The BESII Software Version V100 and the Data Quality Check for R-M Data

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1 The Introduction

The offline data analysis software environment of the BESII, includes the data analysis common programs and the data production system, such as sober.f, drunk.f and raw data filter system; the software environment and job control system($\star$.sh beslogin sober, drunk . . .); the event reconstruction system; the offline calibration system; the offline data analysis utility programs; and the BES software documents system. Some of them is upgraded from BESI, some of them is exploited for BESII in recent years. some of the reconstruction codes have been improved by the data analysis of the 1996-1997 data. we checked the code very careful in Beijing and in US side during this year, more than 200 codes have modified, then we fixed the first BESII software version V100(V10.0).

Using this version, we finished the offline data calibration for each subdetector by the J/ψ data(run11001-11259), got the performance of the MDC with split high voltage and other subdetector. and finished data production of the R-value measurement data(run11001-11970).

The codes of the raw data Filter, Calibration and Reconstruction programs has been checked further when production the data(run11001-11970), more than 10 codes has been put in the BES software version V101(v10.1), the MDC-VC track matching codes and VC-MDC-ESC track matching codes and the new simulation codes(SIMBES) will put in the version V101(V10.1).

2 The BESII Software Version V100(V10.0) and V101

2.1 Reconstruction parts

We checked BESII software and moved some of the bugs of the reconstruction cods through the calibration and reconstruction of data Run10000-10578(taken in 1996-1997) in last year. In order to fixe the BES software version v100, we checked the codes again very carefully. The common blocks over used between the DCJULIE and VCJULI has been solved, in MDC tracking parts, about 45 codes and some common statement have been changed as following:

```
mdcpid.f, dcunpack.f, depipe.f, blkvcj.f, recon100.f,
bokfil.f, calhot.f,   chkcel.f, dbunch.f, countdc.f,
dccons.f, dcjulbk.f,  evalu8.f, mdcout.f, fielbes2.f,
tdcfil.f, fillxy.f,   vcparc.f, hitmap.f, dcunpack.f
objrfi.f, vctket.f,   vcdbch.f, strzee.f, fillsurv.f,
trkcir.f, trkcph.f,   unpack.f, vcacsv.f, read3.f,
vcdbnd.f, vcirsv.f,   vclose.f, vclpit.f, helixv2.f,
vcpfil.f, vcpqsc.f,   vcresd.f, vcscat.f, prouthbk.f,
vctkfd.f, vctnit.f,   vczrec.f, zshard.f, recon.f
vcarccon.inc, vcarcctl.inc, vcarcdrv.inc, vcarcint.inc,
```

The bugs of the VC-reconstruction codes has been taken out; In order to reduce the CPU cast of the VC-tracking and give up the noise events, we improved the VC-tracking method.

The BSC and ESC tracking codes have been checked very carefully and some bugs has been moved. the codes modified is as following:

```
bsccin.f  bsccout.f  bceclu.f    bcezcor.f
bcpclp.f  seedy.f    hitpnt.inc  bsccon.inc
```

The codes of correction for Energy lost on the beam pipe has modified to suitable for the material of the BESII beam pipe. The common statement and the codes changed is: depipe2.inc depipe3.inc depipe.f

The Detector simulation codes, includes the VC, MDC, MU, BSC, ESC and TOF, have been checked for BESII' 98 data. Dr. cheng Baosen will give a talk on this meeting. Some generator codes changed and put into the BES Lib. The new BESII simulation framwork(SIMBES) using GEANT is studying and will be put in the V101, the details see the reports by Dr. Li Can Guo in this meeting

The raw data analysis codes: Filter, the codes of the raw data sort, DRUNK and the SOBER also checked by the 98's data.

The MDC-VC track matching and VC-MDC-ESC track matching is studying, it will put in the V101, the details of this parts see the reports by Liu Jing and Chen Guangpei in this meeting.

Some of the codes grammar error, for example some format can not suitable for all machine, such as HP-UNIX system, VMS(VAX)-system, OFS1(DEC-ALPHA-UNIX) system, have modified. The main problem solved is as following:(Dr. Derrict did lots of works in this parts.)

1). if the variable in the common statement is declared('data') more than one times in same subroutine or different subroutine, it can pass in HP-UNIX (Beijing), But in some machine will causes the: "multiply defined" error.

2). If the function "FUND" is not used in the code, the declaration "EXTERNAL FUND" will lead error while do the link.

3). The declaration: "INTEGER*4 VCOTRK/32/" is not standard formation. for all platform, such as ALPHA.

4). The binary dictionary files used in the MDC and VC tracking, it is created on HP-UNIX(Beijig) can not used in every platform. It will solved soon by Dr. Derrict in Hawai.

5). The declaration of variables type must be done in each code, if without "IMPLICIT NONE" declaration in a code, it may be causes problem in some case.

