Beauty production at HERA : H1 results

DIS Workshop 2003, St. Petersburg

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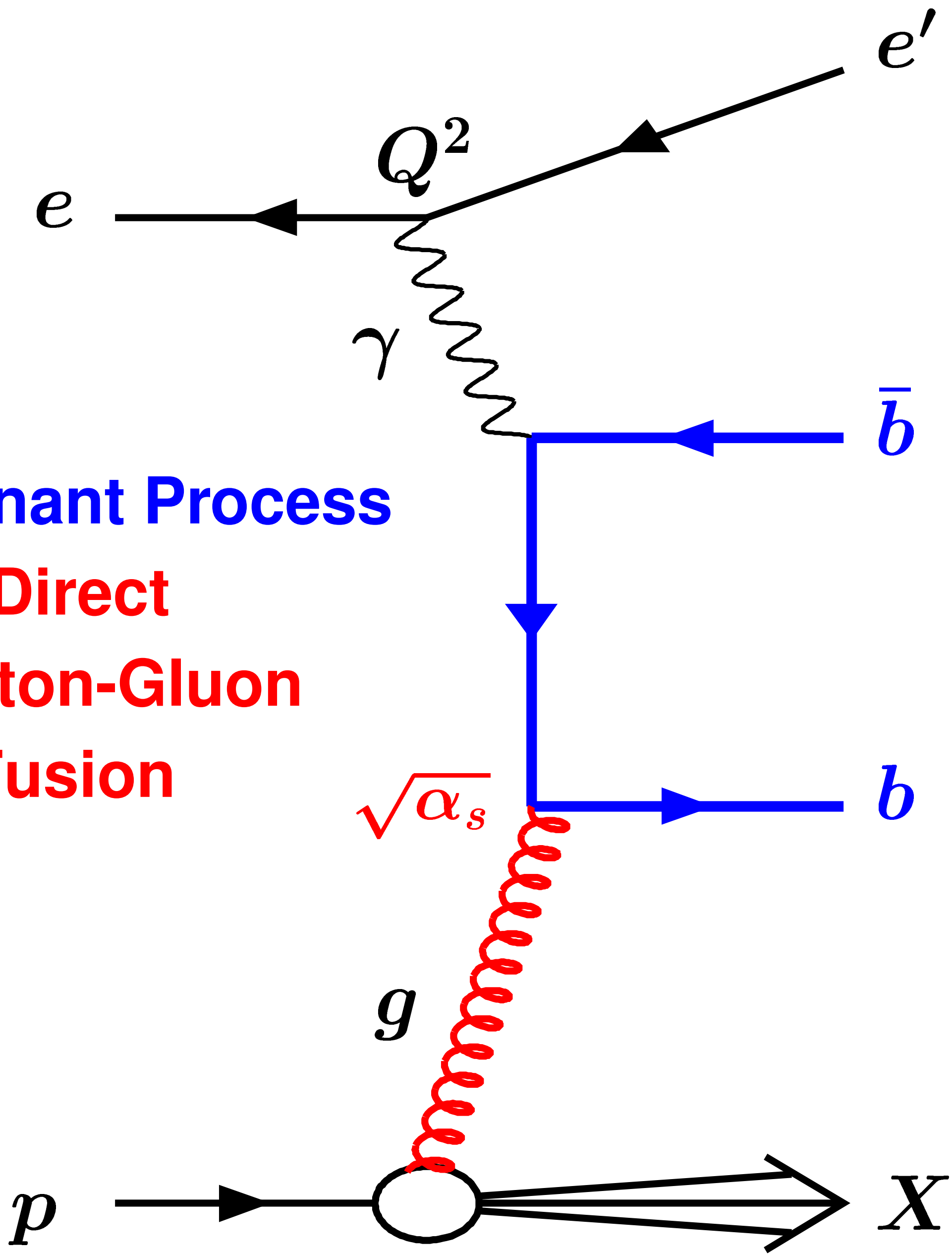
On behalf of the H1 collaboration

Why do we study b production?



Dominant Process

Direct

Photon-Gluon

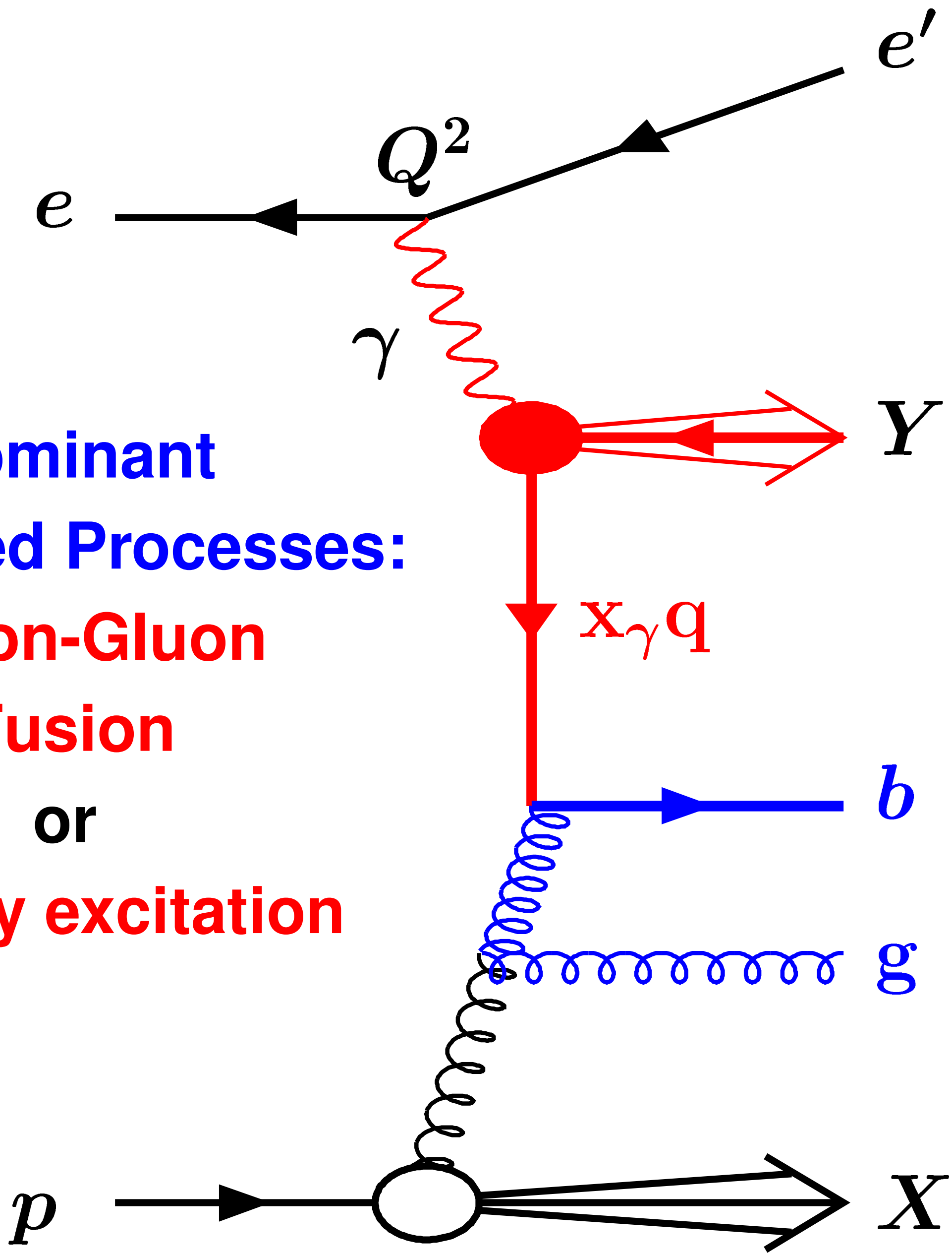
Fusion

- **b mass provides hard scale $\Rightarrow$ α_s small**

$\Rightarrow$ Excellent testing ground for pQCD

- **Sensitive to gluon density in proton**

Resolved photon processes



Dominant

Resolved Processes:

