ψ' FITTING RESULT AND EVENT SELECTION

1. Event seletion
2. Scan Curve Fitting
3. Error Analysis

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$\triangle$ Scan Curve Fitting

$\triangle$ Event seletion

♣ Fitting Result

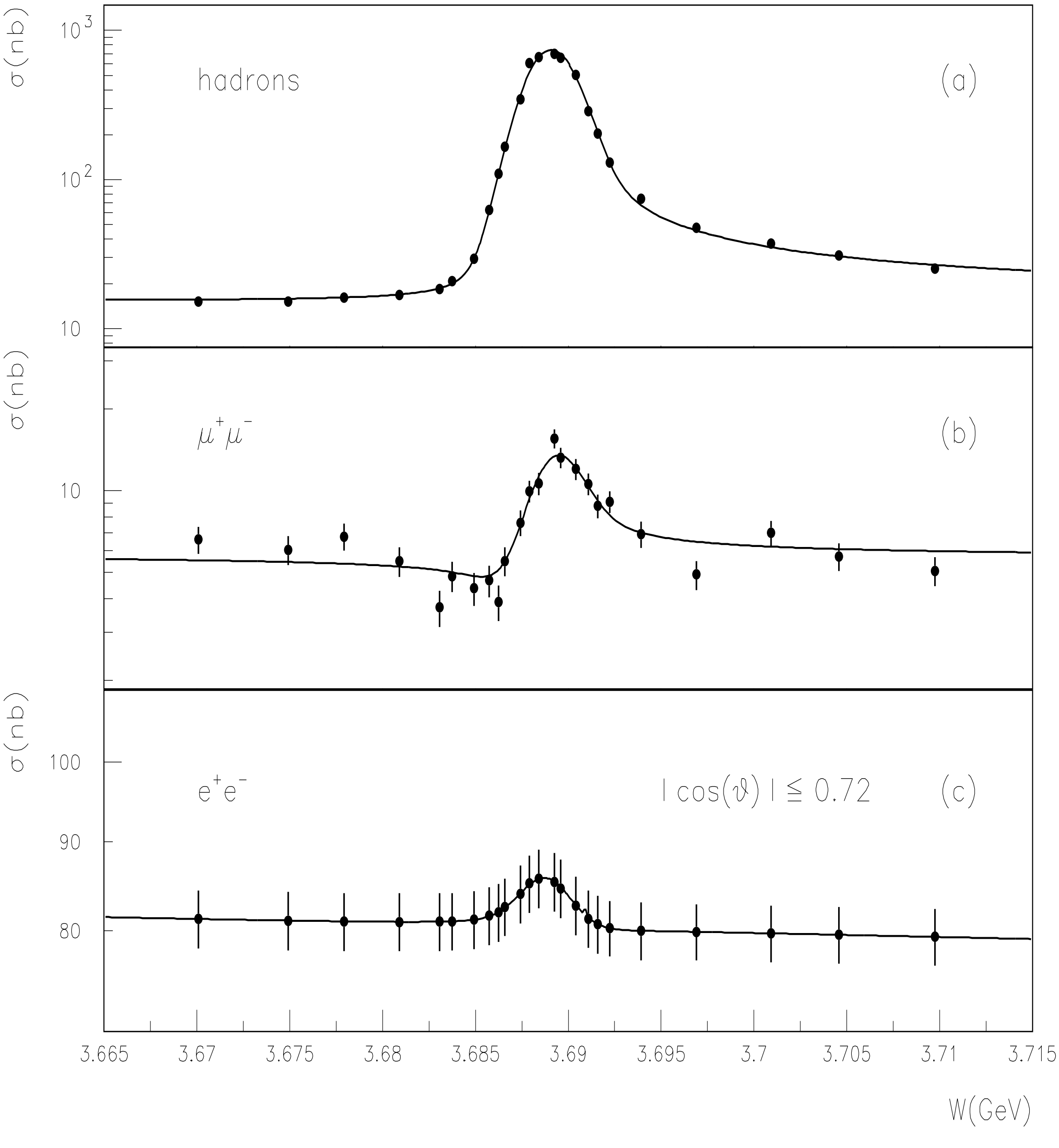

Figure 1: (a) The total cross section for $e^+e^- \to hadrons$, (b) the total cross section for $e^+e^- \to \mu^+\mu^-$, and (c) the total cross section for $e^+e^- \to e^+e^-$ integrated over the range $|cos\theta| \leq 0.72$ versus center-of-mass energy. The solid curves represent the results of the fit to the data.

