Inclusive Particle Production in Two-Photon Collisions at LEP

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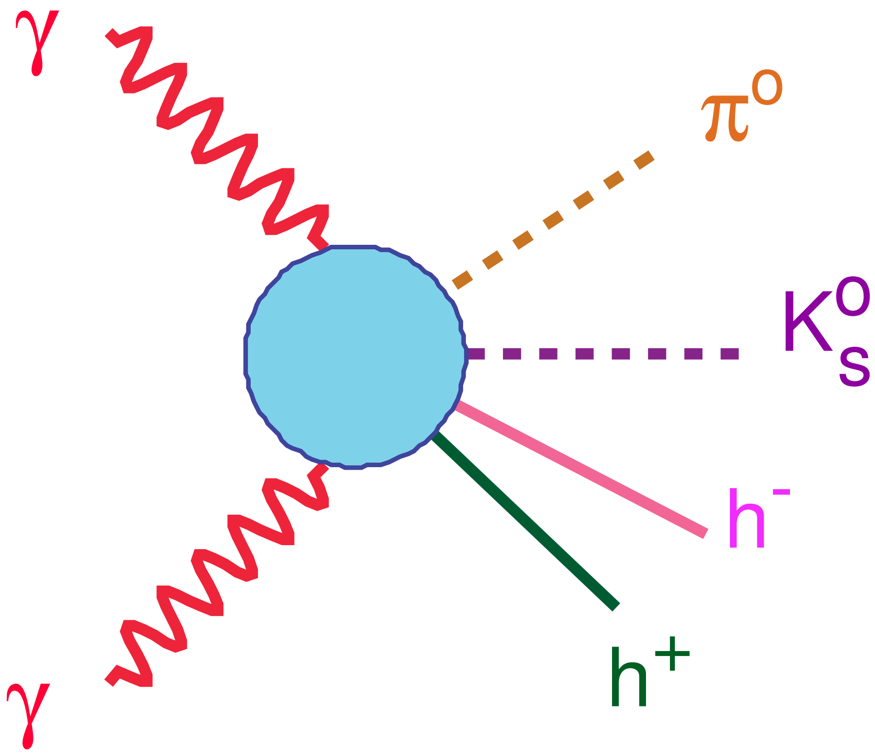
Two-Photon Collision Process:

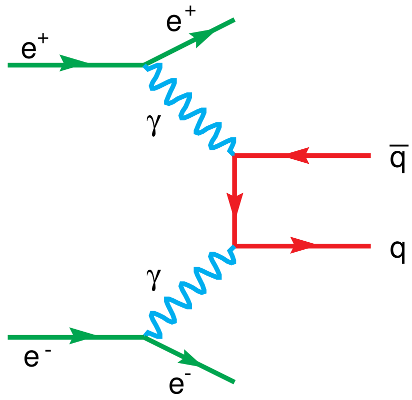


Photons don't interact with each other
($\Rightarrow$ Abelian structure of QED!),
but can interact within a "hadronic blop"

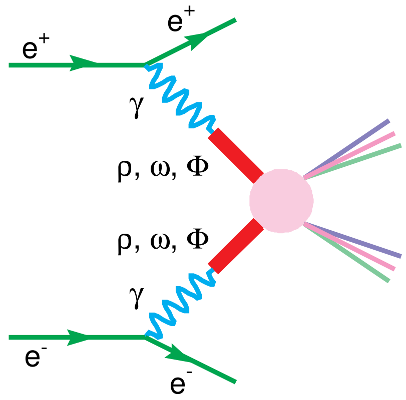
- Look for π^0, K^0_s or charged hadrons ($h^\pm$) in the detector
- Measure their transverse momentum distribution
- Check QCD predictions

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

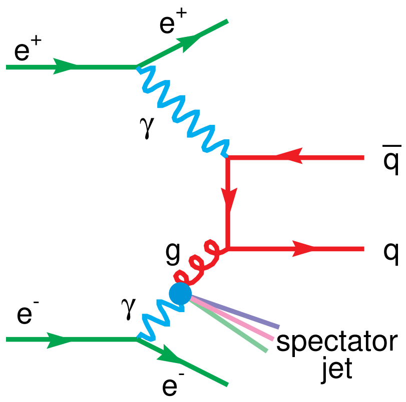
Hadronic Two-Photon Collision Process:



