Lepton flavour violation in Z^0 decays

Search for anomalous couplings of the tau

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Is lepton-family-number conserved?

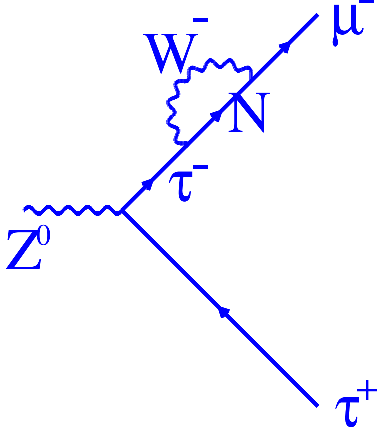
We look for $\mathbf{Z^0 \rightarrow e\tau,\ \mu\tau}$

For example

Superstring, E6 model : Exotic fermion

BR ~ 10^{-4}

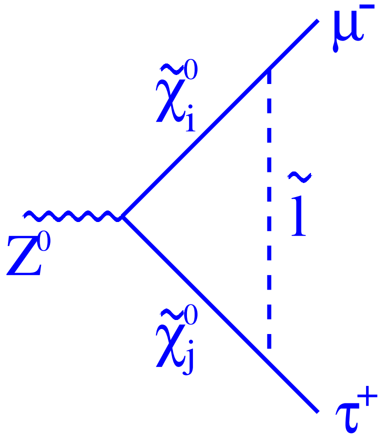
eg.



