THE NATIONAL FUSION COLLABORATORY PROJECT: APPLYING GRID TECHNOLOGY FOR MAGNETIC FUSION RESEARCH

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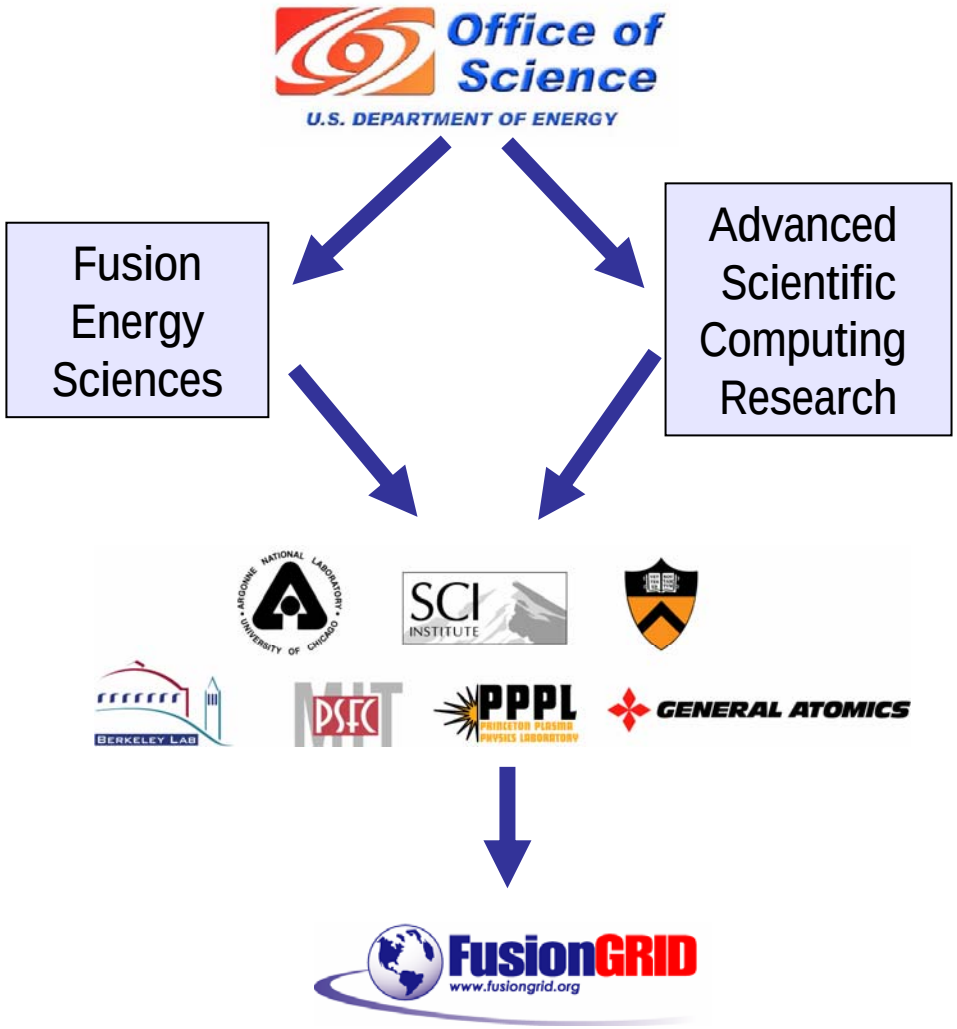
FusionGRID
www.fusiongrid.org

TALK OVERVIEW

- Introducing National Fusion Collaboratory
  - Who we are and what we do
- The vision of Fusion Grid
  - Requirements and challenges
- Grids in National Fusion Collaboratory
  - Typical Grid scenario
  - Grid capabilities
  - Access Grid
  - User and software interfaces
- Fusion Applications
  - Production use of TRANSP
  - Virtual Control Room
- Lessons Learned

COLLABORATORY'S GOAL IS TO ADVANCE SCIENTIFIC UNDERSTANDING & INNOVATION IN FUSION RESEARCH



COLLABORATORY'S GOAL IS TO ADVANCE SCIENTIFIC UNDERSTANDING & INNOVATION IN FUSION RESEARCH

- Enable more efficient use of existing experimental facilities through more powerful data analysis for fusion experiments 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, & modeling
- Facilitate multi–institution collaborations

OVERVIEW OF GRID REQUIREMENTS FOR NFC

- Application Service Provider (ASP) model
  - Emphasis on enabling access for more scientists at less cost rather than access to more hardware
  - Portability issues
  - Optimizes the most expensive resource: people's time
- Data management
  - Experimental and simulation data should be catalogued and accessible in well-defined ways
- Moving towards using Grids in experimental interaction
  - New capabilities: enabling real-time execution in Grids
  - Integrate interactions from geographically diverse groups and codes
  - Collaborative nature of research requires shared visualization applications and widely deployed collaboration technologies

TOWARDS EXPERIMENTAL GRID USE: REAL–TIME ANALYSIS OF LARGE DATA

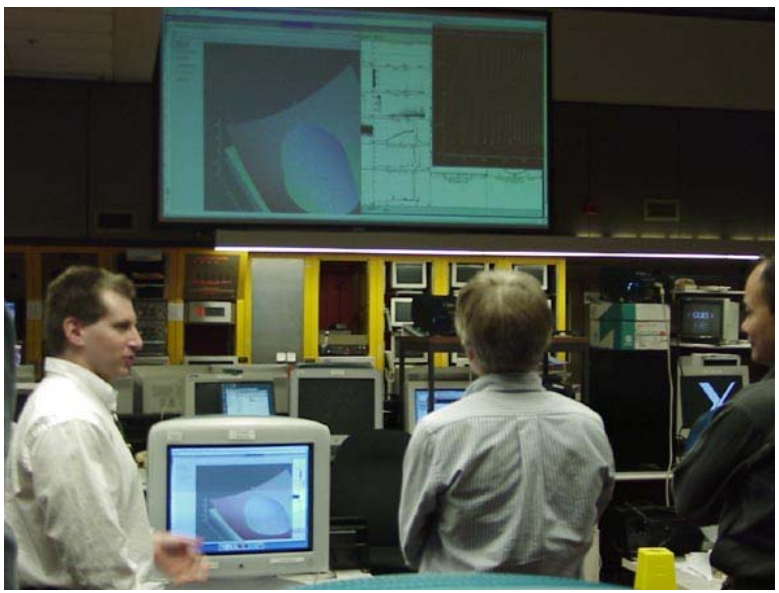
- Pulsed Experiments: 10 s duration plasma roughly every 20 min
- 20 to 40 people in control room plus remote collaborators
- 10,000 separate measurements per plasma
- Long term goal: to do between plasmas what we currently do overnight

