Offices of High Energy Physics and Nuclear Physics
Report on the

LQCD-ext/ARRA
2010 Annual Progress Review

April 29-30, 2010

Executive Summary

The Annual Progress Review of the Lattice Quantum Chromo Dynamics-extension (LQCD-ext) and the LQCD American Recovery and Reinvestment Act (ARRA) projects was held on April 29-30, 2010 at the Thomas Jefferson National Accelerator Facility (TJNAF or JLAB). The purpose of the review was to assess the projects' progress towards their overall scientific and technical goals. Five expert reviewers from the nuclear physics, high energy physics and computer science communities heard presentations on scientific progress, computing hardware acquisitions and operations, allocation of resources, and dissemination of scientific results. In particular, the LQCD-ext/ARRA teams were instructed to address five charges:

1. The continued significance and relevance of the LQCD-ext/ARRA project, with an emphasis on its impact on the experimental programs supported by the Offices of High Energy (HEP) and Nuclear Physics (NP) of the Department of Energy (DOE);
2. The progress toward scientific and technical milestones as presented in the LQCD-ext project's Information Technology (IT) Exhibit 300 and the LQCD/ARRA project's Project Execution Plan;
3. The status of the technical design and proposed technical scope for Fiscal Year (FY) 2009-2010 for both projects;
4. The feasibility and completeness of the proposed budget and schedule for each project; and
5. The effectiveness with which LQCD-ext has addressed the recommendations from last year's review.

The review panel reported that the LQCD-ext/ARRA collaboration had addressed the five charges in their written as well as their oral presentations, and that they met or exceeded technical milestones in all cases. The significance and relevance of the LQCD-ext/ARRA calculations to both the high energy physics and nuclear physics programs have grown dramatically since the LQCD initiative began in 2006. The review panel endorsed both projects' benchmarking and procurement procedures. The coordination of the LQCD-ext/ARRA projects with USQCD SciDAC grants was considered a very productive effort. The allocations procedures were seen to be fair and well executed, and the user survey was judged to be very effective. The USQCD has continued to host workshops which engage the lattice, theory and experimental communities. The ARRA project is constructing a computer processing unit (CPU) cluster as well as a Graphical Processor Unit (GPU) cluster. The GPU cluster is achieving a price performance measure of $0.01/MFlops for two physics projects which compares very favorably with the $0.22/MFlops that the projects' CPU clusters are achieving on a wide mix of calculations. This validation of the GPU technology is expected to lead both projects to employ a mix of CPU and GPU clusters in the immediate future. The review panel had several observations. They recommended that the terms of members of the executive board of the National Lattice Quantum Chromodynamics Collaboration (USQCD) be limited so that younger members of the community could join. The review team also commented that the successes of

GPU clusters are dependent on the continuance of the USQCD/SciDAC initiative in developing a user friendly interface on top of architecture-specific low-level code that can exploit the floating point power of a GPU.

Introduction and Background

The DOE Offices of Advanced Scientific Computing Research (ASCR), HEP and NP have been involved with the USQCD in hardware acquisition and software development since 2001. The LQCD IT hardware acquisition and operations activity, which started in 2006 and ran through 2009, operated a "Quantum Chromodynamics-on-a-chip" (QCDOC) machine at Brookhaven National Laboratory (BNL), and built and operated special purpose commodity clusters at the Fermi National Accelerator Laboratory (FNAL) and the Thomas Jefferson National Accelerator Facility (TJNAF). LQCD met its goal of providing 17.2 Teraflops of sustained computer power for lattice calculations.

The hardware acquisition strategy of LQCD was essential to its success. Each year the collaboration benchmarked the kernels of the QCD code on the newest cluster and supercomputer hardware, and the winner of the price-to-performance competition became that year's provider.

The usage of hardware procured by LQCD has been governed by the USQCD collaboration through its executive board and allocations committee. Members of the USQCD collaboration submitted proposals for computer time, some on general purpose supercomputers run by National Energy Research Scientific Computing Center (NERSC), National Nuclear Security Administration (NNSA), and the National Science Foundation (NSF), and some on the dedicated clusters. The resources were awarded on a merit system. Three classes of computer projects have been considered, ranging from large-scale mature projects (allocation class A) to mid-sized projects (allocation class B) to exploratory projects (allocation class C). Suitable computer platforms were assigned to the various projects.

