Electron Seeding with Silicon Strips

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Motivation

• Increase efficiency of electron seeding, especially at large $\eta$. Complements pixel based matching.

• Provide redundancy
Having both Pixel and SiStrip seeding could be valuable, especially in early days of running when the devices are still being understood.
Overview

Preselect hits near electron trajectory

Find hit pairs (seeds) consistent with electron track

Track seeding? HLT filter?
Tracker layout

Blue = double-sided
Shaded = used here

TIB

TID

TEC
Hit preselection: $r-\phi$

$r-\phi$: $|\Delta \phi| < 0.1$ rad

Driven by SC position resolution

Electron gun
$E=25\text{GeV}$
$\eta=2.25$
TEC1

MC tagged “good” hits (arb. norm.)

Distributions in other layers are similar
Aside on showers and roads

Case:
- 100 GeV electrons, $\eta = 0.75$
- 2 basic clusters in SC, presumably 1 electron, 1 radiated photon
- $|\Delta \phi|$ is narrow when the energy sharing is asymmetric.
- $|\Delta \phi|$ can be large when the energy sharing is more balanced.

Does this reflect difficulty in determining the SC position when the basic clusters overlap?

- Led to widening the cut to $|\Delta \phi| > 0.1$
Hit preselection: r-z

• Road width is driven by beam luminous region
• $z_{\text{miss}} = z$ at beam axis of line through SC and hit.
• $|z_{\text{miss}}| < 15$ cm
Step 2: Form seeds

**r-φ view**

\[ |\phi_{\text{hit}} - \phi_{\text{traj}}| < 0.002 \text{ (TIB)} \]
\[ < 0.005 \text{ (TID)} \]
\[ < 0.01 \text{ (TEC)} \]

**r-z view**

\[ |r_{\text{hit}} - r_{\text{traj}}| < 3 \text{ mm} \]
(in barrel, \(|z_{\text{hit}} - z_{\text{traj}}| < 3 \text{ mm} \))

Electrons
\[ E = 25 \text{ GeV} \]
\[ \eta = 2.25 \]

TEC

**Graphs:**

- Graph showing \( |\phi_{\text{hit}} - \phi_{\text{traj}}| \)
- Graph showing \( |r_{\text{hit}} - r_{\text{traj}}| \)

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Reality checks

\[ \Delta R = \sqrt{\left(\phi_{\text{seed}} - \phi_{\text{gen}}\right)^2 + \left(\eta_{\text{seed}} - \eta_{\text{gen}}\right)^2} \]

10,000 electron gun events
E = 25 GeV  0 < \eta < 2.5
Tracker layout

Blue = double-sided
Shaded = used here
More reality checks

10,000 electron gun events
E = 25 GeV  0 < η < 2.5

\[(p_{T_{\text{seed}}} - p_{T_{\text{gen}}})/p_{T_{\text{gen}}}\]

\[Q_{\text{seed}} - Q_{\text{gen}}\]
Seeding Efficiency

- Electron gun events
  - $E_{\text{SC}} > 15$ GeV
  - L1 energy $> 15$ GeV
  - “found” = seed with $\Delta R > 0.05$ and $\Delta Q=0$

\[ E = 25 \text{ GeV} \]
\[ E = 100 \text{ GeV} \]
Software Structure

Seed Generation
ElectronPixelSeedProducer

TrajectorySeed
SeedSuperClusterAssociation

TRACKING
(HLT, offline)

Track
(TrackSeedAssociation)

Electron Reconstruction

Electron
GSFElectron

ElectronPixelSeedGenerator

ElectronSiStripSeedGenerator

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Track efficiency

Efficiency = Fraction of good SC with at least one track found (includes seeding efficiency)

$E_e = 100$ GeV

$\Delta R_{track} < 0.5$

$\Delta R_{track} < 0.05$

Tracks at large $\eta$ seem to have degraded $\Delta R$, even though the $\Delta R$ of seeds is good.

$1.6 < \eta_{gen} < 2.5$
Track efficiency

Efficiency = Fraction of good SC with at least one track found (includes seeding efficiency)

$\Delta R_{\text{track}} < 0.5$
$\Delta R_{\text{track}} < 0.05$

Tracks at large $\eta$ seem to have degraded $\Delta R$, even though there are seeds with good $\Delta R$.

$E_e = 100$ GeV

CMSSW_1_6_8

1.6 $< \eta_{\text{gen}} < 2.5$
Conclusions

- Silicon strip seeding achieves efficiencies of 88% (25 GeV) to 96% (100 GeV) at large $\eta$.
- Looks encouraging (at least to me), BUT, there are things that need to be studied that could reduce this:
  - Fake rates - may require tightening cuts
  - Timing - may require tightening cuts
  - Multiple seed rejection - may throw out some good seeds with the bad
Backup Slides
**Endcap seed $\Delta R$**

- **All seeds**
- **Best seed**

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**Seed Delta R in Endcap**

- Entries: 23376
- Mean: 0.02864
- RMS: 0.0342

**Seed Minimum Delta R in Endcap**

- Entries: 3439
- Mean: 0.006755
- RMS: 0.009992

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