

# THE U.S. NATIONAL FUSION COLLABORATORY

Presented by David P. Schissel

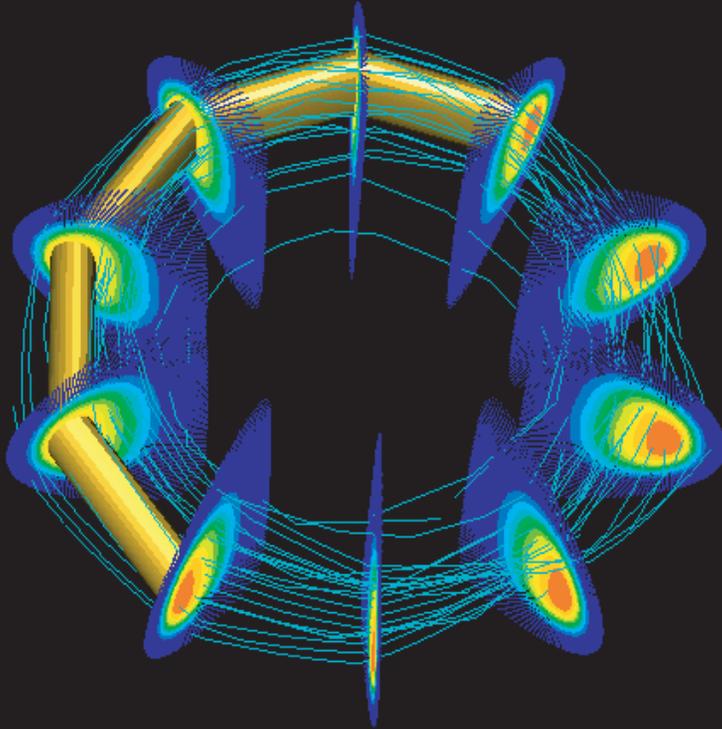
Presented to  
GGD5 ACE-RG

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Edinburgh, United Kingdom

<http://www.fusiongrid.org>

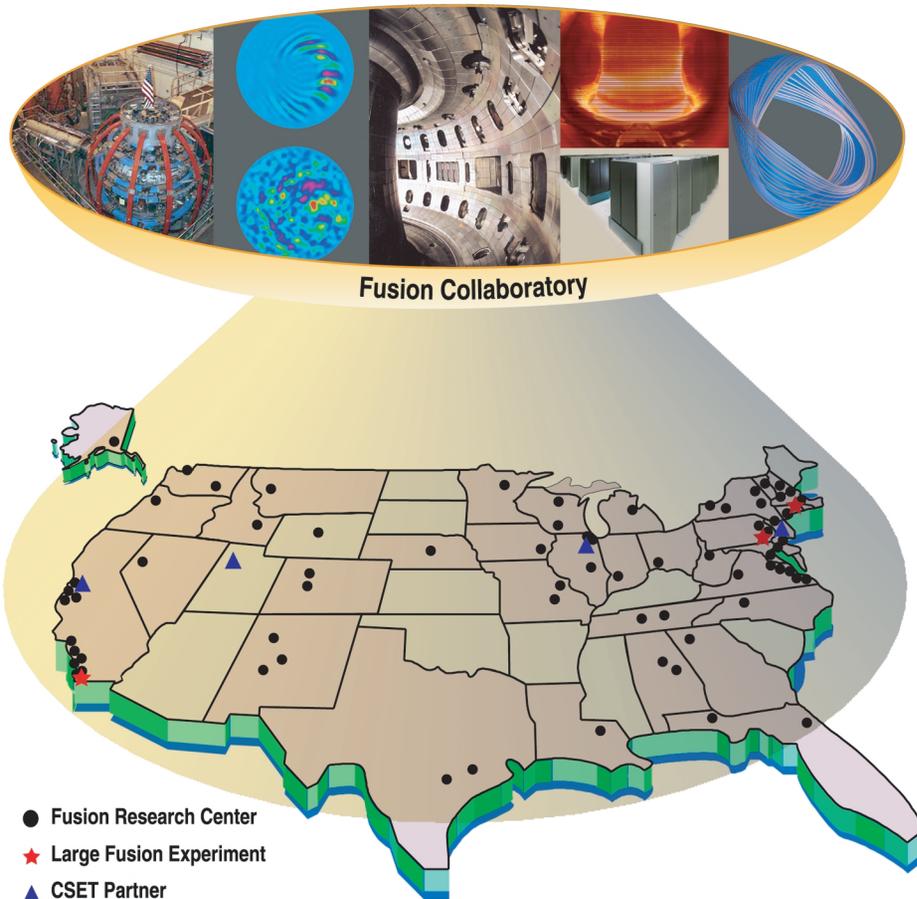
funded by the USDOE SciDAC Program



