



# **b-flavor tagging in $e^+e^- \rightarrow ZH \rightarrow \nu\bar{\nu} b\bar{b}$**

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The University of Mississippi

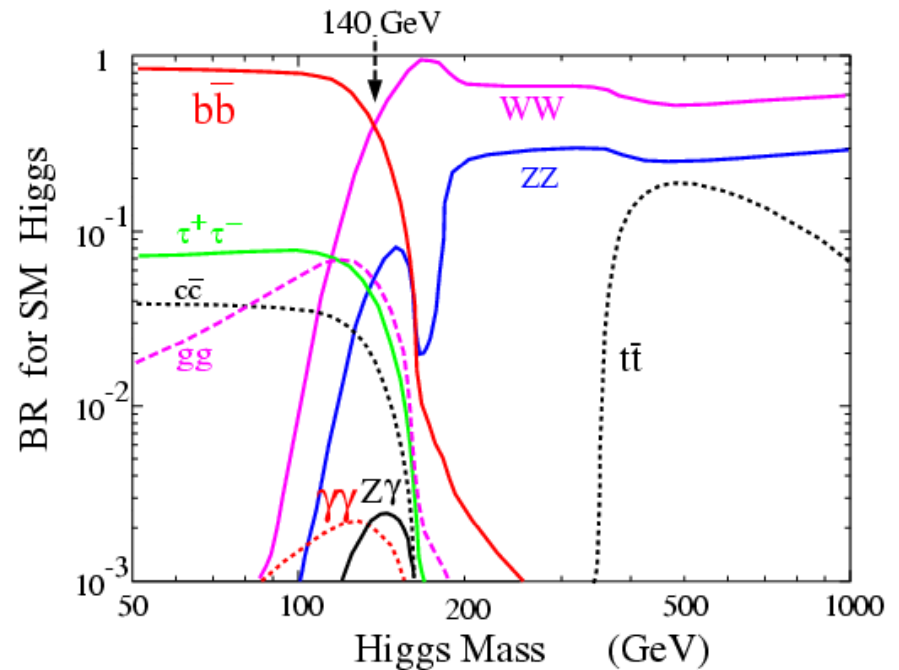
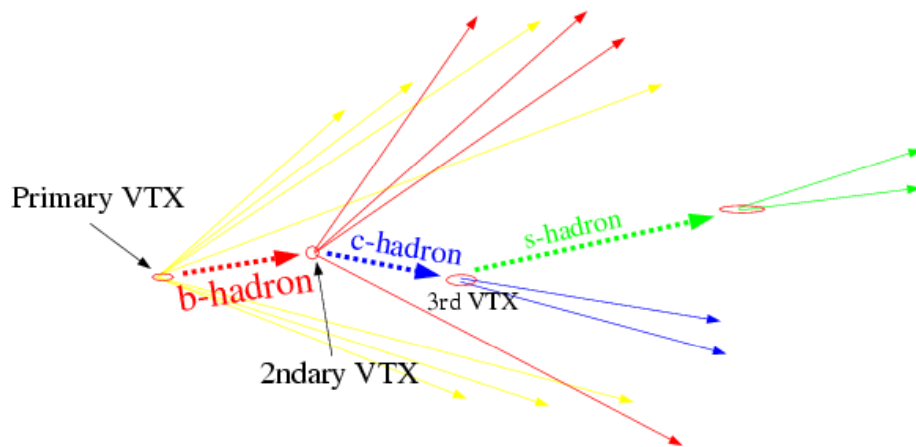
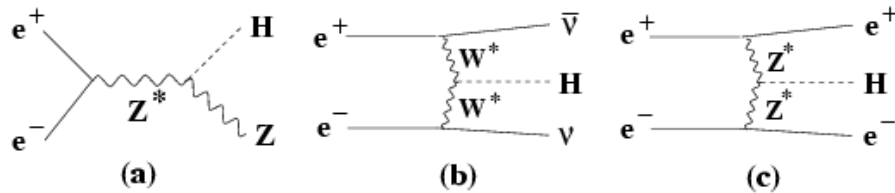
Haiwen Zhao

Oct. 24, ALCPG07

# Introduction

In light Higgs study/measurement, b-flavor tagging is an essential technique.

- Dominant mode of Higgs decay is expected to be  **$b\bar{b}$** .
- b-hadron lifetime is long ( $\beta\gamma c\tau = 3 \sim 5$  mm).
- b-vertex (**secondary vertex**) plays important role in b-flav. tagging.





