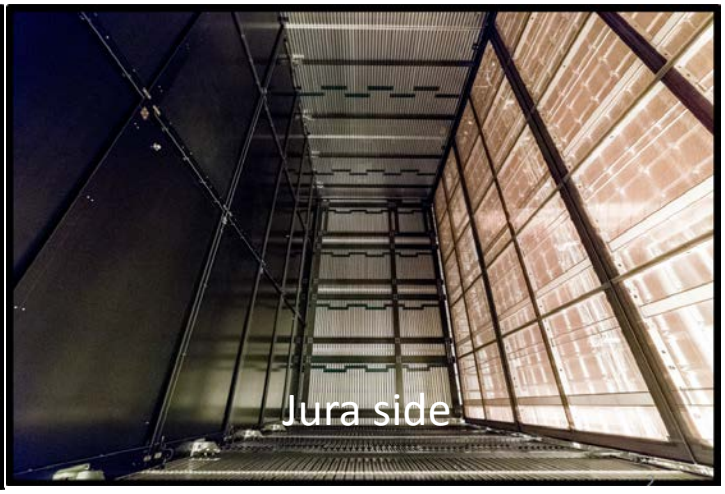
DUNE Project
Monthly Status Report
June 2018



ProtoDUNE-SP TPC completion

Version 3: August 24, 2018

After the ProtoDUNE-SP temporary construction opening (TCO) was closed in mid-June work to finish the TPC and install additional instrumentation was completed by the end of the month. ProtoDUNE-SP commissioning plans continue to develop.

ProtoDUNE-DP CRP#1 was tested in the cold box. LEM and anode production for CRP#2 is well underway.

The 21–24 May LBNC review and 15–18 May collaboration meeting were successfully completed. The 14 May installation meeting reviewed the Integration & Test Facility and underground installation at SURF and engaged significant consortia discussion. The lead DUNE engineers are reviewing the status of interface documents with consortia. The risk registry is being reviewed. ProtoDUNE lessons-learned documentation has started. Statusing of the 2018–19 schedule is being exercised. Consortia are updating interface documents, WBS, risks and schedules.

A cold electronics workshop is planned for 16–18 July at BNL, with a DAQ workshop on 19–21 July. The next LBNC review is 1–3 August.

ProtoDUNE

EHN1 **F. Resnati**

NP02 (ProtoDUNE-DP)

CRP

- Completion of the first CRP in the clean room of building 185.

Cold Box

- CRP moved from building 185 to building 182.
- First test of the CRP#1 in the in the cold box ongoing.

Figure 1: *ProtoDUNE-DP CRP#1 test in cold box*

Installation

Field cage

- HV test at -150 kV on half the length of the field cage ongoing.

NP04

Cryostat

- TCO completely sealed and leak tested.
- Completion of the Jura side field cage.

- Installation of temperature profilers and purity monitors completed.
- Installation of the stress sensors on the cryostat ongoing.

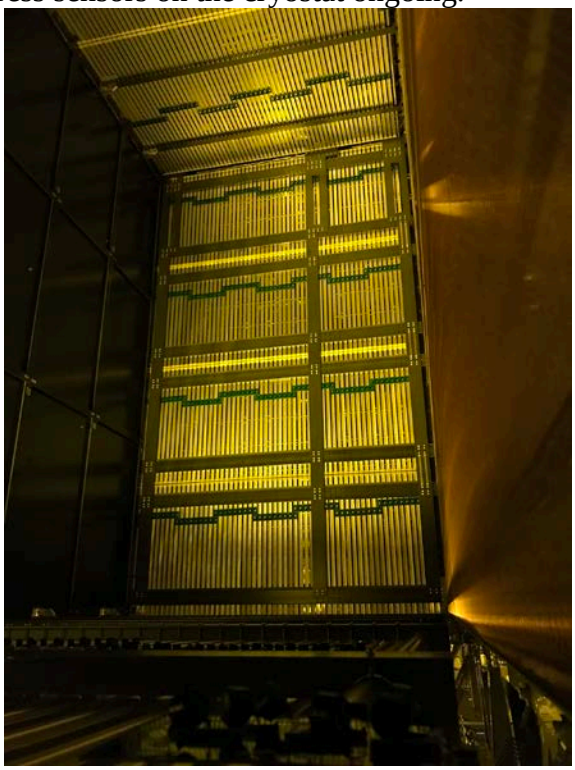


Figure 2: *ProtoDUNE-SP Jura-side TPC completed*

CRT

- Installation of the downstream and upstream CRT modules.
- Cabling of the downstream modules ongoing.

