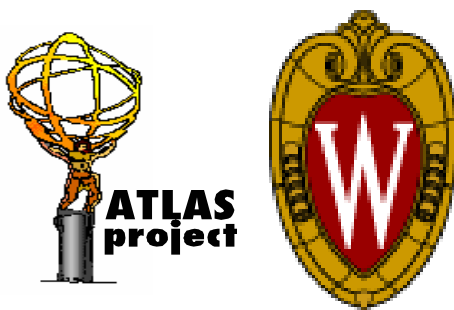


QCD Higher Order Corrections in $H \rightarrow \tau\tau + 1\text{jet}$ at the LHC

B.Mellado, S.Padhi, W.Quayle and Sau Lan Wu
(University of Wisconsin)

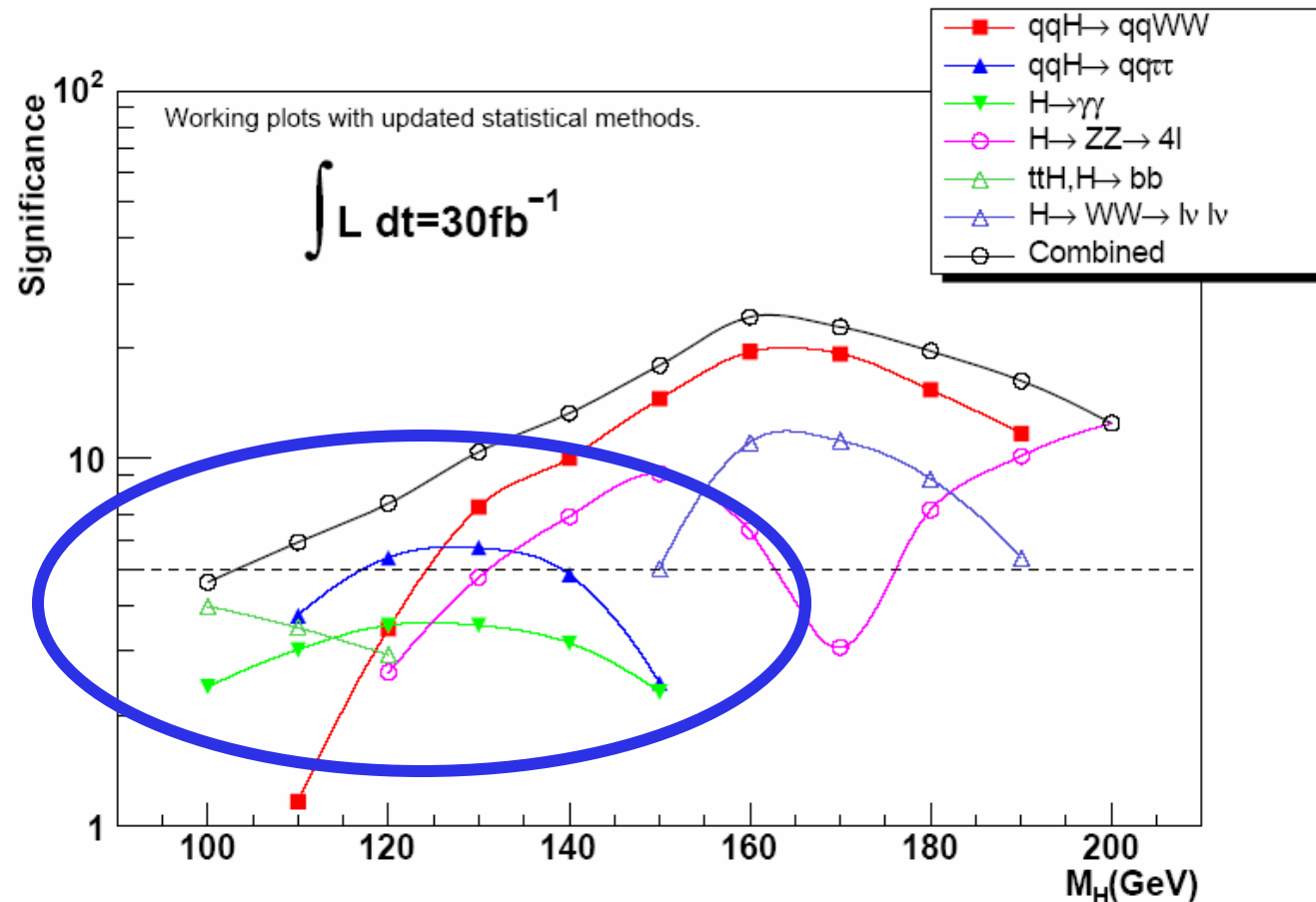


Special thanks to J.Campbell, F.Krauss and K.Ellis
TEV4LHC, Higgs Session 10/21/05

Motivation

✚ $H \rightarrow \tau\tau$ (ll + lh) + jets are fundamental for an early observation and robustness of low mass SM Higgs

➤ Addressing phenomenological and experimental issues



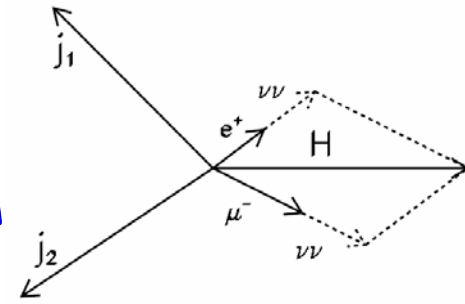
+ We are considering QCD Higher order effects on analyses with +1jet and +2jets

- NLO QCD corrections for VBF signal and Z+jets in H+2jet analysis have been considered in the past
 - ❖ We are assessing (not reported here) the impact of Z+3-4jet tree level Matrix Elements on Z+jets after applying H+2jet analysis cuts. Use ALPGEN/SHERPA
 - Address central jet veto with ALPGEN/SHERPA
- QCD Higher order corrections have not been evaluated within the $H \rightarrow \tau\tau + 1\text{jet}$ analysis neither for signal nor for the Z+jets background
 - ❖ NLO corrections are evaluated here with MCFM
 - ❖ We also address the impact of Z+2-3jet tree level ME on Z+jets using ALPGEN/SHERPA (not reported here)

$H \rightarrow \tau\tau$ Associated
with one hard jet

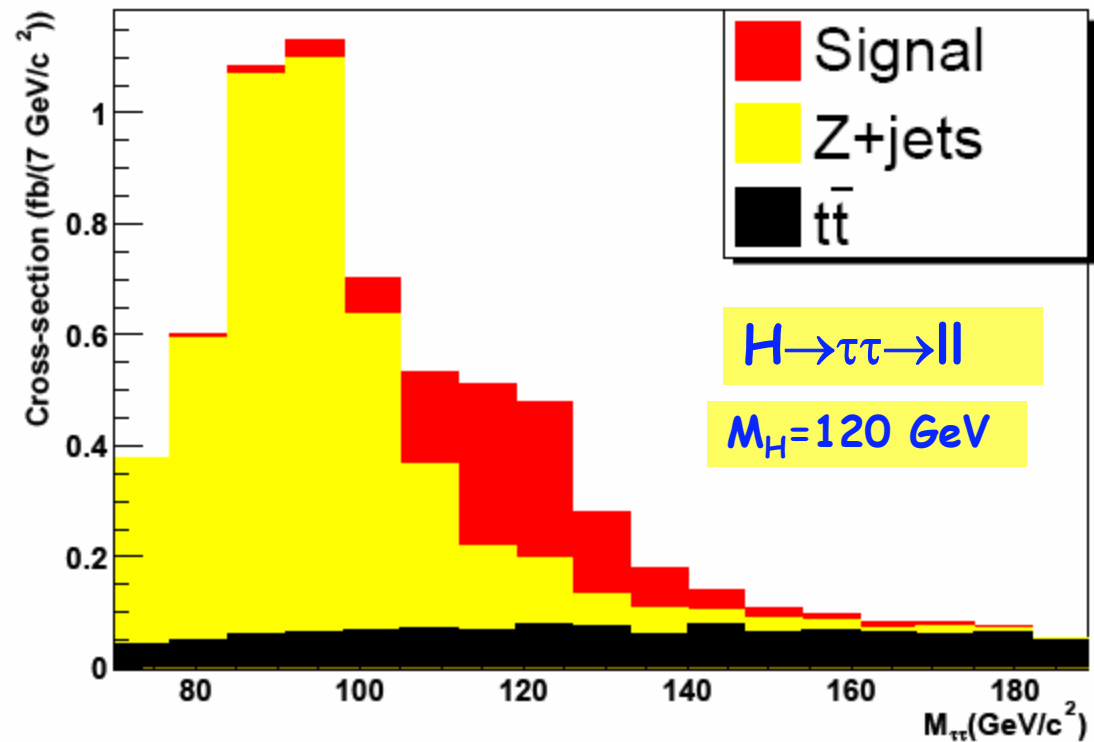
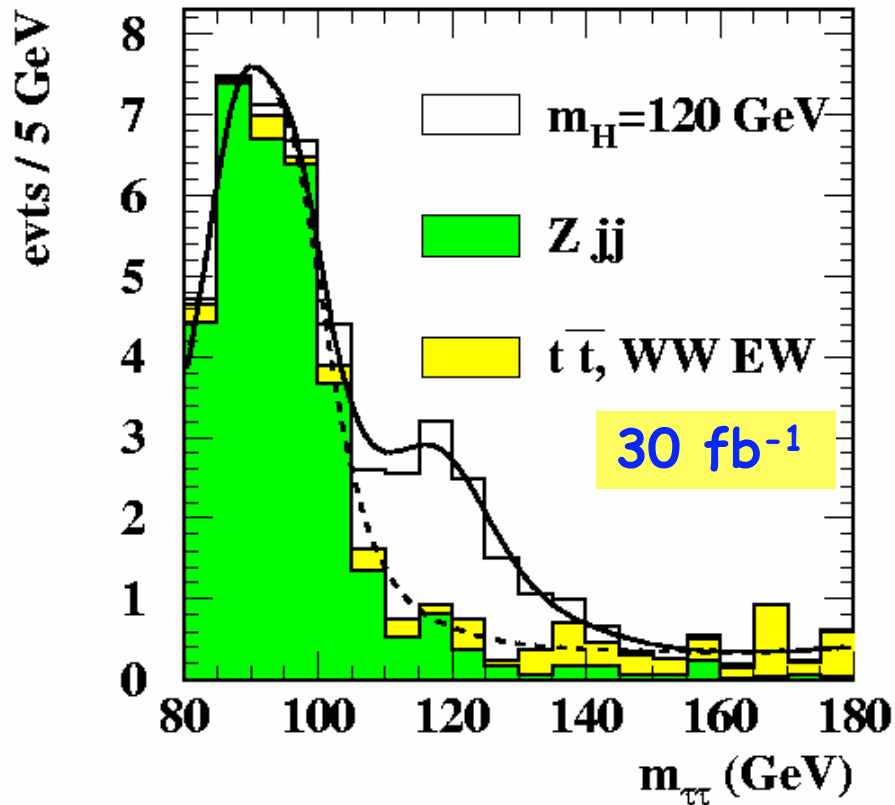
Low Mass SM $H \rightarrow \tau\tau + \text{jets}$

