Exclusive production of charged pion and kaon pairs in photon-photon collisions at LEP2

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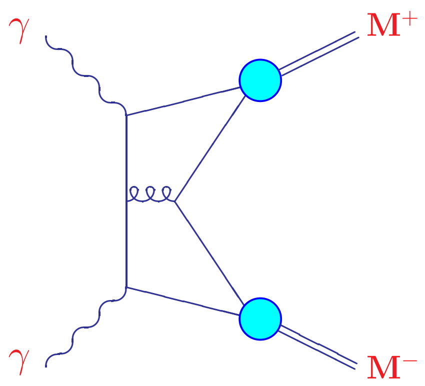
Motivation

Theoretical predictions:

- **QCD-based calculations**
  Brodsky-Lepage, Benayoun-Chernyak, Ji-Amiri



$$\frac{d\sigma}{d\cos\theta^*} = \frac{8\pi\alpha^2}{W_{\gamma\gamma}^6}|W_{\gamma\gamma}^2 F_M(W_{\gamma\gamma}^2)|^2 \times$$

$$\times\left\{\frac{1}{(1-\cos^2\theta^*)^2} - \frac{4}{9(1-\cos^2\theta^*)}g(\theta^*,\phi_M) + \frac{8}{81}g^2(\theta^*,\phi_M)\right\}$$

