WG2 session summary

M. Chefdeville

RD51 collaboration meeting

13-15 April 2011, CERN

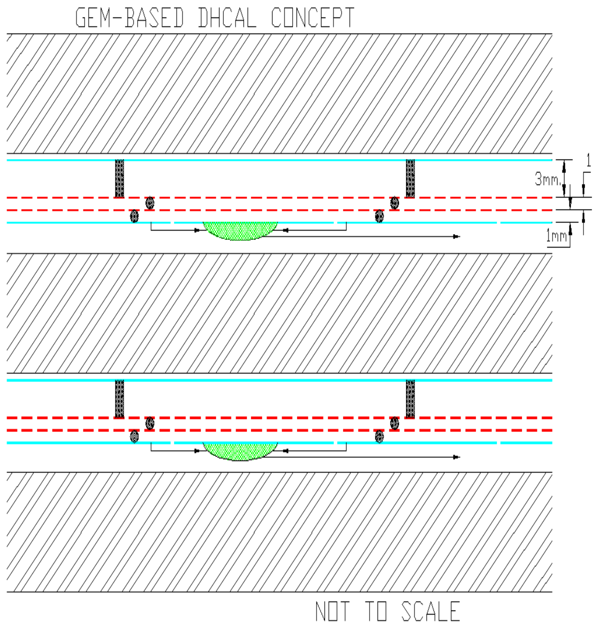
Some variety in topics

09:00	Overview of NIKHEF activities	BE Auditorium Meyrin, CERN	HARTJES, Frederik	09:00 - 09:20
	Status of GEM DHCAL	BE Auditorium Meyrin, CERN	WHITE, Andy	09:20 - 09:40
	Low X-ray background measurements at the Canfranc Underground Laboratory	BE Auditorium Meyrin, CERN	GALAN, Javier	09:40 - 10:00
10:00	Status of the construction of the 250L double phase LEM-TPC	BE Auditorium Meyrin, CERN	RESNATI, Filippo	10:00 - 10:20
	Cofee break	BE Auditorium Meyrin, CERN		10:20 - 10:40
	THCOBRA for Ion Back Flow Reduction in THGEM based photosensors	BE Auditorium Meyrin, CERN	PEREIRA, Fábio	10:40 - 11:00
11:00	Electroluminescence yields in MicroMegas, THGEM and GEM	BE Auditorium Meyrin, CERN	NATAL DA LUZ, Hugo	11:00 - 11:20
	Characterization of the electrical response of Micromegas detectors to spark processes		GALAN, Javier	
	Performance of a resistive Micromegas in a neutron beam	BE Auditorium Meyrin, CERN	TSIPOLITIS, Yorgos	11:40 - 12:00
12:00				

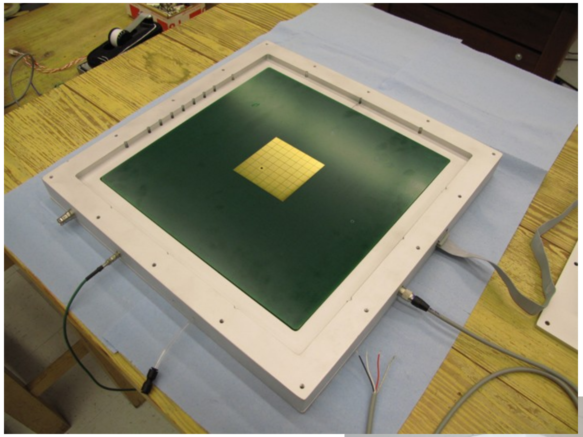
- Status report (GridPix, GEM DHCAL)
- Rare event detectors (CAST, ArDM, EL)
- Single electron detectors (IBF)
- Discharges in Micromegas (modeling, TB)

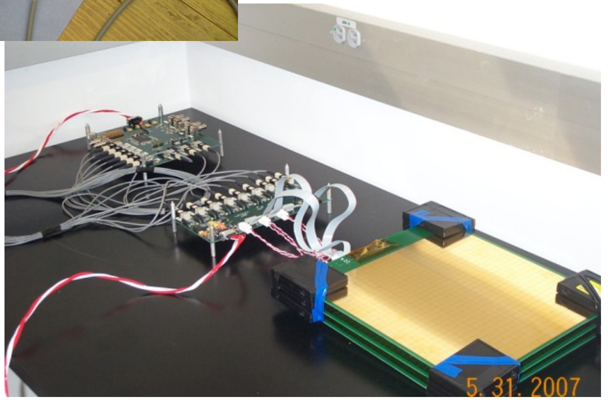
Status of GEM DHCAL, *A. White*

- Calorimetry at future linear colliders
  - High lateral and longitudinal segmentation
  - Thin chambers (1 cm) with small pads (1 cm^2)
- Physics prototype of 1 m^3 composed of 1 m^2 chambers



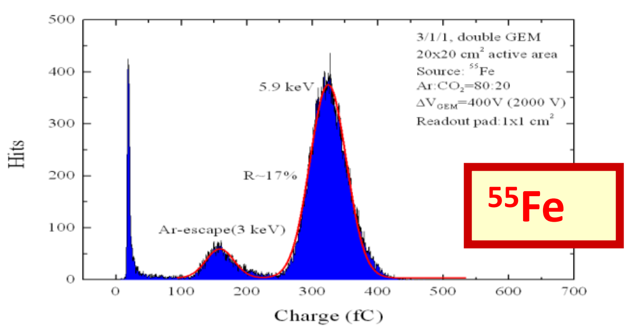
- Report on use of 2 ASICs to read out small chambers:
  - KPiX, analogue information
  - DCAL, purely digital
- Trials with THGEM in beam

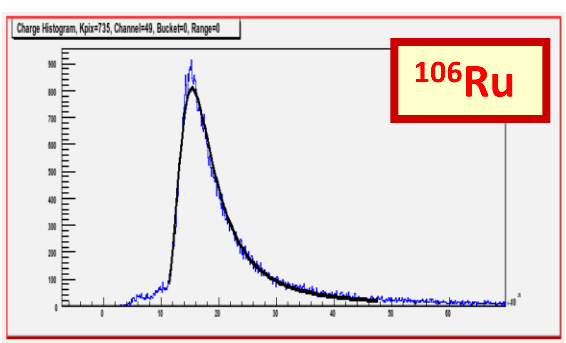


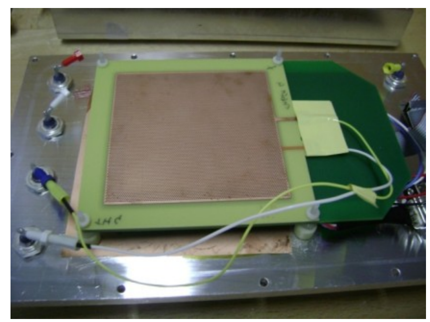


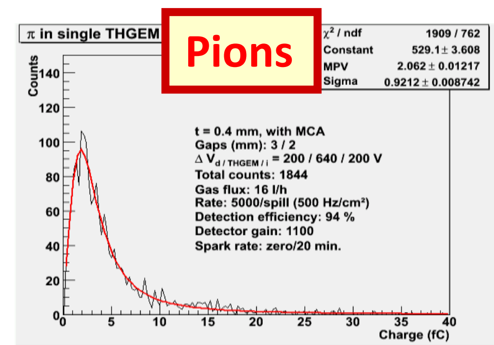
Status of GEM DHCAL, *A. White*

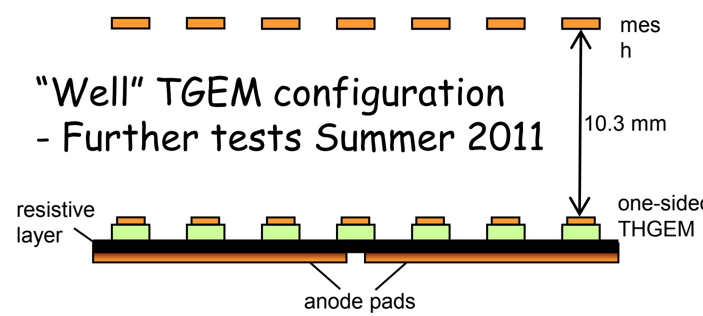
- Double GEM characterisation and KPiX readout (8x8 pads) with sources and cosmics
  - Gas gain, resolution
  - Pressure effects
  - Noisy channels
- Beam test in SPS/H4 2010 of THGEM + KPiX
  - Stability issue
    -> alternative readout
- TB with resistive layer in 2011







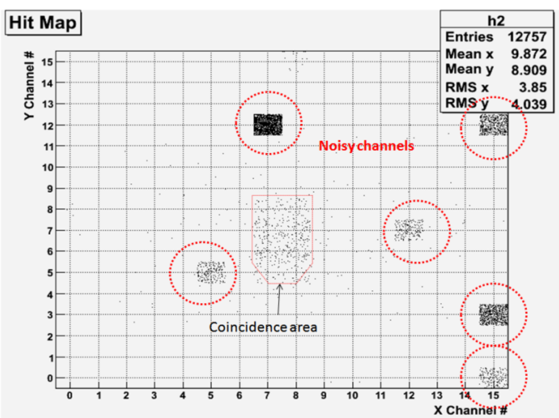


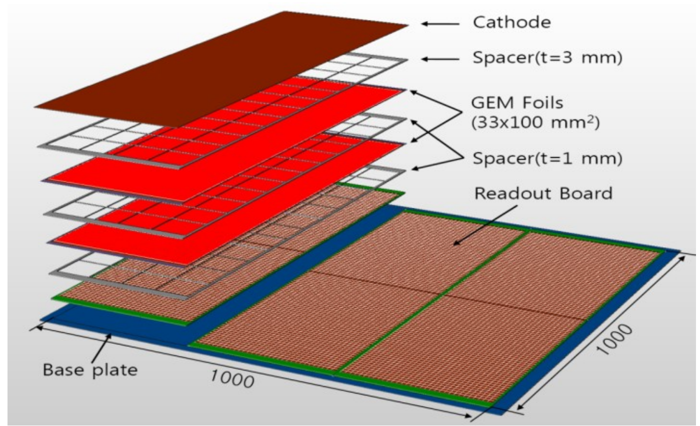


"Well" TGEM configuration
- Further tests Summer 2011

Status of GEM DHCAL, *A. White*

- First test with DCAL chip
  - All channels alive
    few noisy ones
  - Used for US RPC/DHCAL
  - Detection of ^{55}Fe
    and cosmics signals!
- Towards larger area
  - 5 foils of 33x100 cm^2 from
    CERN workshop qualified
  - Characterisation with KPiX and
    DCAL of 2 chambers
  - 2013-2015: build and test
    inside CALICE stack a 1 m^2
    prototype

