

Backgrounds to Higgs production at the LHeC

Masahiro Kuze

Tokyo Institute of Technology

Emmanuelle Perez

CERN

LHeC WS, Divonne-les-Bains, 2/Sep/2008

(with a lot of help from
J. Maeda, K. Nagano and H. Spiesberger)

Disclaimer

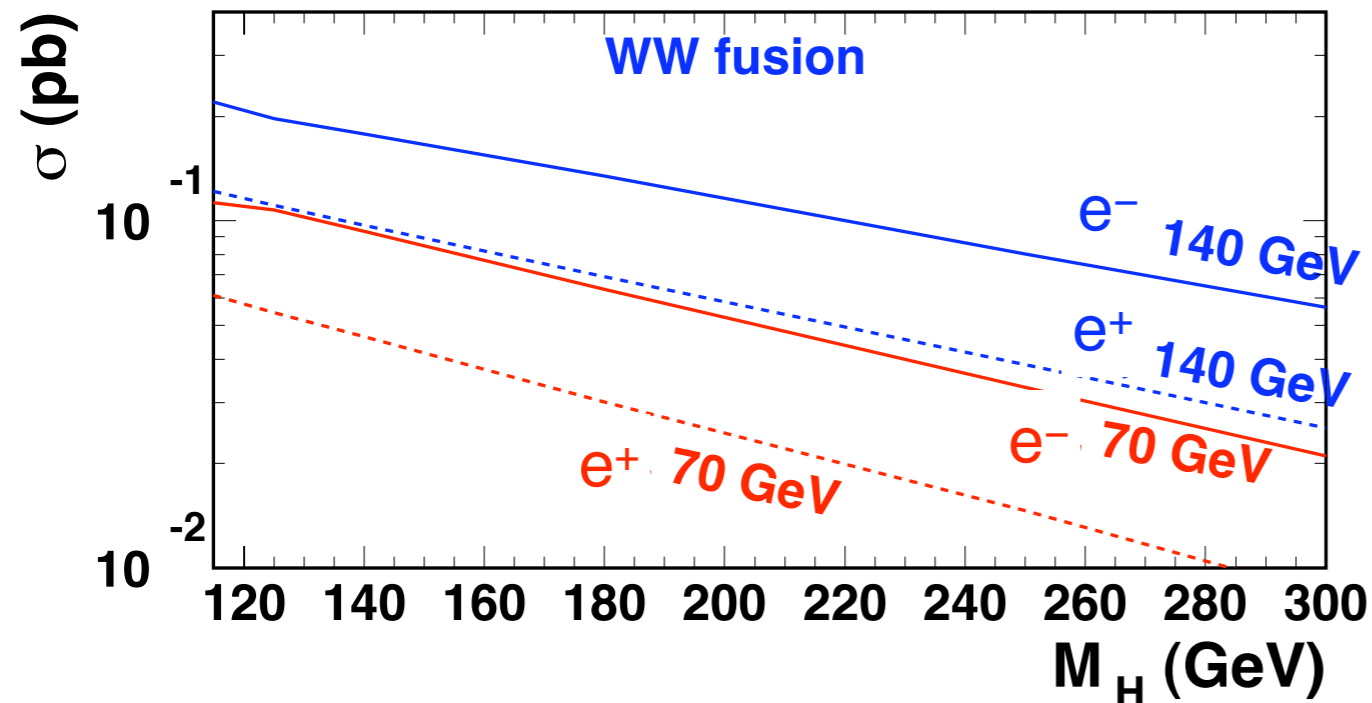
- All results VERY preliminary (started ~ 2 weeks ago).
- Only CC considered (PHP should be).
- DJANGOH gives NaN for radiative-correction integration at LHeC energy: running in Born mode for now.
H.S. notified.

