Adaptive meshless free-boundary non-linear simulation of tokamak plasma disruptions with DSC*

S.A. Galkin**, J.E. Grubert, V.A. Svidzinski (FAR-TECH, Inc.), A.A Martynov, S.Yu. Medvedev (KIAM), L.E. Zakharov (PPPL)

Instability of plasma column placed inside a conductive vessel and separated from the wall structures by a vacuum region, is a problem with free moving plasma boundary carrying surface current. The surface current may play crucial role in the plasma column dynamics and interaction with the wall during the disruption event in tokamak. Accurate adaptive moving boundary presentation as well as the surface current resolution is a key point in such simulations. The Disruption Simulation Code (DSC) was developed to conduct such kind of free-boundary ideal one-fluid MHD simulations and was initially implemented in 2D (helical symmetry) with all basic components of the full 3D version. Vacuum fields, the plasma surface and wall currents are calculated using both Green's functions and Poisson equation methods. Adaptive meshless cloud of computational points is the basis to approximate differential operators. Both almost pure Lagrangian treatment of moving boundary (with relocation of points along the boundary only) and mixed Lagrangian-Eulerian adaptation scheme for plasma and vacuum regions used in the code had allowed us to simulate non-linear stage of the sausage (m=0) and kink (m/n=2/1) modes instabilities successfully. More complex Lagrangian-Eulerian adaptation scheme brings us to the general problem of moving boundary adaptation, which is well-known difficult problem for adaptive grid generators. We will address possible meshless adaptation schemes applicable to the problem. Progress on development of the 3D version of the DSC will be presented also. Fully developed adaptive DSC can be a comprehensive computational tool to address MHD issues of prediction and mitigation schemes of plasma disruption events in large existing tokamaks and ITER.

*Work is supported by the US DOE SBIR grant
**E-mail: galkin@far-tech.com