

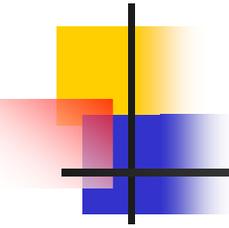
# LQCD Project Overview

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Don Holmgren  
LQCD Project Progress Review

May 25-26, 2006

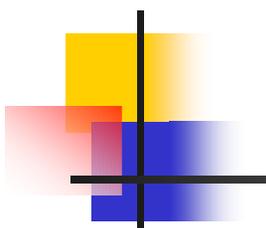
Fermilab



# Project Scope

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- The construction/purchase of new clusters/systems
- The operation of the U.S. QCDOC at Brookhaven, the existing SciDAC clusters at Fermilab and Jefferson Lab, and the systems acquired during the project
- Labor for system administration, hardware support, and site management
- Not in scope (provided by SciDAC/Base):
  - Labor for scientific software support
  - Software development



# Existing Systems (as of Oct 1)

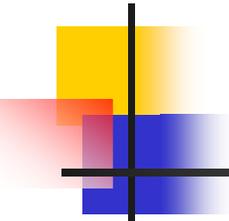
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- BNL:
  - US QCDOC, 12288 nodes, 4.2 Tflops
- Fermilab:
  - QCD, 127 nodes, 0.15 Tflops
  - Pion, 518 nodes, 0.86 Tflops
- JLab:
  - 2M, 128 nodes, 0.06 Tflops (retired May 2006)
  - 3G, 256 nodes, 0.19 Tflops
  - 4G, 384 nodes, 0.46 TFlops

# LQCD Staffing – FY06

Project + Base/SciDAC FTE	sysadmin / technician	Scientific software & user support	site management
BNL	0.75	0.5	0.25
FNAL	1.75	0.5	0.25
JLab	0.65	0.5	0.25

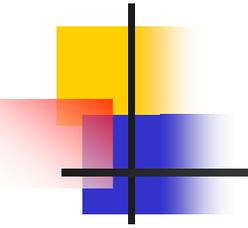
Manpower increases at FNAL, JLab after FY06 as size of operated systems grows.



# LQCD Milestones

- Top level milestones
  - As listed in LQCD OMB FY2007 Exhibit 300
  - Revisions to be discussed in a later talk
  - Deployment and delivery in each year as shown
  - Also, a progress review by June 30 in FY06-FY08

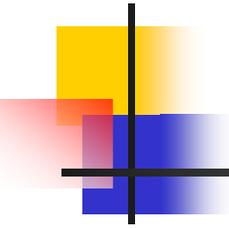
Year	Deliver (Tflops-Yrs)	Deploy (Tflops)
FY2006	6.2	2.0
FY2007	9	3.1
FY2008	12	4.2
FY2009	15	3.0



# Definitions

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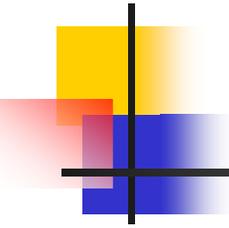
- **TFlops** = average of domain wall fermion (**DWF**) and MILC **asqtad** performance.
  - **asqtad** and **DWF** are the two most common “actions” used in US LQCD calculations
  - Ratio of **DWF:asqtad** performance is typically 1.2:1, but this varies by machine (as high as 1.4:1)
  - “Top500” TFlops are considerably higher (2:1 – 3:1)
- **TFlops-yr** = available time-integrated performance during an 8000-hour year
  - Remaining 800 hours are assumed to be consumed by engineering time and other downtime



# Budget Breakdown

- \$9.2M total, \$2.5M FY06-FY08, \$1.7M FY09
  - HEP funding: 80%
  - NP Funding: 20%
- Mixture of operations and equipment:

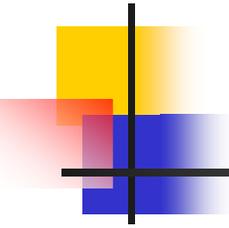
Year	Operations	Equipment
FY06	\$650K	\$1850K
FY07	\$884K	\$1616K
FY08	\$960K	\$1540K
FY09	\$1032K	\$668K
Total	\$3526K	\$5674K



