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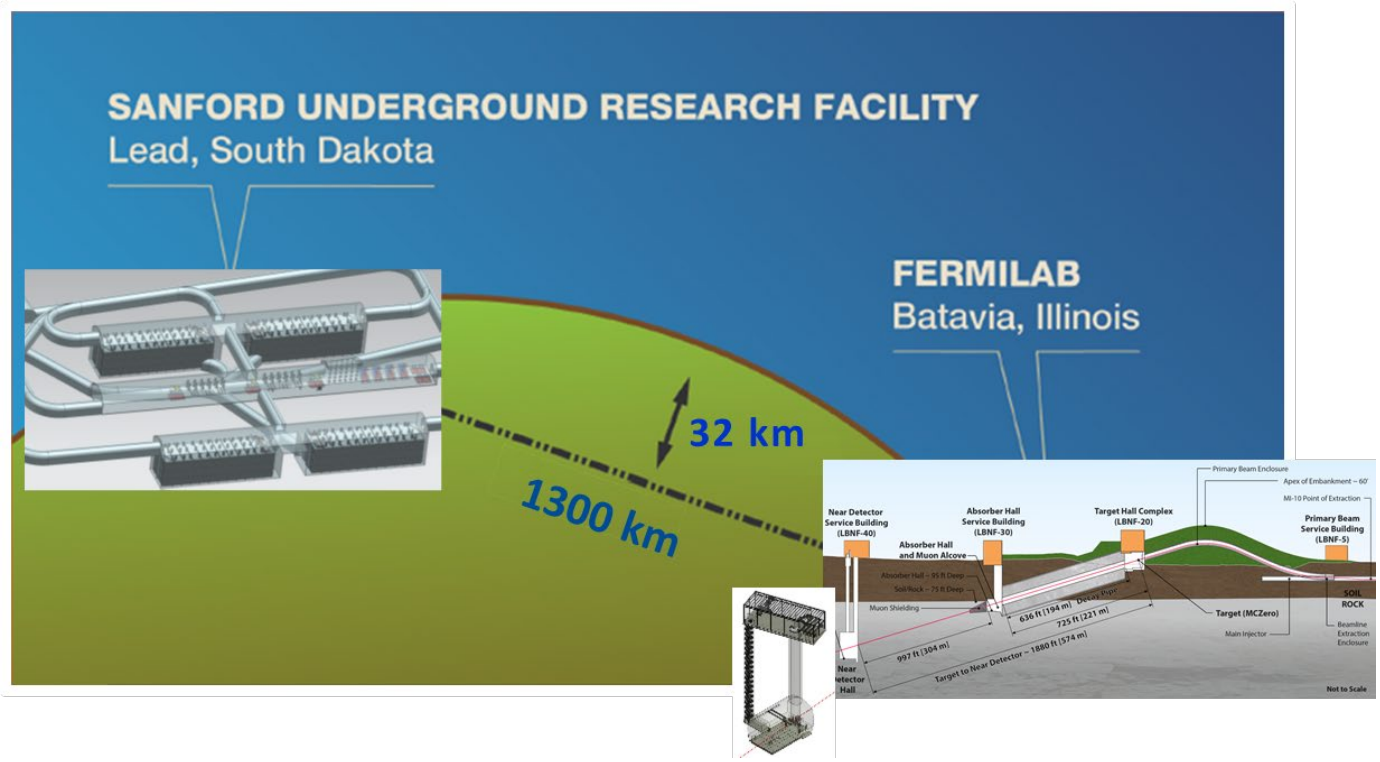
LBNC Closeout

LBNC

25 Oct 2016



LBNF Planning and Schedule [Mossey, McCluskey]

- Findings
  - CD-3a approval granted to LBNF 1st September, 2016
  - Overall sequencing
    - SURF reliability upgrades (FY16/18)
    - Pre-excavation phase ((FY17/18)
    - Excavation (FY18/22)
    - Cryostats/cryogenics (FY20/25)
  - CD-3a approval covers pre-excavation and excavation
    - Scope is only for first two caverns, no drifts associated with third and fourth caverns
    - Ramp-up somewhat slower than anticipated in CD-1R shifts start of DUNE installation by 6 months (neutrino beam remains 2026)
    - $1.536B, slight increase due to shift in deliverable, 36% contingency
  - Workshop planned to assess potential for engagement by other DOE laboratories
  - Development work on code equivalency (US-EU) underway