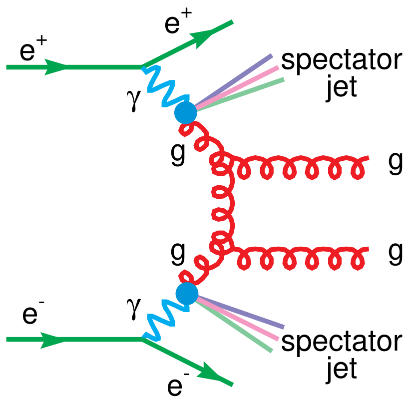
Direct QED



VDM



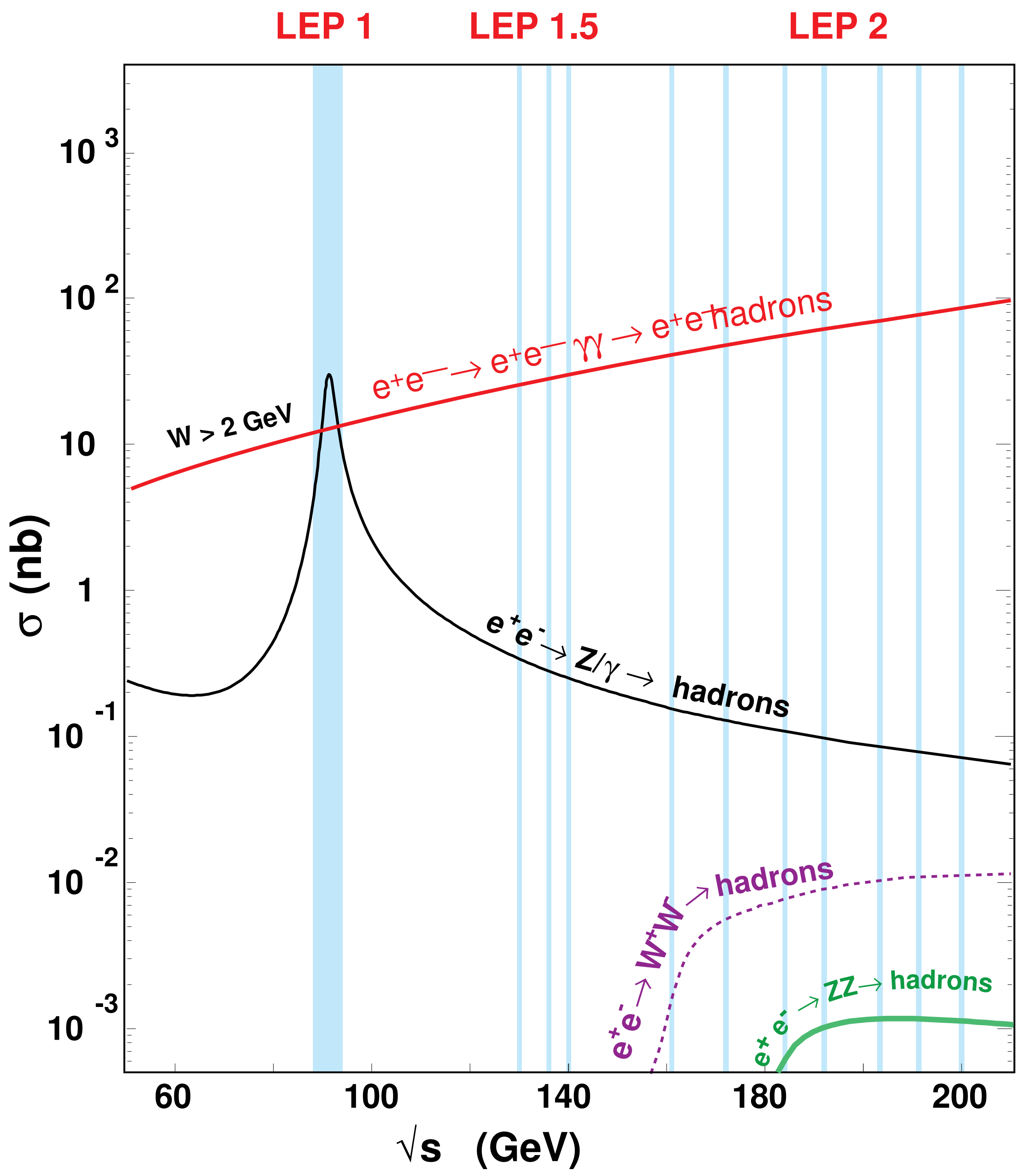
Single Resolved



Double Resolved

- Electron and positron escape undetected along the beam pipe
  $\longrightarrow$ quasi real photons
- Relative contribution of Feynman diagrams depends on p_T-range

$e^+e^- \longrightarrow$ hadrons



Two-Photon cross section dominant at LEP

$\Rightarrow$ Check of perturbative QCD

L3: (π^0, K_s^0)

Integrated Luminosity: $410\ \mathrm{pb}^{-1}$

at $189 < \sqrt{s} < 202$ GeV

(2 million events)

