Analysis of Amplitude Information from 2006 BCAL Cosmics Runs

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1 Data Set

This note describes an analysis of amplitude information in four BCal cosmics run that were taken at Jefferson Lab in 2006: run 2458 (the trigger/paddle was positioned in +100 cm from the center of the calorimeter), run 2459 (+150 cm), run 2475 (-50 cm), and run 2476 (-150 cm). The correspondent **.root* files were taken from */work/halld/bcal06* directory. The time information in the **.root* files was not used.

2 Pedestals Check

The calorimeter consists of 18 segments; the segments were arranged in vertical 6 columns (of 3 segments each). To select the pedestals in the certain segment in some of the columns, we require the low amplitudes (viz., $adc < 10$) in the 2 remaining segments of the column of interest as well as in all segments of the left neighbour and the right neighbour columns (see Fig.1). The pedestals observed from the most of the segments form compact peaks though the abnormal-shaped pedestals were observed in some segments (see Fig.2).

Fig.3 shows the mean pedestal values extracted from all 18 segments in 4 runs for North-side PMTs (top panel) and South-side PMTs (bottom panel). Run-by-run shifts of pedestals were clearly observed, and all amplitudes in the following analysis were pedestal-corrected on run-by-run basis.

3 Cosmic "Muon" Spectra

To select the cosmic "muon" (i.e., particle that are close to MIP) tracks in the certain segment in some of the columns, we require the high amplitudes (viz., $adc > 70$) in the 2 remaining segments of the column of interest as well as low amplitudes (viz., $adc < 10$) in all segments of the left neighbour and the right neighbour columns (see Fig.4). Such a criterion selects about 15-20% of the total number of events in the run (see Fig.5). Typical amplitude spectra from the North and South PMTs are shown in Fig.6. The Poisson-type fit of each spectrum (red line in Fig.6) was made to define the spectrum average amplitude.

The widths of the observed spectra are the result of both the fluctuations in the number of photoelectons (North-South uncorrelated effect) and the variations in the enegry deposited in the calorimeter segment (North-South correlated effect). To remove dependence on the energy variations and extract the mean number of photoelectrons from cosmic "muons", we used the spectra of North/South amplitudes ratio (see Fig.7). The Poisson-type fit of each ratio spectrum

(red line in Fig.7) was made, and the average number of photoelectrons was extracted from the fit parameters according to the formula:

$$N_{pe} \sim 2 \cdot (Mean/RMS)^2. \quad (1)$$

A summary of the average numbers of photoelectrons extracted sector-by-sector for four cosmics runs is shown in Fig.8. Note a significant run-by-run variations in the extracted results.

4 Attenuation Length of the Light in BCal

Significantly unbalanced PMTs (see Fig.9) require sector-by-sector extraction of the light attenuation length in the BCal. Fig.10 shows fit of typical Mean-Amplitude-vs-Trigger-Position dependences for one of the North and one of the South PMTs (left and right panels, correspondently) to the exponent function. Also, Amplitude-Ratio-vs-Trigger-Position dependences were used for the sector-by-sector extraction of the light attenuation length in the BCal (see Fig.11).

Summaries of the attenuation lengths of the light in the BCal extracted from amplitudes from North or South PMTs and from the ratio of North/South amplitudes are shown in Fig.12 (left and right panels, correspondently). Mean light attenuation lengths extracted using "one-side" technique (230.4±2.8 cm) and using the "ratio" technique (234.6±1.7 cm) are in a good agreement.

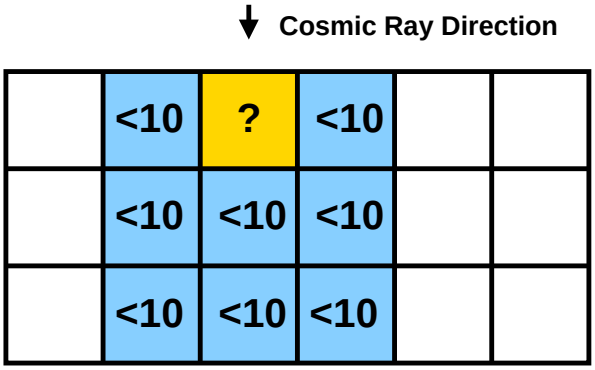

Figure 1: Selection of pedestal events in BCal cosmics data.

