Diagnostics for large tokamaks: from JET to JT-60SA

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The JT-60SA Tokamak is the largest magnetic fusion device in operation, jointly designed, built and exploited by Japan and Europe under the framework of the Broader Approach Agreement and the Japanese National Fusion Programme with the mission of exploring high beta steady state scenarios in the perspective of the economical benefit for a commercial fusion reactor [1]. Its features of highly shaped large superconducting tokamak (major radius Rp $\sim$ 3 m, aspect ratio A $\sim$ 2.6, maximum plasma current Ip = 5.5 MA) with a variety of plasma control actuators including high-power (41 MW × 100 s) heating by neutral beams (NB) and electron cyclotron range of frequency (ECRF) waves (7 MW, 82-110-138 GHz), pellet-based particle flux of up to 1.3 x 10^{22} s^{-1} bring JT-60SA at the forefront in complementing ITER to develop the design basis of DEMO.

The experience gained in developing high quality measurement systems for fusion device gained with JET and the other European machines is now being exploited for JT-60SA, with the unprecedented complexity of the environment of a large size superconducting device. After the successful completion of a pilot project (the EDICAM fast wide angle video system) an ensemble of state-of-art diagnostics is being designed and implemented to support the scientific mission of JT-60SA with the joint effort of EU and Japan. As part of the European contribution a Visible Ultra-Violet Divertor imaging Spectrometer and a High Resolution Thomson Scattering system will be installed during the ongoing Machine Enhancements 1 period. Other diagnostics such a Fast-ion Loss Detector, a Tangential Phase Contrast Imaging System, a Doppler Reflectometry System, a Gamma-ray detector and a Neutron Spectrometer are in preparation.

An overview of the ongoing diagnostic projects, their objectives in the framework of the scientific plan of JT-60SA and the peculiarities of their implementation will be given in this contribution.

[1] Hiroshi Shirai et al 2024 Nucl. Fusion https://doi.org/10.1088/1741-4326/ad34e4