Alcator C–Mod Control Room

DIII–D Control Room

REQUIREMENTS OF A REMOTE CONTROL ROOM

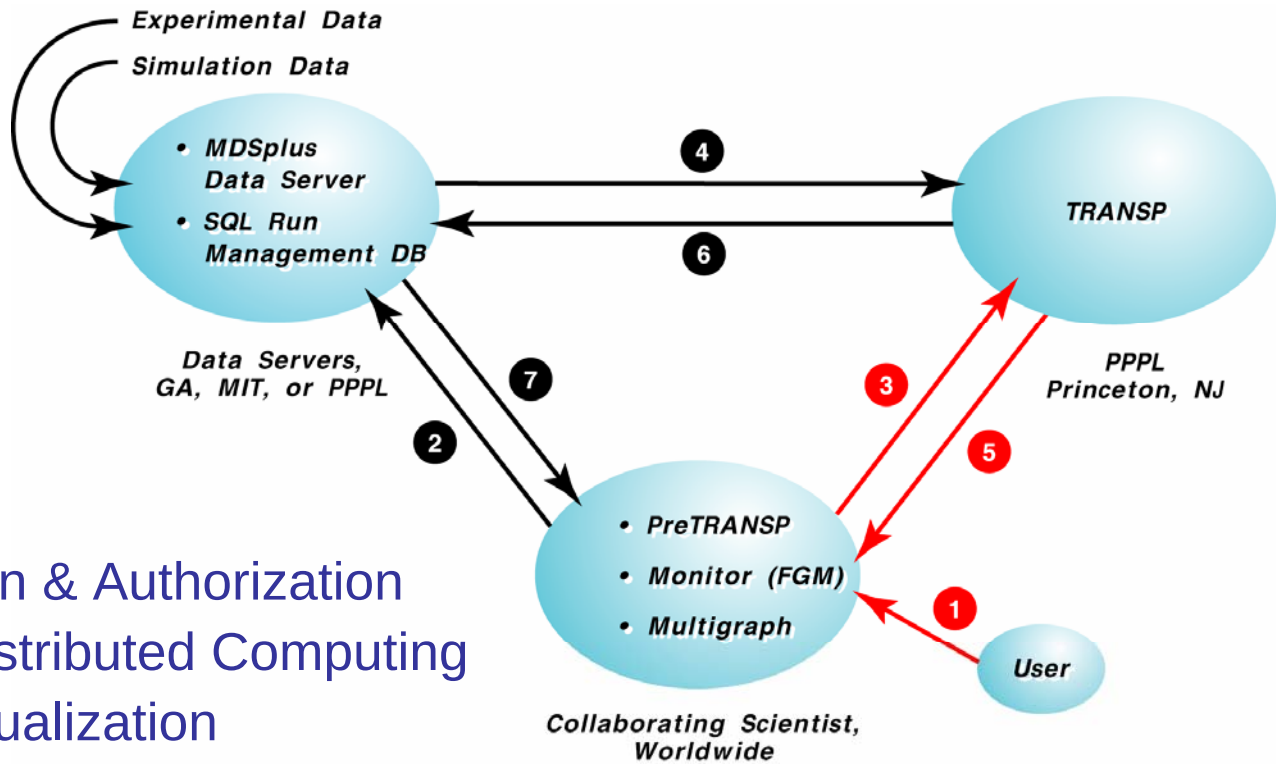
- As rich and as engaging experience if one is on–site
- Timely access to all data
  - No data analysis penalty for being off–site
- Involved in the decision making
  - Audio, video, and shared applications for discussion
- Advanced reservation of computing resources and real-time execution
  - Grid computing to support tokamak operations



SUMMARY OF CHALLENGES FOR THE FUSION GRID

- Scaling to many users
  - Authorization and enforcement
  - Dynamic accounts
  - Policy management
- New computational capabilities
  - Agreement-based interactions
- Collaborative interaction
  - Simultaneous sharing of complex visualization
  - Sense of presence in the control room
- Usability and Deployment
  - Firewalls
  - Certificates
  - Other usability constraints

