Production and optical characterisation of PET and PEN scintillator samples [1]

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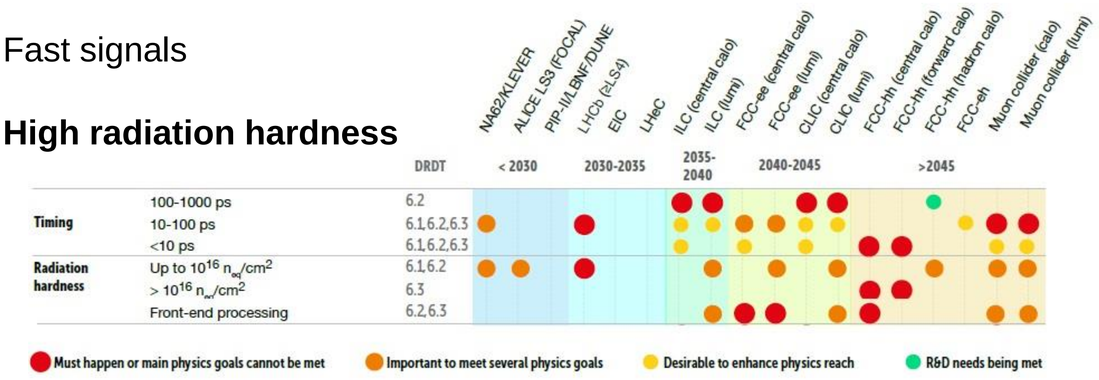
Challenges for future scintillator-based detectors in High-Energy Physics

- Large light yield
- Fast signals
- **High radiation hardness**



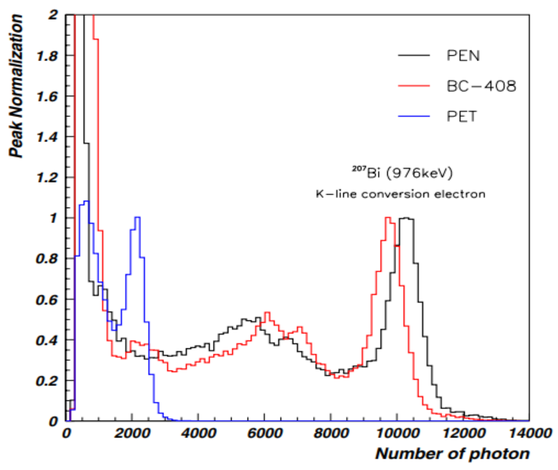
ECFA Detectors R&D Roadmap [2]

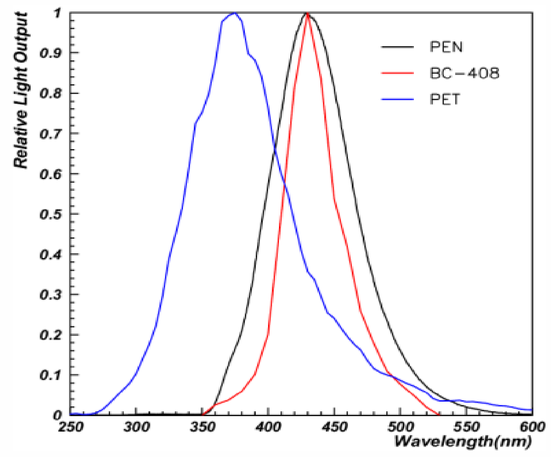
Objectives

Research new plastic scintillating materials, *PEN (Polyethylene Naphthalate)* and *PET (Polyethylene Terephthalate)*, with a specific focus on their optical and scintillation properties.

Scintillation properties of PEN and PET

- Competitive light yield
- Emits light ≅ in the same λ as BC-408 (commercial scintillator)
- Good radiation hardness



