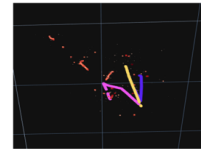
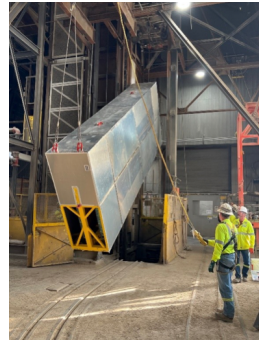
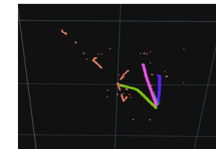


LBNC Report to the PAC



Voxelized edep-sim + reco



larnd-sim + reco



Niki Saoulidou, for the LBNC

January 8th, 2024



Outline

- LBNC Charge and Membership
- LBNC mode of operation and actions
- Recent LBNC TDR reviews
- Last LBNC meeting executive summary
- Outlook

LBNC Charge

- The LBNC is charged by the Fermilab Director to provide external scientific peer review and to monitor the technical progress of the International DUNE collaboration, and those aspects of the facility construction that have direct impact on the DUNE experiment, by:

- Evaluating the **scope** of the **DUNE experiment** relating to **scientific objectives** and the **technical capabilities** including scientific computing to meet them. In particular, evaluating and providing assessments regarding the final technical configuration of the Near Detector, including its phased implementation and upgrade options.
- Evaluating the **technical development** and **overall progress** of the entire **international DUNE endeavor** towards the technical design provided in the **approved Technical Design Reports**. Specifically, reviewing the execution and management of the construction plan, including scope, schedule, interfaces with LBNF, and key technical risks and effectiveness of plans to mitigate these risks.
- Providing **review** and **recommendations** on **interface** and **performance issues** with **LBNF**, which could **impact DUNE**. The LBNC scope **does not include** review of **LBNF** or **PIP-II** beyond these relevant interfaces impacting DUNE, as these projects are reviewed through the U.S. project management process.

LBNC Charge cont'd

- **Assessing the validity and appropriateness of the proposed technical design and construction readiness** of the DUNE experiment, through review of the **remaining Technical Design Reports (TDRs)**.
- **Coordinating with and receiving input from the Neutrino Scope Group (NSG)** to be aware of the **overall resource constraints**.
- **Evaluating scope** or other changes to DUNE (e.g. descoping decisions) and proposed solutions by the DUNE collaboration management, within the input and **resource constraints determined** by the **NSG**, and providing **recommendations** from **scientific and technical perspectives**, in order to reach an overall **optimal solution**. These recommendations **shall be presented** to the **RRB** for **discussion** and **approval** by the **funding agencies**.
- **Evaluating** possible **upgrades** to DUNE, their scientific motivation and merit and technical feasibility.
- In executing the above, **LBNC recognizes and acknowledges DOE's special role** with respect to DUNE, compared with the rest of the funding agencies, as **the sole funding agency** of **Fermilab**, the **DUNE host laboratory**. At the same time, **recognizing and acknowledging** the **essential contributions** from all **international partners** and keeping them **engaged** in all **major discussions** and **decisions** made.

Current Membership

- Chair, Niki Saoulidou (Univ. of Athens)
- Martin Aleksa (CERN)
- Austin Ball (CERN/UKRI)
- Daniela Bortoletto (Oxford)
- Simone Campana (CERN)
- Mark Champion (ORNL)
- Marco Delmastro (Annecy, IN2P3)
- Francesco Forti (INFN Pisa)
- Andre de Gouvea (Northwestern)
- Alexander Gottberg (U. Victoria/TRIUMF)
- Eric Kajfasz (CPPM)
- Joachim Kopp (CERN)
- Adam Para (FNAL)
- John Parsons (Columbia)
- Marco Rescigno (Roma)
- Paolo Rumerio (Alabama)
- Vadim Rusu (FNAL)
- Brigitte Vachon (McGill University)
- Rainer Wallny (ETH/Cornell)
- Darien Wood (Northeastern U.)
- Joseph Zennamo (FNAL, Sci Sec)