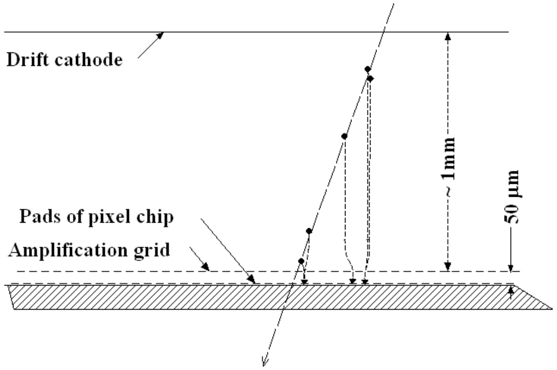


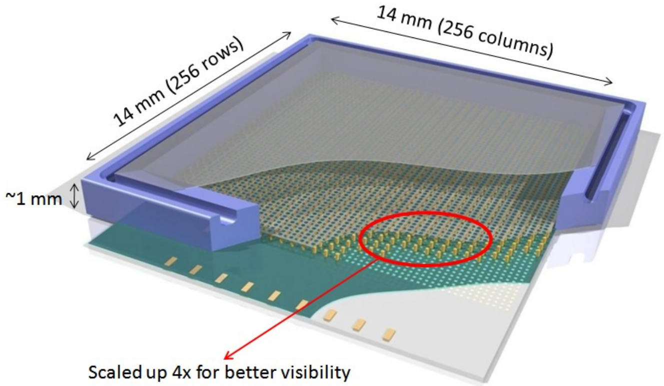


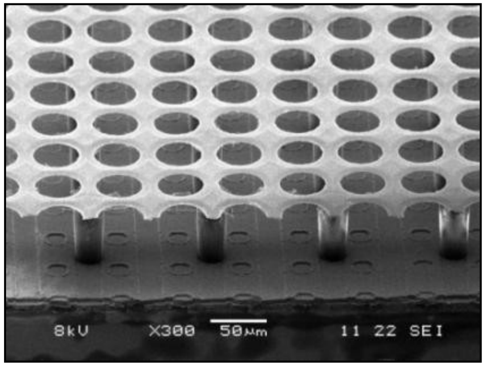
Overview of NIKHEF activities, *F. Hartjes*

- Cross-talk events
- TB data analysis
- DARWIN project

- GOSSIP (GridPix)
  - TimePix chip
  - Integrated Micromegas
  - Silicon protection layer

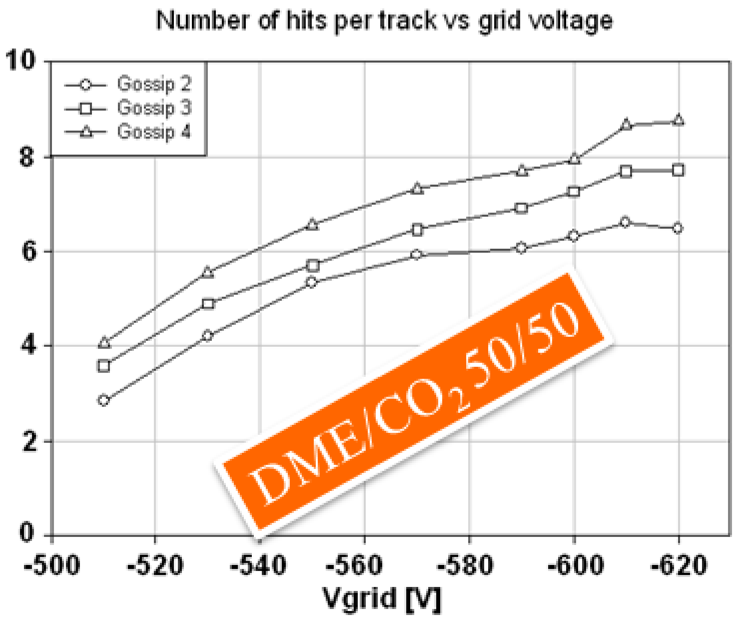




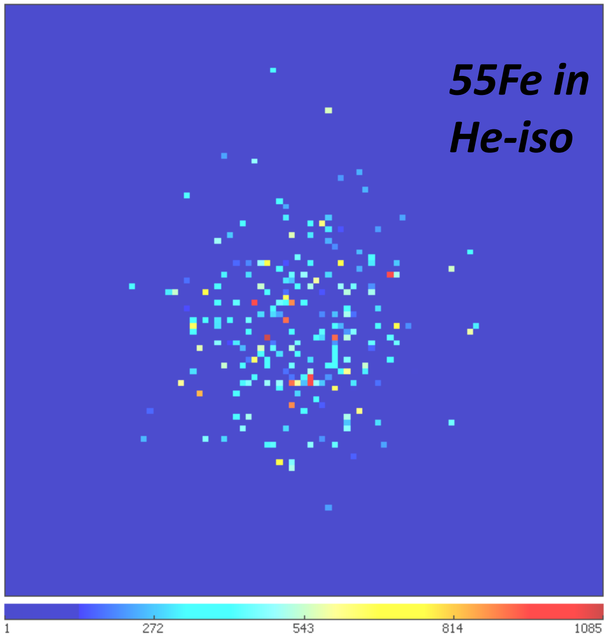


Overview of NIKHEF activities, *F. Hartjes*

- Absence of plateau in TB data
  - Si_3N_4 protection layer
  - Signal can spread to neighboring pixels
  - More pronounced at high gas gains
- Should also show up in other counting experiments
  - Study with ^{55}Fe conversions in 8 cm drift gap chamber
  - Investigation in He/isobutane (max gas gain of 63k)

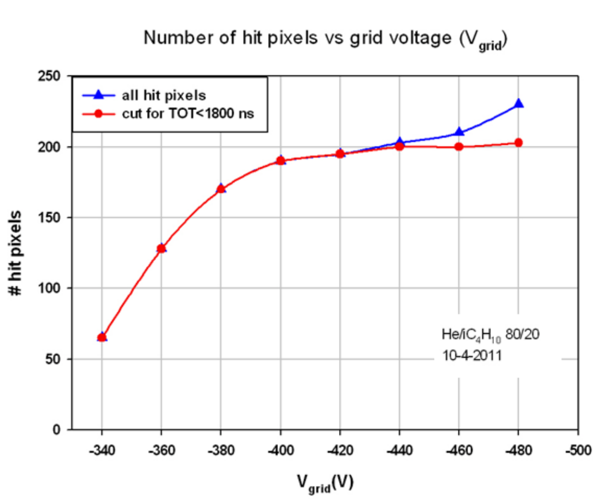


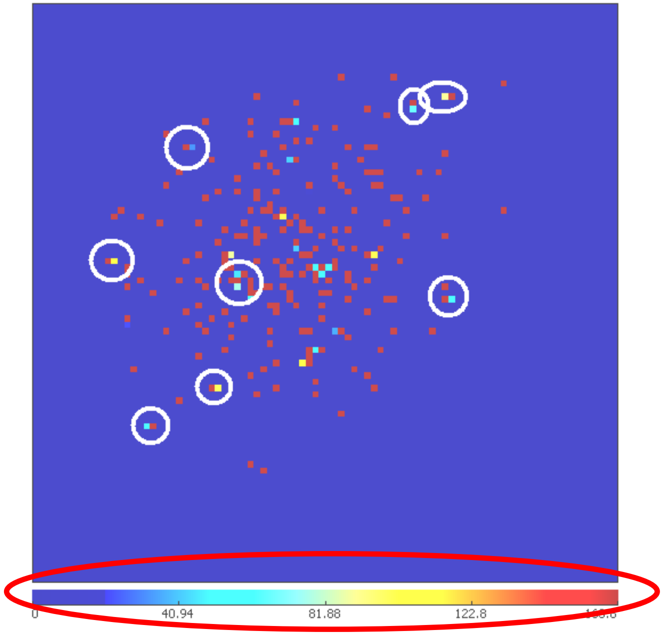
TB data



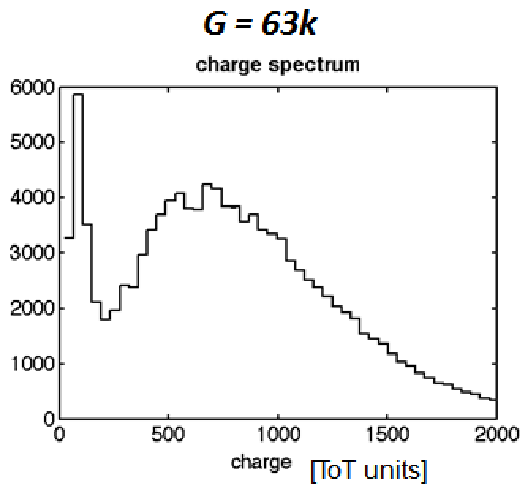
Overview of NIKHEF activities, *F. Hartjes*

- Number of hits from quanta conversion
  - Hits due to resistive layer cleary identified with TOT mode
    Small number of counts and none is isolated
  - Recover plateau after correction!



