

# EW corrections at 100 TeV

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QCD, EW and tools at 100 TeV

CERN, 7-9 October 2015

based on collaboration with G. Montagna, M. Moretti and O. Nicosini

# Tools and sample processes

- POWHEG: (NLO QCD + NLO EW)  $\times$  (QCD and QED) PS

L. Barzè et al., EPJC73 (2013) 6, 2474; arXiv:1302.4606

- ALPGEN: LO matrix elements with EW Sudakov corrections

M. Chiesa et al., PRL 111 (2013) 121801; arXiv:1305.6837

- HAWK: NLO QCD + NLO EW

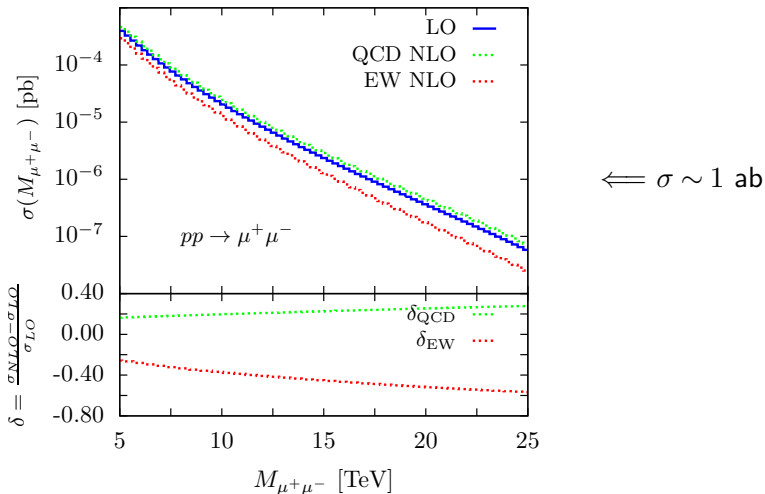
A. Denner et al., CPC 195 (2015) 161; arXiv:1412.5390

- neutral DY (POWHEG)
- $V + \text{jets}$  ( $V = \gamma, W, Z$ ) (ALPGEN)
- $WH, ZH$  (ALPGEN, HAWK)
- dijet production (ALPGEN)
- $t\bar{t} + \text{jets}$  (ALPGEN)

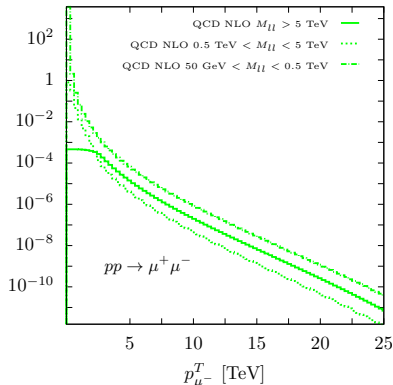
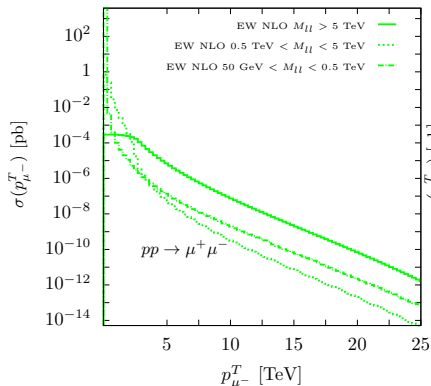
Most of the following results obtained during last few days:  
**VERY PRELIMINARY!**

# N.C. DY@NLO at $\sqrt{s} = 100$ TeV (POWHEG)

$$p_{\perp}^{\mu} > 25 \text{ GeV}, |\eta^{\mu}| < 2.5, M_{\mu^{+}\mu^{-}} > 5 \text{ TeV}$$



$$M_{\mu^+\mu^-} > 50 \text{ GeV}$$

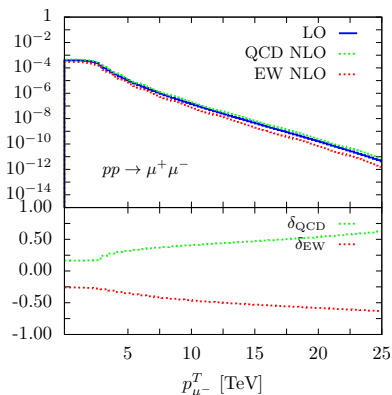
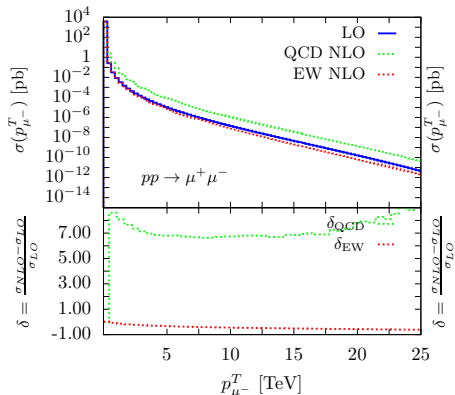


