# The Calibration of the BSC and ESC by BES-V102

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**Abstract**

A new BSC calibration method is exploited to solve the fluctuation of the BSC ADC around the time(RUN), The main principle of this method is to apply the normalization for the raw energy of the cluster, then get the BSC calibration constant based on the consistent BSC ADC in the calibration period.

By this way, the maximum fluctuation of the mean energy of the cluster in the BhaBha events is reduced from 6% to 2%, the energy resolution of the BSC also little better than before.

- **The Improvement of the BSC Calibration**

⋆ **The Problem of the BSC ADC Unstable**

⋆ **A New BSC Calibration Method**

⋆ **The New and Modified Codes in New Cal. Method**

⋆ **The Usage of The New BSC Calibration Constant**

⋆ **The Comparison of the Results with two Method**

- **The Calibration and the Performance of the BSC & ESC for data run13500-16844**

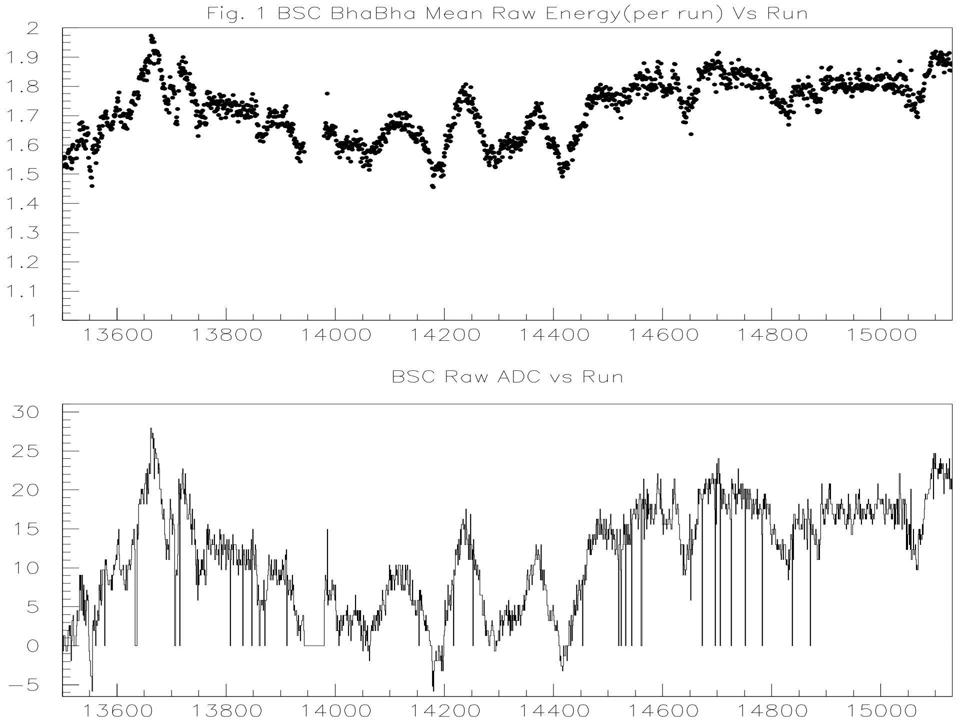
- **The Conclusion and Summary**

# 1 The Improvement of the BSC Calibration

## 1.1 The Problem of the BSC ADC Unstable

The BSC ADC is unstable very much during this period. The maximum changed amplitude up to about 30% as shown in fig.1. This problem fetch in a trouble for BSC offline calibration.

We separate the BSC into 99 calibration region in $\phi$ and Z direction respectively. In order to keep enough tracks statistic quantity in each region, about 20 run is calibrated one times to calculate the mean value of BSC ADC in each region. This fact require that the ADC should be very stable within 20 run. Otherwise it will effect the calibration quality, such as the average track energy in BSC and the energy resolution of the BSC.

