

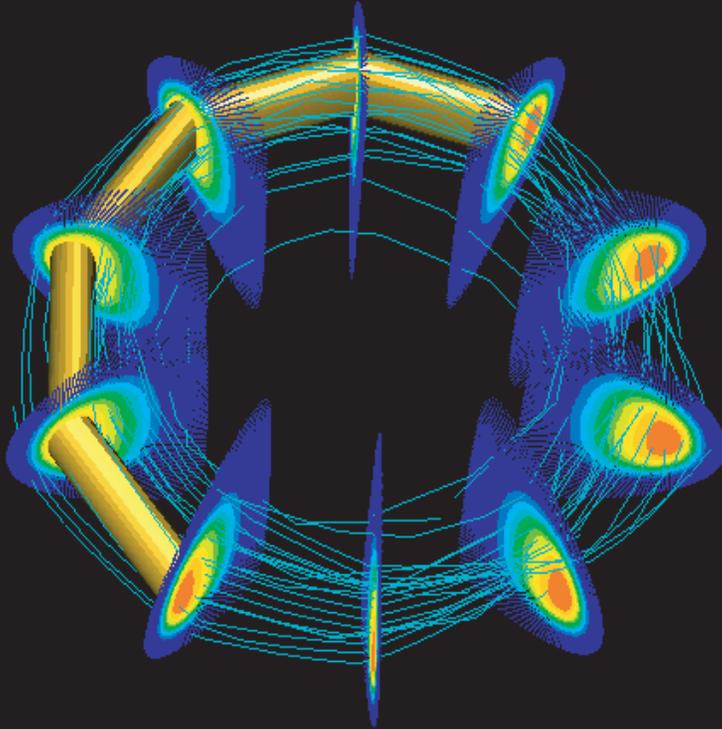
WORK DONE IN THE USDOE SciDAC FUNDED NATIONAL FUSION COLLABORATORY

Presented by David P. Schissel

Presented at the
2nd Workshop on Advanced
Collaborative Environments

July 26, 2002
Edinburgh, United Kingdom

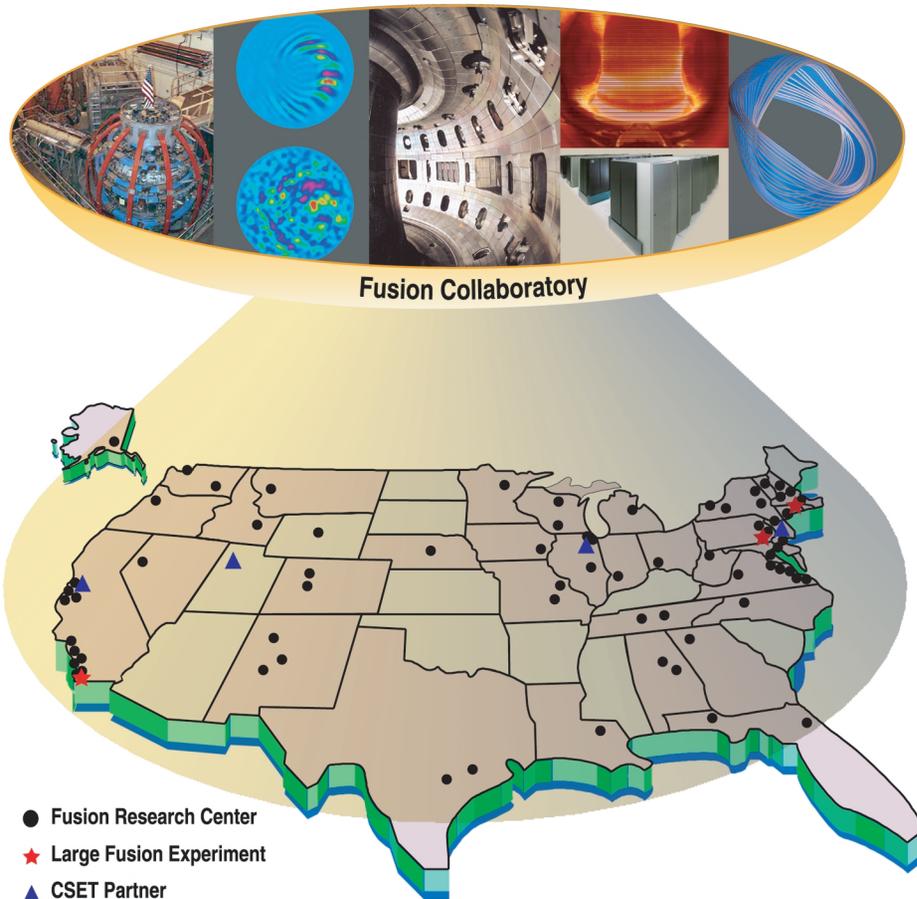
<http://www.fusiongrid.org>
funded by the USDOE SciDAC Program



