Lepton pair production in tagged $\gamma\gamma$ collisions at the L3 experiment

Emanuele Leonardi

Università di Roma "La Sapienza"
and
I.N.F.N. Sez. di Roma

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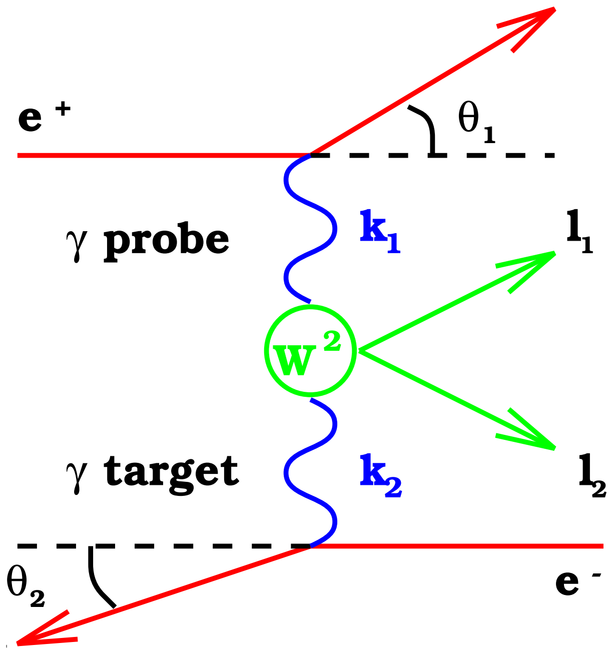
Kinematics



$$x_1 = \frac{E_{\gamma_1}}{E_{beam}} \qquad x_2 = \frac{E_{\gamma_2}}{E_{beam}}$$

$$Q^2 = -k_1^2 \simeq 4E_{beam}^2(1 - x_1)\sin^2\frac{\theta_1}{2}$$

$$W^2 = (l_1 + l_2)^2 = (k_1 + k_2)^2$$

$$x = \frac{Q^2}{Q^2 + W^2}$$

Single–tag $\Longrightarrow \theta_2 \simeq 0 \Longrightarrow t = -k_2^2 \simeq 0$

Cross Section

$$\frac{d^3\sigma}{dx\,dQ^2\,dx_2} = \frac{4\pi\alpha^2}{Q^4 x}(1-x_1)\frac{dn(x_2)}{dx_2}F_2(x,Q^2)$$

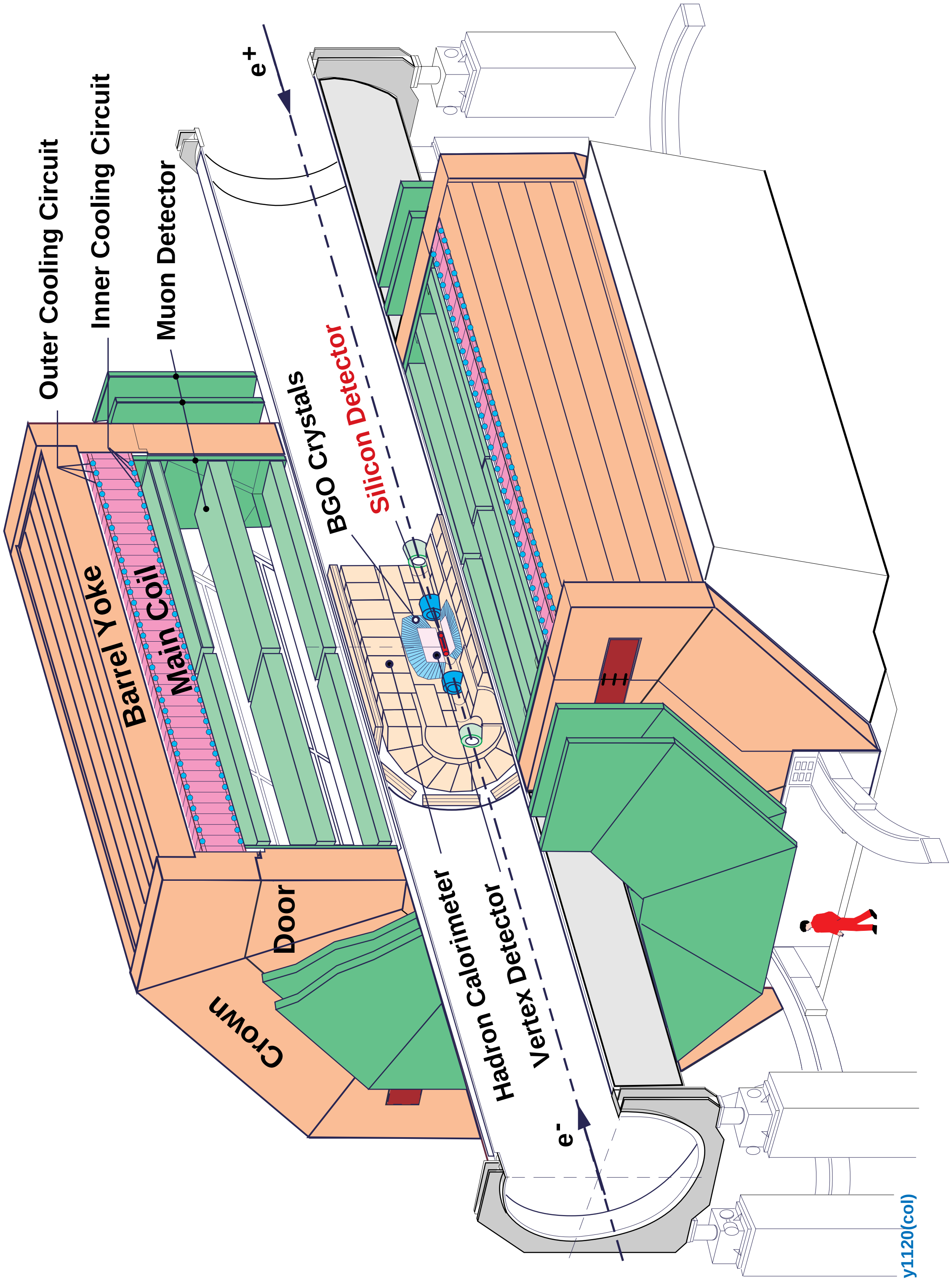
$$\frac{dn(x_2)}{dx_2} = \text{target photon flux}$$