# LQCD Metafacility

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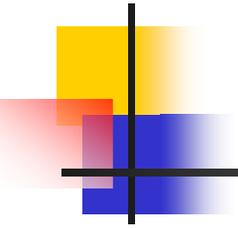
- The LQCD project has no need for a computational grid
  - Scientific allocations are for 12 months and a given allocation runs at one site only
  - Intermediate data products are large so local access more efficient
  - Hardware is heterogeneous (QCDOC, and gigE mesh, Myrinet, and Infiniband clusters) → no binary compatibility possible
- A data grid will be a convenience for users
  - Minimal impact if delayed
  - 99% of all data access is local
  - Users currently rely on [scp](#) and occasionally grid tools to move files
  - ILDG (International Lattice Data Grid) software deployment this summer will provide a metadata catalog, a replica catalog, and data access services



# LQCD Metafacility cont'd

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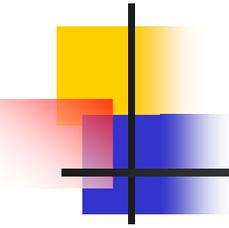
- Common Runtime Environment
  - Goal: Allow site independent Makefiles, batch and run scripts
  - Standards include file system layouts, interactive, batch, and parallel execution environments
  - Part of the SciDAC project (external dependency)
  - **Status:** draft standard available, implementation by end of July
- 0.15 FTE assigned (Metafacility Operations Manager)
  - Defines and coordinates ILDG and Common Run Environment deployments
  - Coordinates documentation and testing



# Integrated Baseline Review – May 2005

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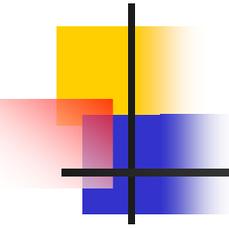
- Major recommendations regarding deployments from May '05 Integrated Baseline Review:
  - Build one system (cluster) per year
  - Alternate sites (Fermilab/Jefferson Lab)
  - Choose site and design of each purchase to maximize science output



# Project Response

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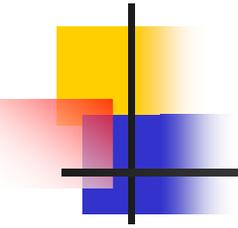
- Delivered at August 8, 2005 meeting in Germantown
- Proposed deployment in FY06:
  - 0.4 Tflops cluster at JLab (0.2 Tflops SciDAC/base, 0.2 Tflops project), based on Infiniband and FY05 Fermilab “Pion” cluster, large enough to do DWF algorithm development and analysis of MILC asqtad configurations with DWF fermions
    - Critical to establish Infiniband expertise at JLab to prepare for a large cluster in FY2007
    - Release to production by June 30
    - Status: released May 1



# Project Response

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- Deployment in FY06, cont'd:
  - 2.0 Tflops cluster at FNAL (0.2 Tflops SciDAC / supplemental, 1.8 Tflops project), based on Infiniband, sufficient for configuration generation and analysis of fine lattices
  - Wait for FBDIMM memory architecture, which promises the memory bandwidth required for meeting our performance goals
  - Release to production by Sept 30
  - Status: On schedule, Opteron-based, delivery in July/August
    - FBDIMM architecture has disappointing performance
- Subsequent deployments would be at most one per year, alternating sites
  - We will discuss in a later talk the advantages of combining FY08/FY09

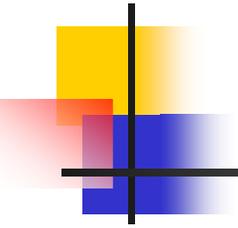


# Significance and Relevance of Research

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## Major research objectives

- Calculate weak interaction matrix elements to the accuracy needed for precise tests of the Standard Model.
- Determine the properties of strongly interacting matter at high temperatures and densities.
- Calculate the masses of strongly interacting particles and obtain a quantitative understanding of their internal structure.

