μ-RWELL detector Letter of Intent

The μ-RWELL is a novel type of Micro Pattern Gas Detector (MPGD). It takes some of the best characteristics of existing MPGDs, like GEMs and MicroMegas, while simplifying the detector construction. It also improves significantly the spark protection by incorporating in the design a resistive layer on the anode board. The μ-RWELL [1] is in fact composed of only two elements: the cathode, a simple FR4 PCB with a thin copper layer on one side, and the μ-RWELL PCB, the core of the detector. The μ-RWELL PCB, realized as a multi-layer circuit by means of standard photo-lithography technology, is composed of a well-matrix patterned on an Apical foil acting as amplification element of the detector; a resistive layer, realized with a Diamond-Like-Carbon (DLC) film sputtered on the bottom side of the polyimide foil, as discharge limitation stage; a standard PCB, segmented as strip, pixel or pad electrodes, for readout purposes. The simplest scheme for the evacuation of the current in a μ-RWELL is based on a single resistive layer with a grounding line all around the active area. Many detector prototypes employing this scheme have been built and characterized in the lab, with radioactive sources and also exposed and tested at high energy test beams with particle rates up to a few tens of kHz/cm^2. For higher rates and large-area devices, the path of the current to ground could be large and strongly dependent on the incidence point of the particle. This problem has been overcome by introducing a high-density grounding network on the resistive stage. The Silver-Grid (SG2++ [2]) is a very simplified high-rate layout based on a single resistive layer with a thin conductive grid deposited on the DLC. The conductive grid acts as a high density 2-D current evacuation scheme. The RD on the high rate version of the μ-RWELL has been essentially concluded. The performances are excellent: gain exceeding 10^4, rate capability larger than 10 MHz/cm^2, efficiency >97%, time resolution <6 ns, spatial resolution <60 μm.

The μ-RWELL technology therefore provides a cost-effective and high-performance particle tracker with many potential applications. An important development being pursued since a few years is the Technology Transfer (TT) to industry of the manufacturing process of the high-rate version that will allow a cost-effective mass production of the detector: a must in view of the construction, for example, of large muon systems at future HEP Colliders where huge detection surfaces (O(10000) m^2) are expected.

Since all the manufacturing steps of a μ-RWELL are based on standard SBU (Sequential Build Up) technology the TT of the construction process of the μ-RWELLPCB to industrial partners is quite straightforward. Focusing on the high rate SG2++ layout, most of the technology for manufacturing the anode-PCB is already available at the Italian Company ELTOS SpA. The DLC dry sputtering is currently performed by a Japanese company (Be-Sputter ltd), while the etching of the polyimide to realize the micro-well pattern is performed by the PCB-Workshop at CERN, even though the involvement of others industrial Companies specialized in photolithography of flexible substrates could be taken under consideration in the near future. RD is ongoing on the industrial engineering of the construction procedure in order to optimise the mass production. Other RD aspects involve the realization of larger μ-RWELL detectors (50x50 cm^2) with bi-dimensional readout with long strips. Another important development is the design and realization of custom-made electronics with a dedicated ASIC to significantly lower the cost per channel, which is needed in order to realise a multi-million channel large detector system. All these RD activities would benefit by new collaborators, both from academia and from industry. It must be stressed that the μ-RWELL is the only MPGD that can be fully manufactured by industry, thus allowing a real mass-production while simplifying the final assembly and quality checks generally performed by the users in the research institutes.

Applications

Many potential applications of the μ-RWELL technology are already envisaged for future HEP experiments.

In particular the IDEA (Innovative Detector for an Electron-positron Accelerator) detector concept conceived for a a very large circular leptonic collider experiment, plans on using this technology to realise the preshower of the dual readout calorimeter as well as the full muon detection system. The IDEA detector concept has been considered by both the FCC-ee [3] collider, proposed to be built at CERN, and the CEPC [4] collider, proposed to be built in China. The IDEA detector is described in detail in both Conceptual Design Reports [5].

A cylindrical μ-RWELL detector is considered as a candidate for the vertex detector of the experiment at the Super charm-tau factory proposed by the Budker Institute of Nuclear Physics, Russia.

The LHCb experiment at the LHC is studying an upgrade of their apparatus for the HL-LHC phase using a station equipped with μ-RWELL detectors.

Important applications of this technology are also happening in Nuclear Physics. A novel type of high resolution and precise-timing thermal-neutron detector based on the μ-RWELL technology has been developed. This detector is in fact a special μ-RWELL detector with a boron layer deposited on the cathode.

The μ-RWELL technology could also used for other applications beyond HEP, like, for example, in several industrial, medical fields and homeland security.

Contacts

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References

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