

Dual Phase Photon Detection System Consortium Meeting

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DPPD Consortium Meeting

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Ciemat
Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas



Topics for today

- Feedback from LBNC meeting
- Photon analysis update (Jose)

LBNC charge

The primary goal of this meeting is to **understand the progress made with the Dual Phase technology**. We have therefore devoted the whole of the first afternoon.

Our hope would be to hear in detail of the **installation and the operations thus far of ProtoDUNE DP**. This should describe both the successes and the difficulties, for example the ion build-up, the bubbling, and the purity. This can be divided among several speakers.

The LBNC imagines that each of the issues is likely to require significant future R&D and would like to hear about those **plans including their schedules**. Of particular interest may be the 600kV Power Supply design issues.

Finally, we expect that this discussion leads to an understanding of a **path forward towards a Dual Phase detector**. The LBNC would like to hear how this path would lead to a future verification program likely including a **second phase of ProtoDUNE DP operation**, and to a **TDR at an appropriate time**.

Agenda LBNC DP session

Thursday, Dec 5

14:00	ProtoDUNE DP: overview of operations and system stability (15+5) 304/1-001, CERN	Dominique Duchesneau	13:45 - 14:05
	ProtoDUNE DP: HV (15+5) 304/1-001, CERN	Francesco Pietropaolo	14:05 - 14:25
	ProtoDUNE DP: Purity (15+5) 304/1-001, CERN	Filippo Resnati	14:25 - 14:45
	ProtoDUNE DP: CRPs (15+5) 304/1-001, CERN	Edoardo Mazzucato	14:45 - 15:05
15:00	ProtoDUNE DP: Electronics and DAQ (15+5) 304/1-001, CERN	Dario Autiero	15:05 - 15:25
	ProtoDUNE DP: Photon System (15+5) 304/1-001, CERN	Ines Gil Botella	15:25 - 15:45
16:00	Break		15:45 - 16:15
	DP Computing and Analysis status (15+5) 304/1-001, CERN	Elisabetta Maria Pennacchio	16:15 - 16:35
	DP R&D: LEM and Component R&D Plans (15+5) 304/1-001, CERN	Edoardo Mazzucato	16:35 - 16:55
17:00	DP R&D: System R&D Plans, ProtoDUNE – II (20+5) 304/1-001, CERN	Marzio Nessi	16:55 - 17:20
18:00	Executive Session 304/1-001, CERN		17:20 - 18:30

Friday, Dec 6

14:00	FD SP (APAs and installation, TPC Electronics) 304/1-007, CERN	Christos Touramani...	DP Follow-up 60/2-023, CERN	Beamline 33/S-004 - KT conference room, CERN	Jonathan Lewis
15:00	Reassemble 304/1-007, CERN				15:15 - 15:30
	Break				15:30 - 16:00

Questions on DPPD talk

- Purity plot correlation with purity monitor measurements?
- TPB/PEN: difference with lab results?
- TPB stability
- TPB reflective foils in protoDUNE phase II
 - Detailed design, coating, installation plan, testing...

Talking Points for DP Parallel Session

(0) TDR – appreciate detailed response to our questions (we’re not yet finished reviewing). We agree with plan to pause TDR in defined state, to be picked up after protoDUNE results

(1) Appreciate detailed talks – really needed a full day rather than the afternoon

- **is there anything further you would like to tell us, or a message you wanted to convey that we may have missed**

(2) **What do you hope to learn with further operation**

- for each issue (maybe use Marzio’s slides)
- and in particular, with the HV surgery – the design will be different for PD-DP-II, so why do this (high risk). Possibly to map purity with depth? Is it worth it?

Discussion

- purity needs to be solved
- may have to design to live with waves and bubbles
- what about ion trapping at surface (“not an issue below ground” is not very satisfying)

(3) **What design changes would make DP robust for operation with waves and bubbles**

(4) **Plans to validate new LEM/CRP design prior to PD-DP-II**

(5) **Priority of 600kV system design at this point, and need for dedicated 12m drift test stand (parallel effort to PD-DP-II)**

(6) **WLS material** – TPB is baseline (but only 6/36 in PD), PEN is new. What is the plan to conclude on material and application method ahead of PD-DP-II. **For PMTs and the WLS reflective panels (large area of the material in LAr)**

(7) **Resources/organization?** ← general impression

DP follow-up session

- TDR: new comments from LBNC coming soon (no major ones). They were pleased with the contents
 - TDR will stay in pause as it is (no more iterations are expected)
- Plans for installing WLS reflective panels in protoDUNE-II in more detail (large surface close to CRPs) -> test installation, performance, etc... There is enough time to prepare it well in advance
- Proposal to have more regular interaction between the DP operations group and the LBNC experts, e.g. on a monthly basis.
 - First meeting end January/ beg February 2020

LBNC committee for DP

ProtoDUNE DP detailed Progress; Install, Operation Results.