In addition to the hardware project LQCD, USQCD has played a role in software development through the Scientific Discovery through Advanced Computing (SciDAC) program. USQCD was awarded a SciDAC I grant (2001-2006) which developed efficient portable codes for QCD simulations. The USQCD now has a SciDAC II grant (2006-2011) which will optimize its codes for multi-core processors and create a physics toolbox. These SciDAC grants provide a user interface to lattice QCD which permits the user to carry out lattice QCD simulations and measurements without the need to understand the underlying technicalities of the lattice formulation of relativistic quantum field theories and its implementation on massively parallel computers.

The USQCD proposed to extend the work of LQCD beyond 2009, and submitted a proposal, "LQCD-ext Computational Resources for Lattice QCD: 2010-2014" in the spring of 2008. The scientific content of the proposal reviewed successfully on January 30, 2008, and the scientific vision and specific goals of the project were enthusiastically endorsed in full by the panel of

scientific content of the proposal reviewed successfully on January 30, 2008, and the scientific vision and specific goals of the project were enthusiastically endorsed in full by the panel of scientific experts. The proposal sought $22.9 million over a five year period to achieve its scientific goals.

In the January 30, 2008, review, USQCD argued that the mid-scale computer hardware purchased, constructed and operated by LQCD was a critical portion of its overall strategy to produce the physical predictions of Quantum Chromodynamics. That strategy depends on access to the largest Leadership Class machines for the generation of large lattice gauge configurations. These configurations are then analyzed for accurate predictions of matrix elements and spectroscopy on the mid-scale computers of LQCD and results of interest to the experimental and theoretical communities in high energy physics and nuclear physics are obtained. The mid-scale hardware of LQCD also produces smaller gauge configurations which are critical to studies of Quantum Chromodynamics in extreme environments that are relevant to the heavy ion collision program at the Relativistic Heavy Ion Collider (RHIC) at BNL which is operated by the Office of Nuclear Physics. Many of these calculations are not suited for Leadership Class machines, but run efficiently on mid-scale platforms. Several computer scientists at the January review carefully evaluated and then endorsed the mix of computers advocated by USQCD. The review panel also assessed USQCD's claim that the accuracy of some of its predictions rival the accuracy of the present generation of experiments running at DOE HEP and NP facilities. The review panel also analyzed USQCD's claim that the proposed project, LQCD-ext, was needed to maintain this parity in the future.

The LQCD-ext project then entered the Critical Decision Review process.

The Critical Decision-0 (CD-0) Mission Need Statement for LQCD-ext was approved on April 14, 2009.

The CD-1, alternative selection and cost range, review occurred at Germantown on April 20, 2009. The review evaluated the LQCD-ext project's documents on conceptual design, acquisition strategy, project execution plan, integrated project team, preliminary system document, cyber security plan and quality assurance program.

The LQCD-ext team updated its documents following recommendations from the CD-1 review panel and it received formal CD-1 approval on August 27, 2009, through a paper Energy Systems Acquisition Advisory Board (ESAAB) presentation and review.

The CD-2/3, project base-lining and readiness, review occurred at Germantown on August 13-14, 2009. Final approval for the project was granted on October 28, 2009.

The Offices of High Energy Physics and Nuclear Physics produced a planning budget for the LQCD-ext CD-2/3 review which read:

Table 1. Planning Budgets for LQCD-ext (in millions of dollars)

	FY2010	FY2011	FY2012	FY 2013	FY 2014	Total
HEP	2.50	2.50	2.60	3.10	3.20	13.90
NP	0.50	0.75	1.00	1.00	1.00	4.25
Total	**3.00**	**3.25**	**3.60**	**4.10**	**4.20**	**18.15**

The TPC of $18.15 million left the LQCD-ext project $4.75 million short of the figure of $22.9 million which was supported by the scientific review of January 30, 2008, and which the USQCD had estimated in their original whitepaper. This shortfall was subsequently addressed, however, by the request of the Office of Nuclear Physics for $4.96 million of funding through the ARRA (American Recovery and Reinvestment Act of 2009) to build a 16 Tflop/s commodity cluster at TJNAF and operate it for four years. Although this effort is not a formal part of this LQCD-ext project, the resulting hardware at TJNAF is being governed by USQCD using exactly the same procedures that apply to LQCD-ext and the acquisition, construction and operation of this hardware is being tracked on a monthly basis by the same team that is running LQCD-ext. In this way, the Offices of High Energy Physics and Nuclear Physics are monitoring the full scope of science put forward in the USQCD proposal "LQCD-ext Computational Resources for Lattice QCD: 2010-2014". It was agreed that the two efforts, LQCD-ext and LQCD/ARRA, would share Annual Progress Reviews and this report is the first in a series.

