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. November 26, 2001

STUDY OF THE NOISE MEASUREMENT IN RICH-1 FRONT-END

S. Dalla Torre and F. Tessarotto

1 Introduction

The general architecture of the COMPASS RICH-1 read-out is described in [1] and more information about it can be found in two COMPASS Notes: [2], [3]. In particular, in [3] the procedure to perform measurements of the noise level of the individual (almost 83000) channels is described.

In this note, we report about some elaborations of the measured noise data.

2 Data

For this analysis, we have used 7 sets of noise data corresponding to seven different measurements performed during October, in the last weeks of the 2001 COMPASS run. The date and time of the measurements are listed here:

October 8, 2001 at 12 p.m.
October 15, 2001 at 5 p.m.
October 16, 2001 at 11 a.m.
October 17, 2001 at 4 p.m.
October 18, 2001 at 8 p.m.
October 21, 2001 at 1 p.m.
October 22, 2001 at 1 p.m.

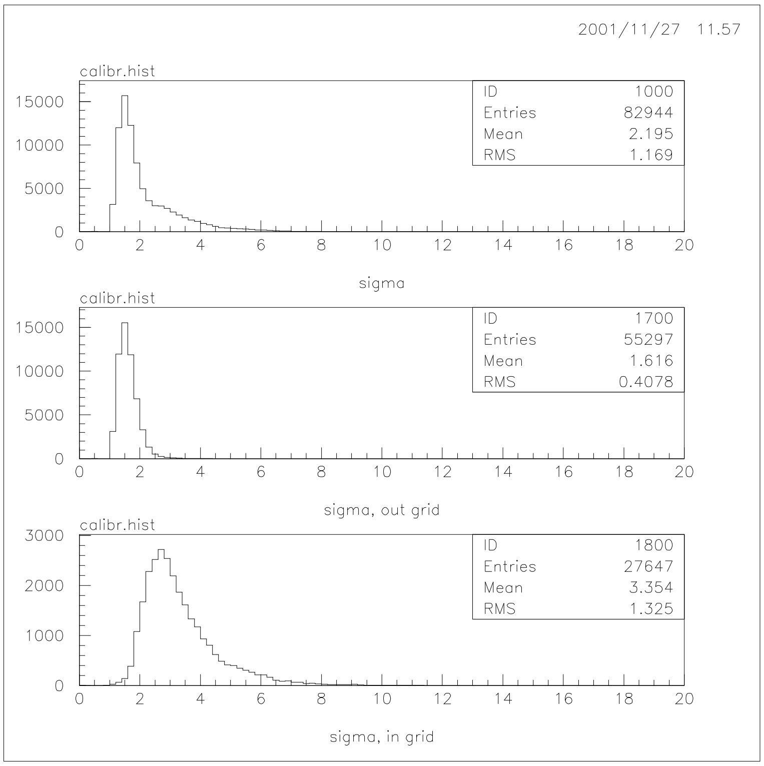

Figure 1: Top: distribution of the noise measurements for all the channels of the read-out system. Centre: distribution of the noise measurements for all the channels not below the mechanical grid (see text). Bottom: distribution of the noise measurements for all the channels below the mechanical grid (see text).

3 General features

The same features are seen in all the 7 sets of measurements studied. The figures refer to measurement: October 16, 2001 at 11 a.m. In the following we call "noise" the standard deviation of the pedestal measured values and pedestal the mean value of these distributions; the units used are ADC channels (ADC ch.s): 1 ADC ch. corresponds to 1000 electrons (A. Colavita, private communication).

Figure 1, top plot, shows the distribution of the noise measurements for all the channels of the read-out system (one entry per channel). A mean value of 2.1 ADC ch.s is obtained.

The noise measurements for all the channels of each photocathode (fig. 2) indicates that the noise is quite homogeneous in the whole system.

