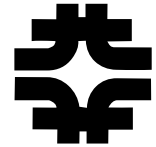


Computing at Fermilab

Fermilab Onsite Review
Stephen Wolbers

August 7, 2002

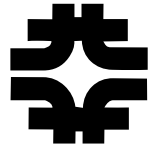
Outline

- Introduction
- Run 2 computing and computing facilities
- GRID Computing
- US CMS Computing
- Lattice QCD Computing
- Accelerator Simulations
- Conclusion/Future

Introduction

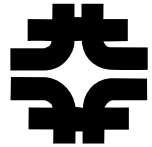
- Computing at Fermilab:
  - Serves the Scientific Program of the laboratory
  - Participates in R&D in computing
  - Prepares for future activities
  - Contributes to nationwide scientific efforts
  - Consists of an extremely capable computing facility
    - With a very strong staff

Introduction (2)



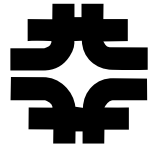
- Fermilab Computing's emphasis has changed to include more participation in non-FNAL and non-HEP efforts.
- Fermilab plans to leverage efforts in computing and expand the "outlook" and involvement with computer scientists, universities and other laboratories.
- Fermilab is in an excellent position to do this because of its involvement in Run 2 (CDF and D0), CMS, lattice QCD, SDSS, and other programs and because of its strong computing facilities.

Run 2 Computing/Facilities



- Run 2 Computing is a major activity of Fermilab Computing Division
- There are many aspects to Run 2 computing, including:
  - Collecting and storing data
  - Processing data
  - Data handling
  - Data analysis

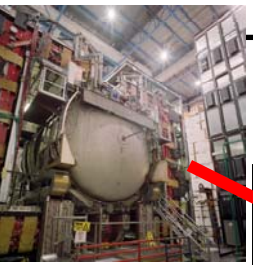
Run 2 Computing/Facilities



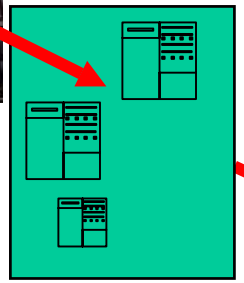
- The activities map into facilities at the laboratory:
  - Networks
  - Mass Storage robotics/tapedrives
  - Large computing farms
  - Databases
  - Operations
  - Support

Run 2 Computing/Facilities

D0 computing systems



"data-logger"



12-20 MBps

"d0-test" and
"sam-cluster"

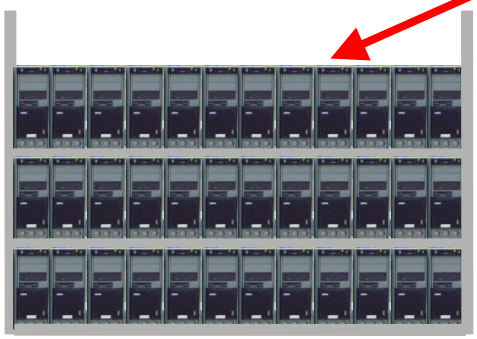
"central-analysis"

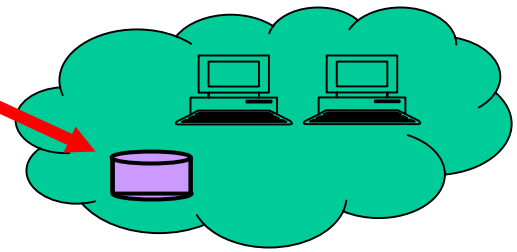
100+ MBps

400+ MBps

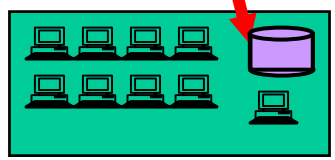
12-20 MBps

"farm"

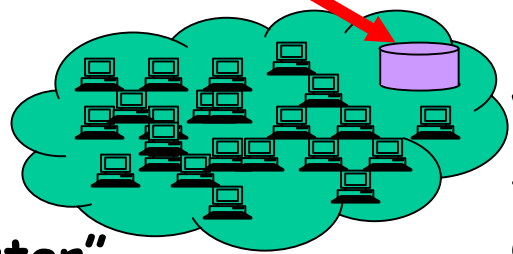




"linux-analysis
-clusters"

