Jefferson Lab

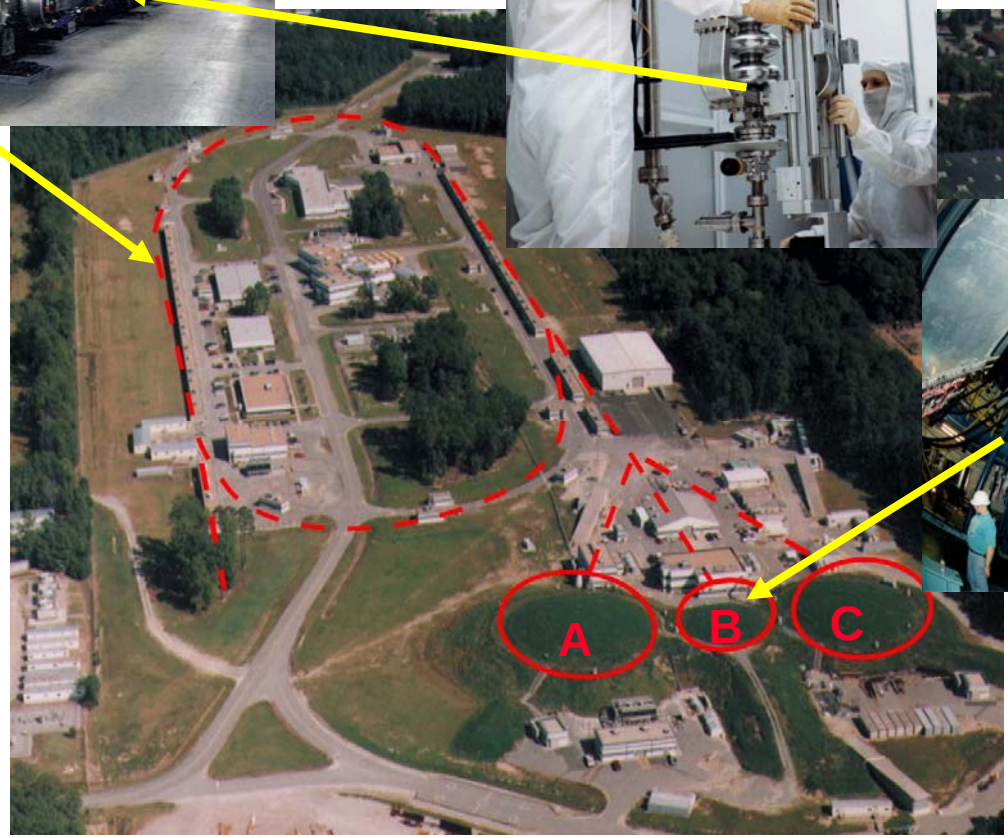
3rd Topical Workshop on Lattice Hadron Physics (LHP06)

Roy Whitney, CIO

Operation of a Unique User Facility Enables Forefront Science

Superconducting radiofrequency (SRF) cavities undergo vertical testing.