♠ Assumption

$\Gamma_{total} = \Gamma_h + \Gamma_\mu + \Gamma_e + \Gamma_\tau, (\Gamma_e = \Gamma_\mu = \Gamma_\tau/0.38847)$

♠ Fitting Variables

$M, \Gamma_{total}, \Gamma_\mu, \Delta, \sigma_{nr}$

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Fit results

Γ	234.73	$\pm 13.75 keV$
Γ_h	228.79	$\pm 13.74 keV$
Γ_μ	2.487	$\pm 0.024 keV$
Γ_h/Γ	0.97469	± 0.0817696
Γ_μ/Γ	0.01059	± 0.000611036

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ψ' decay width and some branching ratios

Group	**yr.**	$\Gamma(KeV)$	$B(\mu\mu)(10^{-3})$	$B(\pi^+\pi^- J/\psi)$	$B(J/\psi X)$
MARK I	**75**	228 ± 56	9.3 ± 1.6	0.32 ± 0.04	0.57 ± 0.08
SPEC	**75**		7.7 ± 1.7		
DASP	**79**	202 ± 57		0.36 ± 0.06	0.51 ± 0.12
E760	**92**	306 ± 39			
	97			0.283 ± 0.029	
PDG	**96**	277 ± 31		$*0.324 \pm 0.026$	$*0.57 \pm 0.08$
PDG	**98**	277 ± 31		$*0.302 \pm 0.019$	$*0.542 \pm 0.030$
PDG	**00**	277 ± 31	10.3 ± 3.5	$*0.310 \pm 0.028$	$*0.550 \pm 0.050$

note:numbers in parenthesis denote the relative error

$*$ fit value

♣ Event Seletion

♣.1 Lepton-paired-event selection

◇ Dimuon event selection

1.Energy : $\sqrt{E^2_{sc1} + E^2_{sc2}} \leq 1.0(GeV)$
2.Time of flight : $\sqrt{(Tof_1 - 5)^2 + (Tof_2 - 5)^2} \leq 4.5(ns)$
3.Acollinearity : $\alpha_{Acol} \leq 10^0(degree)$
4.Momentum : $\left\{\begin{array}{r} p_{track1} \geq 1.75(GeV)\ or \\ p_{track2} \geq 1.75(GeV)\ or \\ \sqrt{(p_{track1} - 1.85)^2 + (p_{track2} - 1.85)^2} \leq 0.25(GeV) \end{array}\right.$
5.Fitting : $(\chi^2_\mu < \chi^2_K) \cap (\chi^2_\mu < \chi^2_p)\ (when\ \chi^2_\mu, \chi^2_K, \chi^2_p < 50)$
6.$\mu -$ Identification : $M_1^{ID} + M_2^{ID} \geq 3$
7.Geometry : $(|\cos\theta_1| \leq 0.60) \cap (|\cos\theta_2| \leq 0.60)$

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◇ Bhabha event selection

1.Charge : $(Q_1 = +1 \& Q_2 = -1) \cup (Q_1 = -1 \& Q_2 = +1)$
2.Energy : $\sqrt{(E_{sc1} - 1.85)^2 + (E_{sc2} - 1.85)^2} \leq 1.2$
3.Rib − Cut : $(0.4 \leq |Z_{SC}| \leq 0.85) \cup (|Z_{SC}| \geq 0.95) \quad (m)$
4.Geometry : $(|\cos\theta_1| \leq 0.72) \cap (|\cos\theta_2| \leq 0.72)$
5.Momentum : $\left\{\begin{array}{r} p_{track1} \geq 1.75(GeV)\ or \\ p_{track2} \geq 1.75(GeV)\ or \\ \sqrt{(p_{track1} - 1.85)^2 + (p_{track2} - 1.85)^2} \leq 0.25(GeV) \end{array}\right.$

