MDC Reconstruction and MDC & VC Track Matching

Jing Liu[1,2] Chang-Chun Zhang[1] Yu Xie[1] Zepu Mao[1]

[1] CCAST
[2] Div.1, IHEP, Beijing 100039, China

Jun.9 1997

Abstract

We describe the latest status of reconstruction and calibration software of MDC,the results show that the software can reconstruct MDC data of BES-II successfully. The status of matching MDC and VC tracks together is described here also, The results show that the method we used to match is feasible.

1 Introduction

BES-II have acquired some J/Ψ data at last running period, so we can debug and test our reconstruction and calibration software though the data is noisy. Because our software is a brand new method to BES, its working status is concerned,we need to give out its running status.

2 Status of MDC reconstruction and calibraciton

Our reconstruction software can run all data BES-II acquired smoothly.What we need to know is whether the software can reflect the real momentum and space resolution of the drift chamber.

2.1 Correction

There are some correction in reconstruction software–DCJULIE.

- Distance caused by gravity on the sense wire, calculated by $\Delta Y = \Delta Y_{Max}(1-(\frac{z}{L/2})^2)$, ΔY_{Max} is the Max sag on the wire and L is the wire length,z is the Z coordinate of the track.
- Flying time of particle from I.P. to the fired wire,calculated by $\Delta t = \frac{S}{c}$, S is arcs length from I.P. to hitted wire,c is the velocity of the light.

- The time of signal propagating on the wire,calculated by $\Delta t = \frac{Len}{V}$, Len is the length of signal propagate on the wire and V is the speed of signal propagate on the wire.

2.2 Calibration

We must decide some importmant constants of MDC before we begin to reconstruct the real data, this process is off-line calibration. Off-line calibration is finished in four steps,every steps calibrate one set of the following constants:

- **RTAC(3216)** : T_0 of every wire.
- **RLSHFT(3216)**: position correction of every wire.
- **DFTVEL(2,40)**: drifting velocity of electrics at every sense wire layer,two sides on the wire.
- **QTCORT(2400)**: Drift time correction of pulse height.

In the process of obtaining every set of the constants, the momentum resolution is improved from 78MeV $\longrightarrow$ 63MeV $\longrightarrow$ 57MeV $\longrightarrow$ 51MeV

2.3 Results

After correction and carefully calibration, we get the momentum resolution of MDC of BES-II is about $\Delta P \approx 51MeV$, that is $\frac{\Delta P}{P} \approx 1.8\%\sqrt{1+P^2}$ and the space resolution is about $190 \sim 210\mu m$,those results reach the level of BES-I. Figure 1 and figure 2 is the momentum distribution, figure 3 is the ϕ and θ angle distribution of $\mu^+\mu^-$ and e^+e^-. figure 4 is the Z distribution of e^+e^- and $\mu^+\mu^-$.

3 Status of matching MDC & VC tracks

BES-II has replaced the original central drift chamber of BES with the straw tube vertex chamber(VC),which can improve the tracking, the space and momentum resulotion. But it is not good in Z reconstruction and VC cann't obtain extact momentum of the track lonely, It must be combined with MDC to get good momentum resolution and improve space resolution in Z direction.

Momentum resolution can be expressed in the Glukstein's formula:

$$\frac{\sigma_P}{P} = \frac{P_T\sigma}{0.3QBL^2}\sqrt{\frac{720}{N+5}}$$

Where σ is the space resolution and N is the number of measurements on a distance L. Obviously,combined VC and MDC together will make L and N larger,and so σ_P less.

