Central Solenoid

US Contribution

The US is responsible for the central solenoid (CS) magnet, including design, R&D, and fabrication of seven CS modules using supplied conductor (from Japan), plus the associated structure, assembly tooling, bus extensions, and cooling connections.

Overview

The central solenoid is the heartbeat of the ITER tokamak and serves as a critical element in the ITER magnet system. The CS induces the majority of the magnetic flux change needed to initiate the plasma, generate the plasma current, and maintain this current during the burn time.

The CS is made of six independent coil packs that use a niobium-tin (Nb3Sn) cable-in-conduit superconducting conductor, held together by a vertical pre-compression structure. The conductor will be produced in unit lengths up to 910 meters. The US is responsible for the six modules of the CS, a spare module, the structure that ties them together and links these modules to the rest of the magnet system, and the assembly tooling for the CS.

1st Plasma Scope

The central solenoid, associated structures and tooling are necessary for first plasma operation. The US will perform all R&D, engineering, design, procurement, testing and shipment activities of the components of the CS magnet (six modules, one spare module, and structure) and the CS assembly tooling. In addition, design, fabrication and testing of a CS insert coil will be completed.

Status

Central solenoid modules, structures and assembly tooling are in fabrication. Delivery of the first components of assembly tooling began in 2017. The CS insert coil was completed in 2015.
## Key Vendors
- General Atomics (San Diego, CA)
- Precision Custom Components (York, PA)
- Major Tool and Machine (Indianapolis, IN)
- Petersen, Inc. (Ogden, UT)
- Hamill Manufacturing Co. (Trafford, PA)
- Robatel Technologies (Roanoke, VA)
- Superbolt, Inc. (Carnegie, PA)
- National High Field Magnetic Lab, Florida State University (Tallahassee, FL)

## Technical Description
- **Height:** 18 m  
- **Diameter:** 4.13 m  
- **Total Weight:** 1000 t  
- **Number of Coil Packs (modules):** 6 plus 1 spare  
- **Individual Module Weight:** 110 t  
- **Peak Field Strength:** 13.1 T  
- **Test Voltage:** 30 kV  
- **Operating Voltage:** 14 kV  
- **Test Current:** 50 kA (@ 4 K)  
- **Operating Current:** 45 kA  
- **Stored Energy Capacity:** 5.5 GJ

## Central Solenoid Superconducting Cable
- **Strand Material:** Niobium-tin (Nb3Sn)  
- **Strand Diameter:** 0.83 mm (unreacted, after coating)  
- **Non-CU Critical Current Density:** >1000 A/mm² (@ 12 T)  
- **CU to Non-CU Ratio:** 1:1  
- **Cable Design:** CICC (cable-in-conduit-conductor)  
- **Total Length of the CICC in CS:** 7 x 6000 meters (42 km)  
- **Number Pancakes per Coil Pack:** 40  
- **Insulation:** glass and Kapton layers impregnated with epoxy resin  
- **Conductor Jacket Material:** JK2LB austenitic stainless steel  
- **Coolant:** supercritical helium  
- **Coolant Temperature:** 4.2 K