Luminosity Calculation in R Measurement at 3.55 GeV

huanggs@pony1.ihep.ac.cn
Div.1,IHEP
BES Annual Meeting (Da Tong)
For more information in detail, go to:
http://hpws3.ihep.ac.cn/~ huanggs/work.html

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1 OUTLINE

1. Motivation
2. Method
3. Bhabha events selection
4. Cross check
5. Summary

2 Motivation

$$R = \frac{1}{\sigma^0_{\mu\mu}\bar{\varepsilon}_{had} \cdot (1+\delta)} \cdot \frac{N^{obs}_{had} - N_{bg} - N_{ll} - N_{\gamma\gamma}}{L} \tag{1}$$

To determine R, L is one of the key factors.

3 Method

The integral luminosity is given by

$$L = \frac{N_{obs}}{\sigma \cdot \varepsilon \cdot \varepsilon_{trg}} \tag{2}$$

N_{obs}: number of events observed,
σ: M.C. production cross section,

ε_{trg}: trigger efficiency,
ε: detection efficiency, given by

$$\varepsilon = N_{mc}^{obs}/N_{mc}^{total} \tag{3}$$

Possible channels to determine luminosity:

- $e^+e^- \to e^+e^-(\gamma)$
  $\sigma(\mid cos\theta \mid < 0.75) = 98.6nb$
- $e^+e^- \to \gamma\gamma(\gamma)$
  $\sigma(\mid cos\theta \mid < 0.75) \approx 11.6nb$

Using information from different dectors:

- Energy in barrel shower counter
- dE/dx information in MDC

4 Bhabha events selection

number of tracks requirement:
- $tottks \geq 2$

geometry acceptance:
- $\mid cos\theta \mid < 0.75$

SHOWER information
Energy cut:
find 2 or 3 tracks with largest energy
- $E_{max1} > 0.6E_{beam}$
- $E_{max2}(+E_{max3}) > 0.45E_{beam}$
- $E_{sum} > 1.15E_{beam}$

back-to-back cut:
- $\mid \theta_1 + \theta_2 - 180° \mid < 10°$
- $\mid\mid \phi_1 - \phi_2 \mid -180° \mid < 20°$

ribbon region cut:
- $\mid z_{sc} \mid < 0.11m$
- $\mid z_{sc} \pm 0.955 \mid < 0.12m$

MDC information
vertex cut:
- $\mid Vx \mid < 2cm, \mid Vy \mid < 2cm, \mid Vz \mid < 20cm$

momentum and χ_{se} cut:

- good track fit: mfit=2
- $P > 1.4 GeV/c$, and $\chi_{se} > 0$
- $CL(\chi_{se1}, \chi_{se2}) > 0.317$

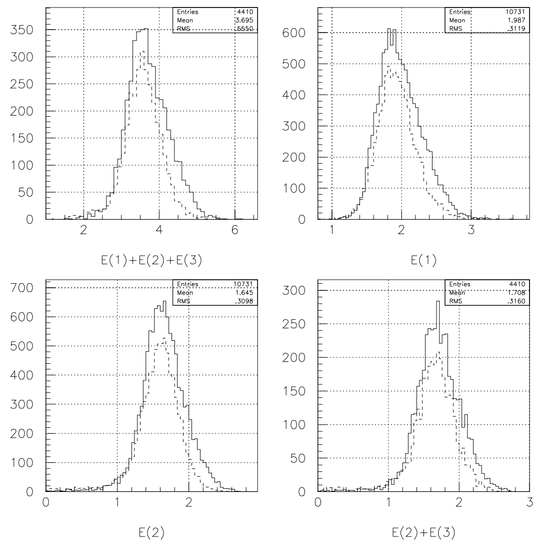


Figure 1: Energy cut to select Bhabha and $\gamma\gamma$, M.C.: solid line, data: dashed line

