WG2 @RD51 in Crete

Introductionary remarks:

WG2 "specialty": physics of MPGDs and common standards

A ancient philosopher definition:
"…if it smells- it is *chemistry*
…if it moves- it is *biology*
..if it does not work –it is *physics*"…
…so the task of the WG2 is to make it working

Agenda of the WG2 meeting in Crete:

Introductory remarks

F. Hartjes, Gridpix/ GoHip developments

P.Colas, Study of energy resolution and avalanche statistics of MICROMEGAS detector

T. Zerguerras, Single-electron response and energy resolution of MICROMEGAS detector

J. Veloso Scintillation yield of avalanches in MPGDs

V. Peskov RICH upgrade in ALICE and challenges for WG2

Discussion 1: Optimization of the T-GEM based RICH with representatives of Amos, Silvia, and CERN groups as well as with any other interested in this subject
Starting questions for the discussion: design choice, gas optimization for better photoelectron extraction and collection, rate effects and reaction of photocathode, aging

V. Peskov Short remarks on Spark protection (for triggering discussion of resent tests of MICROMEGAS with resistive anode)

Discussion 2: Spark's quenching mechanism in InGrid wand Micrimegas with protective layers

Conclusion remarks and discussions

Physics

**MPGD are new detectors and not all yet well understood in their operation**

<u>A few examples :</u>

● Only recently it was established (and now I hope commonly accepted) that in most of MPGD's designs the Rather limit governs the maximum achievable gain

● Discharges in MPGDs: there are some new features like electron jet triggered breakdown, the cathode excitation effect, discharge propagation in cascaded detectors. Some of the feature, like the last one clearly show up only in MPGDs, but not in "classical" one

● Physic of gain limits at high counting rate operation: there is not yet a clear picture

● Aging- a very "dark area!

● Some MPGD's contraction optimization: mostly they are empirical, will be nice to understand why one get an improvements

● Gas optimization- also mostly empirical, for example Ne is so good , why?

● Effect of very clean gases: can MSGCs operate in extremely clean gases necessary for cryogenic applications?

Where common standards are important?

A few examples:

● Aging study: to compare results obtained in different laboratories on need set identical conditions: gas cleanest and composition, gas gain, counting rate

● QE there are several methods to measure it: via comparison to a calibrate detector, comparison to TMAE

It is important then how the QE was measured, at what gain
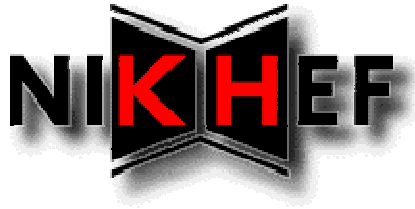
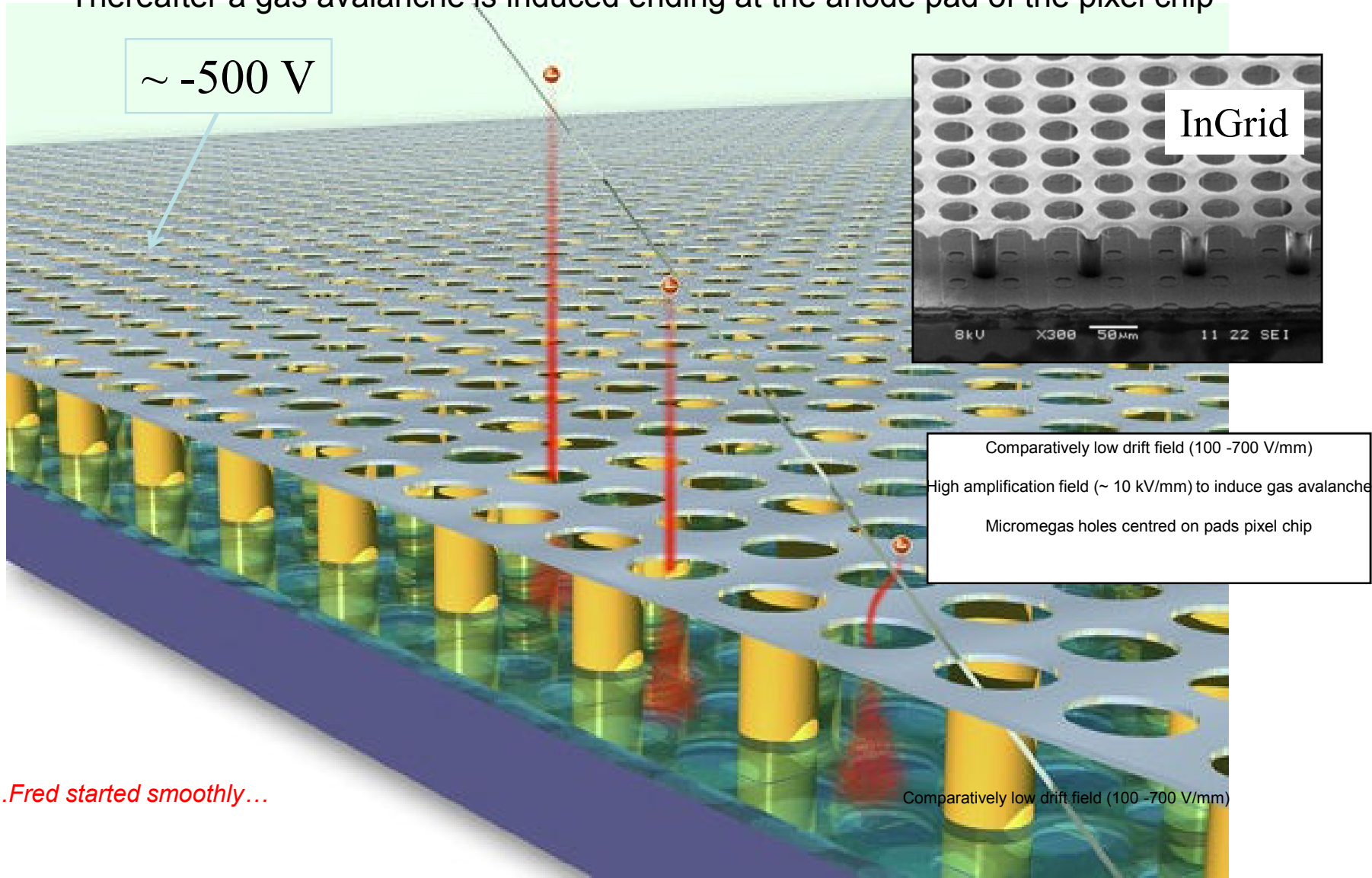# The gaseous pixel detector GOSSIP for the Atlas Inner Detector
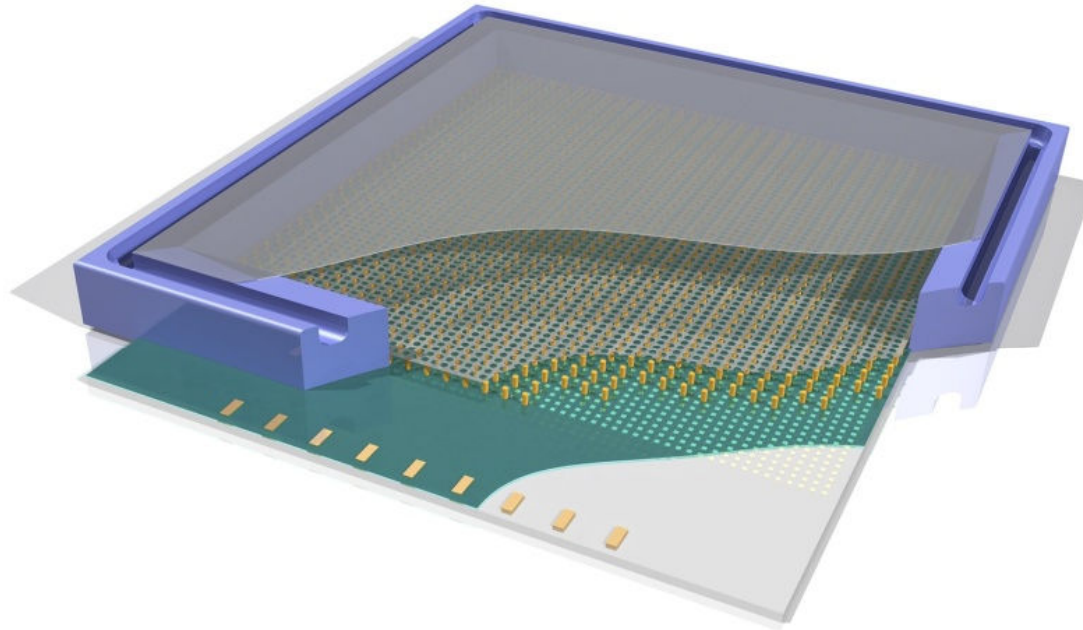
Victor Blanco Carballo,Yevgen Bilevych, Martin Fransen, Harry van der Graaf, Fred Hartjes, Wilco Koppert, Michael Rogers, Sander Smits, Rob Veenhof
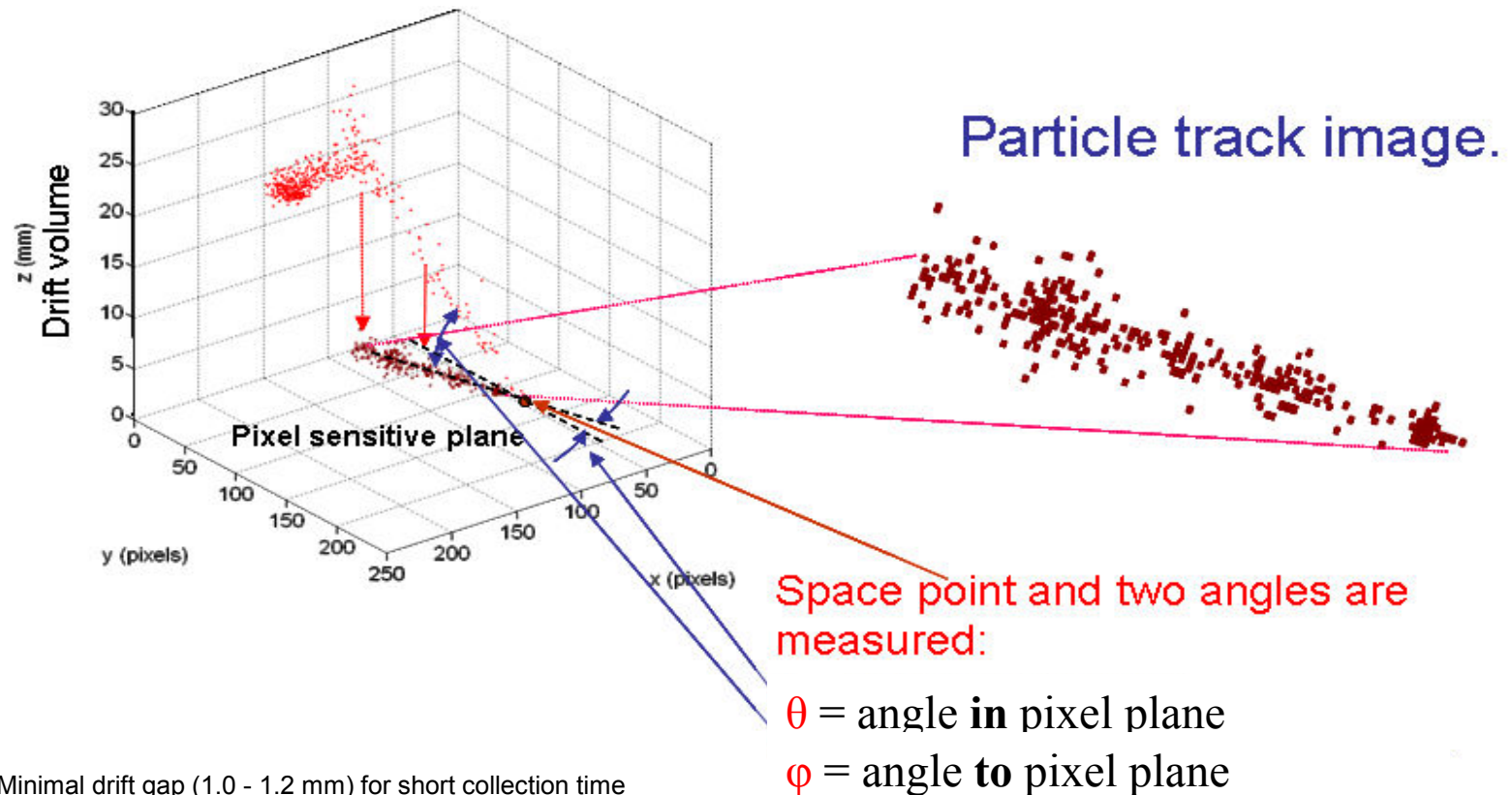
Functioning GridPix/Gossip

- Electron from traversing particle drifts towards Micromegas grid and is focused into one of the holes
- Thereafter a gas avalanche is induced ending at the anode pad of the pixel chip

~ -500 V

InGrid

8kV   X300   50μm   11 22 SEI

Comparatively low drift field (100 -700 V/mm)

High amplification field (~ 10 kV/mm) to induce gas avalanche

Micromegas holes centred on pads pixel chip

..Fred started smoothly…

Comparatively low drift field (100 -700 V/mm)

Operation of Gossip/GridPix

- Track reconstructed from projected ionisation on the pixel plane

Particle track image.

