LQCD-ext and LQCD-ARRA Projects
2013 Annual Review
Response to Questions

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LQCD-ext/ARRA Projects 2013 Annual Review
Jefferson Lab
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1. Tables of publications and recent plenary talks by field.

Intensity Frontier

USQCD Publications on
Lattice QCD for the Intensity Frontier

date: May 9, 2013

Publications in or Submitted to Refereed Journals Since May, 2012

[1] Y. Aoki, E. Shintani and A. Soni [RBC and UKQCD Collaborations]
"Proton decay matrix elements on the lattice"
arXiv:1304.7424 [hep-lat].

[2] M. Gong *et al.*
"Strangeness and charmness content of nucleon from overlap fermions on 2+1-flavor domain-wall fermion configurations"
arXiv:1304.1194 [hep-ph].

[3] R. J. Dowdall, C. T. H. Davies, G. P. Lepage and C. McNeile [HPQCD Collaboration]
"Vus from pi and K decay constants in full lattice QCD with physical u, d, s and c quarks"
arXiv:1303.1670 [hep-lat].

[4] R. J. Dowdall *et al.* [HPQCD Collaboration]
"B-meson decay constants from improved lattice NRQCD and physical u, d, s and c sea quarks"
arXiv:1302.2644 [hep-lat].

[5] A. Bazavov *et al.* [MILC Collaboration]
"Leptonic decay-constant ratio f_{K^+}/f_{π^+} from lattice QCD with physical light quarks"
Phys. Rev. Lett. **110**, 172003 (2013) [arXiv:1301.5855 [hep-ph]].

[6] P. Junnarkar and A. Walker-Loud
"The Scalar Strange Content of the Nucleon from Lattice QCD"
arXiv:1301.1114 [hep-lat].

[7] A. Bazavov *et al.* [Fermilab Lattice and MILC Collaborations]
"Kaon semileptonic vector form factor and determination of $|V_{us}|$ using staggered fermions"
Phys. Rev. D **87**, 073012 (2013) [arXiv:1212.4993 [hep-lat]].

[8] A. Bazavov *et al.* [MILC Collaboration]
"Lattice QCD ensembles with four flavors of highly improved staggered quarks"
Phys. Rev. D **87**, 054505 (2013) [arXiv:1212.4768 [hep-lat]].

[9] P. A. Boyle *et al.* [RBC and UKQCD Collaborations]
"Emerging understanding of the $\Delta I = 1/2$ Rule from Lattice QCD"
Phys. Rev. Lett. **110** 152001(2013) [arXiv:1212.1474 [hep-lat]].

[10] C. McNeile, A. Bazavov, C. T. H. Davies, R. J. Dowdall, K. Hornbostel, G. P. Lepage and H. D. Trottier
"Direct determination of the strange and light quark condensates from full lattice QCD"
Phys. Rev. D **87**, 034503 (2013) [arXiv:1211.6577 [hep-lat]].

[11] R. Arthur *et al.* [RBC and UKQCD Collaborations]
"Domain Wall QCD with Near-Physical Pions"
arXiv:1208.4412 [hep-lat].

[12] G. C. Donald *et al.* [HPQCD Collaboration]
"Precision tests of the J/ψ from full lattice QCD: mass, leptonic width and radiative decay rate to η_c"
Phys. Rev. D **86**, 094501 (2012) [arXiv:1208.2855 [hep-lat]].

[13] C. McNeile, C. T. H. Davies, E. Follana, K. Hornbostel and G. P. Lepage [HPQCD Collaboration]
"Heavy meson masses and decay constants from relativistic heavy quarks in full lattice QCD"
Phys. Rev. D **86**, 074503 (2012) [arXiv:1207.0994 [hep-lat]].

[14] J. R. Green, J. W. Negele, A. V. Pochinsky, S. N. Syritsyn, M. Engelhardt and S. Krieg [LHP Collaboration]
"Nucleon Scalar and Tensor Charges from Lattice QCD with Light Wilson Quarks"
Phys. Rev. D **86**, 114509 (2012) [arXiv:1206.4527 [hep-lat]]. [LHPC]

[15] H. Na, C. T. H. Davies, E. Follana, G. P. Lepage and J. Shigemitsu [HPQCD Collaboration]
"$|V_{cd}|$ from D Meson Leptonic Decays"
Phys. Rev. D **86**, 054510 (2012) [arXiv:1206.4936 [hep-lat]].

[16] J. A. Bailey *et al.* [Fermilab Lattice and MILC Collaborations]
"Refining new-physics searches in $B- > D\tau\nu$ decay with lattice QCD"
Phys. Rev. Lett. **109**, 071802 (2012) [arXiv:1206.4992 [hep-ph]].

[17] A. Bazavov *et al.* [Fermilab Lattice and MILC Collaborations]
"Neutral B-meson mixing from three-flavor lattice QCD: Determination of the SU(3)-breaking ratio ξ"
Phys. Rev. D **86**, 034503 (2012) [arXiv:1205.7013 [hep-lat]].

publications of Lattice Higgs Collaboration (LHC) from last 12 months:

Can the nearly conformal sextet gauge model hide the Higgs impostor?
Zoltan Fodor (Wuppertal U. & IAS, Julich & Eotvos U.), Kieran Holland (U. Pacific, Stockton), Julius Kuti (UC, San Diego), Daniel Nogradi (Eotvos U.), Chris Schroeder (LLNL, Livermore), Chik Him Wong (UC, San Diego). Sep 2012. 10 pp.
Published in **Phys.Lett. B718 (2012) 657-666**
DOI: 10.1016/j.physletb.2012.10.079
e-Print: **arXiv:1209.0391 [hep-lat] | PDF**

The Yang-Mills gradient flow in finite volume
Zoltan Fodor (Wuppertal U. & IAS, Julich & Eotvos U.), Kieran Holland (U. Pacific, Stockton & Bern U.), Julius Kuti (UC, San Diego), Daniel Nogradi (Eotvos U.), Chik Him Wong (UC, San Diego). Aug 2012. 16 pp.
Published in **JHEP 1211 (2012) 007**
DOI: 10.1007/JHEP11(2012)007
e-Print: **arXiv:1208.1051 [hep-lat] | PDF**

publications of SUSY group from last 12 months:

Phase Structure of Lattice N=4 Super Yang-Mills
Simon Catterall, Poul H. Damgaard, Thomas Degrand, Richard Galvez, Dhagash Mehta. Sep 2012. 28 pp.
Published in **JHEP 1211 (2012) 072**
DOI: 10.1007/JHEP11(2012)072
e-Print: **arXiv:1209.5285 [hep-lat] | PDF**

On the decoupling of mirror fermions
Chen Chen, Joel Giedt, Erich Poppitz. Nov 2012. 31 pp.
Published in **JHEP 1304 (2013) 131**
DOI: 10.1007/JHEP04(2013)131
e-Print: **arXiv:1211.6947 [hep-lat] | PDF**

[1] A. Bazavov *et al*. [BNL-Bielefeld Collaboration], "Strangeness at high temperatures: from hadrons to quarks," arXiv:1304.7220 [hep-lat].

[2] A. Bazavov and P. Petreczky, "Static meson correlators in 2+1 flavor QCD at non-zero temperature," arXiv:1303.5500 [hep-lat].