## Data and Tool in Analysis

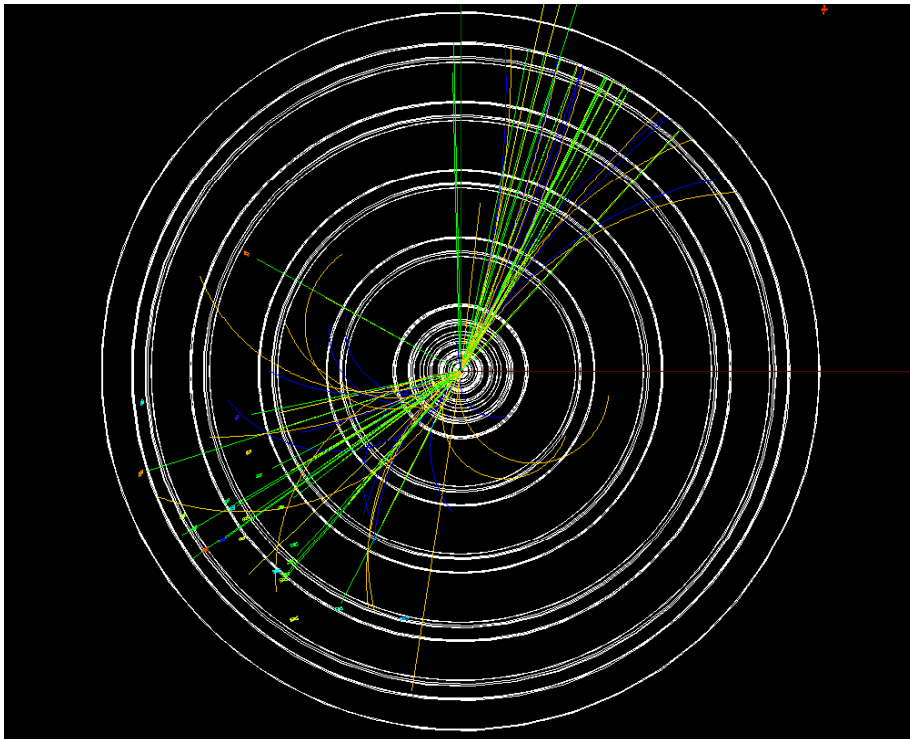
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- Data :  $\sqrt{s} = 250 \text{ GeV}$ 
  - **Signal** :  $e^+e^- \rightarrow ZH \rightarrow \nu\bar{\nu} b\bar{b}$   
`panpy_ZH120_Znunubar_Hbbbar_cms250GeV.stdhep`
  - **Background** :  $e^+e^- \rightarrow ZZ \rightarrow \nu\bar{\nu} q\bar{q}$  ( $q = u, d, s, c, b$ )  
`panpy_ZZ_nunubar_qqbar_cms250GeV.stdhep`
  - **Higgs mass = 120 GeV/c<sup>2</sup>.**
  - 10K signal and 10K background events are normalized to **200 fb<sup>-1</sup>.**
- Tool : org.lcsim
  - step1**: FastMC (sidaug05 , B field=5T, beamSpotConstraint).
  - step2**: jet finding ( JetDriver).
  - step3**: b-flavor jet tagging
  - step4**: look into dijet (b-flavor) mass.

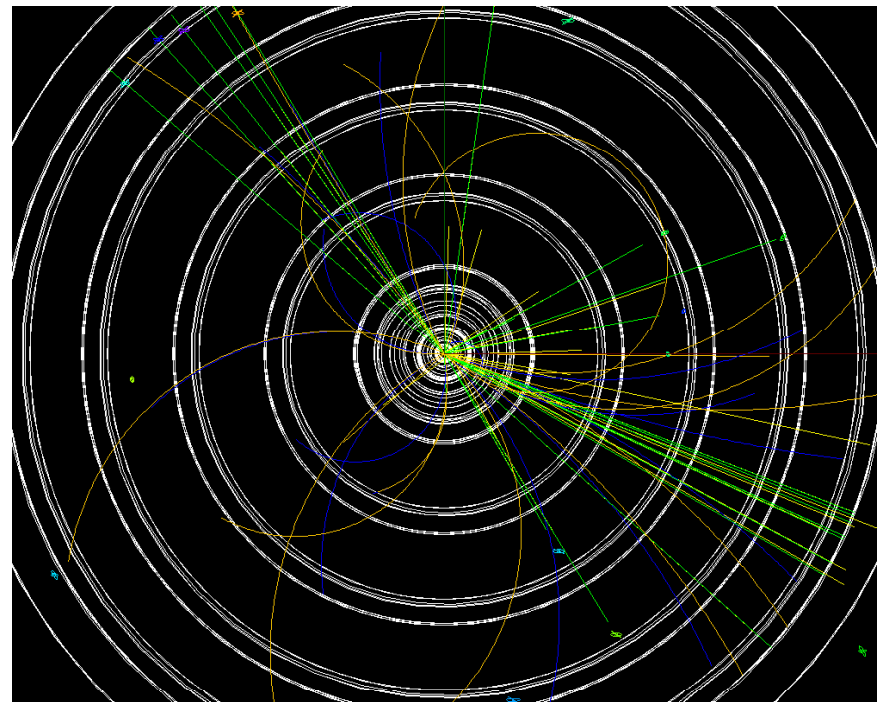


# Di-jet Events

$$e^+e^- \rightarrow ZH \rightarrow \nu\bar{\nu} b\bar{b}$$



$$e^+e^- \rightarrow ZZ \rightarrow \nu\bar{\nu} q\bar{q} \quad (q = u, d, s, c, b)$$





# Jet Finding and b-flavor Tagging

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- **Jet Finding**

- \* Algorithm: JadeEJetFinder ( $y_{\text{cut}} = 0.005$ ).
- \* Forced to find only two jets in an event.

