Measurement of Signal-to-Noise Ratio in Straw Tube Detectors for the PANDA Forward Tracker

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1 Self-Supporting Straw Tube Detectors

The PANDA experiment [1] will be built at the FAIR facility in Darmstadt (Germany) to conduct experimental studies of the strong interaction through $\overline{p}p$ and $\overline{p}$A annihilation. To track charged particles emitted at the most forward angles within acceptance of the PANDA Forward Spectrometer, the Forward Tracker (FT) consisting of a set of planar straw tube layers will be used [2]. The straws for the FT have a diameter of 10 mm and are made of 27 μm thick aluminized Mylar foil [3]. As an anode, gold-plated tungsten-rhenium wire with 20 μm diameter, is used. The straws are made self-supporting by means of 1 bar overpressure of the working gas mixture - Ar/CO_2 (90:10). The straws are read out by Front-End Electronics (FEE) cards based on the PASTTREC chip [4].

2 Signal-to-Noise Ratio

The signal-to-noise ratio was measured for the straw tube pulses at the analog output of the FEE card. The pulses were registered using CAEN Digitizer DT5742 working at a sampling frequency 1 GHz and a resolution of 0.25 mV. Measurements were done for the straw illuminated with 5.9 keV X-rays from ^{55}Fe source, at the anode voltage of 1700 V. At this voltage, the straw pulses have an amplitude close to one observed for minimum ionizing protons crossing the straw in the vicinity of the anode wire and the anode voltage set to the foreseen working voltage of 1800 V. The measurements were done for the gain in the FEE set to 1 mV/fC and three different settings of the peaking time parameter: 15, 20 and 35 ns.

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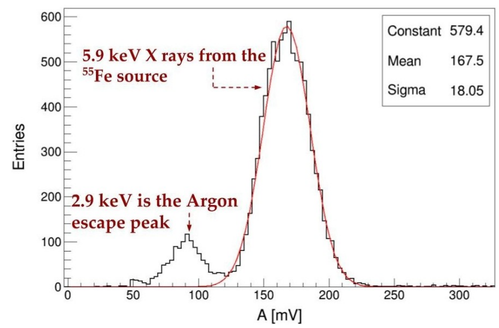

Fig. 1 Amplitude spectrum registered for the peaking time setting of 20 ns (black line) together with a gaussian function fit to the 5.9 keV line.

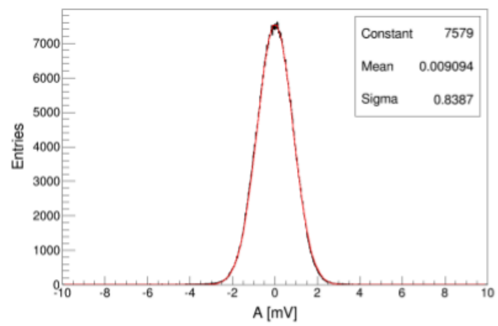

Fig. 2 Distribution of noise for the peaking time setting of 20 ns (black line) together with a fitted gaussian function (red line).

The average amplitude of pulses corresponding to absorption of the 5.9 keV X-rays from ^{55}Fe was determined from a gaussian function fit to the amplitude spectrum (see Fig. 1). For each registered waveform, the baseline level was determined as an average of the first 100 samples preceding the straw pulse and then was subtracted from all samples in the waveform. A distribution of the first 100 samples corrected for the baseline was fitted with a gaussian function and the standard deviation of the function was taken as the level of noise (see Fig. 2). The average amplitude of pulses for the peaking time setting 15, 20 and 35 ns was 162, 168 and 174 mV, respectively, the level of noise was 1.00, 0.84 and 0.80 mV, and the signal-to-noise ratio was 162, 200 and 218. The lowest noise of 0.80 mV is observed for the longest peaking time (35 ns). However, for this peaking time one can expect the biggest drift time uncertainty due to the time walk effect. Therefore, we plan to find the optimal peaking time setting, allowing to obtain a low noise level and a satisfactory drift time resolution. We also conduct studies of additional shielding of the straws with extra layer of aluminized Mylar for further reduction of the noise.

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