Cryomodules in the accelerator tunnel

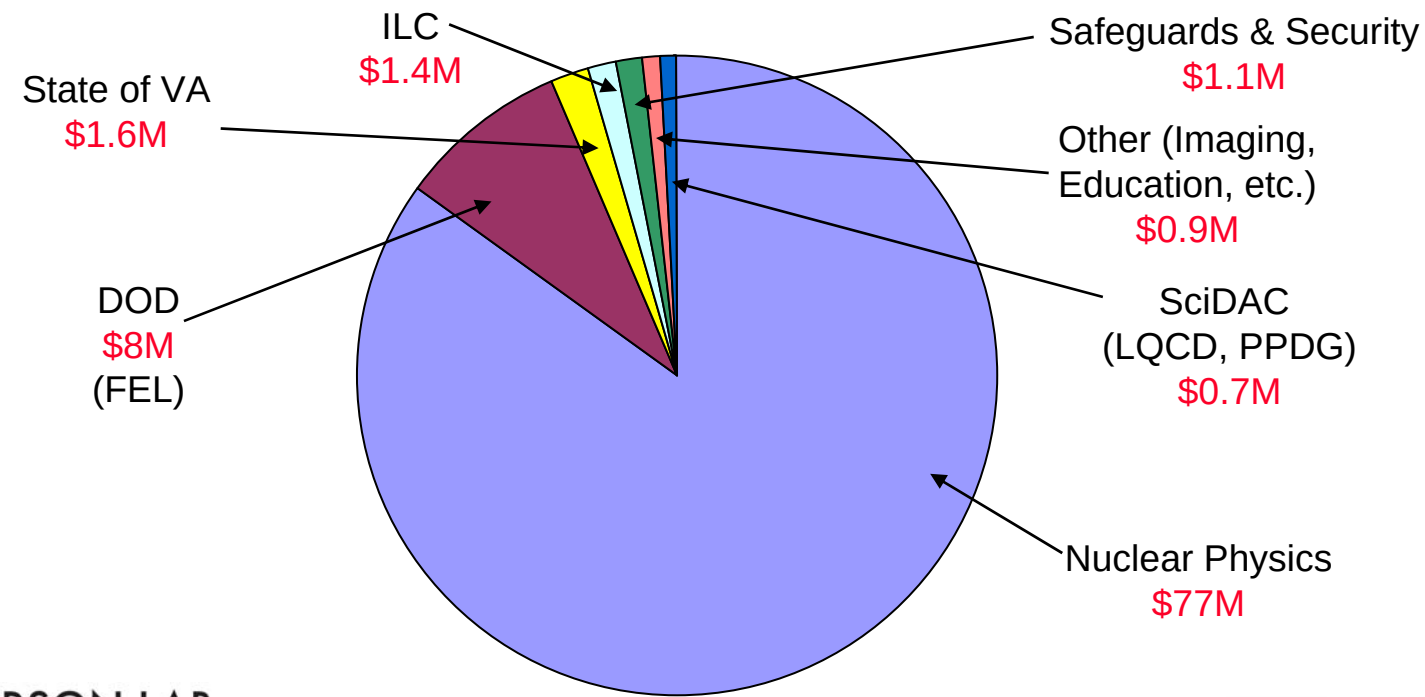


An aerial view of the recirculating linear accelerator and 3 experimental halls.

CEBAF Large Acceptance Spectrometer (CLAS) in Hall B

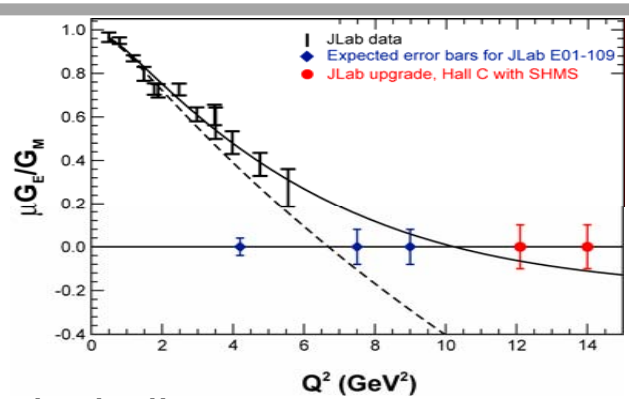
Jefferson Lab at a Glance – Basic Facts

- Managed for DOE by new M&O contractor, Jefferson Science Associates under a cost reimbursable award-fee contract (awarded April 2006)
- ~630 employees, with 37% having advanced degrees, including 134 with Ph.D.s
- International community of more than 2,000 users
- Program-dedicated laboratory with funding of ~$90.7M as follows (FY06):



