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Operational Experience with the CDF Run II Silicon detector

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The CDF Silicon Vertex detector consists of three subdetectors: SVX-II, ISL and L00. Altogether it consists of 8 layers of Silicon with more than 750000 readout channels. This detector is essential for CDF's high precision tracking and is vital for the forward tracking capabilities and the identification of heavy flavor decays. After four years of data taking in Run-II and a delivered luminosity of almost 1 fb-1 a summary of the operational experiences with a silicon detector at CDF is given.
Besides being very important for the tracking, the Silicon detector also plays a vital role in Level 2 decision of the CDF Trigger system. Results from off-line reconstruction showing the detector resolution and tracking efficiency are presented as well. Finally aspects of the longevity of this Detector and the impact on the CDF physics program are presented.

Summary

The Run-II Upgrade of the Tevatron increased the center-of-mass energy from 1.8 to 1.96 TeV as well as the luminosity. The goal for Run-II is now around 8 fb-1. To take advantage of this, a larger Silicon detector was designed. The SVX-II increases the coverage of the interaction region by a factor of two and adds the capability of having 3D hits. It consists of six bulkheads, each one consists of 12 wedges. Each wedge consists of 5 layers of double-sided silicon. To increase the impact parameter resolution, the L00 was added. It is mounted on the beam pipe inside of the SVX-II. It consist of radiation hard single sided silicon and has 48 ladders altogether. The ISL extends coverage in eta and adds additional tracking points as a link between SVX-II tracks and the Central Outer Tracker. The ISL consists 296 double-sided ladders arranged in three barrels, the two forward barrels having two layers, the central barrel having only one.

The readout chips and the DAQ are common for all detectors. The central component of the readout is the radiation hard 128 channel SVX3D chip. It consists of an analog frontend with a 46 capacitor cell deep pipeline which samples the data every 132 ns and a digital backend containing ADCs. The clear separation of the two parts allows the deadtimeless operation of the chip. Five ladders are connected to one Portcard, which serves as an interface between the ladder and the DAQ/power supply side. It distributes the DAQ commands to all attached ladders,as well as low and high voltage. It also converts the data from the chip into an optical signal, which is feed into the VME based DAQ. The cooling and power supply interlock systems are as well shared between all three subdetectors.

Commissioning off the whole system started in 2001 and it took significant effort to become operational. Problems encountered included:

-Complications during the installation
-A lack of testing for the cooling system under operational conditions. The blocked ISL cooling lines remained undetected. Clearing them was a challenging task.
-The common-mode noise in L00 severely affected its performance.
-The optical readout system turned out to be very sensitive in matching transceivers and receivers.

These problems have been addressed Currently 92% of the ladders are powered and 84 % deliver data without errors. During operation some new failure

modes were found and studied.
-Loss of wire bonds due to Lorentz forces on the wire bonds. Synchronous trigger conditions resonated the wire bonds, which lead to failure.
This has been mitigated by a dedicated resonance detection system.
-Beam incidents damaging the chip.
-Single event upsets in the power supplies and DAQ boards in the collision hall.

The silicon sensors are operated at a S/N of about 11-15 depending on the ladder type. With this high S/N, the single hit efficiency is above 99 %. As luminosity increases, a continuous effort is taking place to make Silicon readout as fast as possible. A concern for longevity is the amount of radiation damage to the system. With the current luminosity prospects for Run-II, the damage to the sensors is the prime concern and a continuous effort takes place to measure the radiation damage the system has already accumulated.

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