Operation of 100 micron thick GEM in Krypton-CO_2 mixtures

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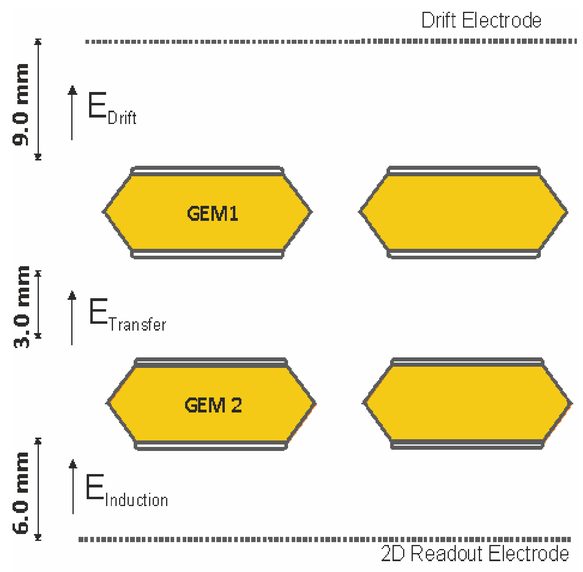
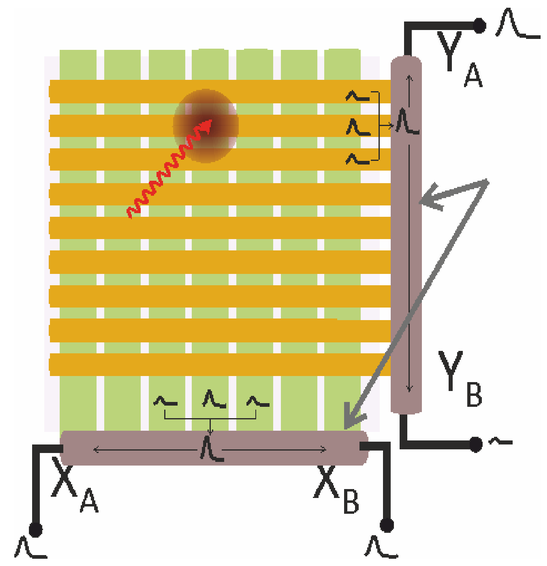
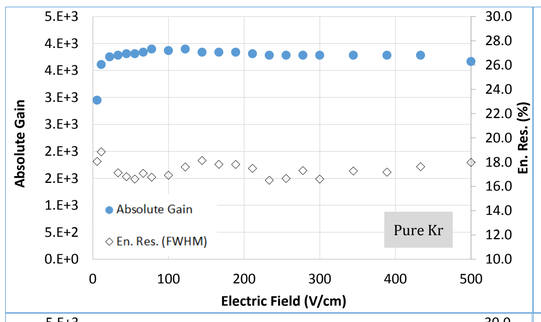
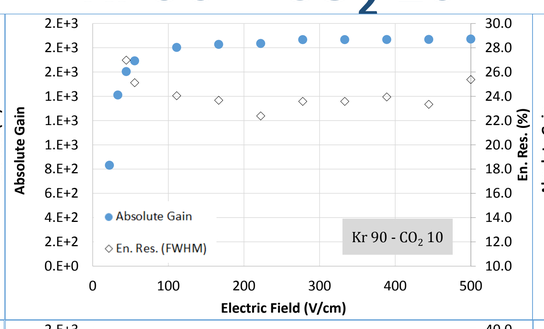
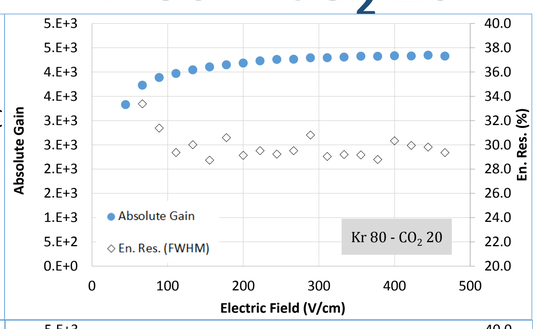
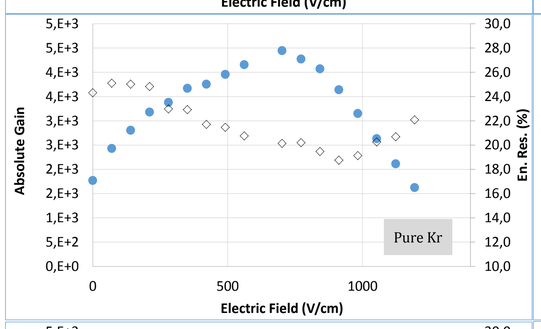
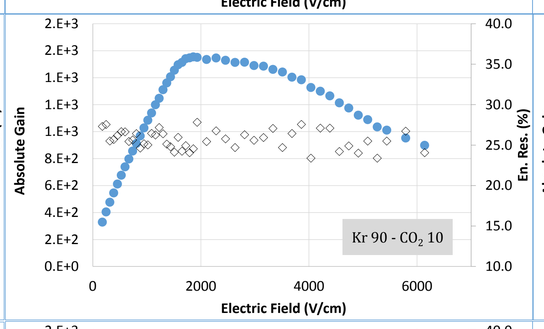
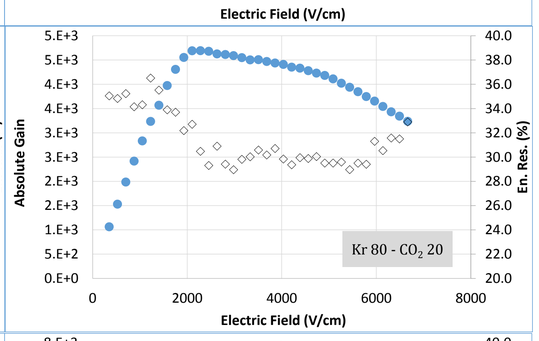
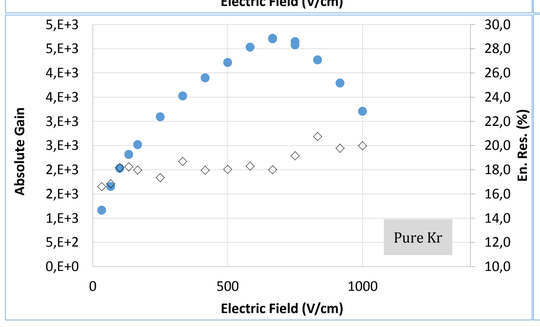
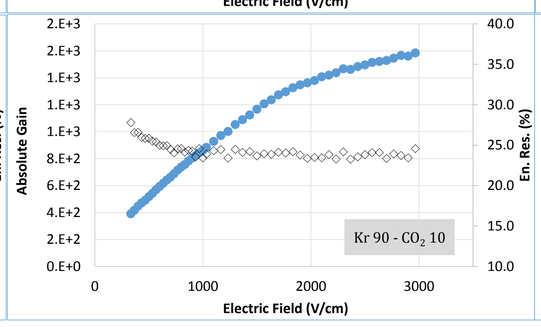
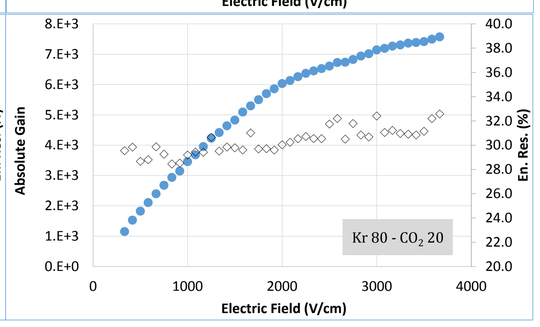
Abstract: We present the results obtained with a cascade of 2 non-standard Gas Electron Multiplier (GEM) (made from a 100 μm thick kapton foil; 2-fold thicker than standard GEM's) coupled to a 2-D resistive readout. The elements have an active area of 10×10 cm^2 and were operated in pure Krypton and Kr-CO_2 mixtures. The 100 micron thick GEM are extremely robust and virtually immune to damage caused by discharges. Krypton is a good candidate for x-ray imaging applications, making use of the 10×10 cm^2 active area of the detector, as it presents the lowest intrinsic position resolution of the noble gases, for energies in the range from 16 to 35 keV. In this work we evaluate the performance of the double GEM 100 micron detector in Kr-CO_2 mixtures.