Pixel sensitive plane

z (mm)
Drift volume

y (pixels)

x (pixels)

Space point and two angles are measured:

θ = angle **in** pixel plane
φ = angle **to** pixel plane

Minimal drift gap (1.0 - 1.2 mm) for short collection time
Actual value determined by cluster density and efficiency demand
1 mm gap and DME/CO2 => 98.9% chance on having at least **one** cluster in the drift gap

Demonstration functional Gossip

- Using PSI 46
  - CMS pixel FE chip
  - 50 x 150 µm pixels
- Gas gap 1.2 mm
- Gas: Ar/iC$_4$H$_{10}$ 85/15
- Protected by 30 µm aSi
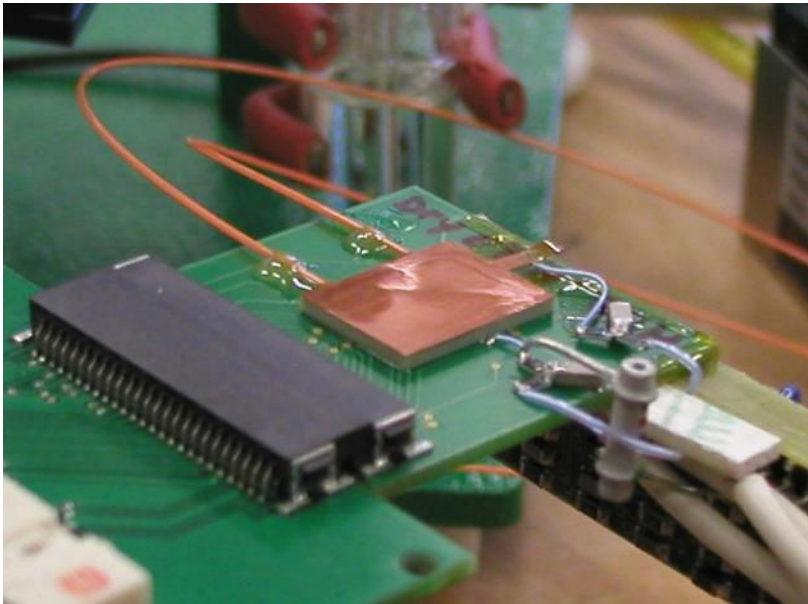
Hits from ^{90}Sr electron tracks
Scintillator triggered
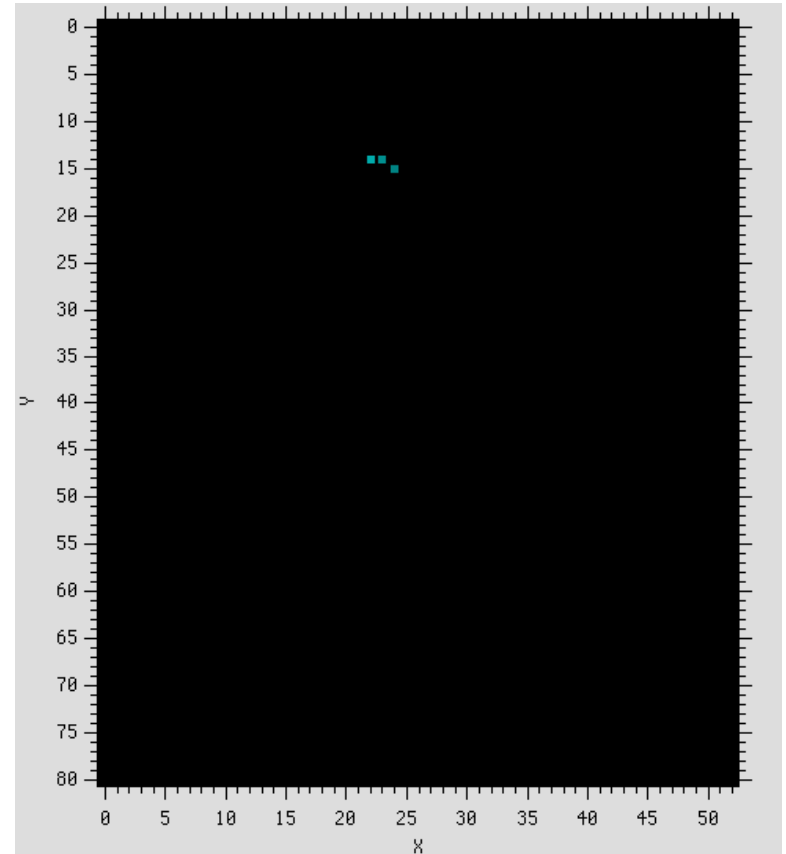
7.8 x 8.0 mm

..but then without loosing much time…he came to a hart of his presentation…

Replacing silicon technology in Atlas ID with Gossip detectors brings a number of crucial benefits

- No bias current, only signal current

- Outlook for extremely high radiation tolerance ($>> 10^{16}$ MIPS/cm^2)

  - By far exceeding the range of any solid state detector

  - BL @ sLHC: 3.5 µA/cm^2 @ 0.9 GHz/cm^2 (~30 pA/pixel of 55 x 55 µm)

  - $\rightarrow$ low power dissipation (2 µW/pixel)

- Operation at wide temperature range, relaxed cooling requirements

- Almost insensitive for neutrons and hard X-rays

- $\rightarrow$ reduced material budget: 1.25 % estimated (services and support **included**)

- No bump bonding $\rightarrow$ major cost reduction

- No additional input capacity $\rightarrow$ very low threshold possible (350 e$^-$)

…Since there were nobody from Si community we accepted the arguments…

Personally I think that there is no science and breakthroughs without "pushers"…*so I like this talk and the main idea*

But everything has its drawbacks

- Additional services required
    - Gas pipes (may be thin: 0.8 mm or even 0.4 mm)
    - 2nd high voltage line for drift field (no critical regulation)
- Lower position resolution than is possible with solid state detectors
    - Limited ionization statistics (about 5 to 10 e$^-$, could be less)
    - Diffusion in the drift gap
    - $\rightarrow$ resolution does not quite meet the B-layer requirements (< 10 µm)
    - more layers needed, more data channels needed
- Critical regulation of grid voltage
    - Variation 30 V $\rightarrow$ factor 2 in gain
    - Many HV channels needed $\rightarrow$ local low power HV PS needed
- Tendency to sparking
    - Rate induced sparking, under investigation
    - FE chip should be made spark proof $\rightarrow$ problem basically solved
- Long charge collection time (30 – 70 ns, to be investigated)
- Risk on accelerated ageing (can be minimized)

Then Fred moved to the subject close to the WG2 "specialty:"

radiation tolerance/aging

spark protection

rate effect

Radiation tolerance of Gossip

- No ageing of detecting medium (gas)

but

- Most important: **deposit** on anode surface caused by the avalanche

  - May be thin insulating layer (polymer)
  - Loss of gain due to voltage drop across the deposited layer (rate dependent)
  - Effect in first order proportional to collected charge
  - → figure of merit of gaseous detector ageing is **collected charge per unit of anode surface**

- Other ageing effects

  - Electrode damage from sparking
    - Can be prevented using resistive materials
  - Ageing of construction materials
    - Addressed in generic studies by RD51 using X-rays

SILICON FILAMENTS ON AGED ANODE WIRES:
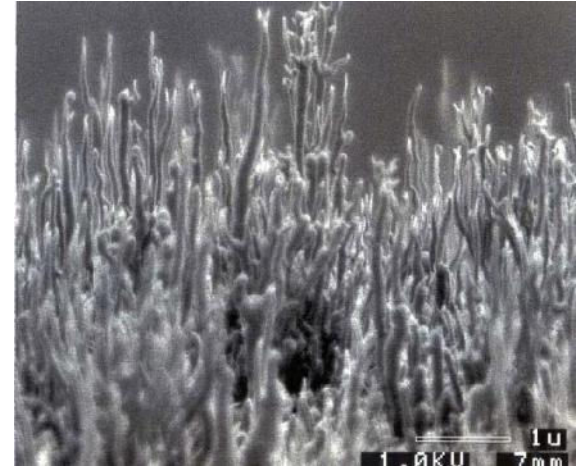
M. Binkley et al, Nucl. Instr. and Meth.A515(2003)53

F.Hartjes, MSGC damage
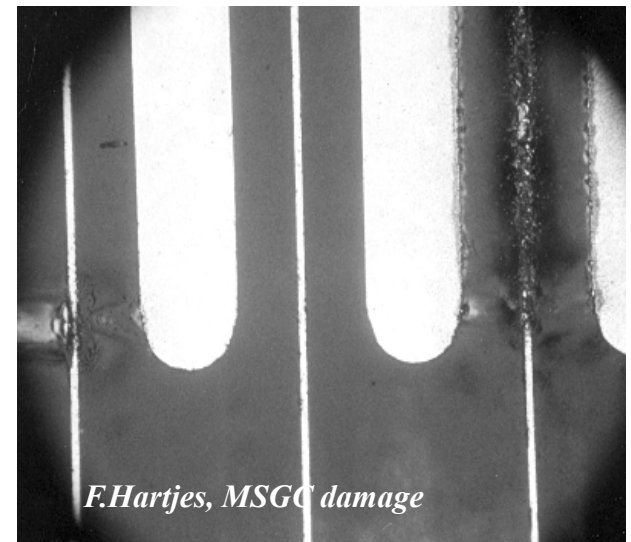
Working point for present studies
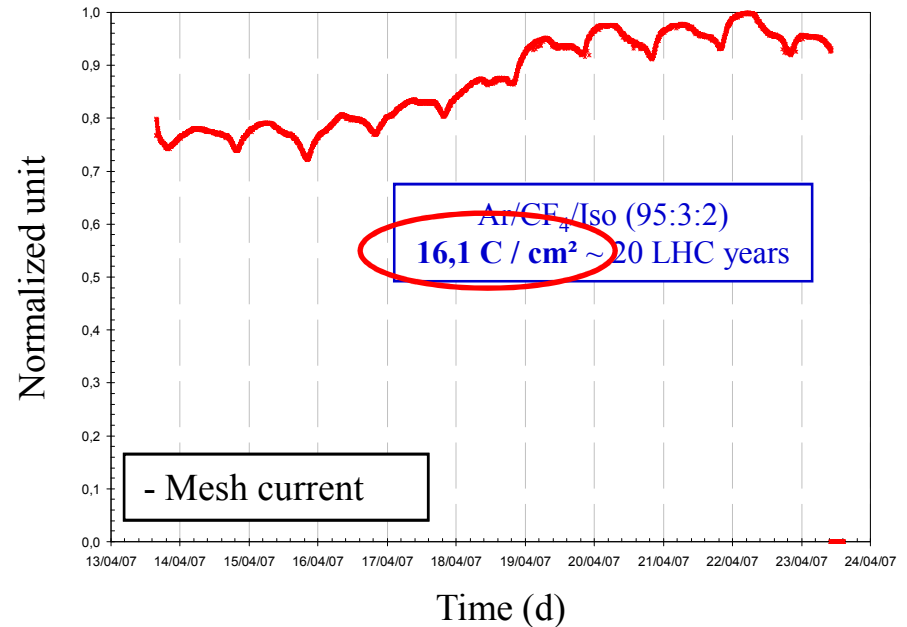
- **Chamber gas**: DME/CO_2 50/50
  - Low, constant mobility, even at high drift fields
  - → low Lorenz angle (~9° at B = 2 T)
  - High primary ionization (45 clusters/cm)
  - Excellent quencher (UV absorption, preventing sparks)
  - Low diffusion (σ = 100 µm/√cm)
- **Gas gain** 5000 - 10000
  - → good Z resolution (slew rate)
  - Optimal hit efficiency
  - Gain of 5000 challenging at B-layer!!!
- **Drift gap** 1 mm
  - → theoretical hit efficiency 98.9%
  - → minimal ballistic deficit
- **Drift field** 7 kV/cm
  - → good drift velocity, short drift time even for this low mobility gas
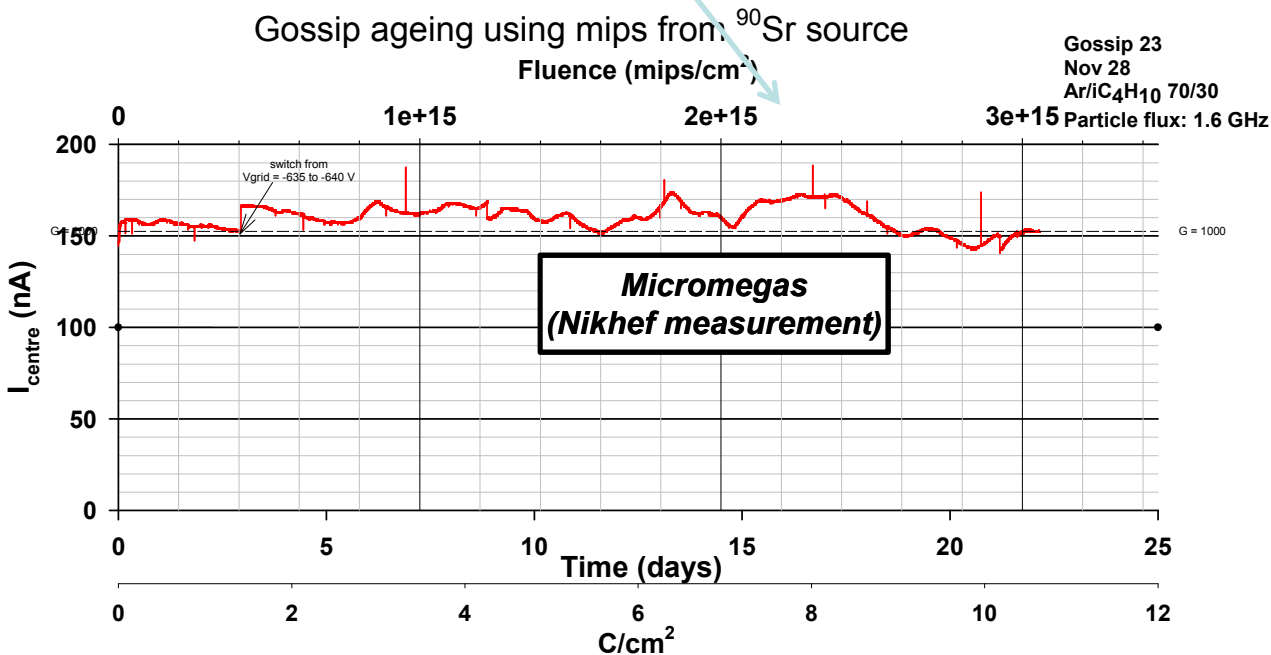
Target dose values for Gossip

