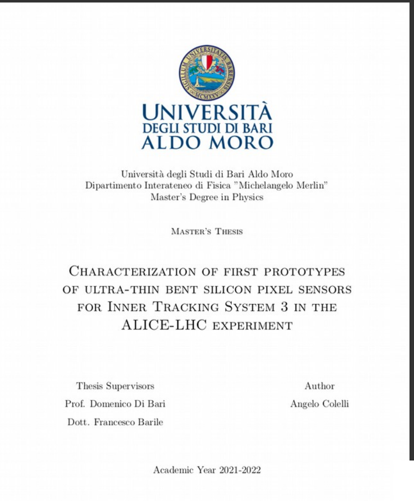
Status & Plan

- Update the OPAMP Bari code after merge request
- Ongoing: test beam with APTS-OPAMP
- Angelo defended his master's thesis in physics
  - *Characterization of first prototypes of ultra-thin bent silicon pixel sensors for Inner Tracking System 3 in the ALICE-LHC experiment*



UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

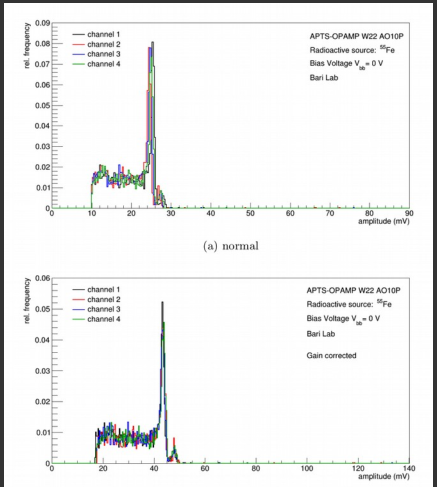
Università degli Studi di Bari Aldo Moro
Dipartimento Interateneo di Fisica "Michelangelo Merlin"
Master's Degree in Physics

MASTER'S THESIS

CHARACTERIZATION OF FIRST PROTOTYPES OF ULTRA-THIN BENT SILICON PIXEL SENSORS FOR INNER TRACKING SYSTEM 3 IN THE ALICE-LHC EXPERIMENT

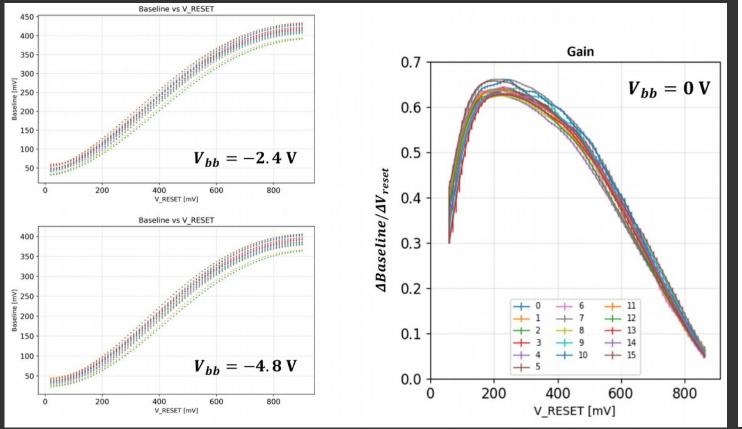
Thesis Supervisors	Author
Prof. Domenico Di Bari	Angelo Colelli
Dott. Francesco Barile	

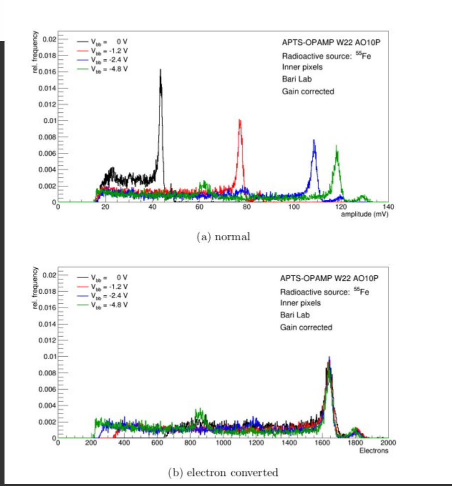
Academic Year 2021-2022



(a) normal

- Plan:
  - Irradiated chips (from CERN)
  - Fe-55 analysis
  - Training sessions in lab