Introduction

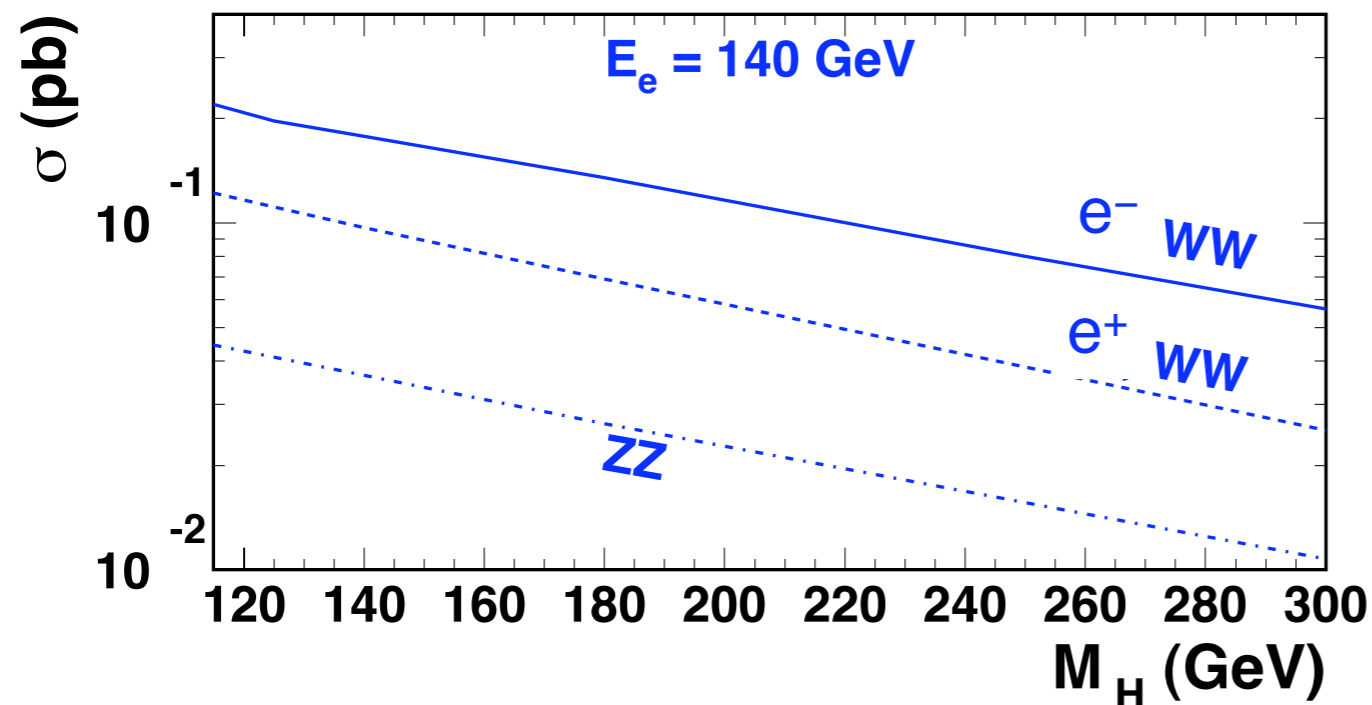
- Higgs production at LHeC $\sim 0.2\text{pb}$ for $140\text{GeV } e^- \times 7000\text{GeV } p$ ($M_H=115\text{GeV}$)
- Mainly WW fusion in CC process
 $ep \rightarrow \nu HX$ (ZZ is small)
- For small M_H , study on Hbb coupling would be interesting, which could be difficult at the LHC.

CompHEP calculation (E.P.)

