Improvement of the calibration file for the AMANDA II detector simulation

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This work describes the study of the calibration of the AMANDA II detector in the frame work of the summer student program 2004. Reconstruction of the trajectories of passing charged particles depends crucially on the measurement of the arrival times of the Cherenkov photons and of the 1 photoelectron signal measured by the photomultiplier. This, requires precise knowledge of the travel delay times for signals from each sensor for simulate the detector properties. In this report is discussed the improve quality of calibration file "Prompt ADC-Peak". This analysis uses data taken during 2003.

1 Introduction

1.1 The AMANDA II detector

The AMANDA II neutrino telescope is located at the South Pole and consists of 680 optical modules (OMs), which are deployed in the ice along 19 strings. The typical spacing along a string is 10–20 meters, and between strings 30–100 meters. In Fig. 1 is shown the AMANDA II detector. Each OM consist of a spherical glass pressure vessel, which contains a PMT (photomultiplier) and electronics components to transfer the signals to the counting room at the surface by signal cables. There, the arrival times and amplitudes of Cherenkov light emitted by muons are recorded.

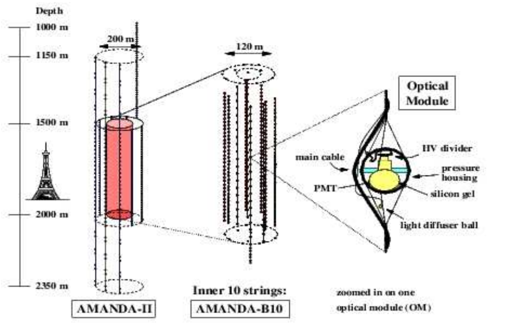

Fig. 1: *The AMANDA II detector after its completion in the beginning of 2000 [1].*

1.2 Program AMASIM

For the simulation of the detector properties the AMASIM program is used which needs the following inputs files:

- geometry file
- electrical file
- pulse file

The detector geometry is given by the geometry file. It consists information about position of optical modules and the time the signals need to travel through the cables to the counting room. The electronics behaviour for the 680 channels is given in the electrical file (information about thresholds of channels, prompt ADC-Peak values etc.).

1.3 Calibration

The standard Data Acquisition system of AMANDA provides the delayed ADC-signal only. The prompt signal was obtained in the year 2000 by a special measurement. Therefore, the meassured ratio prompt ADC/delayed ADC was used until now to calculate the prompt ADC-Peak values for the years 2001 to 2003. Since 2003 an additional electronics system is installed which transforms the PMT signals. The so-called Transient Waveform Recorders (TWR) improve the performance of the detector considerably. A main feature for the ADC-calibration is that one obtains from the measured TWR pulse height spectra the prompt ADC-Peak values. In the following analysis two methods will be used to calculate the prompt ADC-Peak values for the year 2003:

- using the fitted delayed ADC-Peak for 2003 and ratio $= \frac{promptADC}{delayedADC}$ which was measured in 2000
- using the fitted prompt TWR-Peak and transform it to prompt ADC-Peak.

2 Evaluation

2.1 *Improved new ROOT macros*

The peak values of the pulse height spectra were estimated by fitting a Gaussian distribution to the spectra. Based on the existing ROOT macros I did fits to the histograms of run 6916 (2003) and run 7400 (2003). There were a lot of bad fits—21% in ADC signals, 20% in TWR signals for run 6916 and 39% in ADC signals, 106% in TWR signals for run 7400. An example of the bad fits for both kind of signals (ADC and TWR) shows Fig. 2. In the following analysis I improved the ROOT macro by changing the range of fits. In Fig. 3 are shown the same spectra like in Fig. 2 but using improved ROOT macros, with the improved macro also other runs of 2003 were analysed: 6942, 7268, 7302, 7379, 7339, 7369.