LBNF Planning and Schedule [Mossey, McCluskey]

- Findings
  - CM/CG acquisition underway, proposals due November 15th.
    - 7-8 contractors expected to bid
    - Contractor may self-perform work
    - Contract broken into stages to allow interim profits and off ramps
  - SURF operations transitioned to Fermilab on October 1st.
  - Change in senior management structure at site to better support both SURF (Mike Headley) and Far Site Facilities (TBD)
  - SURF reliability projects (SDSTA) includes Oro Hondo fan replacement, hoist motor rebuild, hoist clutch/brake, cage skip replacement
  - Ross shaft infrastructure refurbishment with steel sets is now 81% complete
  - Pre-excavation work includes headframe rebuild, 4850L ventilation drift rehab, underground and surface rock handling systems, concrete slick line, utilities, shaft elec/comms
  - Pre-excavation design work at 60%; 90% expected in November
  - Surface rock removal design includes conveyor and tunnels
  - Change in design peak particle velocity to 2”/s agreed following test blast program.
  - Fire and smoke models complete; AHJ meeting in November
  - Following evaluation of power distribution, redundancy has been removed with reliance on UPS systems

LBNF Planning and Schedule [Mossey, McCluskey]

- Comments
  - Congratulations to collaboration for successful award of CD-3a, (50% larger than any previous CD-3a award)
  - Continuing Resolutions may impact ability to ramp-up LBNF work if they continue through to March 2017
  - Previous LBNC recommendations are being addressed appropriately
  - LBNC supports phased approach to work at SDSTA (reliability, pre-/excavation)
  - Good progress on development of easements and leaseholds
  - Good progress on Ross shaft refurbishment and pre-exc. design work
  - Risks are well identified and managed, with various funding scenarios appropriately reviewed
    - LBNF looking at strategies for funding excavation of chambers 3&4 to ensure no loss of momentum and gap in contracts
  - Contingency of 36% appears appropriate at this stage
  - The reduction in power redundancy appears defensible, although has several implications that should be fully understood
    - Loss of hoist on power failure means the use of the refuge is required. What processes and systems are needed to account for this – 'all-stations' calls to prevent injury during power outages
    - Systemic use of UPS systems may impact fire requirements
  - The implementation of new hoist controls has cost benefits, and also projects a strong professional image of a modern operation

LBNF Planning and Schedule [Mossey, McCluskey]

- Comments
  - CM/GC acquisition strategy has taken longer than anticipated: no float on letting contract (March) although five month float prior to excavation work in January 2019. May not get best value from CMGC model.
  - May need to proceed with final design before CMGC is on board; seem to understand risks/benefits of proceeding versus waiting
  - We commend good start on international codes and standards, which also impacts ProtoDUNE, DUNE, SBN
  - Sensible framework for engaging other DOE Labs; communication generally positive to maintain support among labs; priority for OHEP
  - Is the governance clear for non-DUNE priority setting in other parts of SURF, given Fermilab's new responsibility to represent DOE/HEP's interest broadly in the facility?
  - Slide on tracking LBNC milestones was clear and helpful
  - LBNC is pleased to see progress on assessing options for procurement of liquid argon

LBNF Planning and Schedule [Mossey, McCluskey]

- Recommendations
  - Given the potential benefits and cost savings over the lifetime of DUNE/LBNF, the LBNC would recommend that the potential upgrade of the control systems for the hoist be implemented.
  - Establish and maintain contact between DUNE POC and lead referee for the LBNC subgroups, thereby providing ongoing updates of major developments.

LBNF/DUNE Far Site Interfaces [Dhanaraj]

- Findings
  - Requirements broken into two categories
    - Science and Engineering
    - Programmatic
  - Requirements structure implements a ‘trace-back’ to global science objectives
  - Interface management uses matrix approach across sub-systems with Interface Control Documents specifying requirements
  - Environment engineering drawings updated periodically with input from several sources (e.g. CERN)
  - Change control management follows established DUNE process
  - Near detector and beamline requirements will be needed in a year or so (late 2017)
  - Combination of excel, docdb, SharePoint used to manage requirements and interfaces

LBNF/DUNE Far Site Interfaces [Dhanaraj]