Experimental Setup: A cascade of 2 non-standard Gas Electron Multiplier (GEM) (made from a 100 μm thick kapton foil; 2-fold thicker than standard GEM's) coupled to a 2-D resistive line readout.
The elements have an active area of 10×10 cm^2 and were operated in pure Krypton and Krypton-CO_2 mixtures.
The 2D resistive readout allows to identify the interaction position and record the energy. For each event a vector with x, y and E is recorded.

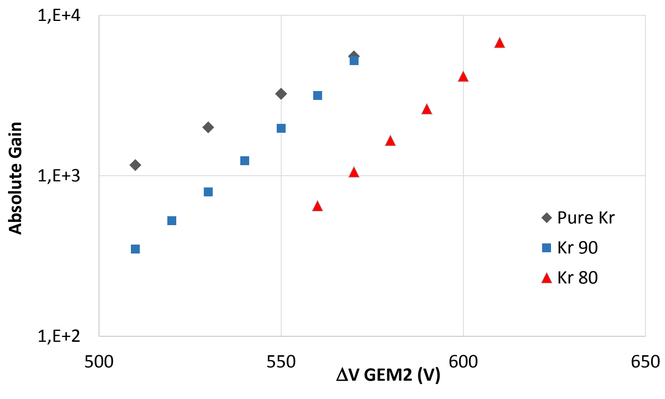


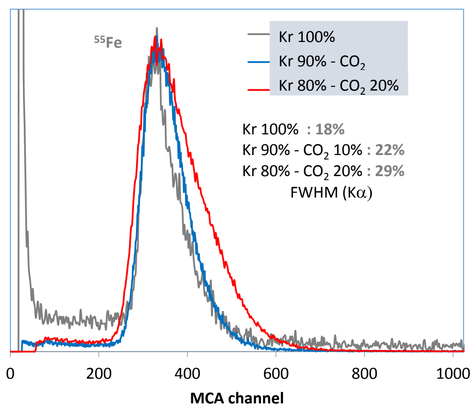


Electric Field Optimization: The electric field configuration was optimized for each of the 3 gas mixtures studied (pure krypton, krypton 90%: CO_2 21% and krypton 80%: CO_2 20%). The electrodes in the cascade were independently biased: a detailed evaluation of the gain and energy resolution (^{55}Fe; 5.9 keV) was performed for each of the mixtures.

Pure Kr	Kr 90 – CO_2 10	Kr 80 – CO_2 20
Drift Region		
		
Fast rise to plateau with Kr. Lower field required for full electron collection. At higher fields, electrons are trapped on top electrode (not reached)		
Transfer between GEM's		
		
Optimization between extraction from first GEM and focusing into holes of the second. Krypton is more sensitive to changes in the electric field		
Extraction from last GEM		
		
Extraction from the holes of the last GEM should increase with increasing electric field. Not true for Krypton.		

Charge gain and Energy Resolution (5.9 keV):





Future Developments:

- Image acquisition (using continuous x-ray generator)
- Position reconstruction using resistive line method:

$$\text{Position along X coordinate:} = \frac{(X_A - X_B)}{(X_A + X_B)} \cdot \text{length}$$

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