Background Studies for Higgs production at the LHeC

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Introduction

- For light Higgs, $e^- p \rightarrow \nu H X$ has sizeable cross section, O(0.1pb), at LHeC (WW fusion).

- Higgs should have been discovered at LHC, but Hbb coupling measurement might be tough in hadron collider environment.

- Using a cleaner environment, can LHeC do something interesting with $H \rightarrow bb$ events?

Reminder: in Divonne 2008

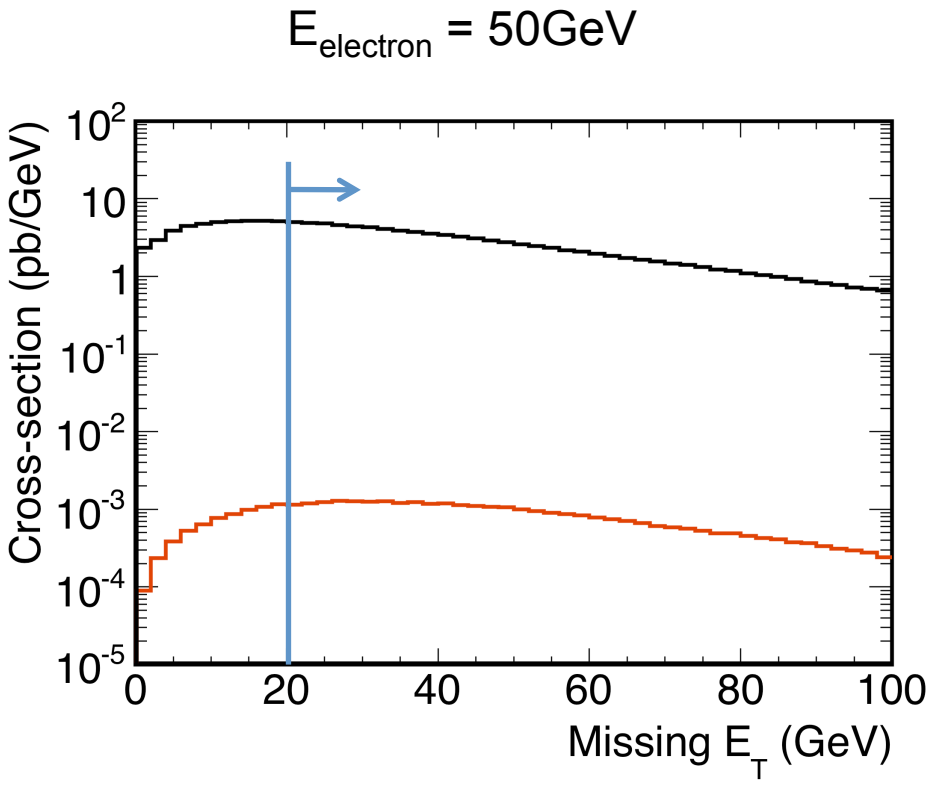
- Signal: CompHEP calculation by E.Perez.
  parton-level cuts on missPt and Pt(jet),
  no detector simulation
- CC background: ZEUS framework (DJANGOH and ZEUS detector simulation. σ ~ 400pb)
- Results for E_e=140GeV, L=10fb^{-1}
  (Higgs mass peak width ±20GeV assumed):
  Signal ~ 1000 evt, Bgd ~ 80,000 evt
  (for missPt > 25GeV, jets Pt > 20GeV)

This time …

- Used MadGraph setup by U. Klein (thanks!!)
- Signal and bgd generated with same framwork
- Hadronization with PYTHIA
- PGS detector simulation, including b-tag
- Considered CC bgd only. NC ongoing.
- For M_H=115 GeV, E_e=50, 90, 140 GeV

Missing Et (PGS variable)

- MissEt > 20 GeV cut applied first.
- Should suppress most of NC and PHP bgd (to be verified!)