After above checking, we fixed the BES software version V100. and created the new version V101(V10.1). the status of the V100 and V101 is as following:

CODE AND SYSTEM	VERSION
Production Codes	10.0
Rec. and Cal. system	10.0
MC system(Sober)	10.0
SIMBES	10.1
VC-MDC-ESC Matching	10.1
MDC-VC Matching	10.1

3 The data Calibration and Production Status

3.1 The data status

The RM(R value Measurement) data taken beginning from April to May in 1998. The data type is listed as table 1. They can be separated three parts. The first one is the machine and detector study from run 21001 to run 21047; From Run11001 to Run11246 is the J/ψ data and used for offline data system calibration; The third one, from Run11247 to 11970 is the RM data.

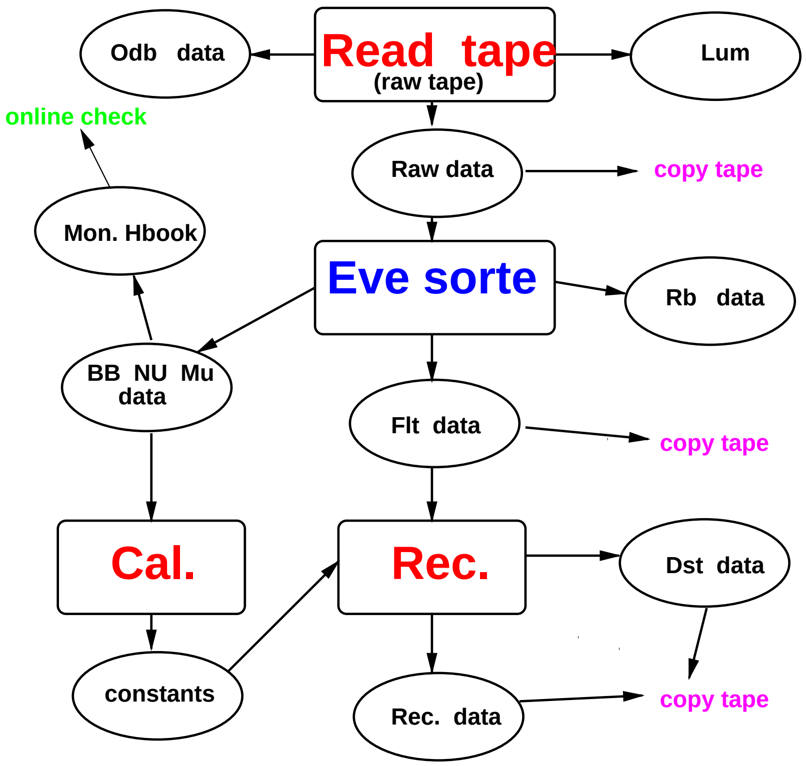
Table 1. The Data type list

3.2 The off-line data calibration of BESII

The flow chart of the raw data analysis is shown as Fig.1, in this step, the raw data has been sorted different kinds of data and save carefully, the BB, MU and NU data is the the Bhabha, dimuon events in barry parts and Bhabha events in the endcape respectively, they are used for the checking of the detector performance in the on-line, and for the offline data calibration.

Run No.	Beam ERG(GeV)	Data Type
21001 - 21074	1.54	**Det. Test**
11001 - 11246	1.54	J/ψ
11247 - 11259	1.54	J/ψ **scan**
11260 - 11291	1.6	**R M**
11292 - 11326	1.7	**R M**
11327 - 11336	1.84	**Scan**
11337 - 11349	1.7	**SP Beam**
11400 - 11409	1.54	**Scan**
11410 - 11419	1.54	**Trigger Study**
11420 - 11482	1.775	**R M**
11483 - 11495	1.775	**SP Beam**
11496 - 11504	1.84	**Scan**
11505 - 11508	1.84	**Trigger Study**
11509 - 11530	1.7	**R M**
11531 - 11562	2.3	**R M**
11563 - 11573	2.3	**SP Beam**
11574 - 11600	2.3	**R M**
11601 - 11698	2.5	**R M**
11699 - 11703	2.5	**SP Beam**
11704 - 11898	1.3	**R M**
11899 - 11908	1.3	**B G**
11909 - 11927	1.3	**R M**
11928 - 11936	1.3	**R M**
11937 - 11947	1.54	**Scan**
11948 - 11957	1.6	**R M**
11958 - 11970		**B G**

The ODB data contends the running condition of the detectors. The FLT data is used for the data reconstruction after finished the offline data calibration. We finished all of the data Calibration and production by BES version V100. The details about this parts see the report by Dr. He Ju in this meeting.



The off-line data Calibration in this period is listed in table 2. The MDC T_0, dE/dx and VC system Calibration is done by the Run11001 to 11246. There are 11 constant has been created by Calibration group. The MDC dE/dx normal Calibration is done Run by Run, the BSC, ESC and TOF Cal. is done per 20 to 30 Run in different region. the details about this parts see the reports by Dr. Liu Jing, Chen Guanpei, Rong Gang and Yuan Ye.

