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LLNL-ABS-405261

Control of edge localized modes through toroidally asymmetric current perturbations in the tokamak scrape-off layer

I. Joseph, R.H. Cohen, D.D. Ryutov

July 9, 2008

Modeling of Plasma Effects of Applied Resonant Magnetic Perturbations
San DIego, CA, United States
August 25, 2008 through August 26, 2008

Abstract

Control of edge localized modes through toroidally asymmetric current perturbations in the tokamak scrape-off layer*

Ilon Joseph, Ronald H. Cohen, Dmitri D. Ryutov

Lawrence Livermore National Laboratory
Livermore, CA, USA

We suggest a new technique of driving magnetic perturbations to suppress the impulsive edge-localized magnetohydrodynamic instabilities (ELMs) that limit the lifetime of the divertor targets of high confinement magnetic fusion reactors. The current method of driving such perturbations must place the current carrying conductors as close as possible to the plasma, and this requirement complicates the design of such components. However, toroidally asymmetric current densities as large as the ion saturation current density can be driven through the edge plasma by biasing the divertor target to potentials of the order of the electron temperature in a toroidally varying fashion. The technique generates an effective surface current parallel to the magnetic field lines on the magnetic flux surfaces in the scrape off layer. The currents produce a magnetic field perturbation that is largest near the X-point and generates a relatively large resonant spectral component due to the natural alignment of the perturbation with the field lines in the X-point and separatrix region. Analytic estimates suggest that the resonant spectral components are larger than the $\delta B/B > 10^{-4}$ criterion required for ELM suppression in DIII-D and JET experimental results.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory Contract DE-AC52-07NA27344.