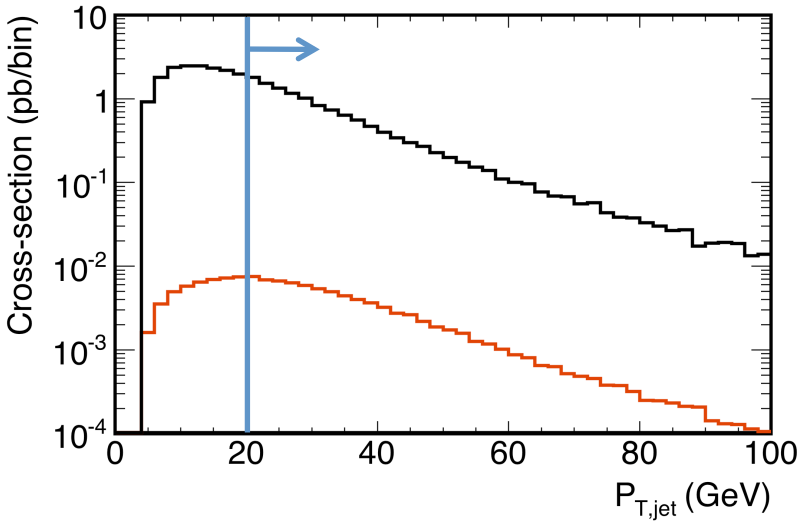


CC (σ = 301 pb)

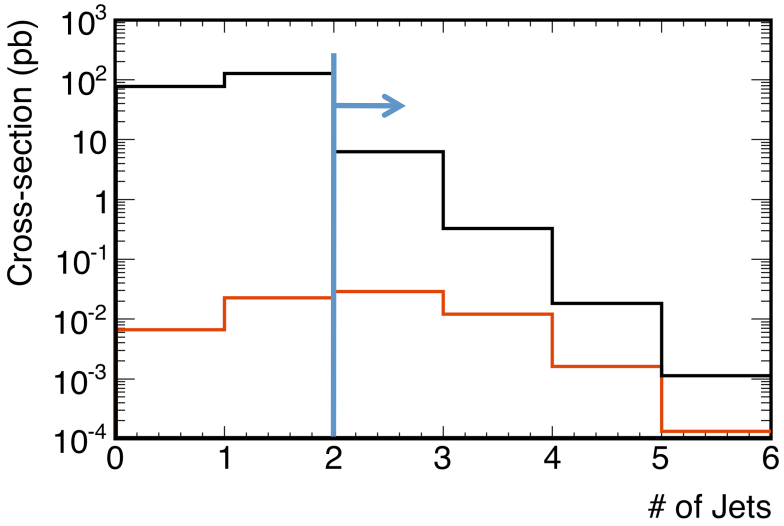
M=115GeV Higgs (σ = 0.086 pb)

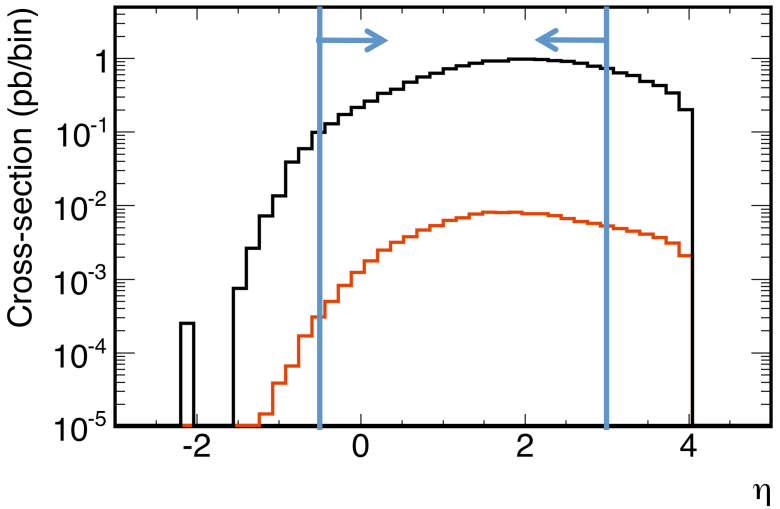
Jet variables (cone algorithm)