Table 2. The BESII Data Off-line Calibration Status

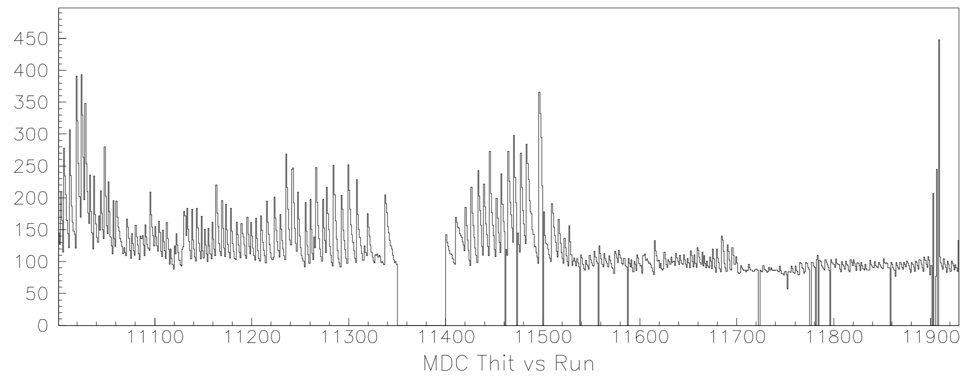
Name of Cal.	Run Period	data type used	Cal. Period
VC Survey	11001–11259	BHabha	System Cal.
VC T_0	11001–11259	BhaBha	System Cal.
MDC T_0 MDC Survey	11001–11259 11001–11259	Bhabha,$\mu\mu$ Bhabha, $\mu\mu$	System Cal. System Cal.
MDC dE/dx	11001–11259	Bhabha	System Cal.
MDC-Hot	11001–11957	Bhabha	per 30 -50 Run
MDC dE/dx	11001–11957	Bhabha	Run by Run
BSC	11001–11957	Bhabha	per 30 Run
ESC	11001–11957	Bhabha	per 30 Run
TOF	11001–11957	Bhabha	per 30 Run
μ ID	11001–11259	$\mu\mu$	one times

4 The Data Quality Checking and Preliminary Calibration Results

4.1 The MDC Noise Study

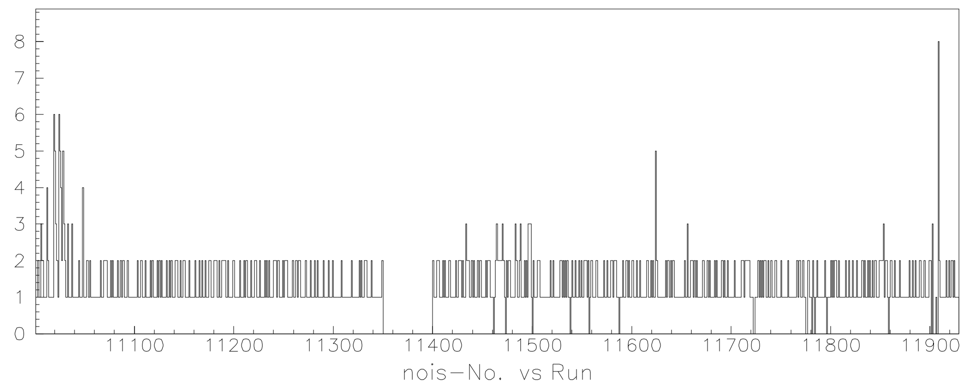
The MDC noise is the serious problem in last year. also it is the most interesting project for the MDC with split high voltages, we checked the hit wires of the time channel in each raw-BhaBha events as shown in Fig. 2. The mean hit wires per event is about 200 as shown in Run11001-11530 region, and 120 in Run11530-11970 region. It is about two times as that of the good Bhabha events(it should be equal to or less than 80 hit wires). From the structure of the curve, we can see that the noise is strongly depended the beam strength. it is very large at beam beginning and decreased around the beam running time. At the later region(after Run11530) the beam strength is limited about 20 MA, so the noise signal come to less.

Fig. 2 Hit(TDC) Wires (Per BB event) vs Run No.



The noise size and the frequency in space is studied, it is almost homogeneous in the detector region from the event display. The number of noise, more or equal to three wires and three layers continuous hit, around the Run number is shown in Fig.3. The mean value of this noise number is about 1 to 2. it is much less than that of last year(about 10 in last year).

