Presentation for Fellesseminar by Kristine Indahl Helle

3D

Content:

About 3D:

- Differences between 3D and traditional planar sensors
- Advantages of 3D sensors

Why 3D:

- For Atlas upgrade

Testbeam:

- 2008 testbeam-setup

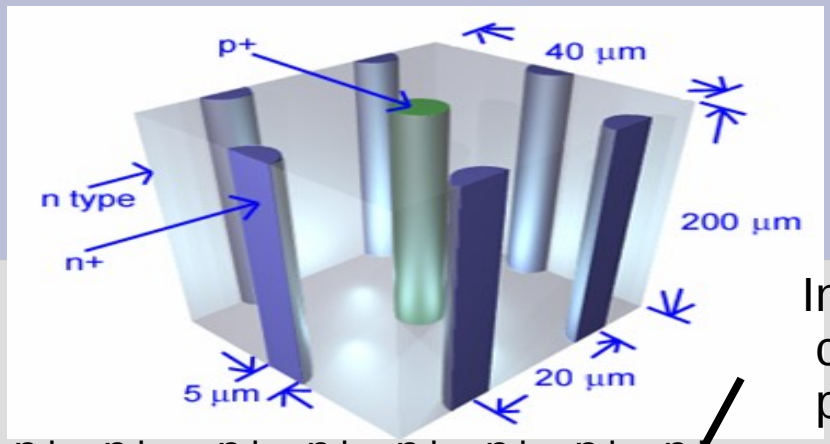
2008 testbeam analysis

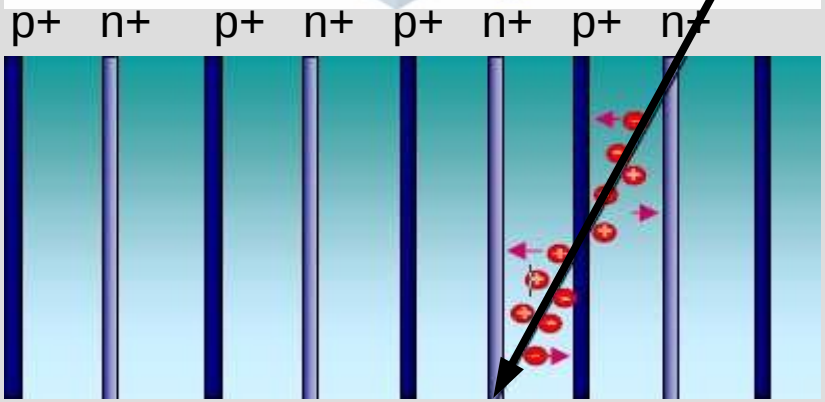
- ToT
- Efficiencys
- active edge studies