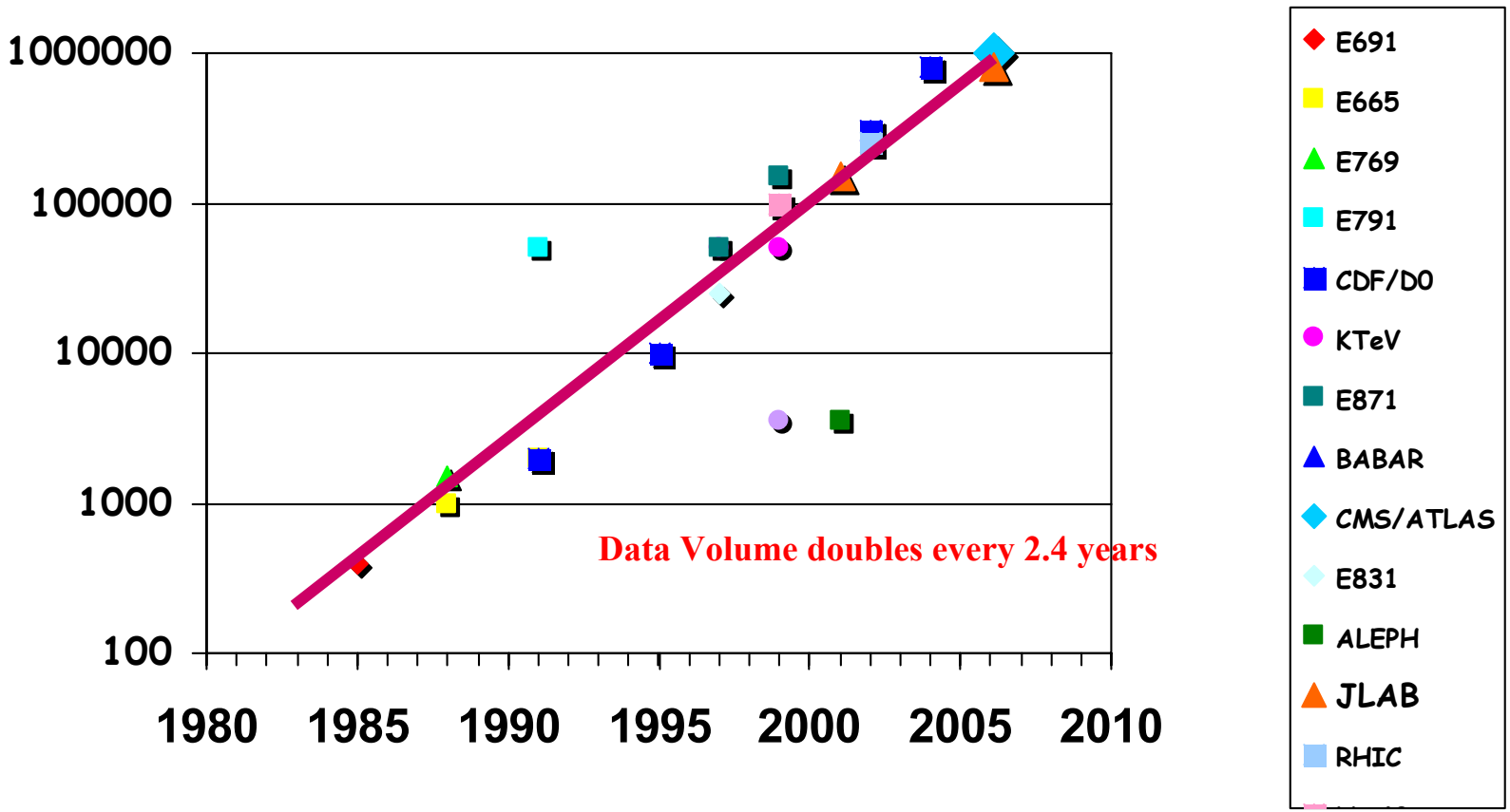


"linux-build-cluster"

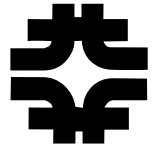


"clueD0"
~100
desktops

Data Volume per experiment per year (in units of 10^9 bytes)