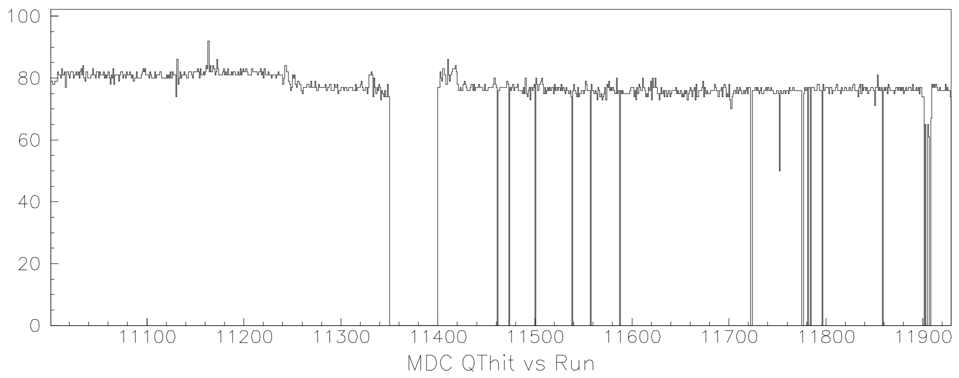
Fig. 3 No. of Noise (Per BB event) vs Run No.



The noise relationship between the charge channel and time channel has been investigated.

The QT-coincidence hit wires of the BhaBha event verses the Run number is shown in Fig. 4. The hit number per event is near real hit wire that we need(80 hits for BhaBha event). It indicates that most of the noise is the TDC channel only in the BhaBha events.

Fig. 4 Hit(Q+TDC) Wires (Per BB event) vs Run No.



In order to reduce the affection of the noise to the MDC tracking, the investigation of the relationship of the TDC and ADC signal has done. We use the QT coincidence(the ADC great than 20) to select the TDC signal for the MDC tracking as we did in last year, and this ADC cut does not affection the tracking efficiency.

4.2 Data Stability Check

We finished the reconstruction of the BhaBha events(Run11001-11259) by the BES version V100, the charged track momentum distribution verses the Run number as shown in the Fig.5. It indicates the MDC stability is good in this region. Because the BhaBha events is too less for RM data, we can not get this kids of plot, but we can estimate the stability of the MDC by the variance of the on-line T_0. The Fig.6(a) shows the average T_0 of each Run in this data taking period. The Fig.6(b) shows the variance of the T_0 within a Run in the data taking time, the shake is around 1 TDC channel, the dE/dx resolution around the Run is shown in Fig.7, those plots show the MDC work condition is stable during the data taking period.

Fig. 5 MDC P−Res.(rms) vs Run

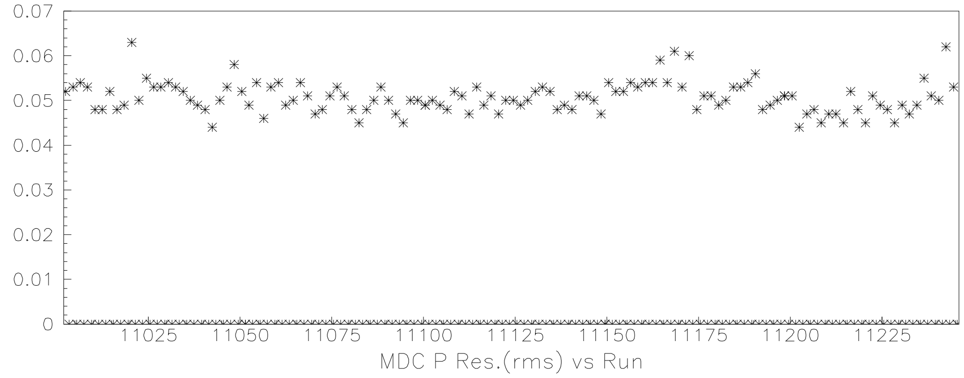
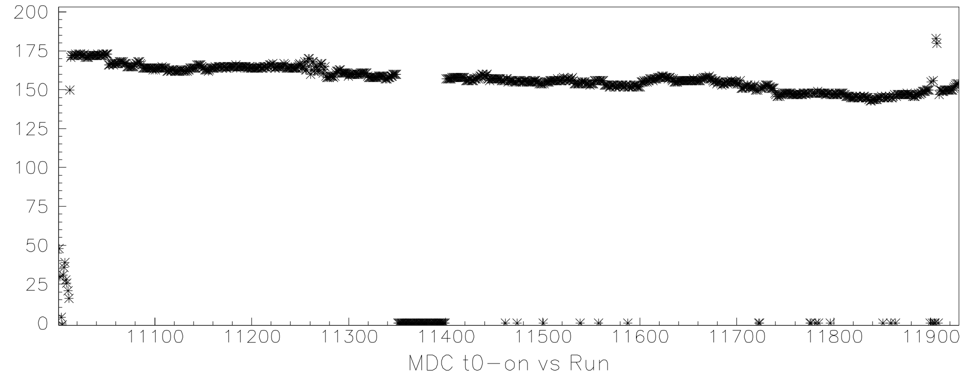


