

Long Baseline Neutrino Committee

July 2019

Fermilab

CLOSEOUT Report

August 2, 2019

Acknowledgements

The LBNC appreciates the effort put into the preparation of the presentations and material, in particular the draft volumes of the Technical Design Report, by the DUNE Collaboration, and the frank responses to questions and queries.

The committee thanks Fermilab for their support and hospitality

LBNC Meeting Charge Draft 7/31/2019

- **The LBNC will hear about the progress towards provision of material suitable to support the approval of TDRs for initial components fabrication of the DUNE experiment and to support ongoing development of components for the longer term DUNE program. The LBNC will prepare a Closeout Report followed by a Full Report. The latter will be a component of discussions between the Director and the RRB.**

LBNC Meeting Assignments 7/31/2019

Wednesday July 31

- 08:00 Executive Session Committee + Director
Discussion of Charge and Agenda. Hugh Montgomery
- 09:00 LBNF Status (30 +15)
General Status
Review Team ([Angela Fava](#), Bob Laxdal (rem), Tom Peterson, Hugh Montgomery)
- 09:45 Break (15)
- 10:00 DUNE Overall Status + Exec Summary (Spokes) (30 +15)
From Exec Summary TDR Review Team ([Dave Charlton](#), Amber Boehnlein, Bob Laxdal(rem))
- 10:45 DUNE Project Schedule (30 + 15)
From Tech Coord TDR Review Team ([Austin Ball](#), [Dave Charlton](#), Tom Peterson, Jeff Spalding)
- 11:30 Technical Coordination Status & TDR (40 + 20)
From Tech Coord TDR Review Team ([Austin Ball](#), [Dave Charlton](#), Tom Peterson, Jeff Spalding)
- 12:30 Lunch/ Executive Session
Discussion Technical Coordination

LBNC Meeting Assignments 7/31/2019

Wednesday July 31

- 14:00 **ProtoDUNE SP Progress** (20 + 10)
From FD-SP TDR Review Team ([Kevin Pitts](#), Jocelyn Monroe, John Parsons, Jim Proudfoot, Ted Liu)
- 14:30 **DUNE FD SP Status & TDR** (60+30)
From FD-SP TDR Review Team ([Kevin Pitts](#), Jocelyn Monroe, John Parsons, Jim Proudfoot, Ted Liu)
- 16:00 **Break** (15)
- 16:15 **Near Detector Design** (20 + 10)
From Near Detector Review Team ([Scott Oser](#), Patrick Huber, Naba Mondal, Beate Heinemann)
- 16:45 **Physics Status (including ND impact) & TDR** (30 + 15)
From Physics Review Team ([Beate Heinemann](#), Sampa Bhadra, Patrick Huber, Naba Mondal, Scott Oser)
- 17:30 **Executive Session**
 Initial Discussion ProtoDUNE SP, FD SP
 Initial Discussion Physics including Near Detector
- 18:30 **Adjourn**

LBNC Meeting Assignments 8/01/2019

Wednesday July 31

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From FD-SP TDR Review Team ([Kevin Pitts](#), Jocelyn Monroe, John Parsons, Jim Proudfoot, Ted Liu)
- 14:30 **DUNE FD SP Status & TDR** **(60+30)**
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 Initial Discussion ProtoDUNE SP, FD SP
 Initial Discussion Physics including Near Detector
- 18:30 **Adjourn**

LBNF Status General: [Angela Fava](#), [Bob Laxdal \(rem\)](#), Tom Peterson, Hugh Montgomery

Findings:

- Ross shaft construction continues and is scheduled to complete in the first quarter 2020.
- Other reliability projects underway include replacement of the Oro Hondo fan VFD, rehab of the hoist motor, replacement of the hoist brakes and clutches, and an update to the refuge chamber.
- All 31 work packages for pre-excavation are awarded to KAJV. The contractor has 80 people on site and completion is expected in NOV2020.
- KAJV – excellent safety record to date – slow start in several areas - headframe 6 weeks behind.
- City of Lead, SD, has jurisdiction for (at least some) mining infrastructure and inspections.
- Excavation and Building and Site Infrastructure tasks are underway with 100% final design is now complete. Scheduling adds 14 months to schedule and 68M\$ to baseline cost.
- In previous LBNC cavern turn-over phases were delayed to OCT2022 and JUL2023 for the North and South caverns respectively. But this delayed date is now further delayed after deeper analysis. Attempts are being made to compress the schedule (eg. with parallel activities). Oct 2022 is being kept as the working date until CD-2 baselining.
- Due to their high quoted cost (more than 10% above the ICE), KAJV will NOT be the excavation contractor but will sub-contract the work – KAJV is preparing the RFP documents. The project views the higher estimate as being “just very conservative”. KAJV agrees with the project that excavation may be subcontracted for a lower cost, while continuing to be the contract manager following an already established process.
- Far site ES&H coordinator(s) are being added to the organization.

LBNF Status General

Findings (cont'd):

- Cryogenics – Detector #1 interface control documents and engineering design specifications near completion – nitrogen system procurement on hold – GTT membrane cryostat design complete
- Near site: procurement of A/E design services awaiting DOE approval - Site preparation construction contract out for bids – requirements document for excavation not yet complete – NS CD-2 Oct 2020. – DOE is looking for costing of whole project for IPR
- Goal is to have work under contract with the CM/GC in August 2020 (a 8 month slip relative to the original DEC2019 date.)
- Baselineing far site is anticipated to be pushed out by 3 months from Dec 2019
- Far site CF under configuration control. Completed all high-level interface requirements and specifications between beamline and NSCF.
- The goal is to complete >90% interfaces by 2019 calendar year end.
- Beamline Project Highlights
 - Advanced the Horn A and target design with RAL
 - Revised morgue design
- Partners engaged - BARC (dipole and quad magnets), KEK (Prototype fabrication and testing for horn stripline feedthrough), RAL (provides prototype and production target plus associated systems), IHEP (corrector magnets – 4 delivered) – there still is missing scope
- Filled open positions for beamline manager and L3 manager – adding more ME resources

LBNF Status General

Comments:

- The project has shown good progress in the area of systems engineering. The Far Site integrated model has matured (v4 now released and under configuration control) and will be a useful tool for coordinating and communicating interfaces and potential interferences
- The presented efforts to understand the detailed logistics regarding delivery of equipment and people to north cavity cryostat and assembly and installation are credible and strongly encouraged. Such planning will give confidence that the infrastructure is sufficient to avoid possible bottlenecks during the site preparation and installation phase of the project.
- The excellent safety record reported for the site work is also encouraging.
- The transitioning of EFIG to a high level steering group is a positive step as the project moves towards the construction phase.
- The delay in the implementation of the Far Site work is concerning. The critical path for the far site runs through getting excavation work under contract and moving forward in a timely way. North cave completion reported delayed to Oct 2022 at the last meeting are now reporting further delays. Understanding the sources of delays and risk of further delay is important and the reported effort to include value engineering to gain back time is an excellent initiative.
- It is encouraging to see that LBNF labor hour actuals are reasonably close to project need for June – a backward looking plot of resource actuals vs project need and forward looking for project need (+-6 months) would be more informative.

LBNF Status General

Comments (cont'd):

- The beamlines continues to make good progress with design advancements and risks retired in a number of key areas . The new hires into lead positions is encouraging to maintain progress.
- External partners are engaged in supporting the LBNF beamline engineering and production. We note that there is still un-allocated scope.
- There was little information presented on remote handling. RH technology is an aspect of the program that can drive cost, complexity and schedule. It would be good to hear more about this at the next meeting.

