Optical analysis of the system

Simulation (TracePro 2.3)
of the YAP-QUARTZ system, source:
9200 photons at
390 nm for each gamma

- Q.E.: 20% (λ_{peak}=390 nm)
- Average optical collection factor (total reflection condition + bulk absorbtion L_a: 14 cm + reflection on the HPD window): 30%

Resulting average signal: 574 p.e. (sum of both sides)

Agreement with Prof. Seguinot's evaluation

ANGLE RECONSTRUCTION IN COMPTON INTERACTIONS

EGS4 simulation. Used approximations:

- Parallel incident rays
- Dead zone is vacuum (only YAP)
- No doppler broadering in Compton interactions
- Average 511 keV gamma pulse height: 574 p.e.

Method:

P.H.=590-30 x min(z,L-z) p.e.

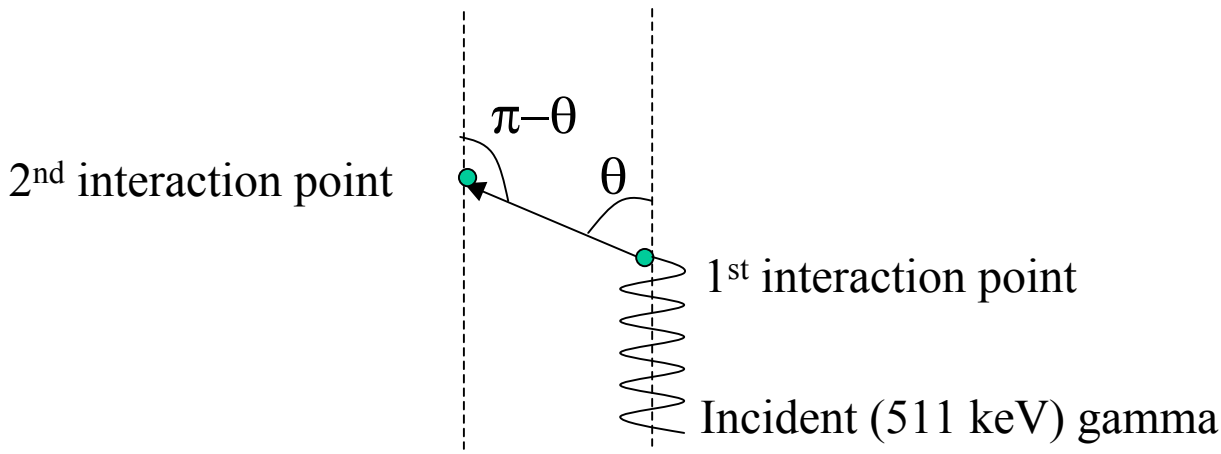
- θ_1 and θ_2 by energy deposit

E=511 keV $\longrightarrow$ $\vartheta = \arccos(2 - E/(E - edep))$ $\qquad E' = \dfrac{E}{1 + E(1-\cos\vartheta)/m_e}$