*NIMROD simulated pressure stored
in MDSplus and visualized with SciRUN*

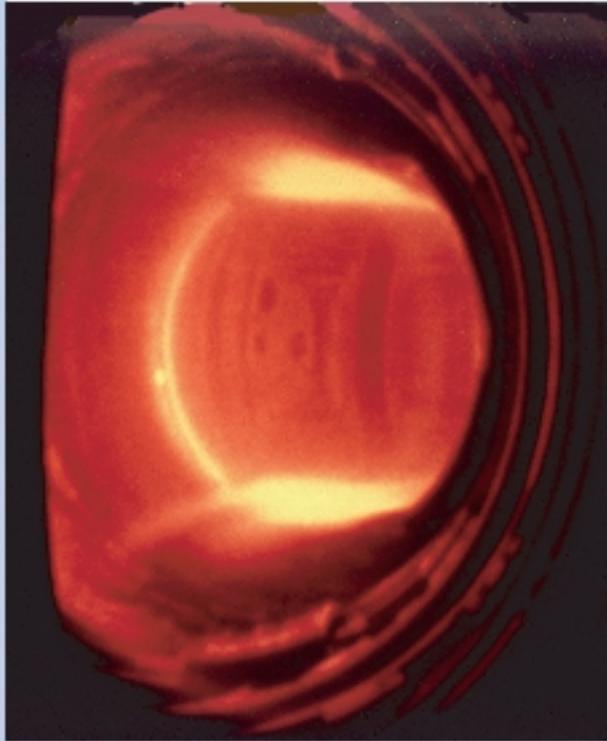


THE COLLABORATORY WILL EMBRACE 40 US SITES IN 37 STATES



- The Collaboratory is being created by a diverse team
 - 3 large fusion experiments
 - * C-Mod, DIII-D, NSTX
 - 4 computer science centers
 - * ANL, LBNL, Princeton U., U. of Utah
- Coordinated with the user community
 - Main experimental sites
 - Theory & simulation community
- 3 year (FY02-04) costing \$5.4 million funded by OASCR SciDAC
 - 2/3 CSET and 1/3 Fusion
 - For software, not hardware

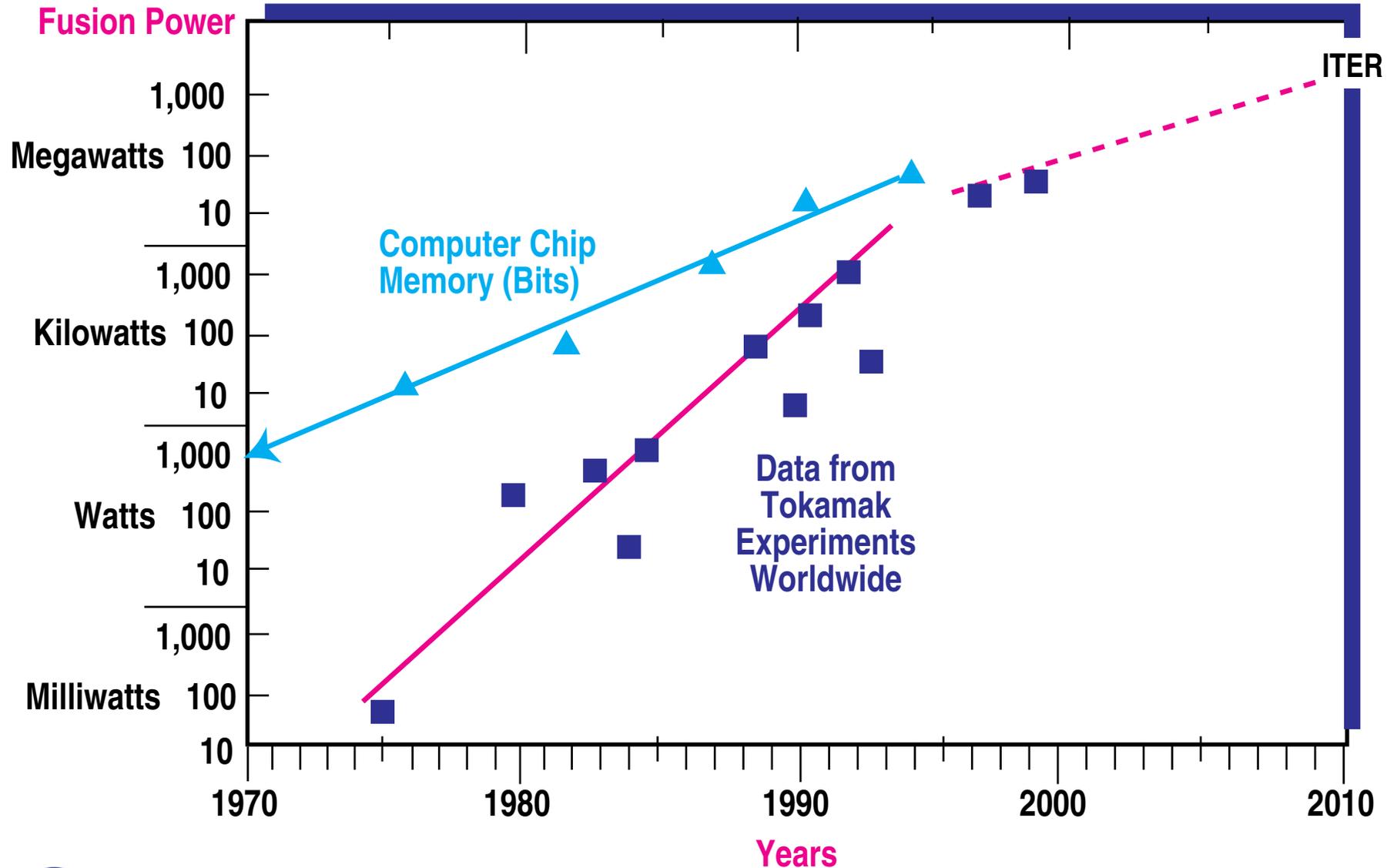
FUSION REPRESENTS A NEARLY INEXHAUSTIBLE ENERGY SOURCE



- Fusion: the joining of two light nuclei releasing energy ($E=mc^2$)
 - Pickup truck of fusion fuel = 21,000 railcars of coal
- Like charges repel so fusion requires high temperature (velocity)
- High temperature rips the electrons away – plasma
- Long term goal – develop reliable energy system that is environmentally and economically sustainable

