LQCD-ext and LQCD-ARRA Projects
2011 Annual Review

Overview and USQCD Collaboration Management

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http://www.usqcd.org

LQCD-ext and LQCD-ARRA Projects
2012 Annual Review
Fermilab
May 16-17, 2012

Synopsis

- Annual review of the LQCD-ext lattice computing hardware project, 2010-14, and the annual review of LQCD-ARRA hardware project, 2009-13.
  - Hardware is located at BNL, JLab, Fermilab.
  - Projects funded jointly by DoE's offices of HEP and NP.
    - LQCD-ext, total budget $18.05 M,
    - LQCD-ARRA total budget $4.96 M,
  - LQCD-ARRA will end at the end of FY12; operations taken over by LQCD-ext
- The LQCD Project is one of several hardware and software efforts overseen by the USQCD Collaboration.
- USQCD is a collaboration consisting of most US lattice gauge theorists. Its purpose is to develop the software and hardware infrastructure required for lattice gauge theory calculations.

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Plan of talks

(Detailed schedule at http://projects.fnal.gov/lqcd/reviews/May2012Review/agenda.shtml .)

May 16

08:30	Executive session (45 min)
09:15	Welcome (10 min) – *Tom Schlagel*
09:25	Logistics and Introductions (5 min) – *Bill Boroski*
09:30	LQCD Overview (45 min) - *Paul Mackenzie*
10:15	Break (15 min)
10:30	Science Talk 1: Fundamental Parameters of the Standard Model (30 min) – *Ruth Van de Water*
11:00	Science Talk 2: Beyond the Standard Model Physics (30 min) – *Julius Kuti*
11:30	Science Talk 3: Hadron Spectroscopy, Structure and Interactions (30 min) – *Kostas Orginos*
12:00	Lunch / Executive Session
1:00	Science Talk 4: High Temperature/Density QCD (30 min) – *Peter Petreczky*
1:30	LQCD-Ext Project: Management and Performance (30 min) - *Bill Boroski*
2:00	LQCD-ARRA Project: Management and Performance (20 min) – *Chip Watson*
2:20	LQCD-ARRA Technical Performance (30 min) – *Chip Watson*
2:50	Combined Break and Compute Facility Tour (40 min)
3:30	LQCD-Ext: Technical Performance of FY2011 Deployments (15 min) - *Don Holmgren*
3:45	LQCD-Ext: Hardware Acquisition Plan & Status for FY2012 (30 min) – *Chip Watson*
4:15	LQCD-Ext: Future Facility at BNL -*Robert Mawhinney*
4:30	LQCD-Ext: Proposed Selection Strategy for FY2013 Deployment (30 min) – *Don Holmgren*
5:00	Executive Session (60 min)
6:00	Committee request for additional information - *Committee/Project Leadership*
6:30	Adjourn 7:00 Dinner

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Plan of this talk

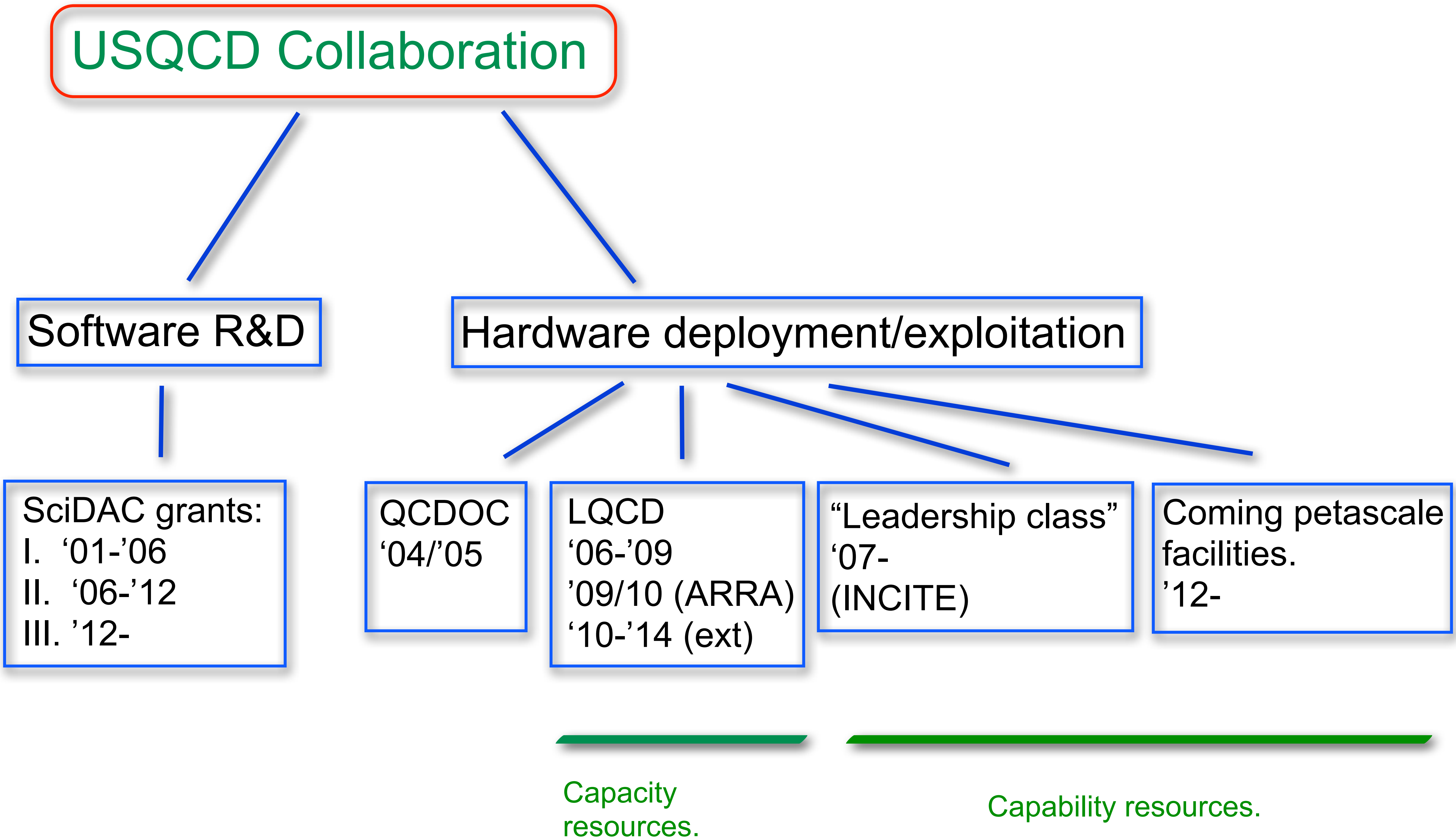
- Organization
  - The USQCD Collaboration
- Science
  - Lattice QCD
  - USQCD scientific goals.

I. The USQCD Collaboration

The importance of lattice QCD calculations to fully capitalize on the enormous investments in the HEP and NP experimental programs led DoE to ask the US lattice gauge theory community to organize itself to create software and hardware infrastructure for lattice calculations.

