Closeout Report on the DOE/SC Status Review of the

SuperCDMS-SNOLAB Project

Conducted at

Fermi National Accelerator Laboratory

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Committee Chair

Office of Science, U.S. Department of Energy

http://www.science.doe.gov/opa/

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Subcommittee 2—ES&H
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Subcommittee 4—Project Management
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Charge Questions

1. Design Maturity: Is the project on track to complete a preliminary design that will deliver the proposed technical scope within the cost envelope established at CD-1? Is the current design maturity and the project on track for CD-2 in the first half of FY 2017? Are there any outstanding R&D issues that need to be addressed before freezing a cost and schedule baseline in preparation for CD-2?

2. Cost, Schedule & Risk:
   - **a. Estimates**: Is the quality of the current cost, schedule and staffing estimates appropriate at this stage of the project?
   - **b. Tailoring Strategy**: Is the status of the project tailoring strategy appropriate at this stage of the project? Is the project considering any long lead procurements and in such case, is the project developing an appropriate procurement plan?
   - **c. Risk and Contingency**: What is the status of the risk analysis and risk registry? Is the contingency at a level commensurate with the current state of project development?

3. Management: Is the management structure appropriate to deliver the scope of the project? Are management roles well defined and conducive to a smooth execution of the project?
   - **a. DOE-NSF Coordination**: Is the management structure appropriate and are the resources adequate for DOE and NSF awardees? Is the communication between the two agencies and the understanding of interfaces between the two different scopes working well?
   - **b. DOE Multi-Lab Partnership**: Do the technical and managerial tasks between SLAC and Fermilab appear to be working well? Is there adequate support from SLAC, the partner laboratories and institutions in all necessary areas (e.g., safety, procurement, human resources, facility support)? Is there any area of concern in terms of resources and/or communication?

4. Previous Reviews Recommendations: What is the status of addressing the post-CD-1 recommendations from the CD-1 IPR?

- **Comments:**
  - **Descoping -** descoping from 5-4 towers did not affect science goals. However, further descoping should be avoided at all costs since the savings are incidental.
    - Nevertheless, it would be useful to show whether an order of magnitude improvement can be maintained with further reduction of number of towers (especially in the 6-10 GeV WIMP mass energy range).
  - **Simulations** – excellent team in place, but documentation about the simulation and its results should be available at future reviews.
  - **Backgrounds** – control, reduction and estimation has been greatly improved as well as simulation package. However further work is required as they critically affect HV detectors sensitivity in lower mass range
    - KPP objective for Ge HV states < 25 /keV/kg/yr total bkg. Current estimates for tritium (cosmogenic) + radiogenic (U/Th) are 30 /keV/kg/yr. No accounting for surface radon plate-out has been added. So further work on the cosmogenic exposure budget is recommended.
    - KPP is needed for Si HV especially since the background contribution is 10 times higher than Ge HV.
    - KPP for iZIP detectors above 10 keVr is < 1 event in 5 years per detector. No comparison of the current bkg levels to KPP was presented.

- **Comments:**
  - **Backgrounds** – continued
    - Background contribution for each detector component (shielding housing, crystals) presented as number of events in the detector before/after discrimination should be presented at future reviews as they are informational to the committee.
    - Document describing details of sensitivity calculations and their dependence on background estimates should be present at future reviews as they are informational to the committee.
    - ^{32}Si has been included. However, it relies on single measurement with large uncertainty. It is essential to energetically continue off-project activities for directly measuring ^{32}Si levels.

- **Recommendations:**
  - Maintain reasonable margin (~30% suggested) between KPPs and expected bulk background contribution:
    - Ge HV KPP and expected bulk background contribution for Ge HV.
    - Create KPP for Si HV especially in the light of high ^{32}Si background contribution and its large uncertainty.
    - Demonstrate that KPP for iZIP detectors is fulfilled (< 1 event for 5 years exposure for each detector) after including all background sources.
  - Prepare a document describing the simulation and its background estimate results; make it available at future reviews.
  - Prepare a document describing details of sensitivity calculations and their dependence on background estimates; make it available at future reviews.

