Electron Identification without the Pixel Detector

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Outline for this talk

- Project outline and goals
- Disadvantages and advantages of electron-finding in the Si-strip tracker
- The importance of realistic Monte Carlo
- Status and next steps

Project Outline and Goals

Goal: Identify electrons (HLT and offline) by matching ECAL superclusters to Si-strip tracker hits

fast	robust	flexible
$\lesssim$ 100 ms per supercluster	ϵ indep. of misalignments (~500 μm in tracker, ~1 mm tracker-ECAL)	provide parameters to tune
$\mathcal{O}(\text{hits}^p)$ where $p \lesssim 2$	ϵ indep. of occupancy	ϵ vs. rejection, ϵ vs. speed

HLT Context: Level 2.5

After ECAL clustering and before track-finding

Provide a list of electron candidates: HLT should accept the event if #candidates > 0

Level 2.0 $\rightarrow$ we insert candidates into event $\rightarrow$ Level 2.5 Filter $\rightarrow$ Level 3.0 tracking

Provide track parameters and possibly cloud of hits for Level 3.0 tracking

Why it's harder without the Pixel detector

Pixel's 2D hits allow for a smaller search region (larger signal/noise)

Pixel's resolution is 150 μm/$\sqrt{12}$, strip tracker's resolution is

- 1 mm/$\sqrt{12}$ in tracker's four stereo layers
- 10–20 cm/$\sqrt{12}$ in segmented RPHI layers

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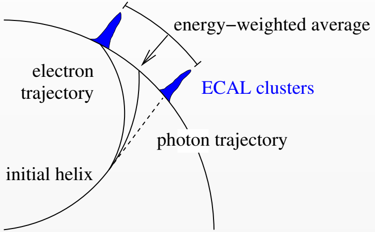
Advantages of the Strip tracker

- More layers: regain signal/noise with coincidence of hits
- Hits close to and far from the ECAL...

Two approaches to electron identification

Thm: if electron and all bremsstrahlung photons are included in a supercluster, energy-weighted position is on the initial helix



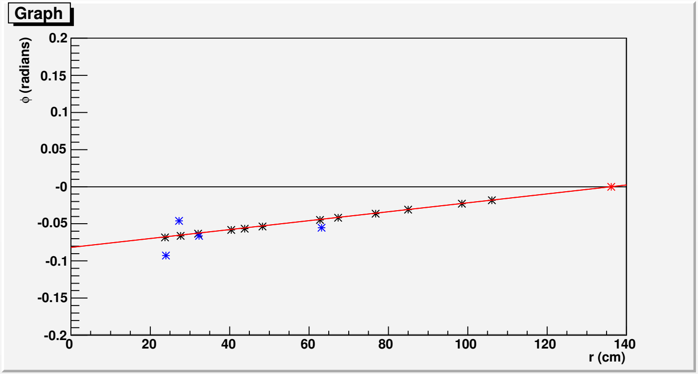
Two approaches to hit matching:

- Inner hits point to supercluster position
- Outer hits point to a basiccluster position

The two approaches may be combined

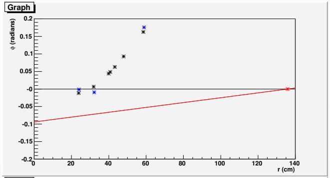
"Event Displays"

- vertical axis is ϕ of each hit with supercluster's ϕ as zero
- horizontal axis is cylindrical radius of each hit

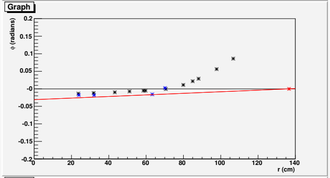


Electron pathologies

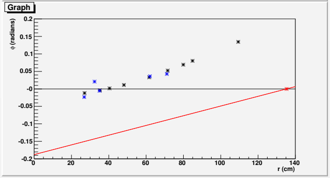
Scatter before tracker (∼4%)



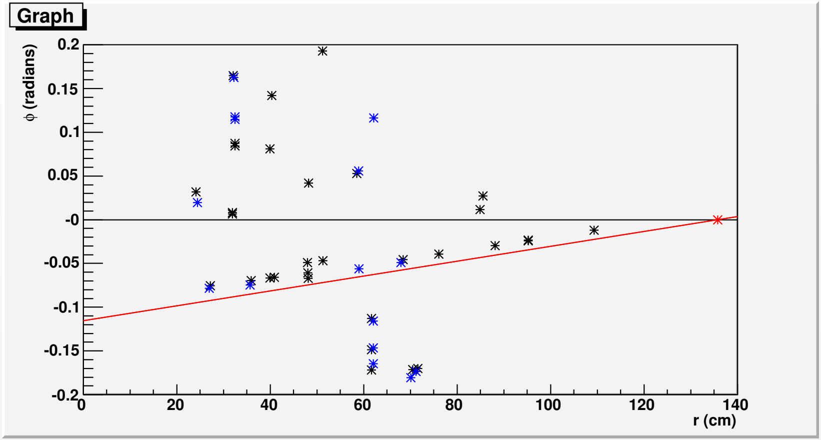
Scatter in tracker (∼4%)



