Contribution ID: **241** Type: **Oral**

GEANT4-based full simulation of the PADME experiment at the DAFNE BTF

Tuesday, 11 October 2016 15:00 (15 minutes)

The long standing problem of reconciling the cosmological evidence of the existence of dark matter with the lack of any clear experimental observation of it, has recently revived the idea that the new particles are not directly connected with the Standard Model gauge fields, but only through mediator fields or ''portals", connecting our world with new ''secluded" or ''hidden" sectors. One of the simplest models just adds an additional U(1) symmetry, with its corresponding vector boson A'.

At the end of 2015 INFN has formally approved a new experiment, PADME (Positron Annihilation into Dark Matter Experiment), to search for invisible decays of the A' at the DAFNE BTF in Frascati. The experiment is designed to detect dark photons produced in positron on fixed target annihilations ($e^+e^- \to \gamma A'$) decaying to dark matter by measuring the final state missing mass.

The collaboration aims to complete the design and construction of the experiment by the end of 2017 and to collect $\sim 10^{13}$ positrons on target by the end of 2018, thus allowing to reach the $\epsilon \sim 10^{-3}$ sensitivity up to a dark photon mass of ~ 24 MeV/c^2.

The experiment will be composed by a thin active diamond target where the positron beam from the DAFNE Linac will impinge to produce e^+e^- annihilation events. The surviving beam will be deflected with a $calO$(0.5 Tesla) magnet, on loan from the CERN PS, while the photons produced in the annihilation will be measured by a calorimeter composed of BGO crystals recovered from the L3 experiment at LEP. To reject the background from bremsstrahlung gamma production, a set of segmented plastic scintillator vetoes will be used to detect positrons exiting the target with an energy below that of the beam, while a fast small angle calorimeter will be used to reject the $e^+e^- \to \gamma\gamma(\gamma)$ background.

To optimize the experimental layout in terms of signal acceptance and background rejection, the full layout of the experiment has been modeled with the GEANT4 simulation package. In this talk we will describe the details of the simulation and report on the results obtained with the software.

Primary Keyword (Mandatory)

Simulation

Secondary Keyword (Optional)

Tertiary Keyword (Optional)

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Session Classification: Track 2: Offline Computing

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