- **b-flavor Jet Tagging (two methods in consideration)**

1. Jet vertex

- \* In principle, the distance ( $r$ ) between primary and secondary vertices and its error should be checked ( $r/\text{err} > ?$ ).
- \* Tag the jet as b-jet if it comes from secondary vertex
- \* Jet vertexing is not ready yet. Instead, we check the average  $|d_0|/\text{err}$  of jet track impact parameter  $d_0$ .

**$\text{jet\_d0\_chi} = \langle |d_0|/\text{error} \rangle$  over the tracks in jet**

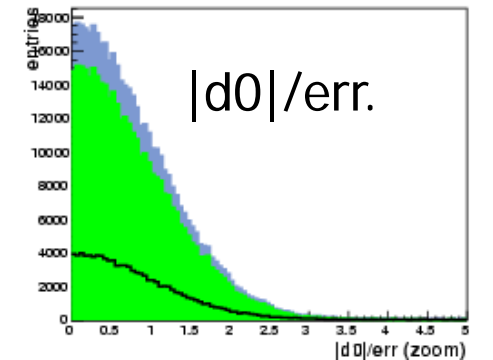
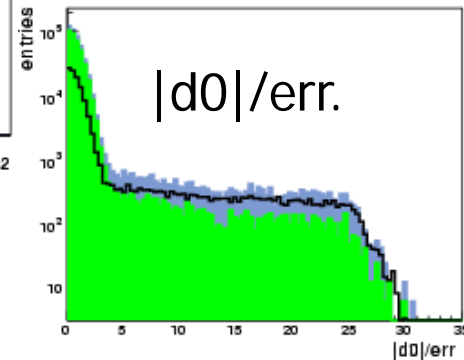
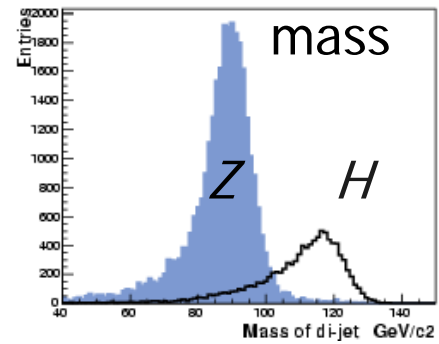
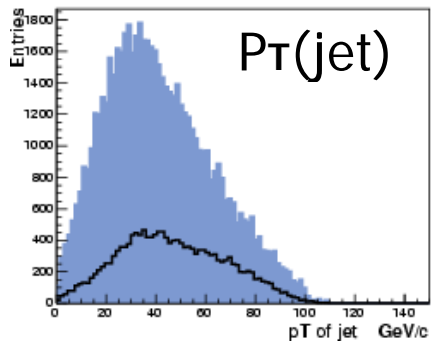
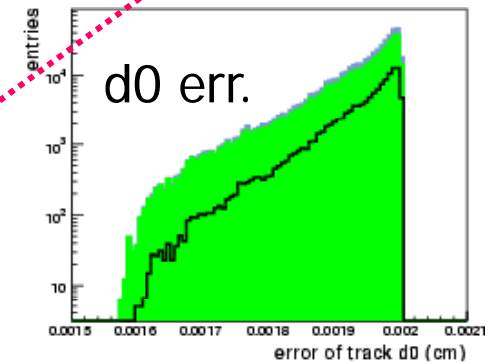
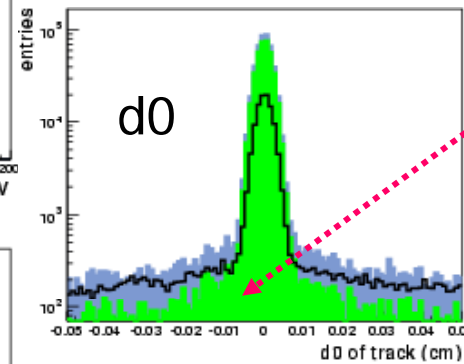
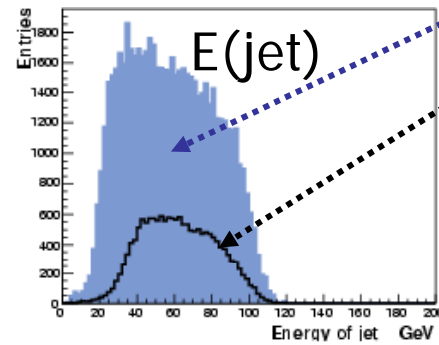
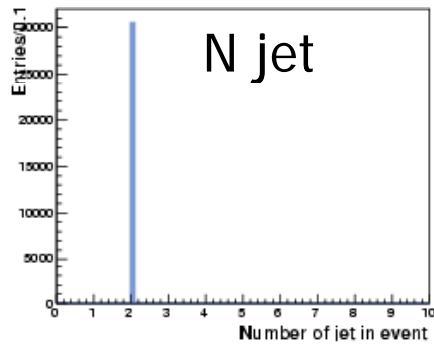
2. Track number with large  $|d_0|/\text{error}$  in jet (T. Barklow)

- \* b-flavour jet has a lot of charged tracks with large impact parameter  $d_0$ .
- \* Check the number of tracks with  $|d_0|/\text{error}$  in jet.
- \* Tag jet as b-jet if it has enough number of tracks with significant  $|d_0|/\text{err}$ .