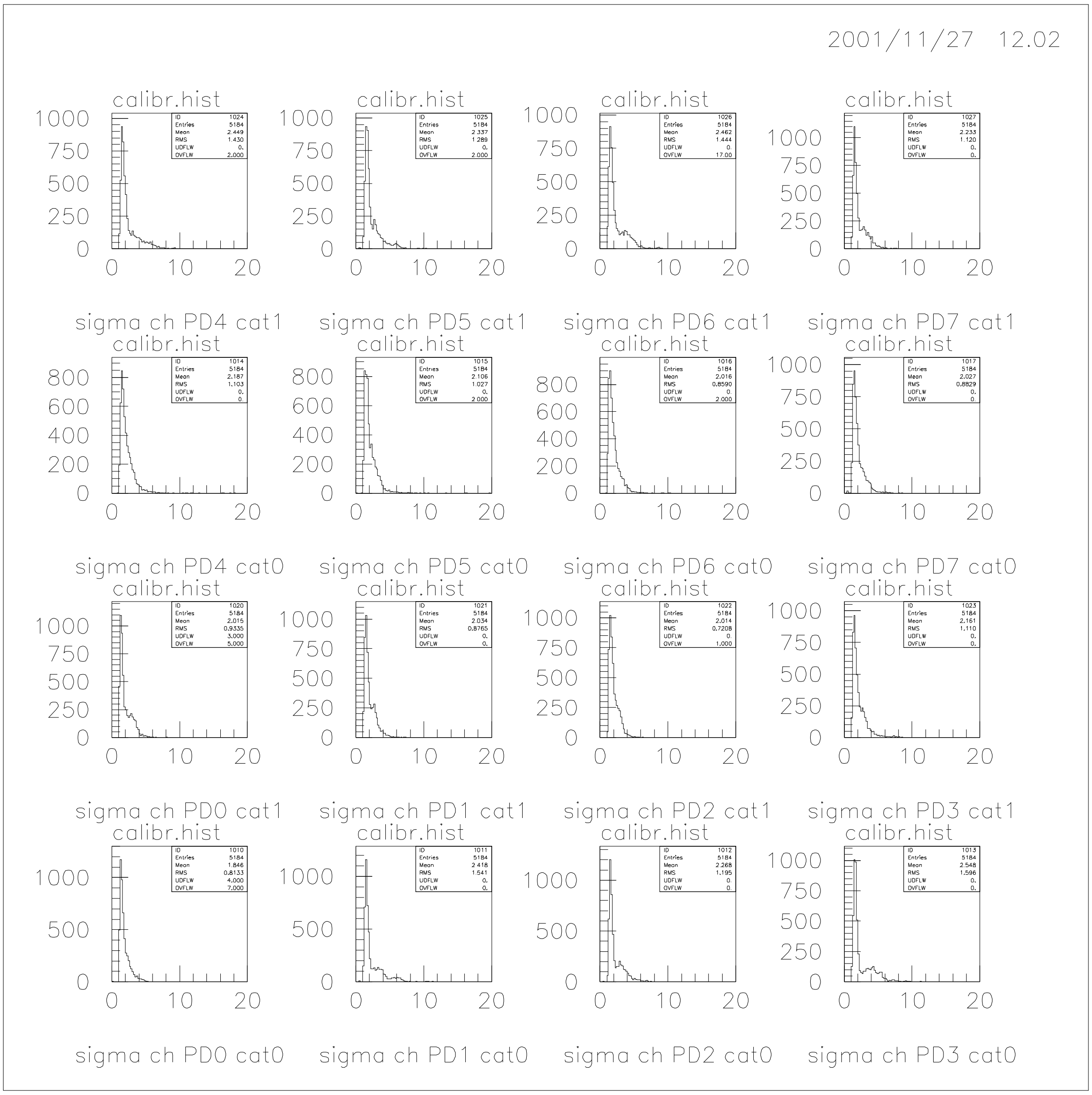

Figure 2: Distributions of the noise measurements for all the channels of each photocathode plane.

Figure 3 is a two-dimensional plot of the noise distribution over the photocathode surface (the measurements for all 16 photocathodes are averaged): the noise induced by the mechanical reinforcement ("grid") needed to keep the photocathode PCB flat is clearly visible. (This effect was already seen on a limited number of BORA boards and report by A. Colavita; here it it studied for the whole read-out system.) The mean value of the noise standard deviation measured for the read-out channel not below the grid (fig. 1, central plot) is 1.6 ADC ch.s , while for the channels below the grid (fig. 1, bottom plot) it is 3.2 ADC ch.s. This suggests to reinforce the grounding connections of the photocathode mechanical structure.

4 Comparison of different measurements

One set of data (measurement performed on October 16, 2001 at 11 a.m.) has been (arbitrarily) selected as reference. The other six sets of measurements have been compared with the reference one. Figure 4 is the histogram of difference of noise values between a set and the reference one. The typical standard deviation of the noise differences is 0.2 ADC ch.s, while they are centred at zero: the measured noise looks quite stable. The corresponding histograms for the central pedestal values (fig. 5) have also quite small standard deviation (typically 0.4 ADC ch.s) but they are not centred at zero: values up to about 1 ADC ch. are observed. Figures 6 and 7 show the histograms of the pedestal differences between two set and the reference set for the individual cathode planes. Figure 7 indicates a largely coherent drift of the pedestal values related to some external cause (SM1 magnet ramping, temperature variation, ...), while fig. 6 is representative of a situation in which the coherence is not complete.

