Diagnostics for large tokamaks: from JET to JT-60SA [plenary-45 min incl. discussion]

C.Sozzi for the JT-60SA Integrated Project Team

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 as high-power (41 MW × 100 s) heating by neutral beams (NBI), including 10 MW of N-NBI at 500 keV, 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.

After the successful completion of the first diagnostics developed in Europe for JT-60SA, the EDICAM fast wide-angle video system, design and implementation of state-of-art diagnostics has become an important part of the EU contribution in support of the scientific mission of JT-60SA. The experience gained in developing high-quality measurement systems for fusion devices is now being leveraged for JT-60SA, taking into account the unprecedented complexity of the large-scale superconducting device environment. Several systems, with different arrangements in terms of sharing of responsibilities between the partners, are now being implemented in preparation of the next operational period under the joint effort of EU and Japan as for example edge and core Thomson Scattering, divertor and core Visible Ultra-Violet Divertor spectrometers, Charge Exchange, Bolometry, Electron Cyclotron Emission, Infrared cameras and, for installation in subsequent machine enhancement period, Tangential Phase Contrast Imaging, Doppler Reflectometry and others.

Fast ion studies have a particular relevance in JT-60SA from the initial stages of its exploitation, since no other tokamak before ITER is equipped with N-NBI. In order to accomplish such task Neutron profile monitor, Neutron spectrometer, Fast-ion Loss Detector, Fast Ion D-alpha are being developed, capitalizing the experience of JET in the design and in the exploitation of some of such diagnostics and extending the support to ITER in this field.

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