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WG2 session minutes

Contributions

First results from the double phase argon LEM-TPC with a projective 2D anode, *F. Resnati*
The study of TGEMs and RETGEMs for the possible ALICE RICH upgrade, *H. Anand*
Use of GEM for hadronic calorimetry at ILC, *J. Yu*
The multigap rpc: a detector for excellent time resolution , *C. Williams*
Space charge and its effects on tracking in a TPC, *J. Thomas*

First results from the double phase argon LEM-TPC with a projective 2D anode, *F. Resnati*

The Large Electron Multiplier (LEM) is a GEM foil with larger hole dimensions (1 mm thick, 800/500 μm hole pitch/diameter). As detailed by Resnati, it can be applied as the readout of a double phase Ar TPC for DM/neutrino search and proton decay experiments where calorimetric and tracking measurements are necessary. Several properties of a prototype TPC equipped with a 10x10 cm^2 LEM foil placed above 2D crossed strip readout plane have been measured at a temperature of 87 K during an 8 days long cosmic run with no purification of the liquid Ar.

The charge distributions collected on the X and Y strips show a Landau-like shape:

- the primary electron life-time is fitted to the change of the most probable value of the distribution with drift time (370 μs at an oxygen concentration of 0.8 ppb);
- the effective gain is the ratio between the mean charge measured on the strips and the expected primary charge. Its maximum value is 26;
- the S/N ratio is computed selecting the cosmic muons crossing the detector and by taking the average of the signal amplitude divided with the pedestal RMS. At maximum gain, it reaches 260 and 163 in the X and Y directions;
- the deviation from equal charge sharing between X and Y strips is measured with long track muons and is about 5 %.

The group is now constructing a new TPC with larger readout area (40x80 cm^2) which will be used to assess the dE/dx particle identification capability of the detector in a charged particle beam. The main challenge for DM searches will be to increase the detector gain (up to 1000) and the sensitivity to WIMP signals in liquid Ar by use of a double stage LEM.

The study of TGEMs and RETGEMs for the possible ALICE RICH upgrade, *H. Anand*

The ALICE experiment uses a Ring Imaging Cerenkov detector made of planar stations of MWPC to identify particles by measuring the radius of the ring (from the projection of light cone onto the chamber planes) and eventually the cone opening angle. To extend the identification capability of hadrons up to 30 GeV/c, an upgrade of the RICH chambers with CsI coated TGEM or RETGEM is foreseen. They can operate in several gases at high gains (up to 10^5) and provide some protection against sparks (in the case of RETGEM).

Characterisation work has been carried out on 10x10 cm^2 foils to determine the optimal working voltages for gain stability of triple foil stacks for the detection of both charged particle and UV photon signals. In particular, H. Amand reported on a sand blasting cleaning technique applied in the CERN workshop which helps pushing the detector gain close to the Raether limit.

A detector made of a triple TGEM stack with a CsI coating on the top foil has recently be tested in a beam at the CERN/PS. To reach stable operation and maintain efficiency to charged particles and single electrons from UV photon conversions, the drift field was reversed. Cerenkov light produced in a 4 mm thick CaF_2 radiator placed at a distance of 4 cm from the detector window was converted to charge onto the CsI layer. The charge is amplified in the triple GEM and readout by 8x8 mm^2 pads. Summing the measured charge signals, a clear image of the beam profile and the Cerenkov light pattern is obtained. The group is now working on a new chamber design housing 6 stacks of triple RETGEM intended for measuring directly the number of Cerenkov photons from a liquid radiator.

Use of GEM for hadronic calorimetry at ILC, *J. Yu*

Calorimeters at future linear colliders will be homogeneous or sampling calorimeters. In the second case, high lateral and longitudinal segmentation of the detectors with very small dead zone will be essential to reach the targeted jet energy resolution. The typical dimensions of an active plane in the HCAL are 1x1 m^2 chambers with 1x1 cm^2 readout pads and single bit readout (digital HCAL), a total thickness below 8 mm and the front-end electronics embedded on the chamber PCB. J. Yu reported on the use of double GEM chambers for a DHCAL. The short-term goal is the fabrication and test of 1x1 m^2 chambers which later will be assembled in a calorimeter prototype.

Characterisation results of 30x30 m^2 GEM foils from 3M's company have been shown. In particular, radioactive source spectra, gas gain, energy resolution at various GEM bias voltages were measured and the signal to pressure dependence was assessed.

The 1x1 m^2 prototype mechanical design is completed and was presented. The prototype will be split into 3 unit gas chambers, each housing a stack of two 33x100 cm^2 GEM divided in 64 HV sectors, with 2 mm transfer and induction gap. An overall thickness of 12.4 mm (including a 2 mm thick stainless steal cover) with about 5 % of dead zone should be achieved. The first 5 foils have just been received from the CERN workshop.

The multigap rpc: a detector for excellent time resolution, *C. Williams*

An overview of the timing aspects of multi-gap resistive plate chambers (MRPC) was given by C. Williams. Although MRPCs do not comply with the MPGD definition, the basic operation principle is the same, namely primary ionisation and charge amplification, Therefore, lessons drawn from MRPC tests can be instructive to the MPGD comunity.

In order to reach the best time resolution with a gaseous detector, the signal should be as short as possible and the electronics is generally set to consider the first primary electron reaching the readout electrode only (very low threshold) and to ignore the information from the later arriving electrons. This is typically the case of MPGDs with distinct drift and amplification gap or of wire counters. In an RPC, all primary electrons are multiplied simultaneously but by very different factors depending on their position in the gas gap. The solution to maintain good efficiency and fast signals is to stack several

RPCs (up to 24) with narrow gaps. The intrinsic time resolution of this detector is excellent: 5 ps for 160 μm gaps. In practice, other effects such as TDC time resolution, time sleewing, and electronics noise dominate the resolution. Also, the particle source (beam sopt size, track angle and straightness) used for a time measurement eventually contributes to the resolution. Signal development and ion recombination in the gas gap were discussed as well.

MRPCs are applied in the ALICE time of flight array (160 000 channels, 150 m^2) and provide a long efficiency plateau and a time resolution of 40-50 ps. Efforts are now devoted to improve the resolution further with smaller gaps. Two MRPCs with 24 gaps of 160 μm readout by the NINO ASIC were tested in the T10 CERN/PS beam line. The distribution of the time difference measured in the two chambers is centered at zero and has a sigma of 22.35 ps which leads, for a single chamber, a time resolution below 16 ps.

Space charge and its effects on tracking in a TPC, *J. Thomas*

Gaseous detectors operated in high rate environments or used to reconstruct high multiplicity events are concerned with space charge issues. Space charge changes the applied field which eventually results in track distorsions or loss of gas gain. J. Thomas discussed the origin of space charge in TPC and other sources of field distorsions. In particular, the tools to calculate the potential and field resulting from specific or arbitrary distributions of charge were mentionned with examples taken from the STAR experiment case. Once the magnetic and electric field inside the TPC volume are known, the distorsions in the x and y directions can be computed using simple linear equations.