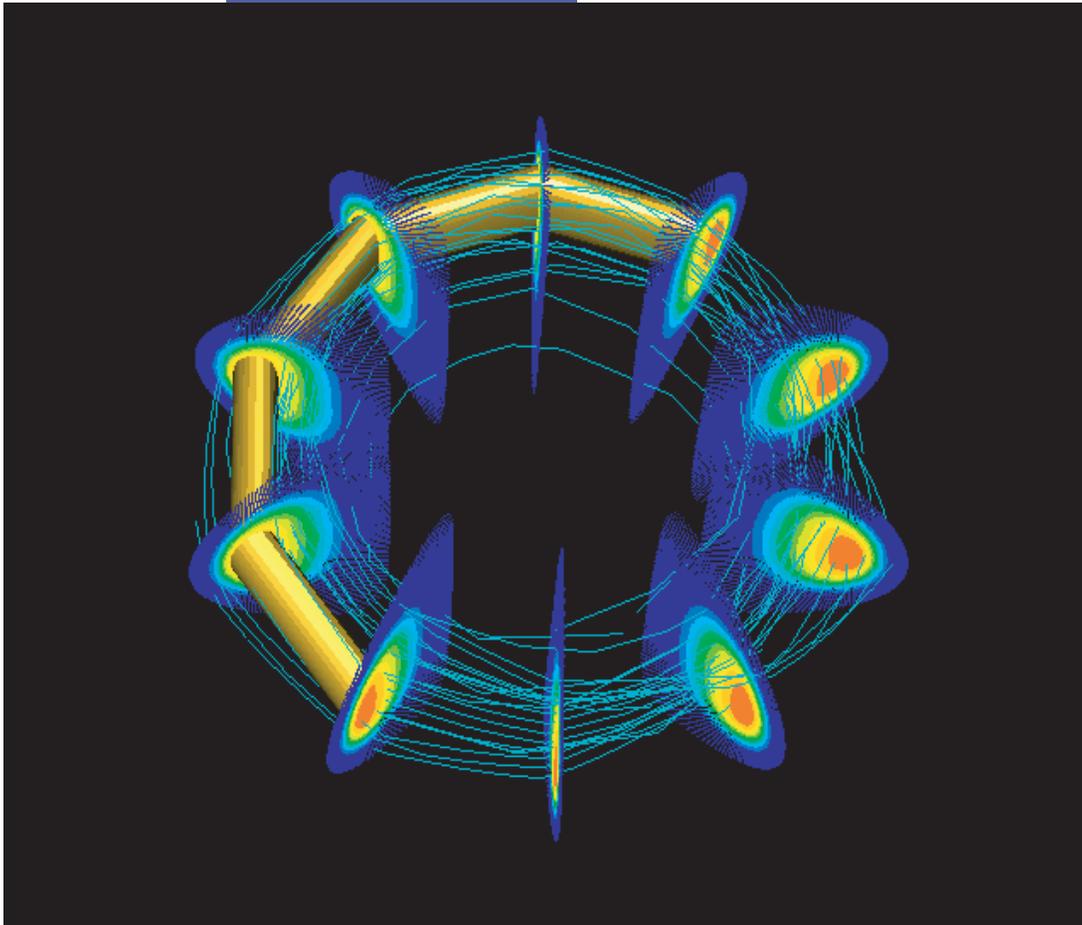


FUSION ENERGY SCIENCES: THOUGHTS ON FUTURE NETWORKING

Presented by David P. Schissel

**Presented at the
DOE High Performance
Network Planning Workshop**

**August 13–15, 2002
Reston, Virginia**

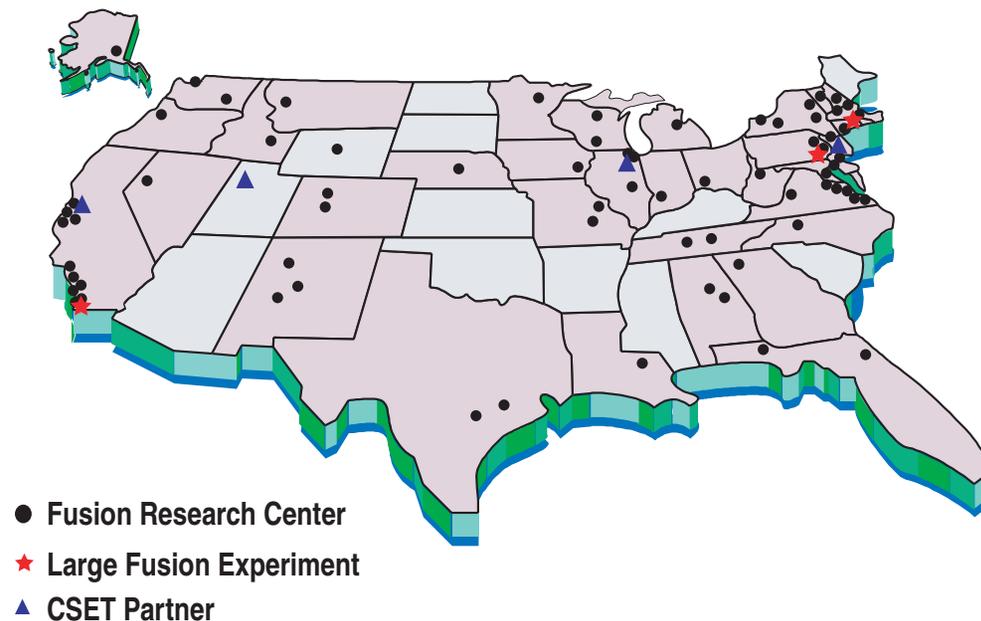


*NIMROD simulated pressure stored
in MDSplus and visualized with SciRUN*



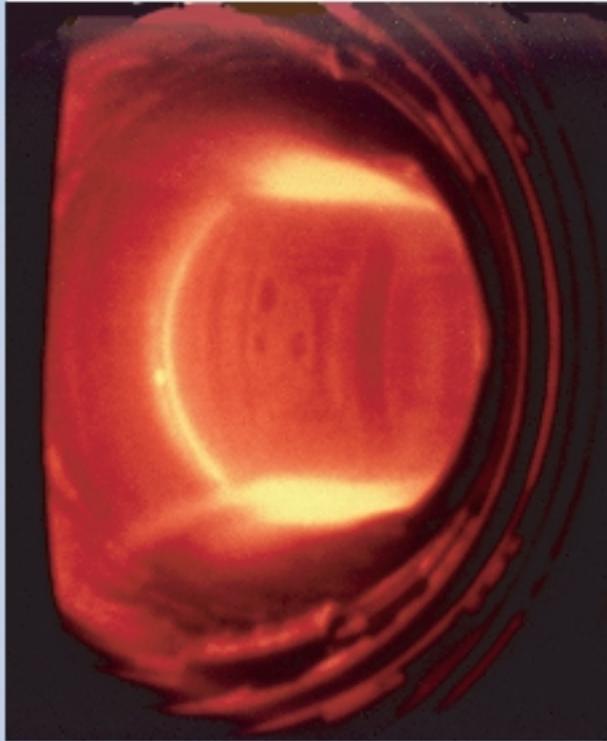
THE MAGNETIC FUSION COMMUNITY HAS 90 US SITES IN 37 STATES

Over 1000 Magnetic Fusion Scientists in the United States - ESNET



- **Three main experimental facilities**
 - CA, NJ, MA worth ~\$1B
 - Pulsed experiments with 15 min cycle
 - ~500 MB/pulse and growing
- **Theory & simulation community**
 - Non-linear 3D plasma models
 - Compare theory & experiment
 - Data sizes similar to other apps
- **Unified data access**
 - Client/Server model
 - TCP/IP based over ESNET