SUSY : Charged-scalar-lepton

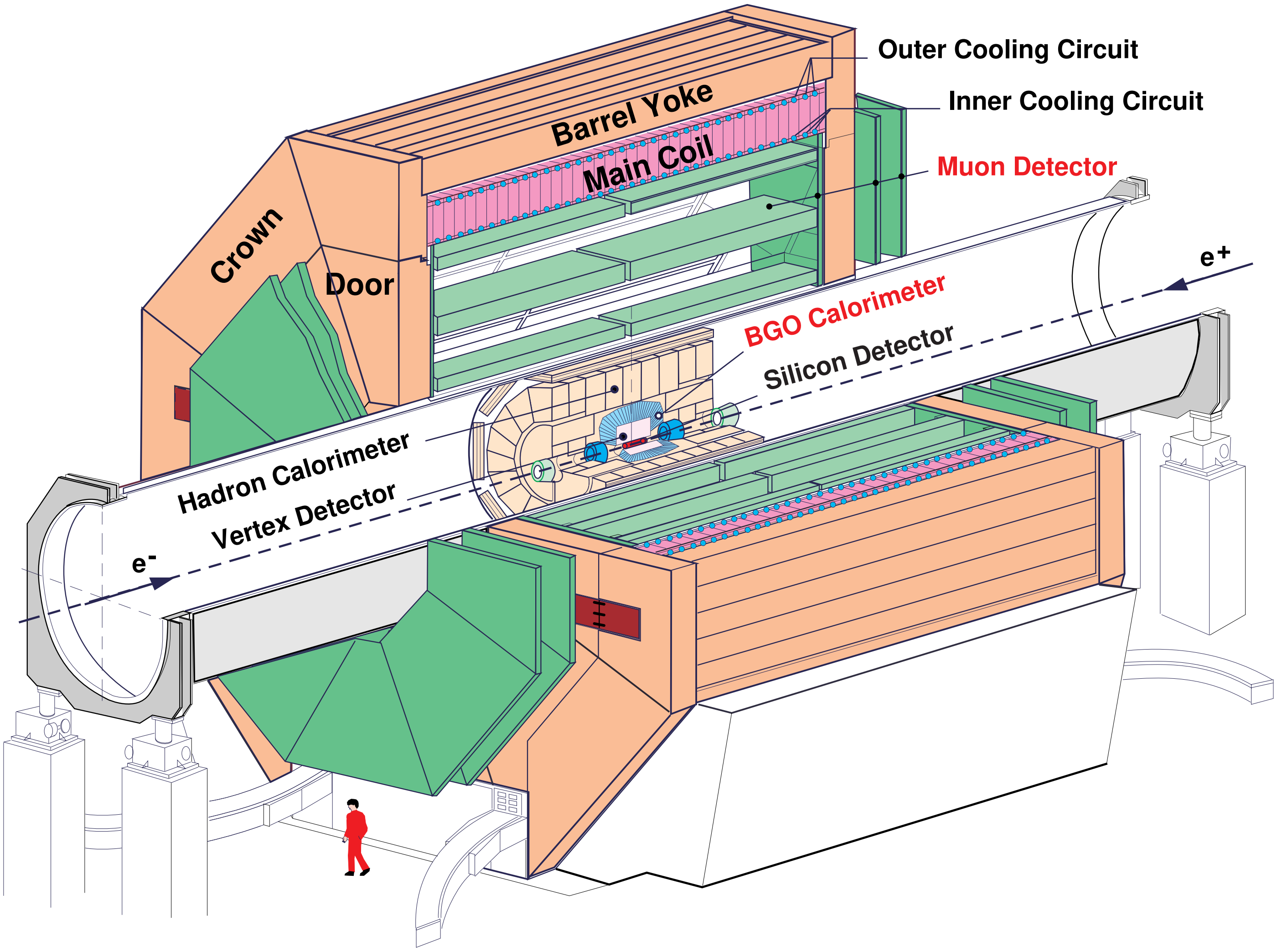
BR ~ 10^{-7}

eg.

