X-ray Polarimetry with Optical Time projection chamber within HypeX project

Thursday, 19 June 2025 12:40 (20 minutes)

X-ray polarimetry is an observational technique with the potential to enrich our understanding of high-energy astrophysics via the measurement of the polarization of X-rays emitted by exotic cosmic phenomena such as black holes, neutron stars, Gamma-Ray Bursts and Solar flares, enabling to unveil new insights on fundamental physics and geometry of Galactic and extragalactic sources. We will present a novel large-volume, extended field-of-view Time Projection Chamber (TPC) tailored for hard X ray polarimetry in the range between 8 and 40 keV. Originally developed for directional Dark Matter searches, the system has been adapted to measure the polarization of X-rays by means of photoelectric effect. The technology, a TPC with triple-GEM amplification stage and optical readout exploiting the sensitivity and granularity of sCMOS cameras and PMTs, aims to achieve 3D reconstruction of photoelectrons and an active volume significantly larger—about 100 times—than the current state of the art. The prototype TPC, with a cylindrical active volume of radius of 3.7 cm and height of 6 cm, achieves full reconstruction of photoelectron tracks in the 10–50 keV range, with angular resolutions reaching 15°. Calibration tests using a collimated ⁹⁰Sr source and a fully polarized 17 keV X ray beam have yielded promising results, including modulation factors above 0.4 at 17 keV. We will also discuss future developments in order to optimize the detector structure and amplification structure, paving the way for innovative X-ray polarimetry missions.

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Session Classification: Detectors and Detection Techniques