$t\bar{t}b\bar{b}$ hadroproduction at NLO accuracy matched with parton shower

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MAGYARORSZÁG MEGÚJUL

A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.

ÚJ SZÉCHENYI TERV

Outline

- Motivation
- Method
- Comparison to NLO
- Predictions
- Conclusions

Motivation

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- In this work we neglect the mass of the b-quarks

Method

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RESULT:

Les Houches file of Born and Born+1st radiation events (LHE) ready for processing with SMC followed by almost arbitrary experimental analysis

Comparison to NLO

Selection cuts in NLO studies

- A track was considered as a possible jet constituent if $|\eta^{track}|<5$, t-quarks were excluded from the set of possible tracks, jets were reconstructed with the k_T-algorithm using R=0.4

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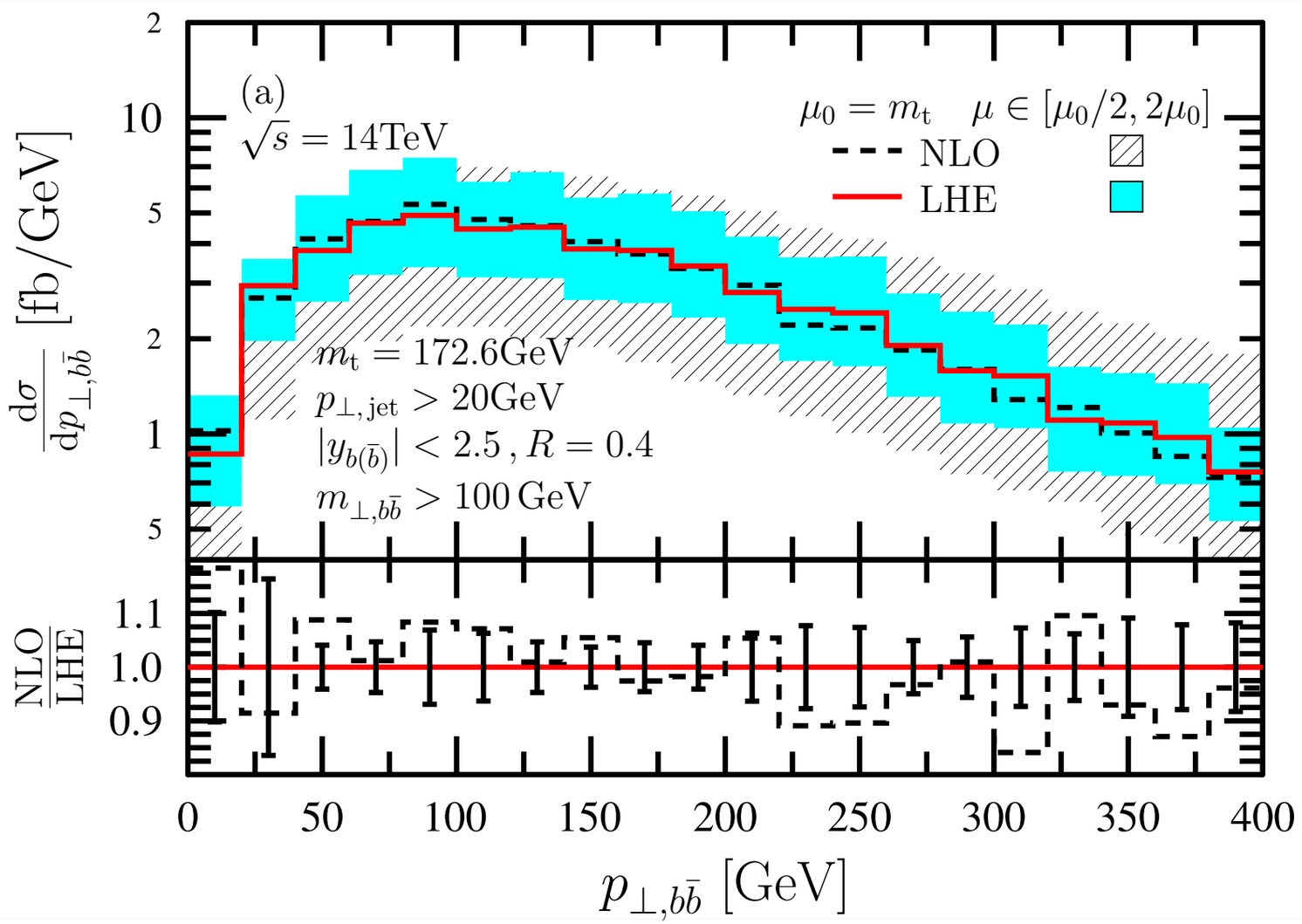
- We require $p_{Tmin,j}$ = 20 GeV and
- at least two, one b- and one $\bar{b}$-jet, with $|y_{b(\bar{b})}|<2.5$