[3] A. Bazavov and P. Petreczky, "On the Polyakov loop in 2+1 flavor QCD," arXiv:1301.3943 [hep-lat].

[4] A. Bazavov and B. A. Berg, "Program package for multicanonical simulations of U(1) lattice gauge theory. Second version," Comput. Phys. Commun. **184**, 1075 (2013).

[5] A. Bazavov, H. T. Ding, P. Hegde, O. Kaczmarek, F. Karsch, E. Laermann, S. Mukherjee and P. Petreczky *et al*. [BNL-Bielefeld Collaboration], "Freeze-out Conditions in Heavy Ion Collisions from QCD Thermodynamics," Phys. Rev. Lett. **109**, 192302 (2012) [arXiv:1208.1220 [hep-lat]].

[6] O. Kaczmarek, F. Karsch, M. Kitazawa and W. Soldner, "Thermal mass and dispersion relations of quarks in the deconfined phase of quenched QCD," Phys. Rev. D **86**, 036006 (2012) [arXiv:1206.1991 [hep-lat]].

[7] A. Bazavov *et al*. [HotQCD Collaboration], Phys. Rev. D **86**, 094503 (2012) [arXiv:1205.3535 [hep-lat]].

[8] A. Bazavov, N. Brambilla, X. Garcia i Tormo, P. Petreczky, J. Soto and A. Vairo, Phys. Rev. D **86**, 114031 (2012) [arXiv:1205.6155 [hep-ph]].

[1] A. M. Abdel-Rehim, A. Stathopoulos and K. Orginos, arXiv:1302.4077 [hep-lat].

[2] A. Stathopoulos, J. Laeuchli and K. Orginos, arXiv:1302.4018 [hep-lat].

[3] S. R. Beane *et al.* [NPLQCD Collaboration], "Nucleon-Nucleon Scattering Parameters in the Limit of SU(3) Flavor Symmetry," arXiv:1301.5790 [hep-lat].

[4] P. Junnarkar and A. Walker-Loud, arXiv:1301.1114 [hep-lat].

[5] R. G. Edwards, N. Mathur, D. G. Richards and S. J. Wallace, "The Flavor Structure of the Excited Baryon Spectra from Lattice QCD," Phys. Rev. D **87**, 054506 (2013) [arXiv:1212.5236 [hep-ph]].

[6] W. Detmold, C. -J. D. Lin, S. Meinel and M. Wingate, "$\Lambda_b - > \Lambda l^+ l^-$ form factors and differential branching fraction from lattice QCD," Phys. Rev. D 87, **074502** (2013) [arXiv:1212.4827 [hep-lat]].

[7] J. J. Dudek, R. G. Edwards and C. E. Thomas, "Energy dependence of the ρ resonance in ππ elastic scattering from lattice QCD," Phys. Rev. D **87**, 034505 (2013) [arXiv:1212.0830 [hep-ph]].

[8] W. Detmold, S. Meinel and Z. Shi, arXiv:1211.3156 [hep-lat].

[9] Z. S. Brown and K. Orginos, Phys. Rev. D **86**, 114506 (2012) [arXiv:1210.1953 [hep-lat]].

[10] J. R. Green, M. Engelhardt, S. Krieg, J. W. Negele, A. V. Pochinsky and S. N. Syritsyn, [LHPC Collaboration] arXiv:1209.1687 [hep-lat].

[11] L. Liu, K. Orginos, F. -K. Guo, C. Hanhart and U. -G. Meissner, "Interactions of Charmed Mesons with Light Pseudoscalar Mesons from Lattice QCD and Implications on the Nature of the $D^*_{s0}(2317)$," Phys. Rev. D **87**, 014508 (2013) [arXiv:1208.4535 [hep-lat]].

[12] R. A. Briceno, H. -W. Lin and D. R. Bolton, "Charmed-Baryon Spectroscopy from Lattice QCD with $N_f = 2+1+1$ Flavors," Phys. Rev. D **86**, 094504 (2012) [arXiv:1207.3536 [hep-lat]].

[13] W. Detmold and K. Orginos, [NPLQCD Collaboration] arXiv:1207.1452 [hep-lat].

[14] R. C. Brower, H. Neff and K. Orginos, arXiv:1206.5214 [hep-lat].

[15] J. R. Green, J. W. Negele, A. V. Pochinsky, S. N. Syritsyn, M. Engelhardt and S. Krieg, [LHPC Collaboration] Phys. Rev. D **86**, 114509 (2012) [arXiv:1206.4527 [hep-lat]].

[16] S. R. Beane *et al.* [NPLQCD Collaboration], "Light Nuclei and Hypernuclei from Quantum Chromodynamics in the Limit of SU(3) Flavor Symmetry," Phys. Rev. D **87**, 034506 (2013) [arXiv:1206.5219 [hep-lat]].

[17] W. Detmold, K. Orginos and Z. Shi, Phys. Rev. D **86**, 054507 (2012) [arXiv:1205.4224 [hep-lat]].

Plenary Talks Since May, 2012 (*Incomplete*)

[1] "Status and Prospects for some MILC and Fermilab/MILC Projects"
Claude Bernard, Washington U.
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[2] "Decaying Pseudoscalars from DWF LQCD"
Bob Mawhinney, Columbia
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[3] "Computing the K_L K_S mass difference in Lattice QCD"
Jiangli Yu, Columbia
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[4] "Progress Towards $\Delta I = 1/2 K \to \pi\pi$ Decays with G-parity Boundary Conditions"
Chris Kelly, Columbia
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[5] "B-physics with domain-wall light and relativistic heavy quarks"
Oliver Witzel, Boston U.
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[6] "An approach to non-leptonic B-decays on the lattice"
Christopher Aubin, Fordham
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[7] "$B \to Kll$ and $B \to K^*\gamma$ decay form factors from three-flavor lattice QCD"
Ran Zhou, Indiana U.
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[8] "Nucleon EDM from Lattice QCD"
Eigo Shintani, RIKEN/BNL
New Horizons for Lattice Computations with Chiral Fermions, May 2012

[9] "Lattice QCD and flavor physics"
Aida El Khadra, U. Illinois
Flavor Physics & CP Violation (FPCP 2012), May 2012

[10] "Lattice QCD for the intensity frontier"
Ruth Van de Water, Fermilab
Project X Physics Study, June 2012

[11] "Lattice QCD Summary"
Andreas Kronfeld, Fermilab
Project X Physics Study, June 2012

[12] "Lattice QCD + QED from Isospin breaking to g-2 light-by-light"
Taku Izubuchi, BNL
International Symposium on Lattice Field Theory (Lattice 2012), June 2012

[13] "Calculating the two-pion decay and mixing of neutral mesons"
Norman Christ, Columbia
International Symposium on Lattice Field Theory (Lattice 2012), June 2012

[14] "Hadronic contributions to the muon g-2"
Tom Blum, U. Connecticut
International Symposium on Lattice Field Theory (Lattice 2012), June 2012

[15] "Weak harmonic matrix elements from Lattice QCD"
Aida El-Khadra, U. Illinois
International Conference on Hyperons, Charm and Beauty Hadrons (BEACH 2012), July 2012

[16] "Isospin breaking studies from lattice QCD + QED"
Taku Izubuchi, BNL
Chiral Dynamics, August 2012

[17] "Lattice QCD and Project X"
Andreas Kronfeld, Fermilab
New Frontiers in Lattice Gauge Theory, September 2012

[18] "Lattice-QCD progress in hadronic contributions to muon g-2"
Ruth Van de Water, Fermilab
g-2 Experiment collaboration meeting, December 2012

[19] "Lattice conquest of the $\Delta I = 1/2$ Rule and its implications"
Amarjit Soni, BNL
Rencontres de Moriond Electroweak, March 2012

[20] "Lattice QCD and Kaon physics"
Jack Laiho, Syracuse
KAON 2013, April 2013

[21] "Nonleptonic Kaon decays from lattice QCD"
Norman Christ, Columbia
KAON 2013, April 2013

[22] "KAON 2013: A view of kaons from the lattice"
Bob Mawhinney, Columbia
KAON 2012, April 2012

Invited plenary talks from USQCD BSM groups in the last twelve months:

Joel Giedt: Lattice gauge theory and physics beyond the standard model

The 30 International Symposium on Lattice Field Theory - Lattice 2012, June 24-29, 2012 Cairns, Australia

Julius Kuti: Can the Higgs Impostor hide close to the conformal window?

