Silicon Detector Response Simulation

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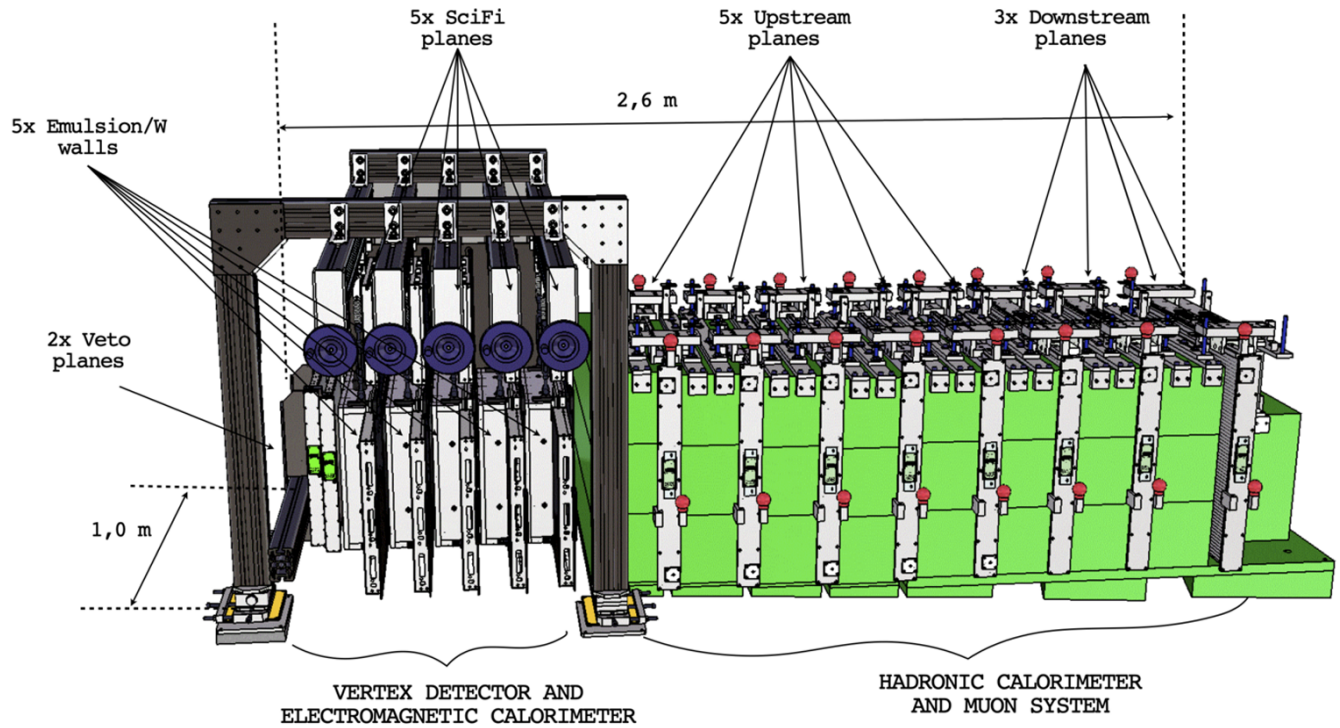
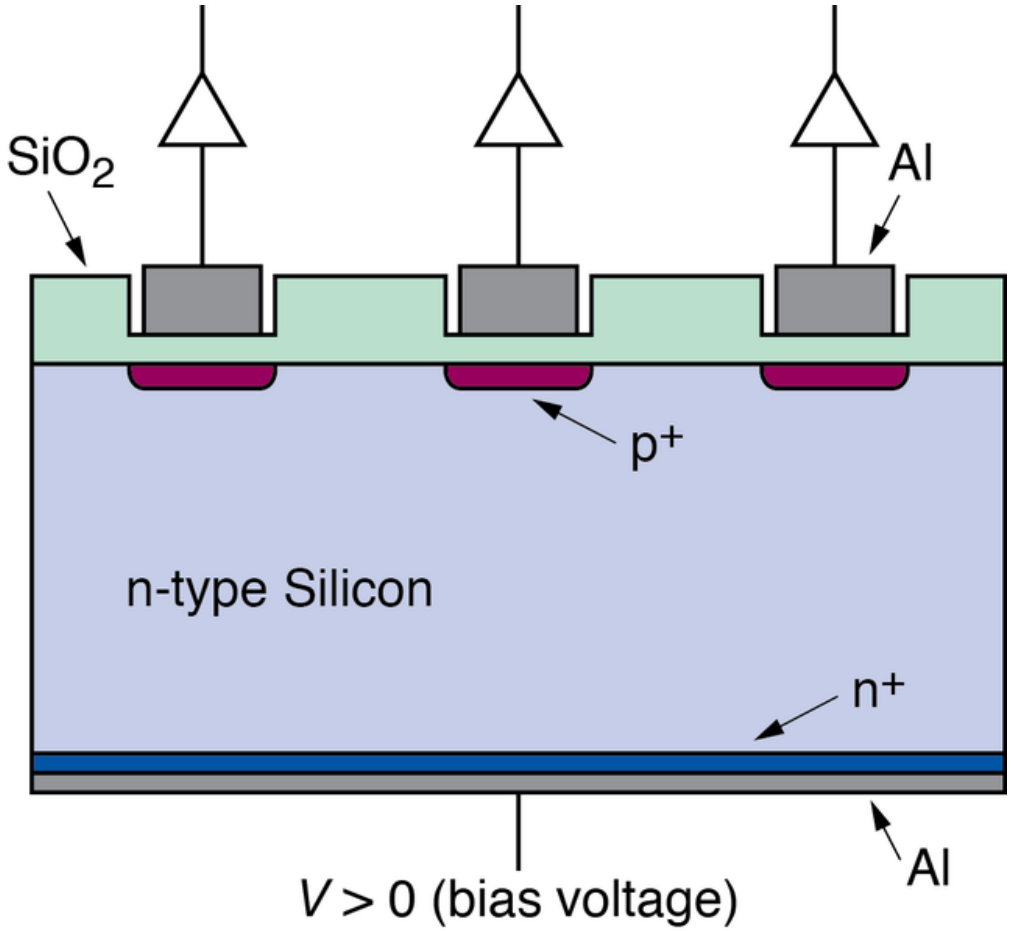
Advanced SND Experiment



