
Top electroweak couplings study using di-muonic state at $\sqrt{s} = 500$ GeV, ILC

Physics Meeting 0120

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Method of considering ISR/BS photons

Collinear approximation :

Photons are emitted on the beam directions

**4-momenta of
electron/positron**

$$\begin{aligned}\vec{e}^- &= \hat{\eta}_{e^-} E_{e^-} \\ \vec{e}^+ &= \hat{\eta}_{e^+} E_{e^+}\end{aligned}$$

Before ISR/BS

$$\begin{aligned}\vec{\gamma}_{e^-} &= \hat{\eta}_{e^-} E_{\gamma_{e^-}} = k_{e^-} \vec{e}^- \quad \text{with} \quad k_{e^-} = \frac{E_{\gamma_{e^-}}}{E} \\ \vec{\gamma}_{e^+} &= \hat{\eta}_{e^+} E_{\gamma_{e^+}} = k_{e^+} \vec{e}^+ \quad \text{with} \quad k_{e^+} = \frac{E_{\gamma_{e^+}}}{E}\end{aligned}$$

$$\begin{aligned}(\vec{e}^-)^* &= \vec{e}^- - \vec{\gamma}_{e^-} = \hat{\eta}_{e^-} E(1 - k_{e^-}) \\ (\vec{e}^+)^* &= \vec{e}^+ - \vec{\gamma}_{e^+} = \hat{\eta}_{e^+} E(1 - k_{e^+})\end{aligned}$$

After ISR/BS

→ Add k_{e^-}, k_{e^+} into minimization parameters

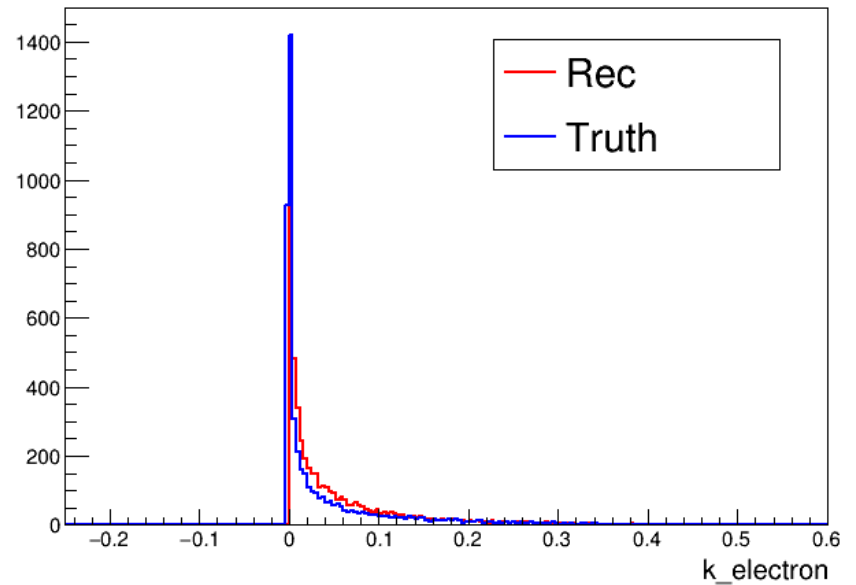
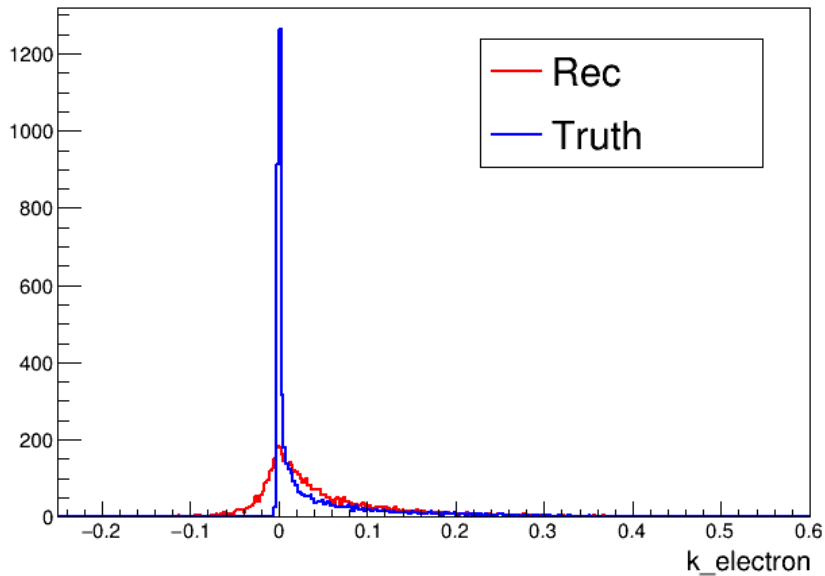
Comparing with the last time