Figure 3: *ProtoDUNE-SP upstream CRT installation*

Cryo

- Installation of the external cryogenic ongoing.

- Testing and validation of the proximity cryogenics ongoing.

Beam

- Testing of the magnets ongoing.
- Hardware installation for the NP02/NP04 zone separation completed.

DUNE

Far Detector Consortia

Single Phase Anode Plane Assembly

No report available.

Single Phase TPC Cold Electronics

No report available.

Single Phase Photon Detector

During June the SP PD Consortium developed a first estimate of the system cost, based on the baseline design described in the IDR. The Consortium has grown in this period since several Italian groups joined us: Bologna, Genova, Milano Bicocca, Lecce and Catania and Laboratori Nazionali del Sud. The Consortium formed a WG to study the requirements of the readout electronic for the photosensors. The leaders of the Integration WG, Yasar Onel (Iowa) and Ernesto Kemp (Campinas), have agreed to coordinate this effort. Finally, the Consortium started planning activities and purchases for the coordination test with the CE Consortium in the small TPC which is being built at Fermilab (PAB), where we plan to test the latest design of ARAPUCA arrays.

Dual Phase Charge Readout Plane

No report available.

Dual Phase TPC Cold Electronics

No report available.

Dual Phase Photon Detector

During June, the Dual Phase Photon Detection System Consortium (DPPD) started to prepare the first draft for the cost estimation. The initial cost estimates are based on the ProtoDUNE-DP photon detection system. In parallel, the consortium has reviewed the schedule of activities, providing updates on ongoing tasks. Discussions on integration and installation plans have continued among the consortium members. Some outstanding issues have been identified and there is a plan to address them in the next months.

Simulation work has continued during June. On the one hand, first attempts to create a photon library within LArSoft for fast optical simulations have been made. As a result, the validation of the simulated detector geometry and of the materials' optical properties has started. On the other hand, work is ongoing to simulate in LArSoft the S2 light produced by the drifted ionization electrons once they reach the gaseous argon volume. In the dual-phase case, PMT waveforms are generally expected to have contributions both from S1 and S2 light.

HV

Deployment of the full TPC field cage of ProtoDUNE-SP has been successfully completed in June as well as the installation of the HV feed-through, HV power supply and HV cables/filters. We had a couple hiccups with the feedthrough installation (metallic end breaking off above HV cup, spring-loaded tip unable to reach cup initially), but we were able to act quickly in

repairing/modifying. Connectivity test has been performed, at low voltage (70 V). The measured current value is in very good agreement with the total resistance of the field cage (~1.39 GOhm), indicating that all the 28 divider boards are well connected.

Ramp in air up the 19.5kV was successful. Heinzinger current monitoring system provided values in agreement with the total FC resistance.

