Too much beauty....

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Introduction : b and c facts in $\gamma\gamma$ (L3) and γg, gg

Analysis tools : PYTHIA LO description & NLO computation

Treatment of heavy quarks : a multi scale problem

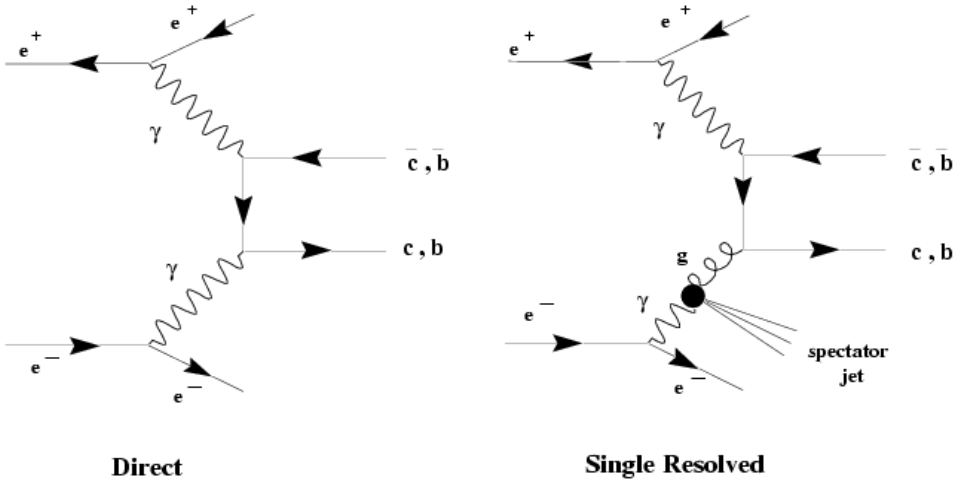
A toy model for γ pdfs