H production at LHeC

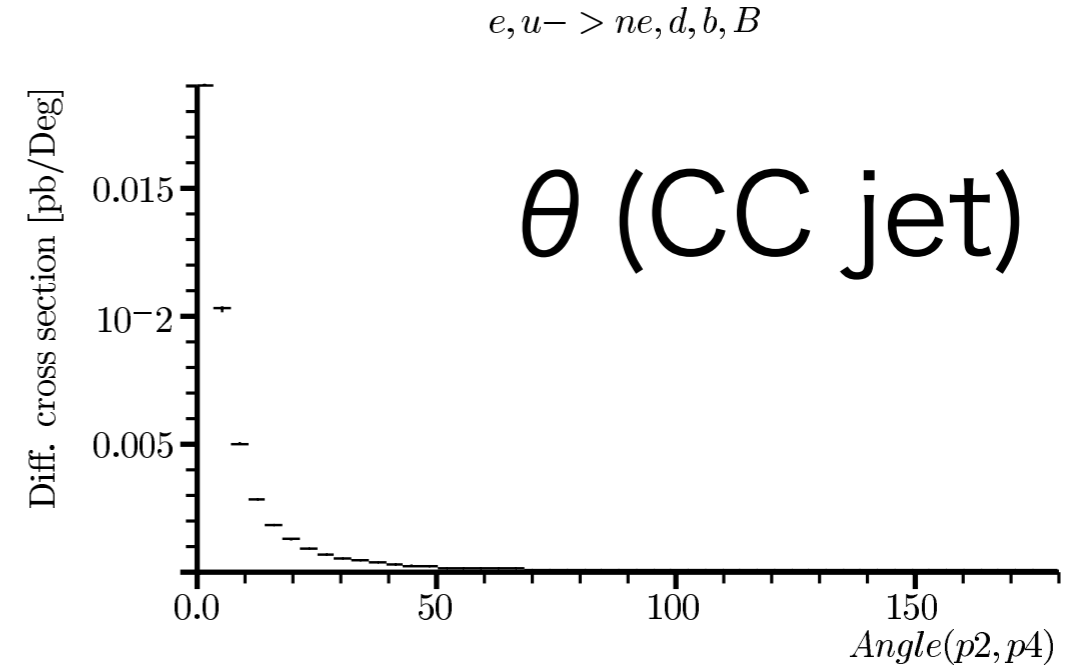
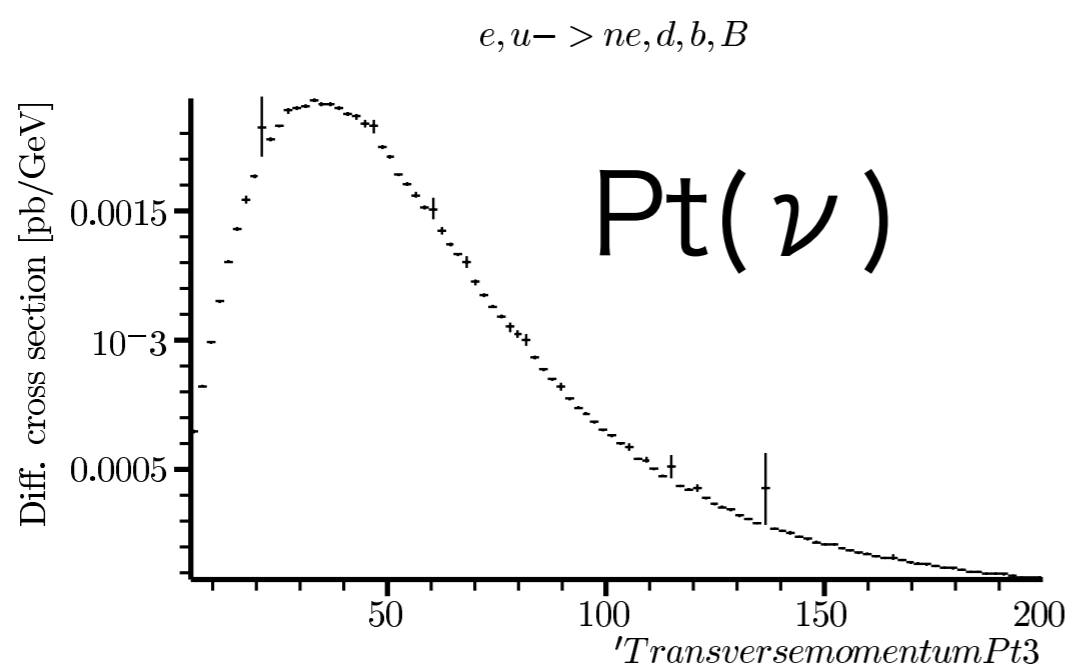