6 GeV – A Productive, High Impact Program Redefines Thinking About Nucleons And Nuclei

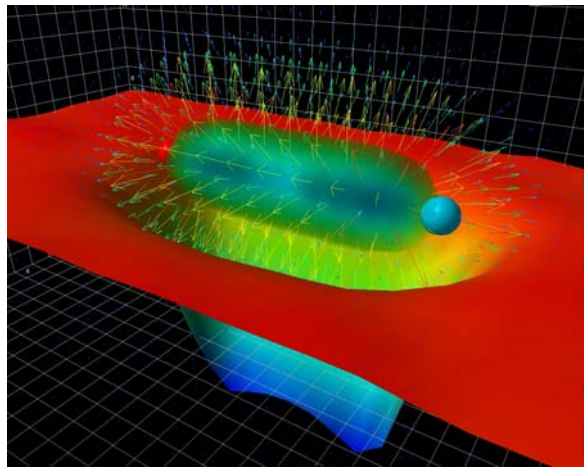
Since Inception



- Form factors
  - G_E/G_M, other n and p form factors
  - Modification of proton form factor in ^{4}He.... new measurements to come
- Measurement of spin dependent structure functions, including:
  - g_{1n} zero crossing seen for the first time
  - Measurement of Bjorken sum-rule vs Q^2 - conformal behavior at low Q^2
- Studies of precocious scaling/duality to low Q^2
- Confirming strong short distance correlations in nuclei
- High energy resolution in a new approach to hyper-nuclear spectroscopy.... new types of states can be studied
- Semi-inclusive deep inelastic scattering in Hall C, a tool to explore flavor dependence of spin dependent parton distributions

The Future - The 12 GeV Upgrade Will Enable Breakthrough Research in Four Areas

- The experimental study of the confinement of quarks – one of the outstanding questions for 21st century science – why are quarks never found alone?