- Njet >= 2 required, with Pt(jet) > 20 GeV and -0.5 < η(jet) < 3



$E_{electron}$ = 50GeV





Implementation of B-tag in PGS

Jet flavor tagging condition

1. Jet vertex: $|z| < 60\text{cm}$
2. Jet direction: $|\eta| < 2.0$

If *b* exists in 20 deg. cone of the jet => $f_b(E_T, \eta)$

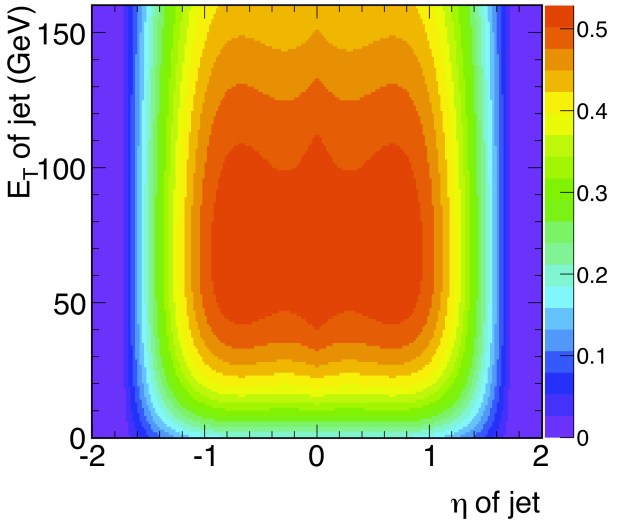
Else if *c* exists in 20 deg. cone of the jet => $f_c(E_T, \eta)$

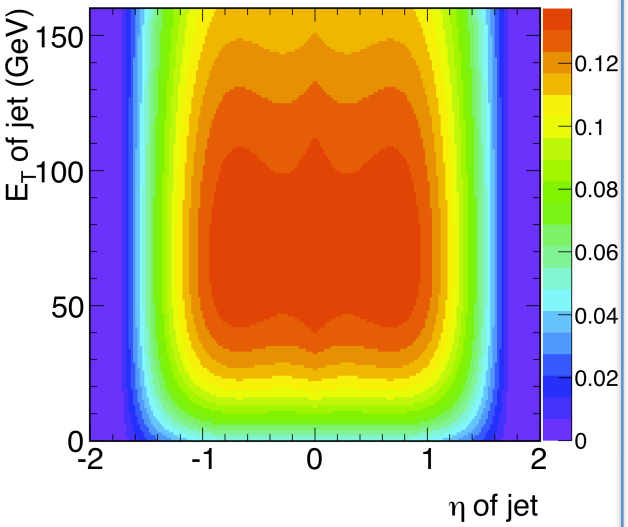
Else if *uds* or *gluon* exists in 20 deg. cone of the jet => $f_{udsg}(E_T, \eta)$

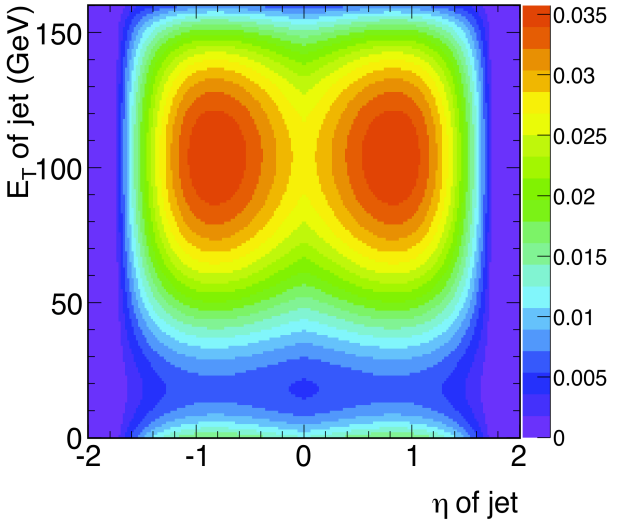
$f_b(E_T, \eta)$, $f_c(E_T, \eta)$ and $f_{udsg}(E_T, \eta)$ are b-tag efficiency functions from CDF Run 2.