Photon Structure Function

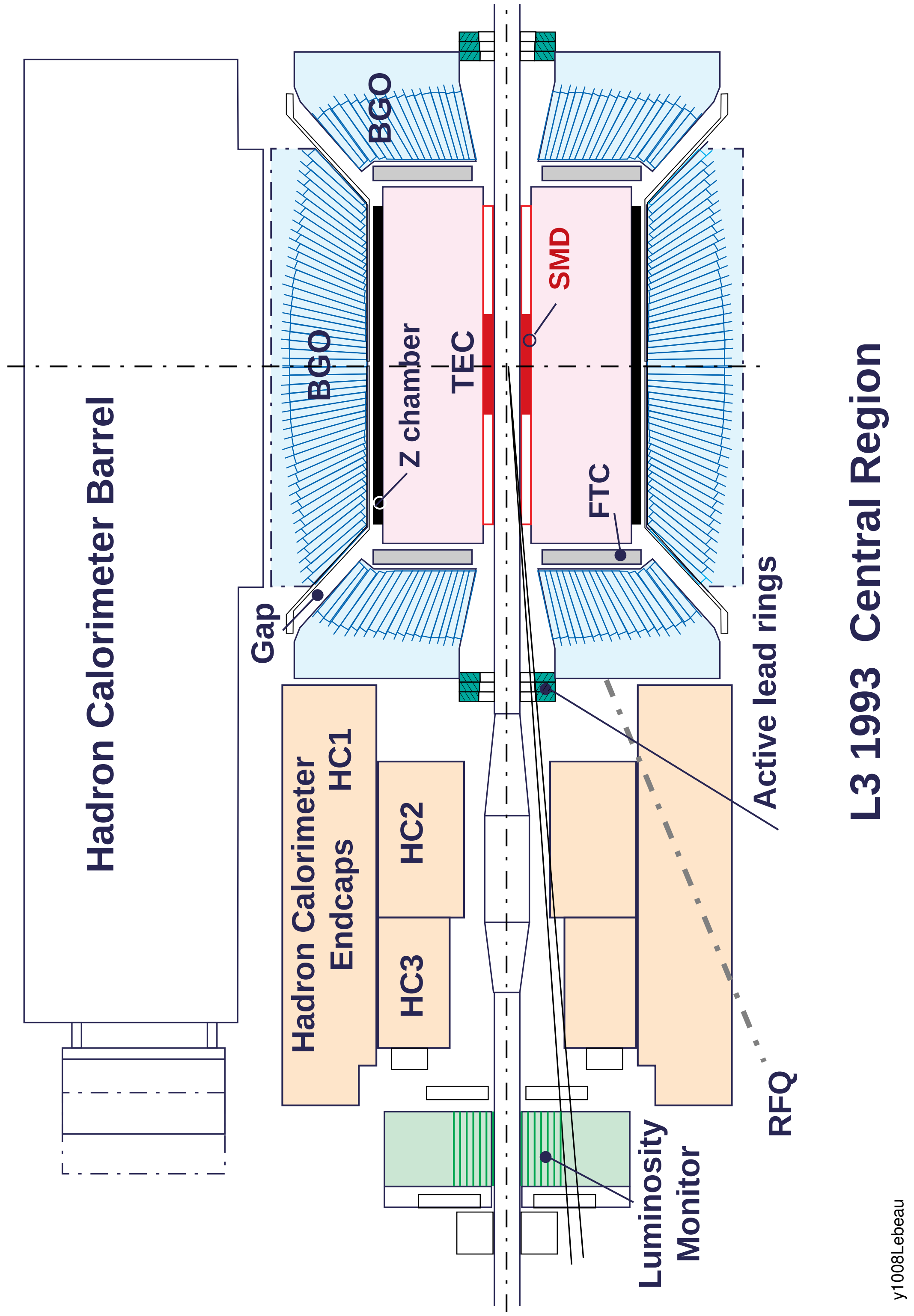
$$F_2(x,Q^2) = \frac{\alpha}{\pi}x\left\{[x^2+(1-x)^2]\ln\frac{W^2}{m_l^2+tx(1-x)}\right.$$
$$\left. -1+8x(1-x)-\frac{tx(1-x)}{m_l^2+tx(1-x)}\right\}$$

