



**Report of the Production Readiness Review of the
ProtoDUNE Photon Detector Readout**

July 19, 2017

1.0 PURPOSE/ SCOPE

The purpose of this review is to ensure there is a fabrication process in place and documented. The fabrication process should include the fabrication steps taken to complete the component and the define the quality control inspections and tests that will be performed to ensure the component meets its design and intended function.

The scope of the review included a review of the applicable documentation that had been uploaded to an Indico site and Docdb. The documentation reviewed is listed at the end of this report in Attachment A. These documents were reviewed by the Project Electrical and Mechanical Engineers, the Project ESH Manager, the Project QA Manager and the DUNE-US Project Manager. The Project QA Manager held the review at Argonne National Laboratory (ANL) on July 19, 2017. The DUNE ESH Manager and the DUNE-US Project Manager participated in the review at ANL. The Project Mechanical Engineer participated in the review by teleconference. The ANL personnel who participated are listed at the end of this report.

2.0 Comments

The ProtoDUNE Photon Detector Readout team at ANL are very experienced and very knowledgeable. The processes for the fabrication of the Photon Detector are under development. The ANL Team gave an overview of the Photon Detector Readout design and fabrication. The recommendations from the Photon Detector Readout Design Review have been addressed.

The Photon Detector Readout circuit design is done in accordance with mutually agreed-upon specification documents. Printed circuit layout is performed in accordance with IPC specifications. Bare PCB manufacturing requirements are embedded within the Gerber file fabrication documents (e.g. layers, spacing, impedance, finish, testing, etc.). Components are assembled onto circuit using either trained ANL technical staff or by external assembly vendors, based upon volume, in accordance with per-design assembly specification documents. Testing occurs at ANL in accordance with a per-design test procedure that typically includes a mix of manual, semi-automatic and automated testing in an engineering test bench followed by overall characterization in a system- or subsystem test stand. The fabrication/assembly of the readout and the automated testing procedures are under development. The PCBs, SSP Chassis, signal and power supply cables and power supplies are subcontracted to qualified vendors. Simple mechanical items such as shield plates are made in-house at ANL.

Original LBNE SSP firmware specified iteratively with collaboration. Final agreed-upon specification of firmware enumerated in talks at Feb. 2014 LBNE Collaboration meeting. Full, detailed description of firmware as implemented for LBNE is found in LBNE SSP User's manual. Since distribution of LBNE SSP, requests for additional firmware development have been made by ProtoDUNE including

- Modified timing interface
- Modified trigger interface
- Sensitivity to in-spill vs. not-in-spill conditions

Documents describing firmware architecture for each major change have been written and distributed to photon detector and DAQ working groups for comment. New ProtoDUNE SSP User's Manual containing all details of new firmware is in development and will be distributed with production units when manufactured.

The Photon Detector Readout Team is utilizing the Argonne Quality Maintenance System in the performance of this work. The Quality Maintenance System is defined in a series of policy documents maintained by laboratory management:

- LMS-POL-9: Quality Policy
- LMS-PROC-3: Control of Nonconforming Items, Services, and Processes
- LMS-PROC-47: Suspect/Counterfeit Items
- LMS-PROC-48: Requesting Supplier Evaluation
- LMS-PROC-49: Receipt Inspection
- LMS-PROC-50: Control and Calibration of Measuring and Test Equipment
- LMS-PROC-114: Software Safety Class and Category
- LMS-PROC-116: Commercial Grade Dedication
- LMS-PROC-125: Applying the Graded Approach for Quality for Procured Items or Services

All HEP division shipping activity is carried-out in accordance with laboratory guidelines, specifically:

- Offsite Shipping Guidance and Completion of Shipping Order (ANL-126c),
- Laboratory Procedure LMS-PROC-223, Use of Argonne Shipping Services,
- Laboratory Procedure LMS-PROC-243, Processing of International Ordinary Shipments.

In addition to the ANL guidelines, the shipping guidelines provided by the DUNE Project will be utilized. Additional labeling and identification markings on the shipments from ANL to CERN will be added.