GRIDS IN NATIONAL FUSION COLLABORATORY: TYPICAL NETWORK SERVICE INTERACTION



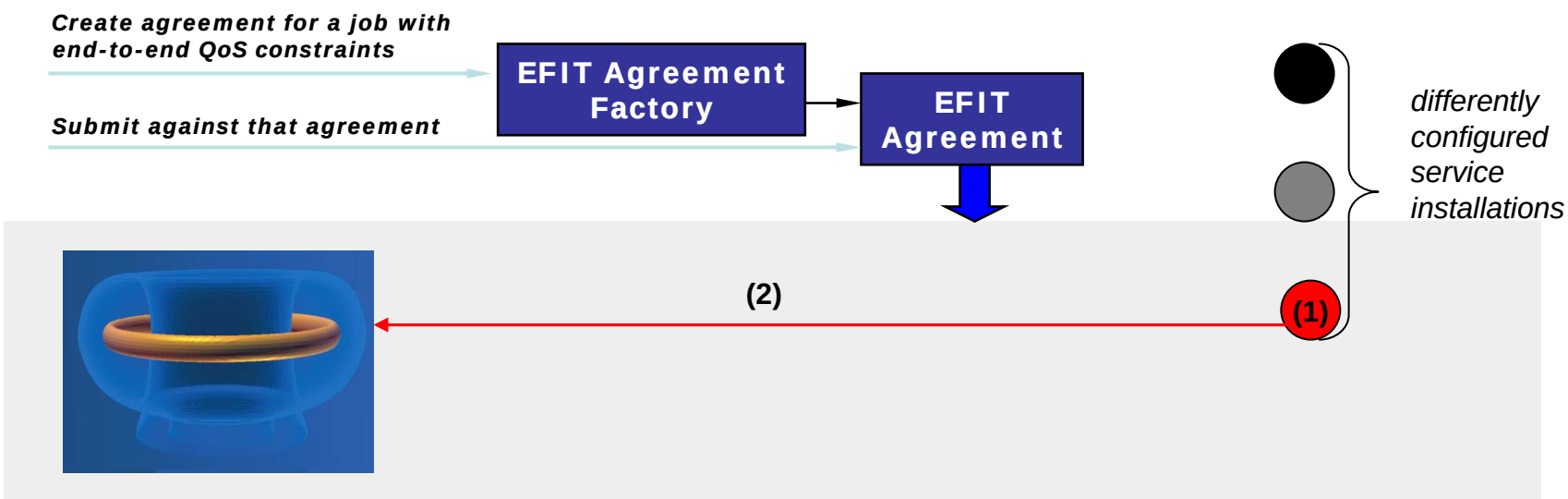
- Authentication & Authorization
- Remote & Distributed Computing
- Scientific Visualization

NATIONAL FUSION COLLABORATORY DEVELOPS GRID CAPABILITIES REQUIRED BY FUSION SCIENCE

- Support for Network Services
  - Akenti authorization (Mary Thompson, LBNL)
  - GRAM callouts (GT3.2 release)
  - Dynamic accounts for GT3
    - Prototype: www.mcs.anl.gov/~keahey/DS/DynamicSessions.htm
  - MDSplus (MIT)
    - Data cataloguing and organization
    - Ongoing integration with Globus XIO for faster transport
  - Fusion Grid Monitor (General Atomics)
  - Visualization of results
- Support for Grids in experimental science
  - Agreement-based interactions
    - Prototype infrastructure available soon
  - Access Grid

GRID SUPPORT FOR FUSION EXPERIMENTS: AGREEMENT-BASED SERVICE INTERACTIONS

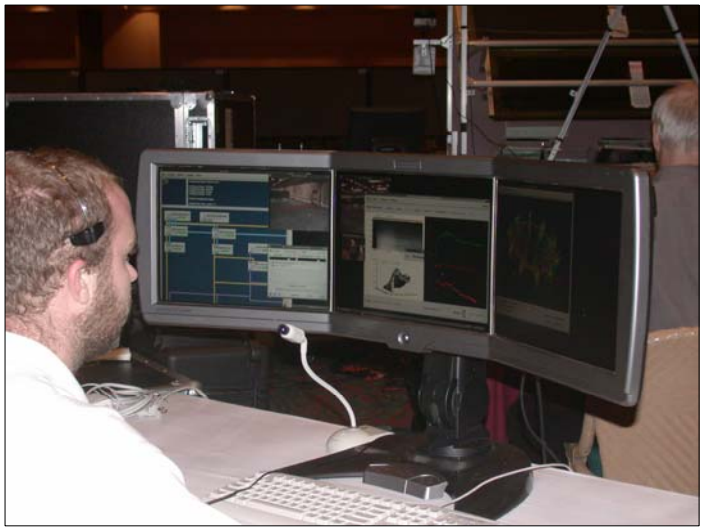
- Allows a user to enter into an agreement with a service providing e.g., analysis
  - "whenever I run a certain configuration of EFIT tomorrow between 9am and 5pm I want it to run as fast as possible and no longer than 4 minutes"
- End-to-end agreement is based on subsidiary agreements with multiple services
  - e.g., resource reservation

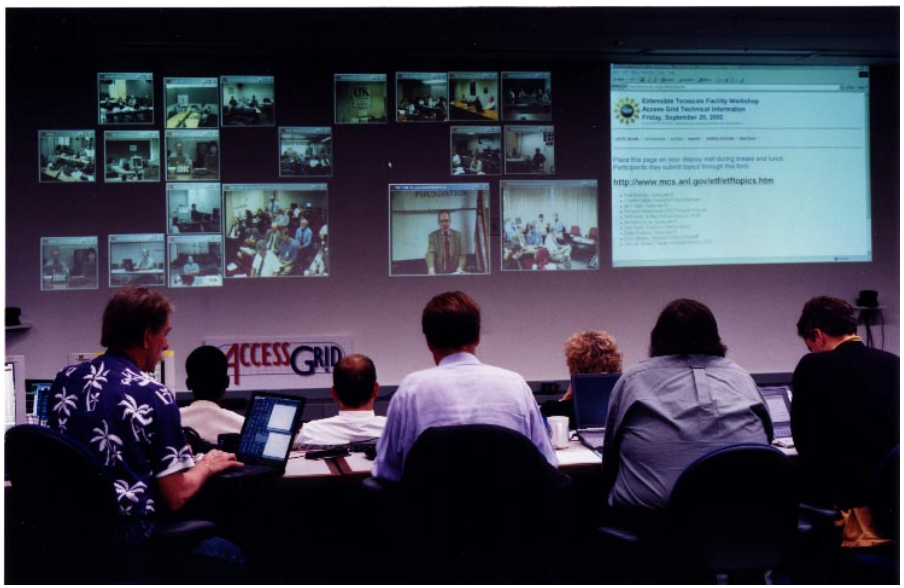


AGREEMENT SCENARIO IN FUSION GRID

- Simplified negotiation and commitment: a discovery process
  - Client retrieves an agreement template
  - Client proposes an agreement (a query)
    - “How long will it take to run EFIT with certain arguments?”
  - Factory refines the agreement and pre-commits (or returns fault)
  - Client commits to the agreement (or posts another query)
- Claiming agreements
  - Services are instantiated ahead of time
  - Claiming is triggered by an event in the system (plasma data is ready)
    - Client may be choosing between more than 1 agreement
  - Agreement may be bound to a specific service
    - i.e., CPU reservation
- Combined agreements
  - End-to-end Quality of Service combines job execution and network transfer
    - Network transfer agreements are based on simple prediction
    - Job execution is based on CPU reservation