(M. Ishitsuka)

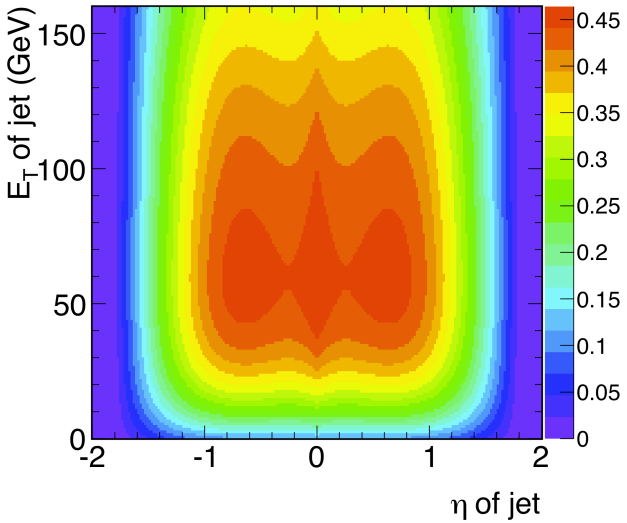
Loose B-tag

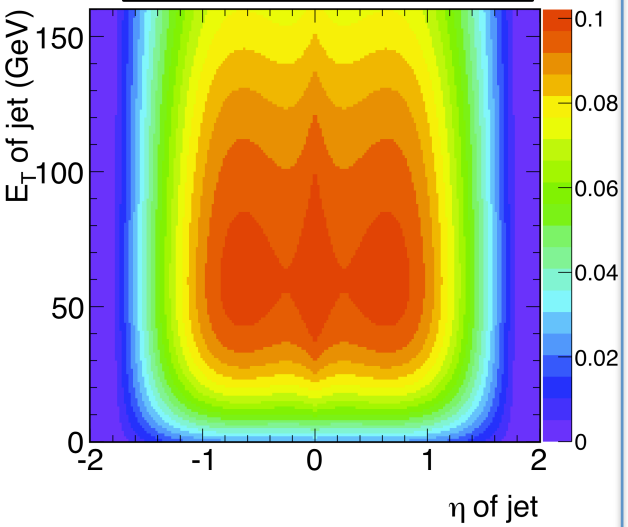


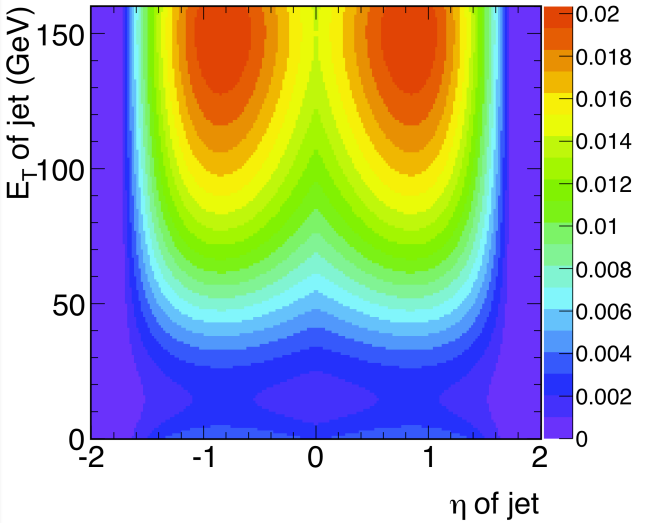




Tight B-tag







B-tag efficiency for jets including *b* ($f_b(E_T, \eta)$)