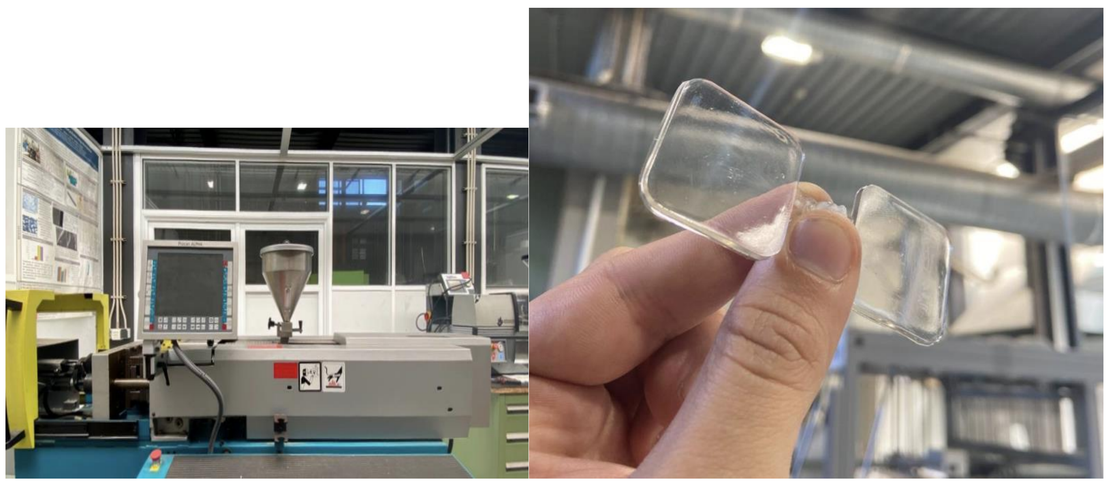


Spectra Emission (Above) and Number of photons (Left) for PEN, PET and BC-408 [3]

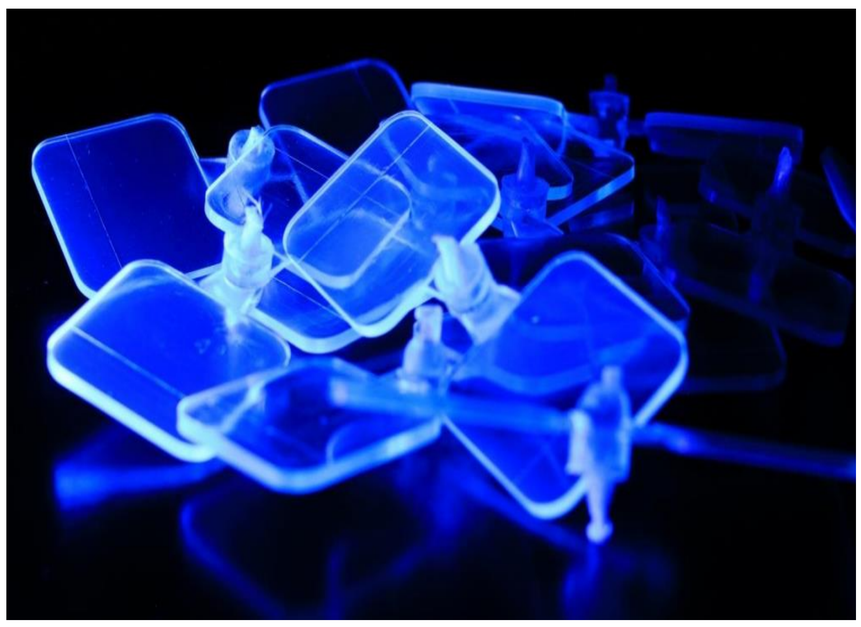
Sample production

PET and *PEN*-based scintillator samples produced in collaboration with the Institute for Polymers and Composites (IPC) of the University of Minho