- EW corrected predictions dominated by the off-shell region (same as for tree-level predictions)
- QCD predictions dominated by “on-shell” production

# NLO EW/QCD effects on $p_{\perp}^{\mu}$

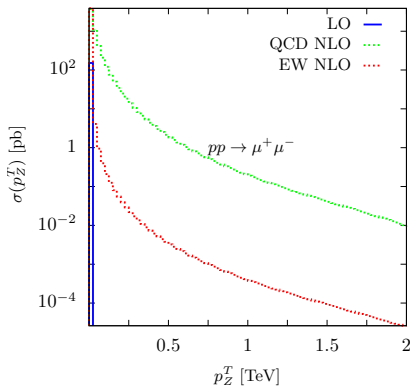
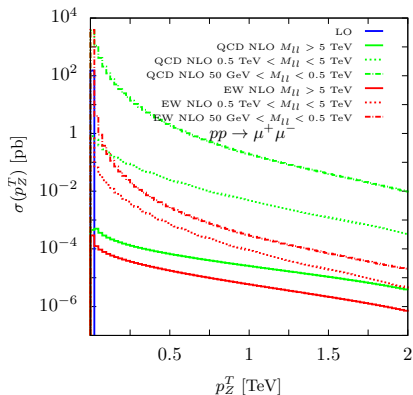
$M_{\mu+\mu^-} > 50 \text{ GeV}$

$M_{\mu+\mu^-} > 5 \text{ TeV}$



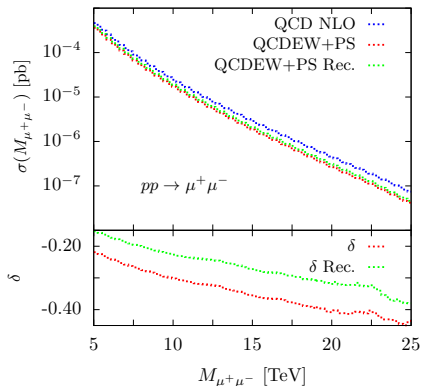
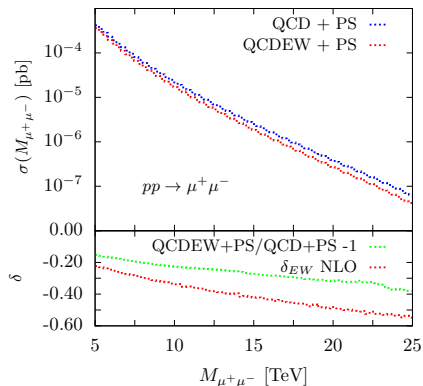
- huge “on-shell” QCD contribution to the lepton  $p_{\perp}$

# NLO EW/QCD effects on $p_{\perp}^{\mu^+ \mu^-}$



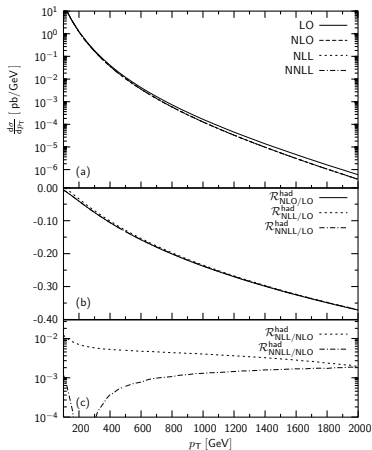
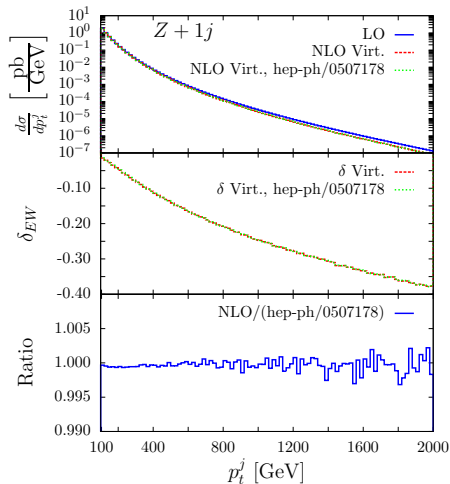
■ huge “on-shell” QCD contribution to the  $\mu^+ \mu^-$  pair  $p_{\perp}$

