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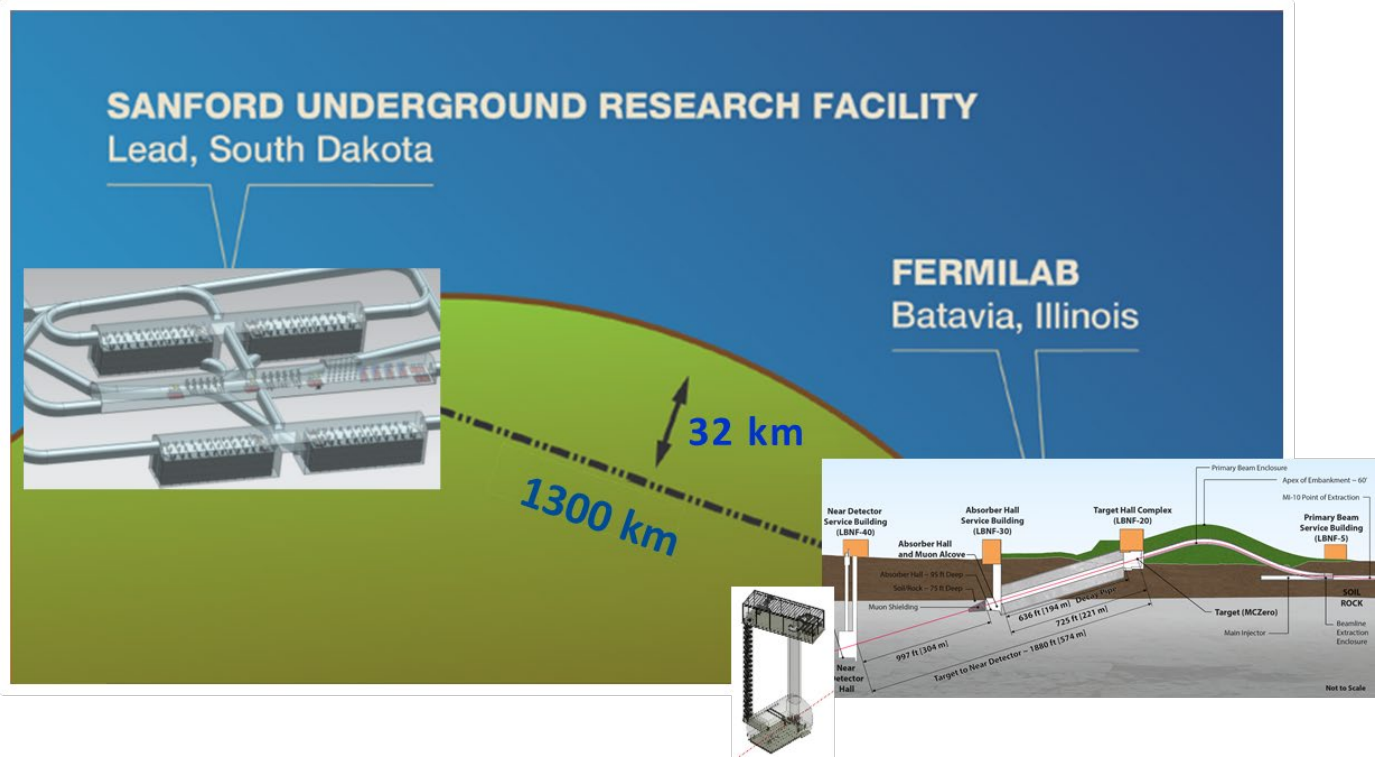
LBNC Closeout Report

March 25, 2017



Referee assignments

Referee subgroups and assignments (lead referee underlined)

