

B-tagging at HERA

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H1 Collaboration

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Why b-tagging?

Higgs and t decays
test of QCD

Outline of this talk

- Technics used elsewhere
- Status of b measurements in H1
- Developments of an inclusive tag

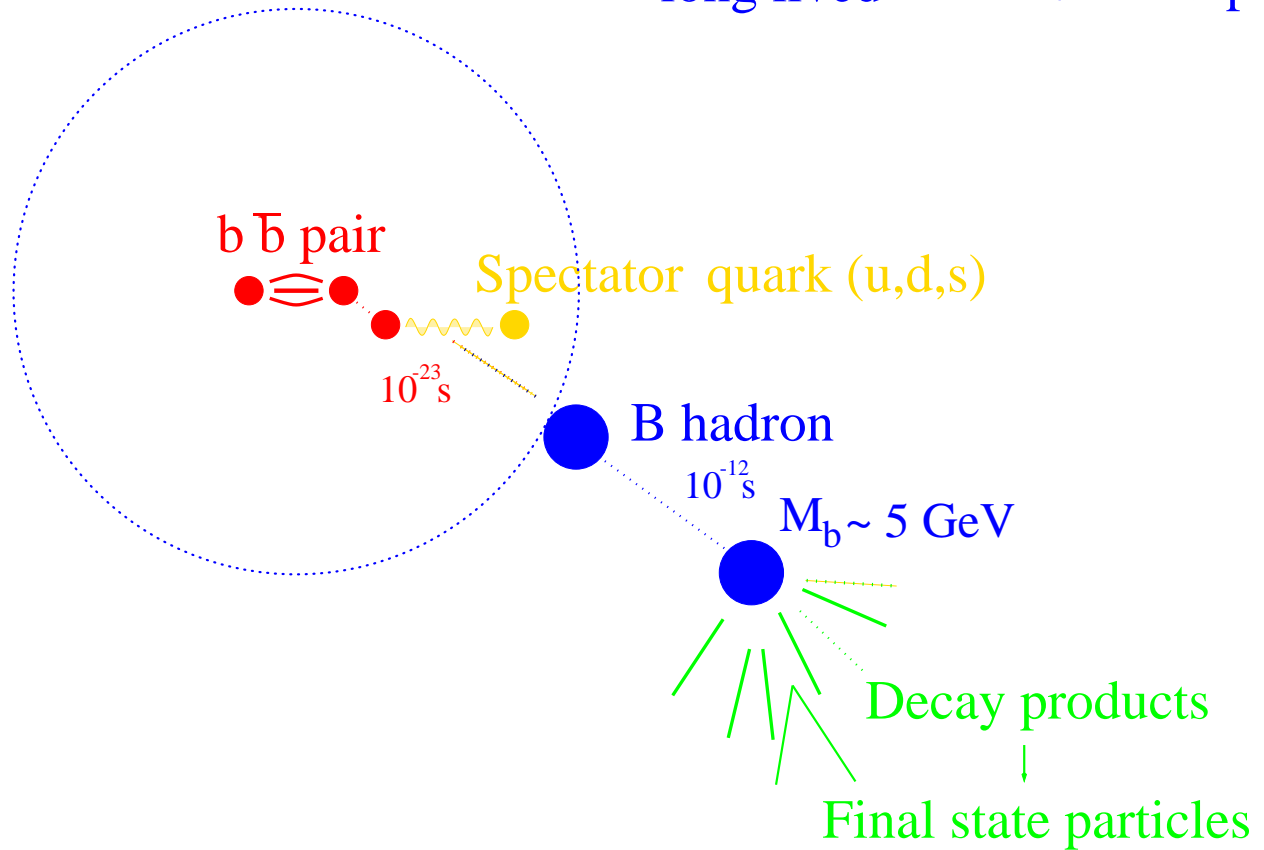
How can we *see* a b quark?