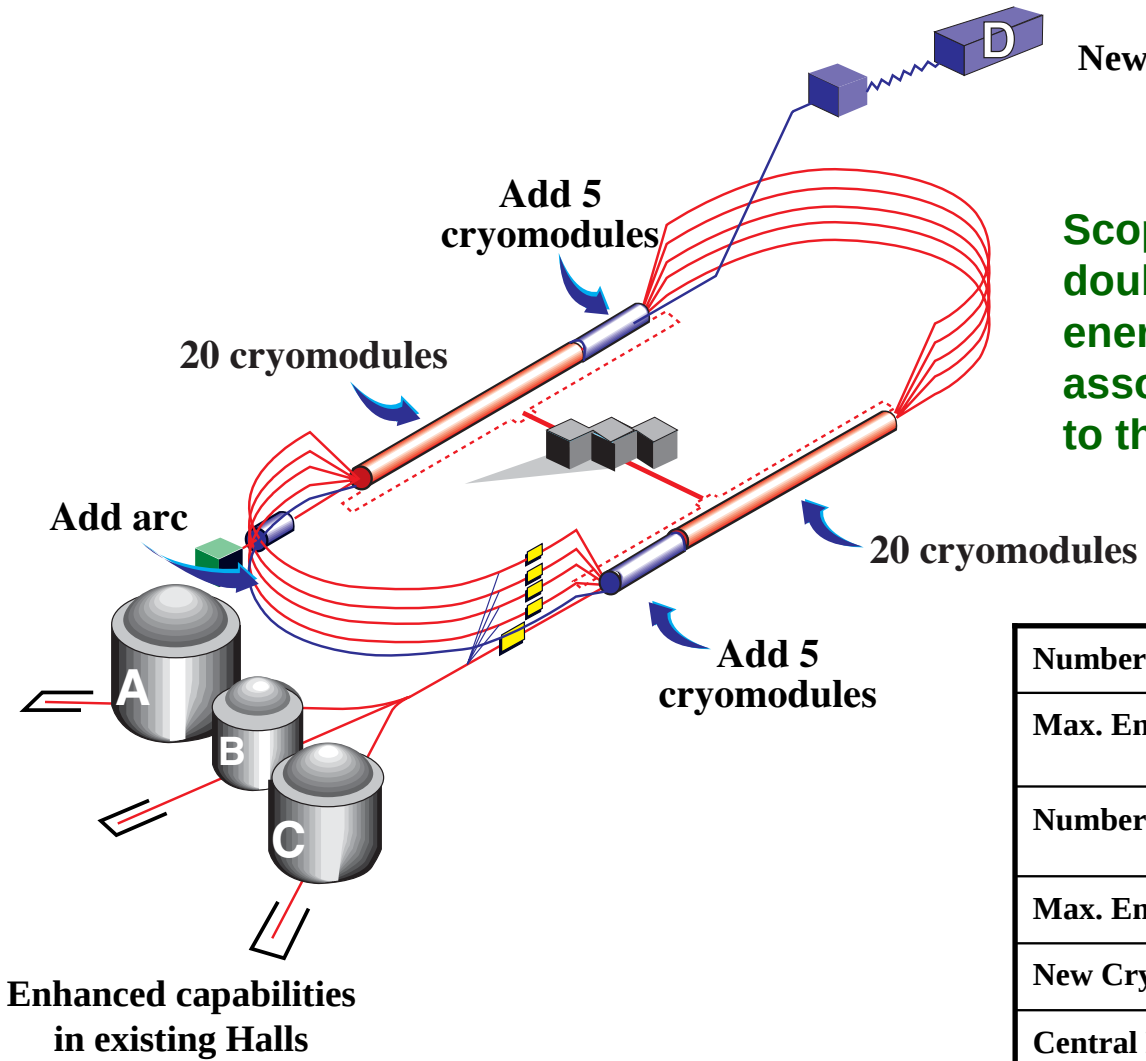


- Increase knowledge of the fundamental quark-gluon structure of the nuclear building blocks: the proton and neutron (3-D tomography of the nucleon and valence quark structure)

- Increase understanding of nuclei in terms of nucleons and the *N-N* force and the QCD basis for that understanding

- Allow precision experiments with sensitivity to new physics beyond the Standard Model

For the Science Of The Next Decade and Beyond: The 12 GeV Upgrade

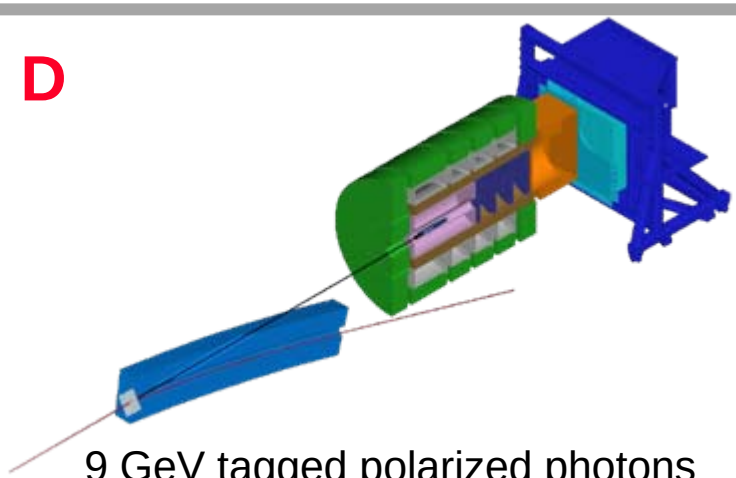


Scope of the proposed project includes doubling the accelerator beam energy, a new experimental Hall and associated beamline, and upgrades to the existing three experimental Halls.

Number of passes for Hall D	5.5 (add a tenth arc)
Max. Energy to Hall D	12 GeV (for 9 GeV photons)
Number of passes for Halls A/B/C	5
Max. Energy to Halls A/B/C	11 GeV
New Cryomodules	10 (5 per linac)
Central Helium Liquefier upgrade	9 kW (from present 4.5 kW)

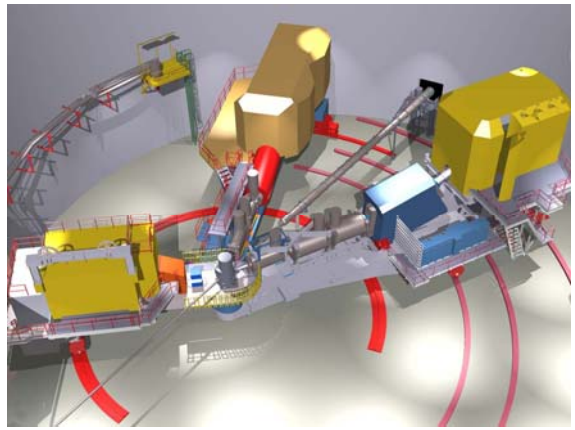
New Capabilities in Halls A, B, & C, and a New Hall D

