Simulation Studies at SCIPP

Momentum Resolution and Non-Prompt Track Reconstruction

ALCPG09

University of New Mexico

Sept 28 – Oct 3, 2009

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CURVATURE RECONSTRUCTION PERFORMANCE

Many thanks to Alex Bogert (Undergraduate student)

One Question: ILD Higgs LOI recoil reconstruction appears somewhat better than SiD's. Could this be due to curvature reconstruction?

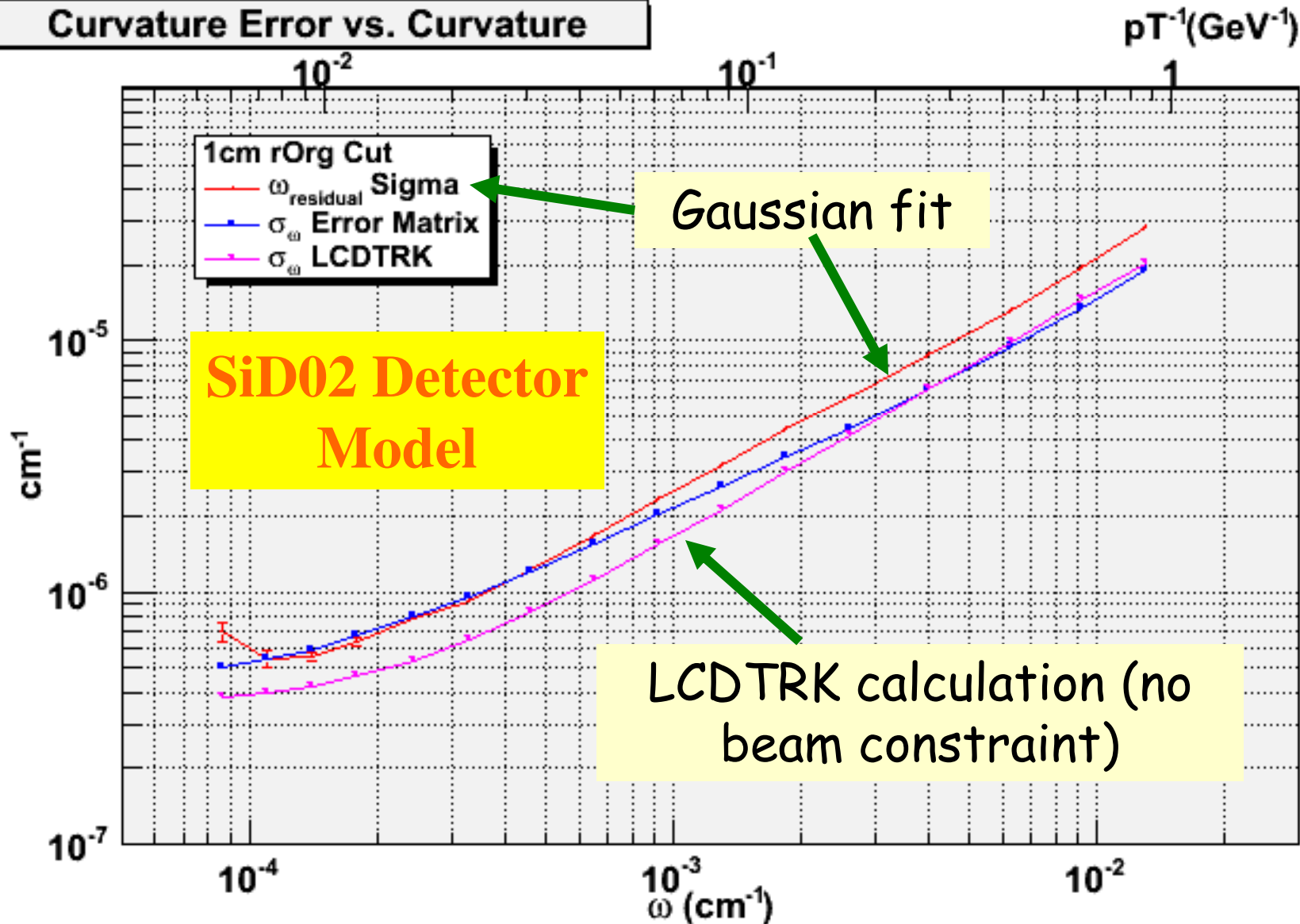(9/30/09 UPDATE: Apparently not! But study still interesting)

CURVATURE RECONSTRUCTION PERFORMANCE

1. Compare width of Gaussian fit to residuals with two different estimates:

   - Error from square root of appropriate diagonal error matrix element

   - Error from Billior calculation (**LCDTRK** program)

