TPC ion gate

- Ion feed back from the readout amplification will cause important distortions of the drift field

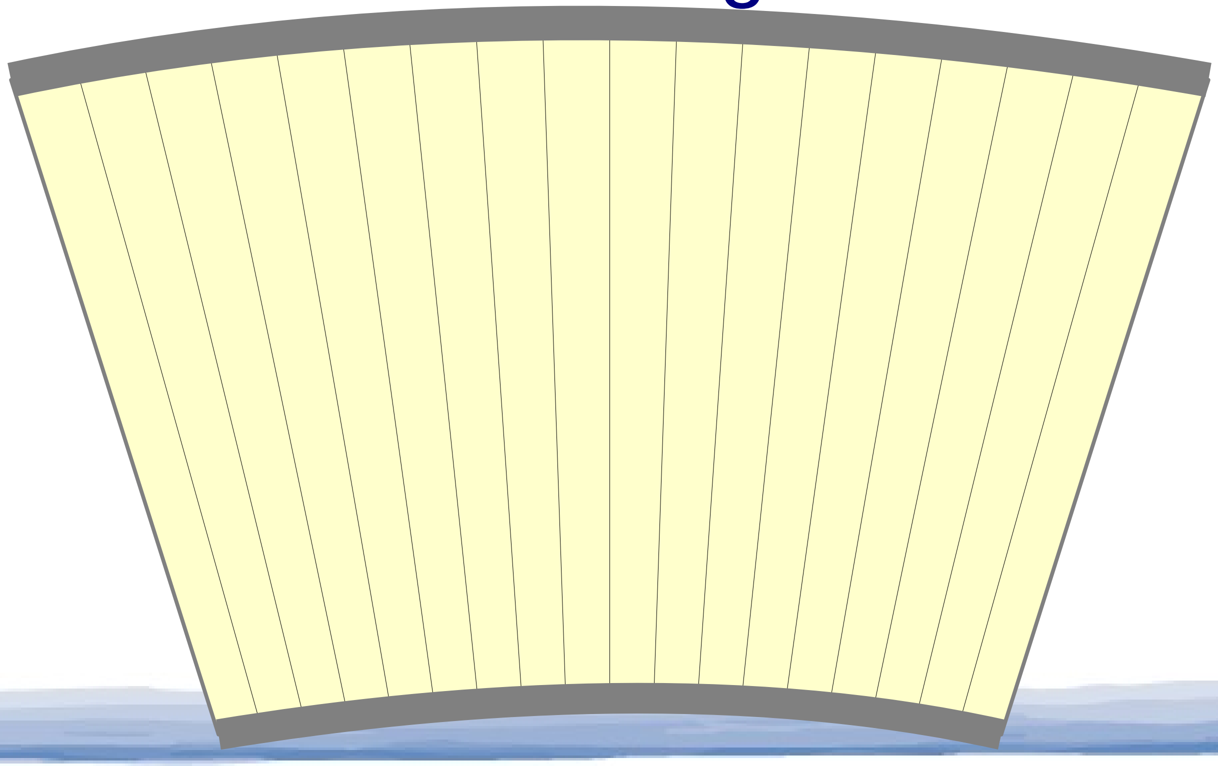
  => **A gating system is necessary**
- A GEM gating system is studied, but the performance is not proven yet
- We need to propose a viable solution for the DBD

  => Back to wire gate

Considerations on a Wire Gating Grid

- An independent gating structure would be difficult to achieve without dead areas
- Integrated in the modules would be better

=>Is it possible to make a gate with radial wires?

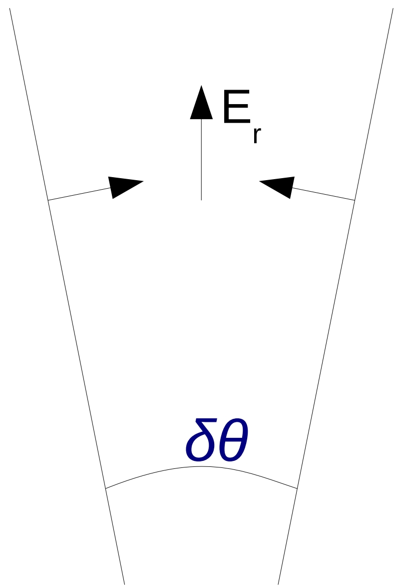


Radial wire gate

- Advantages
  - easier to integrate in the module
  - less dead areas
  - displacement along the wire have less effect on the resolution (?)
- Problems
  - non parallel wires
  - possibly strong angular dependency
  - difficult to make a good model for simulations

Non parallel wires

- non parallel wires will create a radial electric field
- The radial component does not disappear with drift distance



