Mirror charges

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Motivation

- Reconstruction of event position
  - distinction between multi site and single site events
  - homogeneity of 0nbb in detector volume
- Verification of simulation

Outline

- Characteristics of mirror charges
- Parameters to describe mirror charges

Characteristics of mirror charges: Origin

In simulation:
pulse shape calculated using a **weighting potential (Φ)**:

Φ obtained by solving **Laplace equation**

$$\nabla^2 \Phi = 0$$

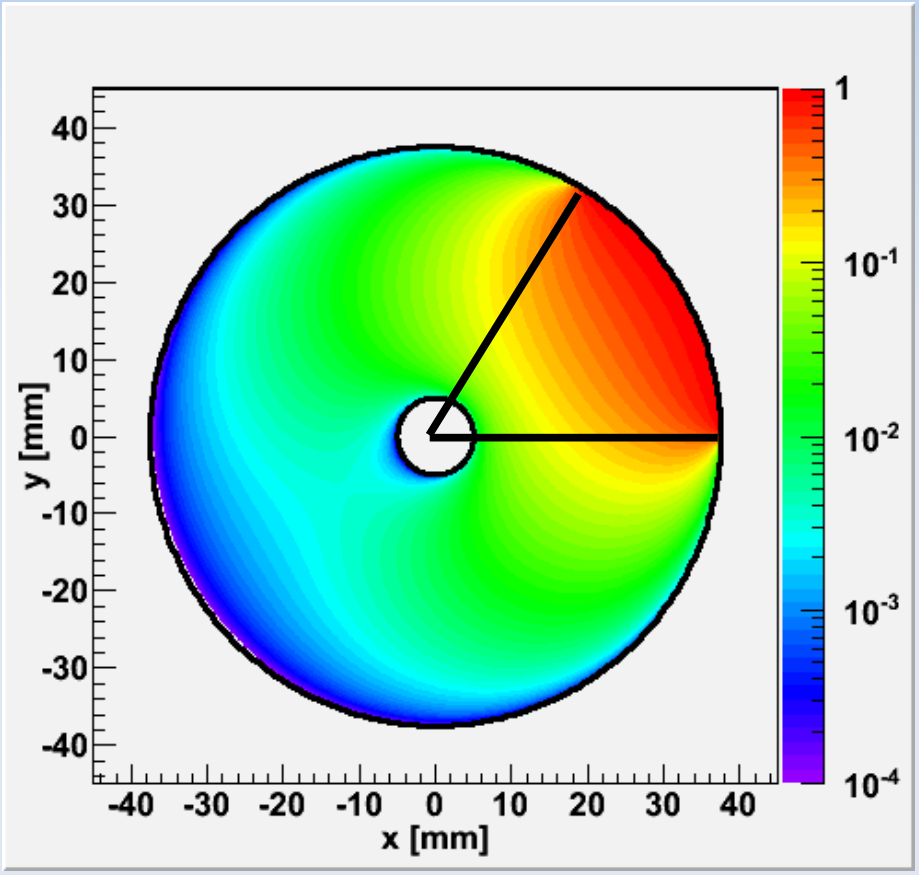
with **boundary conditions**

Pulse: $q(t) = -q_e * \Phi(\vec{r}_e(t)) + q_h * \Phi(\vec{r}_h(t))$

For a segment:
Φ=1 for this segment's boundary, Φ=0 for all other boundaries

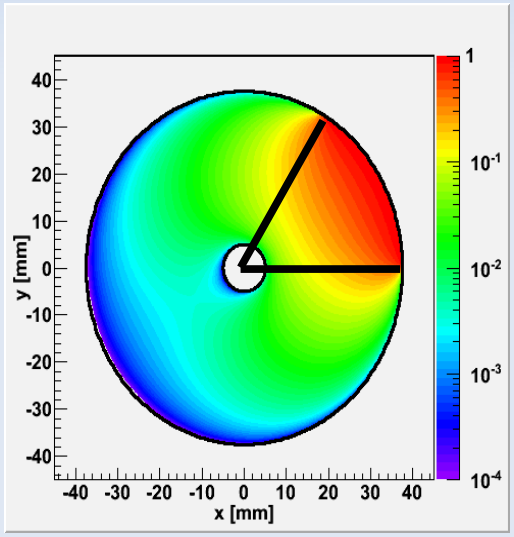
→ also charge drift in one of the other segments causes pulse in this segment

