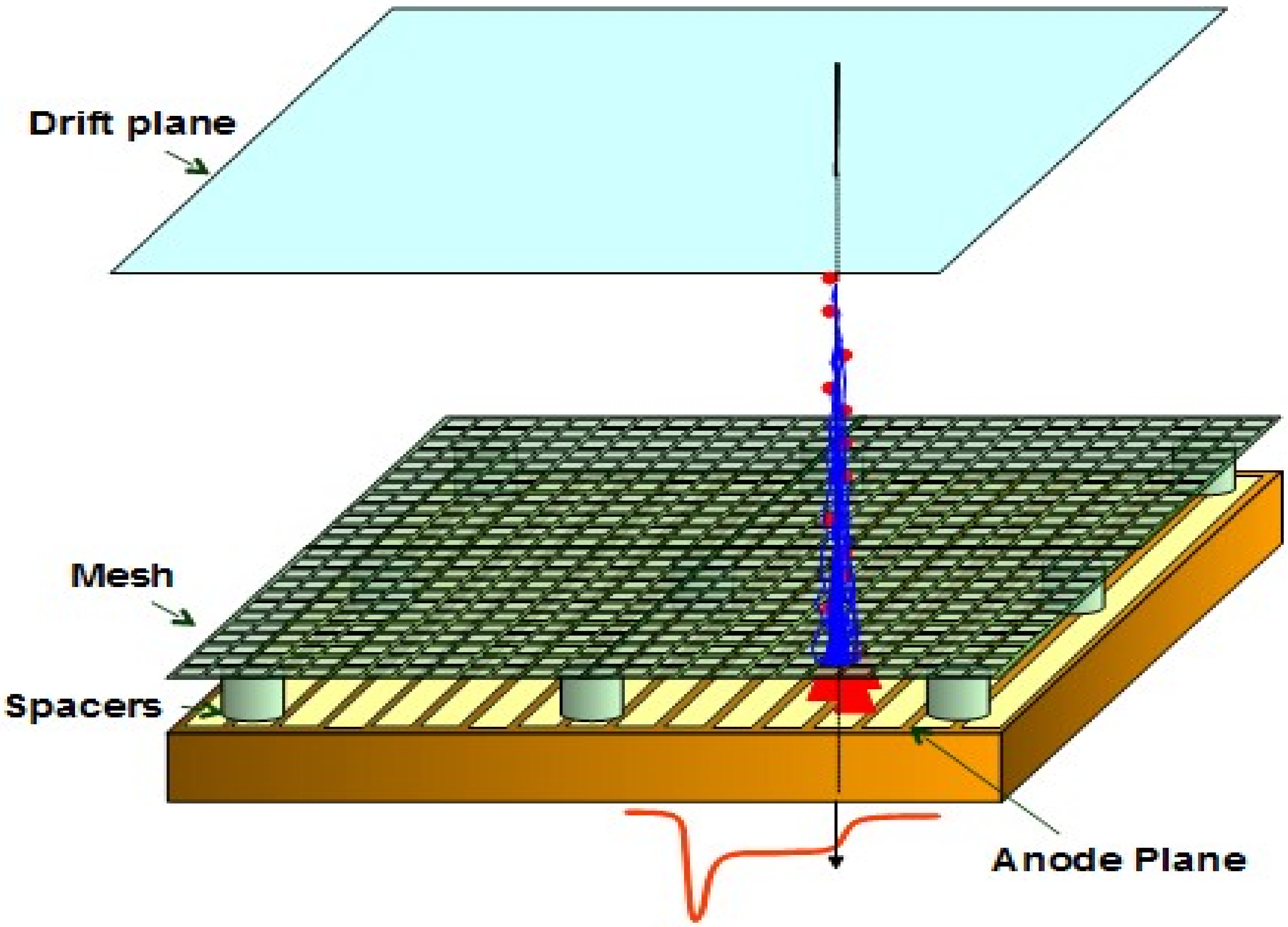
Numerical study of electrostatic field distortion in Micromegas modules based on TPC

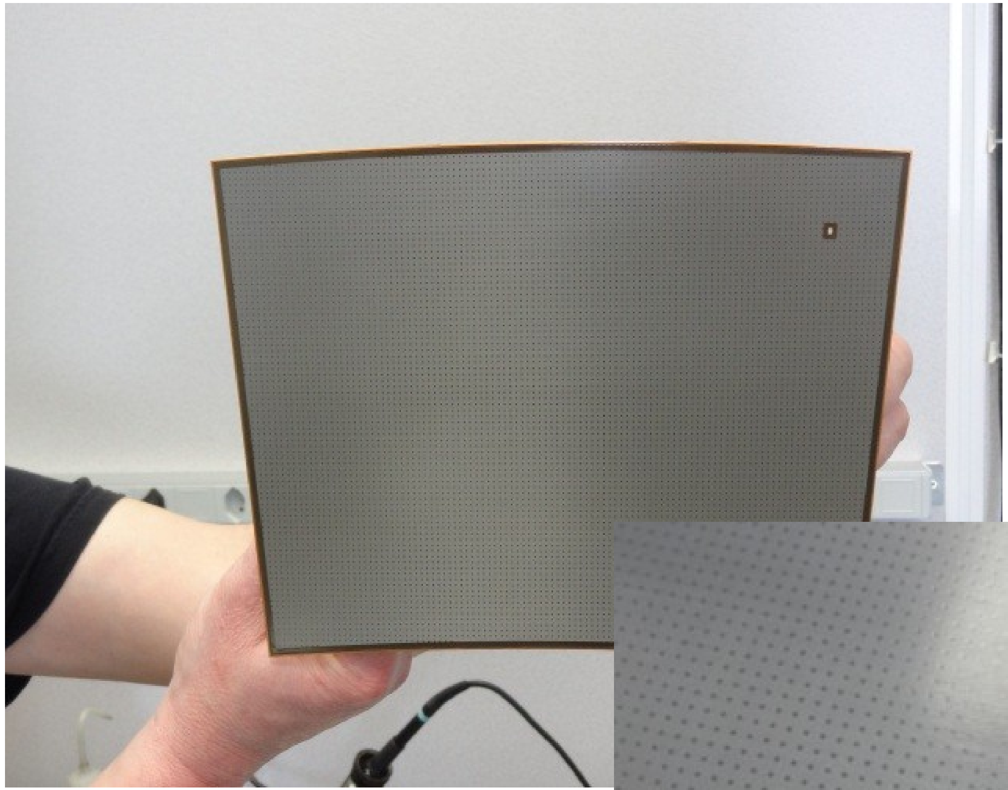
Overview

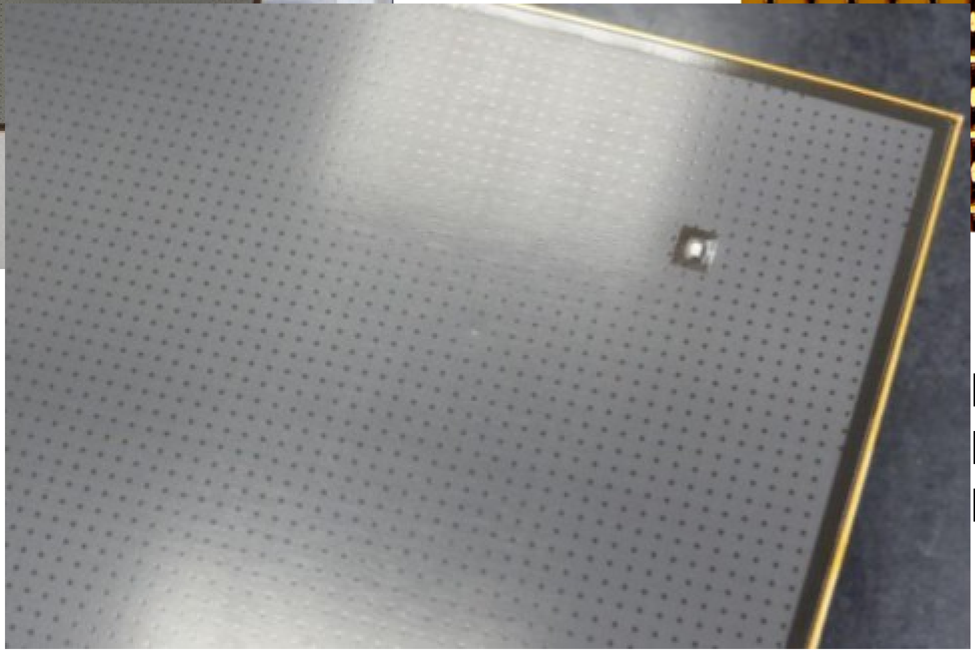
- A brief introduction to Micromegas detector
- Large prototype TPC
- What is distortion
- Numerical studies
- Future plans

The Micromegas Detector



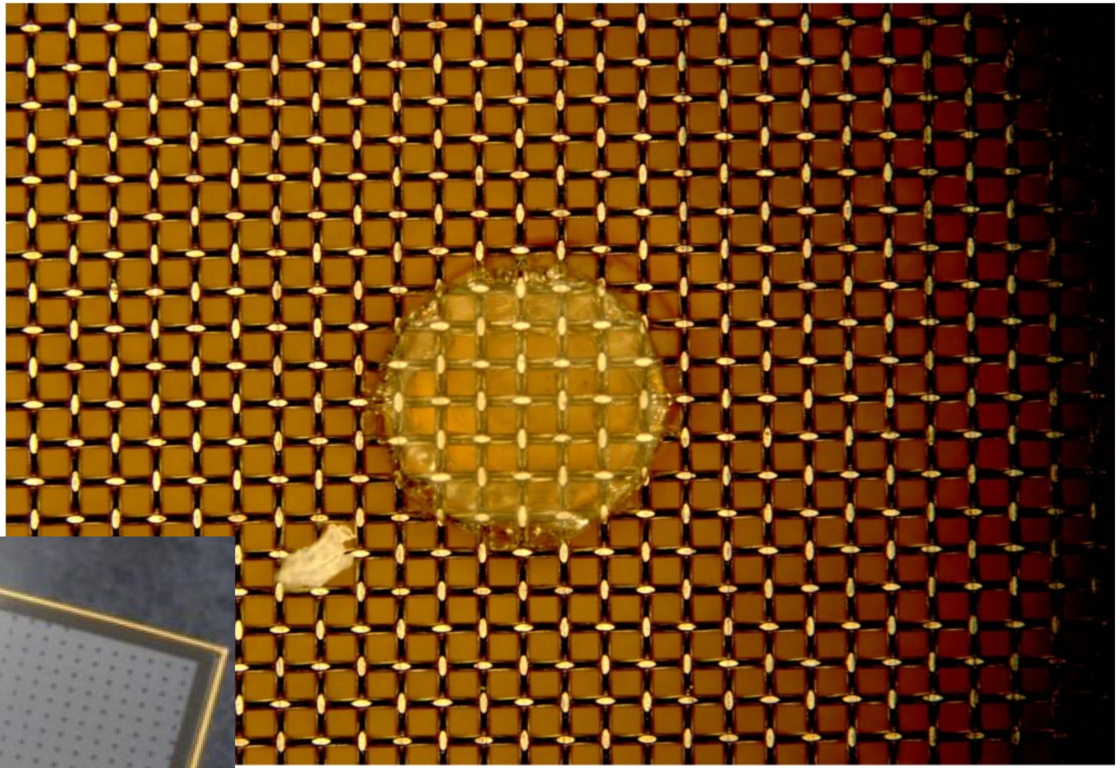
A micromegas module





Module size → 23 cm **X** 17 cm
24 Rows & 72 columns
No of pads → 1726
Pad Size → 3 mm **X** 7 mm