2. Only tracks with all DOF (5 VTX and 5 CT layers) are considered.

3. Require $|\cos\theta| < 0.5$

Use q/qbar at 500 and 1000 GeV, tau samples at 500 GeV, all mixed together (shouldn't matter)

CURVATURE ERROR vs. CURVATURE

Curvature Error vs. Curvature

pT⁻¹(GeV⁻¹)

1cm rOrg Cut
$\omega_{residual}$ Sigma
σ_{ω} Error Matrix
σ_{ω} LCDTRK

SiD02 Detector Model

Gaussian fit

LCDTRK calculation (no beam constraint)

ω (cm⁻¹)

In terms of σ_p/p, at 100 GeV we have

    LCDTRK   **0.28%**

    Residuals   **0.39%**

The figure from the SiD LOI is about **0.33%** (obtained from fits to single muons)

➔ Somewhat contradictory? Need to explore (SCIPP should try single muons, etc.)
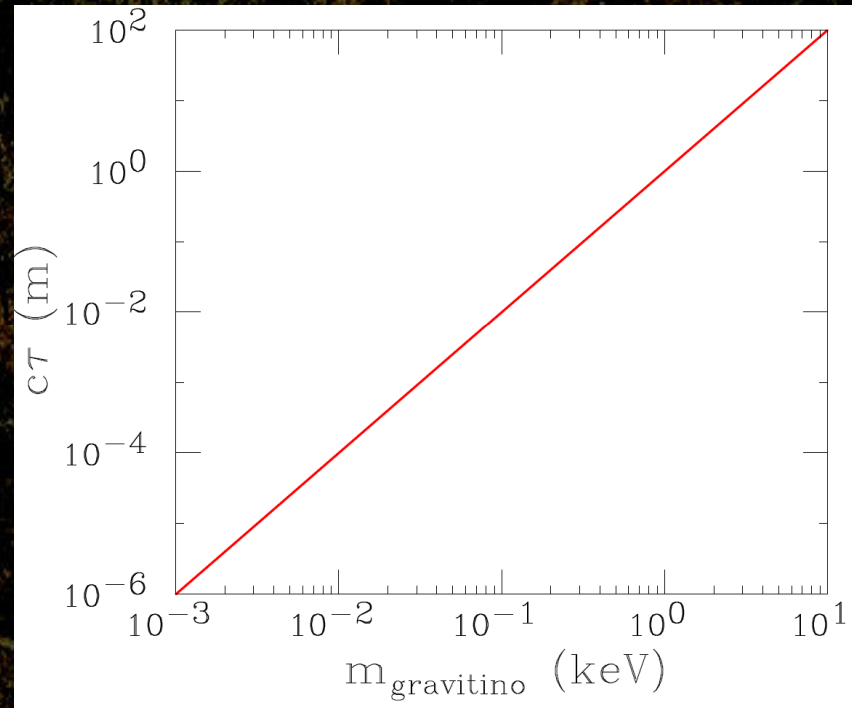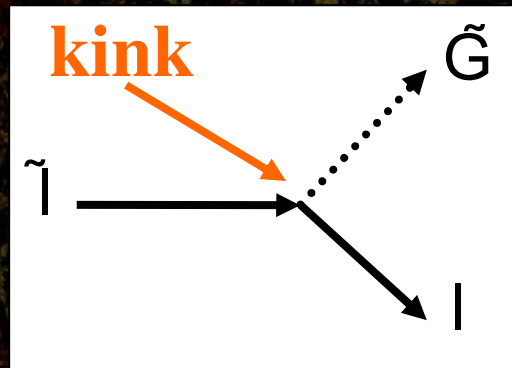
STUDIES OF NON-PROMPT TRACK RECONSTRUCTION AT SCIPP