Status of Run 2 computing

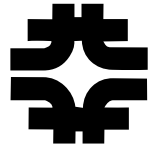


- Total datasets ~ 500 TB /yr /expt (including raw, reconstructed,derived and simulated data)
- Both experiments are logging data reliably and moving data in and out of mass storage on a scale well beyond Run I capability (several TB's / day)
- Both experiments are reconstructing data approximately in real time with reasonable output for start-up analyses
- Both experiments are providing analysis CPU to 150-300 users/day

GRID Computing

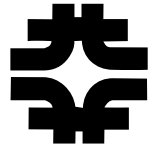
- Fermilab is participating in many GRID initiatives:
  - ppdg (DOE SciDAC)
    - Particle physics data grid
    - Fermilab, SLAC, ANL, BNL, JLAB, Caltech, UCSD, Wisconsin, SDSC
  - Griphyn
    - Grid physics network
  - iVDGL
    - International virtual grid laboratory
- GRID activities have been a very natural outgrowth of distributed computing of the large collaborations.

GRID Computing



- Working on GRID computing projects has many benefits for Fermilab computing
  - Connection with a leading technology in computing
  - Connection with computer scientists in universities and labs in the US and around the world
  - Interaction and participation in real GRID initiatives and software development.
  - Experiment participation in GRID testbeds and production facilities
    - D0, CMS, SDSS, CDF

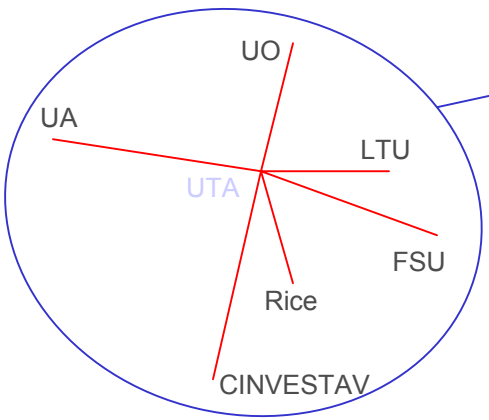
GRID computing

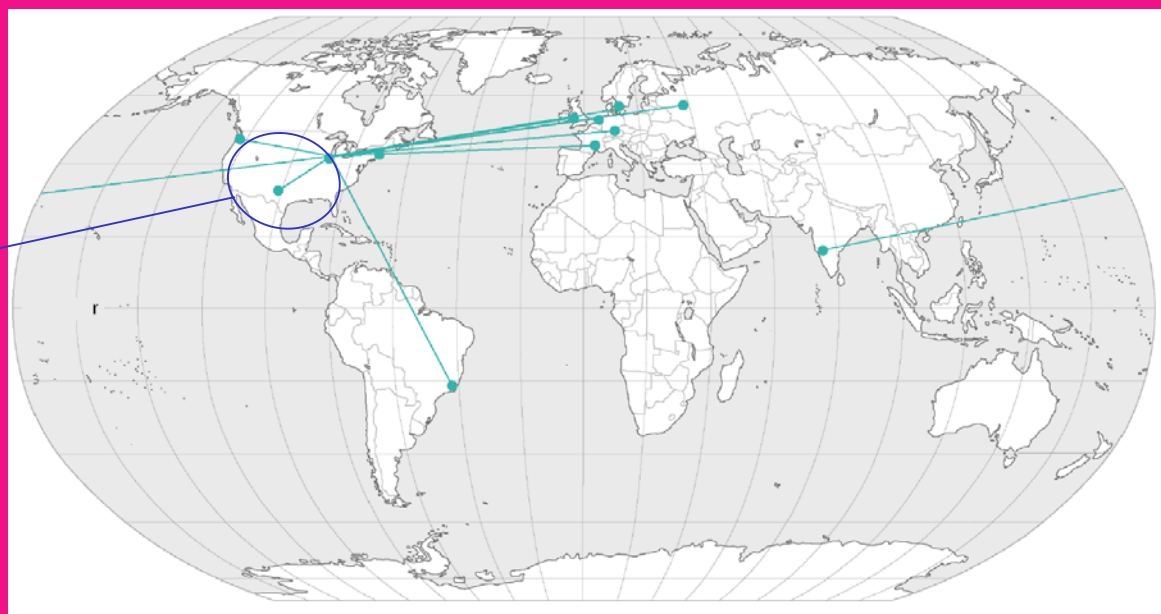


- SciDAC funding for Fermilab is devoted to:
  - D0 GRID work
  - CMS production activities
  - Authentication Issues
  - Mass Storage access across the GRID
- SDSS is working on projects associated with
  - SciDAC
  - Griphyn
  - iVDGL

