Development & Characterization of a PEN-based Wavelength Shifting Reflector

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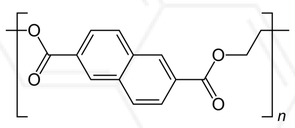
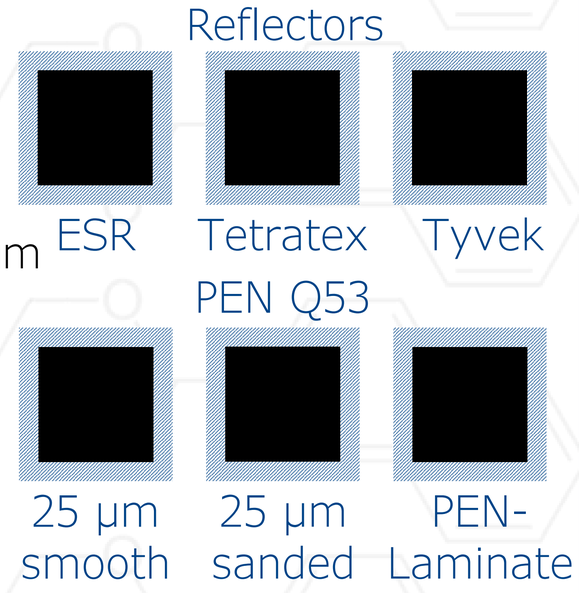
Polyethylene Naphthalate (PEN)



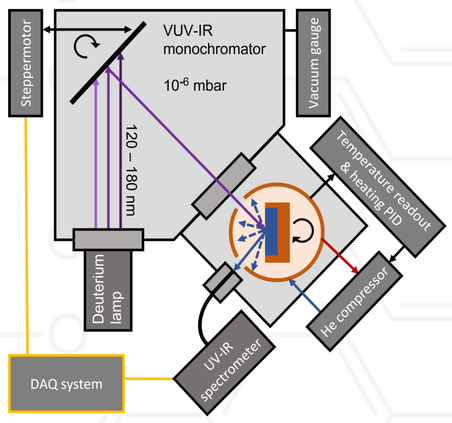
- Organic wavelength shifter (WLS) with quantum efficiency ≥ 49% (90% CL) [1]
- PEN foils studied:
  - Thickness: 25 µm, 50 µm, 125 µm
  - Production grade: Q51, Q53
  - Surface: smooth, sanded
- Reflectors (R) types used: ESR, Tetratex, Tyvek
- Optically coupled or uncoupled



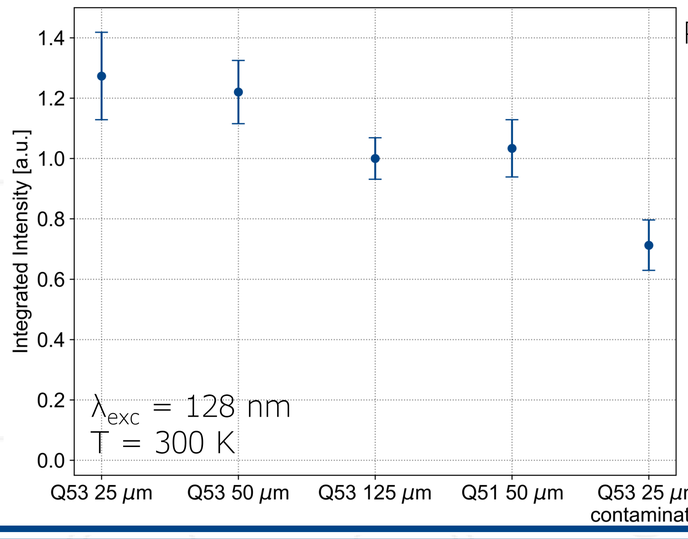
[1] G. R. Araujo, et al., Eur. Phys. J. C, 82(5):442, 2022, arXiv:2112.06675.