- Comments
  - LBNC commends the team as being coherent, competent, and agile in reacting to requirement changes
  - The team demonstrates an understanding of technical aspects of the project and the interplay between sub-systems
  - There appears to be reasonable understanding of the implications of single vs dual phase design (single phase larger in all respects) although confirmation should be sought from collaboration
  - Review and ensure operational and construction aspects are contained within the interfaces matrix
  - Assess whether a more formal approach to reviewing the interface matrix may be beneficial to identify potential gaps
  - Look at assessing if more convenient software planning tools are available as DUNE project develops

LBNF/DUNE Far Site Interfaces [Dhanaraj]

- Recommendations
  - None

Beamline design update: [Papadimitriou]

- Findings:
  - Work is ongoing in various areas of the beamline work, optimization effort, Horns & Target, the Target chase atmosphere (air releases, inert gas) and beam windows.
  - Current planning calls for a decision on beamline final conceptual design in September 2017, based on a start of preliminary design in October 2017, with the optimized design ready for comparison with the reference design before that.
  - A first iteration of a mechanical model for the horn for the optimised beam with 3 horns was shown.
  - FEA for horn A shows acceptable inner and outer conductor temperatures and stresses but Support of target at DS end too hot (> 1,000C) and needs redesign. Helium cooled titanium tubes supports is a possible solution.

Beamline design update: [Papadimitriou] contd.

  - Mechanical design of horn B and C and FEA analysis are in progress.
- Comments:
  - A lot of progress has been made on the optimised beam Design with an aim to maximise CP violation.
  - Use of air vs. inert gas in target chase is still an open issue. This has a big impact on the design, leak tightness, cooling of the target chase area etc.
  - The big difference between observed vs. simulation on activated air is a serious concern
  - Physics performance studies appear to have reached the point of diminishing returns for the overall CP violation goal compared to the engineering studies needed

Beamline design update: [Papadimitriou] contd.

- Recommendations
  - Efforts should be channelled towards completion of mechanical design and FEA analysis and detailed cost estimate
  - Difference between simulation vs observation in air activation needs to be understood.

BO TF [Fields]

- Findings
  - Delivered a preliminary report in July 2016 and scheduled for the final report in March 2016.
  - Focus of the task force is on 3-Horn configuration.
  - Initial simulation shows that realistic material description leads to substantial loss in flux but the sources of this loss is not completed accounted for. Possible source may be the spacing between the 1st and 2nd horn.
  - Various optimization studies based upon the comments and questions from engineers conducted.
  - Impact of decay pipe size on CP sensitivity is very similar for the nominal and optimized beam.

BO TF [Fields]

- Comments
  - Progress by TF is excellent.
  - LBNC does not see a need to revisit the current Decay Pipe design.

BO TF [Fields]

- Recommendation
  - Complete the design. Submit the final report and proceed with engineering studies and cost estimate.

State of DUNE/CD-2 strategy [Thomson]

- Findings
  - Collaboration committed to delivering two large scale engineering prototypes at CERN in 2018
  - DUNE TDR will be delivered for DOE CD-2/3b in 2019
  - 20 kT far detector ready for beam in 2026
  - Near detectors operational in time for first beam
  - Have developed implementation strategy for 2016-2019
  - 946 collaborators from 30 countries
  - Have plan for leadership transition, new IB Chair and RC in place
  - 3 task forces delivered preliminary results Sept. 2016
  - ProtoDUNE-SP team re-organized
  - 75 previous recommendations tracked, 10 closed

State of DUNE/CD-2 strategy [Thomson]

- Comments
  - Strategic goals presented are appropriate
  - Continue to focus on increasing leadership diversity and internationalization – perhaps by appointing deputies
  - ProtoDUNE-SP re-organization will help in meeting technical and schedule goals
  - It is important to continue to build effectiveness and size of international collaboration, with ongoing strong support from Fermilab
  - Near detector plans are not as complete as far detectors and need continued definition
  - Tracking and resolution of recommendations is a best practice and should be continued
    - Leadership should work with LBNC chair on closing additional recommendations
  - Additional focus on software activities is planned, and appropriate

State of DUNE/CD-2 strategy [Thomson]

- Comments
  - Response to previous CE recommendations on investigating options for cold 12 bit ADC and mitigation strategies was unresponsive and demonstrated an unwillingness to explore alternatives

State of DUNE/CD-2 strategy [Thomson]

