Contribution ID: **50** Type: **Oral presentation**

A custom readout electronics for the BESIII CGEM detector

Tuesday 23 May 2017 17:40 (20 minutes)

Design and test of a custom front-end electronics for the readout of the new inner tracker of the BESIII experiment, carried out at BEPCII in Beijing, is presented.
An innovative cylindrical GEM detector with analog and time readout is under development to upgrade the Inner Tracker of the BESIII experiment at the BEPC-II e+e- collider of the Institute of High Energy Physics in Beijing.
The analogue readout of the CGEM enables the use of a charge centroid algorithm to improve the spatial resolution to better than 130 μm while loosening the pitch strip to 650 μm, which allows to reduce the total number of channels to about 10 000. The channels are readout by 160 dedicated integrated 64-channel front-end ASICs, providing a time and charge measurement and featuring a fully-digital output.
The analogue and time readout of the CGEM-IT exploit the full potentiality of the charge centroid algorithm and allows to use a more innovative technique, called microTPC. The combination of the two readout allows to improve the spatial resolution to better than 130 um with a pitch strip of 650 um, that represent a good compromise between the number of total channels and performance. The channels are readout by 160 dedicated integrated 64-channel front-end ASICs, featuring a fully digital output.
The energy measurement is extracted either from the time-over-threshold (ToT) or the 10-bit digitisation of the peak amplitude of the signal. The time of the event is generated by quad-buffered low-power TDCs, allowing for rates up to 60 kHz per channel. The TDCs are based on analogue interpolation techniques and produce a time stamp (or two, if working in ToT mode) of the event with a time resolution better than 100 ps.
The front-end noise, based on a CSA and a two-stage complex conjugated pole shapers, dominate the channel intrinsic time jitter, which is less than 5 ns r.m.s.. The time information of the hit can be used to reconstruct the track path, operating the detector as a small TPC and hence improving the position resolution when the distribution of the cloud, due to large incident angle or magnetic field, is very broad.
Event data is collected by an off-detector motherboard, where each GEM-ROC readout card handles 4 ASIC carrier PCBs (512 channels). Configuration upload and data readout between the off-detector electronics and the VME- based data collector cards are managed by bi-directional fibre optical links.
This talk will cover the design aspects of the detector electronics, the front-end ASIC and will review the silicon results of the chip prototype and the chip test with a CGEM-IT prototype.

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Session Classification: Applications at future nuclear and particle physics facilites - 3 (Chair: Tom Hemmick)