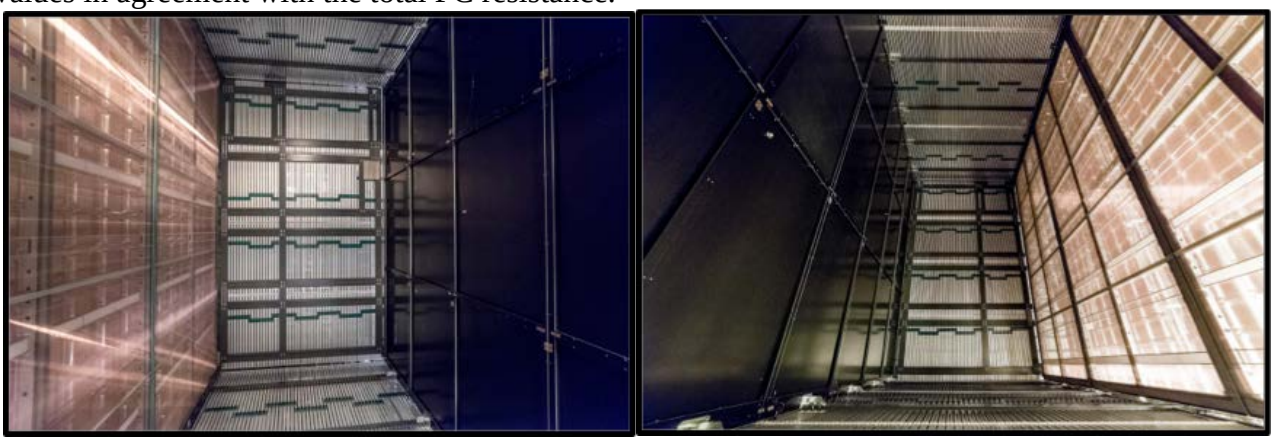


Figure 4: *ProtoDUNE-SP field cages completed*

Figure 5: *ProtoDUNE-SP a) HV donut installation b) power supply cabling*

A problem with some termination boards was identified (with 4 disconnected channels for the current monitoring). Three were repaired, opening the CE feed though and re-connecting the SHV cables. One (upstream beam left endwall) appears to be disconnected at the APA level and is unreachable (no monitoring will be available).

The dedicated camera systems monitoring the HV feed through and the beam plug have been installed. The cabling of the ground plane monitoring system has been completed and available from the flange on the cryostat top.

The CPA/FC/HV document summarizing the Lessons Learned from ProtoDUNE SP assembly and installation (DUNE-doc-8246) continues to be updated.

The HVS consortium activities concerning the DUNE far detector were devoted to the definition of the preliminary cost estimate for both the SP and DP detectors.

Detailed Basis of Estimate spread-sheets, referring to ProtoDUNE experience cost and manpower estimates, have being prepared by the leaders of the main sub-systems: R&D/design optimization, CPA, FC top/bottom. endwalls, HVS distribution, shipping/integration/installation.

Cost estimates, scaling from ProtoDUNE, are being entered in the updated HVS WBS workbook. Material costs and manpower are quite well defined for most sub-systems except for:

- The DP cathode for which a better estimate will be available in the next weeks in parallel with the construction of the ProtoDUNE DP cathode at CERN
- the DP HV system which heavily rely on the joint R&D with Heinzinger that is still in its kick–off phase (again due to ProtoDUNE priority)

Packaging, Shipping to Rapid City, Transport underground and Installation are presently subject of detailed studies and are being finalized.

DAQ

No report available

Cryogenic Instrumentation and Slow Controls

Consortium members are very busy with ProtoDUNE installation. The Purity Monitor to be deployed in ProtoDUNE-DP has been successfully tested at UCL and different photocathodes are currently being tested. Consortium leadership is focused on refining the installation and integration requirements and preparing cost estimates in preparation for the RRB meeting in September. Individual cost sheets have been prepared which will soon be integrated into the CISC WBS.

Near Detector — K.-B. Luk

The coordinators and physics conveners continued to revise the draft recommendations for the DUNE Near Detector based on comments and suggestions received, although due to summer travel progress has been slow.

There was a two-day ArgonCube collaboration meeting at the University of Bern after Neutrino 2018. Status of many tasks were reviewed. Many reports presented are relevant to the design of the DUNE near detector liquid-argon TPC (LArTPC).

The idea of testing four ArgonCube modules with 8 TPCs arranged in a 2 by 2 configuration in front of MINERvA was discussed; however, concern was raised as to whether it could be done in time to provide information for finalizing the design of the DUNE LArTPC ND. Concerns were raised over resources and time to analyze the data.

The Fermilab team discussed potential synergy between LArTPC and high-pressure gaseous argon TPC (HPgTPC). The pixelated readout ASIC of the LArTPC might be useful for the HPgTPC as well. Furthermore, since both kinds of TPCs provide 3-dimensional data, software for pattern recognition and reconstruction should be very similar and can be shared.

The current version of the wire readout electronics for the DUNE far detector was used in PixAr, a beam test of the Bern's large pad planes installed in LArIAT. Hunter Sullivan reported on analysis of the data. Due to the large multiplexing (about 28k pads to 400 readout channels) there were significant ambiguities in hit assignment. New tools will need to be developed to reject these ambiguities before tracks can be reliably reconstructed.

The Berkeley group reported on progress of LArPix using a small 10-cm-drift LArTPC at Berkeley and a 60-cm-drift LArTPC at Bern (these activities have been described in previous DUNE monthly reports). The latest development was a systematic study of the collected data prior to track and event reconstruction. There was a discussion on the second generation DAQ for handling large number of LArPix channels from the Bern group.

The Russian team talked about R&D in detecting the UVU photons of LAr with a plane of scintillating fibers coated with TPB. They found that the efficiency of the TPB dropped rapidly by 40% after it was exposed to ambient light for less than 2 days. As a result, the total photon detection efficiency of their detector was only about 0.9%.