Number	Topic	Referee group	POC
1	protoDUNE-SP CE & TPC	Pitts, MacFarlane, Liu, Pallavicini, Monroe, Proudfoot, Mondal	Gina Rameika
2	protoDUNE-SP DAQ	Liu, Boehnlein, Pitts, Bhadra, Pallavicini	Giovanna Lehmann Miotto & Karol Hennessy
3	protoDUNE-SP schedule and planning	Proudfoot, Jenni, Heinemann, Huber, Lindgren	Eric James
4	DUNE physics & reconstruction	Boehnlein, Bhadra, Mondal, Huber, Heinemann	Ryan Patterson
5	DUNE computing	Boehnlein, Bhadra, Mondal, Huber, Heinemann	Andrew Norman
6	LBNF/DUNE planning for cryogenics	Klebaner, Fuerst, Robinson, Monroe Laxdal	David Montanari, Stephen Pordes
7	LBNF schedule and planning	Smith, Robinson, MacFarlane	Elaine McCluskey
8	LBNF/DUNE interfaces	Lindgren, Smith, Klebaner, Fuerst	Nandhini Dhanaraj, Steve Kettell
9	protoDUNE-DP technical, schedule and planning	Lindgren, Pordes, Monroe, MacFarlane	Dario Autiero

LBNF management, schedule and planning: Subgroup #7 (Smith, Robinson, MacFarlane)

- **Findings**
  - Continuing Resolution 7-month funding plan in place, delay major procurements, focus on ProtoDUNE.
    - FY17 CR through to 28th April ($26M annual funds)
  - Key risks identified by proponents as: conventional construction market volatility at near or far sites; changes to NS facilities layout or design assumptions; tritium mitigation measures found to be inadequate; cost of liquid argon; unavailability of specialized labour.
  - Changes in senior management, Headley reverted to SDSTA Executive Director, added Far Site Facilities Manager (under recruitment)
  - CM/GG contract development: Presentations by 4 contractors in Feb, expect submission to DOE by mid-April 2017, contract let expected in June 2017
    - Three month slippage since October LBNC meeting
  - Engagement with other labs: meeting held at SLAC, looking to define potential opportunities. Meetings with other labs planned.
  - International Codes and Standards: EU standard equivalence being incorporated into FESHM manual, chapter 2110
  - South Dakota tax requirements for contractors (excise tax) and implications for LBNF are under review
  - Insurance requirements in discussion with SD and SDSTA, requirement for insurance “wrap” under evaluation

LBNF management, schedule and planning

- **Findings**
  - Pre-excavation design complete (except Ross headframe work)
  - Excavation and Building/Site Infrastructure design at preliminary design complete
    - Delayed to June 2017 to planned start of CM/GC contract
  - Reliability project contract in place with SDSTA
    - Includes hoist control replacement
    - Change to rock spill methodology, train not scoop, reduces required drift excavation
    - Surface conveyor and tramway design underway to ensure timely start to maintain schedule
    - Coordination meetings with SDSTA underway and ongoing
  - Temporary construction easements in place for surface work, reliability project easement in development
    - Barrick/SDSTA easements being reassigned
  - Property teams working on use of DOE funds in non-leased spaces
  - Vendor visits in December for argon market understanding
  - Cryo design work focused on ProtoDUNE at CERN

LBNF management, schedule and planning

- **Comments**
  - LBNF are well placed to execute the far site project once funding becomes available, and are a well organised team with strong risk and project management
  - The CM/GC contract process delay means there is no float for final design to include CM/GC. It is hoped that this contract can be placed on the planned timescale, based on funding availability.
  - Good progress has been made addressing previous committee recommendations
  - Critical hires are managed and planned appropriately: the committee concurs it is prudent to delay FS logistics manager; procurement and logistics staffing increases planned appropriately to match anticipated work
  - The risk management framework is well managed; LBNF should consider a common centralised issues management process
  - EH&S mangement interfaces to several groups, coverage is well defined and processes are well managed. The committee commends SDSTA in demonstrated improvements in EH&S.
  - Development of code equivalency appropriate, LBNF should consider a prioritised list of relevant EHS codes. Implications of changes to regulatory environments for collaborating nations should be identified.
  - LBNF has appropriate oversight of the tax, realty, and insurance issues related to far site operations, although these represent a risk. The committee looks forward to the timely resolution of these issues. LBNF and DOE may wish to consider insurance and liability implications for the current SDSTA science programme.
    - Does SLAC/LBL experience provide precedence for realty issues?

