

Double-mesh structure for ion back-flow suppression

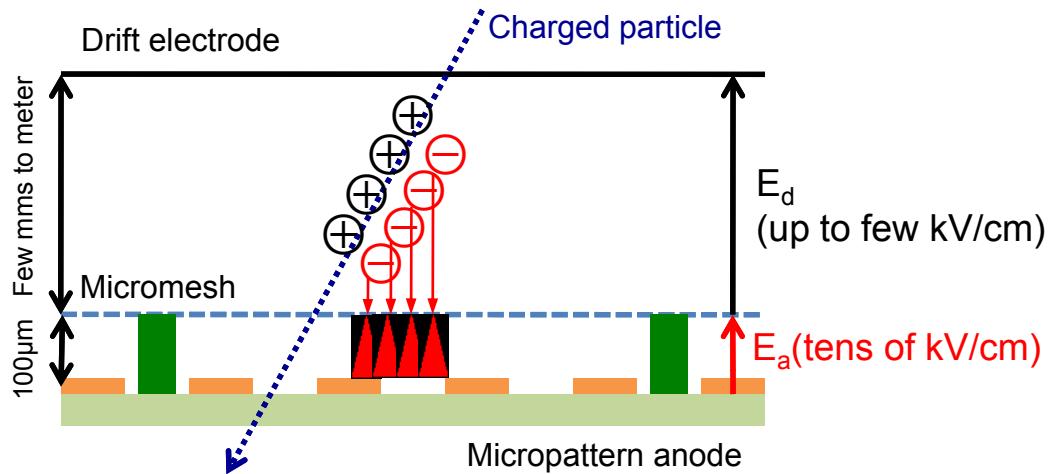
Fabien Jeanneau, Mariam Kebbiri, Vincent Lepeltier



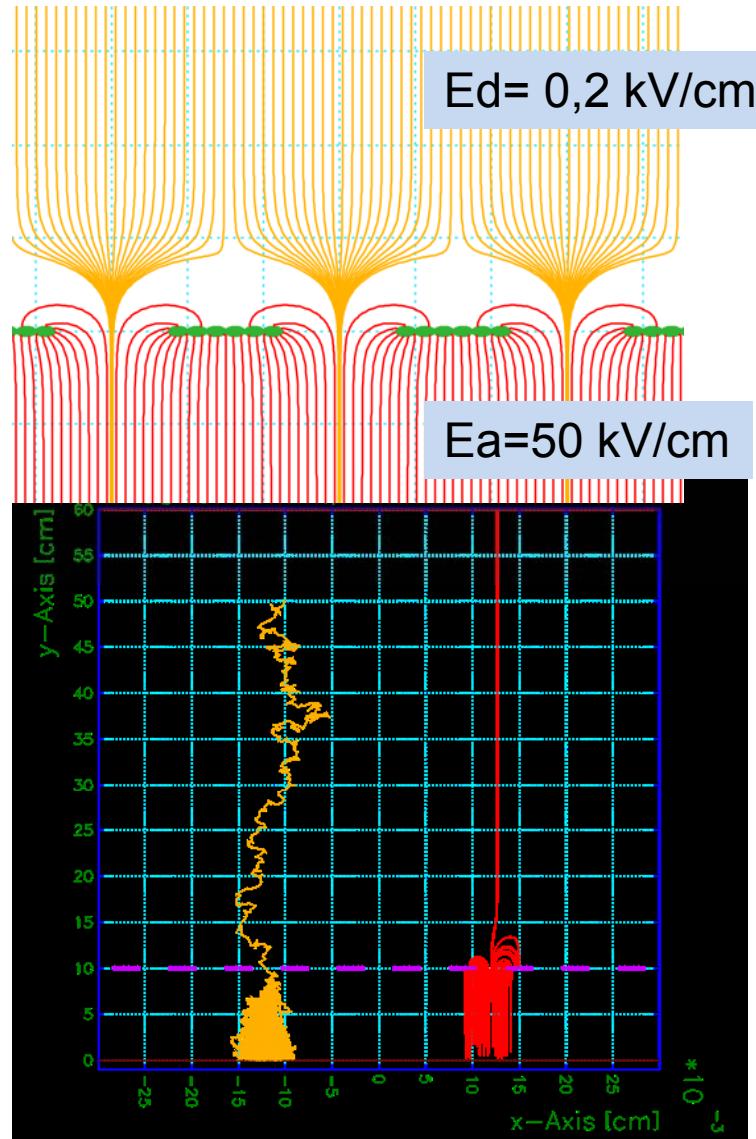
Outline

- Introduction
- Principle of double-mesh ion back-flow gating
- Gain and energy resolutions
- Ion feedback measurements:
 - Setup description
 - Classical μM (single-mesh mode)
 - Double-mesh mode
- Prospects and conclusion

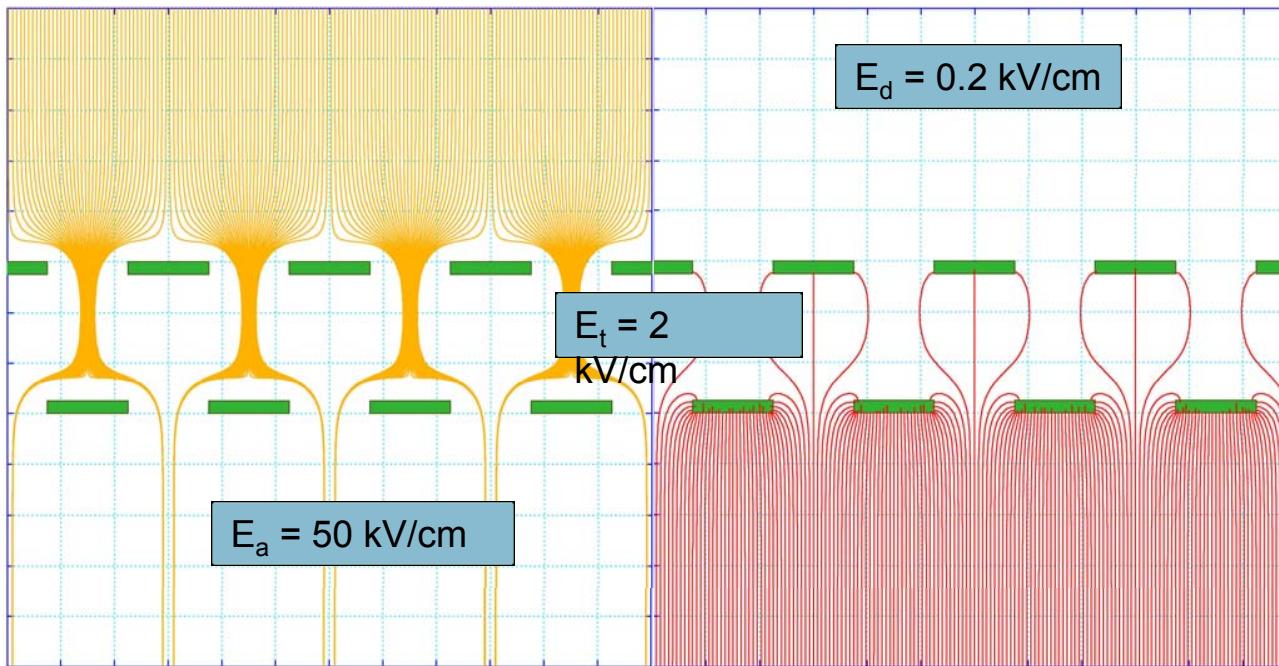
Ion feedback with Micromegas



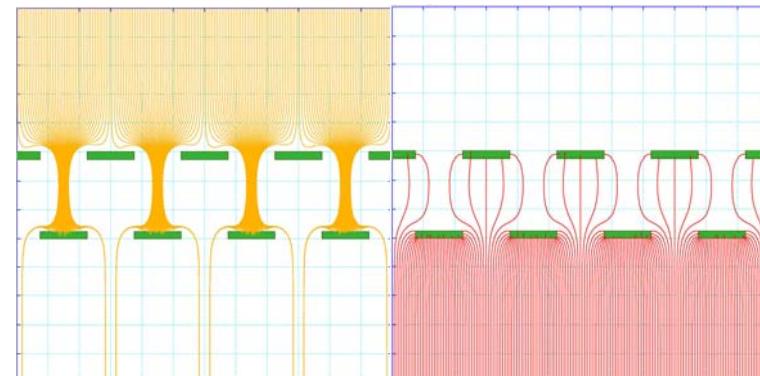
- Funnel effect $\sim \alpha$ ($=E_a/E_d$)
 - Optimal ion feedback is equal to $1/\alpha$
- Obtained for a 1500 LPI mesh
-
- Classically IFB \sim few percents
 - See P. Colas et al., NIM A535 (2004) 226-230