Quasi-real photon mass t effect: O(10%)

The L3 Detector



The L3 Detector



Event Selection

- 1 (and only 1) cluster with $E > 35$ GeV
  in Luminosity Monitor $27 < \theta_1 < 64$ mrad
  or in e.m. EndCap $200 < \theta_1 < 600$ mrad

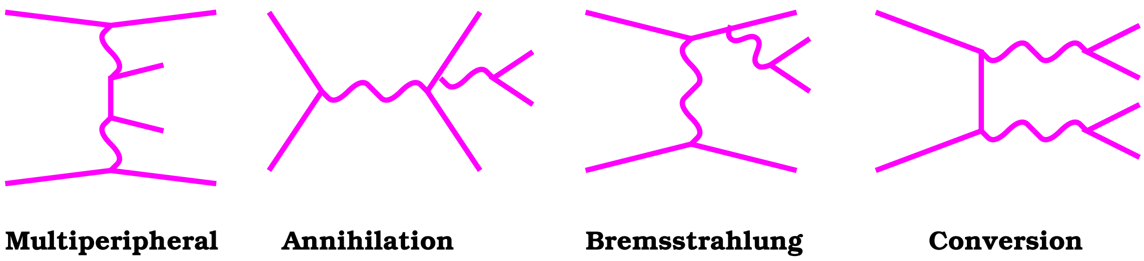
- 2 tracks in the range $28^\circ < \theta < 152^\circ$
  and with invariant mass $W > 0.5$ GeV

Tracks compatible with m.i.p.'s $\Longrightarrow$ $e\mu\mu$

Tracks compatible with electrons $\Longrightarrow$ eee

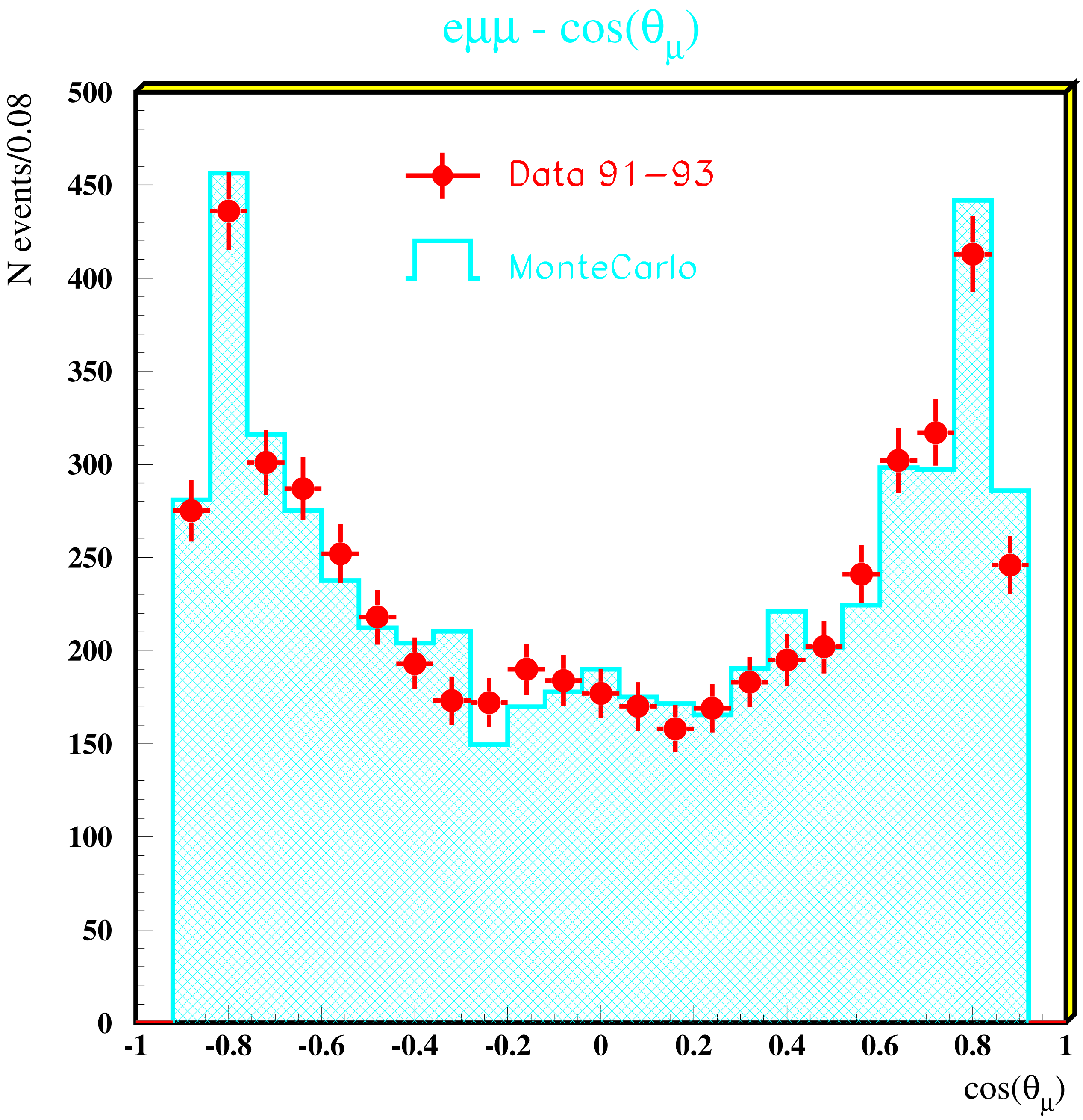
MonteCarlo

Generator: DIAG36 — All 4 fermion diagrams in.