The comparison of 7 measurements taken half an hour one after the other on November 9, 2001 to check short term stability is given in figures 8 and 9, the first one showing the histograms of the difference of noise values, the second showing the distributions of the analogous differences for the pedestals. The measurements have been performed with different voltage applied to the photon detectors (0 V per the measurement used as reference to compare the others, two measurements at 1000 V, two measurements at 2000 V, two at 2200 V). All distributions are quite narrow and centred at zero, indicating good short term stability and no influence of the voltage applied to photon detectors. It has to be notice that these measurements have been performed after the end of the run: several equipments are switched off and the activity in the hall is reduced.

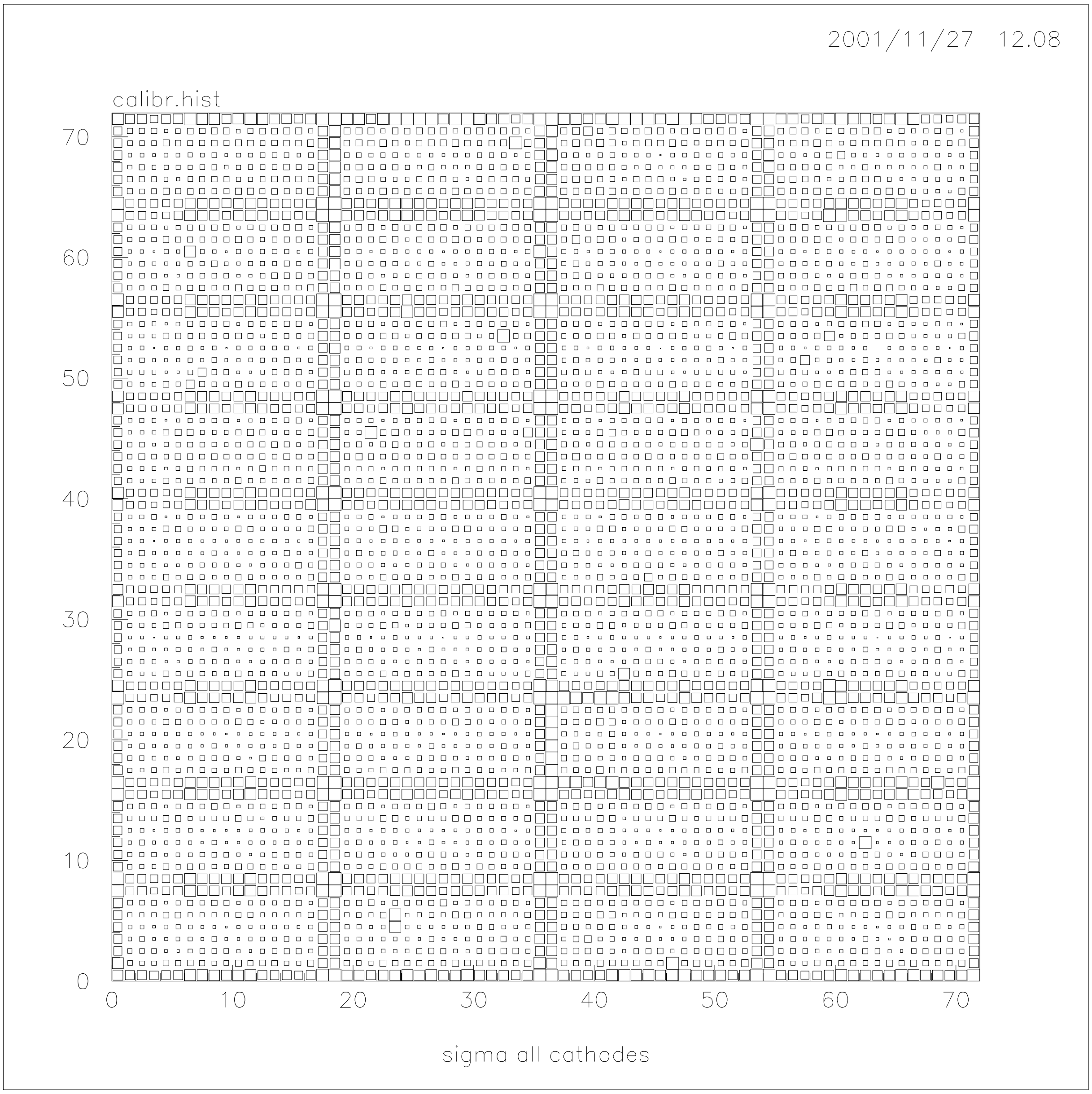

Figure 3: Noise distributions versus pad location in the photocathode surface (the measurements for all 16 photocathodes are averaged).

