

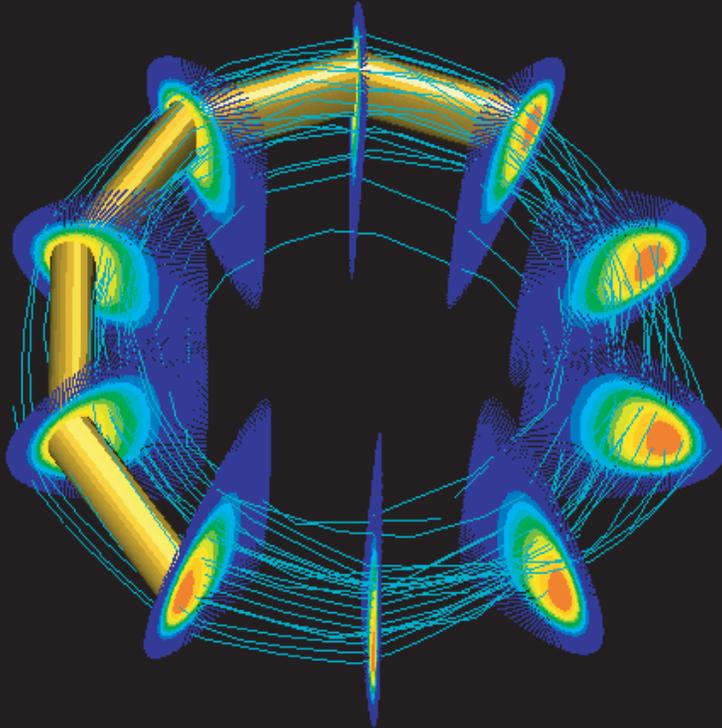
THE NATIONAL FUSION COLLABORATORY

Presented by David P. Schissel

Presented to
EFDA-JET Programme

July 19, 2002
Abingdon, United Kingdom

<http://www.fusiongrid.org>



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

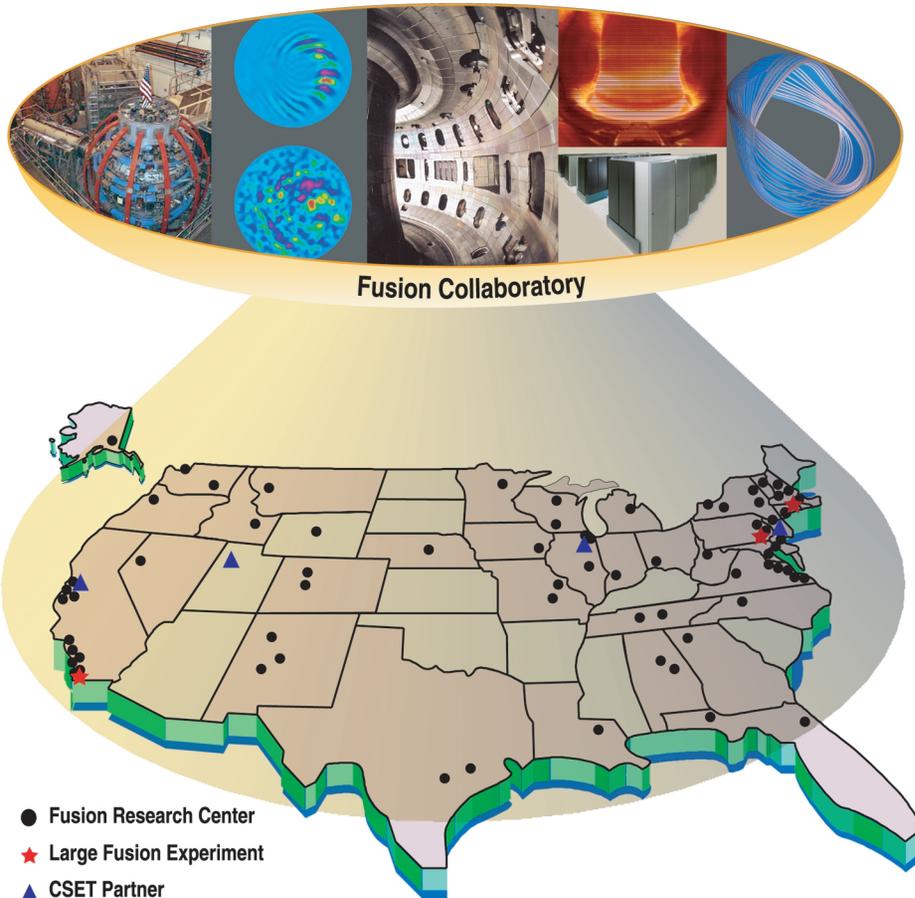


A NEW THREE YEAR PROJECT HAS STARTED TO CREATE A NATIONAL FUSION COLLABORATORY

- The fusion Collaboratory represents a fundamental paradigm shift for the fusion community
- All data, analysis and simulation codes, and visualization tools will be thought of as network services
- The use of resources (data, codes, visualization tools) is separated from their implementation freeing the researcher from the need to know, in detail, how resources are implemented