Field calculation

- Approximation:
  - potential same as for infinite parallel wires (according to calculations following Blum-Rolandi book)
  - wire pitch dependent on radius
  - realistic boundary conditions should reduce even further the radial dependency

- Result (for large z):

$$E_y = -\delta\theta 2\pi z_0 \frac{1 - \ln\frac{2\pi r}{s}}{\left(2\pi z_0 - s\ln\frac{2\pi r}{s}\right)^2}\left(V_g - \frac{z_0}{z_p}V_p\right)$$

  - independent of drift distance z
  - disappears if wire potential Vg matches the drift field

$$E_y/E_z < -\delta\theta\frac{V_g/z_0 - E_{cage}}{E_{cage}}$$

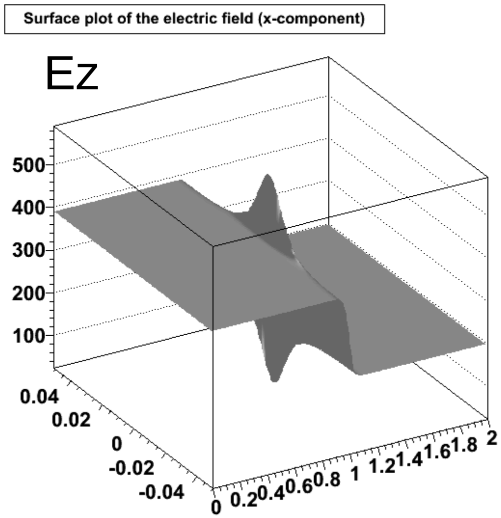
  - *δθ~10*$^{-3}$ => negligible for ΔV/V<0.1

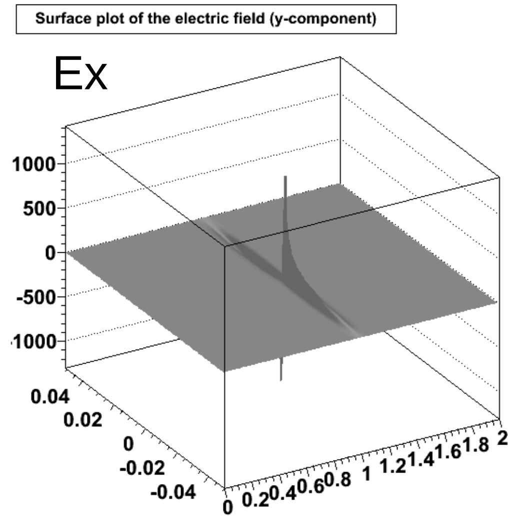
NB: $z_0V_p/z_p = z_0E_{cage} = V_{open}$

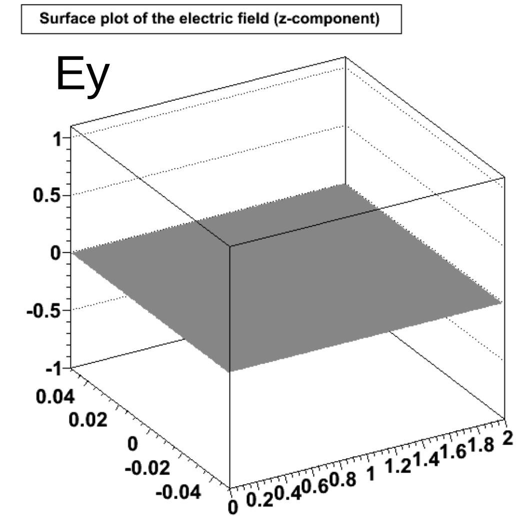
Visualisation/Garfield++

(for exaggerated value of Vg)

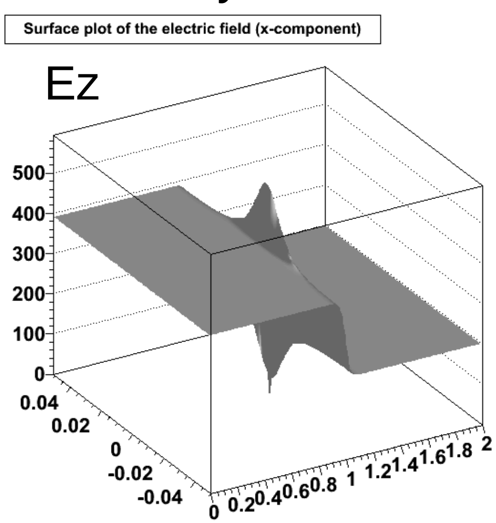
E field created by Parallel Wire (as calculated by Garfield++)