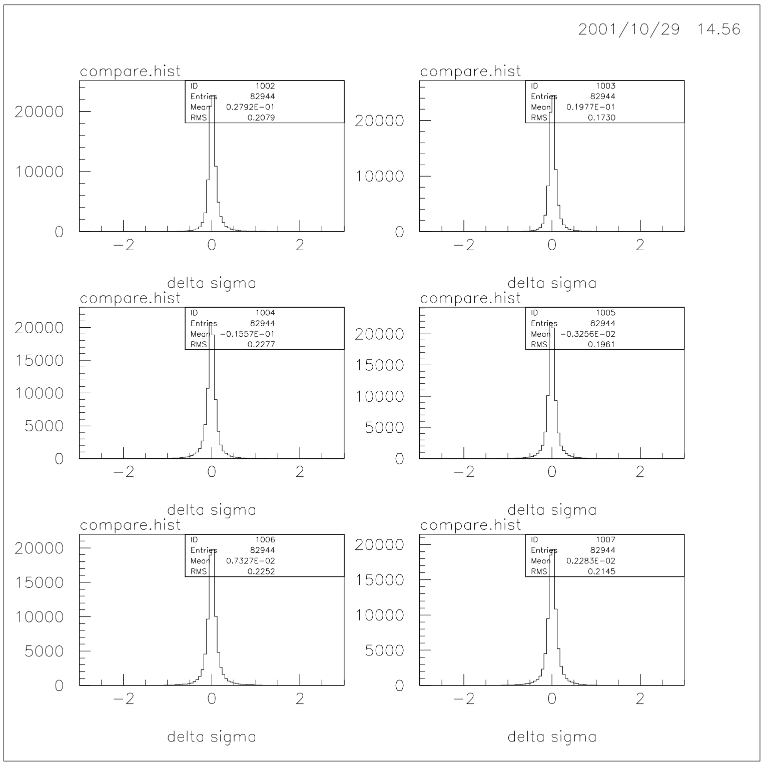

Figure 4: Difference of the noise values of 6 different sets of measurements and a seventh one, regarded as reference (see text).

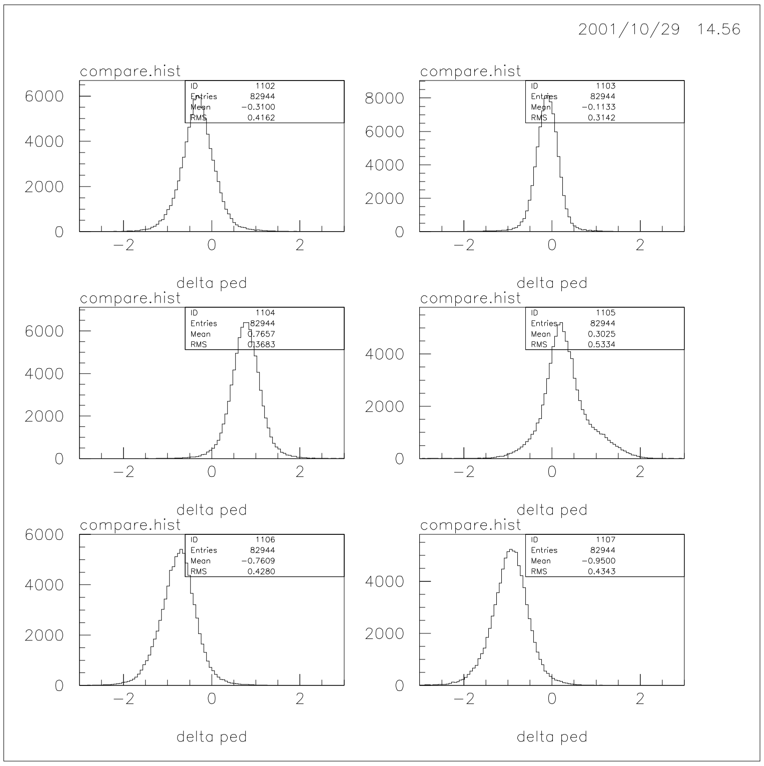

Figure 5: Difference of the central pedestal values of 6 different sets of measurements and a seventh one, regarded as reference (see text).