- Expressing dose as **charge per cm^2** (rather than n_{eq}/cm^2)
  - Assume
    - Gas gain = 5000
    - 12.6 e^- average ionization across 1.0 mm (DME/CO_2 50/50)
  - $\rightarrow$ 1 MIP => 10 fC

  - $\rightarrow$ sLHC BL dose of $3.4*10^{16}$ MIPs/cm^2 translates into **342 C/cm^2**

- Comparison to numbers for wire chambers
  - Assume sense wire $\varnothing$ 20 µm

Fair number for wire chambers

Well possible if **outgassing** elements are avoided

- **342 C/cm^2 $\leftrightarrow$ 2.1 C/cm**

Experimental results using Micromegas based detectors

- 16.1 C/cm^2 obtained so far
  - Non-clean gas system
  - Epoxies used (Araldite)
  - measurement terminated because of sparking
- **Goal: 342 C/cm^2**

Ar/CF$_4$/Iso (95:3:2)
16,1 C / cm^2 ~ 20 LHC years

- Mesh current

Time (d)

David Attié, MPGD workshop CERN Sept. 2007

Gossip ageing using mips from ^{90}Sr source

Gossip 23
Nov 28
Ar/iC$_4$H$_{10}$ 70/30
Particle flux: 1.6 GHz

Micromegas (Nikhef measurement)

switch from Vgrid = -635 to -640 V

G = 1000

Spark protection

MIP response for SiProt2

5 layers of
1.4 μm Si_3N_4

Always needed for gaseous detectors

- Spark induced by dense ionisation cluster from the tail of the Landau
- Unprotected pixel chip rapidly killed by discharges

WaProt: 7μm thick layer of Si_3N_4 on anode pads of pixel chip

- Normal operation: avalanche charge capacitively coupled to input pad
- At spark: discharge rapidly arrested because of rising voltage drop across the WaProt layer
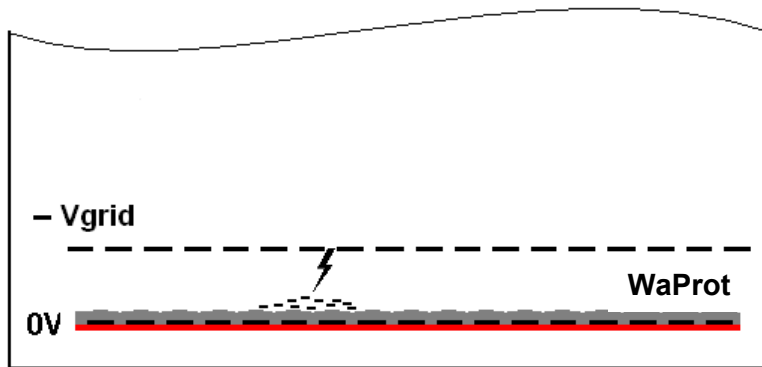
- Conductivity of WaProt tuned by Si doping
- For sLHC BL we should not exceed $1.6*10^9$ Ωcm (10 V voltage
- drop)
- Has proven to give excellent protection against discharges
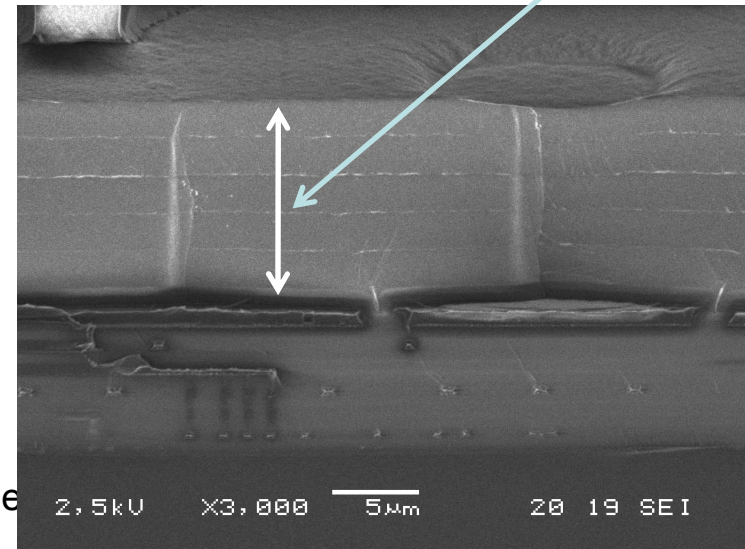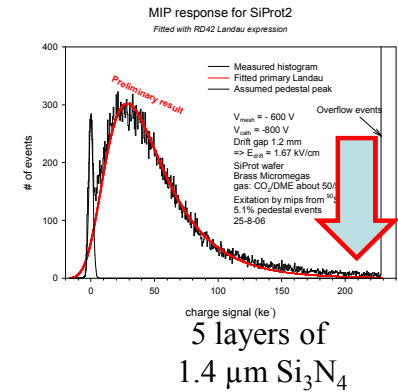
Maximum rate of Gossip possibly limited sparking

- → sLHC BL rate of 0.9 GHz/cm² sparking at total avalanche charge of 3*10⁵ e⁻

- → **sparking** at **60 primary electrons would occur** at a gain of 5000

- Average MIP ionization 10 – 15 e⁻

- \> 60 e⁻ → happens frequently in the Landau tail of the primary ionization

- → we need a good protection against sparking

- → **Gossip at B-layer sLHC would be close to sparking**

- But Gossip prototype sustained **60 µA/cm²** induced by UV light (Nikhef test)
  - → 9 µA/cm² (present working point) would be OK?

- Systematic research using MIPS needed
 - ⁹⁰Sr source
  - SPS muon test beam
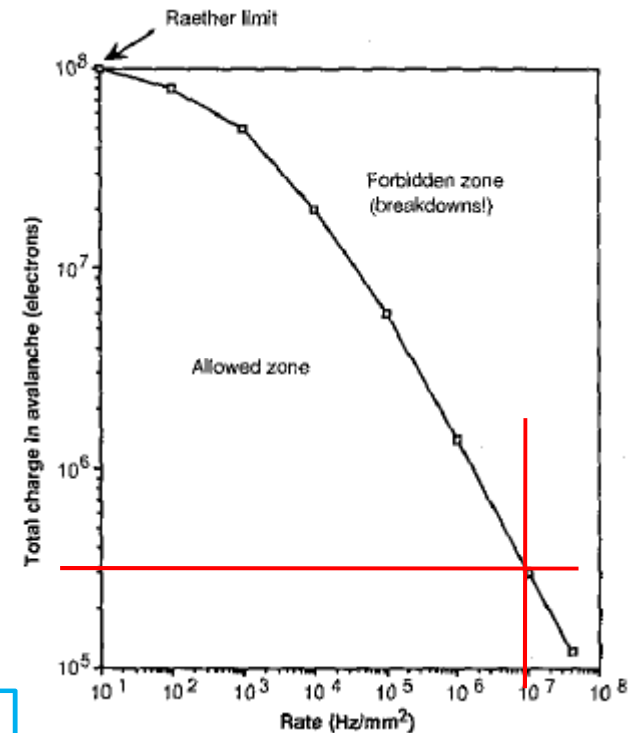
P.Fonte, V. Peskov, B. Ramsey, The fundamental limitations of high-rate gaseous detectors, Nuclear Science Symposium, 1998, 1998 IEEE, vol.1, p 91.

Summary

- <u>Applying the Gossip technology in the pixel layers brings great benefits</u>
  - Very relaxed cooling requirements
  - High radiation tolerance
    - $3.4*10^{16}$ MIPS/cm^2 possible
  - Low costs (no bumpbonding)
  - Low material budget (1.25%)

- <u>But we don't get it for free</u>
  - We might have to face ageing phenomena, but they are probably solvable
    - Many ageing tests to be done, more time consuming than for solid state detectors
  - New technology without running experience
  - Less good position resolution
    - Limited statistics in primary ionization
  - Additional services (HV, gas)
  - Possibly more dead area
    - => more layers required

Single-electron response and energy resolution of a Micromegas detector

T. Zerguerras[*], B. Genolini, V. Lepeltier[†], J. Peyré, J. Pouthas,
P. Rosier
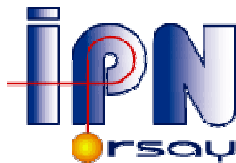
In2p3

* E-mail: zerguer@ipno.in2p3.fr
Web site: http://ipnweb.in2p3.fr/~detect/

Energy resolution in gaseous detectors

Two contributions:

- **- Primary ionisation fluctuations**

⟶ can be quantified by the **Fano factor (values : 0.1 up to 0.4)**

- Gas gain fluctuations during the multiplication process

Two probability distributions:

- **Exponential (Furry distribution)**

- **Polya (generalisation proposed by Byrne) :**

$$ P(Q) \; = \; C_0 \frac{(1+\theta)^{1+\theta}}{\Gamma(1+\theta)} \left(\frac{Q}{\overline{Q}} \right)^{\theta} \exp \left[-(1+\theta)\frac{Q}{\overline{Q}} \right] $$

θ: parameter of the Polya, related to the relative gain variance f by : $f = 1/(1+\theta)$

⟶ Measurement of the **Single-Electron Response (SER)** is a direct method to determine gas gain fluctuations.