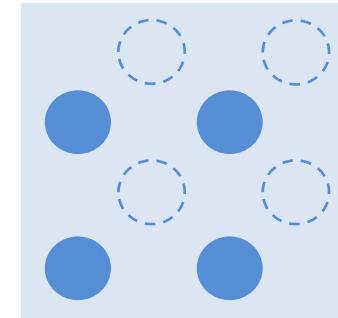
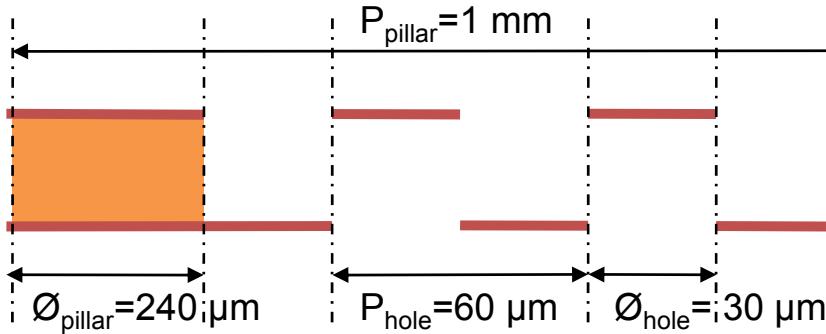
Ion gating with a double-mesh device



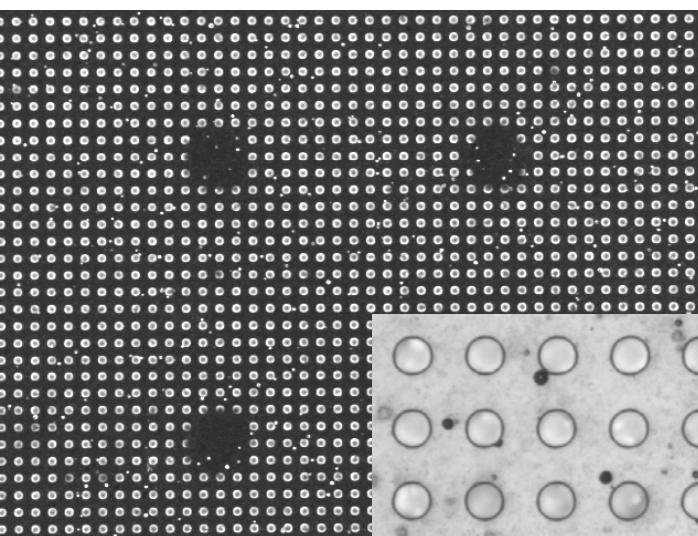
- Aim : gate the ion drift lines escaping the amplification gap
- Transparency depends on the field ratio



Two patterns tested

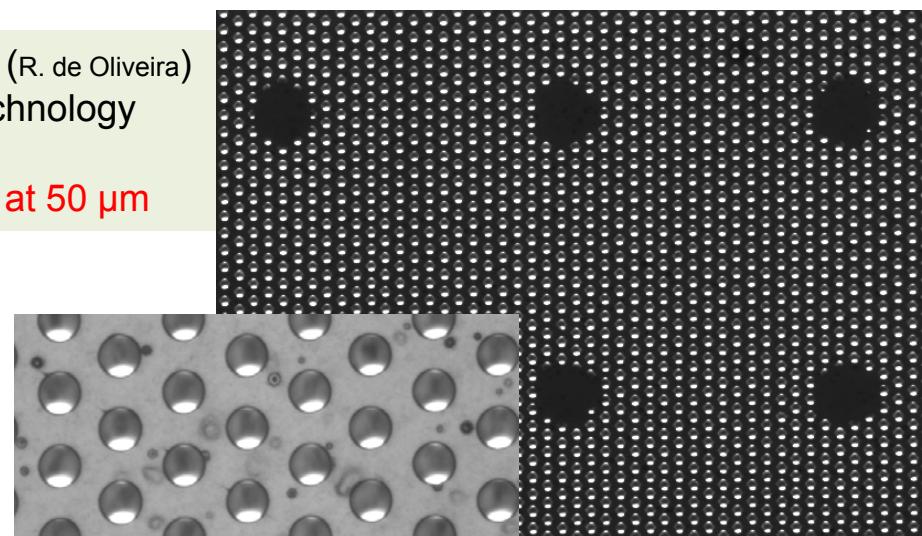


● top
○ bottom

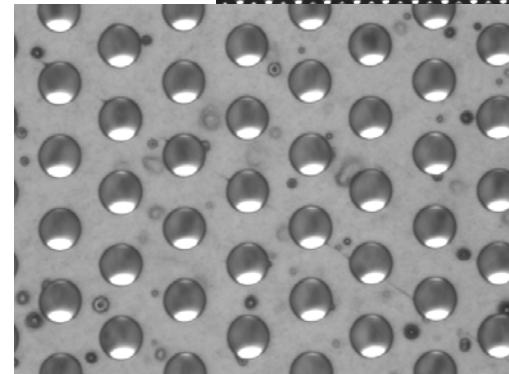
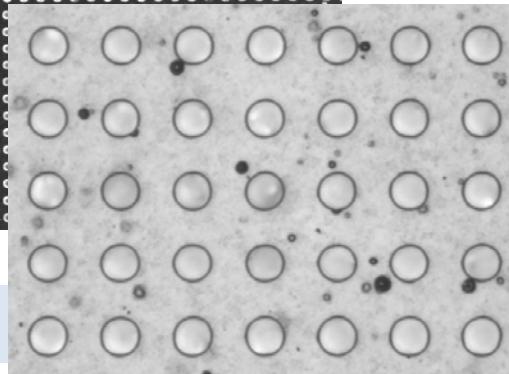


- Made @ CERN (R. de Oliveira)
- PCB etching technology

Transfer gap set at $50 \mu\text{m}$

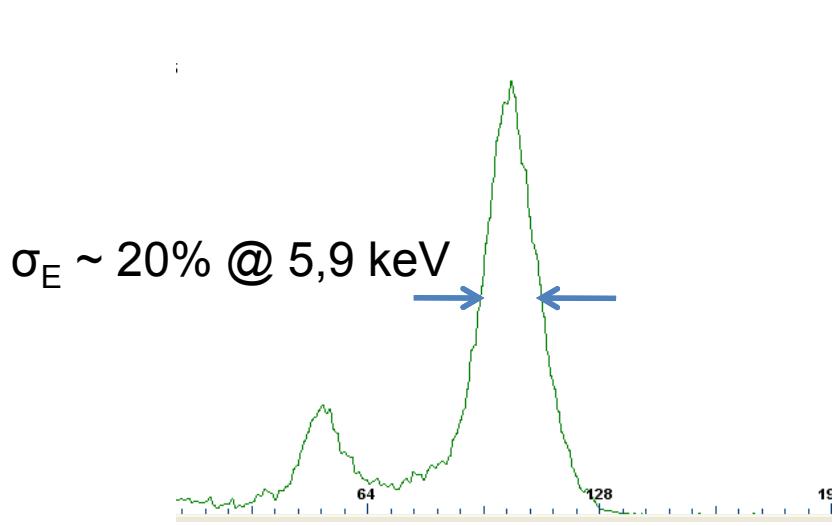
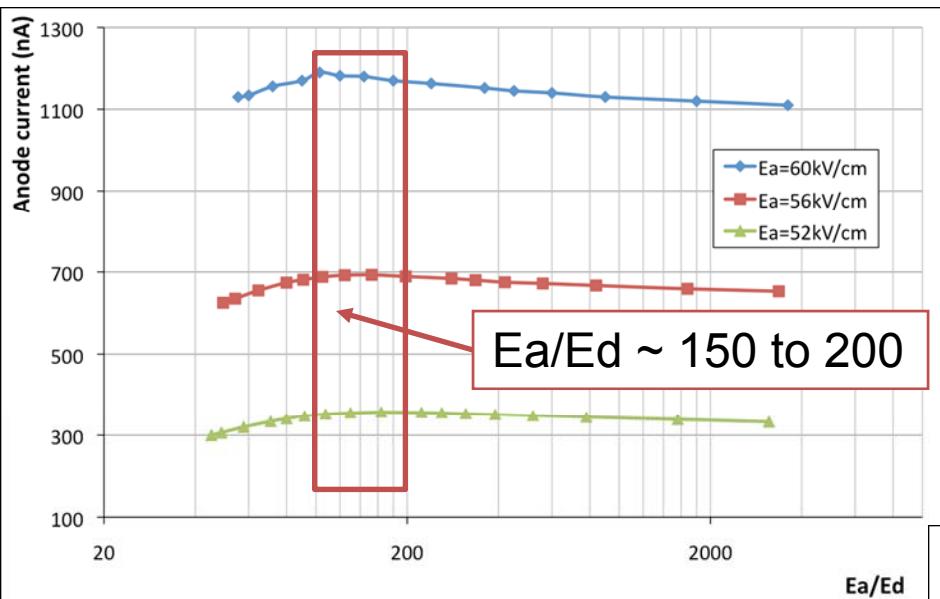