heavy

$m = 5 \text{ GeV}$

long lived

$\tau = 1.5 \text{ ps}$

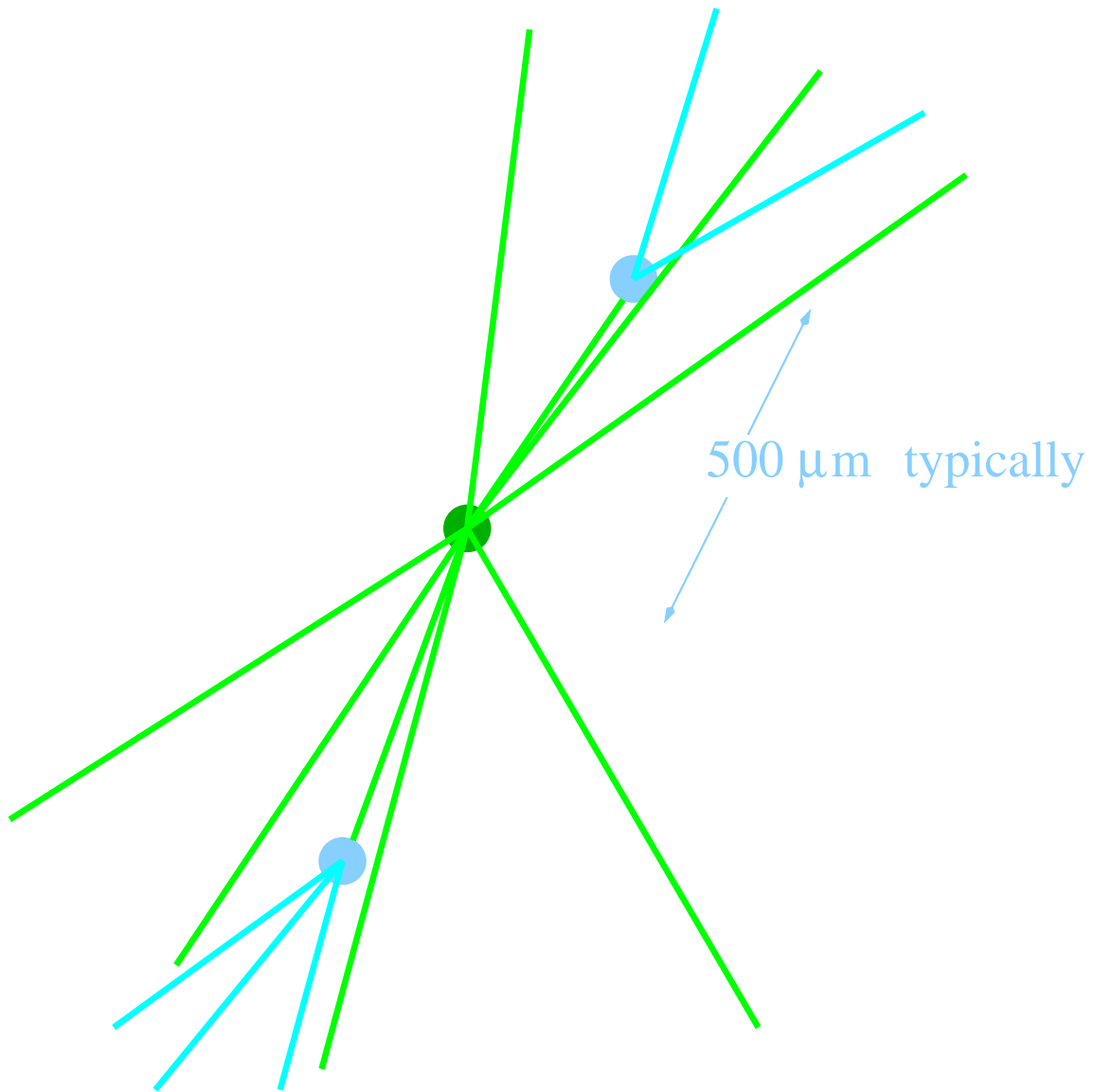


Big mass \Rightarrow small BRs \rightarrow low efficiency
many tracks \rightarrow large BG

Exclusive reconstruction of the invariant mass is difficult

Use lifetime signature?