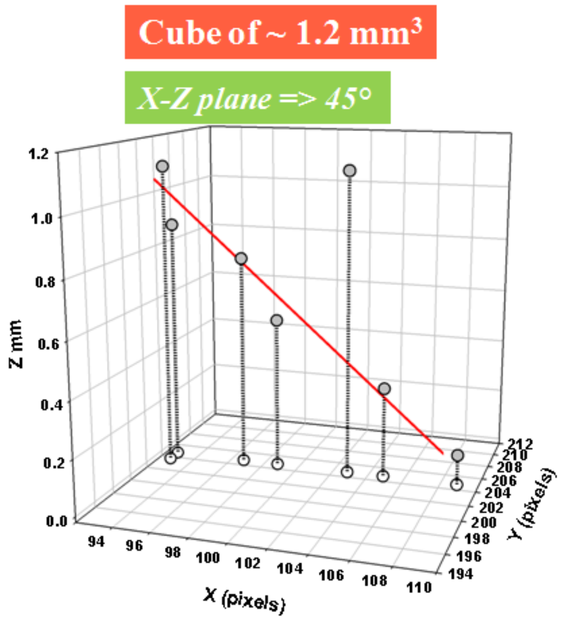


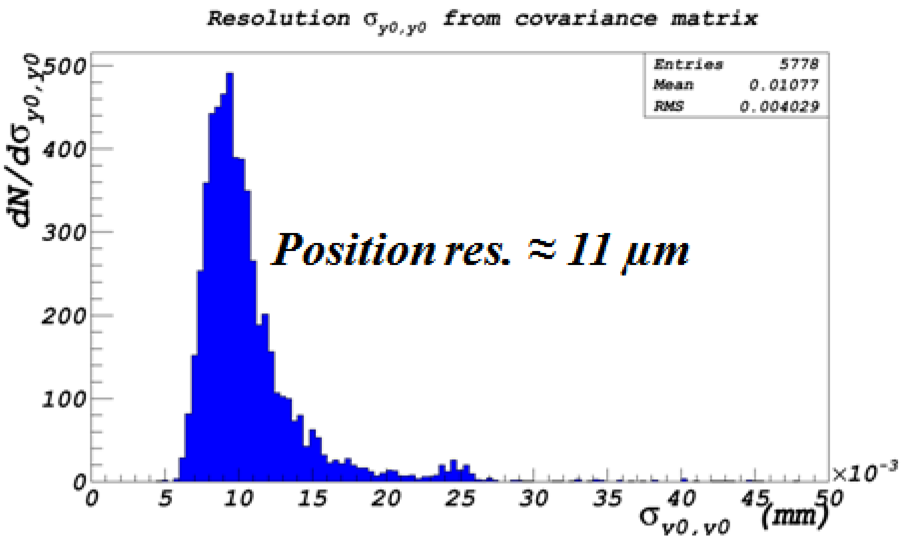
Zoom in small charge range



Overview of NIKHEF activities, *F. Hartjes*

- 2010 TB data analysis
  - Local track fitting
  - Weigth individual electrons as a function of position in drift gap
  - Consider errors on position and time (diffusion, clock, pixel pitch)
- Fit in XZ plane: position and angular resolution of 60 um & 0.26 rad
- Fit in XY plane: position and angular resolution of 11 um & 0.06 rad

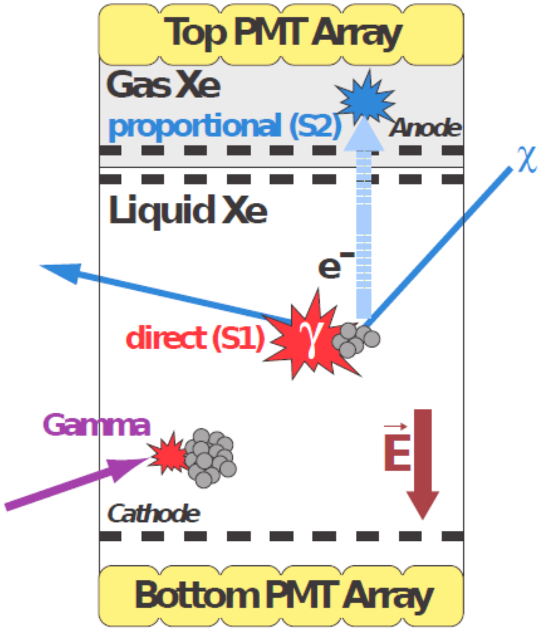


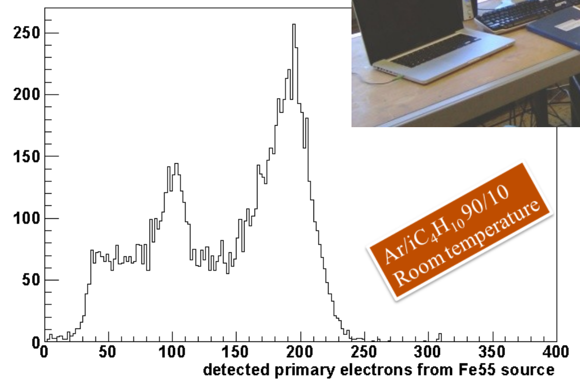


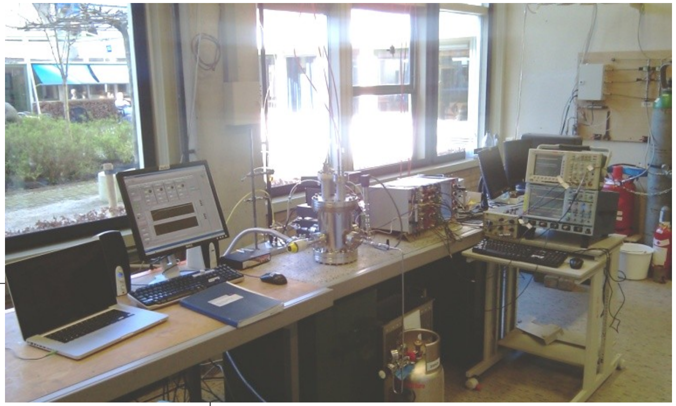
Overview of NIKHEF activities, *F. Hartjes*

- WIMP detection in liquid gases
  - XENON
    100 kg now, upgrade to 1T
  - DARWIN project (Ar, Xe)

- Application of GridPix for DARWIN
  - Thermal stress
  - Operation of TimePix at low temperature
  - Gas gain in pure gas



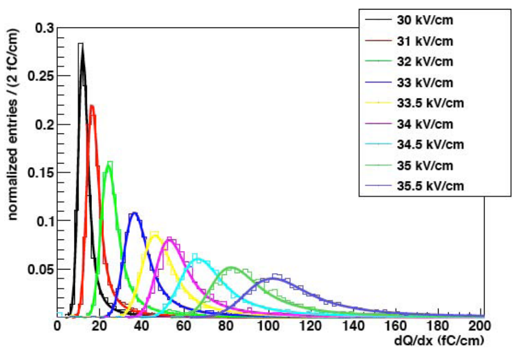


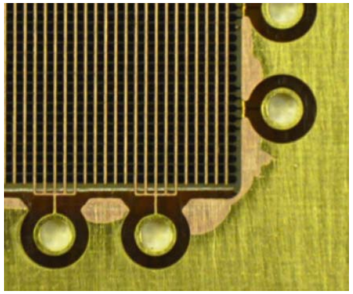


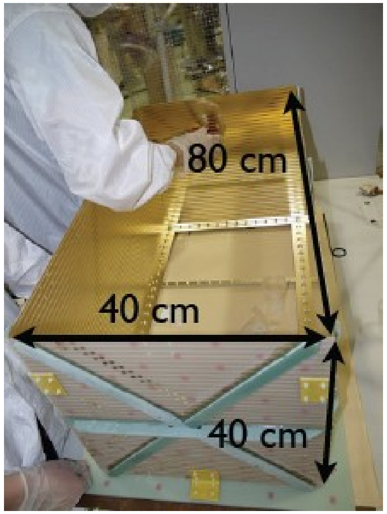
Status and upgrade of the 250L LAr LEM-TPC, *F. Resnati*

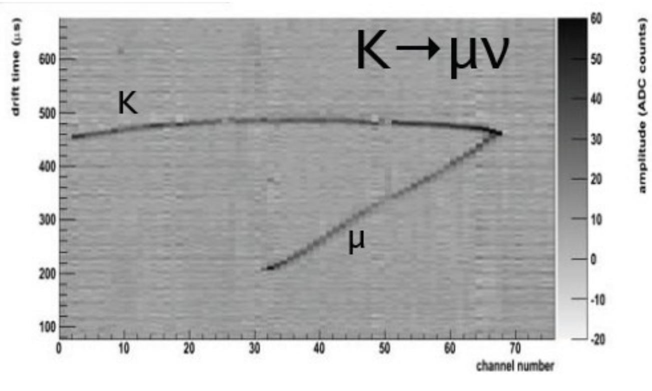
- Proton decay search
  - T32 experiment at J-Parc hadron facility with a 250 l liquid Ar TPC
  - Benchmark performance (pion/kaon separation…)
  - Proposed double phase operation to increase signal to noise ratio (currently 20) and provide 2D readout

- 3L double phase LEM TPC
  - 10x10 cm^2, 2D strip readout
  - Fully caracterised at CERN
  - S/N > 200