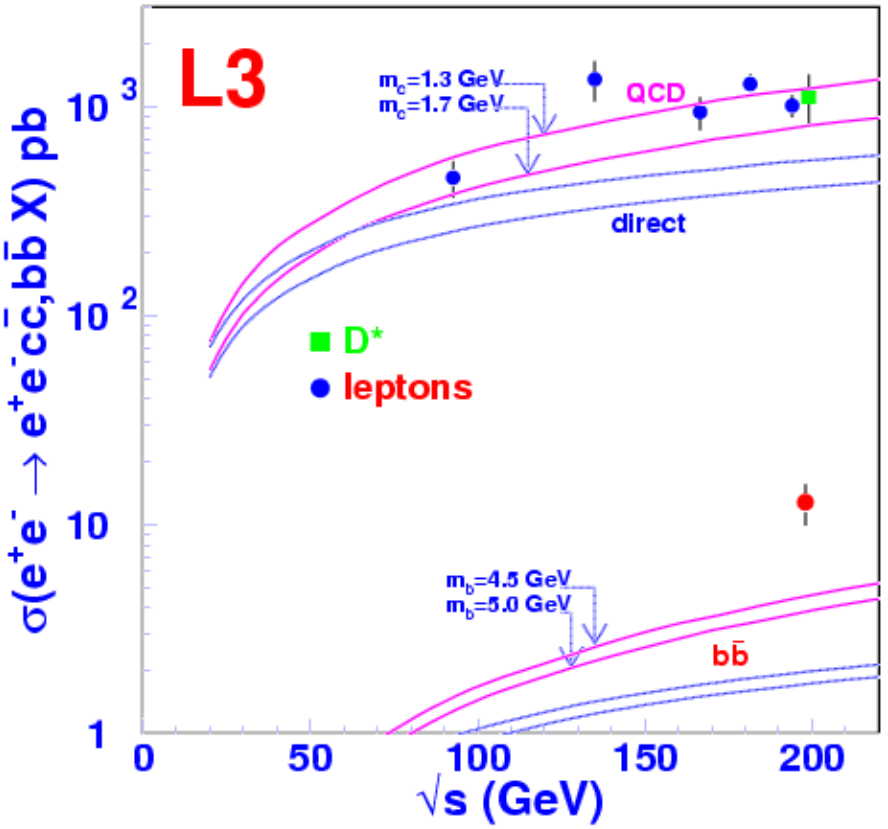
Missing components

Conclusions

Charm and beauty production

$\gamma\gamma$ L3 facts



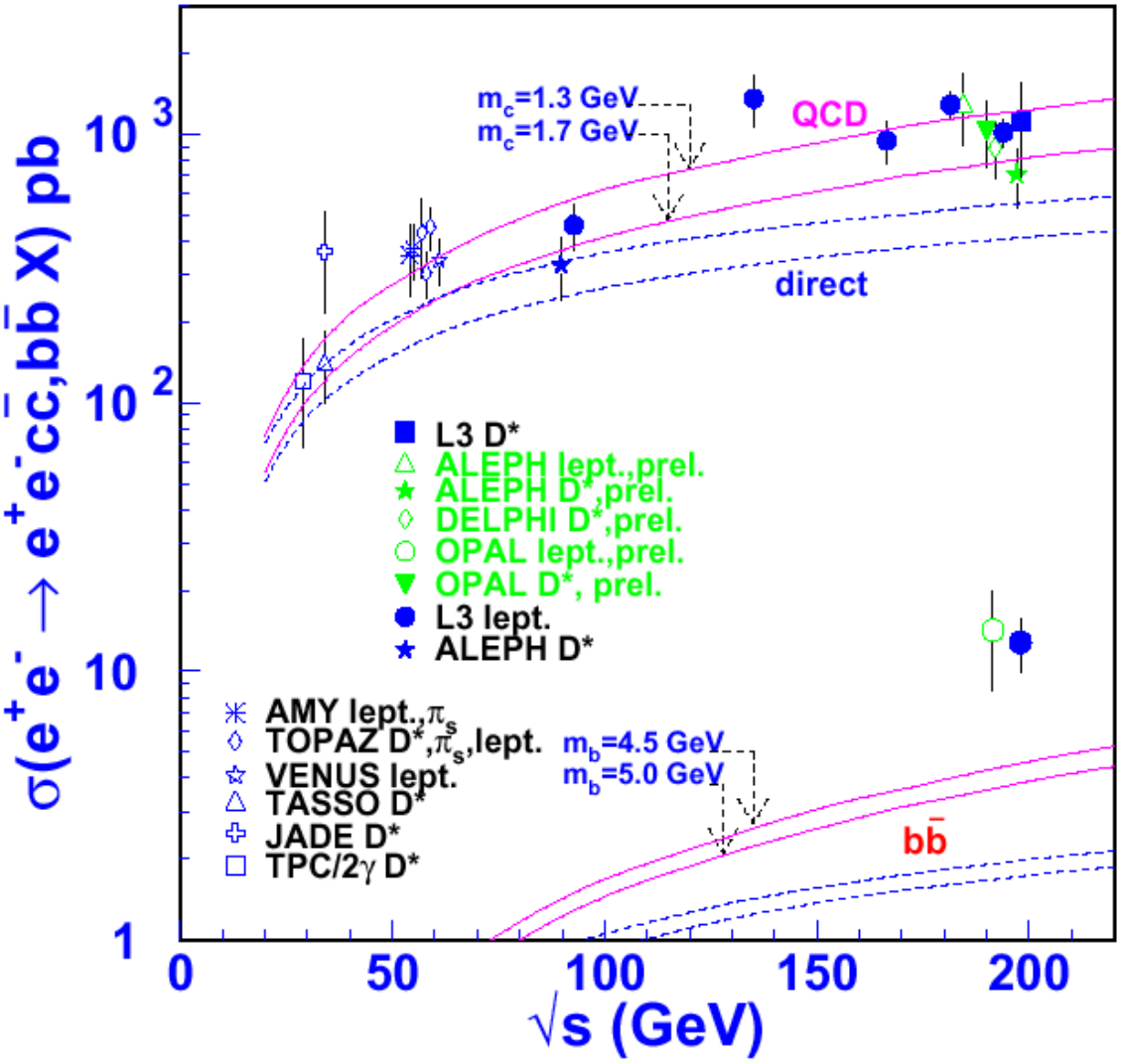


D* tagging used for extracting the open charm cross section

Muon and electron semi-leptonic decays : a global fit gives open c and b cross sections