Recommendations:

- For the next LBNC meeting report resource actuals against the resource loaded schedule over previous 6 months and project resource needs over next 6 months

DUNE Overall Status: From Exec Summary TDR Review Team (Dave Charlton, Amber Boehnlein, Bob Laxdal(rem))

The LBNC:

- Congratulates the DUNE teams for the excellent progress in production of the TDR volumes, noting that the Physics, Single Phase Far Detector, Near Detector and Computing parts are in good shape and converging
- Notes the continuing gradual growth of the collaboration, and believes that this should be reflected in increased resource availability
 - We request that future institutional membership changes are presented explicitly, rather than in aggregate numerical form
- Welcomes the progress in funding applications/approvals with some agencies, including US/NSF and Italy/INFN
- Notes the progress in closing and filling the ProtoDUNE Dual Phase cryostat, and looks forward to seeing its operation and performance
- Notes the substantial progress on the Near Detector design, including LAr detector, MPD (GAR-TPC), and Beam Monitor with the ability to move the first two off-axis
- Welcomes the CERN SPSC's support for running of ProtoDUNE-II, but also notes that APA production must start before that is completed
- Commends the institution of a Code of Conduct Committee

DUNE TDR Executive Summary Volume: From Exec Summary TDR Review Team (Dave Charlton, Amber Boehnlein, Bob Laxdal(rem))

Introduction to DUNE volume of TDR

- High-level summaries – readership expected to be non-specialist (e.g. RRB, FAs)
- Seven chapters, first full view of volume only came last weekend
- Three unique chapters – Executive Summary, Near Detector and Computing
 - Executive Summary came at the weekend, looks reasonable structurally – **we will send detailed feedback in next weeks**
 - Near detector covered in another part of these slides
 - Computing has been iterated and is in good shape now, covered in another slide
- Four chapters are taken from later volumes (Physics, SP, DP, TCN)
 - Physics needs work to adapt content to expected audience, showcase DUNE physics capabilities – **we await new version**
 - TCN is not yet brought in line with current TCN volume – **we await new version**
 - SP in good shape
 - DP chapter review starting, **we'll send feedback in next weeks**

DUNE Project Schedule: From Tech Coord TDR Review Team (Austin Ball, Dave Charlton, Tom Peterson, Jeff Spalding)

The LBNC:

- Endorses the pragmatism of the planning process:
 - incorporating component (= consortia) planning into eventual P6 master schedule through detailed shipping and delivery milestones
 - not baselining until studies are complete of mitigation measures to reduce T0 (= transfer control of an underground area to FNAL)
- Notes that this keeps pressure on component delivery to some extent. DUNE needs to ensure that this does not increase risks in component projects (eg if more time needed for electronics submissions)
- Notes that a detailed installation plan developed with an unspecified T0 carries risks, if the T0 delay is mitigated by accepting major services installation post-T0: eg co-activity with detector installation or double-use of SDSD resources
- Expects to receive updated milestones following LBNF/DUNE project baseline

Recommendations:

- None

Technical Coordination TDR: From Tech Coord TDR Review Team (Austin Ball, Dave Charlton, Tom Peterson, Jeff Spalding)

- The LBNC commends DUNE on the latest draft & (excellent) response to comments on previous draft received in the last few days
 - the committee expects to send feedback in the next few weeks
 - productive discussions on Tuesday of some of us with spokespersons and TC team
- The latest version addresses many recommendations of the TC TDR review team on v3
- Some recommendations require more work & could not be done in time for current version (eg expanded Exec summary, Role & Responsibility definitions, SDS role, risk table clarification)
- Topics that would benefit from further clarification include:
 - Internal structures of (existing and functional) Technical Coordination within DUNE.
 - Resources for TC, PI-DIR and JPO, their management and reporting on their use, given that I&I is a major activity spanning LBNF and DUNE.
 - Consistency of figures, org. charts etc within TDR and between TC-TDR and intro-TDR