Square pattern



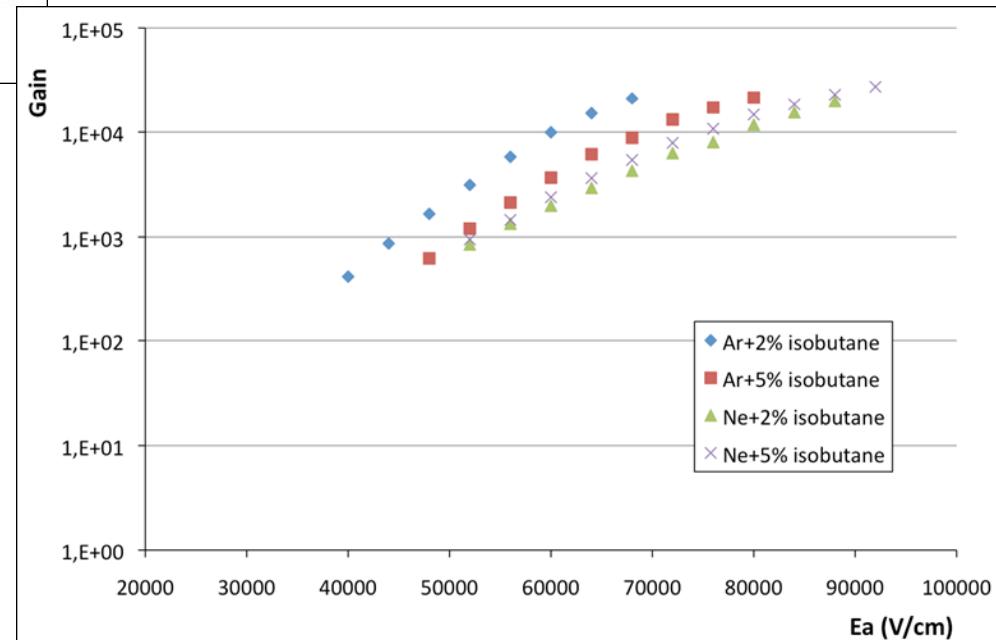
Hexagonal pattern

Gain measurements (^{55}Fe): single mesh mode

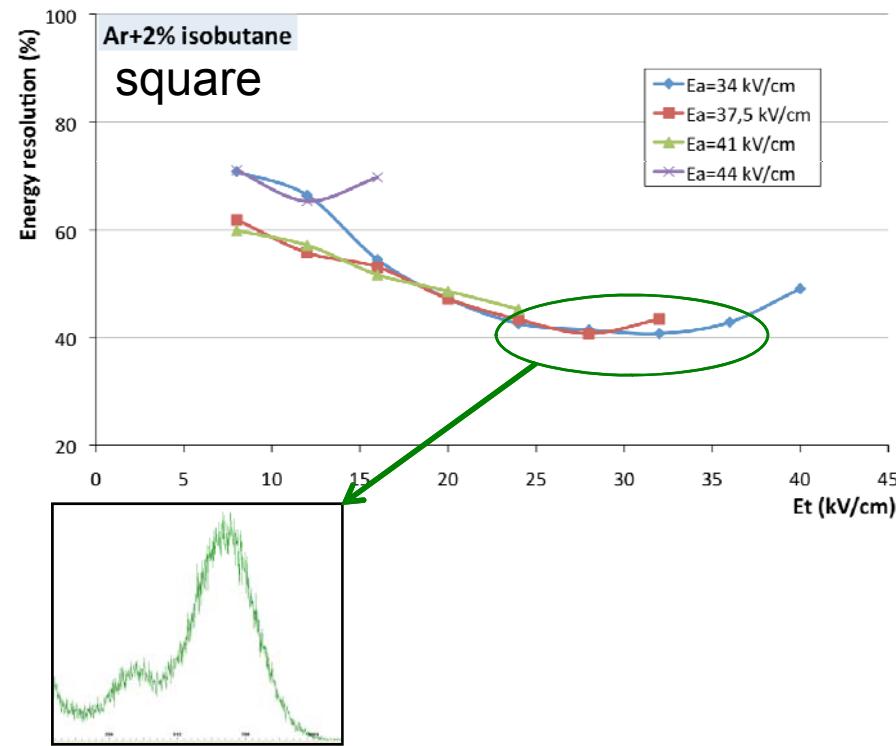


Single mesh
(classical Micromegas working)

- best ratio E_a/E_d
- Gain in single mesh mode
(Ampl. Gap of 50 μm)

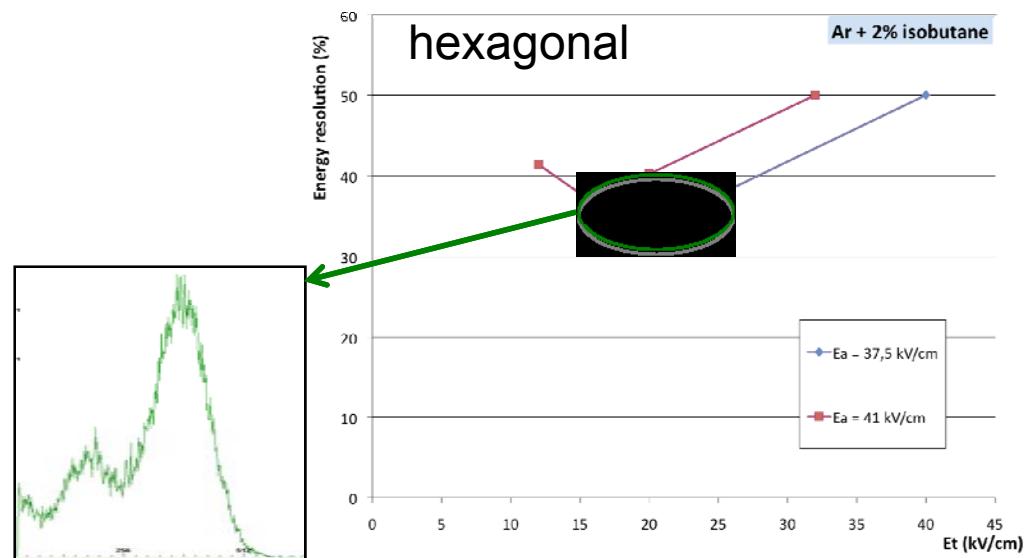
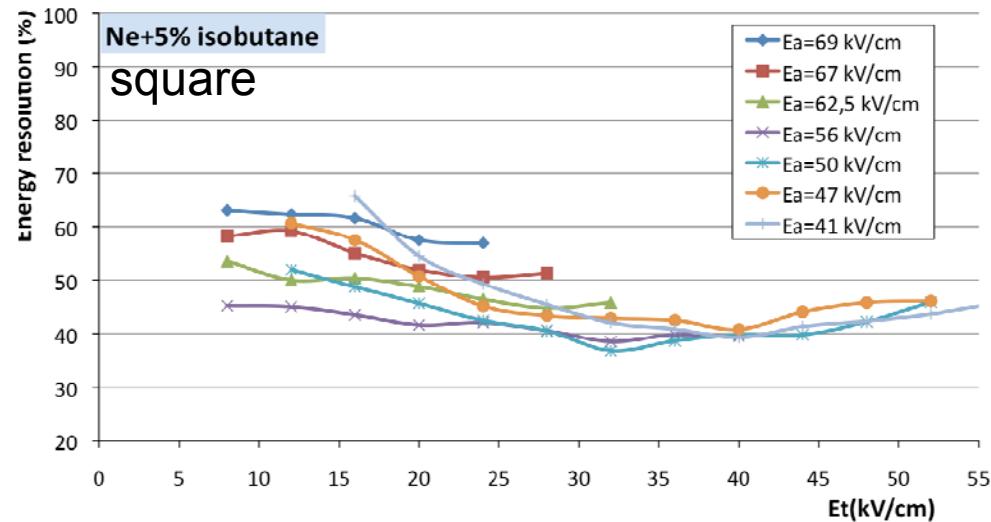


