Alternative Scintillator Option

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DESY

Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

Scintillator Tiles for Large Prototypes

- Well known problem: A few 10k tiles - A bit too much for production “by hand”
  - In addition: start to become “cost sensitive”

- Options being looked at
  - Machining of individual tiles - Material by Bicron, Eljen, “recycled” Polystyrene, …
  - Machining of megatiles - To date based mostly on Polystyrene, other materials possible
  - Injection molding of individual tiles - to date done with Polystyrene

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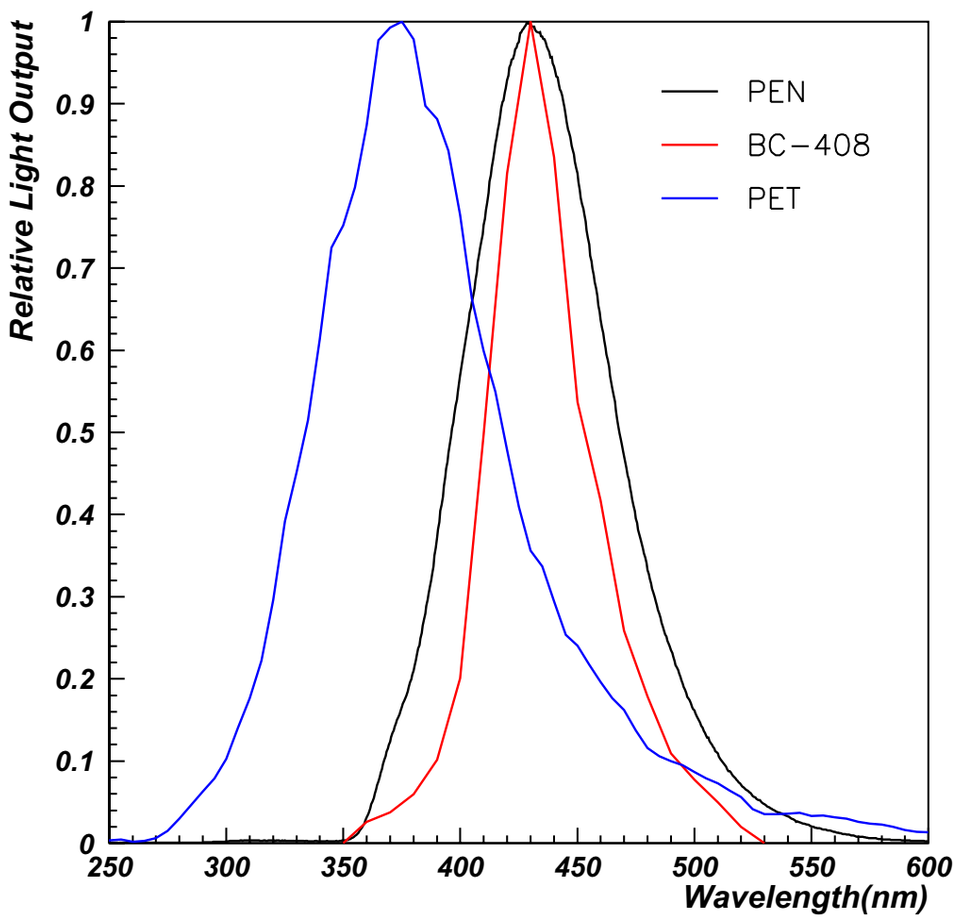
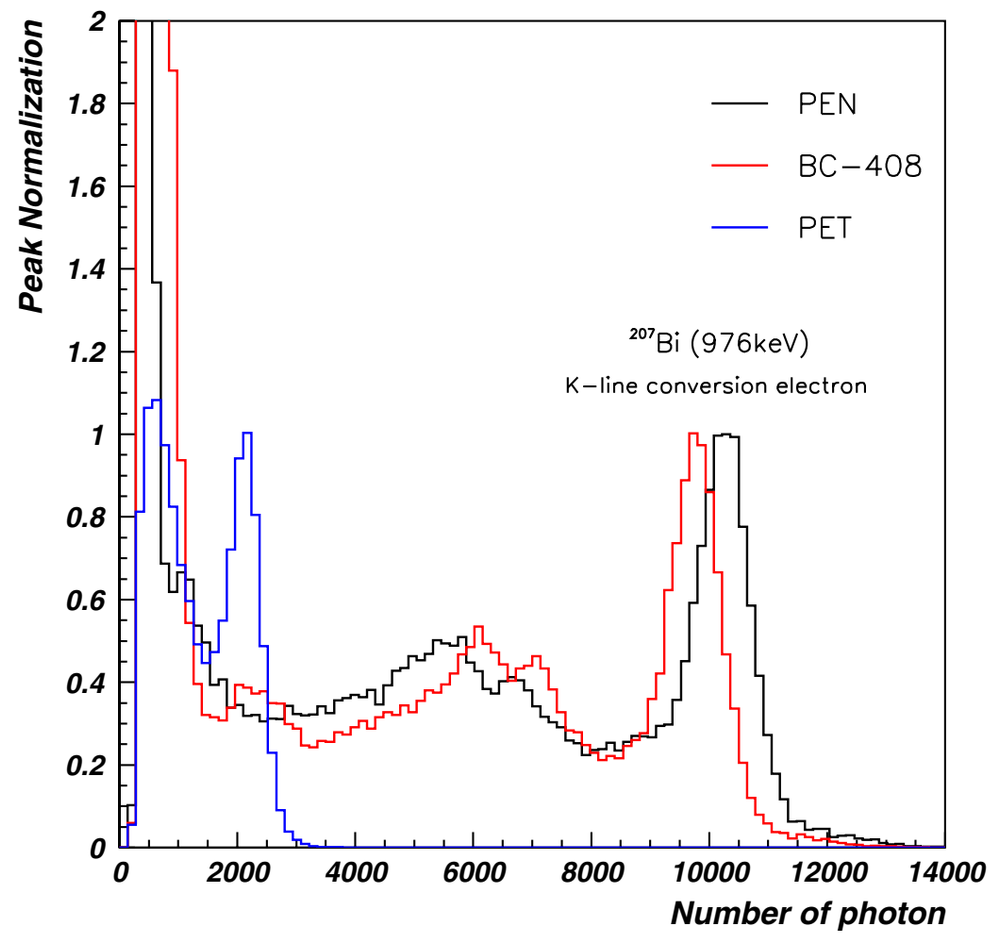
Side remark: The now widespread availability of surface-mount SiPMs allows the design with a bottom dimple for fiberless coupling (“Mainz tile”) - reduces mechanical complexity for machining and injection molding