Backgrounds

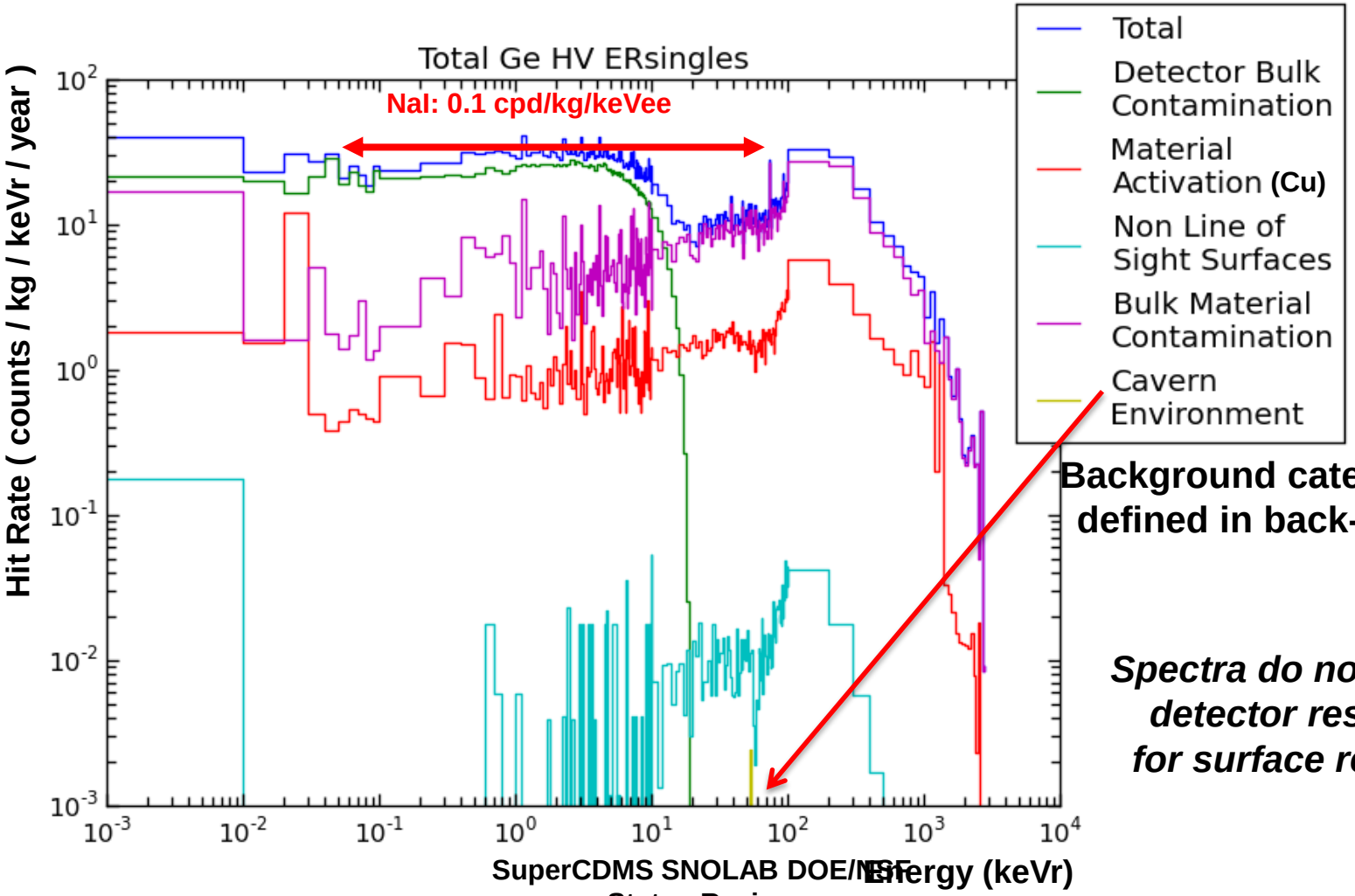
Frank Calaprice

Important Development for Light WIMP Search with HV Detectors.