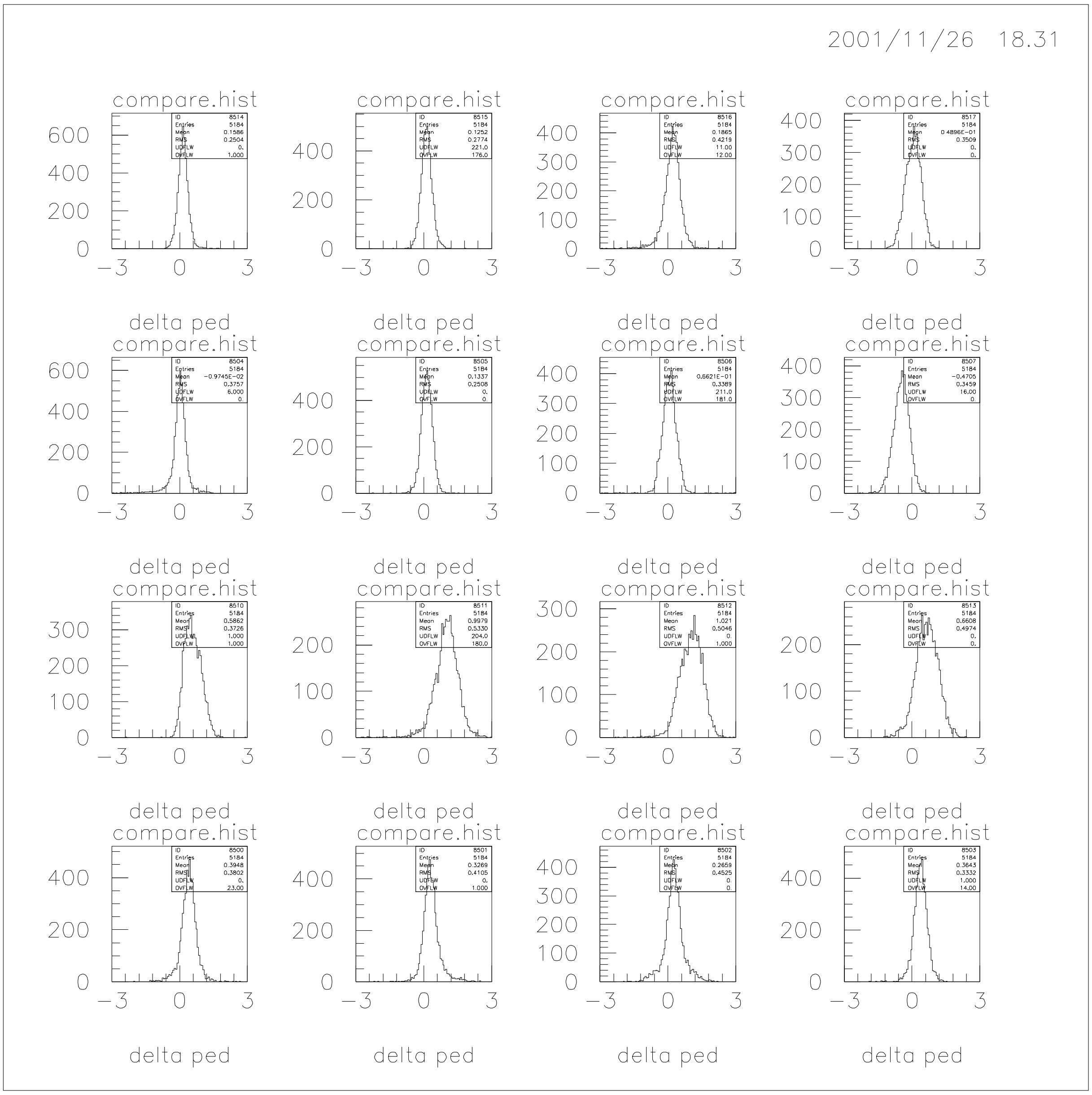

Figure 6: Difference of the central pedestal values of each photocathode plane for two sets of measurements: October 22, 2001 at 1 p.m. and October 16, 2001 at 11 a.m. .