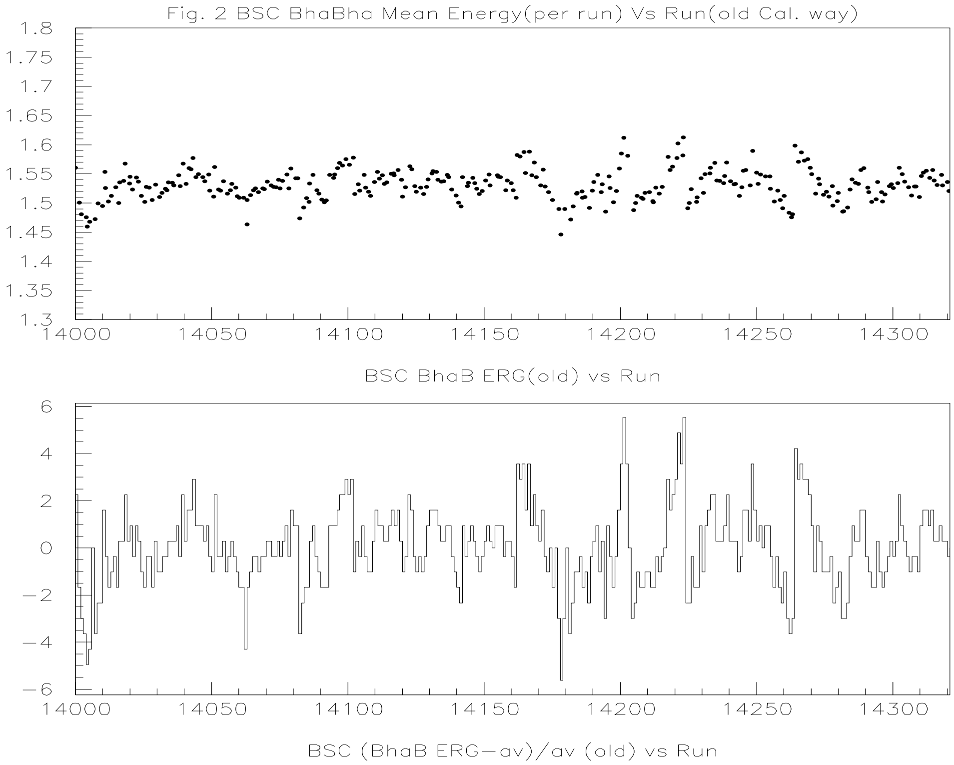



BSC (Raw ADC−1.54)/1.54 vs Run

To solve this problem, one easy way is selection a calibration period according to the status of the ADC fluctuation. But it is hard to find out a continuum 20 run with stable ADC. By this way we calibrated some data from run14000 to run14320, and scan the average cluster energy of BhaBha events for each run as shown in fig.2. In this plot, the maximum differences of the mean cluster energy in BhaBha events up to 6% ( about 100 MeV), This will let physics analysis very difficulty.

It means that the unstable problem of BSC ADC within a calibration period is still not solved. It is evident for the reason, the reconstructed event use calibration constant created by one mean BSC ADC. so the fluctuation of ADC certain effect the cluster energy of the

Bhabha events.




## 1.2 A New BSC Calibration Method

In order to solve the fluctuation of the BSC ADC, after studying the characteristics of the BSC ADC carefully, A new calibration method for the BSC is exploited.

- Calculate the mean raw energy of the cluster of the BhaBha events in BSC run by run. The BhaBha events is selected by MDC information only as following:

  ⋆ Mfit=2 or -19 for both tracks.
  ⋆ require two charged tracks only.
  ⋆ the momentum of each track should be: $0.87\times$ Ebeam $\leq$ P $\leq 1.2\times$ Ebeam
  ⋆ the total charge of the event: $Q_{total}=0$.
  ⋆ the angle between the two track: $\cos\theta \leq -0.998$

- In the process of doing the BSC calibration, the mean raw energy of the cluster of the BhaBha events for each run is got in first step, and then calculate the mean value of cluster for 20 run. The normalize factor for each run is computed by following formula:

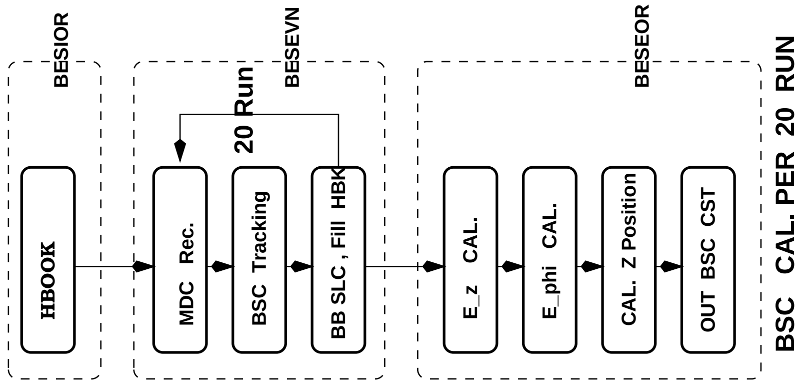
  $NORC_i=MTOT/MRUN_i$ , i=1,. . . 20

and normalize the each clusters in the run as:

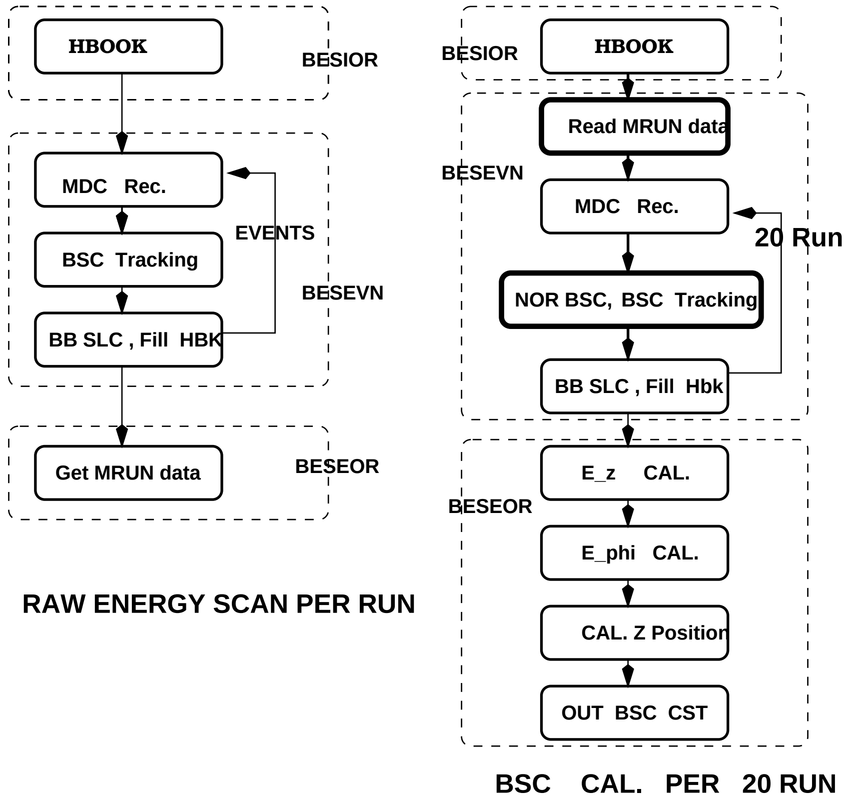
$$\mathrm{EA}_{cluster} = \mathrm{EB}_{cluster} \times \mathrm{NORC}_i$$

Where MTOT is the mean value of the ADC of 20 run, $\mathrm{NORC}_i$ and $\mathrm{MRUN}_i$ is the normalization factor and the mean value of the ADC ith run respectively. EA and EB is the raw energy of the cluster after and before normalization. Do it so, we can get the consistent raw energy within 20 run. Then do the calibration to get the BSC calibration constant.

The flow chart of the old BSC calibration:




The flow chart of the new BSC calibration as:



## 1.3 The usage of the new BSC calibration constant

The normalization factor is different with different run, and MTOT is different with different calibration period. So the new BSC calibration constant is available only for a given period(20 run). For a given BSC constant file, The beginning run number and end run number is put in BSHEAD(6) and BSHEAD(7), BSHEAD(8) is hold the total number of run that current constant can be suitable. the $\mathrm{MRUN}_i$ and MTOT can be got from array SCCSAV, by subroutine NORBSC normalize each cluster raw energy in the reconstruction process.