- **Cosmogenic backgrounds dominate.**
  - ^{3}H is now more certain to be main background.
    - New Edelweiss III direct measurement.
    - Emphasis is to minimize cosmic ray exposure, after crystal growth
  - ^{32}Si less certain but most likely will be present in silicon detectors.
    - Convincing evidence for delayed coincidence from DAMIC experiment: ^{32}Si (172 y)→ ^{32}P (14 d) →^{32}S seen in same pixel of CCD device.
    - Validation should be pursued but could take too long.
    - Design should be based on background from ^{32}Si.

Science Goals – Summer 2016

- **Background budget based on predicted background spectra**



Background categorization defined in back-up slides

Spectra do not include detector response for surface rejection

Science Goals – Summer 2016

Bad news

Background budget – summary – Raw singles event rates

	Electron Recoils				Nuclear Recoils	
	Ge HV	Si HV	Ge iZIP	Si iZIP	Ge iZIP	Si iZIP
Total (counts/kg/keVr/year)	**30**	**300**	**23**	**360**	**0.00330**	**0.00270**
Coherent Neutrinos					0.00230	0.00150
Detector Bulk Contamination	24	280	9.8	260	0	0
Material Activation (Cu)	1	2.4	1.8	14		
Non-Line-of-sight Surfaces	0	0.03	0.01	0.07		
Bulk Material Contamination	5.3	13	11	88	0.00044	0.00065
Interstitial Prompt Radon						
Cavern Environment	0	0	0	0	0.00050	0.00052
Cosmogenic Neutrons						

Background categorization defined in back-up slides

H-3 changes:
- Production rate → 90 atoms/kg/day
- Exposure target → 60 days
- Includes decay "cool down"

Si-32 now include explicitly
- Absent from CD-1 table

Surface Background: Recommendation 1a

Good plan and good people:

WBS 1.7 – Background Control

- Manager: John Orrell
- Deputy: Jodi Cooley
- Organizational management of 1.7 contained in 1.7.5

- Technical Level 3:

WBS	Task Name	Manager
1.7.1	Background budget and material specification	Ben Loer
1.7.2	Material screening and assay	Eric Hoppe
1.7.3	Procedures, tracking, and monitoring	Astrid Tomada
1.7.4	Radon exclusion infrastructure	Ray Bunker

Good facilities for measuring most background activities in detector components:

1. **HP Ge detectors**
2. **ICPMS-PNNL new facility**
3. **Surface screening XIA alpha-counter (But only alphas. Need beta counting!)**

Recommendation 1a.

1. **Develop precision cleaning for reduction of surface backgrounds.**
2. **Specify surface cleanliness requirement based on particulate counting. (Class 50?)**

Radon Background Recommendation 1b

^{210}Pb (22 y) -> ^{210}Bi (5 d) -> ^{210}Po (128 d) -> ^{206}Po (stable)

WBS	Task Name
1.7.4	Radon exclusion infrastructure
1.7.4.1	Radon-contamination model
1.7.4.2	Radon exclusion/monitoring for payload

Good plans, but not enough.

Deliverables:

Measurement validated radon-daughter plate-out model

Addresses estimation of background rate from surface emissions due to radon progeny

Deployment of a low-radon air for cleanroom at SNOLAB

Addresses need to minimize radon exposure during tower installation

Recommendation 1a and 1b:

- **Develop an effective procedure to clean all critical surfaces to remove particulates and radon daughters, especially ^{210}Pb.**
- **Evaluate costs for hardware (precision cleaning module) + manpower.**

Cosmogenic copper background Recommendation 2

- There is a lot of copper very close to the crystals.
- Background from copper will come from surfaces, and bulk radioactivity.
- Bulk radioactivity will likely be dominated by gamma rays from cosmogenic activation of copper.
- No estimate of background from copper is given.
- The worst case is ^{60}Co with long half-life and roughly 1 mBq/kg at saturation.
- Copper parts should be made from new material, cleaned, and then taken underground as soon as possible.

Provide backgrounds from ^{60}Co (5.3 y), ^{56}Co, ^{57}Co, ^{58}Co.

Recommendation 3

Simulations should continue with the most complete information available on all components, including small items that may have significant radioactivity, to assure that the background will be sufficiently reliable to proceed to CD2.

