Small Gap MICROMEGAS MicroBulk

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Motivation

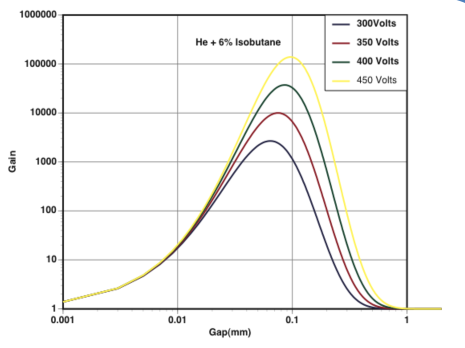
The Microbulk manufacturing technique provides detectors with excellent energy resolution, flexible structure, low material budget and high radio-purity. Small gap micromegas detectors (< 50 µm) are optimized for high pressure applications. Combining the microbulk technique with a small gap can result in attractive detectors for rare event searches, in particular for double beta decay or dark matter search.

Parallel plate detector gain: $G = e^{\alpha d}$

Townsend coefficient α: $\frac{\alpha}{p} = A e^{-Bp/E} = A e^{-Bpd/V}$

Gain variation: $\frac{\delta G}{G} = \alpha p d \left(1 - \frac{Bpd}{V}\right) = \alpha p d \left(1 - \frac{Bp}{E}\right)$

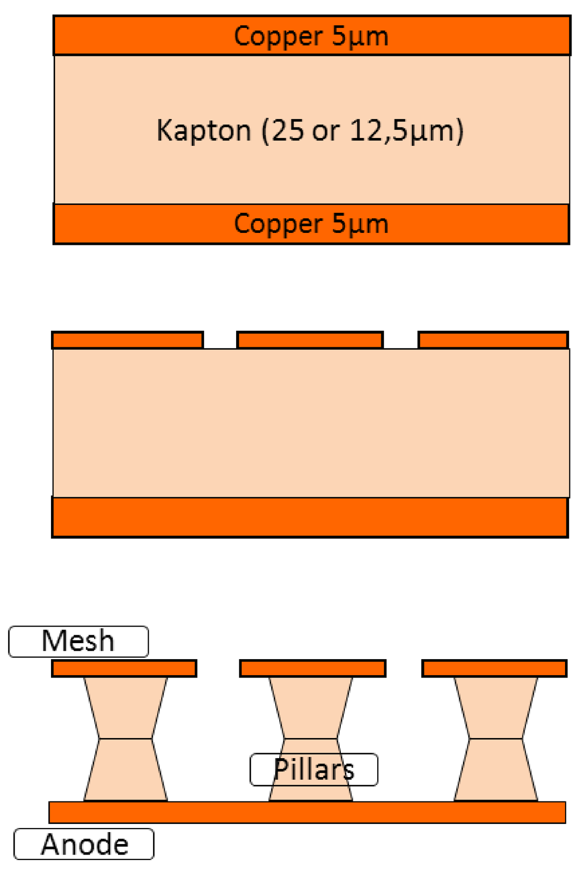
The gain variation exhibits a minimum for : **d = V/Bp**



