Inclusive Charm Production in Two Photon Collisions at LEP with the L3 Detector

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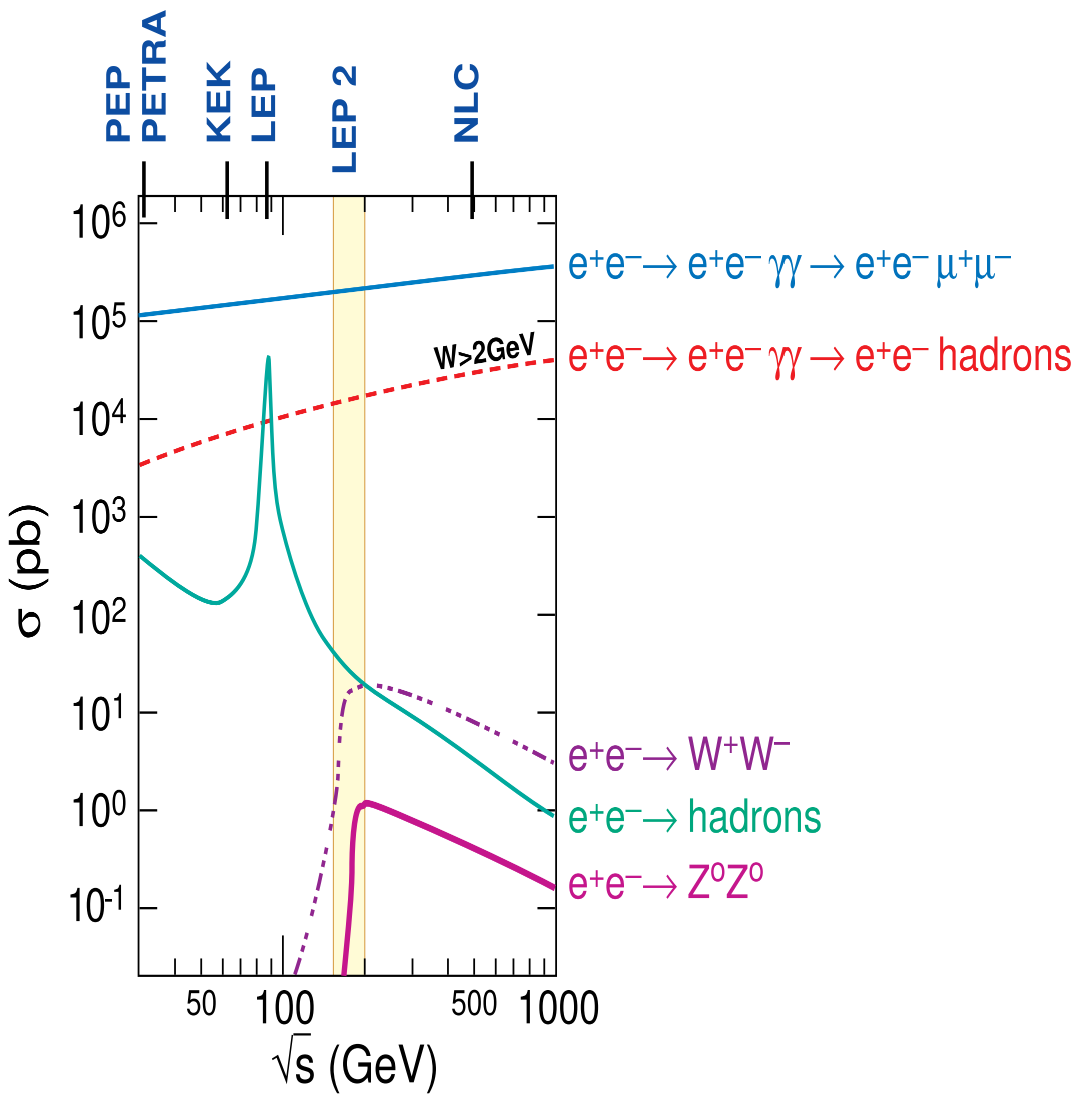
- ❒ Two Photon Introduction
- ❒ Motivation
- ❒ Analysis
- ❒ Results

