July 17, 2013

Answers to questions from the review committee for the CD-1 Director's Review of the LHC CMS Detector Upgrade Project.

1. Please provide a table comparing your status with the CD1 requirements from DOE 413.3B.

Requirement	Status
Approve Acquisition Strategy	Plan submitted and iterated with DOE. Needs final numbers on Cost Range and final Approval
Approve Preliminary Project Execution Plan	Plan submitted and iterated with DOE. Need to enter cost summary, NSF funding information and to verify that milestones conform to RLS. Need to check section on advisory boards for recent changes (CMS). Need to update section on tailoring if necessary.
Appointment of Federal Project Director	Done (Steve Webster)
Establish and charter Integrated Project Team (IPT)	Done. Charter in PPEP. Biweekly meetings since beginning of year
Develop a Risk Management Plan	Draft done. Has been reviewed and can soon be declared final.
Comply with One-for-One building space requirement	Not applicable. There is no building construction in this project
Complete a Conceptual Design	Done.
Document high performance and sustainable environment building and sustainable environment stewardship considerations	Not applicable to this project.
Conduct a conceptual design review	Done. Reviewed by Independent Conceptual Design Review in May 2013. Declared to exceed level required for CD-1
Complete a Conceptual Design Report	Done.
Prepare a Preliminary Hazard Analysis Report	Draft (2 revisions) done. Awaiting approval.
Develop and Implement an Integrated Safety Management Plan	Draft complete. Needs clean up of some tables in appendix and approval
Establish Preliminary Quality Assurance Program (QAP)	Document complete. Needs approval
Identify general Safeguards and Security requirements for recommended alternative	No unique issues that require a separate document
Complete National Environmental Policy Act (NEPA) Strategy by issuing a determination	Categorical Exclusion granted
Conduct Independent Project review or External Independent Review	OPA review.
Update PDS or other funding documents for MIE and OE project and OMB 300's if applicable	Done by FNAL on an annual basis

2. **Please present your staffing needs required by the plan, describe any areas where there may be anticipated shortfalls, and describe your plan for acquiring this labor. In other words, present a staffing plan for the project.**

HCAL

The key personnel for the project are the engineering staff. Engineering staff has been identified and resource leveling applied to support required effort. Effort provided by postdocs and graduate students is identified for the first fiscal year, and partially identified in later years. Under experience from the R&D program and the operations program, we will have no difficulty staffing the unpaid labor.

FPIX

We need 63 FTE's for the project.

Engineering: 8.3 FTE
Technical: 12.4 FTE
Costed Scientific: 7.4 FTE
Contributed Scientific:21 FTE
Undergrad and grad students: 10 FTE

Scientific and Student:

In the last FPiX Project, institutes shared resources, grads, undergrads and postdocs when needed (testing for instance). We also have a large collaboration (20 institutes). We do not think Scientific or student labor will be understaffed. Assuming the bulk of our needs occurs over 2 years, this is less than one FTE/institute(on average).

Engineering:

The engineering we probably need to be a little more careful, but there is depth there also. For the 8.3 FTE's, we have 16 engineers who can share the work. Since we are being more careful here, we can examine the profile in more detail:

2013:3
2014:3
2015:1
2016:1

Colorado: Eric Erdos
Fermilab: CM Lei, Erik Voirin, Greg Derylo, Joe Howell (ME)
Alan Prosser, Ryan Rivera, Sergey Los, Mike Matulik, Boris Baldin, Cristian Gingu (EA)
KSU: Russel Taylor
KU: Bob Young
Purdue: Kirk Arndt

Rutgers: Ed Bartz
UCDavis:John Thompson

The engineering staff looks to be adequate.

Technical:

For technical staff, a lot of the universities do not have a standing in-house technicians, but we can estimate that the bulk of the technical staff will be at Fermilab, Purdue, and Nebraska.

Fermilab: Senior technical staff : John Chramowicz, Bert Gonzalez, Dave Butler, Tammy Hawkes
Technicians: Paula Lippert, Nina, Jorge Montes, Kourosh, SIDET tech
Fermi draftsmen: John Rausch
Purdue: Nick Gordon and Gale Lockwood
Nebraska: Johns Kelty, Brian Farleigh and Mechanical techs (part time)
KU: Jeff Worth

For wire bonding, Purdue previously hired technical staff and this worked well. Purdue and Nebraska will repeat this, though the critical wire bonding personnel are already in place.