Charm and beauty production

$\gamma\gamma$ facts shared by the LEP community

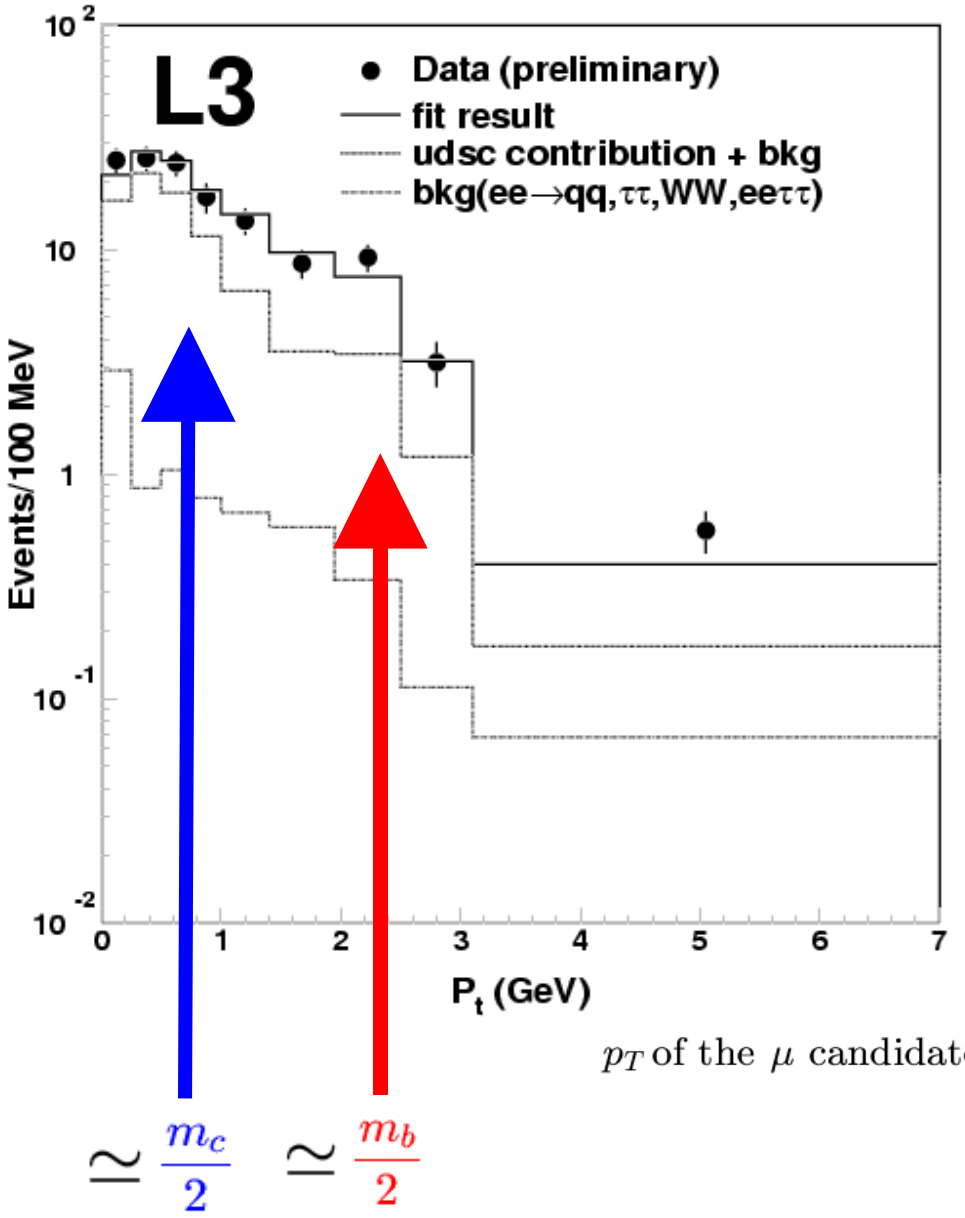


$\sigma^{e^+e^- \to e^+e^- c\bar{c}X} \simeq 1000$ pb $(\pm 10\%)$

$\sigma^{e^+e^- \to e^+e^- b\bar{b}X} \simeq \quad 13$ pb $(\pm 30\%)$

With stat $\simeq$ syst