The LQCD-ext argued at the CD-2/3 review that the budget of Table 1 would support the new deployments and operations of equipment contained in Table 2:

Table 2: Performance of New System Deployments, and Integrated Performance

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Planned computing capacity of new Deployments, Tflop/s	11	12	24	44	57
Planned delivered Performance (JLab + FNAL + QCDOC), Tflop/s-yr	18	22	34	52	90

The original computing goal for the LQCD/ARRA project was 16 Tflops (sustained) from a single cluster at TJNAF. The project team initially estimated that $3.2 million would be used for hardware that would be operated for four years and that labor costs for deployment, operations and management would be $1.2 million with incidental costs for disc space, spares, travel and misc. The project would require the addition of one position at TJNAF. Subsequently, a more quantitative and detailed cost breakdown was developed and it reads:

Table 3: LQCD/ARRA Project Funding in dollars

Budget	FY09	FY10	FY11	FY12	FY13	Total
Steady State Operations	-	237,406	283,279	294,370	305,905	**1,120,960**
Hardware Deployment	1,929,280	1,817,423	-	-	-	**3,746,703**
Project Management	26,000	27,040	14,061	14,623	15,208	**96,932**
Total	**1,955,280**	**2,081,870**	**297,340**	**308,993**	**321,113**	**4,964,596**

However, the planning for hardware acquisition for LQCD-ext/ARRA has been strongly affected very recently by "disruptive technology" developments in the field of PC chips. Although the first year of acquisitions were expected to be based on commodity cluster technologies, the development of GPU for the commercial gaming industry has given new opportunities to these projects. The GPU's consist of several hundred cores per chip and are the heart of high resolution interactive graphics capabilities needed for video game entertainment. Typically they are capable of an order of magnitude more processing per second than general duty desktop CPU's. However, they are difficult to program at this time and are unbalanced (too little memory per core) for general purpose applications. However, low memory but compute intensive and highly parallel algorithms, such as the heart of lattice QCD where 90%+ of the cpu time is spent in inverting a sparse matrix, the Dirac operator describing the dynamics of virtual quarks of QCD, can take advantage of a GPU's floating power capabilities and can run 10-100 times faster than on a CPU of comparable clock period. Anticipating these developments, LQCD/SciDAC has been developing software for several years to run lattice algorithms on GPU's and the fruits of that effort are now apparent in GPU hardware ordered for LQCD/ARRA. Two complete physics projects are running on a GPU cluster at TJNAF. Their price performance is $0.01/Mflops which compares to $0.22/Mflops for the best CPU hardware. This development constituted an important new alternative in the hardware acquisition strategy of LQCD-ext/ARRA and was considered in detail by the review team. The review had several observations about this development: 1. The success of the hardware project LQCD-ext/ARRA is very sensitive to the continuance of the LQCD/SciDAC software grant because this is where the software that will eventually make GPU's more generally useful to the science community will be developed; 2. A mix of CPU and GPU clusters will be needed in the short term for LQC-ext/ARRA because most lattice scientific applications are not ready to be ported to GPU's but would be greatly more productive if and when that happens; 3. The initial estimates of TFlops of clusters that can be built for $22.15M will probably be considerably higher than the planning figures shown above, but it is hard to estimate new milestones at this time; 4. The scientific output and impact of LQCD-ext/ARRA may be considerably higher than originally planned for; and 5. The risk associated with the new GPU hardware will exceed that of the more familiar CPU's. All these considerations became part of the discussions of the planning for LQCD-ext/ARRA in FY2010 and 2011, relevant to this annual review.

