Determination Of The Charm Fragmentation Function

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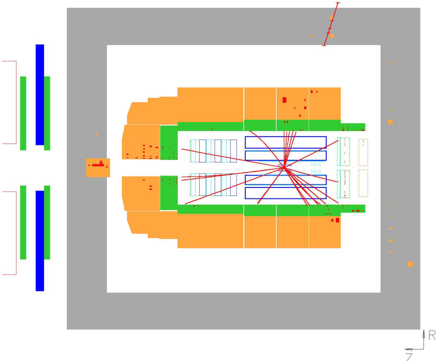
&
Kristoffer Menzel

September 9, 2005

What is fragmentation?



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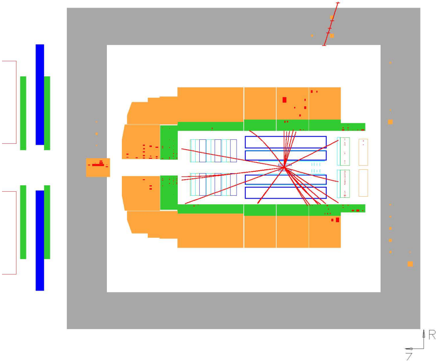

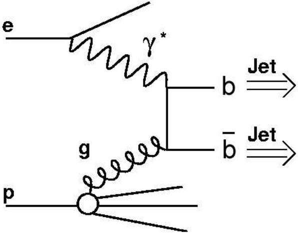

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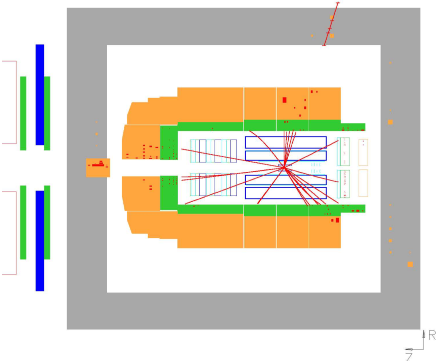

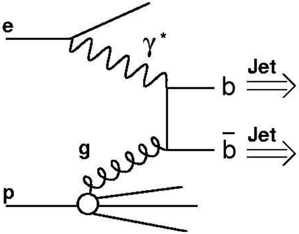

What do we measure?

π^-, π^+, γ, μ^-, γ, K^0_S, γ, γ,
K^-, π^+, p^+, π^+, γ, γ, ...

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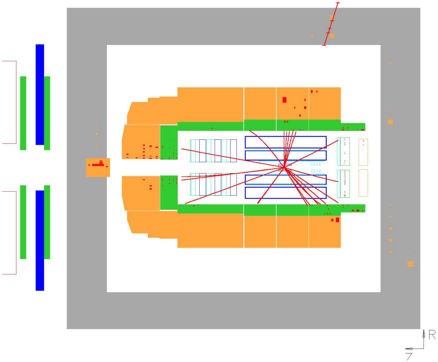

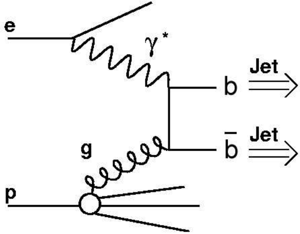

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$\pi^-, \pi^+, \gamma, \mu^-, \gamma, K_S^0, \gamma, \gamma,$
$K^-, \pi^+, p^+, \pi^+, \gamma, \gamma, \ldots$

WHAT IS MISSING?

the process in between:
HADRONIZATION / FRAGMENTATION

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Compare experimental data with theoretical predictions.

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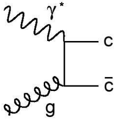
example: photon-gluon fusion:



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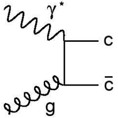

$$\sigma_{total}(\gamma^* g \rightarrow c\bar{c} \rightarrow D^{*\pm}X) = \int \begin{pmatrix} \text{gluon density} \\ \text{in the} \\ \text{proton} \end{pmatrix} \times$$

$$\times \begin{pmatrix} \gamma \text{ g - fusion m. e.} \\ \text{and higher order} \\ \text{corrections} \end{pmatrix} \times \begin{pmatrix} \text{fragmentation function} \\ \text{of c quark} \\ \text{into } D^{*\pm} \text{ meson} \end{pmatrix} \mathrm{d}Q^2 \mathrm{d}y$$