- **M.Diehl, P.Kroll, C. Vogt**
  Phys. Lett. B 532 (2002) 99-110

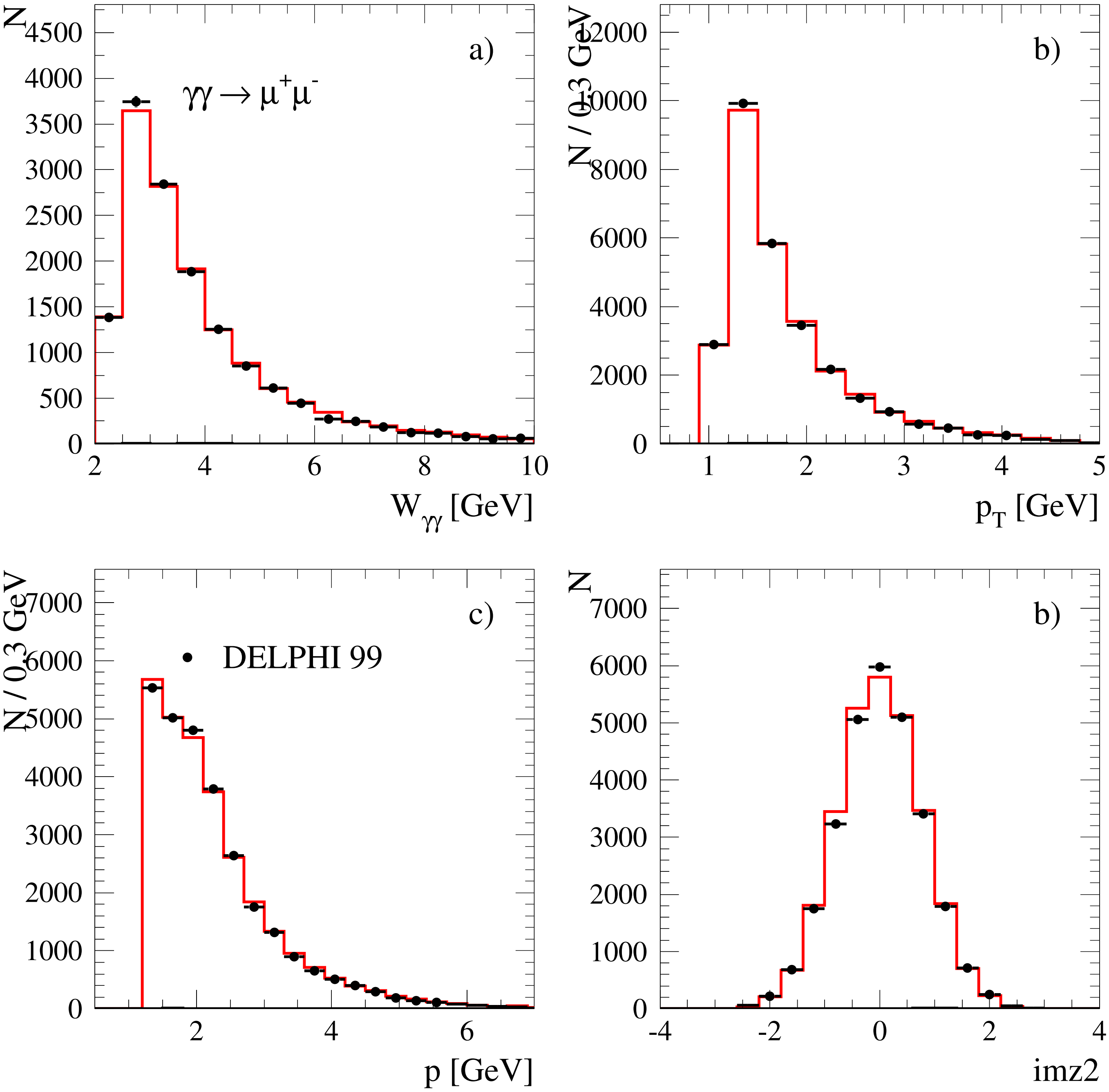
Selection cuts

$N_{track} = 2$ $\sum Q_i = 0$ $Imp_z < 4\text{cm}/\sin\theta$ $Imp_{r\phi} < 4$ cm track length > 30 cm $\Delta p/p < 1$
$30^\circ < \theta < 150^\circ$ $p > 1.2$ GeV $p_T > 1$ GeV
$W_{\gamma\gamma} > 2.3$ GeV $\lvert\cos\theta^*\rvert < 0.6$
$(\Sigma p_T)^2 < 0.02\text{GeV}^2$ $\lvert\pi - \Delta\phi\rvert < 0.17$ rad (K) - back-to-back in $r\phi$ $\lvert\pi - \Delta\phi\rvert < 0.044$ rad (π) $\lvert\pi - \Delta\eta\rvert > 0.1$ rad (π) - not back to back in 3D
$N_{neut} = 0$ (corrected) Good detector performance Rejection of events without TPC6 Events triggered by A or B
Rejection of muons, electrons ≥ 1 good kaon or 2 pions

Trigger efficiency

- **T1 - assumed 100% efficiency**
- **T2 and T3**
  - Two groups of independent trigger functions
    - A = TPC contiguity trigger ($30^\circ < \theta < 150^\circ$, $p > 1.2$ GeV)
    - B = combination of ID, OD and HCAL
  - $$\varepsilon_t = \varepsilon_A + \varepsilon_B - \varepsilon_A \varepsilon_B = \frac{N_{AB}}{N_B} + \frac{N_{AB}}{N_B} - \frac{N_{AB}^2}{N_A N_B}$$
  - trigger corrections per whole event
  - using data after final cuts (muon and hadron sample)
- **T4 ($p_T > 1$ GeV)**
- **ALLD data - DELANA event-filter and DAFNE did not reject events**

$\gamma\gamma \to \mu^+\mu^-$



Signal Monte Carlo

- Based on Galuga 2.0 Monte Carlo
  $\sigma_{\gamma\gamma} \sim 1/W_{\gamma\gamma}^{6}$, flat distribution in $\cos\theta^*$.

