GEMROC2 – a selftriggered high counting rate readout ASIC for Micro Pattern Gas Detectors with integrated input protection against discharges

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Outline

» Motivation

» GEMROC readout system performance

» GEMROC2 preliminary results

» Summary
Motivation

» Much simpler assembling
  – Higher number of channels in one ASIC
    • one plane read out by two ASICs (800 µm readout pitch)
    • one plane read out by four ASICs (400 µm readout pitch)
  – Integrated input protection against discharges

» Optimization of the system energy resolution
  – Higher dynamic range
  – Lower electronic noise level (slower readout)
  – Higher front-end gain (lower gas gain)
- each channel is split into: slow (energy) and fast (timing) sub-channels
- switchable gain (2 modes) and signal polarity selection
- derandomization of data and zero suppression in the token-based readout
- self triggering mode – readout initiated by the input signal
- internal testability functions
- 32 channels per ASIC
- 0.35μm CMOS process
Detection system with triple-GEM (GEMROC)

- custom designed DAQ board with Ethernet based communication protocol
- four 32-channel GEMROCs for each coordinate (one channel per two readout strips)
- triple-GEM with 256 × 256 readout strips (pitch of readout strips is 800 μm)
Energy resolution Fe-55 (FWHM) - 19.8% @ 3860V Ar/CO₂ (70/30)
2-D imaging

Reconstructed events count rate ~ 26 ke/s
Count rate measurements

Simultaneous measurement with two X-ray sources Fe-55 and Cd-109

Reconstructed events count rate ~ 1.5 Me/s (Hits count rate ~ 5.6 Mh/s)
GEMROC2 architecture

- each channel is split into: slow (energy) and fast (timing) sub-channels
- switchable gain (8 modes) and signal polarity selection
- derandomization of data and zero suppression in the token-based readout
- self triggering mode – readout initiated by the input signal
- internal testability functions
- 64 channels per ASIC
- integrated input protection against discharges
- 0.35μm CMOS process
Detection system with triple-GEM (GEMROC2)

- custom designed DAQ board with Ethernet based communication protocol
- two (four) 64-channel GEMROC2 for each coordinate (one channel per two (one) readout strips)
- triple-GEM with $256 \times 256$ readout strips (pitch of readout strips is 400 $\mu$m)
2-D imaging
(800 µm readout pitch)

One ASIC board per plane is used (one forth of the detector is read out)

Energy resolution Fe-55 (FWHM) - 15.7% @ 3600V Ar/CO₂ (80/20)
2-D imaging
(800 µm readout pitch)

Energy resolution Fe-55 (FWHM) - 19.5% @ 3600V Ar/CO₂ (80/20)
Energy resolution Fe-55 (FWHM) - 19.5% @ 3600V Ar/CO₂ (80/20)
Energy resolution
(800 µm readout pitch)

Local energy resolution Fe-55 (FWHM) - 15.5% @ 3600V Ar/CO₂ (80/20)
Summary

» Results
  – Energy resolution at the level of 15.5% for the selected area (800 µm readout pitch)
  – Energy resolution at the level of 19.5% for the whole detector (800 µm readout pitch)

» Plans for near future
  – Debugging of the reconstruction algorithm
  – Optimization of the system operation conditions
  – Measurements with 400 µm readout pitch
  – More results: IWORID and IEEE NSS/MIC
References

» Front-end electronics
  – T. Fiutowski et al., Integrated input protection against discharges for Micro Pattern Gas Detectors readout ASICs. JINST 12 C02021 (2017)

» DAQ hardware and software
  – B. Mindur et al., A compact system for two-dimensional readout of Gas Electron Multiplier detectors, JINST 8 T01005 (2013)

» Application
  – A. Zielińska et al., X-ray fluorescence imaging system for fast mapping of pigment distributions in cultural heritage paintings. JINST 8 P10011 (2013)