Speed-up of SOLPS-ITER code for tokamak edge modeling

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Understanding of edge plasma performance and divertor exhaust is crucial for operation of ITER and other tokamaks. Traditionally this is done by transport codes like SOLPS and others, based on Braginskii model for parallel transport, experimentally based description of anomalous transport and Monte-Carlo model for neutral transport. In the early versions of SOLPS self-consistent electric fields, drifts and currents were ignored. These effects were introduced into the version which is known as SOLPS5.0 [1]. The physics of the edge plasma with drifts is treated much better by the new version, however one has to pay price by slower convergence of the code. Later modifications - SOLPS5.2 [2] and its upgrade by the ITER Organization to form a new package, SOLPS-ITER [3] still exhibit slow convergence.

Account of drifts and currents dramatically decreases the accessible time step for the integration of time dependent equations of the code. Running the code with sophisticated EIRENE Monte-Carlo model for neutrals and large number of fluid equations for multiple ion species makes the computation time unacceptably long.

In the present paper the mechanisms leading to the time step limitations in SOLPS-ITER are analyzed as well as the ways to relax these limitations. The numerical instability driven by drifts is associated with poloidal redistribution of particles inside the separatrix by *ExB* drift in combination with modification of the radial electric field by diamagnetic currents. It can be overcome by implementation of one of two algorithms. The first method uses artificial slowing down of poloidal density and temperatures redistribution. In the second method equations are modified to get faster convergence to a solution close to the true one, which then is used as an initial approximation for convergence to the true solution. Application of these schemes decreases the time of convergence for a steady state solution by more than an order of magnitude. Ways to improve convergence by introducing artificial particle sources and artificial rise of time derivatives are also suggested.

[1] Rozhansky V. et al., Nucl. Fusion **41** (2001) 387

[2] Rozhansky et al., Nucl. Fusion **49** (2009) 025007

[3] S. Wiesen et al., J. Nucl. Mater.**463** (2015) 480