LQCD-ext II Project
2016 Annual Review

Answers to science questions

LQCD-ext II Project 2016 Annual Review
Jefferson Lab
June 28-29, 2016

1. How does the SPC balance allocations among the four main physics areas? Can you be more quantitative about the allocations process?

What criteria are used to decide full funding for proposals?

Type A: address critical needs of USQCD

- Questions:
  - What has been the scientific impact?
  - Is the project sufficiently prepared to start the calculations?
- Large proposals are scrutinized significantly to ascertain whether they do address/achieve the goals of USQCD and broader DOE program
  - Large requests typically from long term, mature projects
  - New projects receive very significant scrutiny and probably will not receive a large allocation
- Support innovation: smaller innovative proposals somewhat protected

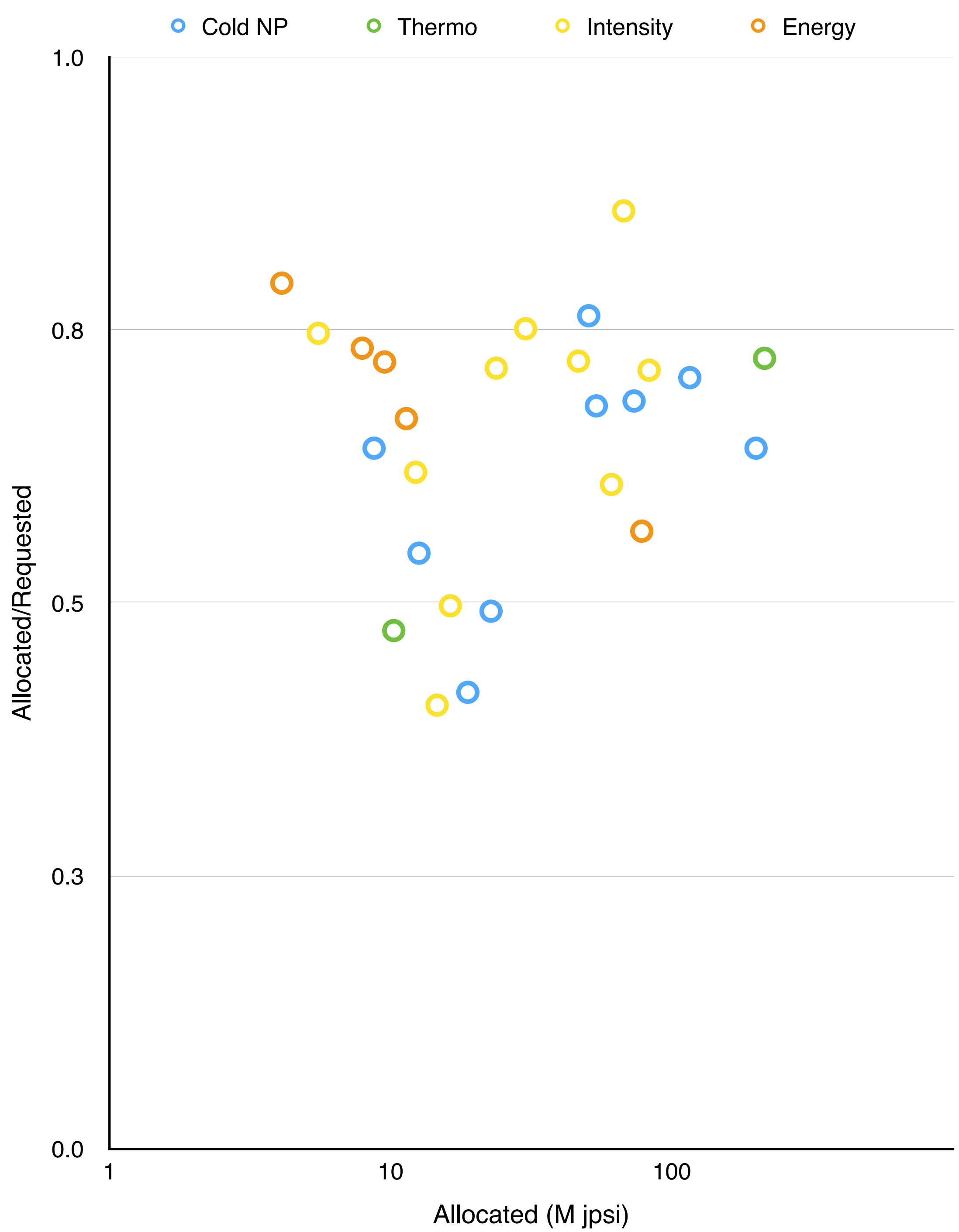
Type B: development proposals

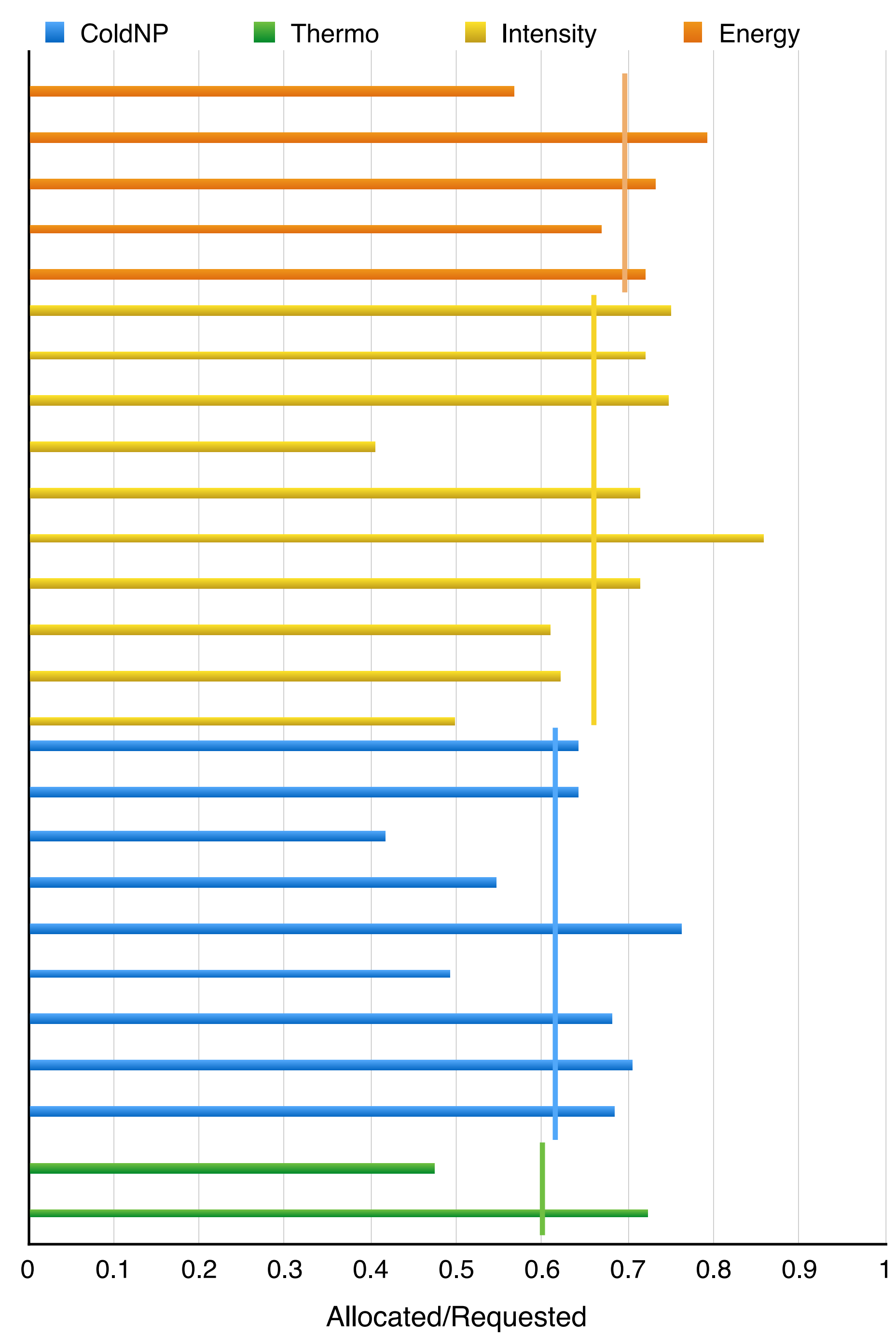
- Much smaller: if a reasonable case is made, then full funding is very likely