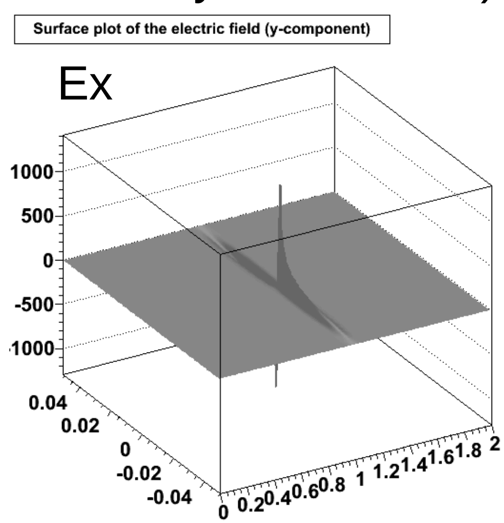


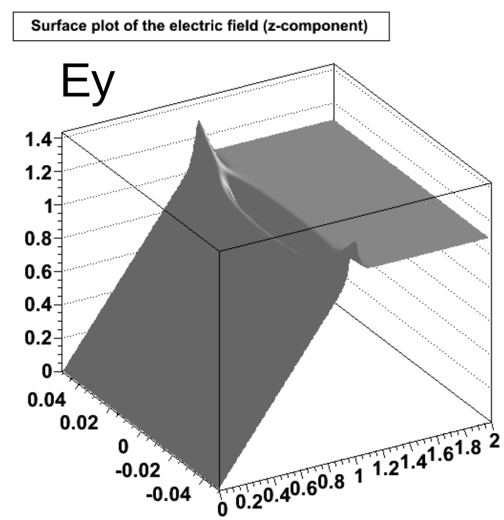




E field created by Radial Wire (result of my calculations)



