ITER Toroidal Field Coils

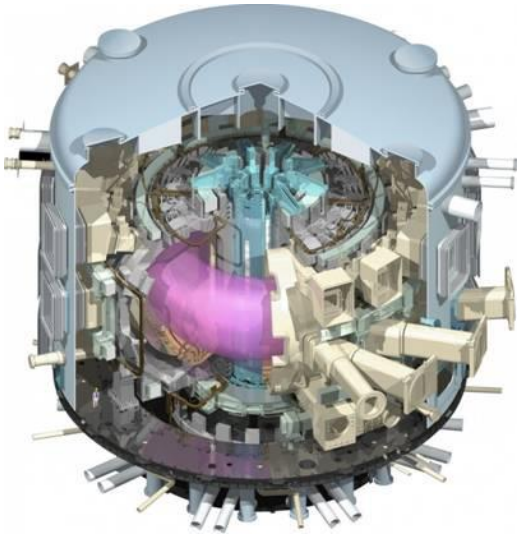
MAGNETS FOR FUSION

MAGNETS FOR HIGH ENERGY PHYSICS

MAGNETS FOR MEDICAL APPLICATIONS

SYSTEMS FOR ENERGY

SERVICES & REPAIRS



The ITER project is aimed at the construction of a nuclear fusion test-plant, a tokamak, dedicated to the investigation of scientific principles and the technologies that will allow to exploit nuclear fusion as the world's primary source of energy. ITER involves many nations from all around the world and each shall contribute components or services to the project.
This machine will allow to perform the controlled thermonuclear fusion in an industrial sized plant. ITER is based on the concept of magnetic confinement, in which the plasma is contained in a doughnut-shaped vacuum vessel.
The fusion process involves two hydrogen isotopes, deuterium and tritium, heated to temperatures in excess of 150 million °C, forming a hot plasma. Strong magnetic fields are used to keep the plasma away from the walls; these are produced by superconducting coils surrounding the vessel, and by an electrical current driven through the plasma.

The heat produced, through proper heat exchangers (steam generators), will allow the production of electric power by a standard turbo-alternator group.
The ITER device will operate with a system of superconducting magnets which relies on the Toroidal Field Coils, the Central Solenoid, the Poloidal Field Coils and the Correction Coils. Europe will manufacture 10 of the 19 TF Coils, including a spare one, while Japan is responsible to produce the remaining nine. Winding packs of this size have never been manufactured before.

Fusion for Energy awarded a contract for the supply of ten winding packs for the ITER Toroidal Field (TF) Coils to Consortium made of the European companies Iberdrola Ingeniería y Construcción SAU, ASG Superconductors SpA and Elytt Energy SL.

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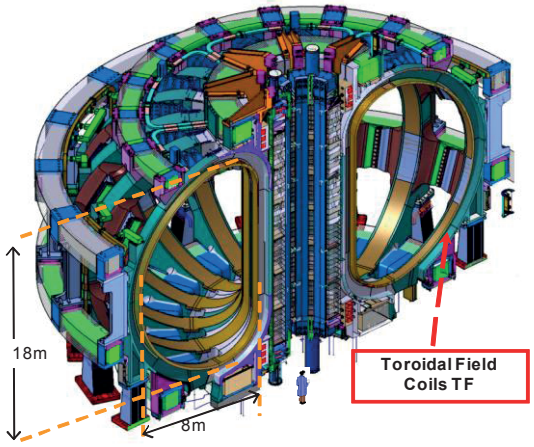
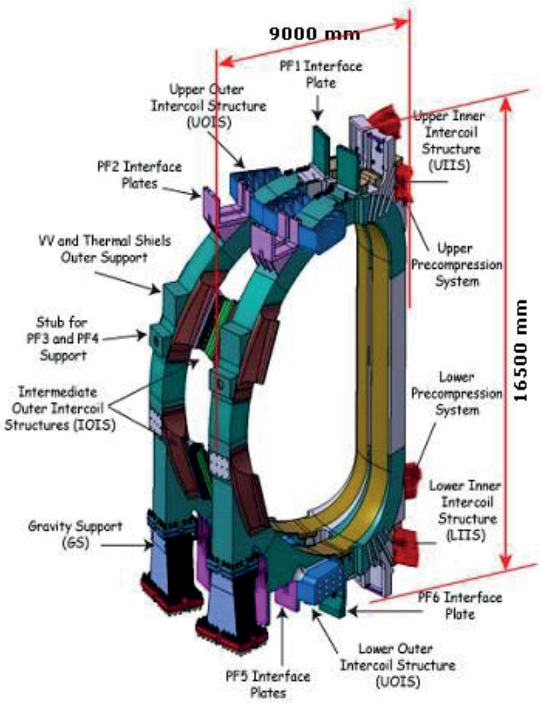
The Toroidal Field Coils are "D" shaped windings, which core task in the ITER device is the confinement of plasma.
They are composed of a Winding Pack (WP) and a stainless steel coil case. Each WP is 14,8 metres high, 1 metre wide and 9 metres long. The weight of a WP is approximately 110 tons. Each WP consists of a set of 7 double pancakes (DPs), 5 regular + 2 side type, stacked together and electrically connected in a series, for an operating current of 68,000 Amps.
Each DP module is made of one radial plate, a D-shaped special grade stainless steel plate in which the conductor is embedded, a conductor length (side 415 m, regular 760 m) plus the insulation.