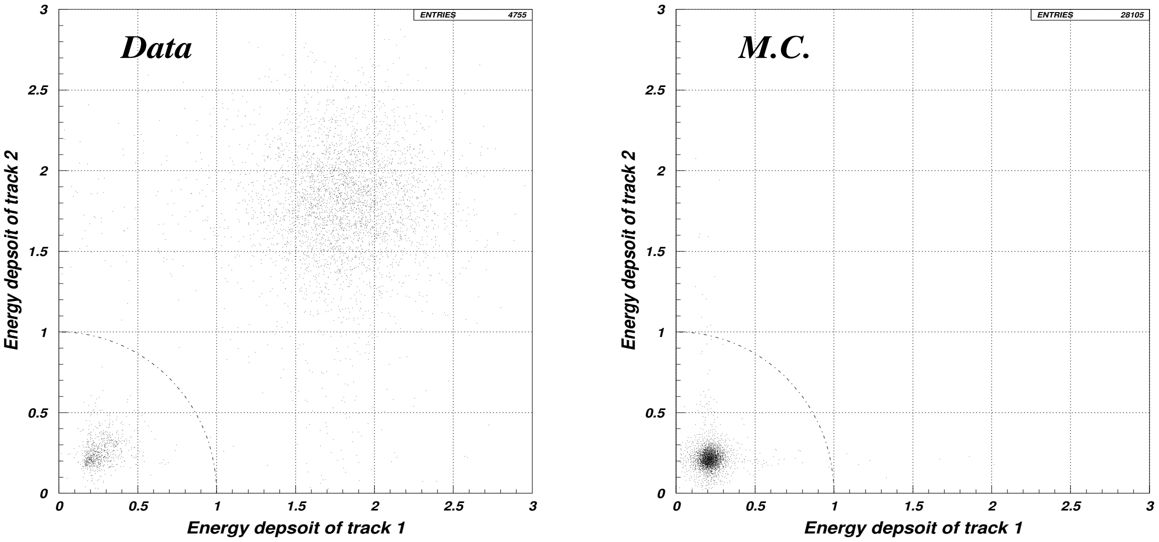


Figure 2: Energy deposit

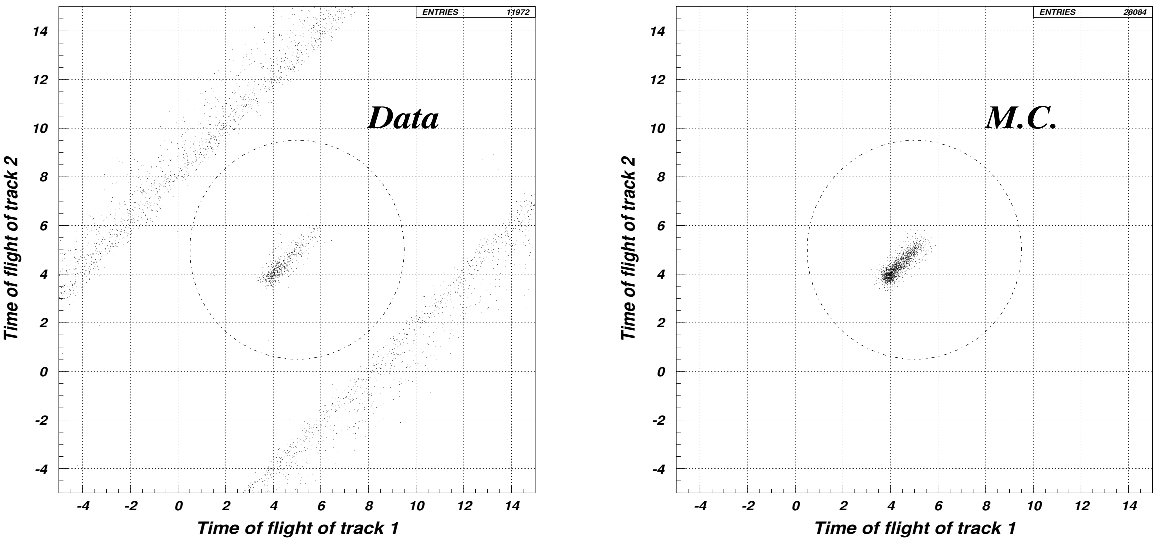


Figure 3: Comparison

♣.2 Hadron event selection

- Track level
  - N_{good} identification(for charged tracks)
    1. $mfit = 2 \ or \ mfit = -19$;
    2. $mfit = 2 \& \rho \leq 0.02, \ where \ \rho = \sqrt{V_x^2 + V_y^2}$;
    3. $mfit = -19 \& N_{dedx} > 16$;
    4. $|cos\theta| < 0.80$.
  - $N_{real\gamma}$ identification(for neutral tracks)
    1. Energy deposit $E_{deposit} > 80 \, MeV$;
    2. First hit layer in BSC $N_{FIRLAY} \neq 6$;
    3. The angle between γ and a charge track $\phi_{charge} > 15^0$;
    4. The angle between emissive direction from event-vertex and developing direction of cluster $\theta_{emit} < 36^0$.
- Event level
  1. Total (charged and neutral) energy deposit $E_{sum} > 0.36 Ebeam$;
  2. Direction deviation index $I_{ddi} = 0$;
  3. Good tracks number $N_{good} \geq 2$;
  4. Real photons number $N_{real\gamma} \geq 4, \ when \ N_{good} = 2$.
  5. Acollinearity $\alpha_{acol} \geq 10^0, \ when \ N_{good} = 2$.

  Note: I_{ddi} (*d*irection *d*eviation *i*ndex)

- $I_{ddi} = 0$: if $n_{trk} = |n_{ddi}|$ indicates that events are unoriented;
- $I_{ddi} = 1$: if $n_{trk} \neq |n_{ddi}|$ indicates that events are orientable.

where:n_{trk} is the number of tracks and n_{ddi} is defined as as the signal sum of z-coordinate of tracks

Relation between Background and Cut

cut condition	$separated-beam$	e^+e^-	$\mu^+\mu^-$	$\gamma\gamma$	$cosmic-ray$
cut-1 $E_{sum} > 0.36E_{beam}$	Y	Y^*	$N_{Y(5)}$	$N^*_{Y(3)}$	$N_{Y(3\&4)}$