The Annual Progress Review of LQCD-ext and LQCD/ARRA took place at TJNAF on April 29-30, 2010. The review consisted of one day of presentations and a second half-day of questions and answers, report writing, and a closeout session. The appendices to this report provide additional detailed material relating to the review: App.A contains the charge letter to LQCD-ext management team, App.B lists the reviewers and DOE participants, and App.C contains the agenda and links to the talks. The remaining five sections of this report detail the findings, comments, and recommendations of the review panel for each of the charge elements that the LQCD-ext/ARRA collaboration was asked to address.

Continued Significance and Relevance

Findings

The LQCD-ext/ARRA program supports activities in several research areas:

1) Precision calculations relevant to the determination of standard model parameters from heavy quark processes.

2) Exploratory calculations based on "beyond the standard model" (BSM) theories, for which LQCD may be the only effective technique for extracting quantitative predictions.

3) Hadronic physics quantities such as the spectrum of hadrons, form factors, moments of structure functions, hadron-hadron interactions and scattering.

4) Calculations of the properties of QCD at finite temperature and baryon density; this regime is explored experimentally in relativistic heavy ion collisions.

The USQCD's scientific goals are focused on carrying out world-leading computations of quantities that are of critical importance to the experimental high energy physics (HEP) and nuclear physics (NP) programs.

Lattice simulation is the only known way to accurately calculate equilibrium properties of hot QCD matter that is produced in the collisions at the Relativistic Heavy Ion Collider (RHIC).

LQCD continues to have workshops with the experimental and theory communities to wider its impact and engage in communications with complementary communities of researchers to enhance its influence and impact. There have been recent workshops on QCD in Extreme Environments and Flavor Physics.

Comments

USQCD activity in QCD thermodynamics has grown through the LQCD initiative, and these results are now among the most highly cited in this field. For example, this work has lead to the world's best result for the equation of state over a large temperature range, with almost physical

quark masses. The program has the potential to have a major impact on our understanding of the QCD phase diagram and the search for the critical point. This prospect serves as one justification for deploying more clusters with considerable computing power for generating configurations on mid-sized lattices and for extracting the physics from those ensembles.

The USQCD work on hadron spectrum, structure and scattering is also world-leading, and is very well aligned with the NP long range plan. There is a growing recognition that lattice simulations are crucial for meeting NP goals: With regard to the Jefferson Lab Scientific Program and the 12-GeV upgrade, much of the experimental program relies on lattice calculations (for example, exotic meson spectroscopy, photo-couplings, and nucleon structure) to interpret the planned measurements. LQCD predictions of hadron properties resulting from the LQCD-ext/ARRA efforts will likely be of increasing importance as the program develops. The recent results of the group led by Dave Edwards at JLAB on excited meson spectroscopy appear to be sound and sophisticated and could have considerable impact on the 12-GeV program.

In HEP, USQCD focuses on the determination of quark masses and provides QCD-based quantities needed for measuring Cabbibo-Kobayashi-Maskawa (CKM) parameters for precision tests of the Standard Model (SM). This effort has produced many of the best results available today. The interaction between the lattice community and the experimental community has been crucial here.

The USQCD collaboration also plays a leading role in exploratory work on some of the more popular "beyond the standard model" (BSM) candidate theories; these include technicolor theories of electro-weak symmetry breaking (EWSB), which require non-perturbative dynamics, and investigations of lattice supersymmetry (SUSY). This rapidly growing activity is broadening the relevance of lattice simulations to the wider HEP program.

In the case of GlueX, there are a number of results that are needed for the experimental program. The exotic meson photo-couplings are now being obtained by LQCD-ext/ARRA. It will tax their resources, however, to achieve accuracies that will make these calculations truly relevant to the related experimental effort. LQCD calculations are now at the cusp of seeing the effects of chiral perturbation theory in extrapolating form factors to the physical pion mass. If this hurdle is surpassed, a major step forward will have been achieved by the field and new relevance of lattice calculations will be found.

The impact of LQCD calculations span large parts of nuclear and high-energy physics and they now play a crucial role in many of those areas. It is important that these efforts continue. Important in this is the software development effort that is currently funded by SciDAC money. SciDAC has been critical in developing LQCD software packages that allow new workers in the field to run physics simulations without being experts at the technical elements of lattice gauge theory and computer algorithms. This has opened up the field to a wide set of users that have increased the physics impact of the effort. Unfortunately, this money may be coming to an end. If this happens, it will be necessary to replace this support.