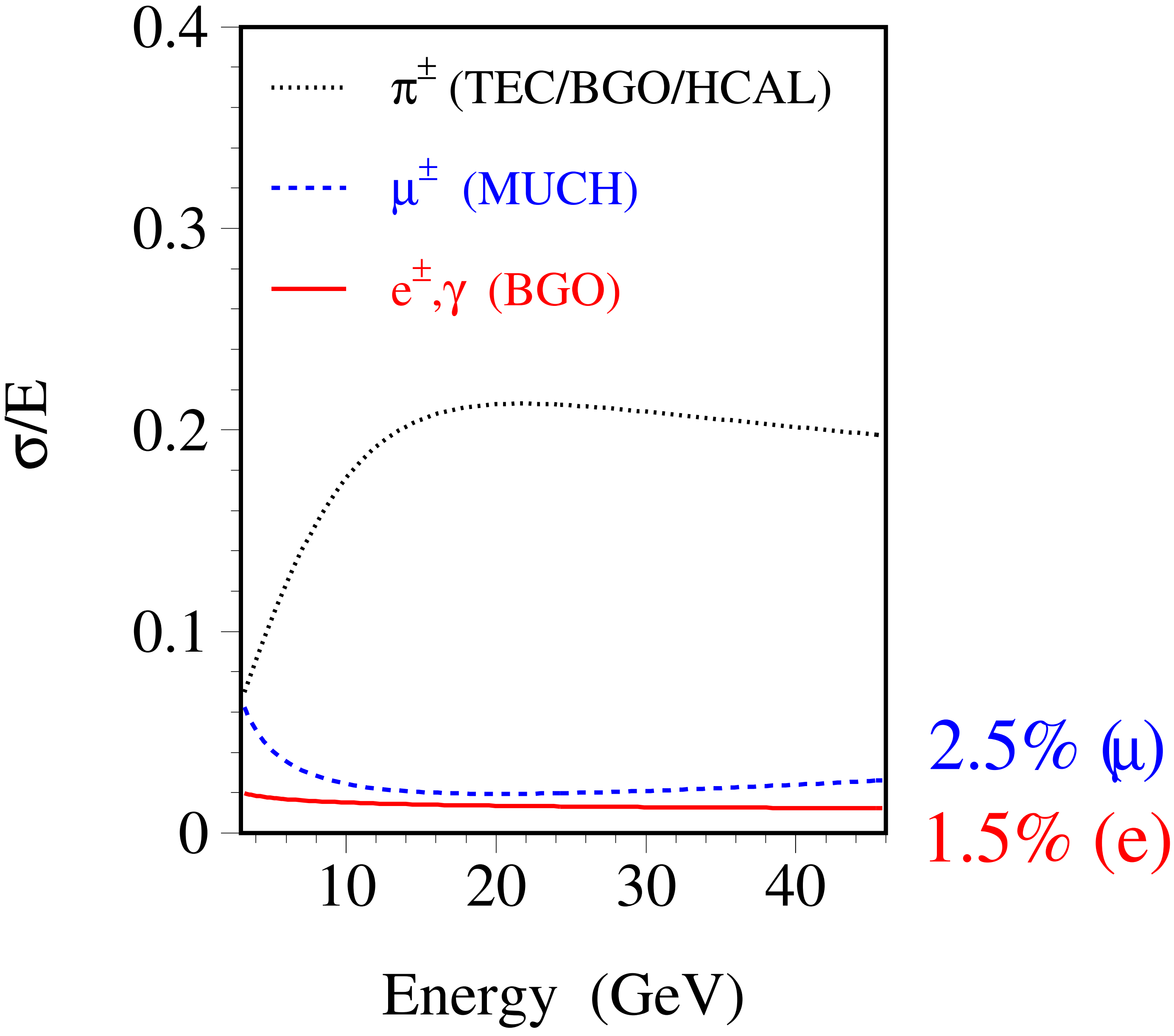


L3 Detector

- Good ECAL made of BGO crystals
- Good Muon detector



Energy Resolution



eτ, $\mu\tau$ Selection

- τ on one side

  - $\tau \longrightarrow e\bar{\nu}_e\nu_\tau$ (reject bhabha)
