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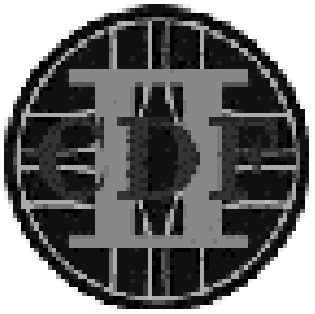


Detecting photons and pions at CDF

Martin Griffiths

First year project: aims

- Study detector response to single photons.
- Repeat analysis for single pions.
- Work towards an algorithm to distinguish the two.
- Become familiar with the TeVatron and CDF.
- Learn the tools of the trade – CDF software, C++, ROOT…

Summary: the work so far

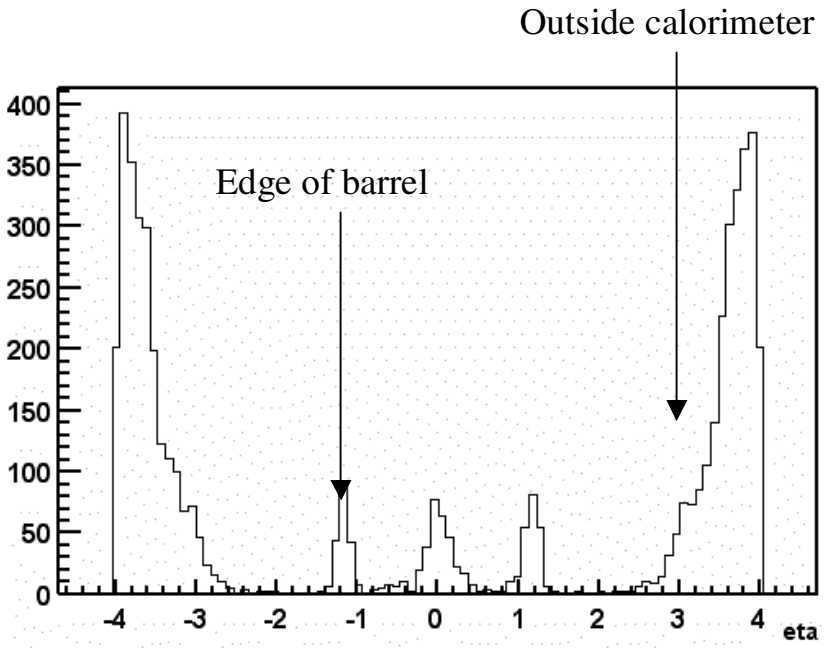
- Generated ntuples of ‘fake events’ – single particle guns of photons and pions over range of momenta and angles.
- Begun investigation of detector response to photons – energy resolution and angular coverage of electromagnetic calorimeter.
- Made a study of opening angle of the two photons produced in pion decay.

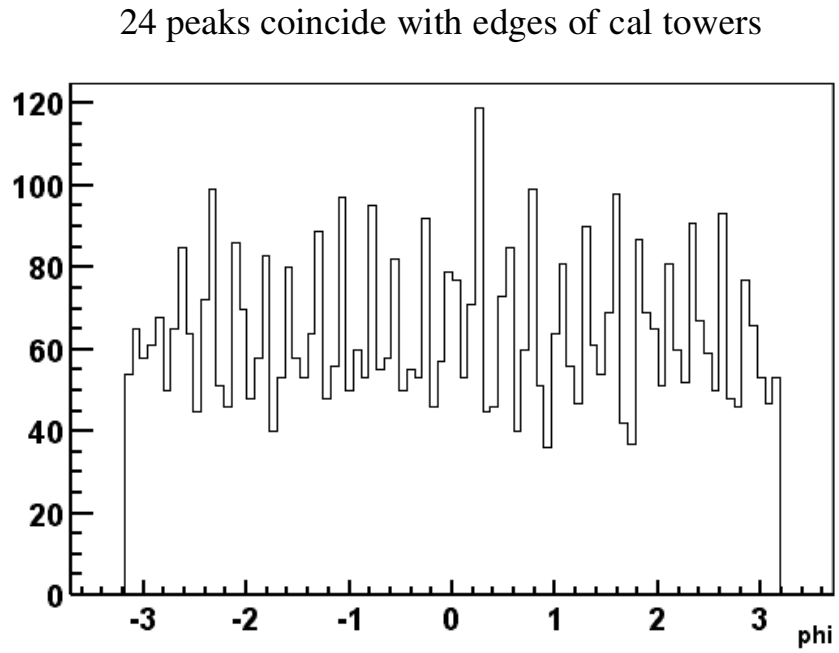
Ntuples generated:

- Photons and pions
- Momenta of 2, 3, 5, 10, 20 and 40 GeV.
- θ of 30^o, 60^o and 90^o.