Optimum gap : 30 - 100 microns

Y. Giomataris, NIM A419, p239 (1998)

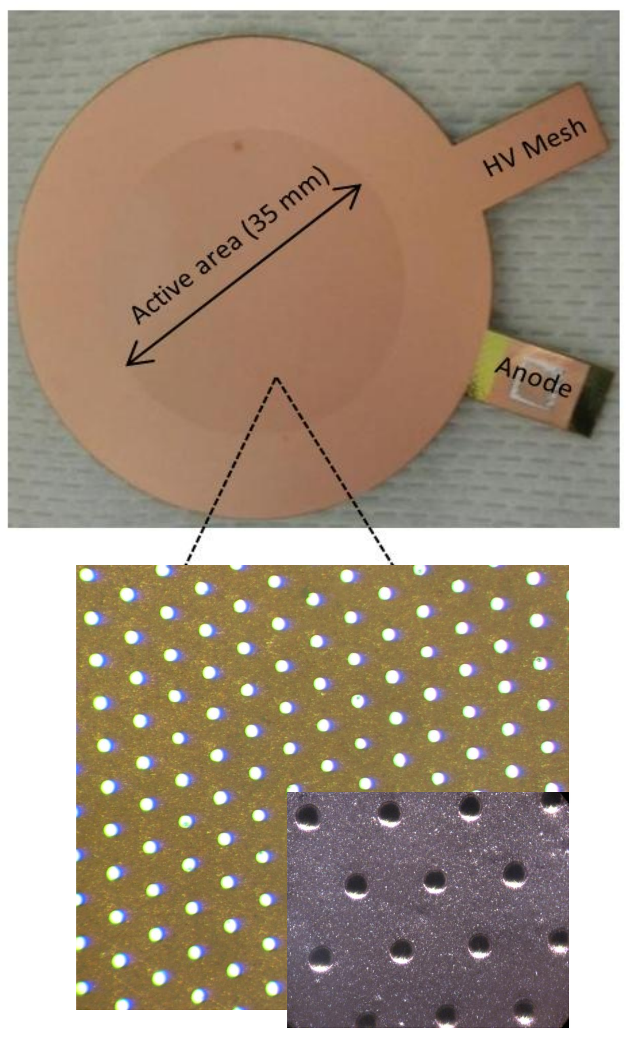
Fabrication process



1) Two thin copper foils are glued on each side of a Kapton foil.

2) Holes are done removing the copper by a standard lithographic process.

3) The kapton is etched and partially removed in order to create tiny pillars in the shadow part of the mesh below the copper mesh.

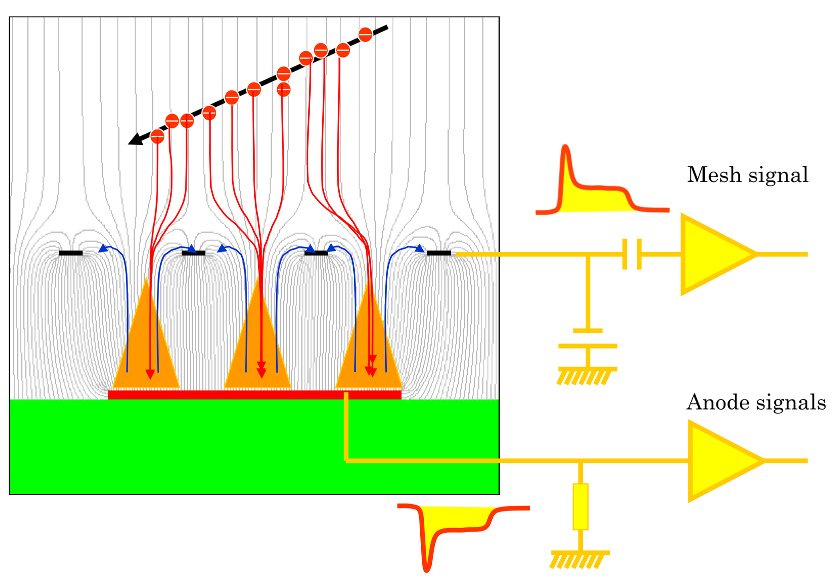


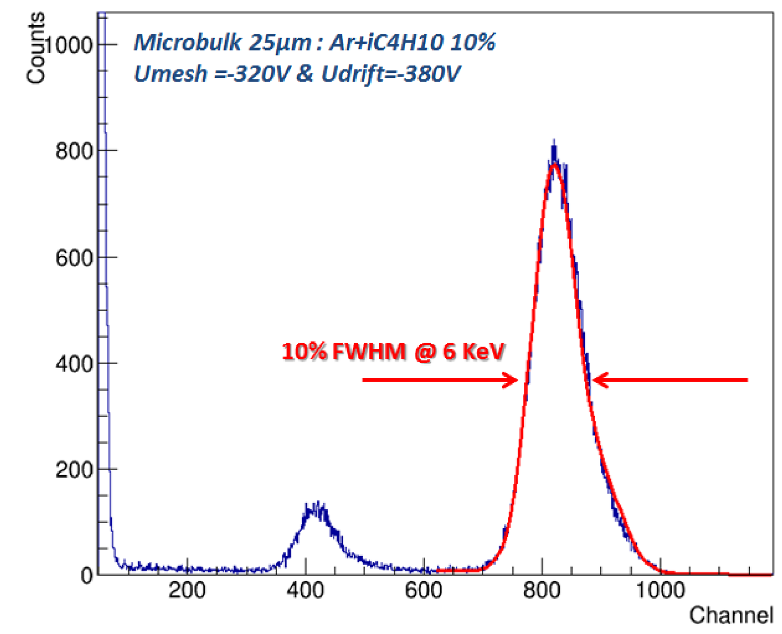
S. Andriamonje et al., JINST 5P02001 (2010)