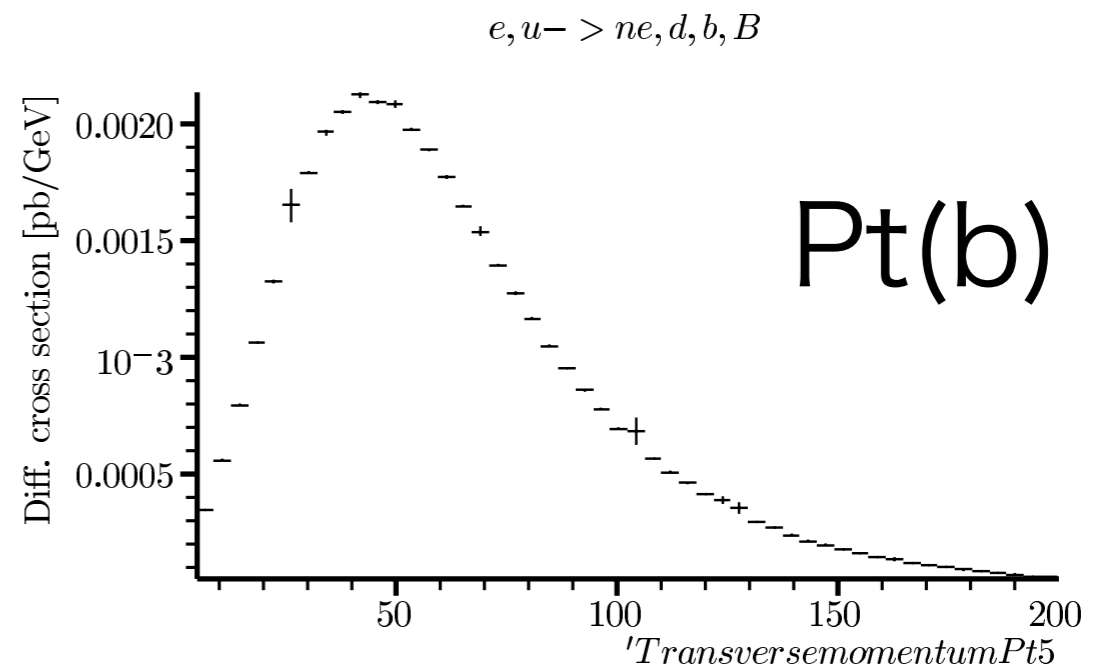
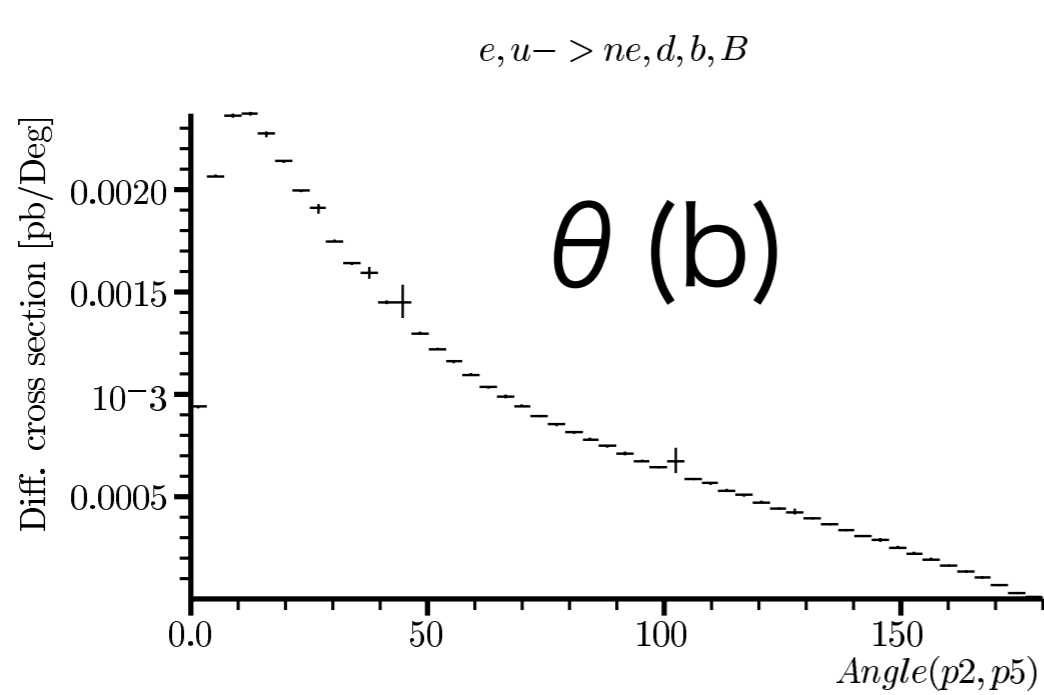


