Overview of Documentation for the DUNE FD2-VD Photon Detector System Preliminary Design Review

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DUNE FD2-VD PDS PDR

3 May 2022

Outline

- Design Documents
- Requirements Documents
- Installation Documents
- Interface Documents
- QA/QC Documents
- Cost & Schedule Documents
- Tracking Documents

Documentation for DUNE FD2-VD Photon Detection System
Preliminary Design Review

May 2022

Color Code: **Ready to Review** | **Preliminary/ In Progress** | **Internal PDS Group review** | **Not yet ready for Review**

Category	Document	EDMS	Review Release Status
Review Aids	This table	CERN-EDMS-2723818	**Ready**
	Introduction (Overview Presentation for PDR)	CERN-EDMS-2733740-1	**Ready**
Design Documents	CDR	CERN-EDMS-2709820	**Ready**
	FD2-VD PDS Prototype Performance Report (in lieu of CDR Chapter Update)	CERN-EDMS-2732678-1	**Ready**
	Mechanical CAD Model for Sub-system	CERN-EDMS-229933	**Ready**
	Mechanical Engineering Drawings	CERN-EDMS-229934	**Ready**
	Mechanical Assembly Drawings and Parts Lists	CERN-EDMS-229934	**Ready**
	Grounding & Shielding Plan	CERN-EDMS-2730056-1	**Ready**
	Specification of Electrical Cabling and Wiring Connections	CERN-EDMS-2730049	**Ready**
	Electrical Schematics & Board Layouts	2730026 - Guide to Links to FD2 PDS Electrical Documentation	**Ready**
	Bills of Materials for Electronic Board Components	2730026 - Guide to Links to FD2 PDS Electrical Documentation	**Ready**
Requirements Documents	Overview	CERN-EDMS-2732677-1	**Ready**
	EB-Held Requirements	CERN-EDMS-2346091-V5	**Ready**
	TB-Held Requirements	N/A	**Ready**
	Consortium-held Requirements	CERN-EDMS-2732674-1	**Ready**
Installation Documents	Detector Installation Plan	CERN-EDMS-2730715-1	**Ready**
Interface Documents	Overview	CERN-EDMS-2733252-1	**Ready**
	Consortium-Consortium	CRP BDE TDE HVS DAQ CALCI	**Ready**
	Consortium-Installation	CERN-EDMS-2648555-1	**Ready**
Engineering Analysis Documents	Analysis Plan	CERN-EDMS-2733739-1	**Ready**
QA/QC Documents	Preliminary QA/QC Plan	CERN-EDMS-2730720-1	**Ready**
	Cold Box #1 Lessons Learned	CERN-EDMS-2731245-1	**Ready**
	Preliminary Manufacturing and Procurement Plan	CERN-EDMS-2730718-1	**Ready**
	Plan for Prototyping Activities	CERN-EDMS-2730719-1	**Ready**
Cost/Schedule Documents	Cost Estimate	CERN-EDMS-2732675-1	**Ready**
	Schedule Summary	CERN-EDMS-2732676-1	**Ready**
Tracking Documents	Responses to Past Review Recommendations	CERN-EDMS-2734605-1	**Ready**

Ready = Version to be reviewed for PDR

Design Documents - General

- FD2-VD CDR
  - Approved in March 2022.
  - TDR Chapter on FD2 PDS expected in “2nd batch” to go to LBNC in September 2022.
    - Will include R&D lessons from Cold Box tests, full simulation+reconstruction studies

- FD2-VD PDS Prototype Report
  - Report covering much of the material from Flavio’s introductory presentation, including performance observed in December 2021 Coldbox 1 Run.

