RECONSTRUCTION OF INCIDENT DIRECTION OF HIGH-ENERGY GAMMA-RAY PARTICLES WITH THE GAMMA-400 γ-RAY SPACE TELESCOPE

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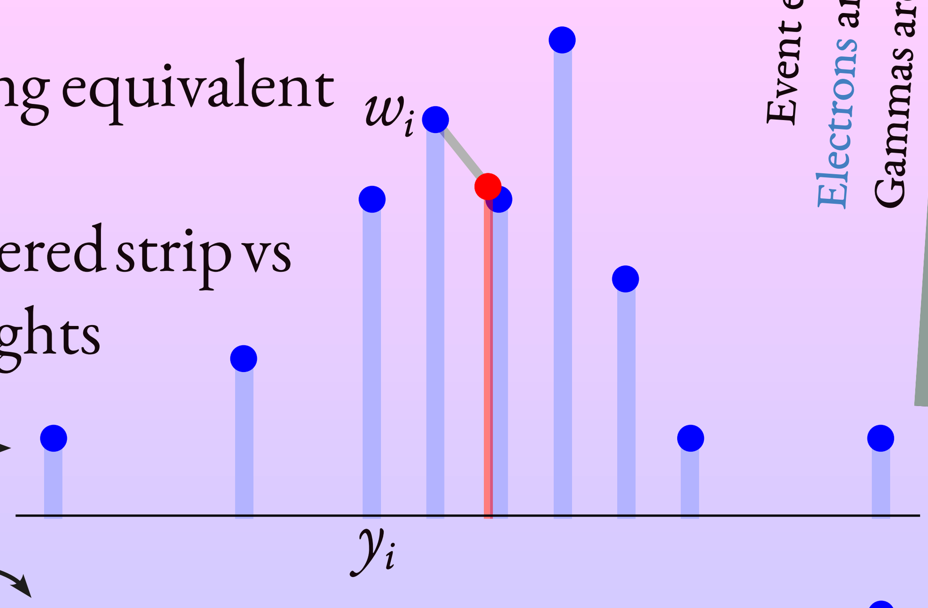
In the GAMMA-400 project, a gamma-ray telescope with high angular and energy resolution is being designed, which permits making a new step in the study of high-energy cosmic gamma radiation. The finest angular resolution among gamma-ray space telescopes of ~ 0.02° at energy 100 GeV can enhance the discrete-source identification and the dark-matter signal selection. A method to reconstruct direction of cosmic gamma-ray particles with fine angular resolution is proposed, implemented and applied. The method allows us to reconstruct the direction of electromagnetic shower axis and extract the trace of an electron-positron pair. The method is parametrised to achieve any necessary trade-off with resolution and efficiency.

RECONSTRUCTION ALGORITHM

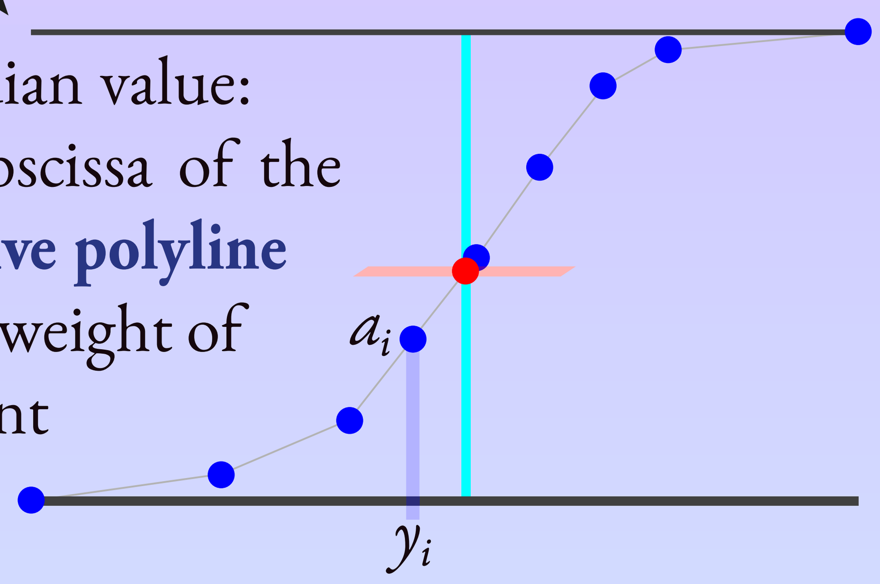
The procedure uses energy deposits in silicon-strip layers both in the converter (C) and spatially-sensitive calorimeter (CC1) in each projection.

Define a **median point** for each layer in the following equivalent way:
Plot weights w_i (initially energy deposits) in i^{th} triggered strip vs strip position y_i (upper figure) and cumulative weights a_i defined by

$$a_i = ½\, w_i + \sum_{j=1}^{i-1} w_j$$



vs strip positions (lower figure). Then, find a median value: a half-sum of outermost cumulative weights. Abscissa of the **intersection of the median line (red) and cumulative polyline (blue) gives the position of the median point**. The weight of the median point is taken as the ordinate of a point on the polyline at its own position.

