X(750) search at the ILC

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status

- arXiv paper published (1607.04187)
- included updated analyses since ECFA LC 2016
  - 6f BG + cut optimisation + correction factor for cross section (0.7)

750 GeV diphoton resonance at the ILC

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Abstract

In this paper we study the direct production of the diphoton resonance X which has been suggested by 2015 data at the LHC, in $e^+e^- \to X\gamma/XZ$ processes at the ILC. We derive an analytic expression for the scattering amplitudes of these processes, and present a comprehensive analysis for determining the properties of X at the ILC. A realistic simulation study for $e^+e^- \to X\gamma$ is performed based on the full detector simulation to demonstrate the capabilities of the ILC experiment. Complementary to the searches at the LHC, prospects of the measurement of the absolute values of production cross-section are obtained for the ILC using recoil technique without assuming decay modes of X. In addition, we have studied the searches for $X \to$ invisible and $X \to b\bar{b}$ modes, which are challenging at the LHC, and found that these decay modes can be discovered with high significance if their branching ratios are large enough.

new project: a new method to measure M_H

- at higher energy, e.g. 500 GeV (Δ~500 MeV from leptonic recoil)
- e+e- —> ZH, Z—>ff, H—>bb/cc/gg
- overcome beamstrahlung, b-jet energy
- take advantage of well measured jet angles
- (px,py) conservation to resolve two jet energy
- analytically done —> going to prove in real detector

In process $e^+e^- \to ZH,\ Z \to f\bar{f},\ H \to b\bar{b}/c\bar{c}/gg$, using conservation of $\sum_i (p_x, p_y)_i = 0$

$$p_1 \sin\theta_1 \cos\phi_1 + p_2 \sin\theta_2 \cos\phi_2 = p_x \tag{1}$$

$$p_1 \sin\theta_1 \cos\phi_1 + p_2 \sin\theta_2 \cos\phi_2 = p_y \tag{2}$$

where index 1 and 2 are for two partons from H decay, p_x and p_y are transverse recoil vector against $Z \to f\bar{f}$. Values obtained from direct measurement are used for all variables except p_1 and p_2 which can be obtained by solving the two equations.

$$\begin{pmatrix} \cos\phi_1 & \cos\phi_2 \\ \sin\phi_1 & \sin\phi_2 \end{pmatrix} \begin{pmatrix} \sin\theta_1 & 0 \\ 0 & \sin\theta_2 \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \end{pmatrix} = \begin{pmatrix} p_x \\ p_y \end{pmatrix} \tag{3}$$

Define $A = \begin{pmatrix} \cos\phi_1 & \cos\phi_2 \\ \sin\phi_1 & \sin\phi_2 \end{pmatrix}$, $C = \begin{pmatrix} \sin\theta_1 & 0 \\ 0 & \sin\theta_2 \end{pmatrix}$. C^{-1} is easy, to get A^{-1},

$$A^T A = \begin{pmatrix} 1 & \cos\phi \\ \cos\phi & 1 \end{pmatrix} \equiv B, \tag{4}$$

where $\phi = \phi_1 - \phi_2$, and B^{-1} can be easily calculated as

$$B^{-1} = \frac{1}{\sin^2\phi} \begin{pmatrix} 1 & -\cos\phi \\ -\cos\phi & 1 \end{pmatrix}. \tag{5}$$

Then A^{-1} can be calculated as

$$A^{-1} = B^{-1} A^T = \frac{1}{\sin^2\phi} \begin{pmatrix} 1 & -\cos\phi \\ -\cos\phi & 1 \end{pmatrix} \begin{pmatrix} \cos\phi_1 & \cos\phi_1 \\ \sin\phi_2 & \sin\phi_2 \end{pmatrix} \tag{6}$$

$$= \frac{1}{\sin^2\phi} \begin{pmatrix} \cos\phi_1 - \cos\phi\cos\phi_2 & \sin\phi_1 - \cos\phi\sin\phi_2 \\ -\cos\phi\cos\phi_1 + \cos\phi_2 & -\cos\phi\sin\phi_1 + \sin\phi_2 \end{pmatrix} \tag{7}$$