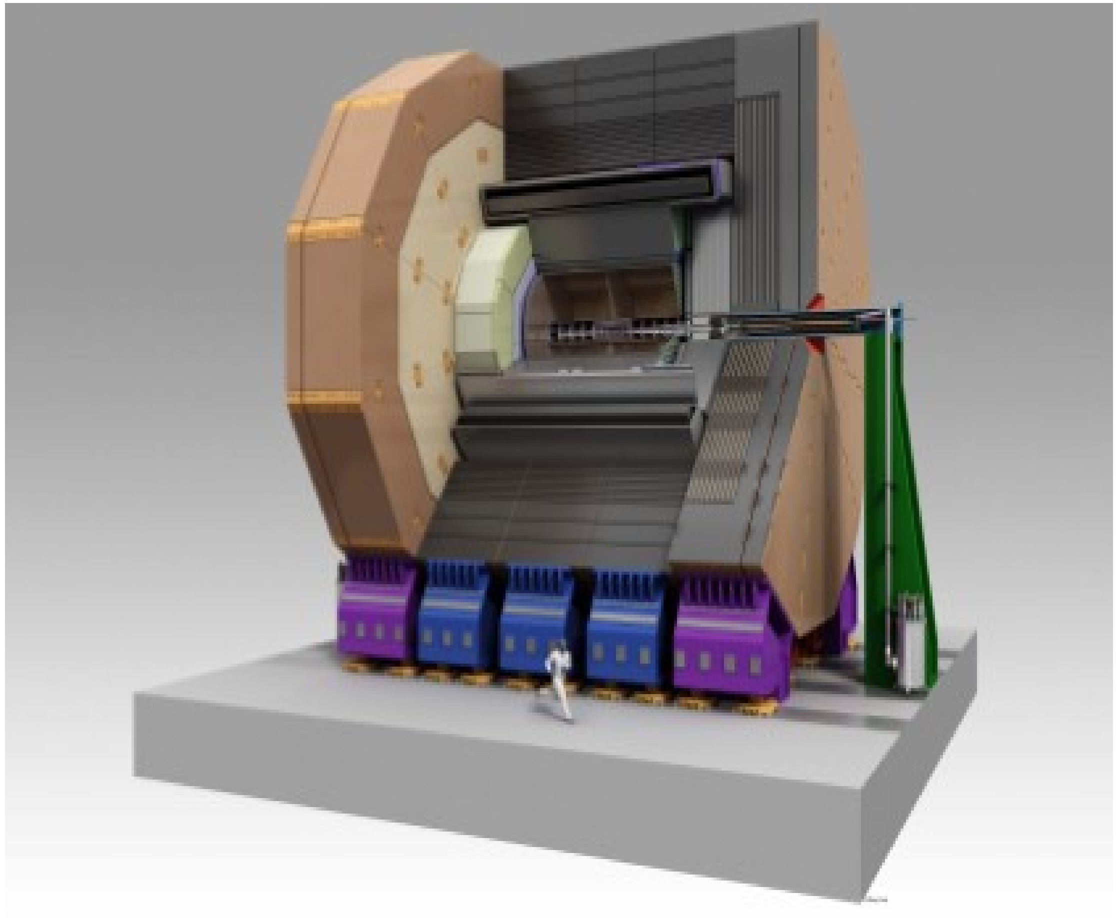
Microscopic view from top

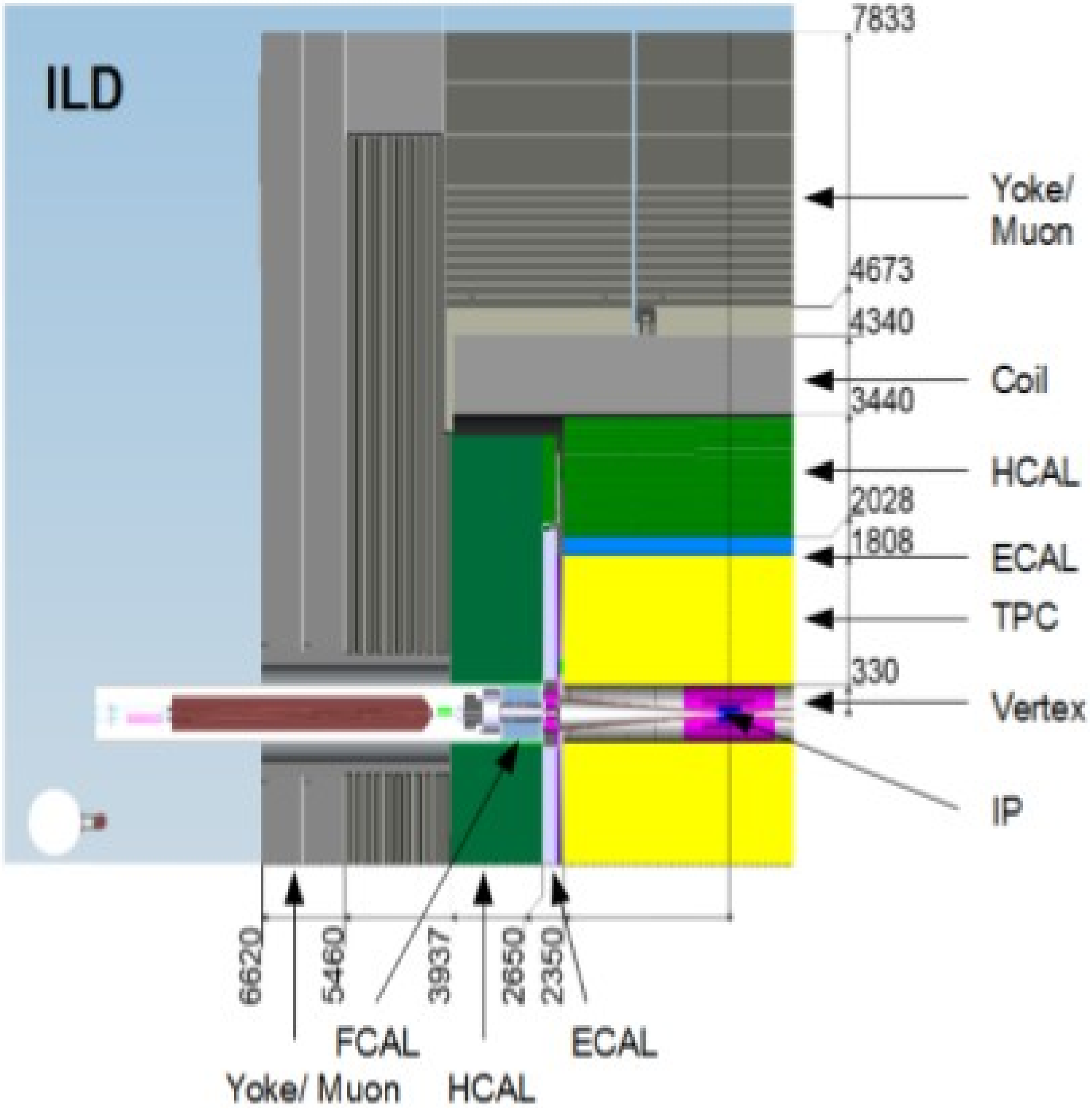


Diameter of dielectric spacers ~ 400 micron
Mesh wire diameter ~ 18 micron
Pitch ~ 45 micron

The ILD concept

Micromegas is a proposed candidate for *International Large Detector* concept for ILC