Emulsions to be replaced with silicon strip sensors for operation during High Luminosity LHC

Silicon Strip Sensor



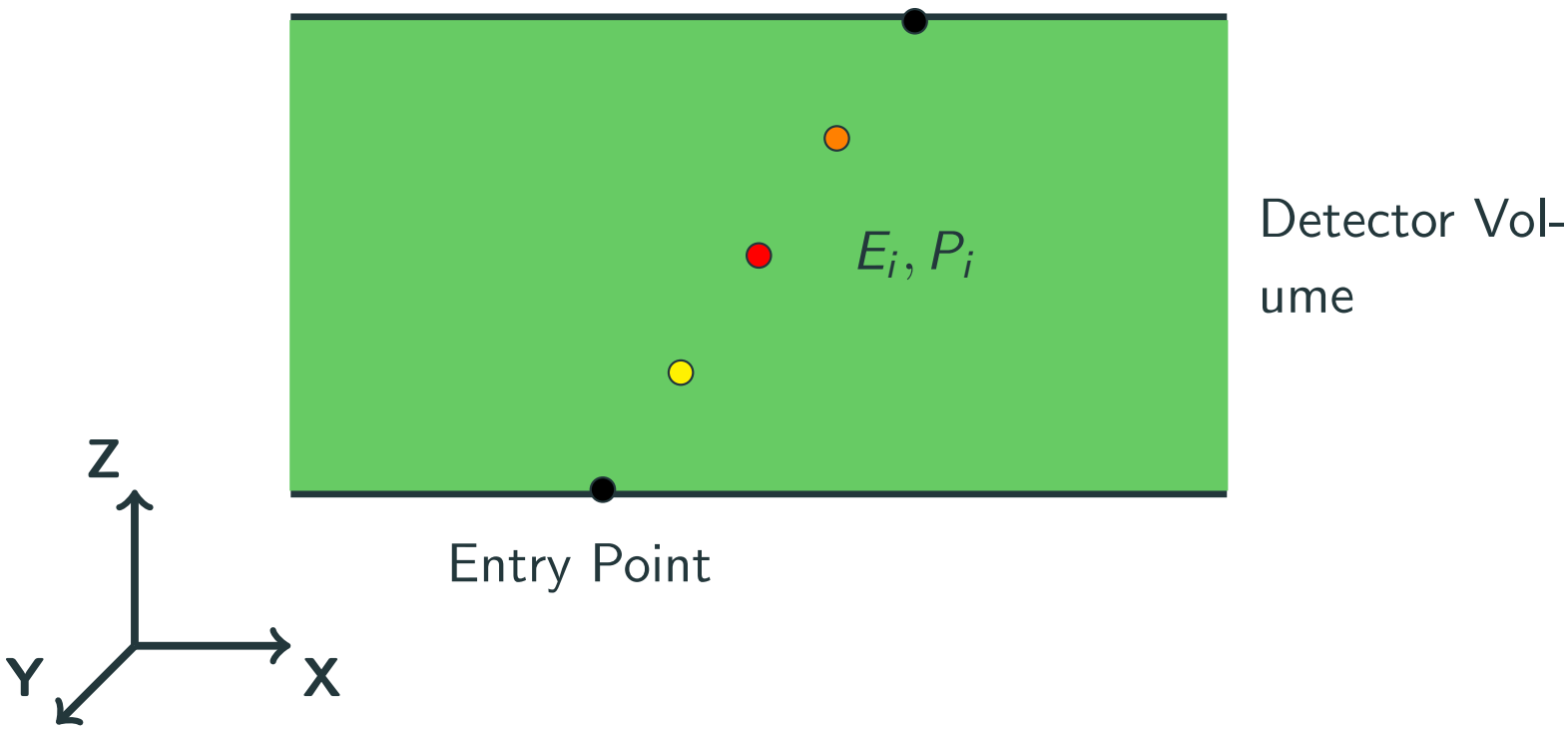
Fully depleted n bulk with p^+ strips connected to readout electronics