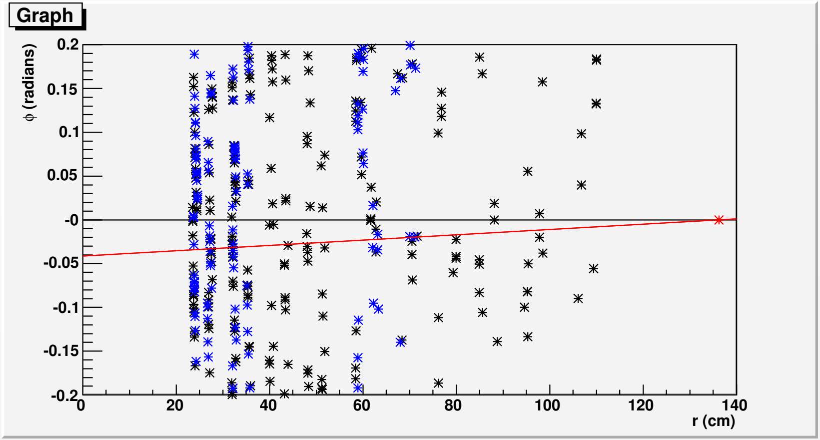
Wrong supercluster position
(∼12% at 10 GeV)



Typical occupancy (superimposed minbias event)

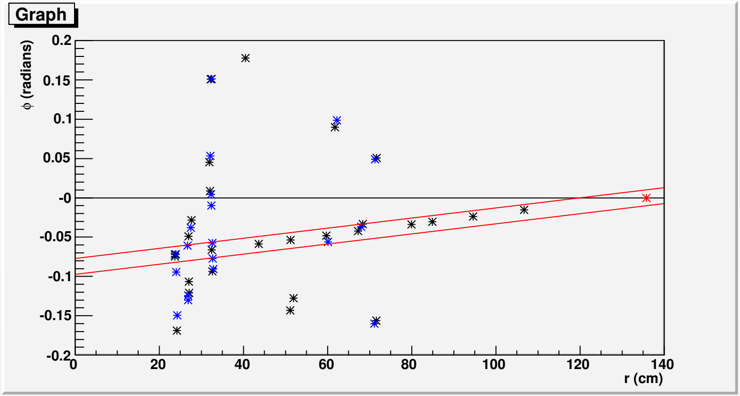


Background: minbias with a 17 GeV supercluster

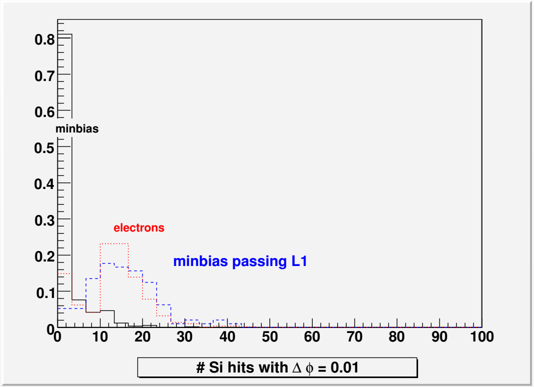


Analysis of a simple algorithm

Define a 10 mrad $\Delta\phi$ band around hypothesis, count hits within that band

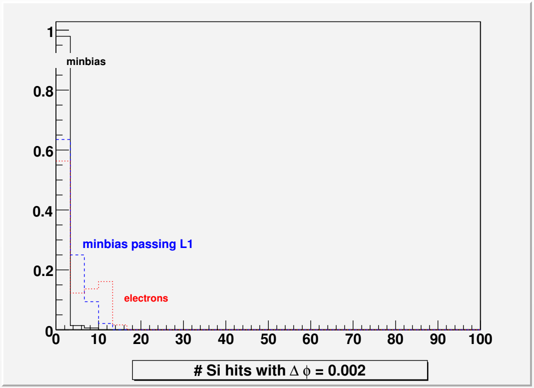


Good discrimination between electrons and minbias,
poor discrimination between electrons and minbias passing L1



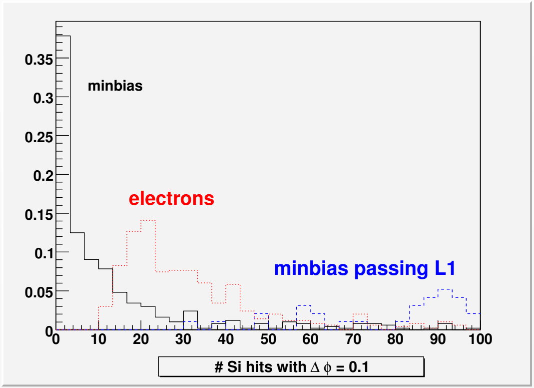
minbias passing L1 ($\geq$ 17 GeV supercluster) points into a jet

Narrow $\Delta\phi$ to 2 mrad?



Not narrow enough to distinguish electrons from background, and too narrow for robustness goals

Widen $\Delta\phi$ to 100 mrad and cut on *maximum* number of hits?



That would be a track isolation cut, not track matching!
Can we afford to isolate electons?

MC studies drive algorithm development

Status

- Performed informal first studies of signal and background
- Implemented placeholder `SiStripElectronCandidate` and `SiStripElectronProducer` in `CMSSW_0_7_0_pre2`

Next Steps

1. Obtain realistic Monte Carlo

   signal: physics electrons (jet overlap?)
   superimpose hadronic background at the generator level

   background: large minbias sample which has passed L2

2. Study event properties (in CMSSW/FWLite)

   $\uparrow \quad \downarrow$

3. Improve algorithm (in CMSSW)