

# Photon Detector System: Documentation Summary

David Warner

SP Photon Detector System Preliminary Design Review

18-19 June, 2020



# Outline

- Documentation goals of the review
  - Design. Document. Execute.
- Required documentation summary
  - Design documents
  - Requirements documents
  - Installation documents
  - Interface documents
  - Engineering analysis documents (compliance office interface)
  - QA/QC documents
  - Cost/schedule documents
  - Tracking documents
  - Extra documents
- Presentations
- Summary

# Project Office List of Required Documentation

Category	Document	Controlled by	Description
Design Documents	TDR Chapter	DUNE EB	Sub-system Design Report from TDR. Assumed to include some discussion of value engineering process.
	Design Updates	Consortium	Need to understand what documentation is needed to describe sub-system design changes subsequent to the release of the TDR (TDR addendum). Is this an updated, stand-alone version of the original TDR chapter (probably at least required for Final Design Review)?
	Grounding & Shielding Plan	DUNE TB	Short document describing plan for sub-system adherence with detector grounding & shielding requirements. Plan should have sign-off from DUNE Grounding & Shielding Committee (contact Terri Shaw at tshaw@fnal.gov).
	Mechanical CAD Model for Sub-system	Consortium	Updated CAD model for sub-system released in EDMs. As part of the process for releasing the sub-system model, it will be integrated and checked within global CAD model.
	Mechanical Engineering Drawings	Consortium	Engineering drawings for all sub-system mechanical components. Drawings do not need to be production quality but should contain all critical dimensions and tolerances. Drawings should be obtained directly from released sub-system CAD model and be marked "Draft/Not for Production". Drawings should also indicate component fabrication materials and masses consistent with EDMs 2281422. Drawings of any specialized components necessary for transporting or installing detector components should also be provided.
	Mechanical Assembly Drawings and Parts Lists	Consortium	Assembly drawings and parts lists for all sub-system detector components. Drawings do not need to be production quality but should contain the baseline design and section views. Drawings should be marked "Draft/Not for Production", contain assembly masses consistent with EDMs 2281422, and indicate the center-of-gravity of the assembly (CG marker). Parts lists should contain full specifications for any custom components.
	Electrical Schematics & Board Layouts	Consortium	Schematics and board layouts for all sub-system electronics components. Along with the schematic and board layout files for each printed circuit board design, the additional board layout and manufacturing information typically sent to PCB manufacturers (e.g. number and configuration of layers, required drill sizes and tolerances, hole plating requirements, and board trace widths and tolerances) should be provided.
Requirements Documents	Specification of Electrical Cabling and Wiring Connections	Consortium	Specification of all electrical connections between sub-system components. Needs to include complete information on all cables and connectors including maximum voltage and current ratings. Wiring diagrams should be provided as necessary such that all system inter-connections are fully defined.
	Bills of Materials for Electronic Board Components	Consortium	Bills of materials including parts list with full manufacturer part numbers for each sub-system electronics component. As appropriate, information regarding the cryogenic qualification of specific parts should also be provided.
	EB-Held Requirements	DUNE EB	High-level detector requirements with impact on physics performance.
	TB-Held Requirements	DUNE TB	Next level detector requirements with potential impacts on multiple subsystems.
Installation Documents	Detector Installation Plan	Integration Office	Chapters detailing sub-system installation plans should be complete and updated.
	Consortium-held Requirements	Consortium	Spreadsheet with four tabs for Integration, Installation, Fabrication, and Transportation requirements. These requirements should be pulled from Interface documents, Far Detector Installation Plan, QA/QC Plan, and Manufacturing Plan as appropriate.
