General Report on the BES-II Software

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the BES2000 Annual Meeting

The Codeman is maintained and operated well after moved to IHEP. BES-II analysis software is in good shape and passes its test on detector performace, Telesis fitting and physics signal searching of J/ψ decays. Further works on the SIMBES and Linux version are still required.

1. Introduction

The upgraded BES-II analysis software has to be carefully maintained and improved in order to meet the needs of R and J/ψ physics. Since MDC and VC JULIE codes are newly written and reconstruction software for individual subsyetems are migrated from VAX/VMS (BES-I) to HP/UX (BES-II), more strict checks are required with J/ψ events. For instantce, momentum, TOF, error matrix of the MDC and BSC tracks and $\pi/K/p$ separation should be carefully investigated by studying physics signal with and without Telesis fitting.

(1) v101 library plus its patches are released for R physics and v102 library for J/ψ physics;
(2) Large ammount of J/ψ data (23M events) have to be calibrated and reconstructed ASAP. Many bugs and problems in the software were found all the way but fixed in the data processing procedures;
(3) Computing resources are increased for data processing and physics analysis;

2. v101 library for R measurement

2.1. Realization constant files

10% difference in R values was found for 3.2 GeV data taken in 1998 and reconstructed with v100 and v101 libraries, and reported at the BES99 meeting. This was caused by uncompleted set of realization constants. Missing files is found out by Baoshen, and added into v101 library by Guangpei.

2.2. Efficiency check

In order to study consistency of R values obtained from different software versions, R data for 2.8 GeV are reconstructed via v100 and v101 libraries, respectively, but using same calibration constatnts obtained under v101 library.

After study of events which selected in v100(v101) but rejected in v101(v100), Guangpei concluded that efficiency gained in v101 are due to bug fixing in MDC initialization routines.

2.3. MC correction on $cos\theta$ deficiency

By using dE/dx threshold for both dEdx and TDC, $cos\theta$ dependence of hadron track for energy deposite in MDC are added, and dEdx distribution is tunned by Jiangchuan for R data taken in 1999 (see Minutes on 12-Jul-99).

2.4. v101 library + patches

This is an official version for R physics. Processing of R data taken in 1999 and 0.8M J/psi events are finished under v101 (+patches) on 12 July 1999.

3. v102 library for J/ψ physics

3.1. v102 library and data production

The BES v102 library must be debuged and improved because of

(1) hiden bugs
(2) run condition-dependent data (such as MDC noisy hits)
(3) weight calculation for error matrix of MDC
(4) dEdx correction for momentum calculation
(5) Telesis for BES-II

It took three months to get v102 libray completely frozen.

3.2. Coincedence of dEdx and TDC in MDC tracking

It is required to reject noisy MDC hits for R data, but removed from v102 library due to improved data quality for new J/Ψ data.

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3.3. Reconstruction with combined MDC and VC hits

Some bugs causing failure of the reconstruction with combined MDC and VC hits is fixed by Mao ZP. More study for the tracking and fitting codes, as well as calibration software, for new J/ψ data is still required.

3.4. VC online caibration

Online calibration constants for VC are made at online site, but read in and calculated in offline data processing step by using correction routine supplied by DAQ group. After one bug is fixed by Xiaonan, T_0 fluctuation comes smaller(by Yuan Y). It puzzled that position resolution become worse if using online calibration constant.

3.5. BSC calibration is improved (Huang XP)

Slow change of hit ADCs of Bhabha tracks from run to run is studied and corrected. Averaged energy of electron per run vs runs become much flat. It improves energy scale with better accuracy. But energy resolution has almost no change.

3.6. Job monitor scheme

A monitor scheme is added to data processing jobs (Mao ZP). It makes job running more effcient. It may check if

(1) reconstruction job reads right calibration constant files
(2) quits if constant file is not ready
(3) parallel processing for calibration and reconstruction is allowed

3.7. Contributions to v102 lib in passed year

(1) data formating (Zhang SQ et.al.)
(2) debuging and improvement on MDC tarck reconstruction (Mao ZP,Liu J,Chen GP)
(3) compatibility of F77 on HP and Alpha (Derrick)
(4) Linux codes(Ye SW)
(5) bug fixing for TOF in Sober(Ye SW)
(6) dEdx, MSC, Error matrix correction n Telesis (Lu F)
(7) BSC calibration (Huang XP)
(8) Muon-counter calibration (Sun LF)
(9) dEdx-dependent weight in MDC (Liu J)
(10) dEdx calibration (Rong G)
(11) updated generators (Zhang DH)
(12) J/Psi generator from CLEO (Cheng BS)

Notice that correction factor for magnetic field is set to 1 as default. v102 library is frozen completely on 14 Apr 2000.

