Characterization and first field results of a new 64ch custom front-end ASIC for GEM readout

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The CGEM-IT project

CGEM-IT is an innovative lightweight Cylindrical Gas Electron Multiplier proposed to substitute the ageing inner MDT chamber of the BESIII experiment.





The BESIII experiment is installed at the BEPCII e+e- collider in Beijing. The data tacking started in 2009 and it is expected to remain in operation at least till 2024. One serious concern is the ageing of the inner MDT that is reducing its gain by ~4% a year. This issue has triggered the search for an replacement for the inner tracker.



To meet the required spatial resolution a combination of charge centroid and μ -TPC methods was selected. This requires analog charge

reconstruction on individula strips. For that purpose a new custom ASIC was designed.



Detector specification:

- -> Spatial resolution $\sigma_{r\Phi} = 130 \ \mu m$
- -> Longitudinal resolution < 500 µm
- -> Momentum resolution 0.5% @ 1GeV
- -> Time resolution ~5 ns
- -> Material budget per layer $X_0 \sim 0.33\%$
- -> Jagged anode strips to reduce their capacitance

TIGER ASIC

(Torino Integrated Gem Electronics for Read-out) ysteresis omparator Time Output Fast shaping TriggeringControl

Charge Output

Logic

The ASIC speicification:

- -> 64 channels with up to 60kHz/ch rates
- ->12 mW/ch power evelop
- -> Analog charge measurement up to 50fC
- -> ENC noise below 2000 e⁻ rms for strip capacity < 100pF
- -> Time-over-Threshold charge measurement possibility
- -> 4 TAC on T and Q branch of every channel
- -> SEU tolerant digital part

Test and characterization



The TIGER ASICs were produced using the UMC-110nm process. All the chips have been delivered and are now being bonded on the PCBs.

Slow shaping

Sample and hold

TDC

PreAmplifier







The laboratory characterization has successfully confirmed that the ASIC did meet the required specification. After that confirmation a series of test beams has been conducted to test performance of the TIGER being operated with real GEM detectors. Presently the testing of the ASICs is ongoing with the real CGEM detector equipped with the final Front-end cards and nominal HV conditions. The expected delivery of the full system to China is in the summer of 2018.

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