# Showering effects on top of NLO: $M_{\mu^+\mu^-}$



- QCD + PS  $\equiv$  NLO QCD matched to PYTHIA8 (QCD/QED showering)
- QCDEW + PS  $\equiv$  NLO EW+QCD matched to PYTHIA8 (QCD/QED showering)
- QCDEW + PS  $\equiv$  NLO EW+QCD matched to PYTHIA8 (QCD/QED showering)
- Rec.: photons are recombined with the lepton if  $\Delta R_{\mu\gamma} < 0.7$

# Z + 1jet at 14 TeV (ALPGEN vs NLO calculation)

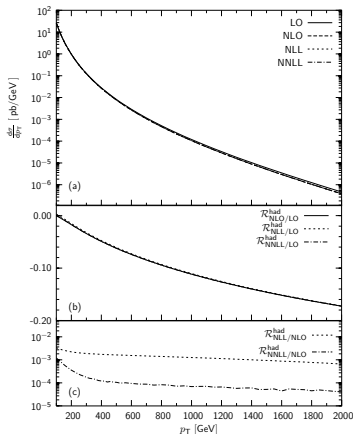
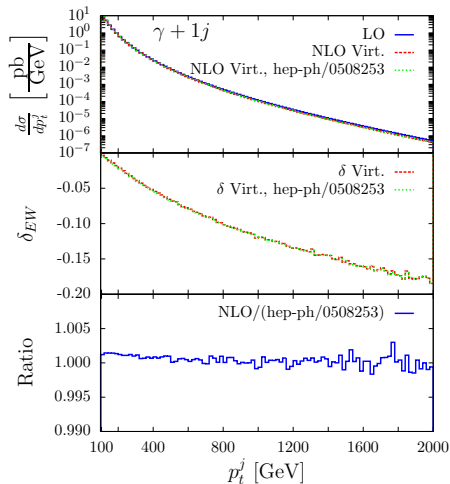


J.H. Kuhn et al.

Nucl.Phys. **B727** (2005), hep-ph/0507178



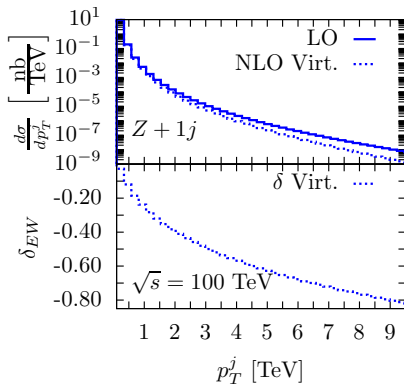
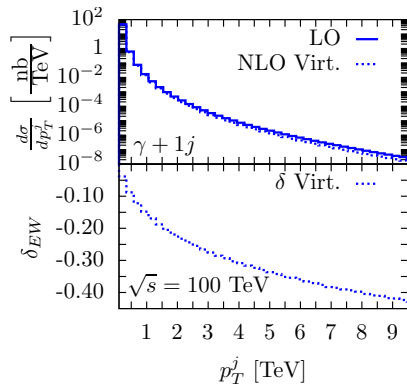
# $\gamma + 1\text{jet}$ 14 TeV (ALPGEN vs NLO calculation)



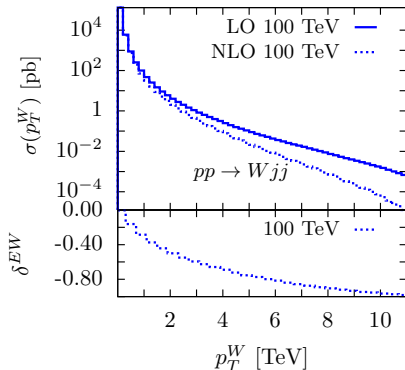
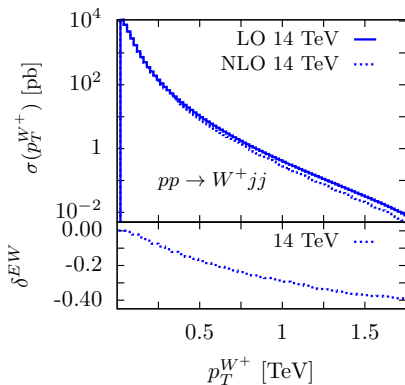
J.H. Kuhn et al.