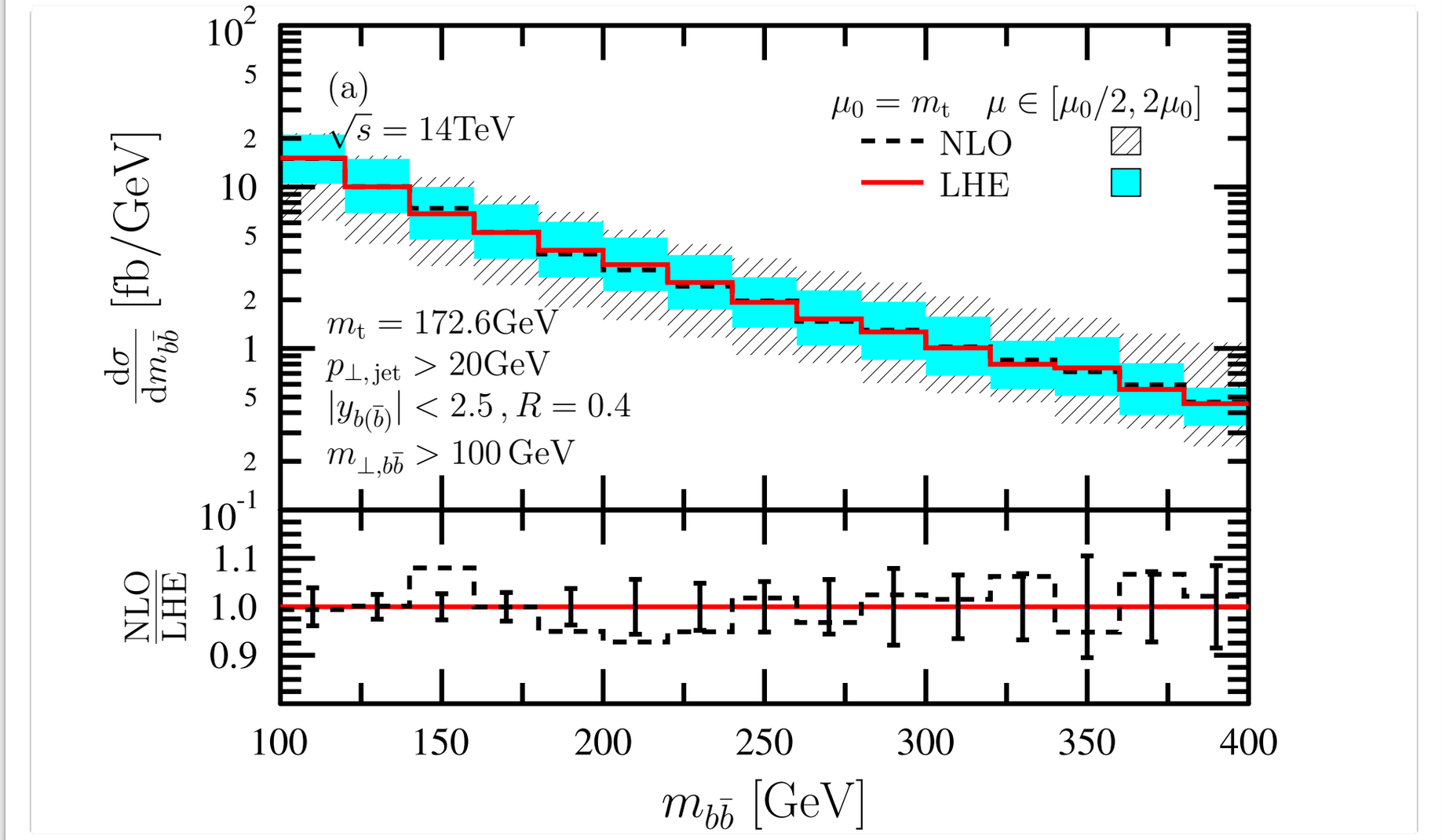
POWHEG vs. NLO



Distribution of the transverse momentum of the $b\bar{b}$ jet pair in $pp \to t\bar{t}\, b\bar{b}$ at LHC (14 TeV)