GRID Computing

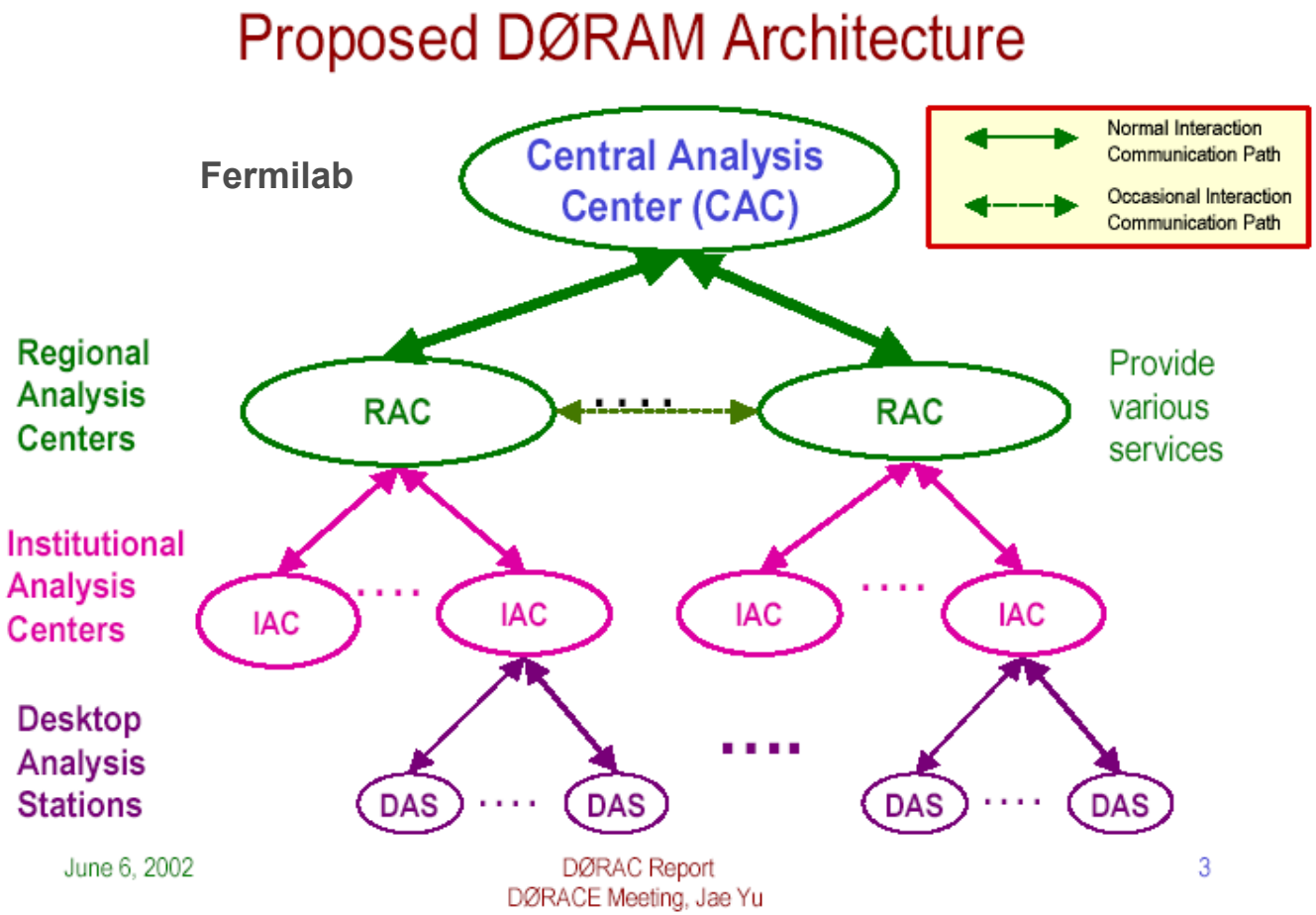
- D0 has a concept of Regional Analysis Centers (RAC's):



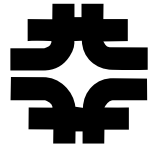


(arbitrary imagined distribution)