Technical Coordination TDR

- Topics that would benefit from further clarification include (cont'd):
 - The JPO's role in supporting EFIG to ensure experiment-facility coherence is already functioning (eg Reviews team organizing a review for LBNF; integrated installation schedule).
 - The division of responsibility and continuity of purpose and expertise between Construction (TC), I & I (PID), and the transition into commissioning and operation.
 - The safety organization from the highest level of oversight down to safety patrols in the field.
 - Be explicit about how changes in the consortia deliverables that could affect integration at SURF are propagated through DUNE to EFIG.
 - Expand Risk discussion to include I & I risks --- eg availability of 144 people underground, facility equipment failure.
 - List external organizations (e.g. city of Lead) involved in oversight of installation activity, and their roles, to avoid schedule impact from unanticipated requirements. We recognize that far site ES&H coordinators will help address and manage the issues arising from multiple authorities at DUNE.

Resource Management (Matrix and Status): From Tech Coord TDR Review Team ([Dave Charlton](#), Tom Peterson, Jeff Spalding)

- The LBNC thanks the collaboration for the enlightening presentation on the process to establish the resource/responsibility matrix for two Single Phase Far Detectors, and its current status.
- The process is well-organized, rigorous and effective.
- The current SP FD responsibility matrix is in a reasonably good shape, with clearly identified opportunities for new money and new collaborators where resources are not yet identified/secured.
- Completing the responsibility matrix looks credible, if not assured.
- The LBNC notes that this process is in a less advanced state for the DP FD, and not yet started for the Near Detector – this will come, as the process is now well-established.

Computing Status Documentation: From Exec Summary TDR Review Team (Dave Charlton, Amber Boehnlein, Beate Heinemann)

The LBNC notes

- The establishment of the Computing Consortium (CSC) and the appointment of the two experienced technical leads to work with the Consortium lead has had a positive impact over the past 9 months.
- That this structure gives the ability to establish cross-consortium working groups and workshops, such as the Event Data Model Workshop.
- That the CSC is drawing essential distinctions between the computing and software needs of different parts of the DUNE physics program.
- Consideration should be given to relationship between computing and software tasks in DUNE, and possibly expanding the consortium to be responsible for some software tasks.
- SDSD is working with FNAL CD on a plan to address the WAN from SURF to FNAL.
- With the establishment of an organization, broad contributions from DUNE collaborators, relationships to other consortia (DAQ, calibration and near detector) and workshops planned, the DUNE CSC should give some consideration to what work needs to be undertaken in order to draft the Computing CDR.

The LBNC Commends the DUNE Computing Consortium

- On delivering the Vol.1 penultimate computing draft which included coordination with the DAQ group on physics motivated data volume estimates.
- For establishing a baseline of responsibilities for DUNE specific computing using LHC-B as a model
- For continuing to establish the ways in which DUNE can collaborate on 'community' computing projects
- For establishing a resource board to track international resource commitments and utilization
- For completing a data challenge for ProtoDune-DP
- For the accomplishment on using NERSC resources to expeditiously improve the DUNE sensitivity curves

Recommendations:

- None

ProtoDUNE DP Progress: From FD-DP Review Team (Jeff Spalding, Cristiano Galbiati (rem), Jim Proudfoot) + Angela Fava

Findings:

- LBNC congratulates DUNE on very significant progress on ProtoDUNE-DP since the last LBNC meeting in April
 - 2 of 4 ProtoDUNE-DP CRPs include fully active LEMs (72 LEMs total)
 - 36 PMTs : 6 with TMP WLS coating and 30 with a PEN WLS sheet
 - Filling is expected to be complete by the end of next week (only a little behind the plan at the April meeting - due to present pause to regenerate filters)
 - DUNE showed significant progress in installing/testing and starting to commission CISC monitoring, HV, photon detection and LEMs
 - The DAQ is being commissioned in parallel with filling and reconstruction will capitalize on the work for SP.
- The committee looks forward to first results from ProtoDUNE in the next 2-3 months and considers it the highest priority for DP to demonstrate stable ProtoDUNE operation and to start to map out the performance parameter space (purity, E-field, LEM gain, S/N)