Performances

F.J. Iguaz et al., JINST 7P04007(2013)
T. Dafni et al., NIM A608, p259 (2009)

- ✓ **Energy resolution** (10% FWHM @ 6 keV)
- ✓ **Low intrinsic background & better particle recognition**
- ✓ **Low mass detector**
- ✓ **Very flexible structure**

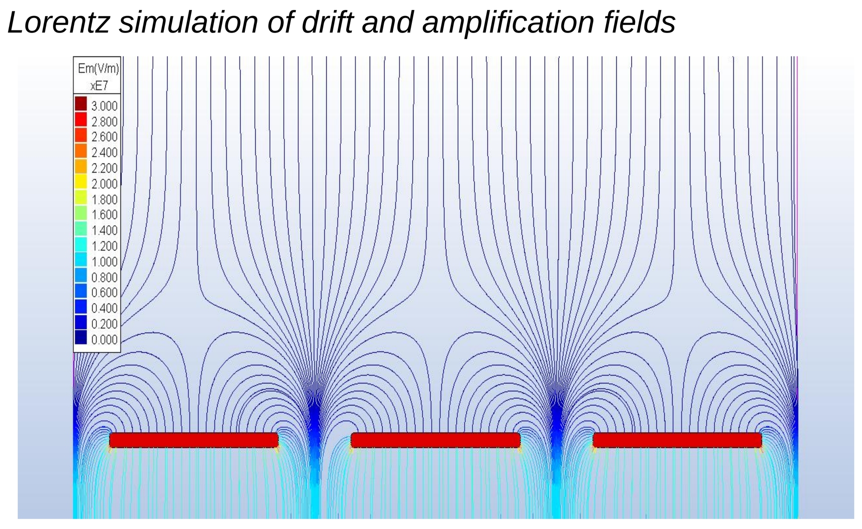




µBulk 25µm (Ø30µm & pitch 100µm)