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

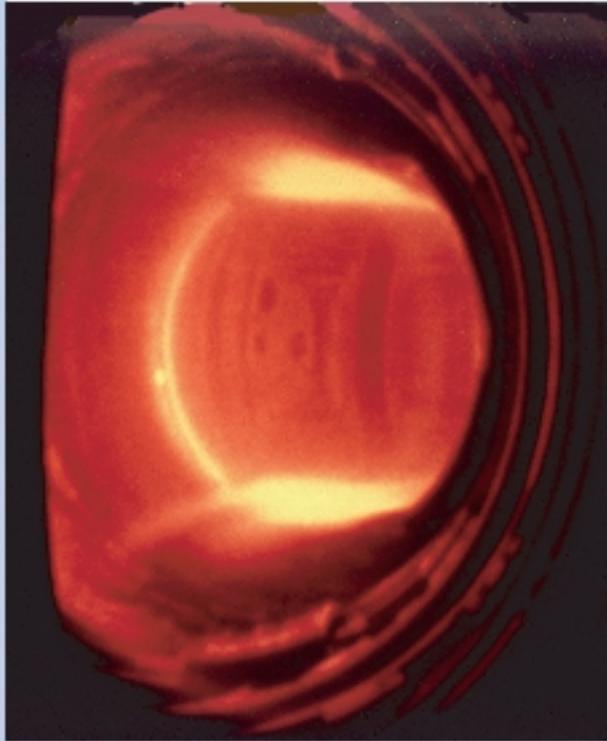


# THE COLLABORATORY WILL EMBRACE 40 US SITES IN 37 STATES



- The Collaboratory 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

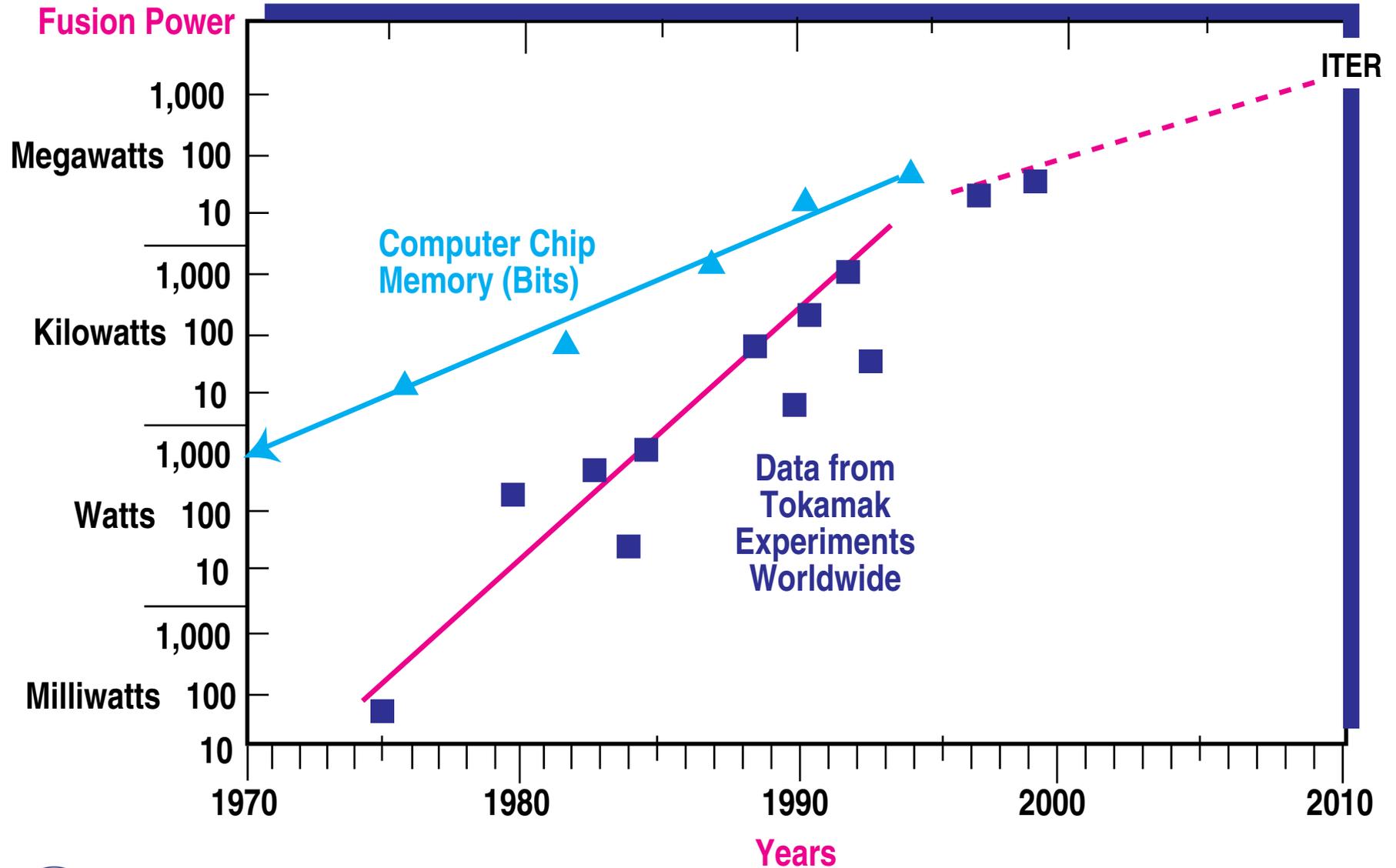