Reconstruct Higgs mass with collinear approximation



$H(\rightarrow \tau\tau \rightarrow 2l) + \geq 2 \text{jets (VBF)}$

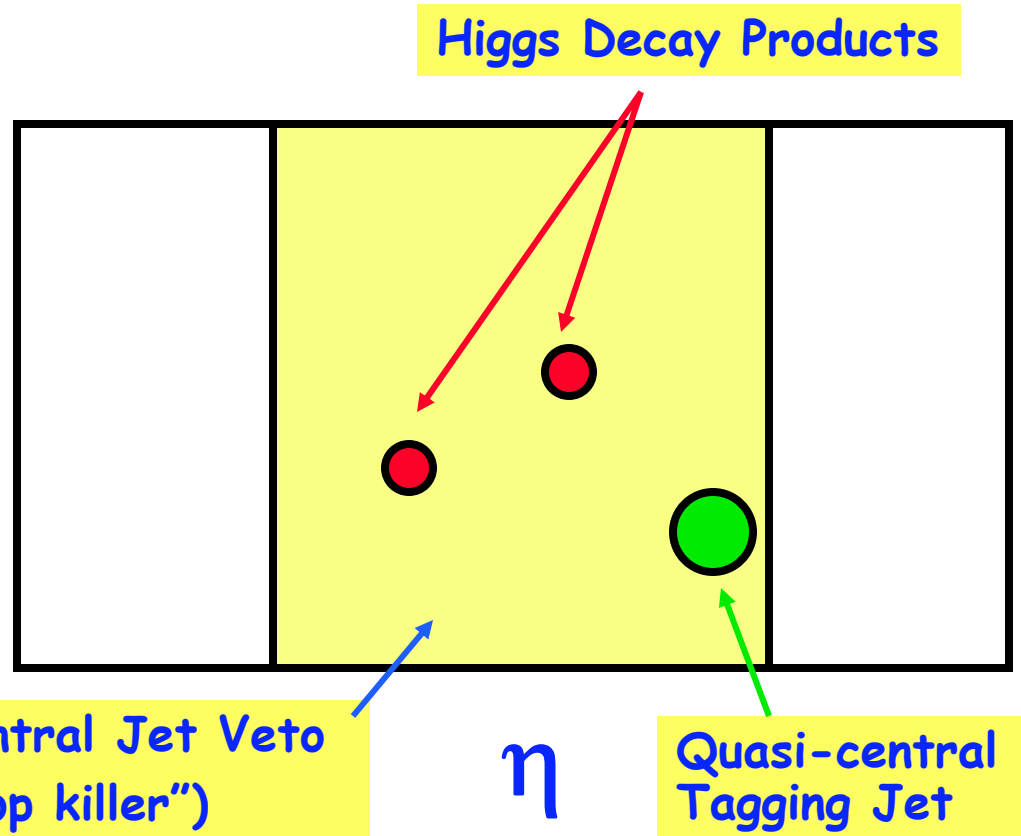
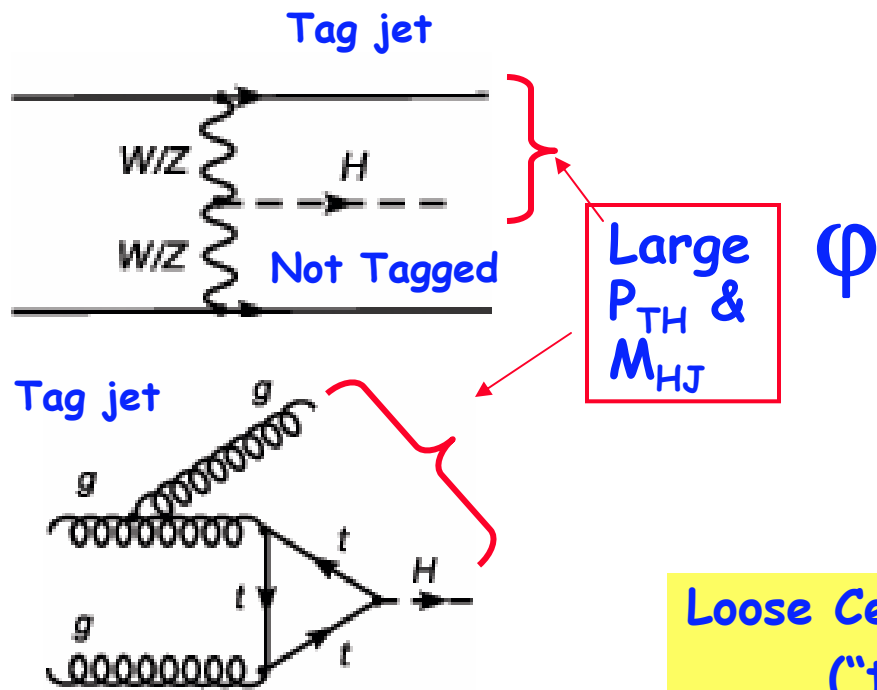
$H(\rightarrow \tau\tau \rightarrow 2l) + \geq 1 \text{jet}$