ACCESS GRID: REAL TIME COMPLEX COMMUNICATION





Access Grid
- Audio & Video services
- Shared applications
- Small to very large meetings
- Grid enabled: secure

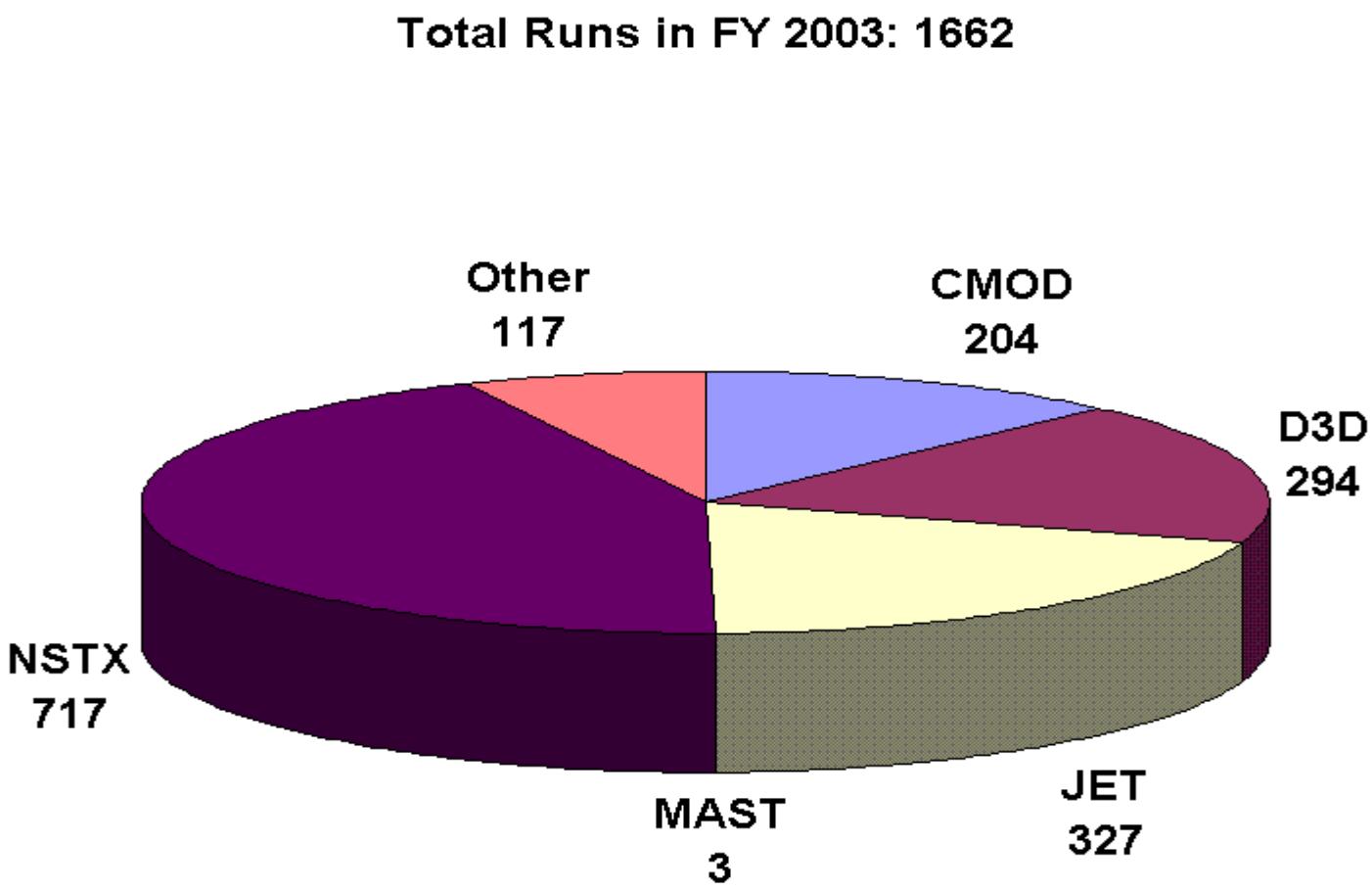
GRIDS IN NFC: USER AND SOFTWARE INTERFACES

- User interfaces
  - Applications used through custom GUIs (PRETRANSP)
  - Portals
    - Fusion Grid Monitor: state of applications
    - Data Monitoring: Data Acquisition and Monitoring
  - Certificate management
    - Ease of use essential
    - myproxy presents a promising solutions
  - Policy editing in Akenti
- Software interfaces
  - Scripting interfaces
  - C APIs

NATIONAL FUSION COLLABORATORY APPLICATIONS

- Production services
  - TRANSP
    - Production use of a year's standing
    - Many accesses from various centers
    - NFC success story
  - GS2 is under way
  - Plans for new services
- Release plans
  - Currently releasing clients
  - Plans to move on to release servers
- Experimental applications
  - Between-pulse executions
  - Mock-up experiment at SC03
    - Combines the agreement-based infrastructure with Access Grid capabilities
  - Plans for moving to the control room