# FUSION REPRESENTS A NEARLY INEXHAUSTIBLE ENERGY SOURCE



- 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

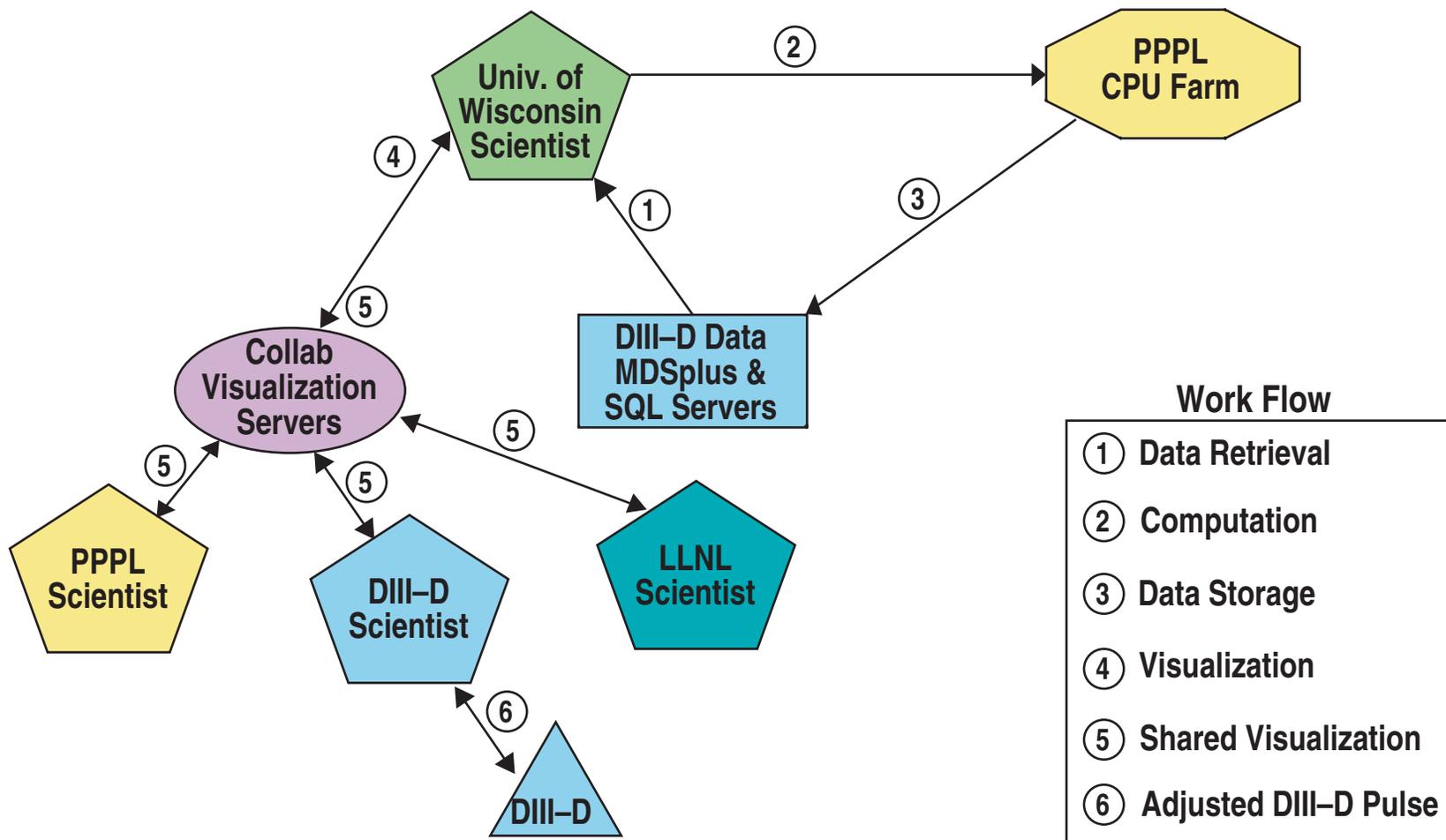


# THE COLLABORATORY WILL CREATE & DEPLOY COLLABORATIVE SOFTWARE TOOLS FOR THE FUSION COMMUNITY

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- **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**

