The improvement of the BSC Calibration

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Mar 11, 2000

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.

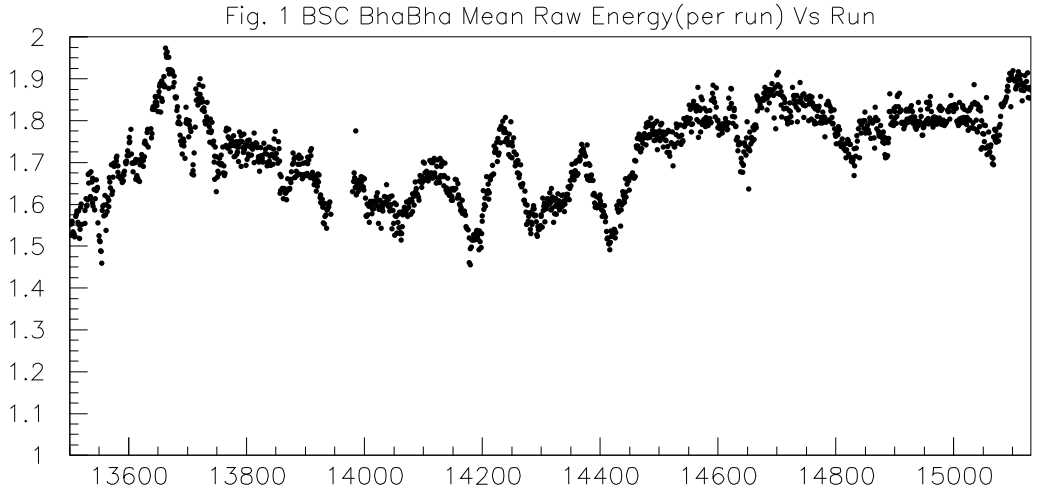
- **The BSC Cal. Problem Due to the BSC ADC Unstable**
- **A New BSC Calibration Method**
- **The New and Modified Codes in New Cal. Method**
- **The Usage Of The New BSC Calibration Constant**
- **The Comparison Of The Results With Two Method**

1 The BSC Calibration Problem

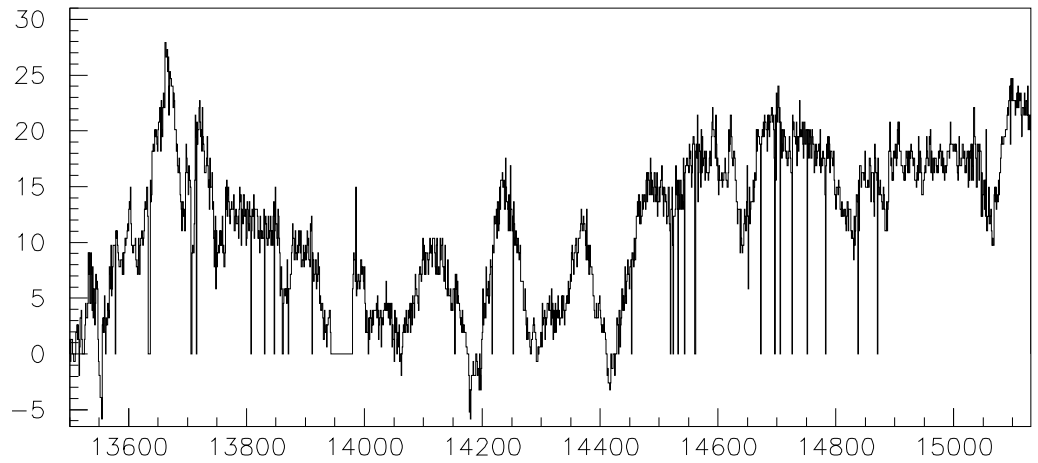
The BSC ADC is unstable very much during this period. The maximum changed amplitude up to about 30% as shown in fig.1. This problem carry out a very trouble for BSC offline calibration.

We separate the BSC into 99 calibration region in ϕ 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 BSC 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.