Gluon-Gluon

Fusion

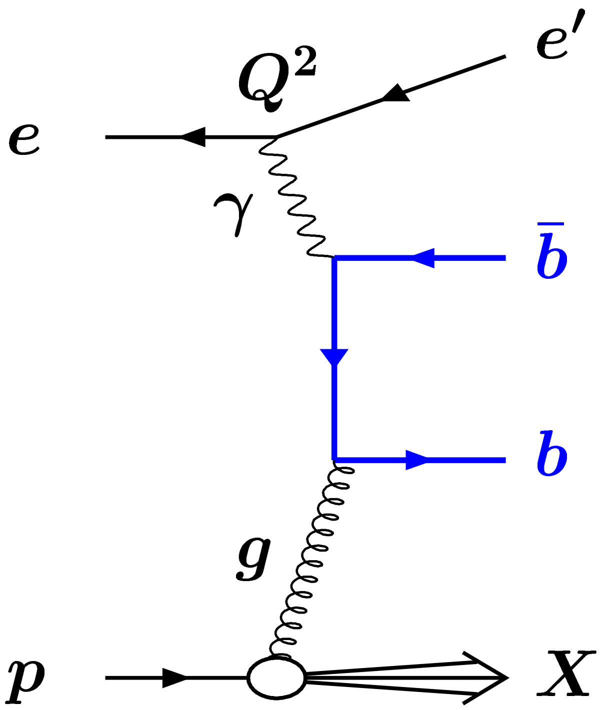
or

beauty excitation

γ fluctuates hadronically

- **Suppressed with Q^2**
- **Sensitive to g and q densities in photons**

Outline



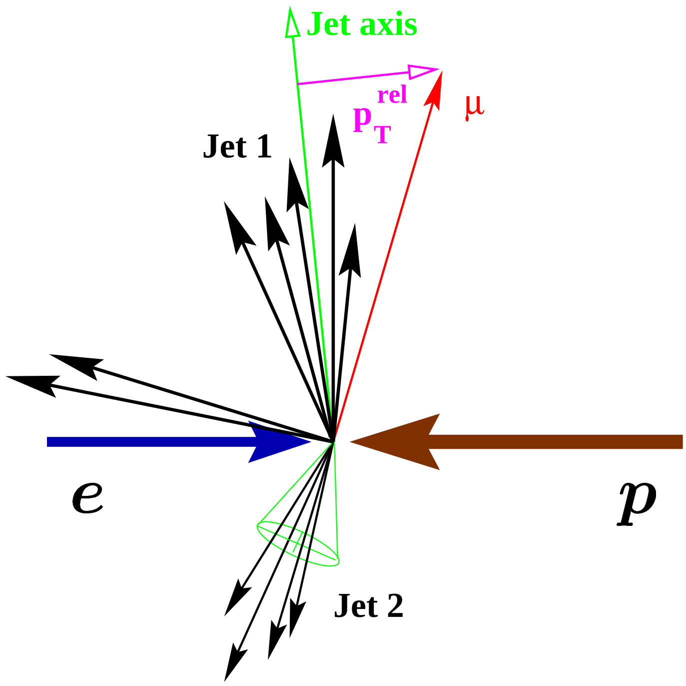
- Beauty in γp
- Beauty in DIS
- $D^*\mu$ correlations
- Current secondary vertex analyses

Beauty signatures and observables

Use semi-muonic B-Decays

(branching ratio $\approx 10\%$)

Select dijet events with high p_T muon



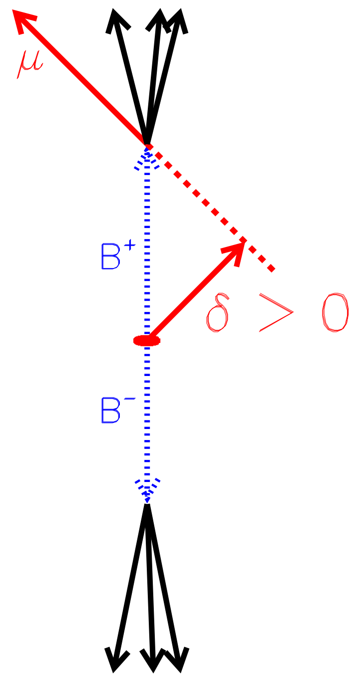
For b, c separation

exploit:

Larger b mass

Use muon p_T w.r.t.

associated jet: $p_{T,rel}$



Longer b lifetime

Use signed transverse

distance of muon to

primary vertex: δ

Impact parameter δ

Selection cuts

$\geq 1\mu$ with:	$p_T^\mu > 2.$ GeV $35^\circ \leq \theta_\mu \leq 130^\circ$
≥ 2 jets with:	$E_T^{jet} > 5.$ GeV $10^\circ \leq \theta_{jet} \leq 170^\circ$

Beauty in γp:

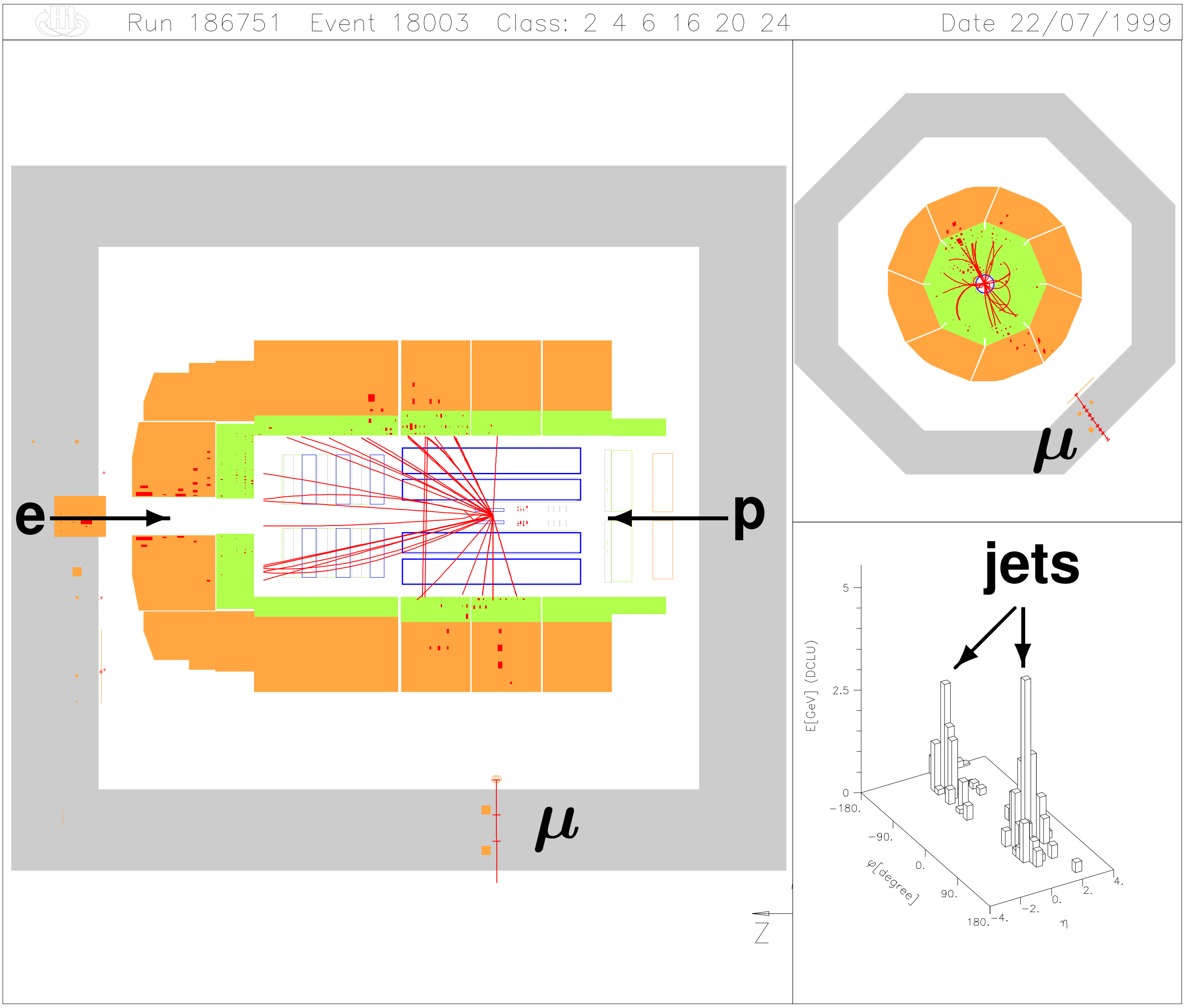
$$Q^2 < 1\ \mathrm{GeV}^2$$
$$0.1 < y < 0.8$$

Beauty in DIS:

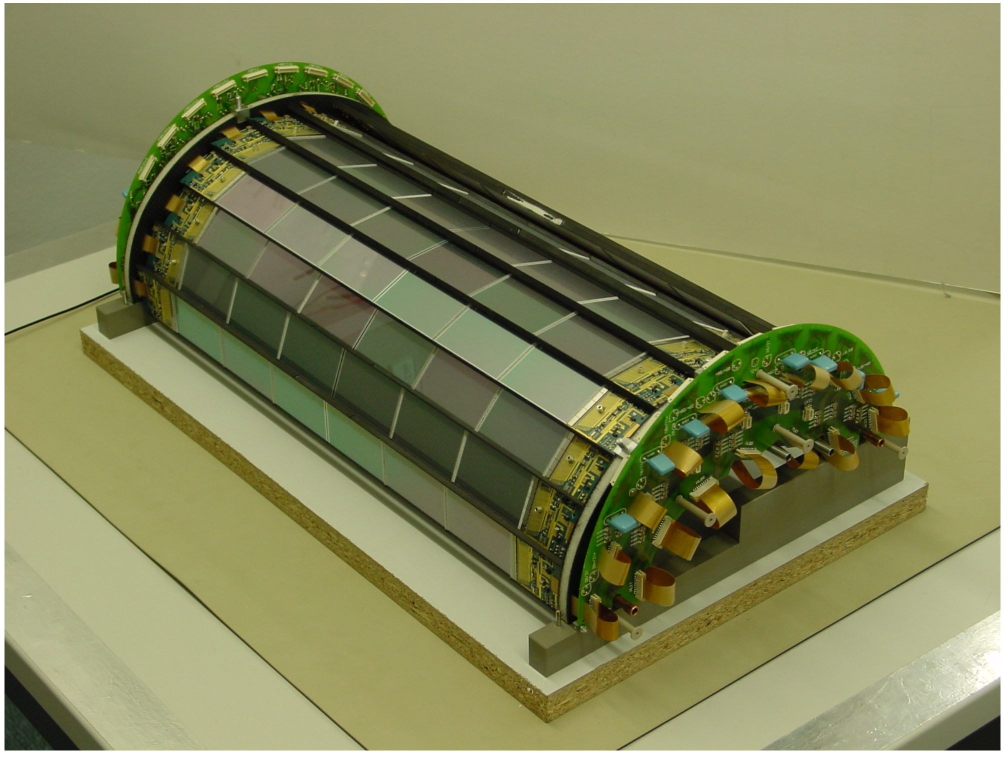
$$2\ \mathrm{GeV}^2 < Q^2 < 100\ \mathrm{GeV}^2$$
$$0.05 < y < 0.75$$

Beauty in γp:

$B \to \mu X$ candidate



H1 vertex detector CST

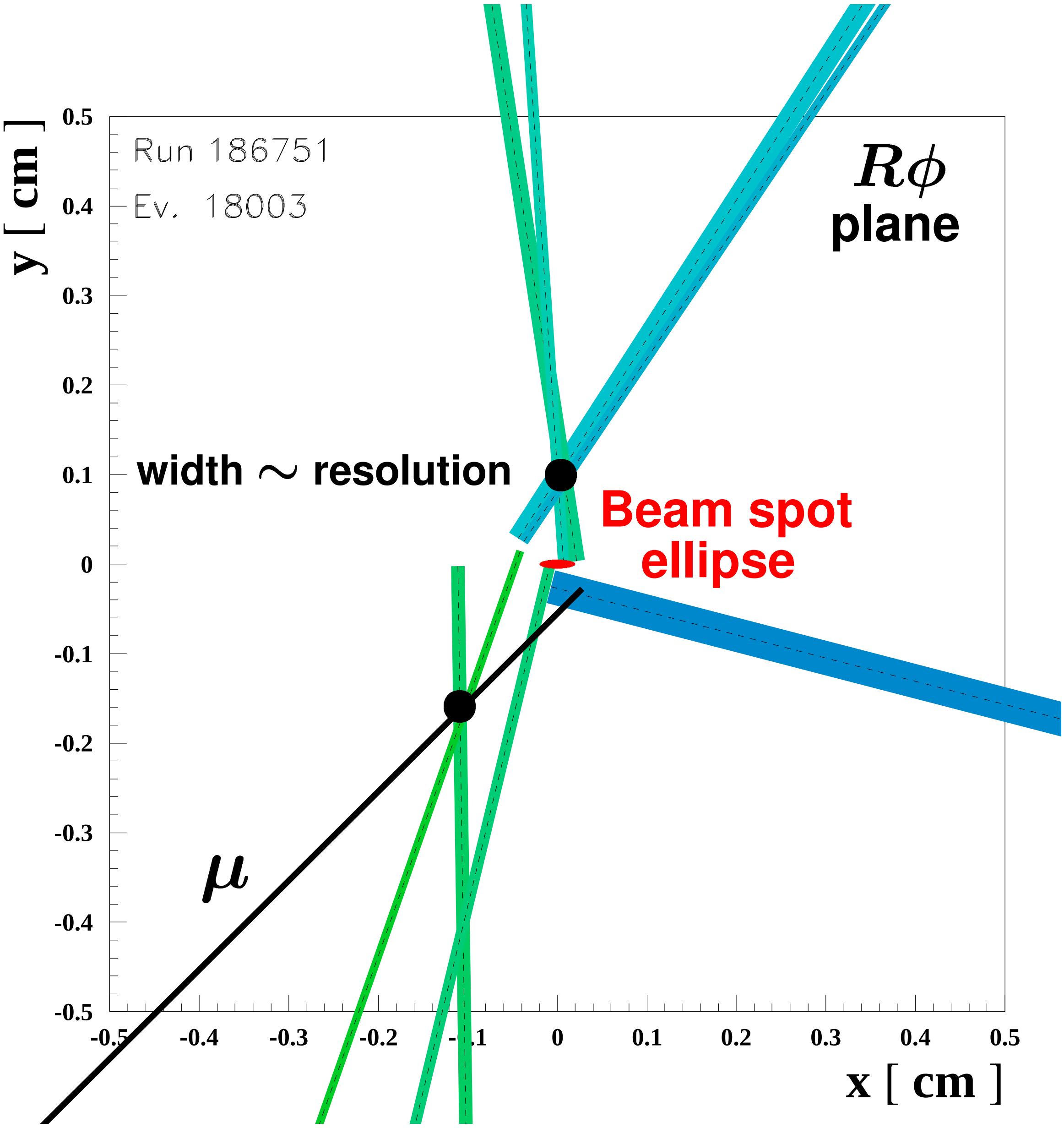


- 36 cm length
- 2 Layers
- Doublesided Si-strips
- 82000 channels
- Achieved $r\phi$ hit resolution: $15\ \mu$m

Beauty in γp:

$B \to \mu X$ candidate

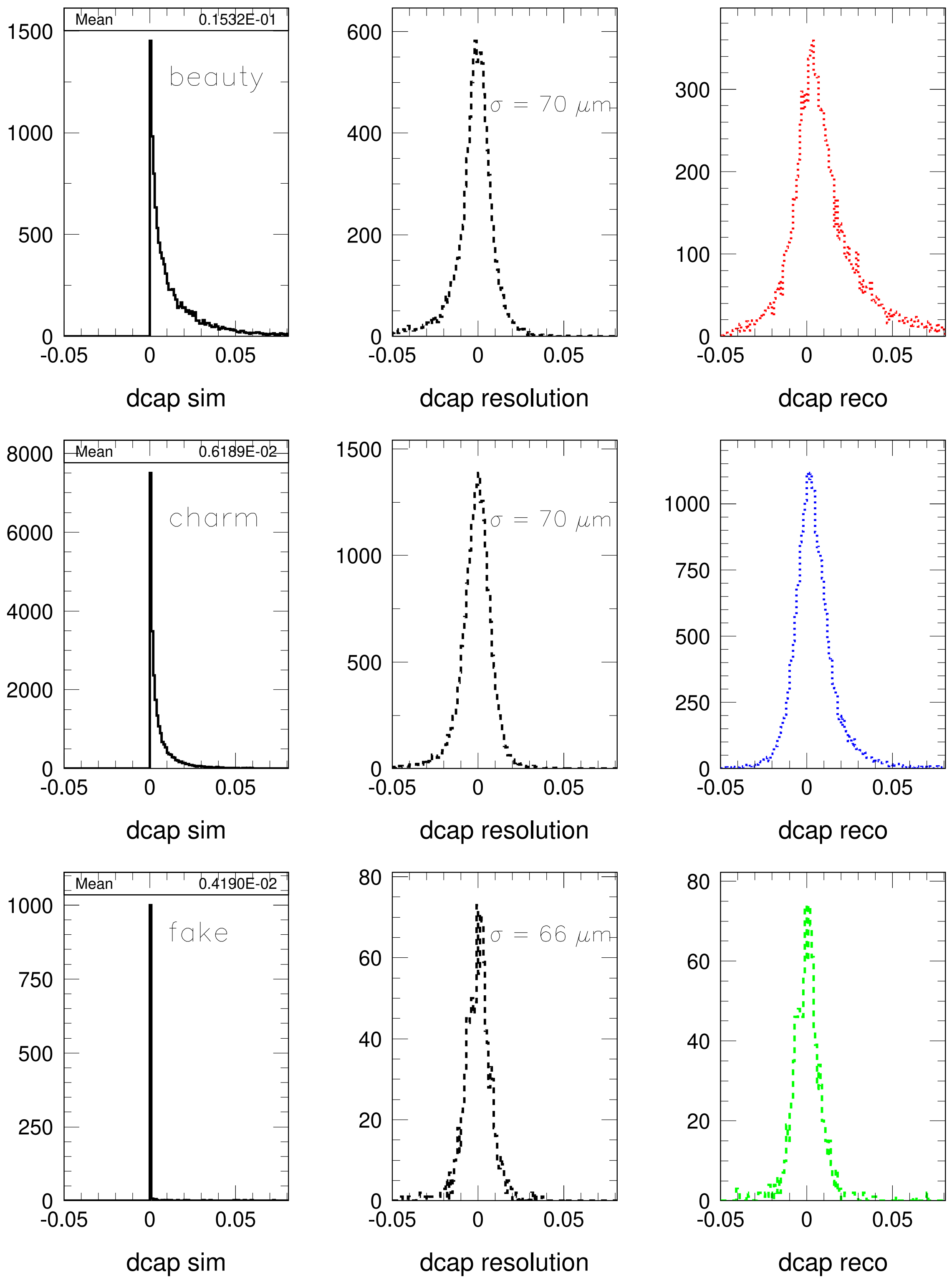
Look at central tracks in the vertex region