Dual Phase R&D Plans

Dual Phase Review/writing Team: **Jeff Spalding**, Cristiano Galbiati, Eric Kajfasz, Adam Para, Jim Proudfoot, Darien Wood

- Closeout report available:

- <https://indico.cern.ch/event/857610/timetable/#20191207.detailed>

Findings:

- NP02 cryostat filling completed in early August. Extensive progress commissioning the various systems (CRP alignment and tracking, LEMs and grids, PMTs, electronics and DAQ), but several issues have limited periods of stable operation:
 - A short in HV extender connection limits the HV to <150kV, providing a uniform field for ~1.5m drift (1/4 of full depth). Within this region, track reconstruction performs well. Plans are under development for surgery that severs the shorted connection to allow deeper drift region.
 - Purity: several gas filter regeneration cycles have been needed – filter clogging with “dust” (chemical analysis in process). e-lifetime is improving slowly, but currently purity monitors and TPC measurement from tracks indicate still below minimum requirement.
 - LAr surface bubbles (seen at two particular locations: HV feedthrough and FC clips – mechanism not understood) and development of surface waves(~1mm peak to trough) limit stable CRP operation (no discharging). Work-around developed with pressure cycles to provide limited periods of more stable operation, while also supporting studies of the bubble/wave phenomena.

Dual Phase: ProtoDUNE DP Progress and R&D Plans

Jeff Spalding, Ties Behnke, Cristiano Galbiati, Eric Kajfasz, Jim Proudfoot, Darien Wood

Findings continued:

- The stable operating margin is compounded by reduced planarity of CRP at LAr temperature - design change needed to improve “stiffness”
- Ion trapping at liquid surface reduces signal –needs further study (expected to be much less of an issue below ground)
- Systems commissioning
 - CRP alignment and HV commissioning: progressing, but limited by stable operating periods
 - Electronics: common mode noise from pickup in slow controls cables partially mitigated. Discharge in a CRP without LEMs damaged the electronics – successfully accessed and replaced (an advantage of the DP design)
 - PD system: 6/36 PMTs with TPB, 30 with PEN sheets for WLS. Calibration established, Comparison TPB/PEN ongoing. No WLS reflector panels in protoDUNE-I
- DUNE discussed initial planning and goals for further operation over next few months
 - An extensive set of potential tasks and goals to (a) develop and document CRP performance, and (b) develop understanding of the purity and liquid surface issues. A campaign.
- LEM/CRP improvement plan
 - Improvements to LEM and CRP are in place to address spark rate (hole rim quality, guard rings) and planarity – plan to install 2 new-design CRPs in ProtoDUNE-II
- ~~LBNC informed of ideas in internal discussions for sharing the NP02 cryostat for DP protoDUNE-II and for validating technology for the 4th “Module of Opportunity”~~

Dual Phase: ProtoDUNE DP Progress and R&D Plans

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Comments:

- The committee appreciates the detailed set of presentations, and the discussions in the breakout session on protoDUNE-DP.
- And would like to extend congratulations to the cryogenic and DP teams on the hard work and significant progress made.
- **It is essential that proto-DP issues are either solved or addressed in the design, with validation in a future protoDUNE demo using near-final components.**
 - Purity – has to be understood and solved
 - Waves and bubbles – may have to modify the design to manage / live with such disturbance. If source not under control, design needs to be robust.
 - Ion trapping at liquid surface – need to fully understand scale and impact on performance – although we note that this expected to be much improved with zero cosmic rate at SURF
- DP should develop and provide a specification for the surface quality necessary for stable CRP/LEM operation. We note that the spec can be developed using the cold box setup.
- We consider the intervention surgery on the HV extender to be high risk – even with development of special tooling and practice mockups. This needs strong justification (need for data with longer drift), and if carried out, should be deferred until after high priority studies are concluded.

Dual Phase: ProtoDUNE DP Progress and R&D Plans

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Comments continued:

- Critical R&D and design work towards close-to-final design for successful ProtoDUNE-DP-II will require well defined interim test steps – [needs detailed planning and realistic timeline to protoDUNE-II](#)
- [eg. for WLS, protoDUNE-II will include the reflective panels and validate final material choice and application method, following R&D with smaller scale pre-testing.](#)
- The plans to develop the 600 kV HV system and 12m drift dedicated test stand should be in parallel, but must not divert the focus on the work towards protoDUNE-II
- With partial mitigation of the noise from the slow control cables, the current noise level is $\sim 1,300e$, still with significant common mode component. It looks promising that $< 900e$ will be achieved with full mitigation and noise filtering (which would meet spec $< 1000e$)
- Mapping CRP gain and S/N versus LEM voltage is ongoing – has been limited by insufficient periods of stable operation. Achieved CRP gain of 7.6 at 3.2kV (compare minimum spec for gain > 6). Plan to extend measurements and to study to higher voltage.

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Comments continued:

- Competing needs: completion of present CRP studies needs ~2 months of stable conditions, while purity, bubble and surface wave studies needs months of unstable conditions
- **Need to define priorities and to map out a “living” run plan**, which in turn needs stronger run coordination and a coherent prioritized plan to ensure efficient operation for next ~8 months.
- It is very important to complete this DP R&D through to conclusion: learning from this run, and the subsequent R&D/design program towards protoDUNE-II.
- **LBNC strongly endorses continuing to run for several months to complete this program.**
- The LBNC DP sub-team would appreciate an ongoing process (perhaps brief interim video meetings) to help us remain abreast of progress

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Recommendations:

- Provide a specification for the surface quality necessary for stable CRP/LEM operation.
- Develop a coherent prioritized run plan and stronger run coordination to support competing needs of mapping the CRP performance and the critical work to understand and mitigate the purity and surface issues.
- Develop planning for R&D and design changes with interim test steps to support successful protoDUNE-II validation of close-to-final design.

Next meetings

- Jan 21, DPPD meeting (in preparation for collaboration meeting)
- DUNE collaboration meeting at CERN (27-31 Jan, 2020)
 - I requested one DPPD session: please think about possible presentations
 - Do we want a joint SP/DP PDS session?