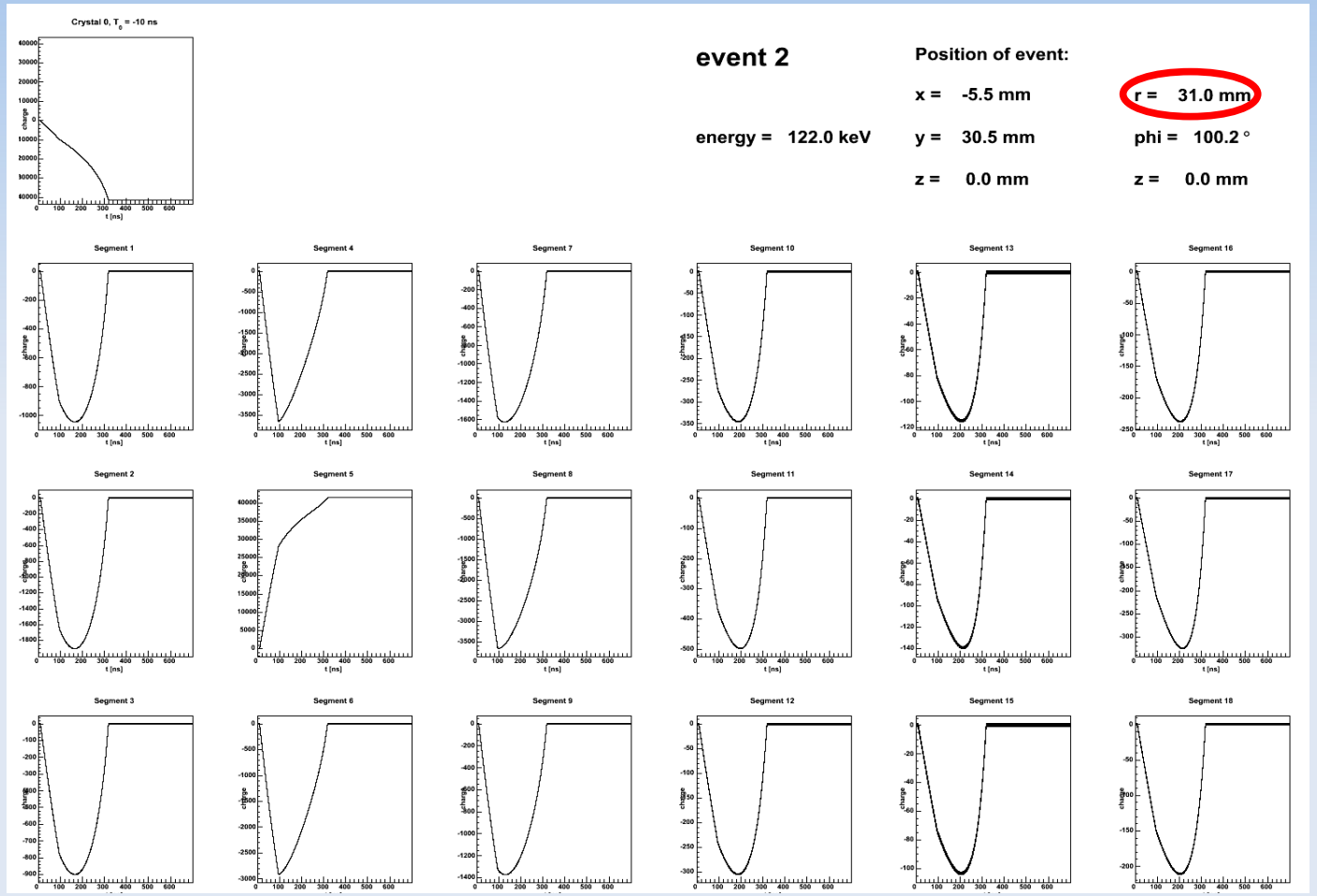
→ pulse drops to zero when boundary reached (Φ=0 for core and other segments)



Characteristics of mirror charges: Examples

One electron-hole pair drifting,
electrons drift to core,
holes to segment contact

