Fast Monte Carlo for LCD Calorimeter

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- Use FastCal in studies that can tolerate drawbacks.
- FastCal can provide large datasets quickly, as detector design develops.
- FastCal should work for all detector designs under consideration: L, SD etc.
- FastCal in the JAS environment.

FastCal Overview

- FastCal specifics:
  - ⋆ Charged and neutral particle propagation.
  - ⋆ Randomized hadronic shower origin.
  - ⋆ Bock parameterization for hadronic shower energy deposition.
  - ⋆ Smear ECAL and HCAL energy.

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- Events: $e^+e^- \to ZZ$ (1,200). Detector: `ldmar01`.

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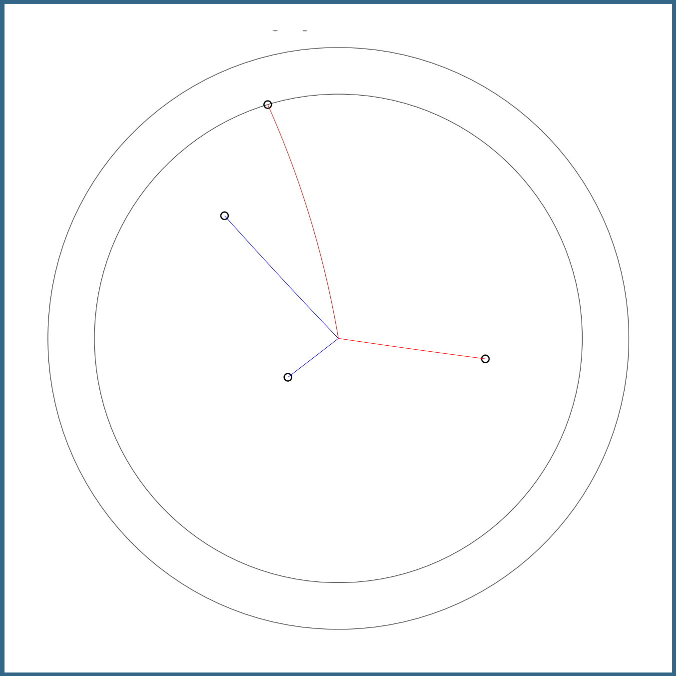

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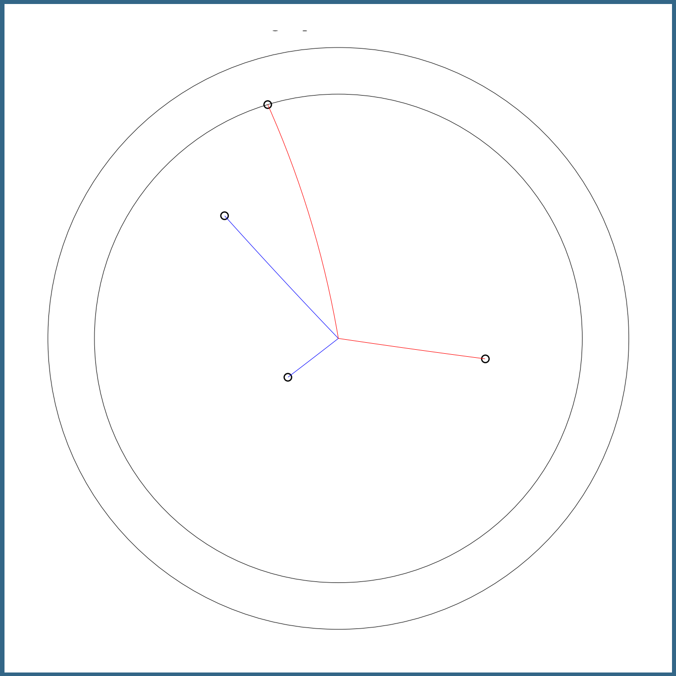
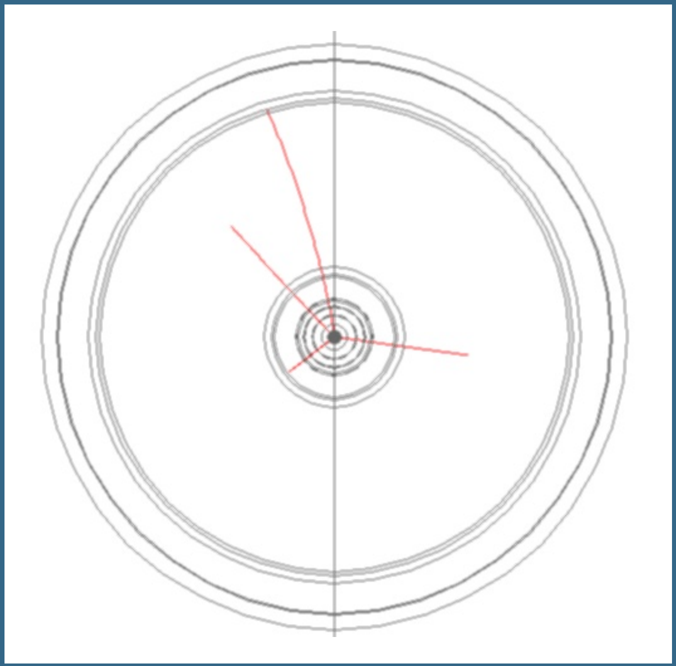


FullSim (LCDWired)



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[Bock *et al.*, NIM **186** (1981) 533-539]

