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J-PET tomograph as a novel detector for discrete symmetries studies in charge leptonic system

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The J- PET tomograph, which consists of inexpensive plastic scintillators, has also demonstrated its potential in the study of fundamental symmetries [1,2]. It consists of 192 plastic scintillators arranged in 3 layers optimized for the registration of multiple annihilation photons emitted in the decays of ortho-positronium atoms (o-Ps) [3], a triplet state of a purely charged leptonic system of electron (e-)
and its antiparticle positron (e+). Due to the constraints imposed by charge conjugation, o-Ps decays into an odd number of photons, predominantly 3. The J- PET detector can register all annihilation photons simultaneously. Thus, it enables precision testing of the discrete symmetries (C, P, T) in the decays of o-Ps by measuring the expectation value event-by-event basis of the odd symmetry operators consisting of the momentum vector of photons and the spin of o-Ps [2,4]. Moreover, the geometric acceptance of J- PET allows the measurement of the polarization direction of the photon based on Compton scattering [5], and thus, for the first time, the study of a new set of symmetry operators involving the polarization of photons.
In this work, the key features of the J- PET tomograph as a novel detector and the experimental techniques used to perform the precision tests of the discrete symmetries will be presented and discussed

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