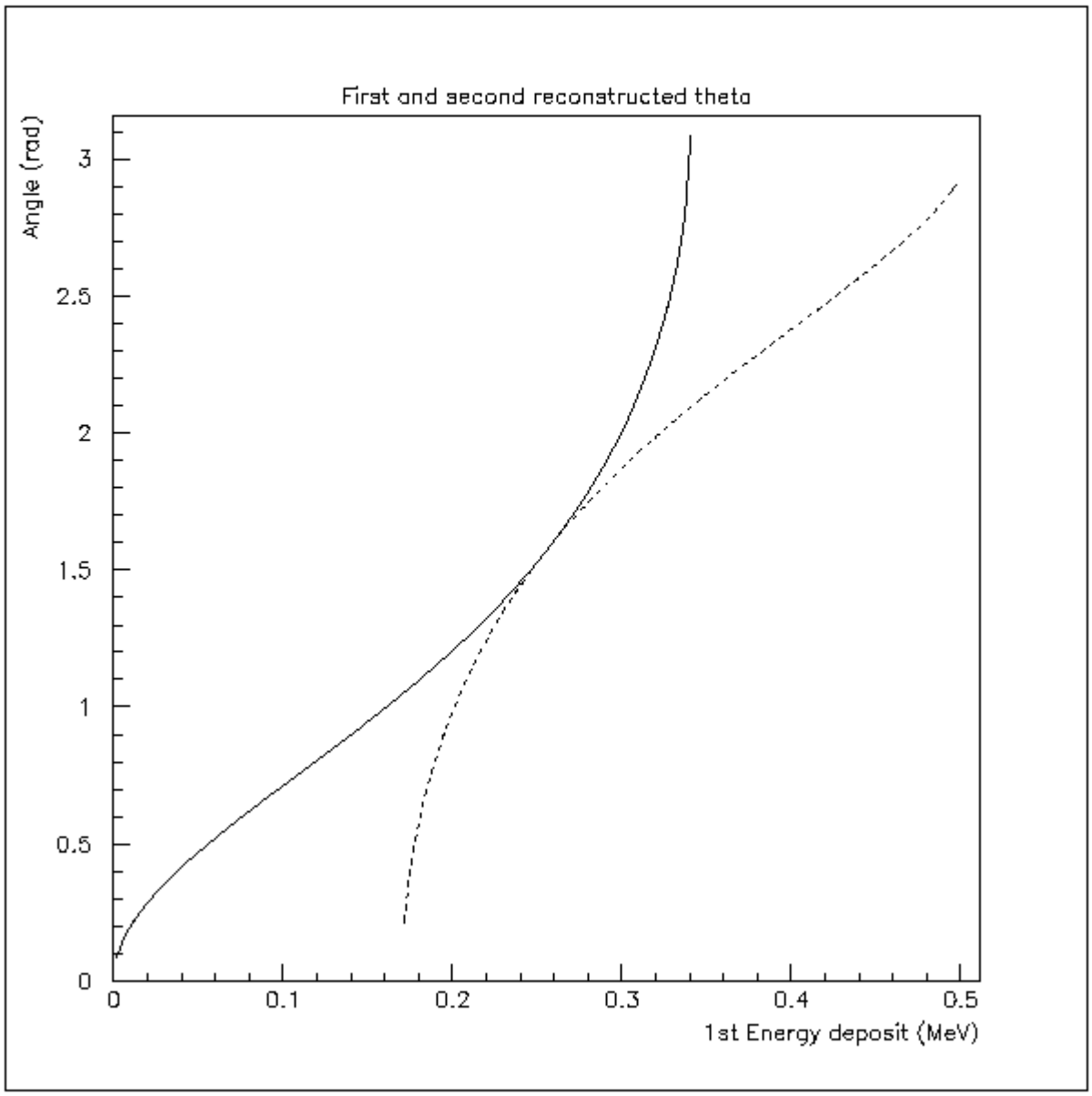
- Comparison: if $\theta_1 - (\pi - \theta_2) > \Delta\theta_{geom}$ then the event can be reconstructed
- Preliminary evaluation of $\Delta\theta_{geom}$ (not yet completely simulated the position reconstrucion, two possible ways):

$\Delta\vartheta = 2\arcsin(|\Delta\vec{r}|/dist)$ $\longrightarrow$ Only dist>10 mm events

$|\Delta\vec{r}| \le \sqrt{2(\sqrt{2}\cdot 3.5/2)^2 + 5^2}$ mm~6.9mm $\longrightarrow$ $\Delta\theta$~1.5 rad (bad)