All data preliminary

Opal: ($h^{\pm}$, K_s^0)

Integrated Luminosity: $20\ \mathrm{pb}^{-1}$

at $161 < \sqrt{s} < 172$ GeV

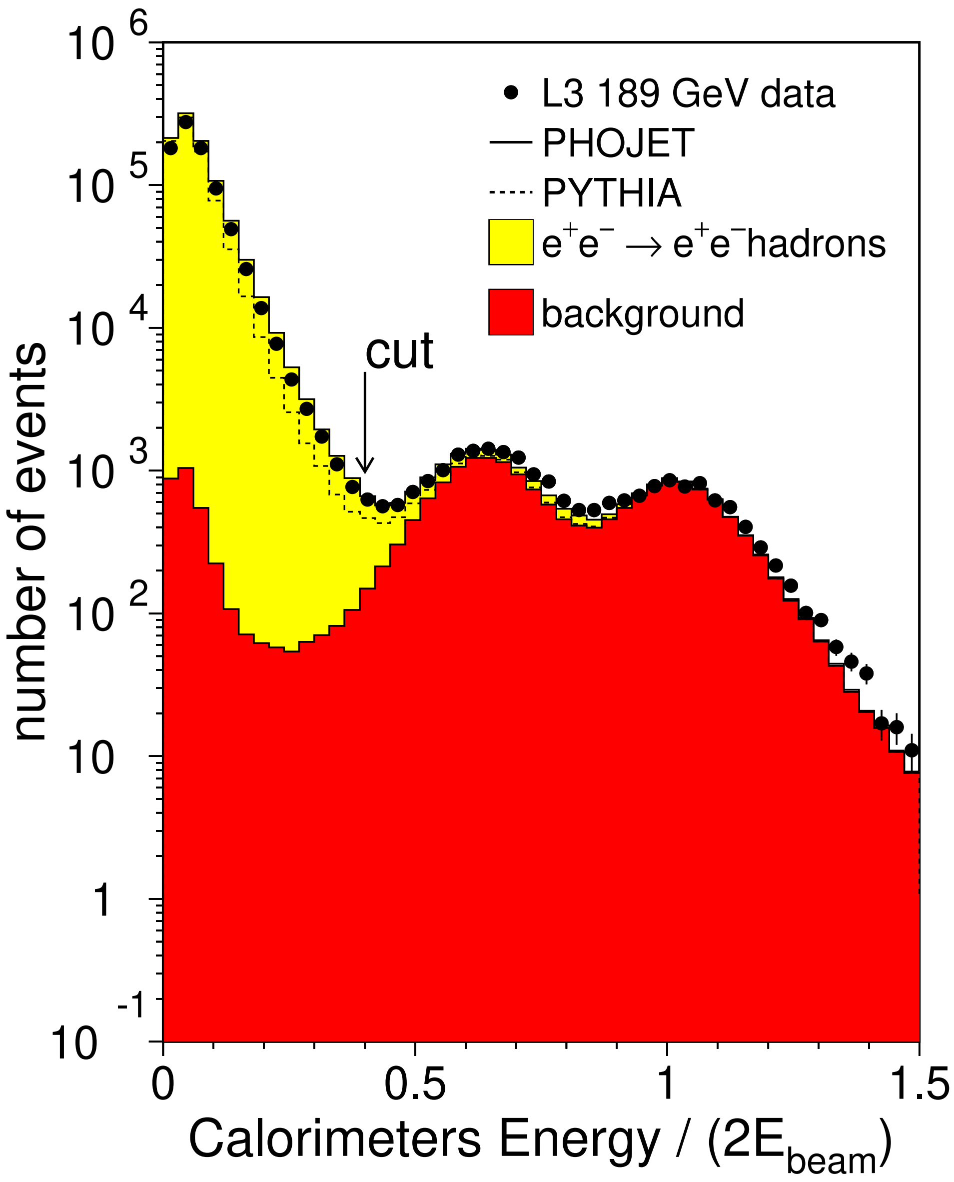
(58 000 events)

(Eur. Phys. J. C 6 (1999) 253)

Monte Carlo Simulation used:

PHOJET: R. Engel and J. Ranft
(Phys. Rev. D54, 4246, 1996, V1.05c)

