

**Risk Management Plan
for the
SC Lattice QCD Computing Project Extension
(LQCD-ext)**

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Operated at
Brookhaven National Laboratory
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**Lattice QCD Computing Project Extension (LQCD-ext) Risk Management Plan
Change Log**

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1 INTRODUCTION

The purpose of this document is to describe the risk management plan associated with the SC Lattice Quantum Chromodynamics (LQCD) Computing Project Extension, referred as LQCD-EXT in the rest of the document, and the annual risk management status updates. This document and the associated Risk register¹ are LQCD-EXT Controlled Documents.

The purpose of LQCD-EXT Computing project is the deployment and operation of a large scale dedicated computing facility capable of delivering an aggregate of over 220 Tflops-years (1 Tflops or teraflop per second = 10^{12} floating point operations) by the end of FY2014 for the study of quantum chromodynamics (QCD). This project plays an important role in expanding our understanding of the fundamental forces of nature and the basic building blocks of matter. The computing hardware is housed at Brookhaven National Laboratory (BNL), Fermi National Accelerator Laboratory (FNAL) and Thomas Jefferson National Accelerator Facility (TJNAF), and is operated as a single distributed computing facility, which is available to lattice gauge theorists at national laboratories and universities throughout the United States.

LQCD-EXT operates a number of systems which were already in existence at the beginning of the investment: (1) the QCDOC purpose-built supercomputer at BNL, (2) two commodity clusters at FNAL constructed as large scale production prototypes during the DOE's SC Lattice QCD Computing Project, and (3) two additional commodity clusters at TJNAF, also from the Lattice QCD Computing Project. LQCD-EXT also deploys new systems. During each year of the five-year project, LQCD-EXT will design, procure, and commission a new system at TJNAF, FNAL, or BNL.

2 LIST OF ABBREVIATIONS

Acronym	Definition
AMD	Advanced Micro Devices, a processor company
BNL	Brookhaven National Laboratory
C&A	Certification and Accreditation (computer security)
CCB	Change Control Board
COTS	Commercial off-the-shelf
CPU	Center Processor Unit
DOE	Department of Energy
FNAL	Fermi National Accelerator Laboratory
Intel	A processor company
IPT	Integrated Project Team
LBL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
LQCD	Lattice Quantum Chromodynamics
NCSA	National Center for Supercomputing Applications
NERSC	National Energy Research Scientific Computing Center
QCD	Quantum Chromodynamics
QCDOC	QCD On a Chip (BNL Supercomputer)
SciDAC	Scientific Discovery through Advanced Computing
TFlop/s	Teraflops per second, 1 teraflop = 10 ¹² flops
TFlop/s-yr	Computing delivered by 1 TFlop/s sustained for one year
TJNAF	Thomas Jefferson National Accelerator Facility

3 OVERVIEW OF THE RISK MANAGEMENT PLAN

3.1 Purpose and Objective

As defined in the LQCD-EXT Project Execution Plan, the Integrated Project Team (IPT) views risk management as an ongoing task that is accomplished using a formalized plan, namely this document, to identify, analyze, mitigate and monitor the risks that arise during the course of the project. LQCD-EXT established its risk management plan during the early stages of the project using the guidelines set forth in Chapter 14 of DOE Publication M 413.3-1ⁱⁱ, Project Management for the Acquisition of Capital Assets. The current revision of the document is based on the guidance provided in the Guide to the Project Management Body of Knowledge (PMBOK Guide, Third Edition)ⁱⁱⁱ and the OMB Circular Number A-11 Part 7 Capital Programming Guide V2.0 (2006) Appendix 5^{iv}.

As defined in above references, risk is a measure of the potential of failing to achieve overall project objectives within the defined scope, cost, schedule and technical constraints. The purpose of this document is to describe how LQCD-EXT IPT plans to minimize the project risks and document actions to put in place in a timely and consistent manner in case of an occurrence. The LQCD-EXT risk management strategy is to avoid risk as much as possible by understanding the possible risks associated with the project and devising methodologies for managing them. LQCD-EXT risks can be envisioned from two points of view:

- a. Enclave-based risks associated with the hosting laboratories, including security, privacy and business continuity: LQCD-EXT equipment hosted by each laboratory remains under the jurisdiction of the hosting laboratory as a part of its General Enclave. Security, privacy and business continuity risk, also called disaster recovery, responsibilities are managed by the hosting laboratory
- b. Project-based risks associated with the overall project: Project-based risks are the risks associated with the overall project execution.

