Compact Gaseous Detectors

Vision

Gaseous detectors have extensive use in scientific research and beyond. They offer adequate and mature solutions in particular for applications in which large areas and flexible geometries need to be covered. Enormous volumes of up to e.g. 90 m$^3$ (ALICE TPC) can be instrumented with excellent spatial resolution at a low number of detector channels and a minimum amount of material. Likewise, large-area economical gaseous detectors with a timing performance on the order of ten to hundreds of picoseconds are achievable.

The participating centres can look back upon a long history of gaseous detector developments, large system design and construction. Thus, over the last fifteen years, a fantastic portfolio of scalable micro-patterned readout structures for gaseous detectors in timing, trigger and tracking applications in the form of ionisation chambers with no gain, TPCs, trackers and RPCs has been developed and is still evolving rapidly.

Goals and Activities

The Topics within the work package are very diverse. Therefore, apart from various individual efforts, strengthening the collaboration especially on very basic topics is seen to be most useful to all participants.

Micro Pattern Gas Detectors. Devices based on Gaseous Electron Multipliers (GEM) or Micro-Mesh Gaseous Structures (Micromegas, MM) boost rate capability and resolution to a level where gaseous detectors can even compete with silicon-based devices. At the same time, they do not suffer from effects which degrade the energy resolution at high levels of energy deposition. So, they can easily adapt to the high dynamic range of primary ionisation that ranges from MIPs on one hand to the heaviest ions on the other.

CMOS Technology and Miniaturization. Traditionally, gaseous detectors had to rely upon tedious manual assembly and manufacturing processes. Various can be exploited. Nowadays, various industrially available and highly automated micro technologies can be exploited for ever higher granularity together with cost effective integration of the readout electronics. Examples are lithography and even CMOS technology. Indeed, this may be essential for FAIR, HL-LHC as well as ILC and CLIC.

With built-in variable-gain amplification stages the signal dynamic range may be adapted to the dynamic range of available integrated readout electronics. As an example, pixelated CMOS devices - of the hybrid type or monolithic (such as Timepix/Medipix) - shall be exploited as a signal interface to electronics for advanced gaseous detector systems. Those systems will especially be optimised in terms of their mass, rate capability and spatial resolution.

Resistive Plate Chambers. An important member of the family of gaseous detectors is the resistive plate chamber (RPC). It relies on an immediate avalanche signal surge that entirely decouples signal amplitude from the amount of primary charge and thus allows for timing performance on the order of ten to hundreds of picoseconds. These devices, covering large areas economically, play the essential role of the "stop"-generating detector in time-of-flight (TOF) systems of modern complex experimental setups.

One goal within this subtopic is to set up a complete, cutting-edge RPC system where timing properties and rate capability, often compromised in system operation, may be tuned to the utmost performance. Here the challenge is to provide an adequate quenching mechanism that balances rate capability and system stability also in high ionisation environments.

Basic Cooperation. In general, concerning gaseous detector technology, little system-relevant know-how may be inherited from industry. It is not a very common part of university curricula, either. As a consequence the entire know-how on system engineering, quality assurance and ageing properties linked to gaseous detector technologies needs to be maintained and pushed forward within the scientific community itself.

Therefore, a major objective within this topic is to provide efficient access to such know-how and technologies. There is the idea to set up a "knowledge base" in a collaborative effort. It shall serve as a central gateway to other sources of information, such as literature, material data, text books, manuals and web sites. Likewise, the exchange of students between centres and their education in the field of gaseous detectors shall be fostered.

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