GRID Computing

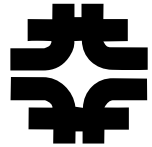


US CMS Computing



- Fermilab is the host lab of U.S. CMS
- Fermilab hosts the project management for the U.S. CMS Software and Computing Program in DOE
  - L1 project manager (Lothar Bauerdick)
  - L2 projects
    - User Facilities (Tier 1 and Tier 2 centers)
    - Core Application Software

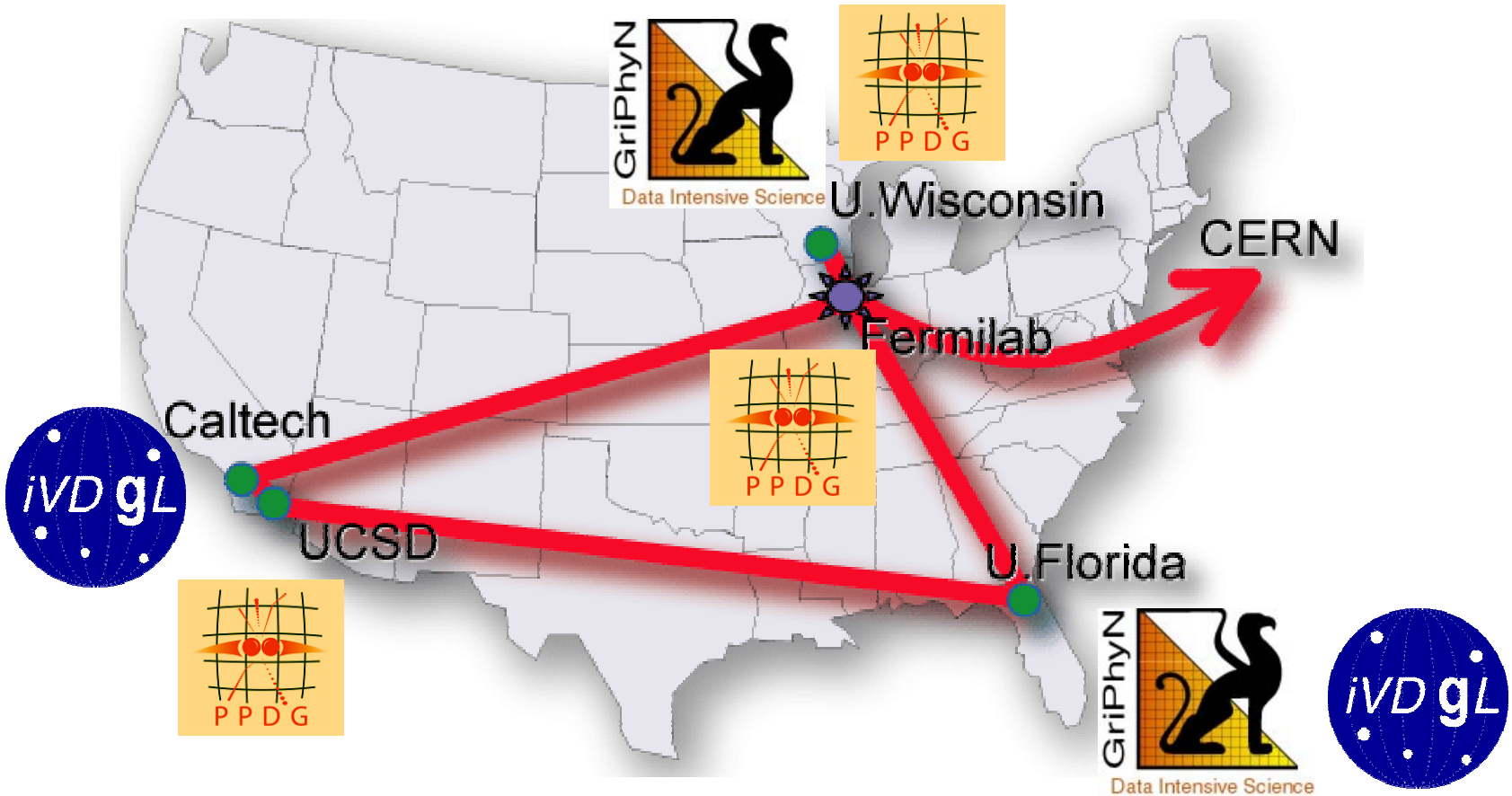
US CMS Computing



- Fermilab and US CMS has been extremely successful and influential in CMS software and computing
  - Influence on CMS software
    - Framework
    - Persistency
    - CMS distributed production environment
  - Tier 1 and Tier 2 regional centers
    - Tier 1 at Fermilab
    - Tier 2 in a small set of universities