Interface Documents	Consortium-Consortium	DUNE TB	Released version of document detailing interfaces between detector sub-systems (APA, HV, SP-PD, SP-ELEC, DAQ, CALCI, COMP). Six in total for each consortium.
	Consortium-Installation	Integration Office	Released version of document detailing detector sub-system interfaces with the detector installation plan.
	Consortium-DSS	Integration Office	Released version of document detailing detector sub-system interfaces with the Detector Support Structure (DSS)
	Consortium-Facilities	Integration Office	Released version of document detailing detector sub-system interfaces with facility infrastructure. Facility infrastructure includes cryostat penetrations, real estate on top of cryostat, racks on the detector and cryogenic mezzanines, as well as cryogenic systems and piping (both internal and external to the cryostat).
	Interface Drawings	DUNE TB & Integration Office	Required interface drawings (both mechanical and electrical) are specified within each interface document. Interface drawings once completed should be posted as an additional material within the EDMs entry of the corresponding interface document.
Engineering Analysis Documents	Analysis Plan	Compliance Office	Documents the load cases that need to be analyzed for the sub-system and the standards that will be used assess the structural calculations. This document is jointly signed-off on by the consortium and compliance office prior to starting any structural analysis.
	Structural Analysis Note(s)	Consortium	Engineering notes detailing the structural analyses performed for each of the sub-system load cases defined in the analysis plan and comparison against identified standards.
	Independent Review Report(s)	Compliance Office	Output from independent review of structural analysis note(s) performed by the Compliance Office. Report(s) should include recommendations for required updates needed prior to Final Design Review.
QA/QC Documents	Preliminary QA/QC Plan	Consortium	Short document describing consortium QA/QC plan with emphasis on sub-system testing plans covering fabrication, transport, storage, and installation stages. Kevin & Jim are in the process of producing a template (example) document.
	ProtoDUNE Lessons-Learned	Consortium	Short document detailing sub-system issues uncovered during ProtoDUNE and the steps being taken to address these.
	Preliminary Manufacturing and Procurement Plan	Consortium	Short document describing consortium plans for the procurement of needed materials, fabrication of detector components, and sub-system assembly. Kevin & Jim are working with Vic to produce a template (example) document.
	Plan for Prototyping Activities	Consortium	Short document describing consortium plans for prototyping activities moving forward from the Preliminary Design Review including any Ash River activities and ProtoDUNE-II. Description of sub-system specific Ash River activities should be consistent with that in document describing overall plan for Ash River activities (EDMS 2169069)
Cost/Schedule Documents	Cost Estimate	DUNE EB	Consortia sub-system cost estimates are prepared by the DUNE Resource Coordinator working closely with the consortia leadership teams. Effort is currently underway to incorporate cost estimates within P6 to enable production of annual M&S and Labor profiles. Resource Coordinator will determine format for sharing this information with review committee.
	Schedule Summary	DUNE TB	Need to define a format to be extracted from P6. Should include a summary of consortium milestones and connections to high-level ProtoDUNE-II and Far Detector milestones.
Tracking Documents	Responses to Past Review Recommendations	Review Office	Consortia should keep a spreadsheet of recommendations received from each stage of the review process. For each recommendation received, the consortia should provide within the spreadsheet a brief description of how the consortium has addressed the recommendation and an assessment of its current status (e.g. closed or in-progress). Review office should sign-off on previous review recommendations having been properly addressed.