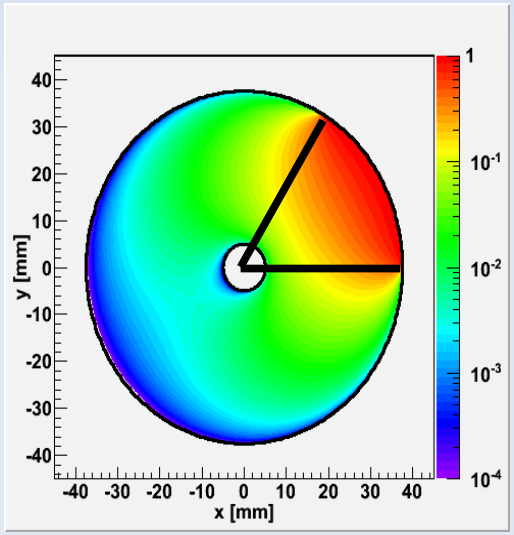


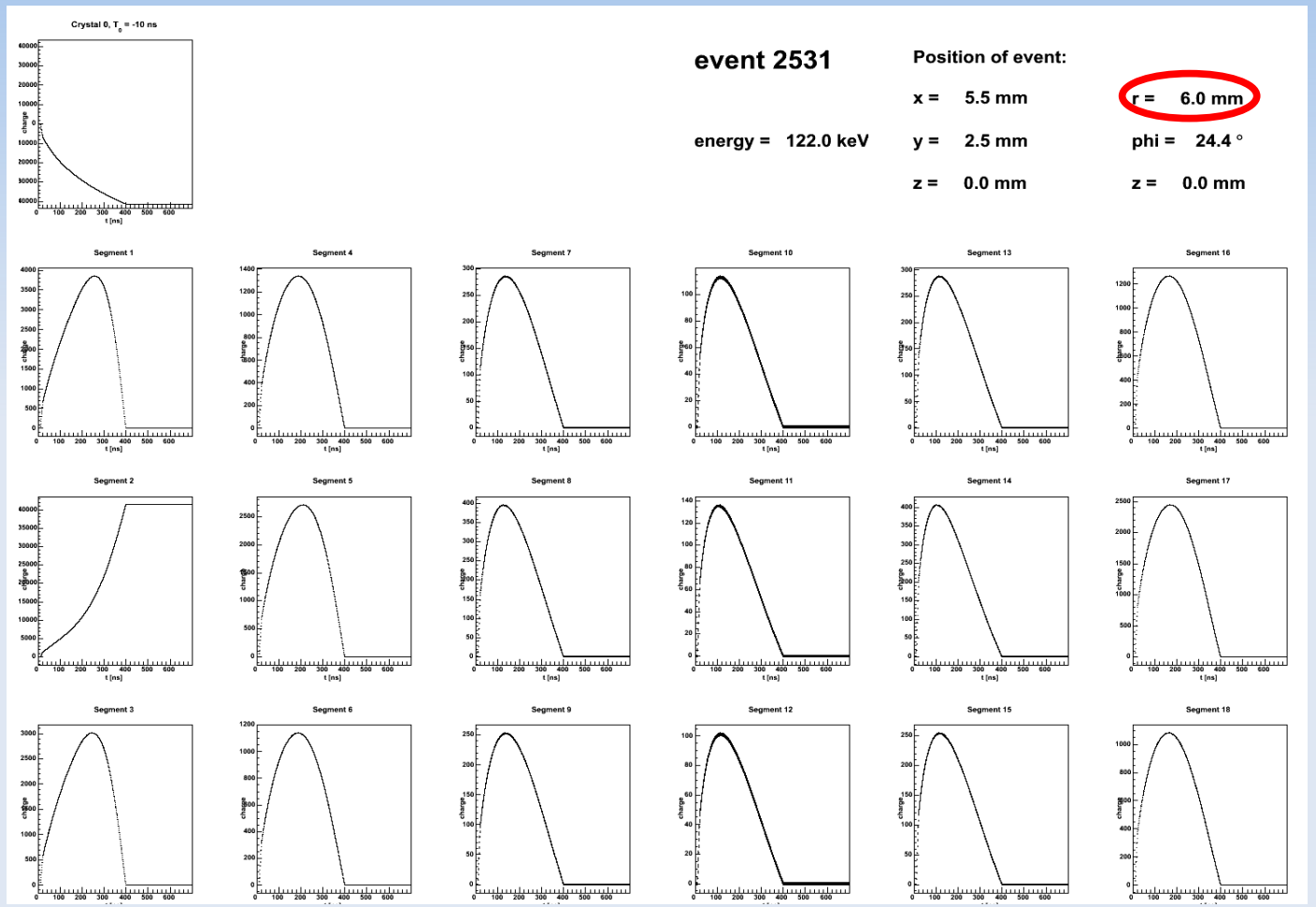


Negative mirror pulses: events close to outer segment boundary
electron drift towards core dominates pulse shape

Characteristics of mirror charges: Examples

One electron-hole pair drifting,
electrons drift to core,
holes to segment contact

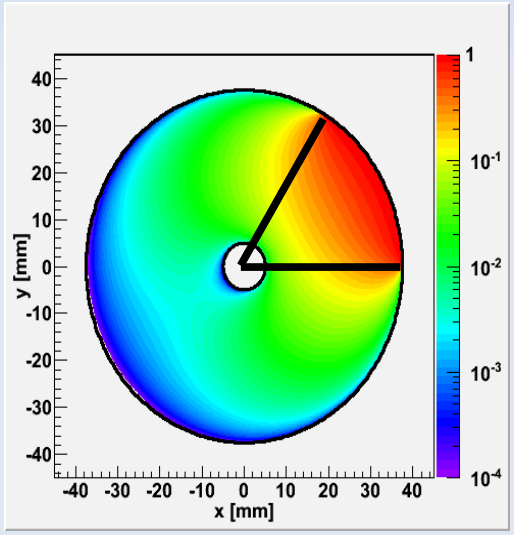


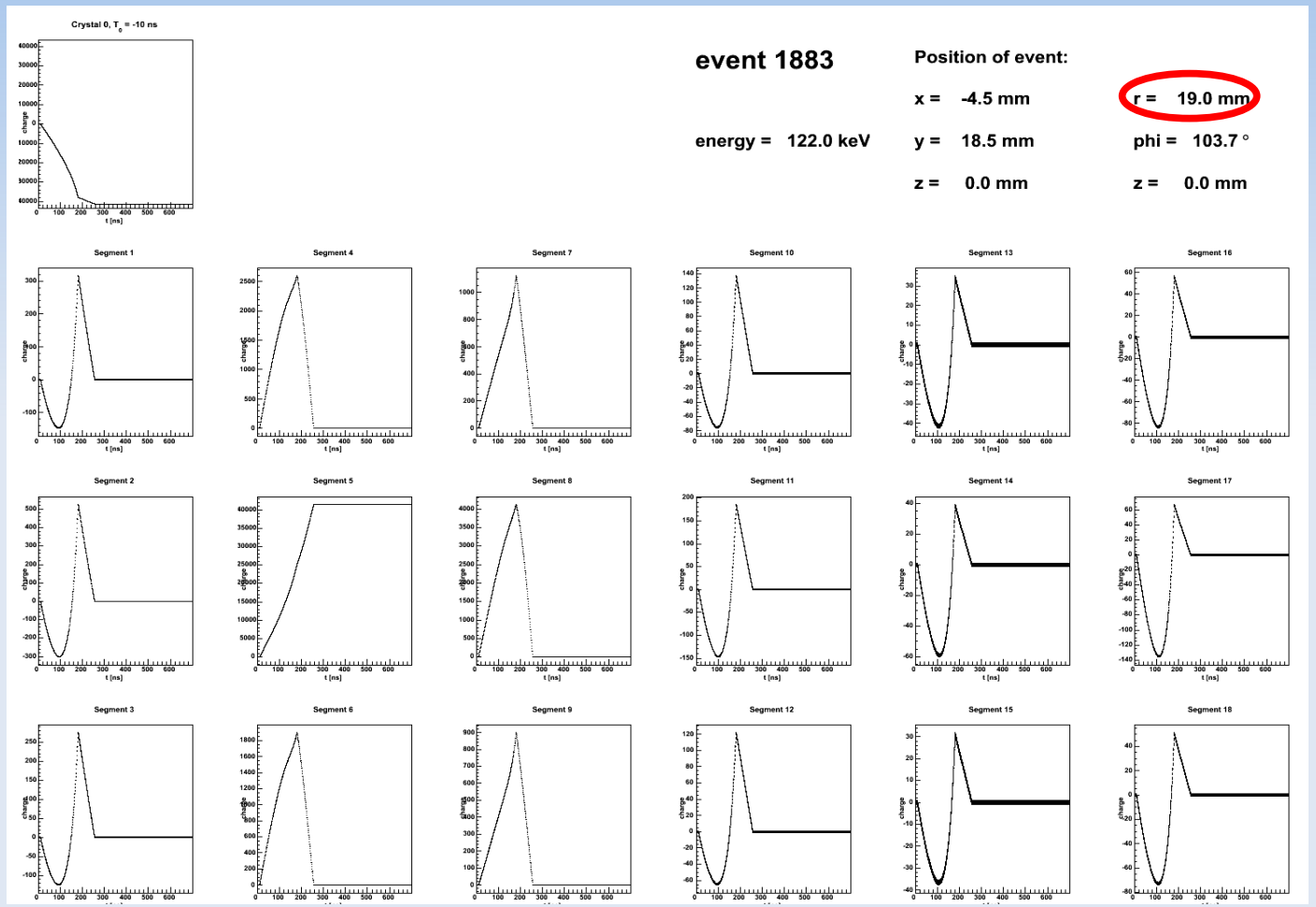


Positive mirror pulses: events close to core
hole drift towards outer contacts dominates pulse shape

