P11. STRIP-PET: CONCEPT OF TOF-PET SCANNER BASED ON POLYMER SCINTILLATOR STRIPS

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The aim of the poster is to present an idea of a new PET scanner based on strips of polymer scintillators arranged in a large acceptance detector system which may allow a simultaneous diagnostic of a large fraction of (or even the whole) human body. Detection chamber of PET made of plastic scintillators would be formed from strips of detectors as shown in Figure 1 [1]. Scintillation light from both sides of each strip is converted into electric signal by photomultipliers. In case of crystal detectors for reconstruction one uses events from photoelectric effect, but in plastic scintillators probability for this phenomenon is negligible. Still it is possible to use events related to Compton effect inside the detector. The maximum energy deposition of electrons from the Compton edge is equal to about 340 keV. Thus Strip PET with low energy threshold of 200 keV will reduce the scattering of gamma quanta in the body of a patient to the same extent as it is in the currently used tomographs which typically use the low energy threshold of 300 or 350 keV [2].

In Figure 2 we show Compton scattered electron energy distributions for the energy of gamma quanta reaching the detector without scattering in the patient's body, after the scattering through an angle of 30 degrees and an angle of 60 degrees. The presented distributions show that in order to limit registration of quanta scattered in the patient to the range from 0 to 60 degrees (as used in the currently produced tomographs) one has to use an energy threshold of about 200 keV. To compensate for low density of plastic scintillators several layers of strips could placed around a patient [3] as it shown in Fig.3. The total thickness of cylinders of 5 cm results in efficiency of 20% when requiring signals with energy deposits larger than 200 keV.

Novelty of the concept lies in employing predominantly the timing of signals instead of their amplitudes. The solution proposed will allow for the determination of position and time of the reaction of the gamma quanta based on the time measurement. The hit position versus the center of the scintillator (Δl) is determined based on time difference measured on both sides of the scintillation strip. The time at which gamma quantum hits the module can be determined

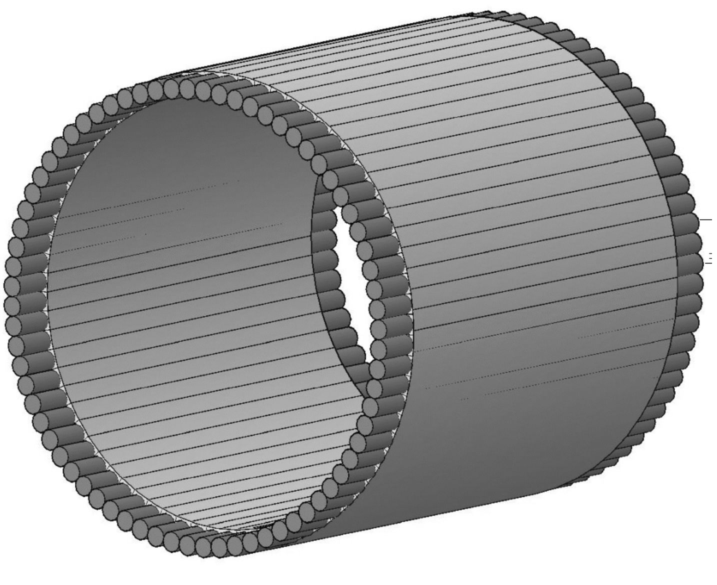

Figure 1. Detector arrangement in plastic scintillator PET. Patient would lie inside the barrel, along scintillator strips

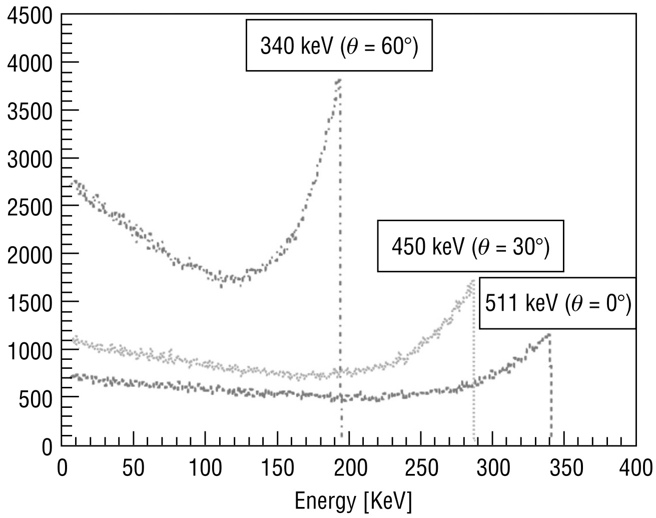

Figure 2. Energy distribution of electrons scattered in the Compton effect by gamma quanta with an energy shown in the plot. The distributions were made without taking into accout the energy resolution, which for the strip detector readout on both sides isabout 18% (compared to LSO blocks which energy resolution is about 12%[4])

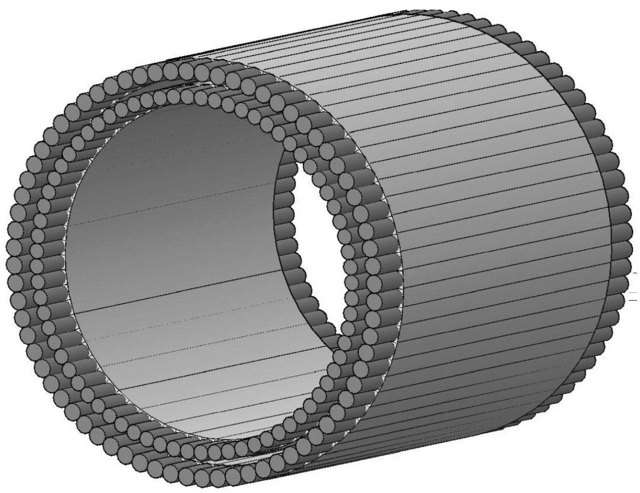

Figure 3. Two layer version of scintillation barrel

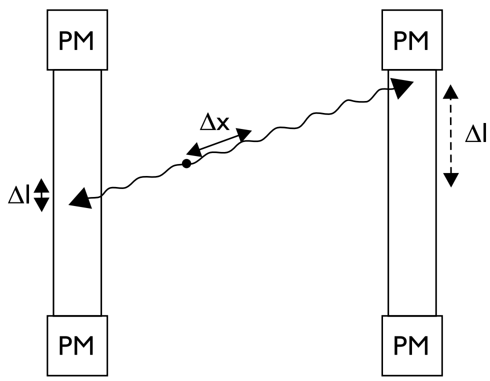

Figure 4. Schematic illustration of a new PET concept — Strip PET

as an arithmetic mean of times measured on both sides of the module. Position (Δx) along the line of response is determined from time difference between two modules [4].

Reference

1. Moskal P. Patent Application No: P 388 555 [WIPO ST 10/C PL388555] (2009), PCT/PL2010/00062 (2010).
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4. Saha G. Basics of PET imaging. Springer, New York 2010.