cut-2 $I_{ddi} = 0$	Y	N	N	N	$N_{Y(1)}$
cut-3 $N_{good} \geq 2$	Y	$N^*_{Y(4\&5)}$	Y	Y	Y
cut-4 $N_{real\gamma} \geq 2$ $(if\ N_{good} = 2)$	Y	Y	$N_{Y(4,5)}$	$N_{Y(3)}$	$N_{Y(1\&3\&5)}$
cut-5 $\alpha_{acol} > 10^0$ $(if\ N_{good} = 2)$	$N_{Y(3,4)}$	Y	$N_{Y(4)}$	$-$	$N_{Y(4)}$

Table 1: note:(a) ‘Y”means that this cut is indispensable whether other cuts exist or not.(b) ‘$N_{Y(i,j)}$” or ‘$N_{Y(i\&j)}$ ‘’ means this cut has distinguishing function but become trivial or unable when the cut-i or cut-j exists,or when the cut-i and cut-j exist. (c) ‘N”means this cut has not or almost not function for distinction of certain kind of event.(d) the * at right shoulder of symbol, say ‘N^*” or Y^*”,means this cut may have distinguishing function but with different value from that given at cut condition. (e) symbol ‘$-$” means this cut-variable has not be defined for special type of background.

$$f = \frac{\int\limits_{col-run} P_{col} \cdot I_{col} \cdot dt}{\int\limits_{sep-run} P_{sep} \cdot I_{sep} \cdot dt}$$

$$N_{bg} = f \cdot N_{sep}$$

$$V_{zvet} = \frac{\sum\limits_{i=1}^{N} V^i_{z,mfit=2}}{N}$$

where only tracks with $mfit = 2$ are used to determine event-vertex.

$$N_{\tau\tau} = L \cdot (\varepsilon_{\tau\tau} \cdot \sigma_{\tau\tau}).$$

$$N_{ee} = L \cdot (\varepsilon_{ee} \cdot \sigma_{ee})$$

$$N_{\mu\mu} = L \cdot (\varepsilon_{\mu\mu} \cdot \sigma_{\mu\mu})$$

$$N_{\gamma\gamma} = L \cdot (\varepsilon_{\gamma\gamma} \cdot \sigma_{\gamma\gamma}).$$

$$N_{hadron} = N^{obs}_{hadron} - N^{bg} - N_{\tau\tau} - N_{ee} - N_{\mu\mu} - N_{\gamma\gamma}$$