Characteristics of mirror charges: Examples

One electron-hole pair drifting,
electrons drift to core,
holes to segment contact

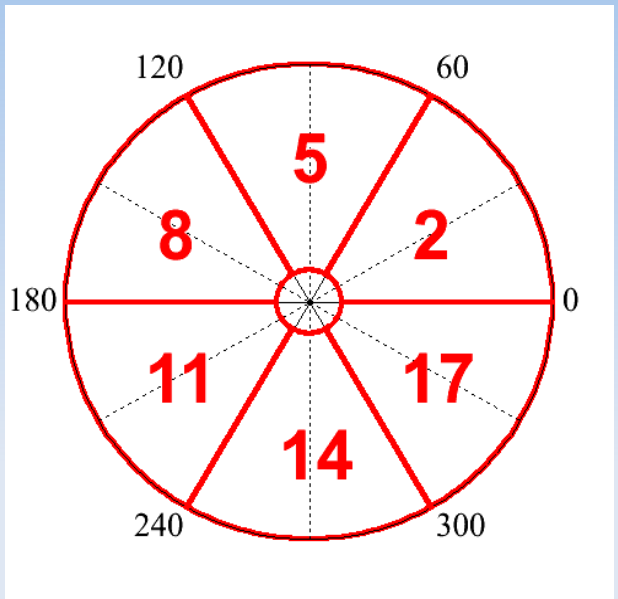




Positive and negative mirror pulses: events at intermediate radii
hole and electron both contribute

Parameters to describe mirror charges

To analyze dependency of mirror charges on radius and azimuth angle:



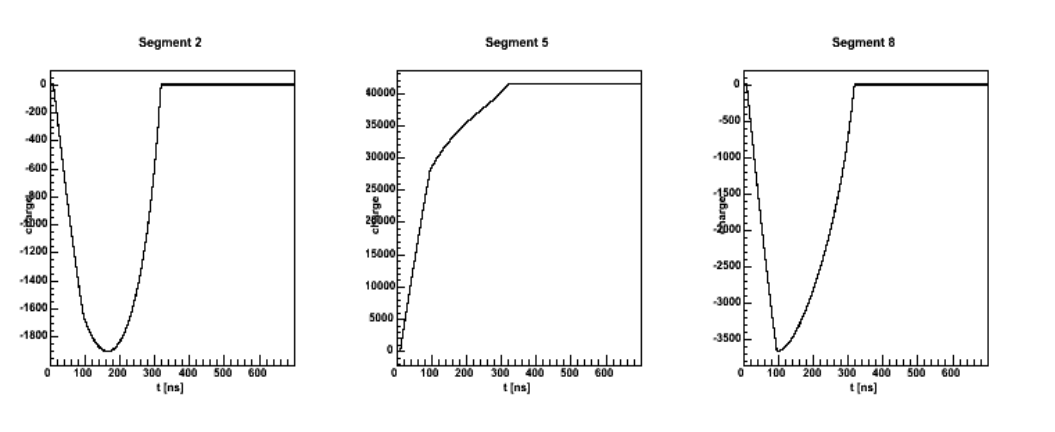
“Scan” one detector layer (steps of 1mm)

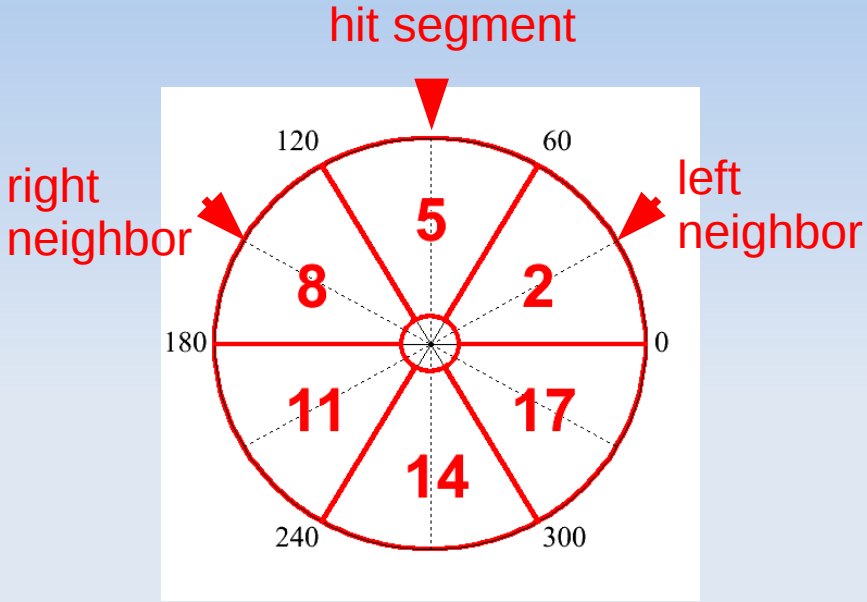
→ Simulate creation of electron-hole pair in respective position

