DUNE ND-LAr Institute Board

1. August 2022

Agenda

- Feedback on recent reviews
  and potential impact on consortium choices
  (and membership involvement)
- MoU (this is becoming urgent)
- Needs for Consortium Institution Involvement
- 2x2 Progress
  - Schedule
  - Additions to Leadership Team

DUNE: ND-LAr Preliminary Design Review

Jun 27, 2022, 9:45 AM → Jun 29, 2022, 3:15 PM America/Chicago

https://indico.fnal.gov/event/54919

- Extremely hard work and first-class delivery
- Achieved a very robust documentation of the detector we will build
- Worthwhile scrolling through slides, they can also serve as source for talks
  ⇒ More important is the documentation in EDMS

- **Report is pending**
  - preliminary indications are that the committee sees no major issue
  - We expect comments on the prototyping (what , where), cryogenic
  - PDR/TDR is pending, should converge soon

- **This moves the design readiness from ~40% to >60% for ND-LAr**
  - Few questions on overall concept, the committee was constructively contributed on moving us forward
  - We have a technical baseline

CD1RR

https://web.fnal.gov/project/LBNF/ReviewsAndAssessments/cd1rr-doe-ipr-july2022/SitePages/Home.aspx

- Just two weeks after the PDR
- Close-out briefing slides available (on the page linked above)
- Overall very positive for the ND, there are still struggles with cost cap, threshold scope and physics reach (more on next slides), positive for ND-LAr!

Findings ND-LAr:
"The ND-LAr detector is a 7x5 array of 1x1x3 m3 modular, optically segmented liquid argon TPCs with pixel readout."
"In the current planning the ND-LAr effort is maintained for the next two years to meet international commitments and provide a window to launch an effort to reach the proposed objective scope that requires the full complement of the ND-LAr detector."
"A comprehensive analysis of alternatives has been carried out for the ND-LAr detector. No option has been identified (yet) that obtains the same performance but would provide a significant cost reduction."

CD1RR comments ND

The Near Detector is an essential component of the DUNE experiment. The Near Detector is not a cost driver of the project, but it is the science driver for neutrino oscillation physics. Within the Near Detector project, a highly performant liquid argon detector is essential to deliver neutrino oscillation physics results.

Given the lack of oscillation physics output with the threshold scope, we encourage the subproject to engage with DOE to discuss reallocation of resources to include a liquid argon detector in the threshold scope.

The ND Team presented a path toward a new proposed Objective KPP which requires securing very significant additional non-DOE contributions. The proposed timeline for converging on the needed international agreements is Spring 2023. Only after such agreements are in place, proposed Objective KPPs for the US project can be finalized.

HURRAY!!!

MoU

Process was stalled due to CD1RR -> risk

PDR: defines the technical design, which in turn defines the scope

CD1RR has not defied the ND-LAr, will happen in the process of defining the objective scope for CD2. Some negotiations underway to include parts in threshold scope.

Overall, given the international needs and successful PDR, an MoU should be agreed on in a preliminary way at this time:

An initial version was prepared,
presented today, shared in the next days per email

DUNE MoUs

One MoU for DUNE, “Multi-Institutional”

Annexes for construction consortia, as for the ND-LAr

For the Construction Phase, the DUNE activities for the construction of the DUNE ND and FD are organized into Consortia, each of which plan to deliver a defined set of deliverables. These deliverables are expected to be **defined in dedicated Annexes to this MOU**, to be signed by Fermilab as the host laboratory and the specific Participant(s) participating in those activities. These dedicated Annexes are expected to address:

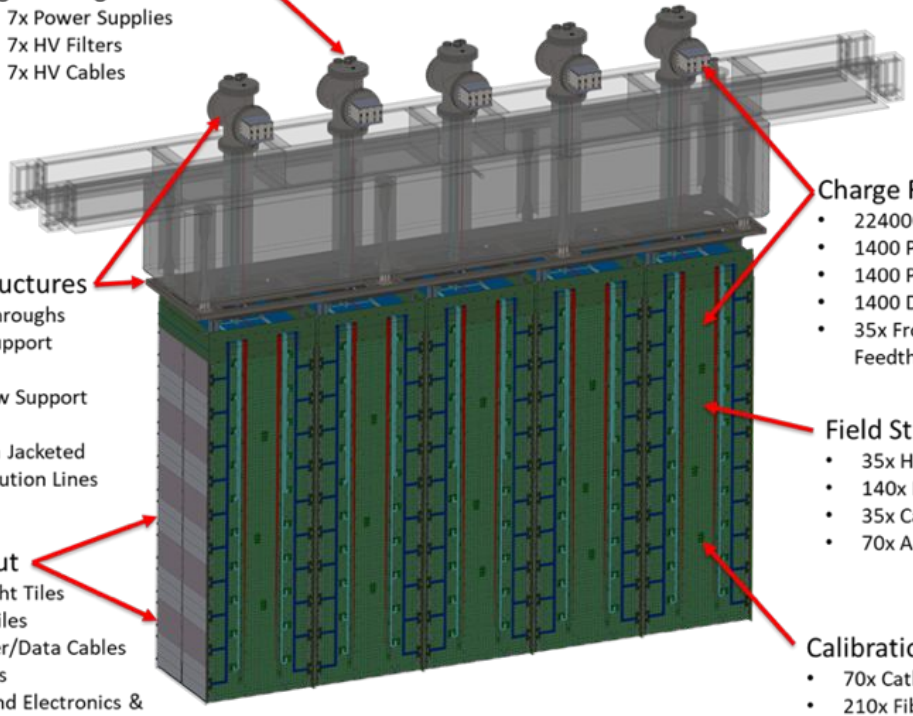
1. The scope of work covered by the Consortium;
2. The technical participation from Participants and/or Contributing Institutions in the activities of the Consortium;
1. The sharing by the Participants and/or Contributing Institutions of any work packages or deliverables and related costs, where relevant;
2. Identification of any areas of support requested from Fermilab as the host laboratory; and
3. A set of construction milestones to be monitored by Fermilab.

Scope of Work

The ND-LAr detector consists of 35 TPC modules, their readout electronics and integration at the Near Site. The cryostat is covered separately and is not in the scope of the ND-LAr consortium.

The requirement on the ND-LAr are derived from the overall DUNE Science Requirements, from which technical system-level specifications are set and consequently requirements on each subsystem. The active size of the ND-LAr TPC is based on the requirement to contain the hadronic particles from the neutrino interactions resulting in a lateral size of 7 m. The length in beam direction of 5 m is given by the muon energy containment up to an energy where the remaining muons can reach and be measured in a downstream detector. Due to the high intensity of the neutrino beam and up to 15 neutrino interaction per spill modular approach based on the Argoncube technology is chosen.

Overview of deliverables



High Voltage Distribution
- 7x Power Supplies
- 7x HV Filters
- 7x HV Cables

Module Structures
- 35x Feedthroughs
- 35x TPC Support Structures
- 7X TPC Row Support Structures
- 7x Vacuum Jacketed LAr Distribution Lines

Light Readout
- 700x ArCLight Tiles
- 700x LCM Tiles
- 1400x Power/Data Cables
- 8400x SiPMs
- 35x Front End Electronics & Feedthroughs

Charge Readout
- 224000x ASICs
- 1400 Pixel Tiles
- 1400 Power Cables
- 1400 Data Cables
- 35x Front End Electronics & Feedthroughs

Field Structures
- 35x HV Delivery Cables
- 140x Field Shaping Panels
- 35x Cathode Panels
- 70x Anode Panels

Calibration
- 70x Cathode Target Sets
- 210x Fibers
- 35x Illumination Sources

The WBS items covered by this MoU are the core detector systems:
131.ND.02.02: Module Structure
131.ND.02.03: High Voltage
131.ND.02.04: Field Structure
131.ND.02.05: Charge Readout
131.ND.02.06: Light Readout
131.ND.02.07: Calibration

Mou is for construction, M&S only

and assembly and integration/installation:
131.ND.02.08: TPC Assembly & Test
131.ND.02.09: TPC Integration & Installation.