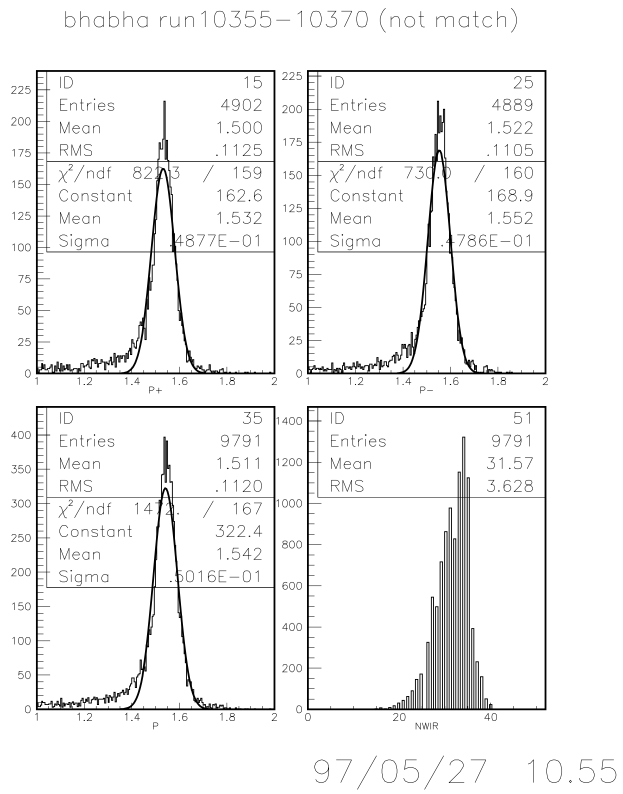

Figure 1: Momentum spectrum of e^+e^- events

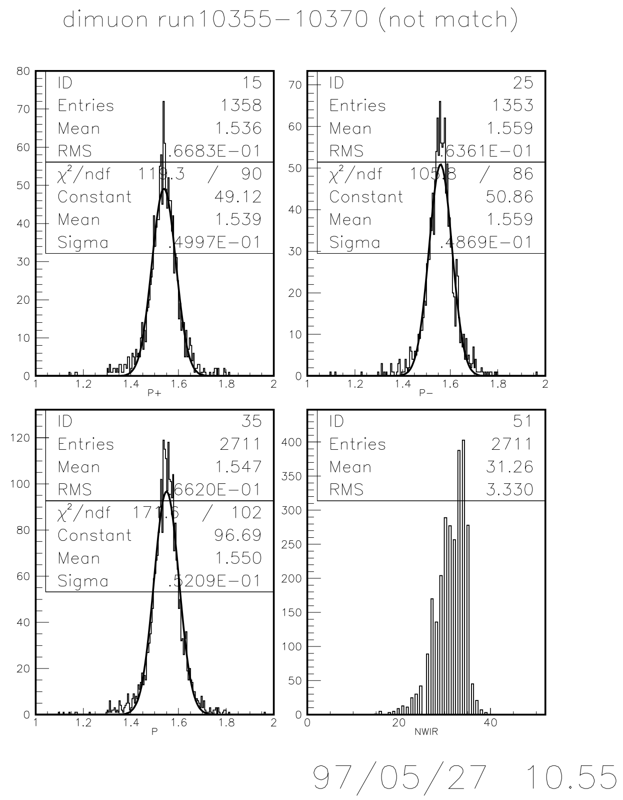

Figure 2: Momentum spectrum of $\mu^+\mu^-$ events

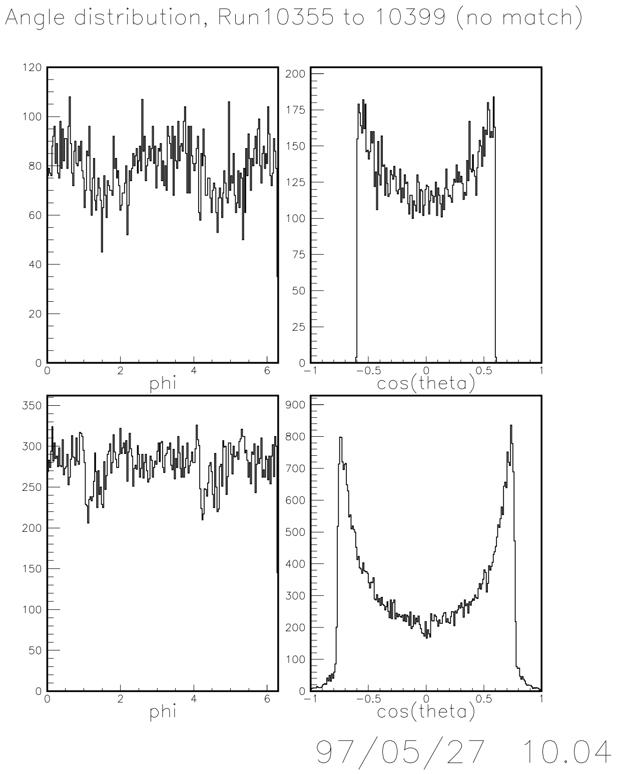

Figure 3: Angle distribution of $\mu^+\mu^-$ and e^+e^- events

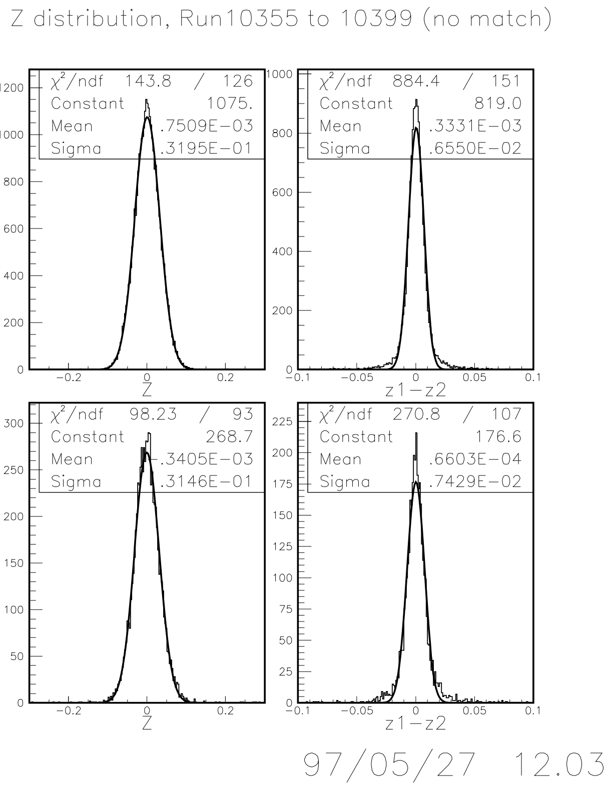

Figure 4: Z distribution of $\mu^+\mu^-$ and e^+e^- events

3.1 How to match?

We have several choice:

1. We use different dictionary and track finding program to find circle tracks in r-ϕ plane in MDC and VC respectively , then match the circle tracks together. The combined circle tracks goes into helix fit program.

2. Use the helix tracks finding by MDC and VC reconstruction program respectively.

Both of the two methods above are easy to write codes but have low matching efficiency and will eat much CPU.

3. Take two detectors as a whole to generate the dictionary and find tracks. This choice will cause two detectors affect each other, any one of them cannot work will cause the software fail and it is difficult to find the align shift between two detectors and how to generate the dictionary is a large problem.

4. To extrapolate DC tracks to VC to pick up VC hitted points. After DC find circle track, We extrapolate it to VC in a defined width of the path to pick up VC hitted points. In this choice, tracks dependent only on DC and the two chamber is independent, only one dictionary use in the track finding and it is easy to find align shift between them by off-line calibration. So we use this choice to combine tracks together in two detectors.

The following chart flow shows how to match DC and VC tracks together, figure 5. The left side is the chart flow of DCJULIE, the right side shows when to pick up VC points.