Spectra & Relative Efficiency of PEN Foils

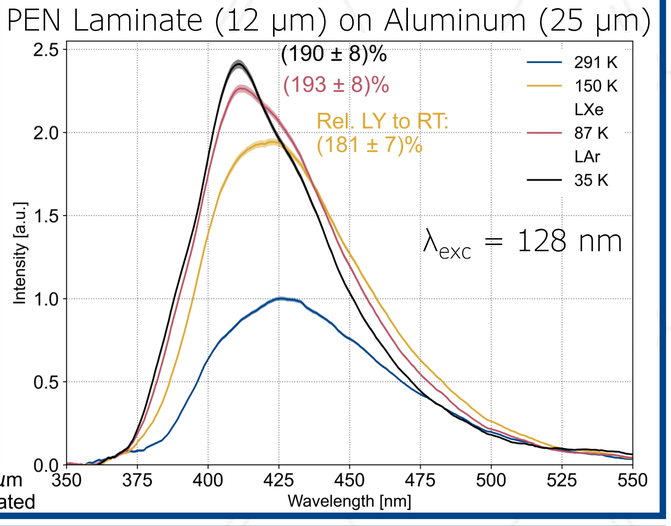
- Excitation by 128 nm (LAr scintillation wavelength)
- Temperature: 300 K – 35 K
- Highest relative efficiency for 25 µm foils and Q53 production grade



Comparison of Thickness & Production Grades

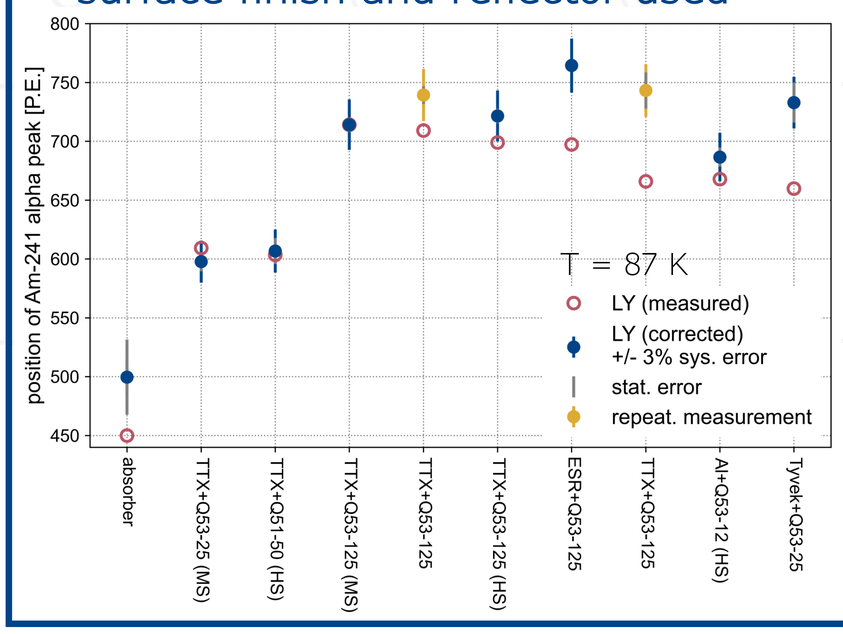


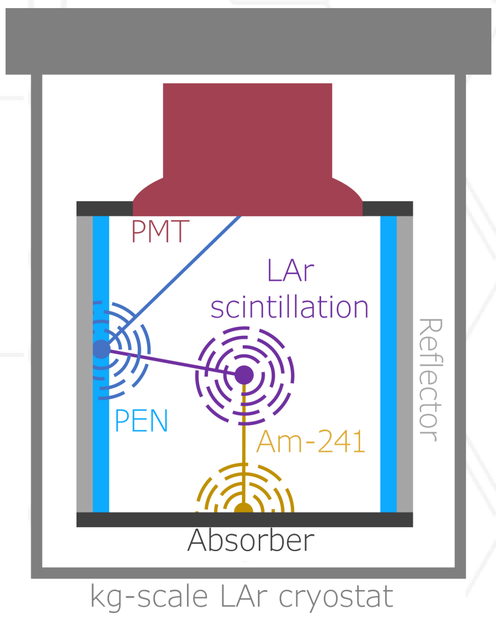
PEN Laminate (12 µm) on Aluminum (25 µm)