- Recommendations
  - Execute the leadership transition plan
  - Update the collaboration resource analysis, particularly for the most critical efforts, and ensure the focus is on the highest priorities
  - Continue efforts to increase international collaboration
    - Find opportunities for additional collaborators, particularly from US, to work on the ProtoDUNE-DP and from outside the US on protoDUNE-SP
  - Develop milestone driven schedule to the TDR
  - Consider, define, and communicate the required deliverables from ProtoDUNE-SP to adequately inform the TDR and FD baseline

State of DUNE/CD-2 strategy [Thomson]

- Recommendations (cont'd)
  - Review decision making process within the DUNE Collaboration for responsiveness, timeliness, and decisiveness
  - Establish and maintain contact between DUNE POC and lead referee for the LBNC subgroups, thereby providing ongoing updates of major developments
  - Adopt best practices for future talks: Milestone reporting (Mossey, slide 10); LBNC recommendations (Mossey, slide 15); risk updates (Mossey, slide 16), organizational updates (Patterson, slide 3), TF reports (Whitehead)
  - We would like to encourage renewed efforts to expand broader collaboration participation in both future TPC design efforts (protoDUNE-SP and protoDUNE-DP)

Computing [Norman]

- Findings
  - A. Norman (newly appointed as Software and Computing Co-Convenor for DUNE) made a presentation that discussed the three elements that needed to be addressed: TDR preparation, ProtoDUNE support, and the computing support for the actual DUNE experiment.

Computing [Norman]

- Comments
  - It is not clear how many people, particularly from the FNAL scientific computing division, are working on the various aspects of the three important topics (TDR preparation, ProtoDUNE support, and the ultimate computing system), neither are their roles and goals.
  - We would like to know how many people are needed to fulfill the tasks in a timely manner
  - We have requested this information in previous LBNC queries.
  - On page 13, there is reference to 42 major computing deliverables for Proto-Dune. We perceive that computing for protoDune and DUNE should be basic as possible, while being commensurate to the task at hand, and does not need to be as complex as presented.

Computing [Norman]

- Recommendations:
  - In order to form a deeper understanding of the progress in matters of computing and software, members of the LBNC will establish regular check-ins. Due to the timetable for the TDR, we recommend that these check-ins be monthly, beginning at the end of November, 2016
  - For the first check-in, we would like to have the information on assigned FTEs from the FNAL SCD to better understand the scope of work that is currently being undertaken.

Reconstruction software [Yang]

- Findings
  - There are approximately 10 people currently working on reconstruction algorithms.
  - Ongoing algorithm work was shown with improved signal efficiency for nu_e events and NC rejection capability. The improved NC rejection is 90% for a signal efficiency of 80%.
  - 3-6 month goal is to improve the NC rejection by a factor of 2 for the same signal efficiency and improve proton decay selection to 80%
  - The low energy efficiency also improved significantly.
  - Common tools are being developed for protoDUNE and DUNE.

Reconstruction software [Yang]

- Comments
  - The NC background rejection still has room for improvement but the analysis is on the right track.
  - Proton decay efficiencies are better than before, and more decay modes are being investigated
  - Users report that LArSoft has reached a new level of maturity with improved documentation and training
  - It is vital to expand the user base as the reconstruction algorithms must be developed by physicists.
  - We are not sure what exactly is the process for quality assurance
  - Kaon tracking efficiency is liming the signal selection efficiency but customized track reconstruction may aid in recovering short kaon tracks.
  - Supernova neutrino reconstruction has been improved allowing a lowering of electron energy threshold to 3 MeV.

Reconstruction software [Yang]

- Recommendations:
  - Senior management should meet with the LBNC referees and the software team regularly to address concerns and queries
  - Fermilab should provide a plan for long-term sustainability of LArSoft that meets the needs of SBN and DUNE

Software [Patterson & breakouts]

- Findings
  - The physics working group is responsible for delivering the systematics table that will enter the TDR.
  - The Far Detector Simulation and Reconstruction group is now a Physics Working Group.