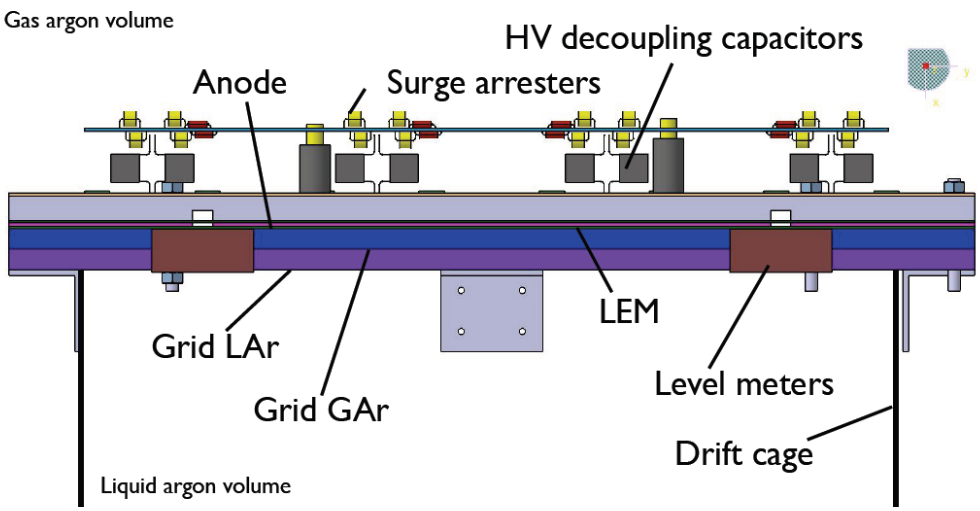




Status and upgrade of the 250L LAr LEM-TPC, *F. Resnati*

- Upgrade of the 250 l TPC with so-called readout “sandwich”
  - Extraction grid
  - LEM
  - Signal plane

- Signal plane
  - 76x40 cm^2
  - 256x256 strips of 55 cm
  - S/N > 200
- LEM
  - 76x40 cm^2
  - 8 HV segments

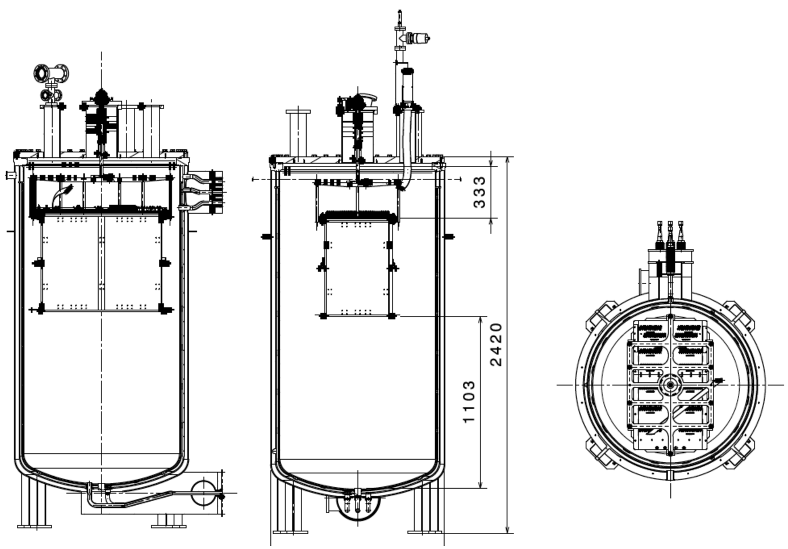


Complete readout unit

LEM of 76x40 cm2 (CERN workshop)

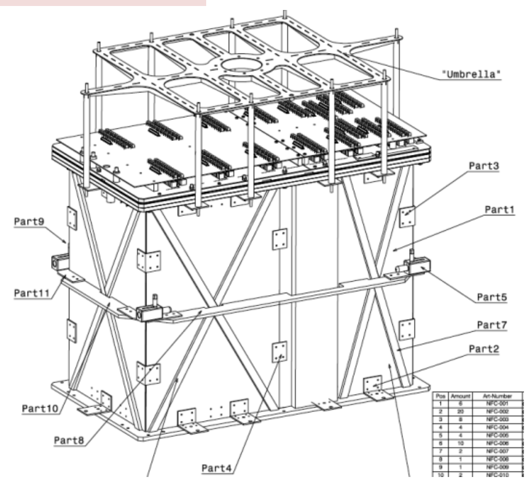
Status and upgrade of the 250L LAr LEM-TPC, *F. Resnati*

- Test of the readout “sandwich”
  - Preliminary test are on-going
  - Cosmic test inside ArDM vessel at CERN before summer
  - Send to Japan



ArDM vessel

Drift cage

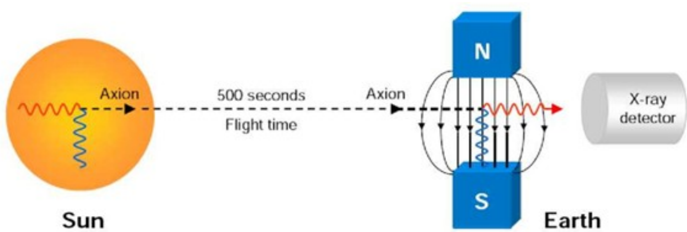


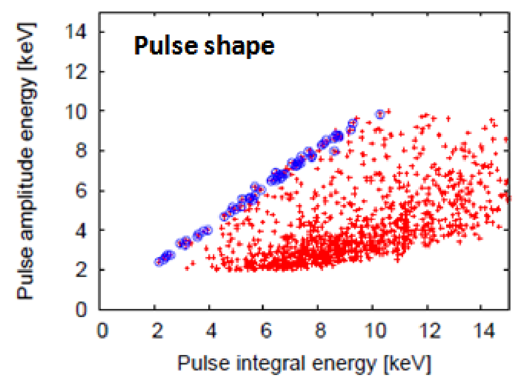
1t liquid Ar detector presently assembled at CERN

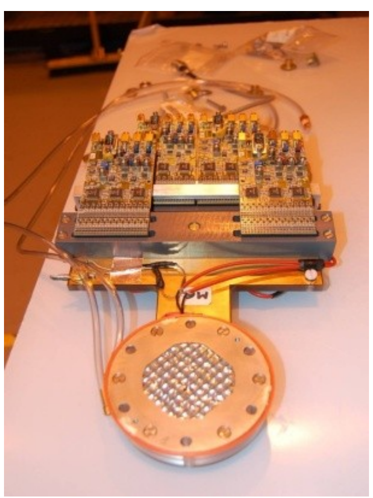
Low X-ray background measurements at the Underground Canfranc Laboratory, *J. Galan*

- CAST experiment
  - Solar axions (DM candidates)
  - Would (re)convert into X-ray inside an intense B field
  - Expected signal in the 1-10 keV region
  - Sensitivity depends on background

- Detector
  - MicroBulk
  - 106x106 strips (6x6 cm^2) + mesh signal
  - Argon/isobutane 98/2
- X-ray event selection
  - Temporal & spatial info.
  - Energy balance mesh/strips
  - Pulse shape…







Low X-ray background measurements at the Underground Canfranc Laboratory, *J. Galan*

- Measured background
  - From 2008 to 2010, rate below 10^{-5} /keV/cm^2/s
  - 2.25 counts/hour
  - Try to reach even lower limit
  - Further test under lab-controlled conditions

New acquisition software completely based in C++, ROOT, python and GNUPLOT.

Gas, Ar + 2% iso, flowing in open loop with flow and pressure controlled

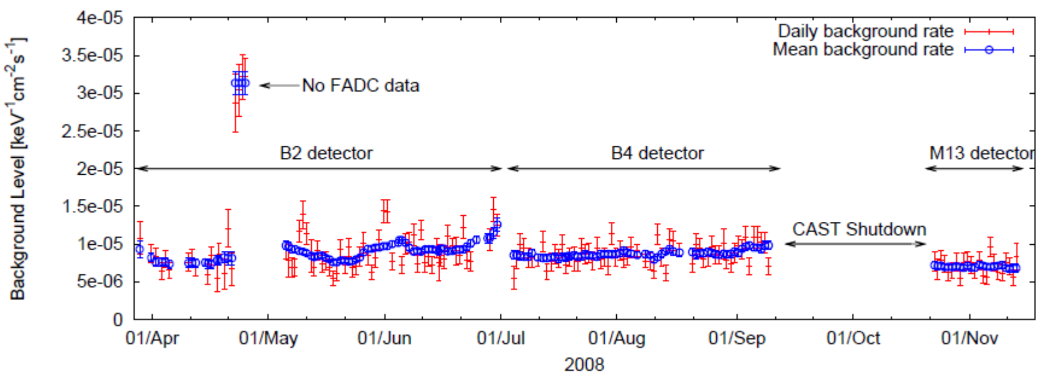
Shielding reproduces sunrise configuration.

Faraday box prepared for automatic calibrations with ^{55}Fe source.

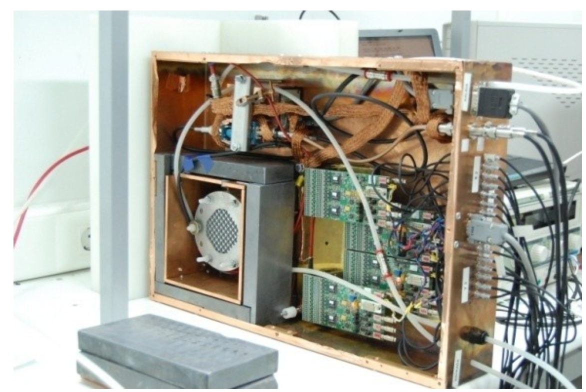
Slow control: temperature and pressure and detector currents

Some modifications in electronics. Fundamental modules are the same.

Nitrogen flux = 30 - 50 l/h (for vol < 17 l)
Capacity for more than 2 weeks.