Recommendations:

- DUNE should maximize the benefit of ProtoDUNE-SP experience in DP operation and analysis to enable rapid results

DUNE FD DP TDR Progress: From FD-DP Review Team (Jeff Spalding, Cristiano Galbiati (rem), Jim Proudfoot) + Angela Fava

- LBNC has received drafts for 6 chapters of the DP volume (2 of the 6 only recently) and provided comments/questions on 4 chapters. The committee would appreciate direct feedback on these comments/questions.
- As discussed at the last LBNC meeting, several of the parameters specified are interrelated; each spec is challenging and the minimum requirements given for each collectively would significantly reduce overall performance from the target goal.
 - ProtoDUNE will provide an opportunity to map out performance with respect to these parameters.
 - The TDR should include results on electronics noise performance and the uniformity achieved in ProtoDUNE-DP (S/N as a function of E-field, LEM Voltage/Gain, LAr purity) to support the DP physics performance.

DUNE FD DP TDR Progress

- Several changes to the design beyond ProtoDUNE are alluded to in the present text. Plans for development and validation for these changes should be described in the TDR, including the role of ProtoDUNE-II.
 - For example a plan is in place to improve the LEM /CRP design to reduce discharging and ensure robust operation, including micro-etching to improve rim quality of the amplification holes. This plan should be described, with intermediate steps and leading to implementation in ProtoDUNE-II.
 - The HV design for operating at 600 kV for the full 12m drift space has many challenges (including the power supply itself, feed-throughs and field cage). The timeline for this development is likely to be a driving consideration for the project.
 - Options for the WLS coating for the PMTs and reflective panels are under study. Again, a development plan is needed with decision points.
- Given limited resources, the rapid progress of the Proto-DUNE program should take precedence in the near term. This may impact the timeline to complete the TDR.

Recommendations:

- None

ProtoDUNE SP Progress: From FD-SP TDR Review Team (Kevin Pitts, Jocelyn Monroe, John Parsons, Jim Proudfoot, Ted Liu)

The LBNC received an update on ProtoDUNE-SP analysis. (1/2)

Findings

- recent analysis progress was presented on cosmic ray muon tagger reconstruction, and first application of MicroBooNE particle ID algorithms.
- Particle ID studies are in progress and promise good performance
- The LBNC was informed of a recent issue in cryogenic operations of ProtoDUNE-SP resulting in a loss of argon purity.

Comments

- It is important that lessons learned from seal failure inform monitoring, instrumentation and inhibit system for DUNE-SP. The LBNC encourages the collaboration to continue developing a full fault analysis to estimate situations such as the pump membrane failure rate in the FD-SP system based on the observations in ProtoDUNE-SP.
- The committee encourages the Collaboration to continue to update the ProtoDUNE-SP lessons learned document.
- At the next meeting the LBNC would like to hear an update on what has been learned from the ProtoDUNE-SP running thus far in 2019, with emphasis on studies to establish the operational safety margin and long-term stability of the system.
- The LBNC would like to see the comparison in the measured number of photons/MeV from the ARAPUCA photo-sensor system vs. the other two designs in the array of deployed PDS units in ProtoDUNE-SP

ProtoDUNE SP Progress

The LBNC received an update on ProtoDUNE-SP analysis. (2/2)

Comments (continued)

- At the April 2019 meeting, the LBNC encouraged the collaboration to pursue these studies:
 - *Noise mitigation, S/N, ADC calibration etc*
 - *Suggest to study the impact by masking off few ADC bits*
 - *dE/dx of beam protons and electrons data vs. MC (after all corrections)*
 - *Would be more useful to see lower level data/MC comparison before the corrections*
 - *Fine tune and explore current technological limits, with three main objectives:*
 - *Investigate limiting factors toward higher LAr purity level*
 - *Collect data to study fluid and space charge dynamics*
 - *LAr Purity + Cryogenics (Fluid Dynamics)*
 - *How different cryogenic conditions affects the electron lifetime*
>> Still not fully understood, more study is needed here to understand how ProtoDUNE-SP results scale to DUNE and quantify the safety margin
- The LBNC reiterates the value of these studies for establishing the technical baseline for the FD-SP TDR, and would like to see these presented in future meetings.