THE COLLABORATORY WILL EMBRACE 40 US SITES IN 37 STATES



- The Collaboratory will be 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

THE GOAL OF THE FUSION COLLABORATORY IS TO ADVANCE SCIENTIFIC UNDERSTANDING & INNOVATION IN FUSION RESEARCH

- Enable more efficient use of existing experimental facilities through more powerful between pulse data analysis resulting in a greater number of experiments at less cost
- Allowing more transparent access to analysis and simulation codes, data, and visualization tools, resulting in more researchers having access to more resources
- Enable more effective integration of experiment, theory, and modeling
- Facilitate multi-institution collaborations
- Create a standard tool set for remote data access, security, and visualization allowing more researchers to build these services into their tools

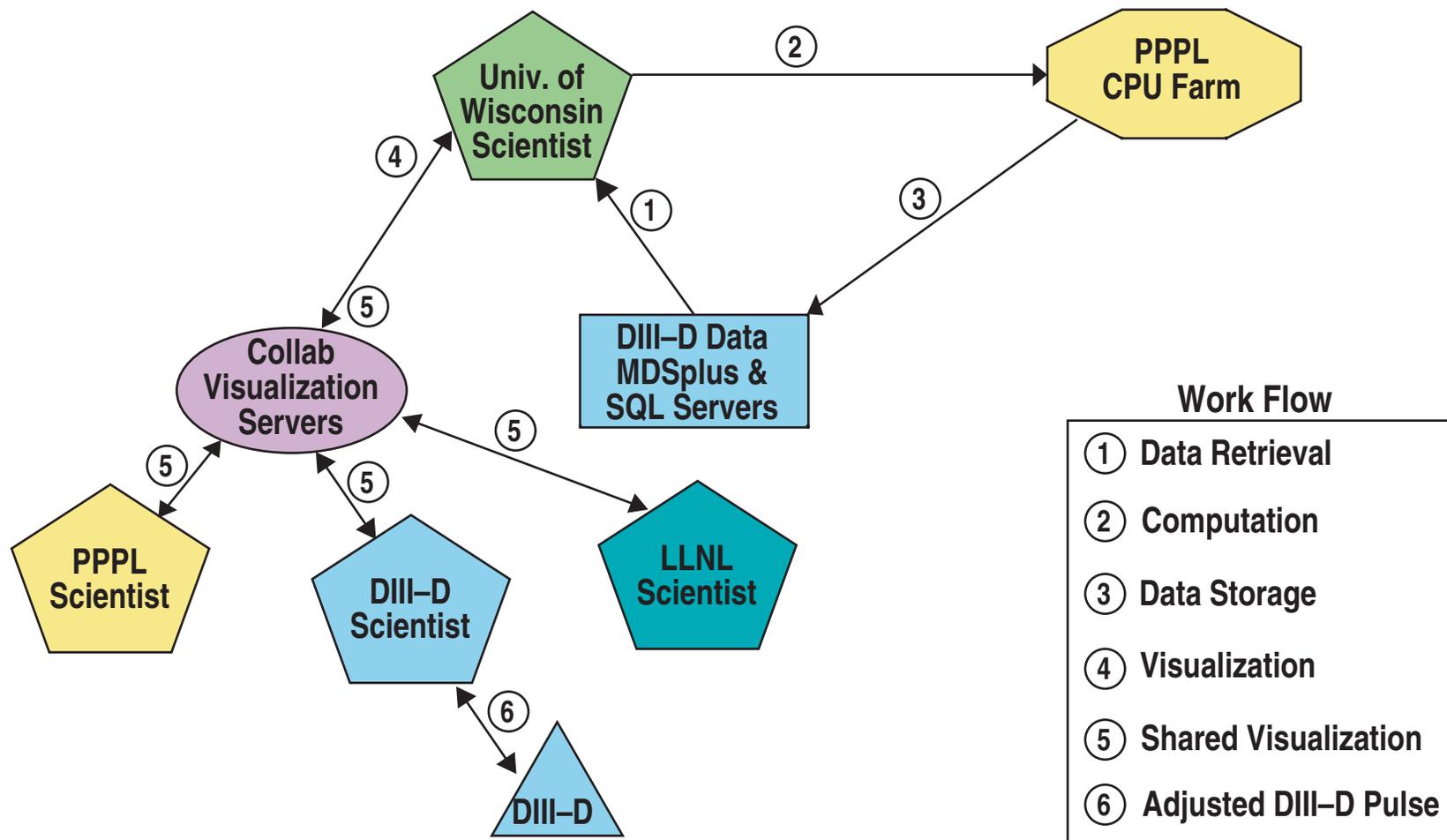
THE COLLABORATORY WILL CREATE & DEPLOY COLLABORATIVE SOFTWARE TOOLS FOR THE FUSION COMMUNITY

