Summary

ELECTRON COUNTING AND ENERGY RESOLUTION STUDY FROM X-RAY CONVERSION IN ARGON MIXTURES WITH AN INGRID-TIMEPIX DETECTOR.

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The 5.9 keV x-ray record resolution of 5% r.m.s. for a gaseous ionisation detector was obtained with an integrated micromesh on Silicon (InGrid) and with a Microbulk Micromegas detector. It is interpreted as a sum of contributions from primary ionisation fluctuations (Fano fluctuations) and gain fluctuations of various origins. A Micromegas (Ingrid) integrated on a 65000 pixel chip (TimePix) was used to measure the number of primary electrons released by 5.9 keV x-rays and 3 keV Auger electrons in Argon mixtures, as well as its fluctuations. The single electrons are separated by diffusion on individual pixels and detected with an efficiency close to 100%. This allows a first direct and precise measurement of the average energy per ionisation in such a mixture and a direct measurement of Fano fluctuations.
Monte Carlo simulation is used to estimate the part of gain fluctuations due to the field configuration in the grid region.

The question of gain fluctuations or avalanche size distribution in gaseous detectors has a renewed importance since it has been recognized as a limitation to the spatial resolution of a MicroPattern Gaseous Detector (MPGD) [1]. It is also an important ingredient in the assessment of the efficiency for single-electron detection. This question can now be studied with recently developed techniques: integrated Micromegas grids (InGrids) which allow a perfect geometry to be realized and the use of CMOS chips for pixellised readout.

InGrid detectors and Microbulk detectors allowed measurement of the K_{α} line of an iron 55 source (filtered with a Chromium foil) with a resolution of 4.8% r.m.s.. Our study intends to interpret this resolution as a combination of primary charge fluctuation (Fano) and gain fluctuations. Monte Carlo is used for estimating the gain variation due to the different fields seen from different entry points of the electrons.

To measure in a direct way the fluctuations of the number of primary electrons produced by the 5.9 keV X-ray, we used a 10 cm drift TPC filled with various gas mixtures and read out by a TimePix CMOS chip. The diffusion over the large drift allows all the electrons to be separated in isolated clusters of 1 to 3 pixels. A 4σ cut on the time of arrival of the electrons allows a very efficient background suppression and thus allows a very low detection threshold, thus a very high single electron efficiency (93%).

The behaviours at low gain and at high gain of the gain distribution are studied separately. The Time Over Threshold capability of the TimePix chip is used to measure the high end of the distribution, which is found to be consistent with an exponential.
The theoretical prejudice for a power-low behaviour at low gain is reviewed.

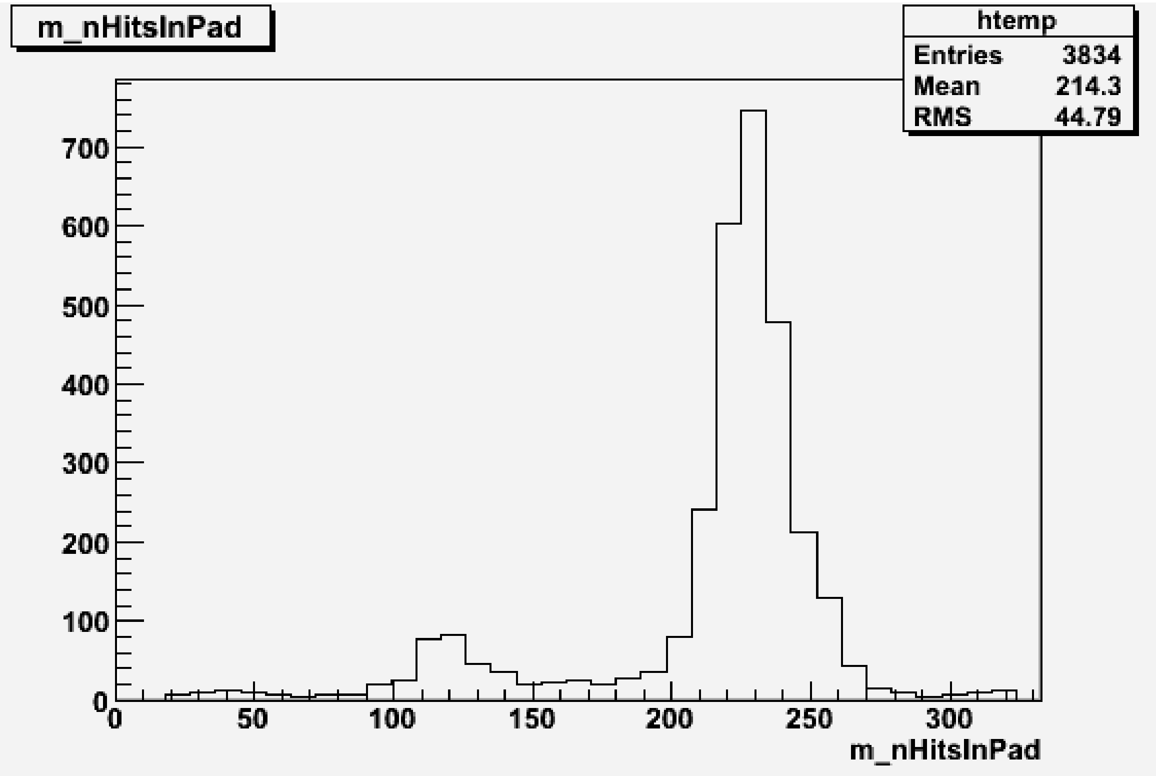

Figure 1. ^{55}Fe line and its escape line observed in a Micromegas detector filled with an Argon mixture

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References

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