- Injection Moulding
- Samples currently measure 30 x 30 x 2 mm^3

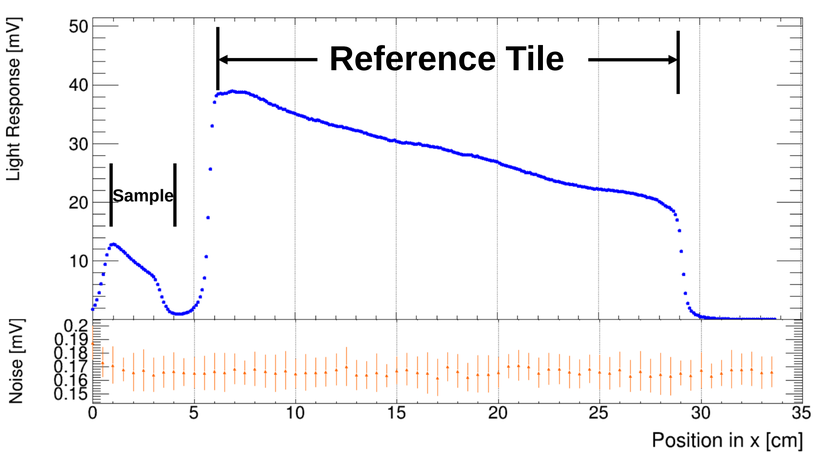


Light response of PEN sample to UV source



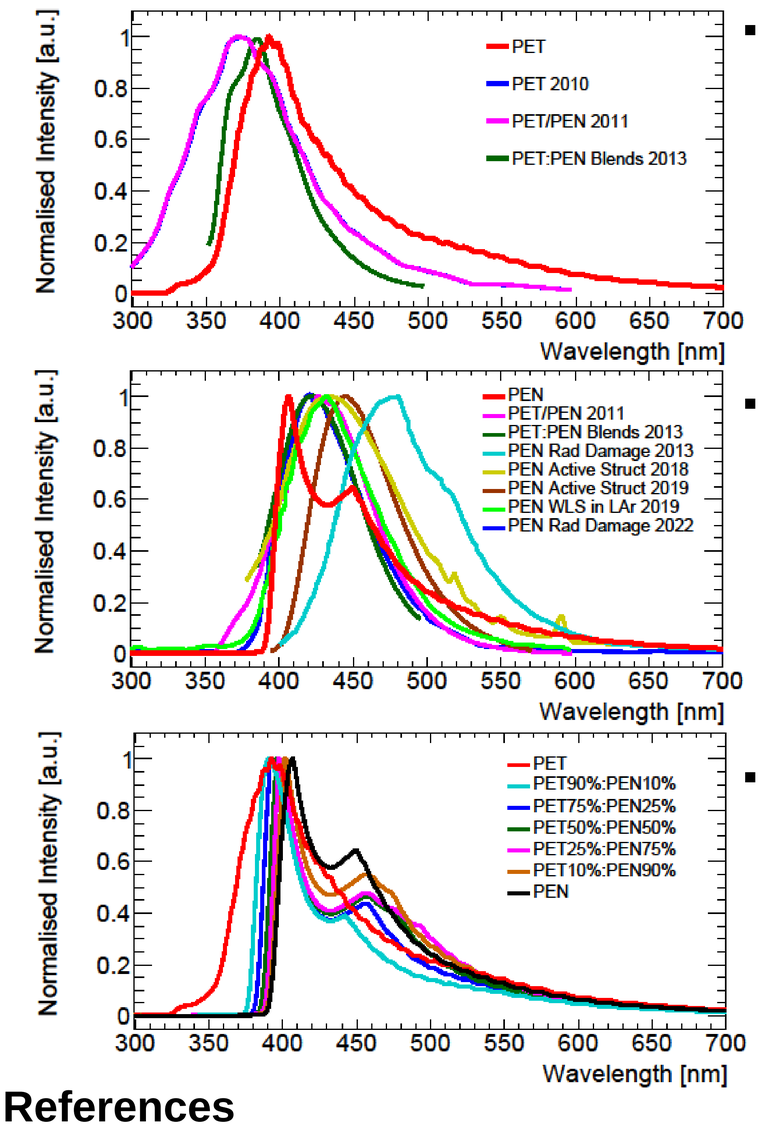
PEN samples excited by a UV lantern.
Photo by Agostinho Gomes

Sample Light Response



- Light response measured with Sr-90 scans of sample and reference tile
- Scintillation light collected by wavelength-shifter fibers and detected with photomultiplier

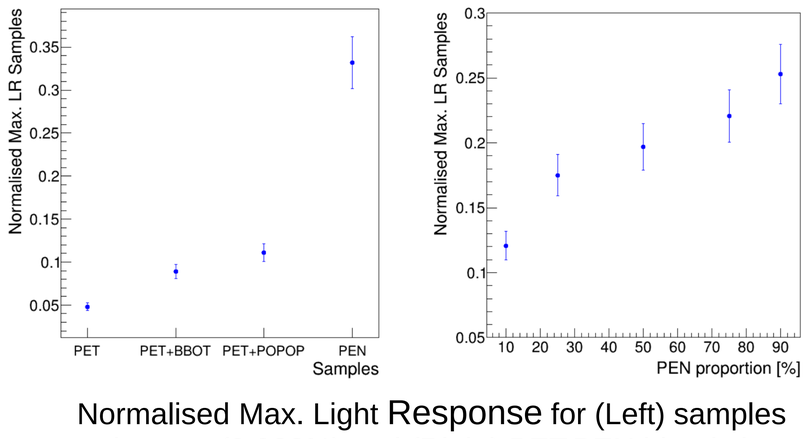
Emission Spectra



- PET sample:
  - Peak ~ 390 nm
  - Shape and peak are similar with Literature
- PEN sample:
  - Main peak ~ 410 nm, slightly below the Literature
  - 2nd peak ~ 450 nm, could be attributed to differences in the source material composition
- PET:PEN mixtures:
  - Depend on the mass proportion
  - Peak gradually shifts 390 nm → 410 nm with increasing PEN proportion

Light Response: PET:PEN blends and PET+dopants

- Dopant addition: +80% (BBOT) and +120% (POPOP) in light response
- In mixtures, Light response increases with PEN proportion



Normalised Max. Light Response for (Left) samples + dopants (0.022%) and (Right) PET:PEN blends in different proportions.

References

[1] R. Machado et al. Submitted to NIM-A, 2024. DOI 10.48550/arXiv.2312.14790
[2] ECFA Detector R&D Roadmap Process Group, 2020, DOI 10.17181/CERN.XDPL.W2EX
[3] H. Nakamura et al., 2011, EPL 95, 22001, DOI: 10.1209/0295-5075/95/22001.

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