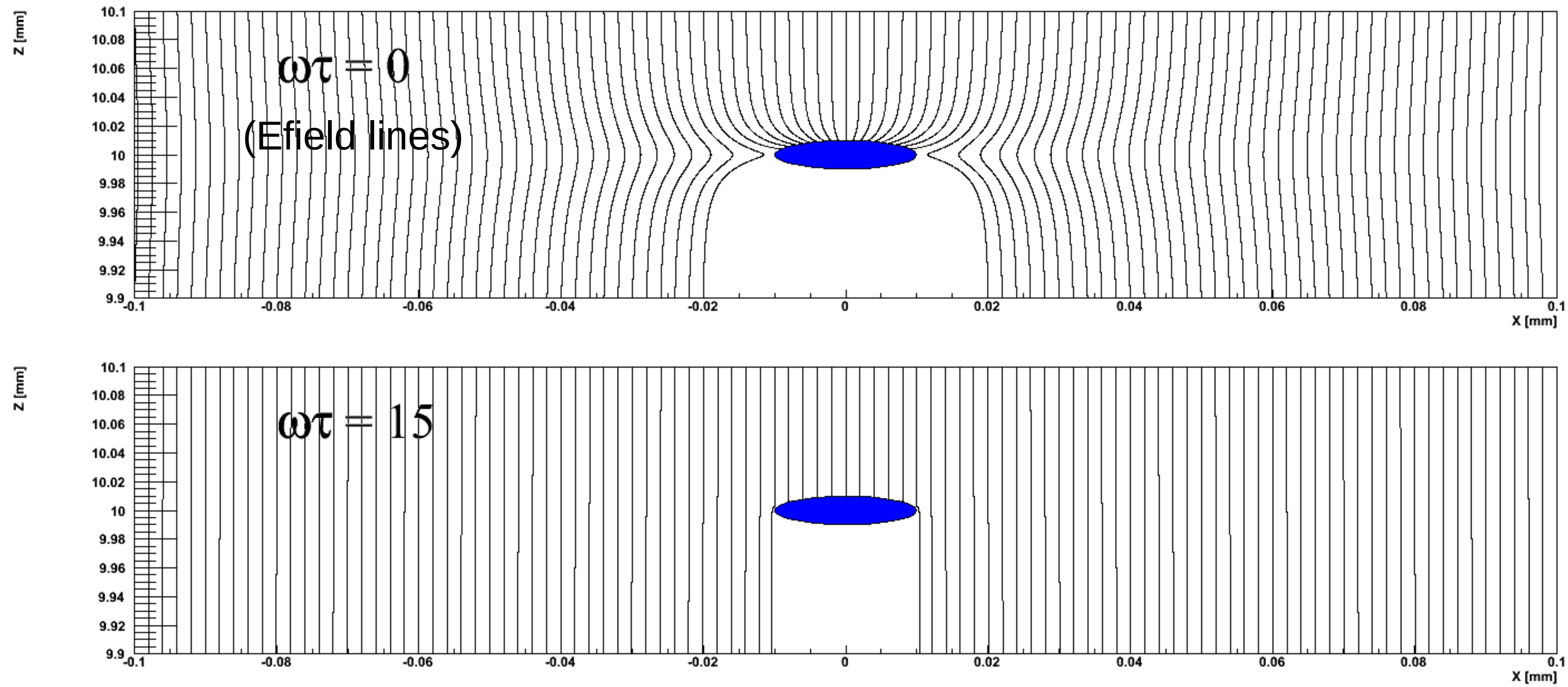




Effects on electron position resolution

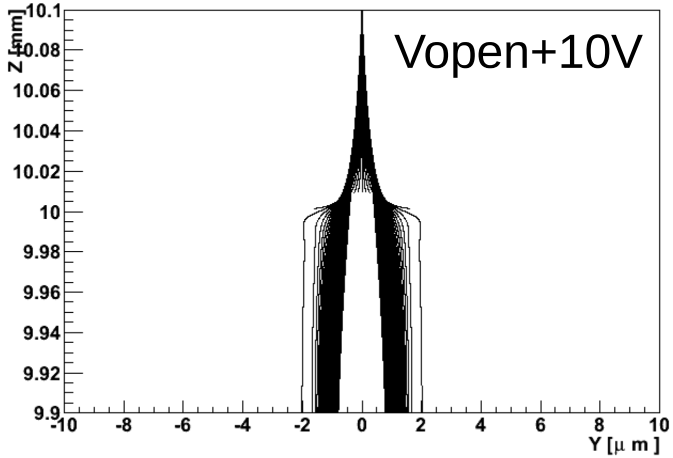
- With large $\omega\tau$, the electrons follow the magnetic field
  - no displacement perpendicular to the wires
- ExB effect close to the wire
  - possible significant displacement along the wire
- *These effects should have less influence on the momentum resolution in a radial config*

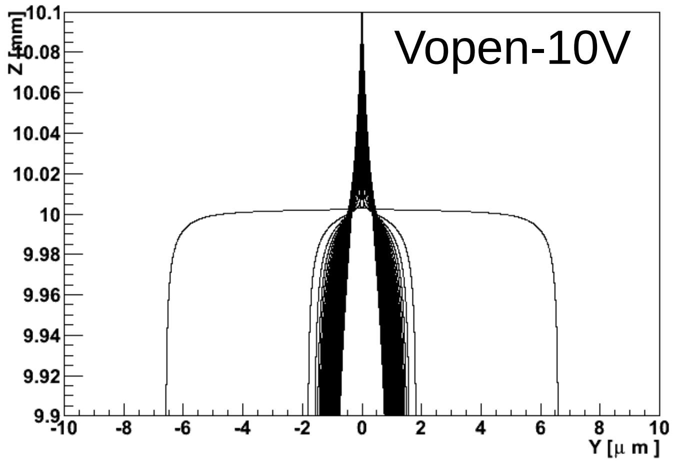
Deviation perpendicular to the wires

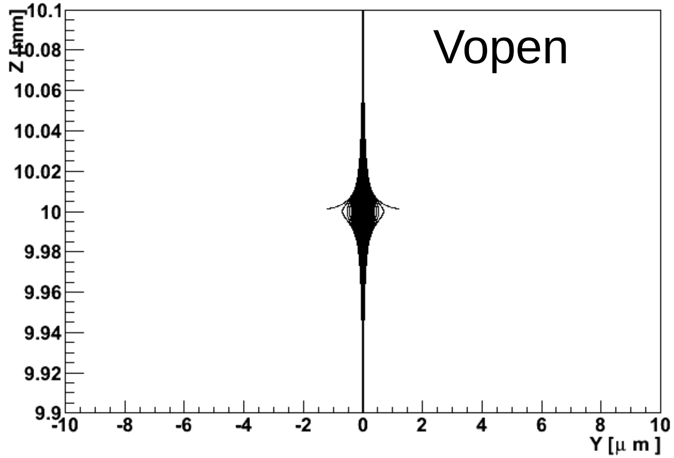


Almost no deviation perpendicular to the wires (~1um)
Opacity = 2xRwire/Spacing ~ 1%

Deviation along the wire







For the ideal open voltage, the deviation are of the order of 1 micron
For a voltage slightly off, it should no go beyond a few microns