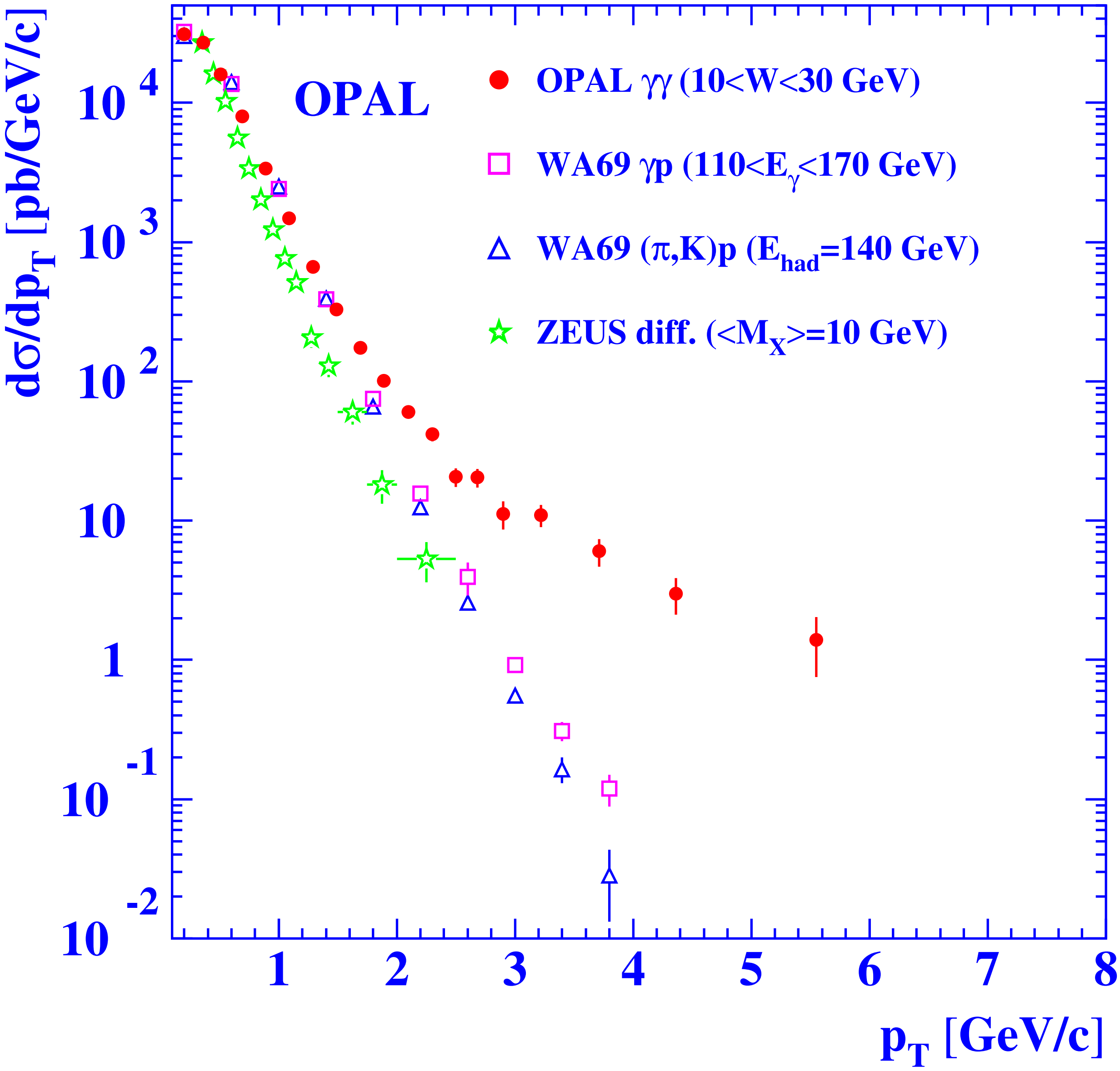
PYTHIA: T. Sjöstrand
(CPC 82, 74, 1994, V5.718)



Typical $\gamma\gamma \rightarrow$ hadrons selection:

- low visible energy
- at least few particles in the detector from the interaction point
- small energy deposit in the luminosity monitor (anti tag)