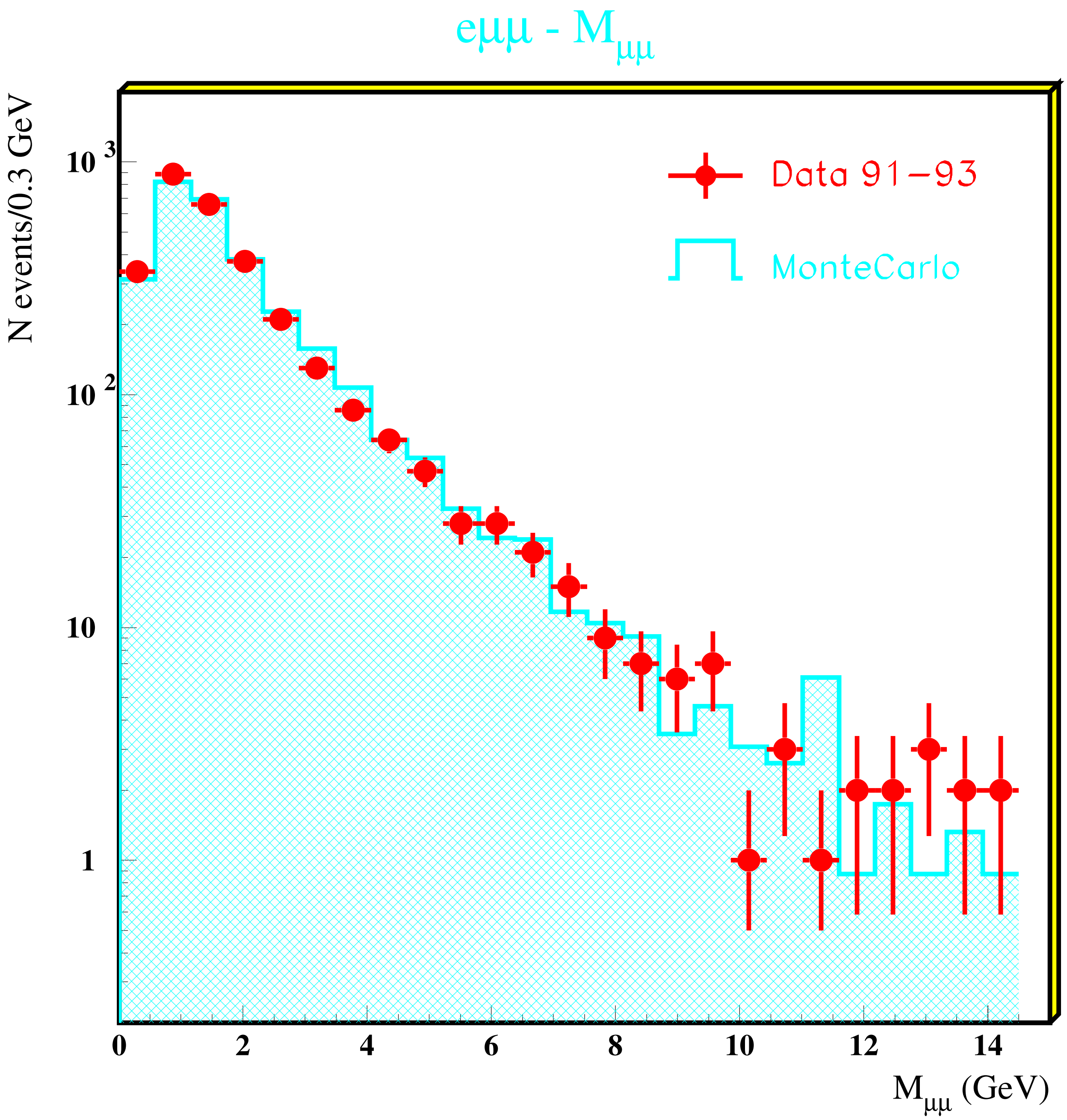


Fully simulated events: 38.09 /pb $ee\mu\mu$ and 5.9 /pb $eeee$

$cos(\theta_\mu)$ distribution



Invariant Mass distribution



Selection Results

Request: "TEC+LUMI" trigger operational

$$\mathcal{L}(91+92+93) = 33.2/\text{pb}$$

$e\mu\mu$ – Lumi $(1.4 \leq Q^2 \leq 7.6\ \text{GeV}^2)$

Selected events	Background $eeee$	Background $ee\tau\tau$	Final selection	Expected from MC
2727	66	29	2632 ± 52	2776 ± 49