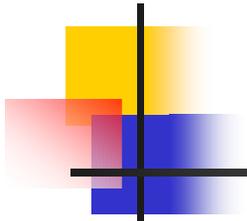


# Significance and Relevance of Research

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Relevance to experimental programs in high energy and nuclear physics:

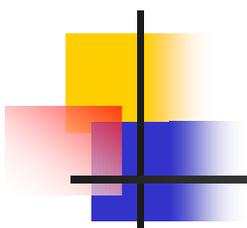
- Weak matrix elements: Babar (SLAC), D0 and CDF (FNAL), CLEO-c (Cornell)
- High temperature/density QCD: RHIC (BNL)
- Hadron structure: CEBAF (JLab), RHIC (BNL)



# Some Recent Achievements

Validation through calculations of quantities that are well determined experimentally (validation of calculational approach):

Quantity	Lattice QCD	Experiment
$\alpha_s (M_Z)$	$0.1170 \pm 0.0012$	$0.1187 \pm 0.0020$
$f_K / f_\pi$	$1.210 \pm 0.014$	$1.223 \pm 0.012$
$V_{us}$	$0.2219 \pm 0.0026$	$0.2262 \pm 0.0023$
$g_A$	$1.226 \pm 0.084$	$1.2695 \pm 0.0029$

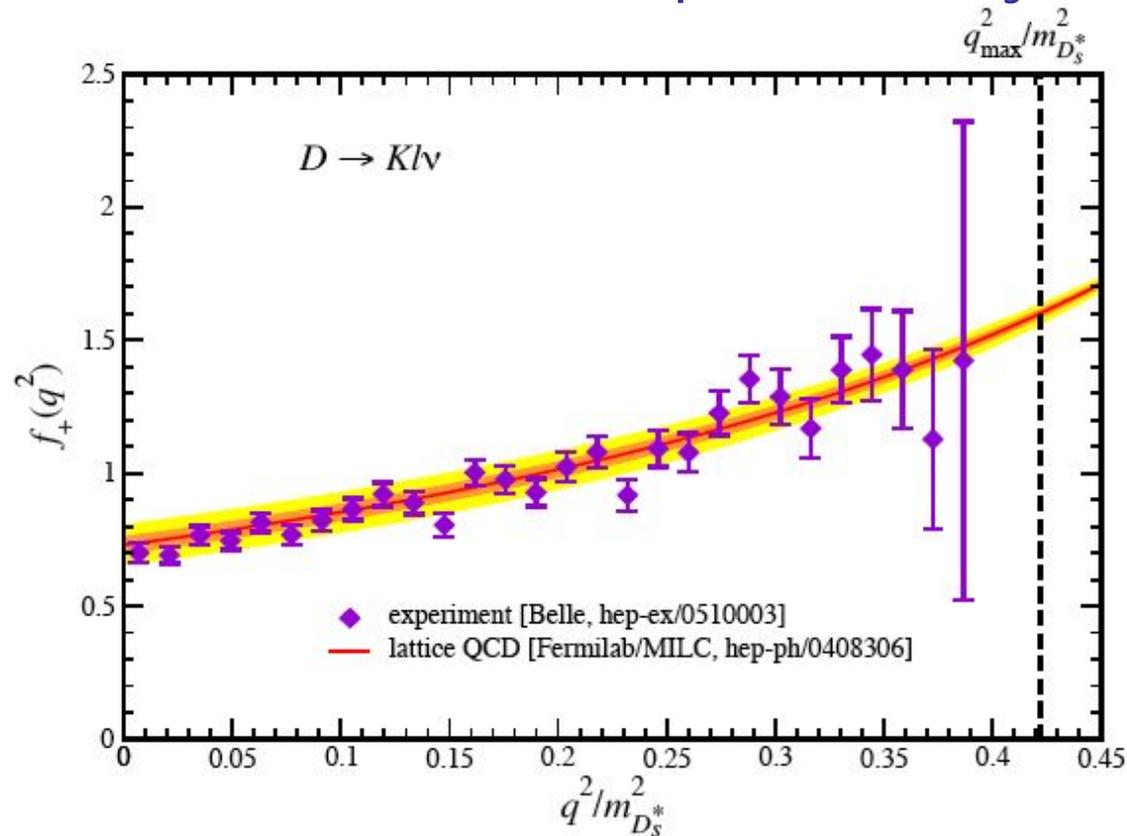


# Some Recent Achievements

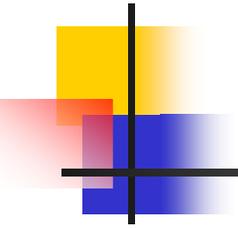
LQCD predictions that have been verified by experiment  
– these analyses were enabled by the availability of the Fermilab clusters.