$\sigma(e^-p) \sim 2 \times \sigma(e^+p)$ (CC DIS)
 $\sigma(140 \text{ GeV}) \sim 2 \times \sigma(70 \text{ GeV})$



$\sigma(\text{CC, via WW}) > \sigma(\text{NC, via ZZ})$

$eu \rightarrow \nu dH, H \rightarrow bb$ ($M_H=115\text{GeV}$)



missPt, central b jets, very forward CC jet

Cross section with parton-level cuts ($E_{e^-}=140\text{GeV}$, $M_H=115\text{GeV}$)

$\text{missPt} >$ $\text{Pt}(b) >$	25GeV	50GeV	75GeV
20GeV	0.099	0.063	0.037
40GeV	0.057	0.037	0.023

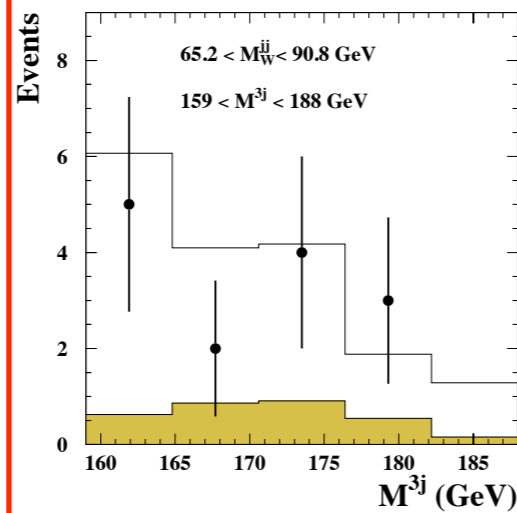
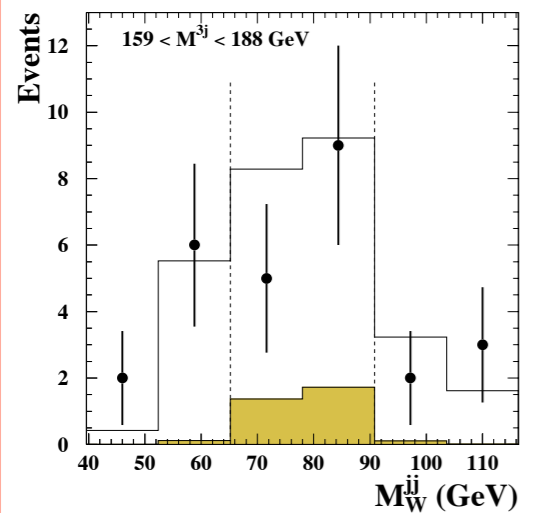
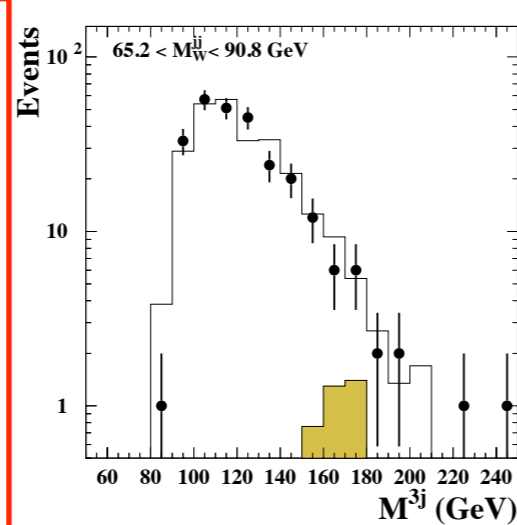
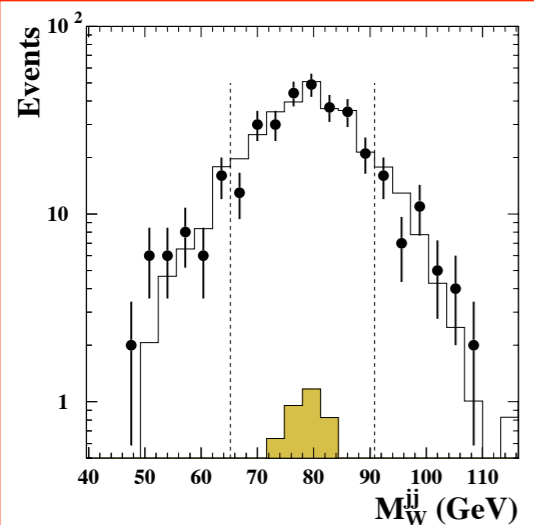
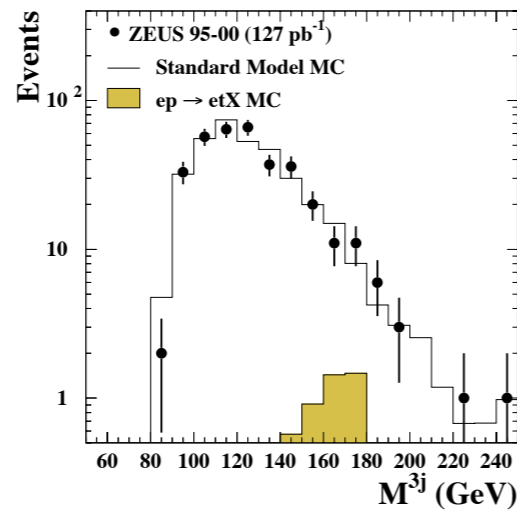
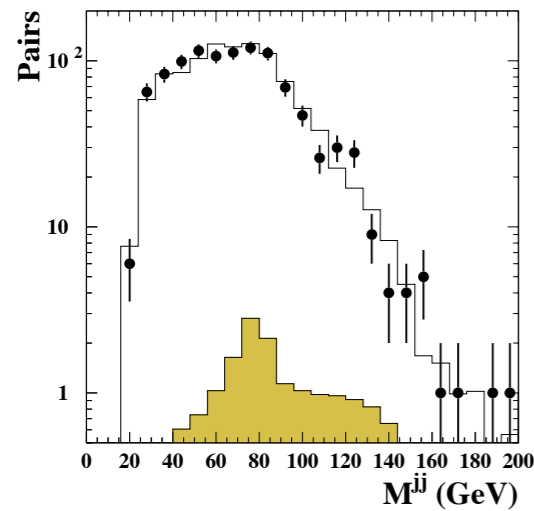
(in pb; b-jet angle cut of $10 < \theta < 170$ applied.)