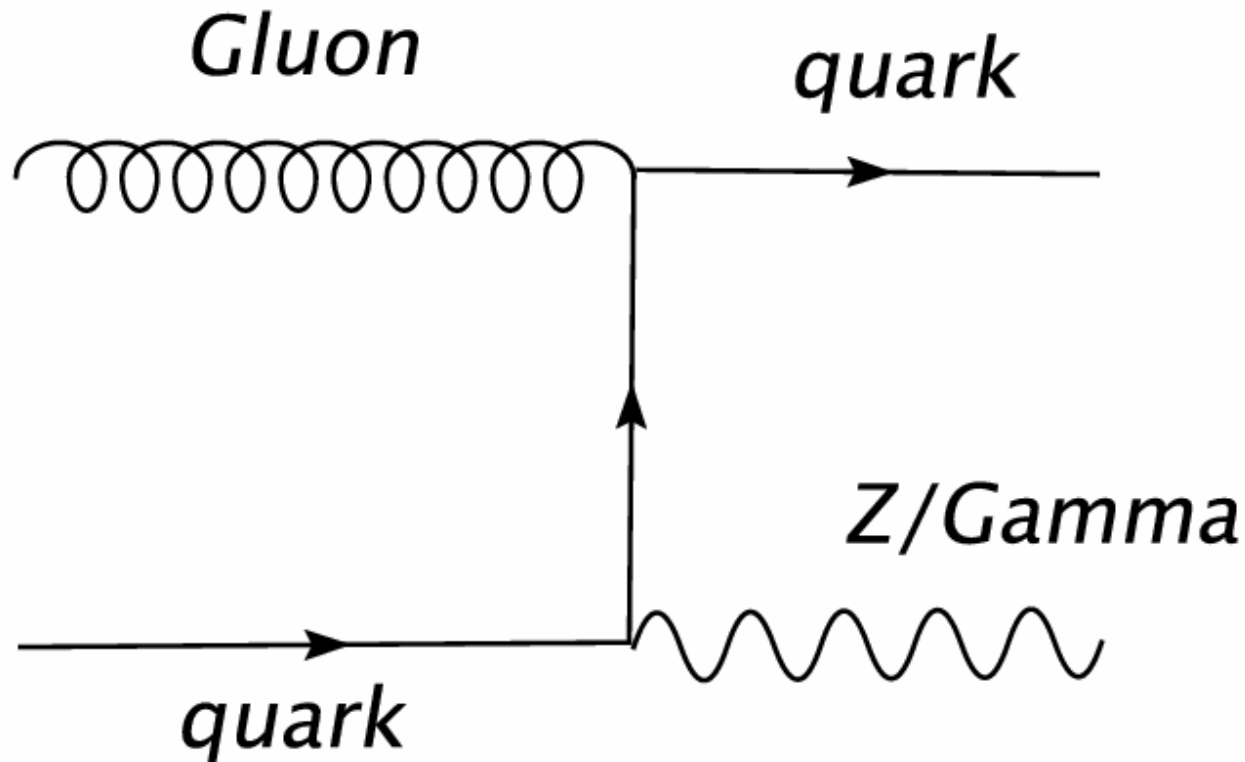
SM Higgs $\rightarrow \tau\tau + 1\text{jet}$

1. Large invariant mass of leading jet and Higgs candidate
2. Large P_T of Higgs candidate
3. Leading jet is more forward than in QCD background

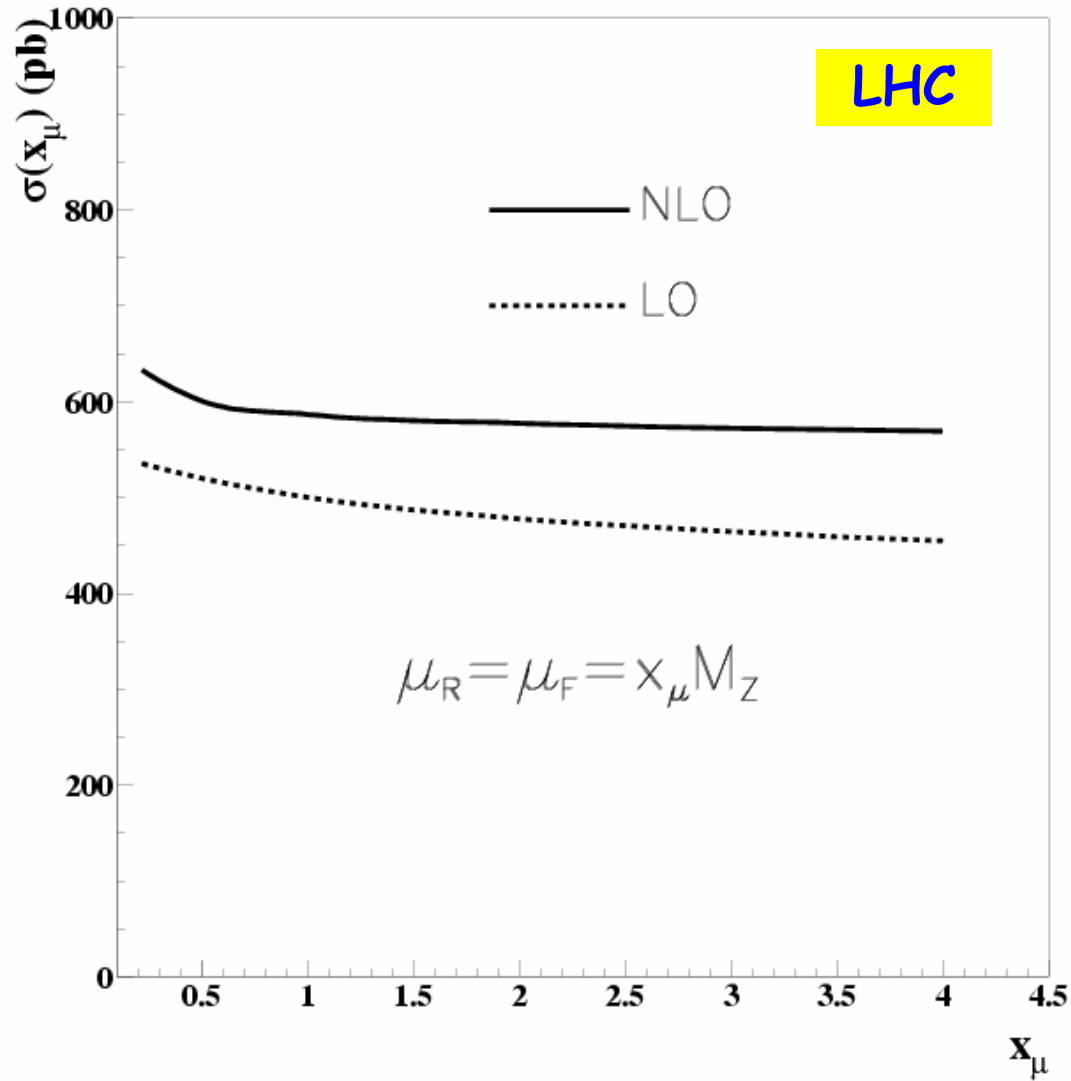
B.Mellado, W.Quayle and Sau Lan Wu
Phys.Lett.B611:60-65,2005



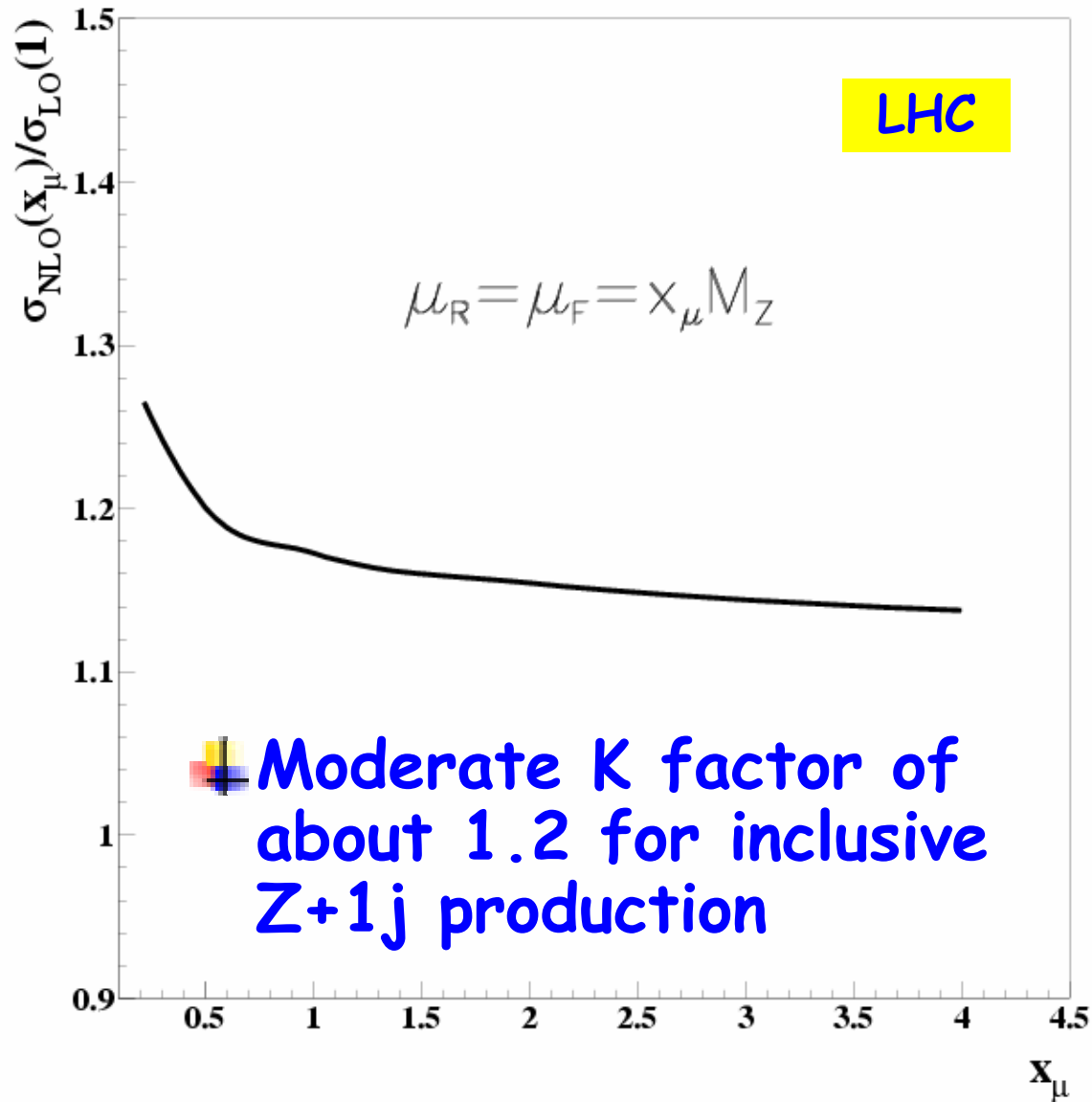
- ✚ QCD $Z+1j$ production gives about 50% of background
 - Need to evaluate role of QCD higher order corrections
 - ❖ These are not trivial due to specifics of cuts