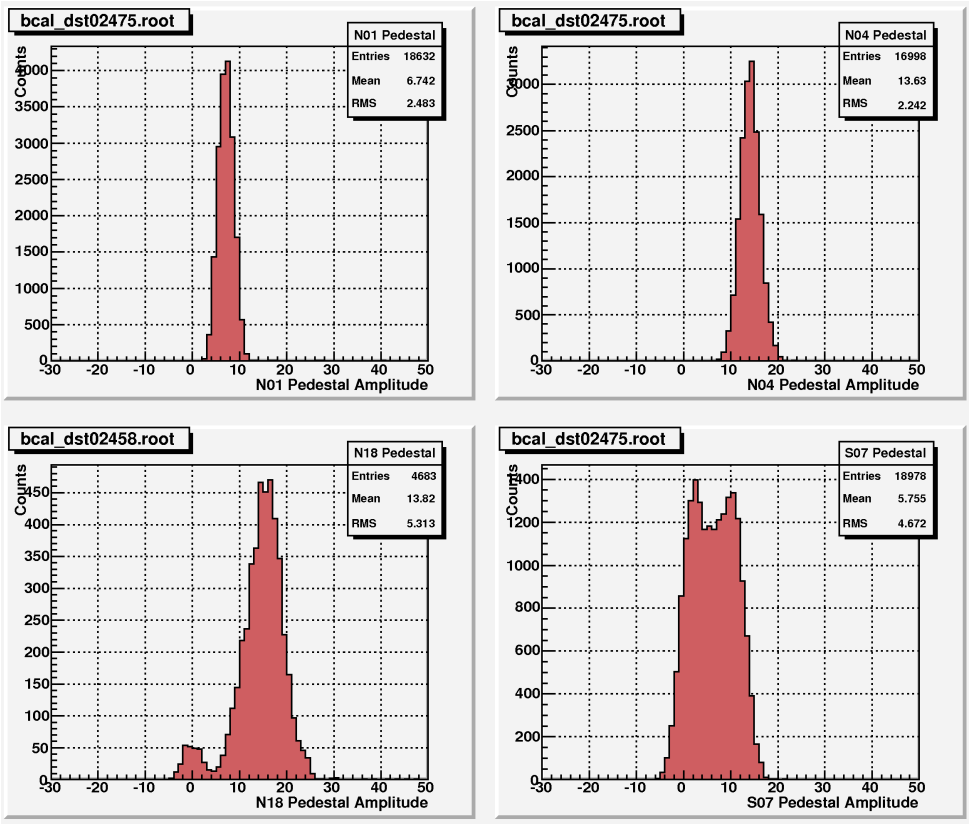

Figure 2: Typical (top-left panel) and abnormal (other panels) pedestal spectra.

