

Scintillation light production, propagation and detection in the 4-ton dual-phase LAr-TPC demonstrator

LP
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The DUNE experiment

Physics:

- neutrino oscillation parameters, mass ordering and CP violation
- sensitivity to non beam searches (proton decay, supernovae events, etc)



- DUNE FD: 4x10kton LArTPC modules
- single and dual-phase technology
 - 3D track reconstruction at high resolution
 - sensitivity to low energetic events

The 4-ton demonstrator

Goal: asses the feasibility of the DP technology at the ton scale towards DUNE

Technological milestones:

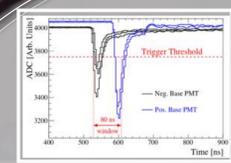
- extraction of ionization charge over 3m² area
- amplification in pure Ar vapor by multiple 50x50 cm² LEMs
- readout of the signal on collection planes with strips up to 3 m

Light detection system five R5921-02 Mod PMTs (8 inch), different bases and TPB coating configurations

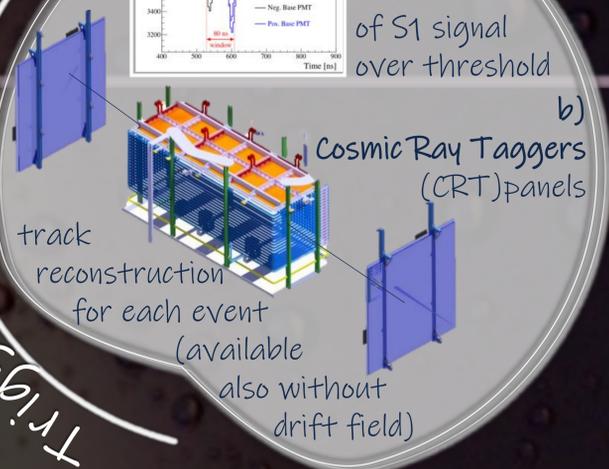
- t_0 time used as a trigger



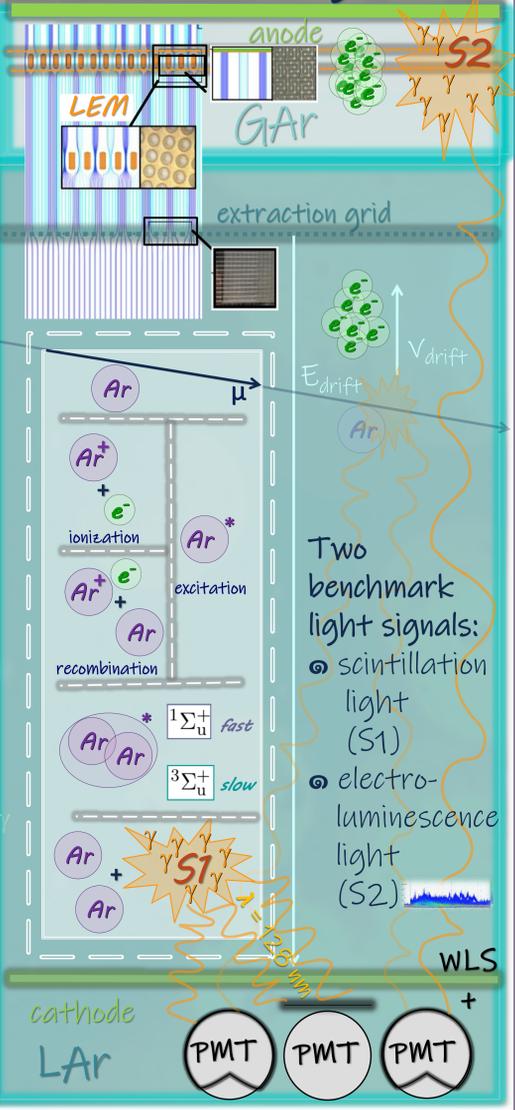
Trigger systems



a) 5 fold coincidence of S1 signal over threshold



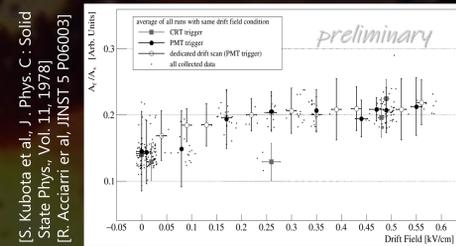
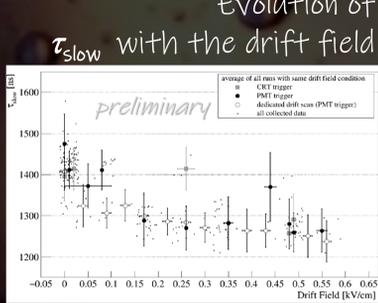
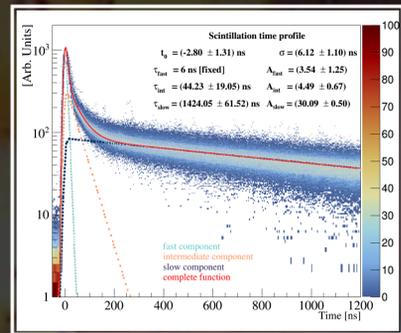
Dual-phase (DP) technology