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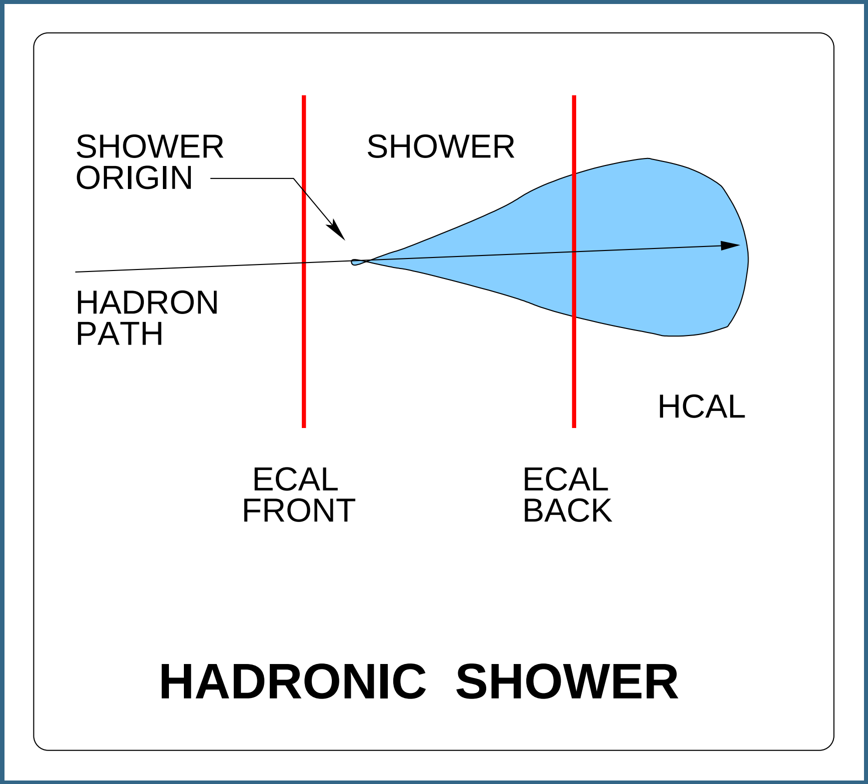
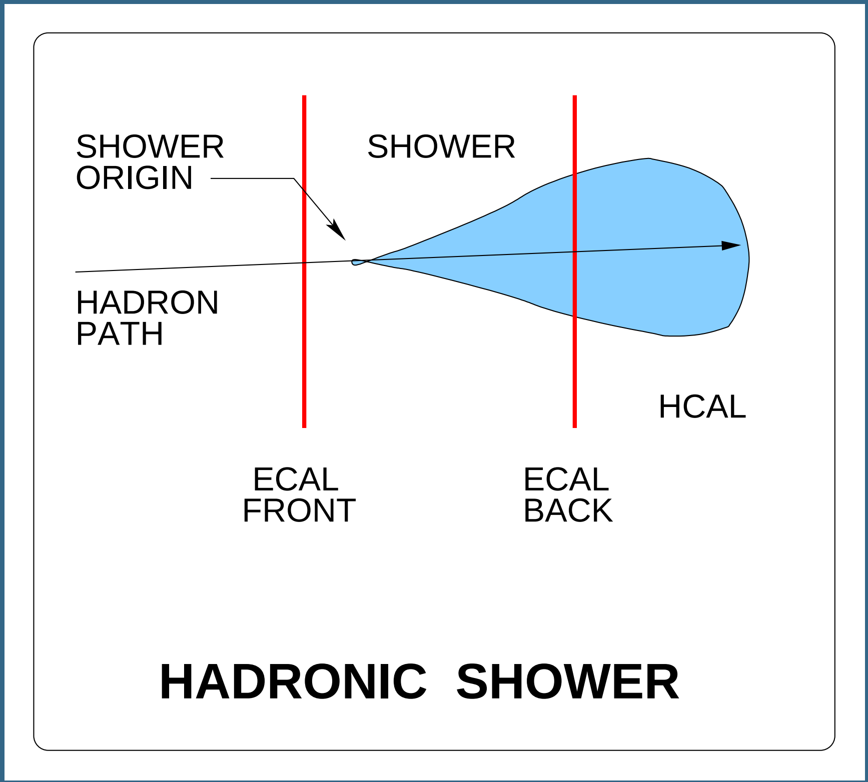
$$\int_0^x dE \;=\; E_0\left(wP(a,bt) + (1-w)P(c,du)\right),$$

Here, $t = x/X_0$, $u = x/\lambda$, $a = 0.6165 + 0.3183 \log E_0$, $b = 0.2198$, $c = a$, $d = 0.9099 - 0.0237 \log E_0$ and $w = 0.4634$.

Hadrons

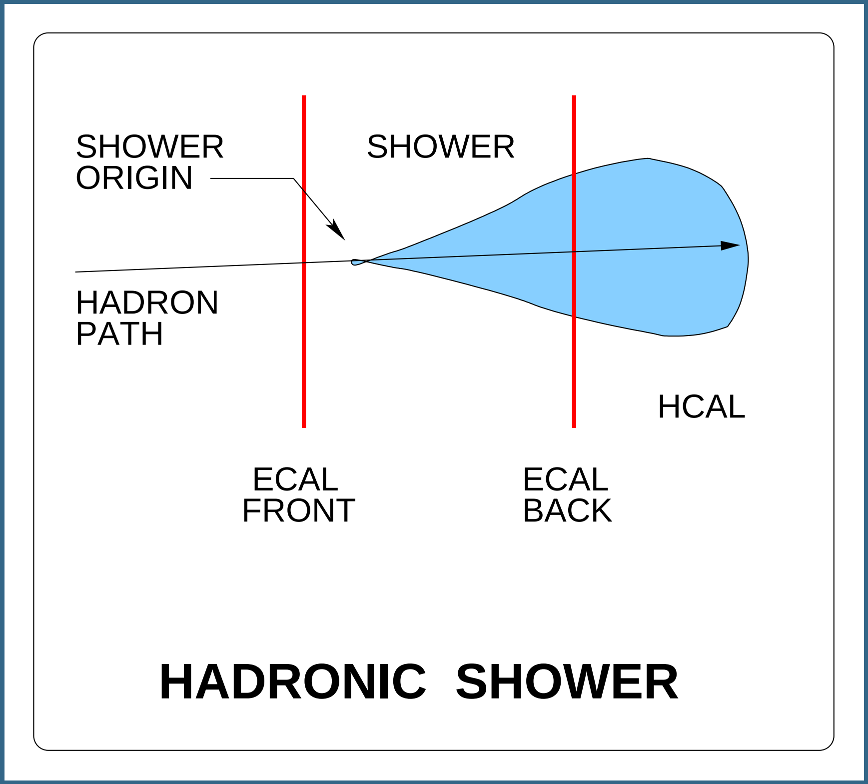

SHOWER
ORIGIN
SHOWER
HADRON
PATH
HCAL
ECAL
FRONT
ECAL
BACK
HADRONIC SHOWER

Hadrons



- $e^{-s/\lambda}$ distribution of shower origin, from the ECAL inner surface.

Hadrons



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- Bock parameterization energy integration performed from shower origin to back of ECAL.