PROGRESS IN MAGNETIC FUSION RESEARCH

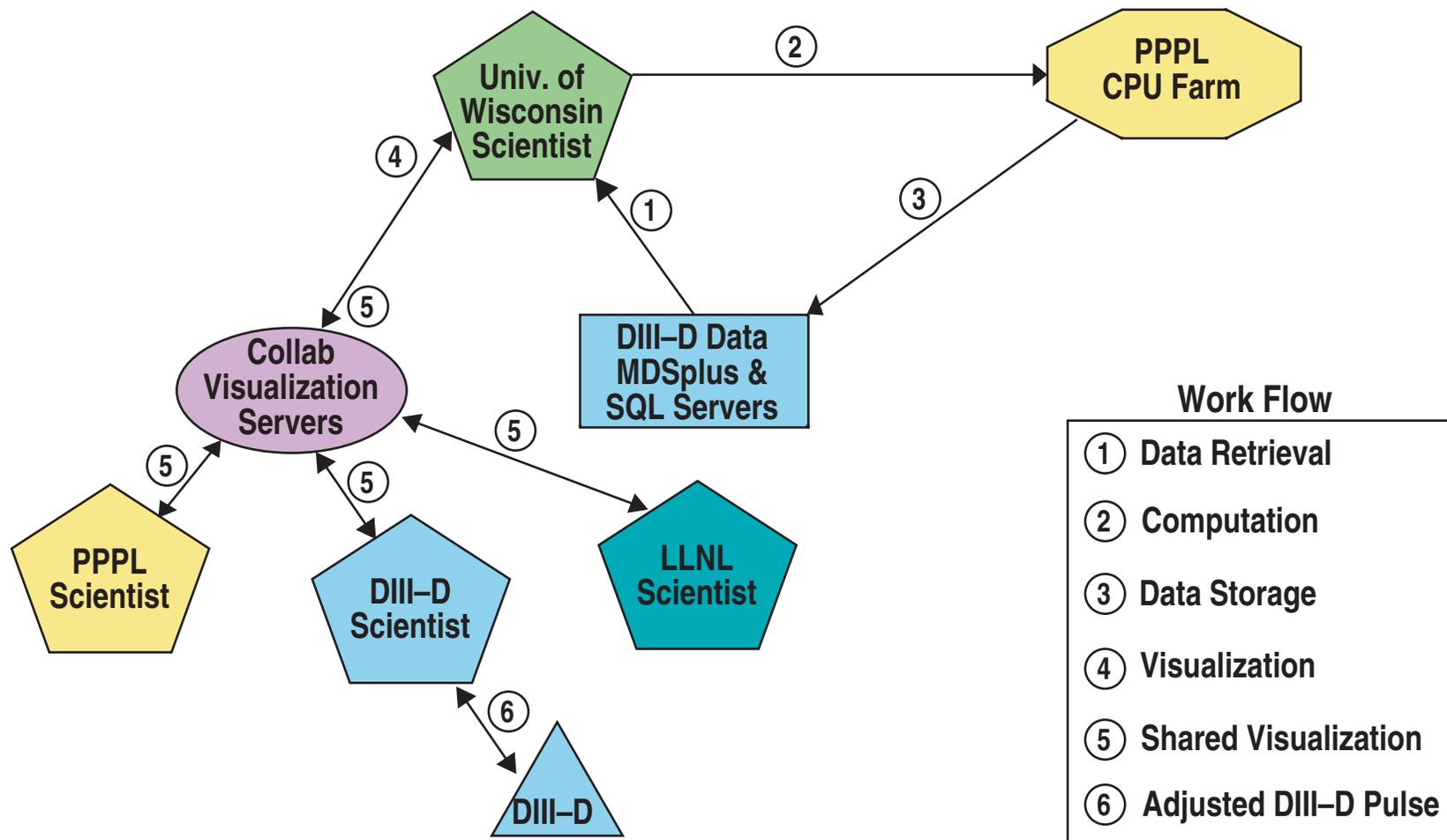
FUSION POWER FROM MICROWATTS TO MEGAWATTS



THE NFC PROJECT IS CREATING & DEPLOYING COLLABORATIVE SOFTWARE TOOLS FOR THE FUSION COMMUNITY

- **Create transparent and secure access to local/remote computation, visualization, and data servers**
- **Develop collaborative visualization that allows interactive sharing of graphical images among control room display devices, meeting room displays, and with offices over a wide area network**
 - 3 large fusion machines, ~\$1B replacement value, “Radical Collocation”
 - ~40 research sites in the US, ~1500 scientists
- **Enable real-time access to high-powered remote computational services allowing such capabilities as between pulse analysis of experimental data and advanced scientific simulations**
 - Experiments pulsed every ~20 minutes, time critical analysis
 - Can we do between pulses what today we do the next day?

EXAMPLE OF COLLABORATORY BENEFITS: ENHANCED EXPERIMENTAL OPERATIONS



THE COMPUTER SCIENCE RESEARCH NECESSARY TO CREATE THE COLLABORATORY IS CENTERED AROUND THREE AREAS

- **Security (Globus & Akenti)**
 - Valuable resources need to be protected: data, codes, & vis tools
 - Collaboratory will require authentication, authorization, and encryption
 - Fair use of shared resources
- **Remote and Distributed Computing (Globus, MDSplus)**
 - Share the community's computational resources
 - Job scheduling, monitoring, exception handling, and accounting
- **Scientific Visualization (SCIRun, AG nodes, Tiled Walls)**
 - Increased data quantities and ease of collaboration requires better visualization technology
 - Collaborative control rooms & meeting rooms, and enhanced vis tools