How is the allocation split between fields decided?

- Overlap with existing projects
  - It is an important criterion and while we see the need for multilevel calculations of the same quantity as a very solid verification process, we have to balance that against unique calculations of other quantities
- Try to maintain HEP vs NP balance over entire USQCD computing resources
  - Proposal driven
  - Consensus of representative committee: discrepancies of opinion are extensively discussed
    - Balance explicitly considered in discussions
  - Constrained problem complicated by different efficiencies on different architectures

Allocated/Requested





2. How has HotQCD affected the RHIC program? How does it affect the calculations of hydrodynamic modelers? How does it affect the parameters of modelers.

Quantities calculated by lattice QCD used in hydrodynamic models of heavy ion collisions:

The LQCD-calculated QCD transition temperature determines when hydrodynamic QGP evolution stops and particles hadronize in each cell of a heavy ion collision model.

The QCD equation of state, obtained from a parametrization of LQCD data, determines the expansion & cooling in the QGP hydrodynamic evolution.

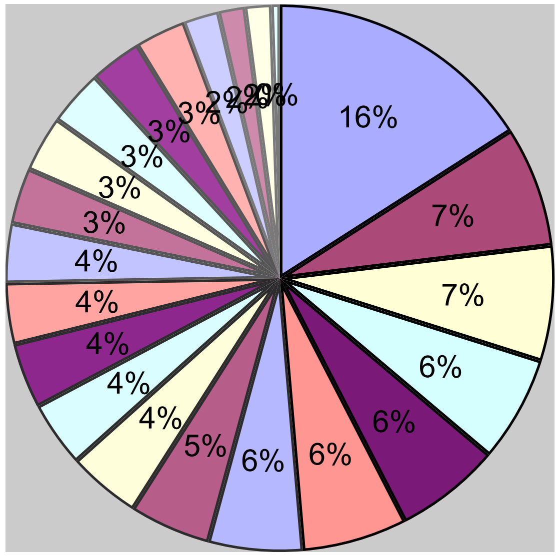
The freeze-out parameters, mapping the collision energy to the temperature and chemical potential, are determined by comparing the LQCD conserved charge fluctuations with those measured in the heavy-ion experiments.

To model the diffusion of conserved charges in the QGP one needs the corresponding diffusion constants that are calculated using LQCD.

The LQCD-calculated electrical conductivity of the QGP determines the lifetime of the magnetic field generated early in heavy-ion collisions.

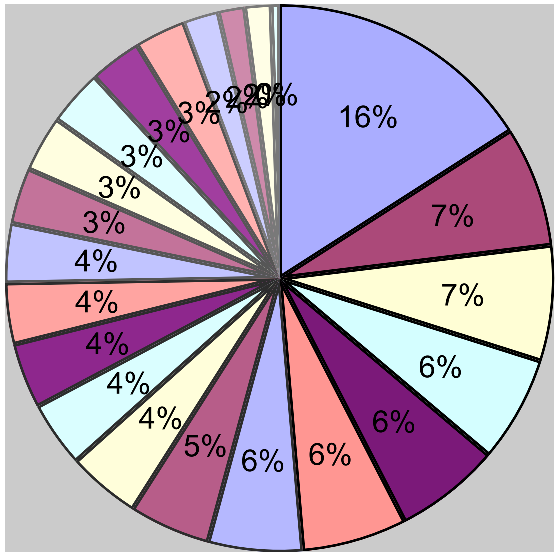
3. How would the productivity of the US lattice gauge theory program be affected in the LQCD IT Project were curtailed or eliminated?
10. How will the needs of USQCD be affected if the LCFs allow high capacity jobs to be bundled together into quasi-capability jobs?