LBNF management, schedule and planning

- **Recommendations**
  - None

Beamline / Target (Laxdal, MacFarlane, Robinson, Smith)

- **Findings**
  - A process to confirm the optimized solution has been launched with an engineering report due in July 2017
  - The beamline final conceptual beamline configuration selection is 1-Oct-2017
  - CD-2 for the entire project is expected in December 2019 (baseline), therefore designs need to be ready for reviews by June 2019
  - The target and horns have been optimized for better physics on the basis of sensitivity to CP violation
    - LBNF has developed mechanical designs of the three horns and a 4π long graphite target, produced MARS energy depositions, started the FEA and got preliminary thermal results.
    - All three optimized horn and horn stripline mechanical designs implemented into MARS and energy depositions complete. FEA in progress.
    - Developing a new horn integration concept – shorter simpler horn – couples horn and target replacements
  - Simulation vs observation in air activation
    - Mechanical designs of the three horns and a graphite target were developed with MARS energy deposition simulations – a fully Helium cooled target has been developed with RAL drawing from the T2K concept – reported expected in June 2017
    - The Beamline radiological team proposed to go to inert gas in the target chase and for the decay pipe cooling chase to avoid ^{41}Ar and O_3 production. The request was endorsed by the Beamline Technical Board in November 2016. A design assuming N_2 in the chase is being pursued
  - Near-term milestones have had some slippage
  - The horn casks for LBNF will be 50 tons vs. the NUMI 30 tons. The remote handling implications of this increased mass is underway.
  - RAL (UK) and IHEP (China) are active international partners – more partners are being sought

Beamline / Target

- **Comments**
  - It is important that resources are sufficient to meet the aggressive schedule which includes the necessary optimized engineering analyses prior to the technical reviews in July 2017
  - Horn design and accompanying analysis, including FEAs appears to be progressing well
  - Horn alternative analysis and the development of the new alternative is commendable
  - It is important to quickly conclude the analyses and baseline the horn design to allow the detailed engineering to progress in preparation for CD-2 – continued physics optimizations that yield ever diminishing returns delay a workable engineering solution which should now be the highest priority

Beamline / Target

- **Comments**
  - The target/horn area represents a significant engineering challenge – international collaboration on the engineering including RAL, KEK and others should be sought to move concepts to a more defined state. Engineering choices impact tunnel envelope, logistics for servicing/infrastructure and costs so concepts need to be nailed down soon
  - The move towards inert gas in the target chase (N_2) appears prudent
  - The engagements with RAL and IHEP appear to progressing well
  - The efforts for securing additional non-DOE contributors are encouraged

Beamline Design

- **Recommendations**
  - None

Breakout #7 – Smith, Robinson, MacFarlane

- LBNF Management
  - Viability of contingency planning based on funding profile options and long-term impacts on the project
    - CR planning managed appropriately
  - Status of critical hires including FS management structure
    - Appropriately managed
  - Update on risk registry, retirement of risks and EH&S management
    - Risk management sound
    - Active issues management – common register needed?
    - Insurance planning
    - Codes and standards
  - Interactions with other DOE facilities
    - Ongoing

LBNF management, schedule and planning: charge topics

- Construction at SURF
  - Potential hoist control systems upgrade
    - Concluded and will be implemented
  - Status of CM/GC and final design contract
    - Three month slippage, no float available for start of final design
    - Contract placement appropriate if funding available
  - FRA-SDSTA interfaces and impact on LBNF, including ability for LBNF to conduct work in leased/non-leased spaces
    - Ongoing, well managed
  - Roles and responsibilities for reliability infrastructure improvement projects
    - Ongoing, clearly specified between LBNF and SDSTA

LBNF/DUNE interfaces: subgroup #8 (Lindgren, Smith, Klebaner, Fuerst)

- Questions
  - Is the cryostat roof penetration planning and coordination between LBNF/DUNE progressing satisfactorily?
  - What is the interaction between the planning for the DUNE installation process and Conventional Facilities and cryogenic systems design and construction sequencing planning? Are the interfaces and requirements communicated, understood, and agreed upon by all?
  - Is the DUNE engineering as it relates to the two above items sufficient and able to meet the schedule?
  - Is the flow down of technical requirements between DUNE and LBNF well defined? If so, how is it defined and controlled?

