

A Time Projection Chamber (TPC) is a candidate for the central tracker of the International Linear Collider (ILC) detectors because of its very good performance in past collider experiments. In order to obtain one order-of-magnitude improvement in momentum resolution and the highest possible track-recognition efficiency, the Linear Collider TPC (LCTPC) groups [1] are pursuing R&D to find the best state-of-the-art technology for the TPC. The TPC has to provide 200 space points (pad readout) along a particle track with the $R\phi$ spatial resolution of $100\ \mu\text{m}$ per pad row or better. The momentum resolution of $\delta(1/pt) \leq 0.5 \times 10^{-4}(\text{GeV}/c)^{-1}$ is envisaged in a magnetic field of 3-4 T. To realize this excellent space point resolution, a TPC with Micropattern Gaseous Detector (MPGD) readout instead of the Multiwire Proportional Chamber (MWPC) readout is needed. The MPGD under consideration are Gas Electron Multiplier (GEM) and Micromesh Gas detector (Micromegas) with standard signal pads as well as with CMOS pixel (TimePix) readout. For the Micromegas option it is intended to use the resistive bulk technology. Modules will also be equipped with gating devices in order to reduce the ion back flow into the sensitive volume. These techniques are described elsewhere in this conference.

Several relevant topics towards the ILC detector have been studied at small and medium sized TPC prototypes and will be pursued with a Large Prototype (LP) of a TPC. The LP will have a diameter of about 750 mm and a length of about 600 mm. This prototype will fit into a superconducting magnet (permanent current magnet, PCMAG) that has been installed in a test beam area at DESY in Hamburg. PCMAG will deliver a magnetic field up to 1.25 T. The test beam will consist of electrons with a momentum of up to 6 GeV/c and will allow to measure tracks with the LP of up to 125 space points with pad readout. The aim of these tests is not only to enhance the results obtained with smaller size TPC prototypes to a system on a large scale, but also to understand the issues which become visible when constructing such a large TPC. Part of the LP is a field cage (FC), which is made out of composite materials (Fig.1, right). The materials were chosen such that they guarantee a maximum of stability, though providing a minimum of material for the traversing particles. The homogeneous electrical drift for the ion and electron clouds in the TPC volume will be provided through a series of field strips, which have to be arranged such that the relative distortions of the field are below 10^{-4} within the drift volume. This can be achieved with mirror strips that lie on an intermediate potential. Endplates were designed such that amplification modules can be mounted in a pattern that is a circular subsection of a possible TPC for the ILC. The endplates allow to position the modules to an accuracy of better than $50\ \mu\text{m}$.

Correction techniques for E- and B-field distortions have to be evaluated and the LP in connection with PCMAG offer a good opportunity to test these techniques since PCMAG does not have a return yoke, thus providing a field inhomogeneity. A system using photoelectrons produced at the cathode can be used for verifying and correcting these distortions.

Gas mixtures will be tested according to their performance, e.g. low diffusion, sufficient number of primary electrons and small electron attachment, etc. .

The LP will operate with a large number of channels that will read out the signals on either pads or CMOS pixels. This readout system is based on readout electronics

that was developed for the ALICE experiment at the LHC: ALICE TPC Read Out (ALTRO). Starting with 125 ALTRO chips, which corresponds to 2000 channels, the chip will digitize the TPC signals with a sampling frequency of 40 MHz. The readout system will be extended by 1600 chips with 25 MHz sampling rate. In order to adopt this chip to the specifics of a MPGD based TPC, a new charge sensitive preamplifier has been developed (PCA16). Furthermore, a TPC readout electronics will be tested, where the time of arrival and charge of the signals on the pads are measured with the help of a TDC. The charge is measured indirectly, with the help of a charge-to-time converter. For the Micromegas option the AFTER-based TPC electronics will be used, from T2K which has been successfully commissioned.

In order to have precise external reference points w.r.t. the tracks within a TPC, a set of highly accurate Si-strip modules will be deployed on the surface of the TPC. They will offer a position accuracy of $\sim 15\mu m$ in $R\phi$ as well as along the TPC-axis. A cosmic muon hodoscope will be installed around the TPC in order to cross-check the obtained results with other than the beam particles. Furthermore, a laser system will be implemented which allows to produce well defined tracks in the TPC.

The preparations for the LP setup are ongoing. It is expected to have a fully working system by the end of 2008. This presentation will give an overview about the LP setup (Fig.1, left) and will describe the production and commissioning of the system.

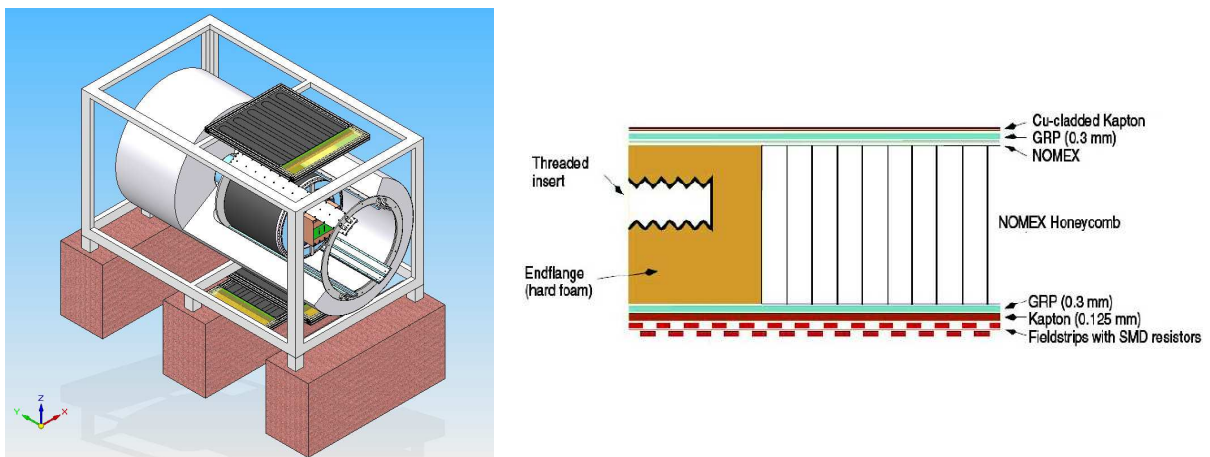


Figure 1: LP setup (left) and FC wall structure (right).

This work is supported by the Commission of the European Communities under the 6th Framework Program “Structuring the European Research Area”, contract number RII3-026126.

References

- [1] TPC R&D for an ILC Detector (Status Report for the WWSOC R&D Tracking Review, Beijing, 6-7 February 2007) LC-DET-2007-005, <http://www-flc.desy.de/lcnotes>