If BSHEAD(6), BSHEAD(7) or BSHEAD(8) is zero, It means that constant is created by old calibration way, the NORBSC subroutine will skip the normalization. The old and new BSC constant is compatible for the BSC reconstruction codes.

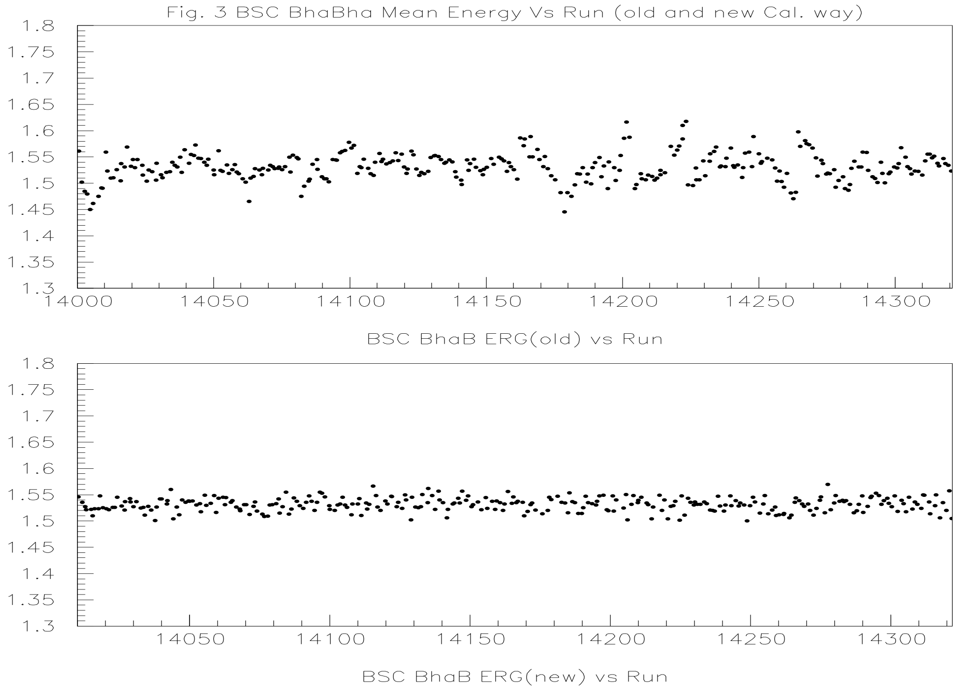
## 1.4 The new and modified codes in new cal. method

- BSCSCAN: new code used to create $\mathrm{MRUN}_i$ data.
- READ_BSCCAN: new code used for read the $\mathrm{MRUN}_i$ data.
- NORBSC: new code used for the normalization of the BSC raw cluster energy.
- CHKCST: new code used to check the BSC constant file.
- BCECLU: be modified to add the NORBSC codes.
- BSCCIN: be modified to add CALBSC logical variable.
- CALBSC: be modified to suitable for new calibration method.
- CALBSC.INC: be modified to add BSCSCAN logical variable.
- BSCCON.INC: be modified to describe the usage of the SCCSAV.