JHEP **0603** (2006) hep-ph/0508253

# $Z/\gamma + \text{jet}$ at 100 TeV (ALPGEN)



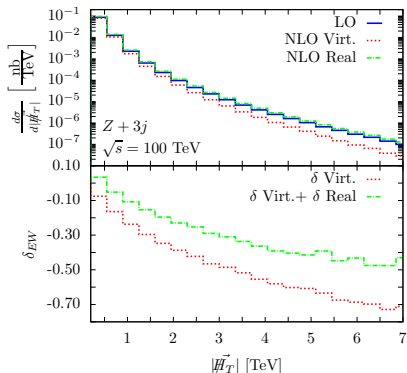
# $W + 2$ jet at 100 TeV (ALPGEN)



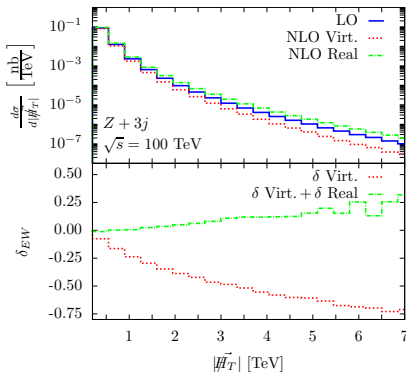
$$p_{\perp}^j > 20 \text{ GeV}, \quad -4 < |\eta^j| < 4, \quad \Delta R > 0.4$$

# $Z(\rightarrow \nu\bar{\nu}) + 3 \text{ jet at } 100 \text{ TeV (ALPGEN)}$

Real with cuts

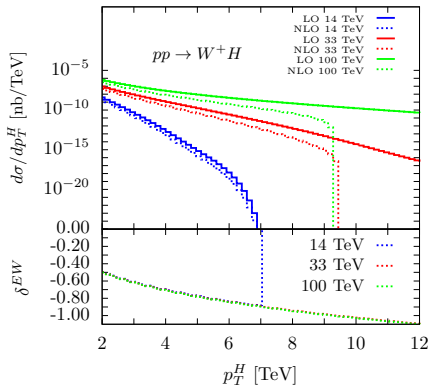
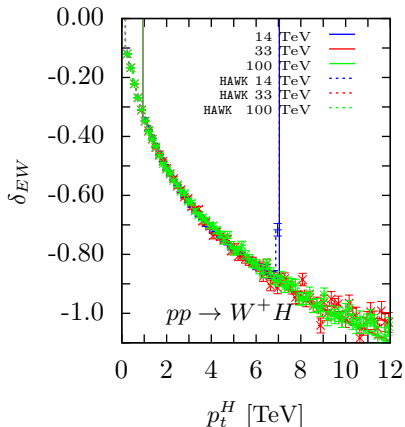


Real without cuts



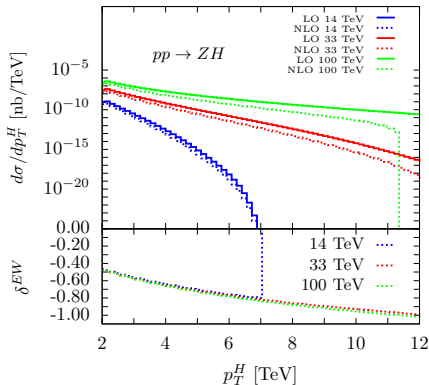
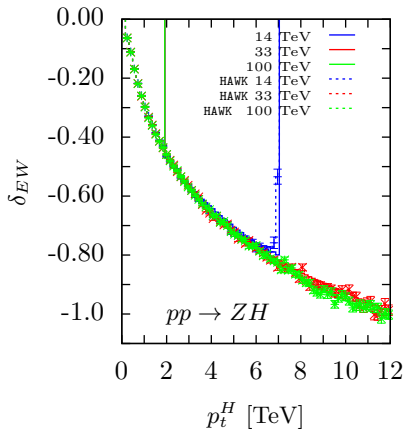
$$\begin{aligned}
 H_T &> 500 \text{ GeV} & |\vec{H}_T| &> 200 \text{ GeV} \\
 p_T^j &> 50 \text{ GeV} & |\eta_j| &< 2.5 & \Delta R_{(j_i, j_k)} &> 0.5 \\
 \Delta\phi(\vec{p}_T^{j1, j2}, \vec{H}_T) &> 0.5 & \Delta\phi(\vec{p}_T^{j3}, \vec{H}_T) &> 0.3
 \end{aligned}$$