$e^+e^- \rightarrow e^+e^- + h^\pm + X$



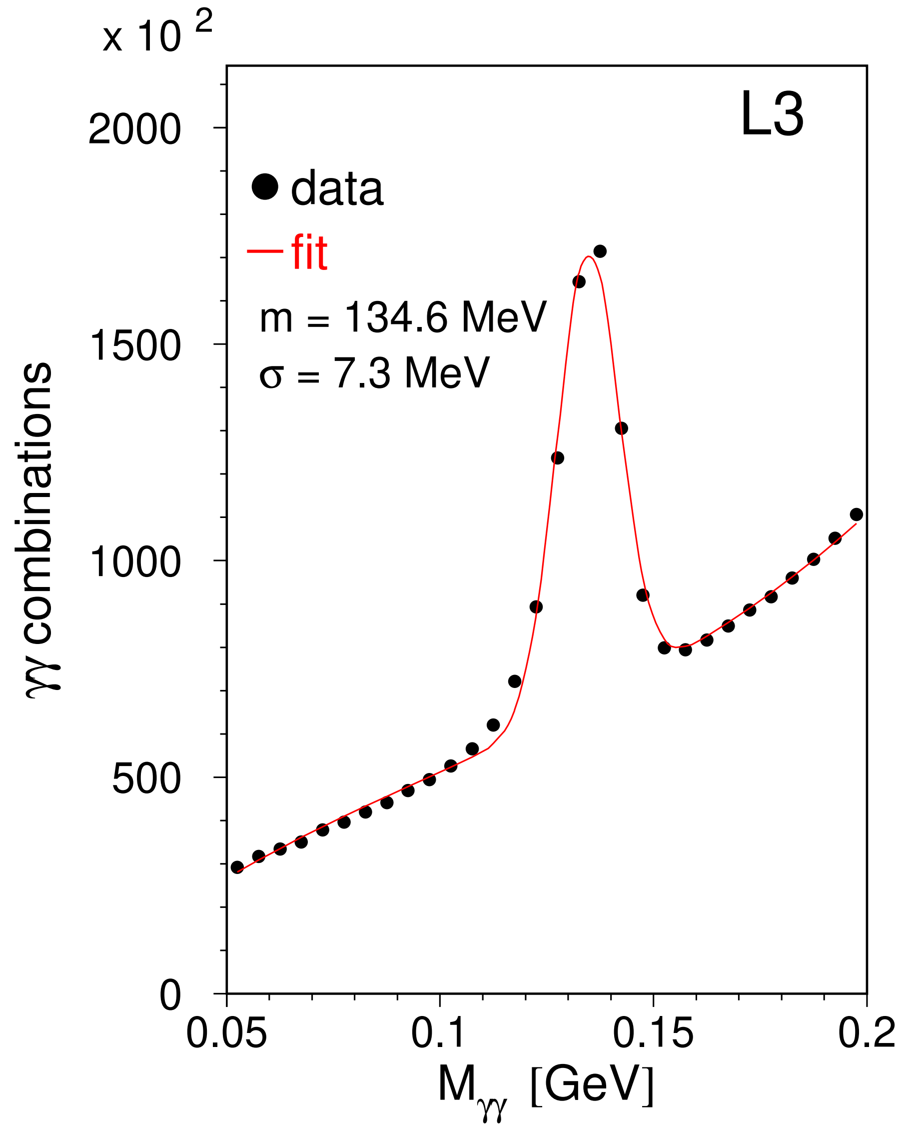
At low p_T : $(< 1$ GeV)

$\gamma\gamma$ behaves like soft hadron-hadron and photon-hadron collisions

At high p_T : $(> 1$ GeV)

Hard QCD and direct QED processes become dominant

Look for two photons from the π^0-decay



Transverse momentum range of the π^0:

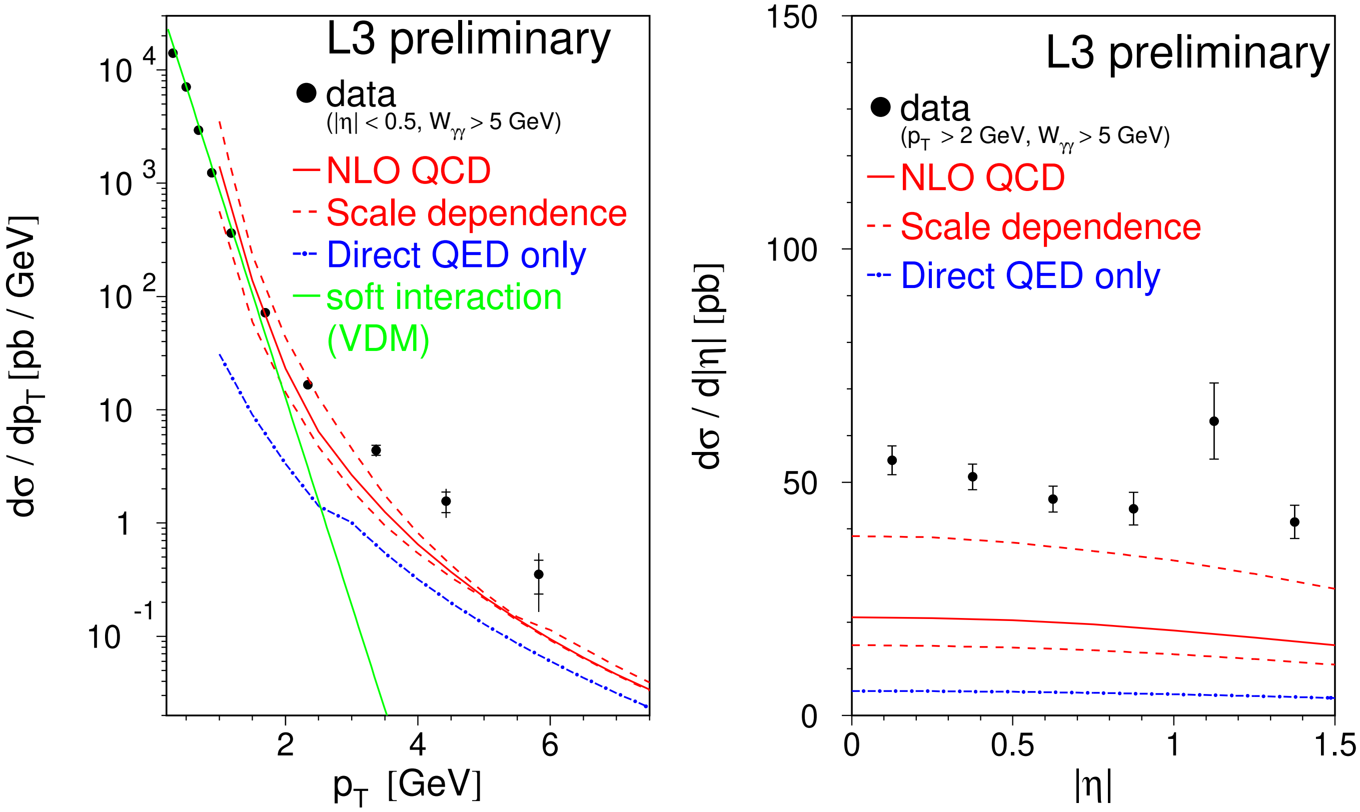
$$0.2 \text{ GeV} < p_T < 7.5 \text{ GeV}$$

Pseudo-Rapidity: $\eta = -\ln(\tan\theta/2)$

$|\eta| < 0.5$ (Barrel-Region)

Differential Cross Sections:

$$e^+e^- \to e^+e^- + \pi^0 + X$$



Exponential fit for $p_T < 1$ GeV:

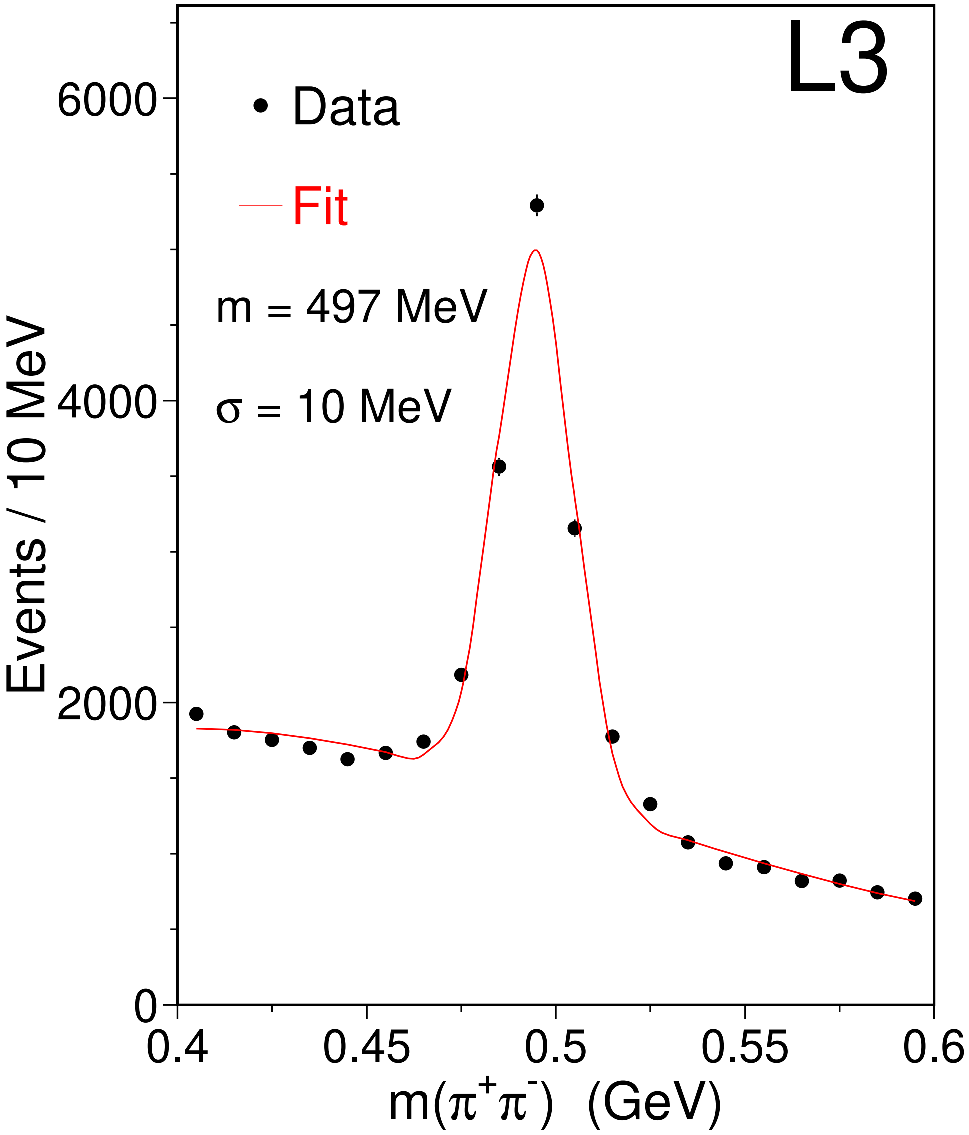
$$< p_T >= 239 \pm 3 \text{ MeV}$$

Compatible with pp- and pγ-collisions

NLO QCD: J. Binnewies et al. (priv. com.)

Phys. Rev. D56 (1996) 6110

Look for two charged Pions from the K_s^0-decay with secondary vertex

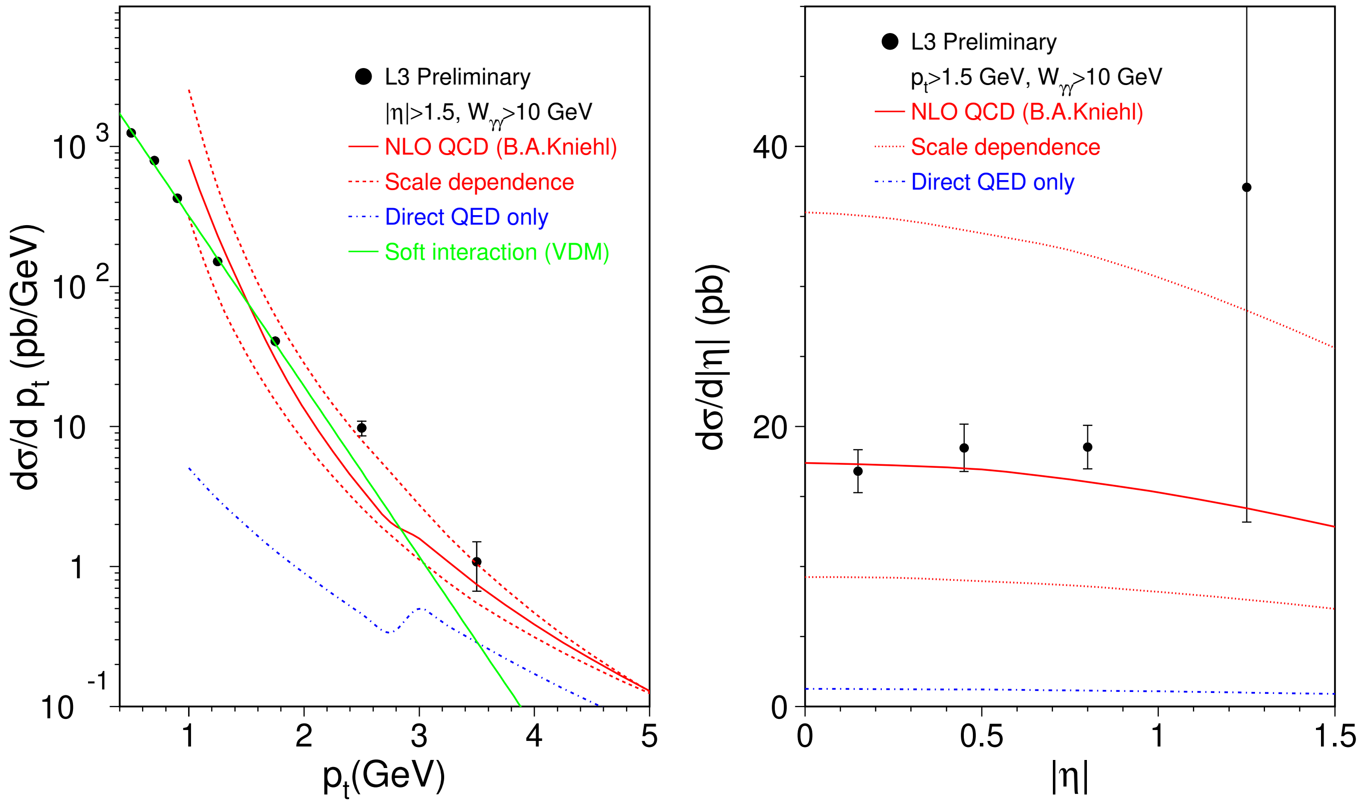


Invariant Mass of the $\pi^+\pi^-$-system

Pseudo-Rapidity $|\eta| < 1.5$ (Barrel + Endcap)