# EXAMPLE OF COLLABORATORY BENEFITS: ENHANCED EXPERIMENTAL OPERATIONS



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

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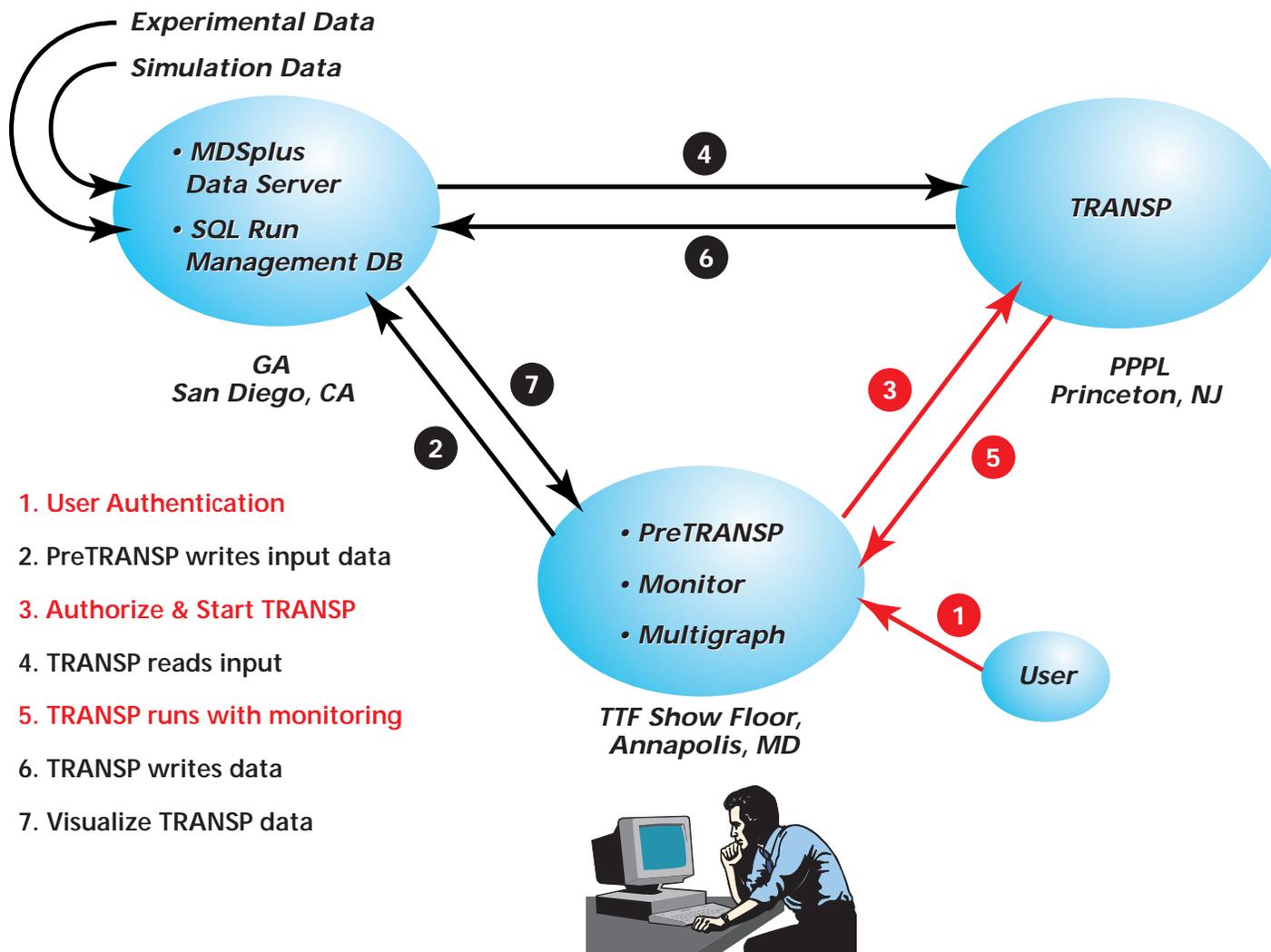
- **Security (Globus & Akenti)**
  - Valuable resources need to be protected: data, codes, & vis tools
  - Collaboratory will require authentication, authorization, and encryption
  - Fair use of shared resources
- **Remote and Distributed Computing (Globus)**
  - Share the community's computational 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 SETUP FOR APRIL FUSION SCIENCE MEETINGS BUT THE EXERCISE PROVED VALUABLE

