Minutes of WP-meeting 153

Attendance:
DESY: David Attie, Stefano Caiazza, Paul Colas, Ralf Diener, Isa Heinze, Leif Jönsson, Nayana Majumdar, Supratik Mukhopachyay, Felix Müller, Jan Timmermans, Wenxin Wang
Webex: Martin Killenberg, Thorsten Krautscheid, Michael Lupberger, Takeshi Matsuda, Dan Peterson, Ron Settles, Jochen Kaminski

PCMAG/LP setup, test beam:
Ralf: PCMAG

- Until yesterday it has been worked on the safety of PCMAG. Tomorrow the safety department will check the setup to see if the safty clearing can be issued.

test beam schedule

- If it does not collide with LCTPC plans, Sascha would like to conduct a testbeam at T24 in the last week of October and the first week of November.

News from the groups:
Felix: - 4 of the new pad planes have been delivered. The fifth one has to be reproduced again. The components will be mounted on the pad plane as soon as possible.
Paul: - 7 modules were delivered and HV-tests have been repeated at DESY to verify that the modules were not damaged during transportation. Of the 7 modules one seems not as stable as the others. Hopefully it improves with some more training. Besides, some O-rings are missing. They have been mailed this morning and are hopefully delivered by tomorrow, so the modules can be installed tomorrow and the LP can be flashed with gas starting from tomorrow evening. The electronics also looks good and there are on average only 2 to 3 channels dead per module. Unfortunately, neither the Indian nor the Canadian could make it to the test beam and David and Paul will need some help from DESY with MarlinTPC to make a quick analysis of the first data and to verify the proper operation of the modules.
Martin gave a presentation on the space charge effects expected in the CLIC-TPC. He has simulated 1 full bunch train of CLIC background. Looking at the distribution of the space charge in r, φ and z very large spikes were observed. The particle-list showed that they were created by hadronic interactions of pions with the gas. Because of the large number of pions in γγ-background, a few of these events can be expected despite the long interaction length. About 10 voxels with very high charge were removed from the data set and for the remaining charge distribution a flat φ-distribution could be assumed. The z and r distribution were approximated by the following fit function: $(p_0 + p_1 z)/(r-p_2)^2$ Similar to the ILC case a very weak z-dependence with charges up to 350 ions/cm³ was observed, but for 50 bunch trains (~1s) a very strong z-dependence with charges up to 10,000 ions/cm³ is expected. Then Martin used the ioneffects-program of Keisuke to calculate the electric field deviations, 'track' the electrons to the endcap and calculate the displacement of the electrons. The electric field distortions for one bunch train are very similar in the case of CLIC and ILC (E_r<1V/cm), which leads to a displacement of about 5µm for single electrons. Because of the higher rate of bunch trains, the field distortions after 1s are much larger (E_r~25 V/cm) for CLIC than for ILC (E_r~2 V/cm). Thus, also the displacement of single electrons is increased to 140 µm. This is quite large, but can still be corrected. Further improvements of the calculation is planned: the effect of local charge spikes will be taken into account, field distortions in E_r and E_z should be calculated and their effect on drift properties (velocity and

diffusion) taken into account.

Michael presented the status of the pixelized readout module. The new readout system based on the Scalable Readout System of RD51 can be operated with one chip and important functions are implemented. Readout rates of up to 60 Hz can be reached. Michael explained that the ultimate goal of placing 115 InGrids on one module may be hard to reach in the first try, that is why Bonn is planning to equip a module with 9 octoboards (→ 72 chips) and a triple GEM stack at the beginning. This should facilitate handling and more naked chips are available currently than InGrids. However, important challenges like cooling, readout, power supply and module design can already be tested. Michael also invited everyone to give some input, in particular on cooling and power supply. He also showed some preliminary ideas on the layout of a modules with different degrees of staggering.

<u>Discussion on data taking at LP test beams:</u>

This discussion was triggered to find a common set of data for each test beam campaign to facilitate the comparison of different readout techniques.