Enclave-based risk management methods are addressed in the laboratory specific documents and technologies.

3.2 Responsibility

The final responsibility for risk management rests with the Contractor Project Manager, who takes appropriate measures in consultation with the LQCD-EXT Integrated Project Team (IPT), the Executive Committee and other project members. Designated Site Managers at each site are responsible for the site specific risks. However, effective risk management is an iterative, multi-step process that requires continued involvement of all project members.

4 SECURITY, PRIVACY, AND BUSINESS CONTINUITY RISK MANAGEMENT

4.1 Security

Security management of the computing facility hosted by each laboratory is administered by the physical and cyber-security infrastructure established by that laboratory. The LQCD-EXT Security Plan for a particular set of computing equipment within an enclave is updated and approved whenever any new equipment is added to the existing enclave. Each laboratory must also keep its Certification and Accreditation (C&A) documents up-to-date. The hosting laboratory also performs required scans and other monitoring and assessments. Since LQCD-EXT computing facility is special purpose equipment dedicated to LQCD simulation, there is very little external access to the equipment.

4.2 Privacy

No private, personal or otherwise, information may be retained on the LQCD-EXT computer facilities.

4.3 Business Continuity and Disaster Recovery

Since delivering technical results to the USQCD user community is the most critical objective of this investment, LQCD-EXT project considered disaster recovery planning from the beginning of the project. The LQCD-EXT project takes advantage of the institutional disaster recovery plans for the computing centers at each of its Laboratory sites. These plans are reviewed periodically. The most valuable data products produced by the project are the vacuum gauge configuration data files, which may require in aggregate many Tflops-yrs of computing. These files are stored redundantly at multiple locations, including two or more of FNAL, TJNAF, NERSC and NCSA. The principal investigator for each computational project executed on the LQCD-EXT systems is responsible for safeguarding the data products produced by his or her scientific project. By standard government policy, the equipment at each facility will not be insured against disasters, though the standard safety protections provided by each laboratory assure as much as possible the protection of the equipment. The distributed nature of the meta-facility partially mitigates the risk of natural disasters, allowing

for critical scientific calculations to be moved from one host site to another in the event of a sustained outage.

5 PROJECT RISK ASSESSMENT

Since the goal of the LQCD-EXT project is to extend the envelope of technology, specifically to establish and operate dedicated systems that optimize performance/price ratio for LQCD computing, it is necessary to accept certain levels of risks to achieve the scientific objectives of the project. Eliminating risk entirely is not a possible option. The LQCD-EXT IPT adopted a “risk aversion to a moderate degree” approach. The strategy is to reduce risk to an acceptable level by using the project plan effectively to mitigate risks as they arise. The project uses various control mechanisms to manage residual risks. The risk management process of LQCD-EXT is integrated with the technical plans, the Project Execution Plan and the Work Breakdown Structure for the project.

5.1 Risk Assessment Planning

The technical plan for the project, as documented in the associated acquisition plans, hardware benchmarks, and alternate strategies, outlines the risks associated with the annual investment and their impacts. This planning process includes identification of risks, probability of occurrence, degree of impact, and risk mitigation strategy. A change management process, as outlined in the LQCD-EXT Project Execution Plan, is in place to manage changes to the project that may occur to mitigate realized risks. Identified risks are documented in the LQCD-EXT Risk Register which also contains records of outcomes of the qualitative risk assessment. Details of LQCD-EXT project risks are given in the risk identification section of this document.

5.2 Execution of Risk Management

As the project progresses, the LQCD-EXT IPT evaluates the risks continuously by using project management metrics and tools including:

- Monthly project completion status reports
- Monthly financial status reports
- Monthly technical accomplishment reports
- Change requests and their approvals or rejections

The LQCD-EXT IPT reviews risks and its net risk levels of the project continuously. If a decision is made that the net risk level of a particular item requires that a risk mitigation strategy should be put in place, then the required change is evaluated against the change control threshold described in the LQCD-EXT Project Execution Plan. If the change level is low, then the site managers and the project manager executes necessary changes needed to mitigate the risks. If the risk level is high, and the change needed to implement the risk mitigation strategy requires the approval of the LQCD-EXT Change Control Board (CCB), then a Change Control Request is issued. Any significant changes needed to mitigate risks are approved by the CCB.

5.3 Re-plan

Mitigation plans for new risk assessment results are incorporated into the plans for subsequent years. If necessary, a change control request is also processed. The list of mitigation plans is given in the risk identification section of this document.