Fig. 1 BSC BhaBha Mean Raw Energy(per run) Vs Run



BSC Raw ADC vs Run

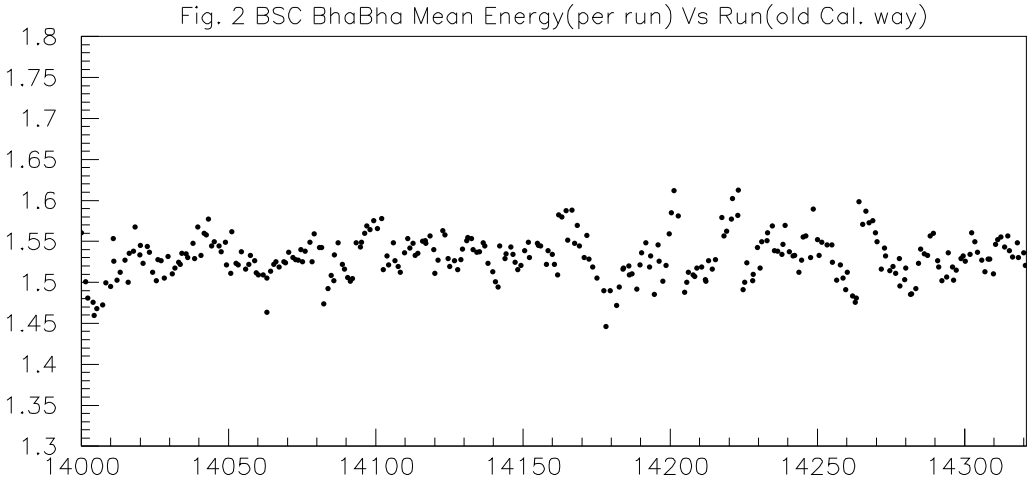


BSC (Raw ADC−1.54)/1.54 vs Run

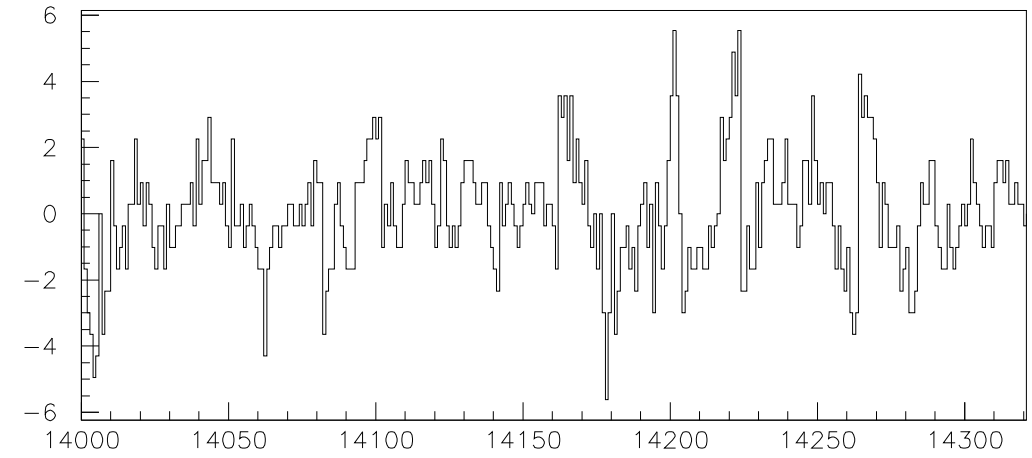
To solve this problem, one easy way is selection a calibration period according to the status of the ADC fluctuation. But it is hard to find a continuum 20 run with stable ADC. By this way we did the BSC calibration from run14000 to run14320, and scan the average cluster energy of BhaBha events for each 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 events is reconstructed using the constant that created by one mean BSC ADC. so the fluctuation of BSC ADC certain effect the cluster energy of the Bhabha events.