# Jet and Track Parameter d0

$$e^+e^- \rightarrow ZZ \rightarrow \nu\bar{\nu} q\bar{q} \quad (q = u, d, s, c, b)$$

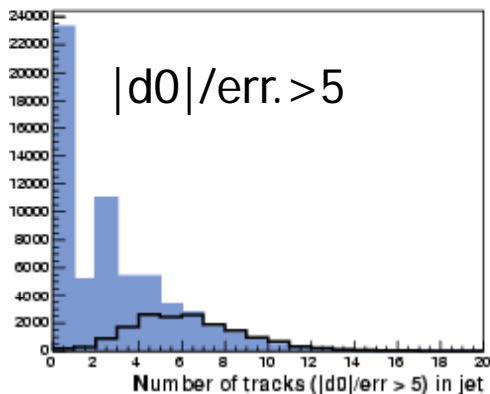
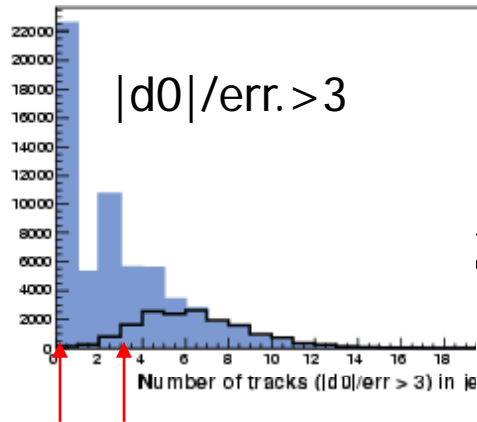
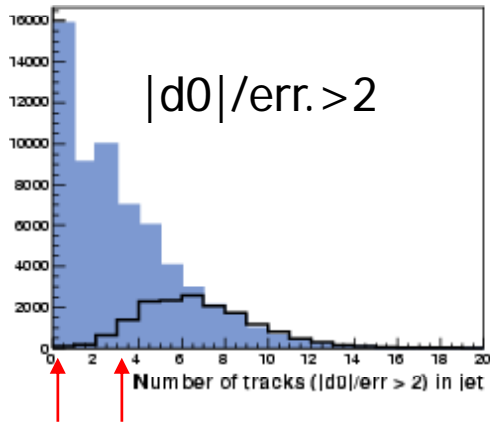
$$e^+e^- \rightarrow ZH \rightarrow \nu\bar{\nu} b\bar{b}$$



Distributions without cut

# Significance of Parameter d0

Number of tracks with different  $|d0|/err$  in jet

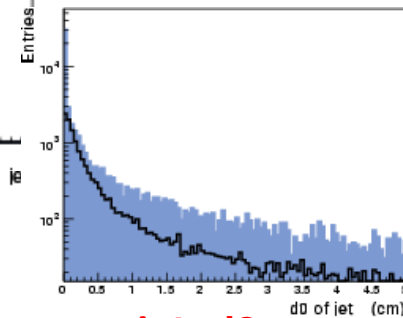


We tag b-jet by cutting the **track number** which have significant  $|d0|/err$ , Or, by cutting **jet\_d0\_chi**.

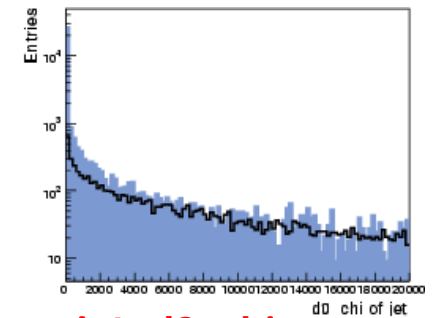
Jet d0 and d0\_chi

Jet pseudo d0 :  $jet\_d0 = \langle |d0| \rangle tracks$

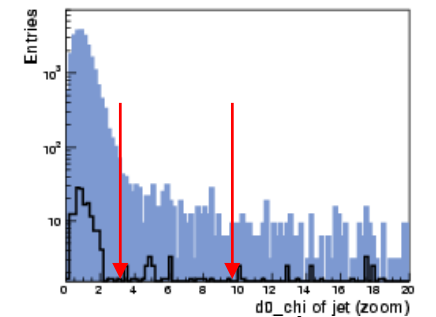
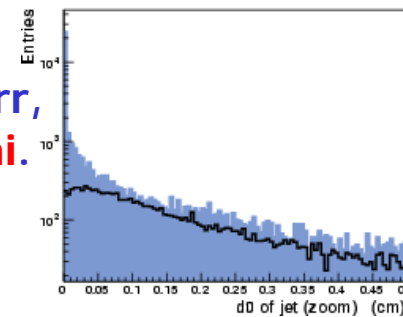
$jet\_d0\_chi = \langle |d0|/err \rangle tracks$