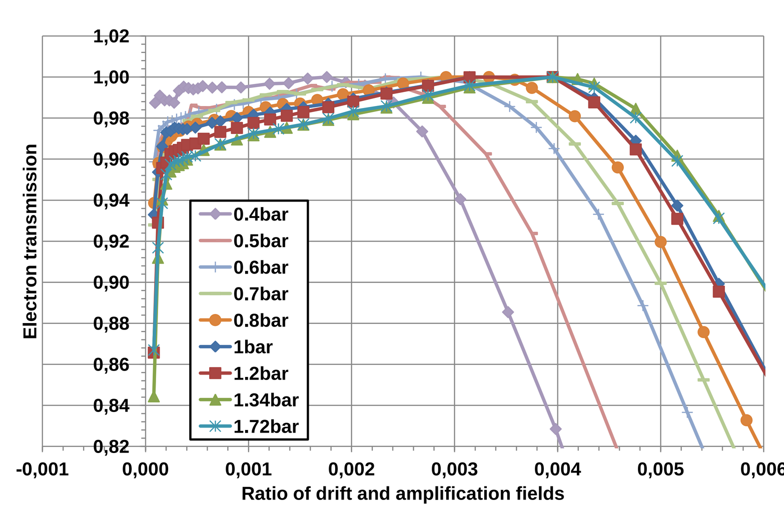
- **Simulation**

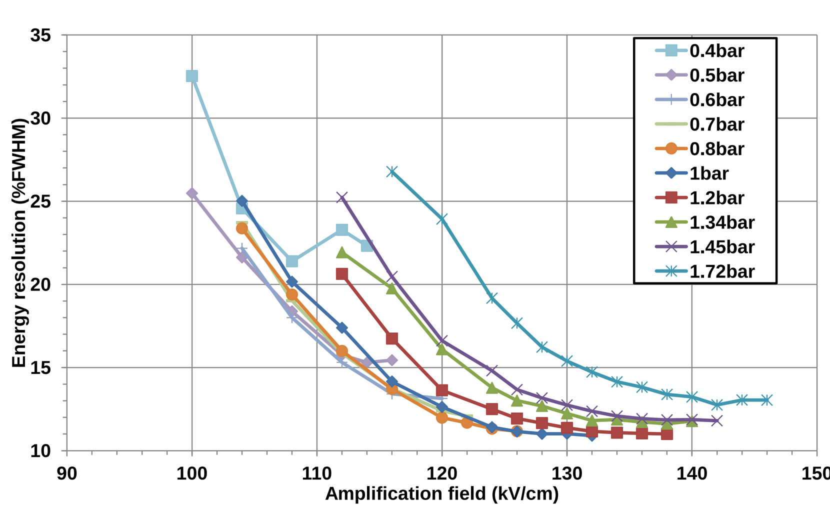
Lorentz simulation of drift and amplification fields

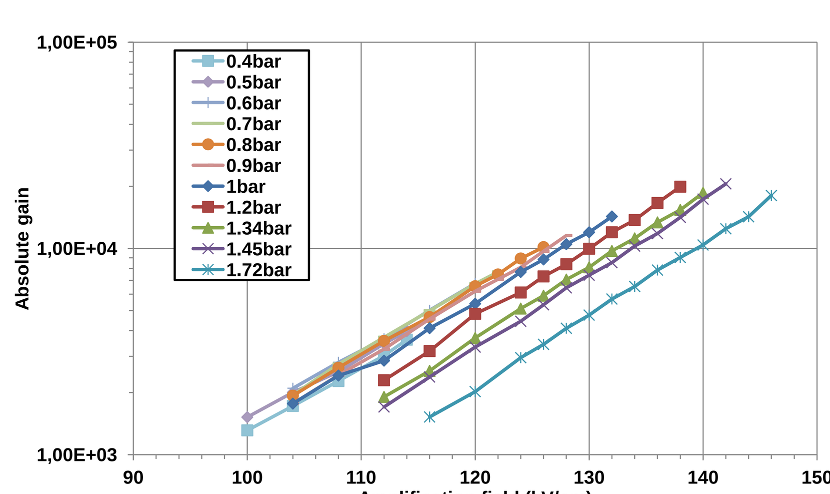


- **Variation of pressure (Ar+10%iC4H10)**

Measurement with a ^{55}Fe source(@5,9KeV)