Fig. 6 MDC T0 distribution vs Run



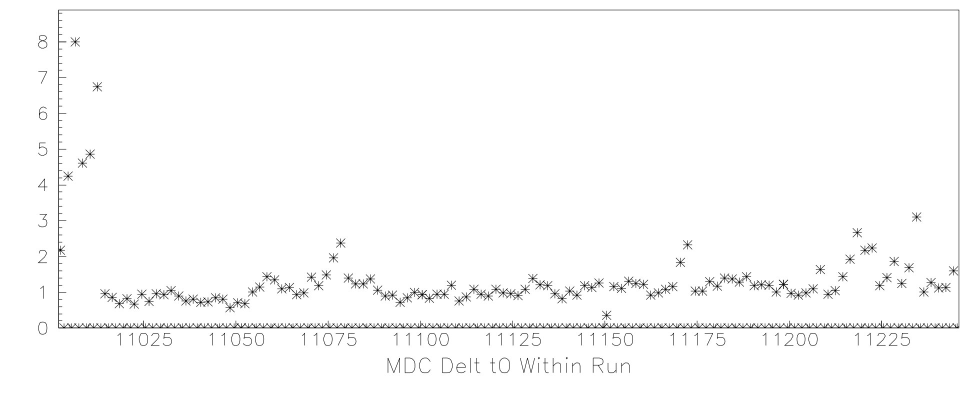
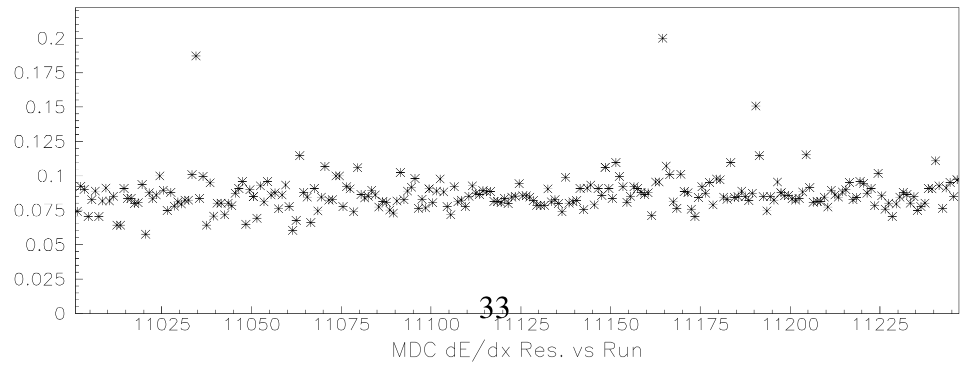
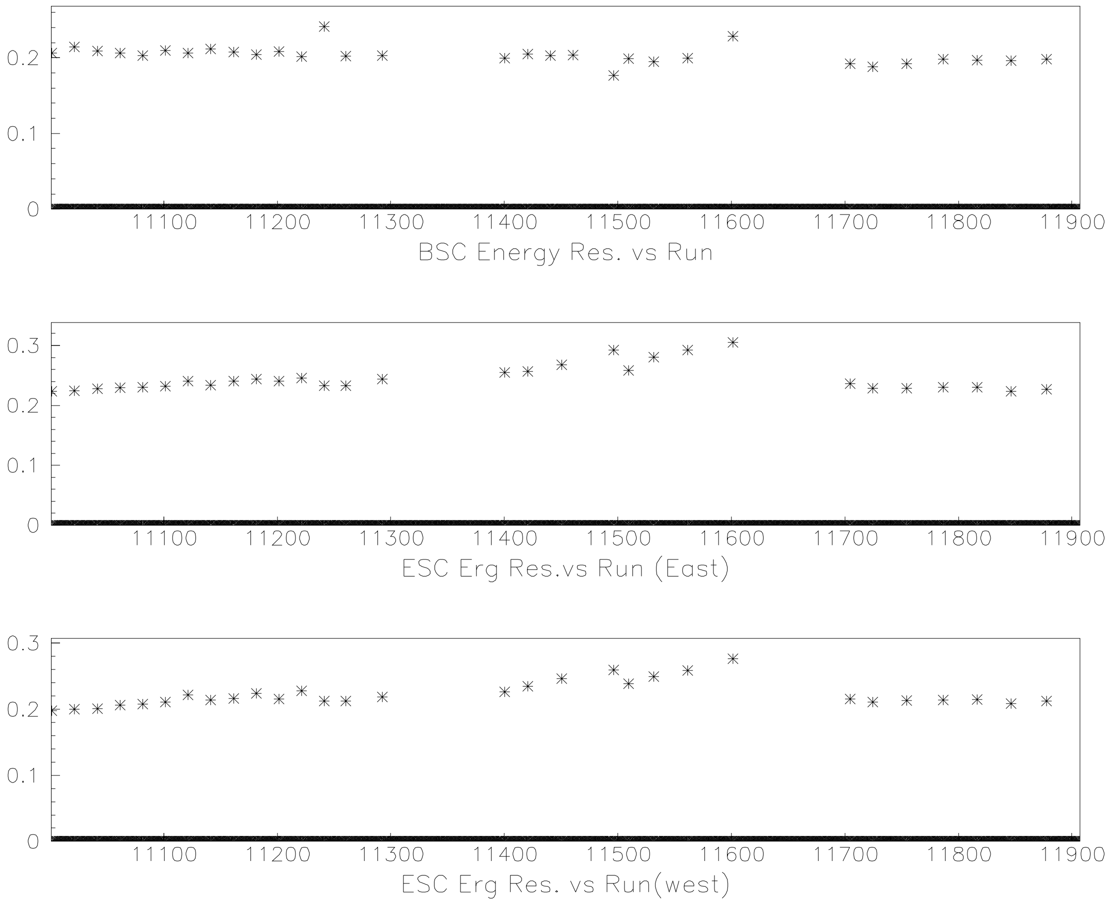