Strong Coupling Gauge Theories in the LHC Perspective (SCGT 12)

December 4 - December 7 , 2012

Kobayashi-Maskawa Institute for the Origin of Particles and the Universe (KMI)

Nagoya University, Nagoya, Japan

Thermodynamics

[1] A. Bazavov, The QCD trace anomaly with 2+1 flavors of Highly Improved Staggered Quarks, CPOD 2013, 8th International Workshop on Critical Point and Onset of Deconfinement, Napa, CA, March 1115, 2013

[2] H.-T. Ding, Electromagnetic emission rate of QGP calculated from lattice QCD, 5th Workshop of the APS Topical Group on Hadronic Physics, April 10-12, 2013, Denver, Colorado, USA

[3] H.-T. Ding, Charmonium properties at finite temperature, workshop of ”QCD structure I”, Central China Normal University, Wuhan, China, Oct 7 -20th, 2012

[4] F. Karsch, Lattice Gauge Theory, Berkeley School on ”Collective Dynamics in High Energy Physics”, May 14-18, 2012

[5] F. Karsch, Hot and dense QCD, Town Meeting Relativistic Heavy Ion Collisions, CERN, June 2012

[6] F. Karsch, QCD thermodynamics at finite T and mu, International workshop ”New Frontiers in Lattice Gauge Theories” at the Galileo Galilei Institute for Theoretical Physics, Florence, Italy, August 28-September 7, 2012

[7] F. Karsch, Recent lattice QCD results on the phase diagram of strongly interacting matter, 42. International Symposium on Multiparticle Dynamics, Kielce, Poland, September 17-21, 2012

[8] F. Karsch, Fluctuations of conserved charges and freeze-out conditions in heavy ion collisions, Erice School/Workshop ”Exploring Nuclear Matter with Heavy Ions”, Erice, Italy, September 17-21, 2012

[9] F. Karsch, Exploring the QCD phase diagram with fluctuations of conserved charges International Workshop, Hadron Structure I, Wuhan October 2012

[10] F. Karsch, Lattice QCD and heavy ion collisions, Prospects and Challenges for Future Experiments in Heavy Ion Collisions, GSI, Darmstadt, February 15-16, 2013

[11] F. Karsch, The last word about CPOD 2013, 8th International Workshop on Critical Point and Onset of Deconfinement, Napa, CA, March 1115, 2013

[12] P. Petreczky, Chiral and deconfinement aspects of QCD transition, INT program: Gauge Field Dynamics In and Out of Equilibrium, March 5 - April 13, 2012

[13] P. Petreczky, Recent progress in finite temperature QCD on the lattice, 28th Winter Workshop on Nuclear Dynamics, Dorado del Mar, Puerto Rico, April 7-14, 2012.

[14] P. Petreczky, QCD at non-zero temperature : status and prospects, XII HADRON PHYSICS April, 22 - 27, 2012, Bento Goncalves, Wineyards Valley Region, Rio Grande do Sul, Brazil

[15] P. Petreczky, LQCD at non-zero temperature : strongly interacting matter at high temperatures and densities, National Nuclear Physics Summer School (NNPSS 2012), July 9-20, 2012, Santa Fe, NM

[16] P. Petreczky, Hot QCD: exploring the hot and dense strongly interacting matter, Workshop on Computational Nuclear Physics, July 23-24, 2012, Washington D.C.

[17] P. Petreczky, Quarkonia at T¿0, Extreme QCD 2012, Washington D.C., September 21-23, 2012

[18] P. Petreczky, Review of Recent Highlights from Lattice Calculations at finite temperature and finite density, Plenary talk at Confinement X, (Quark Confinement and Hadron Spectrum X), Garching, Germany, October 8-12, 2012

[19] P. Petreczky, Recent Theoretical Progress in Studying Quarkonia in QGP, APS April Meeting 2013, April 13-16, 2013, Denver CO

[20] S. Mukherjee, Deconfinement of Strangeness and Freeze-out of Charge Fluctuations, CPOD 2013, 8th International Workshop on Critical Point and Onset of Deconfinement, Napa, CA, March 1115, 2013

[21] S. Mukherjee, Lattice QCD Results at Non-zero Temperatures and Densities: On the Decon nement and the Freeze-out, APS April Meeting 2013, April 2013, Denver, Colorado, USA

[22] S. Mukherjee, Freeze-out Conditions in Heavy Ion Collisions: a lattice QCD based approach, 29th Winter Workshop on Nuclear Dynamics, February 2013, Squaw Valley, California, USA

[23] S. Mukherjee, Freeze-out Conditions in Heavy Ion Collisions: from Lattice QCD to Experiments, QCD Structure I, October 2012, CCNU, Wuhan, China

[24] S. Mukherjee, Ab-initio computation of hot and dense strongly interacting matter, Computational Nuclear Physics Meeting, July 2012, Washington D.C., USA

[25] S. Mukherjee, QCD phase diagram and conserve charge fluctuations: lattice meets experiments; Eleventh Conference on the Intersections of Particle and Nuclear Physics (CIPANP 2012), May-June 2012, St. Petersburg, Florida, USA

[26] S. Mukherjee, Thermodynamics with Domain Wall Fermions and anomaly in hot QCD, New Horizons for Lattice Computations with Chiral Fermions, May 2012, Brookhaven National Laboratory, New York, USA

[27] C. Schmidt, QCD bulk thermodynamics and conserved charge fluctuations with HISQ fermions Xth Quark Confinement and Hadron Spectrum, Technische Universitaet Muenchen, 7-12 October 2012, Muenchen, Germany.

[28] C. Schmidt, Bulk thermodynamics and conserved charge fluctuations with HISQ fermions, Extrem QCD 2012, The George Washington University, Washington DC, USA.

