

DUNE Project Monthly Status Report August 2018



ProtoDUNE-SP liquid argon level above the lower ground plane

Version 3a: September 26, 2018

Purging and cooldown of ProtoDUNE-SP began in early August. Filling was mostly completed in August. Purity monitor data was taken as they were submerged in LAr; DAQ development continues; photon tests ongoing; temperature sensor and cameras are used to cross-check liquid level; cold electronics noise tests continue. Shifts have started, with DAQ and DQM operating.

A second test of ProtoDUNE-DP CRP#1 in the cold box was successful which met HV requirements. A final test is planned for October with a cold test of CRP#2 planned for November. The two other dummy CRPs will be completed in October. The current plan has the detector components installed in ProtoDUNE-DP by the end of 2018 with TCO closure in January.

Technical Coordination organized reviews of the consortia costed-WBS which was submitted to the Neutrino Cost Group 13 August. The NCG will evaluate this for the RRB meeting in September. The 30% final design from ARUP has been under review since early in the month.

Discussion with LBNC on LBNF/DUNE interfaces and current work on understanding the 30% Final Design documents from ARUP in advance of the LBNC review 1–3 August.

A Data Selection workshop was held 13–14 August at Penn. A review of the DUNE-SP DSS was held 20–21 August at CERN; the report is posted in DocDB. An LBNF and DUNE far site integration workshop was held 22–24 August at CERN. The next far site integration workshop is planned for the end of October at SURF. The next conceptual design reviews are planned for photon system in November and DAQ in December. Other preliminary design reviews are being planned in advance of the TDR.

ProtoDUNE

EHN1

F. Resnati

NP02 (ProtoDUNE-DP)

CRP

- Modification of the grid wire tensioning of the CRP#1
- Installation of additional level meters
- Additional tests on HV distribution boxes

Cold Box

- Completion of the second cryogenic test of the CRP#1

Cathode

- Final design of the cathode
- Procurement of the material to build the cathode
- Design of the ground grid ongoing

PMTs

- TPB coating of the PMT completed

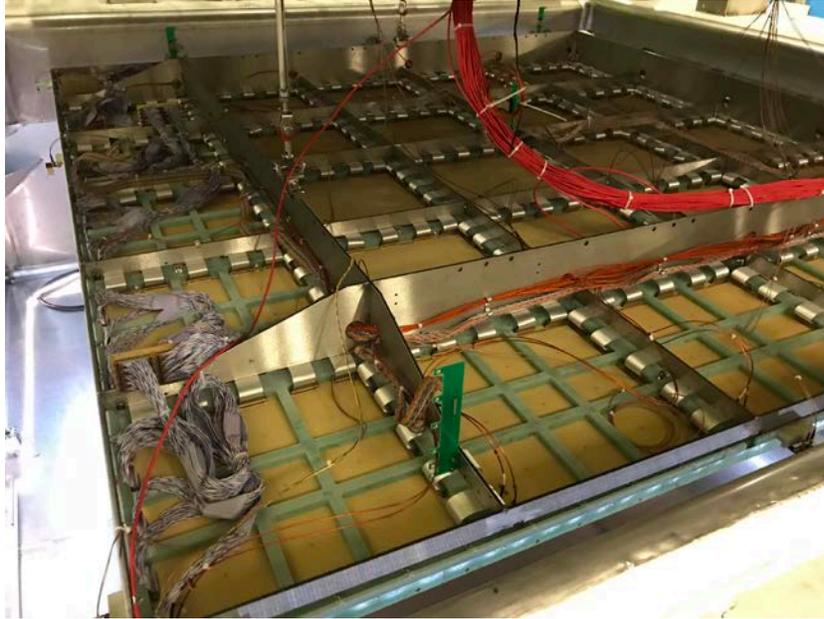


Figure 1: CRP#1

NP04 (ProtoDUNE-SP)

Cryo

- Commissioning of the detector control system
- Cool down of the proximity cryogenics, cryostat and detector
- Start filling with purified liquid argon
- Drifting electron lifetime measured with purity monitors (~50 us)
- Regeneration of the purification cartridges (exhausted while filling)