Scintillation light

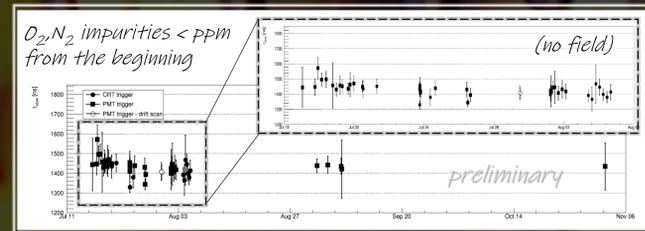
Three exponential contributions are needed to fit the scintillation time profile (S1)

$$f(t) = G(t-t_0, \sigma) \otimes \sum_i (A_i/\tau_i) * \exp(-(t-t_0)/\tau_i)$$



Dependence of the fast/slow ratio with the drift field (opposite behavior found in literature)

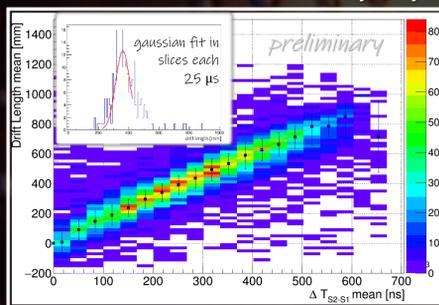
Monitoring of LAr purity through the τ_{slow} (almost constant during all the data taking)



[R. Acciari et al., JINST 5 P05003], [B. Aimard et al., arXiv:1806.03317]

Electro-luminescence light

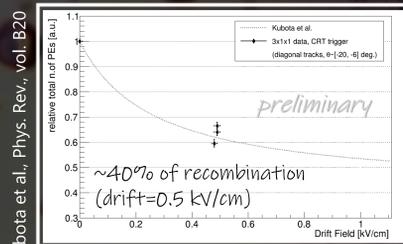
- dedicated algorithm developed to identify the S2 signal
- analysis on the comparison data-MC is ongoing to study unknown parameters related with the S2 light (e.g. electro-luminescence gain, G_{el})



drift velocity $(1.47 \pm 0.12) \text{ mm}/\mu\text{s}$

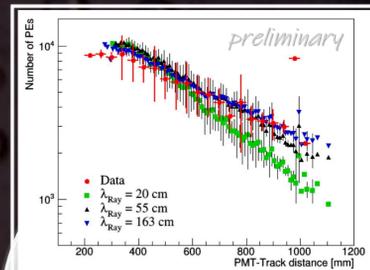
Evolution of τ_{slow} with the drift field

Measurement of the τ_{int} (stable with the drift field)



Measurement of the recombination factor

Rayleigh scattering



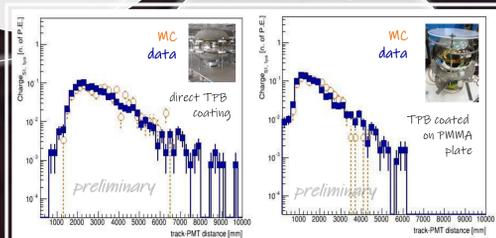
better agreement data-MC for $\lambda_{Ray} \sim 55 - 163 \text{ cm}$

MC

simulation

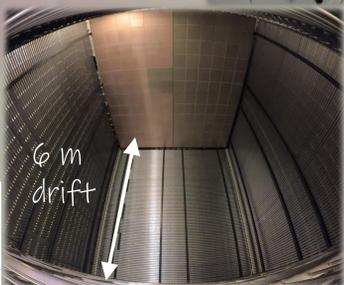
- data driven event generation
- light maps for LAr and GAr
- different Rayleigh scattering length (20cm, 55cm, 163 cm)
- absorption length ($\lambda_{abs} = 30\text{m}$)
- PMT response simulation

good agreement data-MC



Prospects

- a paper is in preparation to summarize all these studies and results
- pursue the analysis in ProtoDUNE-DP
- light data taking already started



p.s. dedicated to Gio Giorgio just...thank you, for always being there.