Energy resolution: ion gate mode

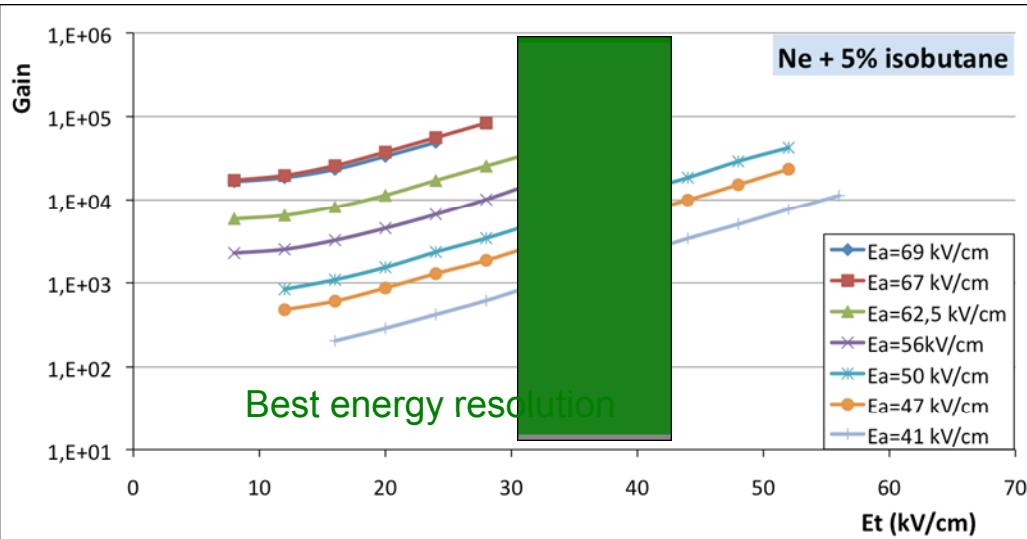


Degradation of the energy resolution compared to a classical μM

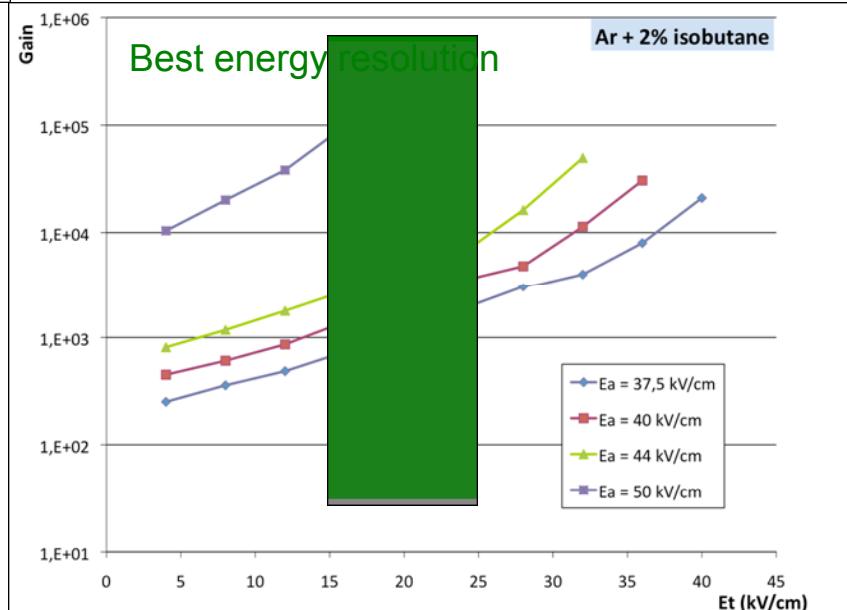
- Fluctuation of the gain in the two stages
- Electronic transparency of the device