- **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**
- **Enable real-time access to high-powered remote computational services allowing such capabilities as between pulse analysis of experimental data and advanced scientific simulations**

MDSplus PROVIDES A COMMON, SHARED NETWORK ENABLED INTERFACE TO ALL DATA

- **MDSplus is a data system jointly developed by MIT, LANL, & Padova Italy**
 - Provides for acquisition, storage, access, and organization of data
 - Client/server system utilizing TCP/IP
 - Can store experimental, simulation & theoretical data
- **Presently used to serve data at 4 sites in US and 8 worldwide**
 - Includes the 3 large US tokamaks
 - Clients at many sites
- **Many physics analysis codes have been or are being integrated with MDSplus**
 - Transport: MIST, ONETWO, TRANSP
 - MacroStability & Equilibrium: DCON, EFIT, M3D, NIMROD, PEST
 - MicroTurbulence: GS2

EXAMPLE OF COLLABORATORY BENEFITS: ENHANCED EXPERIMENTAL OPERATIONS

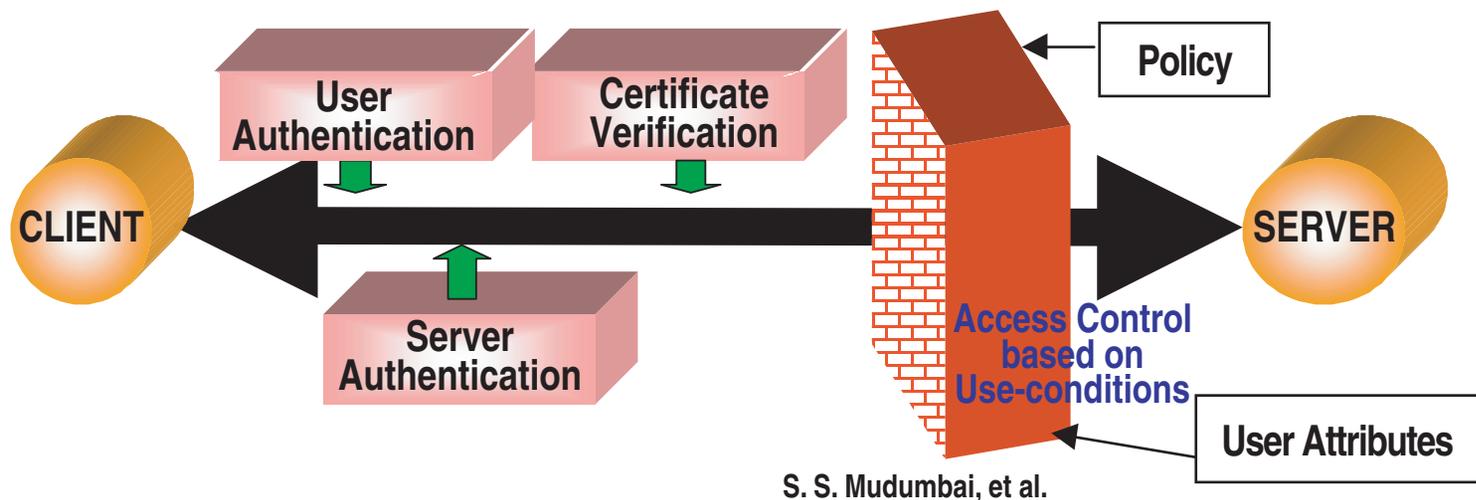


THE COMPUTER SCIENCE RESEARCH NECESSARY TO CREATE THE COLLABORATORY IS CENTERED AROUND THREE AREAS

- **Security**
 - 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**
 - Share the community's computational resources
 - Job scheduling, monitoring, exception handling, and accounting
- **Scientific Visualization**
 - Increased data quantities and ease of collaboration requires better visualization technology
 - Collaborative control rooms & meeting rooms, and enhanced vis tools

SECURITY: THE COLLABORATORY WILL UTILIZE THE GLOBUS SECURITY INFRASTRUCTURE & AKENTI AUTHORIZATION SERVICE

- Clients attempt to access resources controlled by servers (Globus)
- Access control policy: prior authorization decisions for client access to resources (Akeniti)
- Public-key infrastructure and secure message protocols provide confidentiality, message integrity, and user identity authentication
- Existing fusion codes will be modified to use this infrastructure
- The middleware tools will be extended to meet the Collaboratory needs