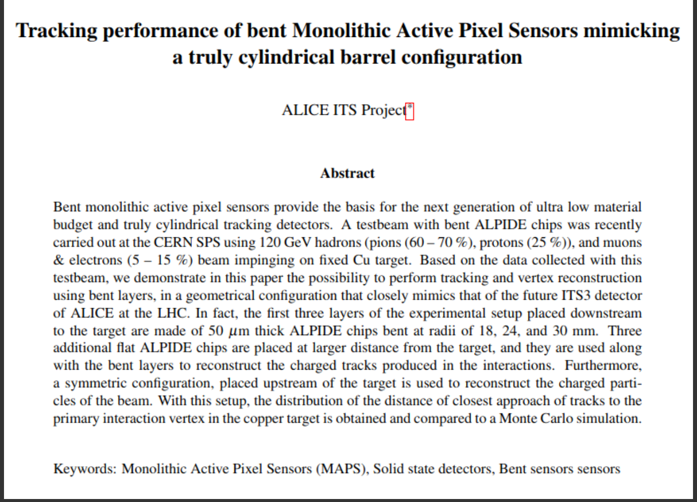


(a) normal

(b) electron converted

Draft

- Version 0 → ~ 10 days more to have the first complete version
  - First part (alignment + Corryvreckan) → some details to be added
  - Shyam updated the analyisis details and results for the DCA
- Currently: 12 pages



Tracking performance of bent Monolithic Active Pixel Sensors mimicking a truly cylindrical barrel configuration

ALICE ITS Project[*]

Abstract

Bent monolithic active pixel sensors provide the basis for the next generation of ultra low material budget and truly cylindrical tracking detectors. A testbeam with bent ALPIDE chips was recently carried out at the CERN SPS using 120 GeV hadrons (pions (60 – 70 %), protons (25 %)), and muons & electrons (5 – 15 %) beam impinging on fixed Cu target. Based on the data collected with this testbeam, we demonstrate in this paper the possibility to perform tracking and vertex reconstruction using bent layers, in a geometrical configuration that closely mimics that of the future ITS3 detector of ALICE at the LHC. In fact, the first three layers of the experimental setup placed downstream to the target are made of 50 μm thick ALPIDE chips bent at radii of 18, 24, and 30 mm. Three additional flat ALPIDE chips are placed at larger distance from the target, and they are used along with the bent layers to reconstruct the charged tracks produced in the interactions. Furthermore, a symmetric configuration, placed upstream of the target is used to reconstruct the charged particles of the beam. With this setup, the distribution of the distance of closest approach of tracks to the primary interaction vertex in the copper target is obtained and compared to a Monte Carlo simulation.

Keywords: Monolithic Active Pixel Sensors (MAPS), Solid state detectors, Bent sensors sensors

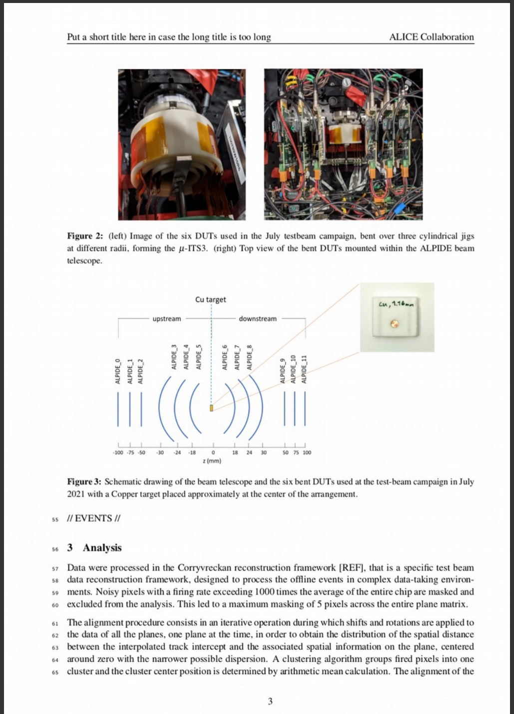


Figure 2: (left) Image of the six DUTs used in the July testbeam campaign, bent over three cylindrical jigs at different radii, forming the μ-ITS3. (right) Top view of the bent DUTs mounted within the ALPIDE beam telescope.