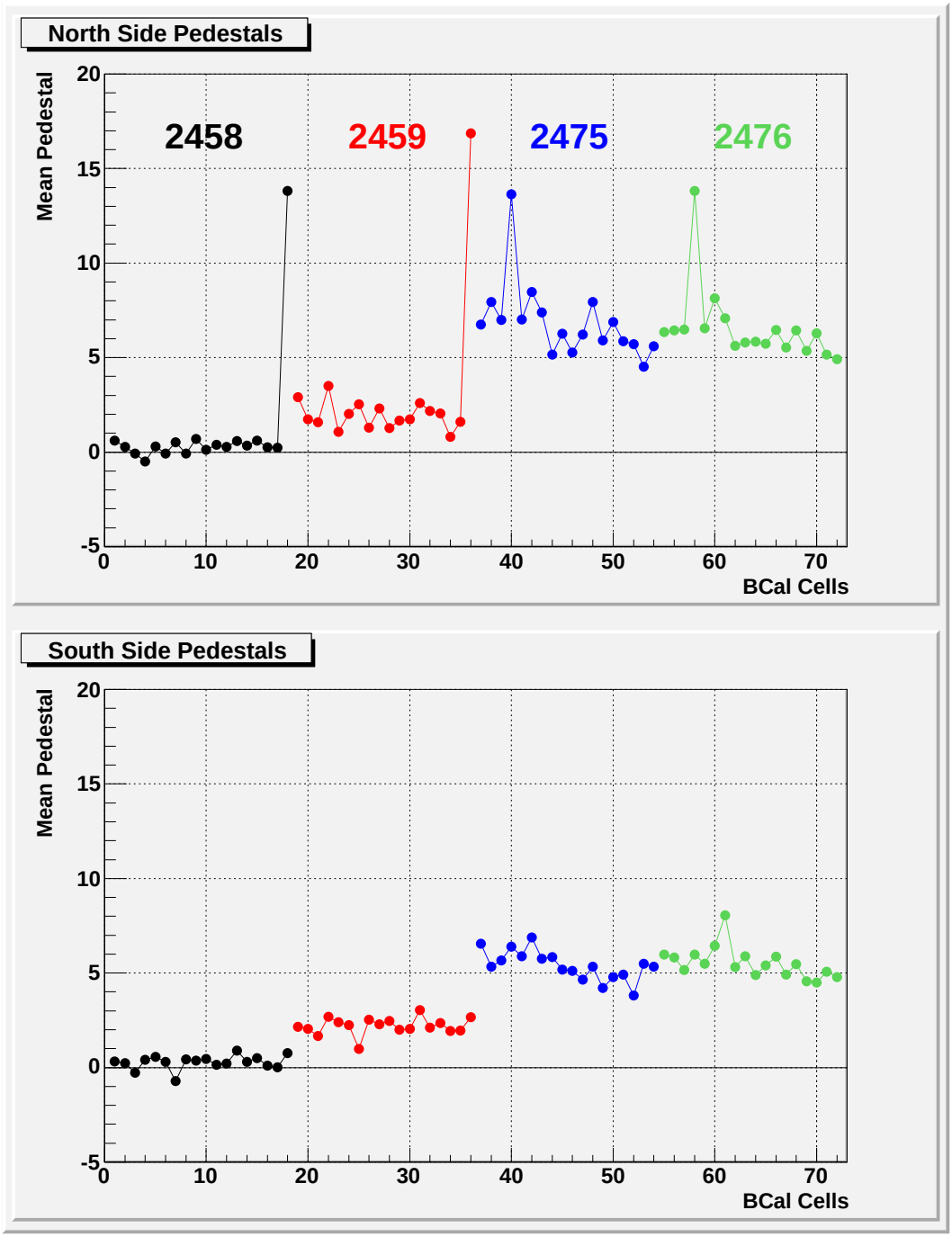

Figure 3: Mean pedestal values extracted from all 18 segments in 4 runs for North-side PMTs (top panel) and South-side PMTs (bottom panel).

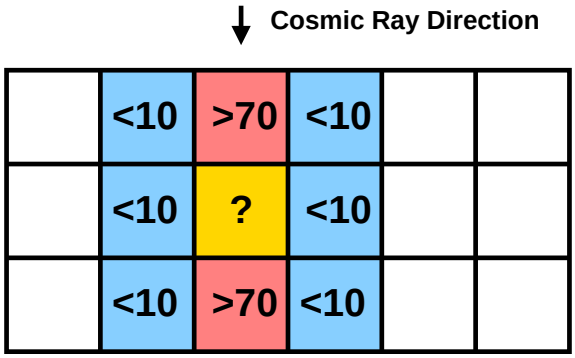

Figure 4: Selection of "muon" events in BCal cosmics data.

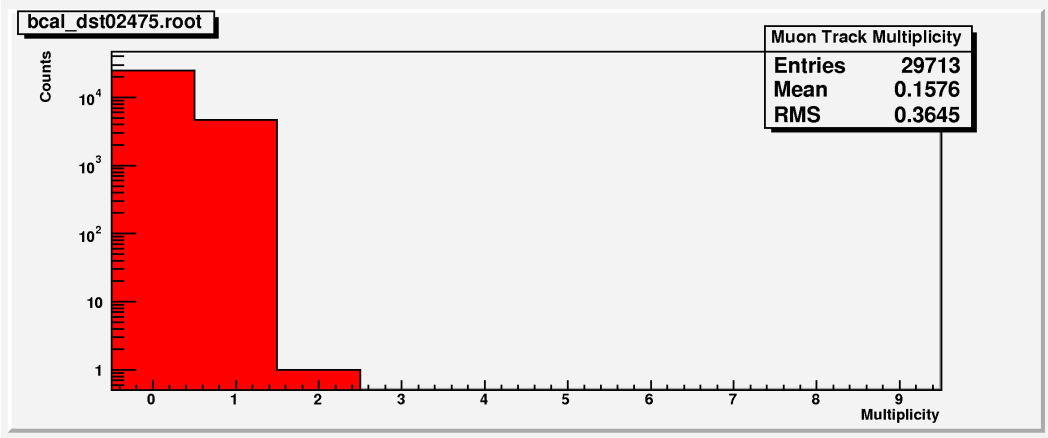

Figure 5: "Muon" event multiplicity in the run 2475.