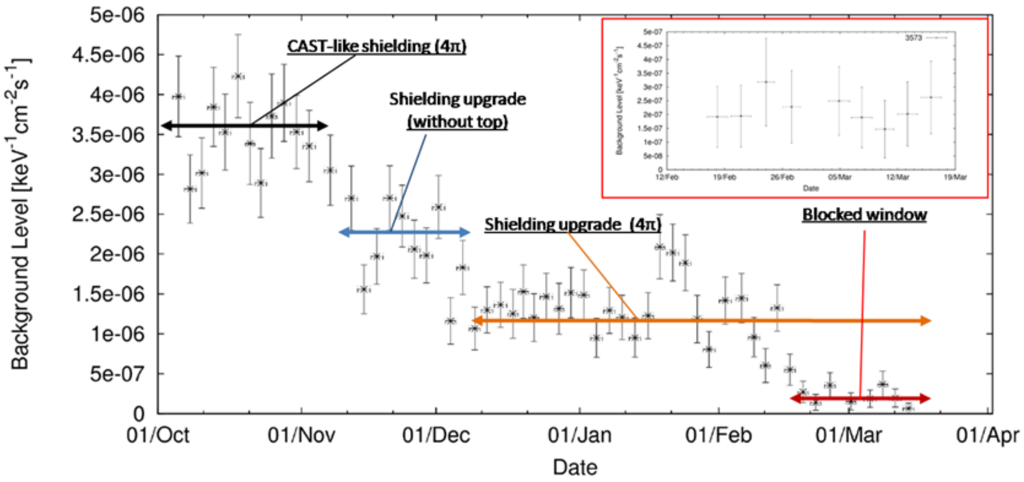
- Set-up in Zaragoza



Low X-ray background measurements at the Underground Canfranc Laboratory, *J. Galan*

- Set-up in Canfranc (LSC)
  - 10^4 reduction of cosmic flux
  - Hard equipping, installing and cleaning work! (4 tons of Pb bricks)

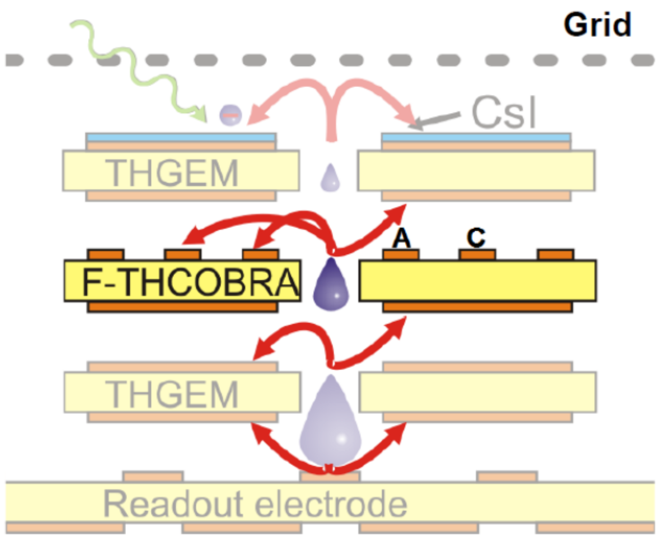
- Improvement by a factor > 20
  - 2.10^{-7} /keV/cm2/s
  - 1 count/day
  - Limited only by detector material radioactivity

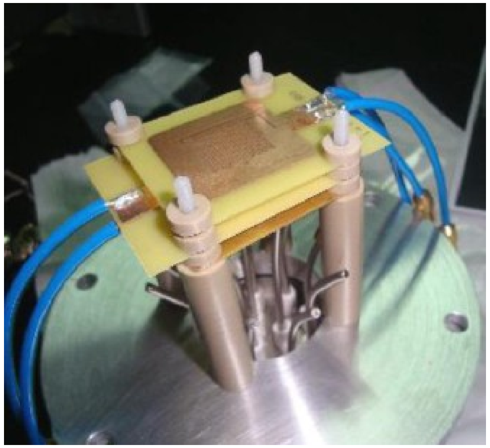


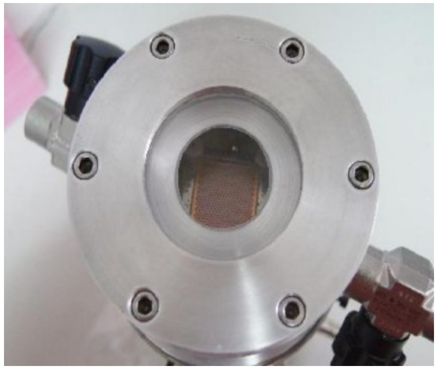
- Starting GEANT4 simulations
  - Background nature
  - Optimise future shielding

THCOBRA for ion backflow reduction in THGEM based photosensors, *F. Pereira*

- Detection of single photons in the UV or visible range
  - High gas gain
  - Large number of ions
  - Feedback pulses
  - E field distortion
  - Photocathode aging
- THCOBRA
  - One THGEM with strips
  - Tuning of V_{AC} -> trap ions
- Study ion back flow and detection efficiency in Ne/CH_4 95/5 for various V_{AC} settings



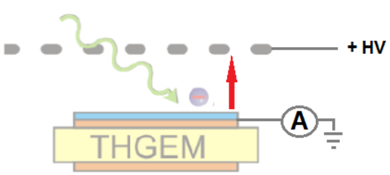


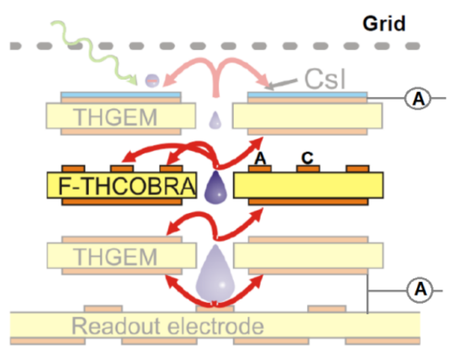


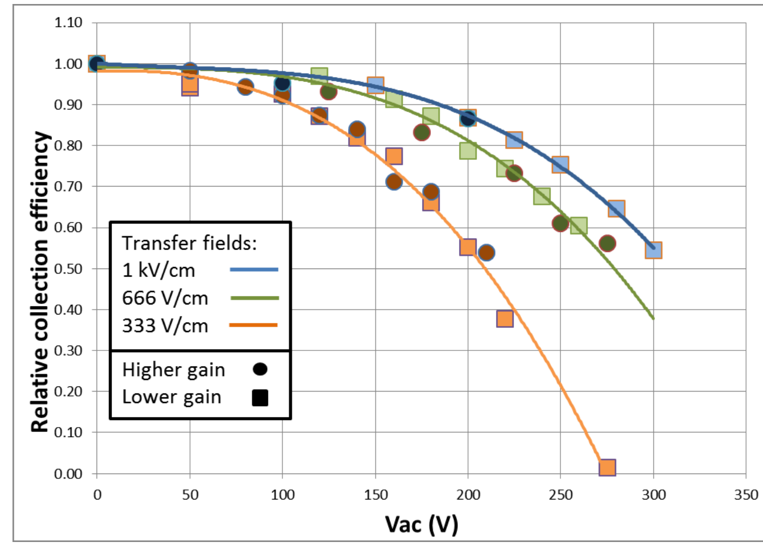
THCOBRA for ion backflow reduction in THGEM based photosensors, *F. Pereira*

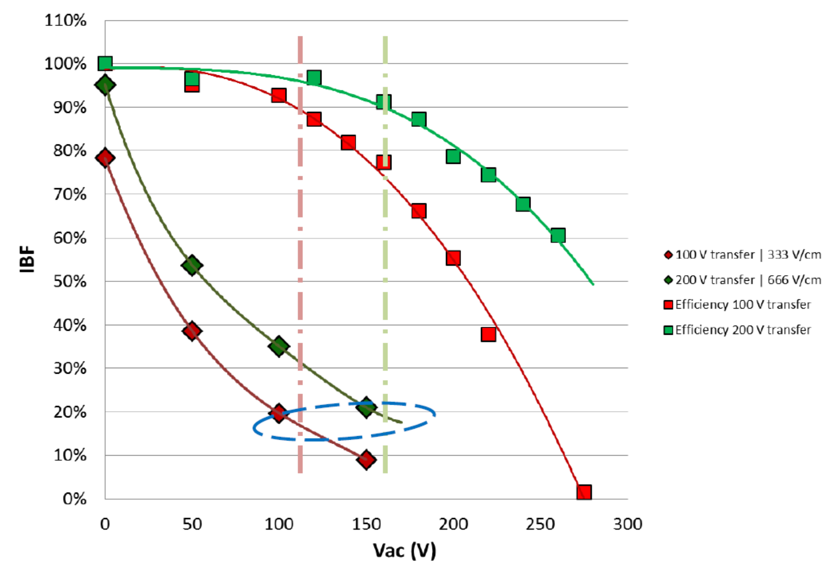
- Detection efficiency (pulse mode)
  - Keep gas gain constant
  - Measure single photon spectrum
  - Number of entry yields efficiency

- Ion backflow fraction (current mode)
  - Measure photo-current with simple //-plate geometry
  - Measure THCOBRA top and bottom currents