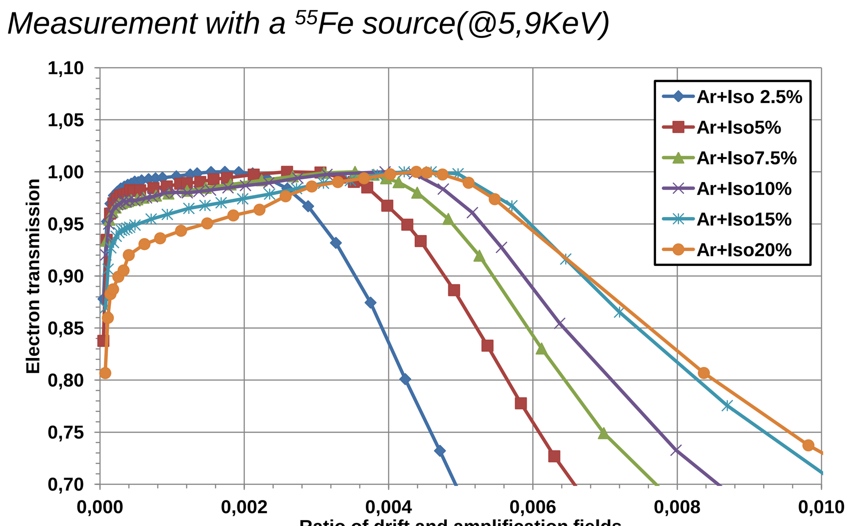


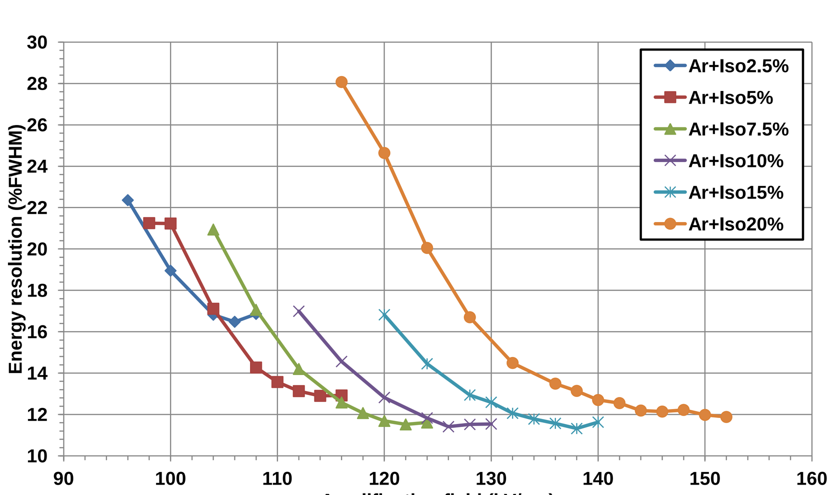


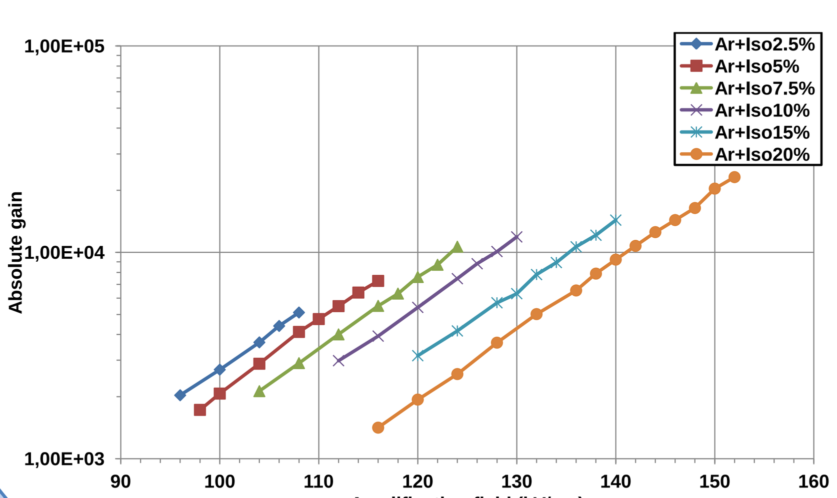


- **Variation % iC4H10+Ar**

Measurement with a ^{55}Fe source(@5,9KeV)