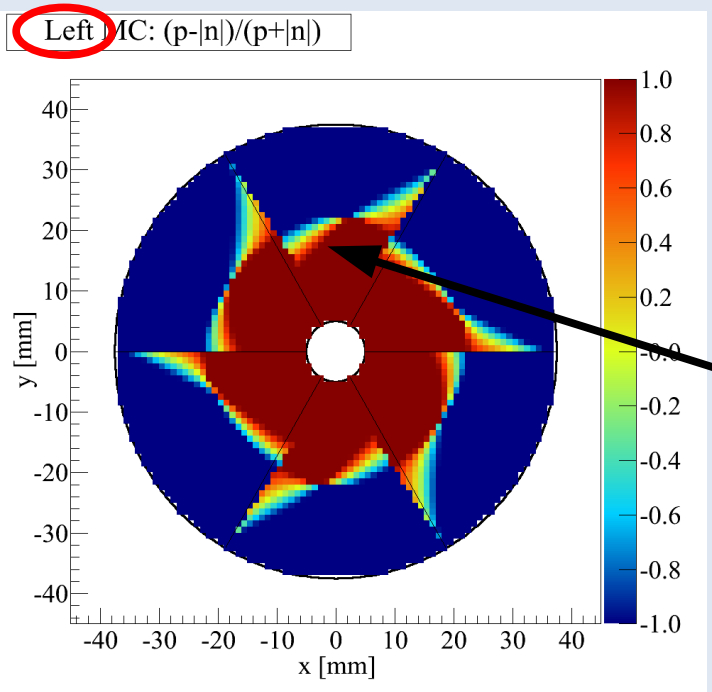
Find parameters that characterize mirror charge in next neighbor segments:

- Amplitudes
- Integrals
- Type (positive or negative amplitude)
- Left-Right Asymmetry

Parameters to describe mirror charges



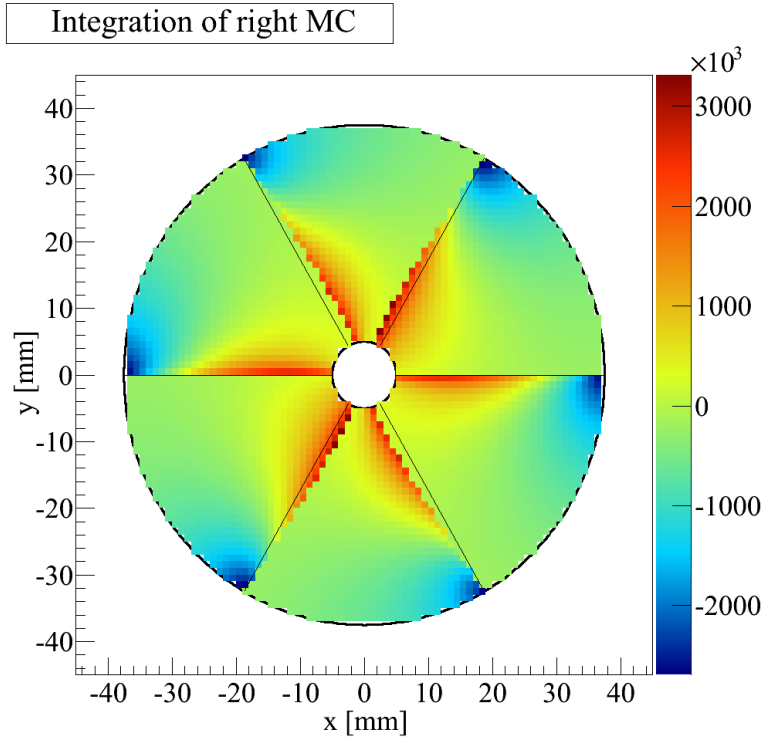


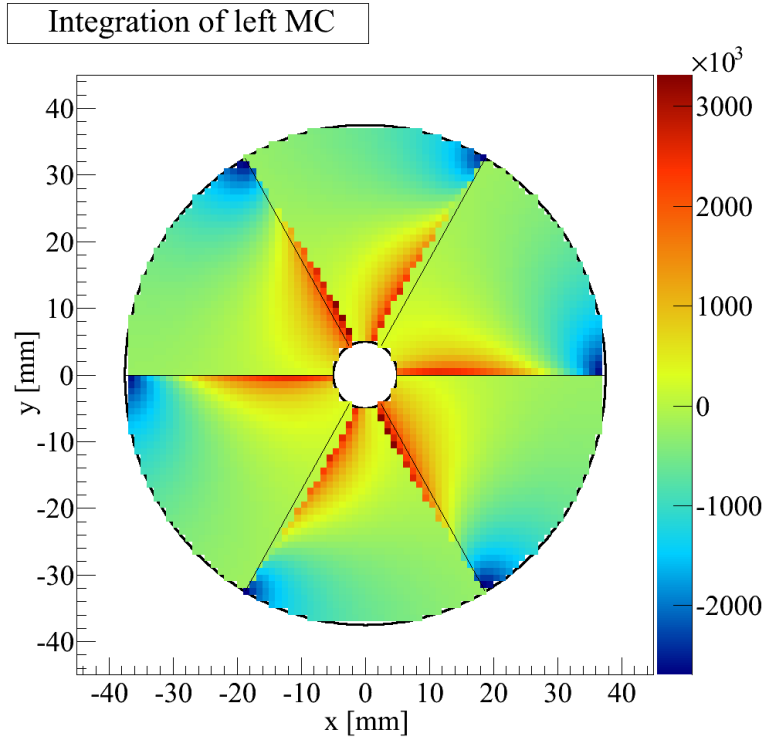


Electron-hole pair creation point

Plotted: parameter of mirror charge in left neighbor segment

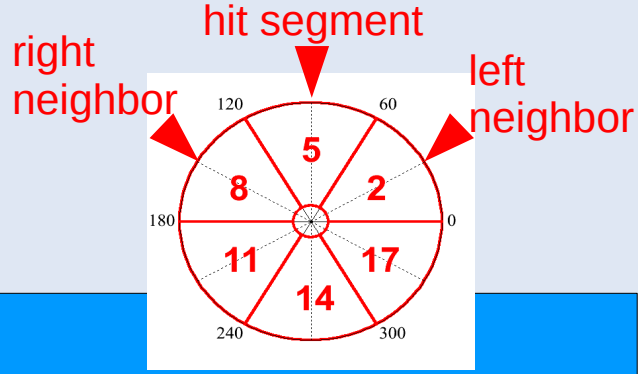
Parameters to describe mirror charges: Integral



