CDF Silicon status

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Outline

- CDF Silicon Overview
- Failure modes
- Current Status
- Outlook
The CDF Silicon Detector

**SVXII (SVX)**
- 5 layers ($r\phi$ & $rZ$)
- 3D micro-vertexing
- Triggering at Level 2 on 2D displaced tracks

**ISL (6th & partial 7th layer)**
- Extends coverage to $|\eta| = 2$

**Layer 00 (L00)**
- On Beam pipe at $r=1.1$ cm
- Improves impact parameter resolution to increase B tag efficiency
- Rad hard vs SVX-II Si

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Layer 00

$64\: \text{cm}$
A closer look

Layer 0

Detector is not accessible till 2009

Former Silicon SPL:
The Silicon might as well be in space
Radiation Hardness of SVX3D

- The SVX3D Chip is made in a radiation hard process
- For LO of SVX we expect 17% noise increase at 8 fb$^{-1}$
- Chip Rad Hardness is not considered an issue, the Chip can take up to 4 MRad
- The bigger concern is the instantaneous deposit of a huge amount of charge in the Chips due to beam incidents
Reading out CDF Silicon

The CDF silicon is readout in a daisy chain
AVDD2 Failures

- AVDD2: sudden loss of communication to front end of chip - compatible with loss of two wire bonds (aka AVDD2) to chip which provide power or the failure of silver epoxy joint
- Chip chain (most of the time) severed at affected chip
- Main beam incident failure mode - but also some evidence that thermal cycles are generating these failures
- Prominent in SVX only
How does it show up?

- After a Beam incident you see an AVDD current drop
- Affected Chip has problems in analog part
- All following chips are lost
Impact on a SVX ladder

The AVDD2 failure prevents talking to the downstream chips, Daisy chain ends at this chip.
Evidence for Charge deposits

• Each L00 Ladder has a fuse (originally for other reasons) on its bias line

• After each big beam incident we have to replace crowbars

• The fuse blows at a current of 5 mA
Charge deposit in SVX3D

Analog Current

Protons

AntiProtons

PINK CELL indicates overcurrent !!
The last 3 Kicker prefires

17 Kicker Prefires in total for Run II

1. 8/Mar/2005 Silicon was ramping
2. 9/Mar/2005 Silicon was in Standby (We dodged the bullet)
3. 20/Mar/2005 Silicon was biased and running

All three times we fired a Radiation Abort (>160 Rad/S)

Having the Silicon in Standby (chips are powered, Silicon not biased) makes a difference, Collimators make one as well.
Chip Body count

This is only for the first kicker prefire

- 8 Chips gone (AVDD2 failures)
- 2 chips heavily damaged
- 1 ladder got a final blow (Error rate from 80% to 100 %)
- SVX-II has ~3100 Chips in total

Analysis for the Friday afternoon hit is ongoing
CDF Silicon Current status

<table>
<thead>
<tr>
<th>Detector</th>
<th>Total</th>
<th>Powered</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>L00</td>
<td>48</td>
<td>98%</td>
<td>96%</td>
</tr>
<tr>
<td>SVX</td>
<td>360</td>
<td>92%</td>
<td>84%</td>
</tr>
<tr>
<td>ISL</td>
<td>148</td>
<td>91%</td>
<td>82%</td>
</tr>
</tbody>
</table>
Damage to SVX3D Chips

[Graph showing the percentage of permanent failed chips over time, with key events such as ANOMALOUS TRIGGERING PROTECTION IMPLEMENTED, BEAM INCIDENT INTERLOCKED AGAINST IT, and KICKER PREFIRE highlighted.]
SVX and SVT

- SVX is crucial for CDF Secondary Vertex Trigger (SVT) for Level2
- SVT uses $r\phi$ information only
- SVT requires 4/5 working ladders in a wedge
- At the moment 3 dead wedges for SVT, 16 wedges are 4/5
Eating up redundancy

• SVX-II is designed to be a very redundant detector

• Loosing Z-side affects Silicon Standalone tracking (require at least 2 3D-Hits)

• Loosing whole ladders affects SVT coverage

• This is long-term issue
A look in the future

Prediction: ~13 Dead SVT Wedges

Impact on SVT
Reduce failure rate by factor 2

- Reduce Kicker prefire rate
- Reduce thermal cycles of detector, this has been already done
Summary

- Kicker prefires and resulting AVDD2 failures are the main concern for CDF Silicon lifetime
- A reduction of kicker prefires by a factor of 2 can already make a big difference
SB0W5L3 – A biography

- 01/31/03 During **turn-on** the ladder looses the z-side chips
- 02/08/03 Ladder recovered
- 12/01/03 Z side lost after **quench**
- 12/10/03 Signs of recovery
- 12/20/03 Ladder got hammered again by **quench**, Z-side again lost.
- 07/23/04 Z side is recovered
- 03/08/05 Z side lost after recent **Kicker Prefire**