In an ideal world



In the real world



Look for inclusive methods

- lepton decays
- secondary vertices

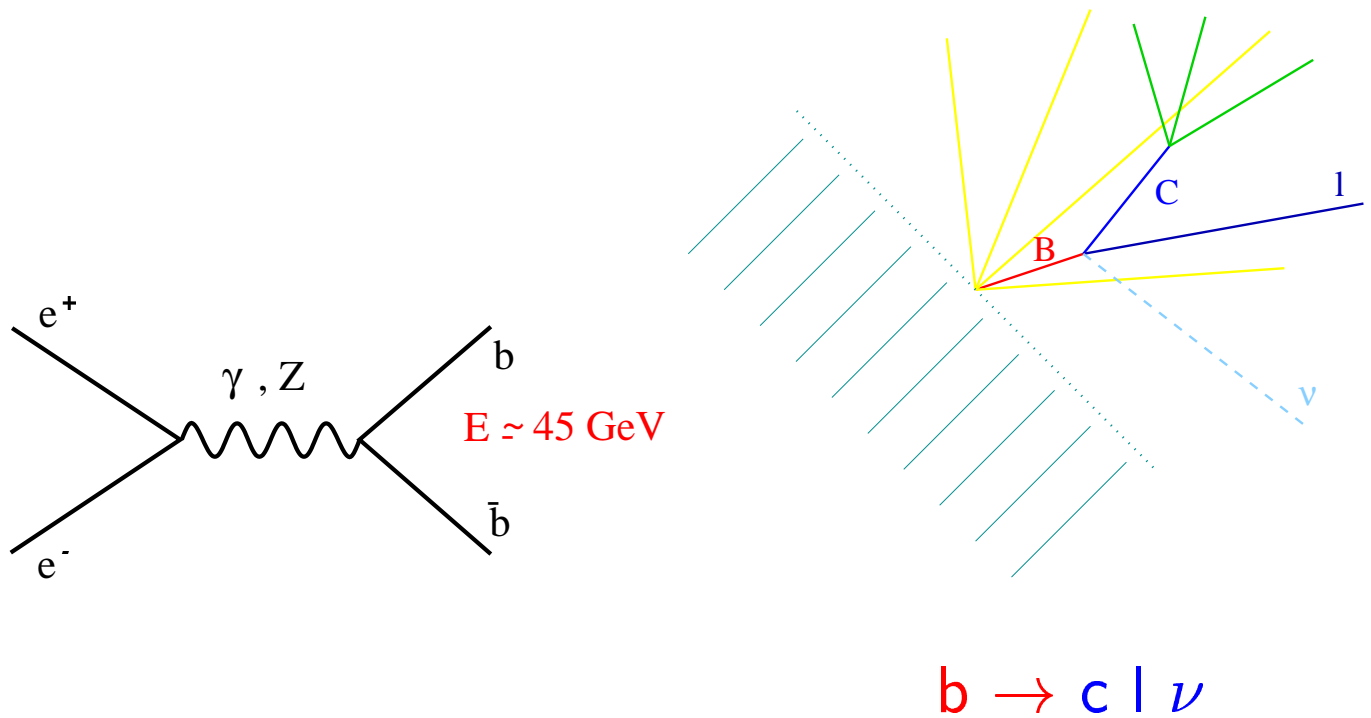
EXAMPLES OF B-TAGGING

I) Search for secondary vertices

II) Probability for secondary vertices

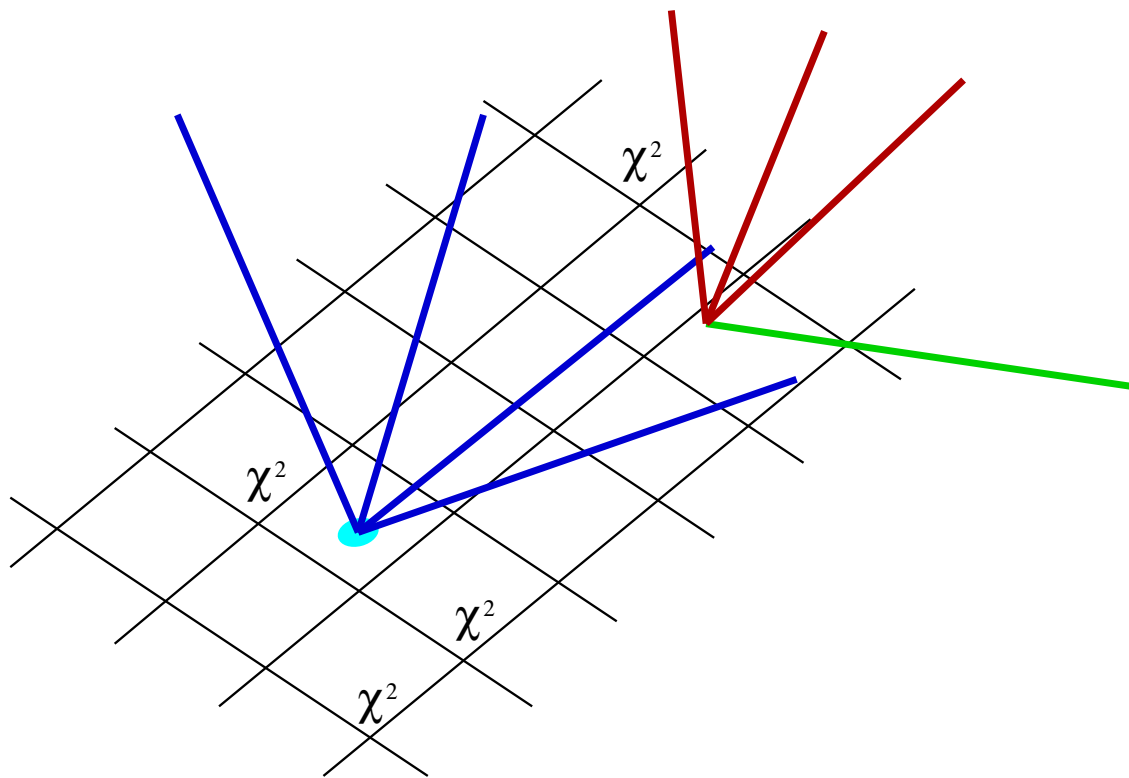
I) RECONSTRUCTION OF SECONDARY VERTICES

[ref. ALEPH]



