ZPD Algorithm Performance

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OUTLINE

Data Sample
ZPD Algorithm Sequence
Track Efficiency
Event Efficiency for Data/MC
Background Rejection
Summary
Data Sample

Real Data
L1-pass through –
Colliding beams.
  PEP-II luminosity $2.4 \times 10^{33}$
  Her-1.17A, LER-0.77A
  L1-trigger 1.08 Hz

1 Beam HER/LER
  HER 0.78A
  LER 1.04 A

MC Sample
Matching between
TSF/DCH hit efficiency
in DATA/MC
Random beam crossing is
overlaid before the
trigger simulation
C++ simulation package integrated in BaBar

TSF segment selection

Seed Track Finder

Z-fitter
The probability to accept a track from the IP

Depends on:
\[ P_T, \tan(\lambda) \]
Multiplicity of the event
The track efficiency calculation denominator is:
Offline reconstructed tracks (Reco tracks) which

Satisfy the following track selection criteria:
P_T > 250 MeV
|D0| < 1 cm
|Z0| < 4 cm
15 hits on track
Exit the DCH at R > SL7
Chi2<5

In the event level:
Pure DCT lines were selected
For Data/MC Performance comparison
- L3 event selection used
- Had sample has additional had selection
The track efficiency of the ZPD algorithm is defined as the fraction of Reco tracks satisfying the previous track selection criteria successfully found and fitted by the ZPD algorithm.

ZPD operate independently from the Reco tracks therefore:

- Association is made between the Seed tracks that are found by the algorithm and the Reco tracks
- Z0 output from the ZPD algorithm is tested
- The track is accepted if the absolute value $|z0|$ is within the threshold

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Track efficiency comparing Data/MC
The difference in Bhabha and Hadronic events reflects track hits merging in high multiplicity events.

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An example of the $z$-fit value
The probability for the ZPD to accept a physics event with at least 1 track with z less than a threshold

Data sample used : L3 event selection of Bhabha and Multihadronic events

L3-decision was used as denominator

<table>
<thead>
<tr>
<th>Sample</th>
<th>EMT %</th>
<th>Z track %</th>
<th>Combined %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10 15 20</td>
<td>10 15 20</td>
</tr>
<tr>
<td>Bhabha</td>
<td>99.9</td>
<td>97.7 98.7 99.0</td>
<td>99.98 99.99 99.99</td>
</tr>
<tr>
<td>Multihadron</td>
<td>99.0</td>
<td>99.9 100 100</td>
<td>100 100 100</td>
</tr>
</tbody>
</table>
TRG Event efficiency comparison between Data/MC
BaBar

TRG

Event efficiency for various physics sources

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Event efficiency for rare B decay samples

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A z trigger was added to all GLT lines that include DCT objects

The fraction triggered for each of the trigger lines – L1pass though

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The total trigger rate reduction due to the DCT+Z Requirement with $|z|<15$ is 30%.

And improves to 38% for $|z|<10$ cm.

About 40% is an irreducible rate due to at least one EMT only trigger lines.
Fraction of DCT+Z triggered event vs. Z value events with GLT lines involving DCT objects
This plot indicates that the addition of the Z trigger:

- Can reject 53% (65%) of the HER DCT Background triggers at a $|z|$ cut of 15cm (10 cm)
- Can reject 57% (69%) of the LER DCT background Triggers at a $|z|$ cut of 15 cm (10cm)
Improvements

New LUT with 6 bit phi values lead to 15-20% spatial resolution improvement.

Pattern recognition simulation has not yet implemented the $P_T = 200-250$ MeV/c region and parameters for low angle tracks are not optimal.

The event efficiencies presented utilized a single $|z|$ cut and a $P_T$ cut. The ZPD design can supply 3 or 4 output objects based on desired combinations of $|z|$, $P_T$, and $\tan(\lambda)$ values.
Multiple random background events overlaid on the MC for assessing performance at high background conditions.

Effect on efficiency due to reduced DCH gain in case we need to run at lower DCH voltage.