

# **Long Baseline Neutrino Committee Report**

***Fermilab PAC  
January, 2020  
Fermilab***

**Montgomery  
January 15, 2020**

# Outline

- LBNC Scope and Process
  - Membership update
  
- DUNE TDR Status
  
  
  
  
  
  
  
  
  
  
- LBNC December 2019 Meeting
  - Agenda
  - Executive Summary
  
- Summary

# Scope of LBNC

- LBNC is used by the Director for oversight of the international experiment DUNE.
- Oversight of LBNF is limited to those aspects of DUNE which feed directly into DUNE activities. (Below was discussed between LBNC and LBNF leadership and agreed by Fermilab Director.)
  - Cryostat and Cryogenic Systems
  - Beamline Implementation for DUNE and Facility for Near Detector
  - Management of LBNF-DUNE Interfaces
  - Monitoring of Risks to Milestones
  - Regular Plenary Status Report, (subgroup as needed.)

# Membership & Consultants

## • **New Members added at end of 2019.**

- Chair, Hugh Montgomery, Jefferson Lab
- Ties Behnke, DESY
- **Simone Campana, CERN**
- David Charlton, Univ. of Birmingham
- **Phillipe Farthouat CERN**
- Joel Fuerst, SLAC
- Cristiano Galbiati, Princeton Univ.
- **Heather Gray, UC Berkeley/LBNL**
- **Eric Kajfasz, CPPM, France**
- **Joachim Kopp, CERN**
- Robert Laxdal, TRIUMF
- Tiehui Liu, Fermilab
- Naba Mondal, Saha INP
- Scott Oser, U. British Columbia
- Marco Pallavicini, DIFI Genova
- John Parsons, Columbia U.
- Thomas Peterson, SLAC
- Kevin Pitts, Univ. of Illinois-UC
- **Nikki Saoulidou, U. Athens**
- Jeffrey Spalding, FNAL-Ret
- Angela Fava, Fermilab  
(Scientific Secretary)

## **Consultants**

- Austin Ball, CERN
- Patrick Huber, Virginia Tech
- Dean Karlen, U. Victoria
- Hugh Lipincott, FNAL
- Adam Para, FNAL
- Anna Pla-Dalmau, FNAL
- Vadim Rusu, FNAL
- Darien Wood, Northeastern U.

# Process

- LBNC three face-to-face meetings per year:
  - July 2019 at Fermilab: “Final Review of TDRs”
  - November 2019 Teleconf “Recommend approval of 4 TDR Vols”
  - December 2019 at CERN
  - March 2020
  - July 2020
  - December 2020
- Report to Director
- Report to DUNE RRB
- Report to FNAL PAC
- Report to DOE Independent Project Review (Jan 2019)

# Intended Outcomes for RRB

- **Provide credible validation of TDR and monitoring of project for RRB and sponsoring agencies.**
  - Gateway for international agencies to move forward with their funding decisions with confidence that the whole project has a valid and credible plan
  - Neutrino Cost Group (NCG) is separate panel working in parallel but coordinated with the LBNC on cost/risk/schedule.
  - NCG Chair is Steve Nahn

# TDR Review Status

- **Final Reviews of 4 TDR Volumes – November 2019**
  - Executive Summary
  - Physics
  - Far Detector – Single Phase
  - Technical Coordination
  
  - November 2019 LBNC Meeting Report
  - Letter to FNAL Director
  
- **Interim Review**
  - Far Detector – Dual Phase
  
  - December 2020 LBNC Meeting Report

# TDR: November 2019 LBNC Meeting Report

## High Level Recommendations

The recommendations for action in this section of the report are to be taken as mandatory.

### **Volume I: Introduction to DUNE**

The DP Chapter should be edited to reduce the level of detail to the same level and structure as currently used for the SP Chapter.

The Executive Summary chapter is not considered to be of a quality and level appropriate for the education of congressional staffers or similarly educated persons.

**The Introduction volume of the TDR is recommended for approval.**

### **Volume II: DUNE Physics**

**The Physics volume of the TDR is recommended for approval.**

### **Volume III: DUNE Far Detector Single-phase Technology**

**The Far Detector Single Phase volume is recommended for approval.**

### **Volume V: DUNE Far Detector Technical Coordination**

The treatment of Risk in Chapter 11, the compendium of risks from all other chapters, should also include the risks associated with installation. These may be in three parts those associated with the Single Phase detector, those associated with the Dual Phase, and the more general risks associated with the situation and special conditions underground.