1. Design Maturity: Is the project on track to complete a preliminary design that will deliver the proposed technical scope within the cost envelope established at CD-1? Is the current design maturity and the project on track for CD-2 in the first half of FY 2017? Are there any outstanding R&D issues that need to be addressed before freezing a cost and schedule baseline in preparation for CD-2? Yes, the scope is well-defined and the designs inherit a great deal from Soudan. The ability of the project to be ready for CD-2 in April 2017 hinges on the availability of cryogenic engineering resources at FNAL. No significant R&D is needed.

4. Previous Reviews Recommendations: What is the status of addressing the post-CD-1 recommendations from the CD-1 IPR? All recommendations have either been addressed or studies necessary to address them are in progress.

2.3 Comments

- The committee was pleased to learn that the dilution refrigerator RFP was out and that maximum cooling capacity was sought.
- Vacuum conductance of the SNOBOX/stem/E-tank system should be specifically reviewed during the pre-CD2 design review process.
- The project requires 2.7 FTE of engineering labor (mostly cryo engineering) between now and CD2 (April 2017) in order to bring the design to 80% completion.
- Cryo engineering resources are tight at FNAL and the project/FNAL must find a solution that meets the project's requirements without jeopardizing other projects in the FNAL portfolio. New hires to fill this need will have some initial inefficiencies.
- Given the above, being ready for a CD-3a approval in April '17 might be difficult.
- Reducing the scope of the FNAL cryo test (no cooldown of SNOBOX) is a good strategy for reducing risks of cosmogenic activation but reduces effectiveness of planned cryo risk mitigation strategy. Risk register should reflect this.
- Shield vendor's final design should be thoroughly reviewed by background controls group to ensure requirements are met.

2.3 Recommendations

- Current ongoing studies of the vibration susceptibility are important and should continue.
- An installation sequence has been worked out. The SNOLAB gateway review should provide a good milestone for having installation plans well-defined.

- RECOMMENDATIONS

1. Develop a detailed work plan for the Lab G SNOBOX assembly test that emphasizes minimizing above-ground time.
2. Address the recommendations from the June 2016 Director's Review.

Towers

Comment: Experiment goals and requirements were not very precisely specified during presentations. It appears that the goal is the lower bound shown on the cross section plots, and the requirement is a factor of 10 below currently existing limits at all energies below 10 GeV.

Recommendation: Show these two limit lines explicitly. The requirement line below ~0.7 GeV may require some creativity.

Comment: Flowdown of requirements and goals to the various KPPs was not clearly presented.

Recommendations:

- **Revisit all KPPs and show flowdown to values corresponding to requirements and goals.**
- **Show current established limits for these KPPs and planned path and schedule for reaching ones not yet met.**

Comment: The planned vibration susceptibility tests are vital to quantify the engineering design requirements for isolation from disturbing sources. The various mechanical coolers with their gas and liquid circulation are the primary internal sources. External sources are the seismic and acoustic environment in the mine. The test results coupled with engineering analysis may also identify susceptibilities that need to be mitigated with design changes in the tower (such as the detector mounting clamps).

Recommendations:

- **Obtain seismic and acoustic survey data for the Ladder Lab. These need to be pursued in detail if (and only if) they appear to be significant compared to internal sources in the experiment.**
- **Assess which susceptibilities can be handled by engineering sufficient isolation into the experiment structure, and which require mitigation.**
- **Tests need to be scheduled sufficiently in advance of CD-2 review.**

Comments:

1) **These WBS Components do not present any significant technical and schedule issue towards CD2**
2) **A key component, the DCRC RevD is under testing at UC Denver with a SQUID and MIDAS DAQ**
3) **Detector 4K connector with Fuzz Button technology met the radioactivity requirement**
4) **A prototype of vacuum interface board has been produced**
5) **A working MIDAS DAQ system operating with a prototype DCRC RevD board is being used at collaboration institutions; no major issue in DAQ system is expected towards CD2**
6) **Computing/Offline Software team in place and no significant technical issue is expected**

7) The budget for computing/offline is heavily front-loaded and there could be a potential issue of maintaining expertise in outer years

8) Testing of the whole electronics chain including detector 4K connectors, HEMT and SQUID readout board, wiring and DCRC board with a prototype detector inside a cryogenic system will be an important step towards characterizing performance and production readiness

Recommendation

Ensure timely completion of the test of electronics chain in the project schedule

Charge Question 3

Is the management structure appropriate to deliver the scope of the project?
Are management roles well defined and conducive to a smooth execution of the project?