Capacity and capability computing



- The LCFs are only set up to handle a small number (~30) of very large projects.
  - Only simple queues are set up, user support assumes sophisticated users.
- NERSC can handle smaller projects, but competition is much worse so lattice QCD gets much less time there.
- Most of the smaller projects in our portfolio would be close to impossible to do at LCFs.
  - These include many of our most important projects:
    - Innovative calculations on new quantities. E.g, g-2 calculations 5-10 years ago.
    - Projects developing new algorithms and methods that will ultimately make the flagship project more efficient.

Capacity and capability computing



- Some of our projects consist of a large number of medium-sized jobs. By bundling medium-sized jobs together it may be possible to create jobs suitable for the LCFs.
    - This is now allowed at the LCFs — policy is evolving here.
- Inefficient in several ways:
    - Diverts human time away from physics into software and painful work-flow wrangling.
    - A hit from unnecessary large scale communications degrades performance.
    - .
- We're working to understand the proper role for this in our program.
- The LCFs are great for parts of our program but not for all.

- Don’t know the exact rules for LCFs yet.
    - The capacity jobs that we know about at the LCFs consist of bundled job streams of large numbers of identical, independent jobs.
- The majority of our projects are relatively small projects that are not suitable for the LCFs.
    - These include projects such as prototype g-2 projects that are now among our flagships but began as small speculative projects on LQCD hardware ~10 years ago.
- In principle, NERSC could support these projects at the scale needed if its capacity were increased by a factor of 10.
    - A NERSC-based program wouldn’t duplicate the effectiveness of the USQCD program. The SPC, composed of lattice theorists, is much better able to:
        - recognize a good proposal from a starting postdoc or even graduate student than a multi-field allocation committee.
        - evaluate competing ideas and methods aimed at similar physics.
        - evaluate the promise of new ideas (e.g., early g-2 work).
        - evolve the science portfolio in response to HEP and NP needs.
- A world without the IT project would not only have to find the computing capability and capacity needs for lattice QCD but also reconstruct USQCD's procedures for maximizing science output.

- The US lattice community functions coherently with a well argued national program. The hardware project is a spur to this community coherence, and produces a stronger national program as a result.
- The hardware project serves other important, less visible functions for the US community: e.g., it serves as archival storage of last resort when other centers eliminate permanent storage for one of our projects as has happened at NCSA, NERSC, and ALCC.

4a. How much computing for lattice gauge theory is available in Japan and Europe compared with the US?

Country	Sustained teraflop/s (2013)	2016
Germany	390	
Japan	260	
United Kingdom	260	+ now ~ 350.
Unites States		
LQCD Project	195	
DOE Leadership Class Centers	170	+ now a comparable ~170 from ALCC
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 capability resources abroad are shown in the Table. There are some significant capacity resources, but they are smaller and we do not have them tabulated.

4b. Could you compare the physics productivity of the three regions.

