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The upgrade of the ALICE Inner Tracking System

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Summary. — The upgrade of the Inner Tracking System represents an important part in the overall upgrade strategy of ALICE, which will be implemented during the second long shutdown of the LHC scheduled in 2018-19. In this contribution, a brief overview of the upgraded ITS is presented.

PACS 29.40.Gx – Tracking and position-sensitive detectors.
PACS 29.40.Wk – Solid-state detectors.

1. – Introduction

ALICE (A Large Ion Collider Experiment) is an experiment at the CERN LHC, optimized to study the physics of strongly interacting matter at unprecedented energy densities using heavy ion collisions [1]. The ALICE collaboration has devised a comprehensive upgrade strategy [2, 3] to enhance the capabilities of the experiment and to fully exploit the scientific potential of the LHC with heavy ions after the second long shutdown (2018-19). In this strategy, the upgrade of the Inner Tracking System (ITS) represents an important part. The upgraded ITS will provide highly improved vertexing and tracking capabilities in the central rapidity region to perform new measurements for a detailed characterisation of the Quark Gluon Plasma (QGP) with focus on the production of heavy-flavour, low-mass dileptons and thermal photons. The present ITS, consisting of six layers of silicon detectors (two layers each of Silicon Pixel Detectors, Silicon Drift Detectors and double-sided Silicon Strip Detectors), will be completely replaced by a new ITS along with a narrower beam pipe.

2. – Detector layout, specifications and expected performance

The design goal of the new ITS is the improvement of the impact parameter resolution by a factor of 3 or more below $p_{\mathrm{T}} = 1\,\mathrm{GeV}/c$ with respect to the present ITS, the standalone tracking capability (particularly at $p_{\mathrm{T}} < 1\,\mathrm{GeV}/c$) and the readout rate up to 50 kHz Pb-Pb interactions. The new ITS will consist of seven concentric cylindrical layers (left panel of fig. 1) of Monolithic Active Pixel Sensors manufactured using TowerJazz 0.18 μm technology [4]. The three innermost layers constitute the Inner Barrel (IB) and the four outermost layers constitute the Outer Barrel (OB).

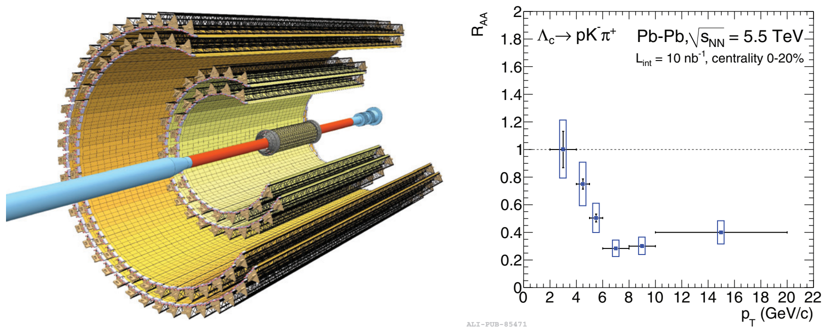

Fig. 1. – The left panel shows the layout of the upgraded ITS consisting of seven concentric cylindrical layers. The right panel shows the Λ_c R_{AA} as a function of p_T in central Pb-Pb collisions (0–20%) for $L_{int} = 10\,\mathrm{nb}^{-1}$.

The upgraded ITS will provide a pseudo-rapidity coverage of $|\eta| < 1.22$ and a radial coverage of 22 mm–430 mm. A material budget of 0.3% (0.8%) of the radiation length for the IB (OB) and a spatial resolution of $5\,\mu$m in both $r - \phi$ and z directions for all the layers is targeted. The pixel chip requirements are mainly: low power density (< 100 mW cm), low integration time ($< 30\,\mu$s), low fake hit rate ($< 10^{-5}$ per pixel and event) and sufficient radiation hardness (the reference values including a safety factor of 10 are a Total Ionisation Dose of 700 krad and a fluence of 10^{13} 1 MeV $\mathrm{n_{eq}cm^{-2}}$ of Non Ionising Energy Loss). The pixel cell size will be of the order of $30\,\mu$m with a silicon thickness of $50\,\mu$m. A dedicated R&D programme is ongoing to design and characterise these pixels. Several prototypes, including full scale ones, have been designed to validate the different parts of the pixel chip [5].

Physics performance studies were carried out for heavy flavour, low-mass dielectrons and hypernuclei using specific benchmark channels [5]. The right panel of fig. 1, for example, shows the expected performance for the measurement of the nuclear modification factor R_{AA} for Λ_c baryons (in the decay channel $\Lambda_c \rightarrow \mathrm{pK}^-\pi^+$) as a function of p_T, for central Pb-Pb collisions (0–20%) at $\sqrt{s_{NN}} = 5.5$ TeV with an integrated luminosity $L_{int} = 10\,\mathrm{nb}^{-1}$, which is not accessible with the current ALICE setup. The detailed physics reach for various observables with the upgraded ITS can be found in [5].

The upgraded ITS will be installed in the ALICE cavern in 2019, in order to be able to collect physics data in 2020 with LHC providing high luminosity Pb-Pb collisions.

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