  - $\tau \longrightarrow \mu\bar{\nu}_\mu\nu_\tau$ (reject dimuon)
  - $\tau \longrightarrow$ 1 hadron$^\pm$ ν_τ (nπ^0) (use HCAL)
  - $\tau \longrightarrow$ 3 hadrons$^\pm$ ν_τ (nπ^0) (use HCAL)

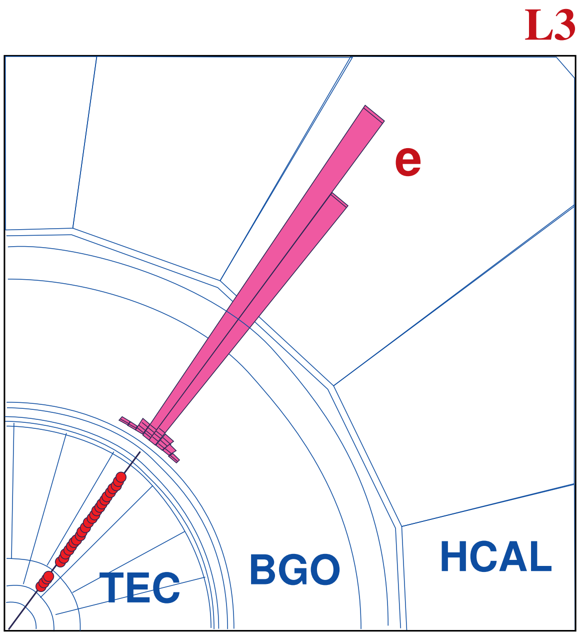
- One good e or μ on the other side with beam energy