Change the range of k 's

$$-1 < k < 1$$

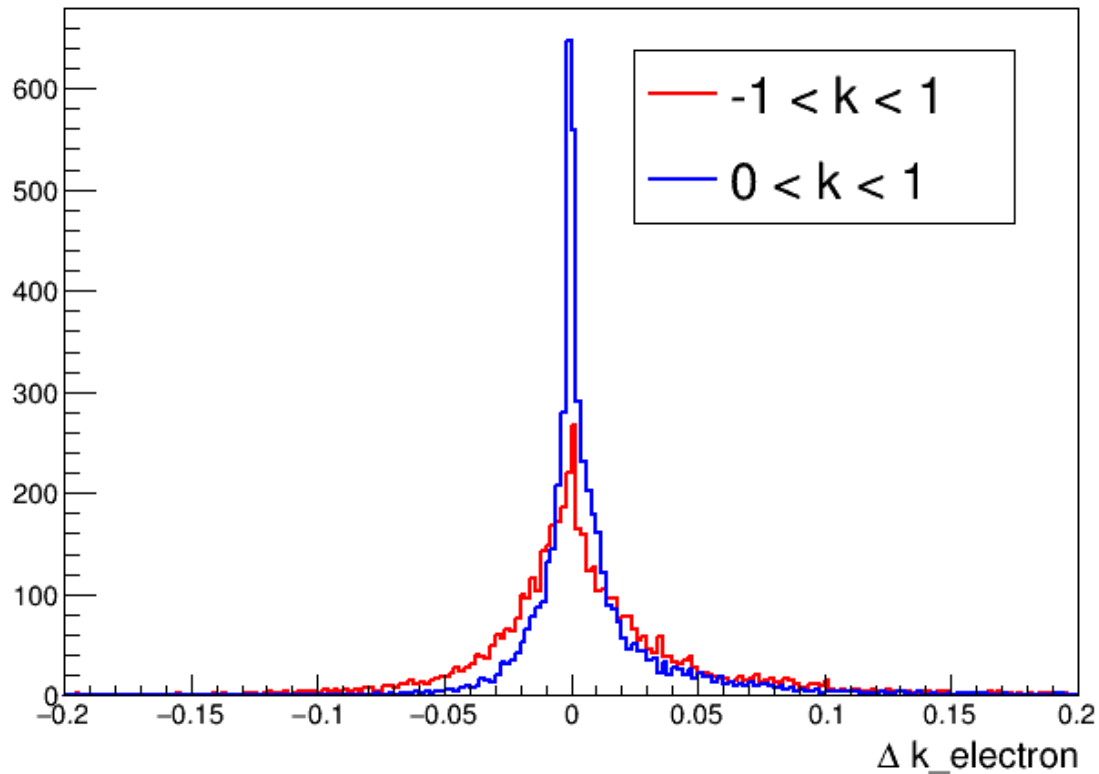


$$0 < k < 1$$



Comparing with the last time

Deviation distribution of k



Backup

χ^2 algorithm : General

1. Define the χ_μ^2 ;

$$\chi_\mu^2 = \chi_{\mu^+}^2 + \chi_{\mu^-}^2, \quad \chi_{\mu^\pm}^2 = \left(\frac{E_{\mu^\pm}^{**}(\theta_t, \phi_t, m_t, m_{\bar{t}}, m_{W^+}, m_{W^-}) - m_{W^\pm}/2}{\sigma[E_{\mu^\pm}^{**}]} \right)^2$$

The energy of μ^\pm in the W^\pm rest frame, $E_{\mu^\pm}^{**}$, must be equal to $m_{W^\pm}/2$.

2. Define the δ_b^2 ;

$$\delta_b^2 = -2 \log L_b - 2 \log L_{\bar{b}}, \quad L_b = \text{CB} \left(E_b^{\text{meas.}} - E_b^{\text{rec.}}(\theta_t, \phi_t, m_t, m_{\bar{t}}, m_{W^+}, m_{W^-}) \right)$$

The likelihood function is obtained from the assessment of b-jets energy.

3. Compound $\chi_{\text{tot.}}^2$; $\chi_{\text{tot.}}^2 = \chi_\mu^2 + \delta_b^2$

One minimizes the $\chi_{\text{tot.}}^2$ to obtain the optimal solution; $(\theta_t, \phi_t, m_t, m_{\bar{t}}, m_{W^+}, m_{W^-})$.

χ^2 algorithm : Optional

The direction of b-jets is obtained by thrust axis method.

→ Add 4 angles $(\theta_b, \phi_b, \theta_{\bar{b}}, \phi_{\bar{b}})$ to the minimization parameters

→ Add constraints of 4 angles $(\theta_b, \phi_b, \theta_{\bar{b}}, \phi_{\bar{b}})$ to $\chi_{\text{tot.}}^2$ as follows;

$$\chi_{\text{direction}}^2 = \chi_{\theta_b}^2 + \chi_{\phi_b}^2 + \chi_{\theta_{\bar{b}}}^2 + \chi_{\phi_{\bar{b}}}^2, \quad \chi_{\theta_b}^2 = \left(\frac{\theta_b^{\text{meas.}} - \theta_b}{\sigma[\theta_b^{\text{meas.}}]} \right)^2$$

$(\chi_{\phi_b}^2, \chi_{\theta_{\bar{b}}}^2, \chi_{\phi_{\bar{b}}}^2)$ are same as $\chi_{\theta_b}^2$)

$$(\chi_{\text{tot.}}^2)' = \chi_{\text{tot.}}^2 + \chi_{\text{direction}}^2$$

We can use $(\chi_{\text{tot.}}^2)'$ instead of $\chi_{\text{tot.}}^2$ to get the optimal solution, which is written in $(\theta_t, \phi_t, m_t, m_{\bar{t}}, m_{W^+}, m_{W^-}, \theta_b, \phi_b, \theta_{\bar{b}}, \phi_{\bar{b}})$

Method of considering ISR/BS photons

Thrust axis method

- ① Collect all hadronized particles from b and \bar{b} quark and photons from isolated leptons in the ILC frame
- ② Boost them to their rest frame and calculate thrust axis in this frame (defined as the BB frame in this slide)
- ③ Boost the vectors along the thrust axis to the ILC' frame (ILC' frame : the frame in which head-on-collision occurs)

Boost the vectors to the e^+e^- rest frame with k_{e^-}, k_{e^+}