**The Technical Coordination volume of the TDR is recommended for approval.**



# TDR Review Recommendations



Hugh E. Montgomery  
Director Emeritus

November 27, 2019  
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Dr Nigel Lockyer, Director  
Fermi National Accelerator Laboratory,  
Wilson and Kirk,  
Batavia, Illinois 60510

Dear Nigel,

The Long Baseline Neutrino Committee, held a meeting, by teleconference, of its members and consultants on November 18, 2019. As a result, I am pleased to recommend to you the approval of four Deep Underground Neutrino Experiment Technical Design Report volumes concerning: the Introduction to DUNE, which gives an overview of the different aspects of the physics and the detector and includes a preview of the Near Detector and Computing design reports; the DUNE Physics; the DUNE Far Detector Single-phase Technology; and the DUNE Far Detector Technical Coordination.

Accompanying this letter you will find a relatively long report, in two parts, compiled following our meeting, which documents a very small number of actions which the committee considers mandatory and then numerous comments on content, grammar and punctuation, to which we expect DUNE to respond as they have on previous versions. Given those expectations we do not need to examine the product before publication.

In making these recommendations we would like to express our appreciation of the way that DUNE has responded to our, sometimes demanding, commentaries to their various drafts over the course of the past year. We believe the resulting documents justify the efforts of both the collaboration and the LBNC team. The Technical Design Report is a prerequisite for approval for an experiment to move to construction. It is usually seen as a major milestone for an experiment. We congratulate DUNE on reaching that milestone.

On behalf of the Long Baseline Neutrino Committee.

A handwritten signature in black ink, appearing to read 'Hugh E. Montgomery'.

Hugh E. Montgomery

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# Far Detector – Dual Phase TDR

The LBNC DP-subcommittee appreciates the detailed response to our comments and questions that you provided in DUNE-doc-16892 (<https://docs.dunescience.org/cgi-bin/private/ShowDocument?docid=16892>).

The committee has reviewed the responses and finds them thorough and informative, and we believe that the new version of the document DUNE-FD-TDR-vol4-DP-8nov2019.pdf provides a solid basis for going forward.

Our understanding is that the next release will follow completion of the work on protoDUNE, and the development of plans for the R&D and design changes to address issues found, including system tests to validate the changes.

In addition, we believe there should be further development of the following areas in the TDR:

- The CRP improvement plan, including spark mitigation, planarity at LAr temperature, and design margin for liquid surface instabilities
- Development plan for the 600kV power supply and delivery systems and demonstration of the 12m drift
- R&D program for the WLS (both for the PMTs and the reflector panels), including final selection of the WLS material and application method (for each) and demonstration of long term stability
- Plans to validate the final designs for all aspects of the Dual Phase FD

Congratulations on the progress to date.

Jeff Spalding (for the LBNC DP review team: Ties Behnke, Phillippe Farthouat, Cristiano Galbiati, Adam Para, Jimmy Proudfoot, Darien Wood, Jeff Spalding)

# LBNC Meeting Agenda: December 5-7, 2019

- LBNF Status
- DUNE Status
  
- ProtoDUNE SP Status Operations and Analysis
  
- ProtoDUNE DP Computing
- ProtoDUNE DP Detailed Progress
  - Operations & System Stability, High Voltage, Purity,
  - Charge Readout Planes, Electronics & DAQ, Photon System
- Dual Phase Technology R&D
  - Large Electron Multiplier and Component R&D
- Future DP for ProtoDUNE DP
  - System R&D Plans: ProtoDUNE - II

# LBNC Meeting Agenda: December 5-7, 2019

- Near Detector Conceptual Design
  - Strategy, ArgonCUBE, MPD, SAND, Conceptual Design Report
- DUNE Computing
  - Software & Computing: Consortium Progress
  - International Contributions to Computing
- Technical Breakouts
  - Beamline Progress
  - Single Phase Issues (APA, Electronics)
  - Dual Phase Further Detailed discussion
- Spokesperson's Session with Committee
- Closeout

# DUNE Executive Summary I

The committee congratulates DUNE and LBNF on its achievements over the past 5 months, since the summer meeting of this committee

The progress with LBNF is very visible at SURF and is exciting. Additionally, the committee recognizes the challenges involved in maintaining the momentum in excavation in the context of a changing DOE view of CD approval strategy.

Overall, DUNE as a collaboration continues to grow adding countries, institutions, and individuals between each of our meetings. As the scope of the work of the collaboration is better understood, DUNE gains experience with the Consortium based structure and adjusts its organization. In the next several months it is intended to create new consortia to cover the Near Detector scope. This change should be done carefully to ensure that fragmentation does not lead to a lack of coherence.