2009 testbeam

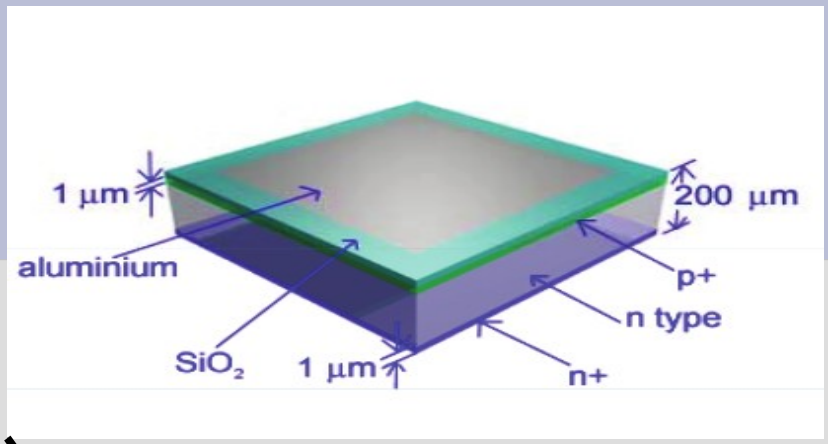
3D-setup at detector-lab in Bergen

3D : The electrodes are fabricated inside the silicon bulk

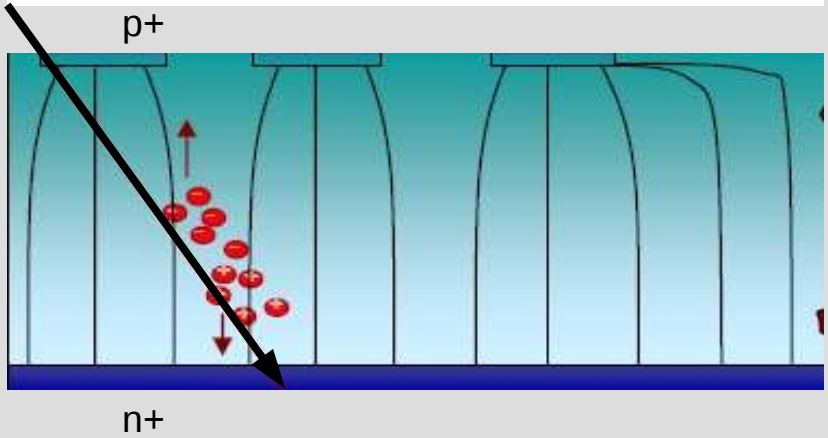




Planar: Electrodes implanted on wafer surfaces



Incoming charged particle



Short inter-electrode distance

➔ Faster signal (a few ns time-resolution)

➔ Radiation hard (Smaller trapping probability after irradiation)

Larger collection area of 3D electrodes than planar implanted electrodes:

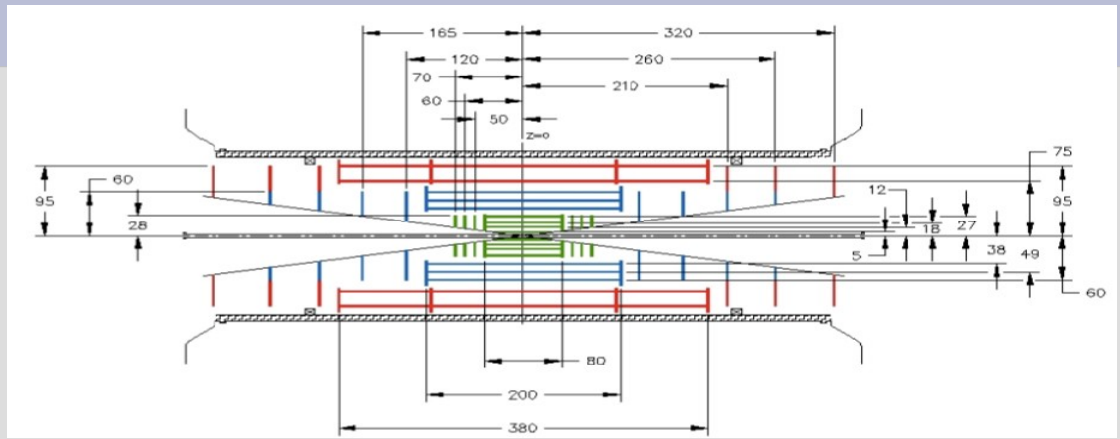
➔ Low depletion voltage (electric field higher for any given maximum applied field)

Active edge (Sensors surrounded by an “active edge”-electrode)

➔ Less dead area (a few um)

Why 3D:

Atlas upgrade:



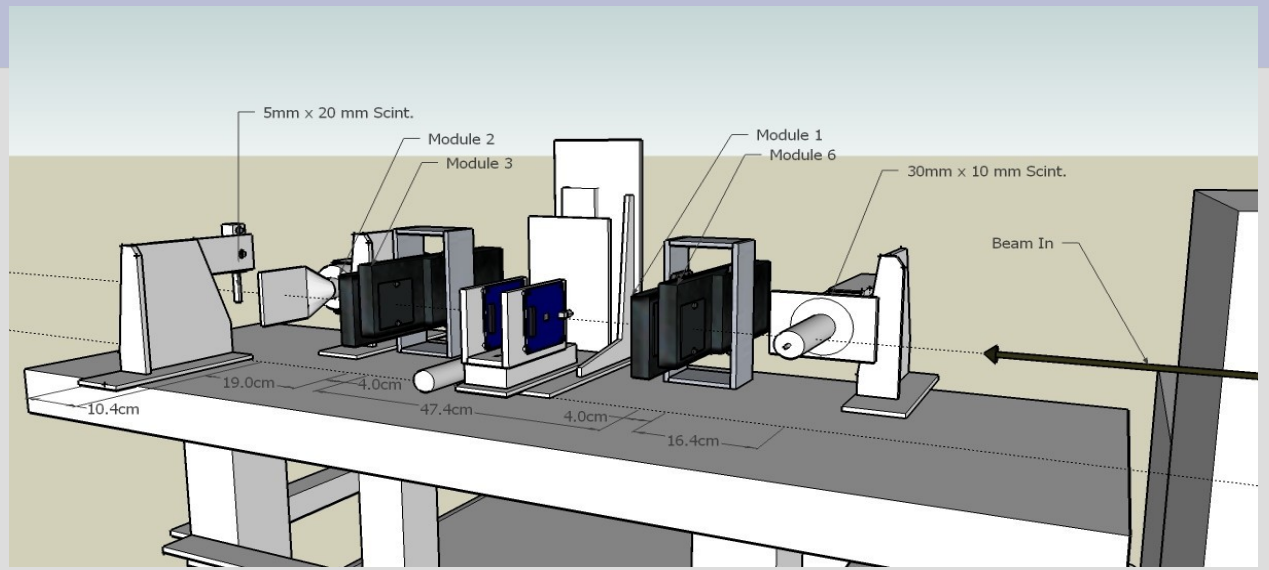
New Inner Detector layout for the ATLAS upgrade :9 layers of silicon detectors, 4 pixel layers (~5 m2), 3 layers of short strips (~60 m2) and 2 layers of long strips (~100 m2).