LQCD received support from ARRA to purchase, deploy and run a ~16 Tflops computing cluster at Jefferson Lab for the use of the U.S. Lattice QCD community (USQCD). This deployment is being carried out as a two-stage purchase that is responsive to the scientific research interests of the USQCD community. Of particular note here was the decision to deploy a cluster of graphical processor units (GPU's) in addition to a cluster of normal CPU's. Recent software developments within the USQCD effort have found that parts of the LQCD software can be very effectively deployed on GPU's. The result is that for certain types of lattice problems, the goal of ~16 Tflops may be exceeded by a factor of ~5 within the budget profile of the ARRA funds. This decision on GPU's has already had a significant impact of the LQCD program relevant for JLAB physics by producing the first calculations of the entire light-meson spectrum.

Progress towards Scientific and Technical Milestones

LQCD-ext

Findings

The LQCD-ext Project has made excellent progress on its scientific goals, as recorded in its IT Exhibit 300. The relevant goals and milestones have been either met or surpassed.

The LQCD Project exceeded all performance goals for systems and support in FY 2009, with high customer satisfaction levels. LQCD-ext is on track to achieve elevated goals for FY 2010. The total Teraflops deployed has exceeded the baseline targets every year, and is on track to do so this year.

Utilization has typically been above 90% for all machines.

USQCD is making very efficient use of a wide range of high performance computer (HPC) architectures, and this has stimulated a community-based open QCD software development, enabling USQCD to rapidly exploit new systems (e.g., through INCITE). The result has been that USQCD has had access to more than double the machine cycles provided by the clusters of LQCD-ext/ARRA.

Comments

LQCD-ext monitors the usage of its clusters effectively.

Many benchmark performance numbers were in the high 90-ties range (e.g. average uptime was 98%). The LQCD-ext operation appears to be well-tuned.

The LQCD-ext hardware procurement strategy is responsive to rapidly evolving technology, and is on track to deliver excellent value for the money.

The USQCD requires a hardware strategy that reflects the growing architectural complexity of computer systems, particularly the growth of parallelism at chip and system levels. This affects

physics analyses as much as configuration generation. It will be increasingly important to integrate hardware with algorithm and software planning and development. Continued SciDAC support for software development is therefore vital to the success of LQCD-ext and subsequent similar projects.

LQCD/ARRA

Findings

The LQCD-ext/ARRA funding will be split between conventional clusters and new GPU-technology clusters.

Progress has been excellent and the change control process was very efficiently used to take advantage of new technology (GPU's) and deploy them in a timely fashion.

The LQCD-ext/ARRA funding has been planned to be implemented in two phases. Resources from Phase 1 were planned to be ordered in FY2009 and put in operation by the end of 2009. Resources from Phase 2 were to be ordered in Q1 FY2010 and put into operation in Q2-Q3 FY2010.

Phase 1 hardware, a CPU cluster and a GPU cluster, has been installed and is in use.

The Phase 2 conventional Infiniband cluster of CPU's has been installed and is in transition to early use. Another GPU cluster will be installed in July, 2010.

For Phase 2, a decision has been made on the basis of excellent performance of the GPU clusters in simulating two physics problems, one on excited meson spectroscopy and the other on models beyond the Standard Model, to double the fraction of GPU's compared to Phase 1.

Comments

The strategy and decisions made by the LQCD-ext/ARRA team to install a mix of CPU and GPU clusters appears very sensible and may lead the project to exceed its original milestones in Tflops delivered by a wide margin.

Technical design and scope for FY 2010-11

LQCD-ext

Findings

The procurement plan for LQCD-ext foresees one acquisition per year, but allows for using single contracts across fiscal year boundaries.

LQCD-ext carefully reviews the computational requirements and the available new hardware to optimize the scientific program based on a variety of benchmarks.

Comments

The design and scope for FY2010 looks very solid. LQCD-ext has a well established procedure for implementing the technical aspects of the proposal. Purchases are designed to minimize overhead, leverage off facilities at national labs and provide a balance between known and new hardware.

For FY2010-11 the plan to reduce the size of the 2010 hardware in favor of purchasing GPU's as part of the FY2011 acquisition is appropriate as the LQCD community starts taking up the new technology.

LQCD/ARRA

Findings

The LQCD/ARRA resources were placed at Jefferson Lab.

