Particle tracking and radiation field characterization with Timepix3 in ATLAS

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The ATLAS experiment at the LHC features a unique and complex radiation environment (neutrons, minimum ionizing particles, gammas, electrons), affecting detector operation and performance. These mixed radiation fields and their detrimental effects are predicted using Monte Carlo simulations during the design phase of the experiment and its upgrades. Once the experiment has started, it is important to benchmark simulations with measurements.

In addition to standard types of radiation monitors, a network of Timepix and Timepix3 detectors was installed in ATLAS to characterize the radiation field between 2015 and 2018. Each detector allows the discrimination of different particle types and their contribution to the measured total ionizing dose (TID). This is done by analysis of the pixel clusters left by interactions in silicon sensors. It is also possible to measure the incident angles and stopping power of MIPs. Timepix3 offers the possibility to distinguish radiation field particles present during and in-between bunch crossings.

Measurement of radiation levels in ATLAS during and after collision periods

Timepix3 allows continuous measurement of the particle flux rate. Each pixel has a 1.56 ns timestamping precision.

Synchronization with orbit clock and bunch crossing ID

Distribution of directions of incoming particles was projected

Stopping power was calculated

The timestamping precision of Timepix3 allows the analysis of radiation field components during and in-between LHC bunch crossings.

The Timepix3 chip allows the measurement of MIP directions and dE/dX (with a single sensor layer). Data-driven readout and simultaneous ToA and ToT information of Timepix3 will improve the capabilities of particle discrimination.

Timepix3 is considered for ATLAS-Run3 operation.

References