DOE Multi-Lab Partnership:

- Do the ES&H technical and managerial tasks between SLAC and Fermilab appear to be working well? **YES**
- Is there adequate ES&H support from SLAC, the partner laboratories and institutions in the area of ES&H? **YES**
- Is there any area of concern in terms of resources and/or communication? **NO**

Charge Question 4

What is the status of addressing the post-CD-1 recommendations from the CD-1 IPR?

REC 1: Ensure that – where applicable – crane operation training requirements are addressed.

REC 2: Ensure that – where applicable – lockout/tagout (LOTO) requirements are addressed.

REC 3: Determine mine-specific training requirements and accountability for delivery of training to project staff who will work in the SNOLAB mine spaces.

REC 4: Establish the extent to which inspection of non-NRTL (nationally recognized testing laboratory) electrified equipment must be conducted.

REC 5: Review configuration of project equipment to establish where – if any – Confined Space Entry requirements may be applicable.

STATUS: **All are in progress and on target for CD-2.**

Comments

- An experienced and qualified ES&H team – in concert with the application of ISEM and Work Planning and Control processes – will continue identifying hazards. This may create additional resource demands.
- The Project Safety Manager notes the following ES&H program elements warranting further consideration:
  - Identifying fire risks associated with operations at technical project sites and SNOLAB. For example: polyethylene and polypropylene "soft materials are combustible. Such an incident, however probable it might be, could be devastating.
  - Determining R&Rs regarding safety oversight during installations at SNOLAB, including application of ISEM and WPC prior to initiating the installations.
  - Confirming Project Team understanding regarding SNOLAB operational safety requirements.
  - Achieving effective coordination of ES&H team efforts during the project (e.g., hazard analysis, design review, communications, etc.).

Comments (con't)

- Project hazard management currently emphasizes ISEM 1-4. In the future, application of an assurance process consistent with ISEM 5 (feedback and improvement) will help verify effectiveness of controls.
- The operational safety model for SuperCDMS draws from DOE's ISEM model. SNOLAB's model, though similar, may vary in key areas. In particular, (1) hazard recognition and control and (2) work authorization practices should be confirmed to ensure an equivalent level of protection for work performed at all project sites.
- The engagement of senior project leaders and sub-level managers in the work planning and control process is apparent. Their leadership in line "at the bench" implementation will help ensure successful execution of ISEM (or ISEM analogs) at all project locations.

The project is ready to proceed to CD-2 after addressing the following recommendations

- Complete and document (prior) CD-1 review recommendations.
- Ensure that ISEM-driven hazard analysis and work authorization processes, respectively, are consistent, leader-driven, and provide equivalent levels of protection at all SuperCDMS sites.
- Consider implementing an assurance model for evaluating the effectiveness and sustainability of hazard controls and ISEM processes employed.
- Complete a fire hazard risk analysis of SuperCDMS/SNOLAB hardware.
- Consider establishing appropriate R&Rs regarding safety oversight during installation of equipment at SNOLAB.
- Coordinate with the SNOLAB safety office to understand site work planning and authorization requirements for SuperCDMS personnel.

1. Design Maturity: Is the project on track to complete a preliminary design that will deliver the proposed technical scope within the cost envelope established at CD-1? Is the current design maturity and the project on track for CD-2 in the first half of FY 2017? Are there any outstanding R&D issues that need to be addressed before freezing a cost and schedule baseline in preparation for CD-2? – Due to needed updates to the plan, additional assessment is needed. See recommendations.