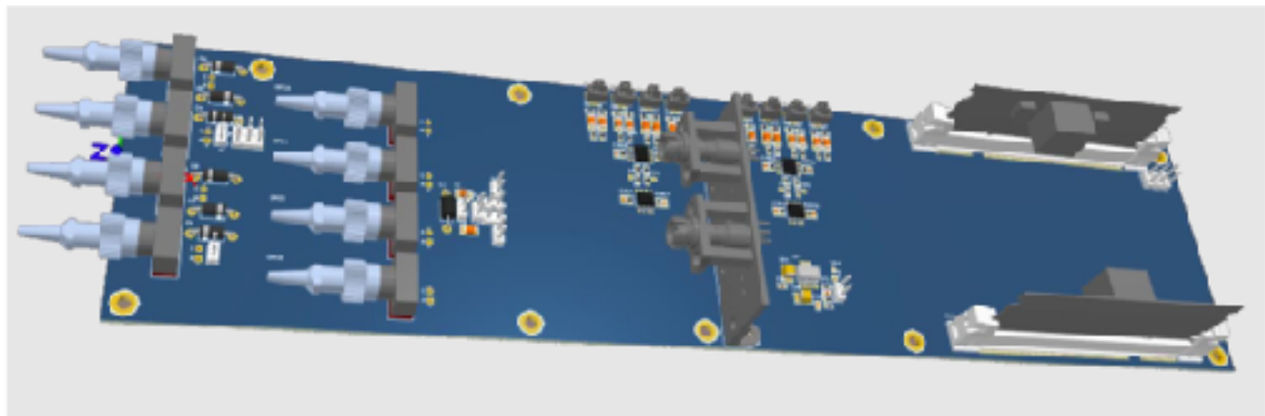
Design Documents - System-level Electrical

- Grounding & Shielding Plan - EDMS-2730056-1
  - Last updated 2022-04-20. Description of system topology, grounding at flange, interconnections between components, and connection to cathode reference.

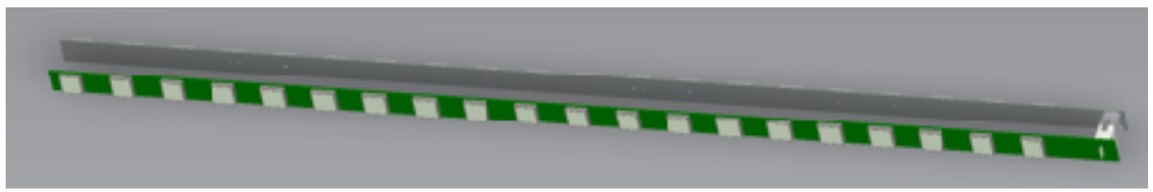
- Cabling and Wiring Specification - EDMS-2730049-1
  - Last updated 2022-05-02. Description and specifications of cabling within PD modules, between modules and flange, and between flange and DAPHNE readout cards. Description of feedthrough usage for PDS modules and Detector Response Monitoring system. Specification of fibers.

Design Documents - Cold Electronics

- Motherboard - EDMS-2729826-1
  - Last update 2022-04-29 (addition of fab. files).
  - Schematic, BOM, Fabrication Drawings, Fabrication Files
  - 30 exist - 1 populated and in testing since end of April 2022.



- (SiPM) Flex Circuit - EDMS-2729829-1
  - Last update 2022-04-29 (addition of .stp file)
  - Schematic, BOM, .stp file
  - V1 used at Coldbox 1. V2 expected week of 2022-05-02.



- Daughter Cards
  - SiPM bias generator using DC-DC converter - EDMS-2729827-1, Active Laser Adapter (SoF) - EDMS-2733204-1
    - Last updated 2022-04-29 (addition of fab. files).
    - Schematic, BOM, fabrication Drawings & Files.
    - Both exist and are currently being tested at PAB (Fermilab).

Design Documents - Warm Electronics

- Digitization & Readout will be based on DAPHNE card developed for FD1.
  - 12 boards produced in 2021.
  - Modification required for single-ended signal.
  - See Dave Christian's talk.

Design Documents - Detector Response Monitoring

- System will be largely informed by design of FD1 Light Calibration Module
- Design studies in progress, e.g. FD2 vs FD1 geometry.

Design Documents - Mechanical (See D. Warner presentation)

- 3-D Models
  - Cathode-mount XARAPUCA .stp file
    - Not yet fabricated.
  - Spring Blocks & Spring Block Assembly for Coldbox 1
- Mechanical Drawings
  - Flanges for Coldbox 1
  - Feedthroughs for Coldbox 1
  - XARAPUCA Shielding Concept
- Assembly drawings and parts lists
  - Coldbox 1Spring Block Assembly

Requirements Documents

- See E. Segreto's presentation and R. Rivera summary document
- EB-held requirements
  - Approved by EB in July 2021, "In Work" Status.
- TB-held requirements
  - None defined at this time.
- Consortium-held requirements EDMS-2732674-1
  - "In Work" status.
  - Identifies requirements for subsystems for Integration, Design, Fabrication, Installation, Miscellaneous.