B-tagging steps

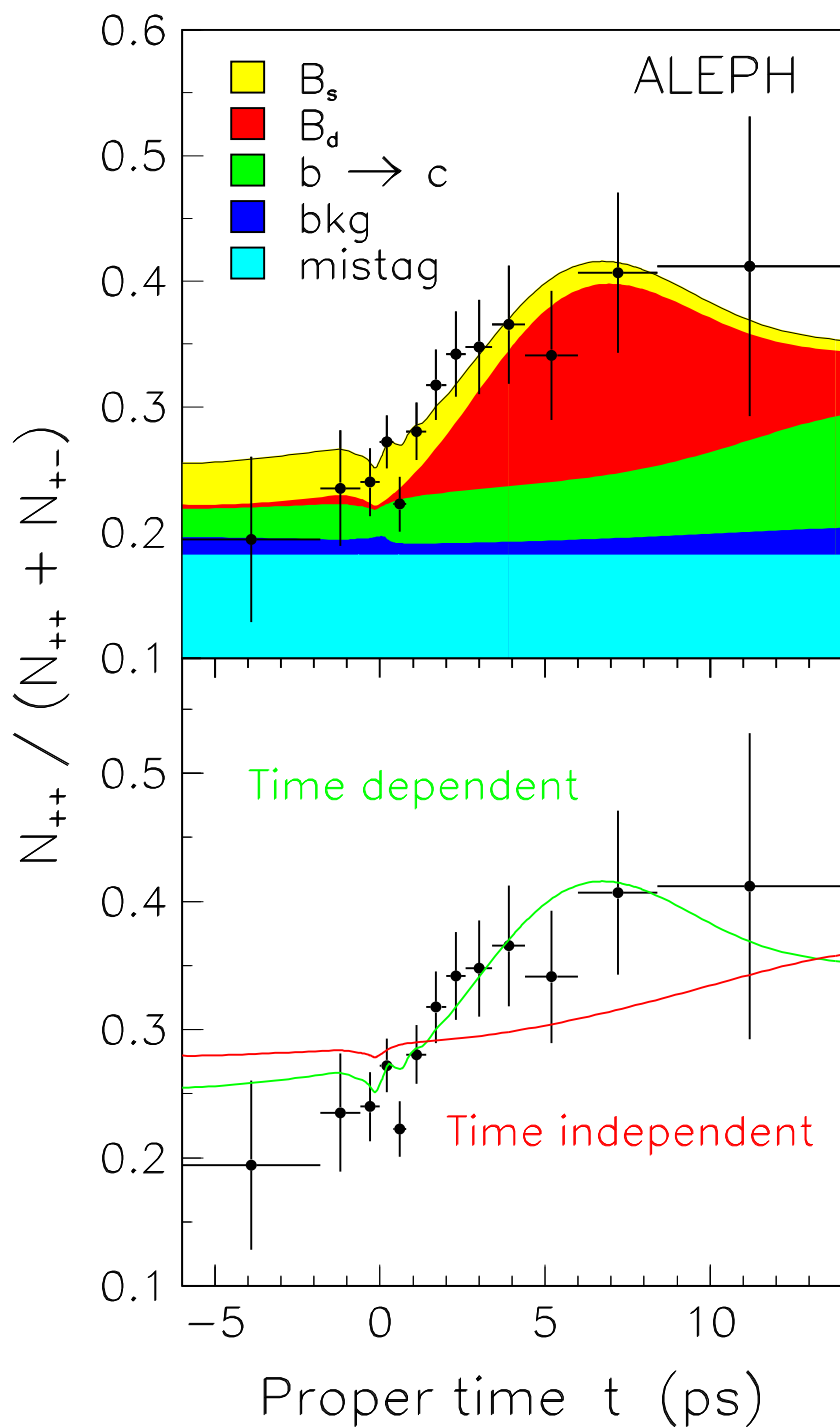
- primary VX reconstruction
- secondary VX reconstruction \rightarrow
- determination of the B decay length



Secondary vertex fit

- loop over space points
- assign track to the vertex that fits better
- calculate $\chi^2 \rightarrow$ best χ^2 is VX2

OBSERVATION OF B OSCILLATION



II) MULTI IMPACT PARAMETER METHOD

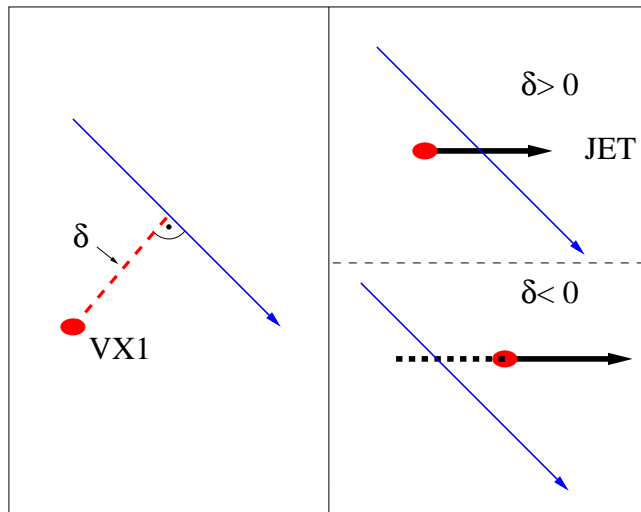
Looking at the probability that a group of tracks comes from the (primary) vertex

B-tagging steps

- primary vertex reconstruction
- impact parameter calculation
- significance of the impact parameter
- single track probability
- combined probability

New variables to define

- Impact parameter



- Impact parameter significance

$$S = \frac{\delta}{\sigma_{\delta}}$$

(Phis.Rew. D64 032002, fig. 3)

- Track probability

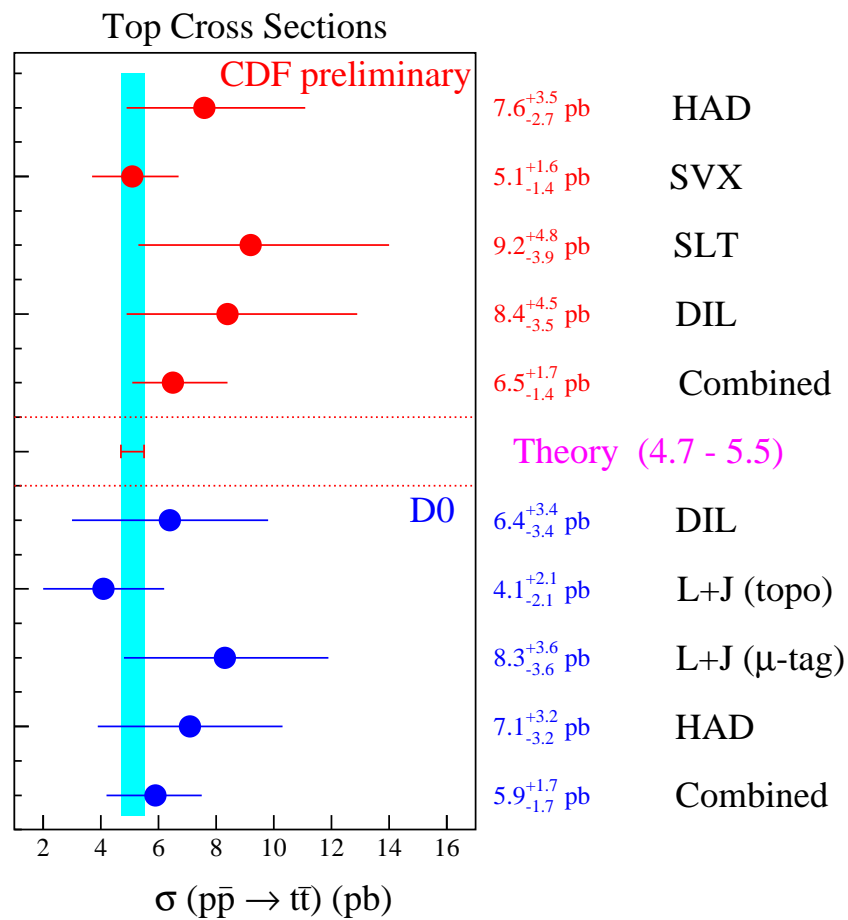
$$p = \frac{\int_{-\infty}^{-|S_0|} R(S) dS}{\int_{-\infty}^0 R(S) dS}$$