# PD EDMS Guide (EDMS 2383199)

## Guide to links to PDS documents in EDMS and their status

Color Code: **Ready to review**

**Partially ready (will update)**

**Not yet ready**

Category	Document	EDMS	Release Status
Design Documents	TDR Chapter	<a href="#">EDMS 2383194</a>	Yes
	TDR Chapter Update	<a href="#">EDMS 2383195</a>	Yes
	Grounding & Shielding Plan	<a href="#">EDMS 2383681</a>	Yes
	Mechanical CAD Model for Sub-system	<a href="#">EDMS 2384656</a>	Yes
	Mechanical Engineering Drawings	<a href="#">EDMS 2384656</a>	Yes
	Mechanical Assembly Drawings and Parts Lists	<a href="#">EDMS 2384656</a>	Yes
	Electrical Schematics & Board Layouts	<a href="#">EDMS 2384981</a>	Yes
	Specification of Electrical Cabling and Wiring Connections	<a href="#">EDMS 2383682</a>	Yes
	Bills of Materials for Electronic Board Components	<a href="#">EDMS 2384981</a>	Yes
	Requirements Documents	EB-Held Requirements	<a href="#">EDMS 2346091</a>
TB-Held Requirements		<a href="#">EDMS 2384645</a>	Yes
Consortium-held Requirements		<a href="#">EDMS 2382763</a>	Yes
Installation Documents	Detector Installation Plan	<a href="#">EDMS 2233449</a>	Yes
Interface Documents	Consortium-Consortium	<a href="#">CERN 0000195979</a>	Yes
	Consortium-Installation	<a href="#">EDMS 2145176</a>	Yes
	Consortium-DSS	<a href="#">EDMS 2339392</a>	Yes
	Interface Drawings	Contained in interface document EDMS links	Yes
Engineering Analysis Documents	Analysis Plan	<a href="#">EDMS 2380161</a>	Yes
	Structural Analysis Note(s)	<a href="#">EDMS 2380229</a>	Yes
	Independent Review Report(s)	<a href="#">EDMS 2380230</a>	Yes
QA/QC Documents	Preliminary QA/QC Plan	<a href="#">EDMS 2384692</a>	Yes
	ProtoDUNE Lessons-Learned	<a href="#">EDMS 2384687</a>	Yes
	Preliminary Manufacturing and Procurement Plan	<a href="#">EDMS 2384693</a>	Yes
	Plan for Prototyping Activities	<a href="#">EDMS 2384653</a>	Yes
Cost/Schedule Documents	Cost Estimate	<a href="#">EDMS 2382764</a>	Yes
	Schedule Summary	<a href="#">EDMS 2383672</a>	Yes
Tracking Documents	Responses to Past Review Recommendations	<a href="#">EDMS 2384615</a>	Yes

# EDMS Layout

(PDR documents of links to documents found here)

The screenshot displays the EDMS (Electronic Document Management System) interface. The top navigation bar includes the EDMS logo and a 'Home' button. The main content area is divided into a left sidebar and a right main panel.

**Left Sidebar (Navigator):**

- Search bar with a filter icon and a 'Tags' dropdown menu.
- Text: "No active tags."
- Home icon and "[...]" link.
- Tree view showing the document structure:
  - SP PDS consortium
    - Interface Documents (PDS-Consortium Interfaces)
    - DAPHNE Warm Front End Module (DAPHNE Internal Review-- Obsolete)
    - Engineering Reports (Compliance Office Documents)
      - PD Design Documentation (Compliance Office Documents)
    - PD Mechanicals (Module, Rail, flange design)
    - PD Electricals (DAPHNE, Cold amplifiers, flange feedthrough, cables, grounding)
      - SiPM (Not currently used-- see presentations, PD Electricals)
    - Production Documents (Not currently used)
    - Requirements Documents (Consortium held requirements)
      - Installation Documents (Not currently used)
    - Cost/Schedule Documents (P6 budget, schedule summary)
    - Reviews (Documents specific to reviews, including internal reviews)

**Right Main Panel:**

- Document ID: CERN-0000194527
- Document Name: SP PDS consortium
- Status: Public access
- Info section
- More info section with tabs: Documents, Structure, Used in, Access rights, History.
- Actions: Create new document, Attach document, Detach, etc.
- Table header: #, Id, Title.
- Content: No documents
- Page navigation: Page 1 of 1