Fig. 2 BSC BhaBha Mean Energy(per run) Vs Run(old Cal. way)



BSC BhaB ERG(old) vs Run



BSC (BhaB ERG−av)/av (old) vs Run

2 The New BSC Calibration Method

In order to solve the fluctuation of the BSC ADC, after study 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× Ebeam $\leq$ P $\leq$ 1.2 × Ebeam
  ⋆ the total charge of the event: Q_{total}=0.
  ⋆ the angle between the two track: cos$\theta \leq -0.998$
  The corresponds plot of the cut condition is shown as following:

- In the processing of doing the BSC calibration, at first, get the mean raw energy of the cluster of the BhaBha events for each run(MRUN) created in first step, and calculate the mean value of cluster of the BhaBha for 20 run(MTOT). Then calculate the normalize factor(NORC) for each run by

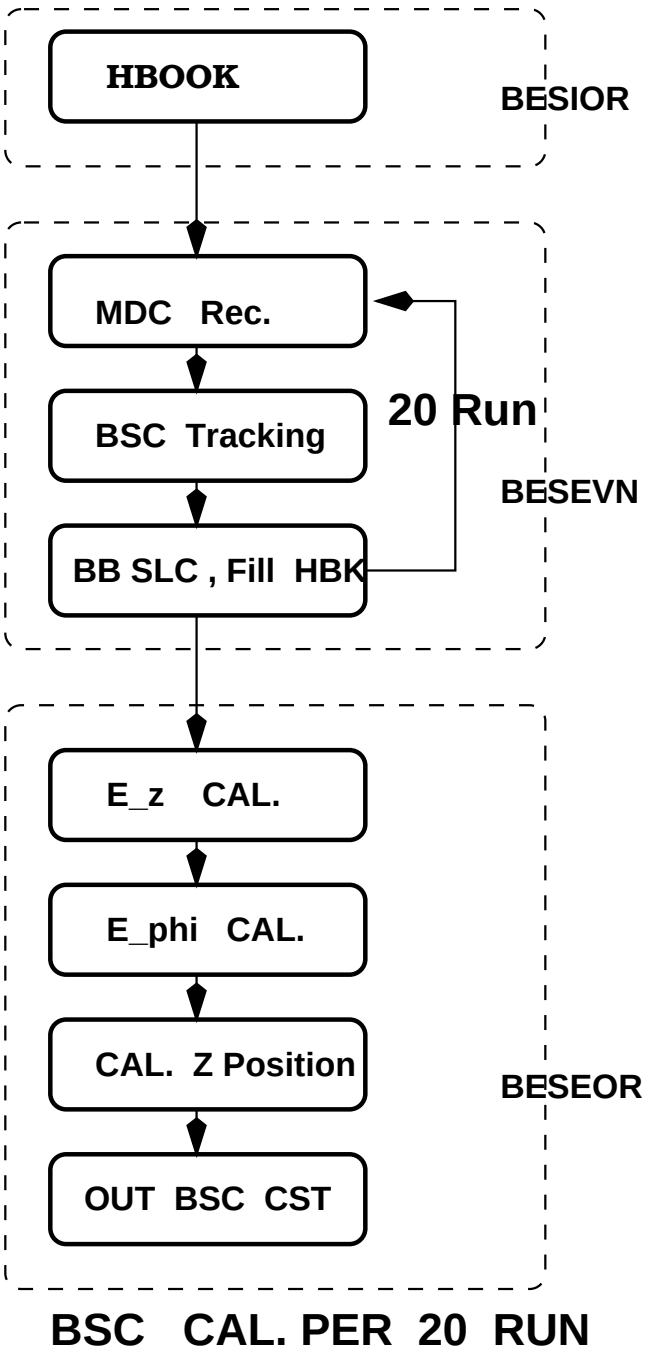
  $NORC_i$=MTOT/$MRUN_i$, i=1,...20

  and normalize the each clusters in the run as:

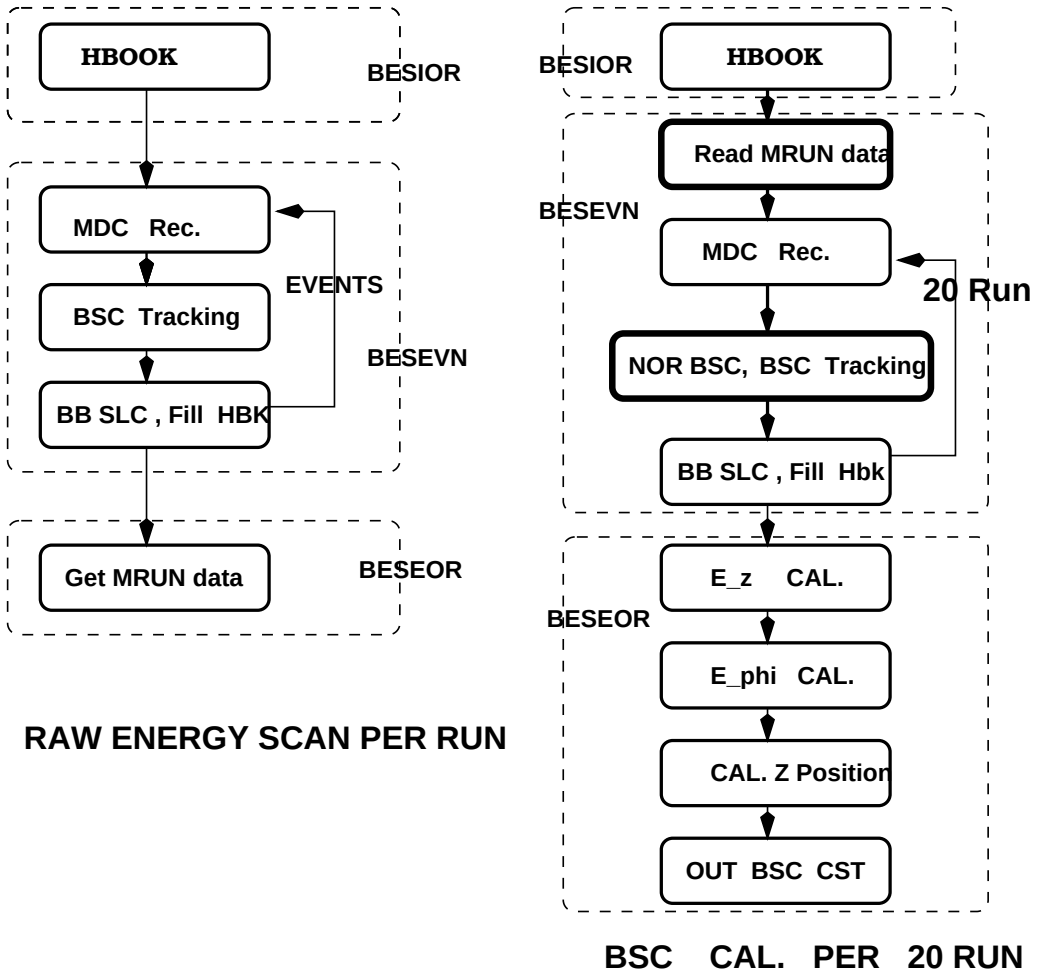
  $EA_{cluster} = EB_{cluster} \times NORC_i$

  Where MTOT is the mean value of the ADC of 20 run, $NORC_i$ and $MRUN_i$ 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:



3 The usage of the new BSC calibration constant

The 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, The beginning run number and end run number can be got from BSHEAD(6) and BSHEAD(7), BSHEAD(8) is hold the total number of run that current constant can be suitable. the $MRUN_i$ can be got from SCCSAV(i) for each run. the MTOT can be got from the last SCCSAV, then the normalization can be done by subroutine NORBSC before calculation the cluster energy in the reconstruction processing.

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.