<u>This should still be tested experimentally</u>

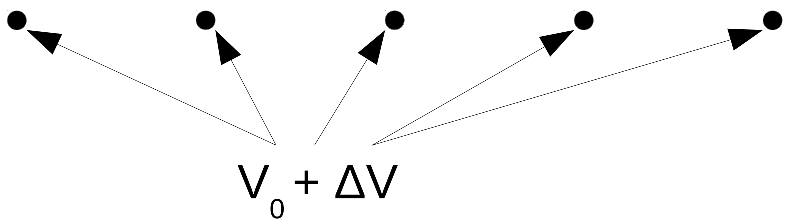
Angular effects

- For high momentum tracks, there is the possibility that the track is on top of a wire
  - Probability ~2*Rwire/Pitch~0.02 (Rwire~10um, pitch~1mm)
  - The radius of influence of the wire is R_{wire}~10um, smaller the electron cloud after diffusion
  - Effect should average out over multiple modules

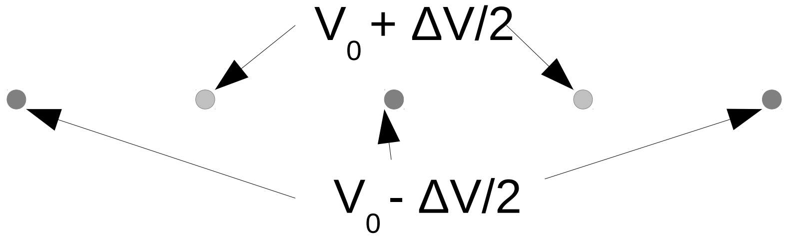
  => <u>The effect on momentum resolution should be negligible</u>
- Might have a significant effect on dE/dx resolution at high momentum

Closed Gate configuration

- Single voltage
  - Much simpler to implement
  - Higher voltages
  - More strain on the wires/sagging

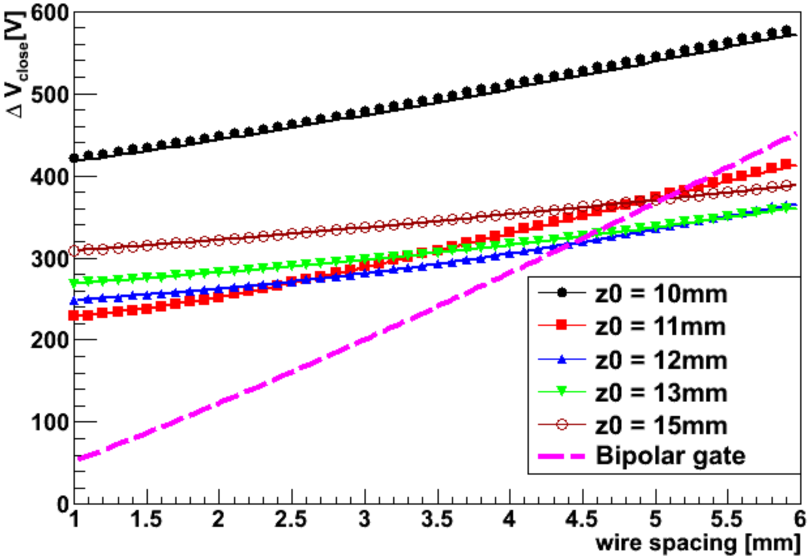


- Alternate potential
  - Lower voltages
  - Does not alter the drift field
  - Extra HV line required



Required voltage

- Need to maximize the wire spacing
  - 1mm => 10kg tension on the frame
- Need to close the region up to 1cm from the readout (ion disc)
  - single potential: gate needs to be a bit further
-



For single potential, V_{close} is such that $E_z(z=1cm)$ is negative

(dots from Garfield++, lines from formula)