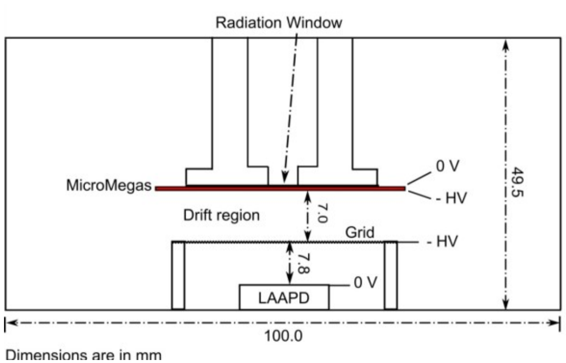




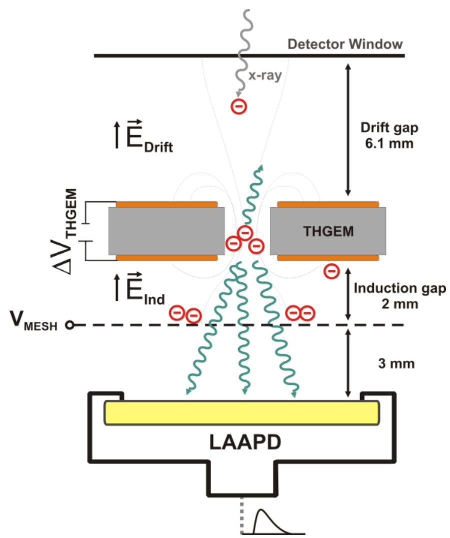
Electroluminescence yields in Micromegas, THGEM & GEM, *H. Natal da Luz*

- Light signal
  - Decoupled to electronic noise
  - Better signal to noise ratio compared to charge readout
  - Application for rare events search

- Comparison of charge VS light in different MPGD
  -> 2 setups

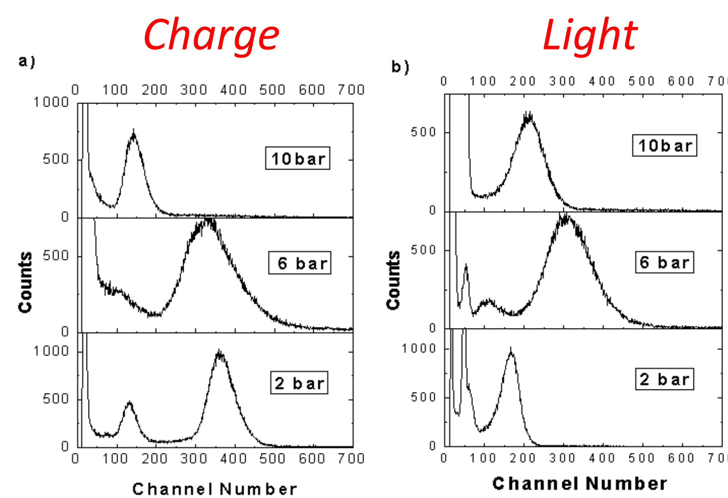


Gap: 50 um
Hole diameter: 25 um



Thickness: 0.4 mm
Hole diameter: 0.4 mm
Rim: 0.1 mm

- Spectrum of 22.1 keV X-rays in Xe



$$N_{e,XR} = \frac{22100\,\text{eV}}{3.62\,\text{eV}} = 6.1\times 10^3$$

$$N_{UV} = \frac{A_{Sc}}{A_X} \times \frac{N_{e,XR}}{QE}$$

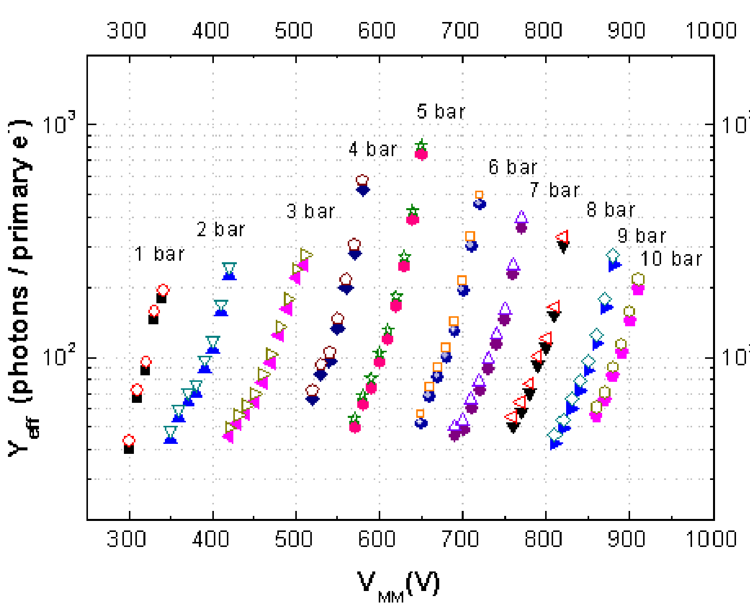
$$Y_{eff} = N_{UV} \times \frac{2\pi}{\Omega_{Sc}} \times \left(\frac{E_x}{w\,E_x}\right)^{-1}$$

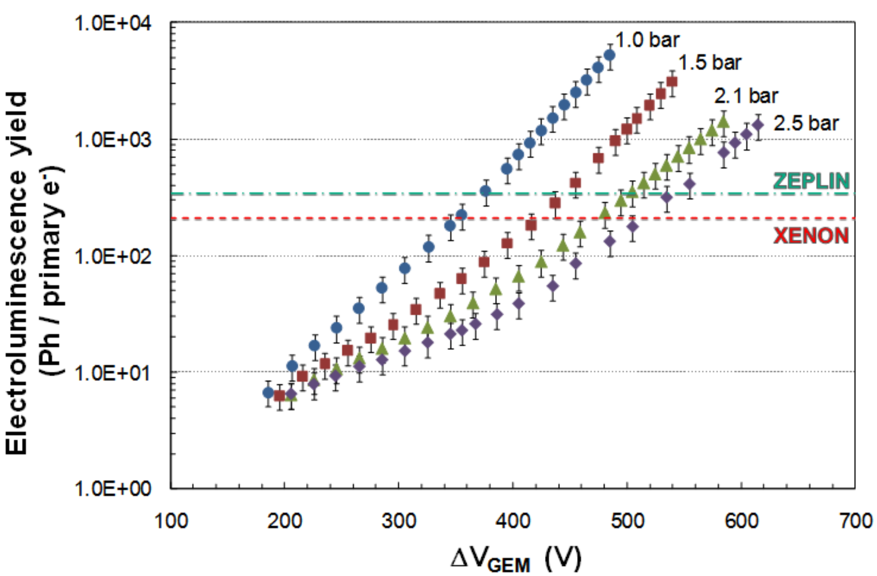
$$N_{UV,e} = QE^{-1} \times \frac{G_{tot}}{G_{APD}}$$

$$Y_{eff} = N_{UV} \times \frac{2\pi}{\Omega_{Sc}}$$

Electroluminescence yields in Micromegas, THGEM & GEM, *H. Natal da Luz*

- Micromegas
  - Q Gain in xenon VS E/P at various P
  - Q Resolution in xenon
  - Sc Gain
  - Scintillation yield
  - Ratio Q/Sc gains
- THGEM, GEM
  - Same study
  - Additional measurements in Ar





Electroluminescence yields in Micromegas, THGEM & GEM, *H. Natal da Luz*

- Summary

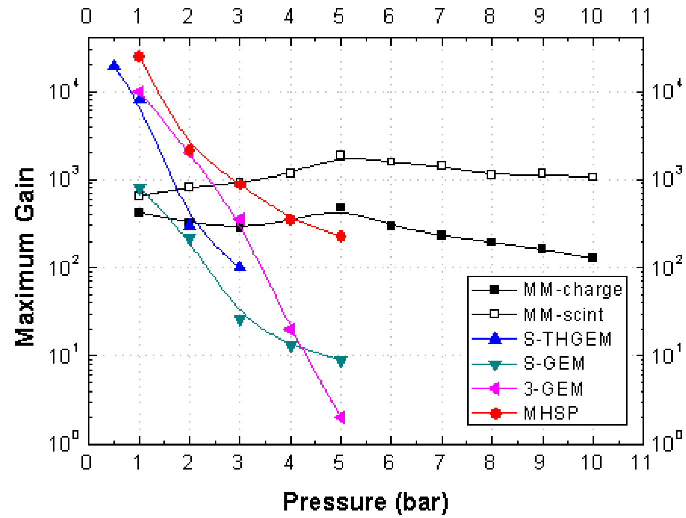
Table I – Maximum gain and scintillation yield for GEMs and THGEMs operating in argon and xenon at 1 bar and 2.5 bar.

		Xenon		Argon	
		1 bar	2.5 bar	1 bar	2.5 bar
GEM	Gain	1.5×10^5	4×10^4	5×10^3	5×10^3
	Yield	6×10^3	1.5×10^3	3×10^2	3×10^2
THGEM	Gain	1.2×10^6	4×10^4	1.2×10^5	3×10^4
	Yield	7×10^4	2×10^3	1.5×10^4	4×10^3

Double mesh, uniform field scintillation gap yields

466 photons/e^-/cm @ 4.1 kV/cm/bar

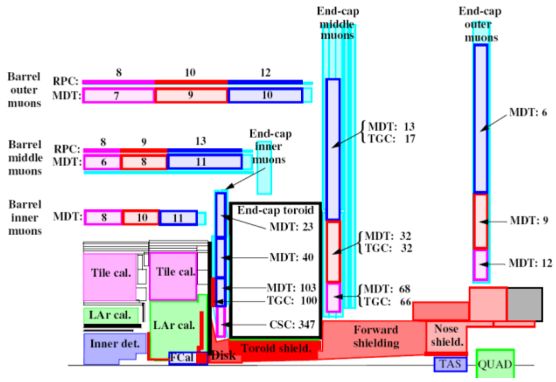
- Maximum Q gain VS P
  - Interesting difference in maximum gain behaviour with pressure

