Ongoing activities at Saclay

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Abstract

We report on gain measurements which have been done all using the same Micromegas detector and several gas mixtures containing Argon. These results are a step in understanding gas properties and they will guide the choice of the best gas mixtures for the next Micromegas detectors using a Medipix2 readout chip..

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1 Introduction

Micromegas is a parallel-plate micropattern gaseous detector using an amplification gap of a few tens microns. The electron multiplication factor and the energy resolution depend mainly on the gap, the electric field and the gas mixture [1, 2, 3].
The gain of such a detector has been measured as a function of the amplification electric field for nearly 50 gas mixtures and compared with simulations showing thus their limitations. For each gas the charge deposited by 5.9 keV X-rays is used.
Using the same detector systematic measurements have been carried out with double mixtures and triple mixtures of gases (Ar, Ne, CO_2, CH_4, C_2H_6, Iso-C_4H_{10}, CF_4, ...) at various concentrations.

2 The gain measurements

2.1 Goals

The objective of those measurements was to find a gas mixture with comfortable gain margin to use into a Micromegas TPC and know as much as possible the maximum gain (to avoid sparks which damage the readout chip).

2.2 Description

The detector is a transparent plastic box of 23 cm × 23 cm × 8 cm size including a standard Micromegas mesh of 10 cm × 10 cm size.
Two kind of sources have been used: the ^{55}Fe radioactive source providing a 5.9 keV energy line and a x-rays source providing by the Amptek Cool-X X-Ray Generator[2] (line at 8.1 keV).
The atmospheric pressure and the water present inside the detector have been monitoring during the 4 weeks of data taking.

2.3 Results

Figure 3 shows the gain curves as a function of the amplification field E for many gas mixtures. Three groups of curves can be distinguished. The first group is formed by the Iso-C_4H_{10} mixture which yields the higher gains, up to 10^5 (50 kV/cm < E < 70 kV/cm). The second group, mainly composed by cold gases (CH_4, CO_2), have a maximum gain up to a few 10^4 (70 kV/cm < E < 100 kV/cm). Finally, between those two families (60 kV/cm < E < 80 kV/cm) is the C_2H_6 gas mixtures.
The gain of such a detector has been measured as a function of the amplification electric field for nearly 50 gas mixtures and compared with simulations showing thus their limitations. For each gas the charge deposited by 5.9 keV X-rays is used.

It appears that the more the quencher contains hydrogen the higher the maximum gain is. The (argon+isobutane) mixture shows a significant deviation from the exponential gain at high fields. We believe that it is due to photons from the avalanche which re-ionize the medium, increasing the gain.

Adding CF_4 in a mixture translates this curve to the right side and keeping exactly the same shape which means that it gives us less gain at the same electric field.