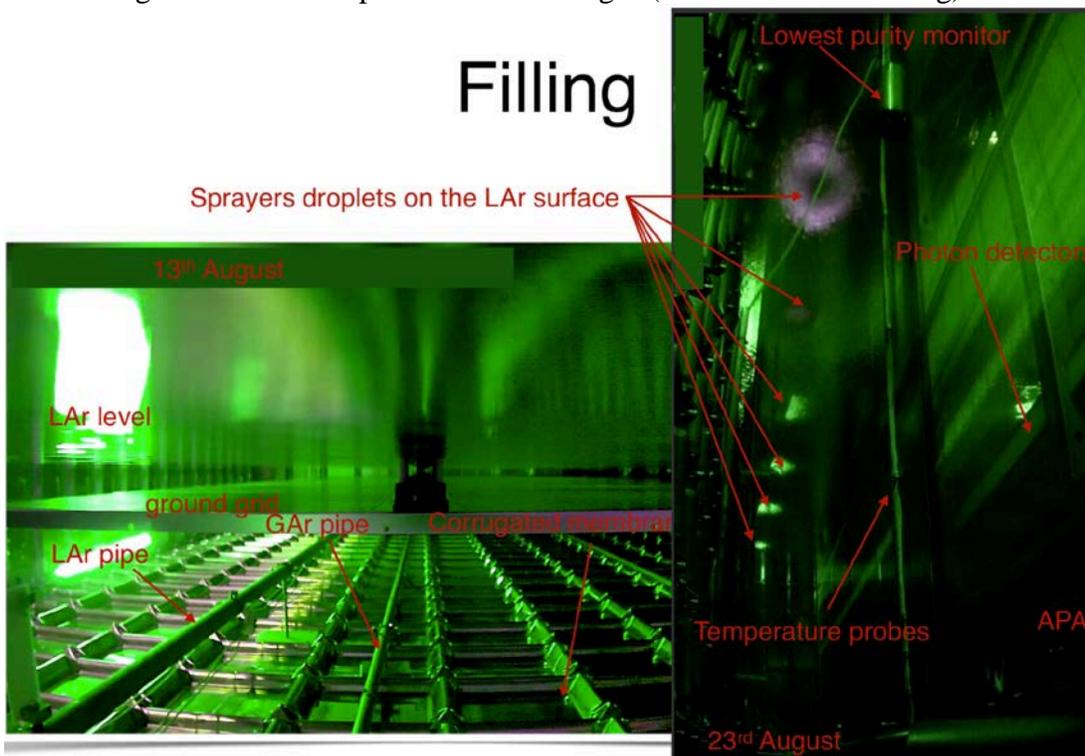


Figure 2: Filling of ProtoDUNE-SP with LAr

Beam and beam instrumentation

- First particle beam in the EHN1 extension.
- Commissioning of the new beam instrumentation.