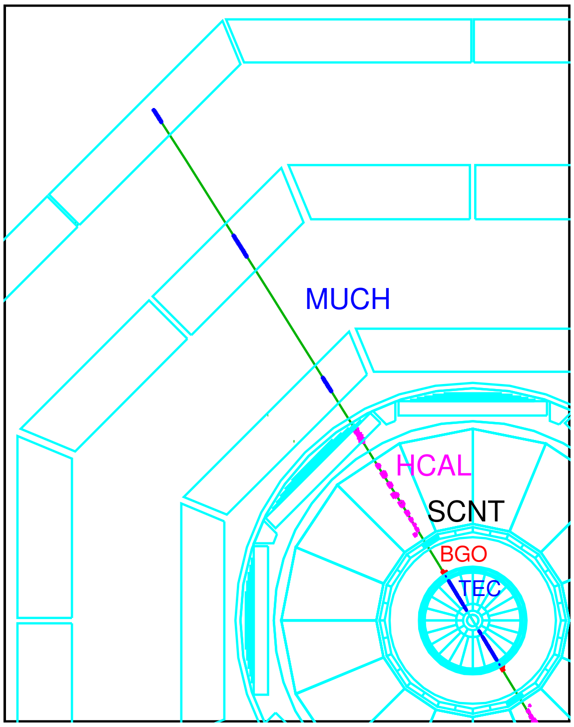
Data

$\approx$ 2,400,000 Z^0 (70 pb^{-1}) 1990-1993

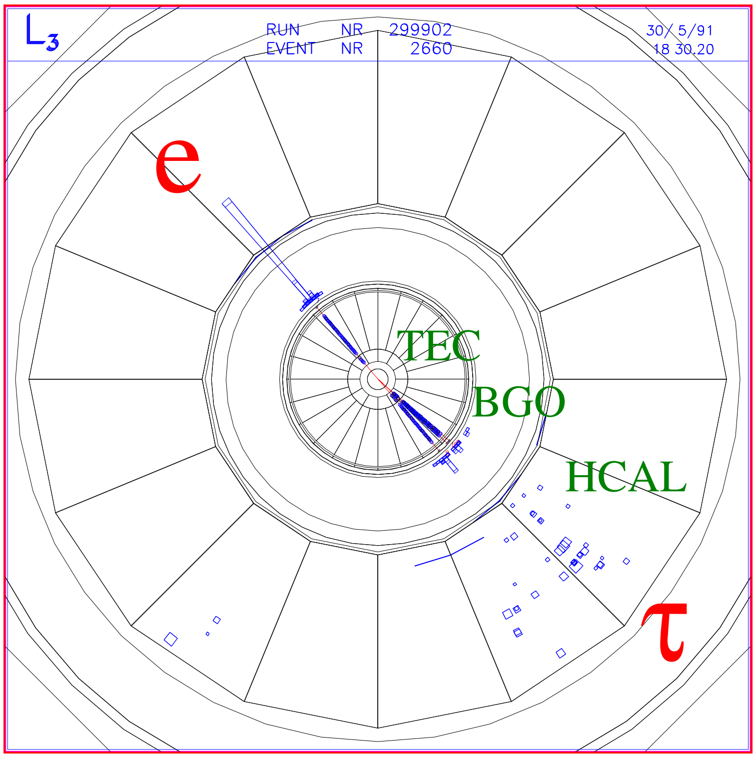
Monte Carlo

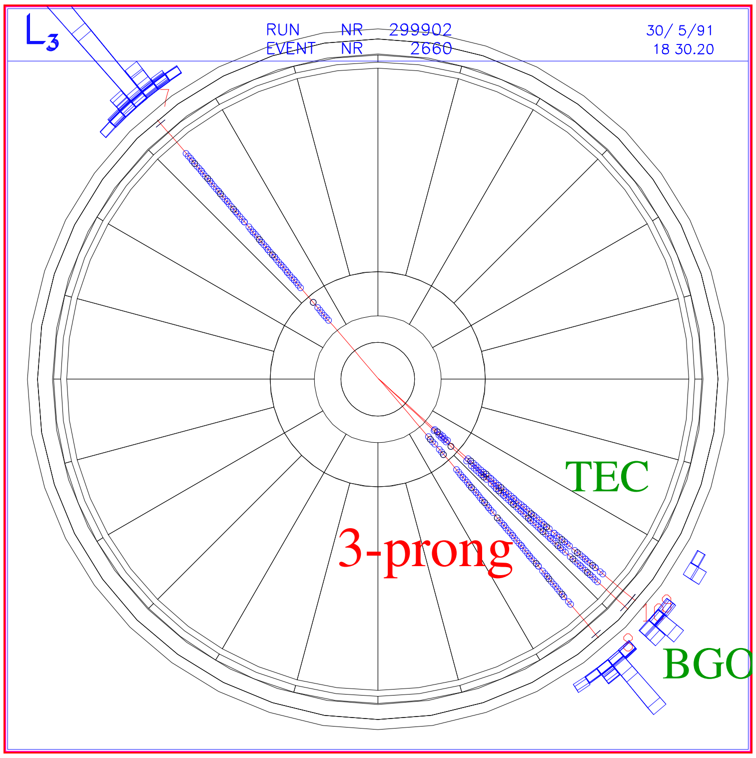
- Signal : Z$^0 \longrightarrow$ eτ, $\mu\tau$
- Background : $q\bar{q}$, e^+e^-, μ^+ μ^-, τ^+ τ^-,eeff