SER in single GEM

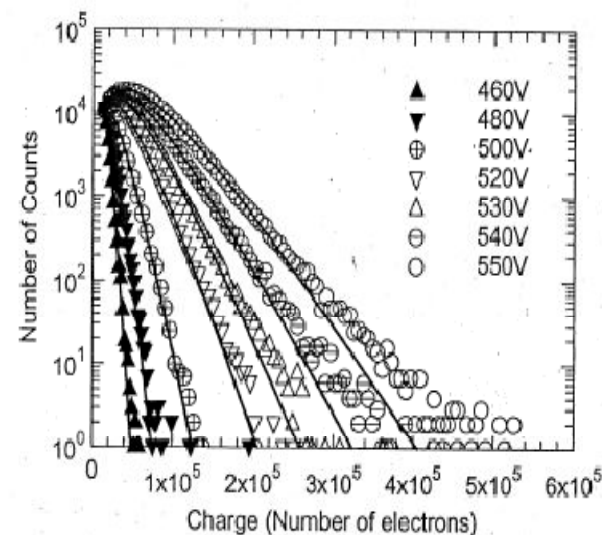**Ne 50% DME 50%**
Gain: 7.9 10^3

Polya distribution

$$P(G/\bar{G}) = \frac{Nm}{\Gamma(m)}(mG/\bar{G})^{m-1}e^{-mG/\bar{G}}$$

$$\bar{G} = 7940 \pm 14$$

N	3452 ± 13.8
m	3.217 ± 0.021
$\bar{G}$	7940 ± 14.5
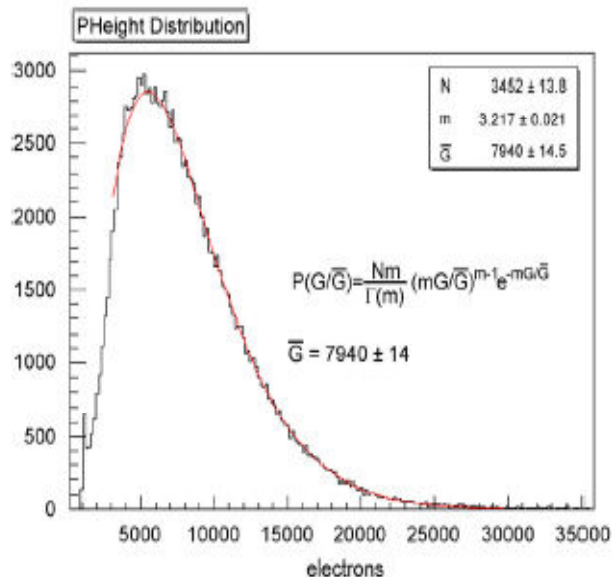
$\theta = 2.2 \longrightarrow f = 0.31$

R. Bellazzini et al.,
NIM A 581 (2007) 246

GEM-MIGAS in GEM mode
He 85% iC_4H_{10} 15%
Gains of a few 10^4

Polya distribution

$1.4 \leq \theta \leq 2.5 \longrightarrow 0.3 \leq f \leq 0.4$

Jamil A. Mir et al, IEEE Trans. Nucl.
Sci. NS-55 (2008) 2334.

SER in Micromegas

Polya distribution

Micromegas:

Conversion zone: 5 mm
Amplification gap: 100 μm

He 90% iC$_4$H$_{10}$ 10%

Gain ≈ 10^6
(Electronic noise: 4 10^4 e$^-$
RMS)

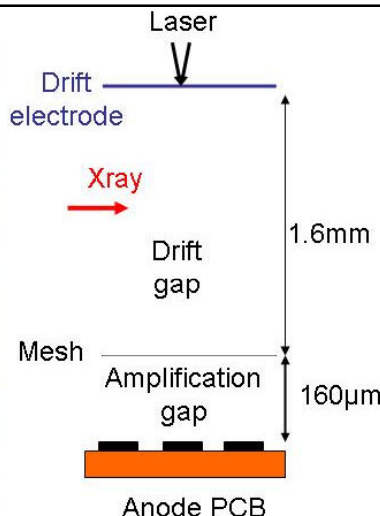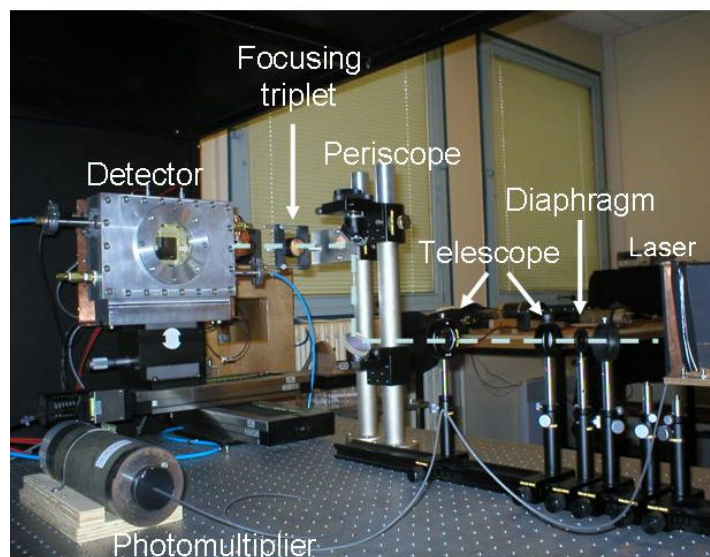*J. Derré et al., NIM A 449 (2000), 314.*

$\theta = 0.43$

$\theta = 0.39$
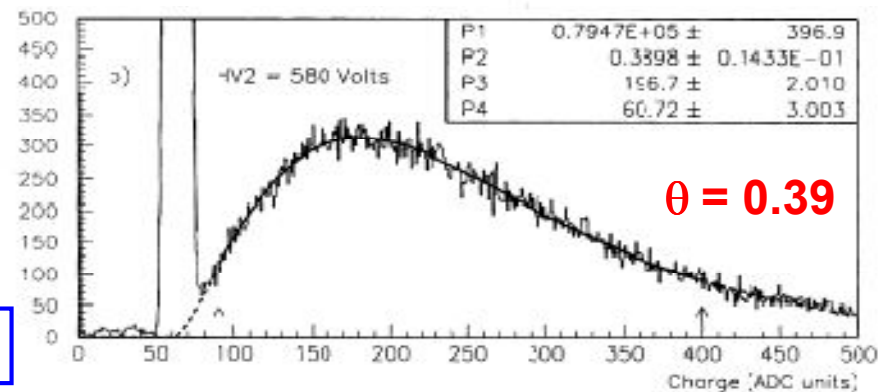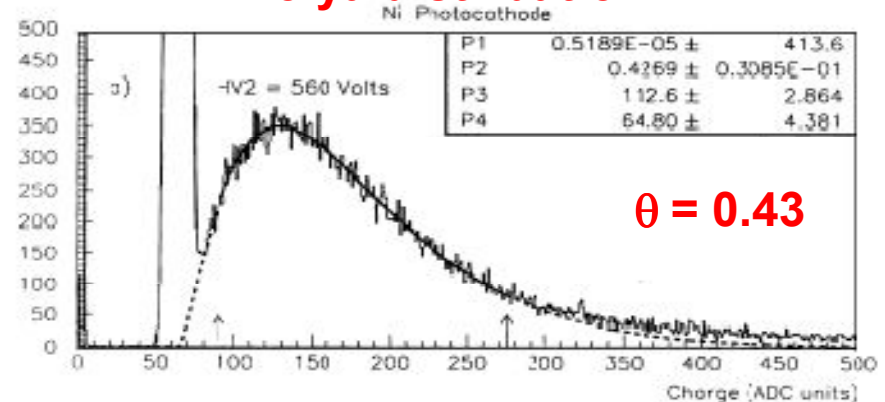
⟶ $f \approx 0.7$

Study with a laser test bench @ Orsay

- **Production of an intensity and position monitored electron source using a 337 nm wavelength laser**
- **Focused laser beam size $\leq$ 100 μm**

  → *T. Zerguerras et al. , NIM A 581 (2007) 258*

Drift electrode: Quartz window with a 0.5 nm thick Ni-Cr layer

Mesh: 333lpi Buckbee-Mears© 70% optical transmission Nickel

Measurements with a set of 9 pads (3*3), size of 4*4mm^2

Electronics:
  Pads: Gassiplex chips (noise: 2 000 e$^-$ RMS)
  Mesh: gain 100 voltage amplifier

Ne 95% iC$_4$H$_{10}$ 5% @ 1 bar

Drift field: 1kV/cm

Trigger:
  - Mesh signal in ^{55}Fe source mode.
  - Photonis© XP2282B photomultiplier anode signal in laser mode
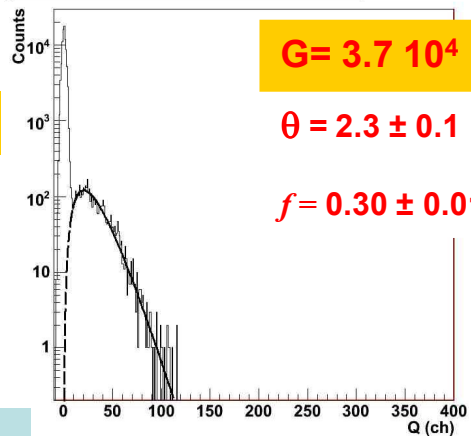
Single-electron response

Laser intensity light attenuated by a factor of 2 000.
Rate of non-zero events: 7%
Measurement on the central pad
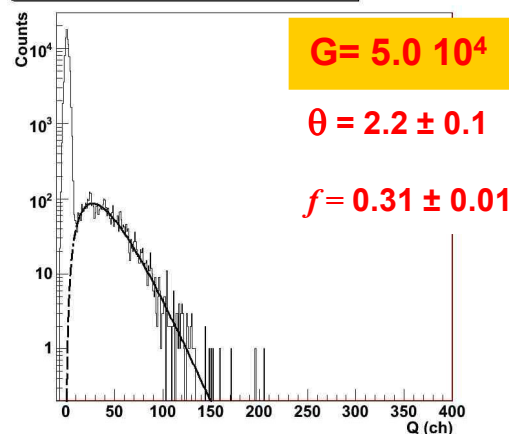
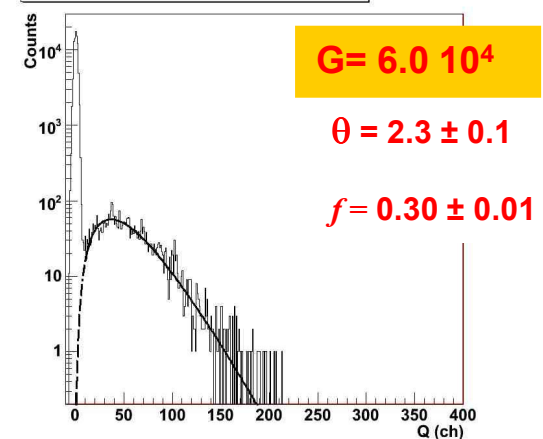**Polya distribution adjusted on data**

V_{Mesh} <500V

(a) SER Ne 95% iC_4H_{10} 5% - V_{Mesh}=470V

G= 3.7 10⁴

θ = 2.3 ± 0.1

f = 0.30 ± 0.01

(b) SER Ne 95% iC_4H_{10} 5% - V_{Mesh}=480V

G= 5.0 10⁴

θ = 2.2 ± 0.1

f = 0.31 ± 0.01

(c) SER Ne 95% iC_4H_{10} 5% - V_{Mesh}=490V

G= 6.0 10⁴

θ = 2.3 ± 0.1

f = 0.30 ± 0.01

V_{Mesh} ≥ 500V

(d) SER Ne 95% iC_4H_{10} 5% - V_{Mesh}=500V

G= 7.6 10⁴

θ = 1.9 ± 0.1

f = 0.34 ± 0.01
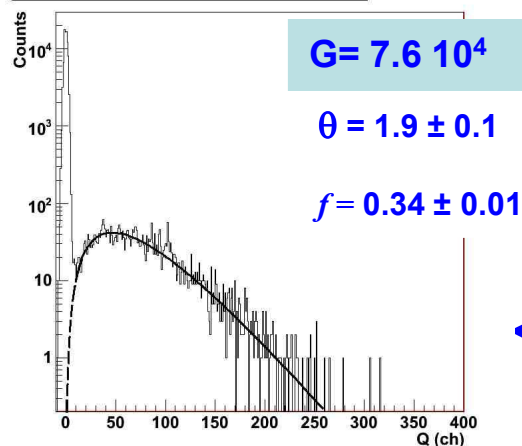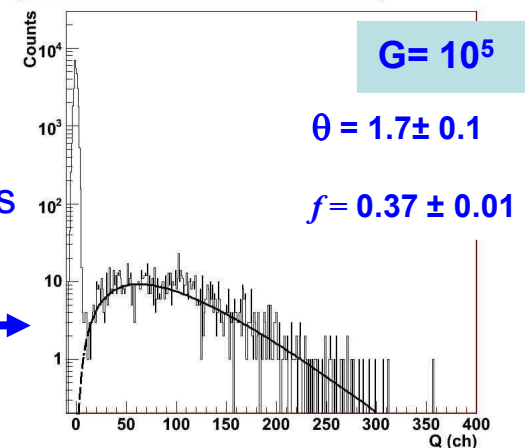
- Gain 10-15% lower than expected from gain calibration curve extrapolation.
- Relative gain variance increases

Unquenched photon effect

(e) SER Ne 95% iC_4H_{10} 5% - V_{Mesh}=510V

G= 10⁵

θ = 1.7± 0.1

f = 0.37 ± 0.01

Conclusions

- Gas gain fluctuations in MPGDs are lower than in MWPC (0.7) for the same gain values.

