

Reconstruction of gamma quanta interaction in scintillator based on energy deposition



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Outline

1. Motivation
2. Single photoelectron
3. Resolution of deposited energy in plastic scintillators
4. Effective light attenuation in the plastic scintillator strips
5. Method of gamma quanta hit position determination based on deposited energy

Motivation

Main idea of developed J-PET scanner is to use time information for gamma hit point determination (great time resolution properties of plastic scintillators)

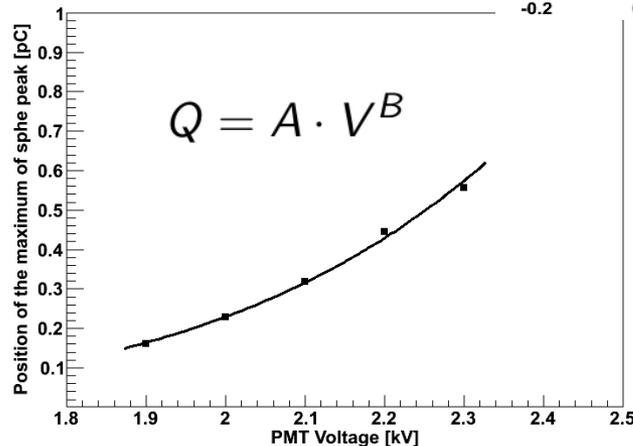
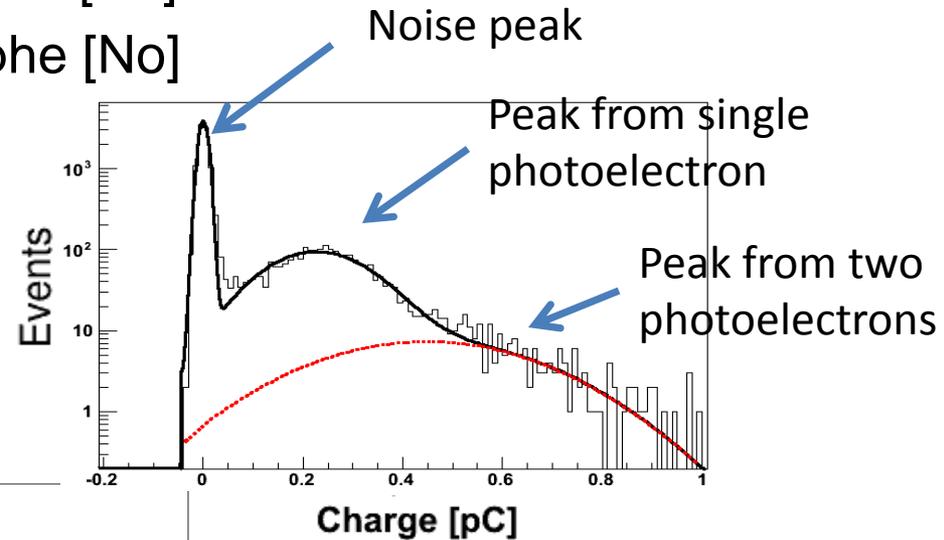
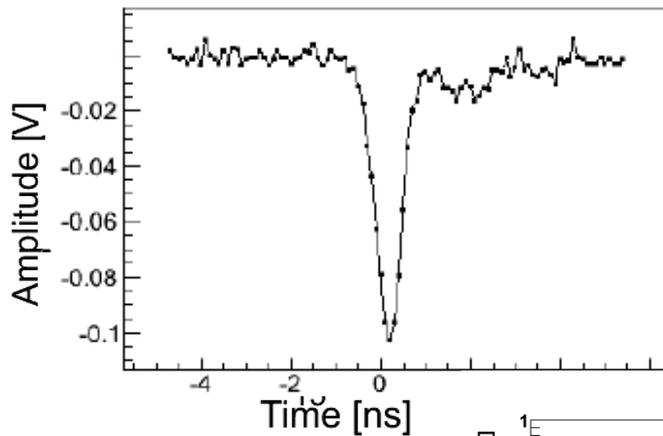
Hit-position determination with plastic scintillator is also possible from information about deposited energy

Independent from time, hit-position determination let us reject wrongly reconstructed events and allows to improve resolution.

