Electron Drift in Xe Gas

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Detecting Dark Matter

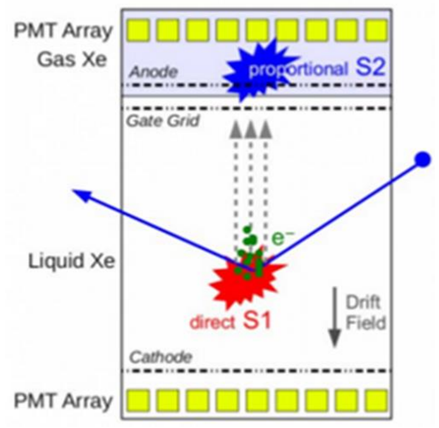


Figure 1. Functions of Dual-Phase TPC

Dual-Phase TPC

- Particle interaction generates direct scintillation light (S1) and electrons
- Drift field (~1 kV/cm) directs electrons to gaseous region
- Secondary light (S2) produced by electrons in gas region subject to high electric field (~10 kV/cm)

WIMPs will interact via nuclear recoils. The S1/S2 ratio distinguishes nuclear recoils from electron recoils. High transparency to charge is crucial to measuring an accurate S2.

What Is a Gas Purity Monitor (GPM)?

To measure the charge transparency of Xe, electrons are produced, drifted through gaseous Xe, and collected. Understanding electron drift in Xe gas is crucial to developing a functional and efficient gas purity monitor.

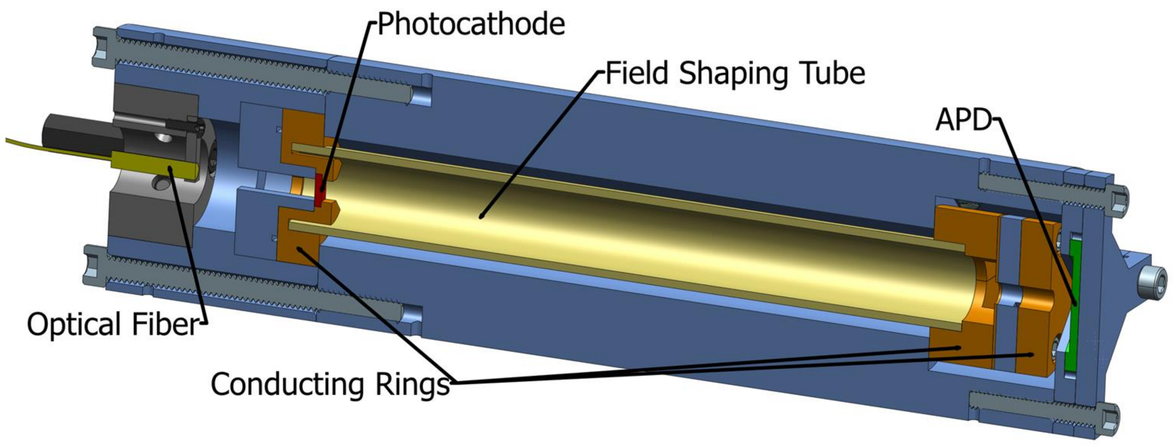


Figure 2. Gas Purity Monitor Design

Design Features:

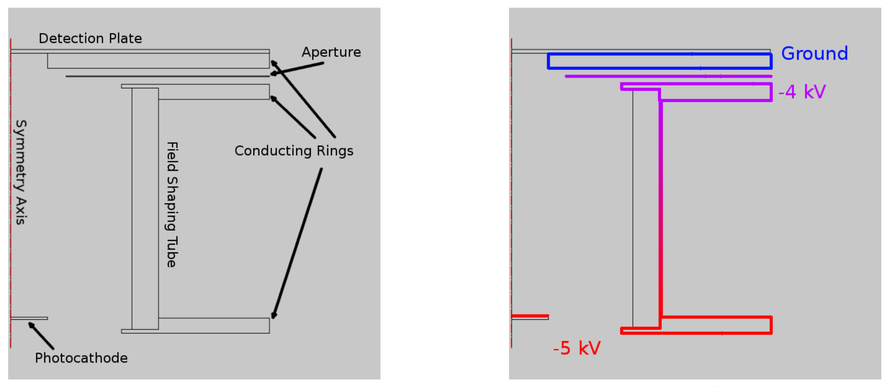
- Transmissive Mode Mg Photocathode
- Cylindrical Resistor for Primary Drift Field
- Conducting Rings for High Field Region
- Photodiode for Scintillation Light Collection

❖ Thin-film deposition is used to produce the photocathode and cylindrical resistor.