PRODUCTION GRIDS SUCCESS STORY: SUCCESSFUL DEPLOYMENT OF TRANSP



TRANSP DEPLOYMENT: SUMMARY OF RUNS ON A RANDOM DAY

FGM (Fusion Grid Monitor) - Runs - Mozilla {Build ID: 2002051319}

File Edit View Search Go Bookmarks Tasks Help

Back Forward Reload Stop http://nssrv1.gat.com:8000/fgm Search Print

Home Bookmarks Google Timecard ScienceDaily Merriam-Webster

FusionGRID www.fusiongrid.org

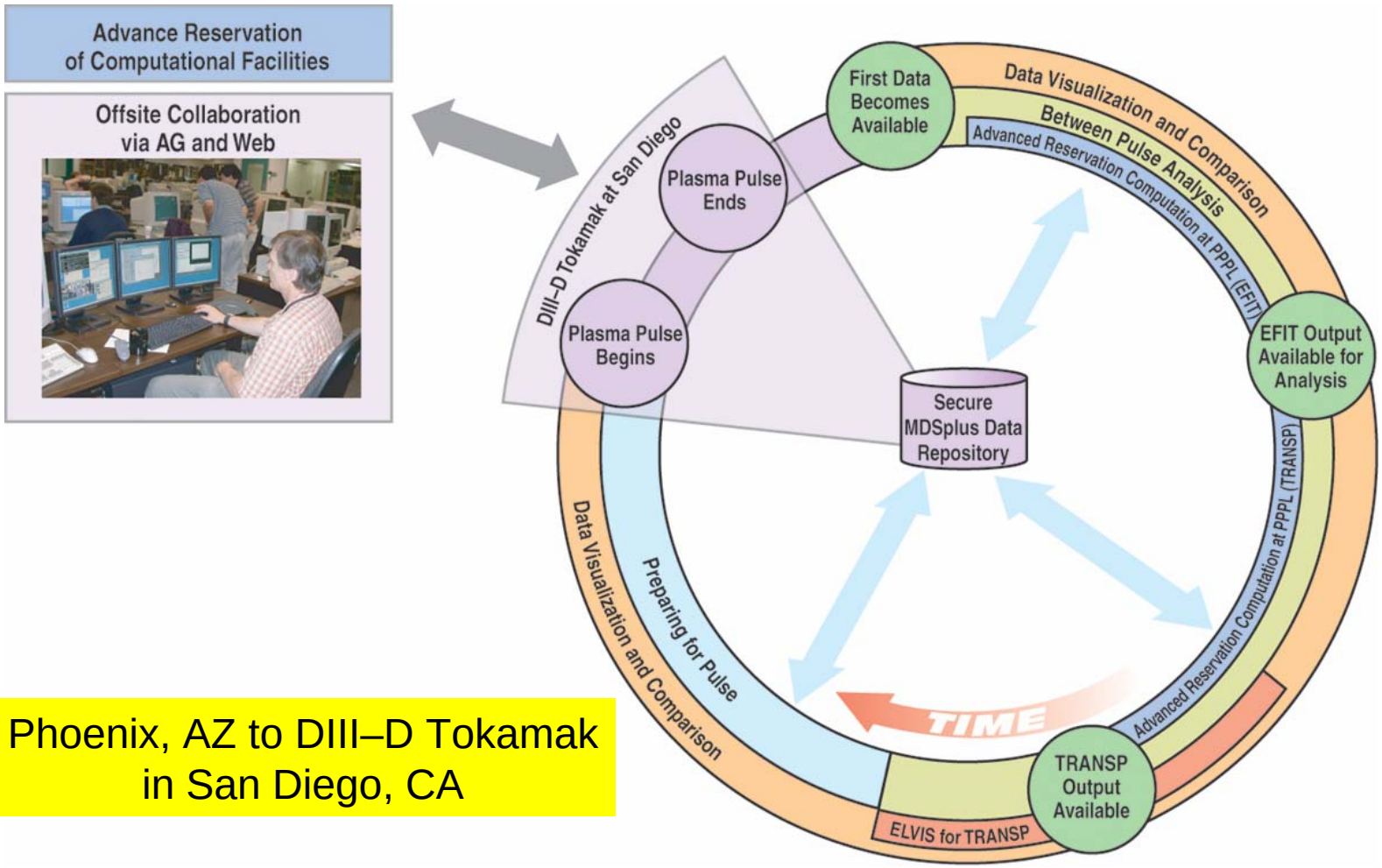
FGM (Fusion Grid Monitor) - Runs

Fusion Grid Monitor - Runs | Fusion Grid Monitor - Users | Fusion Grid Monitor - Tokamaks | Help

Run ID	Code	User	Tokamak	State	Last Updated	Comments
42982C40	TRANSP	budny	JET	Running	Wed Dec 17 12:24:45 PST 2003	Restart at 10.82 (sec) - cpu time = 0.3763 (hrs)
109070Z61	TRANSP	leblanc	NSTX	Completed	Wed Dec 17 10:00:51 PST 2003	Completed on petrel011.pppl.gov on Wed Dec 17 13:00:33 EST 2003
08419C10	TRANSP	pshare	MAST	Stopped	Wed Dec 17 06:54:21 PST 2003	Wed Dec 17 09:53:33 EST 2003: on petrel012.pppl.gov during runtrx_pre
99411O98	TRANSP	peng	D3D	Completed	2003-12-16 05:54:46.0	Completed on transpcomp.pppl.gov on Mon Nov 17 22:33:02 EST 2003
84293U01	TRANSP	murakami	D3D	Completed	2003-12-16 05:49:14.0	Completed on petrel014.pppl.gov on Tue Nov 25 02:12:19 EST 2003