4 The new and modified codes in new cal. method

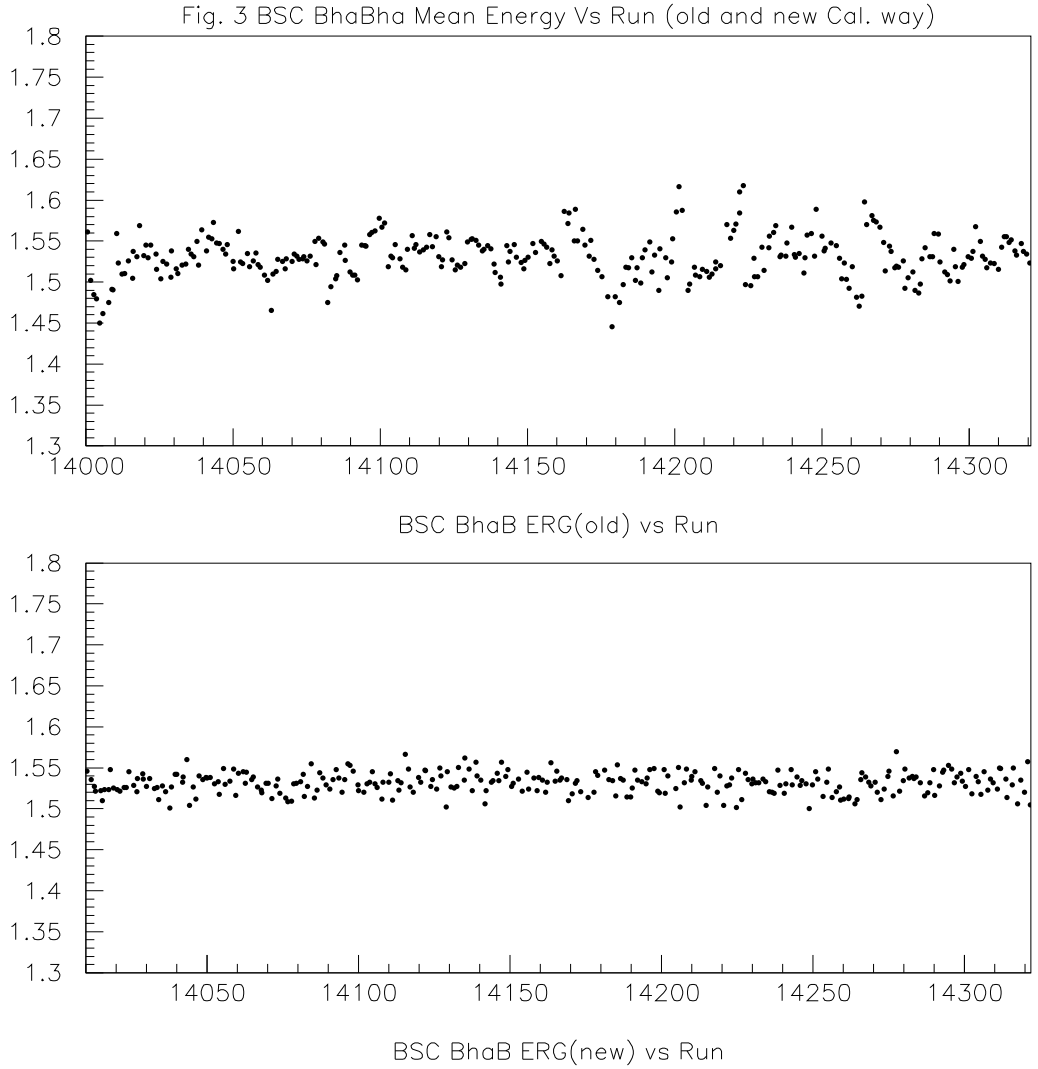
- BSCSCAN: new code used to create MRUN$_i$ data.
- READ_BSCCAN: new code used for read the MRUN$_i$ data.
- NORBSC: new code used for the normalization of the BSC raw cluster energy.
- CHKCST: new code used to check the BSC constant file.
- BCECLU: be modified to add the NORBSC codes.
- BSCCIN: be modified 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

