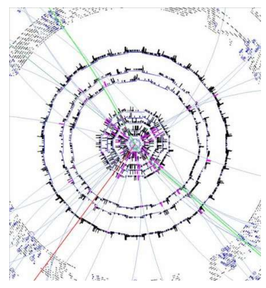
Operational Experience with the CDF Run II Silicon Detector



INTRODUCTION

Since the start of its operations in 2001, the CDF Run II Silicon Detector at Tevatron has served extensively in almost every physics analysis performed at CDF. Throughout these years a valuable experience has been accumulated which is offered for the benefit of new and future HEP silicon detectors

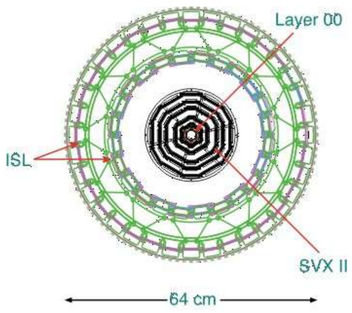
OVERVIEW OF THE CDF SILICON DETECTOR

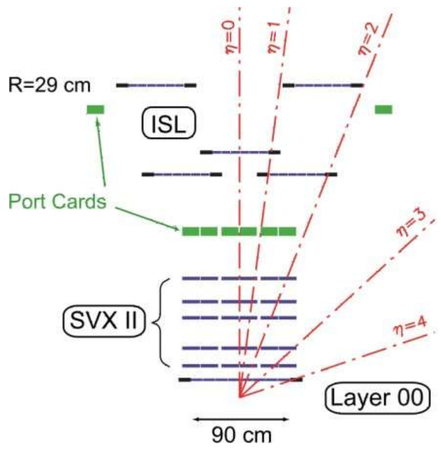
Three component subdetectors:

- SVX-II
  Main component for vertex and track reconstruction.
  Compact, double sided sensors
- L00
  Mounted on the beam pipe,
  improves vertex resolution
- ISL
  The most outer subcomponent,
  extends coverage to forward and
  backward regions

Features:

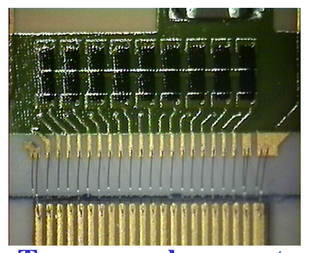
- Deadtimeless operation
- Fast parallel readout
- ~ 7 m^2 of silicon sensors





LORENTZ INDUCED RESONANCES

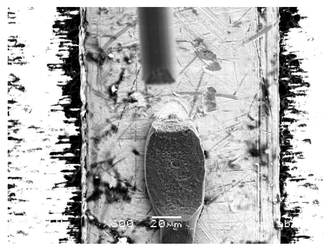
- In 2002 internal connections with some sensors of the detector were permanently lost
- The cause was attributed to the breakage of wire-bonds due to Lorentz force induced resonances



Transversal current (wires step up)

Magnetic field

Lorentz Forces (oscillating)



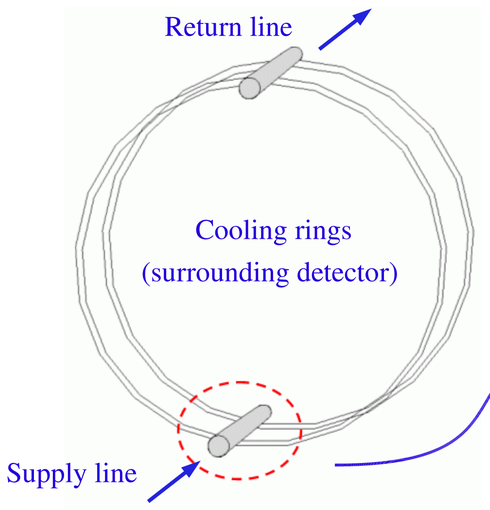
In resonance condition, breakage of bonds

- The resonance frequencies were investigated in laboratory tests
- Successful solution: a system was implemented to momentarily interrupt DAQ near resonance condition (halt at 35 KHz)
- Laboratory tests also revealed that encapsulation (with silicon elastomer) of wire-bonds would dampen the oscillation amplitude and prevent breakage
- Protection systems have been now emulated by newer silicon detectors

BATTLE AGAINST CORROSION IN COOLING SYSTEMS

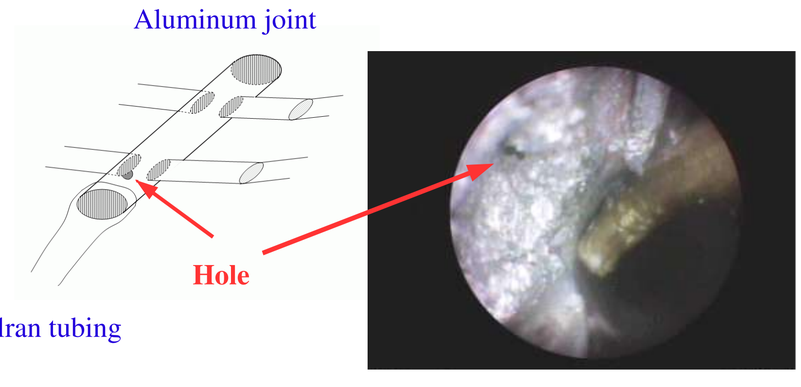
The Problem

- In 2007, leakage in the ISL cooling internal pipelines
- Found high acidity in coolant, pH = 2 ~ lemon juice
- Formic acid had been formed out of the glycol/water mixture (after warming up during a long shutdown)
- Corrosion had affected the aluminum pipes