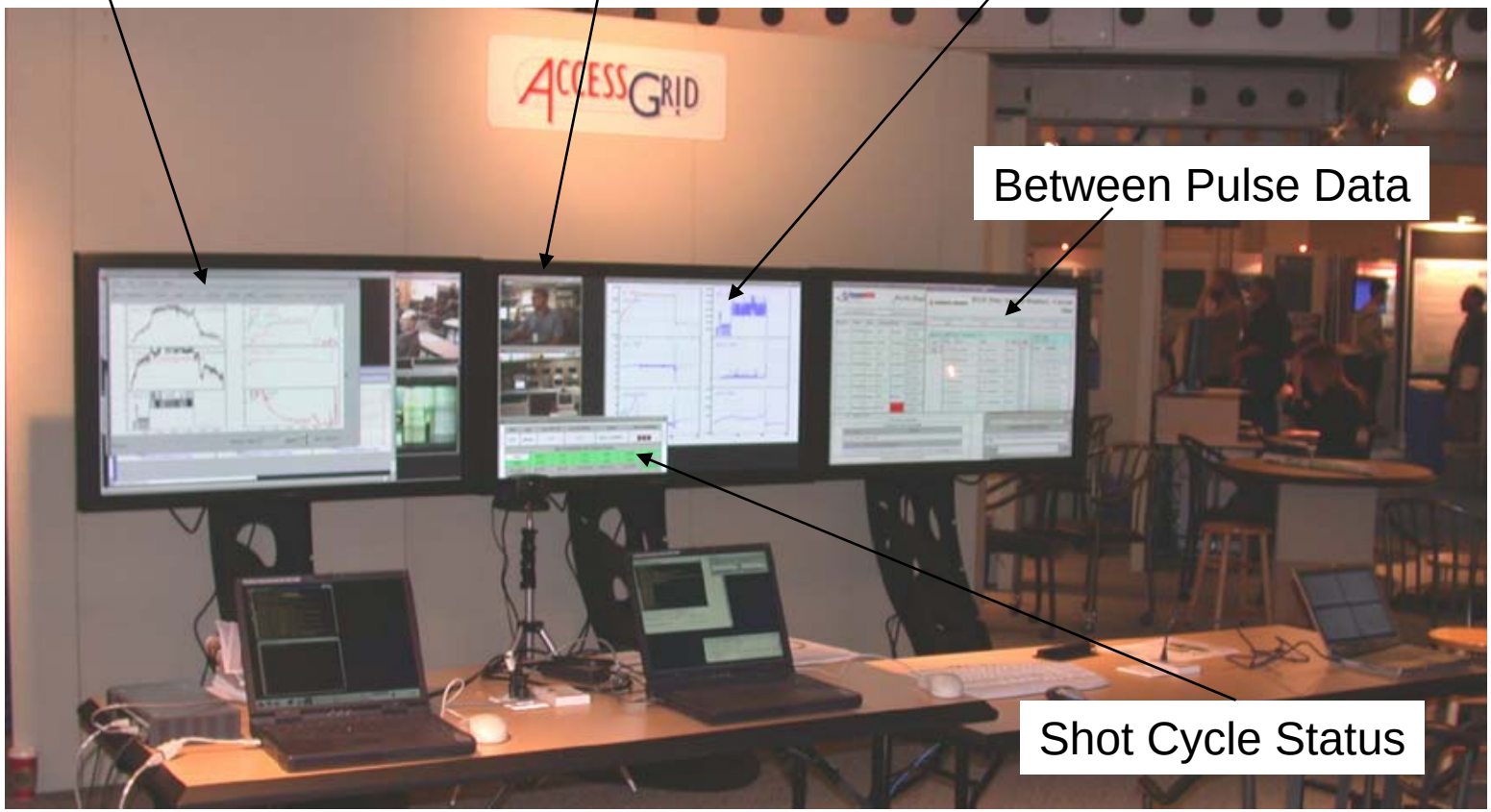
Transferring data from nssrv1.gat.com...