2. Cost, Schedule & Risk:
   - **a. Estimates**: Is the quality of the current cost, schedule and staffing estimates appropriate at this stage of the project? – No. While substantial work has been done since CD-1, additional assessment is needed. See recommendations.
   - **b. Tailoring Strategy**: Is the status of the project tailoring strategy appropriate at this stage of the project? Is the project considering any long lead procurements and in such case, is the project developing an appropriate procurement plan? – The project is considering a tailoring strategy for long lead procurements but due to needed schedule updates assessment on approach to this plan and a final decision is still needed.
   - **c. Risk and Contingency**: What is the status of the risk analysis and risk registry? Is the contingency at a level commensurate with the current state of project development? – Further assessment of the risk register and assessment is needed. The contingency level as presented (39% to go) appears acceptable for this stage but this is pending further analysis. See recommendations.

4. Previous Reviews Recommendations: What is the status of addressing the post-CD-1 recommendations from the CD-1 IPR? – Work is still underway to address those identified for completion prior to CD-2.

- **Findings**

- Funding profile is $17.6M for DOE, $12.0M for NSF, and $2.8M for CFI giving a total project cost (TPC) of $32.4M.
- Project cost is currently at $12.9M for DOE scope, $9.4M for NSF scope, and $2.8M for CFI giving a total PMB of $25.1M. This is a net increase of $0.7M since CD-1 approval.
- The overall project cost contingency is currently $7.3M (39% on To Go) - DOE's scope of work is at $4.65M; NSF, $2.65M; and CFI, $0M. The overall project schedule contingency is currently18 months (44% on To Go).
- The project is still within the TPC cost range established at CD-1.
- Cost/Schedule estimates were traceable to the Basis of Estimate (BOE) documents
- During the BOE traces the most recent quote was from June 2016 and the eldest from 1999.
- The BOEs contained contingency (estimate uncertainty/maturity) applied by the L3 subsystem manager provided for each line item.

- **Findings (cont'd)**

- A qualitative Risk Registry with post mitigation strategies was presented with 35 total threats, of which 0 are high, 5 are moderate, and 28 are low. No opportunities are in the register.
- Primavera P6 and Cobra are used for developing and maintaining the cost and schedule baseline.
- Project states the critical path as Cryogenics to Infrastructure to DAQ to Integration
- Acumen Fuse analysis results provide a schedule quality score of 79% and a Defense Contract Management Agency (DCMA) 14 point assessment score of 17%
- The project identified 46 Control Accounts (CAs), with three exceeding the 15% LOE threshold
- The project has 3 CAMs and 11 subsystem managers who supplement the duties of the CAMs. Statement about some lower being promoted to CAM heading into CD-2.
- The project presented a staffing plan by work breakdown structure (WBS) and Level 2 task leaders

- **Findings (cont'd)**

- The project presented a plan to establish an internal baseline in August 2016 to begin EVMS practice, in preparation for CD-2.
- The project is considering a tailored approach of a CD-2/3a for Long Lead Procurement (LLP) of shielding and cryogenics, in order to mitigate risks.
- The project is working toward a goal of 50% design maturity for CD-2 with 80% design maturity for cryogenics.
- Since CD-1, SLAC has negotiated reduced rates on the SLAC labor resulting in a cost savings.

- **Comments**

- While the project states that they are funding constrained, the team is taking advantage of accelerated spending agreements between universities and subcontracting Principal Investigators to move the project forward where possible.
- Of the BOEs traced, the majority were detailed and appropriate based on the state of design maturity. There were instances where the units summarized in the BOE did not match the P6 schedule and it was observed that the cost basis on Cryostat was from a similar item purchased in 1999. An update of documents and estimates would be appropriate prior to CD-2.
- The schedule has missing predecessors/successors, constraints without obvious justification, high total floats, and gaps in the critical path. This does not accurately reflect when the project is ready for CD-2 nor CD-3.

- **Comments (cont'd)**

- Integration milestones should be clearly defined and added to the schedule to aid in managing and providing visibility to key handoffs between the subsystems and control accounts. This would additionally assist in removal of excessive float present within the schedule.
- The planned FTE profiles at the activity level seem to be reasonable at this stage of the project, assuming commitments related to the Cryogenics Engineers is met. The committee notes that much of the Level 2 staffing for the project are fractionally assigned.
- The risk register only contains threats and the recent exercise of moving from pre-mitigated to post-mitigated assessments has caused a significant reduction the expected value for risks on the project. However, the post-mitigated strategies are not obviously included in the baseline plan nor are they all true mitigations that should result in reduction of the threat's probability or impact. This needs to be reassessed prior to CD-2 to ensure that the expected values for risks are not understated.

