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THE NEW DØ LAYER 0 SILICON DETECTOR

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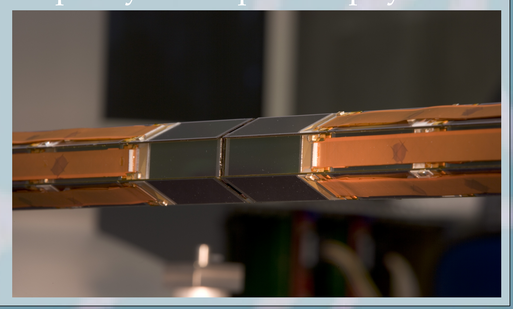
RUN IIb UPGRADE

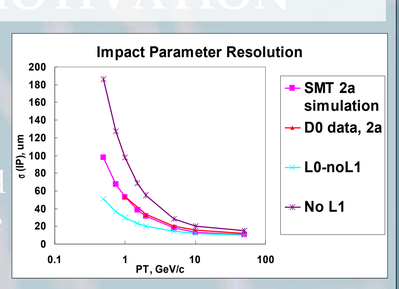
During the Run IIb Upgrade, the DØ Experiment installed a new single layer of 48 silicon sensors, called Layer 0. Inserted into the Run IIa silicon detector (SMT), Layer 0 will optimize DØ's potential for tracking particles and improve its impact parameter resolution, benefiting physics measurements including the B_s mixing frequency. Turned on just weeks ago, Layer 0 is already demonstrating great capacity for improved physics at DØ.



This image shows silicon strip sensors connected to low-mass analog readout cables.

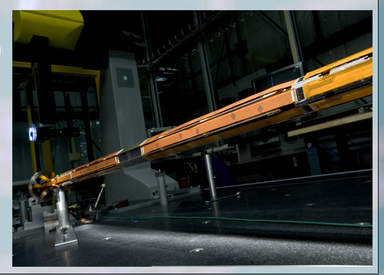
DETECTOR MOTIVATION

*Improve impact parameter resolution
*Mitigate degradation of silicon performance caused by radiation damage to the inner SMT layers



*SMT Layer 1 sensors expected to degrade after 3-4 fb-1
*Improve tracking and b quark tagging efficiency
*Improve B_s mixing measurements

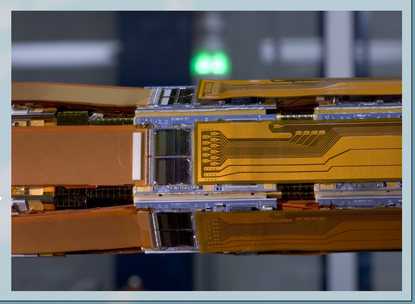
This is the completed Layer 0 detector on a test bed at SiDet. Construction finished in August 2005. Electrical tests continued throughout the following months.



DESIGN & CONSTRUCTION

48 silicon sensors are glued to a carbon fiber support structure. Sensors are arranged on 6 segments in the Φ-direction by 8 segments in the z-direction. Sensors close to the interaction point are 70mm in length; sensors on the ends are 120mm. 4 sensor types provide 98.4% acceptance. SVX4 readout chips are mounted on ceramic hybrids and connect to sensors via low-mass analog cables. Digital cables connect the SVX4 chips to downstream electronics.

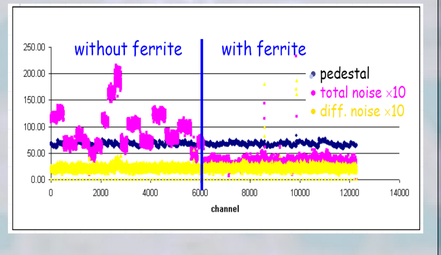
Shown here is the low-mass analog cable connected to SVX4 chips on a ceramic hybrid (blue). Digital readout cables are shown on the left.



PRE-INSTALLATION TESTING

A team of physicists and electronic engineers ensured noise levels were minimized for each sensor. Extensive tests revealed effects outside sources, such as power supplies, have on detector noise. Filters were constructed and demonstrated to be effective in reducing interference from these sources.