Backgrounds

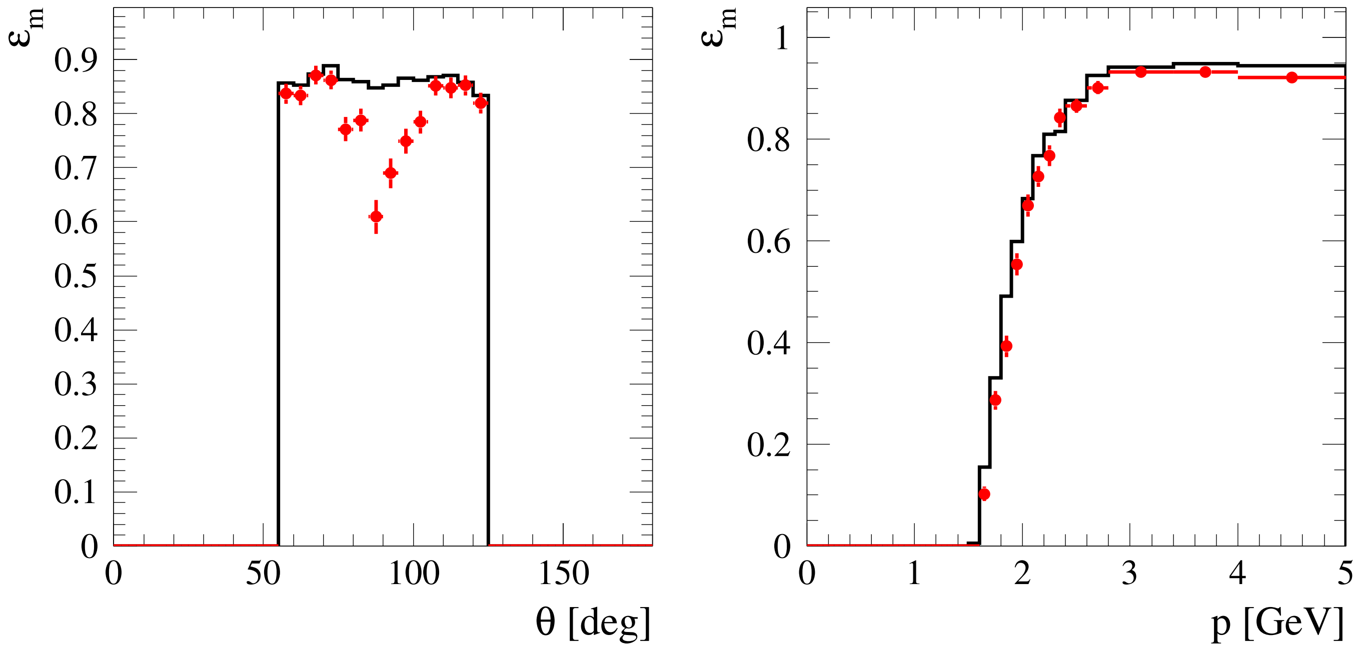
- $\gamma\gamma \to \pi^+\pi^-/K^+K^-$ - Galuga
- $\gamma\gamma \to p\bar{p}$ - Galuga, $\sigma_{\gamma\gamma} \sim 1/W_{\gamma\gamma}^{10}$,
- Four-fermion processes - BDK MC
- $\gamma\gamma \to \mu^+\mu^-$ - Bdkrc/Vermaseren
- $\gamma\gamma \to \tau^+\tau^-$ - Vermaseren
- $\gamma\gamma \to q\bar{q}$ - Phojet

The most important background: in case of $\gamma\gamma \to \pi^+\pi^-$ irreducible background from $\gamma\gamma \to \mu^+\mu^-$

