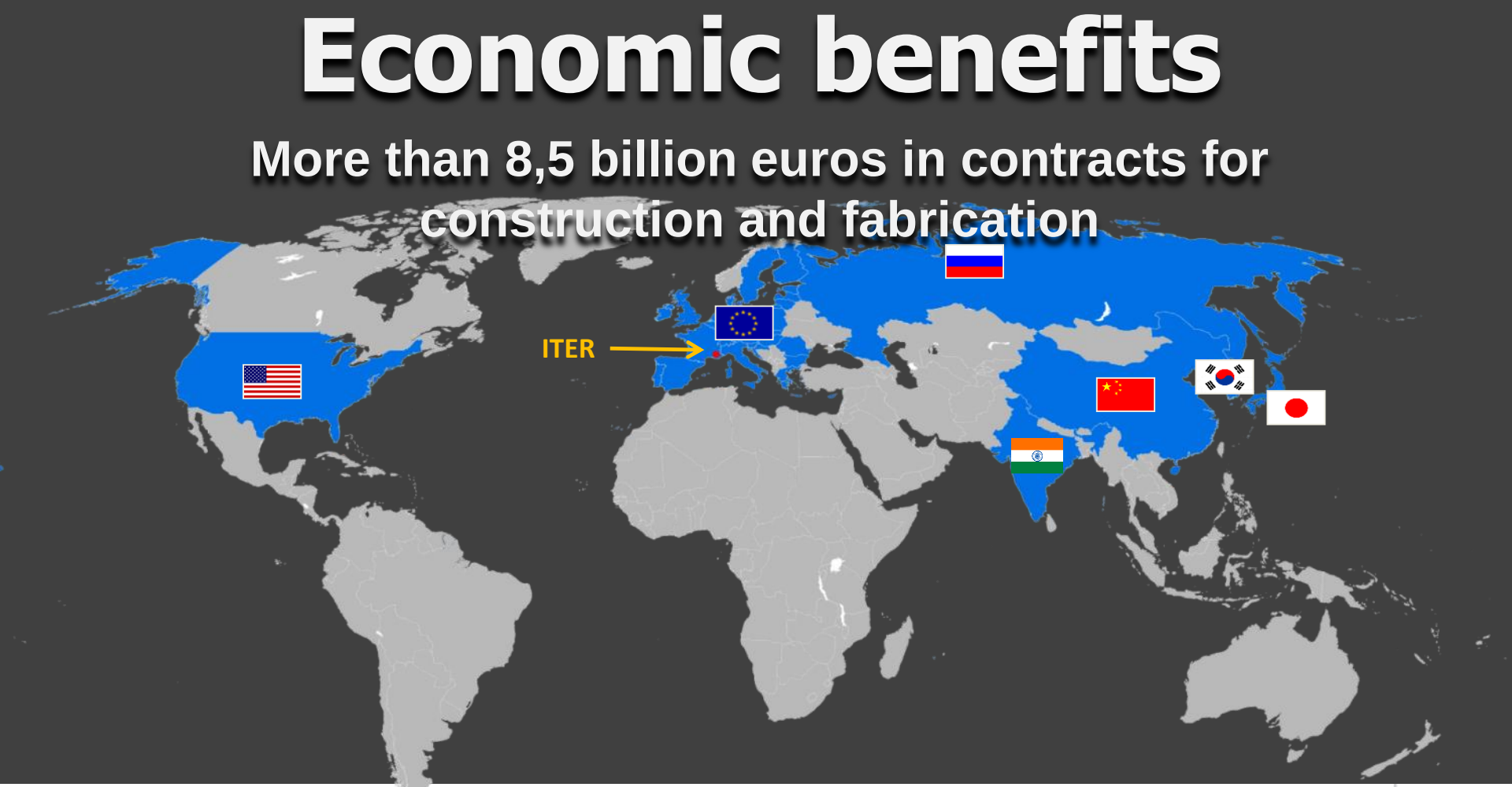
• 4 out of 9 vessel sectors under construction

• Full-scale tests of sealing flange mock-up

• 1,000-ton Central Solenoid fabrication on-going

Economic benefits

More than 8,5 billion euros in contracts for construction and fabrication



ITER is moving forward!

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