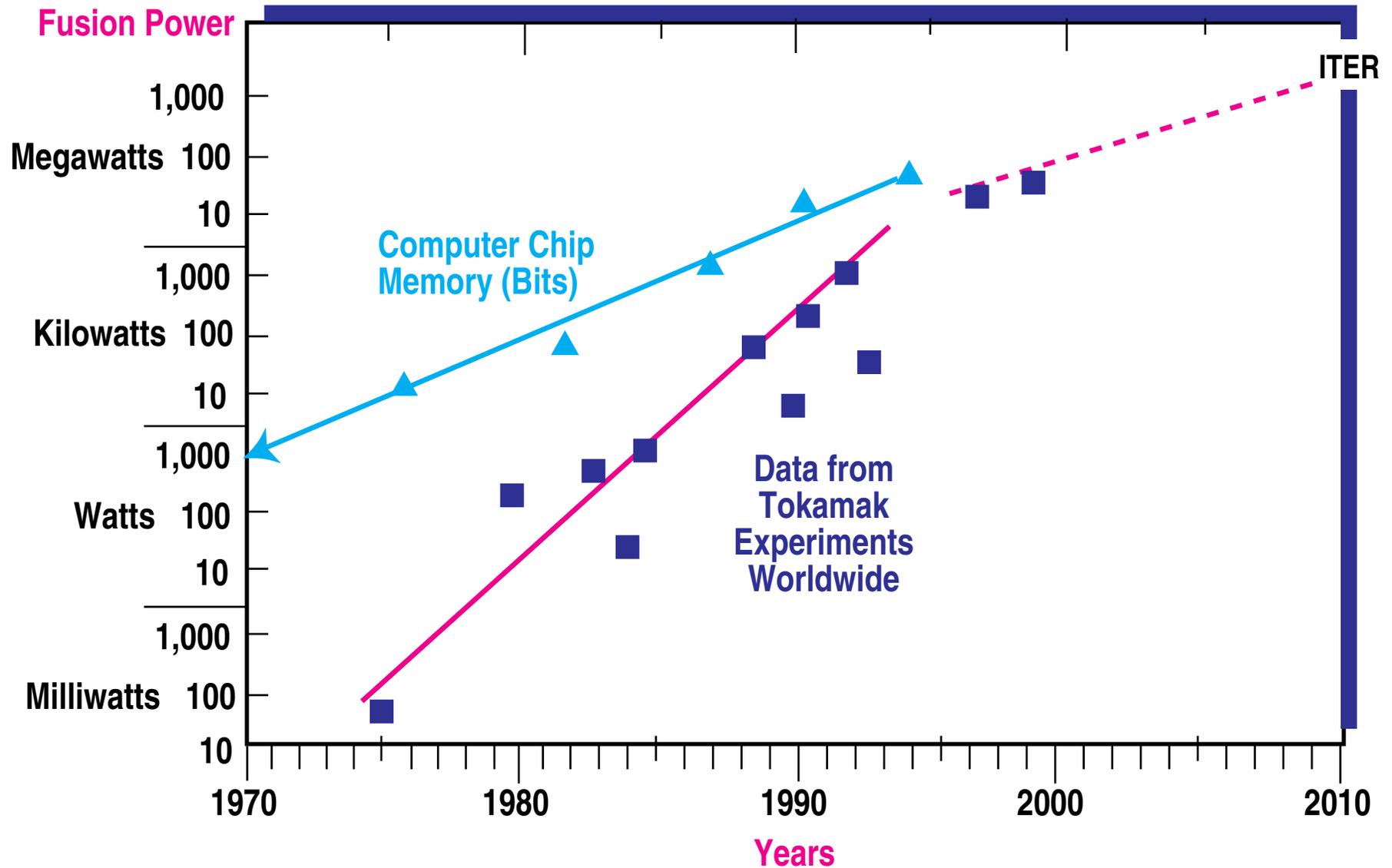
FUSION REPRESENTS A NEARLY INEXHAUSTIBLE ENERGY SOURCE



- 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

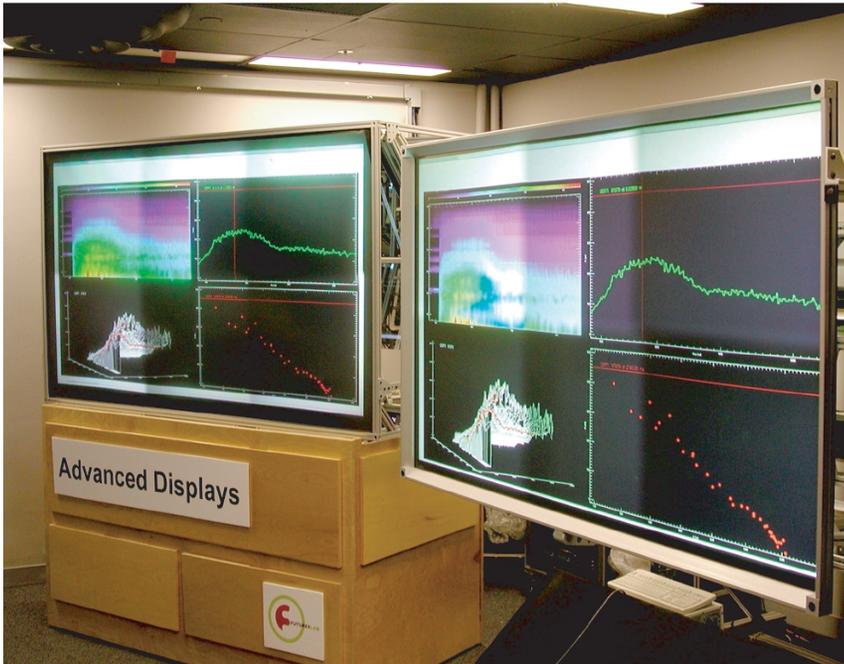


EXPERIMENTAL SCIENCES PLACES A LARGE PREMIUM ON RAPID DATA ANALYSIS IN NEAR-REAL-TIME



- **Pulsed Experiments**
 - 10 s duration plasma every 20 min
- **20 - 40 people in control room**
 - More from remote locations
- **10,000 separate measurements per plasma**
 - kHz to MHz sample rates
 - MDSplus client/server data management
 - Between pulse simulations
- **Expected to be at the 1 GByte level in the next 3 to 5 years**
 - 500 Mbits/sec (20 s to transfer, remaining time to compute and interpret)
 - Intermittently over the year (8 hrs/day, 30 pulses/day, 20 weeks.year)
- **Long Term Goal – What we do overnight, or the next week, we want to do between plasma pulses.**
 - Moving forward with the Fusion Grid (www.fusiongrid.org)

LONG HISTORY OF PRODUCTIVE USE OF ADVANCED COMPUTATION AND MODELING OF FUSION PLASMAS



- Presently 5 SciDAC Initiatives
 - Integrated simulation of plasma core, edge, and plasma-wall interactions.
- Datasets easily to the 1 TB level soon
 - Analyzed like experimental data
 - Dynamic data repository
- Similar network rates of 500 - 1000 Mbits/sec
 - Subset of code run (~1 GB) analyzed interactively (20 s)
- Complex shared visualization will be required
 - Pushing towards the 20 minute experimental pulse cycle

NETWORK SERVICES ARE COMMON TO BOTH SCENARIOS

- **Successful sharing of distributed resources for collaboration**
 - Computers, data, instruments – Grid
 - Challenge: real-time interactions among large experimental teams, the requirement for interactive visualization, processing of very large simulation data sets
 - Shared tools and solutions are valuable so as to reduce the $n \times m$ interactions to a more tractable scale
- **The conflicting requirements of transparency and security**
 - Central management of PKI or equivalent technologies
 - Include international collaborators
- **Global directory and naming services**
 - Distributed computing services for queuing and monitoring
- **Guaranteed bandwidth at particular times or with particular characteristics**