Nuclear physics

Plenary and Invited Talks in Cold QCD

Meeting	Location	Date	Speaker	Collaboration	Title
Gordon Conference on Photonuclear Reactions	Holderness School, NH	August-12	R. Edwards	HadSpec	Spectroscopy
INT Summer School on Lattice QCD for Nuclear Physics	Seattle	August-12	S. Ryan	HadSpec	Lattice Methods for Hadron Spectroscopy
BEACH12	Wichita	July-12	C. Thomas	HadSpec	Excited Charmonium Spectroscopy from Lattice QCD
KITPC Workshop	Beijing, China	July-12	J. Dudek	HadSpec	Hadron Spectrum from Lattice QCD
Lattice 2012	Cairns, Australia	July-12	J. Dudek	HadSpec	Review of Hadron Spectroscopy
Electron-Nucleus Scattering XII	Elba, Italy	June-12	M. Peardon	HadSpec	The Spectrum of Hadrons in LQCD
Jlab Users Group Annual Meeting	Newport News	June-12	R. Edwards	HadSpec	Spectroscopy from LQCD
HITES 2012	New Orleans	June-12	D. Richards	HadSpec	The Excited State Spectrum of QCD through LQCD Calculations
Meson 2012	Krakow, Poland	June-12	M. Peardon	HadSpec	Meson Spectroscopy from Lattice QCD
FPCP2012	Beijing, China	May-12	S. Ryan	HadSpec	Quarkonium Spectra in LQCD
GHP Workshop	Denver	April-13	D. Richards	LHPC	Hadron Structure and Lattice QCD
HITES 2012	New Orleans	June-13	K. Orginos	NPLQCD	Lattice Gauge Theory and Applications to Nuclear Physics
Lattice 2012	Cairns, Australia	July-12	H-W Lin	PNDME + ChiQCD	Lattice Hadron Structure: applications within and beyond QCD
Lattice 2012	Carins, Australia	July-12	W. Freeman	GWU	Sea Contributions to Hadron Electric Polarizabilities through Reweighting
DNP Meeting	Newport Beach	October-12	H-W Lin	PNDME	Lattice-QCD Inputs for Probing TeV-Scale Physics in Ultra-Cold Neutron Beta Decay
7th Int. Workshop on Chiral Dynamics	Jefferson Lab	August-12	J. Dudek	HadSpec	Meson Spectra from Lattice QCD
Quark Confinement and the Hadron Spectrum X	TUM, Munch, Germany	October-12	S. Beane	NPLQCD	Nuclear Physics from First Principles: a Status Report
International Conference on Hypernuclear and Strange Particle Physics XI	Barcelona, Spain	July-12	S. Beane	NPLQCD	Hypernuclei from Lattice QCD
National Nuclear Physics Summer School	St. John's College, Santa Fe	July-12	S. Beane	NPLQCD	Lattice QCD for Nuclear Physics
11th Confernece on Intersections of Particle and Nuclear Physics	St. Petersburg, FL	June-12	S. Beane	NPLQCD	Nuclear Forces from Lattice QCD
Gordon Conference on Photonuclear Reactions	Holderness School, NH	August-12	W. Detmold	NPLQCD	Few-body Systems in Lattice QCD
7th Int. Workshop on Chiral Dynamics	Jefferson Lab	August-12	W. Detmold	NPLQCD	Few-body Systems in Lattice QCD
Quark Confinement and the Hadron Spectrum X	TUM, Munch, Germany	October-12	W. Detmold	NPLQCD	Nuclear Physics from Lattice QCD and EFT
DNP Meeting	Newport Beach	October-12	W. Detmold	NPLQCD	Bound states in Lattice QCD
Future Prospects of Hadron Physics at J-PARC and Large Scale Computational Physics	Tokai, Japan	February-13	H-W Lin	PNDME + ChiQCD	Hadron Physics from Lattice QCD
Workshop on Lattice Field Theory and Strong Dynamics in the LHC Era	NCTU, Taiwan	December-12	H-W Lin	PNDME	Nucleon Matrix Elements for New-Physics Searches
20th International IUPAP Conference on Few-Body Problems in Physics	Fukuoka, Japan	August-12	T. Luu	NPLQCD	Multi-Baryon Systems for Lattice QCD
HITES 2012	New Orleans	June-12	T. Luu	NPLQCD	Nuclear Physics in a Box
International Conference on Nuclear Theory in the Supercomputing Era	Ames, Iowa	May-13	M. Savage	NPLQCD	Nuclear Forces from Quantum Chromodynamics
7th Int. Workshop on Chiral Dynamics	Jefferson Lab	August-12	A. Walker-Loud	NPLQCD	Baryons in/and Lattice QCD
INT Summer School on Lattice QCD for Nuclear Physics	Seattle	August-12	M. Savage	NPLQCD	Extreme Scale Computing Trilogy: Nuclear Physics
INT Workshop on Nuclear Reactions from Lattice QCD	Seattle	March-13	M. Savage	NPLQCD	Nuclear Reactions from Lattice QCD - Summary Talk
QCD Evolution Workshop	Jefferson Lab	May-13	H-W Lin	PNDME + ChiQCD	Recent Progress on Nuclear Structure with Lattice QCD
7th Int. Workshop on Chiral Dynamics	Jefferson Lab	August-12	M. Engelhardt	LHPC	Transverse momentum-dependent parton distribution functions in Lattice QCD
QCD Evolution Workshop	Jefferson Lab	May-12	M. Engelhardt	LHPC	Transverse momentum-dependent parton distribution functions in Lattice QCD
KITPC Workshop	Beijing, China	July-12	K-F Liu	ChiQCD	Nucleon Structure from Lattice QCD
INT Workshop on Excited States from Lattice QCD	Seattle	August-12	K-F. Liu	ChiQCD	Roper Resonance and 1-+ Meson

COMPUTING TALKS

INT Summer School in Nuclear Physics	Seattle	July/Aug 2012	B. Joo		Lectures on Chroma and Optimization

11. How much computing for lattice gauge theory is available in Japan and Europe compared with the US?
How is this divided between capability and capacity?

Country	Sustained teraflop/s
Germany	390
Japan	260
United Kingdom	260
Unites States	
LQCD Project	195
DOE Leadership Class Centers	170
US Total	365

TABLE X: Major computing resources in sustained teraflop/s estimated to be available for the study of lattice QCD in various countries, as of March, 2013.

The capacity resources abroad are shown in the Table.
There are some significant capacity resources, but they are smaller and we do not have them tabulated.
In addition, the Japanese and European lattice gauge theorists own their BG/Qs and are free to use these (very expensive) resources for capacity work as the need arises. Only the US LCFs require projects to use capability resources only for capability work.

12. Could you compare the physics productivity of the three regions.

International competition

- USQCD is leading the world in quark-flavor physics

Quantity	CKM element	Present expt. error	2007 forecast lattice error	Present lattice error	2014 lattice error	2018 lattice error
f_K/f_π	$\lvert V_{us}\rvert$	0.2%	0.5%	0.5%	0.3%	0.15%
$f_+^{K\pi}(0)$	$\lvert V_{us}\rvert$	0.2%	–	0.5%	0.35%	0.2%
f_D	$\lvert V_{cd}\rvert$	4.3%	5%	2%	1%	$< 1\%$
f_{D_s}	$\lvert V_{cs}\rvert$	2.1%	5%	2%	1%	$< 1\%$
$D \to \pi\ell\nu$	$\lvert V_{cd}\rvert$	2.6%	–	4.4%	3%	2%
$D \to K\ell\nu$	$\lvert V_{cs}\rvert$	1.1%	–	2.5%	2%	1%
$B \to D^*\ell\nu$	$\lvert V_{cb}\rvert$	1.3%	–	1.8%	1.5%	$< 1\%$
$B \to \pi\ell\nu$	$\lvert V_{ub}\rvert$	4.1%	–	8.7%	4%	2%
f_B	$\lvert V_{ub}\rvert$	9%	–	2.5%	1.5%	$< 1\%$
ξ	$\lvert V_{ts}/V_{td}\rvert$	0.4%	2-4%	4%	1.5%	$< 1\%$
ΔM_s	$\lvert V_{ts}V_{tb}\rvert^2$	0.24%	7–12%	11%	8%	5%
B_K	$\mathrm{Im}(V_{td}^2)$	0.5%	3.5–6%	1.3%	1%	$< 1\%$