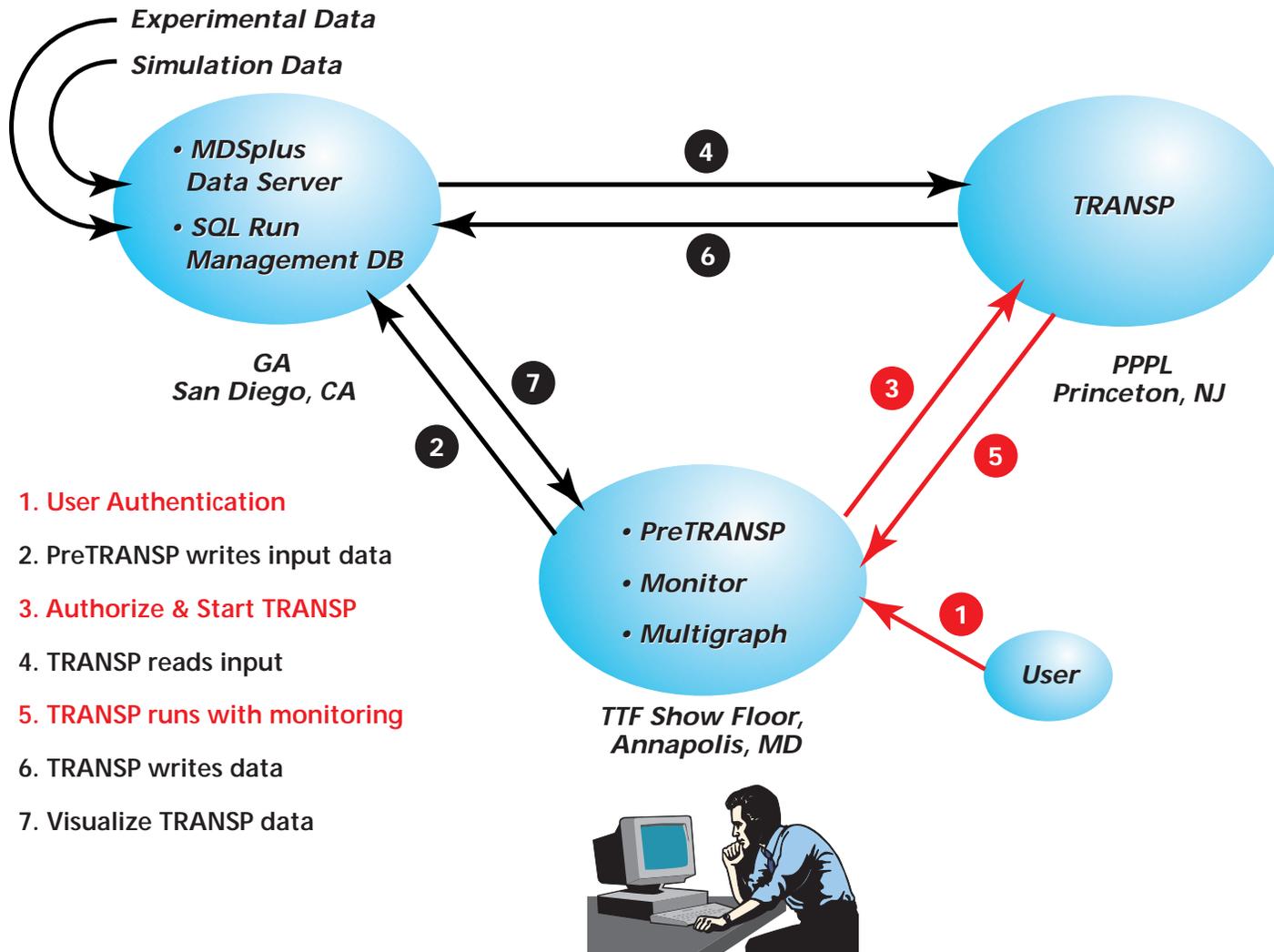
SUBSTANTIAL PROGRESS SINCE LAST WACE

- **Coupling of Akenti, Globus, and MDSplus for secure data access**
 - Fundamental requirement for success
 - Prototype demonstration at SC01
- **Demonstration at 2 major fusion science meetings**
 - Prototype of fusion analysis code as a network service
 - SCIRun coupled to MDSplus and visualizing 3D simulation data
 - Positive feedback and encouragement
- **Visualization demonstrations to fusion scientists**
 - Fusion AG node meeting
 - Shared visualization between tiled walls
 - Feedback folded in to work plan

