Contribution ID: **197** Type: **poster**

Position reconstruction studies with GEM detectors and the charge-sensitive VMM3a ASIC

Thursday, September 16, 2021 10:41 AM (1 minute)

Gas Electron Multiplier (GEM) detectors are a prominent example of Micro-Pattern Gaseous Detectors (MPGDs). One of their main features is that they provide a good spatial resolution over large areas (square metre sized detector modules). When the interacting particle deposits energy inside the detector volume, primary electrons are created that drift towards the readout anode (here: 9 mm drift distance). During the drift, the electron cloud diffuses (sigma of 250 µm) over fine pitch granularity readout electrodes (here strips with 400 µm pitch). With such granularities, spatial resolutions of about 100 µm are achieved. Due to the charge spread over several readout electrodes, even better spatial resolutions can be achieved (around 40 µm with high-energy MIPs in COMPASS-like GEM detectors) by using position reconstruction algorithms, like for example the centre-of-gravity (COG) method.

To apply the COG method, multi-channel charge-sensitive readout electronics is needed. For the here presented studies, the VMM3a ASIC was used, which will be briefly introduced. It records the charge information and allows a self-triggered high-rate, position and energy-sensitive readout of large area particle detectors.

Due to the discretised readout structure, a bias is introduced in the reconstructed position, which was similarly observed with Multi-Wire Proportional Chambers (MWPCs), indicating that a pure usage of the COG method may not be the optimal choice. In this presentation, a simple modification of the COG method to mitigate the bias effect is shown and its applicability is discussed. Further, a hardware feature of the VMM3a is presented, which allows to recover otherwise lost charge information in its threshold-based self-triggered readout scheme and thus improves the position reconstruction.

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Session Classification: Poster Session 5 (Gas-based Detectors; Medical Applications of Position Sensitive Detectors)

Track Classification: Gas-based Detectors