Quantity	Lattice QCD	Experiment
$f_D$	$201 \pm 3 \pm 17 \text{ MeV}$	$223 \pm 16 + 7 - 9 \text{ MeV}$
$f_{D_s}$	$249 \pm 3 \pm 16 \text{ MeV}$	$279 \pm 17 \pm 20 \text{ MeV}$
$m_{B_c}$	$6304 \pm 20 \text{ MeV}$	$6287 \pm 5 \text{ MeV}$

# Form Factor for the Semileptonic Decay of the K Meson



The semileptonic form factor  $f_+(q^2)$  for the decay of a D meson into a K meson and leptons, as a function of the momentum transfer to the leptons  $q^2$ . The orange curve is the lattice prediction, and the violet points are the experimental results of the Belle Collaboration.

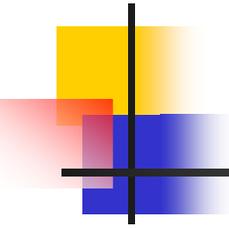


# Talks Today

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- Computational Requirements
- JLab 2006 Acquisition Details
- Fermilab 2006 Acquisition Details
- Proposed 2007 Acquisition Plan
- Project Management

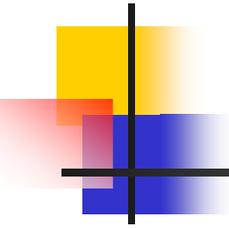
Backup Slides



# Manpower - BNL

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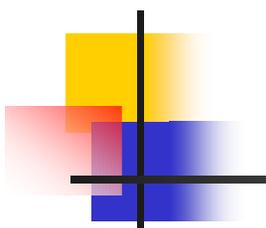
- Management
  - Eric Blum 0.10 FTE (LQCD)
  - Tom Schlagel 0.04 FTE (LQCD)
- Hardware Support
  - Joe DePace 0.35 FTE (LQCD)
  - Don Gates 0.35 FTE (LQCD)
- System Administration
  - John Reddy 0.05 FTE (LQCD)
- Software Support
  - Efstratios Efstathiadis 0.50 FTE = 0.25 SciDAC + 0.25 Base
  - Chulwoo Jung 0.37 FTE (SciDAC I and II)
  - Enno Schultz 0.25 FTE (SciDAC I and II)



# Manpower - JLab

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- Chip Watson 0.75 FTE = 0.15 LQCD + 0.25 SciDAC + 0.35 Base
- Balint Joo 1.00 FTE = 0.15 LQCD + 0.85 SciDAC
- Ying Chen 1.00 FTE = 0.20 LQCD + 0.60 SciDAC + 0.20 Base
- Jie Chen 0.90 FTE (SciDAC)
- Sherman White 0.50 FTE = 0.40 LQCD + 0.10 Base
- Robert Edwards 0.20 FTE (Base)
- New Hire (October 2006) 1.00 FTE = 0.85 LQCD + 0.15 Base



# Manpower - FNAL

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- Don Holmgren 1.00 FTE = 0.25 LQCD-PM + 0.25 LQCD  
+ 0.25 SciDAC + 0.25 Base
- Bakul Banerjee 0.50 FTE = 0.25 LQCD-PM + 0.25 Base
- Amitoj Singh 1.00 FTE = 0.50 LQCD + 0.50 SciDAC
- Kurt Ruthmansdorfer 1.00 FTE = 1.00 LQCD
- Jim Simone 0.50 FTE (SciDAC)
- Jim Kowalkowski 0.50 FTE (SciDAC/Base)
- Bob Forster 0.25 FTE LQCD
- New Hire (August 2006) 1.00 FTE (SciDAC/Base)