SUBSTANTIAL SETUP FOR APRIL FUSION SCIENCE MEETINGS BUT THE EXERCISE PROVED VALUABLE

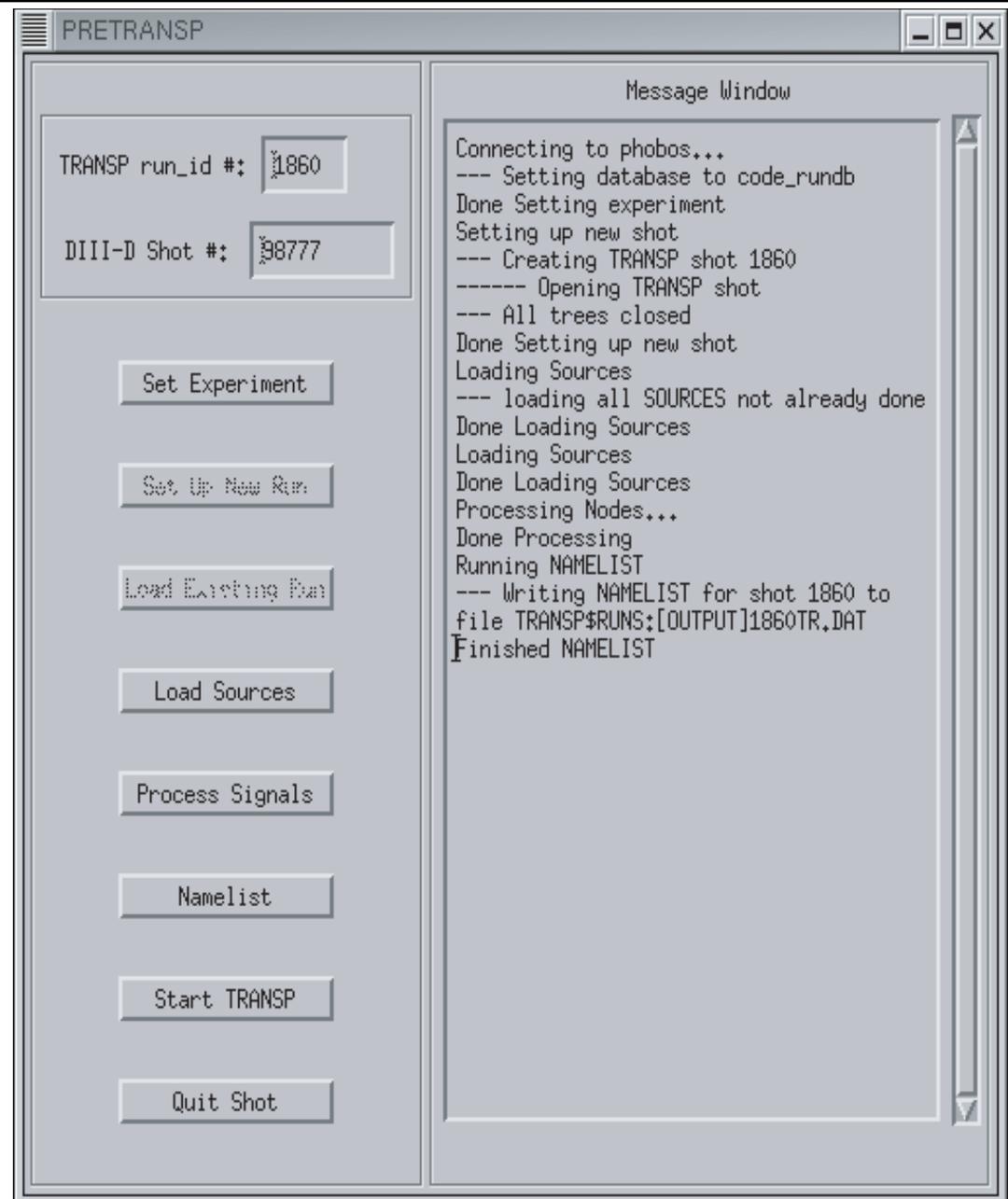


SUCCESSFULL DEMONSTRATION OF GRID COMPUTING AT APRIL FUSION SCIENCE MEETINGS



A GUI WAS CREATED TO SETUP AND LAUNCH A TRANSP RUN: WEB PORTAL CONCEPT BEING INVESTIGATED

- First log onto the Grid
- Prepare data for TRANSP run and store inputs in MDSplus
- Submit TRANSP run
- Monitor state of run
- TRANSP writes data to MDSplus
- Visualize TRANSP data

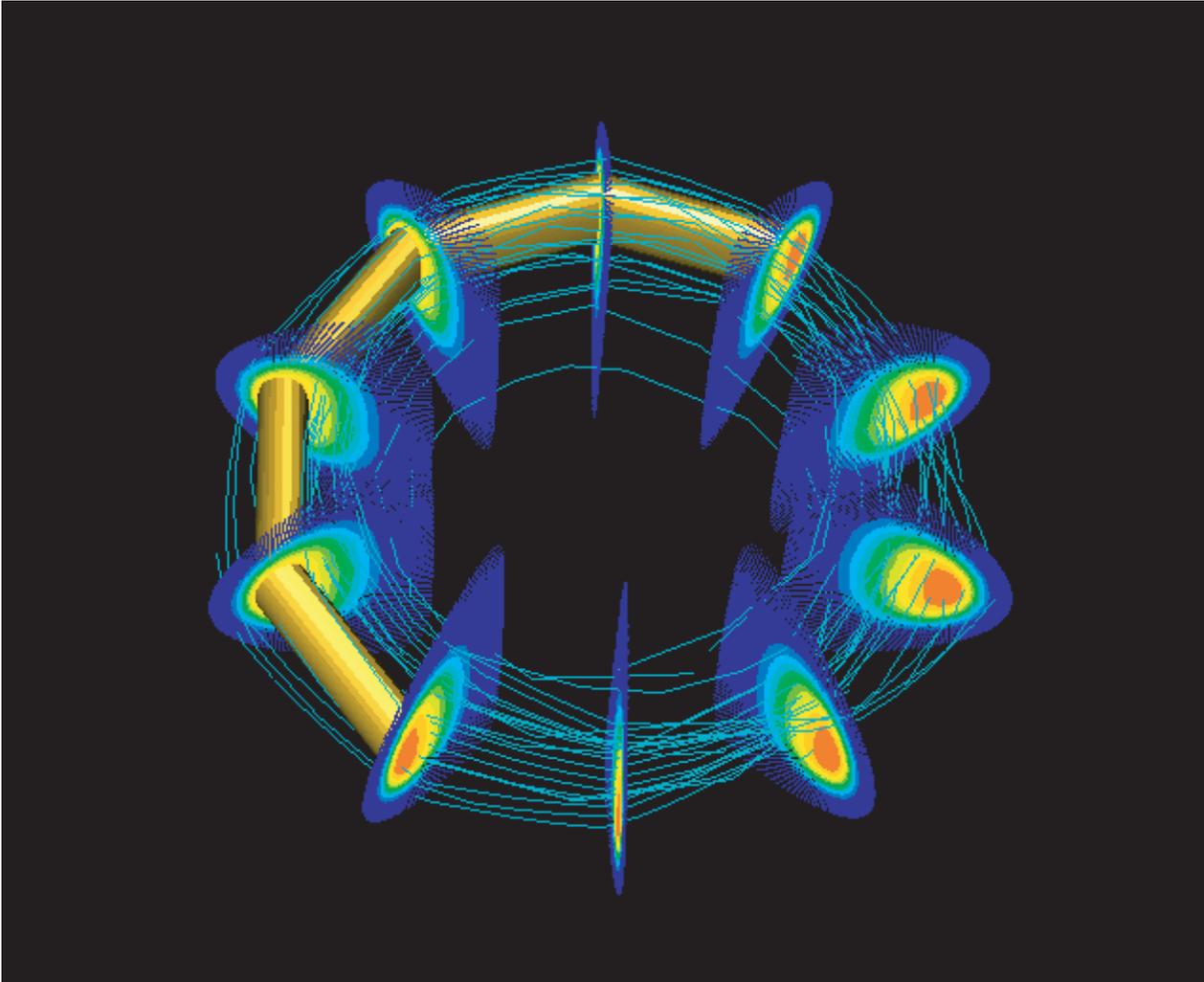


A VARIETY OF VISUALIZATION TOOLS BROUGHT THE DEMO ALIVE

- US map to visualize demo & make it real
- Monitor run via a web browser
- Visualize results using IDL based tool