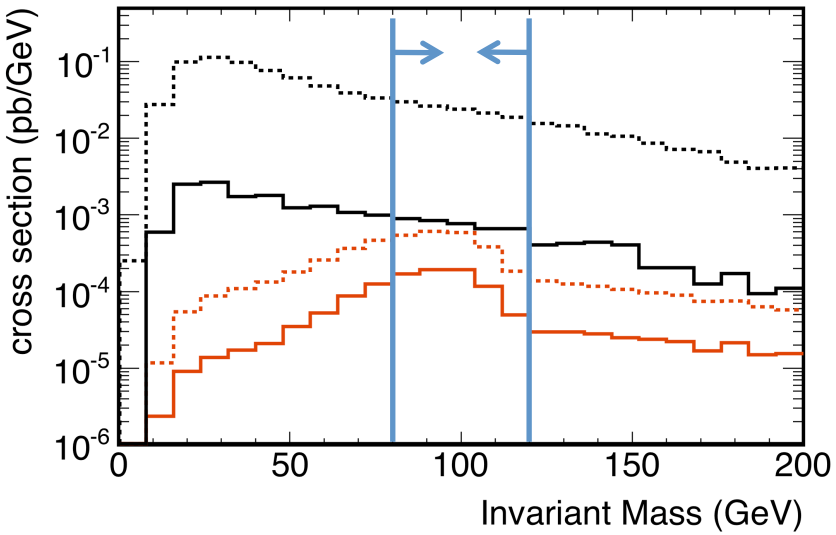
B-tag efficiency for jets including *c* ($f_c(E_T, \eta)$)

B-tag efficiency for jets including *uds* or *g* ($f_{udsg}(E_T, \eta)$)

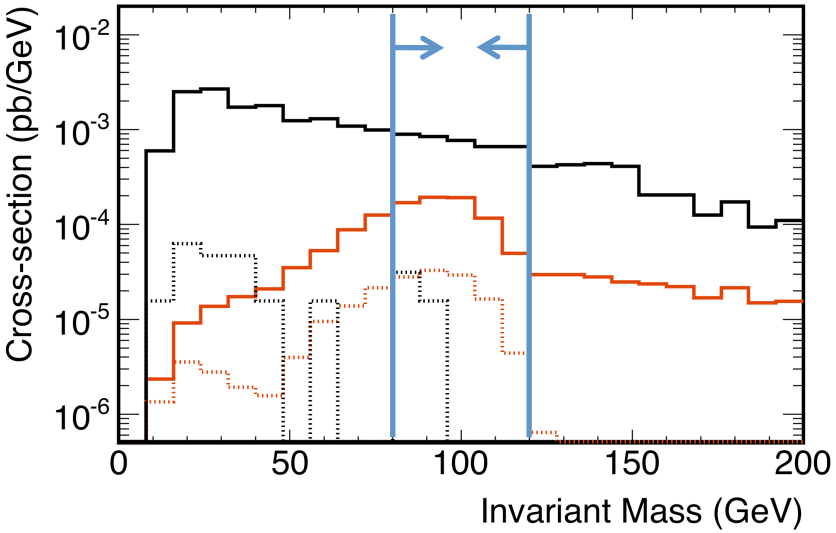
B-tag requirement (loose)

$E_{electron}$ = 50GeV

- 1-tag
  dashed: before b-tag
  solid: single b-tag



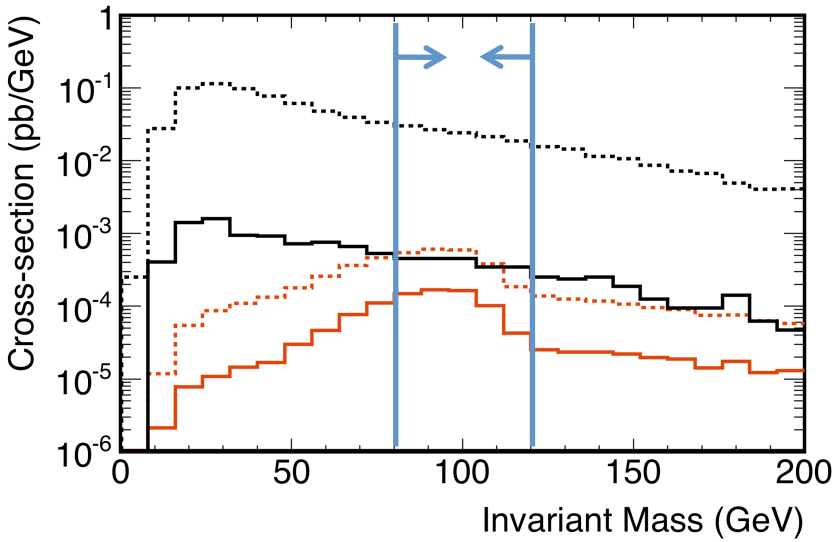
- 2-tag
  solid: single b-tag
  dotted: double b-tag