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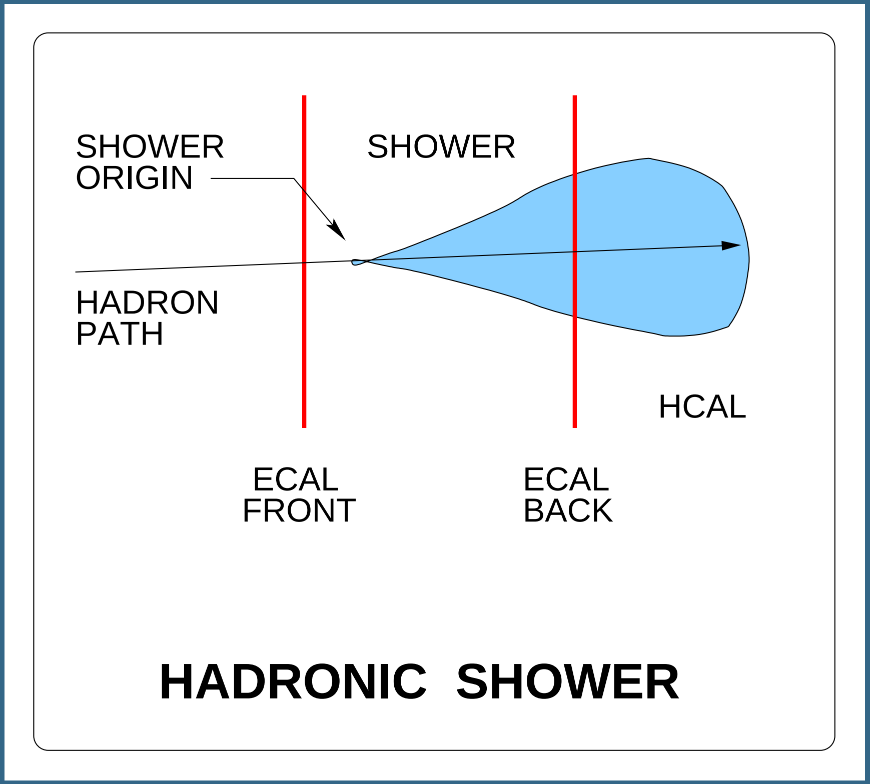

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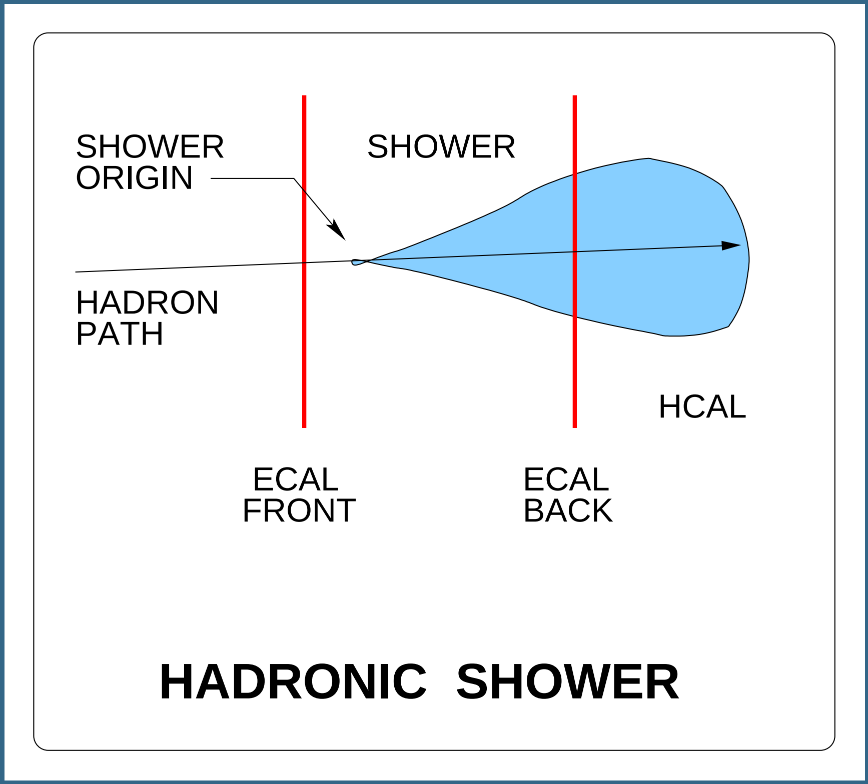
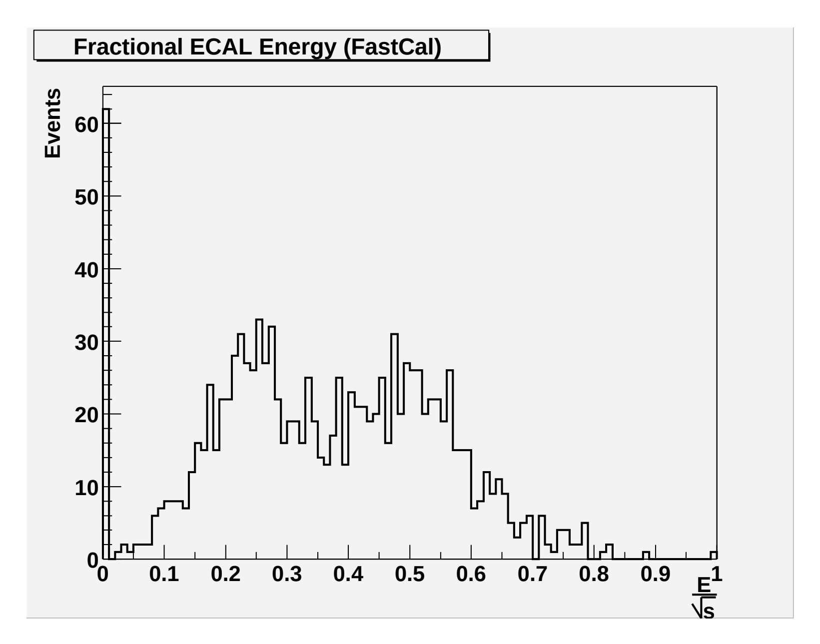


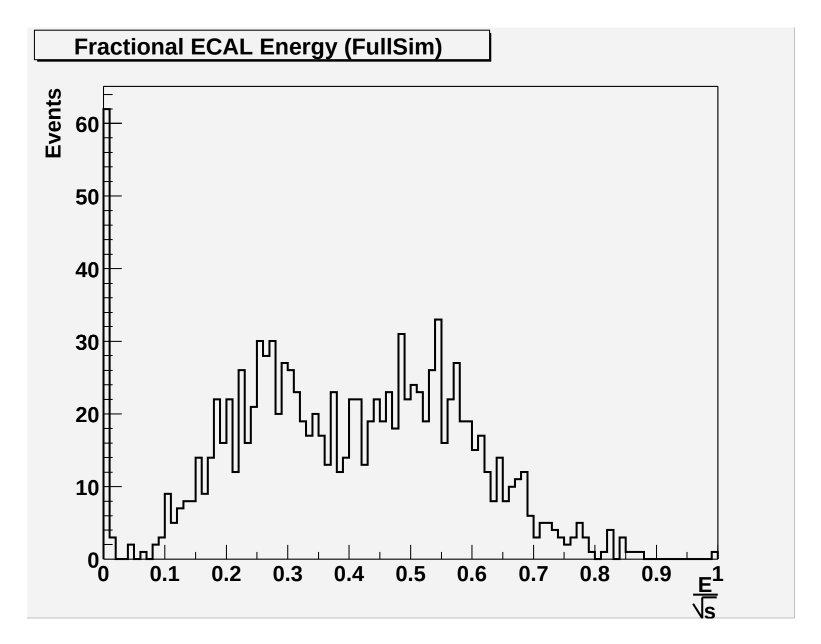
- $e^{-s/\lambda}$ distribution of shower origin, from the ECAL inner surface.
- Bock parameterization energy integration performed from shower origin to back of ECAL.
- Energy smeared according to calorimeter energy resolution and deposited at ECAL.
- Rest of the energy smeared and deposited in the HCAL.