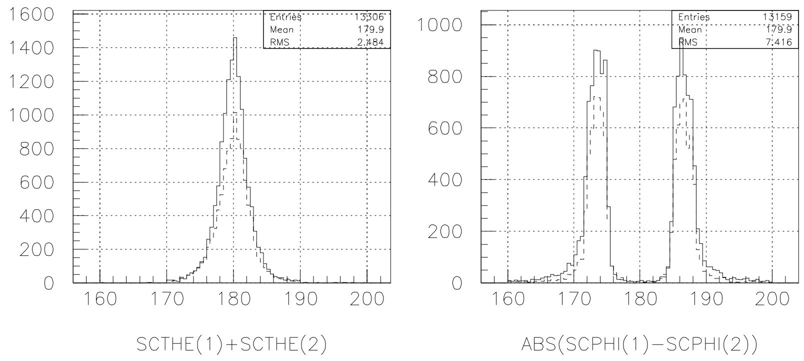


Figure 2: back-to-back cut to select Bhabha, M.C.: solid line, data: dashed line

5 Cross check

1. $e^+e^- \to \gamma\gamma(\gamma)$ channel

$\gamma\gamma(\gamma)$ events selection criteria:

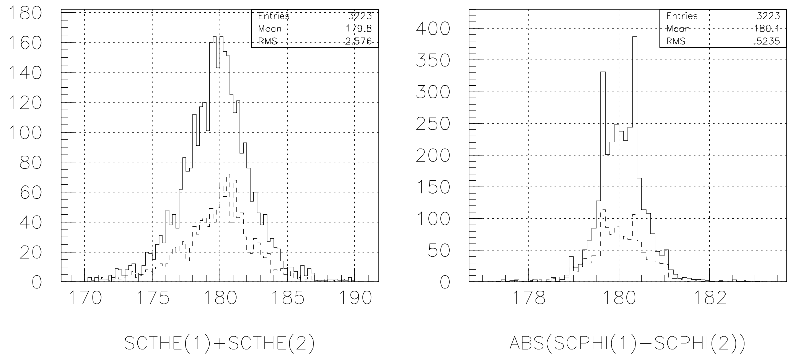


Figure 3: back-to-back cut to select $\gamma\gamma$, M.C.: solid line, data: dashed line

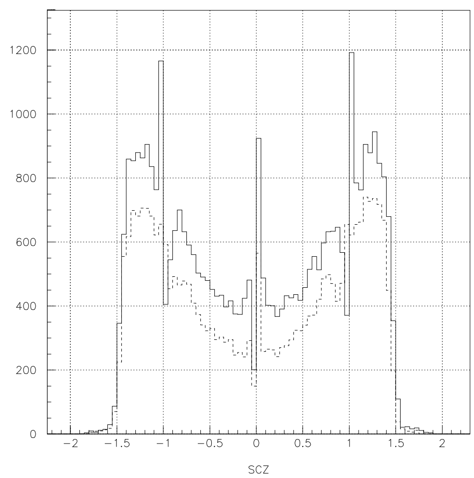


Figure 4: Shower ribbon region should be removed, M.C.: solid line, data: dashed line

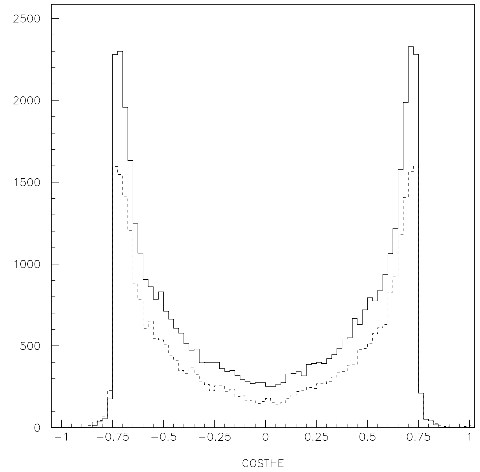


Figure 5: $cos\theta$ distribution of Bhabha events, M.C.: solid line, data: dashed line

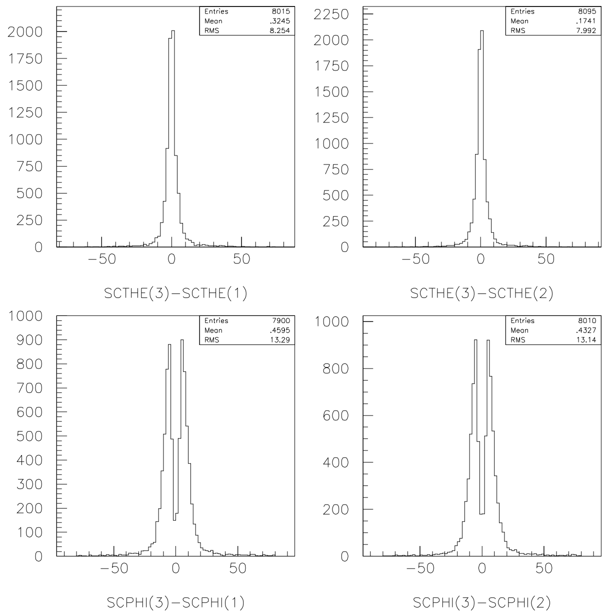


Figure 6: θ and ϕ separation of radiative γ, from radee sample, 40° cut is used for both θ and ϕ