Installation Documents

- See D. Pushka presentation
- Installation Plan - https://edms.cern.ch/document/2730715/1
  - Describes installation steps, prerequisites for each phase, time estimates, labor coordination plan.

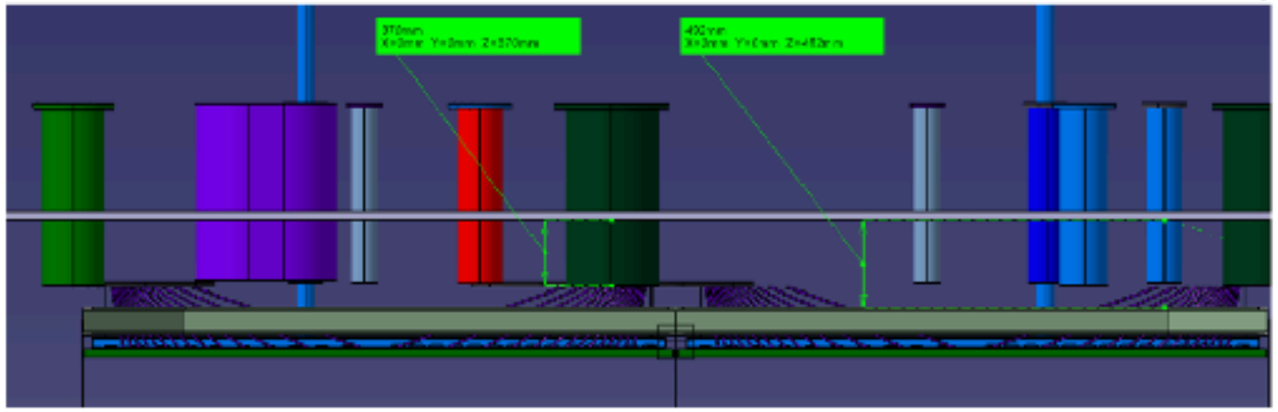
Interface Documents

Interface Documents: PDS - CRP

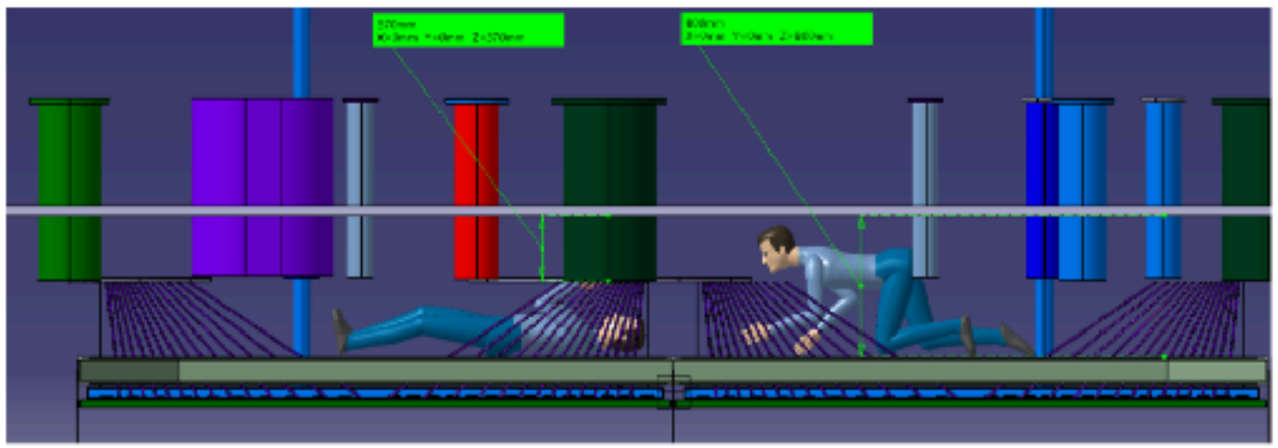
- EDMS-2619004-1 - “In Work”
- Skeleton Document noting potential hardware interfaces of fiber routing and mounting Detector Response Monitoring components.
- PDS power and signal fiber routing will have an interface with top CRP
  - installation plan under development in collaboration with CRP.

- Fibers for Detector Performance Monitoring system may have interface with both CRPs.
- Document requires update to reflect this ongoing work.