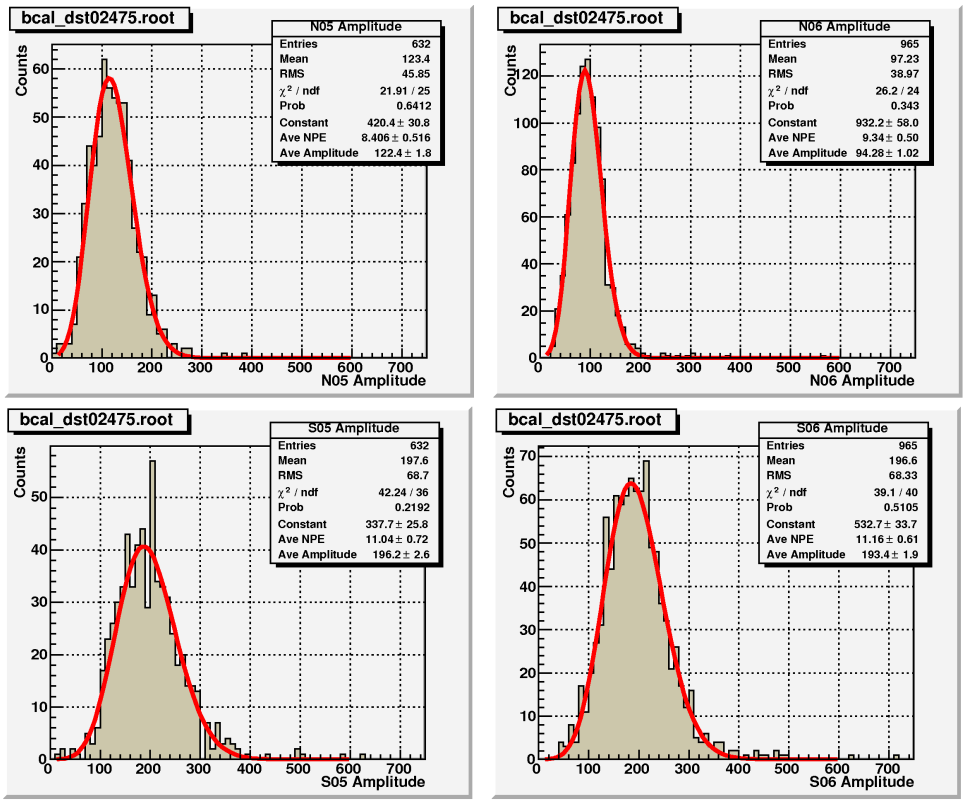

Figure 6: Typical amplitude spectra from the North (top panels) and South (bottom panels) PMTs in the run 2475.

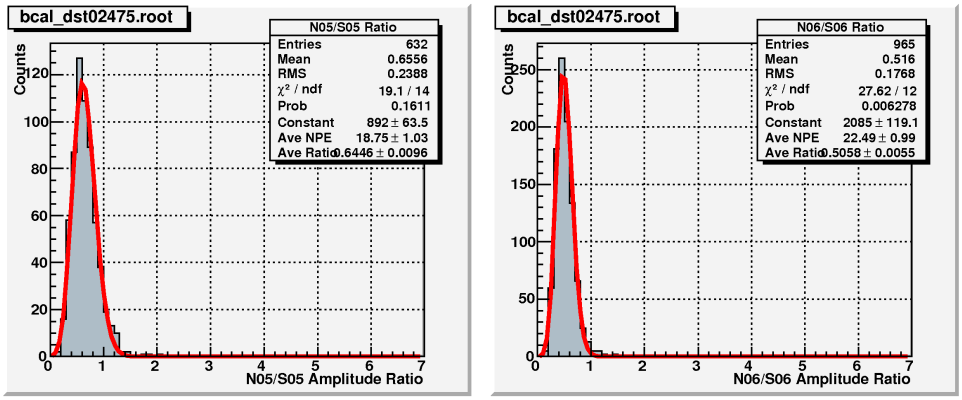

Figure 7: Typical ratio spectra in the run 2475.