COLLABORATIVE CONTROL ROOM DEMONSTRATION: INTEGRATE OFF–SITE SCIENTIST INTO THE EXPERIMENT



Phoenix, AZ to DIII–D Tokamak in San Diego, CA

REMOTE CONTROL ROOM DEMONSTRATION AT SUPERCOMPUTING MEETING NOVEMBER 2003



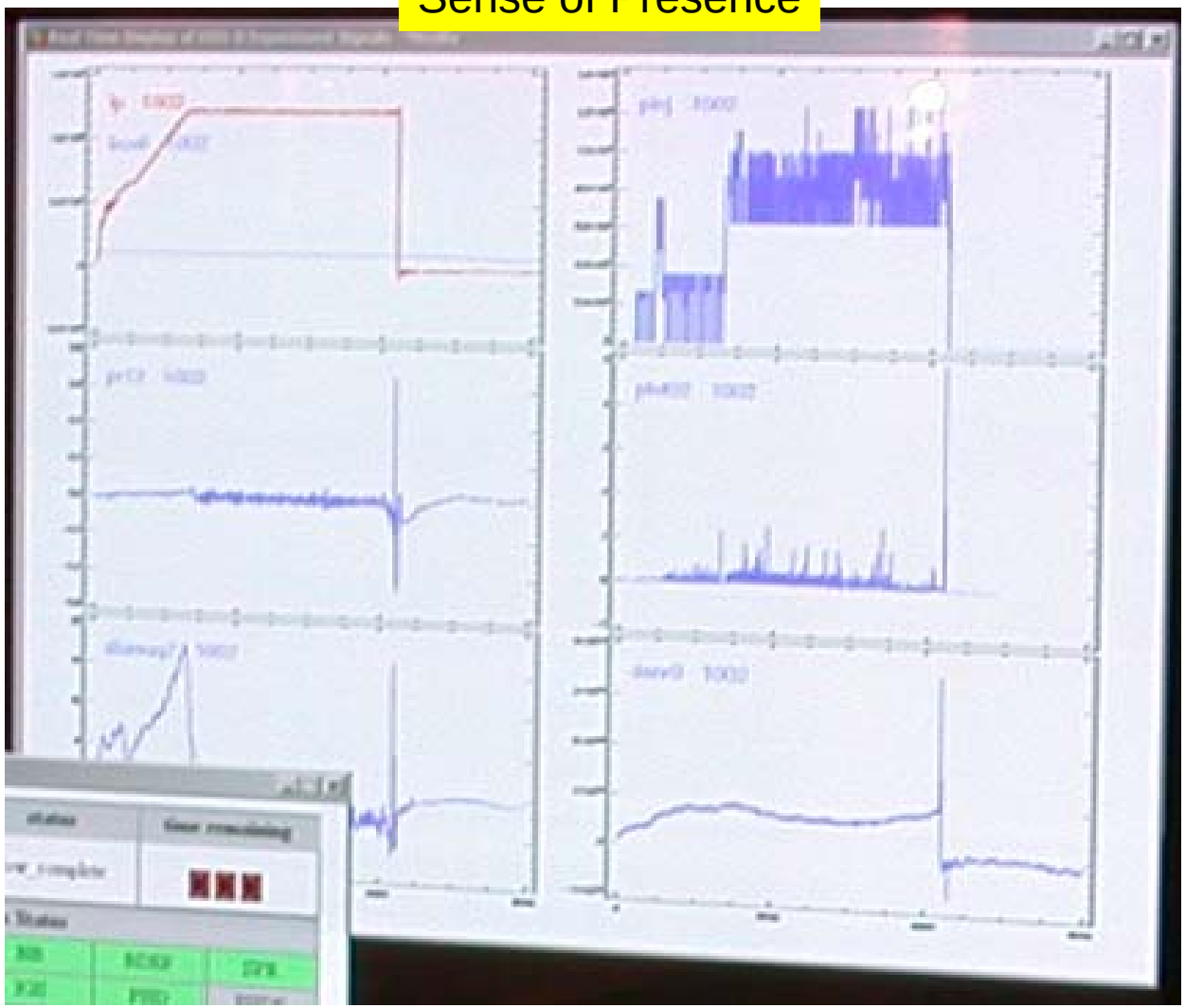
SuperComputing 2003, Phoenix AZ

AUDIO AND VIDEO FROM THE CONTROL ROOM

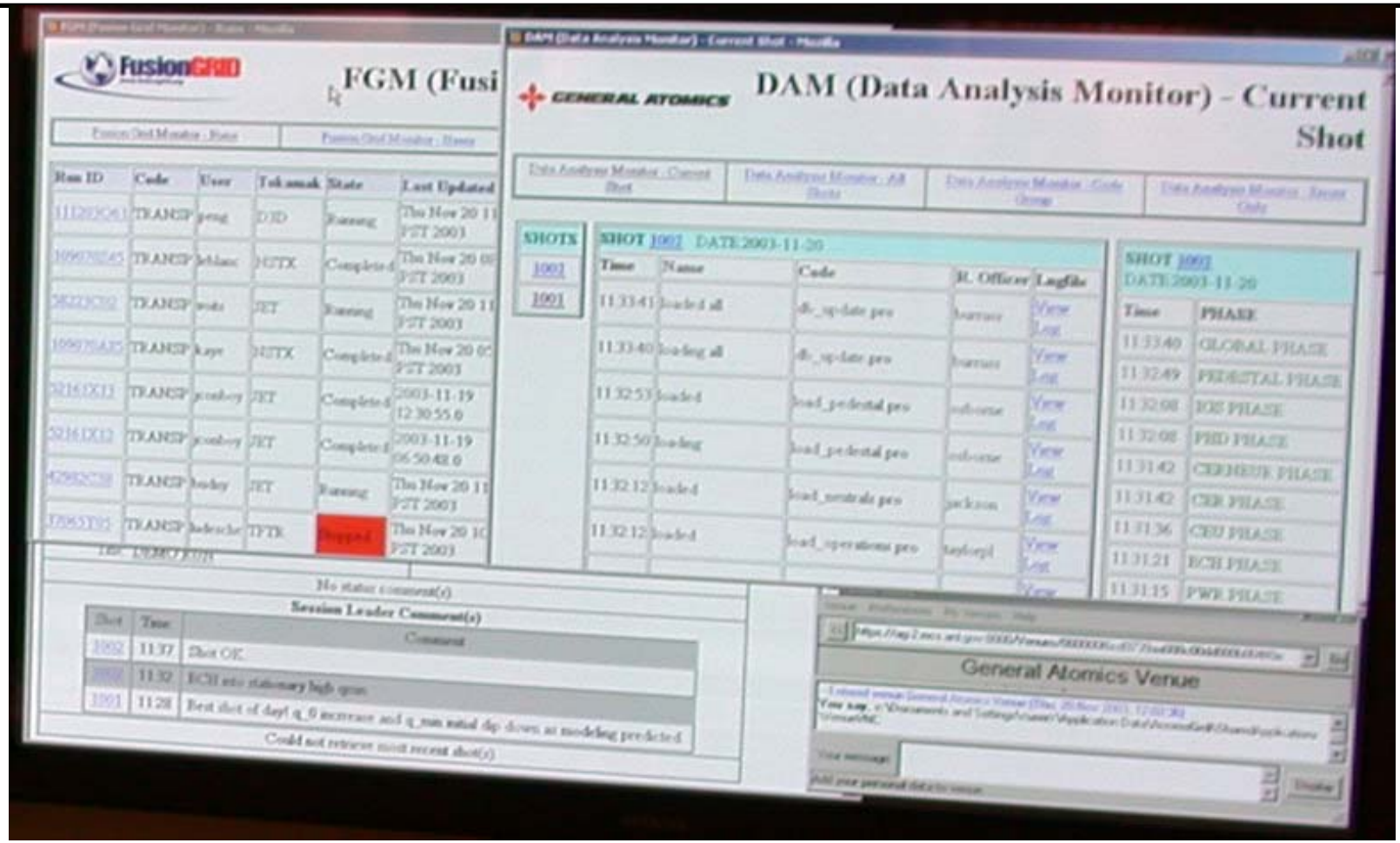
- Moveable camera
  - “Look around” control room
- Multiple audio/video feeds
- For our demonstration, Access Grid
  - Many to one in control room