Two Photons

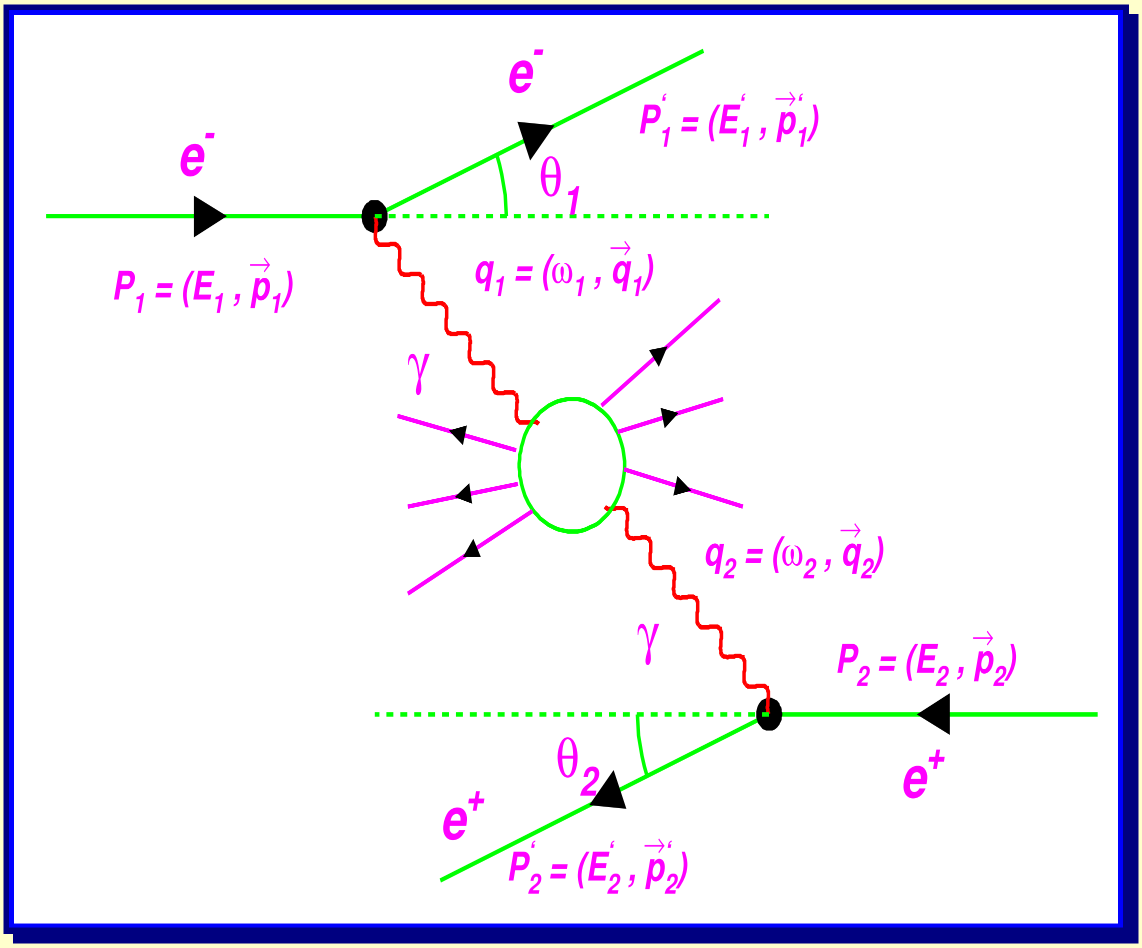


- **Main contribution to hadron production at LEP**

$e^+e^- \rightarrow e^+e^-\gamma\gamma \rightarrow e^+e^-\ hadrons$

- **Bkgd to other processes.**

Two Photons

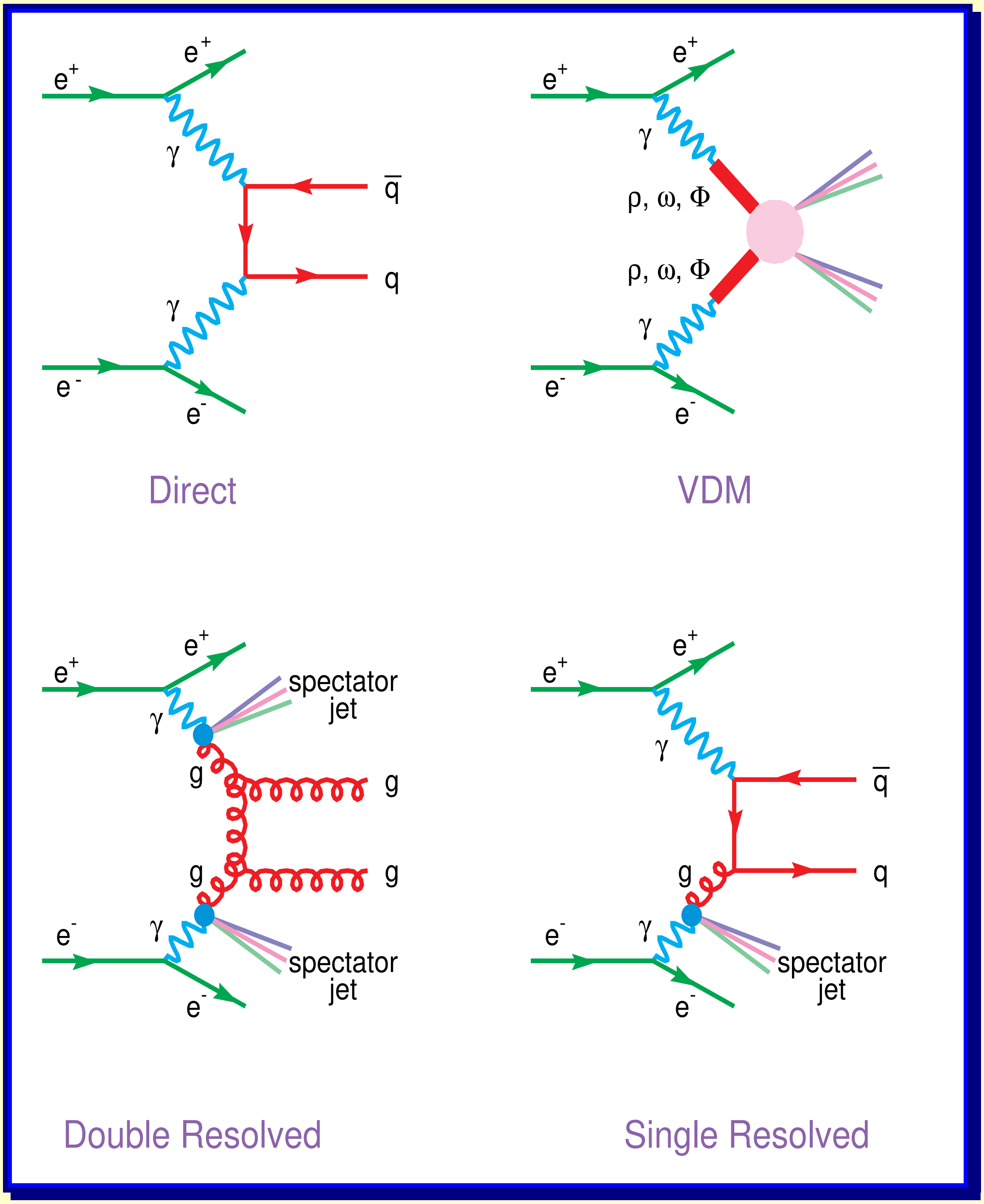


- $Q_i^2 = -q_i^2 = 2E_iE_i'(1 - \cos\theta_i)$
- $W_{\gamma\gamma}^2 = (\sum_h E_h)^2 - (\sum_h \vec{p})^2$