Exploring metastable Stau signatures

Thanks to undergraduates Chris Betancourt, Alex Bogert and Dustin Stolp (and former thesis students Chris Meyer and Tyler Rice)
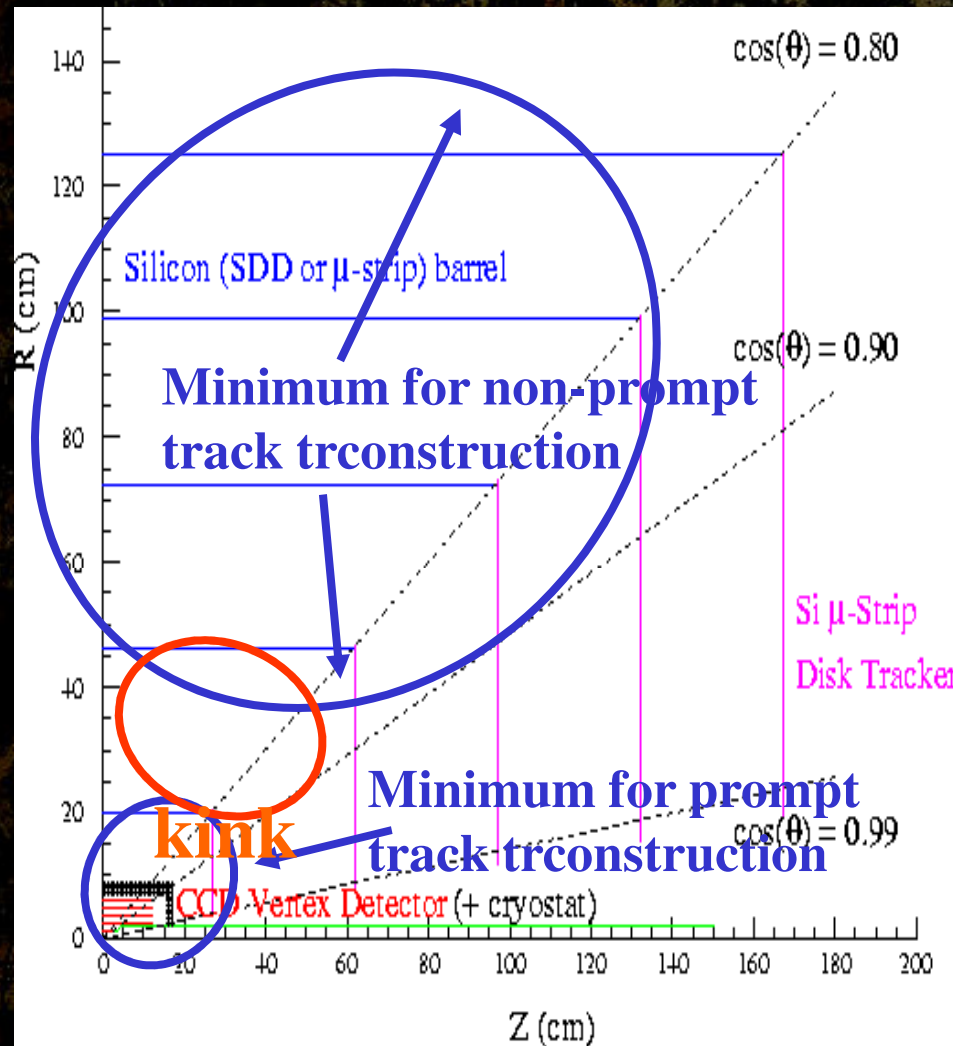
Gauge-Mediated Supersymmetry Breaking

Scenarios with in-flight decay not disfavored by cosmological constraints

For a reasonable range of, e.g., gravitino mass, signature would be kinked track (possibly with change in rate of ionization loss)

Gauge-Mediated Supersymmetry Breaking II

Well-motivated, tractable signal.

This will challenge SiD, and perhaps provide constraints on layout and z segmentation.

