ELMs control on ITER with resonant magnetic perturbations

E. Nardon[(1)], M. Bécoulet[(1)], P. R. Thomas[(1)], G. Huysmans[(1)], J. F. Artaud[(1)], M. Lipa[(1)], P. Ghendrih[(1)], A. Grosman[(1)], R.A. Moyer[(2)], T.E. Evans[(3)], V. Chuyanov[(4)], G. Federici[(4)]

[1] *Association Euratom-CEA, CEA Cadarache, F-13108, St. Paul-lez-Durance, France*
[2]*University of California, San Diego, La Jolla, CA 92093, USA*
[3]*General Atomics, P.O. Box 85608, San Diego, CA 92186-5688, USA*
[4]*ITER JWS Garching Co-center, Boltzmannstrasse2, 85748 Garching, Germany*

The recent successful experiments on Type I ELMs suppression in DIII-D using a radial magnetic perturbation are of great interest for the next-step tokamak ITER. The present paper deals with the possibility to implement, on ITER, a system of perturbation coils specifically designed to control ELMs. In a first part, the work on the design itself is presented and one particular coils configuration is selected. In a second part, a model for ELMs control is presented and applied to this particular configuration.

As the mechanisms for ELMs suppression are not completely clear yet, it is hard to tell which features of the magnetic perturbations are important or not in order to suppress the ELMs. For the design of the perturbation coils system, we assume that edge ergodisation is the essential feature. We select the design that seems the best in regard of three criteria:

- technical feasibility of the coils installation;
- required values of currents in the coils in order to ergodise the edge;
- size of the generated (but undesired for NTMs concerns) core islands that go along with edge ergodisation.

We developed for this a series of tools that allows us to compute the islands size and Chirikov parameter given by any configuration of coils.

To complete this work, we then assume a mechanism for ELMs suppression and test our design for this mechanism. The assumption is that ergodicity at the plasma edge enhances the energy transport and consequently reduces the pressure gradient, preventing MHD instabilities to develop, and thus removing ELMs. The enhancement of transport is due to the radial component of the $\chi_{//}\vec{\nabla}_{//}T_e$ term in the heat flux $\vec{q}$. Transport simulations are made, with non-linear energy transport 2D code TELM, and MHD stability is tested with the ideal linear MHD stability code MISHKA. The three ITER reference scenarios (H-mode, hybrid and steady-state) are tested.