Fig. 7 De/dx Res(BB) vs Run



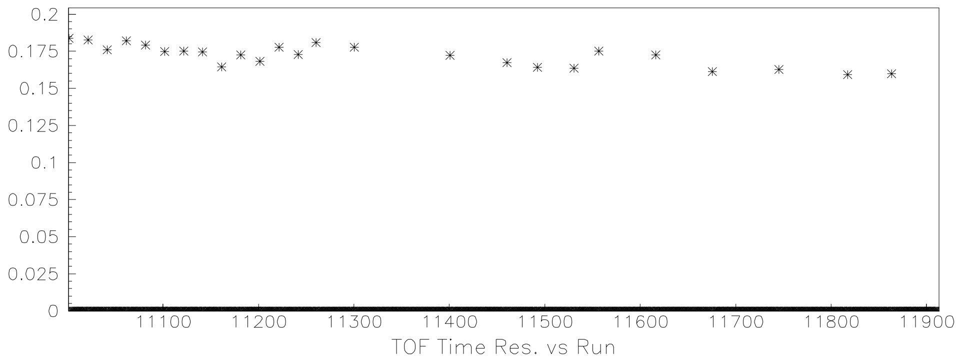
The Fig. 8 show the energy resolution of shower counter in the barry and endcape parts, we can see the shower counter work well in all of the data taking time.

Fig. 8 BSC and ESC ERG Res(BB) vs Run



The TOF time resolution around the Run is shown as Fig. 9 It shows the TOF works stable in all of the data taking time.

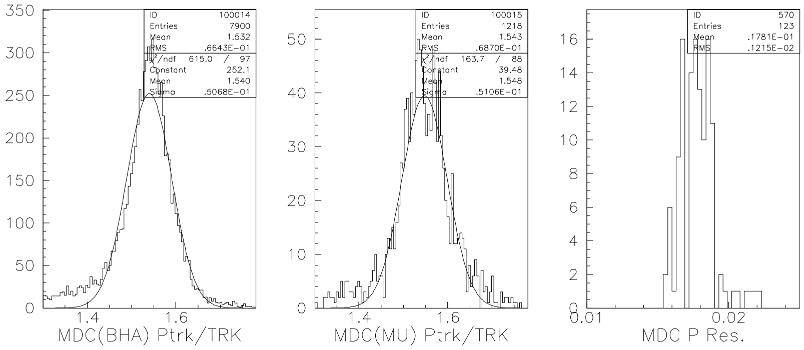
Fig. 9 TOF Time Res(BB) vs Run



5 The performance of the detectors

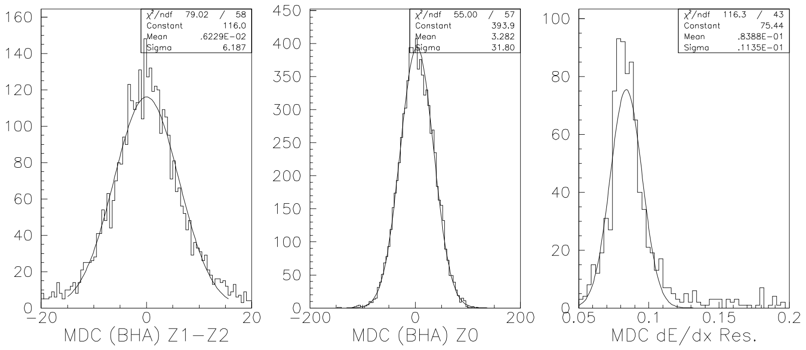
A typical momentum distribution of charged tracks in BhaBha and dimuon events is shown in Fig.10(a) and Fig.10(b) respectively. the average momentum resolution of charged tracks of BhaBha event, the distribution of the momentum resolution of each run in the Run11001 to 11259 region, is about $1.78\%\sqrt{(1+p^2)}$ as shown in fig. 10(c).

