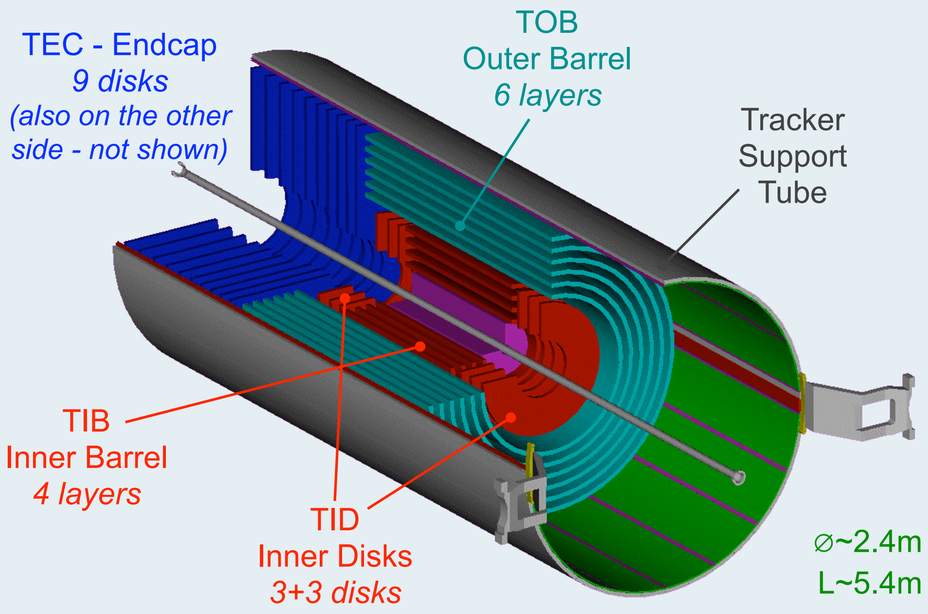
Frontier Detectors for Frontier Physics • 11th Pisa Meeting on advanced detectors • May 24 - 30, 2009 • La Biodola, Isola d'Elba, Italy

CMS Silicon Strip Tracker Operation in Cosmic Run at Four Tesla

Vitaliano Ciulli on behalf of the CMS Silicon Strip Tracker Collaboration



A sketch of the CMS Silicon Strip Tracker and its subsystems.

The world largest Si-strip detector

• 5.5 m long and 2.4 m in diameter • instrumented by ~15000 silicon strip modules • 200m^2 of Silicon active area • 9 million channels with full optical analog readout • LHC radiation resistant (operated at -10^{o}C).

Cosmic Run at Four Tesla

First operation of the full tracker detector together with the rest of CMS took place in **fall 2008** during a test with cosmic muon. Cosmic rays were detected in the muon chambers and used to trigger the readout of all CMS sub-detectors. The superconducting solenoid provided **3.8 T magnetic field**. As a preparation towards successfull operation of the tracker in LHC collisions, all aspects of the reconstruction were studied using these data, corresponding to about **6 millions reconstructed muons**, and compared to Monte Carlo simulations.

COMMISSIONING

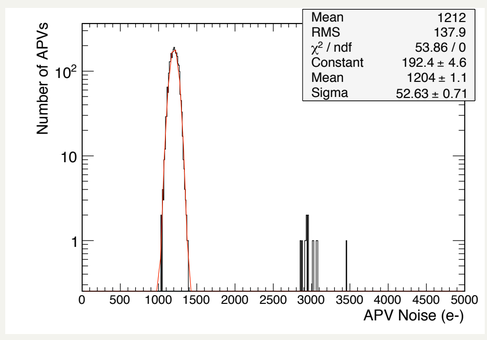
Among all 15148 tracker modules about 98% were fully configured and read-out.

DAQ Partition	Modules read-out	Fraction (%)
TIB/TID	3422	96.7
TOB	5106	98.1
TEC+	3144	98.3
TEC-	3175	99.2

NOISE STUDIES

The strip noise depends on the input capacitance and therefore on the strip length plus a costant term due to the pitch adapter and the bare APV noise:

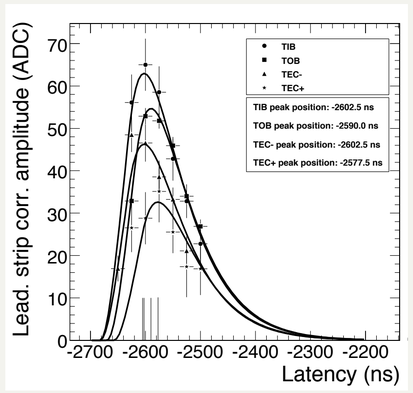
$$N(e^-) = (427 \pm 39) + (38.7 \pm 3) \times L(cm)$$



Noise measurement for all APVs of TOB r-phi Layer 3 modules. The module with no bias voltage applied have a larger noise.

SYNCHRONIZATION

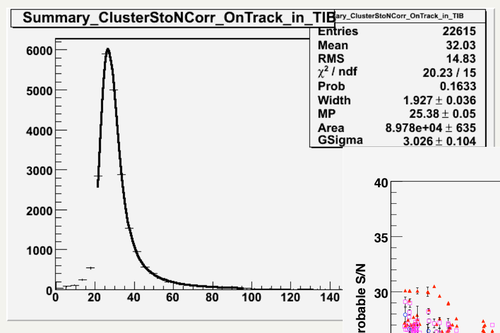
The timing alignment to the level 1 trigger of CMS was measured with a scan of the full delay range of the APV.