SUCCESSFUL DEMONSTRATION OF ADVANCED VISUALIZATION AT APRIL FUSION SCIENCE MEETINGS



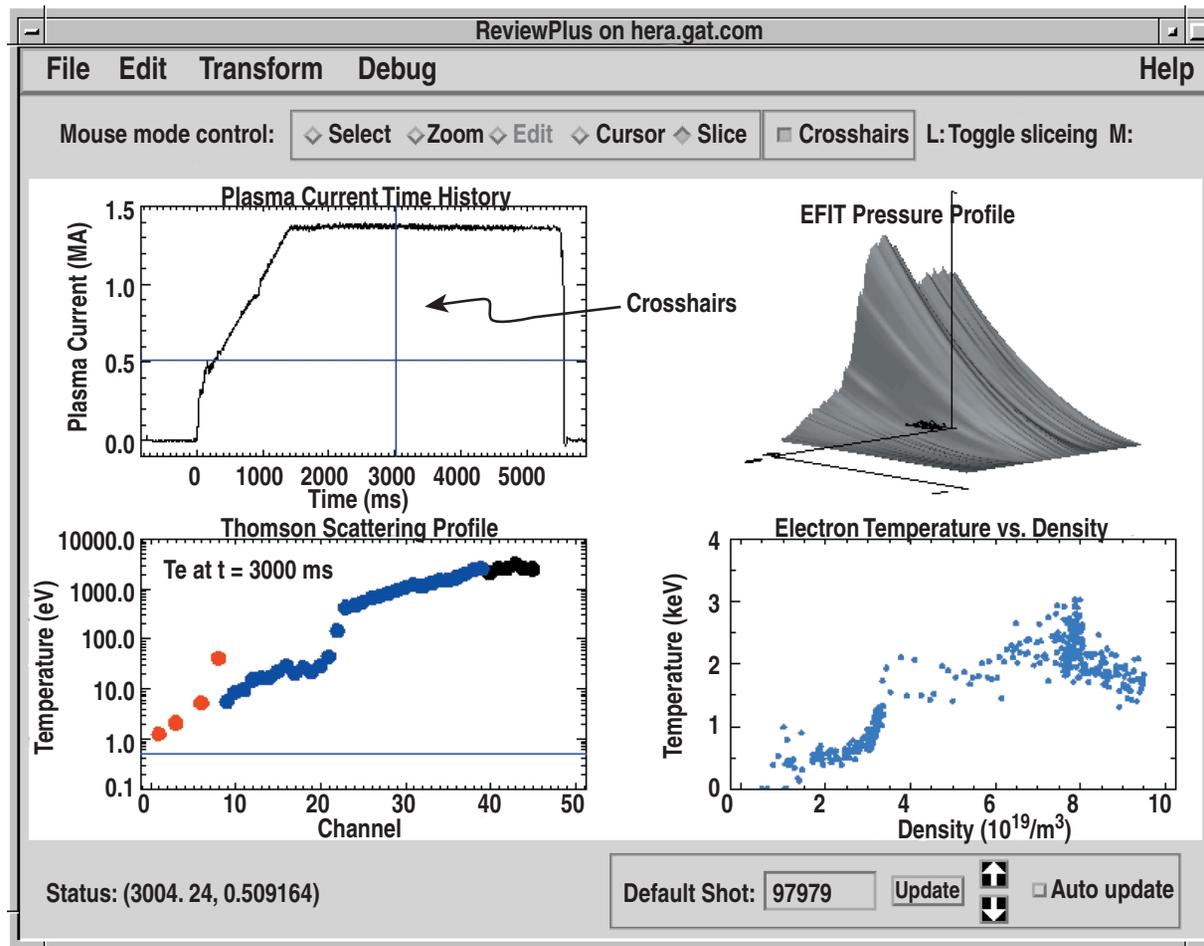
- **SCIRun adapted for Fusion**
 - Utah Imaging Institute
 - Open source, low cost & can be customized
- **NIMROD data from MDSplus**
 - Pushing MDSplus storage
 - Testing storage paradigm
- **Deployable hardware path**
 - Linux vis stations
 - Low cost (~\$2K)

TILED DISPLAYS WALLS ALLOW A LARGE GROUP OF SCIENTISTS TO EXPLORE INFORMATION IN COLLABORATION MORE EFFECTIVELY



- Access Grid (www.accessgrid.org) compliments and extends the data grid
 - Ensemble of network, computing and interaction resources that supports group to group collaboration and communication
- Display wall research has focused on low-cost commodity components