3.8. v103 library

v103 library has been created and will be connected to the Codeman after BES2000 meeting.

4. Data processing and problem shooting

4.1. HV tunned for MDC potential wires (Li XN)

(1) To recover problem of $cos\theta$ deficiency
(2) Done in end of Nov-99
(3) dEdx peak positions of Bhabha tracks for 40 layers are moved up

4.2. New data after J/ψ scan and HV tunning

(1) RUN13531 - 16835 : J/ψ data
(2) RUN16836 - 16844 : J/ψ scan
(3) RUN16845 - 16852 : $\psi(2s)$ scan
(4) RUN16853 - 17018 : $\psi(2s)$ data

4.3. $cos\theta$ deficiency check

$cos\theta$ of hadron tracks shows (3-Jan-00) no obvious deficiency from new J/ψ data, and its distribution agrees well with BES-I J/ψ data (BES-I : RUN1438-1458; BES-II: RUN13644-13674)

4.4. $cos\theta$ of di-muon tracks

(1) MC shows $1 + cos^2\theta$
(2) Data is studied by Heng YK and Huang GS
(3) Further check is required for new J/ψ data
(4) dEdx threshold in MC needs to be studied

4.5. more checks on $cos\theta$ deficiency

$cos\theta$ of hadron tracks (see Fig 1) shows no obvious deficiency for RUN15500-15509 but clear deficiency for RUN3645-3653 (BES-I) and RUN14300-14309 (BES-II). It means that

(1) MC correction on dEdx for $cos\theta$ deficiency is required for RUN13850-14530.
(2) averaged dEdx from Bhabha tracks should not lower than 850 (see Fig 2)

4.6. Debuging processing jobs

Wrong tag word, caused by DAQ, was found. Mods in processing job is made to avoid overflow failure of wrong tag word. Bug, which causes dip in phi of Bhabha tracks, is fixed. Reprocessing of RUN13500-13690 with preliminary calibration is done after recovering of dip problem in ϕ.

4.7. MDC fine calibration with new J/Ψ data

It took 2 weeks more to go over all calibration procedures by using 150 runs (RUN13531-13680), and done on 21 Dec 1999.

(1) recon. and calib. software checked under v102 library
(2) drift velocity, T_0 and others carefully determined
(3) Resolutions of track momentum and TOF is normal.

Calibration for other subsystems, that requiry MDC track information, started on 27 Dec 99.

4.8. Detector performance from fine calibration (10-Jan-2000)

Table : Performance of BES-II

Type	resolution	note
momentum	49 MeV	
dEdx	8-9%	
BSC E	20-21%	
ESC E	25%	wrong cabling
TOF	180-190 ps	
Muon Z(L1)	7.3 cm	old calib

Muon counter calibration is done (Sun LF) by using improved software method. Z resolution for 1st layer of muon counter is improved to be 5.7 cm. Data quality for individual subsystems after RUN13570 is good and stable.

4.9. Reconstruction jobs started for RUN13700-13800

Error message from REC job are debuged. One kind failure is caused by adjecent noisy hits of MDC, and another happened in trkevl.f due to noisy hits also. 500 events per run in average are rejected by reconstruction jobs due to adjecent noisy hits of MDC. $10 - 20\%$ of these 500 events are found to be multi-track events. However Reconstruction of noisy events will be cpu-time consuming. One guess that no bias happened from the rejection procedure.

4.10. Dips in ϕ of muon tracks

Two dips in ϕ of muon tracks are observed by Shen XY on 21 Feb 00. Zhu YS commented that dead region of μ counter is at $\phi = 248^o, 292^o$. No conclusion yet and more check is required with large statistics.

4.11. Note on overflow in MDC ADC readout

2% of dEdx hits with ADC > 4095 is estimated. 12 bits for digitized data transfered and stored in BADC module. However ADC with > 4095 is allowed due to DAQ correction.

4.12. 1st round of Rec finished till 27-Mar

Executive for reconstruction jobs is linked on 17 Jan 00.

(1) RUN13700-13800 : fine offline calibration; private patches; old mu-ctr calib with SIGz(L1) = 7.3 cm.
(2) RUN13801-13900 : μ ctr Z(L1) resolution = 5.7 cm; patches checked into v102 library; mods of trkevl.f for job protection from noisy MDC hits.
(3) RUN13901-15500 : mod of mdcpid.f on dEdx corr. added as patch; Thresh. of Ebb TRG condition changed (40→45) on 18 Feb.

4.13. 2nd round of Reconstruction started on 27 March

Improved weight (1/position resolution) is refered in error matrix calculation. It uses prefrozen v102 library plus 2 patches on MDC error matrix. Systematic shift in MDC T_0 is carefully corrected for 9 run regions from RUN13700 to 15500 (by Qiu JF).