# Mechanical BOM/Drawing/Model Guide (EDMS 2384656)

SPPD Part Number	System	Title	Material	Mass (g)	No/system	Model EDMS	Drawing EDMS
<b>SPPD-01-XXX Supercell Parts</b>							
SPPD-01-001	Supercell	Side Rail Filter Plate Clamp Top	FR-4 G-10	3.63	6	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-002	Supercell	Side Rail Filter Plate Clamp Bottom	FR-4 G-10	3.77	6	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-003	Supercell	Central Filter Clamp	FR-4 G-10	2.17	4	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-004	Supercell	Supercell Filter Locating Plate	FR-4 G-10	13.24	1	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-005	Supercell	Supercell Center End Rail	FR-4 G-10	8.96	2	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-006	Supercell	Supercell 2mm top rail	FR-4 G-10	10.4	2	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-007	Supercell	SiPM PCB Mounting Block	FR-4 G-10	4.96	8	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-008	Supercell	Photosensor Mount Screw Shim Block	FR-4 G-10	0.24	6	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-009	Supercell	Photosensor End Mount Screw Shim Block	FR-4 G-10	0.12	4	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-010		OBSOLETE	OBSOLETE				
SPPD-01-011	Supercell	Dichroic Filter Plate	Fused Silica	16.94	6	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-012	Supercell	WLS Plate (Blue Polystyrene)	Polystyrene	190.66	1	<a href="#">2380160</a>	<a href="#">2383677</a>
SPPD-01-013	Supercell	One Direction Supercell Backing Plate	FR-4 G-10	101.37	1	<a href="#">2380160</a>	<a href="#">2383677</a>
<b>SPPD-02-XXX Module Parts</b>							
SPPD-02-001	PD Module	Module End Stop Block	FR-4 G-10	24.33	1	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-002	PD Module	Front Guide Bar (molded polycarbonate)	Polycarbonate	7.48	1	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-003	PD Module	Active Ganging Support Rail	FR-4 G-10	14.01	2	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-004	PD Module	Contact Block Spacer Block	FR-4 G-10	2.41	1	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-005	PD Module	End Module Side Support Bar	FR-4 G-10	33.84	4	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-006	PD Module	Center Module Side Support Bar	FR-4 G-10	63.44	2	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-007	PD Module	Module End Captive Screw Block	FR-4 G-10	9.69	2	<a href="#">2384229</a>	<a href="#">2384230</a>
SPPD-02-010	PD Module	Side Readout Bar	FR-4 G-10	62.61	4	<a href="#">2384229</a>	<a href="#">2384230</a>
<b>SPPD-03-XXX Guide Rail Parts</b>							
SPPD-03-001	APA Slot	PD Rail Mount Angle	Stainless Steel 304	15.51	8	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-002	APA Slot	PD Guide Rail-Far Side	Stainless Steel 304	491.64	2	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-003	APA Slot	PD Rail Mount Plate- Insertion End	Stainless Steel 304	104.85	1	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-004	APA Slot	PD Readout PCB Backing Plate	FR-4	48.28	1	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-005	APA Slot	PD Readout PCB	FR-4	17.02	1	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-006	APA Slot	Signal Cable Clamp	Polycarbonate	2.03	1	<a href="#">2384650</a>	<a href="#">2384651</a>
SPPD-03-007	APA Slot	PD Guide Rail-Readout Side	Stainless Steel 304	487.39	2	<a href="#">2384650</a>	<a href="#">2384651</a>
<b>SPPD-04-XXX-Cryostat Flange Parts</b>							
SPPD-04-001	PD Flange	PD Flange Blank	Stainless Steel 304	14467.58	1	<a href="#">2384689</a>	<a href="#">2384690</a>
SPPD-04-002	PD Flange	Flange Connector Cover Plate	Stainless Steel 304	277.7	1	<a href="#">2384689</a>	<a href="#">2384690</a>
<b>SPPD-05-XXX Assemblies</b>							
SPPD-05-001	Supercell	Hamamatsu Photosensor 8-pin PCB Sub-Assembly		3.52	8	<a href="#">2384654</a>	<a href="#">2384655</a>
SPPD-05-002	PD Module	Single-Side Supercell Assembly		636.89	4	<a href="#">2383678</a>	<a href="#">2383679</a>
SPPD-05-003	Supercell	Photosensor Sub-Assembly		8.48	8	<a href="#">2384654</a>	<a href="#">2384655</a>
SPPD-05-004	PD Module	ARAPUCA electrical connector Assembly		16.08	1	<a href="#">2384654</a>	<a href="#">2384655</a>
SPPD-05-005	N/A	Single Sided PD Module		3201.77	N/A	<a href="#">2383678</a>	<a href="#">2383679</a>
SPPD-05-006	PD Module	Cold Amplifier Motherboard Assembly		51.73	1	<a href="#">2384654</a>	
SPPD-05-007	PD Rail Assembly	Far Side Rail Assembly		524.54	2	<a href="#">2384649</a>	<a href="#">2384652</a>
SPPD-05-008	PD Rail Assembly	Connector PCB Assembly		87.37	1	<a href="#">2384649</a>	<a href="#">2384652</a>
SPPD-05-009	PD Rail Assembly	Near Side Rail Assembly		1285.07	1	<a href="#">2384649</a>	<a href="#">2384652</a>
SPPD-05-010	Flange Assembly	PD Flange Assembly		15006.33	1	<a href="#">2384688</a>	<a href="#">2384691</a>
SPPD-05-011	Flange Assembly	Flange PCB Assembly		139.72	1	<a href="#">2384688</a>	<a href="#">2384691</a>