QCD HO Corrections in QCD Z+1jet

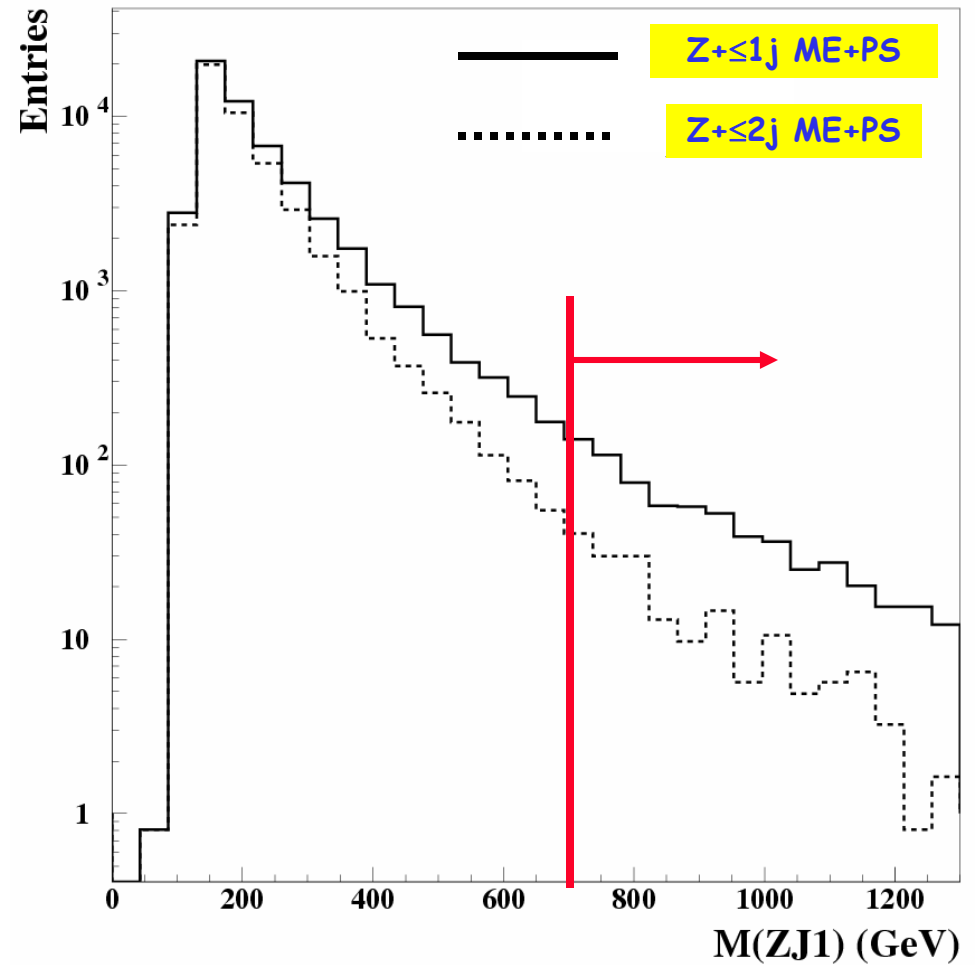
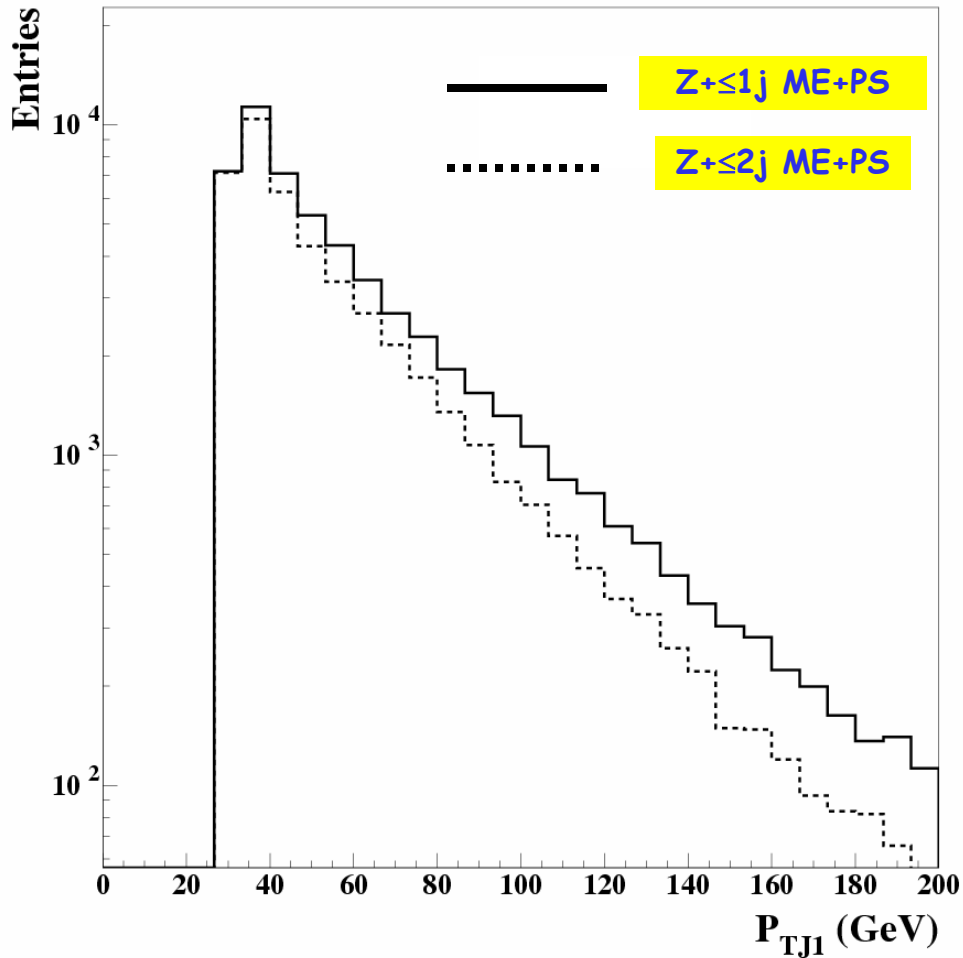