Our NLO agrees with Bevilacqua et al [0907.4723]

POWHEG vs. NLO



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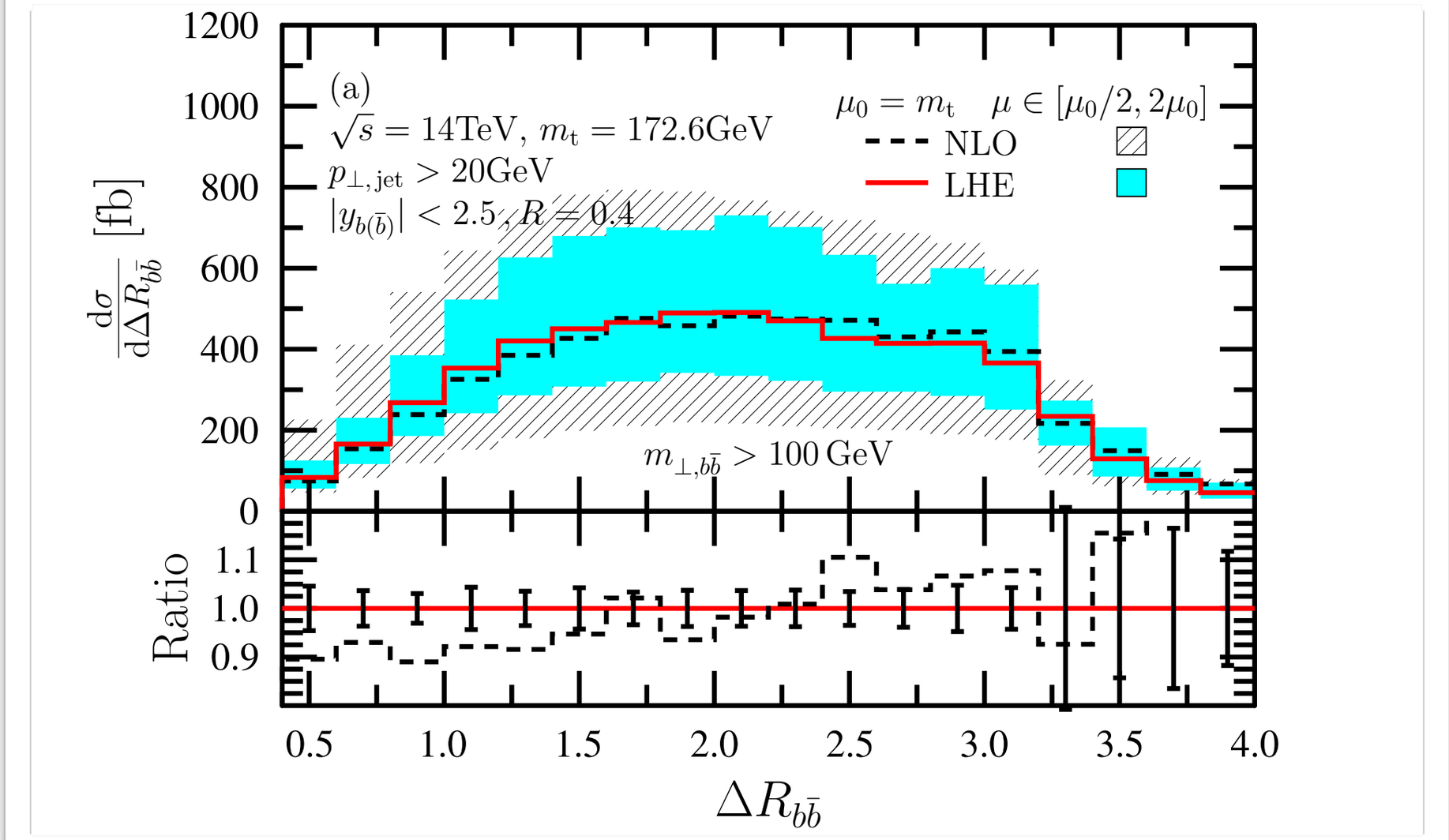
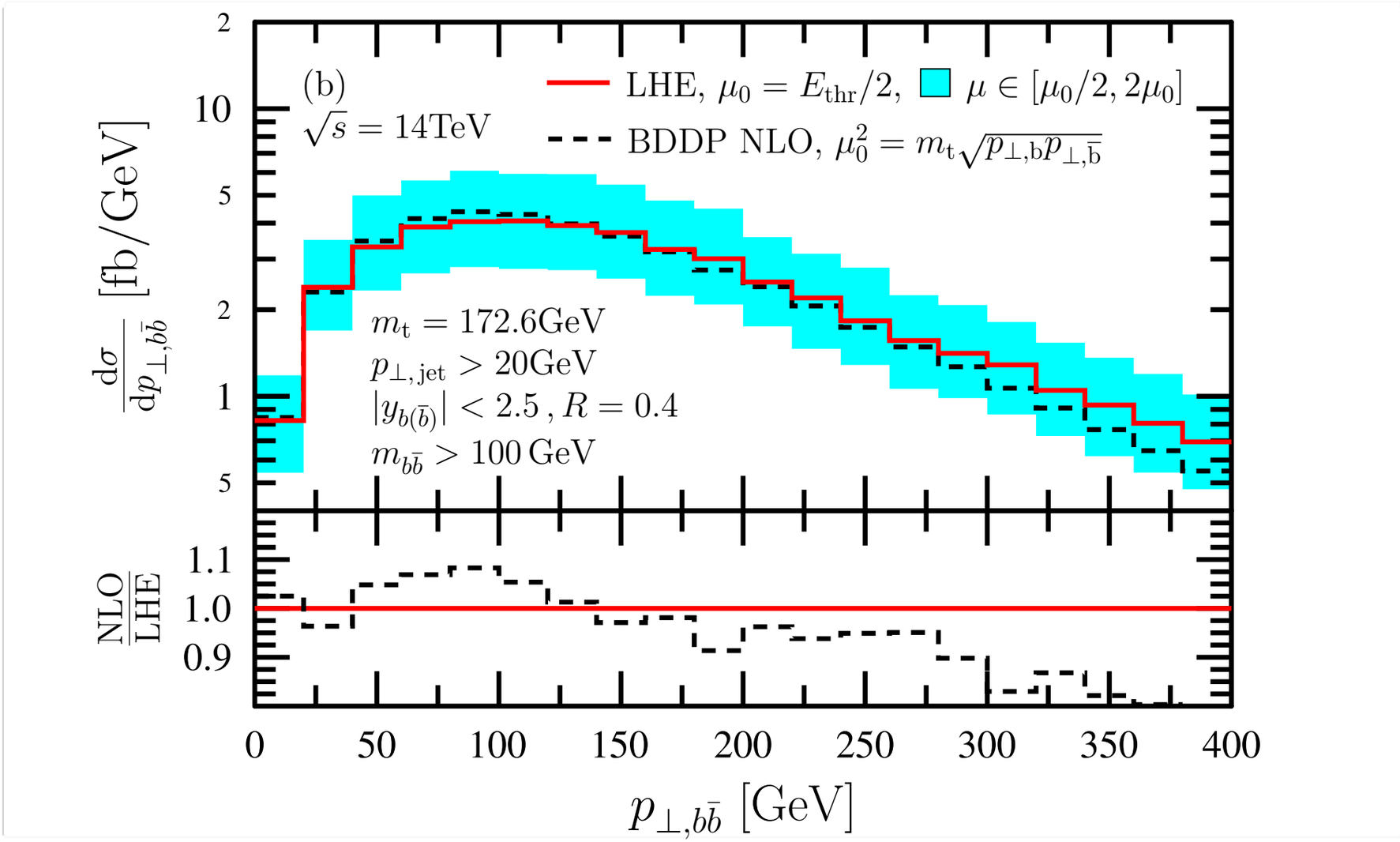