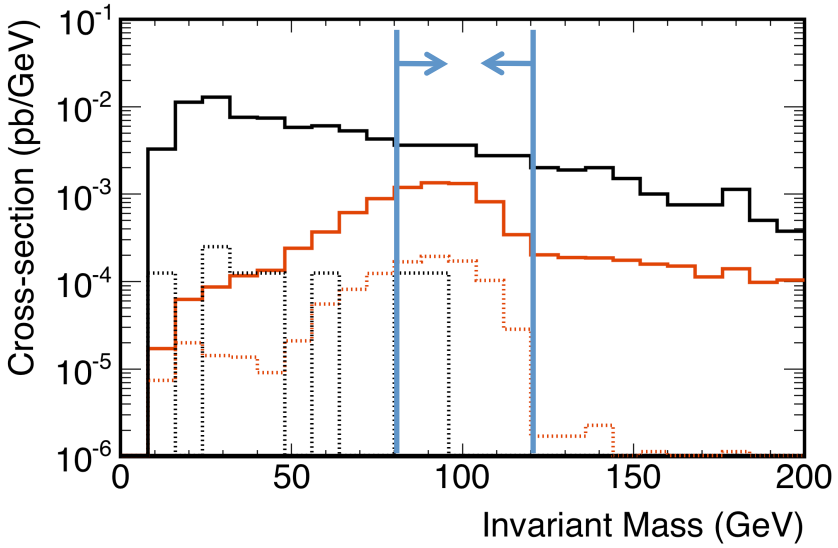
B-tag requirement (tight)