❐ Photon Photon Scattering

- Untagged Events $(Q_i^2 \approx 0)$
- Exclusive/Inclusive Hadronic States

Inclusive Hadronic Production



VDM Diagram is dominant at low Q^2

Motivation

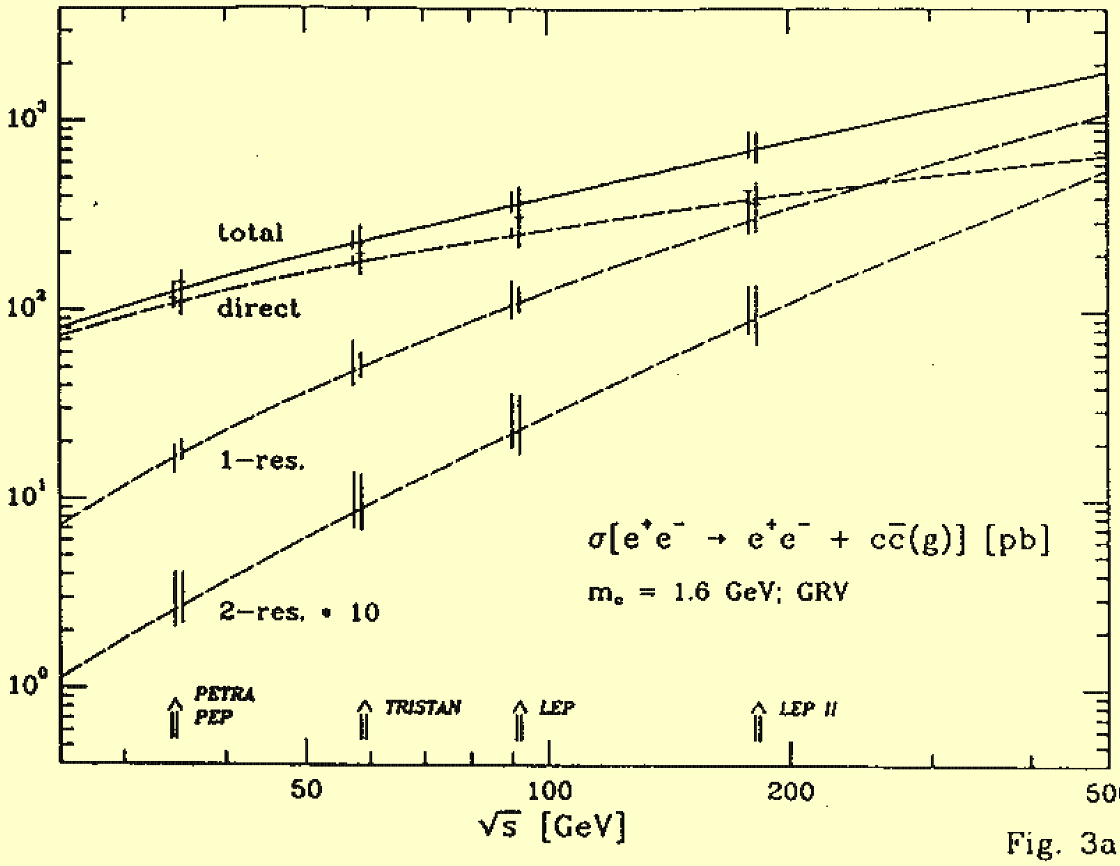


Fig. 3a

Ref: M.Drees, M.Kramer, J.Zunft & P.M. Zerwas
Physics Letters B 306 (1993) 371

- ❒ Test of QCD
- ❒ Gluon content of Photon (resolved...)
- ❒ Constrain Mass of Charm Quark
- ❒ First LEP2 measurement

$$\int \mathcal{L}\, \mathrm{dt} = 165\ pb^{-1} \text{ at } \sqrt{s} = 91 - 183\ GeV$$

Hadron Selection

- $N_{tracks} \geq 5$
- $E_{Lumi}/E_{beam} < 0.4$
- $E_{total}/\sqrt{s} < 0.38$
- $W_{vis} > 3\ GeV$

$\sqrt{s}$ (GeV)	L (pb^{-1})	Events	Bkgd (%)
183	52	116760	0.2
161-172	21	44444	0.2
130-140	12	21045	0.2
91	80	93204	2.4

- **MC: PYTHIA vers. 5.722**
- L$_{\gamma\gamma}$ EPA ($Q^2 < 1$ GeV)

- **Background Sources**

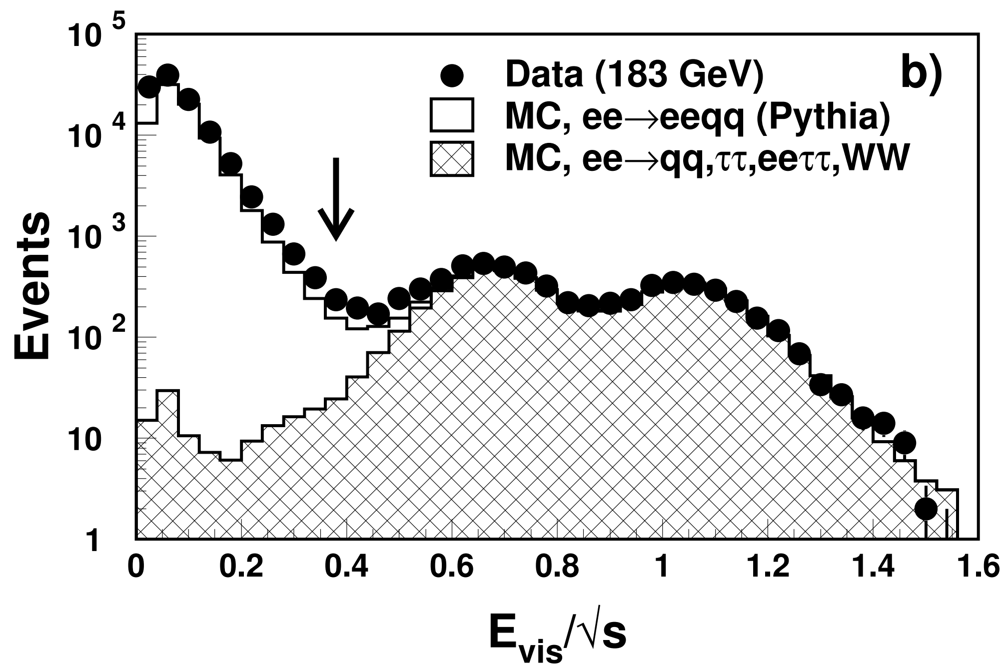
$e^+e^- \rightarrow q\bar{q}$ **(PYTHIA)**