- Radiation hardness a key requirement for the innermost tracker detectors at forward LHC experiments
- Role of reconstructing vertices of very short lived particles demands high efficiency
- Needs to be replaced when preformance is significantly degraded.
- LHC upgade in 2017 to a new peak luminosity of 10^{35} $cm^{-2}s^{-1}$ (At this point several detectors will need replacement)
- The B-layer however might need replacement already in 2013 as it is situated only~4cm from interactionpoint

Medical applications:

- Medical imaging

Testbeam-setup 2008:



180 GeV/s pi+/- beam passes through setup.

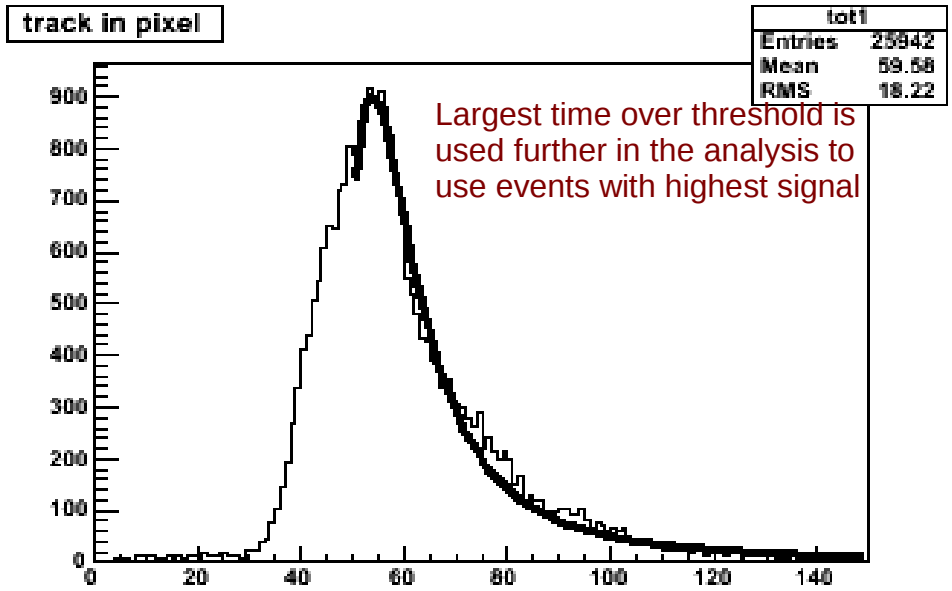
When scintillators in front and back of sensors are hit, readout of detectors are triggered.