ECAL Energy Deposition (Events vs $E/\sqrt{s}$)

FastCal

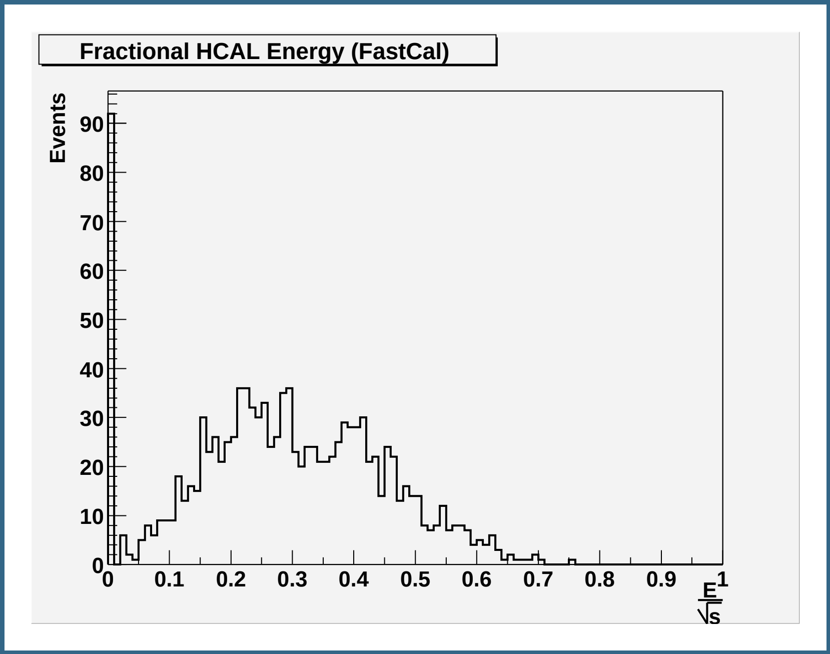


FullSim

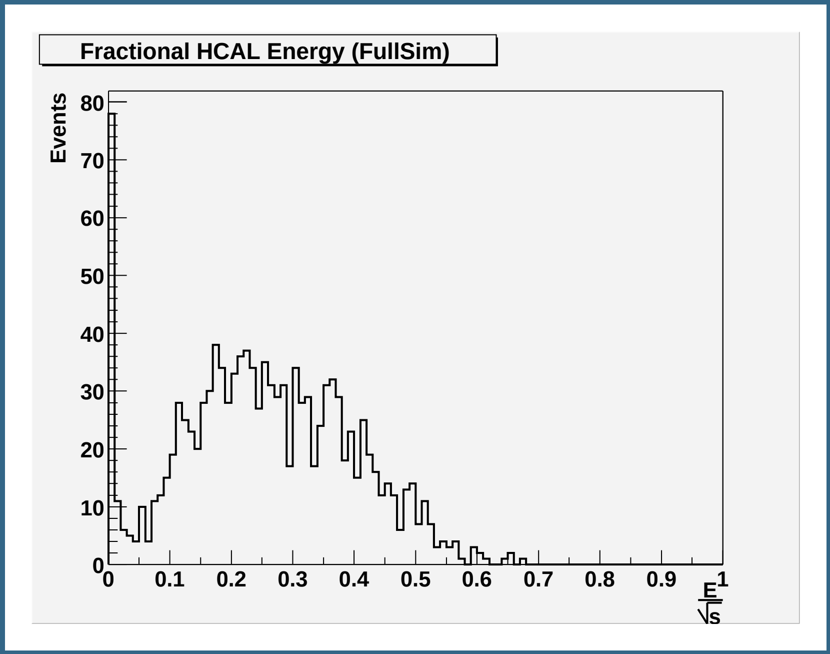


HCAL Energy Deposition (Events vs $E/\sqrt{s}$)

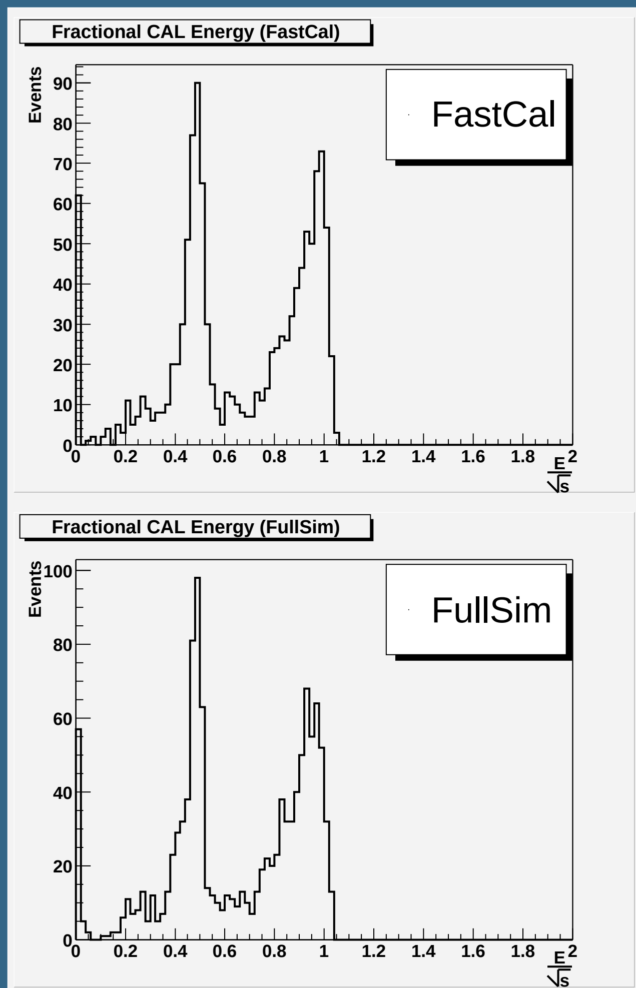
FastCal



FullSim



Total Energy Deposition (Events vs $E/\sqrt{s}$)



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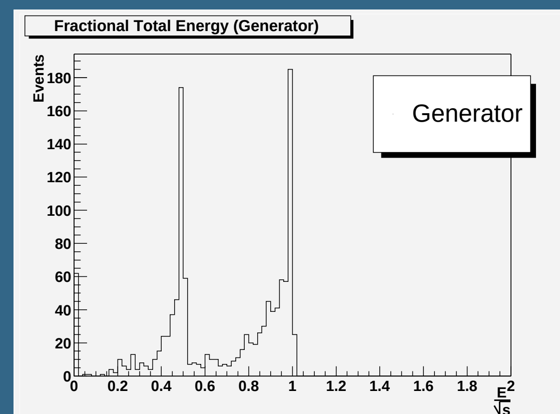

Generator Level

FastCal Cluster Energy

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  FastCal: use energy deposits in Calorimeters.