K Factor



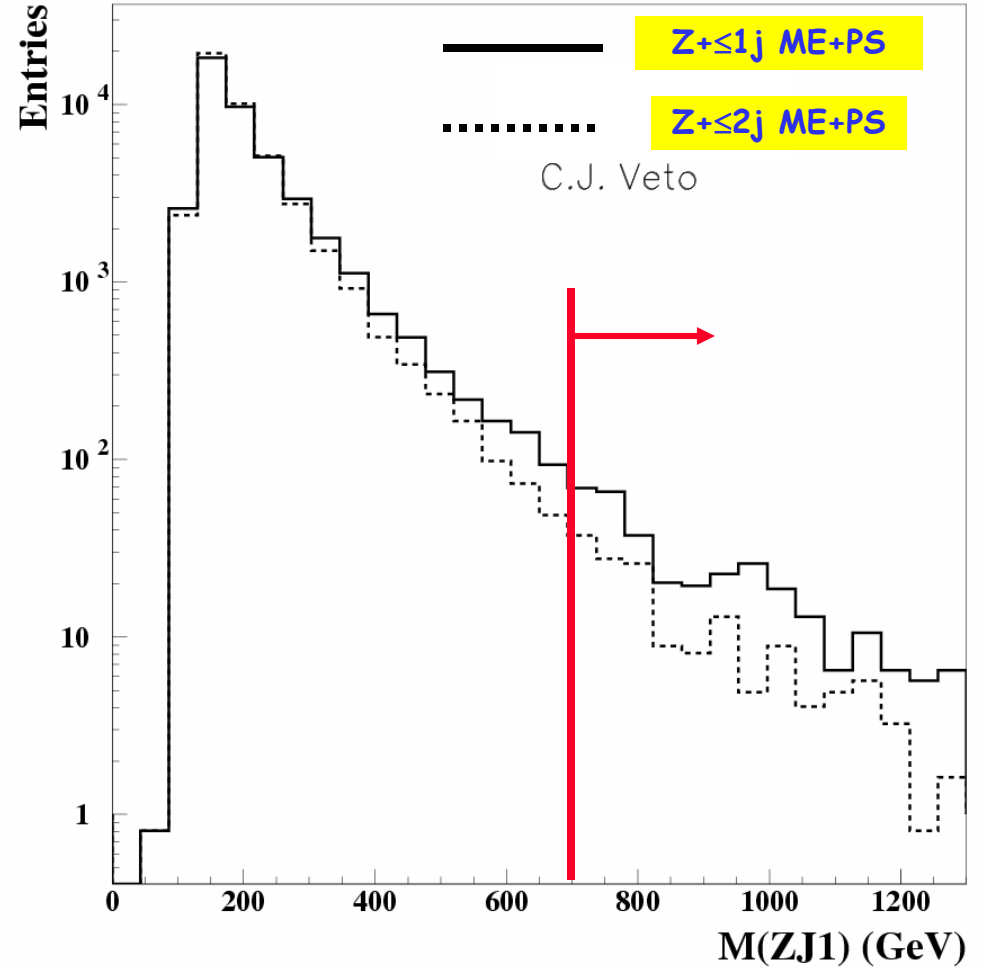
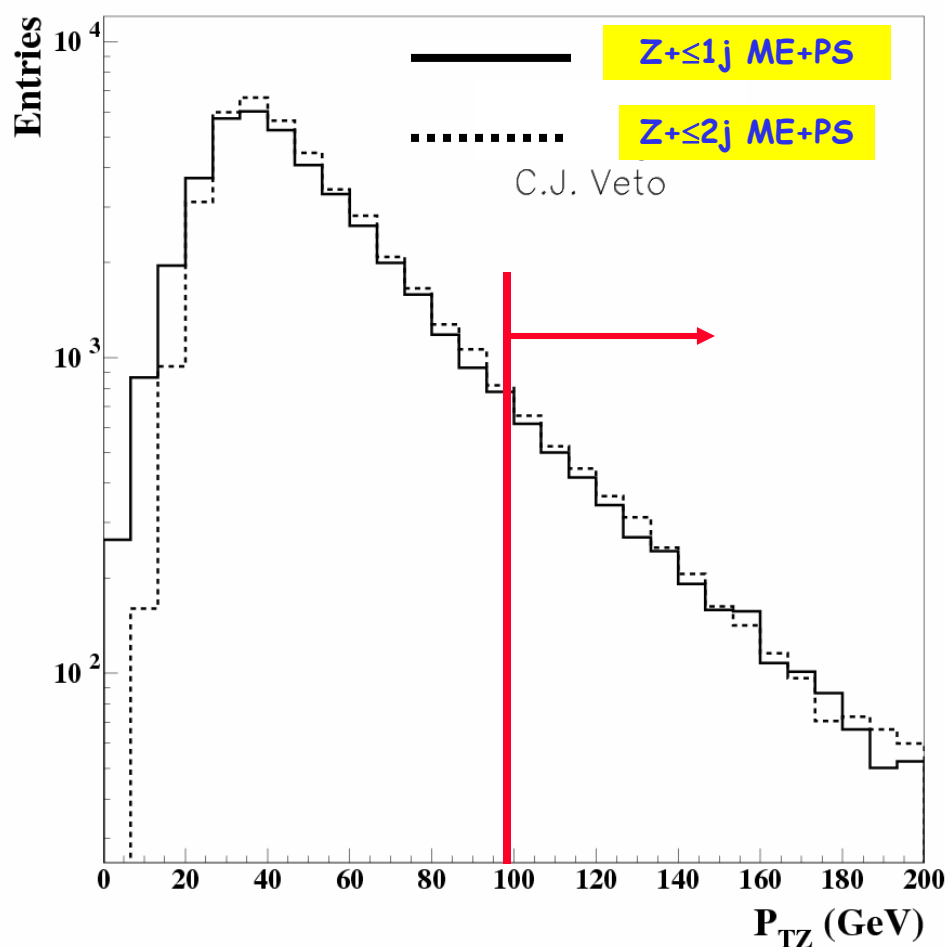
Strong effect on P_T of leading jet and the invariant mass of Z and the leading jet

Sherpa



✦ Central jet veto ("top killer", $P_{TJ} < 30\text{GeV}$) significantly reduces effect of higher order corrections

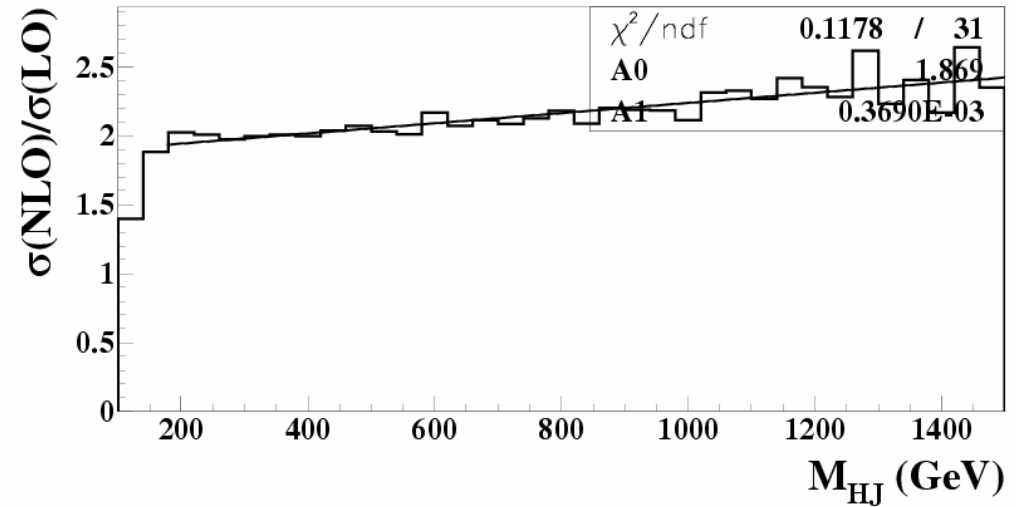
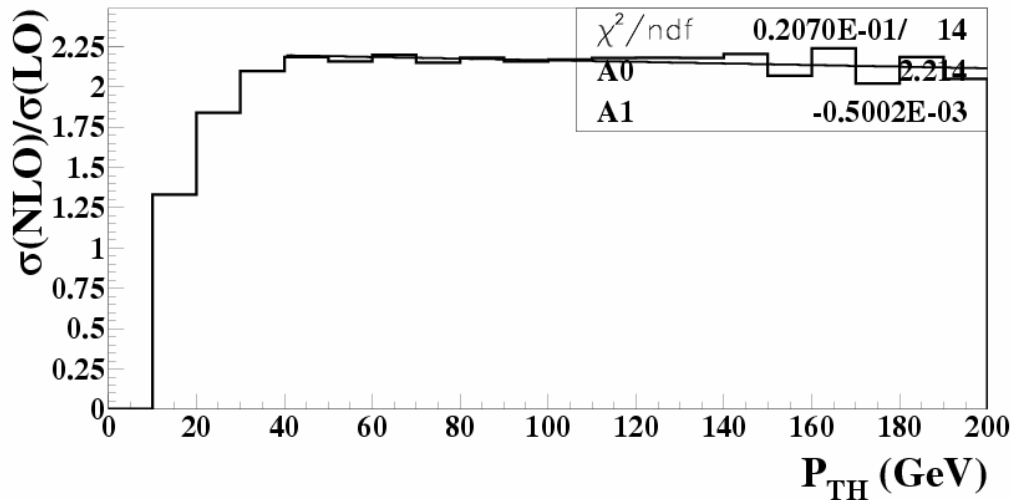
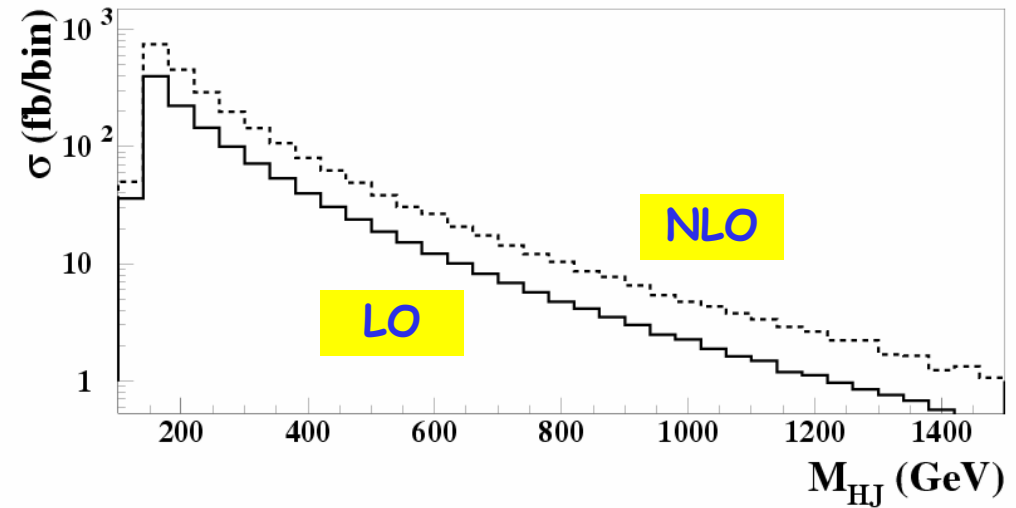
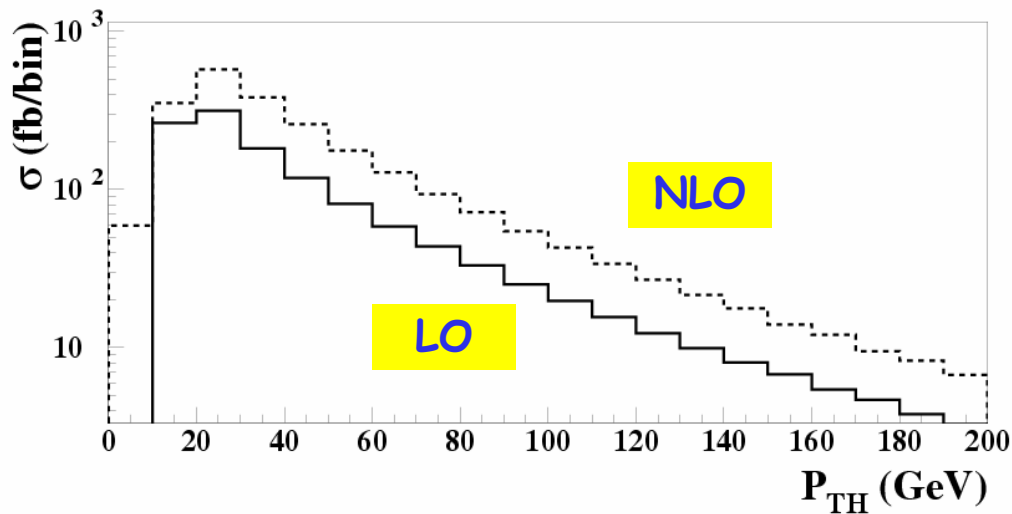
➤ With $M_{ZJ} > 700\text{ GeV}$ $Z+1j$ increases by factor of 2



