

Clustering and Calibration

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Clustering

Cluster Information

Calibration from Calibration Run

Calibration from Production Run

- ▶ sort hits by decreasing energy
 - ▶ loop on hits:
 - ▶ loop on clusters:
 - ▶ if $\text{distance}(\text{hit}, \text{cluster_center}) < 2\sqrt{2} \cdot \text{cell_size}$: add hit to cluster (and break loop)
 - ▶ if hits doesn't belong to any cluster and $\text{distance}(\text{hit}, \text{clusters_center}) > 4\sqrt{2} \cdot \text{cell_size}$: create cluster
- drawbacks:
- ▶ cluster can be larger than 5x5
 - ▶ some hits are left out

- ▶ sort hits by decreasing energy
 - ▶ loop on hits:
 - ▶ loop on clusters:
 - ▶ if hit is a neighbour of the cluster: add hit to cluster
 - ▶ if hit belongs to several clusters: dispatch energy following shower profile
 - ▶ if hits doesn't belong to any cluster: create cluster
 - ▶ merge neighbouring clusters depending on χ^2
- drawbacks:
- ▶ weird shape → high χ^2
 - ▶ merging depends on χ^2 calculation

Clustering

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- ▶ shower profile:

$$\begin{aligned} f(dx, dy) &= \frac{E(dx, dy)}{E_{cluster}} \\ &= \frac{a}{2\pi} \cdot (g_f(dx + 0.5, dy + 0.5) - g_f(dx + 0.5, dy - 0.5) - g_f(dx - 0.5, dy + 0.5) + g_f(dx - 0.5, dy - 0.5)) \\ g_f(x, y) &= \text{atan}(x/b) + \text{atan}(y/b) + \text{atan}(x * y / \sqrt{b^2 + x^2 + y^2}) \\ dx, dy &= (x - x_{center})/x_{size}, (y - y_{center})/y_{size} \end{aligned}$$

- ▶ χ^2 :

$$\begin{aligned} \chi^2 &= E_{cluster} \sum_{\text{hits+surrounding modules}} (f(dx, dy) - E_{hit}/E_{cluster})^2 / \sigma^2 \\ \sigma^2 &= \alpha \cdot f(dx, dy) + (\beta_1 + \beta_2 \sqrt{E_{cluster}}) \cdot \nabla^2 f(dx, dy) + \gamma / E_{cluster} \end{aligned}$$

- ▶ Barycenter with logarithm weight:

$$\vec{r}_{cluster} = \sum_{hits} (cste + \log(E_{hit}/E_{cluster})) \vec{r}_{hit}$$

The constant must be adjusted depending on the minimal $E_{hit}/E_{cluster}$ allowed (weight > 0)

- ▶ χ^2 minimization (with gradient method) to fit the profile
→ not used so far in order to speed up calculations

- ▶ Energy calculation:

$$E_{cluster} = \sum_{hits} (adc_value - pedestal) \cdot lms_gains \cdot calibration_gain$$

- ▶ Energy correction: not used so far (may need χ^2 minimization)

$$E_{corr} = E_{cluster} / \sum_{hits+surrounding\ modules} f(dx, dy)$$

→ reject cluster if correction is too important?

Clustering

Cluster Information

Calibration from Calibration Run

Calibration from Production Run

- ▶ Matching right and left TCounter hits
- ▶ Merging Tcounter hits from consecutive TCounters
→ “Tchannel”
- ▶ Merging Ecounter hits from consecutive ECounters
→ “Echannel”
- ▶ Matching Tchannel and Echannel
→ “ETchannel”

Iterative process over the calibration gain
(start at $gain_{module} = 0.25$)

- ▶ loop on events:
 - ▶ skip bad events (stability) and events with triggers different of 1 or 2
 - ▶ get ETchannel $\rightarrow E_\gamma$ (skip if > 1)
 - ▶ get hycal clusters
 - ▶ loop on clusters:
 - ▶ skip if $n_{hit} < 3$, $E_{cluster} < 100\text{MeV}$ or $\chi^2 > 100$
 - ▶ fill histogram for the cluster center module with $E_{cluster}/E_\gamma$
- ▶ fit histograms to get the mean value of gaussian
 $\langle E_{cluster}/E_\gamma \rangle_{module}$
- ▶ adjust gains: $gain_{module} = gain_{module} / \langle E_{cluster}/E_\gamma \rangle_{module}$

Clustering

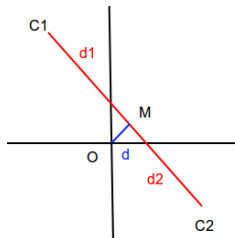
Cluster Information

Calibration from Calibration Run

Calibration from Production Run

▶ Moller events:

- ▶ look at all pairs of clusters
- ▶ select pairs with $d < 5\text{cm}$
- ▶ select pairs with $(E_1 + E_2 - E_{beam})/E_{beam} < ?$
(depending on the step of the calibration)
- ▶ for symmetric Moller: $2(E_1 - E_2)/(E_1 + E_2) < 0.1$



▶ ep events:

$(E_{cluster} - E_{beam})/E_{beam} < ?$ depending on the step of the calibration

Iterative process over the calibration gain

(start at $gain_{module} = 0.25$)

- ▶ loop on events:
 - ▶ skip bad events (stability) and events with triggers different of 1 or 2
 - ▶ get hycal clusters
 - ▶ loop on clusters:
 - ▶ skip if $n_{hit} < 3$, $E_{cluster} < 50\text{MeV}$ or $\chi^2 > 100$
 - ▶ for Moller $cluster1$: fill moller histogram for the $cluster1$ center module with $E_{cluster1} * (d1 + d2) / E_{beam} / d2$
 - ▶ for Moller $cluster2$: fill moller histogram for the $cluster2$ center module with $E_{cluster1} * (d1 + d2) / E_{beam} / d1$
 - ▶ for ep : fill ep histogram for the cluster center module with $E_{cluster} / E_{beam}$
- ▶ fit histograms to get the mean value of gaussian
 $\langle E_{cluster} / E_{\gamma} \rangle_{module}$
- ▶ adjust gains: $gain_{module} = gain_{module} / \langle E_{cluster} / E_{\gamma} \rangle_{module}$