The new EFCC controller system in the JET tokamak

D. Alves[1], R. Vitelli[2], L. Zaccarian[2], L. Zabeo[3], A. Neto[1], F. Sartori[4], P. McCullen[5], P. Card[5] and JET EFDA contributors*

JET-EFDA, Culham Science Centre, OX14 3DB, Abingdon, UK

[1]*Associação EURATOM/IST, Instituto de Plasmas e Fusão Nuclear - Laboratório Associado, P-1049-001, Lisboa, Portugal*
[2]*Dipartimento di Informatica, Sistemi e Produzione, Università di Roma, Tor Vergata, Via del Politecnico 1-00133, Roma, Italy*
[3]*ITER Organisation, Cadarache, France*
[4]*Fusion for Energy, Barcelona, Spain*
[5]*EURATOM-CCFE Fusion Association, Culham Science Centre, Abingdon OX14 3EA, United Kingdom*

Corresponding author: dalves@ipfn.ist.utl.pt

Magnetic field perturbations which break the toroidal symmetries are inevitable in tokamaks due to imperfections in magnetic field coils and to the presence of magnetic materials. Magnetic islands arising from these asymmetries can cause the appearance of locked modes which, if uncontrolled, frequently lead to disruptions. One of the main goals of the Error Filed Correction Coil (EFCC) systems in modern tokamaks is to alleviate this effect by applying magnetic perturbations that compensate the natural error field at the plasma boundary [1]. More recent results extend the benefits of the EFCCs to the mitigation of Edge Localised Modes (ELMs) by increasing their frequency, thus, reducing their size and transient heat load at limiter surfaces whilst maintaining good plasma confinement [2].
Recently at JET, performance issues and practical limitations led to the decision of changing the EFCCs voltage amplifiers. The opportunity was also taken to reformulate and improve the controller application by incorporating it into a new real-time software framework, developing a new control algorithm and revising the time synchronisation mechanism whilst maintaining essentially the same VME based hardware components. The Multi-threaded Application Real-Time executor (MARTe) [3] is a robust multi-platform software framework that provides a complete set of common real-time application functionality enabling the developer to focus mainly on the data processing algorithms while taking advantage of the various sophisticated tools and logging facilities made available. The new control algorithm is a non-linear scheme containing both adaptive feed-forward and feed-back contributions. This controller has not been tested yet in JET campaigns however, simulation results are presented pointing out its main benefits. The new synchronisation scheme allows the controller application to run on a real-time cycle time of 200 μs based on its internal clock and at the same time to make use of the ordinary millisecond resolution JET clock information in order to stay in phase with the absolute JET time. Furthermore, a new graphical user interface configuration utility has been developed mainly to accommodate the new controller's waveform generator capability of nesting waveforms and enabling simultaneous sweeping in frequency, amplitude and offset. In this paper, a global overview of the new controller application will be provided focusing mainly on the above mentioned improved elements. Preliminary results of the operation of this system during JET pulses will also be presented.

[1] L.T. Chapman et al, Nuclear Fusion, 47, 2007, L36-L40
[2] Y. Liang, Phys. Rev. Lett., 98, 2007, 265004 (5 pages)
[3] A. Neto, IEEE Trans. Nucl. Sci., accepted for publication

*See the Appendix of F. Romanelli et al, Proceedings of the 22nd IAEA Fusion Energy Conference 2008, Geneva, Switzerland.