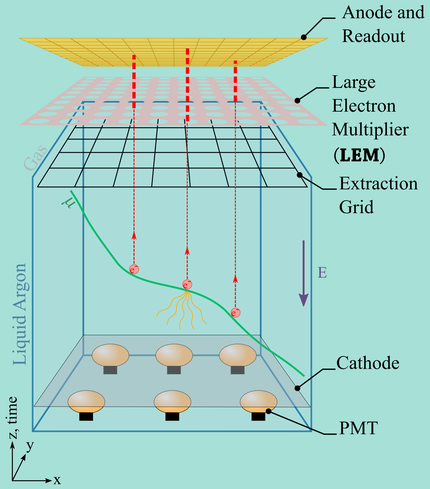
Performance of ProtoDUNE Dual-Phase

Laura Zambelli (LAPP/CNRS) for the DUNE collaboration

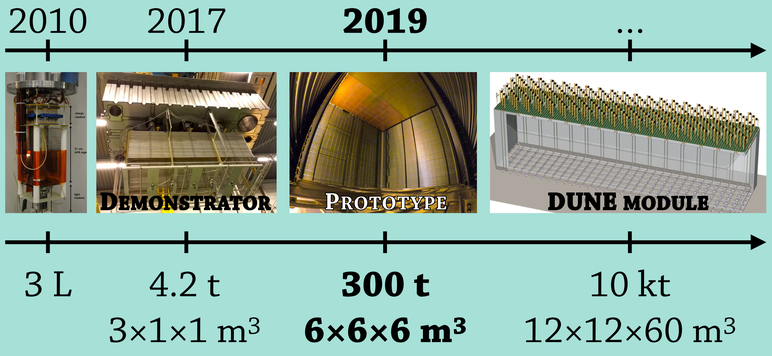
Dual Phase LArTPC

A Liquid Argon TPC with an argon gas layer to amplify the e^- in LEMs before collection



⇢ Design foreseen for one far detector module of DUNE

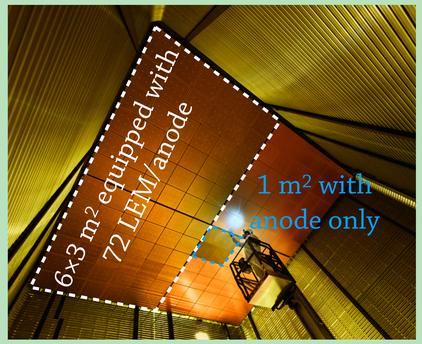
⇢ 10 years of R&D to optimize the technology and its scalability



⇢ Prototype built at CERN (Neutrino Platform) collecting cosmic rays (Phase I)

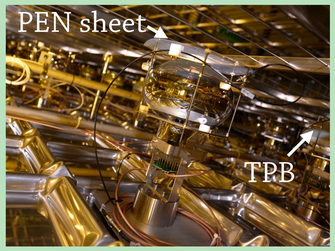
Prototype Commissioning

2018-19: Construction, Jul. 19: LAr filling



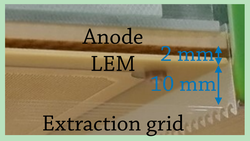
Part of the collection area is fully instrumented.
All sub-system were tested in a cold box prior to installation.

36 8" PMTs installed below the cathode with 2 wavelength shifters



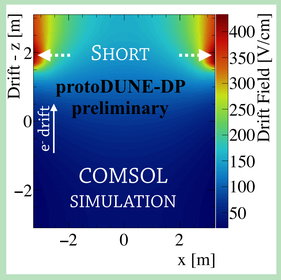
See Poster 41 for details

Operation : Extraction grid at ~6kV. LEM operated at ΔV=2.5~3.3kV/cm. HV kept over several days. Sparks limiting run acquisition.



Short between HV extender and the field cage

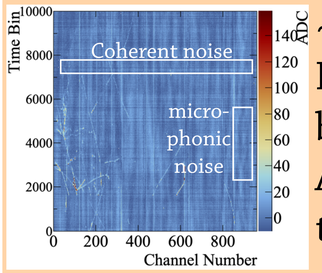
⇢ Non uniform drift field



Preliminary Performances

See Posters 298 and 449 on track reconstruction

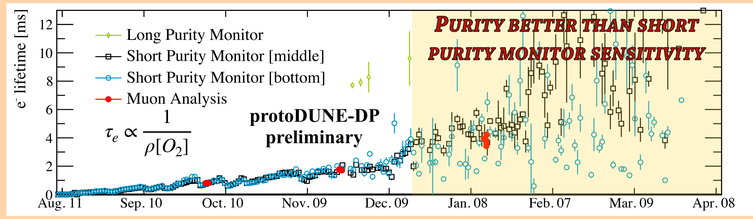
Data Quality



~2 M events collected so far
Noise RMS at ~2 ADC, well below signal.
All channels alive, some get temporarily noisy after spark

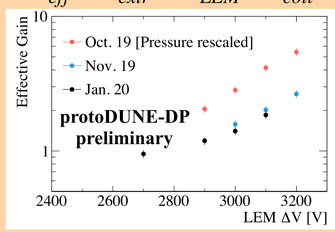
LAr Purity

Daily e^- lifetime measurement and results from muon-like sample analysis in cosmic runs



Effective Gain

$G_{eff} = \varepsilon_{extr} \times G_{LEM} \times \varepsilon_{coll}$



Effective Gain compared at similar conditions. LEM gain decreases with time due to charging up.

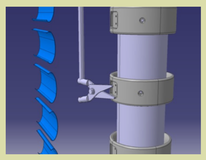
See Poster 42 on light system performances

Future improvements

⇢ Phase II in preparation with CERN

⇢ Possibility of test beam data after LS2 (2022+)

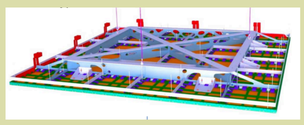
Short surgery (summer 2020)



Cut the 3 upmost connections to the field cage with tools inserted and controlled remotely. Training with 1:1 mockup.

20% of LAr in evaporation; full refill by end of summer

Charge Readout Upgrade (2021)



Structure robustness improved
Grid spark elimination/attenuation
Larger LEM active area (86%→95%)
Improved LEM HV stability over time

Posters #41 by Jose Soto, #42 by Ana Gallego Ros, #298 by Etienne Chardonnet, #449 by Maria Brigida Brunetti