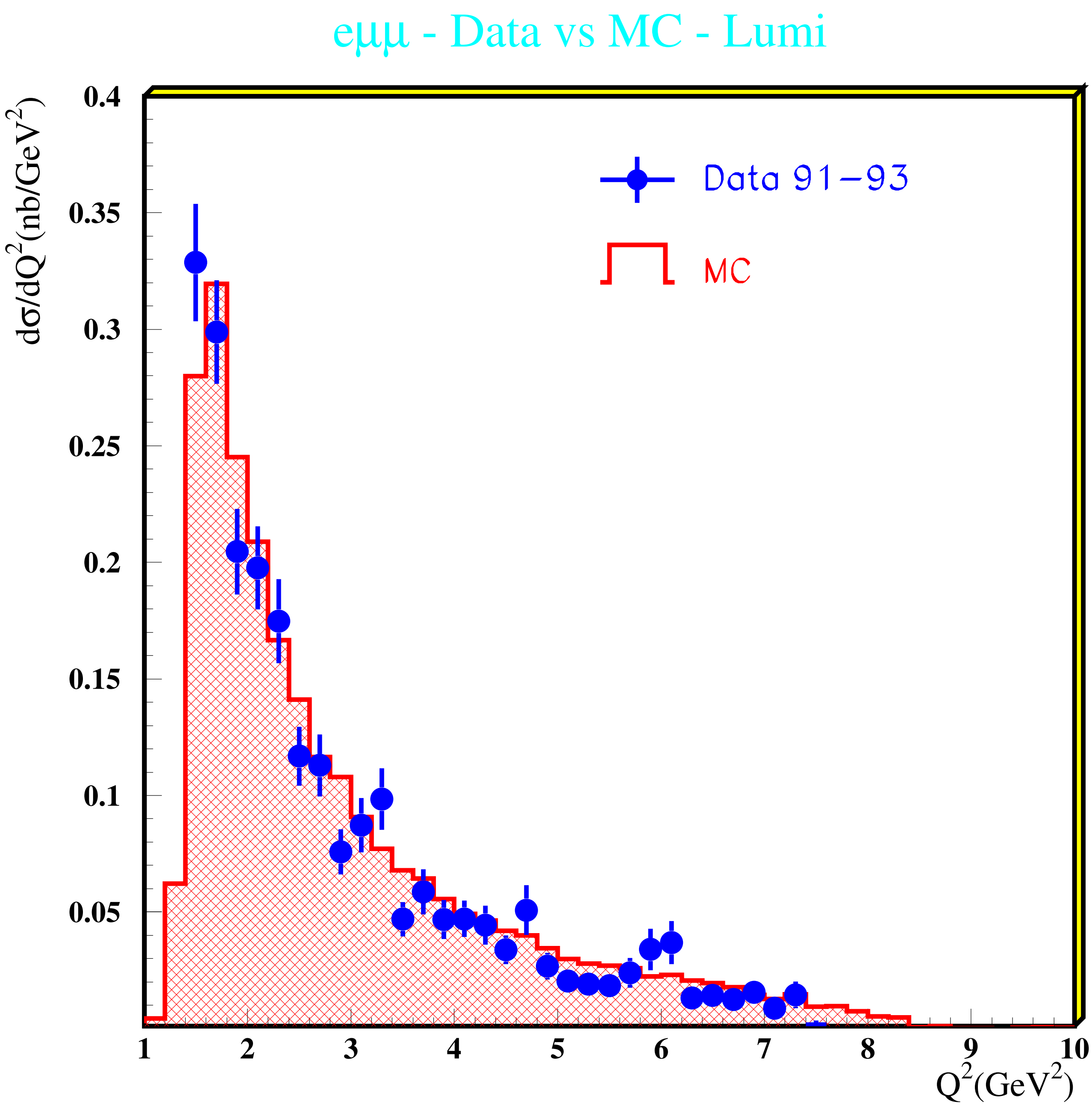
eee – Lumi $(1.4 \leq Q^2 \leq 7.6\ \text{GeV}^2)$

Selected events	Background $ee\mu\mu$	Background $ee\tau\tau$	Final selection	Expected from MC
1430	0	13	1417 ± 38	1336 ± 87