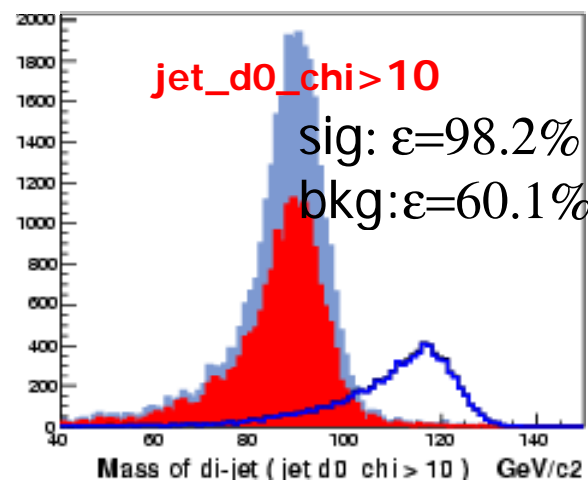
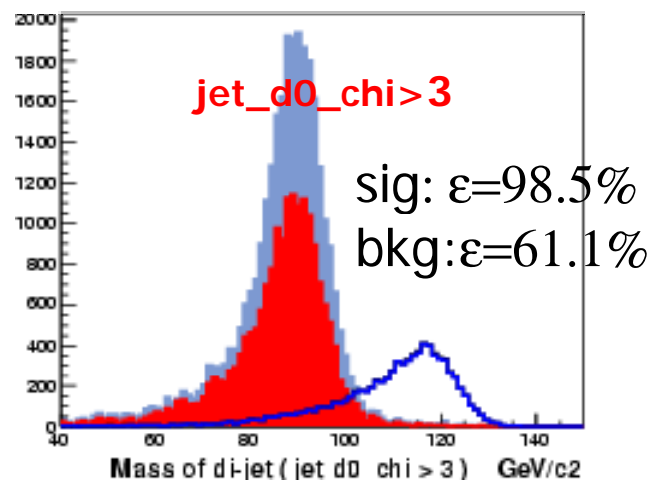
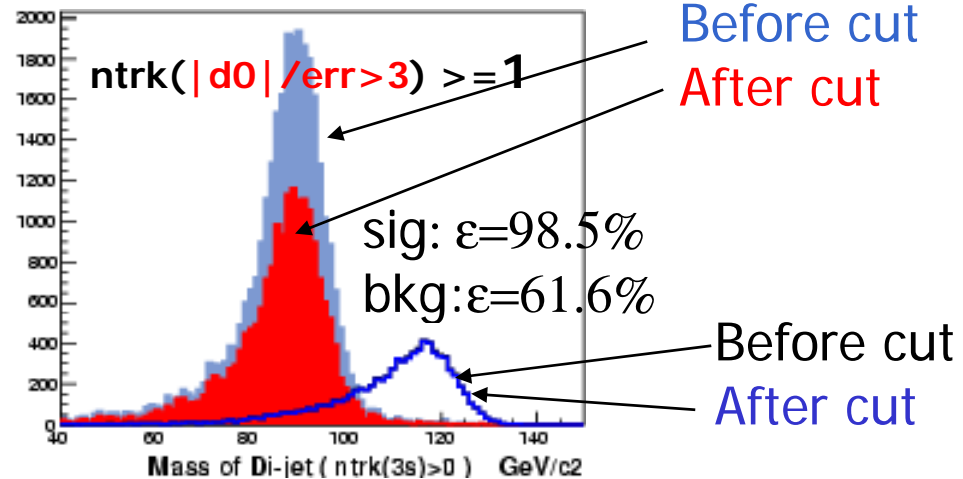
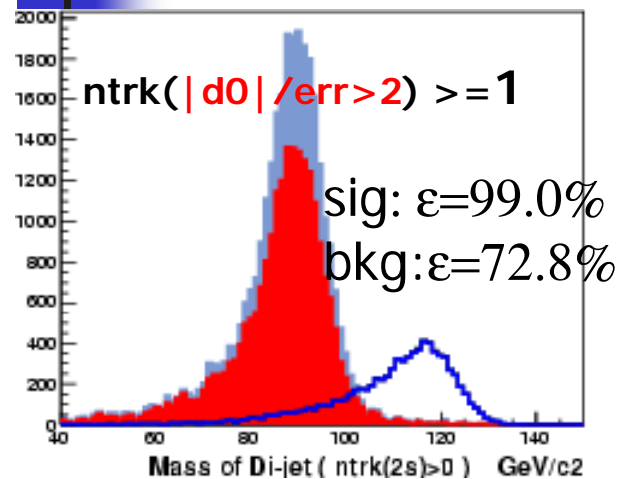
jet\_d0