# EW corrections to $p_t^H$ in $pp \rightarrow WH$ (ALPGEN vs HAWK)



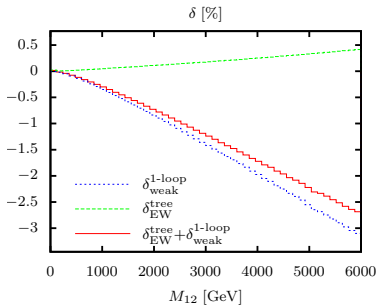
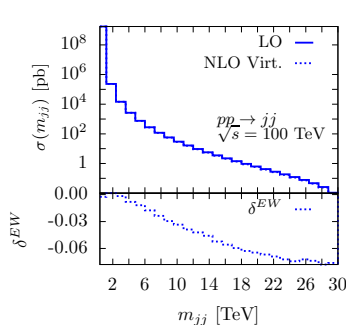
- Tuned comparison
- Sudakov approximation compares well to the full EW NLO
- 100% NLO corrections at  $p_t^H \sim 10$  TeV, independently of the collider energy

# EW corrections to $p_t^H$ in $pp \rightarrow ZH$ (ALPGEN vs HAWK)



- Very similar to the  $pp \rightarrow WH$  case

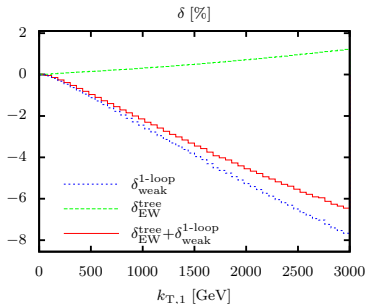
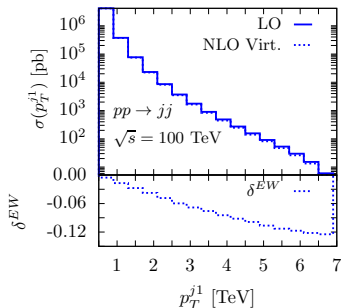
# EW corrections to dijet production (ALPGEN)



Kalanand Mishra et al., arXiv:1308:14430

- not a tuned comparison
- small logarithmic corrections, expected large relative deviations w.r.t. complete NLO calculation

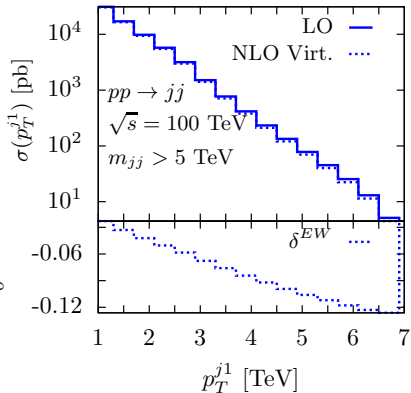
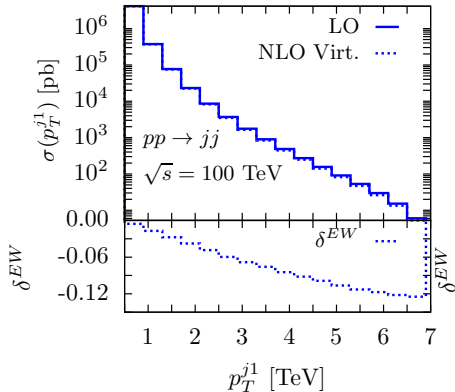
# EW corrections to dijet production (ALPGEN)