Software [Patterson & breakouts]

- Comments
  - The physics working groups have demonstrated progress on many fronts.
  - We note that the group continually addresses and updates the physics case in the context of the evolving global knowledge of neutrino physics. We commend them on this.
  - We commend the move of the Far Detector Simulation and Reconstruction group into the Physics Working Groups.
  - We noted that the ND Task Force, the Senior Management and the Physics Coordinator, did not appear to have a coordinated and definite plan for resolving the currently unrealistic VALOR output uncertainties

Software [Patterson & breakouts]

- Recommendations:
  - See ND task force recommendations

ND Task Force [Brice]

- Findings
  - The TF has continued to implement the plan as outlined in earlier meetings
  - A third run through of the analysis process has been completed and described in a detailed report, with advances in the flux and cross section uncertainties, the background modelling, figure of merit, and other upgrades
  - The run through considered 3 different near detectors, a Fine-grained tracker, high-pressure gas TPC, and a magnetized LAr
  - The analysis is still based on a combination of cheating and smeared truth for the ND reconstructions
  - The analysis is now based on actual FD reconstruction, but no estimates are yet made of uncertainties in the reconstruction

ND Task Force [Brice]

- Findings (continued)
  - No additional information was provided about the impact of unobserved neutral particles on the analysis
  - Details of manpower needs/availability were not presented

ND Task Force [Brice]

- Comments
  - The systematic uncertainties produced by the 3rd run through continue to be unrealistically small, and there appears no clear understanding of why
  - It was not clear to the committee how the TF plans to overcome this problem
  - How will the TF know when their results are valid, rather than when the process has just started producing numbers which are plausible?
  - We were not reassured that there was sufficient concern about these issues, and that the collaboration is devoting enough personnel to get credible results by the scheduled end of the TF
  - The TF results are just the first step in the process leading through CD2 to a viable ND construction project, so convergence is critical and the schedule important

ND Task Force [Brice]

- Comments
  - The ability to produce credible systematic error analyses for proposed detector configurations is only the first step in settling on a near detector design
  - The VaLOR framework has been successfully used by T2K, and has been used to perform a very similar analysis of the impact of near detectors on systematic uncertainties and oscillation sensitivities for Hyper Kamiokande, so we do not believe there is an inherent problem with the tools available.
  - Near detectors are not only needed to quantify the final systematics, they are also needed to determine the beam flux, spectrum, and direction; and they need to do this when the beam is in its early operation stages at powers far below the full design power

ND Task Force [Brice]

- Recommendations
  - TF management should present to an upcoming LBNC weekly call a manpower-loaded plan for achieving realistic uncertainties
  - TF management should also consider whether alternative techniques should be considered if convergence is not achieved within 2016, and present ideas for alternatives to the LBNC

protoDUNE-SP Schedule and Plan [James, Rameika, Cavanna]

- Findings:
  - A detailed assembly and construction plan and schedule were presented. There is a well-defined plan for conducting internal reviews at critical stages of the project.
  - The installation schedule is driven by APA delivery, it fits with the cryogenic installation schedule
  - The prototype frame is presently being used to develop expertise in APA winding at PSL; the production of the first APA is planned to begin on schedule.
  - Three APAs will be constructed at PSL and 3 at Daresbury, using common techniques and tooling, a Production Readiness Review is scheduled for January 2017 following the construction of the first APA

protoDUNE-SP Schedule and Plan [James, Rameika, Cavanna]

- Findings:
  - Since July 2016 there has been a weekly phone meeting between PSL and the UK groups, exchange of engineers will take place to maximize learning experience in the winding of the first APA.
  - The stuck code bit issue with the ADC is being evaluated but there is no expectation that it will be resolved in time for protoDUNE-SP
  - Integration and installation tests are being carried out at Ash River and will continue for several months.
  - The most challenging part of the installation in the cryostat will be the installation of the final part of the field cage

protoDUNE-SP Schedule and Plan [James, Rameika, Cavanna]

- Comments:
  - A number of design decisions need to be made. While these do not impact the schedule at this point making these decisions in a timely way will allow the collaboration to focus on the baseline and reduce risk
  - The specific goals of the protoDUNE-SP test beam run were not well specified.
  - While the construction and installation plan is well defined it is tightly coupled and will need careful monitoring to meet the test beam schedule

protoDUNE-SP Schedule and Plan [James, Rameika, Cavanna]

- Recommendations:
  - Make decisions on the remaining open options (FC, extrusions, PDS) in a timely way
  - The collaboration should review the goals of the test beam run taking into account the trade-off between meeting the current schedule versus the risk of the detector not performing as required
  - Identify milestones and key steps, which must be accomplished to meet the construction and installation schedule. Implement a regular monitoring of progress on these items, such as a watch list

ProtoDUNE-SP TPC [James, Rameika, Cavanna]