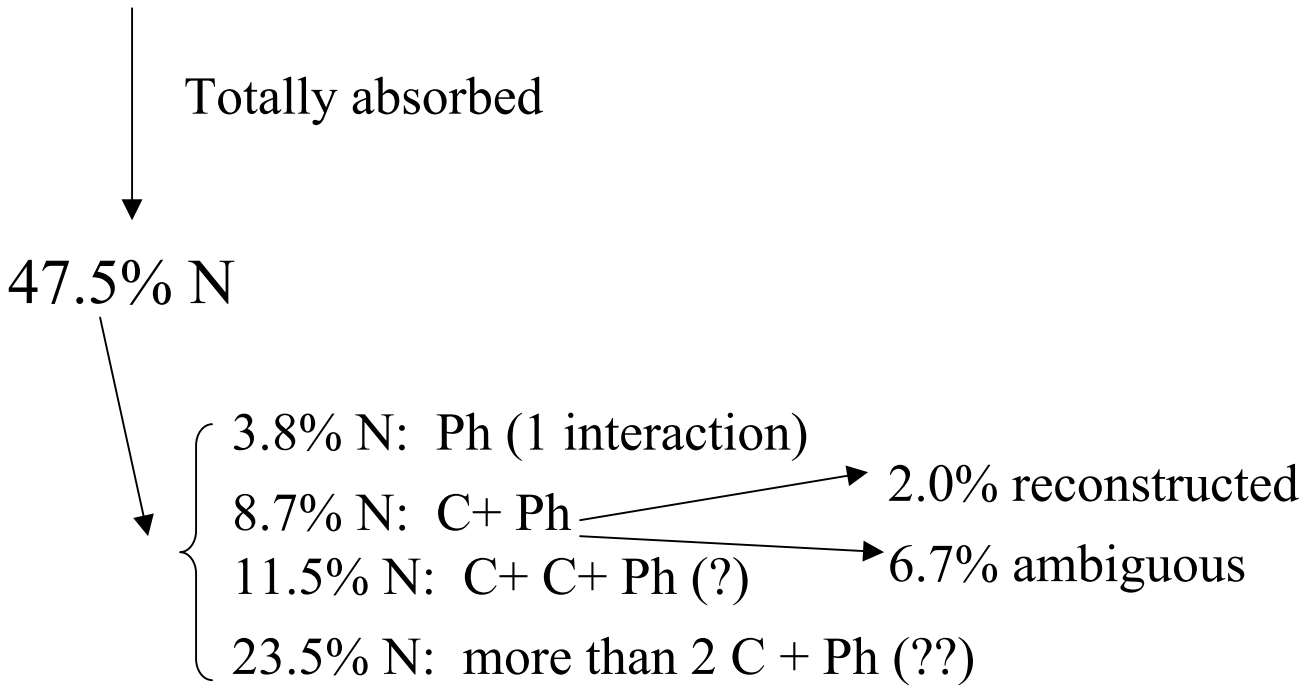
The scattering angle θ as function of the energy deposit (continuous line) and $\pi - \theta_{rec}$ by the second (photoelectric) energy deposit (dotted line). Ambiguity is expected in ~ 200 - 300 keV energy deposit range.



