Demonstration of tracking capabilities of bent Monolithic Active Pixel Sensors mimicking a truly cylindrical barrel configuration

ALICE ITS Project*

Abstract

Bent monolithic active pixel sensors constitute the foundation for the next generation of ultra-low material budget and truly cylindrical tracking detectors. A testbeam featuring bent ALPIDE chips with a thickness of 50 µm was carried out at the CERN SPS where a mixed-particle beam of 120 GeV momentum impinged on a fixed copper target, placed at the exact center of the experimental setup.

Based on the data collected during this testbeam, we demonstrate in this paper the feasibility of tracking and vertex reconstruction using bent layers. The geometrical configuration closely emulates the future ITS3 detector of ALICE at the LHC, particularly the first three layers situated downstream of the target, which are bent at radii of 18, 24 and 30 mm. Three additional flat ALPIDE chips are placed farther from the target and they are used in conjunction with the bent layers to reconstruct the trajectories of charged particles produced in the interactions. Furthermore, a mirrored configuration of sensors, placed upstream of the target, is used to reconstruct the charged particles from the incoming beam.
With this setup, the distribution of the distance of closest approach of the reconstructed tracks following the interaction with the Cu target to the incoming beam is extracted and compared with the Monte Carlo simulation, showing a good agreement.

Keywords:
tracking sy

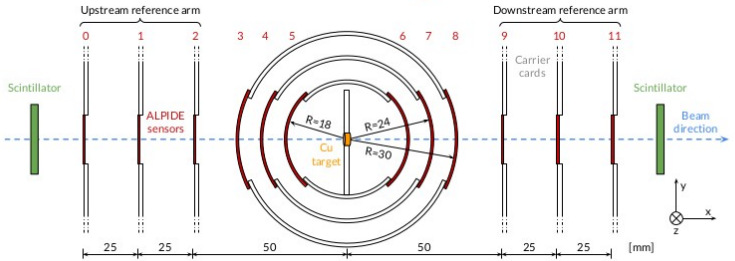

Figure 1: Schematic drawing of the experimental setup (not to scale). The telescope consists of an upstream and downstream reference arm, comprised of flat ALPIDE sensors, as well as stacked cylindrical 3D-printed jigs on which bent ALPIDE sensors are placed. In the very middle of the setup, a copper target is placed to induce hadronic interactions.

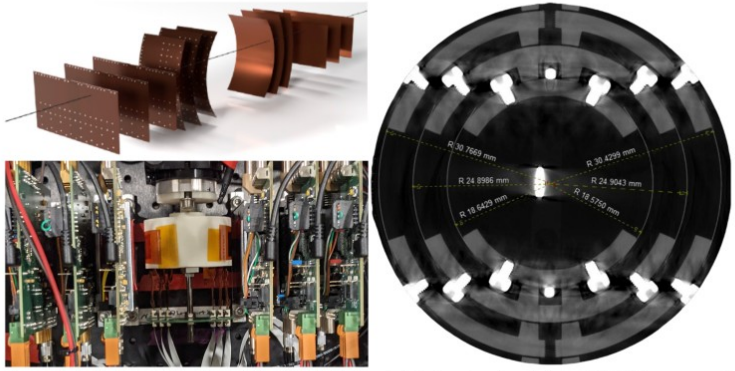

Figure 2: Artistic representation of the ALPIDEs (top right), showing that the bent ALPIDEs are rotated by 90° with respect to the reference planes. Top view (bottom right) image of the μ-ITS3 jig containing the bent sensors, alongside the reference planes and associated readout electronics. CT scan (right) of the μ-ITS3. The copper target and fixing screws are clearly visible. The six bent ALPIDEs can be distinguished, alongside radius fits using the dedicated scanner software.

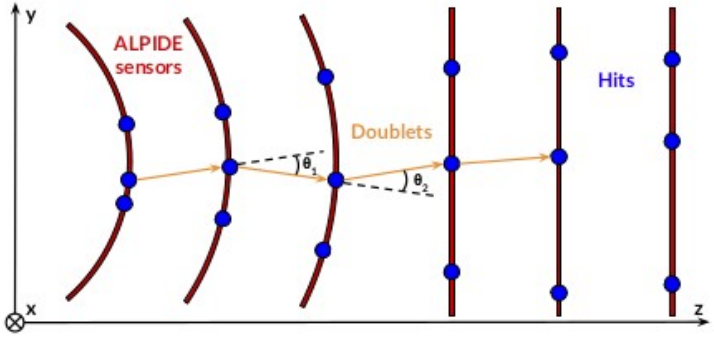

Figure 3: 2D schematic view of track finding algorithm logic, highlighting the consecutive doublets matching procedure, which is described in the text.