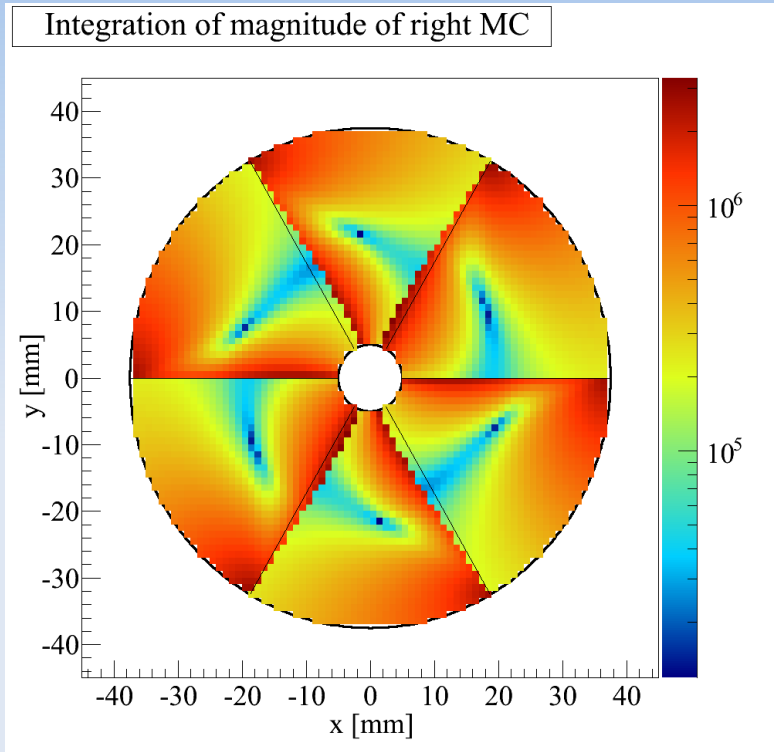


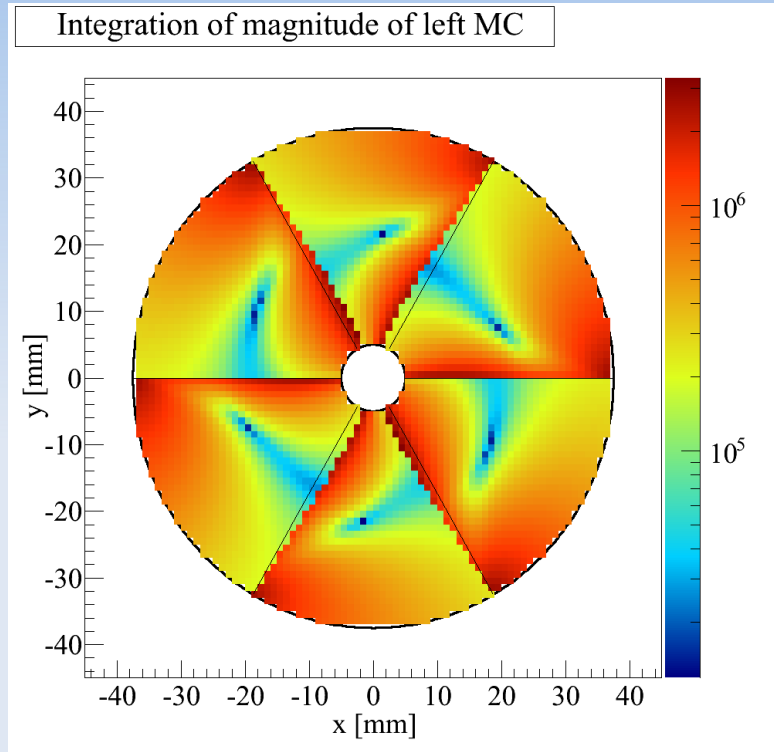
Integral of pulse:
variations in r and phi throughout entire layer

- dependent on position especially close to segment boundaries



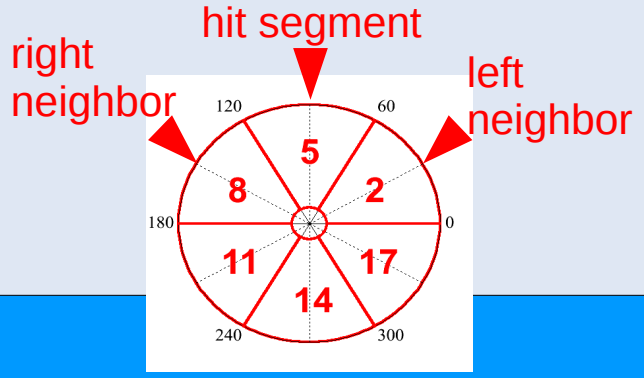
Parameters to describe mirror charges: Integral of magnitude