LBNF/DUNE interfaces: subgroup #8

- Findings
  - There is a cryostat layout that is being used to design feed through locations and cryogenic layout with effort of about 1.4 fte + a scientist.
  - There is a labor profile for the future cyrostat penetrations/electronics layout, and cryogenic system work that is based on people moving from Proto-DUNE. There are not formal agreements in place for this to happen, and many contributors of labor resources. Do anticipate people wanting to transition to the DUNE .
  - The interaction between the planning for the DUNE installation process and Conventional Facilities and cryogenic systems design and construction sequencing planning was explained clearly.
  - CM/GC proposers have reviewed the conceptual plan for the DUNE installation process and Conventional Facilities and cryogenic systems design and construction sequencing, and accepted the concept as possible, and say there is adequate time to prepare additional levels of details to be ready for baseline and then construction.
  - The plan for communication and configuration control is to have 30/60/90 reviews and weekly DUNE participation in CM/GC, ARUP, LBNF meetings

LBNF/DUNE interfaces: subgroup #8

- Findings
  - There is a standard system in place to flow down from the science requirements, with the ability to trace back to them
  - The project is using a unified system for requirements for LBNF and DUNE
  - The configuration control and definition process is being used, with regular interface meetings and an appropriate level of internal review
  - DUNE team stated it needs to continue to develop content, but were happy with the tools and framework
  - The IPR was recent enough that this subgroup did not examine recommendation responses from it in this area

LBNF/DUNE interfaces: subgroup #8

- Comments
  - In general the interfaces are well understood, and a workable system in in place that the project can effectively use going forward.
  - The number of FTE's working on the cryostat penetrations is currently limited, as the bulk of the effort is appropriately focused on Proto-DUNE
  - Knowledge gained from Proto-DUNE will be helpful in designing the FD penetrations
  - The plan to have people currently working on Proto-Dune transitioning to this design work is good. It would be a good idea to confirm availability with the management of the people expected to transition.
  - There is a long list of identified tasks to be designed in and integrated. Continuing to ensure good communication, requirements, and configuration management should be a high priority.
  - The teams working on DUNE installation, CF, and Cryogenic systems have good communications, and an appropriate level of interaction and coordination.
  - The level of shaft usage planning is adequate for this stage. They have a good understanding of when more detailed logistic plans to avoid shaft interferences are needed.
  - The plan for communication and change control for design of drifts, etc., should work.

LBNF/DUNE interfaces: subgroup #8

- Comments (cont)
  - The level of effort on the above logistics planning and cryostat penetration design is going to grow in a planned manner. The current level of effort would not be sufficient, but the planned increases may be. Experience from the Proto-DUNE work on the penetrations and detector/cryostat/cryogenics will be very valuable in understanding the level of effort needed to deliver the final system for the single phase detector.
  - The committee agrees with the comment and recommendation of the recent DOE IPR about the far and near site management organization changes. The interface between LBNF/DUNE and SDSTA in an operational sense, ensuring that requirements for logistics, etc. needs to be clearly communicated and managed.
  - There is an adequate system in place and being used effectively so that the interfaces and requirements are communicated, understood, and agreed upon by the team.
  - The usage of that system is at an appropriate level the interface control structure in place that should work well.