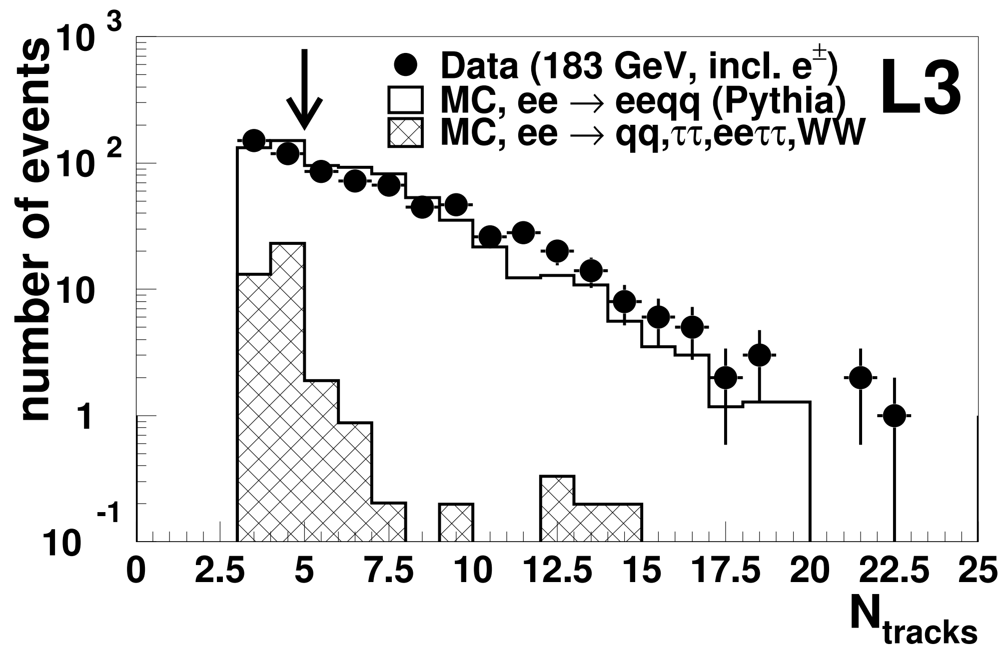
$e^+e^- \rightarrow \tau^+\tau^-$ **(KORALZ)**

$e^+e^- \rightarrow W^+W^-$ **(KORALW)**

$e^+e^- \rightarrow e^+e^-\tau^+\tau^-$ **(DIAG36)**

Analysis

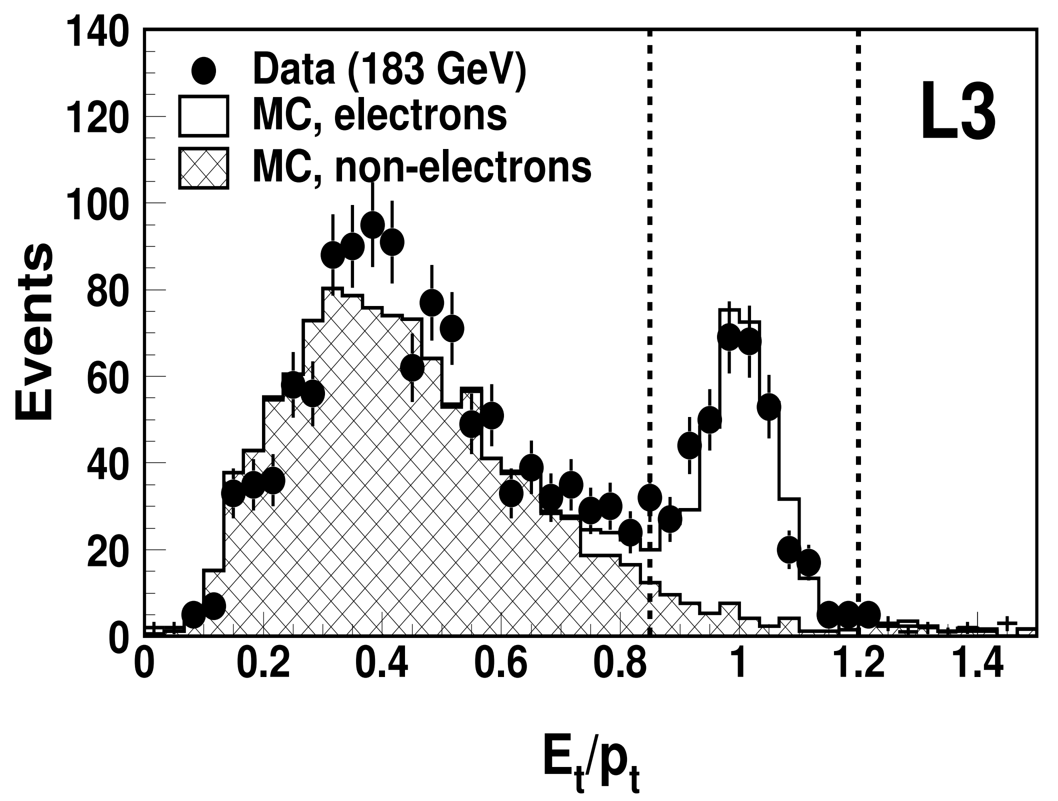

Events
Data (183 GeV)
b)
MC, ee→eeqq (Pythia)
MC, ee→qq,ττ,eeττ,WW
$E_{vis}/\sqrt{s}$


number of events
Data (183 GeV, incl. e±)
MC, ee → eeqq (Pythia)
MC, ee → qq,ττ,eeττ,WW
L3
N_{tracks}

