Characterisation of the first large-scale prototypes for the new ALICE ITS3 Upgrade

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It is of utmost importance in experimental physics to perform very precise measurements, in order to be able to accept or reject the theoretical predictions. In high-energy physics, such measurements are conducted in specially designed detectors, that are located all around the world. The biggest complex of such detectors is the European Organization for Nuclear Research, known as CERN, which includes the largest particle accelerator in the world, the so-called Large Hadron Collider (LHC).

At the LHC, several experiments are conducted, and one out of the four major experiments is A Large Ion Collider Experiment (ALICE), which primarily studies collisions between heavy nuclei. The ALICE experiment consists of several different detectors, where each one of them has a specific role. One of them is the Inner Tracking System (ITS), whose primary role is to reconstruct the tracks of particles produced after the collisions in the LHC. This master thesis project focuses on the ITS detector.

At regular intervals, LHC is shutdown for 2-3 years in order to perform maintenance on the detectors or install new upgraded detectors. In the next such long shutdown, a new ITS is planned to be installed, the so-called ITS3, that will change the three innermost tracking layers by using the ground-breaking technology of bent silicon pixel detectors.

The ITS3 detector, in addition to the bending of the silicon, uses the technology of stitching, where all the electrical parameters of the detector are interconnected, thus reducing the need for mechanical support. Since this technology was used for the first time in High-Energy Physics, this thesis focuses on the characterization of the first large-scale prototypes of the new ITS3 detector, with a view to understand their functionality.

During the thesis work, tests were conducted on the prototypes under beam conditions at the CERN facility, where the detection efficiency and spatial resolution were determined, after the appropriate analysis. Different number of pixels and different sizes of pixel pitches, as well as different layouts in the circuits were used in the prototypes, so as to find the most effective design for the new detector. The prototypes were also irradiated, to test their performance in the course of time, at levels similar to the irradiation in the ALICE detector in the future.

All studies conducted on these prototypes, are going to be used for the design of the final ITS3 detector, for the purpose of improving ALICE track reconstruction precision in the future.