



Time Over Threshold as a measure of energy loss in the J-PET scanner

S. Sharma, S. Niedzwiecki on behalf of the J-PET collaboration



sushil.sharma@uj.edu.pl, szymonniedzwiecki@googlemail.com



Introduction

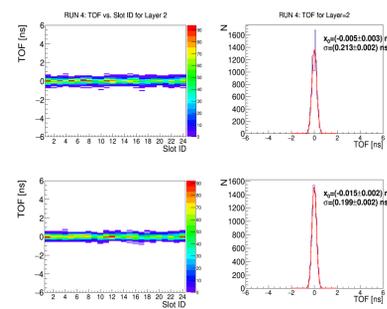
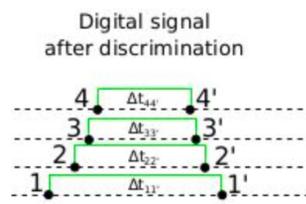
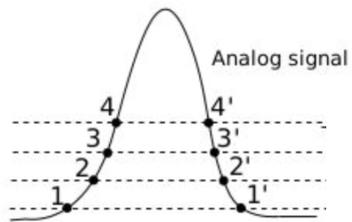
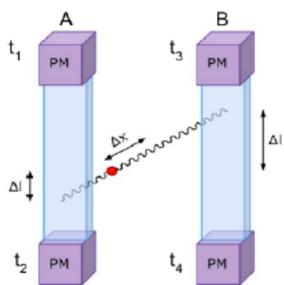
- J-PET detector is composed of 192 plastic scintillator axially arranged in 3-layers [1-5].
- Charge collection is replaced by **Time Over Threshold (TOT)** measurements.
- In organic scintillator, gamma quanta interact predominantly via **Compton** scattering: only partial energy deposition
- Relationship between energy deposition by incident photon and corresponding TOT values is strongly non-linear [6].

Motivations

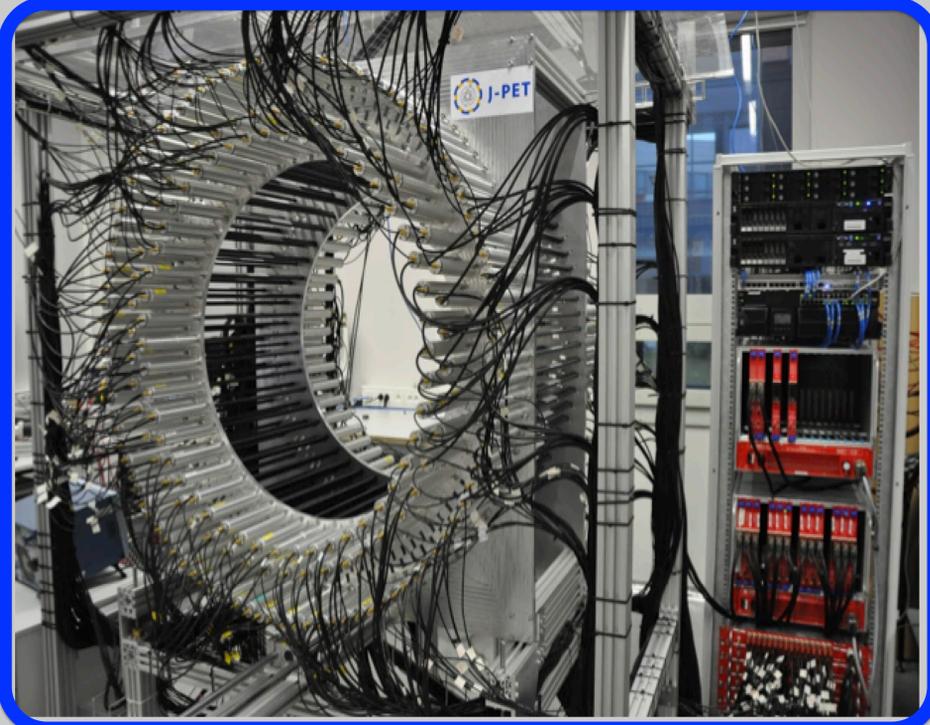
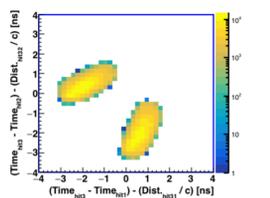
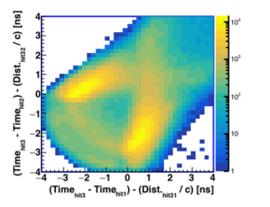
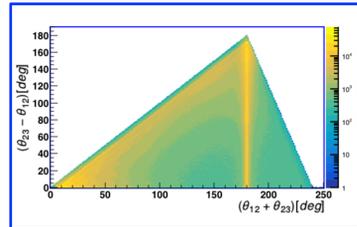
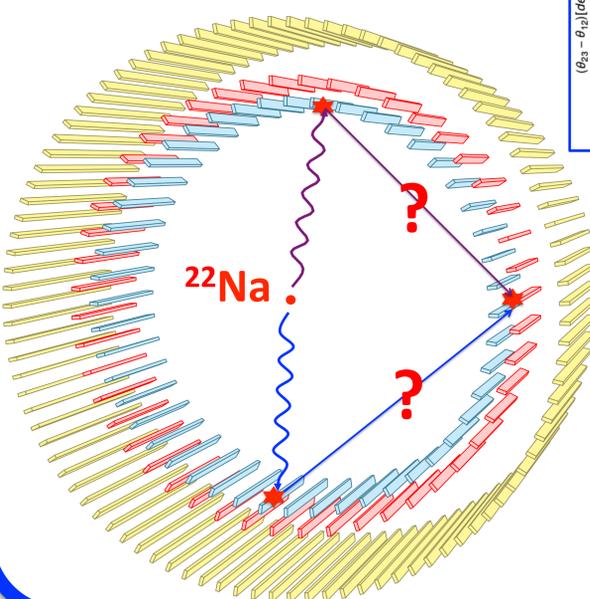
- ☑ All state-of-art scanners use energy window to subtract photons which scattered in patients body. Determination of deposited energy by incident photons is the first step towards this goal.
- ☑ **Energy deposit** by photon (e.g., 511 keV) can be estimated based on the Compton scattering angle(θ):