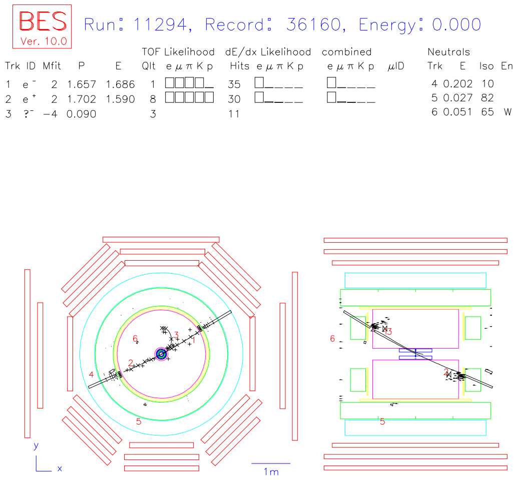


Figure 7: Bhabha event, Nchrg=3 due to MDC noise

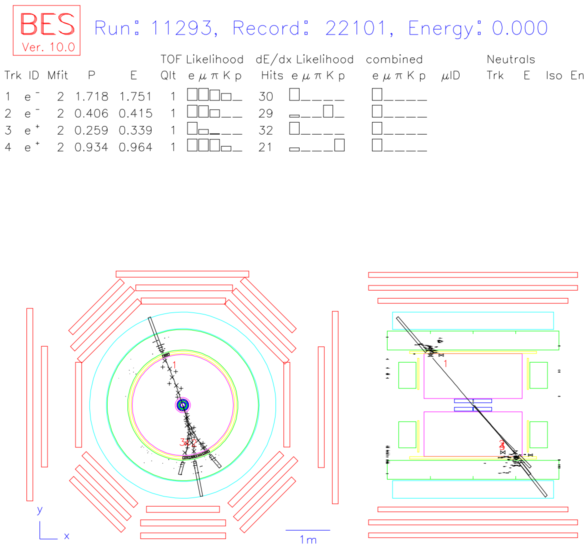


Figure 8: Bhabha event, Nchrg=4

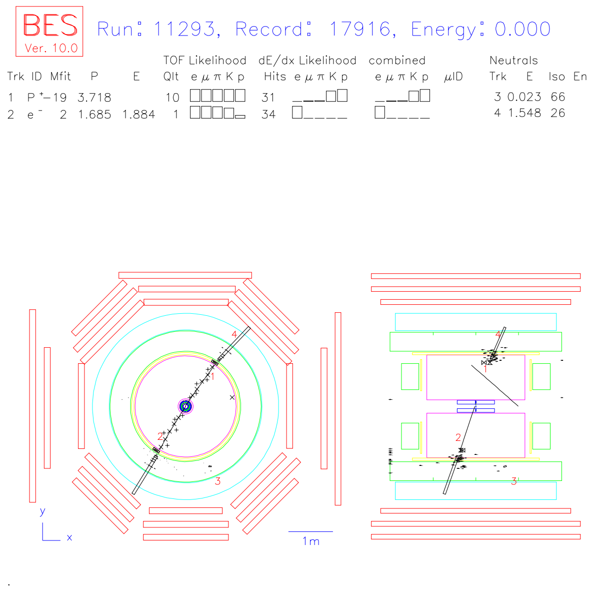


Figure 9: Bhabha event, bad track fit

number of tracks requirement:

- $tottks \geq 2$
- $Nchrg = 0$

ribbon region cut:

- $\mid z_{sc} \mid < 0.11m$
- $\mid z_{sc} \pm 0.955 \mid < 0.12m$

Energy cut:
find 2 or 3 tracks with largest energgy

- $E_{max1} > 0.6E_{beam}$
- $E_{max2}(+E_{max3}) > 0.45E_{beam}$
- $E_{sum} > 1.15E_{beam}$

back-to-back cut:

- $\mid \theta_1 + \theta_2 - 180° \mid < 10°$
- $\mid\mid \phi_1 - \phi_2 \mid -180° \mid < 3°$

