Performance of the straw tube readout based on PADI chip*

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A prototype of the CBM MUCH straw tube detector [1] consisting of six individual straws of 6mm inner diameter and approx. 22cm length was flushed with a gas mixture of Ar/CO_2 (70/30) at ambient pressure. The straw anodes signals where connected to the PADI-6 ASIC [2] inputs via single twisted pair cables, decoupled by HV capacitors of 400pF and protected by PIN diodes in back-to-back orientation

The PADI have been mounted and wire bonded at GSI Detector Laboratory to the FEET-PADI6-HDa PCB [3]. For every PADI-6 with four input channels the discriminator threshold could be adjusted by a dedicated potentiometer to 'just above noise'-level ($Q_{Thr} \approx 2.2fC$).

The experiment has been conducted at the COSY accelerator in Jülich. Protons of 2.95GeV energy at an intensity of $I \approx 5 \cdot 10^3 s^{-1} cm^{-2}$ in a nearly elliptical beam spot ($x \approx 7.6mm, y \approx 15mm$) where hitting two neighbouring straw tubes and the tracking diamond detector in about 20mm distance downstream.
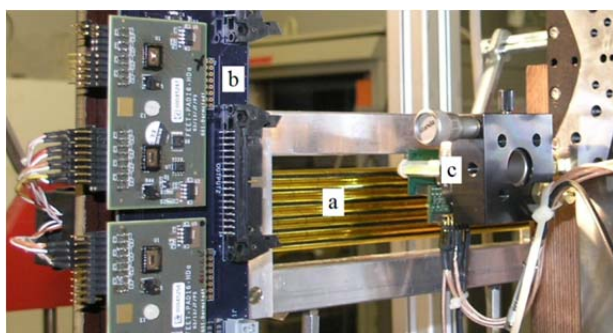

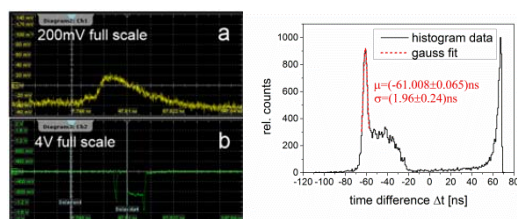Figure 1: Experiment setup with straw tubes (a), PADI readout (b) and diamond tracking detector (c).

Figure 2: PADI-6 analogue output (a) and corresponding discriminator signal (b), 200ns full scale. (right) Example histogram of proton tracks near the straw wall. Background events show full range of drift times for this straw. Inefficiency hits are at the upper end of the spectrum.

The straw tubes, and as a consequence of this - their anodes, where placed horizontally and aligned in parallel to the $(0.09 \cdot 2.1)mm^2$ gap between two electrodes of the diamond tracker. The trigger for the measurement was set to choose only signals with charge sharing between these electrodes. So only particles, traversing the gap were rec-

ognized [4]. Additionally the tracking detector was mounted on a movable stage with micrometre precision to define the particle track distance to the anode wires.

After LVDS-NIM conversion only signals of one straw detector (figure 2) and two signals (D1, D2) from the diamond electrodes where fed into the R&S® RTO1044 (4GHz, 10GS/s) digital oscilloscope. The time difference $\Delta t = t_{trigger} - t_{straw}$ between the trigger ($D1 \cap D2$) and the PADI discriminator output was measured and analysed. Δt corresponds to the electron drift time in the straw and additional signal latencies.

The main drift time peak of the Δt histogram in the range $-60ns \leq \Delta t \leq -20ns$ was fitted with a Gauss function for different track positions over two straw diameters (figure 2). A mean drift time resolution of $\sigma_{\Delta t} = 2.26ns$ was achieved (1.8ns...2.7ns) corresponding to a mean position resolution of $\sigma_{\Delta y} = 157\mu m$ with the measured electron drift velocity (see figure 3). Further analysis is needed for data taken with the self-tracking method for two straws.
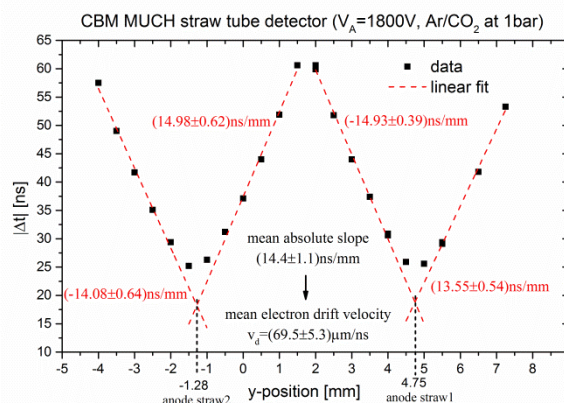

Figure 3: electron drift time dependent on the track position y (error bars are smaller than symbols). The electron drift velocity for the used detector gas was calculated.

References

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