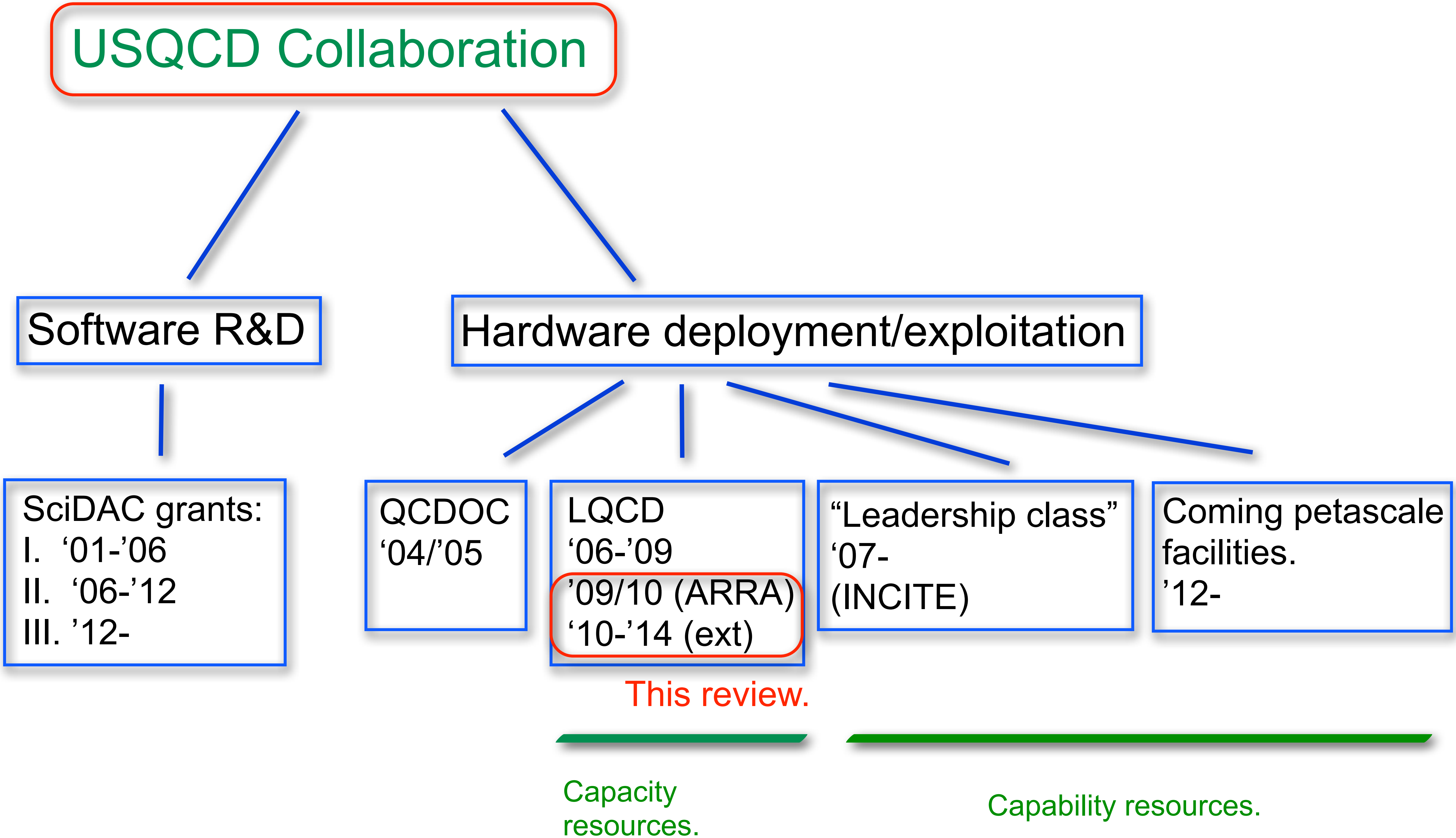
The USQCD Collaboration was the result.

Consists of almost all US lattice gauge theorists, ~145 members.
Purpose: develop hardware and software infrastructure for the US lattice community. (Physics projects are done by individual groups within USQCD.)



USQCD has grants for

- R&D for software development through the SciDAC program.
- Hardware deployment and use from several sources, including the current LQCD-ARRA and LQCD-ext projects.



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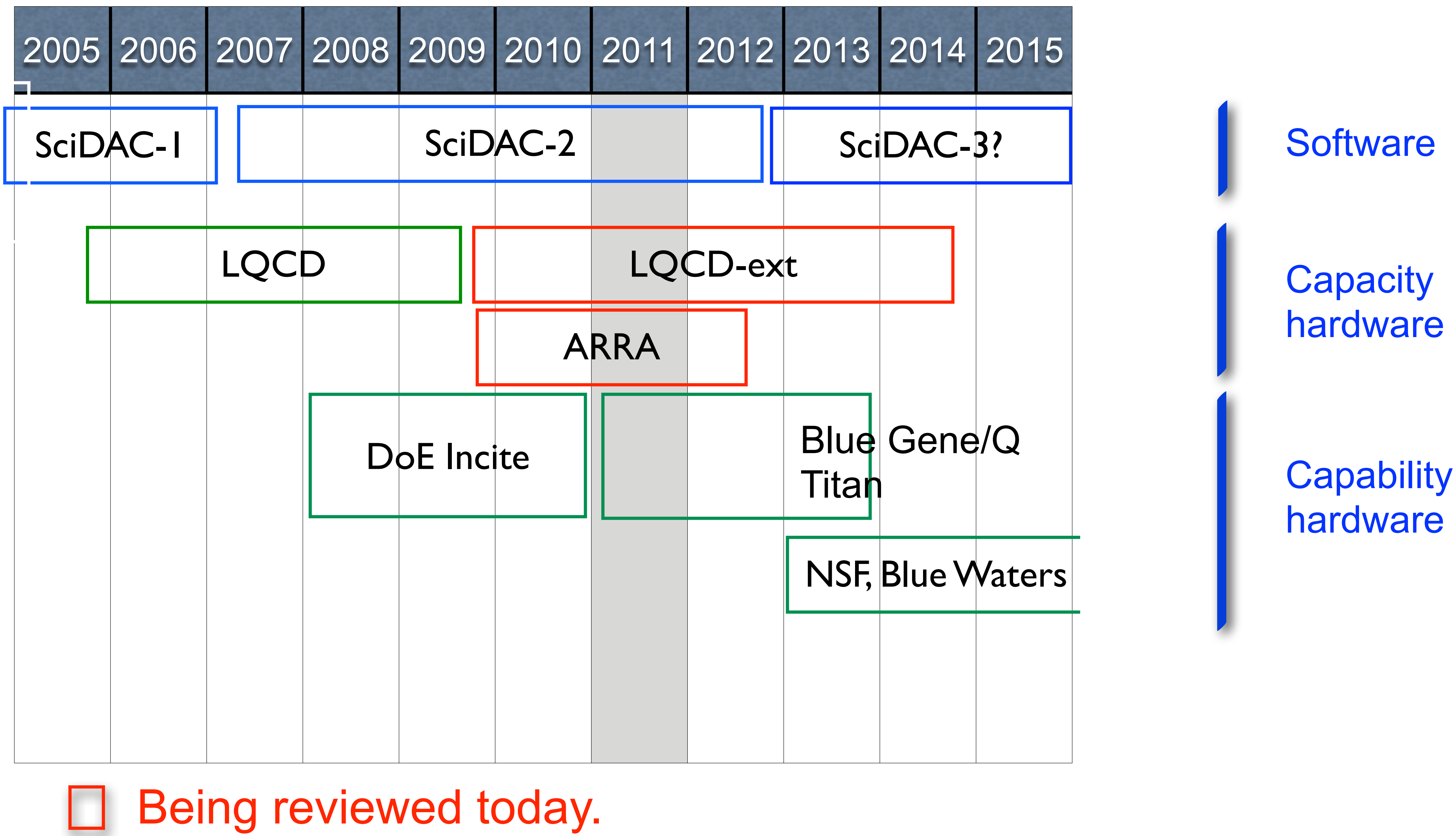
Activities of USQCD



USQCD Collaboration

LQCD-ext Project

LQCD-ARRA Project

Executive Committee:
Paul Mackenzie (chair), Rich Brower, Norman Christ, Frithjof Karsch, Julius Kuti, John Negele, David Richards, Steve Sharpe, Bob Sugar

Scientific Program Committee:
Robert Edwards (chair)

Software Committee:
Rich Brower (chair)

USQCD members present today.