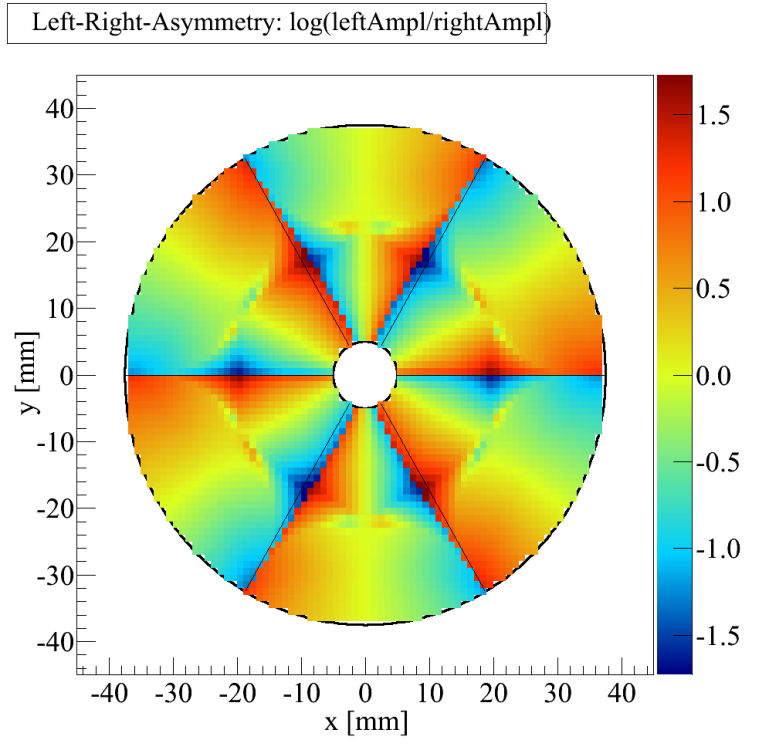


Integral of magnitude of pulse:
variations in r and phi throughout entire layer

- highly dependent on position throughout entire layer

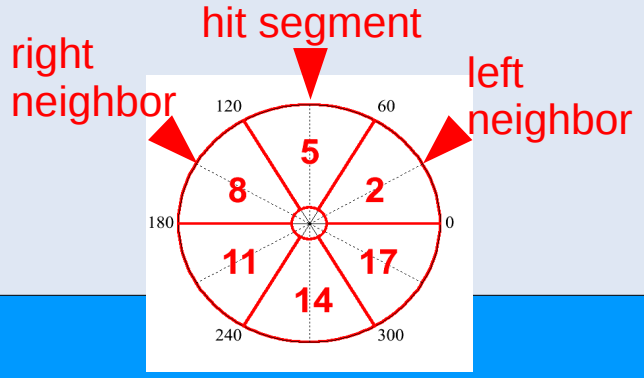


Parameters to describe mirror charges: Asymmetry

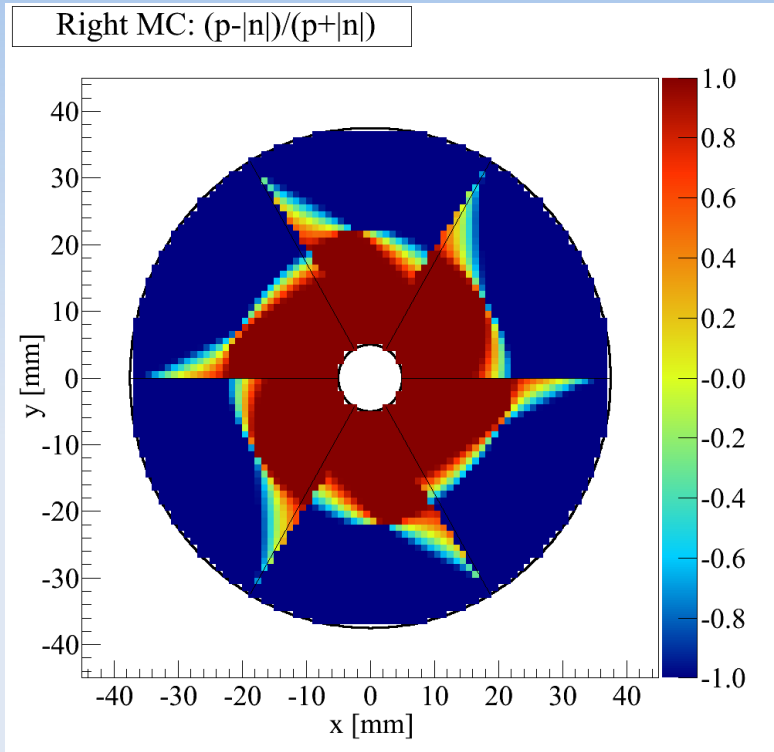


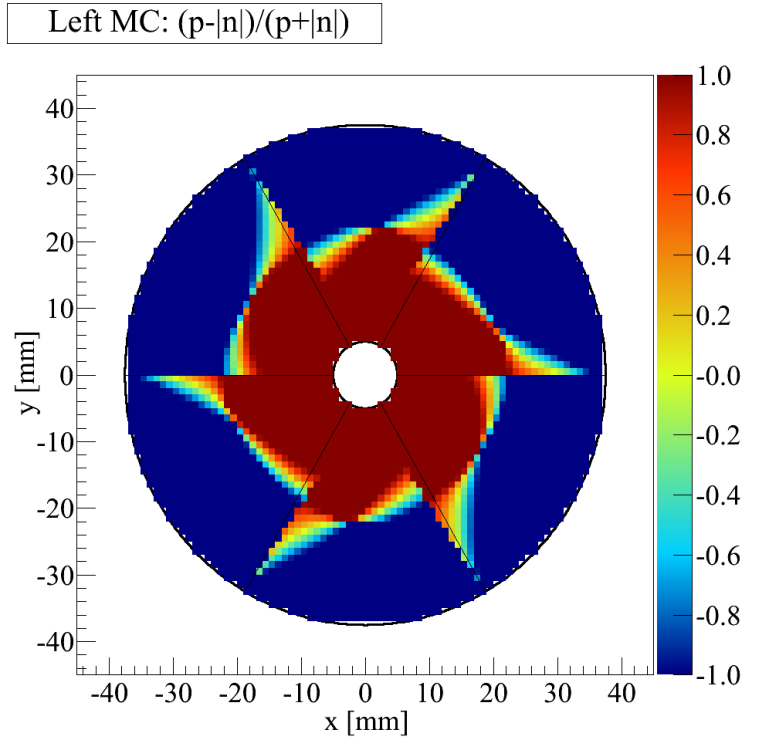
Asymmetry of left and right amplitude:

- highly dependent on phi (the closer the charge drift is to neighbor segment, the higher the amplitude of the mirror charge gets)