- Combined probability of n tracks

$$P = Q \sum_{i=0}^{n-1} \frac{(-\ln Q)^i}{i!} \quad Q = \prod_{i=1}^n p_i$$

(Phis.Rew. D64 032002, fig. 5a)

MEASUREMENT OF THE t CROSS SECTION



b-tagging does work
in different environments



WE

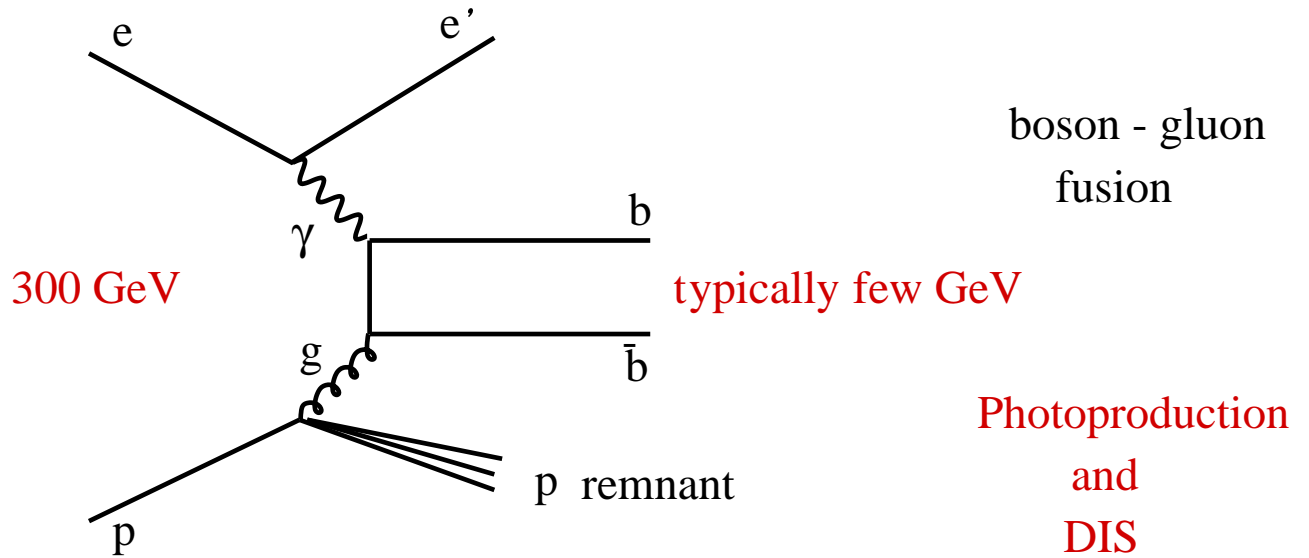
WANT

IT

TOO

! ! ! ! !