QCD NLO Corrections to H+1j

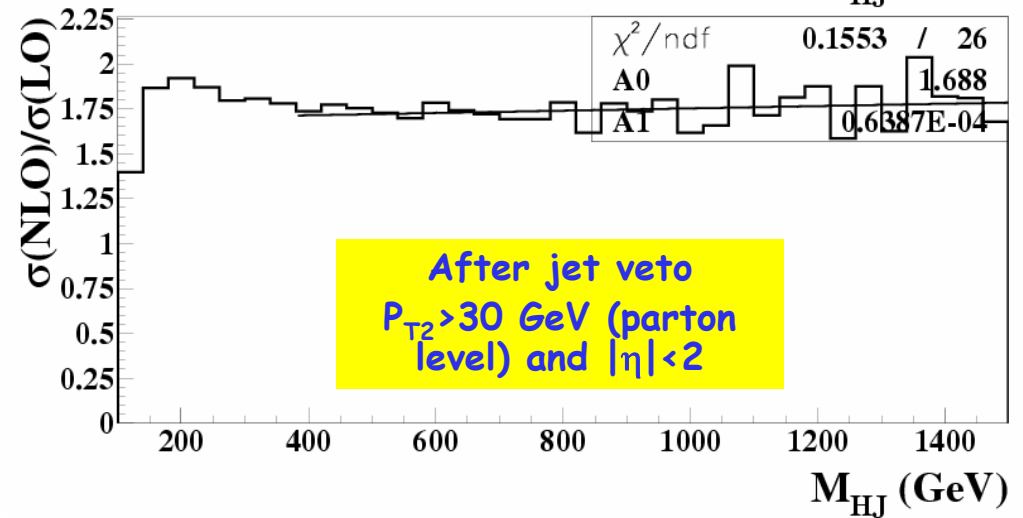
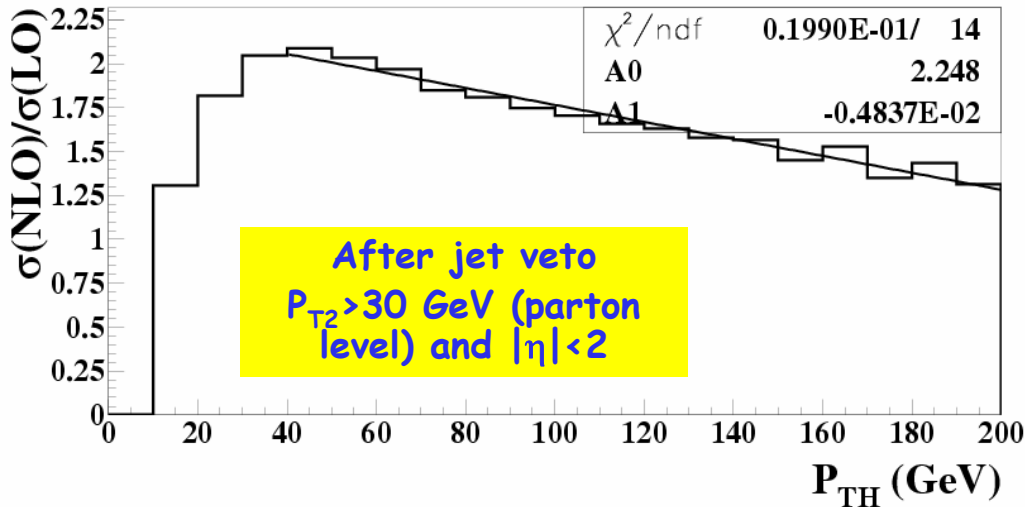
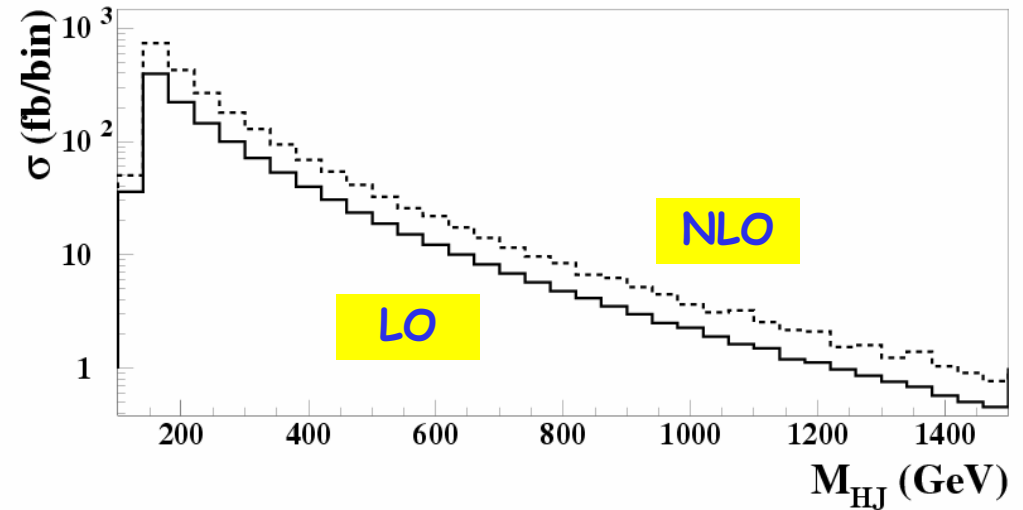
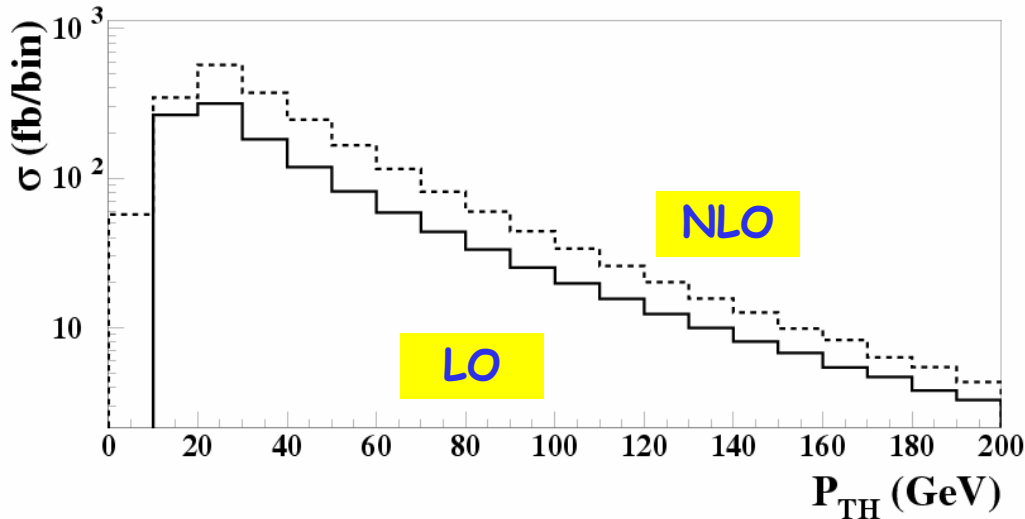
K-factors are strong for large P_{TH} and M_{HJ}