References:
1. J. C. Bowe, Drift Velocity of Electrons etc., Phys. Rev. Lett., 117, 1411 (1960)
2. Z. J. Cendes, Adaptive mesh refinementetc., IEEE Transactions on Magnetics, 21-5, 1811 (1985)
3. W. T. Chen et. al., arXiv:1109.3300 (2011)

From Design to Simulation

An axially-symmetric model is chosen for electric field computation. Electrons are then traced through the field to examine the performance and acceptance of the GPM. A mesh refinement is performed utilizing trajectory convergence.



A B

Figure 3. (A) Components of Simulation Geometry (B) Electrostatic Boundary Conditions

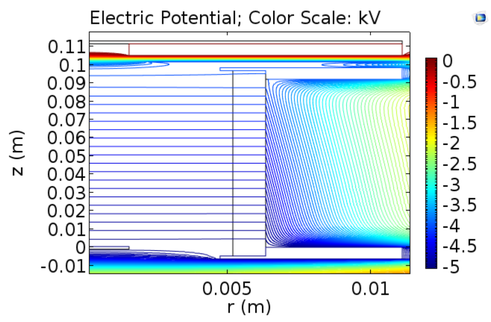


Figure 4. Equipotential Lines of Electric Field

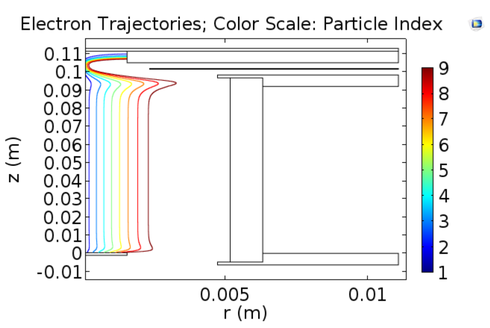
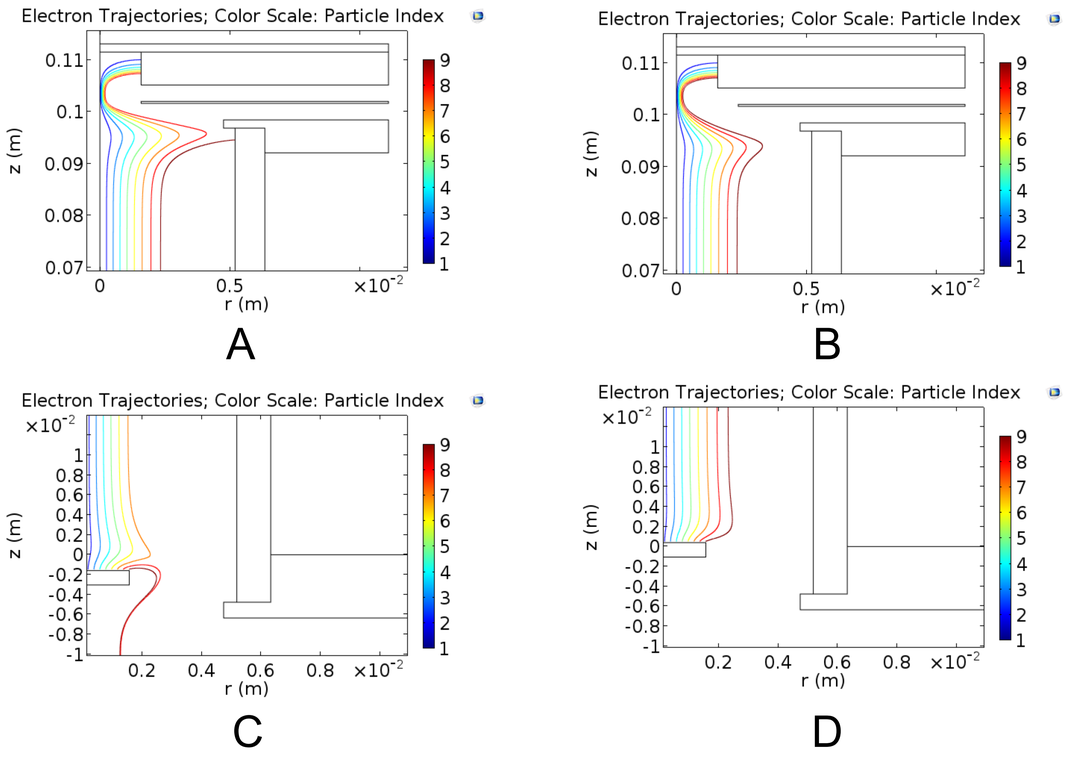


Figure 5. Electron Trajectories Through Full GPM

Results

Simulating the electric field and electron trajectories allows the tuning of GPM components to avoid charge build-up and optimize performance.



A B C D

Figure 6. (A) Charge Build-up on Field Shaping Tube (B) Well Behaved Electrons in the High Field Region (C) Electrons Ejected Behind the Photocathode (D) Well Behaved Electrons Near the Photocathode

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