Additional WBS items for management (131.ND.02.01) and facilities (131.ND.02.10—13) are defined in the consortium to track contributions of individual institutions or funding agencies. They are not covered by this MoU. Included are the shipping crates for modules in Integration and Installation, not covered are indirect costs for packaging and shipping. Not included is design and prototyping as well as R&D.

	K$	CH	USA DoE	JINR	Total
131.ND.02.02: Module Structure	2639.0	100%			**100**
131.ND.02.03: High Voltage	1000.0	100%			**100**
131.ND.02.04: Field Structure	3560.1		100%		**100**
131.ND.02.05: Charge Readout	3366.0		100%		**100**
131.ND.02.06: Light Readout	4896.2	44%		56%	**100**
131.ND.02.07: Calibration	600	83%			**83%**
131.ND.02.08: TPC Assembly & Test	103.0		100%		**100**
131.ND.02.09: TPC Integration & Installation	426.0		100%		**100**
TOTAL	**16’490.3**				

Funding update

- Russia
  - light system committed
- Switzerland
  - Funding for construction available in budget 2021-2024
  - Hand in request in October 2022
  - Need MoUs (PDR as input)
- USA/DOE
  - Cuts in 2020 and 2021 (calibration, testing), ND cost cap
  - CD1RR, new baseline for ND-LAr: maybe in threshold, rest in objective for CD2

- Canada
  - Support for York
- UK
  - Several groups supported

- Potential negotiations
  - CEA/France

Here we will need input from each PI

Consortium Contributing Institutions
Principal Investigators (PIs), and Areas of Contribution

Contributing Institution	Principal Investigator(s)	Areas of Contribution
Switzerland		
U. of Bern	Michele Weber	Module structure, HV, Light readout, calibration, assembly, testing, integration, installation
United States		
ANL	Zelimir Djurcic	Assembly and testing
BNL	Mary Bishai	Assembly and testing
Caltech	Ryan Patterson	Assembly and testing
CSU	Mike Mooney	Assembly and testing, tooling
		R&D, Assembly and

Temporary text, will need input

Identified needs for more participation

- In general all systems: assembly, testing, installation, integration
- Simulation, reconstruction

- Interfaces to DAQ, slowcontrol

- **Module structures:** reasonably covered
- **Charge r/o:** reasonably covered

- **Field structures:** working on final technology down-select
- **HV:** Bern, Cambridge. Can handle production. Would profit from more institutes

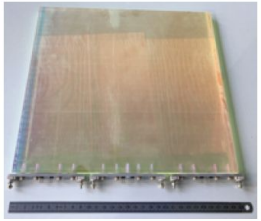
- **Light r/o:** Could profit from more institutes, Bern and JINR only.
- **Calibration:** scope and funding needs more support

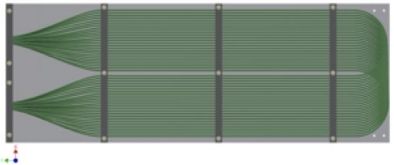
One page for each WBS

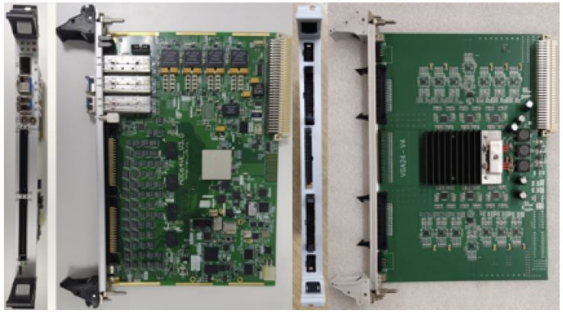
Example light readout to explain the concept,
will need input from each PI and funding agency