$$\text{Energy Deposit} = \frac{511(1 - \cos(\theta))}{(m_e c^2 / 511) + (1 - \cos(\theta))}$$

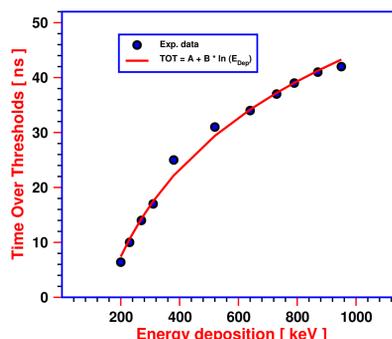
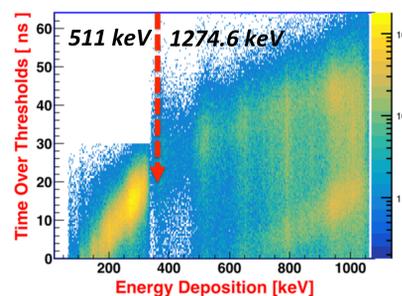
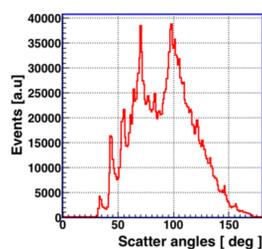
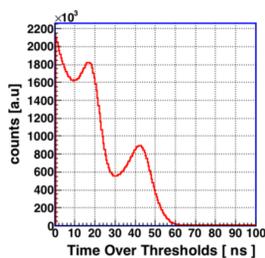
Principle, Signal processing, DAQ



Analysis Algorithm



- ⊙ Photons were tagged 511 keV and 1274.6 keV
- ⊙ Scatter Test was devised $S = (\text{time}_{\text{Meas.}} - \text{time}_{\text{Cal}})$
- ⊙ Eventwise TOT Vs Edep(Scatt. angle)



Conclusions

- ☑ The state-of-art energy calibration procedure for the J-PET detector is developed.
- ☑ Relationship between **TOT** and **Energy deposit** by incident gamma is established.
- ☑ Based on the developed relationship, the J-PET detector acquires the sensitivity to identify the photons (energy loss) after the interaction in scintillator.

References:

- [1] P. Moskal et al., Nucl. Instr. and Meth. **A 764**, 31 (2014) [4] L. Raczyński et al., Phys. Med. Biol. **62**, 5076 (2017)
 [2] P. Moskal et al., Nucl. Instr. and Meth. **A 775**, 54 (2015) [5] M. Palka et al., Journal of Instru. **12**, P08001 (2017)
 [3] P. Moskal et al., Phys. Med. Biol. **61**, 2025 (2016) [6] Wu Jin-Jie et al., Chinese Phys. **C 32**, 186 (2008)

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