Fig. 10 MDC Performance Run11194−11204(ee)



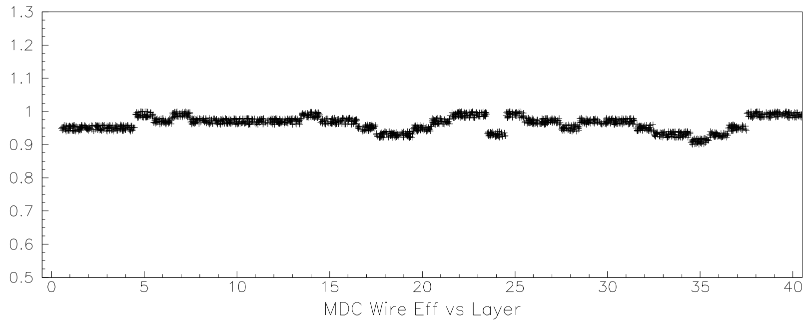
The Fig.11(a) shows the differences of the track vertex-Z position in the BhaBha events($Z_0$1 and the $Z_0$2). It present the tracking vertex Z position standard deviation is about 6.18 mm. The Fig.11(b) shows the vertex Z_0 distribution of the tracks in the BhaBha events, we can estimate the beam spread in Z direction is about 3.18cm from this plot. The MDC dE/dx resolution is about 8.38% as shown in Fig. 11(c)

Fig. 11 MDC Performance Run11194−11204(ee)



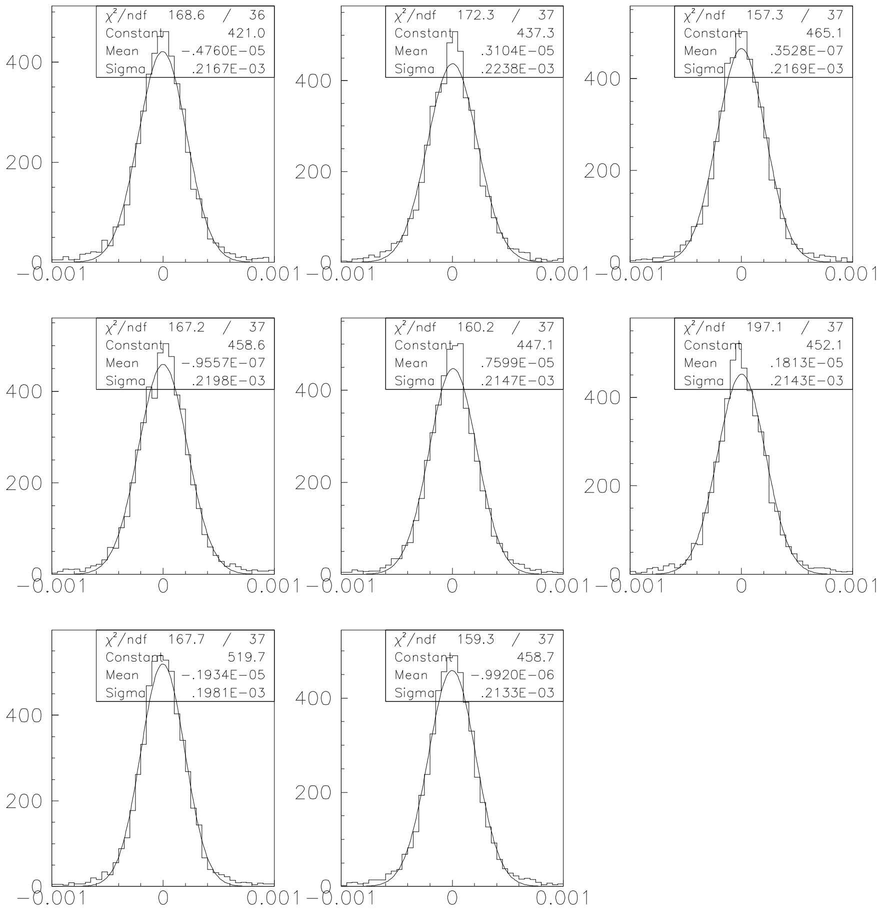
The MDC wire efficiency, defend as the No. of hit wires found by the MDC tracking divided by the No. of wires of the track go through, is shown in Fig. 12, The MDC wire efficiency is about 96.2 %.

Fig. 12 MDC Track Efficiency vs Layer



The MDC spatial resolution is about 190-210μm as shown in Fig. 13. It is the residual of the tracking fitting got from the DCJULIE, so it is the combination the error of hardware and software.

Fig. 13 MDC Track Fit Residual L 1−8



A typical energy distribution of the BhaBha events in BSC and ESC is shown in Fig.14(a) and Fig.15(a) respectively. The average energy resolution of the BSC and ESC(from BhaBha events) is about 20.33% and 22.19% as shown in Fig.14(b), Fig.15(b) and Fig.15(c). The

BSC spatial resolution in Z direction, the Z position in BSC comparison with that of MDC track, is about 2.2cm as shown in Fig.14(c).