Differential Cross Sections:

$$e^+e^- \rightarrow e^+e^- + K^0_s + X$$

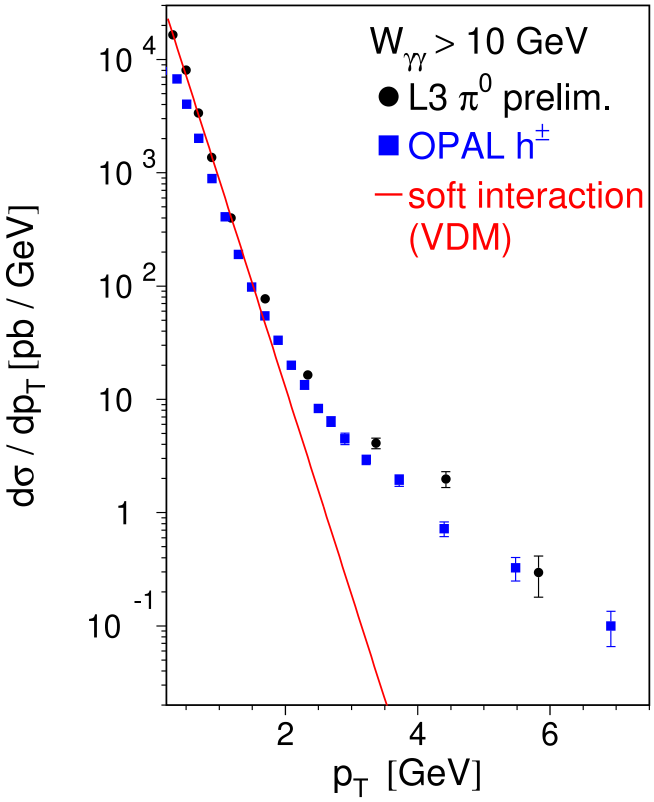


Exponential fit for $p_T < 2$ GeV:

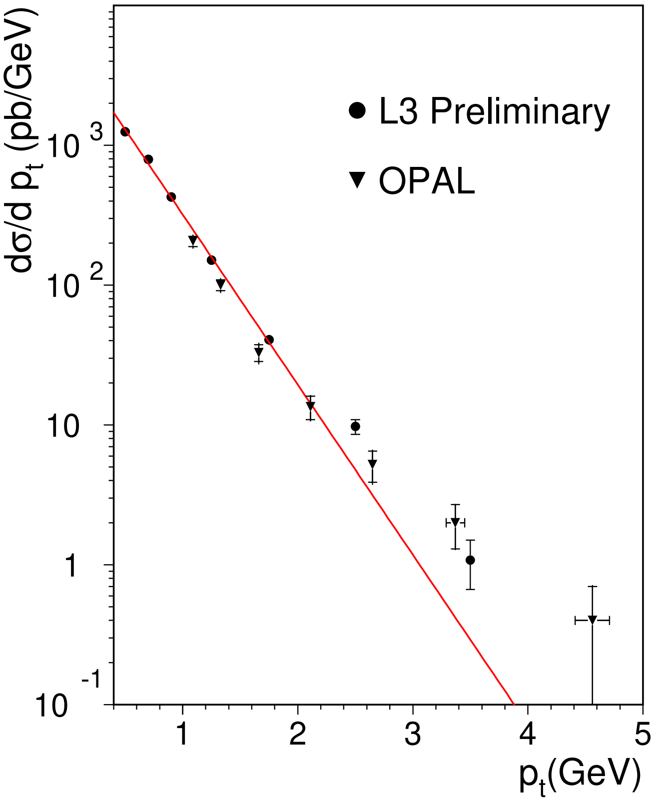
$$< p_T >= 357 \pm 8 \text{ MeV}$$

Kink at $p_T \approx 3$ GeV due to charm production

Hadrons/Pions



Kaons



Good agreement between L3 and OPAL

Conclusions

- Clean π^0 and K^0_s signal in $\gamma\gamma$-collisions

- First study of π^0 and K^0_s differential cross sections at LEP

- Measurements from L3 and OPAL are consistent

- At low p_T, exponential behaviour in both channels; typical for soft pp/pγ interactions

- At high p_T, evidence for contributions of hard QCD and direct QED processes