Will connect to PBS Structure

# Using the BOM table

ITEM NO.	Part Number	Title	QTY.
1	SPPD-04-001	PD Flange Blank	1
2	HN-0275	2.75 Inch Conflat Flange	3
3	SPPD-05-011	Flange PCB Assembly	1
4	SPPD-04-002	Flange Connector Cover Plate	1

**DRAFT: NOT FOR PRODUCTION**

		UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MM TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± ONE PLACE DECIMAL ± 0.25° TWO PLACE DECIMAL ± 0.10 THREE PLACE DECIMAL ± 0.025	NAME DWW	DATE	Colorado State University Deep Underground Neutrino Facility Single-Phase Photon Detector TITLE: PD Flange Assembly	
		INTERPRET GEOMETRIC TOLERANCING PER:	CHECKED			Q.A. COMMENTS: Dimensions per ASME Y14.5M-2009
		MATERIAL	ENG APPR.			
NEXT ASSY	USED ON	FINISH	MFG APPR.			SCALE: 1:10 Mass (g) 15006.3 SHEET 2 OF 2
APPLICATION		DO NOT SCALE DRAWING				

**PROPRIETARY AND CONFIDENTIAL**  
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF COLORADO STATE UNIVERSITY. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF COLORADO STATE UNIVERSITY IS PROHIBITED.

# Guide to Electrical Documents ([EDMS 2384981](#))

## Guide to links to PDS Electrical documentation in EDMS

The present document is a quick guide to the electrical documentation available for the 60% review. The main folder in EDMS is [PD Electricals](#), the folder is divided in five subsections:

1. [System Levels documents](#): This category include
  1. [Grounding and shielding Documentation](#) with the file Photon\_Detector\_Grounding\_and\_Shielding\_6-15-20.pdf
  2. [Cable and Wiring](#): with the file Photon\_Detector\_Cable\_Harness\_Document\_Rev\_5.pdf
  3. [System Interface Documentation](#): with the file Cold\_Warm\_PDS\_Interface\_4\_27\_2020.pdf
2. [Cold Electronics Documentation](#): In this folder can be find the documentation related to the PD electronics planned to be located inside the cryostat. It includes the files:
  1. 202006\_DUNEcoldamp\_daughter\_Layout.pdf
  2. 202006\_DUNEcoldamp\_daughter\_Schematic.pdf
  3. 202006\_DUNEcoldamp\_daughter\_BOM.pdf
  4. 6-8-2020\_Active\_Ganging\_Motherboard\_PCB.pdf
  5. 202006\_DUNEcoldamp\_mother\_Schematic.pdf
3. [Warm Electronics Documentation](#): Documentation related to the digitalization board is available in this folder
  1. [Electrical Schematics and Board Layout](#) with files DAPHNE\_PCB\_Layer\_Strategy.pdf DUNE\_DAPHNE\_FEB\_Schematic\_6\_7\_2020.pdf
  2. [Warm Electronics BOMs](#) With files Bill\_of\_Materials-DUNE\_DAPHNE\_FEB\_6\_7\_2020.xlsx
  3. [Other Documents](#) With files DAPHNE\_Overview.pdf DAPHNE\_Hardware\_description.pdf DAPHNE\_Firmware\_-\_Gateway\_description.pdf
4. [Light Calibration Module](#): This folder includes documents describing the calibration modules to be used for the PDS
  1. [Electrical Schematics and Board Layouts](#) with sub folders
    1. [LBNE Calibration System](#)
    2. [LED Mounting Board](#)
    3. [DUNE-Calibration](#)
    4. [DUNE-SSP](#)
  2. [Light Calibration Module BOMs Documentation](#) with files LBNE\_CALIBRATION\_SYSTEM.BOM

