8th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging.

Contribution ID: **147** Type: **contributed paper**

Performance of the EUDET-type beam telescopes

Beam telescopes are vital tools for R&D projects focussing on position sensitive particle detection sensors. These range from collider-specific detectors with high radiation tolerance [1-2], high resolution and low material requirements [3] to medical applications [4], among others. Test beam studies are used at various stages of sensor and read-out chip development and are considered as the "gold standard" of sensor and detector testing. Besides the LHC experiments, many others like Mu3e, Belle-II, BEAST, etc. use a EUDET-type beam telescope to characterise their sensors, covering examples from specific upgrade scenarios to generic sensor R&D.

Summary

Test beam measurements at the test beam facilities of DESY have been conducted to characterise the performance of the EUDET-type beam telescopes originally developed within the EUDET project. The beam telescopes are equipped with six sensor planes using MIMOSA26 monolithic active pixel devices. A programmable Trigger Logic Unit provides trigger logic and time stamp information on particle passage. Both data acquisition framework and offline reconstruction software packages are available. User devices are easily integrable into the data acquisition framework via predefined interfaces.

In this talk, the biased residual distribution is studied as a function of the beam energy, plane spacing and sensor threshold.
Iterative track fits using the formalism of General Broken Lines are performed to estimate the intrinsic resolution of the individual pixel planes. The mean intrinsic resolution over the six sensors used is found to be (3.24 ± 0.09)
$upmu$
$meter$. With a 5\,GeV electron/positron beam, the track resolution halfway between the two inner pixel planes using an equidistant plane spacing of 20\,mm is calculated to be (1.83 ± 0.03)
$upmu$
$meter$. Towards lower beam energies the track resolution deteriorates due to increasing multiple scattering.

Sensor threshold studies show an optimal working point of the MIMOSA26 sensors at a sensor threshold of between five and six times their RMS noise.
Measurements at different plane spacings are used to calibrate the amount of multiple scattering in the material traversed and allow for corrections to the predicted angular scattering for electron beams.

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