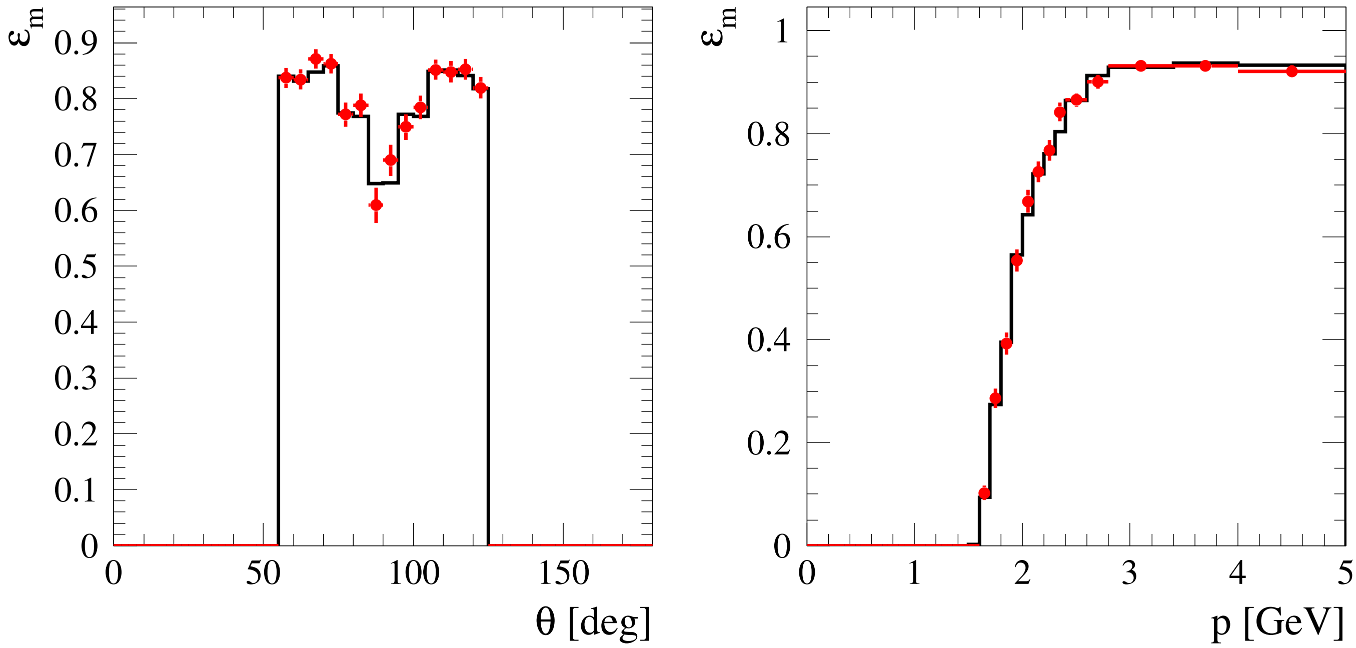
Muon identification

Hadron calorimeter (cathode readout) + muon chambers

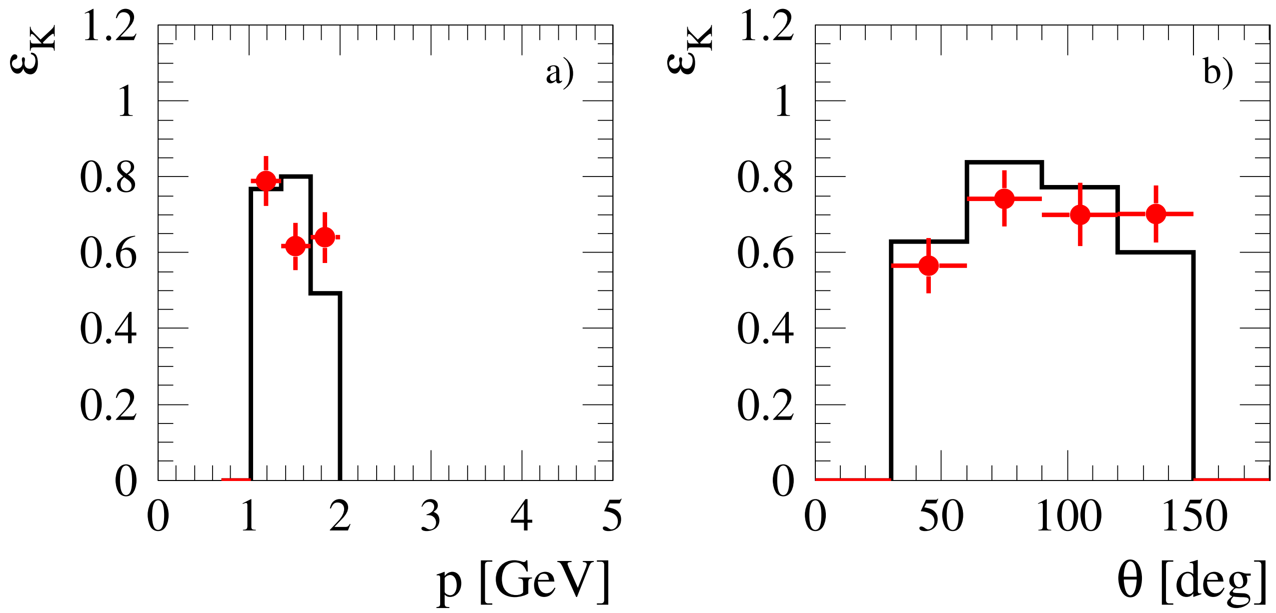
Before corrections



After corrections



Kaon identification



Cross-sections

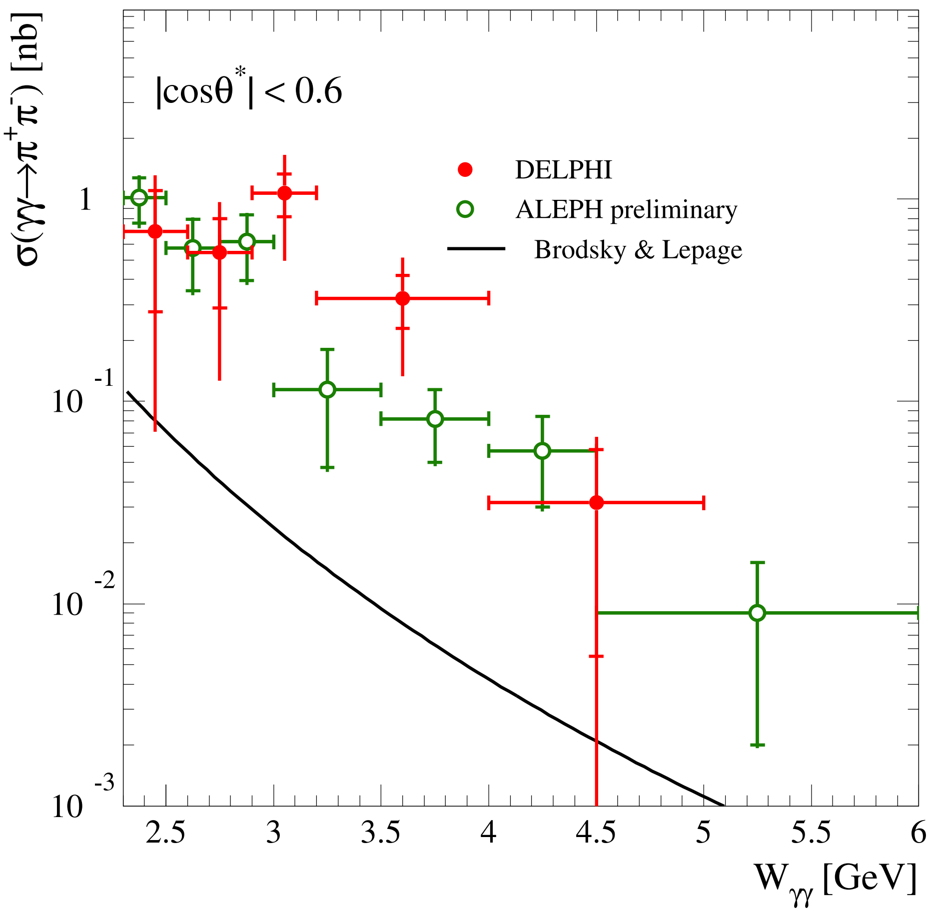
$$\sigma(\gamma\gamma \to M\overline{M}) = \frac{dN_{M\overline{M}}/dW_{\gamma\gamma}}{\varepsilon \mathcal{L}_{e^+e^-} d\mathcal{L}_{\gamma\gamma}/dW_{\gamma\gamma}}$$