Federal project director:
John Kogut (HEP)
Federal project monitor:
Helmut Marsiske (NP)

Contract project manager:
Bill Boroski
Associate project manager:
Bakul Banerjee

Change control board:
Paul Mackenzie (chair), Bill Boroski, Steve Gottlieb, Tom Schlagel, Vicky White, Roy Whitney

DoE program manager:
Helmut Marsiske (NP)

Contract project manager:
Chip Watson

Change control board:
Paul Mackenzie, Chip Watson, Steve Gottlieb, Roy Whitney

The USQCD collaboration is funded through SciDAC, through the LQCD project, and through base HEP and NP funds at BNL, Fermilab, and JLab.

USQCD collaboration web page: http://www.usqcd.org

These two projects being reviewed today are managed cooperatively and operated as a coherent whole.

USQCD hardware resources

			Cores	M jpsi core-hours	GPUs
LQCD Project resources	Fermilab	JPsi	6,912	50	
		Ds	13,440	129	
		Dsg			152
	JLab	9q	2,560	41	
		10q	1,536	25	
		9g+10g			480
	BNL	10% rack BG/Q	1,600	12	
	Total		28,768	259	
USQCD Incite resources (non-Project)					
2012		Argonne allocated		27	
		Argonne low priority (2011)		70	
		Oak Ridge		23	

Current USQCD resources normalized to JPsi core-hours.

GPUs for lattice gauge theory

A dramatic speed up has been achieved in some of our projects with GPUs. A major effort is underway to understand what fraction of our program can be accomplished with GPUs and to create the necessary codes.

- USQCD GPU history
  - 2008, Kuti. Lattice gauge theory on GPUs.
  - 2008. USQCD SciDAC software starts GPU coding effort.
  - Oct. 2008, Fermilab meeting. NVIDIA, Fermilab, BU, NCSA, ...
  - Feb. 2009, Fermilab purchase with LQCD funds. 16 GPUs.
  - Aug. 2009, JLab workshop. USQCD+NVIDIA.
  - 2009/10, ARRA 9g and 10g clusters.
  - 2011, GPU cluster installed at Fermilab. (Don Holmgren's talk.)
  - 2012, GPU cluster planned at JLab. (Chip Watson's talk.)
  - 15 projects now running at Fermilab and JLab.

New Issues in GPU hardware

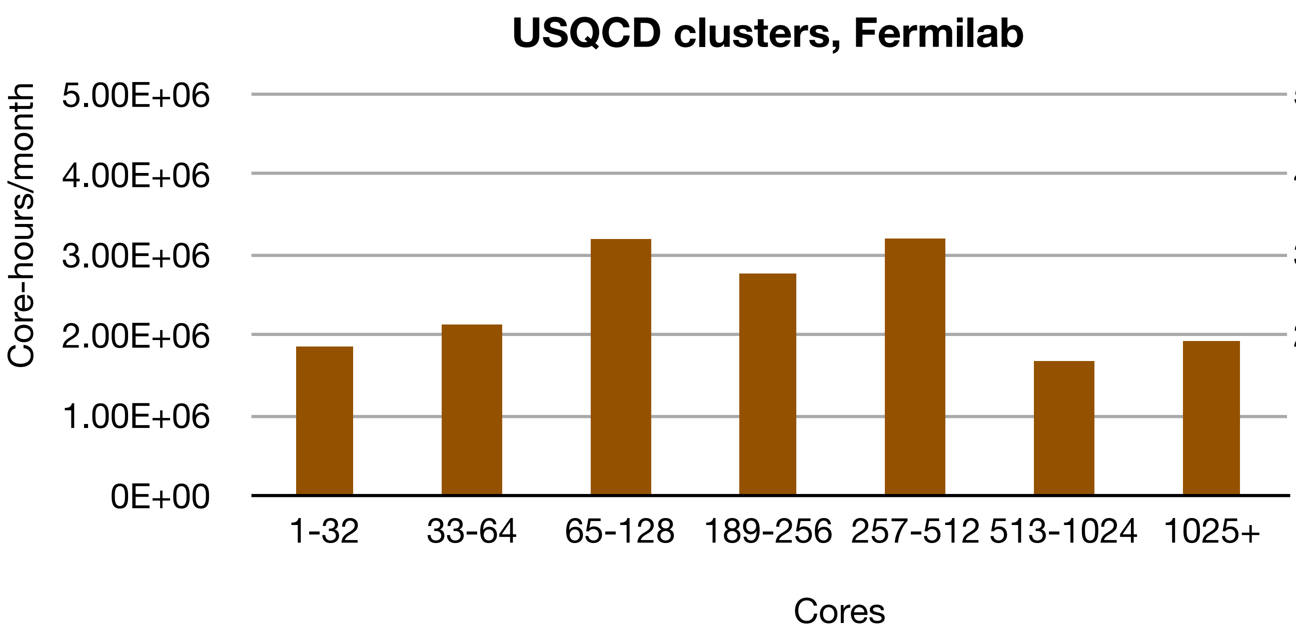
- Speedups of 2-10 observed for some projects.
  - Speed-up must be measured by wall clock hour comparisons with unaccelerated hardware.
- What fraction of GPU-enabled hardware is needed in new purchases?
  - Must take into account fraction of our science program that can use GPUs (software!), GPU cost, ...
- How should we allocate GPU-enabled systems.
  - A possibility is service units that equate a core-hour on a new conventional clusters with a cost-equivalent amount of hardware on a new GPU-enabled system.
- How should the CPU power of a system including GPUs be reported.
  - One measure is the amount of CPU based computers that GPUs replace.
- The speedup we find has been enabled by the terrific work of our software committee.
  - Software essential to effective use of all our hardware.

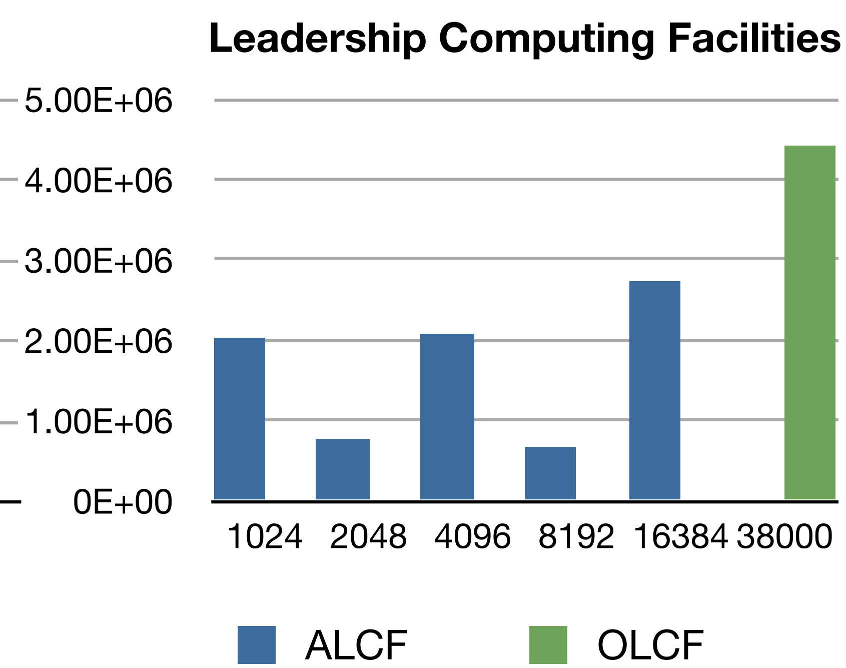
Hardware choices for 2013 capacity computing

- The LQCD-ext Project will have an unusually rich set of hardware possibilities for our capacity computing needs to choose from in 2013:
  - Infiniband clusters,
  - GPU-accelerated clusters,
  - Blue Gene/Q.
- With GPU clusters especially, cost efficiency varies greatly physics project to physics project, and is not well predicted by inverter performance.