The acquisition was done in two phases. Phase 1 hardware consists of a conventional infiniband cluster with 320 nodes and a GPU cluster with 65 nodes (200 GPU's). Phase 2 consists of an Infiniband cluster with 224 nodes and a GPU cluster with 50 nodes (300 GPU's).

Comments

The project is on track to complete its hardware implementation in 2010. Depending on the final technical measure of GPU performance, they may have already exceeded the technical scope of the project.

The ratio of conventional CPU to GPU hardware in the two phases takes into account the readiness of the LQCD community to move to the new technology and allows the optimal exploitation of the GPU's superior performance. The decision to double the GPU cluster from Phase 1 to Phase 2 appears appropriate.

Software development, which is crucial for the general utilization of the GPU clusters, is currently funded through FY2011 from the SciDAC-2 program. It is crucially important that the SciDAC funding be continued beyond FY2011 to make a successful transition to GPU's, which promise significant gains over conventional clusters for LQCD calculations.

In the past USQCD has successfully used DOE Leadership class computers through the DOE's INCITE program. It is important that these hardware capability resources remain available to the USQCD program in the future at a level that allows making optimal use of all of LQCD-ext/ARRA hardware resources.

The new GPU technology is very promising and the software development to port the various LQCD algorithms to GPU's is necessary to exploit the technology optimally.

Feasibility and Completeness of Budget and Schedule

LQCD-ext

Findings

The LQCD-ext acquisitions for FY2010 and FY2011 are installed at FNAL. The new systems will be acquired across the 2010-11 fiscal year boundary to allow for a more efficient and cost effective process. The FY2010 part will be a conventional cluster while the FY2011 part will likely contain GPU's. The FY2010 procurement process is well underway and on schedule. It is expected to be on budget. There are no identified areas of concern.

LQCD/ARRA

Findings

Jefferson Lab deployed 12 Tflops from a conventional Infiniband cluster and 200 GPU's in Phase 1 of the LQCD/ARRA computing project. Operations on these resources are running well. Phase 1 of the project was on cost and on schedule. For Phase 2 the new Infiniband cluster has been installed and is in transition to early use. The GPU cluster of Phase 2 will be delivered in July. Phase 2 of the LQCD/ARRA project is on cost and on schedule.

Comments

The introduction of GPU clusters into the compute mix could put additional stress on the project. In particular, more staffing might be necessary to support new users on the GPU clusters because of limited documentation and software. This possibility should be carefully monitored by the project.

In addition, the GPU clusters may have reliability and power issues that the project has not yet encountered. These possible problems should be monitored carefully and some planning in advance of problems is probably warranted.

Although the storage requirements of the project have been modest and easily handled to date, these requirements need to be monitored carefully. The present satisfactory situation could change rapidly as more resources from the INCITE program become available and the job flow increases quickly as the computational power of the CPU and GPU clusters increase over the next year or two.

Effectiveness of Management Structure and Responsiveness to past Recommendations

LQCD-ext

Findings

Last year's review of the LQCD computing project resulted in 12 recommendations of which 11 were focused on the scientific program and one concerned technical aspects of the project. In their report the USQCD group has responded satisfactorily to the recommendations of the review.

Comments

The LQCD-ext management structure appears to be very effective.

The project has been tracking user satisfaction with surveys quite effectively with good response success. However, it might be informative to solicit input from members of the LQCD community who are not engaged in day-to-day operations of running codes to see if there are "hidden" needs in the community that have not been addressed.

The annual survey of users should be widened to address the GPU clusters, their scheduling, support and effectiveness.

Recommendations

The review panel noted that members of the USQCD executive board which governs all the computational efforts of the collaboration do not have fixed terms and that several of its members have served for over a decade. They recommended that the terms of members of the executive board of USQCD be limited so that younger members of the community could join

LQCD/ARRA

Findings

The management structure for LQCD/ARRA is modeled after LQCD-ext. Both management teams work together.

Comments

The LQCD/ARRA management structure appears to be very effective.

APPENDIX A

Department of Energy
Washington, DC 20585

MAR 4 2010

Dr. W. Boroski
LQCD Contractor Project Manager
Fermi National Laboratory
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Batavia, IL 60510-0500

Dear Dr. Boroski:

The Department of Energy (DOE) Office of High Energy Physics and the Office of Nuclear Physics plan to conduct an Annual Progress Review of the Lattice Quantum Chromodynamics (LQCD-ext) Computing Project on April 29-30, 2010, at the Thomas Jefferson National Accelerator Facility (TJNAF). A review panel of experts in high energy physics, nuclear physics, project management and computer science is being convened for this task.