We have 14 technicians already identified.

Here is the FTE profile:

2013:1
2014:5
2015:5
2016:2

We anticipate there will not be a problem to staff the technical labor with a planned staff of 13 technicians.

Trigger

Trigger annual costed FTE requirements for 3 years: 5.25 engineers, 2.75 technicians. Contributed annual FTE physicists: 4 postdocs, 3 students, 4 scientists/faculty. All are presently on staff. No shortfalls anticipated.

3. **Show the critical path for the entire project.**

Critical path for the project shown separately.

4. **Present a list of procurements for the project.**

LHC CMS Upgrade Major Procurements

HCAL	Date	Base Cost	Funding sourc
HB SiPM Packaging Purchase	1-Sep-15	$232,245	NSF
HE SiPM Packaging Purchase	1-Sep-15	$232,245	NSF
Full Production Order placed and Production of HB SIPM	11-Nov-15	$584,000	NSF
Full Production Order placed and Production HE SIPM	11-Nov-15	$214,000	NSF
Mechanical unit fabrication HB ODU	11-Dec-15	$270,000	NSF
Mechanical unit fabrication HE ODU	22-Apr-16	$270,000	NSF
Fabrication of production QIE10 ASIC for HF	21-Feb-14	$150,000	DOE
Receive Production Optical Splitters	29-Oct-14	$137,500	DOE
Procure production FPGAs	3-Oct-16	$456,060	DOE
HBHE QIEcard misc parts	3-Oct-16	$276,400	DOE
HBHE regulators	3-Oct-16	$192,600	DOE
HBHE GBT Chips	3-Oct-16	$174,960	DOE
HBHE QIE PCB Fabrication	3-Oct-16	$108,200	DOE
Procurement of parts for production LV system (A3050HBP)	1-Nov-16	$360,000	DOE
HBHE VTTx Lasers	1-Nov-16	$211,120	DOE
HBHE QIE11 Board assembly	30-Nov-16	$110,000	DOE

FPIX	Date	Base Cost	
Place order for pre-production sensor wafers	1-Oct-14	$285,000	NSF
Place the order for production Al cable	1-Oct-14	$102,600	NSF
Place order for production sensor wafers	21-Apr-15	$508,000	NSF
Procurement of the production readout wafers	2-Dec-13	$178,300	DOE
Place bump bonding contract	14-Apr-15	$479,340	DOE

Trigger	Date	Base Cost	
Place Order for CTP7 FPGAs P2	1-Oct-14	$228,391	DOE
Produce pre-production version of CTP7 Cards	1-Nov-13	$138,000	DOE
Place Order for CTP7 Optical Components P2	1-Oct-14	$119,000	DOE

5. **In what areas are there non-vanishing risk of substantial delays to the US project in the case of delays in providing components by non-US US CMS participants? How will the project mitigate such delays?**

HCAL

The primary risk for the HCAL upgrade is in the provision of the GBTX chip from the CERN microelectronics group. HCAL project managers are actively investigating alternatives to this chip. Provision of readout module mechanical parts and the SiPM bias board could also delay the Project. The risk is low due to the large float available for the delivery of these items in the Project and the positive experience from previous very similar efforts. The project managers will actively track these efforts and accelerate their provision when problems are identified.

FPIX

We do not technically list problems related to a foreign vendor as a risk in our risk register. The readout chip (ROC), token bit manager (TBM) and ancillary chips are fabricated by IBM in the US but purchased through CERN. However, we know more about the ROC now and it appears to function well. There is one final high rate test (there was a high rate test already in Germany this summer) at Fermilab at October that can act as a veto for the production. If a problem is found it is likely to be minor, and there are 4.5 months in the schedule that can be used if a delay in the December submission is needed in order to address a minor problem. A minor problem was addressed before the previous Pixel detector.