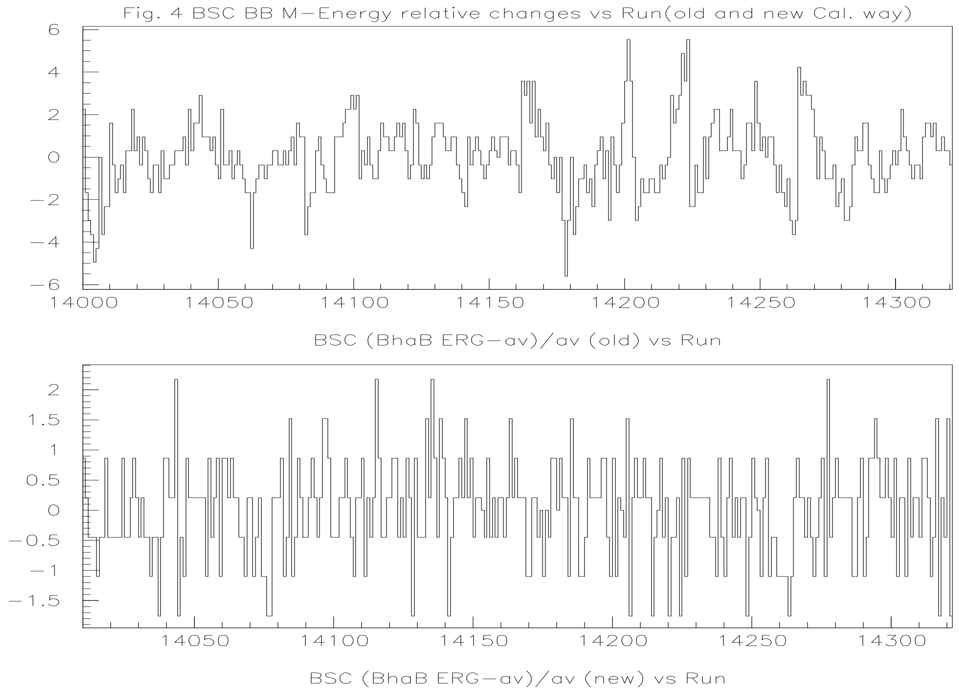
The other details of the changes can be found in the codes and the common statements

## 1.5 The Comparison of the Results with two Method

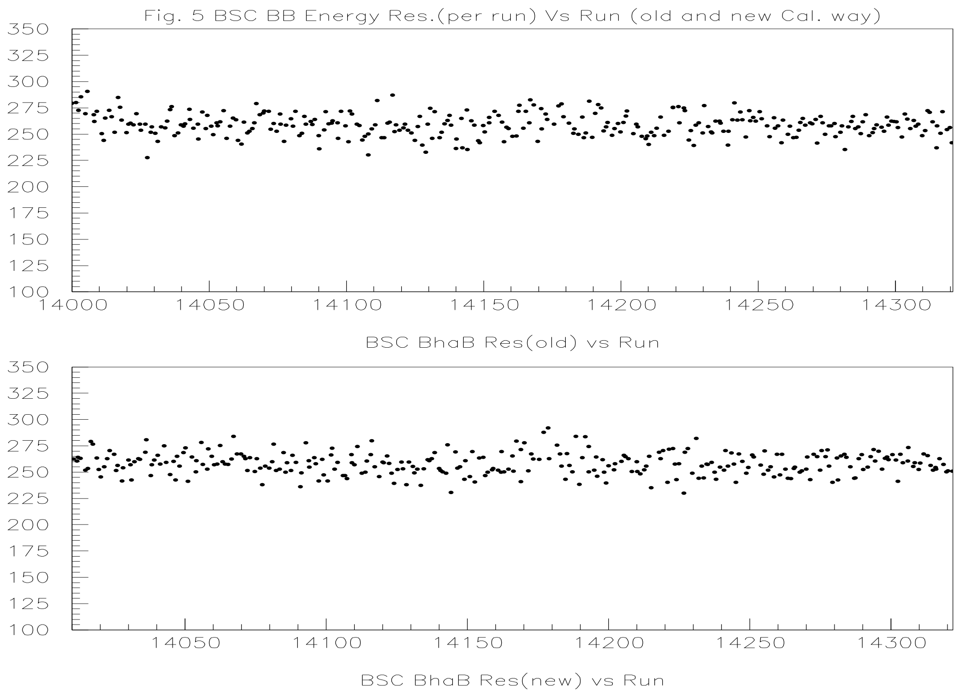
- The mean energy of the cluster of the BhaBha events in each run versus the run number comparison with old calibration way is shown in Fig. 3., from this plot we can see the stability of the mean cluster energy is much better than that by the old way.