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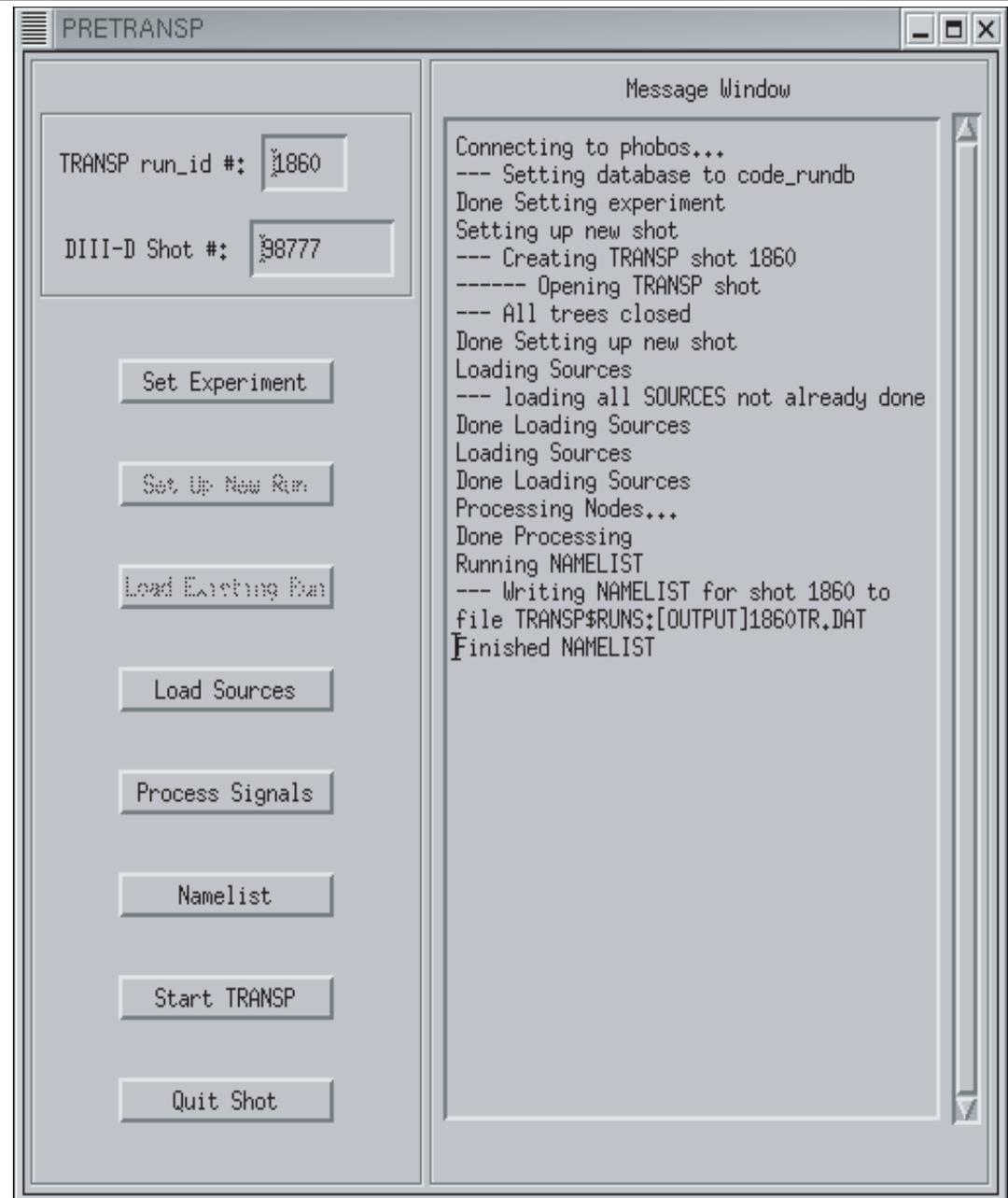


# SUCCESSFULL DEMONSTRATION OF GRID COMPUTING AT APRIL FUSION SCIENCE MEETINGS



# 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



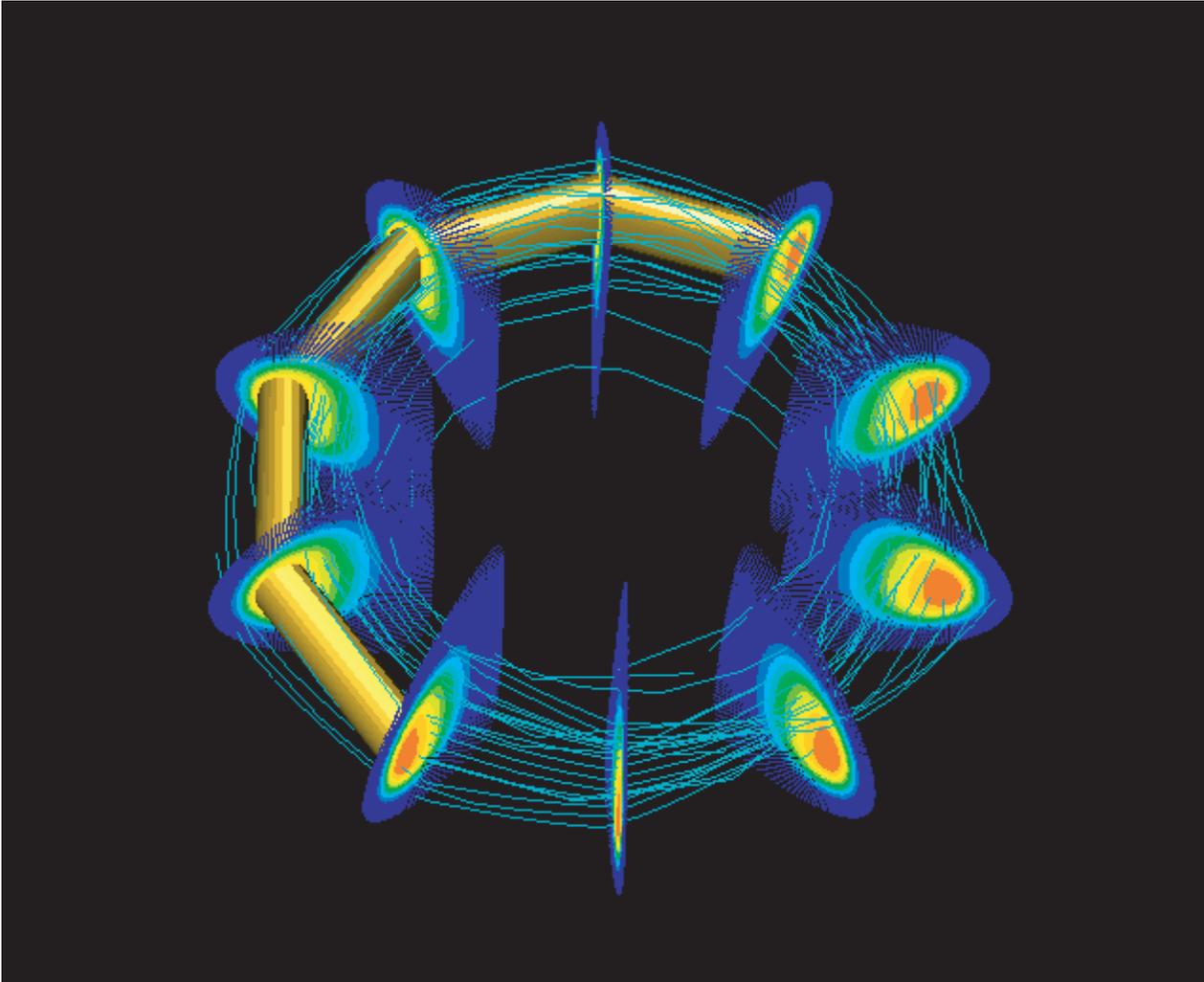
# VISUALIZATION: COLLABORATIVE NATURE OF FUSION RESEARCH NECESSITATES A SHARED VISUALIZATION ENVIRONMENT