2. Using Endcap Information

Advantages: not so sensitive to position precision;
large acceptance, good statistics

Integral Bhabha cross section:

$\sigma \approx 2000nb$, $2.45° < \theta < 3.14°$, $\mid \phi \mid < 21.2°$

$\sigma = 478.5nb$, $0.87 <\mid cos\theta \mid < 0.95$

$(\sigma_{\gamma\gamma(\gamma)} \approx 9.3nb, \sigma_{f\bar{f}} \approx 0.75nb)$

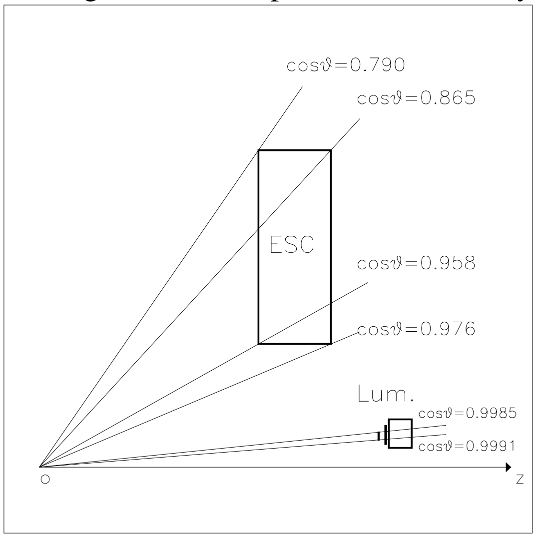
$\sigma = 98.6nb$, $\mid cos\theta \mid < 0.75$

$e^+e^-(\gamma)$ events and $\gamma\gamma(\gamma)$ events cannot be separated clearly, however we can treat them together

$$N_{obs} = L \cdot (\sigma_1 \cdot \varepsilon_1 \cdot \varepsilon_{trg1} + \sigma_2 \cdot \varepsilon_2 \cdot \varepsilon_{trg2}) \tag{4}$$

Bhabha and $\gamma\gamma(\gamma)$ selection criteria in ESC:

Figure 10: Diagram of Endcap SC and luminosity monitor



Energy cut:

- $E_{max1} > 0.6E_{beam}$
- $E_{max2}(+E_{max3}) > 0.45E_{beam}$
- $E_{sum} > 1.15E_{beam}$

geometry acceptance:

- $0.87 <\mid cos\theta \mid< 0.95$

back-to-back cut:

- $\mid \theta_1 + \theta_2 - 180° \mid< 7°$
- $\mid\mid \phi_1 - \phi_2 \mid -180° \mid< 25°$

6 Summary

R scan at 3.55 GeV: 63 runs all together,
pure collection time 43:32

- From combined BSC and MDC information,
  $N_{Bhabha} = 16768, \varepsilon = 0.4566, \sigma = 193.86nb$

$$L = 189.4 \pm 9.4\ nb^{-1} \tag{5}$$

- From $e^+e^- \to \gamma\gamma(\gamma)$ channel, As a cross check,
  $N_{\gamma\gamma} = 1234, \varepsilon = 0.0322, \sigma = 193.8nb$

$$L = 197.6nb^{-1} \tag{6}$$

The above value is preliminary result, we are still trying to improve it!

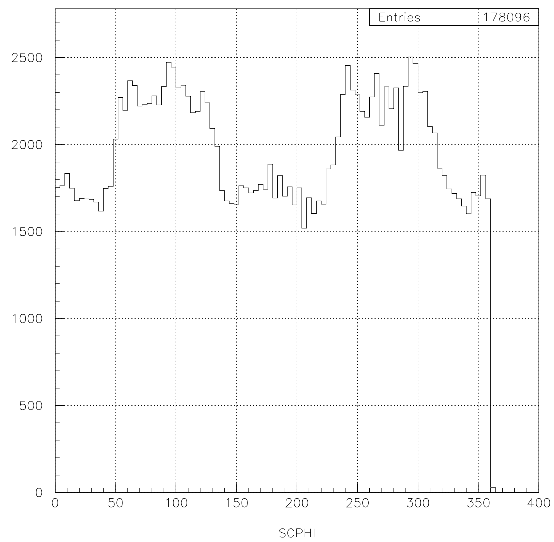


Figure 11: Possible cosmic ray contamination in ESC. Endcap TOF information not available at present, and trigger efficiency maybe different from barrel, only rough estimation given here: $L = 228.3nb^{-1}$.