- Recommendations
  - None

protoDUNE-SP schedule and planning: subgroup #3 (Proudfoot, Jenni, Heinemann, Huber, Lindgren, Pitts)

- **Findings**
  - The APA delivery schedule determines the installation critical path
  - The DSS design is behind schedule due to lack of engineering resources to address recommendations resulting from an engineering review in November 2016
  - A number of design reviews have been conducted since October: Cathode Plane Assemblies, DAQ(SP), Detector Support Structure.
  - A design review of the Cryo/Beam Instrumentation is scheduled for April 2017
  - The engineering effort for the DSS is a concern to ProtoDUNE management. The management team is in discussions to strengthen it

protoDUNE-SP schedule and planning

- **Findings**
  - Mitigation of the APA delivery on the installation schedule is being considered through faster APA production, dropping the cold test at the production site, and improved schedules for shipping.
  - Cold electronics and detector support structure carry significant technical risks that could impact production schedules
  - Construction of detector components is underway and there is a current focus on production readiness reviews (chaired by DUNE QA Manager) – the first of these on the Cathode Plane Assemblies took place in February
  - The collaboration has worked with Fermilab and DOE to identify operations resources needed for installation, commissioning and operation at CERN

protoDUNE-SP schedule and planning

- **Comments**
  - The ProtoDUNE Team is to be congratulated on the work done since the October review and have made significant progress in addressing the recommendations from the October 2016 review. Key decisions have been made and approved where necessary by the DUNE Technical Board:
    - the FC is proceeding with the extruded aluminum extrusion design,
    - the BNL design for the cold electronics has been adopted,
    - a document defining the scientific and technical goals for ProtoDUNE has been written and approved by the DUNE Executive Committee,
    - a clear plan and milestones have been prepared for most detector systems and the milestones are routinely monitored by the management team
    - A full organization chart for the ProtoDUNE-SP has been put in place defining roles and responsibilities

protoDUNE-SP schedule and planning

- **Comments**
  - The management team is following good practice in its preparation for construction through internal design reviews and PRRs which also provide a mechanism to inform the collaboration on technical issues.
  - The installation schedule is tight and the management team is preparing plans both for work to be done (such as planning the installation team) and for schedule mitigation (speeding up APA production). The committee agrees with the plan to pursue measures to generate more contingency in the APA construction/shipment schedule without compromising their quality.

protoDUNE-SP schedule and planning

- **Comments**
  - The one area of concern is the DSS design, production and installation schedule, where the committee feels strengthening the effort, including the effort on integration and communication, is needed.
  - The ProtoDUNE team is working on an action plan to insure that the DSS does not impact the “ready for beam” date. Only part of this plan was presented to the committee and the committee considers that this plan is needed in the very near future.

protoDUNE-SP schedule and planning

- **Recommendations**
  - Incorporate the results of negotiations on resources and manpower in the DSS Action Plan by mid-April 2017. The action plan should identify roles and responsibilities for design review, component procurement and installation. Establish a watch list for weekly management review.

Physics, Reconstruction, FD TF & ND TF: Subgroup #4 (Boehnlein, Bhadra, Mondal, Huber, Heinemann)

Findings:

- The main result of the near detector task force is a set of input systematic uncertainties for flux, cross sections and detector performance and a framework to perform an oscillation analysis.
- The near detector task force is close to its scheduled end of life cycle and many of its task will be transitioned into the physics and reconstruction working groups.
- VALOR is the method of choice in ND TF for fitting. The VALOR analysis now contains close to 600 parameters and produces results which are difficult to validate.
- The various tools that are needed for a full automated reconstruction are now available and good progress on reconstruction was reported. However no comparison to established milestones was shown.

Physics, Reconstruction, FD TF & ND TF [Worcester, Yang, Whitehead, Brice**]**

Findings:

- A new set of sensitivity plots are available with full MC simulation and reconstruction chain.
- The physics working group is pursuing an increasing number of physics studies besides three flavor oscillations.
- The physics working group is preparing for the TDR and planning for a separate physics TDR.

Physics, Reconstruction, FD TF & ND TF [Worcester, Yang, Whitehead, Brice**]**

Comments

- The committee is pleased to see that the reconstruction tools appear to be reaching the necessary level of maturity to support the majority of physics studies.
- At the same time, it remains difficult for the committee to assess progress of reconstruction versus a defined set of milestones and thus it is not possible to judge whether progress in view of the TDR is adequate.
- The status of the photon detector system and its impact on DUNE physics remains unclear.
- A short note on key inputs for physics sensitivity studies (with supporting material for final plots) will be useful.

