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Upgrading the ATLAS ITK detector for the HL-LHC era

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The High-Luminosity Large Hadron Collider (HL-LHC) is the upgrade of the existing Large Hadron Collider (LHC) located at CERN in Switzerland. Its primary objective is to enhance the potential for scientific discoveries by substantially increasing the integrated luminosity. Specifically, the HL-LHC aims to deliver approximately five times the nominal instantaneous luminosity of the LHC, accompanied by luminosity leveling. This boost in luminosity will yield an order of magnitude more data, though at the cost of approximately 200 inelastic proton-proton collisions per beam crossing on average. The physics phase is currently scheduled to start in 2029.

The high luminosity of the HL-LHC opens up exciting opportunities for a wide range of new physics measurements. However, it also poses significant challenges for the detector and the trigger and data acquisition systems. These challenges manifest as increased trigger rates, higher detector occupancy, and the need for enhanced radiation hardness. The ATLAS detector, a critical detector of the LHC experiments, must operate seamlessly throughout the entire LHC Phase II program, accumulating an integrated luminosity of 4000 fbˆ−1 over a decade.

To fully exploit the enhanced physics potential offered by the HL-LHC, the ATLAS experiment is undergoing substantial upgrades to its internal detectors. Notably, the ATLAS Inner Tracker (ITk) will be completely redesigned. The new ITk will rely exclusively on silicon-based technology and must withstand the extreme radiation environment near the HL-LHC interaction point. It will consist of several layers of pixel and microstrip sensors, carefully engineered to maintain radiation lengths at or below the levels of the current system.

The Instituto de Física Corpuscular (IFIC) plays a pivotal role in the ATLAS ITk upgrade. IFIC focuses on the design and construction of the endcap region of the silicon microstrip tracker within the ITk. Our activities span from initial design to endcap commissioning, including the fabrication of critical components such as silicon microstrip sensors, modules, local support structures (petals), service modules, and distribution systems (power, cooling, control signals, and data). Additionally, IFIC contributes to endcap support structures, design and optimization of cooling lines, conducts system tests, and will ensures a successful commissioning. Given these responsibilities, IFIC's group plays a critical role in advancing the ITk upgrade within the ATLAS collaboration, given our responsibilities and the commitments in so many aspects of the detector.

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