- The relative percent shift of mean energy of the cluster in each run versus the run number comparison with old calibration way is shown in Fig. 4., in this plot we can see the shift of the mean energy is around 1% by new way and 6% by old way.




- The standard energy deviation of the BSC from BHaBha events in each run versus the run number comparison with old calibration way is shown in Fig. 5. In this plot we can see the energy resolution of the BSC from Bhabha events is little better than that by old way.




- From above comparison between the old and new calibration method, the new calibration method can almost solves the shift problem of the mean cluster energy caused by the raw BSC ADC unstable. and keep almost same BSC energy resolution(little better than old way). we will use the new way for the BSC calibration.

# 2 The Calibration and the Performance of BSC & ESC for data run13500-16844

- All the J/$\psi$ data from run13500 to 16844 has been calibrated by the 20 run one times, and by the new calibration method described above, there are about 168 constants files in total.

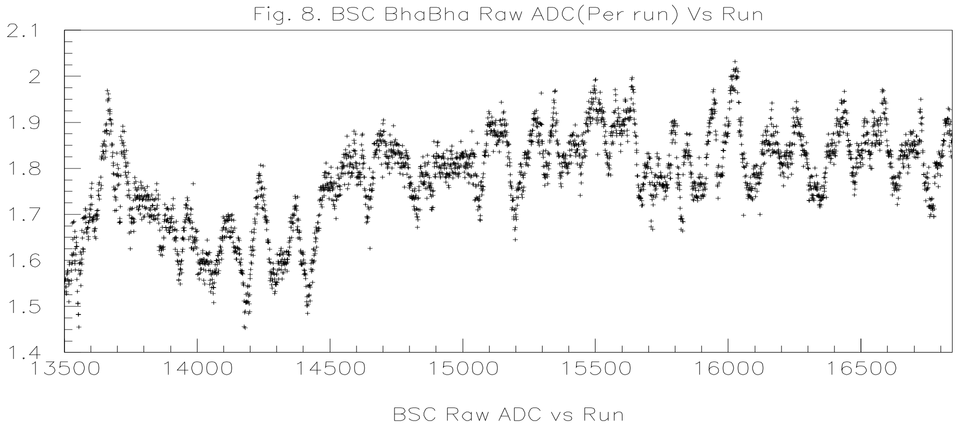
- For ESC, there are about 166 constants files in total. also about 20 run do the calibration one times.

- All of these files have been put into bes/share/const2/v102/. and keep them in /data/d54/runcal/v102/const.

- The data quality and performance of the BSC and ESC are shown in the following figers:

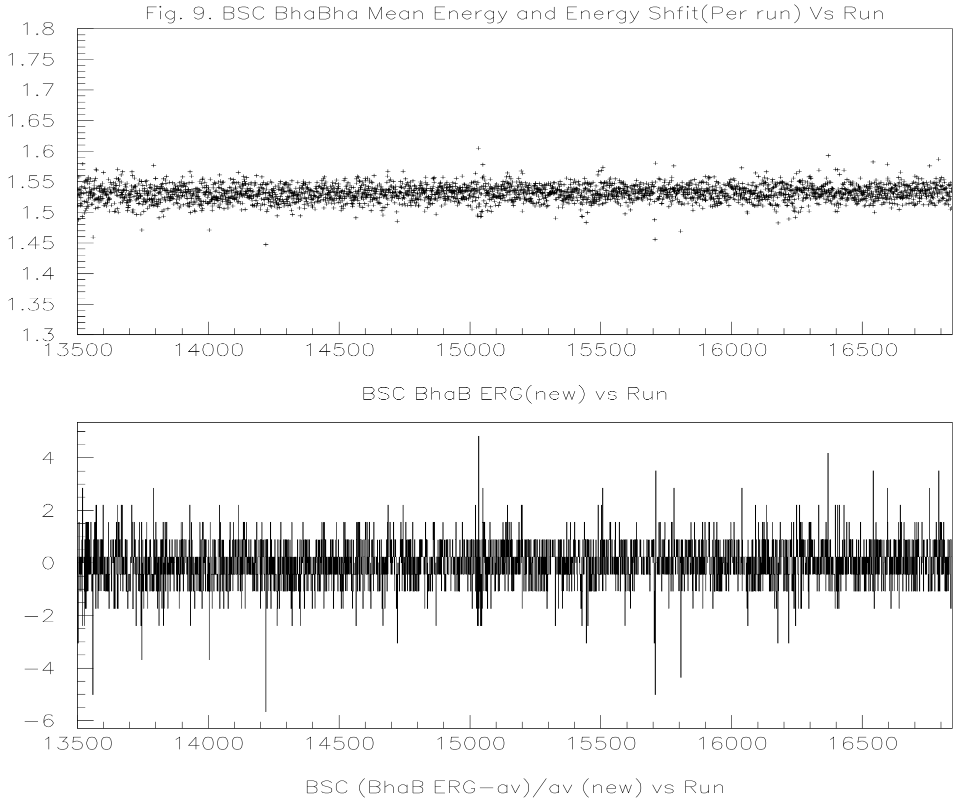
The run-average BSC raw ADC around the run numbers is shown as in Fig.8, It is very unstable in some times, the maximum variable value is up to 30%.