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- **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

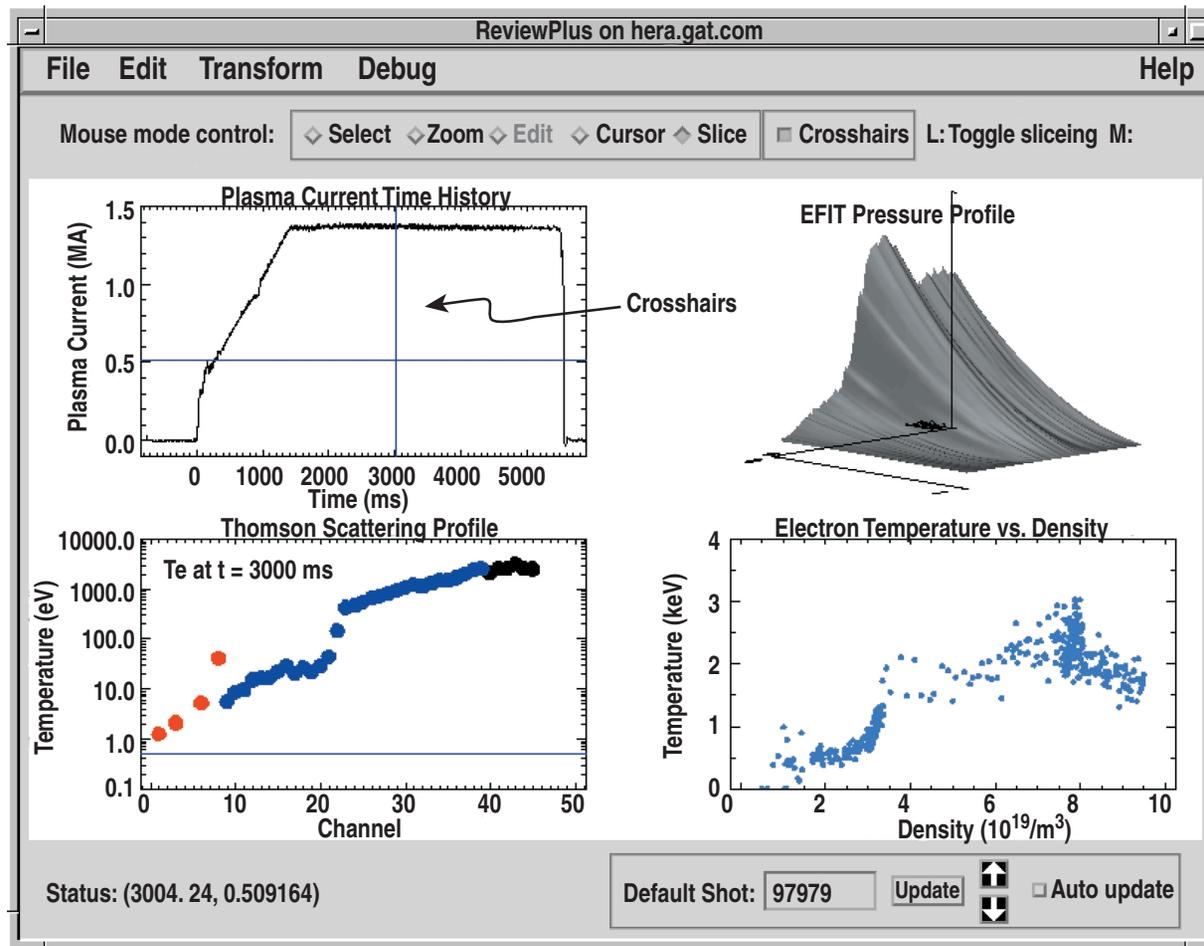
# SUCCESSFUL DEMONSTRATION OF ADVANCED VISUALIZATION AT APRIL FUSION SCIENCE MEETINGS

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- **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