The detector performance required for ILC physics measurements*

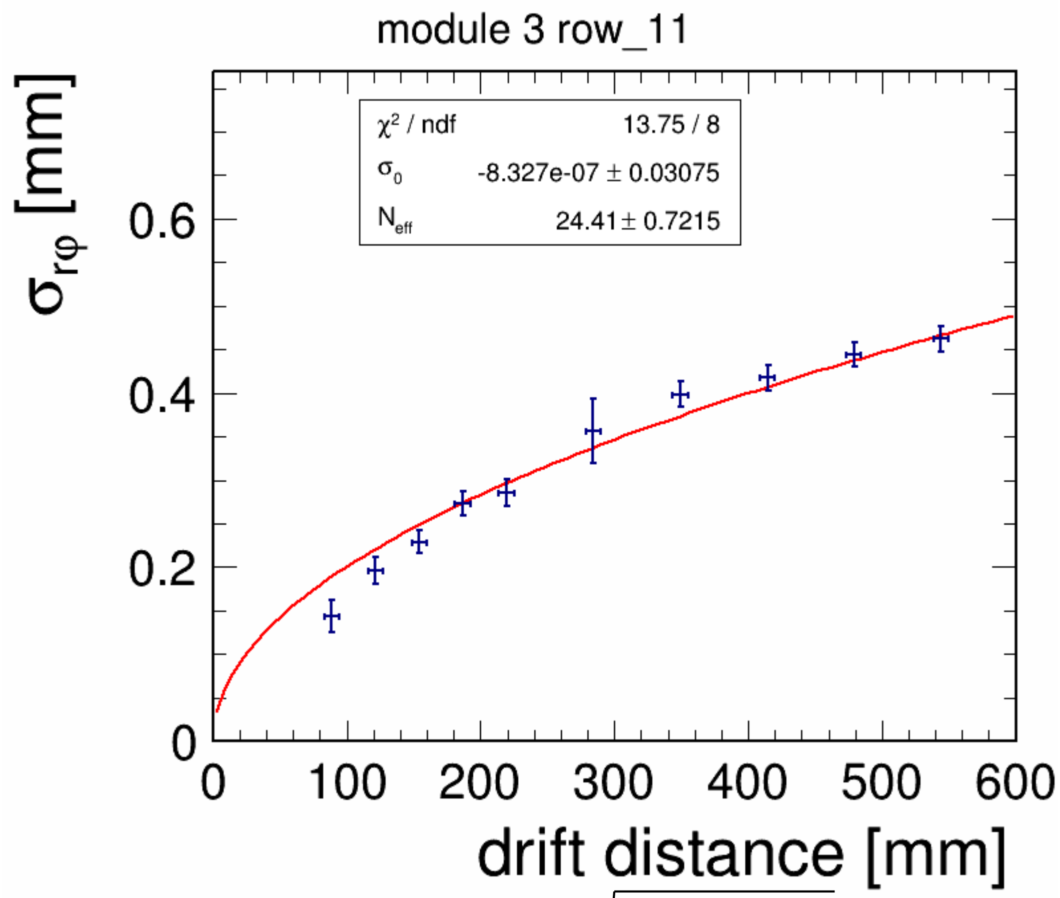
Physics Process	Measured Quantity	Critical System	Critical Detector Characterstic	Required Performance
ZHH $HZ \to q\bar{q}b\bar{b}$ $ZH \to ZWW^*$ $\nu\bar{\nu}W^+W^-$	Triple Higgs Coupling Higgs Mass $B(H \to WW^*)$ $\sigma(e^+e^- \to \nu\bar{\nu}W^+W^-)$	Tracker and Calorimeter	Jet Energy Resolution, $\Delta E/E$	3to4%
$ZH \to \ell^+\ell^- X$ $\mu^+\mu^-(\gamma)$ $ZH + H\nu\nu \to \mu^+\mu^- X$	Higgs Recoil Mass Luminosity Weighted E_{cm} $B(H \to \mu^+\mu^-)$	Tracker	Charged Particle Momentum Res., $\Delta p_t/p_t^2$	5×10^{-5}
$HZ, H \to b\bar{b}, c\bar{c}, gg$ $b\bar{b}$	Higgs Branching Fractions b quark charge asymmetry	Vertex Detector	Impact Parameter, δ_b	$5\mu m \oplus 10\mu m/p(\mathrm{GeV}/c)\sin^{3/2}\theta$
SUSY, eg. $\tilde{\mu}$ decay	$\tilde{\mu}$ mass	Tracker, Calorimeter	Momentum Res., hermeticity	

* ILC Reference Design Report IV-i

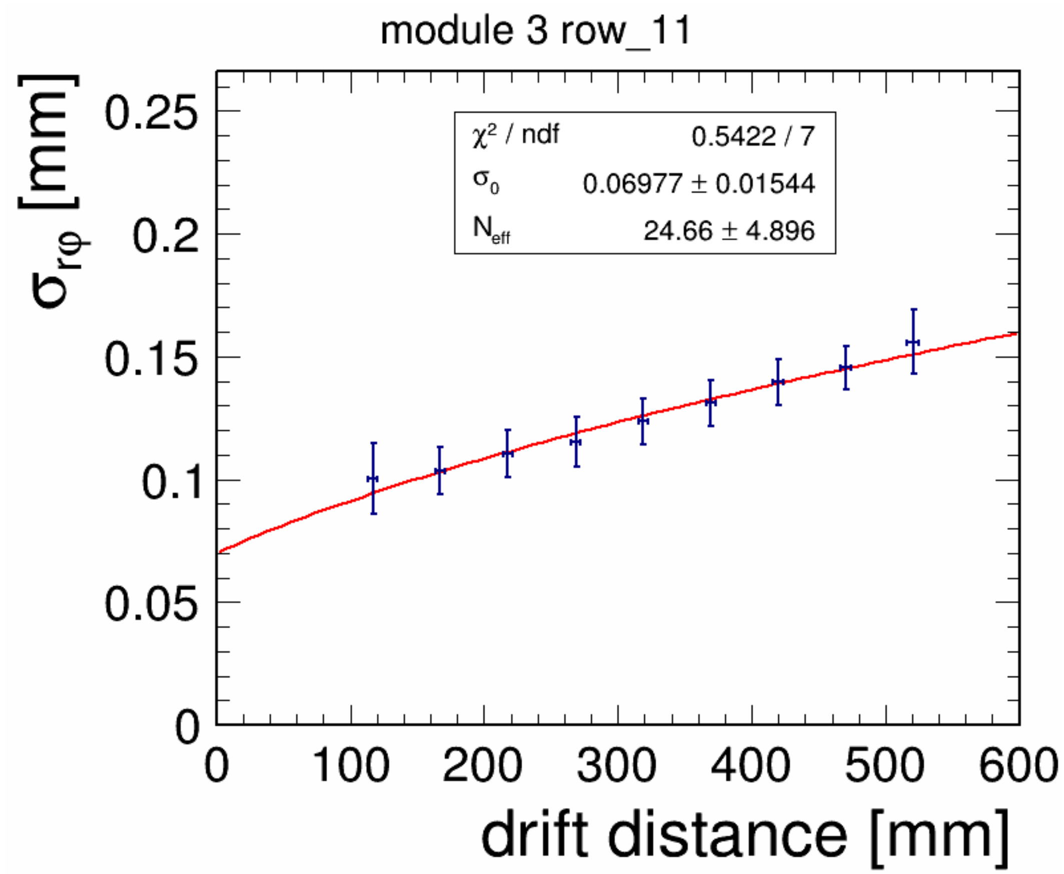
Space resolution of resistive Micromegas