MCFM



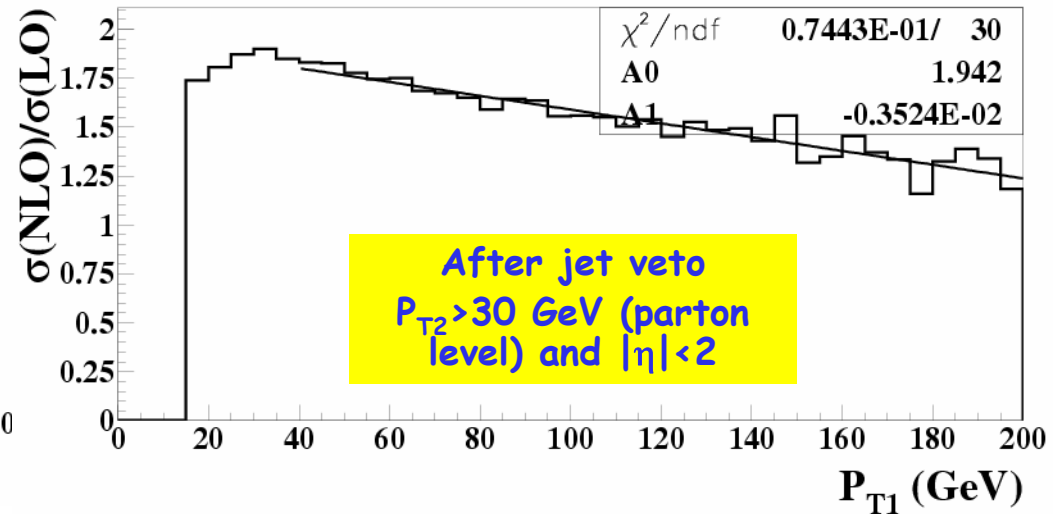
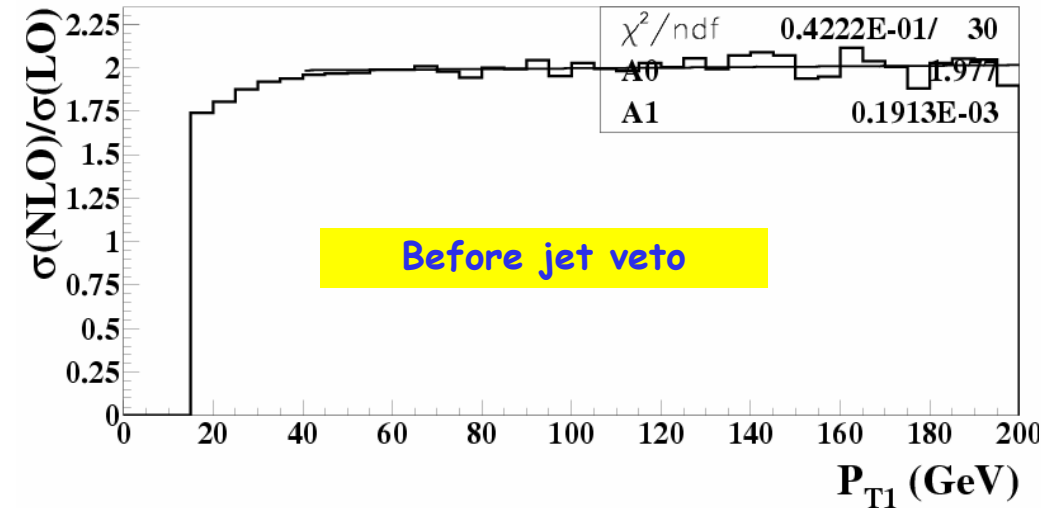
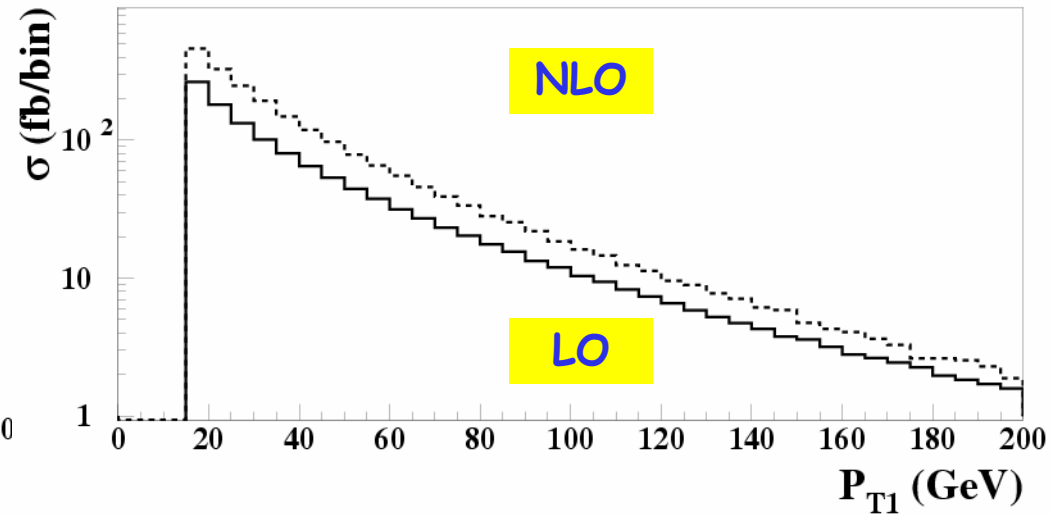
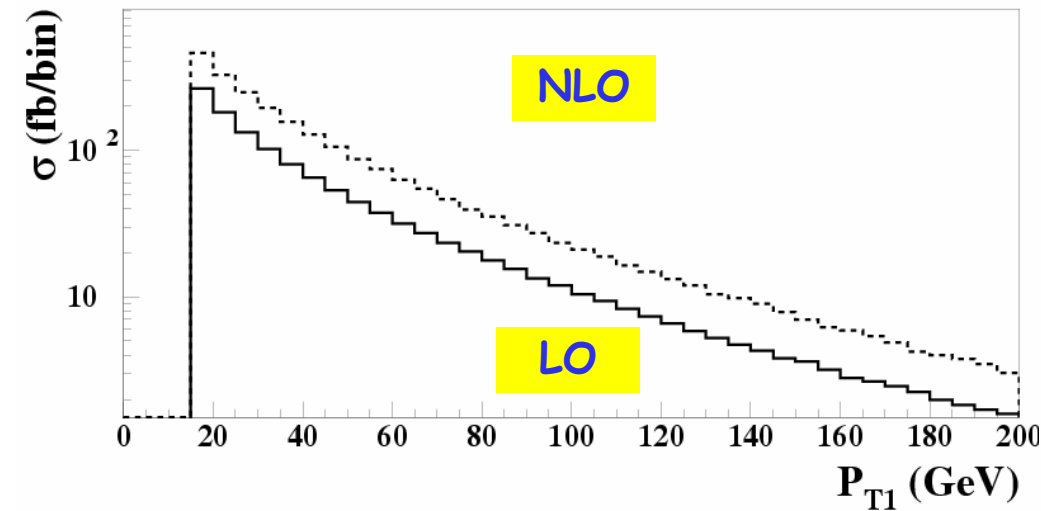
QCD NLO Corrections to H+1j