[2] See web site: http://www.amptek.com/coolx.html

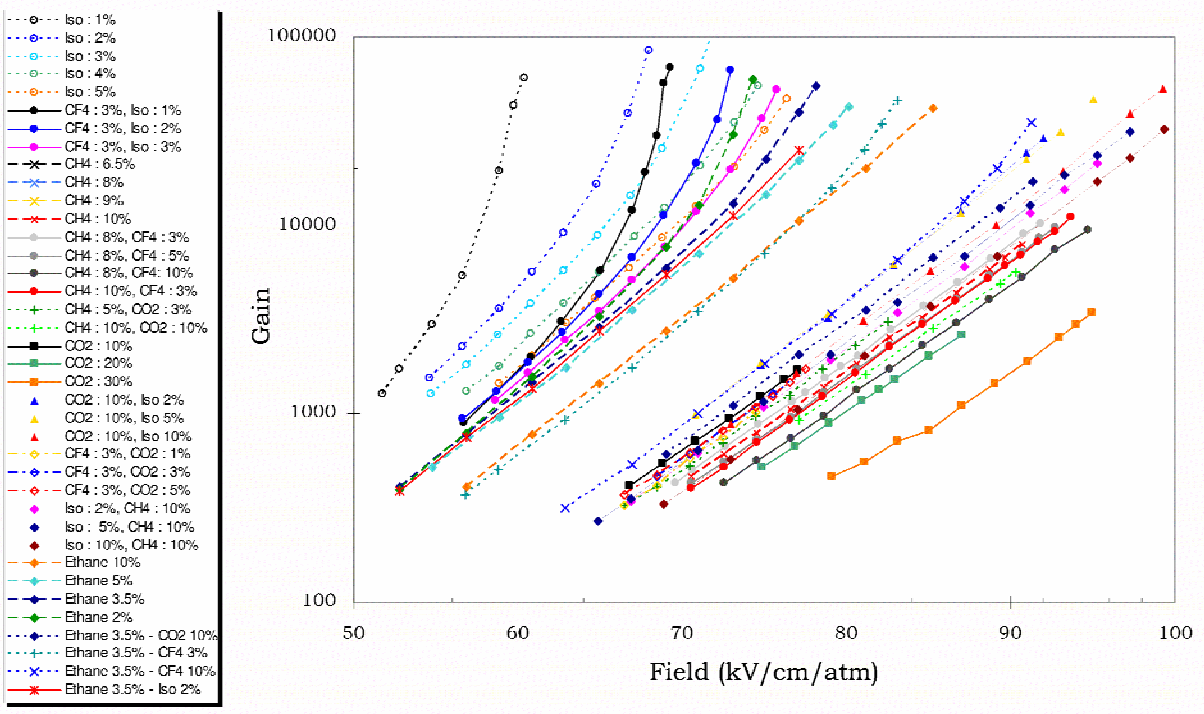

Figure 1: Gain curves vs. amplification field measured by a Micromegas detector using gas mixtures containing Argon and a few percent of CO_2, CH_4, C_2H_6, Iso-C_4H_{10}, and CF4.

2.4 Comparisons with simulations

The GARFIELD[3] software has been used to simulate the gain curves (it contains the Magboltz program, by S. Biagi, which estimates the gain).
The comparisons are shown Fig. 2 and Fig. 3 as a function of the electric field E for two gas mixtures (Ar/CH_4 and Ar/Iso-C_2H_{10}) at various percentages.

3 Next steps

The next stage is to build a test detector using both technologies Micromegas and a Medipix2 chip ([4]) or its time-sensitive version TimePix. To this end we designed a small chamber sitting above a chip as shown in Fig. 4, i.e. a SiTPC with a 6cm drift length. The parallepipedic (2 cm × 2 cm × 6 cm) field cage is applied on a Micromegas mesh support. Two mylar windows, one on its side and one on its top, provide the transparency to β and X-ray sources. A careful choice of the materials is under study for this chamber.

4 Conclusion

Good progress has been achieved this year on the understanding of the gas gain properties using a Micromegas detector and these studies will continue. The forthcoming measurements with a small chamber using Micromegas and a Medipix2/TimePix readout chip together will allow reproducing the early (2004) measurements. It will even allow new and precise measurement and hopefully will demonstrate the possibility of integrating it to the ILC Large Prototype.