Test Feb 2014, E = 140 V/cm

B = 0T



B = 1T

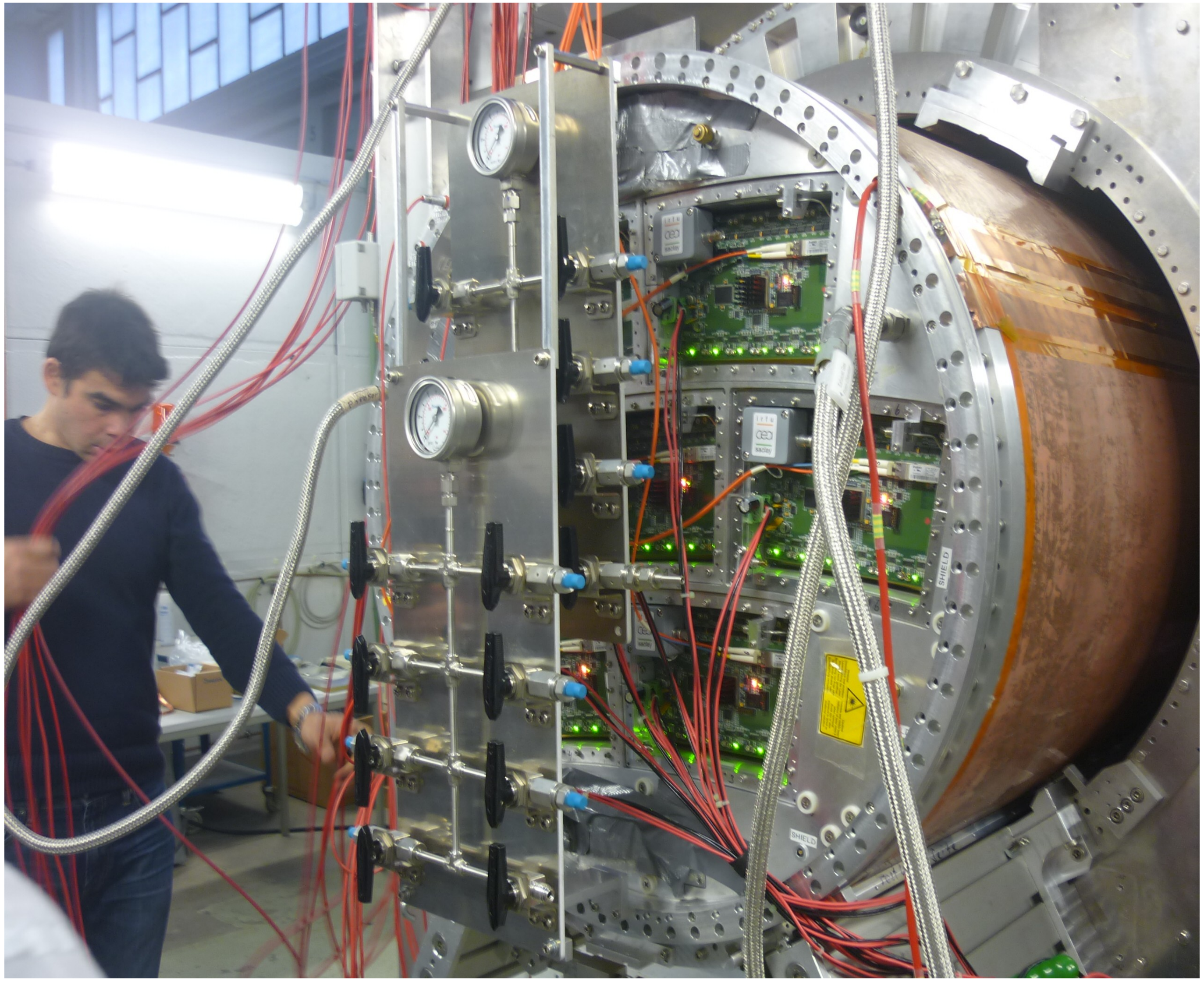


Fit formula, $\sigma = \sqrt{\sigma_0{}^2 + \frac{C_d^2 \cdot z}{N_{eff}}}$

σ_0 : the resolution at Z=0

N_{eff} : the effective number of electrons

The Large Prototype TPC



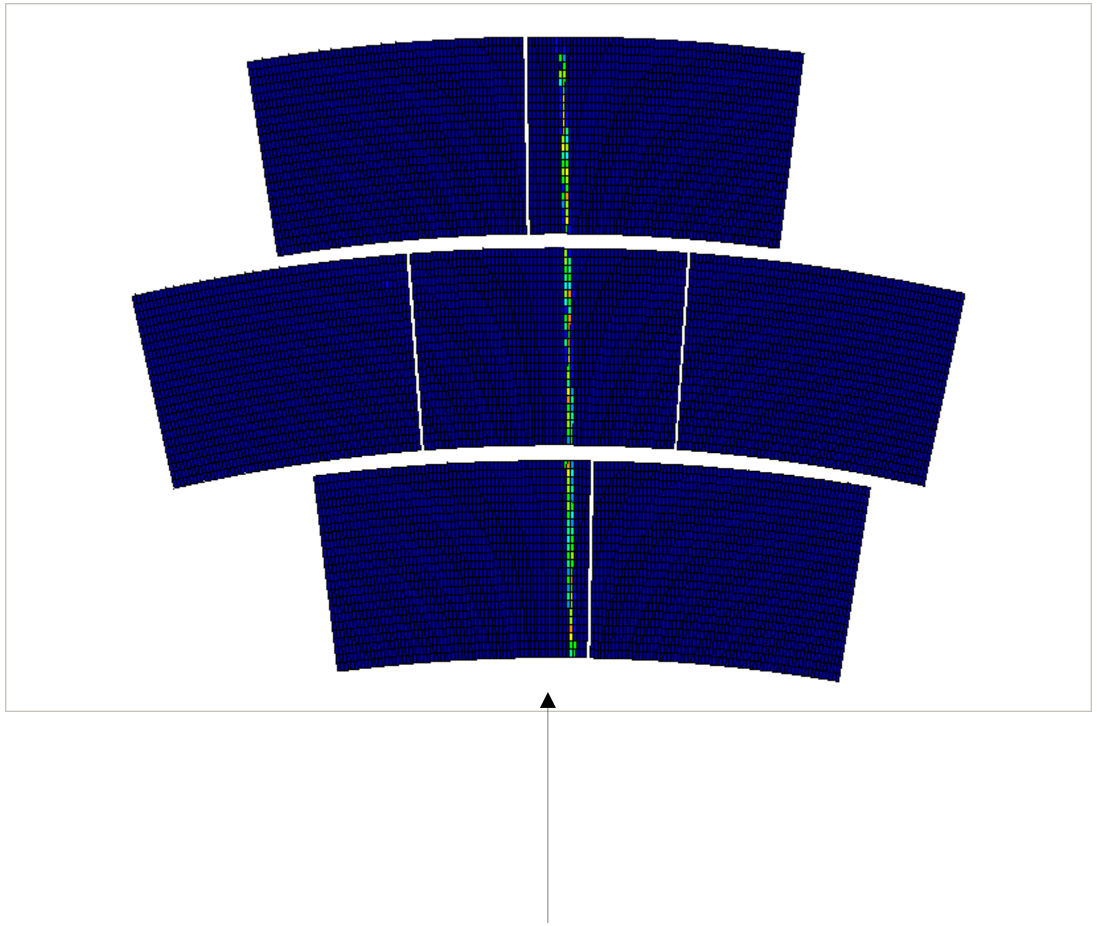
Description of the TPC

