

# LCFIVertex + Kinematical Variables

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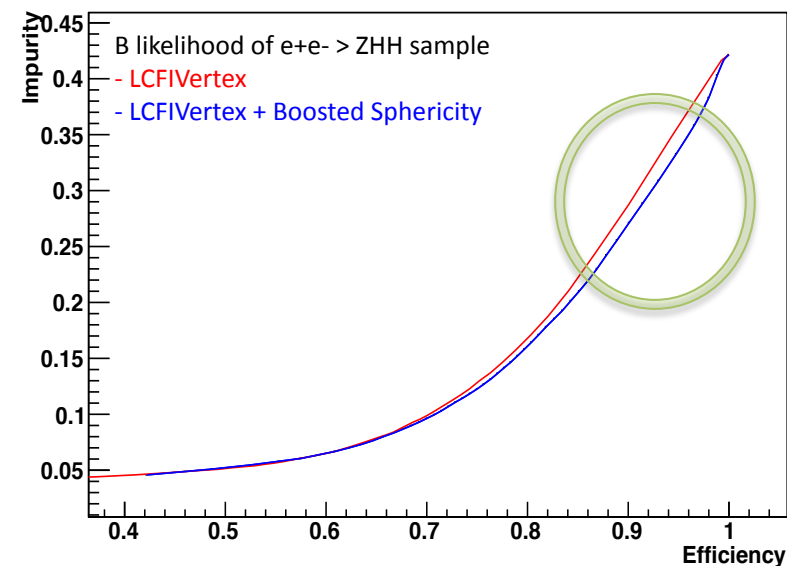
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# Kinematical Variables in Flavor Tagging

- In our last presentation, we showed that combining the boosted sphericity with LCFIVertex results in an improvement in flavor tagging in the high efficiency region
- Today we show results of combining the lepton  $p_T$
- $p_T$  is computed with respect to jet direction



# Lepton Selection

- Select one lepton per event (pick the one with highest energy)
- Require lepton energy  $> 5$  GeV
- Electrons:
  - PFOID is electron
- Muons:
  - $(E_{\text{cal}}/E < 0.4)$  or  $(E_{\text{cal}}/E < 0.6$  and PFOID is muon)

