Time precision of the CBM RICH readout system

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During common CBM beam tests at CERN-PS in Nov 2014 a CBM RICH prototype including a camera of 16 MAPMTs has been successfully tested. Details about the readout and DAQ system can be found in [1, 2]. There are two types of events in the data gathered during the beamtime. In both cases almost simultaneous hits are registered by multiple pixels of the photosensitive camera. The first type — flash of the laser with ≈40 ps duration — one order of magnitude lower than the transition time spread in the MA PMT. The second type of events is formed by simultaneous hits from the Cherenkov photons of one charged particle. The time spread of photons' arrival can be as high as 100 ps for Cherenkov rings and 70 ps for a laser flash due to the geometry of the setup. Analysis of such events allows characterization of time precision of the full readout system.

It is impossible to measure the exact time of the photon arrival in the absolute time scale so the distribution of relative times for simultaneous hits is analysed. Timestamps in each channel fluctuate independently ??? so the measured width of the distribution is $\sqrt{2}$ larger than the actual time precision.

For a pair of channels the full width at half maximum (FWHM) of the distribution is 750 ps which corresponds to time precision of 530 ps. This value is almost twice higher than the transition time spread of the MA PMT. There are two main reasons for that: instability of inter-channel delay corrections over time and absence of walk correction. In order to implement the walk correction procedure one needs to have stable time-over-threshold measurements which are not available in the beamtime data.

In order to characterize the time precision of the readout system in general, the simultaneous signals have been analysed in four subsets of channels: (1) one pair of channels, (2) 16 channels read out by one PADIWA FEB, (3) 64 channels of one MA PMT, (4) 256 channels of 4 MA PMTs. In each case, after fine time calibration and inter-channel delay correction, a number of distributions have been built using hits corresponding to one event.

Results for laser flashes are shown in the fig. 1. Table 1 shows the evolution of the RMS and FWHM with increasing the number of analysed channels. Note that for events with laser flashes the RMS almost does not change while the FWHM increases and the shape of the distribution gets closer to Gaussian. This can be interpreted as smearring of the features of individual channels. For hits from one Cherenkov ring (see fig. 2) the FWHM and RMS increase with increasing the number of analysed channels.

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Table 1: FWHM and RMS of the distributions for different analysed areas.

Analysed area	Pair ofchannels	PADIWA FEB	One MA PMT	Four MA PMTs
Num.of channels	2	16	64	256
FWHM, laser, ns	1.1	1.2	1.5	1.7
FWHM, rings, ns	0.6	0.8	1.0	1.3
RMS, laser, ns	0.913	1.093	0.997	1.034
RMS, rings, ns	1.238	1.379	1.430	1.487

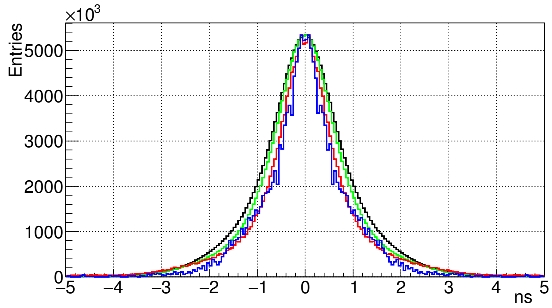

Figure 1: Distributions for 4 different sets of channels for events with laser flashes.

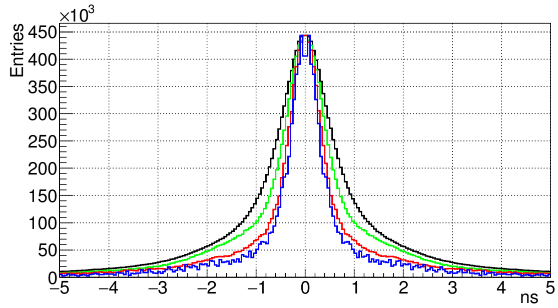

Figure 2: Distributions for 4 different sets of channels for events with Cherenkov rings.

References

[1] E. Ovcharenko et al. // Development of the CBM RICH readout electronics and DAQ, RICH2016 proceedings, Submitted to NIM A

[2] E. Ovcharenko et al. // Tests of the CBM RICH readout and DAQ prototype, Submitted to PEPAN letters