Length = 60 cm

Diameter = 38 cm

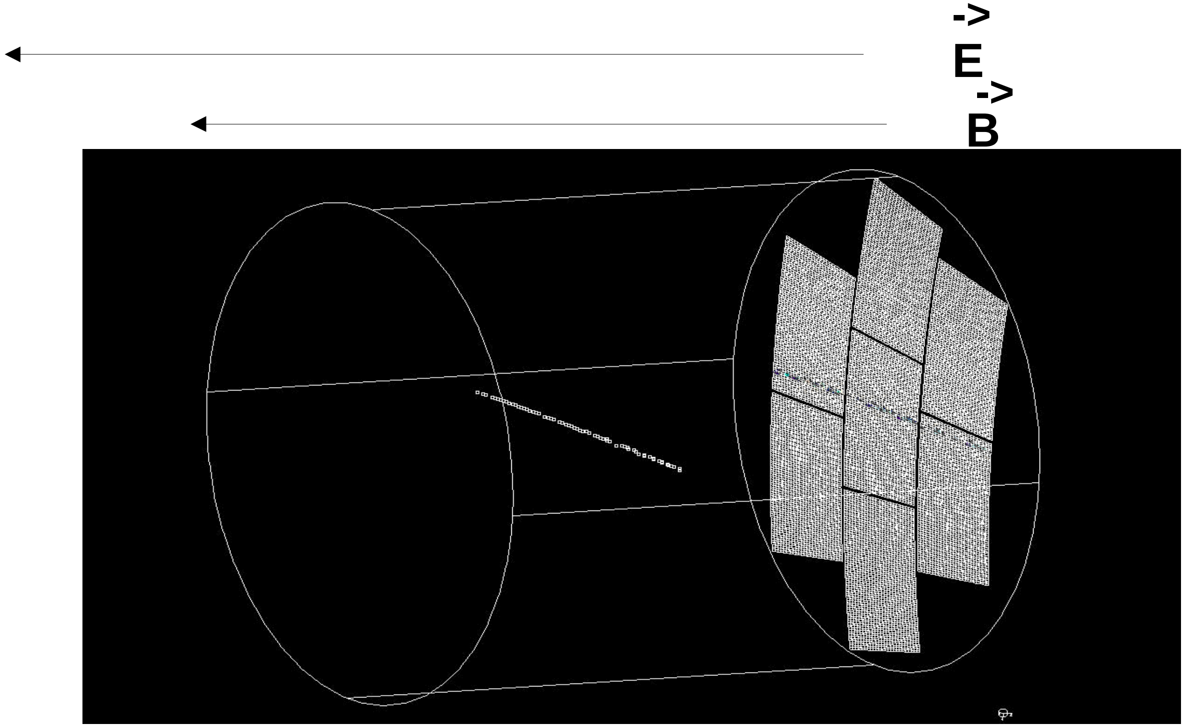
Magnetic Field = 1T

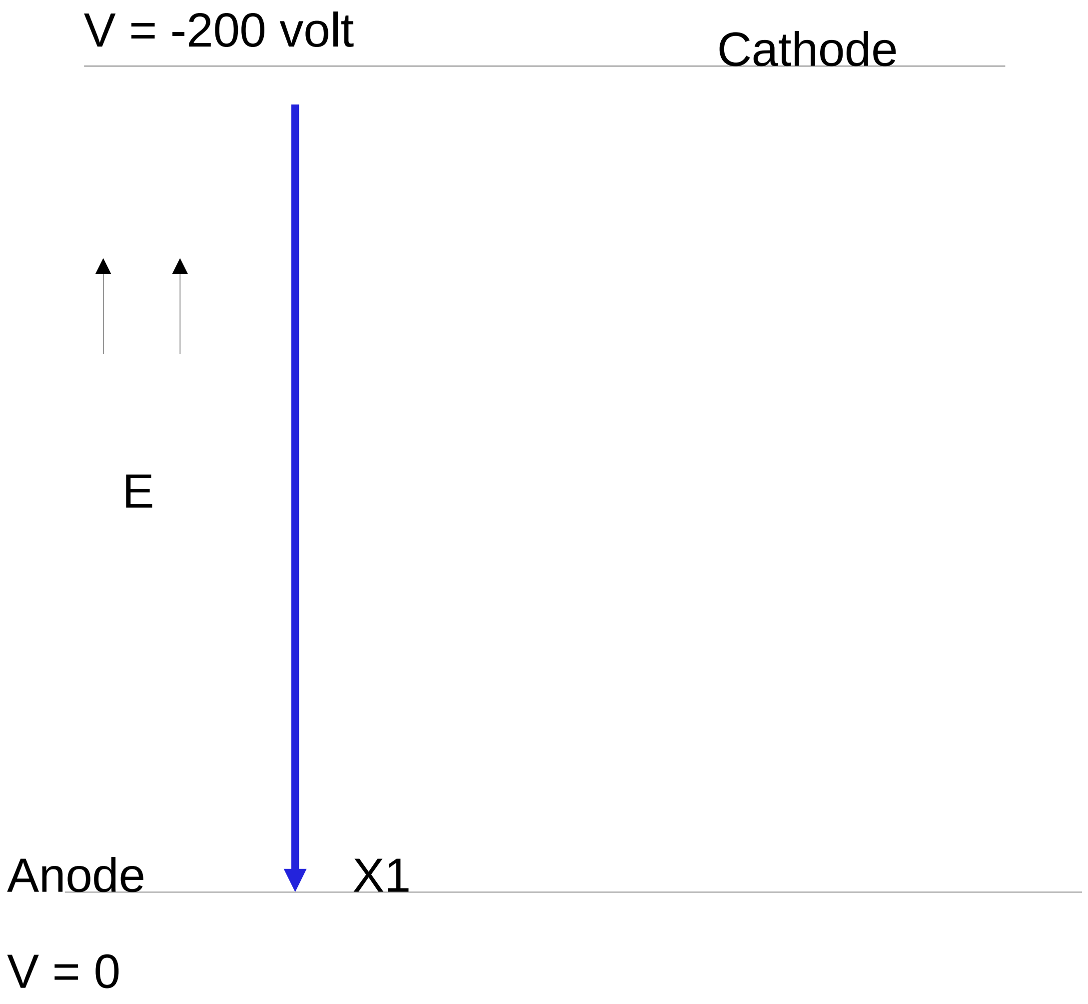
visualization of a TPC

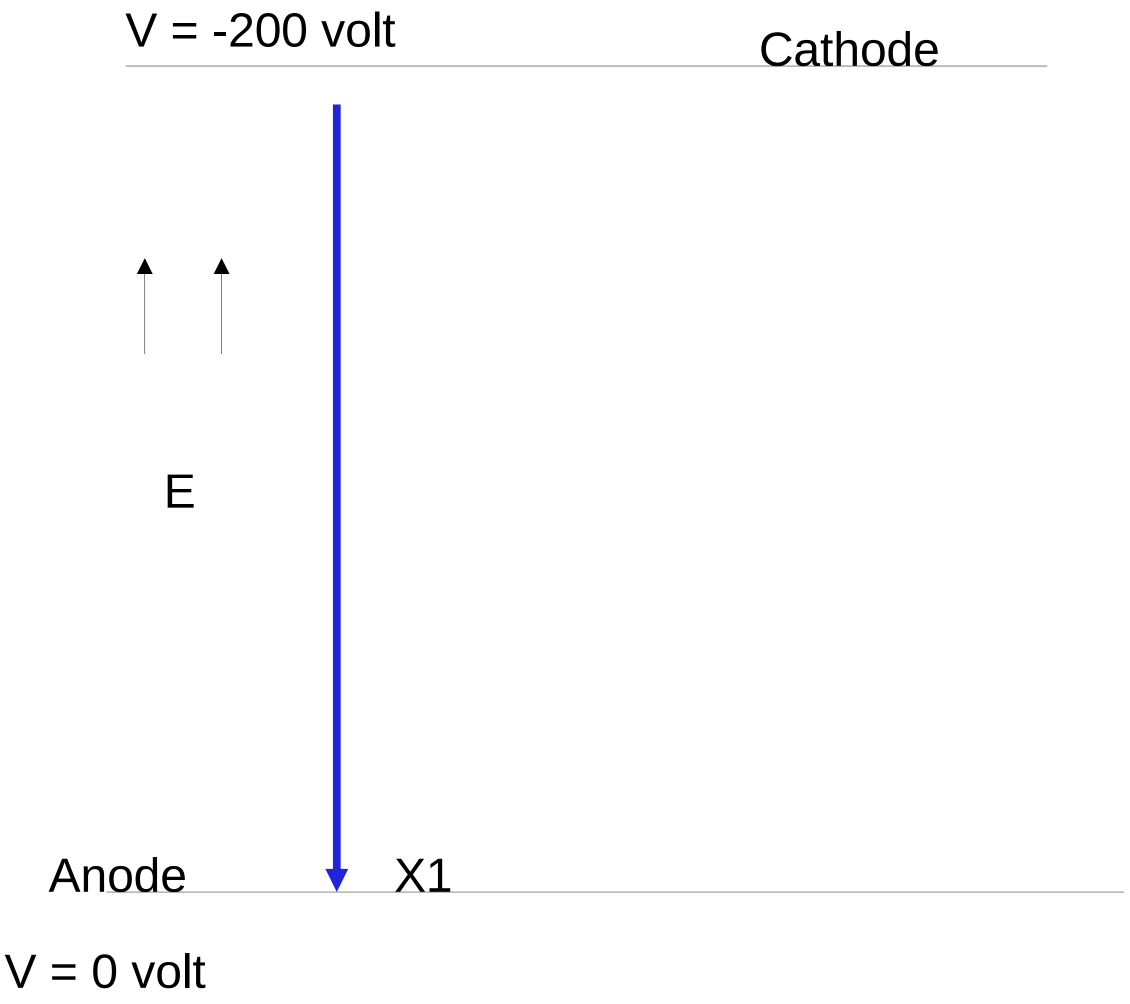


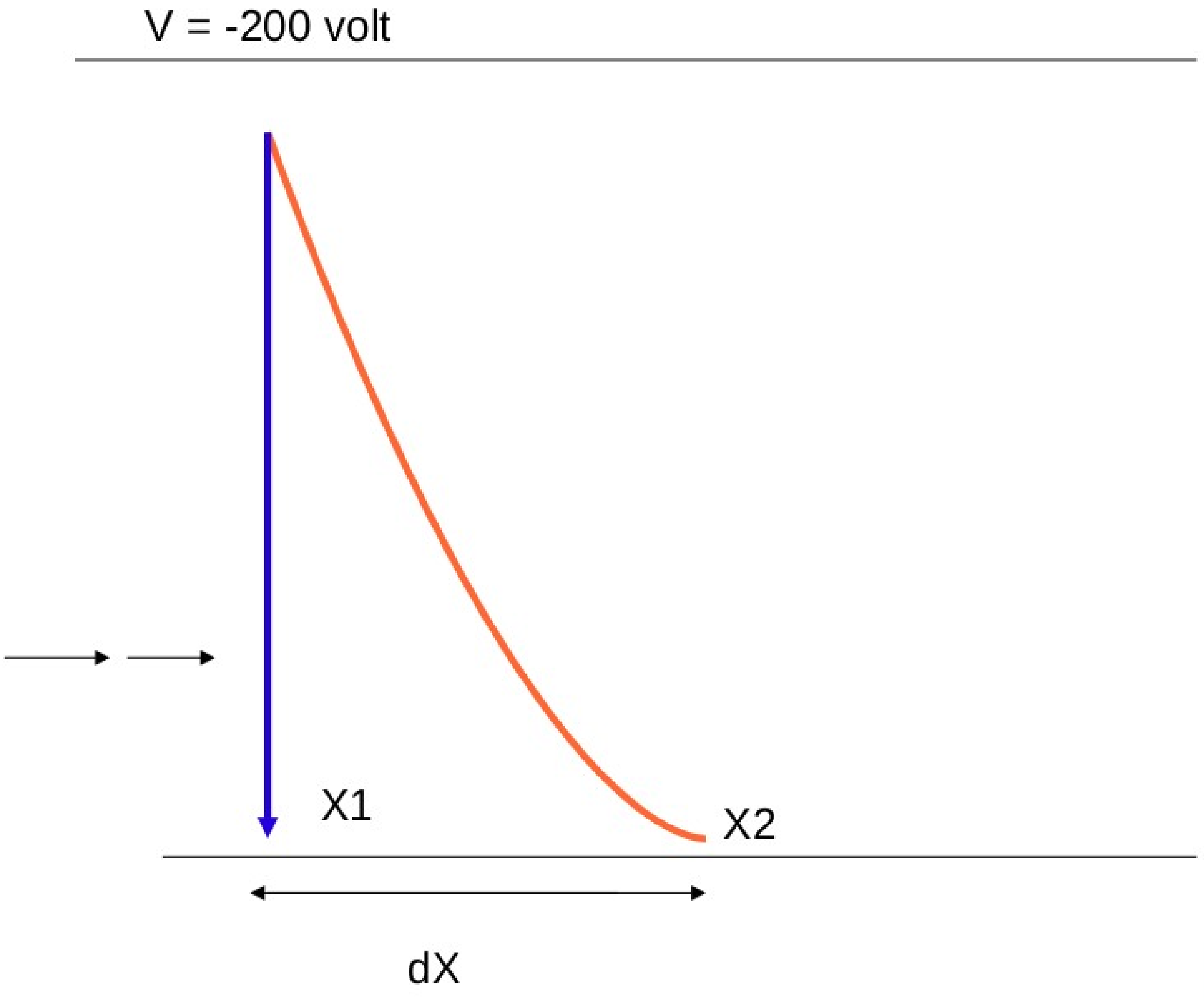
5 GeV electron beam

Magnetic field reduces transverse diffusion and improves resolution.



