National Fusion Collaboratory – *"Advancing the Science of Fusion Research"*

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Summary

The National Fusion Collaboratory is developing a persistent infrastructure to enable scientific collaboration for all aspects of magnetic fusion energy research. Specifically, the project is creating a robust, user-friendly collaborative software environment and deploying this to the more than one thousand fusion scientists in forty institutions who perform magnetic fusion research in the United States. This activity is transforming the way fusion does business: existing experimental facilities are being used more efficiently; experiment, theory, and simulation are effectively integrating; our infrastructure is ultimately accelerating understanding and innovation towards the design of an attractive new fusion energy source.

The long–term goal of Fusion Energy Science (FES) research is to develop a reliable energy system that is economically and environmentally sustainable. In the U.S., FES experimental research is centered at three large facilities with a present day replacement value of over $1B. As these experiments have increased in size and complexity there has been a concurrent growth in the number and importance of collaborations among large groups at the experimental sites and smaller groups located nationwide. Teaming with the experimental community is a theoretical and simulation community whose efforts range from the applied analysis of experimental data to fundamental theory (e.g. creation of realistic non–linear 3D plasma models). As a result of the highly collaborative nature of FES research, the community is facing new and unique challenges.

The SciDAC funded National Fusion Collaboratory (NFC) Project unites fusion and computer science researchers to directly address these challenges by creating and deploying collaborative software tools. In particular, the NFC is developing and deploying a national FES "Grid" (FusionGrid or FG) that is a system for secure sharing of computation, visualization, and data resources over the Internet. The goal of FG is to allow scientists at remote sites to participate as fully in experiments and computational activities as if they were working at a common site thereby creating a virtual organization of the U.S. fusion community.

FusionGrid uses the Globus and Akenti toolkits, with appropriate modifications, to provide the necessary security of authentication, authorization and encryption. Extensions to these toolkits are being done in collaboration with other SciDAC computer science projects on data grids and group policy. The main data repositories at the three experimental facilities have been made securely accessible via FG. The first fusion code placed on FG was TRANSP, a widely used system for simulation of fusion experiments. Scientists recently used the FG

TRANSP to perform over 300 simulations spanning 5 different experimental fusion devices. The scientists were able to perform significantly more calculations, and therefore make more rapid progress than prior to the deployment of FG. These scientific results were presented at the recent American Physical Society Division of Plasma Physics meeting (APS).

Future work on FG includes adding a number of new scientific codes, including one from the SciDAC Microturbulence project, thereby increasing the breadth of science and the number of researchers benefiting from this new capability. Additionally, quality–of–service issues are being addressed so that FG can meet the near–real–time requirements of some FES data analysis. Finally, to expand the usage scenarios of FG, significantly finer grain authorization capabilities are being investigated.

The demand placed on visualization tools by the NFC is intense, because of the highly collaborative nature of fusion research and the dramatic increase in data resulting from the enhanced computational capabilities. To meet this demand, the NFC has extended the SCIRun problem solving environment for 3D visualization of fusion data. SCIRun software has been released and is currently being used by the SciDAC Macrostability project to produce still and animated scientific visualizations that were presented at the APS meeting.

The NFC is also developing a collaborative fusion experimental control room. Access Grid (AG) technology, used worldwide to support remote distributed meetings utilizing audio, video, and shared applications such as PowerPoint, has been extended to include the ability to share complex visualizations between two large tiled display walls. Additionally, small–scale AG nodes have been developed for usage by small research groups. This new collaborative control room technology will be tested during fusion experiments early in CY 2003. Feedback from these tests will be used to make the collaborative control room a production system.

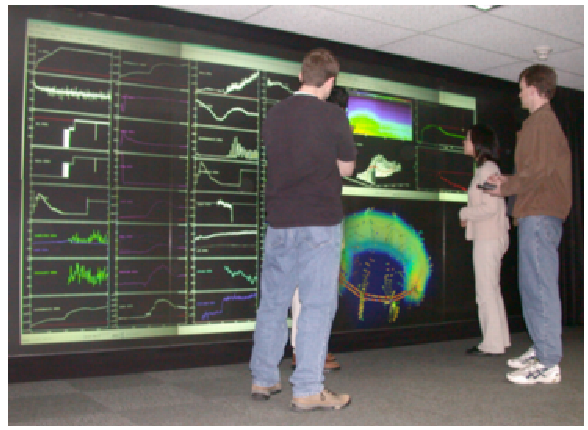

Figure 1. Tiled display walls with shared visualizations and communication are being prototyped for a collaborative fusion experimental control room.

The collaborative technology being deployed by the NFC is scalable to fusion research well beyond the present U.S. program. The goal of the proposed Fusion Simulation Project (FSP) is the fully predictive capability of fusion–relevant plasmas, an effort that will require uniting theorist and simulation scientists into a unified research team. Experimentally, the world fusion community is moving towards building one next generation experimental device (ITER). Key to the success of such efforts is collaborative technology like that being developed by the NFC.

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