Development of Fast Plastic Scintillators for Positron Annihilation Lifetime Spectroscopy

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Jagiellonian Positron Emission Tomograph (J-PET) is a PET scanner based on plastic scintillators [1, 2, 3]. The aim of the J-PET Collaboration is to build a modular, light and portable PET scanner for the total body examination. Currently we are building prototype modules consisting of 1000 mm long plastic scintillator strips with silicon photomultipliers coupled at both ends [4].

Result of styrene and vinyltoluene polymerization will be presented. The time-temperature cycles were established for polymerization in small cylinders as well as for polymerization in the glass mold allowing to manufacture long plastic scintillator strips. A new method developed for the fast quality control of plastic scintillator strips was successfully applied during J-PET prototype building and will be introduced. The new scintillator was manufactured via bulk polymerization of vinyltoluene and the optimal concentration of the 2-(4-styrylphenyl)benzoxazole wavelength shifter [5]. The light yield for the best sample was established to be equal 10 000 photons per MeV. Obtained plastic scintillators were optimized for short rise and decay times needed in time of flight PET an PALS detectors. The rise time and decay time of the developed plastic scintillator were determined to be 0.5 ns and 1.9 ns, respectively.

J-PET is a multi-purpose detector designed for medical imaging and for studies of properties of positronium atoms in porous matter and in living organisms [6]. The obtained results prove that J-PET is capable of performing simultaneous imaging of the density distribution of annihilation points as well as positron annihilation lifetime spectroscopy [7]. Possibility of performing the three gamma photons imaging based on ortho-positronium annihilation, as well as the possibility of positronium mean lifetime imaging with the J-PET tomograph constructed from plastic scintillators will be also explored [6].

References

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