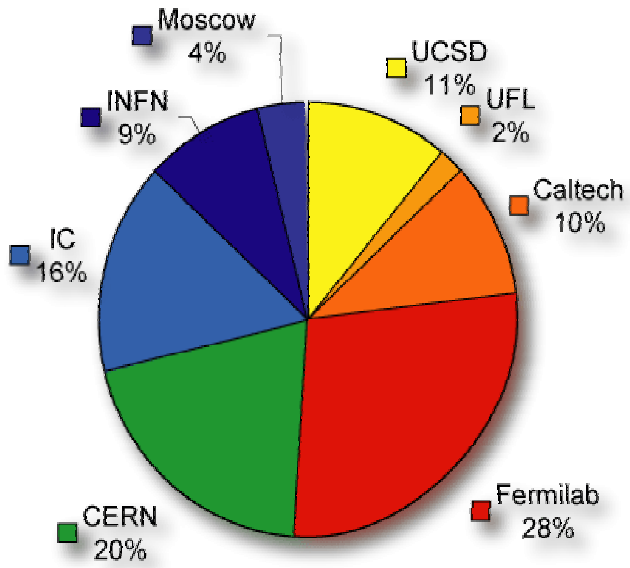
US CMS Computing

Tier 1/Tier 2 Centers and Prototypes

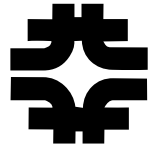


US CMS Computing

- Contribution to CMS is substantial
- Spring production 2002
  - 8.4 million events fully simulated
    - 50% in US
  - 29 TB processed
    - 14 TB in US

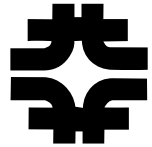


US CMS Computing



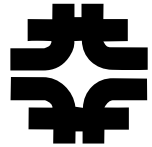
- The US CMS Software and Computing project has been reviewed and “morally baselined”
- Funding has been lower than hoped for
  - Slower ramp-up of staff
  - Smaller hardware purchases
  - Fewer projects being completed
- This will become a bigger issue as CMS data-taking gets closer.

Lattice QCD



- SciDAC-funded Lattice QCD facility at Fermilab
  - Part of a nationwide coordinated effort to provide facilities and software for lattice QCD calculations (Computational Infrastructure for Lattice Gauge Theory)
    - Fermilab
    - Jefferson Lab
    - Columbia/RIKEN/BNL (QCD on a chip, QCDOC)
  - Fermilab is pursuing PC-based solutions along with software from the MILC collaboration.

Lattice QCD

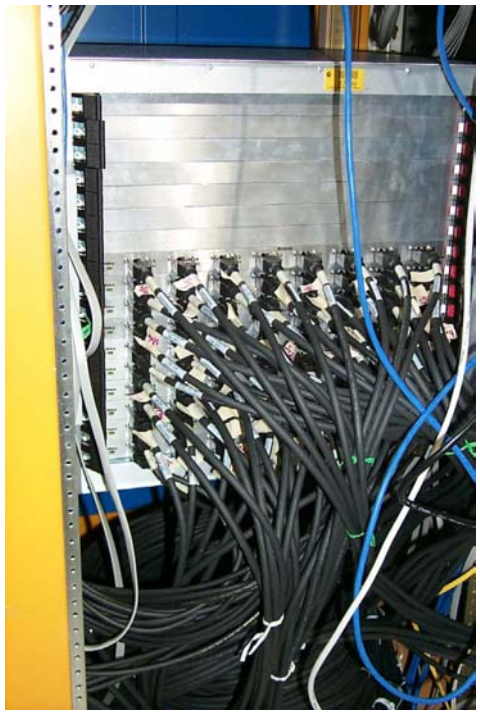


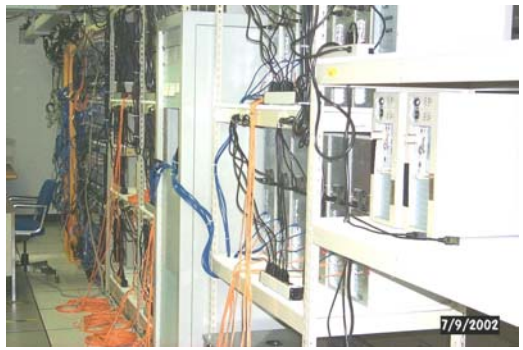
- Fermilab's contributions
  - Large PC clusters
    - Acquisition (128 nodes now)
    - Operation and maintenance
  - Interconnect technologies
    - Commercial/Myrinet
    - Ethernet R&D
  - Software infrastructure
    - Joint effort with MILC collaboration