- **Comments (cont'd)**

- Promotion of additional Control Account Managers (CAMs) to CD-2 needs to be sooner rather than later so that they can take ownership of the process and of the plan. Transfer of ownership can cause further reassessment of cost, schedule, and risk.
- The project should be aware of those Control Accounts (CAs) exceeding Level of Effort (LOE) amounts heading into establishment of an internal baseline and beginning rotation into EVMS reviews.
- The plan to establish an internal baseline in August appears aggressive based on the items remaining for optimization and review related to schedule, cost, risk, and selection of a tailoring strategy.

- **Recommendations**

- Update and optimize the schedule to accurately reflect the required work drive leading to when CD-2 and CD-3 are needed, prior to establishing internal baseline.
- Review the BOEs and schedule to ensure that values are accurate between all systems and, where possible, updated cost quotes exist for key procurements, prior to establishing internal baseline.
- Update the risk register by converting risks from qualitative to quantitative, review the post-mitigated exercise recently performed, and incorporate any missing opportunities or threats that may exist, prior to CD-2.
- Reassess the associated contingency needs for cost and schedule based on the results of the risk register update and schedule optimization, prior to CD-2.
- Develop a contingency plan that includes when risks and estimate uncertainty are retired to allow for maximizing the use of the funding profile while including sufficient contingency to allow for risk events that may occur, prior to CD-2.

PROJECT STATUS – May 2016		
Project Type	DOE-MIE / NSF-Cooperative Agreement	
CD-1	Planned: Dec 2015	Actual: Dec 2015
CD-2	Planned: Jun 2017	Actual: Mar 2018
CD-3	Planned: Mar 2018	Actual:
CD-4	Planned: Jun 2021	Actual:
TPC Percent Complete	Planned: _20 %	Actual: _19 %
TPC Cost to Date	$6.3M (DOE $2.9M, NSF $3.4M)	
TPC Committed to Date	$3.95M	
TPC	$32.4M (DOE $17.6M, NSF $12M, CFI $2.8M)	
TEC	$27.5M (DOE $14.7M, NSF $10M, CFI $2.8M)	
Contingency Cost (w/Mgmt Reserve)	$7.3M (DOE $4.65M, NSF $2.65M, CFI $0M)	_____39% to go
Contingency Schedule on CD-4b	18 months	_____44% to go
CPI Cumulative	N/A	
SPI Cumulative	N/A	

3. Management: Is the management structure appropriate to deliver the scope of the project? Are management roles well defined and conducive to a smooth execution of the project?
    a. **DOE-NSF Coordination**: Is the management structure appropriate and are the resources adequate for DOE and NSF awardees? **See comments.** Is the communication between the two agencies and the understanding of interfaces between the two different scopes working well? **Yes.**
    b. **DOE Multi-Lab Partnership**: Do the technical and managerial tasks between SLAC and Fermilab appear to be working well? **See comments.** Is there adequate support from SLAC, the partner laboratories and institutions in all necessary areas (e.g., safety, procurement, human resources, facility support)? **See comments.** Is there any area of concern in terms of resources and/or communication? **See comments.**

4. Previous Reviews Recommendations: What is the status of addressing the post-CD-1 recommendations from the CD-1 IPR? **In process, some items remain.**

- **Findings**

- **Comments**

  - **The Project is to be commended for the considerable progress made since the June 2016 Director's Review.**

  - **The collaboration is transitioning from a historically strong R&D and research driven effort into a construction project. This requires a major shift in emphasis and focus in order to adhere to the significant demands associated with modern project execution. The collaboration will have to continue to adapt to this as quickly as possible in order to develop a viable and robust project plan on a sensible time frame.**

- **Comments (cont'd)**

- **Commitment to the experiment, and its establishment as a priority, will be required on the part of all parties in order to achieve success. This includes the project team and collaboration, the lead Laboratory, and all collaborating institutions.**

- **The Project Office (PO) is capable, although additional engineering and other support may be required. PO roles, responsibilities and lines of authority should be clear, and adhered to moving forward with the appropriate emphasis on all that is entailed in establishing a project baseline.**

