

Design developments for the ITER in-Vessel equilibrium pick-up Coils and Halo current Sensors

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The ITER magnetic diagnostics must provide essential information to be used both for plasma diagnostic purposes, and as feedback signals for the machine control loops. Some of the sensors have to be installed in a hostile environment characterized by severe neutron irradiation and plasma heat loads, which can reduce the sensor lifetime (due to mechanical and electrical damage) and also generate undesired DC signals, which might compromise the accuracy of the measurements obtained by time-integration.

The paper is focused on the design development and optimization of a typical in-vessel tangential pick-up Coil. The work is aimed to achieve the required measurement precision in spite of Radiation Induced Electromotive Force (RIEMF) and Radiation Induced Thermo-Electric Sensitivity (RITES), which have recently been documented to take place in Mineral Insulated Cables (MIC). To this purpose, a substantial reduction of the thermal gradient and the maximum temperature due to nuclear heating in the pick-up coils is considered necessary. Within the limits of several heavy engineering constraints, a new concept of magnetic pick up coil has been developed. A winding made of a ceramic-coated conductor (instead of a MIC) and "impregnated" with ceramic filler is proposed. Different material choices for the coil support structure have been investigated.

Similar issues are related to the Halo Sensor design. The possibility of replacing the circular tubes used as support of the rogowski coils with a ceramic support in order to avoid the non-linear effect of the magnetic material has also been studied. The replacement of the MIC of the winding with a ceramic-coated wire is also investigated in order to increase of the effective area of the sensor.

The paper includes also a critical review of each stage of the measurement chain (probes, cabling, conditioning electronics and data acquisition) in order to assess the compliance with the overall system precision that is required for a reliable reconstruction of the plasma position. Particular attention is paid to the performance of the integrator in the presence of differential and common mode noise.