SINGLE\_CHANNEL\_PULSER.BOM  
17pc001-A\_as\_built\_bom.xlsx

5. [Other Electronics](#): Additional documentation related to the PDS electrical under codename

Cryostat Flange PCB [NIOBE]  
Arapuca Connector Board [AECB]  
PD Connector Block PCB [SASEBO]

1. [PD Module Electrical](#) With files including schematics, layer drawings, BOM and 3D Models for Arapuca Connector Board and PD Connector Block PCB.

[Signal Routing PCB Milano](#) in this folder are files for the SiPM Routing board the files include: BOM, Standard Gerber, Extended Gerber, step, NC drill file and a project design file.

[SiPM PCB Milano](#) in this folder are files for the SiPM Mounting board the files include are: BOM, Standard Gerber, Extended Gerber, step, NC drill file and a project design file.

2. [Cryostat Flange](#) With files including schematics, layer drawings, BOM and 3D Models for Cryostat Flange PCB

3. [Power Supplies](#) With files DUNE\_PD\_DAPHNE\_Power\_Distribution\_System-CablingTable.pdf DUNE\_PD\_DAPHNE\_Power\_Distribution\_System-RackDiagram.pdf DUNE-LV-A3\_Cable\_Production.pdf DUNE\_PD\_DAPHNE\_Power\_Distribution\_System-BillOfMaterials.pdf WIENER\_MPOD\_Manual\_3.1.pdf



## Design Documents (Design remains significantly unchanged since TDR)

- [TDR](#) and [TDR update](#) document
- Full set of [electrical specifications](#)
  - Grounding and shielding description
  - Schematic and (most cases) board layout and Gerber files
  - Cabling plan
  - Bill of Materials for major (and most minor) components
- Full set of [mechanical specifications](#)
  - Component CAD models (.step) and drawings (.pdf)
  - Assembly CAD models (.step) and drawings (.pdf)
  - Bill of materials (Workbook and assembly drawing BOMs, including fasteners in many cases)

# Requirements Documents

- 3 [EB-held requirements](#)

Executive Board Held		
2235	SP Light yield	The average light yield (LY) shall be high enough to reach similar calorimetric energy resolution with the PDS for low energy supernova neutrinos as with the TPC. The average LY shall also be sufficient to enable triggering on neutrinos from supernova bursts. The minimum LY in the active volume shall be sufficient to correctly associate scintillation light with events with energy >200 MeV with efficiency >99%.
2237	Time resolution	The time resolution of the photon detection system shall be less than 1 microsecond in order to assign a unique event time.
2254	SP LAr nitrogen contamination	The nitrogen contamination in the LAr shall remain below 25 ppm in order not to significantly affect the number of photons that reach the detectors (for both fast and late light components).

- Four [TB-held requirements](#)

2292	Specification	SP PDS spatial localization in y-z plane	Events inside the active volume shall be localized in the y-z plane to within < 2.5m using light signals.	Spatial localization in the photon detectors themselves enables more accurate matching of photon detector signals with TPC signals.
2304	Specification	Signal-to-noise in SP-PD	The signal-to-noise ratio (single PE pulse height / baseline noise RMS) shall be greater than 4.	The signal to noise must be kept above this level to keep the DC data rate within the bandwidth limits of the PDS electronics. The direct impact of signal-to-noise on physics is small.
2305	Specification	Dark noise rate in SP-PD	The dark rate per electronics channel (e.g., summed across all ganged photosensors) shall be no more than 1 kHz.	The dark rate must be kept below this level to keep the DC data rate within bandwidth limits and to prevent significant contamination of physics events.
2306	Specification	Dynamic Range in SP-PD	The dynamic range shall be large enough that no more than 20% of expected beam events have channels which saturate.	Saturating channels degrade the ability to reconstruct energy calorimetrically, but a small amount of saturation can be mitigated. The equivalent TPC requirement is 10%.