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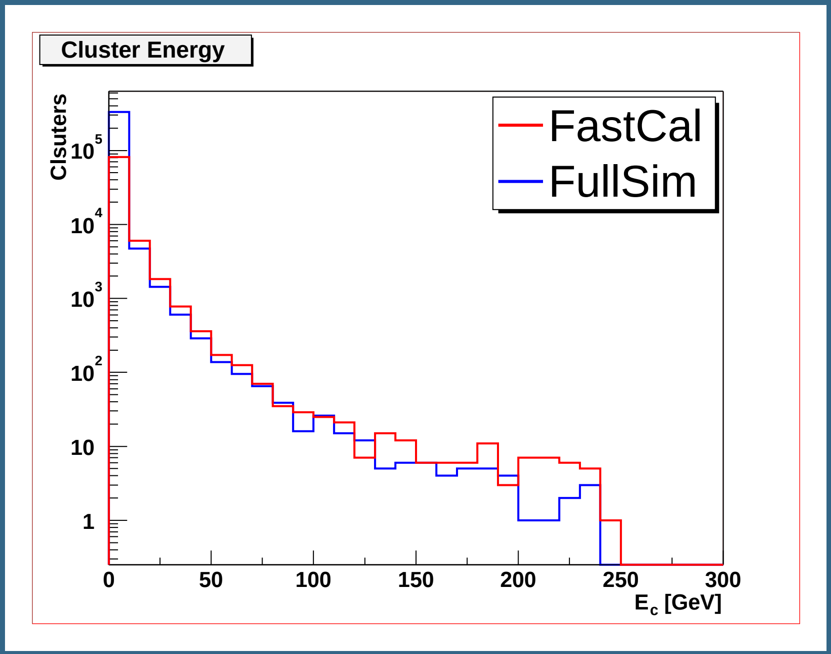
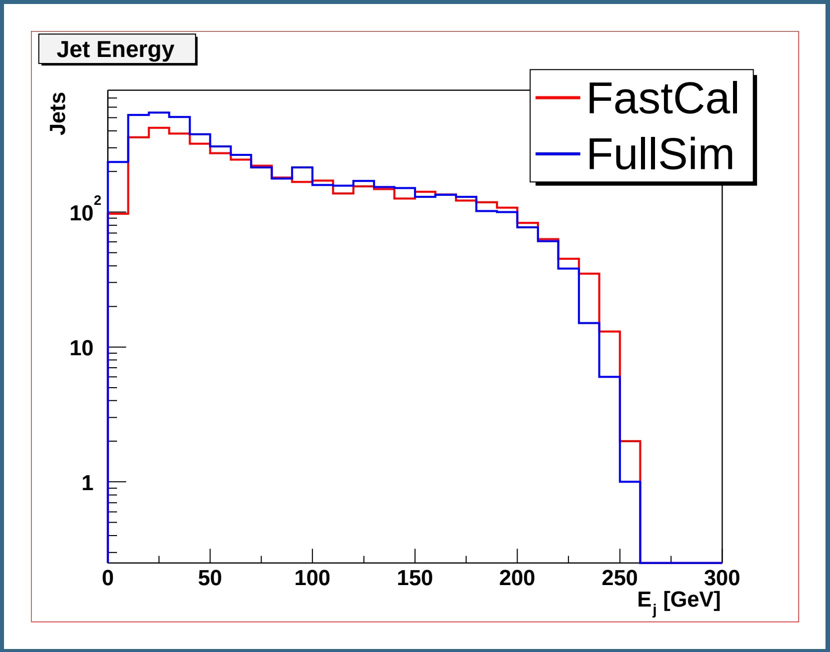


Expand first bin

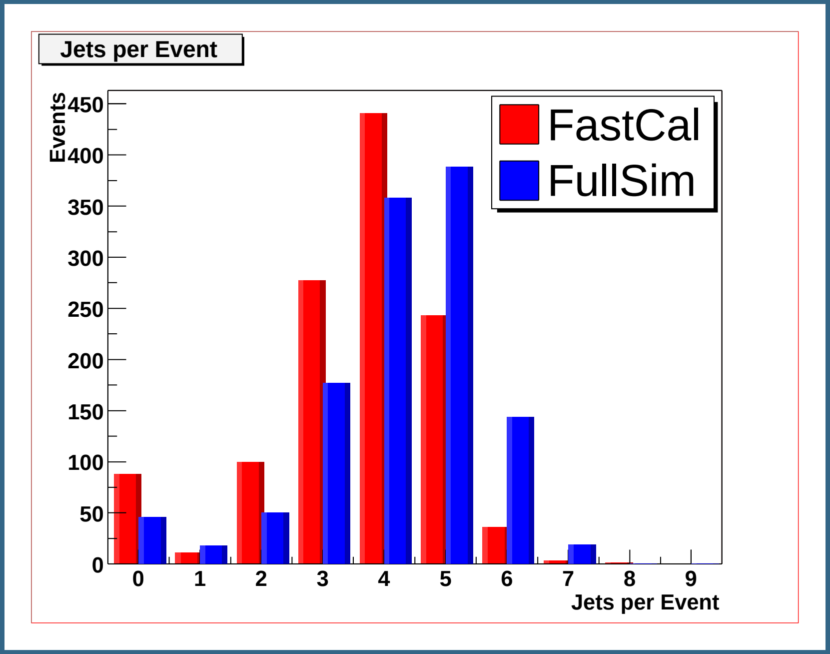
FastCal Jet Energy

- **Jet Finding**: use JadeEJetFinder for both FastCal and FullSim
- Consider jets with more than 1 particle.