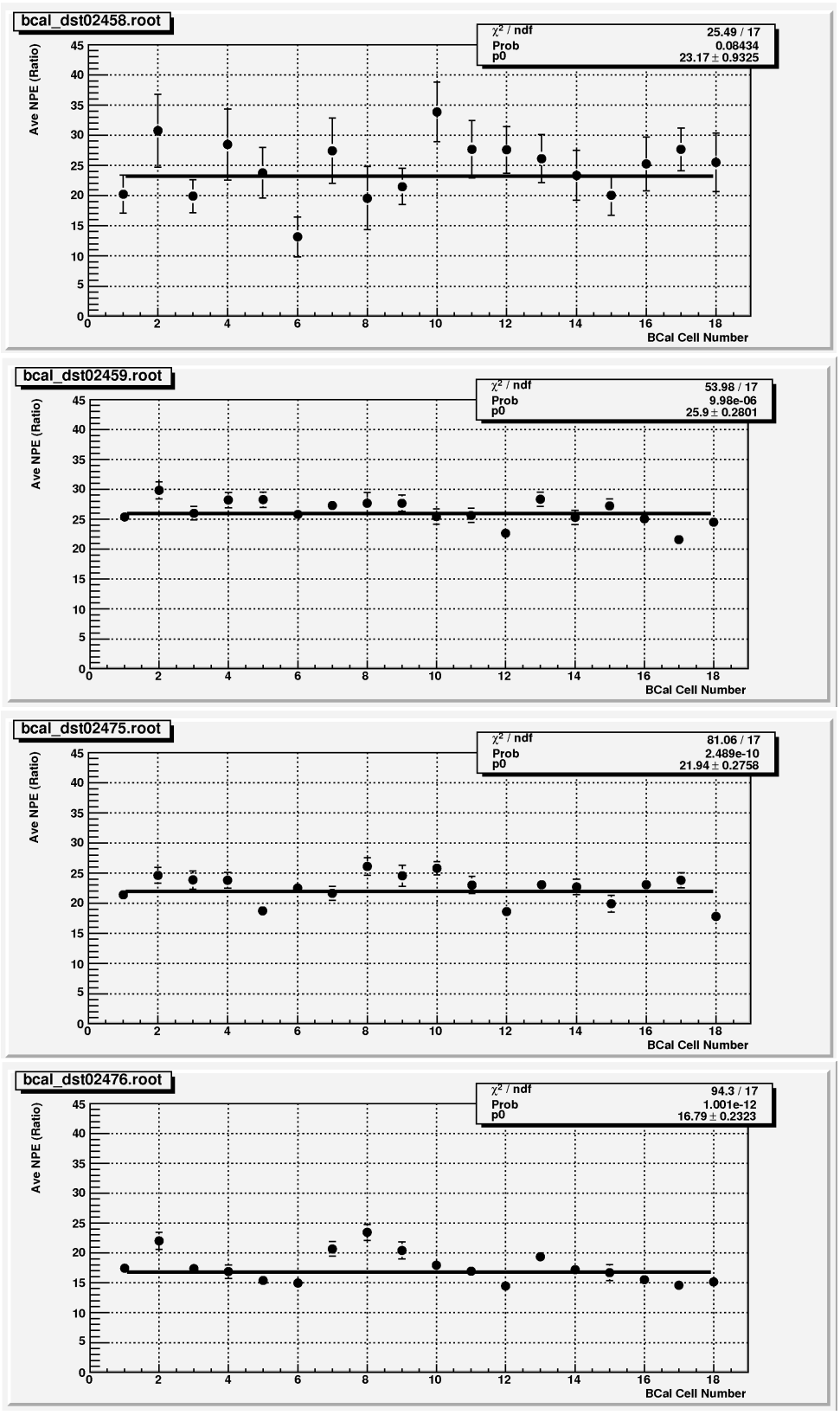

Figure 8: Average number of photoelectrons (sector-by-sector) extracted from the fit parameters of the ratio spectra for four cosmics runs.