5 The Comparison of the Results with two Method and the conclusion

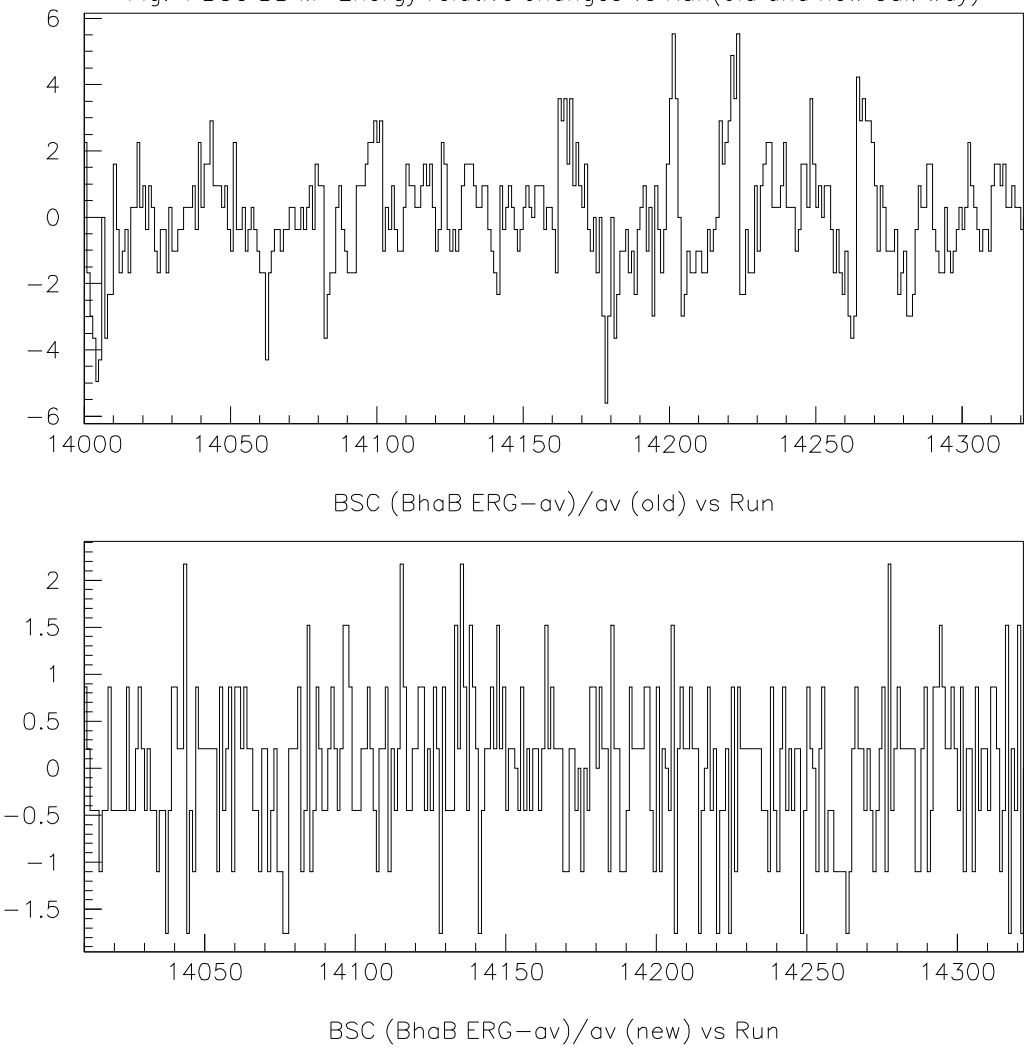
- The mean energy of the cluster of the BhaBha events in each run versus the run number comparison with old calibration way is shown in Fig. 3., from this plot we can see the stability of the mean cluster energy is much better than that by the old way.