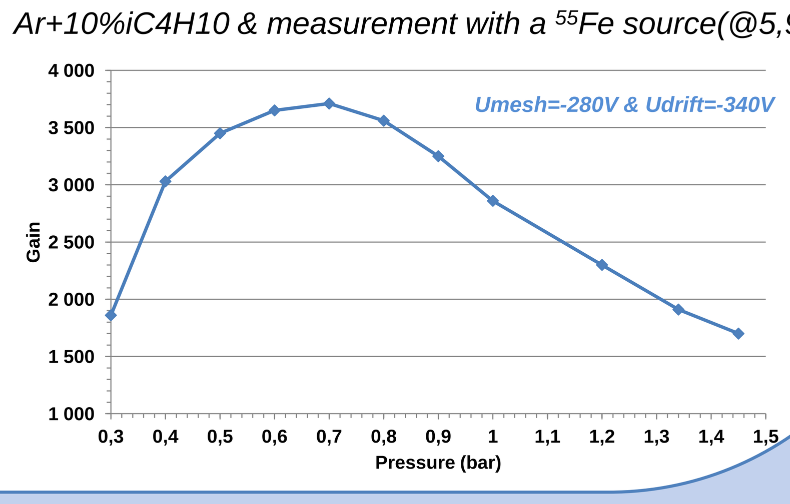






- **Gain versus Pressure**

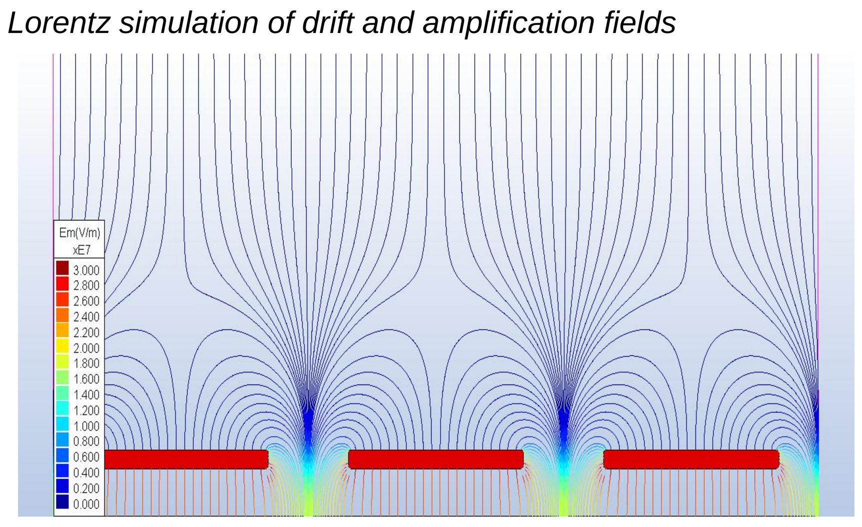
Ar+10%iC4H10 & measurement with a ^{55}Fe source(@5,9KeV)



µBulk 12,5µm (Ø25µm & pitch 80µm)