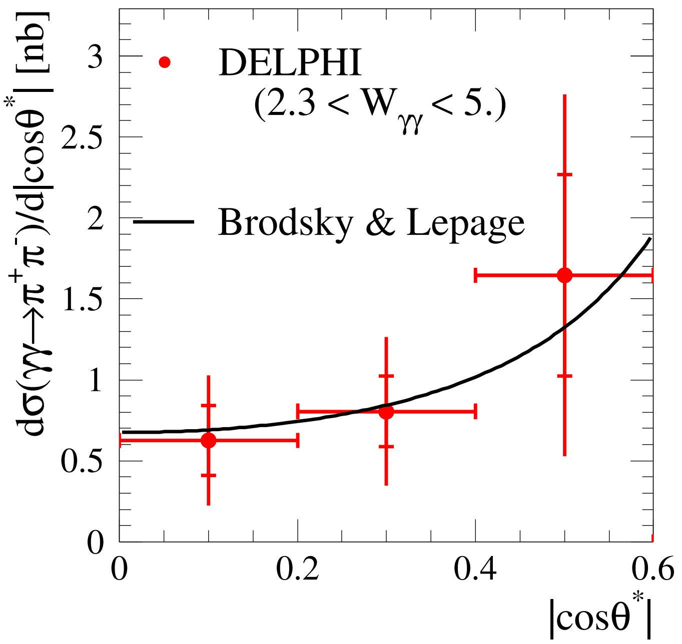
$$\frac{d\sigma}{d\cos\theta^*} = \frac{dN/d\cos\theta^*}{\varepsilon \mathcal{L}_{e^+e^-} \mathcal{L}_{\gamma\gamma}}$$

- K^+K^- sample
  $\mathcal{L}_{e^+e^-} = 490.5pb^{-1}$
  129 events selected

- $\pi^+\pi^-/\mu^+\mu^-$ sample
  $\mathcal{L}_{e^+e^-} = 461.6pb^{-1}$
  1889 events selected

Cross-sections, $\gamma\gamma \rightarrow \pi^+\pi^-$





Cross-sections, $\gamma\gamma \to K^+K^-$