- The present experimental method can be used for all kind of MPGDs and allows direct SER measurements down to gains of a few 10^4.
  It could help provide experimental data for simulation software improvement (see R. Veenhof's talk @MPGD 2009)

- Study of the energy resolution as a function of the primary number of electrons can be performed.

- From the relative gain variance f deduced from the SER, the Fano factor can be estimated.

$\longrightarrow$ | Present work to be published in NIM A. |

Perspectives:

   - Spatial resolution

   - Gas gain fluctuations for different pressures and in other gas mixtures

Next talk was in the same stream…

Study of avalanche fluctuations and energy resolution with an InGrid-TimePix detector

Paul Colas, CEA/Irfu Saclay

Progress report, based on PC, IEEE Dresden 2008, Max Chefdeville's thesis 2009, and more recent analysis

Gain fluctuations

Though there is no clear justification for this, we use Polya to parameterize the gain distribution.

$$P_G(G/\bar{G};\theta) = \frac{(\theta+1)^{\theta+1}}{\Gamma(\theta+1)}\left(\frac{G}{\bar{G}}\right)^{\theta}\exp\left(-(\theta+1)\left(\frac{G}{\bar{G}}\right)\right)$$

$$\sigma^2_{G/\bar{G}} = 1/(1+\theta)$$

For $\theta=0$, the distribution is an exponential (Furry model)

Alternative convention is parameter $m=1+\theta$

New experimental handles

Many measurements have been carried out (see T. Zerguerras's talk). New detectors provide new handles:

•Electron counting with InGrid on TimePix provides a direct measurement of Fano fluctuations, giving access to the contribution of gain fluctuations to the width of the observed ^{55}Fe peak (itself measured by InGrids or Microbulks).

•Time-over-threshold on single pixels give the charge distribution of single electron avalanches

•Study of electron counting vs gain gives a sensitivity to θ

See electrons from an X-ray conversion one by one and count them, study their fluctuations

(Nikhef-Saclay)
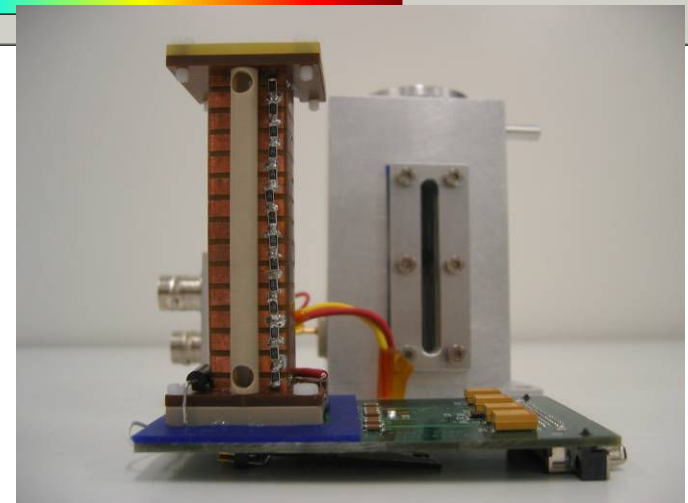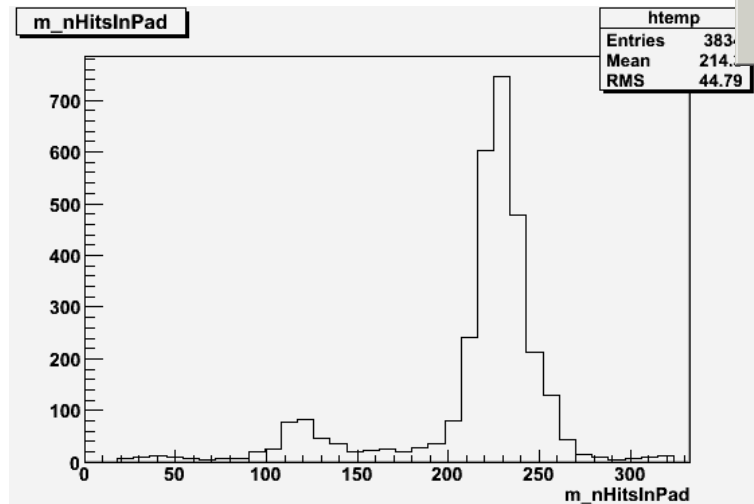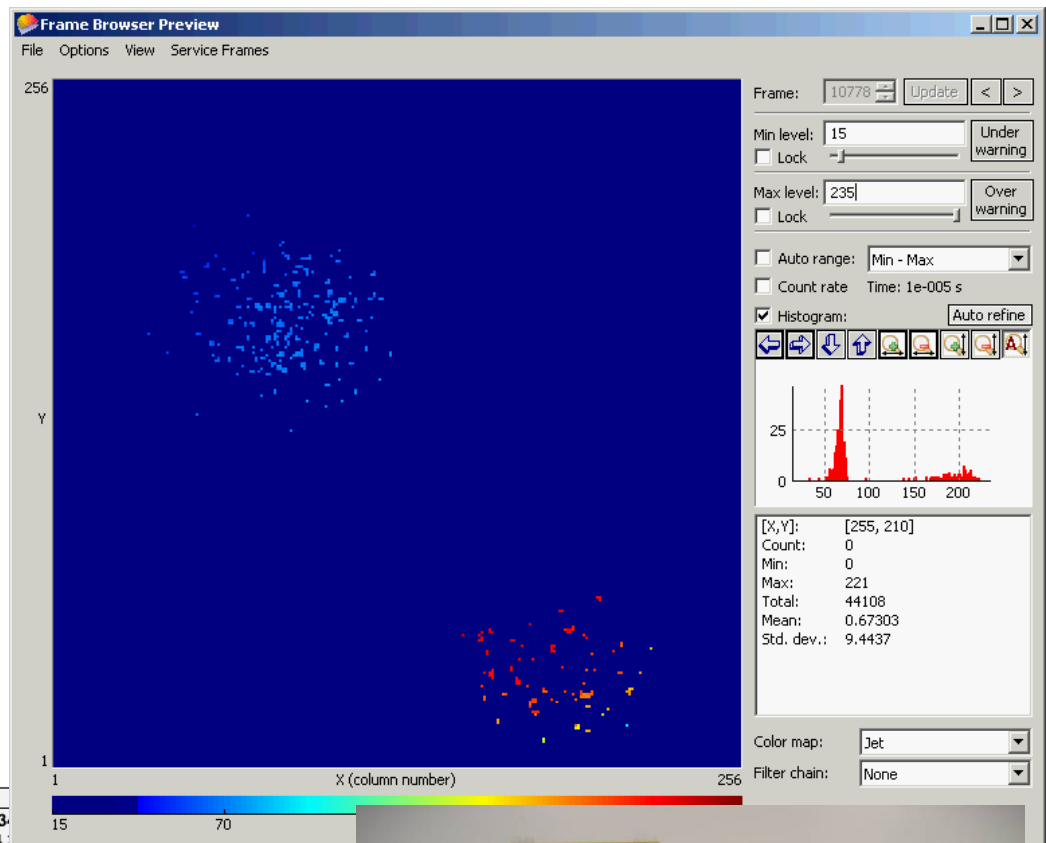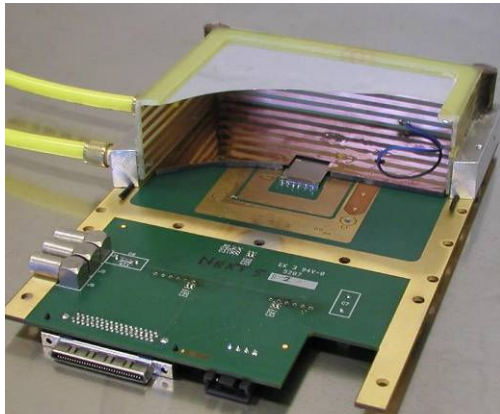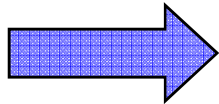
W and F in Ar/iso 95/5 at 2.9 keV

Assume full collection efficiency of detector #1
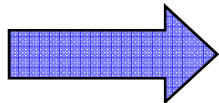
$N_p = N_c = 115 \pm 2$ e-

➡️ W = 25.2 ± 0.5 eV

Extrapolation to 5.9 keV photo-peak straightforward

$N_p = 230 \pm 4$ e-

Consistent with, and more precise than previous measurements

Peak width measured with detector #2 corrected for detection and collection eff. (87 %)

$RMS(N_p) \sim 4.3$ %

➡️ F = 0.21 ± 0.06

Consistent with measured values and theoretical estimate 0.17 for pure Ar

Conclusions

- New 'almost perfect' detectors give gain fluctuations wich can be parametrized by polya with $\theta \sim 2$.

  – from e-counting vs V_{mesh} : $\theta = 2.2^{+1.5}_{-0.6}$

- Fano fluctuations are now accessible by electron counting.

- Best resolution understood as sqrt((F+B)/N), with F=0.2 and B=0.3 for Micromegas

- More systematic measurements with best possible InGrids+TimePix to be made

..so both these talks touched the fundamentals of avalanche statistics, there is tremendous progress in this direction and it was a very important contribution to the WG2

Electroluminescence Yield in Electron Avalanche Development for MPDGs

João Veloso

C.A.B.Oliveira

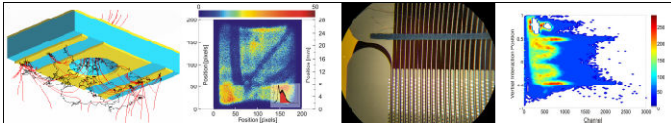Physics Department – University of Aveiro