PET MODULE EGS SIMULATION

Simulated gammas: 10^5

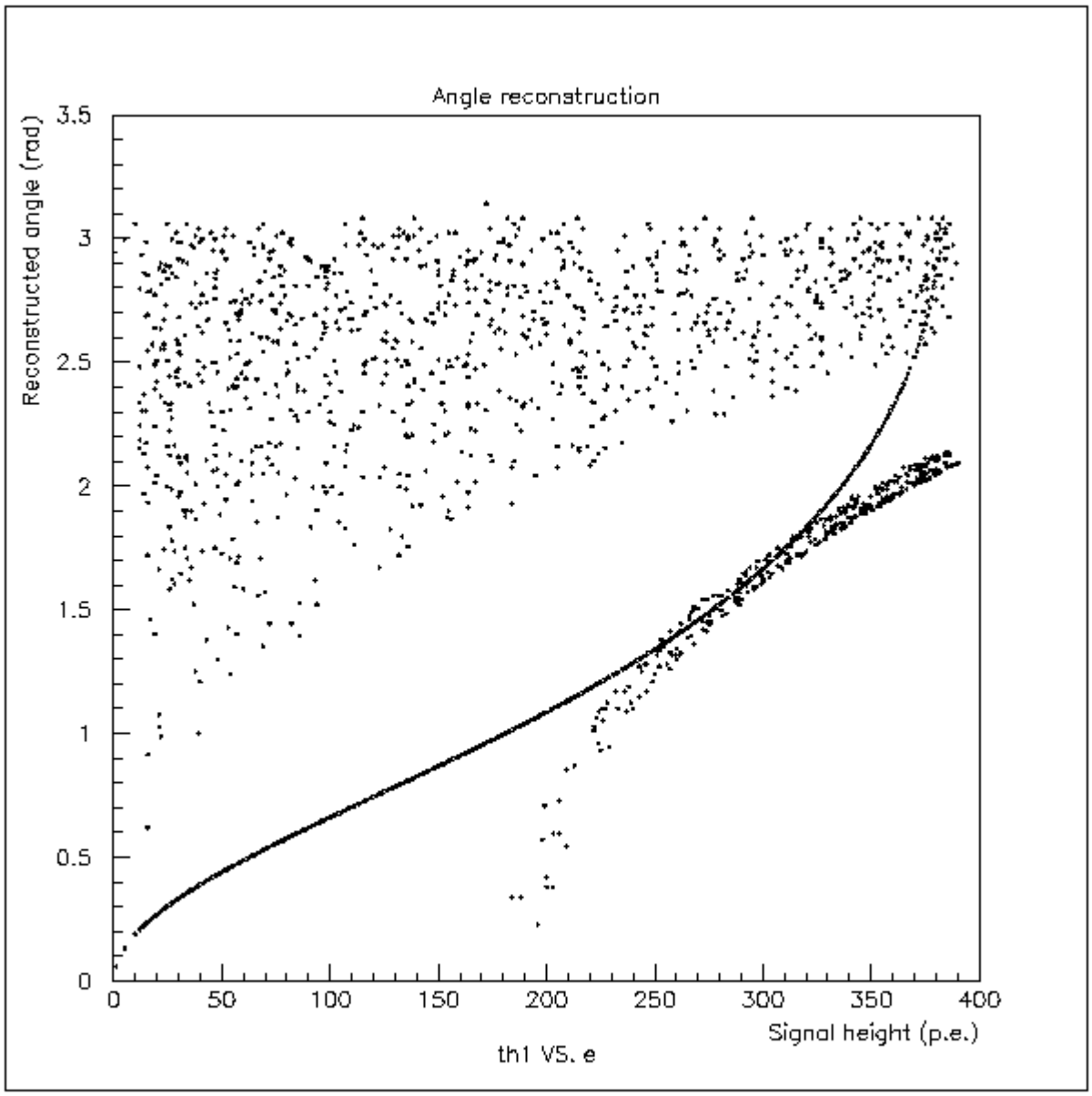
Interacting gammas (N) : 83.7%

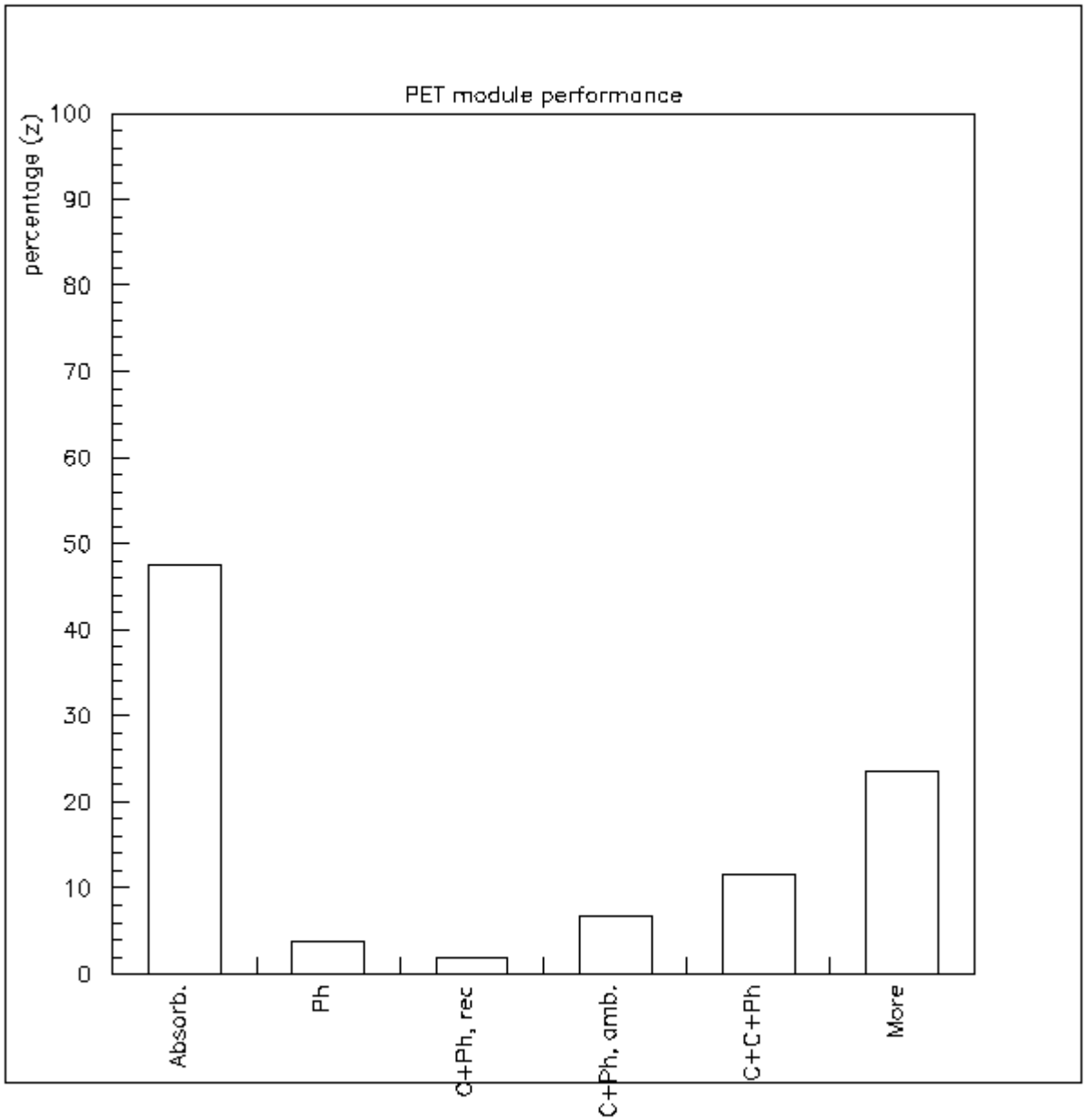


Coincidence efficiency= $\varepsilon_{Ph} \times \varepsilon_{Ph} + \varepsilon_{rec} \times \varepsilon_{rec} + 2\ \varepsilon_{rec} \times \varepsilon_{Ph}$ =
(0.038)2 + (0.020)2 + 2 (0.035 x 0.020)=0.32 %

Efficiency Gain =0.32%/(3.8%)² =2.3

The Monte Carlo reconstructed scattering angle θ_1 as function of the pulse height and $\pi-\theta_2$ by the second energy deposit. High not-correlated values of $\pi-\theta_2$ are reconstructed in second Compton interaction case




PET module performance
percentage (z)
100
90
80
70
60
50
40
30
20
10
0
Absorb.
Ph
C+Ph, rec
C+Ph, amb.
C+C+Ph
More

TO BE DONE

- Angular reconstruction by points of interactions
- Analysis of the C+C+Ph events
- Possibility of reconstruction of C+C+C+Ph events?
- EGS simulation of the body (Compton from tissue)