Approach in an MC event generator: RAPGAP 3.1 & PYTHIA 6.2

LUND fragmentation scheme: COLOR strings

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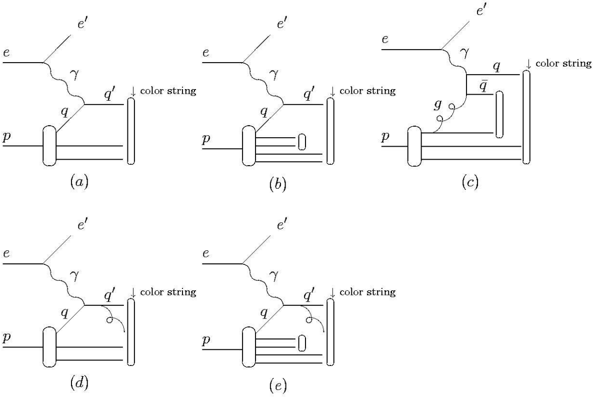

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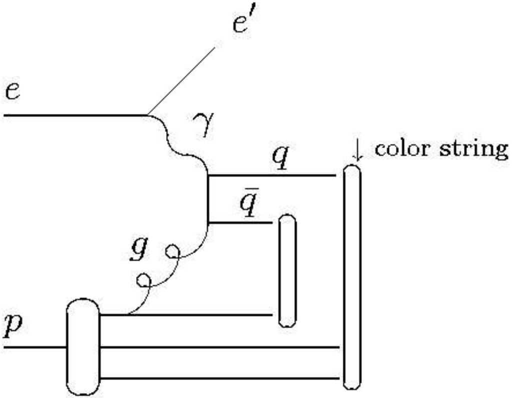

(c)

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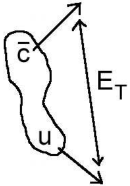

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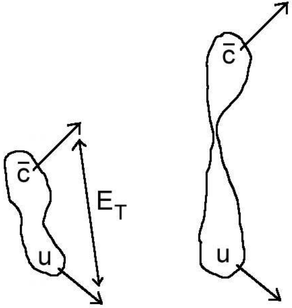

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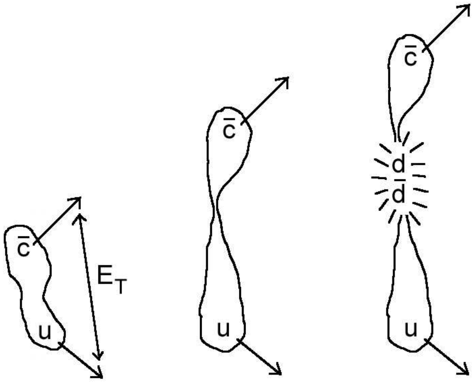

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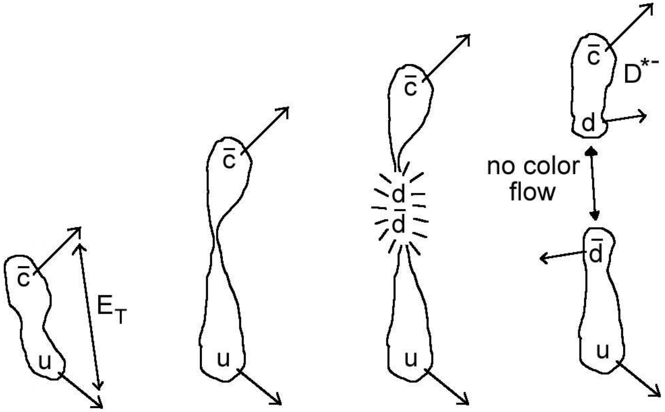

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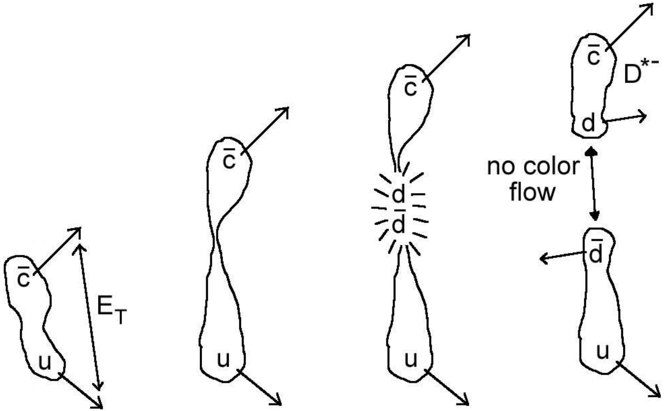

What energy fraction of the string has the D^{*-} Meson?