D



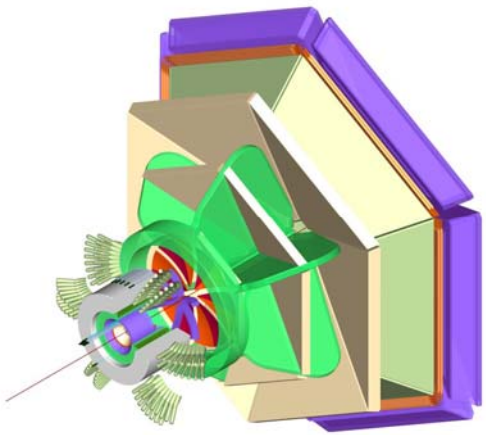
9 GeV tagged polarized photons and a 4π hermetic detector

C



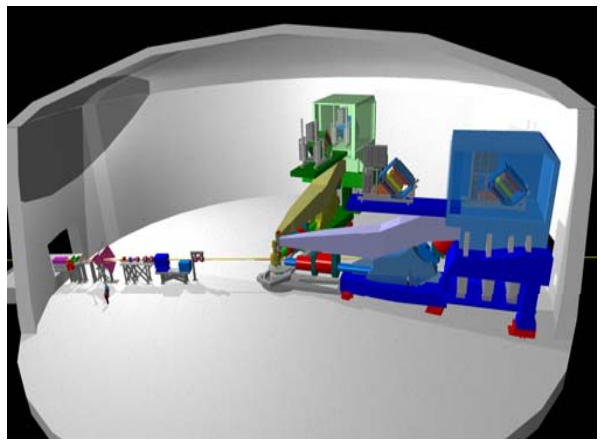
Super High Momentum Spectrometer (SHMS) at high luminosity and forward angles

B



CLAS upgraded to higher luminosity and coverage

A



High Resolution Spectrometer (HRS) Pair, and specialized large installation experiments

Lattice QCD at Jefferson Lab

- Lattice QCD at Jefferson Lab is both a theory program and a platform (hardware and software) development program
- SciDAC is a key R&D vehicle

  Develop infrastructure and tools

  - Machine abstraction – enable portable code between clusters and custom and commercial hardware
  - Numerical kernel optimization for high performance on specific platforms
  - Libraries and tools for data analysis and sharing
  - Prototype hardware for code development and architecture evaluation
- R&D Effort feeds greater LQCD Computing Project

SciDAC Prototyping

Under the SciDAC-1 project, JLab evaluated and deployed a series of commodity technologies for optimized clusters for Lattice QCD.

2001	16 node DEC Alpha +myrinet cluster	0.015 TF
2002	128 node Xeon + myrinet cluster	0.08 TF
	(64 nodes funded by JLab as matching)	
2003	256 node Xeon + gigE mesh cluster	0.19 TF
	(128 nodes funded by JLab as matching)	
2004	384 node Xeon + gigE mesh cluster	0.46 TF
	(128 nodes funded by JLab for theory group)	
2005-6	140 node Pentium-D + infiniband cluster	0.34 TF
	(70 nodes funded by JLab for theory group)	
	(this cluster later expanded to 280 nodes)	0.67 TF