Efficiency of PEN-based WLSRs in LAr

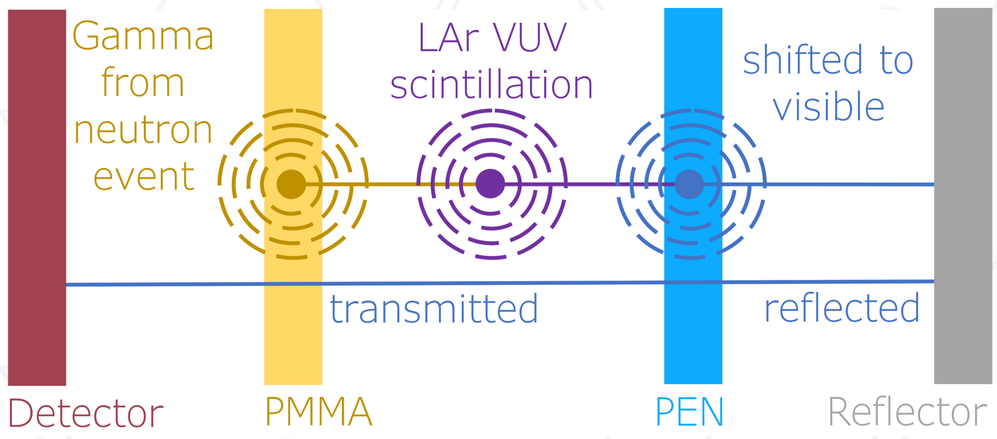
- 25 µm films not optimally mounted due to weak structural integrity
- Identified no significant difference in light yield between surface finish and reflector used





PEN-based WLSR in Rare-Event Searches

- Large-scale liquid argon (LAr) volumes for rejection of neutron background
- Covering ~ 100 m² of optically inactive surfaces with PEN-based WLSR for increased veto efficiency
- PEN scalable alternative to commonly used WLSs



LEGEND-1000

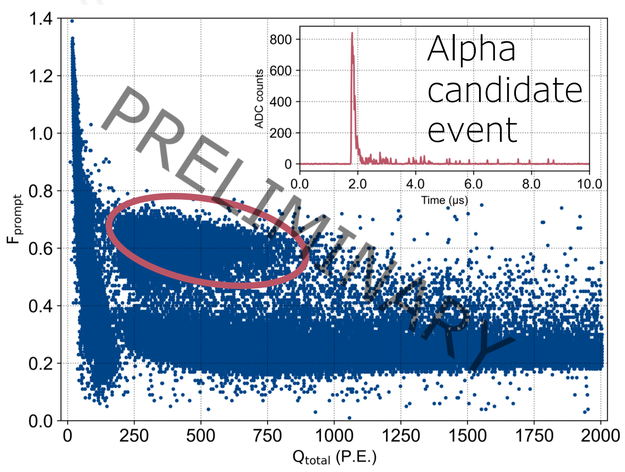
- Neutrinoless double-beta decay in ^{76}Ge
- Segmented LAr volumes lined with WLSRs

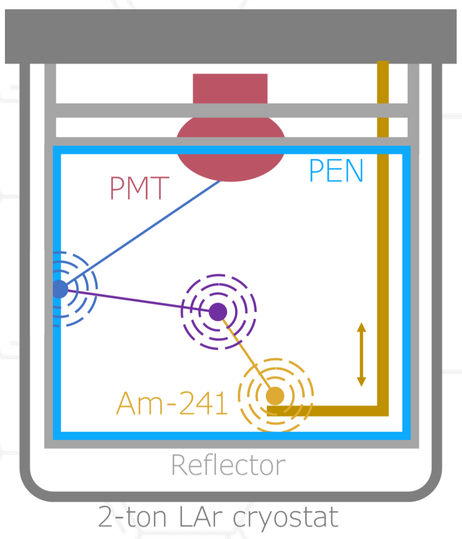
DarkSide-20k

- Dark Matter WIMP Search
- Dual-Phase argon TPC
- Neutron Veto with Gd-loaded PMMA lined with ESR+PEN

Stability of Large-scale PEN-based WLSR

- Validate light yield & light yield stability
- 4 m² of ESR+PEN Q53 25 µm





ICP-MS of Commercial PEN Batch

- ICP-MS of insufficiently performing batch of PEN Teonex Q53 25 µm
- VUV-absorbing In and Zn contaminations found
- screening of optical performance before installation in experiments

Element	Contam. Batch [ppm]	Regular Batch [ppm]
Zn	4.1 +/- 1.2	0.3 +/- 0.1
In	15.4 +/- 4.6	0.010 +/- 0.003

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