What is a fragmentation function? How does it look like?

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- fraction of hadron's energy from the parton: $z = \frac{(E+p_L)_{hadron}}{(E+p_L)_{parton}}$

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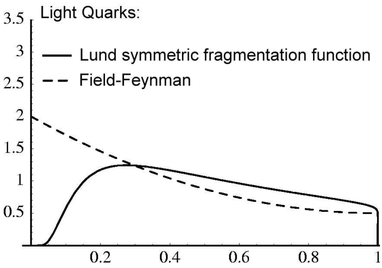
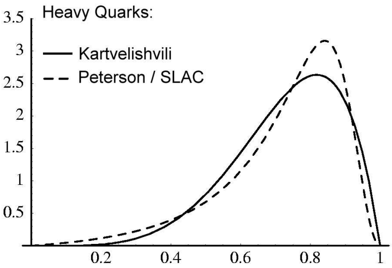
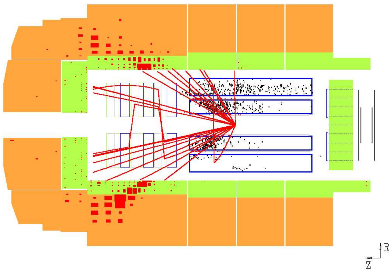
- $\Rightarrow$ phenomenological parametrizations expressing the distribution of the final state energy
- some widely used ones:





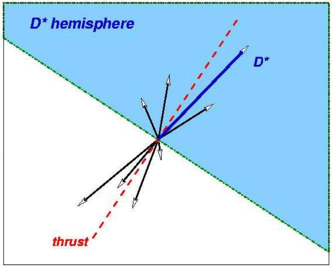
How to measure z

JET METHOD



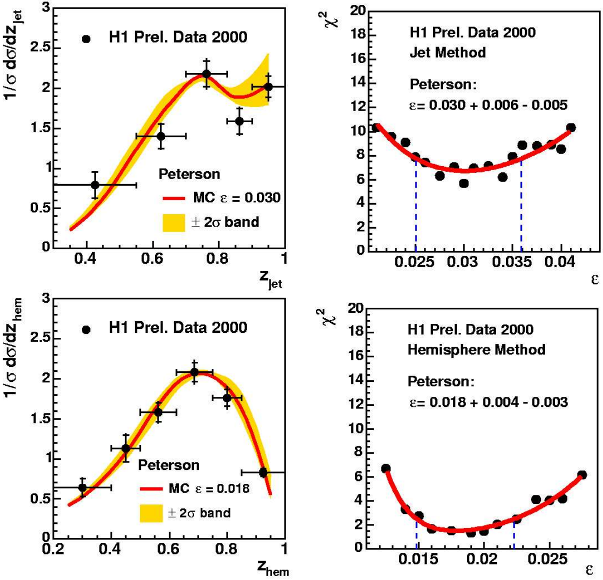
$$z = \frac{(E + p_L)_{hadron}}{(E + p_L)_{jet}}$$

HEMISPHERE METHOD



$$z = \frac{(E + p_L)_{hadron}}{\sum_{hemisphere}(E + p_L)}$$

RESULTS FOR PETERSON



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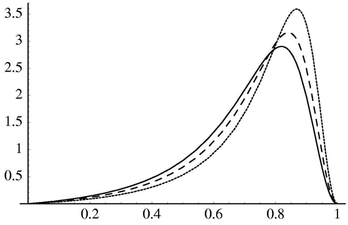
- needed to write out 'real' fractions z generated at MC simulation to obtain weights