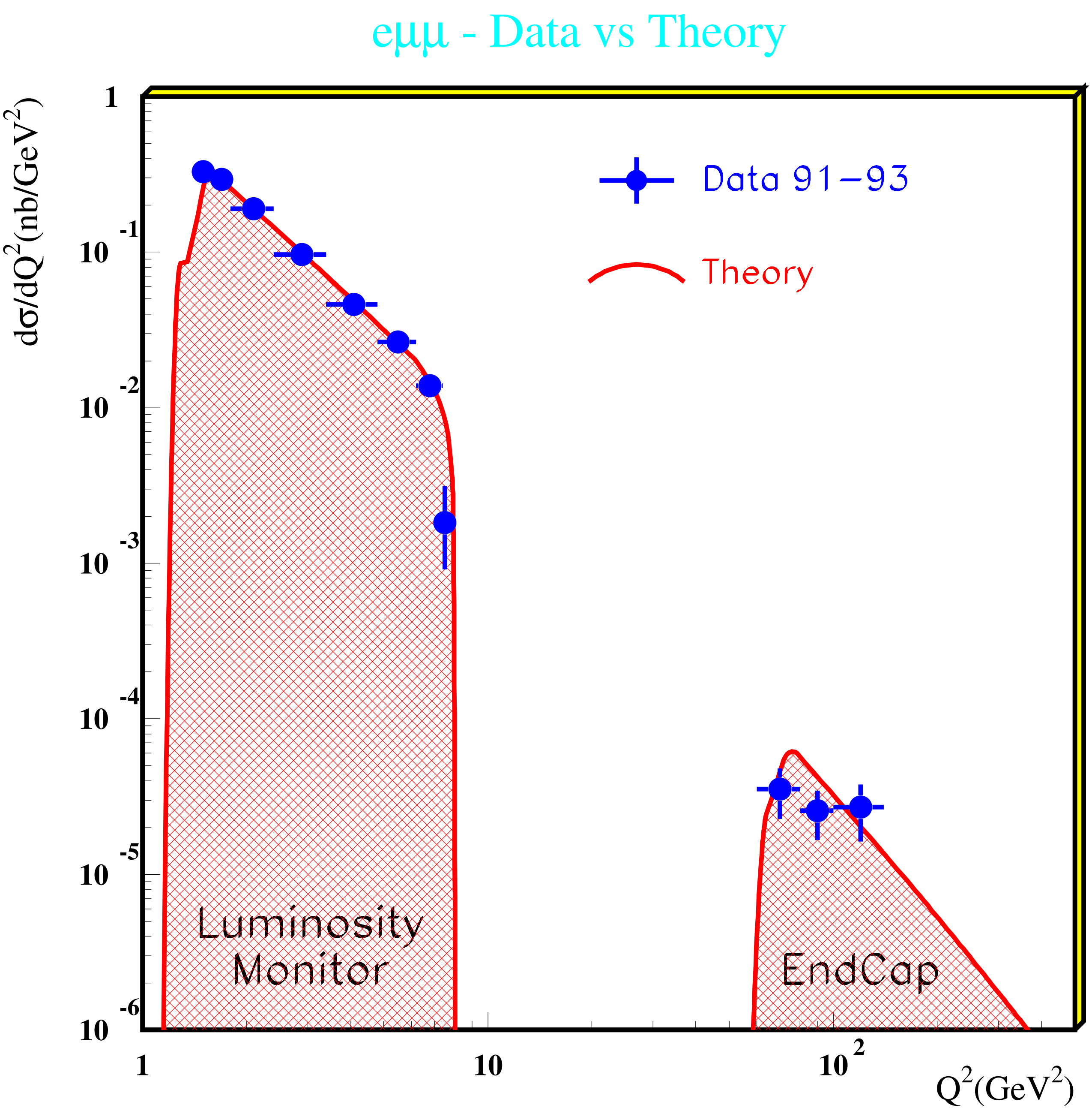
EndCap $(60 \leq Q^2 \leq 140\ \text{GeV}^2)$

Channel	Selected events	Expected from MC
$e\mu\mu$	36	28 ± 5
eee	6	11 ± 8

Cross Section



Cross Section



$F_2(x, Q^2)$ extraction recipe

$$\frac{d^2\sigma}{dx dQ^2} = K(x, Q^2) F_2(x, Q^2)$$

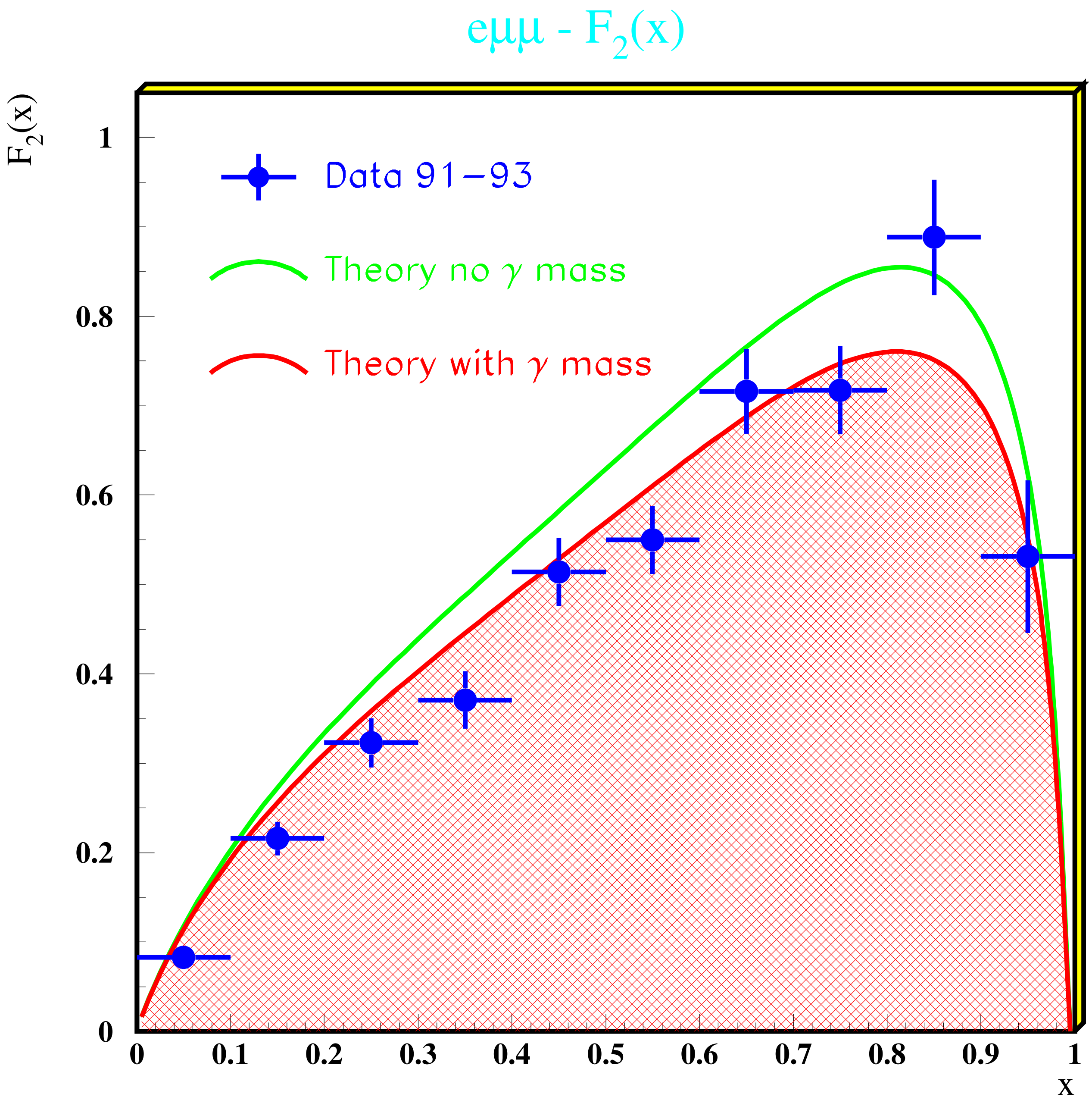
$$K(x, Q^2) = \frac{4\pi\alpha^2}{Q^4 x} \quad (1 - x_1) \frac{dn(x_2)}{dx_2} dx_2$$