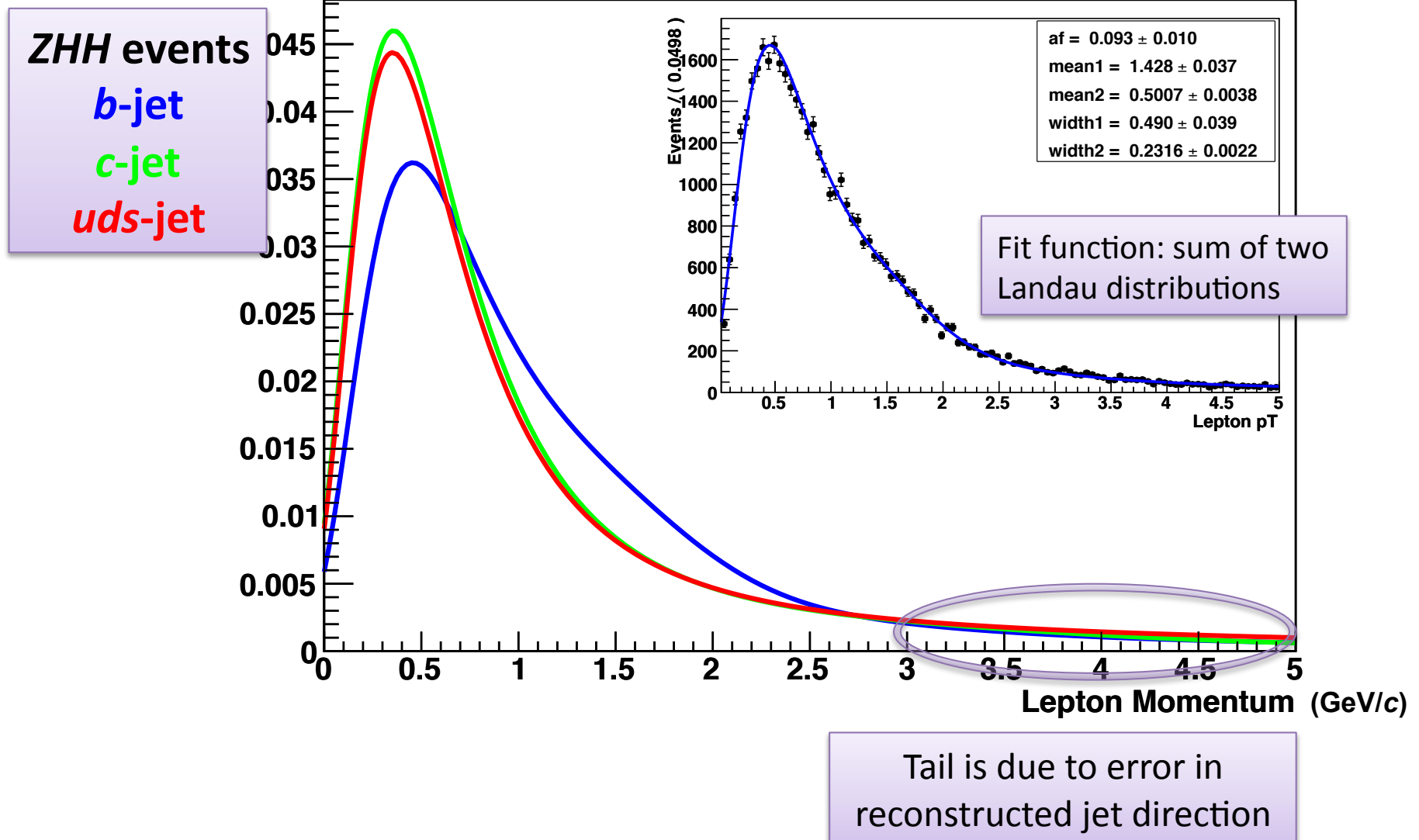
# Lepton Selection

$e^+e^- \rightarrow bb$  sample ( $E_{cm}=500\text{GeV}$ )

	Electron	Muon	
Cut: $E$	$>5$	$>5$	
Cut: $E_{cal}/E$	n/a	$E_{cal}/E < 0.4$	$0.4 < E_{cal}/E < 0.6$
Cut: PFOID	11	n/a	13
Purity	37.5%	55.9%	61.5%
		56.6% (overall)	
Efficiency	34.7%	31.4%	4.99%
		36.4% (overall)	

In  $e^+e^- \rightarrow ZHH$  sample:  
 -34.6% of jets have a lepton candidate.

# Lepton $p_T$ Shape



# Likelihood Method

- We take the probability from the shape of the sphericity & lepton pT distributions

$$f_b^S, f_c^S, f_{uds}^S, f_b^\ell, f_c^\ell, f_{uds}^\ell$$

- We assume the NN output is proportional to probability (need to confirm this)

$$f_b^{\text{NN}} = \text{NN output (BTag)}$$

- For light jets, we take:

$$f_{uds}^{\text{NN}} = (1 - f_b^{\text{NN}})(1 - f_c^{\text{NN}})$$

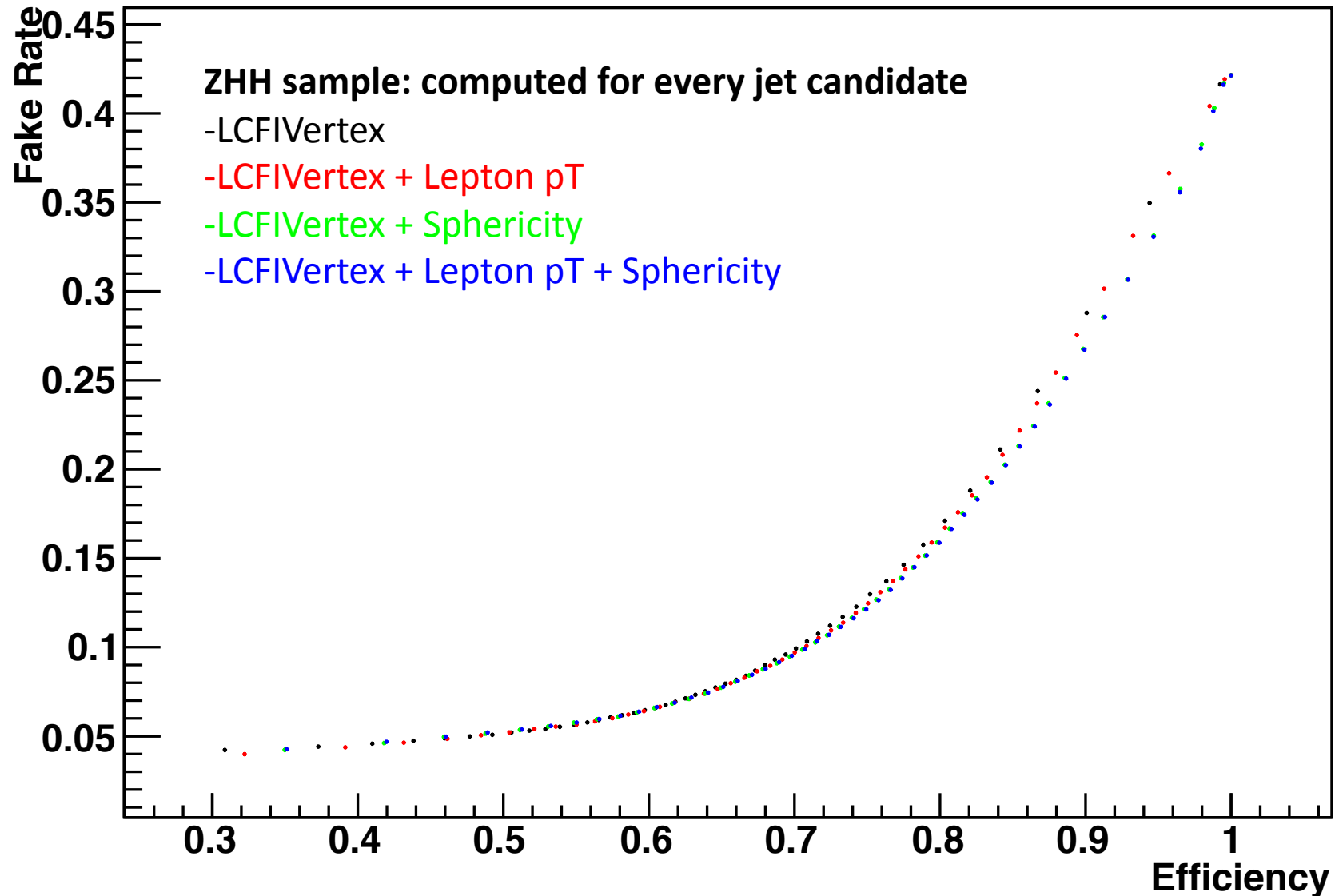
# Likelihood Method (2)

- The likelihood of b-jet is defined in terms of the probabilities

$$\mathcal{L}_b = \frac{N_b f_b^{\text{NN}} f_b^S f_b^\ell}{N_b f_b^{\text{NN}} f_b^S f_b^\ell + N_c f_c^{\text{NN}} f_c^S f_c^\ell + N_{uds} f_{uds}^{\text{NN}} f_{uds}^S f_{uds}^\ell}$$

- $N_i$  is the fraction of events

# Result



Small improvement without degradation by adding lepton pT information.



# Summary

- Adding lepton  $p_T$  + boosted sphericity results in improved flavor-tagging
- It could be improved further by using better particle ID & optimizing boost