[3] See web site: http://cern.ch/garfield

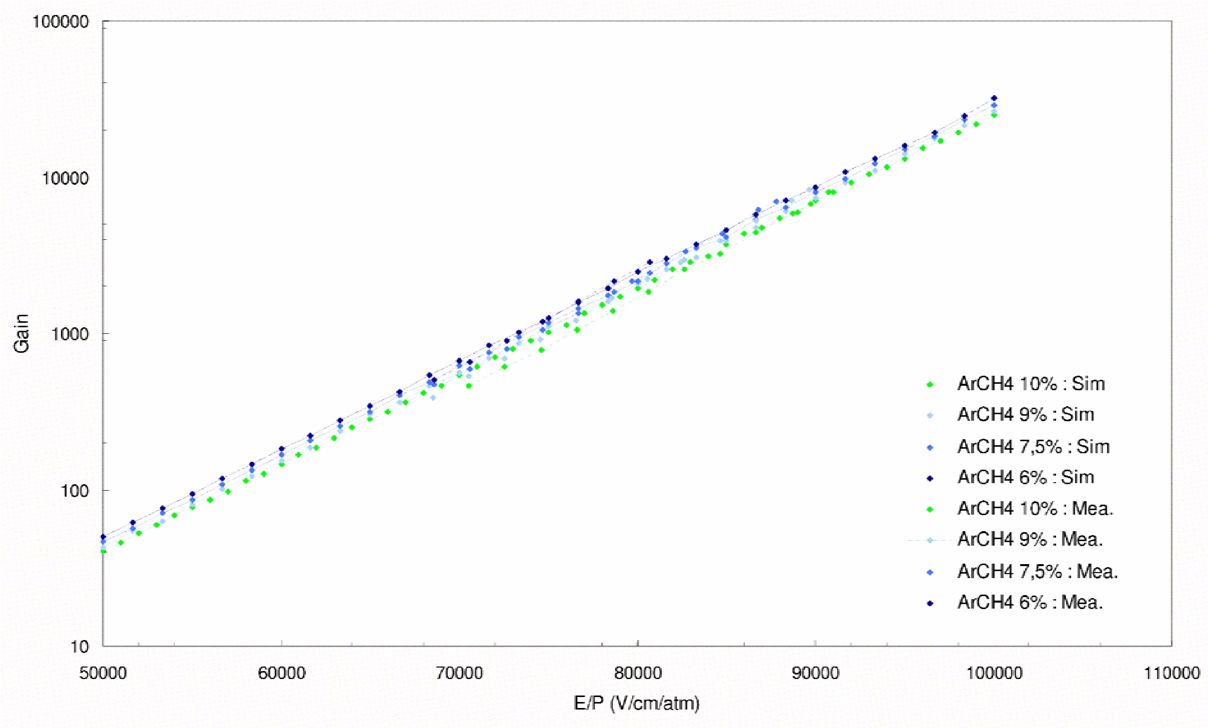

Figure 2: Simulated and measured gain as a function of the electric fields E for Ar/CH_4 at several percentages.