We have not yet received the prototype sensor wafers from Norway. We are a little worried about the quality since there was a problem in an earlier submission, and we would like to test the prototypes that are expected next week before we declare the production ready. Fortunately, there are 6 months of calendar float in the current schedule before we place the order for the production wafers, and an additional calendar month before we need to send the wafers to the bump bonder. This should be sufficient time for another submission if the sensor vendor can deliver another prototype in their expected time of 24 weeks.

We do not anticipate a major foreign vendor delivery delaying the critical path at this time.

Trigger

None. The built-in capabilities of trigger electronics provide signals for their own inputs and outputs that allow demonstration of KPP and existing signals can be used to drive the upgrade trigger system.

6. What elements of the HCAL upgrade are expected to continue to perform reasonably well after Long Shutdown III (after ~2022)?

The upgrades to the HCAL Barrel and Forward detectors (up to at least eta=4.5) will continue to operate well through the full 3000 /fb without additional intervention on the detector. For the Endcap, continued performance will require an intervention. One of the proposed solutions is the replacement of the scintillator tiles with designs having a shorter optical path length to mitigate the darkening effect. If this proposal is feasible, the electronics portion of the endcap upgrade would be compatible with the new active detector and could be used for the full 3000/fb.

7. **How are future required changes to the project organized: both technical (with CMS collaboration) and funding/manpower (with the project and funding agencies)?**

We have a draft document describing our Configuration Management Program and Change Management Plan. We will implement this process through discussions in the Technical Board, which result in a decision to move forward by the Project Manager. The Project Manager may be required to propose this to the PMG and, based on thresholds established in the PMP, the proposed change might need DOE approval. The Project Manager has the responsibility to ensure that the CMS Upgrade Technical Coordinator knows about the change. We can require that the CMS Upgrade Technical Coordinator approve or at least acknowledge the change by being a signatory on change requests that affect technical issues, project scope, or schedule. The Upgrade Technical Coordinator and the CMS Spokesperson will receive the project's monthly report that will include a log of all change requests. These were the mechanisms used in the US CMS Construction project to maintain coherence between the US and international efforts.

The funding agencies monitor the project through the IPT, the PMGs. various reviews and the change control process. They also will receive the monthly reports which will contain change logs, financial information and project management metrics. There will be annual or semi-annual reviews. Significant changes generally require agency pre-approval. This has been the practice in both the original Construction Project and the current Operations Program.

8. **We would like to have a presentation tomorrow afternoon that summarizes what has been learned about how to make the thermal and mechanical joint between pixel blades and rings. The schedule now says that a decision on how to make this joint will be made in October. What new results does the group expect to have that might lead them to choose some other option than the "gluing" option.**

Question 8 done in parallel session for FPiX

9. **How has each section of the project assigned ESH&Q Risk Levels to their section of the project?**

The Project has not yet completed the task of assigning ESH&Q risk levels to each section of the Project. The ESH&Q Coordinator has a preliminary hazard list for the Project. He will work with the L2 Managers for HCAL, FPIX, and Trigger to review the list and make any necessary changes. Then he will assign severities

and probabilities by working with his ES&H liaison in PPD and produce tables that identify risk levels before and after passive risk mitigation.

10. **Is it intended to include activities and milestones, with logic, in the schedule related to CMS Shutdowns, Off-Project Work and CD Approvals in the Funded Leveled schedule?**

Yes, the Project will include activities and milestones, with logic, in the schedule related CMS Shutdowns, Off-Project Work and CD Approvals in the Funded Leveled schedule?

11. **Please provide a list of items to complete (i.e. include updating each individual required CD-1 document), which requires completion once the schedule is finalized (funding profile met). Include on a timeline?**

The issues that need to be done are

1. Milestones: include in the schedule the Critical Decisions, the ETS and LS2 shutdowns (possibly LS1), make sure the delivery of all external products are captured, and that the milestones are all properly entered
2. Spending Profile: adjust the obligation profile to match the availability of funds
3. Critical path: produce the new critical path analysis
4. Recomputed cost range for DOE
5. Document updates:
    a. Acquisition Strategy: cost range in Table 2 and final reading (few hours)
    b. PEP: update cost summary, milestones, enter NSF funding expected (section 2.5), check consistency with Acquisition Strategy, review/modify tailoring section, and make sure section of Advisory Boards reflects reality (1-2 days)
    c. Add appendices to Procurement Plan (information has already been provided by L2's and it just needs to be entered (a few hours)
    d. Review any other documents needing approval (even if it is internal to the project) for final changes (Risk Management, Risk Registry, Configuration Management, Quality Assurance Plan, Integrated Safety Management Plan, etc)

Items 5c and 5d do not depend on the effort to complete the RLS and can be done immediately.