PEN - A New Option for AHCAL Tiles?

- Currently investigating a new material - as a “joint venture” with Gerda group at MPP
- First publication of scintillation of PEN (Polyethylene Naphtalate) in 2011
  - Very common material: Used in plastic bottles (Soda Stream bottles for example), widest use as dielectric in high-density condensers





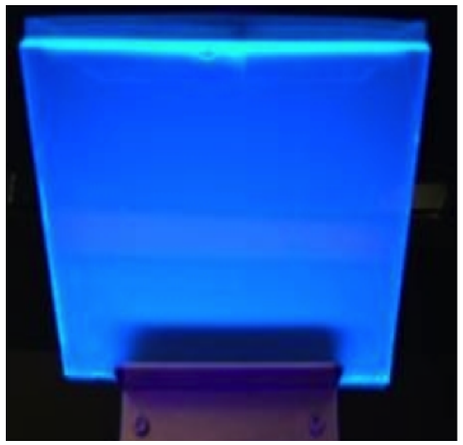
NB: PEN light yield slightly higher than BC-408!

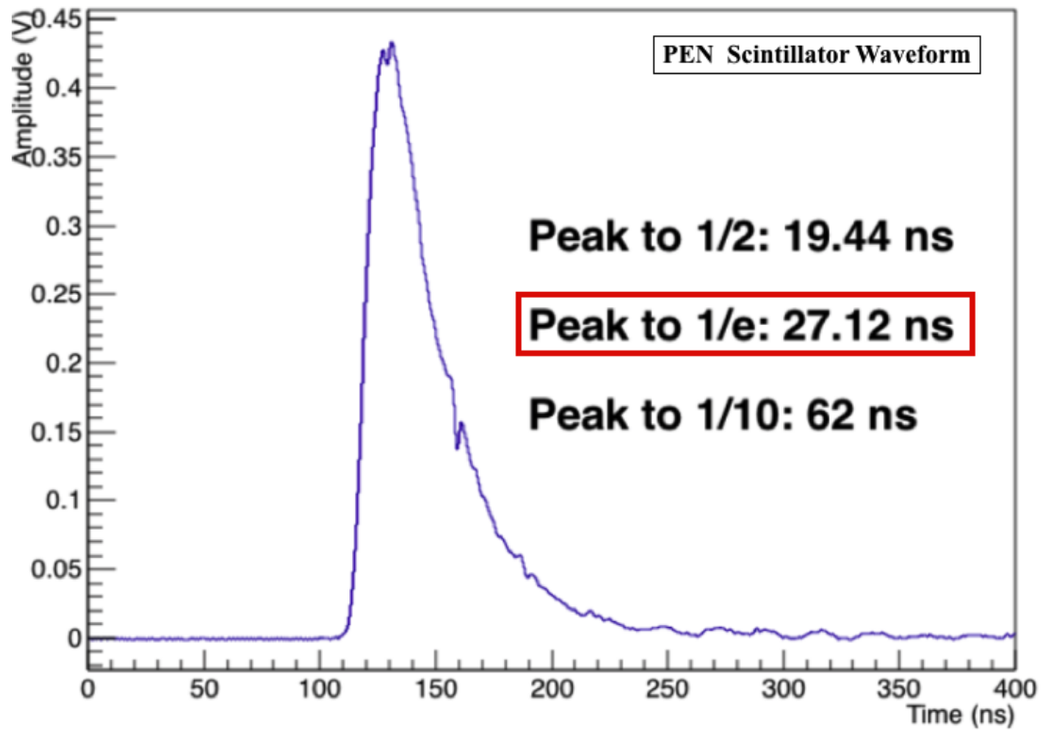
Nakamura et al., EPL 95, 22001 (2011)

PEN - Also looked at by CMS

- Additional benefit - also for us (for Belle-II activities): PEN potentially much more radiation hard than more “sophisticated” scintillators
  - First tests by CMS

arXiv:1510.08572





Potential downside:
PEN relatively slow

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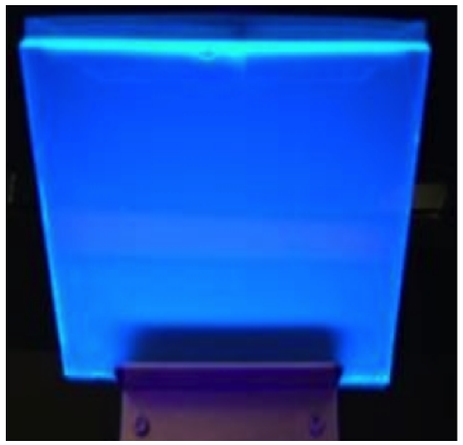