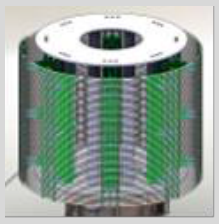
Number of TF coils	18
Magnetic energy in TF coils (GJ)	~ 41
Maximum field in TF coils (T)	11.8
Centering force per TF coil (MN)	403
Vertical force half TF coil (MN)	202
TF discharge time constant (s)	11
Total weight of TF coils system	~6540 t
TF cases	~190 t
TF WP	~110 t
Pre-compression system, keys and bolts	~60 t
Weight (no precom.)	300 t/coil
Peak Field	11.8 T
Constant Current	68 KA



ITER Toroidal Field Coils Manifacturing Process

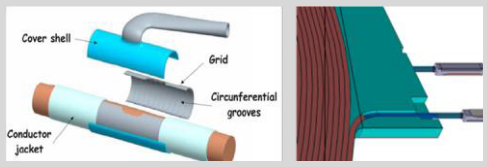
Incoming Inspection

- SC Cable
- Radial Plates



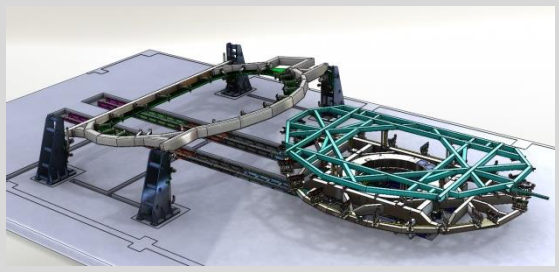
Conductor Winding

He inlet and DP terminations manufact.



Reaction Heat Treatment

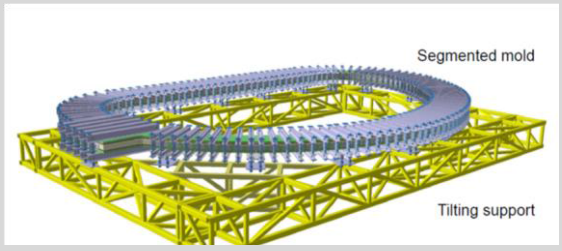
RP insertion inside DPs



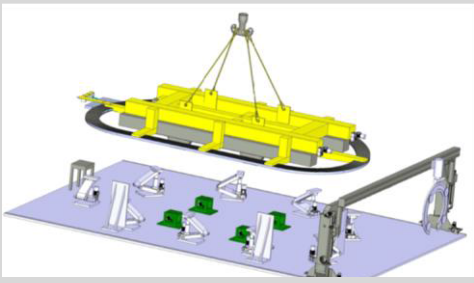
Conductor Insulation & Cover Plates Tack Welding

DP Ground Insulation Wrapping

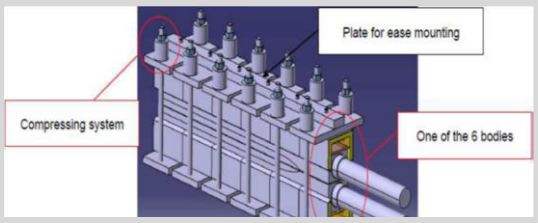
DP VPI



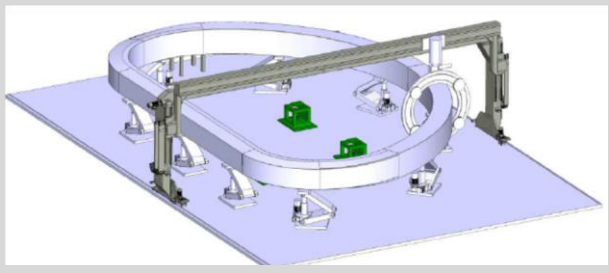
Stacking of 7 DPs



DPs Joints Assembly

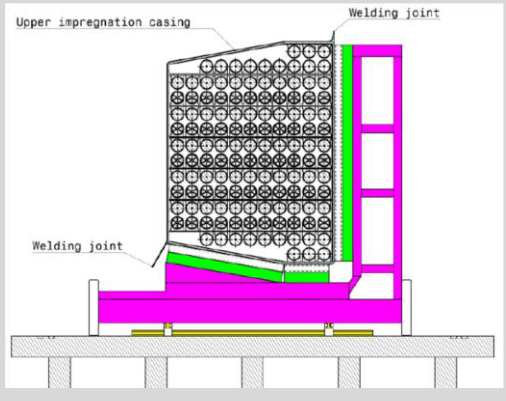


WP Ground Insulation Wrapping



WP Support Plate and Joint Boxes Installation

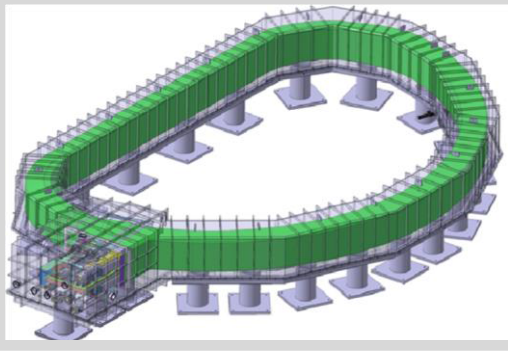
WP VPI



Terminal Area for Details Assembly

WP Assembly of He Cooling Pipes & Instrumentation

Perform WP acceptance Test



Prepare WP for shipment