DATA MANAGEMENT, CODE DEPLOYMENT, AND SCIENTIFIC VISUALIZATION TO ENHANCE SCIENCE DISCOVERY THROUGH ADVANCED COMPUTING*

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The USDOE/OFES supported Plasma Science Advanced Computing Initiative (PSACI) is designed to revolutionize fusion research by greatly enhancing simulation and modeling capabilities made accessible by terascale computing. These advanced computational resources aim to improve fusion research by improving scientific understanding of experimental data, by stimulating new theories, and by providing better designs for future facilities. The power of advanced computing to solve critical plasma science problems can be fully exploited only if a capable infrastructure is established and effective software tools are made available. This infrastructure includes establishing standardized data structures and access methods, synthetic diagnostics, standard analysis and visualization utilities, and common code interfaces. Work to date has included support of two PSACI pilot programs: Macroscopic Modeling and Microturbulence Simulation of fusion plasmas. Specifically, MDSplus has been utilized to provide a standard interface to simulation data from NIMROD, M3D, and GS2. Tools have been created in IDL to act as both synthetic diagnostics and to provide interactive scientific visualization for these simulation codes.

Going beyond the PSACI pilot projects is the design of a National (U.S.) Fusion Collaboratory to transform fusion research and accelerate scientific understanding and innovation so as to revolutionize the design of a fusion energy source. The vision can be realized through the creation and deployment of collaborative software tools that will enable more efficient utilization of existing experimental facilities and more effective integration of experiment, theory, and modeling. These tools will link together the large United States magnetic fusion research community that is spread over more than 40 sites in 37 states, enabling networked real–time data analysis and instantaneous communication amongst geographically dispersed teams of experimentalists and theoreticians. Such a collaboratory represents a dramatic shift for the fusion community where access to resources (data, codes, visualization tools) would be separated from details of their implementation, eliminating barriers to their widespread use by the research community. Built on a foundation of established computer science toolkits, successful deployment of the Collaboratory will nevertheless require significant computer science research to extend the toolkits beyond their present capabilities. The computer science research necessary to create the collaboratory is centered on three main activities: security, remote and distributed computing, and scientific visualization. This paper will present the work done under PSACI and the design of the National Fusion Collaboratory including a discussion on the computer science research required to make the Collaboratory a success.

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Topic: Techniques for remote participation