Gain measurements: ion gate mode

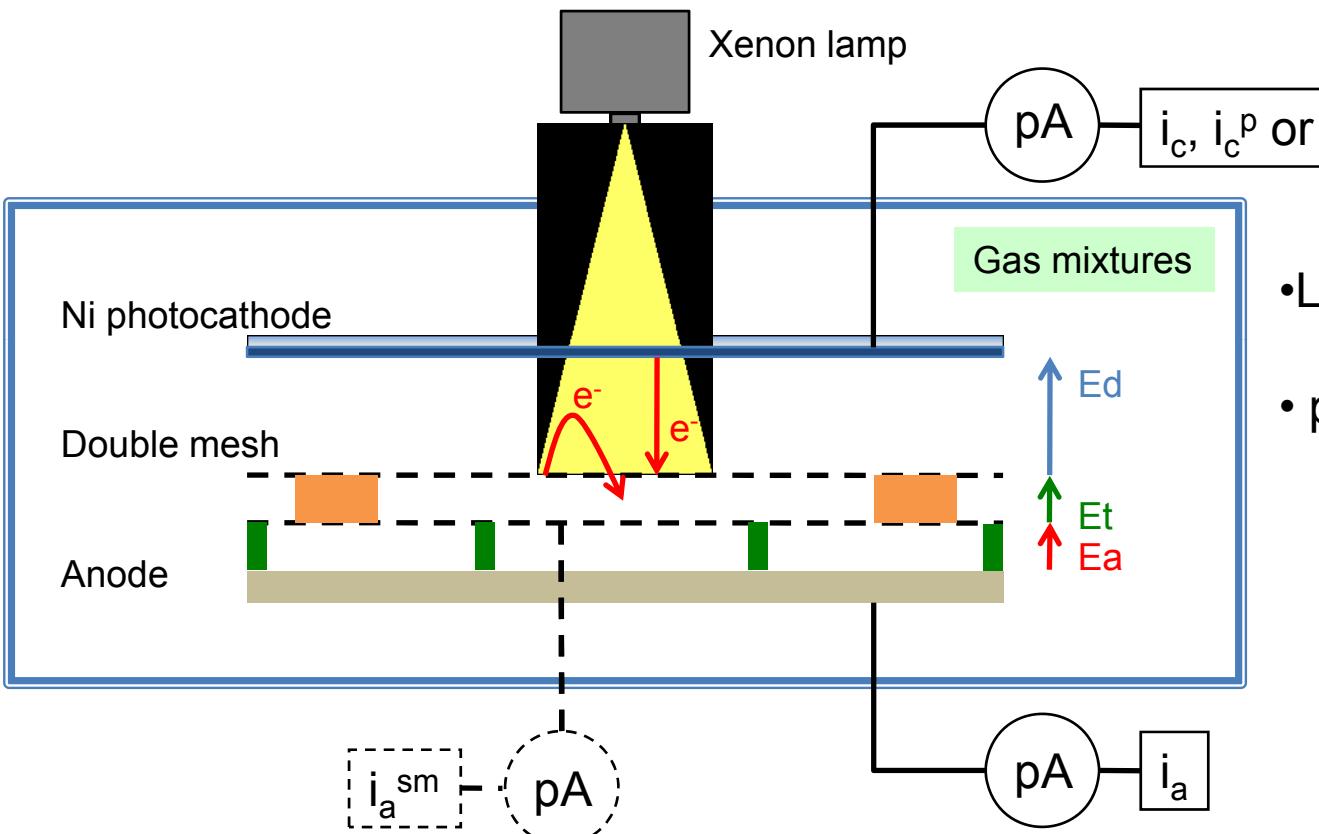


Square pattern



Hexagonal pattern

Setup description



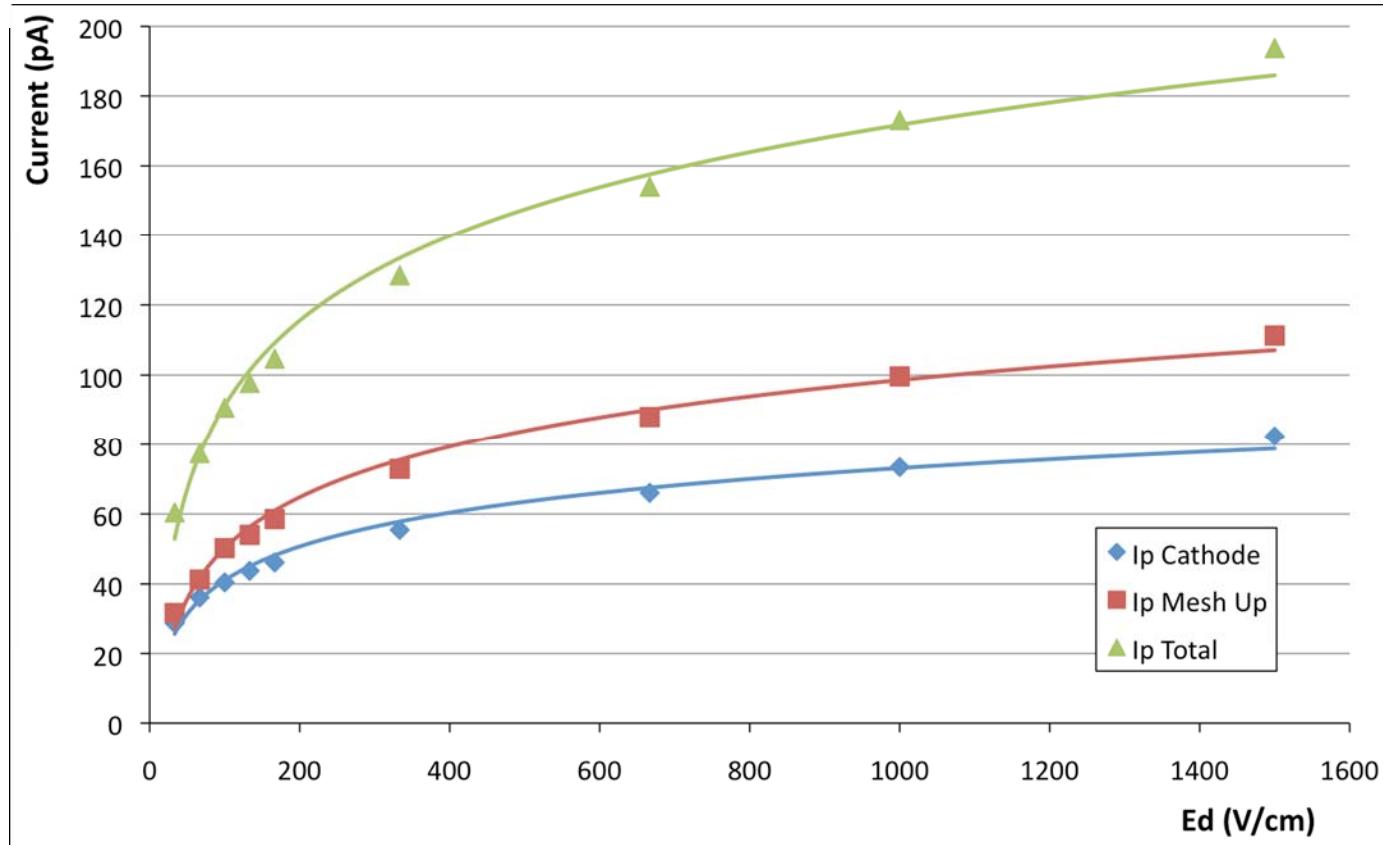
- Lamp Xe (hamamatsu)
→down to 180 nm
- picoammeter Keithley 6485

