In-Beam Test of the TwinTPC at FRS*

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One of the crucial requirement for the future tracking detector at the Super-FRS [1] is a high efficiency tracking at particle intensities around 1 MHz. To improve the efficiency at high rates of the standard TPC [2] and future GEMTPC detector [3] so called Twin design is proposed.

The main idea of the Twin design is to use two independent drift volumes with electric fields of opposite direction. This allows to calculate a Control Sum which is in principle sum of the drift times from the drift volumes. As the sum should be a constant it can be used for for pile-up and noise rejection and for multi-hit track reconstruction.

The TwinTPC prototype was built at Comenius University Bratislava. The TwinTPC drift volumes were filled with P10 gas at normal temperature and pressure and were operated at electric field of $400V/cm$. Each drift space was read by two anode wires and a delay line. The anode wires were used to calculate drift time (y-coordinate) and delay line was used to measure x-coordinate. For the future the single-strip readout with multi-hit digital electronics is foreseen for x-coordinate measurement. The signals were processed by conventional electronics (pre-amplifiers, shaping amplifier, discriminator) and time was measured by multi-hit TDC (Caen V1290) with $25ps$ time resolution. All times were measured relative to reference times derived from the hits of a plastic scintillator. The Control Sum was calculated as $t_{CS} = t_1 + t_2 - 2 \cdot t_t$, where t_1 and t_2 are drift timed from the two drift spaces and t_t is the reference time coming from scintillator. All times are measured in multi-hit mode.

The test was done using Au beam at $700MeV/u$ at the FRS. The particle rate was estimated from the number of hits registered by the plastic scintillator which were sent to scaler unit and the mutli-hit TDC. The efficiency was measured at different beam intensities and was estimated from the number of events for which we can unambiguously assign drift times fulfilling the control sum condition. The typical distribution of the control sum is shown in Fig 1. The width of the control sum is partially determined from the time resolution of the drift time measurement. The achieved time resolution (RMS) of the single drift volume was around $1ns$ for rates below 100kHz, corresponding to about $50\mu m$ position resolution for P10 gas. At higher rate (700kHz) the time resolution dropped to $3ns$.

The measured efficiency of the drift time reconstruction using the Twin design at different rates is shown in Fig. 2. The obtained results are compared with the efficiency of the single-volume TPC with single-hit readout and with simulation as described in [4]. The results conclude the Twin design works and show possible areas for improvement.

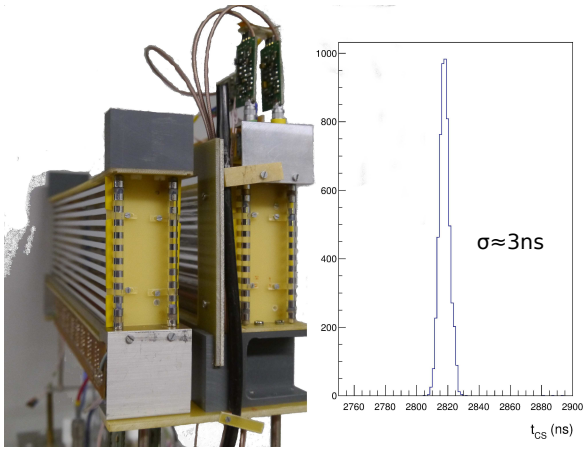

Figure 1: Left: TwinTPC prototype photo showing two drift volumes. Right the distribution of the Control Sum

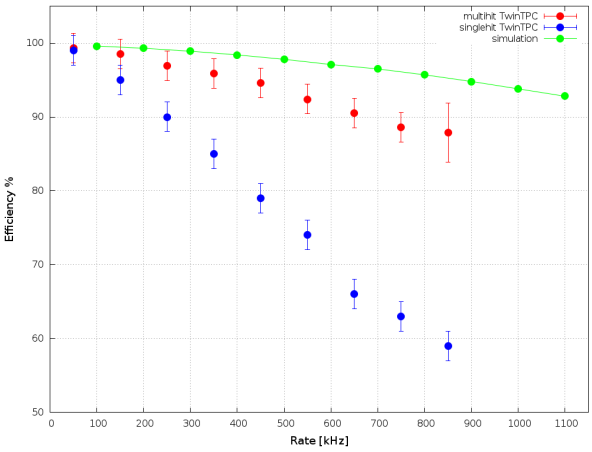

Figure 2: The TwinTPC drift time reconstruction efficiency (red points) as a function of rate. The blue points are efficiency of the single drift volume with single-hit electronics, the green points are simulation.

References

[1] H. Geissel et al.,Nucl. Instr. and Meth. B204(2003)71-85
[2] R. Janik et al.,Nucl. Instr. and Meth. A640(2011)54-57
[3] F. Garcia et al.,GSI Scientific Report 2012(2013)173
[4] A. Prochazka et al., GSI Scientific Report 2012(2013)174

* PSP code: 2.4.6.1.3

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