Jet Finding II

Jets per Event



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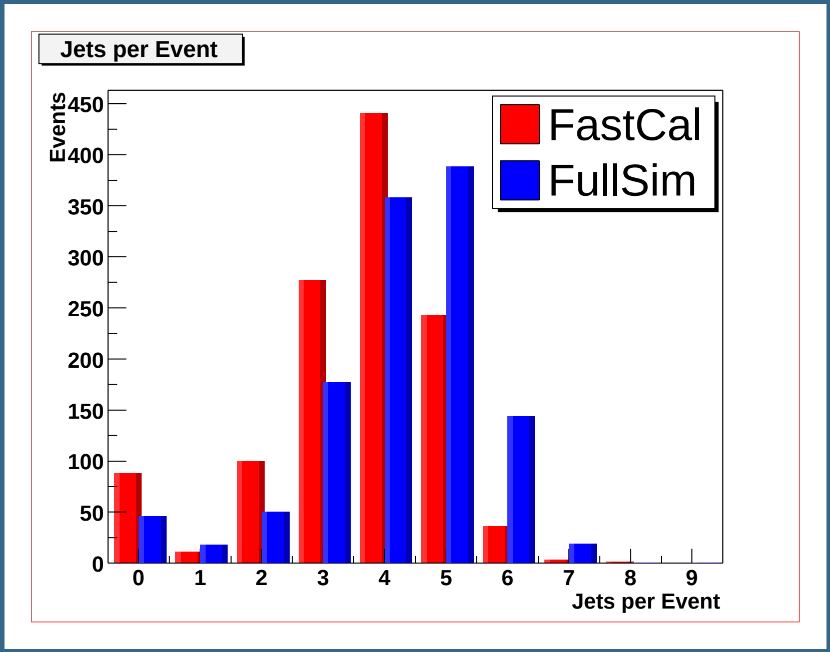
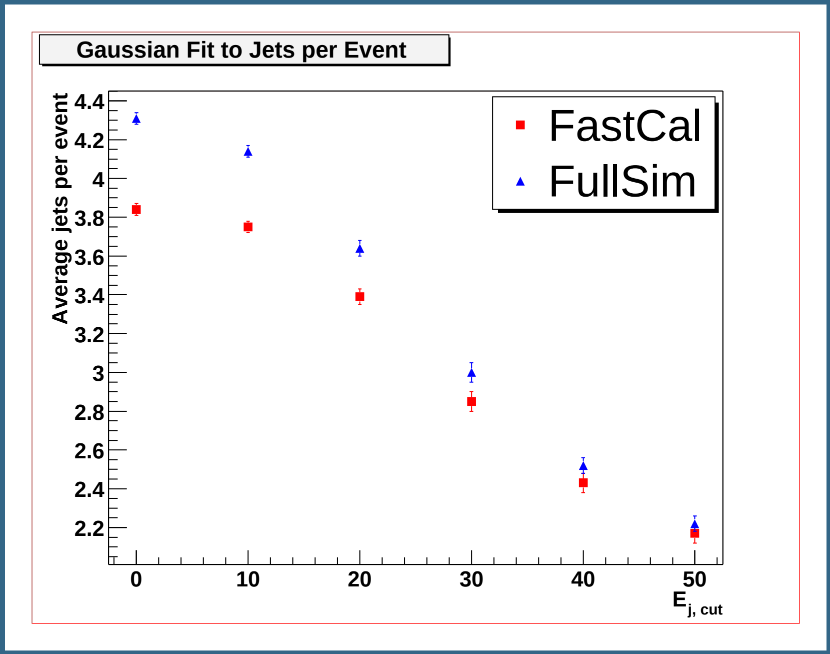
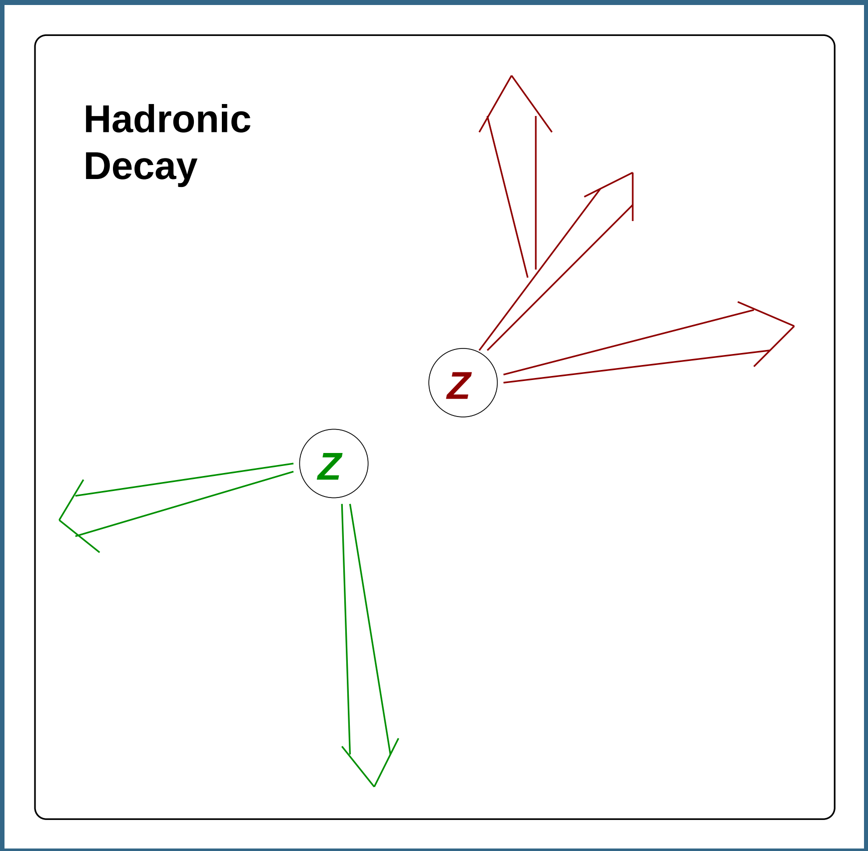


