

Integration of advanced feedback control techniques on Tore Supra (P2-C-193)

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Tore Supra tokamak plays an important role in development and optimisation of steady-state scenarios. Its real-time feedback control system is a key instrument to improve plasma performances. For this reason, new feedback control schemes have been recently put into operation and others are being developed. This work deals with the implementation in Tore Supra of these advanced algorithms, reports the technical details and shows the first positive results that have been achieved.

For instance, encouraging results have been obtained in the field of profiles control. Controls of the full width at half maximum of the suprathermal electrons local emission profile at very low loop voltage and of the maximum of the thermal Larmor radius, normalised to the characteristic length of the electron temperature gradient, have been attained. While the first quantity can be directly associated to the current profile, the second one characterises the pressure profile. A new feedback control algorithm, employed to maximise a given quantity by means of a “Search Optimisation” technique, has been effectively tested too: the hard X-ray width has been maximised with simultaneous use of lower hybrid heating power and wave parallel index as actuators.

These and other promising results, whose detailed description will be given in the article, have been obtained thanks to the real-time availability of several diagnostic systems. Using a shared memory network as communication layer, they send their measurements to a central computing unit that, in its turn, dispatches the necessary requirements to the actuators. A key issue is the possibility to integrate these controls in such a way as to cope with different requests at the same time. As an example, simultaneous control of the plasma current by means of the lower hybrid heating power, of the loop voltage by means of the poloidal field system and of the hard X-ray width through the lower hybrid heating phase shift has been successfully accomplished.

The robustness of the Tore Supra real-time feedback control system is another fundamental characteristic as well as the possibility of exchanging data at different frequencies (from hundredths of Hz to 1 Hz or less), depending on the physical process and on the type of required control.