4.14. Wrose resolution of MDC dEdx

One found that dEdx resolution after run15800 is between 8.5% to 8.8%, and little worse than expected. It is caused by lower HV on cell 1-4, MDC L4 after 3 April, and solved by re-calibration in part.

4.15. Worse TOF resolution

It gets worse by 10 ps for $\psi(2s)$ data after RUN16845, and is possiblely caused by beam condition.

4.16. A milestone for data processing (22 May)

The Calibration and reconstruction of 23M J/ψ data are completed 10 days later than the day data taking ends. It takes 45 days to get 23M J/ψ data reconstructed on HP/UX J5000.

5. Sober MC Software

5.1. New J/ψ generator installed

It is introduced by Walter, and migrated from CLEO/Babar by Chen BS. $J/\psi \to e^+e^-, \mu^+\mu^-, \rho\pi$ successfully produced (see BES Web page).

5.2. New generator developed

Exclusive hadronic final states of J/ψ, $\psi(2s)$ decays used to estimate total number of hadrons has been developed by Chen JC. A English paper on the generator is published.

5.3. MC realization constants ready (Bian JG)

It includes (1) dead channels in MDC and BSC; (2) effciency of MDC wires; (3) MDC position resolution; (4) TOF resolution.

5.4. check on TOF resolution in Sober

Plot of β vs momenta is made by Shen XY by using BES-I v86 library and BES-II v101 library. An agreement between MC and data is reached, and reasonale TOF resolutions in Sober/BES-II is observed.

5.5. JETSET7.4 linked with v102 library (Chen JC)

JETSET7.4 is default setting in v102 library, while v101 library is linked to JETSET6.3 as default and to JETSET7.4 through private opt file.

5.6. New MC generator

A generator, ugnt.f, is newly written by Zhang DH for J/ψ and $\psi(2s)$ decays. ppgen.f has bug in lorentz transfers and not fixed yet according to him. One may contact Mo Xiaohu on correct sobcard for using generators of radee.f, radmu.f and radgg.f.

5.7. Energy scale of BSC tracks

Bian JG observed that averaged energy for electron and photon is 40 MeV lower than expected for Sober MC in v102 library. Huang GS find that energy scale is correct but energy simulation in the rib region needs to be studied and tunned.

6. SIMBES

6.1. SIMBES based on GEANT3

(1) checked, improved and stored as stand-along library
(2) 25 physics generators installed
(3) much better simulation of hadrons in detecotr comparing to Sober

6.2. SIMBES maintainance and improvement

(1) took over by Cheng BS and Zhang DH
(2) TOF simulation is improved by Ye SW and installed to SIMBES library by Chen BS.

7. Error matrix for MDC tracks

Error matrix of tracks is refered by Telesis routines, and is ruther sensitive to the correctness of kinematic fitting.

7.1. Widths of pull distributions in Telesis

Width of pull distribution from Telesis study is far apart from 1 by using di-muon events. Errors of ϕ, $1/P_{xy}$ and $cot\theta$ have more narrow distributions from MDC-II tracks than from MDC-I (see Fig 3a,3c). However calculation algorithm of error matrix is basicly same for BES-I and BES-II though BES-II use JULIE method.

7.2. Weight in error matrix calculation

One noticed that position resolutions of MDC wires are described by 40 dEdx-dependent functions for BES-I but 40 constants for BES-II.

7.3. First test till middle of this March

Position resolutions used in MDC fitting are 40 constants with about 200 μm at first and then updated to 200 to 250 μm (calculated by Mao ZP). Track errors after using updated position resolution looks better than that obtained by using 200 μm.

7.4. MDC Error matrix not correct

Error matrix is corrected from pull analysis by using di-muon events(Lu F). Shen XY's analysis shows that errors are reasonable for π^+ tracks from $J/\psi \to \omega\pi^+\pi^-$, which have good efficiency and good ratio of signal to noise. However worse efficiency for K^+ tracks from $J/\psi \to \phi f_0(975)$ and worse ratio of signal to noise is clearly observed.

7.5. 2nd test after 27 March

dEdx dependent functions are studied and found by using Bhabha tracks, and used in the MDC track fitting as weight (Liu J and Mao ZP. see Fig 3b). Notice that T0 for MDC wires are re-calibrated with the improved weight. Then event reconstruction is made again for RUN13700-15984. The result shows that momentum resolution is slightly improved by 1.5 MeV. Then a correction for error matrix is made again via pull analysis.

7.6. *Improved kaon selection*

After above procedures, Shen XY made comparison again for ϕ signals from $J/\psi \to \phi\pi^+\pi^-$ between BES-I and -II. New plot from BES-II looks (see Fig 6) slightly better than that from BES-I, and much better than that from 1st round of reconstruction (see Fig 5). Telesis fitting works well with improved error matrix for both π and K tracks.