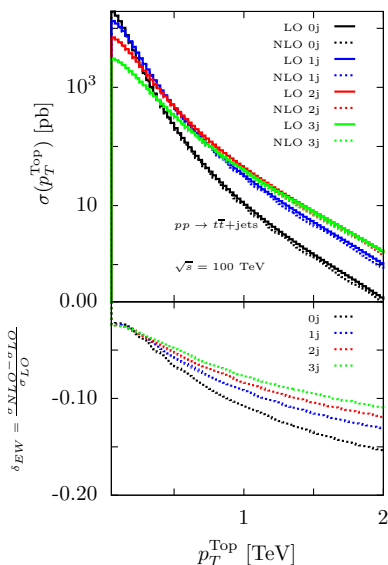
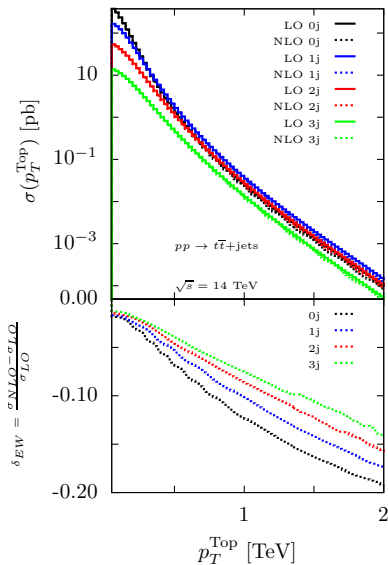
Kalanand Mishra et al., arXiv:1308:14430



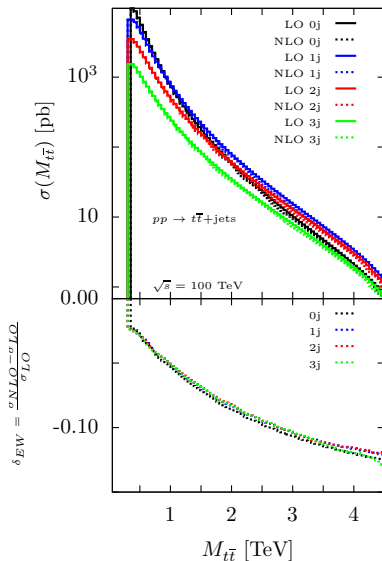
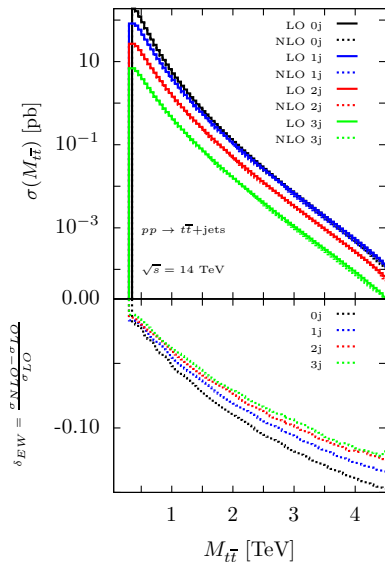
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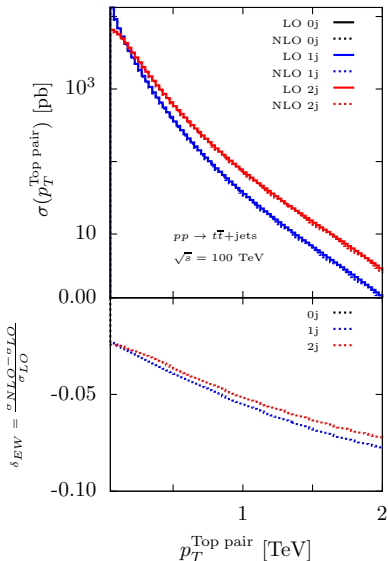
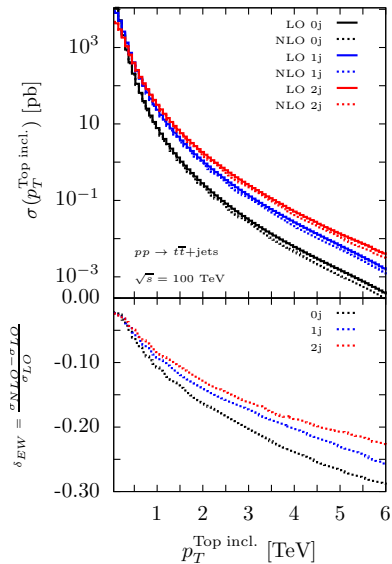
# EW corrections to $t\bar{t}$ + jets production (ALPGEN)



# EW corrections to $t\bar{t}$ + jets production (ALPGEN)



# EW corrections to $t\bar{t}$ + jets production (ALPGEN)



- very preliminary numerical results for few selected processes
- could be completed in more detail for the report
- suggestions/comments welcome