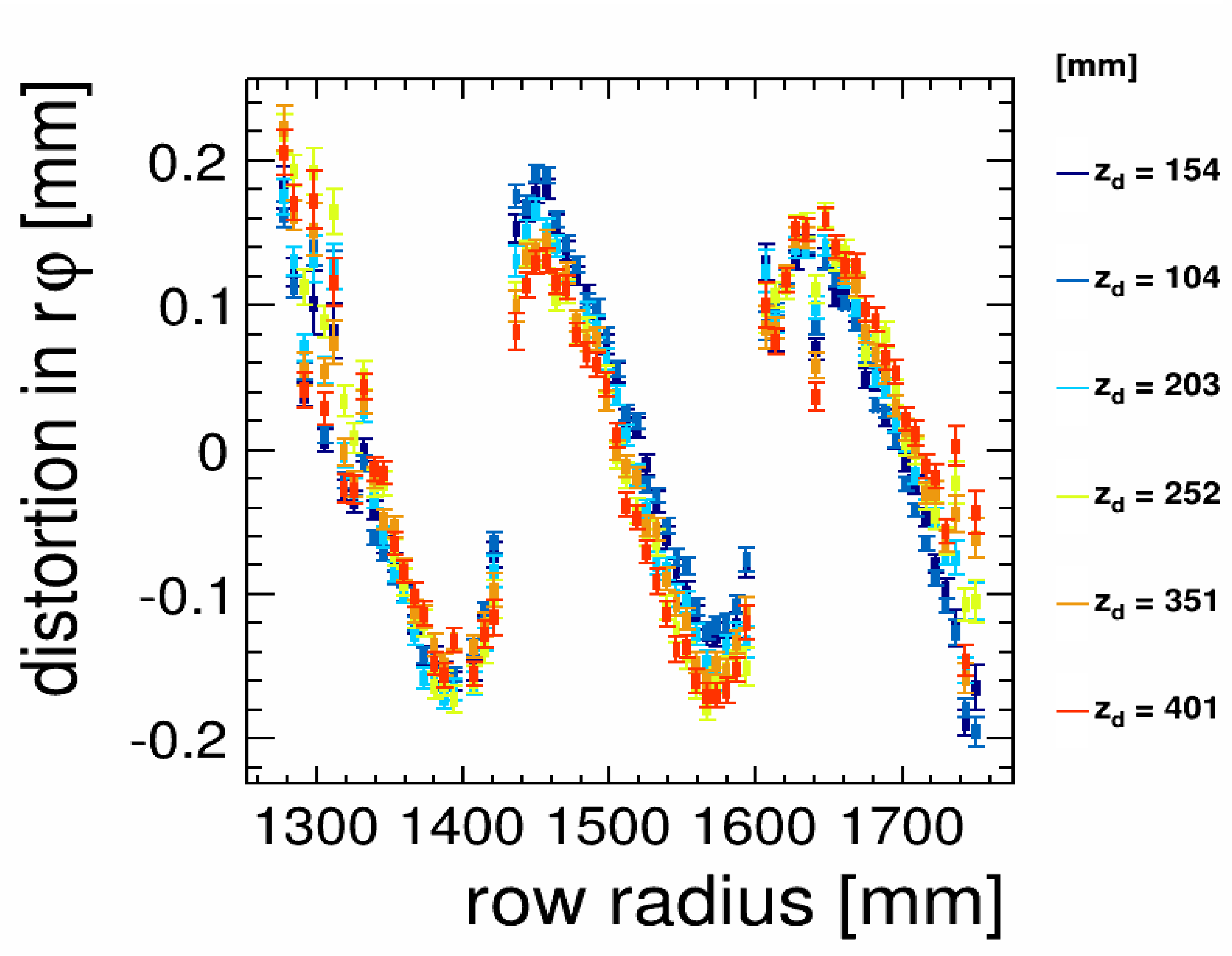

V = -200 volt
Cathode
E
Anode
X1
V = 0


V = -200 volt
Cathode
E
Anode
X1
V = 0 volt

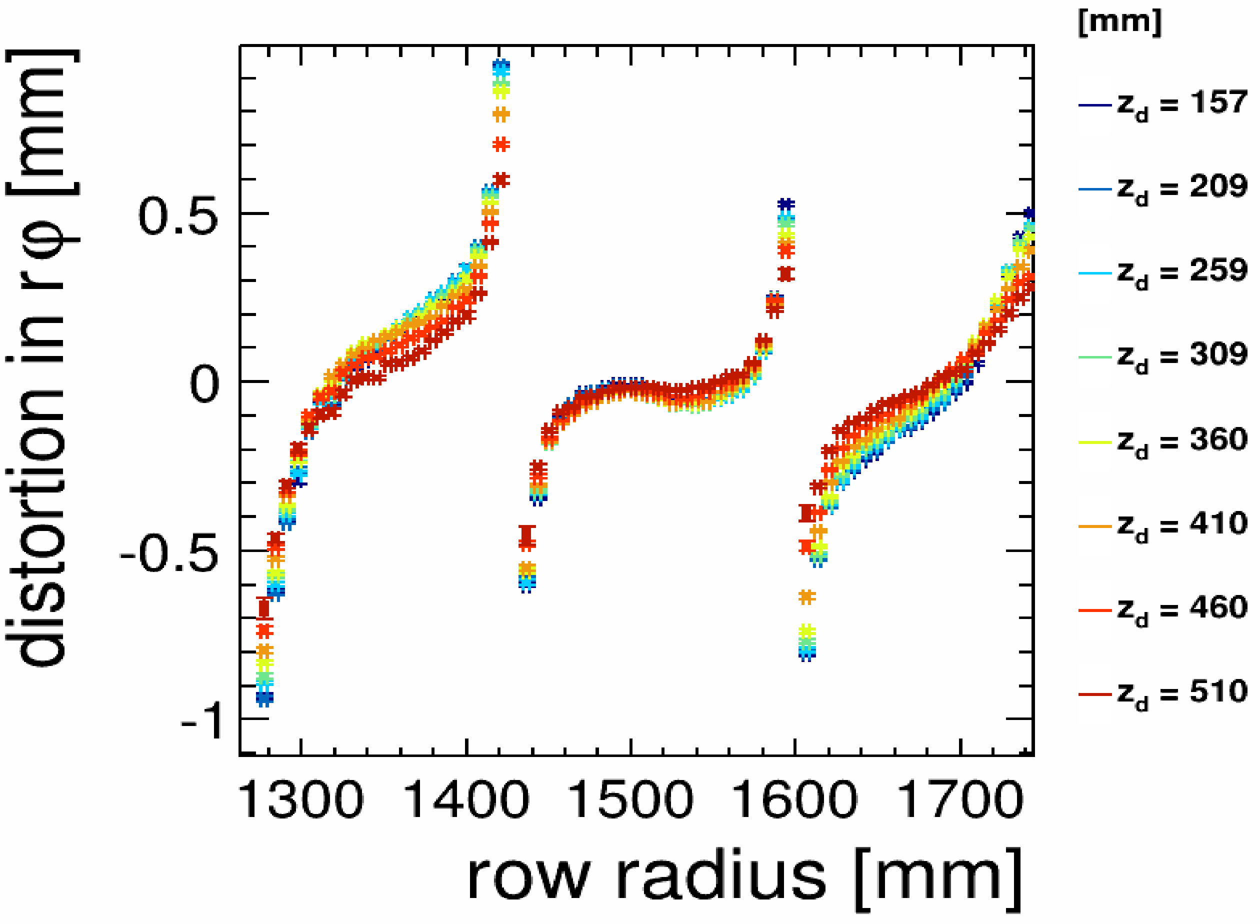

V = -200 volt
X1
X2
dX

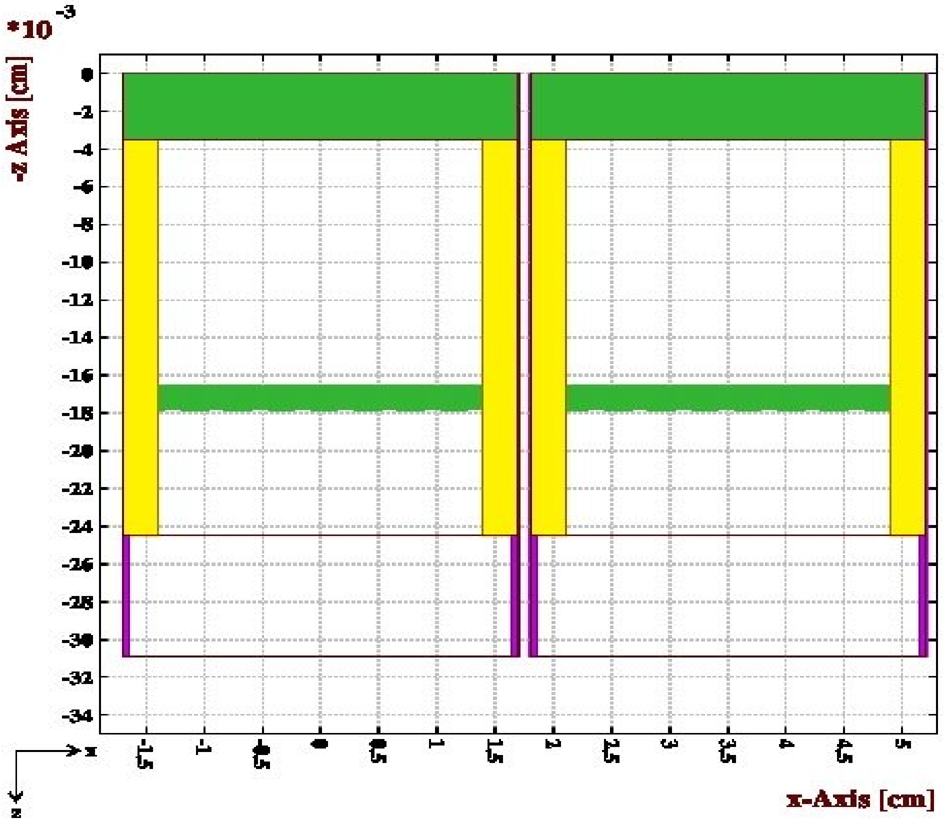
Residual plots

B = 0T

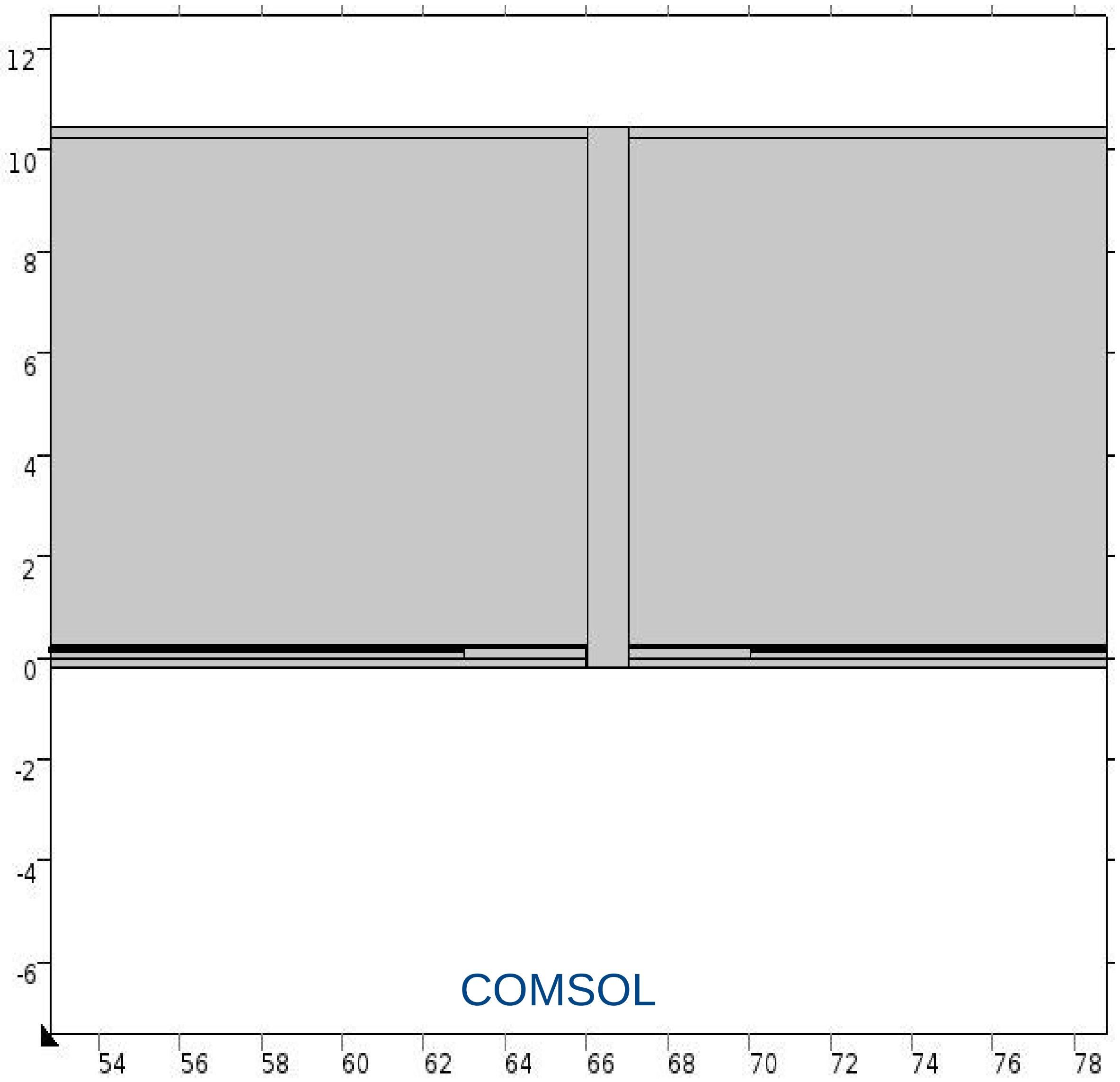


B = 1T



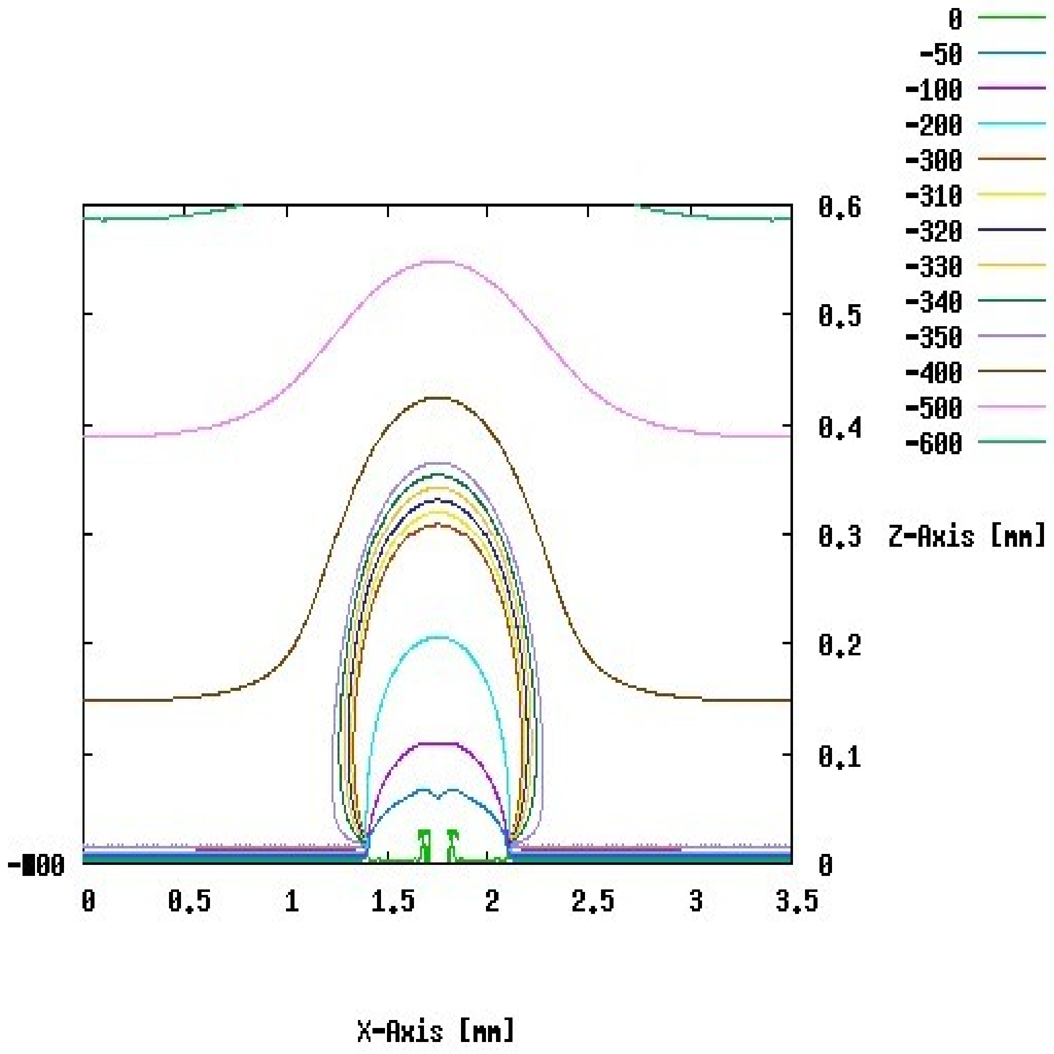


Garfield

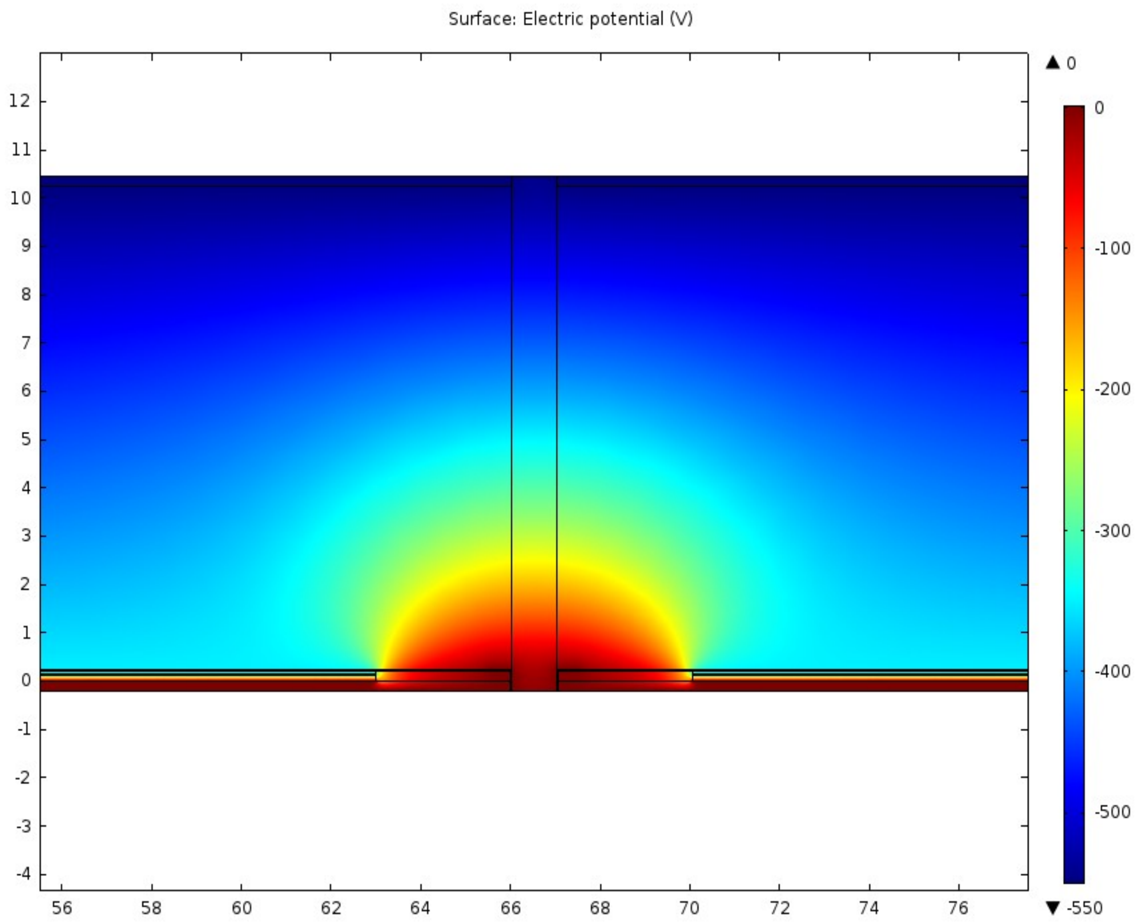