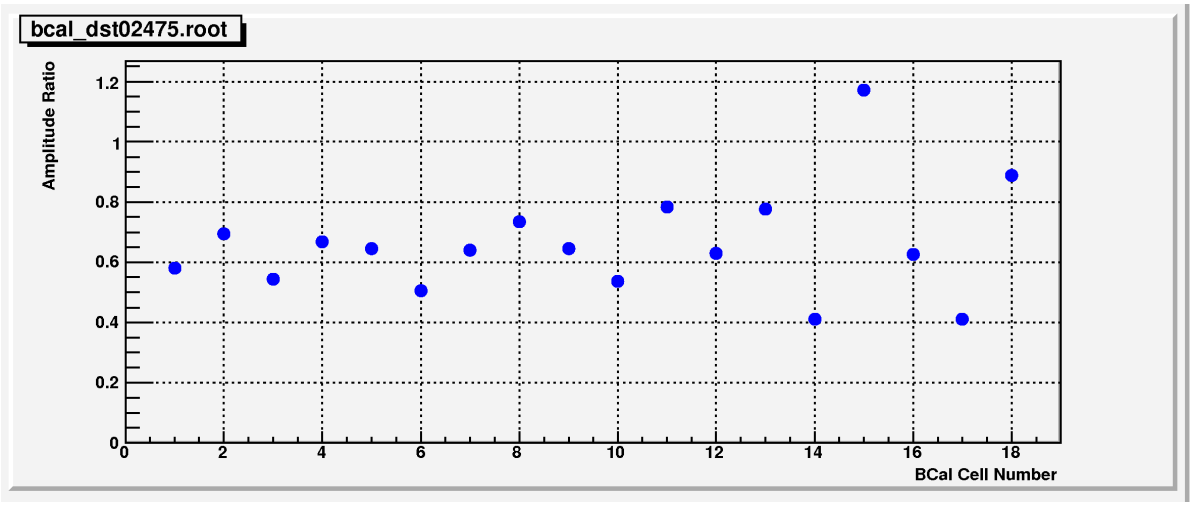

Figure 9: Sector-by-sector mean values of North/South amplitudes ratios in the run 2475. Note the significant spread.

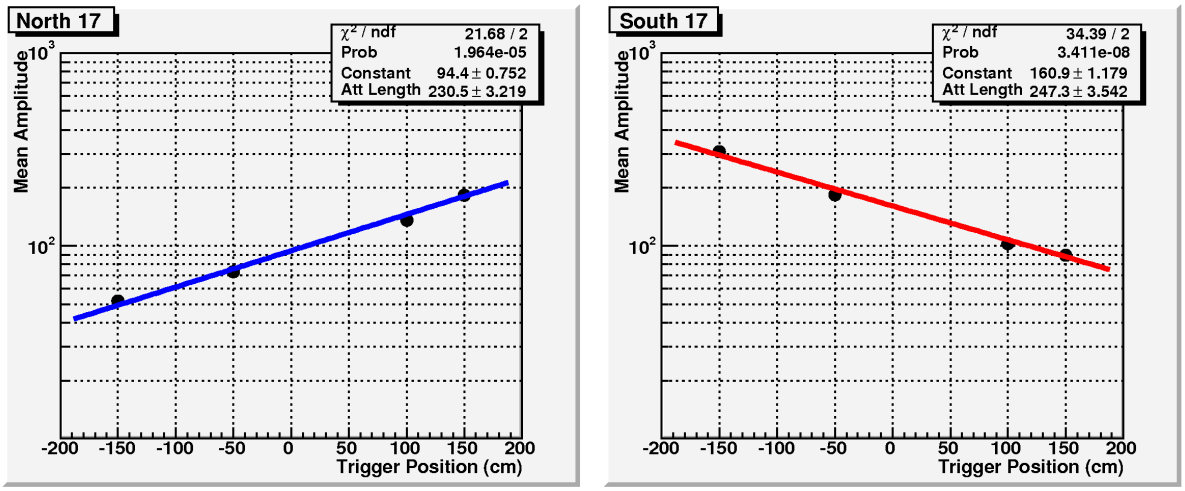

Figure 10: Extraction of the attenuation length of the light in the BCal using amplitudes from North or South PMTs.