We can reject bhabha and dimuon easily



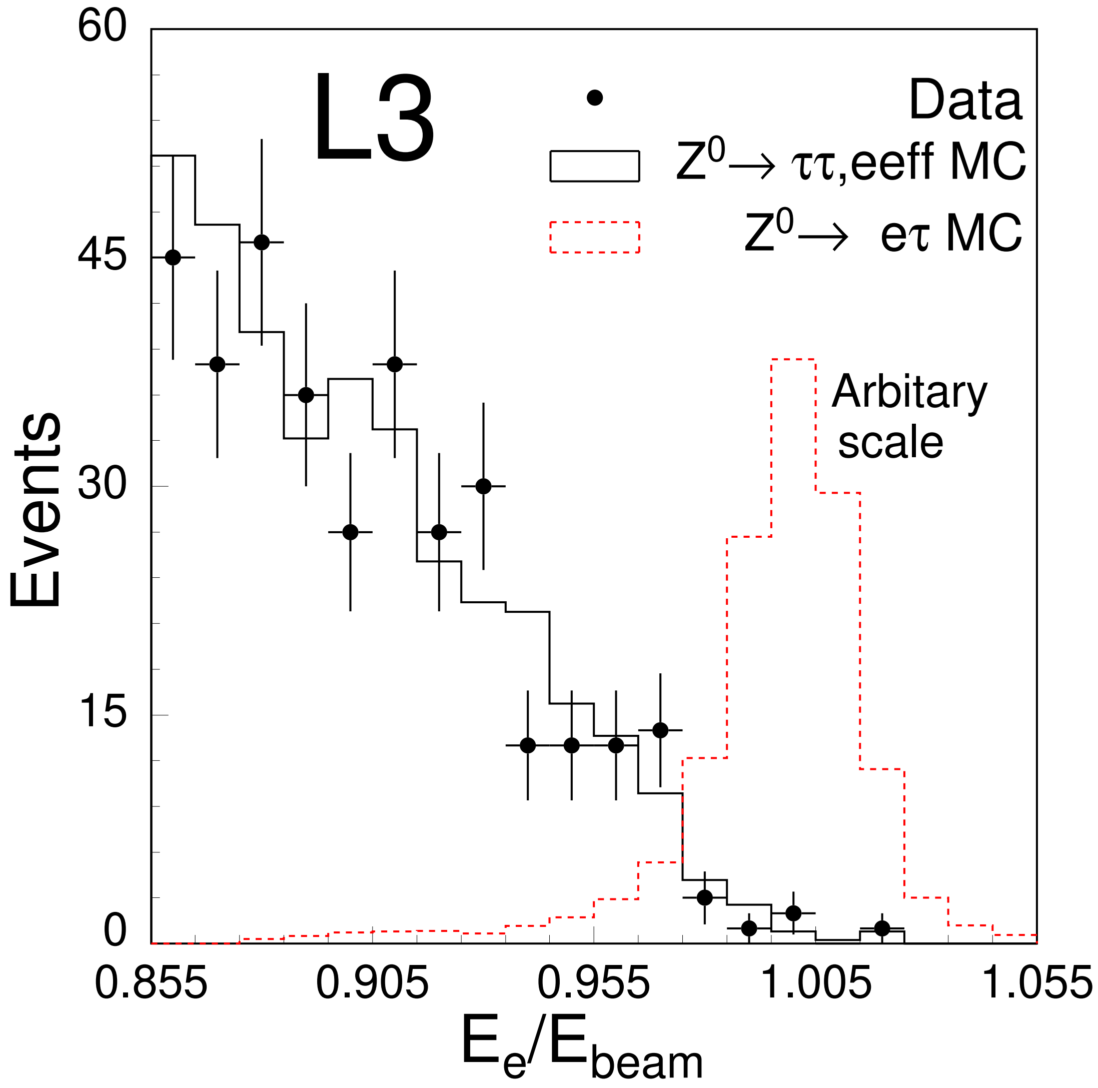


- Select $\tau \longrightarrow$ hadrons, using <u>HCAL</u> <u>ECAL</u> <u>TEC</u>
- $Z^0 \longrightarrow e\tau$ (Signal if $E_e \sim E_{beam}$)
- $Z^0 \longrightarrow \tau\tau \longrightarrow (e\bar{\nu}_e\nu_\tau)\tau$ (background)

- Similarly for $Z^0 \longrightarrow \mu\tau$

$\mathbf{Z}^0 \rightarrow e\tau$

$$\textbf{Total} = \alpha \cdot \textbf{ Background} + \beta \cdot \textbf{ Signal}$$