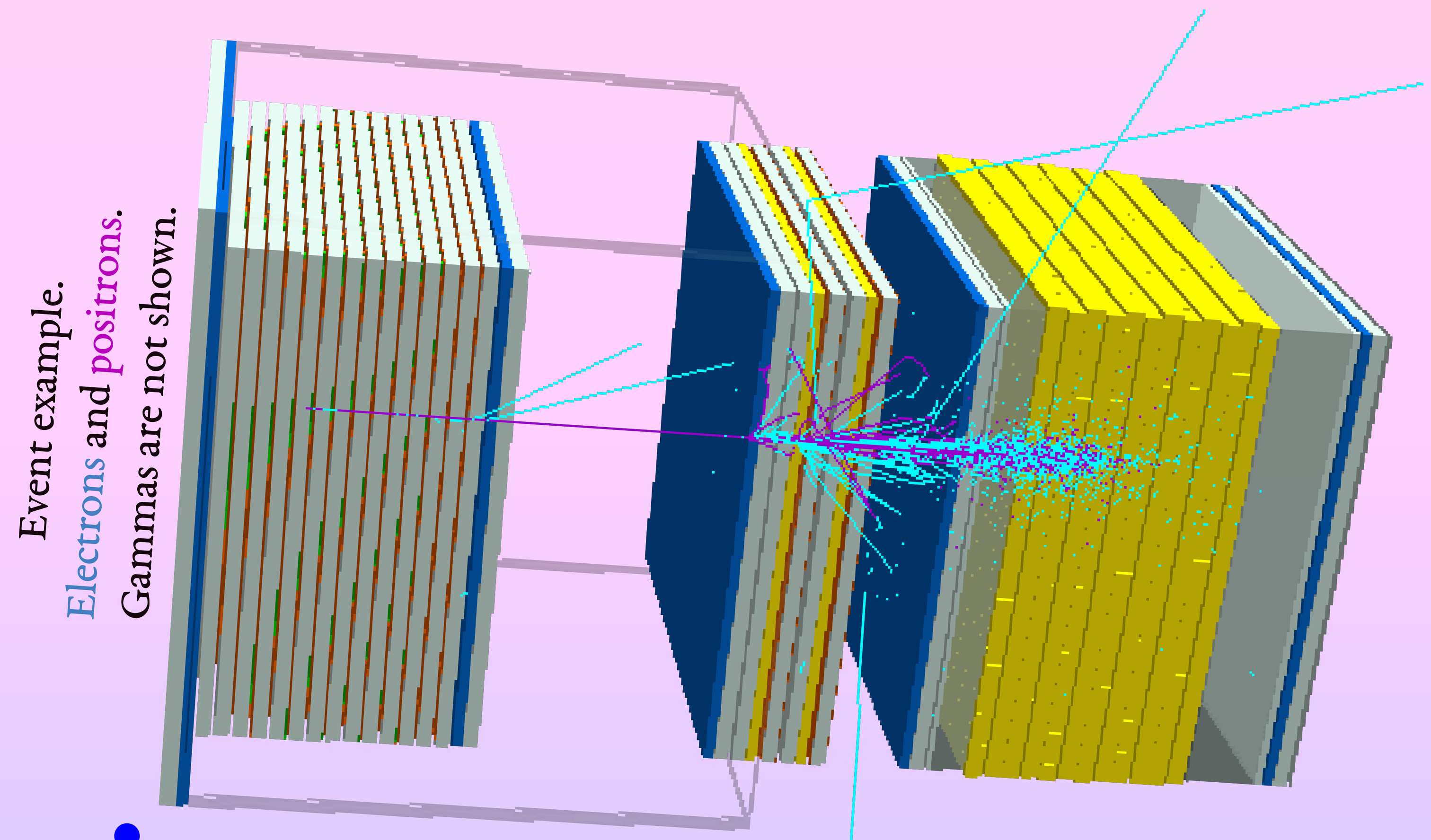


After that:

i) **Fit** linearly all planes with defined medians.
ii) Construct a **band** of *SOME WIDTH* in the converter and *MAYBE ANOTHER WIDTH* in the calorimeter around the estimated line.
iii) **Ignore strips** outside the band.
iv) Repeat the iteration procedure *A NUMBER OF TIMES*.

A weight correction is done once. All weights of strips closer than *SOME DISTANCE* to the line are multiplied by *A FACTOR INCREASING* toward upper planes of the converter and to lower planes of the calorimeter.

This algorithm has **a number of parameters** shown above in (*BROWN CAPITALS*). Varying values of these parameters we can acheive some trade-off between high angular resolution and high efficiency of the method. For example, by narrowing the *BAND WIDTH*, we can reconstruct the direction of a gamma-ray source more accurately by rejecting those events with highly deflected electron-positron pair. Specific trade-off values are to be decided with taking into account a scientific task to be done.



CONCLUSION

Angular resolution, taken as 68th percentile of deflection angles, is shown on a plot below with different *BAND WIDTHS*. We get resolution camparable with a limit set by the multiple scattering process. This method has an efficiency above 10% in the energy range above 30–500 MeV, depending on parameter values.