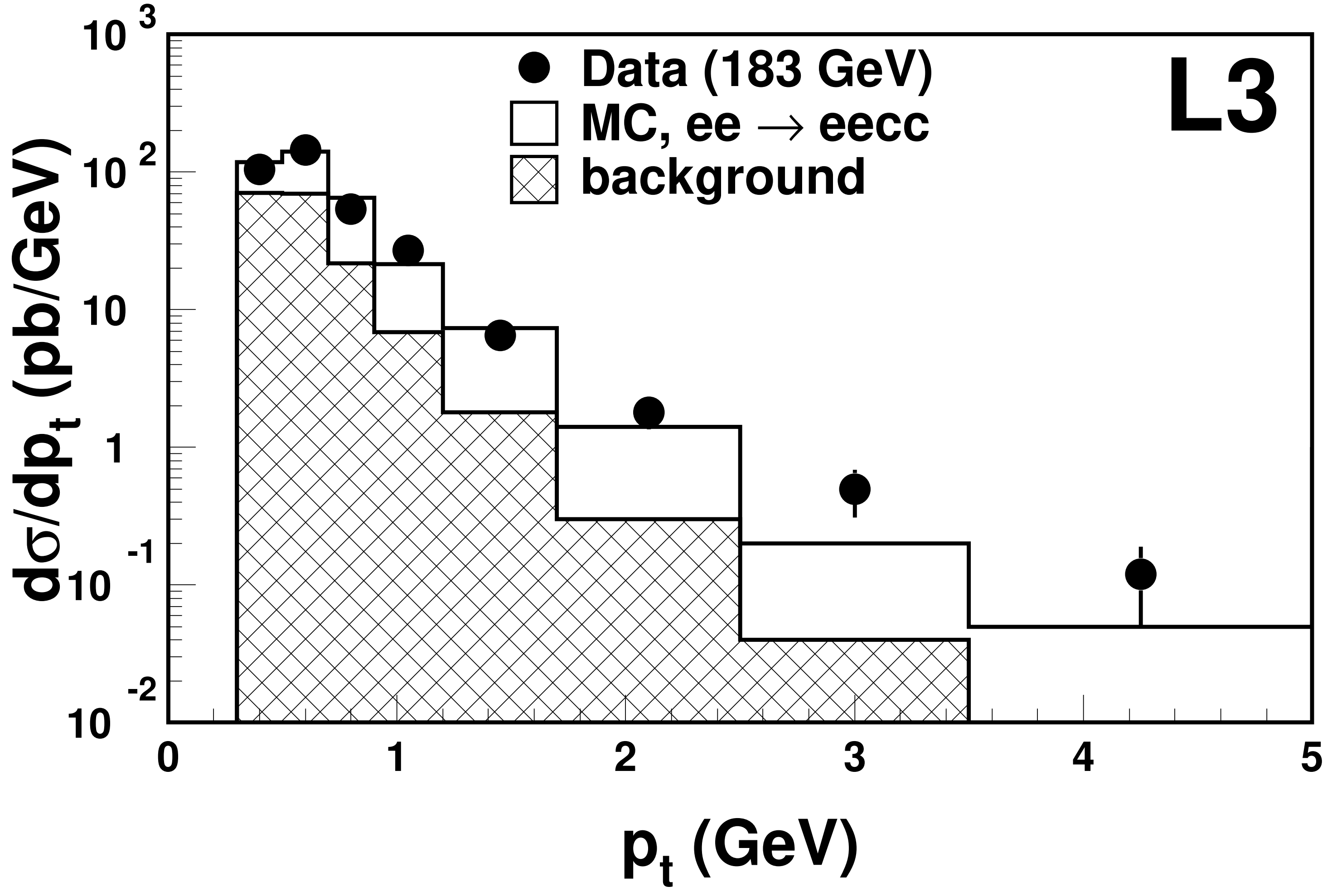
Lepton Selection

$c \longrightarrow$ lepton(s)

$\mu^{\pm}$ Selection	$e^{\pm}$ Selection
$\lvert\cos\theta\rvert < 0.90$	$\lvert\cos\theta\rvert < 0.90$
$P_{\mu} > 2$ GeV/c	$E_e > 0.6$ GeV
$P_{\mu} < 0.2E_{beam}$	$\Delta\phi < 20$ mrad
	$0.85 < E_T/p_T < 1.2$



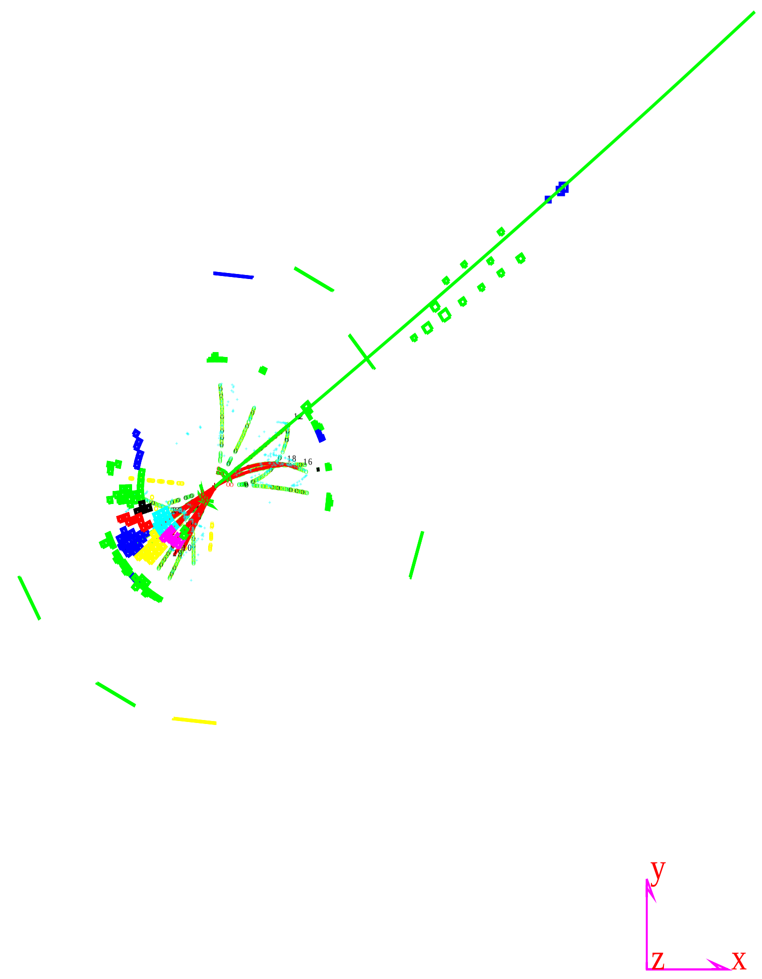
Results



L3
Data (183 GeV)
MC, ee → eecc
background
dσ/dp$_t$ (pb/GeV)
p$_t$ (GeV)
10^{3}
10^{2}
10
1
10^{-1}
10^{-2}
0
1
2
3
4
5