Separation in rapidity-azimuthal angle plane of the $b\bar{b}$ jet pair in $pp \to t\bar{t}\, b\bar{b}$ at LHC (14 TeV)

POWHEG fixed vs. NLO w. dynamical scale



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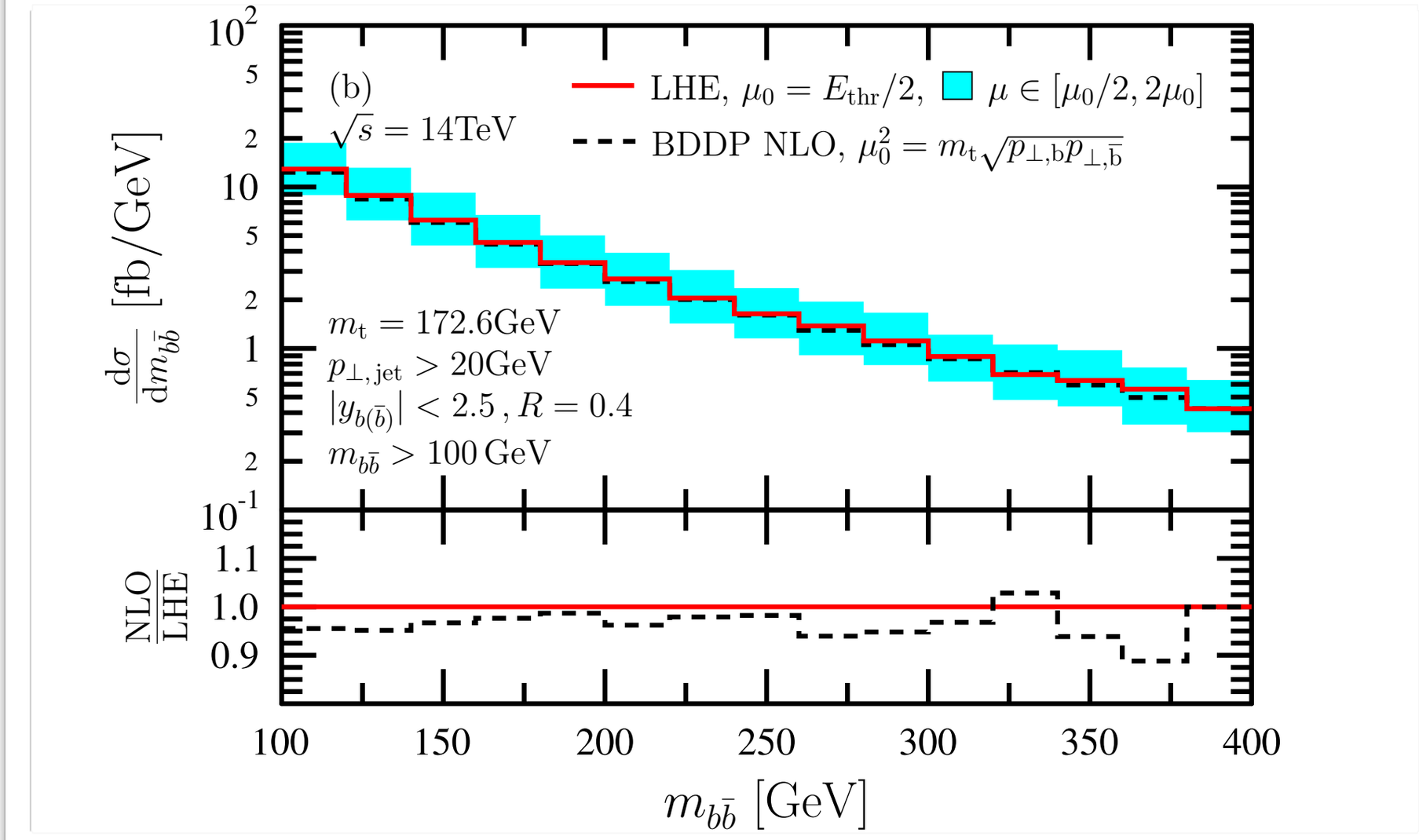
NLO with dynamical scale by Bredenstein et al [1001.4006]