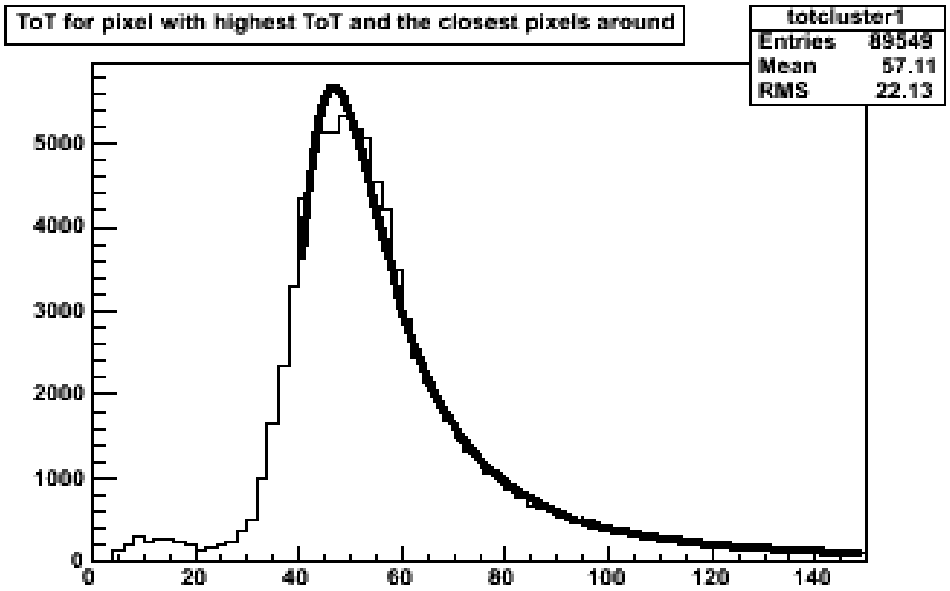
When a particle pass through several pixel layers in a row, track is constructed.

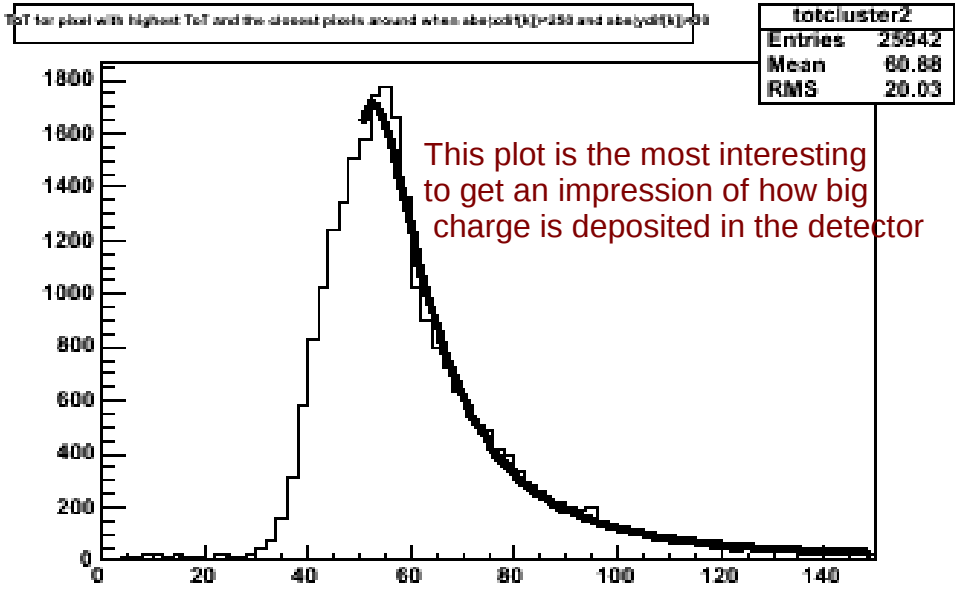
In addition a very well calibrated beam telescope gives “real tracks”

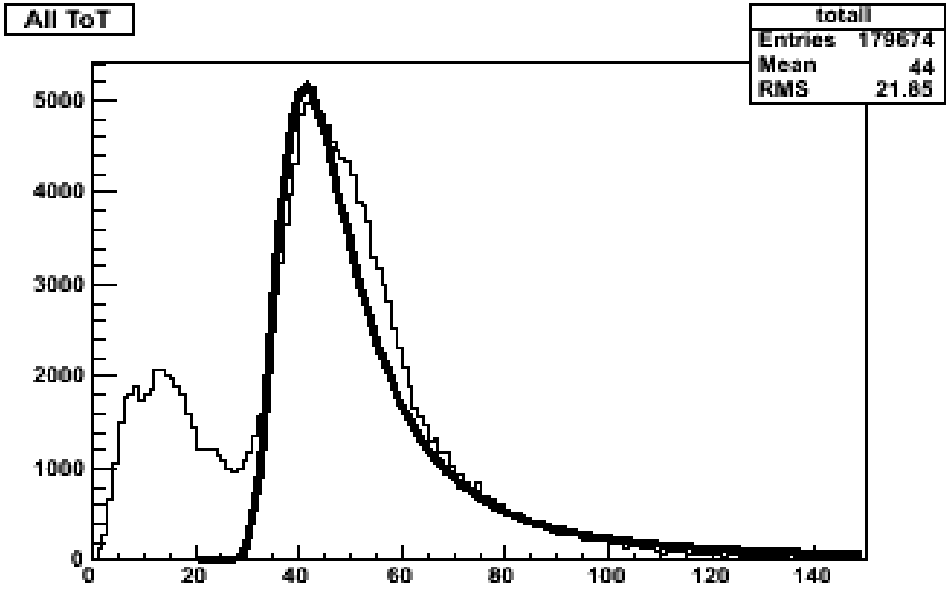
In the analysis we have compared the reconstructed and the real tracks