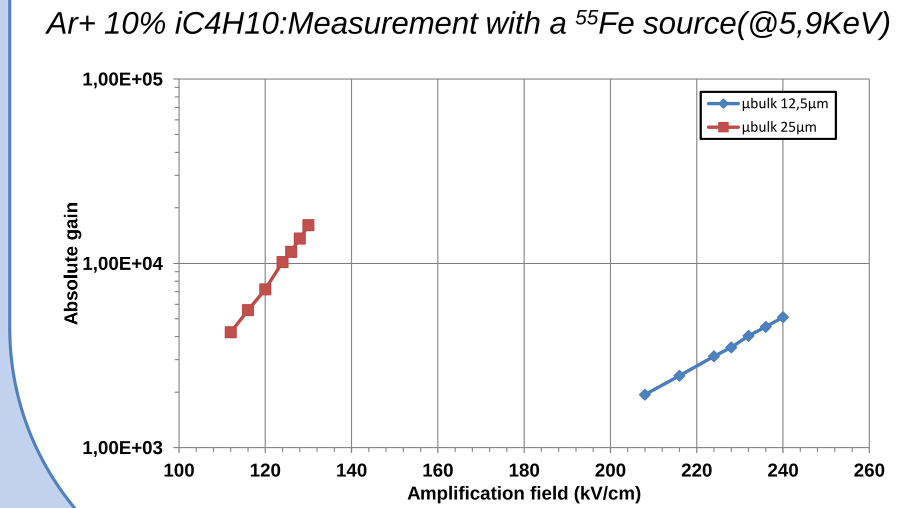
- **Simulation**

Lorentz simulation of drift and amplification fields



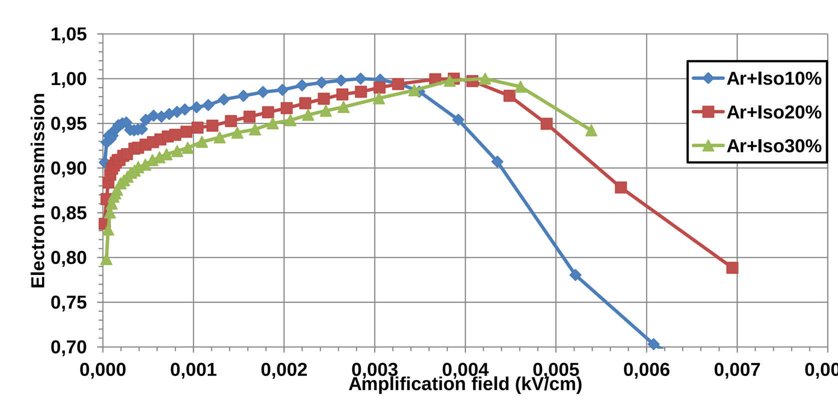
- **Gap 25 vs 12,5µm**

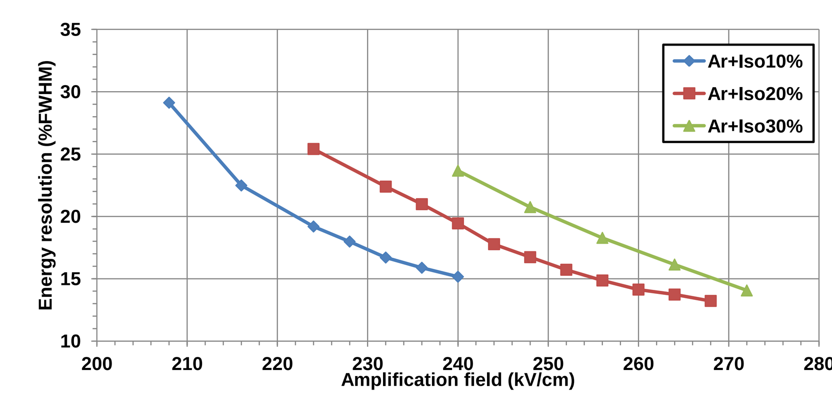
Ar+ 10% iC4H10:Measurement with a ^{55}Fe source(@5,9KeV)

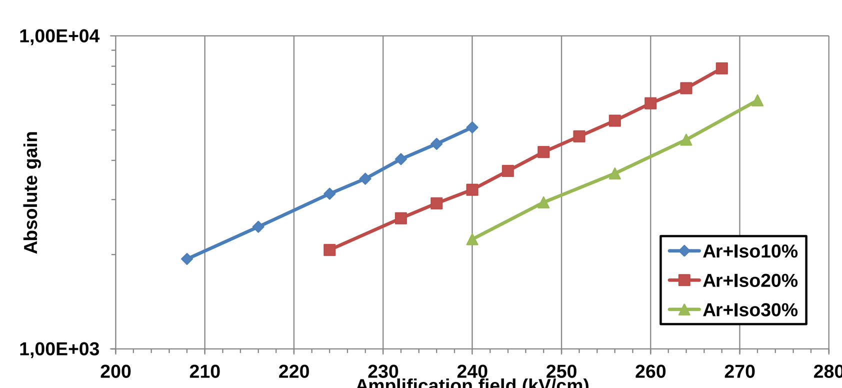


- **Variation of %iC4H10**

Measurement with a ^{55}Fe source(@5,9KeV)







Conclusions

Microbulks of 25 and 12.5 µm have been manufactured and tested with success.

Gains greater than 10^4 in Argon-Isobutane mixtures have been obtained for the 25 µm gaps and 8×10^3 for the 12.5 µm.

Energy resolutions as low as 11% and 15% for the 25 and 12.5µm respectively have been reached even in the hole diameter of the microbulk is not optimal ($hole_{\varnothing} < d_{gap}$) and is reaching the limit of the fabrication technique.

Studies of performance as a function of pressure and gas will be pursued.