POWHEG fixed scale vs. NLO dynamical scale



Distribution of the invariant mass of the $b\bar{b}$ jet pair in $pp \to t\bar{t}\, b\bar{b}$ at LHC (14 TeV)

Message:

we can trust the LHE's, so can make

Predictions

Four possible forms of predictions

LHE: distributions from events at BORN+1st radiation

Decay: on-shell decays of heavy particles (t-quarks), shower and hadronization effects turned off

PS: decays, parton showering (PYTHIA or HERWIG) included

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Number and type of particles are very different =>
to study the effect of SMC we employ selection cuts
to keep the cross section fixed

Selection cuts for decay vs. SMC

- Applied on the LHE's:
  - A track was considered as a possible jet constituent if $|\eta^{track}|<5$, t-quarks were excluded from the set of possible tracks. Jets were reconstructed with the k_T-algorithm using R=0.4.

Selection cuts for decay vs. SMC

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  - A track was considered as a possible jet constituent if $|\eta^{track}|<5$, t-quarks were excluded from the set of possible tracks. Jets were reconstructed with the k_T-algorithm using R=0.4.
  - Events with invariant mass of the bb-jet pair below $m^{min}_{b\bar{b}} = 100$ GeV were discarded.

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- Applied on the LHE's:
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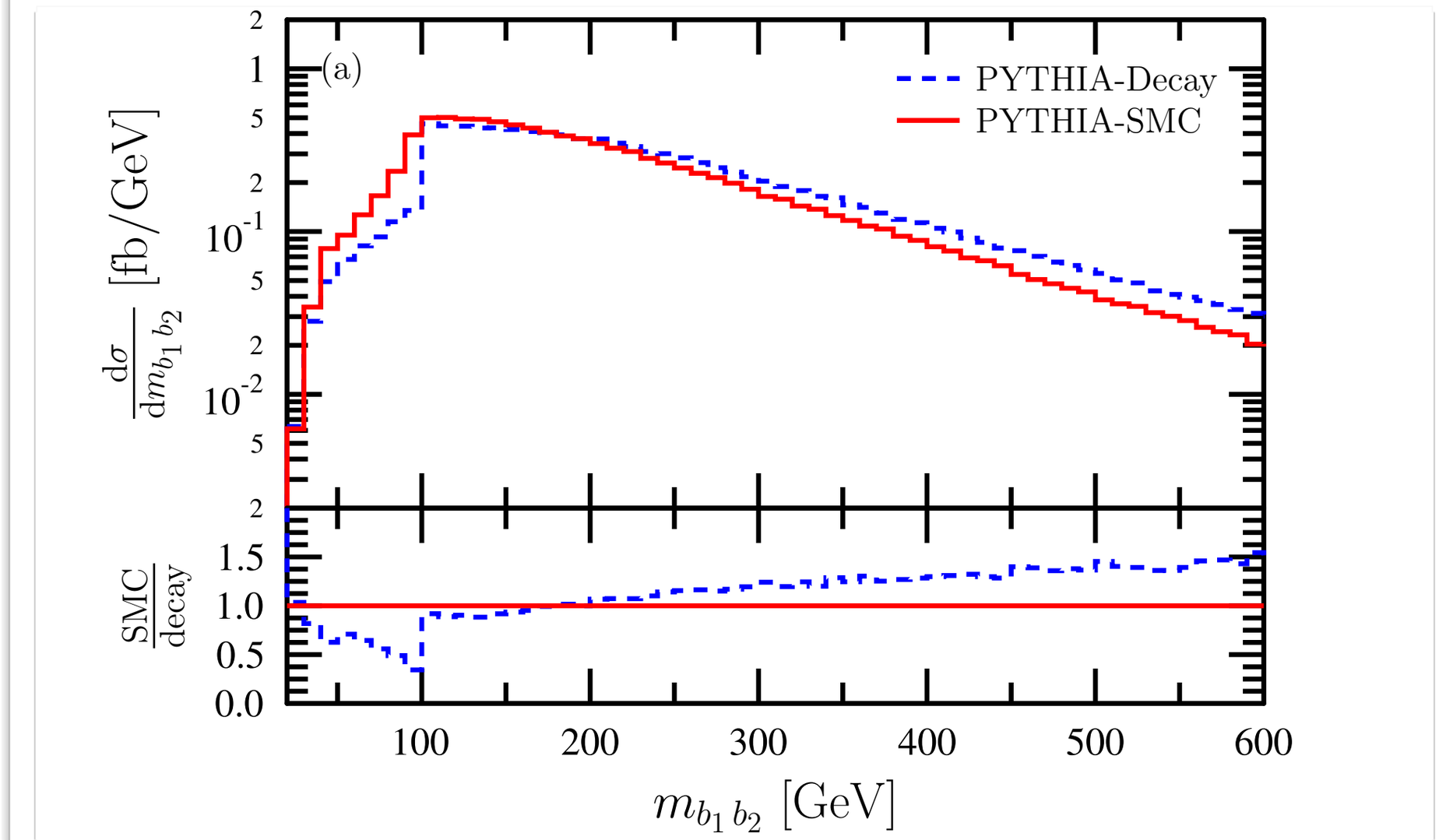
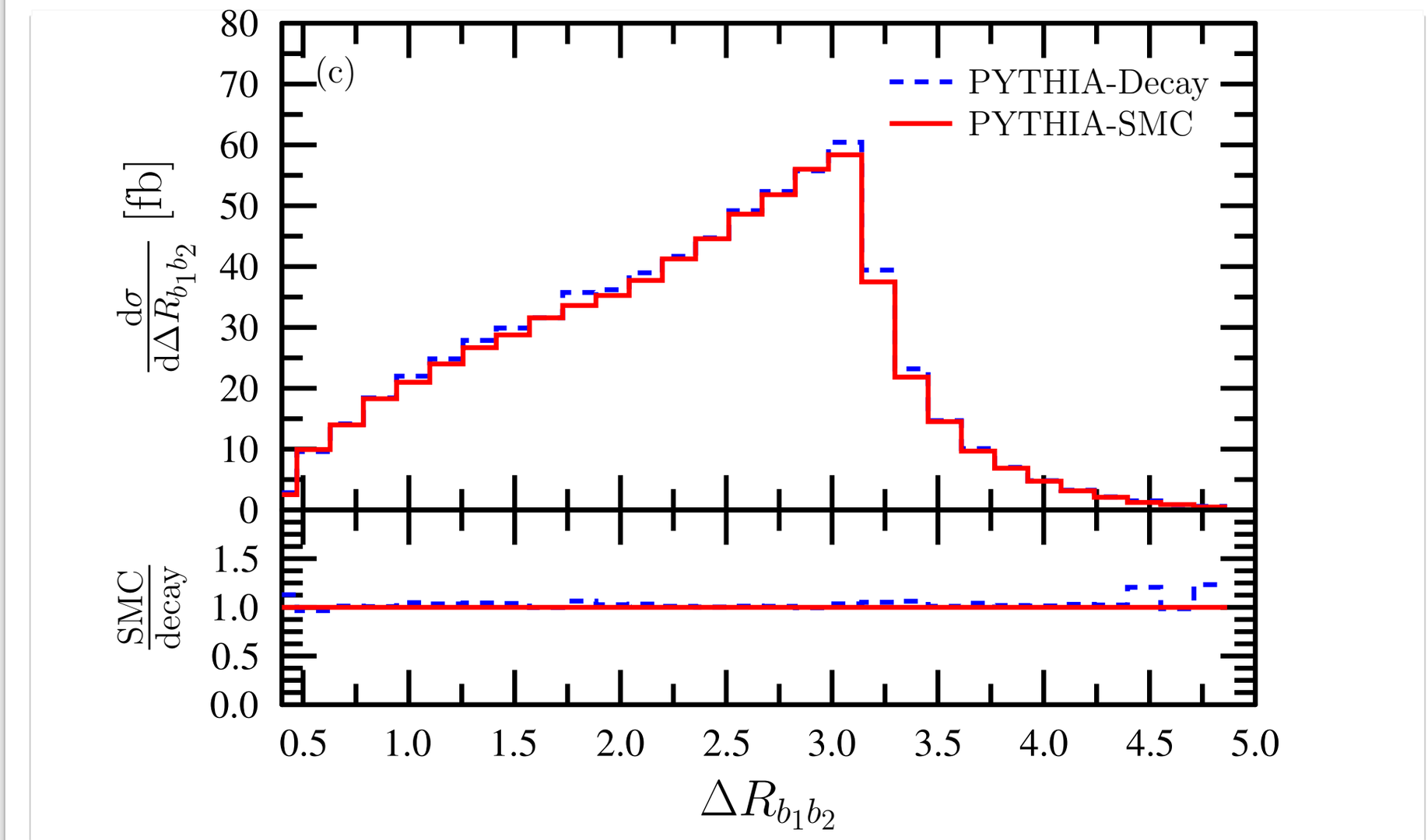
  - Events with invariant mass of the bb-jet pair below $m^{min}_{b\bar{b}}$ = 100 GeV were discarded.
- Applied on LHE's and checked also on the existing particles at different stages of evolution:
  - we require $p_{Tmin,j}$ = 25 GeV and
  - at least two, one b- & one $\bar{b}$-jet with $|\eta_{b(\bar{b})}|<2.5$.