Time over threshold plots:

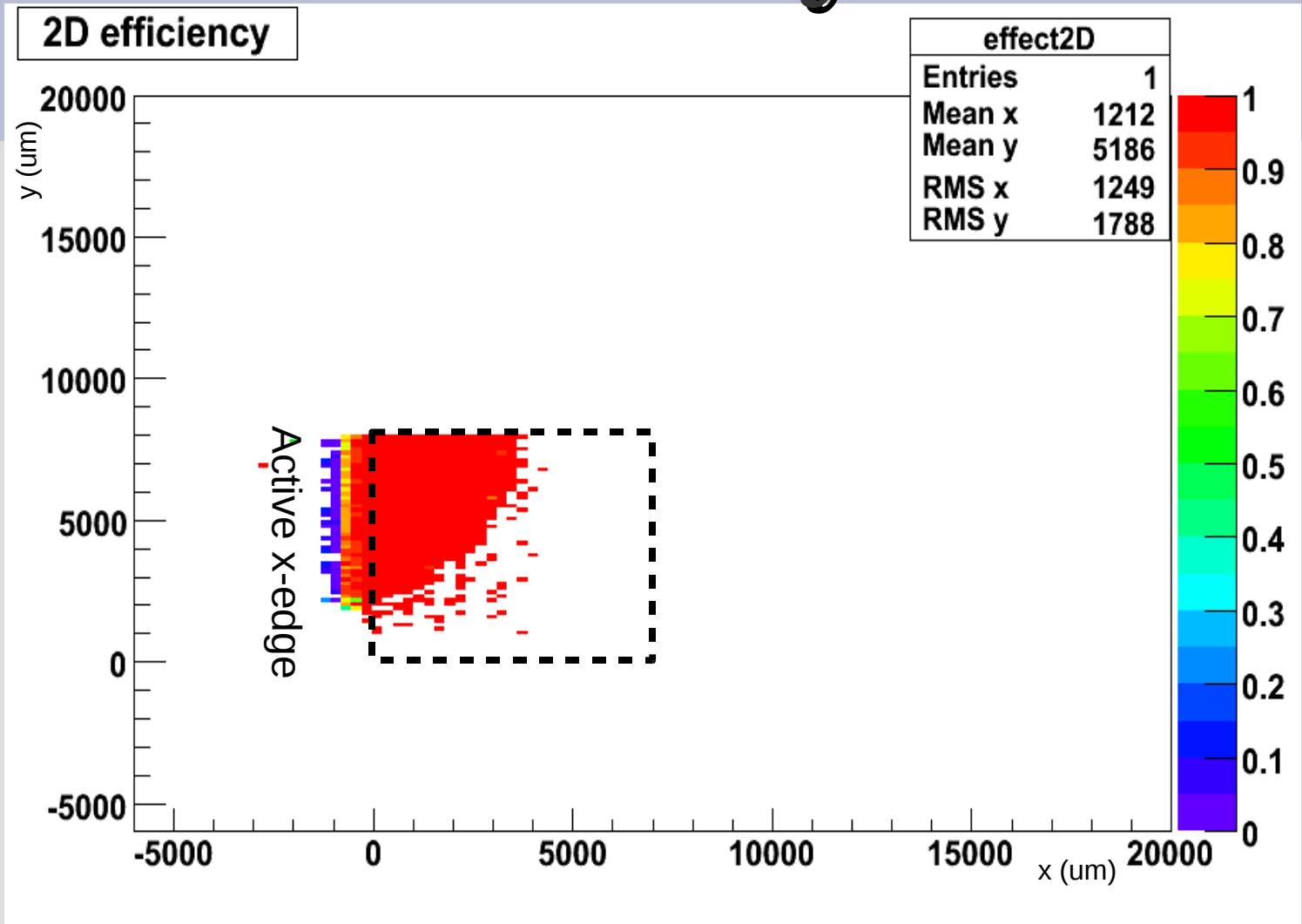








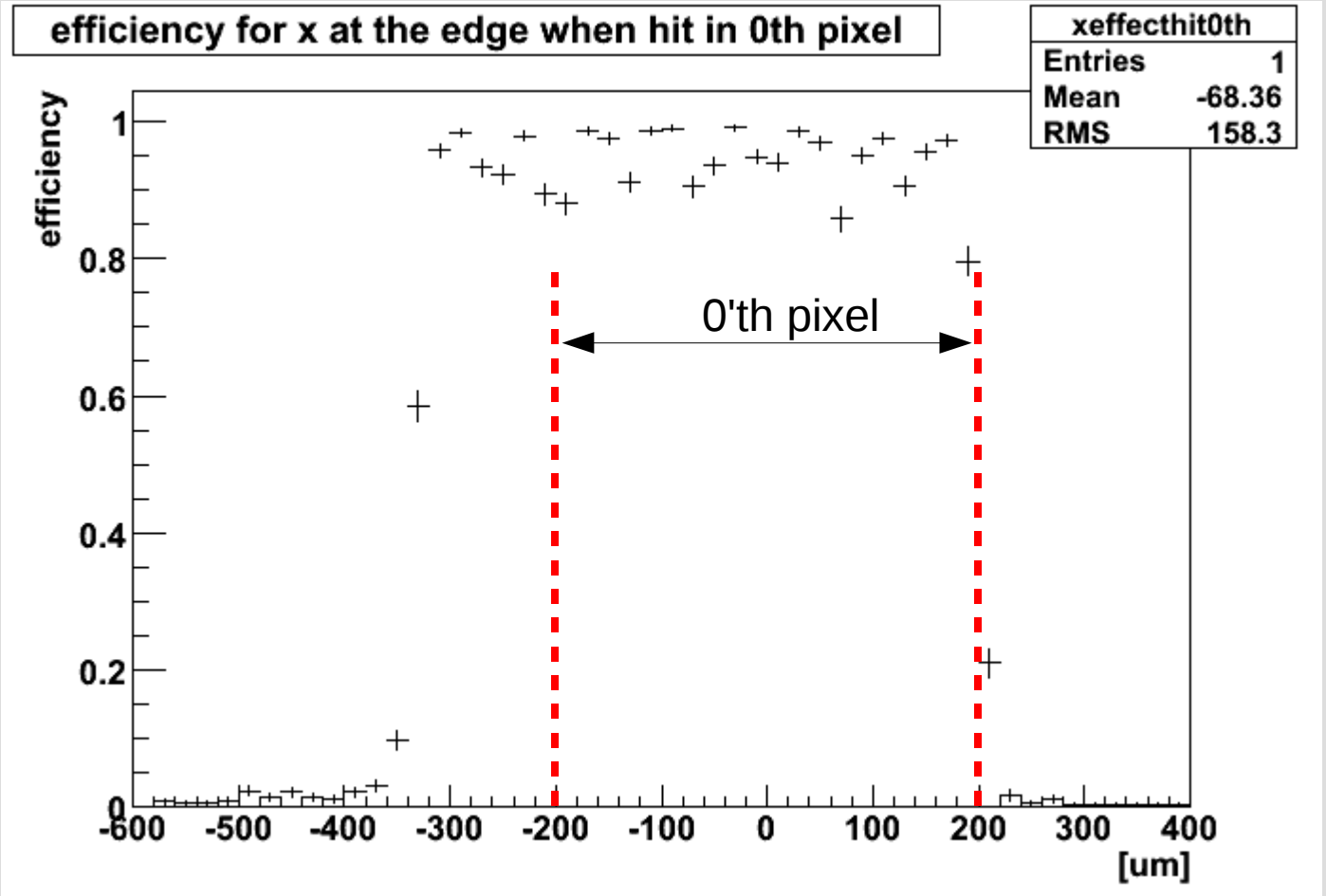
Efficiency



2D efficiency plot shows tracks with registered hits divided on number of real tracks passing

The beam is centered at the detectors edge to study the active edge.
The detector stretches from 0 to 7200um in x direction and from 0 to 8000um in y direction.