Physics, Reconstruction, FD TF & ND TF [Worcester, Yang, Whitehead, Brice**]**

Comments

- The preliminary results of VALOR appear to be plausible but a detailed validation has not been presented. It is unclear whether a blow-by-blow validation of VALOR results is a good use of resources
- The committee is pleased to learn that several ideas for alternative analyses are being considered within the collaboration which will also enhance the physical understanding of the results.
- Use of recent literature could be beneficial for better understanding of systematics, e.g. impact of missing energy due to neutral particles.

Physics, Reconstruction, FD TF & ND TF [Worcester, Yang, Whitehead, Brice**]**

Comments

- For the physics TDR, authorship from outside the DUNE collaboration by involving theorists could be considered.
- The TDR preparation appears to be on track but continued attention to available FTEs and realistically achievable results is required.

Physics, Reconstruction, FD TF & ND TF [Worcester, Yang, Whitehead, Brice**]**

Recommendations:

- For reconstruction, develop a set of milestones so that progress can be gauged against this set.
- Determine which detector deficiencies are most relevant for physics sensitivities in order to understand the robustness of the detector design for the TDR.

Dune Computing: Subgroup #5 (Boehnlein, Bhadra, Mondal, Huber, Heinemann, [A Norman])

Findings:

- The LarSoft toolkit provides common components and integrates contributions from multiple experiments, and the DUNE-specific simulation, reconstruction and analysis software is developed mostly by DUNE collaborators.
- The FNAL SCD is a highly matrixed organization that focuses on providing common services and tools to multiple experiments. 2.22 FTE of value is currently provided in support of DUNE/protoDUNE as part of much larger common services. The SCD plans to increase dedicated effort for protoDUNE and the TDR.
- The Software and Computing Organization has been restructured to clarify roles and establish an interface group to coordinate between FNAL SCD, CERN IT, ProtoDune-DP and ProtoDune-SP
- The DUNE collaboration issued an Expression of Interest for Computing and Software, with first responses expected in March, although it is anticipated to be an on-going process.
- A resource request was made to FNAL for FY18-19. One aspect of this involves 12-20pb of tape storage.

Dune Computing: Boehnlein, Bhadra, Mondal, Huber, Heinemann

Comments:

- The SCD matrix model is successful in providing a base level of common services to the neutrino program.
- The separation of responsibilities in the LArSoft Toolkit is working well. It allows for contributions from multiple experiments while providing common support and integration.
- Meeting DUNE priorities requires DUNE dedicated scientists to develop and tune reconstruction algorithms and simulation packages
- The SCD/DUNE relationship appeared to be a transactional service provider/customer relationship.
  - We suggest also fostering a collaborative relationship
  - Other FNAL hosted experiments have embedded SCD scientists

Dune Computing: Boehnlein, Bhadra, Mondal, Huber, Heinemann

Comments:

- We welcome formation of the interface group that will provide a forum for information exchange between CERN IT and FNAL SCD; essential for the smooth operation and analysis of data from the Proto-DUNEs
- Currently, the computing model for DUNE is not yet fully defined.
- The planning for DUNE Computing & Software remains in a formative stage. The EOI process is intended to lead to a robust and collaborative DUNE Computing that can tackle the longer term planning and preparation essential for the success of the full experiment, as well as to contribute to the success of the ProtoDUNEs and Physics TDR.

Dune Computing: Boehnlein, Bhadra, Mondal, Huber, Heinemann

Recommendations:

- *Ramp up the scientific effort for protoDUNE/TDR as proposed—with the reminder that these efforts are 18 months out.*
- *It would be ideal to engage some of the experienced scientists currently on CMS and ATLAS who are experienced with SW developments for large international collaborations, and solving problems with large data sizes and CPU consumption.*

protoDUNE-SP CE & TPC: subgroup #1 (Pitts, MacFarlane, Liu, Pallavicini, Monroe, Proudfoot, Mondal)