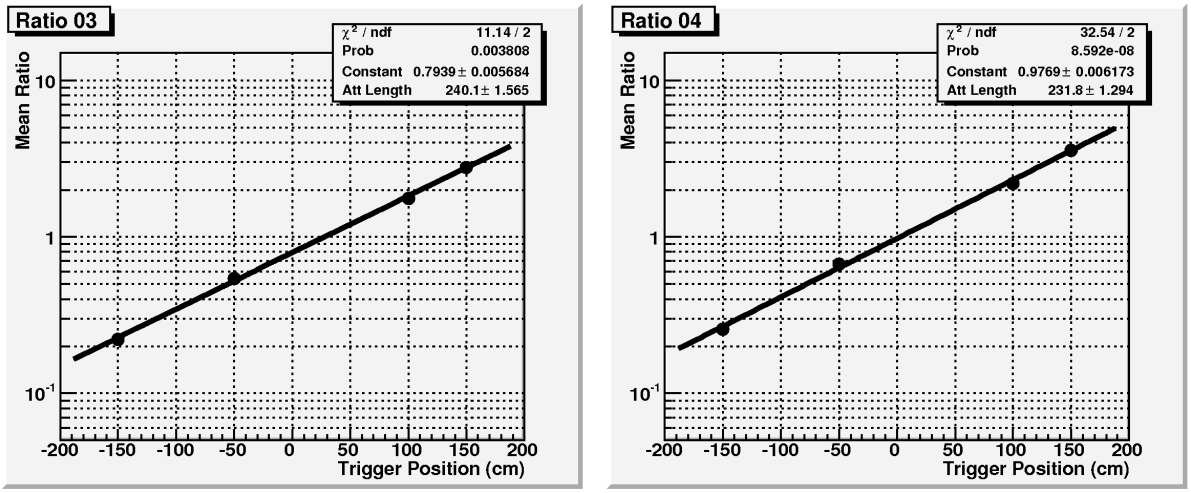

Figure 11: Extraction of the attenuation length of the light in the BCal using the ratio of amplitudes from North and South PMTs.

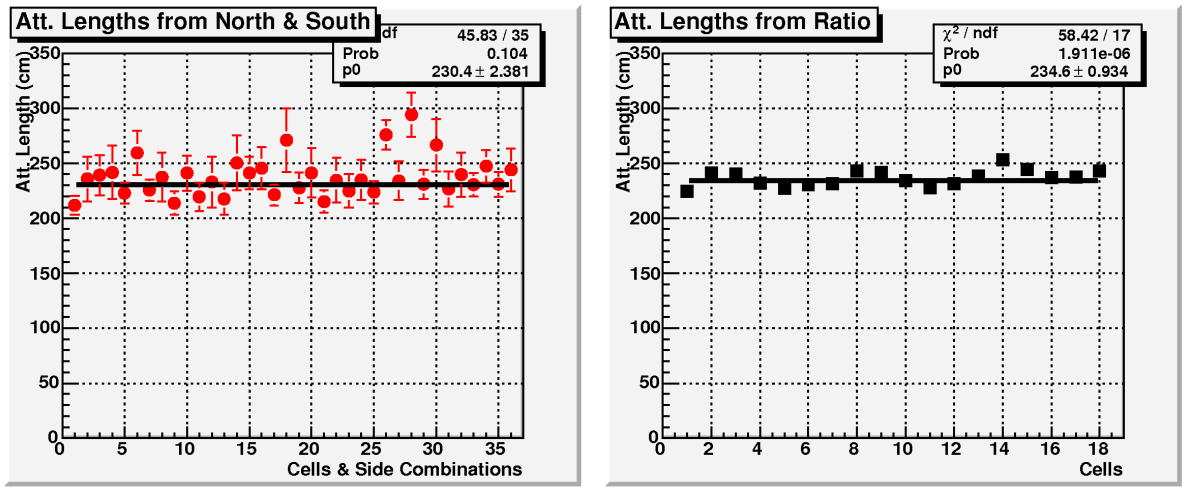

Figure 12: Summary of the attenuation lengths of the light in the BCal extracted from amplitudes from North or South PMTs (left pannel) and from the ratio of North/South amplitudes (right panel).