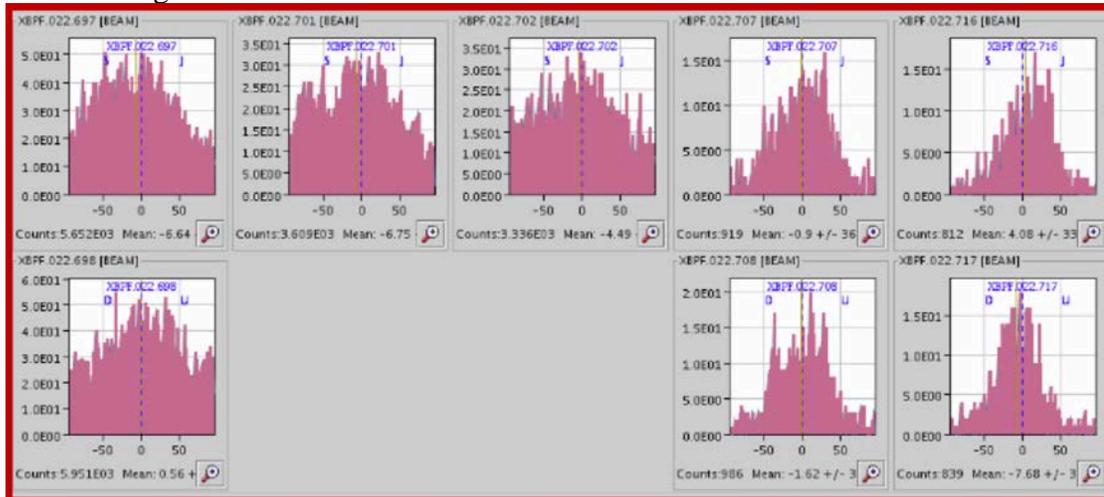


Figure 3: Beam instrumentation diagnostic plots

ProtoDUNE-SP

R. Acciarri

- Commissioning of the upstream CRT was completed.
- CE noise runs were taken regularly during cryostat cooling and filling to monitor noise levels with respect to cryostat temperature and LAr level.
- Test and development of DAQ and Run Control systems is ongoing. Development and test of timing and triggering systems continues. Commissioning of the PD system started with the tuning of thresholds and bias voltage levels for all the PD channels.
- Data taking shifts started in a light version (i.e., only 8 hours/day, no nights, no weekends) to develop shifts procedure and manuals, and to stress test the DAQ.
- Purity monitor measurement have been taken regularly as soon as each monitor became progressively submerged in liquid.
- Hawaii and Valencia temperature profilers are used to monitor the LAr level inside the cryostat during filling.

DUNE

Far Detector Consortia

Single Phase Anode Plane Assembly

No report available.

Single Phase TPC Cold Electronics

During August the design of the new COLD ADC neared completion. Analog and mixed-mode simulations including parasitics extracted from the layout were done and verification of digital design began in earnest.

to estimate it. The consortium discussed advantages of ProtoDUNE-DP running after the long-shutdown including beam data.

LArSoft photon libraries for fast optical simulations have been produced for the first time for the full Dual-Phase Far Detector geometry. This is a pre-requisite for physics studies based on realistic simulated data for the Far Detector TDR. The optical Far Detector geometry is based on ProtoDUNE-DP and assumes 720 equally spaced PMTs (8-inch diameter) under the cathode.

HV

During August ProtoDUNE-SP filling operations, the HV system was continuously monitored with a voltage of 1kV applied to the CPA. No unexpected current behavior through the voltage divider board has been observed, confirming that resistors have not failed. Current fluctuations due to temperature variation have been observed to steadily decrease as liquid Argon levels reached the voltage divider boards.

Construction and welding of the four $3 \times 3 \text{m}^2$ ProtoDUNE-DP cathode and ground plane elements continued on the CERN assembly gig as shown in Fig. 5.

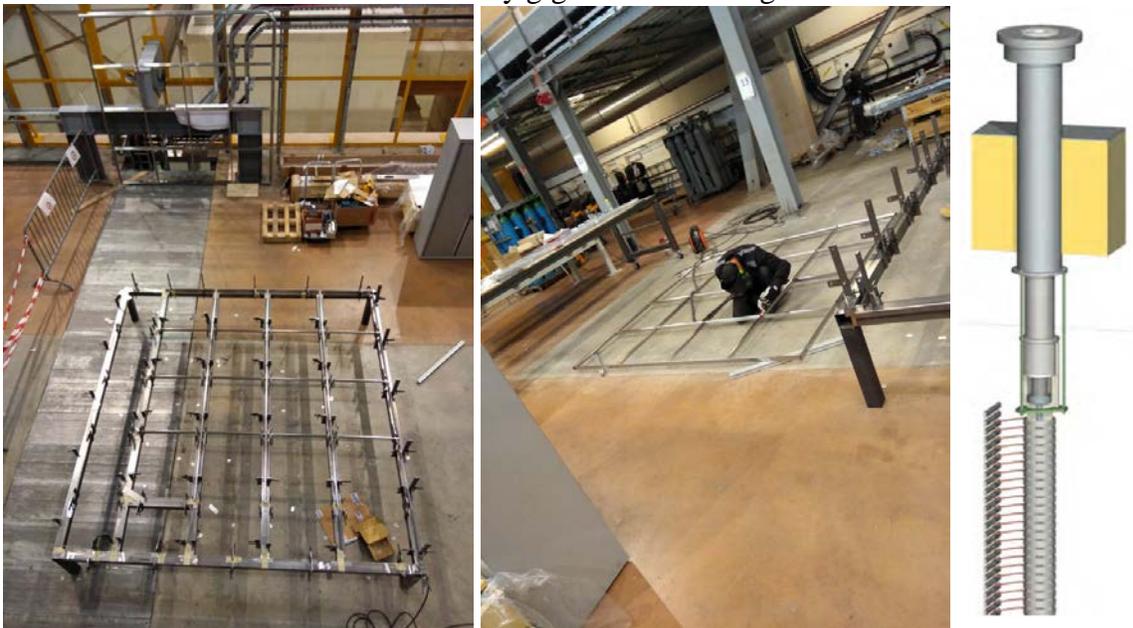


Figure 5. Left and center: construction and welding of one module of the ProtoDUNE-DP cathode. Right: design of the extender connected between the HV feedthrough and field cage rings.

