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Oral_13: Diagnostics on the stellarator TJ-II

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The TJ-II is a heliac-type stellarator device with major radius of 1.5 m and averaged minor radius ≤0.22 m that has been operated at Ciemat, Madrid since 1998.1 Its magnetic field (B ≤1 T at plasma axis) is generated by a system of poloidal, toroidal and vertical field coils. Plasmas created with hydrogen, deuterium or helium, tpulse ≤300 ms, are heated using two gyrotrons operated at 53.2 GHz, the 2nd harmonic of the electron cyclotron resonance frequency (Pech ≤600 kW). With this set-up, central ne and Te up to 1.7x1019 m-3 and 2 keV, respectively, are achieved. Additional heating is undertaken by injecting accelerated neutral hydrogen atoms (≤31 kV) using 2 tangential neutral beam injectors. These provide up to 1 MW for ≤120 ms so that a central ne up to 5⊠1019 m-3 is attained. Moreover, TJ-II possesses a complicated vacuum-vessel layout, a bean-shaped plasma cross-section and a fully 3-dimensional plasma structure. Nonetheless, it has excellent diagnostic access (96 portholes).
During its initial operational phase, TJ-II was equipped with a limited set of essential diagnostics.2 These included passive systems such as H⊠ monitors, spectrometers, an Electron Cyclotron Emission radiometer, X-ray monitors, neutral particle analysers as well as magnetic diagnostics such as Rogowski coils, diamagnetic loops and Mirnov coils. In addition, some active systems, e.g., a single pulse per discharge Thomson Scattering system, were operational. Thereafter, over the following years, a larger set of diagnostics was installed some of which are dual, or double, systems that are unique to this device. These include a dual fast-reciprocating Langmuir probe system, impurity injection using both the laser ablation and Tracer Encapsulated Solid Pellet (TESPEL) techniques,3 a helium gas puff based system to study edge turbulence using a fast-frame imaging camera equipped with a triple bundle fitted and transmission filters, a compact neutral beam injector with a fibre optic based light collection system (to measure impurity ion temperature and velocity profiles plus radial electric fields using Charge Exchange Recombination Spectroscopy or magnetic field components using the Motional Stark effect),4 a dual Heavy Ion Beam probe system that has allowed obtaining 2-dimensional distribution plots of plasma potential and density,5 a pulsed helium beam (to obtain ne, Te and Ti at the plasma edge by the Line Ratio method), and a 2 channel Doppler reflectrometer to study plasma fluctuations and radial electric fields.6 Of particular note is the TESPEL system which shares its injection line and diagnostic systems with a cryogenic pellet injector.7 This unique combination has provided information for pellet ablation and deposition comparisons and on the impact of pellets on plasma parameters. The experience and knowhow gained from the development, installation and operation of these systems has provided valuable input for TJ-II Team participation in diagnostics for new and future fusion devices, i.e., dual Doppler reflectometer and TESPEL systems for W7-X,8,9 the Wide Angle Viewing and Collective Thomson systems for ITER, and UV, visible and IR diagnostic systems for DEMO.

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