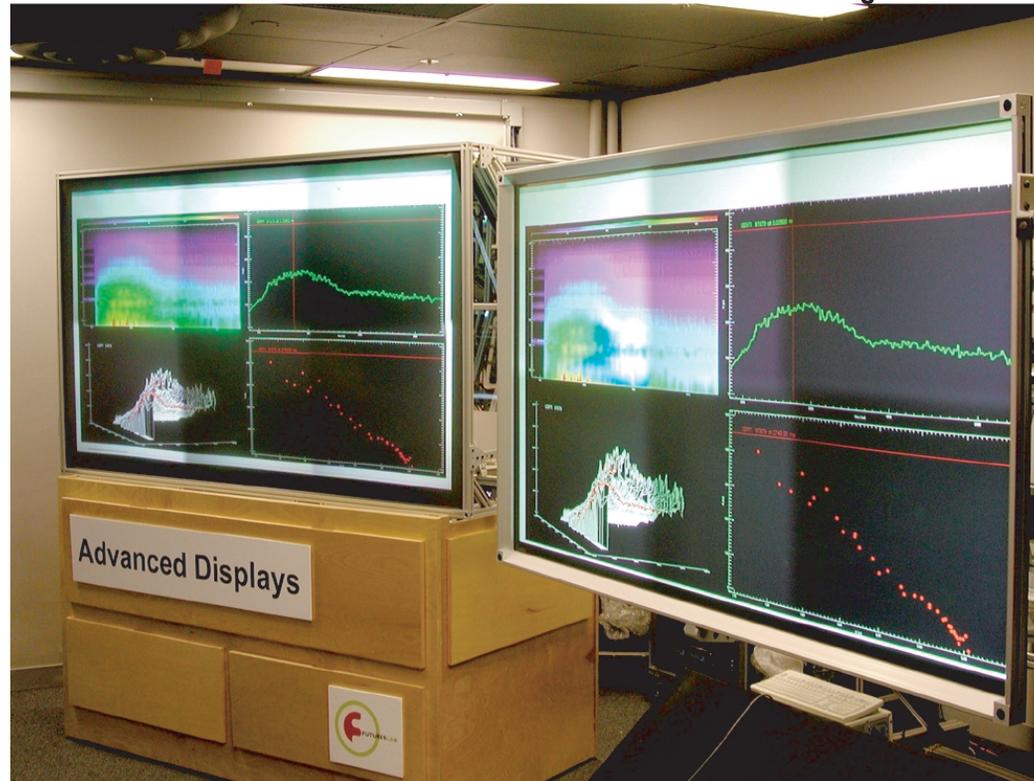
ReviewPlus: GENERAL IDL-BASED DATA VISUALIZATION TOOL DEVELOPED IN THE FUSION COMMUNITY



- Data combinations
- Overplotting
- Any Y versus any X
- Math functions
- 2D and 3D coupling
- Signal menu and web help
- Automatic updating