12. **Can the team provide an order of magnitude estimate for work in the Cost**

Estimate that is not required to meet the Threshold KPPs?

HCAL

HF : $39k ($48k with contingency)
HB/HE : $183k ($233 with contingency)
Backend: $0

FPIX

In order to meet the KPP, we do not need to make all the modules we are planning on producing. For CD-1 we are showing a schedule that pushes the final 200 modules (of 1000) production into FY17. We will also sell these modules to the operations program: order of $500k

Order: $500K

Trigger

Difference between threshold and objective KPP is trigger performance that results from personnel effort on software and firmware. The effort in the project is calculated to be sufficient to achieve the objective KPP. The effort required to achieve the objective KPP beyond the threshold KPP is estimated to be one third of the final high luminosity software and firmware tasks, which are 1.6 FTE of effort of which 50% is contributed physicists and $140K of costed engineering labor.

13. **Can the expected Funding $s for FY13 and the Project's expected Obligations be provided. Also, is there a Funding Projection in FY14?**

For FY13, the funding is in good shape. We did the FY'13 budget in July and August, before we had CD-1. However, the amount allocated for all R&D was a little over $3M with nearly all going to Phase 1. We had a good idea of what was needed to complete prototyping activities for the three upgrade subprojects. When we got CD-1, we were given $2M of OPC from R&D. However, we had ~$1M of Phase 1 R&D (pixels and HCAL/SIPMs) planned for NSF out of the normal Operations Budget. This gave us the funding we needed. We provided a detailed remapping of R&D activities and funding into the DOE OPC and NSF Operations at a PMG and in the DOE/NSF review.

For FY14, we have $6M in OPC from DOE (that is a recent change from $3M). We have discussed funding with NSF. There are many options in NSF as to how the funds are delivered. We agreed that we could, for planning purposes, use $3.5M as the funding that would be available in FY14.

In the first cost rollup, the proposed funding for FY14 was over $12M with no contingency, an obviously unrealistic plan. After two exercises to adjust the profile, we now have a base cost of $7.7M. This would give us 23.3% contingency. This is a satisfactory situation.

14. **Does the Project plan to request a CD-3a – Early Procurement during the CD-1 DOE review? If so, will this be represented in the Project Plan?**

The Project is considering a request for CD-3a during the CD-1 DOE Review.

15. **What is your plan for completing the RLS development called for at the May internal review?**

The RLS is in development and will be completed by August 12 in time for the DOE CD-1 Review. The Project Team has been using the 40-point plan that was developed by the Cost and Schedule Assessment Team for guidance, and will continue to resolve the remaining issues as discussed in today's (July 17) Project Management breakout session.

16. **What has to be done for a DOE CD-1 review-capable RLS, in addition to the items identified in May that are not yet complete?**

CMS is developing the RLS to match the funding profile, incorporate the Project Level Milestones, and continue to develop the logic to ensure the integrity of the schedule. During the next few weeks, descriptions of work will be reviewed and where necessary they will be changed to provide more insight to the work being performed. Longer duration tasks will be reduced to a series of tasks providing a basis to better manage the work scope and establish a basis to analyze work progress. The RLS will continue to be adjusted where necessary to reflect work scope in sufficient detail to manage the project and report progress, adjust resource data to provide a level of support consistent with work requirements, and durations changed to provide reflect time to complete the effort. Additional coding will be added to facilitate reporting requirements and provide management tools to gather data for managing the effort.

17. **Does the schedule consistently include resource-loaded tasks for project-required contributed scientific effort, other than at CERN?**

Yes, the schedule consistently includes resource-loaded tasks for project-required contributed scientific effort. This includes undergraduate students and graduate students paid by their home institution as well as more senior scientific staff. For example, many of the design, assembly, and testing activities are done by contributed scientific effort.