Commissioning and Performance of the New ALICE Inner Tracking System in the First Phase of LHC Run 3

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ALICE is one of the four experiments at the CERN Large Hadron Collider (LHC) specifically designed to study nuclear matter at extreme conditions of temperature and pressure. The LHC Run 3 started officially in July 2022 with proton-proton (pp) collisions at a centre-of-mass energy $\sqrt{s} = 13.6$ TeV after a shutdown of more than two years to allow for the upgrade of both the accelerator and the experiments. To fulfill the requirements of the ALICE physics program for Run 3, new timing, tracking and multiplicity detectors have been installed in the ALICE central barrel both at mid- and forward rapidities, the readout electronics of the majority of the detectors has been upgraded and the ALICE Offline and Online computing farm has been completely renewed. A key detector of the apparatus is the new, ultra-light, high-resolution Inner Tracking System (ITS2) that significantly enhances the resolution on the determination of the distance of closest approach to the primary vertex, the tracking efficiency at low transverse momenta, and the read-out rate capabilities with respect to what was achieved in the LHC Run 2 with the older tracker. The new tracker consists of seven layers, azimuthally segmented into Staves, equipped with silicon Monolithic Active Pixel Sensors with a pixel size of $27 \times 29 \ \mu m^2$ covering a sensitive area of about $10 \ m^2$. A long effort allowed the construction, characterization, installation and commissioning of the ITS2 before starting Run 3. The in-pixel discriminator threshold calibration represents a challenging procedure due to the hage number of channels and it is carried out by exploiting the power of the ALICE Offline and Online farm. The detector took data for the full 2022 and its first performance results represent the second key part of this article.

KEYWORDS: LHC, ALICE, tracker, track, cluster, pixel, silicon, run, calibration, detector, alignment

1. The upgraded Inner Tracking System

To fullfil the requiments of the Run 3 physics program of the CERN Large Hadron Collider (LHC), the Inner Tracking System (ITS) of the ALICE experiment has been upgraded with seven cylindrical and concentric layers of silicon Monolithic Active Pixel Sensors (MAPS) called ALPIDE covering a total active area of about 10 m² [1]. The detector is divided into three Inner Layers (IL), two Middle Layers (ML) and two Outer Layers (OL) as shown in Fig. 1. The four outermost layers constitute the Outer Barrel (OB) while the three innermost layers form the Inner Barrel (IB). The main features of the upgraded ITS (simply called ITS2 in the following) compared to the ones of the older detector (called ITS1) are summarised in Table I.

The sensor, produced by TowerJazz in the 0.18 μ m CMOS imaging process technology, features a pixel size of $\sim 27 \times 29 \,\mu$ m² with a total of 512 \times 1024 pixels. The main characteristics of ALPIDE are:

- a n-well diode about 100 times smaller than the pixel size, leading to a small capacitance of few fF;
- (2) a fast data driven encoder [2];

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Table of Contents First Run Three New Plays By New Writers First Run

- 1. Understanding the eBook First Run Three New Plays By New Writers First Run
 - The Rise of Digital Reading First Run Three New Plays By New Writers First Run
 - Advantages of eBooks Over Traditional Books
- 2. Identifying First Run Three New Plays By New Writers First Run
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an First Run Three New Plays By New Writers First Run
 - User-Friendly Interface
- 4. Exploring eBook Recommendations from First Run Three New Plays By New Writers First Run

- Personalized Recommendations
- First Run Three New Plays By New Writers First Run User Reviews and Ratings
- First Run Three New Plays By New Writers First Run and Bestseller Lists
- 5. Accessing First Run Three New Plays By New Writers First Run Free and Paid eBooks
 - First Run Three New Plays By New Writers First Run Public Domain eBooks
 - First Run Three New Plays By New Writers First Run eBook Subscription Services
 - First Run Three New Plays By New Writers First Run Budget-Friendly Options
- 6. Navigating First Run Three New Plays By New Writers First Run eBook Formats
 - o ePub, PDF, MOBI, and More
 - First Run Three New Plays By New Writers First Run Compatibility with Devices
 - First Run Three New Plays By New Writers First Run Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of First Run Three New Plays By New Writers First Run
 - o Highlighting and Note-Taking First Run Three New Plays By New Writers First Run
 - Interactive Elements First Run Three New Plays By New Writers First Run
- 8. Staying Engaged with First Run Three New Plays By New Writers First Run
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers First Run Three New Plays By New Writers First Run
- 9. Balancing eBooks and Physical Books First Run Three New Plays By New Writers First Run
 - Benefits of a Digital Library
 - o Creating a Diverse Reading Collection First Run Three New Plays By New Writers First Run
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine First Run Three New Plays By New Writers First Run
 - Setting Reading Goals First Run Three New Plays By New Writers First Run
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of First Run Three New Plays By New Writers First Run

- Fact-Checking eBook Content of First Run Three New Plays By New Writers First Run
- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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