REAL TIME DATA DISPLAY OF KEY PLASMA PARAMETERS

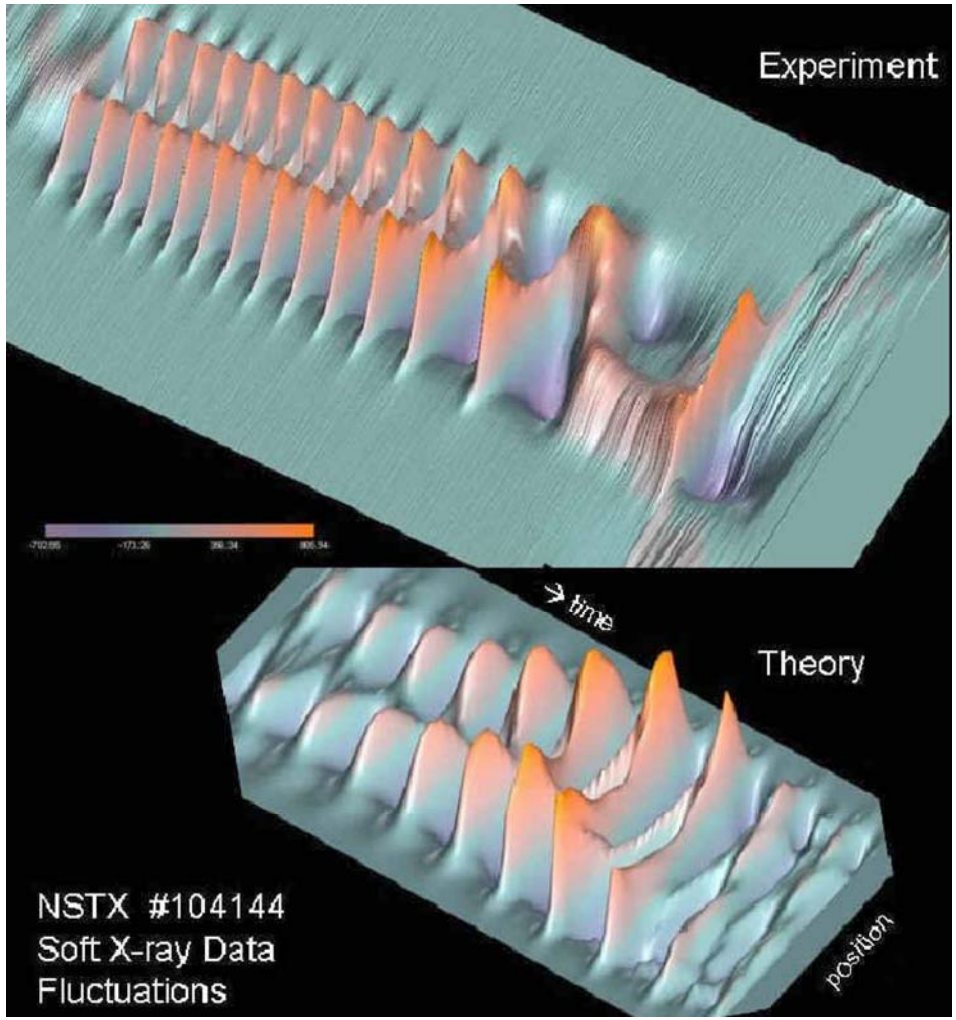
Sense of Presence



ANALYSIS MONITORING AND ELECTRONIC LOGBOOK



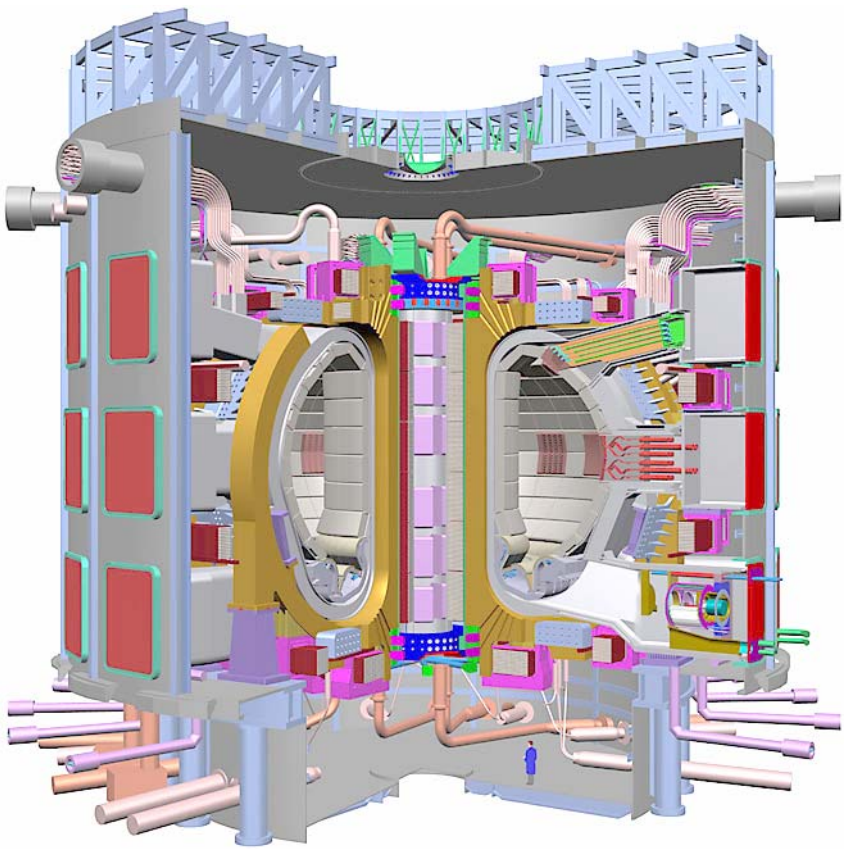
EXPERIMENTAL AND THEORETICAL COMPARISONS ARE CRITICAL TO UNDERSTANDING



IS FUSION GRID READY FOR PRODUCTION?

- Is Fusion Grid ready for production?
  - Successful production release of a service
  - Working on new ways to release software
  - Developing new capabilities
- Some glitches: ease of use and deployment issues
  - Certificate management
  - Firewalls
  - Documentation, training, etc.
- Today's development is tomorrow's production: Fusion services in the control room
  - Agreement-based infrastructure
    - Appropriate for fusion use
    - Needs hardening before use in the control room
  - Access Grid issues
    - Improving sense of presence

BEYOND TOMORROW: THE ITER COLLABORATION



- Successful operation requires effective remote collaboration
- Scalability issues are critical: policy and enforcement
- Timely prototyping of technology can assure ITER needs are met