Capacity and capability computing

Lattice QCD needs a combination of capacity and capability computing resources.
Similar numbers of core-hours are needed for small jobs and for large jobs.





Funny job-size distributions at the two facilities caused by queue policies, not user needs.

Jpsi core-hours/month used at USQCD Fermilab clusters as a function of job size. (JLab is similar.)

Jpsi core-hours/month used by USQCD at the Argonne and Oak Ridge Leadership Computing Facilities as a function of job size.

This year we are light on largest scale resources. Next year, this will be reversed.

Incite resources

for capability computing.

- The DOE allocates time on its leadership class supercomputers, the Cray XT4/XT5 at ORNL and the BlueGene/P at ANL, through its Incite Program.
  - These are very well suited to that part of our program requiring high capability computing, such as generation of large gauge configuration ensembles.
- USQCD currently has a three year grant running from calendar year 2011 though calendar year 2013.
- Resources are allocated one year at a time. The USQCD allocation for 2012 is one of the three largest in the program. It consists of:
  - 46 M core-hours on the Cray XT4/XT5 allocated . Used 23 M core-hours in ’09, 54 M in ’10, and 50 M in ’11.
  - 50 M core-hours on the BlueGene/P allocated, one of three largest. Total time used was 359 M core-hours in 2008, 279 M in 2009, 187 M in 2010, and 180 M in 2011.

Large-scale resources coming in 2013

- In 2013, new leadership-class resources will become available at Argonne and Oak Ridge.
  - ALCF: IBM Blue Gene/Q, “Mira”. 768,000 cores.
    - 0.768 - 3 B core-hours will be allocated in 2013
  - OLCF: GPU-accelerated Cray, “Titan”. 299,088 AMD Interlagos cores + 14,592 GPUs.
    - 2 B core-hours will be allocated in 2013.
- These are aimed at projects that require 20% of the machines.
  - 150,000-core jobs, projects that can’t be run on current leadership-class resources like the ALCF Blue Gene/P.
  - They will add new job-size bins to the high end of our distribution, enabling new calculations that are currently impossible on present resources, but they will increase and not reduce our need for small and medium size resources.

SciDAC lattice QCD software R&D

Software Committee:
Richard Brower (chair), Boston University, Carleton DeTar, University of Utah, Robert Edwards, JLab, Rob Fowler, UNC, Donald Holmgren, Fermilab, Robert Mawhinney, Columbia University, Pavlos Vranas, Lawrence Livermore Lab, Chip Watson, JLab

Present today.

Regular Thursday phone conferences for people working on USQCD software.

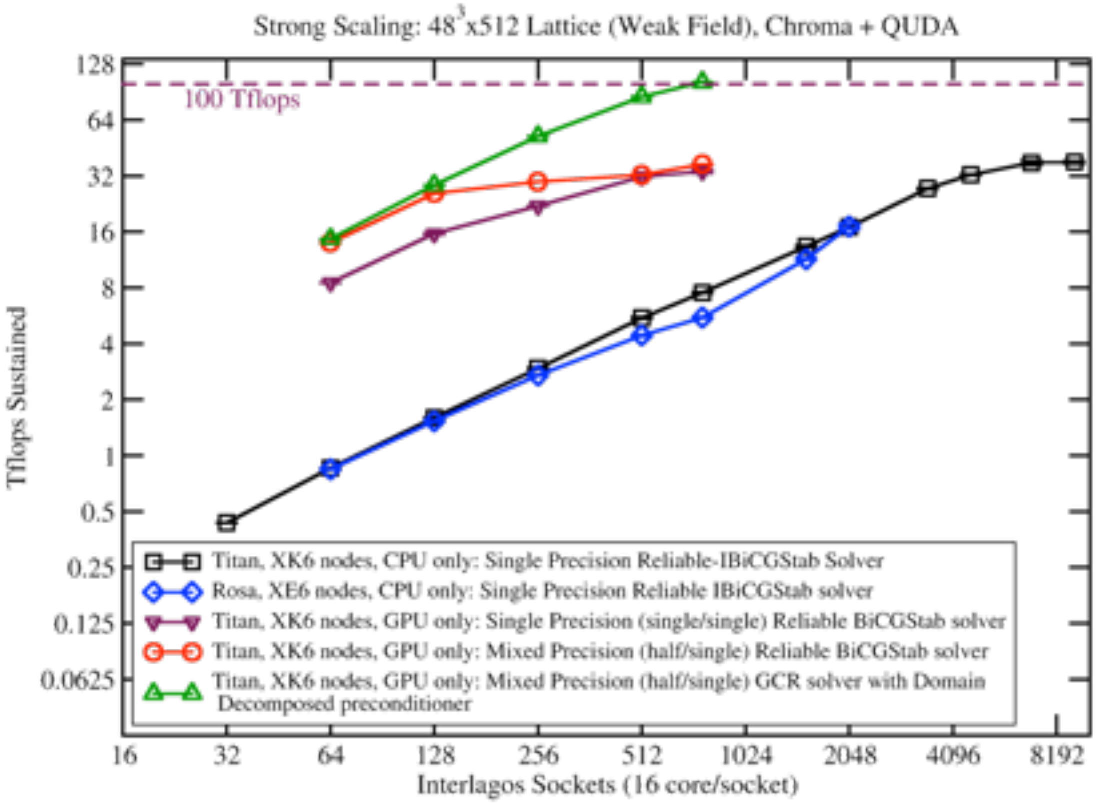
USQCD has had a SciDAC-2 grant (~$1.8M in 2011-12) for creating lattice QCD software infrastructure: community libraries, community codes, optimization and porting to new architectures, implementation of up-to-the-minute algorithm advances...
This has enabled optimally efficient operation on the USQCD hardware.

We hope for new, multi-year SciDAC-3 grants.
Scope was enlarged to include software for beyond-the-standard-model gauge theories.

Software achievements

- The QCD API and community libraries
  - Lower entrance barriers to lattice QCD.
  - Enable postdocs to run major projects without being part of major collaborations.
- Porting and optimizations for new platforms
  - In 2008, USQCD was the only project with a multiyear program ready to run on the Argonne BG/P from the start. Used ~1/3 of cycles in 2008, accomplished a three-year program of configuration generation in one year.
  - Now undertaking serious programs

    getting ready for new platforms:
    - GPUs (now!),
    - BG/Q, Titan, Blue Waters.



Scientific Program Committee

Scientific Program Committee:
Robert Edwards (chair), JLab ,Simon Catterall, Syracuse, Taku Izubuchi, BNL, Peter Petretzky, BNL, Martin Savage, U. Washington, Doug Toussaint, Arizona, Ruth Van de Water, BNL→Fermilab

Present today.

Each year, the many smaller physics collaborations within USQCD submit proposals to the Scientific Program Committee for allocations of time on USQCD's LQCD and Incite resources.

The SPC creates a program to accomplish the goals set forth in the USQCD Collaboration's proposals.

The Executive Committee seeks the advice of the SPC on physics priorities when writing new proposals for DoE computing resources.

Chair rotates every two years. Members rotate every four years.

Allocation process

- Each year, the SPC issues a call for proposals for use of LQCD resources and DoE leadership class (Incite) resources.
  - Three types of proposals.
    - Type A. Large projects expected to benefit the whole collaboration by producing data, such as gauge configurations, for general use, or by producing physics results listed among USQCD's strategic goals.
    - Type B. Need not share data or work toward USQCD's goals (although if they do, it's a plus). Goal is 10-15% of total allocation.
    - Type C. Exploratory calculations such as for developing or benchmarking code. <100 K JPsi core-hours.
  - The SPC reviews proposals, then organizes an all-hands meeting of USQCD. Plans of proposals are discussed by their proponents and by the collaboration as a whole. Allocation year is July 1, 2011-June 30, 2012.
  - This year the SPC will begin giving a brief report to each proponent on their considerations for their allocation, to improve the transparency of the allocation process.