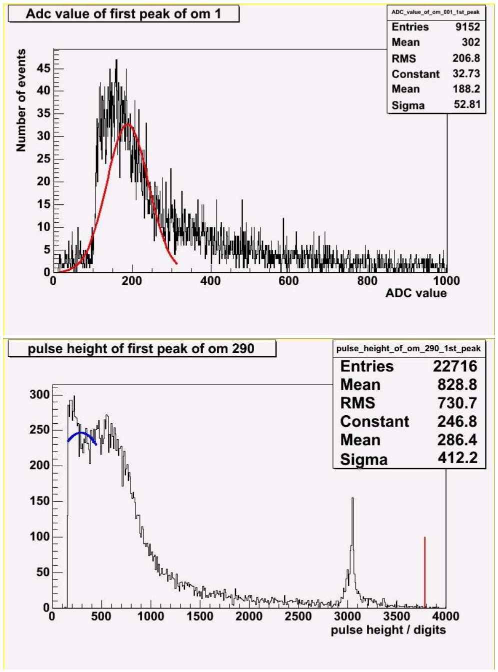

Fig. 2: *Result of using older version of ROOT macros. Top picture shows fit for ADC signal and bottom for TWR.*

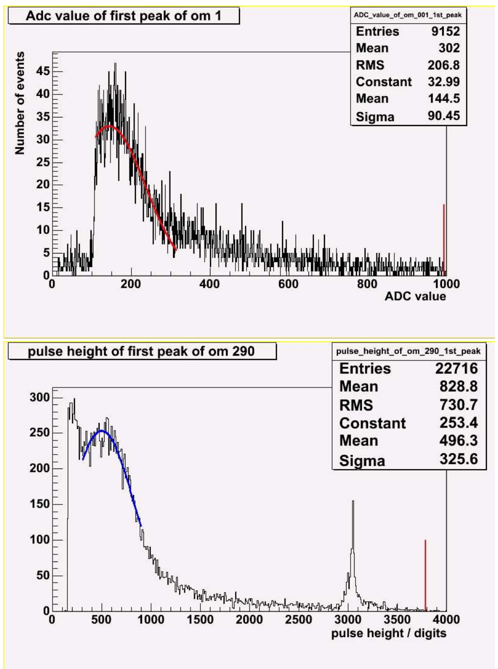

Fig. 3: *Result of using improved version of ROOT macros. Top picture shows fit for ADC signal and bottom for TWR. Both the fits are made for histograms from run 6916.*

2.2 *Time stability of pulse height spectra*

To prove the time stability of the pulse height spectra the mean values of fits were compared for the first and last run of 2003. The differences between corresponding signals are presented in the Fig. 4 and 5. Comparing the fitted mean and sigma, the TWR data seem to be more stable than the ADC data.

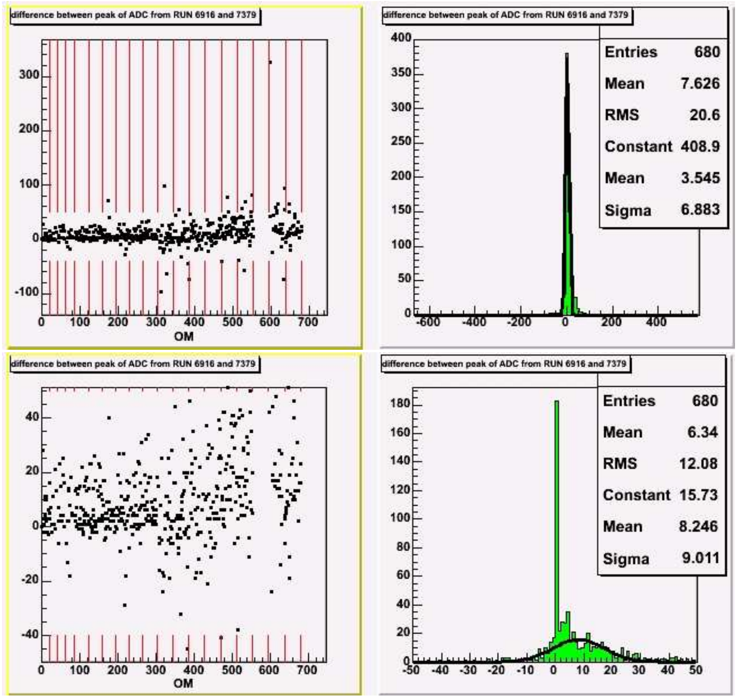

Fig. 4: *Difference between first run (6916) and last run (7379) for ADC signals. Lines on the top of graph presenting all 19 string. On the bottom both the graph and the histogram are the same like on the top but in the bigger scale.*

