Abstract

The ATLAS Transition Radiation Tracker (TRT) is an integral subsystem for precision tracking at ATLAS. In addition, transition radiation signatures allow for particle identification capabilities. Monitoring the performance of the TRT helps establish the necessary foundation for understanding higher level tracking reconstruction and particle identification. We present our current studies on how the TRT is performing, in particular as the number of interactions per bunch crossing increases.

The ATLAS Inner Detector

Recent run conditions provide increased challenges for tracking in the inner detector. As instantaneous luminosity increases, the number of interactions per bunch-crossing ($\langle \mu \rangle$) will also increase, leading to increased detector occupancy. ($\mu$) is a measure of both in-time and out-of-time pileup, and depends proportionally on the instantaneous luminosity. For example, in 2011 data, ($\mu$) = 22 corresponds to $L \approx 6 \times 10^{33}$ cm$^{-2}$s$^{-1}$.

Performance at High Pileup

Studies in high pileup conditions indicate that tracking becomes inherently more difficult when detector occupancy reaches high levels; position residuals increase and the number of precision hits decreases with increasing ($\mu$). Despite high pileup conditions, the TRT is continuing to perform well in tracking and electron identification, indicated by the extension fraction and high threshold fraction remaining relatively flat.

TRT Overview

The TRT is the outermost component of the inner detector, consisting of a barrel and two end-cap partitions. Immersed in a 2T magnetic field, it provides tracking and particle identification coverage out to $|\eta| < 2.0$.

- 4mm-diameter Kapton straws filled with Xe/CO$_2$/O$_2$ gas provide tracking coverage. As charged particles pass through the straws, they ionize the gas and electrons collect on the wires at the straw center.
- The space between straws is filled with radiator material, the surfaces of which provide interfaces of different indices of refraction which can lead to the emission of transition radiation as a particle traverses these interfaces. This in turn is used for particle identification (see below).

Signal Digitization

TRT tracking information is read out in 24 time bins of 2.12 ns using a low threshold (LT) of 300 eV. In addition, electron identification information is read out in 3 time bins of 25 ns using a high threshold (HT) of 6 keV.

Electron Identification

The probability of emitting transition radiation depends on a particle’s relativistic gamma factor. We use the fraction of hits with a HT bit to discriminate between high $\gamma$ and low $\gamma$ particles, providing an effective means of distinguishing electrons from heavier particles like pions.