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High-performance gamma-ray astronomy and polarimetry with low-density homogeneous active targets: gas detectors.

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Present sub-GeV gamma-ray telescopes are afflicted by the multiple scattering of the electron and of the positron in their tungsten converters. Due to the same reason, the gamma-ray polarimetry of cosmic sources has never been achieved.
We have first characterised by simulations the potential of low-density homogeneous detectors for high-performance gamma-ray astronomy. We have shown that the single-track angular resolution is so good that polarimetry can be achieved.

We have then designed, built and characterised on beam a high-pressure gas time-projection chamber (TPC) prototype with which we have demonstrated the polarimetry of a linearly-polarised MeV gamma-ray beam with an excellent dilution factor.

En route, we have written an exact (five-dimensional) Monte Carlo event generator of the Bethe-Heitler differential cross section and have made it the first gamma-conversion Geant4 physics model that provides a target recoil-momentum distribution and a polarisation asymmetry compatible with the predictions of QED. (G4BetheHeitler5DModel, 10.5beta release)

Gamma-ray polarimetry could enable the identification of the emitting particles in blazar jets (leptons, ionized matter), the emission mechanism in young pulsars (synchrotron or curvature radiation), and provide a smoking gun to dark matter annihilations in the Galactic center.

Are you presenting on behalf of collaborations or institutions?

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