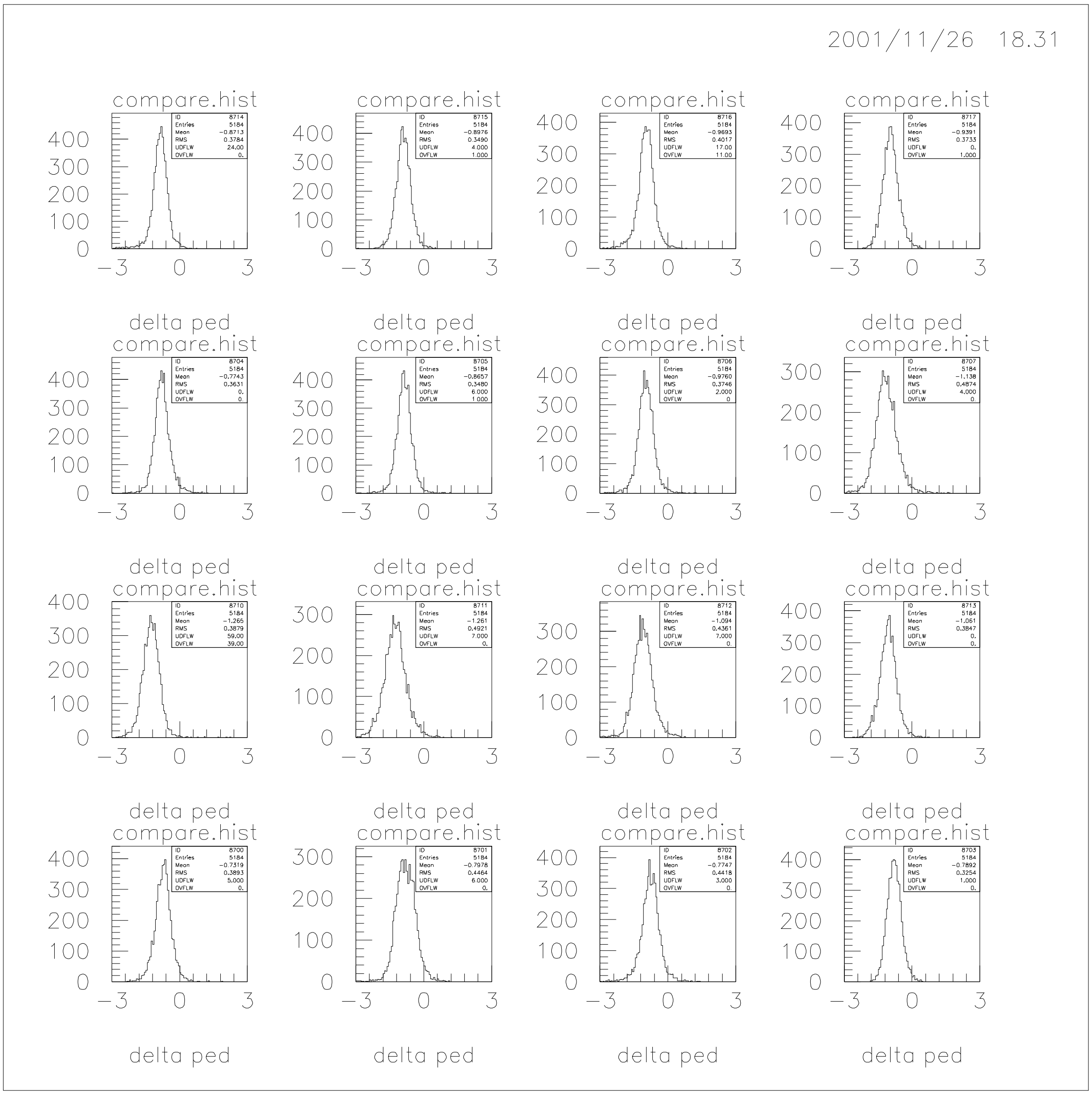

Figure 7: Difference of the central pedestal values of each photocathode plane for two sets of measurements: October 18, 2001 at 8 p.m. and October 16, 2001 at 11 a.m. .