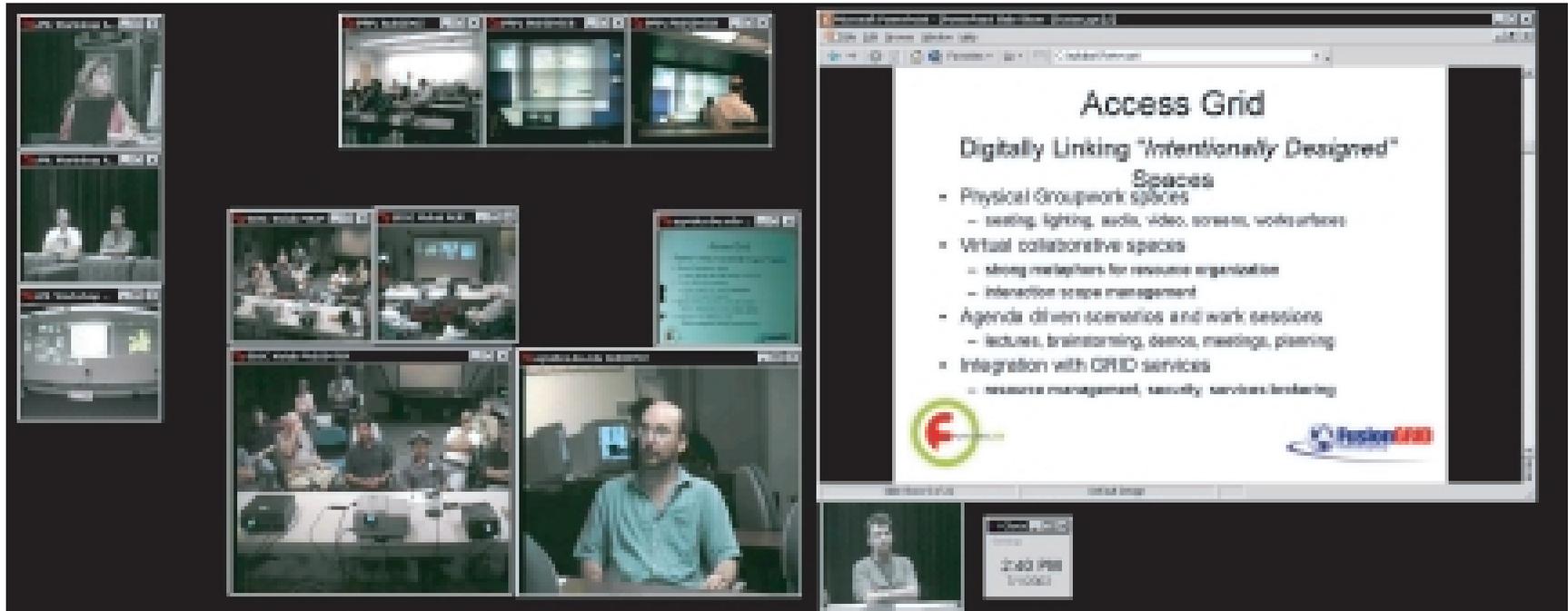
SHARED VISUALIZATION BETWEEN TILED WALLS HAS BEEN DEMONSTRATED

ANL using the IDL based tool ReviewPlus



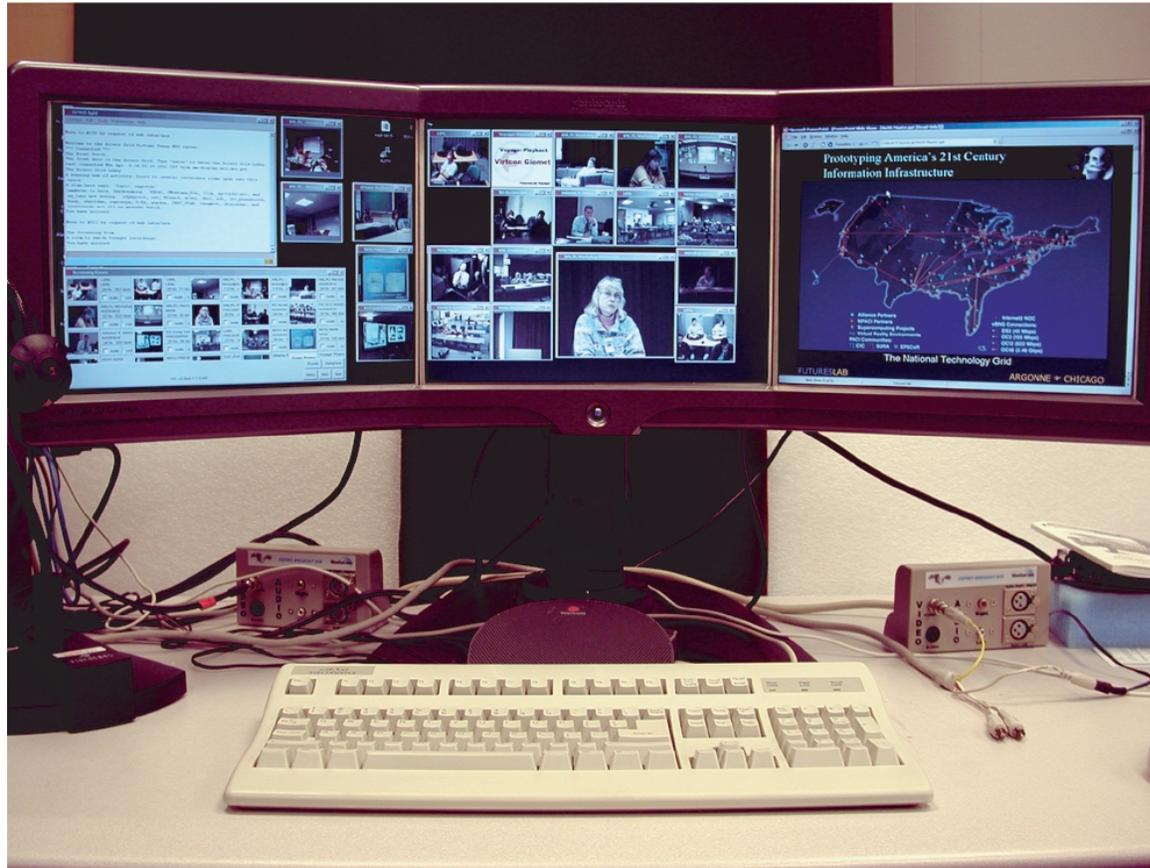
- Workstation to Wall and Wall to Wall is possible - communicate to the control room
- Demonstrated from ANL to DIII-D and PCS to PPPL with positive feedback

A DEMONSTRATION ACCESS GRID MEETING TOOK PLACE BETWEEN C-MOD, DIII-D, NSTX, AND ANL



- Wide variety of opinions on how the technology might be useful
 - PPPL has a large node, C-Mod & DIII-D will explore desktop nodes
- Need to have complex visualization available via the AG
- Interested in adopting security into our future AG usage

SMALL DESK TOP ACCESS GRID NODE HAS BEEN DEMONSTRATED



ANL

- Targeted for the small research center
 - For one to one and one to many interactions
- Usage example: communication to a tokamak control room

FEEDBACK FROM THE DEMONSTRATIONS

- **Experimentalists interested in a network code service like TRANSP**
 - Not as interesting to theorists who run large codes at NERSC
 - There is an international interest in this TRANSP service
 - Need a much better monitoring capability
- **Theory scientists very much interested in advanced visualization**
 - Cost of deployment a concern
- **Shared visualization for the control room very desirable**
 - Interaction modalities complicated, require work to understand
 - Interest in using for small meetings (true for theorists also)
- **Access Grid potentially very valuable – need to define usage scenarios**
 - Will have one large, two small nodes for testing
- **Firewall issues have the potential to stop our ability to deploy the Grid**
 - Need a unified plan to coordinate with site–security plans (ESNET)

FUTURE WORK

- **Site–security (Firewalls) limit our ability to deploy the Fusion Grid**
 - Globus needs non-deterministic ports for both client and server
 - Firewalls block ports, open only for certain Ips, NAT issues, SecureID
 - Working with the ESCC, the PPDG, and the DOE Science Grid
- **Policy Control: Authorization**
 - Integration of Globus and Akenti
 - Globus on Windows for secure access to SQL meta–data
- **Between tokamak pulse data processing**
 - Reliable, prioritization, pre–emption
- **Visualization**
 - Implement same security protocols as for TRANSP computing
 - Tiled Displays: AG nodes, enhanced remote visualization capability, shared work environments
 - SCIRun: 2D capability, enhanced fusion interface, RPM distribution, uncertainty visualization, remote visualization issues

NOVEMBER 2002 RELEASES TO GENERAL COMMUNITY

- **TRANSP service**
 - PreTRANSP GUI being finalized
 - Monitoring being modeled after Data Analysis Monitoring at DIII-D
- **SCIRun visualization tool**
 - For testing and feedback from scientists
- **Collaborative visualization in the control room**
 - Both shared visualization and the Access Grid
- **Security issues being discussed with ESNET community**
 - Motivating site–security and grid– computing groups to work together to find an agreeable solution
 - How can we integrate in our International partners' concern
- **November 2002 release coincides with APS/DPP meeting in Orlando, FL**
 - Robust software, easier to deploy

SUMMARY

- **A positive start to a 3–year project and acceptance by fusion scientists**
 - PSACI PAC, C–Mod & DIII–D new 5–year proposals
 - Substantial interest by the international fusion science community
- **Deployment of the production Fusion Grid services scheduled – November**
 - TRANSP computation service
 - Major MDSplus data repositories
 - SCIRun visualization tool released for detailed usage & feedback
 - Collaborative visualization tested late in control rooms
- **Further demonstrations on new capabilities at SC02**
 - A between pulse computation scenario
 - Enhancements to shared visualizations and the AG
- **More information at <http://www.fusiongrid.org/>**