$E_{electron}$ = 50GeV

- 1-tag
  dashed: before b-tag
  solid: single b-tag



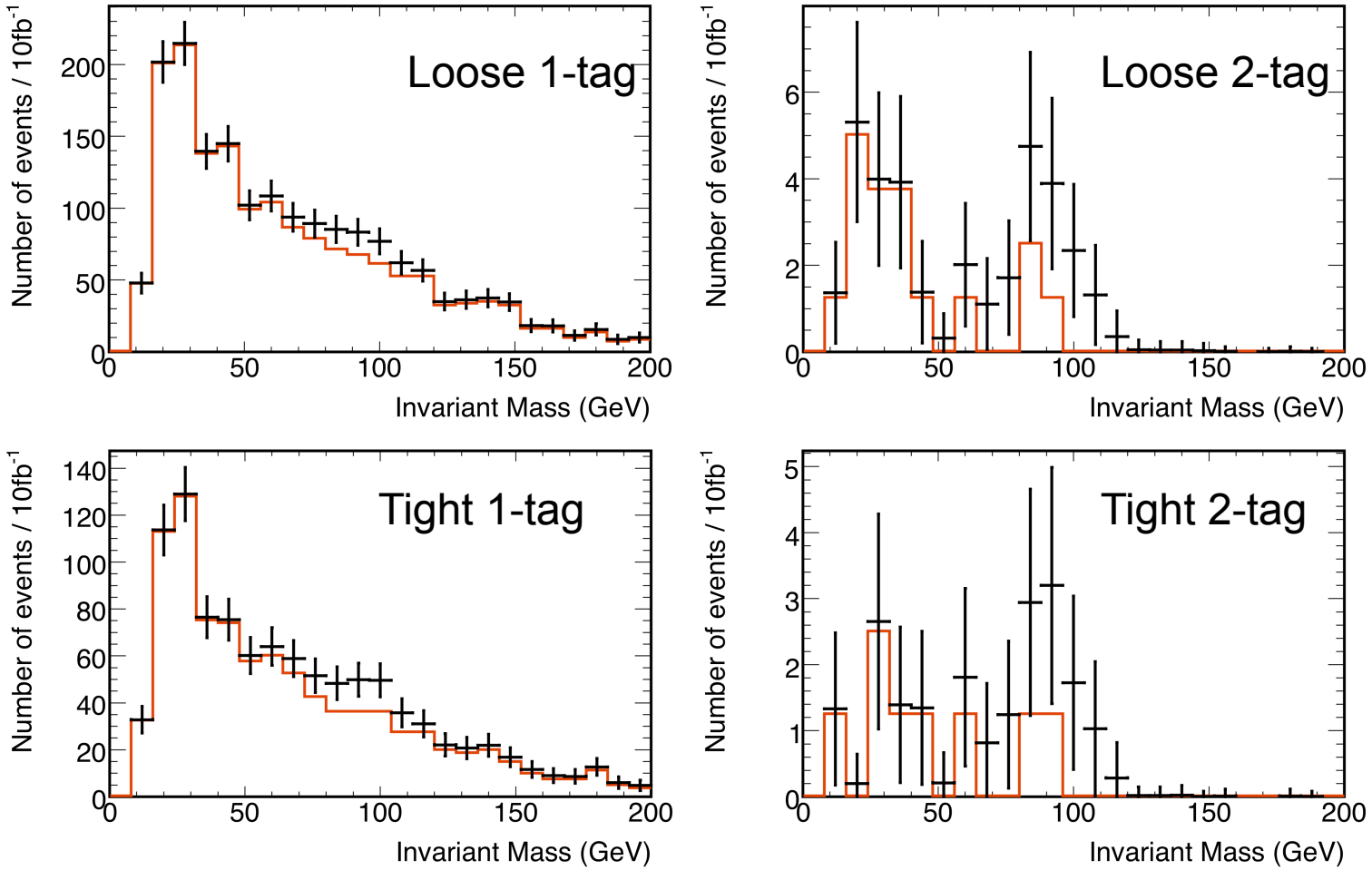
- 2-tag
  solid: single b-tag
  dotted: double b-tag



How the data would look like…

- Mass plot of CC(red) and CC+Higgs(black)