C. Monteiro, J.M.F. dos Santos

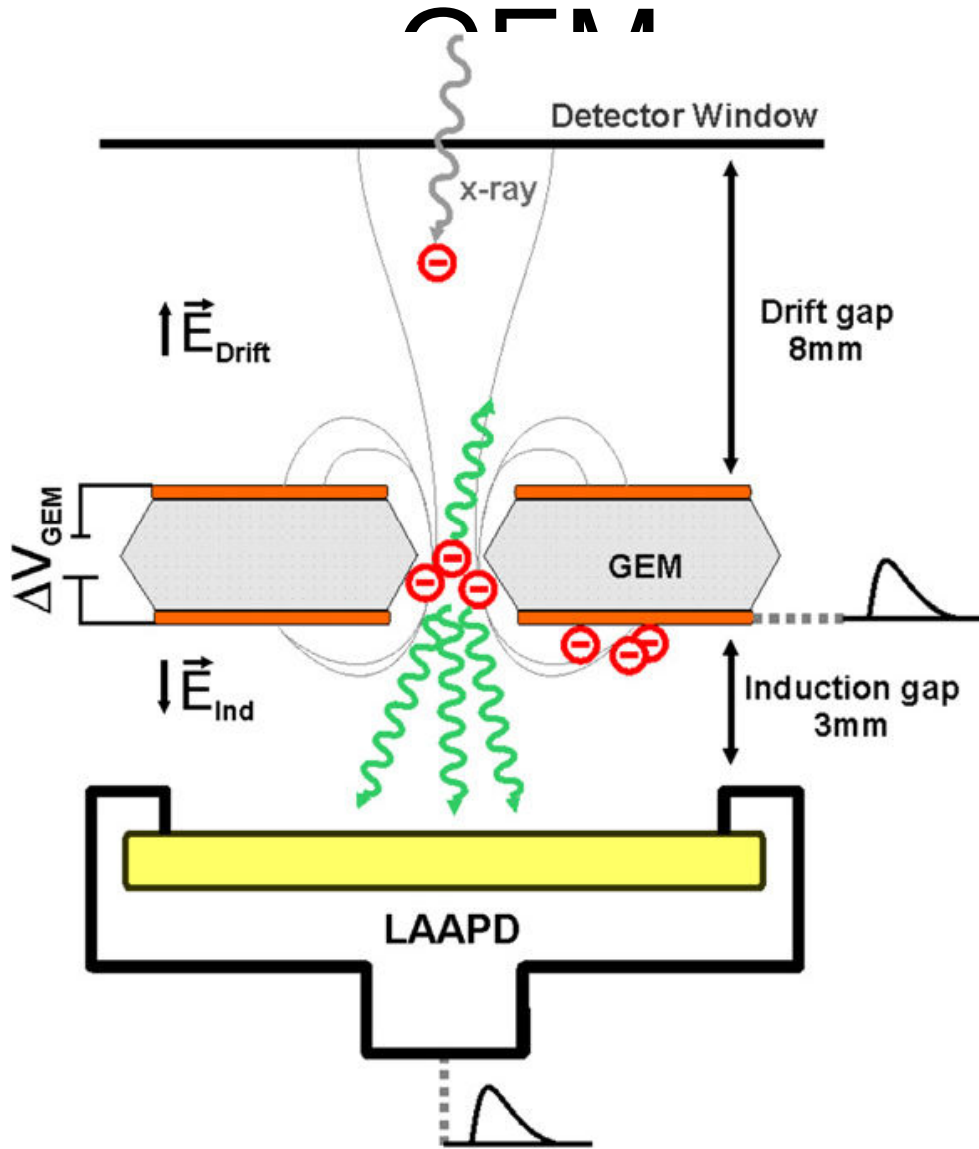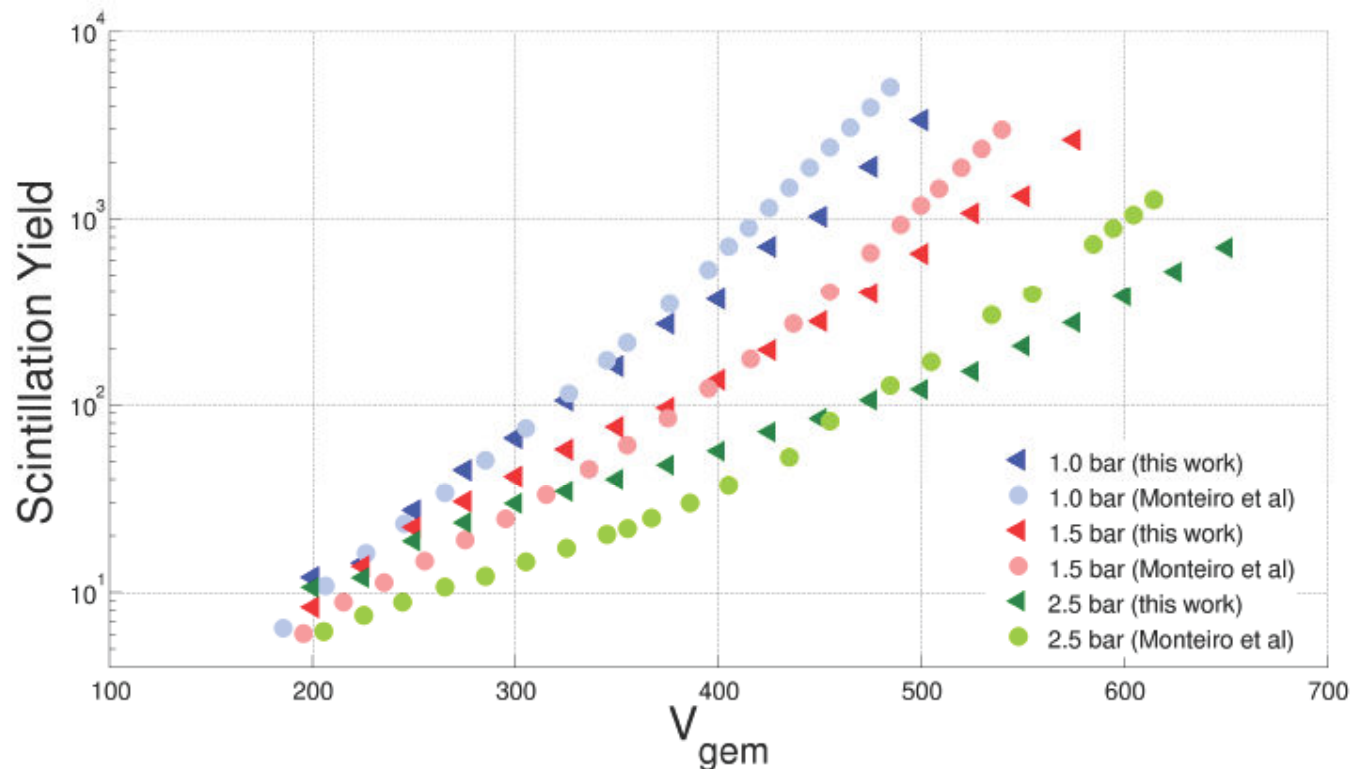Physics Department – University of Coimbra

A. Breskin and R. Chechik

Weizmann Institute of Science, Rehovot

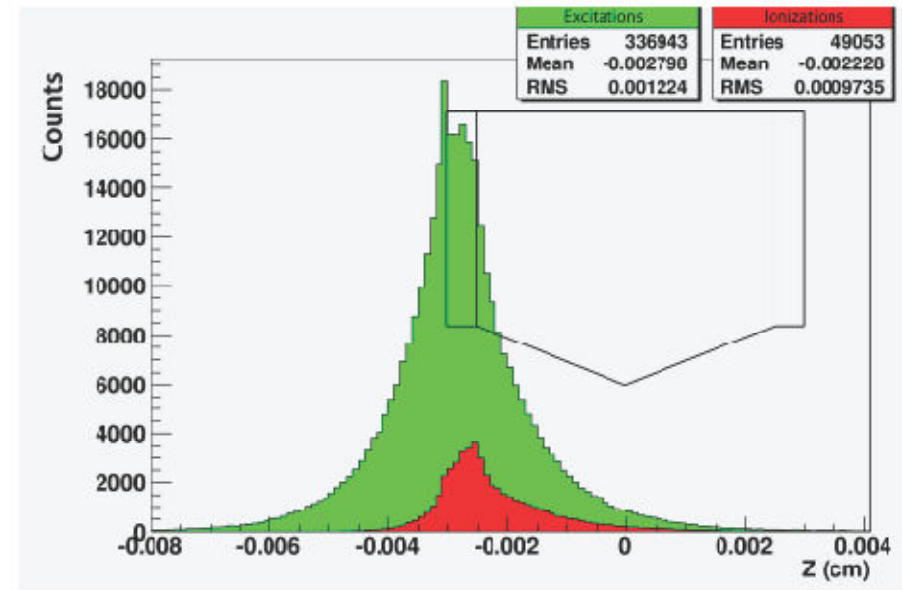# Experimental setup for Y in a GEM

Comparison with experimental results for GEM
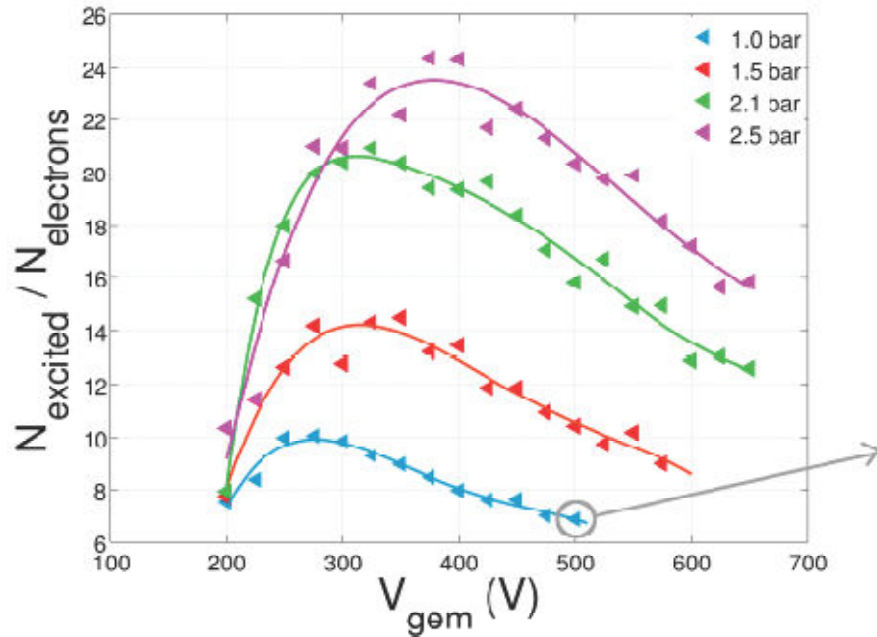

- Similar behaviour as experimental data (Monteiro et al, PLB)

- Little differences are being studied

Ratio between excitations and ionizations

- $N_{exc} >> N_e$

- $\dfrac{N_{exc}}{N_e}$ increases with p (λ decreases -> less $\varepsilon_{electron}$ -> P_{ion} decreases)

All four talks are <u>an excellent example</u> what should e presented and discussed @WG2

ALICE RICH upgrade and challenges for WG2

Due to the money constrains… a much more modes option is now considering
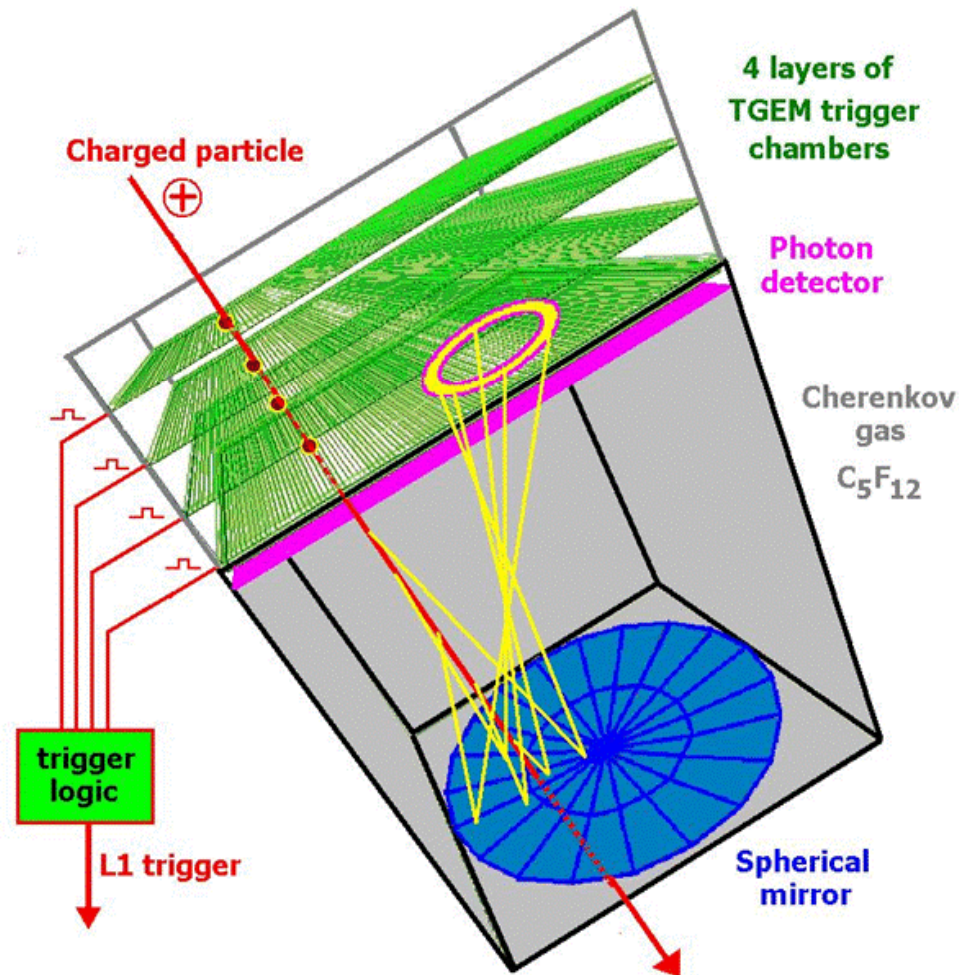
Due to the very limited space available in the ALICE detector, the VHMPID will be composed by several small (~1x1x1 m3) modules

Challenges in the frame of WG2

1. What to choose: the "optimized GEM" developed by us earlier or "thick GEM"
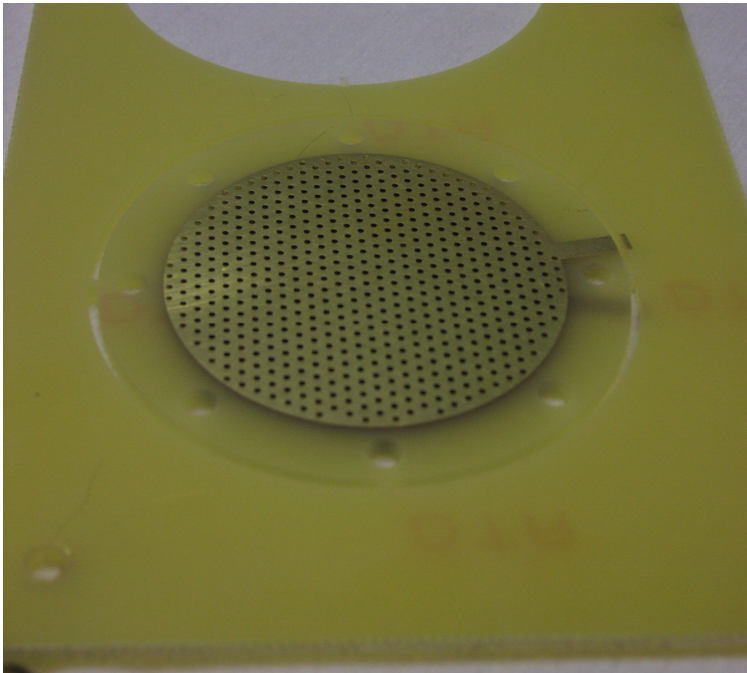
Thickness 1-2 mm, diameter of holes 0.3-1 mm