Jets with E_{jet} Cut



An Application

Z Reconstruction in Hadronic Final States



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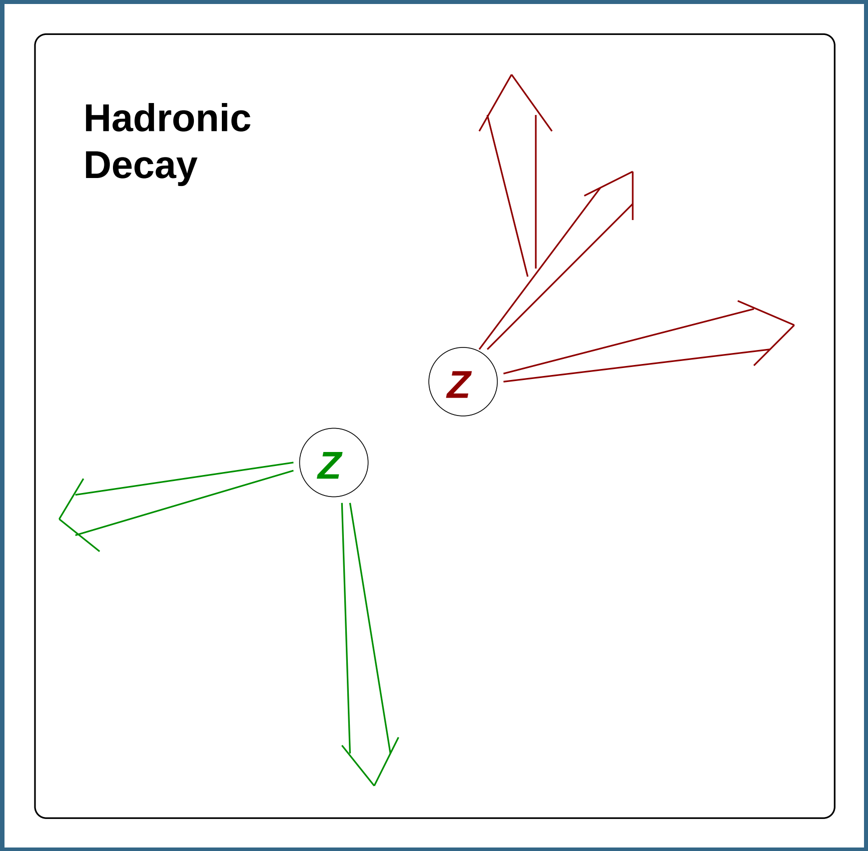

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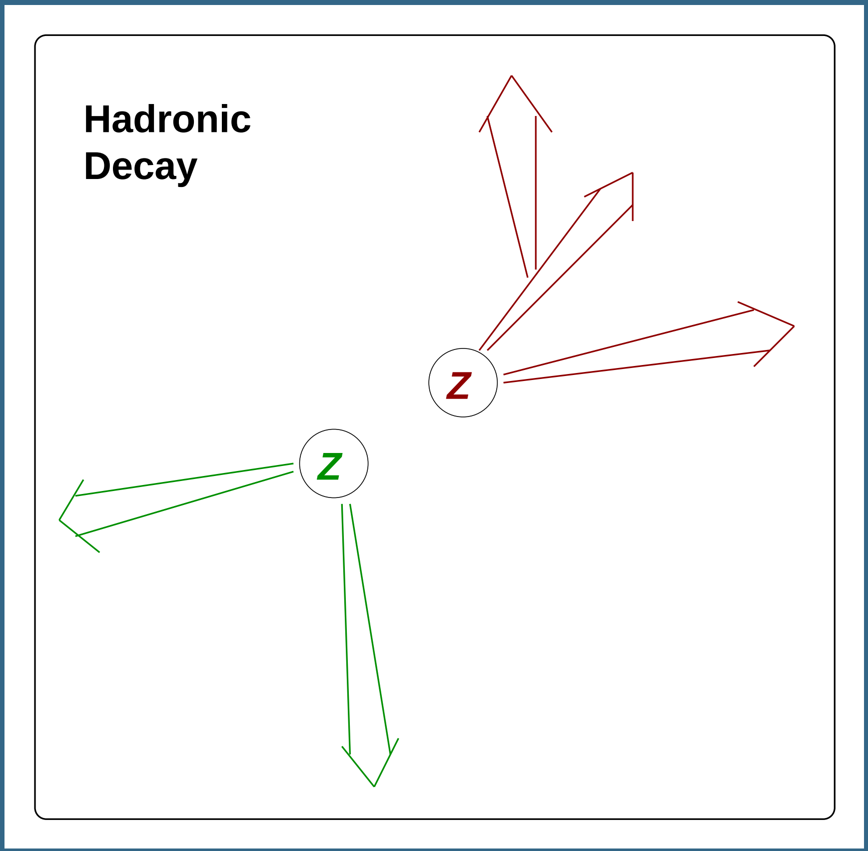

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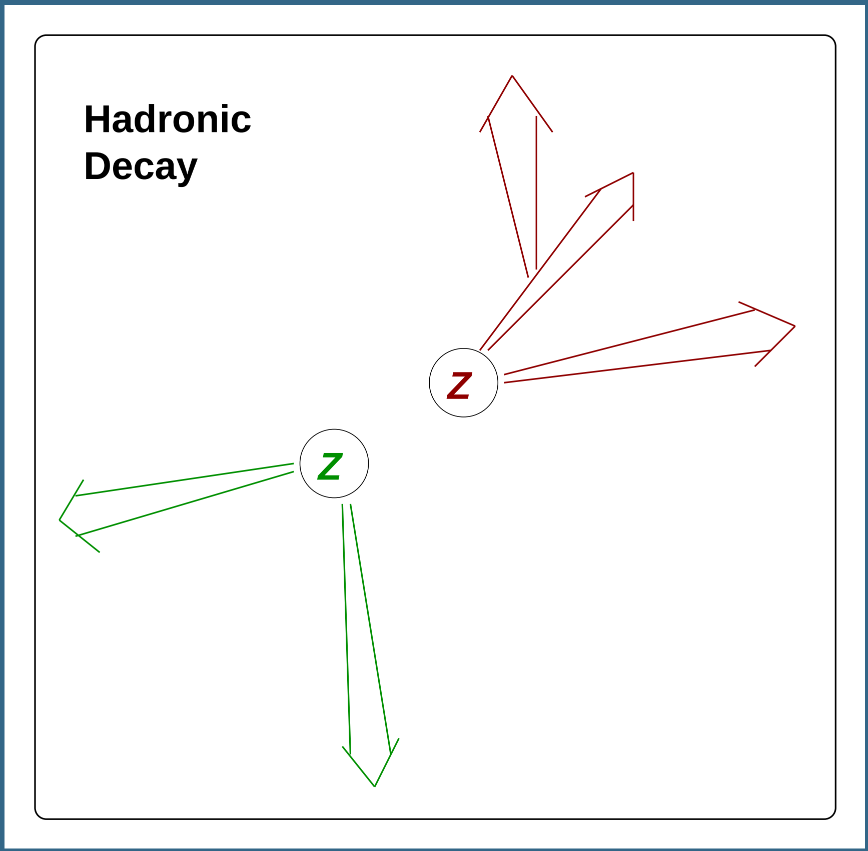