$E_{electron}$ = 50GeV



Number of events for $10fb^{-1}$

- Mass window set to $80 < Mjj < 120$ GeV

- #Higgs/#CC table for E_e and b-tag setting

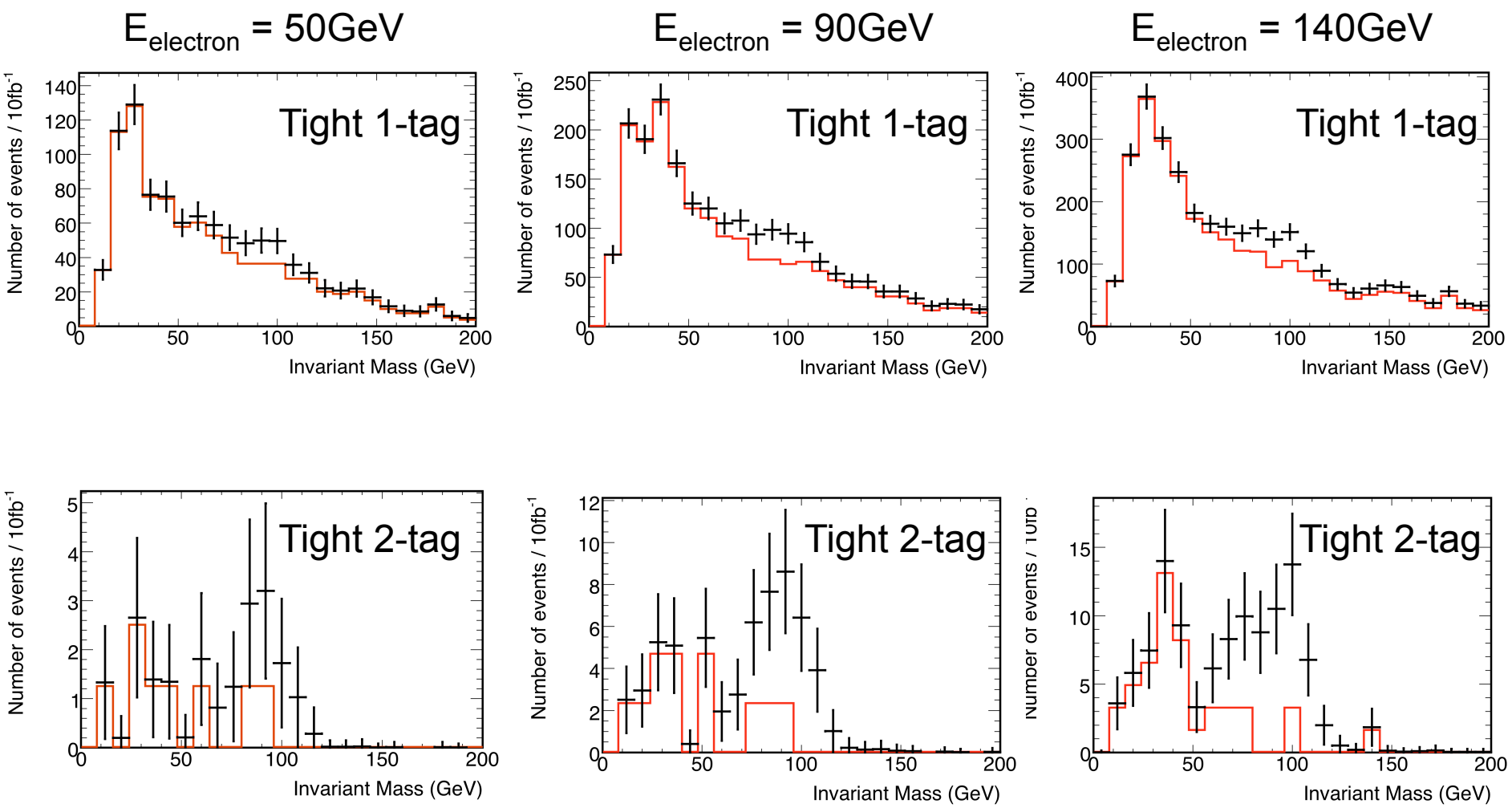
	50GeV	90GeV	140GeV
Loose 1-tag	57.7/306	132/591	199/776
Loose 2-tag	8.88/3.77	31.5/7.06	53.1/11.5
Tight 1-tag	50.2/165	116/322	176/483
Tight 2-tag	6.68/2.51	22.9/4.71	38.5/3.28

(CC numbers for 2-tag cases are MC statistics limited)

Summary

- CC background study for Higgs→bb was made using consistent framework of MadGraph + detector simulation PGS (default), set up by U.Klein
- S/N of 0.19(0.31) could be achieved for loose(tight) 1-tag with 58(50) Higgs candidates in mass peak. (with 50 GeV beam and 10 fb^{-1})
- For 2-tag, S/N will be 2.4(2.7) for 8.9(6.7) events.
- This kind of b-tag performance (taken from CDF2) would be nice to have in the LHeC detector.
- Next: NC (soon) and PHP (hard?) bgd estimation.

Of course, higher E_e is nice…



Backup

Cross sections

	Ee = 50GeV	Ee = 90GeV	Ee = 140GeV
M_{higgs} = 115GeV	0.08551 pb	0.1568 pb	0.2354 pb
M_{higgs} = 125GeV	0.07590 pb	0.1419 pb	0.2152 pb
M_{higgs} = 135GeV	0.06739 pb	0.1287 pb	0.1974 pb
CC Background	301.4 pb	400.0 pb	494.1 pb

MC statistics

	Ee = 50GeV	Ee = 90GeV	Ee = 140GeV
M_{higgs} = 115GeV	150k	150k	150k
M_{higgs} = 125GeV	150k	150k	150k
M_{higgs} = 135GeV	150k	150k	150k
CC Background	2.4M	2.3M	3.0M