Results

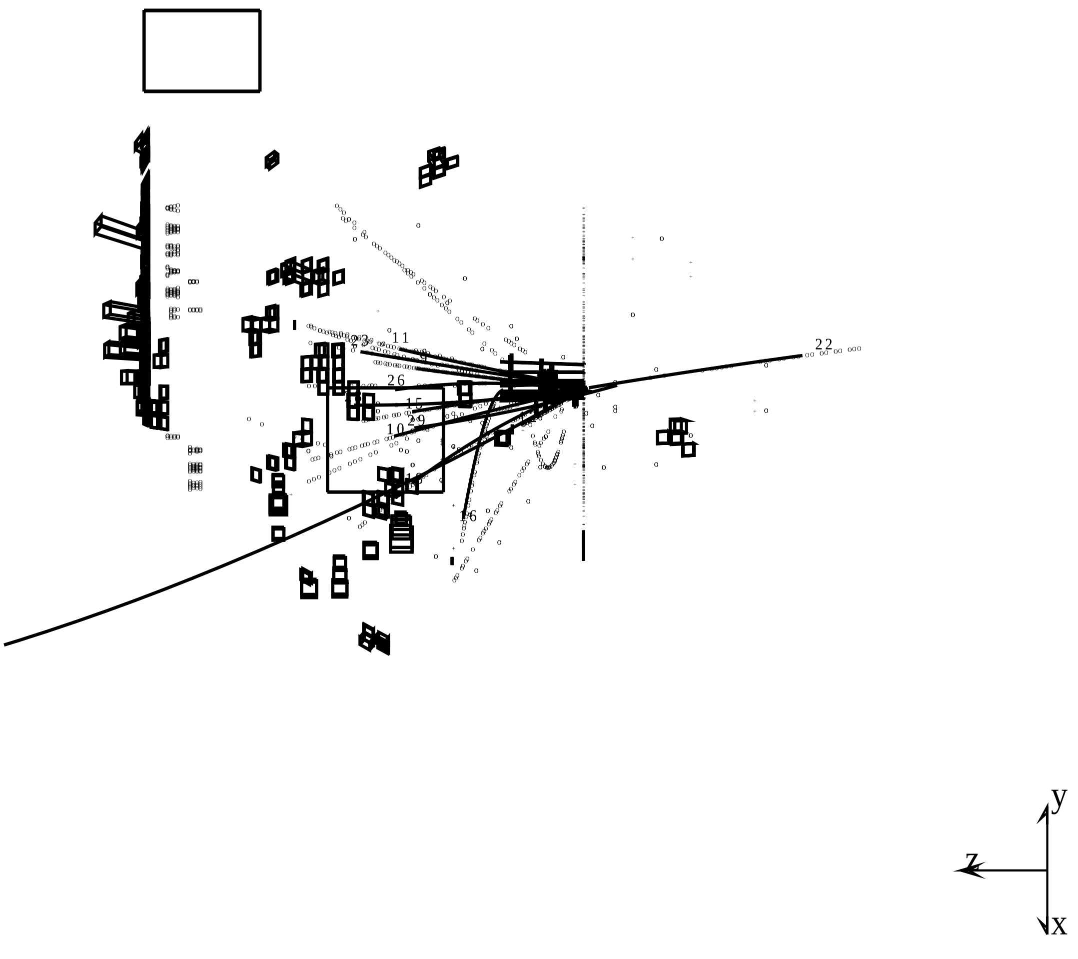
Run # 658001 Event # 3689 Total Energy : 36.91 GeV



Transverse Imbalance :	.1674	Longitudinal Imbalance :	.5708
Thrust : .7686	Major : .5903	Minor : .0808	
Event DAQ Time :	960717 43936		

Results

Run # 658001 Event # 3689 Total Energy : 36.91 GeV



Transverse Imbalance : .1674		**Longitudinal Imbalance :** .5708	
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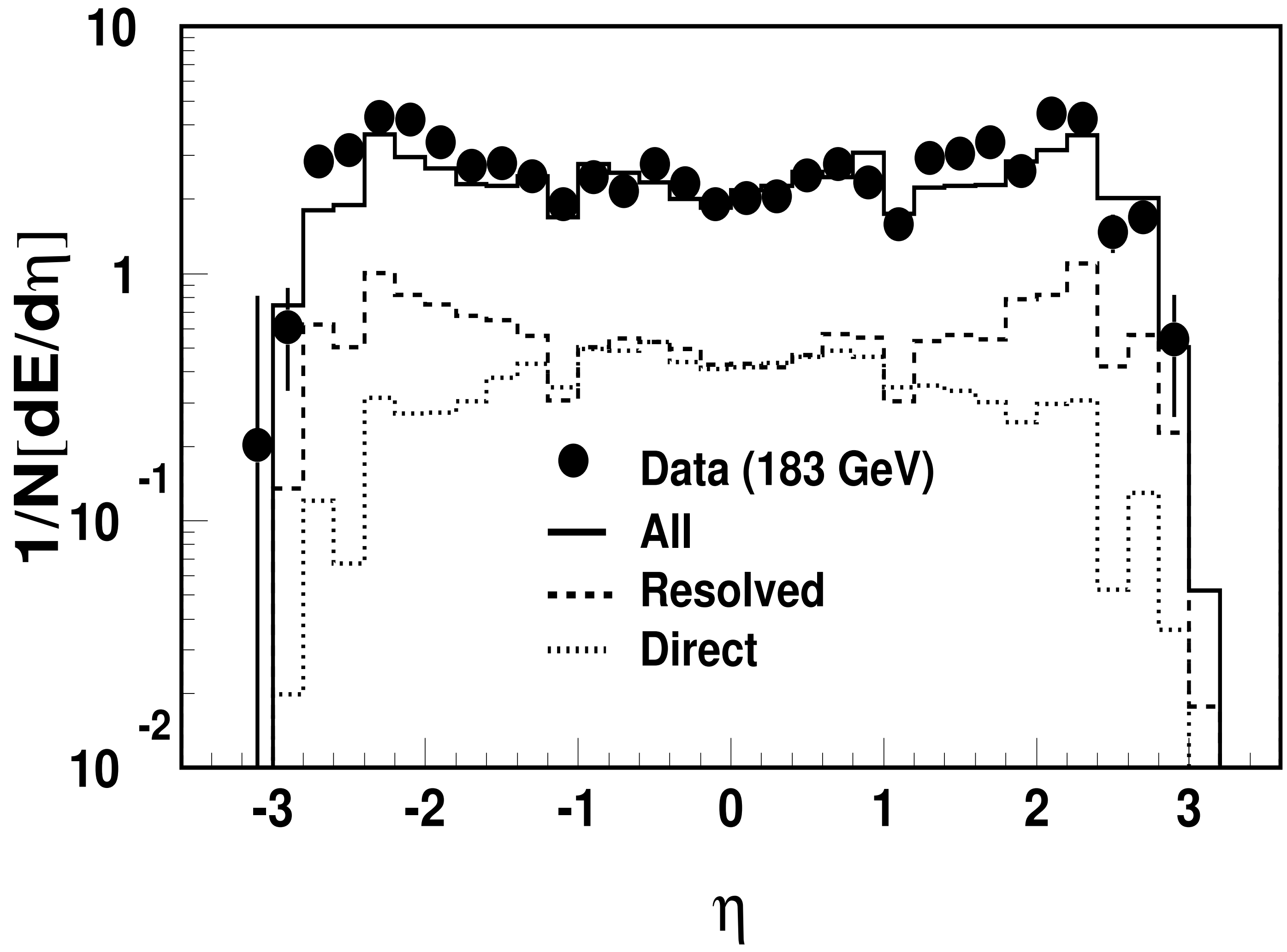
Event DAQ Time : *960717 43936*			