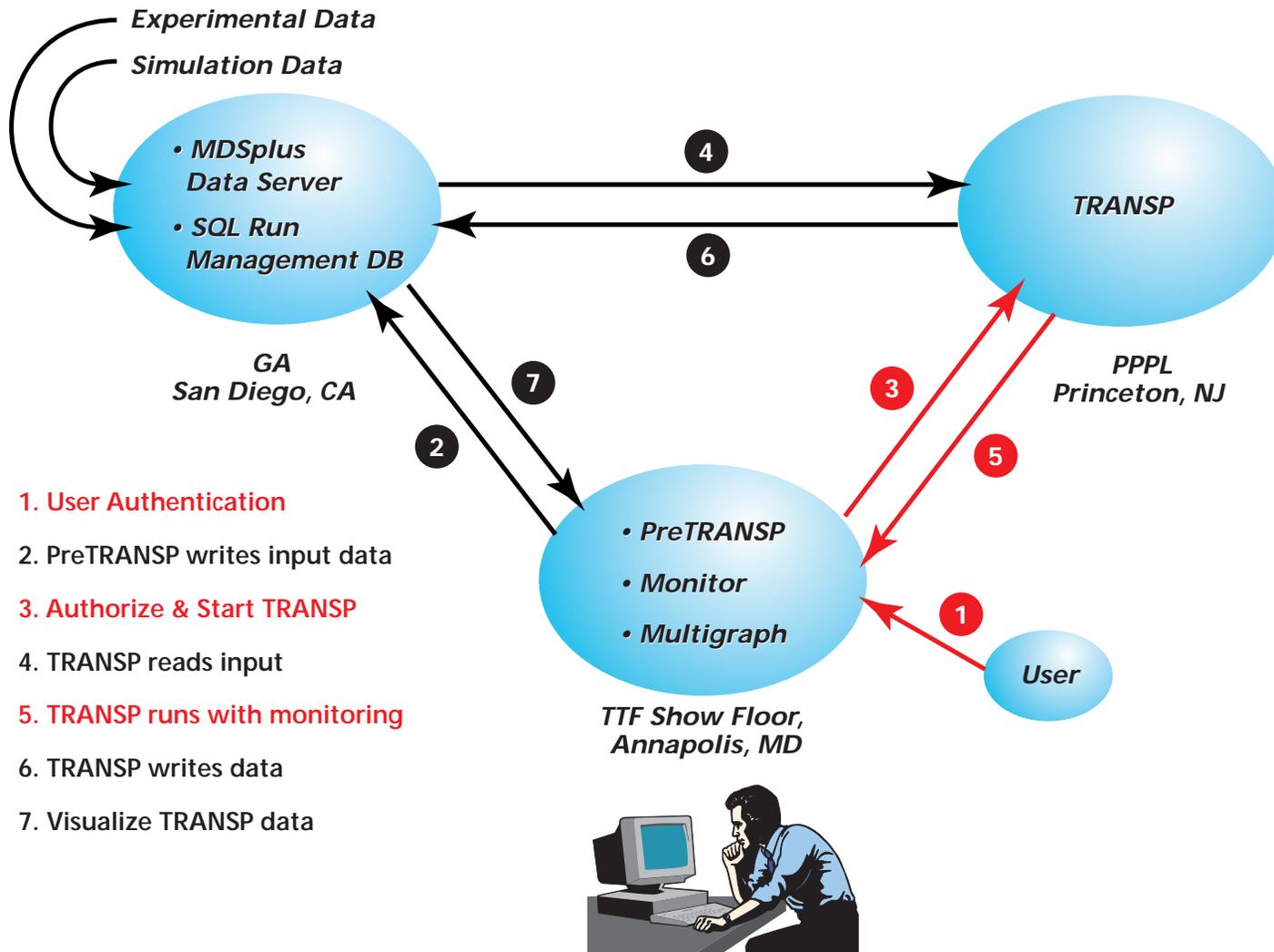
REMOTE & DISTRIBUTED COMPUTING: ACCESS TO POWERFUL DATA ANALYSIS & SIMULATION CODES AS NETWORK SERVICES

- **Fusion codes will run on hardware appropriate for each code**
 - Fast serial workstations – midrange parallel clusters – supercomputers
- **Collaboratory will enable detailed time dependent transport and stability analysis between pulses**
 - Equitable sharing and preemptive data analysis
- **Globus can provide for the required capabilities**
 - Create grids connecting computational resources with users
 - Track the capabilities of resources within a grid
 - Specify the resource needs of user's computing tasks
 - Mutually authenticate both users and resources