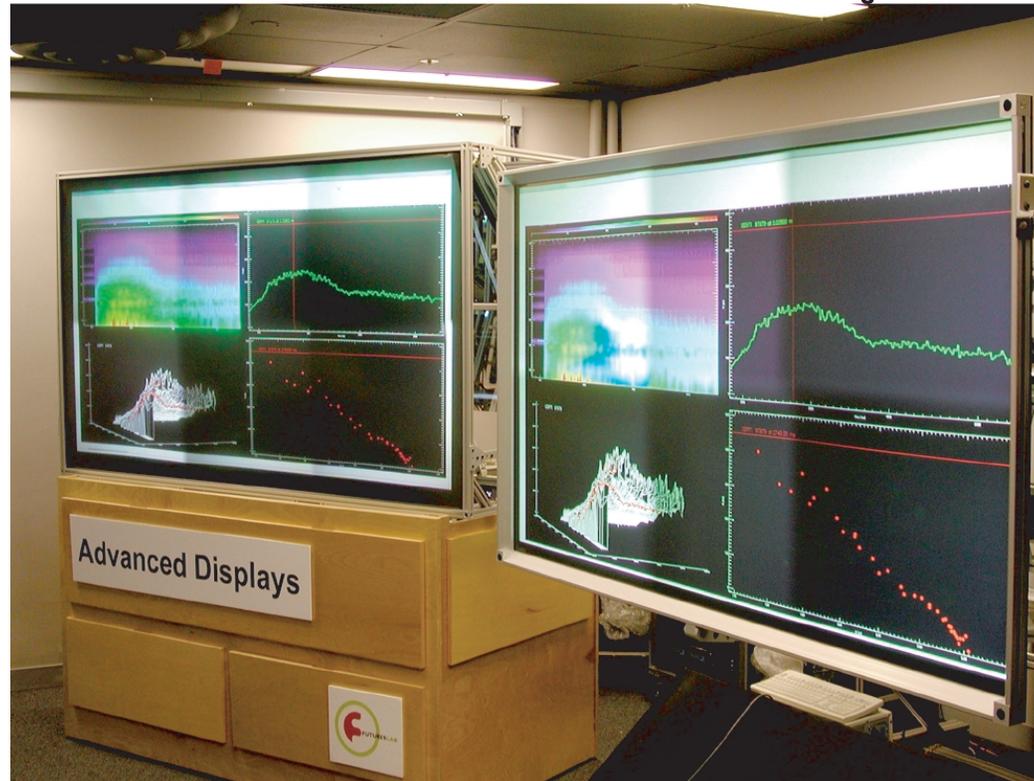


- Data combinations
- Overplotting
- Any Y versus any X
- Math functions
- 2D and 3D coupling
- Signal menu and web help
- Automatic updating

# SHARED VISUALIZATION BETWEEN TILED WALLS HAS BEEN DEMONSTRATED

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ANL using the IDL based tool ReviewPlus



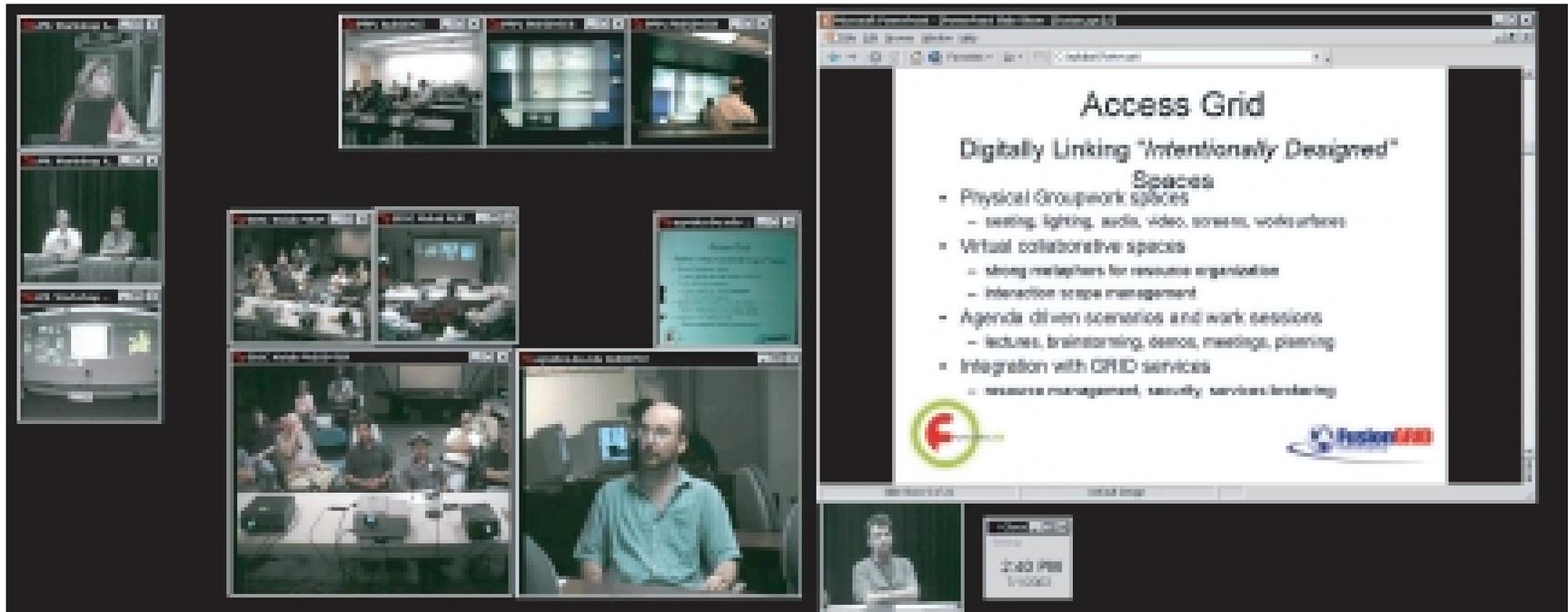
- Workstation to Wall and Wall to Wall is possible - communicate to the control room
- Demonstrated from ANL to DIII-D and PCS to PPPL with positive feedback