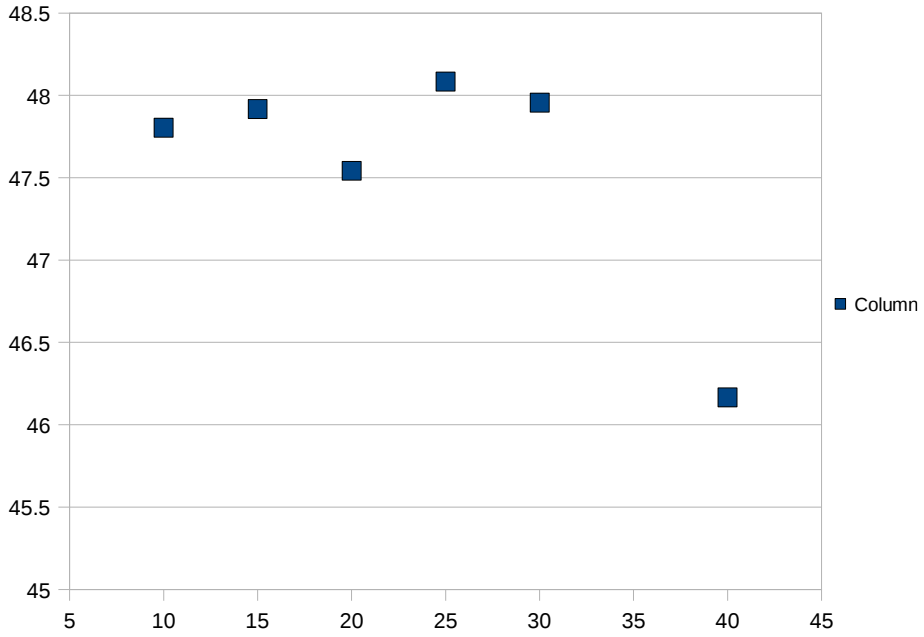
Active edge:



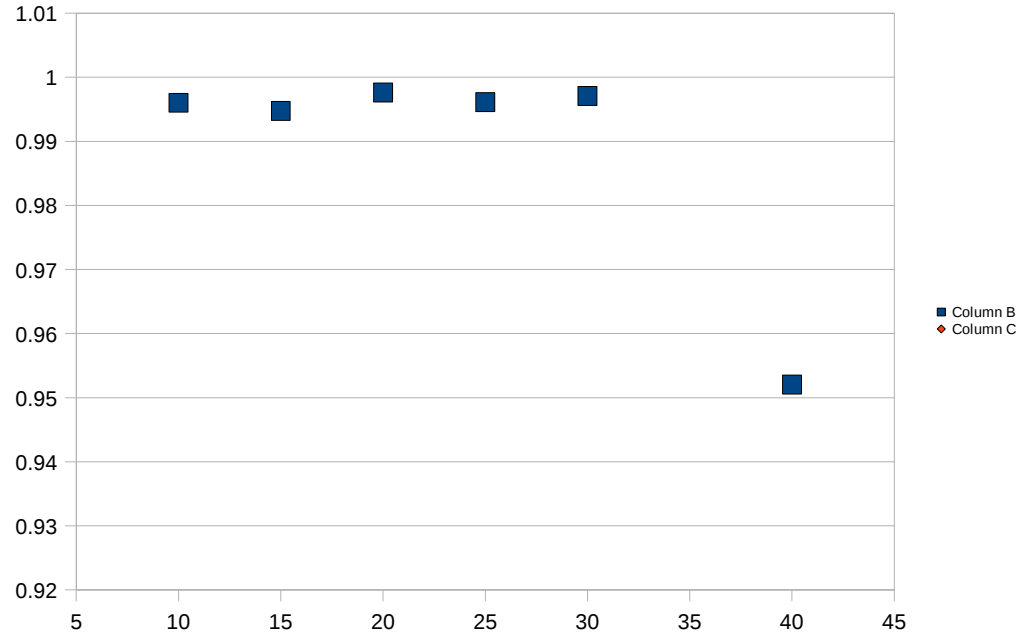
Efficiency when 0^{th} pixel has a registered hit

One can see high efficiency also outside the detector edge at -200um

ClusterToT as a function of bias voltage:



Efficiency as a function of bias voltage:

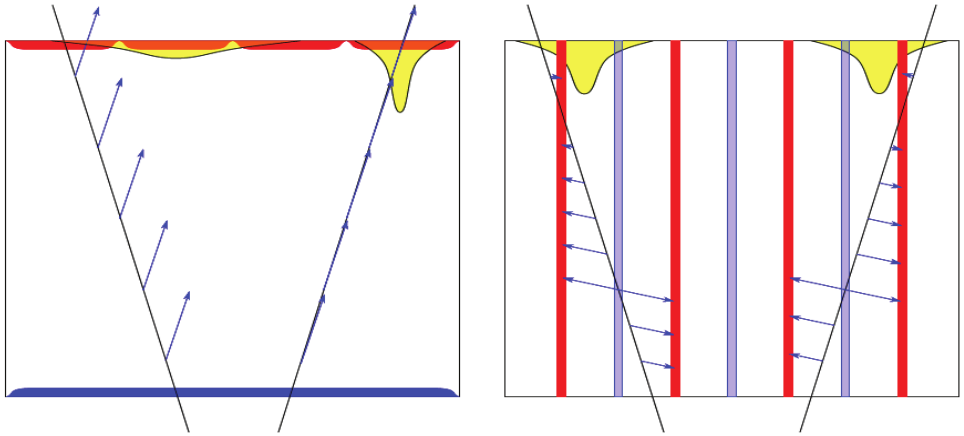


The drop one can see at 40Vmight be a pre-stage to detector break-down at 50V

2009 Testbeam

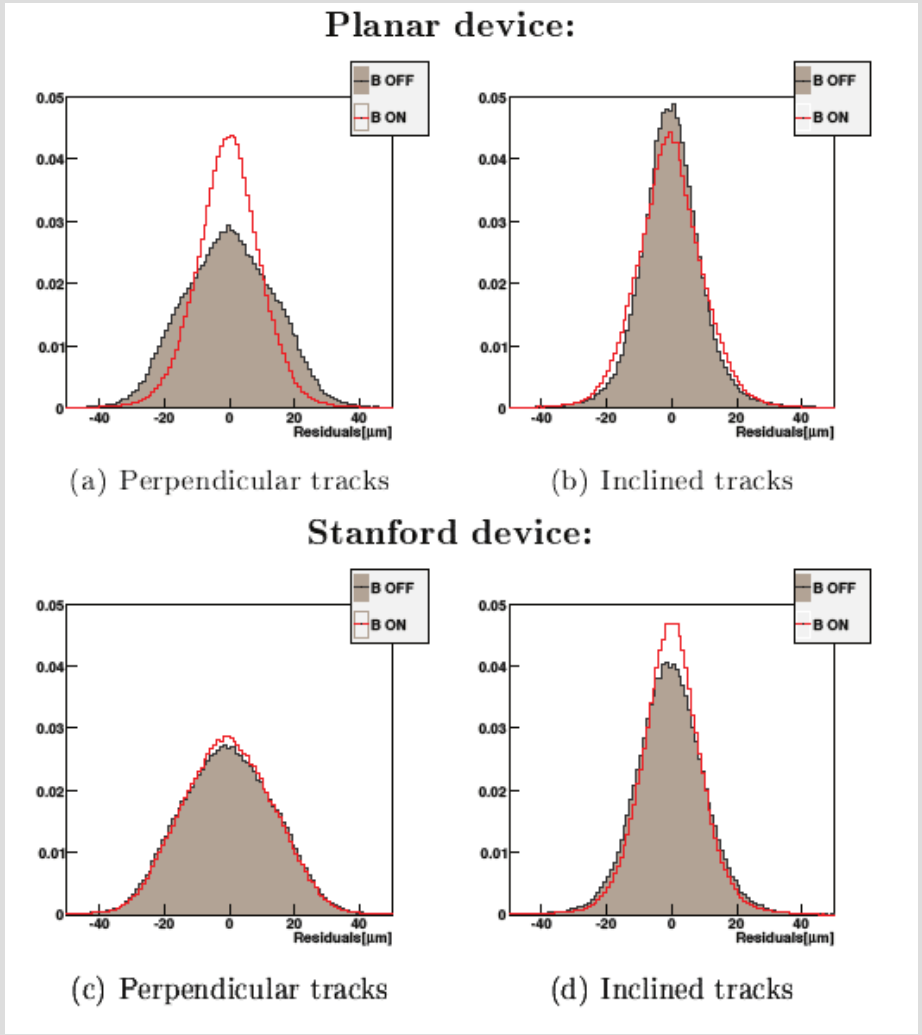
Main goal to test the detectors in a magnetic field (1.4T) at various angles

The charge collection in a magnetic field:



Planar: Effect can be focusing and de-focusing

3D: only very small effect



3D setup in detector -lab