Design of the High Voltage extender has been completed and simulation of the electric field verified. Construction bids from companies are expected soon. The HV extender connects the feedthrough and cathode; it is made of an inner conductor (at max HV) surrounded by an insulator; metallic degrader rings, installed on the insulator, are electrically connected to the field shaping ring at the same height to minimize electric field distortion near the Field Cage.

Preliminary Cost Estimates of the DUNE-SP/DP HV systems were finalized for NCG review.

A new joint activity with the PD consortium was started to examine the possibility of adding UV shifting reflector panels on the CPA to enhance the scintillation light collection efficiency and uniformity of DUNE photon-detectors. Two meetings were held in August to identify possible solutions, compatible with the requirement of minimal changes in the present resistive CPA design. R&D activities to achieve these goals are under investigation. The main milestone is possible inclusion of this option in the CPA TDR.

DAQ

August consortium activities focused on commissioning of the ProtoDUNE-SP DAQ system, review of the data selection strategy, and preparations for the DAQ demonstrator systems for the TDR.

The ProtoDUNE-SP DAQ system, whilst not identical in design to the final system for DUNE, uses many of the same technologies and components. Many consortium members have been intensively involved in the final commissioning of the system in preparation for beam, with activities encompassing software, hardware and firmware development and debugging. At the time of writing, the system is operating smoothly, with data analysis activities under way.

The consortium held a data selection workshop at the University of Pennsylvania, where the trigger strategy and data volume estimates were reviewed. A detailed definition of TPC trigger primitives, which are extracted from the data in real time and then used as the basis of trigger decisions, was proposed. This has allowed work to start on prototype systems which can generate trigger primitives from ProtoDUNE-SP data, an essential test of the robustness of the system in the face of realistic detector conditions. Two approaches are currently under study: a FPGA-based system for data buffering, compression and trigger primitive extraction; and an entirely software-based system that fulfills the same functions. The performance of these two approaches will be compared later in the year and used to inform future design decisions for this part of the system.

Cryogenic Instrumentation and Slow Controls

- Consortium cost estimates have been prepared and successfully integrated into the WBS. The WBS format required some changes to accommodate cost estimates. Some of the labor estimates across various tasks require more subsystem expert input. Discussions are planned during the collaboration meeting to produce an improved draft. DocDB-5609 holds CISC cost estimate documents.
- A summary of CISC installation and integration requirements and far site logistics has been sent to the Installation conveners (Jim Stewart et al) with a goal to hold more detailed discussions at the collaboration meeting.
- The CISC Cryogenics working group held a dedicated meeting on 12 August with the ProtoDUNE-SP team to discuss CFD validation plans using ProtoDUNE-SP instrumentation data. The goal is to produce a document outlining the plan by early September to submit to the LBNC following their recommendation from the last LBNC meeting.
- The LAr Instrumentation working group started discussions with consortium leadership to outline activities and goals for the TDR with a focus on input needed from ProtoDUNE-SP to validate instrumentation designs. A dedicated meeting is planned in early September. Horton-Smith and Palomares continue as CISC TDR editors.
- The CISC consortium plans continued close work with the ProtoDUNE teams (both SP and DP) in the coming weeks for lessons learned from installation and commissioning experience, collaborating on instrumentation data analysis for validation of CFD models and instrumentation designs. More joint sessions will be planned.
- Initial temperature measurements from ProtoDUNE-SP are being reviewed (thanks to the excellent ProtoDUNE-SP slow controls system interface that allows easy access!). Screenshots from ProtoDUNE-SP Static T-Gradient monitor and temperature measurements from slow controls are shown in Figs. 6 and 7.