- Findings
  - Final Design Reviews were held on the Anode Plane Assembly, the Charge Electronics, and the Photon Detection System in June-Oct. 2016.
  - Final Design Reviews are planned on the DAQ, Cathode Plane / Field Cage, and Detector Support Structure in Nov. 2016.
  - Assembly and integration studies of the APA and field cage structures have begun at Ash River
  - Wire winding on a prototype APA plane has begun at PSL, 3 APA planes planned.
  - Wire winding of 3 APA planes is planned at Daresbury, using a common frame and winding machine design.
  - No material was presented on integration with the CERN safety systems DCS and PVSS

ProtoDUNE-SP TPC [James, Rameika, Cavanna]

- Comments
  - Presentation of the outcomes of the reviews, and the response plan, would have been helpful.
  - Of the 3 noise problems in the 35T, 2 seem well understood and the explanation for the 3rd seems plausible but is not demonstrated.
  - Getting the planned test stands at FNAL and BNL up and running to identify the LV noise source should be a high priority
  - While work on installation planning has begun, details such as the support from the roof remain to be finalized
  - A detailed installation plan is needed to avoid unforeseen schedule delay associated with space and manpower assignment constraints in EHN1
  - There does not seem to be sufficient involvement of non-US collaborators working on ProtoDUNE-SP.

ProtoDUNE-SP TPC [James, Rameika, Cavanna]

- Recommendations:
  - At the next LBNC, present the response plan from the Final Design Reviews and their outcomes
  - Investigation of the variable high frequency noise problem should continue to be pursued with high priority to understand the root cause, which may not reside in the LV power supply.
  - The collaboration together with FNAL should allocate resources, and identify new collaborators if possible, to carry out the planned testing program
  - Since solving the LV system noise problem is critical, it would be appropriate to solicit advice and review from experts outside the DUNE collaboration
  - Schedule an installation review in a timely way to ensure that issues associated with the cryostat design and installation of APA, CPA and FC are covered

ProtoDUNE-SP TPC [James, Rameika, Cavanna]

- Recommendations, continued:
  - Make a decision about steel vs. Al field cage profiles and move forward.
  - Engage in discussions with CERN personnel and ProtoDUNE-DP experts on the safety systems with high priority.

Cold Electronics (overall)

- Findings:
  - The cold electronics (CE) system will reside in LAr, mounted directly on the APA. The system is based on an architecture with ASIC chips to provide signal amplification, shaping, digitization, buffering and multiplexing. The system will be continuously readout, with a digitized ADC sample from each APA channel or wire up to every 500ns (2MSPS).
  - The front-end CE consists three ASIC chips: FE preamplifier ASIC, ADC ASIC, and cold data ASIC (currently implemented in FPGA).
  - The entire CE system has been recently reviewed at BNL (Oct 12-14, 2016). Review report is now available to LBNC.
  - For this review the focus of presented material was on the ASIC chips

Findings: FE ASIC

- P1 FE ASIC:
  - has been tested on FEMB with good noise performance
  - Two design issues to be addressed: (1) glitch of bias current design, 1GOhm resistor is necessary to bring channels up, and (2) imperfect pole-zero cancellation in cold operation
  - Distortion of baseline caused by stress from new P1 package in cold operation. The MicroBooNE package is no longer available
- P2 FE ASIC:
  - The two design issues above have been addressed
  - Submitted in late August, is scheduled to be back early November 2016
  - Package issue being followed up with three packaging houses

Comments: FE ASIC

- The preamp noise performance is excellent given the large input capacitance, and this low noise will be crucial for DUNE
- Whereas the qualitative explanation on package stress is plausible, it would be good to also have a quantitative study. Package stress is known to induce offsets, but usually in the mV range and effects follow the stress distribution, worse on the edges. In the preamp design, it is not clear what transistors would induce such large offset at the output.

Findings: ADC ASIC (12-bit 2MSPS)

- P1 ADC:
  - P1 ADC was submitted in early July, 2016
  - One P1 ADC ASIC die has been tested over past weeks
  - While pre-tape out simulations suggested the stuck bit problem would be solved in the latest ADC ASIC submission, preliminary test results indicate it has not been fixed. Therefore, the core problem has not been completely understood
  - The average LSB of each ADC channel shows significant variance at cold, indicating large mismatch under cold.
  - 38 P1 ADC ASICs were packaged and delivered last week. However, they do not work due to wire bonding problems.
  - ~200 bare dies are available for packaging and testing
  - 40 chips will be packaged in the coming weeks by Quik-pak

Comments: ADC ASIC (12-bit 2MSPS)

- The “domino” ADC architecture used in this ASIC fundamentally depends on matching between active devices. Moreover, current source mismatch is expected to be roughly four times worse at LAr temperature than at room temperature. This is reflected by worse cold performance, and in particular, stuck bits.
- A12-bit ADC operating at 2MSPS at cryogenic temperature is extremely challenging given the power and area constraints.
- It is not clear that the requirement for a linear 12-bit ADC is fully justified.