Lattice QCD

Muon Lab

Complex Interconnects

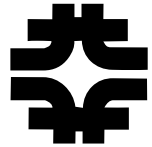




Room To Expand

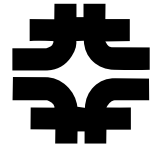
128 Nodes

Lattice QCD



- Goals
  - Larger clusters
    - 128 more nodes within 6 months (0.5 Tflops)
    - Substantially larger within years (>6 Tflops)
  - Software framework and support
  - Facility for research on Lattice problems

Accelerator Simulations



- CD is involved in a SciDAC program of accelerator simulations
  - With SLAC and LBNL
- Plan to work on many topics
  - Booster simulations at Fermilab
  - General beam-beam codes

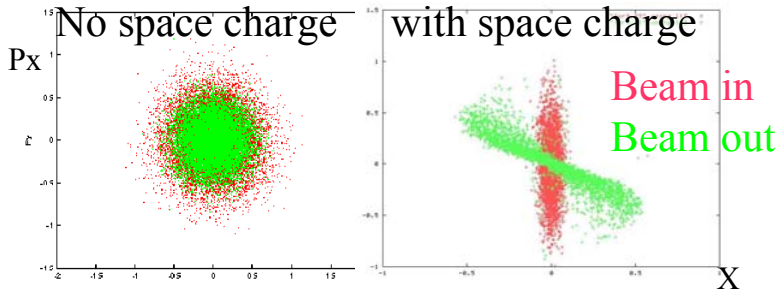
Accelerator Simulations

- Incorporate Ionization Cooling modules in Beam Dynamics Codes
- Develop code with 3D space-charge capabilities for circular accelerators

  (in collaboration with BD theory)
  - Model & study the FNAL Booster.
  - Beam data comparison with simulation: almost unique in this business!

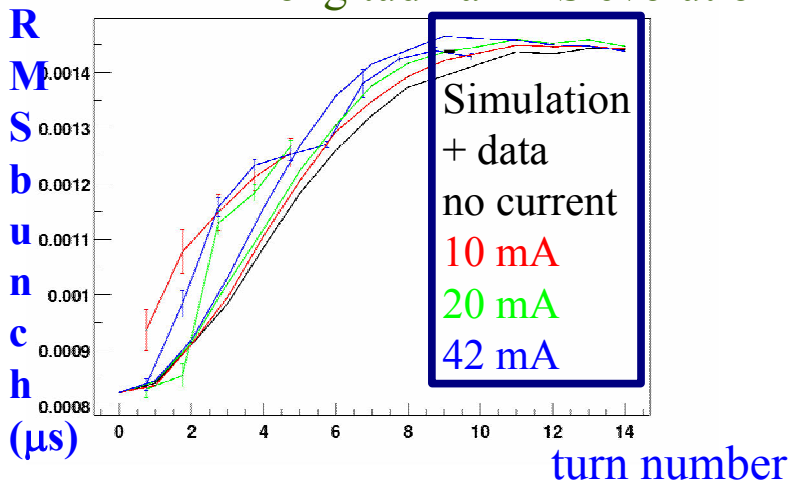
  (in collaboration with Booster group)

Ionization Cooling Channel

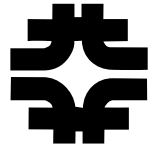


1PE: 500 particles, 460 sec 128 PE: 500K particles, 4400 sec

Longitudinal PhS evolution



Summary



- Fermilab Computing is in an excellent position to support the physics program of the laboratory and to participate in and foster partnerships with our collaborators, computer scientists and other institutions.
- By participating in these programs and by building working relationships we are in a position to better extend our capabilities in:
  - Distributed and GRID computing (important for most of our collaborations)
  - Lattice QCD
  - Beam simulations