2012/13 allocation requests

Report from Robert Edwards and the SPC at the 2012 All-Hands Meeting.

Allocation requests

	WME	BSM	New Tests SM	NP	Thermo
INCITE:	34M	16M	0M	42M	17M
Cluster:	140M	60M	45M	185M	59M
GPU:	787K	775K	0K	5300K	491K

WME
Mackenzie
Mawhinney
Shigemitsu
Sugar
Witzel
Ishikawa
Sharpe

BSM
DeGrand
Fleming
Hasenfratz
Kuti
Neil
Catterall
Giedt

New Tests SM
Aubin
Izubuchi
Lin
Shintani

NP
DeTar
Detmold
Edwards
Liu
Negele
Orginos
Richards
Alexandru
Engelhardt-1
Engelhardt-2
Osborn
Renner

Thermo
Bazavov
Ding
Mukherjee
Maezawa
Mehta

Executive Committee

- Provides overall leadership for the collaboration and point of contact for the DoE.
- Writes the proposals for hardware and software and chooses the members of the other committees.
- Regular rotations are planned.
  - Close to full rotation over ~ 10 years is planned.
  - We plan to rotate in a way that preserves rough balance between physics interests, HEP and NP, collaborations, etc.

2012 USQCD all-hands meeting

- Took place May 4-5, 2012 at Fermilab. ~57 members attended. (http://www.usqcd.org/meetings/allHands2012/.)
- Reports from most physics projects requesting time on USQCD resources.
- Reports from the Executive Committee, the LQCD-ext and LQCD-ARRA Project Managers, the SPC, and the hardware site managers.
- Round table discussions with
  - The Software Committee.
- Report from beyond-the-standard-model phenomenologist Adam Martin on the workshop Lattice Meets Experiment 2011: Beyond the Standard Model, which was held at Fermilab in October, 2011.

Lattice QCD meets experiment meetings

To increase the interaction between lattice gauge theory and experiment and phenomenology, members of USQCD have organized a series of workshops with experimenters and phenomenologists.

- SLAC, Sept. 16, 2006, Standard Model physics. With BaBar.
- Fermilab, December 10-11, 2007, "Lattice Meets Experiment" in flavor physics.
- Livermore, May 2-3, 2008, "Lattice Gauge Theory for LHC Physics".
- JLab, Nov. 21-22, 2008, "Revealing the Structure of Hadrons", Nuclear.
- BNL, June 8-9, 2009, "Critical Point and Onset of Deconfinement", QCD thermodynamics.
- BU, Nov. 6-7, 2009, "Lattice Gauge Theory for LHC Physics". BSM.
- Fermilab, April 26-27, 2010, "Lattice Meets Experiment" in flavor physics.
- BU, 8-10 September 2010, "Sixth Workshop on QCD Numerical Analysis, Boston.
- JLab, Feb. 23-25, 2011, "Excited Hadronic States and the Deconfinement Transition".
- Fermilab, Oct. 14-15, 2011, "Lattice Meets Experiment: Beyond the Standard Model".

International collaboration

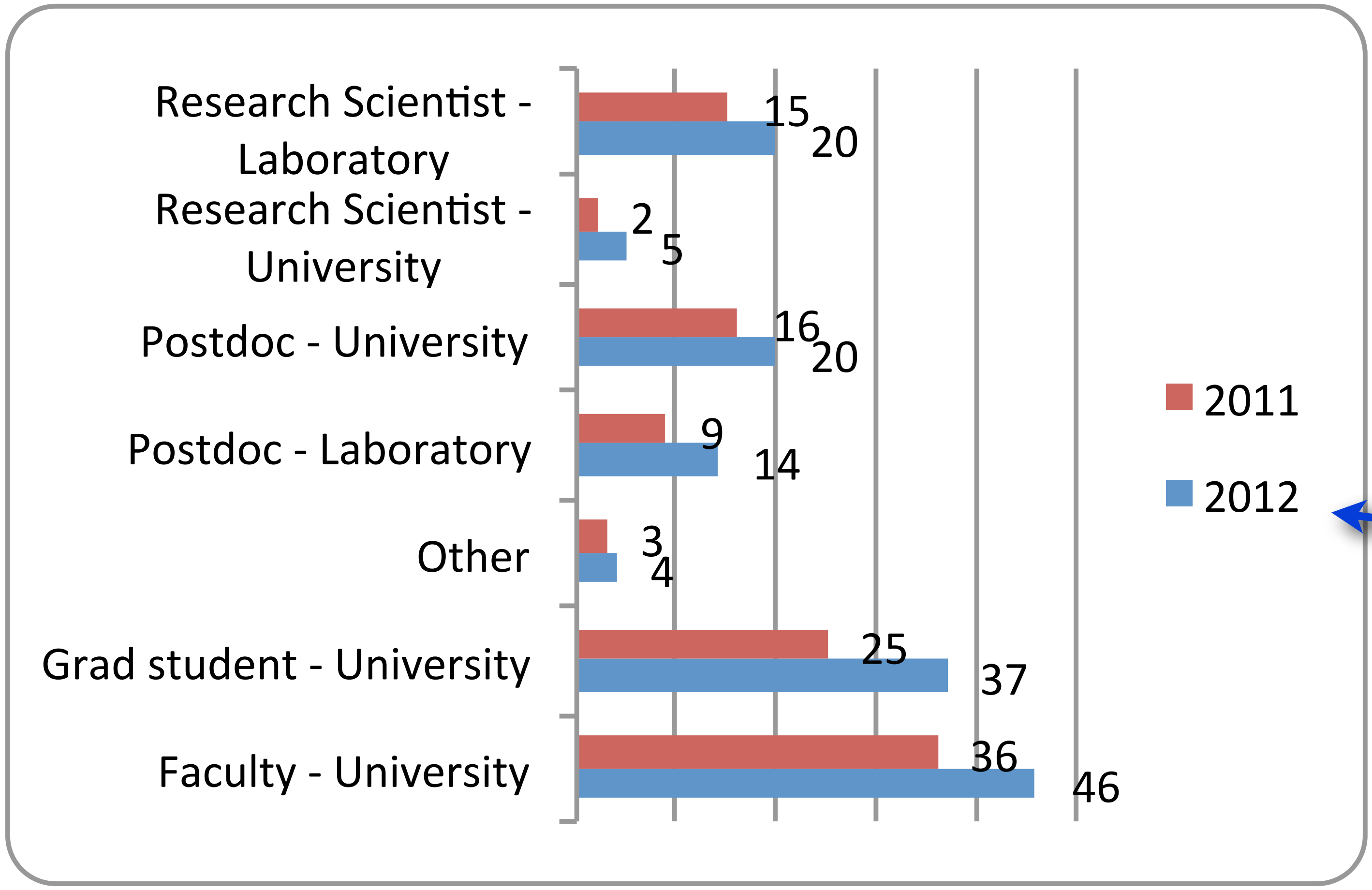
- Lattice QCD is an international field with very strong programs in Germany, Italy, Japan and the United Kingdom, and elsewhere. Groups within USQCD have formed a number of international collaborations:
  - The USQCD effort using DWF quarks is an international effort between the United States based RBC, the Edinburgh, and Southampton members of the UKQCD Collaboration, and RIKEN.
  - The Fermilab Lattice, HPQCD and MILC Collaborations have worked together in various combinations to study heavy quark physics using improved staggered quarks. HPQCD includes physicists in both USQCD and UKQCD.
  - Members of the RBC Collaboration studying QCD thermodynamics using improved staggered quark actions have a long term collaboration with physicists at the University of Bielefeld, Germany.
  - Members of USQCD working on the hadron spectrum using Clover quarks on anisotropic lattices have close ties with colleagues in Trinity College, Dublin.
  - ...