Parameters to describe mirror charges: Type of mirror charge

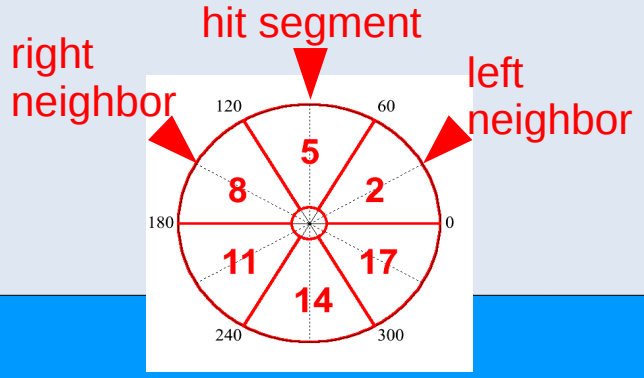




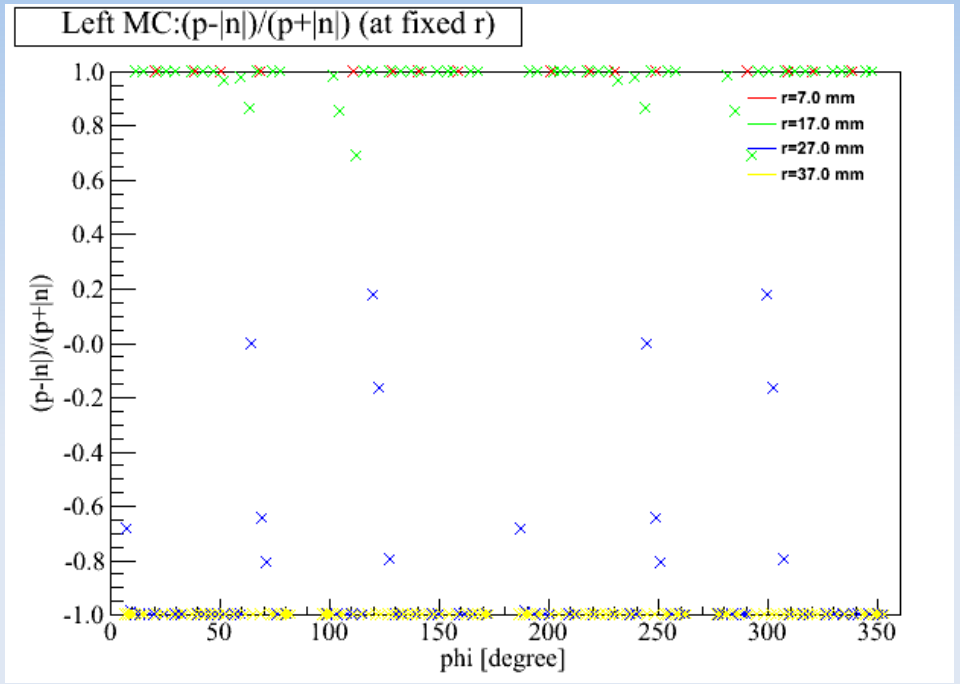
$$\frac{p-n}{p+n}$$:

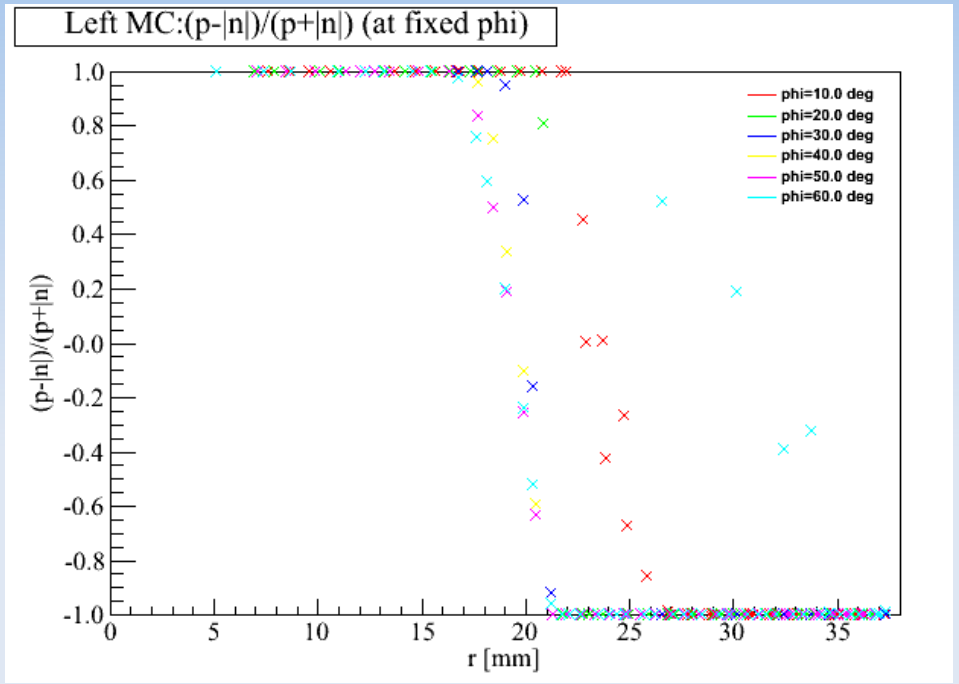
(p: maximum of positive amplitude
n: minimum of negative amplitude)

- position sensitive at intermediate radii where other parameters are less sensitive



Parameters to describe mirror charges: 1-dimensional distributions

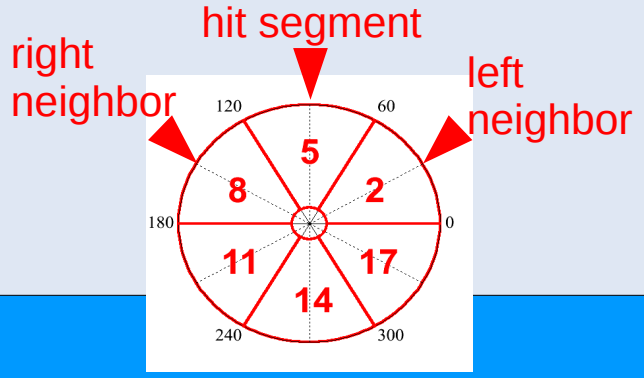




$$\frac{p-n}{p+n}$$:

Good parameter to describe dependency on radius at intermediate radii

Not a good parameter to determine phi of event position



Summary and Outlook

Summary:

- simulated mirror charges for one detector layer
- parameters depending on position

Outlook:

- two dimensional distributions of all parameters
- record real mirror charges of single site events
- develop algorithm to determine position of real event using parameter distributions obtained from simulation