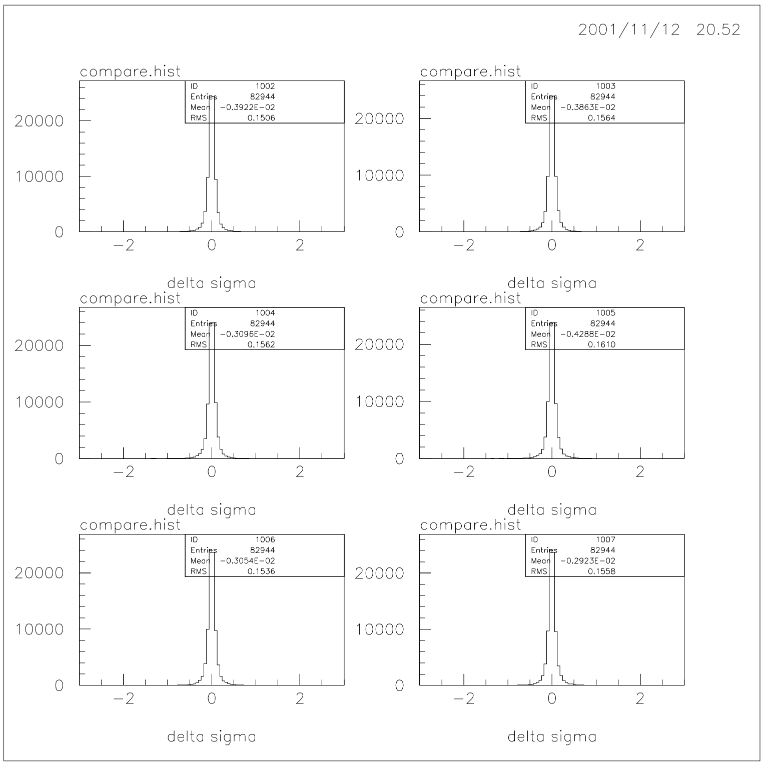

Figure 8: Difference of the noise values of 6 different sets of measurements and a seventh one, regarded as reference; all measurements compared in these histograms have been permormed within 4 hours (see text).

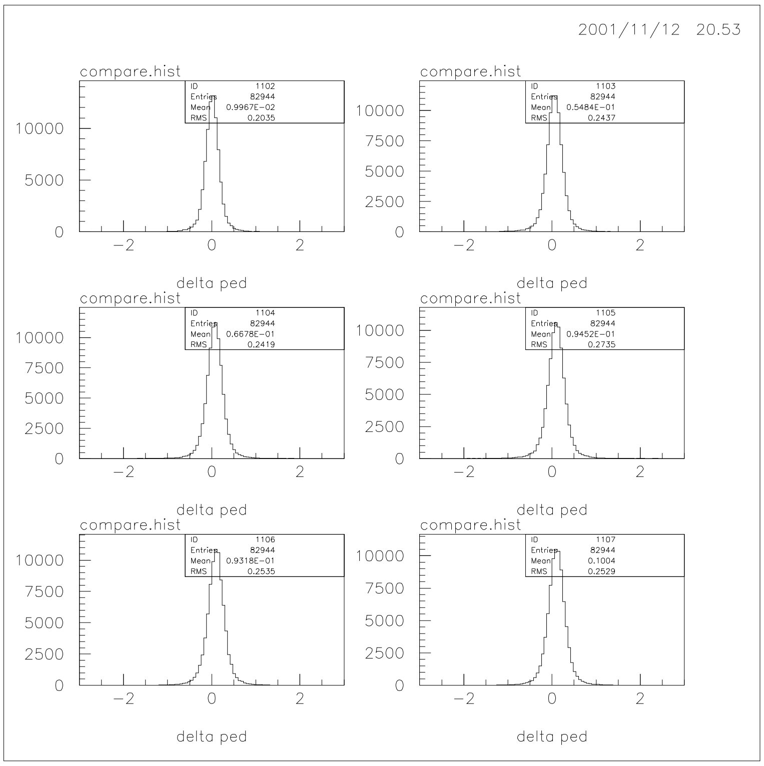

Figure 9: Difference of the central pedestal values of 6 different sets of measurements and a seventh one, regarded as reference; all measurements compared in these histograms have been permormed within 4 hours (see text).

5 A hint for RICH-1 decoding

The study of the noise pattern has produced an interesting by-product, namely has allowed to understand an unforeseen feature of the data encoding. The noise pattern on the cathode, as obtained at the beginning of these studies, can be found in fig. 10 (to be compared with fig. 3). The mechanical grid is visible, but the picture is confused: this has suggested that the assumed algorithm for data decoding needed to be modified. The noise pattern has offered clear suggestions, thus guiding us to identify a possible mechanism for distorted encoding.

The data from the two GASSIPLEX outputs (still analogic information) are multiplex to the ADC with an 8-cycle long clock sequence. In the current picture, it is assumed that the information related to GASSIPLEX input number 1 (output 1) and number 9 (output 2) are transfered with the first clock and so on. In the hypothesis of one cycle clock shift, i.e. that the transfered information at the first clock cycle is input number 2 (output 1) and number 10 (output 2), the clean grid picture of fig. 3 is obtained.

Acknowledgements

This studies would not be possible without the implementation and the excellent performances of the RICH-1 read-out system.

The authors are grateful to A. Cicuttin and V. Diaz for helping them in accessing the pedestal data.