International collaboration: Japan

- In April, 2011, during the electricity crisis created by the earthquake in Japan, USQCD offered Japanese lattice gauge theorists affected the use of a portion of our computing resources in 2011 while the crisis lasted.
- 4.5 M core-hours were used by the Japanese from July to December, 2011.
- Statement of thanks from Japanese lattice gauge theory leader Akira Ukawa in final report on Japanese use of the US resources:
    - “The US support was one of the crucial factor enabling us to keep the research going through the time of hardship, and with all my Japanese colleagues in lattice field theory, we wish to express our sincere gratitude for your support. We sincerely hope that this experience paves the way for further international collaboration in our field.”

Membership survey and demographic information

- We are starting to collect membership and demographic information in a more organized way.
  - New membership list. Currently, ~ 145 members.
  - Demographic survey.



Better response to the survey this year, not a increase in the field.

We've grown from about 90 people in 2000 to about 145 today.

Faculty and staff hirings in the last ten years.

When the survey is better established, we plan to track the career advancement of grad students and postdocs directly from the survey.

	Year	Research institution, HEP	Research institution, NP	Computational scientist	Teaching college	Industry	Foreign
Tom Blum	2003	Connecticut					
Silas Beane	2003		UNH				
Kostas Orginos	2005		Wm & Mary				
George Fleming	2005			Yale			
Matthew Wingate	2006						Cambridge
Jozef Dudek	2006		Old Dominion				
Jimmy Juge	2006				U. of the Pacific		
Peter Petreczky	2006		BNL				
Balint Joo	2006			JLab			
Kieran Holland	2006				U. of the Pacific		
Chris Dawson	2007	Virginia					
Nilmani Mathur	2007						Tata Institute
Joel Giedt	2007	RPI					
Taku Izubuchi	2008	BNL					
Will Detmold	2008		Wm & Mary				
Jack Laiho	2008						Glasgow
James Osborn	2008			Argonne			
Harvey Meyer	2009						Mainz
Enno Scholz	2009						Regensburg
Christopher Aubin	2010				Fordham		
Elizabeth Freeland	2011				Benedictine U.		
Brian Tiburzi	2011		CUNY				
Andrei Alexandru	2011		GWU				
Elvira Gamiz	2011						Granada
Mike Clark	2011					NVIDIA	
Ron Babich	2011					NVIDIA	
Ruth Van de Water	2012	Fermilab					

5 out of 16 HEP people found jobs in research institutions.

7 out of 11 NP people found jobs in research institutions.

This year we found that for staff hirings, we could do a more complete job collecting data “by hand”.

There is a net in-flow to the US at the grad student and postdoc level.

There is a net out-flow at the junior faculty level.

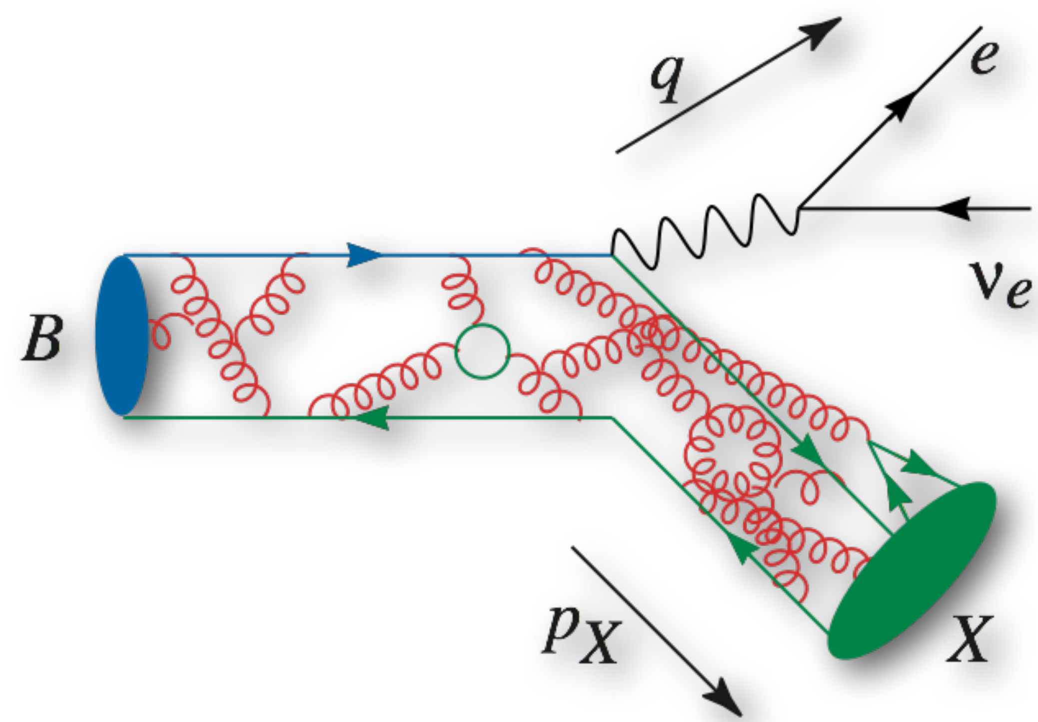
II. Lattice QCD

QCD is the theory of quarks and gluons. Quarks and gluons cannot be directly observed because the forces of QCD are strongly interacting.

Quarks are permanently confined inside hadrons, even though they behave as almost free particles at asymptotically high energies.

"Asymptotic freedom", Gross, Politzer, and Wilczek, Nobel Prize, 2004.

Lattice QCD is used to relate the observed properties of hadrons from the properties of their quark and gluon constituents.

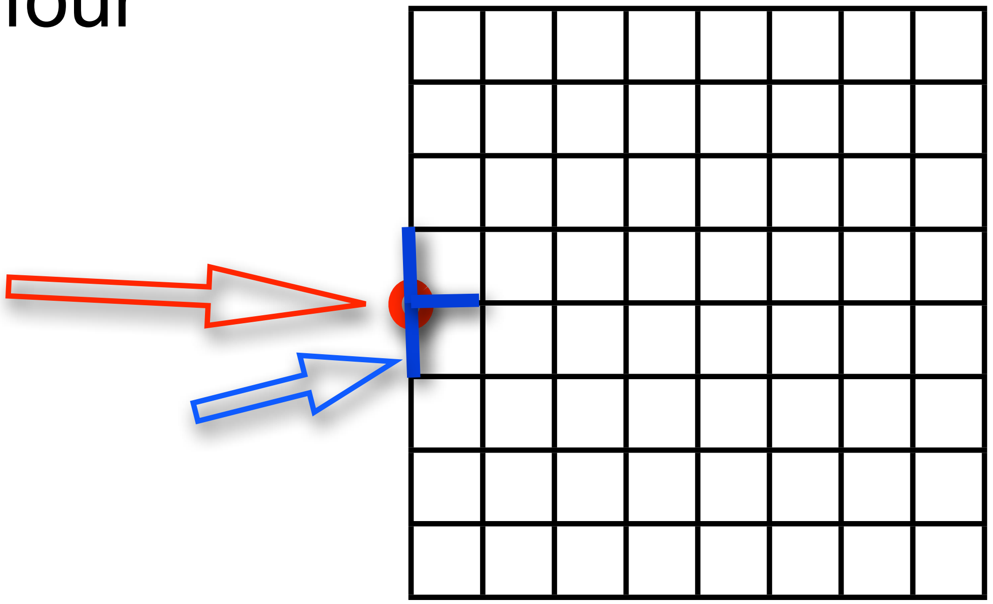


$B \to \pi l \nu$ semileptonic decay

Luke

Lattice quantum field theories

Approximate the path integral of quantum field theory by defining the fields on a four dimensional space-time lattice.



Quarks (ψ) are defined on the sites of the lattice, and gluons (U_μ) on the links.