- USQCD is **leading the world in quark-flavor physics.**

FLAG	Quantity	CKM element	Present expt. error	2007 forecast lattice error	Present lattice error	2018 lattice error	2016 lattice error
🥇🥇🥇	f_K/f_π	$\lvert V_{us}\rvert$	0.2%	0.5%	2013	0.15%	0.23%
🥇🥈	$f_+^{K\pi}(0)$	$\lvert V_{us}\rvert$	0.2%	–	0.5%	0.2%	0.33%
🥇🥇	f_D	$\lvert V_{cd}\rvert$	4.3%	5%	2%	$<1\%$	0.5%
🥇🥇	f_{D_s}	$\lvert V_{cs}\rvert$	2.1%	5%	2%	$<1\%$	0.6%
🥇🥈	$D\to\pi\ell\nu$	$\lvert V_{cd}\rvert$	2.6%	–	4.4%	2%	4.4%
🥇🥈	$D\to K\ell\nu$	$\lvert V_{cs}\rvert$	1.1%	–	2.5%	1%	1.4%
🥇🥈	$B\to D^*\ell\nu$	$\lvert V_{cb}\rvert$	1.3%	–	1.8%	$<1\%$	1.7%
🥇🥈	$B\to\pi\ell\nu$	$\lvert V_{ub}\rvert$	4.1%	–	8.7%	2%	4%
🥇🥇🥈	f_B	$\lvert V_{ub}\rvert$	9%	–	2.5%	$<1\%$	2.1%
🥇🥇🥉	ξ	$\lvert V_{ts}/V_{td}\rvert$	0.4%	2–4%	4%	$<1\%$	1.6%
🥇🥇🥉	ΔM_s	$\lvert V_{ts}V_{tb}\rvert^2$	0.24%	7–12%	11%	5%	7.5%
🥈🥈🥉	B_K	$\mathrm{Im}(V_{td}^2)$	0.5%	3.5–6%	1.3%	$<1\%$	1.3%

- "Medals" for most precise in FLAG 2013; USQCD best for all but B_K.
- Recent updates are on track to meet forecasts; all are USQCD.

Comparable size of lattice BSM efforts in USA, Japan, Europe overall

Many international collaborations: LatHC (U.S./Europe), Tel Aviv/Colorado, Canada/Denmark…

Larger collaborations predominant in U.S. (Lattice Strong Dynamics, Lattice Higgs Collaboration) and Japan (LatKMI Collaboration); many smaller efforts in Europe

Top 200 cited hep-lat papers since 2012, lattice BSM papers:

- 4 from USA (2 joint w/Europe)
- 6 from Europe (2 joint w/USA)
- 4 from Japan

35. **Novel phase in SU(3) lattice gauge theory with 12 light fermions**
(88) Anqi Cheng, Anna Hasenfratz, David Schaich (Colorado U.). Nov 2011. 4 pp.
Published in **Phys.Rev. D85 (2012) 094509**
DOI: 10.1103/PhysRevD.85.094509
e-Print: **arXiv:1111.2317 [hep-lat] | PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
Detailed record - Cited by 88 records 50+

48. **Lattice study of conformality in twelve-flavor QCD**
(78) Yasumichi Aoki, Tatsumi Aoyama, Masafumi Kurachi, Toshihide Maskawa, Kei-ichi Nagai, Hiroshi Ohki (KMI, Nagoya), Akihiro Shibata (KEK, Tsukuba), Koichi Yamawaki, Takeshi Yamazaki (KMI, Nagoya). Jul 2012. 36 pp.
Published in **Phys.Rev. D86 (2012) 054506**
KEK-2012-18, KEK-PREPRINT-2012-18
DOI: 10.1103/PhysRevD.86.054506, 10.1103/PhysRevD.86.059903
e-Print: **arXiv:1207.3060 [hep-lat] | PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
Detailed record - Cited by 78 records 50+