- **The coordination between DOE, NSF and CFI is working well. This is a notable and significant ingredient for the success of a project of this kind.**

- **Comments (cont'd)**

- **The project should expand the design review process to one that includes external reviewers.**

- **The agencies should continue to ensure that the spending of any construction funds is properly coordinated with the project approval process.**

- **The necessary management bandwidth on projects is considerable. The lead Laboratory and Project Management should make sure to complement the PO with appropriate personnel as the plans evolve, as required, in order to keep pace with planning, reporting and other demands.**

- **Comments (cont'd)**

- **Insufficient justification for the April CD-2 date was presented to the committee.**

- **The present plan to request CD-2 in April 2017 has a low probability of success, given the current progress on the precursor R&D activities and the maturity of the engineering efforts. The Project should carefully consider a revised path to CD-2 that enables the R&D activities to inform the engineering efforts in a more integrated and risk-balanced manner. This will likely require some changes to the existing Critical Decision dates.**

- **The project should reconsider their cost, schedule and risks fully bottom up, releasing the constraints from CD gates or other sources, and integrating a realistic consideration of technical demonstrations that would be required for a baseline. In creating this bottom up schedule, the current scope should be realistically costed and all tasks captured.**
  - **Any adjustments made to fit within the funding envelope should be made only after the foundation cost/schedule benchmark is established.**

- **Comments (cont'd)**

- **In developing their plan, the project should derive a suitable CD tailoring strategy and schedule that is informed by the analysis of the project work flow, and discuss this with the funding agencies by September 2016.**

- **The Joint Oversight Group performs an oversight, not a line management, function. The project should not rely on them in this latter capacity, and should consider revamping the organization chart in a manner that reflects this role.**

- **Comments (cont'd)**

- **The actions required to capture CD-2 have several thrust areas: R&D completion, engineering analysis and design, stakeholder management, and integration of the overall project. The Project will benefit from developing a one-page timeline segregated by thrust area, with the significant peg-posts for each thrust area. This would provide a consistent and transparent view into the progress towards CD-2 and facilitate regular and concise communication.**

- **The recent actions by SLAC senior management to enable the Project leadership team to focus more directly on project delivery are beginning to yield results. Continued efforts to enhance and extend these efforts will continue to benefit the project.**

- **Identification of an individual to fill the role of Project Engineer will greatly enhance the project delivery process by ensuring that an appropriate engineering emphasis is brought to bear as the design process matures.**

- **Comments (cont'd)**

- During the presentations, several potential risks were identified that were not explicitly included in the Risk register. The project should carry out another bottom up and top down review well in advance of CD-2.

- A number of potential ES&H mitigation additions, for example fire suppression for the shield plastics, are not yet included in the current schedule and cost estimates.

- Cosmogenic backgrounds have been identified as some of the most important contributors to the overall background model. The KPPs should include an overall total background goal based on both material assay results and estimated cosmogenic activation of materials.

- **Comments (cont'd)**

- The project needs to complete the key R&D items in order to develop a more mature baseline. This information needs to feed into the CD-2 baseline plan. The completion of the R&D should inform the development of the risk analysis and that of the baseline cost and schedule.

- At this stage of the project, the FTE level for many of the level 2 managers is a concern. The project leadership should review and evaluate the levels of commitment in terms of the project scope and schedule.

- The project manager in most cases only receives level 2 summaries in the monthly reports (level 3 summaries are collected by level 2s). The project management team should consider reviewing these summaries on a monthly basis in order to have a better understanding of the level 3 progress.

- **Recommendations**

- **DOE and NSF should perform a status review of the project prior to CD-2 to assess the project progress and plans and its readiness for the next steps in the approval process.**

- **The Project shall submit a revised plan to achieve CD-2 and begin CD-3 work to the Federal Project Director, Federal Program Manager, and NSF Program Manager by August 30, 2016. This Plan will provide the framework within which the baseline will be developed and proposed, and include clear decision points for**
  - **Key R&D program deliverables and dates**
  - **Design Reviews**
  - **Proposed DOE Status reviews**