

## Jagiellonian-PET: A Novel TOF-PET Detector Based on Plastic Scintillators

**Authors :** P. Moskal, T. Bednarski, P. Bialas, E. Czerwinski, A. Gajos, A. Gruntowski, D. Kaminska, L. Kaplon, G. Korcyl, P. Kowalski, T. Kozik, W. Krzemien, E. Kubicz, Sz. Niedzwiecki, M. Palka, L. Raczynski, Z. Rudy, P. Salabura, N. G. Sharma, M. Silarski, A. Slomski, J. Smyrski, A. Strzelecki, A. Wieczorek, W. Wislicki, M. Zielinski, N. Zon

**Abstract :** A new concept and results of the performance tests of the TOF-PET detection system developed at the Jagiellonian University will be presented. The novelty of the concept lies in employing long strips of polymer scintillators instead of crystals as detectors of annihilation quanta, and in using predominantly the timing of signals instead of their amplitudes for the reconstruction of Lines-of-Response. The diagnostic chamber consists of plastic scintillator strips readout by pairs of photo multipliers arranged axially around a cylindrical surface. To take advantage of the superior timing properties of plastic scintillators the signals are probed in the voltage domain with the accuracy of 20 ps by a newly developed electronics, and the data are collected by the novel trigger-less and reconfigurable data acquisition system. The hit-position and hit-time are reconstructed by the dedicated reconstruction methods based on the compressing sensing theory and the library of synchronized model signals. The solutions are subject to twelve patent applications. So far a time-of-flight resolution of ~120 ps (sigma) was achieved for a double-strip prototype with 30 cm field-of-view (FOV). It is by more than a factor of two better than TOF resolution achievable in current TOF-PET modalities and at the same time the FOV of 30 cm long prototype is significantly larger with respect to typical commercial PET devices. The Jagiellonian PET (J-PET) detector with plastic scintillators arranged axially possesses also another advantage. Its diagnostic chamber is free of any electronic devices and magnetic materials thus giving unique possibilities of combining J-PET with CT and J-PET with MRI for scanning the same part of a patient at the same time with both methods.

**Keywords :** PET-CT, PET-MRI, TOF-PET, scintillator

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