Decay vs. full SMC



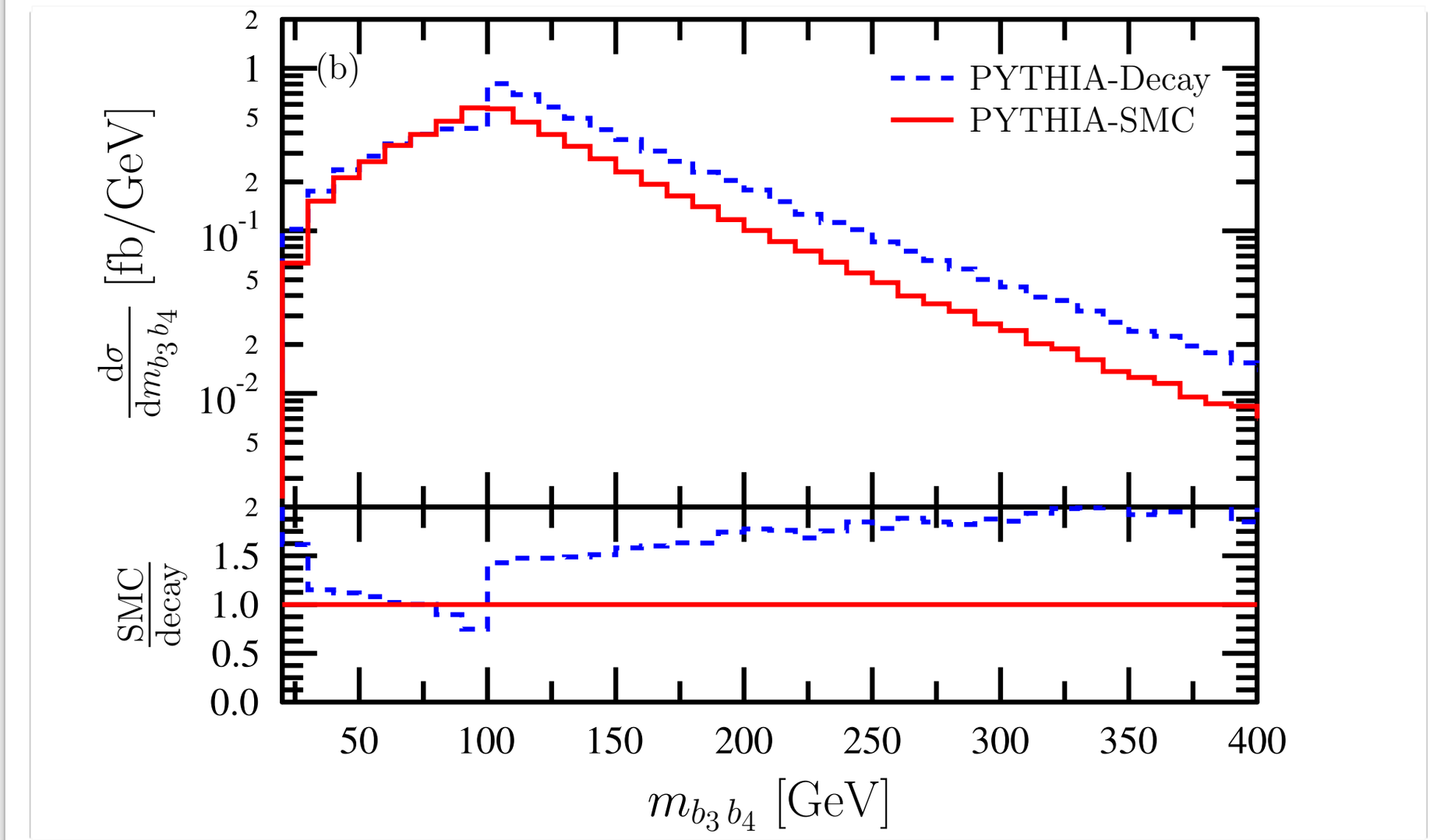
Distribution of the invariant mass of the hardest $b\bar{b}$ jet pair in $pp \to t\bar{t}\, b\bar{b}$ at LHC (8TeV)

Decay vs. full SMC



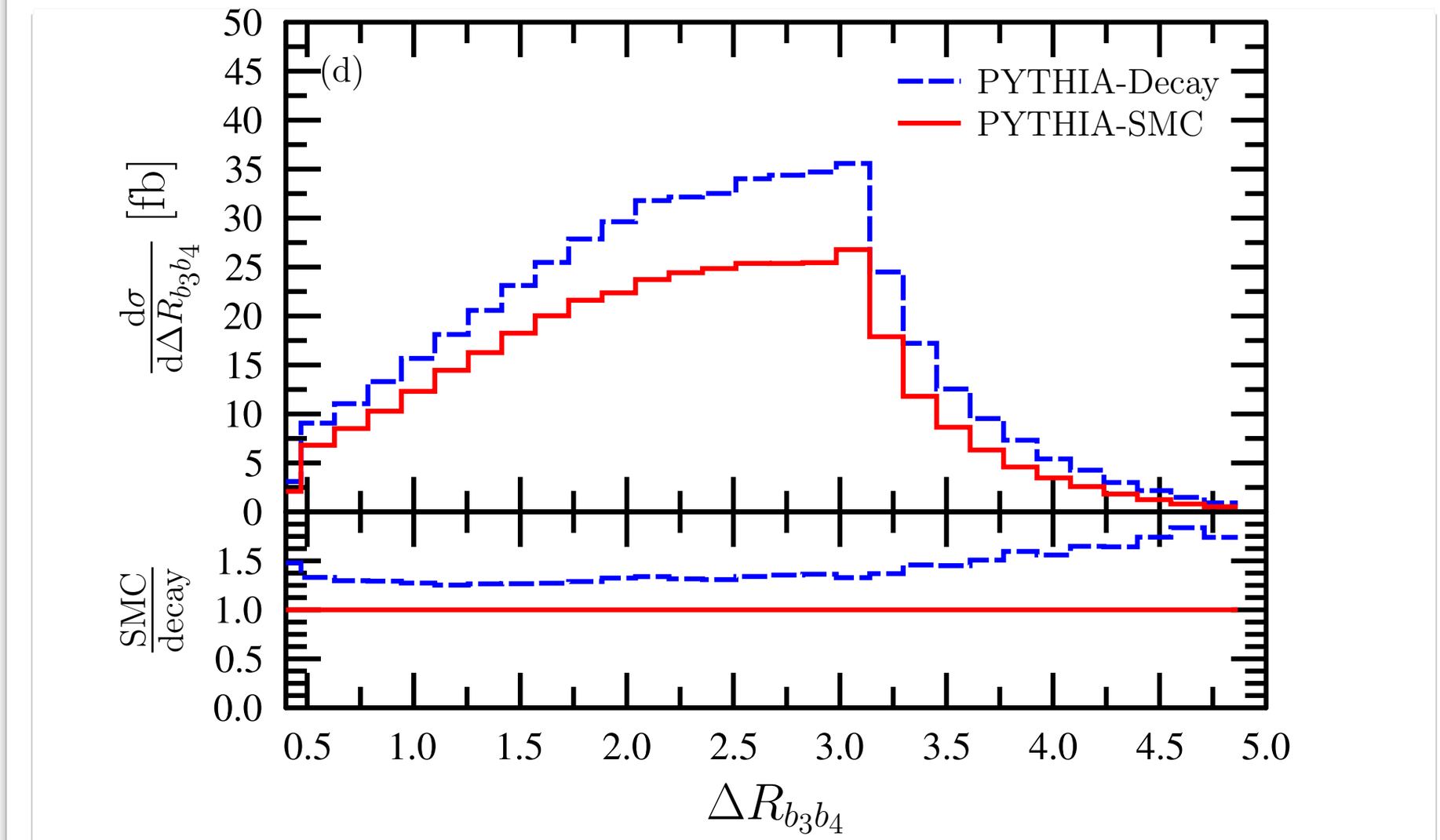
Separation in rapidity-azimuthal angle plane of the hardest $b\bar{b}$ in $pp \to t\bar{t}\, b\bar{b}$ at LHC (8TeV)

Decay vs. full SMC



Distribution of the invariant mass of next hardest $b\bar{b}$ jet pair in $pp \to t\bar{t}\, b\bar{b}$ at LHC (8TeV)