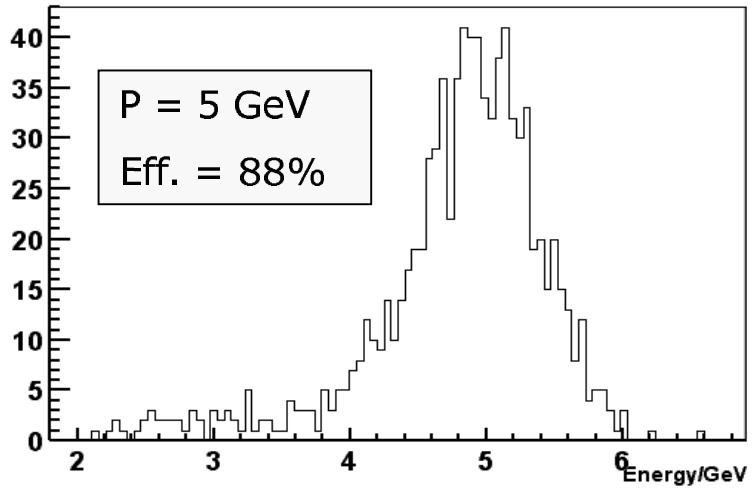
Angular coverage of em cal

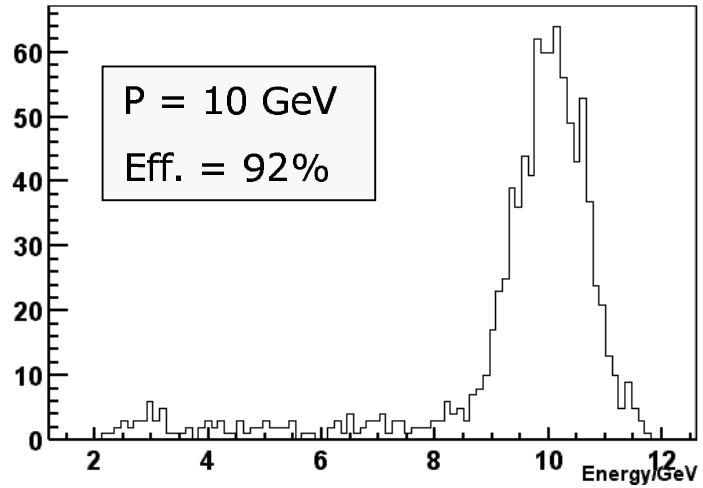
- 'em' block in ntuple contains clusters with energy > 2 GeV and $E_{had}/E_{em} < 0.125$ – mainly photons but also electrons and positrons from conversions.
- For some events no such clusters are found – 'lost' photons.
- Looked at true angular distribution of the lost photons in a large ntuple (30,000 photons) spread over $-4 < \eta < 4$ to look for features of the calorimeter.