Fig. 14 BSC Performance(ee)

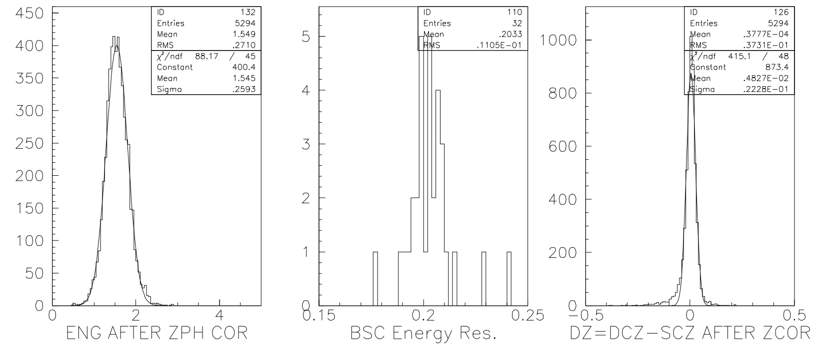
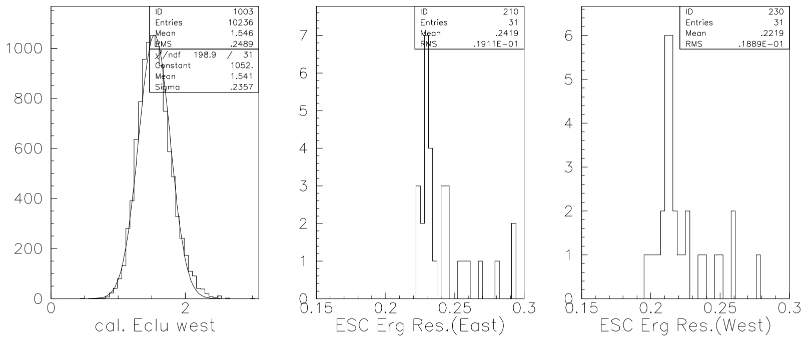
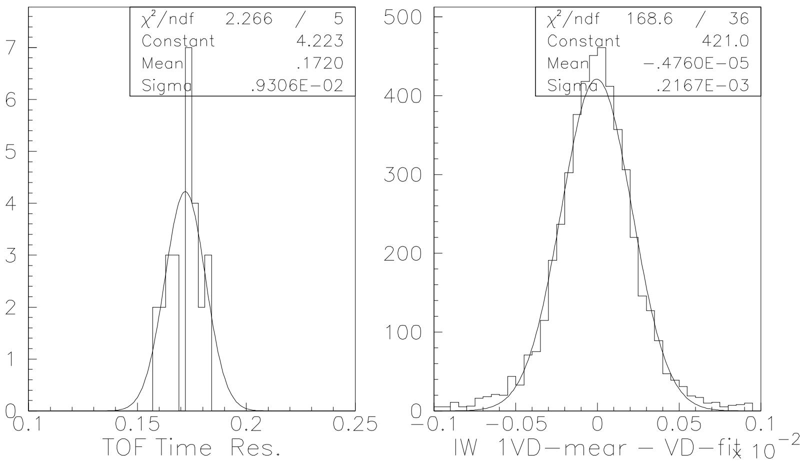


Fig. 15 ESC Performance(ee)



The time resolution of TOF is about 172.2 ps as shown in Fig.16(a). The spatial resolution of the VC in xy plan is about 99.4μm as shown in the Fig.16b(the residual of the track fitting). the track find efficiency is about 97.6%. The more detials performance of the detectors is listed in table 3.

Fig. 16 TOF Time and VC Spatial Resoloution



Detector	Performance BES-II
MDC:	
Wire$_{Eff}$	$\simeq$ **96.2** $\%$.
Spatial-Res.σ_{xy}	$\simeq$ **190-220** μ**m**
Mom-Reso.	$\delta p/p \simeq 1.78\%\sqrt{(1+p^2)}$
Z Vert. Posit.	$\simeq$ **0.62 cm**
Z-Beam Spread	$\simeq$ **3.18 cm**
dE/dx: σ_{tru}	$\simeq$ **8.4** $\%$.
BTOF:	
Time-Rec.σ_T	$\simeq$ **172 ps.**
Atten. Leng.	**3.5-5.5 m**
BSC:	
ERG-Res.	$\delta E/\sqrt{E} \simeq 20.3\%.$
Err-Z-Posit.	$\simeq$ **2.3 cm**
ESC:	
ERG-Res.	$\delta E/\sqrt{E} \simeq 22.1\%.$
Vert. Chamber:	
Spatial-Res. σ_{xy}	$\simeq$ **99.4**μ**m**
Trk$_{Eff}$	$\simeq$ **97** $\%$
Muon Counter	
Mu-Trk$_{Eff}$	AS BES-I (**95** $\%$)
Spatial-Res.σ_z	AS BES-I(**5.5cm**)

6 The Conclusion

1). From the preliminary results of BESII in table 3 and the plots Fig.10 to Fig.16, we can see all of the detector works well and better than the BESI.

2). Those results also indicates the BESII software version V100, includes the Calibration and Reconstruction codes of the MDC, BSC, ESC, TOF and Muon detector, works very well.

3). Next step the VC-MDC and VC-MDC-ESC track matching codes and the new simulation programs(SIMBES) will be added in the V101. It will open the new page for BES software and the BES physics analysis.