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Space Charge Effects on Gas Gain in Non-Uniform Field Argon-Based Detectors

The charge carriers in the detector volume created in the gas amplification process cause a space charge effect. The fluctuation in gas amplification process is one of the main factor in the energy resolution of proportional counters. At low bias voltages only a very small number of charge carriers are generated and so the space charge effect is negligibly low. However, as bias voltage increases so does the gas amplification factor and the number of the secondary charge carriers grows, reducing the electric field strength between space charges and the anode wire.

In the present work, a Monte Carlo simulation code [1] has been used in order to investigate the influence of space charge effect on the gas gain and its fluctuation for different operation voltages and gas mixture ratios. In order to compare simulation and experimental results, the simulation code has been applied for the well-known ALEPH Inner Tracking Detector geometry which is a non-uniform field argon-based gas detector that is operated in a proportional mode.

The results show that under normal operation conditions such space charge effect can cause significant change in the relative variance of the gain distribution started by a single primary electron generated in the different position.

References

[1] - I. TAPAN and N. DEMIR, Simulation of gain fluctuation for non-uniform field argon based gas detector, Nuclear Instruments and Methods in Physics Research A 525 (2004)p53

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