COMSOL

Potential distribution in 'ZX' plane

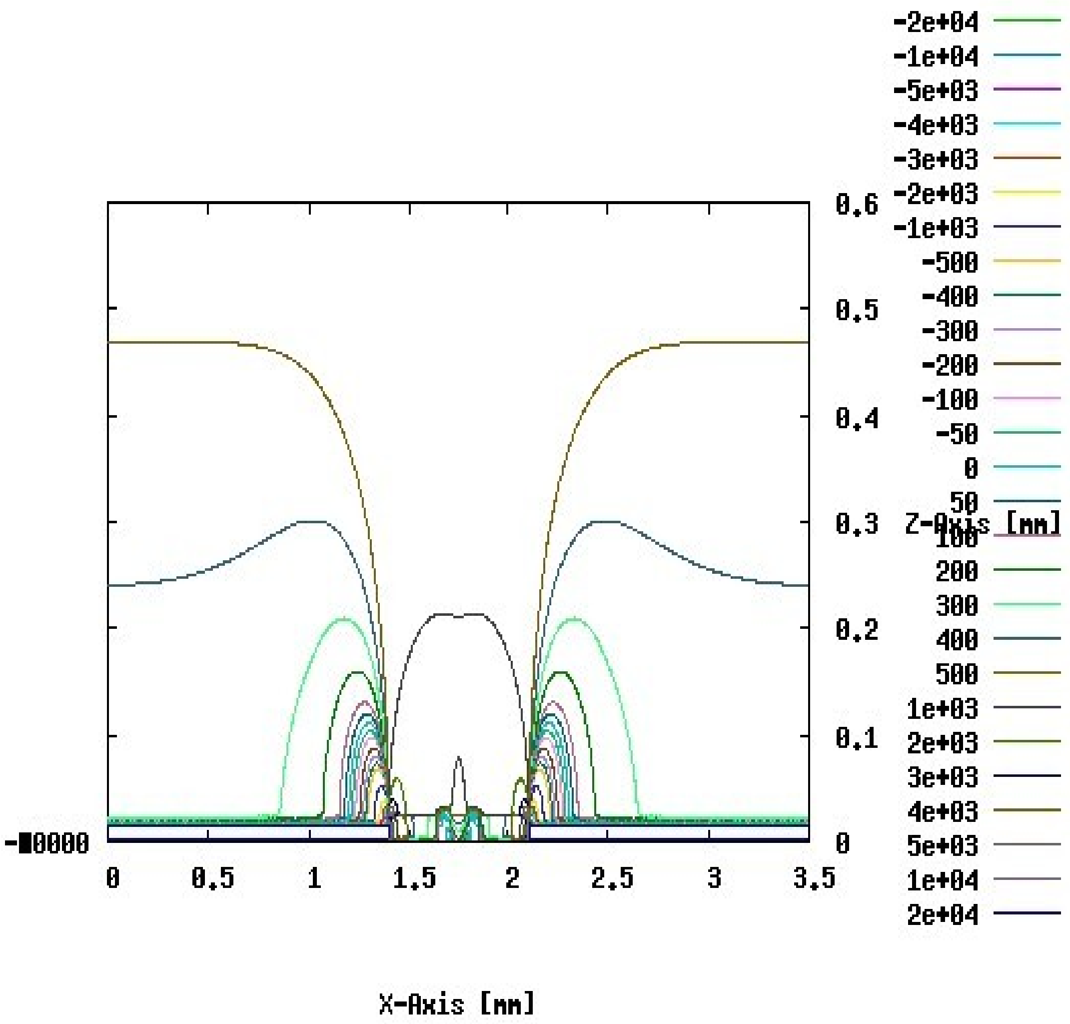


Boundary Element Method (BEM)
Garfield

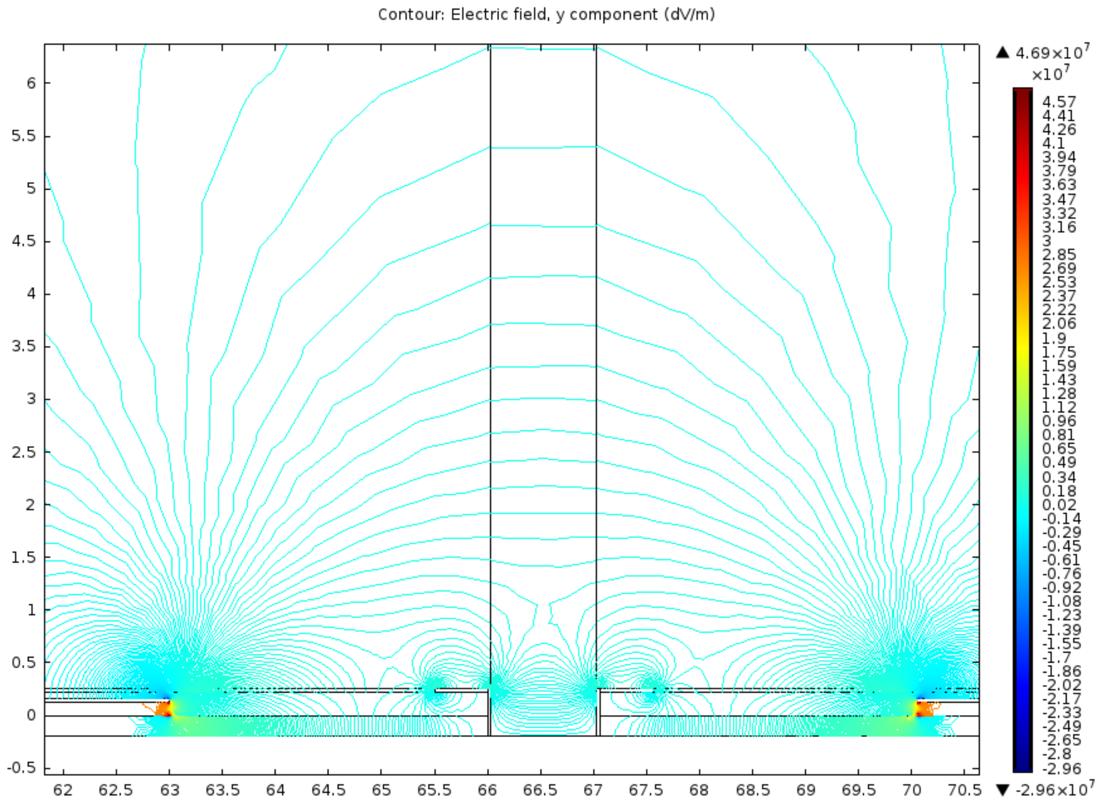


Finite Element Method (FEM)
COMSOL

Z-component of Field in 'ZX' plane

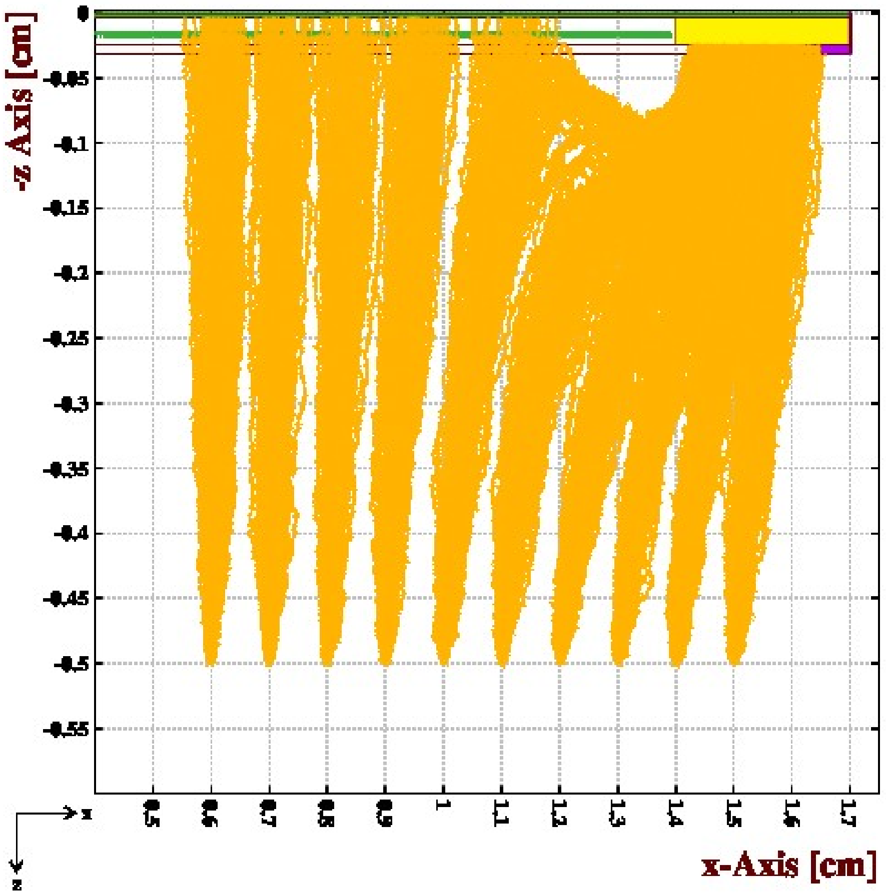


BEM (Garfield)

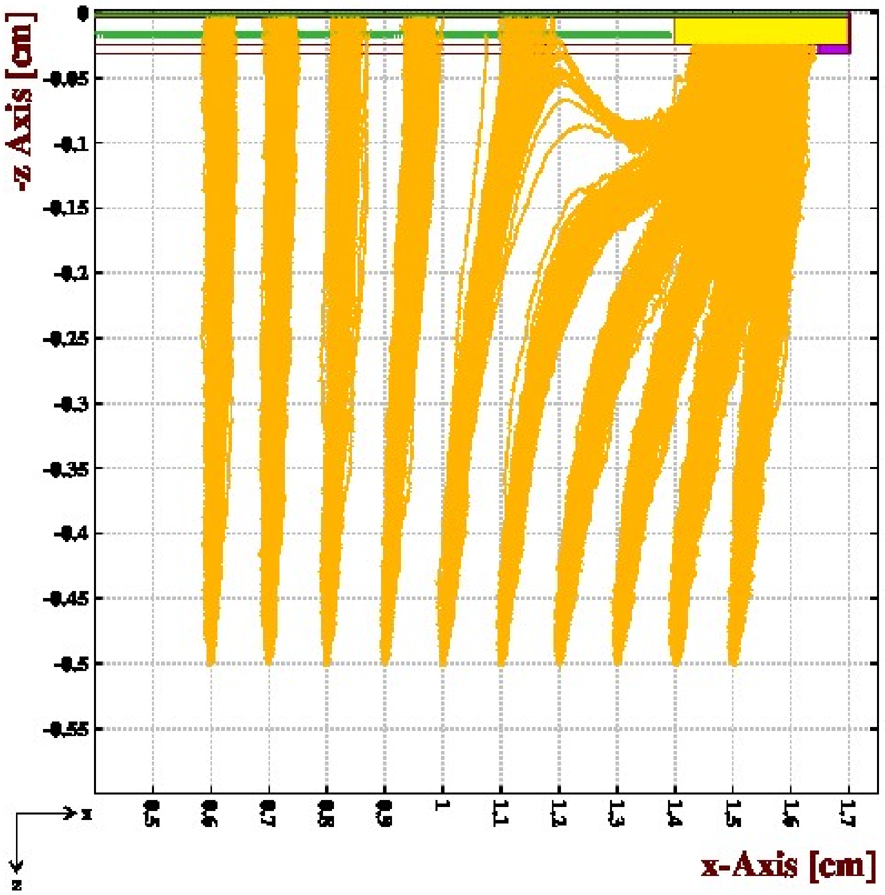


FEM (COMSOL)

Drift and Diffusion of electrons