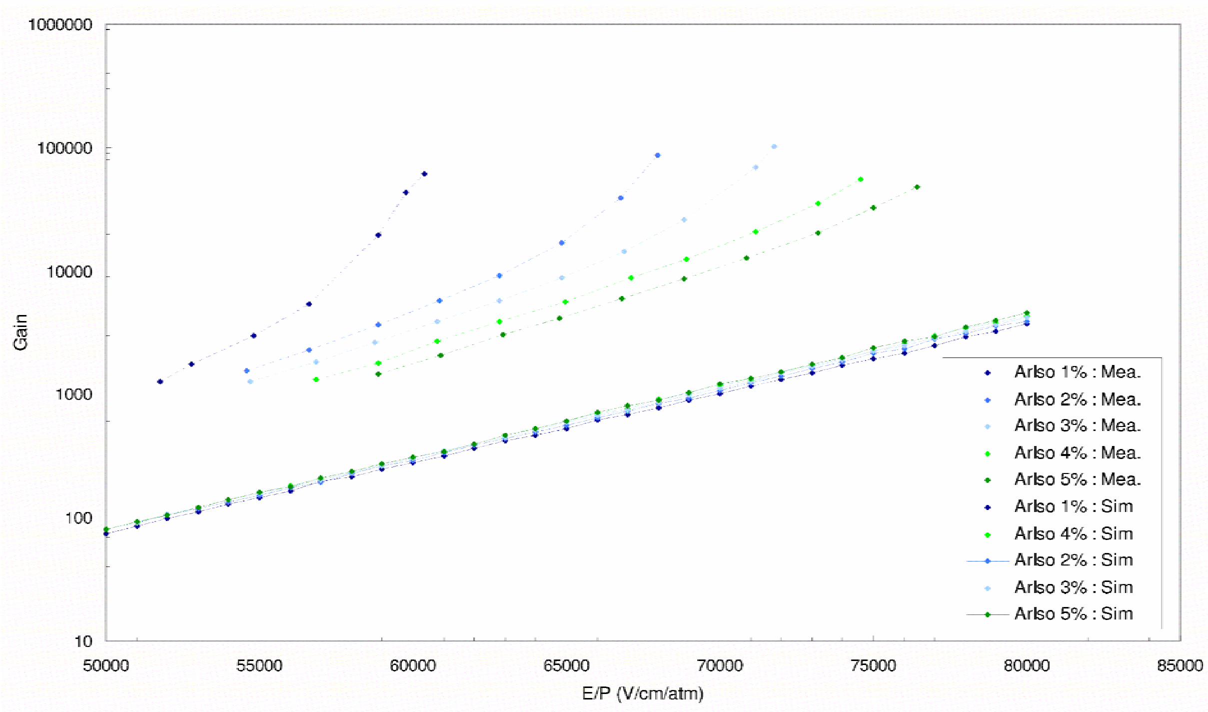

Figure 3: Simulated and measured gain as a function of the electric fields E for Ar/C_4H_{10} at several percentages.

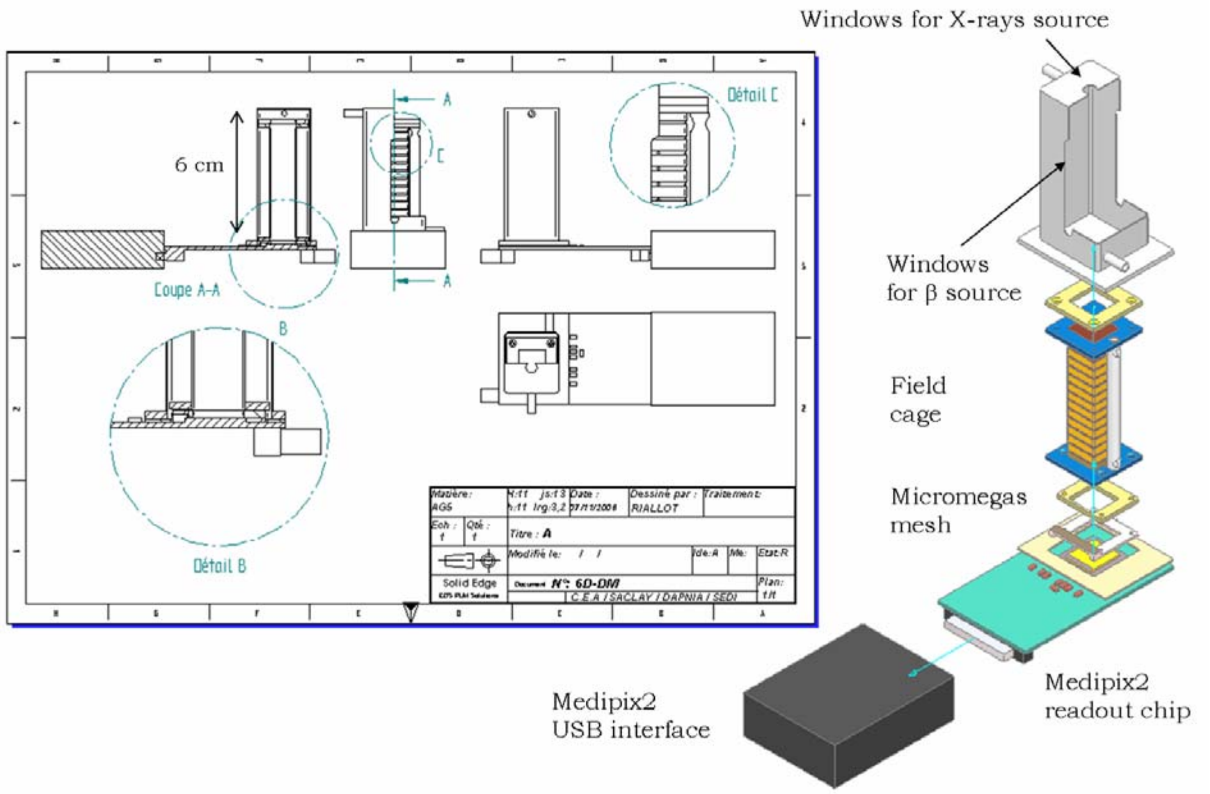

Figure 4: Design for a small chamber with a Micromegas mesh built inside and placed above the PCB of Medipix2/TimePix readout chip.

Acknowledgement

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References

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