Recommendations

- While recovering from contamination, take cosmic ray data with 3ms electron lifetime to validate existing DUNE specification, explore operational parameter space.

DUNE FD SP Status & TDR: From FD-SP TDR Review Team (Kevin Pitts, Jocelyn Monroe, John Parsons, Jim Proudfoot, Ted Liu)

The LBNC participated in two breakout sessions on SP FD status.

Cold Electronics (1/2)

Findings

- The Collaboration continues to carry 3 potential cold electronics solutions forward.
- Prototype LArASIC, ColdADC and Cryo chips have been received and are under test.
- LArASIC “ledge effect” reproduced in simulation.
- Several issues identified in ColdADC and Cryo, many lessons learned.
- Heat load from the ASICs will be studied in test setup at BNL to test for bubble formation under pressure

DUNE FD SP Status & TDR

The LBNC participated in two breakout sessions on SP FD status.

Cold Electronics (2/2)

Comments

- Considerable progress has been made on the 3 ASIC and SLAC Cryo implementations. Preliminary tests have indicated a number of issues with the current ASIC iterations, but the issues do not prevent a number of important measurements from being made.
- Some of the design issues have been understood and fixes already determined. Others still require further study and testing
- ASIC Power density specification should be developed, from the heat load study
- Plans exist for continued testing and further review prior to the next submission. The lessons learned, including the need for stringent internal design reviews, will be important to be implemented in preparation of the next iterations.
- Long term strategy calls for 60 fully populated FEMB on 3 APA in ProtoDUNE-II.
- ProtoDUNE-II planning should give careful consideration to the cold electronics schedule.
- It is appropriate to integrate the third submission cycle into current schedule as a high risk.
- Demonstration of long term system level reliability is important
- Collaboration should ensure that the cold electronics timeline is consistent with LBNF/DUNE.

Recommendations

- None

DUNE FD SP Status & TDR

The LBNC participated in two breakout sessions on SP FD status.

TPC breakout:

Findings

- The Collaboration has clearly set out the evolution in the design for DUNE with respect to the ProtoDUNE-SP instrumentation.
- APA production in the UK will launch before the ProtoDUNE-II run, resulting in ~10% of the UK APAs being built when ProtoDUNE-II turns on.
- The field cage re-design to address the likely streamer source is in an advanced state.
- Two SiPM species will be carried forward in the PDS to ProtoDUNE-II.
- The collaboration plans to validate changes in the instrumentation relative to ProtoDUNE-SP in ProtoDUNE-II running.

Comments

- The plan for the testing of design evolution post-ProtoDUNE-I is credible and builds confidence that the DUNE FD-SP APAs will be fully validated through the 'Module-0' prototypes in ProtoDUNE-II
- The LBNC fully endorses the plan discussed to initiate the ProtoDUNE-II run when the 'Module-0' prototype electronics are available.
- Given the planned ex-situ testing, the risk of launching APA production in the UK prior to ProtoDUNE-II running seems acceptable.

Recommendations

- None

DUNE FD SP Status & TDR

Findings

- Initial chapters were delivered early in calendar year 2019.
- LBNC+ provided multiple rounds of feedback.
- All “v3” chapters were delivered earlier this summer. Feedback has been provided on those chapters.
- The latest draft was delivered on July 26.

Comments

- We appreciate the considerable effort the Collaboration has put into the TDR, as well as the coordination efforts of the editors and collaboration leadership.
- The majority of chapters were in good shape prior to the July 26 version. We anticipate that further improvements in the most recent submission should finalize the overall FD SP volume.
- Although ProtoDUNE-SP results are included in each of the detector chapters, the collaboration might consider a segment dedicated to summarize ProtoDUNE construction, operation and results. This would provide outsiders a clear understanding of the strong proof of concept that ProtoDUNE-SP has served.