- **Findings:**
  - Considerable progress has been made on all aspects of protoDUNE-SP since the last review.
  - Efforts to test components of the system continue while construction is underway.
  - The DUNE Collaboration has clarified the goals and requirements of protoDUNE as they pertain to the DUNE TDR and detector performance.
  - The design now utilizes an extruded aluminum field cage and resistive cathode. The 35 ton setup is being used to test the new design.
- **Comments:**
  - Project management understands the components of this effort, is actively monitoring progress and identifying areas that need additional resources.
  - The CPA/FC/HV test is an important check of system design and should be closely monitored.
- **Recommendations:**
  - none

protoDUNE-SP CE & TPC: subgroup #1
Detector Support Structure

- **Findings:**
  - The Detector Support Structure (DSS) is a crucial, foundational component that must be installed prior to detector elements.
  - Work is ongoing on the design and analysis of the DSS.
  - The current proposed timeline has the system complete in June.
- **Comments:**
  - Competition for resources has slowed progress on the DSS.
  - The current schedule for the DSS is very optimistic and further delay is a significant schedule risk to protoDUNE-SP.
  - We feel that additional personnel for DSS design and analysis is needed.
- **Recommendations:**
  - *Re-evaluate the DSS design, production and installation resource needs and work with collaborating institutions to identify the resources needed to complete the DSS in a timely manner.*

protoDUNE-SP CE & TPC: subgroup #1
Cold Electronics

- **Findings:**
  - The Collaboration decided to proceed with cold Front End prototype 2 and ADC prototype 1 for protoDUNE.
  - Production of these chips is underway, with delivery in April and May. An assembly and testing plan is in place.
  - The Collaboration has established a Cold Electronics Task Force to consider and evaluate options and alternatives for the DUNE front end.
- **Comments:**
  - The decision to use existing designs for protoDUNE has alleviated much of the schedule risk associated with cold electronics.
  - The work of the Task Force is important to chart the plan for DUNE cold electronics.
  - It is important that the Collaboration carry out the simulation work necessary to clearly define the specifications for the cold electronics.
  - As their work continues, the Christian Task Force and Shaevitz Task Force (SBN cold electronics) should be in contact with one another.
- **Recommendations:**
  - *none*

protoDUNE-SP CE & TPC: subgroup #1
SiPM

- **Findings:**
  - Photon detection system production underway
  - Recent packaging change led to cracking of SiPM package when cold.
  - Chips that didn't crack work.
  - Collaboration has identified a significant number of "old" packaging SiPMs
- **Comments:**
  - Strategies to mitigate this problem are good. Unlikely to be a problem for protoDUNE.
  - The Collaboration will need to evaluate packaging options for DUNE.
- **Recommendations:**
  - *none*

ProtoDUNE-SP-DAQ : subgroup #2 (Amber, Kevin, Ted…)

- **Findings**
  - ProtoDUNE-SP-DAQ is not meant as a prototype platform for DUNE. However, it has to be put together as soon as possible for reliable data taking for ProtoDUNE SP.
    - A basic working system needs to be in place in time for cold box testing this summer (2017)
  - At last LBNC review, the DAQ project was busy getting ready for a design review. Since the design review, the group has been focused on the implementation of the design:
    - key milestones have been established and monitored regularly
    - key contact person has been identified for each sub-system
    - a detailed plan to achieve the first goal for cold box testing is in place
  - The data flow software framework and the back-end software (run control, monitoring, configuration service) are progressing. Similarly, the software and firmware development for detector readout is progressing
    - However, they do not have the final electronics hardware to integrate with
    - WIB and SSP hardware are delayed, so is the timing system (firmware/software)

ProtoDUNE-SP-DAQ: subgroup #2

- **Comments**
  - Getting the full DAQ system working together with a brand new detector over such a short time will be a major undertaking
    - This can only be achieved over such a short time by a group of highly dedicated and talented people working closely together in a coherent way. Effective communication with other (external) subsystems is crucial for success as well.
  - It is crucial that subsystems (or components) such as timing, WIB and SSP become available for DAQ development, testing and integration before May 2017, to make sure the DAQ system is ready for the initial cold box testing over the summer

ProtoDUNE-SP-DAQ: subgroup #2

- **Recommend**
  - none