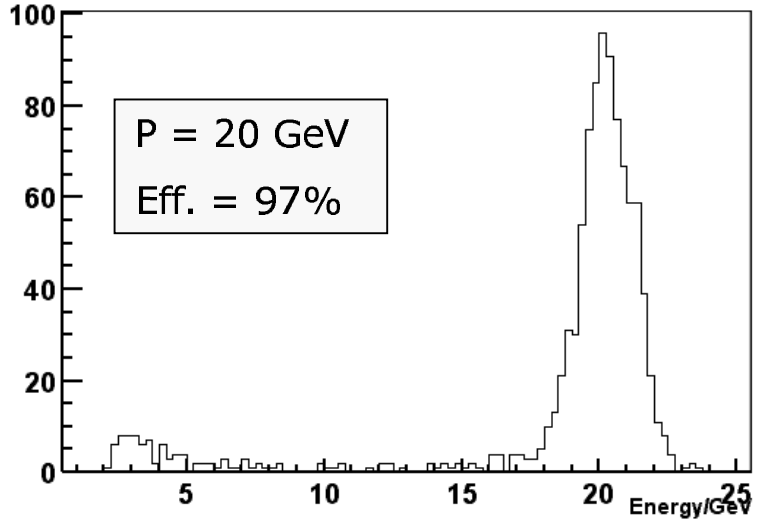


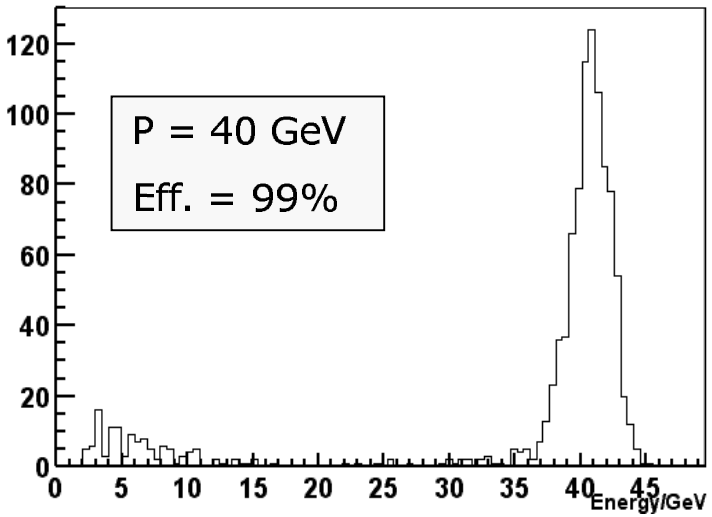


Efficiency and energy resolution





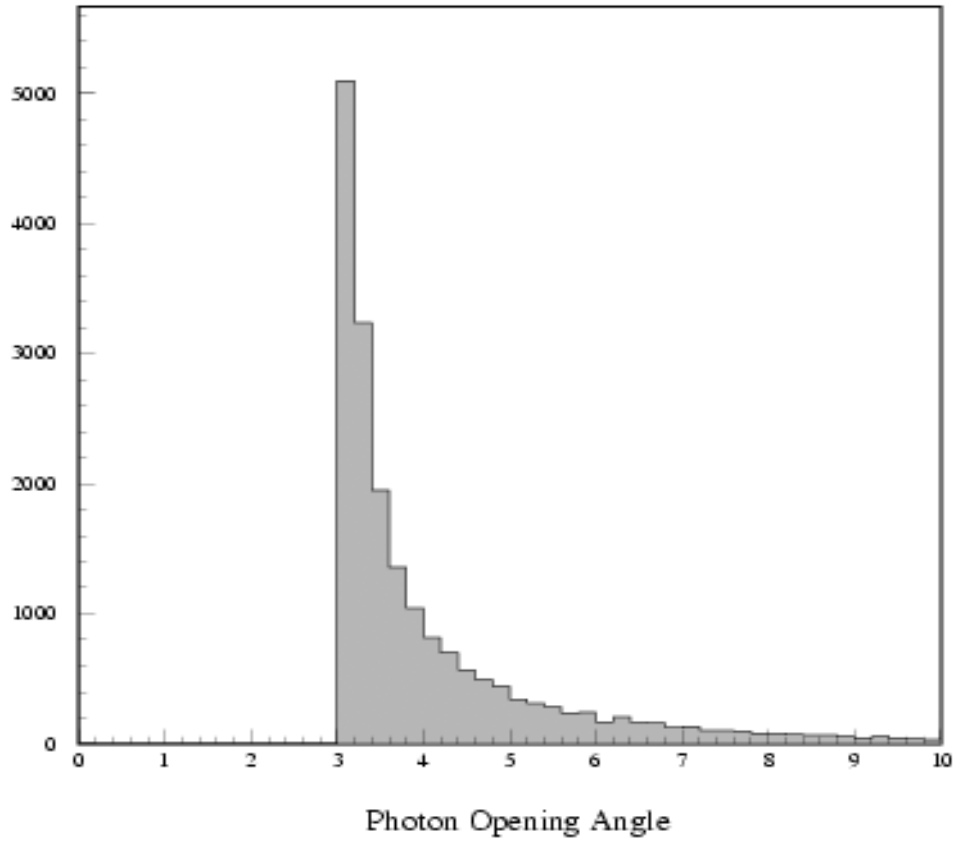




(efficiency at 2 GeV is 5% and at 3 GeV 68%)