In single–tag events $x_1 \simeq \dfrac{W^2 + Q^2(1 - x_2)}{4E^2_{beam} x_2}$

$K(x, Q^2)$ is extracted from MonteCarlo and applied to Data

$$F_2^{data}(x, Q^2) = \frac{1}{K^{MC}(x, Q^2)} \frac{d^2\sigma^{data}}{dx dQ^2}$$

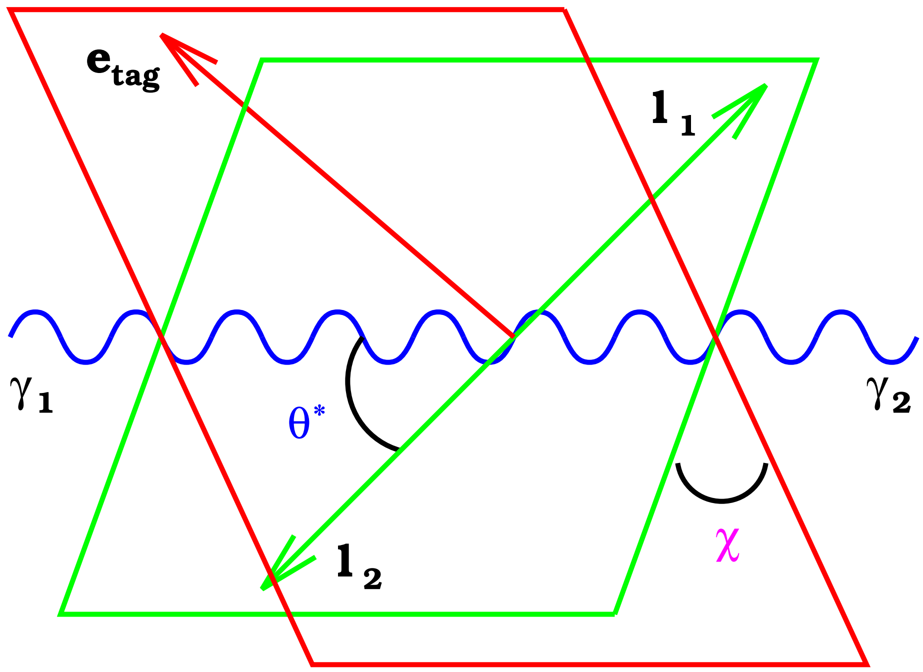
$F_2(x, Q^2)$ – x dependence



Preliminary

Angular Distribution

2 photon center of mass system



Single tag $\Longrightarrow \overrightarrow{\gamma_2} \sim|| \overrightarrow{\textbf{Beam}}$ **(lab)**