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

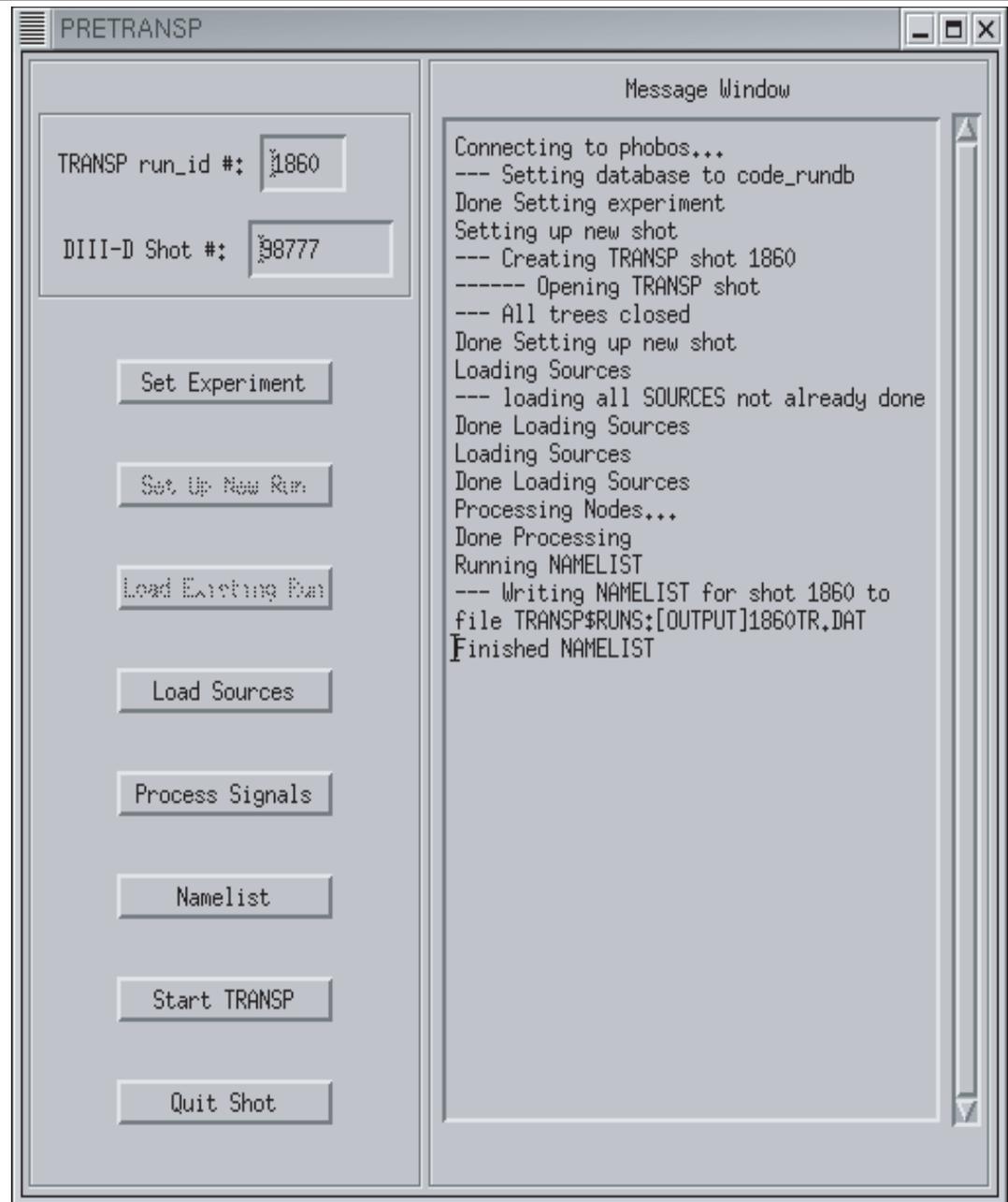


SUCCESSFUL DEMONSTRATION OF GRID COMPUTING AT APRIL FUSION SCIENCE MEETINGS



A GUI WAS CREATED TO SETUP AND LAUNCH A TRANSP RUN