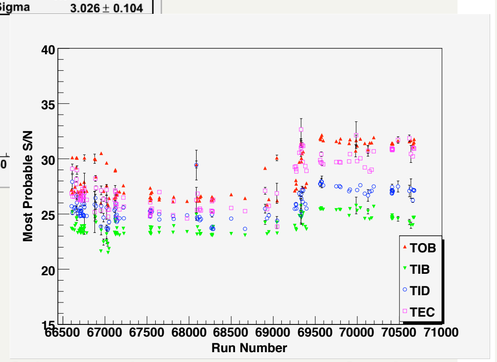
Highest strip signal latency scan results. The four partitions are fitted separately but the overall timing is adjusted to TOB.

SIGNAL TO NOISE RATIO

The charge of reconstructed clusters, normalized to the path-length for perpendicularly incident tracks, is divided by single strip noise.



S/N distribution in the Inner Barrel

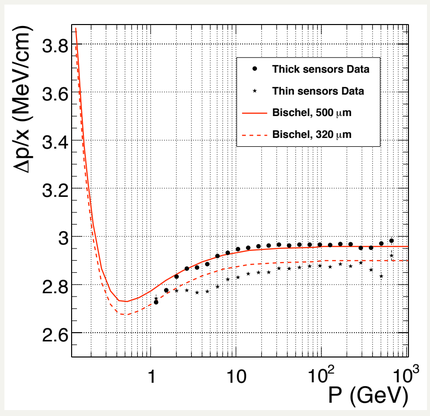


Signal-to-noise trend during CRAFT. .

In the first period part of the tracker was not perfectly synchronized, thus a lower signal was observed.

ENERGY LOSS

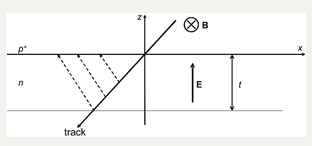
In thin silicon sensors it is decribed by Laundau-Vavilov-Bichsel function. A fit of energy loss vs momentum yields the ratio e-/ADC.

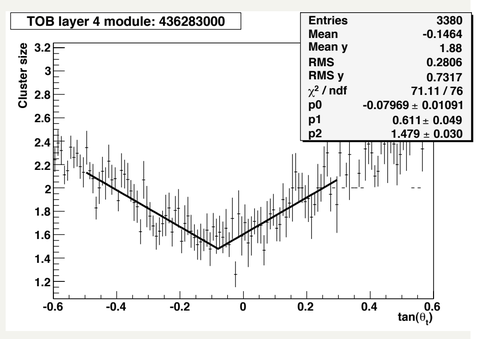


Subdetector	e$^-$/ADC
TIB	$262.3^{+2.5}_{-3.5}$
TOB	$261.5^{+0.5}_{-1.5}$
TEC+ thin	272.5^{+7}_{-9}
TEC+ thick	269.8^{+7}_{-9}
TEC- thin	263.9^{+3}_{-4}
TEC- thick	260.9^{+3}_{-4}

LORENTZ ANGLE

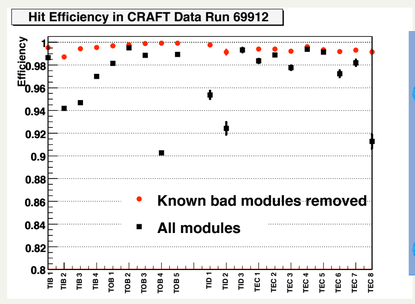
The distribution of the cluster width vs the track incident angle on the sensor it is used to measure the lorentz angle of charge carriers (holes)

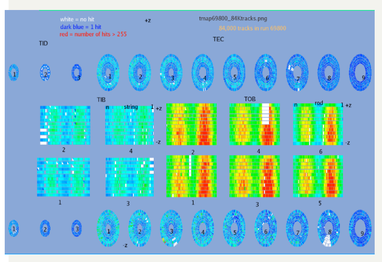




HIT EFFICIENCY

The probability to find an hit where expected from track extrapolation is found to be above 99%.

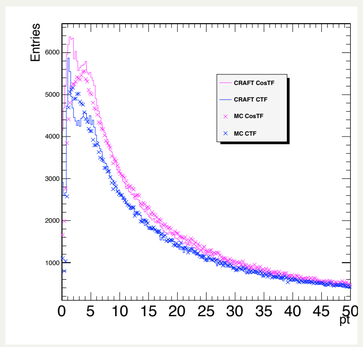


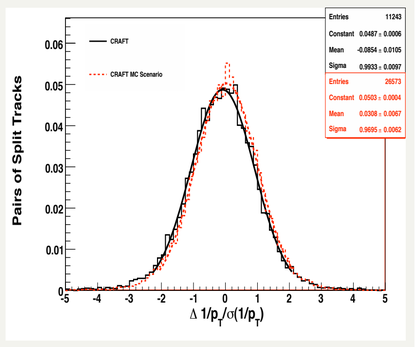


The hit efficiency including or excluding modules known to be problematic (left). These modules are clearly visible as white spots (no hit) in the 2D tracker map (right)

TRACK RECONSTRUCTION

Tracks are reconstructed with two different algorithms: CTF is the standard one with slightly modified seeding while CosTF is developed for cosmic ray.





Distribution of track transverse momentum for CTF and CosTF in real and Monte Carlo simulated data (left). The distribution of the pull on the transverse momentum as measured by CTF (right). The resolution is obtained splitting the muon in two tracks and comparing the reconstructed parameters.

CONCLUSIONS

In fall 2008 the whole silicon strip tracker was fully commissioned and operated together with the rest of CMS. Performances were studied using about 6 millions reconstructed muons, showing the readiness of the tracker for the LHC start-up

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