$\Downarrow$

χ **and** $cos(\theta^*)(\equiv z)$ **can be computed from lab kinematics**

$$\frac{d^3\sigma}{dx\,dy\,d\Omega} = \frac{4\pi\alpha^2}{Q^4}[1 + (1-y)^2]\times$$

$$\times\,[A_1 + A_2 cos(\chi) + A_3 cos(2\chi)]$$

Angular Distribution

$A_i = A_i(x, z)$ give access to the other
γ structure functions

$$A_1(x,z) = 2x F_T(x,z) + \epsilon(y) F_L(x,z)$$

$$A_2(x,z) = -\rho(y) F_A(x,z) \Longleftarrow \text{azimuthal asymmetry}$$

$$A_3(x,z) = \tfrac{1}{2}\epsilon(y) F_L(x,z)$$

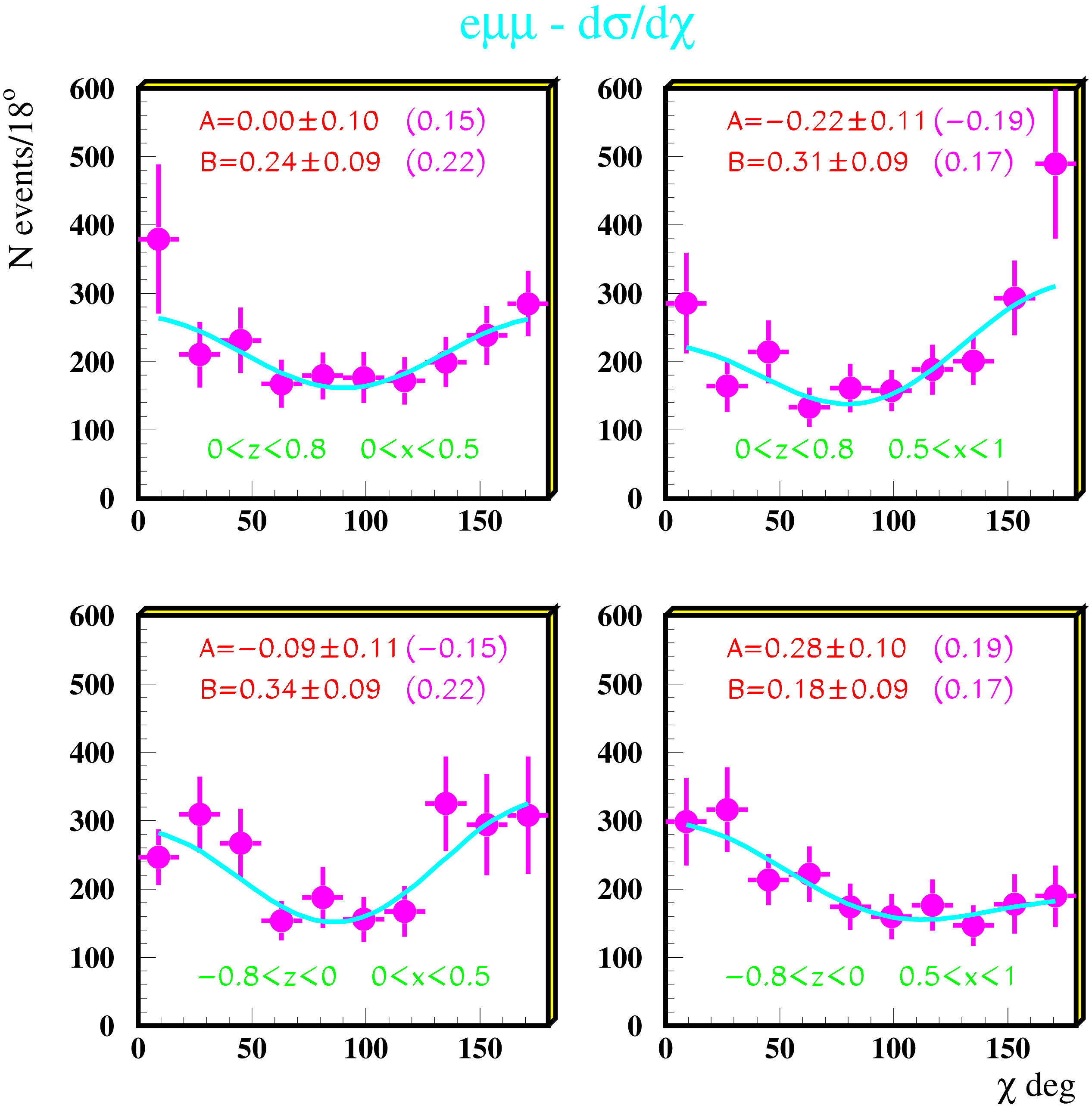
with $\epsilon(y), \rho(y) \simeq 1$

$$A = \frac{\int_{\Delta x}\int_{\Delta z} A_2(x,z)\,dx\,dz}{\int_{\Delta x}\int_{\Delta z} A_1(x,z)\,dx\,dz}$$

$$B = \frac{\int_{\Delta x}\int_{\Delta z} A_3(x,z)\,dx\,dz}{\int_{\Delta x}\int_{\Delta z} A_1(x,z)\,dx\,dz}$$

$$\frac{d\sigma}{d\chi} = K(1 + A\cos(\chi) + B\cos(2\chi))$$

Angular Distribution



Preliminary

Conclusions

- L3 studied single-tag $e\mu\mu$ cross section in the range $1.4 < Q^2 < 7.6 \ \mathrm{GeV}^2$ and $60 < Q^2 < 140 \ \mathrm{GeV}^2$.

- Extraction of $F_2(x, Q^2)$ photon structure function showed a good agreement with theoretical predictions.

- A study of lepton pair angular distributions highlighted contributions from F_T, F_L, and F_A structure functions.

- Future:

  Systematics

  More statistics (1994+1995)

  ALR and VSAT will fill actual angular gaps

  LEP2 will enlarge explorable Q^2 range