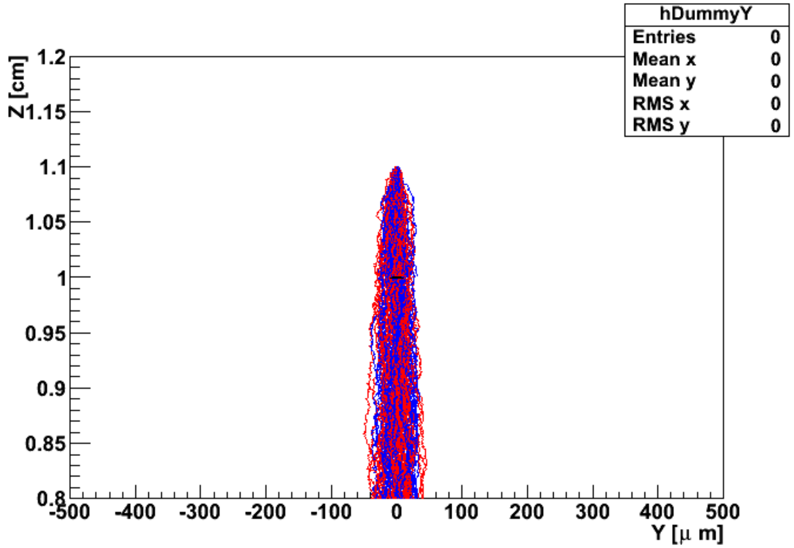
Conclusions

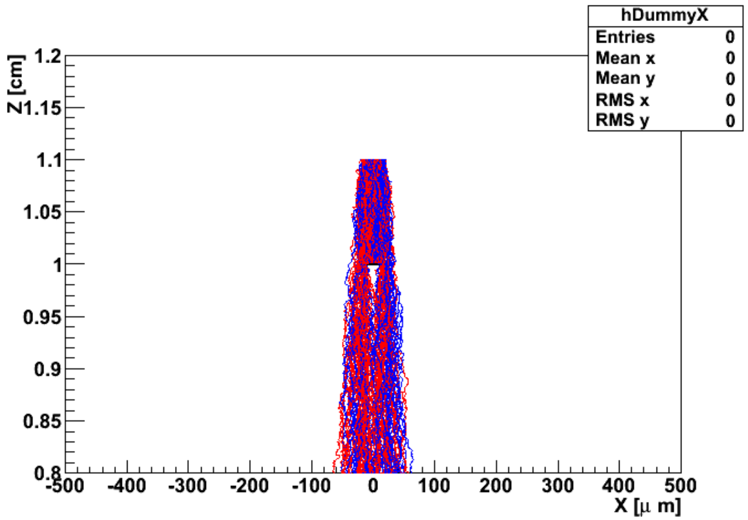
- After preliminary considerations, I think that a radial wire grid is a viable candidate for a gating system
  - Open gate with V matching E_{drift} (non maximal transparency, but minimal distortions)
  - Closed gate with single potential can be considered
- Possible on ceramic frame]
  - Preliminary study by REPIC
- Such a gate should be tested in high magnetic field to get realistic ExB effects

GEM gate

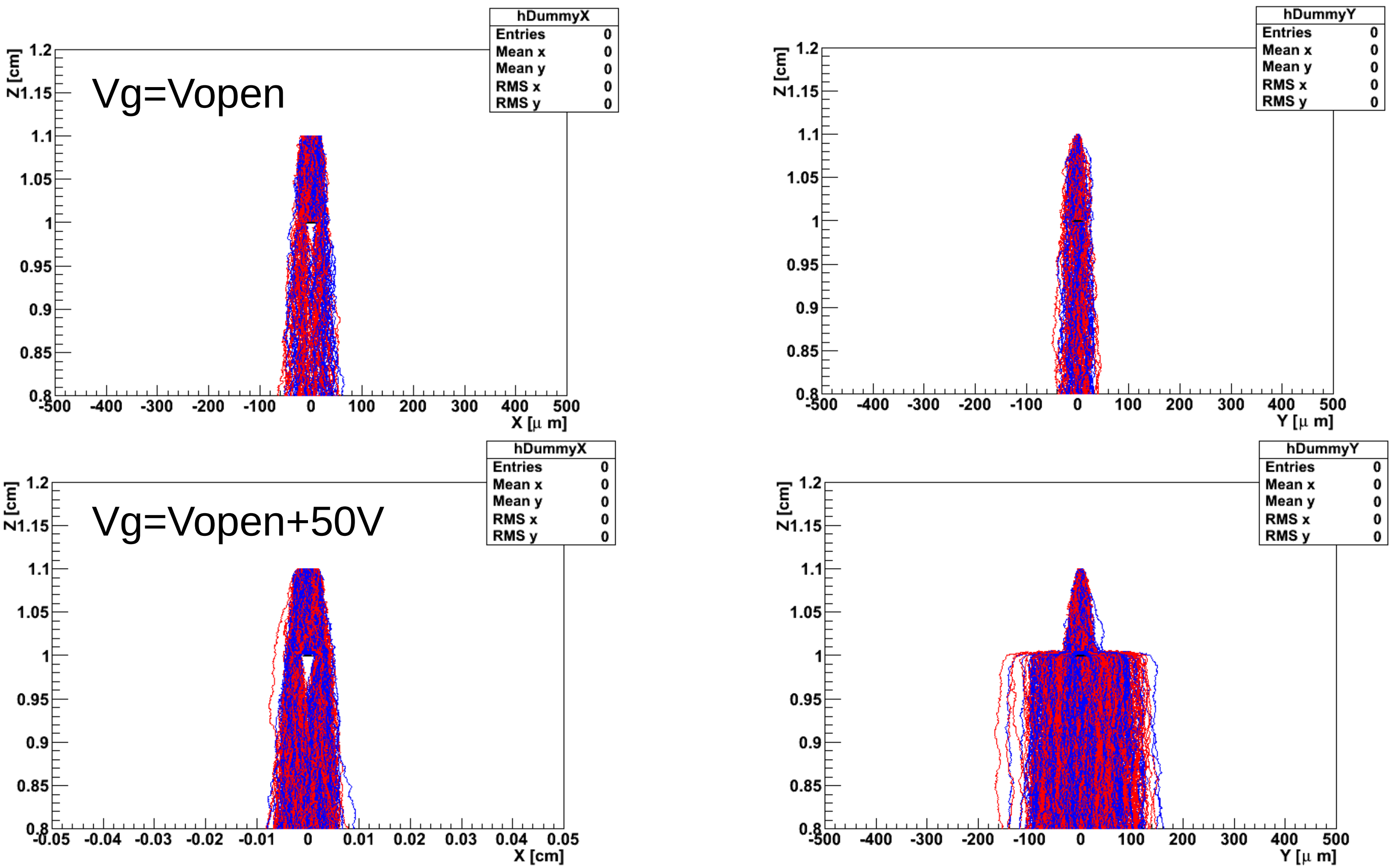
- GEM gate studies continue in Saga
- Not much progress unfortunately
- Simulation with Garfield++ finally consistent