Results



1/N[dE/dη]
10
1
10^-1
10^-2
-3
-2
-1
0
1
2
3
η
Data (183 GeV)
All
Resolved
Direct

Results

Cross section of Charm Production in $\gamma\gamma$ Collisions

$$\sigma = \frac{N_{sel}}{\mathcal{L}} \frac{P_{charm}}{\epsilon_{charm}}$$

❐ $e^+e^- \rightarrow e^+e^- c\bar{c}$ (**Electron Tag**)

$$\sigma_{183\ GeV} = 1290 \pm 110\ (\text{stat}) \pm 120\ (\text{syst})\ [\text{pb}]$$
$$\sigma_{161-172\ GeV} = 1010 \pm 150\ (\text{stat}) \pm 110\ (\text{syst})\ [\text{pb}]$$
$$\sigma_{130-140\ GeV} = 1360 \pm 240\ (\text{stat}) \pm 180\ (\text{syst})\ [\text{pb}]$$
$$\sigma_{91\ GeV} = 440 \pm 60\ (\text{stat}) \pm 80\ (\text{syst})\ [\text{pb}]$$

❐ $e^+e^- \rightarrow e^+e^- c\bar{c}$ (**Muon Tag**)

$$\sigma_{183\ GeV} = 1260 \pm 330\ (\text{stat}) \pm 250\ (\text{syst})\ [\text{pb}]$$
$$\sigma_{161-172\ GeV} = 580 \pm 360\ (\text{stat}) \pm 190\ (\text{syst})\ [\text{pb}]$$
$$\sigma_{91\ GeV} = 600 \pm 170\ (\text{stat}) \pm 160\ (\text{syst})\ [\text{pb}]$$

Results

Cross section of Charm Production in $\gamma\gamma$ Collisions

$$\boxed{\sigma = \frac{N_{sel}}{\mathcal{L}} \frac{P_{charm}}{\epsilon_{charm}}}$$

- $e^+e^- \rightarrow e^+e^- c\bar{c}X$ (Combined Lepton)

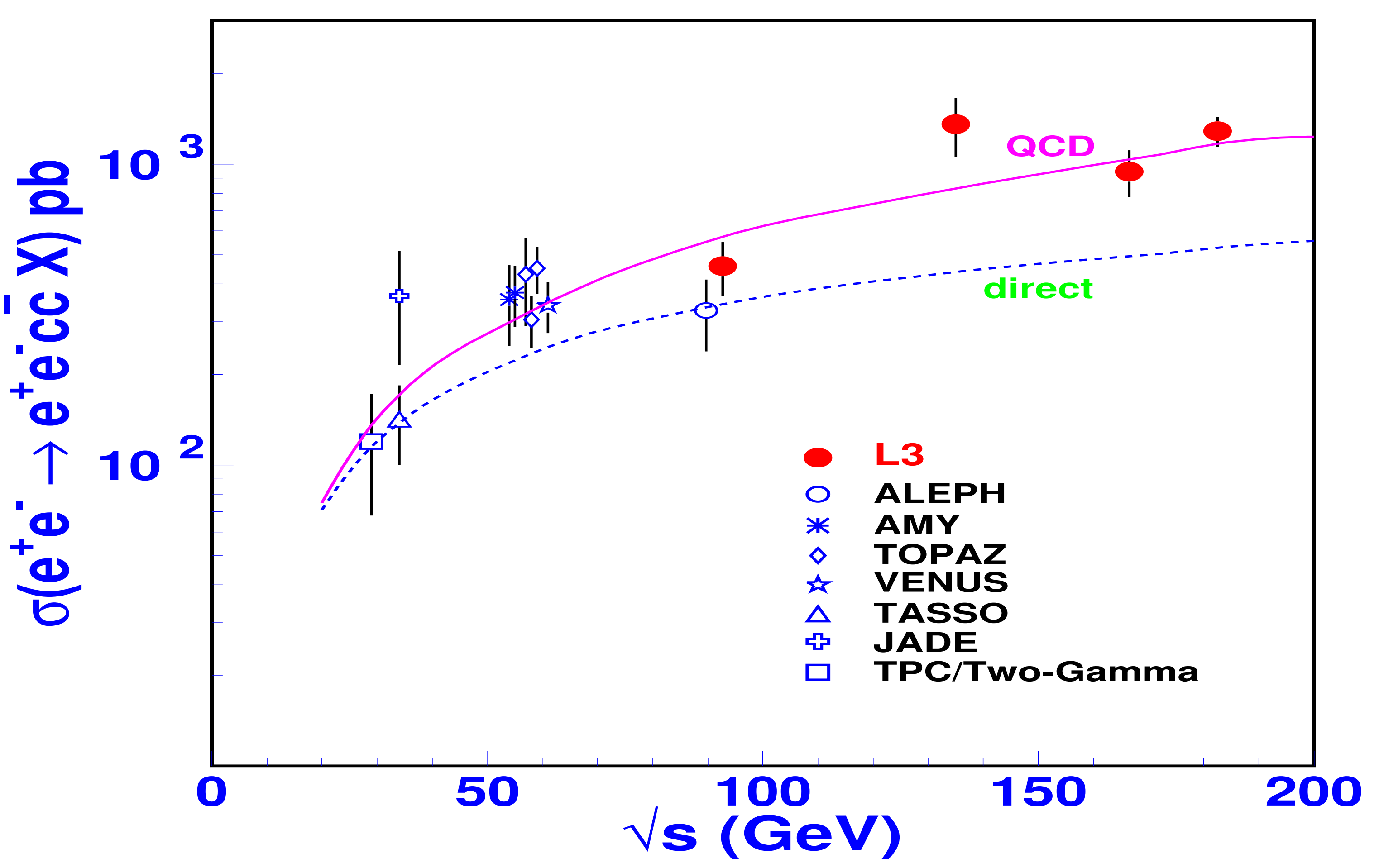
$$\sigma_{183\ GeV} = 1290 \pm 100\ (\mathrm{stat}) \pm 110\ (\mathrm{syst})\ [\mathrm{pb}]$$