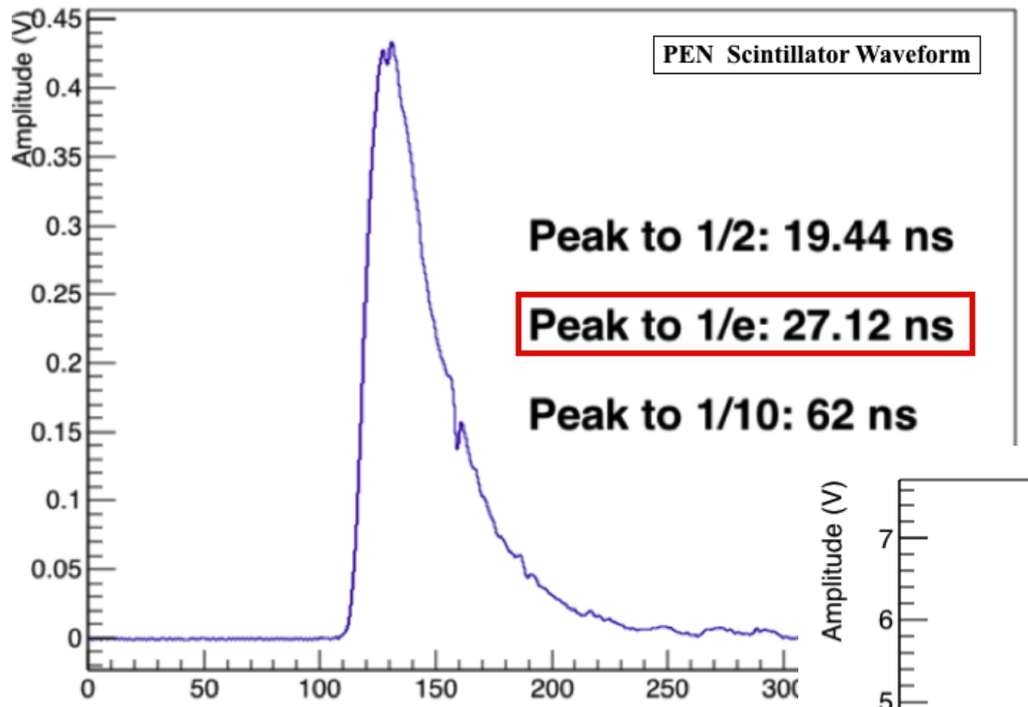

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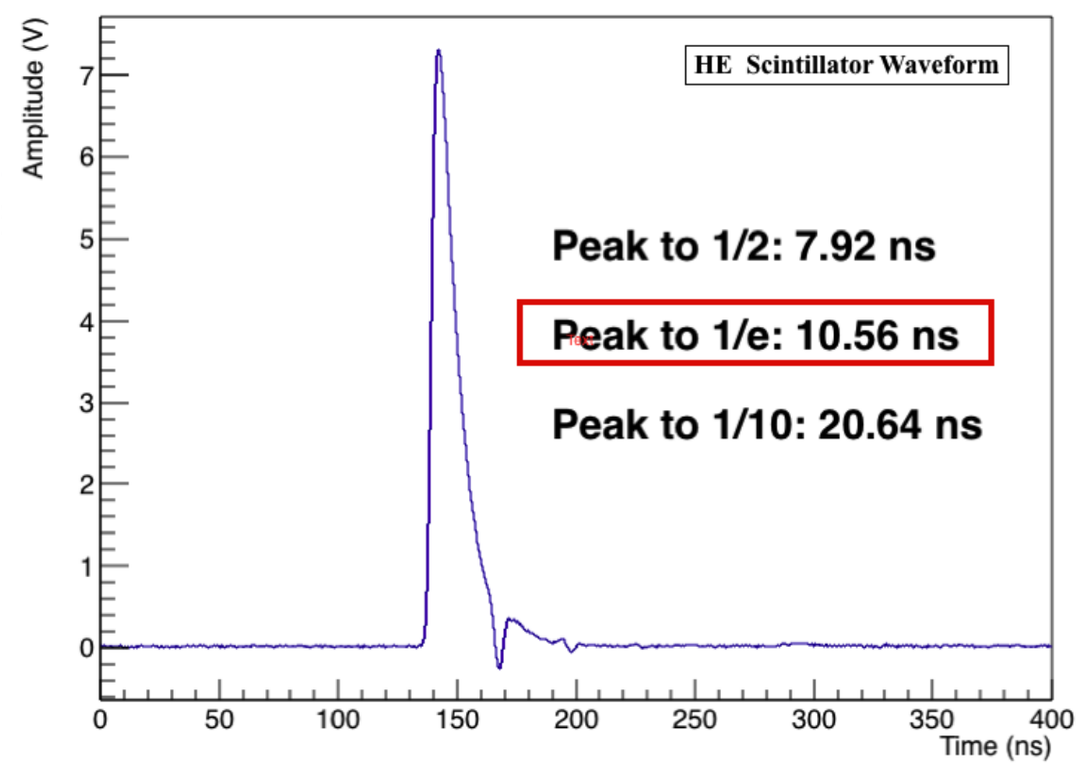
compare Kuraray SCSN-81