Fig. 8. BSC BhaBha Raw ADC(Per run) Vs Run




The mean value of the track energy(per run) of the BhaBha events in BSC around the run numbers is shown as in Fig.9(a). It indicates that the mean energy of BhaBha event of BSC is very consistent, because the new calibration method normalized the unstabled raw adc at the beginning of the BSC calibration. The maximum variances of the mean energy of the BhaBha is less than 20 MeV as shown in Fig. 9(b).

Fig. 9. BSC BhaBha Mean Energy and Energy Shfit(Per run) Vs Run




The performance of the BSC during this data taken period is shown in Fig. 10, the energy resolution is about 20.5%.

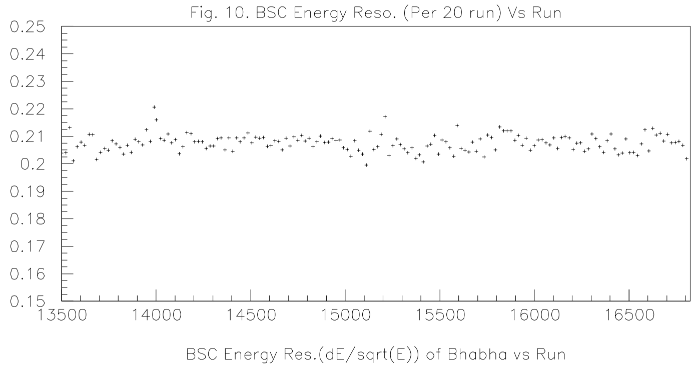
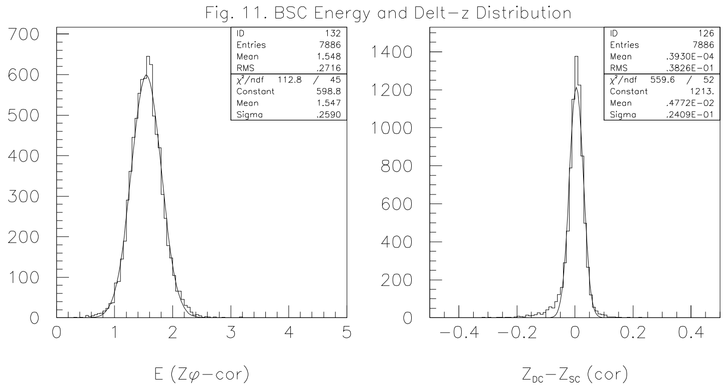
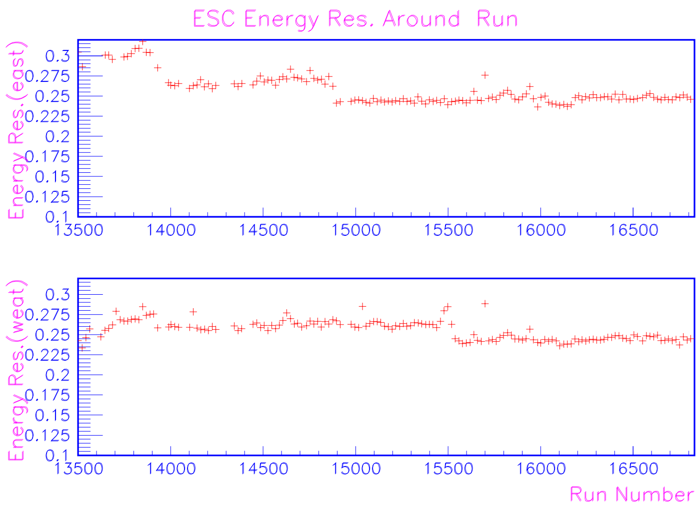