jet\_d0\_chi



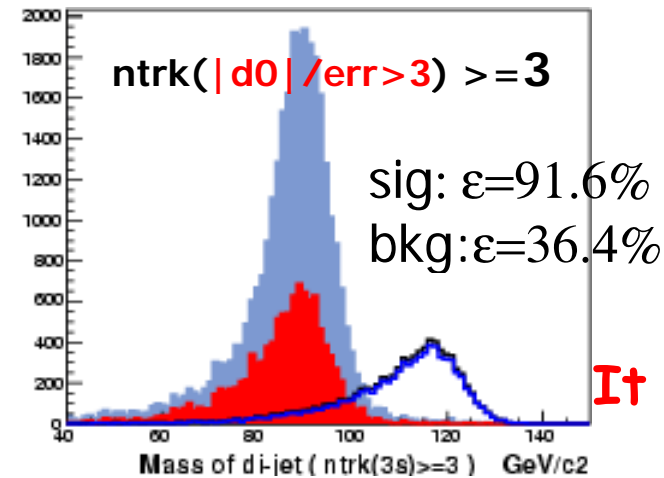
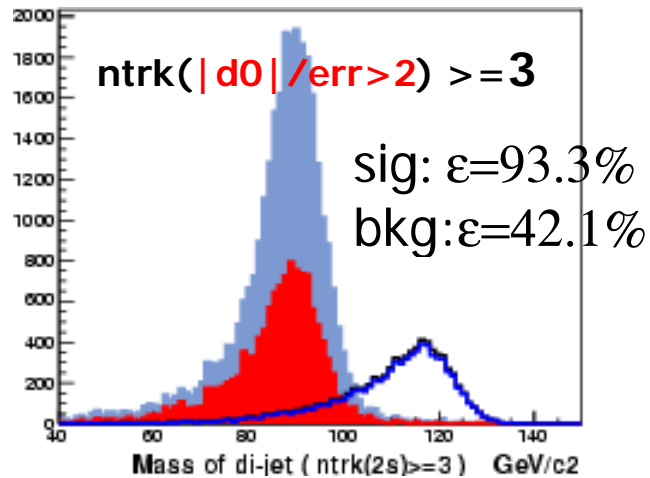
# Dijet Mass with b-flavor Tagging



Not sensitive on jet\_d0\_chi cut.