Procedure

Detector Response

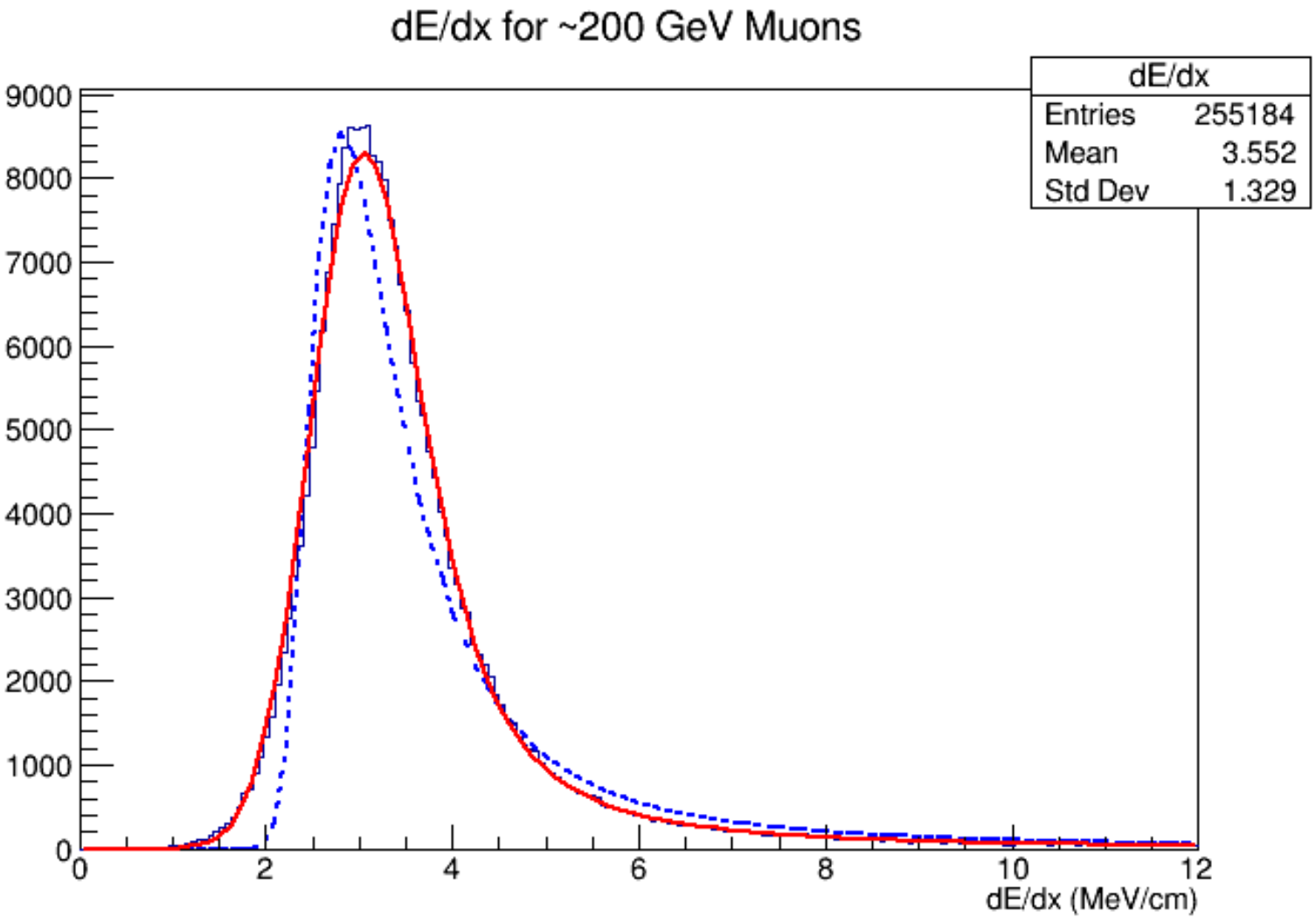
1. **Charge Division**
    - Energy fluctuation along particle track
2. **Charge Drift and Diffusion**
    - Calculate drift time of e-h pairs
    - Calculate diffusion area of charge on surface
3. **Induced Charge**
    - Integrate charge along strip