The roles and responsibilities for Environmental, Safety, and Health support and oversight are clearly integrated into the management of the ProtoDUNE Photon Detector Readout work at Argonne National Laboratory. The Zelimir Djurcic, ANL team leader, understands his ESH oversight responsibilities for the work taking place at ANL. The ANL Physics Department ESH Manager, Leon Reed, provides ESH support and oversight to validate that the ProtoDUNE work activities are compliant with ANL ESH requirements.

Each member of the HEP Division is trained in accordance with the Job and Hazard Questionnaire (JHQ) developed for their employment classification. It is part of the Argonne Training Management System. The JHQ identifies environment, safety, and health training requirements related to an individual's job. Answers to questions on the JHQ reflect a person's current job responsibilities. The Argonne Work Planning and Control (WPC) application implements the process for scoping, planning, and controlling work that identify and analyzes hazards, controls, and ensures that the work is performed within these controls. Part of WPC is the correct assignment of tasks to appropriately trained and skilled individuals. Relevant Laboratory documents on this process include:

-LMS-POL-16: Work Planning and Control

-LMS-PROC-65: Skill of the Worker

-LMS-PROC-200: Local Work Planning and Control Implementing Procedures

3.0 Recommendations

- 3.1 Complete the development of the software mediated test procedure and the automated test procedure.
- 3.2 Develop fabrication/assembly procedure for the SSP being assembled at ANL.
- 3.3 Update the labeling of the power cables.
- 3.4 Complete the Verification and Validation of the software used for testing the PCBs.
- 3.5 Update existing LBNE-SSP user manual to reflect additions/changes in ProtoDUNE SSP.
- 3.6 Document the review and approval of the schematics.
- 3.7 Complete the QC Plan template.

4.0 Photon Detector Readout Production Readiness Review Team

Name	Title
Kevin Fahey	LBNF/DUNE QA Manager
Michael Andrews	LBNF /DUNE ESH Manager
Theresa Shaw	DUNE Project Electrical Engineer
Jack Fowler	DUNE Project Mechanical Engineer
Jolie Macier	DUNE-US Project Manager

5.0 ANL Photon Detector Readout Team

Name
Zelimir Djurcic (HEP)
John Anderson (HEP)
Gary Drake (HEP)
Leon Mualem (CalTech)
Leon Reed (ESH)
Ranjan Dharmapalan (HEP)

6.0 Summary

The major components of the Photon Detector Readout are subcontracted and then assembled at ANL. A small production of five SSPs has been completed and delivered to CERN for integration testing. The recommendations are to document plans that ANL has already planned to ensure the large production is successful. Upon completion of the recommendations, ANL will be ready for production. A written response to the recommendations is requested within two weeks of the receipt of this report. The response should be sent to Kevin Fahey at Kfahey@fnal.gov. If there any questions or a need for more information, contact Kevin Fahey at 630-840-2693.

Attachment A

Photon Detector Readout Production Readiness Review Documentation

- Argonne SSP Characterization Testing for ProtoDUNE-SP, July 14, 2017
- SSP 2017-5-19_17PC001-A, Bill of Material
- DUNE SiPM Signal Processor(SSP) Overview of Post-Assembly and Characterization testing methodology, Revision 20170717
- DUNE SiPM Signal Processor(SSP) DUNE SSP POST-ASSEMBLY Manual Test Procedure
- ProtoDUNE SiPM Signal Processor Interface between SSP and timing system
- DUNE SiPM Signal Processor(SSP) ECO/FCO Verification & initial checkout procedure
- ProtoDUNE Photon-Detection Readout Integration Test Plan
- Quality Assurance and Control for the ProtoDUNE-SP Photon Detector Readout Electronics
- Specifications for Electronic Assembly SiPM (Silicon Photo-Multiplier) Signal Processor (SSP) Design #PC17001A May 22, 2017 Document Revision 1.1
- ProtoDUNE SSP Change Log
- SSP Gerber Files
- SSP Impedance Characteristics
- ProtoDUNE SSP Bias and LV Cable Drawings
- Engineering Note on SSP Power Cables
- SSP Mechanical Drawings
- SSP Schematics
- ProtoDUNE SSP software test plan Revision 1.4 20170613 JTA

Note: These documents are filed in Docdb 3126