✦ The world's single most precise calculation for all of the quantities in this table entry are by USQCD (except the last, where we are still closely competitive)

The BSM groups of Europe and Japan are roughly comparable in size to the USQCD BSM group

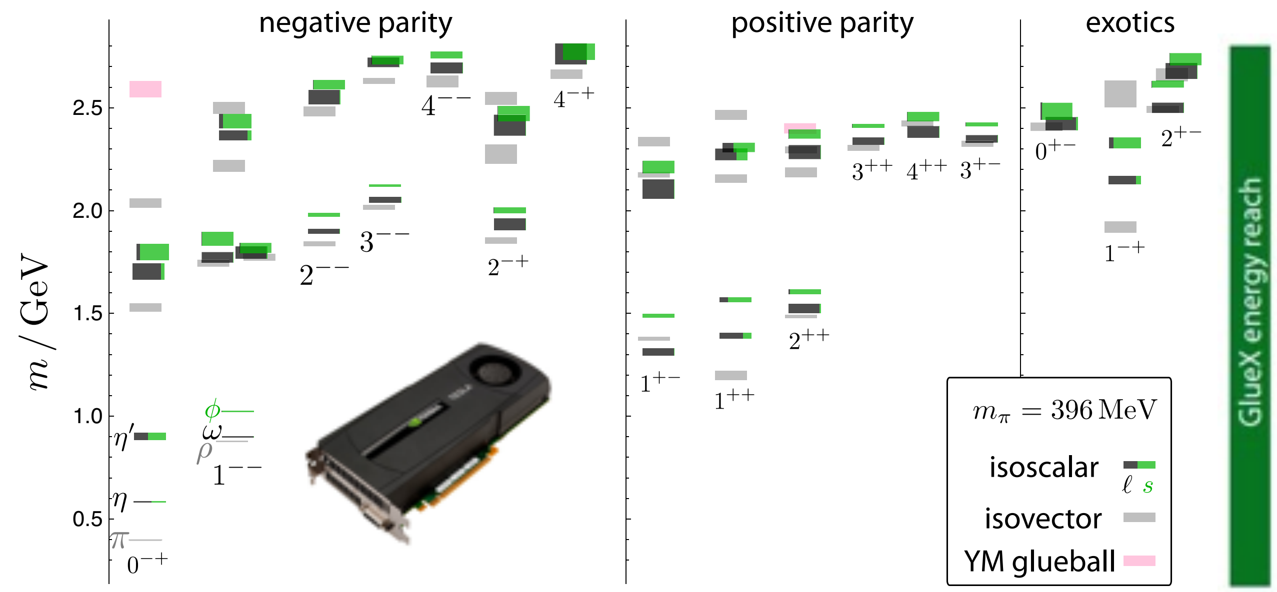
USQCD BSM group has approximately 120 spires entries over the last five years (including proceedings) with approximately 2400 citations

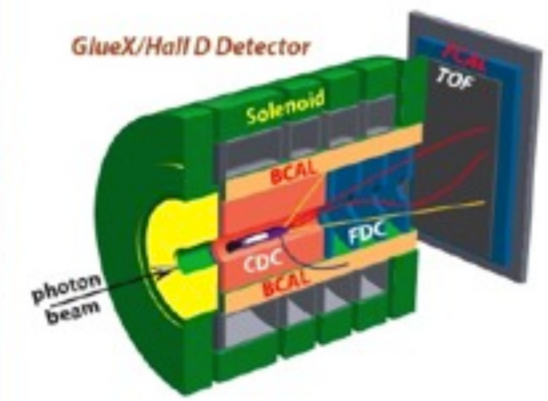
European BSM group has approximately 70 spires entries over the last five years (including proceedings) with approximately 1000+ citations

Japanese BSM group has approximately 40 spires entries over the last five years (including proceedings) with several hundred citations

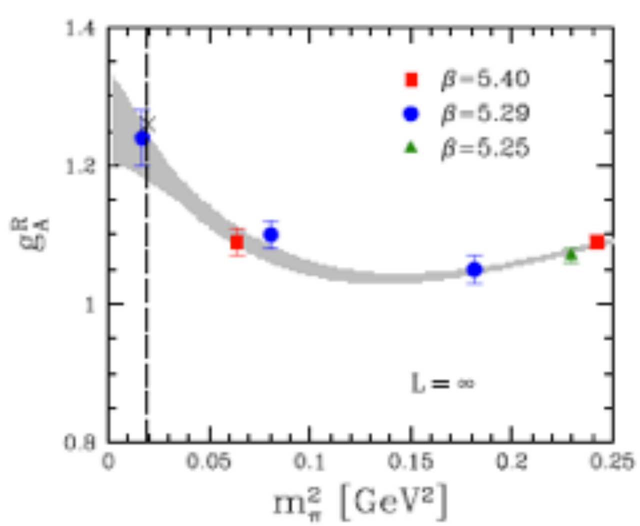
ColdQCD vs Competition

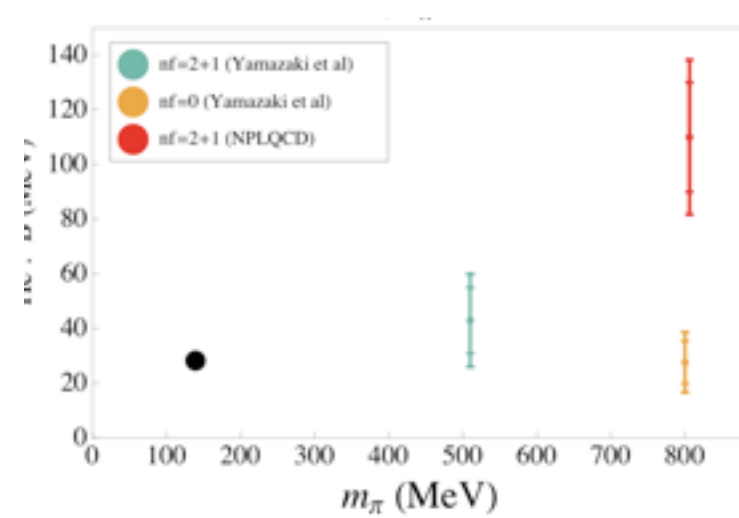
"The GlueX experimental program is coupled with both detailed lattice QCD predictions... This puts the U.S. in a unique position to explore this important new science ... the 12 GeV CEBAF Upgrade"; *focus project in USA*





High-precision calculations of hadron structure: *Important competition, notably in Germany*





Nuclear Interactions; *focus project in Japan*

All projects integral to US NP Program, and key components of future program

QCD Thermodynamics Effort in the International Context

hotQCD/BNL-Bielefeld: Tc, EoS, finite-density via Taylor expansion;
spectral functions, transport
staggered fermions, DWF
Publication 2009-2013: 11 (1000 cit); cited>100: EoS 357, Tc 128,
finite-mu 129

Budapest-Wuppertal (Z. Fodor et al.): Tc, EoS, finite-density (recently
via Taylor expansion);
staggered fermions, overlap
Publication 2009-2013: 13 (1000 cit); cited>100: EoS 252, Tc 251, 225
finite-mu 129

Mumbai (Gavai+Gupta): finite density QCD; staggered fermions

WHOT (T. Hatsuda, K. Kanaya, S. Ejiri et al): Tc, EoS, finite-density
(Taylor expansion),
spectral functions
Wilson fermions

2. Could you show computation maps of the future program in all the subject areas similar to the one showed in the cold nuclear physics talk?

