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Uncovering the quark-gluon plasma: scientific and technological challenges

The semiconductor technology that fueled the rapid growth of the information technology industry in the past 50 years, also plays a key role in the remarkable development of detectors for High-Energy Physics (HEP) experiments. The amazing evolution of CMOS transistors in terms of speed, integration, and cost decrease, allowed a continuous increase of density, complexity and performance of sensors, front-end and readout circuits for HEP. This enabled the development of detectors that can measure the properties of hundreds of millions of particles generated every second in high-energy collisions of proton and heavy-nuclei beams at the CERN Large Hadron Collider. The advent of 2D and 3D pixel sensors paved the way to a new generation of detectors, which allow to measure the trajectory and velocity of particles with a precision of micrometers and picoseconds respectively, and to resolve very complex patterns of collision events with tens of thousands of particles generated simultaneously. After a brief overview of CMOS sensors and their most recent developments and applications in HEP, I will discuss their use in the ALICE experiment and their key role to study the quark-gluon plasma, the state of primordial matter that is thought to have existed in the first instants of the Universe.