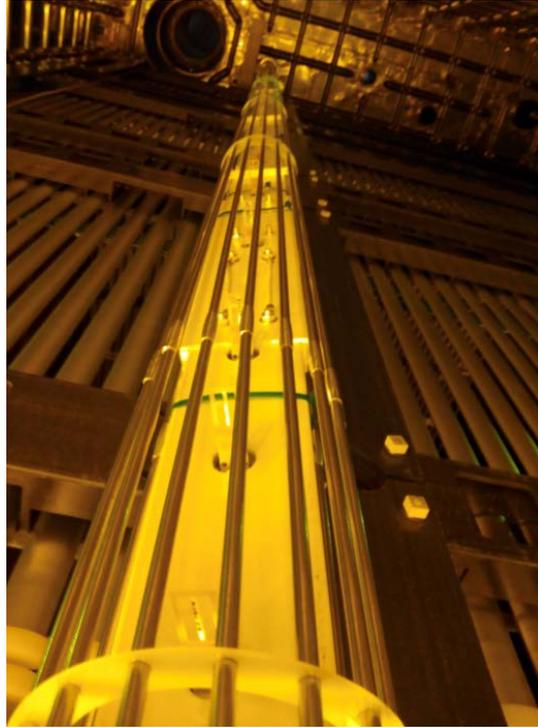


Figure 6: IFIC T-gradient monitor installed in the ProtoDUNE-SP cryostat

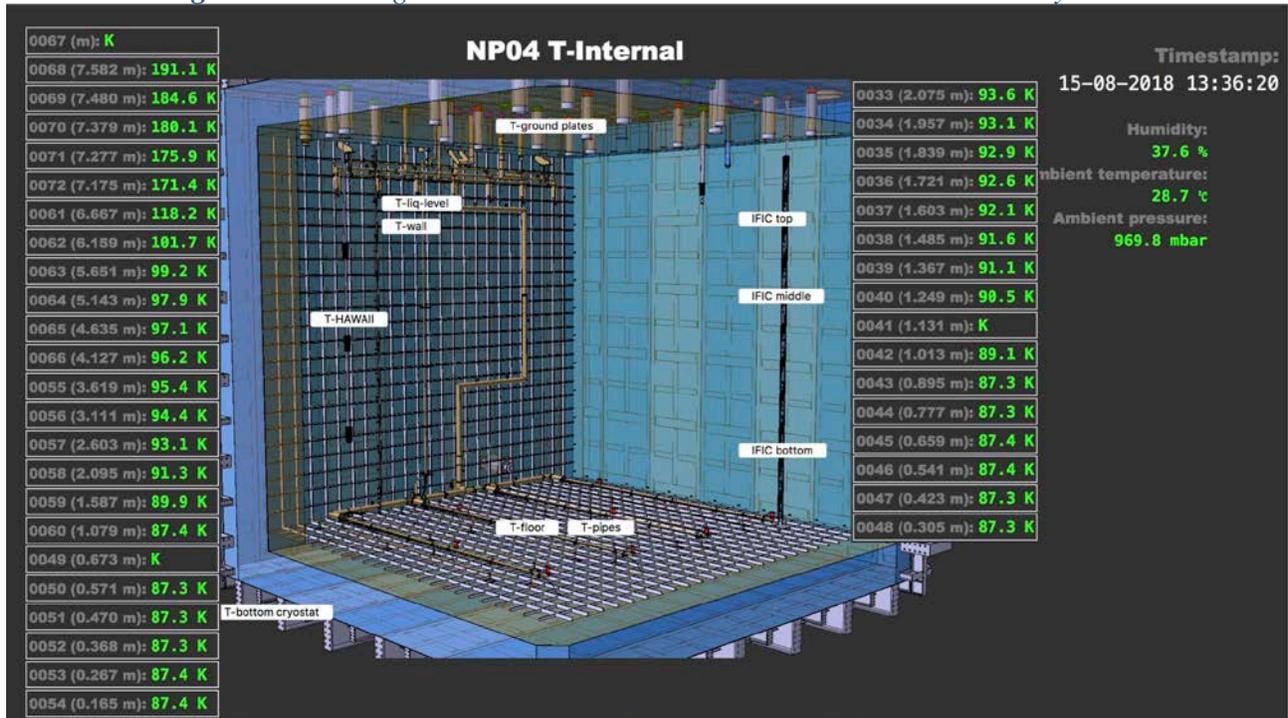


Figure 7: Screen capture of temperatures from the ProtoDUNE-SP T-gradient thermometers

Calibration

- The calibration group presented calibration hardware recommendations to the Executive Board (EB) in early August and is addressing comments from the EB. Calibration recommendations will be discussed at the September EB meeting.