Fig. 3 BSC BhaBha Mean Energy Vs Run (old and new Cal. way)



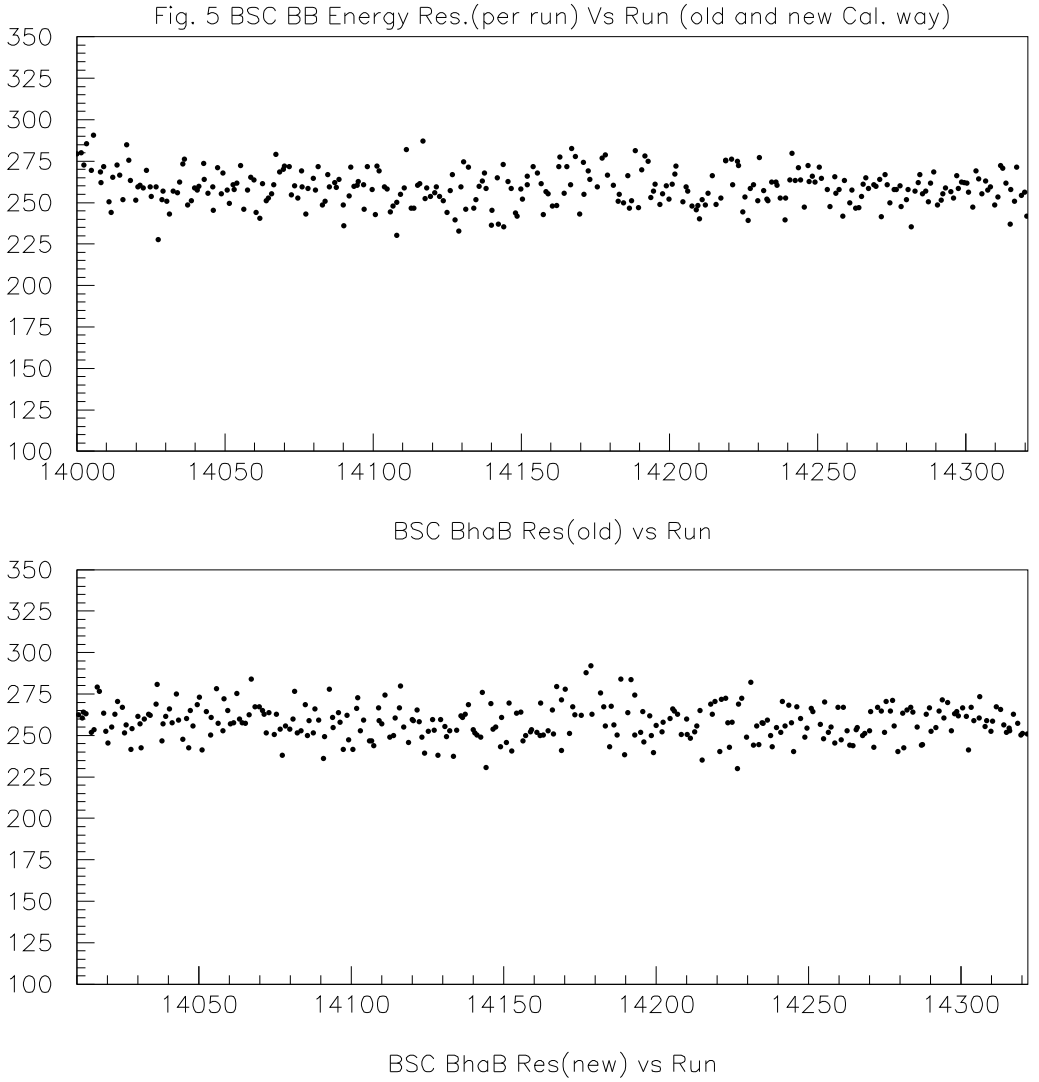
- The relative percent shift of mean energy of the cluster in each run versus the run number comparison with old calibration way is shown in Fig. 4., in this plot we can see the shift of the mean energy is around 1% by new way and 6% by old way.

Fig. 4 BSC BB M−Energy relative changes vs Run(old and new Cal. 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 almost same by new way and old way.

Fig. 5 BSC BB Energy Res.(per run) Vs Run (old and new Cal. 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.