

# Search for $\mathcal{T}$ -violation in Positronium decay using the J-PET detector

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Time reversal symmetry ( $\mathcal{T}$ ) violation has been one of the most intriguing aspects of the tests on discrete symmetries. So far,  $\mathcal{T}$ -violation has not been observed in purely leptonic systems [1, 2, 3]. According to the standard model predictions, photon-photon interaction or weak interaction can mimic the symmetry violation at the level of  $10^{-9}$  (photon-photon interaction) and  $10^{-13}$  (weak interactions) respectively, posing as a physical restriction to these tests [4-6].

The Jagiellonian Positron Emission Tomograph (J-PET) developed at Jagiellonian University in Krakow, Poland, is one of its kind being based on organic scintillators [7, 8, 14]. J-PET is an axially symmetric and high acceptance scanner that can be used as a multi-purpose detector system. It is well suited to pursue tests of discrete symmetries in decays of positronium in addition to medical imaging [9, 10, 12, 14]. J-PET enables the measurement of the momentum vector  $\mathbf{k}_i$  and the polarization vector  $\mathbf{\epsilon}_j$  of annihilation photons [10, 11, 13]. Measurement of polarization of annihilation photons is a unique feature of the J-PET detector which allows the study of  $\mathcal{T}$ -violation by determining the expectation values of the time reversal symmetry odd operator [10],

$$(\mathbf{\epsilon}_j \cdot \mathbf{k}_i), \text{ (for } j \neq i \text{)} \quad [10].$$

J-PET collaboration aims to improve the sensitivity for the tests of the time reversal symmetry with respect to the previous experiments in the leptonic sector beyond the present established level of  $10^{-3}$  [2]. At the turn of 2017 and 2018, a three month data-taking campaign with the positronium produced in the porous polymer was conducted. The results of the analyzed data will be presented in the conference.

## References

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