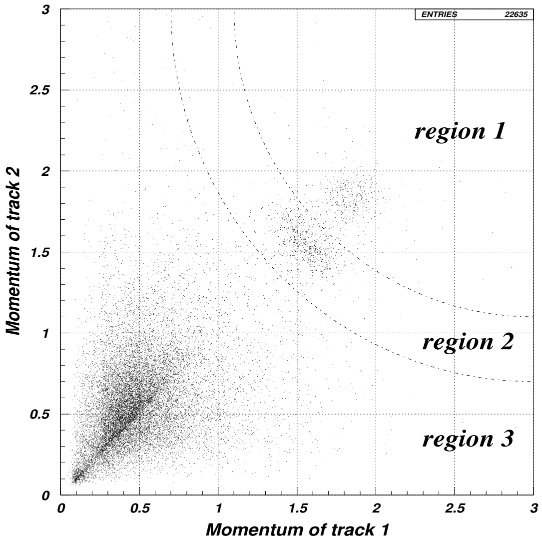


Figure 4: Momentun(all thing)

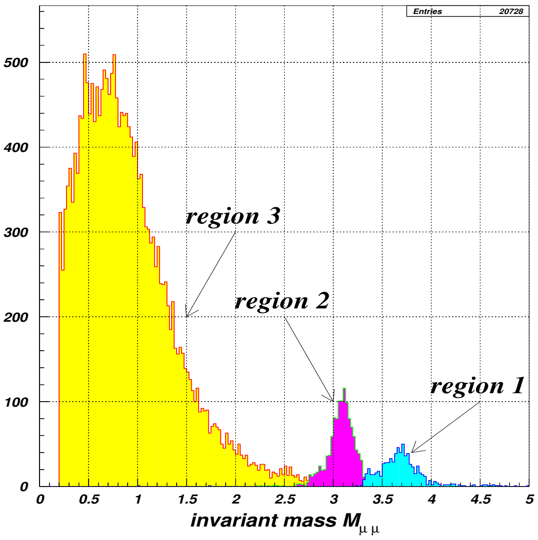


Figure 5: Invariant Mass

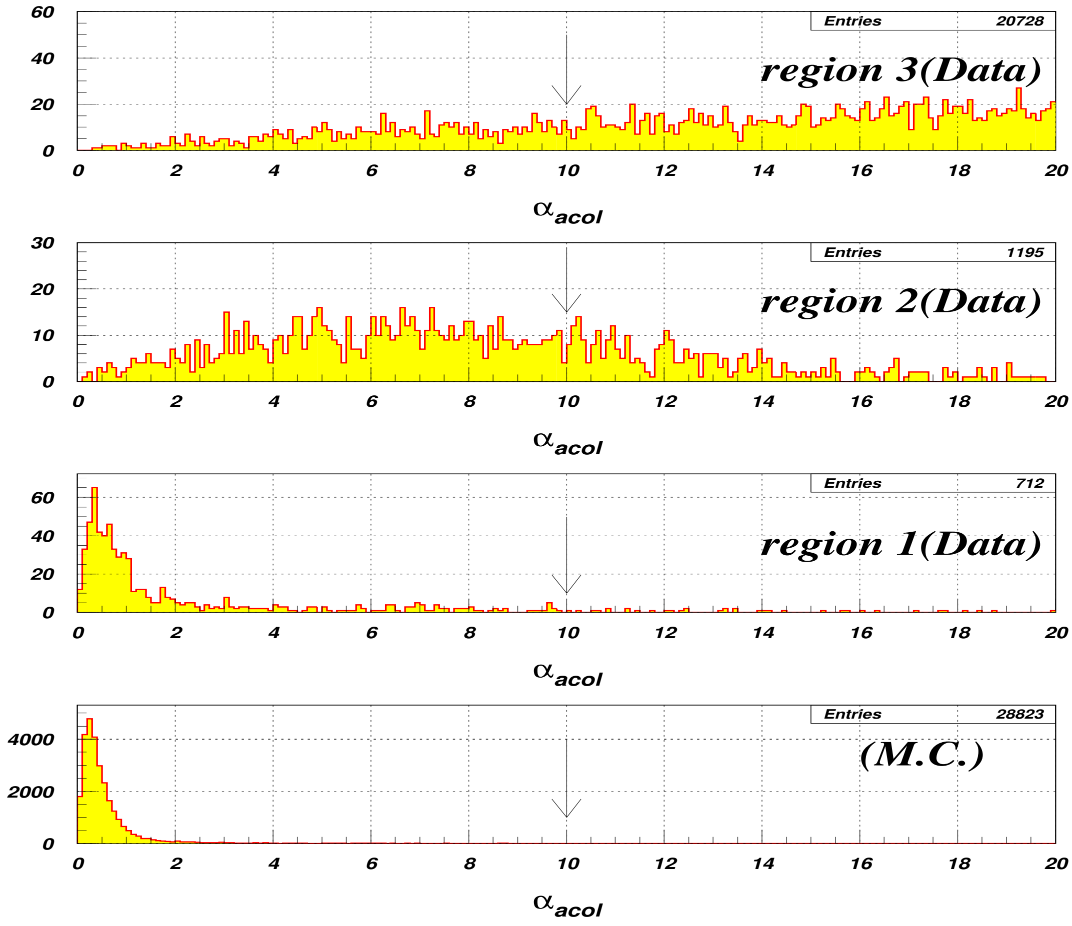


