The location efficiency in the bulk emulsion

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Abstract

I review the vertex location in the bulk emulsion. I also report my study about the origin of inefficiency of this procedure by using the sample of ν_μ C.C.-like event in 1995. I will conclude this report by proposing the idea to improve the efficiency.

1 The scan back location

One module of bulk emulsion consists of 36 plates along the beam direction. The original thickness is 790μm. In order to locate vertexes in bulk emulsion we follow tracks measured on special sheet(SS) plate by plate from down stream to up stream. We call this procedure "scan back location" and these tracks "scan back track". When the scan back tracks reach vertexes in a certain plate, they stop and we miss them. We require that scan back track is missed in two subsequent plates to confirm the vertex plate.

Track selector(TS) search scan back tracks on up stream surface(100μm of thickness) in every plate with the help of angular and positional predictions. We apply the measured angle on SS to angular prediction. And we make positional prediction by extrapolating from measured position on just before one plate.

After we take data by TS, we calculate angular and positional displacement with respect to the prediction. The width of angular displacement is $\sigma \sim 0.009$rad for each projection and it is caused by angular distortion mainly. The width of positional displacement is $\sigma \sim 4\mu$m for each projection. We apply the cut to pick up "good" scan back tracks as below.

angle : $\sqrt{\Delta\theta_y^2 + \Delta\theta_z^2} \leq \frac{2}{\sqrt{\pi}}(0.025 + 0.05 \times \Delta\theta_{x7})rad$

position : $\sqrt{\Delta y^2 + \Delta z^2} \leq \frac{2}{\sqrt{\pi}}(15 + 50 \times \Delta\theta_{x7})\mu m$

$\Delta\theta_{x7} = \sqrt{(\theta_y - \theta_{x7_y})^2 + (\theta_y - \theta_{x7_z})^2}$

Δ : (found)-(prediction)

(θ_y, θ_z)rad : slope of scan back track

$(\theta_{x7_y}, \theta_{x7_z})$rad = (-0.08,0.) : slope of x7 (center value)
In result we pick up most of scan back tracks as a single good candidate and 2% of them as multiple candidates including background tracks.

We have three methods to confirm the vertex in the vertex plate. The first one is a traditional manual scan. The second one is analysis of video image data. We can detect the 1ry vertex by observing the stopping scan back track in the video image data. We require the presence of heavy flagment(so called black) from the vertex point in order to confirm the vertex. The third one is to search other tracks from vertex and reconstruct the vertex(so called vertex scan back). We calculate the impact parameter between the scan back track and another track. We require small impact parameter (2$\sim$8μm) in order to confirm the vertex.

The position distribution of located vertex along the beam direction is nearly flat. That means our scan back procedure is going well. But tracks found on SS include many fake. That makes a lot of candidates of fake vertex plate. So we give up to perform vertex analysis on the first 3 plate from down stream for the moment.

2 Study of inefficiency of scan back location in bulk

I used the sample of ν_μ C.C.-like event in 1995. They are in stack 6,7 and 8 and scanned at Nagoya. We select only muon as scan back tracks. The number of event found on SS is 26355. 15% of events are out of fiducial area. And then 10% of events are missed on plate 1. These events are originated from fake tracks found on SS. 6% of events have no track which stop in the bulk (so called punch through). And about 6% of events stopped in plate 2 and 3. It is consistent with expected ratio of events in these two plates. After these cuts, 16916 events stopped in bulk plate 4 to 36.
We can expect higher efficiency of automatic vertex confirmation for the D.I.S-like events having multiple track prediction because we can apply vertex scan back. 10020 events of 12500 D.I.S.-like events stopped in bulk plate 4 to 36 are automatically confirmed by either video image analysis or vertex scan back. 2480 D.I.S-like events are not confirmed automatically.

I studied what happen for these events by means of manual scan. I performed manual scan 50 events pickked up 2480 events. In result the efficiency of track following is 93%. About 2% events are lost because of wrong connection of scan back track. And about 2% events are lost because of failure of track following. 3% of events are not found becouse of fake prediction.

3 Possible improvement of the location efficiency

We have applied 31.2cm$\times$31.2cm$\times$2parts(top and bottom) of our scanning area in RUN1 emulsion. We change the position of fiducial mark in RUN2 and don't cut emulsion. We can apply 33.15cm$\times$68.25cm of scanning area. So we can improve 16% of efficiency.
We have not analized events on plate 2 and 3. However if we apply the special diffinition of good candidate or vertex plate on these two plates, we can reduce the fake vertex plate candidate. By recovery in plate 2 and 3 we can improve 6.8% of efficiency.
Recently we started the parent search on vertex plate. This method improve local anguler and positional accuracy. So even if scan back track is missed by big distortion, we can find that the scan back track is passing through and continue the track following. This method improve 1.1% of efficiency.
So we can improve the location efficiency 8% in RUN1 and 25% in RUN2.