Given the perceptions of good progress with the Proto-DUNE single phase analysis, the topic was given relatively limited Plenary Session time. In general, the progress overall continues to be impressive. There is some concern that the photon detection system appears to enjoy little margin. In a breakout session, particular attention was paid to the fine tuning of the design, and installation trials of the Anode Plane Assemblies. Also in the breakout, discussions were held with the electronics development group, which continues to work multiple options for the readout solution. In both cases, the LBNC team felt that good progress is being made.

# DUNE Executive Summary II

An important part of the charge to this meeting concerned the progress with ProtoDUNE Dual Phase, and the derivative research and development plans and strategy going forward. In fact ProtoDUNE DP is operational and DUNE is congratulated for achieving this status. Although significant progress has been made, several issues have appeared during these initial months of operation. These include limitations in the HV distribution and drift field, reduced LAr purity, and LAr surface instabilities that impact CRP operation. At a breakout devoted to the Dual Phase technology, we heard that, despite these constraints on stable operations, a CRP gain slightly in excess of the minimum requirement has been achieved, and improvements in the noise performance indicate that the noise specification can likely be met.

DUNE is encouraged to put in place a plan to systematically address these issues during the anticipated months of operation during 2020. To maximize the productivity, they are encouraged to strengthen the technical and run coordination. An increase in overall participation would also be desirable.

A plan should also be developed, with realistic schedule for the needed R&D and changes to incorporate in a future ProtoDUNE DP operation.

It may take some time, however, the LBNC committee would like to see the development and articulation of an overall plan for the anticipated four Far Detector modules.

# DUNE Executive Summary III

The progress with the Near Detector towards a Conceptual Design Report was presented with specific implementations of the three primary components. This approach is consistent with the recommendations of the positive LBNC review of the Near Detector, which was conducted in mid- 2019. The LBNC looks forward to the opportunity to review this report.

The progress of the Computing Consortium is very positive. A report was heard from the ProtoDUNE DP analysis team, which is well integrated into the broader organization. In looking at the scope of the plans, the LBNC sees opportunities for enhanced interaction and participation by the algorithm and analysis efforts in the provision of core software frameworks.

# DUNE Executive Summary IV

In summary, the LBNC sees DUNE making considerable progress. In the past year DUNE:

Has completed four technical design reports which cover an important baseline technology, planned to be used for two of the installed modules.

Has made great progress on exploring the dual phase technology in ProtoDUNE DP, the primary candidate for another of the planned modules.

Has made strides toward the completion of the Near Detector Conceptual Design.

Has established the DUNE Computing Consortium as a significant player in the world of HEP computing while provisioning the extant ProtoDUNE (both SP and DP) data handing and analysis program.

Is exploring options for a fourth module, perhaps with a new technology, as well as for innovative enhancements to baseline detector configurations. The consideration of such demands a certain level of prudence.



# Summary

- LBNC recommended for approval four DUNE Technical Design Report volumes: The Introductory, Physics, Far Detector Single Phase Technology, and Technical Design volumes
- LBNC Reviewed DUNE progress on a number of issues in its December 2019 meeting
- Over the next several months the LBNC:
  - Will continue to monitor progress with the Far Detector Technologies.
    - Regular teleconferences planned with DP team
  - Once the LBNF/DUNE DOE process has established a CD2 Baseline, expects to receive for consideration, detailed schedule milestones as a basis for future LBNC reviews of DUNE progress.
  - Expects to provide a dedicated review of the Near Detector Conceptual Design Report
  - Expects to receive a comprehensive plan for progression towards a “4-Module Far Detector Plan”

- **Backups Follow**

# DUNE Science Program

## Neutrino Oscillation Physics

### Search for leptonic (neutrino) CP Violation

Resolve the mass hierarchy ( $m_3 > m_{1,2}$  or  $m_{1,2} > m_3$ )

Precision oscillation physics

Parameter measurements,  $\theta_{23}$  octant

Testing the current three-neutrino model, non-standard interactions, ...

## Nucleon Decay

Particularly sensitive to channels with kaons

## Supernova burst physics and astrophysics

3000  $\nu_e$  events in 10 sec from SN at 10 kpc

+ many other topics ( $\nu$  interaction physics with near detector, atmospheric neutrinos, sterile neutrinos, WIMP searches, Lorentz invariance tests, etc.)