Nicolas Geffroy



Nominal Position 492mm



Cabling Position 800mm

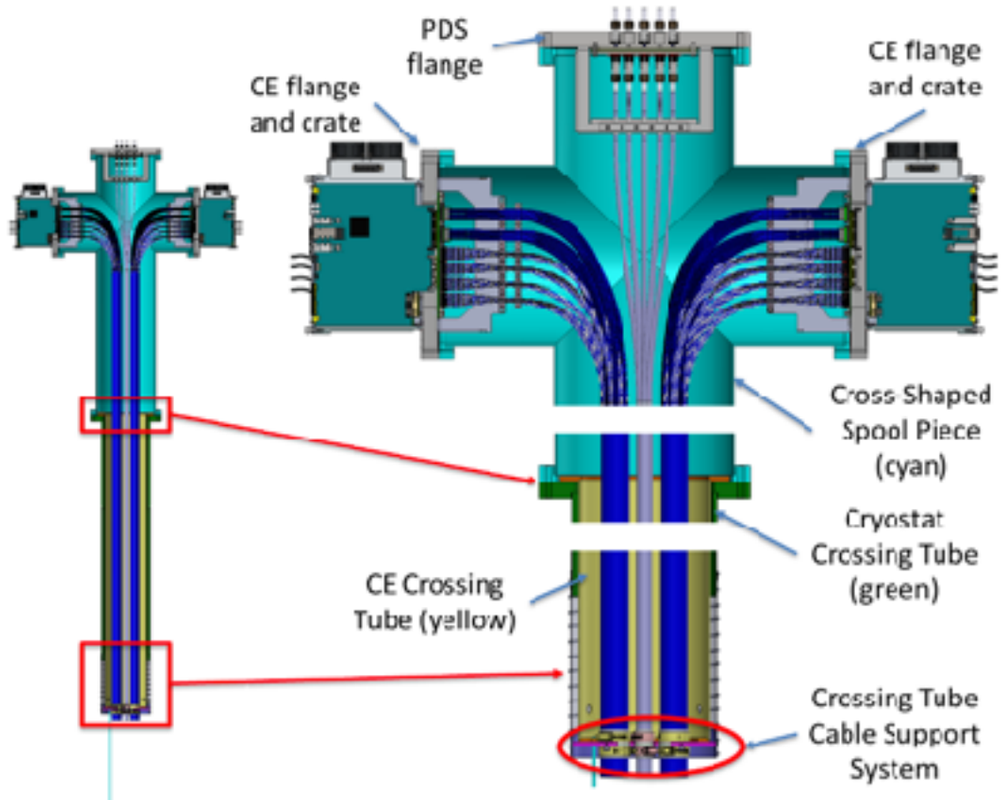
Interace Documents: PDS - TDE

- EDMS-2619001-1
- Skeleton Document - “In Work”
- Potential mechanical interfaces
  - Fiber routing - most likely indirect through Integration.
  - Mounting of PDS Detector Performance Monitoring system components.
- Electrical interfaces
  - No electrical connection other than common (membrane PDs and TDE) reference voltage at the cryostat.
  - Potential noise generation by either system on the other.

Interface Documents: PDS - BDE

- EDMS-2618994-1 - “In Work”
- Main interfaces identified.
  - Mechanical:
    - shared cryostat penetrations.
    - usage of cryostat wall cable trays.
  - Electrical:
    - No contact other than common reference voltage (for membrane detector) via flange.
    - Potential for cross-system noise.
- Cable tray usage handled in Integration.
  - PDS usage remains to be specified in I&I interface documents
- Detailed plan for penetration/spool piece design
- Testing plans
  - BNL penetration mock-up
  - Module 0 - attempt to use same penetration for cathode-mount PDS fibers & BDE
- Integration, Installation, Commissioning
  - Following installation of cables & fibers through penetrations, two efforts decouple.
  - Address any noise identified during commissioning.

FD1 penetration/cross-shaped spool piece to serve as basis for FD2 design.