No.	N_f	a(fm)	$N_s \times N_t$	Time units	TF years (configs.)	TF years (meas.)
#1	2+1	0.110	$48^3 \times 96$	2,500	90	60
#2	2+1	0.086	$64^3 \times 128$	2,500	95	70
#3	2+1+G	0.144	$32^3 \times 64$	4,000	90	50
#4	1+1+1+QED	0.110	$48^3 \times 96$	2,500	130	90
#5	1+1+1+QED	0.086	$64^3 \times 128$	2,500	145	100
#6	2+1	0.057	$96^3 \times 192$	1,800	320	220
#7	2+1+1	0.057	$96^3 \times 192$	1,800	320	220
#8	2+1+1	0.043	$128^3 \times 256$	1,400	1,050	750
Total DWF intensity frontier resource estimate						3,800

TABLE II: Resources to generate gauge configurations and perform important measurements with domain-wall fermions. The flavor notation is intended to be self-explanatory. For example, "2+1+1" indicates that the simulation masses of the up and down quark are equal and that strange and charmed sea quarks are also included. The combination "1+1+1" indicates unequal up and down quark masses and only a dynamical strange quark. Ensembles with +QED in the N_f column include dynamical photon fields while +G indicates imposed G-parity boundary conditions. The measurements determine the meson spectrum, pseudoscalar decay constants, $K \to \pi\pi$ decay amplitudes (A_0 in run #3 and A_2 for the others) and $Kl3$ form factors.

N_f	a (fm)	m_u/m_d	$N_s^3 \times N_t$	Configuration generation (TF years)	Pseudoscalar measurements (TF years)
2+1+1	0.060	1.00	$96^3 \times 192$	14	24
2+1+1	0.045	1.00	$128^3 \times 256$	72	100
2+1+1	0.030	1.00	$192^3 \times 384$	650	760
1+1+1+1+QED	0.060	0.44	$96^3 \times 192$	32	56
1+1+1+1+QED	0.045	0.44	$128^3 \times 256$	170	240
Total HISQ intensity frontier resource estimate					2,118

TABLE III: Resources to generate gauge configuration ensembles with four flavors of HISQ quarks. Notation as in Table II; 1+1+1+1 indicates that all four quark masses are unequal. The fifth and sixth column give the resources in TF years for 6,000 molecular dynamics time units (1,000 equilibrated gauge configurations).

TABLE IV: Resources for the program of calculations in Sec. II B. We show the lattice sizes, fermion actions, labeled as isotropic Wilson-clover (W), anisotropic Wilson-clover (AW) and domain-wall (DWF), and the cost of generating the configurations; those for DWF listed in Table II are not repeated. Entries in the last four columns show the cost of the measurement calculations proposed on each of the ensembles: two for hadron structure (Str-A and Str-B), one for hadron spectroscopy (HSp) and one for hadronic interactions (HI). For the Str-B measurements, the additional cost of high-precision isovector calculations and the disconnected contributions to flavor-separated quantities are denoted by † and $*$ respectively.

$N_s^3 \times N_t$	Action	a fm	m_π MeV	$m_\pi L$	$m_\pi T$	Traj.	Configs. (TF-yrs)	Str-A	Str-B (TF-yrs)	HSp	HI
$64^3 \times 128$	W	0.076	250	6.1	12.3	5×10^3	8				
$64^3 \times 128$	W	0.09	200	5.8	11.7	5×10^3	9			167	27
$32^3 \times 512$	AW	0.12	200	3.8	17.6	1×10^4	44			41	
$48^3 \times 512$	AW	0.12	200	5.8	17.6	1×10^4	197			142	
$48^3 \times 192$	W	0.09	140	3.0	12.3	5×10^3	7	40			
$64^3 \times 192$	W	0.09	140	4.1	12.3	5×10^3	21	40			
$96^3 \times 64$	W	0.09	140	6.1	4.1	5×10^3	24	13			
$96^3 \times 96$	W	0.09	140	6.1	6.1	5×10^3	40	20			
$96^3 \times 192$	W	0.076	140	6.1	12.3	5×10^3	96	40	350*	334	288
$128^3 \times 192$	W	0.076	140	6.9	10.4	5×10^3	323	67		792	970
$48^3 \times 96$	DWF	0.110	140	3.9	7.8	5×10^3		28	360†		
$64^3 \times 128$	DWF	0.086	140	3.9	7.8	5×10^3		64	844†		
Total structure, spectrum, and interactions of hadrons resource estimate											5,396

Project	lattice size	temps	quark masses	trajecs per param. set	cost [TFlo/ps-years]
phase boundary at $\mu > 0$ in the chiral limit	$(6A)^3 \times 6$ $6 \leq A \leq 12$	5	3	100,000	750
higher order cumulants of conserved charges	$(4N_\tau)^3 \times N_\tau$ $N_\tau = 8,\ 12,\ 16$	4	1	100,000	2,900
light and heavy quark spectral functions	$(4N_\tau)^3 \times N_\tau$ $N_\tau = 32,\ 48$	3	1	10,000	450
	$N_\tau = 64$	3	1	5,000	500
bulk and shear viscosities	$(3N_\tau)^3 \times N_\tau$ $N_\tau = 32,\ 48$	1	1	50,000	800
chiral transition with chiral fermions	$(8A)^3 \times 8$ $A = 6,\ 8$	5	2	10,000	500
Total QCD thermodynamics resource estimate					5,900

Table V: Summary of simulation parameters and cost estimates for QCD thermodynamics. Cost estimates are based on current experience with calculations on leadership class computers (BlueGene/Q) and GPU enhanced clusters.