Decay vs. full SMC



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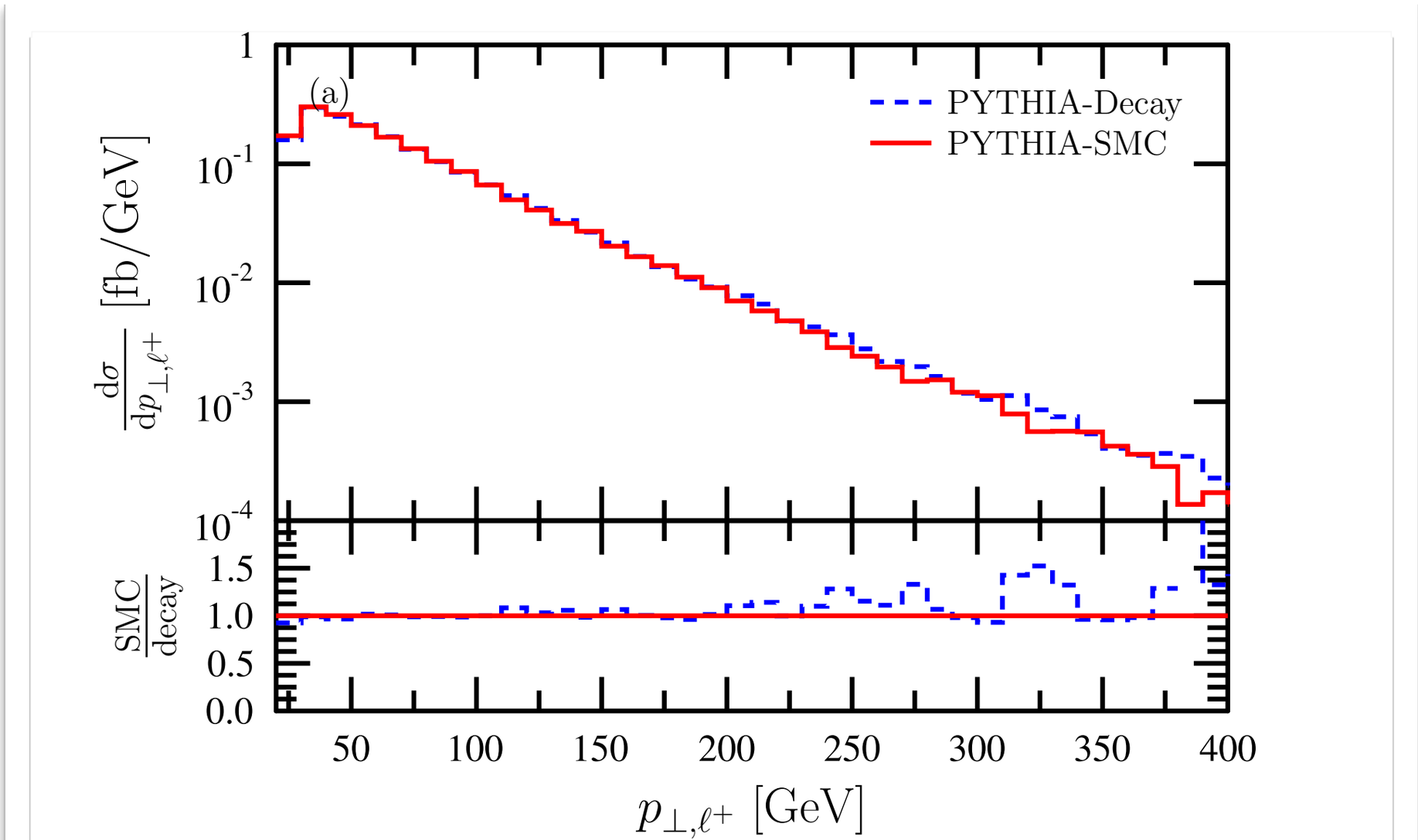
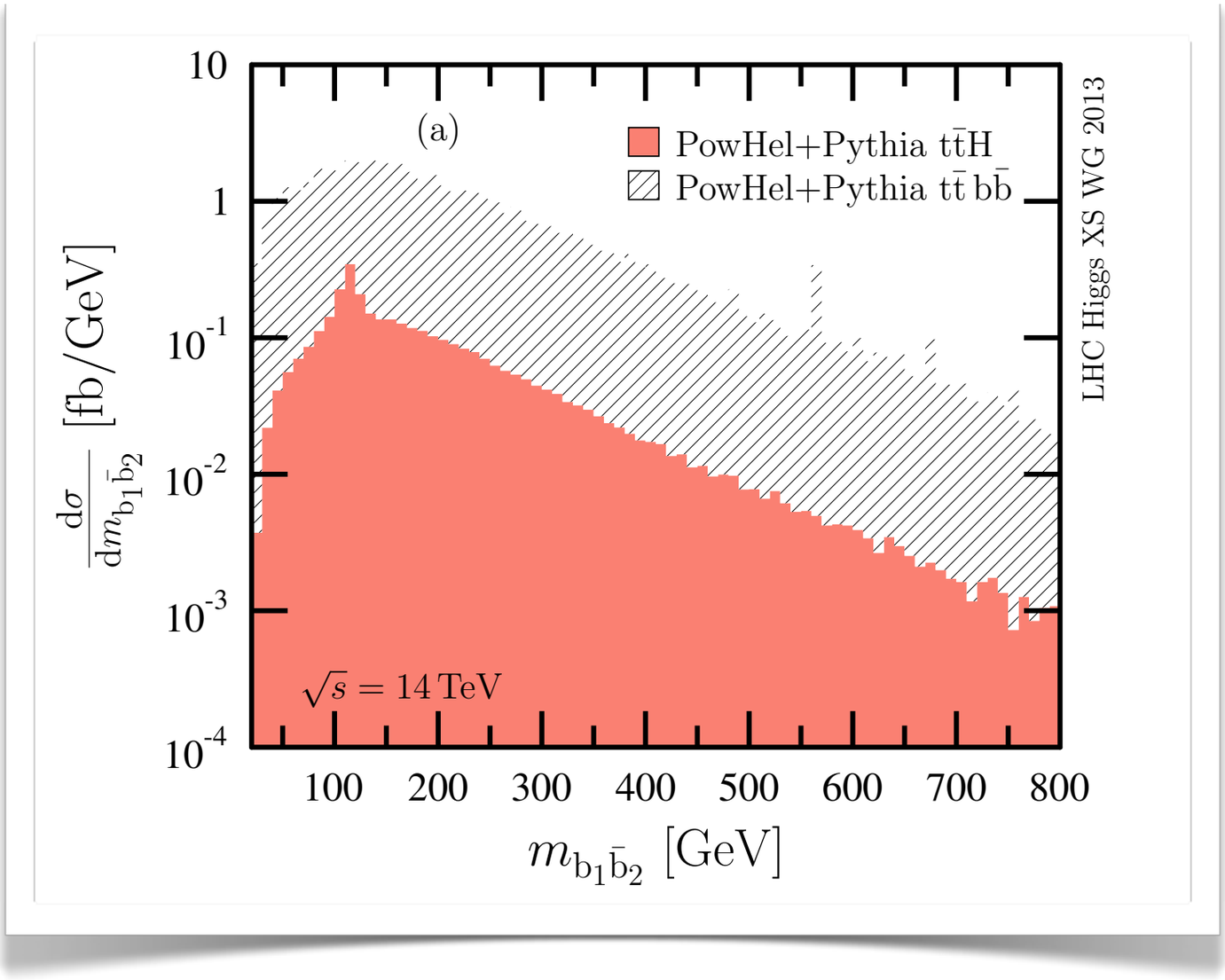


