Minutes of WP-meeting 221

<u>Attendance:</u>
DESY: Ties Behnke, Ralf Diener, Ulrich Einhaus, Oleksiy Fedorchuk, Paul Malek, Felix Müller, Volker Prahl, Oliver Schäfer
Fuzebox: Madhu Dixit, Keisuke Fujii, Takahiro Fusayasu, Serguei Ganjour, Katsuma Ikematsu, Jochen Kaminski, Takeshi Matsuda, Rashid Mehdiyev, Amir Shirazi, Ron Settles, Akira Sugiyama, Junping Tian, Jan Timmermans

<u>News from the groups:</u>
Madhu showed a few introductory slides, in which he discussed the principles of time measurement in MPGDs. He first showed the influence of the different electronic components on the signal. Then he explained the development of the signal. The inflexion point of the preamplifier charge pulse would always have the best timing information. The shaper amplifier pulse is obtained from the charge preamplifier pulse after differentiation, undershoot removal (pole zero adjustment), integration and further amplification. If the shaping time is long enough to integrate almost all electrons arriving at the pad, the inflexion point, or possibly the half amplitude point on the rising edge of the shaper amplifier pulse should have the best timing information.
The peak or maximum amplitude point of the amplifier pulse is not as good, since it is dominated by the diffusion fluctuation of the last arriving electrons.

Rashid showed the longitudinal spatial resolution in the Micromegas analysis. He first showed the shape of pulses recorded with different resistive layers. During the test beam a digitization frequency of 40 MHz and a 100 ns shaping time were used. Thus, the rising part of the signal is sampled by about 5-6 time bins, which are available for determining the inflection point. The signal of the central pad of a hit is higher for the CLK resistive layer, since the dispersion is lower than with the black diamond layer. Rashid then showed a comparison between two different inflection point determination numerical and by using a Gaussian fit to the rising part of the signal. He also varied the number of points included, but this did not have any significant influence. However, he observed, that the fitting method gives lower values than the numerical method. He showed the residuals of rows for two different drift distances both for CLK and BD. In general, the residuals look quite Gaussian. Some small tails are visible to systematically one side and this side changes when using a different inflection point determination. Rashid also compared the different methods for the final width determination (RMS90, 3 σ and 5 rms cut) and found that in the case of MM the lowest values are reached with the 3 σ method. Following the presentations other impacts on the longitudinal spatial resolution were discussed. For example it was stated that no-one had studied the impact of electrical field distortions and of inclined tracks, where the signal is elongated not only by diffusion but also by the geometry. The later could exceed significantly the shaping time of the electronics and, thus, have a yet unstudied effect on the resolution. It was observed that the electrical field distortions have a similar effect on the resolution as a θ-inclination, since the signal is spread over a longer arrival time.

Felix reported the status of the GEM analysis, but admitted that the longitudinal spatial resolution hadn't been worked on very intensely because of time constraints. For the GEM data the digitization frequency was 20 MHz and the shaping time 120 ns resulting in 3-4 time bins for the rising part only. While studying the residuals it was observed, that the residuals have a strong tail to one side. This effect increases at short drift distances. This effect degrades the result. While studying the origin of this,

it was observed that signals with lower charge arrive earlier. Therefore, the following study was done: The arrival time of the signal on the central pad of the hit is defined as the time of the hit. Then, Felix determined both the charge and the arrival time of the signals on the neighboring pads and showed the time difference between the hit time and the arrival time on the pad in dependence on the charge collected by this pad. It can be clearly observed that the time difference is smaller for signals with higher charge, unfortunately, there seem to be additional dependencies, which prevents an easy correction of the effect. To estimate the effect he fitted only the left side of the residual distribution where the effect is not observed and by this the longitudinal spatial resolution decreases by more than 100 µm. However, the overall systematic effects remain. For example the characteristic degradation of the spatial resolution with the drift distance is much larger in data with B = 0T than with B = 1 T. This could be explained, if a B = 0 T would lead to an increased number of N_{eff} (~N_{tot}), while for B= 1 T N_{eff} corresponds to the value obtained in the r-ϕ case. A possible explanation for this effect is the higher diffusion coefficient, which results in a lower number of effective electrons collected on the central pad of the hit and thus in a degraded spatial resolution. This effect increases with longer drift distance. To verify this hypothesis a detailed Monte Carlo study would be necessary.
Following the presentation a discussion on the necessity of a detailed Monte Carlo tool. The signal generation and drifting should be done in Garfield++ and. After implementing also the effect of the electronics the signal should be parameterized and made available in MarlinTPC.

Jochen summarized the procedure applied during the analysis of InGrid data. The analysis presented in the WPmtg was done by Robert Menzen in 2013 with the data of the 2013 test beam. Jochen showed, that in principle the timing information is good, as for example the drift velocity is in good agreement with Magboltz calculations. The track fitting is done first with all n hits on the track and the track is refitted with n-1 hits discarding the hit under study. Though this procedure works well in the r-ϕ plane, the residuals in the longitudinal direction show a long tail towards later times. This is because of the time walk effect: Signals with a low gas amplification pass over the threshold of the electronics later and are therefore detected later. The effect can be estimated by fitting only the left side of the residuals with a Gaussian and comparing this to the RMS of the complete distribution. The half-Gaussian fit gives about 2 mm smaller residuals. Additional contributions to the degradation of the longitudinal spatial resolution are the rather large bin sizes of about 25 ns and the strong field distortions between the InGrids. Some of these issues have been addressed in this year's test beam, for example the clock has been increased from 40 to 80 MHz for several runs, and also the field forming electrode has been partially extended into the area between the chips. Other issues can only be solved by using the new Timepix3 chip, which can measure for example both charge and time and thus the timewalk effect can be corrected.

At the end it was suggested to have a look at the ALICE procedure of determining the longitudinal spatial resolution.

AOB:

The next workpackage meeting will take place on June 18th.