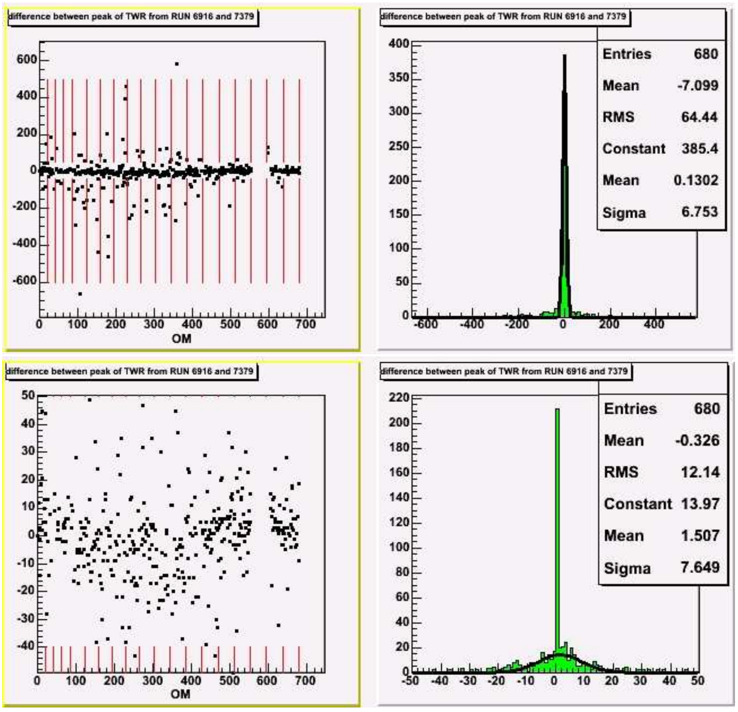

Fig. 5: *Difference between first run (6916) and last run (7379) for TWR signals. Lines on the top of graph presenting all 19 string. On the bottom both the graph and the histogram are the same like on the top but in the bigger scale.*

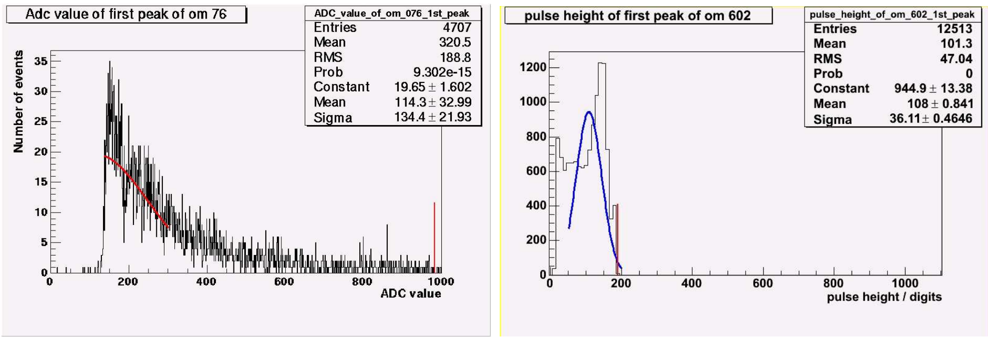

Fig. 6: *Example of bad OMs fits for run 7379. Tables look the same for the rest of runs. Left picture shows fit for ADC signal and right for TWR.*