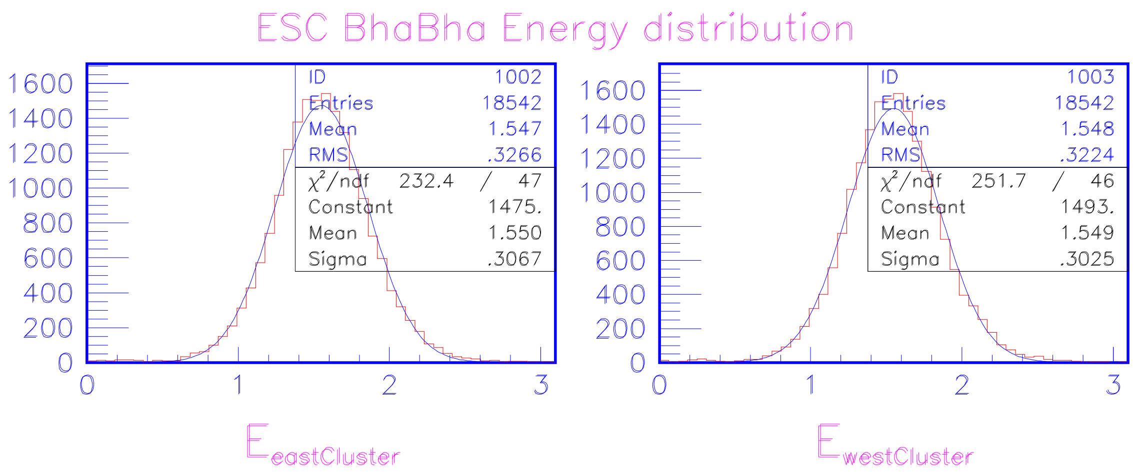

Fig11(a) is a typical track energy distribution of the BhaBha events. The resolution of the z-position ($Z_{MDC}$-$Z_{BSC}$) is about 2.5 cm as shown in the Fig.11(b).




The Fig. 12 shows the stability of the ESC in east and west side respectively, It is stable except east side in the beginning region, which is due to the mistake of the cable-connection of the electronic system.




The energy distribution of the BhaBha events of the ESC in east and west side is shown in Fig.13, from this plot we get the energy resolution is about 24.5 and 24.3 % in east and west side respecitively.




# 3 The Conclusion and Summary

- The results from the calibration of the BSC and ESC indicates the data quality from run13500 to 16844 is good. it is almost same as BESI(for ESC) or little better than BESI(for BSC).

- After the application of the new calibration method, the stability of data quality of BSC is very good, the mean energy shift is less 2%, and much better that by the old calibration method.

- The Preliminary BSC & ESC Performance of Run13500-16844 is shown as following table

| **Parameters** | **Performance** |
|---|---|
| **BSC:** | |
| **ERG-Reso.** | $\delta E/\sqrt{E} \simeq 20.58\%$. |
| **Err-Z-Posit.** | $\simeq$ **2.6 cm** |
| **ESC:** | |
| **ERG-Reso.(WS)** | $\delta E/\sqrt{E} \simeq 25.5\%$. |
| **ERG-Reso.(ES)** | $\delta E/\sqrt{E} \simeq 24.5\%$. |