Charge Division

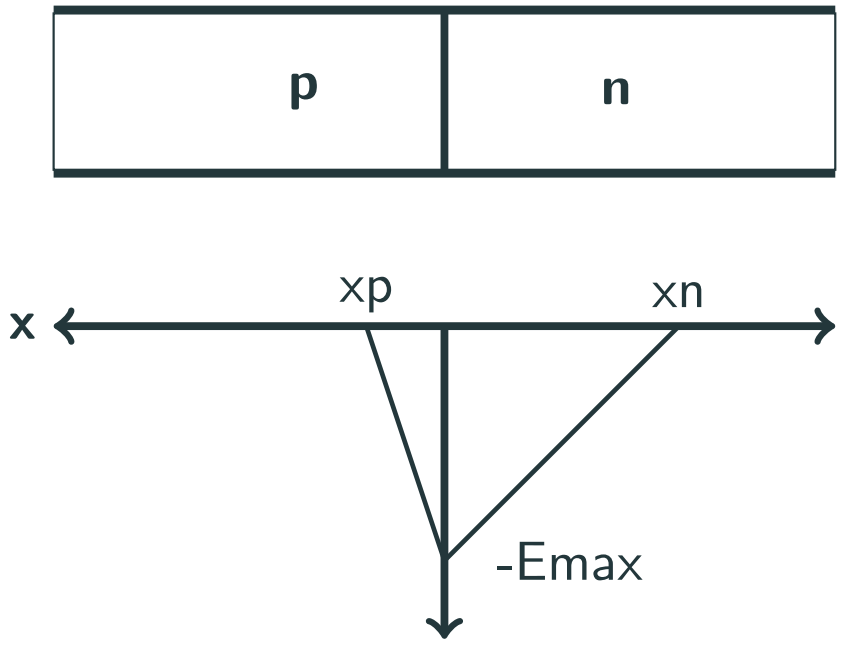


- Returns subsegment position
- Returns energy loss in subsegment

dE/dx

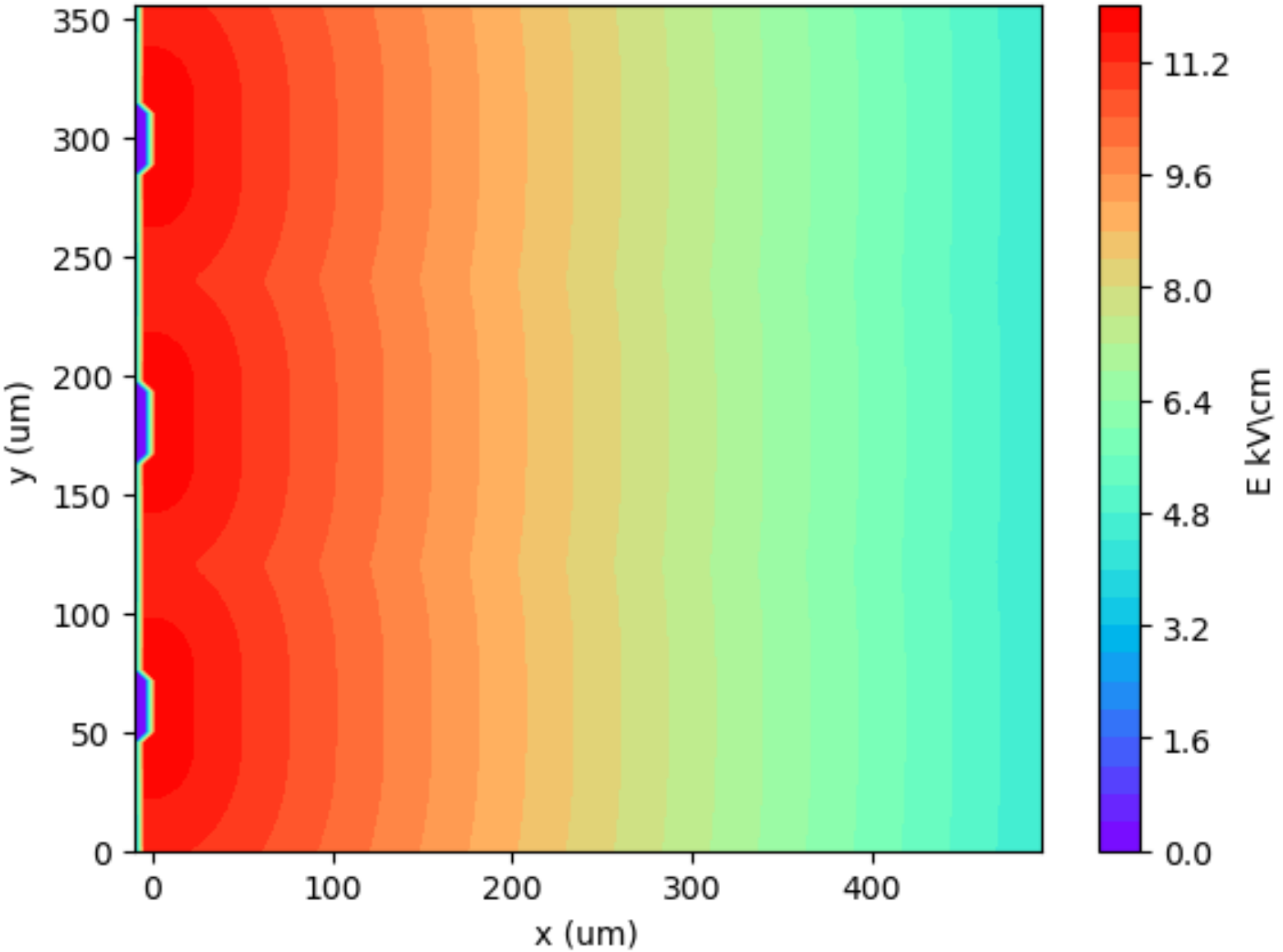

dE/dx for ~200 GeV Muons
dE/dx
Entries 255184
Mean 3.552
Std Dev 1.329
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