$$i_c = i_c^p + i^{fb}$$

$$i_a = (i_c^p + i_u^p) \times G$$

Ion back-flow measurement
for single and double mesh mode
on the same setup

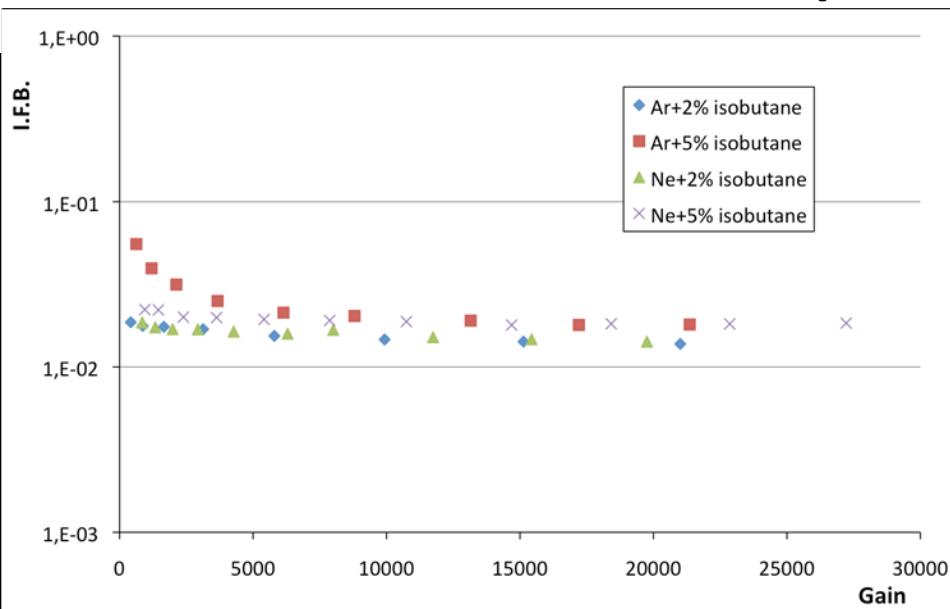
Primary currents



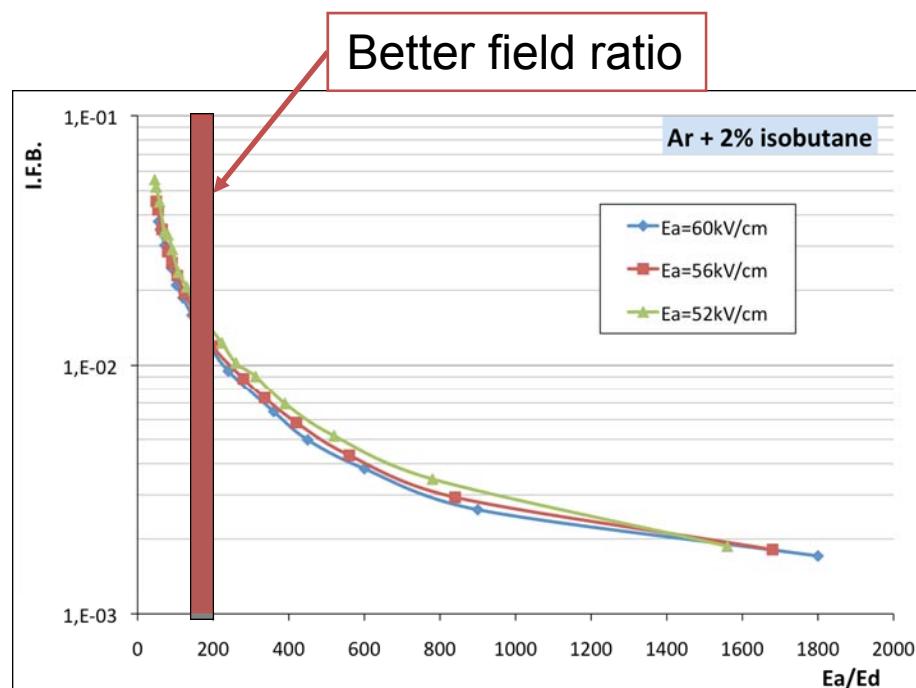
$$\bullet IFB = (I_c - I_{p_c}) / i_a$$

• Ip total → gain

IFB: simple mesh mode

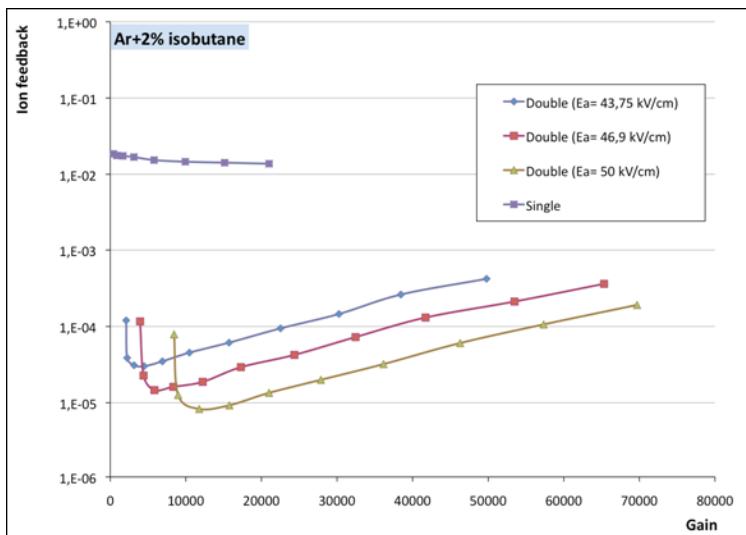


IFB of few percents like in a classical μM

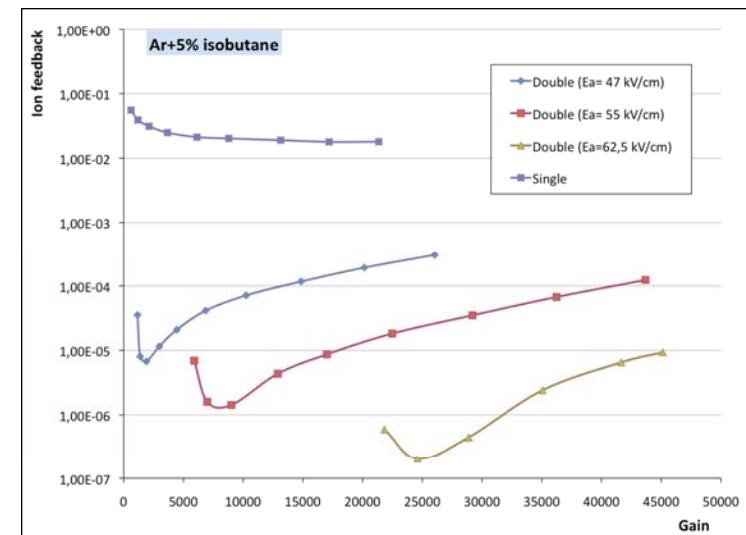
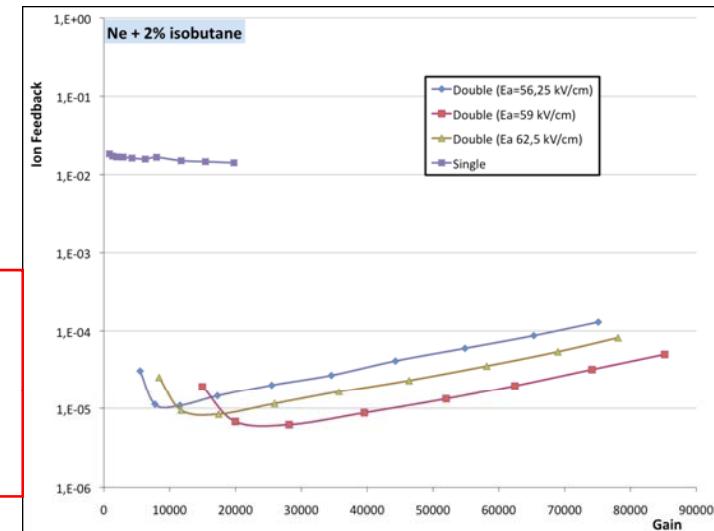


IFB is decreasing with the field ratio

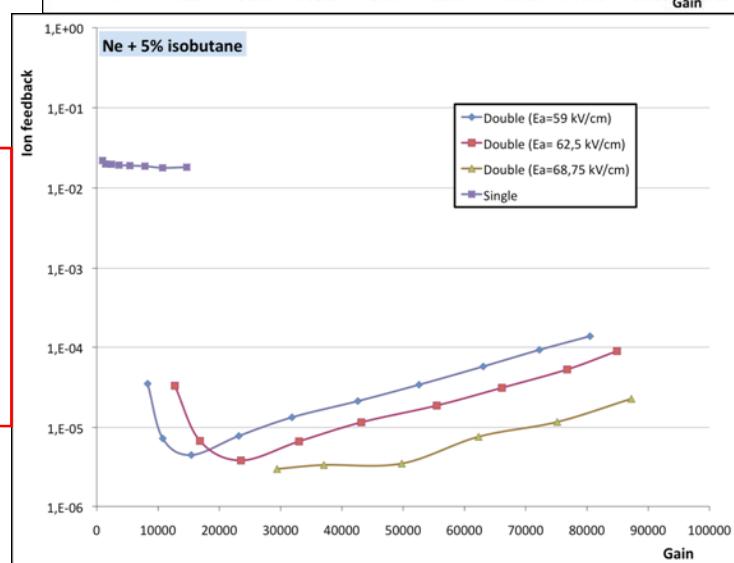
Double-mesh ion gate mode



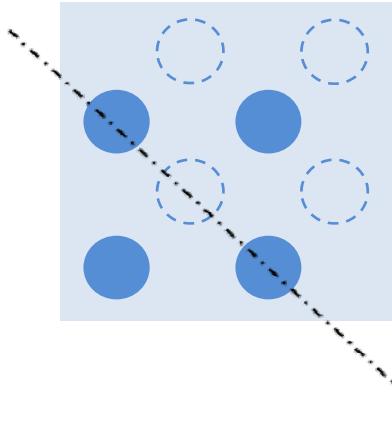
Double mesh gating decreases the ion back-flow of at least 2 orders of magnitude



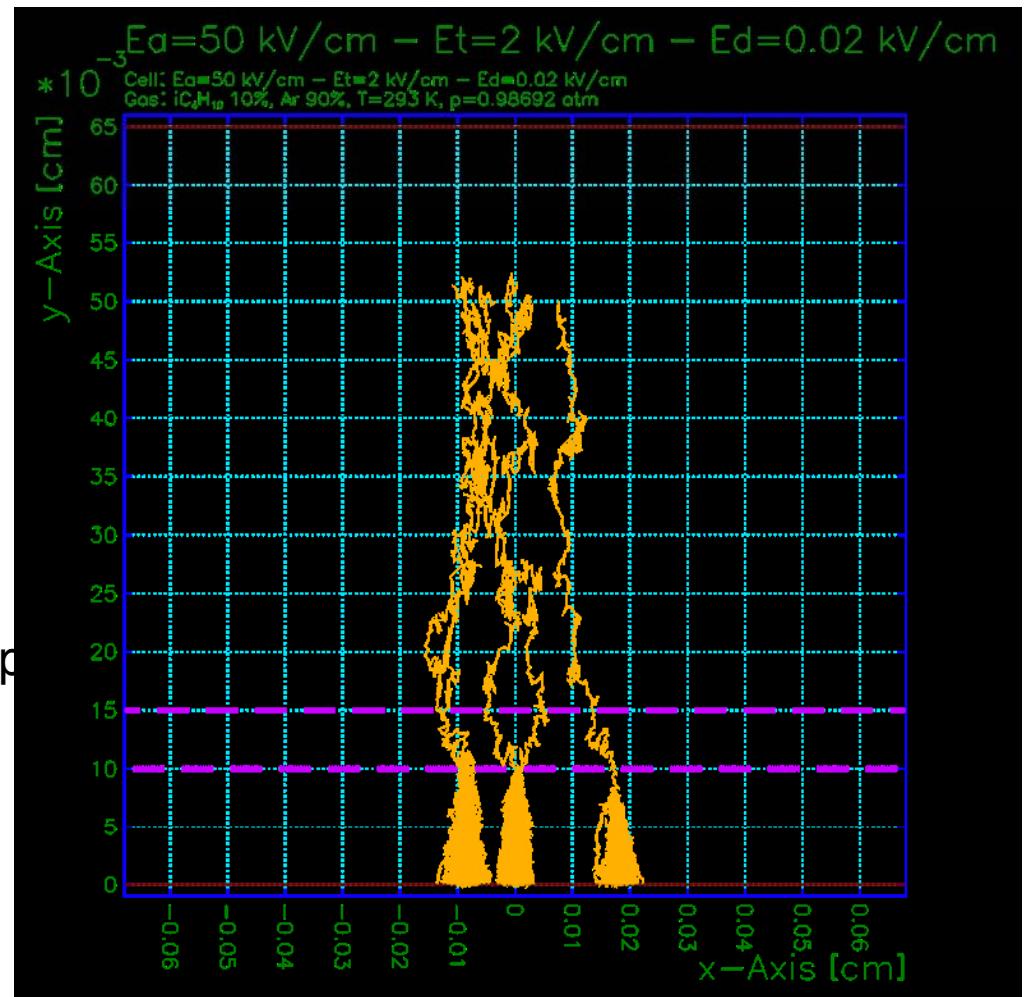
The ion feedback is increasing as the transfert gap contribute to the total gain