8. Telesis for BES-II (see Lu F's talk)

8.1. *Multi Scattering Correction (MSC)*

After dEdx correction of BES-II materials for momenta is made and checked (Liu F and Sun LF), the error matrix for MSC correction is calculated for BES-II materials.

8.2. *Error matrix*

Regular correction for error matrix via pull analysis is carefully studied and checked by using $J/\psi \to \mu\mu$ events. A flat CL distribution is obtained from MC events. However CL shape in data strongly depends on how noisy in MDC. It much more close to MC case, if less noisy in MDC, except low CL region. It shows that it is necessary to make error matrix calibration run-by-run. This has been done by Lu F.

8.3. *Error matrix for neutral tracks*

Same correction for error matrix of neutral tracks is made by using $e^+e^- \to \gamma\gamma$ events. However it is not checked by $\rho\pi$ events.

8.4. *1st version of Telesis package for BES-II*

The 1st version of Telesis package for BES-II physics analysis is available under v102 libray, and it passed preliminary check for charged final states for both charged pion and kaon tracks.

9. B field correction and dEdx correction

Table : B correction factor for BES-I

WMD	0.99585
FAH (June 93)	0.9966
B NMR Meas.	0.99697
recoil mass ('94 data)	0.9969
recoil mass ('95 data)	0.9971
inv. mass ('94 data)	0.9949
inv. mass ('95 data)	0.9959
LWG (1995)	0.9961

9.1. *Mass scale for BES-I*

By using Bill's factor, Xinchou obtained that

Table : $M_{J/\psi}$ for BES-I

Data set	H corr	D_s $4.03GeV$	$\psi(2s)$	$D_s + \psi(2s)$
$M_{J/\psi}$ MeV	no	3113 ± 7	3109 ± 4	3110 ± 4
	yes	3101 ± 8	3096 ± 4	3097 ± 4
PDG98 MeV				3096.88

Good agreement is also reached for D^0, D^+ mass. dEdx correction and H correction factor for BES-I had been checked by many others.

9.2. *dEdx correction for momentum at BES-II*

dEdx correction of momentum for BES-II materials is calculated by Sun LF and Mao ZP, and Checked and debuged by Lu F. Materials included in the calculation are

(1) beam pipe
(2) VC : Outer barrel, gas, wires
(3) MDC: Inner barrel

Correction for electron momentum is not considered because of its big uncertainty from radiation effect. Routines for dEdx correction are depipe.f and pin.f. Notice that bpcorr2.f is called by Telesis package.

9.3. *B correction factor s for BES-II*

Lu F obtained s = 0.99634 from J/ψ data by using $J/\psi \to \mu\mu$ events. More study and check on the B factor for BES-II data is required.

9.4. *Check With high statistics (Dong LY)*

Table : Resonance mass w/o dEdx or B field correction. Here B corr factor s = 0.99634

dEdx corr	B corr	M_ϕ MeV	$M_{K_s^0}$ MeV	M_Λ MeV
no	no	1019.1 ± 0.1	494.34 ± 0.03	1114.0 ± 0.1
yes	no	1019.6 ± 0.1	497.70 ± 0.01	1115.5 ± 0.1
yes	yes	1017.0 ± 0.1	494.91 ± 0.03	1113.7 ± 0.1
PDG98		1019.413	497.672	1115.683

From Dong LY's observation (see Fig 7,8) it is shown that dEdx correction for BES-II materials is done in right direction for charged $\pi/K/p$. However it needs more check for lower momentum hadrons. There is no conclusion on Lu F's B correction factor yet because lower momentum of $\pi/K/p$ tracks, which has big dEdx correction, is included.

9.5. B correction factor from $\psi(2s)$ data taken in 1999

From $\psi(2s) \to \pi^+\pi^- J/\psi$, $J/\psi \to \mu\mu$, Fred found that s $= 0.9983 \pm 0.0019(sta)$. In his fit, $N_{obs}(J/\psi \to \mu\mu) = 432$. By using Fred's invariant mass and Bill's method, similar value as Fred's is obtained by Changchun, i.e. s $= 0.9986 \pm 0.0019(sta)$.

Advantage of this method that muon tracks have high momentum and constant dEdx correction. If dEdx correction is made in right way, then B field correction factor found from this study is reliable and accurate. Notice that its accuracy is due to big mass of J/ψ and its Q-value. Its correctness also can be simply checked with ϕ, Λ and K_s^0 mass. However big statistical error for s is suffered so far due to small data sample.