- 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

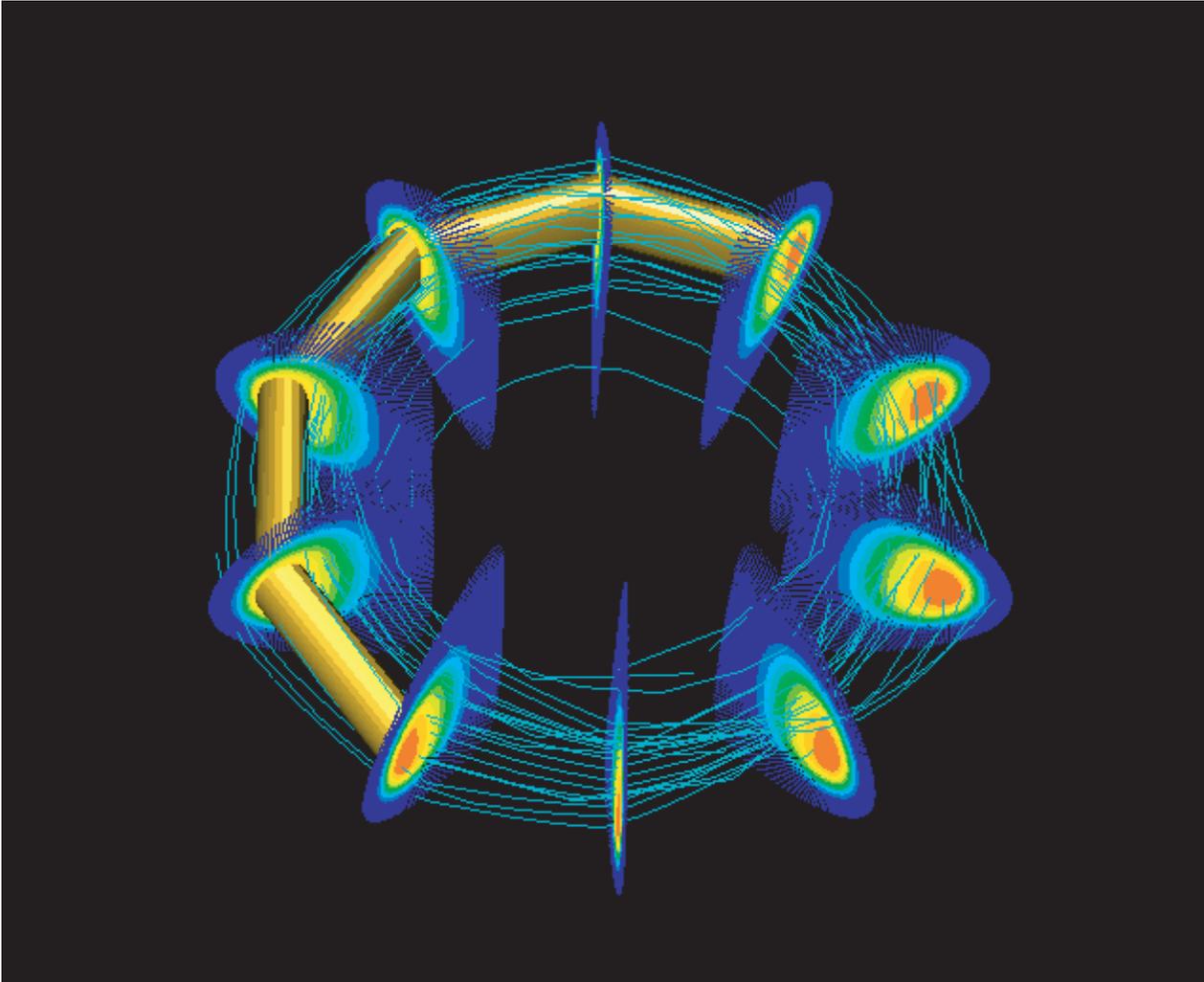
- US map to visualize demo & make it real
- Monitor run via a web browser
- Visualize results using IDL based tool