$\Longrightarrow$ **Secondary vertex topology visible!**

Separation of b,c and uds

Show case: Muon impactpar. $p_t^\mu > 2$ GeV

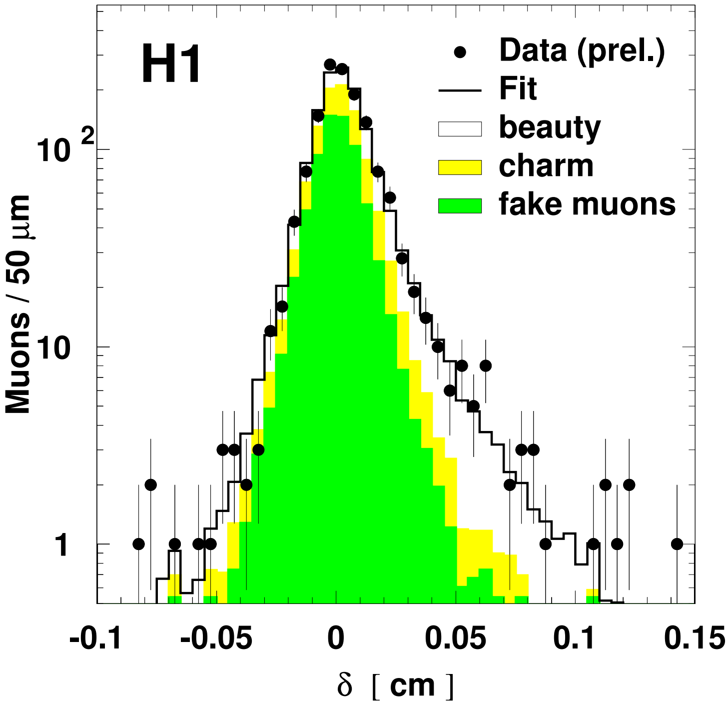


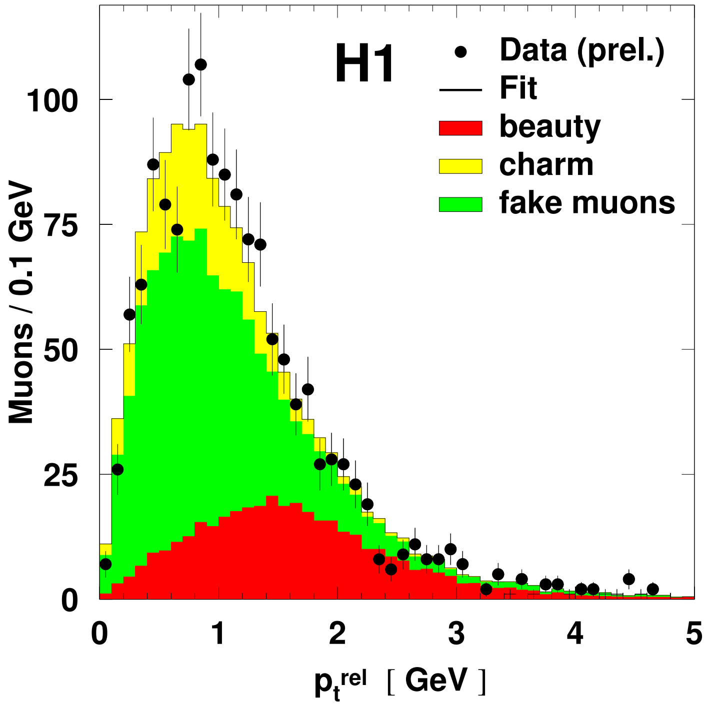
$\Rightarrow$ **Lifetime effects in the order of the resolution**

$\Rightarrow$ **Understanding of resolution is crucial!**

Beauty in γp: H1 muon analysis

H1 data : 97 **1415 μ cand. in 15 pb^{-1}**



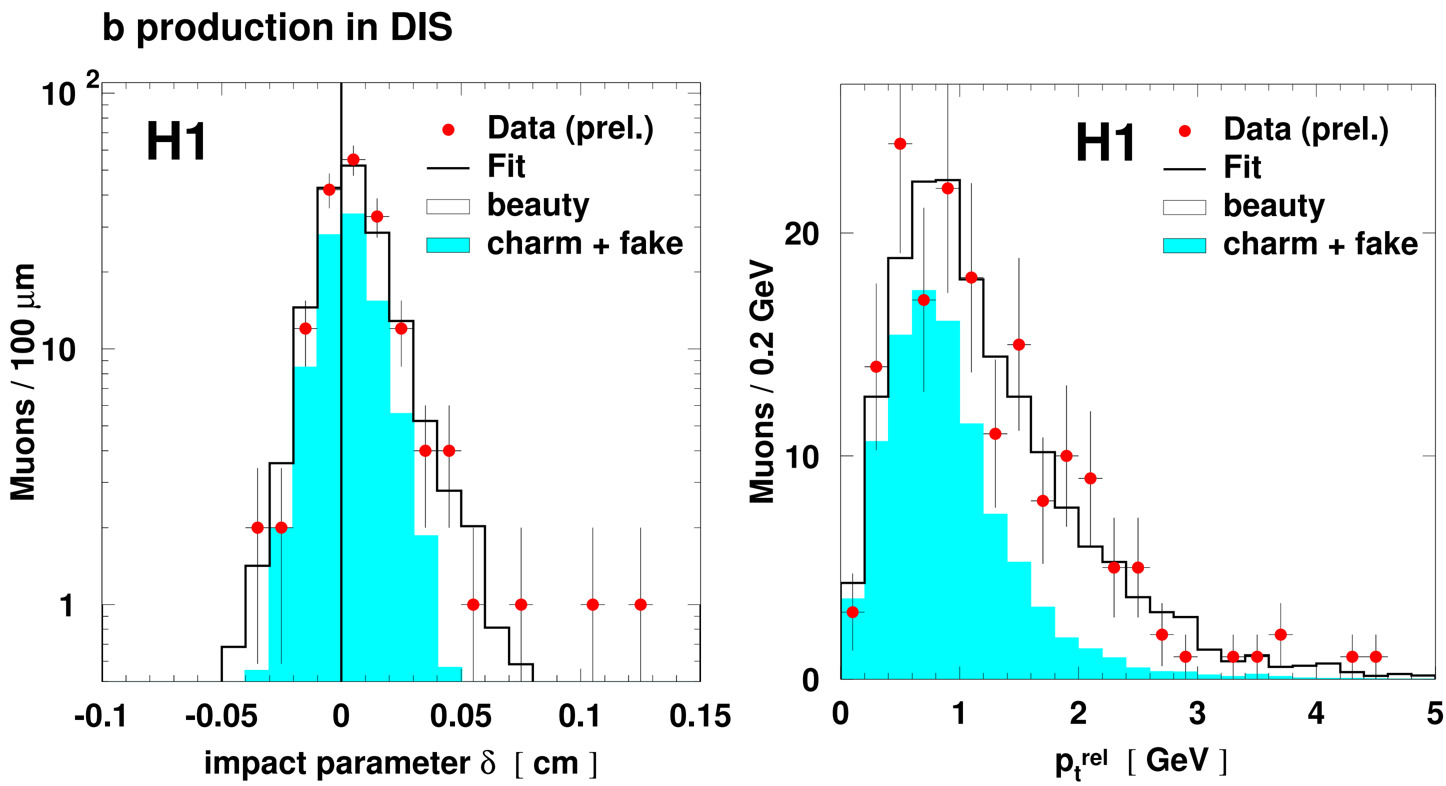


2-D-fit (δ, p_T^{rel}): $f_b = (27 \pm 3)\%$

Results: $\sigma_{vis}(ep \rightarrow b\bar{b}X \rightarrow \mu^{\pm}X)$		
H1 measurement	**NLO (FMNR):**	**54 ± 9 pb**
(96 + 97 comb.) :	**CASCADE (CCFM):**	**67 pb**
(170 ± 25) pb	**AROMA (DGLAP):**	**38 pb**

Beauty in DIS:

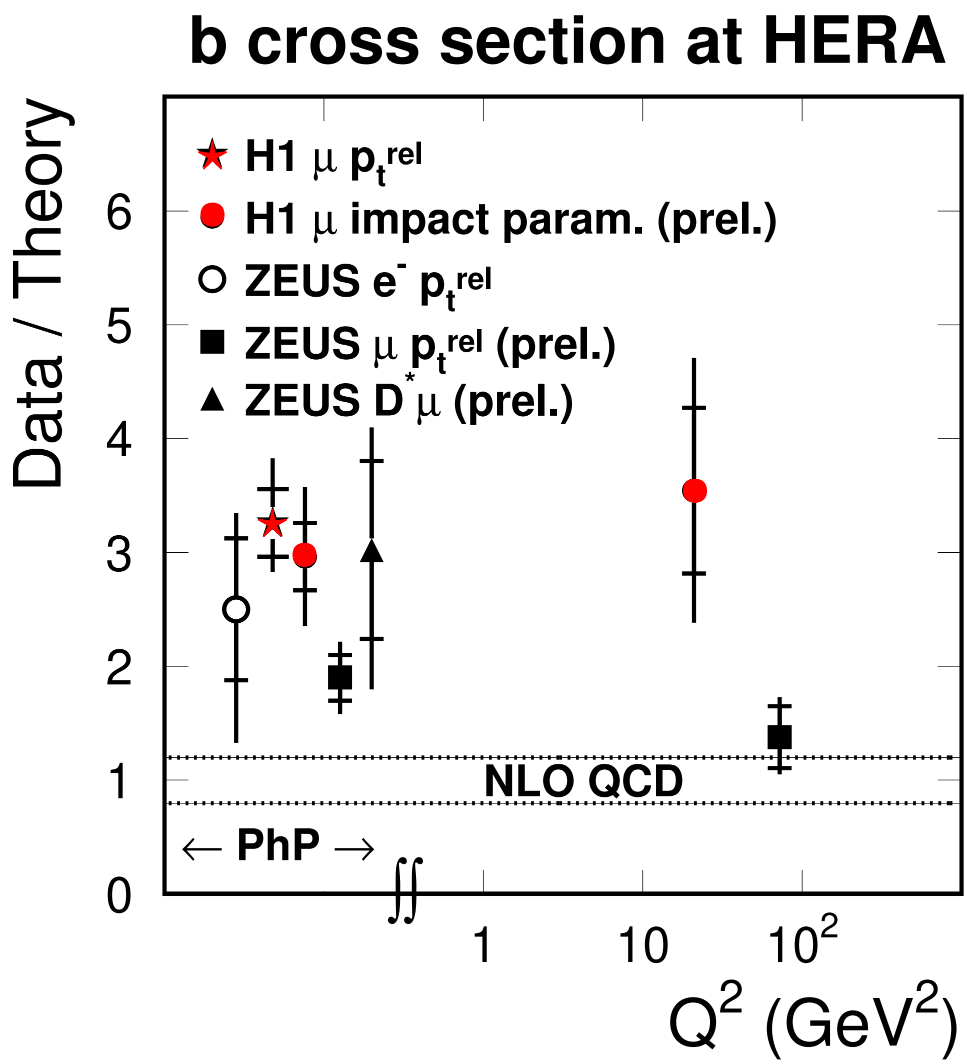
H1 data : 97 **171 μ cand. in 11 pb^{-1}**



2-D-fit (δ, p_T^{rel}): $f_b = (43 \pm 8)\%$

Results: $\sigma_{vis}(ep \to b\bar{b}X \to \mu^{\pm}X)$		
H1 preliminary :	**NLO (HVQDIS):**	**11 $\pm$2 pb**
$(39 \pm 8 \pm 10)$ pb	**CASCADE : (CCFM)**	**15 pb**
	AROMA : (DGLAP)	**9 pb**

Beauty at HERA: Summary



Compare Data/NLO QCD:

- Excess seen in γp and in DIS at H1
- Similar excesses as seen in $p\bar{p}$ and $\gamma\gamma$ collisions
- Seen both by H1 and ZEUS except ZEUS DIS measurement

$D^*\mu$ analysis

Detection of **both heavy quarks** of the BGF

by their decay and fragmentation products:

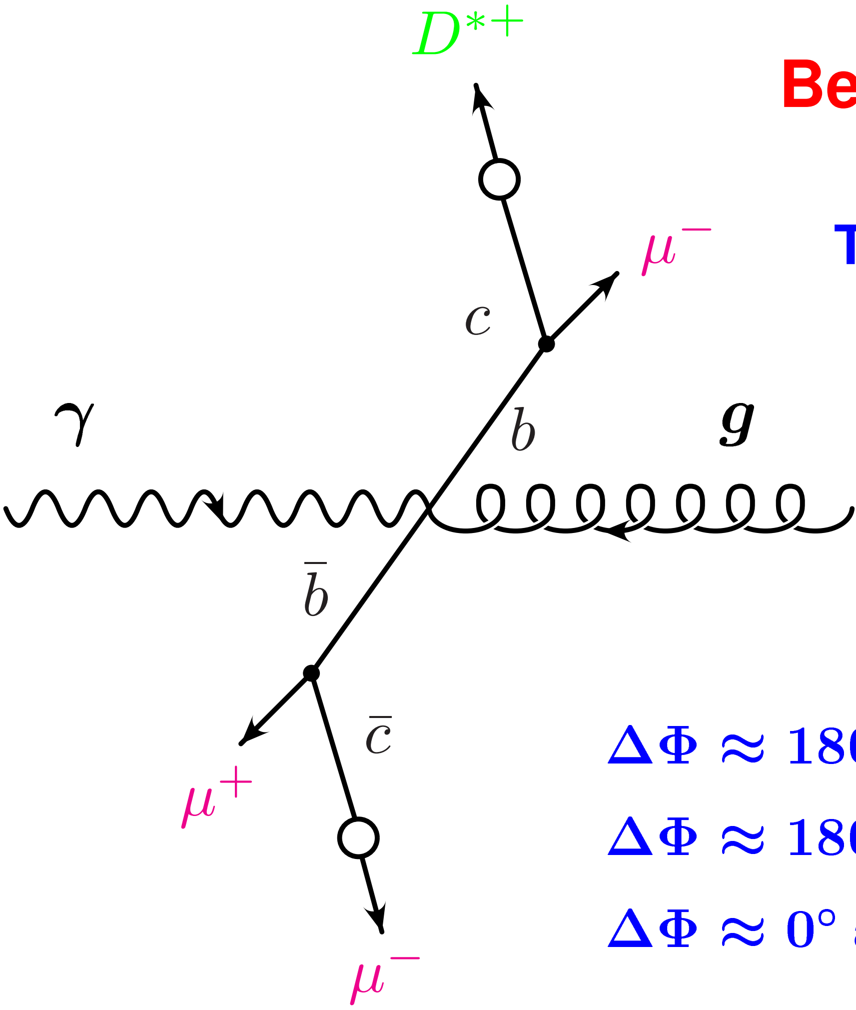
$$Q \longrightarrow D^* \to D^0\pi_s \to K\pi\pi_s$$
$$\bar{Q} \longrightarrow \mu$$

H1 data : 97-00 $\mathcal{L} = 91.2\ \mathrm{pb}^{-1}$

$p_T(D^*) > 1.5$ GeV/c	$\lvert\eta_{D^*}\rvert < 1.5$
$p_T(\mu) > 1.0$ GeV/c	$20^\circ \leq \theta_\mu \leq 160^\circ$
$0.05 < y < 0.75$	no cut on Q^2

$\Rightarrow$ 195 ± 21 $D^*\mu$ candidates

Correlations in the γg-CMS :