The Bern group articulated their approach of detecting the LAr scintillation photons. Their ArCLight detector is made of a 4-mm-thick EJ-280 green wavelength shifter plate sandwiched between a layer of 3M Vikuiti ESR and a layer of 3M DF-PA Chill, of which the other surface is coated with TPB. The converted green photons are detected by an array of SiPMs mounted along one of the 4-mm-wide edges of the shifter plate. A prototype was installed in LArINIT for a beam test. The measured photon detection efficiency of the prototype was 0.7%.

Patrick Koller (Bern) found from simulation that pixelated readout can identify recoiled protons with energies more than 10 MeV. These protons will be the best tool for tagging events with mis-reconstructed neutrino energy due to the unseen neutrons. Light readout with timing resolution of ~1 ns will provide sufficient spatial resolution to separate proton recoils from other activity in the LArTPC.

The SLAC team delivered several talks on their involvement in DUNE and in MicroBooNE. At this moment, they are involved in developing the PRISM concept for DUNE. They also shared their experience in reconstruction for LArTPC. With wire readout such as the DUNE far detector and MicroBooNE, the fundamental problem is the hit ambiguities when 3-d space points are reconstructed from the 2-d hits obtained with the wire planes. Their thinking is to come up with an algorithm to form the 3-d hits 'directly'. They showed some examples illustrating the potential of their Projection Matching Algorithm. Another area that they are exploring is application of machine learning to neutrino interactions

Technical Coordination — E. James

After the ProtoDUNE-SP cryostat TCO was closed final detector installation was completed by the end of the month.

Table #1 shows important ProtoDUNE milestones and current estimates.

Milestone	Original Date	New Date	Impact on Close SP TCO
Photon Detector system ready for ProtoDUNE operations	12-Mar-18	13-Jul-18	12-Jun-2018
ProtoDUNE SP Cryostat Purging Complete	5-Oct-18	14-Aug-18	12-Jun-2018
UK APA #3 (APA#7) Start Winding	15-Nov-17	1-Aug-18	12-Jun-2018

Table 1: *ProtoDUNE-SP key milestone watch for June*

Progress continues to define DUNE costs, schedules, interfaces, deliverables and risks.

Installation

June was very busy for ProtoDUNE-SP installation. This limited effort available for DUNE installation planning. A floor plan for the integration test facility was revised to include consortia input from the collaboration meeting and the footprint of a potential site near SDSM&T. A revised floor plan is shown in 6.

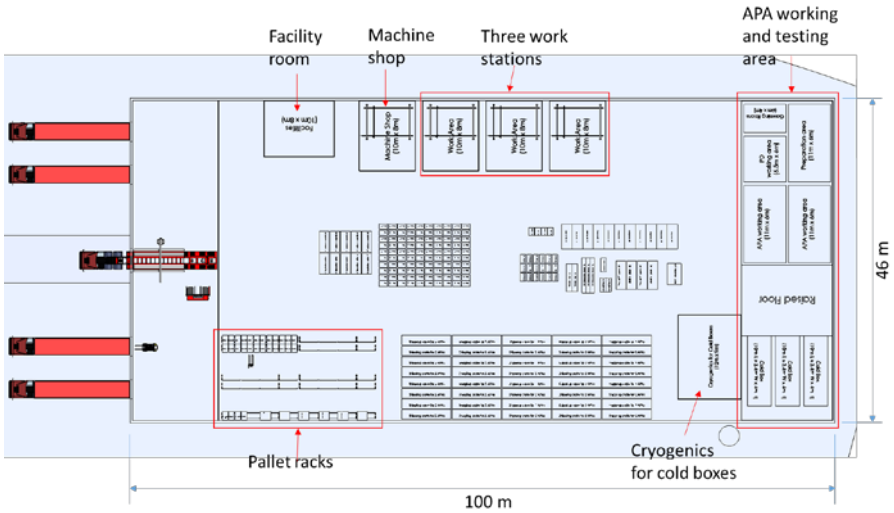


Figure 6: *Conceptual ITF layout with functional regions indicated. This gives an indication of the space needs. This layout considers space available on a potential lot near SDSM&T.*

Much of the remaining effort was dedicated to completing the cost estimate for installation, ITF and TC detector infrastructure. Where possible, quotes were solicited for large capital equipment and catalog prices were gathered. Some progress was made on the DSS design in preparation for an August design review. Use was made of the time following the collaboration meeting when D. Smargianaki visited Ash River to start design of facilities to prototype the installation process.