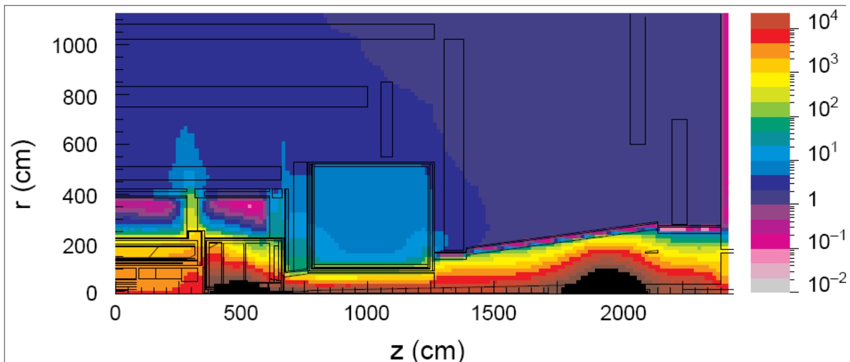


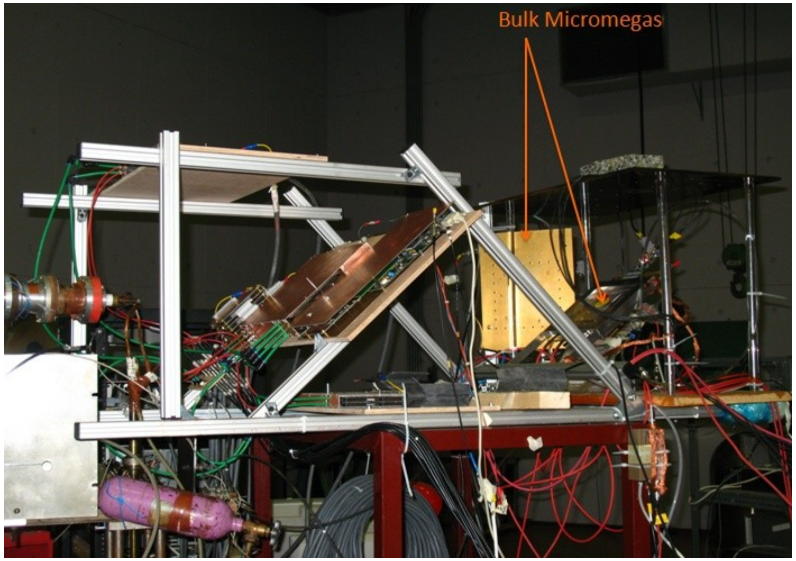
Performance of resistive Micromegas in a neutron beam, *Y. Tsipolitis*

- Context
  - Spark-proof chamber for Super-ATLAS (MAMMA)
  - High neutron flux expected close to the beam pipe
  - Rate up to 10^4 kHz/cm^2
  - Energy up to 10 MeV roughly

- Tandem at Demokritos
  - 3 neutron energy ranges
  - Between 0.1 and 26 MeV
  - Fluxes up to 5.10^6 /cm^2/s

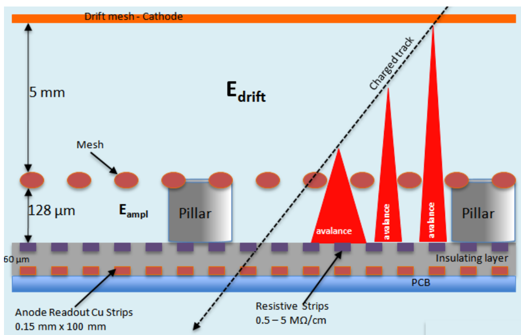


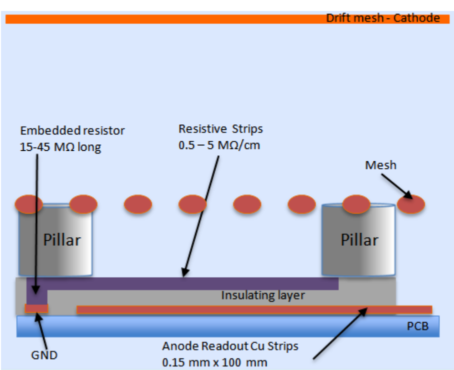




Performance of resistive Micromegas in a neutron beam, *Y. Tsipolitis*

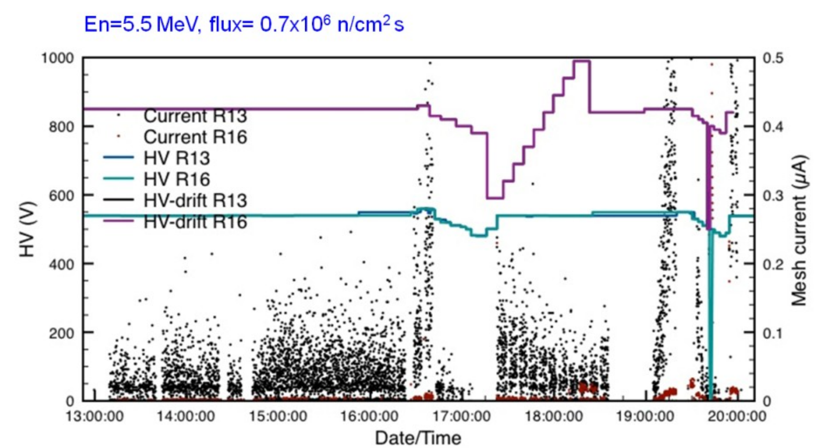
- Detector under test
  - Resistive Bulk (Ar/CO2)
  - Different resistance to ground and along strips





CHAMBER	R11	R12	R13	R16
Resistance to Ground (MΩ)	15	45	20	55
Resistance along strip (MΩ/cm)	2	5	0.5	35

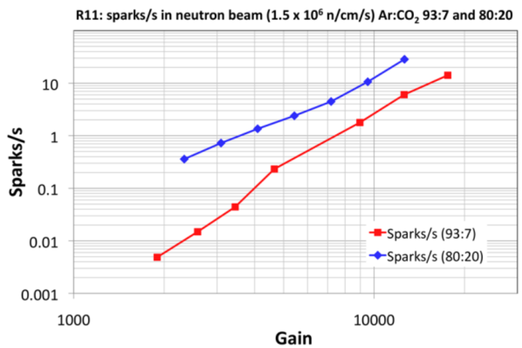
- Results
  - Basically no voltage drop
  - Spark current depends on chamber
  - Best lies below 100 nA
  - Compatible with first test in same beam (2010) of R11 chamber

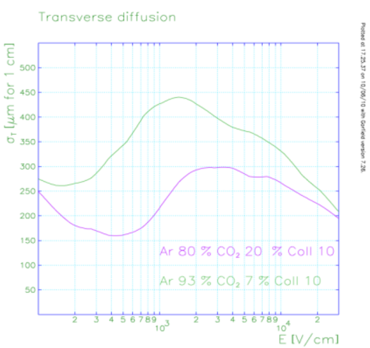


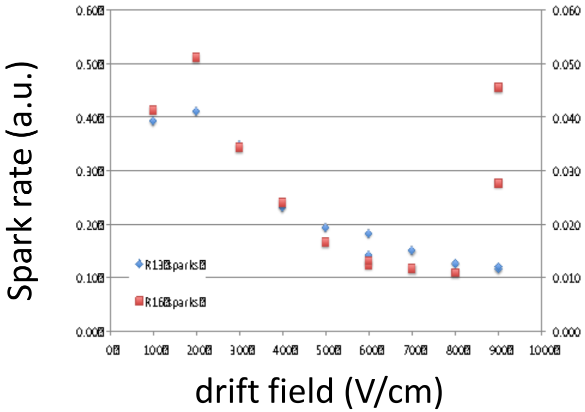
Performance of resistive Micromegas in a neutron beam, *Y. Tsipolitis*

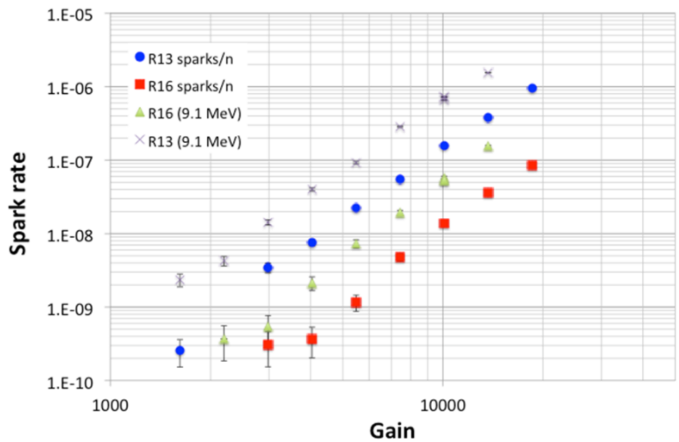
- Drift field scan
  - 4 x higher spark rate in Ar/CO2 80/20 than in 93/7
  - Spark rate trend follows that of transverse diffusion!