Cold Electronics: Recommendations

- The Collaboration (detector, physics working groups) should evaluate the requirements necessary (e.g., ADC precision, linearity) for successful achievement of physics goals.
- In parallel with ongoing efforts to provide front-end electronics for ProtoDUNE-SP and SBND, the Collaboration should initiate an effort to look globally at the FD front-end architecture. Particular attention should be given to the cold/warm partitioning of the front end electronics system. This effort should consider performance requirements, design alternatives, and system-wide risk analysis. As part of this risk analysis, alternative cold ADC architectures and implementation should be evaluated.
- For each experiment (SBND, DUNE), the acceptance criteria for the FE and ADC ASICs should be defined and documented.
- Given the development timeline and longevity requirements for DUNE cold electronics, planning should commence for a large scale “cold electronics test facility” that can permit large-scale testing, evaluation and burn-in.

ProtoDUNE-SP DAQ:

- Findings:
  - The baseline plan is a system based upon the SLAC RCE ATCA system along with artDAQ.
  - The requirements and main interfaces are understood.
  - The system is based upon existing tools.
  - A partitioning system will be established that allows multiple vertical slices to be utilized concurrently.
  - An R&D goal for ProtoDUNE-SP is to read out 1 APA using the CERN FELIX system.
  - ProtoDUNE-SP and ProtoDUNE-DP are utilizing different DAQ architectures.

ProtoDUNE-SP DAQ:

- Comments:
  - The ProtoDUNE-SP DAQ effort seems well-staffed and brings together several European and US contributors.
  - Software development is in progress and will need to continue to integrate existing pieces.
  - Calibration system and monitoring software are both places that need significant attention.
  - The plan to develop the ability to inject fake data at many different places along the chain is crucial for test and debugging.
  - Given the short timeline, it will likely be a challenge to develop two DAQ systems. Management should ensure that the baseline system gets enough attention to be ready.
  - Early visualization (can be primitive) methods will be needed to examine data, such raw bank dumps, event display.
- Recommendations:
  - none

ProtoDUNE-DP [Autiero]

- Findings
  - The 3x1x1 m^3 “pilot” detector was installed in the cryostat in July’16.
  - DEMACO has installed its deliverables on time.
  - Work by CERN to complete the piping is underway with a two-week delay in the delivery of some valves.
  - A production readiness review for the 6 x 6 x 6 m^3 is scheduled for January’17, with input from the 3x1x1 m^3 data.
  - A second LEM vendor has been identified and qualified.
  - The HV feedthrough has been tested to 300 kV.

ProtoDUNE-DP [Autiero]

- Comments
  - The progress on the mechanical integration of the 3x1x1 m^3 is impressive.
  - The strategy of definitizing the executive design of the 6x6x6 m^3 in Nov.'16 without data from the 3x1x1 m^3 carries risk.
  - The tiled cathode design employing TPB and ITO-coated PMMA appears challenging; has excess illumination been evaluated?
  - We look forward to seeing the results of the decoupling mechanism tests demonstrating CRP planarity within specification for the 6x6x6 m^3 detector.
  - We support the collaboration in its request for CERN help to meet the challenging schedule of filling before the holiday shutdown.

ProtoDUNE-DP [Autiero]

- Comments:
  - We would like to encourage involvement of more US collaborators working on ProtoDUNE-DP.
- Recommendations
  - Run the 3x1x1 m^3 for several months to establish the stability of the system.

FD Task Force [Whitehead]

- Findings
  - Preliminary TF report is available
  - Basic validation of DP reconstruction in LArSoft completed.
  - Photon detection system studies are in progress.
  - For LBL physics -preliminary full MC based sensitivity studies completed. Still not as good as assumed in CDR
  - Low energy SN neutrinos with 10 MeV and lower energy deposition have been reconstructed.
  - For Nucleon Decay events tracking efficiencies and particle ID efficiencies evaluated with real reconstruction . Currently assessing photon detector performance.
  - Detector optimisation studies with full simulation and reconstruction have just begun.