81. **Can the nearly conformal sextet gauge model hide the Higgs impostor?**
(63) 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**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
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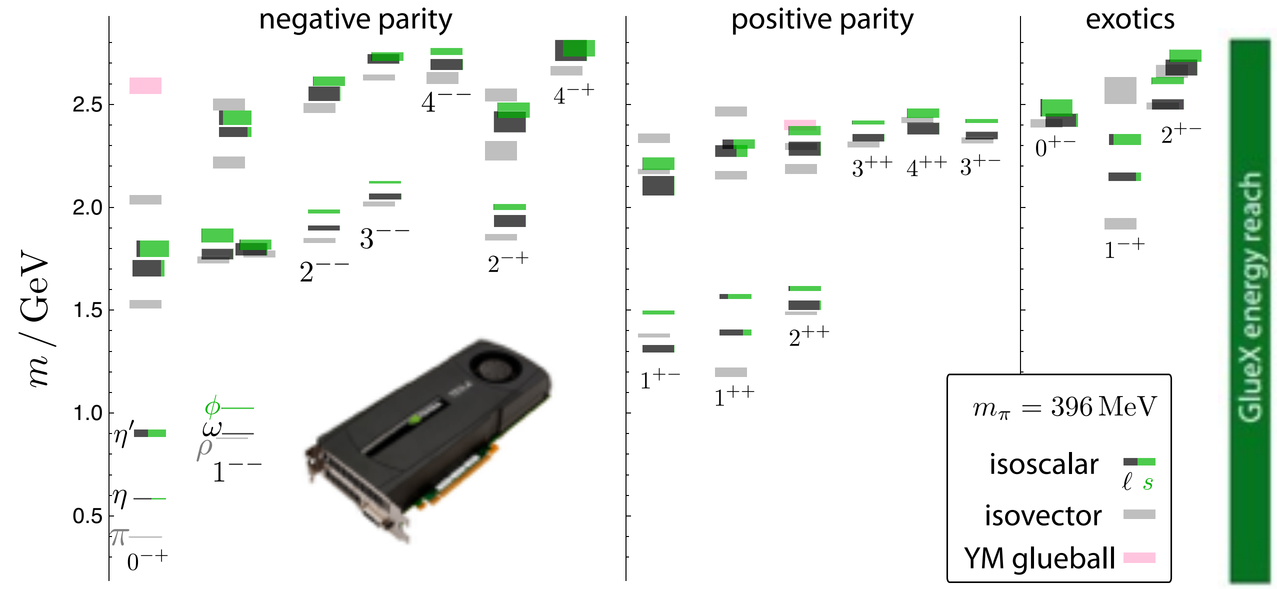
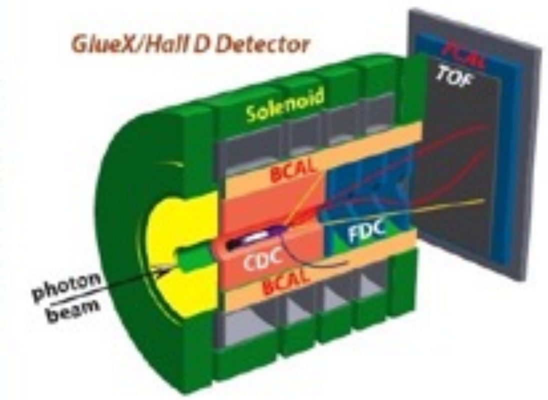
Detailed record - Cited by 63 records 50+