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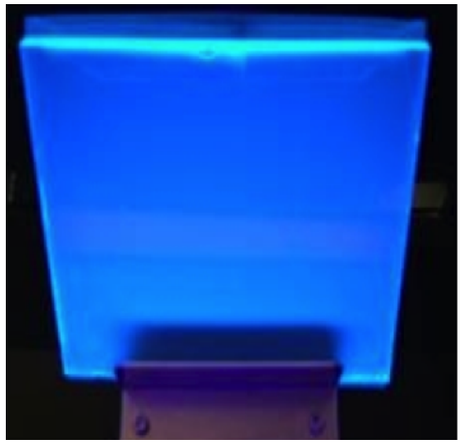

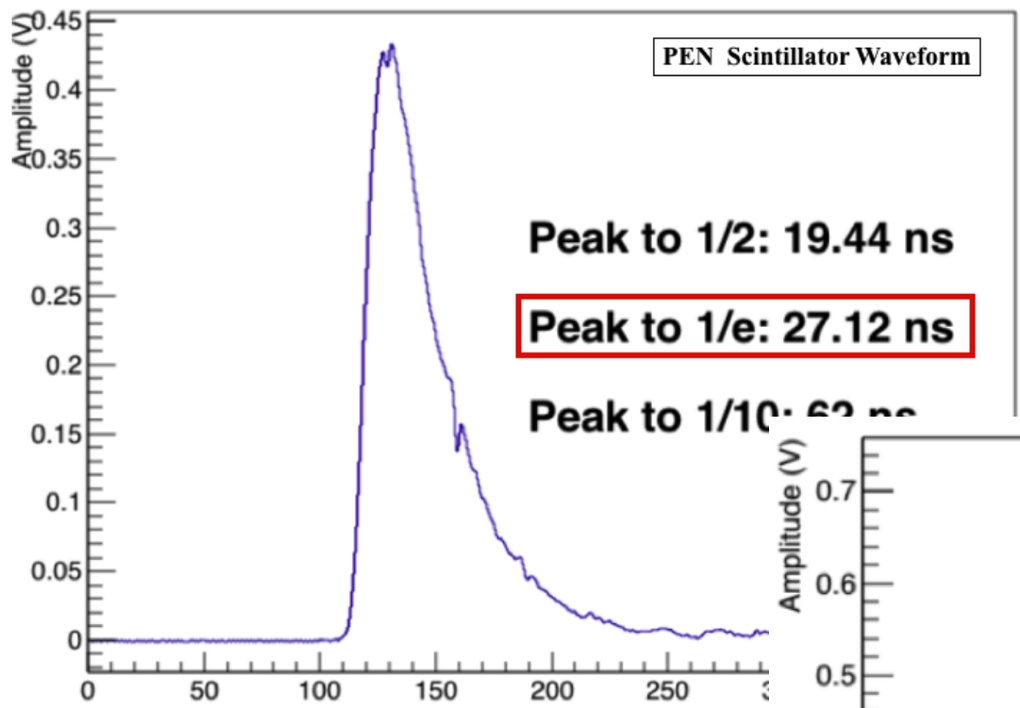

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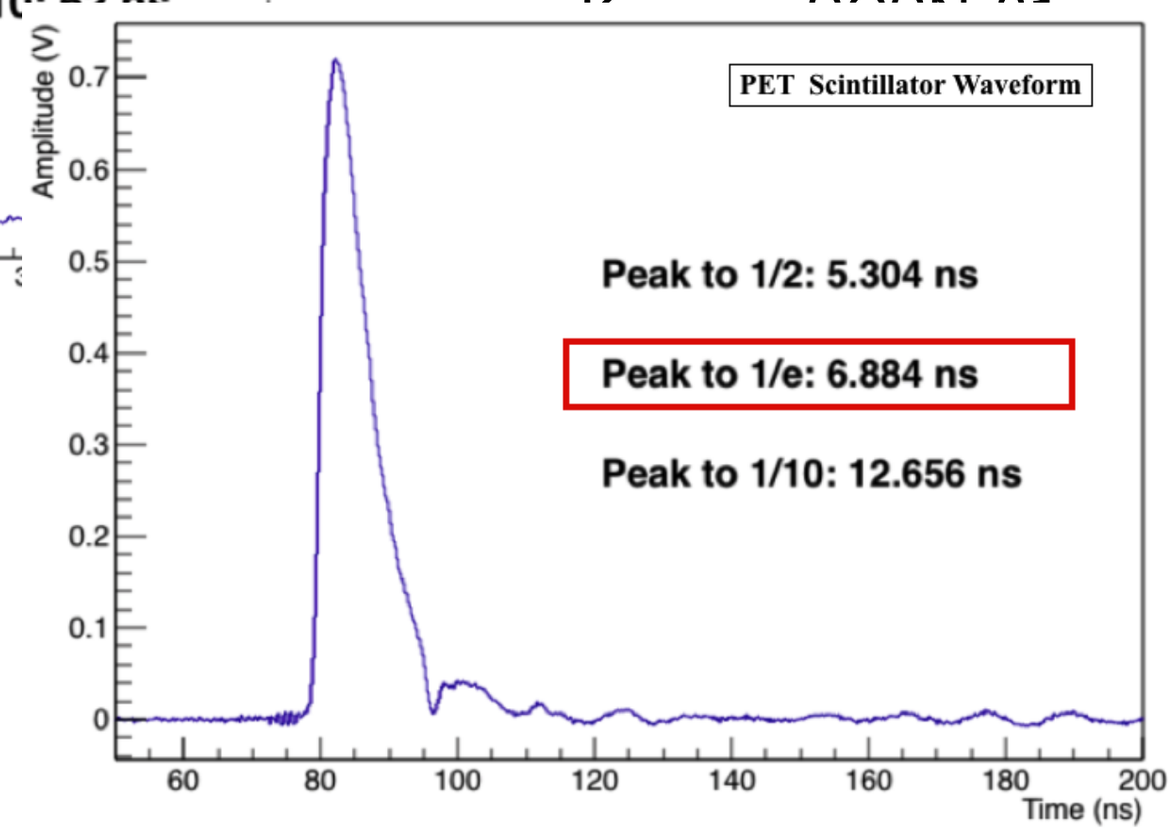

PET: even faster - but lower light yield (CMS claims ~ 30% less than PEN, not factor 5)

MPP Status & Plans

- Recently a 25 kg bag of PEN granulate was delivered to MPP bei Teijin (JP)- will be split for several uses:
  - Radio-purity tests (interesting for Gerda, not us)
  - Injection molding tests at different facilities (first just making a 3 mm thick plate)
- In parallel: Discussions with Katsu on obtaining samples directly from Japanese vendor

Further action will depend on outcome of the first tests

Optimistic scenario: If the material fulfills our requirement and injection molding works, large numbers could be produced on not too long time scales

A note on costs: Material ~ 20 - 30 EUR / kg => ~ 0.1 EUR / tile, injection molding tbd

Scintillator Properties - Summary

Table 1: Properties of the three samples used in the present study.

Material	Polyethylene naphthalate	Organic scintillator (ref. [14])	Plastic bottle (ref. [13])
Supplier	Teijin Chemicals	Saint-Gobain	Teijin Chemicals
Base	$(C_{14}H_{10}O_4)_n$	$(C_9H_{10})_n$	$(C_{10}H_8O_4)_n$
Density	$1.33\,g/cm^3$	$1.03\,g/cm^3$	$1.33\,g/cm^3$
Refractive index	1.65	1.58	1.64
Light output	$\sim$ 10500 photon/MeV	10000 photon/MeV	$\sim$ 2200 photon/MeV
Wavelength max. emission	425 nm	425 nm	380 nm

Nakamura et al., EPL 95, 22001 (2011)