Single-photoelectron (Sphe)

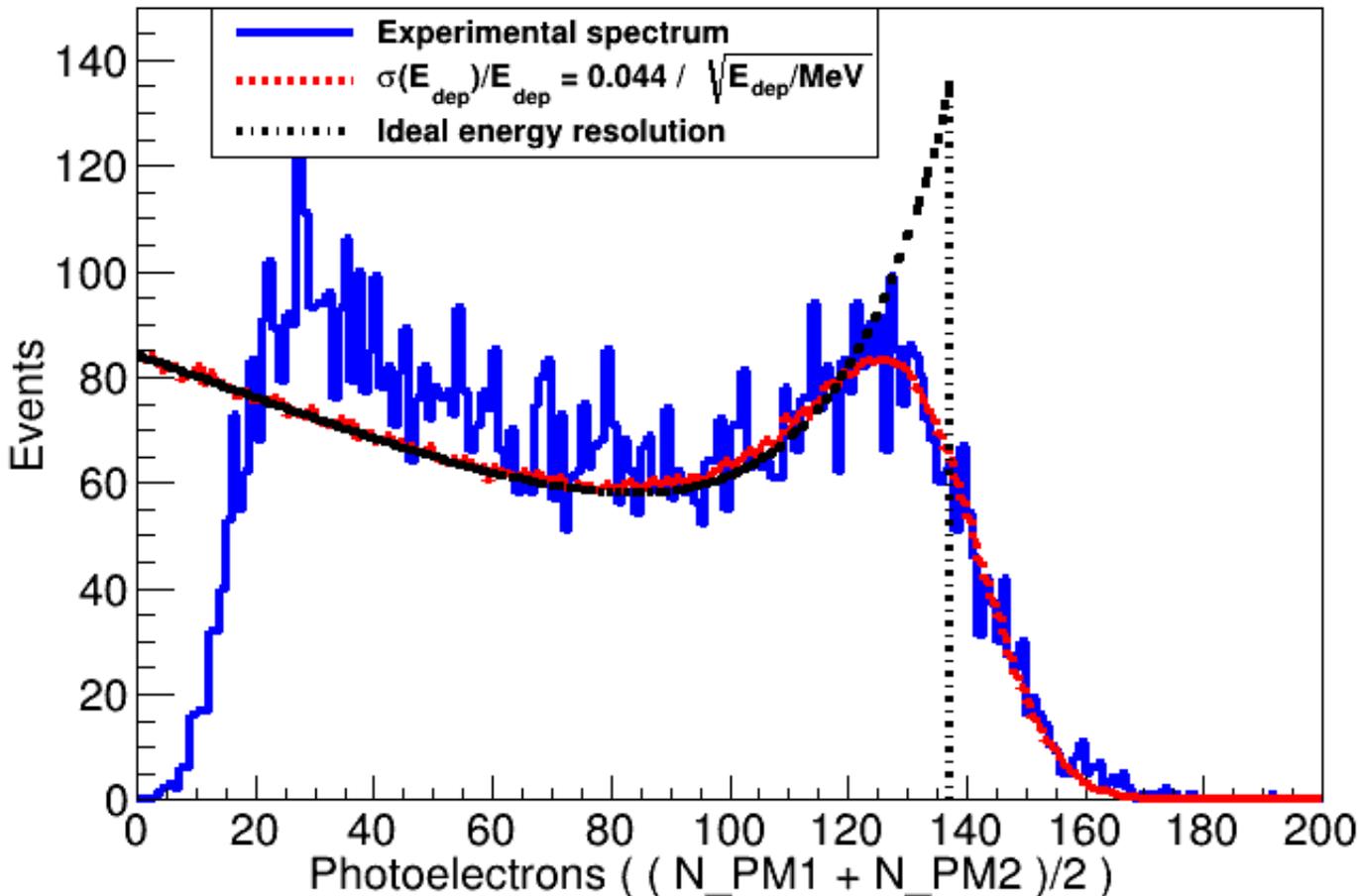
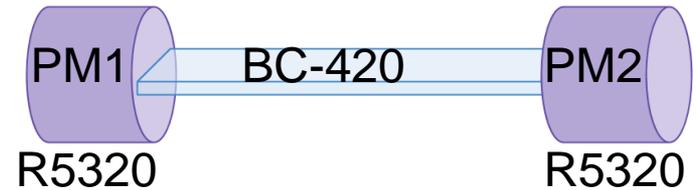
We can measure single-photoelectron and calibrate charge value h corresponding to it. $Q[C] = h \text{ phe}[No]$