Figure 6: Acollinearity

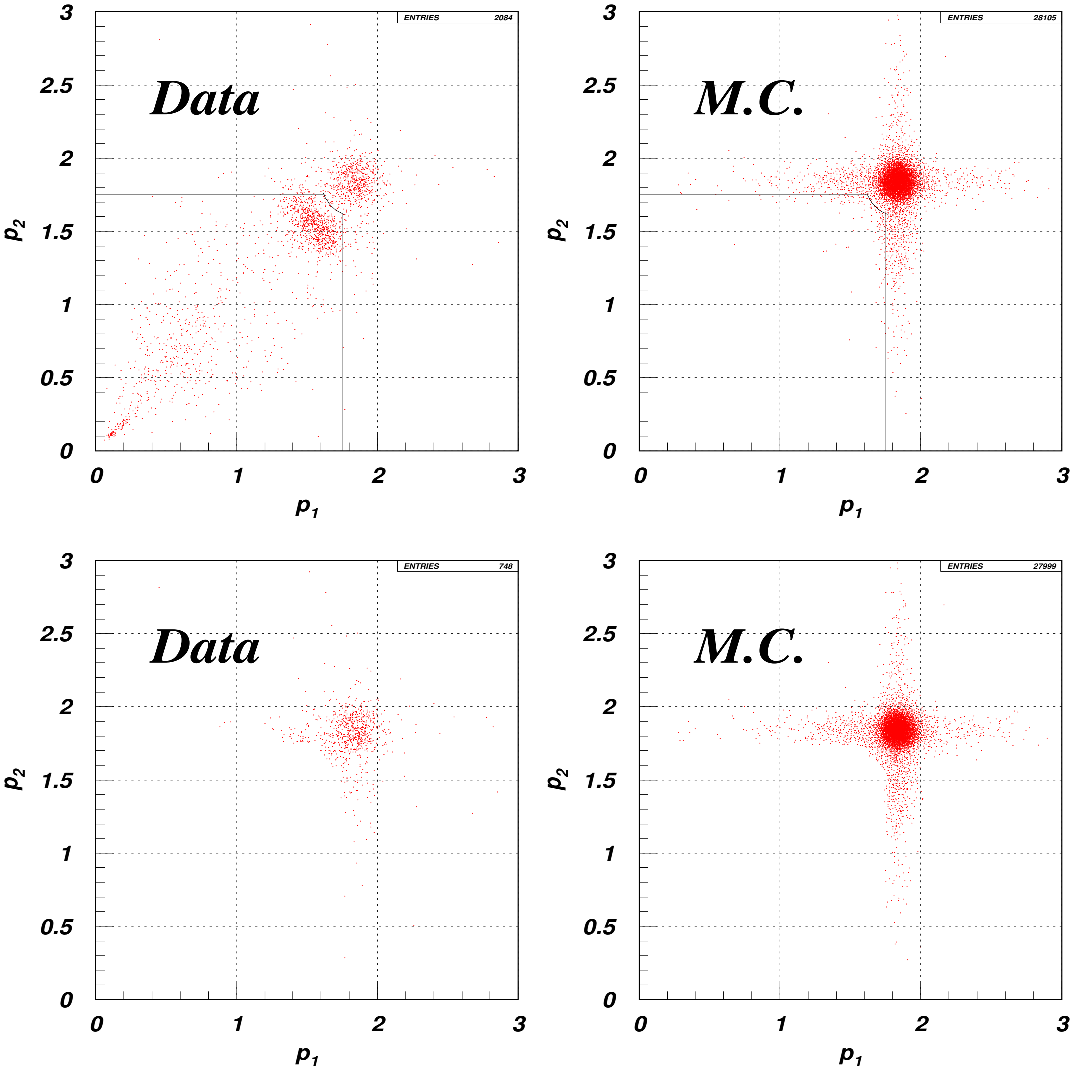
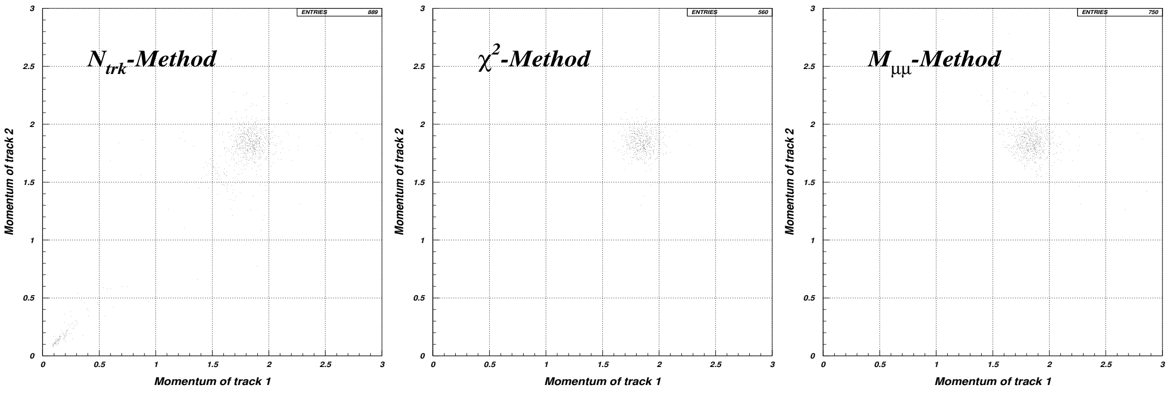
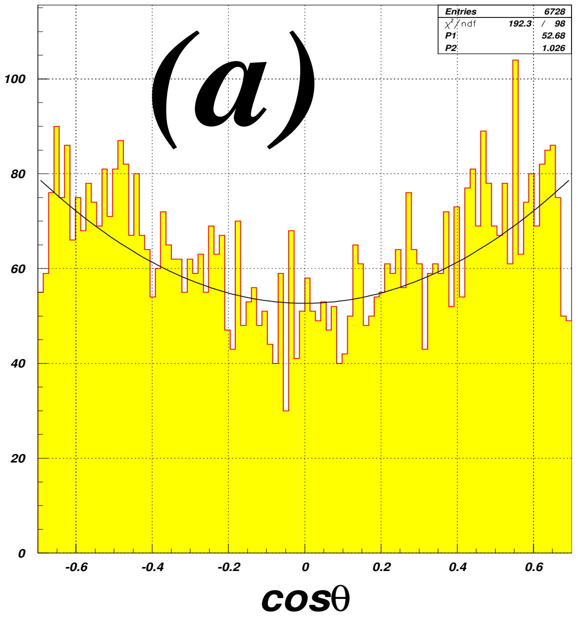


Figure 7: Momentum Comparason



(a)Method-1 (b)Method-2 (c)Method-3

Figure 8: Momentum distribution


(a)
Entries 6728
χ²/ndf 192.3 / 98
P1 52.68
P2 1.026
0
20
40
60
80
100
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
cosθ