Resolution studies using $e^+e^- \rightarrow \gamma\gamma$ events

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Outline

- Kinematics
- Analysis
- Fit considerations:
  - to show why Crystal ball function was chosen over Novosibirsk.
- Energy resolution result (data, MC)
- Summary
Kinematics in CM frame

* indicates CM frame

Calculated energy of photon in Lab frame:

\[ E_{\text{calc}} = \gamma \left( \frac{E_{CM}}{2} \right) \left( 1 + \beta \cos \theta_{1}^* \right) \]

Notice: \( E_{\text{calc}} \) is a unique function of \( \cos \theta^* \) and \( \cos \theta_{\text{Lab}} \)

\[
dE/E = \frac{E_{\text{meas}} - E_{\text{calc}}}{E_{\text{calc}}}
\]

\[ k_{1\mu} = (k_{1}^*, E_{CM}/2) \]

\[ k_{2\mu} = (k_{2}^*, E_{CM}/2) \]
Analysis

- Data: taken in January, 2002
- Monte Carlo: SP4, \( e^+e^- \rightarrow \gamma\gamma \)
- Require to pass L3 \( e^+e^- \rightarrow \gamma\gamma \) trigger
- Select 2 highest energy photons
- Cut: Maximum acolinearity=0.03 rad
- Study energy resolution
  - As function of \( \theta_{\text{Lab}}, \phi, E_{\text{calc}} \)
Fit consideration

Considered fit functions:
- Novosibirsk
- Crystal Ball

Considered fit ranges:
- Whole ranges: give poor $\chi^2$ probabilities (Look at the previous talk)
- Optimal ranges searched:
  - Which gives the biggest $\chi^2$ probability, and
  - Whose function value at each fit end point $\leq 0.3 \cdot$ function maximum (Look at next page)
Example: worst Novo fit

\[ \text{function maximum} \]

\[ \leq 0.3 \cdot \text{max.} \]

\[ \text{function value} \]

\[ \leq 0.3 \cdot \text{max.} \]
Example: worst CB fit

function maximum

function value \( \leq 0.3 \cdot \text{max.} \)

function value \( \leq 0.3 \cdot \text{max.} \)
Novosibirsk, $\theta_{\text{Lab}}$
Crystal ball, $\theta_{\text{Lab}}$
$\sigma_{E/E} \text{ vs. } E_{\text{calc}}$

From Novosibirsk

From Crystal ball
Crystal ball function is preferred over Novosibirsk function, because it:

1. has a little bit better $\chi^2$ probability distribution
2. covers more of the distribution

Puzzling:

$\sigma_E/E$ from Novo $>$ $\sigma_E/E$ from CB systematically
Mean of $dE/E$ vs. $E_{\text{calc}}$

Data

MC
\[ \sigma_{E/E} \text{ vs. } E_{\text{calc}} \]

**Data**

Formula:

\[ \frac{0.025}{\sqrt{E(\text{GeV})}} \]

**MC**
σ_{E}/E vs. E_{calc}
Summary

Crystal ball function has been used for the energy resolution study, because it:
1. has a little bit better $\chi^2$ probability distribution
2. covers more of the distribution than Novosibirsk.

Energy resolution
- of low gain area rather agrees with monte carlo.
- of high gain area
  - is worse than monte carlo.

Next step:
- Study angular resolution.
Appendix

Energy resolution as function of $\theta_{\text{Lab}}, \phi$
are given here...

They are fitted with Crystal ball function for the optimal ranges...
Mean of $dE/E$ vs $\theta_{\text{Lab}}$
$\sigma_{E/E}$ vs. $\theta_{\text{Lab}}$
Mean of $dE/E$ vs $\phi$
$\sigma_E/E$ vs. $\phi$