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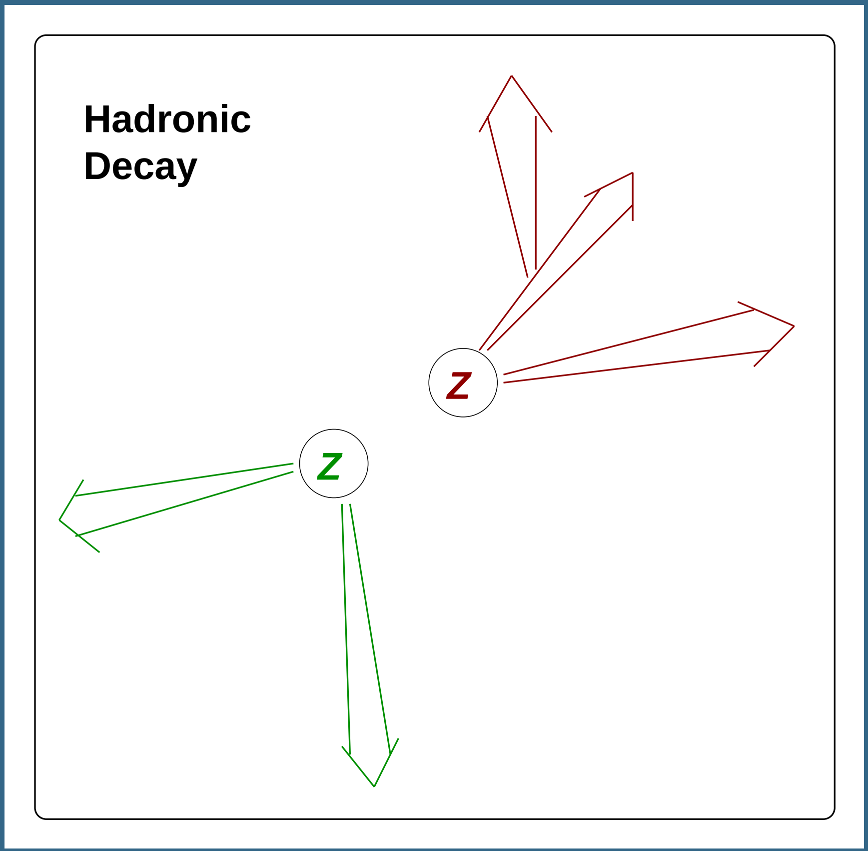

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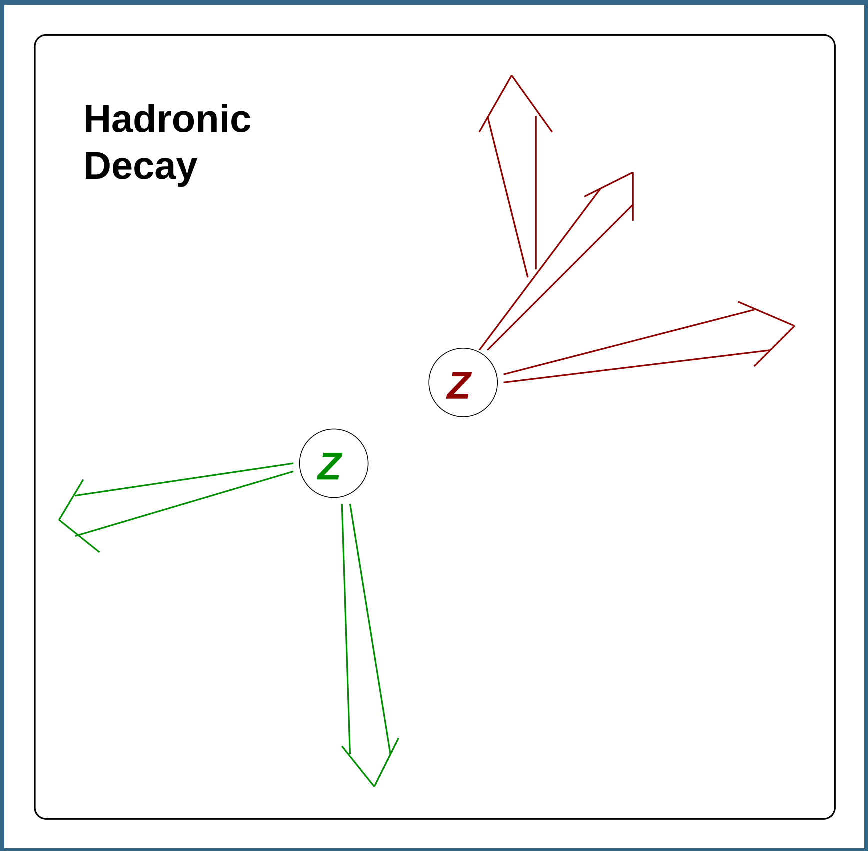

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- Require large datasets for training – more than 50,000 events.
- FastCal suited for use.

To Do

- Muon ionization in ECAL and HCAL.
- Electron and photon energy leakage into HCAL.
- Energy leakage out the back of HCAL.
- Lateral Shower smearing.

FastCal Results

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- Code available for download.

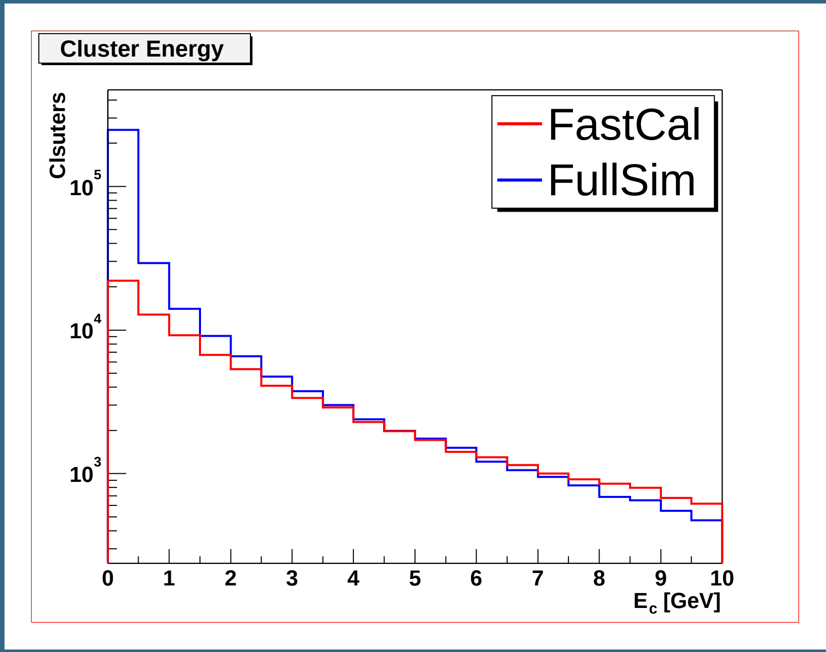
Final Slide

- Download:
  - ⋆ URL: `http://nscp.upenn.edu/∼saurav/nlc/fcal`
  - ⋆ contact: `saurav@nscp.upenn.edu`

- Acknowledgements:
  - ⋆ Kevin Sterner, Pavlos Protopapas and Robert Hollebeek for guidance and advice.
  - ⋆ Gary Bower for help at crucial stages.

Low Energy Clusters in FullSim ?

- Too many very low energy clusters in FullSim



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