9.6. Bill's suggestion

Bill has made his suggestion on determination of B field scale. He defined Q-value as $Q = \sqrt{(M_{eff}^2 - m_{sum}^2)/2}$, where $m_{sum} = m_1 + m_2 + m_3 + ...$, m_i daughters. It is approximately proportional to B scale factor. Any mass discrepancy measures scale factor directly because of big Q value. Bill commented that this procedure is better than that used for BES-I, and good check is to take data at $\psi(2S)$ and measure J/ψ mass.

9.7. B field factor directly from J/ψ data

Since big ammount of J/Ψ data are collected, this method, if succeded, could easyly reach high statistics. Details can be found from talks given on 27 April meeting :

(1) Mass global calibration (momentum scaling/correction factor) by Rong G
(2) Study on effect of radiation correction for J/ψ mass determination by Zhang DH

9.8. Discussion

Is dE/dx correction correct?

(1) Masses of ϕ, Λ, K_s^0 come much better after dEdx correction (see Dong LY's check).
(2) dEdx correction curves are compared between BES-I and -II. dEdx loss in BES-II slightly lower than in BES-I, and it looks reasonable.
(4) However, after improsing both dE/dx correction and Lu F's B correction factor, one find from new $\psi(2s)$ data that it causes worse mass of ϕ, Λ, K_s^0. We do not understand why. Notice that B factor ,used in this test, is closed to BES-I's value.

B correction factors of BES-I & -II are same ? It is known that B field current is same for BES-I and -II but sensor of NMR moved apart from colliding point by 20-30 cm. NMR measured B value for BES-II is 4000 gauss still.

9.9. New $\psi(2s)$ data

New $\psi(2s)$ data with 1 pb^{-1} has been collected in this May (RUN16853-17018). Answer to following questions will soon come out : same B correction factor for BES-I and -II ? and Does it agree with B correction factor from J/Psi data ?

10. Codeman

10.1. Current status

It runs smoothly after its Primary is migrated to IHEP site. Aidong did good job as Codeman manager with help of Derrick and Shaoqiang.

(1) v102 library is frozen for J/ψ physics
(2) v103 library is created at IHEP site and linked to HP and Linux at IHEP and Alpha at HU.

10.2. Codeman in future

The codeman has syncronized software development in the BES, and manpower is much saved with its function. It needs discussion on how the codeman at HP/UTD, HP/CSU and Alpha/HU :

(1) who is software coodinater, after Derrick
(2) who is contact person as each site

We would greatly appreciate Derrick for his excellent contributions to BES library management in passed years. It makes us possible to get Codeman running in efficient way.

11. Computing resources

For this round of data processing, a HP/J2240 ($15 \times SPECINT95$) is used for data calibration and a new HP/J5000 ($60 \times SPECINT95$) for data reconstruction. HP/UX system for HP/J5000 is installed by Yang DJ, Su J from computer center, NIS, NQS and AMD are managed by Zhang SQ, environment setting for data processing is managed by Liu HM. Performance of the workstation HP/J5000 is good as expected. In average, 80 runs per day can be reconstructed while 30 runs per day are collected by DAQ.

More computing resources for future J/Ψ data processing should be considered. That is because of

(1) new and cheaper technology on market
(2) repeated and improved reconstruction
(3) Production and reconstruction of MC events
(4) Physics analysis of 50M J/ψ events

11.1. PC-Farm with 5 CPU supplied (Liu TR's talk)

A PC-Farm with 5 CPU is built and supplied for physics analysis at DST level. Network conneting each PCs is upgraded from 10M to 100M.

11.2. IHEP Network upgrade (Wu Lin's talk)

A new project with 1000M Ethernet is put forward by Computer Center. Layout of cables in building 3 has finished. It is expected that the IHEP network can be upgraded to 1000M this summer.

12. BES Linux

12.1. New contribution

Careful comparisons between HP/UX and Linux on Reconstruction codes in 101 library are made by Ye SW. Different behaviour of ifix function, which causes obvious discrepancy in dEdx reconstruction at HP and Linux is observed and fixed. It then found that ifix problem can be solved by proper opt on Linux (Rong G, He KL). However sizeable difference in momentum calculation needs further study.

12.2. Linux v102 library (Mao ZP)

A Linux v102 library, which is converted from HP/UX v102 library, is created and installed on Lunix/PC (bespcfarm and beslx12).

It is workable for Physics analysis at DST level, and runnable for MC Sober job.

13. Summary

Fine calibration and reconstruction of 23M new J/ψ events have been completed with good quality in efficient way. As 1st time its speed has catched up with J/ψ data collection.

BES-II analysis software (v102 lib) is in good shape and passes its test on detector performace, Telesis fitting and physics signal searching of J/ψ decays.