Monte Carlo methods are used to generate a representative ensemble of gauge fields. Relaxation methods are used to calculate the propagation of quarks through the gauge field.

Continuum quantum field theory is obtained in the zero lattice spacing limit. This limit is computationally very expensive.

The Dirac, or “Dslash”, operator

The fundamental operation that consumes the bulk of our cycles is the solution of the Dirac equation on the lattice.

The fundamental component of the Dirac operator is the discrete difference approximation to the first derivative of the quark field on the lattice.

$$\partial_\mu \psi(x) \rightarrow \Delta_\mu \psi(x) \approx \frac{1}{2a}(\psi(x+\hat{\mu}a) - \psi(x-\hat{\mu}a)) + \mathcal{O}(a^2)$$

Quarks in QCD come in three colors and four spins.
The color covariant Dslash operator of lattice QCD is

$$D_\mu \gamma_\mu \psi(x) \equiv \frac{1}{2}\left(U_\mu(x)\gamma_\mu \psi(x+\hat{\mu}) - U^\dagger_\mu(x-\hat{\mu})\gamma_\mu \psi(x-\hat{\mu})\right)$$

γ operates on spin four-vector.

U operates on color three-vector of the quark.

The bulk of the flops envisioned in this project are consumed in multiplying complex 3-vectors by 3x3 complex matrices.

The computational challenge of lattice QCD

Lattice	Quark			Gauge	ensembles		Analysis propagators, correlators		
spacing *a* (fm)	mass *ml/ms*	Volume (sites)	Configu rations	Core-hours (M)	TB/ ensemble	Files/ ensemble	Core-hours (M)	TB/ ensemble	Files/ ensemble
0.15	1/5	16^3*48	1000	1	0.1	1,000	1	4	155,000
0.15	1/10	24^3*48	1000	2	0.2	1,000	2	12	"
0.12	1/5	24^3*64	1000	3	0.3	1,000	3	16	155,000
	1/10	32^3*64	1000	8	0.6	1,000	8	39	"
	1/27	48^3*64	1000	26	2.0	1,000	26	130	"
0.09	1/5	32^3*96	1000	10	0.9	1,000	10	58	155,000
	1/10	48^3*96	1000	35	3.1	1,000	35	196	"
	1/27	64^3*96	1000	46	7.2	1,000	46	464	"
0.06	1/5	48^3*144	1000	38	4.6	1,000	38	294	155,000
	1/10	64^3*144	1000	128	10.9	1,000	128	696	"
	1/27	96^3*144	1000	218	36.7	1,000	218	2,348	"
0.045	1/5	64^3*192	1000	135	14.5	1,000	135	928	155,000
	1/10	88^3*192	1000	352	37.7	1,000	352	2,412	"
	1/27	128^3*192	1000	1083	116.0	1,000	1,083	7,422	"
0.03	1/5	96^3*288	1000	685	73.4	1,000	685	4,697	155,000
				2,770					

Example gauge ensemble library.

CPU times normalized in JPsi core-hours.

Planned MILC HISQ ensembles of guage configurations. $m_l = 1/27 m_s = m_{phys}$

Operationally, lattice QCD computations consist of

1) Sampling a representative set of gauge configurations with Monte Carlo methods,

    E.g., the Metropolis method, the hybrid Monte Carlo algorithm, ...
    Consists of one long Markov chain. A capability task.

2) Calculating the propagation of quarks through the gauge configurations,

    Solve the Dirac equation on each configuration with relaxation methods, e.g., biconjugate gradient algorithm, etc. A capacity task.

3) Constructing hadron correlation functions from the quark propagators (smaller task).

Anatomy of a typical lattice calculation

TB file sizes

Generate gauge configurations on a leadership facility or supercomputer center.
Many tens of millions of BG/P core-hours in a single job.

Transfer to labs for analysis on clusters.
Comparable CPU requirements.

A single highly optimized program,
very long single tasks,
moderate I/O and data storage.
Needs high capability computing.

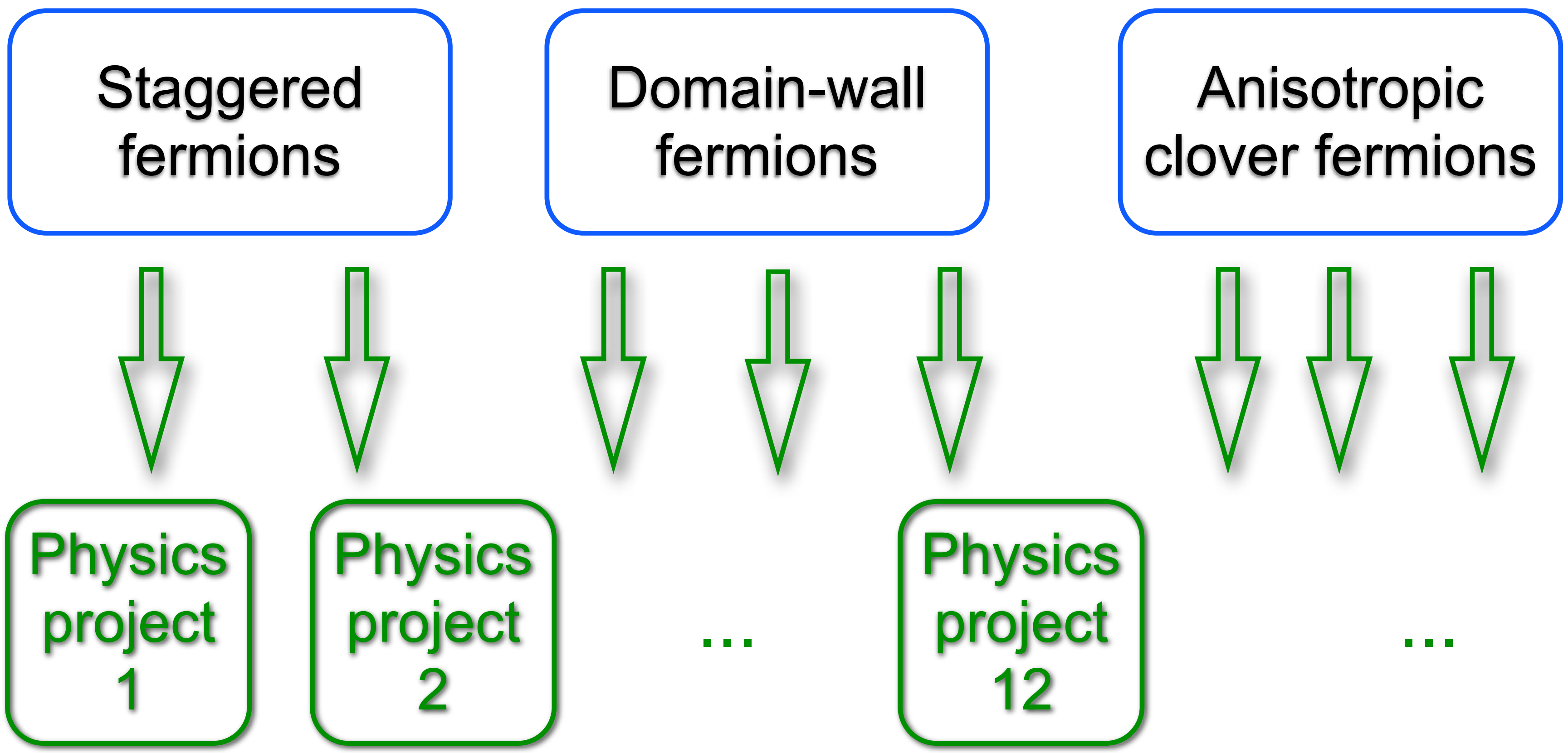
Large, heterogeneous analysis code base,
10,000s of small, highly parallel tasks,
heavy I/O and data storage.
Needs high capacity computing.

Two comparably sized jobs with quite different hardware requirements.