dE/dx (MeV/cm)

Electric Field

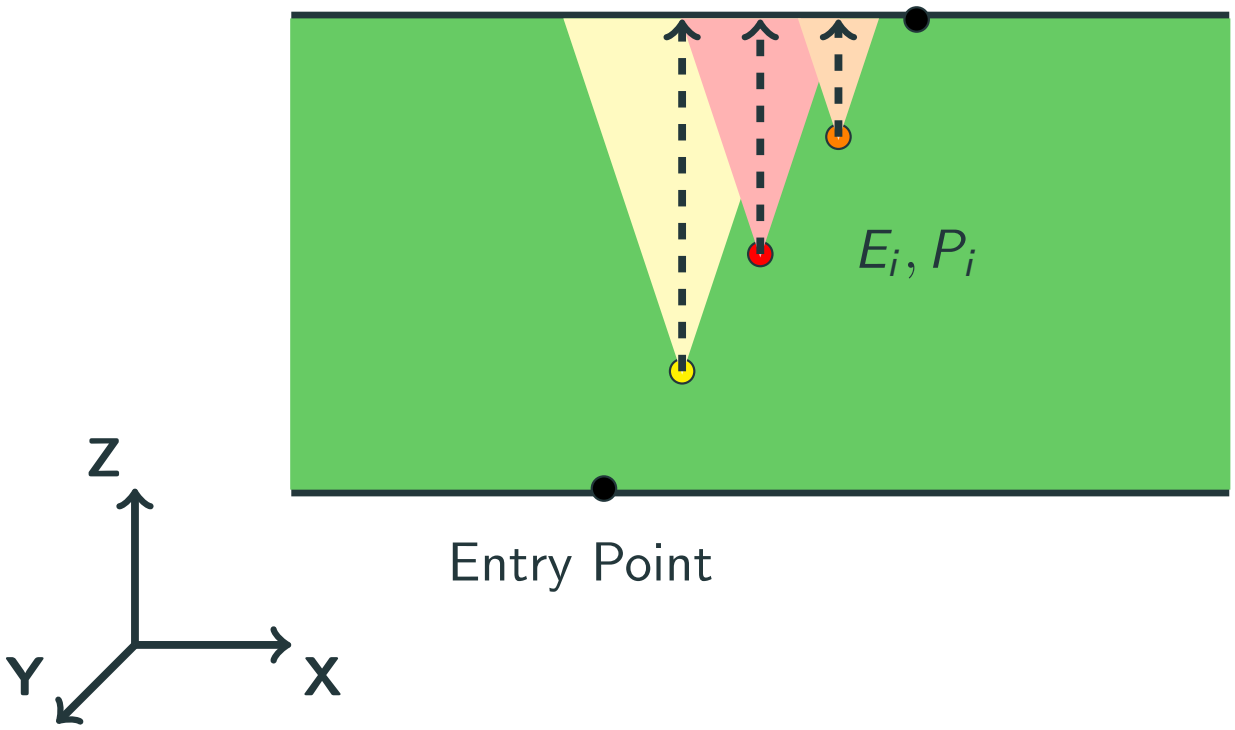


$$E = \begin{cases} -\frac{qN_A}{\epsilon}x - \frac{qN_A}{\epsilon}x_p, & \text{, for } -x_p \leq x < 0 \\ \frac{qN_D}{\epsilon}x - \frac{qN_D}{\epsilon}x_n, & \text{, for } 0 \leq x < x_n \end{cases}$$