6 RISK IDENTIFICATION

The risk register workbook contains multiple worksheets including the list of risks identified for the project and their attributes and the risk ratings. Attributes associated with each risk are as follows:

Initial Risk ID

Risk Area grouped under Technology, Funding and Staffing categories

Probability of Occurrence (initial)

Description

Initial date of identification

Last update

Probability of occurrence of the risk (latest)

Impact of occurrence of the risk (latest)

Risk rating (probability * impact)

Detailed information regarding each identified risk is recorded in the narrative document associated with the Risk Register.

7 RISK ANALYSIS

Each identified risk for the project is analyzed for the probability and impact of occurrence. Individual ratings for probability and impact of occurrence are assigned to each of them. Numerical values assigned to each probability and impact category are shown in Table 1. The risk rating is derived by multiplying probability and impact values. Table 2 shows the rating matrix

Table 1: Values of risk probability and impacts

Probability	Value	Impact	Value
High	0.75	Severe	0.9
Medium	0.5	Moderate	0.5
Low	0.25	Low	0.1

Table 2: Risk ratings

	Severe	Moderate	Low
High	0.675	0.375	0.075
Medium	0.45	0.25	0.05
Low	0.125	0.125	0.025

8 RISK HANDLING

The primary risk handling strategy for the LQCD-EXT project is to avoid risks by making best possible project assumptions validating those using inputs from the DOE Review Committee and Scientific Program Committee. However, it is often necessary to address mitigation actions for individual risks.

8.1 General Risk Mitigation

The risk mitigation strategies for each risk categories are developed to minimize and mitigate the risks involved with most project deliverables. General mitigation strategies for each risk area are described below.

Following the DOE guidelines, all risks for the project are grouped into three interrelated major areas, namely, technology, cost and schedule. The fourth risk area is related to security and safeguards. The detailed list of risks is given in the LQCD-EXT Risk Register.

Technology: The major technical concern for the LQCD-EXT project is the annual delivery of computing capabilities, expressed in Tflop/s-yrs. Since this is related in part to the cost of the new systems, and the schedule for their delivery, the risk involved is of low to moderate probability and with moderate impact. In any given year, the computing capacity of the new system commissioned in that year will not exceed 30% of the total computing capacity available to the project. Further, each new system is planned to be operated for at most the last 3 months of a given fiscal year, except possibly for the last year of the project. Consequently LQCD-EXT can reliably predict prior to the beginning of any fiscal year the Tflop/s-yrs that will be delivered in the fiscal year. This allows for detailed planning, by the Scientific Program Committee, of allocations to scientists for access to these computing resources. It is also possible to track and benchmark new products available in the market.

Possible schedule overrun is also a risk associated with technology. The risk of schedule overrun by the LQCD-EXT project is of low to moderate probability and of moderate impact. The schedule estimates are based on the promised release dates (“roadmaps”) for hardware components as given by the manufacturers, and the delivery dates given by the third-party vendors and integrators with whom the LQCD-EXT project subcontracts for the hardware purchases. Since the LQCD-EXT project must rely on state-of-the-art technologies to deliver highest possible computing power within the project budget, it is often necessary to wait for the most advanced technologies, for example, processor and switching technologies, promised by the manufacturer. However, if the manufacturer fails to make good on the promised dates, the schedule may slip, or the project may have to procure the existing technology at lower performance.

Cost: Because LQCD-EXT funding is directly associated with the Congressional release of funds, there may be a delay in the availability of moneys for major procurements. To mitigate this risk, all major LQCD-EXT procurements are scheduled after the end of first quarter of each fiscal year. The risk of cost overrun or exceeding the available fund by the LQCD-EXT project is of low probability and of low impact. The cost estimates are based in part on previous procurements for the SciDAC prototype systems, procurements during the LQCD-EXT project, and the actual costs of labor for deploying and operating the LQCD-EXT project systems. Together, these firmly establish the historical performance and price trends for COTS-based parallel computing systems for LQCD-EXT calculations. Because of the build-to-cost nature of the project, LQCD-EXT has minimal risk for completing over budget. Hardware cost variances from the estimates described above will result in adjustments to the sizes of the computing systems developed each year. That is, higher than anticipated hardware costs will result in the procurement of a smaller cluster in a given year, or a cluster of different composition (for example, selection of high performance network and/or processor). Labor cost variances, for example, the need to change the amount of user support, will result in adjustments of the division between subsequent equipment and labor budgets. The performance risks associated with computing and network system are estimated to be low due to the successful R&D during the SciDAC project, and the use of COTS hardware wherever possible.