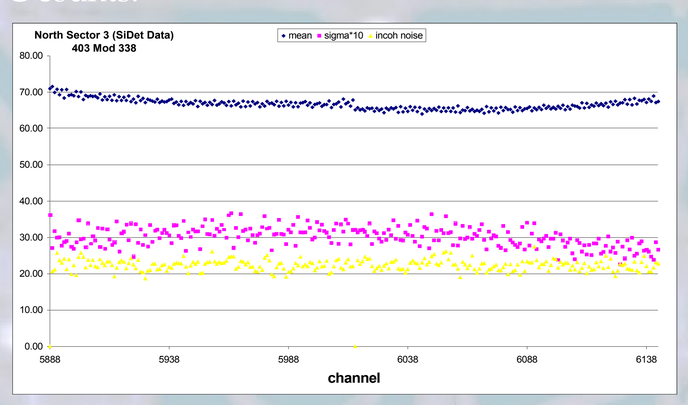
This plot shows how Ferrite cores reduce noise (magenta) from power supplies.



Alignment tests are critical to Layer 0's success. Here Mike Roman carefully aligns Layer 0 on a table at SiDet, preparing for deflection measurements.

PRE-INSTALLATION RESULTS

This plot shows total ADC counts (blue) for the 256 channels in one sensor, coherent noise (magenta), and differential noise (yellow). Coherent and differential noise are multiplied by 10 in this plot. Average differential noise is ~2.2 ADC counts.



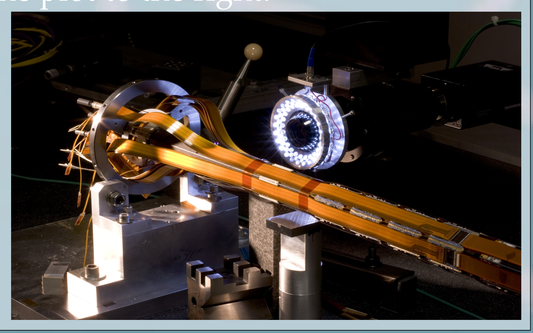
INSTALLATION

The Run IIb Upgrade began February 27, 2006. During this time readout electronics were modified, new hardware was installed, Layer 0 was inserted, cabled, and tested, and new software was tested. The first data came just two weeks after insertion! This task was possible only through the effort of many dedicated people. Pictured is the Layer 0 installation in the DØ collision hall. Meticulous care by the Mechanical Group ensured Layer 0 was installed without a scratch.

POST-INSTALLATION TESTING

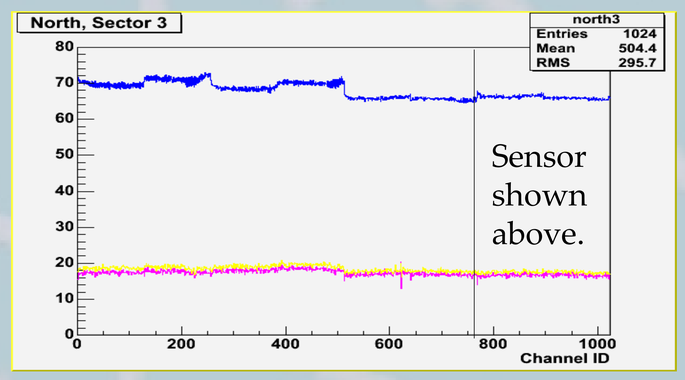
Although Layer 0 had been electrically tested with great success before the installation, there was no guarantee it would behave similarly in its new environment. What will happen when the entire system is enabled? How will surrounding detectors affect Layer 0's noise? What happens when a welder is turned on? While these were all concerns, Layer 0's performance was slightly better in its new home, as demonstrated in the plot to the right.

Layer 0 has an exceptional grounding scheme that isolates it from potential outside noise sources.



POST-INSTALLATION RESULTS

Like the plot above, shown here is total ADC counts (blue), coherent noise (magenta), and differential noise (yellow) after Layer 0 was installed, for 4 sensors in one Φ segment. Average differential noise is ~1.7 ADC counts, an improvement over results seen prior to insertion.



THE LAYER 0 TEAM

Contributing institutions: Brown, CINVESTAV, Fermilab, Fresno, U. Illinois Chicago, U. Indiana, U. Kansas, Kansas State, Louisiana Tech, U. Mississippi, Michigan State, Moscow State, Northwestern, Rice, Stony Brook, U. Washington, Zurich .