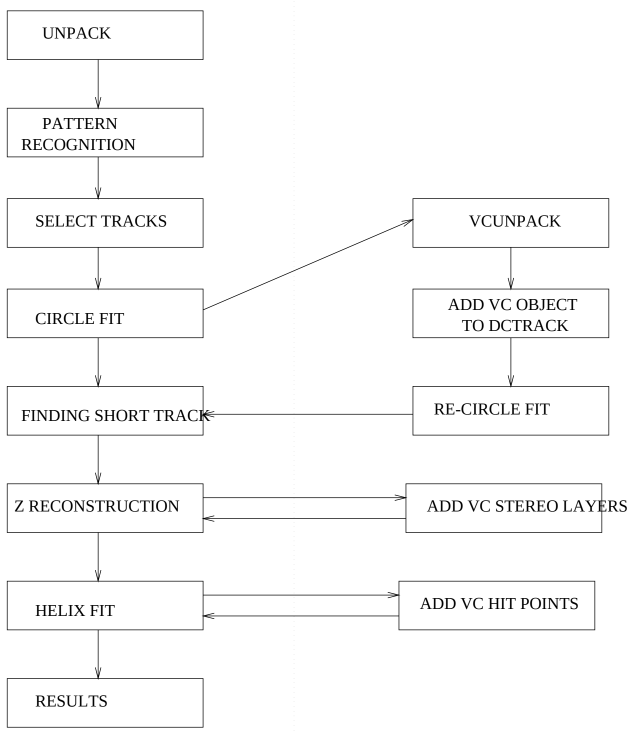

Figure 5: Chart flow of the matching program

3.2 Calibration of VC

We have combined track in two chambers together, to obtain good momentum resolution,two off-line calibration constants of VC,T_0 of every tube and position shift of every tube,need to calibrate carefully.

We consider the MDC has been correctly calibrated, so we fixed all MDC constants and assign 0 to fitting weights of every VC tubes to find the align shift between VC and MDC. To get residue of every tube of VC we use $\Delta S = S_F - S_M$ where S_F is distance of closest approach (DCA), S_M is measured drift distance. ΔS includes ΔS_L and ΔS_R,is the residue when track pass wire on the Left and right respectively.

Next step we calculate ΔT and ΔW, correct T_0 and wire position W,use following formula:

$$\Delta T = \frac{\Delta \bar{S}_L + \Delta \bar{S}_R}{2\bar{V}}$$

$$\bar{V} = \frac{V_L + V_R}{2}$$

$$\Delta W = \frac{1}{2}\left(\frac{\Delta \bar{S}_L}{V_L} - \frac{\Delta \bar{S}_R}{V_R}\right)$$

$$T_0 = T_0 + \Delta T, W = W + \Delta W$$

After iterate several times, we get final T_0 and wire pisition W.W is the position (SURVEY) correction of every tube. figure 6 is the results of calibrating T_0 of every VC tubes, the first plot is correction of T_0 at the first time calibration, and the second plot is correction of T_0 after several times calibration. figure 7 is the results of calibrating SURVEY of every VC tubes, the first plot is correction of SURVEY at the first time calibration, and the second plot is correction of SURVEY after several times calibration.

3.3 Initial results

After calibration of VC, we use the combined program to reconstruct the data of BES-II,e^+e^- and $\mu^+\mu^-$, we obtain good momentum resolution, which is never reached on BES before. All the results is listed in follow table, that show our method to match tracks is feasible. figure 8 is the momentum spectrum of e^+e^- after matching tracks. figure 9 is the momentum spectrum of $\mu^+\mu^-$ after matching tracks. figure 10 is the residue of VC every layers, the width of the peak stand for space resolution. figure 11 is the residue of one layer of DC. figure 12 is the Z distribution of e^+e^- and $\mu^+\mu^-$. events after matching tracks.

