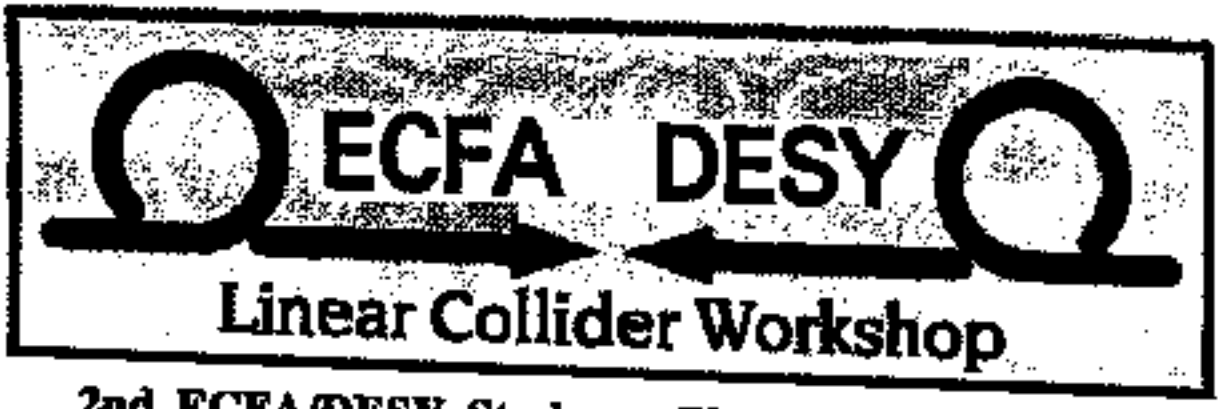
S10



2nd ECFA/DESY Study on Physics and Detectors for a Linear Electron-Positron Collider

LAL - Orsay - France, April 5-7, 1998

Date : April 6, 1998 - 09:00

Parallel groups to plan tasks :

Alternative

Z' limits at a LC with high Luminosity

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1. $e^+e^- \to f\bar{f}$, no signal at normal L_{int}

- Scaling: $M_{Z'}^{lim} \sim \sqrt[4]{\frac{5L_{int}}{1+r^2}}$, $r = \frac{\Delta^{syst}O}{\Delta^{stat}O}$
- At a LC with normal L_{int}:

  $r \approx 1$ for observables O with final leptons
  $r > 1$ for observables O demanding flavour tagging ($\epsilon \approx 2\%$ for b quarks)

- $L_{int} \to 10 \cdot L_{int}$ and $\Delta^{syst}O = const.$

$$\Rightarrow M_{Z'}^{lim} \to \sqrt[4]{\frac{5 \cdot 10 L_{int}}{1+10r^2}} = M_{Z'}^{lim} \sqrt[4]{\frac{10(1+r^2)}{1+10r^2}} \approx 1.16\, M_{Z'}^{lim}$$

- $L_{int} \to 10 \cdot L_{int}$ and $\Delta^{syst}O / \Delta^{stat}O = const.$

$$\Rightarrow M_{Z'}^{lim} \to \sqrt[4]{\frac{5 \cdot 10 L_{int}}{1+r^2}} = M_{Z'}^{lim} \sqrt[4]{10} \approx 1.78\, M_{Z'}^{lim}$$

➡ The gain in $M_{Z'}^{lim}$ for $L_{int} \to 10\, L_{int}$ depends crucially on the syst. errors.

2. $e^+e^- \to f\bar{f}$, Z' signal at normal L_{int}

- Scaling: $\frac{\Delta M_{Z'}}{M_{Z'}}, \frac{\Delta \text{coupling}}{\text{coupling}} \sim \sqrt{\frac{1+r^2}{s L_{int}}}$

- $L_{int} \to 10 \cdot L_{int}$ and $\Delta^{syst} = \text{const.}$

  $\Rightarrow \frac{\Delta M_{Z'}}{M_{Z'}} \to \sqrt{\frac{1+10r^2}{s \cdot 10 L}} = \frac{\Delta M_{Z'}}{M_{Z'}} \cdot \sqrt{\frac{1+10r^2}{10(1+r^2)}} \approx \begin{cases} 0.74 \frac{\Delta M_{Z'}}{M_{Z'}} & \text{lepto} \\ 0.91 \frac{\Delta M_{Z'}}{M_{Z'}} & \text{b-qua} \end{cases}$

- $L_{int} \to 10\, L_{int}$ and $\Delta^{syst}0 / \Delta^{stat}0 = \text{const.}$

  $\to \frac{\Delta M_{Z'}}{M_{Z'}} \to \sqrt{\frac{1+r^2}{s \cdot 10 L}} \approx \frac{\Delta M_{Z'}}{M_{Z'}} \cdot \frac{1}{\sqrt{10}} \approx 0.31 \frac{\Delta M_{Z'}}{M_{Z'}}$

➡ The increase of the precision of a Z' model measurement depends even more on the systematic errors than $M_{Z'}^{lim}$.

3. Other processes

- Processes with smaller σ don't suffer from systematics

⇒ Processes with $\sigma \gtrsim \frac{1}{10}\sigma(e^+e^- \to \mu^+\mu^-)$ could give interesting information

- Examples: $e^+e^- \to \nu\bar{\nu}\gamma$

  $\gamma e \to (\nu W') \to f_1 \bar{f}_2 \nu$

  $\gamma e \to (e Z') \to e f \bar{f}$

- Can these (or other) processes help to improve $M_{Z'}^{\text{Lin}}$ or $M_{W'}^{\text{Lin}}$ for high L_{int} ?

- What can they contribute to a model measurement?

4. $e^+e^- \to \nu\bar{\nu}\gamma$

- Proposal to measure the # of generations:
  A.D. Dolgov, L.B. Okun, V.I. Zakharov, Nucl. Phys. B41 (1972) 197
  E. Ma, J. Okada, Phys. Rev. Lett. 41 (1978) 287
  K.J.F. Gaemers, R. Gastmans, F.M. Renard, Phys. Rev. D19 (1979) 16
- SM calculation with 1-loop QED corr.:
  F.A. Berends, G.J.H. Burgers, C. Mana, M. Martinez, W.I. van Neerven, Nucl. Phys. B301 (1988) 583
- Higher order RC's:
  G. Montagna,

- Well studied background for neutralino production
- ∃ preliminary study (J.A. Hewett, Snowmass 97) on the sensitivity to W' in the point interation approximation of the W and the W'.
  result: $M_{W'}^{lim} \approx (1-2)\sqrt{s}$ seems to be acheavable for $\sqrt{s} = 500$ GeV and $L_{int} = 50 fb^{-1}$.
- Point interaction approximation is known to break down for the W at $\sqrt{s} > M_W$.
- If there exists a light W', most model predict a light Z' too.

⇒ Process is under investigation by
S. Godfrey, P. Kalyniak and A. Leike.