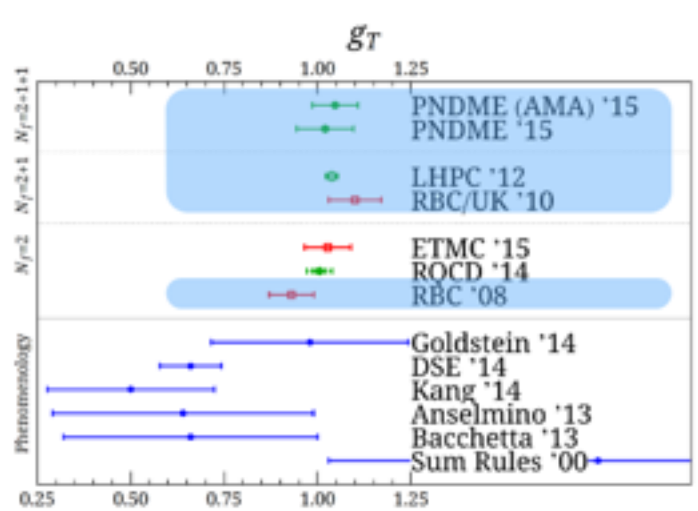
ColdQCD vs Competition

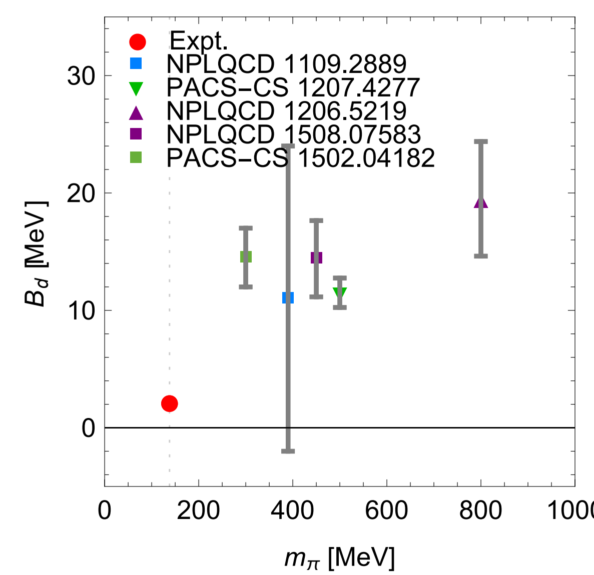
“The GlueX experimental program is coupled with both detailed lattice QCD predictions... This puts the U.S. in a unique position to explore this important new science ... the 12 GeV CEBAF Upgrade”; *focus project in USA*





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

Thermodynamics

publications in refereed journals during 2015-16: 14

among 20 most cited hep-lat papers during 2015:

14 hot-dense LQCD, 5 USQCD hot-dense LQCD

4c. Are there IT projects in Japan or Europe comparable to the US project?

The UK purchases Blue Gene Q's and other machines for the lattice community. Japan has created the K computer for computational science although not much seems to go to lattice QCD at this time.

4d. Are there analogues of USQCD in other countries?

UKQCD proposes hardware nationally somewhat similarly to USQCD. The K computer is a national effort, but more analogous to the Leadership Class Centers rather than USQCD.

8. Can you give more details about the election process.

- This year, we instituted a new type of position on the Executive Committee.
  - filled by election,
  - a period of two years.
- Goals:
  - provide a window into the Executive Committee for younger people,
  - provide the Executive Committee improved input from the community,
  - provide management experience for younger members of USQCD.
- Election was managed by the SPC prior to the All Hands Meeting.
- ⇨ Will Detmold was elected to the Executive Committee.

- The Executive Committee decided an electorate of the members of active proposals who were post-doc level or above.
- Most other details of process were left to the SPC.
  - Four people at the Assistant and Associate Professor level were nominated: Andrei Alexandru, Will Detmold, Ethan Neil, and Ruth Van de Water.

Election process was implemented by Rob Kennedy.

EC Election Process: Candidates to Election

- Election Period:
  - From 5PM EDT/4PM CDT Friday April 22 to 6PM EDT/5PM CDT Thursday April 28, 2016.
- The election used "Instant Runoff" rules as defined in Wikipedia.
- Tool: Survey Monkey – configured to support the election
  - You will be asked to rank all candidates from most preferred (1) to least preferred (4).
  - Candidates are listed in random order, varying from ballot to ballot.
  - All voting is confidential. No one will access voter names, emails or any other identifying information. Anonymized ballots will be used in the Instant Runoff procedure.
  - Your link to the election tool in the invitation email is unique and tied to your ballot. Please do not share it with anyone else, eligible or not.
  - Once you cast your ballot, you will not be able to change it.
- Election Results:
  - Announced on Friday April 29, 2016 (at All Hands Meeting)