The Solution

- Internal walls of pipes were probed and repaired from outside introducing long boroscopes and catheters
- Holes were filled with epoxy (1 m depth inside the CDF detector!!)
- The coolant fluid was replaced by deionized water
- The pH and conductivity are controlled at safe values by means of deionizer resin filters

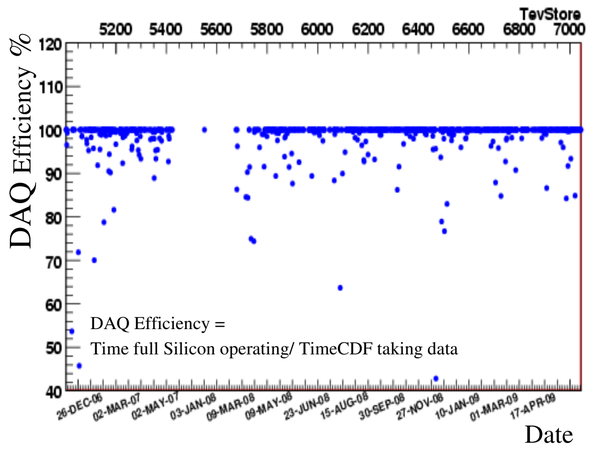


AUTOMATION OF HV OPERATIONS

- Human intervention has been minimized by automatic systems

Features of the system

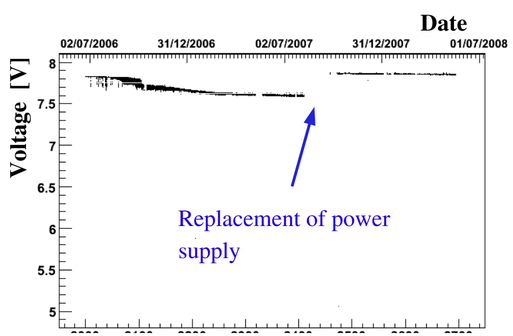
- Recognizes, resets and recovers unresponsive power supplies
- Recognizes trips and recovers sensors



Efficiency of the Silicon Detector while CDF is taking data is 98%

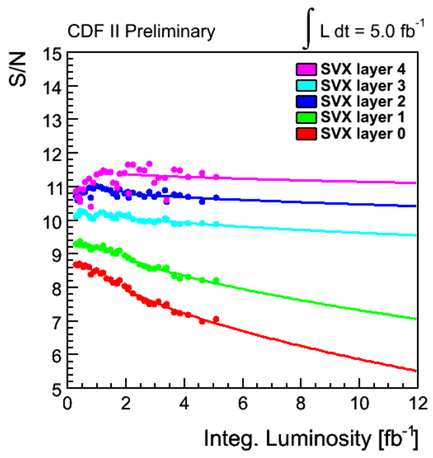
ONGOING MAINTENANCE

- Aging of power supplies, decrease in delivered voltage
- In 2007 the majority of power supplies were repaired
- Most of the detector hardware issues can be fixed in ~1 hour work in Collision Hall



Analog voltage of a sensor chip after replacement of a power supply

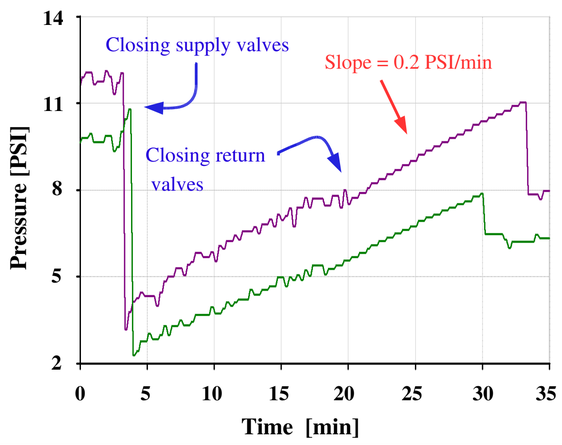
PERFORMANCE



Good Signal-to-Noise ratio projection until 2011 (minimum for b-tagging is ~3)

- Track efficiency ~ 95%

Satisfactory hermeticity in cooling lines
(leakage rate = 0.2 PSI/min, after closing all valves)



CONCLUSIONS

- Eight years of operational experience have left a legacy for newer and future detectors
- Potential damage of Lorenz induced resonances MUST be studied and prevented in any collider silicon detector
- Corrosion prevention MUST be taken into account in the design and operations of any silicon detector
- The CDF Silicon Detector is in good condition to run until the end of the Tevatron operations

Complementary poster
"The CDF Run II Silicon Detector: Longevity Studies"

11th Pisa Meeting on Advanced Detectors; La Biodola (Elba), Italy, 24-30 May 2009

Miguel N Mondragon (Fermilab) on behalf of the CDF Silicon Detector Group