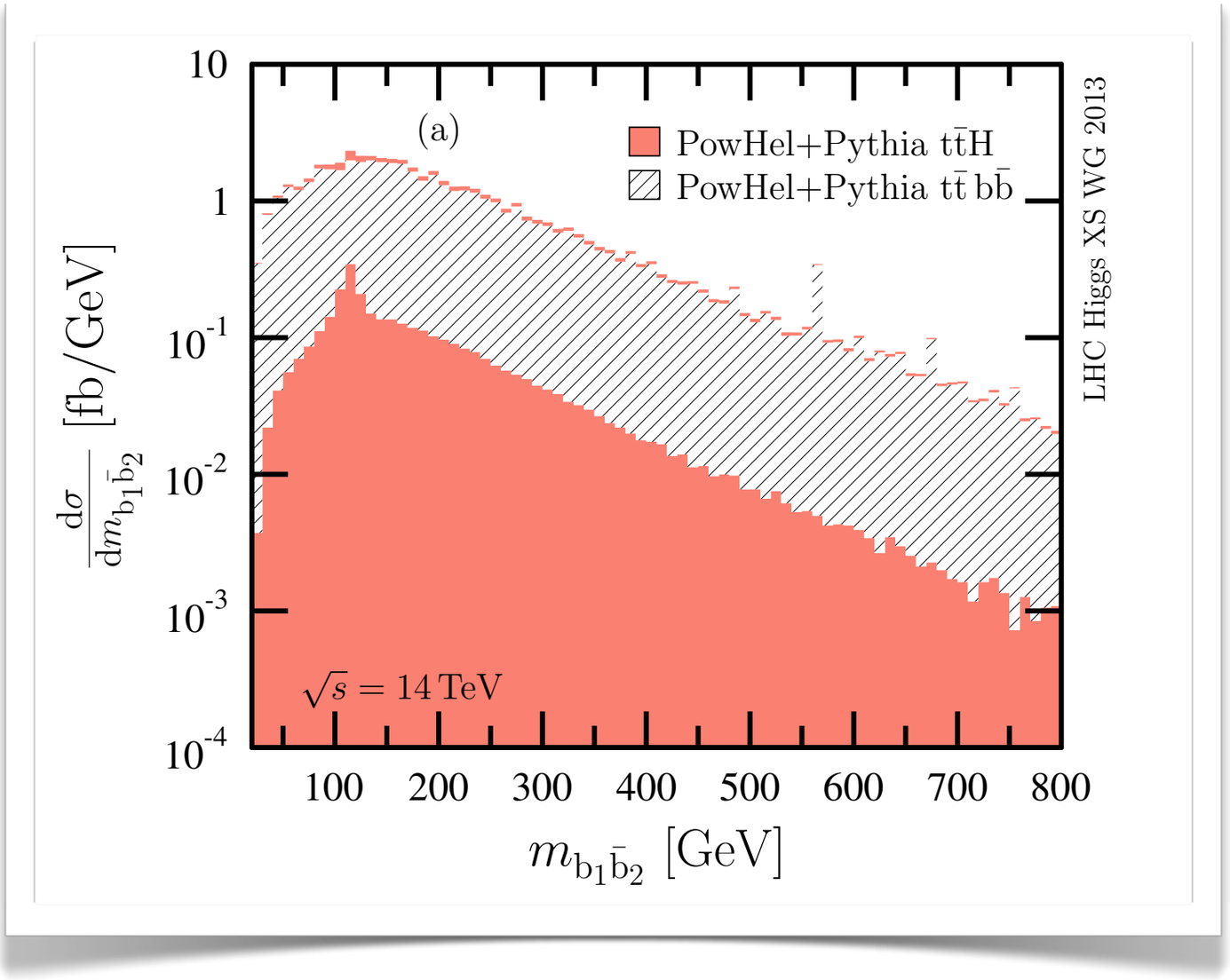
Distribution of the transverse momentum of the positive lepton in $pp \to t\bar{t}\,b\bar{b}$ at LHC (8TeV)

$t\bar{t}H$ signal on $t\bar{t}b\bar{b}$ background



Distribution of the invariant mass of the hardest $b\bar{b}$ jet pair in $pp \to t\bar{t}H$ and $t\bar{t}b\bar{b}$ at LHC (14 TeV)

$t\bar{t}H$ signal on $t\bar{t}b\bar{b}$ background



Distribution of the invariant mass of the hardest $b\bar{b}$ jet pair in $pp \to t\bar{t}H$ and $t\bar{t}b\bar{b}$ at LHC (14 TeV)

Conclusions

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- ✓ First computation of $pp \to t\bar{t}b\bar{b}$ at NLO + SMC accuracy [A. Kardos and Z.T. arXiv:1303.6291]
- ✓ NLO cross sections agree with published predictions
- ✓ Effects of SMC are often important, depending on shower setup, variables and cuts strongly
- ✓ LHE event files for $pp \to t\bar{t}$, $t\bar{t}H$, $t\bar{t}W$, $t\bar{t}Z$, $t\bar{t}$jet, $t\bar{t}b\bar{b}$ processes available, to put into SMC and perform experimental analyses on events with hadrons
- ➡ Predictions for LHC with NLO + SMC accuracy and optimization of selections for $pp \to t\bar{t}H$ is in progress

The end