FD Task Force [Whitehead] contd

- Comments
  - Implementation of Dual Phase simulation and reconstruction in LArSoft is progressing well.
  - Both VALOR and LOAF are in good shape.
  - Current CP sensitivity achieved with reconstructed events is lower than that assumed in CDR. Detector optimisation studies for CP violation sensitivity and Nucleon Decay need to be completed.
  - We would like to know what needs to be done for the TDR

- Recommendation
  - Complete the DP implementation in LArSoft
  - Lack of manpower in various analysis efforts needs to be addressed.

LBNC closeout: DUNE – cryogenics [Montanari]

- Findings
  - ES&H oversight authority rests with the lease holder of any given space.
  - CERN plans to stage all cryostat material in the vicinity prior to starting underground assembly for DUNE.
  - The first DUNE LAr cryostat will use single-phase technology; the follow-on detector technology is to be determined.
  - The possibility to create a single DUNE cryostat roof design capable of supporting both SP and DP technologies is being explored.
  - Cryostats, cryogenics, and infrastructure at CERN are managed by the CERN Neutrino Platform.
  - The Proto-DUNE SP & DP cryostats each hold 750t of LAr, 300t of which represents the fiducial mass.

LBNC closeout: DUNE – cryogenics [Montanari]

- Findings (continued)
  - Joint working groups including “Cryogenics & Instrumentation” have been formed to address issues common to DUNE SP & DP.
  - LAr purification for 3 x 1 x 1 m^3 is a mixture of FNAL and CERN elements similar to the Proto-DUNE design but with an internal pump
  - Infrastructure installation in the EHN1-NP building extension at CERN is scheduled from SEP16 to APR17 including both Proto-DUNE cryostats: NP02 (DP) and NP04 (SP).
  - All NP04 material will be on hand by end of OCT16, all NP02 material by end NOV16.
  - There is a plan to submit the acquisition plan for the DUNE LN2 plants for two cryostats worth in December 2016

LBNC closeout: DUNE – cryogenics [Montanari]

- Findings (continued)
  - There are currently 10 technicians and 2 engineers available to the CERN neutrino platform.
  - During cryostat fabrication, leak checking of the membrane is stated to be performed using a helium mass spec leak detector with a sensitivity in the 10^{-9} mbar/L-s range.
  - An integrated cold test stand adjacent to the proto-DUNE cryostats allows APA testing in cold gas prior to installation in the cryostat.
  - In a power outage,the plan is for LAr in the DUNE cryostats to be recondensed and returned directly to the cryostats.

LBNC closeout: DUNE – cryogenics [Montanari]

- Findings (continued)
  - The project is confident that the established cryostat/TPC cooldown rate for protoDUNE is conservative relative to the limits given by the detector specifications (50K/hr).
  - The funding sources for “Proximity” cryosystems for DUNE (LAr pumps & purification including those for Cryostat # 1) are not yet identified.

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- Comments
  - If there were value in doing so, the ability to transfer LAr between DUNE cryostats could be integrated into the cryogenic design.
  - Maintaining the schedule for the cryogenics system delivery by DEMACO for protoDUNE is crucial.
  - The allowable cooldown/warmup rates for the integrated cold test stand at the protoDUNE-SP should be understood.
  - It may be wise to consider venting LAr boil-off during a power-outage to avoid contamination, given the (relatively) small liquid volumes involved.
  - Some CFD analyses of LAr convection exist but could use additional validation. protoDUNE could provide valuable input.
  - The pursuit of a common cryostat-roof design for DUNE is worthwhile and may not represent an undue effort relative to the benefit.

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- Comments
  - The committee commends the ES&H effort, particularly in the area of codes & standards.
  - The committee notes that this will be the first activation/ regeneration of proto-DUNE's Fermi-style purification system
  - Requirements on the LAr liquid level and level stability should be evaluated for the full DUNE DP cryostat
  - The committee looks forward to seeing how the project fills the non-DOE gaps in support of the cryogenic systems.
  - protoDUNE provides an opportunity to test cryogenic performance at the kton level of: purge process, cool down process, argon surface and level stability, filter activation (and regeneration)

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- Recommendations
  - Fermilab should proactively engage with CERN in the commissioning of this first 1 kTon scale LAr purification system.