Further, the use of conservative extrapolations from historical LQCD computing performance trends mitigates the risk of delivering less capable computing systems than planned.

Staffing issues may also affect the project cost. Since only a small number of technical staff members are associated with the LQCD-EXT project, there is a low probability of risk associated with the loss of key project members. However, the impact of the loss of key personnel can be high in terms of full release of new computing systems to the scientific community and annual technical delivery. To mitigate this risk, as much as practical, LQCD-EXT staff members at two or more of the host sites participate in the prototyping, planning, and execution of each major system acquisition. Cross-training of system administration duties is encouraged whenever possible. This ensures that LQCD-EXT maintains project expertise in at least several individuals.

Schedule: Schedule risk for the LQCD-ext project is tied to the technology and the cost risks. If technology does not keep up with the technology roadmap or if the cost becomes higher than projected, the primary scientific delivery schedule will be affected. The general risk mitigation strategy in this area consists of optimizing the annual procurements, both from cost and schedule point of view, to deliver the most TFlops-yrs.

Security and safeguard: Security, privacy and business continuity issues described in the section 3 are categorized as security and safeguards risk in the Risk Register.

The LQCD-EXT project uses various risk minimization tools and techniques. These are:

- System and subsystem prototyping
- Benchmarking using modeling and simulation
- Formal and informal technology assessments
- Quality control and system validation
- Alternative acquisition analysis
- System and subsystem level risk assessments including prioritization
- Continuous monitoring of technical and financial performance measures
- Establishing various surety measures including security and disaster recovery measures

8.2 Detailed List of Risk Ratings

Table 3 below provides a summary of the risk rating for the LQCD-EXT project. As of date, 27 risk items has been identified, grouped under four above-mentioned categories and documented in the Risk Register. Risk probabilities and impacts are updated during the annual review of the risk management plan. As predicted in the initial planning the technology and funding have the highest risk ratings.

Table 3: Summary of risk ratings by areas (from Risk Register)

LQCD-ext FY11 Risk Register Pivot Table					
Sum of Risk Rating	FY11 Risk Area				
Last Status	Cost	Schedule	Security Safeguard	Technology	Grand Total
Closed					
6				0.125	0.125
9				0.125	0.125
14			0.125		0.125
15				0.125	0.125
22		0.25			0.25
23		0.125			0.125
Closed Total		0.375	0.125	0.375	0.875
Open					
1		0.25			0.25
2	0.25				0.25
3	0.125				0.125
4				0.025	0.025
5				0.025	0.025
7	0.125				0.125
8			0.125		0.125
10	0.125				0.125
11				0.125	0.125
12				0.25	0.25
13	0.125				0.125
16				0.025	0.025
17			0.125		0.125
18			0.025		0.025
19				0.025	0.025
20				0.025	0.025
21	0.25				0.25
24	0.125				0.125
25				0.125	0.125
26			0.25		0.25
27			0.125		0.125
28			0.025		0.025
29				0.25	0.25
30		0.675			0.675
Open Total	1.125	0.925	0.675	0.875	3.6
Grand Total	1.125	1.3	0.8	1.25	4.475

9 RISK MONITORING

The Risk Register is reviewed and updated continuously. During a given year, whenever the probability of occurrence and impact of occurrence of an individual risk changes, the status change is indicated in the register. The status of the new risks added to the register in a given year is identified as new. New and revised mitigation actions are also recorded. LQCD-EXT Project Office reviews the Risk Register before completing each DOE Quarterly Report. At those times the Risk Register is updated, adding and/or closing risks, and initiating and revising risk mitigations as needed. This Risk Register will also be reviewed and updated if a risk is perceived before a scheduled review. During the third quarter of each fiscal year, an external DOE Progress Review committee assesses the LQCD-EXT project. The LQCD-EXT IPT takes advantage of this assessment process to review the long-term risk management plans with the reviewers. The LQCD-EXT Risk Management Plan is updated annually.

10 REFERENCES

ⁱ Risk Register for the LQCD-ext project: Updated on July 21, 2010

ⁱⁱ DOE G 413.3-7 Risk Management Guide (9-16-08)

ⁱⁱⁱ A Guide to the Project Management Body of Knowledge (PMBOK® Third Edition), Project Management Institute

^{iv} OMB Circular Number A-11 Part 7 Capital Programming Guide V2.0 (2006) Appendix 5