Monitoring Radiation Aging of the DØ Silicon Detectors

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December 1, 2008
All Experimenters Meeting
Outline

- Introduction
  - DØ Silicon Microstrip Tracker
  - Motivation

- Depletion Voltage
  - Depletion Voltage Measurement from Charge Collection Efficiency Studies
  - Projection to 8 fb⁻¹

- Summary
- **Barrels**
  - **Original SMT**: $R=2.7$ to 10.1 cm, 4 super layers (2 sub layers for each), various sensor types (Single-Sided, Double-Sided, Double-Sided Double-Metal)
  - **Layer 0**: Installed in 2006, $R=1.6$ to 1.7 cm, Single-Sided sensors

- **Disks**
  - 12 F-Disks: $R=2.6$ to 10.5 cm, Double-Sided sensors
  - 2 H-Disks: $R=9.5$ to 26 cm, Single-Sided sensors
Motivation

Run II Integrated Luminosity
as of Nov 23, 2008

High luminosity

High radiation level

Innermost detectors accumulate larger dose

Consequences:
- Full Depletion Voltage changes
- Signal to Noise decreases

Luminosity (/fb)

Delivered  Recorded
Depletion Voltage Measurement from Signal Charge

- Amount of collected charge depends on depleted volume
- If fully depleted, charge collection efficiency is maximized
- Take special runs to scan bias voltage and measure collected charge
Depletion Voltage Measurement from Signal Charge: cont’d

- Signal peak position as a function of bias voltage
- Take the bias voltage at 95% charge collection efficiency as Full Depletion Voltage

- Consistent results between p-side and n-side measurements
- Studies of noise levels as a function of bias voltage also provide a means of assessing the full depletion voltage (prior to type-inversion)

consistent results
Projection to 8 fb\(^{-1}\)

- Project to 8 fb\(^{-1}\) by fitting existing data using Hamburg Model
- A few Layer 1 sensors might reach the bias voltage limit
Aging Status

DØ Silicon Detector Radiation Aging Status as of July 2008

- ↑ Only showing data points from p-side charge collection study
- Layer 0 and outer layers will be fine through the end of RunII
Summary

• SMT continues to perform well
• Monitoring radiation damage via bias scans
• A few of the inner Layer 1 sensors might not be fully depleted at 8 fb\(^{-1}\)
  ◆ Layer 0 sensors installed to preserve tracking performance
• Expected to be able to continue fully depleting all other sensors through the end of RunII
• We will continue monitoring the impact of radiation on the silicon detector
  ◆ Adjust bias voltages as necessary
Backup Slides
Depletion Voltage Measurement from Noise at n-strip side

- Bias voltage removes free charge carriers
- Strongly decreases at n-side when fully depleted
- This method works until the type-inversion point