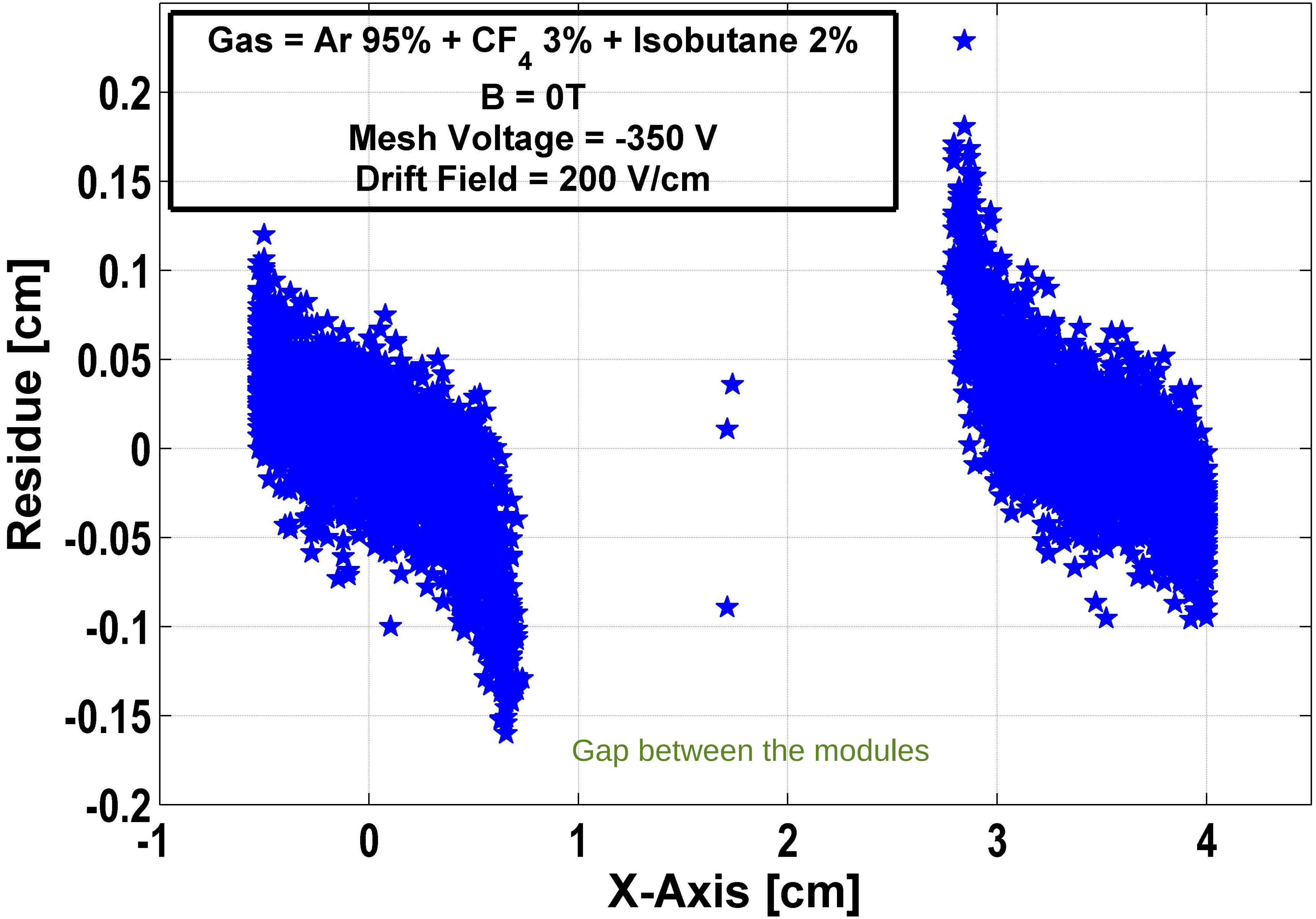
B = 0 T



B = 1 T

Distorted signals from Garfield

Preliminary



B = 0 T

Future plans

More detail simulation considering the actual size of the module

Application of resistive layer

Application of magnetic field for signal simulation

Interfacing COMSOL with Garfield++

Acknowledgement

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Thank You

Backup slides