## Dijet Mass with b-flavor Tagging (cont.)



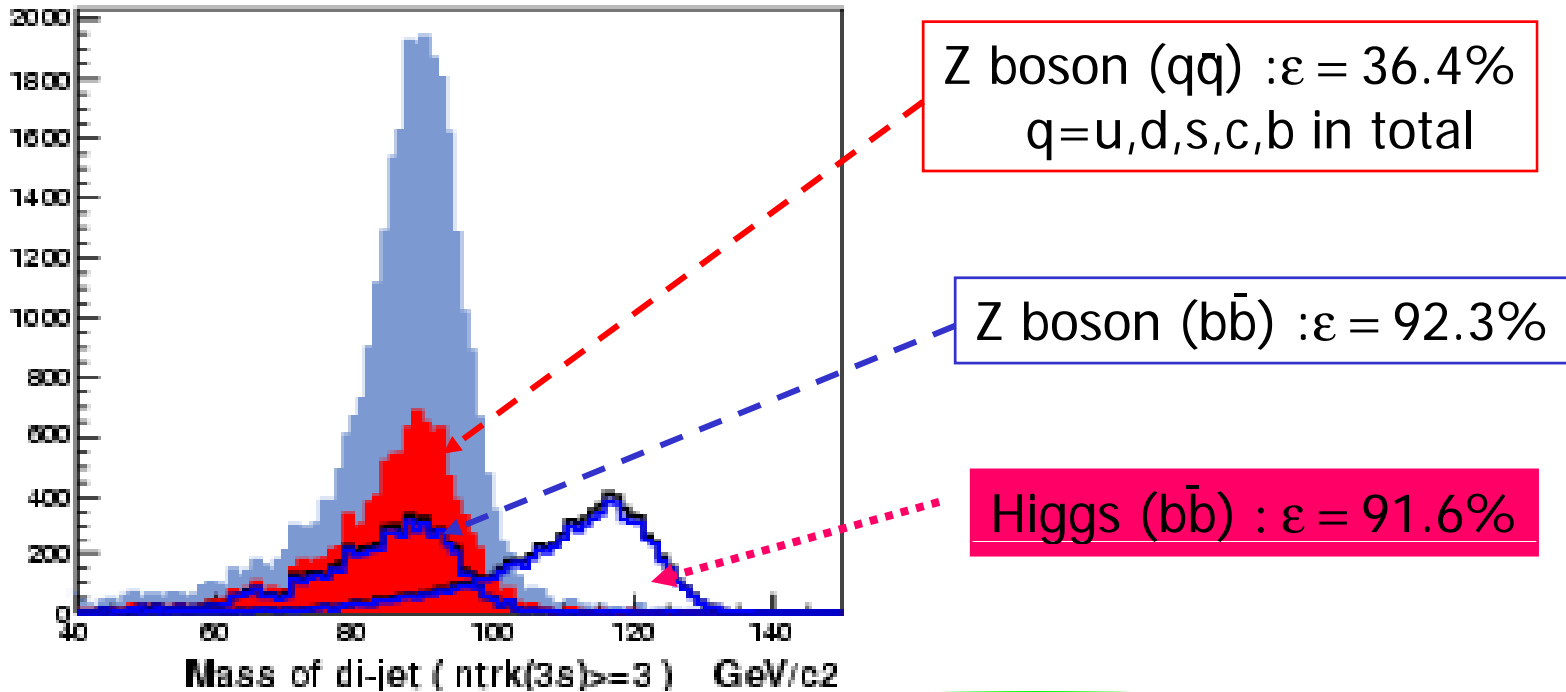
**It works!**

Cut on the number of tracks which have significant  $|d0|/err$  is an effective way to suppress the background from non-b-flavor jets.

Sensitive on track number cut.

# Dijet Mass with b-flavor Tagging (cont.)

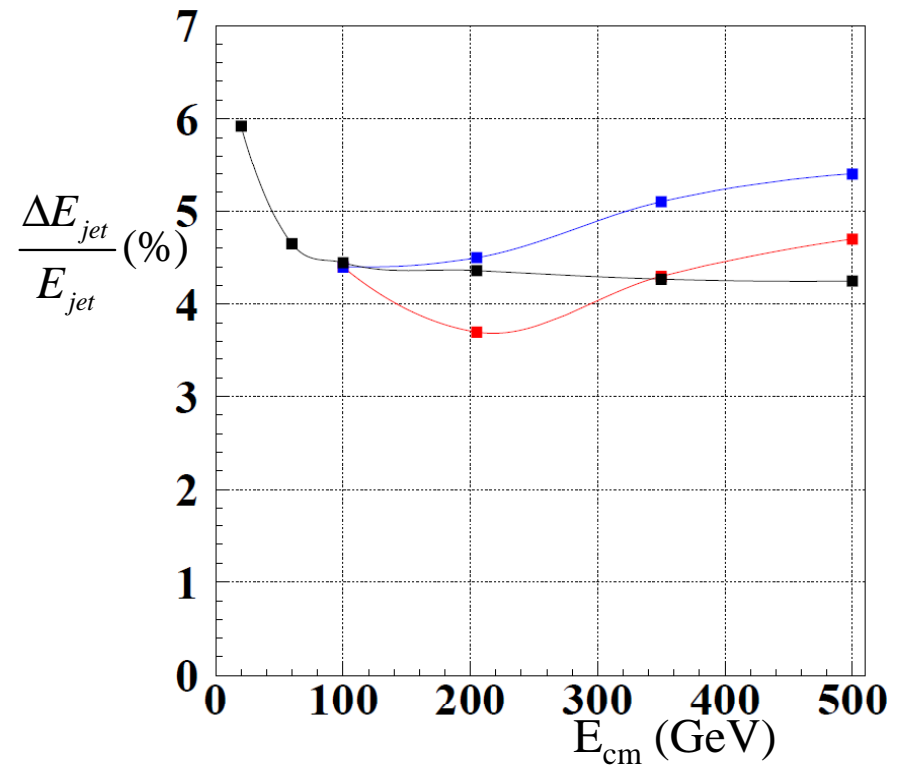
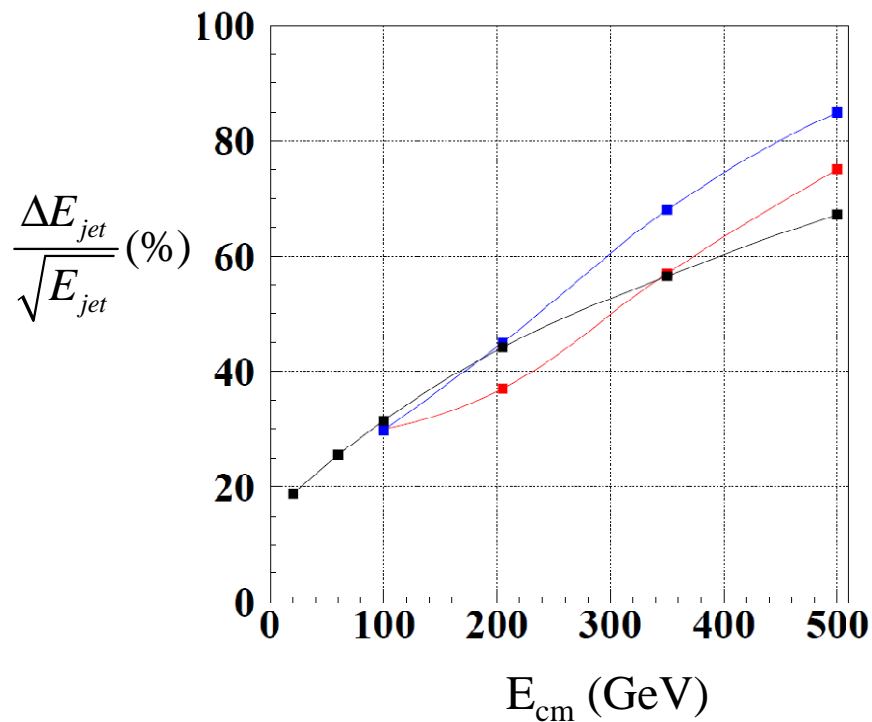
Cut : number o track ( $|d_0|/err > 3$ )  $\geq 3$  in jet



78.7% non-b-flavor Z background removed.