Background study

- Generate DJANGO $Q^2 > 400 \text{ GeV}^2$ CC events at LHeC energy, run through ZEUS detector MC.
- 140 GeV e^-p . $\sigma_{\text{tot}} = 383.31 \text{ pb}$. 10,000 events (very CPU consuming...)
- Run kt jet-finder, cut on missPt and Pt(jets) (jet $|\eta| < 3$), count events in dijet-mass bin ($M_H \pm \text{width}$).
- Compare w/ signal (parton-level cut), calculate S/N and S/\sqrt{N} (for $L = 10 \text{ fb}^{-1}$)

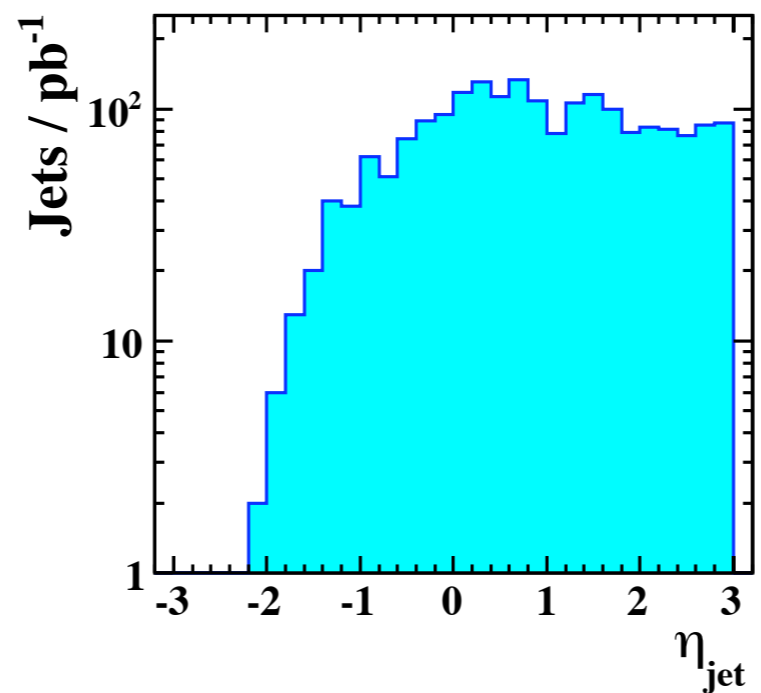
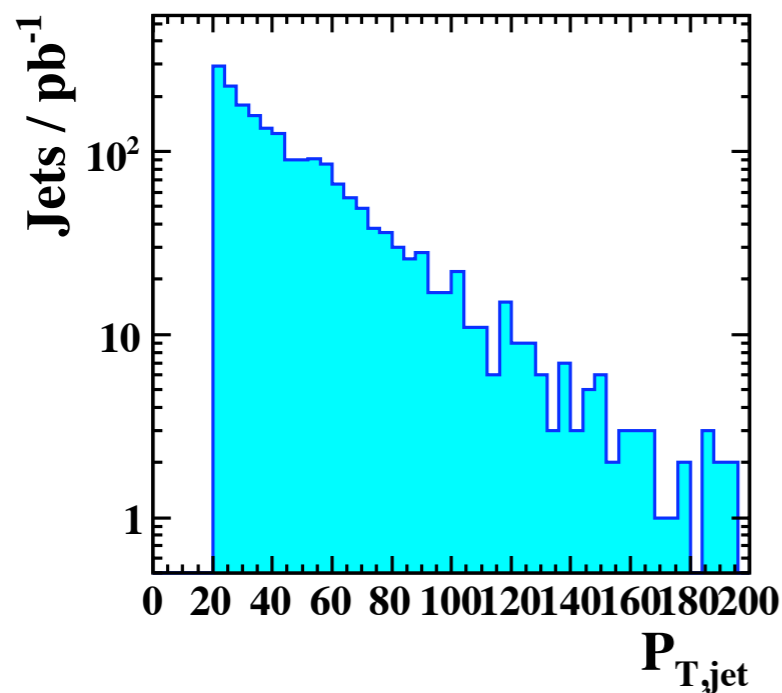
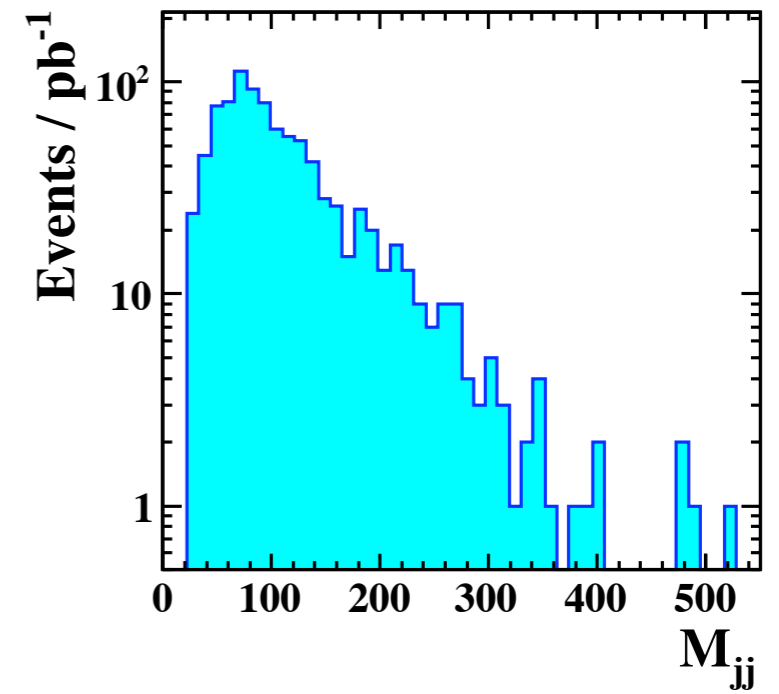
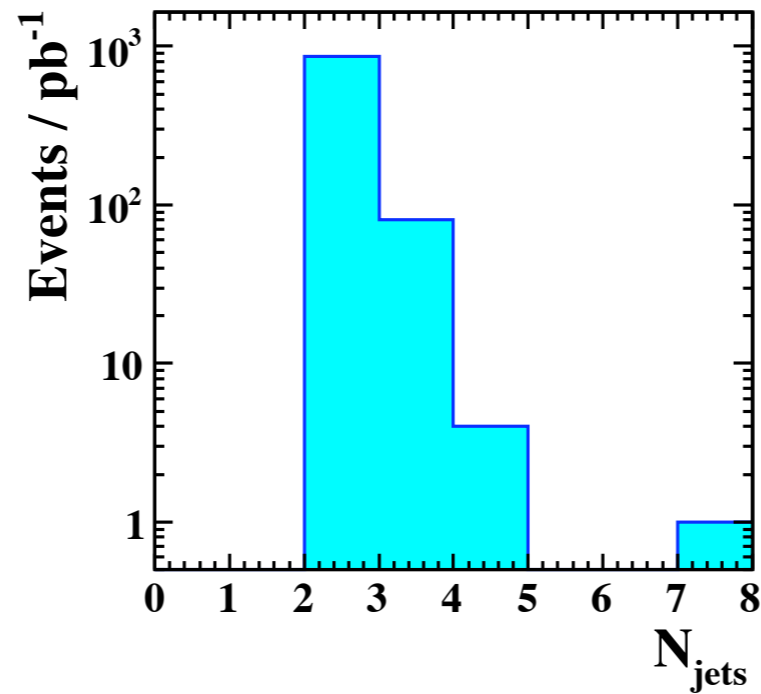
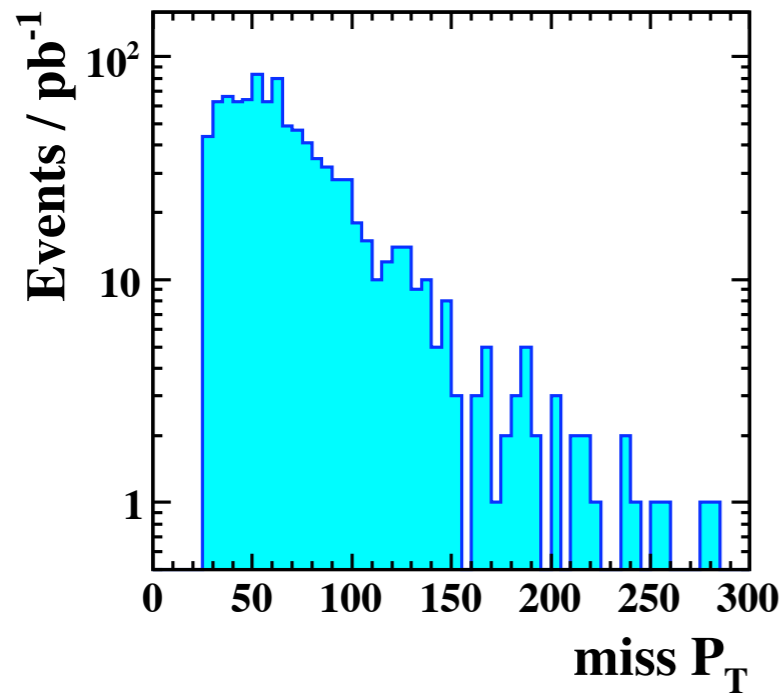
mass resolution for $H \rightarrow bb$?