<u>Stefano</u> reported on the experience of the DESY group during their test beam last year. The original test beam plan foresaw first to find the module working point, then do a z-scan with and without magnetic field in 5 cm steps with some finer steps close to the cathode and the anode. Then a x-scan in steps of 5mm across the module with magnetic field was planned to test the homogeneity of the performance across the module, an angular can with and without magnetic field consisting of three different angles at a drift distance of 5 cm and 45 cm and also 3 angles in theta should have been tested. Then a B-field scan by moving the TPC in the B-field was planned to study the influence of the magnetic field distortions. As a final measurement a drift field scan was planned with and without magnetic field at several values of the drift field. This plan consists of about 100 runs. If everything would have gone smooth, every run would have taken 15 minutes to record 20,000 tracks and the complete schedule would have taken about one week. Unfortunately, several problems with the PCMAG and destructive discharges cut the program short and only a few of the planned measurements could be performed. For the next test beam with the improved modules no final plans have been made, but similar plans as for the first test beam have been considered.

In a second part Stefano presented the data processing steps for the first DESY test beam. He showed, that many steps and different software packages were necessary beginning with the data acquisition, conversion into the LCIO format reconstruction with MarlinTPC, event visualization, ROOT tree conversion and final summary plots with ROOT. This chain took about 20 minutes and it is clear that many errors can happen and many informations are stored multiple times. Besides, many features necessary to make the information available to the full collaboration (grid, conditions data base...) have not been used yet. To simplify these procedures Stefano has developed a new set of software tools which handles these tasks. These tools are collected in an test beam analysis library and after beta-tests the library will be made available within MarlinTPC.

<u>Leif</u> gave a short summary of the measurements that are still needed to evaluate the TPC performance both with GEMs and MMs and to compare the results. Data for both modules should be taken with the same electronics and data should be analyzed with the same software (e.g. MarlinTPC). The standard measurements should be the spatial resolution in rφ. But also the longitudinal spatial resolution in dependence on the shaping time should be measured. Also testing the homogeneity of the gas amplification over the module (x-scan) is important. Some further measurements like two track resolution, dE/dx and momentum resolution are currently not possible, but it should be kept in mind, that they should be done at some point at CERN. Leif also started a discussion on the optimization of the pad size for both gas amplification types. But not only performance aspects like spatial resolution

and double track resolution should be taken into account, but also issues like cost and power consumption should be discussed. In the following discussion Ralf pointed out, that the currently preferred pad size of 1×6 mm² for the triple GEMs is the result of an optimization study done at DESY with the midi-TPC, where several pad sizes were compared. Martin reminded everyone, that the results he showed on May 22nd were not final, and the small performance difference of pads and pixels were also based on different fit algorithms: the more advanced Kalmanfitter was used for the pad results and a simpler χ^2-fitter. Dan, finally, summarized a simulation study he had done in 2008 on optimizing the pad size which showed that 2.5 mm wide pads may be enough for the double track resolution. He had studied various pad sizes between 2 mm and 10 mm and had assumed a charge spread of $0.7\times$pad with. The simulation showed that for pad widths larger than 2.5 mm the limiting factor was the track location, that is that the two tracks could not be separated at sufficient pad rows and the tracks were not recognized as separate.

The discussion then focused on the question which measurements are essential during the upcoming series of test beam campaigns. The importance of the different measurements was discussed and it was agreed that a small data set with fixed parameters should be of importance. These are:

1. zscan with and without magnetic field with 5 cm steps and some additional points close at the cathode and anode. The drift field should be 240 V/cm
2. φ-angle scan, 3-4 angles up to 20°, with magnetic field and E_{drift}=240 V/cm, at a relatively short drift distance
3. x scan across the module, closer steps should be chosen at the border and module dependent interesting points (additional frames, HV-connections,...), while wider steps can be done in the middle, with magnetic field and E_{drift}=240 V/cm. For this a wider beam spot should be used to cover at least one complete pad.
4. drift field scan: E_{drift}=130 V/cm (field with lowest diffusion) and E_{drift}=240 V/cm (field with highest drift velocity), with magnetic field

All these measurements should be done with the T2K gas and with a minimum gain possible for the amplification technology. Additional measurements could be:

1. Angular scan without magnetic field
2. θ-scan: several different angles with magnetic field
3. B-field scan: moving the TPC in the magnetic field to study the effect of the magnetic field distortions.
4. Vary shaping times during z-scan
5. test various momentums of the beam
6. Laser dots (once it is made available again)

At the end it was observed, that the B-field map we currently have is obsolete, since the magnet moved in the experimental hall and because of the iron in the walls the magnetic field inside PCMAG has slightly changed. It was also remarked that it would be a good idea to have a permanent magnetic sensor inside PCMAG on a fixed position. This should serve as a reverence and calibration source for the current to magnetic field conversion.

<u>AOB:</u>
The next workpackage meeting will take place on July 19th with a discussion on electrical field.