(A) Resource estimates of the near-conformal BSM project				
lattice spacing a (in fermi)	fermion mass (in a units)	lattice volume $V \times T$	config generation (TF-Years)	measurements (TF-Years)
2.25×10^{-5}	0.003	$64^3 \times 128$	24	72
2.25×10^{-5}	0.004	$64^3 \times 128$	20	60
2.25×10^{-5}	0.005	$64^3 \times 128$	18	54
1.75×10^{-5}	0.0023	$96^3 \times 192$	100	300
1.75×10^{-5}	0.0030	$96^3 \times 192$	90	270
1.75×10^{-5}	0.0035	$96^3 \times 192$	80	240

(B) Resource estimates of the PNGB project				
min. M_H (GeV)	lattice volume $V \times T$	MD trajectory (time units)	config generation (TF-Years)	measurements (TF-Years)
650	$32^3 \times 64$	10000	1	2
520	$40^3 \times 80$	10000	9	12
433	$48^3 \times 96$	10000	44	60
371	$56^3 \times 112$	10000	180	270

(C) Resource estimates of the SUSY project				
lattice volume $V \times T$	wall separation L_s	bare coupling $\beta = 4/g_0^2$	trajectory. (time units)	config generation (TF-Years)
$16^3 \times 32$	24	2.4	10000	5
$16^3 \times 32$	48	2.4	10000	11
$24^3 \times 48$	24	2.4	10000	42
$24^3 \times 48$	48	2.4	10000	84
$32^3 \times 64$	24	2.4	10000	171
$32^3 \times 64$	24	2.45	10000	342
$32^3 \times 64$	48	2.45	10000	380

Total BSM resource estimate	2,941

TABLE VI: **(A)** Requested resources for the SU(3) two flavor sextet project. The fourth column shows the resources needed to generate 2,000 configurations from 20,000 MD time units. The fifth column shows the required resources for all the physics measurements. **(B)** Resources to generate gauge configuration ensembles in SU(2) gauge theory with $N_f = 2$ fermions in the fundamental representation. The inverse lattice spacing is held fixed at $a^{-1} = 5$ TeV. The first column gives the minimum Higgs mass that can fit in the volume assuming $LM_H \geq 4$ and the second column gives the corresponding lattice volume. The fourth column gives the resources in teraflop/s-years (TF-Years) needed to generate 10,000 molecular dynamics time units (1,000 equilibrated gauge configurations) for each ensemble for the Wilson fermions. **(C)** Resources needed for DWF simulation of $SU(2)$ $\mathcal{N} = 1$ Yang-Mills theory are estimated. As in previous studies, we set the bare fermion mass $m_f = 0$ for these estimates. Residual masses fall in the range 0.02-0.1 for these values of the parameters using Shamir (non-Möbius) domain wall fermions. Using three lattice volumes, two lattice spacings and two values of L_s should allow for careful extrapolation to the chiral continuum limit while maintaining control over finite volume effects.

3, 4, 10 Are there opportunities for young people to advance their careers by holding leadership positions, such as membership in the Executive Committee and the Scientific Program Committee? Is there grumbling among young people about membership in the Executive Committee or SPC?

We are trying to promote the careers of young people by maximizing their opportunities to play leadership roles in science projects. We are doing that by providing them with opportunities to lead their own projects, and by providing the software and hardware infrastructure needed to carry out these projects. We believe that opportunities for scientific leadership for young people in USQCD are unparalleled in large experimental groups, and greater than they would be if USQCD did not exist. In our view, asking young people to spend the significant time required to serve on the Executive Committee would hinder, rather than advance their careers. We have not heard any grumbling by young people about membership in the Executive Committee, and it is our impression that they are more interested in opportunities for scientific leadership than in administrative leadership. Younger members of the collaboration have served on the Scientific Program Committee, which takes much less time than serving on the Executive Committee. At present, three out of the seven members of the Scientific Program Committee are junior faculty (untenured). Our practices are in line with the approach of most academic departments, which often ask junior members to serve on department committees, but very rarely ask them to serve as department chair.

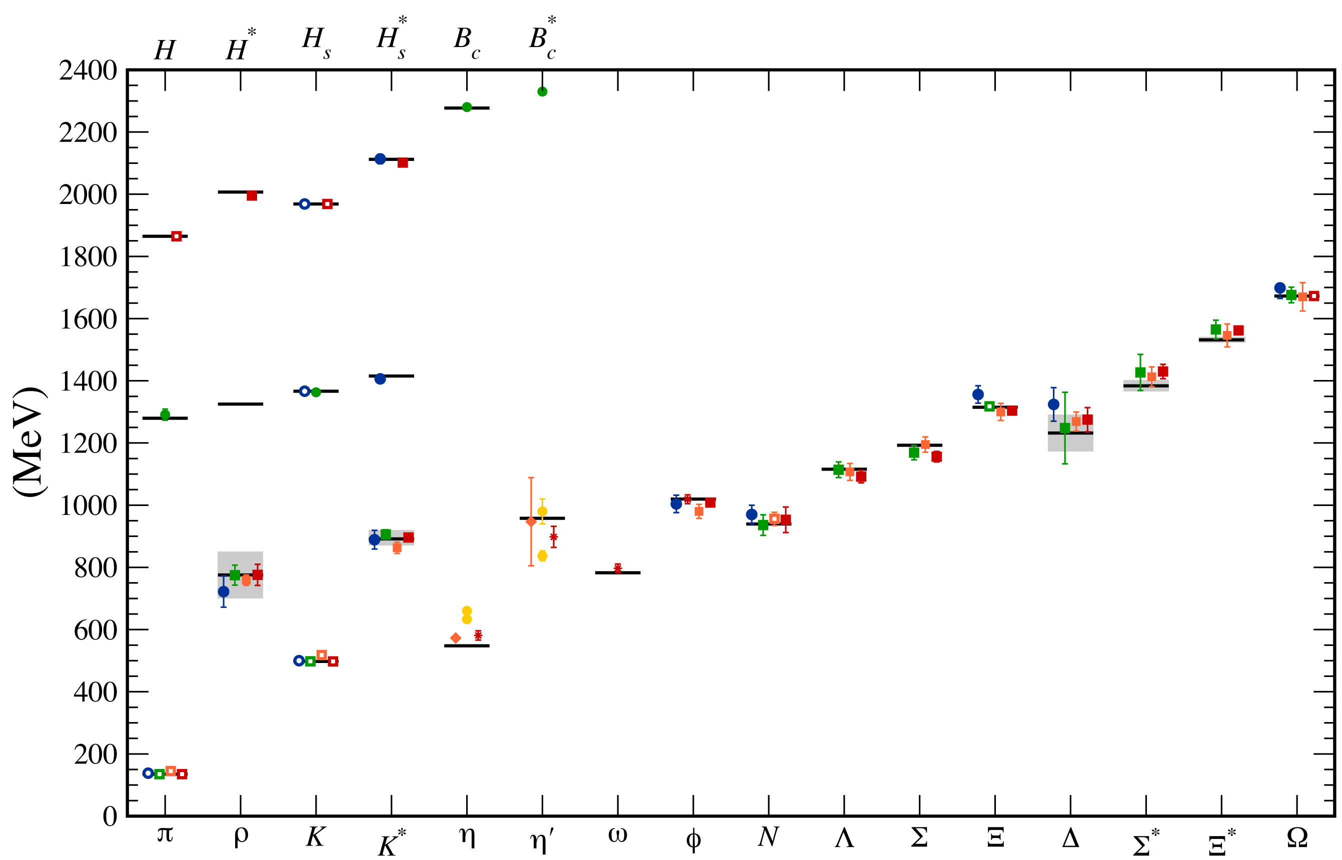
Has there been discussion of membership of the Executive Committee and the Scientific Program Committee at All Hands meetings?

We have not discussed membership in these committees at All Hands Meetings, but we have had extensive discussions of the output of these committees: the hardware and software infrastructure that is available to the entire collaboration. There have also been discussions of the scientific directions proposed by these committees, and the allocations of the Scientific Program Committee.