Back up


hDummyY
Entries 0
Mean x 0
Mean y 0
RMS x 0
RMS y 0
Z [cm]
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
-500 -400 -300 -200 -100 0 100 200 300 400 500
Y [μ m]


hDummyX
Entries 0
Mean x 0
Mean y 0
RMS x 0
RMS y 0
Z [cm]
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
-500 -400 -300 -200 -100 0 100 200 300 400 500
X [μ m]

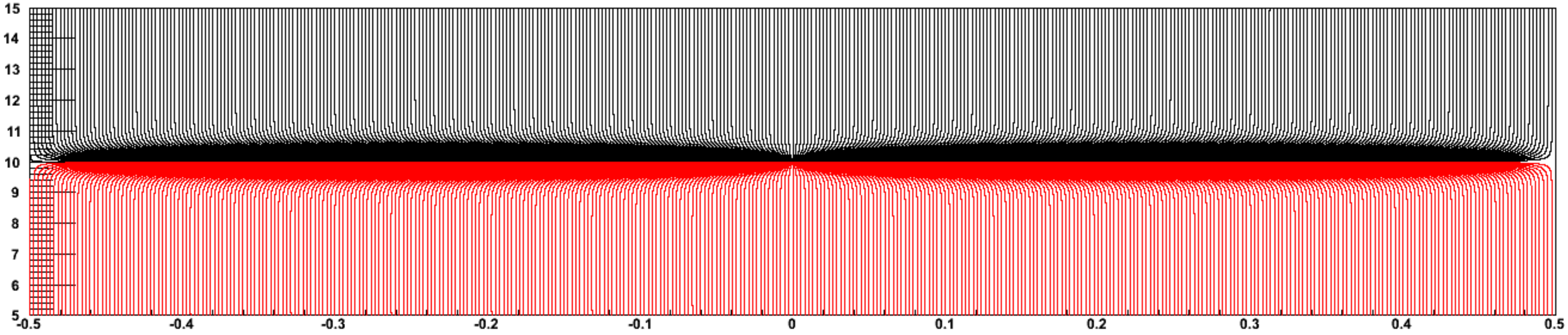
Garfield++



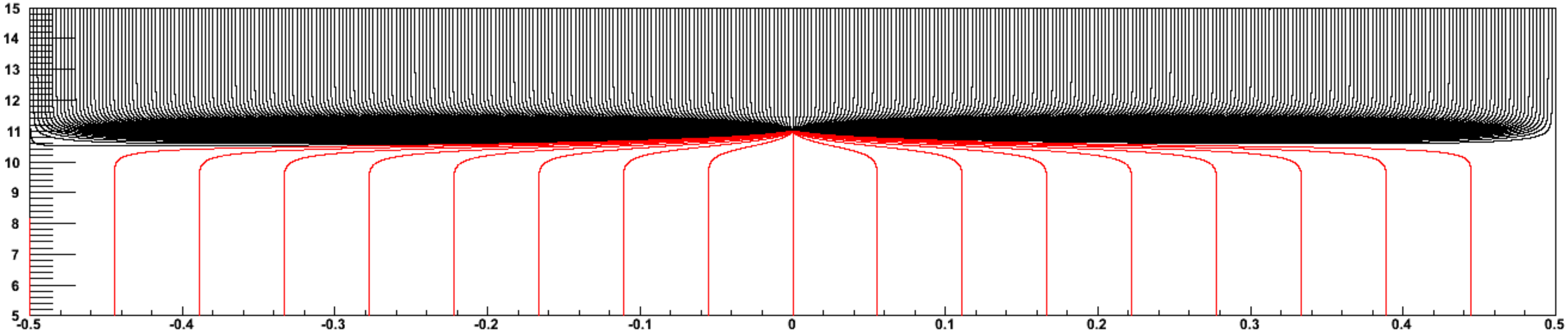
Vg=Vopen
Vg=Vopen+50V
hDummyX
hDummyY
Entries 0
Mean x 0
Mean y 0
RMS x 0
RMS y 0
Z [cm]
X [μ m]
Y [μ m]
X [cm]