Big ammount of works for BES-II software development is expected to be done in future :

(1) Further improvement on MDC tracking and weight calculation
(2) Reconstruction with combined VC and MDC hits
(3) put SIMBES into run for J/ψ physics
(4) Reconstruction codes on Linux
(5) To build up C++ platform for physics analysis users

It is clear that more experienced software experts is urgently required, and computing resources should be upgraded further in future.

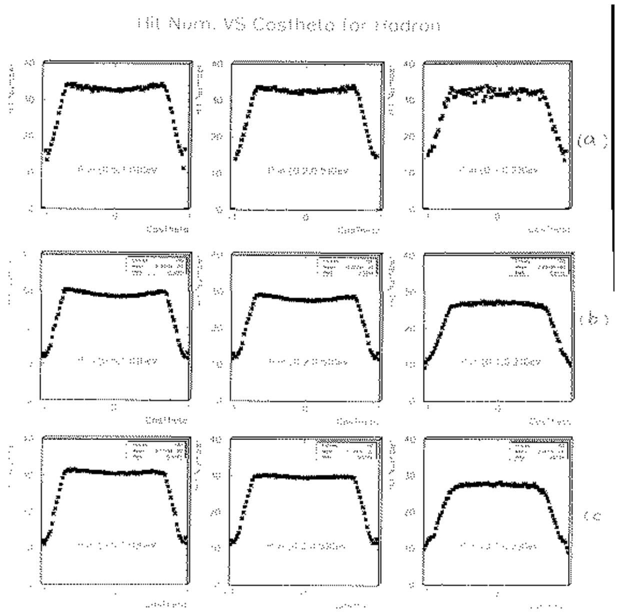

Fig 1. N_{hit} of MDC p tracks vs. $\cos\theta$
(a) BES-I : RUN 3645-3653
(b) BES-II : RUN 14300-14309
(c) BES-II : RUN 15500-15509

Figure 1. Number of hits on charged tarcks vs $cos\theta$ (a) BES-I : RUN3645-3653; (b) BES-II : RUN14300-14309; (c) BES-II : RUN15500-15509.

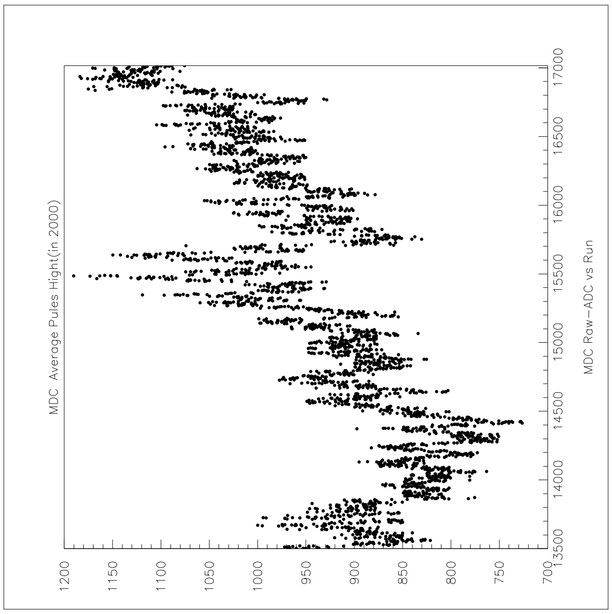

Figure 2. Averaged hit ADC from MDC dEdx readout vs Run

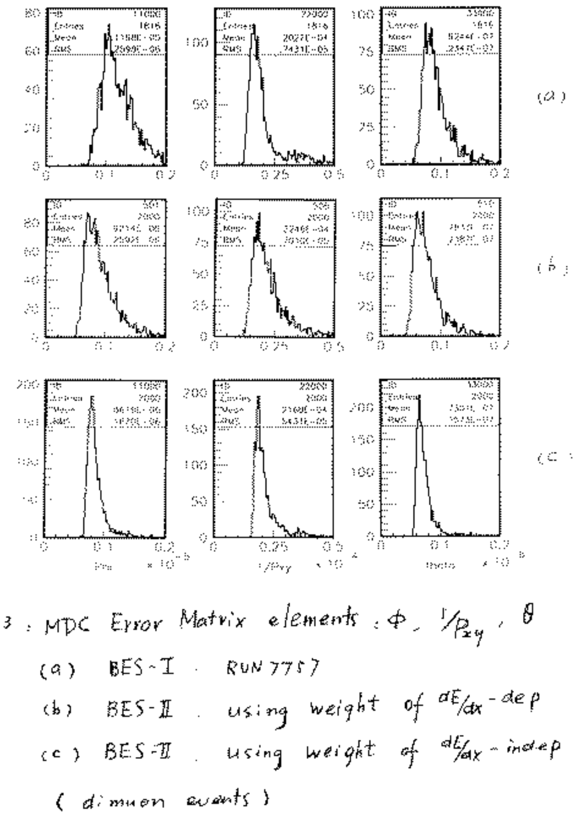

Figure 3. MDC error matrix elements for ϕ, $1/P_{xy}$, θ from di-muon events. (a) BES-I : RUN7757; (b) using weight of dEdx-dep functions; (c) using weight of dEdx-indep constants.