- Effort is underway to propagate various calibration related effects (e.g. E-field distortions, alignment modes) into physics and simulations. A hit shifter module (among other things) will be used to study alignment issues.
- Several neutron generator simulation studies are underway to understand shielding and placement of the system on the cryostat. Work is ongoing to produce neutron capture cross section results from the data collected at the LANSCE facility.
- The first Double Chooz radioactive source deployment system was decommissioned in July and shipped to SDSMT for retrofit for use in DUNE. Progress is being made on radioactive source simulations.
- The calibration group is focused on understanding requirements for a laser system and associated challenges.
- Updates on all the above topics will be presented at the collaboration meeting calibration session. Joint sessions with DAQ and Software and Computing are scheduled and will touch on various open issues.
- Calibration will have chapters in the TDR SP and DP volumes and a section on the overall calibration strategy in the physics volume.

Near Detector

A. Bross

The Near Detector Design Group (NDDG) has replaced the Near Detector Concept Study. Conveners of the NDDG are Alan Bross, Hiro Tanaka and Alfons Weber. The first NDDG deliverable will be the Conceptual Design Report for the DUNE near detector complex. Mike Kordosky and Steve Manly have agreed to serve as editors for the CDR as well as continuing their work on long baseline physics analyses. The Executive Board has reviewed the recommendations from the Concept Study and has signed off on the recommendations with some minor modifications. The recommendations are given here:

1. The LArTPC at the near site should be optically segmented, with a short drift space and 2-dimensional pixelated readout, similar to the concept being studied by the ArgonCube collaboration.
2. The design of a mobile LAr detector that can make measurements at one or more off-axis positions should go forward (DUNE-PRISM)
3. Additional study of DUNE-PRISM for technical feasibility and cost, including the option of moving the MPT, should be made.
4. The underground experimental hall should be rotated by 90° about the vertical axis to allow for moving the near detector off the beam axis.
5. The dimension of the hall in the beam direction that is usable for the experiment must be at least 17m. A wider span should be considered, if the geotechnical conditions are favourable.
6. The experimental floor area should be at least 42.5m×17m and the hook height must be at least 13m, measured from the floor. The minimum lateral dimension of the hall needs further study and will ultimately be settled in the EFIG.
7. A newly built dipole is the preferred magnet for the downstream spectrometer of the DUNE near-detector complex. “Dipole” does not imply a particular design, except that the primary field component is perpendicular to the beam.
8. The recommended concept is a near detector suite consisting of a LArTPC (not in a magnetic field), a HPgTPC in a magnet and a 3DST, possibly located in the same magnet.
9. The option of filling the HPgTPC with hydrogen should be investigated.

The NDDG conveners are working on an organization for the NDDG and will describe their plans for the organization at the September collaboration meeting.

Initial cost books for DUNE-SP and DUNE-DP were provided to the Neutrino Cost Group in advance of the RRB meeting on 13 September. Progress continues to define DUNE cost, requirements, schedule, interfaces, deliverables and risks. The LBNC review 1–3 August focused on the Interim Design Report. A Detector Support System conceptual design review (30% design) was held at CERN 20–21 August. The DUNE collaboration meeting is scheduled for 24–28 September, with some consortia and detector sessions. Planning is underway for conceptual design reviews of the photon system in November and the DAQ in December. Preliminary design reviews are in preparation for early 2019. An LBNF/DUNE Interface workshop was held 22–24 August at CERN and another is scheduled 31 October – 2 November at SURF. An Integration and Test Facility workshop is planned for 29–30 October.

Installation

August was busy for the installation team. The conceptual design review of the Detector Support System was held on 21 August at CERN. The review focused on the requirements, DSS conceptual design, engineering analysis, interfaces, quality assurance, installation and preliminary cost. The conclusions of the review were that the design concept was reasonable and the requirements were understood. Numerous suggestions were given to improve the design and possible alternates to various design elements were suggested. The committee suggested areas where more analysis would be helpful.

At the start of August LBNF provided the 30% final design from ARUP for the Building Site Infrastructure (BSI). This submission covered outfitting of the underground areas and required careful review by the installation team. A dedicated LBNF/DUNE workshop was held 22–24 August to discuss the interfaces to CF. Detailed cost estimates for DUNE installation were submitted in August. These cost estimates were reviewed by the neutrino cost group.