L. Periale et al., NIM A478,2002,377
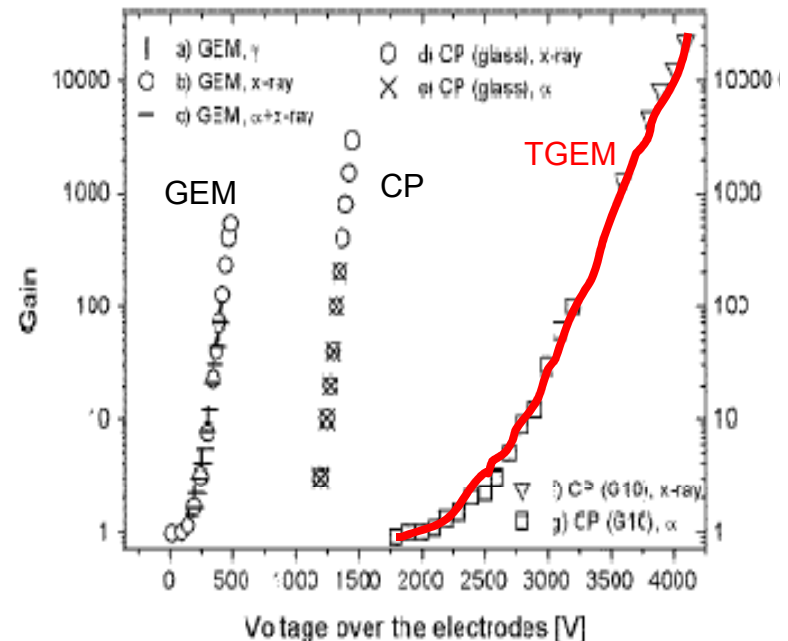
J. Ostling et al., IEEE Nucl. Sci 50,2003,809

In some designs of "optimized GEMs" rims we manufactured by additional drilling

TGEM is an" optimized GEM" with rims manufactured not by a drilling technique, but by photolithographic technology

Standard GEM
10^3 gain in single GEM

THGEM
10^5 gain in single-THGEM

1mm

Cu

0.1mm G-10 rim.
reduces discharges
-> high gains
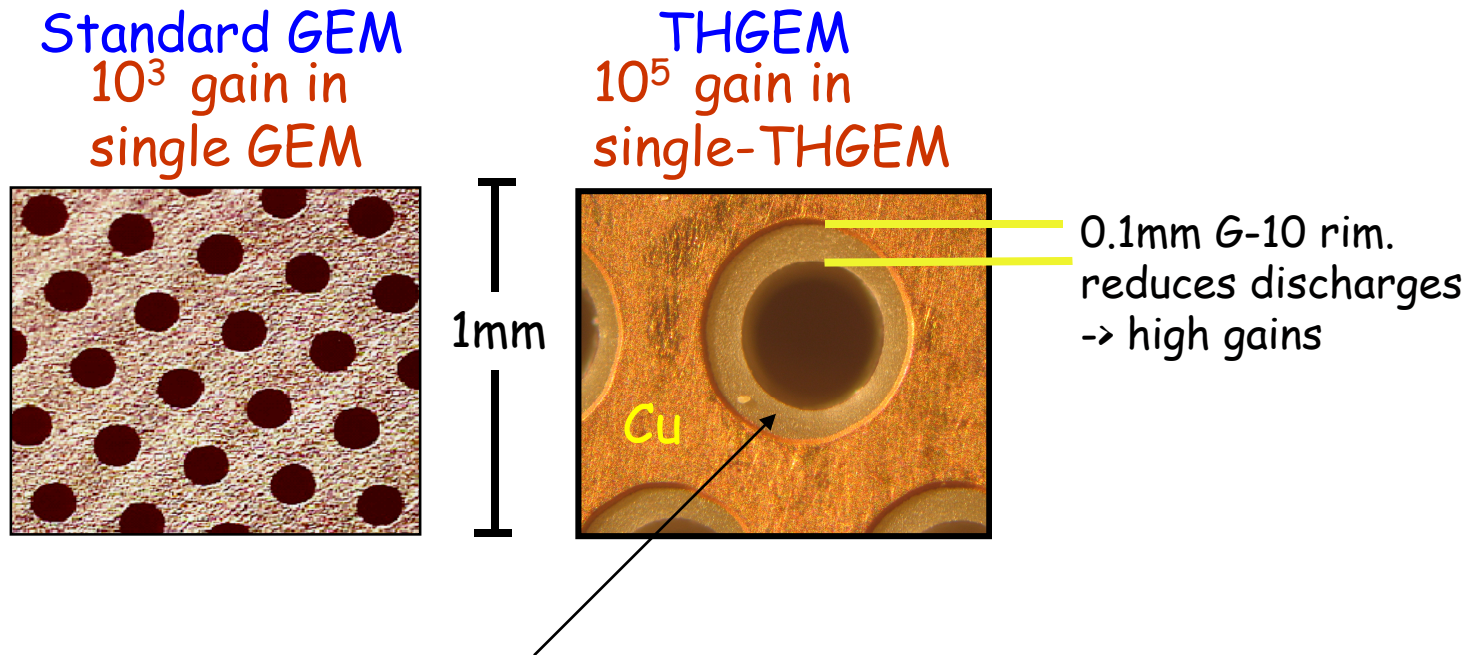
Breskin's TGEM, see: *Shalem, C. et al., NIM.,A558, (2006) 475*

Can this be accepted by the VHMPID collaboration?

Long–Term Stability (after gas stabilization)

UV

Ref. PC

1mm

0.4mm

0.5mm

Single THGEM (t=0.4mm, d=0.5mm, a=1mm, rim=0.12mm)
Gain = 10^4, UV light, e- flux ~ 10^4 Hz/mm^2

Anode Current (A)

$6x10^{-10}$

$4x10^{-10}$

$2x10^{-10}$

Ne, ΔV_{THGEM} = 450 V
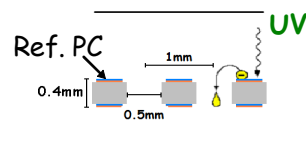Ne/CH$_4$ (5%), ΔV_{THGEM} = 770 V
Ar/CH$_4$ (5%), ΔV_{THGEM} = 1400 V

0   1   2   3   4   5   6   7

Time (h)
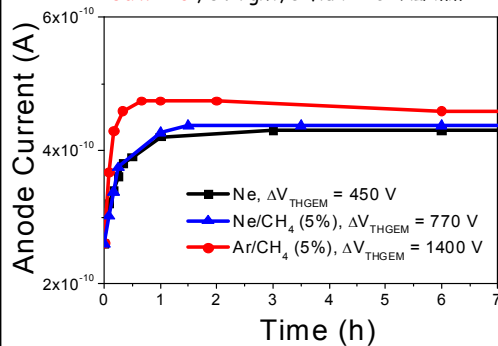
Insulator Charging up ➔
few hours of stabilization
gain variation~ x2, depends on:
• voltages, currents, gas, materials

Stabilization time function of:
• Total gain (potentials)
• Counting rate (current)
• Material & hole-geometry
• Production method (adsorbed chemicals)
• Gas & purity

2. Gas?

Ne+CH$_4$?

Extraction efficiency w CsI ref. PC

Ne/5%CF$_4$ Ne/10%CF$_4$
CF$_4$
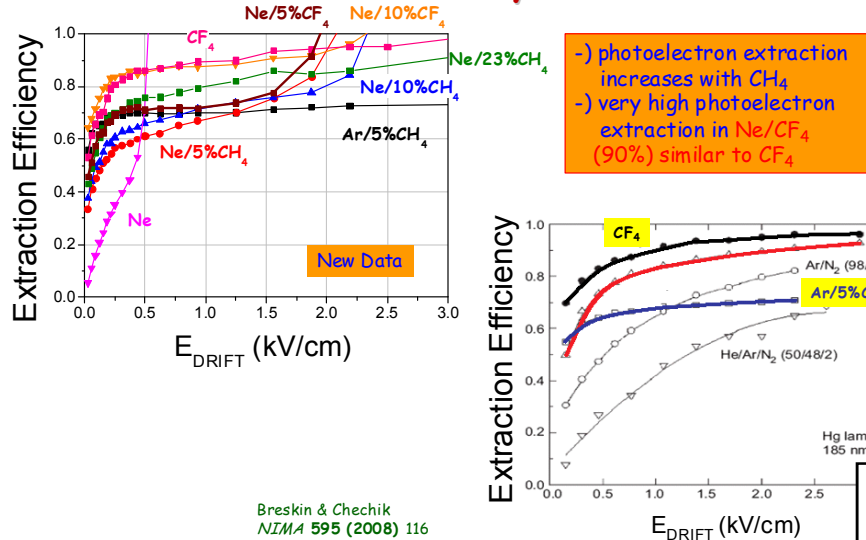Ne/23%CH$_4$
Ne/10%CH$_4$
Ar/5%CH$_4$
Ne/5%CH$_4$
Ne

New Data

- -) photoelectron extraction increases with CH$_4$
- -) very high photoelectron extraction in Ne/CF$_4$ (90%) similar to CF$_4$

CF$_4$
CH$_4$
Ar/N$_2$ (98/2)
Ar/5%CH$_4$
He/Ar/N$_2$ (50/48/2)
Hg lamp 185 nm

Breskin & Chechik
NIMA **595 (2008)** 116

**Example: For typical operation voltages in Ne/5%CH$_4$ (E ~ 2.8-3 kV/cm)
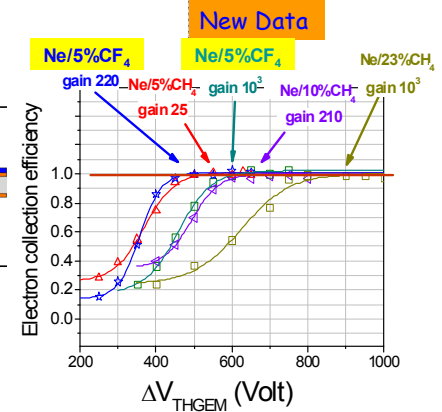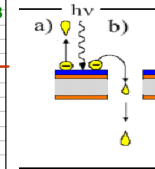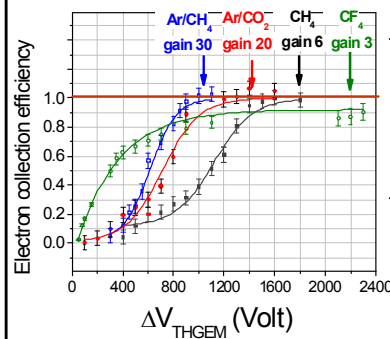Effective QE ~ 70% (similar to Ar/5%CH$_4$!)**

Electron collection efficiency

3x3cm^2 THGEM (thickness = 0.4 mm, hole diameter = 0.3 mm, pitch = 0.7 mm, rim = 0.1 mm)

Method: Pulse-counting of the fraction of single-e$^-$ events reaching the THGEM bottom

New Data

Shalem et al. NIMA **558 (2006)** 475

Ne/5%CF$_4$ Ne/5%CF$_4$ Ne/23%CH$_4$

Ar/CH$_4$ Ar/CO$_2$ CH$_4$ CF$_4$
gain 30   gain 20   gain 6   gain 3

gain 220 Ne/5%CH$_4$ gain 10^3 Ne/10%CH$_4$ gain 10^3
gain 25   gain 210

**THGEM large hole dimensions ➔ efficient e$^-$ collection into the hole:
↳ full single-e$^-$ detection efficiency @ gain <100 (depends on %CH$_4$)**

From *M. Cortesi tal at this conference*

3. CsI QE and stability.

- The CsI QE in Ne+CH$_4$ and other promising mixtures should still be measured

- Long term stability at low rate was demonstrated

- Short term and stability in high rate environment is a tricky phenomena… there is a cathode excitation effect

Discussion1

●Silvia's advice during the discussion: "stay away from any instability…"
● Silvia and Fulvio remarks concerning Ne+CH$_4$ mixture
● M. Cortesi advocated this mixture