Fermilab

Interface Documents: PDS - HVS

- EDMS-2619007-1 - file version 1.2 - “Released”
- Interfaces
  - Distribution of PDS LV, Bias between cells on otherwise resistive cathode (potential to undermine HV discharge safety).
  - Mounting of PDS modules & components on cathode
  - Routing of PDS fibers & cables through cathode.
  - Potential need for shielding for membrane-mount PDS electronics in high field.
- Identification of responsibilities and strategies as applicable for Design, R&D/ Testing, Fabrication, and Installation.
- For example, discharge testing. See R. Rivera presentation.

Interface Documents: PDS - DAQ

- EDMS-2088726-4 - Joint FD1/FD2 Document - “Released”
- Addresses data formats, readout, timing, and controls.
- Data Format, architecture essentially the same for FD1 and FD2.
  - FD2 differences expected to have “negligible” impact on DAQ interface.
- Minor changes will likely be needed as PDS design matures.
- Note: *Slow Controls are no longer in DAQ. PDS-SC interface does not seem to appear in other documentation as of May 1, 2022.*

Interface Documents: PDS - CALCI

- EDMS-2619009-1 - FD2 - no file.
- EDMS-2145137-3 - FD1 - “In Work” (-2 “Released”)
- Main interfaces relevant to FD2
  - Need for interlocks to prevent concurrent operation of PDS and CALCI light-sources.
  - CACLI ionization laser will not be aimed at PD Modules.
  - Potential warm interfaces of rack and (external) cable tray space.

Interface Documents: PDS - I&I

- EDMS-2648555-1 - “In Work”
- Several flagged questions to be addressed by PDS.
- Installation plan - see D. Pushka presentation.

Analysis Plan

- EDMS-2733739-1 - Status “In Work” - See D. Warner presentation.
- With Compliance Office, hoping for responses this week.

QA/QC - QA/QC Plan

- Preliminary plan - EDMS-2730720-1 - Status “In Work”
- Strategy
  - establish Continuous Improvement Process (CIP) team for defining & maintaining QA/QC procedures,
  - establish communication channels between CIP team and those implementing QA/QC procedures,
  - track test history results by component label,
  - enable CIP team to enhance procedures from Cold Box, Module 0, and initial 10% production phase.
- Organized by
  - Cold mechanical (XARAPUCAs), cold electrical, warm electrical, warm mechanical, firmware, software, full chain.
- Leverages experience from FD1 (HD).

QA/QC

- Procurement & Manufacturing - EDMS-2730718-1 - “In Work”
  - Identifies preferred approach for critical components.
  - Identifies responsibilities by organizational title, with names.
  - Lays out Objectives & Scope, responsibilities for Manufacturing Process, Materials requirements, Inspection requirements, Shipping plans.
  - for XARAPUCAs, SiPMs, Warm & Cold Electronics, Supports/Flanges/Feedthroughs/Fibers/Cables, Response & Monitoring system.
  - Leverages experience and progress with FD1.

- Prototyping plan - EDMS-2730719-1 - “In Work”. *(Made public 2022-05-02)*
  - Describes plan for X-ARAPUCAs, SiPMs, Warm & Cold Electronics, Supports/Flanges/Feedthroughs/Fibers/Cables, Response & Monitoring system.
    - With timeline
  - See S. Sacerdoti presentation.

Cost & Schedule, Tracking docs

- Cost Estimate - EDMS-2732675-1 - “In Work” - Restricted Access
  - Cost Book and Cost Book Narrative.
  - See R. Rivera Presentation (Thursday 2022-05-05).
- Schedule Summary - EDMS-2732676-1 - “In Work”
  - Overview, Schedule snapshot from P6.
  - See R. Rivera Presentation (Thursday 2022-05-05).
- Tracking Documentation
  - Responses to Questions from Previous Reviews - EDMS-2734605-1

Summary

- Our assessment of level of completion

DESIGN ELEMENT	*PERCENT COMPLETE*	*Comment*
Requirements	*80*	*Partly informed by FD1*
Interfaces	*60*	
Cathode-mount mechanical	*80*	
Membrane-mount mechanical	*60*	
Cathode-mount electronics	*80*	
Membrane-mount electronics	*60*	*Informed by FD1*
Power-over-fiber	*70*	
Response Monitoring	*60*	*Informed by FD1*
Warm electronics	*80*	*Informed by FD1*
Integration & Installation	*60*	
Grounding, Cabling, Shielding	*70*	
Analysis Plan	*60*	
Cost & Schedule	*80*	
QA/QC	*60*	
Tracking Documents	*80*	