Charm and beauty production



Difficult for c quarks
to mimic the b contribution

Even without a signed impact parameter

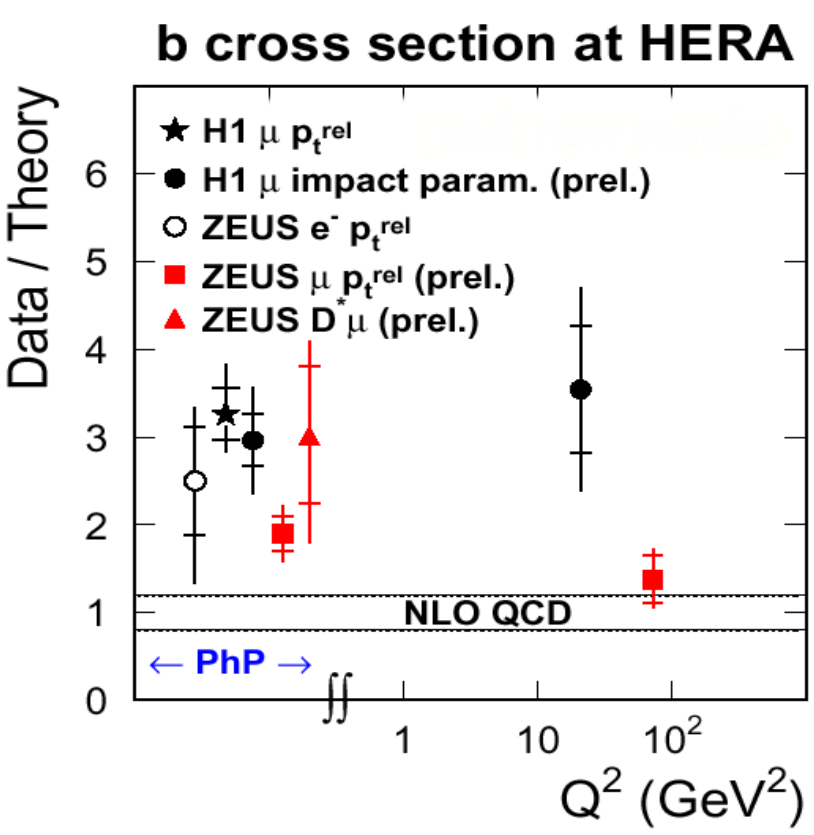
2 distinct kinematical regions

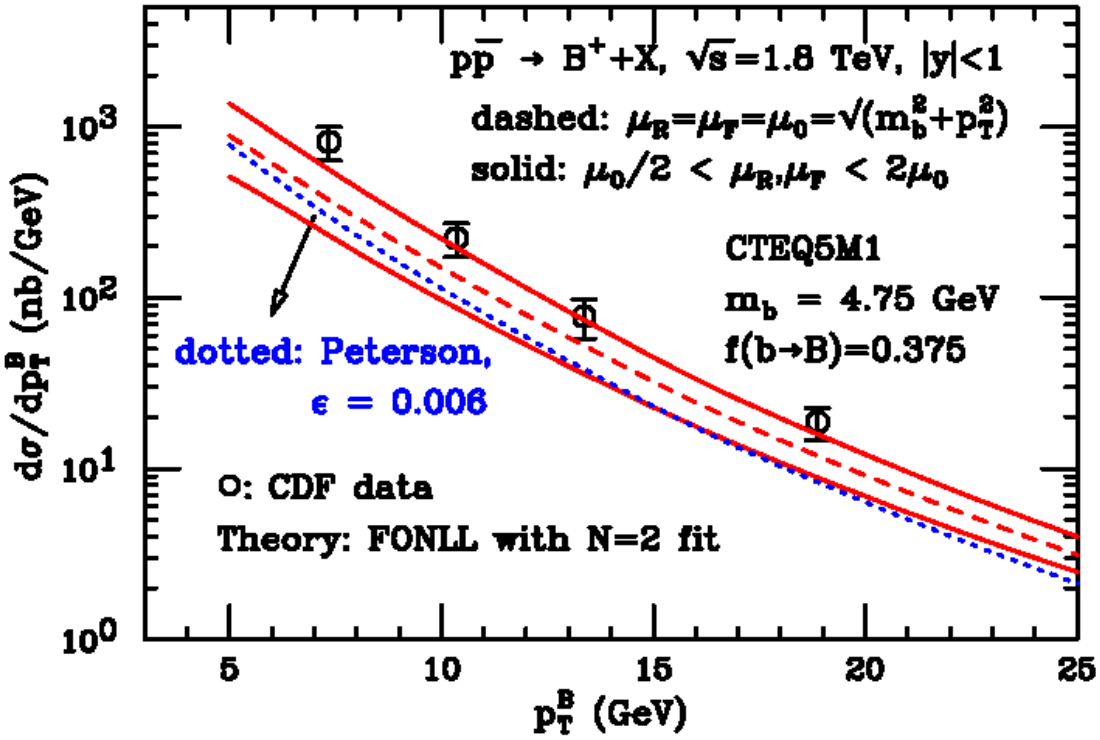
p_T of the μ candidate with respect to the closest jet

