Overview of Framework Application for Core-Edge Transport Simulations (FACETS)

S.E. Kruger[1], J.R. Cary[1], A. Pletzer[1], R. Cohen[2], T. Rognlien[2], D.M. McCune[3], S. Krasheninnikov[4], J. Larson[5], L. McInnes[5], D. Estep[6], A.D. Malony[7], P.H. Worley[8], R. Bramley[9], D. Keyes[10]

1) Tech-X Corp., 2) LLNL, 3) PPPL, 4) UCSD, 5) ANL,
6) Colorado State Univ., 7) ParaTools, Inc. 8) ORNL,
9) Indiana Univ., 10) Columbia Univ.

The Framework Application for Core-Edge Transport Simulations (FACETS) will develop a parallel framework for multiphysics computations with early application to whole-device modeling in the form of a coupled core-edge-wall transport application. The problem of coupled core-edge transport simulations exemplifies the multiphysics challenges faced by the fusion program. The core and edge regions are very different in their spatial and temporal scales. Core plasma transport is dominated by turbulence with relatively short spatial scales. This transport can be summarized in terms of surface fluxes for the basic moments (densities, temperatures, and momenta) and so is essentially one-dimensional (radial). On the open field lines, which contact material walls, perpendicular and parallel transport compete, so that edge transport is two-dimensional and essentially kinetic. Thus, whole-device modeling requires the development of a multiphysics application able to use different computational approaches in different regions of the plasma.

FACETS will be targeted at modeling the International Thermonuclear Experimental Reactor (ITER), the next-step fusion plasma experiment [1]. FACETS will follow the development model of evolutionary delivery, in which an initial prototype subset of the software is built and tested, and then features are added or refined with successive versions. The initial subset will be global simulation by coupling core and edge computations at a surface where both approaches are valid. This first task should reveal the main issues of building a parallel, multiphysics application. Subsequent versions will incorporate additional physics including more dynamic interactions with walls and coupling to near- first-principles models of turbulent transport in the core and edge. The result will be a major stepping stone toward the goal of full-physics whole-device integrated simulation of tokamaks.

Here we present an overview and initial progress in development of FACETS.