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Studies of the Assembled CMS Tracker

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During the latter months of 2006 and the first half of 2007, the CMS
Tracker was assembled and operated at the Tracker Integration Facility in Building 186 at CERN. During this time, several dedicated studies were carried out to validate the performance of the tracker after assembly, testing general noise performance, potential interference between subdetectors, and performance at high acquisition rates. We report on the the results of these studies and their consequences for operation of the Tracker at the experiment.

Summary

The CMS collaboration has designed and constructed a completely silicon-based tracking system for the initial running period of the Large Hadron Collider. This tracker by any measure is much larger than any tracker built previously, which required meticulous attention to detail during the design and construction process. As a result, the detector "as built" performance is more than adequate to produce the data quality required for success at the LHC. Building a good detector is a necessary but not sufficient condition to guarantee performance in operation, and silicon detectors have been known to exhibit unforseen operational problems after construction, which are not amenable to repair due to the lack of accessibility. To guard against this possibility, the Tracker group made a large effort to test as much of the functionality of the tracker as possible during operations at the Tracker Integration Facility (TIF) before installation at the experiment.

The first tests at the TIF were functionality tests of the each of the components after integration. These tests showed the high level of quality in terms of noise and bad channels established during construction persists after integration. However, the TIF also afforded a first look at the assembled tracker system. First, the final power supply components allowed the study of different grounding schemes. This is crucial for the Outer Barrel of the Tracker (TOB), which is susceptible to noise pickup on particular modules from a coupling of the power distribution to the front end electronics. The noise profiles for the TOB were studied as a function of different grounding schemes, producing an optimal final configuration for the experiment. Also, at the TIF for the first time one could run the Tracker Inner Barrel (TIB), TOB, and Endcaps (TEC) simultaneously, to assess any potential interference between one subdetector and another. These studies found no evidence of crosstalk between the different subdetectors.

The TIF also provided the opportunity to test at high readout rates expected during operations. To accomplish this, a small slice of the CMS Event Builder system was constructed, and data was taken at rates up to 100 kHz. These studies uncovered a source of increased occupancy not visible at low rate. The source was traced to the pickup in the APV front end electronics chip due to the interplay between simultaneous readout and acquisition for specific timing separations sampled at rates above 20 kHz. The signature of the effect is a simultaneous anticorrelated excursion from the pedestal for channel 0 and 127, where one goes low and the other high, resulting in a fake cluster similar to a MIP signal for the channel which swings high. The effect occurs in all APV chips and therefore all subdetectors simultaneously, but is localized to the edge channels, and the scale varies from chip to chip due to geometry. Thus, for particular timing intervals between two aquisitions the event occupancy is increased dramatically, which impairs downstream pattern recognition. Potential solutions for this problem are under development.

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