US lattice gauge theory work flow

Zero-temperature QCD:

Currently three main streams of QCD gauge configurations are being generated by USQCD:

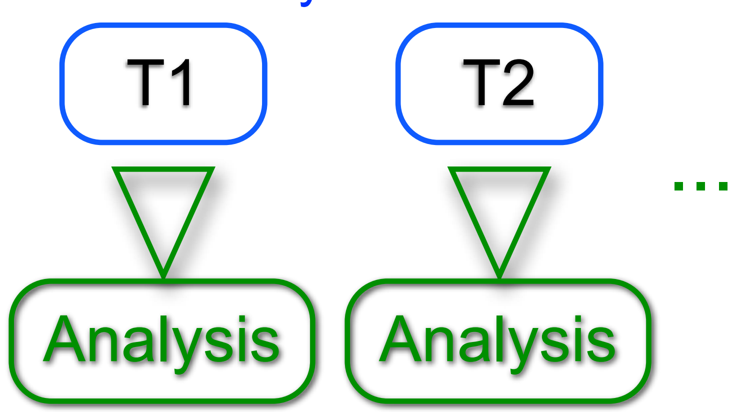


Shared among a couple of dozen groups, in both HEP and NP.

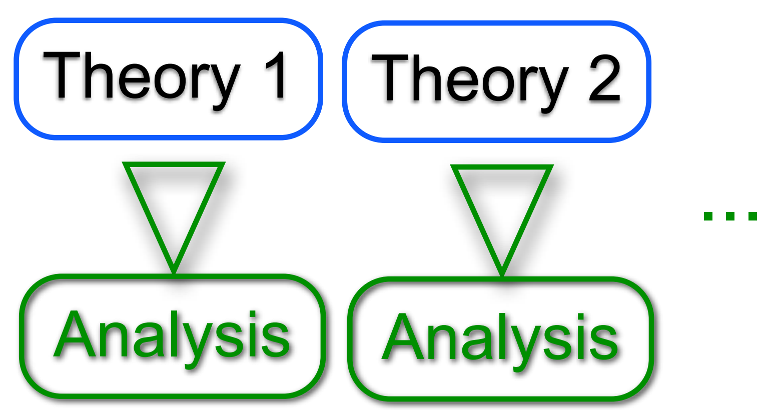
Physics projects are done on these configurations by smaller groups of 5-15 members within USQCD.

Around 90 of the 145 members of USQCD have submitted jobs to USQCD hardware.

QCD thermodynamics:



BSM gauge theory:



Purposes of ensembles

Currently three main streams of QCD gauge configurations for zero temperature QCD are being generated by USQCD:

Staggered fermions	Domain-wall fermions	Anisotropic clover fermions
Tuned toward small lattice spacings and light quark masses for precision on Standard Model parameters. Planned HISQ program: $a \sim 0.03$ - 0.15 fm, $m_l \geq 1/27\ m_s$, V~(3-5 fm)^3.	Clean chiral action. Physics aims are accurate nucleons, standard model tests in kaon and pion system, two-pion final states. DSDR action. $a \sim 0.086$ - 0.143 fm, $m_l > m_s/25$, V ~ (4.6 fm)^3.	Tuned toward very small temporal lattice spacings for investigation of excited states. $a_s \sim 0.122$ fm, $a_t \sim 0.035$ fm, $m_l \geq m_s/27$ V → (5-6 fm)^3.

2011 USQCD physics projects

Projects for configuration generation

Projects initiated by post-docs or students

Non-QCD Beyond-the-Standard-Model projects.

(Some QCD calculations are also looking for BSM effects in hadrons.)

2011 Type A Proposals (more than 2,500,000 J/Psi core-hours)

PI	Project
Christopher Aubin	Hadronic contributions to the muon g–2 using Asqtad staggered fermions
Norman Christ	Simulations with Dynamical Domain-wall Fermions
Robert Edwards	Dynamical Anisotropic-clover Lattice Production for Hadronic Physics
George Fleming	Lattice Gauge Theory for Physics beyond the Standard Model on Leadership Class Machines
Prasad Hegde	Fluctuations and correlations of conserved charges with Highly Improved Staggered Quark action
Taku Izubuchi	Applications of QCD+QED simulations: Isospin breaking in the hadron spectrum and Hadronic contributions to the muon anomalous magnetic moment
Julius Kuti	BSM studies in fundamental and sextet fermion representations of SU(3) color
Peter Lepage	Heavy quark physics from attoscale lattice QCD
Huey-Wen Lin	Probing TeV Physics through Neutron-Decay Matrix Elements
Keh-Fei Liu	Hadron Spectroscopy and Nucleon Form Factors
Paul Mackenzie	B and D Meson Decays with Unquenched Improved Staggered Fermions
Robert Mawhinney	Pion and Kaon Physics from 2+1 Flavor DWF Lattices with m_π = 250 and 180 MeV, III
Swagato Mukherjee	Exploring the phase diagram of QCD using Highly Improved Staggered Quark action
Ethan Neil	Exploration of Many-Fermion Gauge Theories for TeV Physics
David Richards	Excited Meson and Baryon States using Anisotropic Clover Lattices
Martin Savage	Lattice QCD Study of Hadronic Interactions
Stephen Sharpe	B_K and related matrix elements with unquenched, improved staggered fermions
Ron Soltz	HotQCD studies with the HISQ action
Robert Sugar	QCD with Four Flavors of Highly Improved Staggered Quarks
Sergey Syritsyn	Nucleon Structure in the Chiral Regime with Domain Wall Fermions
Ruth Van de Water	Pion and kaon decay constants, quark masses and B_K with close-to-physical light-quark masses with mixed-action lattice QCD
Andre Walker-Loud	Hadronic electromagnetic properties
Oliver Witzel	*B*-meson decay constants and B^0-$\bar{B}^0$-mixing with domain-wall light quarks and relativistic heavy quarks

2011 Type B Proposals (less than 2,500,000 J/Psi core-hours)

PI	Title (click title to see pdf)
Andrei Alexandru	Hadron electric polarizability in the chiral limit
Simon Catterall	Simulations of N = 4 Super Yang-Mills
Saul Cohen	Radiative Decays of Neutral Mesons
Carleton DeTar	Quarkonium Physics in Full QCD
Heng-Tong Ding	Quark number susceptibilites at high temperatures
Michael Engelhardt	Spin polarizability of the neutron
Joel Giedt	Monte Carlo Renormalization Group for Minimal Walking Technicolor
Anna Hasenfratz	Study of many flavor systems with Monte Carlo renormalization group
Anyi Li	Study of QCD critical point using canonical ensemble method
Bernhard Musch	The Boer-Mulders Function of the Pion
James Osborn	Disconnected contributions to nucleon form factors with chiral fermions
Dru Renner	Step-scaling methods for QCD form factors at large Q^2
Stephen Sharpe	Non-perturbative renormalization with improved staggered fermions
Junko Shigemitsu	High-Precision Heavy-Quark Physics

Main scientific thrusts

- Testing the Standard Model and the search for new physics at the Intensity Frontier. Talk by Ruth Van de Water.
  - Experiments impacted: BaBar (SLAC), Belle (KEK), CLEO-c (Cornell), CDF, D0, g-2 (FNAL), NA62 (CERN), KOTO (J-Parc), Belle II (KEK), and LHC-b (CERN).
- Understanding the properties of new strongly interacting gauge theories that may be discovered at the LHC. Talk by Julius Kuti.
  - Experiments impacted: LHC (CERN).
- Understanding the structure and interactions of nucleons. Talk by Kostas Orginos.
  - Experiments impacted: CEBAF (JLab), RHIC (BNL), COMPASS and HERMES (DESY).
- Understanding the behavior of QCD in extreme conditions. Talk by Peter Petreczky.
  - Experiments impacted: RHIC (BNL), FAIR (GSI), and LHC (CERN).

Extra slides