ZEUS



- DESY-03-012
(ZEUS FCNC top)
- $W \rightarrow$ dijet in $t \rightarrow bW$
- Let's take width = ± 10 GeV and also look at 5 GeV and 20 GeV.

CC distributions



DJANGO CC $Q^2 > 400 \text{ GeV}^2$
($E_p = 7,000 \text{ GeV}$, $E_e = 140 \text{ GeV}$)
at ZEUS detector

- $P_T^{\text{miss}} > 25.0 \text{ GeV}$
- at least 2 jets with :
 - $P_{T,\text{jet}} > 20.0 \text{ GeV}$
 - $|\eta_{T,\text{jet}}| < 3.0$

Width=10 GeV, LHeC 10fb^{-1}

missPt> Pt(jet)>	25GeV	50GeV	75GeV
20GeV	990/39098 S/N=0.025 S/ \sqrt{N} =5.0	630/26065 S/N=0.024 S/ \sqrt{N} =3.9	370/16482 S/N=0.022 S/ \sqrt{N} =2.9
40GeV	570/17632 S/N=0.032 S/ \sqrt{N} =4.3	370/12266 S/N=0.030 S/ \sqrt{N} =3.3	230/7666 S/N=0.030 S/ \sqrt{N} =2.6

Width=20 GeV, LHeC 10fb^{-1}

missPt> Pt(jet)>	25GeV	50GeV	75GeV
20GeV	990/77812 S/N=0.013 S/ \sqrt{N} =3.5	630/49064 S/N=0.013 S/ \sqrt{N} =2.8	370/29132 S/N=0.013 S/ \sqrt{N} =2.2
40GeV	570/28365 S/N=0.020 S/ \sqrt{N} =3.4	370/19166 S/N=0.019 S/ \sqrt{N} =2.7	230/11499 S/N=0.020 S/ \sqrt{N} =2.1

Width=5GeV, LHeC 10fb^{-1}

missPt> Pt(jet)>	25GeV	50GeV	75GeV
20GeV	990/19166 S/N=0.052 S/ \sqrt{N} =7.2	630/13033 S/N=0.048 S/ \sqrt{N} =5.5	370/8433 S/N=0.044 S/ \sqrt{N} =4.0
40GeV	570/8050 S/N=0.071 S/ \sqrt{N} =6.4	370/5750 S/N=0.064 S/ \sqrt{N} =4.9	230/3833 S/N=0.060 S/ \sqrt{N} =3.7

post-Remark

- Yesterday, I learned that 10fb^{-1} (1yr@ 10^{33}) with $E_e=140\text{GeV}$ may be 'ultimate goal'.
- For $L=1\text{fb}^{-1}$ (1yr@ 10^{32}) and 140GeV :
 $S \rightarrow 1/10$, $N \rightarrow 1/10$: $S/N \rightarrow \text{same}$, $S/\sqrt{N} \rightarrow 1/3$
- For $E_e=70\text{GeV}$ and 10fb^{-1} :
 $S \rightarrow \sim 1/2$, $N \rightarrow \sim 0.7(?)$ (CC $\sigma_{\text{tot}}=280.16\text{pb}$)
(MC generation needed for actual dijet bg)

Summary

- A very preliminary look at CC bgd to light Higgs production at the LHeC.
- Mass bump could be seen (5.0 sigma), but tough N/S (>30) for coupling study?
- MissPt slope is similar. Hard cut on Pt(jet) improves S/N (but worsens S/ \sqrt{N})
- More thoughts on cuts needed.
b-tag (vertex), forward jet, ... (signal MC!)
- Photoproduction and other bgd sources?