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Overview of the ITER magnetics diagnostic

ITER (International Thermonuclear Experimental Reactor) is the world's largest Tokamak fusion project designed to demonstrate the feasibility of nuclear fusion as large-scale energy source.
It will be equipped with a large array of diagnostic instruments to provide the measurements necessary to control, evaluate and optimize plasma performance in ITER and to further the understanding of plasma physics.
Magnetics is an essential diagnostic to provide magnetic equilibrium; measure currents in the plasma or in structures; measure plasma stored energy; and it is directly integrated in the plasma control system to provide feedback on plasma shape and position.
It provides high-resolution, real-time measurements of the magnetic fields within and around the plasma, which are critical for maintaining effective magnetic confinement.
The system provides measurements of the magnetic properties of the plasma, from raw parameters (local field and flux changes) through time-integrated quantities (field and fluxes) to complete equilibria and derived plasma properties (shape, position, speed, energy, slow and fast instabilities). To do this, the diagnostic uses more than 2000 sensors, divided in the following groups as subsystems:
• Sets of pick-up coils, saddle and voltage loops mounted on the inner wall of the vacuum vessel;
• Rogowski coils mounted around earth straps of the blanket shield modules;
• Sets of pickup coils, Rogowski coils and shunts mounted on the divertor cassettes;
• Sets of pick-up coils, voltage loops, hall sensors and fiber optic sensors mounted on the outer surface of the ITER vacuum vessel;
• Continuous poloidal Rogowski coils mounted within the TF coil case.
Signals from these sensors are conditioned, calibration factors are applied and plasma properties like position, shape, current and modes are derived, in real-time, quasi-real time and offline using a dedicated set of bespoke integrators boards, which integrate, elaborate the signals during the plasma pulse time and transmit the information to the plasma control system and the archive network.
After a general introduction on the ITER construction status and assembly with focus on the diagnostics, this talk will give an overview on the challenges and technological solution adopted for different the magnetic sensors types, the cabling solutions to bring the signals outside the vessel and the electronics
and the software that will be used to calculate in real-time the plasma parameters.
This talk will also cover other magnetic measurements tools that are not directly involved in the plasma control but are essential to characterize and protect the tokamak like toroidal field mapping system based on NMR sensors and the plasma current measurements system for interlock and safety.

Primary author: GOLLUCCIO, Giancarlo (ITER Organization)

Presenter: GOLLUCCIO, Giancarlo (ITER Organization)