Contribution ID: **3680** Type: **not specified**

P5.3011 Time dependent kinetic flux limiters during ELMs in ITER Scrape-Off-Layer

Friday, 12 July 2019 14:00 (2 hours)

See full abstract here http://ocs.ciemat.es/EPS2019ABS/pdf/P5.3011.pdf

The divertor targets in tokamaks are constantly bombarded with high-energy neutral and charged particles and such violent events can pose a serious threat to the long-time resistance of the divertor materials. The wall erosion, caused by the bombardment, releases impurities, that migrate towards the bulk plasma and due to the effects, the plasma state is deteriorated [1]. In order to keep the limits of wall erosion, it is important to estimate the plasma characteristics in the Scrape-off Layer (SOL) i.e the region outside the last closed magnetic surface (separatrix). This is a complex region where many processes such as low collisionality, geometrical effects, physical and chemical reactions, can cause deviation of the parallel transport from the classical one during time. However, the transient heat loads such as ELMs (Edge-Localized modes) occur in tokamak edge during H-mode confinement lead to a significant loss of stored plasma energy [1]. Once the ELM-driven plasma pulse has crossed the magnetic separatrix, it travels mainly parallel to the magnetic field lines and ends up hitting the divertor plate.
Most of the studies are focused on the problem of the transition between a hot plasma and a material surface. The effects caused by the wall erosion represent the boundary conditions in regions of plasma-surface interaction and the limiting expressions for the parallel heat flux and viscosity. The formulation of boundary conditions (BCs) and their time dependence is an interesting and important task for plasma edge studies.
The aim of this work is to derive time-dependent BCs at the PWT of Type I ELMs state from the kinetic simulation in ITER tokamak. This contribution describes the first results of efforts to address this issue for ITER simulations under high performance conditions using the 1D3V electrostatic parallel Particle-in-Cell (PIC) code BIT1 [2]. As a first approximation plasmasurface interaction processes are not included in this model. The burning plasma conditions correspond to the ITER Q = 10, 15 MA baseline at q95 = 3, for which the poloidal length of the 1D SOL is 20 m from inner to outer target. Typical upstream separatrix parameters of ne ~ 3 - 5 1e^19 m^-3, Te ~ 100 - 150 eV and Ti ~ 200 - 300 eV are assumed. Inclined magnetic fields at the targets of (~5°) are included, as are the particle collisions, with a total of 3.4. 10^5 poloidal grid cells giving shortening factors of 20. Secondary electron emission at the tungsten targets is neglected. In the first instance, a SOL flux tube just outside the separatrix is considered. A typical simulation requires up to 60 days running massively parallel 11522304 cores of the EU Marconi super-computer. The duration of the ELM pulse is taken to be between 100-200 μs. In a later stage of the work, these will be used as boundary conditions for calculations of ELM target heat loads using the SOLPS-ITER [3]code.

References

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Presenter: VASILESKA, I. (EPS 2019)

Session Classification: Poster P5