

Development of a Front-end Pixel Chip for Read-out of Micro-Pattern Gas Detectors.

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With a growing need for high resolution, radiation hard and low mass pixel detectors the Micro-Pattern Gas Detector is a good candidate. This detector requires a dedicated front-end read-out chip with improved readout architecture to deal with the high data rate. In addition, it is highly required to keep power consumption as low as possible.

Some of prototype IC's have already been submitted and tested in order to demonstrate high performance of a new front-end (preamplifier and comparator) and feasibility to implement high resolution TDC-per-pixel architecture.

In line with the present results we will discuss design goals and system requirements for a full-reticle chip.

Summary

Recently the RD51 collaboration has been initiated with the purpose to bundle and coordinate developments of Micro-Pattern Gas Detectors (MPGD). MPGD's could very well be used in tracking detectors for upgrades of ATLAS and CMS and large area TPC's.

Optimization of the read-out electronics is one of the goals of the collaboration. At this moment seven institutes and organizations have expressed interest in a common development of a pixel front-end chip optimized for MPGD's.

Some of the system requirements are the following:

- 1) For high spatial resolution pixel's pitch is to be about 55 μm .
- 2) For 3D track reconstruction high resolution (σ is 0.5 ns) drift time measurements are required.
- 3) Low gas gain operation and high single electron efficiency are needed. This requires low-threshold operation (threshold of 400 electrons) and therefore low input referred noise (σ is 80 electrons).
- 4) Pulse height measurements are required (time-over threshold method).
- 5) Simultaneous data taking and data readout is required.
- 6) Required modes of operation.
 - a) All pixels data readout mode (image frame based).
 - b) Data (hit) driven readout mode (continuous readout with zero suppression).
 - c) Triggered data readout mode (only data associated within a certain time window).
- 7) Power consumption 200mW/cm² (preliminary target).

The GOSSIP0-2 chip is a prototype for the MPGD front-end electronics [1]. The main goal of the prototype was to demonstrate the feasibility and behaviour of TDC-per-pixel concept based on local oscillator (540MHz) architecture [1] in a 16x16 pixels array. It has been reported before that such a TDC block itself complies with system requirements such as high precision of the drift time measurements, low power consumption and good robustness to instability of the power supply voltage and temperature.

At the same time, the ongoing testing of the GOSSIPO-2 chip indicates that the time resolution of the digital TDC block is limited by the performance of the preamplifier and the comparator. We will discuss these limitations and other unexpected problems occurring in the front-end block of the pixel read-out and possible improvements.

Proposal for dedicated readout architecture with different modes of operation will also be discussed.

[1] R.Kluit, V.Gromov, H. van der Graaf "Development of a small-scale prototype of the GOSSIP chip in 0.13 μm CMOS technology", Topical Workshop on Electronics for Particle Physics, TWEPP-07, Prague, Czech Republic, 3-7 September 2007.

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