Double-mesh simulations



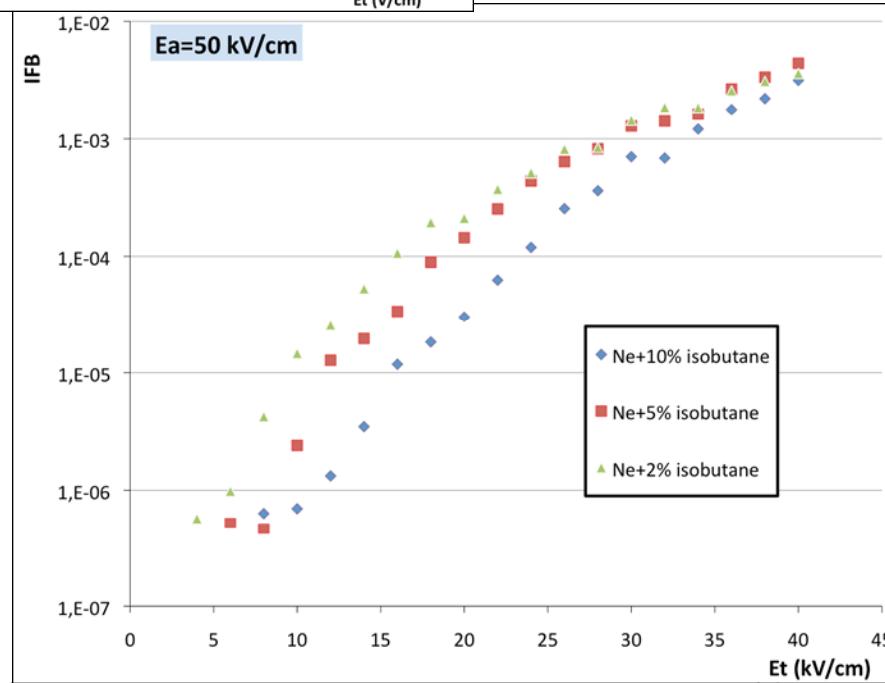
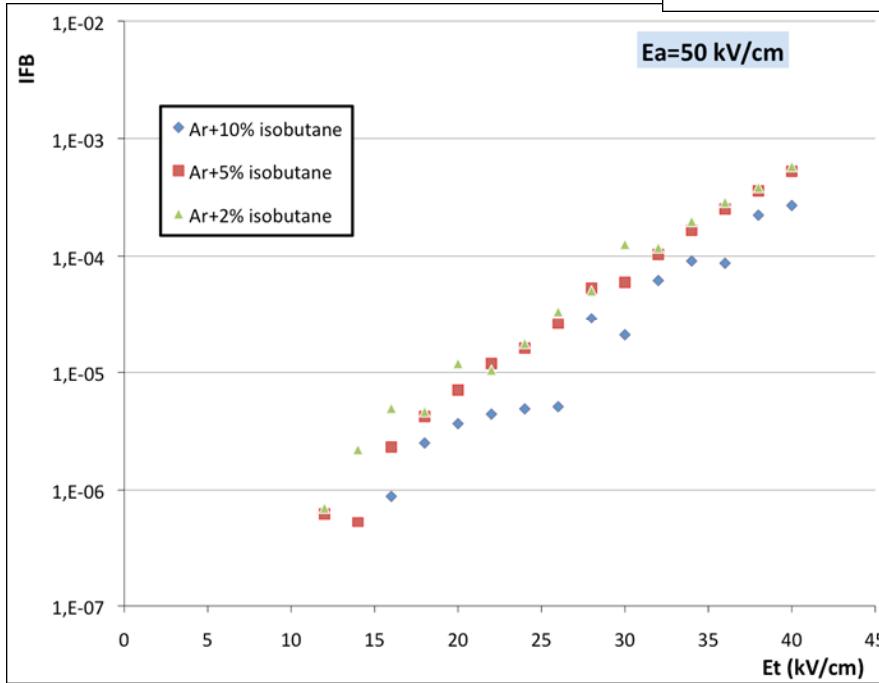
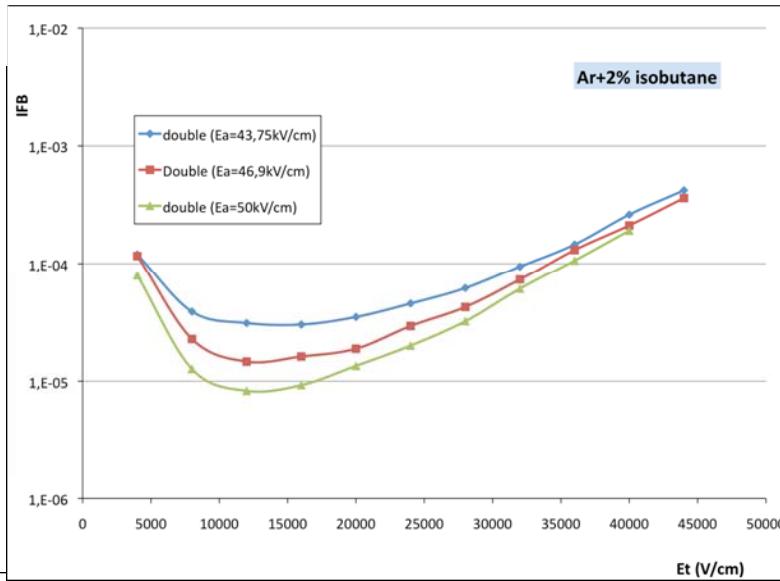
- comparison with measurements
- Transparency vs amplification gap
- Transparency vs transfer gap
- IFB vs amplification gap
- IFB vs transfer gap