Electric Field



Charge Drift and Diffusion



Calculated fraction of module to drift through

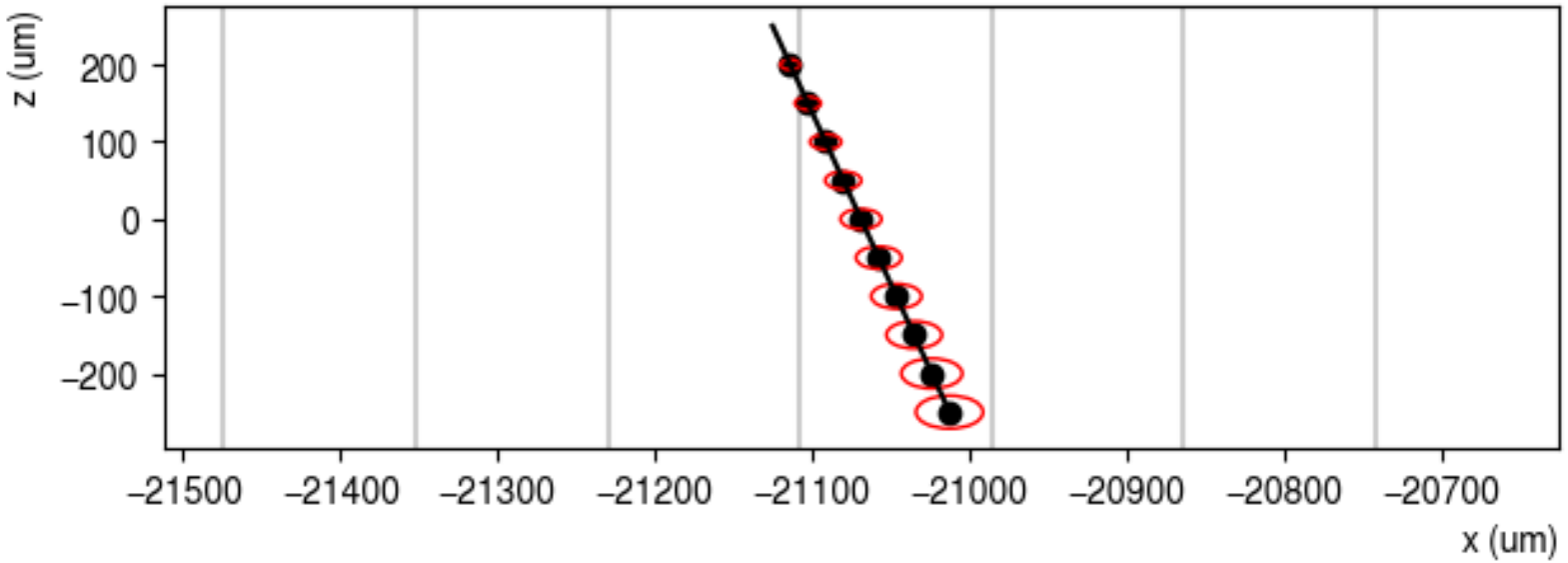
Calculated drift time and spread : $\sigma = \sqrt{2Dt}$

