FIRST PLASMA OPERATION OF THE ENHANCED JET VERTICAL STABILISATION SYSTEM

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A project dedicated to the enhancement of the JET Vertical Stabilization (VS) system was launched in 2006, including an upgrade of the Power Supply of the Radial Field Amplifier and a complete overhaul of hardware and software of the VS control system [1]. The main aim was to double the JET capability in stabilising high current plasmas when subject to perturbations, in particular large Edge Localised Modes (ELMs). We present here the results of first plasma operation with the new Enhanced Radial Field Amplifier (ERFA) and its data acquisition and control system (V5), focussing on the benefits of an approach based on phased commissioning, modelling and offline algorithm validation. With the installation of ERFA the current capability of the Power Supply has doubled and the output voltage has increased by 30%. The new controller V5 is based on Advanced Telecommunication Computing Architecture (ATCA) hardware and on the Multi-threaded Application Real-Time executor (MARTe) framework. Its modular architecture allows the use of up to 4 controllers and 10 controlled VS variables in a discharge. Electromagnetic modelling of the interaction between the plasma and the surrounding conductors is used for the design of controllers and observers. V5 was commissioned early in 2009 with the old amplifier. Following the installation and connection of ERFA to the JET Radial Field coils, a campaign of plasma experiments was dedicated to the basic commissioning of ERFA, the exploration of the operating range of ERFA/V5 and the overall physics optimisation of the new JET VS system. Experiments started with quiescent plasmas, with increasing values of plasma current and instability growth rate, $\gamma \sim 100 - 1400\ s^{-1}$, progressing to ERFA/V5 response to controlled perturbations, then to small ELMs and, finally, large ELMs regimes. A special effort was devoted to assessing different options for connection of ERFA to the Radial Field Coils, and a low inductance configuration was selected as the best overall. The final step has been the assessment of ERFA/V5 behaviour in realistic H-mode scenarios. The new ERFA/V5 system behaved flawlessly in challenging ELMs conditions, with more than 1 MJ of rapid energy loss, or high current operation up to 4.5 MA. Extrapolations based on these results indicate that the ERFA/V5 system amply met its design objectives and will allow safe JET operation in a significantly expanded parameter space with respect to instability growth rate and tolerable perturbations.

[1] F. Sartori et al., "The JET PCU project: an international plasma control project", Fus. Eng. Design, vol. 83, no. 2–3, pp. 202–206, Apr. 2008