Sub-committees formed **focusing** on the **review** of the **different** **thematics** : *Far detector Vertical Drift, Far Detector Horizontal Drift, Near Detector Complex, Beam, Computing, Simulation and Reconstruction, Physics Reach*

Recent LBNC Meeting and Report

- The **full Meeting Report** from the recent, October 2023, LBNC Meeting is **complete**.
 - **Information related** to the **LBNC activities** can be found at:

<https://lbnc.fnal.gov/>
 - **Last LBNC meeting October 2nd 2023**
- *In the process of updating LBNC membership replacing Colleagues that have served for several years.*

In between LBNC Meetings

- LBNC Chair, CRO, DUNE Spokespersons: discussions and formulation of the charge ~ 3-4 weeks prior to meeting
- **Review of TDRs (*Vertical Drift TDR endorsed in June of 2023, Horizontal Drift TDR endorsed in September 2023*) and CDRs (*DUNE ND, endorsed in March of 2021*) and provide feedback.**
- **Hold special mini-reviews (i.e. ND review) requested by the Fermilab Directorate**

A Typical LBNC Meeting

- **Day 1**
 - **Executive Session**
 - **Plenary Presentations:** Status of LBNF, DUNE, Far Detectors Near Detector, Computing, Reconstruction-simulation and updated of oscillation analyses
 - **Executive Session**
- **Day 2**
 - **Executive Session**
 - **Breakouts (2 hrs)**
 - ✓ Beamline Status and Progress
 - ✓ Vertical Drift Progress
 - ✓ Horizontal Drift Progress
 - ✓ Computing Progress
 - ✓ Near Detector Progress
 - **Meeting LBNC and Spokespersons only (no management)**
 - **Executive Session**
- **Day 3**
 - **Executive Session/Report Preparation/Discussion**
 - **Dry Run of Closeout with Director**
 - **Closeout with LBNF/DUNE, Management, DOE**

LBNC, NSG and RRB

- **LBNC Charge:**
 - *Coordinating with and receiving input from the Neutrino Scope Group (NSG) to be aware of the overall resource constraints.*
 - *Evaluating scope or other changes to DUNE (e.g. descoping decisions) and proposed solutions by the DUNE collaboration management, within the input and resource constraints determined by the NSG, and providing recommendations from scientific and technical perspectives, in order to reach an overall optimal solution. These recommendations shall be presented to the RRB for discussion and approval by the funding agencies.*
- **In the past year LBNC presented a summary/reported to the :**
 - **March 30th DUNE Resources Review Board (RRB) Meeting**
 - **May 18th FNAL Neutrino Scope Group (NSG) Meeting**
 - **June 6th FNAL Physics Advisory Committee (PAC) Meeting**
 - **November 17th DUNE Resources Review Board (RRB) Meeting**

Recent (2023) LBNC TDR Reviews

LBNC Far Detector Vertical Drift Reviews (1) :

- **Far Detector Vertical Drift (FD-VD)** is an **evolution** of the initial **DUNE Dual Phase** concept, **preserving** and **capitalizing** on the **successes** of **ProtoDUNE-DP**, while **addressing** the **major challenges** by:
 - **Shortening the drift distance**, and hence significantly reducing the required HV
 - **Replacing gas-gain readout** by the **well established single-phase charge collection**, enabled by the **successful demonstration** of **excellent levels** of **LAr purity** attained in **ProtoDUNE-SP** and **DP**.
- The Vertical Drift was presented at LBNC in **December of 2020** as the **most prominent detector technology** for DUNE's **2nd Far Detector Module**, followed by a **technical proposal** that was reviewed by the **Collaboration** and then handed to **LBNC**.
- Between **March and June 2021** LBNC conducted a series of **FD-VD mini-reviews** focusing on **technical, physics** and **simulations aspects**, that resulted in a **very positive report** about **progress being made**, **plans for R&D** and a **ProtoDUNE-VD in the future** , suggesting to **DUNE** to **proceed towards a CDR**.