Beauty production

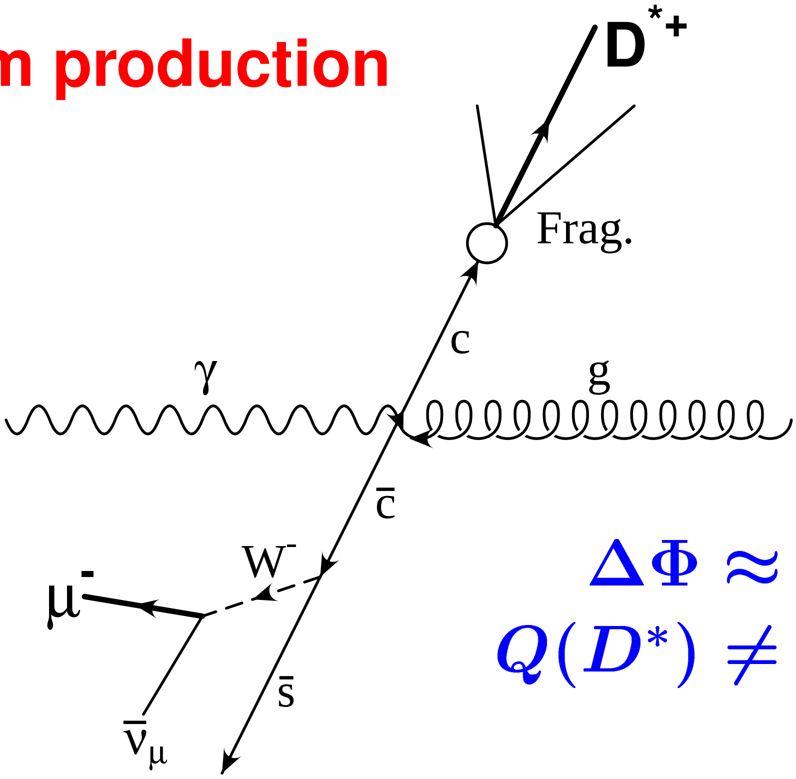
Three correlations possible

$\Delta\Phi \approx 180^\circ$ and $Q(D^*) \neq Q(\mu)$

$\Delta\Phi \approx 180^\circ$ and $Q(D^*) = Q(\mu)$

$\Delta\Phi \approx 0^\circ$ and $Q(D^*) \neq Q(\mu)$

Charm production



$$\Delta\Phi \approx 180^\circ$$

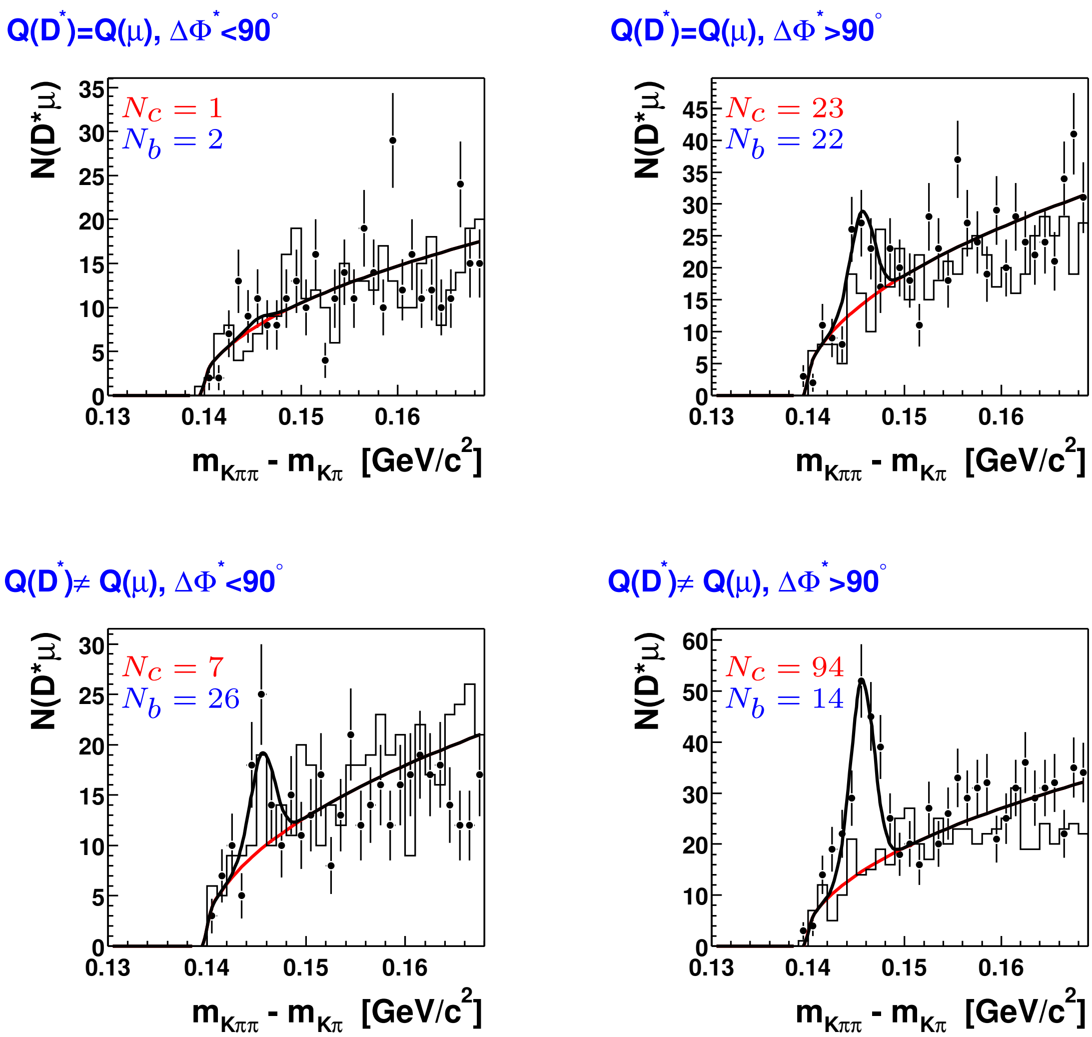
$$Q(D^*) \neq Q(\mu)$$

Correlations in the lab frame:

	$\Delta\Phi \leq 90^\circ$	$\Delta\Phi \geq 90^\circ$
$Q(\mu) = Q(D^*)$	1 no charm few beauty	2 no charm beauty
$Q(\mu) \neq Q(D^*)$	3 few charm beauty	4 charm beauty

2 dim. Log-Likelihood-Fit

H1 Preliminary



$D^*\mu$ results

Subtract background due to fake muons

$(c \;:\approx 30\%, b \;:\approx 5\%)$:

$N_c = 88 \pm 14 \;\;\Rightarrow$ **c contribution:** 59%

$N_b = 62 \pm 19 \;\;\Rightarrow$ **b contribution:** 41%

Total c and b cross sections

$$\sigma^c_{vis}(ep \rightarrow e' D^* \mu X) \;=\; (720 \pm 115 \pm 245)\ \mathrm{pb}$$

$$\sigma^b_{vis}(ep \rightarrow e' D^* \mu X) \;=\; (380 \pm 120 \pm 130)\ \mathrm{pb}$$