John Kogut of the Office of High Energy Physics is responsible for this review; he will be assisted by Helmut Marsiske of the Office of Nuclear Physics.

Each panel member will evaluate background material on the LQCD-ext project and attend all the presentations at the April 29-30 review. The focus of the 2010 LQCD-ext Annual Progress Review will be on understanding:

- The continued significance and relevance of the LQCD-ext project, with an emphasis on its impact on the experimental programs' support by the DOE Offices of High Energy Physics and Nuclear Physics;
- The progress toward scientific and technical milestones as presented in the project's IT Exhibit 300;
- The status of the technical design and proposed technical scope for FY 2010;
- The feasibility and completeness of the proposed budget and schedule;
- The effectiveness of the proposed management structure, and responsiveness to any recommendations from last year's review.

In addition, we will also be using this review to assess the plans for, and progress on, the construction and operation of the TJNAF LQCD cluster which is funded by the American Recovery and Reinvestment Act (ARRA) of 2009. We are consolidating these reviews because the LQCD ARRA cluster will be operated by

the USQCD collaboration like any other hardware platform of the LQCD-ext project. However, since ARRA funding is subject to special scrutiny, it will receive a separate progress report. Chip Watson, the Contractor Project Manager for the LQCD ARRA cluster, should present the relevant information in the LQCD ARRA project documentation so as to allow the panel to evaluate the project according to the above charge elements.

Each panel member will be asked to review these aspects of the LQCD-ext and LQCD ARRA projects and write an individual report on his/her findings. These reports will be due at the DOE two weeks after completion of the review. John Kogut, the Federal Project Manager, will accumulate the reports and compose a final summary report based on the information in the letters.

The two days of the review will consist of presentations and executive sessions. The later half of the second day will include an executive session and preliminary report writing; a brief close-out will conclude the review. Preliminary findings, comments, and recommendations will be presented at the close-out. You should work with Chip Watson and John Kogut to generate an agenda which addresses the goals of the review.

Please designate a contact person at TJNAF for the review panel members to contact regarding any logistics questions. Word processing, internet connection and secretarial assistance should be made available during the review. You should set up a web site for the review with relevant background information on LQCD-ext, links to the various LQCD-ext sites the collaboration has developed, and distribute relevant background and project materials to the panel at least two weeks prior to the review. Please coordinate these efforts with John Kogut so that the needs of the review panel are met.

We greatly appreciate your willingness to assist us in this review. We look forward to a very informative and stimulating review at TJNAF.

Sincerely,

Dennis Kovar
Associate Director of Science
for High Energy Physics

Timothy Hallman
Associate Director of the Office of Science
for Nuclear Physics

APPENDIX B

Reviewers for LQCD-ext/ARRA Review, April 29-30, JLAB

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Department of Energy
Washington, DC 20585

JUL 12 2010

Dr. William Boroski
LQCD-ext Contract Project Manager
Fermi National Accelerator Laboratory
Mail Station: 127 (WH 7W)
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Dear Dr. Boroski:

We have enclosed a copy of the report resulting from the Department of Energy review of the Lattice Quantum-Chromo Dynamics (LQCD)-ext/American Recovery and Reinvestment Act (ARRA) 2010 Annual Progress Review that was held at Thomas Jefferson National Accelerator Facility on April 29-30, 2010. We very much appreciate the work that the LQCD-ext/ARRA project team and the National Lattice Quantum Chromodynamics Collaboration (USQCD) invested in preparation for this review and in the presentations to the review committee.

The review committee was very favorably impressed by the review and its associated materials. They did, however, have a few comments that you should consider and respond to. The details of their findings, comments, and recommendations can be found in the enclosed report. Please address the review committee's suggestions and recommendations in a response to this office within the next two weeks.

We hope that the review report is helpful to you in continuing the LQCD-ext/ARRA project. Congratulations for getting this interesting project off to a fine start.

Sincerely,

Dennis Kovar
Associate Director of Science
for High Energy Physics

Timothy Hallman
Associate Director of Science
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Enclosure