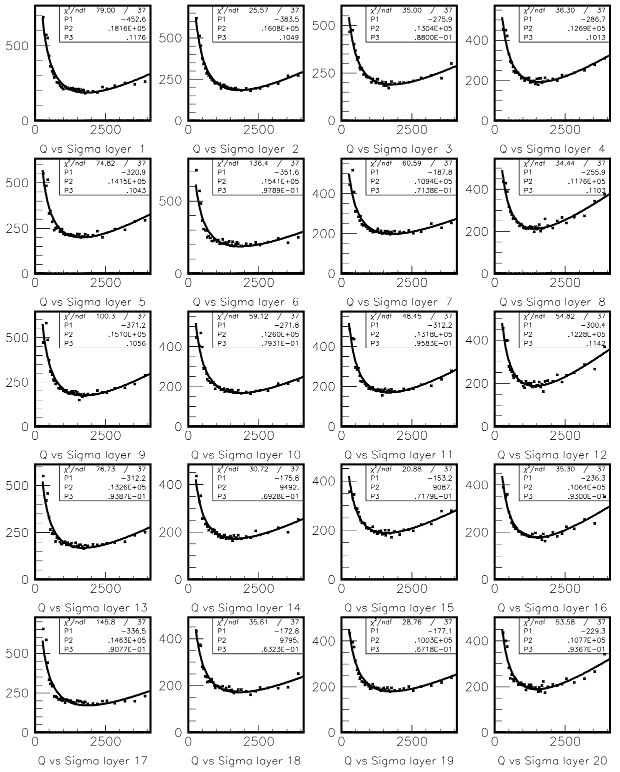

Figure 4. Position resolution as function of dEdx readout for MDC charged tracks

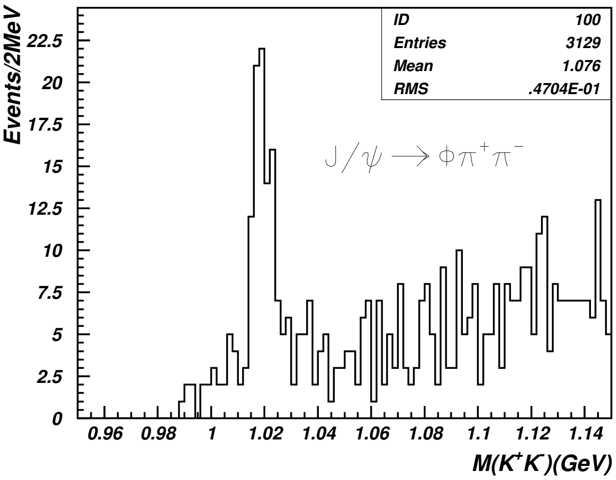

Figure 5. Physics signal from J/Ψ data, that are reconstructed by using error matrix from weight calculated with 40 constants.

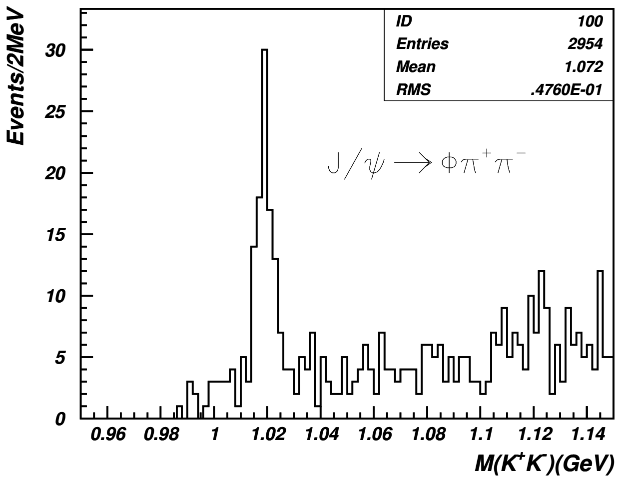

Figure 6. Physics signal from J/Ψ data, that are reconstructed by using error matrix from weight calculated with 40 functions of dEdx-dep.