Charm and beauty production

γg

$g\,g$





With recent theoretical improvements

The experimentalist toolkit

- $\gamma\gamma$ Physics with PYTHIA

  SaS parameterizations (à la FKP)

  Phase Space slicing at the LO

  Massless vs massive quarks

  Takes into account all scales

  Acceptance corrections

  Effective fragmentation

  Simulation of the signal

- The old Drees, Kramer, Zunft, Zerwas computation

A toy model

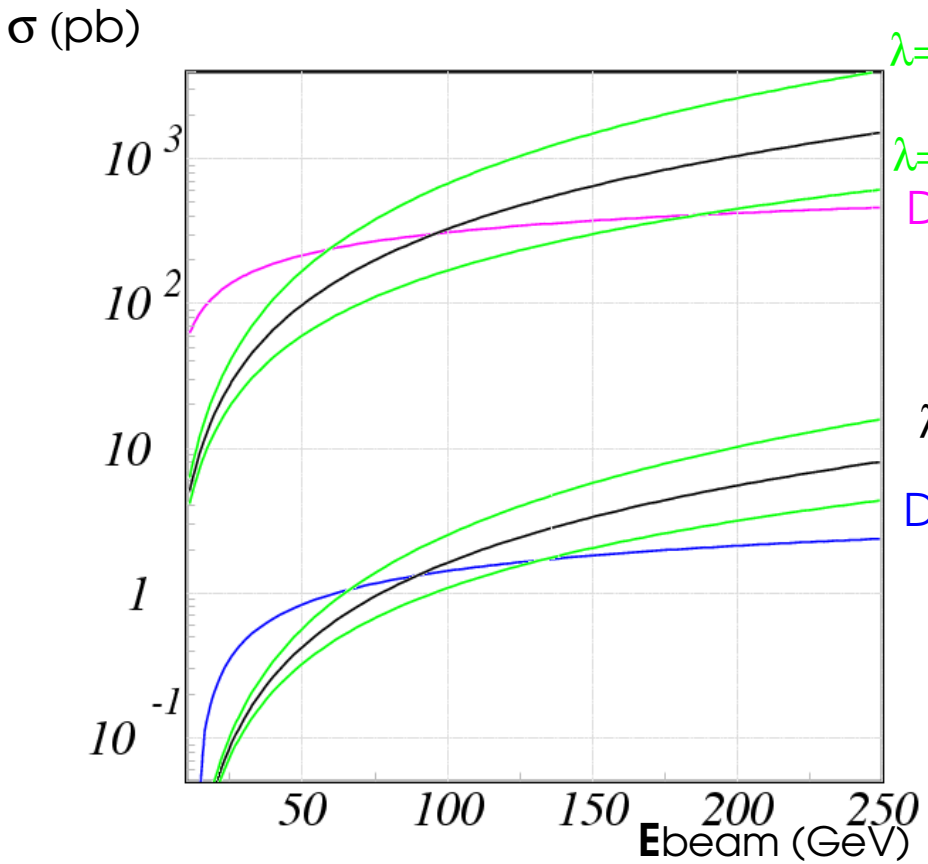
Different scales at LO with PS slicing with a "gluon" density $P(y, p_T^2) = \frac{\alpha}{2\pi} a \frac{1}{y^\lambda} \ln \frac{p_T^2}{p_{T0}^2}$

