Sensitivity of GRETINA position resolution to hole mobility

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The Team

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Segmented Quad Modules



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Signal Basis Generation

- Quasi-cylindrical non-linear grid
- Spacing weighted by electric field gradient
- Signal shapes depend on electric field, weighting potentials at each electrode, charge drift velocities, plus electronics response, segment cross-talk etc.
- Electron mobilities available in literature
- Hole mobilities less well known: vary it to see effect

Hole Mobility & Shaping Time

Drift velocities of electrons and holes currently used. Dashed lines show ± 15% variation in hole velocities Preamp shaping time correlated with hole mobility. Constrained fits performed with shaping times fixed.

Experimental averaged "superpulse" from a ⁶⁰Co source compared ("fitted") to that from simulation

Method originally introduced to extract electronic corrections to calculated basis

Shallow minimum at ~15% lower than currently used values Question: How badly is position resolution affected by this?

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"Pencil beam" measurements

Pencil beam measurements with a ¹³⁷Cs source (Q4A8) Inner hexagon defines the front face Segments labeled A-F in azimuthal direction Dashed lines indicate segment boundaries 7 different collimated pencil beams (black dots) Radial: 1,2,3,4,5 Azimuthal: 2, 2', 2"

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Pencil Beams: 2D y-z histograms

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current (solid lines) and 15% lower (dashed lines) hole mobilities.

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Pencil beams: Experiment

Difference of pencil beam centroids for (a) x- and (b) yprojections for all collimation points

Only Point 1 shows a ~1.5 mm difference (note FWHM ~4 mm) Point 1 closest to central core, so holes have to move farthest

Pencil beam: Simulations

(a) X-Z histogram of a simulated pencil beam with current hole mobilities

(b) X and (c) Y projections for current and 15% lower hole mobilities

0

No observable difference between the two mobilities Note: simulations are free from electronic cross-talk effects

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(b)

(c)

Summary

- Sensitivity of GRETINA position resolution to the hole mobility parameter investigated
- The χ^2 results from a fit of the averaged "superpulse" exhibit a shallow minimum for hole mobilities 15% lower than currently adopted values
- Calibration pencil beam data on position resolution analyzed
- Simulations performed, that isolate the hole mobility dependence of signal decomposition from other effects such as electronics cross-talk
- No appreciable impact with a15% reduction in hole mobilities applied to the analysis of experimental data from collimated sources
- Hole mobilities appear to be largely optimized and not currently limiting position resolution.
- Hole mobility effectively excluded as a dominant parameter for improving the position resolution for reconstruction of γ-ray interaction points in GRETINA.

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NUCLEAR NSTRUMENTS & METHODS IN PHYSICS

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