In the framework of the construction of the new tokamaks JT-60SA, ITER and DEMO, predicting the performance of the main operation scenarios has been identified as a key objective, both for the detailed requirements of various machine subsystems (H&CD, control coils, diagnostics) and to establish a reliable starting point for plasma operation. For this purpose, and focusing on JT-60SA, an extensive physics analysis and modelling has been undertaken with a series of representative discharges of the main operational scenarios selected from JT-60U and JET devices, with which JT-60SA share several characteristics: designed on the basis of the JT-60U results and with similar size as JET.

Predictive simulations have been carried out in different steps in order to analyse the predictability of heat and particle transport as well as pedestal pressure. For the core, Bohm-GyroBohm, CDBM and GLF23 transport models have been used for simulating electron and ion temperatures by adjusting, as a first step, the pedestal, rotation and density to the experimental values. In order to carry out this programme, the integrated modelling codes CRONOS [1] and TOPICS [2] are used. Results show how, for both devices, GLF23 and Bohm-GyroBohm transport models tend to reproduce better standard ELMy H-mode inductive scenarios whereas CDBM tends to be better for hybrid regimes. In particular, GLF23 overestimates the impact of the rotation on hybrid scenarios. A comparison made with simulations performed with the TGLF transport model, shows that the impact of rotation is weak, whereas the interplay between electromagnetic effects and fast ions, with a large population in hybrid regimes, is a key effect for turbulence suppression, something that can have a strong impact in future devices as ITER. Regarding particle transport, GLF23 transport model is able to reproduce density profile with reasonable accuracy. Therefore, fully predictive simulations of temperatures, density and pedestal have been performed with GLF23 and CDBM models for the temperatures and GLF23 for the density. In the case of the pedestal, the density at the edge is forced to follow neoclassical transport, whereas the pedestal temperature is calculated by using MHD Cordey scaling for the pedestal energy [3]. The general root-mean-square error obtained is below 20% for the average densities and temperatures as well as for the pedestal pressure, something that gives confidence on the extrapolation to JT-60SA on the basis of the models applied.

The analysis previously carried out gives a framework for JT-60SA modelling which has been used to simulate two scenarios: inductive H-mode and hybrid. In general, the typical characteristics of each scenario have been recovered. For the inductive scenario, $q_{95} \approx 3$, with moderate density peaking and thermal improved confinement $H_{98}(y,2) \approx 1$ has been found at $I_p=5.5\,\text{MA}$ when $41\,\text{MW}$ of input power is added. The pedestal pressure is $P_{\text{ped}} \approx 50\,\text{kPa}$. The pedestal width, $\Delta \rho = 0.06$, has been calculated using the scaling $\Delta \psi_N = 0.076 \beta_{p,\text{ped}}^{0.2}$, where $\psi_N$ is the normalized poloidal flux and $\beta_{p,\text{ped}}$ is the poloidal beta. For the hybrid scenario, at lower total current, $I_p=3.5\,\text{MA}$, and input power, $37\,\text{MW}$, $q_{95} \approx 4.5$ with $q<1$ only for $\rho<0.2$ and $H_{98}(y,2) \approx 1.2$ is obtained. The pedestal pressure is $P_{\text{ped}} \approx 30\,\text{kPa}$ with $\Delta \rho = 0.05$. This confirms, on the basis of the analysis of present day experiments, that the power and magnetic systems available on JT-60SA are adequate for the operation of these plasma scenarios.