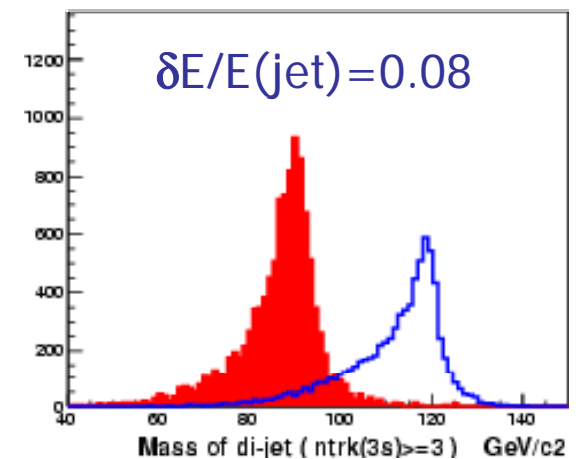
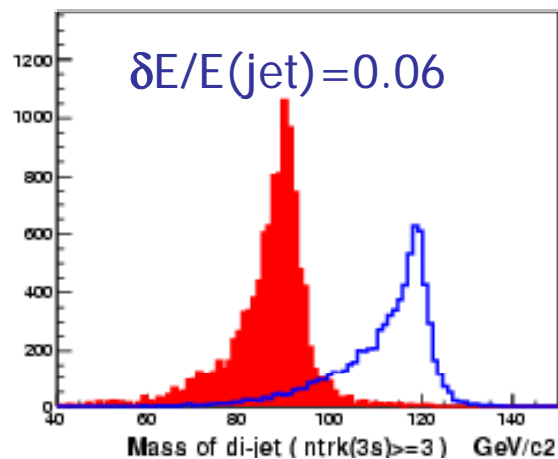
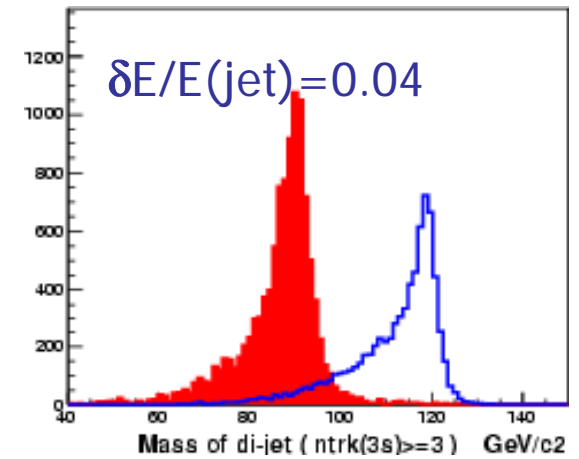
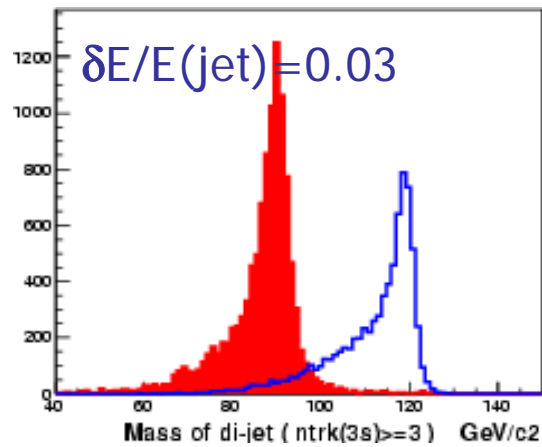
# Light quark jets $e^+e^- \rightarrow qq\bar{q}$ (T. Barklow)

GLD PFA — LDC PFA — FASTMC with  $\frac{\Delta E_\gamma}{E_\gamma} = \frac{0.18}{\sqrt{E_\gamma}}$   $\frac{\Delta E_{n,K_L^0}}{E_{n,K_L^0}} = 0.28$



## Dijet Mass with $\delta E/E(\text{jet})$

Mass of dijet with different  $\delta E/E(\text{jet})$  setting.  
(with b-tagging cut).





## Summary & Plan

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- b-flavor tagging is studied by checking the track numbers with large parameter  $d_0$  in jet.
- Background from light flavor (u,d,s,c) can be suppressed effectively by the requirement on the number of tracks in jet with  $|d_0|/err >$  certain numbers (e.g., 3).
- b-flavor cut can be optimized according to S/N ratio.
- Ycut in jet finding can be optimized.
- Jet vertexing is in consideration.
- Neural Network is in consideration.
- Move to full simulation/reconstruction events + more background modes.