

DESIGN AND TEST OF FEEDBACK CONTROL LOOPS WITH A GENERIC MULTIPURPOSE TOKAMAK PLASMA DISCHARGES FLIGHT SIMULATOR

N. Ravenel¹, S. Mannori², S. Brémond¹, Ph. Moreau¹,

J.F. Artaud¹, F. Imbeaux¹, B. Guillerminet¹, Ph. Huynh¹, E. Nardon¹, P. Pastor¹, J. Signoret¹,

¹ CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France

² INRIA, Rocquencourt

Corresponding author: nathalie.ravenel@cea.fr

Over the years, feedback controls are becoming more and more crucial in tokamak plasma experiments and in view of ITER operation both for increasing performance, stability and ensuring machine protection. The development of advanced controls, such as for instance MHD modes or plasma profiles control, have to deal with non-linear, complex physical processes that can hardly be addressed by “trial and error” methods. The tokamak plasma discharges event and/or exceptions handling, that is now recognised to be crucial for machine protection especially on ITER, require pre-discharge qualification. All these issues highlight the necessity to build new tools for the preparation of advanced control algorithms.

A project aiming at developing such tools was launched in the framework of the development of a generic multipurpose tokamak plasma discharges flight simulator [1]. It provides a new generic and flexible framework for the design, qualification and test of control algorithms. The control toolbox is the open source Scicoslab software [2] under which feedback control laws can be designed and pre-tested. The resulting feedback control laws can then be qualified on more sophisticated tokamak engineering or physics oriented plasma response models provided under the European Integrated Tokamak Modelling Task Force (ITM-TF) simulation platform (based on the Kepler open source software). New developments have been performed that now allow, starting from Scicos block diagrams, to generate C codes that can be easily wrapped into Kepler unit blocks called actors to feed time loop workflows under the ITM-TF simulation platform. Once qualified on simulation, the feedback control laws may be implemented on real-time control and data acquisition units using the adapted Scicos C code generator. This process is being developed for instance on the Tore Supra control and data acquisition units based on either VME or PC technology. Final test of the control loops before experiments are also foreseen in a “hardware in the loop” configuration.

The paper will report on the different software developments performed in order to enable a flexible and user friendly design and test of feedback control loops with application on Tore Supra.

[1] P. Moreau, this conference

[2] Scicoslab <http://www.scicoslab.org/>