Remarks on spark protection

A primitive model:

-V

Spark

Discharge power

d
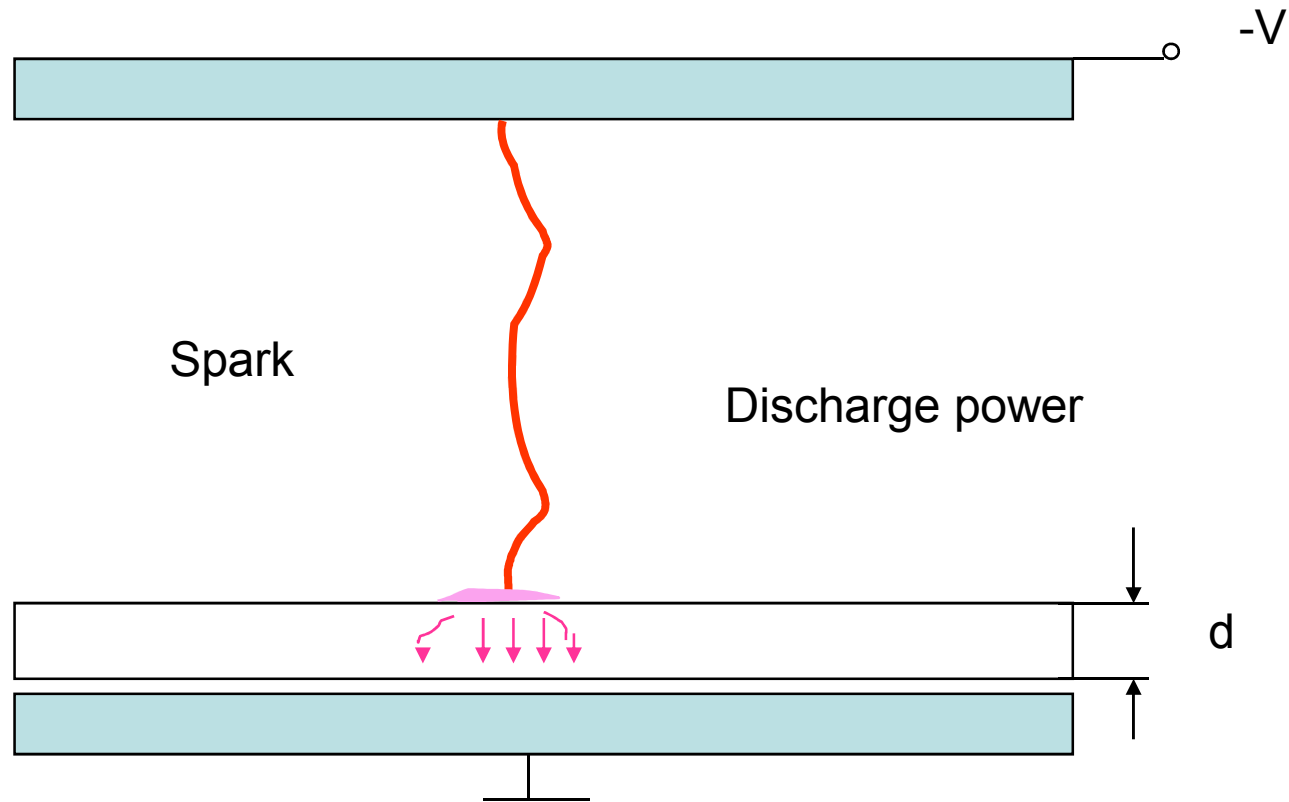
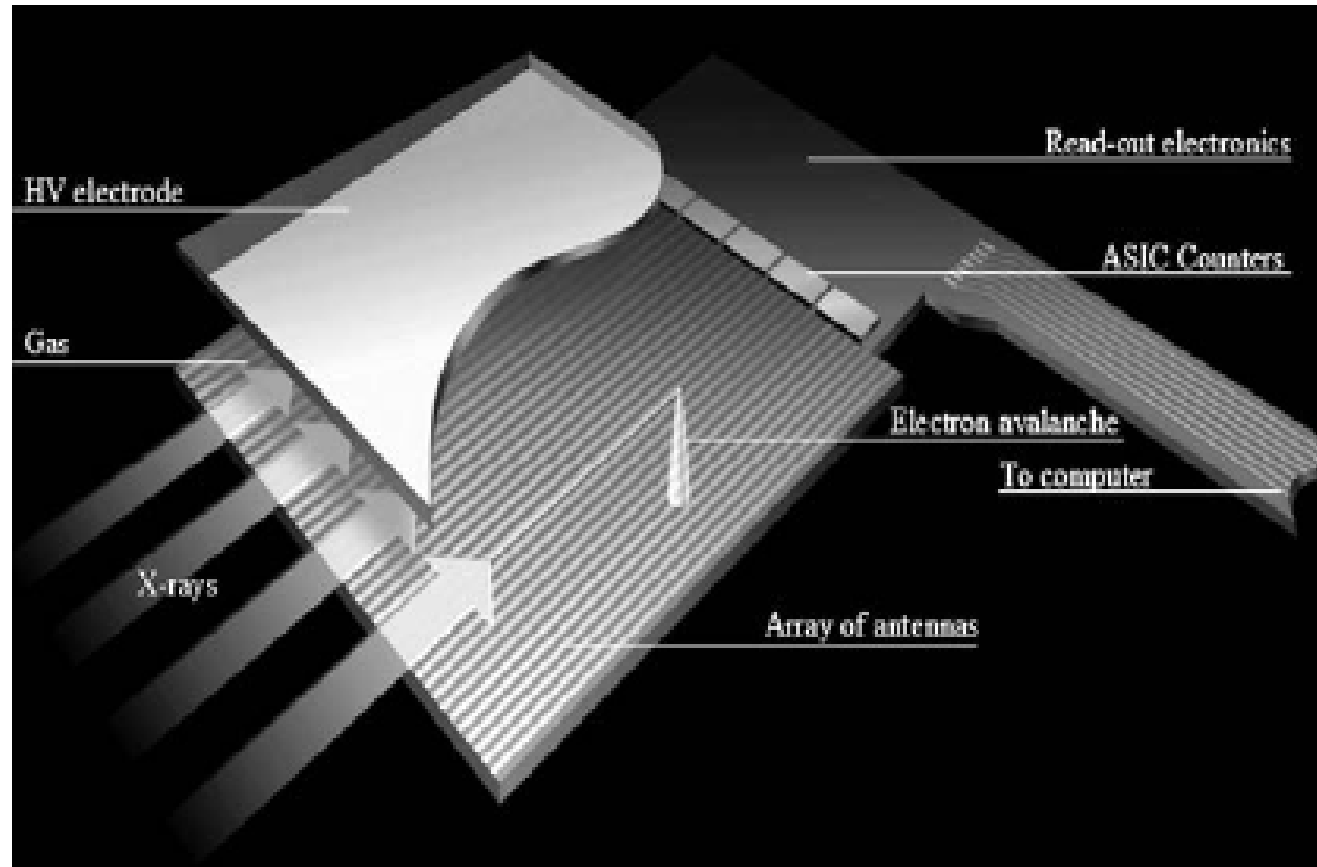$\Delta V = V_s - V_q$
$q = \Delta V C \sim \Delta V \varepsilon / d$
$I = \Delta V / R$, $\Delta t \sim RC >$ cathode de-excitation time

$\Delta V = V_s - V_q$ depends on gas

XCounter high rate microgap/microstrip RPC

Iacobaeus, C. et al., Nuc. Insr. Methods, Vol. A513, No. 1-2 (2003), pp. 244-249

Recently appeared on the market Bruker x-ray detector

(Pos. resol. 120 μm, rate $5 \cdot 10^5 Hz/mm^2$)

X-ray photon

Be-window

E_d

e^- Conversion/Drift Gap

Grid

Amplification Gap   1mm   Resistive Anode

E_a

Insulator

Induced Charge

Readout strips
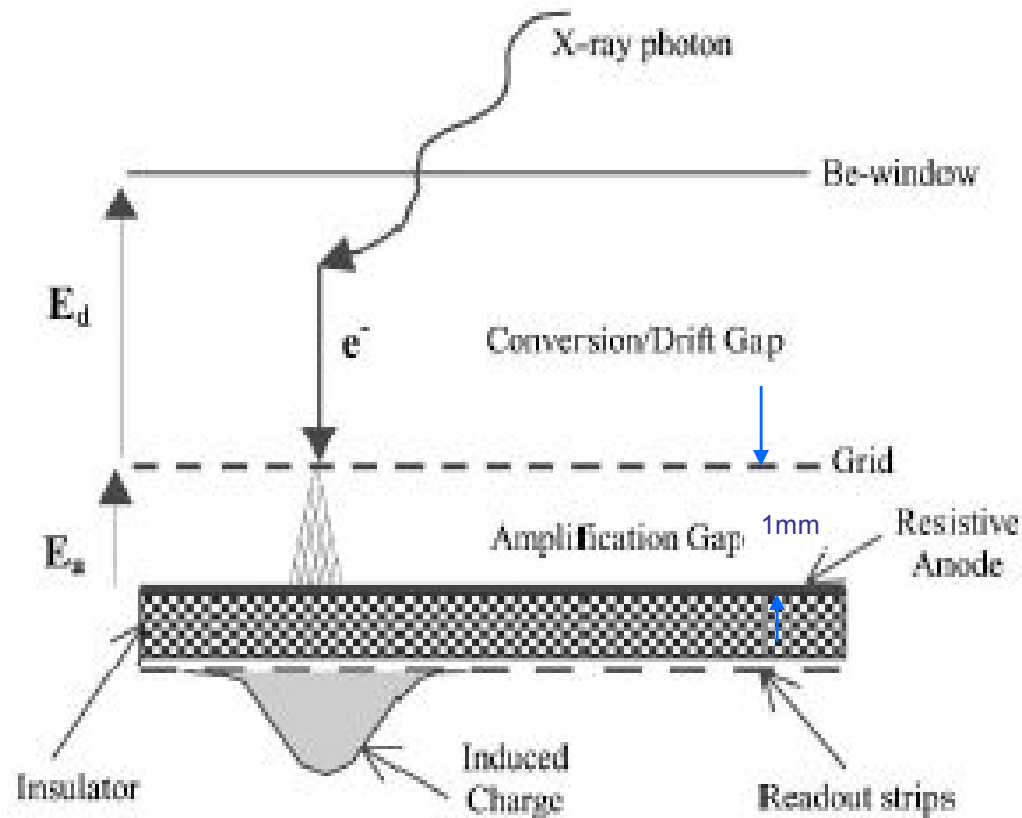
Fig. 1. Schematic of the parallel-plate resistive-anode chamber with the readout electrode separated from the anode. Details are not in scale.

D. Khazins et al., IEEE Nucl. Sci 51,2004,943

Discussion2

- Paul informed us about the plans to develop and test MICROMEGAS with protective resistive layers

- Fred share with us the experience of his group in the spark protection

Final remarks

- How do you see the future of the WG2?

- How should we organize ourself?

- Passive "coordination" or more?

- How often the WG2 meetings should be?

- Should we try to organize exchange of visitors to attack the problem or to accomplish task (for example I often work in Israel, somebody can come and wok with me …or also go to Israel.. or in Leszek group and so on)?

Lack of communications between current conveners themselves and between them and RD51was admitted

So we should improve this!

However, in general the work of activities in WG2 was evaluates as <u>successful</u> so far

Achievements:

1. Discharges studies (mainly educational activity- reports at WG2 of P.Fonte and myself, our RD51 Internal report is in progress)

2. Experimental discharges studies and protection measures (resistive anodes) for pixelized detectors, for example MICROMEGAS (NIKHEF, Sacley)

3 Aging studies (an internal report exist)

4. RETGEM studies (ALICE RICH group), TGEM optimization activity for RICH applications (ALICE CERN group, Leszek group, COMPASS group, Breskin group): stability, energy resolutions, high rate operation

5. Gas optimization activity for TGEMs and RETGEMs applications in RICH (Breskin group and ALICE CERN group)

6. MHCP studies, application for photodetectors+ basic studies: photoelectlron extraction , back scattering effect, ion back flow suppression (Portuguese group and Brskin group)

7.Studyies of avalanche statistics: energy resolution and cetera of various MPGDs , light emission, transition of exponential distribution to Polia (Sacley, Breskin group, Portuguese group)

8. Study of operation of TGEMs and RETGEMs at cryogenic temperatures (CERN ALICE RICH and ICARUS group, Novosibirsk group, Nantes)

9. Simulations (Veenhof+ charging up effects :Silvia and Ropelewki group)

So, as it should be, with difficulties, but we are moving forward!