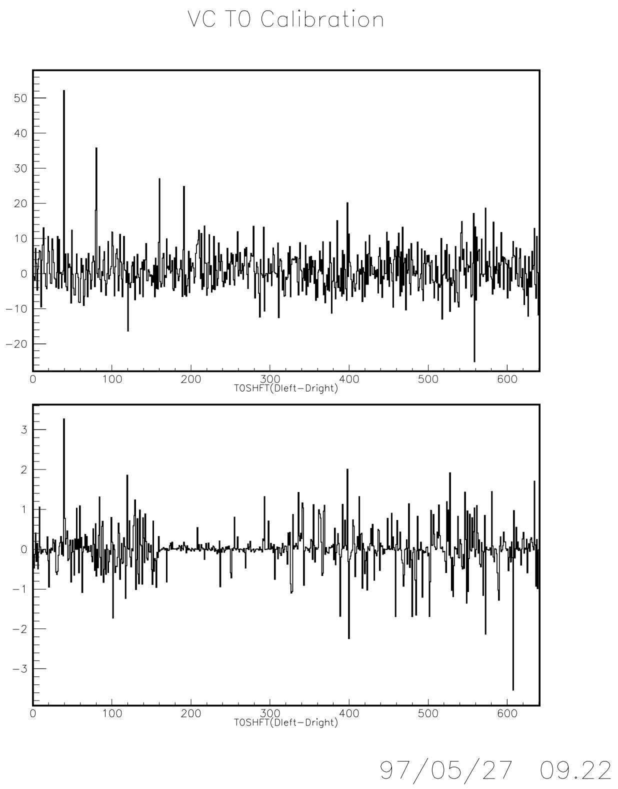

Figure 6: Calibration of VC T_0

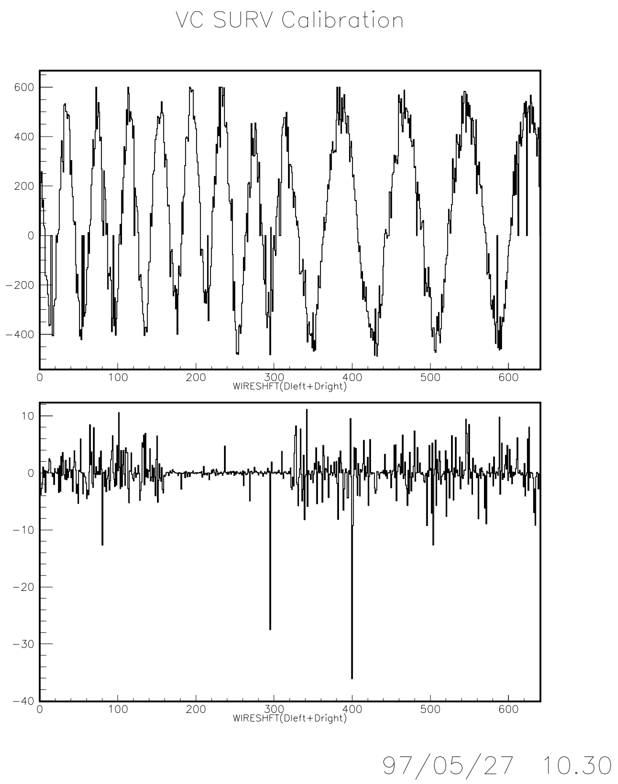

Figure 7: Calibration of VC SURVEY

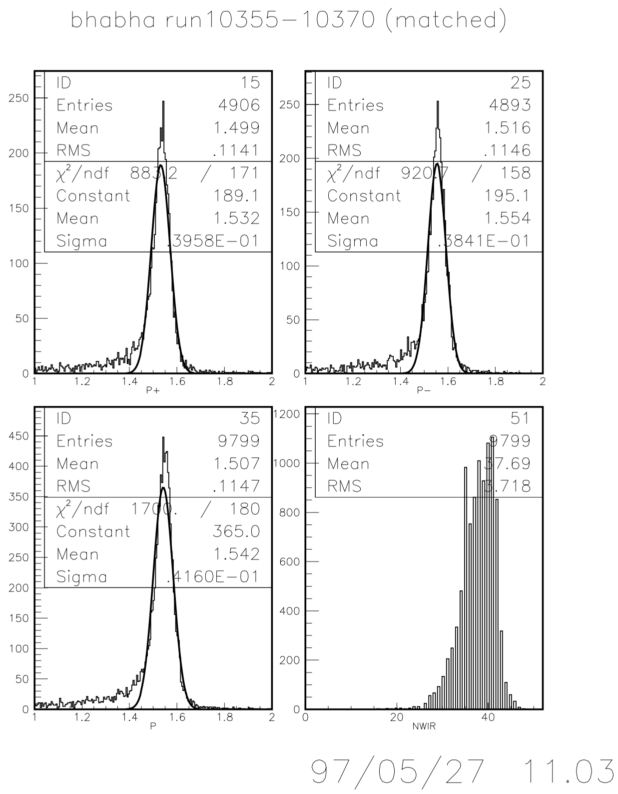

Figure 8: Momentum distribution of e^+e^- after matching

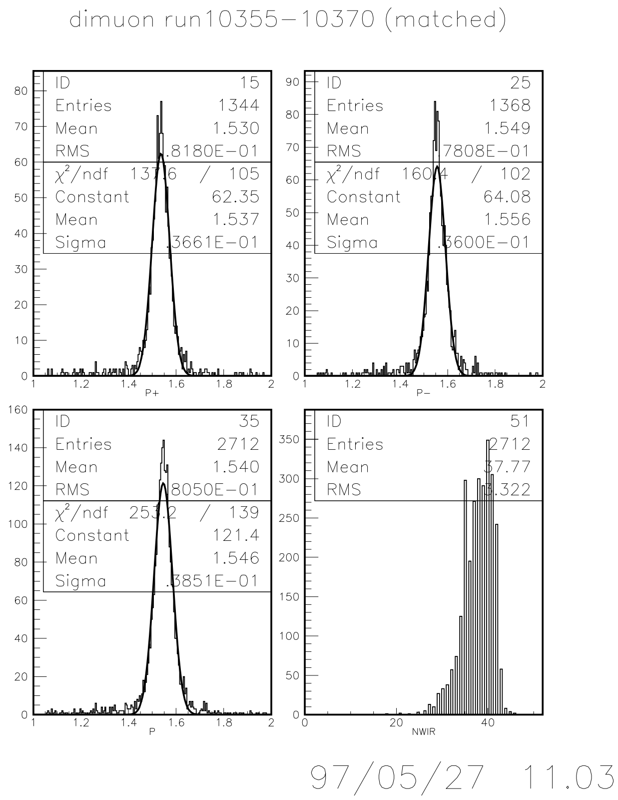

Figure 9: Momentum distribution of $\mu^+ mu^-$ after matching

