International Collaborative Initiative for RF Simulation Models in support of ITER and the ITER Integrated Modeling Program

C. K. Phillips[1]and P. T. Bonoli [2], L. A. Berry[3], N. Bertelli[1], D. D'Ippolito[4], D. L. Green[5], R.W. Harvey[5], E. F. Jaeger[3], J. Myra[4], M. Porkolab[2], S. Shiraiwa[2], D.N. Smithe[5], E. J. Valeo[1], and J. C. Wright[2]

[1]PPPL, [2]MIT, [3]XCEL Engineering, [4]Lodestar, [5]ORNL, [6]CompX, [7]TechX

Proposal: The US fusion program should expand its RF physics modeling program to focus on the development, validation and implementation of various RF modules (ICRF, ECCD and LHCD) in the ITER Integrated Modeling infrastructure. This modeling will be needed for the planning of ITER scenarios as well as the single- and multi-time slice analysis of the ITER discharges. By coordinating our efforts with the ITER Organization as well as our colleagues in the EU and Asia, the US will help mount a unified international effort that would best support the physics needs of the ITER physics program.

Background: Over the past decade or more, the USDOE has invested more than $1M per year on the development of a range of detailed ICRF and lower hybrid simulation packages, with some more recent work on ECCD codes and NTM stabilization. Consequently, the US now has a significant number of the most advanced RF simulation tools in the world. These include a first ever ICRF antenna coupling model with RF sheath boundary conditions and 3D solid geometry for modeling RF losses in the SOL; an all-orders full-wave ICRF solver self-consistently coupled to a continuum Fokker Planck code, including finite ion orbit width effects, for modeling RF modifications of fast ion distributions for possible stabilization of energetic particle modes; and suite of full-wave LH field solvers self-consistently coupled to Fokker Planck codes for evolving nonthermal electron distributions.

Project Overview: Based on past experience with the C-Mod, NSTX, DIII-D and TFTR programs, this effort will require (1) refinement of the physics in the codes to specifically address physics issues of importance to ITER, such as power losses in the wide gap between the separatrix and the antenna structure, RF modifications of the plasma evolution due to interactions with fast ion populations, and RF plasma profile control both in non-reactive start-up phases and in the presence of large fusion alpha power production; (2) continuing validation of RF codes against existing experimental measurements to insure that the necessary underlying physical processes are accurately modeled; (3) transformation of developer's codes into user-friendly robust modules and subsequent technical support for stand-alone studies by the community at large and in the ITER Integrated Modeling simulation infrastructure for scenario planning and analysis of actual ITER discharges. This effort would require a moderate increase in funding levels beyond those currently in the program in order to focus on the ITER-specific physics issues and code modifications described above, as well as to coordinate efforts with our EU and Asian colleagues.

Connections to other ongoing and proposed fusion program elements: This program element would provide advanced RF models that could support proposals by R.R. Parker et al; R. Prater; and L.R. Baylor et al., as well as the US experimental program in RF applications and studies for the FNSF.

Responsive to Greenwald 2007 report: Scientific work relevant to many identified gaps in Chapter 4, including gaps in 4.b.2; 4.b.3; 4.b.6 (a, b, e); 4.b.8 (d); and Major Gaps G-4, G-7, G-9.