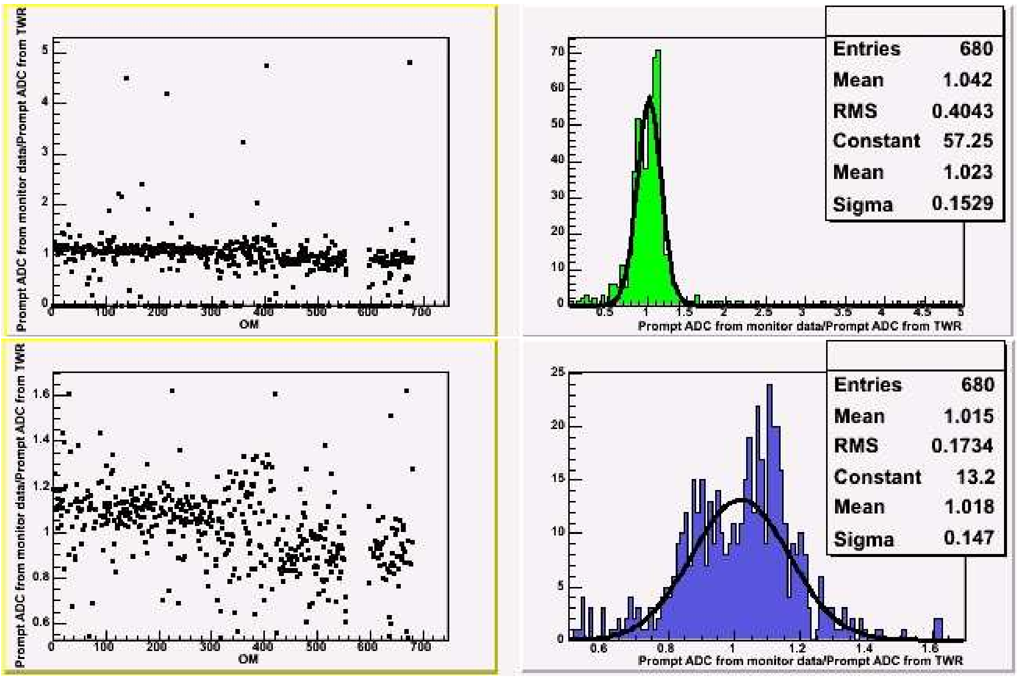

Fig. 7: *Graphs and histograms (top in the normal scale and bottom in bigger scale) presented the ratio of prompt ADC signal from monitor data to the prompt ADC signal from transformation from TWR calculated for all selected runs.*

RUN___7379

OM	mean_adc	Fit	mean_twr	Fit
7	73		5	b
23	-26	b	-4554	b
24	-575	b	177	
39	-1622	b	159	
63	-540	b	169	
73	-1707	b	181	
76	114	b	167	
327	171		-2769	b
349	-4787	b	279	
415	-645	b	172	
442	134		-4070	b
522	154		-2673	b
589	0		93	b
602	65		108	b

Tab. 1: *Bad OMs fits for run 7379.*

3 Results

3.1 Fraction of bad OM fits

For further analysis it is reason for to select the good and bad OMs fits. The bad fits can be that something is wrong with the optical module or that the fit procedure of the ROOT macro is not perfect. The table 1 shows the number of bad OMs fits for all selected runs from 2003 and Fig. 6 shows an example of the bad OMs fits of improved macros.

For 680 OMs 17% do not work (no signal), it means that there are 567 OMs which give a signal. For 567 OMs there are only 14 bad OMs fits for all the runs.

3.2 Comparison of methods

To compare both methods described in 1.3, first, I calculated mean values and their average for all selected runs. Then, I transformed mean values of the TWR signal to the prompt ADC signal using the numbers from the file ampcalib_2003.dat. In the last step I calculated the ratio of prompt ADC signal from monitor data to the prompt ADC signal from transformation from TWR. The results are presented in Fig. 7.

4 Conclusion

In general the results are satisfactory. However it is necessary to find the reasons of the deviation from zero peak values for the difference between ADC-Peak values for first run and last run for 2003. The ratio of both methods shown in Fig. 7 allows the conclusion that the TWR data can be used to improve the calibration quality.

References

[1] Ch. Wiebusch (The AMANDA Collaboration), *Phys. Lett. A*, CERN EP, Geneva, Sep. 2001