Figure 3: Schematic drawing of the beam telescope and the six bent DUTs used at the test-beam campaign in July 2021 with a Copper target placed approximately at the center of the arrangement.

// EVENTS //

3 Analysis

Data were processed in the Corryvreckan reconstruction framework [REF], that is a specific test beam data reconstruction framework, designed to process the offline events in complex data-taking environments. Noisy pixels with a firing rate exceeding 1000 times the average of the entire chip are masked and excluded from the analysis. This led to a maximum masking of 5 pixels across the entire plane matrix.

The alignment procedure consists in an iterative operation during which shifts and rotations are applied to the data of all the planes, one plane at the time, in order to obtain the distribution of the spatial distance between the interpolated track intercept and the associated spatial information on the plane, centered around zero with the narrower possible dispersion. A clustering algorithm groups fired pixels into one cluster and the cluster center position is determined by arithmetic mean calculation. The alignment of the

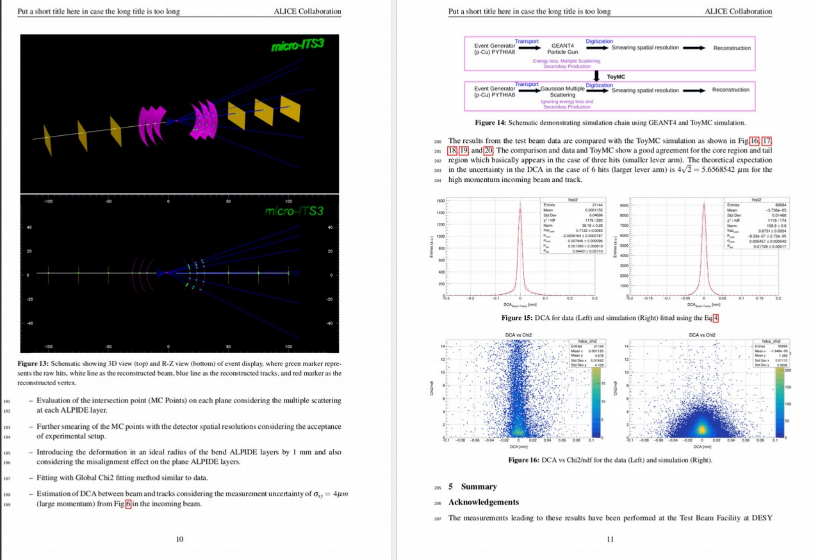


Figure 13: Schematic showing 3D view (top) and R-Z view (bottom) of event display, where green marker represents the raw hits, white line as the reconstructed beam, blue line as the reconstructed tracks, and red marker as the reconstructed vertex.

- Evaluation of the intersection point (MC Points) on each plane considering the multiple scattering at each ALPIDE layer.
- Further smearing of the MC points with the detector spatial resolutions considering the acceptance of experimental setup.
- Introducing the deformation in an ideal radius of the bend ALPIDE layers by 1 mm and also considering the misalignment effect on the plane ALPIDE layers.
- Fitting with Global Chi2 fitting method similar to data.
- Estimation of DCA between beam and tracks considering the measurement uncertainty of $\sigma_{xy} = 4\mu m$ (large momentum) from Fig 6 in the incoming beam.

Figure 14: Schematic demonstrating simulation chain using GEANT4 and ToyMC simulation.

The results from the test beam data are compared with the ToyMC simulation as shown in Fig 16, 17, 18, 19, and 20. The comparison and data and ToyMC show a good agreement for the core region and tail region which basically appears in the case of three hits (smaller lever arm). The theoretical expectation in the uncertainty in the DCA in the case of 6 hits (larger lever arm) is $4\sqrt{2} = 5.6568542$ μm for the high momentum incoming beam and track.

Figure 15: DCA for data (Left) and simulation (Right) fitted using the Eq 4.

Figure 16: DCA vs Chi2/ndf for the data (Left) and simulation (Right).

5 Summary

Acknowledgements

The measurements leading to these results have been performed at the Test Beam Facility at DESY