E field, closed gate

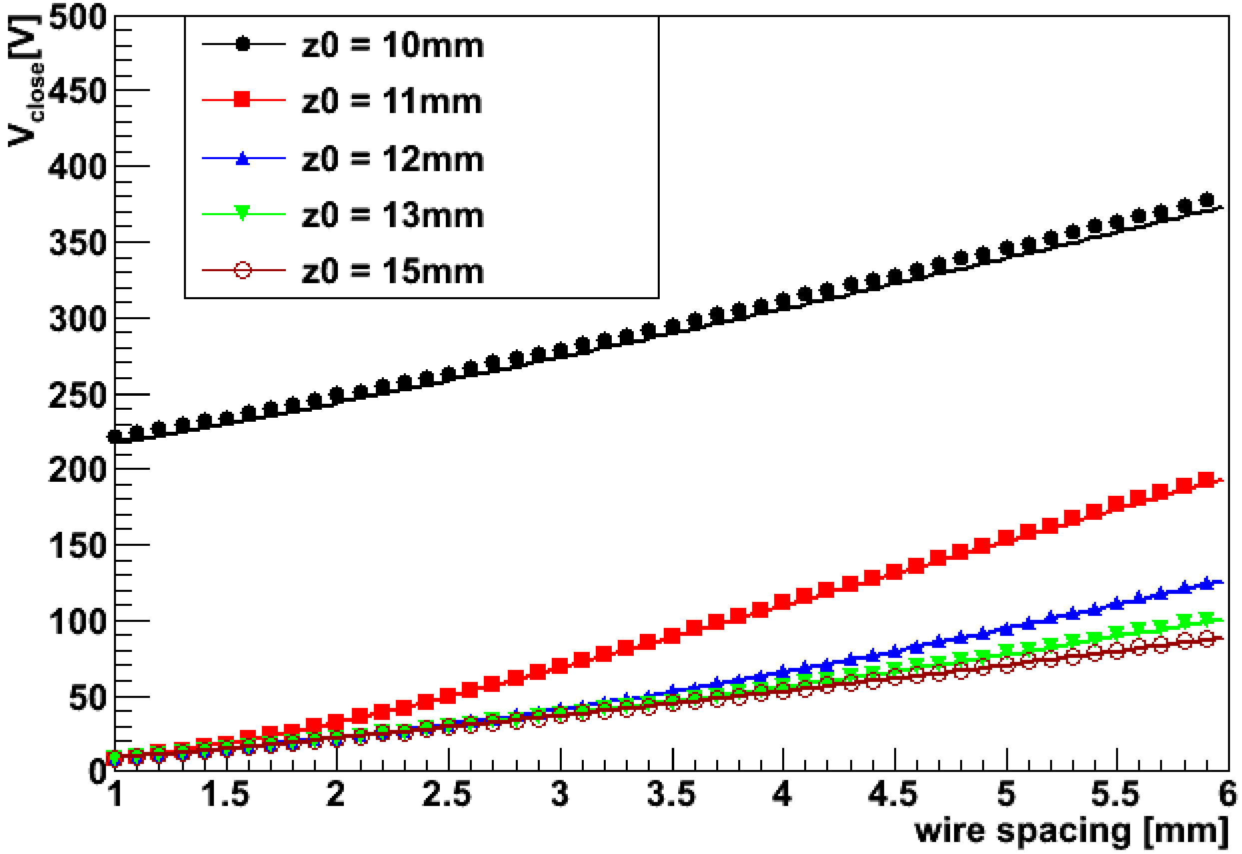
Zclosed = Zgate



Zclosed = Zgate - 1mm



Vclose



z0 = 10mm
z0 = 11mm
z0 = 12mm
z0 = 13mm
z0 = 15mm
V_{close}[V]
500
450
400
350
300
250
200
150
100
50
0
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
wire spacing [mm]