OPEN BEAUTY PRODUCTION AT HERA

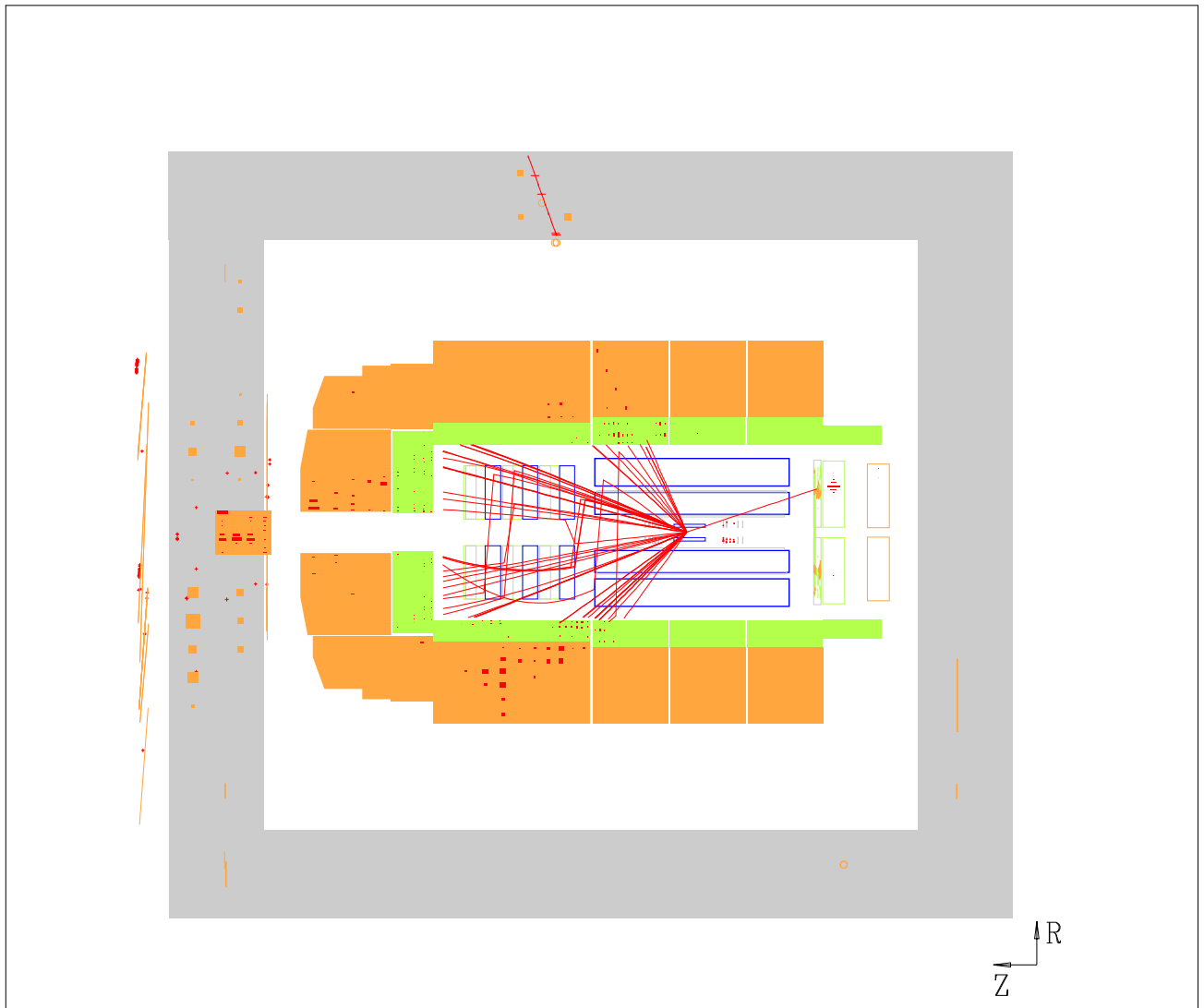


rare process

small cross section
(σ_b 100 times small than σ_c)