Current Clusters at Jlab

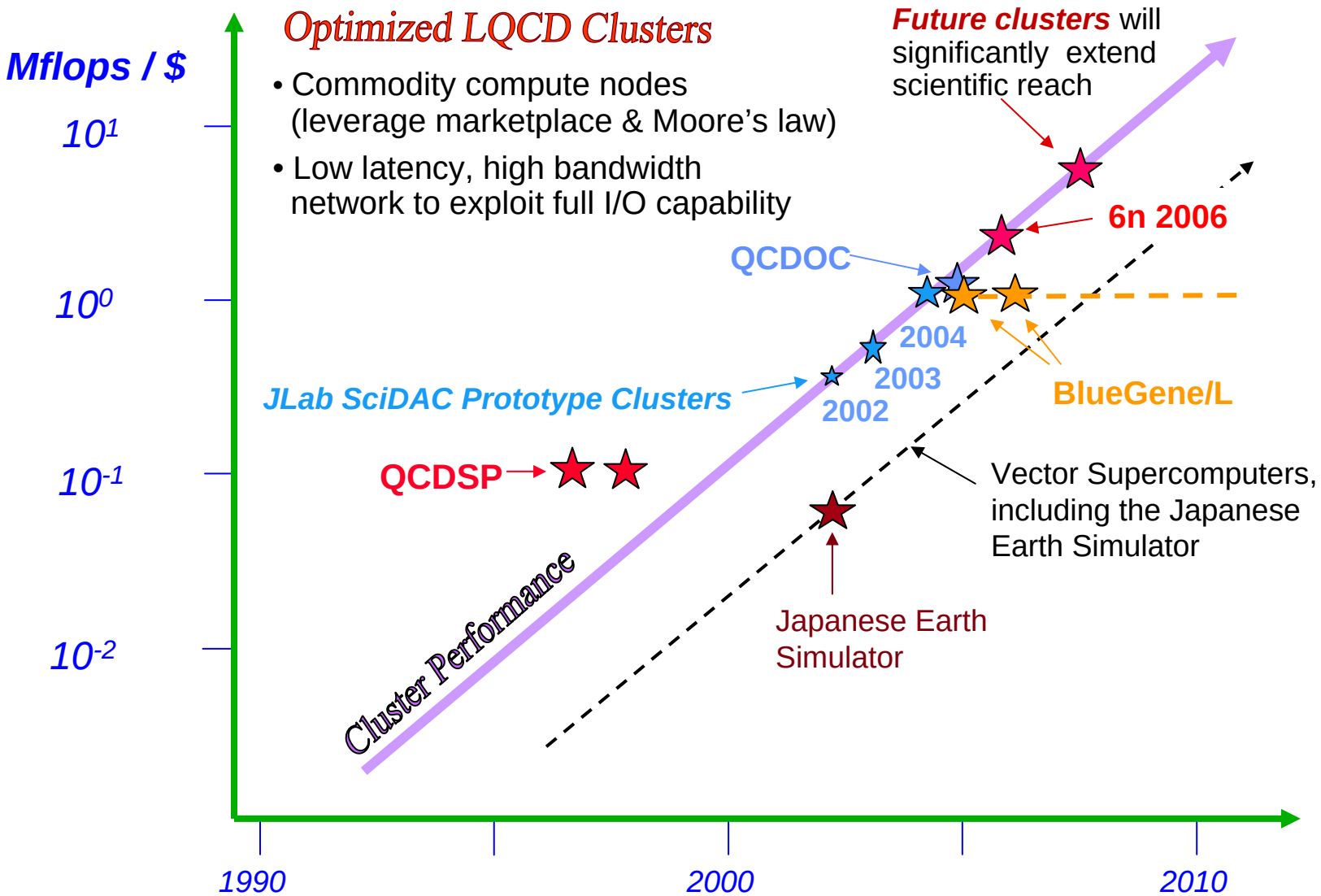
2003 – 3G Cluster
3D Gigabit Ethernet fabric
256 2.67 GHz Xeons
190 Gflops sustained

2004 – 4G Cluster
5D Gigabit Ethernet fabric
384 x 2.8 GHz Xeons
460 Gflops Sustained

Over 1 Tflop/s Computational Capacity for Science

2006 – 6N Cluster
Infiniband fabric
280 2.8 GHz Pentium-D dual core nodes
670 Gflops Sustained

Performance per Dollar for Lattice QCD Applications



National Lattice QCD Computing Project

This HEP + NP funded activity complements the SciDAC project by deploying large scale resources in support of Lattice QCD for a national user community.

2006	Analysis cluster at JLab
2006	Large cluster at FNAL (deploying Sept 06)
2007	Large cluster at JLab
2008+9	Large cluster at FNAL

The Lattice QCD Computing Project also funds the operation of the QCDOC and SciDAC prototype clusters as a coherent resource, with a single allocations committee.