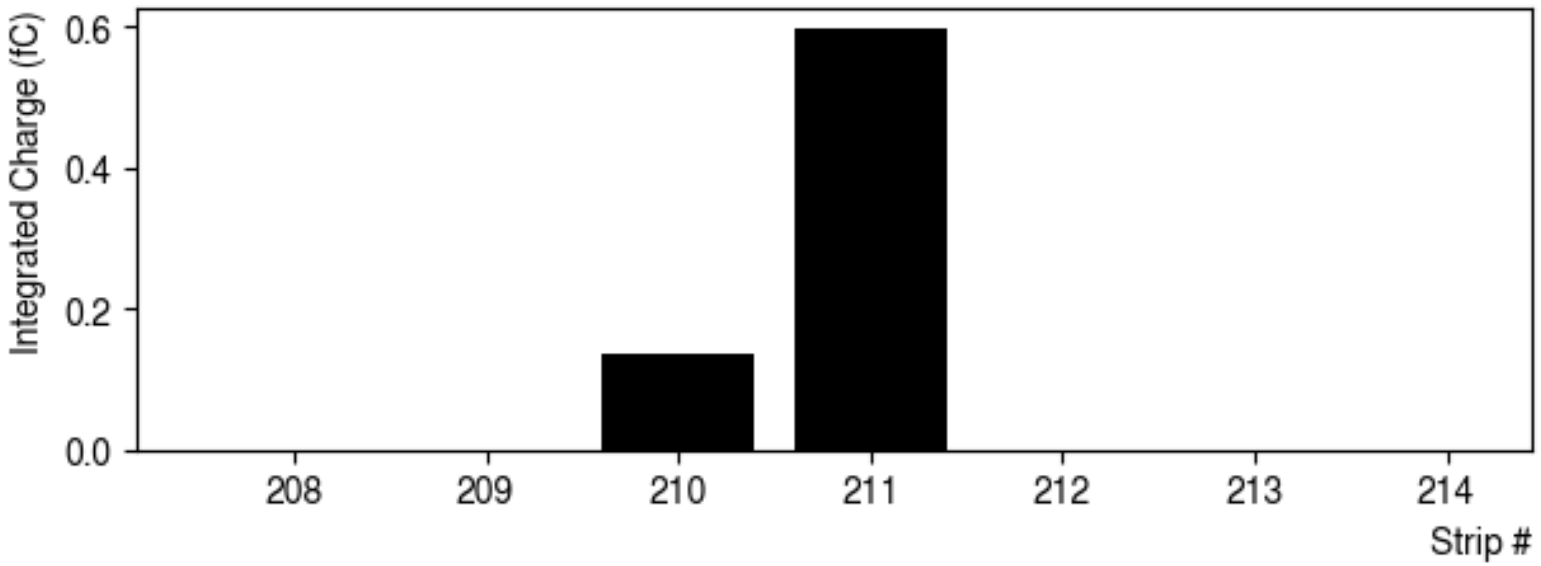
Induced Charge

- Vectorize to strips

  $\Rightarrow 3\sigma\pm$ Surface Position / Pitch
- $n_h = \frac{Eloss}{3.61eV}$
- Integrate over Gaussian diffusion for each strip
- Normalize with n_h

Induced Charge





References

[1] G. Acampora et al, SND@LHC: the scattering and neutrino detector at the LHC, 2024 JINST 19 P05067

[2] P. Azzurri et al, The CMS Silicon Strip Tracker, J.Phys.Conf.Ser. 41 (2006) 127-134

[3] S Meroli et al, Energy loss measurement for charged particles in very thin silicon layers, 2011 JINST 6 P06013

[4] M.Brigida et al. A new Monte Carlo code for full simulation of silicon strip detectors, Nucl. Instrum. Meth. A **533**, 322-343 (2004) doi:10.1016/j.nima.2004.05.127

Backup

Charge Division - Energy Loss Fluctuations

Distribution of energy loss of a particle in a material depends on the significance parameter.

- Significance parameter :

$$\kappa = \frac{\xi}{E_{max}} \tag{1}$$

- $\kappa > 10 \rightarrow$ Gaussian distribution
- $0.01 < \kappa < 10 \rightarrow$ Vailov distribution
- $\kappa < 0.01 \rightarrow$ Landau distribution
- Need to take into account atom binding energies for thin materials (Gauss $*$ Landau)