Advances in the Real-Time Interpretation of Fusion Experiments*

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Developing a reliable energy system that is economically sustainable and environmentally attractive is the long-term goal of Fusion Energy Sciences research. The leading candidate for magnetically confining fusion plasmas is the tokamak, a doughnut-shaped vessel in which a strong, helical magnetic field guides the charged particles around it. In the U.S., FES experimental research is centered at three large facilities with a replacement value of over $1B. One goal of the SciDAC funded National Fusion Collaboratory Project is to enable more efficient utilization of experimental time on these three large facilities through more powerful between pulse data analysis and enhanced scientific collaboration resulting in a greater number of experiments at less cost. This goal is being realized through the development and deployment of the Collaborative Control Room that requires (1) secured computational services that can be scheduled as required, (2) the ability to rapidly compare experimental data with simulation results, (3) a means to easily share individual results with the group by moving application windows to a shared display, and (4) the ability for remote scientists to be fully engaged in experimental operations through shared audio, video, and applications. The capabilities of the Collaborative Control Room were first demonstrated at SC03 where offsite collaborators (in Phoenix) joined in a mockup of a DIII–D experiment located in San Diego. Access Grid technology allowed for shared audio and video as well as shared applications. The offsite collaborators could hear DIII–D announcements and see via a web interface the state of the pulse cycle, the status of data acquisition, and the state of between pulse data analysis. The fusion visualization application ReviewPlus was shared between the two sites allowing for joint scientific exploration. Between pulse data analysis of the plasma shape (EFIT running at PPPL) was conducted on FusionGrid through a computational reservation system that guaranteed a specific analysis to be completed within a set time window. Additionally, the TRANSP computational service was run at PPPL for the first time between pulses giving scientists data that was previously only available after the experimental day had ended. The offsite team was able to collaborate more efficiently amongst themselves by being able to share their personal display with the room's shared display. This capability allowed visualizations to be efficiently compared side-to-side for debate before reporting results back to the DIII–D control room. Since that first demonstration, components of the Collaborative Control room have been used to enhance utilization of experimental run time on the main U.S. experimental facilities as well as those in England, France, Germany, and Japan. Although significant progress has been made, more work is required on ease-of-use and efficiency so that these technologies become ubiquitous within the fusion community. Issues such as the interplay of grid and site security, the efficiency of high-resolution visualization sharing, large-scale simulation data storage, and the seamless integration of analysis tools with remote collaboration tools have been identified as needing more work and are now in the NFC Project's work plan. Our long-term vision is that the collaborative technology being deployed is scalable to fusion research beyond the present programs, in particular to the design, construction, and operation of the ITER experiment that will require extensive collaboration capabilities worldwide. The poster will present results as well as discuss future work.

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