Photoproduction and DIS events

$$B \rightarrow X \mu \nu$$



Jet selection

- dijet events
- $E_T \geq 5 \text{ GeV}$

Muon selection

- $p_T \geq 2 \text{ GeV}$
- $30^\circ \leq \theta \leq 135^\circ$

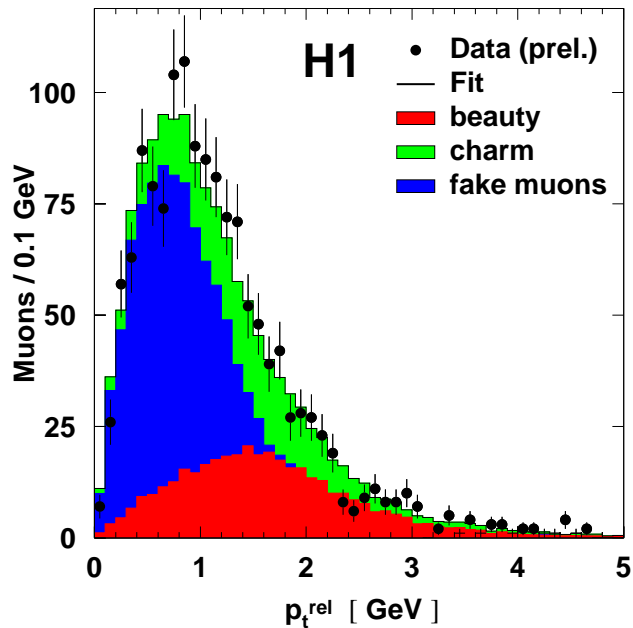
Beauty signatures

1) big mass \rightarrow high p_T^{rel}

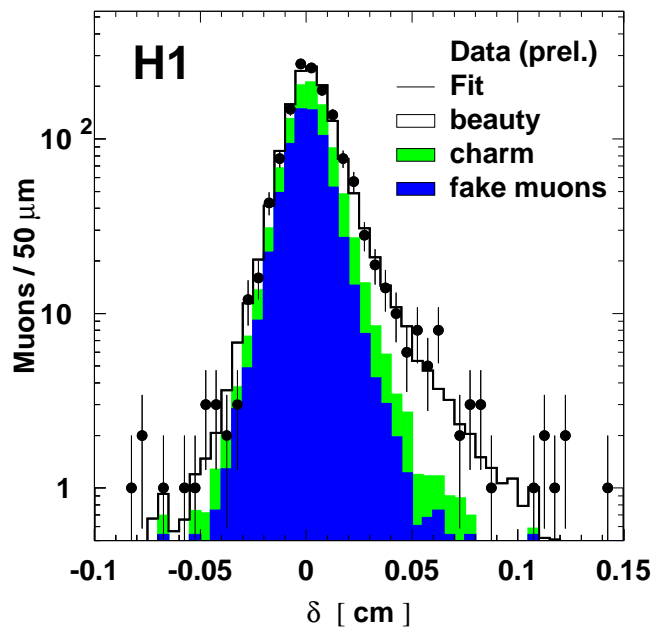
2) long life \rightarrow large δ

*independent
methods*

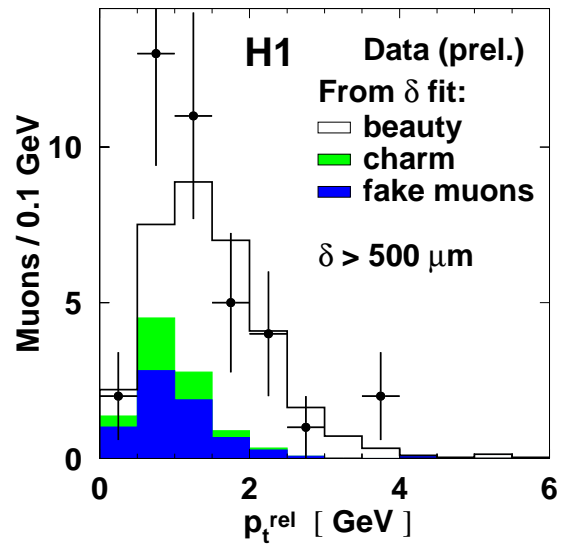
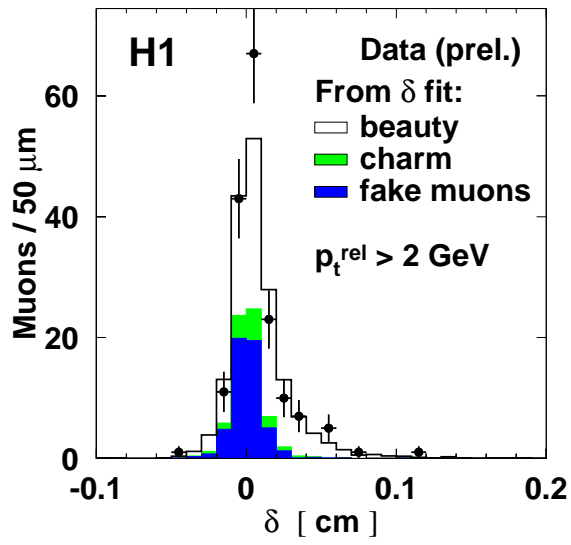
1) p_T^{rel} method