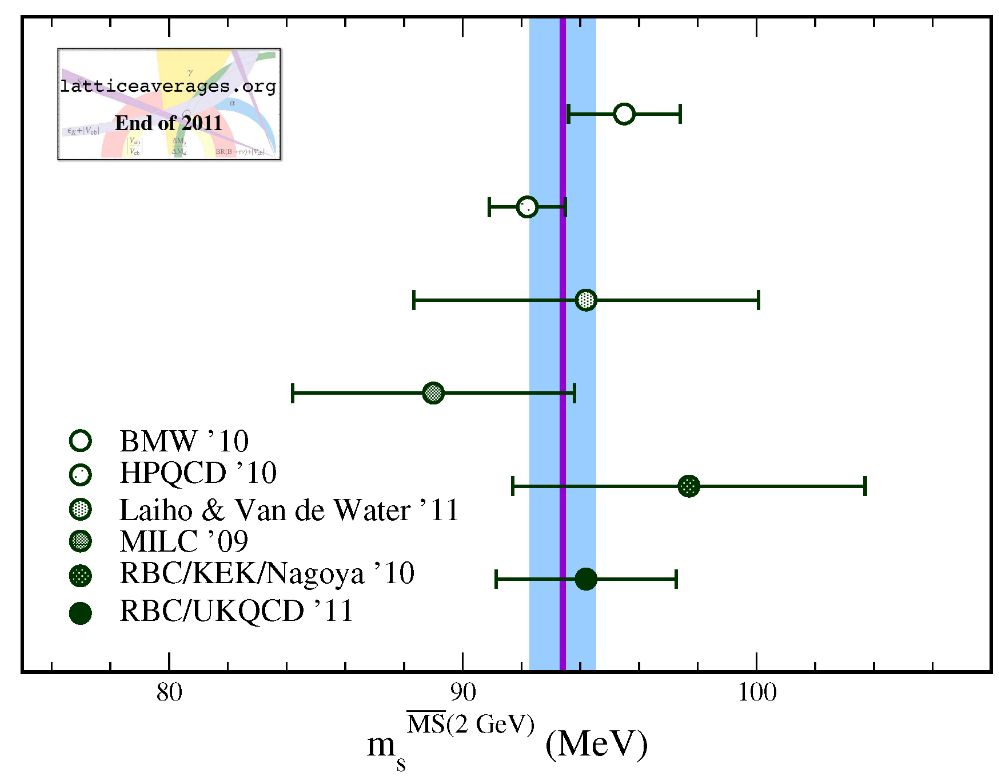
5. How are lattice calculations validated? How can we tell when lattice errors are as believable as experimental errors.

✦ Verify understanding and control of systematic uncertainties in lattice calculations by

(1) comparing results for known quantities with experiment, *e.g.* light and heavy hadron spectrum



(2) comparing independent results using different lattice actions and methods, e.g. quark masses



✦ Eventually all lattice calculations used for Standard-Model tests must be independently checked by at least two collaborations ...

6. More information about the progress in advancing junior faculty jobs. (We do not have data on the number of people leaving the field.)

	Year	Research institution, HEP	Research institution, NP	Computational scientist	Teaching college	Industry	Foreign
Jack Laiho	2013	Syracuse					
Will Detmold **	2013		MIT				
Ethan Neil	2013	Colorado					
Christopher Thomas	2013						Cambridge
Ruth Van de Water	2012	Fermilab					
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	
Christopher Aubin	2010				Fordham		
Swagato Mukherjee	2010		BNL				
Changhoan Kim	2010					IBM	
Enno Scholz	2009						Regensburg
Taku Izubuchi	2008	BNL					
James Osborn	2008			Argonne			
Chris Dawson	2007	Virginia					
Nilmani Mathur	2007						Tata Institute
Joel Giedt	2007	RPI					
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		
Kostas Orginos **	2005		Wm & Mary				
George Fleming	2005			Yale			
Tom Blum *	2003	Connecticut					
Silas Beane *	2003		UNH				
Total		7	8	3	4	3	6

* NSF Early Career Award

** DoE OJI/Early Career

7. How many PhD theses has USQCD produced?

We have not collected data on this in the past.

The finished PhDs that we know about include:

Julius Kuti 3
Martin Savage 4
Steve Sharpe 4
Silas Beane 2
David Kaplan 1
MILC 10
Columbia 13
Frithjof Karsch 3
Boston University 3
MIT 5
University of Maryland 3
CMU 3
William and Mary 3
University of Kentucky 3

Total: 60 (over the last 10 years)

We will present a more systematic collection of these statistics at next year's review.

14.

What criterion is used to decide full funding for proposals

- Proposals are classified according to the criterion they are to be evaluated: Type A or B.
- Type A: address critical needs of USQCD
  - Large requests we would expect from only long term, mature, well established projects. New projects requesting large amounts of time will receive very significant scrutiny and probably will not receive a large allocation
  - Large proposals are scrutinized significantly to ascertain whether they do address/achieve the goals of USQCD. . Does the project have an established track record? Is the project sufficiently prepared to start the new set of calculations? Are publications coming out? What has been the scientific impact?
  - Ultimately, only a fixed amount of time is available. Long term projects requiring more than the available time will not fair well
- Type B: development
  - Upper bound to time (2.5M): threshold much lower. If a reasonable case is made, then full funding is very likely
  - Projects seeking a renewal are scrutinized to determine if progress is being made along with the potential for growth to type A

What feedback is given to PI-s after allocation

- Resources almost invariably over-subscribed
- This is the type of response for strong proposals:
    - *The study of light pseudoscalar physics, especially the K -> pi pi decay, is important to the goals of the USQCD collaboration. Also, the SPC recognizes that this work, including the scale setting from the Omega mass and the quark mass tunings, is an essential part of your collaboration's physics program. However, the total resources needed by all of the important projects was considerably larger than the available resources, and we therefore cannot grant all of your request. The allocation listed above is the amount available for your project while balancing the needs of the entire collaboration.*
- Based upon complaints received by the SPC that not enough feedback was given to PI-s, last year the SPC wrote more extensive reports to the PI-s.
- Encouragement for future calculations were suggested: i.e.,
    - *As noted in our earlier comments, the SPC is very interested in seeing the Delta-I = 1/2 K -> pi pi calculation move forward, although that is not part of the work proposed here.*
  - The SPC received a proposal for this work this year
- We emphasize that significant critical (but constructive) criticism was given to several proposals (but not displayed here)

15.

How does SPC avoid COI

- All proposals clearly indicate co-PI-s.
- During SPC discussions, any SPC members that are co-PI-s of a specific proposal are not allowed to participate in discussions of that proposal.
- Votes (actual allocation) are taken from each member.
- During voting of allocations, an unbiased average of non-participating members is taken. This average is compared to a straight average from all SPC members. Discrepancies are reconciled among the committee. Votes/allocations may be recast.
- Final allocation usually based on unbiased average (although little difference from straight average by design of process)

- Anecdotal remark: have never observed significant discrepancy.

17. Software for the BG/Q. Will it develop so that it is widely useful for the community, will it broadly penetrate the community.

The BG/Q is expected to supply over 1/3 of our total cycles over the next few years, and preparing code for it is a major effort now among our software committee. Good code already exists and is now in use a Argonne for generating domain-wall ensembles, HISQ ensembles, and for HOT-QCD calculations. We expect the key kernels of the code to be written by experts (which is our standard procedure). This code is available to all members of USQCD. The Blue Gene machines represent only a fraction of USQCD hardware, so it is not necessary that every project develop a Blue Gene version of their software. Each project that runs on the Blue Gene frees time on the other USQCD machines for the other projects, which may have chosen to focus on these other platforms.