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



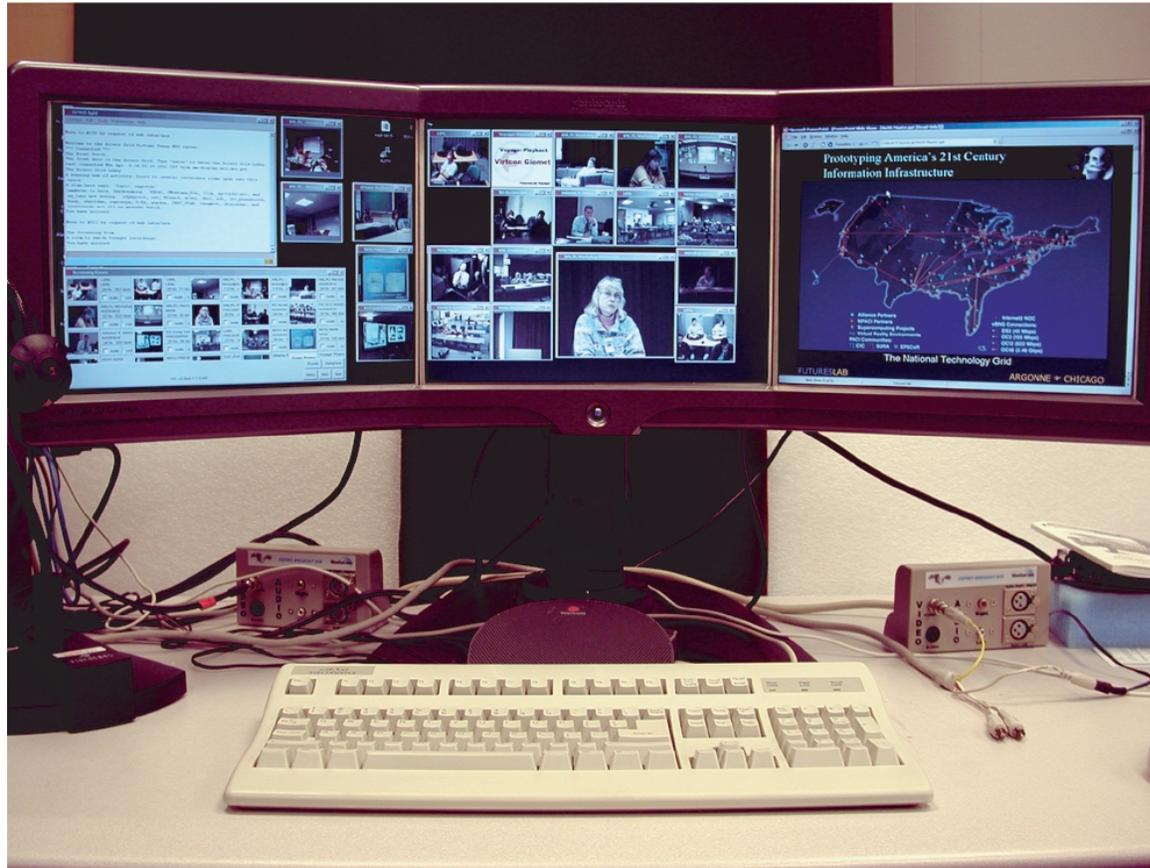
- Access Grid ([www.accessgrid.org](http://www.accessgrid.org)) compliments and extends the data grid
  - Ensemble of network, computing and interaction resources that supports group to group collaboration and communication
- Display wall research has focused on low-cost commodity components

# 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
- 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

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- **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)

# NOVEMBER 2002 RELEASES TO GENERAL COMMUNITY

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- **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**

# SUMMARY

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- **A 3–year project to create a Fusion Collaboratory has begun**
  - **Team effort comprised of fusion scientists and computer scientists**
- **The collaboratory will enable networked real–time data analysis and instantaneous communication amongst geographically dispersed teams of experimentalists and theoreticians**
- **Progress has been made with positive feedback from the scientists**
  - **Demonstrations to and feedback from the scientific community**
  - **Major demonstrations planned for APS 2002**
  - **Release of grid–enabled TRANSP service targeted for APS 2002**
  - **Collaborative control room visualization tested late in the year**
- **More information at <http://www.fusiongrid.org/>**