Can we extend this by reconstructing tracks originating outside second tracking layer?
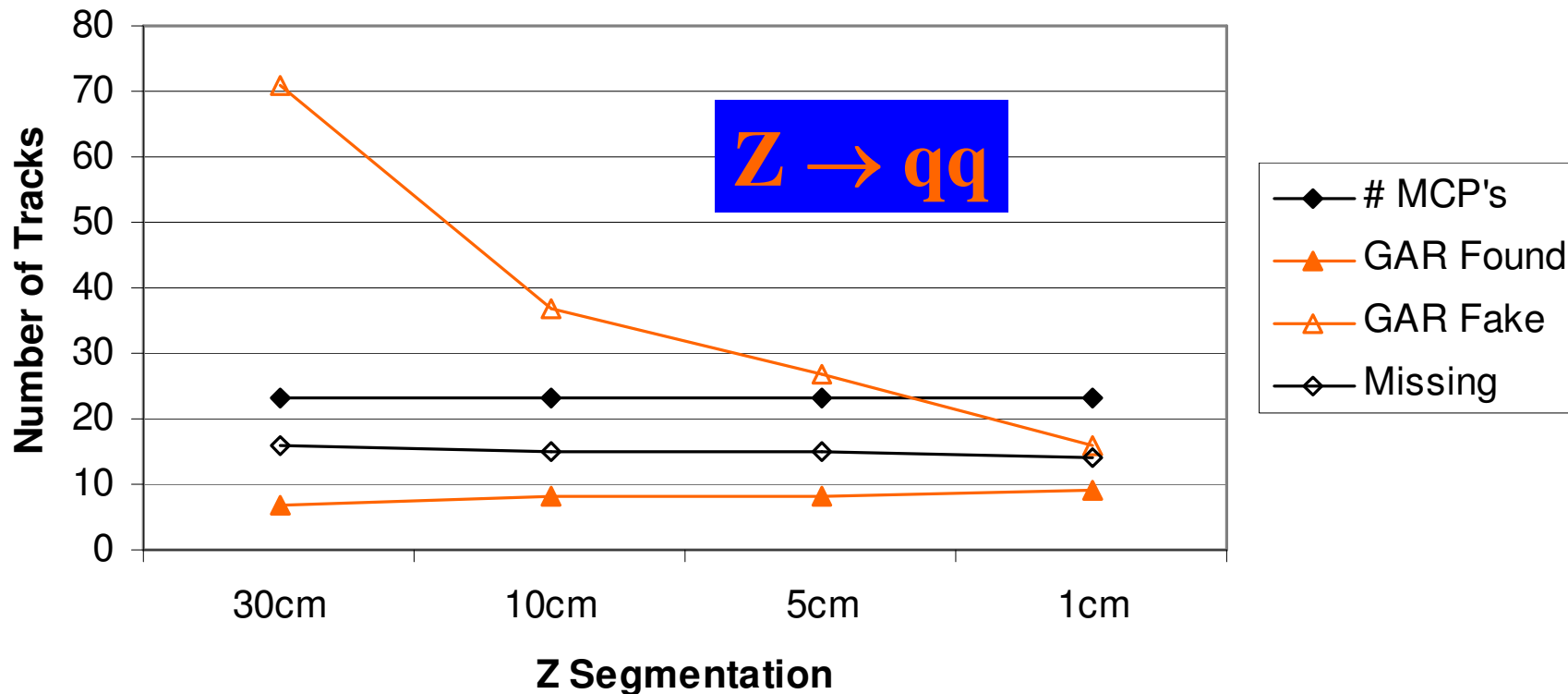
GARFIELD and SeedExtend

Two algorithms attempt to use minimum-ionizing track stubs in SiW Cal

GARFIELD (Onoprienko): Extend calorimeter stubs back into tracker; motivated by K^0_S reconstruction

SeedExtend (former UC students Meyer, Rice): Match three-hit tracker seeds with calorimeter tracking stubs. Geared toward Stau reconstruction.

GARFIELD performance on three-hit tracks

3 Hit Tracks

$Z \rightarrow qq$

Legend: # MCP's, GAR Found, GAR Fake, Missing

X-axis: Z Segmentation (30cm, 10cm, 5cm, 1cm)
Y-axis: Number of Tracks (0–80)

3-hit efficiency and purity not optimal ➔ SeedExtend alorithm developed at SCIPP

SeedExtend Approach

UCSC students proposed matching precise three-hit tracker seeds to Garfield stubs

Helix – Stub Matching (optimized for Z → qq)

- **Base Difference < 2 mm**
- **Phi Difference < 100 milliradians**
- **Curvature Ratio ((κ_{seed} - κ_{stub})/ κ_{seed}) < 10**

Diff of Base

Entries : 5651
Mean : 0.83621
Rms : 0.57118

e.g.: Position-matching for isolated muons (mm)

SeedExtend Performance; Z → qq

Of a total of 20 3-hit particles:

• 12 were reconstructed as 3-hit tracks, with only 4 fakes

• Two additional 4-hit particles were found

Encouraging results; how will this do for reconstructing long-lived Stau decays?

GMSB Stau Reconstruction Study

SiDSeedTracker algorithm (Partridge) now available for tracker-only tracking:

• Optimize SiDSeedTracker strategy for prompt stub (Stau track)

• Run Garfield and SeedExtend sequentially, eliminating hits for found tracks

• Match inside-out (Stau) stubs with outside in (tau-decay) tracks with "Kinker" algorithm

• Work being done by UCSC undergrads Alex Bogert and Dustin Stolp

How wide a range in R_{dec} can we detect?

Summary

Have looked into accuracy of momentum SiD reconstruction simulation; some questions raised that require further exploration.

Full simulation study of non-prompt signature (GMSB Staus) underway for SiD to explore reach in R_{dec}.

ILD assumed to be robust, but similar study would be of interest.