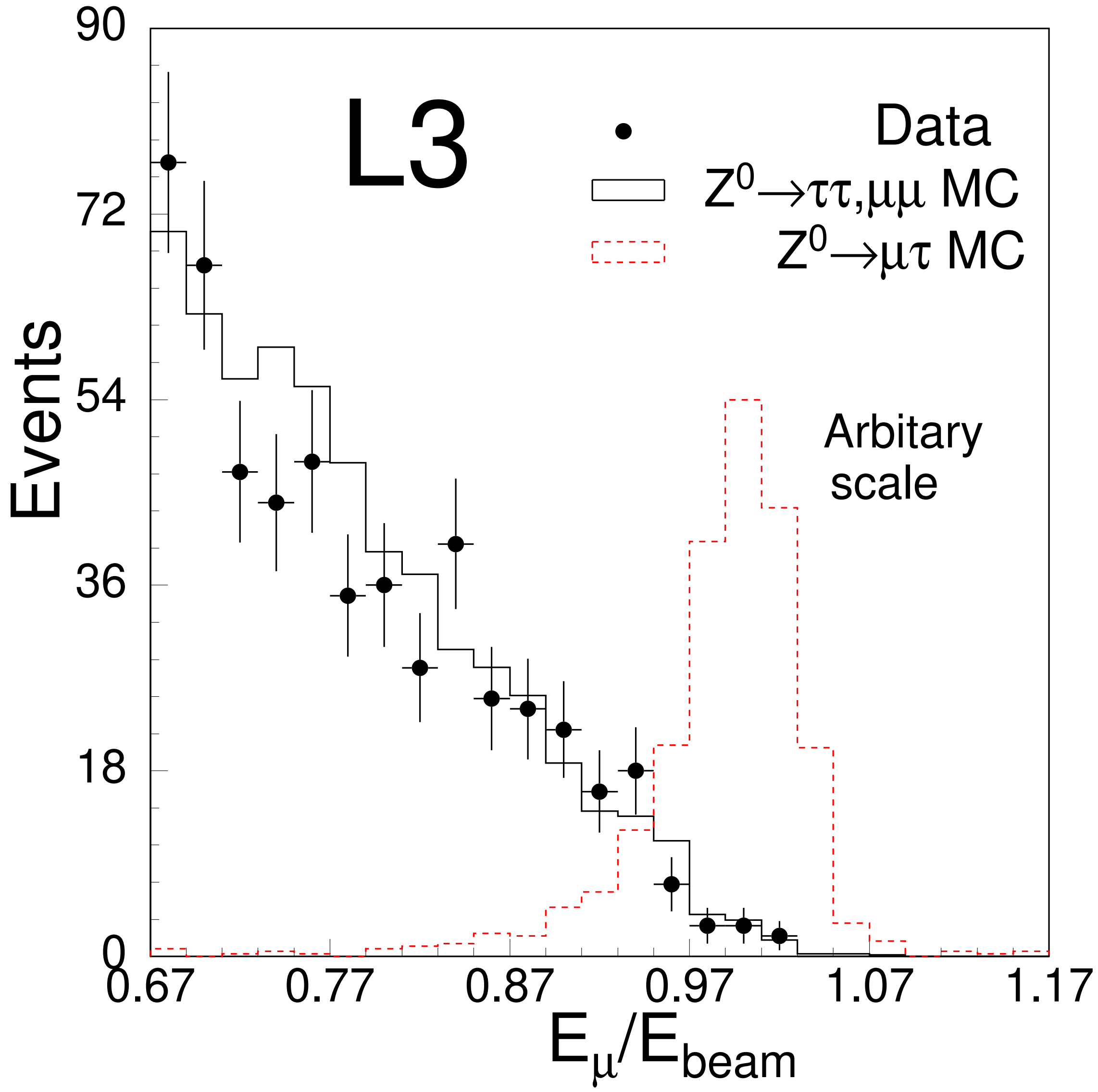


$$Br(Z^0 \rightarrow e\tau,\ 95\%CL) = \frac{Signal}{\epsilon N_Z} = \frac{6.2 \quad events}{0.297 \times 2,400,000}$$

$$= 8.7 \times 10^{-6}$$

$\mathbf{Z}^0 \rightarrow \mu\tau$

$$\textbf{Total} = \alpha \cdot \textbf{ Background} + \beta \cdot \textbf{ Signal}$$



$$Br(Z^0 \rightarrow \mu\tau,\ 95\%CL) = \frac{Signal}{\epsilon N_Z} = \frac{7.8 \quad events}{0.29 \times 2,400,000}$$

$$= 11 \times 10^{-6}$$

Results

$$\boxed{\begin{array}{l}\mathrm{Br}(\mathrm{Z}^0 \to e\tau) < \mathbf{8.7 \times 10^{-6}} \text{ at 95 \% C.L.} \\ \mathrm{Br}(\mathrm{Z}^0 \to \mu\tau) < \mathbf{11. \times 10^{-6}} \text{ at 95 \% C.L.}\end{array}}$$

In the LEP

	$\mathrm{Br}(\mathrm{Z}^0 \to e\tau)$ at 95% CL	$\mathrm{Br}(\mathrm{Z}^0 \to \mu\tau)$ at 95% CL	$\mathrm{Z}^0(\times 10^6)$
ALEPH	$< 17. \times 10^{-6}$	$< 35. \times 10^{-6}$	1.66
DELPHI	$< 36. \times 10^{-6}$	$< 15. \times 10^{-6}$	2.15
L3	$< 8.7 \times 10^{-6}$	$< 11. \times 10^{-6}$	2.4
OPAL	$< 9.8 \times 10^{-6}$	$< 17. \times 10^{-6}$	4.0