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## Design of a Novel Compact Detector based on the BGO and SiPM for Ortho-Positronium Physics

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### Design of a Novel Compact Detector based on the BGO and SiPM for Ortho-Positronium Physics

HyeoungWoo Park<sup>1</sup>, D.W. Jung<sup>1</sup>, Sanghoon Hwang<sup>2</sup>, H.J. Kim<sup>1\*</sup>

<sup>1</sup>Department of Physics, Kyungpook National University, Daegu 702-701, Korea

<sup>2</sup>Korea Research Institute of Standards and Science (KRISS), Daejeong, Republic of Korea

Positronium decay research is one of the sensitive probe to discover new physical phenomenon. Because of the pairing system of electron (particle) and positron (antiparticle), we can study reactions which is forbidden by standard model. The reported positronium decay systems were composed of positron trigger and gamma detection parts. The trigger part is usually coupled to an optical fiber and the photomultiplier tube (PMT). The optical fiber trigger efficiency degrades due to significant scintillation light loss. Therefore, we designed a novel compact detector that directly collects scintillation light. In general, the size of the PMT is relatively large, so a silicon photomultiplier (SiPM) was used to make compact trigger part for direct collection of scintillation light. In this research, the trigger part consists of plastic scintillator coupled directly to single channel SiPM to obtain the positron's signal from the center of the detector. The trigger part is surrounded by the gamma detection part with an array of  $14 \times 14$  BGO scintillators ( $7.5 \times 7.5 \times 150 \text{ mm}^3$ ) to detect gamma decay in all directions. For dual readout both sides of the BGO scintillators are coupled with  $7 \times 7$  arrangement of  $2 \times 2$  arrays for a total of  $14 \times 14$  SiPMs. The designed frame and grid are used to support BGO scintillators and SiPMs. We obtained pretest data of a positron trigger signal and a gamma energy spectrum of  $^{22}\text{Na}$  and  $^{137}\text{Cs}$  radioactive sources for the novel compact detector. The detector will be used to study of C-parity violation, invisible decay, and rare decay.

**Primary authors:** PARK, HyeoungWoo (Kyungpook National University); KIM, Hong Joo (Kyungpook National University)

**Co-authors:** Mr JOUNG, Dongwoo (Department of Physics, Kyungpook National University, Daegu 702-701, Korea); Dr HWANG, Sanghoon (Korea Research Institute of Standards and Science (KRISS))

**Presenter:** PARK, HyeoungWoo (Kyungpook National University)

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