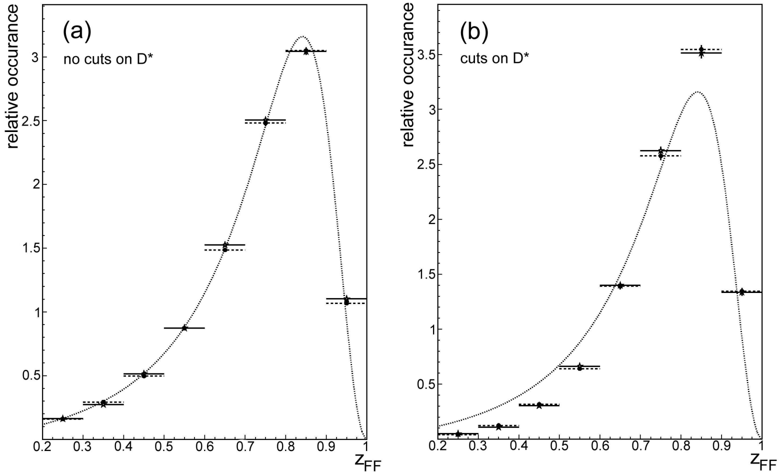


Our work

What was necessary for this rescaling?

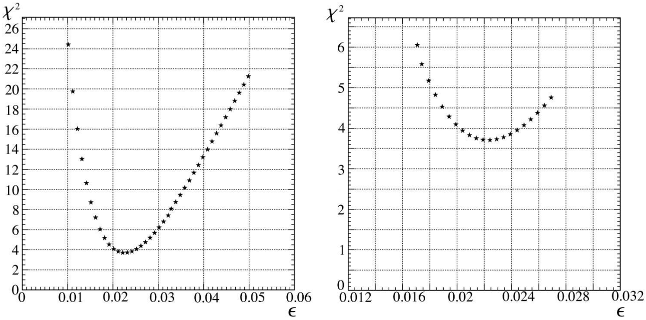
- Generating data with the same detector cuts (Q^2, y, $\eta(D^{*\pm})$, ...)
- Writing out only interesting events: $D^{*\pm} \rightarrow D^0\ \pi_s^\pm \rightarrow K^\pm\ \pi^\mp\ \pi_s^\pm$
- Obtain generated 'real' values z
- Reweighing
- Cross check with generated data
- Implement Jet and Hemisphere Method
- Writing a routine to calculate χ^2

RESULT



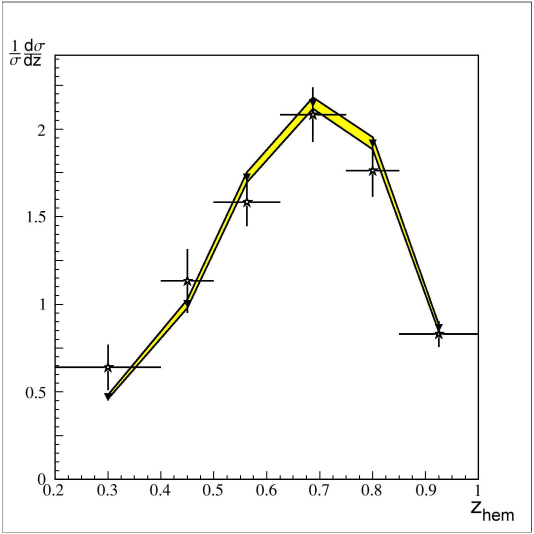
(a)
no cuts on D*
relative occurance
0.5
1
1.5
2
2.5
3
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
z_{FF}
(b)
cuts on D*
relative occurance
0.5
1
1.5
2
2.5
3
3.5
z_{FF}

RESULT



χ²
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
0.01
0.02
0.03
0.04
0.05
0.06
ϵ
χ²
6
5
4
3
2
1
0
0.012
0.016
0.02
0.024
0.028
0.032
ϵ

RESULT



$\frac{1}{\sigma}\frac{d\sigma}{dz}$
2
1.5
1
0.5
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
z_{hem}

CONCLUSION

- The reweighing worked
- Fitting can be done much faster now

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NOT ONLY OUR WORK WAS EXCITING, BUT THE PEOPLE HERE WERE GREAT!