2) impact
parameter
method

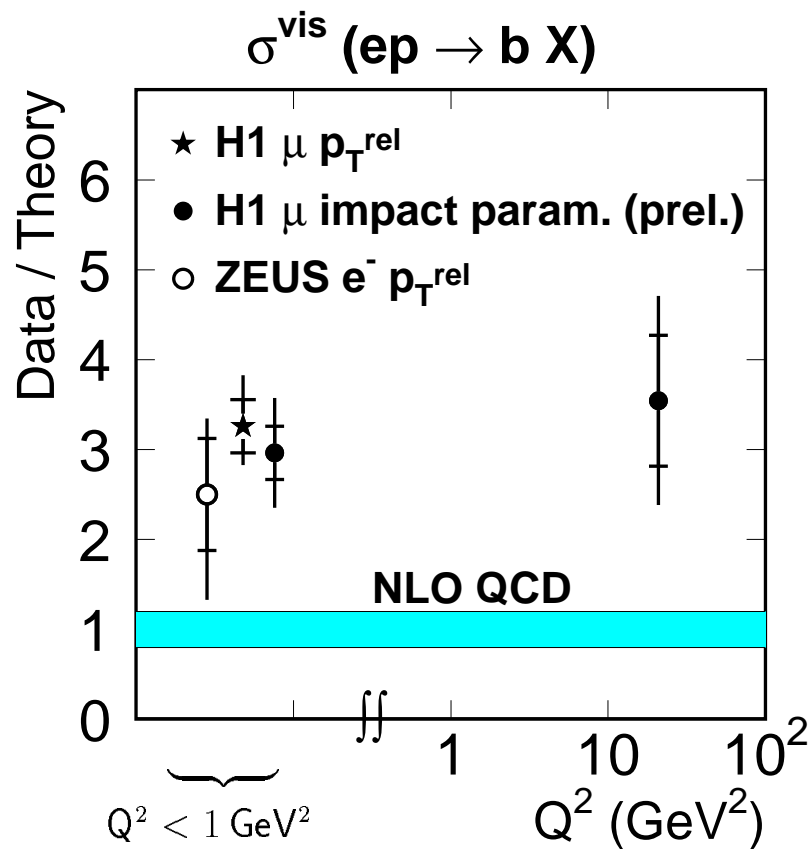


ENRICHED SAMPLE



Combined separation power

SUMMARY OF HERA RESULTS



σ^{meas} exceeds σ^{theor} (QCD, LO + NLO)
and is Q^2 independent

True also in $\bar{p}p$, $\gamma\gamma$

TOWARDS A MULTITRACK METHOD

Same sample as above
but
all tracks used

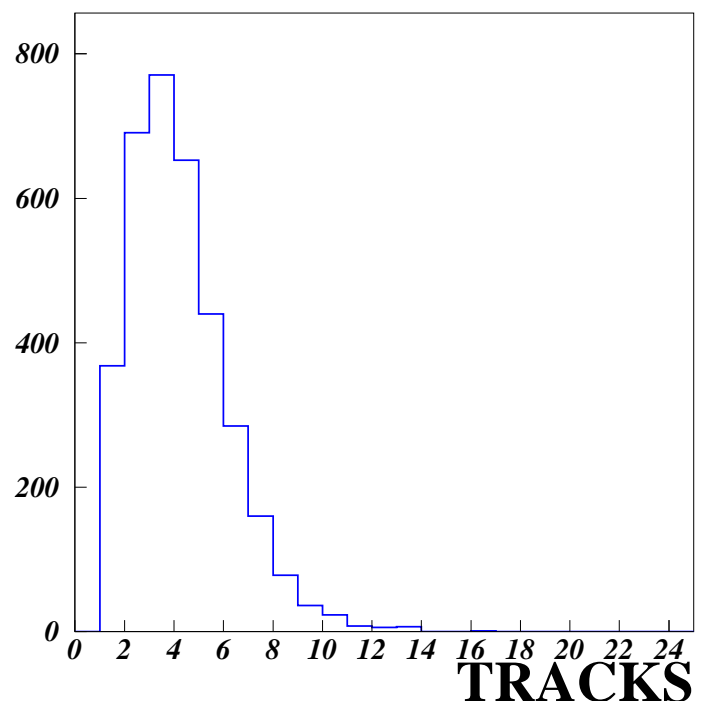
CST resolution \leftrightarrow Need for high P_T tracks

Jet selection

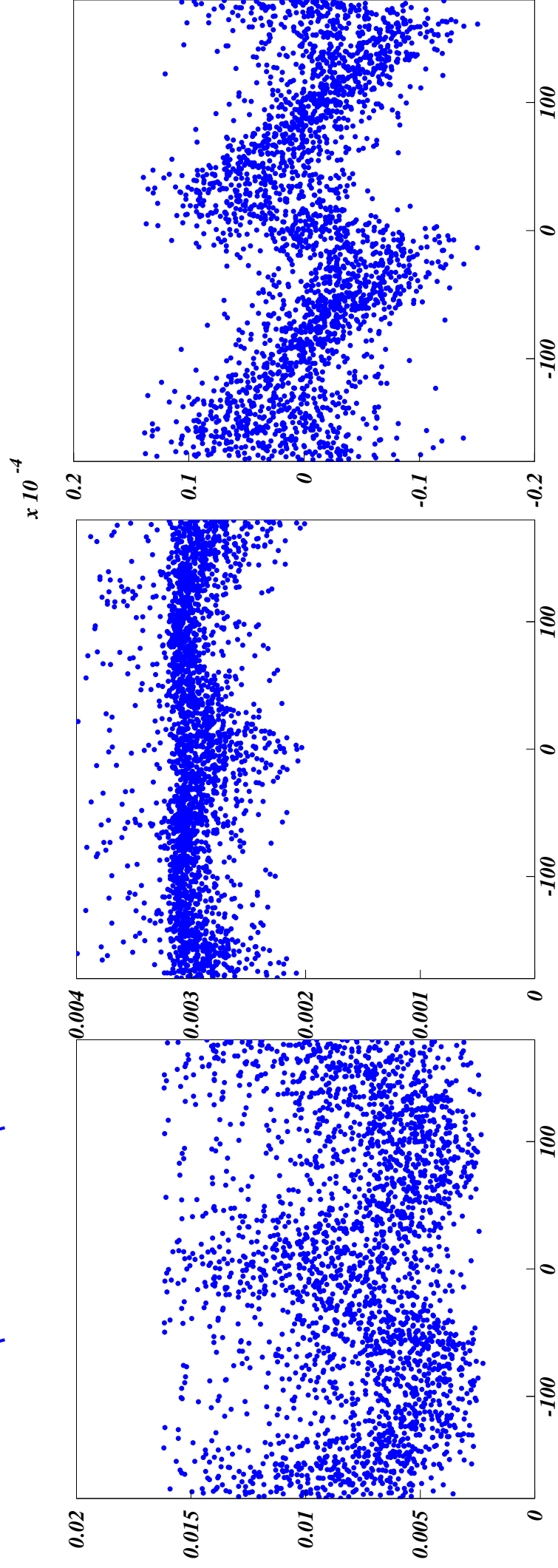
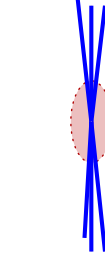
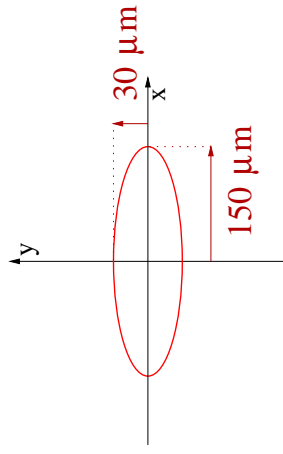
- dijet events
- $P_T \geq 5$ GeV

Track selection

- $P_T \geq 1$ GeV
- $20^\circ \leq \theta \leq 140^\circ$



PRIMARY VERTEX RECONSTRUCTION



OUTLOOK

go on !

Next steps

- δ significance
 - single track probability
 - combined probability
 - gain statistics
- × 10 drop μ
- × 10 more data on tape
- × 10 luminosity upgrade

Other approaches

VX2 method (S. Lueders)

Dileptons (M. Hilgers)