$$E_{\text{dep}} \sim \text{phe} [No]$$



Energy resolution of Compton spectrum

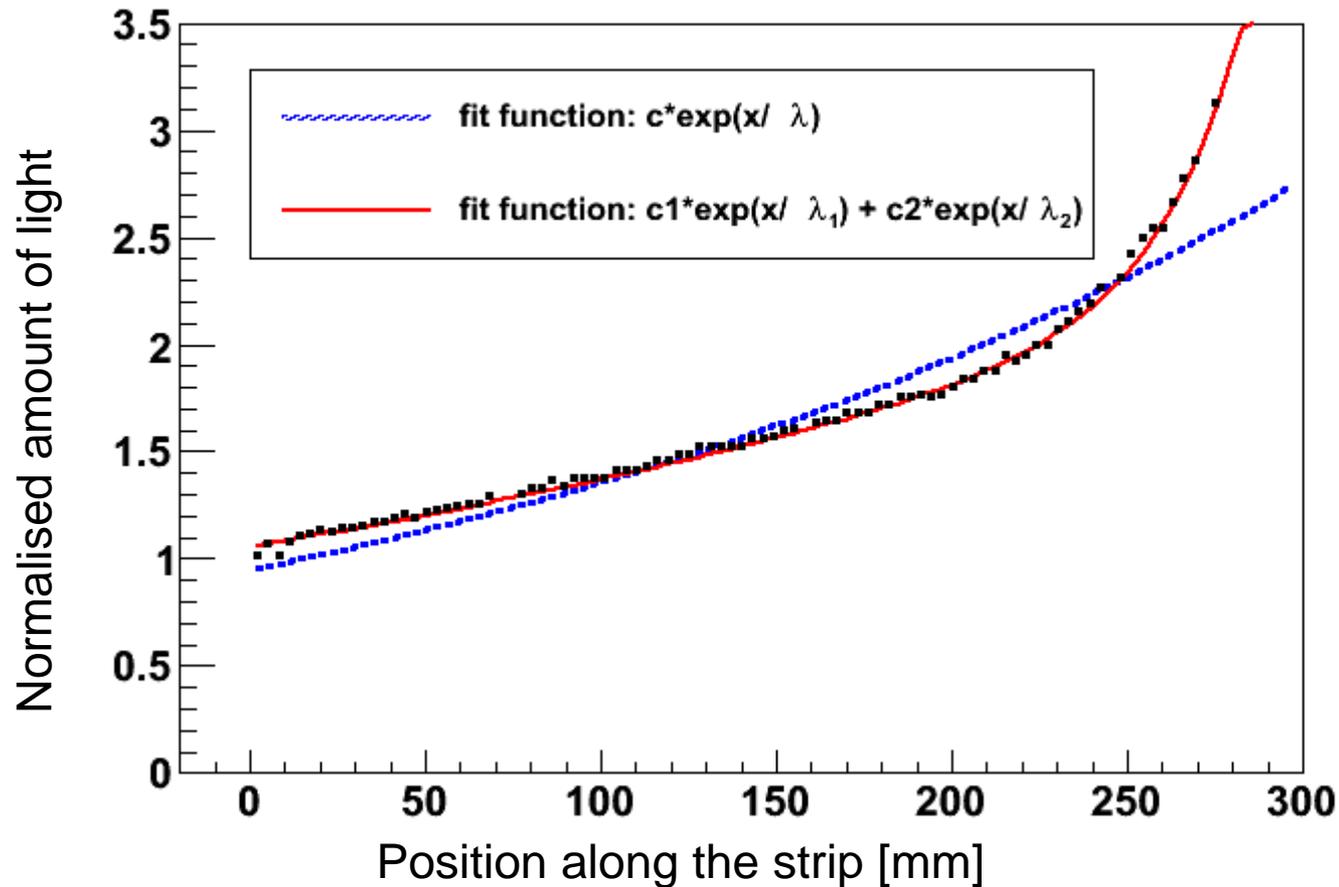
Fit range:
from 80 photoelectrons



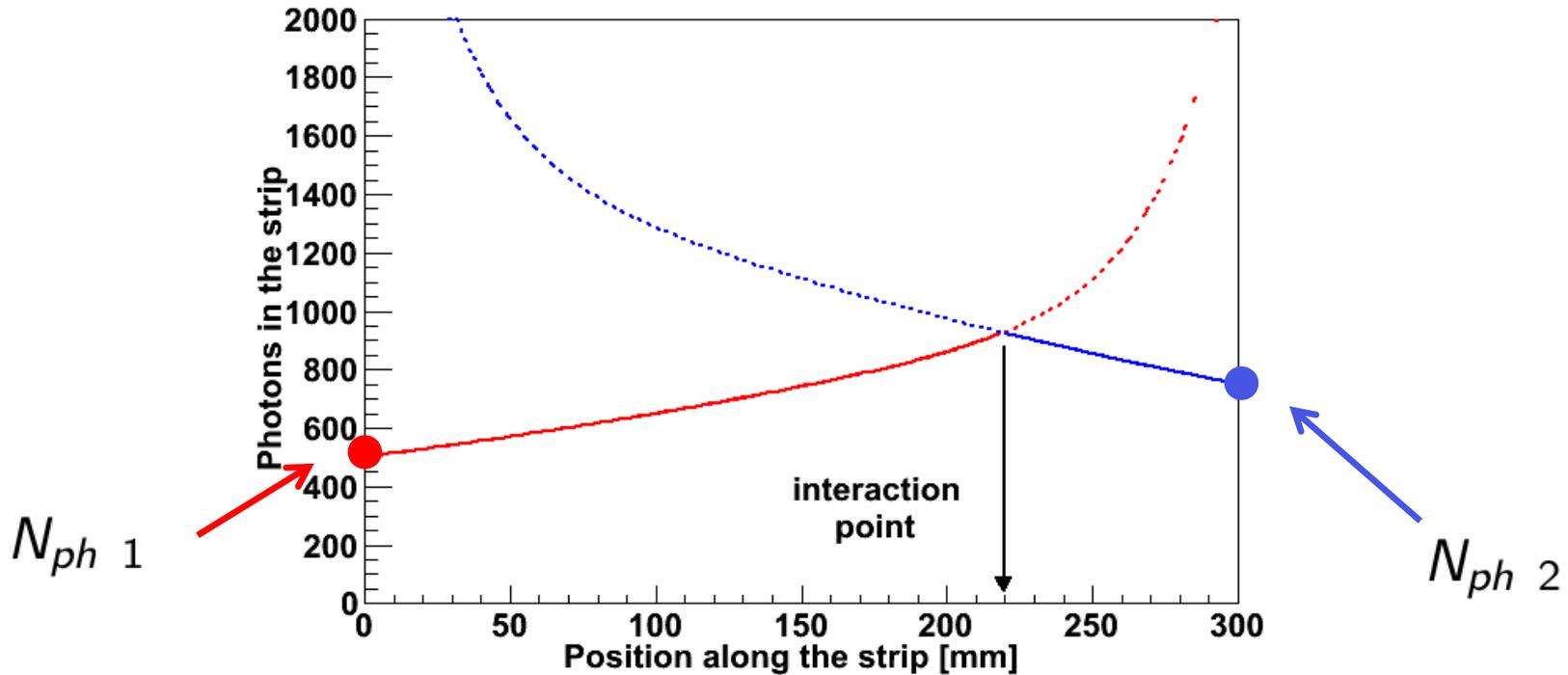
Resolution at
the Compton edge
 $\sigma(E_{\text{dep}})/E_{\text{dep}} = 7.5\%$