Recommendations

- None

Near Detector Design: From Near Detector Review Team (Scott Oser, Patrick Huber, Naba Mondal, Beate Heinemann)

- The LBNC strongly endorses the need for a ND containing a movable liquid argon TPC and magnetic spectrometer, and a fixed on-axis beam monitor. These are the minimum elements required for DUNE to achieve its physics goals, and are needed from the start of data-taking.
- A high-pressure gaseous argon TPC with a low-mass magnet is the preferred choice for the movable magnetic spectrometer. It may be possible to optimize its surrounding ECAL to balance cost vs. physics performance.
- The proposed on-axis beam monitor using the KLOE magnet can satisfy DUNE's requirements, although it is possible that a simpler array of rate monitors might suffice.
- The proposed ND concept seems capable of achieving DUNE's goals.
- We are looking forward to a ND CDR by the end of CY2019 supported by optimization studies of options for the on-axis beam monitor, and for the details of the magnetic spectrometer.

Recommendations

- Develop more complete physics simulation studies for the ND using more realistic event reconstruction, and more fully incorporating ND samples into the physics analysis.

Physics Status (including ND impact) & TDR: From Physics Review Team (Beate Heinemann, Sampa Bhadra, Patrick Huber, Naba Mondal, Scott Oser)

- The LBNC congratulates the DUNE collaboration for delivering a high quality physics TDR based in large parts on full simulation and realistic reconstruction performance.
- In general, the committee considers both the document and the analyses it is based on to be in very good shape but will still need to review the most recent (pen-ultimate) draft and the responses to the comments made
- For the oscillation analysis, very important work has been done to justify the need of a powerful near detector to constrain in particular the neutrino flux and neutrino interaction model as function of the neutrino energy.
- The CP sensitivity is similar to that presented in the CDR but now based on full simulation and reconstruction.
- The Exec. Summary is not yet quite at the level required to summarize the physics case concisely for non-experts who want to get an overall view.

Recommendations

- None

DUNE Executive Summary: **Montgomery**

- The overall LBNF/DUNE project is proceeding towards a CD2 DOE Baseline approval in 2020. With that baseline established, DUNE should resubmit the proposed TDR milestones against which the LBNC will monitor progress.
- The resource/responsibility matrix development is coming together well for the Far Detector Single Phase modules, and also for FD-Dual Phase a start has been made.
- ProtoDUNE Dual Phase is making enormous progress and will be operational within weeks. Consideration of the Far Detector Dual Phase Volume is delayed partially due to an appropriate emphasis on the technical work with ProtoDUNE-DP.
- The LBNC is convinced that the Near Detector as described and discussed within the Executive Summary Volume, would enable the DUNE goals for the CP Violation measurements. It looks forward to receipt of the Conceptual Design Report.
- The DUNE planning and description of the work of the Computing Consortium laid out in the Executive Summary volume represents an enterprise which has made great progress during its first year. In due time, the LBNC will expect to see a Conceptual Design report as a precursor to a Technical Design Report.

DUNE Executive Summary: **Montgomery**

- The LBNF/DUNE project may be the largest within the US DOE Office of Science. It enjoys all the associated challenges and the added complication of underground construction. The LBNC looks forward to the baselining of this enabling project.
- Based on the reading of the several preliminary drafts and the drafts submitted on July 26, supplemented by presentations including those made during this LBNC meeting:
 - The LBNC anticipates recommending for approval the Executive Summary TDR Volume, The Physics Volume, the Far Detector Single Phase Volume and the Technical Coordination Volume.
 - The LBNC Review teams will make one further round of comments before September 15, 2019, and will expect subsequent responses by the Dune Collaboration teams.
 - This would lead to recommendations by the review teams to the Full LBNC which would hold a teleconference before submitting its recommendation to the Fermilab Director.