National Fusion Collaboratory — Advancing the Science of Fusion Research

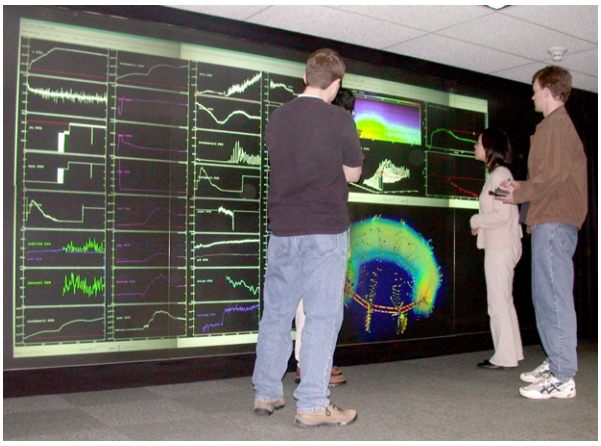
The National Fusion Collaboratory is developing a persistent infrastructure to enable scientific collaboration for all aspects of magnetic fusion energy research by creating a robust, user-friendly collaborative software environment and deploying this to the more than one thousand fusion scientists in forty institutions who perform magnetic fusion research in the U.S.

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 nonlinear 3-D plasma models). As a result of the highly collaborative nature of FES research, the community is facing new and unique challenges.

The USDOE 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) that is a system for secure sharing of computation, visualization, and data resources over the Internet. In such an environment, these resources become computer network accessible services, shielding the scientific user from the implementation details and allowing them to concentrate on the science. The ultimate goal of FusionGrid 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 thus creating a virtual organization of the U.S. fusion community.

The main data repositories at the three experimental facilities have been made securely accessible via FusionGrid. Additionally, the first fusion code placed on FusionGrid TRANSP, a widely used system for simulation of fusion experiments, has performed over 1,500 simulations taking over 10,000 CPU hours for nine different experimental fusion devices. Scientists are able to perform significantly more calculations, and therefore make more rapid progress than prior to the deployment of FusionGrid. Recently made securely available on FusionGrid is the simulation code GS2 that is used to study low-frequency turbulence in magnetized plasmas. Scientific results utilizing FusionGrid are being presented at this years American Physical Society Division of Plasma Physics meeting (APS).

The scientific visualization component of FusionGrid includes the creation of a collaborative fusion experimental control room. Access Grid 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 scientific visualizations. This technology is being installed in fusion experimental control rooms to allow scientists across the U.S. to contribute their data analysis and be involved in the real time decision making of experimental fusion operations. Large scale tiled display wall technology is also being deployed for experimental operations to facilitate collaboration within the control room as well with the off-site scientific team.



Tiled display walls with shared visualizations and communication are being installed to create collaborative fusion experimental control rooms.

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 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 magnetic fusion community is moving towards building the first burning plasma experiment (ITER). Key to the success of such efforts is collaborative technology like that being developed by the NFC.

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