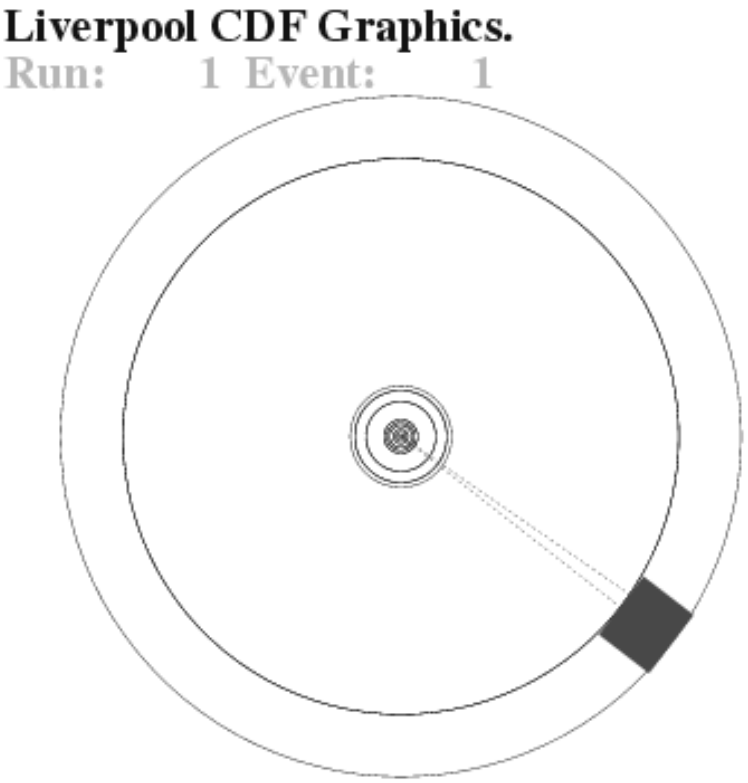
Pions: opening angle of photons

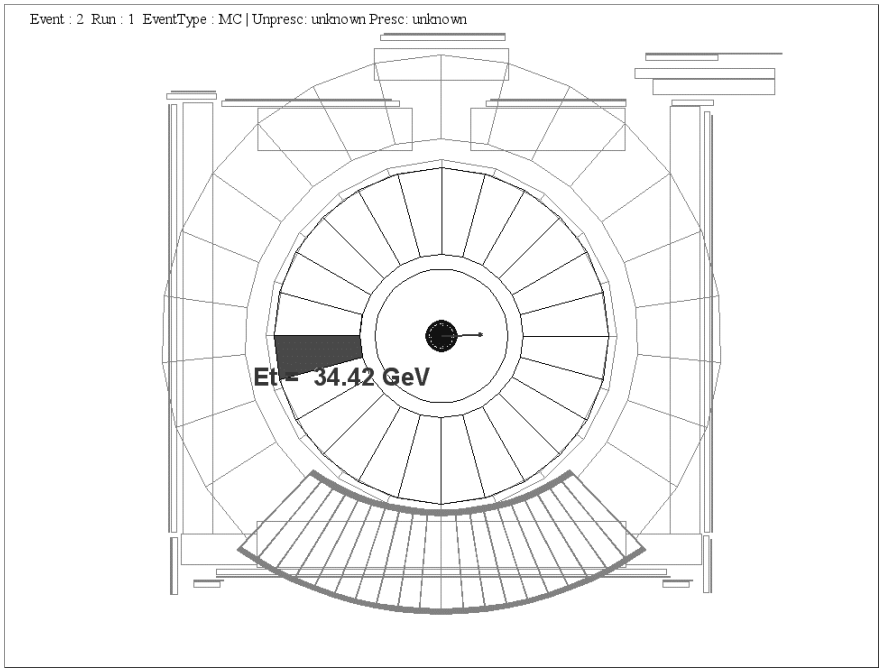
- Two clusters in ‘em’ block would be a good signal for a pion, but didn’t find any of these in single pion ntuples.
- Theory says angular distribution is peaked at opening angle of $2/\gamma$. For 5 GeV pions this is approx. 3^{o} compared to tower width of 15^{o}.
- Need to look at information from wire chamber inside calorimeter.



Pions: opening angle of photons

Both photons from pion decay fall within same calorimeter tower.





Summary: what next?

- Have begun study of photons and pions, learning about the tools along the way.
- Many more things to look at:
  - Frequency and position of $\gamma \rightarrow e^+e^-$ conversions – map out detector.
  - Look at energy deposited in hadronic calorimeter – leakage.
  - Access wire chamber information to resolve two photons from pion decay.
  - Think about ways to distinguish photons and pions.