

VD-CDR Updates

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Recent developments

- VD-CDR sent to LBNC for review on Aug 10th
- Comments from LBNC received on Sep 5th
- 10 “high-level” comments
 - Related to us: move PDS prototype and demonstrator plans from “PDS” chapter to “Prototypes and Demonstrators” chapter
- 73 PDS-specific comments
 - We have been working with Central Editing Team (Anne, Marvin, Sandro) to address those
 - Thanks to those of you who also contributed!
 - Selected LBNC comments follow

Timeline for full physics studies

- LBNC asked when PDS simulation fully integrated within LArSoft will be ready to go → end of 2021
- Until then, hard to answer some LBNC questions, eg what is the expected sensitivity improvement of the VD for nucleon decay in comparison with HD

PDS specifications

- We assume same Signal-to-Noise specification as HD: $S/N > 4$
 - Single-PE signals over baseline RMS
- Motivated as reachable based on a ProtoDUNE measurement with a different ganging configuration (12 SiPMs)
 - Do we have a more relevant S/N measurement to quote now, more similar to ganging foreseen for VD (80 SiPMs)?

Nitrogen contamination

- LBNC recognised N2 contamination can have large effect on light yield
- N2 specs < 10 ppm ($\lambda_{\text{abs}} > 7 \text{ m}$ at 128 nm, $\lambda_{\text{abs}} > 27 \text{ m}$ at 175 nm), while simulations made in more optimistic conditions: $\lambda_{\text{abs}} = 50 \text{ m}$
- LBNC particularly concerned fall-back design (with 720 membrane-mount modules, no cathode-mount modules) unable to meet LY specs for N2 = 10 ppm
- With Xe doping, N2 absorption becomes more benign, so fall-back design with ~720 modules should still (barely) meet LY specs
 - Need to rephrase to explain no increase in number of modules, nor tightening of N2 specs, necessary for fall-back design
- Also need to expand discussion of N2 contamination to baseline design

Fall-back PDS and field cage designs

- LBNC did not understand fall-back design assumed membrane-mount modules not only at 2.5 - 6.5 m distance from cathode, but also closer to it
 - Implies using narrower (more transparent) field cage profiles closer to cathode as well
 - Current assumption: narrow field cage profiles can be used up to 50 cm distance from cathode without risks of discharges
 - This coverage would be sufficient for fall-back design

Improvements to X-ARAPUCA design in HD

- For VD, assuming same 3% photon detection efficiency despite x2.4 lower ratio of photosensors per optical area
- Justified based on improved light collector design for VD
 - Dichroic filters with enhanced substrate and sharper wavelength cuts, more efficient WLS plates, reflector coatings on WLS slab edges, direct SiPM-to-WLS optical coupling
- LBNC: which of these expected improvements for VD can be propagated back to HD, at this (late) stage?
 - We need to clarify this

Adhesion of SiPMs to WLS plates

- LBNC wonders about long term properties of glued optical contact in cryogenic environment
- Now explicitly mention ongoing studies on adhesion (Milano, CSU)

Ambient light

- LBNC: is there a concern that ambient light (at longer wavelengths) from PoF/SoF may produce background in PDS modules?
- PoF carrying much larger amount of optical power (IR photons)
- CERN tests: use of black jacketed fibres found to reduce glow below detection sensitivity with high thermal resolution IR cameras → not a concern.

Dynamic range

- LBNC wonders whether HD and VD necessary dynamic ranges are the same despite different module sizes and different module locations, given that same warm electronics is anticipated
 - Is 12-bit ADC adequate for both?
 - We are assuming so: necessary dynamic range from 1 to ~1000 PEs assumed in both systems

Readout electronics selection criteria

- LBNC notes the large phase space on readout electronics R&D and asks for a clearer down-selection decision process
 - When decisions will be made and on what basis
 - Mention cold box prototype progression, our simulation plan, and cold qualification activities
- LBNC also asks whether we are sufficiently prioritising over baseline solution
 - Stress baseline solution for readout has been identified (analog transmission), with potential enhancements to this design not deflecting significant efforts away from baseline design R&D