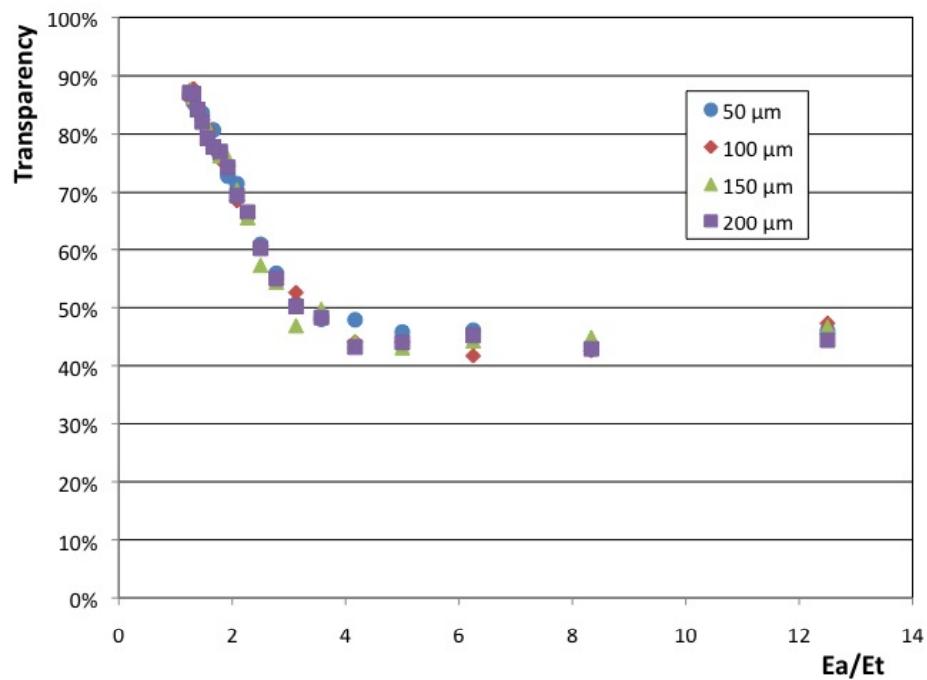
Performed with GARFIELD

Comparison with measurements

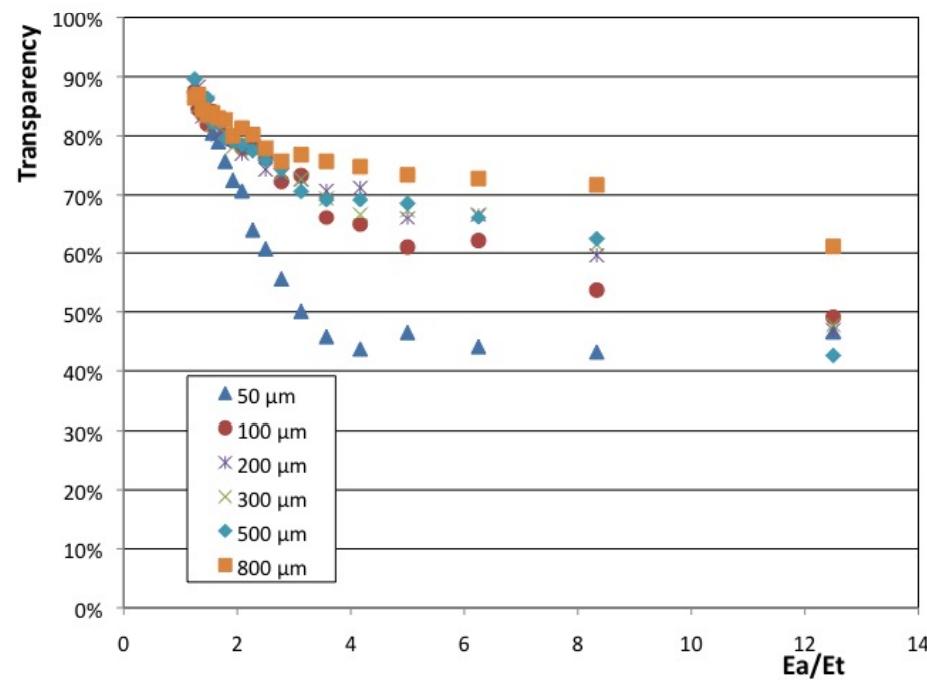
Good agreement
between
measurements and
simulations



Transparency versus transfer and amplification gaps

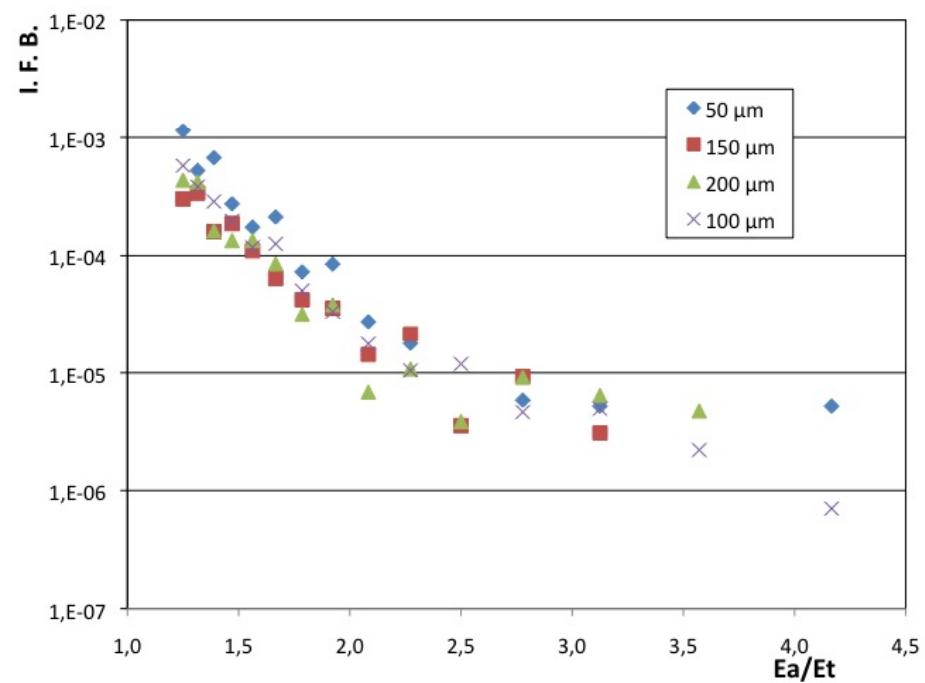


Amplification gap – no influence

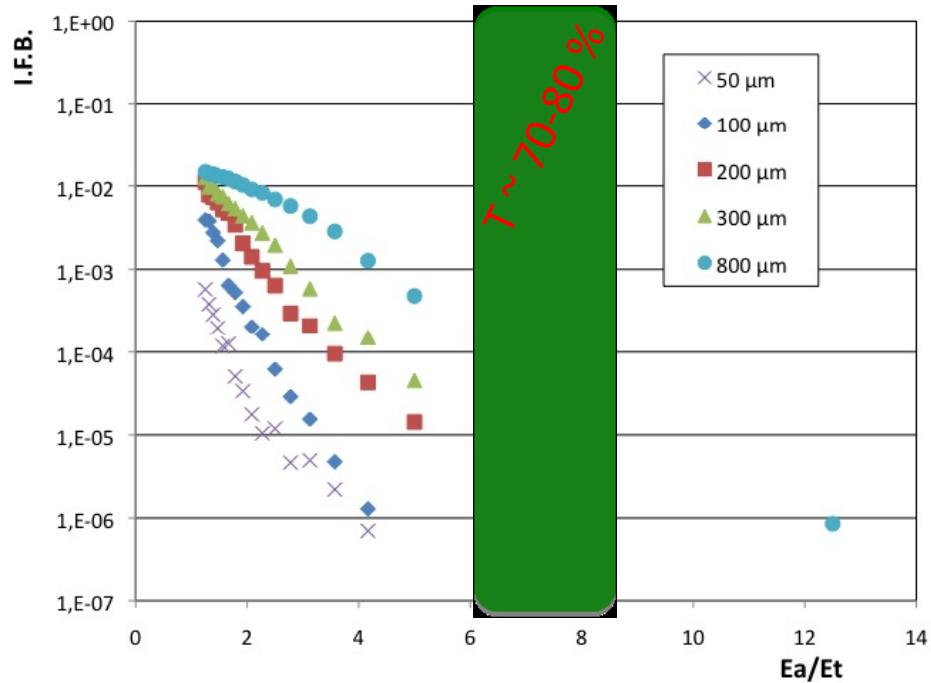


Transfer gap – better for large gaps

IBF vs transfer and amplification gap



Amplification gap – no influence



Transfer gap – better for small gaps
BUT
 10^{-4} to 10^{-5} still achievable with
 $T \sim 70\text{-}80\%$

Prospects

- Simulations
 - 3D simulations → different mesh patterns
- Test prototype in a beam?
 - Effect on spatial resolution
 - Effect on efficiency
- Flux limitations (charging effect?)
- Building technology

Conclusion

- A double mesh device for the gating of the ion back-flow in a Micromegas has been tested successfully
- The factor of ion back-flow reduction is at least of two orders of magnitude (10^{-5} to 10^{-6})
- The electron transparency and energy resolution are good if the gain in the transfer gap stays low
- Simulations are needed to optimize the device
- Test of efficiency and spatial resolution