VISUALIZATION: COLLABORATIVE NATURE OF FUSION RESEARCH NECESSITATES A SHARED VISUALIZATION ENVIRONMENT

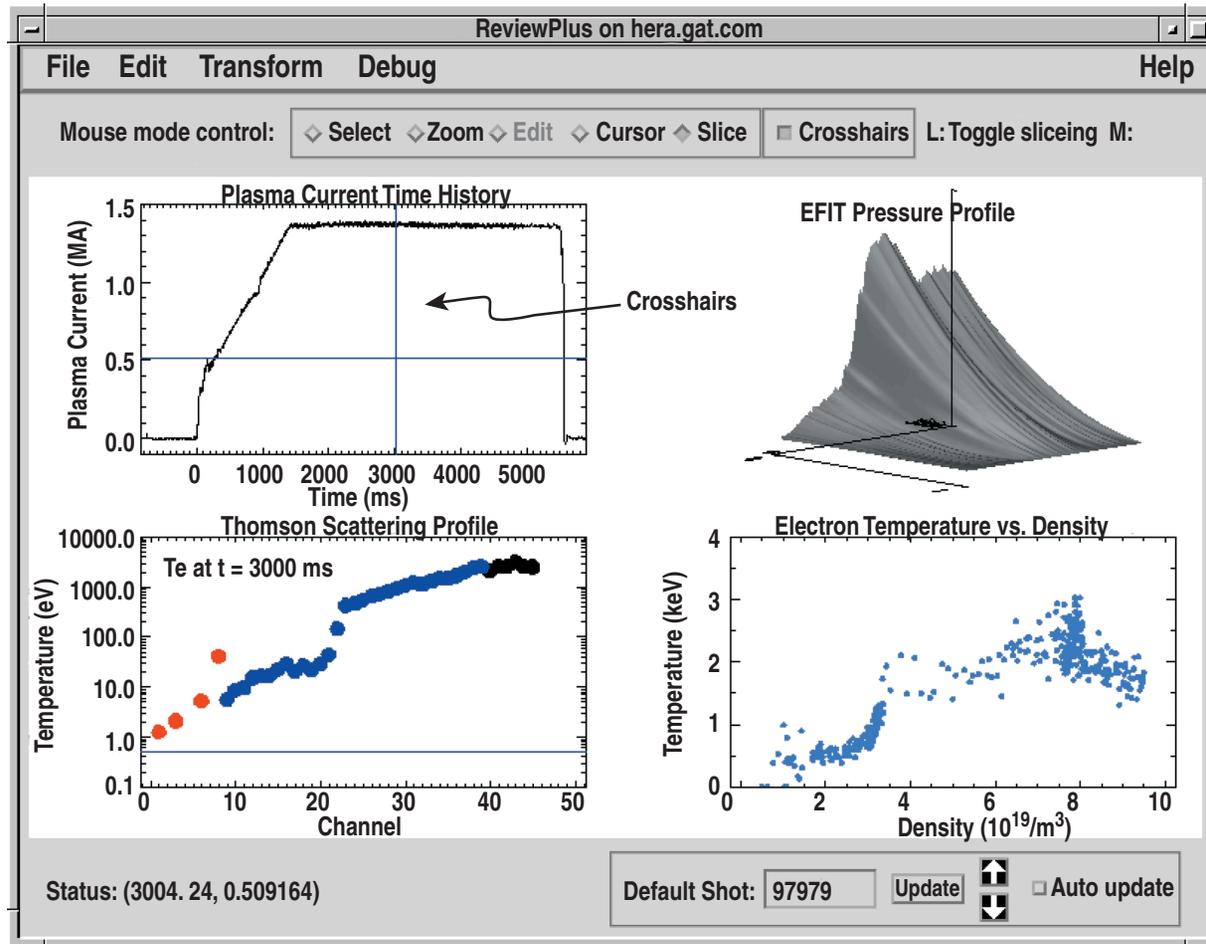
- **Strive to dramatically reduce the hurdles that presently exist for collaborative visualization**
- **Leverage existing technology where possible**
 - Workspace docking using the Access Grid (AG)
 - Integrate existing AG collaborative tools with tiled display walls
- **Collaborative Control Room**
 - Large on-site group to interactively work with small to large off-site group
- **New visualization software**
 - Simultaneous sharing of complex visualizations
 - Error representation in complex experimental and simulation data

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)

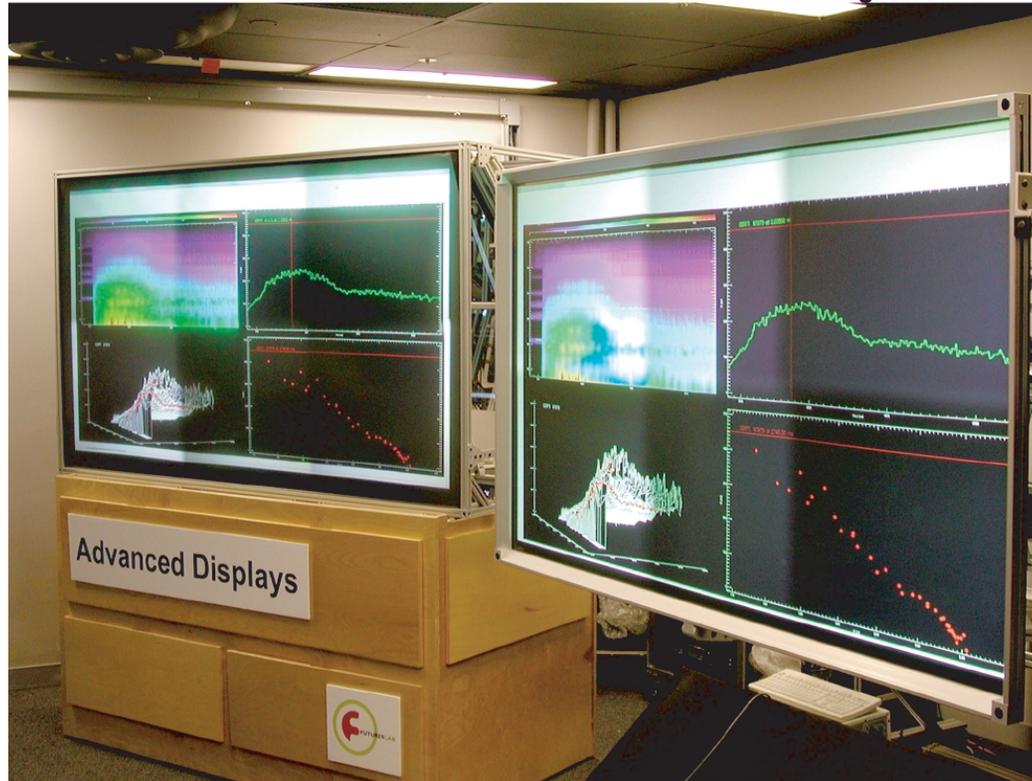
ReviewPlus: GENERAL DATA VISUALIZATION TOOL DEVELOPED IN THE FUSION COMMUNITY