LBNC Far Detector Vertical Drift Reviews (2) :

- DUNE handed the **FD-VD CDR** to **LBNC** on **August of 2021**: **LBNC** conducted a **very thorough review**, that resulted in the **FD-VD CDR endorsed** by LBNC on **December of 2021**. The final version of the CDR can be found at:
https://edms.cern.ch/file/2619631/1/Vertical_Single_Phase_FD_Technology_CDR.pdf
- **During 2022 LBNC** was **reviewing** the **status** and **progress** of **FD-VD** in all subsequent LBNC meetings, with individual meetings in between when needed, with a **critical eye**, while **witnessing** the **phenomenal progress** **DUNE** made in addressing the **most prominent technical risks**, **advancing** and **finalizing** the **design**, and **progressing towards a TDR**.
- DUNE handed the **FD-VD TDR** to **LBNC** on **December of 2022** : **LBNC** conducted a **very thorough review**, **that resulted in the FD-VD TDR endorsed** by LBNC on **July 2023**. The final version of the TDR can be found at:
<https://edms.cern.ch/file/2810246/1/DUNE-FD2-TDR-v3-04June2023.pdf>
- A **key aspect** of the **FD-VD TDR** in terms of the **physics performance and capabilities** is that it is **compared** and **benchmarked**, using it as a **reference**, to the **very mature and well established FD-HD one** in terms of **signal efficiency** and **background rejection**, **energy estimation**, and **residual calibration uncertainties**

LBNC Far Detector Horizontal Drift Reviews (1):

- The **Far Detector Horizontal Drift (FD-HD) technology** is a very mature one, building upon many years of experience with LAr detectors (ICARUS, MicroBOONE, ProtoDUNE-SP), albeit not on a 17 kT scale.
- The **DUNE FD-HD CDR** was produced in 2016 : <https://arxiv.org/abs/1601.02984>
- DUNE handed an **Interim Design Report (IDR)** to LBNC on May of 2018. LBNC **thoroughly reviewed and endorsed** it in **August of 2018**: The final version of the IDR can be found at : <https://arxiv.org/abs/1807.10327>
- This was **followed** by a **very successful installation, commissioning, and running of ProtoDUNE-SP**, a 0.78 kT prototype, at the CERN neutrino platform during 2018-2020.
- DUNE handed the **FD-HD TDR** to LBNC on **November of 2019**: LBNC **conducted a very thorough review**, that resulted in the **FD-HD TDR endorsed** by LBNC on **January of 2020**. The final version of the report can be found at: <https://inspirehep.net/literature/1779523>

LBNC Far Detector Horizontal Drift Reviews (2):

- Since 2019, there have been **updates** and **some advances** to the FD-HD design informed by **ProtoDUNE-SP**, hence the need arose to produce an updated TDR.
- DUNE handed an updated **FD-HD TDR** to **LBNC** on **May of 2023**. **LBNC thoroughly reviewed it and endorsed it in September of 2023** : The final version of the TDR can be found at :

<https://edms.cern.ch/file/2938808/1/DUNE-FD1-TDR-Update.pdf>

Executive Summary of the LBNC Oct. 2-4 2023 meeting

Executive Summary (1)

- The committee commends DUNE for the completion of the FD1 and FD2 TDRs and their approval by the Directorate in September of 2023, and for the preparations and completion of the FDC CD2/3 DOE review concluding that the detector TPC and detector readout systems are ready for CD2/3 approval with only minor recommendations.
- LBNC is pleased to see substantial progress from DUNE on several fronts : the re-organization of Software and Computing, work towards completion of the Near and Far Detector prototypes and preparations for data-taking in 2024, ramping-up of the FD production factories, continued advancements on reconstruction, simulation and physics analysis with the Near, Far and Prototype detectors, technical progress on all sub-detectors of the Phase I ND, and growing international efforts on Phase II R&D for both the Near and Far detectors.
- The committee notes significant progress made on Computing on several fronts, and highlights the need for the timely definition and a subsequent validation of the future software framework with a review by a team of experts, along with a clear plan for making the final choice.