References

[1] G. Baum et al., *BORA: A front end board, with local intelligence, for the RICH detector of the COMPASS collaboration*, *Nucl. Instr. and Meth. A* 433 (1999) 426.

[2] A. Colavita, *All you wanted to know about decoding the RICH-1 but were afraid to ask*, COMPASS note 2001-5, April 17, 2001.

[3] ICTP Compass group, *Guide for pedestrian operators, How to operate the RICH Data Acquisition System*, September 28, 2001.

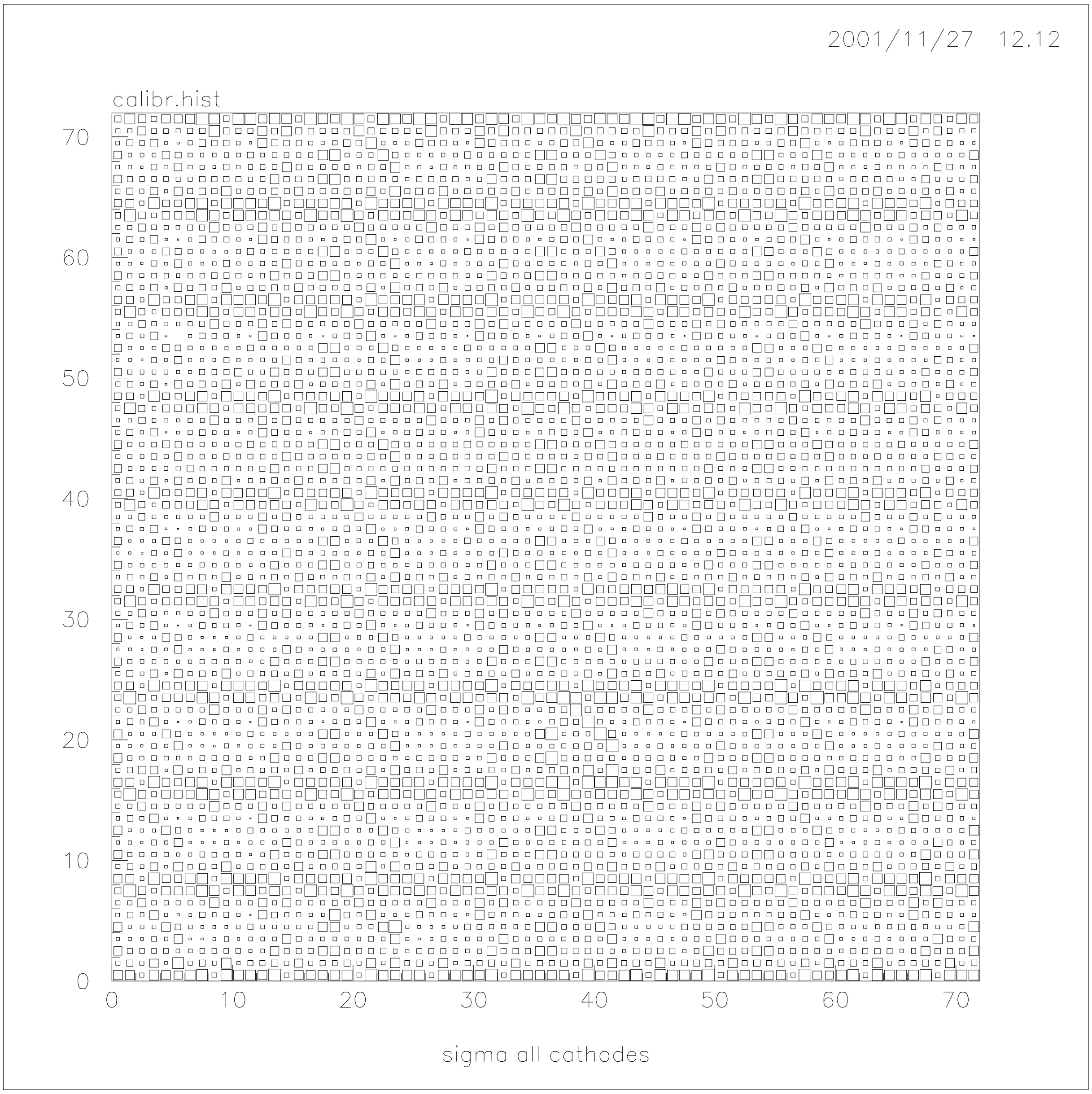

Figure 10: Noise distributions versus pad location in the photocathode surface (the measurements for all 16 photocathodes are averaged) using original decoding algorithm.