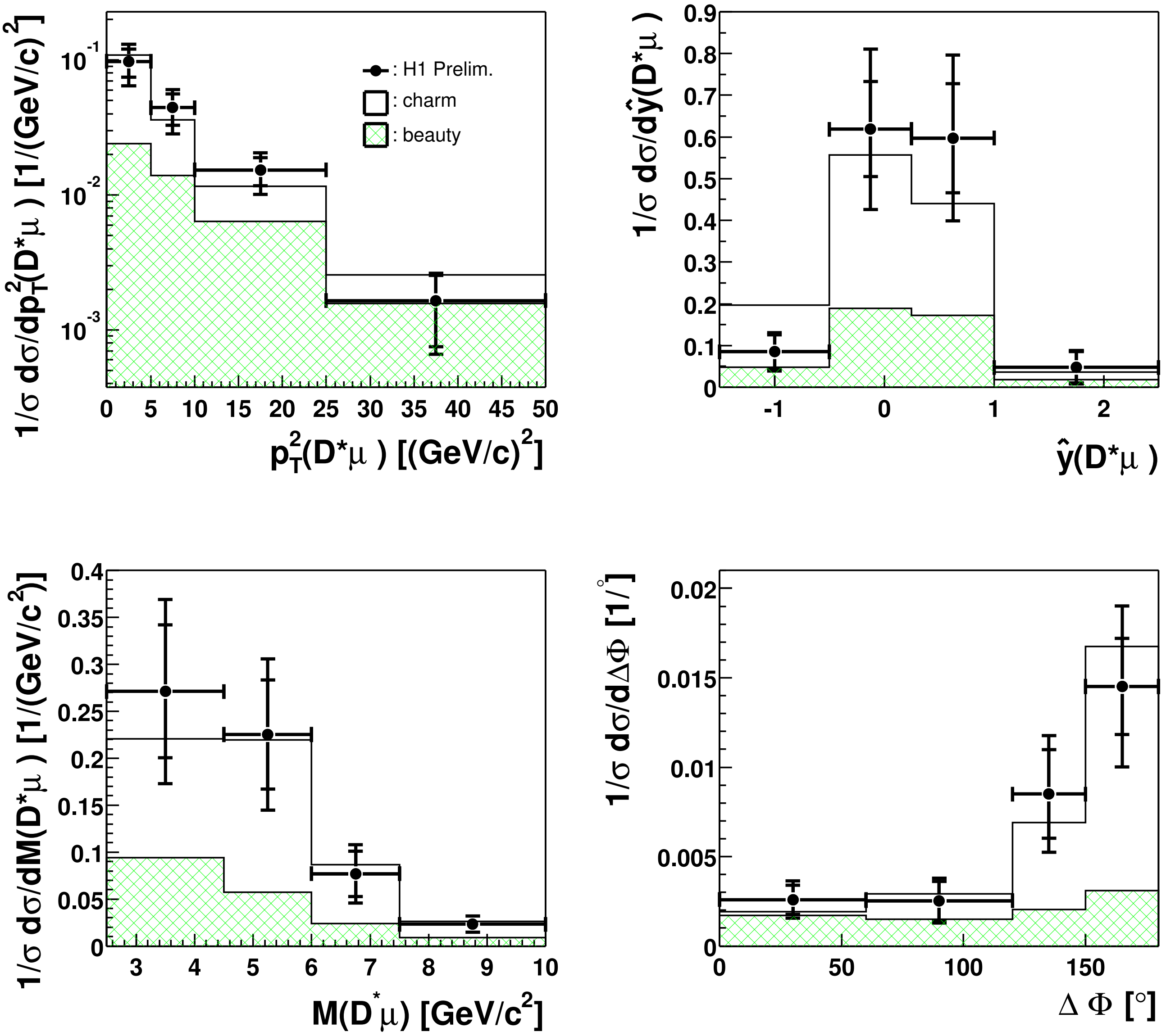
Comparison with LO direct prediction

(AROMA) :

c: Data/MC = 1.8   b: Data/MC = 3.6

Differential cross sections

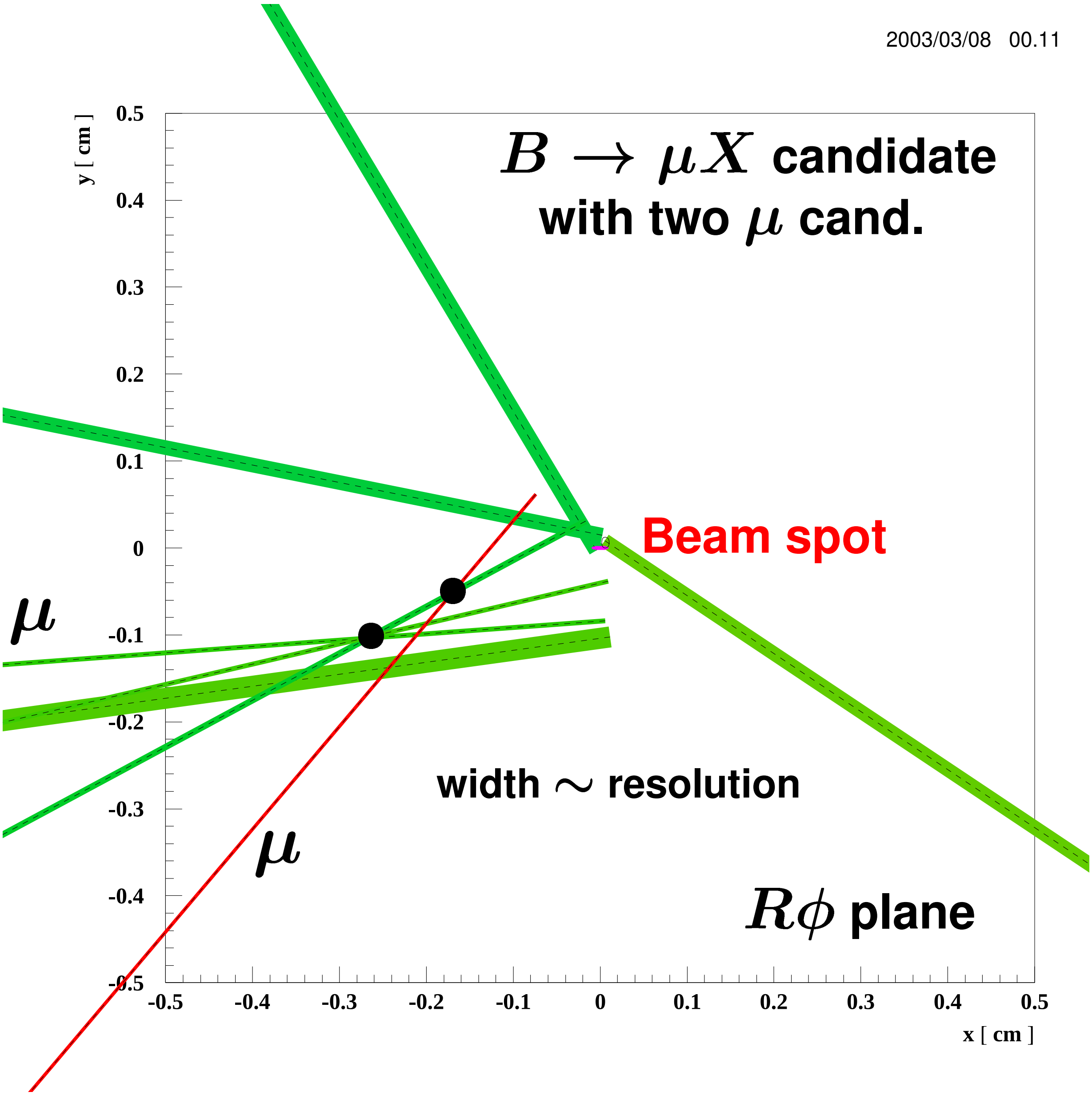
Data vs. (1.8 c -MC + 3.6 b -MC)



$\Rightarrow$ **LO + PS (AROMA) prediction describes the shape of the data**

Current secondary vertex analyses

H1 data 99-00 : 5000 μ cand. in 56 pb^{-1}



So far: exploiting p_t^{rel} and δ of μ

New: use also other tracks that come from B decays (e.g. multi impact par. method)

Summary and outlook

- All H1 results (γp, DIS and $D^*\mu$) show excess of data over (N)LO QCD
- Still many results to come with the large 99-00 data sample
- For perspectives of HERA II see talk of Benno List this afternoon