Executive Summary (2)

- LBNC commends the collaboration and project on the very substantial efforts and progress made on several fronts in preparation for the FDC CD2/3 DOE review, and urges the collaboration and project to put together a clear strategy, accompanied with a timeline and contingency plans where necessary, with which the remaining CD2/3 recommendations can be satisfied. To that end, LBNC would also like to better understand what the follow up review process will be for the FDC CD2/3 approval.
- The committee welcomes the CD3b approach that DUNE plans to follow in order to mitigate effects related with the delay of FDC CD2/3 approval, but would like to better understand its scope.
- LBNC is concerned with possible ramifications the delay of PIP II might have on the start of DUNE oscillation physics, and urges DUNE to continue to assess the situation.
- LBNC is also concerned on the impact the delay of the NUMI beam delivery will have on the successful completion of the ND two-by-two prototype run and on baselining ND-LAr, and proposes that DUNE work together with the Host Lab in order to develop possible mitigation strategies

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Executive Summary (3)

- LBNC is pleased to see progress made on the several beamline components. The committee notes the need for advanced planning for spares, and the need to identify critical skills and their near and long-term availability.
- The committee is very pleased to see the formation of the FNAL-DUNE Coordination Office with a mission to execute the plan for the FDC construction, and welcomes initial efforts on this front. However, LBNC is concerned with the SURF hiring profile presented, and would like to better understand the staffing profile needed as a function of time, together with a realistic plan and timeline for achieving this, and how that affects the overall schedule. The committee notes that training and safety considerations should factor in this plan.
- LBNC is happy to see repairs taking place at the Yates Shaft, and would like to stress that maintaining this infrastructure is important given the risks its absence might pose to the project execution. Hence, LBNC is looking forward to updates on this front.
- The committee acknowledges significant technical progress made on all sub-detector systems of the DUNE Phase I ND, and given this would like to see a clear plan and timeline for the Phase I ND baselining.

Executive Summary (4)

- LBNC notes the substantial progress made on resolving the APA broken wire issues, and is looking forward to an updated construction plan and schedule. LBNC notes that this must be followed carefully in order to determine the new APA production schedule, and satisfy the FDC CD2/3 DOE review recommendations regarding the optimization of the installation schedule.
- The committee acknowledges the great effort and time DUNE and LBNF/DUNE puts into preparing the necessary material for this review. In order to facilitate the process and preserve continuity, the committee would like to kindly request that all talks are uploaded a week ahead of time, they start with a summary of the status of previous recommendations, and in case, for good reasons, they focus only on a specific issue finish with a high level summary of the status on all remaining areas.

Status - Outlook

- **DUNE** is entering a **different phase** with :
 - ❖ Final production, construction, installation and commissioning of the DUNE Far Detectors.
 - ❖ Finalization of the designs for the ND Detector with a goal to produce an ND TDR within 2024.
 - ❖ Optimization, finalization and validation of the future software framework.
 - ❖ The beamline work progressing well in a funding limited schedule, and with a CD2-3 review planned for the end of 2024.
- LBNC is **prepared to review progress** on the **above areas** receiving **input and feedback also** from the **NSG** and the **RRB**.

Thank you

BACKUP

NSG Charge

- The NSG is a review and advisory committee charged by and reporting to the Fermilab Director as well as to the Resources Review Board (RRB). Along with the Long Baseline Neutrino Committee (LBNC) and RRB, the NSG is part of the Deep Underground Neutrino Experiment (DUNE) oversight governance.
- The overall purpose of the NSG is to review the scope completeness, the availability and sufficiency of resources to complete the scope on schedule, and identify any non-technical risks associated with the DUNE program. The primary responsibilities of the NSG include:
 - Evaluating the completeness of the DUNE scope necessary to deliver the detectors, the complete mapping onto the DUNE partners, and verifying there are no scope gaps.
 - Assessing the credibility of the schedule for DUNE, major milestones, and coordination with the LBNF/DUNE-US project schedule.
 - Assessing the appropriateness of the estimate of available resources, including staffing resources and M&S funding for the DUNE experiment, including computing.
 - Reviewing non-technical risks for DUNE, such as supply-chain issues, including proposed levels of cost realism and schedule contingency to address identified strategies for mitigation of those risks.
 - Monitoring DUNE progress against the scope and schedule associated with the Technical Design Reports.
 - Coordinating and receiving input from the LBNC on the overall scientific and technical status of DUNE program.

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 Scope Group (NSG) is separate panel working in parallel but coordinated with the LBNC on cost/risk/schedule.
 - NSG Chair is Dmitri Denisov