Effective light attenuation length

$$P(x) = e^{-x/\lambda}$$



Position determination

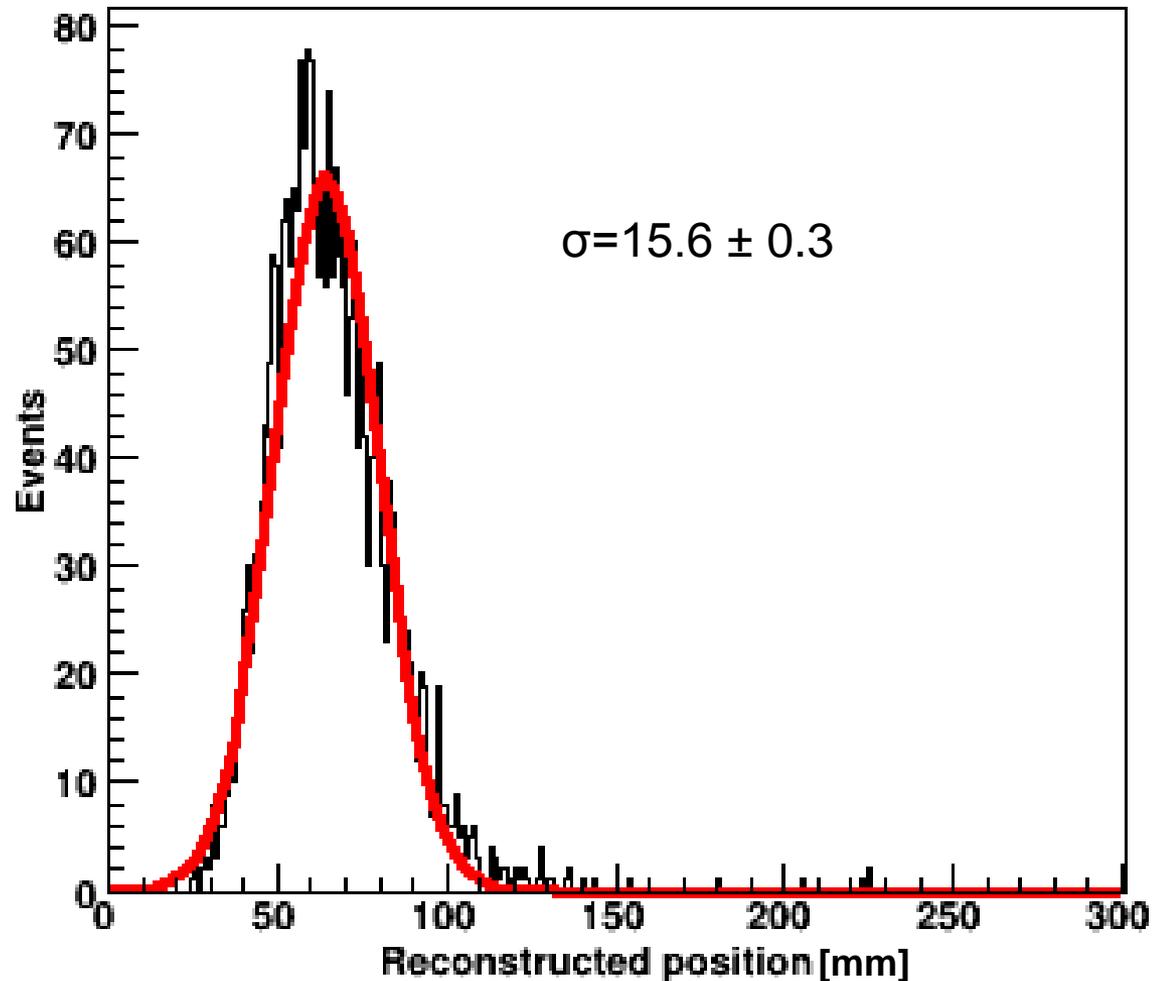


Red curve: $N_{ph\ 1} = a \cdot e^{\frac{x}{\lambda_1}} + b \cdot e^{\frac{x}{\lambda_2}}$