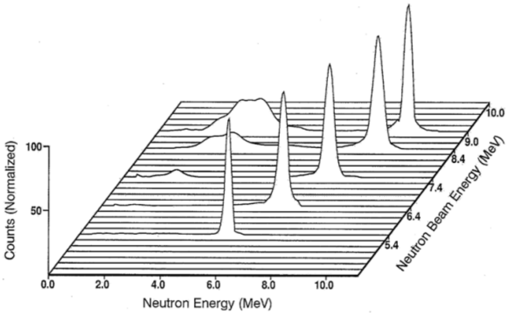
- Neutron energy
  - Higher rate at higher energy
  - Understood as parasitic neutrons from D(D,np)D reactions above 4.45 MeV





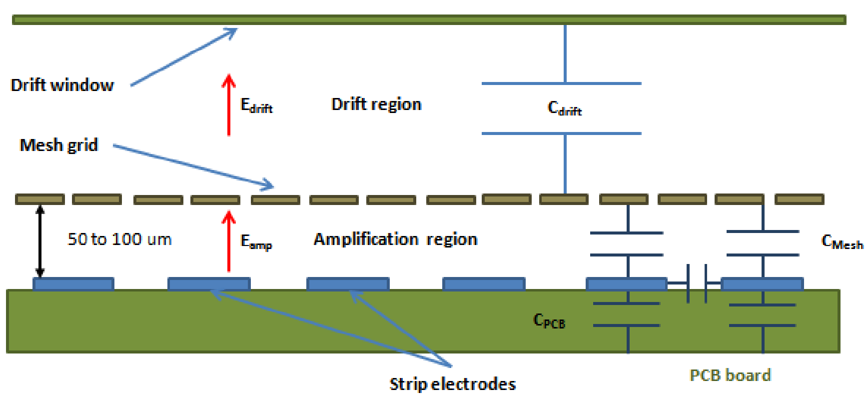




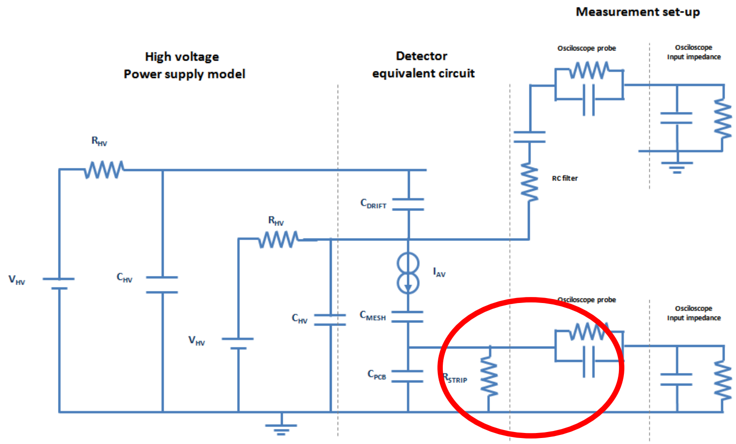


Characterisation of the electrical response of Micromegas detectors to spark processes, *J. Galan*

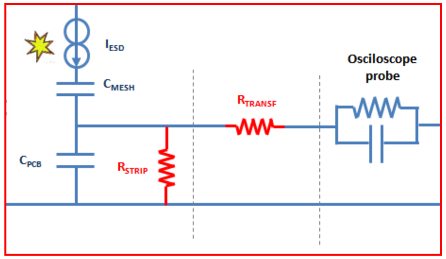
- Aim
  - Establish a methodology and electrical modeling of sparking phenomena
  - Understand electronic response of different RO systems
- Standard Bulk Micromegas
  - Measure spark signals
  - Adjust model parameters on measured signals



- Full detector equivalent circuit

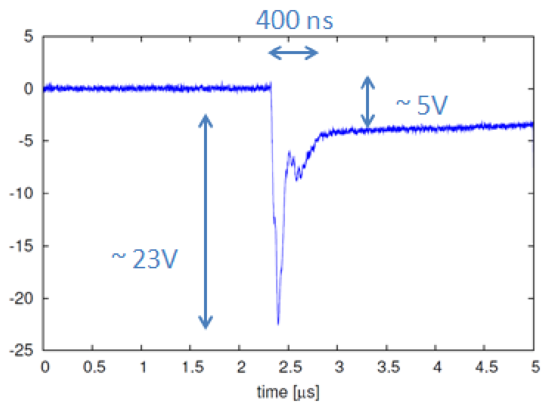


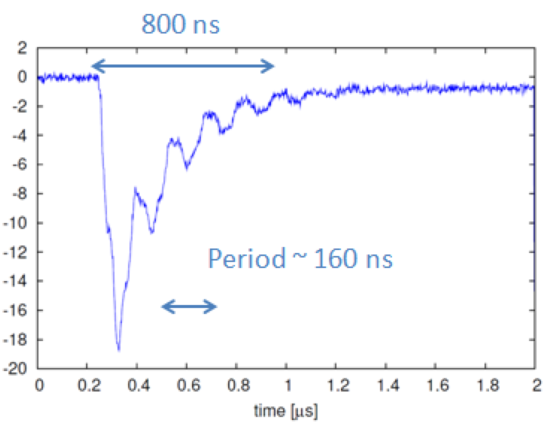
- Study just started
  - Measure pulse shape with different connection schemes



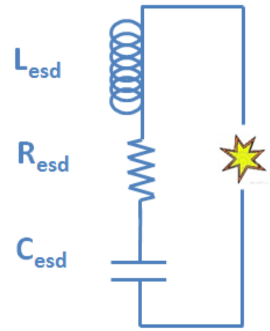
Characterisation of the electrical response of Micromegas detectors to spark processes, *J. Galan*

- Signals measured on scope
  - Raise HV beyond sparking voltage





- Model of the spark
  - ElectroStatic Discharge (ESD)



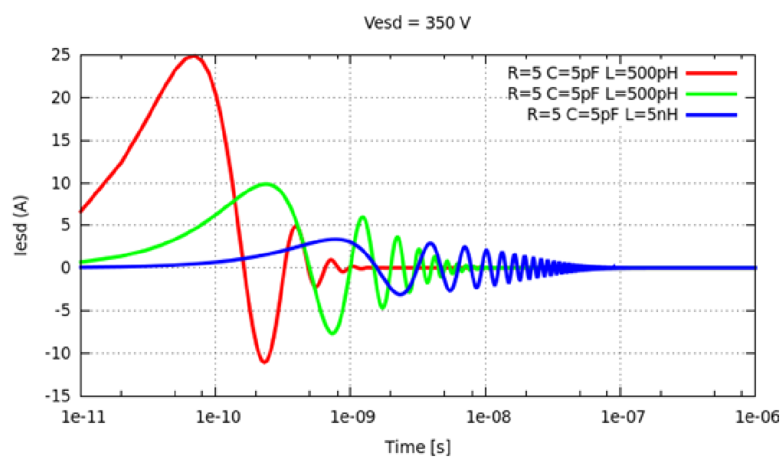
Capacitor is charged initially at a given voltage V_{esd}

$$L_{esd}\frac{d^2i}{dt^2} + R_{esd}\frac{di}{dt} + \frac{1}{C_{esd}}i = 0$$

Total ESD charge

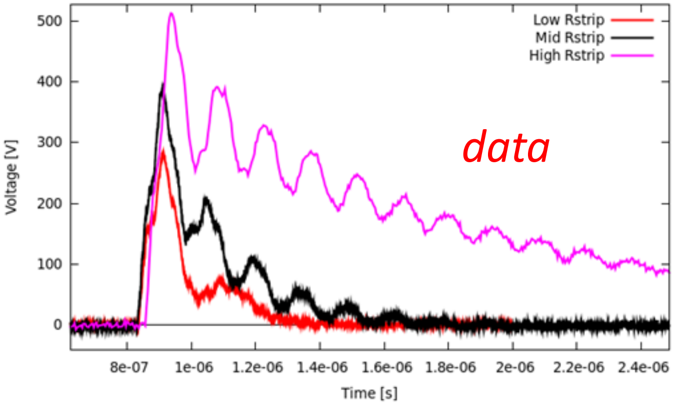
$$I_{esd}(t) = V_{esd}C_{esd}\frac{\omega_o^2}{\alpha^2 - \omega_o^2}e^{-\alpha t}\sinh\left(\sqrt{\alpha^2 - \omega_o^2}\,t\right) \quad \text{for } \alpha > \omega_o$$

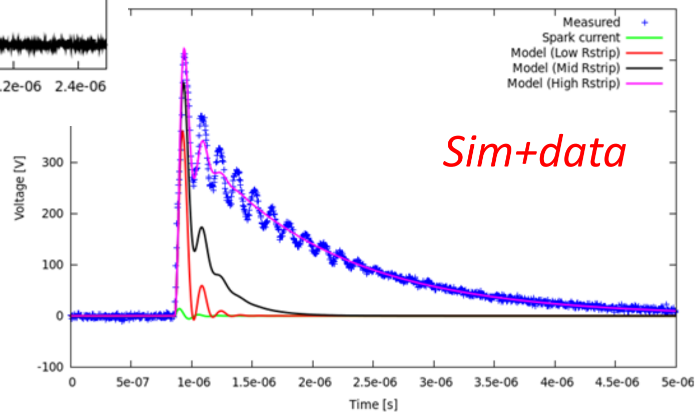
$$I_{esd}(t) = V_{esd}C_{esd}\frac{\omega_o^2}{\omega_o^2 - \alpha^2}e^{-\alpha t}\sin\left(\sqrt{\omega_o^2 - \alpha^2}\,t\right) \quad \text{for } \alpha < \omega_o$$

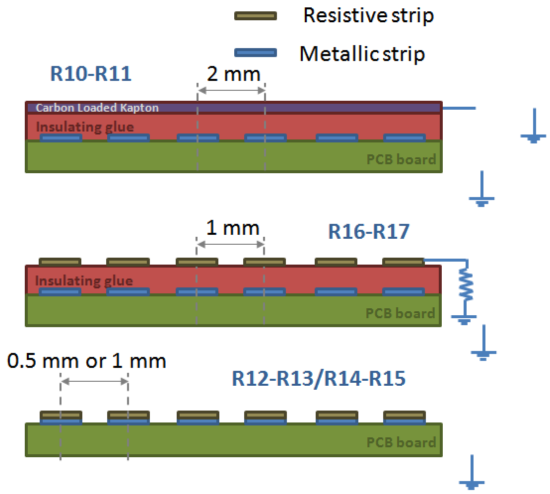


Characterisation of the electrical response of Micromegas detectors to spark processes, *J. Galan*

- First fits of model parameters to spark signals measured on neighboring strips
  - Fit does not work on all observed shapes
  - But effect of strip resistance nicely reproduced
- Next steps
  - Investigate resistive detectors
  - Influence of inductive elements at high frequencies







Last slide

- Thanks to the speakers for their contributions
- Thanks you all for your attention