- Consortium held-requirements in [EDMS 2382763](#)

- Approximately 140 consortium-held requirements and specifications covering the entire PD system

# Installation and Interface Control Documents

- Detector installation plan in [EDMS 2233449](#)
- Interface control documents
  - PDS/Consortium documents in [CERN 0000195979](#)
    - PDS/APA
    - PDS/JT-HV
    - PDS/JT-DAQ
    - PDS/JT-CALCI
    - PDS/TPC
    - PDS/JT-COM
  - PD/Installation [EDMS 2145176](#)
  - PD/Detector Support Structure (DSS) [EDMS 2339392](#)
- Released and in-progress versions

# Engineering Analysis Documents (Compliance Office)

- Analysis plan [EDMS 2380161](#)
- Structural analysis note [EDMS 2380229](#)
- Independent Review Reports [EDMS 2385859](#)

## 7. Conclusion for the 60 % design review:

The status of the design of the PD is in a status acceptable for the PD 60 % design review. The analysis plan is validated and can be used for the structural analysis required for the Final Design review.

# QA/QC Documents

- Preliminary QA/QC plan [EDMS 2384692](#)
  - Extensively developed for X-ARAPUCA
  - SiPM QA plan posted
  - Continuing for other PD subsystems
- ProtoDUNE 1 lessons learned [EDMS 2384687](#)
- Manufacturing and procurement plan [EDMS 2384693](#)
  - “International flavor” to capture needs of an international consortium
- Plan for Prototyping activities [EDMS 2384653](#)
  - Ash River & PSL module tests
  - Supercell tests in Brazil, Italy, Spain
  - ICEBERG
  - Cold box test at CERN (end-to-end readout test into DAQ)
  - ProtoDUNE 2
- Documentation being developed on ProtoDUNE 1 Structure

## Cost and schedule

- Costbook and narrative description from P6 ([EDMS 2382764](#))
  - Based on detailed BOMs, including vendor quotes and estimates as well as time and motion studied from ProtoDUNE and other test stations
- Schedule with key milestones, schedule narrative, based on P6 ([EDMS 2383672](#))
  - NOTE: Does not include COVID-19 impacts

## Additional documents

- Responses to past reviews ([EDMS 2384615](#))
- Results from internal DAPHNE review ([EDMS 2385075](#))
- An introduction to PDS and 60% design review documentation ([EDMS 2383202](#))
- Xenon doping at ProtoDUNE update ([EDMS 2382770](#))
  - Status of data analysis and plans for future development

# Presentations (Execution)

- We will describe the full PD system in presentations at this review including:
  - Physics simulation justifying performance specifications of PDS
  - Prototype and ProtoDUNE 1 results validating fundamental design choices
  - Mechanical design including:
    - Module design
    - Support Structure
    - Monitoring system
    - Cryostat flange design
  - Photosensors including results from ProtoDUNE and first data from custom splits
  - Electronics including
    - PD electrical connections, signal routing on module
    - Active ganging (cold amplifier) design and testing
    - Signal cable plan, routing, grounding plan
    - DAPHNE design and prototype planning
    - Power supplies and cabling
  - Monitoring system design and validation



# Summary

- We are presenting a photon detector system design and documentation set ready to proceed to preparing for the final design review (FDR).
- We have validation in ProtoDUNE and other test sites to demonstrate we will meet our specifications and requirements, and prospects to do better yet by the FDR.
- We have a plan for additional validation and testing.
- While delays due to the COVID 19 crisis have slowed our prototyping plans, our laboratories are re-opening and exciting times await.
- We understand our cost and schedule.
- Exciting opportunities are being investigated (e.g. xenon doping) but they are not baseline and **not required to meet PD system requirements.**