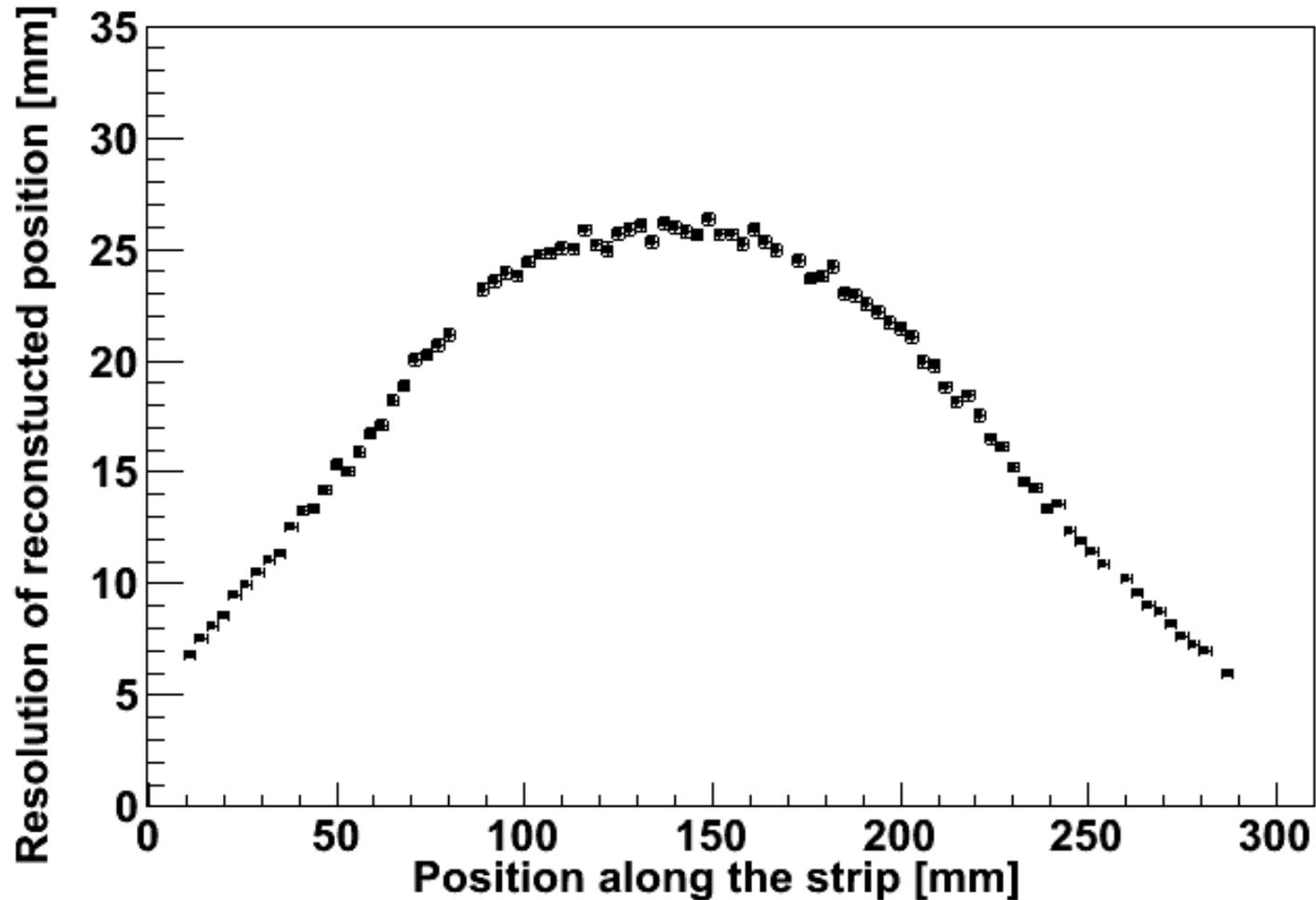
Blue curve: $N_{ph\ 2} = c \cdot e^{\frac{L-x}{\lambda_1}} + d \cdot e^{\frac{L-x}{\lambda_2}}$

Spectrum of one reconstructed position

Irradiated position: 63 mm



Resolution of reconstructed position



Summary

Hit position determination based on deposited energy can be determined in the setup built of plastic scintillators

Resolution of deposited energy at the Compton edge is
 $\sigma(E_{\text{dep}})/E_{\text{dep}} = 7.5\%$

Resolution of gamma quanta hit position (Gaussian sigma) is about 25 mm in the center of the scintillating strip and improving towards the strip edges.

Hit position determination based on deposited energy can be used as an independent information from time based methods.

Thank you for
your attention.