$$\sigma_{161-172\ GeV} = 940 \pm 140\ (\mathrm{stat}) \pm 100\ (\mathrm{syst})\ [\mathrm{pb}]$$

$$\sigma_{130-140\ GeV} = 1360 \pm 240\ (\mathrm{stat}) \pm 180\ (\mathrm{syst})\ [\mathrm{pb}]$$

$$\sigma_{91\ GeV} = 460 \pm 60\ (\mathrm{stat}) \pm 70\ (\mathrm{syst})\ [\mathrm{pb}]$$

Results

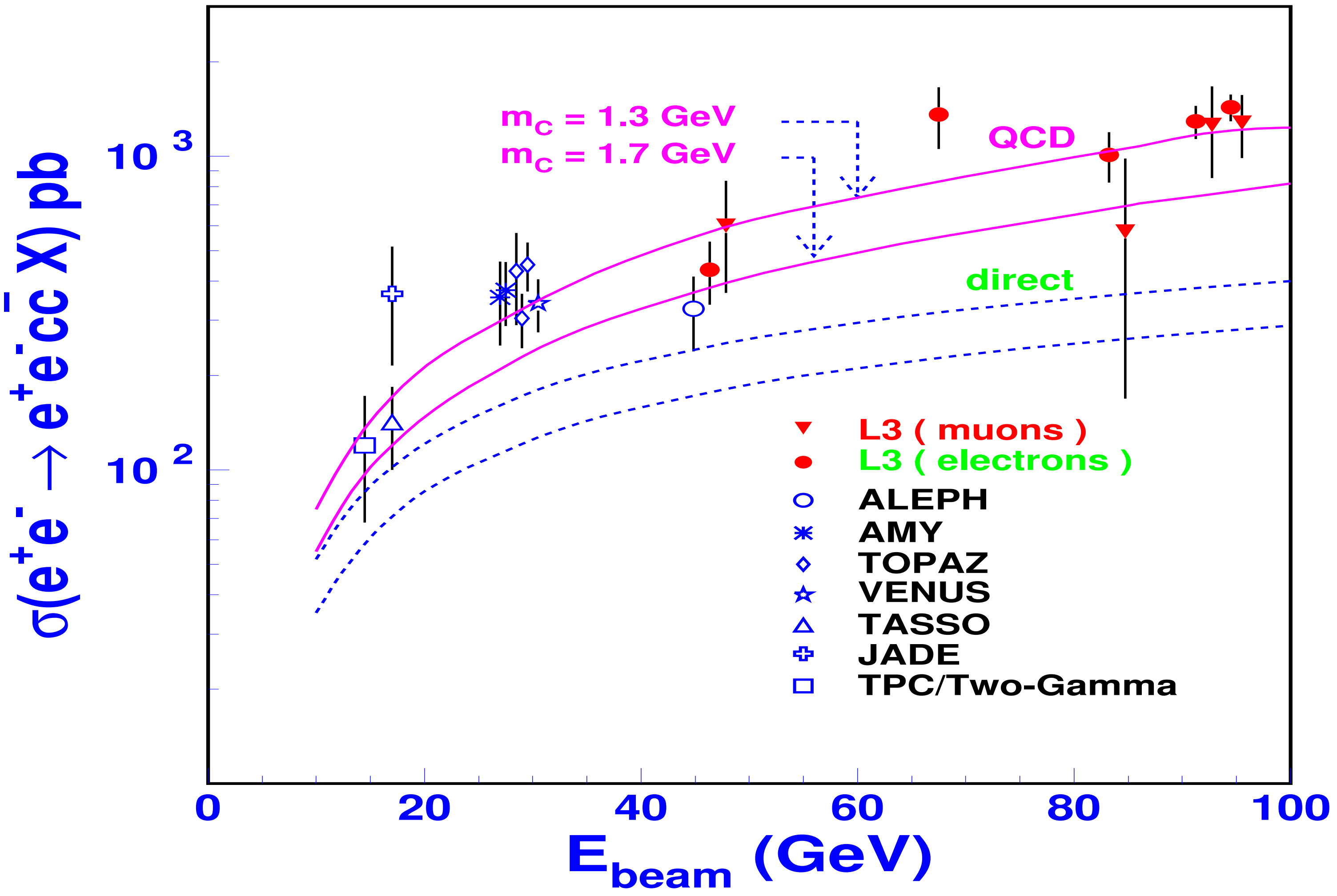


CERN-EP/98-185

Conclusion

- ❐ Cross Sections of inclusive charm production in $\gamma\gamma$ collisions have been measured with L3 detector at LEP1, LEP1.5 and LEP2 energies using lepton tag.
- ❐ Results are in agreement with QCD predictions. There is a need for resolved processes.
- ❐ Higher energy Charm Tag analyses are in progress.

Preliminary Results



Preliminary Results