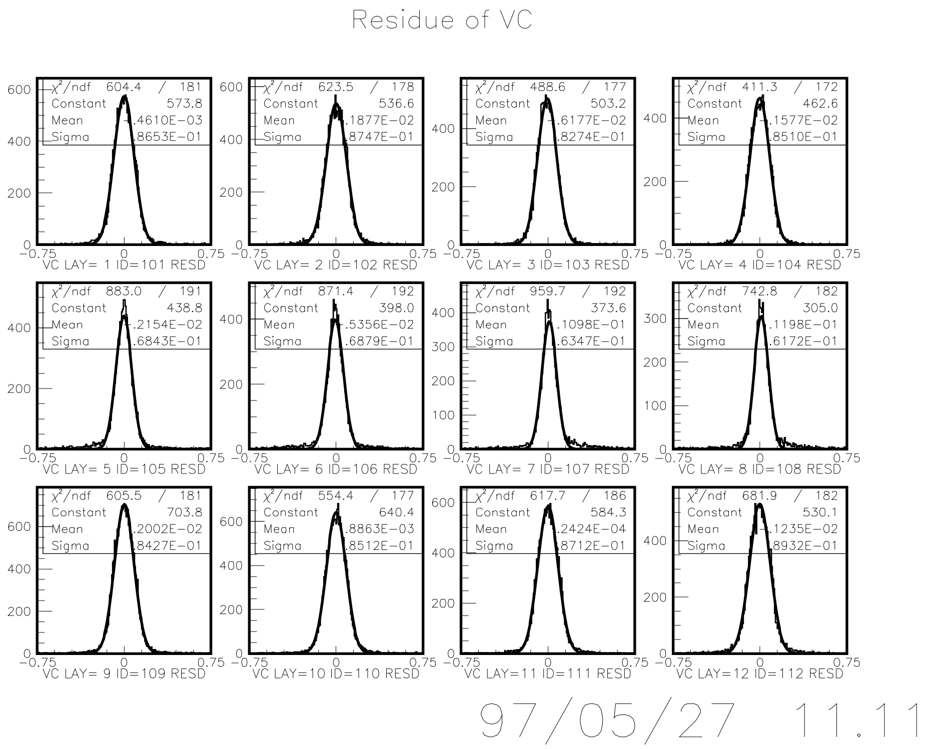

Figure 10: Residue distribution of VC layers after matching

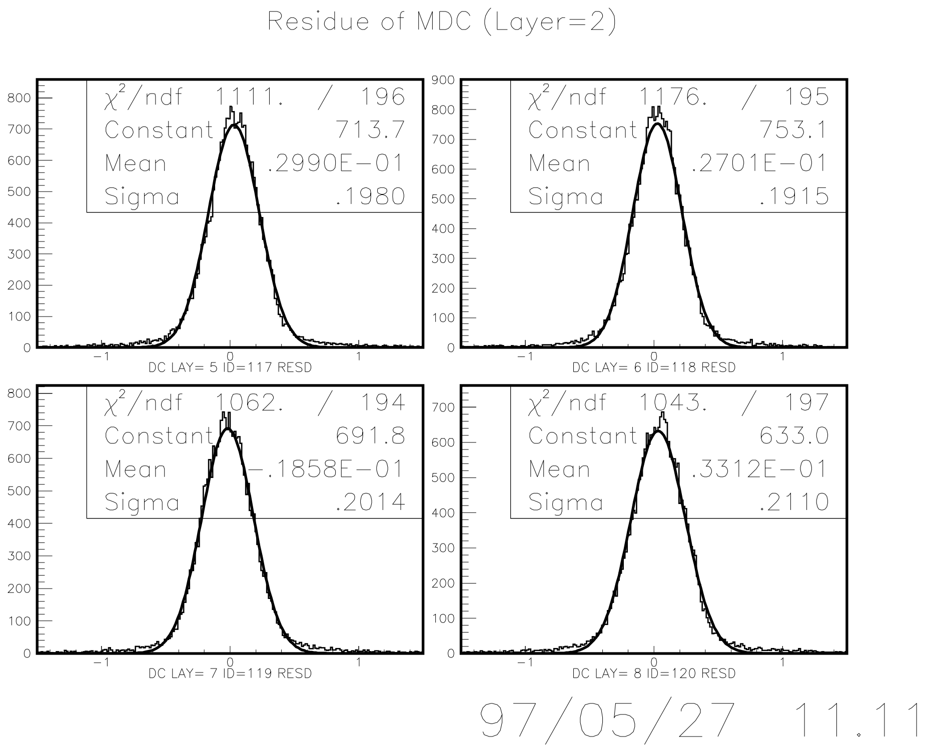

Figure 11: Residue distribution of layer 2 of DC after matching

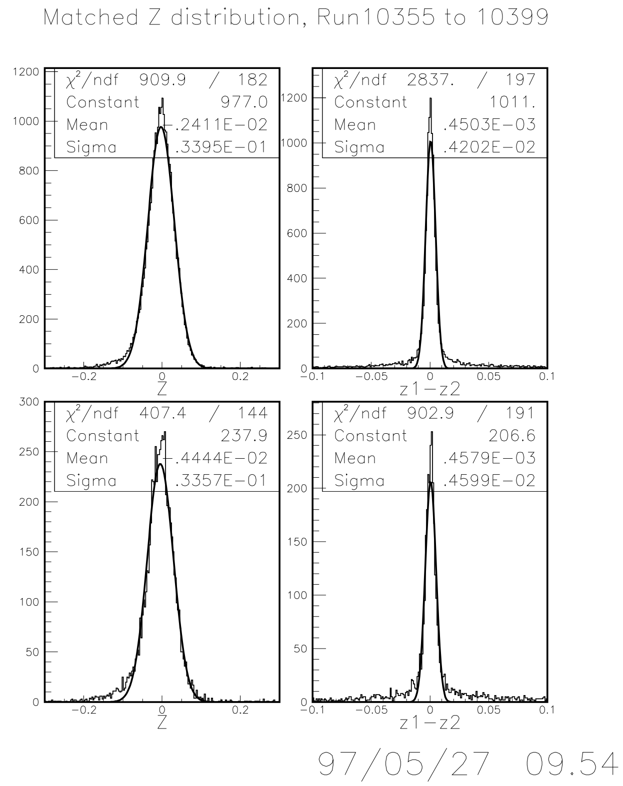

Figure 12: Z distribution of $\mu^+\mu^-$ and e^+e^- events after matching

	Before matched	Matched
$\Delta P(e^+e^-)$	51 MeV	41 MeV
$\Delta P(\mu^+\mu^-)$	52 MeV	39 MeV
Wires/TRK	31.4	37.4
ΔD (MDC) VC	$190 \sim 220\mu m$(DC) $\sim 89\mu m$(Axial layers) (by Chengp)	No obvious change $\sim 90\mu m$(Axial layers) $\sim 70\mu m$(Stereo layers)
Z1-Z2 (e^+e^-) Z1-Z2 ($\mu^+\mu^-$)	6.6 mm 7.4 mm	4.2 mm 4.6 mm
Width of Z	3.1 cm	3.3 cm
ϕ and θ		No obvious change.