- 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
- To be demonstrated at APS/DPP 2002 in Orlando

FEEDBACK FROM THE DEMONSTRATIONS

- **Experimentalists interested in a network code service like TRANSP**
 - Not as interesting to theorists who run large codes at NERSC
- **Numerous requests (both U.S. and international) to use TRANSP service**
- **Security and Firewall issues hampered deployment of demonstrations**
 - Need a unified plan to coordinate with site–security plans
- **Theory scientists very much interested in advanced visualization**
 - Cost of deployment a concern; consistent with PAC statement
- **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)
- **Consensus is that the demos were valuable and we are on track**

GRID-ENABLED TRANSP SERVICE TARGETED FOR NOVEMBER 2002 RELEASE TO GENERAL COMMUNITY

- **PreTRANSP GUI being finalized**
 - General application useable at any site
 - Data driven design
- **Monitoring service being created to TRANSP**
 - Modeled after Data Analysis Monitoring at DIII-D
- **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**

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



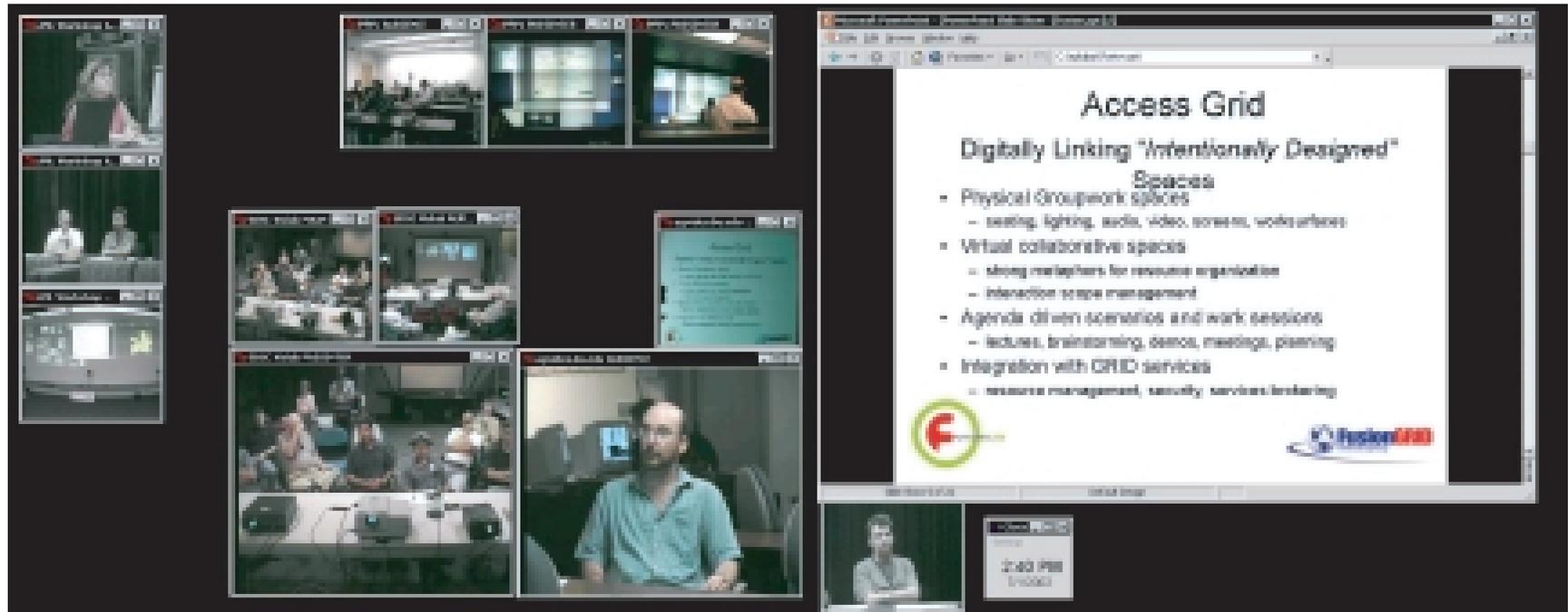
AG Nodes near JET

CLRC Rutherford Appleton Lab
<http://www.clrc.ac.uk/>
C.D. Osland

University of Oxford
<http://web.comlab.ox.ac.uk/access-grid/>
Mike Giles

- 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

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

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

SUMMARY

- **A 3–year project to create a Fusion Collaboratory has begun**
 - Demonstrations to and feedback from the scientific community
 - Major demonstrations planned for APS 2002
 - Release of grid–enabled TRANSP service targeted for APS 2002
- **Team effort comprised of fusion scientists and computer scientists**
 - We welcome the participation of our International Partners
- **The collaboratory will enable networked real–time data analysis and instantaneous communication amongst geographically dispersed teams of experimentalists and theoreticians**
- **More information at <http://www.fusiongrid.org/>**