K-factors remain strong after jet veto



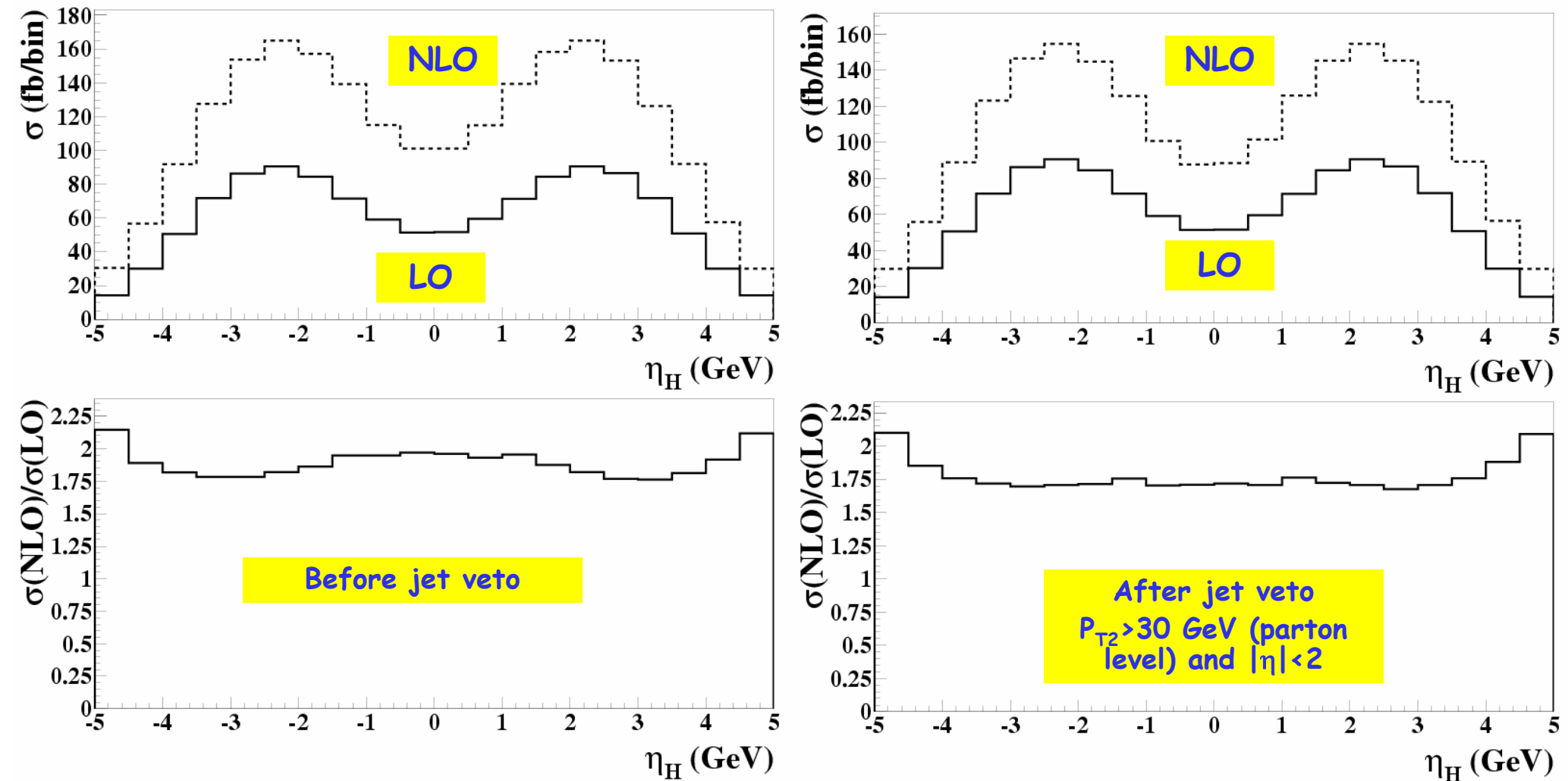
QCD NLO Corrections to H+1j

Leading jet's P_T before and after veto

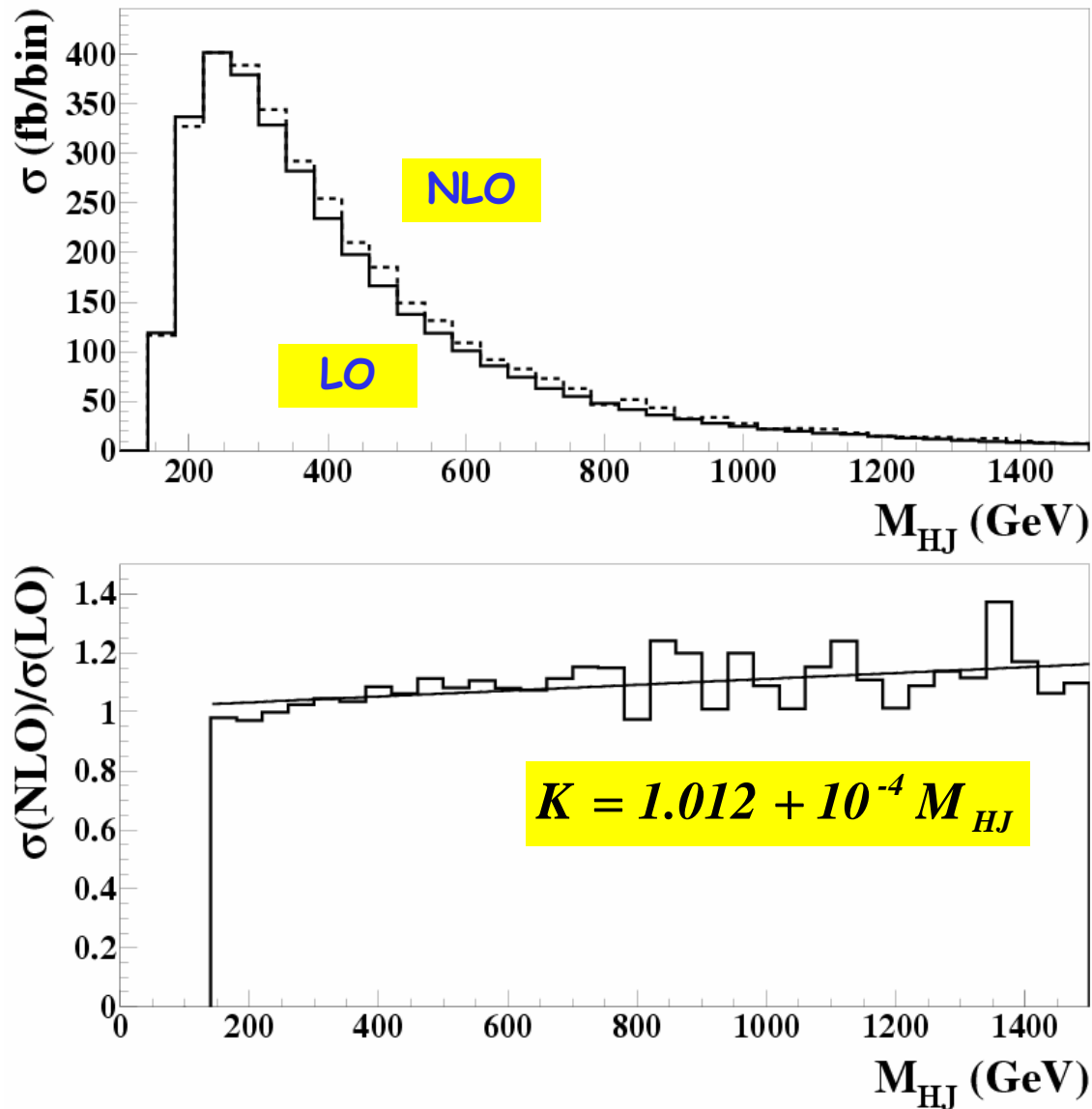


QCD NLO Corrections to H+1j

Higgs pseudorapidity before and after veto



QCD NLO Corrections to VBF H



Outlook and Conclusions

- ✦ Low mass Higgs searches with $H \rightarrow \tau\tau$ in association with high P_T jets are crucial at the LHC
- ✦ We are investigating QCD Higher order corrections to signal and background for $\tau\tau + 1\text{jet}$
- ✦ QCD HO corrections are large in the region of the phase space where the signal-to-background is optimal for searches
 - QCD $Z+1j$ is enhanced by a factor of 2
 - Signal, $H+1j$ is enhanced by a factor 1.75
 - Need to re-optimize the analysis
 - Signal significance does not decrease