JT-60SA Toroidal Field Coils

JT-60SA is a fusion experiment designed to support the operation of ITER and to investigate how best to optimise the operation of fusion power plants that are built after ITER. It is a joint international research and development project involving Japan and Europe, and is to be built in Naka, Japan using infrastructure of the existing JT-60 Upgrade experiment. SA stands for "super advanced", since the experiment will have superconducting coils and study advanced modes of plasma operation.

ENEA is in charge, following the agreement between Japan and Europe (Broader Approach 2007) of supplying, as an in kind contribution to the project, part of the toroidal field coils for the plasma confinement in the JT-60SA machine.

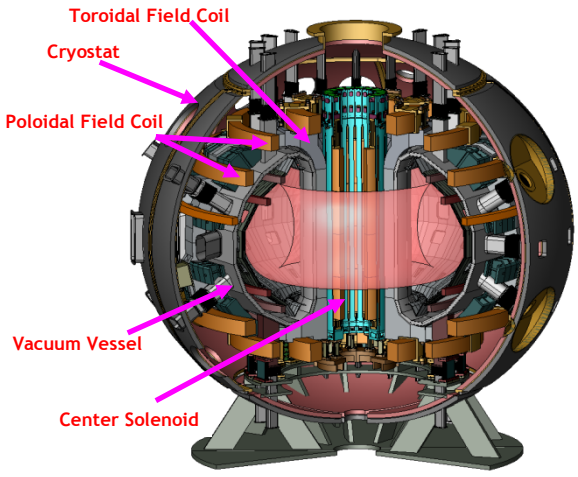
This activity is shared between ENEA and CEA and is coordinated by Fusion for Energy (F4E) that is the Implementing Agency for the EU contributions to JT-60SA.

The magnetic system for JT-60SA consists of 18 TF coils, a central solenoid (CS), and 6 equilibrium field (EF) coils. The four CS modules use Nb_3Sn type superconductors, while the TF and EF coils are made of NbTi.

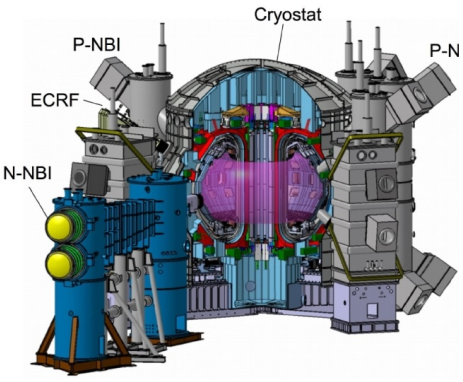
Each of these coils are superconducting, cooled by supercritical helium at 4.4 K and thermally protected in a cryostat.

In 2011 ASG has been awarded with a contract for the supply of 9 TF coils.

Each TF coil is composed of a Winding Pack (WP) embedded into a steel casing; the WP consists of a stack of six Double Pancakes (DPs) wound using a NiTi cable in conduit conductor.



Plasma Current	5.5 MA/3.5 MA
Toroidal Magnetic Field	2.7 T
Major Radius	3 m
Minor Radius	1 m
Plasma Pulse Length	100 s
Heating Power	41 MW
Divertor Heat Flux	15 MW/m^2



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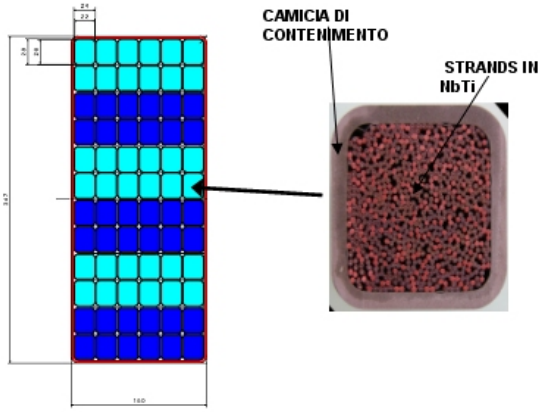
TF Coils Manifacturing

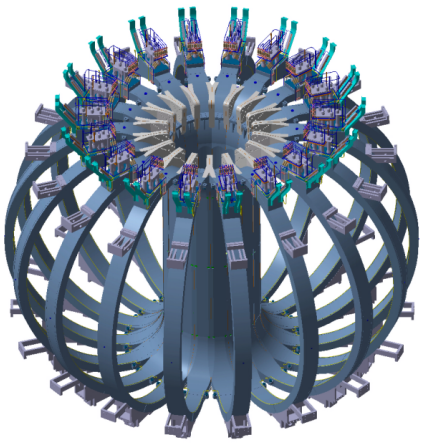
The WP is composed by the stacking of 6 DPs, each DP having six turns. The DP, each in a single conductor length, is electrically connected by joints at its end. The WP is then wrapped in a layer of ground insulation and vacuum impregnated with epoxy resin.

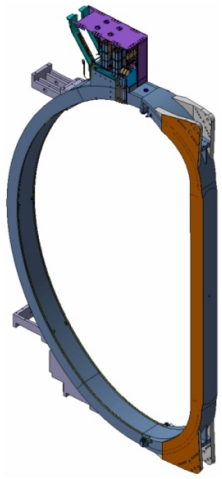


WP cross section
150 x 347 mm

Conductor cross section
22 x 26 mm

The first and last terminals of the side DPs will be connected to the feeders during the machine assembly. Six helium inlets are welded to the jacket at the mid-point of the DP.
The WP is inserted into a stainless steel casing.
The work includes also the manufacturing of all the tooling needed for winding the pancakes, winding pack handling, coil integration, instrumentation and delivery of the 9 integrated coils to the cold test facility site.
Special components and manufacturing procedures are qualified through the development of samples and full-scale mock-ups.
The first TF coil will be ready by mid-2014 and, after passing the cold tests, will be sent to Naka (Japan).
The completion of the TF coils manufacturing is scheduled for the second half of 2016





TF coils assembly

TF coil:
overall dimensions
8,3 x 4,5 x 0,6 m
weight 15,5 t