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A study of double dark photon visible decay mode at e+e- colliders using HPC

Dark sector, which includes dark matter and dark photon, is one of the most important and challenging research subject in particle physics. Dark matter is known to play a crucial role in the formation of cosmic structure including stars, galaxies, and clusters of galaxies. However, we do not know the identity of dark matter to date. In order to find identity of dark matter, various searches including direct search, indirect search, and particle collider search are actively on-going. However, dark matter study heavily depends on computing simulation due to small cross-section and unknown parameters. The unknown parameters are dark photon mass and coupling constant. We studied double dark photon visible decay mode at electron-positron colliders at center-of-mass energy √s = 10.58~1000 GeV using KISTI-5 supercomputer.

According to a theory, dark photon can decay into muon pair. From this theory, we studied dark photon (A') in the decay mode of e+ e-⟶A' A' and A' A' γ where each dark photon decays into muon pair. We used a simplified model for the generation of the dark matter. At first, we scanned √s and dark photon mass in order to know dependency of cross-section with them. Because lots of event generation are required for this scan, we conducted our study efficiently using KISTI-5 supercomputer. Based on the scan, we found the dark photon mass for the maximum cross-section for each collider. For given dark photon masses, we generated one million events of signal modes with MadGraph5 at √s of each collider using KISTI-5 supercomputer. To study optimization of event generation using KISTI-5 supercomputer, we compared CPU time and memory which are used at √s of each collider. The result will help to optimize the CPU time and memory for event generation using high performance computing.

Then, we performed detector simulation using Delphes applying those dark photon masses. We reconstructed dark photon from muon pairs. Finally, we found the expected number of event and detector efficiency for each collider. The results of this study will help to search for double dark photon visible decay mode at electron-positron colliders.

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