$$\sigma(\gamma\gamma \to q\bar{q}) \simeq \frac{4\pi\alpha^2}{W^2}(3e_q^4)\ln\frac{W^2}{s_0}$$

$$\sigma_{\text{direct}}^{e^+e^- \to e^+e^- q\bar{q}} \simeq 3e_q^4 (\frac{\alpha}{\pi}\ln\frac{s}{m_e^2})^2 \frac{4\pi\alpha^2}{s_0}\ln\frac{s}{s_0}$$

$$\sigma_{\text{1res}}^{e^+e^- \to e^+e^- q\bar{q}X} \simeq 3e_q^2 (\frac{\alpha}{\pi}\ln\frac{s}{m_e^2})^2 (6\frac{a}{b}) \frac{4\pi\alpha^2}{s_0}$$

$$\left\{\frac{1}{\lambda^2(1-\lambda)^2}\left[(\frac{s}{s_0})^{\lambda-1} - 1\right] + \left[\frac{-1}{\lambda-1} - \frac{s_0}{\lambda s}\right]\ln\frac{s}{s_0} + \frac{2\lambda+1}{\lambda^2}\left[1 - \frac{s_0}{s}\right]\right\}$$



0.6 GeV

$s_0 = 4(m_q^2 + p_{T0}^2)$

Running masses ?

Mc =1.55 GeV Mb =4.9 GeV

Use a=0.05, $b = 33 - 2N_f$

3

Mimics LEPII DKZZ GRV LO

A naive increase of beauty gives an excess of charm

Hints towards a solution ?

Play with fragmentation functions (you can also do that within PYTHIA)

Fit pdfs to LEP and HERA data

Improve QCD calculations with masses and different scales

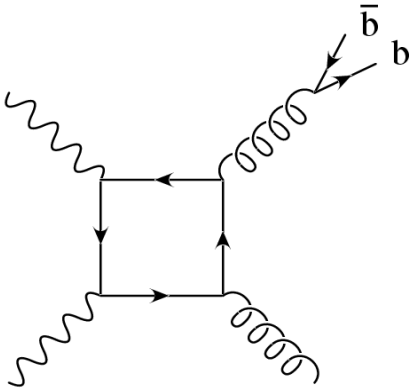
Recent theoretical computations are getting closer :

(... many good reviews at International Conferences)

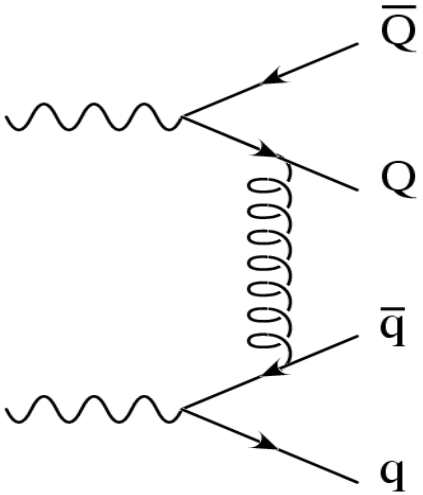
Missing components ?

$\gamma\gamma \rightarrow$ gg through the box diagram (cf B. De Tollis...)

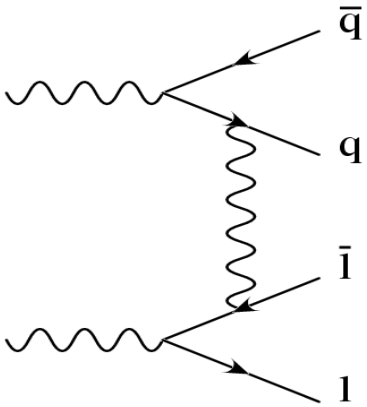
All the physics is in the box.



The $\gamma\gamma \rightarrow$ 4 quarks connection (cf Jiri Chyla ...)



The $\gamma\gamma \rightarrow$ 2quarks 2leptons background



In a more general way 2 lepton QED corrections.. to the total $\gamma\gamma$ cross section .

Conclusions

A new measurement of open beauty production with real photon collisions is needed ... maybe soon at SLAC with the LEPC.

And wait a bit for an open top cross section measurement at the PLC