FD1 PDS Final Design Review
Replies to Committee Questions 5, 9 and 12

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SP Photon Detector System Final Design Review

Mechanical Sub-Systems

24 March, 2023

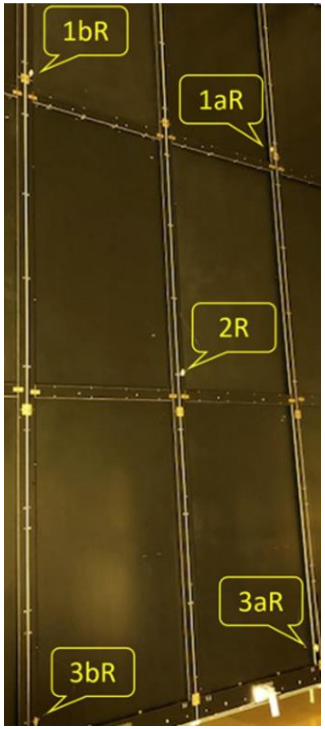
Q5: What are the 2-3 biggest risks associated with ProtoDUNE II delay in completion of the design?

ProtoDUNE II Is already a success for the FD1 PDS

- Demonstrated end-to-end validation of the entire PD procurement, fabrication, testing and logistics chain.
  - 40 modules fabricated and installed
  - Detection efficiency measurements
  - Installation of baseline design monitoring

- Demonstrated operation of modules inside APA in cold box.
  - Did not see cross-talk with APA cold electronics

- Demonstrated PD/APA installation
  - Successfully installed 40 modules and tested in the cold box



Remaining PDS Goals for ProtoDUNE II

- Validation of end-to-end operation of PDS:
  - Operation of full 40 module-system at full cryogenic temperature in LAr.
    - Delays in ProtoDUNE II operation may require us to go to PRR without this full system validation. In this case we will not have tested a full-size module in LAr.
    - Cold box only reached ~180K (LAr is 87K).
    - 10 full modules tested in LN2 at CSU.
  - Operation of full monitoring system with modules.
    - Delays in ProtoDUNE II operation may require us to go to PRR without this full system validation.
    - Extensive component testing at Argonne, SDSMT.
    - System validation (with DAQ) in ProtoDUNE II cold box.
  - "Vertical slice" testing of end-to-end electronics, Detection Efficiency with tracks in TPC and beam.
    - Delays in ProtoDUNE II operation may require us to go to PRR without this full system validation.
    - Cold box testing will allow end-to-end validation of the electronics and testing of new DAPHNE
    - Detection efficiency measurements during initial QC testing have provided valuable insights into module behavior

Q5 Summary

- The ProtoDUNE II experience has already provided critical insights to the FD1 PDS system.
- ProtoDUNE II operation is expressly included in the validation plan for the PDS Production Readiness Review
- Mitigations are already in place, however the late ProtoDUNE II operation will be an unfortunate blow to the PDS consortium.

- Q9: Specs on storage and handling – please provide and justify.

- (i) Is water absorption an issue?
- (ii) What are temperature range specs
- (iii) Is there a radioactivity spec on radon exposure? Are any mitigation measures (e.g. Mylar bag on units pre-installation) planned?
- Post-installation environment and cleanliness. Is ISO-8 OK for you? How do we know?

- Please see draft report “FD1 PDS Storage Requirements”

PDS Environmental Specification Justifications

- **Temperature:**
  - SiPM storage specifications from Hamamatsu drive the temperature specifications to a range of +35C to -196C.
- **Humidity:**
  - SiPM storage and dichroic filter plate both require no dew condensation to avoid damage
  - Negotiated to 85% relative humidity due to constraints in SURF cryostat
- **Light exposure**
  - Sensitivity to light exposure is dominated by the coated dichroic filter plates. Testing at UNICAMP and in ProtoDUNE I and ProtoDUNE II has demonstrated that filtering all wavelengths below 400nm for short exposures (<2 weeks) and filtering all wavelengths below 520nm for longer uncontrolled exposures avoids damage to the coatings.
- **Clean environment requirement**
  - Class 100,000 (ISO 8) clean room conditions have been shown to meet requirements for radiologicals and dust collection on exposed WLS plates (see draft report “FD1 PDS Storage Requirements”)
  - These studies will need to be repeated underground in SURF when the underground facility is available.

[Table 1] Recommended storage conditions

Product		Storage conditions	Remark
Product packed in moisture-proof bag	Unopened product	Temperature: 15 °C to 35 °C Humidity: 45% to 75% Period: within 12 months	A sharp item coming in contact with the moisture-proof bag might open a hole in it, so use caution.
	Opened product	Temperature: 15 °C to 35 °C Storage in a low-humidity desiccator Period: within 3 months	

3.2. Absolute Maximum Ratings *1

Parameter	Symbol	Value	Unit	Remark
Operating Temperature	Topr	-196 to +60	°C	No dew condensation. *2
Storage Temperature	Tstg	-196 to +80	°C	No dew condensation.|*2
Maximum temperature cycle (below -40°C to room temperature)	--	20 times	--	Please avoid rapid temperature change.
Solder temperature	Tsol	260°C or less, within 3 seconds, once	--	*3

General PDS Environmental Specifications

- **Assembly areas:**
  - Temperature: <35 Celsius
  - Relative Humidity: <85%
  - Light exposure: Light exposure: filter <520 nm for >2 weeks exposure, <400 nm for shorter exposures.
  - Environmental controls: Class 100,000 (ISO 8) clean room conditions
- **Surface storage areas (South Dakota Storage Warehouse):**
  - Note that during long-term storage environmentally sensitive components will be stored in aluminized anti-static Mylar bags (or equivalent) to limit exposure. This leaves only the temperature to be regulated
  - Temperature: <35 Celsius
- **Underground assembly and integration areas, inside cryostat:**
- Temperature: <35 Celsius
- Relative Humidity: <85%
- Light exposure: Light exposure: filter <520 nm for >2 weeks exposure, <400 nm for shorter exposures.
- Environmental controls: Class 100,000 (ISO 8) clean room conditions

- Q12 Re: QA/QC plan in general

  (i) Will there be spot checking of materials delivered from manufacturers to ensure they are following agreed upon procedures?

Answer:

Yes. As described in the QA/QC document provided as part of the review documentation, reception travelers will be generated for all incoming materials. In addition, procedure documents will specify the QC checks to be conducted for each component, the required outcomes of these measurements, and the sample sizes to be checked. Each batch of materials will be assigned a DUNE lot number and the data stored for future reference.

The disposition of each batch will be indicated on the reception traveler.