131.ND.02.06: Light Readout

Design sketches







Example light readout: scope and cost

Scope and overall cost (M&S)

Design and production of the light readout system for the ND LArTPC modules

		k$
1	LCM light traps with SiPMs and circuit boards	1000
2	ArCLight light traps with SiPMs and circuit boards	894.6
3	Cabling and feedthroughs	953.4
4	SiPM biasing, readout, and control electronics and enclosures	1’346.6
5	Electronics power supplies	201.6
6	Clock distribution/synchronization system for the light readout	500
	TOTAL	**4896.2**

Example light readout: funding and involvements

Funding shares

Funding	
Switzerland (2: 100%; 3: 50%; 4: 50%; 5: 50%)	2’145.4
JINR (1: 100%; 3: 50%; 4: 50%; 5: 50%; 6: 100%)	2’750.8
TOTAL	**100%**

Involvement

Bern, ArcLight and readout: procurement, design, prototyping, construction, QA/QC, integration, installation

JINR, LCM and readout: procurement, design, prototyping, construction, QA/QC, integration, installation

Here we need input/commitments

131.ND.02.06: Light Readout

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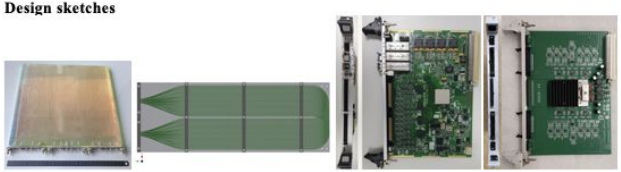

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Technology development from the PDR toward the Final Design Review

Single Cube

Published July 2021

CDR

Conceptual design review

Single Module

TRL-6

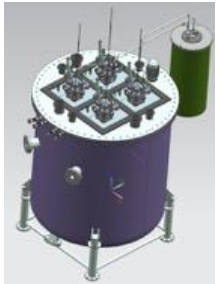
We are here

June 2022

PDR

Preliminary design review

2x2 neutrino beam test



Full size demonstrator(s)

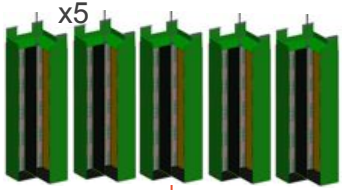
TRL-7

+ 1.5 Years

FDR

Final design review

Pre-production x5



+ 1 Year

PRR

Production readiness review

2x2

- Cryostat at FNAL, Mod-0 and Mod-1 at FNAL
- Minerva installation underground significantly advanced
- Team at FNAL went through approval procedures for testing Mod-0 and Mod-1 in LArTF

Added **James Sinclair (SLAC) and Louise Suter** (FNAL) to the 2x2 leadership team. They coordinate the activities related to the modules.

Next steps:

- Build Mod-2 and Mod-3. Delays due to War in Ukraine (light r/o) and construction of charge r/o tiles. Currently estimate the modules to be built and tested by the end of September (TBC).
- Rework Mod-0 (top flange) and Mod-1 (electronics filter) at FNAL, planned
- Plan is to start installation of modules underground in November
- Cryosystem delivered in November
- Complete 2x2 assembly by the end of the year

Physics

- Contact Andy Mastbaum and Pedro Ochoa for any questions / commitments
- DUNE simulation/reco/analysis of ND, ND-LAr, would profit from more dedicated involvement
- We need to have the simulation / reconstruction for the 2x2 data in early 2023
  - **Data ! Neutrino data!**
  - Benchmark for ND-LAr
  - We plan a set of workshops in 2022 to channel and drive effort

    If you have PostDocs to contribute to preparations, please let Andy/Pedro know
- In general we plan to expand significantly the analysis/physics organization of the consortium over the next weeks/months.