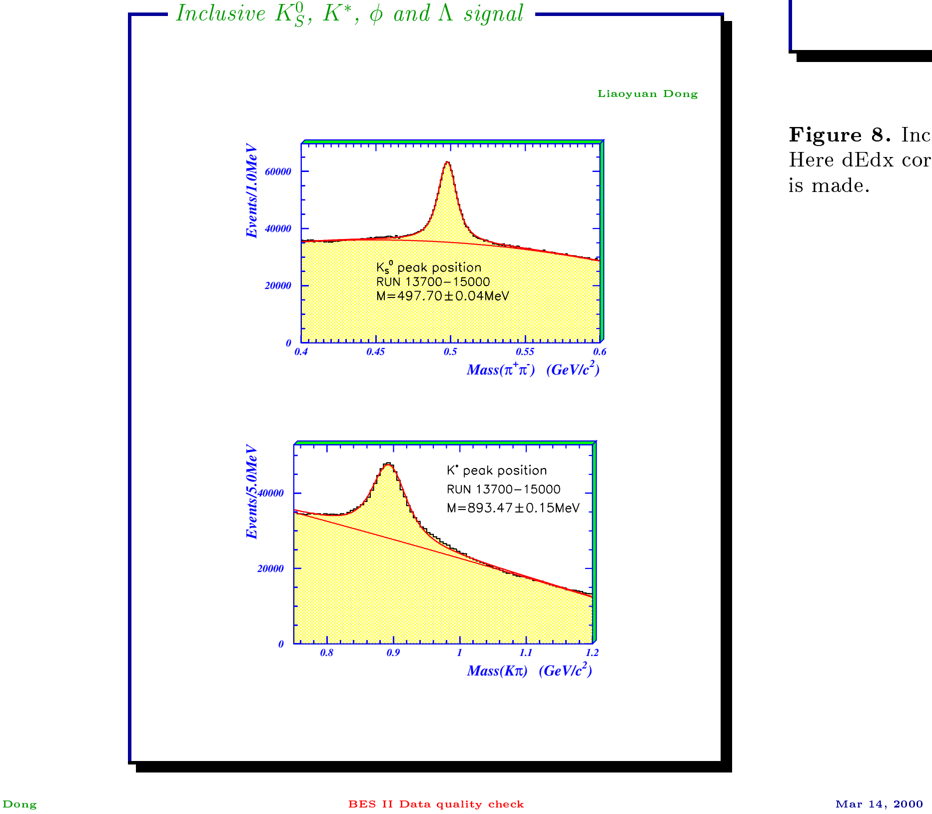

Figure 7. Inclusive signals for K^0_s, K^* and their masses. Here dEdx correction but no B field correction for momentum is made.

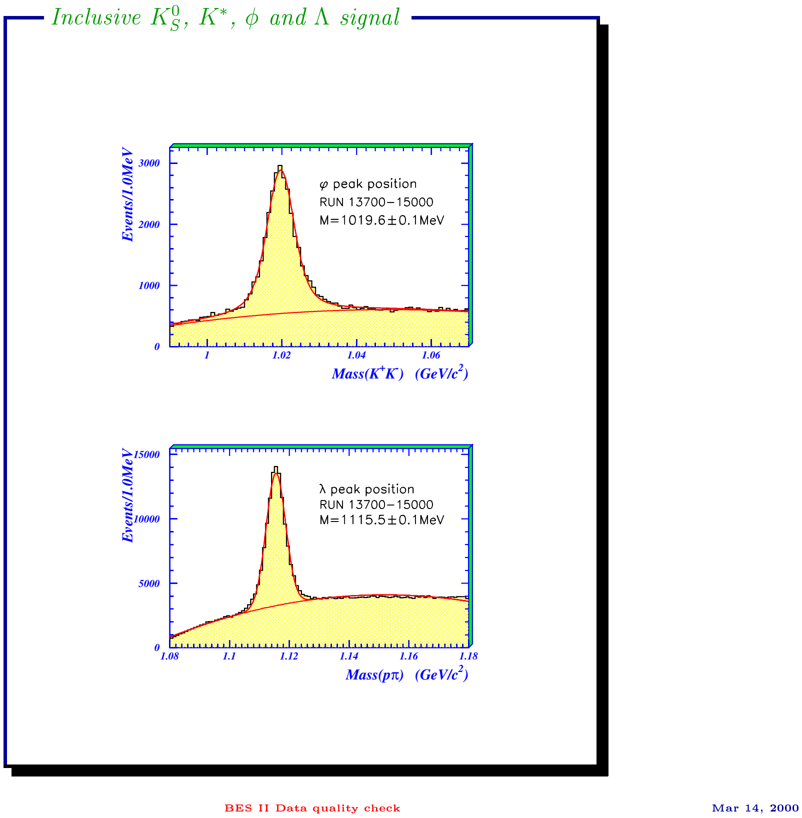

Figure 8. Inclusive signals for ϕ and Λ and their masses. Here dEdx correction but no B field correction for momentum is made.